

## ROBERT W. HOWARTH

Department of Ecology and Evolutionary Biology  
Corson Hall, Cornell University  
Ithaca, NY 14853-2701 USA

<http://www.eeb.cornell.edu/howarth/>  
e-mail: [howarth@cornell.edu](mailto:howarth@cornell.edu)  
Tel.: (1)-607-255-6175

### *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.
2009	Visiting Professor, Institute of Pierre and Marie Curie, University of Paris
2000-Present	Adjunct Senior Scientist, Marine Biological Laboratory, Woods Hole.
1983-Present	Founding Editor, <i>Biogeochemistry</i> (Editor-in-Chief, 1983-2004).
2010-2012	Director, Agriculture, Energy, & Environment Program, Cornell University
2005-2009	Director, Agricultural Ecosystems Program, Cornell University.
2000-2001	Oceans Program Director and Senior Scientist, Environmental Defense Fund.
1995-2000	Director, Program in Biogeochemistry & Environmental Change, Cornell.
1992-1995	Senior Fellow, and coordinator for the Initiative in Earth, Atmospheric, & Aquatic Sciences, Center for the Environment, Cornell University.
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.

### *National and International Committees and Activities*

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-Present	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, U.S. EPA
1997	Member, Panel on Non-Point Source Pollution, Ecological Soc. of America.
1996	Member, Panel on Human Alteration of the N Cycle, Ecol. Soc. of America.
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.

### ***Recent Awards and Honors (since 2000)***

Recognized as the David Schindler Visiting Scholar, Trent University (2013).  
Received the Pritchard Award for the best physical oceanography paper published in *Estuaries and Coasts* in 2011 and 2012 (with 6 other co-authors)  
Named one of Time Magazine's 50 "People Who Mattered," 2011 Person of the Year issue.  
Awarded the Zayed International Prize for the Environment (2007), jointly with the other lead authors of the Millennium Ecosystem Assessment.  
Presented invited briefing on coastal water quality at the White House to the President's Science Advisor and staff of the Office of Science and Technology Policy (2006).  
Selected by ISI Web of Science (Scientific Citation Index) as one of 250 most cited scientists globally in ecology and environmental science disciplines (2006, 2007, 2008, 2009, 2010, 2011, and 2012).  
Appointed to "Biology Faculty of 1,000" (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013).  
Received the Lindeman Award in Ecology, University of Minnesota (2003).  
Selected as an Aldo Leopold Leadership Fellow, Ecological Society of America (2000).  
Recognized as "Eminent Ecologist," Kellogg Biological Station, Michigan State Univ. (2000).

### ***Publications:***

- 2013 Begon, M., R. W. Howarth, and C. Townsend. 2013. *Essentials of Ecology*, 4<sup>th</sup> Edition. Wiley, in press.
- Howarth, R. W., and J. Mohan (editors). 2013. *Biomes and Ecosystems*. Salem Press. 1,440 pages, ISBN 978-1-4298-3813-9
- Howarth, R. W., and A. Ingraffea. 2013. Shale gas: Time to go slow. *World Energy Monitor*, World Energy Forum. United Nations. New York, NY. In press.
- Howarth, R.W., M. Hayn, R.M. Marino, K. Foreman, P. Berg, A.E. Giblin, K. McGlathery, and D. Walker. 2013. Metabolism of a nitrogen-enriched coastal marine lagoon during the summertime. *Biogeochemistry* DOI 10.1007/s10533-013-9901-x
- Hayn M, Howarth RW, Marino R, Ganju N, Berg P, Foreman PB, Giblin AE, and McGlathery K. 2013. Exchange of nitrogen and phosphorus between a shallow lagoon and coastal waters. *Estuaries & Coasts* 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*, 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*. 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, in press.
- 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* 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.  
<http://www.eeb.cornell.edu/howarth/Howarth%20et%20al.%20--%20National%20Climate%20Assessment.pdf>
- 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*, 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.
- Swaney, D. P., B. Hong, C. Ti, R. W. Howarth, and C. Humborg. 2012. Net anthropogenic nitrogen inputs to watersheds and a riverine N export to coastal waters: a brief overview. *Current Opinion in Environmental Sustainability* 4: 1-9.
- Swaney, D.P., R.L. Santoro, R. W. Howarth, B. Hong, and K. Donaghy. 2012. Historical changes in the food and water supply systems of the New York City metropolitan area. *Regional Environmental Change*, doi 10.1007/s10113-011-0266-1
- Davidson, E. A., M. B. David, J. N Galloway, C. L. Goodale, R. Haeuber, J. A. Harrison, R. W. Howarth, D. B. Jayne, R. R. Lowrance, B. T. Nolan, J. L. Peel, R. W. Pinder, E. Porder, C. S Snyder, A. R. Townsend, and M. H. Ward. 2012. Excess nitrogen in the U.S. environment: Trends, risks, and solution. *Issues in Ecology*, report #15, Ecological Society of America.
- 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*, doi: 10.1007/s10584-011-0061-5
- Santoro, R., R. W. Howarth, and A. Ingraffea. 2011. Indirect emissions of carbon dioxides from Marcellus shale gas development. A technical report of the Agriculture, Energy, and Environment Program at Cornell University. [http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment\\_June302011%20.pdf](http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment_June302011%20.pdf)
- Howarth, R. W., G. Billen, F. Chan, D. Conley, S. C. Doney, J. Garnier, and R. Marino. 2011. Coupled biogeochemical cycles: Eutrophication and hypoxia in coastal marine ecosystems. *Frontiers in Ecology & Environment* 9: 18-26.
- Billen, G., M. Silvestre, B. Grizzetti, A. Leip, J. Garnier, M. Voss, R. Howarth, F. Bouraoui, H. Behrendt, A. Lepisto, P. Kortelainen, P. Johnes, C. Curtis, C. Humborg, E. Smedberg, O. Kaste, R. Ganeshram, A. Beusen, & C. Lancelot. 2011. Nitrogen flows from European regional watersheds to coastal marine waters. Pages 271 -297 in M.A. Sutton et al. (editors), *The European Nitrogen Assessment: Sources, Effects, and Policy Perspectives*. Cambridge University Press.
- Grizzetti, B., F. Bouraoui, G. Billen, H. van Grinsven, A. Cardoso, V. Thieu, J. Garnier, C. Curtis, R. Howarth, and P. Johnes. 2011. Nitrogen as a threat to European water quality. Pages 379 – 404 in M.A. Sutton et al. (editors), *The European Nitrogen Assessment: Sources, Effects, and Policy Perspectives*. Cambridge University Press.
- Hong, B., D. Swaney, and R. W. Howarth. 2011. A toolbox for calculating net anthropogenic nitrogen inputs (NANI). *Environmental Modeling and Software* 26: 623–33.
- McLenaghan, N. A., A. C. Tyler, U. H. Mahl, R. W. Howarth, and R. M. Marino. 2011. Benthic macroinvertebrate functional diversity regulates nutrient and algal dynamics in a shallow estuary. *Mar. Ecol. Progr. Ser.* 426: 171-184.
- Baojing Gu, Yimei Zhu, Jie Chang, Chanhui Peng, Dong Liu, Yong Min, Weidong Luo, R. W. Howarth, and Y. Ge. 2011. The role of technology and policy in mitigating regional nitrogen pollution. *Env. Res. Letters* 6: 014011. doi:10.1088/1748-9326/6/1/014011
- 2010 Townsend, A. & R. W. Howarth. 2010. Human acceleration of the global nitrogen cycle. *Scientific American* 302: 32-39
- Howarth, R. W. 2010. Solutions to environmental challenges: Nitrogen cycle. *Scientific American* 302 (#4, April 2010): 38.
- Johnson, P. T. J., A. R. Townsend, C. C. Cleveland, P. M. Glibert, R. W. Howarth, V. J. McKenzie, E. Rejmankova, and M. H. Ward. 2010. Linking environmental nutrient enrichment and disease emergence in humans and wildlife. *Ecological Applications* 20: 16-29.
- Howarth, R. W. 2010. Celebrating 100 volumes. *Biogeochemistry* 100: 1-2.
- Naijar, R., C. R. Pyke, M. B. Adams, D. Breitburg, C. Hershner, M. Kemp, R. Howarth, M. R. Mulholland, M. Paolisso, D. Secor, K. Sellner, D. Wardrop and R. Wood. 2010. Potential climate-change impacts on the Chesapeake Bay. *Estuarine and Coastal Shelf Science* 86: 1-20.
- Dale, V. H., C. L. Kling, J. L. Meyer, J. Sanders, H. Stallworth, T. Armitage, D. Wangsness, T. Bianchi, A. Blumber, W. Boynton, D. J. Conley, W. Crumpton, M. David, D. Gilbert, R. W. Howarth, R. Lowrance, K. Mankin, J. Opaluch, H. Paerl, K. Reckhow, A. N. Sharpley, T. W.

