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Estuarine Response Analyst
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EDUCATION

2012	Ph.D from Johns Hopkins University in Geography and Environmental Engineering
2002	ME from Cornell University in Biological and Environmental Engineering
2001	BS from Cornell University in Agricultural and Biological Engineering

EMPLOYMENT

2023-	Associate Research Scientist. UMCES Chesapeake Bay Program. Annapolis, Maryland
2014-2023	Assistant Research Scientist. UMCES Chesapeake Bay Program.
2012-2014	Engineer III. EA Engineering, Science, and Technology. Hunt Valley, Maryland
2007-2012	Research Assistant. Johns Hopkins University, Department of Geography and Environmental Engineering. Baltimore, Maryland
2003-2007	Senior Associate. ICF International. Research Triangle Park, North Carolina
2002-2003	Engineering-in-training. Blue: Land, Water, Infrastructure. Clayton, North Carolina

PROFESSIONAL EXPERIENCE

My work and research involve identifying, linking, and using the right mix of analysis tools, models, and data to examine environmental problems. I collaborate with a range of academic, federal, state, and private partners to make this work cutting-edge and relevant to current management needs. At the Chesapeake Bay Program, I am computing and evaluating long-term trends in water quality throughout the estuary. I use Generalized Additive Models (GAMs) and apply them both for trend analyses as well as in analyses evaluating factors influencing these changes. Currently I am also working on combining GAMs and spatial interpolation techniques to develop a new tool to interpolate dissolved oxygen throughout space and time to meet the needs of Bay Program partners. My previous research was closely related and involved conducting long-term data analyses of hypoxia, stratification, nutrients, climate, and other relevant environmental variables in Chesapeake Bay. While a consultant, I worked on various projects throughout the U.S. modeling and analyzing data related to sediment, water, and air pollution.

SKILLS

- Statistical data analyses using generalized additive models, geostatistics (kriging), regression, and other parametric and non-parametric statistics.
- Spatial data analysis and mapping in ArcGIS.
- Scientific programming in R.

PEER-REVIEWED PUBLICATIONS

Hensel, M.J.S., C.J. Patrick, R.J Orth, D.J. Wilcox, W.C. Dennison, C. Gurbisz, M.P. Hannam, J.B. Landry, K.A. Moore, **R.R. Murphy**, J.M. Testa, D.E. Weller, and J.S. Lefcheck. 2023. Rise of *Ruppia* in Chesapeake Bay: Climate change-driven turnover of foundation species creates new threats and management opportunities. *Proceedings of the National Academy of Sciences.* 120(23) https://doi.org/10.1073/pnas.2220678120

Murphy, R.R., J. Keisman, J. Harcum, R.R. Karrh, M. Lane, E.S. Perry, and Q. Zhang. 2022. Nutrient Improvements in Chesapeake Bay: Direct Effect of Load Reductions and Implications for Coastal Management. *Environmental Science and Technology* 56(1): 260-270. https://doi.org/10.1021/acs.est.1c05388.

Beck, M.W., P. de Valpine, **R. Murphy**, I. Wren, A. Chelsky, M. Foley, and D.B. Senn. 2022. Multi-scale trend analysis of water quality using error propagation of generalized additive models. *Science of The Total Environment* 802: 149927. https://doi.org/10.1016/j.scitotenv.2021.149927.

Zhang, Q., T.R. Fisher, C. Buchanan, A.B. Gustafson, R.R. Karrh, **R.R. Murphy**, J.M. Testa, R. Tian, and P.J. Tango. 2022. Nutrient limitation of phytoplankton in three tributaries of Chesapeake Bay: Detecting responses following nutrient reductions. *Water Research* 226: 119099. https://doi.org/10.1016/j.watres.2022.119099.

Orth, R.J., W.C. Dennison, D.J. Wilcox, R.A. Batiuk, J.B. Landry, C. Gurbisz, J. Keisman, M. Hannam, J.S. Lefcheck, **R.R. Murphy**, K.A. Moore, C.J. Patrick, J.M. Testa, D.E. Weller, M.F. Merritt, and P. Hobaugh. 2022. Data synthesis for environmental management: A case study of Chesapeake Bay. *Journal of Environmental Management* 321: 115901. https://doi.org/10.1016/j.jenvman.2022.115901.

