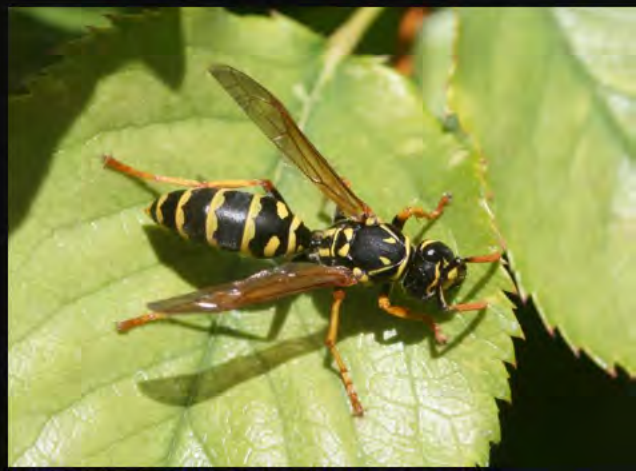
Updates on Some Shade Tree/Ornamental Insect Pests

Whitney Cranshaw
Colorado State University

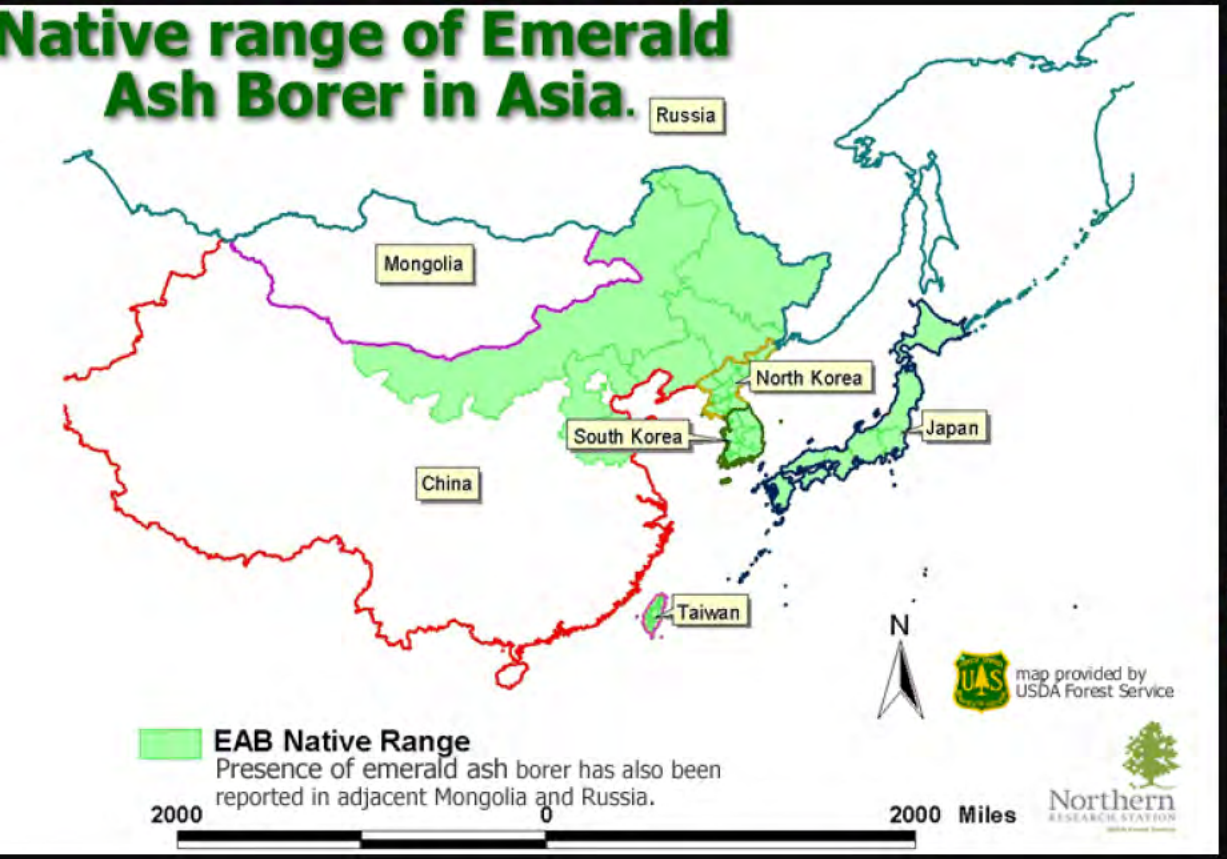


Status of Emerald Borer Activity in Colorado

Emerald ash borer (EAB) is a green-colored beetle…….

…that develops in ash trees (*Fraxinus* species)…

……and is native to Asia



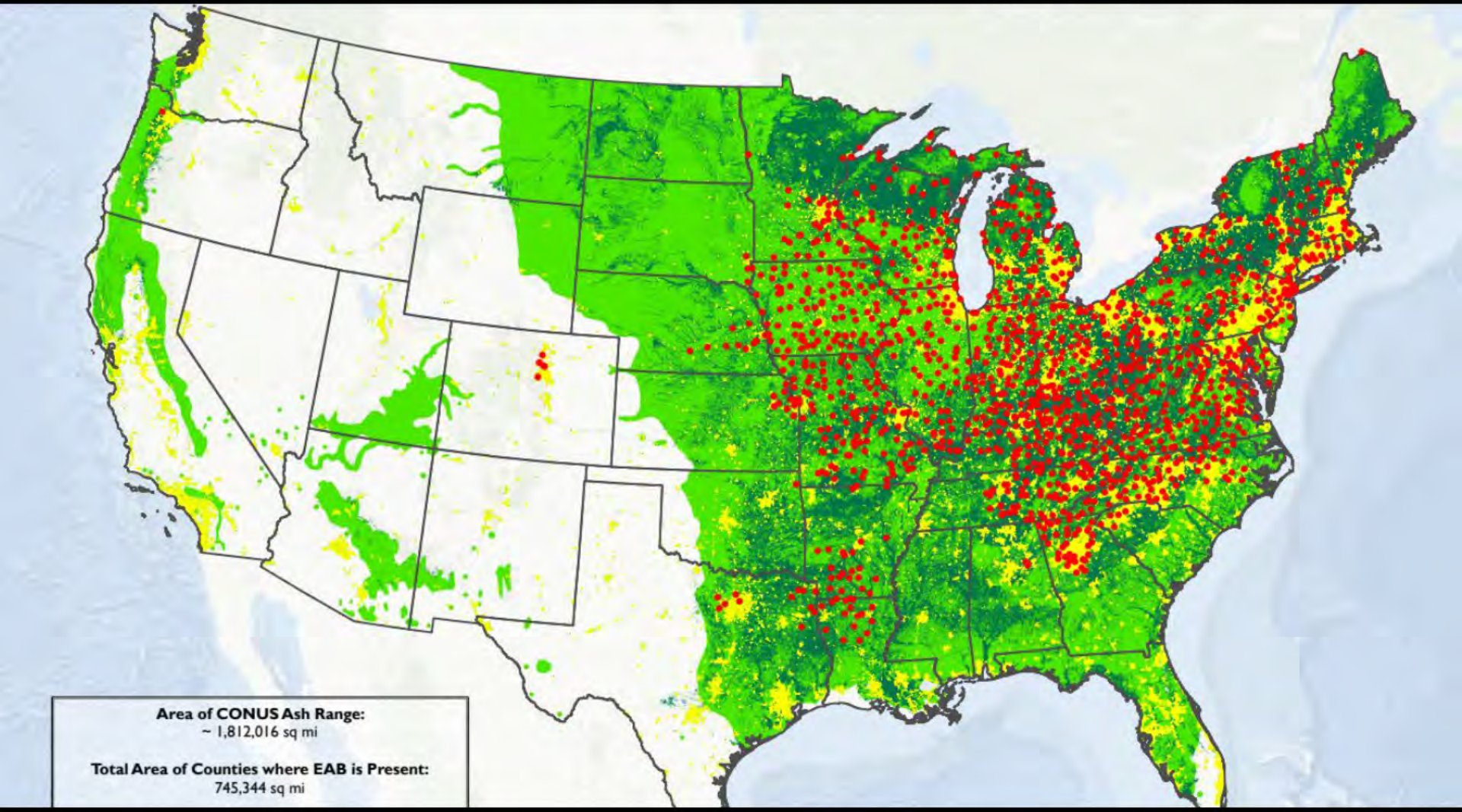
In its native range emerald ash borer is insignificant as a species, limiting attacks to very stressed trees.

Damage is done by the larvae that tunnel under the bark, girdling the cambium.

Photo by Edward Czerwinski

Progressive injuries ultimately lead to tree death, unless controlled

Emerald ash borer distribution reported in May 2023



Colorado EAB Tree #1

Located near the intersection of 30th and Valmont, Boulder

September 23, 2013

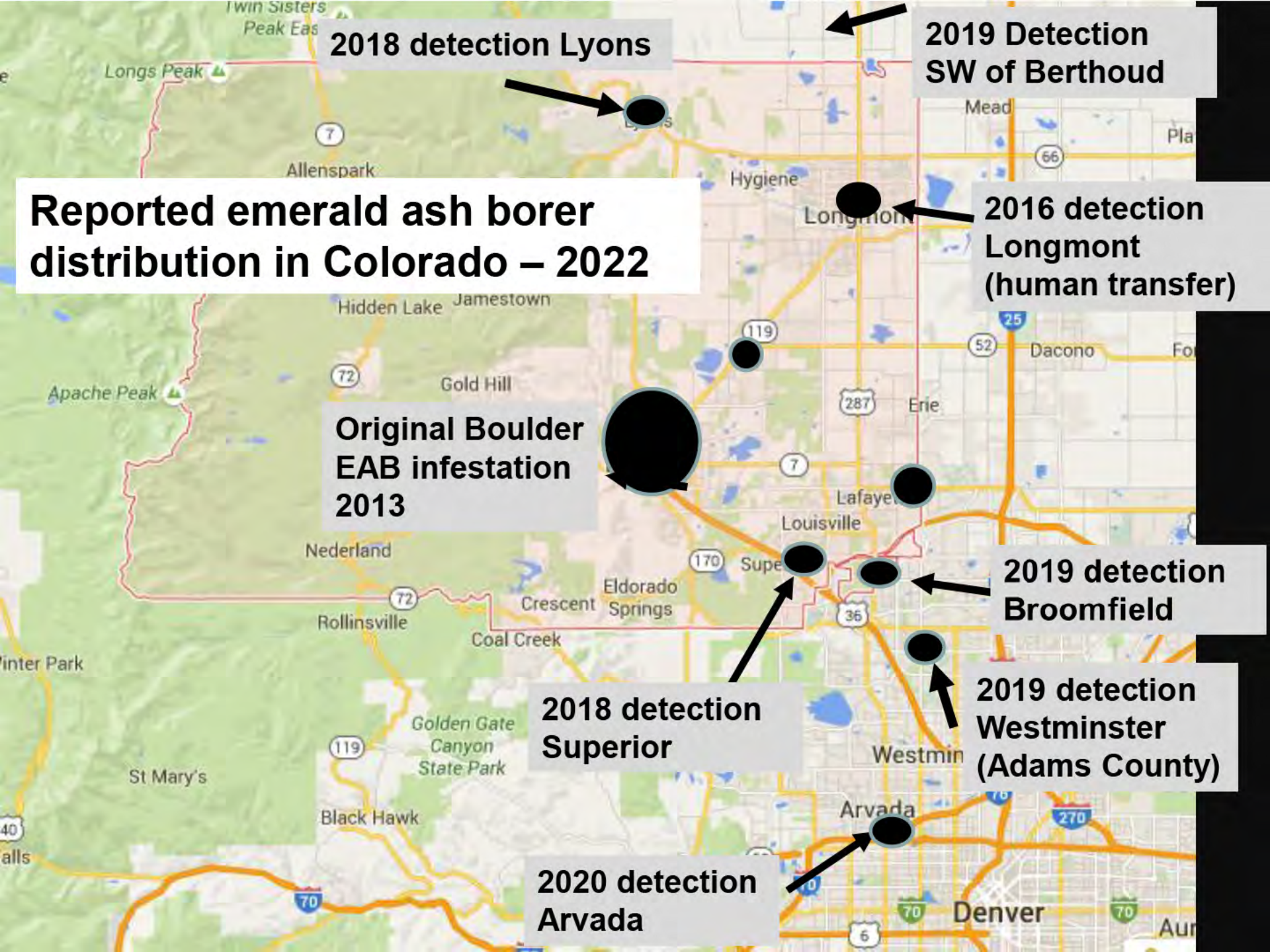
Eleventh Anniversary!

Emerald Ash Borer in Colorado

Designed by Starline/Freepik

How will EAB spread once established?

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


2018 detection Lyons
2019 Detection SW of Berthoud
Reported emerald ash borer distribution in Colorado – 2022
2016 detection Longmont (human transfer)
Original Boulder EAB infestation 2013
2019 detection Broomfield
2018 detection Superior
2019 detection Westminster (Adams County)
2020 detection Arvada
Twin Sisters Peak East
Longs Peak
Allenspark
Mead
Hygiene
Longmont
Hidden Lake
Jamestown
Dacono
Apache Peak
Gold Hill
Erie
Lafayette
Louisville
Nederland
Eldorado Springs
Crescent
Rollinsville
Coal Creek
Golden Gate Canyon State Park
St Mary's
Black Hawk
Arvada
Denver
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270

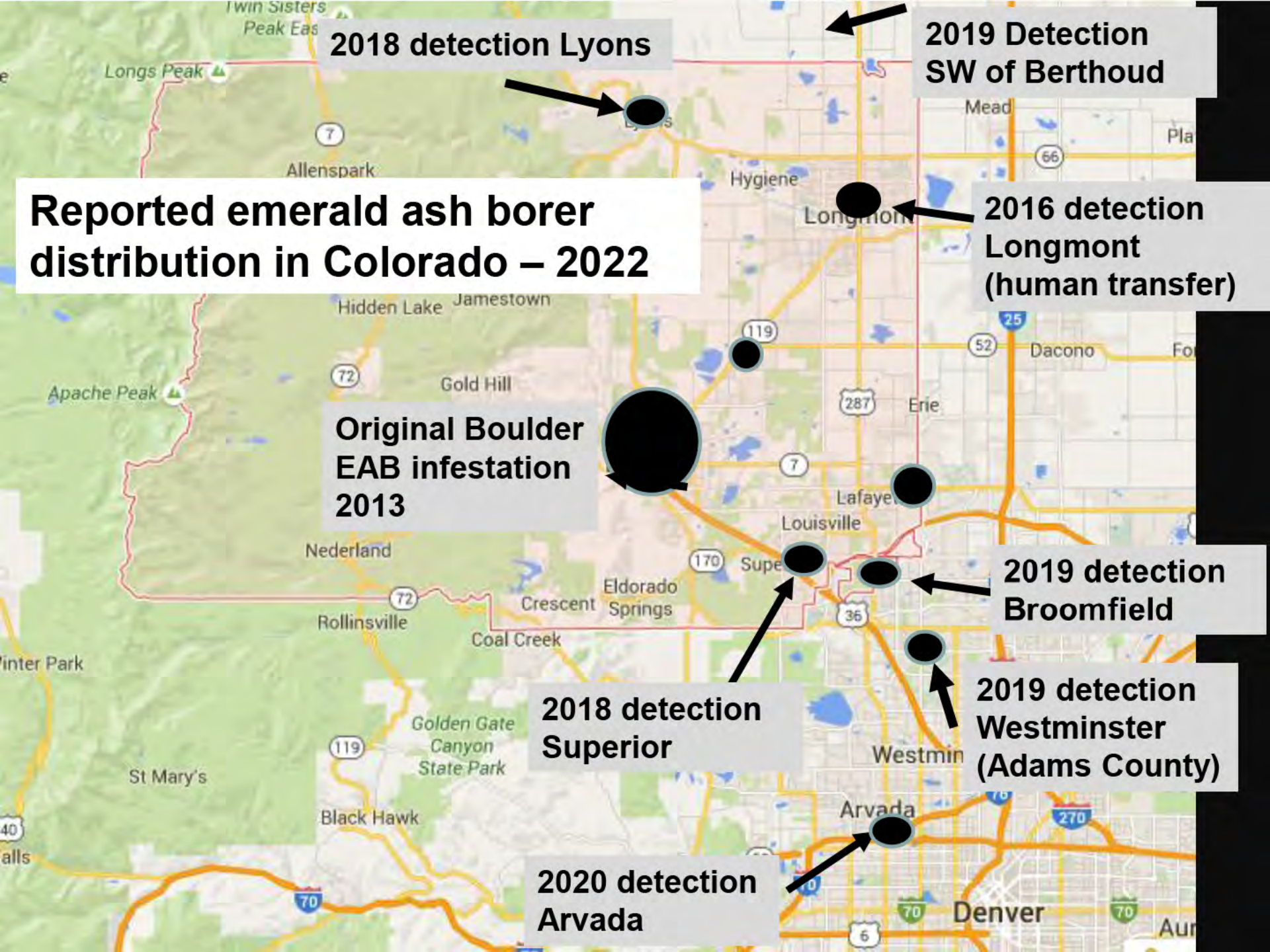
Photograph by David Cappaert

EAB likely will emerge sometime in mid-late May.

