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Education

B.A., Amherst College (*Magna cum laude*), 1974

Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint
Program in Biological Oceanography, 1979

Professional Experience

1993-Present	David R. Atkinson Professor of Ecology & Environmental Biology, Cornell University.
2020-Present	Member, Climate Action Council, State of New York (appointed by the Speaker of the State Assembly).
2021-Present	Co-Editor-in-Chief, <i>Ocean-Land-Atmosphere Research</i> (OLAR)
2021-Present	Member of editorial board, <i>Energy Science & Engineering</i>
2019-2020	Chair, the University Assembly, Cornell University.
2018-2019	Vice Chair, the University Assembly, Cornell University.
2014-2019	Editor-in-Chief, <i>Limnology & Oceanography</i> .
2017-Present	MBL Fellow, Marine Biological Laboratory, Woods Hole.
2016-Present	Distinguished Visiting Fellow, Woods Hole Research Center.
2000-2017	Adjunct Senior Scientist, Marine Biological Laboratory, Woods Hole.
1983-Present	Founding Editor, <i>Biogeochemistry</i> (Editor-in-Chief, 1983-2004).
2005-2012	Director, Agriculture, Energy, & Environment Program, Cornell University.
2000-2001	Oceans Program Director & Senior Scientist, Environmental Defense Fund.
1995-2000	Director, Program in Biogeochemistry & Environmental Change, Cornell.
1992-1995	Senior Fellow, and coordinator for Initiative in Earth, Atmospheric, & Aquatic Sciences, Center for the Environment, Cornell.
1990-1993	Professor, Section of Ecology & Systematics, Cornell University.
1988-1991	Director, Ecosystems Research Center (US EPA National Center of Excellence), Cornell University.
1985-1990	Associate Professor, Section of Ecology & Systematics, Cornell University.
1980-1985	Assistant and Associate Scientist, Marine Biological Lab, Woods Hole.
1979	Noyes Postdoctoral Fellow, Marine Biological Laboratory, Woods Hole.

Recent Awards and Honors (since 2000)

- One of the ten ever most highly cited marine biologists/aquatic scientists in the world (*PLoS Biol* 18(10): e3000918. <https://doi.org/10.1371/journal.pbio>)
- One of 50 “Most Influential People” driving energy policy in New York State, City & State New York magazine, three years in a row (2019, 2020, and 2021).
- Invited briefing to US Congress on the Fracking Ban Act (2020)

- Invited briefing to European Parliament on “Fueling the Fracking, Plastics, Methane Emissions and the Gas Lobby” (2020)
- ASLO John Martin Award, Association for Sciences of Limnology & Oceanography (2018).
- Moore Lecturer, University of Virginia (2017).
- ASLO Sustaining Fellow, Association for Sciences of Limnology & Oceanography (2017).
- Invited briefing on methane, shale gas development, and climate change to the Office of Science and Technology Policy, Executive Office of the White House (2016).
- Keynote speaker, Earth Day, State University of New York at Stony Brook (2014).
- Ian Morris Distinguished Scholar, Horn Point Laboratory, University of Maryland (2014).
- Featured plenary speaker, World Water Day, Michigan Technological University (2014).
- Co-Winner, 2013 Atlas Award, “honoring climate heroes worldwide”
- David Schindler Visiting Scholar, Trent University (2013)
- Pritchard Award, best physical oceanography paper published in *Estuaries & Coasts* (2013).
- One of Time Magazine’s 50 “People Who Mattered,” 2011 Person of the Year issue.
- Zayed International Prize for the Environment (2007), jointly with the other lead authors of the Millennium Ecosystem Assessment.
- Invited briefing on coastal water quality to the Office of Science and Technology Policy, Executive Office of the White House (2006).
- Selected by ISI Web of Science (Scientific Citation Index) as one of 250 most cited scientists globally in ecology and environmental science disciplines (every year, 2006 to the present).
- Biology Faculty of 1,000 (every year, 2005 to the present).
- Lindeman Award in Ecology, University of Minnesota (2003).
- Aldo Leopold Leadership Fellow, Ecological Society of America (2000).
- Eminent Ecologist award, Kellogg Biological Station, Michigan State Univ. (2000).

