Wood Boring Insects: Diagnosis and Management

Whitney Cranshaw
Colorado State University
Insects that Develop under the Bark of Trees, Shrubs

Bark Beetles

Tip Moths, Twig Borers

Wood Borers
Wood Borers
Some General Features of Wood Borers

• Eggs are laid singly on, into, or just underneath the bark
• The larvae enter the woody parts of the plant (branches, trunk, roots) to feed
• Primary feeding sites vary by species
  – Cambium and associated Phloem, Xylem
  – Heartwood
  – Roots
Several insects work as borers:

- **Some beetle larvae** (Coleoptera)
  - Flatheaded borers/Metallic wood borers
  - Roundheaded borers/Longhorned beetles
  - Weevils
- **Some moth larvae** (Lepidoptera)
  - Clearwing borers
  - Carpenterworms
  - Pyralid borers
- **Some wasp larvae** (Hymenoptera)
  - Horntails
Flatheaded Borers/Metallic Wood Borers

Coleoptera: Buprestidae
Flatheaded Borer
Larvae make meandering tunnels packed with fine grained sawdust
Granular sawdust is typically excreted and packs the larval tunnels.
Many flatheaded borers are “non-aggressive” and limit their tunneling to areas of the trunk that were previously damaged or recently killed by pathogens.
Outbreak attacks by flatheaded borers can extensively destroy the phloem and outer xylem of trunks or limbs
On thin-barked hosts external evidence may be raised ridges of the bark where the tree has formed callus tissue in response to borer wounding.
Thinning of the crown is a common symptom of flatheaded borer infestation. This is the result of the cumulative effects from the larval tunneling.
After the larva is full-grown......

....it will pupate under the bark.
When the pupal stage is complete, an adult then works its way to the outside, chewing through the bark.
Metallic wood borer - an adult of a flatheaded borer
D-shaped exit holes made by flatheaded appletree borer
The emerging insect cuts an exit hole that is D-shaped.
Metallic Wood Borer
Adult form of a flatheaded borer
Some metallic wood borers have bright coloration

Photographs on left courtesy of Steven Valley, Oregon Department of Agriculture
Earrings made from wing covers of a metallic wood borer
Adults insert eggs into protected sites such as bark cracks and under flaps of loose bark.
Four common *Agrilus* species metallic wood borers

- Bronze cane borer/Rose stem girdler
- Twolined chestnut borer
- Bronze birch borer
- Honeylocust borer
Bronze birch borer
*Agrilus anxius*
Bronze birch borer has a range of aggressiveness, related to birch species

- **Highly Susceptible**
  - European white birch
  - Jacquemonti birch

- **Moderately Susceptible**
  - Paper birch
  - Yellow birch
  - Whitespire birch

- **Very Low Susceptibility**
  - River/Red birch
The meandering larval tunneling damages the cambium.

Trees can try to recover from these wounds by producing callous tissue.

Trees in poor condition cannot respond in this manner.
Affected birch trees may see progressive thinning of the canopy, branch dieback, and ultimately death of the tree.
Adults chew their way through the bark, creating a D-shaped exit hole that is in the shape of their body.
Bronze birch borers emerge from D-shaped exit holes; a natural enemy (parasitoid wasp) comes out of a round hole.
A native insect acting badly

Gambel oak borer

*Agrilus quercicola*
A native insect acting badly

Gambel Oak Borer

This insect is native to Gambel oak but had never been reported to cause injury.

Populations exploded during the 2001-2003 drought years.

In 2003 a massive flight of adult insects colonized and killed red oak trees that were at least 30 miles away.
Native Gambel oak and source of Gambel oak borer

Large plantings of red oaks killed by Gambel oak borer in 2003
Gambel oak borer – Postscript

Return of rains in 2003 brought outbreak to an end
Gambel oak borer – Postscript

Reemerged since 2017 as a pest of English oak
Will Gambel oak borer develop as a persistent pest of English oak?
A flatheaded borer that is minimally aggressive

Honeylocust borer
*Agrilus difficilis*

Attacks are almost always limited to areas of the tree killed by sunscald, wounds or damaged by fungal cankers.
Flatheaded appletree borer
*Chrysobothris femorata* (complex)

An insect that develops in many hardwoods that are in decline
Flatheaded appletree borer is usually found in damaged limbs and trees in serious decline.