Most eggs will be laid in June, egg laying will continue through summer

Photograph by Dan Herms

Wind Direction from Boulder
(with wind speed correction)
May-August 2013-2015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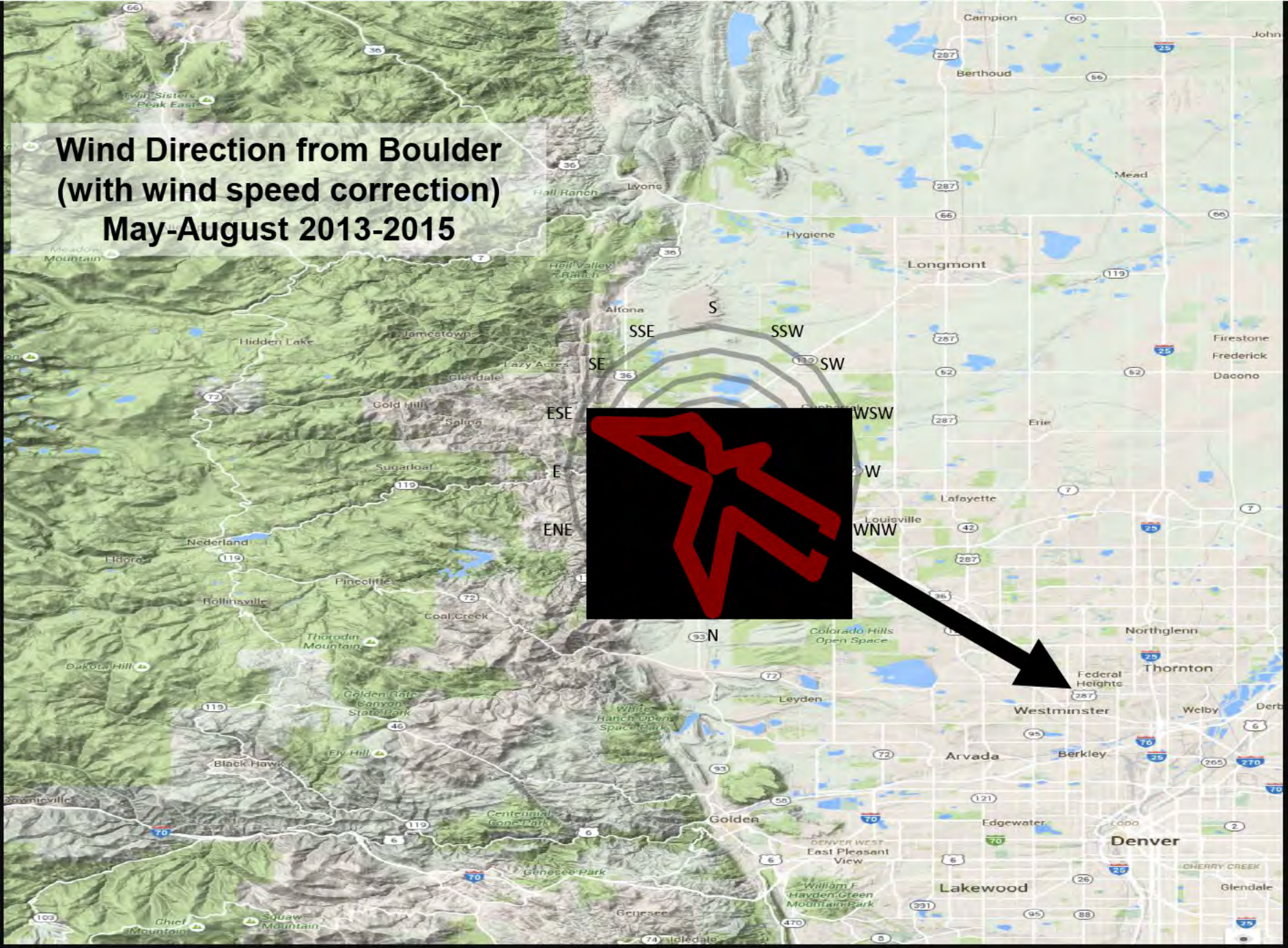
Wind Direction from Boulder
(with wind speed correction)
May-August 2013-2015
S
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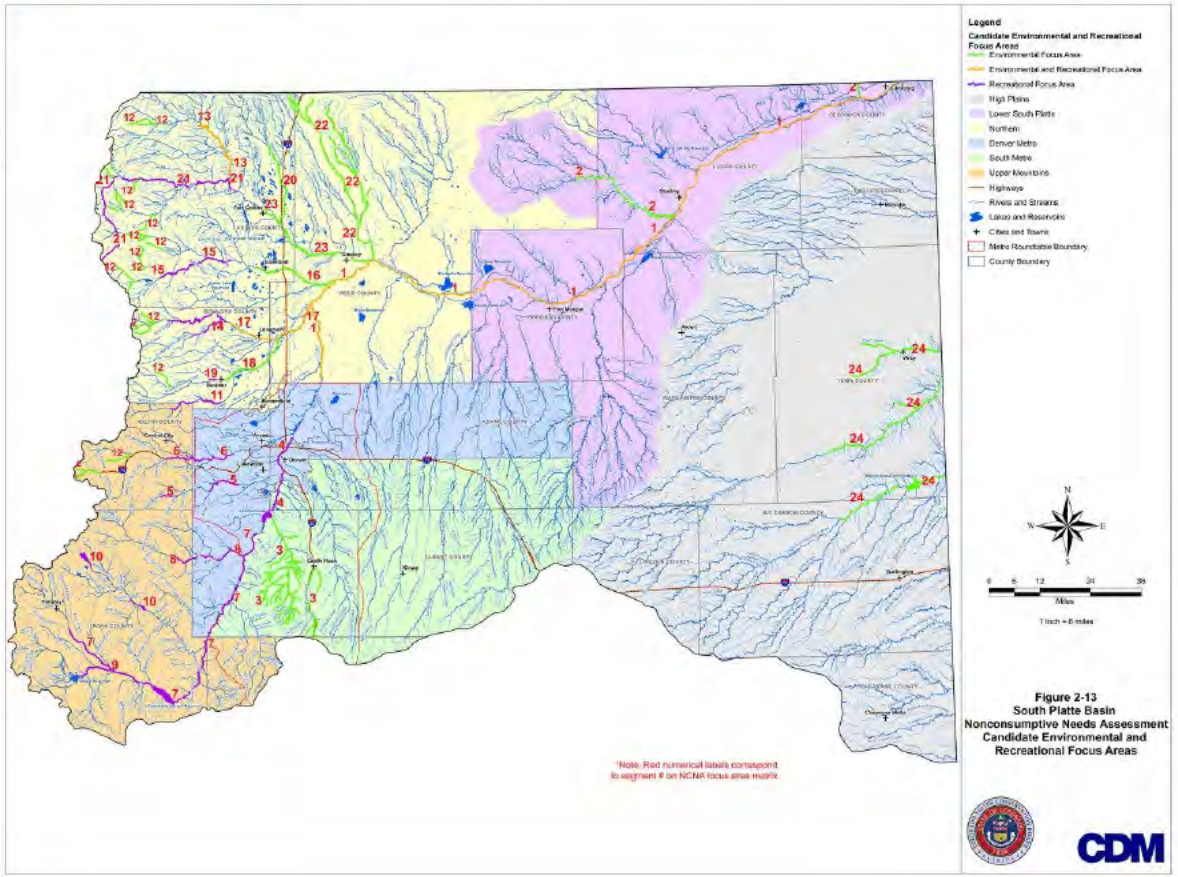
Berthoud
Mead
Hygiene
Longmont
Lyons
Hall Ranch
Hell Valley Ranch
Altona
Jamestown
Hidden Lake
Lazy Acres
Glendale
Gold Hill
Salina
Sugarloaf
Nederland
Eldora
Pinecliffe
Rollinsville
Coal Creek
Thorodin Mountain
Dakota Hill
Golden Gate Canyon State Park
Ely Hill
Black Hawk
Centennial Cone Park
Genesee Park
Genesee
Chief Mountain
Squaw Mountain
Idledale
Golden
Leyden
Colorado Hills Open Space
White Ranch Open Space Park
Arvada
Berkley
Edgewater
Lakewood
Denver
DENVER WEST
East Pleasant View
William F. Hayden Green Mountain Park
Westminster
Federal Heights
Northglenn
Thornton
Welby
Lafayette
Louisville
Erie
Firestone
Frederick
Dacono
Glendale
CHERRY CREEK
LODO


Cheyenne
Sidney
Julesburg
Fort Collins
Loveland
Greeley
Sterling
Holyoke
Steamboat Springs
Craig
Yampa River
Estes Park
Longmont
Fort Morgan
Akron
Wray
Meeker
White River
Boulder
Broomfield
Arvada
Denver
Aurora
Englewood
Littleton
Lakewood
Idaho Springs
Vail
Rifle
Glenwood Springs
ROAN PLATEAU
Mt Evans 14264
Castle Rock
Limon
Burlington
Leadville
Aspen
Mt Massive 14421
Mt Elbert 14433
Grand Junction
Pikes Peak 14110
Mt Harvard 14420
Colorado Springs
Cheyenne Wells
Delta
COLORADO
Gunnison
Montrose
Salida
Canon City
Pueblo
Uncompahgre Plateau
Ouray
Mt Wilson 14246
Silverton
Rocky Ford
La Junta
Las Animas
Lamar
Syracuse
Arkansas River
Del Norte
Monte Vista
Alamosa
Blanca Pk 14345
Walsenburg
Springfield
Cortez
Durango
Mesa Verde
Pagosa Springs
Trinidad
Antonito
Raton
Des Moines
Shiprock
Aztec
Farmington
Navajo Reservoir
Boise City
Black Mesa 4973
Bridger Pk 11004
Arikaree River
Platte River
Purgatoire R
Dolores R
Sawatch Range
Park Range
Front Range
Sangre de Cristo Mts
San Juan Mts

Unlike states to the east, Colorado – and Montana - is well compartmentalized due to its geography

Within Colorado the original infestation is *an infestation of the South Platte River drainage*, not the State of Colorado



Ten years in, the emerald ash borer breaches the Western Slope as it continues its steady — but slow — spread in Colorado

Evidence of the ash-devouring beetle was found in Carbondale in June

Biggest news in 2023 was that EAB was found in the town of Littleton, just south of Denver – and Carbondale, a mountain town located near Aspen.

Colorado State Forest Service News

Emerald Ash Borer Confirmed on Colorado's Western Slope for First Time

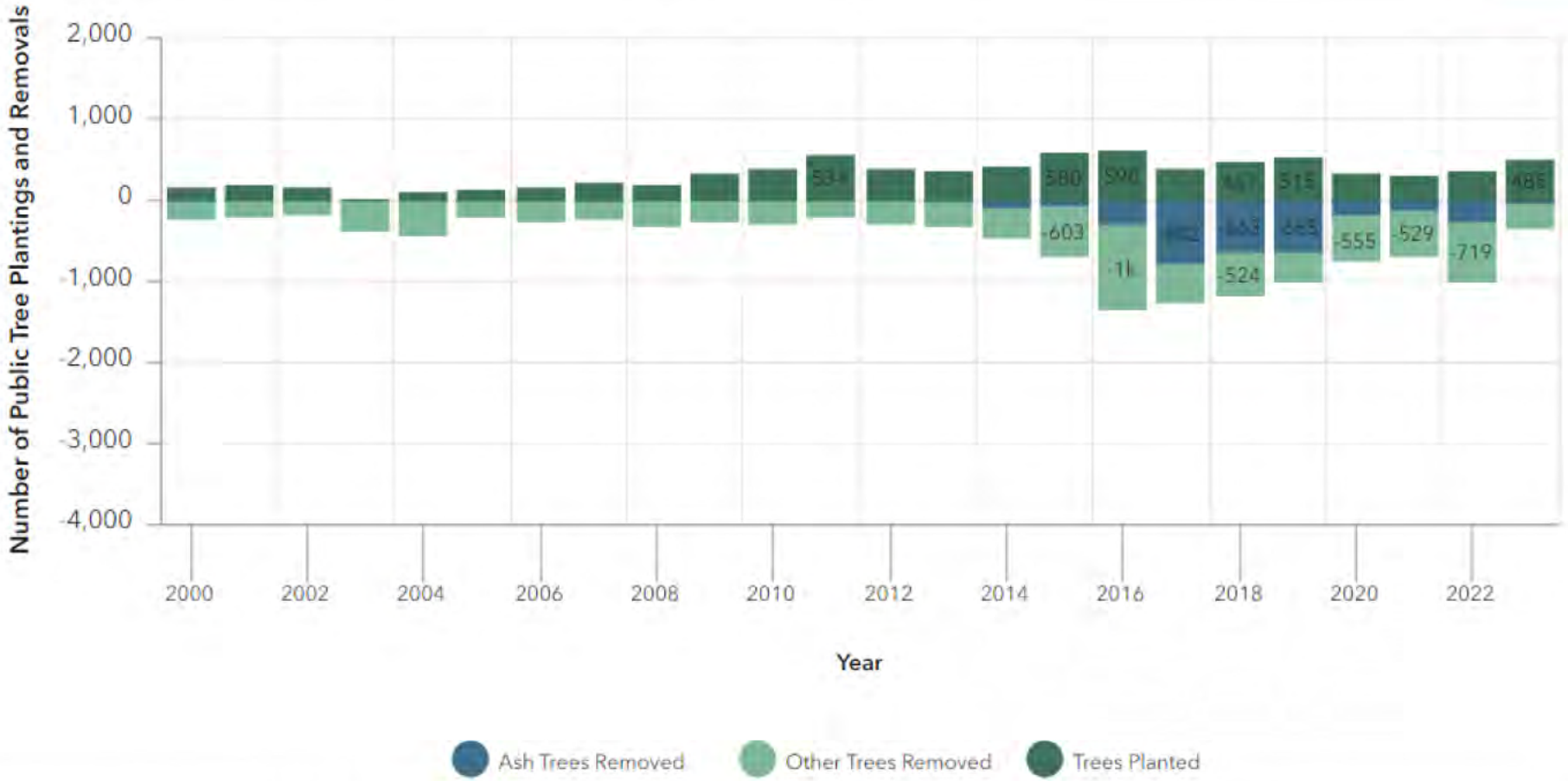
06 Jul, 2023

FORT COLLINS, Colo. – In June 2023, experts from Colorado State University confirmed the presence of emerald ash borer (EAB) in two new towns in Colorado: Carbondale and Littleton. EAB has been present on Colorado's Front Range since 2013, and the detection in the Town of Carbondale marks the first time EAB was confirmed in western Colorado.


