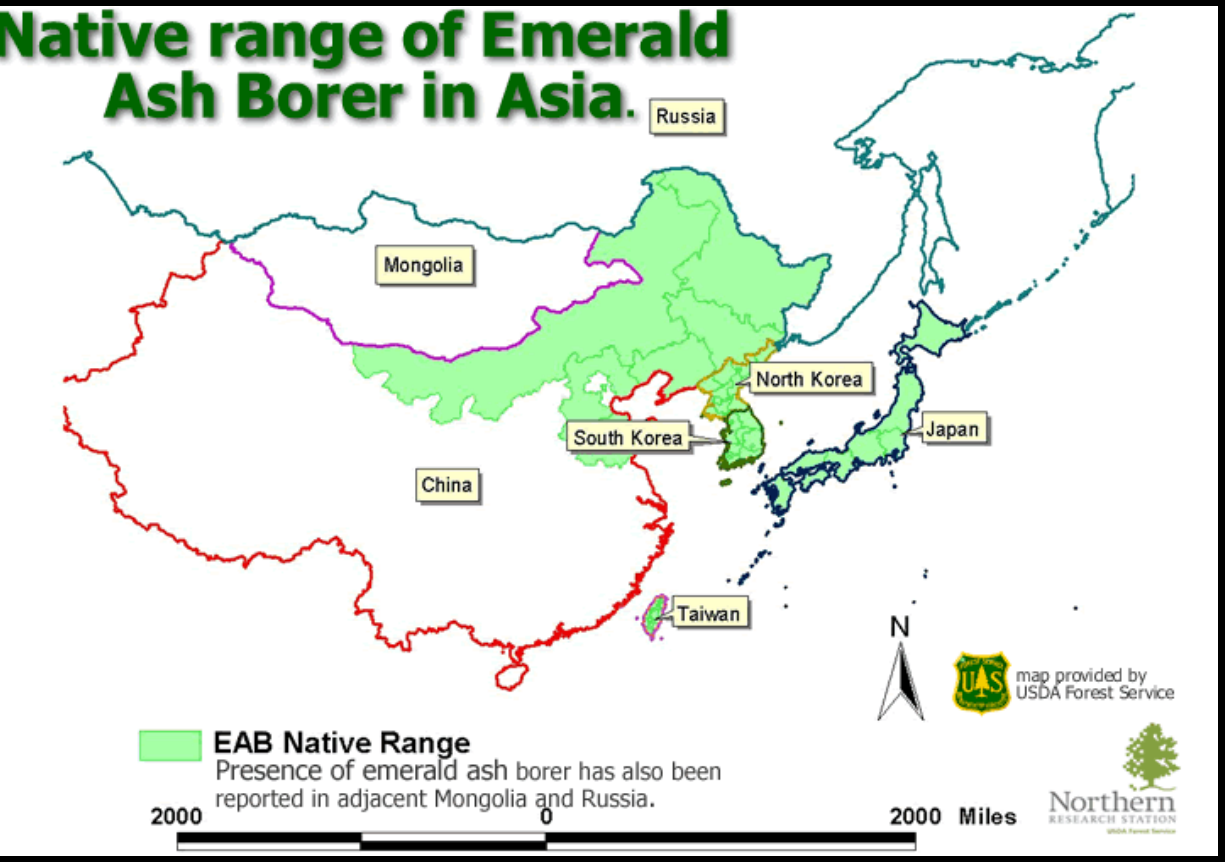
Metallic Wood Borer in the News

Emerald Ash Borer

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

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

……and is Native to Asia



Larvae tunnel under the bark girdling the cambium.

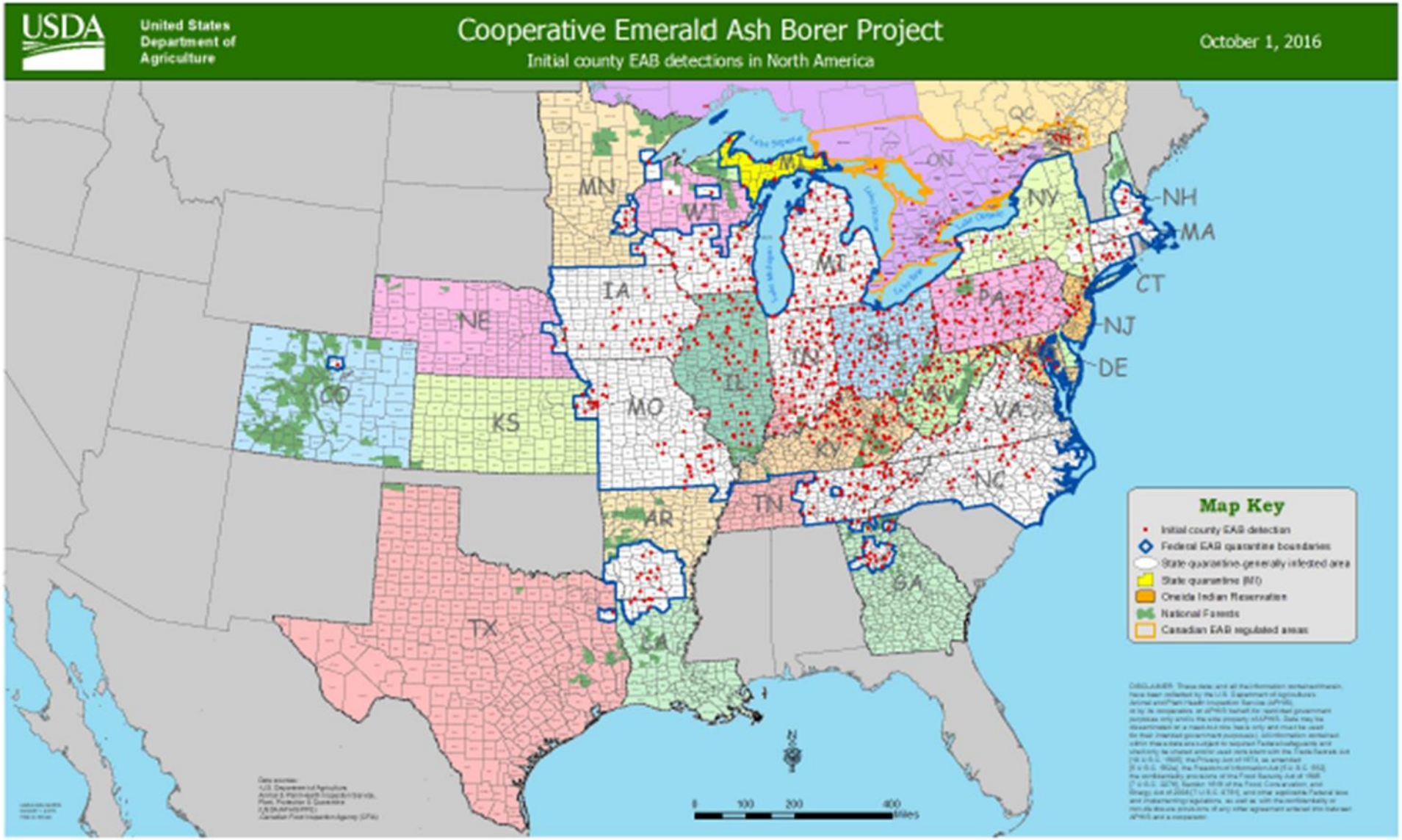
Photo by Edward Czerwinski

Effects of larval tunneling are cumulative, and ultimately lethal to the tree. Most trees are dead within 5 years after the initial colonization.

Photograph by Art Wagner

Photograph by MI Department of Agriculture

Emerald ash borer was accidentally introduced into and has since spread through North America



Lilac/Ash Borer does not equal Emerald Ash Borer!

Lilac/ash borer, a clearwing borer moth

Emerald ash borer, a metallic wood borer/ flatheaded borer

Photograph by Debbie Miller

Emerald ash borer

Agrilus plannipennis

Photograph by David Cappaert

Order Coleoptera (beetles)

Family Buprestidae (metallic wood borers, flatheaded borers

Lilac/Ash Borer

Podosesia syringae

Order: Lepidoptera (Moths and butterflies)
Family: Sesiidae (Clearwing borers)

Emerald ash borer larvae create meandering tunnels in the cambium that produce girdling wounds.

Note: **Attacks can occur throughout the crown and on the trunk of the tree.**

Photograph by Eric Day

Photograph by
David Cappaert

Lilac/ash borer larvae create irregular gouging wounds that extend often into the heartwood.

Attacks are concentrated at the lower trunk of the tree

EAB adults chew through the bark, producing D-shaped exit holes

Lilac/ash borer emerges from *irregularly round holes*. The pupal skin is pulled out when the adult emerges.

After emergence emerald ash borer adults feed on ash foliage for a period and eggs mature.

Photograph by David Cappaert

EAB likely will emerge sometime in midMay.

Eggs will be laid in June, perhaps into early July

Photograph by Dan Herms

Adult stages of the lilac ash borer do not feed on any parts of the ash tree.

Male flying to a pheromone trap

Adults of the lilac/ash borer are present in mid-late spring. Most eggs are generally laid in May through early June.

Eggs of both species are laid on the bark of the host tree

EAB egg

Clearwing borer eggs

Damage potential to its host

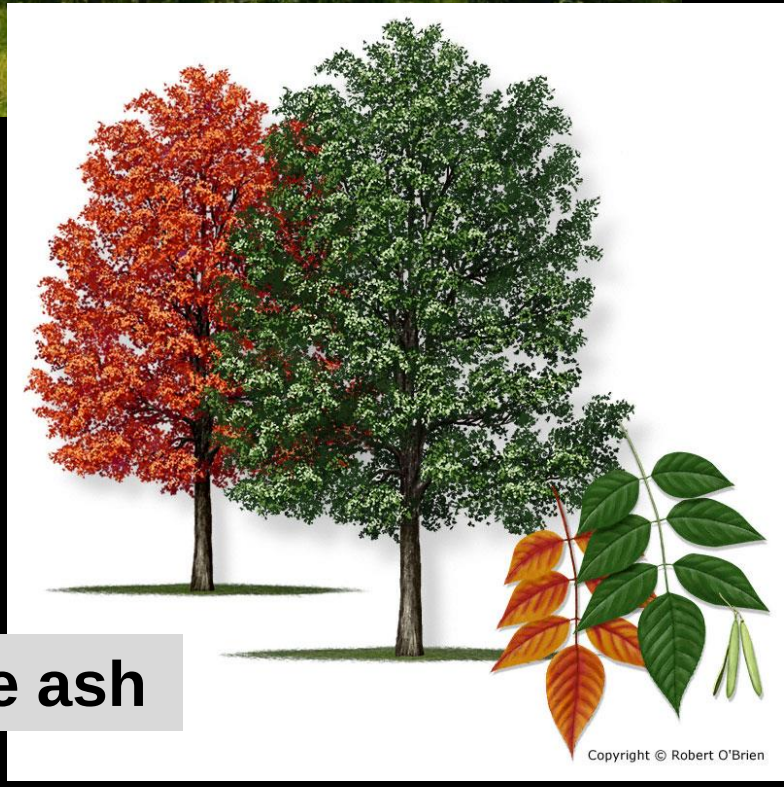
10 – EAB now defines an aggressive tree killing insect in North America.

Damage potential to its host

2, maybe 3 – Lilac/ash borer has far lower ability to seriously damage its host

Emerald ash borer ***is devastating to all species of ash that are native to North America***

Green ash



White ash

Why is EAB so destructive to ash trees in North America?

NA ash species lack ability to ability to resist EAB

Chestnut blight – Devastated American chestnut in early 1900s, caused by a fungus

Dutch elm disease – Devastated American elm in mid century. Caused by a fungus, vectored by a bark beetle

EAB Will Kill All Unprotected Ash

These trees can't be saved. They are already dead.

