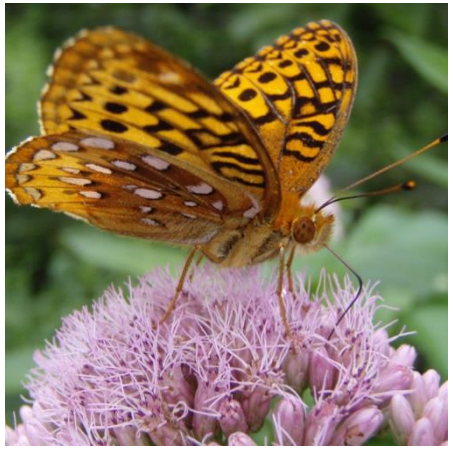
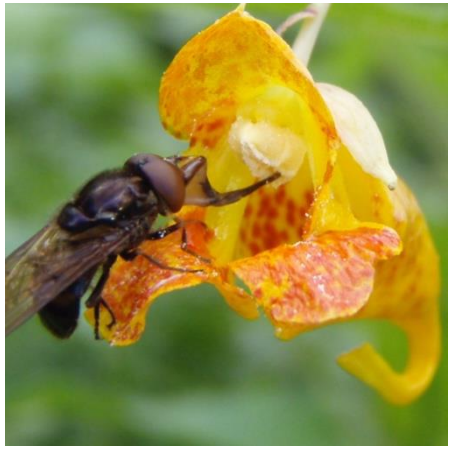
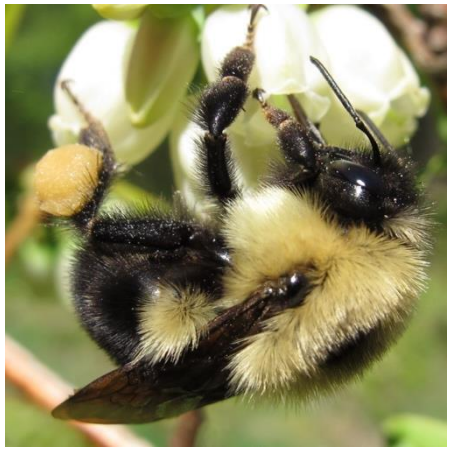
Status and trends of wild insect pollinators in Vermont and beyond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VERMONT FISH & WILDLIFE

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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?

Review

Cell PRESS

Global pollinator declines: trends, impacts and drivers

Simon G. Potts[1], Jacobus C. Biesmeijer[2], Claire Kremen[3], Peter Neumann[4], Oliver Schweiger[5] and William E. Kunin[2]

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[2] Earth and Biosphere Institute and Institute of Integrative and Comparative Biology, University of Leeds, Leeds, UK, LS2 9JT
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[5] Department of Community Ecology, Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser-Strasse 4, 06120 Halle, Germany

Pollinators are a key component of global biodiversity, associated loss of pollination services impact floral biodi-

Parallel Declines in Pollinators and Insect-Pollinated Plants in Britain and the Netherlands

J. C. Biesmeijer,[1]* S. P. M. Roberts,[2] M. Reemer,[3] R. Ohlemüller,[4] M. Edwards,[5] T. Peeters,[3,6] A. P. Schaffers,[7] S. G. Potts,[2] R. Kleukers,[3] C. D. Thomas,[4] J. Settele,[8] W. E. Kunin[1]

Despite widespread concern about declines in pollination services, little is known about the

PNAS

Patterns of widespread decline in North American bumble bees

Sydney A. Cameron[a,1], Jeffrey D. Lozier[a], James P. Strange[b], Jonathan B. Koch[b,c], Nils Cordes[a,2], Leellen F. Solter[d], and Terry L. Griswold[b]

[a]Department of Entomology and Institute for Genomic Biology, University of Illinois, Urbana, IL 61801; [b]United States Department of Agriculture-Agricultural Research Service Pollinating Insects Research Unit, Utah State University, Logan, UT 84322; [c]Department of Biology, Utah State University, Logan, UT 84321; and [d]Illinois Natural History Survey, Institute of Natural Resource Sustainability, University of Illinois, Champaign, IL 61820

Edited* by Gene E. Robinson, University of Illinois, Urbana, IL, and approved November 24, 2010 (received for review October 3, 2010)

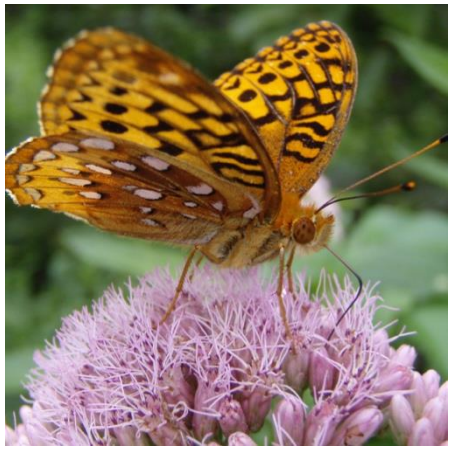
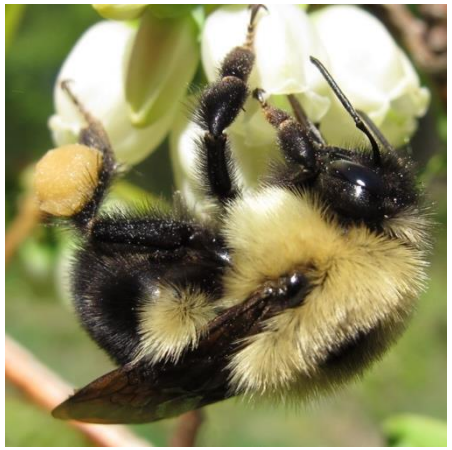
Bumble bees (*Bombus*) are vitally important pollinators of wild study in the United States identified lower genetic diversity and

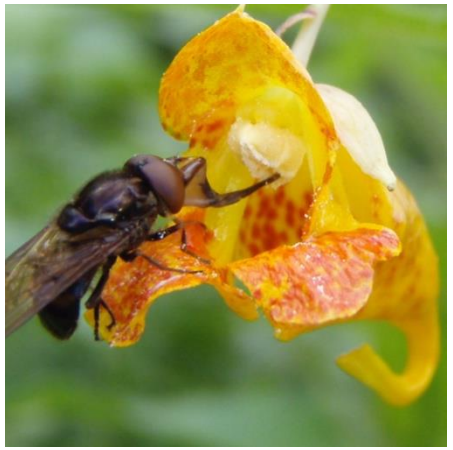
What do we mean by pollinator ‘declines’?

- 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

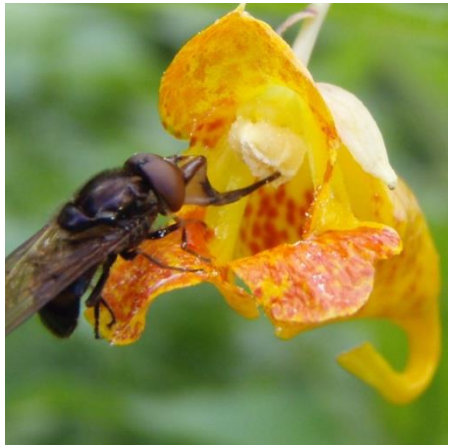



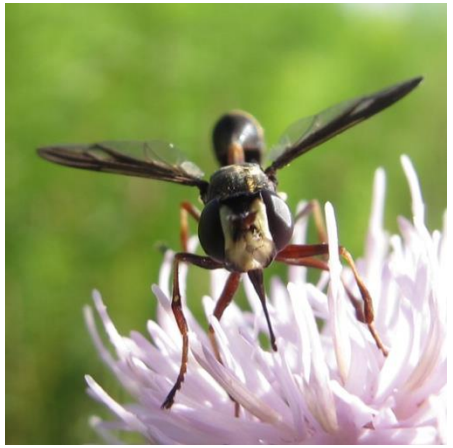


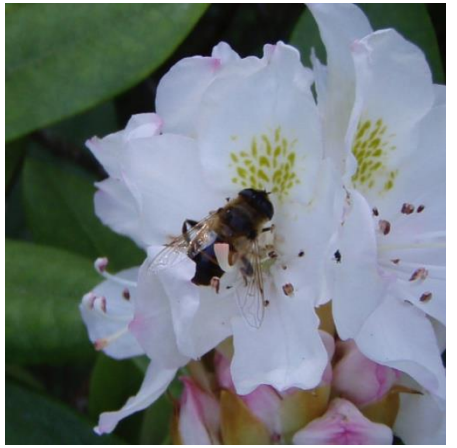

1. Flies (Diptera)

- 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





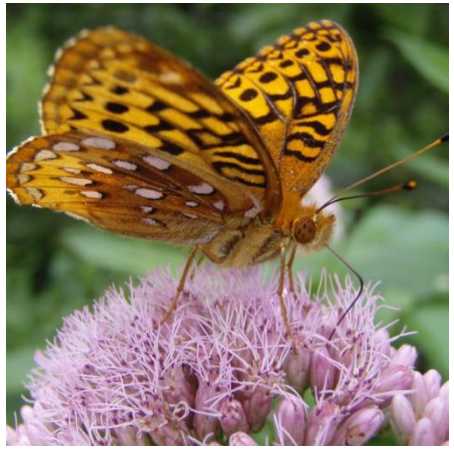





2. Butterflies and moths (Lepidoptera)

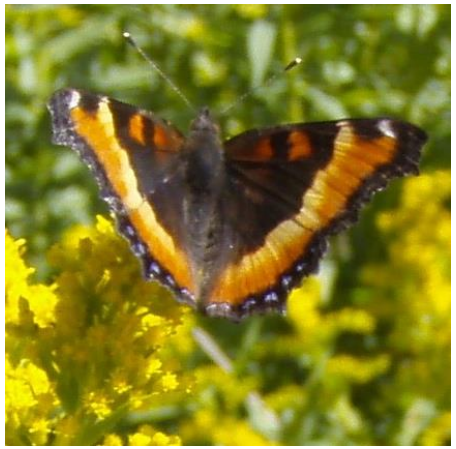
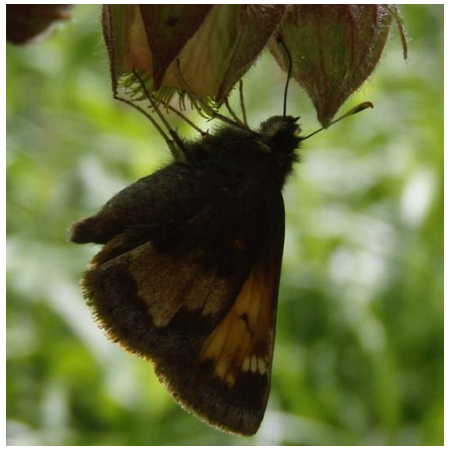
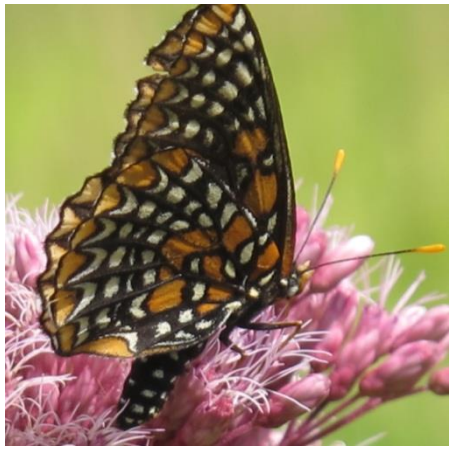
- 700+/ 13,000+ species in North America
- Declines of VT grassland butterflies
- Declines, range retractions and shifts: California, US prairies, UK, EU
- Vermont?