Scavia, D., I. Bertani, J.M. Testa, A.J. Bever, J.D. Blomquist, M.A.M. Friedrichs, L.C. Linker, B.D. Michael, **R.R. Murphy**, and G.W. Shenk. 2021. Advancing estuarine ecological forecasts: seasonal hypoxia in Chesapeake Bay. *Ecological Applications* 31(6). https://doi.org/10.1002/eap.2384.

Zhang, Q., T.R. Fisher, E.M. Trentacoste, C. Buchanan, A.B. Gustafson, R. Karrh, **R.R. Murphy**, J. Keisman, C. Wu, R. Tian, J.M. Testa and P.J. Tango. 2021. Nutrient limitation of phytoplankton in Chesapeake Bay: Development of an empirical approach for water-quality management. *Water Research* 188. https://doi.org/10.1016/j.watres.2020.116407.

Murphy, R.R., E. Perry, J. Harcum, and J. Keisman. 2019. A generalized additive model approach to evaluating water quality: Chesapeake Bay case study. *Environ. Modelling Software* 118: 1-13. https://doi.org/10.1016/j.envsoft.2019.03.027.

Lefcheck, J.S., R.J. Orth, W.C. Dennison, D.J. Wilcox, **R.R. Murphy**, J. Keisman, C. Gurbisz, M. Hannam, B. Landry, K.A. Moore, C.J. Patrick, J. Testa, D.E. Weller, and R.A. Batiuk. 2018. Long-term nutrient reductions lead to the unprecedented recovery of a temperate coastal region. *Proceedings of the National Academy of Sciences* 115(14): 3658-3662. https://doi.org/10.1073/pnas.1715798115.

Testa, J.M., **R.R. Murphy**, D.C. Brady, and W.M. Kemp. 2018. Nutrient- and Climate-Induced Shifts in the Phenology of Linked Biogeochemical Cycles in a Temperate Estuary. *Frontiers in Marine Science* 5:114. https://doi.org/10.3389/fmars.2018.00114.

Zhang, Q., P.J. Tango, **R.R. Murphy**, M.K. Forsyth, R. Tian, J. Keisman, and E.M. Trentacoste. 2018. Chesapeake Bay dissolved oxygen criterion attainment deficit: Three decades of temporal and spatial patterns. *Frontiers in Marine Science* 5:422. https://doi.org/10.3389/fmars.2018.00422.

Zhang, Q., **R.R. Murphy**, R. Tian, M.K. Forsyth, E.M. Trentacoste, J. Keisman, and P.J. Tango. 2018. Chesapeake Bay's water quality condition has been recovering: Insights from a multimetric indicator assessment of thirty years of tidal monitoring data. *Science of the Total Environment* 637-638:1617-1625. https://doi.org/10.1016/j.scitotenv.2018.05.025.

Beck, M.W. and **R.R. Murphy**. 2017. Numerical and Qualitative Contrasts of Two Statistical Models for Water Quality Change in Tidal Waters. *Journal of the American Water Resources Association (JAWRA)* 53(1):197–219. https://doi.org/10.1111/1752-1688.12489.

Lefcheck J.S., D.J. Wilcox, **R.R. Murphy**, S.R. Marion, and R.J. Orth. 2017. Multiple stressors threaten the imperiled coastal foundation species eelgrass (Zostera marina) in Chesapeake Bay, USA. *Global Change Biology* 23(9):3474–3483. https://doi.org/10.1111/gcb.13623.

Orth, R.J., W.C. Dennison, J.S. Lefcheck, C. Gurbisz, M. Hannam, J. Keisman, B. Landry, K.A. Moore, **R.R. Murphy**, C.J. Patrick, J. Testa, D.E. Weller, and D.J. Wilcox. 2017. Submersed Aquatic Vegetation in Chesapeake Bay: Sentinel Species in a Changing World. *BioScience* 67(8): 698–712. https://doi.org/10.1093/biosci/bix058.

Murphy, R., E. Perlman, W. Ball, W., and F. Curriero. 2014. Water-Distance-Based Kriging in Chesapeake Bay. *Journal of Hydrologic Engineering 20(9).* https://doi.org/10.1061/(ASCE)HE.1943-5584.0001135.