THIS ASH TREE IS AT RISK OF BEING KILLED BY THE EMERALD ASH BORER

(ACTUAL SIZE ⟶)

punch hole here

punch hole here

If you see dying ash trees in your neighborhood, submit a report to:
WWW.MASSNRC.ORG/PESTS

For more information about emerald ash borer and the damage this invasive pest causes, visit:
WWW.EMERALDASHBORER.INFO

This tree was tagged on _____ by:
_____

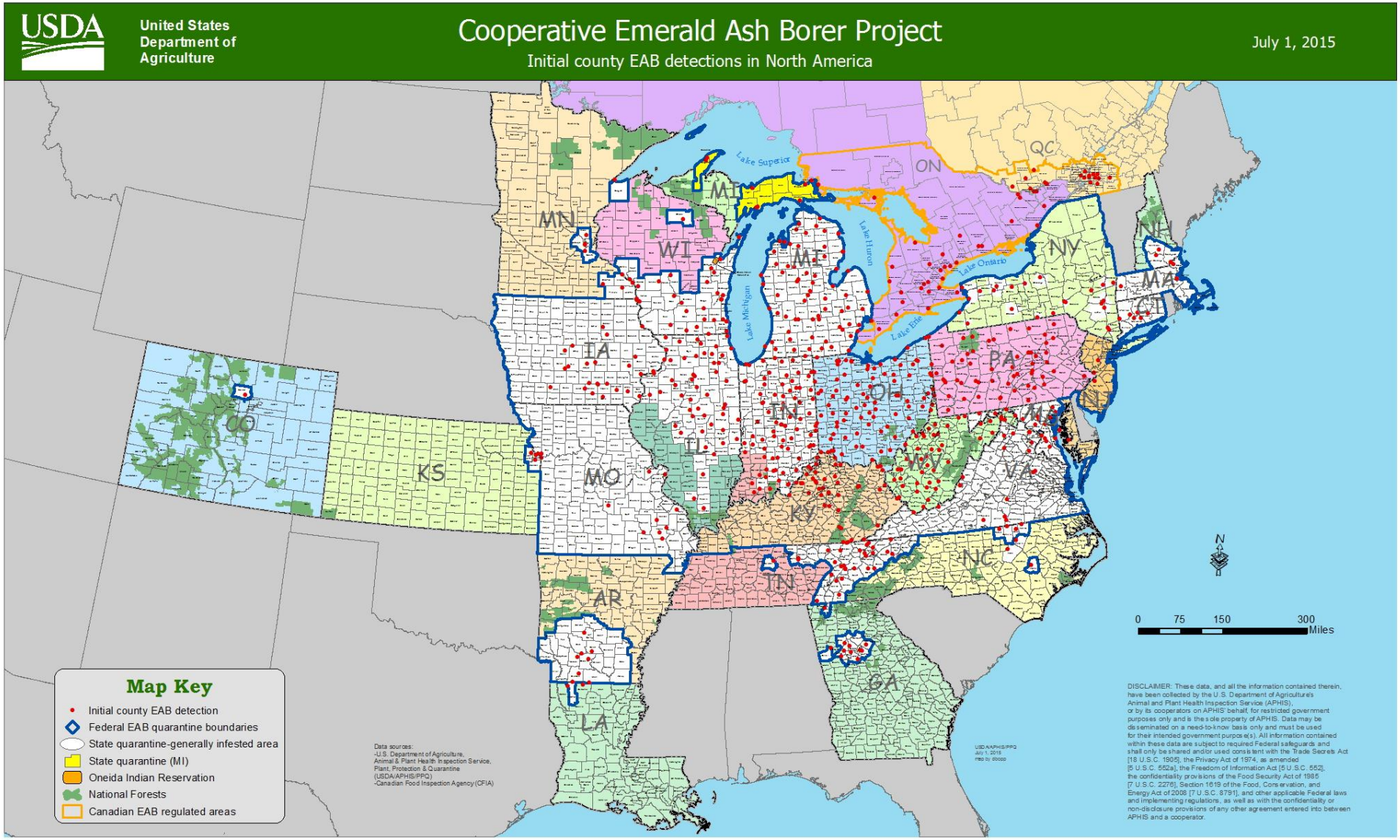
MDAR
massnrc.org/pests

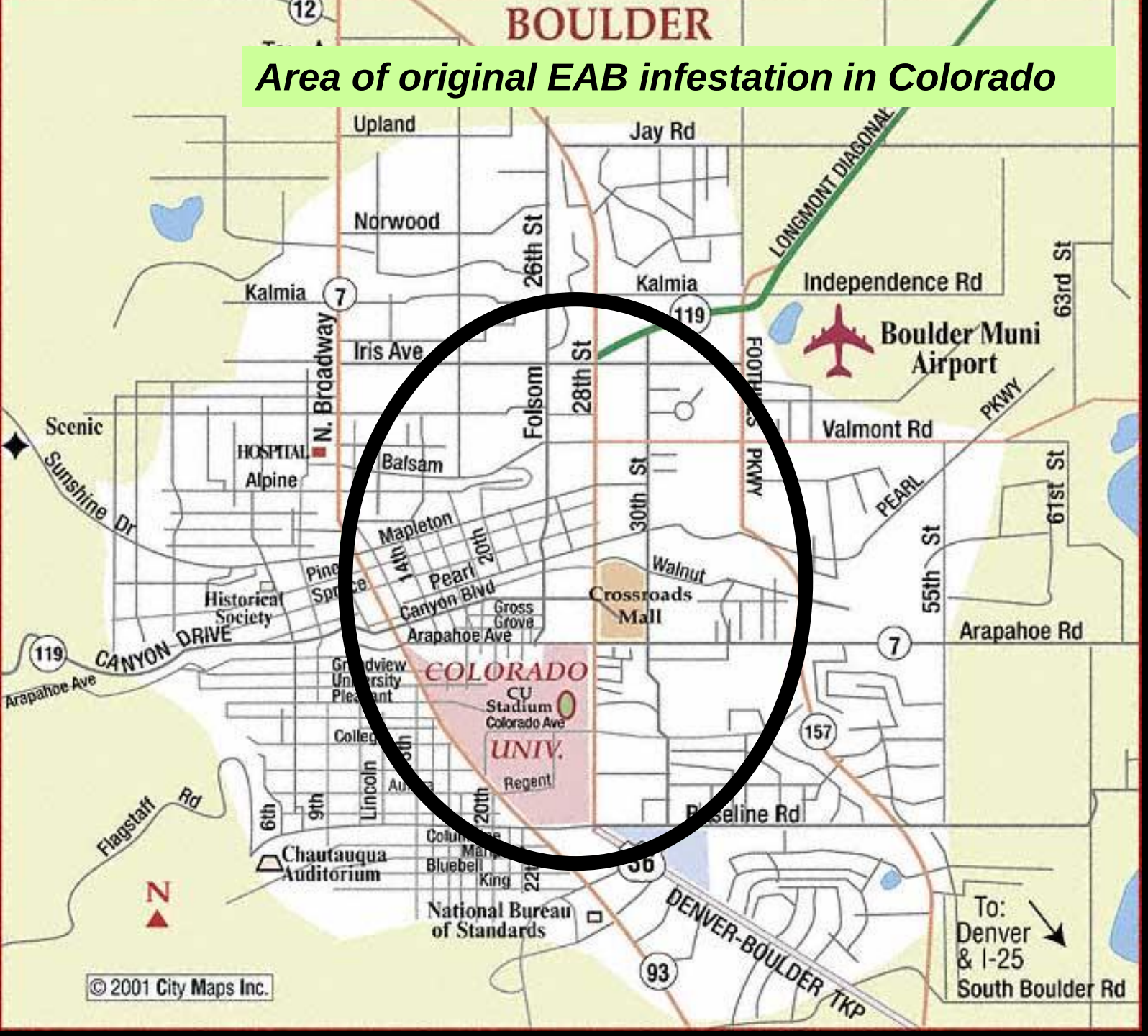
Colorado EAB Tree #1

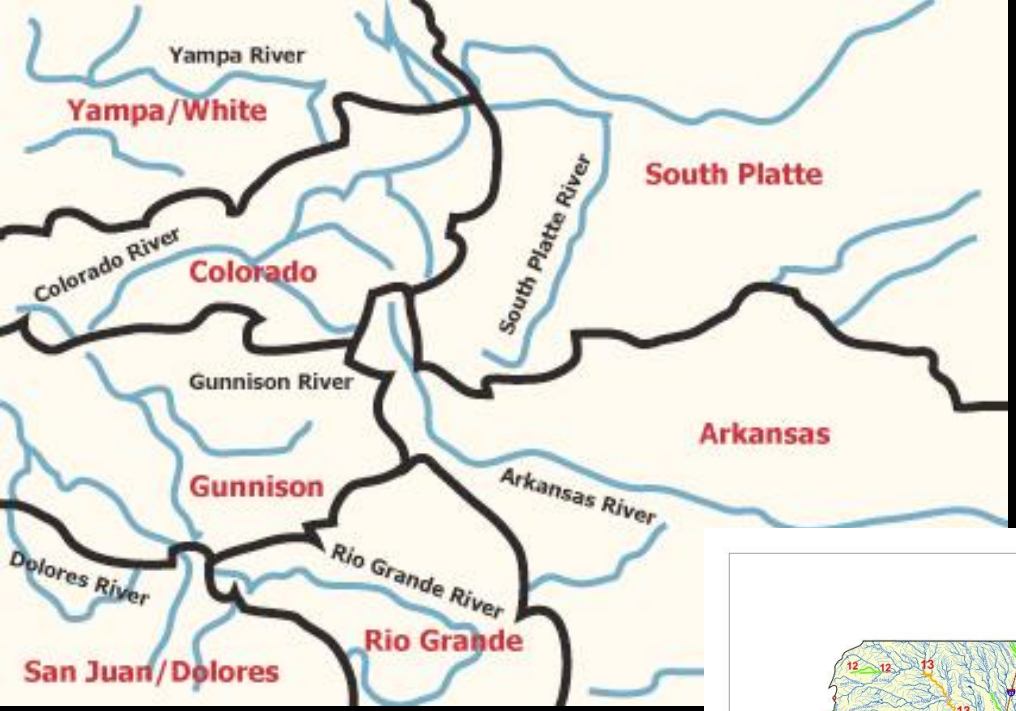
Located near the intersection of 30th and Valmont, Boulder

September 23, 2013

Emerald ash borer was accidentally introduced into and has since spread through North America




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
PKWY
Scenic
Sunshine Dr
HOSPITAL
Alpine
Balsam
30th St
PEARL
61st St
Mapleton
14th
20th
Pearl
Canyon Blvd
Walnut
Historical Society
Crossroads Mall
55th St
Gross Grove
Arapahoe Ave
Arapahoe Rd
CANYON DRIVE
COLORADO
CU Stadium
Colorado Ave
UNIV.
Regent
Flagstaff Rd
6th
9th
Lincoln
20th
Pleasant
Chautauqua Auditorium
Bluebell
King
National Bureau of Standards
DENVER-BOULDER TKP
To: Denver & I-25
South Boulder Rd
N
© 2001 City Maps Inc.