The sawdust excrement is usually dry, reflecting the condition of the wood where they occur.
Flatheaded appletree borer larvae produce dry, powdery sawdust excrement.
Flatheaded appletree borer is the only flatheaded borer – aside from emerald ash borer – that makes D-shaped exit holes in ash
Emerald ash borer
*Agrilus planipennis*

Order Coleoptera
(beetles)
Family Buprestidae
(metallic wood borers, flatheaded 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.
EAB adults chew through the bark, producing D-shaped exit holes
EAB adults begin to emerge in late May, often about the time when black locust is flowering.
After emergence, emerald ash borer adults feed on ash foliage for a period of a couple of weeks.
Larvae tunnel under the bark girdling the cambium
Effects of larval tunneling are cumulative, and ultimately lethal to the tree. Most trees are dead within 5 years after the initial colonization.
Symptoms of EAB injury are expressed as progressive thinning of the crop canopy.
EAB larval injuries progress to tree death, if the tree is not effectively treated to control the insect.
Damage potential to its host

10 – EAB now defines an aggressive tree killing insect in North America.
Known Distribution of Emerald Ash Borer as of last October
Colorado EAB
Tree #1

Located near the intersection of 30th and Valmont, Boulder

September 23, 2013

How did it get to Colorado?
This is the known distribution of EAB in North America at the time it was first found in Colorado in 2013.
Area of original EAB infestation in Colorado
Important difference with Colorado infestation – Colorado has geography!
Unlike states to the east, Colorado is well compartmentalized due to its geography.

Within Colorado the current infestation is an infestation of the South Platte River drainage, not the State of Colorado.
Within the next five years, emerald ash borer will move out of Boulder into the surrounding counties.

This is a slide I have been using since January 2014. The title should now read, “After 6 years, emerald ash borer has moved into the edge of adjacent counties.”
Over time the South Platte River Drainage will be colonized by emerald ash borer.
Colorado EAB
Tree #1

Located near the intersection of 30th and Valmont, Boulder

September 23, 2013
Area of original EAB infestation in Colorado
Areas known to be infested with emerald ash borer in Boulder (original site of Colorado establishment)
Reported emerald ash borer distribution in Colorado – four years after Day Zero.
Sixth Anniversary!
Emerald Ash Borer in Colorado
Reported emerald ash borer distribution in Colorado – Today

- 2018 detection Lyons
- 2018 detection Superior
- 2019 detection Broomfield
- 2019 detection Westminster (Adams County)
- Original Boulder EAB infestation
- 2019 Detection SW of Berthoud
This is the map you can find of EAB distribution on the Colorado Department of Agriculture (CDA) Web Site.

The newest findings are outside Boulder County, which has been an EAB quarantine zone since 2013.
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
EAB likely will emerge sometime in mid-late May.

Most eggs will be laid in June, egg laying will continue through summer.
Wind Direction from Boulder
(with wind speed correction)
May-August 2013-2015
Reported emerald ash borer distribution in Colorado – Today

- 2018 detection Lyons
- 2019 Detection SW of Berthoud
- 2019 detection Broomfield
- 2019 detection Westminster (Adams County)
- 2018 detection Superior
- Original Boulder EAB infestation
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
Diagnosis – Flatheaded Borer Injury

- Meandering tunnels produced under the bark
  - Tunnels packed with fine sawdust
- Plant shows decline/thinning crown
- D-shaped exit holes in bark
Roundheaded Borers/Longhorned Beetles

Coleoptera: Cerambycidae
Adults – longhorned beetles – have long antennae
When laying eggs, the female longhorned beetle first chews a pit in the bark. She later lays an egg into the pit.
The egg is inserted underneath the bark; it is not laid on the surface.
Roundheaded Borer – the larval stage of a longhorned beetle
Much of the feeding by roundheaded borers is in the interior of the tree, producing a damage pattern that riddles the trunk.
The tunnels are generally oval in cross-section.
The excreted sawdust can be either coarse and stringy, or finely grained.
Coarse sawdust may be expelled from the tree by roundheaded borers.
After the roundheaded borer has completed feeding, it transforms to the pupal stage, a transition to the longhorned beetle adult form.
The adult longhorned beetle chews its way through the bark. An oval-round exit hole is produced.
The adult longhorned beetle chews its way through the bark. An oval-round exit hole is produced.

