Pollinator Protection Efforts in Vermont:
UVM IPM Program & VT Pollinator Protection Committee

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RESEARCH ASST PROF
TREE FRUIT & VITICULTURE SPECIALIST
DIRECTOR, CATAMOUNT EDUCATIONAL FARM
CHAIR, VT POLLINATOR PROTECTION COMMITTEE (2016-2017??)

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My involvement in Pollinator Work in VT

- Apple grower, researcher, educator, 1995-present
- Support staff for Fruit IPM Specialist Dr. Lorraine Berkett, 2000-2013
- UVM Fruit IPM Specialist, 2013-present

Who's an 'expert'?

- President of VT Tree Fruit Growers Association, 2009-2014
- Occasional testimony on behalf of orchard industry regarding various pesticide regulation bills
- 2016: VT pollinator Protection Committee
  - Tapped by VT House Speaker Shap Smith
  - Committee met for 1 year by statute, *but we're getting the band back together*

H.539 An Act relating to the establishment of a Pollinator Protection Committee

1. Evaluate the status in Vermont of the U.S. Department of Agriculture's five pillars of pollinator health. The five pillars of pollinator health are: pollinator biology; nutrition and habitat; pathogens and pests; pesticide use; and genetics and breeding.
2. Evaluate the effectiveness of pesticide applicator licensing and other pesticide requirements in the State in protecting pollinator health.
3. Evaluate other state or international pesticide regulations that are more protective of pollinator health than the pesticide regulations of Vermont or the U.S. Environmental Protection Agency.
4. Study available education and outreach plans from other states that have been successful in increasing public awareness of pollinator health issues

H.539 An Act relating to the establishment of a Pollinator Protection Committee

5. Evaluate best management practices for application of neonicotinoid pesticides in a manner that avoids harm to pollinators.
6. Identify possible sources of funds for use in the protection of pollinator health.
7. Consider the requirements in 2015 Vt. Acts and Resolves No. 64 (State Clean Water Act) regarding buffers along State waters and whether and how areas in buffers or other areas that require perennial vegetation should be encouraged for use as pollinator forage zones or pollinator growing areas.
8. Develop a State pollinator protection plan using the framework and critical elements from the Association of American Pesticide Control Officials Pollinator Protection Plan guidance

The Pollinator Protection Committee shall be composed of the following ten members:

1. the **Secretary of Agriculture**, Food and Markets or designee;
2. a person who is a **beekeeper**, appointed by the Governor;
3. a **dairy farmer**, appointed by the Governor;
4. a person representing a **not-for-profit organization** advocating the protection of pollinators, appointed by the Governor;
5. a person who is a **beekeeper**, appointed by the Speaker of the House;
6. a person who is **a university employee with expertise in the protection of pollinators**, appointed by the Speaker of the House;
7. a **tree fruit farmer**, appointed by the Speaker of the House;
8. a **vegetable farmer**, appointed by the Committee on Committees;
9. a **person licensed or certified to sell or apply pesticides**, herbicides, or other economic poisons in the State, appointed by the Committee on Committees; and
10. a person who **owns or operates a greenhouse or plant nursery**, appointed by the Committee on Committees.

Members

Katie Ballard - Ballard Acres Farm, Georgia, VT and Director of Research at W.H. Miner Institute

Eric Boire - Crop Production Services, Addison, Vermont and President of Vermont Tree Fruit Growers Association

Terence Bradshaw - Tree Fruit and Viticulture Specialist, University of Vermont, Chair of the Pollinator Protection Committee

Chris Conant - Claussen's Greenhouses, Colchester, Vermont

Ross Conrad - Dancing Bee Gardens, Middlebury, VT. Member of Vermont & Addison County Beekeepers Associations and a regular contributor to Bee Culture

Cary Giguere - Agrichemical Program Manager and Chair of State FIFRA Issues Research and Evaluation Group (SFIREG)

John Hayden - The Farm Between, Jeffersonville VT

Mike Palmer - French Hill Apiaries, St. Albans, VT. Member of the Vermont Beekeepers Association.

Leif Richardson - Research fellow, Gund Institute, University of Vermont and research associate with the Vermont Center for Ecostudies

Jane Sorensen - River Berry Farm, Fairfax, Vermont. Also owns Northeast Pollinator Plants

VPPC Activities

- Five public meetings 2016-2017
- Review of literature between meetings
- Public testimony & expert witnesses
- Collectively wrote VPPC Report to the Legislature
- https://agriculture.vermont.gov/food-safety/apiary-program/pollinator-protection-committee

What did we (I) learn?

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

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]

[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. 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)

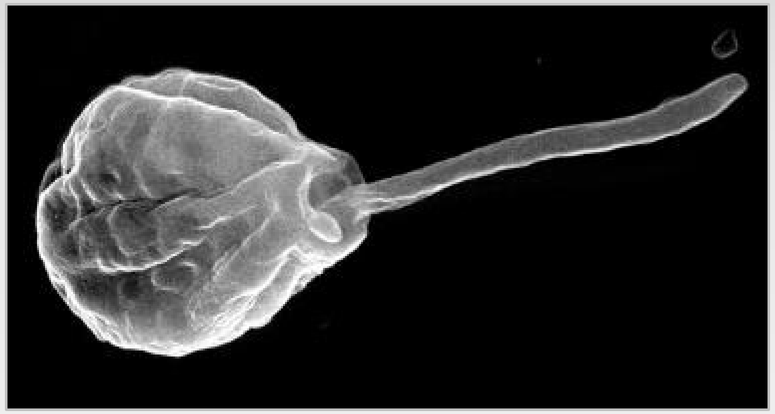
Bumble bees (*Bombus*) are vitally important pollinators of wild study in the United States identified lower genetic diversity and

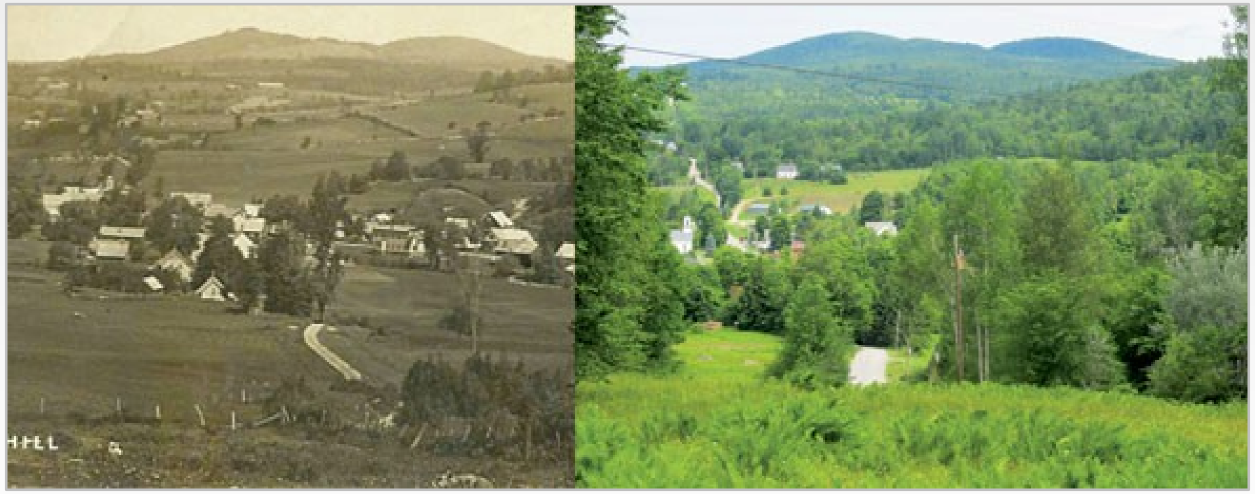
What do we mean by pollinator 'declines'?

- Reduction in overall pollinator density/ abundance
- Reduction in species diversity or shifts in community
- Reduction in plant reproductive success

Why are bees (& other pollinators) declining?