National and International Committees and Activities

2021	Delegate observer to the UN COP26 negotiations, Glasgow, Scotland.
2017-present	Member, Board of Directors, Food & Water Watch.
2017	Delegate observer to the UN COP23 negotiations, Bonn, Germany.
2017	Chair, Review Panel for Integration of Monitoring and Evaluation into Environmental Restoration Projects to Improve Outcomes in the Gulf of Mexico, National Academy of Sciences.
2015-present	Member, EPA Clean Air Scientific Advisory Committee (CASAC) Secondary National Ambient Air Quality Standards Review Panel for Oxides of Nitrogen and Sulfur, US Environmental Protection Agency.
2015	Delegate observer to the United Nations COP21 negotiations, Paris, France.
2014-2016	Member, National Estuarine Research Reserves Science Collaborative Advisory Board, National Oceanic & Atmospheric Administration.
2010-2014	Member, Working Group on Land and Soils, International Resource Panel, United Nations Environment Programme.
2007-2012	Chair, International SCOPE Biofuels Project: Environmental Consequences of Biofuels (International Council of Science).
2007-2009	President, Coastal & Estuarine Research Federation.
2008-2010	Member, Board of Directors, Council of Scientific Society Presidents.

2007-2011 Co-chair, Committee on Energy & Environment, Council of Scientific Society Presidents.

2005-2013 Representative from the State of New York to the Scientific and Technical Advisory Committee of the Chesapeake Bay Program.

2006-2008 Member, Gulf of Mexico Hypoxia Advisory Panel, US EPA.

2005-2007 Member, Steering Committee, N2007 International N Symposium, Brazil.

2004-2007 Member, Biogeochemistry Rapid Response Team, Ecological Society of America.

2003-Present Editor, book series on Environmental Management, Springer.

2003-2008 Member, Coast and Oceans Working Group, the Heinz Center.

2003-2006 Director, North American Regional Center, International Nitrogen Initiative.

2003-2014 Member, Advisory Committee, International Nitrogen Initiative.

2002-2005 Coordinating Lead Author, chapter on responses to nutrient pollution, the Millennium Ecosystem Assessment.

2002-2004 Member, Advisory Committee, N2004 International N Symposium, China.

2002-2003 Coordinator and lead author, Working Group to Develop a Federal Interagency Research Plan for Coastal Nutrient Pollution.

2001-2002 Consultant on coastal nutrient pollution, the Pew Oceans Commission.

2000-2003 Member, US Committee for SCOPE, National Academy of Sciences.

2000-2003 Member, Scientific Advisory Board, National Center for Ecological Analysis & Synthesis, University of California at Santa Barbara.

2001-2002 Member, Committee to Evaluate the Water Programs of the US Army Corps of Engineers, National Academy of Sciences.

1992-2002 Co-Chair, International SCOPE Nitrogen Project on Nitrogen: A Regional and Global Analysis (International Council of Science).

2000-2001 Member, Advisory Committee, N2001 Symposium, Potomac, MD.

1998-2001 Member, National Climate Change Assessment (Coastal Marine Sector).

1998-2000 Chair, Committee on Causes and Management of Coastal Eutrophication, National Academy of Sciences.

2000 Chair, Panel on Coastal Nitrogen Pollution, Ecological Society of America.

1996-1998 Member, Board of Scientific Counselors, US Environmental Protection Agency

1994-1995 Member, Panel on Nitrogen Cycling in China, Committee on Scholarly Communication with China, National Academy of Sciences.

1995 Chair, Working group on Scientific Studies in Pristine Areas, National Academy of Sciences.

1994-1997 Member, Steering Committee, Sustainable Biosphere Initiative, ESA.

1994 Member, Committee on High-Priority Science to Meet National Coastal Needs, National Academy of Sciences.

1992-1998 Member, Committee on Ethics, Am. Soc. of Limnol. & Oceanography.

1990-1993 Member, Committee on Opportunities to Improve Wastewater Management for Urban Coastal Areas, National Academy of Sciences.

1991-1995 Member, Advisory Committee for the National Water-Quality Assessment Program, U.S. Geological Survey.