Vermont Lepidoptera pollinators







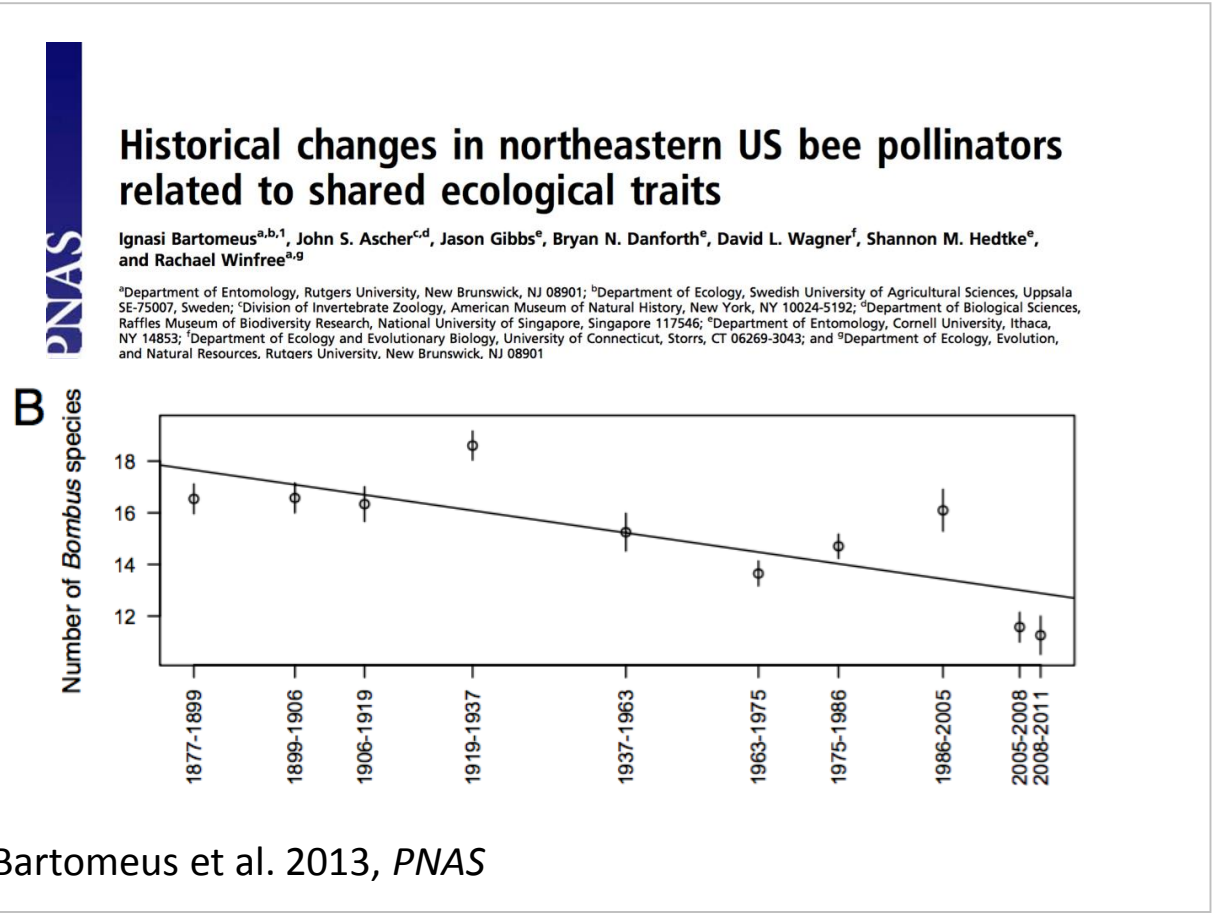





3. Bees (Hymenoptera)

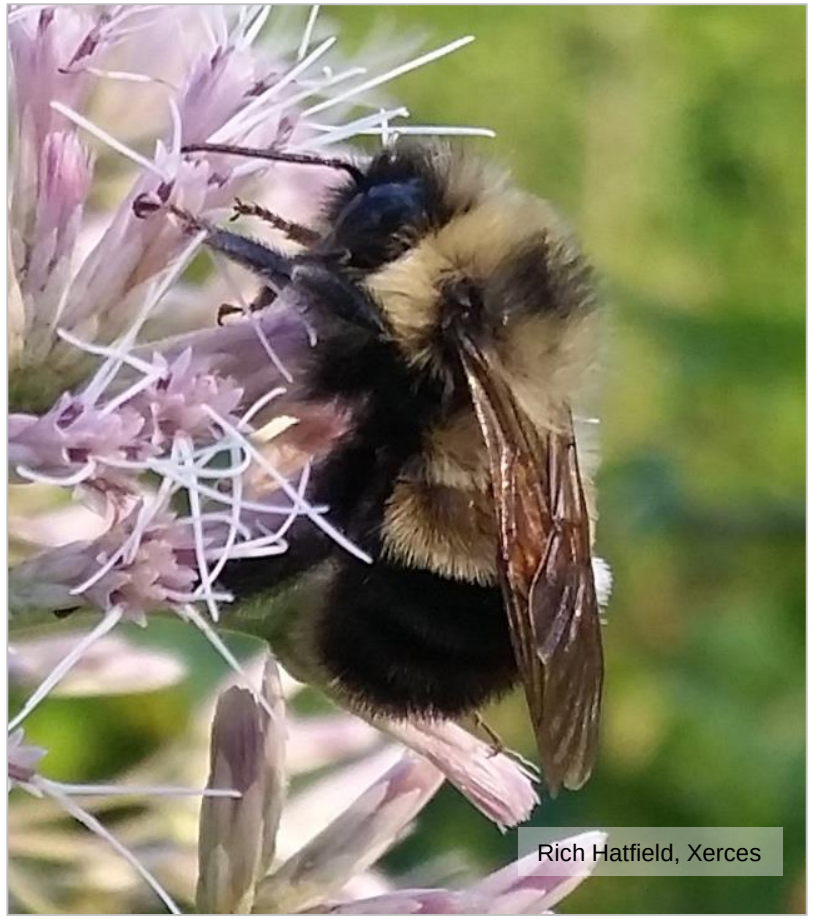
- 4,000+ species in North America; ~275 in Vermont
- Plant pollen = protein source for bees
- Range retractions: EU, UK, North America
- Widespread declines in diversity (and abundance?)
- Evidence of competition with non-native bees driving some declines

Bee declines

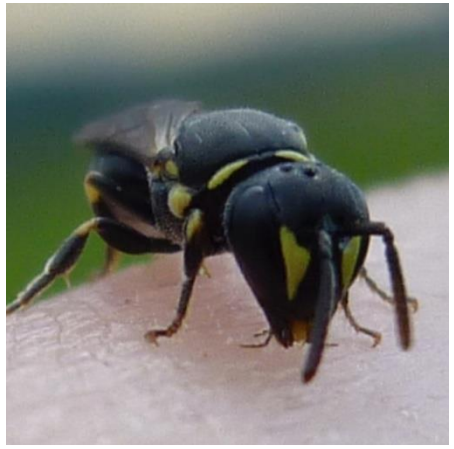
- In eastern North America, bumble bees in decline, but most other bees apparently stable

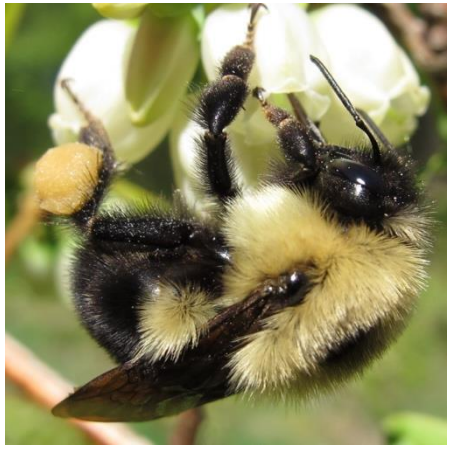


Bartomeus et al. 2013, *PNAS*



Vermont bee pollinators



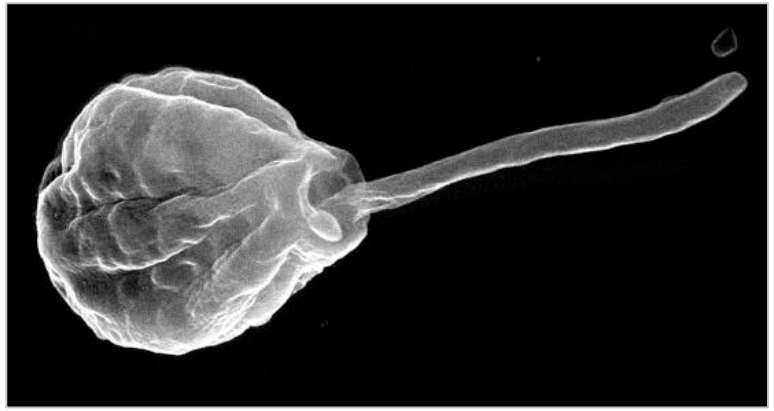



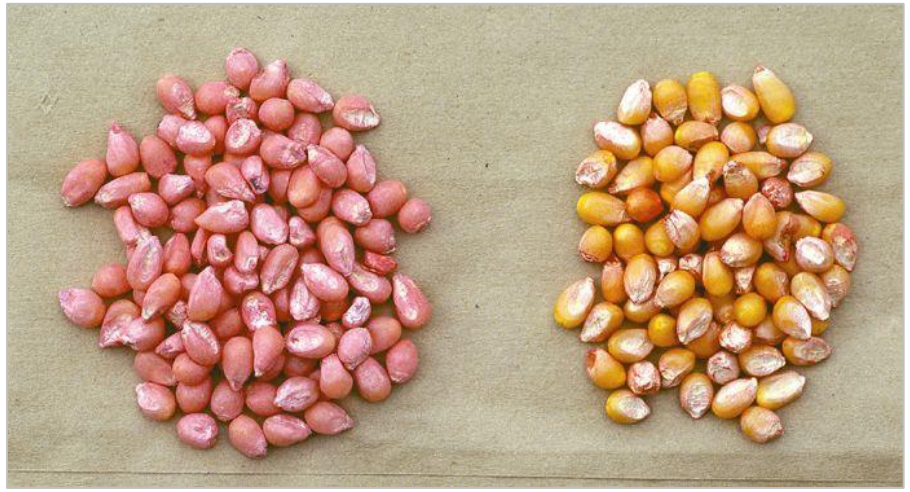


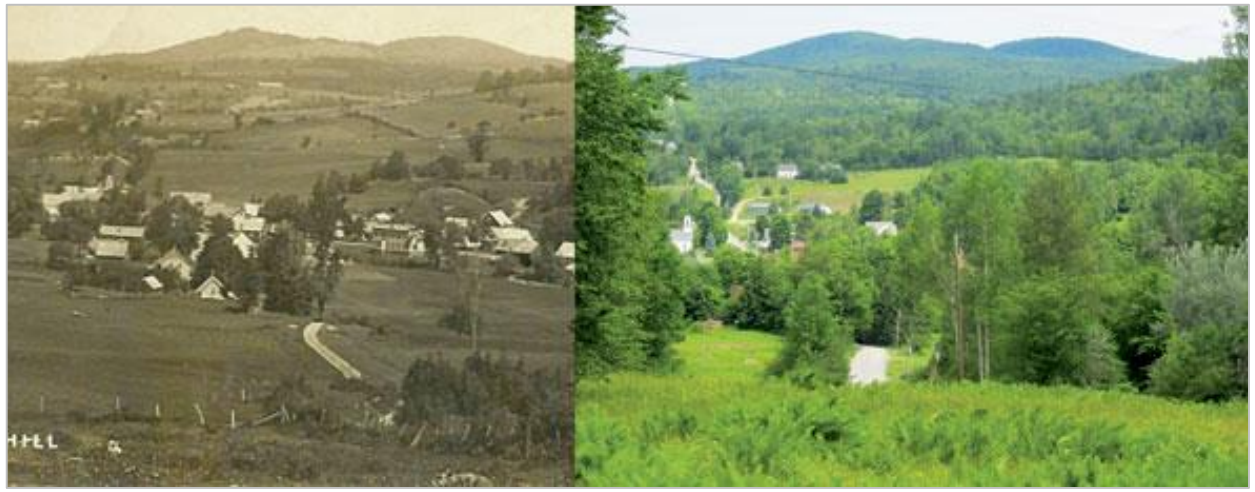


Why are pollinators declining?

