

Leif L. Richardson

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Appointments

Senior Ecologist, **Stone Environmental, Inc.**, 2017-present

Postdoctoral Research Associate, **Gund Institute for Environment, University of Vermont**, 2017-present

Education

- PhD **Dartmouth College**
Ecology and Evolutionary Biology, 2014
Thesis: *Bittersweet: Tritrophic effects of nectar secondary metabolites on plants, pollinators, and parasites* (Advisor: R.E. Irwin)
- MS **University of Arizona**
Ecology and Evolutionary Biology, 1999
Thesis: *Community ecology of some manzanita species and their mutualist and antagonist flower visitors* (Advisor: J.L. Bronstein)
- BA **Earlham College**
Biology (Honors), 1994

Additional Professional Experience

- 2017 Visiting Instructor, Middlebury College
- 2015-2017 Postdoctoral Research Fellow, Gund Institute for Environment, University of Vermont
- 2001-2010 State Lands Ecologist, Nongame and Natural Heritage Program, Vermont Fish and Wildlife Department
- 2009 Visiting Instructor, Middlebury College

Areas of Specialization and Interest

Ecology and evolution: plant-insect interactions; pollination; chemical ecology; bees; botany; agriculture; herbivory; mutualism; biological diversity and conservation; ecosystem services; climate change.

Grants & Awards

- 2017 Jean, R. and **L.L. Richardson**. US Fish and Wildlife Service Funding Opportunity F17AS00253. "Bumble bee inventory and bee habitat assessment at northeastern National Wildlife Refuges." (\$52,000)
- 2017 Hayden, J. and **L.L. Richardson**. United States Department of Agriculture National Institute of Food and Agriculture Specialty Crop Block Grant: "Establishing populations of ground-nesting native bees (*Colletes*) for orchard pollination services." (\$6,980)
- 2016 Alger, S., A. Burnham, **L.L. Richardson**, and Z. Lamas. Crowdfunded research grant: "Home sick: Effects of migratory beekeeping on honey bee disease." (\$5,970) (www.experiment.com/projects/home-sick-effects-of-migratory-beekeeping-on-honey-bee-disease)
- 2016 **Richardson, L.L.**, J. Hayden, S. Alger, S. Waterman, and T.H. Ricketts. United States Department of Agriculture National Institute of Food and Agriculture Specialty Crop Block Grant: "Managing locally sourced native bees as alternative pollinators for Vermont specialty crops." (\$36,000)
- 2014 **Richardson, L.L.**, A.K. Brody, and T.H. Ricketts. United States Department of Agriculture National Institute of Food and Agriculture Postdoctoral Research Fellowship: "Multispecies interactions affect crop yield and pollinator health." (\$150,000)
- 2014 **Richardson, L.L.** Dartmouth Graduate Assistance in Areas of National Need (GAANN) Fellowship (\$40,000)
- 2013 **Richardson, L.L.** Dartmouth College Graduate Travel Award (\$1,000)
- 2012 **Richardson, L.L.** New England Botanical Club Graduate Research Award: "Toxic nectar in turtlehead (*Chelone glabra*): Pollination by self-medicating bees." (\$1,000)

Publications

Peer-Reviewed Publications

20. **Richardson, L. L.**, K. P. McFarland, S. Zahendra, and S. Hardy. 2018. Bumble bee (*Bombus*) distribution and diversity in Vermont, USA: a century of change. *Journal of Insect Conservation*. <https://link.springer.com/article/10.1007%2Fs10841-018-0113-5>.
19. Alger, S.A., P.A. Burnham, Z.S. Lamas, A.K. Brody, and **L.L. Richardson**. 2018. Homesick: impacts of migratory beekeeping on honey bee (*Apis mellifera*) pests, pathogens, and colony size. *PeerJ* 6: e5812.
18. Sonter, L.J., J. Gourevitch, I. Koh, C.C. Nicholson, **L.L. Richardson**, A. Schwartz, N.K. Singh, K.B. Watson, M. Maron, and T.H. Ricketts. 2018. Biodiversity offsets forgo opportunities to mitigate impacts on ecosystem services. *Frontiers in Ecology and Environment* 16: 143-148.
17. Nicholson, C.C., I. Koh, A. Beauchemin, **L.L. Richardson**, and T.H. Ricketts. 2017. Farm and landscape factors interact to affect the supply of pollination services. *Agriculture, Ecosystems and Environment* 250: 113-122.
16. Bronstein, J.L., J.L. Barker, E.M. Lichtenberg, **L.L. Richardson**, and R.E. Irwin. 2017. The behavioral ecology of nectar robbing: why be tactic constant? *Current Opinion in Insect Science* 21: 14-18.

