**Jessica A. Savage, PhD**

Assistant Professor

University of Minnesota - Duluth

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**Education**

PhD(2010) **Plant Biological Sciences**, University of Minnesota Advisor: Dr. Jeannine Cavender-Bares

BS (2002) **Ecological and Evolutionary Biology***, University of Rochester*, Minor in Environmental Engineering

**Research Interests**

My research examines (1) the role of the xylem and phloem transport in determining stress tolerance and carbon allocation, (2) the impact of species’ physiology and phenology on their range limits, and (3) community assembly using both functional trait and community phylogenetic approaches. My primary goal is to advance our understanding of the physiological and ecological mechanisms that maintain species distributions at multiple geographic scales.

**Peer-reviewed Publications** (†graduate/undergraduate students)

**Savage, J.A.**, Beecher, S.D. †, Clerx, L. †, Gersony, J.T. †, Knoblauch, J. †, Losada, J.M., Jensen, K.H., Knoblauch, M. and N.M. Holbrook (2017) Maintenance of carbohydrate transport in tall trees. *Nature Plants*. 3: 965–972.

* Highlighted by News and Views: Ryan, M. and E. Robert. Zero-calorie sugar delivery to roots. *Nature Plants* 3: 922–923.

Wei, X.†, **Savage, J.A.**, Riggs, C.E.† and J.M. Cavender-Bares (2017) An experimental test of fitness variation among willow and poplar species across a hydrologic gradient predicts species distributions. *Ecology* 98(5): 1311-23.

Knoblauch, M., Knoblauch, J.†, Mullendore, D.L., **Savage, J.A.**, Babst, B.A., Beecher, S.D.†, Dodgen, A.C., Jensen, K.H. and N.M. Holbrook (2016) Phloem transport in plants: A test of the Münch pressure flow hypothesis. *eLife*. 5: e15341.

* Highlighted in Surridge, C. (2016) Phloem transport: Pressure vessel. *Nature Plants.* 2: 16103 & Hammes, U.Z. (2016) Long distance transport: Under pressure. *eLife.* 5: e18435.

Sack, L., … **Savage, J.A.**, et al.(2016) Plant hydraulics as a central hub integrating plant and ecosystem function: meeting report for “Emerging Frontiers in Plant Hydraulics” *Plant, Cell and Environment* 39(9): 2085-2094.

**Savage, J.A.**, Clearwater, M.J., Haines, D.F, Klein, T., Mencuccini, M., Sevanto. S., Turgeon, R. and C. Zhang (2016) Allocation, stress tolerance and carbon transport in plants: How does phloem physiology affect plant ecology? *Plant, Cell and Environment* 39(4):709-725.

* Highlighted by commentary: Knoblauch, M. and W.S. Peter (2016) Think outside the sieve element! *Plant, Cell and Environment.* 39(4): 707-708.

Erlandson, S.R.†, **Savage, J.A.**, Cavender-Bares, J.M., and K.B. Peay (2016) Soil moisture and chemistry influence diversity of ectomycorrhizal fungal communities associating with willow along a hydrologic gradient. FEMS *Microbiology Ecology.*92 (1):1-9.

Riggs, C.E.†, Hobbie, S.E., Cavender-Bares, J.M., **Savage, J.A.** and X. Wei† (2015) Contrasting effects of plant species traits and moisture on the decomposition of multiple litter fractions. *Oecologia.* 179(2): 573-584.

**Savage, J.A.**, Haines, D.F. and N.M. Holbrook (2015) The making of giant pumpkins: How selective breeding changed the phloem of *Cucurbita maxima* from source to sink. *Plant, Cell and Environment.* 38(8): 1543-1554. Cover photograph.

* Highlighted by *BBC Earth* (Jan. 2015) and *Smithsonian.com* (Oct.2015), Philadelphia NPR station-WHYY (Oct. 2015), *the Botanist in the Kitchen* (Oct. 2015)

**Savage, J.A.,** Zwieniecki, M. and N.M. Holbrook (2013) Phloem transport velocity varies over time and among vascular bundles during early cucumber seedling development. *Plant Physiology* 163:1409–1418.

**Savage, J.A.** and J. Cavender-Bares (2013) Phenological cues drive an apparent trade-off between freezing tolerance and growth in the family Salicaceae. *Ecology* 94(8):1708–1717.

Jensen, K. **Savage, J.A.** and N.M. Holbrook (2013) Optimal concentration for sugar transport in plants. *Journal of the Royal Society Interface* 10(83). Cover photograph.

