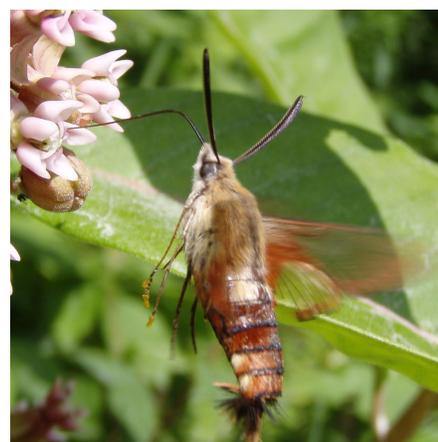


Pollination in the Green Mountains: Insects, Agriculture, and Us



Leif Richardson

USDA Postdoctoral Research Fellow
Gund Institute for Ecological Economics, UVM

leif.richardson@uvm.edu

www.leifrichardson.org



What is pollination?

- Coevolved mutualism between plants and pollinators
- Exchange of food for service of pollen transfer



THE PROCESS OF POLLINATION

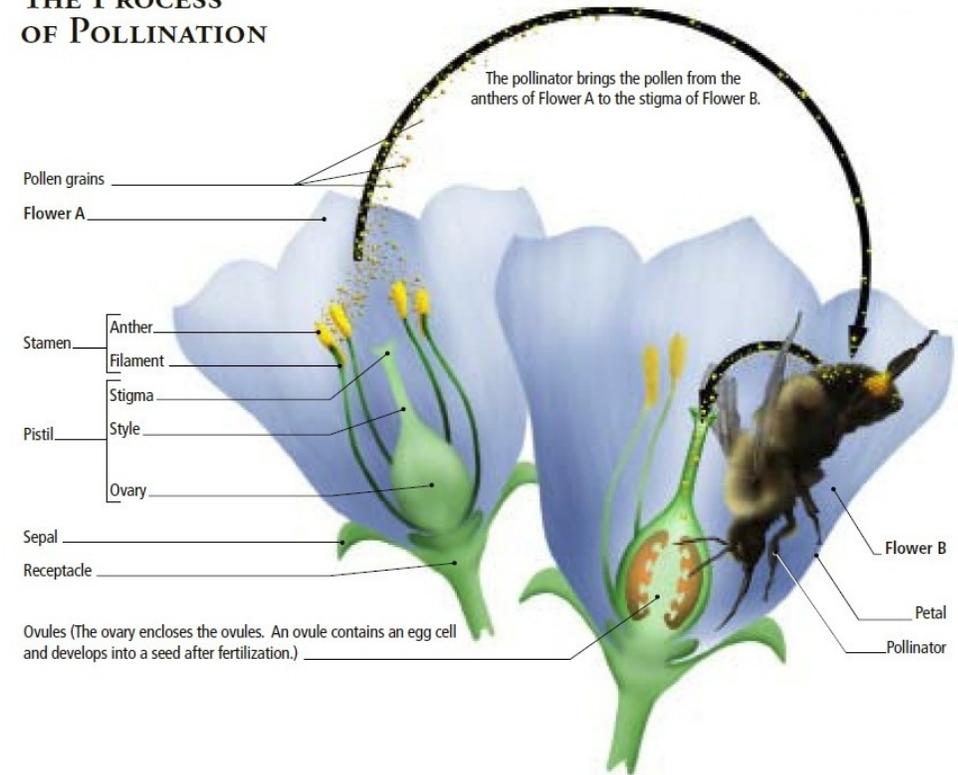


Image: Canadian Wildlife Federation

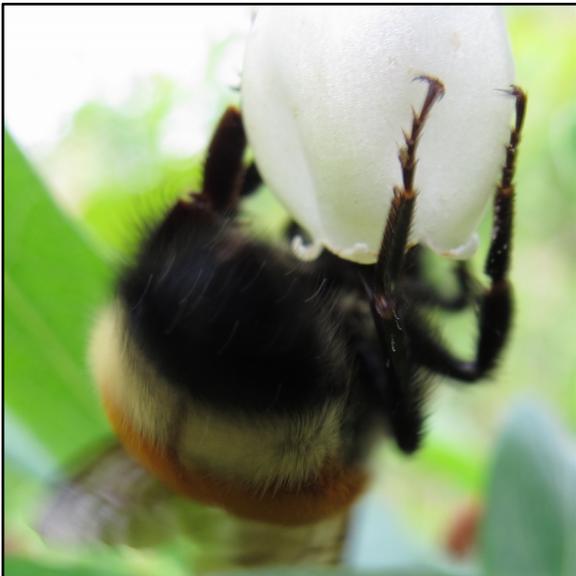
Pollination, a critical ecosystem service

- 88% of flowering plants are animal pollinated
- 75% of crop plants benefit from animal pollination
- Pollination = 10% of total value of agriculture
- 20,000 species of bees (honey bee = 1)
- *Wild bees often vital for pollination, regardless of honey bee presence*



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. Potts¹, Jacobus C. Biesmeijer², Claire Kremen³, Peter Neumann⁴, Oliver Schweiger⁵ and William E. Kunin²

¹ Centre for Agri-Environmental Research, School of Agriculture, Policy and Development, University of Reading, Reading, UK, RG6 6AR
² Earth and Biosphere Institute and Institute of Integrative and Comparative Biology, University of Leeds, Leeds, UK, LS2 9JT
³ Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3114, USA
⁴ Swiss Bee Research Centre, Agroscope Liebefeld-Posieux, Research Station ALP, Schwarzenburgstrasse 161, CH-3003 Bern, Switzerland
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. Kunin¹

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

^aDepartment of Entomology and Institute for Genomic Biology, University of Illinois, Urbana, IL 61801; ^bUnited States Department of Agriculture-Agricultural Research Service Pollinating Insects Research Unit, Utah State University, Logan, UT 84322; ^cDepartment of Biology, Utah State University, Logan, UT 84321; and ^dIllinois 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
- Reduction in plant reproductive success



Who are Vermont's pollinators?

