

Joshua M. Rapp

Postdoctoral Researcher
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INTERESTS

Plant Ecology, Global Change, Life-history Theory, Forest Ecology, Ecosystem Ecology, Plant Demography, Plant-Animal Interactions, Masting, Tropical Ecology, Natural Resource Economics

EDUCATION

2010 Ph.D., Biology, Wake Forest University
2003 M.S., Forestry, University of Vermont
1997 B.S., Geology, Duke University

RESEARCH EXPERIENCE

2017 Research Assistant, Harvard Forest: *Sustainable Working Landscapes*
2015-present Postdoctoral Researcher, University of Massachusetts Amherst: *Climate effects on the culture and ecology of sugar maple*
2015-2016 Charles Bullard Fellow in Forest Research, Harvard Forest, Harvard University: *Maple syrup, climate change, and the ecology and management of New England forests*
2014-2015 Postdoctoral Scholar, University of California, Davis: *Stochastic life-history theory: pollination and resource limitation in plant reproduction* (Dr. Sebastian Schreiber, Dr. Neal Williams, and Dr. Jay Rosenheim, Advisors)
2011-2014 Postdoctoral Fellow, Tufts University and Harvard Forest, Harvard University: *Masting dynamics in sugar maple and whitebark pine* (Dr. Elizabeth Crone, Advisor)
2004-2010 Doctoral student, Wake Forest University: *Climatic control on plant performance across an Andean altitudinal gradient* (Dr. Miles Silman, Advisor)
2004 Research Assistant, University of Montana: *Snowshoe hare ecology*
2004 Botany Intern, Ashoka Trust for Research in Ecology and the Environment (India): *Epiphyte diversity*
2004 Botanist (GS-5), USDA Forest Service, Northeastern Research Station: *Vascular plant diversity*
2001-2003 Masters student, University of Vermont: *Ecological community mapping using the National Vegetation Classification System at the Lake Umbagog National Wildlife Refuge: an evaluation of methodology* (Dr. Deane Wang, Advisor)
2002 Ecologist, LIA Consultants: *Ecological community mapping and vascular plant diversity*
2001 Research Assistant, University of California, Berkeley: *Marbled Murrelet ecology*
2000-2001 Research Assistant, University of Massachusetts, Amherst: *Darwin's fox ecology*
1997 Geologist (GS-5), United States Geological Survey (NAGT_USGS Cooperative Summer Field Training Program): *Paleolimnology*

PUBLICATIONS

Faison E.K., S. DeStefano, D.R. Foster, **J.M. Rapp**, J.A. Compton. 2016. Multiple Browsers Structure Tree Recruitment in Logged Temperate Forests. *PLoS ONE* 11(11): e0166783.
doi:10.1371/journal.pone.0166783

Faison, E. K., S. DeStefano, D.R. Foster, G. Motzkin, and **J. M. Rapp**. 2016. Ungulate browsers promote herbaceous layer diversity in logged temperate forests. *Ecology and Evolution*.
doi:10.1002/ece3.2223

Rosenheim, J.A., N.M. Williams, S.J. Schreiber, and **J.M. Rapp**. 2016. Modest pollen limitation of lifetime seed production is in good agreement with modest uncertainty in whole-plant pollen receipt. *American Naturalist*. **187**:397-404.

Rapp, J.M. and E.E. Crone. 2015. Maple syrup production declines following masting. *Forest Ecology and Management*. **335**:249-255.

Clark, K.E., M.A. Torres, A.J. West, R.G. Hilton, M. New, A.B. Horwath, J.B. Fisher, **J.M. Rapp**, A. Robles Caceres, and Y. Malhi. 2014. The hydrological regime of a forested tropical Andean catchment. *Hydrology and Earth System Sciences*. **18**: 5377-5397.

Girardin, C.A.J., Y. Malhi, K.J. Feeley, **J.M. Rapp**, M.R. Silman, P. Meir, W. Huaraca Huasco, N. Salinas, M. Mamani, J.E. Silva-Espejo, K. García Cabrera, W. Farfan Rios, D.B. Metcalfe, C.E. Doughty, L.E.O.C. Aragão. 2014. Seasonality of above-ground net primary productivity along an Andean altitudinal transect in Peru. *Journal of Tropical Ecology*. **30**:503-519.

