

# Marcus W. Beck, Ph.D.

*Tampa Bay Estuary Program*  
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St. Petersburg, FL 33701

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## *Education*

**Ph.D., Conservation Biology, Fisheries and Aquatic Biology track** Jun. 2013  
**Statistics minor**

Conservation Biology Graduate Program, University of Minnesota, Twin Cities, MN  
Thesis title: Minnesota macrophytes: Linking aquatic plants, lake health, and human activities  
Advisors: Drs. Bruce Vondracek, Lorin Hatch

**M.Sc., Conservation Biology, Fisheries and Aquatic Biology track** Jun. 2009

Conservation Biology Graduate Program, University of Minnesota, Twin Cities, MN  
Thesis title: Development of an ecological assessment method for Minnesota lakes  
Advisor: Dr. Lorin Hatch

**B.Sc., Zoology *summa cum laude*** Dec. 2006

Department of Zoology, University of Florida, Gainesville, FL  
Thesis title: Reproductive characteristics of the green treefrog *Hyla cinerea*: effects of agricultural contaminants.  
Advisor: Dr. Krista McCoy

**A.A., Zoology** Apr. 2004

Santa Fe Community College, Gainesville, FL

## *Professional Appointments*

**Program Scientist** Nov. 2019 - Present

Tampa Bay Estuary Program

**Scientist** Sep. 2017 - Sep. 2019

Biology Department, Southern California Coastal Water Research Project

**Post-Doctorate Researcher** Dec. 2015 - Sep. 2017

Ecosystem Dynamics and Effects Branch, Gulf Ecology Division, United States Environmental Protection Agency

**Post-Doctorate Research Fellow** Jul. 2013 - Nov. 2015

Oak Ridge Institute for Science and Education, Ecosystem Dynamics and Effects Branch, Gulf Ecology Division, United States Environmental Protection Agency

**Research Fellow** Sep. 2012 - Jun. 2013

Water Resources Center, Conservation Biology Graduate Program, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**Research Assistant, University of Minnesota** Sep. 2007 - Sep. 2012

Conservation Biology Graduate Program, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**Intern** Jun. 2009 - Aug. 2009

Minnesota Department of Natural Resources

**Creel Clerk**

**Jan. 2007 - May 2007**

Florida Fish and Wildlife Conservation Commission

**Undergraduate Researcher**

**Jan. 2006 - Dec. 2006**

Department of Zoology, University of Florida

**Biological Technician**

**summer 2006**

Florida Integrated Science Center, United States Geological Survey

*Teaching Experience*

**Remote Workshop Instructor**

**Jun. 2020**

Tampa Bay Estuary Program R Training, Remote Webinar ([link](#))

**Workshop Co-Instructor**

**Sep. 2019**

Tampa Bay Estuary Program Open Science Workshop, St. Petersburg College STEM Center ([link](#))

**Workshop Co-Instructor**

**Oct. 2018**

Special Cal SFS workshop: Visualizing and mapping bioassessment data in R, California Aquatic Bioassessment Workgroup ([link](#))

**Workshop Co-Instructor**

**May 2018**

Fundamentals of spatial data access and analysis in R, Annual meeting of the Society of Freshwater Science ([link](#))

**Workshop Co-Instructor**

**Nov. 2017**

Introduction to R for analysis of coastal and estuarine data, Biennial meeting of the Coastal and Estuarine Research Federation ([link](#))

**Workshop Co-Instructor**

**Nov. 2016**

R, SWMP, SWMP,prats for non-beginners, System Wide Monitoring Program, National Estuarine Research Reserve System, NOAA. ([link](#))

**Workshop Co-Instructor**

**Oct. 2015**

An Introduction to SWMP, System Wide Monitoring Program, National Estuarine Research Reserve System, NOAA. ([link](#))

**Workshop Co-Instructor**

**Nov. 2014**

NERRS/SWMP Data Analysis (Time-series) Workshop, System Wide Monitoring Program, National Estuarine Research Reserve System, NOAA.

**Workshop Co-Instructor**

**May 2013**

Using Available Software for Basic Analysis, Restoring Minnesota, University of Minnesota.

**Primary Instructor**, University of Minnesota

**Jan. 2012 - May 2012**

FW 5604 (Fisheries Ecology and Management), Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**Undergraduate Advisor**, University of Minnesota

**Mar. 2009 - May 2011**

Justine Koch (Gustavus Adolphus College), Kristan Maccaroni (University of Minnesota)

**Teaching Assistant**, University of Minnesota

ESPM 4061/5061 (Water Quality and Natural Resources), Department of Environmental Sciences, Policy, and Management, University of Minnesota

**Sep. 2008 - Dec. 2008**

## *Service*

### **Reviewer**

*Acta Oecologica*, 2015 • *Aquatic Botany*, 2011, 2014 • *Aquatic Ecology*, 2018 • *Aquatic Sciences*, 2015, 2018, 2020 • *Chemosphere*, 2019 • *Coastal Management*, 2020 • *Development in Practice*, 2012, 2013 • *Ecological Indicators*, 2010, 2019 • *Ecological Modelling*, 2016, 2020 • *Ecological Research*, 2012 • Elsevier book chapter, 2014 • *Engineering Computations*, 2016 • *Environmental Management*, 2010 • *Environmental Modelling & Software*, 2015 • *Environmental Science & Technology*, 2019 • *Environments*, 2019 • *Estuaries and Coasts*, 2014, 2015, 2018 • *Estuarine, Coastal and Shelf Science*, 2016(2), 2017 • *Expert Systems with Applications*, 2019 • *Freshwater Science*, 2019 • *Frontiers in Ecology and the Environment*, 2019 • *Frontiers in Plant Science*, 2017 • *Geocarto International*, 2017 • *Hydrobiologia*, 2012 • *International Journal of Tropical Biology and Conservation*, 2013 • *International Journal of River Basin Management*, 2013 • *ISPRS Journal of Photogrammetry and Remote Sensing*, 2017 • *Journal of Applied Phycology*, 2015 • *Journal of Environmental Management*, 2020 • *Journal of the American Water Resources Association*, 2020 • *Journal of the North American Benthological Society*, 2011 • *Journal of Statistical Software*, 2020 • *Lake and Reservoir Management*, 2013, 2014, 2015, 2017(2) • *Limnology & Oceanography*, 2013 • *Marine Chemistry*, 2020 • *Marine Ecology*, 2014 • *Marine Pollution Bulletin*, 2014 • Minnesota Department of Natural Resources, 2011 • *New Zealand Journal of Marine and Freshwater Research*, 2019 • *North American Journal of Fisheries Management*, 2010, 2011, 2012, 2016 • *PeerJ*, 2018 • *Polar Biology*, 2011 • *The R Journal*, 2016(3) • *Remote Sensing*, 2014, 2015, 2016(2), 2017 • *rOpenSci*, 2016 • *Science of the Total Environment*, 2011 • *Scientific Reports*, 2018 • *Thalassas*, 2018 • USEPA Office of Research and Development, 2014, 2015 • *Water Research*, 2015, 2016