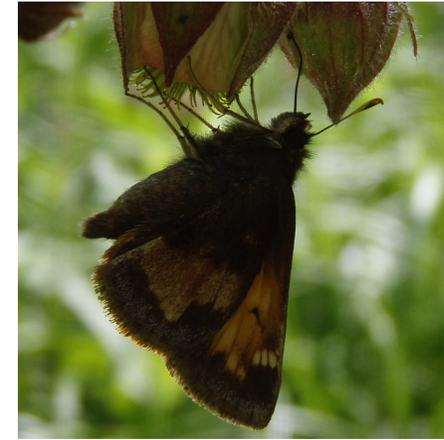
- Bees
- Flies
- Butterflies and moths
- Wasps and ants
- Beetles
- Birds
- Thrips

1. Butterflies and moths (Lepidoptera)

- Pollinators of native plants
- Declines of VT grassland butterflies
- Declines, range retractions, and shifts: California, US prairies, UK, EU
- Vermont?



Vermont Lepidoptera pollinators



2. Flies

- 71 fly families feed at flowers
- Pollinate >100 crop plants, including mango, onion, canola, cacao
- Changes in hoverfly diversity in UK, Netherlands
- What about Vermont?



Vermont fly pollinators

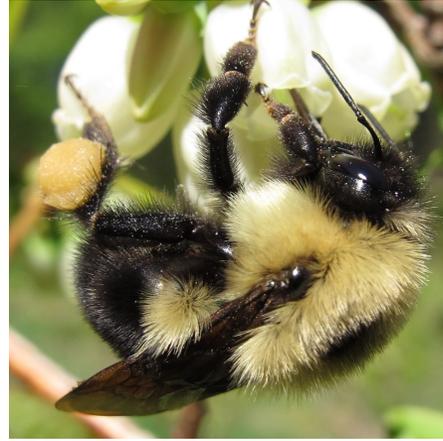


3. Bees

- Plant pollen = protein source for bees
- Range retractions: EU, UK, North America
- Diversity declines: UK, Netherlands, North America, EU, Asia, S. America
- Evidence of competition with non-native bees driving some bee losses