- Habitat loss
- Disease
- Pesticides
- Climate change





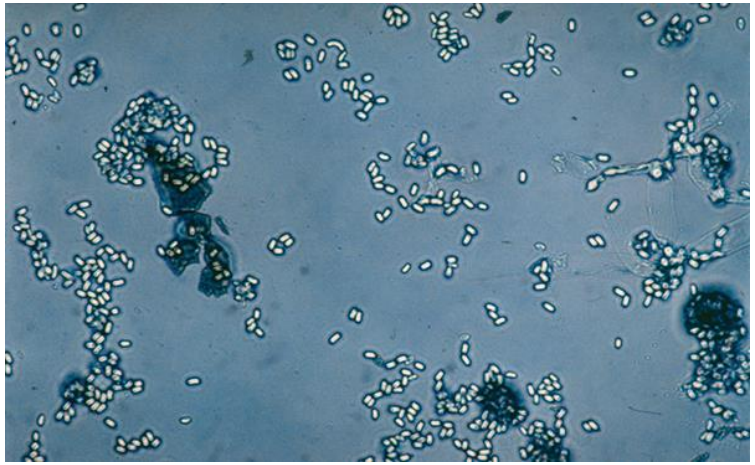


Habitat loss

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

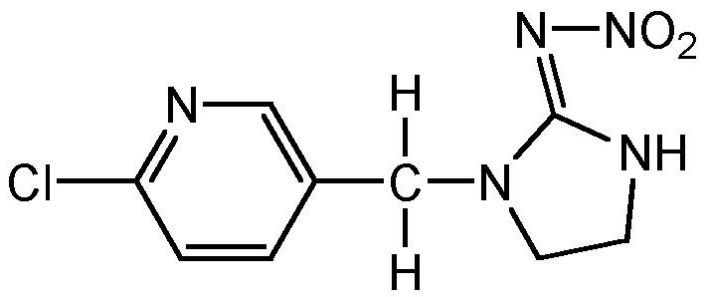
Disease

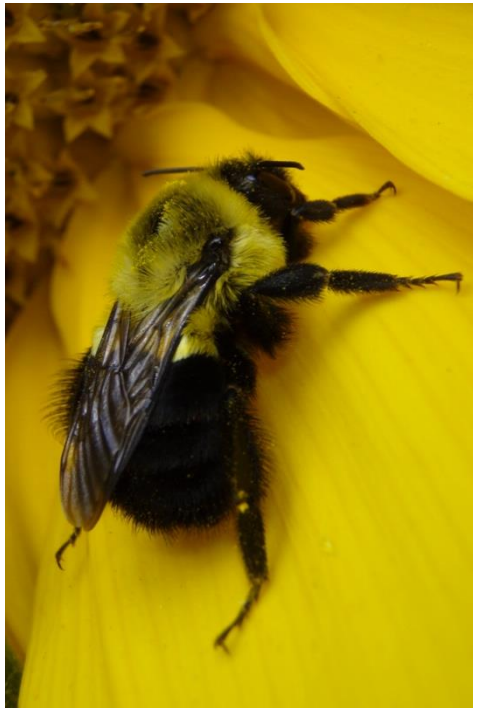
- Pathogen spillover from commercial bees



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



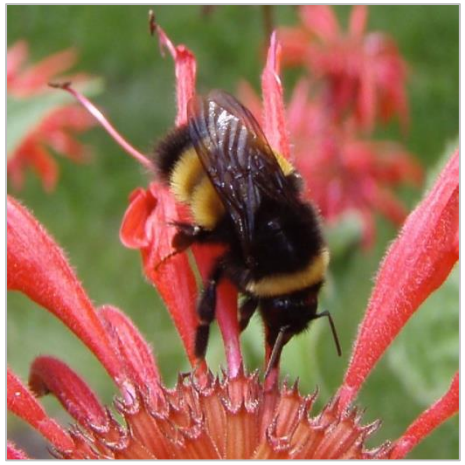


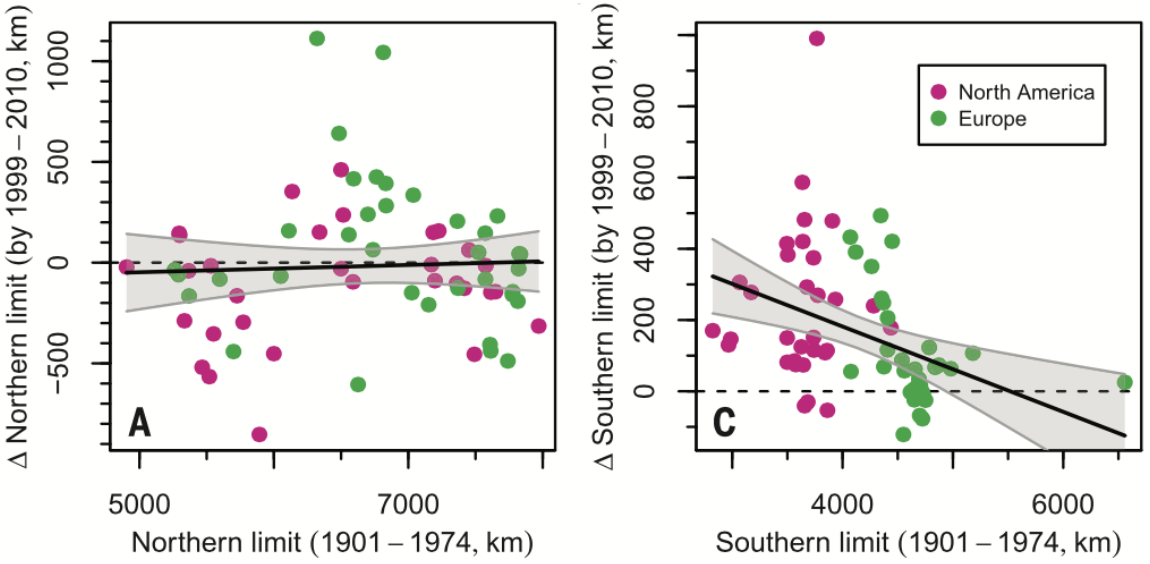
Climate change

- 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*

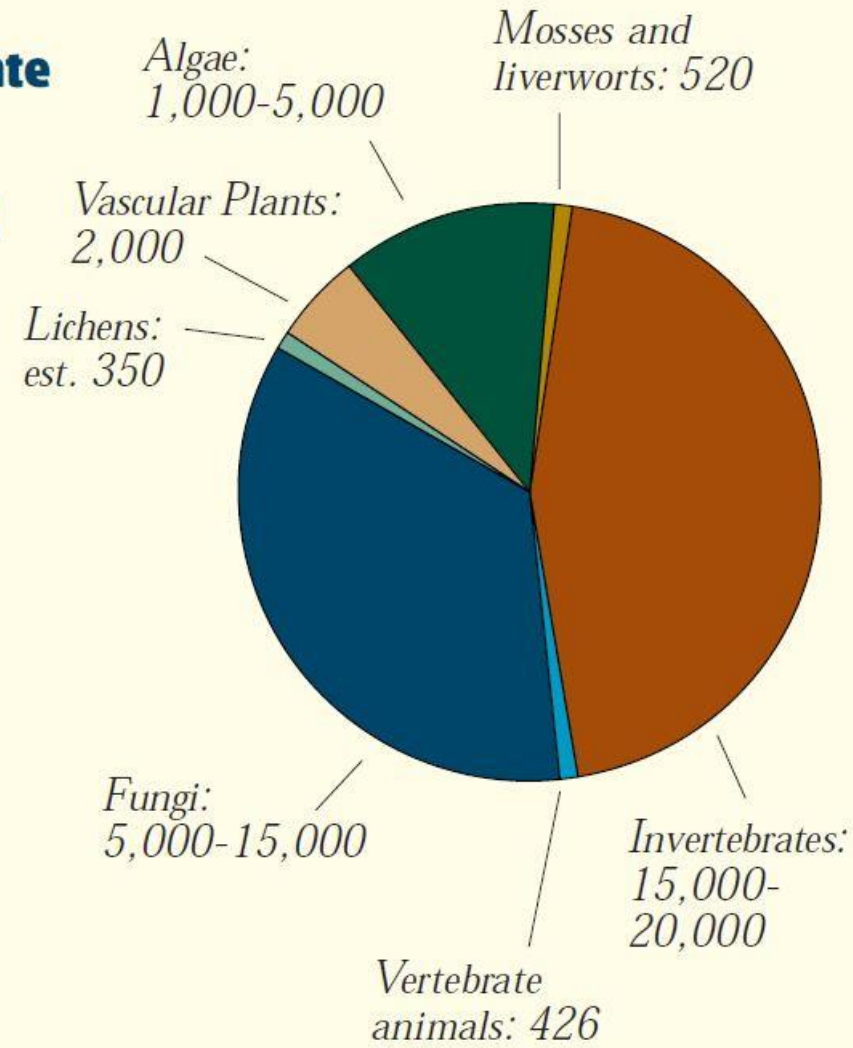
What to do?

- We need to address threats
- Need better assessments of pollinator status…

Challenges of Assessing Pollinator Species Status

Biodiversity in Vermont

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.



Vermont Biodiversity Project

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

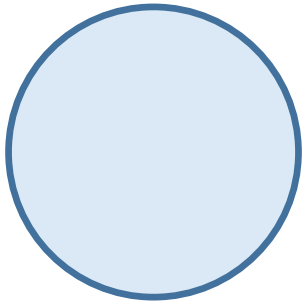
Wasps

Natural Heritage Database

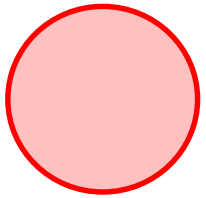
Invertebrates	
Rare Species	206
Common	173
Nonnative / Accidental	53
***Status Unknown**	**604**
***Total**	**1036**

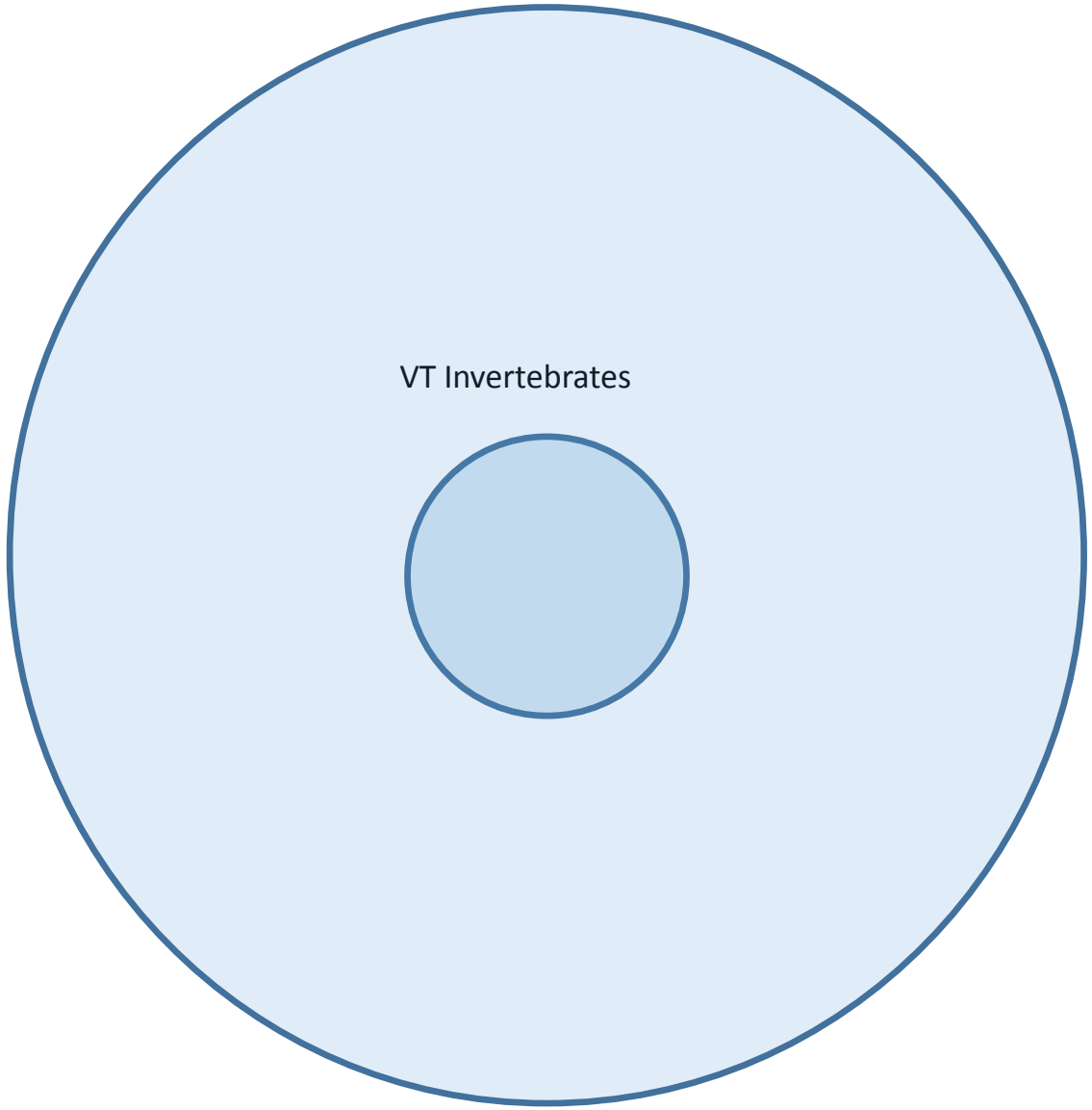
Vertebrates	
Rare Species	159
Common	216
Nonnative / Accidental	76
***Status Unknown**	**6**
***Total**	**457**