### **Graduate Student Representative**

Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**Jan. 2013 - May 2013**

### **Student Activities Committee Co-Chair**

2012 annual meeting of the American Fisheries Society

**Jun. 2010 - Aug. 2012**

### **Fundraising Coordinator**

Conservation Biology Graduate Program, University of Minnesota

**spring 2011, spring 2012**

### **Seminar Coordinator**

Conservation Biology Graduate Program, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**2009, fall 2011, spring 2012**

### **Student Representative**

Minnesota Chapter of the American Fisheries Society

**Aug. 2009 - Aug. 2012**

### **Student Club Officer**

Fisheries and Wildlife Club, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota

**Sep. 2010 - May 2012**

### **Lab Volunteer**

Florida Museum of Natural, University of Florida

**summer 2005**

## *Peer-reviewed Publications*

### *In Review*

1. Sun, H., Le, C., Long, S., **Beck, M.W. In review.** Linking phytoplankton variability to atmospheric blocking in an eastern boundary upwelling system. *Environmental Research Letters*.
2. Raulerson, G.E., Robison, D.E., **Beck, M.W.**, Burke, M.C., Ries, T.F., Saarinen, J.A., Sciarrino, C.M., Sherwood, E.T., Tomasko, D.A. **In review.** Seizing diminishing habitat conservation and restoration opportunities in the Tampa Bay, FL watershed: An urban estuary in recovery. *PLOS One*.
3. Bednaršek, N., **Beck, M.W.**, Applebum, S.L., Feely, R.A., Pelletier, G., Butler, R., Byrne, M., Peabody, B., Davis, J., Štrus, J. **In review.** The range of fluctuations, rather than pH decline, define biological responses of the native Olympia and introduced Pacific oysters under current estuarine-related coastal acidification. *Science of the Total Environment*.
4. Wessel, M.R., Leverone, J.R., **Beck, M.W.**, Sherwood, E.T., Hecker, J., West, S., Janicki, A. **In review.** A nutrient-based framework for tidal creeks in Southwest Florida. *Estuaries and Coasts*.
5. Rogers, J.B., Stein, E.D., **Beck, M.W.**, Flint, K., Kinoshita, A.M., Ambrose, R.F., **In review.** Modeling future changes to the hydrological and thermal regime of unaltered streams using projected changes in climate. *Ecohydrology*.

*In Press or Published*

1. Meyers, S., Landry, S., **Beck, M.W.**, Luther, M. **In press.** Using logistic regression to model the risk of sewer overflows triggered by compound flooding with application to sea level rise. *Urban Climate*.
2. Bednaršek, N., Newton, J., **Beck, M.W.**, Alin, S.R., Feely, R.A., Christman, N., Klinger, T. **In press.** Severe biological effects under present-day estuarine acidification in the highly variable Salish Sea. *Science of the Total Environment*. ([10.1016/j.scitotenv.2020.142689](https://doi.org/10.1016/j.scitotenv.2020.142689))
3. Rogers, J.B., Stein, E.D., **Beck, M.W.**, Ambrose, R.F. 2020. The impact of climate change induced alterations of streamflow and stream temperature on the distribution of riparian species. *PLoS ONE*. 15(11):e0242682. ([10.1371/journal.pone.0242682](https://doi.org/10.1371/journal.pone.0242682))
4. Theroux, S., Mazor, R.D., **Beck, M.W.**, Ode, P., Stein, E., Sutula, M., 2020. Predictive biological indices for algae populations in diverse landscapes. *Ecological Indicators*. 119:106421. ([10.1016/j.ecolind.2020.106421](https://doi.org/10.1016/j.ecolind.2020.106421))
5. Larkin, D.J., **Beck, M.W.**, Bajer, P.G. 2020. An invasive fish promotes invasive plants in Minnesota lakes. *Freshwater Biology*. 65(9):1608-1621. ([10.1111/fwb.13526](https://doi.org/10.1111/fwb.13526))
6. **Beck, M.W.**, O'Hara, C., Stewart Lowndes, J., Mazor, R.D., Theroux, S.T., Gillett, D.J., Lane, B., Gearheart, G. 2020. The importance of open science for biological assessment. *PeerJ*:e9539. ([10.7717/peerj.9539](https://doi.org/10.7717/peerj.9539))
7. Bednaršek, N., Feely, R.A., **Beck, M.W.**, Alin, S.R., Siedlecki, S.A., Calosi, P., Norton, E.L., Saenger, C., Štrus, J., Greeley, D., Nezlin, N.P., Spicer, J.I. 2020. Carapace dissolution, growth decline and mechanoreceptor damages in Dungeness crab related to severity of ocean acidification gradients. *Science of the Total Environment*. 716:136610 ([10.1016/j.scitotenv.2020.136610](https://doi.org/10.1016/j.scitotenv.2020.136610))
8. **Beck, M.W.**, Mazor, R.D., Johnson, S., Wisenbaker, K., Westfall, J., Ode, P.R., Hill, R., Loffen, C., Sutula, M., Stein, E.D. 2019. Prioritizing management goals for stream biological integrity within the developed landscape context. *Freshwater Science*. 38(4):883-898. ([10.1086/705996](https://doi.org/10.1086/705996))
9. **Beck, M.W.**, Sherwood, E.T., Henkel, J.R., Dorans, K., Ireland, K., Varela, P. 2019. Assessment of the cumulative effects of restoration activities on water quality in Tampa Bay, Florida. *Estuaries and Coasts*. 42(7):1774-1791. ([10.1007/s12237-019-00619-w](https://doi.org/10.1007/s12237-019-00619-w))