Adults feed on foliage or twigs, but the resultant injuries that are rarely noticeable.
Common borers that develop in dying, recently killed pines.

Pine Sawyers
Monochamus species
Two species of pine sawyers are present in Colorado.

Spotted pine sawyer
*Monochamus clamator*

Whitespotted pine sawyer
*Monochamus scutellaris*
Pine Wilt

Pine wilt nematode

Pine sawyer
Nematodes in infected tree migrate to pine sawyer pupa

Pine sawyers infect new trees when adults feed on twigs.

The nematodes then move from the beetle into the wounded tissue.
Adult activity of pine sawyers

(Data from poster by David Atkins)

- **Spotted pine sawyer**
  - July 14, 5% capture
  - August 25, 50% capture

- **Whitespotted pine sawyer**
  - July 25, 5% capture
  - August 30, 50% capture
Poplar Borer

**Hosts:** Mature aspens, poplars

*Note: This species takes two years to complete its life cycle*
Brownish ooze is often produced at wound sites of the poplar borer on aspen.
Locust Borer

Host: Black locust
‘Purple Robe’ locust is extremely susceptible to locust borer.
Larvae sculpt out areas underneath the bark of dead conifers
Sawdust is packed and usually granular

Note: This insect only appears in trees that are dead or very, very near dead
Diagnosis – Roundheaded Borer Injury

• Tunneling penetrates into heartwood of the tree
  – Riddling, structural weakening
• Coarse sawdust typically produced
• Oval-round exit holes in bark
Clearwing Borers
Lepidoptera: Sesiidae
Adult clearwing borers are day-flying moths that mimic bees and wasps.
Some Common Clearwing Borers of the Region

- Peach tree borer (*Prunus* spp.)
- Lilac/Ash borer (ash, lilac, privet)
- Currant borer (*Ribes* spp.)
- Viburnum borer (*Viburnum* spp.)
- Raspberry crown borer (raspberry)
- Cottonwood crown borer (Cottonwood)
Larvae chew, irregular gouging wounds under the bark.

Most larvae of clearwing borers feed at or below the soil surface – the crown area of the roots – and may be known as crown borers.
What kind of wood borer do you have?

Clearwing borer? (Lepidoptera)

Flatheaded borer? (Coleoptera)

Roundheaded borer? (Coleoptera)
All larvae of moths and butterflies (Lepidoptera) have prolegs on the abdomen.

These legs are tipped with hooks, the crochets.
Top view of peachtree borer larva

Prolegs on the abdomen, tipped with the crochets

Bottom view of peachtree borer larva

Top (dorsal) side, and bottom (ventral) view of a Zimmerman pine moth larva

Photographs courtesy of David Shetlar, Ohio State University

Photograph courtesy of Jim Kalisch, University of Nebraska
Lilac/Ash Borer

*Podosesia syringae*
Larvae of the lilac/ash borer are known to damage ash, lilac and privet.

In Colorado it has proven to be primarily an insect associated with ash trees in sites with some growing stresses.
Ash trees are particularly susceptible during establishment and when bark is thin.
Lilac/ash borer injury to base of ash - exterior
Lilac/ash borer damage to base of ash -interior
Exit holes made by the adult moth upon emergence are slightly oval, nearly round.
Lilac ash borer adults emerge early in the year – sometimes beginning in late April.
Peachtree Borer
(aka Peach Crown Borer)

Synanthedon exitiosa
Peach tree borer larvae feed at the crown area of the plant or on larger roots.
Pupation occurs with a cocoon, covered with bits of wood chips, and is produced just beneath the soil line.

The moth, as it emerges, draws out the skin that had surrounded the pupa.

