Rare and endangered bumble bees of Ohio

Dr. Karen Goodell
Department of EEOB
The Ohio State University, Newark
Goodell.18@osu.edu

Kurt Hennige, BugGuide.net

Johanna James-Heinz, BugGuide.net
Causes of bee declines

• Bees exposed to multiple interacting stressors
  • some fungicides can greatly increase toxicity of insecticides
  • exposure to insecticides reduces resistance to diseases
  • Habitat loss, especially food monotony
• May contribute to declines of wild and managed bees

Goulson et al. Science 2015;347:1255957
Rusty-patch bumble bee historic distribution

Goulson et al. 2015. Science
Yellow-banded bumble bee
(*Bombus terricola*) change in range
Declining relative abundances

- *Bombus* from 382 collections
- Historic range maps (grayscale)
- Orange = proportion of bees seen that are target species

Cameron et al. PNAS 2011;108:2:662-667
Proportional change in abundance of 5 eastern *Bombus* spp.

- Comparisons of historical (1900 – 1999; black bars) and current (2007–2009)
- All have changed! (z tests of equal proportions)

Cameron et al. PNAS 2011;108:2:662-667
Rusty-patch bumble bee present distribution

Historic (red circles) and contemporary (yellow triangles) distribution of the rusty patched bumble bee (The Xerces Society)
Conservation status of Rusty patched bumble bee

http://explorer.natureserve.org/servlet/NatureServe?searchName=Bombus+affinis+
Rusty-patched bumble bee decline is remarkable

- Was extremely broadly distributed and common 30 years ago
- Highly generalized forager
- Uses similar habitat to thriving species

Hypotheses for its decline
- Habitat fragmentation
- Cryptic differences in nesting or overwintering habitat requirements from thriving species
- Lacks resistance to parasites or diseases
Decline of common species

- German insect declines in protected areas over 27 years
  - 76% loss in biomass
  - Mid-summer 82% loss
- No effect of land use, habitat type

Decline of common species: genetic factors?

- Genetic variation of generalist populations generally high pre-WWII
- Intensification of habitat loss and fragmentation broke up generalists
- Species of limited mobility suffer inbreeding and chance loss of genetic variation
- Protection measures will help
  - Specialists – stochastic losses
  - Generalists – further losses due to inbreeding

Habel and Schmitt. 2018. Biological Conservation
Phylogeny of Bumble bee subgenera

• Nest architecture, tongue-length shared by thriving and declining species
  • *Rusty patched Bumble Bee* Bombus affinis (Bombus)
  • *Yellow-banded bumble bee* Bombus terricola (Bombus)
  • Common Eastern Bumble Bee Bombus impatiens (Pyrobombus)

Rasmont. 2008. Apidologie
Cause of rusty-patched bumble bee declines

• Introduction of a virulent strain of *Nosema bombi* from Europe through commercial bumble bee trade
  • Timing is right for RPBB and Western bumble bee, also in decline
  • Largely debunked by genetic analysis showing strains of *Nosema* have been in US since 1980’s, pre-decline (Cameron et al, 2016)
Ohio Bumble Bee Survey 2017-2018

Dr. Karen Goodell, PI
Dr. Randy Mitchell, PI
Paige Reeher, grad student
Dr. Jessie Lanterman, Post-doc
Denise Ellsworth, Outreach
Project Goals (2017-2018)

• Are rusty-patched and yellow-banded bumble bees extant or extirpated in Ohio?
  • survey near locations of historical records
  • new sites where habitat looks favorable
• Assess status of other bumble bee spp. common in Ohio
  • Identify key flower resources
  • Describe habitats that support them
Public Lands of all kinds
Public Lands of all kinds

Big Creek powerline
Geauga Park District
Public Lands of all kinds

Scenic Vista Park
Columbiana Co.
Public Lands of all kinds
Roadsides

I90 at SR84, Kingsville OH
Private Residences

Sulphur Springs Rd,
Shawnee, OH
Private Nature Preserves

James H. Barrow Field Station, Hiram College

Wenwick Wetland, Clark Co.
Sampling Sites 2017

130 sites
46 counties
Sampling Sites 2017

Columbus area

Toledo area

focus on areas where *Bombus affinis* was most recently seen
Bee Sampling Methods

- 1.5 hours of netting/observation
- record all bumble bees, honey bees, and “other” bees to species and social caste,
- ID bumble bees on the wing or catch, photo, release
- flower visited

<table>
<thead>
<tr>
<th>Bee</th>
<th>Caste</th>
<th>Trifolium pratense red clover</th>
<th>Monarda fistulosa bee balm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apis mellifera</td>
<td>W</td>
<td>150</td>
<td>67</td>
</tr>
<tr>
<td>Bombus impatiens</td>
<td>W</td>
<td>16</td>
<td>35</td>
</tr>
<tr>
<td>Bombus impatiens</td>
<td>M</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Bombus pensylvanicus</td>
<td>Q</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>
“Other” bees included many other bees