10. **Beck, M.W.**, Mazor, R.D., Theroux, S.T., Schiff, K.C. 2019. The Stream Quality Index: A multi-indicator tool for enhancing environmental management communication. *Environmental and Sustainability Indicators*. 1(2):100004. ([10.1016/j.indic.2019.100004](https://doi.org/10.1016/j.indic.2019.100004))
11. Le, C., Wu, S., Hu, C., **Beck, M.W.**, Yang, X. 2019. Phytoplankton decline in the eastern North Pacific transition zone associated with atmospheric blocking. *Global Change Biology*. 25(10):3485-3493. ([10.1111/gcb.14737](https://doi.org/10.1111/gcb.14737))
12. Bednaršek, N., Feely, R.A., **Beck, M.W.**, Glippa, O., Kanerva, M., Engström-Öst, J. 2018. El Niño-related thermal stress coupled with ocean acidification negatively impacts cellular to population-level responses in pteropods along the California Current System with implications for increased bioenergetic costs. *Frontiers in Marine Science*. 5(486):1-17. ([10.3389/fmars.2018.00486](https://doi.org/10.3389/fmars.2018.00486))
13. Bokde, N., Martínez Álvarez, F., **Beck, M.W.**, Kulat, K. 2018. A novel imputation methodology for time series based on pattern sequence forecasting. *Pattern Recognition Letters*. 116:88-96. ([10.1016/j.patrec.2018.09.020](https://doi.org/10.1016/j.patrec.2018.09.020))
14. **Beck, M.W.** 2018. NeuralNetTools: Visualization and analysis tools for neural networks. *Journal of Statistical Software*. 85(11):1-20. ([10.18637/jss.v085.i11](https://doi.org/10.18637/jss.v085.i11))
15. **Beck, M.W.**, Jabusch, T.W., Trowbridge, P.R., Senn, D.B. 2018. Four decades of water quality change in the upper San Francisco Estuary. *Estuarine, Coastal and Shelf Science*. 212:11-22. ([10.1016/j.ecss.2018.06.021](https://doi.org/10.1016/j.ecss.2018.06.021))
16. Zhang, Z., **Beck, M.W.**, Winkler, D. A., Huang, B., Sibanda, W., Goyal, H. 2018. Opening the black box of neural networks: methods for interpreting neural network models in clinical applications. *Annals of translational medicine*. 6(11):1-11. ([10.21037/atm.2018.05.32](https://doi.org/10.21037/atm.2018.05.32))
17. **Beck, M.W.**, Bokde, N., Asencio-Cortés, G., Kulat, K.D. 2018. R package imputeTestbench to compare imputation methods for univariate time series. *The R Journal*. 1-16.
18. Bajer, P.G., **Beck, M.W.**, Hundt, P. 2018. Effect of non-native versus native invaders on macrophyte richness: are carp and bullheads ecological proxies? *Hydrobiologia*. 817(1):379-391. ([10.1007/s10750-018-3592-1](https://doi.org/10.1007/s10750-018-3592-1))
19. Murrell, M.C., Caffrey, J.M., Marcovich, D.T., **Beck, M.W.**, Jarvis, B.M., Hagy, J.D. 2018. Seasonal oxygen dynamics in a warm temperate estuary: Effects of hydrologic variability on measurements of primary production, respiration, and net metabolism. *Estuaries and Coasts*. 41(3):690-707. ([10.1007/s12237-017-0328-9](https://doi.org/10.1007/s12237-017-0328-9))
20. **Beck, M.W.**, Cressman, K., Griffin, C., Caffrey, J. 2018. Water quality trends following anomalous phosphorus inputs to Grand Bay, Mississippi, USA. *Gulf and Caribbean Research*. 29(1):1-14. ([gcr.2901.02](https://doi.org/10.2901/02))
21. **Beck, M.W.**, Hagy, J.D., Le, C. 2018. Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization. *Estuaries and Coasts*. 41(2):592-610. ([10.1007/s12237-017-0287-1](https://doi.org/10.1007/s12237-017-0287-1))
22. Sutula, M., Kudela, R., Hagy, J.D., Harding, L.W., Senn, D., Cloern, J.E., Bricker, S., Berg, G.M., **Beck, M.W.** 2017. Novel analyses of long-term data provide a scientific basis for chlorophyll-a thresholds in San Francisco Bay. *Estuarine, Coastal and Shelf Science*. 197:107-118. ([10.1016/j.ecss.2017.07.009](https://doi.org/10.1016/j.ecss.2017.07.009))
23. **Beck, M.W.**, Lehrter, J.C., Lowe, L.L., Jarvis, B.M. 2017. Parameter sensitivity and identifiability for a biogeochemical model of hypoxia in the northern Gulf of Mexico. *Ecological Modelling*. 363:17-30. ([10.1016/j.ecolmodel.2017.08.020](https://doi.org/10.1016/j.ecolmodel.2017.08.020))
24. **Beck, M.W.**, Alahuhta, J. 2017. Ecological determinants of *Potamogeton* taxa in glacial lakes: assemblage composition, species richness, and species-level approach. *Aquatic Sciences*. 79(3):427-441. ([10.1007/s00027-016-0508-x](https://doi.org/10.1007/s00027-016-0508-x))