* Highlighted in *Science Now* and *Discover Magazine* (March 2013).

Kurtz,C**.**M.†, **Savage, J.A.,** Huang, I-Y† and J. Cavender-Bares (2013) Consequences of salinity and freezing stress for two populations of *Quercus virginiana* Mill. (Fagaceae) grown in a common garden. *Journal of the Torrey Botanical Society* 140(2):145–156*.*

**Savage, J.A.**and J. Cavender-Bares (2012) Habitat specialization and the role of trait lability in structuring diverse willow (genus: *Salix*) communities. *Ecology* 93(8):S138–S150.

* Highlighted in NSF Press Release 12-146 at *http://www.nsf.gov/*

**Savage, J.A.** and J. Cavender-Bares (2011) Contrasting drought survival strategies of sympatric willows (genus: *Salix*): consequences for coexistence and habitat specialization. *Tree Physiology* 31: 604–614.

**Savage, J.A.,** Cavender-Bares, J. and A. Verhoeven (2009) Willow species (genus: *Salix*) with contrasting habitat affinities differ in their photoprotective responses to water stress. *Functional Plant Biology* 36: 300–309.

Cavender-Bares, J., Sack, L. and **J. A.** **Savage** (2007) Drought reduces nocturnal transpiration in two live oak species. *Tree Physiology* 27: 611–620.

**Research Grants**

**National Science Foundation - Integrative and Organismal Systems** (April 2017- April 2020) Research grant for $395,163. *PI: J.A. Savage*.

**Sinnott Award** (Feb. – Dec. 2017) Research and travel grant for work at the Arnold Arboretum, $2,000. *PI: J.A. Savage*. Competitive grant with one given per year.

**Thesis Research Grant** (2007) University of Minnesota. Intramural research grant for $1,500. *PI: J.A. Savage.* Competitive with two given per department per year.

**Carolyn Crosby Research Grant** (2007) University of Minnesota. Intramural research grant for$3,000. PI: *J.A. Savage.* Competitive with two given per year.

**Dayton Wilkie Research Award** (2006, 2008 and 2009) University of Minnesota. Intramural research grant for $3,400. PI: *J.A. Savage.* Competitive with variable number given per year.

**Fellowships/Honors**

**Putnam Fellowship**(2014-2016) Competitive, two-year fellowship and grant for research in the Arnold Arboretum collections. Arnold Arboretum of Harvard University. Two awarded per year.

**DaRin Butz Foundation Climate Change Fellowship** (2015 & 2016) Intramural grant for $4,500. *P.I.: J.A. Savage.* Arnold Arboretum of Harvard University. One to two given per year for the purpose of supporting undergraduate research assistants.

**Plant, Cell and Environment Postdoctoral Award in Physiological Ecology** (Aug. 2014) Competitive award for oral presentation at the Ecological Society of America that “represents a significant advancement in the field”. One awarded per year.

**Doctoral Dissertation Fellowship** (2008-2009) Intramural, competitive, one-year fellowship for exceptional doctoral students. University of Minnesota. Variable number awarded per year.

**Charles J. Brand Fellowship** (2007-2008) Intramural, competitive, one-year fellowship for exceptional research in the botanical sciences. University of Minnesota. One awarded per year.

**Carolyn Crosby Summer Fellowship**(2007)Intramural, competitive, summer stipend fellowship for students studying field botany. University of Minnesota. Two awarded per year.

**Plant Biological Sciences Summer Fellowship** (2006 and 2008) Intramural, summer stipend fellowship for studying plant biological sciences. University of Minnesota.

**Graduate School Fellowship** (2004-2005) Intramural, one-year fellowship for promising in-coming students. University of Minnesota. Variable number awarded per year.

**Keynote Speaker**

**Savage, J.A.** (2017) Primed for spring: Unraveling the secrets of a dormant twig. *Minnesota Phenology Network Annual Meeting.* Itasca, MN.

**Invited Presentations**

**Savage, J.A.** (2017) How can plants maintain phloem transport as they grow taller? *iPhloem: International Workshop on Physics, Physiology and Genetics of Sugar Transport in Plants*. Copenhagen, Denmark.

**Savage, J.A.** (2016) Is the road as important as the destination? Investigating the limits of phloem transport. *Biology Colloquium at University of Wisconsin*, Madison, WI.

**Savage, J.A.** (2015) The stability of phloem transport velocity: Does phloem structure constrain carbon transport in plants? *School of Biological Sciences Seminar Series at Washington State University*, Pullman, WA.