The pupal skins may be observed around the base of infested plants.
Upper left: Peach tree borer female
Upper right: Peach tree borer male
Lower left: Pupal skin extruded from case of silk and wood fragments
After mating, the females lay eggs on the surface of the bark, near the base of the plant.
Diagnosis – Clearwing Borer Injury

- Tunneling often concentrated at the base (root crown) of the plant
- Tunneling an irregular gouging
- Pupal skins often are pulled out upon adult emergence
Pyralid Borers

Lepidoptera: Pyralidae

Zimmerman pine moth, pinyon pitch mass borer, pitch twig borer
Pinyon pitch mass borer

*Dioryctria ponderosae*
Zimmerman pine moth

*Dioryctria zimmermani*
External evidence – Zimmerman pine moth
Horntails

Hymenoptera: Siricidae

One last group of Wood Borers!
Pigeon Tremex
*Tremex columba*

A wood boring wasp that attacks hardwood trees in advanced decline.
Larva in wood

Adults emerge from perfectly round exit holes in early-mid summer
Pigeon Tremex and Giant Ichneumon Wasp

Fact Sheet 5.604
Giant Ichneumon Wasp
*Megarhyssa lunator*

Parasitoid of the pigeon tremex larva (borer)
Giant ichneumon wasp – a spectacular natural enemy of the pigeon tremex
Wood Borer Management Fundamentals

- Optimize conditions for plant growth/host plant resistance
- Sanitation practices that limit breeding material
- Preventive applications of insecticides directed at exposed stages
Preventive Use of Insecticides

Treatments are not available *for most borer* s currently in a plant.
Preventive Use of Insecticides

Timed to periods when insects are exposed to treatments
Trunk sprays of insecticides are timed to kill adults and newly hatching larvae.
For most borers flight periods can be estimated.

Fact Sheet 5.530 (Borers) or Bulletin 506A
<table>
<thead>
<tr>
<th>Common Name (If any), Scientific Name</th>
<th>Common Hosts</th>
<th>Typical Flight Period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>METALLIC WOOD BORERS</strong> (Coleoptera: Buprestidae)</td>
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<td></td>
</tr>
<tr>
<td>Flatheaded appletree borer - <em>Chrysobothris femorata</em></td>
<td>Apple, maple, oak, other hardwoods</td>
<td>June-August</td>
</tr>
<tr>
<td><em>Chrysobothris texana</em></td>
<td>Junipers</td>
<td>mid June-early August</td>
</tr>
<tr>
<td>Emerald ash borer - <em>Agrilus planipennis</em></td>
<td>Ash</td>
<td>late May-early August</td>
</tr>
<tr>
<td>Bronze birch borer - <em>Agrilus anxius</em></td>
<td>Birch</td>
<td>June-July</td>
</tr>
<tr>
<td>Honeylocust borer - <em>Agrilus difficultis</em></td>
<td>Honeylocust</td>
<td>June-July</td>
</tr>
<tr>
<td>Bronze poplar borer - <em>Agrilus ligarum</em></td>
<td>Aspen, other <em>Populus</em></td>
<td>June-August</td>
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<tr>
<td>Bronze cane borer - <em>Agrilus cuprescens</em></td>
<td>Raspberry, currant, rose</td>
<td>late May-June</td>
</tr>
<tr>
<td>Gambel oak borer - <em>Agrilus quercicola</em></td>
<td>Oak</td>
<td>early June-late July</td>
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<tr>
<td><strong>LONGHORNED BEETLES</strong> (Coleoptera: Cerambycidae)</td>
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<tr>
<td><em>Cottonwood borer</em> - <em>Plectodera scalator</em></td>
<td>Willows, poplars, cottonwoods</td>
<td>July-August</td>
</tr>
<tr>
<td><em>Locust borer</em> - <em>Megacyllene robiniae</em></td>
<td>Black locust (<em>Robinia</em>)</td>
<td>August-September</td>
</tr>
<tr>
<td><em>Poplar borer</em> - <em>Saperda calcarata</em></td>
<td>Populus, willow</td>
<td>June-August</td>
</tr>
<tr>
<td>Redheaded ash borer - <em>Neoclytus acuminatus</em></td>
<td>Ash, fruit trees, other hardwoods</td>
<td>April-June</td>
</tr>
<tr>
<td>Pine sawyers - <em>Monochamus</em> species</td>
<td>Pines, spruce, fir</td>
<td>May-October</td>
</tr>
<tr>
<td>Blackhorned pine borer - <em>Calidium antennatum</em></td>
<td>Pines</td>
<td>May-June</td>
</tr>
</tbody>
</table>
Approximate Periods when Adult Stages of Some Borers are Active

• Lilac/ash borer – late April-early June
• Peachtree borer – late June-early August
• Emerald ash borer – late May-July
• Bronze birch borer – late May-July
• Zimmerman pine moth – August-September
• Locust borer – August-September
Active Ingredients of Wood Borer Insecticides (Trunk Sprays)