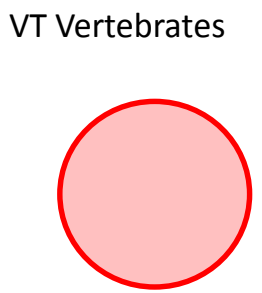
VT Invertebrates



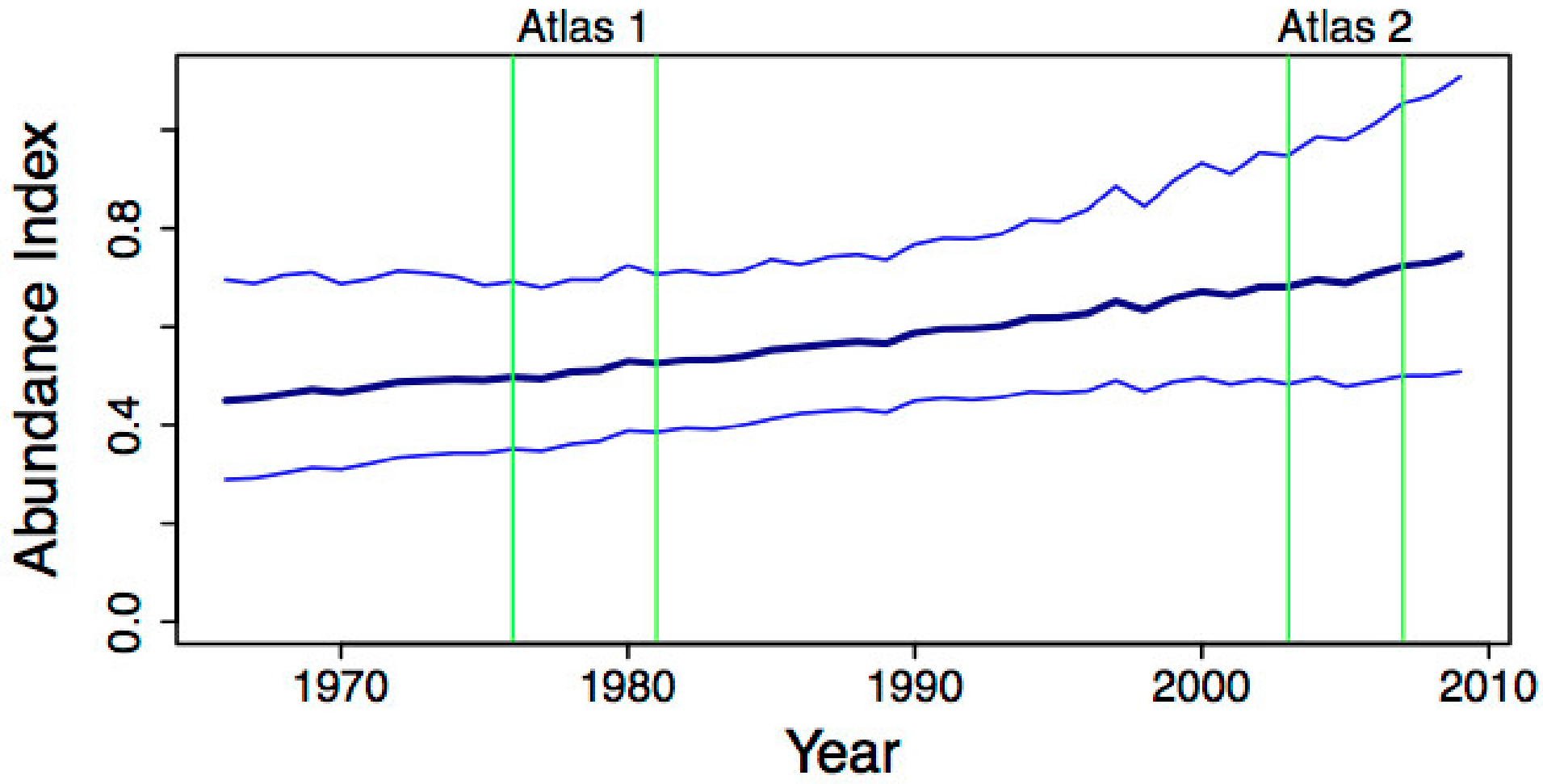
VT Vertebrates

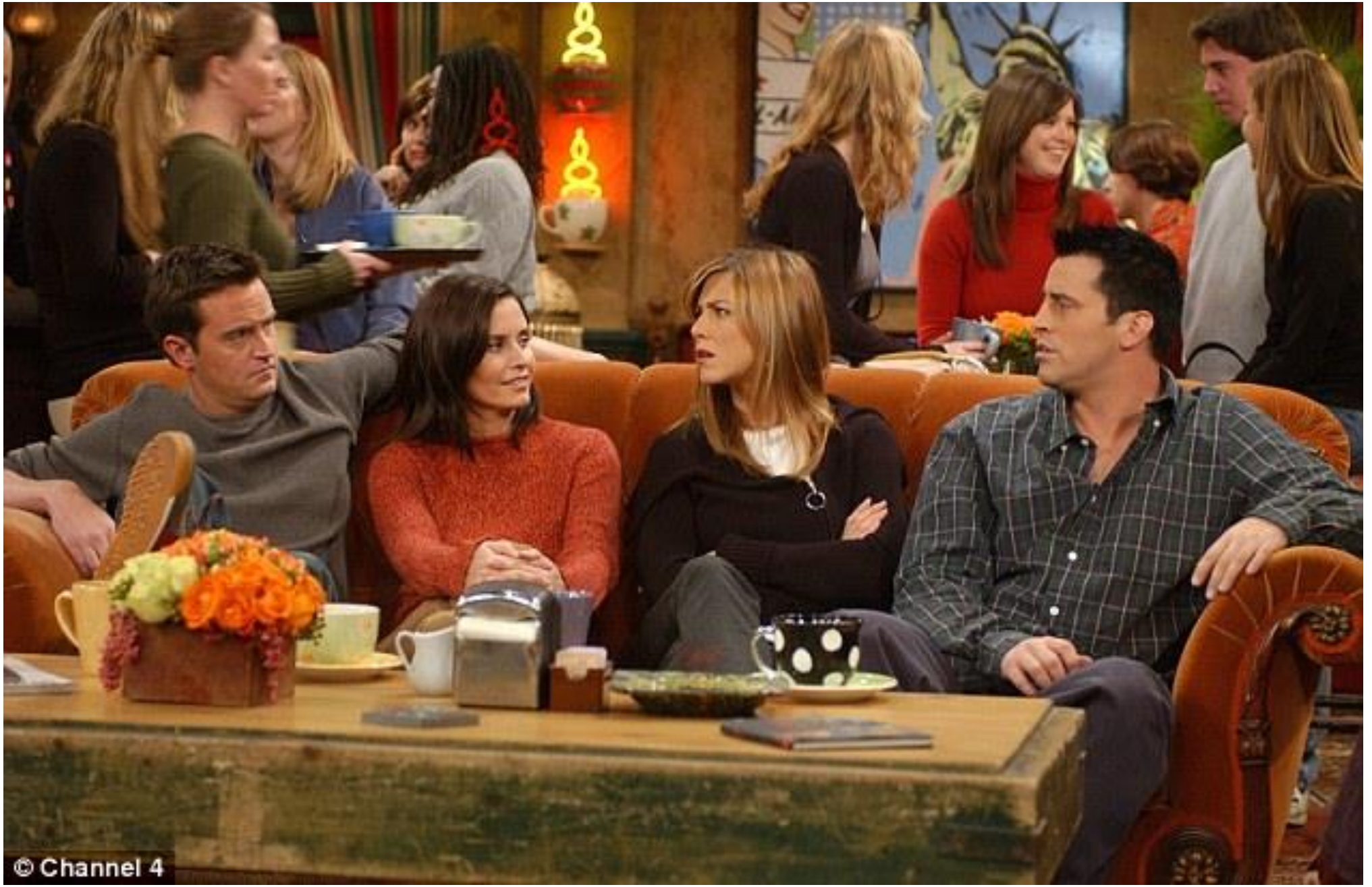



VT Invertebrates


VT Vertebrates


© Dave Hollender


Atlas 1
Atlas 2
Abundance Index
0.0
0.4
0.8
1970
1980
1990
2000
2010
Year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Vermont Bumble Bee Survey 2012-2014

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The University of Vermont

Vermont Center for Ecostudies

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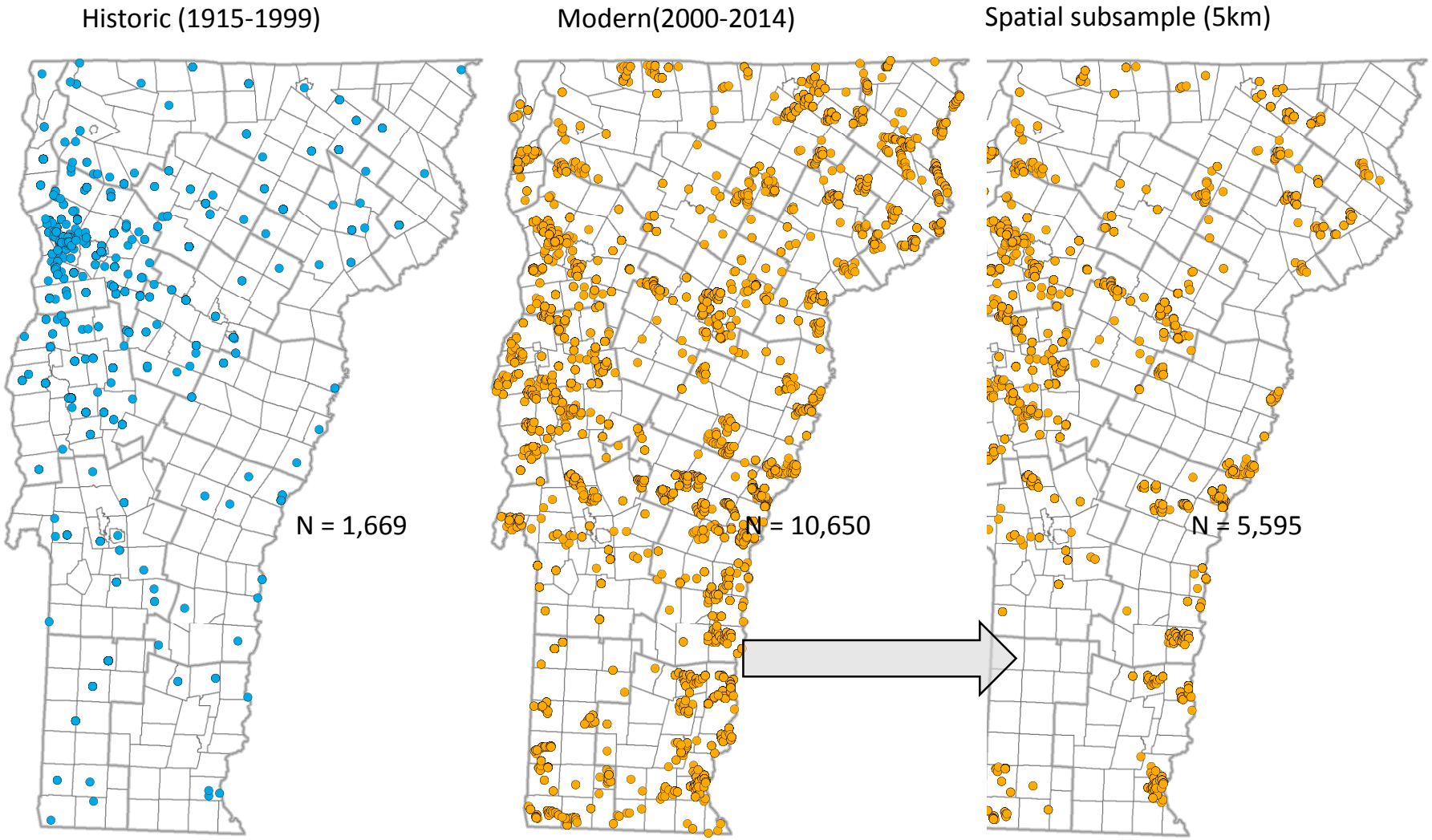
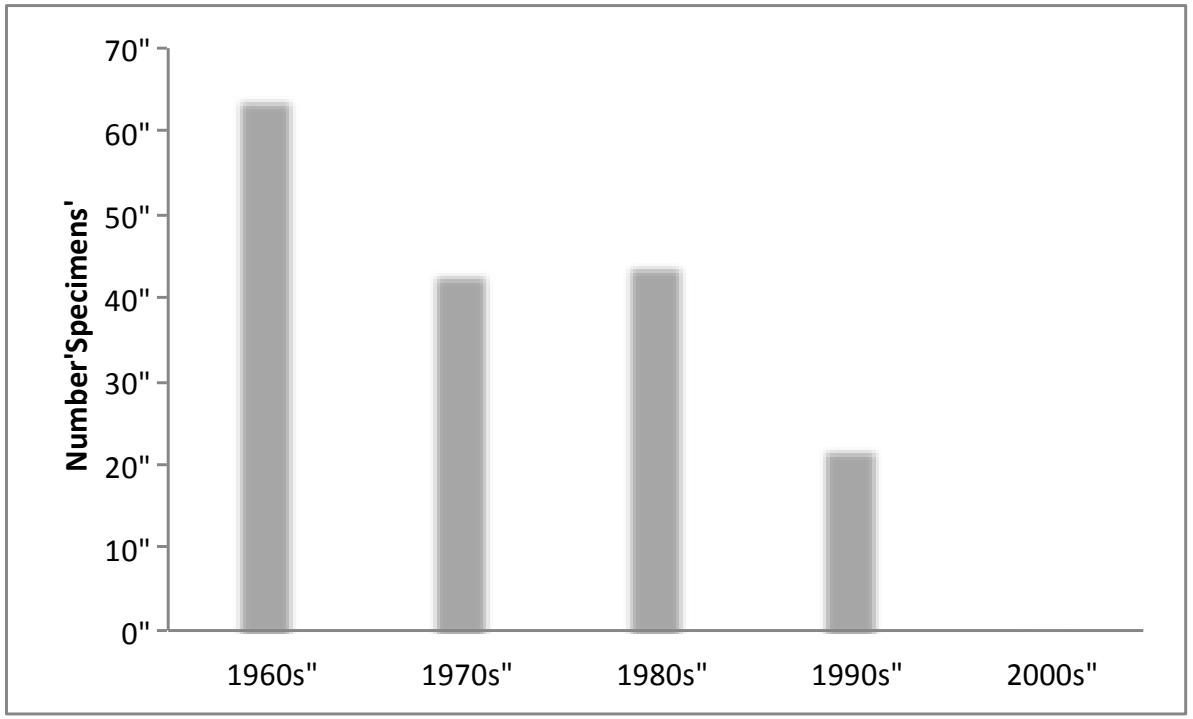
Vermont Fish & Wildlife