Location of
Carbondale, Colorado
COLORADO
Cheyenne
Sidney
Julesburg
Fort Collins
Loveland
Greeley
Sterling
Holyoke
Steamboat Springs
Craig
Yampa River
Estes Park
Longs Pk 14255
Longmont
Fort Morgan
Akron
Wray
Meeker
Boulder
Broomfield
Arvada
Denver
Aurora
Lakewood
Englewood
Littleton
Idaho Springs
Vail
Mt Evans 14264
Castle Rock
Limon
Burlington
Leadville
Aspen
Mt Massive 14421
Mt Elbert 14433
Grand Junction
Delta
Mt Harvard 14420
Pikes Peak 14110
Colorado Springs
Cheyenne Wells
Gunnison
Montrose
Salida
Canon City
Pueblo
Rocky Ford
La Junta
Las Animas
Lamar
Syracuse
Ouray
Mt Wilson 14246
Silverton
Del Norte
Monte Vista
Alamosa
Blanca Pk 14345
Walsenburg
Springfield
Cortez
Durango
Mesa Verde
Pagosa Springs
Antonito
Trinidad
Raton
Des Moines
Shiprock
Aztec
Farmington
Navajo Reservoir
Black Mesa 4973
Boise City
Arkansas River
Platte River
Arikaree River
Purgatoire R
Uncompahgre Plateau
Dolores R
Sawatch Range
Park Range
Front Range
Sangre de Cristo Mts
San Juan Mts
Roan Plateau
Bridger Pk 11004
Mt Peale 12721
Ship Rock 7178

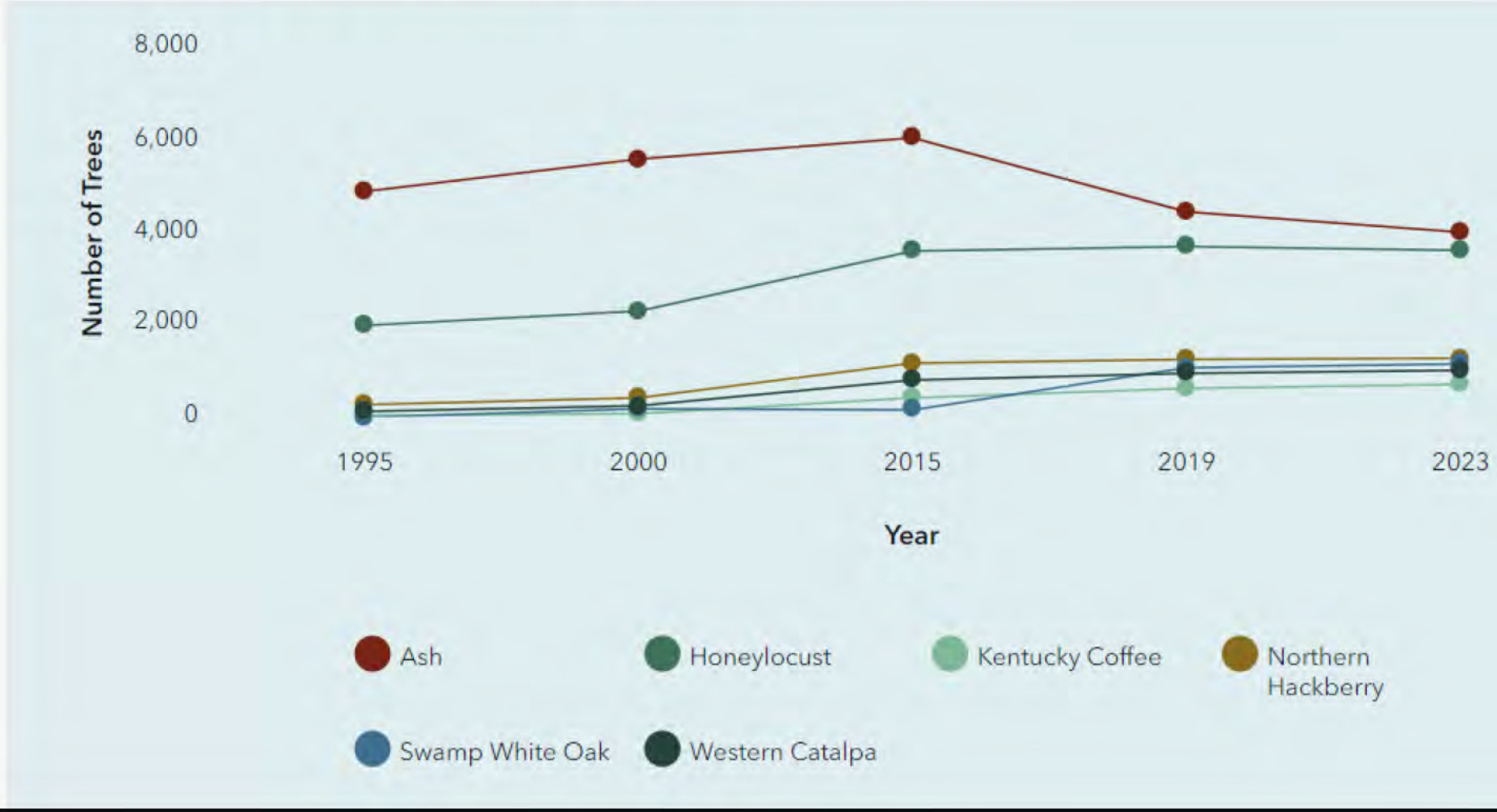
An excellent review of the history of Emerald Ash Borer in Boulder, Colorado has just been released

Public Tree Plantings and Removals



Preservation of significant ash trees, prompt removal of infested ash trees, planting replacement trees for those lost to EAB, and a long-term push to increase species diversity has been key to maintaining tree canopy.

Public Tree Inventory Composition



The Lessons Learned section can provide some excellent guidance to communities in the western US on how to handle EAB

To find this entire document search **10 Years with Emerald Ash Borer in Boulder**

EAB in a Western State vs. the Midwest

How might it play out here?

- **Geographic barriers will greatly limit natural spread**
- **Lack of contiguous corridors of host plants (ash) will slow spread**
- **Other common injuries (drought, freezing, fungi, bark beetles) may interact with EAB**
  - **Late spring frosts!**

Other wood boring insects can be found in ash trees

COLORADO STATE UNIVERSITY
EXTENSION

Recognizing Wood Boring Insects of Ash Trees in Colorado

Fact Sheet No. 5.620

Insect Series | Crops

by W.S. Cranshaw*

Ash is one of the most widely planted trees in Colorado, with most plantings involving various cultivars of green ash (*Fraxinus pennsylvanica*) or white ash (*F. americana*). Several insects are associated with these plants, including leafcurling aphids, various caterpillars and sawflies that chew the leaves, and wood borers and bark beetles that develop within the trunk and limbs of the tree.

Quick Facts

- Being able to recognize the wood boring insects found in a tree is essential when making informed decisions on the need for control.
- In most of Colorado, the most

Ash bark beetles

An important contributor to limb dieback in Colorado ash

Ash bark beetles usually are found in limbs – but can occur in the trunk

Flatheaded appletree borer

A generalist flatheaded borer/metallic wood borer that is associated with many hardwood that are in decline

Flatheaded appletree borer larvae produce dry, powdery sawdust excrement

Late Spring Freeze Events can have great impact on EAB populations

Overwintering EAB larvae can tolerate very low temperatures.

But what about after they lose winter hardiness and resume activity in spring?

After emergence emerald ash borer adults feed on ash foliage for a couple of weeks as eggs mature

A Late Spring Freeze can eliminate the food used by the adult borers, ash leaves

Japanese Beetle Management and Biological Control Update

Japanese beetle damages plants in *two distinct ways*

Japanese beetle adults chew on leaves and flowers **of many plants**

Japanese beetle larvae (grubs) – *among the most damaging turfgrass insects in the US*

Japanese beetle affects yard/garden plants *in two distinct ways*

Japanese beetle

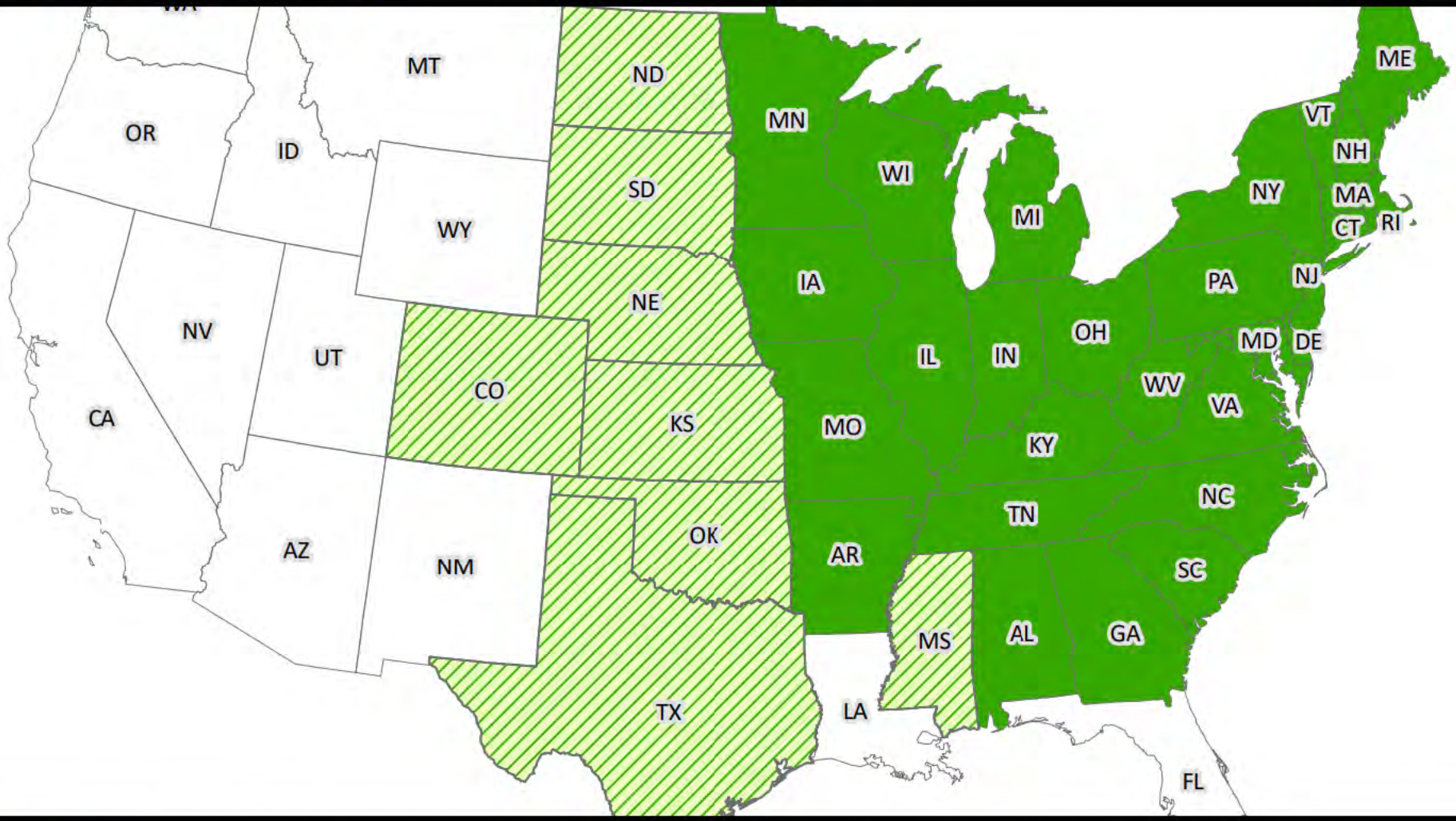
Popillia japonica

Coleoptera: Scarabaeidae

The Spread of Japanese Beetle in North America, 1908-1998

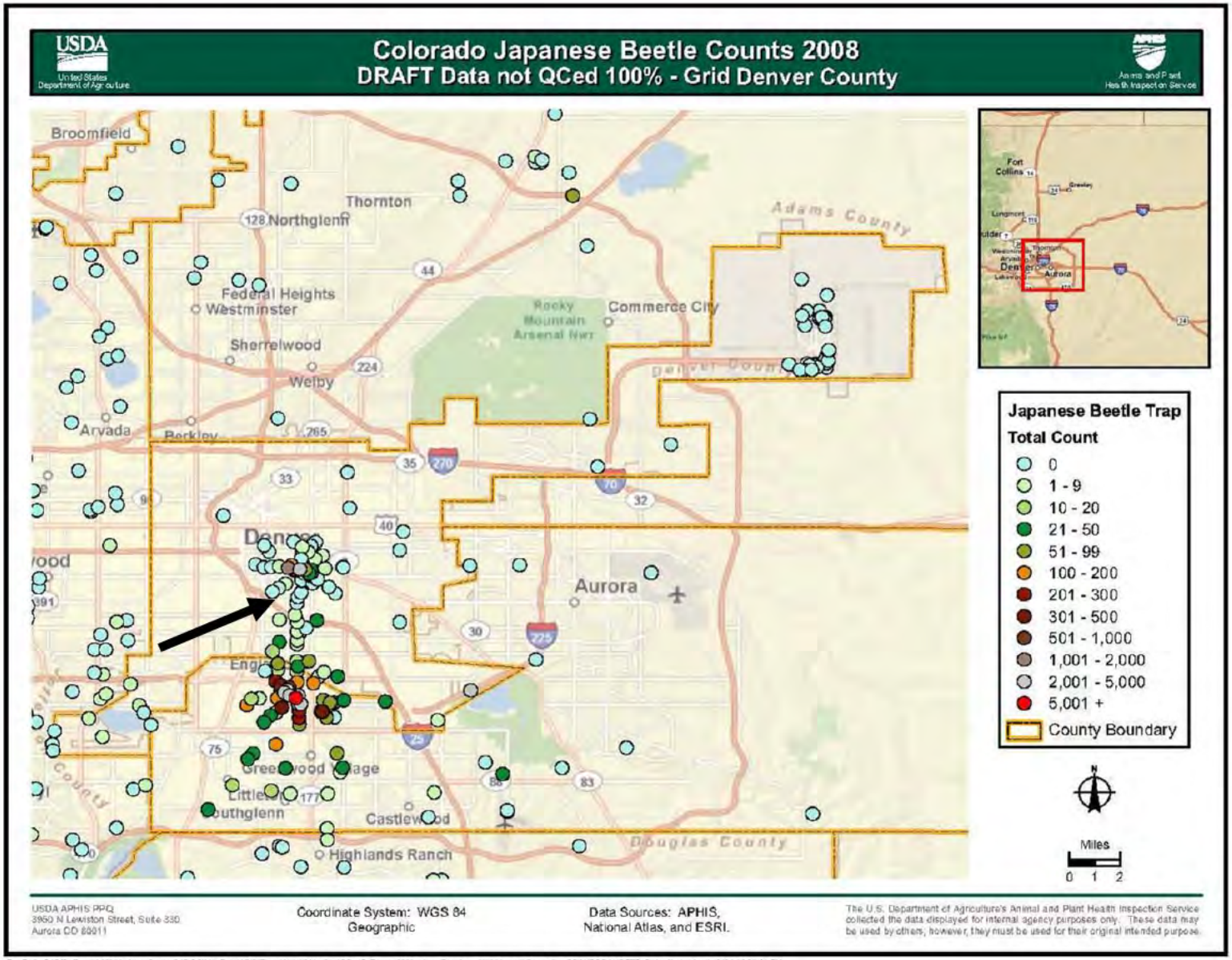
First U.S. detection – **1916** near Riverton, New Jersey

Generalized distribution of reported for Japanese beetle in 2018

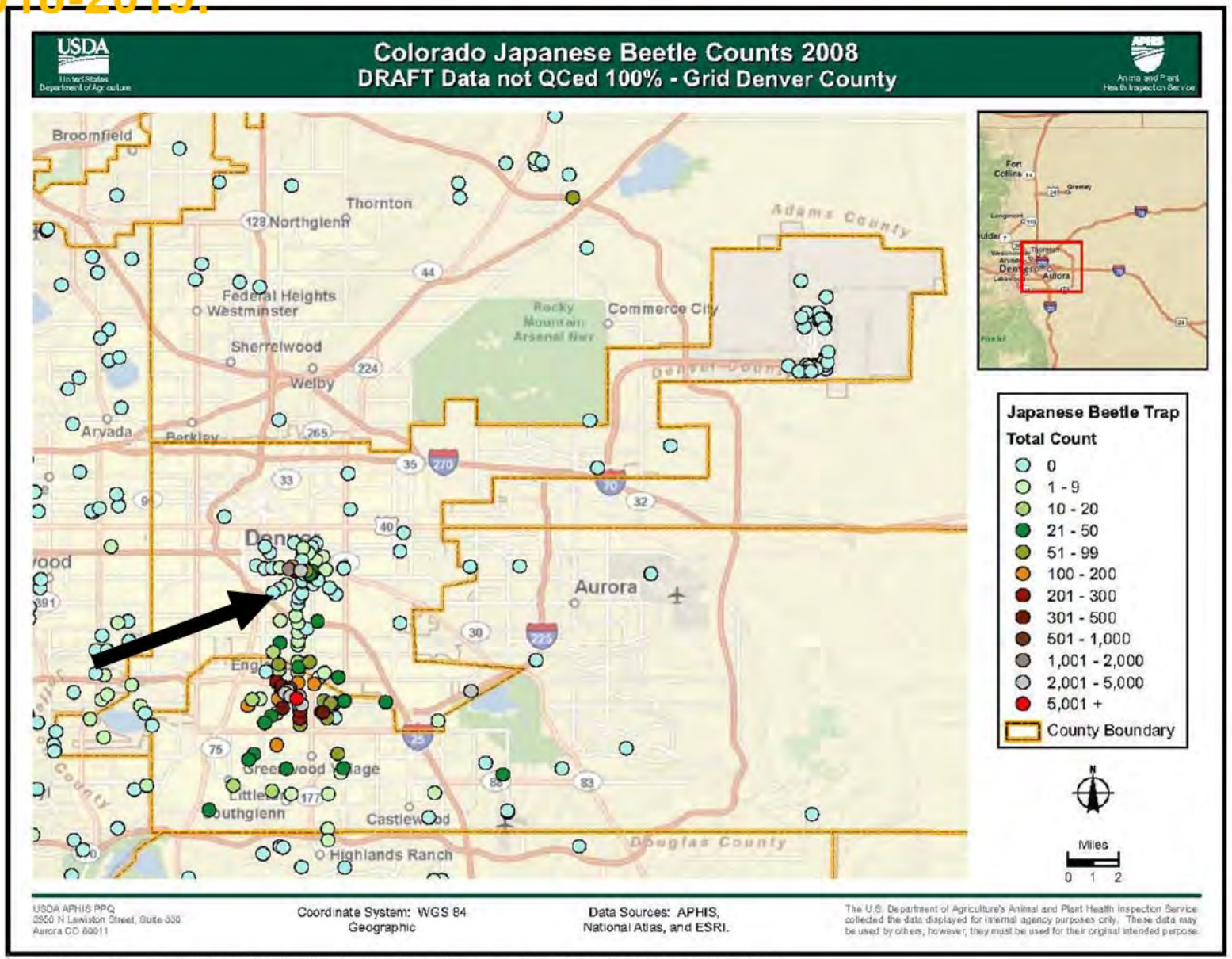


Note: This does not include isolated infestations in California, Oregon, Utah, and Montana