- Permethrin (Astro, Permethrin, etc.)
- Bifenthrin (Onyx)
Permethrin

- Pyrethroid insecticide
- Use rates
  - *Borers that are moths*
    - 1-2 qts/100 gal
  - *Borers that are beetles*
    - 2-5 qts/100 gal
- Maximum use rate 2 lbs a.i./acre
  - Equal to 100 gallons at 2.5 gal product/100 gal rate
Bifenthrin

- Pyrethroid insecticide

- Use rates
  - *Borers that are moths*
    - 6.4 fl oz/100 gal
  - *Borers that are beetles*
    - 12.8 fl oz/100 gal

- Maximum use rate 12.8 fl oz/acre
Only One OTC product, containing permethrin, has a label and use rate that allows effective use against Borers and Bark Beetles!
Key Timing Point in Wood Borer Prevention

Target exposed life stages (Egg Laying/Egg Hatch)

Flatheaded borer egg on bark

Clearwing borer eggs on bark
Systemic insecticides for wood borers?
Imidacloprid for Borers?

Yes.....but
Imidacloprid will not work well on borers that are the larval stage of moths.
Imidacloprid *will not* work well if the borer spends much of its life in the heartwood of the plant.
Imidacloprid soil drenches *may work well* against flatheaded borer larvae (aka metallic wood borers)
For prevention of damage by most wood boring insects, persistent insecticides are applied as sprays to the trunk and limbs to kill wood borers before they enter the tree.

To control flatheaded borers, systemic insecticides can be used, usually applied either to the roots or injected into the lower trunk.
Emerald Ash Borer Control Options

- Soil applications with systemic insecticides
  - imidaclorpid, dinotefuran
- Non-invasive trunk sprays of systemic insecticides
  - dinotefuran
- Trunk injections of systemic insecticides
  - emamectin benzoate
  - azadirachtin
Target Life Stages for flatheaded borers using systemic insecticides

Adults as they feed on foliage

Young larvae that tunnel in the phloem and cambium
Primary method of imidacloprid application – soil applications for root uptake

Photograph courtesy of Jeff Findlay, Iowa State University
Applying systemic insecticides to the soil of trees

Soil drench

[Image of soil drench]

Soil injection

[Image of soil injection]

Photograph courtesy of David Cappaert
Soil Injection Patterns

A circle of 40-ft diameter (i.e., 40-ft canopy spread) covers 1250 sq ft.

Circular Pattern

Injections are made at each "X" spaced apart every 2.5-feet. Rings are also spaced apart by 2.5-feet.

Bird's eye views from above the tree looking through the canopy to the ground. The dark spot represents the trunk, while the irregular grey line represents the border of the canopy (the drip line).
The area around the base of a tree has many feeder roots that can allow good uptake of a soil applied systemic insecticide.
Imidacloprid Soil Drenches for EAB Control

- Best applied in spring shortly after bud break (after flowering)
  - Fall applications are inefficient, waste chemical and provide reduced control
Imidacloprid Soil Drenches for EAB Control

• Best applied in spring shortly after bud break (after flowering)

• Insecticide mixed with water and drenched around the base of the tree
  – Rates of use vary with tree size
  – Do not apply if there are flowering plants at the base of the tree!
Soil applications of systemic insecticides should not be made if there are flowering plants at the application site.
Modifying DBH-based rates by tree size

With imidacloprid large trees (>15 inch DBH) require a doubling of the rate per inch DBH.
Use rates vary by tree size.

For large trees, over 15-inch diameter, rates need to be doubled.

Over-the-Counter imidacloprid formulations do not have labels that allow the higher rate.
Imidacloprid Soil Drenches for EAB Control

• Best applied in spring shortly after bud break (after flowering)
• Insecticide mixed with water and drenched around the base of the tree
• **The site must be watered after application**
  – The soil must be kept moist for the roots to pick up the insecticide and move it

**Water moves the insecticide into the roots and allow transport through the tree**
Imidacloprid Soil Drenches for EAB Control

• Best applied in spring shortly after bud break (after flowering)
• Insecticide mixed with water and drenched around the base of the tree
• The site must be watered after application
• Expect it to take 2, probably 3 weeks to be present in sufficient quantity in plant tissues to kill the insect
Target Life Stages for flatheaded borers using systemic insecticides