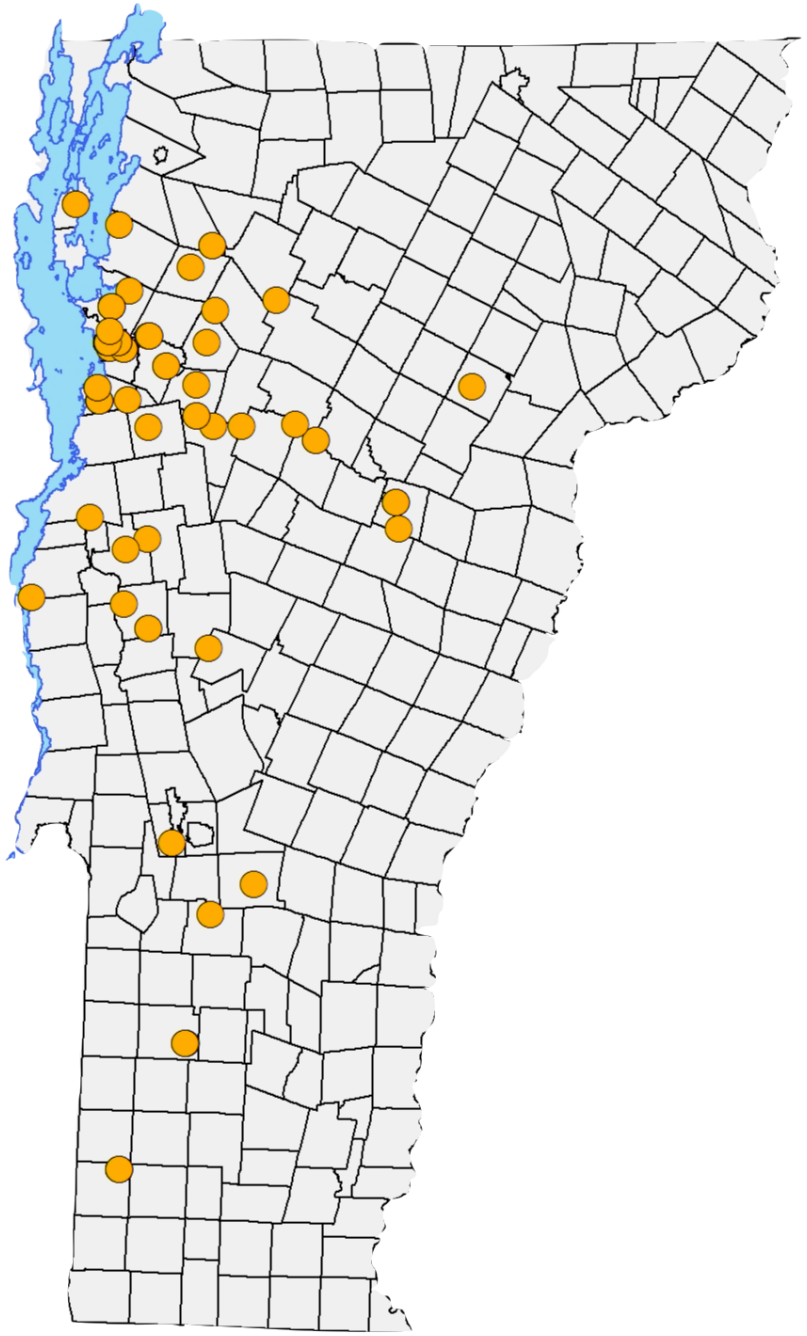
The data


Historic (1915-1999)
Modern(2000-2014)
Spatial subsample (5km)
N = 1,669
N = 10,650
N = 5,595

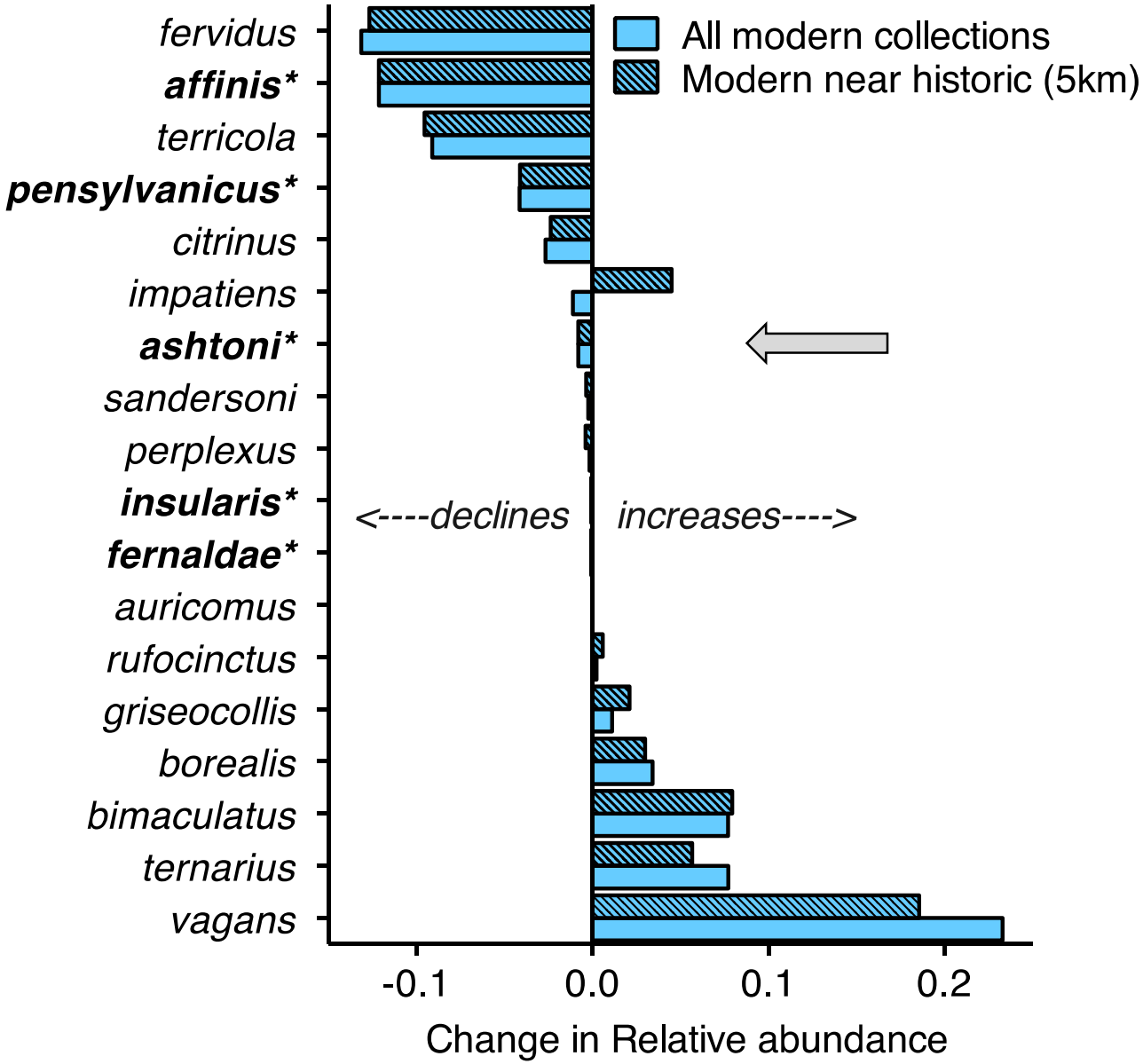
Bombus affinis Disappears



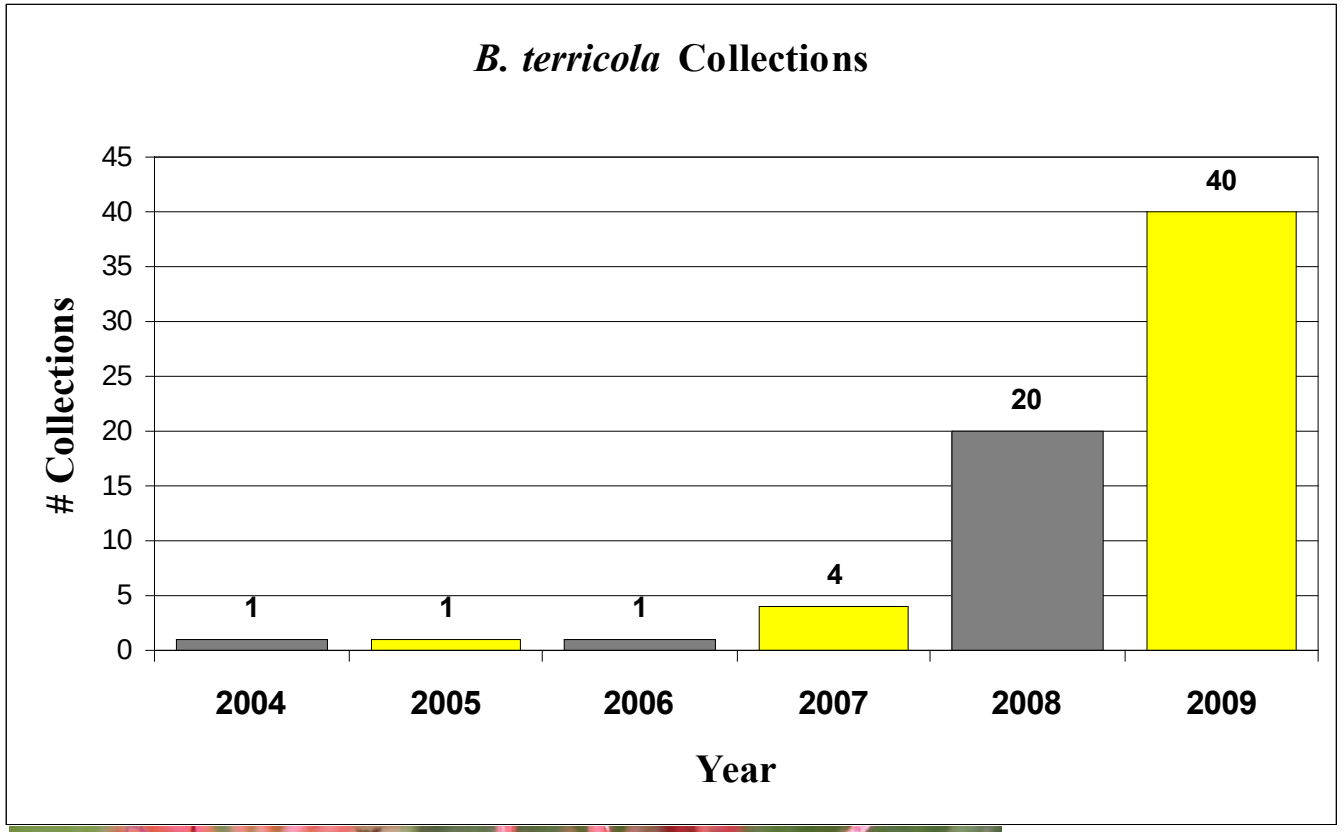
The number of *Bombus affinis* records by decade in Vermont.