Unlike states to the east, Colorado is highly compartmentalized due to its geography

The current infestation is an infestation of the South Platte River drainage, not the State of Colorado

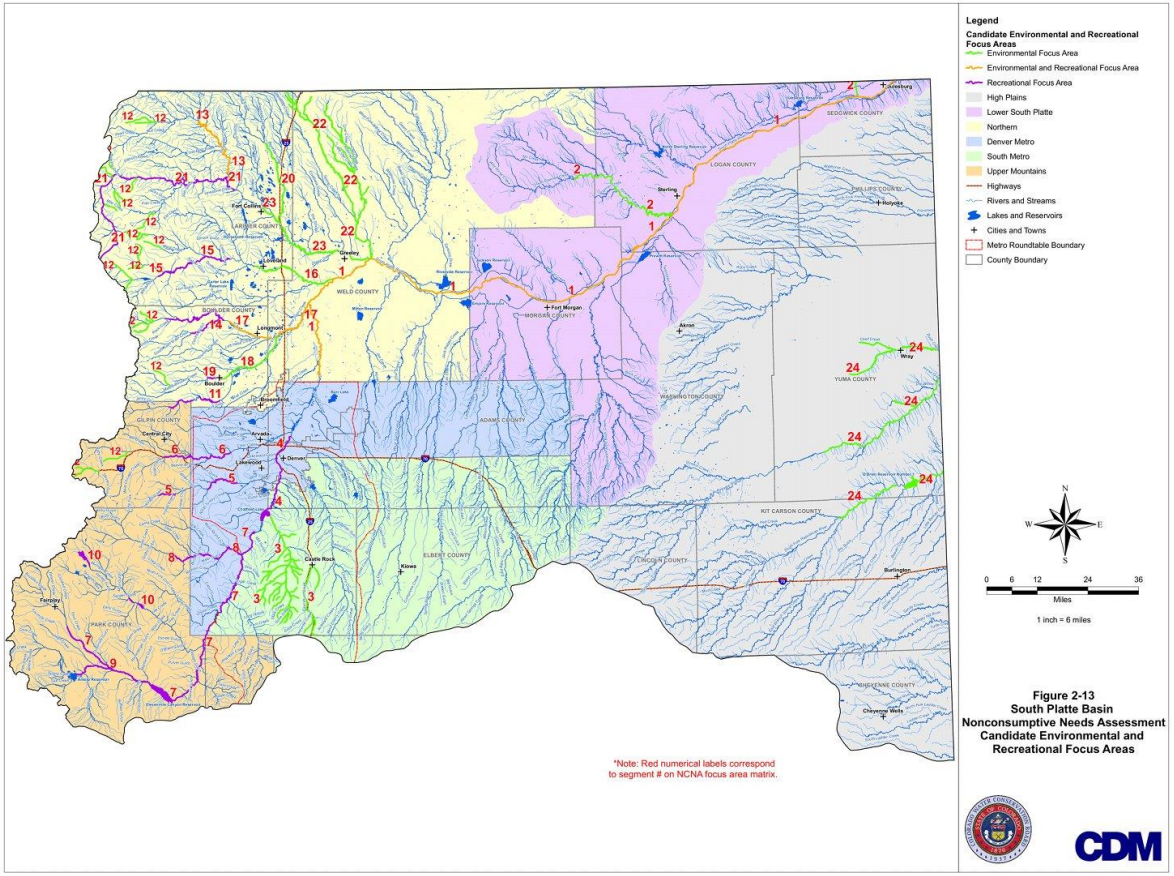
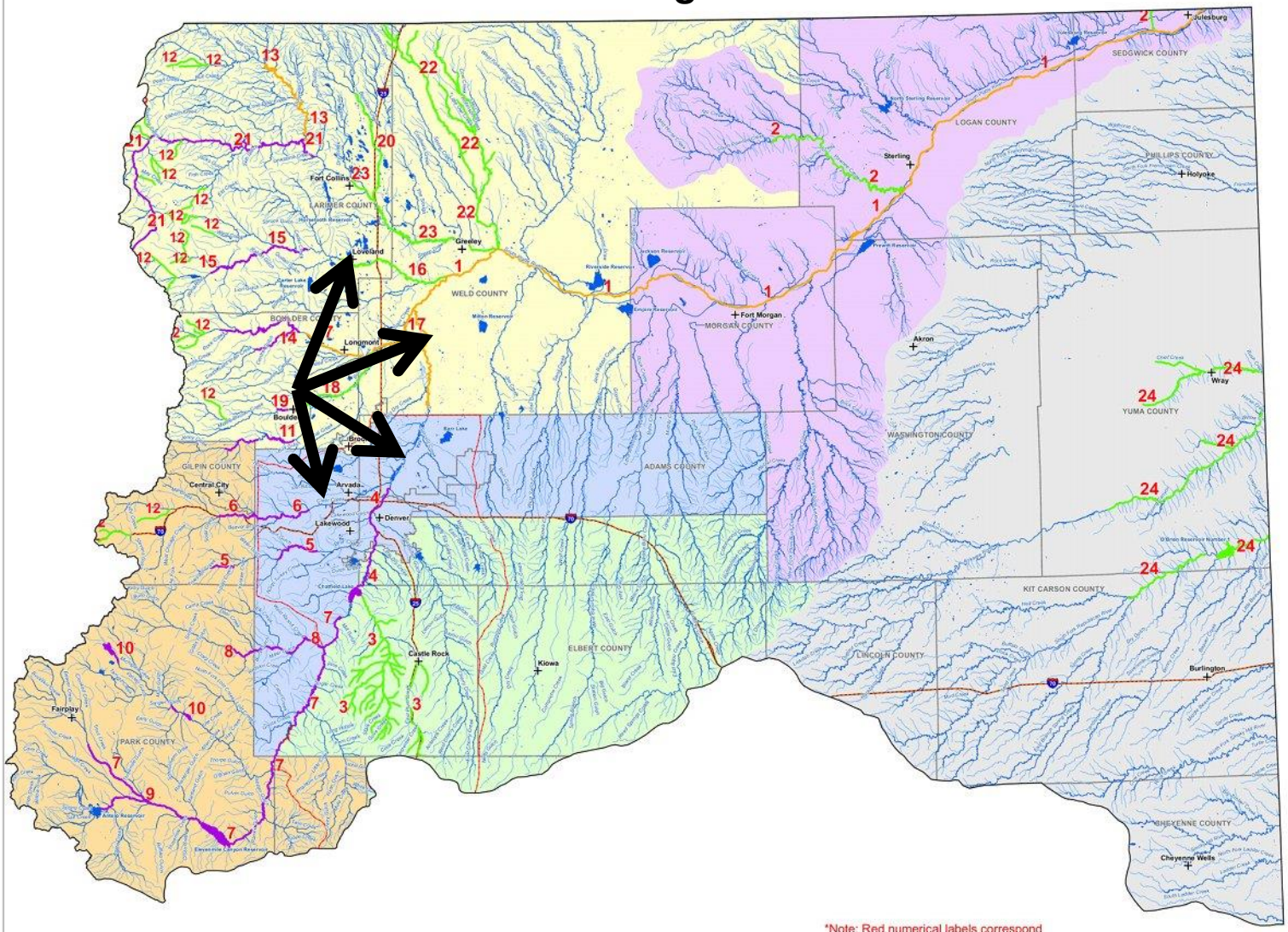


Figure 2-13
South Platte Basin
Nonconsumptive Needs Assessment
Candidate Environmental and Recreational Focus Areas

Within the next five years, emerald ash borer *will* move out of Boulder into the surrounding counties



*Note: Red numerical labels correspond to segment # on NCNA focus area matrix.

Legend

Candidate Environmental and Recreational Focus Areas

- Environmental Focus Area
- Environmental and Recreational Focus Area
- Recreational Focus Area
- High Plains
- Lower South Platte
- Northern
- Denver Metro
- South Metro
- Upper Mountains
- Highways
- Rivers and Streams
- Lakes and Reservoirs
- Cities and Towns
- Metro Roundtable Boundary
- County Boundary

N W E S

0 6 12 24 36

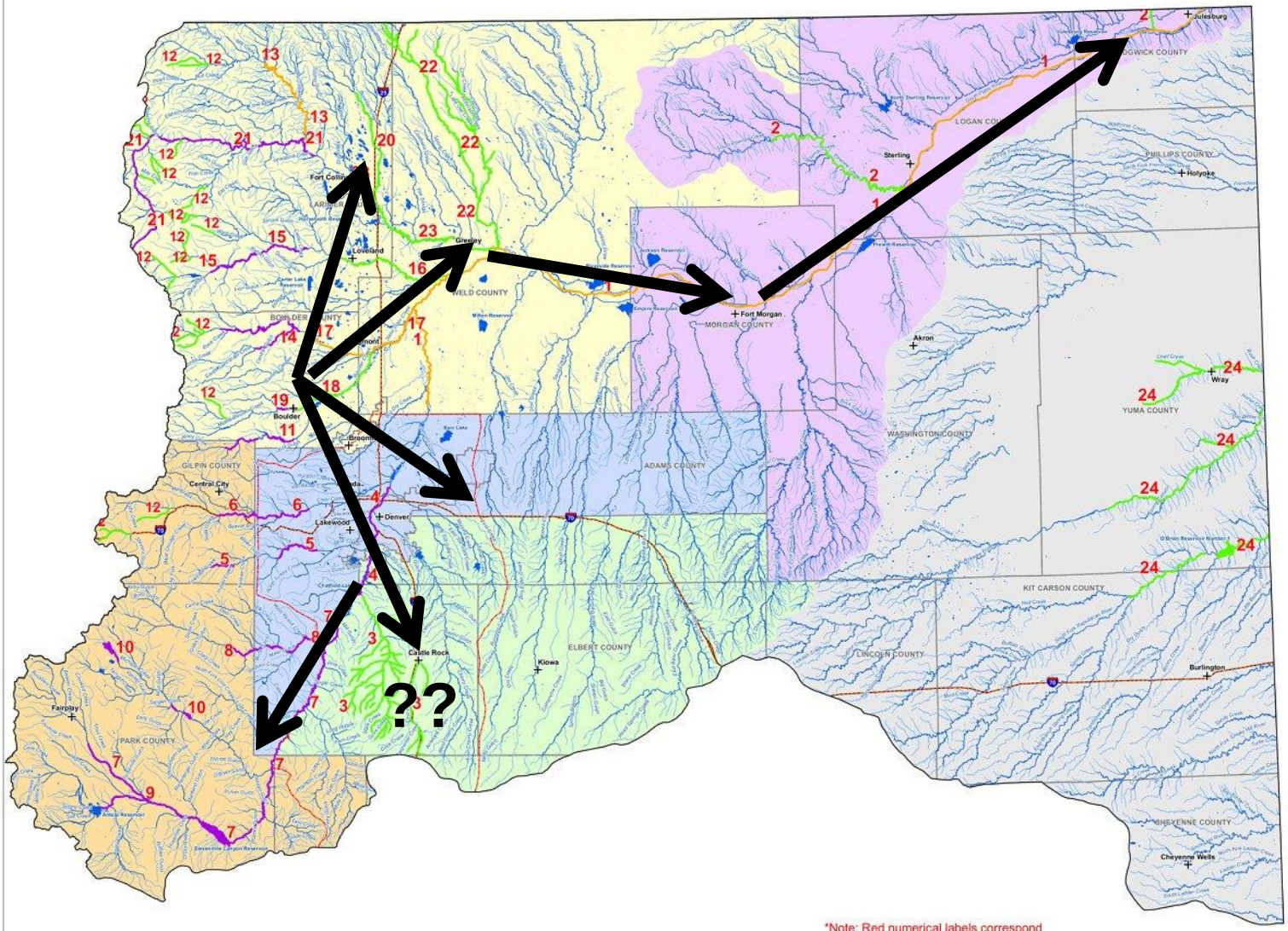
Miles

1 inch = 6 miles

Figure 2-13
South Platte Basin
Nonconsumptive Needs Assessment
Candidate Environmental and Recreational Focus Areas