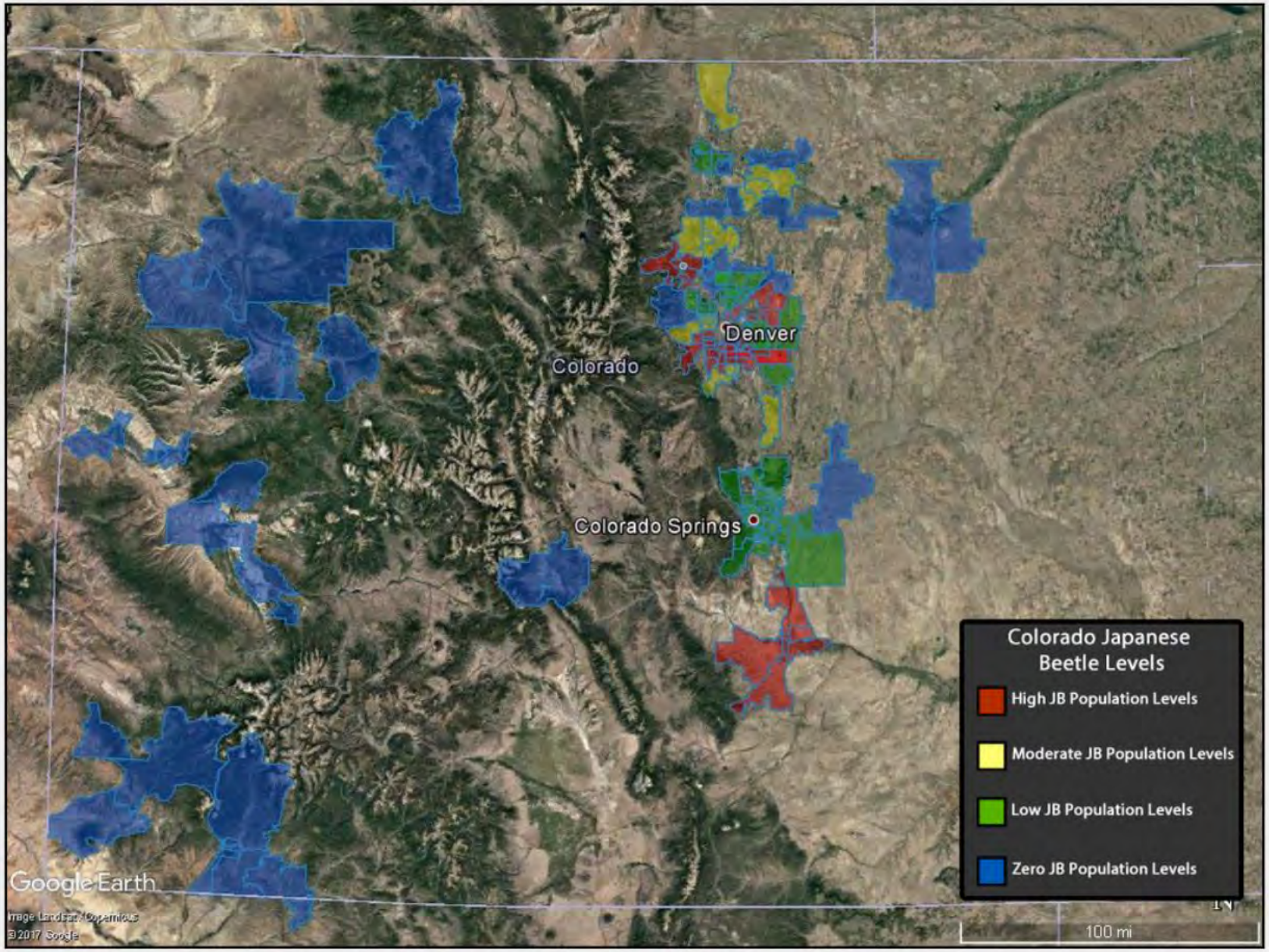
This is a map of the JB situation in the Denver metro area thirteen years ago



A trap in a backyard in the area of the arrow was capturing over 1000 Japanese beetles/day during peak periods in July in 2018-2019.



Incidence of Japanese beetle in Colorado based reported at the CDA website a few years ago



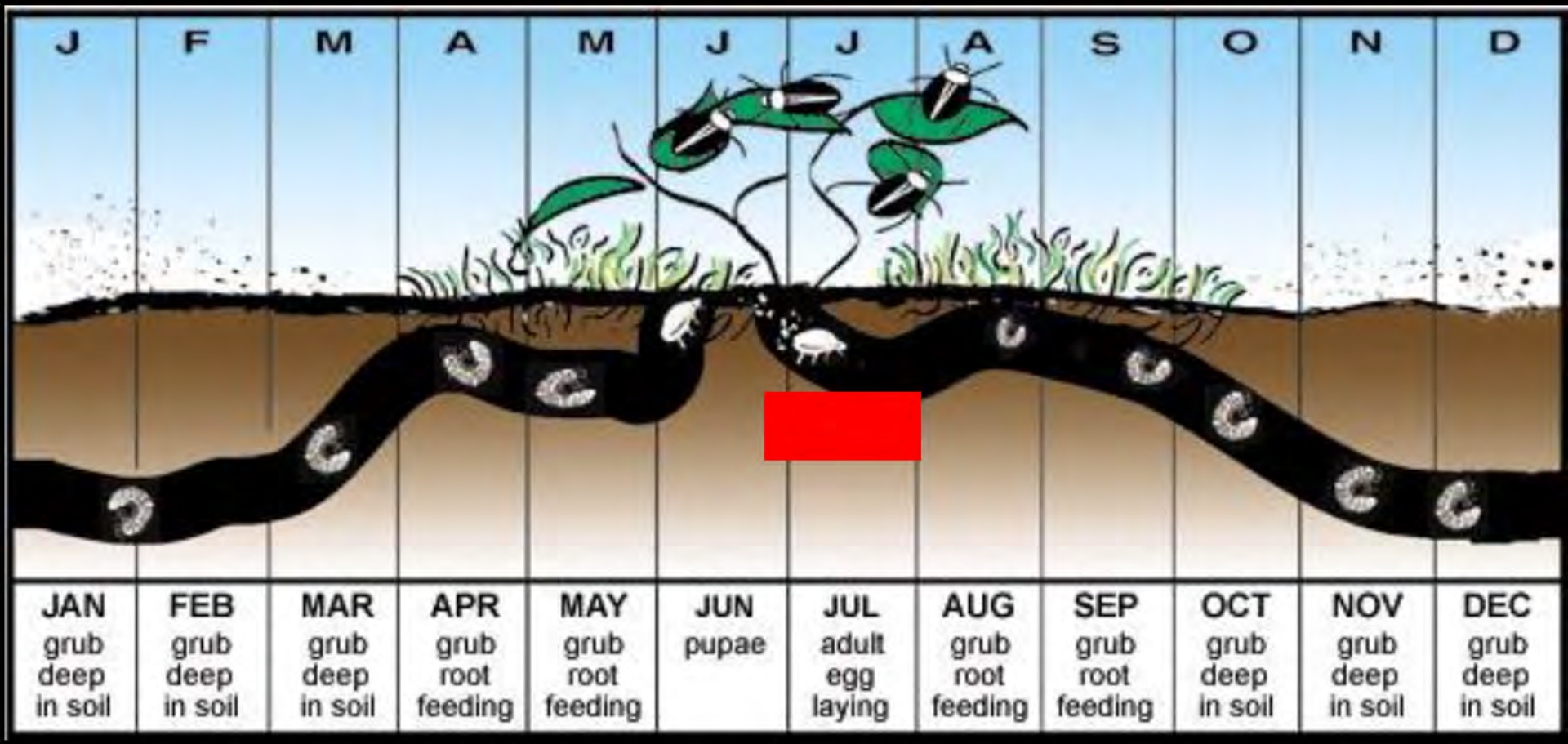
Japanese beetle damages plants in *two distinct ways*

Japanese beetle adults chew on leaves and flowers **of many plants**

Japanese beetle larvae (grubs) – ***among the most damaging turfgrass insects in the US***

Japanese beetle affects yard/garden plants ***in two distinct ways***

Generalized Life History Sequence of Japanese Beetle



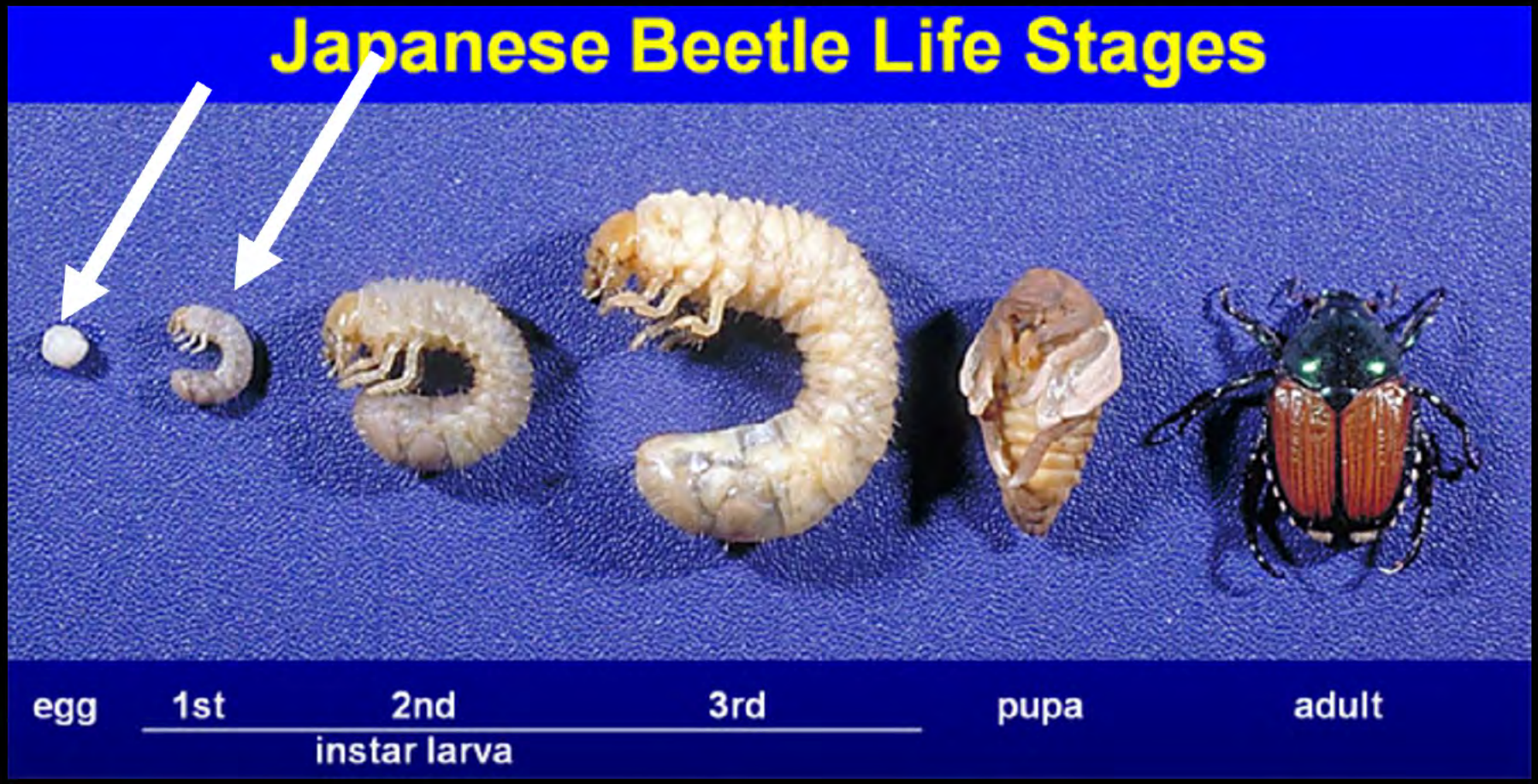
Japanese Beetle Life Stages

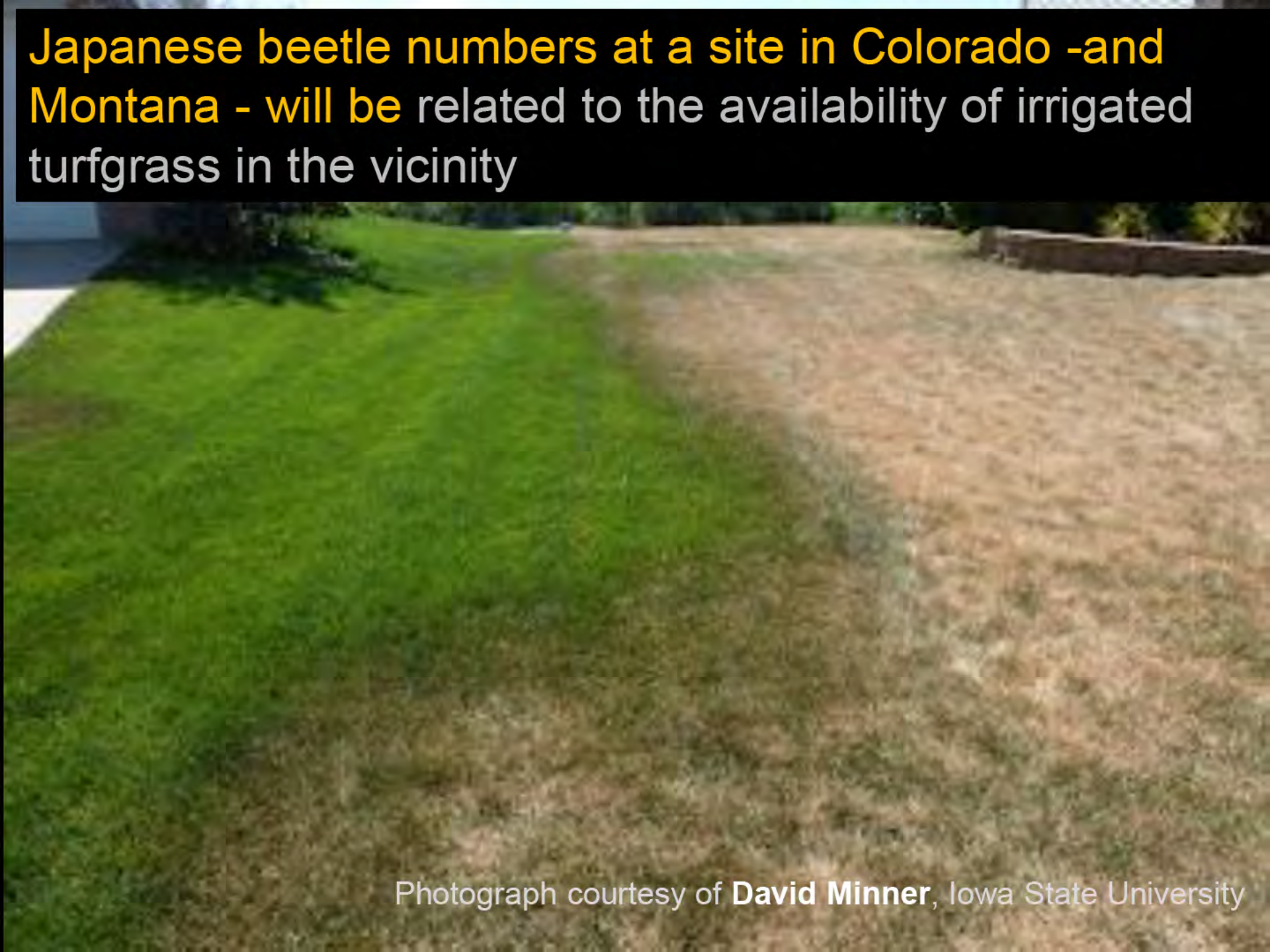
egg | 1st | 2nd | 3rd | pupa | adult

instar larva

Adults burrow into the ground to lay eggs. Eggs are only laid in soil that is suitably moist.