- Habitat loss
- Disease
- Pesticides
- Climate change



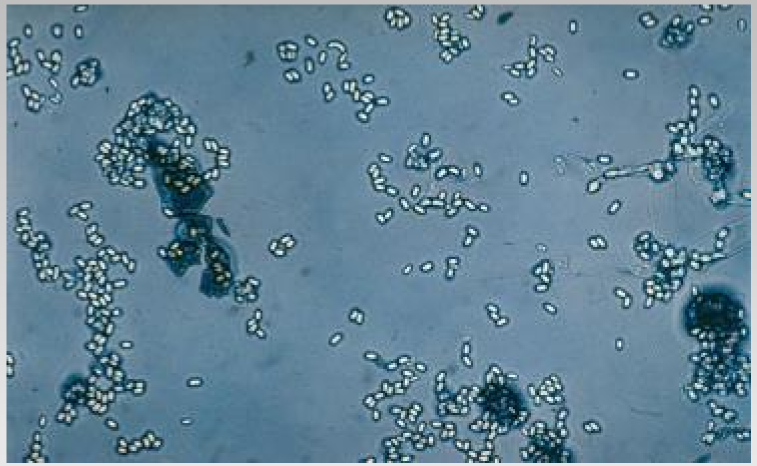


Habitat loss

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

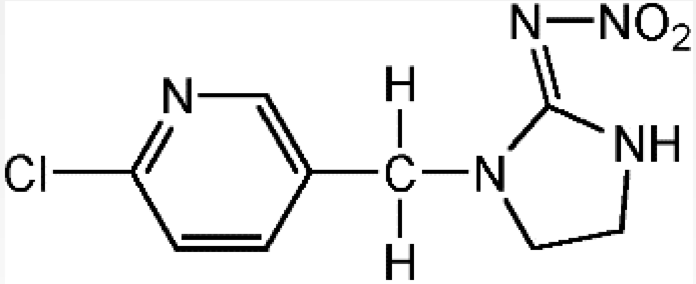
Disease

- 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

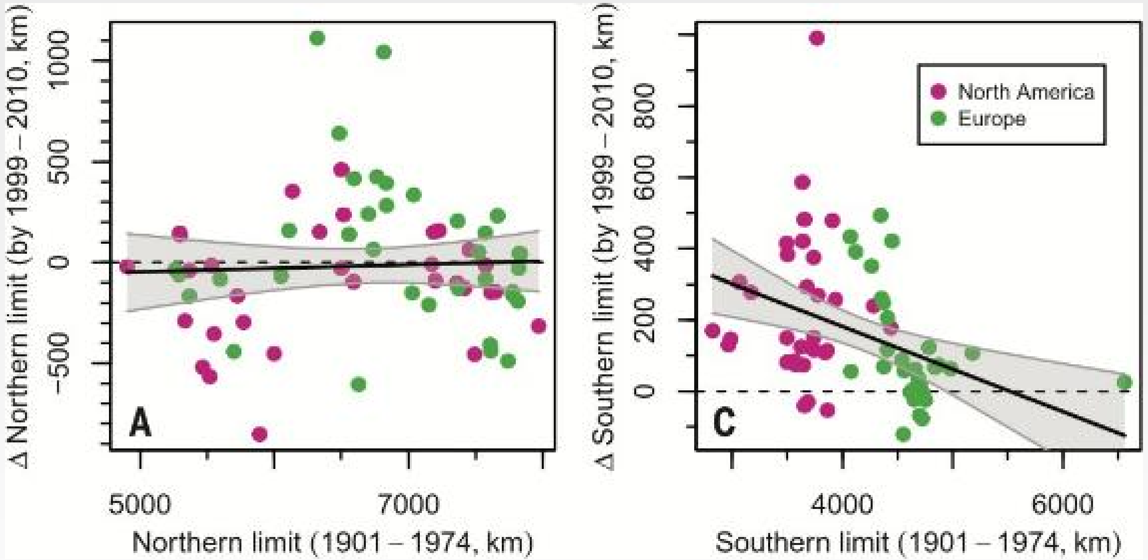


Climate change

- 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

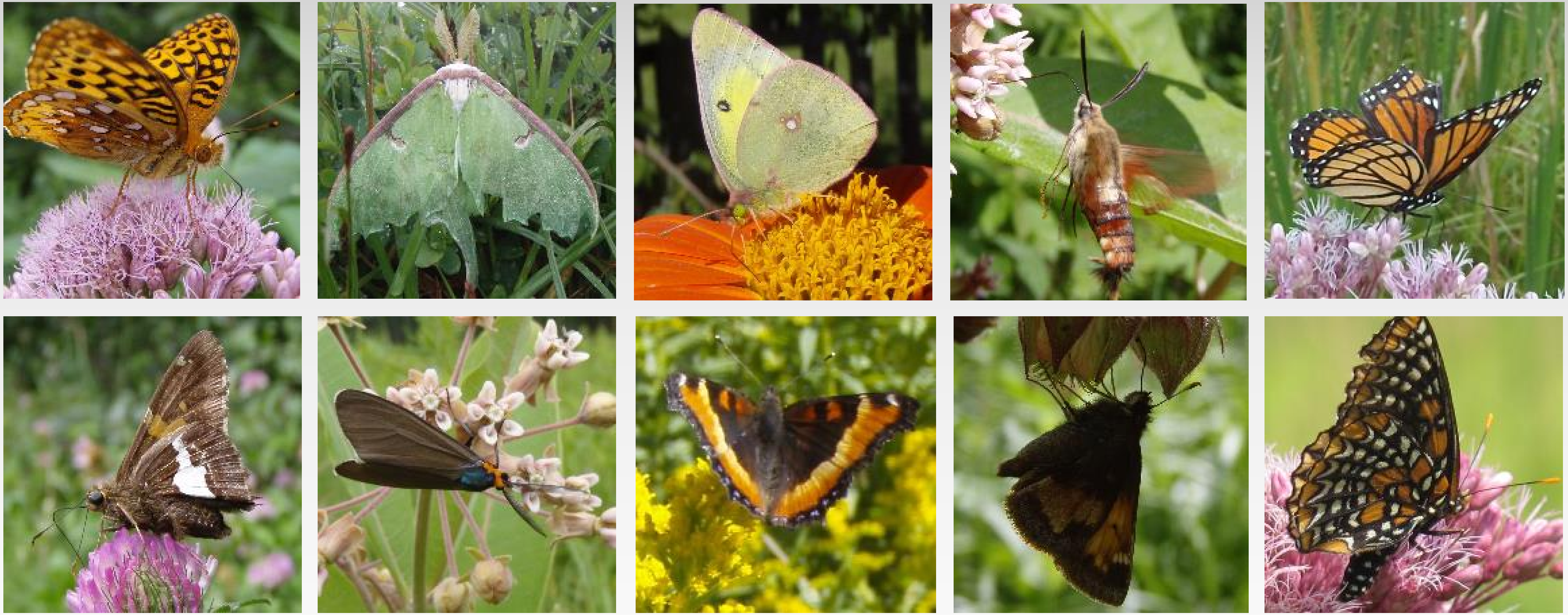


Kerr et al., *Science 2015*

Who are Vermont’s pollinators?

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

Vermont Lepidoptera pollinators



Vermont fly pollinators










Vermont bee pollinators





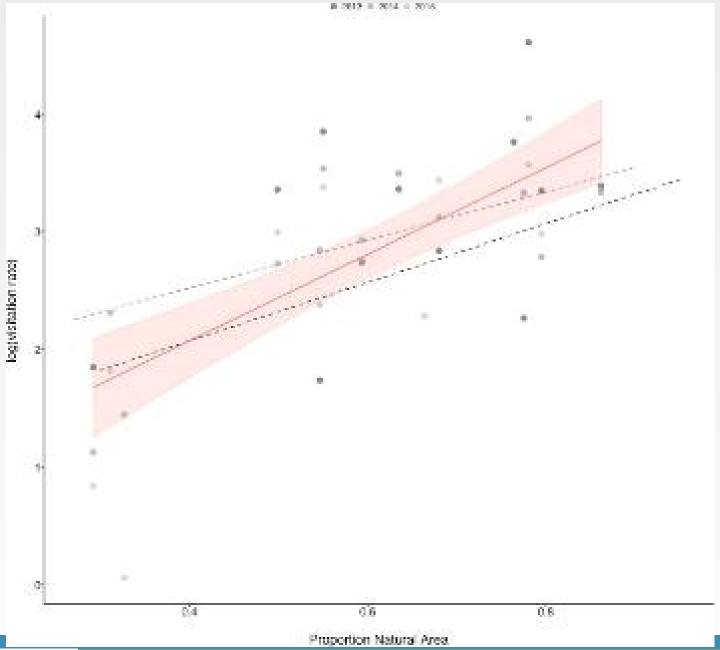


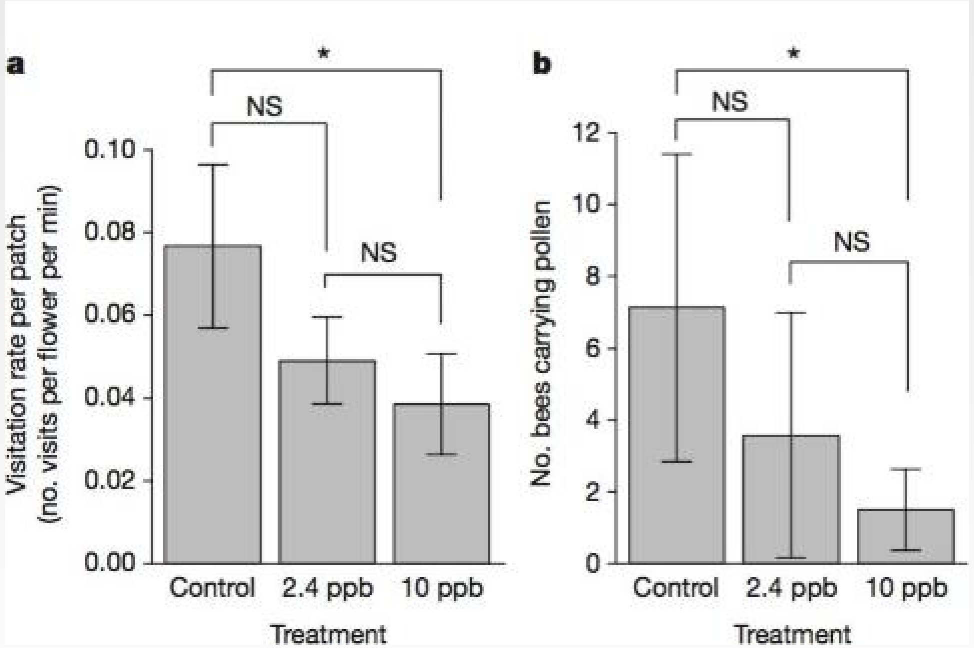



Agricultural problems, *Agricultural solutions?*

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)





HOME » THE PESTICIDE PROBLEM » FOOD & FARMING DERAILED

Bees in Crisis

Bee-toxic pesticides in dozens of widely used products, on top of many other stresses our industry faces, are killing our bees and threatening our livelihoods.

— Steve Ellis, MN & CA beekeeper

Take Action

URGE YOUR STATE TO STEP UP FOR BEES!

Bees are at risk from common crop pesticides, California study finds

By GEOFFREY MOHAN
AUG 03, 2018 | 2:30 PM

Pesticides

EU agrees total ban on bee-harming pesticides

Pesticides in U.S. Agriculture

- Potential crop loss from pest damage for staple crops estimated at ~30-40%
- Crop protection reduces losses up to 75%
- Crop protection required to maintain both crop *quantity* & *quality*

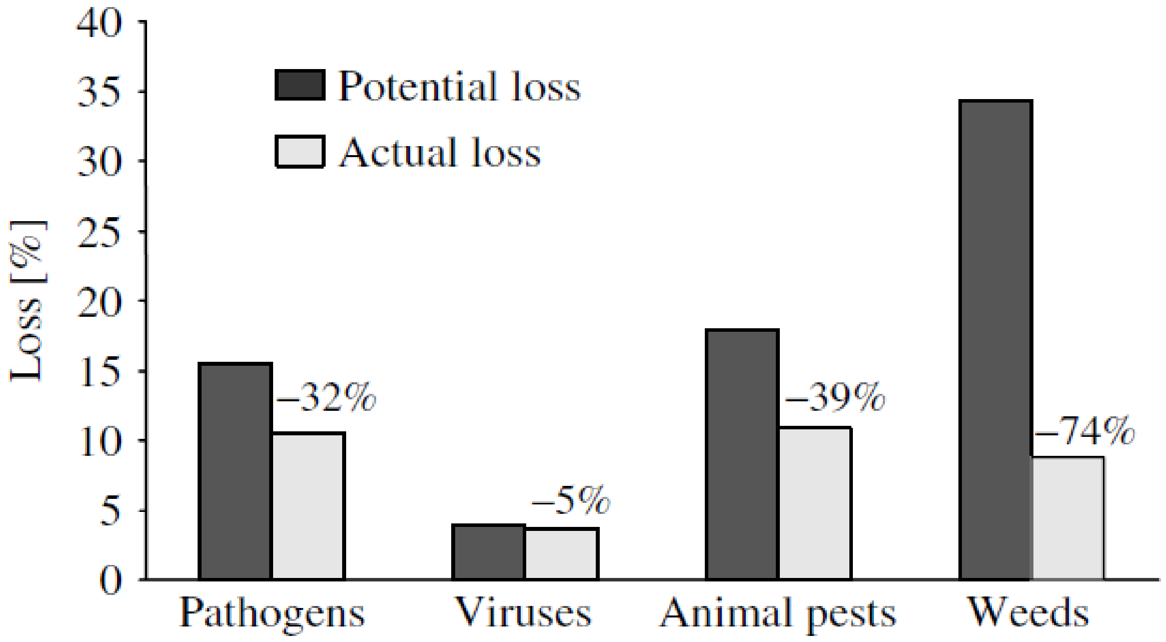


Fig. 7. Average efficacy of pest control practices worldwide in reducing loss potential of pathogens, viruses, animal pests, and weeds, respectively (reduction rates calculated from estimates of monetary production losses in barley, cottonseed, maize, oilseed rape, potatoes, rice, soybean, cotton, sugar beet, tomatoes and wheat, in 2001–03).