CDM

Over time the South Platte River Drainage will be colonized by emerald ash borer



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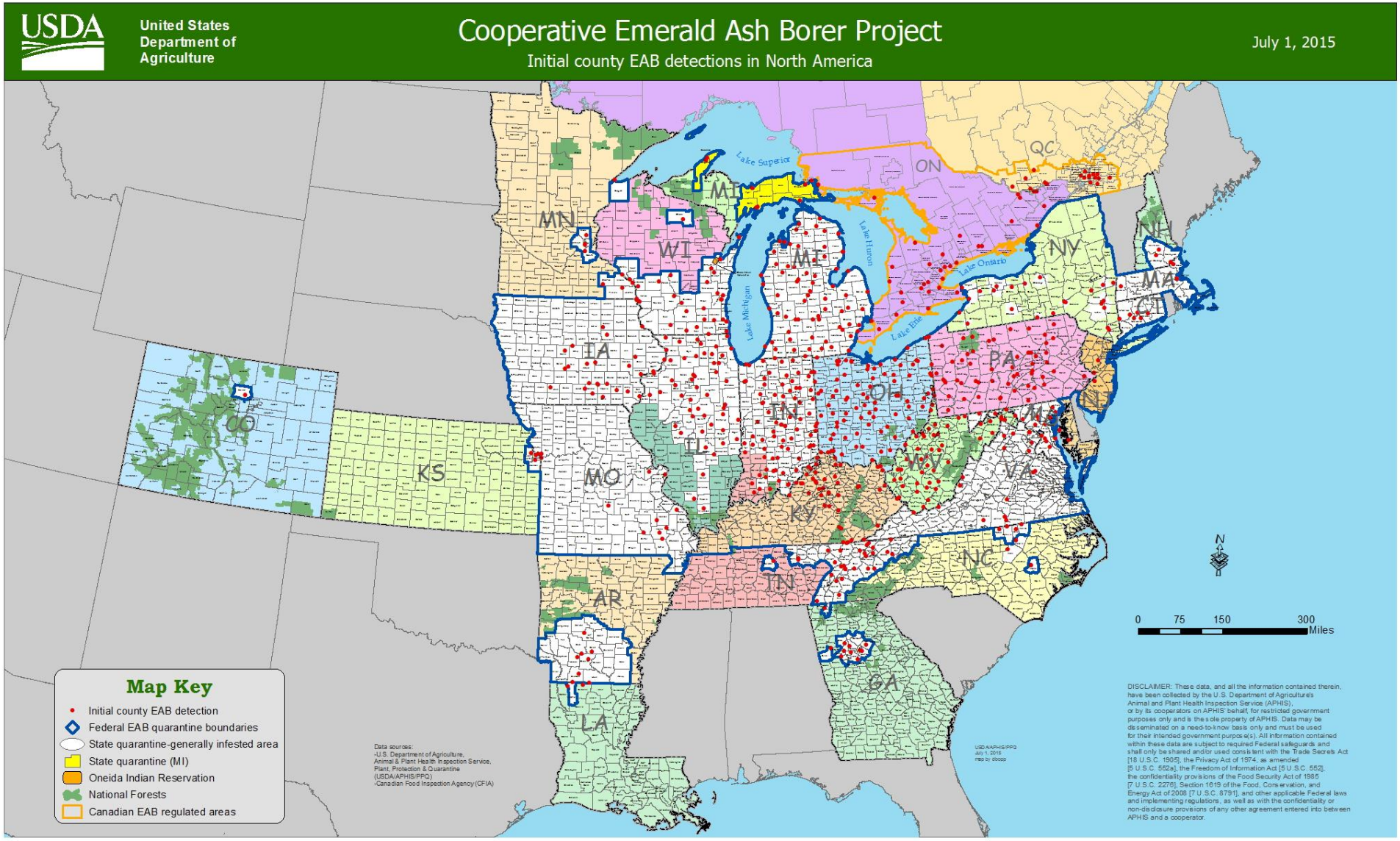
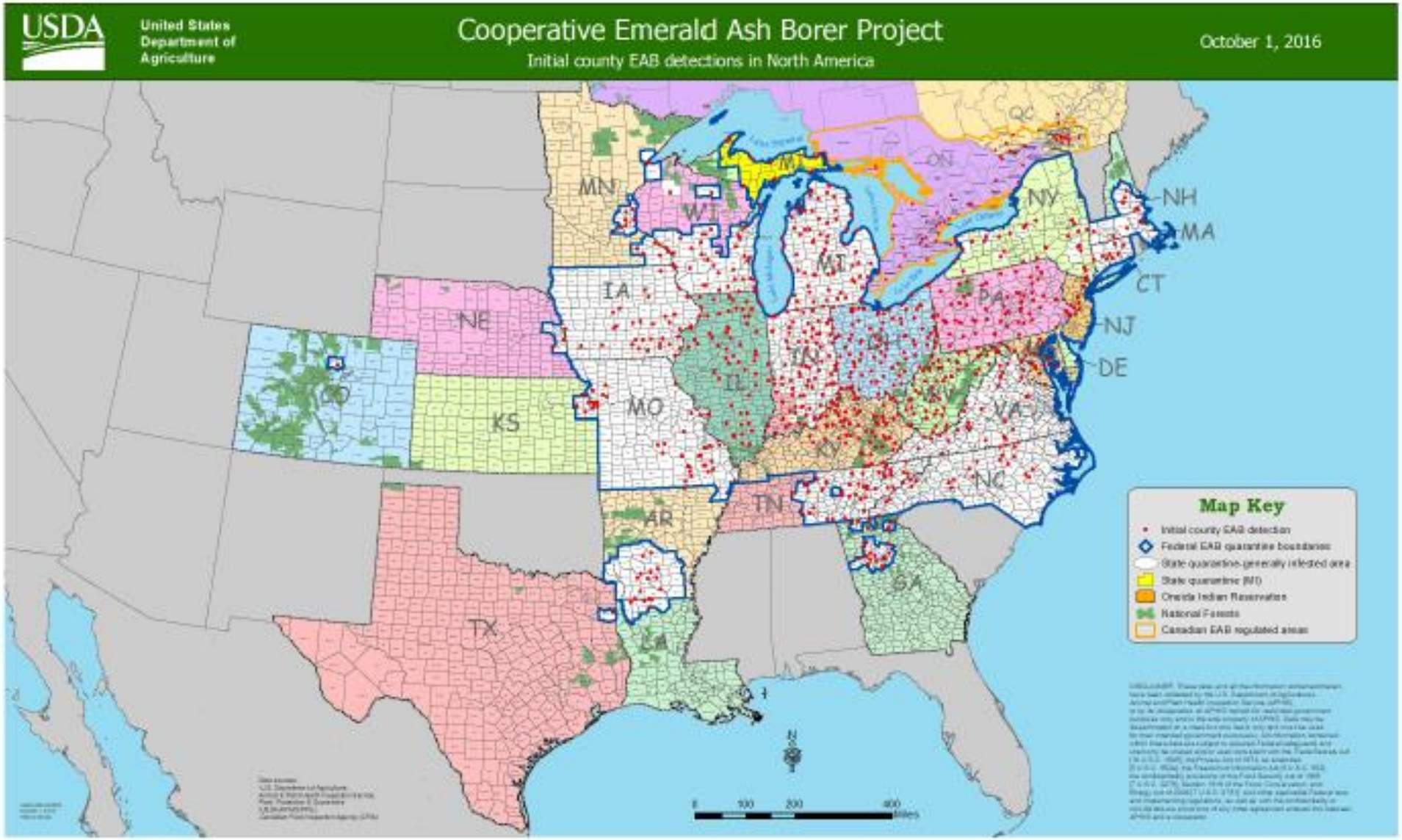
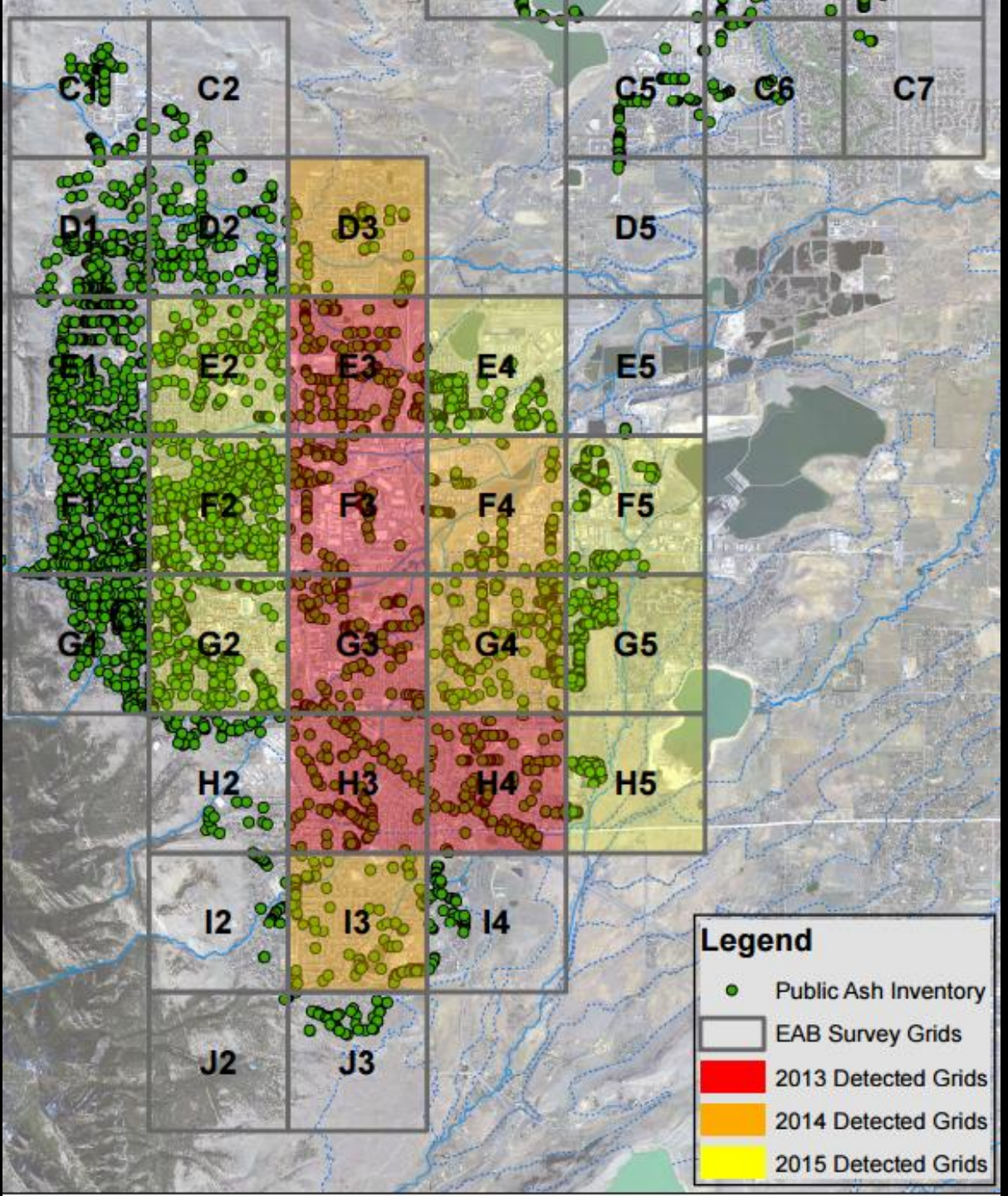
CDM

