Status and trends of wild insect pollinators in Vermont and beyond

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What is the status of pollinators?

- Widespread reports of decline—**and persistence**
- Loss of ecosystem function?
- Loss of ecosystem service to agriculture?
- How do we know?
What do we mean by pollinator ‘declines’?

- Reduction in overall pollinator density/ abundance
- Reduction in species diversity or shifts in community
- Consequent decline in plant reproductive success
‘Case studies’ for 3 insect pollinators

• Flies, Lepidoptera and bees
• Status in Vermont and beyond, if known
• Examples
1. Flies (Diptera)

- 71 fly families feed at flowers
- 15,000+ species in North America
- Pollinate >100 crop plants, including mango, onion, canola, cacao
- Changes in hoverfly diversity in UK, Netherlands
- What about Vermont?
Vermont fly pollinators
2. Butterflies and moths (Lepidoptera)

- 700+/13,000+ species in North America
- Declines of VT grassland butterflies
- Declines, range retractions and shifts: California, US prairies, UK, EU
- Vermont?
Vermont Lepidoptera pollinators
3. Bees (Hymenoptera)

• 4,000+ species in North America; ~275 in Vermont
• Plant pollen = protein source for bees
• Range retractions: EU, UK, North America
• Widespread declines in diversity (and abundance?)
• Evidence of competition with non-native bees driving some declines
Bee declines

- In eastern North America, bumble bees in decline, but most other bees apparently stable

Historical changes in northeastern US bee pollinators related to shared ecological traits
Ignasi Bartomeus$^{1,8,4}$, John S. Ascher$^{1,5}$, Jason Gibb$^6$, Bryan N. Danforth$^8$, David L. Wagner$^5$, Shannon M. Hedtke$^8$, and Rachael Winfree$^{1,4}$

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Bartomeus et al. 2013, *PNAS*
Vermont bee pollinators
Why are pollinators declining?

- Habitat loss
- Disease
- Pesticides
- Climate change
Habitat loss

- Habitat conversion, fragmentation
- Afforestation
- Agricultural intensification
- Documented negative effects on flies, butterflies and bees
Disease

• Pathogen spillover from commercial bees
Pesticides

- Neonicotinoids and others
- Lethal, sublethal and synergistic effects on consumers
- Linked to declines in abundance and diversity of crop pollinators
- Avoidance of treated crops by pollinators
Climate change

- Range contractions: bumble bees, butterflies
- Evolution: rapid changes in bumble bee tongue length
- Phenological mismatch for plant and pollinators: flower flies, bumble bees, solitary bees, hummingbirds (and maybe bats)
- Negative effects on survival, reproduction: solitary bees (*Osmia*)
Bumble bee declines due to climate change

• Retreat from southern margin of range, but no increase to north
• Elevation shifts in response to climate
• Geographical shifts *not* due to pesticides, land use change

Kerr et al., *Science* 2015
What to do?

• We need to address threats
• Need better assessments of pollinator status...
Challenges of Assessing Pollinator Species Status
Scientists estimate that there are between 24,000 and 43,000 species of higher plants, algae, fungi, lichens, invertebrates, and vertebrate animals in Vermont. Nearly half of these are invertebrates such as insects, crayfish, and mussels.
Invertebrate Groups with Information Available:

- Dragonflies and Damselflies
- Ground Beetles
- Mussels
- Butterflies
- Moths
- Bumble Bees
Invertebrate Groups with Information Available:

Dragonflies and Damselflies:
Ground Beetles
Mussels
Butterflies
Moths
Bumble Bees

Still to Explore:

All other bees – over 250 species
All other beetles
Flies
Wasps
### Natural Heritage Database

#### Invertebrates

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<th>Count</th>
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#### Vertebrates

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<td><strong>Total</strong></td>
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Vermont Bumble Bee Survey
2012-2014

Kent McFarland\textsuperscript{2}, Leif L. Richardson\textsuperscript{1}, and Sara Zahendra\textsuperscript{2}
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The data

Historic (1915-1999)  N = 1,669

Modern (2000-2014)  N = 10,650

Spatial subsample (5km)  N = 5,595
Bombus affinis Disappears

The number of Bombus affinis records by decade in Vermont.
Changes in relative abundance

- fervidus
- affinis*
- terricola
- pensylvanicus*
- citrinus
- impatiens
- ashtoni*
- sandersoni
- perplexus
- insularis*
- fernaldae*
- auricomus
- rufocinctus
- griseocollis
- borealis
- bimaculatus
- ternarius
- vagans

Legend:
- All modern collections
- Modern near historic (5km)
Is *Bombus terricola* recovering in Vermont?

![Graph showing *Bombus terricola* collections over years](image)

*Graph: B. terricola Collections*


*Map showing locations of *Bombus terricola* collections in Vermont*
Standardized roadside surveys

- 64 routes (124 surveys)
- 1,295 stations total
- 10 minute collection
Standardized roadside surveys

- 4.71 bees/station (range: 0-22)
- 1.76 species/station (range: 1-7)
- With 0 bumble bees: 17.5%
## Diversity and Abundance (@500m)

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From 2002 - 2007 volunteers of all kinds searched fields and fens, mountains and meadows, even their own backyards, to document the status of Vermont butterflies.
Over 36,000 records representing 103 species from over 140 volunteers
Species of Greatest Conservation Need

- West Virginia white (*Pieris virginiensis*)
- Early hairstreak (*Erora laeta*)
- Hackberry emperor (*Asterocampa celtis*):
- Tawny emperor (*Asterocampa clyton*)
- Edward’s hairstreak (*Satyrium edwardsii*)
- Bog copper (*Lycaena epixanthe*)
- Jutta arctic (*Oeneis jutta*)
- Dion skipper (*Euphyes dion*)
- Black dash skipper (*Euphyes conspicua*):
- Two-spotted skipper (*Euphyes bimacula*)
- Mulberry wing (*Poanes massasoit*)
- Broad-winged skipper (*Poanes viator*)
- Dusted skipper (*Lycaena epixanthe*)
- Cobweb skipper (*Hesperia metea*)
- Persius duskywing (*Erynnis persius*)

[Images of butterflies]
Life History of the West Virginia White

Toothwort
Conservation Issues

- Mid-nineteenth century deforestation and fragmentation
- Poor spring weather / host plant senescence
- Garlic-mustard (Alliaria petiolata) introduced to Long Island in 1868
Life History of Early Hairstreak

Erora iaeta female
Beech Bark Disease

Beech bark disease is caused by a unique relationship between an introduced insect called the Beech Bark Scale (Cryptococcus fagisuga), and Nectria fungi (Nectria coccinea and N. galligena). It was accidentally introduced to North American at Halifax, Nova Scotia in 1890 on a shipment of ornamental trees.

Recent data from plots in Vermont, New Hampshire, and Maine show that about 28 percent of the large beech died, another 22 percent were dying, and many of the surviving trees were severely injured.
Call to action

- Increased funding for assessments of bee, fly, Lepidoptera and other pollinator taxa.
- Rethinking agriculture: pesticides, land management
- Habitat restoration/ enhancement
- Better regulation of disease in commercial bee industry
Thank you!

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• Sam Droege, USFWS
• Taylor Ricketts, UVM
• Rebecca Irwin, North Carolina State U