**Savage, J.A.** (2015) Is the road as important as the destination? The implications of structural and physiological constraints on carbon transport. *School of Biological Sciences Seminar Series at Purdue University*, West Lafayette, IN.

**Savage, J.A.** (2015) The untold story of plant carbon transport: How physiology mediates plant-environment relationships. *Biology Seminar at University of Minnesota*,Duluth, MN.

**Savage, J.A.** (2014) Ecological implications of whole plant physiology from leaf to root. *Arnold Arboretum Research Talk Series,* Boston, MA.

**Savage, J.A.** (2014) Ecological implications of whole plant physiology from leaf to root: a story of stress tolerance and carbon allocation. *Ecology and Evolutionary Biology Seminar Series at University of Connecticut*, Storrs, CT.

**Savage, J.A.**, Zwieniecki, M. and N.M. Holbrook (2012) The dynamic nature of phloem transport in cucumber seedlings. *Herbaria Seminar at Harvard University,* Cambridge, MA.

**Savage, J.A.**, Zwieniecki, M. and N.M. Holbrook (2012) Changes in phloem transport during seedling development. *Physics and Physiology of Phloem Transport Workshop*, Pullman, WA.

**Savage, J.A.** (2012) An ecological and evolutionary perspective on functional diversity in the genus *Salix.* *Biology Colloquium at University of Wisconsin*, Madison, WI.

**Savage, J.A.**, and J. Cavender-Bares (2010) Niche differentiation and the role of evolutionary trait lability in structuring diverse willow communities along a water availability gradient. *NCEAS Phylogenetic Ecology Symposium.* Santa Barbara, CA.

**Symposia and Working Groups**

**Participant in “Flower Form and Function Workshop”** (2017) Upperville, VA. A workshop for a small number of invited specialists on floral physiology and evolution sponsored by the Oak Spring Garden Foundation. Workshop will lead to a review paper.

**Participant in “Birds of a Feather Climate Change Workshop”** (2016) Two Harbors, MN. Funded by Institute on the Environment. Focused on establishing collaborations across disciplines at UMD.

**Co-organizer of NSF Workshop on “Emerging Frontiers in Plant Hydraulics”** (2015) Washington, D.C. Led to an article, Sack et al. 2016 on the state of the field.

**Organizer of ESA Symposium on “Phloem Ecophysiology”** (2013–2014) Sacremento, CA.Partially funded by *Plant, Cell & Environment* and resulted in review article, Savage et al. 2015.

**Participant in “Physics and Physiology of Phloem Transport Workshops”** (2011 & 2012)Copenhagen, Denmark and Pullman, WA. Designed to establish collaborations and determine the next steps required to move the field forward.

**Participant in “NCEAS Phylogenetic Ecology” Working Group** (2009–2010) Santa Barbara, CA. Focused on current advances in integrating ecology and phylogenetics and resulted in a special issue of *Ecology*, where I published Savage and Cavender-Bares 2012.

**Conference Presentations** (\* presenter)

**Savage, J.A.\*** (2015) Vascular constraints on flower development: Understanding resource allocation and vascular transport in precocious flowering specie. *Botanical Society of America Annual Conference.* Edmonton, Alberta, Canada.

**Savage, J.A.\***,Knoblauch, M., Beecher, S., Knoblauch**,** J. and N.M. Holbrook (2014) The complexity of phloem structural diversity and its implications for angiosperm evolution. *Ecological Society of America Annual Conference.* Sacremento, CA.

Wei, X.**\***, **Savage, J.A.,** Keefover-Ring, K., Lindroth, R.L. and J.M. Cavender-Bares (2014) Testing growth-defense trade-off among 14 willow and poplar species along a hydrological gradient. *Ecological Society of America Annual Conference.* Sacremento, CA.

**Savage, J.A.\***, Zwieniecki, M. and N.M. Holbrook (2013) The dynamic nature of phloem transport in cucumber seedlings. *Ecological Society of America Annual Conference.* Minneapolis, MN.

Erlandson, S.R.\*, **Savage, J.A.**, Cavender-Bares, J. and K. Peay (2012) Ectomycorrhizal fungal community response to a water availability gradient. *Ecological Society of America Annual Conference*. Portland, OR.

**Savage, J.A.\***, and J. Cavender-Bares (2010) An ecological and evolutionary perspective on the role of functional trade-offs in determining willow species (genus: *Salix*) distributions at two geographic scales. *Ecological Society of America Annual Conference.* Pittsburgh, PA.

