

CAROLYN BUCHWALD

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INTRODUCTION

Natural abundance stable isotopes of N and O in nitrite and nitrate can be powerful tools for interpreting nitrogen biogeochemistry in the environment. My research interests focus around measuring the isotope systematics of relevant microbial nitrogen transformation processes and using these values to interpret natural abundance isotopes in a wide range of environments including wastewater, lakes, estuaries, rivers and the ocean. The goal of my research is to use these tools to evaluate and predict the effects of anthropogenic nitrogen from the global scale to small pervasive effects on individual ecosystems.

EDUCATION

Ph.D. in Chemical Oceanography, MIT/WHOI Joint Program in Oceanography, (2/2013)

Thesis: Nitrogen Cycling in Oxygen Deficient Zones: Insights from the $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of nitrite and nitrate
Advisor: Karen Casciotti

S.B. in Earth, Atmospheric and Planetary Sciences, Minor in Chemistry, MIT, (6/2007)

RESEARCH EXPERIENCE

Dalhousie University Assistant Professor (6/2016 - present)

- Canada Research Chair in Ocean Chemistry

Woods Hole Oceanographic Institution Postdoctoral Investigator (9/2013 - 6/2016)

- Studying anaerobic abiotic reduction of nitrogen by iron minerals in the laboratory and in coastal sediments in Germany, California and Cape Cod.

Harvard University Postdoctoral Fellow (11/2012 - 9/2013)

- Measured the isotope systematics of $\delta^{18}\text{O}$ and $\delta^{15}\text{N}$ of abiotic nitrite reduction by iron (II)

Marine Biological Laboratory Microbial Diversity Course (summer 2011)

- Intensive 6 week course on microbiology for graduate students and early career scientists
- Learned how to culture a wide range of microbes from soil, salt marshes to the ocean

Woods Hole Oceanographic Institution Summer Student Fellow (summer 2006)

- Measuring the oxygen isotope systematics of nitrification

School for Field Studies in Turks and Caicos Islands (fall 2005)

- Semester course in coastal resources management

TEACHING EXPERIENCE

Introduction to Chemical Oceanography (OCEA 3002), Halifax, NS, Canada (9/2020 to present)

Dalhousie University

- Third year undergraduate course that teaches the fundamentals of chemical oceanography

Honours Research in Ocean Sciences (OCEA 4201/4202), Halifax, NS, Canada (9/2020 to present)

Dalhousie University

- Guides students through their honours research projects and teaches the skills required to write a thesis and present research on a poster at a conference

Chemical Oceanography (OCEA 4130/5130), Halifax, NS, Canada (9/2018 to 12/2018)

Dalhousie University

- Graduate and upper undergraduate course that teaches the fundamentals of chemical oceanography with a focus on quantitative problem solving

Conversations with Ocean Scientists (OCEA 1000X/Y), Halifax, NS, Canada (9/2016 to 4/2018)

Dalhousie University

- Currently teaching first year students in a writing intensive course that introduces students to ocean science and how scientists disseminate their research results
- Students are tasked with multiple writing projects including a blog post, lab report and review paper

STEM course organizer and teacher, Falmouth, MA (4/2014, 4/2015, 4/2016)

Waquoit Bay National Estuarine Research Reserve

- Helped develop a course on “Wastewater in Wastersheds” for local school teachers
- Taught the nitrogen cycle to teachers and designed educational projects and activities on nitrogen cycling for middle and high school age students

Mentor for 2 high school science fair projects, Falmouth, MA (9/2014)

Falmouth Academy

- Taught each student the basics of the nitrogen cycle and nitrogen issues on cape cod and helped them develop a project to answer important questions related to what they learned.
- Aided students with experimentation, measurements and writing the final report

Guest scientist at boarding high school for sophomore girls, Freeport, ME (8/2014)

Coastal Studies for Girls: A Science and Leadership School

- Gave a lecture to the students, attended dinner and talked with the girls in evening.
- Inspired the girls to do a project on nitrogen in Freeport and helping to run the samples they collected.