Distribution end of 2015

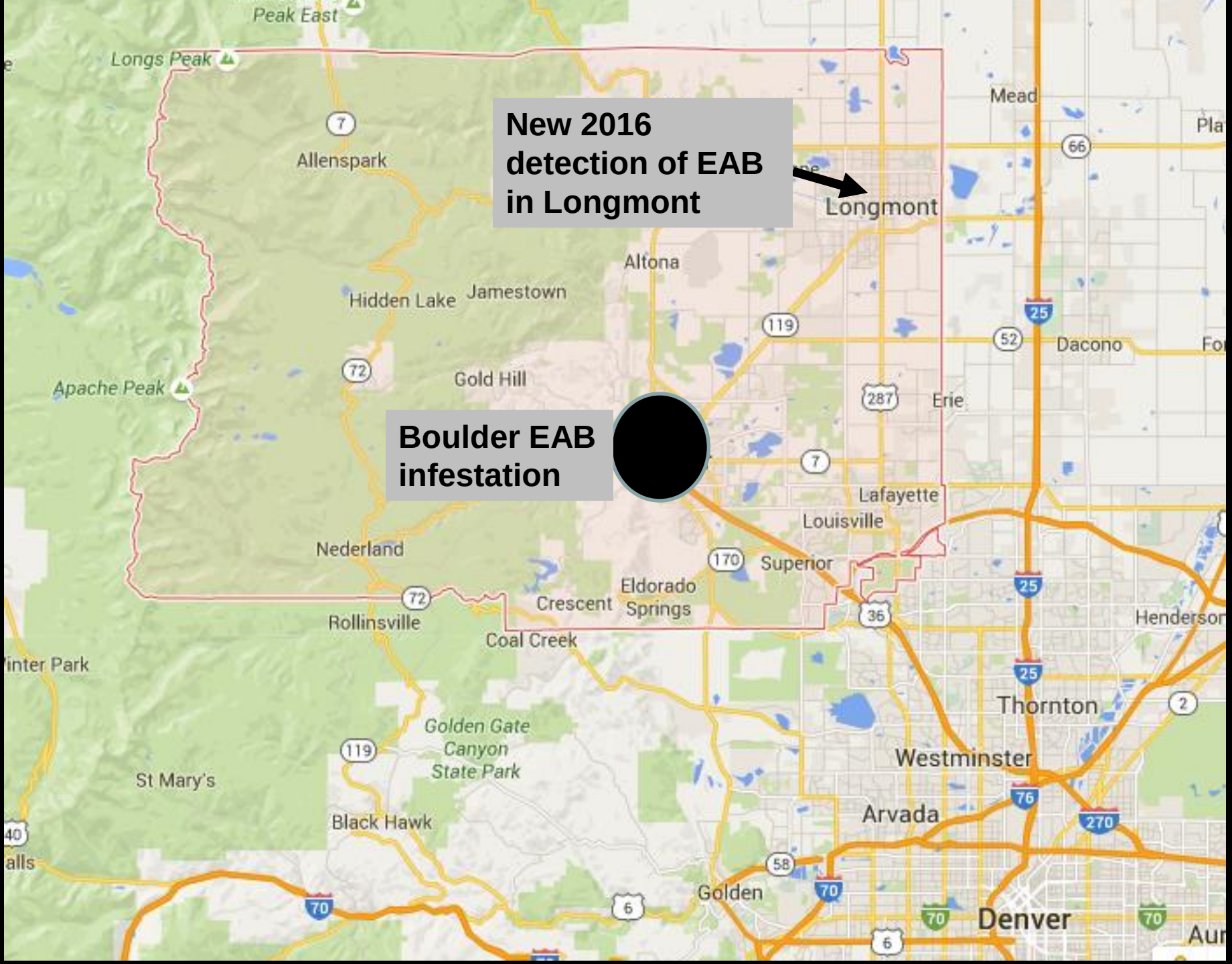


Distribution end of 2016





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


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
Thornton
Golden Gate Canyon State Park
Westminster
St Mary's
Arvada
Black Hawk
Golden
Denver

Known Distribution of Emerald Ash Borer (EAB) at End of 2016

- **Known infestation is still presently confined to areas within Boulder County limits**
  - **Steady expansion has occurred within the original areas of infestation**
  - **Tree decline symptoms are advancing as predicted in core area of infestation**
  - ***Extensive trapping and surveys conducted in 2016 have still not detected EAB anywhere outside Boulder County***

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**

Photograph by David Cappaert

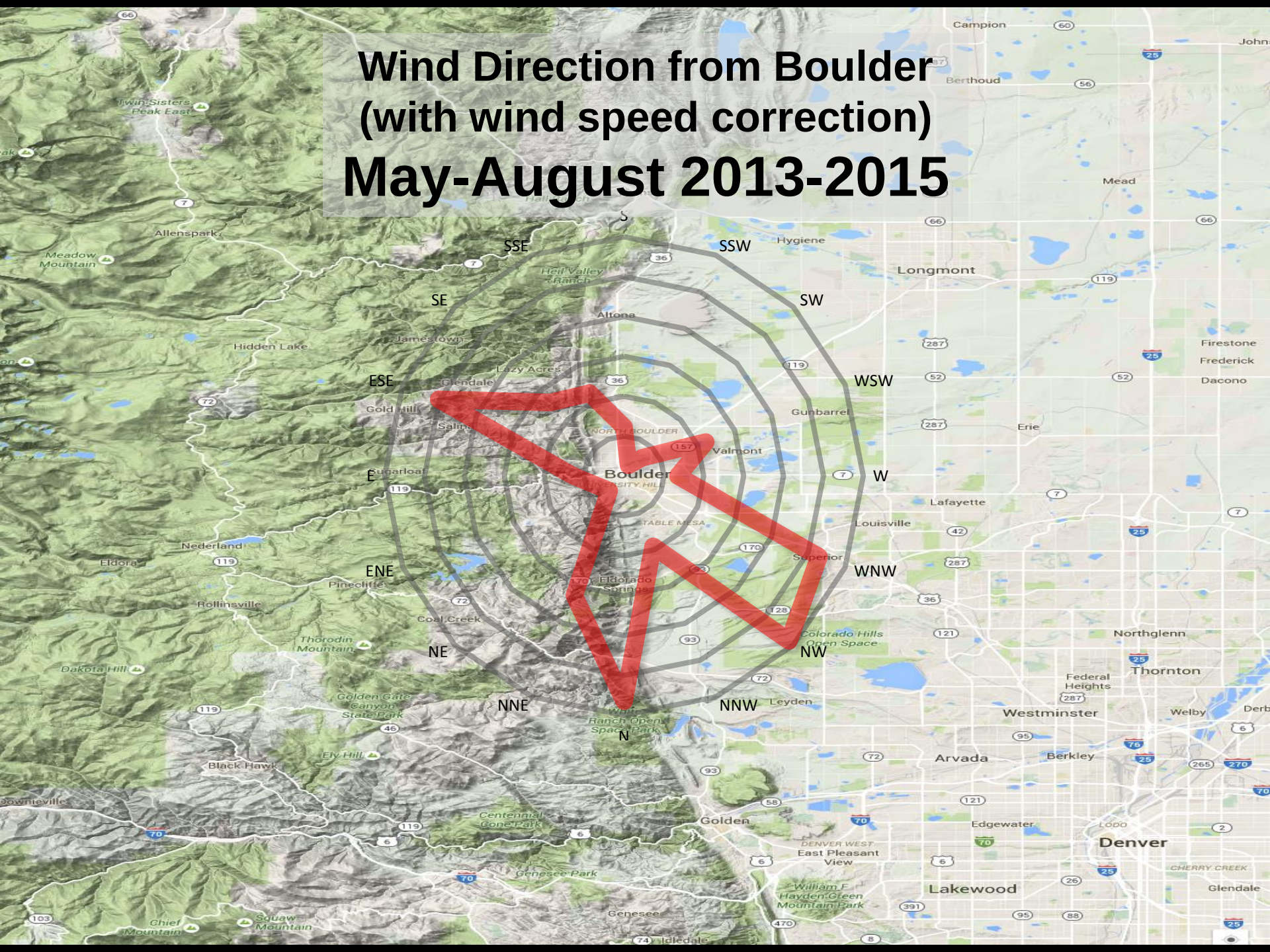
EAB likely will emerge sometime in mid-late May.

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



How far away is emerald ash borer from your community?

How far away is emerald ash borer from your community?

One truckload

Main Points About Emerald Ash Borer in Colorado Today

- **Known infestation presently confined to areas within Boulder City limits – and a neighborhood in Longmont**
  - In time 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

Control Options for Management of Emerald Ash Borer

Important note regarding EAB control

Present controls can allow trees to recover if EAB-induced crown thinning has not exceeded 30-50%

0%

10%

20%

30%

40%

50%

60%

70%

80%

90%

100%

Smitley, Davis and Rebek. 2008. Progression of ash canopy thinning … in Southeast Michigan. J. Econ. Entomol. 101: 1643 – 1650.

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 (TREE-Age), azadirachtin (TreeAzin), imidacloprid

Adults as they feed on foliage

Young larvae that tunnel in the phloem and cambium

Target Life Stages for EAB Treatments

Emerald Ash Borer Insecticides

- Imidacloprid (Merit, Xytect, Criterion, etc.)
  - Soil drench, possible trunk injection
- Dinotefuran (Safari, Zylam)
  - Basal trunk spray, possible soil drench
- Emamectin benzoate (Tree-Age, others)
  - Trunk injection only
- Azadirachtin (Treeazin, Azasol, others)
  - Trunk injection only

Soil application option – imidacloprid applied as drench or injection

Primary method of imidacloprid application – soil applications for root uptake

Basal trunk spray with dinotefuran (Safari, Zylam)

Basal Trunk Sprays of Dinotefuran

- Enters tree through thin areas of bark
- Can be expected to reach peak levels in foliage in about 2-3 weeks
- Adjuvant? – May help some to increase deposition into trunk fissures, slow drying

Trunk Injections

Trunk injection with emamectin benzoate (TREE-age)

New formulations of emamectin benzoate are coming onto the market. This should decrease costs.

Trunk injection with azadirachtin (TreeAzin, Azasol, AzaGuard, etc.)

Check the Insect Information Web Site for Links to Publications on Emerald Ash Borer

Emerald Ash Borer

Insecticide Options for Protecting Ash Trees from Emerald Ash Borer, 2nd Edition (North Central IPM Center)

National Emerald Ash Borer Information

Colorado Department of Agriculture EAB

Control Options for Emerald Ash Borer in Colorado

Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used to Control Emerald Ash Borer

Emerald Ash Borer in Colorado – Identification of Insects and Damage of Similar Appearance

Emerald Ash Borer: A Guide to Identification and Comparison to Similar Species

Emerald Ash Borer Questions and Answers

Statement On Recommended Areas For EAB Treatment In 2014

Spread Sheet Of Systemic Insecticides Used To Control Emerald Ash Borer

A Comparison Of Lilac/Ash Borer And Emerald Ash Borer

Colorado Department of Agriculture Emerald Ash Borer Web Site

Managing Emerald Ash Borer in Colorado

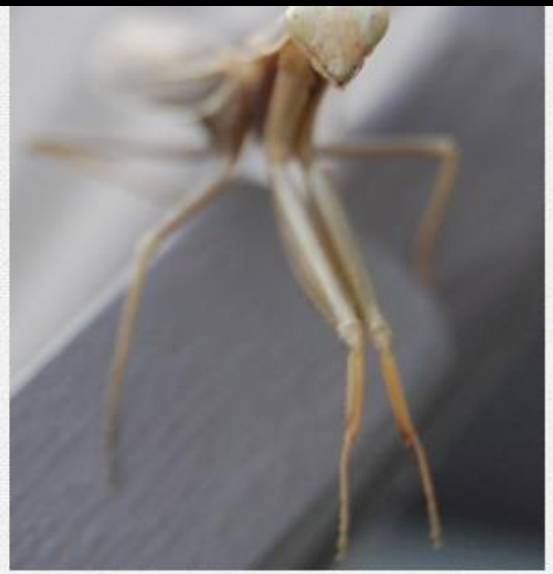
Wood Boring Insects of Ash Trees

Map of EAB Risk Zones in Colorado for 2014

Bed Bugs

Bat Bugs, Bed Bugs, and Relatives (Extension Fact Sheet)