Crone, E.E. and **J.M. Rapp**. 2014. Resource depletion, pollen coupling and the ecology of mast-seeding. *Annals of the New York Academy of Sciences*. **1322**:21-34.

Rapp, J.M. and M.R. Silman. 2014. Epiphyte response to drought and experimental warming in an Andean cloud forest [v2; ref status: indexed, <http://f1000r.es/3le>] *F1000Research*. **3**:7.

Rapp, J.M., E.J.B. McIntire, and E.E. Crone. 2013. Sex allocation, pollen limitation and masting in whitebark pine. *Journal of Ecology*. **101**:1345-1352.

Rapp, J.M. and M.R. Silman. 2012. Diurnal, seasonal, and altitudinal trends in microclimate across a tropical montane cloud forest. *Climate Research*. **55**:17-32.

Rapp, J.M., M.R. Silman, J.S. Clark, C.A.J. Girardin, D. Galiano, and R. Tito. 2012. Intra- and inter-specific tree growth across a long altitudinal gradient in the Peruvian Andes. *Ecology*.

93:2061-2072. 

Marthews, T.R., Y. Malhi, C.A.J. Girardin, J.E. Silva-Espejo, L.E.O.C. Aragão, D.B. Metcalfe, **J.M. Rapp**, L.M. Mercado, R.A. Fisher, D.R. Galbraith, J.B. Fisher, N. Salinas-Revilla, A.D. Friend, N.

Restrepo-Coupe, and R.J. Williams. 2012. Simulating forest productivity along a neotropical elevational transect: temperature variation and carbon use efficiency. *Global Change Biology*. **18**:2882-2898.

Fierer, N., C.M. McCain, P. Meir, M. Zimmerman, **J.M. Rapp**, M.R. Silman, R. Knight. 2011. Microbes do not follow the elevational diversity patterns of plants and animals. *Ecology*. **92**:797–804.

Girardin, C.A.J., Y. Malhi, L.E.O.C. Aragão, M. Mamani, W. Huaraca Huasco, L. Durand, K. J. Feeley, **J. Rapp**, J.E. Silva-Espejo, M. Silman, N. Salinas, R. J. Whittaker. 2010. Net primary productivity allocation and cycling of carbon along a tropical forest elevational transect in the Peruvian Andes. *Global Change Biology*. **16**: 3176-3192.

Meier, C.L., **J. Rapp**, R. Bowers, M.R. Silman, and N. Fierer. 2010. Fungal growth on a common wood substrate across a tropical elevation gradient: temperature sensitivity, community composition, and potential for above-ground decomposition. *Soil Biology & Biochemistry*. **42**: 1083-1090.

Rapp, J., D. Wang, D. Capen, E. Thompson, and T. Lautzenheiser. 2005. Evaluating error in using the National Vegetation Classification System for ecological community mapping in northern New England. *Natural Areas Journal* **25**: 46-54.

Reynolds, R. L., J. G. Rosenbaum, **J. Rapp**, M. W. Kerwin, J. P. Bradbury, S. M. Colman and David Adam. 2004. Record of late Pleistocene glaciation and deglaciation in the southern Cascade Range; I, Petrological evidence from lacustrine sediment in Upper Klamath Lake, southern Oregon. *Journal of Paleolimnology* **31**: 217-233.

In review or preparation

Rapp, J.M., S. Ahmed, B. Dufour, R.D. Huish, D.A. Lutz, T.L. Morelli, and K. Stinson, 2017. Finding the sweet spot: climate optimum for maple syrup production. *In preparation*.

Rapp, J.M., S.J. Schreiber, J.A. Rosenheim, N.M. Williams, and L.D. Harder. Increase the mean, reduce the variance, or bet on a bonanza: plant evolutionary response to environmental variability in pollen receipt. *In preparation*.

Rapp, J.M., C.R. Mangnall, E.J.B. McIntire, A. Fajardo, and E.E. Crone. Climate and stand characteristics determine whitebark pine mortality risk from mountain pine beetle. *In preparation*.

