

Jessica A. Savage, PhD

Assistant Professor, University of Minnesota – Duluth
Associate, Institute on the Environment
<http://www.d.umn.edu/biology/faculty/savage.html>
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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 and (2) the physiological-basis and ecological consequences of plant phenology. 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)

O’Connell E. † and **Savage, J.A.** (in press) Extended leaf phenology has limited benefits for invasive species growing at northern latitudes. *Biological Invasions*.

Savage, J.A. (in press) It’s all about timing or is it? Exploring the potential connection between phloem physiology and whole plant phenology. *American Journal of Botany*.

Clerx, L.E. †, Rockwell, F.E., **Savage, J.A.** and N.M. Holbrook (in press) Ontogenetic scaling of phloem sieve tube hydraulic resistance with tree height in *Quercus rubra*. *American Journal of Botany*.

Savage, J.A. (2019) A temporal shift in resource allocation facilitates flowering before leaf out and spring vessel maturation in woody species. *American Journal of Botany* 106(1):113-122.

Huggett, B.A. †, **Savage, J.A.**, Hao, G.-Y., Preisser, E.L. and N.M. Holbrook (2018) Impact of hemlock woolly adelgid (*Adelges tsugae*) infestation on xylem structure and function and leaf physiology in eastern hemlock (*Tsuga canadensis*). *Functional Plant Biology*. 45(5):501-508.

Erlandson, S. †, Wei, X. †, **Savage, J.A.** Cavender-Bares, J. and K. Peay (2018) Soil abiotic variables are more important than Salicaceae phylogeny or habitat specialization in determining soil microbial community structure. *Molecular Ecology*. 27(8): 2007-2024.

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.

Erlanson, 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-WHYE (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.

Book chapters

Savage, J.A. and M. Zwieniecki (2019) Phloem transport velocity on a tissue-level using a phloem-mobile dye. In *Phloem: Methods and Protocols*. J. Liesche, editor, Springer Nature, New York. P. 203-211.

Research Grants

National Science Foundation CAREER Grant (June 2020 – June 2025) Integrative and Organismal Systems “*Linking phloem anatomy and physiology with whole plant changes in resource allocation*” PI: J.A. Savage. Research grant for \$ 723,556.

Grant-in-Aid (July 2019 – Jan. 2021) University of Minnesota.
“*Flowers are often an indicator of spring but are they also the canary in the coal mine?*”
PI: J.A. Savage. Intramural research grant for \$46,217.

National Science Foundation Grant (April 2017 – April 2020) Integrative and Organismal Systems “*Vascular constraints on leaf out and flowering in plants*”
PI: J.A. Savage. Research grant for \$395,163.

Sinnott Award (Feb. – Dec. 2017) Arnold Arboretum.
“*Role of xylem re-activation in the timing of leaf out in the spring*”
PI: J.A. Savage. Research grant for \$2,000.

Outreach/Education Grants

Plant Biology Learning Objectives, Outreach Materials and Education Grant (BLOOME)
(August 2018 – August 2019) American Society of Plant Biologists.
“*Closing the Gap: Engaging the public with Citizen Science Phenology Data*”

PI: J.A. Savage. CO-PI: Ryan Hueffmeier. Grant to support outreach for \$19,925.

Environmental Education Fund Grant (LEEF) (August 2018 – August 2019) LI-COR. Grant to help with purchase of a LI-6800 ecophysiology kit for use in classroom and with undergraduate research.

PI: J.A. Savage, Equipment grant for \$37,600.

Fellowships/Honors

IonE Associate (2019 – present) Program for early career scientists that show promise for becoming recognized for research in the environment and sustainability.

Putnam Fellowship (2014 – 2016) Competitive, two-year fellowship and grant for research in the 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.

Graduate School Fellowship (2004 – 2005) Intramural, one-year fellowship for promising incoming 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. (2020) It’s about time: understanding interplay between vascular physiology and leaf and flower phenology. *Ecology and Evolutionary Biology Seminar Series*, Boulder, CO.

Savage, J.A. (2018) A sweet journey: Structural and physiological constraints on phloem transport. *Horticulture Seminar Series at Cornell University*, Ithaca, NY.

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.

Conference Presentations (* presenter, † graduate/undergraduate students)

Savage, J.A.*, Montgomery, R., Primack, R., Rothendler, M. and K. Mosher† (2018) Hydraulic constraints on the timing of leaf out in angiosperms. *Botanical Society of America Annual Conference*. Rochester, MN.

O'Connell, E. †* and **J.A. Savage** (2018) Testing for a Potential Trade-off between Freezing Tolerance and Growth Rate in Invasive Woody Shrubs and their Native Associates. *Botanical Society of America Annual Conference*. Rochester, MN.

McMann, N. †* and **J.A. Savage** (2018) Flowering without leaves: Does stem hydraulic supply constrain floral water loss? *Plasticity in Plant Vascular Systems: Roles, Limits and Consequences - Gordon Conference*. West Dover, VT.