Bed Bug Identification Poster



Japanese Beetle

Popillia japonica

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

Japanese beetle adults chew on leaves and flowers of many plants

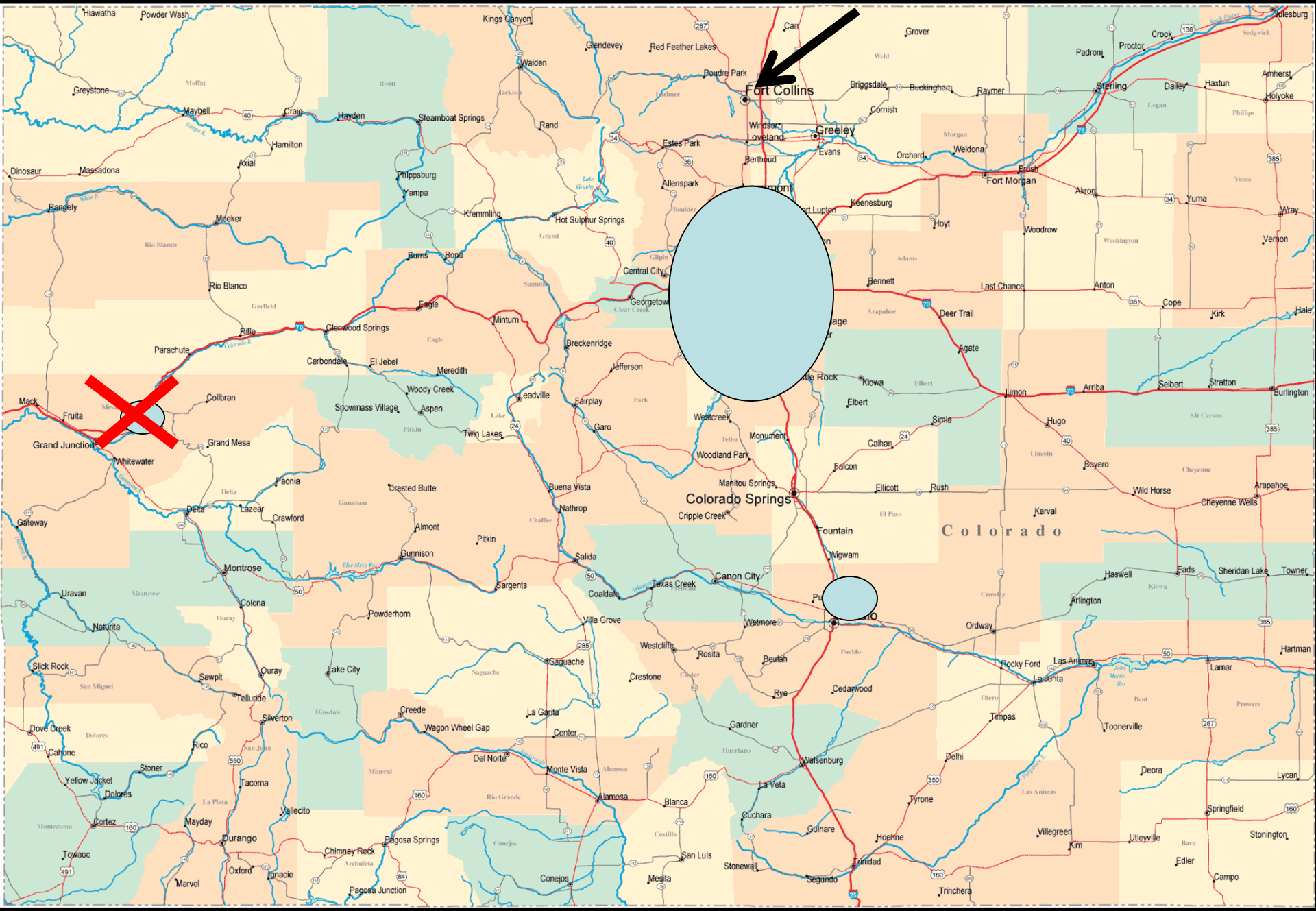
Flowers are often a favored plant part targeted by adult Japanese beetles

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

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

White grubs prune the roots, producing drought stress symptoms

Skunk digging damage associated with white grub infestations



Japanese beetle is present in two main areas

Managing Japanese beetle in the larval (white grub) stage

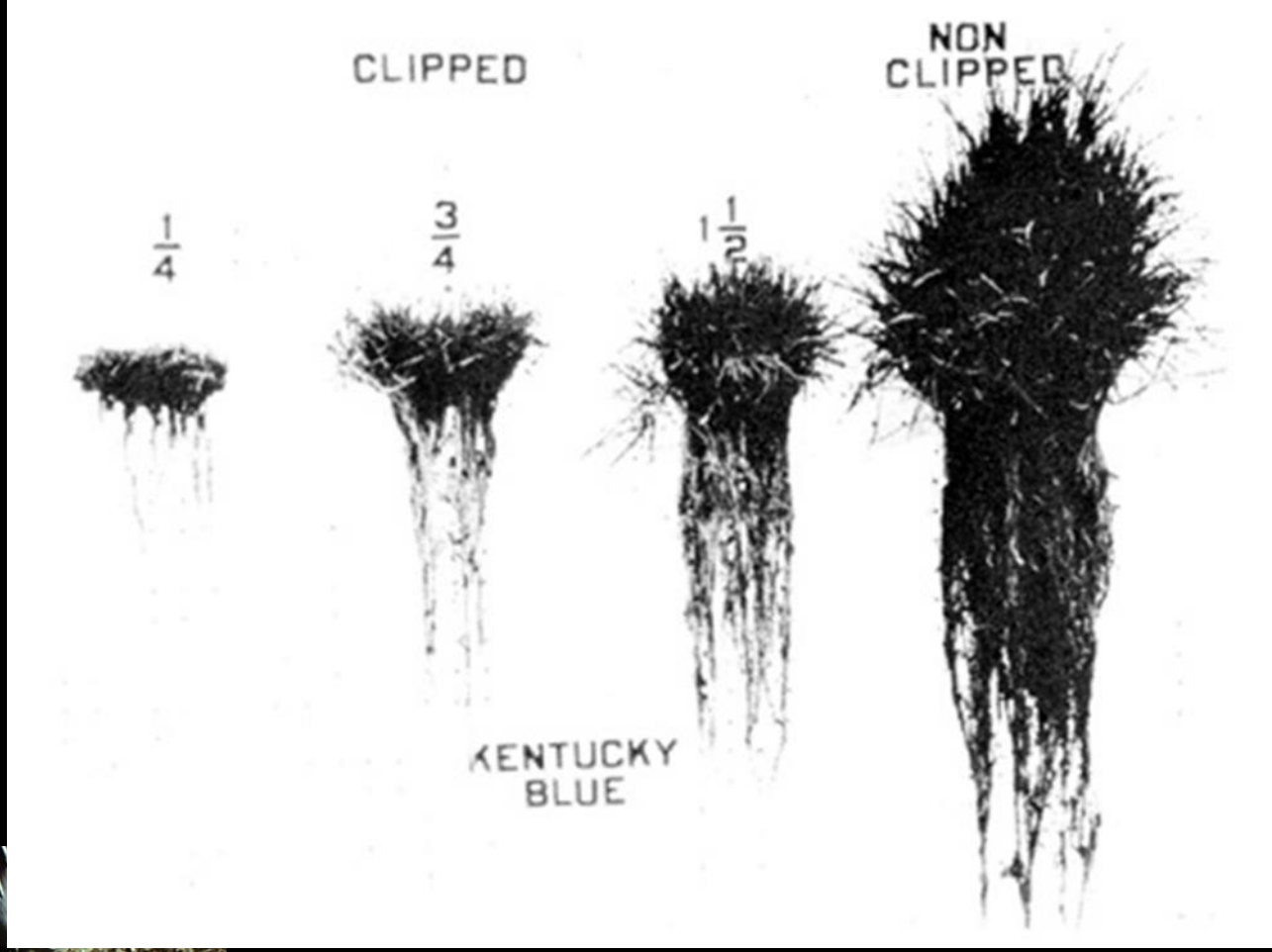
Recommendations for Japanese Beetle Larval Control

- Cultural Controls
- Biological Controls
- Chemical Controls

Recommendations for Japanese Beetle Larval Control

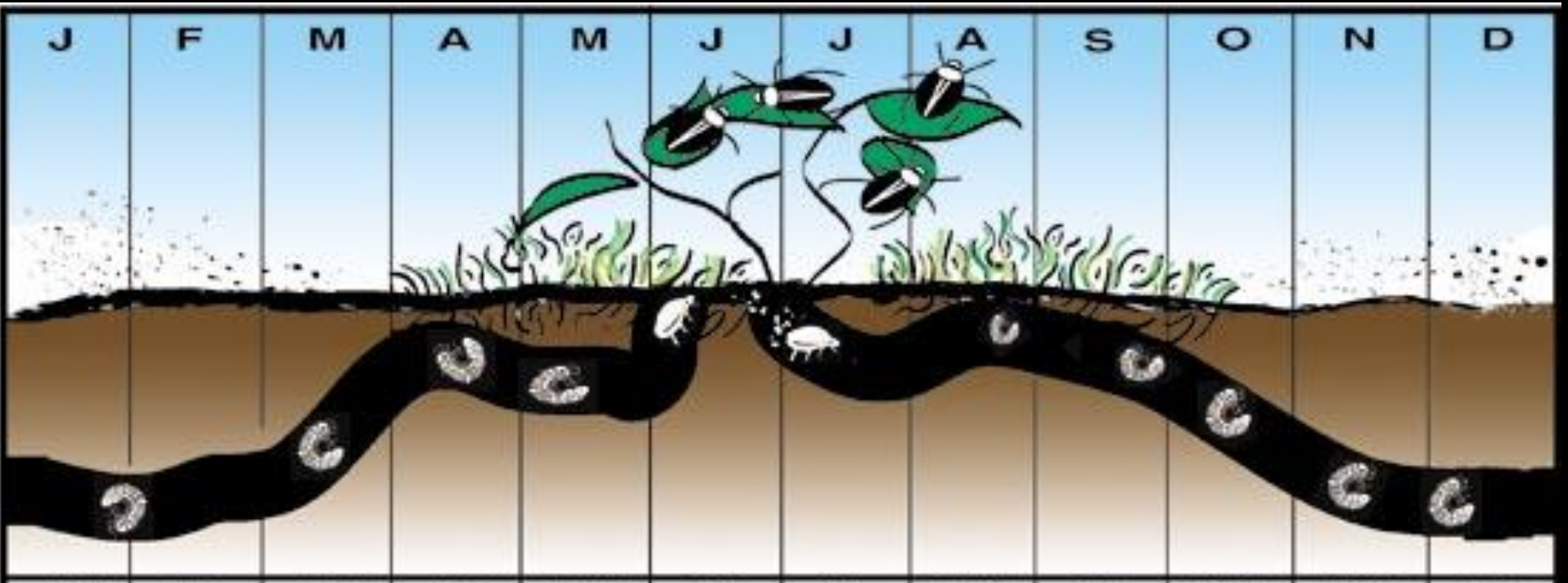
- **Cultural Controls**
  - Promotion of root growth to tolerate larval feeding
  - Allowance of some soil drying during critical JB life stages
  - Provision of water to allow tolerance and recovery from root loss

Grasses with larger root mass are better able to tolerate effects of root pruning insects