Oerke, E.-C., & Dehne, H.-W. (2004). Safeguarding production—losses in major crops and the role of crop protection. *Crop Protection, 23*(4), 275-285.

Ohio Agric. Res. & Dev. Ctr. 1973

Apples $5 per pound without pesticides

X
$28

F. R. HALL

Pesticides have long been known to play a vital role in world food production. The consequences of farming without pesticides are striking, particularly when weather conditions create havoc with increased insect and disease potentials.

Upon completion of a 2-year study of how fruit losses from insects and diseases are produced in an unsprayed apple orchard, the question arose: "how fast can we bring these trees back to a productive state?" Consequently, in 1973, a block of four cultivars (Stayman, Yellow Delicious, Red Delicious, and Jonathan) was divided into two sections. One section was left unsprayed and the other placed on an integrated spray program using reduced rates (25-50 percent) of both insecticides and fungicides.

The spray program consisted of three pre-bloom applications of Benlate in after-infection sprays against apple scab (*Venturia inequalis* (Cke) Wint.). Post-bloom applications included Benlate, lead arsenate, Diazinon, and Guthion at reduced rates in four sprays. The petal-fall and cover sprays were timed according to pheromone trap records in nearby orchards for both codling moth (*Laspeyresia pomonella* L.) and redbanded leafroller (*Argyrotaenia velutinana* Walker). A total of seven sprays were applied in a year of numerous apple scab infection periods and where conventional spray programs in nearby orchards consisted of 12-14 separate applications.

Franklin R. Hall is associate professor, Department of Entomology, Ohio Agricultural Research and Development Center, Wooster.

Costs

The cost inputs for the sprayed block totaled $71.49 per acre for spray materials and $21.00 per acre for labor and machinery. In comparison, a standard spray program in 1973 totaled $110.00 per acre for spray materials and $36.00 per acre for labor and machinery. Thus, the integrated program represented about a 40 percent re-

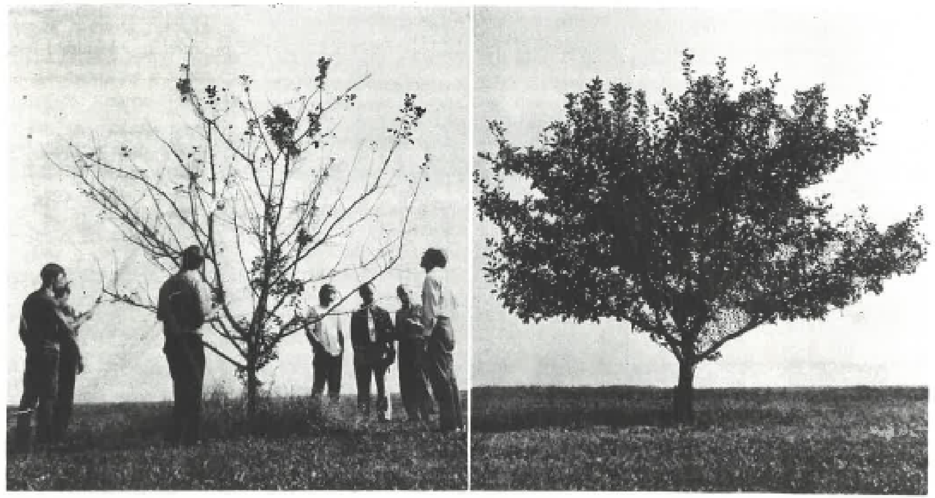


Figure 1—Stayman unsprayed apple tree (left). Stayman sprayed apple tree at harvest (right).

TABLE 1—Evaluation of Harvested Apples from Sprayed and Unsprayed Trees, 1973.

Variety	Percent Fruit Damage: Plum Curculio	Codling Moth	Other Insects	Apple Scab	Percent Marketable Fruit
SPRAYED					
Stayman	0	2.5	1.6	0	96.2
Yellow Delicious	0.4	0.4	0	0	94.9
Red Delicious	0	0	0	0	100.0
Jonathan	8.1	2.3	4.1	0.5	85.4

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Yield Effects from apple scab and other diseases

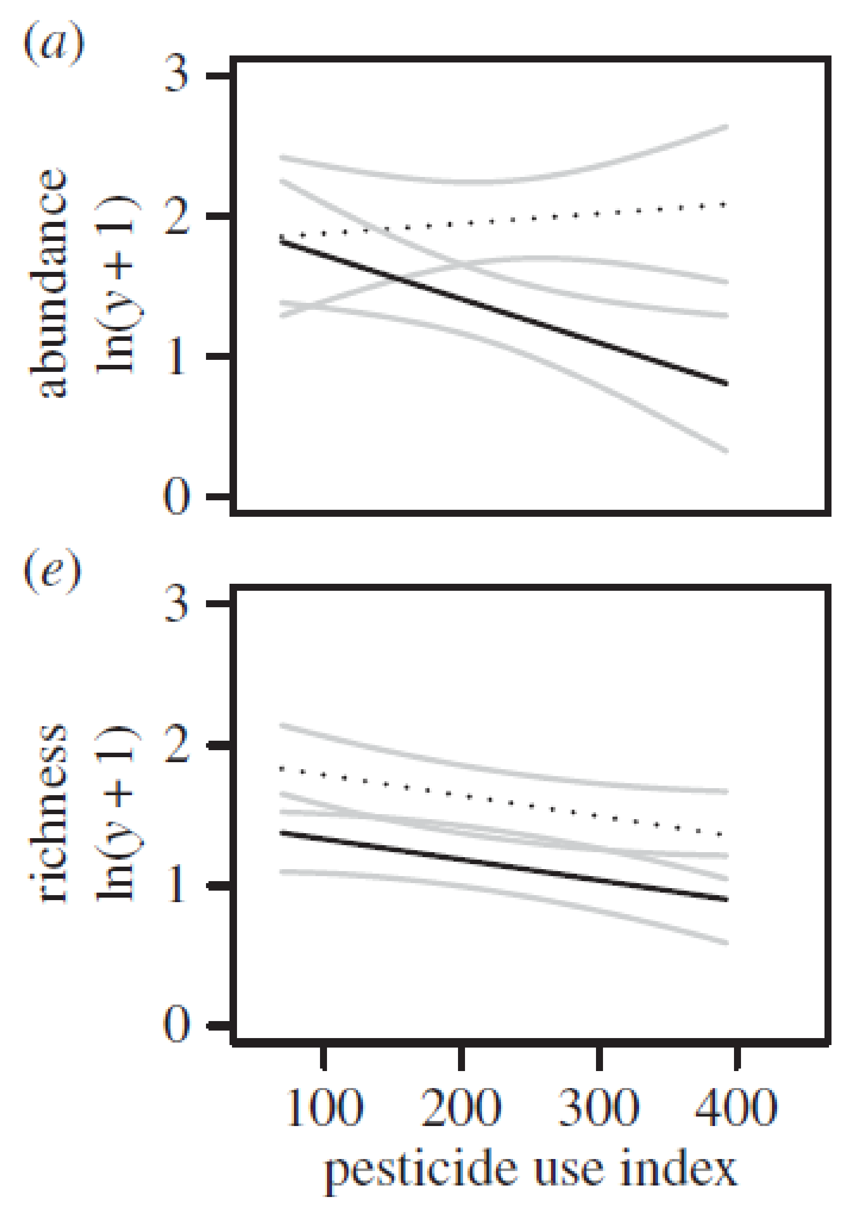
Annual yield (bu/acre) from fungicide treated vs non-treated McIntosh apple trees in Surround assessment project at University of Vermont (1)			
	2002	2003	2004
Fung	437	689	620
No Fung	202	43	62
% yield reduction	54%	94%	90%

Correlation coefficient for scab incidence vs yield = -0.423

(1) Berkett, Garcia, Bradshaw. *Unpublished data.*

Current research on pollinator protection in orchards

- On-going research
  - Federal mandate
  - Popular concern
- Recent research (NY)
  - Pesticide use index decreases species richness & abundance of native pollinators
    - Fungicides pre-bloom
    - Insecticides post-bloom



Park, M. G., E. Blitzer, J. Gibbs, J. E. Losey and B. N. Danforth (2015). Negative effects of pesticides on wild bee communities can be buffered by landscape context. Proc. R. Soc. B, The Royal Society.