1989-1992 Member, Committee on the Coastal Ocean, National Academy of Sciences.

1991-1993 Member, Governing Board, Estuarine Research Federation.

1988-1990	Member, U. S. National Committee for SCOPE, National Academy of Sciences.
1985-1991	Member, Scientific Advisory Committee, the International SCOPE Sulphur Project (Moscow, USSR), International Council of Science.
1989-1990	Member, Panel on Fluxes of Trace Gases and Nutrients to and from Terrestrial Ecosystems, Committee on Global Change, National Academy of Sciences.
1986-1988	Member, Public Affairs Committee, Am. Soc. of Limnol. & Oceanography.
1981-1984	Member, Panel on Ecological Effects, Committee on Fate and Effects of Oil in the Sea, National Academy of Sciences.

Research Interests

Application of science to sustaining the biosphere; biogeochemistry and aquatic ecosystem science; global and regional nitrogen and phosphorus cycles; global methane cycle; environmental consequences of biofuels; role of trace gases in global warming and climate disruption; life-cycle analysis for greenhouse-gas footprint of energy technologies; influence of land-use, management practices, and climate change on nutrient fluxes from the landscape; atmospheric deposition of nitrogen onto the landscape; controls and consequences of eutrophication in estuaries; biotic, physical, and geochemical controls on nitrogen fixation; environmental management and the effects of pollutants on aquatic ecosystems; alternative energy systems.

Publications:

Editor of eight books and treatises. Author of one textbook: Begon, M., R.W. Howarth, and C. Townsend. 2014. *Essentials of Ecology*, 4th Edition. Wiley. ISBN-13: 978-0470909133

Author or co-author of over 230 peer-reviewed papers. These papers have been cited more than 76,000 times in other peer-reviewed publications. Fifteen of these papers have been cited more than 1,000 times each, seven have been cited more than 3,000 times each, and two have been cited more than 7,500 times each. Howarth is the first author on four of these. All publications are listed chronologically below, with those papers cited at least 1,000 times highlighted in bold.

2022 Haviland, K. A., R. W. Howarth, R. M. Marino, and M. Hayn. 2022. Variation in sediment and seagrass characteristics reflect multiple stressors along a nitrogen-enrichment gradient in a New England lagoon. *Limnology & Oceanography* doi: 10.1002/lno.12025

Howarth, R. W. 2022. Nitrogen. In: Thomas Mehner and Klement Trockner (editors), *Encyclopedia of Inland Waters*, 2nd Edition. Elsevier.

Marino, R. M., and R. W. Howarth. 2022. Nitrogen fixation. In: Thomas Mehner and Klement Trockner (editors), *Encyclopedia of Inland Waters*, 2nd Edition. Elsevier.

