Conserving bees for sustainable crop pollination

Rufus Isaacs
Department of Entomology
Michigan State University

Michigan Family Farms Conference
Battle Creek, MI
January 15, 2010
Many valuable and nutritious crops are dependent on bees for pollination.
Pollination

- The transfer of pollen from the stamen to the stigma
- Bees are well adapted to move pollen

Self pollination

Cross pollination
Honey Bee

- Main commercial pollinator
- In US, annual value of honey bee pollination = $14.6 billion
Honey bees are the dominant managed crop pollinators

But,
Many farms do not rent honey bees

Long-term honey bee health is in question (mites, diseases, CCD, etc.)

Diversifying pollinators can provide pollination “insurance”

Some crops are more efficiently pollinated by native bees

So, what about the other bees?.....
Over 4,000 bee species in the U.S.
Some species are very efficient crop pollinators: *Bumble bees, Orchard bees, etc*

Native bees are adapted to local weather conditions

Some species emerge in synchrony with specific crops to pollinate them exclusively

Long term sustainability of pollination: $3$ billion of fruit and vegetable pollination

‘Pollination insurance’ for intensively blooming spring crops, and may provide all needed pollen transfer for summer-blooming vegetables
Historical Michigan Landscapes

Diverse habitats provide

- Biodiversity
- Pest suppression
- Pollination
Modern Agricultural Landscapes

Intensive land management reduces area available to bees for food and nests

Places for bee habitat

- meadows
- woodlots
- tree lines
- marginal areas left semi-natural
Major Native Bee Groups in Michigan

- bumble bees
- digger bees
- sweat bees
- carpenter bees
- mason bees
- leafcutter bees
Bumble bees

2nd most important pollinator, globally
Bumble bees (Apidae)

- Medium (workers, drones) to large (queens) yellow or white and black.
- A single queen produces a colony of workers.
- Nest in abandoned rodent burrows or other cavities in the ground.
- Commercially produced colonies available.
- Visit many different flowering plants

Bombus spp.
Other ground nesting bees
Mining, Digger, and Long-horn bees (Andrenidae and Apidae)

- Small to large bees with very hairy hind legs.
- Solitary, nest in soil.
- Usually one generation produced per season.
- May visit many different flowers, or will collect pollen from only a few related plant species.
Sweat bees (Halictidae)

- Three size/color groups:
  - Medium-sized, brown, with or without stripes
  - Small to medium, metallic green
  - Small bronze/golden metallic
- Solitary and social species.
- Some produce several generations per season.
- Most nest in soil; some in soft wood.
- Visit many different flowering plants.

*Halictus* sp.  *Lasioglossum* sp.  *Agapostemon* spp.
Wood-nesting bees
Carpenter bees (Apidae)

- Two distinct types:
  - large (often mistaken for bumble bee queens).
  - Small (metallic blue).

- Most females are solitary, building and provisioning their own nests (no workers are produced).

- Nest in wood or pithy stems.

- Visit many different flowers.
Mason bees (Megachilidae)

• Small to medium, bluish metallic or black with white hair on thorax, with dense abdominal hairs for carrying pollen.

• Solitary, but often nesting in aggregations.

• In nature, nesting in galleries made by beetles in wood or pithy stems; will readily nest in man-made straws.

• Separate and cap off nest cells with mud.
Leafcutter bees (Megachilidae)

- Medium, black, often with a striped abdomen on which they collect pollen.
- Solitary, nesting in aggregations.
- Nest in galleries made by beetles in wood or pithy stems; will readily nest in man-made straws.
- Cut leaf sections to make nests.
Nests for solitary bees
What do native bees need?

Critical Ecological Requirements

1. flowers for nectar and pollen
2. nesting habitat
3. non-toxic environment
1. Flowering Resources

- nectar, floral oils, and pollen from diverse plants
- season long bloom
Integrating Native Flowering Plants into Farm Landscapes

- Ditches
- Field margins
- Meadows
- Row middles
2. Nesting habitat
Undisturbed vegetation/thatch for bumble bees
Nesting boxes or straws and access to mud for mason bees
3. Non-toxic environment

- Use IPM and least toxic options, if sprays needed.
- Apply in the late evening/night
- Do not use dust formulations
- Minimize drift into flowering borders

Relative toxicity of selected insecticides

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Chemical Class</th>
<th>µg required to kill 50% (LD&lt;sub&gt;50&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua Malathion</td>
<td>Organophosphate</td>
<td>0.27</td>
</tr>
<tr>
<td>Asana XL 0.66 EC</td>
<td>pyrethroid</td>
<td>0.06</td>
</tr>
<tr>
<td>Sevin 80 WSP</td>
<td>carbamate</td>
<td>1.50</td>
</tr>
<tr>
<td>Provado 1.6 F</td>
<td>neonicotinoid</td>
<td>0.05</td>
</tr>
<tr>
<td>Spintor 2 SC</td>
<td>naturalyte</td>
<td>0.025</td>
</tr>
<tr>
<td>Confirm 2 F</td>
<td>IGR</td>
<td>234.00</td>
</tr>
<tr>
<td>Dipel</td>
<td>biological</td>
<td>&gt;500.00</td>
</tr>
</tbody>
</table>