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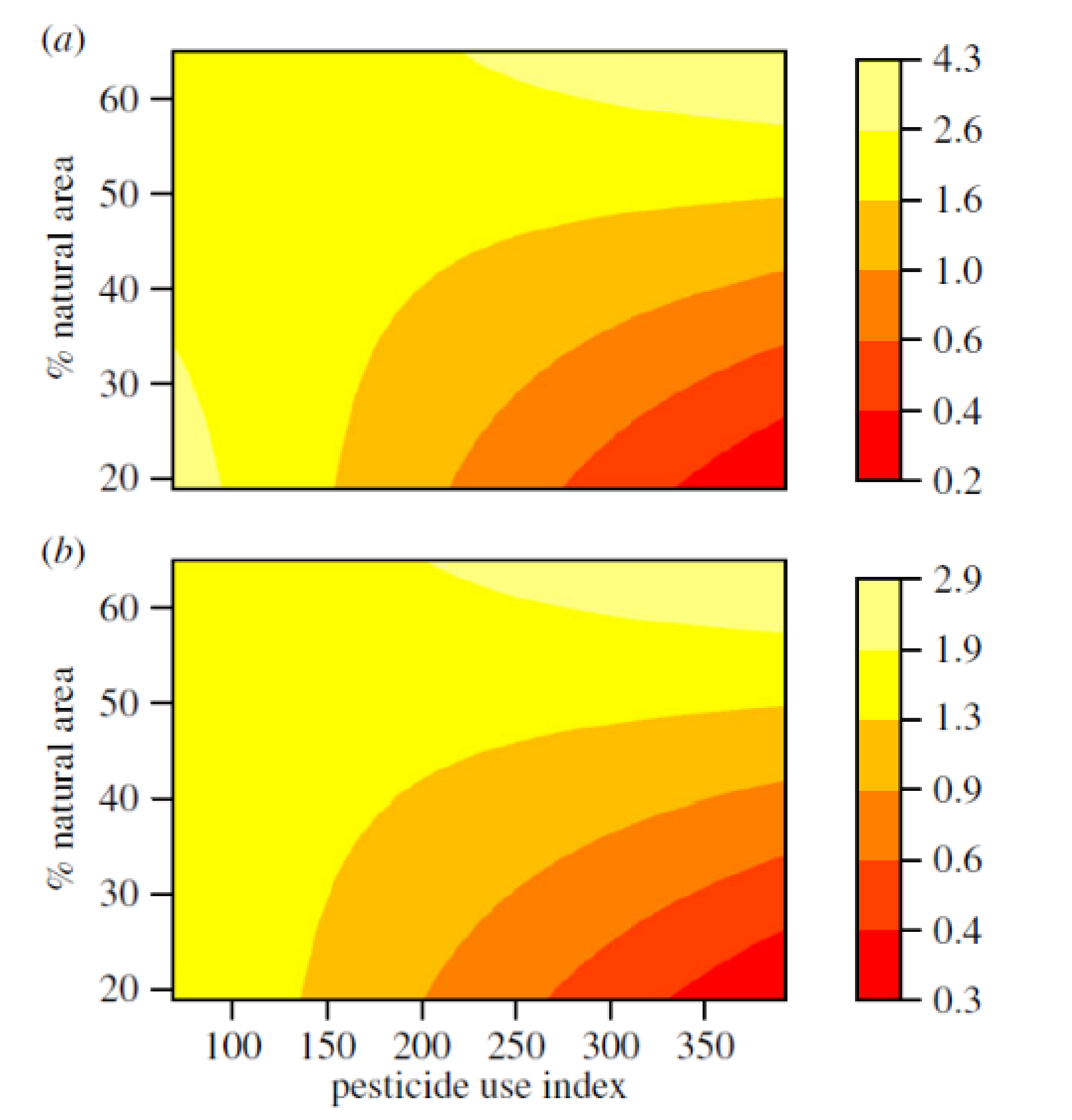
  - Pesticide use index decreases species richness & abundance of native pollinators
    - Fungicides pre-bloom
    - Insecticides post-bloom
  - 'Natural' landscape surrounding orchards buffers negative impacts



Park, M. G., E. Blitzer, J. Gibbs, J. E. Losey and B. N. Danforth (2015). Negative effects of pesticides on wild bee communities can be buffered by landscape context. Proc. R. Soc. B, The Royal Society.

Joshi, N., Otieno, M., Rajotte, E., Fleischer, S., & Biddinger, D. (2016). Proximity to Woodland and Landscape Structure Drives Pollinator Visitation in Apple Orchard Ecosystem. Front. Ecol. Evol. 4: 38. doi: 10.3389/fevo.

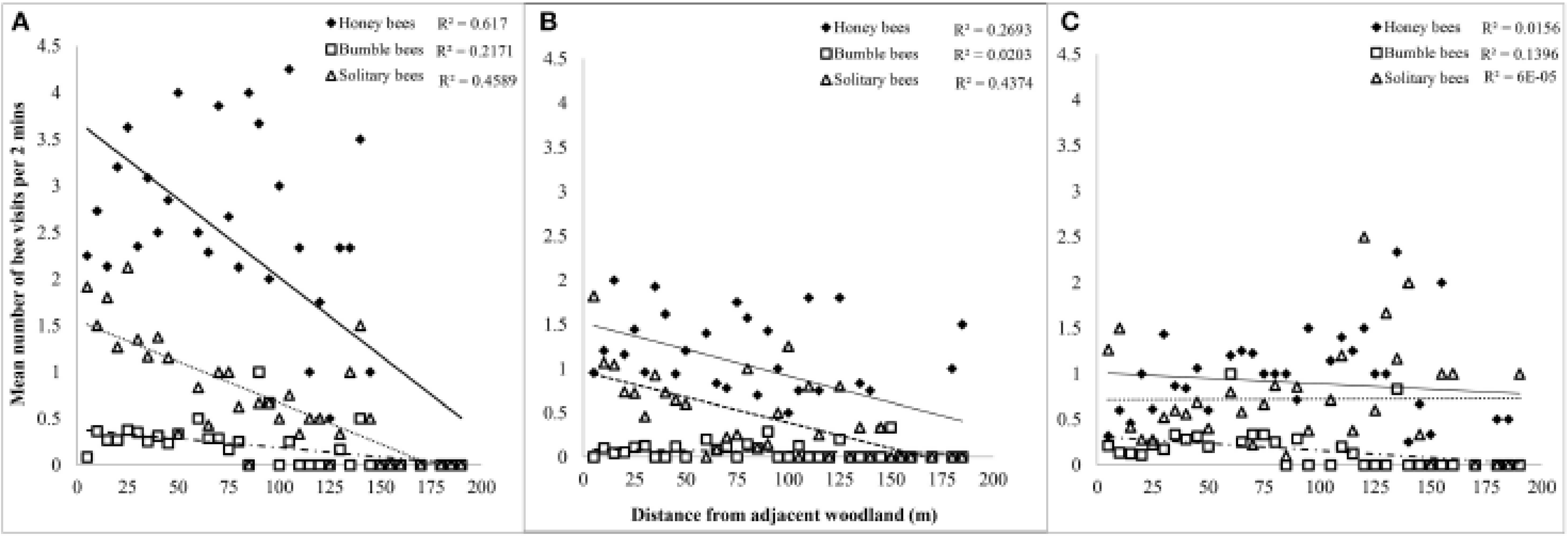


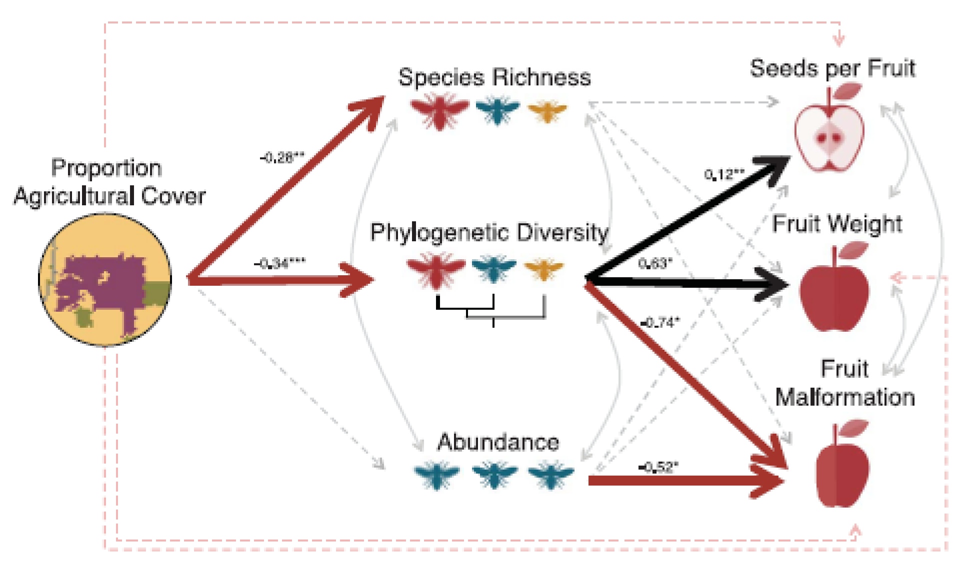
FIGURE 2 | Relationship between number of bee visits by taxa to apple flowers per unit time vs. distance (in meters) from woodland adjacent to orchard for (A) 2011, (B) 2012, and (C) 2013.