Vermont bee pollinators

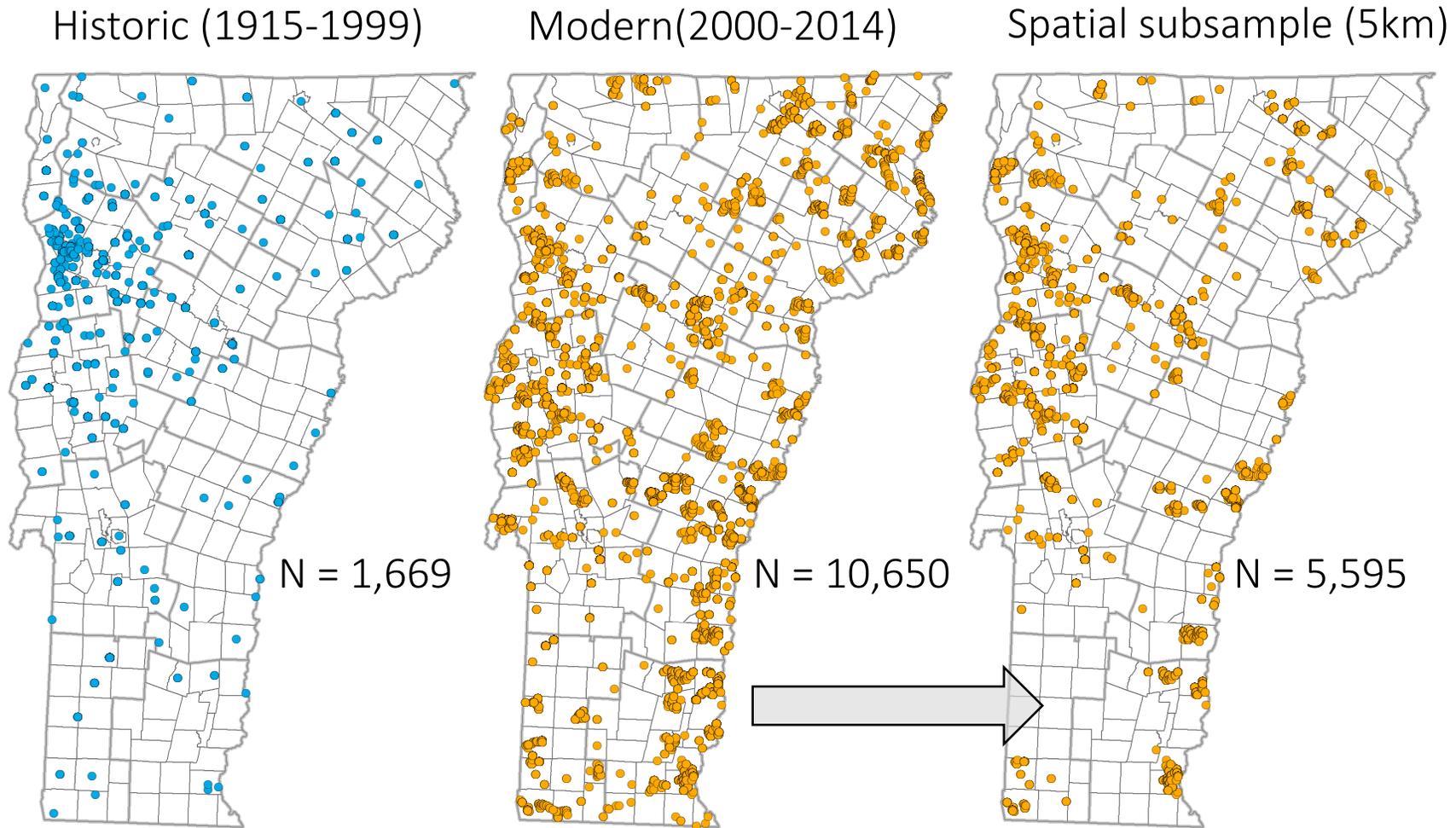


Status of bumble bees in Vermont?

- Modern collections (2000-2014)
 - N = 10,650
 - Citizen science volunteers
- Historic collections (1915-1999)
 - N = 1,669