15. Sonter, L.J., T.H. Ricketts, B. Fisher, C.C. Nicholson, J.A. Johnson, K.B. Watson, and **L.L. Richardson**. 2017. Multi-site interactions: understanding the offsite impacts of land use change on the use and supply of ecosystem services. *Ecosystem Services* 23: 158-164.
14. Ricketts, T.H., K.B. Watson, I. Koh, A.M. Ellis, C.C. Nicholson, S. Posner, **L.L. Richardson**, and L.J. Sonter. 2016. Disaggregating the evidence linking biodiversity and ecosystem services. *Nature Communications*: 7:13106.
13. de Keyzer, C.W., S.R. Colla, C.F. Kent, N.E. Rafferty, **L.L. Richardson**, and J.D. Thomson. 2016. Delving deeper: questioning the decline of long-tongued bumble bees, long-tubed flowers and their mutualisms with climate change. *Journal of Pollination Ecology* 18 (6): 36–42.
12. **Richardson, L.L.**, R.E. Irwin, and M.D. Bowers. 2016. Nectar chemistry mediates the behavior of parasitized bees: consequences for plant fitness. *Ecology* 97(2): 325-337.
11. Sheffield, C.S., **L.L. Richardson**, S. Cannings, H. Ngo, J. Heron, and P.H. Williams. 2016. Biogeography and designatable units of *Bombus occidentalis* Greene and *B. terricola* Kirby (Hymenoptera: Apidae) with implications for conservation status assessments. *Journal of Insect Conservation* 20(2): 189-199.
10. Williams, P.H., A.M. Byvaltsev, B. Cederberg, M.V. Berezin, F. Ødegaard, C. Rasmussen, **L.L. Richardson**, J. Huan, C.S. Sheffield, and S.T. Williams. 2015. Genes suggest ancestral colour polymorphisms cut across morphologically cryptic species in Arctic bumblebees. *PLOS One* 10(12): e0144544.
9. **Richardson, L.L.** and R.E. Irwin. 2015. Floral ecology of turtlehead (*Chelone glabra* L.; Plantaginaceae). *Journal of Pollination Ecology* 17(20): 132-144.
8. Kerr, J.T., A. Pindar, P. Galpern, L. Packer, S.G. Potts, S.M. Roberts, P. Rasmont, O. Schweiger, S.R. Colla, **L.L. Richardson**, D.L. Wagner, L.F. Gall, D.S. Sikes, and A. Pantoja. 2015. Climate change impacts on bumblebees converge across continents. *Science* 349 (6244): 177-180.
7. **Richardson, L.L.**, L.S. Adler, A.S. Leonard, J. Andicoechea, K.H. Regan, W.E. Anthony, J.S. Manson, and R.E. Irwin. 2015. Secondary metabolites in floral nectar reduce parasite infections in bumblebees. *Proceedings of the Royal Society of London B: Biological Sciences* 282 (1803), 20142471.
6. Irwin, R.E., **L.L. Richardson**, J.S. Manson, D.R. Gardner, and D. Cook. 2014. Secondary compounds in floral rewards: impacts on pollinators. *Journal of Agricultural and Food Chemistry* 62(30): 7335-7344.
5. Bowers, M.D. and **L.L. Richardson**. 2013. Use of two oviposition plants in populations of *Euphydryas phaeton* Drury (Nymphalidae). *Journal of the Lepidopterists' Society* 67(4): 299-301.
4. Colla, S.R., F. Gadallah, **L.L. Richardson**, D. Wagner, and L. Gall. 2012. Assessing declines of North American bumble bees (*Bombus* spp.) using museum specimens. *Biodiversity and Conservation* 21(14): 3585-3595.
3. **Richardson, L.L.** and J.L. Bronstein. 2012. Reproductive biology of pointleaf manzanita (*Arctostaphylos pungens*) and the pollinator-nectar robber spectrum. *Journal of Pollination Ecology* 9(15): 115-123.

2. Millette, T.L., D. Slaymaker, E. Marcano, C. Alexander, and **L.L. Richardson**. 2011. AIMS-thermal—a thermal and high resolution color camera system integrated with GIS for aerial moose and deer census in northeastern Vermont. *Alces* 47: 27-37.

1. Irwin, R.E., J.L. Bronstein, J.S. Manson, and **L.L. Richardson**. 2010. Nectar robbing: ecological and evolutionary perspectives. *Annual Review of Ecology and Systematics* 41: 271-292.