Rapp, J.M., I. Le Roncé, and E.E. Crone. Resource-dependence of sex allocation within and among trees and years in *Acer saccharum*. *In preparation*.

GRANTS and AWARDS

2015-2016	Charles Bullard Fellowship in Forest Research. Harvard Forest, Harvard University. \$40,848.
2015-2017	Northeast Climate Science Center: Climate Effects on the Culture and Ecology of Sugar Maple. Senior Personnel and Primary Grant Writer (<i>with</i> co-PIs-Toni Lyn Morelli and Kristina Stinson, University of Massachusetts Amherst; Selena Ahmed, Montana State University; David Lutz, Dartmouth University; and Ryan Huish, Hollins University). \$149,867
2008, 2009	Alumni Student Travel Award, Wake Forest University, Graduate School. \$300
2008, 2009	Elton C. Cocke Travel Award, Wake Forest University, Biology Department. \$500
2005, 2009	Vecellio Grant for Graduate Research, Wake Forest University. \$1500
1997	Monetary Award for contribution to the Western Lakes Project, USGS. \$500

WORKSHOPS

- 2017 What are the impacts of climate change on maple syrup production and can we manage for them? Forest Ecosystem and Monitoring Cooperative Conference, University of Vermont. *Discussion group leader.*
- 2015 Sugar Maple in a Changing Climate. Northeast Climate Science Center, University of Massachusetts. *Organizer and Host.*
- 2014 Eddy Covariance and Eddy Pro Workshop. LI-COR Biosciences. At Harvard University.
- 2014 LI-6400XT Introductory Workshop. LI-COR Biosciences. At Harvard University.
- 2013 Integrating Evidence on Forest Response to Climate Change: Physiology to Regional Abundance: A Training Workshop for Macrosystems Research, Duke University
- 2011 Mixed models and matrix models: Workshop on statistical analysis of stochastic models of plant population dynamics, Harvard Forest, funded workshop
- 2011 Adaptation to climate from a spatial perspective, European Science Foundation sponsored workshop, Lammi Biological Station, University of Helsinki, Finland
- 2010 OTS-PASI, Expanding the Frontier in Tropical Ecology through Embedded Sensors, La Selva Costa Rica, funded workshop

TEACHING and MENTORING

- 2016-2017 Project Ecologist, Harvard Forest Schoolyard Ecology, Our Changing Forests
- 2016 Instructor, University of Massachusetts Amherst: Ecology, Economy, and Future of Maple Syrup
- 2015, 2016 Guest Instructor, University of Massachusetts Amherst: Experimental Methods in Ecology
- 2014 Guest Instructor, University of Massachusetts Amherst: Forest tree and shrub identification
- 2013 Guest Instructor, Tufts University: Tropical Ecology and Conservation
- 2013 Teaching Assistant, Harvard Forest: Workshop on mixed-effects modeling in R
- 2012, 2013, 2016 Guest Instructor, Harvard University: Global Change Ecology: Forests, Ecosystem Function, and the Future
- 2005-2010 Lab Instructor, Wake Forest University: *Biological Principles (3x); Ecology and Evolutionary Biology (3x); Community Ecology; Biology & the Human Condition*
- 2009 Guest Lecturer, Wake Forest University: *Tropical Ecology*
- 2001-2003 Lab Instructor, University of Vermont: *Natural History and Field Ecology (2x); Introduction to Environmental Science; Biostatistics; Insect Biodiversity*
- 2005-2017 Mentor for Undergraduate Research: Richard Amick (Salem College); Mitchel Buder, Andrew Collins, Oran Basel, Roger Kirkpatrick, (Wake Forest University); Darcy Galiano, Richard Tito (Universidad Nacional de San Antonio Abad y Perú); Dash Donnelly (Montana State University); Casey Mangnall (University of Oregon); Patrick O'Hara (Harvard University); Iris Le Ronce (M.S., University of Lyon); Jasmine Olins, Dylan Quinn, Richard, Li (Brandeis University)
- 1998-1999 Teacher, Mayatan School, Copan Ruinas, Honduras: 3rd Grade
- 1997-1998 Environmental Educator, Student Conservation Association New Hampshire Parks AmeriCorps program