- Simpson, C. S. Snyder, and D. Wright. 2010. Hypoxia in the Northern Gulf of Mexico. 284 pages. Springer.
- Davidson, E. A., K. E. Savage, N. D. Bettez, R. Marino, and R. W. Howarth. 2010. Nitrogen in runoff from residential roads in a coastal area. *Water Air Soil. Pollut.* 210: 3-13.
- 2009 Conley, D. J, H. W. Paerl, R. W. Howarth, D. F. Boesch, S. P. Seitzinger, K. E. Havens, C. Lancelot, & G. E. Likens. 2009. Controlling eutrophication: Nitrogen and phosphorus. *Science* 323: 1014-1015.
- Conley, D. J, H. W. Paerl, R. W. Howarth, D. F. Boesch, S. P. Seitzinger, K. E. Havens, C. Lancelot, & G. E. Likens. 2009. Reply to comments on “controlling eutrophication: nitrogen and phosphorus.” *Science* 324: 724-725.
- Boesch, D., W. Boynton, L. Crowder, R. Diaz, R. Howarth, L. Mee, S. Nixon, N. Rabalais, R. Rosenberg, J. Sanders, D. Scavia, and R. Turner. 2009. Nutrient enrichment drives Gulf of Mexico hypoxia. *Eos* 90: 117-128.
- Bringezu, S., H. Schutz, M. O’Brien, L. Kauppi, R. Howarth, and J. McNeely. 2009. Towards Sustainable Production and Use of Resources: Assessing Biofuels. International Panel for Sustainable Resource Management, United Nations Environment Program, Paris, France (<http://www.unep.fr/scp/rpanel/biofuels.htm>).
- Howarth, R. W., and S. Bringezu (eds). 2009. Biofuels: Environmental Consequences and Interactions with Changing Land Use. Proceedings of the International SCOPE Biofuels Project Rapid Assessment, International Council of Science (<http://cip.cornell.edu/biofuels/>)
- Howarth, R.W., S. Bringezu, M. Bekunda, C. de Fraiture, L. Maene, L. Martinelli, O. Sala. 2009. Rapid assessment on biofuels and environment: Overview and key findings. Pages 1-13 in R.W. Howarth and S. Bringezu (eds), Biofuels: Environmental Consequences and Interactions with Changing Land Use. Proceedings of the International SCOPE Biofuels Project Rapid Assessment, International Council of Science (<http://cip.cornell.edu/biofuels/>)
- Howarth, R.W., S. Bringezu, L.A. Martinelli, R. Santoro, D. Messer, O.E. Sala. 2009. Introduction: biofuels and the environment in the 21st century. Pages 15- 36, in R.W. Howarth and S. Bringezu (eds) Biofuels: Environmental Consequences and Interactions with Changing Land Use. Proceedings of the International SCOPE Biofuels Project Rapid Assessment, International Council of Science (<http://cip.cornell.edu/biofuels/>)
- Simpson, T.W., L.A. Martinelli, A.N. Sharpley, R.W. Howarth. 2009. Impact of ethanol production on nutrient cycles and water quality: the United States and Brazil as case studies. Pages 153-167 in R.W. Howarth and S. Bringezu (eds) Biofuels: Environmental Consequences and Interactions with Changing Land Use. Proceedings of the International SCOPE Biofuels Project Rapid Assessment, International Council of Science (<http://cip.cornell.edu/biofuels/>)
- Howarth R. 2009. Nitrogen. Pages 57-64 in Gene E. Likens (ed.), Encyclopedia of Inland Waters, Volume 2. Elsevier, Oxford.
- Marino, R. & R. W. Howarth. 2009. Nitrogen fixation. Pages 65-72 in G. E. Likens (ed.), Encyclopedia of Inland Waters. Elsevier, Oxford.
- Townsend, A. R., L. A. Martinelli, & R. W. Howarth. 2009. The global nitrogen cycle, biodiversity, and human health. Pages 159-178 in O. E. Sala, L. A. Meyerson, & C. Parmeson. Biodiversity Change and Human Health. SCOPE #69. Island Press, Washington.
- Entringer, R., and R. Howarth. 2009. Workshop on Atmospheric Deposition of Nitrogen -- Chesapeake Bay Program Science and Technical Advisory Committee. January 8, 2009.

STAC Publication 09-001.

(<http://www.chesapeake.org/stac/Pubs/atmosphericnitrogen.report.pdf>)