- Adults as they feed on foliage
- Young larvae that tunnel in the phloem and cambium
Basal trunk spray with dinotefuran (Safari, Zylam, Transtect)
Dinotefuran Trunk Sprays for EAB Control

• Best applied in spring about time adults first begin to emerge

• Insecticide mixed with water and sprayed on trunk
  – Insecticide can move into tree directly through thin areas of the bark

• Uptake more rapid than with imidacloprid
  – Week? Uptake dependent on respiration of the tree
Relative Water Solubility of Neonicotinoids:

**Water Solubility (Active Ingredient)**

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Milligrams A.I. per liter</th>
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<tbody>
<tr>
<td>Clothianidin</td>
<td>327</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>2950</td>
</tr>
<tr>
<td>Acetamiprid</td>
<td>4100</td>
</tr>
<tr>
<td>Thiamethoxan</td>
<td>39830</td>
</tr>
</tbody>
</table>

**Information sources**
Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet
Imidacloprid (Marathon), Thiamethoxan (Flagship) – MSDS for Products

Slide information courtesy J. Chamberlin
Water Solubility

There is wide range of water solubility among the neonictioides.

Dinotefuran is highly water soluble.
$K_{OC}$ Values of Neonicotinoids:

- Clothianidin: 166
- Imidacloprid: 440
- Acetamiprid: 267
- Dinotefuran: 245
- Thiamethoxam: 26

Source Data: EPA Pesticide Fact Sheets
Koc Value

There is a wide range of Koc values (measure of adsorption to organic matter) among the neonicotinoids. This affects mobility within plants.

**Dinofuran** has a much lower Koc value than do other neonicotinoids.
2013 Oregon Bumble Bee Kills

Involved use of dinotefuran, applied shortly before bloom. Treatment timing produced high residues during bloom.
Trunk Injections

Probably not great on thin-barked trees such as birch.

This is a standard treatment for emerald ash borer.
Trunk injection with azadirachtin (TreeAzin, Azasol, AzaGuard, etc.)
Trunk injection with emamectin benzoate
Emamectin Benzoate for Wood Borers

• **Advantages**
  – Active against both borers that are both beetles and moths/caterpillars
  – Well established to provide high level of control for 2, likely 3, years
  – Very little-no movement into pollen

• **Limitations**
  – High cost, requires specialized equipment
  – Trunk wounding associated with injection
This presentation will be posted at the Insect Information Website

• **Housed at** Department of Bioagricultural Sciences and Pest Management
  – **Search** “BSPM CSU”

• **Within** “Entomology”

• “Insect Information”
  – Extension presentations are posted at the bottom of the page, most recent at end
Insect Information

All materials needed in an accessible format can be made available upon request.

Arthropods of Colorado Fact Sheets
This is a listing of about 200 downloadable fact sheets related to insects and other "bugs" found in Colorado. It contains fact sheets that are written for the Colorado Arthropods of Interest series and the Extension fact sheets that are related to insects.

Some Entomology Hot Links:
- Colorado Hemp Insect Website
- Western Colorado Entomology Website
- IFM Images/Bugwood (Chrysanthemum)
- IFM Images/Bugwood (Pea
- Entomology Resources List
- Honey Bee Swarm Hotlines

Miscellaneous Insect Information
This contains a variety of downloadable fact sheets and pamphlets on diverse miscellaneous subjects, from "Bug Mugs" and "Life in a Colorado Water Garden" to "Mystery Bites and Itches" and "Commercially Available Sources of Biological Control Organisms: Sources and Uses in Colorado."

Bottom of the Website page

Hemp Insect Information
This links directly to the Hemp Insect Website, which includes information being developed to better recognize and manage insects associated with industrial hemp.

Master Gardener Information
This includes the handouts and PowerPoint presentations (as PDF) used in Master Gardener Entomology training. These will get updated annually at the end of the winter/spring training programs.

Handouts
PowerPoint Presentations Used in 2018

Recent Extension Presentations
This is a listing that provides the PowerPoint presentations (as PDF) of most Extension entomology programs conducted during the past 12 months.

PowerPoint Presentations/Webinars

Top of the Insect Information Website
Thank you!

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For more information on Colorado Insects check out the CSU Insect Information Website
For more information on Hemp Insects check out the CSU Hemp Insect Website