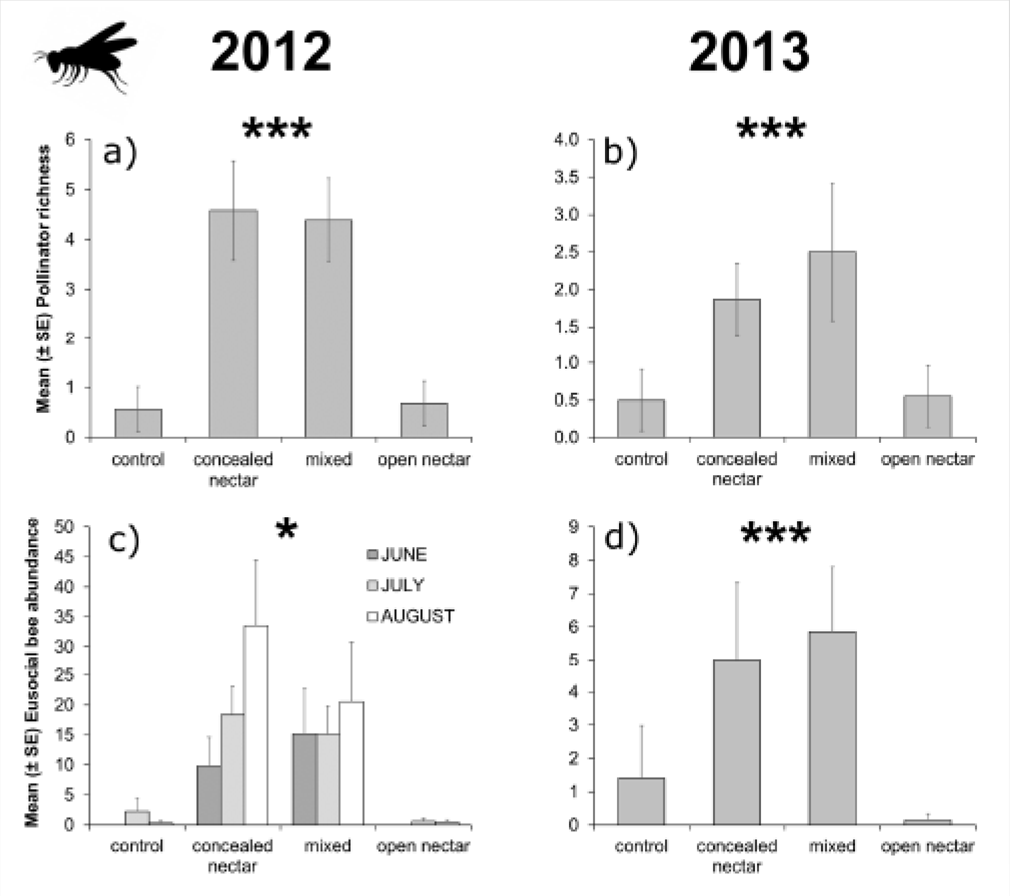
JAN 18, 2019

Natural habitats, bee diversity aids better apple production

"A Cornell-led study, [published Jan. 18 in the journal Science], shows that apple orchards surrounded by agricultural lands are visited by a less diverse collection of bee species than orchards surrounded by natural habitats."

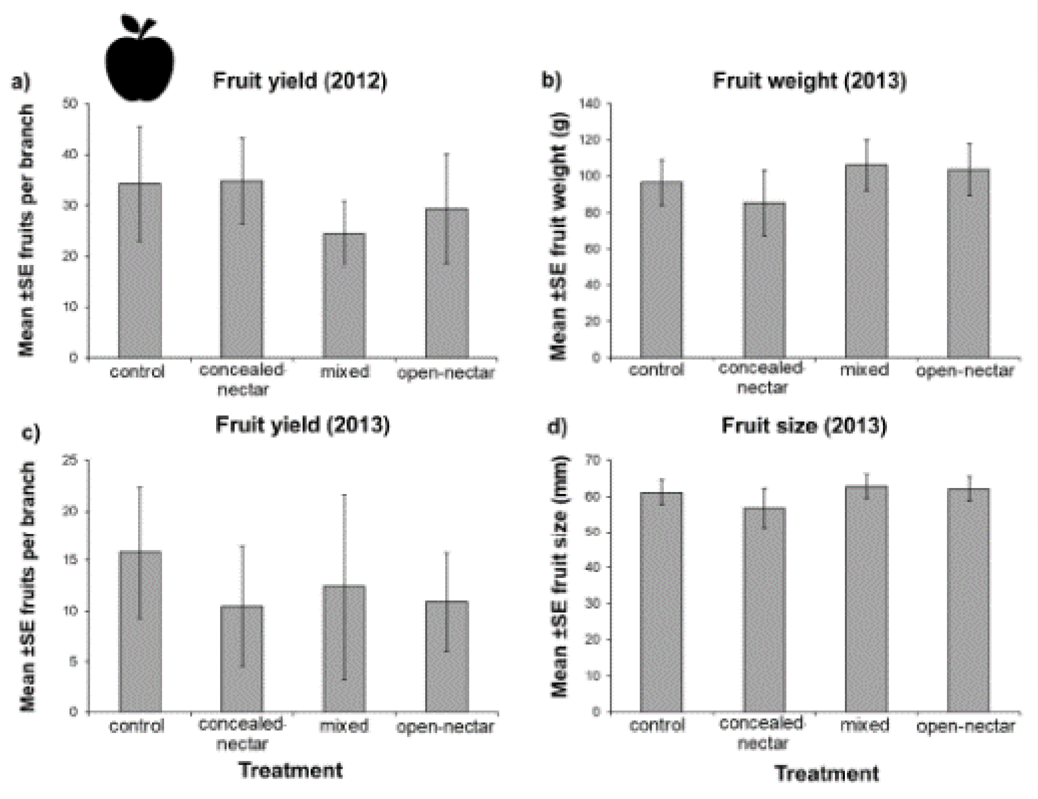
Grab, H., Branstetter, M. G., Amon, N., Urban-Mead, K. R., Park, M. G., Gibbs, J., . . . Danforth, B. N. (2019). Agriculturally dominated landscapes reduce bee phylogenetic diversity and pollination services. *Science*, *363*(6424), 282-284. doi:10.1126/science.aat6016





"We conclude that 'multi-functional' flower strips that contain flowering plant species with opposing floral traits can provide nectar and pollen for both pollinators and natural enemies, but further work is required to understand their potential for improving pest control services and yield in cider apple orchards."

Campbell, A., Wilby, A., Sutton, P., & Wäckers, F. (2017). Getting More Power from Your Flowers: Multi-Functional Flower Strips Enhance Pollinators and Pest Control Agents in Apple Orchards. *Insects*, *8*(3), 101.



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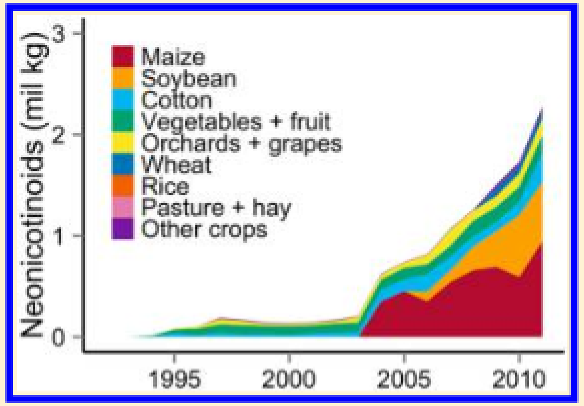
Large-Scale Deployment of Seed Treatments Has Driven Rapid Increase in Use of Neonicotinoid Insecticides and Preemptive Pest Management in U.S. Field Crops

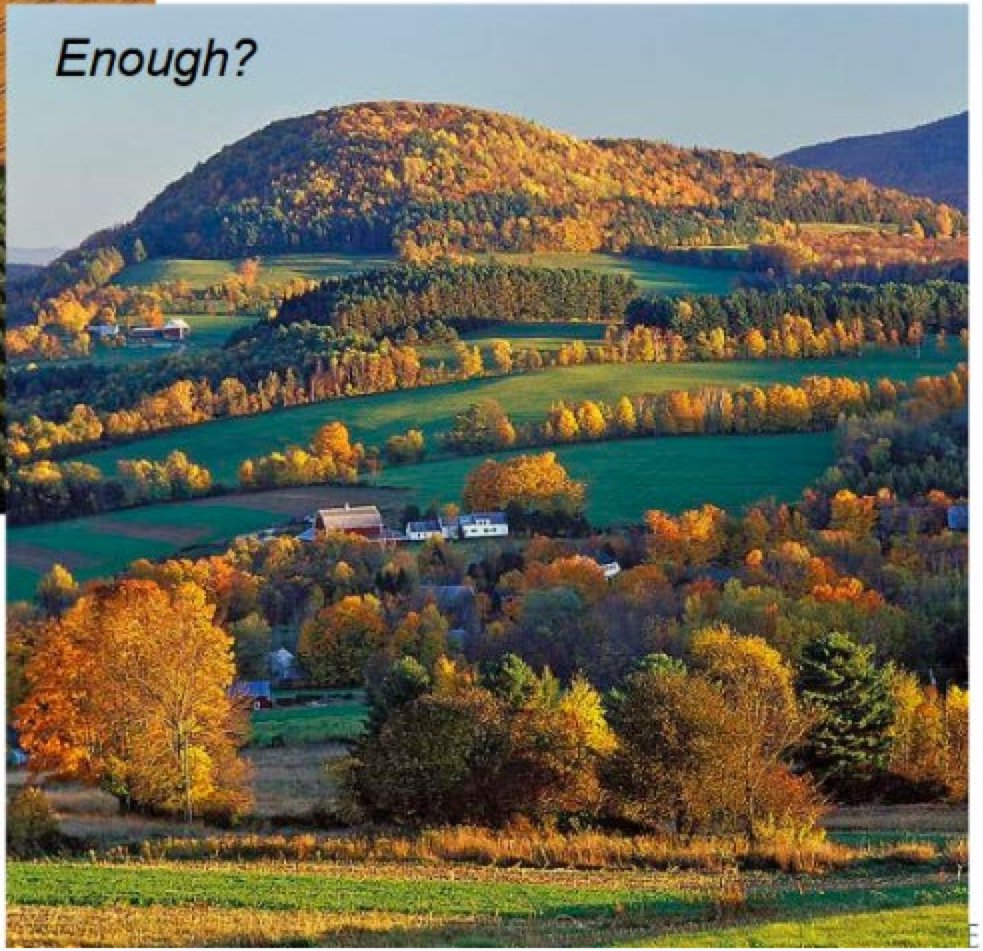
Margaret R. Douglas and John F. Tooker*

Department of Entomology, The Pennsylvania State University, 101 Merkle Laboratory, University Park, Pennsylvania 16802, United States

Supporting Information

ABSTRACT: Neonicotinoids are the most widely used class of insecticides worldwide, but patterns of their use in the U.S. are poorly documented, constraining attempts to understand their role in pest management and potential nontarget effects. We synthesized publicly available data to estimate and interpret trends in neonicotinoid use since their introduction in 1994, with a special focus on seed treatments, a major use not captured by the national pesticide-use survey. Neonicotinoid use increased rapidly between 2003 and 2011, as seed-applied products were introduced in field crops, marking an unprecedented shift toward large-scale, preemptive insecticide use: 34–44% of soybeans and 79–100% of maize hectares were treated in 2011. This finding contradicts recent analyses, which concluded that insecticides are used today on fewer maize hectares than a decade or two ago. If current trends continue, neonicotinoid use will increase further through application to more hectares of soybean and other crop species and escalation of per-seed rates. Alternatively, our results, and other recent analyses, suggest that carefully targeted efforts could considerably reduce neonicotinoid use in field crops without yield declines or economic harm to farmers, reducing the potential for pest resistance, nontarget pest outbreaks, environmental contamination, and harm to wildlife, including pollinator species.