- Howarth, R. W. 2022. Methane and climate change. In: John F. Stolz, W. Michael Griffin, and Daniel J. Bain (editors), *Environmental Impacts from Development of Unconventional Oil and Gas Reserves*, Cambridge University Press.
- Howarth, R. W., and M. Jacobson. 2022. Reply to comment on “how green is blue hydrogen?” *Energy Science and Engineering* doi: 10.1002/ese3.1154
- 2021 Howarth, R.W., and M. Jacobson. 2021. How green is blue hydrogen? *Energy Science and Engineering* 9: 1676-1687, doi: 10.1002/ese3.956
- Howarth, R.W., F. Chan, D.P. Swaney, R.M. Marino, and M. Hayn. 2021. Role of external inputs of nutrients to aquatic ecosystems in determining prevalence of nitrogen vs. phosphorus limitation of net primary productivity. *Biogeochemistry* 154: 293-306, doi: 10.1007/s10533-021-00765-z
- Wong, M.Y., S.D. Rathod, R. Marino, L. Li, R.W. Howarth, A. Alastuey, M.A. Alaimo, F. Barraza, M.C. Carneiro, S. Chellam, C. Yu-Cheng, D.D. Cohen, D. Connelly, G. Dongarra, D. Gomez, J. Hand, R.M. Harrison, P.K. Hopke, C. Hueglin, Y. Kuang, F. Lambert, J. Liang, R. Losno, W. Maenhaut, C. Milando, M.I.C. Monteiro, Y. Morera-Gomez, X. Querol, S. Rodriguez, P. Smichowski, D. Varrica, Y. Xiao, Y. Xu, and N.M. Mahowald. 2021. Anthropogenic perturbations to the atmospheric molybdenum cycle. *Global Biogeochemical Cycles*, doi: 10.1029/2020GB006787
- 2020 Howarth, R.W. 2020. Methane emissions from fossil fuels: Exploring recent changes in greenhouse-gas reporting requirements for the State of New York. *Journal of Integrative Environmental Sciences*, doi: 10.1080/1943815X.2020.1789666.
- Wong, M.Y., C. Neill, R. Marino, D. Silverio, and R.W. Howarth. 2020. Molybdenum, phosphorus, and pH do not constrain nitrogen fixation in a tropical forest in the southeastern Amazon. *Ecology* doi: 10.1002/ecy.3211
- Wong, M.Y., N.M. Mahowald, R. Marino, E.R. Williams, S. Chellam, and R.W. Howarth. 2020. Natural atmospheric deposition of molybdenum: a global model and implications for tropical forests. *Biogeochemistry*, doi: 10.1007/s10533-020-00671-w
- 2019 Howarth, R.W. 2019. Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane? *Biogeosciences* 16: 3033–3046, doi:10.5194/bg-16-3033-2019.
- Wong, M.Y., C. Neill, R. Marino, D.V. Silvério, P.M. Brando, and R.W. Howarth. 2019. Biological nitrogen fixation does not replace nitrogen losses after forest fires in the southeastern Amazon. *Ecosystems* doi.org/10.1007/s10021-019-00453-y
- Swaney, D.P., and R.W. Howarth. 2019. Phosphorus use efficiency and crop production: Patterns of regional variation in the United States, 1987-2012. *Science of the Total Environment*, 685, 174e188.https://doi.org/10.1016/j.scitotenv.2019.05.228
- 2018 McCrackin, M.L, B.G. Gustafsson, B. Hong, R.W. Howarth, C. Humborg, O.P. Savchuk, A. Svanbäck, and D.P. Swaney. 2018. Opportunities to reduce nutrient inputs to the Baltic Sea by improving manure use efficiency in agriculture. *Regional Environmental Change* doi.org/10.1007/s10113-018-1308-8
- McCrackin, M.L, B. Muller-Karulis, B.G. Gustafsson, R.W. Howarth, C. Humborg, A. Svanback, and D.P. Swaney. 2018. A century of legacy phosphorus dynamics in a large drainage basin. *Global Biogeochemical Cycles* 32: 1107-1122. doi.org/10.1029/2018GB005914