**Savage, J.A.\***, and J. Cavender-Bares (2009) The ecological consequences of niche evolution in the genus *Salix*. *Ecological Society of America Annual Conference.* Albuquerque, NM.

**Savage, J.A.\***, and J. Cavender-Bares (2008) Variation in the cold-acclimation and growth of twenty-seven North American willow (*Salix*) species relates to their latitude of origin. *Ecological Society of America Annual Conference.* Milwaukee, WI.

**Savage, J.A.\***, and J. Cavender-Bares (2008) Willow (*Salix*) habitat specialization and community assembly at Cedar Creek. *Cedar Creek Ecosystem Science Preserve Symposium.* East Bethel, MN.

**Savage, J.A.\***, Cavender-Bares, J. and A. Verhoeven (2007) Variation in the nonphotochemical energy dissipation of six co-occurring willow (*Salix*) species during an experimental dry-down. *Botanical Society of America Annual Conference.* Chicago, IL.

**Savage, J.A.\*,** and J. Cavender-Bares (2006) Drought response strategies of co-occurring willow (*Salix*) species. *Ecological Society of America Annual Conference.* Memphis, TN.

Cavender-Bares, J.\*, **Savage, J.A.**, Hoerner, F., Pahlich, A., Deacon, N., and J. Klemens (2006) Ecophysiological and genetic differentiation of live oaks across a latitudinal gradient from the tropics to the temperate zone. *Ecological Society of America Annual Conference.* Memphis, TN.

**Conference Posters** (\* presenter)

O’Connell, E\*. and **J.A. Savage** (2017) Extended Leaf Phenology and Freezing Tolerance of Invasive Shrub. *Minnesota Phenology Network Annual Meeting.* Itasca, MN.

**Savage, J.A.**\*, Knoblauch, M., Beecher, S., Clerx, L., Gersony, J., Knoblauch, J. and N.M. Holbrook (2016) Scaling of phloem resistance and its implications for long distance transport. *Multiscale Vascular Biology – Gordon Conference*, Newry, ME.

Clerx, L., **Savage, J.A**.\*, Haydek, J. and N.M. Holbrook. (2016) How do leave maintain photosynthate transport from leaves to roots as they grow taller? Ontogenetic scaling of phloem sieve tube resistance with tree height in *Quercus rubra*. *Multiscale Vascular Biology – Gordon Conference*, Newry, ME.

**Savage, J.A.**\*, Knoblauch, M., Beecher, S., Knoblauch, J. and N.M. Holbrook (2015) The anatomy of transport: How do tall trees get carbon to their roots? *Plant Biology Symposium.* Harvard University, Cambridge, MA.

**Savage, J.A.**\*, Zwieniecki, M. and N.M. Holbrook (2013) Heterogeneity in phloem transport within developing cucumber seedlings*. International Conference on Plant Vascular Biology Meeting.* Helsinki, Finland.

Jensen, K., **Savage, J.A.** and N.M. Holbrook\* (2013) Optimal concentration for sugar transport in plants*. International Conference on Plant Vascular Biology Meeting.* Helsinki, Finland.

Wei, X.\*, **Savage, J.A.** and J.M. Cavender-Bares (2013) Habitat differentiation among closely-related willow species along a water table gradient. *Ecological Society of America Annual Conference.* Minneapolis, MN.

**Savage, J.A.\***, Zwieniecki, M. and N.M. Holbrook (2012) The dynamic nature of phloem transport during seedling development*. Ecological Society of America Annual Conference.* Portland, OR.

**Savage, J.A.\*,** and J. Cavender-Bares (2009) Is there evidence for a trade-off between cold tolerance and growth in North American willows? *Long Term Ecological Research Network All Scientist’s Meeting.* Estes Park, CO.

**Savage, J.A. \*,** and J. Cavender-Bares (2006) Drought response strategies of co-occurring willow (*Salix*) species. *Long Term Ecological Research Network All Scientist’s Meeting.* Estes Park, CO.

**Public Lectures**

**Savage, J.A.** (2015) What plants do when you aren't paying attention. *Harvard Museum of Natural History Family Festival.* Cambridge, MA.

**Savage, J.A.** (2014) The great pumpkin Charlie Darwin. *New Hampshire Giant Pumpkin Grower’s Association Educational Workshop.* University of New Hampshire Cooperative Extension. Goffstown, NH.