Halictus  Lasioglossum  Augochlorella  Agapostemon
Osmia  Megachile  Coelioxys  Melissodes
Ceratina  Xylocopa  Andrena  Hylaeus
Flower Sampling Methods

- Four 25m x 1m transects
- Count all flowers
- “Bee-walkable” units
- Sometime estimate

*B. impatiens* on teasel *(Dipsacus fullonum)*
Sampling Site Categories 2017

- 130 sites
- 46 counties

Percent of sites:
- Roadside: 13%
- Private Nature Preserve: 19%
- Public Park: 18%
- Private Residence: 50%
Bee abundance by type

28,949 bumble bees total

Apis mellifera
Bombus spp.
Other
Bumble bee abundance by species

10,078 bumble bees total

Absent:
B. affinis
B. terricola
Ohio Bumble Bees

- B. impatiens
- B. griseocollis
- B. bimaculatus
- B. fervidus
- B. vagans
- B. auricomus
- B. pennsylvanicus
- B. perplexus
- B. affinis
- B. terricola

common | rare | extirpated?
Other species of concern

- Extant in Ohio, but not common
- Should focus on these because still have a chance to protect them
- Some evidence for their decline

<table>
<thead>
<tr>
<th>Species</th>
<th>1897-1926</th>
<th>1987-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. fervidus</td>
<td>14.4%</td>
<td>0.05%</td>
</tr>
<tr>
<td>B. vagans</td>
<td>37.8%</td>
<td>10.7%</td>
</tr>
</tbody>
</table>

New Hampshire bumble bee relative abundances

Cameron et al. 2011. *PNAS*

Jacobson et al. 2018. *Biological Conservation*

IUCN Redlist Status:
- B. fervidus: Decreasing
- B. vagans: Stable
- B. auricomus: Stable
- B. pennsylvanicus: Decreasing
- B. perplexus: Stable
Queen survey goals

• Distribution of Ohio’s rare bumble bees
  • Rusty patched bumble bee
  • Yellow-banded bumble bee
• Compare distributions of queens to workers later in the season
  • Shifts in species composition that indicated differential nesting success?
  • Unexpected phenological trends?
• Habitat requirements for Ohio’s bumble bees
  • Determine local and landscape factors
  • Temporal windows for habitat
• Illuminate factors associated with bumble bee diversity, like lack of flower resources and land use change.
Focus on critical life-history stage

1. Emergence from hibernacula
2. Feeding
3. Nest searching
4. Provisioning first brood
Nest-searching queens predicts nest density

• Null hypothesis
  • *Nest establishment is random with respect to species*
  • Evidence from England suggests so

• Alternative hypothesis
  • *Queens of common species are more successful than those of rare species*
  • Floral resources
  • Nest/overwintering site availability
  • Nest usurpation of early species by later species

O’Connor et al. 2017, Ecological Entomology
When to survey queens

- April – June on warm, sunny days (> 65 °F)
- 8 am – 6 pm
  - Sometimes, if warm enough queens forage for nectar early in the morning and in the evening.
  - Also can be foraging for food or nest-searching anytime warm enough
- Duration of 15 min
  - Keep track with a timer
  - Make sure survey has your full attention for the duration
  - Can be done multiple times of day or over multiple days in one location
Where to survey bees

• Sunny spots in yard, fields, forests, or other attractive flower patches (2 - 10 m²)
  • Make sure you can see flowers well
  • Do not cast a shadow on then flowers
  • Get comfortable at a distance of ~1 m so that your movements do not disturb bees

• Choose flowers attractive to bees
• Can be native or non-native
• Can be ornamentals
• Must have pollen/nectar and be accessible to bees
Which would be a good place to survey for queens?
Garden and wild flower patches
Native and invasive flower patches
Data sheets for recording observations

- Species of flower (latin if possible)
- Rough count of flowers
- Count of queen bees
  - ID to Species
  - Photographs for verification

<table>
<thead>
<tr>
<th>Plant names →</th>
<th>Mertensia virginica</th>
<th>Dicentra cucullaria</th>
<th>Lonicera Morrowii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate # of Flowers →</td>
<td>20</td>
<td>100</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>B. impatiens</td>
<td>3</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>B. griseocollis</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>B. bimaculatus</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
Other data to gather

- Name
- Date
- Time
- Location
- Photos? (yes/no)
- Brief habitat description

- Karen Goodell
- 23 April 2018
- 1015 – 1030
- 251 Pine Tree Dr. Granville, OH
  - 40.090735, -82.480857
- Yes. Site and 2 bumble bees (attached)
- Suburban residential area, mixed pine/maple forest, lawn, ivy/myrtle ground cover. Redbud, dogwood, magnolia trees, and dafodils in bloom
Searching for a nest

https://youtu.be/_wxqd8m6XB8

https://youtu.be/pKv1IOVVlu4
Queen *Bombus pensylvanicus* in nest

https://youtu.be/tXUYOYzMOIQ

- Sign up to volunteer for the queen survey today!
- If you love it, continue to survey workers in June and July!
- Thank you and happy bee hunting!