SERVICE

New Salem (MA) Conservation Commission member (2016-present)

Reviewer: American Naturalist, BioScience, Canadian Journal of Forest Research, Global Ecology and Biogeography, Ecology, Ecospheres, Journal of Ecology, Journal of Biogeography, American Journal of Botany, Journal of the Torrey Botanical Society, Journal of Environmental Management, PLOS ONE, Plant Ecology, Ecography, Swiss National Science Foundation, Trees – Structure and Function, Canadian Journal of Forest Research

Organizer: Ecolunch, Department of Biology, Wake Forest University (2009)

Member: Ecological Society of America (2004-present)

Panelist: Harvard Forest Summer Student Program Graduate School panel (2013)

PRESENTATIONS

Conference Presentations

Rapp, J.M., S. Ahmed, B. Dufour, R.D. Huish, D.A. Lutz, T.L. Morelli, and K. Stinson, 2017. *Finding the sweet spot: climate optimum for maple syrup production*. Forest Ecosystem and Monitoring Cooperative Conference, Burlington, Vermont.

Rapp, J.M., S. Ahmed, A. Brunelle, B. Dufour, R.D. Huish, D.A. Lutz, T.L. Morelli, and K. Stinson, 2017. *Maple syrup in a changing climate*. Northeast Climate Science Center's Regional Science Meeting. Amherst, Massachusetts. Poster.

Rapp, J.M., M.J. Duveneck, and J.R. Thompson. 2016. *(Re)expansion of the maple syrup industry in New England: projecting where the taps will be in a changing environment*. 27th Annual Harvard Forest Ecology Symposium, Harvard Forest, Harvard University, Petersham, Massachusetts. Poster.

Rapp, J.M. 2015. *Sugar maple in a changing climate: What do we know?* Sugar Maple in a Changing Climate. Northeast Climate Science Center, University of Massachusetts Amherst. Massachusetts.

Rapp, J.M., S.J. Schreiber, J.A. Rosenheim, N.M. Williams, and L.D. Harder. 2015. *Increase the mean, reduce the variance, or bet on a bonanza: How should plants respond to environmental variability in pollen receipt?* Ecological Society of America 100th Annual Meeting. Baltimore, Maryland.

Rapp, J.M., S.J. Schreiber, J.A. Rosenheim, N.M. Williams, and L.D. Harder. 2015. *Plant evolutionary response to stochastic pollen receipt: Increase the mean, reduce the variance, or bet on a bonanza?* 10th Annual Plant Biology Symposium, Arnold Arboretum, Harvard University, Boston, Massachusetts. Poster.

Rapp, J.M. and E.E. Crone. 2014. *Endogenous resource dynamics drive sugar maple masting and maple syrup production*. Ecological Society of America 99th Annual Meeting. Sacramento, California.

Rapp, J.M. and E.E. Crone. 2014. *Resource allocation to reproduction drives carbon dynamics from shoots to landscapes in sugar maple (*Acer saccharum*)*. Gordon Research Conference: Unifying Ecology Across Scales. Biddeford, Maine.

Rapp, J.M. 2013. *Maple syrup production declines following masting*. Vermont Monitoring Cooperative Conference, Burlington, Vermont.

Rapp, J.M. and M.R. Silman. 2013. *The role of species and diversity in forest ecosystem function along an Andes-to-Amazon gradient*. Association of Tropical Biology and Conservation 50th Anniversary Meeting, San José, Costa Rica.

Rapp, J.M. 2012. *Intra- and inter-specific tree growth across a long altitudinal gradient in the Peruvian Andes*. Andes Biodiversity and Ecosystem Research Group Conference, Sequoia National Park, California.

Rapp, J.M. and E.E. Crone. 2012 *Pollination limitation, sex allocation, and masting in whitebark pine*. Ecological Society of America 97th Annual Meeting, Portland, Oregon

Rapp, J.M., E.C. Crone, and J.D. Crall. 2012 *Bees, keys, and maple syrup: Investigating seed production in sugar maple*. 8th Annual Plant Biology Symposium, Arnold Arboretum, Harvard University, Boston, Massachusetts. Poster.