**Savage, J.A.** (2014) How to transport enough carbon to make a one ton pumpkin? Vascular development in Atlantic Giant Pumpkins. *New England Giant Pumpkin Grower’s Association Winter Meeting.* Peabody, MA.

**Popular Articles**

**Savage, J.A.** (2015) Giant pumpkin plants do not need a superhighway to feed their fruit, only lots of country roads. *Northern New England Giant Pumpkin Growers Newsletter*. Spring issue.

**Savage, J.A.** (2014) The perfect flower (or is it?) *Southern New England Giant Pumpkin Growers Newsletter*. Spring issue.

**Teaching Experience**

**Instructor**

* *Plant Physiology, BIOL 4604* (Spring 2017 & 2018), University of Minnesota – Duluth
* *Ecology Lab, BIOL 2802* (Fall 2017), University of Minnesota – Duluth
* *Integrated Biological Systems I, IBS 8011* (Fall 2017), University of Minnesota – Duluth
* *Integrated Biological Systems II, IB 8013* (Spring 2018), University of Minnesota – Duluth

**Guest Lecturer**

* *MicroMorph Course on Plant Anatomy* (Summer 2015), Arnold Arboretum
* *Plant Physiological Ecology* *course* (Spring 2014), University of Minnesota
* *Plant Physiological Ecology course* (Spring 2007), University of Minnesota
* *Introductory Biology course* (Spring 2001), University of Rochester

**Honors**

* *Honorable Mention for Outstanding Performance Award for Teaching Assistants* (2008), University of Minnesota. Ten given per year.

**Mentoring**

**Graduate students**

*Integrated Biosciences Graduate Program*, University of Minnesota - Duluth

* Erin O’Connell (Master’s), 2016 – present
* Natalie McMann (Master’s), 2016 – present

**Graduate committee**

*Integrated Biosciences Graduate Program*, University of Minnesota – Duluth

* Haley Golz (Master’s), 2017 – present
* Riley Pizza (Master’s), 2017 - present

**Undergraduate students**

* Kennedy Mosher, junior scientist, May 2017 – present
* Rishika Quick-Singh, BURST and UROP, Mar. 2017 – present
* Collin Monette, volunteer, Jan. 2017 – present
* Sydney Hudzinski, volunteer and independent research (BIOL 3994), Jan. 2017 – present
* Alexander Peichel, volunteer and BURST Sept. 2017 – present
* Thomas Kiecker, volunteer, Jan. 2018 - present

**Other Mentoring Experience**

**DaRin Butz Foundation Climate Change Fellowship** (Summer 2014–present)

* Mentored five student research assistants involved in projects on phloem physiology and plant phenology

**High School Student Mentorship** (Fall 2013)

* Mentored a high school student interested in learning more about biology research

**Plant Physiological Ecology Research Project** (Spring 2007–2013)

* Aided two students in the design and execution of a class experiment
* Assisted with writing and submitting a manuscript (as corresponding author) to a peer-reviewed journal (*Kurtz. et al. 2013*)

**Graduate Student Mentoring** (Summer 2010)

* Assisted and provided guidance to three graduate students studying willows (*see recent publications Riggs et al. 2015 and Erlandson et al. Accepted*)

**Research Experiences for Undergraduates**, **REU** (Summer 2010)

* Mentored a REU student who helped establish field common gardens and designed HPLC protocols for examining plant defenses

**Cedar Creek LTER Internship Program** (Summer 2007, 2008 and 2009)

* Mentored five interns that assisted with field research on willow ecology
* Provided guidance for their independent research projects

**Undergraduate Research Assistants** (Fall 2005–Spring 2009)

* Supervised six students in the laboratory and greenhouse that assisted with collecting data and maintained greenhouse collections of diverse willow species

**Previous Professional Experience**

**Putnam Research Fellow**, Arnold Arboretum,Harvard University(Aug. 2014–June 2016)

*Independent research fellow*

* Examining the physiological basis of precocious flowering
* Investigating the connection between vascular activity and plant phenology

**Postdoctoral Fellow/Research Associate**, Harvard University (Mar. 2011–July 2014)

 *Advisor: Dr. N. Michele Holbrook, Professor*

* Developing and optimizing techniques to measure *in situ* phloem transport with the goal of examining the response of plants to environmental stimuli
* Examining evolution of sieve tube anatomy
* Involved in a collaborative effort to characterize phloem transport with Michael Knoblauch (WSU), Maciej Zwieniecki (UC-Davis) and Kaare Jensen (Harvard), Carel Windt (Jülich) and Henk Van As (Wageningen)