- 2008 Howarth, R. W. & H. Paerl. 2008. Coastal marine eutrophication: Control of both nitrogen and phosphorus is necessary. *Proceedings of National Academy of Sciences* 105: E104
- Howarth, R. W. 2008. Coastal nitrogen pollution: A review of sources and trends globally and regionally. *Harmful Algae* 8: 14-20.
- Boyer, E. W., and R. W. Howarth. 2008. Nitrogen fluxes from rivers to the coastal oceans. Pages 1565-1587 in D. Capone, D. A. Bronk, M. R. Mulholland & E. J. Carpenter (eds.), *Nitrogen in the Marine Environment*, 2<sup>nd</sup> Edition, Elsevier, Oxford.
- Swaney, D. P., D. Scavia, R. W. Howarth, & R. M. Marino. 2008. Estuarine classification and response to nitrogen loading: Insights from simple ecological models. *Estuarine, Coastal & Shelf Science* 77: 253-263.
- Simpson, T. W., A. N. Sharpley, R. W. Howarth, H. W. Paerl & K. R. Mankin. 2008. The new gold rush: Fueling ethanol production while protecting water quality. *Journal of Environmental Quality* 37: 318-324.
- Glibert, P.A., R. Azanza, M. Burford, K. Furuya, E. Abal, A. Al-Azri, F. Al-Yamani, P. Andersen, D. Anderson, J. Beardall, G. M. Berg, L. Brand, D. Bronk, J. Brookes, J. M. Burkholder, A. Cembella, W. P. Cochlan, J. L. Collier, Y. Collos, R. Diaz, R. Doblin, T. Drennen, S. Dyhrman, Y. Fukuyo, M. Furnas, J. Galloway, E. Granéli, Dao Viet Ha, G. Hallegraeff, J. Harrison, P. J. Harrison, C. A. Heil, K. Heimann, R. Howarth, C. Jauzein, A. Kana, T. M. Kana, H. Kim, R. Kudela, C. Legrand, M. Mallin, M. Mulholland, S. Murray, J. O'Neil, G. Pitcher, Yuzao Qi, N. Rabalais, R. Raine, S. Seitzinger, P. S. Salomon, C. Solomon, D. K. Stoecker, G. Usup, J. Wilson, Kedong Yin, Mingjiang Zhou & Mingyuan Zhu. 2008. Ocean urea fertilization for carbon credits poses high ecological risks. *Marine Pollution Bulletin* 56: 1049-1056.
- Pyke, C. R., R. G. Najjar, M. B. Adams, D. Breitburg, M. Kemp, C. Hershner, R. Howarth, M. Mulholland, M. Paolisso, D. Secor, K. Sellner, D. Wardrop, and R. Wood. 2008. Climate change and the Chesapeake Bay: State-of-the-science review and recommendations. A report of the Chesapeake Bay Program Science and Technical Advisory Committee (STAC), Annapolis, MD. 59 pages.
- Howarth, R. W. 2008. How important is atmospheric deposition as a source of nitrogen to coastal marine ecosystems in the northeastern United States? Pages 47-65 in A. Desbonnet and B. A Cost-Pierce (eds.), *Science of Ecosystem-Based Management*. Springer, NY.
- 2007 Davidson, E. & R. W. Howarth. 2007. Nutrients in synergy. *Nature* 449: 1000-1001.
- Gittel, G. M., A. E. Giblin, & R. W. Howarth. 2007. The effect of grazing by the snail, *Lymnae elodes*, on benthic N<sub>2</sub> fixation and primary production in oligotrophic, Arctic lakes. *Limnology & Oceanography* 52: 2398-2409.
- Hambright, D., N. G. Hairston, Jr., W. R. Schaffner, & R. W. Howarth. 2007. Grazer control of nitrogen fixation: Synergisms in the feeding ecology of two freshwater crustaceans. *Fundamental and Applied Limnology/Archiv fur Hydrobiologie* 170: 89-101.
- Hambright, D., N. G. Hairston, Jr., W. R. Schaffner, & R. W. Howarth. 2007. Grazer control of nitrogen fixation: Phytoplankton taxonomic composition and ecosystem functioning. *Fundamental and Applied Limnology/Archiv fur Hydrobiologie* 170: 103-124.

- Turner, R. E., N. N. Rabalais, R. B. Alexander, G. McIsaac, & R. W. Howarth. 2007. Characterization of nutrient and organic matter loads from the Mississippi River into the northern Gulf of Mexico. *Estuaries & Coasts* 30: 773-790.
- 2006 Howarth, R. W. & R. Marino. 2006. Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: Evolving views over 3 decades. *Limnol. Oceanogr.* 51: 364-376.
- Martinelli, L. & R. W. Howarth (eds.). 2006. Nitrogen Cycling in the Americas: Natural and Anthropogenic Influences and Controls. Springer, Dordrecht. 427 pages.
- Howarth, R. W., E. W. Boyer, R. Marino, D. Swaney, N. Jaworski, & C. Goodale. 2006. The influence of climate on average nitrogen export from large watersheds in the northeastern United States. *Biogeochemistry* 79: 163-186.
- Chapin, F. S. III, G.M Woodwell, J. Randerson, G. Lovett, D. Baldocchi, D. A. Clark, M.E. Harmon, E. Rastetter, D. Schimel, R. Valentini, C. Wirth, J. Cole, M. Goulden, J. Harden, M. Heimann, R. Howarth, P. Matson, A.D. McGuire, J. Melillo, H. Mooney, J. Neff, R. Houghton, M. Pace, M.G. Ryan, S. Running, O. Sala, W. Schlesinger & D. Schulze. 2006. Reconciling carbon cycle concepts, terminology, and methods. *Ecosystems* 9: 1041-1050.
- Martinelli, L. A, R. W. Howarth, E. Cuevas, S. Filoso, A. T. Austin, L. Donos, V. Huzsar, D. Keeney, L. L. Lara, C. LLerena, G. McIssac, E. Medina, J. Ortiz-Zaya, D. Scavia, D. W. Schindler, D. Soto & A. Townsend. 2006. Sources of reactive nitrogen affecting ecosystems in Latin America and the Caribbean: Current trends and future perspectives. *Biogeochemistry* 79: 3-234.
- Filoso, S., L. Martinelli, R. W. Howarth, E. W. Boyer & F. Dentener. 2006. Human activities changing the N cycle in Brazil. *Biogeochemistry* 79: 61-89.
- Marino, R., F. Chan, R. W. Howarth, M. L. Pace & G. E. Likens. 2006. Experimental tests of ecological constraints on planktonic nitrogen fixation in saline estuaries: 1. Nutrient and trophic controls. *Marine Ecology Progress Series* 309: 25-39.
- Chan, F., R. Marino, R., R. W. Howarth & M. L. Pace. 2006. Experimental tests of ecological constraints on planktonic nitrogen fixation in saline estuaries: 2. Mechanisms of trophic control. *Marine Ecology Progress Series* 309: 41-53.
- Joye, S. B., V. H. Smith, R. W. Howarth, R. W. Bachmann, J. E. Cloern, R. E. Hecky, & D. W. Schindler (editors). 2006. Eutrophication of Freshwater and Marine Ecosystems. *Limnol. Oceanogr.* (special issue), Vol. 51, number 1, part 2.
- Roberts, B. J. & R. W. Howarth. 2006. Nutrient and light availability regulate the relative contribution of autotrophs and heterotrophs to respiration in freshwater pelagic ecosystems. *Limnol. Oceanogr.* 51: 288-295.
- Howarth, R. W., R. Marino, D. P. Swaney & E. W. Boyer. 2006. Wastewater and watershed influences on primary productivity and oxygen dynamics in the lower Hudson River estuary. Pages 121-139 in J. S. Levinton & J. R. Waldman (eds.), *The Hudson River Estuary*, Cambridge Univ. Press.
- Howarth, R. W. 2006. Atmospheric deposition and nitrogen pollution in coastal marine ecosystems. Pages 97-116 in G. R. Visgilio & D. M. Whitelaw (eds.), *Acid in the Environment: Lessons Learned and Future Prospects*. Springer, NY.
- Boyer, E. W., R. W. Howarth., J. Galloway, F. J. Dentener, P. A. Green & C. A. Vorosmarty. 2006. Riverine nitrogen export from the continents to the coasts. *Global Biogeochemical Cycles* 20, No. 1, GB1S91, 10.1029/2005GB002537