Books

Williams, P.H., R.W. Thorp, **L.L. Richardson**, and S.R. Colla. 2014. *Bumble bees of North America: An identification guide*. Princeton University Press. Princeton, NJ, USA. ISBN: 978-0-691-15222-6. 208 pp. (Recipient, 2014 *American Library Association's Outstanding Reference Source Award*.)

Letters, Non-Refereed Articles, and Technical Reports

Egan, P.A., **L.L. Richardson**, and P.C. Stevenson. 2017. Nectar feeders take their vitamins. *Science* 63(26): eLetters.

Kerr, J.T., A. Pindar, P. Galpern, L. Packer, S.G. Potts, S.M. Roberts, P. Rasmont, O. Schweiger, S.R. Colla, **L.L. Richardson**, D.L. Wagner, L.F. Gall, D.S. Sikes, and A. Pantoja. 2015. Relocation risky for bumblebee colonies—Response. *Science* 350, 287.

Richardson, L.L. 2015. Flower pharmacies help bees fight parasites. *The Conversation*. Available online: www.theconversation.com/flower-pharmacies-help-bees-fight-parasites-37614.

Colla, S.R., **L.L. Richardson**, and J. Heron. 2015. Status report on the yellow-banded bumble bee, *Bombus terricola*. Report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Canadian Wildlife Service, Environment Canada. Ottawa, Ontario.

Colla, S.R., M. Otterstatter, C.S. Sheffield, **L.L. Richardson**, and J. Heron. 2014. Status report on the western bumble bee, *Bombus occidentalis*. Report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Canadian Wildlife Service, Environment Canada. Ottawa, Ontario.

Colla, S.R., C.S. Sheffield, and **L.L. Richardson**. Status report on the gypsy cuckoo bumble bee, *Bombus bohemicus*, in Canada. 2014. Report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Canadian Wildlife Service, Environment Canada. Ottawa, Ontario.

Hatfield, R., S. Jepsen, R.W. Thorp, **L.L. Richardson**, and S.R. Colla. 2014. IUCN Red List assessments for North American *Bombus* species. The IUCN Red List of Threatened Species. Version 2015.2. Available online: www.iucnredlist.org.

McFarland, K.P. and **L.L. Richardson**. 2014. Species status report for *Bombus affinis*. Endangered Species Committee, Vermont Agency of Natural Resources. Montpelier, Vermont.

McFarland, K.P. and **L.L. Richardson**. 2014. Species status report for *Bombus bohemicus*. Endangered Species Committee, Vermont Agency of Natural Resources. Montpelier, Vermont.

McFarland, K.P. and **L.L. Richardson**. 2014. Species status report for *Bombus terricola*. Endangered Species Committee, Vermont Agency of Natural Resources. Montpelier, Vermont.

Colla, S.R., **L.L. Richardson**, and P.H. Williams. 2011. Bumblebees of the eastern United States. U.S. Forest Service and The Pollinator Partnership. (*Recipient, American Library Association's Notable Government Document Award.*)

Richardson, L.L. 2009. The buzz on pollination. Northern Woodlands Magazine. May 9, 2009.

Richardson, L.L. and E. Thompson. 2002. *Panicum flexile* conservation plan. New England Plant Conservation Program. New England Wild Flower Society, Framingham, Massachusetts.

Richardson, L.L. and E. Thompson. 2002. *Hackelia deflexa* var. *americana* conservation plan. New England Plant Conservation Program. New England Wild Flower Society, Framingham, Massachusetts.

Teaching & Mentoring

Full Courses

Middlebury College, 2017

BIO 1002 Experimental Approaches to the Ecology and Conservation of Bees
 Winter Term Visiting Instructor, designed curriculum, and taught lab/
 lecture course

Middlebury College, 2009

BIO 1002 Bee Diversity and Ecology
 Winter Term Visiting Instructor, designed curriculum and taught lab/
 lecture course

Teaching Assistantships

Dartmouth College, 2011-2014

BIO 16 Ecology (Dr. Rebecca Irwin)
 BIO 23 Biology of Plants, (Dr. Rebecca Irwin)
 BIO 29 Biostatistics (Dr. Kathryn Cottingham)
 ENVS 20 Conservation of Biodiversity (Drs. Douglas Bolger, Selena Ahmed)

University of Arizona, 1996-1999

ECOL 181 Introductory Biology, (Dr. Michael Rosenzweig)
 ECOL 206 Environmental Biology, (Dr. William Calder)
 ECOL 302 Ecology, (Dr. Judith Bronstein)
 ECOL 406 Conservation Biology, (Dr. William Calder)
 ECOL 472 Systematic Botany, (Dr. Lucinda McDade)