The data

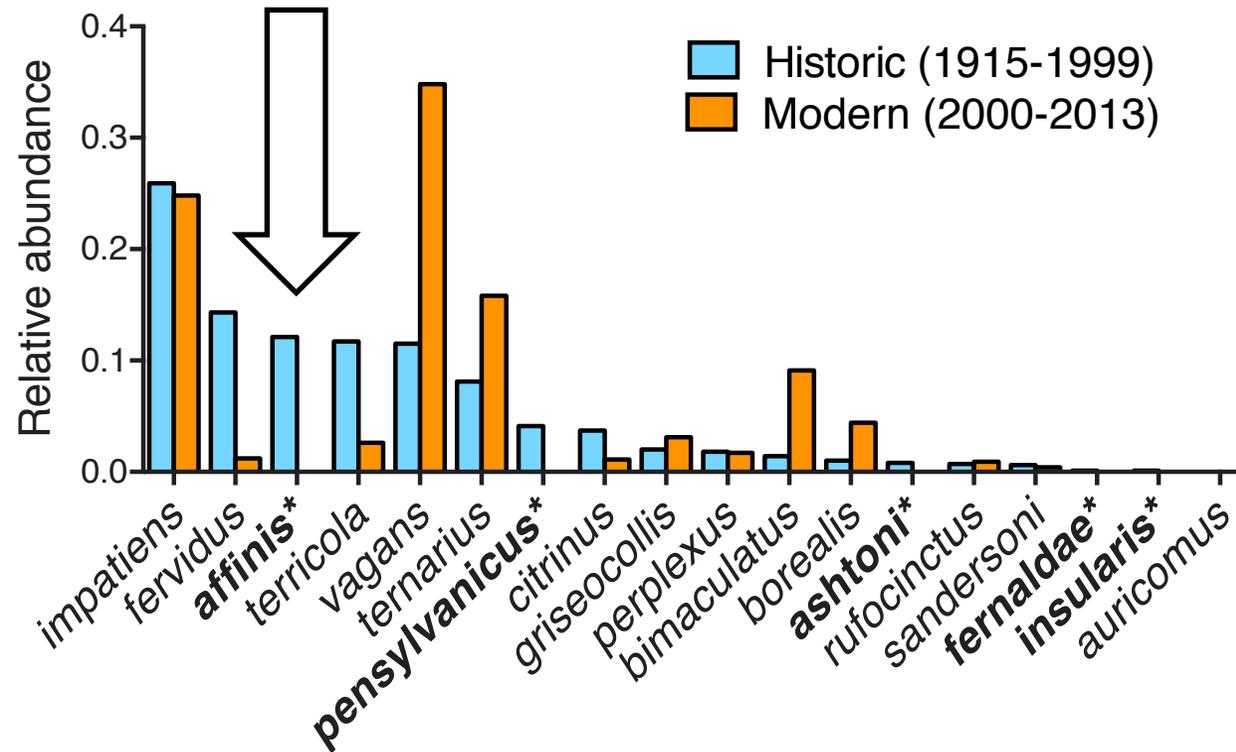


Bee declines—relative abundance

- Loss of species, changes in relative abundance



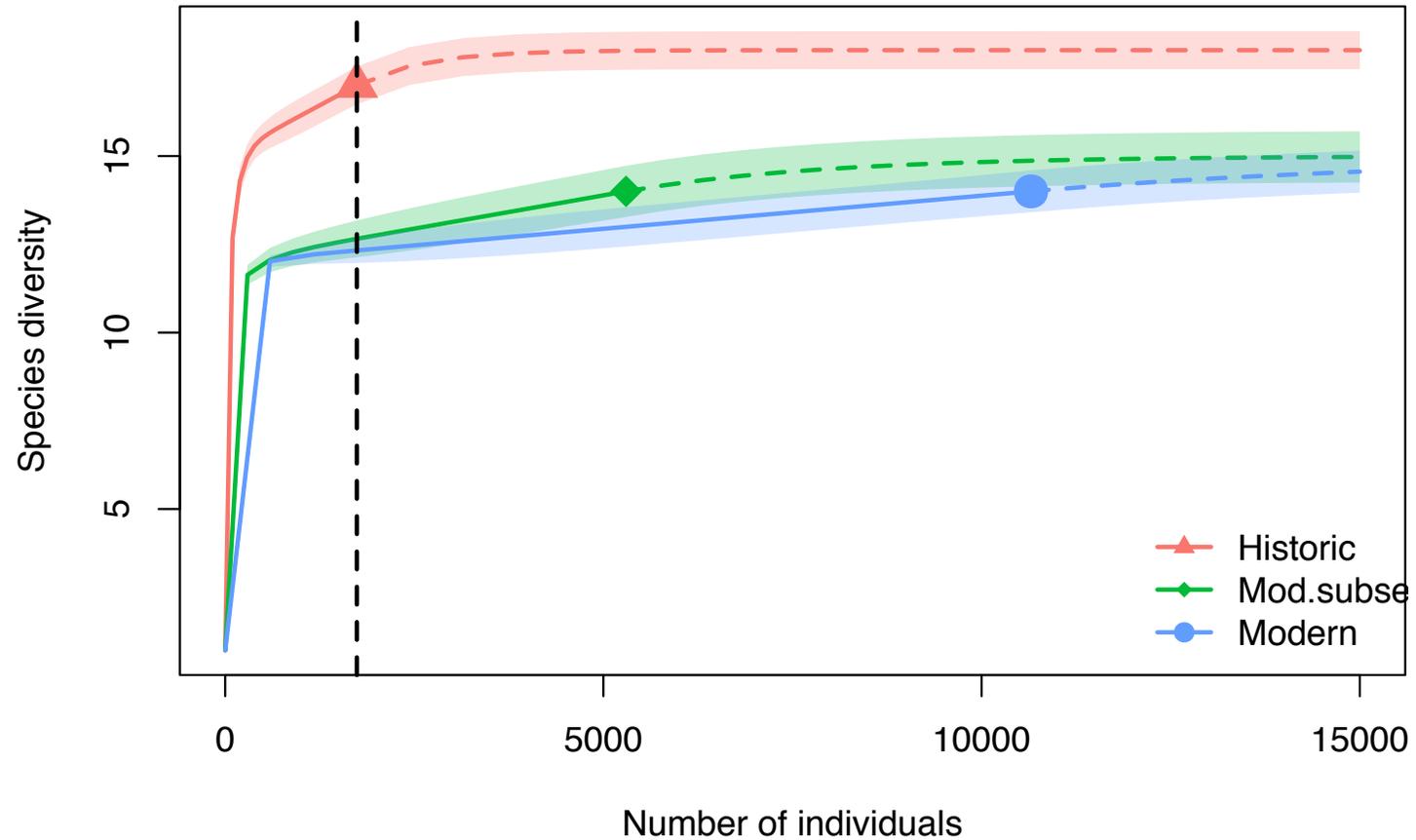