- 2005 Howarth, R. W., K. Ramakrishna, E. Choi, R. Elmgren, L. Martinelli, A. Mendoza, W. Moomaw, C. Palm, R. Boy, M. Scholes & Zhu Zhao-Liang. 2005. Chapter 9: Nutrient Management, Responses Assessment. Pages 295-311 in *Ecosystems and Human Well-being, Volume 3, Policy Responses*, the Millennium Ecosystem Assessment. Island Press, Washington, DC.
- Howarth, R. W. 2005. The development of policy approaches for reducing nitrogen pollution to coastal waters of the USA. *Science in China, Ser. C Life Sciences* 48: 791-806
- 2004 Boyer, E. W., R. W. Howarth, J. N. Galloway, F. J. Dentener, C. Cleveland, G. P. Asner, P. Greene, and C. Vorosmarty. 2004. Current nitrogen inputs to world regions. Pages 221-230 in A. R. Mosier, J. K. Syers & J. R. Freney (eds.), *Agriculture and the Nitrogen Cycle*. SCOPE #65. Island Press, Washington, DC.
- Galloway, J. N., F. J. Dentener, D. G. Capone, E. W. Boyer, R. W. Howarth, S. P. Seitzinger, G. P. Asner, C. Cleveland, P. A. Green, E. Holland, D. M. Karl, A. Michaels, J. H. Porter, A. Townsend & C. Vorosmarty. 2004. Nitrogen cycles: past, present, and future. *Biogeochemistry* 70: 153-226.
- Chan, F. M. Pace, R.W. Howarth & R. Marino. 2004. Bloom formation in heterocystic nitrogen-fixing cyanobacteria: The dependence of colony size and zooplankton grazing. *Limnol. Oceanogr.* 49: 2171-2178.
- David, M. B., G. F. McIsaac, R. W. Howarth, C. L. Goodale, & L. E. Drinkwater.. 2004. Fertilizer: Complex Issue Calls for Informed Debate. *Nature* 427: 99.
- 2003 Howarth, R. W., R. Marino & D. Scavia. 2003. Priority Topics for Nutrient Pollution in Coastal Waters: An Integrated National Research Program for the United States. National Ocean Service, NOAA, Silver Spring, MD.
- Townsend, A. R., R. Howarth, F. A. Bazzaz, M. S. Booth, C. C. Cleveland, S. K. Collinge, A. P. Dobson, P. R. Epstein, E. A. Holland, D. R. Keeney, M. A. Mallin, C. A. Rogers, P. Wayne & A. H. Wolfe. 2003. Human health effects of a changing global nitrogen cycle. *Frontiers in Ecology & Environment* 1: 240-246.
- Galloway, J. N., J. D. Aber, J. W. Erisman, S. P. Seitzinger, R. H. Howarth, E. B. Cowling & B. J. Cosby. 2003. The nitrogen cascade. *BioScience* 53: 341-356.
- Marino, R., R. W. Howarth, F. Chan, J. J. Cole & G. E. Likens. 2003. Sulfate inhibition of molybdenum-dependent nitrogen fixation by planktonic cyanobacteria under seawater conditions: a non-reversible effect. *Hydrobiologia* 500: 277-293.
- Howarth, R. W. 2003. Human acceleration of the nitrogen cycle: Drivers, consequences, and steps towards solutions. *Water Science and Technology* 49: 7-13.
- Austin, A., R. W. Howarth, J. S. Baron, F. S. Chapin, T. R. Christensen, E. A. Holland, M. V. Ivanov, A. Y. Lein, L. Z. Martinelli, J. M. Melillo, and Chao Shang. 2003. Human disruption of element interactions: Drivers, consequences, and trends for the 21<sup>st</sup> Century. Pages 15-45 in Melillo, J. M., C. B. Field & B. Moldan (eds.), *Interactions of the major Biogeochemical Cycles: Global Change and Human Impacts*. SCOPE #61. Island Press, Washington, DC.
- Howarth, R. W. 2003. Coastal ecosystems. Pages 65-74 in J. C. White & J. Teninko (eds.), *Acid Rain: Are the Problems Solved?* American Fisheries Society Trends in Fisheries Science and Management 2, Bethesda, MD.
- Howarth, R. W. & D. M. Rielinger. 2003. Nitrogen from the atmosphere: Understanding and reducing a major cause of degradation of our coastal waters. Science and policy bulletin #8, Waquoit Bay National Estuarine Research Reserve, NOAA.

- 2002 Howarth, R. W., E. W. Boyer, W. J. Pabich & J. N. Galloway. 2002. Nitrogen use in the United States from 1961-2000 and potential future trends. *Ambio* 31: 88-96.
- Howarth, R. W., D. Walker & A. Sharpley. 2002. Sources of nitrogen pollution to coastal waters of the United States. *Estuaries* 25: 656-676.
- Howarth, R. W. 2002. Nutrient over-enrichment of coastal waters in the United States: Steps toward a solution. Pew Oceans Commission, Washington, DC.
- Howarth, R. W. 2002. The nitrogen cycle. Pages 429-435 in H. A. Mooney and J. G. Canadell (eds.), *Encyclopedia of Global Environmental Change*. Vol. 2, the Earth System: Biological and Ecological Dimensions of Global Environmental Change. Wiley, Chichester.
- Marino, R., F. Chan, R. Howarth, M. Pace & G. Likens. 2002. Ecological and biogeochemical interactions constrain planktonic nitrogen fixation in estuaries. *Ecosystems* 5: 719-725.
- Scavia, D., J. C. Field, Boesch, R. Buddemeier, V. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. W. Howarth, C. Mason, D. J. Reed, T. C. Royer, A. H. Sallenger & J. G. Titus. 2002. Climate change impacts on US coastal and marine ecosystems. *Estuaries* 25: 149-164.
- Boyer, E. W. & R. W. Howarth (eds.). 2002. *Global and Regional Synthesis of the Nitrogen Cycle*. Kluwer, Dordrecht. 519 pages.
- Vitousek, P. M., K. Cassman, C. Cleveland, T. Crews, C. B. Field, N. B. Grimm, R. W. Howarth, R. Marino, L. Martinelli, E. B. Rastetter & J. I. Sprent. 2002. Towards an ecological understanding of biological nitrogen fixation. *Biogeochemistry* 57&58: 1-45.
- Van Breemen, N., E. W. Boyer, C. L. Goodale, N. A. Jaworski, K. Paustian, S. Seitzinger, K. Lajtha, B. Mayer, D. van Dam, R. W. Howarth, K. J. Nadelhoffer, M. Eve & G. Billen. 2002. Where did all the nitrogen go? Fate of nitrogen inputs to large watersheds in the northeastern USA. *Biogeochemistry* 57&58: 267-293.
- Seitzinger, S. P., R. V. Styles, E. W. Boyer, R. Alexander, G. Billen, R. Howarth, B. Mayer & N. van Breemen. 2002. Nitrogen retention in rivers: model development and application to watersheds in the northeastern US. *Biogeochemistry* 57&58: 199-237.
- Boyer, E. W., C. L. Goodale, N. A. Jaworski & R. W. Howarth. 2002. Anthropogenic nitrogen sources and relationships to riverine nitrogen export in the northeastern USA. *Biogeochemistry* 57&58: 137-169.
- Mayer, B., E. Boyer, C. Goodale, N. Jaworski, N. van Breemen, R. Howarth, S. Seitzinger, G. Billen, K. Lajtha, K. Nadelhoffer, D. van Dam., L. J. Hetling, M. Nosal & K. Paustian. 2002. Sources of nitrate in rivers draining sixteen watersheds in the northeastern US: Isotopic constraints. *Biogeochemistry* 57&58: 171-197.
- Barron, S., C. F. Weber, R. Marino, E. A. Davidson, G. Tomasky, and R. W. Howarth. 2002. Effects of varying salinity on phytoplankton growth in a low-salinity coastal pond under two nutrient conditions. *Biological Bulletin* 203: 260-261.
- Weber, C. F., S. Barron, R. Marino, R. W. Howarth, G. Tomasky, and E. A. Davidson. Nutrient limitation of phytoplankton growth in Vineyard Sound and Oyster Pond, Falmouth, Massachusetts. *Biological Bulletin* 203: 261-263.
- 2001 Tilman D., J. Fargione, B. Wolff, C. D'Antonio, A. Dobson, R.W. Howarth, D. Schindler, W. Schlesinger, D. Simberloff & D. Swackhamer. 2001. Forecasting agriculturally driven global environmental change. *Science* 292: 281-284.
- Howarth, R. W. 2001. Hypoxia, fertilizer, and the Gulf of Mexico. *Science* 292: 1485-1486.