Eggs and 1st stage larvae are very sensitive to drying




Japanese beetle numbers at a site in Colorado -and Montana - will be related to the availability of irrigated turfgrass in the vicinity
Photograph courtesy of **David Minner**, Iowa State University

Sites with limited irrigated turfgrass will have minimal numbers of Japanese beetles

White grubs prune the roots, producing drought stress symptoms

Skunks and raccoons will dig up lawns at night to feed on white grubs

Managing Japanese beetle in the larval (white grub) stage

Information on control of white grubs (and billbugs) in lawns is found in Fact Sheet 5.616

COLORADO STATE UNIVERSITY
EXTENSION

White Grubs and Billbugs: Control in Home Lawns

Fact Sheet No. **5.516** | Insect Series | **Home and Garden**

by W.S. Cranshaw*

White grubs and billbugs can be important pests of turfgrass in parts of Colorado. Both groups of insects feed below ground and damage roots or feed within the growing crown area of the plant.

Figure 1a: White grub. **Figure 1b:** Billbug larva. Photos by David Shetlar, The Ohio State University.

White Grubs

White grubs feed on the roots of grasses and usually can be found within the top couple inches of soil. The body is creamy white with a reddish-brown head and they have three pairs of legs on the thorax. Normally they will be seen to curve their bodies into a distinctive C-shape and grubs of the larger Colorado species may reach nearly 1 inch long.

Figure 2: White grub in root zone of a lawn. Photo by David Shetlar, The Ohio State University.

Quick Facts

- Billbugs and white grubs are insects that damage turf grasses by feeding on the roots.
- Heavy infestations of white grubs may kill grass or attract mammals, such as skunks, that damage grass when digging to feed on grubs.
- White grubs are best controlled with insecticides when eggs are beginning to hatch.
- Billbugs are best controlled when adults are present on the surface of the lawn in spring.
- Insect parasitic nematodes are a biological control option for both white grubs and

General Information on controlling Japanese beetle in all stages is in Fact Sheet 5.601

COLORADO STATE UNIVERSITY EXTENSION

Japanese Beetle

Fact Sheet No. **5.601** Insect Series | **Home and Garden**

by W. Cranshaw*

For close to a century, the Japanese beetle (*Popillia japonica*) has been one of the most seriously damaging insect pests of both turfgrass and landscape plants over a broad area of the eastern US. Recently, there have become a few permanent, reproducing populations of this insect in some communities along the Front Range of Colorado. At some of these sites high numbers of Japanese beetles now regularly occur and adult beetles are causing significant damage to leaves and flowers of many susceptible landscape plants.

Figure 2. Japanese beetle damage to leaves of grape.

Description of the Japanese Beetle

The adult Japanese beetle has an

body with a dark head and the legs on the thorax are well developed. Normally the body curves into a "C-shape". These features are also typical of other white grubs found in association with turfgrass in Colorado, such as

Quick Facts

- Japanese beetle adults chew flower blossoms and leaves of many commonly grown plants.
- Japanese beetle larvae are a type of white grub that feeds on the roots of grasses.
- Adults are best controlled by handpicking or by use of certain insecticide sprays.
- Japanese beetle traps can capture many adults have never been shown to reduce damage to nearby plants.

A “cheat sheet” summary of insecticides that can be used to Japanese beetle white grubs.

This is found in the **Japanese Beetle subsection** of the **Insect Information Website**

Insecticide and Biological Control Options for Control of Japanese Beetle Larvae (White Grubs) in Lawns

Common Name	Trade Names (Commercial)	Trade Names (Retail)	Insecticide Class	Comments
imidacloprid	Merit, Mallet, Zenith, others	Hi-Yield Grub Free Zone II, Bayer Advanced Complete Insect Killer for Soil & Turf (with beta-cyfluthrin), Bayer Advanced Season-Long Grub Control, Bonide Grub Beater	neonicotinoid	Has moderate-long persistence. ***Applications are most effective when made in June through early August.*** Fairly fast (a couple of weeks) in providing control of grubs following application. Moves systemically in plants. Hazardous to bees if applied when flowering plants in lawns are present during application
chlothianidan	Arena	None	neonicotinoid	Has long persistence. ***Can provide control if applied from May into August.*** Fairly fast (a couple of weeks) in providing control of grubs following application. Moves systemically in plants. Hazardous to bees if applied when flowering plants in lawns are present during application.
chlorantraniliprole	Acelepryn	GrubEx	diamide	Has very long persistence but moves relatively slowly into soil. ***Best applied in May/June; some control possible with applications made in April or early August.*** Fairly slow (weeks) in providing control after application. Has some ability to move systemically in plants. Very low hazard to bees. Very low hazard to humans, pets.

Question: **Does control of larvae in a yard affect the number of adults in a yard?**

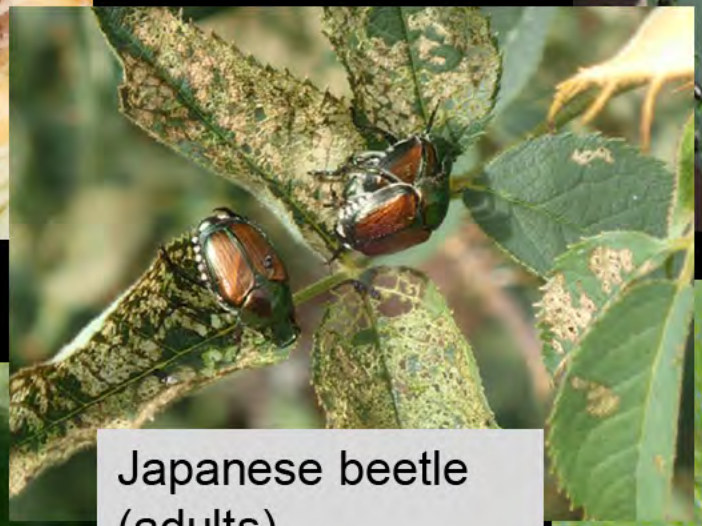
???????
?

Answer: Very likely, **NO**

Some Highly Mobile Insects

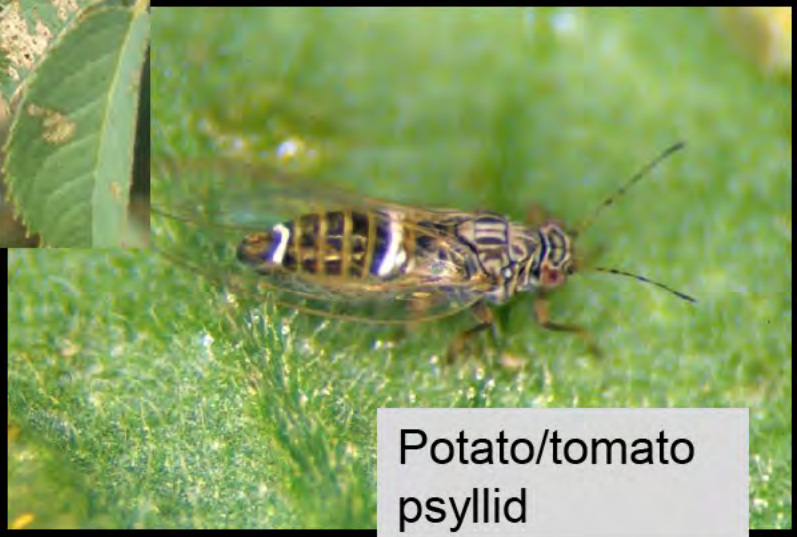
Corn earworm (adults)

Crucifer flea beetles



Japanese beetle (adults)

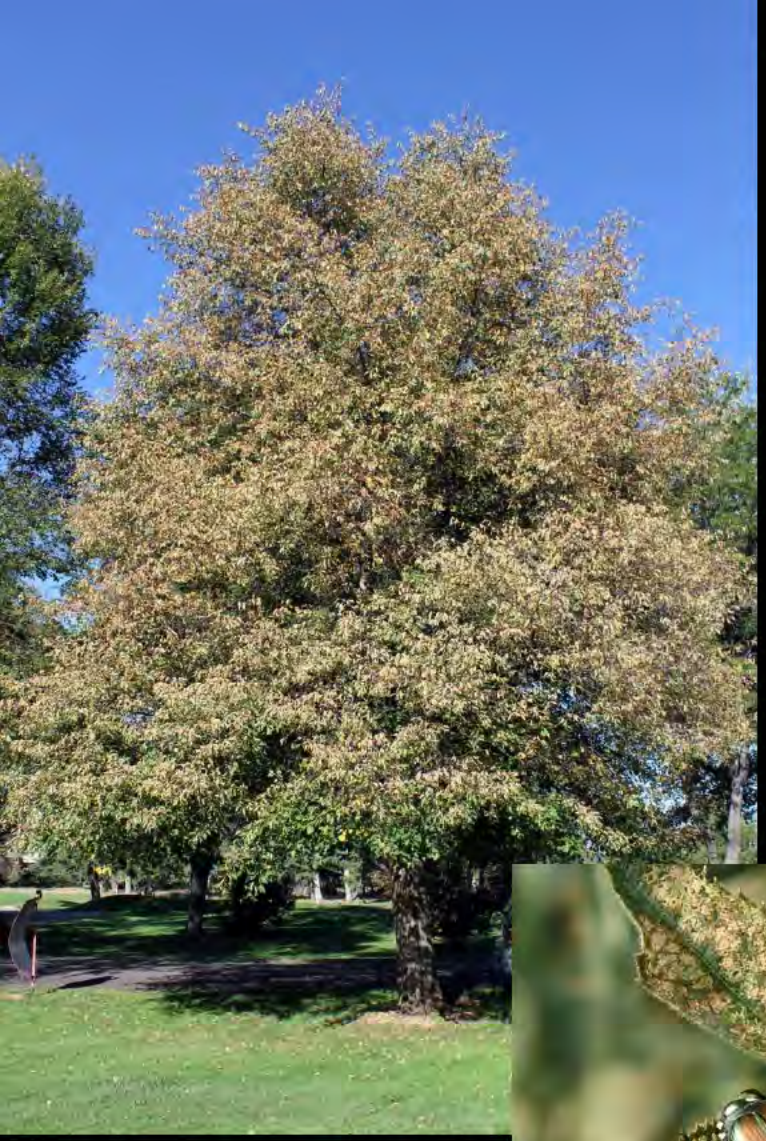
Grasshop pers



Potato/tomato psyllid

Adult beetles feed on both flowers and leaves of many ornamental plants as well as garden vegetables and herbs

Skeletonizing injuries
produced by Japanese beetle
adults feeding on leaves



Flowers are often a favored plant part targeted by adult Japanese beetles

Issue of unusual concern with Japanese beetle

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

Uber-host Plants Favored by Japanese Beetle Adults in CO

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

Other Plants Commonly Grown in CO that are Highly Favored by Japanese Beetle

Ornamentals

- Hollyhock*
- Gaura**
- Rose-of-Sharon**
- Crabapple
- Japanese maple
- Canna lily
- Peking cotoneaster

Food Crops

- Beans (green, edamame)
- Basil
- Raspberry*
- Grape

- * JB populations overlap with flowering
- ** JB populations overlap >*a lot*< with flowering

Japanese beetle traps are excellent for detecting presence **of the insect in an area**

Japanese beetle traps *are minimally useful - at best* - for control of existing Japanese beetle infestations!

Do you have >a lot< of Japanese beetles in your trap??

There are about **836 Japanese beetles per cup**

If you insist on using a Japanese beetle trap

- Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed
- Avoid placing them in a site where they are likely to draw beetles from long distances

If you insist on using a Japanese beetle trap

- Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed
- Avoid placing them in a site where they are likely to draw beetles from long distances

….and preferably give the trap to your neighbor!

Chemical Controls Most Effective for Control of Japanese Beetle Adults

- Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)
- Carbaryl
- Acetamiprid
- Imidacloprid
- Chlorantraniliprole

Do not treat plants with flowers in bloom!

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

Never apply persistent insecticides to plants that are in flower and attractive to pollinators!!

Chemical Controls Most Effective for Control of Japanese Beetle Adults

- ~~Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)~~
- ~~Carbaryl~~
- ~~Imidacloprid~~
- ~~Acetamiprid~~
  - ~~Tristar~~
- Chlorantraniliprole
  - Acelepryn

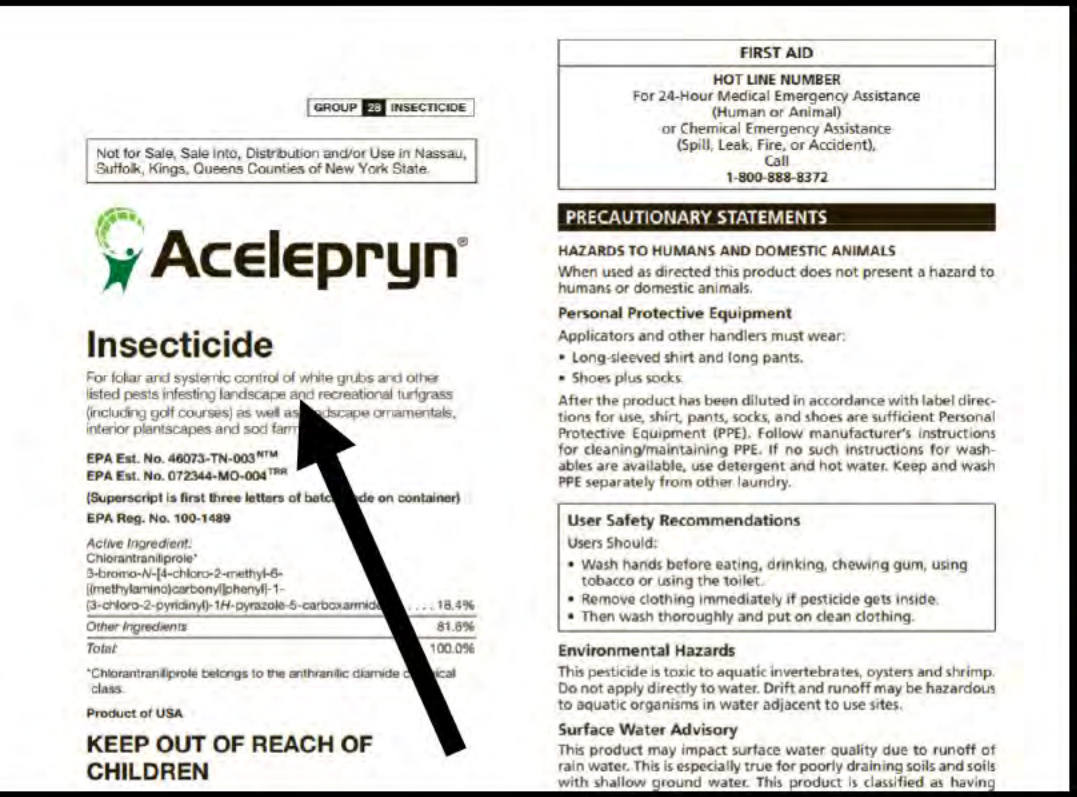
Do not treat plants with flowers in bloom!

Pollinator hazard warning statement regarding use of Tristar 8.5 SL (acetamiprid)

ENVIRONMENTAL HAZARDS

This product is toxic to wildlife. This product is toxic to bees and other pollinating insects exposed to direct treatment. Do not apply this product while bees or other pollinating insects are actively visiting the treated area. Risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made at dawn or dusk or when temperature is below 55°F at the site of application. Do not apply directly to water, or to

This type of warning statement allows use of this product on a plant in flower *only during times of day when pollinators are not visiting the plant*



GROUP 28 INSECTICIDE

Not for Sale, Sale into, Distribution and/or Use in Nassau, Suffolk, Kings, Queens Counties of New York State.

Acelepryn®

Insecticide

For foliar and systemic control of white grubs and other listed pests infesting landscape and recreational turfgrass (including golf courses) as well as landscape ornamentals, interior plantscapes and sod farm

EPA Est. No. 46073-TN-003[NTM]
EPA Est. No. 072344-MO-004[TRR]
(Superscript is first three letters of batch code on container)
EPA Reg. No. 100-1489

Active Ingredient:
Chlorantraniliprole* 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide 18.4%
Other Ingredients 81.6%
Total 100.0%

*Chlorantraniliprole belongs to the anthranilic diamide chemical class.

Product of USA

KEEP OUT OF REACH OF CHILDREN

FIRST AID

HOT LINE NUMBER
For 24-Hour Medical Emergency Assistance
(Human or Animal)
or Chemical Emergency Assistance
(Spill, Leak, Fire, or Accident),
Call
1-800-888-8372

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

When used as directed this product does not present a hazard to humans or domestic animals.