Rich Hatfield, Xerces



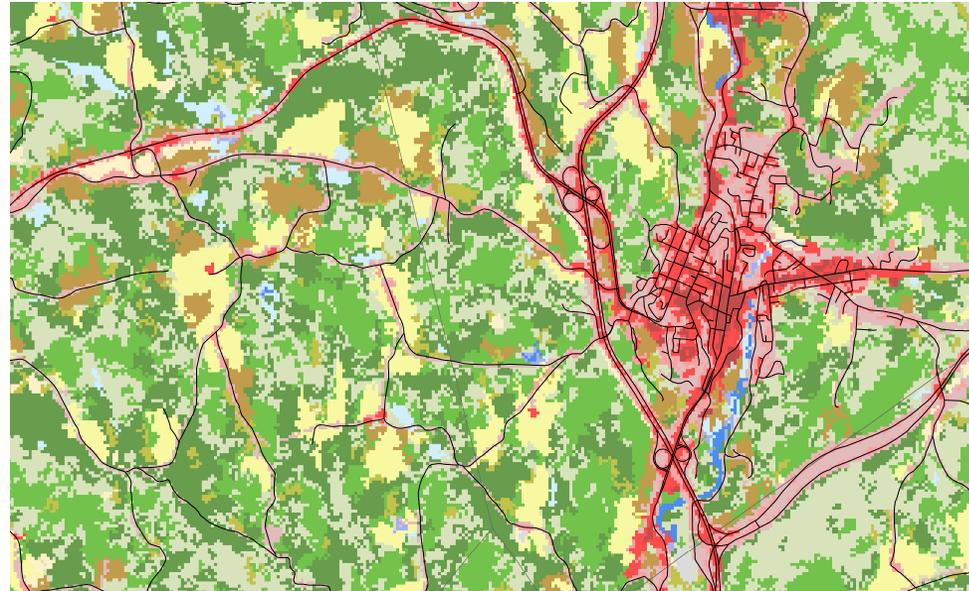
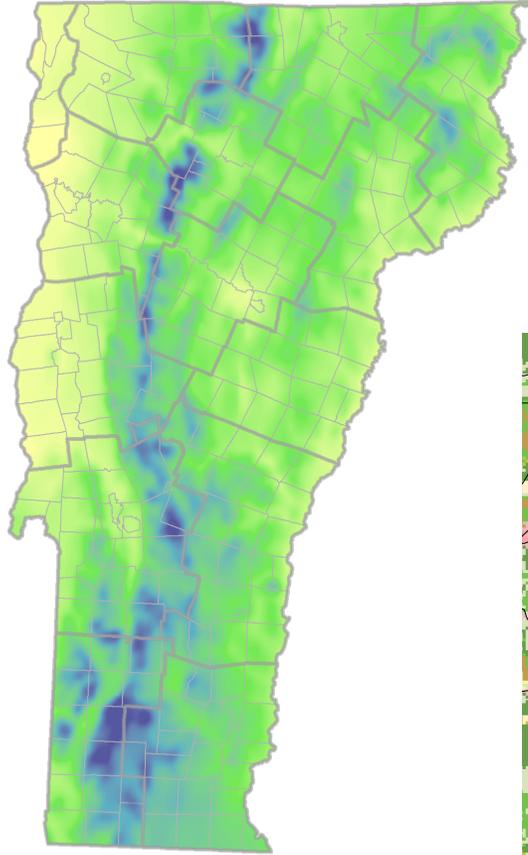
- Loss of 28% of historical diversity