- 2000 Howarth, R. W., D. Anderson, J. Cloern, C. Elfring, C. Hopkinson, B. Lapointe, T. Malone, N. Marcus, K. McGlathery, A. Sharpley & D. Walker. 2000. Nutrient pollution of coastal rivers, bays, and seas. *Issues in Ecology* 7: 1-15.
- Howarth, R. W., D. Swaney, T. J. Butler & R. Marino. 2000. Climatic control on eutrophication of the Hudson River estuary. *Ecosystems* 3: 210-215.
- Tartowski, S. & R. W. Howarth. 2000. Nitrogen, nitrogen cycling. *Encyclopedia of Biodiversity*. 4: 377-388.
- Sala, O., R. Jackson, H. Mooney, and R. W. Howarth (eds.). 2000. *Methods in Ecosystem Science*, Springer, NY. 430 pages.
- Howarth, R.W. & A. F. Michaels. 2000. The measurement of primary production in aquatic ecosystems. Pages 72-85 in: O. Sala, R. Jackson, H. Mooney, and R. W. Howarth (eds.), *Methods in Ecosystem Science*, Springer, NY.
- Howarth, R. W., N. Jaworski, D. Swaney, A. Townsend & G. Billen. 2000. Some approaches for assessing human influences on fluxes of nitrogen and organic carbon to estuaries. Pages 17-41 in: J. E. Hobbie (ed.), *Estuarine Synthesis: The Next Decade*. Island Press, Washington, DC.
- Fisher, T. R., D. Correll, R. Costanza, J. T. Hollibaugh, C. S. Hopkinson, R. W. Howarth, N. N. Rabalais, J. E. Richey, C. Vorosmarty & R. Wiegert. 2000. Synthesizing drainage basin inputs to coastal systems. Pages 81-101 in: J. E. Hobbie (ed.), *Estuarine Synthesis: The Next Decade*. Island Press, Washington, DC.
- Howarth, R. W. 2000. Review of "Estuary restoration and maintenance: the National Estuary Program" *Limnology & Oceanography*. 45: 1889.
- 1999 Howarth, R.W., F. Chan & R. Marino. 1999. Do top-down and bottom-up controls interact to exclude nitrogen-fixing cyanobacteria from the plankton of estuaries: explorations with a simulation model. *Biogeochemistry* 46: 203-231.
- Downing, J. A., M. McClain, R. Twilley, J. M. Melack, J. Elser, N. N. Rabalais, W. M. Lewis, R. E. Turner, J. Corredor, D. Soto, A. Yanez-Arancibia & R. W. Howarth. 1999. The impact of accelerating land-use change on the nitrogen cycle of tropical aquatic ecosystems: Current conditions and projected changes. *Biogeochemistry* 46: 109-148.
- Corredor, J.E., R. W. Howarth, R. R. Twilley & J. M. Morell. Nitrogen cycling and anthropogenic impact in the tropical inter-American seas. *Biogeochemistry* 46: 163-178.
- Howarth, R. W. & R. Marino. 1999. Oil spills: Containment and clean-up. Pages 456-458 in D. E. Alexander & R. W. Fairbridge (eds.), *Encyclopedia of Environmental Science*. Kluwer, Dordrecht.
- Swaney, D. P., R. W. Howarth & T. J. Butler. 1999. A novel approach for estimating ecosystem production and respiration in estuaries: application to the oligohaline and mesohaline Hudson River estuary. *Limnol. Oceanogr.* 44: 1509-1521.
- Cleveland, C. C., A. R. Townsend, D. S. Schimel, H. Fisher, R. W. Howarth, L. O. Hedin, S. S. Perakis, E. F. Latty, J. C. von Fischer, A. Elseroad & M. F. Wasson. 1999. Global patterns of terrestrial biological nitrogen (N<sub>2</sub>) fixation in natural systems. *Global Biogeochemical Cycles* 13: 623-645.
- 1998 Howarth, R. W. & R. Marino. 1998. A mechanistic approach to understanding why so many estuaries and brackish waters are nitrogen limited. In: *Effects of Nitrogen in the Aquatic*