Urquhart, E.A., M.J. Hoffman, **R.R. Murphy**, and B.F. Zaitchik. 2013. Geospatial interpolation of MODIS-derived salinity and temperature in the Chesapeake Bay. *Remote Sensing of Environment* 135:167-177. http://dx.doi.org/10.1016/j.rse.2013.03.034.

Murphy, R.R., W.M. Kemp, and W.P. Ball. 2011. Long-Term Trends in Chesapeake Bay Seasonal Hypoxia, Stratification, and Nutrient Loading. *Estuaries & Coasts* 34:1293-1309. https://doi.org/10.1007/s12237-011-9413-7.

Murphy, R.R., F.C. Curriero, and W.P. Ball. 2010. Comparison of Spatial Interpolation Methods for Water Quality Evaluation in the Chesapeake Bay. *ASCE Journal of Environmental Engineering* 136(2):160-171. https://doi.org/10.1061/(ASCE)EE.1943-7870.0000121.

Perlman E., R. Burns, M. Kazhdan, **R.R. Murphy**, W.P. Ball, and N. Amenta. 2010. Organization of Data in Non-Convex Spatial Domains. *Scientific and Statistical Database Management, Lecture Notes in Computer Science* 6187: 342-359. https://doi.org/10.1007/978-3-642-13818-8_25.

CBEO Project Team (W. Ball, D. Brady, M. Brooks, R. Burns, B. Cuker, D. DiToro, T. Gross, W.M. Kemp, L. Murray, **R. Murphy**, E. Perlman; M. Piasecki, J. Testa, I. Zaslavsky). 2008. A Prototype System for Multi-Disciplinary Shared Cyberinfrastructure –Chesapeake Bay Environmental Observatory (CBEO). *ASCE J. Hydrologic Engineering* 13(10):960-970. https://doi.org/10.1061/(ASCE)1084-0699(2008)13:10(960).

Murphy, R. and D.A. Haith. 2007. Inhalation Health Risks to Golfers from Turfgrass Pesticides at Three Northeastern U.S. Sites. *Environmental Science and Technology* 41:1038-1043. https://doi.org/10.1021/es060964b.

REPORTS

Hyer, K.E., S.W. Phillips, S.W. Ator, D.L. Moyer, J.S. Webber, R. Felver, J.L. Keisman, L.A. McDonnell, **R. Murphy,** E.M. Trentacoste, Q. Zhang, W.C. Dennison, S. Swanson, B. Walsh, J. Hawkey, and D. Taillie, 2021. "Nutrient trends and drivers in the Chesapeake Bay Watershed," U.S. Geological Survey Fact Sheet 2020–3069. U.S. Geological Survey, Baltimore, MD, p. 4. https://pubs.er.usgs.gov/publication/fs20203069

Keisman, J., **R. R. Murphy**, O. H. Devereux, J. Harcum, R. Karrh, M. Lane, E. Perry, J. Webber, Z. Wei, Q. Zhang, and M. Petenbrink, 2020. "Potomac Tributary Report: A summary of trends in tidal water quality and associated factors, 1985-2018," Chesapeake Bay Program., Annapolis, MD. https://pubs.er.usgs.gov/publication/70216971.

Keisman, J., C. Friedrichs, R. Batiuk, J. Blomquist, J. Cornwell, C. Gallegos, S. Lyubchich, K. Moore, **R. Murphy**, R. Orth, L. Sanford, P. Tango, J. Testa, M. Trice, and Q. Zhang, 2019. "Understanding and explaining 30 years of water clarity trends in the Chesapeake Bay's tidal waters," Chesapeake Bay Program STAC Publication Number 19-004, Edgewater, MD, p. 25. http://www.chesapeake.org/pubs/411_Keisman2019.pdf.

Keisman, J., J. Blomquist, J.K. Bohlke, J. Davis-Martin, W. Dennison, C. Friedrichs, **R. Murphy**, S. Phillips, J. Testa, E. Trentacoste, and D. Weller. 2018. Integrating Recent Findings to Explain Water-Quality Change: Support for the Mid-Point Assessment and Beyond. STAC Publication Number 18-005, Edgewater, MD. 27 pp. http://www.chesapeake.org/pubs/394_Keisman2018.pdf

DISSERTATION

Murphy, R.R. 2012. *Development and Use of Spatial Interpolation Methods to Analyze Trends in Chesapeake Bay Seasonal Hypoxia and Stratification*. Johns Hopkins University, Baltimore, MD.