Bee declines—species diversity

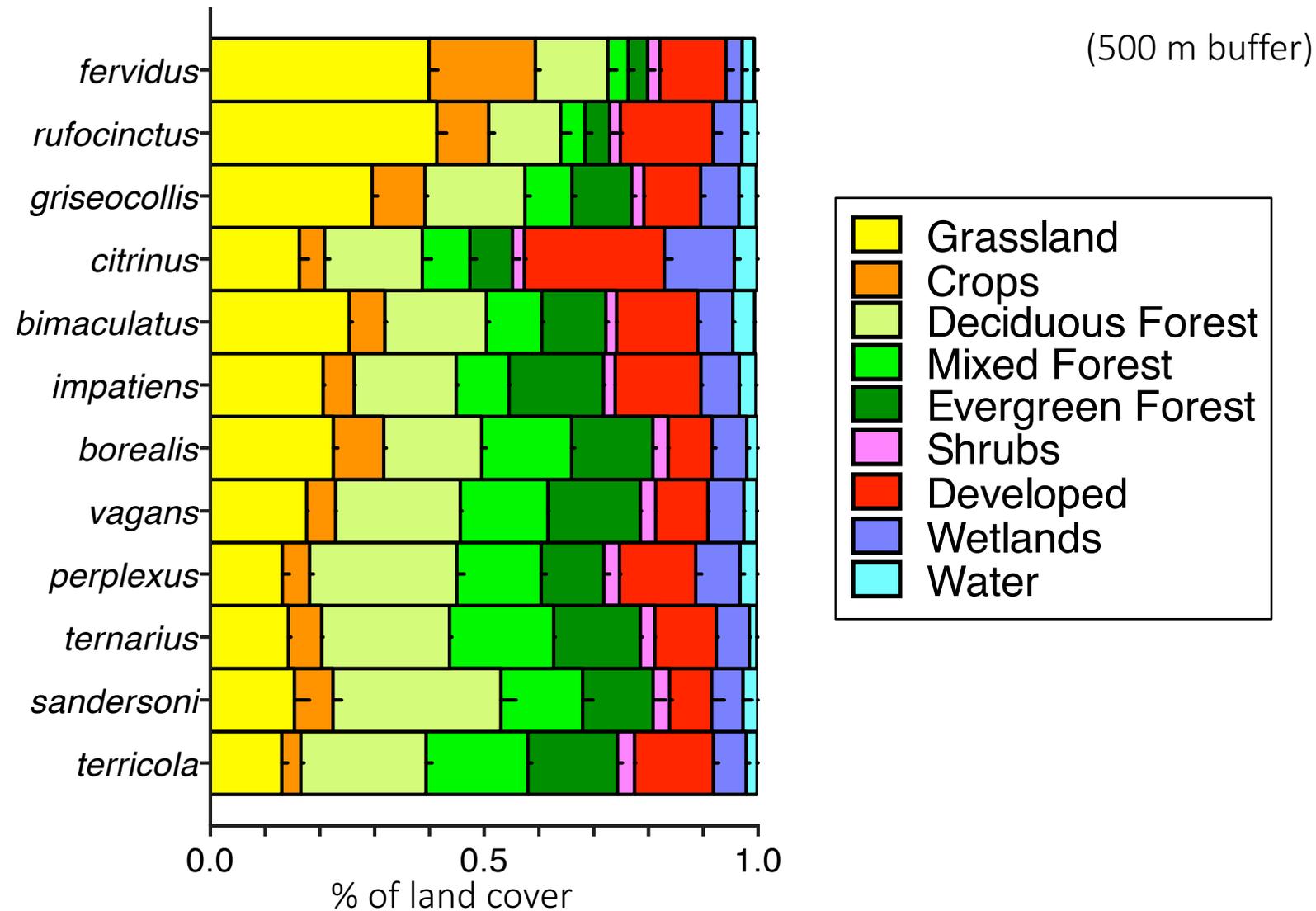
- Vermont has lost bumble bee species



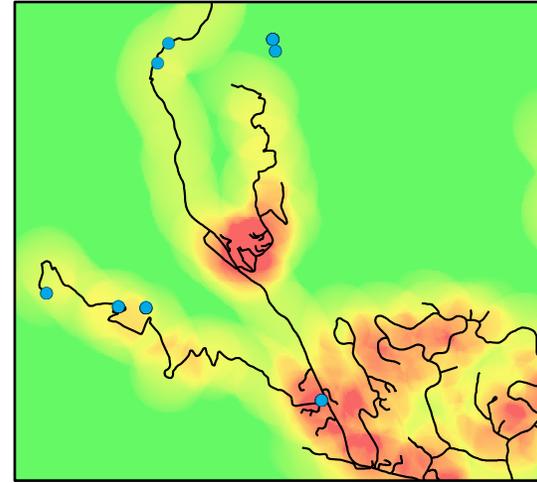
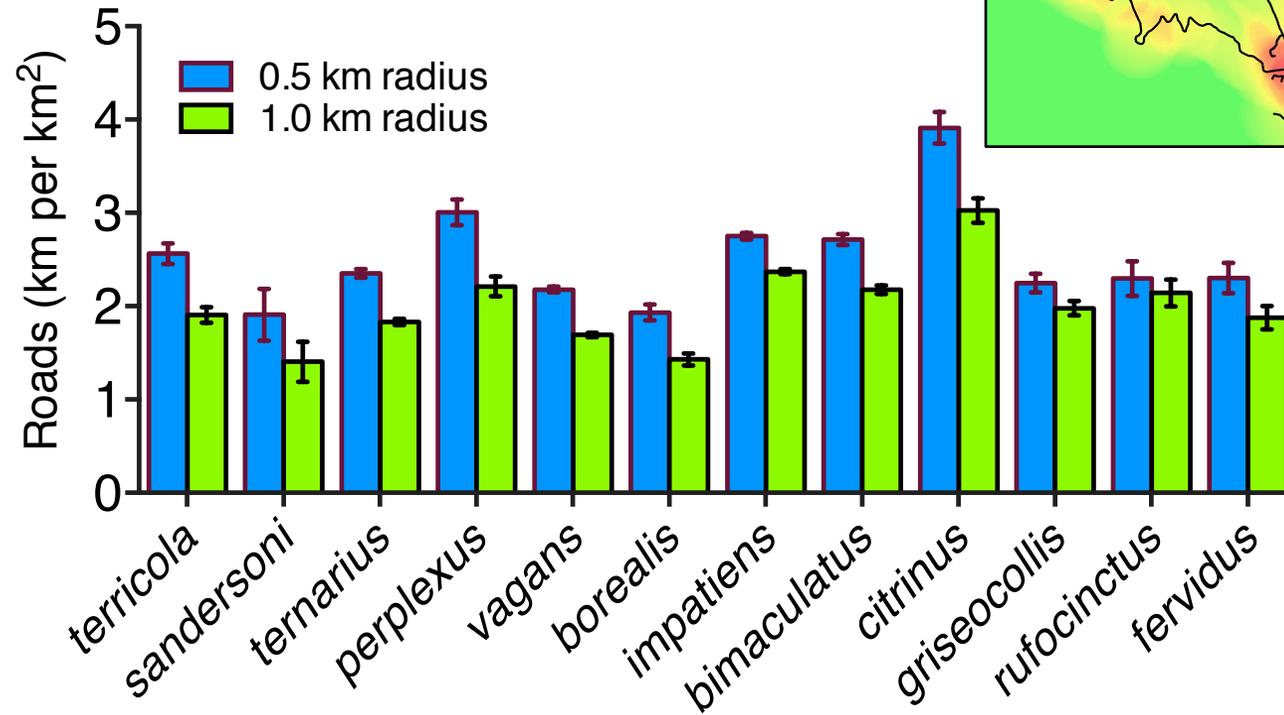
Landscape changes affect bee persistence



Effect of landscape on bee occurrence

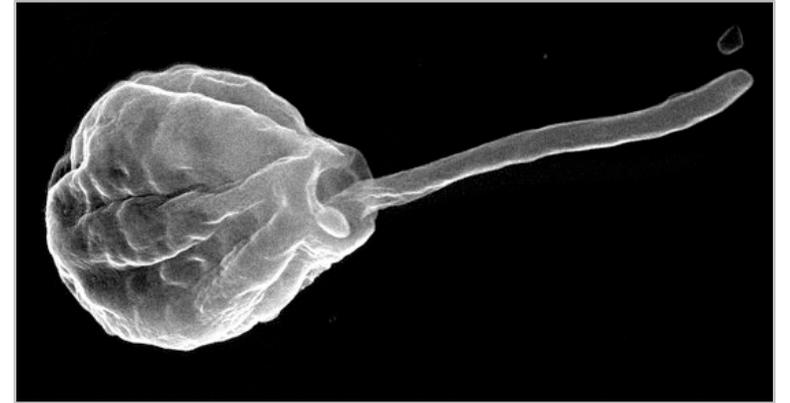


Association with roads



Why are bees (& other pollinators) declining?