- Harada, Y., T.H. Whitlow, P.H. Templer, R.W. Howarth, M.T. Walter, N.L. Bassuk, and J. Russell-Anelli. 2018. Nitrogen biogeochemistry of an urban rooftop farm. *Frontiers in Ecology and Evolution*. doi.org/10.3389/fevo.2018.00153
- Swaney, D.P., R.W. Howarth, and B. Hong. 2018. Nitrogen use efficiency and crop production: Patterns of regional variation in the United States, 1987-2012. *Science of the Total Environment* 635:498–511. doi.org/10.1016/j.scitotenv.2018.04.027
- 2017 Zhang, W.S., D. Swaney, B. Hong, R. Howarth, and X. Li. 2017. Influence of rapid rural-urban population migration on riverine nitrogen pollution: perspective from ammonia-nitrogen. *Environmental Science and Pollution Research*, DOI 10.1007/s11356-017-0322-6
- Zhang, W.S., D. Swaney, B. Hong, and R. Howarth. 2017. Anthropogenic phosphorus inputs to a river basin and their impacts on riverine phosphorus fluxes along its upstream-downstream continuum. *J. Geophys. Res. Biogeosciences*, 122. https://doi.org/10.1002/2017JG004004
- 2016 Goyette, J.O., E. Bennett, R.W. Howarth, and R. Maranger. 2016. Changes in anthropogenic nitrogen and phosphorus inputs to the St. Lawrence Basin over 110 years: Impacts on riverine export. *Global Biogeochemical Cycles* 30: 1000–1014, doi:10.1002/2016GB005384.
- Marino, R.M., and R.W. Howarth. 2016. Why is planktonic nitrogen fixation so rare in coastal marine ecosystems? Insights from a cross-systems approach. Pages 127-139 in P. Glibert and T. Kana (editors), *Aquatic Nutrient Biogeochemistry and Microbial Ecology: A Dual Perspective*. Springer, Dordrecht. doi: 10.1007/978-3-319-30259-1_11
- Gao, W., B. Hong, D.P. Swaney, R.W. Howarth, and H. Guo. 2016. A system dynamics model for managing regional N inputs from human activities. *Ecological Modelling* 322: 82-91, doi: 10.1016/j.ecolmodel.2015.12.001
- Hong, B., and R.W. Howarth. 2016. Greenhouse gas emissions from domestic hot water: heat pumps compared to most commonly used systems. *Energy Science & Engineering* 4: 123-133, doi: 10.1002/ese3.112
- 2015 Reynolds, L.K., R. Marino, M.F. Muth, N. McLenaghan, M. Hayn, A.C. Tyler, K.J. McGlathery, and R.W. Howarth. 2015. Evidence of grazer control on nitrogen fixation by eelgrass epiphytes in a temperate coastal bay. *Marine Ecology Progress Series* 526: 11-19, doi: 10.3354/meps11234
- Zhang, W.S., D.P. Swaney, B. Hong, R.W. Howarth, H. Han, and X. Li. 2015. Net anthropogenic phosphorus inputs and riverine phosphorus fluxes in highly populated headwater watersheds in China. *Biogeochemistry* 126: 269–283, doi:10.1007/s10533-015-0145-9
- Zhang, W.S., D. P. Swaney, X.Y. Li, B. Hong, R.W. Howarth, and S.H. Ding. 2015. Anthropogenic point-source and non-point-source nitrogen inputs into Huai River basin and their impacts on riverine ammonia–nitrogen flux. *Biogeosciences* 12: 4275-4289, doi:10.5194/bg-12-4275-2015
- Gao, W., D. P. Swaney, B. Hong, Y. Liu, R. W. Howarth, H. C. Guo. 2015. Evaluating Anthropogenic N inputs to Diverse Lake Basins: A Case Study of Three Chinese Lakes. *Ambio*. 44: 635-646.
- Gao, W., R.W. Howarth, D.P. Swaney, B. Hong, and H. Guo. 2015. Enhanced N input to Lake Dianchi Basin from 1980 to 2010: Drivers and consequences. *Science of The Total Environment* 505: 376-384, doi.org/10.1016/j.scitotenv.2014.10.016.