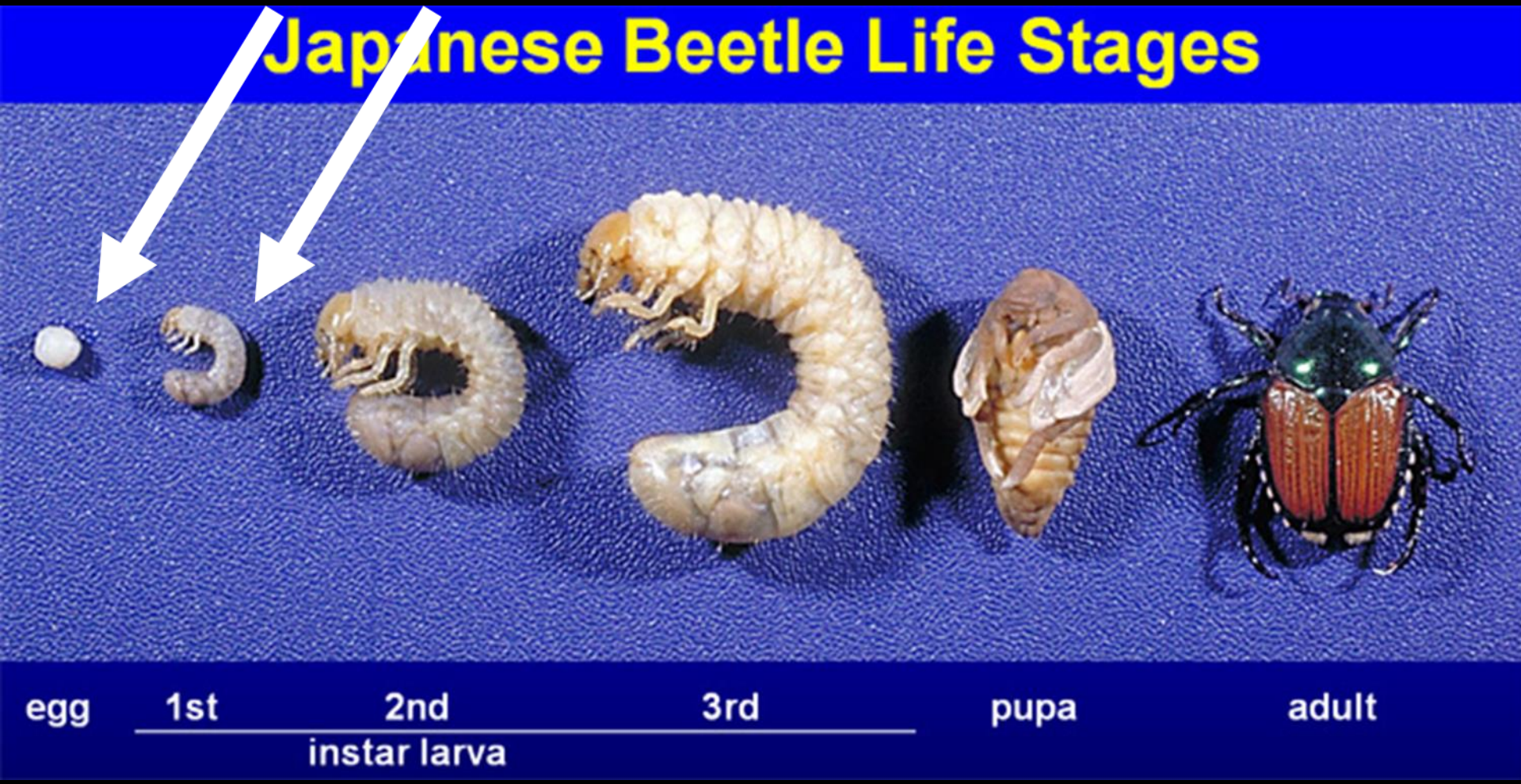
Mowing height greatly affects root mass of turfgrasses!

Generalized Life History Sequence of Japanese Beetle



JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
grub deep in soil	grub deep in soil	grub deep in soil	grub root feeding	grub root feeding	pupae	adult egg laying	grub root feeding	grub root feeding	grub deep in soil	grub deep in soil	grub deep in soil

Early stages of Japanese beetle grubs are highly sensitive to soil drying



Recommendations for Japanese Beetle Larval Control

- **Cultural Controls**
  - Promotion of root growth to tolerate larval feeding
  - Allowance of some soil drying during critical JB life stages
  - Provision of water to allow tolerance and recovery from root loss

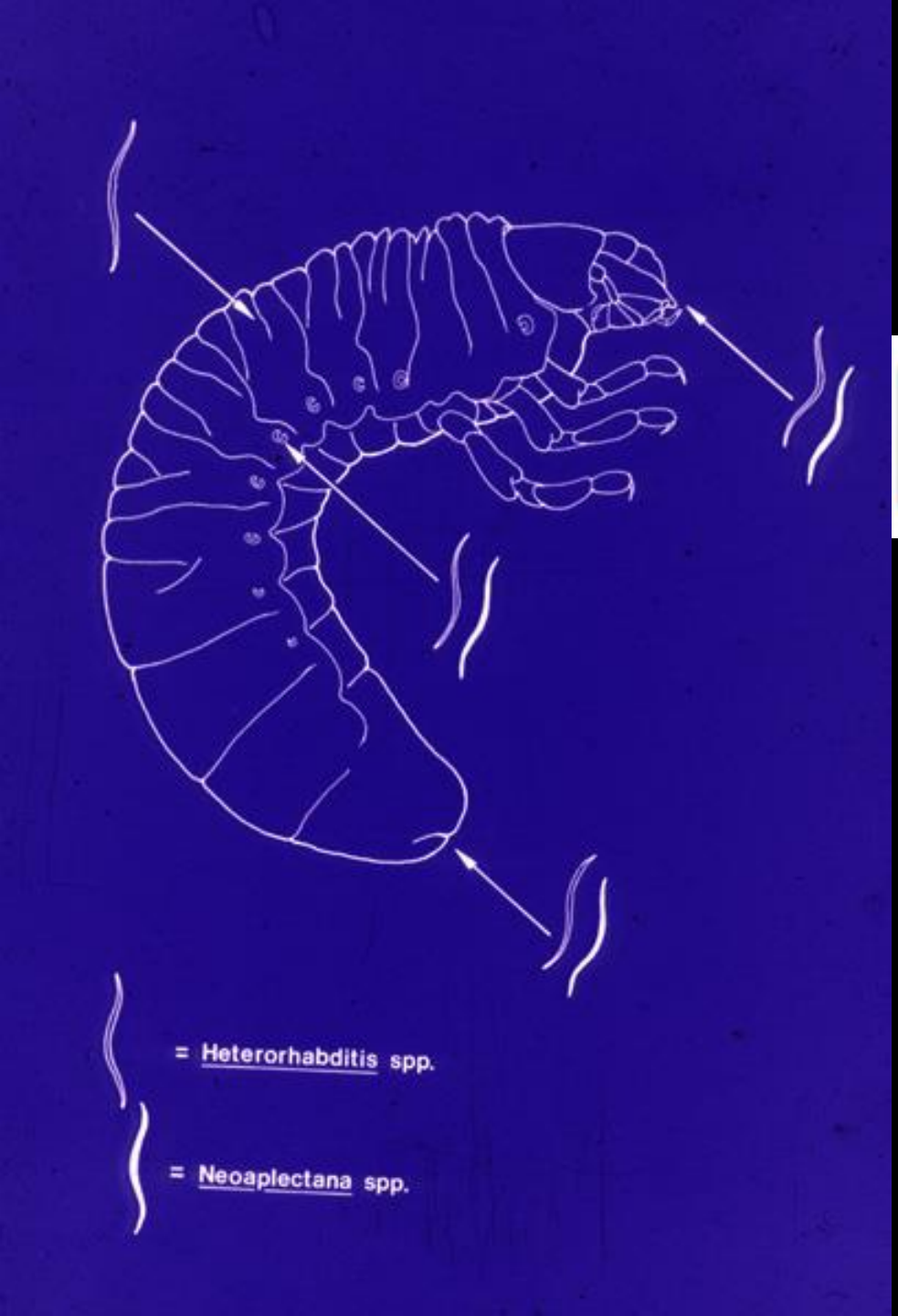
As grubs get older, more root pruning occurs

Recommendations for Japanese Beetle Larval Control

- Cultural Controls
- Chemical Controls
- **Biological Controls**
  - Insect parasitic nematodes (*Heterorhabditis* spp.)
  - *Bacillus thuringiensis* var. *galleriae*
  - Milky spore

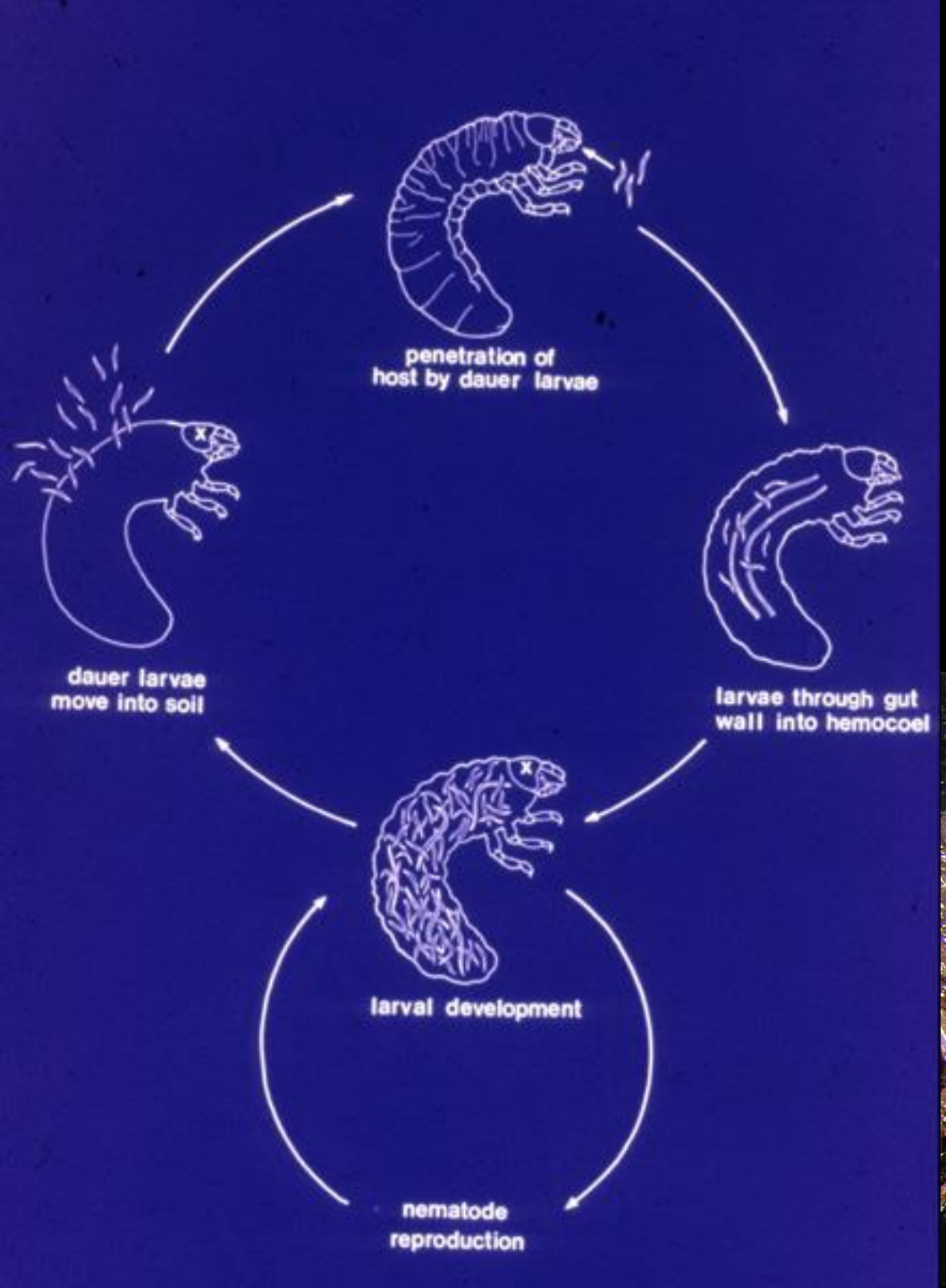
Insect Parasitic Nematodes (“Beneficial Nematodes”, “Predator Nematodes”)

Photograph courtesy of Peggy Greb



Nematodes enter insects through natural openings

***Heterorhabditis* spp. nematodes can penetrate directly through the body wall**



Insect Parasitic Nematodes Can Control Many Turf Insects

- White grubs
- Billbugs
- Cutworms and sod webworms
- Mole crickets

Grubs turn a reddish color when killed by *Heterorhabditis* nematodes

White Grub Larval Treatments

- Imidacloprid (Merit, Zenith, Criterion, etc.)
- Clothianidin (Arena)
- Chlorantraniliprole (Acelepryn, Scott's Grub-Ex)
- Trichlorfon (Dylox, Proxol)
- *Heterorhabditis* spp. parasitic nematodes
- *Bacillus thuringiensis* var. *galleriae* (grubGONE!)