LD<sub>50</sub> = Dose killing 50% of worker honey bees after 24 h. Topical application method.
For some species, need access to clean water/mud

- ponds
- bird baths
- ditches
GOAL: Use native plants to provide beneficial insects with nectar and pollen.
Native Plants

Benefits

– Enhance native biodiversity
– Re-creation of imperiled habitats
– Less likely to be invasive
– Adapted to local climate
– Habitat permanency

Disadvantages

– Greater initial cost
– Longer establishment time
Golden alexanders (Zizia aurea)

• Natural enemies: ★★★
  Chalcid wasps, dance flies

• Bees: ★★★
  yellow-faced bees, Andrenid bees, sweat bees, cuckoo bees

• Bloom: late May - mid June
Yellow giant hyssop (*Agastache nepetoides*)

- **Natural enemies:** ★★★★
  - minute pirate bug, predatory plant bug, spiders, dance flies, Chalcid wasps
- **Bees:** ★★★
  - yellow-faced bees, sweat bees, bumble bees
- **Bloom:** throughout August

<table>
<thead>
<tr>
<th>Sunlight</th>
<th>moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>sun</td>
<td>dry</td>
</tr>
<tr>
<td>range</td>
<td>range</td>
</tr>
<tr>
<td>shade</td>
<td>wet</td>
</tr>
</tbody>
</table>
Horsemint (*Monarda punctata*)

- **Natural enemies:** ★★★★★
soldier beetle, predatory plant bug

- **Bees:** ★★★☆☆
large carpenter bees, digger bees, bumble bees

- **Bloom:** throughout August
New England aster \textit{(Aster novae-angliae)}

- **Natural enemies:** ★★★
  Chalcid wasps, dance flies

- **Bees:** ★★★★
  Andrenid bees, sweat bees, small carpenter bees, bumble bees

- **Bloom:** late May - mid June
Native grasses

- Provide structural support for wildflowers.
- Fill in gaps that wildflowers can’t early in establishment, decreasing weed pressure.
- Have root systems of different depths that complement wildflowers
- Examples:
  - Canada wild rye (*Elymus canadensis*)
  - Little blue stem (*Andropogon scoparius*)
  - Switch grass (*Panicum virgatum*)
### Season-long bee-attractive native floral resources

[www.nativeplants.msu.edu](http://www.nativeplants.msu.edu)

<table>
<thead>
<tr>
<th>Native plant</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>willow, <em>Salix</em> spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>black chokecherry, <em>Aronia melanocarpa</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wild cherry, <em>Prunus</em> spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American elder, <em>Sambucus canadensis</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silky dogwood, <em>Cornus amomum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>golden Alexanders, <em>Zizia aurea</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>common ninebark, <em>Physocarpus opulifolius</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>beardtongue, <em>Penstemon hirsutus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>late figwort, <em>Scrophularia marilandica</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>swamp milkweed, <em>Asclepias incarnata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culver's root, <em>Veronicastrum virginicum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellow coneflower, <em>Ratibida pinnata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nodding wild onion, <em>Allium cernuum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meadowsweet, <em>Spiraea alba</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellow giant hyssop, <em>Agastache nepetoides</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>horsemint/spotted beebalm, <em>Monarda punctata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missouri ironweed, <em>Vernonia missurica</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cup plant, <em>Silphium perfoliatum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pale Indian plantain, <em>Cacalia atriplicifolia</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>boneset, <em>Eupatorium perfoliatum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>blue lobelia, <em>Lobelia siphilitica</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pale-leaved sunflower, <em>Helianthus strumosus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riddell's goldenrod, <em>Solidago riddellii</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New England aster, <em>Aster novae-angliae</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>smooth aster, <em>Aster laevis</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bee-friendly farming

• Provide flowers through growing season.

• Provide nesting resources.

• Only use bee-safe insecticides if pest control is necessary.

• Provide clean water source.
Resources

- MSU Native Plants Website: [www.nativeplants.msu.edu](http://www.nativeplants.msu.edu)
- Michigan Native Plant Producers [www.mnppa.org](http://www.mnppa.org)
- The Pollinator Partnership [www.pollinator.org](http://www.pollinator.org)
- USDA – NRCS and FSA Programs [E-2985](#) [E-2973](#)