Earlham College, 1994

BIOL 348 Ornithology, (Dr. William Buskirk)
 BIOL 350 Field Botany, (Dr. Brent Smith)

Guest Lecturing

University of Vermont, 2016

HCOL 186 Environmental Literature of the Anthropocene (Dr. Amy Seidl)
 PSS 106 Entomology and Pest Management (Dr. Yolanda Chen)

Student Mentoring**Graduate**

York University: Victoria MacPhail (PhD student, 2016-present)

Antioch New England University: Caroline Scully (MS, 2010)

Undergraduate

University of Vermont: Jordyn Chace (Honors thesis research, 2016), Felix Holdorf (Independent study, 2016)

Johnson State College: Zacheriah Cota-Weaver (Independent study, 2016)

Marlboro College: Megan Stypulkoski (Thesis committee member, 2016)

Dartmouth College: Yu Zhu Mei (Women in Science Project, 2014), Alison Hogeboom (NSF Research Experience for Undergraduates Program, 2011)

High School

South Burlington High School: Lena Ginawi and Mia McKenzie (Independent research project, 2016)

Presentations

Richardson, L.L. "Mycorrhizal Fungi Alter Aboveground Plant Traits Important to Pollination and Crop Yield." Ecological Society of America Annual Meeting, Portland, OR. August 9, 2017.

Richardson, L.L. "Mycorrhizal Fungi Affect Pollination Mutualisms Between Bees and Crop Plants." Cornell University, March 27, 2017.

Richardson, L.L. "Native Bee Conservation in Vermont and Beyond." Naturalist Journeys Lecture Series, North Branch Nature Center, Montpelier, VT. February 24, 2017.

Richardson, L.L. and J. Hayden. "Managing Blue Orchard Bees." Northeast Organic Farming Association of Vermont Annual Meeting, Burlington, VT. February 18, 2017.

Richardson, L.L. "Mycorrhizal Fungi Affect Pollination Mutualisms Between Bees and Crop Plants." Department of Biological Sciences Seminar, University of New Hampshire, Durham, NH. February 17, 2017.

Richardson, L.L. "Pollination is a Multispecies Interaction: Bees, Parasites, and Fungi Structure Reproduction of Wild and Cultivated Plants." Johnson State College, Johnson, VT. November 2, 2016.

Richardson, L.L., A.K. Brody, and T.H. Ricketts. "Mycorrhizal Fungi Affect Floral Traits Important to Pollination and Crop Yield." International Congress of Entomology, Orlando, FL. September 25, 2016.

Richardson, L.L., S. Alger, A.K. Brody, and T.H. Ricketts. "Mycorrhizal Fungi Affect Pollination Mutualisms Between Bees and Crop Plants." USDA National Institute of Food and

Agriculture Project Directors' Meeting, Washington, DC. August 30, 2016.

Richardson, L.L. "Pollination: Effects of Plant Chemistry, Mycorrhizae, and Bee Declines." USDA Northeastern Integrated Pest Management Pollinator Habitat Working Group meeting, University of Massachusetts Cranberry Station, Wareham, MA. August 19, 2016.

Richardson, L.L., S. Alger, A.K. Brody, and T.H. Ricketts. "Mycorrhizal Fungi Affect Pollination Mutualisms Between Bees and Crop Plants." International Conference on Pollination Biology, Health, and Policy, Penn State University, State College, PA. July 19, 2016.

Richardson, L.L., M. Ferguson, and K.P. McFarland. "Status and Trends of Wild Insect Pollinators in Vermont and Beyond." Vermont Agency of Natural Resources Pollinator Symposium, Burlington, VT. March 17, 2016.

Richardson, L.L., K.P. McFarland, and S. Zahendra. "Declines in Bumble Bee Species Diversity in Vermont, 1915-2014." Vermont Monitoring Coop Annual Conference, Burlington, VT. December 11, 2015.

Richardson, L.L. "Multiple Mutualisms in Agriculture: Implications for Plants, Pollinators, and Yield." Rubenstein School of Environment and Natural Resources Seminar Series, University of Vermont, Burlington, VT. November 19, 2015.

Richardson, L.L. "Chemical Ecology of Multispecies Interactions: Implications for Plants, Bees, and Agriculture." Biology Department Seminar, Middlebury College, Middlebury, VT. November 7, 2015.