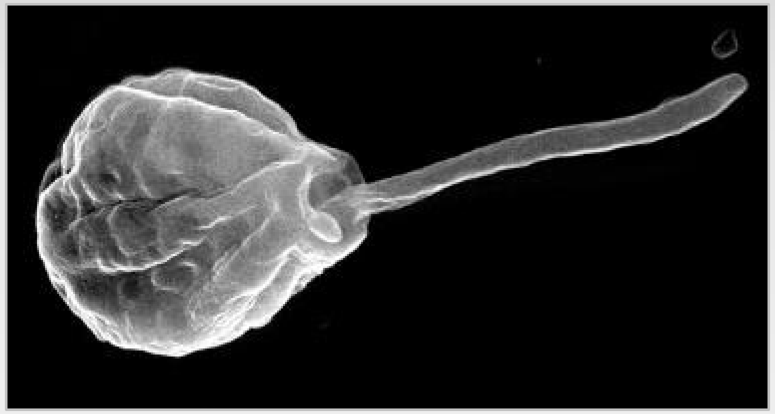


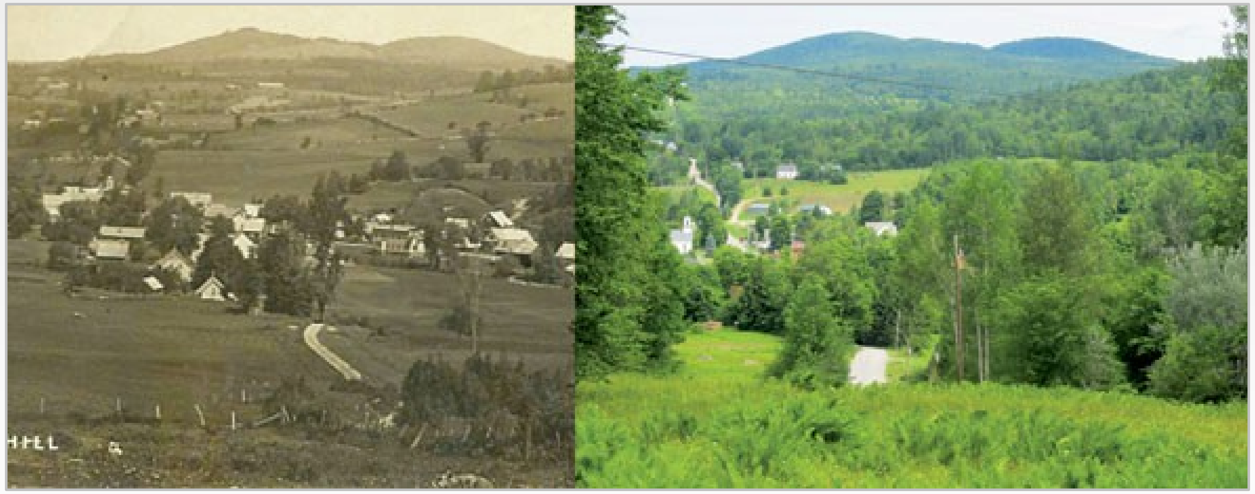
Slide gratuitously borrowed from T. Ricketts

Is it all the farmers' fault??

Why are bees (& other pollinators) declining?

- Habitat loss
- Disease
- Pesticides
- Climate change





Loss of Vermont hay fields limits food for bees

"Everything with bees is a negative. They don't have anything going for them right now," said Chas Mraz, who operates Champlain Valley Apiaries, one of the oldest commercial beekeeping operations in Vermont. Mraz's family started their bee business in 1931, and he took over in 2004.

Local bees skirt colony collapse

Posted Saturday, May 10, 2008 1:11 am

By HOWARD WEISS-TISMAN, Reformer Staff

Saturday, May 10

PUTNEY -- Commercially managed bee hives continue to suffer from a mysterious loss across the country, though local beekeepers say the situation in Vermont is stable.

A survey released this week by the Apiary Inspectors of America found that the nation's beekeepers lost about 32 percent of their hives since last year.

Museum specimens reveal loss of pollen host plants as key factor driving wild bee decline in The Netherlands

Jeroen Scheper, Menno Reemer, Ruud van Kats, Wim A. Ozinga, Giel T. J. van der Linden, Joop H. J. Schaminée, Henk Siepel, and David Kleijn

PNAS December 9, 2014 111 (49) 17552-17557; published ahead of print November 24, 2014 https://doi.org/10.1073/pnas.1412973111

Edited by May R. Berenbaum, University of Illinois at Urbana-Champaign, Urbana, IL, and approved October 30, 2014 (received for review July 9, 2014)

We assessed the relative importance of a range of proposed factors responsible for wild bee decline and show that loss of preferred host plant species is one of the main factors associated with the decline of bee populations in The Netherlands.

Interestingly, species foraging on crop plant families have stable or increasing populations.

These results indicate that mitigation strategies for loss of wild bees will only be effective if they target the specific host plants of declining bee species.

Biol Rev Camb Philos Soc. 2010 Nov;85(4):777-95. doi: 10.1111/j.1469-185X.2010.00125.x.

Multiple stressors on biotic interactions: how climate change and alien species interact to affect pollination.

Schweiger O[1], Biesmeijer JC, Bommarco R, Hickler T, Hulme PE, Klotz S, Kühn I, Moora M, Nielsen A, Ohlemüller R, Petanidou T, Potts SG, Pyšek P, Stout JC, Sykes MT, Tscheulin T, Vilà M, Walther GR, Westphal C, Winter M, Zobel M, Settele J.

Author information

Buzzkills: abiotic and biotic stressors of pollinators

Share

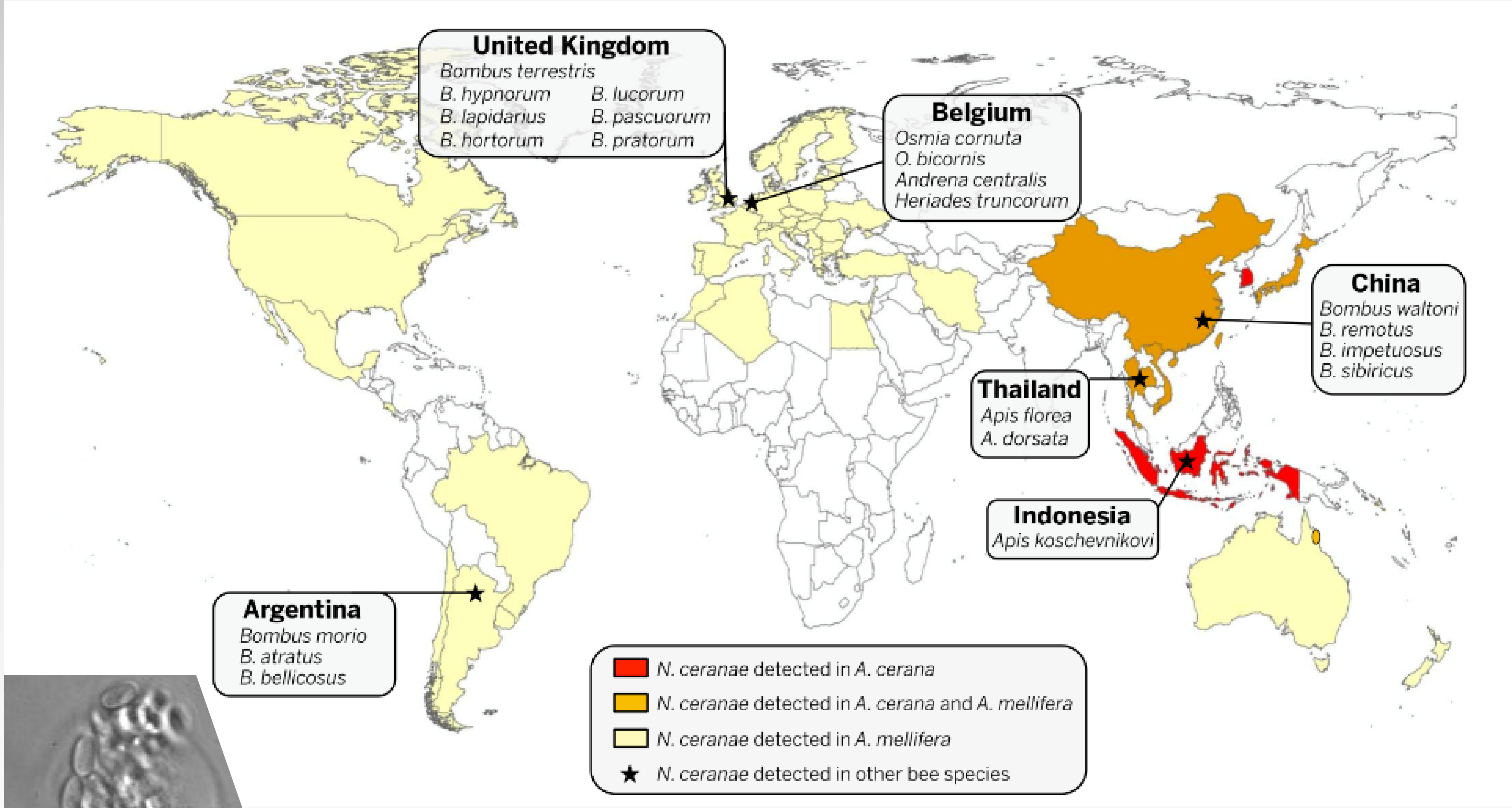
Due to their important role in agriculture and well-documented, ongoing losses, a great deal of research has focused on characterizing and mitigating challenges to honey bee health. Using honey bees as a model species, this article summarizes biotic and abiotic stressors of pollinators including: exposure to parasites and pesticides, poor nutrition, habitat destruction and climate change.