- Habitat loss
- Disease
- Pesticides
- Climate change



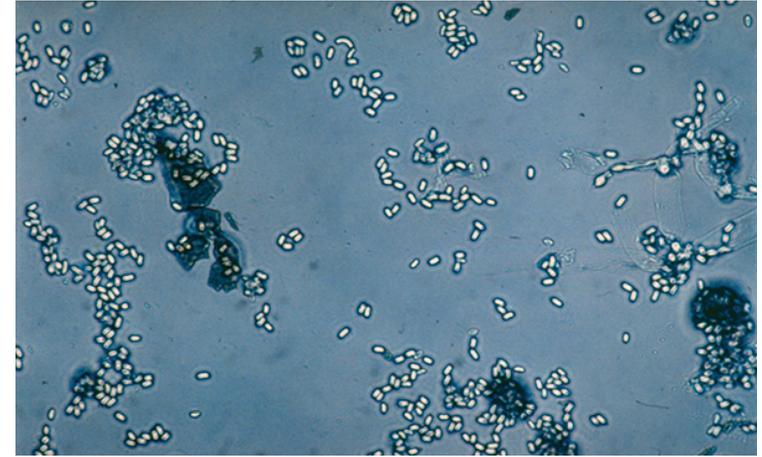
Habitat loss

- Habitat conversion, fragmentation
- Change—e.g., increased efficiency of ag, incentives, technology
- Documented negative effects on flies, butterflies and bees



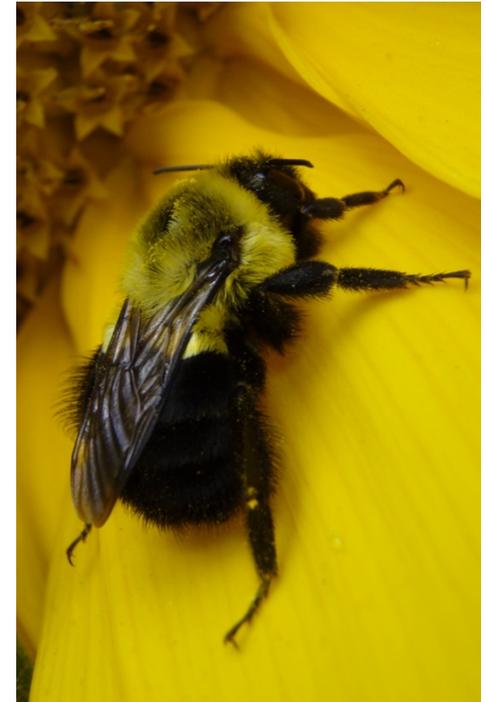
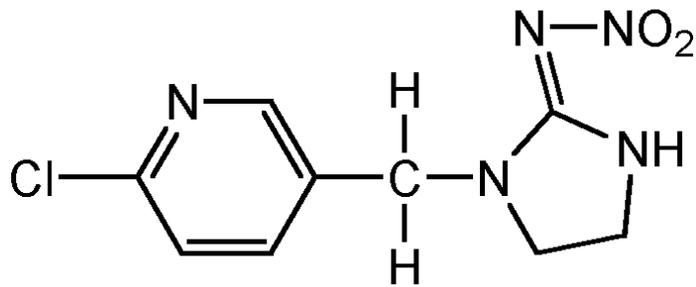
Disease

- Pathogen spillover from commercial bees



Pesticides—insecticides, fungicides, herbicides

- Neonicotinoids, many others
- Lethal, sublethal and synergistic effects on consumers
- Linked to declines in bee abundance and diversity



Climate change

- Range contractions: bumble bees
- Phenological mismatch for plants and pollinators
- Negative effects on survival, reproduction: solitary bees (*Osmia*)
- Rapid evolutionary change?