Personal Protective Equipment

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants.
- Shoes plus socks.

After the product has been diluted in accordance with label directions for use, shirt, pants, socks, and shoes are sufficient Personal Protective Equipment (PPE). Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables are available, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users Should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside.
- Then wash thoroughly and put on clean clothing.

Environmental Hazards

This pesticide is toxic to aquatic invertebrates, oysters and shrimp. Do not apply directly to water. Drift and runoff may be hazardous to aquatic organisms in water adjacent to use sites.

Surface Water Advisory

This product may impact surface water quality due to runoff of rain water. This is especially true for poorly draining soils and soils with shallow ground water. This product is classified as having

Labeled for use on turfgrass and landscape ornamentals

Environmental hazards statements do include warnings for aquatic organisms.

They do not have any pollinator warning statements

Btg - Bacillus thuringiensis var. *galleriae*

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

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

Adult control

Btg-susceptible Insects

Bacillus thuringiensis (Bt)

- 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 Bt strains are present, each with specific activity

Caterpillars – kurstaki, *aizawi* strains
Leaf beetles – *tenebrionis* strain
Gnat, mosquito larvae – *israelensis* strain

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

Btg - Bacillus thuringiensis var. *galleriae*

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

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

Adult control

Btg-susceptible Insects

beetleJUS treated

Water check

Bacillus thuringiensis var. *galleriae* (Btg) for adult Japanese beetle control?

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.

Shortly after application:

Are they dead? (probably not yet)
Are they still feeding? (probably not)

A "cheat sheet" summary of insecticides that can be used to control adult Japanese beetles.

This is found in the Japanese Beetle subsection of the Insect Information Website

Insecticide Options for Control of Adult Japanese Beetle on Leaves and Flowers

Common Name (Insecticide Class)	Trade Names	Persistence of control	Labeled Uses on Food Crops	Pollinator Hazards, Cautions
acetamiprid (neonicotinoid)	Tristar, Ortho Flower, Fruit, and Vegetable Insect Killer	Moderate persistence; provides control of damage for days-week. Moves systemically within plants.	Label allows use on some fruits and vegetables.	Can be used on plants that are in blossom but cannot be applied at times when bees are visiting (i.e., dusk, dawn applications allowed).
azadirachtin (unspecified, botanical origin)	BioNeem, Azasol, AzaGuard, AzaMax, others	Short persistence; provides control of damage for a couple of days.	Uses allowed for essentially all food crops.	Hazardous to bees if directly sprayed. Can be used on plants that are in blossom but cannot be applied at times when bees are visiting (i.e., dusk, dawn applications allowed).
Bacillus thuringiensis* var. *galleriae (microbial)	beetleGONE!, beetleJUS!	Persistence is 2-3 days. Acts as stomach poison that causes beetles to stop feeding very shortly (hours) after it is eaten. Beetles may not die for several days.	Many food crop uses are allowed.	Very low hazard to bees. Can be applied to plants that are in flower and are being visited by pollinators.
bifenthrin (pyrethroid)	Ortho Max Insect Killer for Lawns and Gardens, Talstar, Onyx	Persistence moderate-long; provides control of damage for about a week.	No food crop uses are allowed.	High hazard and can kill bees for days after application. Cannot be used on plants bees visit that are in bloom.
carbaryl (carbamate)	Sevin, Carbaryl	Persistence moderate-long; provides control of	Label allows many food crop uses.	High hazard and can kill bees for days after application. Cannot be used on

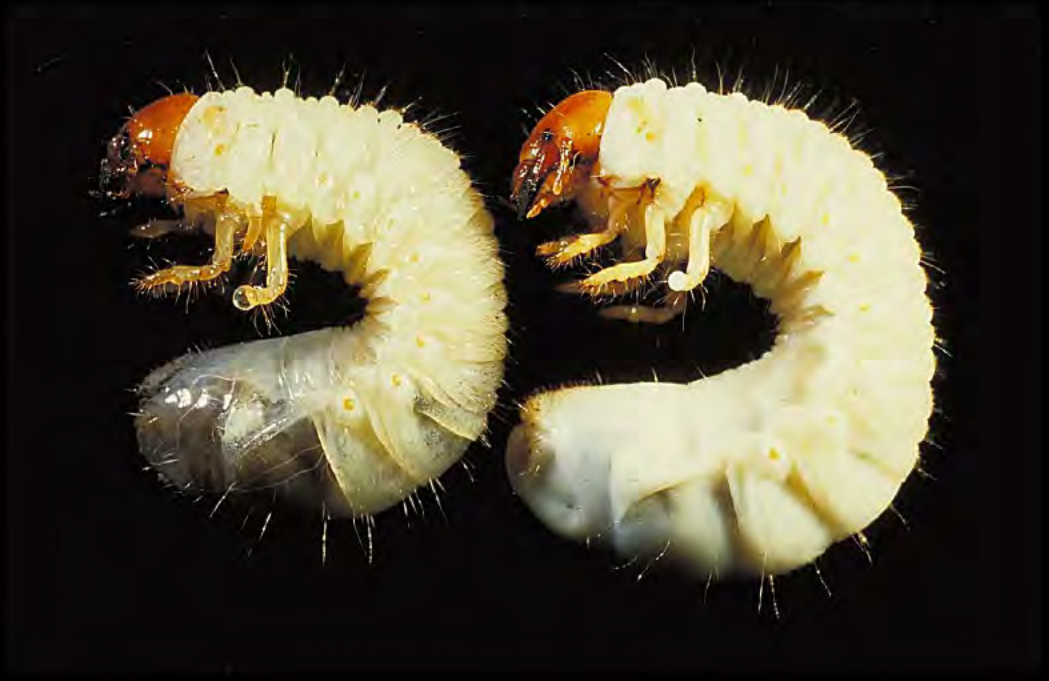
What should we do about the Japanese Beetle?

We should attempt transfers, *for permanent establishment in Colorado*, of some Japanese beetle natural enemies present in states to the east.

Introduced Natural Enemies of Japanese Beetle in Many Areas of the Eastern US

- ***Paenibacillus popilliae*** **(Milky spore)**
  - –Bacterium
- ***Istocheta aldrichi***
  - –Parasitoid (tachinid) fly
- ***Tiphia vernalis***
  - –Parasitoid (tiphiid) wasp
- ***Ovavesicula popilliae***
  - –Fungus (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.**

Milky Spore for Japanese Beetle?

Anyone can purchase this product and try to establish it on their property. If successfully established once, it will then spread by itself.

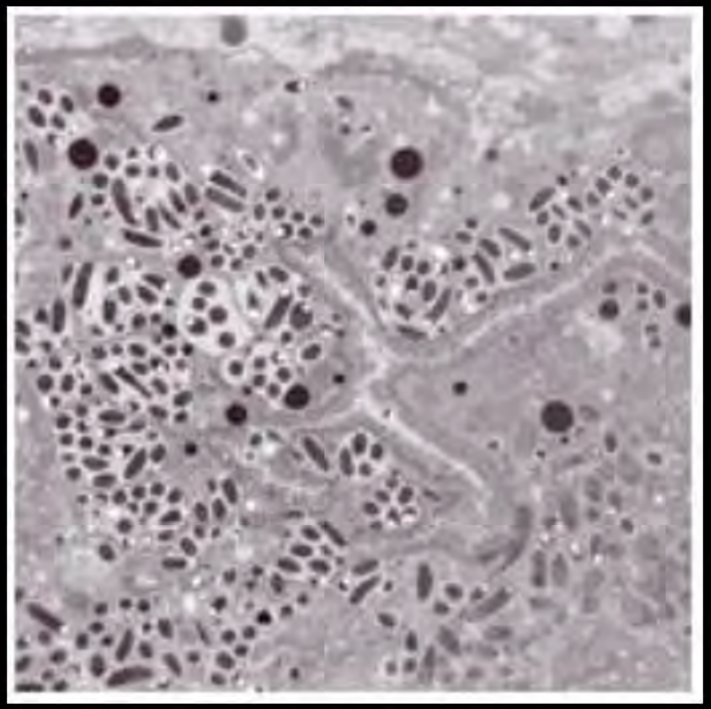
Natural enemies of Japanese Beetle that were introduced once and now established elsewhere in the United States

- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- ***Ovavesicula popilliae****
  - Microsporidium (fungus)
- ***Istocheta aldrichi****
  - Parasitoid (tachinid) fly
- ***Tiphia vernalis****
  - Parasitoid (tiphiid) wasp

* Species involved in Colorado Japanese Beetle Biological Control Program

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

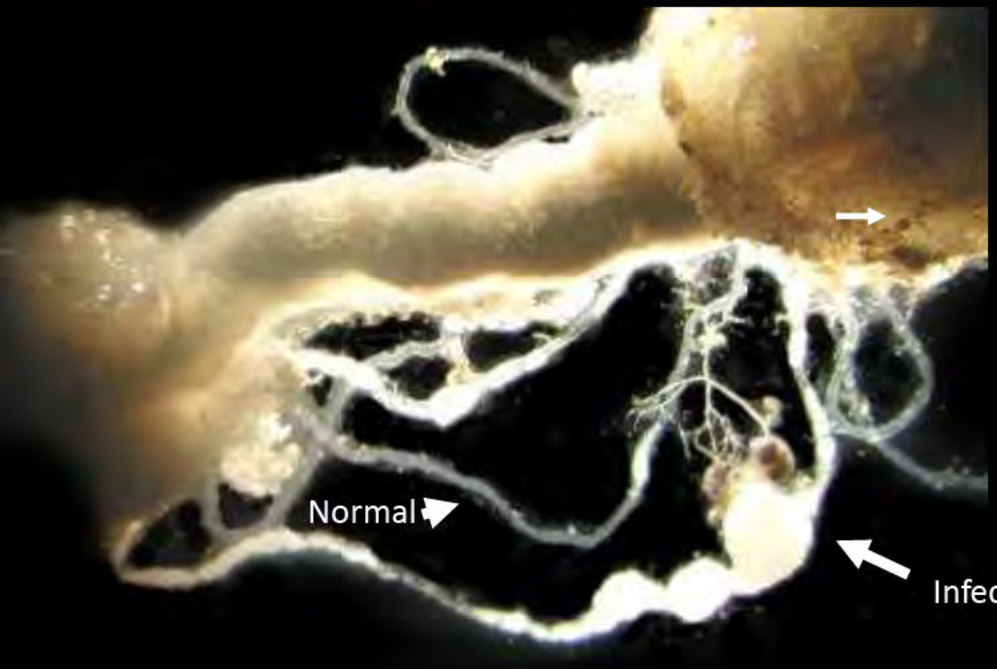
Ovavesicula popilliae – a fungal disease of Japanese beetle larvae

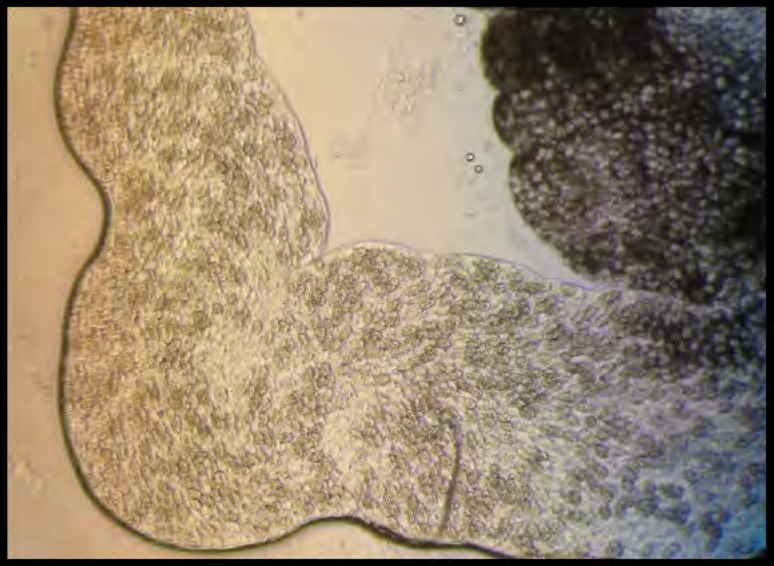


Ovavesicula infection of Malpighian tubules of Japanese beetle larva

Target stage – larvae in soil

Ovavesicula popilliae infects the Malpighian tubules of Japanese beetle larvae and adults

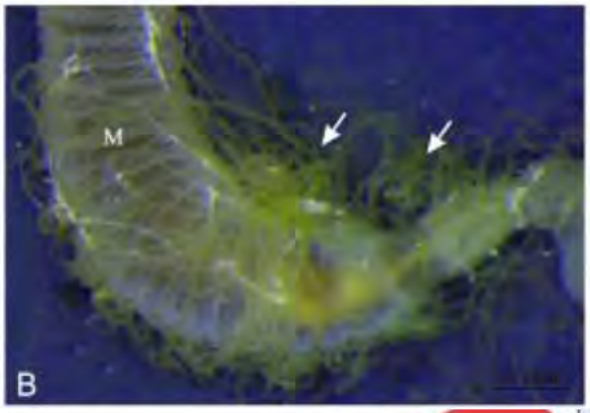


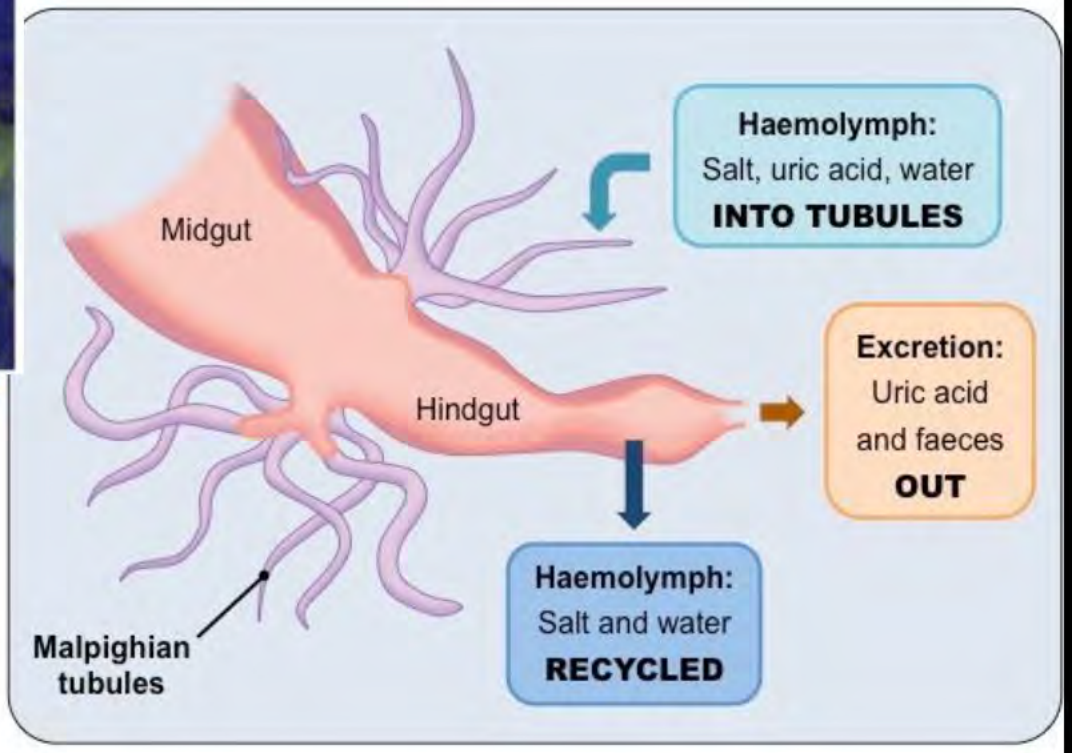


Malpighian tubules packed with spores of *Ovavesicula popilliae*

Source: David Smitley, Michigan State University

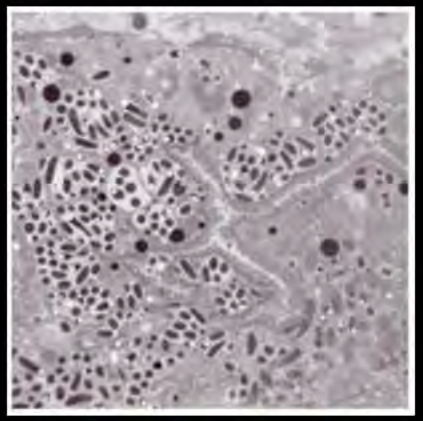
The **Malpighian tubules** of insects filter wastes from the blood, functioning somewhat like what the kidney does in humans