Rapp, J.M. and E.C. Crone. 2012 *Trees make seeds: Does reproductive ecology matter for forest carbon dynamics?* 23rd Annual Harvard Forest Ecology Symposium, Harvard Forest, Harvard University, Petersham, Massachusetts

Rapp, J.M. 2011 *Bees, keys, and maple syrup: seed production in sugar maple*. LTER graduate student and post-doc retreat, Hubbard Brook Experimental Forest, New Hampshire

Rapp, J.M. 2011 *Tree growth across a 1700 meter altitudinal gradient in the humid tropics*. Adaptation to climate from a spatial perspective, Lammi Biological Station, University of Helsinki, Finland

Rapp, J.M. 2010 *Growth phenology and climate seasonality in an Andean cloud forest*. Andes Biodiversity and Ecosystem Research Group Fourth Annual Conference, Marathon, Florida

Rapp, J.M. and M.R. Silman. 2009 *Diameter growth across an altitudinal gradient in the cloud forest tree genus Weinmannia*. Ecological Society of America 94th Annual Meeting, Albuquerque, New Mexico

Rapp, J.M. and M.R. Silman. 2009. *Epiphyte survival across an altitudinal gradient during drought*. 5th International Canopy Conference, Bangalore, India. Poster.

Rapp, J.M., K.J. Feeley, and M.R. Silman. 2009. *Using demography to understand distribution limits in the Cloud Forest Tree Genus Weinmannia*. Association for Tropical Biology and Conservation, Marburg, Germany. Poster.

Rapp, J.M. and M.R. Silman. 2009. *Do natural history collections and plot data predict the same species distributions?* Southeastern Ecology and Evolution conference. Gainesville, Florida. Poster.

Rapp, J.M. and M.R. Silman. 2008. *Does adult performance control distributions of Weinmannia?* Andes Biodiversity and Ecosystem Research Group Third Annual Conference, Bettmeralp, Switzerland

Rapp, J.M. 2002 *Ecological Community Mapping of the Lake Umbagog National Wildlife Refuge*. Graduate Research Symposium, School of Natural Resources, University of Vermont

University Seminars

Rapp, J.M., and S. Ahmed. 2017. *What are the impacts of climate change on maple syrup production and can we manage for them?* Northeast Climate Science Center, University of Massachusetts Amherst.

Rapp, J.M. 2015. *Seeds and Syrup: Ecological forecasting for a non-timber forest industry.* University of Massachusetts Amherst.

Rapp, J.M. 2013. *Masting, carbon, and maple syrup economics.* Tufts University.

Rapp, J.M. 2010. *Tree growth and temperature in the tropics: Analysis across an Andean altitudinal gradient.* Harvard Forest.

Rapp, J.M. 2010. *Demographic performance of cloud forest trees across an altitudinal gradient.* Wake Forest University.

Rapp, J.M. 2003. *Evaluation of ecological community mapping using the National Vegetation Classification System at the Lake Umbagog National Wildlife Refuge.* University of Vermont.

POPULAR ARTICLES and TECHNICAL REPORTS (non-peer reviewed)

Rapp, J.M. 2016. How will climate change affect maple syrup? *Maple Syrup Digest*. **55**:16-20.

Rapp, J.M. 2015. Examining the impact of seed production on sap sugar content. *Maple Syrup Digest*. **53**: 14-19.

Rapp, J. 2004. A Place in Mind. *Northern Woodlands* magazine, Corinth, Vermont, U.S.A.

Rapp, J. 2003. Ecological Communities of the Lake Umbagog National Wildlife Refuge: Classification and Mapping with the National Vegetation Classification System (report submitted to the Trust for Public Land and the U.S. Fish and Wildlife Service.) School of Natural Resources, University of Vermont, Burlington, Vermont, U.S.A.

Rapp, J. 2003. Costa Rica: Crossroads in the Plant World. *Ecolog*, Newsletter from the Ecological Planning students, School of Natural Resources, University of Vermont, Burlington, Vermont, U.S.A.