25. Le, C., Lehrter, J.C., Hu, C., MacIntyre, H., **Beck, M.W.** 2017. Satellite observation of particulate organic carbon dynamics in two river-dominated estuaries. *Journal of Geophysical Research: Oceans*. 122(1):555-569. ([10.1002/2016JC012275](https://doi.org/10.1002/2016JC012275))
26. **Beck, M.W.**, Murphy, R. 2017. Numerical and qualitative contrasts of two statistical models for water quality change in tidal waters. *Journal of the American Water Resources Association*. 53(1):197-219. ([10.1111/1752-1688.12489](https://doi.org/10.1111/1752-1688.12489))
27. Bajer, P.G., **Beck, M.W.**, Cross, T.K., Koch, J., Bartodziek, B., Sorensen, P.W. 2016. Biological invasion by a benthivorous fish reduced the cover and species richness of aquatic plants in most lakes of a large North American ecoregion. *Global Change Biology*. 22(12):3937-3947. ([10.1111/gcb.13377](https://doi.org/10.1111/gcb.13377))
28. **Beck, M.W.** 2016. SWMPPr: An R package for retrieving, organizing, and analyzing environmental data for estuaries. *The R Journal*. 8(1):219-232.
29. Le, C., Lehrter, J.C., Schaeffer, B.A., Hu, C., Murrell, M.C., Hagy, J.D., Greene, R.M., **Beck, M.W.** 2016. Bio-optical water quality dynamics observed from MERIS in Pensacola Bay, Florida. *Estuarine, Coastal and Shelf Science*. 173:26-38. ([10.1016/j.ecss.2016.02.003](https://doi.org/10.1016/j.ecss.2016.02.003))
30. **Beck, M.W.**, Hagy, J.D., Murrell, M.C. 2015. Improving estimates of ecosystem metabolism by reducing effects of tidal advection on dissolved oxygen time series. *Limnology & Oceanography: Methods*. 13(12):731-745. ([10.1002/lom3.10062](https://doi.org/10.1002/lom3.10062))
31. **Beck, M.W.**, Hagy, J.D. 2015. Adaptation of a weighted regression approach to evaluate water quality trends in an estuary. *Environmental Modeling and Assessment*. 20(6):637-655. ([10.1007/s10666-015-9452-8](https://doi.org/10.1007/s10666-015-9452-8))
32. **Beck, M.W.**, Tomcko, C.M., Valley, R.D., Staples, D.F. 2014. Analysis of macrophyte indicator variation as a function of sampling, temporal, and stressor effects. *Ecological Indicators*. 46:323-335. ([10.1016/j.ecolind.2014.07.002](https://doi.org/10.1016/j.ecolind.2014.07.002))
33. **Beck, M.W.**, Wilson, B.N., Vondracek, B., Hatch, L.K. 2014. Application of neural networks to quantify utility of indices of biotic integrity for biological monitoring. *Ecological Indicators*. 45:195-208. ([10.1016/j.ecolind.2014.04.002](https://doi.org/10.1016/j.ecolind.2014.04.002))
34. Vondracek, B., Koch, J.D., and **Beck, M.W.** 2014. A comparison of survey methods to evaluate macrophyte index of biotic integrity performance in Minnesota lakes. *Ecological Indicators*. 36:178-185. ([10.1016/j.ecolind.2013.07.002](https://doi.org/10.1016/j.ecolind.2013.07.002))
35. **Beck, M.W.**, Vondracek, B. Hatch, L.K. 2013. Between- and within-lake responses of macrophyte richness metrics to shoreline development. *Lake and Reservoir Management*. 29(3):179-193. ([10.1080/10402381.2013.828806](https://doi.org/10.1080/10402381.2013.828806))
36. **Beck, M.W.**, Vondracek, B., Hatch, L.K., and Vinje, J. 2013. Semi-automated analysis of high-resolution aerial images to quantify docks in glacial lakes. *ISPRS Journal of Photogrammetry and Remote Sensing*. 81:60-69. ([10.1016/j.isprsjprs.2013.04.006](https://doi.org/10.1016/j.isprsjprs.2013.04.006))
37. **Beck, M.W.**, Vondracek, B., and Hatch, L.K. 2013. Environmental clustering of lakes to evaluate performance of a macrophyte index of biotic integrity. *Aquatic Botany*. 108:16-25. ([10.1016/j.aquabot.2013.02.003](https://doi.org/10.1016/j.aquabot.2013.02.003))
38. **Beck, M.W.**, Claassen, A.H., and Hundt, P.J. 2012. Environmental and livelihood impacts of dams: Common lessons across development gradients that challenge sustainability. *International Journal of River Basin Management*. 10(1):73-92. ([10.1080/15715124.2012.656133](https://doi.org/10.1080/15715124.2012.656133))
39. **Beck, M.W.**, Hatch, L.K., Vondracek, B., and Valley, R.D. 2010. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Ecological Indicators*. 10:968-979. ([10.1016/j.ecolind.2010.02.006](https://doi.org/10.1016/j.ecolind.2010.02.006))



40. **Beck, M.W.**, and Hatch, L.K. 2009. A review of research on the development of lake indices of biotic integrity. *Environmental Reviews*. 17:21-44. ([10.1139/A09-001](#))