Richardson, L.L. "Chemical Ecology of Multispecies Interactions: Implications for Plants, Bees, and Agriculture." Ecology, Evolution and Environmental Biology Group Seminar, University of Vermont, Burlington, VT. September 23, 2015.

Richardson, L.L. "Sex, Drugs, and Bees: How Plant Chemistry Structures Pollination Mutualisms." Vermont Center for Ecostudies 'Suds and Science' lecture series, Norwich, VT. September 1, 2015

Richardson, L.L., M.D. Bowers, L.S. Adler, and R.E. Irwin. "Foraging Behavior of Bee Pollinators Structured by Parasites and Plant Chemistry." Ecological Society of America Annual Meeting, Baltimore, MD. August 11, 2015.

Richardson, L.L. "Multispecies Effects of Floral Chemistry on Plants, Bees, and Parasites." Ecology and Evolutionary Biology seminar, University of Vermont, Burlington, VT. March 25, 2015.

Richardson, L.L. "Bittersweet: Tritrophic Effects of Nectar Secondary Metabolites on Plants, Pollinators, and Parasites." Doctoral Dissertation Defense presentation, Dartmouth College, Hanover, NH. December 18, 2014.

Richardson, L.L. "Plant Secondary Metabolites in Floral Nectar: Effects on Plants, Bees, and Parasites." Biology Department Seminar Series, University of Vermont, Burlington, VT. September 29, 2014.

Richardson, L.L., R.E. Irwin, and M.D. Bowers. "Iridoid Glycosides in Floral Nectar Alter Pollinator Behavior and Pollen Transfer Dynamics." Ecological Society of America Annual Meeting, Sacramento, CA. August 13, 2014.

Richardson, L.L., R.E. Irwin, and M.D. Bowers. "Plant Secondary Metabolites in Floral Nectar Alter Pollinator Behavior and Pollen Transfer Dynamics." Northeast Natural History Conference, Springfield, MA. April 9, 2014.

Richardson, L.L., K.P. McFarland, and S. Zahendra. "An Overview of the Vermont Center for Ecostudies Bumble Bee Atlas." Northeast Natural History Conference, Springfield, MA. April 9, 2014.

Richardson, L.L., L.S. Adler, A.S. Leonard, K. Henry, W. Anthony, and R.E. Irwin. "Plant Secondary Compounds in Floral Nectar Reduce Bumble Bee Parasite Load." Ecological Society of America Annual Meeting, Minneapolis, MN. August 8, 2013.

Richardson, L.L. "Bumble Bees: Identification, Ecology, and Conservation." Vermont Bumble Bee Survey, Vermont Center for Ecostudies, Norwich, VT. April 27, 2012.

Richardson, L.L. "Bumble Bee Trends in Northeastern North America." Public Symposium: Plight of the Bumblebees. Smithsonian Institution's Natural History Museum, Washington, D.C. June 22, 2009.

Professional Associations

American Chemical Society
 Ecological Society of America
 Entomological Society of America
 IUCN Species Survival Commission, Bumblebee Specialist Group, North American Region
 Northeast IPM Center Northern New England Pollinator Habitat Working Group
 Society of Environmental Toxicology and Chemistry
 US Fish and Wildlife Service, *Bombus affinis* Endangered Species Working Group
 Vermont Center for Ecostudies
 Vermont Entomological Society
 Vermont Endangered Species Committee, Invertebrate Species Advisory Group
 Vermont Pollinator Protection Committee
 Xerces Society for Invertebrate Conservation

Professional Service

Ad hoc review of manuscripts (~10/ year): *Acta Oecologica*, *American Journal of Botany*, *The American Naturalist*, *Annals of Botany*, *Basic and Applied Ecology*, *Biological Conservation*, *Biotropica*, *The Canadian Entomologist*, *Current Opinion in Insect Science*, *Ecological Applications*, *Ecology*, *Ecology and Evolution*, *Ecology Letters*, *Frontiers in Ecology and the Environment*, *Insect Conservation and Diversity*, *Frontiers in Ecology and the Environment*, *Functional Ecology*, *Journal of Ecology*, *Journal of the Kansas Entomological Society*, *Journal of Melittology*, *Journal of Pollination Ecology*, *Nature Scientific Reports*, *Plant Species Biology*, *Plant Systematics and Evolution*, *PLOS One*, *PLOS Pathogens*, *Proceedings of the Royal Society: Biology*

Reviews of grant applications and technical publications: *National Geographic Society*, *U.S.-Israel Binational Science Foundation*, *Sigma Delta Epsilon Graduate Women in Science Fellowship*, *U.S. Army Research Office*, *U.S. Fish and Wildlife Service*