- Environment (pages 117-136), KVA Report 1998: 1, Kungl. Vetenskapsakademien (Royal Swedish Academy of Sciences), Stockholm.
- Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley & V. H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications* 8: 559-568.
- Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley & V. H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. *Issues in Ecology* 3: 1-12.
- Sherman, R. E., T. J. Fahey & R. W. Howarth. 1998. Soil-plant interactions in a neotropical mangrove forest: iron, phosphorous, and sulfur dynamics. *Oecologia* 115: 553-563.
- Jensen, H. S., K. J. McGlathery, R. Marino & R. W. Howarth. 1998. Forms and availability of sediment phosphorus in carbonate sand of Bermuda seagrass beds. *Limnol. Oceanogr.* 43: 799-810.
- Howarth, R. W. 1998. An assessment of human influences on inputs of nitrogen to the estuaries and continental shelves of the North Atlantic Ocean. *Nutrient Cycling in Agroecosystems* 52: 213-223.
- Breitburg, D. L., J. Baxter, C. Hatfield, T. W. Howarth, C. G. Jones, G. M. Lovett & C. Wigand. 1998. Understanding effects of multiple stressors: Ideas and challenges. Pages 416-431 in M. Pace and P. Groffman (eds.), *Success, Limitations, and Frontiers in Ecosystem Science*, Springer, NY.
- 1997 Vitousek, P.M., J. Aber, S. E. Bayley, R. W. Howarth, G. E. Likens, P. A. Matson, D. W. Schindler, W. H. Schlesinger & G. D. Tilman. 1997. Human alteration of the global nitrogen cycle: Causes and consequences. *Issues in Ecology* 1: 1-15.
- Vitousek, P.M., J. Aber, S. E. Bayley, R. W. Howarth, G. E. Likens, P. A. Matson, D. W. Schindler, W. H. Schlesinger & G. D. Tilman. 1997. Human alteration of the global nitrogen cycle: Causes and consequences. *Ecological Applications* 7: 737-750.
- Jaworski, N. A., R. W. Howarth & L.J. Hetling. 1997. Atmospheric deposition of nitrogen oxides onto the landscape contributes to coastal eutrophication in the northeast US. *Environmental Science & Technology* 31: 1995-2004.
- Moore, M. H., M. Pace, J. Mather, P. S. Murdoch, R. W. Howarth, C. L. Folt, C. Y. Chen, H. F. Hemond, P. A. Flebbe & C. T. Driscoll. 1997. Potential effects of climate change on the freshwater ecosystems of the New England/mid-Atlantic region. *Water Resources* 11: 925-947.
- 1996 Jaworski, N. A. & R. W. Howarth. 1996. Preliminary estimates of the pollutant loads and fluxes into the northeast shelf LME. Pages 351-357 in K. Sherman, N. A. Jaworski & T. J. Smayda (eds.), *The Northeast Shelf Ecosystem: Assessment, Sustainability, and Management*. Blackwell, Cambridge, MA.
- Howarth, R. W., G. Billen, D. Swaney, A. Townsend, N. Jarworski, K. Lajtha, J. A. Downing, R. Elmgren, N. Caraco, T. Jordan, F. Berendse, J. Freney, V. Kueyarov, P. Murdoch & Zhu Zhao-liang. 1996. Riverine inputs of nitrogen to the North Atlantic Ocean: Fluxes and human influences. *Biogeochemistry* 35: 75-139.
- Galloway, J., R. W. Howarth, J. Prospero, S. Nixon & A. Michaels. 1996. Summary of the nitrogen cycle for the North Atlantic Ocean and its watersheds and airshed. *Biogeochemistry* 35: 3-25.

- Howarth, R. W. (ed.). 1996. Nitrogen Cycling in the North Atlantic Ocean and its Watersheds. Kluwer Academic, Dordrecht. 304 pages.
- Howarth, R. W., R. Schneider & D. Swaney. 1996. Metabolism and organic carbon fluxes in the tidal, freshwater Hudson River. *Estuaries* 19: 848-865.
- Swaney, D. P., D. Sherman & R. W. Howarth. 1996. Modeling water, sediment, and organic carbon discharges in the Hudson-Mohawk Basin: Coupling to terrestrial sources. *Estuaries* 19: 833-847.
- 1995 Howarth, R. W., H. Jensen, R. Marino & H. Postma. 1995. Transport to and processing of phosphorus in near-shore and oceanic waters. Pages 323-345 in H. Tiessen (ed.), Phosphorus in the Global Environment, SCOPE #54. Wiley & Sons, Chichester.
- Fisher, T. R., J. M. Melack, J. U. Grobbelaar & R. W. Howarth. 1995. Nutrient limitation of phytoplankton and eutrophication of inland, estuarine, and marine waters. Pages 301-322 in H. Tiessen (ed.), Phosphorus in the Global Environment, SCOPE #54. Wiley & Sons, Chichester.
- Howarth, R. W., D. Swaney, R. Marino, T. Butler & C. R. Chu. 1995. Turbulence does not prevent nitrogen fixation by plankton in estuaries and coastal seas (reply to the comment of Paerl et al.). *Limnol. Oceanogr.* 40: 639-643.
- 1994 McGlathery, K. J., R. Marino & R. W. Howarth. 1994. Variable rates of phosphate uptake by shallow marine sediments: Mechanisms and ecological significance. *Biogeochemistry* 25: 127-146.
- Schaffner, W. R., N. G. Hairston, Jr. & R. W. Howarth. 1994. Feeding rates and filament clipping by crustacean zooplankton consuming cyanobacteria. *Verh. Internat. Verein. Limnol.* 25: 2375-2381.
- 1993 Howarth, R. W. Microbial processes in salt-marsh sediments. 1993. Pages 239-259 in T. E. Ford (ed.), Aquatic Microbiology: An Ecological Approach. Blackwell, Oxford.
- Howarth, R. W. 1993. The role of nutrients in Coastal Waters. Appendix A in: Managing Wastewater in Coastal Urban Areas (pp. 137-158). Report of the Committee on Alternatives for Wastewater Management in Coastal Urban Areas, National Research Council, Washington, D.C.
- Cole, J. J., J. M. Lane, R. Marino & R. Howarth. 1993. Molybdenum assimilation by cyanobacteria and phytoplankton in freshwater and salt waters. *Limnol. Oceanogr.* 38: 25-35.
- Howarth, R. W. 1993. River sciences: A review of the rivers handbook, vol. a, hydrological and ecological principles. *BioScience* 43: 17-21.
- Howarth, R. W., T. Butler, K. Lunde, D. Swaney & C. R. Chu. 1993. Turbulence and planktonic nitrogen fixation: A mesocosm experiment. *Limnol Oceanogr.* 38: 1696-1711.
- Marino, R. & R. W. Howarth. 1993. Atmospheric oxygen exchange in the Hudson River: Dome measurements and comparison with other natural waters. *Estuaries* 16: 433-445.
- 1992 Howarth, R. W. & J. W. B. Stewart. 1992. The interactions of sulphur with other element cycles. Pages 67-79 in: R. W. Howarth, J. W. B. Stewart, and M. V. Ivanov (eds), Sulphur Cycling on the Continents: Wetlands, Terrestrial Ecosystems, and Associated Water Bodies. SCOPE #48. John Wiley and Sons, Chichester, U.K.