### *Technical Reports*

1. Meyers, S.D., Landry, S., **Beck, M.W.**, Luther, M.E. 2020. Understanding risk at wastewater treatment plants in Tampa Bay during extreme high-precipitation events. Tampa Bay Estuary Program Technical Report #14-20. St. Petersburg, FL. ([link](#))
2. **Beck, M.W.**, Mazor, R.D. 2020. A decision framework for evaluating bioassessment samples and landscape models. Technical Report #1115. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
3. Taylor, J.B., Stein, E.D., **Beck, M.W.**, Flint, K., Kinoshita, A. 2019. Vulnerability of stream biological communities in Los Angeles and Ventura counties to climate change induced alterations of flow and temperature. Technical Report #1084. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
4. **Beck, M.W.**, Mazor, R.D., Theroux, S.T., Schiff, K.C. 2019. The Stream Quality Index: A multi-indicator tool for enhancing environmental management communication. Technical Report #1080. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
5. **Beck, M.W.**, Kittleson, K., O'Connor, K. 2019. Analysis of the Juvenile Steelhead and Stream Habitat Database, Santa Cruz County, California: Web products and recommendations. Technical Report #1082. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
6. Afrooz, N., **Beck, M.W.**, Hale, T., McKee, L., Schiff, K. 2019. BMP performance monitoring data compilation to support reasonable assurance analysis. Technical Report #1081. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
7. Mazor, R.D., **Beck, M.W.**, Brown, J. 2018. 2017 report on the SMC Regional Stream Survey. Technical Report #1029. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))
8. **Beck, M.W.**, Mazor, R.D., Stein, E.D., Maas, R., De Mello, D., Bram, D. 2017. Mapping of non-perennial and ephemeral streams in the Santa Ana region. Technical Report #1012. Southern California Coastal Water Research Project. Costa Mesa, CA. ([link](#))

### *Software<sup>1</sup> and Websites*

1. **Beck, M.W.**, Schrandt, M., Wessel, M., Sherwood, E., Best, B. 2020. tbeptools: Data and Indicators for the Tampa Bay Estuary Program, v0.0.1. R package. ([link](#))
2. Bokde, N., **Beck, M.W.** 2019. imputeTestbench: Test bench for the comparison of imputation methods, v3.0.3. CRAN R package. ([link](#))
3. **Beck, M.W.** 2019. SWMPPr: An R package for the National Estuarine Research Reserve System, v2.3.1. CRAN R package. ([link](#))
4. **Beck, M.W.**, Kittleson, K., O'Connor, K. 2019. Juvenile Stream Survey Habitat Web (JSSH web). ([link](#))
5. **Beck, M.W.**, Villarroel, P., Padfield, D. 2019. rStrava: Functions to access data from Strava's v3 API, v1.1.0. R package. ([link](#))
6. **Beck, M.W.** 2019. ggord: A take on ordination plots with ggplot2, v1.1.4. R package. ([link](#))

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<sup>1</sup>software version numbers with .9000 indicate under development

7. **Beck, M.W.** 2018. SCCWRP R training. ([link](#))
8. **Beck, M.W.** 2018. WRTDStidal: Weighted regression for water quality evaluation in tidal waters, v1.1.1. CRAN R package. ([link](#))
9. Payton, Q., Olsen, T., Weber, M., McManus, M., Kincaid, T., **Beck, M.W.** 2018. micromap: Linked micromap plots, v1.9.3. CRAN R package. ([link](#))
10. **Beck, M.W.** 2018. NeuralNetTools: Visualization and Analysis Tools for Neural Networks, v1.5.2. CRAN R package. ([link](#))
11. **Beck, M.W.** 2016. Jabbrev: Convert journal names from long to short formats, v0.0.1.9000. R package. ([link](#))
12. **Beck, M.W.** 2016. Aggregation of SWMP parameters within/between reserves. Shiny Web Application. ([link](#))
13. **Beck, M.W.** 2016. CTDplot: Plot CTD water quality data along an estuarine axis, v0.0.4.9000. R package. ([link](#))
14. **Beck, M.W.** 2015. WtRegDO: Supplementary package to support the manuscript “Improving estimates of ecosystem metabolism by reducing the effects of tidal advection on dissolved oxygen time series”, v0.0.7.9000. R package. ([link](#))
15. O’Brien, T.D., **Beck, M.W.** 2015. Time series and data analysis information and tool resource for NERRS/SWMP. Website. ([link](#))
16. **Beck, M.W.** 2015. Trends in SWMP parameters. Shiny Web Application. ([link](#))
17. **Beck, M.W.** 2015. Monthly and annual summary of SWMP parameters. Shiny Web Application. ([link](#))

### *Outreach and Non-Technical Documents*

1. **Beck, M.W.** 2020. Automated reporting in Tampa Bay with Open Science. OpenScapes blog, National Center for Ecological Analysis & Synthesis, University of California Santa Barbara. ([link](#))
2. **Beck, M.W.**, DeCicco, L. 2016. EGRET plotFlowConc using ggplot2. US Geological Survey, Office of Water Information Blog. ([link](#))
3. **Beck, M.W.** 2012 - 2017. R is my friend - numerous posts. R-bloggers: R news and tutorials contributed by R bloggers. ([link](#))
4. **Beck, M.W.** 2012. 2nd annual bike across Minnesota fundraiser June 1<sup>st</sup> through 4<sup>th</sup>: Mission accomplished! The Cons Bio Blog, Conservation Biology Graduate Program, University of Minnesota. ([link](#)).
5. **Beck, M.W.** 2012. Biking for bread. The Cons Bio Blog, Conservation Biology Graduate Program, University of Minnesota. ([link](#)).
6. **Beck, M.W.** 2011. Are values and conservation inseparable? The Cons Bio Blog, Conservation Biology Graduate Program, University of Minnesota. ([link](#)).
7. **Beck, M.W.** 2011. What I do: An exercise in hyperbole. The Cons Bio Blog, Conservation Biology Graduate Program, University of Minnesota. ([link](#)).