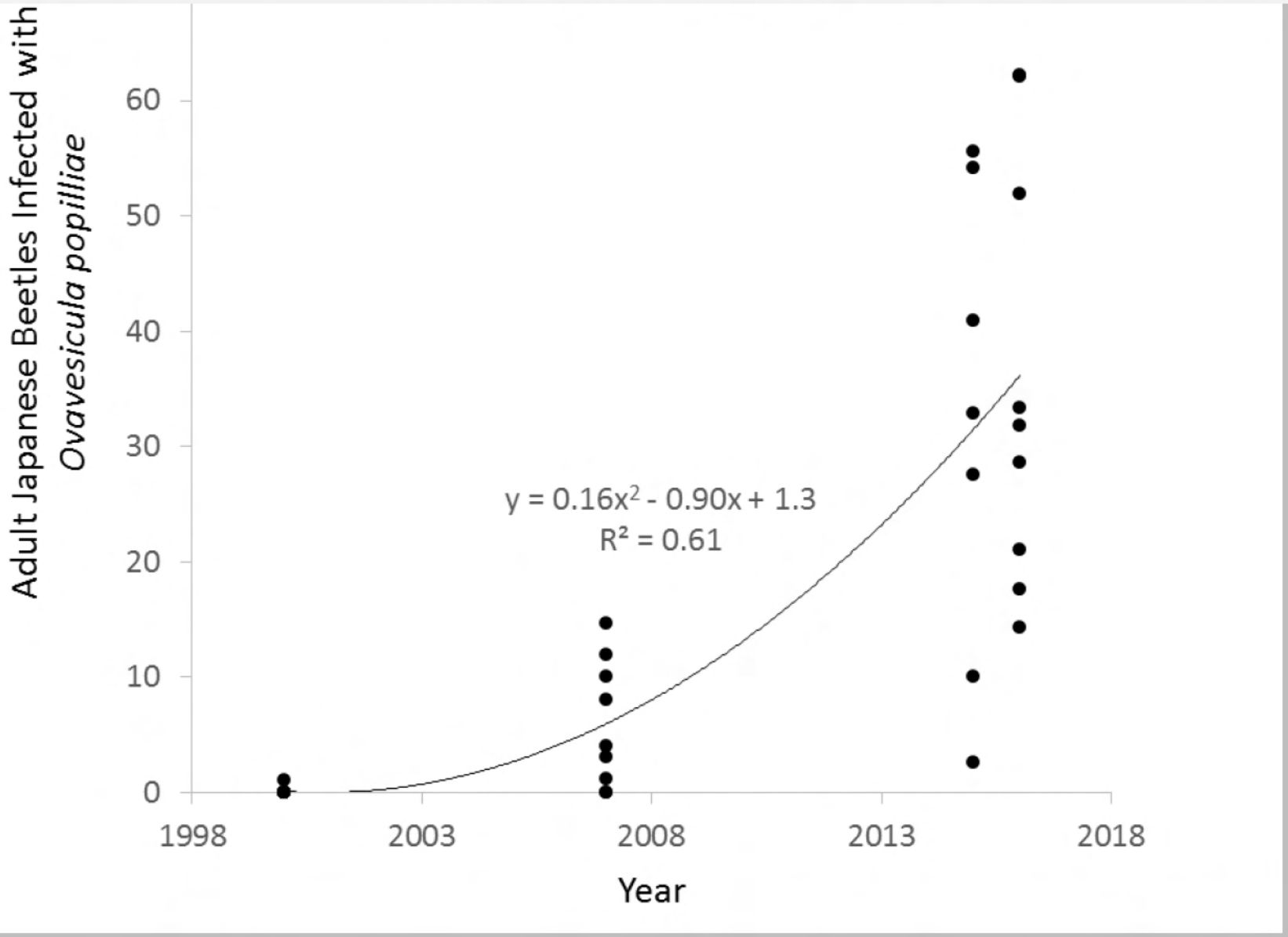
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Ovavesicula popilliae – a fungal disease that infects Japanese beetle larvae



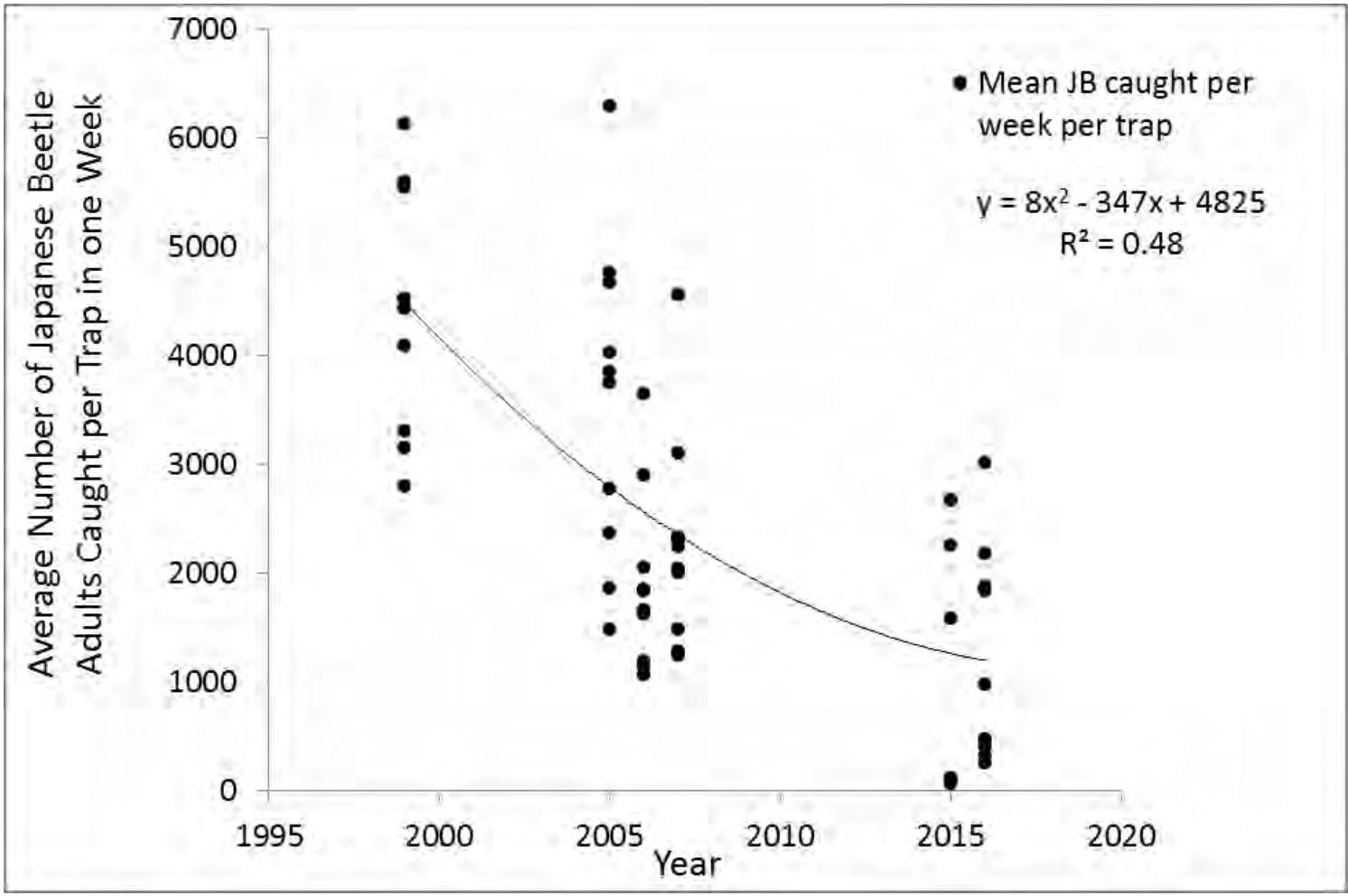
Main observed effects from infection – reduced winter survival (larvae), shortened life span, reduced fecundity (adults)

Ovavesicula popilliae: % infection of adult Japanese beetles at ten golf courses in Michigan from 2000 to 2016



Source: David Smitley, Michigan State University

Japanese beetle trap catches at ten golf courses in southern Michigan from 1999 to 2016



Source: David Smitley, Michigan State University

Experimental releases of *Ovavesicula popilliae* were first made in 2015

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 spores of the pathogen are still viable.

The infected (but dead and frozen) beetles were applied in several ways

Dead, frozen Op-infected beetles arrive

Beetles are blended into a slurry

Diluted with water the slurry is poured over sites where high numbers of JB grubs are present, and immediately watered in

2015 releases of *Ovavesicula popilliae* – It took!

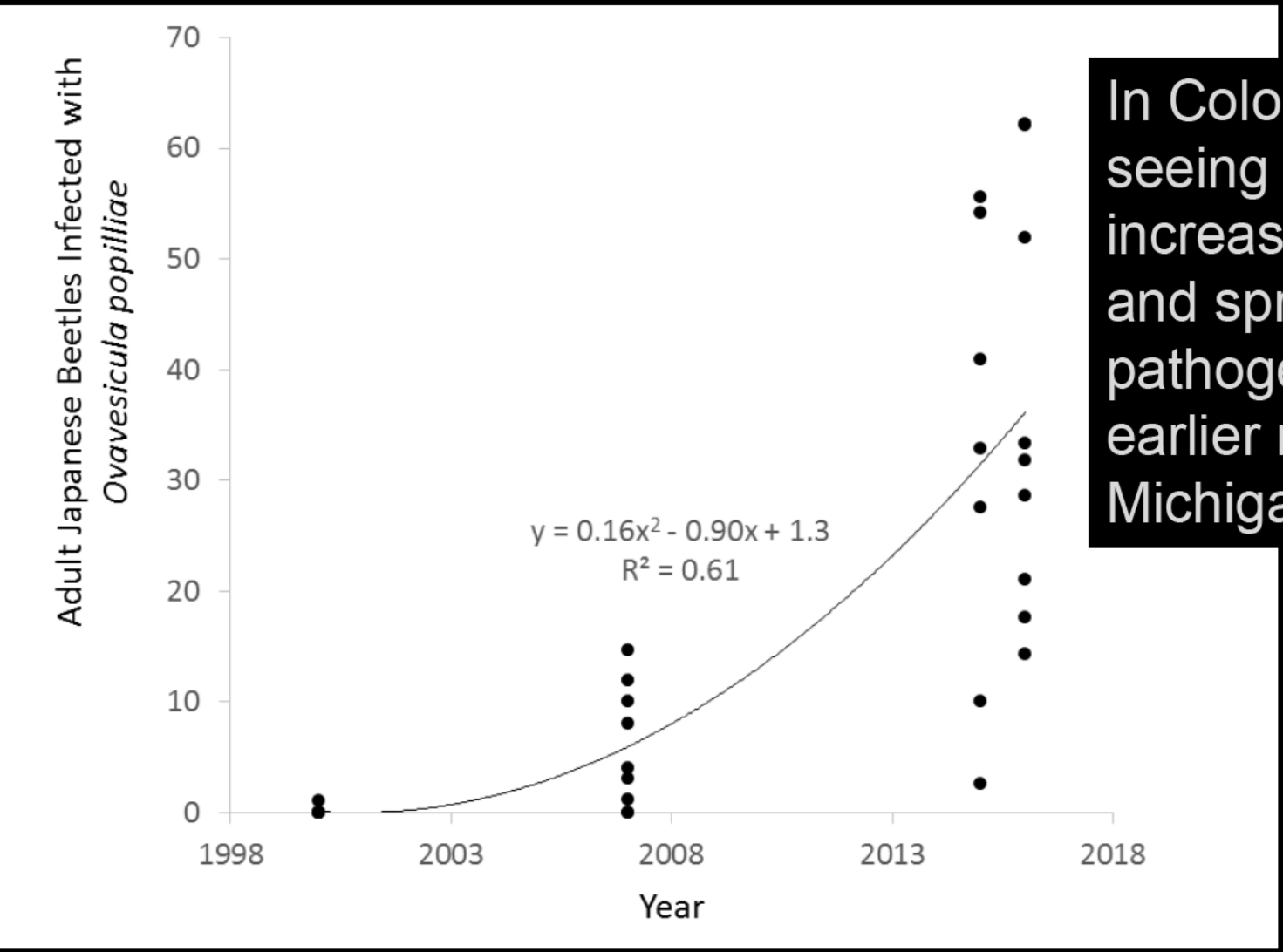
Positive infections confirmed in 2017 from both Flatirons Golf Course (Boulder) and Pueblo Zoo release sites!!!!

Status of *Ovavesicula popillae* Releases

- **Boulder**
  - –3 Release Sites (2015, 2020, 2021) Confirmed established; **one site can be used for transfers**
- **Pueblo**
  - –3 Release Sites (2015, 2018)
    - One site confirmed established, **can be used for transfers**
- **Denver/West Arapahoe Counties**
  - –9 Release Sites (2018, 2020, 2021)
    - At least on site confirmed established, **can be used for transfers**

Key Change Identified in 2021

- In at least 3 sites infection incidence is very high
- This can allow further distribution of the disease agent by transferring live beetle to new sites



In Colorado we are seeing the type of increase in infection and spread of the pathogen as was earlier reported in Michigan

At sites of high infection in Colorado, beetles can now be collected, and transferred to new sites.

The infected beetles can then disperse on their own.

Spores of the OP fungus are shed in their feces and are released into the soil when they die.

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Tiphia vernalis (Spring Tiphia) – parasitoid wasp of late stage Japanese beetle grubs

Photograph by David Shetlar, The Ohio State University

David Shetlar photo

Female wasps dig into the soil to locate Japanese beetle grubs that are nearly full-grown.

They then lay an egg on the grub.

The **developing larva** of the wasp **feeds on and kills the grub**.

It then pupates. The adult emerges next spring.

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Istocheta aldrichi – tachinid fly
parasitoid of Japanese beetle adults

A female *Centeter cinerea* in the act of ovipositing upon *Popillia japonica* female

Istocheta aldrichii ("winsome fly") lays eggs on adult Japanese beetles in July

Ultimately the beetle is killed.

The larva then migrates out of the beetle and moves into the soil where it pupates.

The adult emerges the following year.

The egg(s) hatches and the larva of the fly enters the beetle.

What would be a considered a good success with the JB BioControl Program?

In ten years, instead of finding 20 Japanese beetles on your rose……

…you are only finding 4 or 5.

European Elm Scale – *and resistance to neonicotinoid insecticides*

Crawler stages of EES are produced over several weeks in mid-late June

European elm scale nymphs originally move to leaves where they feed during much of summer

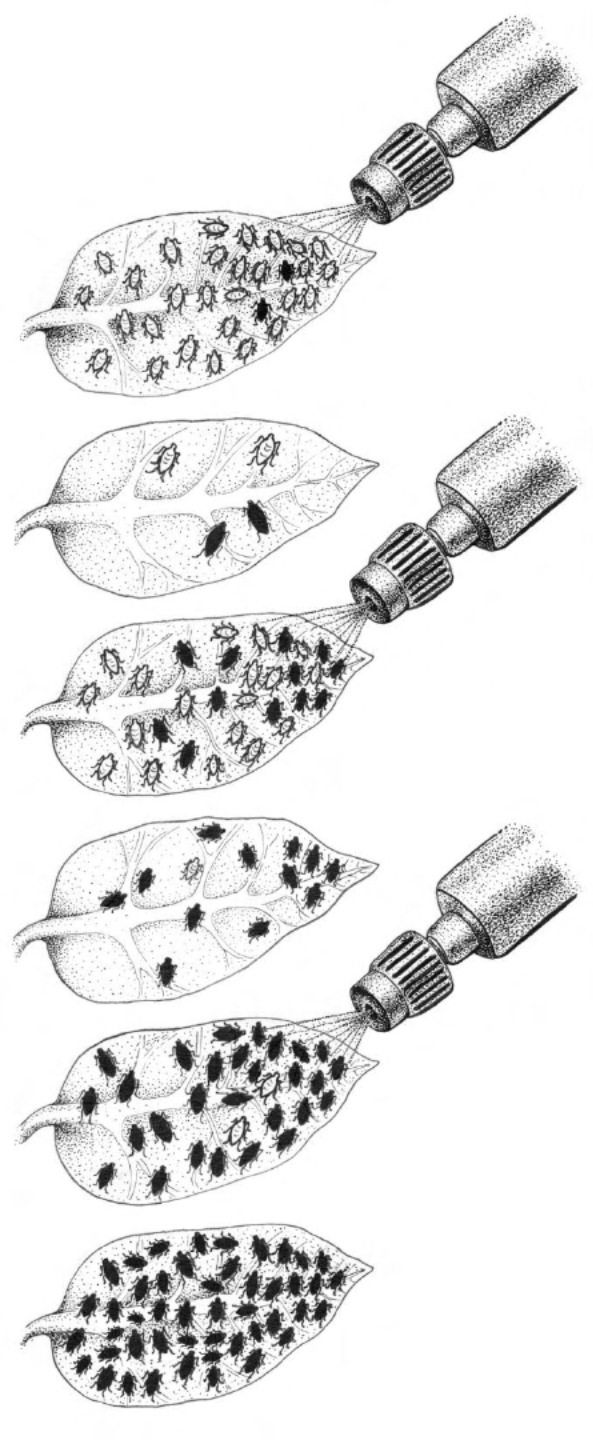
Honeydew is excreted. Where it lands and persists, sooty molds grow.