- Howarth, R.W., J. W. B. Stewart, and M. V. Ivanov (editors). 1992. Sulphur Cycling on the Continents: Wetlands, Terrestrial Ecosystems, and Associated Water Bodies. SCOPE #48. John Wiley and Sons, Chichester, U.K. 350 pages.
- McGlathery, K. J., R. W. Howarth & R. Marino. 1992. Nutrient limitation of the macroalga, *Penicillus capitatus*, associated with subtropical seagrass meadows in Bermuda. *Estuaries* 15: 18-25.
- Howarth, R. W. 1992. Indirect effects of sulfur on the carbon cycle of aquatic ecosystems: Molybdenum availability, planktonic nitrogen fixation, and nitrogen limitation. In E. T. Degens, S. Kempe, A. Lein, and Y. Soroken, (eds.) Interactions of Biogeochemical Cycles in Aqueous Ecosystems. Proceedings of SCOPE/UNEP workshop at Listvyanka/Irkutsk, USSR, September 2-8, 1988. University of Hamburg.
- Giblin, A. E., G. E. Likens & R. W. Howarth. 1992. The importance of reduced inorganic sulfur to the sulfur cycle of lakes. In E. T. Degens, S. Kempe, A. Lein, and Y. Soroken, (eds.) Interactions of Biogeochemical Cycles in Aqueous Ecosystems. Proceedings of SCOPE/UNEP workshop at Listvyanka/Irkutsk, USSR, September 2-8, 1988. University of Hamburg.
- Howarth, R. W., R. Marino, R. Garritt & D. Sherman. 1992. Ecosystem respiration in a large, tidally influenced river: The Hudson River. *Biogeochemistry* 16: 83-102.
- 1991 Vitousek, P. M. & R. W. Howarth. 1991. Nitrogen limitation on land and in the sea. How can it occur? *Biogeochemistry* 13: 87-115.
- Howarth, R. W. & R. Marino. 1991. Oil and water-- a bad mix. Pages 40-53 in: Science Year. World Book Encyclopedia, Chicago.
- Howarth, R. W., J. R. Fruci & D. M. Sherman. 1991. Inputs of sediment and carbon to an estuarine ecosystem: Influence of land use. *Ecological Applications* 1: 27-39.
- Kitchell, J. F., S. R. Carpenter, S. Bayley, K. C. Ewel, R. W. Howarth, S. W. Nixon & D. W. Schindler. 1991. Aquatic ecosystem experiments in the context of global climate change: working group report. In: H. Mooney et al. (eds.), Ecosystem Experiments. SCOPE, John Wiley and Sons, Chinchester, U.K.
- Howarth, R. W. 1991. Assessing the ecological effects of oil pollution from outer continental shelf oil development. *Tran. of American Fisheries Society* 11: 1-8.
- Howarth, R. W. 1991. Comparative responses of aquatic ecosystems to toxic chemical stress. Pages 169-195 in: J. Cole, G. Lovett, and S. Findlay (eds.), Comparative Analyses of Ecosystems: Patterns, Mechanisms, and Theories. Springer-Verlag, NY.
- Morin, A., K. D. Hambright, N. G. Hairston, Jr., D. M. Sherman & R. W. Howarth. 1991. Consumer control of gross primary production in replicate freshwater ponds. *Verh. Internat. Verein. Limnol.* 24: 1512-1516.
- Howarth, R. W. & R. Marino. 1991. Oil in the Oceans. Greenpeace, London.
- Giblin, A. E., G. E. Likens, G. E. & R. W. Howarth. 1991. Reply to the comments by Robert Stauffer on "Sulfur storage and alkalinity generation in New England lake sediments" by Giblin et al. *Limnol. Oceanogr.* 36: 1265.
- Muramoto, J., S. Honjo, B. Fry, J. Hay, R. Howarth & J. Cisne. 1991. Sulfur, iron, and organic carbon fluxes in the Black Sea: Sulfur isotopic evidence for origin of sulfur fluxes. *Deep Sea Research* 38: S1151-S1187.

- 1990 Giblin, A. E., G. E. Likens, D. White & R. W. Howarth. 1990. Sulfur storage and alkalinity generation in New England lake sediments. *Limnol. Oceanogr.* 35: 852-869.
- Marino, R., R.W. Howarth, J. Shames & E.E. Prepas. 1990. Molybdenum and sulfate as controls on the abundance of nitrogen-fixing cyanobacteria in saline lakes in Alberta. *Limnol. Oceanogr.* 35: 245-259
- Howarth, R. W. & R. Marino. 1990. Nitrogen-fixing cyanobacteria in the plankton of lakes and estuaries: A reply to the comment by Smith. *Limnol. Oceanogr.* 35: 1859-1863.
- Howarth, R. W., J. Boreman, G. Colvin, C. Decker, S. Findlay, J., Levinton, R. Malouf, J. Waldman & P Woodhead. 1990. Report of the working group on "ecosystems and fisheries". Pages. 24-37 in: A Research Program for the Hudson River Estuary. New York State Department of Environmental Conservation. No. 3-1990.
- 1989 Howarth, R. W. 1989. Determining the ecological effects of oil pollution in marine ecosystems. In S. A. Levin, M. A. Harwell, J. R. Kelly, and K. D. Kimball, (eds.) Problems in Ecotoxicology. Springer-Verlag, New York.
- 1988 Howarth, R. W., R. Marino, J. Lane & J. J. Cole. 1988. Nitrogen fixation in freshwater, estuarine, and marine ecosystems. 1. Rates and importance. *Limnol. Oceanogr.* 33: 669-687.
- Howarth, R. W., R. Marino & J. J. Cole. 1988. Nitrogen fixation in freshwater, estuarine, and marine ecosystems. 2. Biogeochemical controls. *Limnol. Oceanogr.* 33: 688-701.
- Lodge, D. M., J. W. Barko, D. Strayer, R. W. Howarth, J. Melack, B. Menge, G. G. Mittelbach & J. E. Titus. 1988. Spatial heterogeneity in lake communities: the benthos and habitat interactions. Page 181-208 in S. R. Carpenter (ed.), Complex Interactions in Lake Communities. Springer-Verlag, New York.
- Howarth, R. W. 1988. Nutrient limitation of net primary production in marine ecosystems. *Annual Review of Ecology & Systematics* 19: 89-110.
- Novelli, P. C., A. R. Michelson, M. J. Scranton, G. T. Banta, J. E. Hobbie & R. W. Howarth. 1988. Hydrogen and acetate cycling in two sulfate reducing sediments: Buzzards Bay and Town Cove, Massachusetts. *Geochem. Cosmochim. Acta* 52: 2477-2486.
- 1987 Peterson, B. J. & R. W. Howarth. 1987. Sulfur, carbon and nitrogen isotopes used to trace organic matter flow in the salt marsh estuaries of Sapelo Island, Georgia. *Limnol. Oceanogr.* 32: 1195-1213.
- Gallagher, J. L. & R. W. Howarth. 1987. Seasonal differences in *Spartina* recoverable underground reserves in the Great Sippewissett Marsh in Massachusetts. *Estuarine, Coastal & Shelf Science* 25: 313-319.
- Howarth, R. W. 1997. Potential impacts of petroleum on the biotic resources of Georges Bank. In R. Backus (ed.), An Atlas of Georges Bank. M.I.T. Press, Cambridge, MA.
- 1986 Luther, G. W., T. M. Church, A. E. Giblin & R. W. Howarth. 1986. Speciation of dissolved sulfur in salt marshes by polarographic methods. Pages 340-355 in M. Sohn (ed.), Organic Marine Geochemistry. American Chemical Society, Washington, D. C.
- Peterson, B. J., R. W. Howarth & R. H. Garritt. 1986. Sulfur and carbon isotopes as tracers of salt-marsh organic matter flow. *Ecology* 67: 865-874.
- Whelan, J. K., R. Oremland, M. Tarata, R. Smith, R. Howarth & C. Lee. 1986. Evidence for sulfate reducing and methane producing microorganisms in sediments from sites 618, 619, and 622. Reports of the Deep-Sea Drilling Project.