Savage, J.A.* (2015) Vascular constraints on flower development: Understanding resource allocation and vascular transport in precocious flowering species. *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*. Sacramento, 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*. Sacramento, 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.

Conference Posters (* presenter, [†]graduate/undergraduate students)

Savage, J.A.*, McMann, N. [†], Montgomery, R., Primack, R. Quick-Singh[†], R., Rothendler, M. [†] and K. Mosher[†] (2019) Seasonal changes in vascular physiology are closely tied with leaf and flower phenology. *Fifth International Conference on Plant Vascular Biology*. Asilomar, CA.

Ray, D.* and **J.A. Savage**. (2019) Spring floral phenology of temperate trees in relation to vascular cambium reactivation. *Fifth International Conference on Plant Vascular Biology*. Asilomar, CA.

Savage, J.A.*, O'Connell, E.† and R. Hueffmeier (2019) Closing the gap: Engaging the public in phenology-based citizen science. *American Society of Plant Biologist Annual Conference*. San Jose, CA.

Barnett, L., Gerst, K., O'Connell, E.†, O'Neil, C., **Savage, J.A.** and Steiner, B.* (2019) Visualization tool helps students use citizen science data to answer real-world questions. *Ecological Society of America Annual Conference*. Louisville, KY.

Sevanto, S.*, Ryan, M.G., Losko, A. Watkins, E., Kuske, C., Espy, M., Gehring, C., **Savage, J.A.**, Majewski, J. and S. Vogel. Measuring root and flower water uptake with neutron radiography (2019) *Los Alamos Neutron Science Center Group Meeting*. Los Alamos, NM.

Savage, J.A.*, Montgomery, R., Primack, R., Rothendler, M. and K. Mosher† (2018) The relationship between wood anatomy and the timing of leaf out in angiosperms. *Plasticity in Plant Vascular Systems: Roles, Limits and Consequences - Gordon Conference*. West Dover, VT.

McMann, N.†* and **J.A. Savage** (2018) Flowering without leaves: Does stem hydraulic supply constrain floral water loss? *Botanical Society of America Annual Conference*. Rochester, MN.

Quick-Singh, R.†* and **J.A. Savage** (2018) Does vessel transport capacity influence leaf out time in woody species? *Botanical Society of America Annual Conference*. Rochester, MN.

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 leaves 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.

Symposia and Working Groups

Participant in “NSF Rules of Life Workshop” (2019) Invited to participated in a cross-disciplinary workshop focused on invasive species. Workshop will lead to a review paper.

Participant in “Flower Form and Function Workshop” (2017) Upperville, VA. Invited to a small workshop for specialists on floral physiology and evolution sponsored by the Oak Spring Garden Foundation.

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) Sacramento, 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.

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 - University of Minnesota, Duluth, MN

- **Methods in Forest Ecology**, BIOL 4804 (Fall 2019 – present)
- **Plant Physiology**, BIOL 4604 (Spring 2017 – present)
- **Ecology Lab**, BIOL 2802 (Fall 2017 – present)
- **Integrated Biological Systems I**, IBS 8011 (Fall 2017 – Fall 2018)
- **Integrated Biological Systems II**, IBS 8013 (Spring 2018 – Spring 2019)

Invited Guest Lecturer

- **National Advanced Siviculture Program**, Cloquet, MN (Summer 2020): I gave two full-day lectures on plant physiology for a certification course for siviculturists
- **Connecticut College**, CT (Fall 2019): I gave a guest lecture on phloem physiology in Environmental Plant Physiology (BOT 320) remotely with video conferencing.
- **Yale School of Forestry and Environmental Studies**, CT (Fall 2018): I gave a guest lecture on phloem physiology in Plant Ecophysiology (F&ES 679a) remotely with video conferencing.
- **Arnold Arboretum**, MA (Summer 2015): I gave a guest lecture on phloem anatomy and physiology for the MicroMorph Course on Plant Anatomy.
- **University of Minnesota**, St. Paul, MN (Spring 2014 & 2017): I gave guest lectures on phloem physiology remotely with video conferencing.

Mentoring

Current graduate students, *Integrated Biosciences Graduate Program*. University of Minnesota, Duluth, MN

- Danielle Lake Diver, Master's student. DOVE Fellowship recipient.

Former graduate students, *Integrated Biosciences Graduate Program*. University of Minnesota, Duluth, MN.

- Erin O’Connell, M.S. (Degree awarded Feb. 2019). “*Costs and benefits of extended leaf phenology in invasive shrubs*”
- Natalie McMann, M.S. (Degree awarded Jan. 2019). “*Investigation of vascular limitations on floral water loss in temperate woody species*”

Current postdoctoral associate, University of Minnesota, Duluth, MN

- Dr. Dustin Ray (Feb. 2019 – present). Funded by NSF grant.