Rapp, J. 2002. Kinglets in the Cold: Small Survivors. *Ecolog*, Newsletter from the Ecological Planning students, School of Natural Resources, University of Vermont, Burlington, Vermont, U.S.A.

Barton, J., C. Dacey, J. Hilke, J. Kart, E. Faison, K. Lange, V. Levesque, **J. Rapp**, and A. Wheeler. 2002. *Wheeler and Farm Bureau Tracts: Assessment and Recommendations for the Vermont Youth Conservation Corps.* Botany Department, University of Vermont, Burlington, Vermont, U.S.A.

OUTREACH

Events

Flowers on your Pancakes? *Drop in activity at the Collections Up Close: Magnificent Maples event at The Arnold Arboretum, Boston, Massachusetts, April 21, 2013.*

Maple research presentation for Arbor Day. *Assembly of 3rd – 6th graders at the Petersham Center School, Petersham, Massachusetts, April 26, 2013.*

Ecological Communities of the Lake Umbagog National Wildlife Refuge: Classification and Mapping with the National Vegetation Classification System. Lake Umbagog National Wildlife Refuge *staff meeting*. Errol, New Hampshire, May, 2003.

Natural History of the LaPlatte River. LaPlatte Watershed Partnership *meeting*. Shelburne, Vermont, April, 2003.

Landscape Inventory and Assessment of the Wheeler and Farm Bureau Tracts, Richmond, Vermont. (with J. Barton, C. Dacey, J. Hilke, J. Kart, E. Faison, K. Lange, V. Levesque, and A. Wheeler). *Public meeting sponsored by Richmond Land Trust and Vermont Youth Conservation Corps*. April, 2002.

Media interviews

'Weird' is the word to describe 2017 maple sugaring season. Dianne Lederman. Mass Live. March 28, 2017.

Maple Mayday. Joanna Cummings. The Analytical Scientist. July 2016.

Indiana Park Studies Impact of Climate Change on Maple Syrup. Nick Janzen. Indiana Public Radio. April 4, 2016.

Climate Change Is Coming for Your Maple Syrup. Brian Kahn. Climate Central. March 28, 2016.

What Climate Change Means for Maple Syrup. Allyson Morin. Stories for Strangers. March 24, 2016.

Sap to syrup: In Petersham, researcher tracks climate effects on sugar maples. George Barnes. Worcester Telegram. March 7, 2016.

Is Climate Change Killing the Maple Syrup Industry? Evan Garcia. Chicago Tonight. February 22, 2016.

Climate Change May Impact Maple Syrup Production. Christin Nance Lazerus. Post-Tribune. February 19, 2016.

Studying Climate Change Impact on Maple Syrup Quality. Janet Lathrop. UMass Amherst press release. February 10, 2016.

Sugar and Seeds. Todd McLeish. Discoveries. Northern Woodlands magazine. Spring 2015.

The Bloom is On for Maple Syrup. Joshua A. Krisch. New York Times. January 5, 2015.

Study: Maple Syrup Production Declines After a Big Seed Year. Carrie Healy. New England Public Radio. December 28, 2014.

How New Research is Changing What We Know About Maple Syrup Production. David Oliver. Food Dive. December 10, 2015.

More Maple Seeds, Less Maple Syrup. Clarisse Hart. Tufts Now. November 7, 2014.

Who Feasts: You, or the Squirrels? New Findings from Harvard Forest. Lynda Mapes. Blog post. November 4, 2014.

Interview with Joshua Rapp – Sex allocation, pollen limitation and masting in a pine species. Scott Chamberlain. Journal of Ecology blog. August 2, 2013.

Whitebark Pine Trees: Is Their Future at Risk? NSF press release 13-101. June 10, 2013.

Whirlybirds and Maple Syrup. Alvin Powell. Harvard Gazette. March 22, 2012.

A Walk in the Clouds. Jim Robbins. Condé Nast Traveler. March 2008.

Climbing Against Time. Michael Tennesen. National Wildlife. April 2007.

Uphill Battle. Michael Tennesen. Smithsonian Magazine. August 2006.

LANGUAGES

English (native), Spanish (conversational), R programming language (fluent)