- Cole, J. J., R. W. Howarth, S. S. Nolan & R. Marino. 1986. Sulfate inhibition of molybdate assimilation by planktonic algae and bacteria: some implications for the aquatic nitrogen cycle. *Biogeochemistry* 2: 179-196.
- Peterson, B. J., R. W. Howarth & R. H. Garritt. 1986. Multiple stable isotopes used to trace the flow of organic matter in estuarine food webs. *Science* 227: 1361-1363.
- 1985 Rowe, G. & R. W. Howarth. 1985. Early diagenesis of organic matter in sediments off the coast of Peru. *Deep-Sea Res.* 32: 43-55.
- Howarth, R. W. & J. J. Cole. 1985. Molybdenum availability, nitrogen limitation, and phytoplankton growth in natural waters. *Science* 229: 653-655.
- 1984 Giblin, A. & R. W. Howarth. 1984. Pore water evidence for a dynamic sedimentary iron cycle in salt marshes. *Limnol. Oceanogr.* 29: 47-63.
- Howarth, R. W. 1984. The ecological significance of sulfur in the energy dynamics of salt marsh and marine sediments. *Biogeochemistry* 1: 5-27.
- Howarth, R. W. 1984. Global sulfur budgets, a review of "The Global Biogeochemical Sulfur Cycle, SCOPE 19, M. B. Ivanov & J. R. Freney (eds.)." *Ecology* 65: 1336.
- Howarth, R. W. & B. B. Jorgensen. 1984. Formation of <sup>35</sup>S-labeled elemental sulfur and pyrite in coastal marine sediments (Limfjorden and Kysing Fjord, Denmark) during short-term <sup>35</sup>SO<sub>4</sub><sup>2-</sup> reduction measurements. *Geochem. Cosmochim. Acta* 48: 1807-1818.
- Howarth, R. W. & R. Marino. 1984. Sulfate reduction in salt marshes, with some comparisons to sulfate reduction in microbial mats. Pages 245-263 in Y. Cohen, R. W. Castenholz & H. O. Halvorson (eds.), *Microbial Mats: Stromatolites*. Alan R. Liss, Inc., NY.
- Howarth, R. W. & S. Merkel. 1984. Pyrite formation and the measurement of sulfate reduction in salt marsh sediments. *Limnol. Oceanogr.* 29: 598-608.
- Teal, J. M. & R. W. Howarth. 1984. Oil spill studies: a review of ecological effects. *Environmental Management* 8: 27-44.
- Howarth, R. W. & A. Giblin. 1984. Sulfate reduction in the salt marshes at Sapelo Island, Georgia. *Limnol. Oceanogr.* 28: 70-82.
- Howarth, R. W., A. Giblin, J. Gale, B. J. Peterson & G. W. Luther. 1984. Reduced sulfur compounds in the pore waters of a New England salt marsh. *Ecol. Bull.* (Stockholm) 35: 135-152.
- Peterson, B. J., P. A. Steudler, R. W. Howarth, A. I. Friedlander, D. Juers & F. P. Bowles. 1984. Tidal export of reduced sulfur from a salt marsh ecosystem. *Ecol. Bull.* (Stockholm) 35: 153-165.
- 1982 Howarth, R. W. 1982. Debunking the myth of the "inexhaustible" ocean, a review of "The Oceans: Our Last Resource" by W. Marx. *Technology Review* 85: 85-86.
- Howarth, R. W. & J. E. Hobbie. 1982. The regulation of decomposition and heterotrophic microbial activity in salt marsh soils. Pages 183-207 in V. S. Kennedy (ed.), *Estuarine Comparisons*. Academic Press, NY.
- Luther, G. W., A. Giblin, R. W. Howarth & R. A. Ryans. 1982. Pyrite and oxidized iron mineral phases in salt marsh and estuarine sediments. *Geochem. Cosmochim. Acta* 46: 2665-2669.
- Valiela, I., B. L. Howes, R. W. Howarth, A. Giblin, K. Foreman, J. M. Teal, and J. E. Hobbie. 1982. The regulation of primary production and decomposition in a salt marsh ecosystem.

- Pages 151-168 in B. Gopal, R. E. Turner, R. G. Wetzel, & D. F. Whigham (eds.), *Wetlands: Ecology and Management*. Proceedings of First International Wetlands Conference, New Delhi, India.
- 1981 Howarth, R. W. 1981. Fish versus fuel: a slippery quandary. *Technology Review* 83: 68-77.
- Howarth, R. W. 1981. Oil and fish: can they coexist? Pages 49-72 in *Coast Alert: Scientists Speak Out*. Friends of the Earth Publishers, San Francisco.
- Howes, B. L., R. W. Howarth, J. M. Teal & I. Valiela. 1981. Oxidation-reduction potentials in a salt marsh: 1. Spatial patterns and interactions with primary production. *Limnol. Oceanogr.* 26: 350-360.
- Teal, J. M. & R. W. Howarth. 1981. Biological effects of oil spills. Background paper, NAS Panel on Petroleum in the Marine Environment. National Academy Press, Washington, DC.
- 1980 Howarth, R. W. & J. M. Teal. 1980. Energy flow in a salt marsh ecosystem: the role of reduced inorganic sulfur compounds. *American Naturalist* 116: 862-872.
- Lee, C. L., R. W. Howarth & B. L. Howes. 1980. Sterols in decomposing *Spartina alterniflora* and the use of ergosterol in estimating the contribution of fungi to detrital nitrogen. *Limnol. Oceanogr.* 25: 290-303.
- Peterson, B. J., R. W. Howarth, F. Lipshultz & D. Ashendorf. 1980. Salt marsh detritus: an alternative interpretation of stable carbon isotope ratios and the fate of *Spartina alterniflora*. *Oikos* 34: 173-177.
- 1979 Howarth, R. W. 1979. The role of sulfur in salt marsh metabolism. Ph.D. thesis, MIT/WHOI Joint Program (SeaGrant publ. #WHOI 79-39).
- Howarth, R. W. 1979. Pyrite: its rapid formation in a salt marsh and its importance to ecosystem metabolism. *Science* 203: 49-51.
- Howarth, R. W. & J. M. Teal. 1979. Sulfate reduction in a New England salt marsh. *Limnol. Oceanogr.* 24: 999-1013.
- 1978 Hall, C. A. S., R. W. Howarth, B. Moore & C. J. Vorosmarty. 1978. Environmental impacts of industrial energy systems in the coastal zone. *Annual Review of Energy* 3: 395-475.
- Howarth, R. W. 1978. A rapid and precise method for determining sulfate in seawater, estuarine waters, and sediment pore waters. *Limnol. Oceanogr.* 23: 1066-1069.
- Howarth, Robert W. and C.A.S. Hall. 1978. What Do You Want to Do With Your Last 27,000 Gallons of Oil? *Human Ecology Forum.* 8: 2-5
- 1977 Connor, M. S. & R.W. Howarth. 1977. Potential effects of oil production on Georges Bank communities: A review of the draft environmental impact statement of outer continental shelf oil and gas lease sale no. 42. SeaGrant publ. #WHOI 77-1.
- 1976 Howarth, R. W. & S. G. Fisher. 1976. The dynamics of carbon, nitrogen, and phosphorus during leaf decomposition in stream micro-ecosystems. *Freshwater Biol.* 6: 221-228.
- 1975 Whitney, D., G. M. Woodwell & R. W. Howarth. 1975. Nitrogen fixation in Flax Pond, a Long Island salt marsh. *Limnol. Oceanogr.* 20: 640-643.