Graduate committees, University of Minnesota, Duluth, MN

- Sophie LaFond-Hudson, Ph.D. student, *Water Resources* (Jan. 2020 – present)
- Maria Jose Gomez, Master’s student, *Integrated Biosciences* (2019 – present)
- Lilhac Medina, Ph.D. student, *Integrated Biosciences* (2019 – present)
- Shelby Hammerschmidt, Master’s student, *Water Resources* (2019 – present)
- Erin Bergen, Master’s student, *Integrated Biosciences* (Nov. 2019 – present)
- Riley Pizza, Master’s student, *Integrated Biosciences* (Jan. 2017 – present)
- Haley Golz, Master’s student, *Integrated Biosciences* (Jan. 2017 – Dec. 2019)

Undergraduate students, University of Minnesota, Duluth, MN

- Margaret Martin. *Independent research - BIOL 3994* (Spring 2020)
- Andrew Arthur. *Technician* (Sept. 2019 – present)
- Max Bonfig. *Research - BIOL 3994* (Fall 2019), *Teaching assistant* (Fall 2019), *BURST* (Summer 2019), *UROP* (Spring 2019) & *Volunteer* (June – Dec. 2018)
- Thomas Kiecker. *Technician* (May 2018 – Aug. 2019) & *Volunteer* (Jan.– May 2018)
- Abigail Roufs. *Technician* (Sept. –Dec. 2019) & *volunteer* (Feb. 2019 – Sept. 2019)
- Shauna Blake. *Volunteer* (Sept. 2018 – May 2019)
- Nihaar Joshi. *Research - BIOL 3994* (Spring 2019) & *Volunteer* (Sept. 2018– Dec. 2018)
- Alexander Peichel. *Teaching assistant* (Spring 2019), *BURST* (Summer 2018) & *Volunteer* (Sept. 2017– May 2018)
- Rishika Quick-Singh. *UROP* (Spring and Fall 2018) & *BURST* (Summer 2017)
- Kennedy Mosher. *Technician* (May 2017 – May 2018)
- Sydney Hudzinski. *Research - BIOL 3994* (2017 – 2018) & *Volunteer* (Jan. 2017 – May 2017)
- Collin Monette. *Volunteer* (Jan. 2017 – May 2018)

Summary: 3 BURST students, 3 UROP students, 4 BIOL 3994 students and 4 technicians

Previous Professional Experience

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

Independent research fellow

- Examined the physiological basis of precocious flowering
- Investigated the connection between vascular activity and plant phenology

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

Advisor: Dr. N. Michele Holbrook, Professor

- Developed and optimized techniques to measure *in situ* phloem transport
- Involved in a collaborative effort to characterize phloem transport

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 species distributions using physiological, ecological and phylogenetic approaches
- 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

- **Strategic Planning** (Fall 2019 – Spring 2020), UMD, Duluth, MN
- **Greenhouse Committee** (Fall 2016 – Spring 2019), UMD, Duluth, MN
 - **Committee Chair** (Fall 2018 – Spring 2019)
- **Seminar Committee Chair** (Fall 2018 – Spring 2019), UMD, Duluth, MN
- **UROP Reviewer** (Spring 2018), UMD, Duluth, MN
- **Curriculum Committee** (Fall 2016 – Spring 2017), UMD, Duluth, MN

Professional Services

National Science Foundation. Ad hoc reviewer (Spring 2020 & 2019) and Panelist (Fall 2017)

Natural Sciences and Engineering Research Council of Canada (2019) External reviewer

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

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

Botanical Society of America, Poster and presentation judge for 2018 conference.

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), American Society of Plant Biologists (2013 – present) and Minnesota Phenology Network (2017 – present).

Citizen Science

Founder of Nature's Timekeepers. *University of Minnesota – Duluth* (Fall 2018 – present)

- Developed a citizen science project for monitoring phenology at Bagley Nature Area, Boulder Lake and the Lake walk.
- Designed workshops, outreach phenology stations and curriculum to engage public and K-12 in plant phenology research.
- Started the *Lake Superior Phenology Network*, a local phenology group.
- Funding to start the program received by the BLOOME grants from the American Society of Plant Biologists.

Other Science Outreach

Science Day. *University of Minnesota - Duluth* (Fall 2016) Designed and led a demonstration on plant movement.

Tree Mob. *Arnold Arboretum* (2015 – 2017) Organized public talks led by myself and my graduate student Natalie McMann on the grounds at the arboretum.

Arnold Arboretum Outreach Programs. *Harvard University* (2015 & 2016) Designed and led a lab for high school students on plant physiology and helped lead a tour for program about women in STEM careers.

Harvard Life Sciences Outreach Program. *Harvard University* (2013 – 2016) Designed and led a physiology lab for high school students on carbon assimilation and transport annually and a workshop for K-12 teachers.

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.

Great River Greening. *Saint Paul, MN* (2005 – 2010) and member of Steering Committee (2009 – 2010).

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.