- Howarth, R.W. 2015. Perspectives on air emissions of methane and climatic warming risk from hydraulic fracturing and shale-gas development: Implications for policy. *Energy & Emission Control Technologies* 3: 45-54.
- Costello, C., X. Xue, and R.W. Howarth. 2015. Comparison of production-phase environmental impact metrics derived at the farm- and national-scale for United States agricultural commodities. *Environmental Research Letters* 10: 114004 doi:10.1088/1748-9326/10/11/114004
- Butler, T., R. Marino, D. Schwede, R. Howarth, J. Sparks, and K. Sparks. 2015. Atmospheric ammonia measurements at low concentration sites in the northeastern USA: implications for total nitrogen deposition and comparison with CMAQ estimates. *Biogeochemistry* 122: 191-210.
- Howarth, R.W. 2015. Editorial: Misconduct in scientific publications. *Limnology & Oceanography*, 60(#4), doi: 10.1002/lno.10131
- Howarth, R.W. 2015. Editorial. *Limnology & Oceanography*, 60(#1), doi:10.1002/lno.10030
- 2014 Howarth, R.W. 2014. A bridge to nowhere: Methane emissions and the greenhouse gas footprint of natural gas. *Energy Science & Engineering* 2: 47-60, doi:10.1002/ese3.35
- Begon, M., R.W. Howarth, and C. Townsend. 2014. *Essentials of Ecology*, 4th Edition. Wiley, Chichester. 480 pages. ISBN-13: 978-0470909133
- Bringezu, S, H. Schütz, W. Pengue, M. O'Brien, F. Garcia, R. Sims, R. Howarth, L. Kauppi, M. Swilling, and J. Herrick. 2014. *Assessing Global Land Use: Balancing Consumption with Sustainable Supply*. A Report of the Working Group on Land and Soils of the International Resource Panel. United Nations Environment Program, Paris, France. ISBN: 978-92-807-3330-3
- Caulton, D.R., P. B. Shepson, R.L. Santoro, J.P. Sparks, R.W. Howarth, A. Ingraffea, M.O. Camaliza, C. Sweeney, A. Karion, K.J. Davis, B.H. Stirm, S.A. Montzka, and B. Miller. 2014. Toward a better understanding and quantification of methane emissions from shale gas development. *Proceedings of the National Academy of Sciences* 111: 6237-6242. doi/10.1073/pnas.1316546111
- Howarth, R.W., M. Hayn, R.M. Marino, N. Ganju, K. Foreman, K. McGlathery, A.E. Giblin, P. Berg, and D. Walker. 2014. Metabolism of a nitrogen-enriched coastal marine lagoon during the summertime. *Biogeochemistry* 118: 1-20, doi:10.1007/s10533-013-9901-x
- Gao, W., R.W. Howarth, B. Hong, D.P. Swaney, and H.C. Guo. 2014. Estimating net anthropogenic nitrogen inputs (NANI) in the Lake Dianchi basin of China. *Biogeosciences* 11: 4577 – 4586, doi:10.5194/bg-11-4577-2014
- Del Barrio, P., N. Ganju, A. L. Aretxabaleta, M. Hayn, A. Garcia, and R. W. Howarth. 2014. Modeling future scenarios of light attenuation and potential seagrass success in a eutrophic estuary. *Estuarine and Coastal Shelf Science* 149: 13-23, doi 10.1016/j.ecss.2014.07.005
- Jacobson, M.Z., M.A. Delucchi, A.R. Ingraffea, R.W. Howarth, G. Bazouin, B. Bridgeland, K. Burkart, M. Change, N. Chowdhury, R. Cook, G. Escher, M. Galka, L. Han, C. Heavey, A. Hernandez, D.F. Jacobson, D.S. Jacobson, B. Miranda, G. Novotny, M. Pellat, P. Quach, A. Romano, D. Steward, L. Vogel, S. Wang, H. Wang, L. Willman, and T. Yeskoo. 2014. A roadmap for repowering California for all purposes with wind, water, and sunlight. *Energy*, doi.org/10.1016/j.energy.2014.06.099
- Howarth, R. W., and A. Ingraffea. 2014. Shale gas: Time to go slow. In *World Energy Monitor, World Energy Forum*. United Nations. New York, NY.