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

grubGONE!

Bacillus thuringiensis* var. *galleriae

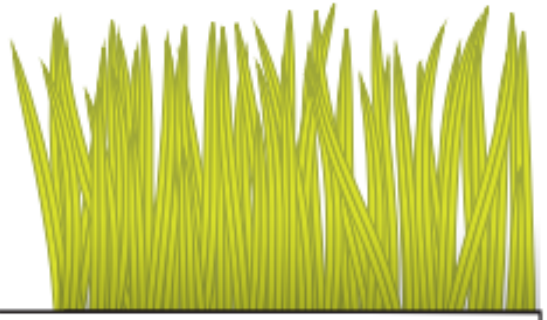
grubGONE!® G

BIOLOGICAL INSECT CONTROL

Biological Insecticide Granule Controls Annual White Grubs in Turf and Ornamentals

ACTIVE INGREDIENT: Bacillus thuringiensis subsp. galleriae, Strain SDS-502 fermentation solids, spores, and insecticidal toxins* ..... 9.0% w/w
OTHER INGREDIENTS: ..... 91.0% w/w
TOTAL: ..... 100.0% w/w

*Contains a minimum of 1 x 10^{10} CFU per gram.



KEEP OUT OF REACH OF CHILDREN

CAUTION: See side/back panel for additional precautionary statements.

EPA Reg No.: 88347-2
EPA Est. No.: 9198-OH-1, 9198-OH-2

FIRST AID	
If on skin or clothing:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If swallowed:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.

HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or when going for treatment. For emergency information concerning this product, call the National Pesticide Informaiton Center (NPIC) at 1-800-858-7378 seven days a week, 6:30 am to 4:30 pm. Pacific Time (NPIC website: www.npic.orst.edu). During other times, call your poison control center at 1-800-222-1222.

Manufactured for:
Phyllom BioProducts

made in USA

Phyllom BioProducts Corp.
484 Lake Park Ave #23
Oakland, CA 94610
Tel: 650.322.5000
Email: products@phyllom.com

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.**

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

????????

Answer: Very likely, NO

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
- Peking cotoneaster

Food Crops

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

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

Japanese Beetle Damage Evaluations on Roses – War Memorial Rose Garden

- Seven observations were made during season
  - Damage rated on 0-3 scale
- Little (< 0.5 rating) or no damage observed on 45/197 (23%) of the cultivars
- High injury (>2.0 rating) observed on 19/197 cultivars (10%)

Roses that *Were Not* Observed Damaged by Japanese Beetle

- Angel Face
- Debut
- Hondo
- Joseph's Coat
- Mardi Gras
- Picotee
- Popcorn
- Prima Donna
- Ralph Moore
- Singin' in the Rain
- White Lightnin'

Roses that *Were Most Damaged* by Japanese Beetle

- Pink Promise
- Honey Perfume
- Whisper
- Love and Peace
- Day Breaker
- Strike it Rich
- Cherry Parfait
- Eureka
- Starry Night
- Rainbow Knock Out
- Lady Elsie May
- Carefree Delight
- June Lover

Issue of unusual concern with Japanese beetle

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

Pollinator Use on Roses – 2016 Observations at the Littleton War Memorial Rose Garden

- Six observations were made during season
  - Use by bees ranked on a 0-2 scale
- No bees were ever observed on 81 cultivars (41%)
- Nineteen cultivars (10%) had high use by bees (above 0.5 ranking)

Examples of Cultivars on Which Bees *Were Never Observed*

- Floribunda **(11/37, 30%)**
  - Amber Queen, Cherish, Eureka, Scentimental….
- Hybrid Tea **(34/77, 44%)**
  - Anticipation, Candy Stripe, Fragrant Memory….
- Grandiflora **(16/30, 53%)**
  - Camelot, Glowing Peace, Touch of Class…..
- Miniature **(9/29, 31%)**
  - Best Friends, Gala, Minnie Pearl, Picotee….

Roses with Highest Visitation by Bees Included:

- Rainbow Knock Out*
- Strike it Rich*
- Prominent
- Home Run
- Easy Does It
- Apricot Nectar
- Gemini
- Starry Night
- Lady Elsie May*
- Baby Boomer
- Sweet Diana
- Julia Child
- Cathedral
- Betty Boop
- Mon Cherie
- Cloud Dancer

Roses with High Visitation by Bees and are JB Susceptible Included:

- **Rainbow Knock Out***
- **Strike it Rich***
- Prominent
- Home Run
- Easy Does It
- Apricot Nectar
- Gemini
- Starry Night
- **Lady Elsie May***
- Baby Boomer
- Sweet Diana
- Julia Child
- Cathedral
- Betty Boop
- Mon Cherie
- Cloud Dancer

Recommendations for Japanese Beetle Adult Control

- Physical/Cultural Controls
  - Traps
  - Hand Picking
- Chemical Controls

Japanese beetle controls

Hand Picking

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!

They can lure high populations of both male and female beetles into the area and cause more problems than they solve!

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!

OTC Chemical Controls Most Effective for Control of Japanese Beetle Adults

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

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!!

OTC Natural Products with Some Ability to Control JB Adults

- Pryethrins
- Azadirachtin
- Insecticidal Soaps?

Do not treat plants with flowers in bloom!

The Naturally-derived (usually Organic) Products for Use in JB Adult Control

- **Pyrethrins**
  - active ingredient in pyrethrum
- **Azadirachtin**
  - active ingredient in neem seed extracts

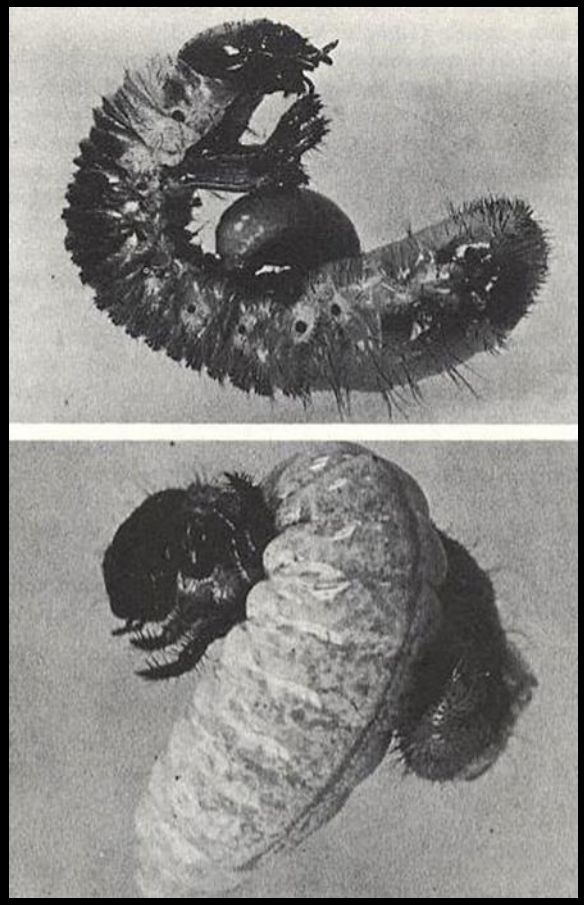
Overlap of adult feeding on flowers – ***and use of those flowers by pollinators***

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

Recommendations for Japanese Beetle Adult Control

- Physical/Cultural Controls
- Chemical Controls
- Biological Controls??

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



Natural Enemies of Japanese Beetle Exist Elsewhere in the US

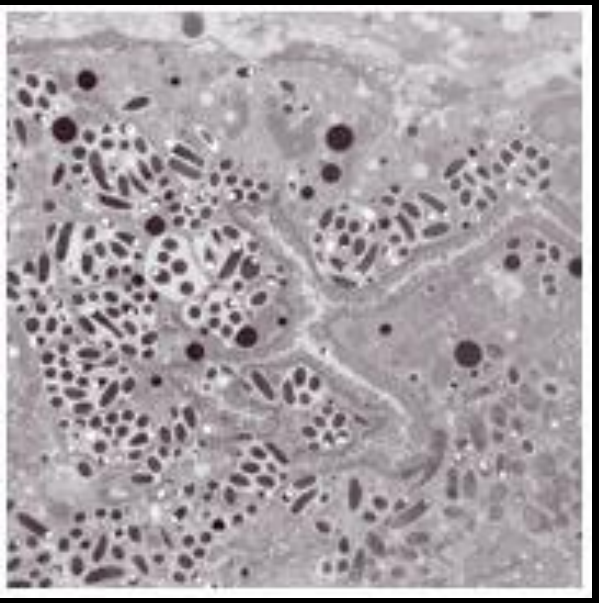
- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- *Istocheta aldrichi*
  - Tachinid fly
- *Tiphia* species
  - Parasitic wasps
- *Ovavesicula popilliae*
  - Microsporidium

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Paenibacillus popilliae **(milky spore) –** bacterial disease of Japanese beetle larvae

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Ovavesicula popilliae – a microsporidian disease of Japanese beetle larvae



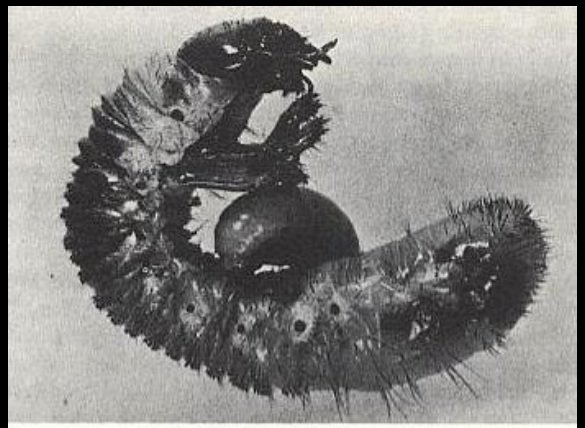
Ovavesicula infection of Malphighian tubules of Japanese beetle larva

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.

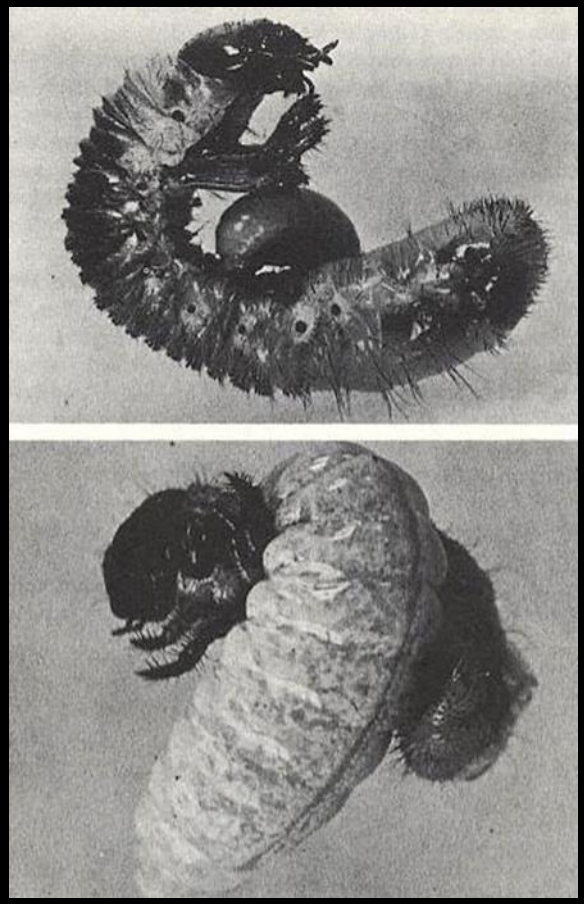
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

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!