### *Invited Presentations*



1. **Beck, M.W.**, Wren, I., Murphy, R.R., de Valpine, P., Senn, D. 2019. Tracking San Francisco Bay water quality using generalized additive models in an R Shiny framework. *Oral presentation*. Coastal and Estuarine Research Federation biennial meeting, Mobile, AL.
2. **Beck, M.W.** 2018. Actionable bioassessment data: Using visualization to bridge the research - management divide. *Oral presentation*. California Aquatic Bioassessment Workgroup, Davis, CA.
3. Mazor, R., **Beck, M.W.**, Ode, P., Johnson, S., Wisenbaker, K., Westfall, J., Markle, P. 2018. Supporting management decisions with a landscape model to predict biotic condition in California. *Oral presentation*. Society for Freshwater Science Annual Meeting, Detroit, MI.
4. **Beck, M.W.**, Sherwood, E., Dorans, K., Henkel, J.R., Ireland, K., Varela, P. 2018. Use of open science to inform restoration projects in estuaries: A Tampa Bay example. American Water Resources Association GIS Spring Specialty Conference, Orlando, FL.
5. **Beck, M.W.**, Senn, D., Novick, E., Bresnahan, B., Hagy, J.D., Jabusch, T. 2016. Four decades of water quality changes in the upper San Francisco Estuary. *Poster presentation*. Interagency Ecological Program Annual Workshop, Folsom, CA.
6. **Beck, M.W.**, Hagy, J.D. 2015. Adaptation of a weighted regression approach to evaluate water quality trends in an estuary. *Oral presentation*. Coastal and Estuarine Research Federation Biennial Conference, Portland, OR.
7. **Beck, M.W.**, O'Brien, T.D. 2015. SWMPrats: A community of practice for NERRS data analysis. *Oral presentation*. NERRS research coordinators virtual meeting, USEPA NHEERL ORD, Gulf Breeze, FL.
8. **Beck, M.W.** 2014. The search for truth in numbers: Quantitative approaches for evaluating trends in water quality data. *Oral presentation*. Biology Department seminar (PCB 3930/4922/5924), University of West Florida, Pensacola, FL.
9. **Beck, M.W.**, Vondracek, B., Wilson, B., and Hatch, L.K. 2013. Understanding indicators of lake health and the utility of a plant-based index. *Oral presentation*. Gulf Ecology Division seminar series, USEPA NHEERL ORD, Gulf Breeze, FL.
10. **Beck, M.W.**, Vondracek, B., Hatch, L.K., and Wilson, B. 2013. Minnesota macrophytes: Linking aquatic plants, lake integrity, and human activities. *Poster presentation*. Doctoral Research Showcase, University of Minnesota, Minneapolis, MN.
11. **Beck, M.W.**, Vondracek, B., and Hatch, L.K. 2012. Between and within lake responses of macrophyte richness metrics to shoreline development. *Oral presentation*. MN Department of Natural Resources Fall research meeting, Itasca State Park, MN.
12. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2011. Biological assessment of aquatic macrophytes in Midwest glacial lakes. *Oral presentation*. University of Minnesota Water Resources Graduate Program student symposium, Stillwater, MN.
13. **Beck, M.W.** 2009. Perspectives on sustaining Minnesota's lakes: Biological monitoring, IBIs, and stressor identification. *Oral presentation*. University of Minnesota Water Resources Graduate Program seminar, St. Paul, MN.
14. **Beck, M.W.** 2009. The Minnesota macrophyte IBI for lake assessment. *Oral presentation*. Habitat research meeting, Minnesota Department of Natural Resources, St. Paul, MN.
15. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Aquatic plant assessment meeting, Minnesota Pollution Control Agency, St. Paul, MN.

16. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Fisheries research meeting, Minnesota Department of Natural Resources, Cloquet, MN.

### *Contributed Presentations*

1. Wessel, M., **Beck, M.W.**, Leverone, J., Sherwood, E.T., Hecker, J., Raulerson, G., Janicki, T. 2020. Tidal tribulations: Overcoming hurdles in identifying a stressor-response relationship to develop a water quality management framework for Southwest Florida tidal creeks. American Water Resources Association Virtual Conference.
2. **Beck, M.W.**, Wessel, M., Leverone, J., Sherwood, E.T., Raulerson, G., Janicki, T. 2020. Using an applied open source toolbox for tidal creek assessment in Southwest Florida. American Water Resources Association Virtual Conference.
3. Bednaršek, N., Feely, R.A., Alin, S.R., Siedlecki, S.A., **Beck, M.W.**, Calosi, P., Pelletier, G., Saenger, C., Spicer, J.I. 2019. Modelling carapace dissolution and growth under present-day low pH gradients in larval Dungeness crab. Coastal and Estuarine Research Federation biennial meeting, Mobile, AL.
4. Sherwood, E., **Beck, M.W.**, Henkel, J.R., Dorans, K., Ireland, K., Varela, P. 2019. Assessing the cumulative effects of restoration activities on improving water quality in Tampa Bay, Florida. Coastal and Estuarine Research Federation biennial meeting, Mobile, AL.
5. **Beck, M.W.**, O'Hara, C., Stewart Lowndes, J., Mazor, R.D., Theroux, S.T., Gillett, D.J., Lane, B., Gearheart, G. 2019. The importance of open science for biological assessment. *Oral presentation*. Society for Freshwater Science Annual Meeting, Salt Lake City, UT.
6. **Beck, M.W.**, Sherwood, E., Kirsten, D., Ireland, K., Varela, P., Henkel, J. 2019. Use of open science to inform restoration projects in estuaries: A Tampa Bay example. *Oral presentation*. Gulf of Mexico Oil Spill & Ecosystem Science Conference, New Orleans, LA.
7. **Beck, M.W.**, Kittleson, K., O'Connor, K. 2018. Customized web-based exploration of a long-term fisheries monitoring program. *Ignite presentation*. California Estuarine Research Society, Long Beach, CA.
8. **Beck, M.W.**, Sutula, M., Howard, M., Stein, E. 2018. Landscape scale risk assessment of cyanobacteria blooms in California lakes. *Oral presentation*. Society for Freshwater Science Annual Meeting, Detroit, MI.
9. Wan, Y., **Beck, M.W.**. 2017. Comparative analysis of long-term chlorophyll data with Generalized Additive Model. *Oral presentation*. Coastal and Estuarine Research Federation biennial meeting, Providence, RI.
10. **Beck, M.W.**, Hagy, J.D., Le, C. 2017. Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization. *Oral presentation*. Coastal and Estuarine Research Federation biennial meeting, Providence, RI.
11. **Beck, M.W.**, O'Brien, T.D., Cressman, K., St. Laurent, K., Eslinger, D. 2016. SWMPPrats.net: A web-based resource for exploring SWMP data. *Poster presentation*. National Estuarine Research Reserve System annual meeting, Williamsburg, VA.
12. **Beck, M.W.**, Hagy, J.D., Le, C. 2016. Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization. *Oral presentation*. Gulf Estuarine Research Society biennial meeting, Pensacola Beach, FL.
13. **Beck, M.W.**, O'Brien, T.D., Bundy, M.H. 2016. Integrated analysis tools for the NERRS System-Wide Monitoring Program Data. *Oral presentation*. National Water Quality Monitoring Council biennial meeting, Tampa, FL.