- 2013 Howarth, R. W., and J. Mohan (editors). 2013. *Biomes and Ecosystems*. Salem Press. 1,440 pages, ISBN 978-1-4298-3813-9
- Hayn M., R.W. Howarth, R. Marino, N. Ganju, P. Berg, K. Foreman, A.E. Giblin, and K. McGlathery. 2013. Exchange of nitrogen and phosphorus between a shallow lagoon and coastal waters. *Estuaries & Coasts*, 37: 63–73, doi:10.1007/s12237-013-9699-8
- Jacobson M.Z., R.W. Howarth, M.A. Delucchi, S.R. Scobies, J.M. Barth, M.J. Dvorak, M. Klevze, H. Katkhuda, B. Miranda, N.A. Chowdhury, R. Jones, L. Plano, and A.R. Ingraffea. 2013. Examining the feasibility of converting New York State’s all-purpose energy infrastructure to one using wind, water, and sunlight. *Energy Policy* 57: 585-601, doi.org/10.1016/j.enpol.2013.02.036i
- Jacobson, M.Z., R.W. Howarth, M.A. Delucchi, S.R. Scobies, J.M. Barth, M.J. Dvorak, M. Klevze, H. Katkhuda, B. Miranda, N.A. Chowdhury, R. Jones, L. Plano, and A.R. Ingraffea. 2013. Response to comment on paper examining the feasibility of changing New York State's energy infrastructure to one derived from wind, water, and sunlight. *Energy Policy* 62: 1212-1215, doi.org/10.1016/j.enpol.2013.07.105i
- Hong, B., D.P. Swaney, and R.W. Howarth. 2013. Estimating net anthropogenic nitrogen inputs (NANI) to US watersheds: comparison of methodologies. *Environmental Science & Technology* 47: 5199–5207
- Gettel, G., A. Giblin, and R.W. Howarth. 2013. Controls of benthic nitrogen fixation and primary production from nutrient enrichment of oligotrophic, arctic lakes. *Ecosystems*, doi 10.1007/s10021-013-9701-0
- Tartowski, S.L., and R. W. Howarth. 2013. Nitrogen, nitrogen cycle. *Encyclopedia of Biodiversity*, Elsevier.
- Bettez, N., R. Marino, R.W. Howarth, and E.A. Davidson. 2013. Roads as nitrogen deposition hot spots. *Biogeochemistry* 114: 149-163.
- Berg, P., M.H. Long, M. Huettel, J.E. Rheuban, K.J. McGlathery, R.W. Howarth, K.H. Foreman, A.E. Giblin, and R. Marino. 2013. Eddy correlation measurements of oxygen fluxes in permeable sediments exposed to varying current flow and light. *Limnology & Oceanography* 58: 1329-1343.
- Howarth, R. W. 2013. Shale gas extraction. Pages 354-359 in Craig, R.K., B. Pryd, J.C. Nagle, O. Schmitz, and W. Smith (eds.), *The Berkshire Encyclopedia of Sustainability: Vol. 5, Ecosystem management and Sustainability*. Berkshire, Great Barrington, MA.
- 2012 Howarth, R. W., D. Swaney, G. Billen, J. Garnier, B. Hong, C. Humborg, P. Johnes, C. Morth, and R. Marino. 2012. Nitrogen fluxes from large watershed to coastal ecosystems controlled by net anthropogenic nitrogen inputs and climate. *Frontiers in Ecology & Environment* 10: 37-43.
- Howarth, R. W., R. Santoro, and A. Ingraffea. 2012. Venting and leakage of methane from shale gas development: Reply to Cathles et al. *Climatic Change* 113: 537-549, doi:10.1007/s10584-012-0401-0
- Howarth, R. W., D. Shindell, R. Santoro, A. Ingraffea, N. Phillips, and A. Townsend-Small. 2012. Methane emissions from natural gas systems. Background paper prepared for the National Climate Assessment, Reference # 2011-003, Office of Science & Technology Policy Assessment, Washington, DC.
- Hong, B., D. P. Swaney, C. Mörth, E. Smedberg, H. E. Hägg, C. Humborg, R. W. Howarth, and F. al Bouraoui. 2012. Evaluating regional variation of net anthropogenic nitrogen and

- phosphorus inputs (NANI/NAPI), major drivers, nutrient retention pattern and management implications in the multinational areas of Baltic Sea basin. *Ecological Modeling*, 227: 117-135, doi:10.1016/j.ecolmodel.2011.12.002
- Ganju, N.K., M. Hayn, S. Chen, R.W. Howarth, P.J. Dickhudt, A.L. Aretxabaleta, R. Marino. 2012. Tidal and groundwater fluxes to a shallow, microtidal estuary: constraining inputs through field observations and hydrodynamic modeling. *Estuaries and Coasts* 35: 1285-1298** (Winner of the Pritchard Award, Coastal & Estuarine Research Federation for best paper in physical oceanography, 2013).
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- 2011 Howarth, R., W., and A. Ingraffea. 2011. Should fracking stop? Yes, it is too high risk. *Nature* 477: 271-273.
- Howarth, R. W., R. Santoro, and A. Ingraffea. 2011. Methane and the greenhouse gas footprint of natural gas from shale formations. *Climatic Change Letters* 106: 679–690, doi: 10.1007/s10584-011-0061-5** (Cited 1,753 times in other peer-reviewed papers as of June 23, 2022).
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