**Postdoctoral Fellow**,University of Minnesota (July 2010–Feb. 2011)

*Advisor: Dr. Jeannine Cavender-Bares, Associate Professor*

* Assisted with the design of a long-term experiment with twenty common gardens that will test for a trade-off between defense and growth in the family Salicaceae
* Mentored graduate students and undergraduates at Cedar Creek LTER

**Graduate Research Assistant and Fellow**,University of Minnesota (Sept. 2004–July 2010)

*Advisor: Dr. Jeannine Cavender-Bares, Associate Professor*

* Investigated willow community assembly and niche differentiation using physiological, ecological and phylogenetic approaches
* Examined the role of growth, phenology and freezing tolerance in determining species broader geographic distributions
* Investigated intraspecific variation in drought and freezing tolerance in *Quercus oleoides*

**Research Assistant**,San Diego State University (Mar. 2003–June 2004)

*Supervisor: Jonathan Dunn, Restoration Ecologist*

* Designed and carried out restoration projects on San Clemente Island, CA
* Developed propagation techniques for use with rare plant species

**Academic Services**

* **Seminar Committee Chair** (Fall 2018-Spring 2019), University of Minnesota – Duluth
* **UROP Reviewer** (Spring 2018), University of Minnesota – Duluth
* **Curriculum Committee** (Fall 2016-Spring 2017), University of Minnesota – Duluth
* **Greenhouse Committee** (2016-present), University of Minnesota – Duluth

**Professional Services**

**NSF Panelist** (Fall 2017) Served on a NSF review panel. Alexandria, VA.

**Review Board Member**, *Tree Physiology* (2010–present).

**Subject Editor** for peer-reviewed journal, *Skvortsovia: International Journal of Salicology and Plant Biology* (2013–present).

**Reviewer** for: *Ecology;* *Ecology Letters;* *Journal of Ecology; New Phytologist; Plant, Cell and Environment; Evolution; Ecography; Global Change Biology; The American Naturalist; Oikos; Tree Physiology; Annals of Botany; American Journal of Botany; Basic and Applied Ecology; Trees; Photosynthetica; Agricultural and Forest Meteorology; Wetlands Ecology and Management; Great Plains Research; Entomologia Experimentalis et Applicata; Journal of Experimental Botany; BioEnergy Research;* *Applications in Plant Sciences and Physiologia Plantarum*

**Advisor for *Life on Earth* Textbook**, high school biology textbook developed by Edward O. Wilson, Morgan Ryan & Gael McGill (2013–2014).

**Professional Associations:** Botanical Society of America; 2005–present, Ecological Society of America; 2005–present and Minnesota Phenology Network; 2017–present.

**Science Outreach**

**Tree Mob**, Arnold Arboretum, Summer 2017

* Organized a public talk led by my graduate student Natalie McMann on the grounds at the arboretum

**Science Day**, University of Minnesota, Fall 2016.

* Designed and led a demonstration on plant movement

**Arnold Arboretum Outreach Programs**, Harvard University, 2015–2016.

* Designed and led a lab for high school students on plant physiology
* Led multiple “Tree Mobs” which are public talks about research at the Arboretum that take place out on the grounds
* Helped lead a tour for program about women in STEM careers

**Harvard Life Sciences Outreach Program**.*Harvard University.*2013–2016.

* Designed a physiology lab for high school studentson carbon assimilation and transport
* Hosted the lab for a week every year
* Lectured and led a workshop for K-12 teachers on plant physiology

**Gradwagon.** *Harvard University.*2013–2015.

* Planned and executed programs and tours for high school students interested in learning about botany and field research

**Explorations.** *Cambridge, MA.*  2012–2014.

* Organized and led activities aimed at teaching middle school students about careers in research science

**Cambridge Science Festival.** *Cambridge, MA.*  2012–2014.

* + Volunteered at education outreach events during the festival

**Monarchs in the Classroom.** *Saint Paul, MN.*  2009.

* Assisted in planting and developing interpretive information for a display teaching garden on campus

**Great River Greening**. *Saint Paul, MN*.2005-2010.

* + 2009–2010. Member of the Steering Committee
	+ 2005–2010. Volunteer Restoration Supervisor

**Minnesota Master Naturalist.** *Saint Paul, MN*. 2009–2010.

* Completed 40 hours service a year doing community outreach and restoration plus completed specialized coursework on Minnesota natural history