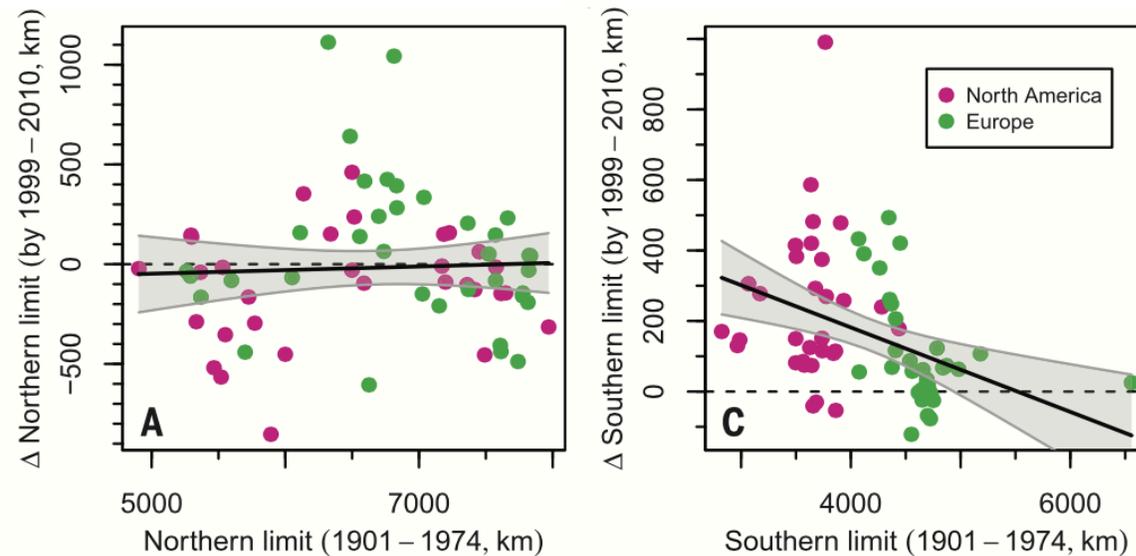


Bumble bee declines due to climate change

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

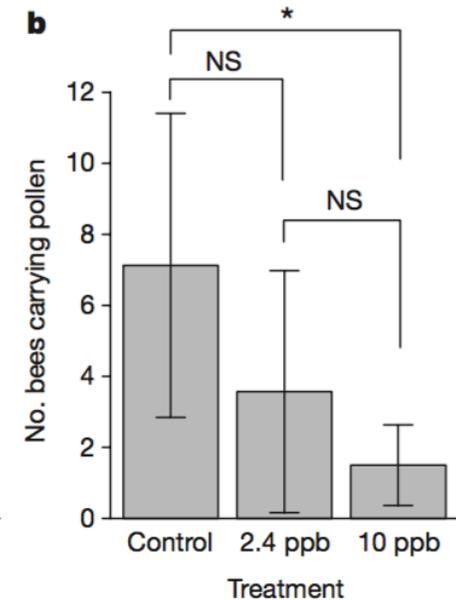
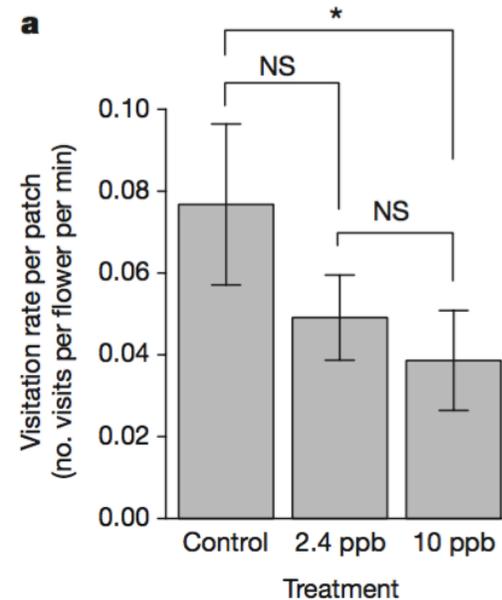
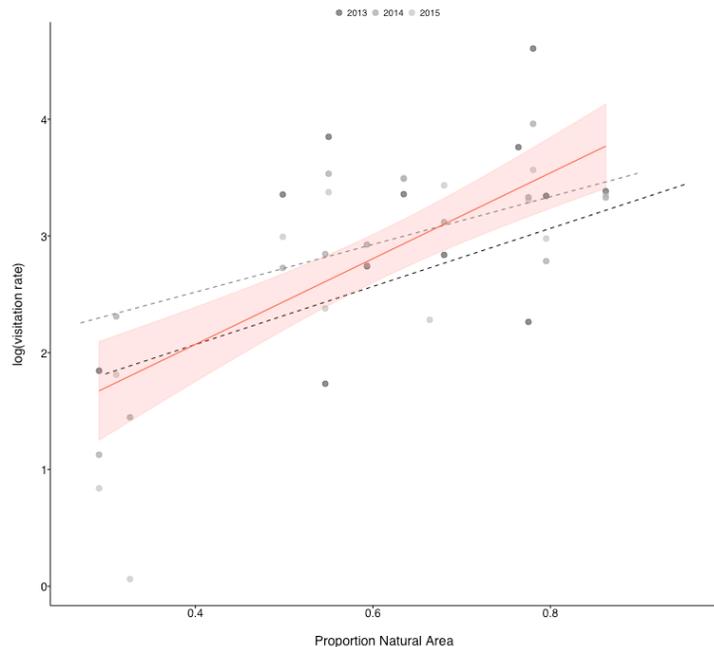


Kerr et al., *Science* 2015



We can measure effects of threats on agriculture

- Blueberry in VT: Pollination service increases with % natural area around farms (Nicholson et al. *in review*)
- Apple in UK: Neonicotinoid exposure reduces bee pollination service to trees (Stanley et al. 2015)



Solutions for a pollination crisis?

- Rethinking agriculture: pesticides, land management
- Habitat restoration/ enhancement
- Better regulation of disease in commercial bee industry
- Increased funding for assessments of bee, fly, butterfly/ moth and other pollinator taxa.
- Address climate change effects
 - CO₂
 - Predict effects and adapt (research needed)

Acknowledgements

- Taylor Ricketts, UVM
- Alison Brody, UVM
- Rebecca Irwin, North Carolina State U
- Lynn Adler, U Massachusetts, Amherst
- M. Deane Bowers, U Colorado, Boulder
- Jeanne Harris, UVM
- Robert Hondal, UVM
- Juha-Pekka Salminen, University of Turku
- Samantha Alger, UVM
- Charlie Nicholson, UVM
- Kent McFarland, Vermont Center for Ecostudies
- Sara Zahendra, Vermont Center for Ecostudies