14. Cressman, K., Caffrey, J., **Beck, M.W.**, Griffin, C. 2016. Understanding long-term changes by linking monthly chlorophyll measurements to high-frequency water quality data. *Oral presentation*. National Water Quality Monitoring Council biennial meeting, Tampa, FL.
15. Senn, D., Otten, T., Stewart, R., Bresnahan, P., **Beck, M.W.**, Hagy, J.D., Guerin, M., Jabusch, T., Kendall, C., Novick, E., Trowbridge, P., Young, M. 2016. Probing archived samples and historic data for improved understanding of nutrient cycling and ecosystem response in the Bay-Delta. *Oral presentation*. Interagency Ecological Program Annual Workshop, Folsom, CA.
16. Hagy, J.D., **Beck, M.W.**, Murrell, M.C. 2015. Improving estimates of ecosystem metabolism by reducing effects of tides on DO time series. *Oral presentation*. Coastal and Estuarine Research Federation Biennial Meeting, Portland, OR.
17. Bundy, M.H., **Beck, M.W.**, O'Brien, T.D. 2015. Synthesis of NERRS System-Wide Monitoring Program data: Using integrated analysis tools to detect trends. *Oral presentation*. Coastal and Estuarine Research Federation Biennial Meeting, Portland, OR.
18. **Beck, M.W.** 2015. SWMPPr: An R package for estuarine water quality time series. *Oral presentation*. USEPA R User Group meeting, USEPA NHEERL ORD, Gulf Breeze, FL.
19. **Beck, M.W.**, Hagy, J.D., Murrell, M.C. 2014. A novel approach for evaluation of water quality trends in Gulf Coast estuaries. *Oral presentation*. Bays and Bayous Symposium, Mobile, AL.
20. Murrell, M.C., Hagy, J.D., Aukamp, J., **Beck, M.W.**, Beddick, D., Craven, G., Duffy, A., Jarvis, B.M., Marcovich, M., Yates, D., Caffrey, J. 2014. Environmental drivers of ecosystem and plankton metabolism in Pensacola Bay, Florida. Bays and Bayous Symposium, Mobile, AL.
21. Hagy, J.D., Jarvis, B.M., Murrell, M.C., **Beck, M.W.**. 2014. Modeling remediation of aquatic life impacts of episodic and diel cycling hypoxia via nutrient loading rate reduction. Bays and Bayous Symposium, Mobile, AL.
22. **Beck, M.W.** 2014. ggplot2 redux. *Oral presentation*. USEPA R User Group meeting, USEPA NHEERL ORD, Gulf Breeze, FL.
23. **Beck, M.W.**, Tomcko, C.M., Valley, R.D., and Staples, D.F. 2014. Analysis of macrophyte indicator variation as a function of sampling, temporal, and stressor effects. *Poster presentation*. Joint Aquatic Sciences Meeting, Portland, OR.
24. **Beck, M.W.**, Hagy, J.D. 2014. Adaptation of a weighted regression approach to evaluate water quality trends in Tampa Bay, Florida. *Oral presentation*. National Water Quality Monitoring Council biennial meeting, Cincinnati, OH.
25. **Beck, M.W.**. 2014. The nuts and bolts of Sweave/Knitr for reproducible research. *Oral presentation*. USEPA R User Group meeting, USEPA NHEERL ORD, Gulf Breeze, FL.
26. **Beck, M.W.**, Vondracek, B., Hatch, L.K., and Wilson, B. 2013. Evaluating the utility of a plant-based index of lake condition using neural networks. *Oral presentation*. Ecological Society of America annual meeting, Minneapolis, MN.
27. **Beck, M.W.**, Vondracek, B., Wilson, B., and Hatch, L.K. 2013. Understanding indicators of lake health and the utility of a plant-based index. *Oral presentation*. Conservation Biology Graduate Program seminar, University of Minnesota, St. Paul, MN.
28. Vondracek, B., Koch, J.D., and **Beck, M.W.** 2013. A comparison of survey methods to evaluate macrophyte index of biotic integrity performance in Minnesota lakes. *Oral presentation*. Minnesota chapter of the Am. Fisheries Society annual meeting, St. Cloud, MN.