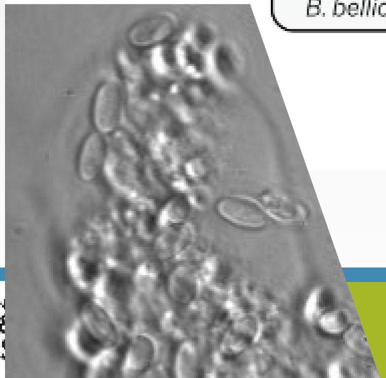
https://ento.psu.edu/pollinators/resources-and-outreach/buzzkills-abiotic-and-biotic-stressors-of-pollinators

Varroa destructor: the bee parasites that feed on fatty organs, not blood

16th January 2019

© iStock/William Jones-Warner





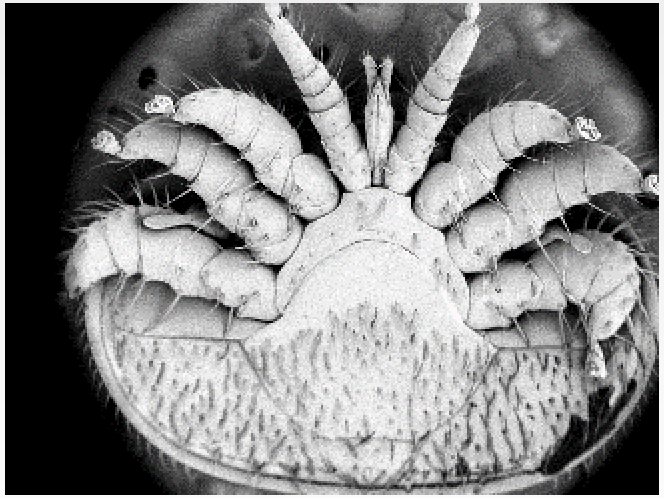
Goulson et al., 2015, Science

"*Varroa destructor*, the most damaging pest in modern beekeeping"

N. Reif

Vermont Beekeeper Statistics:

- Only 2/3 of beekeepers report treating for *Varroa* mites.
- 23% of beekeepers use no treatments in their hives
- Beekeepers who use miticides had significantly fewer losses ($p = 0.003$)



Alger et al., in prep

Beekeeper Education: improve management practices to reduce disease loads

VERMONT BEEKEEPERS ASSOCIATION
SINCE 1886

VERMONT
AGENCY OF AGRICULTURE, FOODS & MARKETS

Photo: Michael Willard

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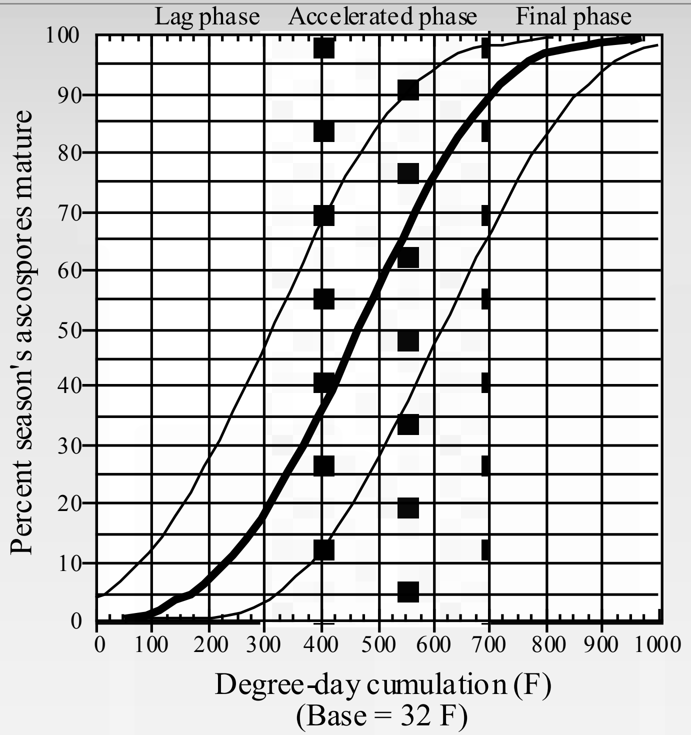
Integrated Pest Management in Orchard Systems

•Vermont IPM Extension Implementation Program: 2017-2020.
PD: A. Hazelrigg. Co-PIs: S. Bosworth, T. Bradshaw, H. Darby, M. Skinner.
Sponsor: USDA NIFA CPPM EIP Program.

- System for managing pests with understanding of:
  - Pest/predator populations
  - Understanding of ecology/ life cycles of both
  - Weather monitoring and expert systems
  - Understanding of chemistries, weather



Curve describing the relationship between the percentage of the season's ascospores that have matured and accumulated degree-days.

The two curves that identify the upper and lower boundaries between which the model is accurate 90% of the time. The two curves show the variation in predicted maturity that can be expected at different times during the primary scab season.

Accelerated phase of ascospore maturation.

NEWA: Apple Models

- Three disease models
  - Apple scab, fire blight, sbfs
- Six insect models
  - Codling moth, plum curculio, obliquebanded leafroller, Oriental fruit moth, apple maggot, San Jose scale
- Multiple horticultural models
  - Carbohydrate thinning, evapotranspiration, irrigation, frost risk, degree days
- Archived weather data

- Caveat: NEWA is a tool, not a silver bullet. It needs to be used as part of a comprehensive IPM program!!

New York State Integrated Pest Management Program
NEWA Network for Environment and Weather Applications

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Daily Summary

Shoreham - Daily Data Summary

Date	Avg Temp (F)	Max Temp (F)	Min Temp (F)	LW Hours	Total Rain (in)	RH Hrs >= 90%	Avg Wind Speed (mph)	Solar Rad (langley)
2/1/2014	28.8	37.4	19.5	6	0.00	11	2.3	89
2/2/2014	34.6	39.3	30.6	10	0.16	23	1.5	37
2/3/2014	23.3	30.2	17.9	0	0.00	15	4.0	75
2/4/2014	20.9	34.7	12.0	0	0.00	14	1.5	135
2/5/2014	17.9	21.0	13.2	0	0.00	24	5.6	45
2/6/2014	11.2	20.6	4.3	0	0.00	18	2.1	129
2/7/2014	15.3	32.1	6.4	0	0.05	11	3.0	159
2/8/2014	14.3	27.3	5.9	0	0.04	8	2.6	159
2/9/2014	15.0	30.1	1.5	0	0.01	18	1.1	125
2/10/2014	14.9	23.6	5.8	6	0.00	18	2.1	89
2/11/2014	7.5	20.2	-2.5	3	0.01	14	1.8	122
2/12/2014	3.1	25.8	-16.0	3	0.00	14	1.4	167
2/13/2014	17.2	23.0	3.1	15	0.00	18	3.8	59
2/14/2014	26.8	33.4	22.1	9	0.03	13	4.3	109
2/15/2014	26.6	35.2	19.9	0	0.08	18	3.1	140
2/16/2014	15.9	35.0	5.0	0	0.03	11	2.2	172
2/17/2014	5.3	27.0	-7.7	0	0.00	8	1.2	198
2/18/2014	13.7	27.6	-5.2	10	0.00	24	0.8	98
2/19/2014	24.2	30.8	15.3	20	0.00	23	1.3	90
2/20/2014	33.5	44.2	21.0	11	0.17	14	2.0	107
2/21/2014	34.3	38.0	29.6	24	0.83	0	0.7	35
2/22/2014	37.9	48.2	27.8	7	0.01	2	4.2	185

Key IPM practices to minimize pollinator impacts in orchards

- No insecticides when bees are foragi
- Consider bee poisoning hazard

Table 7.1.3. Relative toxicity of pome fruit insecticides and miticides to beneficial arthropods.

	Beneficial Species				
Trade Name (active ingredient)	Honeybee[1]	*Amblyseius fallacis*[2]	*Typhlodromus pyri*[2]	*Stethorus punctum*[3]	*Aphidoletes aphidimyza*[4]
Acramite (bifenazate)	M	M	M	L	L
Actara (thiamethoxam)	M	L	L	L	L
Admire Pro, Pasada, Sherpa (imidacloprid)	H	L	L	M	L
***Agri-Flex** (abamectin/thiamethoxam)	M	M	M	M	L
***Agri-Mek, *Abacus, *Abba, *Epi-Mek, *Temprano** etc. (abamectin)	L	M	M	M	L
***Altacor** (chlorantraniliprole)	L	L	L	L	L
Apollo (clofentezine)	L	L	L	L	L
***Asana** (esfenvalerate)	H	H	H	H	M
Assail (acetamiprid)	L	M	L	M	M
Avaunt (indoxacarb)	M	L	L	L	L
§**Aza-Direct**, §**Azatin**, §**Trilogy** (azadirachtin)	M	L	L	L	L
***Battalion, *Decis** (deltamethrin)	M	H	H	H	M
***Baythroid, *Tombstone** (cyfluthrin)	H	H	H	H	H
Belay (clothianidin) w/ suppl. label	H	L	L	M	L
Beleaf (flonicamid)	L	L	L	?	?
Belt (flubendiamide)	L	L	L	L	L
***Bifenture, *Brigade, *Fanfare** (bifenthrin) [Pears only]	M-H	?	?	?	?

Key IPM practices to minimize pollinator impacts in orchards

- No insecticides when bees are foraging
- Consider bee poisoning hazard
  - Select appropriate materials when possible
- Thinning:
  - Use liquid carbaryl formulations when possible
- Maintain good bee habitat
  - No flowering plants in orchard during spray season
  - Flowering ‘natural’ habitat within 2 km of orchard

2017 VT Apple Grower IPM Survey

Table 5. Practices employed to improve crop pollination or reduce impacts on pollinators in respondent's orchards

	Yes	No	Unsure
Use of migratory honey bees during bloom	54.5%	36.4%	9.1%
Keeping honey bees on the orchard property year-round	9.1%	90.9%	0.0%
Use of purchased bumble bees in the orchard	20.0%	80.0%	0.0%
Reliance on wild bees for pollination	54.5%	45.5%	0.0%
Use of nest boxes to encourage wild bee populations	9.1%	81.8%	9.1%
Minimum tillage to improve ground bee habitat	72.7%	18.2%	9.1%
Not spraying insecticides during apple bloom	100.0%	0.0%	0.0%
Not spraying insecticides when any plants are blooming in the orchard	45.5%	45.5%	9.1%
Mowing to reduce flowering weeds prior to spraying	72.7%	27.3%	0.0%
Herbicides to reduce flowering weeds prior to spraying	9.1%	72.7%	18.2%
Maintaining flowering habitat within the orchard to encourage pollinators	27.3%	63.6%	9.1%
Maintaining flowering habitat outside but near the orchard to encourage pollinators	81.8%	9.1%	9.1%
Avoiding use of neonicotinoid insecticides	63.6%	36.4%	0.0%
Avoiding use of neonicotinoid insecticides before bloom	100.0%	0.0%	0.0%
Avoiding use of pesticides rated highly toxic to bees	81.8%	18.2%	0.0%
Avoiding use of demethylase/sterol inhibitor fungicides during bloom	90.9%	9.1%	0.0%

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Apple IPM in Vermont: Where are we?