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 were 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!

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, Endeavor
- 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***

Primary EES Predators

American elms resistant to the scale insect?

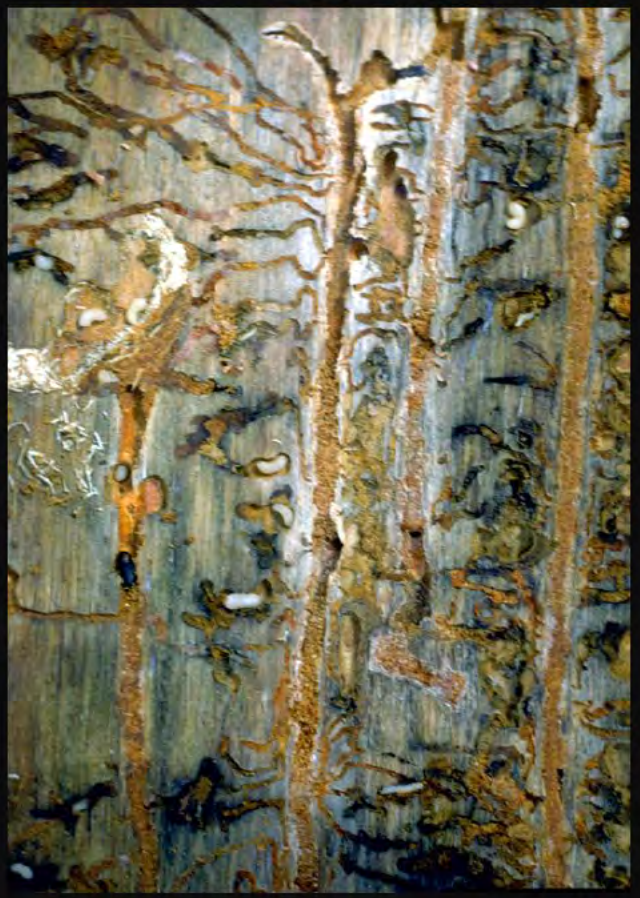

Ulmus americana
'Scale Buster'
Discovered by Tim Buchanan, City Forester, Fort Collins


Typical American elm


‘Scale Buster’

Bark Beetles

Coleoptera: Curculionidae (Scolytinae)



Mountain Pine Beetle

Dendroctonus ponderosae

Mountain pine beetle, *Dendroctonus ponderosae*

Females excavate an egg gallery under the bark. Eggs are laid along this gallery.

Pitch tubes – External evidence of recent attack by Mountain pine beetle

Pitch out of a Mountain pine beetle.

Tree wins.

Mountain pine beetle pitch outs

Right: Likely successful mountain pine beetle ‘hit”

Below: Cream colored pitch produced by successful “pitch out” by the tree

Ips Beetles

Ips beetles. Note the jagged terminal edge of the wing covers.


UGA1254008

Ips beetles may limit attacks to isolated branches or tops of trees.

Spruce Ips

Ips hunteri

A native species that formerly was of little concern

Emerged as a significant pest during the 2000-2003 drought…and remains an insect of concern on stressed trees

Spruce Ips (*Ips hunteri*)

No water, no pitch out

Primary bark beetle defenses are rapidly depleted with drought

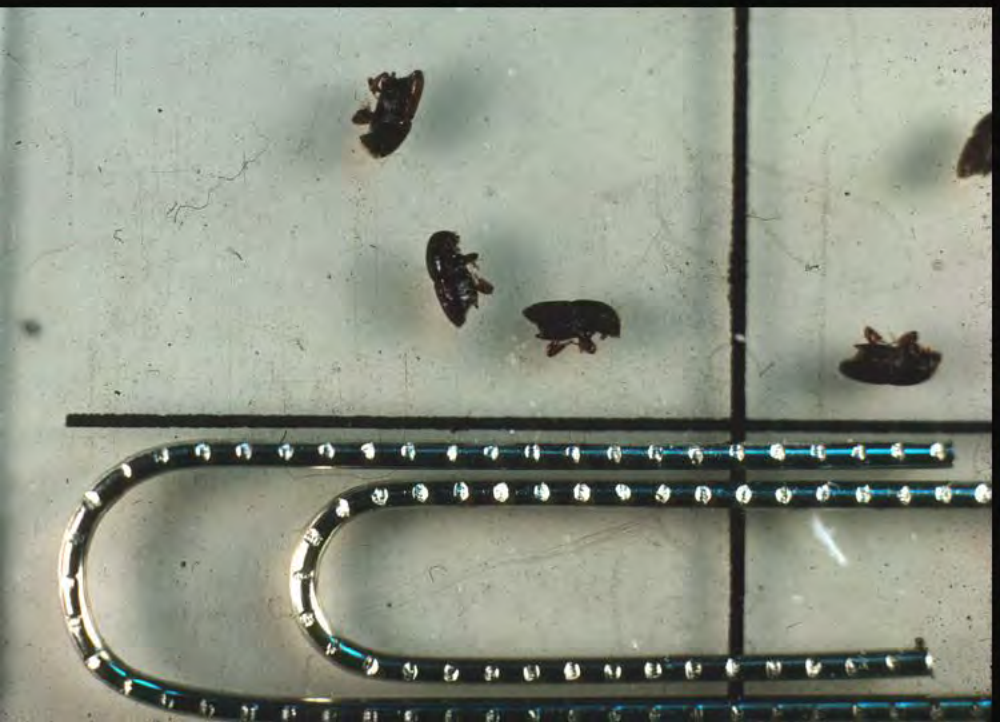
Elm bark beetle hand-off

The “original” elm bark beetle

Smaller European elm bark beetle

Scolytus multistriatus

SEEBB



The ”new” (post-2003) elm bark beetle

Banded elm bark beetle

Scolytus schevyrewii

BEBB

Most behaviors and aspects of life history of the BEBB are similar to SEEBB

Banded elm bark beetle (BEBB) vs. Smaller European elm bark beetle (SEEBB)

- Both species occupy same ecological niche
- BEBB spring emergence is ahead of SEEBB
- BEBB summer generation is ahead of SEEBB
- *Banded elm bark beetle wins!*

Elm bark beetle hand-off

Within ten years after its discovery, this new bark beetle of elm seems to have locally extirpated the old invasive bark beetle of elm through competitive displacement.

Changes from the elm bark beetle hand-off

Banded elm bark beetle appears to be a bit more aggressive in attacks on highly vulnerable trees

Both species appear similar in ability to transmit the DED fungus

Honeylocust Podgall Midge

versus

Honeylocust plant bug

Honeylocust Podgall Midge

Dasineura gleditschiae

Honeylocust podgall midge was the most common insect on honeylocust in the early and mid 1980s

The developing larvae cause the merging leaflets to curl and thicken, forming a “podgall” within which the insect develops

There can be several generations/year, depending on the continued production of new leaflets

Honeylocust Plant Bug

Blepharidopterus chlorionis

This insect started showing up in damaging populations in the late 1980s

Photograph courtesy of Jim Kalisch, University of Nebraska

Most damage is done by the nymphs, which are present in late May and June.

Feeding is done with piercing-sucking mouthparts in a **"lacerate and flush"** manner.

This destroys the cells at the feeding site.

Photograph courtesy of David Shetlar, Ohio State University

Nymphs feeding on new growth

Crown thinning in midJune from heavy infestation of honeylocust plant bug

Symptoms from spring injury by honeylocust plant bug can be observed throughout the summer

Honeylocust podgall midge (HPM) vs. Honeylocust plant bug (HPB)

- Both species develop on the developing leaves of honeylocust
- HPM requires new growth leaflets to produce a protective podgall
- HPB destroys the new growth (and perhaps feeds on some HPM?)
- *Honeylocust plant bug wins!*

There are two insects, of similar appearance – but different feeding habits – on honeylocust leaves in spring

Honeylocust leafhopper

Macropsis fumipennis

Honeylocust plant bug

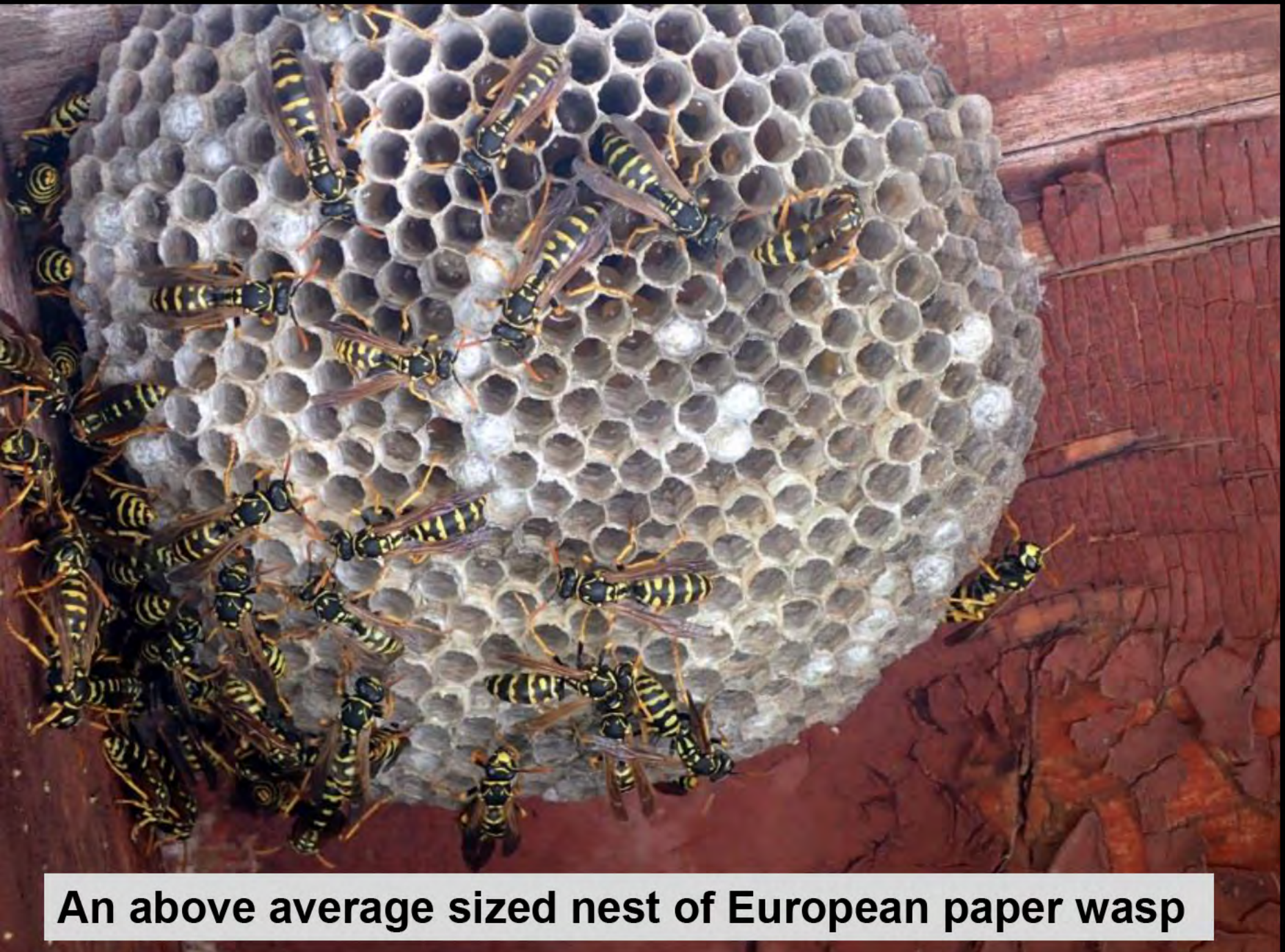
Honeylocust leafhopper

European Paper Wasp

1st western Colorado record – 1998

1st eastern Colorado record - 2001

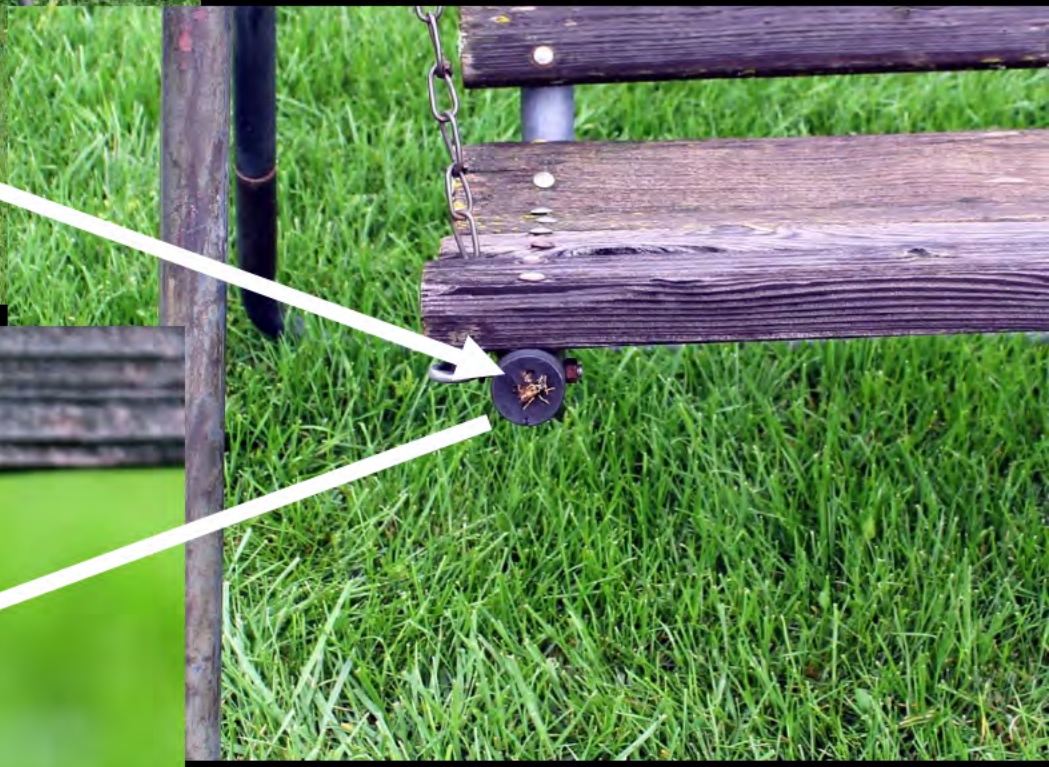
Photograph by Joseph Berger



An above average sized nest of European paper wasp

Some Impacts of the European paper wasp on the Rocky Mountain West

- Added a significant new stinging pest to region
  - Highly visible
- Impacts on yard/garden Lepidoptera
- Stimulates inappropriate purchases of wasp traps



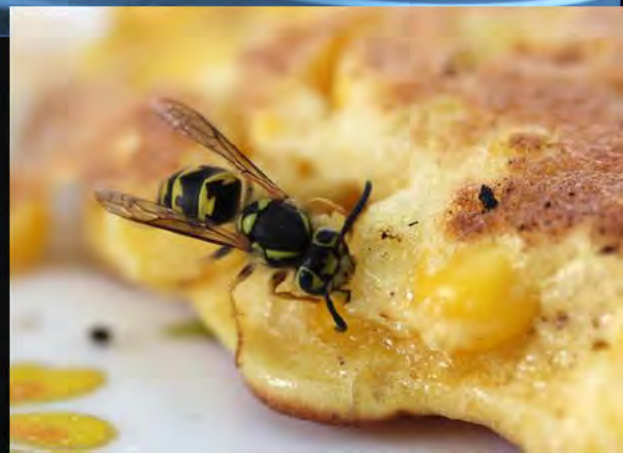

PLASTIC CAP

Nests are ubiquitous and very frequently observed.

Stings are common, although not nearly as common as produced by western yellowjacket.

European Paper Wasp

Western Yellowjacket – A notorious scavenger and #1 stinging insect of the west



Paper wasps are predators that feed their young chewed up insects

They do not scavenge human foods

Impacts on yard/garden Lepidoptera

Impacts on Butterfly Gardening

Traps do not capture the European paper wasp or any other paper wasps

They only catch the western yellowjacket, a native insect.

Questions?

whitney.cranshaw@colostate.edu

PestTalk (pestserv-l)

A listserv discussion group that has been going on since 1995(?)

If you ever wish to join, contact me at my email: whitney.cranshaw@colostate.edu