29. **Beck, M.W.**, Vondracek, B., Wilson, B., and Hatch, L.K. 2013. Understanding indicators of lake health and the utility of a plant-based index. *Oral presentation*. Conservation Biology Graduate Program seminar, University of Minnesota, St. Paul, MN.
30. **Beck, M.W.** 2012. Effects of shoreline development on aquatic macrophytes: Summary of analyses. *Class lecture*. Ecological Modeling (FW 8200), University of Minnesota, St. Paul, MN.
31. **Beck, M.W.**, Vondracek, B., Hatch, L.K., and Vinje, J. 2012. Image analysis techniques to evaluate effects of lakeshore development on aquatic habitat. *Oral and poster presentation*. Am. Fisheries Society annual meeting, St. Paul, MN.
32. **Beck, M.W.**, Vondracek, B., Hatch, L.K., and Vinje, J. 2012. Image analysis techniques to evaluate effects of lakeshore development on aquatic habitat. *Oral presentation*. Water Resources Conference, St. Paul, MN.
33. **Beck, M.W.**, Vondracek, B., Hatch, L.K., 2012. Identifying covariates of a lake assessment index to improve biological assessment. *Oral presentation*. Minnesota chapter of Society for Conservation Biology annual meeting, St. Paul, MN.
34. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. *Oral presentation*. Midwest Fish and Wildlife Conference, Des Moines, IA.
35. **Beck, M.W.** 2011. R is my friend: Or how I learned to stop worrying and love the machine. *Oral presentation*. Conservation Biology Graduate Program breakfast seminar, University of Minnesota, St. Paul, MN.
36. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. *Poster presentation*. Water Resources Conference, St. Paul, MN.
37. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. *Oral presentation*. Am. Fisheries Society annual meeting, Seattle, WA.
38. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. *Oral presentation*. Minnesota chapter of the Am. Fisheries Society annual meeting, Sandstone, MN.
39. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2010. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Poster presentation*. Midwest Fish and Wildlife Conference, Minneapolis, MN.
40. Koch, J.D., **Beck, M.W.**, Carlin, J. 2010. A comparison of survey methods to evaluate macrophyte index of biotic integrity performance in Minnesota lakes. *Poster presentation*. Midwest Fish and Wildlife Conference, Minneapolis, MN.
41. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2010. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. International Congress for Conservation Biology, Edmonton, Alberta.
42. **Beck, M.W.**, Vondracek, B., Hatch, L.K. 2010. Assessing the health of Minnesota's lakes using indices of biotic integrity. *Oral presentation*. Joint meeting of the Minnesota chapters of Am. Fisheries Society, Society for Conservation Biology, and The Wildlife Society, Nisswa, MN.
43. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Water Resources Conference, St. Paul, MN.

44. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Poster presentation*. Land Conservation and Clean Water Summit, Chaska, MN.
45. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Symposium for best student paper, Am. Fisheries Society annual meeting, Nashville, TN.
46. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2009. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Minnesota chapter of the Society for Conservation Biology annual meeting, St. Paul, MN.
47. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2008. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Poster presentation*. Water Resources Conference, St. Paul, MN.
48. **Beck, M.W.** 2008. The index of biotic integrity: A review. *Class lecture*. Water quality and natural resources (ESPM 4061), University of Minnesota, St. Paul, MN.
49. **Beck, M.W.**, Hatch, L.K., Vondracek, B., Valley, R.D. 2008. Development of a macrophyte-based index of biotic integrity for Minnesota lakes. *Oral presentation*. Conservation Biology Graduate Program seminar, University of Minnesota, St. Paul, MN.
50. Hatch, L.K., **Beck, M.W.**, Vondracek, B. 2007. Ecological assessment method development for Minnesota lakes. *Oral presentation*. North Am. Lake Management Society annual meeting, Orlando, FL.

### *Grants, Contracts, Awards, and Honors*

Penn State University Contract No. OCE 19-24559	<b>\$42441</b>	<b>Jan. 2020</b>
San Francisco Estuary Institute Contract No. 1456	<b>\$18952</b>	<b>Jan. 2020</b>
Southern California Coastal Water Research Project Task Order No. 17171	<b>\$21893</b>	<b>Jan. 2020</b>
Janicki Environmental, Inc. TBEP Tech Support Contract for Work Order 1	<b>\$10600</b>	<b>May 2019</b>
Aquatic Bioassay and Consulting Labs, Inc. PR No. SCC0419.003	<b>\$99488</b>	<b>Apr. 2019</b>
County of Santa Cruz, California PR No. BR410375	<b>\$5000</b>	<b>Oct. 2018</b>
San Francisco Estuary Institute Contract No. 1358	<b>\$10000</b>	<b>Aug. 2018</b>
US EPA Gulf Ecology Division Green Award		<b>May 2017</b>
ORISE post-doctorate research highlights		<b>Feb. 2015</b>
LaBounty Best Paper Award nomination, N. Am. Lake Management Society		<b>Oct. 2014</b>
Interdisciplinary Doctoral Fellowship, University of Minnesota	<b>\$22500</b>	<b>Sep. 2012</b>
Best student paper award, MN chapter for Society of Conservation Biology		<b>Mar. 2012</b>
Carolyn Crosby Fellowship, University of Minnesota	<b>\$1000</b>	<b>Jan. 2012</b>
Best student paper award, MN chapter of Am. Fisheries Society	<b>\$200</b>	<b>Feb. 2011</b>
Fenske Memorial Award finalist, Midwest Fish and Wildlife Conference		<b>Dec. 2010</b>
Travel award, Strategic Env. Research and Development Program	<b>\$700</b>	<b>Jul. 2010</b>
Travel award, Graduate and Professional Student Assembly	<b>\$200</b>	<b>Jul. 2010</b>
Finalist in best student paper symposium, Am. Fisheries Society		<b>Sep. 2009</b>
Conservation Biology Graduate Program summer fellowship	<b>\$3500</b>	<b>Jun. 2008</b>
Phi Beta Kappa Honor Society		<b>Dec. 2006</b>
Dean's list for academic excellence duration of undergraduate education		<b>2004 - 2006</b>
Florida Bright Futures undergraduate scholarship	<b>\$5250</b>	<b>2003 - 2006</b>

### *Professional Society Membership*

Coastal and Estuarine Research Federation	<b>Sep. 2013 - Present</b>
Society for Conservation Biology	<b>Feb. 2008 - Present</b>

*Technical Training and Additional Experience*

Expert knowledge in open science tools and their application, including R, RStudio,  
R Shiny, Git, GitHub, L<sup>A</sup>T<sub>E</sub>X, Sweave, knitr

Workshop participant, Master R Developer, San Francisco, CA

Webinar participant, The Grammar and Graphics of Data Science

Workshop participant, New Tools for Water Quality Data Access and Trend

Analysis. An Overview of the USGS R Packages: dataRetrieval and EGRET

Workshop participant, An Introduction to the Fundamentals of Linear

Quantile Regression in R

Workshop participant, Aquatic Plant Identification, Itasca State Park, MN

SCUBA open water and advanced Nitrox certification

CPR and first aid certification