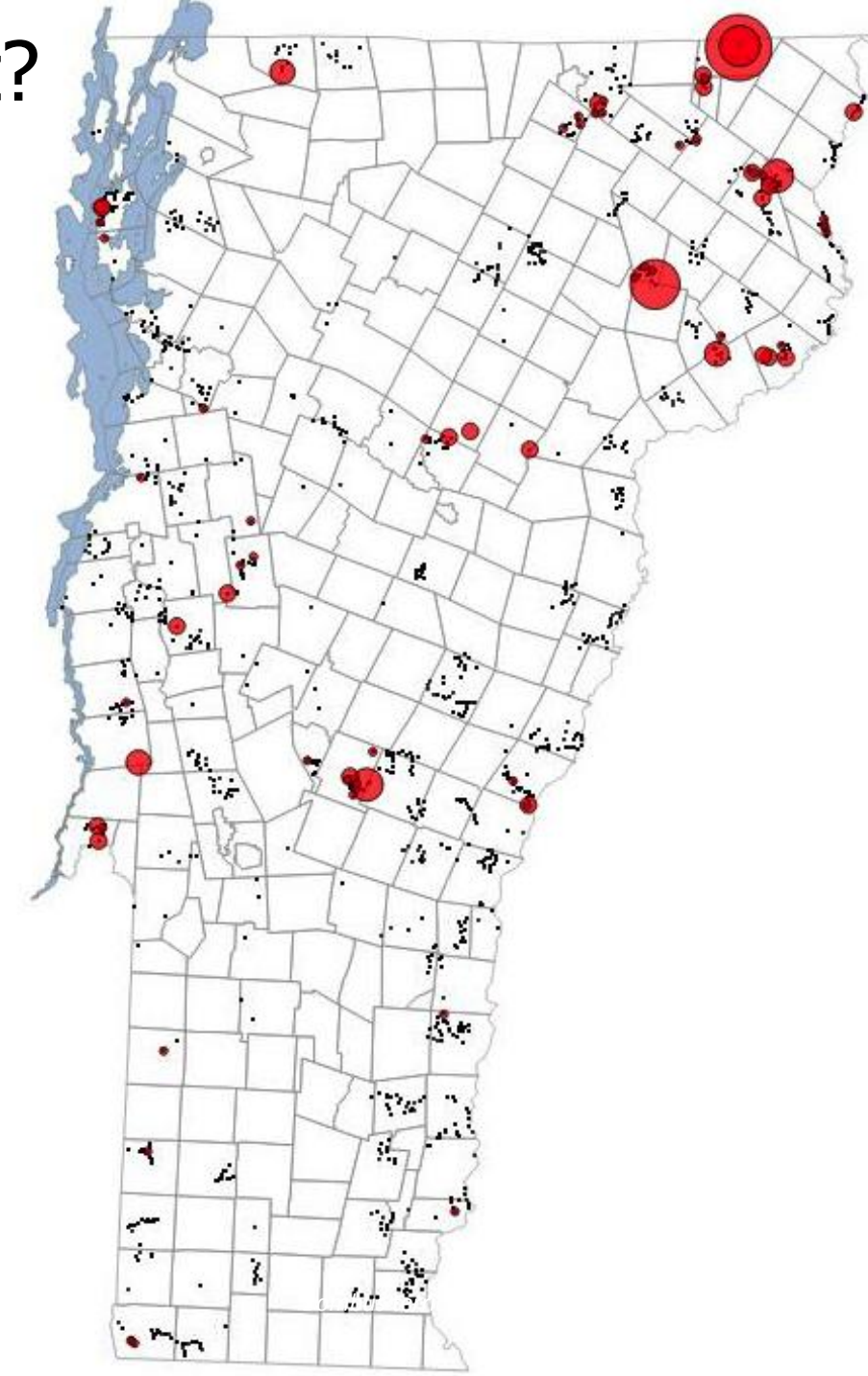


Changes in relative abundance



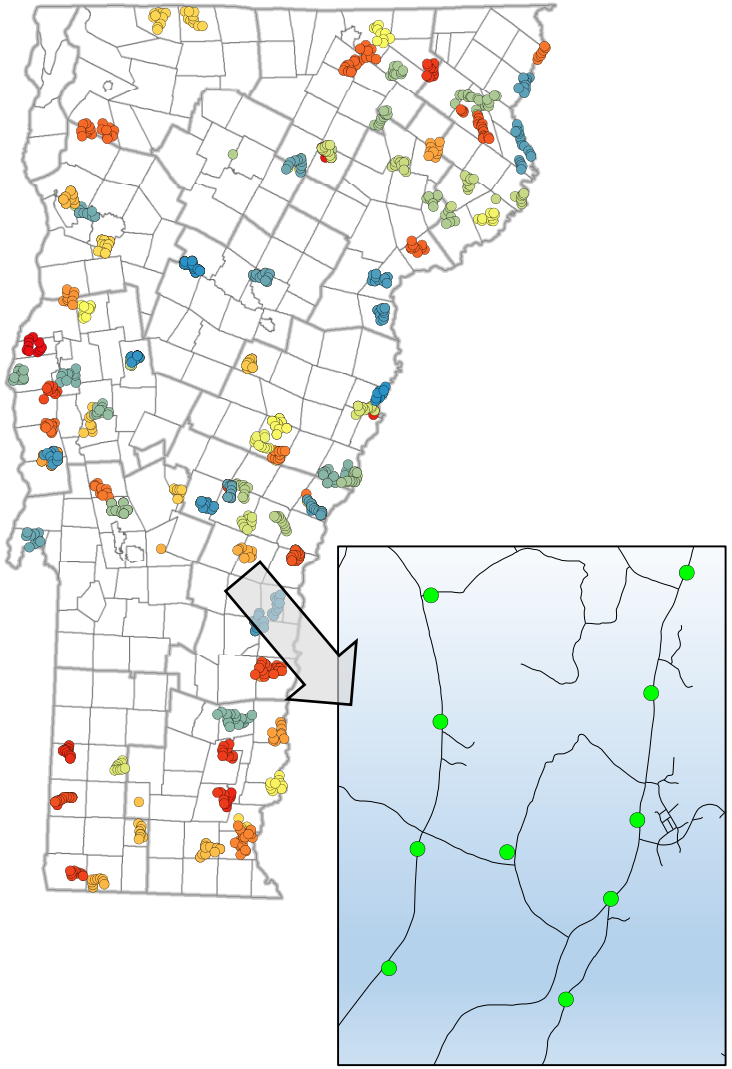
Is *Bombus terricola* recovering in Vermont?