PUBLISHED TOOLS

Murphy, R., E. Perry, J. Keisman, J. Harcum, and E.W. Leppo. 2022. Baytrends: Long Term Water Quality Trend Analysis, version 2.0.8. R package. https://CRAN.R-project.org/package=baytrends

CONFERENCE SESSIONS

Co-convener, session "Water-quality patterns and trends in the Chesapeake Bay and its watershed: Integrated monitoring, modeling, and science communication approaches to advance science and inform management" at Chesapeake Community Research Symposium, Annapolis, MD, June 6-8, 2022.

Co-convener, session "Innovative approaches for estuarine/watershed data analysis, mining, and visualization" at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Mobile, AL, November 3-7, 2019.

Lead convener, session "Linking changing watershed characteristics to water quality trends" at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Providence, RI, November 5-9, 2017.

Co-convener, session "Explaining Drivers of Change in Riverine and Estuarine Water Quality" at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Portland, OR, November 8-12, 2015.

CONFERENCE PRESENTATIONS (as lead author from 2015-present)

Murphy, R., J. Keisman, J. Harcum, R. Karrh, M. Lane, E. Perry, and Q. Zhang. 2023. "Nutrient improvements in Chesapeake Bay: Direct effect of load reductions and implications for coastal management," oral presentation at the 13th National Monitoring Conference, Virginia Beach, VA, April 24-28, 2023.

Murphy, R., J. Keisman, J. Harcum, R. Karrh, M. Lane, E. Perry, and Q. Zhang. 2022. "Nutrient improvements in Chesapeake Bay: Direct effect of load reductions and implications for coastal management," oral presentation at Chesapeake Community Research Symposium, Annapolis, MD, June 6-8, 2022.

Murphy, R., J. Keisman, E. Perry, J. Harcum, and M. Beck. 2021. "Identifying, visualizing, and explaining estuarine water quality changes with Generalized Additive Models," invited anchor presentation at Coastal & Estuarine Research Federation (CERF) Biennial Conference, virtual, Nov 1-11, 2021.

Murphy, R. and J. Keisman. 2019. "Evaluating water quality response trajectories in Chesapeake Bay using statistical models," oral presentation at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Mobile, AL, Nov 3-7, 2019.

Murphy, R. and J. Keisman. 2018. "Comparison of Secchi depth and K_d trends while adjusting for freshwater input variations," oral presentation at Chesapeake Community Research Symposium, Annapolis, MD, June 12-14, 2018.

Murphy, R. and E. Perry. 2017. "Using Generalized Additive Models to Inform Water Quality Management in Chesapeake Bay," oral presentation at American Statistical Association (ASA) Joint Statistical Meetings, Baltimore, MD, August 1, 2017.

Murphy, R. E. Perry, J. Harcum, J. Keisman, R. Karrh, M. Lane, and M. Arora. 2017, "A tool for evaluating long-term water quality change in a complex estuarine system," oral presentation at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Providence, RI, November 5-9, 2017.

Murphy, R. 2016, "Chesapeake Bay Estuary Monitoring Trends," oral presentation at Environment Virginia Symposium, Lexington, VA, April 5-7, 2016.

Murphy, R. and E. Perry. 2016. "Seasonal Adjustment of Water Quality Trends in Chesapeake Bay," oral presentation at Bureau of Labor Statistics and U.S. Census Bureau's Seasonal Adjustment Workshop, Washington, D.C., November 4, 2016.

Murphy, R. and E. Perry. 2015. "Identifying trends and responses to nutrient reductions in Chesapeake Bay water quality," oral presentation at Coastal & Estuarine Research Federation (CERF) Biennial Conference, Portland, OR, November 8-12, 2015.

PEER-REVIEW SERVICES

Biogeosciences

Continental Shelf Research

Environmental Science & Technology

Environmental Science & Pollution Research

Estuaries & Coasts

Estuarine, Coastal and Shelf Science

JGR: Oceans

Journal of the American Water Resources Association

Limnology and Oceanography

Ocean Dynamics

Peer J

PLOS ONE