- 100% of respondents report practicing IPM
- 100% report UVM Apple Program as:
  - "Useful", "Somewhat useful", or "Highly useful"
- 92% use UVM Apple Program information in decision making
- 92% report and economic impact from using IPM information
  - 100% of those report the impact as positive

Has the information obtained through the UVM Apple IPM Program allowed you to:	Yes	No
Increase your knowledge or understanding of Apple IPM	**84.62%** 11	**15.38%** 2
Increase your knowledge on how to prevent pest management problems	**84.62%** 11	**15.38%** 2
Adopt at least one new IPM practice	**50.00%** 6	**25.00%** 3
Reduce or minimize pesticide use	**69.23%** 9	**23.08%** 3
Determine if pesticides are needed in your orchard	**76.92%** 10	**15.38%** 2
Effectively time pesticides if they were needed	**76.92%** 10	**15.38%** 2
Adopt a reduced-risk alternative to manage a pest (e.g., insect, disease, weed, vole, deer, etc.)	**61.54%** 8	**23.08%** 3

Bradshaw, T., & Hazelrigg, A. (2018). Status of IPM practice adoption in Vermont apple orchards in 2017.

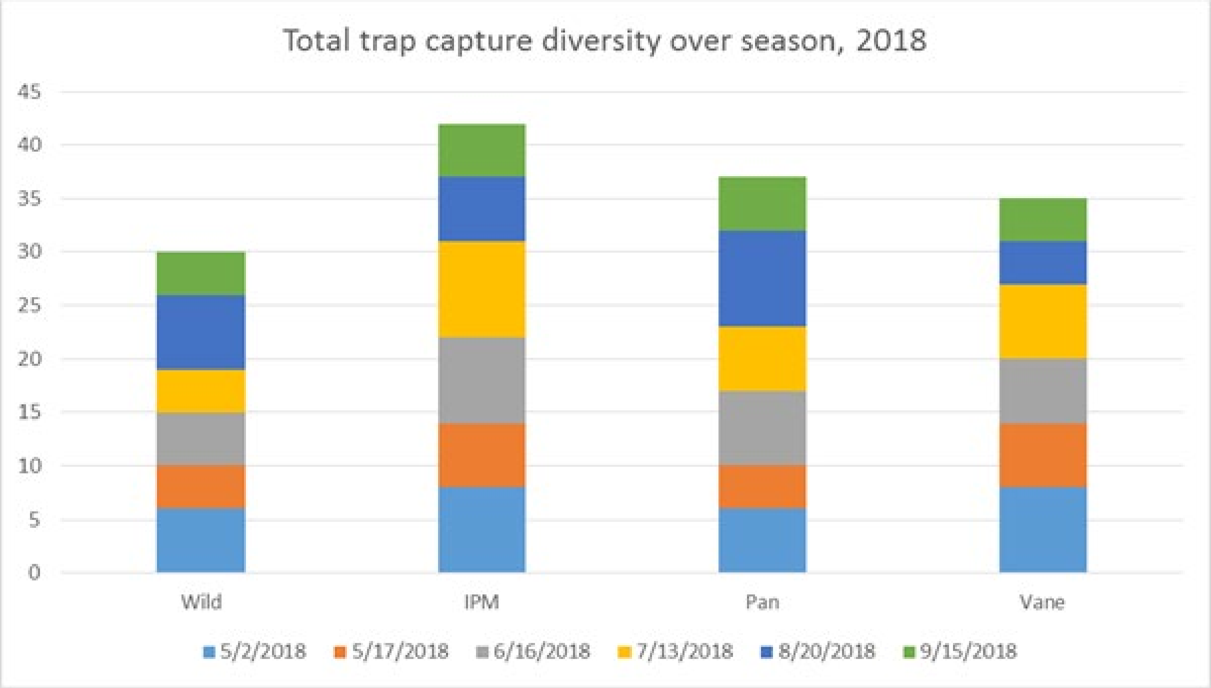
Which of the following practices do you employ to reduce impacts on pollinators in your orchard?

	Yes	No	Unsure	Total	Weighted Average
Mowing to reduce flowering weeds prior to spraying	72.73% 8	27.27% 3	0.00% 0	11	0.73
Herbicides to reduce flowering weeds prior to spraying	9.09% 1	72.73% 8	18.18% 2	11	0.09
Maintaining flowering habitat within the orchard to encourage pollinators	27.27% 3	63.64% 7	9.09% 1	11	0.27
Maintaining flowering habitat outside but near the orchard to encourage pollinators	81.82% 9	9.09% 1	9.09% 1	11	0.82
Avoiding use of neonicotinoid insecticides	63.64% 7	36.36% 4	0.00% 0	11	0.64
Avoiding use of neonicotinoid insecticides before bloom	100.00% 11	0.00% 0	0.00% 0	11	1.00
Avoiding use of pesticides rated highly toxic to bees	81.82% 9	18.18% 2	0.00% 0	11	0.82
Avoiding use of demethylase/sterol inhibitor fungicides (e.g. Inspire, Rally, Procure, etc.) during bloom	90.91% 10	9.09% 1	0.00% 0	11	0.91

Which of the following practices do you employ to reduce impacts on pollinators in your orchard?

	Yes	No	Unsure	Total	Weighted Average
Use of migratory honey bees during bloom	54.55% 6	36.36% 4	9.09% 1	11	0.55
Keeping honey bees on the orchard property year-round	9.09% 1	90.91% 10	0.00% 0	11	0.09
Use of purchased bumble bees in the orchard	20.00% 2	80.00% 8	0.00% 0	10	0.20
Reliance on wild bees for pollination	54.55% 6	45.45% 5	0.00% 0	11	0.55
Use of nest boxes to encourage wild bee populations	9.09% 1	81.82% 9	9.09% 1	11	0.09
Minimum tillage to improve ground bee habitat	72.73% 8	18.18% 2	9.09% 1	11	0.73
Not spraying insecticides during apple bloom	100.00% 11	0.00% 0	0.00% 0	11	1.00
Not spraying insecticides when any plants are blooming in the orchard	45.45% 5	45.45% 5	9.09% 1	11	0.45

Orchard Pollinator Survey



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Pollinator habitat program for ornamentals/vegetables in greenhouses/high tunnels and nursery settings

Beneficial insects provide valuable ecological roles to growers, such as pollination or pest management.

Some beneficials provide both of these services, acting as pest-fighting pollinators.

Providing habitat hedges to attract these natural enemies may suppress pest populations and minimize or eliminate the need for harmful chemical pesticides.

Habitat hedges of annuals, including alyssum, coreopsis, blue cornflower, Indian blanket, cosmos, sunflowers and zinnias were established and monitored though visual inspections and passive trapping for natural enemies at 6 locations around VT.

Habitat hedges at local nursery/greenhouses

Cheryl Frank Sullivan & Margaret Skinner
Univ. of Vermont, Entomology Research Laboratory
January 18, 2019
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The Entomology Research Laboratory
https://www.uvm.edu/~entlab/

Vermont Nursery and Landscape Association Green Works

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

This project is supported by UVM Extension System and National Institute of Food & Agriculture, US Dept. of Agriculture, Extension IPM Program & Green Works, VT (The Vermont Nursery & Landscape Association)

Pollinator habitat program for ornamentals/vegetables in greenhouses/high tunnels and nursery settings

Syrphid flies (over 40% of visitors). As adults, they are important pollinators. As immatures, the larvae (maggots) of many species are predators of soft-bodied insects, particularly aphids. Trapping results will indicate common species present in VT visiting these hedges.

The insidious flower bug, *Orius insidiosis* (38% of visitors) is a predator of small insects, like thrips, aphids and mites and also consume pollen and nectar. These bugs are also sold commercially but can be attracted for free using habitat hedges.

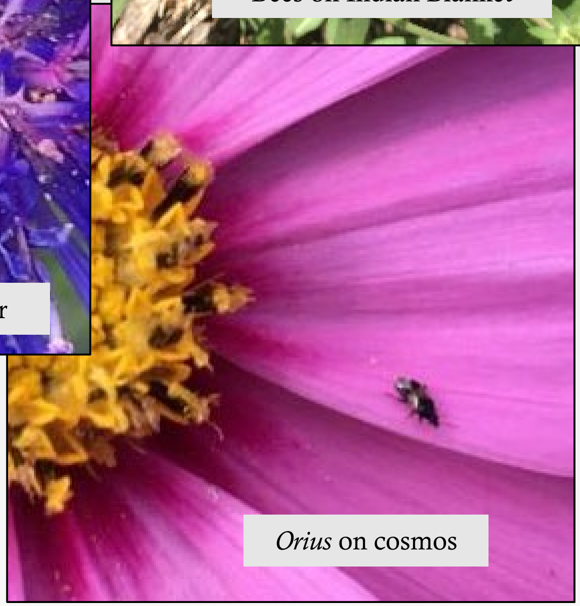
Several other natural enemies were observed: several lady beetle species, assassin, ambush and damsel bugs and parasitic tachinid flies.

Educational signs were also established at sites to inform the public about the importance of protecting beneficial insects.

New locations will recruited to establish these habitat hedges and be monitored over the next few years.

Bees on Indian Blanket

Syrphid fly on cornflower



Orius on cosmos

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College of Agriculture and Life Sciences
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MG Pollinator Short Course

THE UNIVERSITY OF VERMONT EXTENSION MASTER GARDENER

- Planned launch summer 2019
- Pollinator Friendly Habitat for landowners in Vermont and/or Northern Climates
- Audience:
  - Homeowners
  - Master Gardeners
  - Consumer Horticulture Industry
  - Small Landowners
  - Green Industry Professionals (Landscapers)

Next steps…Remember the VT Pollinator Protection Committee?

2017 Report, Recommendations to Legislature

- Multiple recommendations for action
  - Habitat improvement
  - Beekeeper training
  - Continued research
  - BMPs for field crops
  - Pesticide regulations

2019, VT Pollinator Protection Plan

- Working with VAAFM to write draft pollinator protection plan
- Currently in the collaborative writing phase
- Plan would direct state policy at executive level and serve as guidance for future legislation
- Continued bills already being discussed for present session