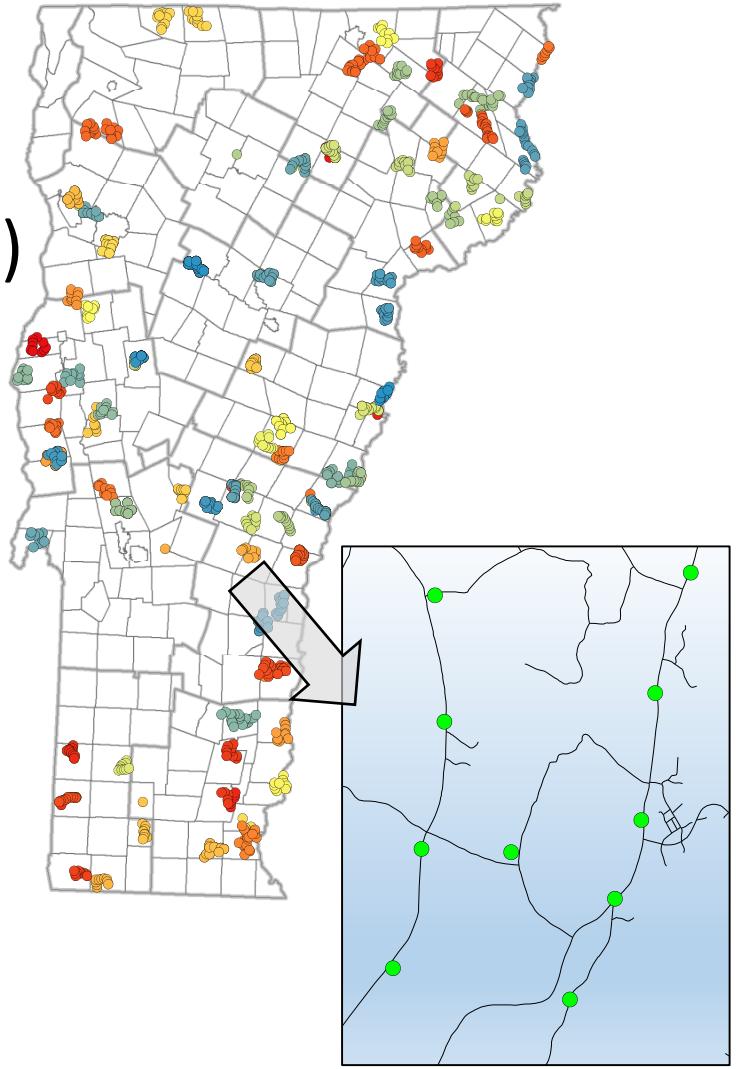
Standardized roadside surveys

- 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%

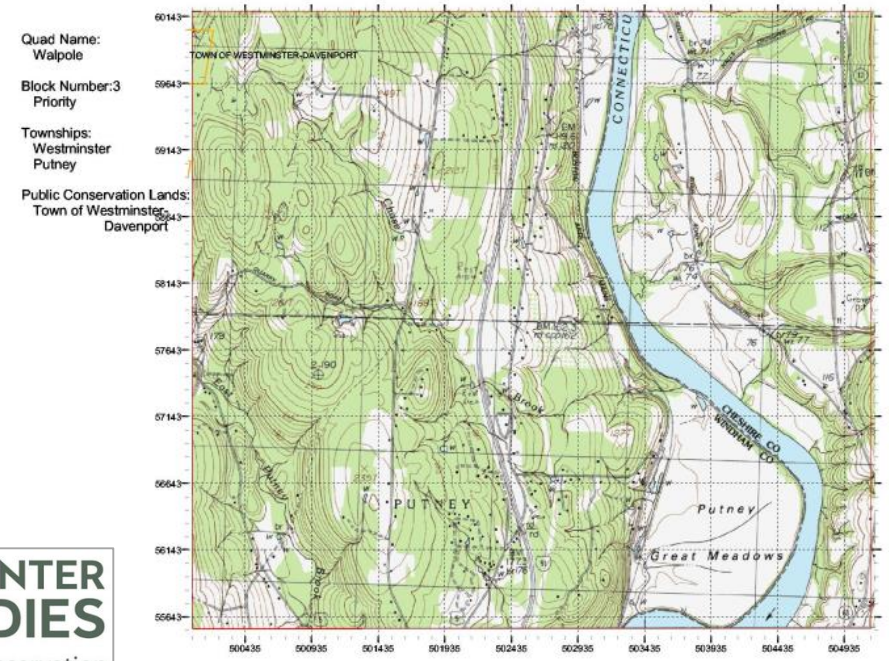


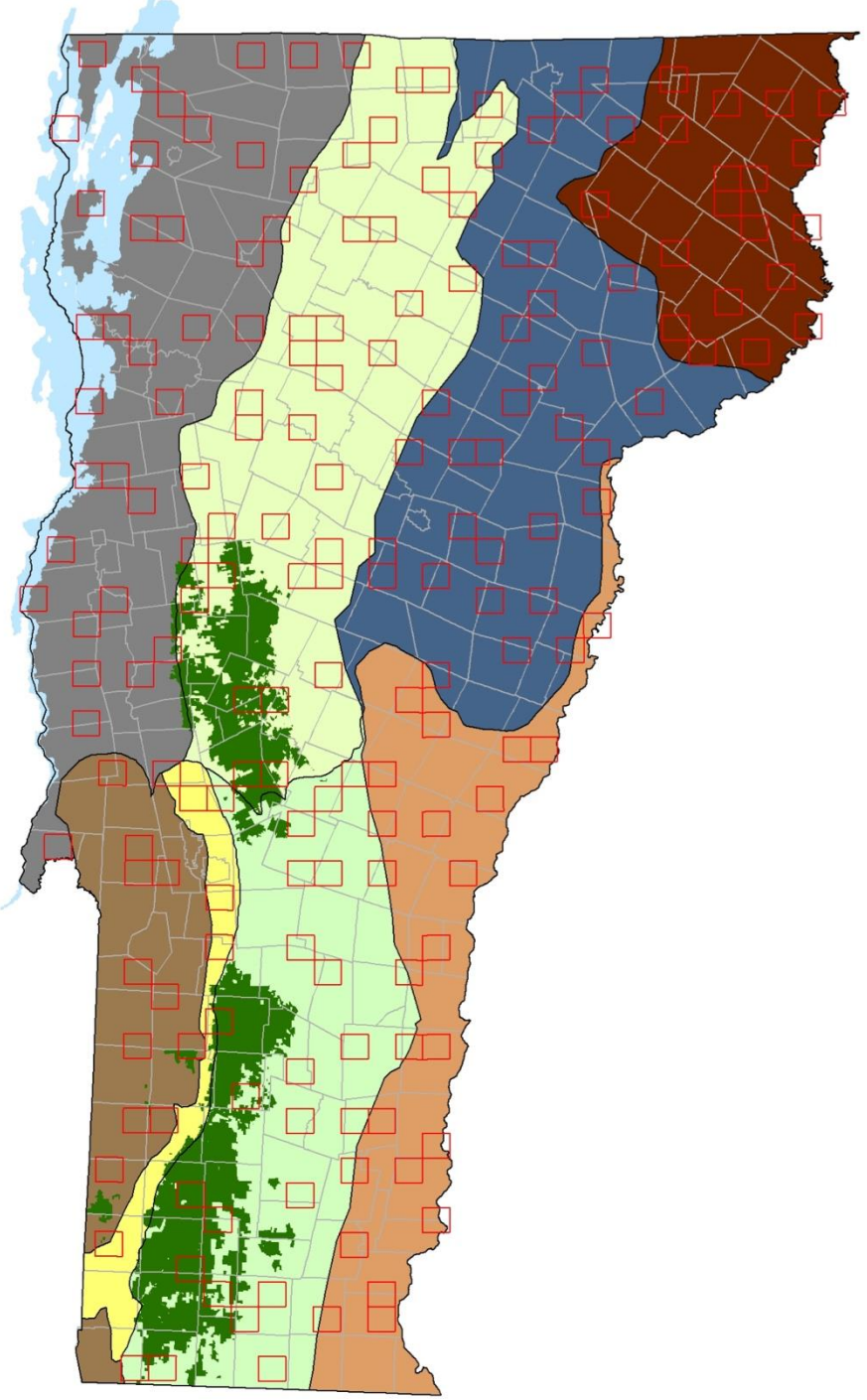
Diversity and Abundance (@500m)

Response	Variable	Estimate	SE	t	P	Effect
Shannon's H	**Grasslands**	0.23	0.11	2.12	**0.0344**	+
	Development	-0.01	0.22	-0.06	0.9555	
	Forest	-0.01	0.09	-0.10	0.9210	
	Day of year	0.00	0.00	4.15	**0.0001**	+
	Elevation	0.00	0.00	-1.58	0.1144	
	Roads (500m)	0.00	0.02	0.06	0.9539	
Abundance	Grasslands	2.28	1.18	1.94	**0.0528**	(+)
	Development	1.91	2.37	0.81	0.4191	
	Forest	2.05	0.99	2.08	**0.0379**	+
	Day of year	0.03	0.01	5.81	**0.0001**	+
	Elevation	0.00	0.00	-1.30	0.1938	
	Roads (500m)	-0.02	0.18	-0.13	0.8992	
Richness	**Grasslands**	0.81	0.28	2.89	**0.0039**	+
	Development	0.28	0.56	0.49	0.6235	
	Forest	0.15	0.23	0.63	0.5273	
	Day of year	0.00	0.00	2.77	**0.0058**	+
	Elevation	0.00	0.00	-1.52	0.1278	
	Roads (500m)	-0.04	0.04	-0.96	0.3349	

Vermont Butterfly Survey

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.





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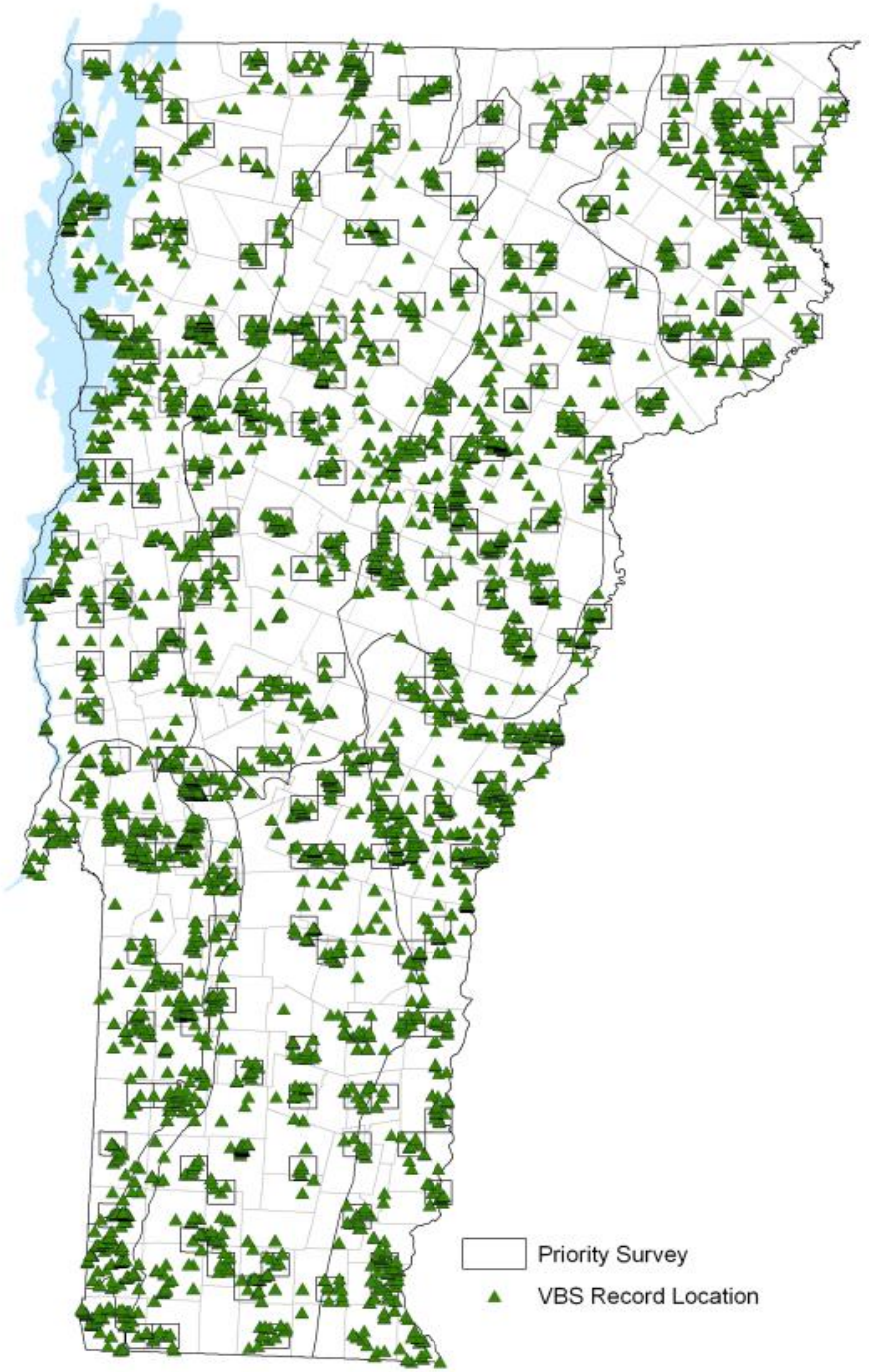
Vermont Butterfly Survey



Species of Greatest Conservation Need

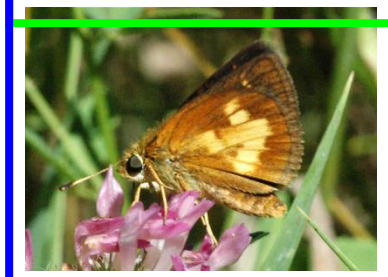
West Virginia white
(*Pieris virginiensis*)

Early hairstreak
(*Erora laeta*)

Hackberry emperor
(*Asterocampa celtis*)

Tawny emperor
(*Asterocampa clyton*)

Edward's hairstreak
(*Satyrium edwardsii*)



Mulberry wing
(*Poanes massasoit*)

Dion skipper
(*Euphyes dion*)

Black dash skipper
(*Euphyes conspicua*)

Two-spotted skipper
(*Euphyes bimacula*)

Bog copper
(*Lycaena epixanthe*)

Broad-winged skipper
(*Poanes viator*)

Dusted skipper
(*Lycaena epixanthe*)

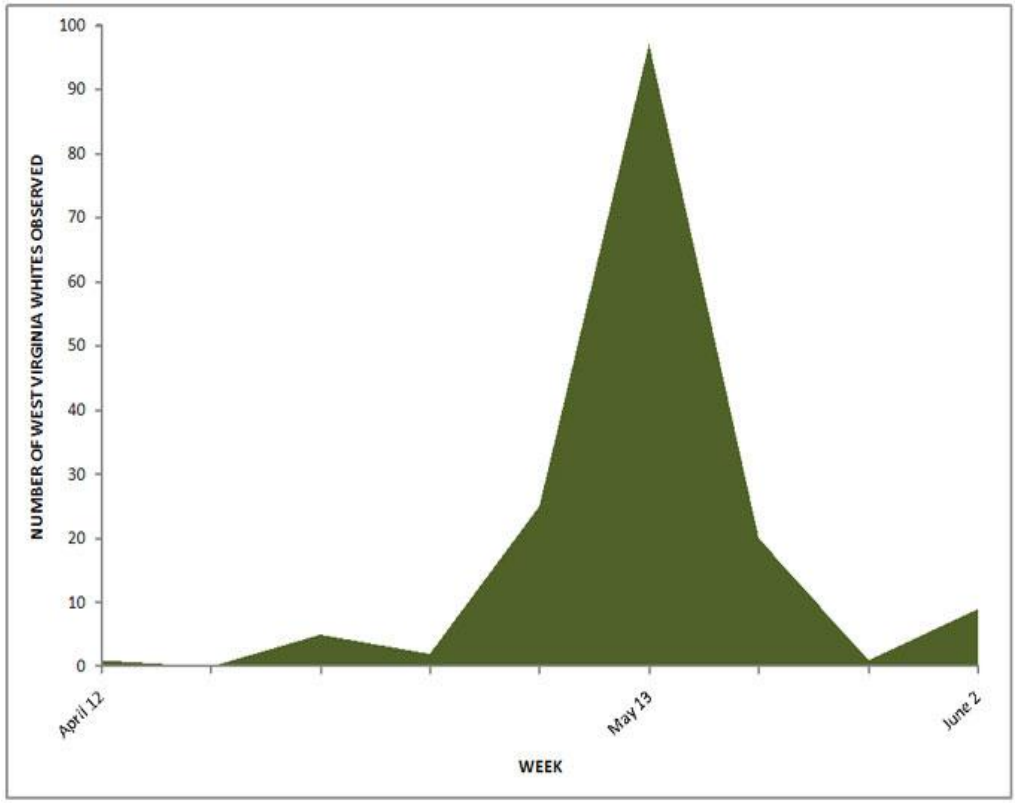
Cobweb skipper
(*Hesperia metea*)

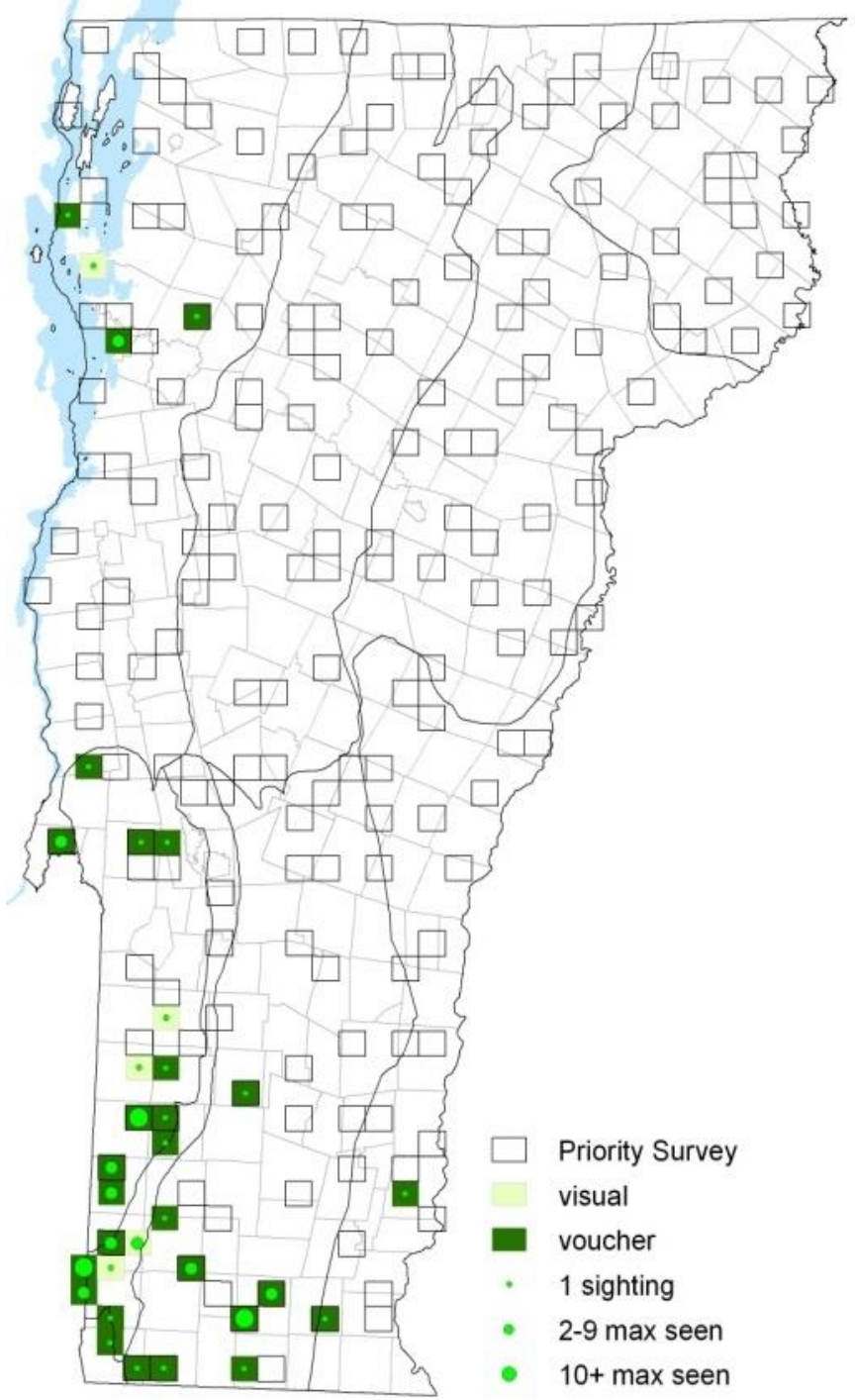
Persius duskywing
(*Erynnis persius*)

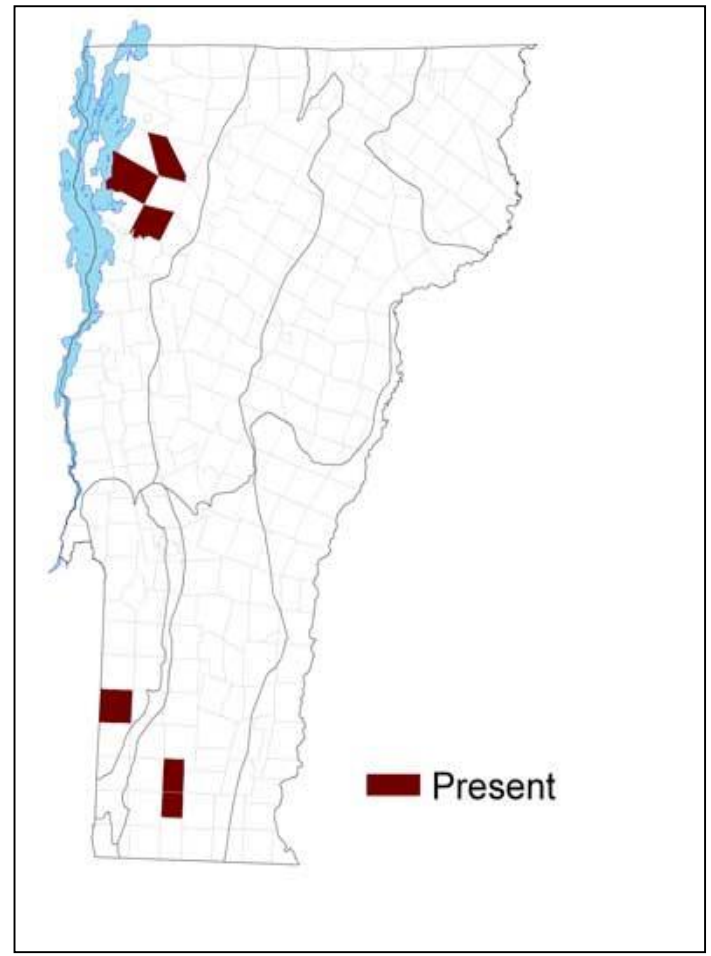
Jutta arctic
(*Oeneis jutta*)

Life History of the West Virginia White

Toothwort




Priority Survey
visual
voucher
1 sighting
2-9 max seen
10+ max seen


Present

Conservation Issues

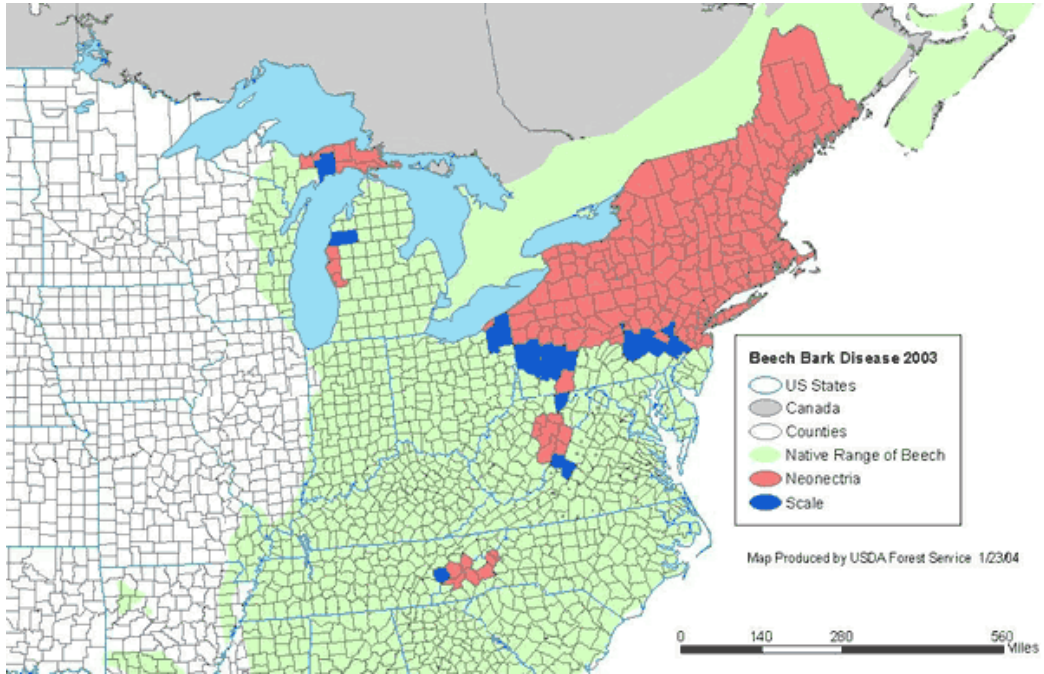
- Mid-nineteenth century deforestation and fragmentation
- Poor spring weather / host plant senescence
- Garlic-mustard (Alliaria petiolata) introduced to Long Island in 1868

Life History of Early Hairstreak

Erora laeta female

Beech Bark Disease

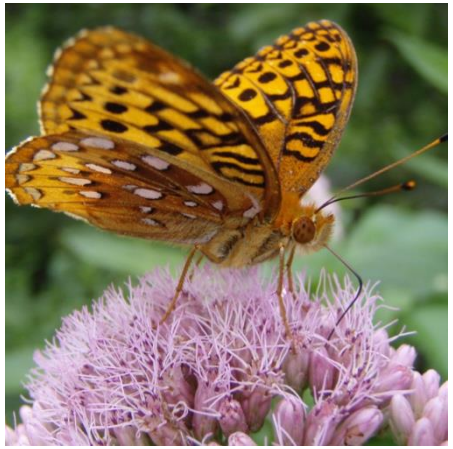
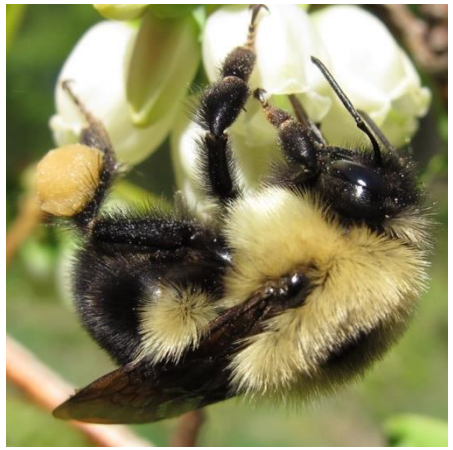
Beech bark disease is caused by a unique relationship between an introduced insect called the Beech Bark Scale (Cryptococcus fagisuga), and Nectria fungi (Nectria coccinea and N. galligena). It was accidentally introduced to North American at Halifax, Nova Scotia in 1890 on a shipment of ornamental trees.

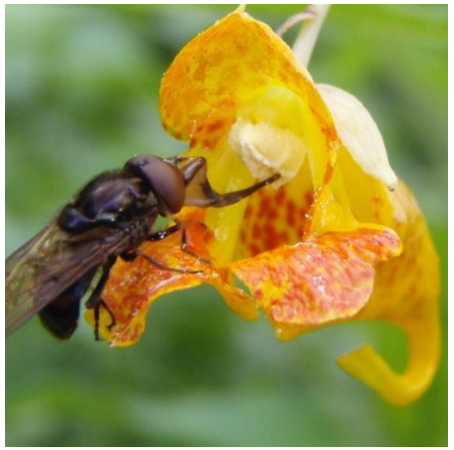


Recent data from plots in Vermont, New Hampshire, and Maine show that about 28 percent of the large beech died, another 22 percent were dying, and many of the surviving trees were severely injured.

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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- Collections: Middlebury, UVM, Lyndon State, Dartmouth College, American Museum of Natural History
- Sam Droege, USFWS
- Taylor Ricketts, UVM
- Rebecca Irwin, North Carolina State U

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