STEM course organizer and teacher, Falmouth, MA (4/2014, 4/2015, 4/2016)

Waquoit Bay National Estuarine Research Reserve

- Helped develop a course on “Wastewater in Wastersheds” for local school teachers
- Taught the nitrogen cycle to teachers and designed educational projects and activities on nitrogen cycling for middle and high school age students

Guest Course Lecturer, Woods Hole, MA (6/2010)

Woods Hole Partnership Education Program

- Taught lectures on the marine nitrogen cycle to visiting undergraduates

Teaching Assistant at MIT/WHOI JOINT PROGRAM, Woods Hole, MA (9/2009 - 12/2009)

Department of Marine Chemistry and Geochemistry

- 12.742, *Marine Chemistry*, introductory course on chemical oceanography for first year graduate students
- Led one recitation a week, graded problem sets and helped develop tests

Graduate Student Teaching Certificate Program at MIT, Cambridge, MA (2009-2010)

MIT Teaching and Learning Laboratory

- Constructed a class syllabus, problem sets and exam questions
- Taught active-learning exercises
- Gave a videotaped lecture with personalized feedback

TRAINING AND SUPERVISORY EXPERIENCE

2014-2016 Kalina Grabb, undergraduate summer student fellow

2016-2018 Shona MacDonald, undergraduate honours student and USRA in 2018

2016-2017 Jaimie Keeping, undergraduate honours student

2017- Daniel Reed, post doc

2018-present, Mary Katie Frame, MSc student

2018-present, Jennifer Butler, MSc student, graduating this semester

2019-present, Nadine Lehman, OFI post doctoral fellow

2020-present, Britton Dempsey, MSc student

2020-present, Mandi Newhook, undergraduate honours student

starting 2021, Corday Seldon, OFI post doctoral fellow

PUBLICATIONS

- Santoro, A.E., **Buchwald, C.**, Knapp, A.N., Berelson, W.M., Capone, D.G., and K. L. Casciotti. Nitrification and nitrous oxide production in the offshore waters of the Eastern Tropical South Pacific. 2020.
- Babbin, A. R., **Buchwald, C.**, Morel, F.M.M., Wankel, S.D., and B .B. Ward. Nitrite oxidation exceeds reduction and fixed nitrogen loss in anoxic Pacific waters. *Mar. Chem.* **224**: 103814. 2020.
- Howarth, L.M., Filgueira, R., Jiang, D., Koepke, H., Frame, M.K., **Buchwald, C.**, Finnis, S., Chopin, T., Costanzo, S.D. and J. Grant. Using macroalgal bioindicators to map nutrient plumes from fish farms and other sources at a bay-wide scale. *Aquaculture Environ. Interactions.* **11**: 671-684. 2019.
- **Buchwald, C.**, Homola, K., Spivack, A.J., Estes, E.R., Murray, R.W., and S.D. Wankel. *Global Biogeochemical Cycles.*

32: 1688-1702. 2018.

- Fuchsman, C.A., Devol, A.H., Casciotti, K.L, **Buchwald, C.**, Chang, B.X., and R.E.A. Horak. An N isotopic mass balance of the Eastern Tropical North Pacific oxygen deficient zone. **Buchwald, C.** *Deep Sea Research Part II: Topical Studies in Oceanography*. **156**: 137-147. 2018
- Wankel, S. D., Ziebis, W., **Buchwald, C.**, Charoenpong, C.N., de Beer, D., Dentiger, J., and Z. Xu. Evidence for fungal and chemodenitrification based N₂O flux from nitrogen impacted coastal sediments. *Nature Comms.* **8**: 15595. 2017.
- **Buchwald, C.**, Grabb, K., Hansel, C.M., and S. D. Wankel. Constraining the role of iron in environmental nitrogen transformations: Dual stable isotope systematics of abiotic NO₂ reduction by Fe (II) and its production of N₂O. *Geochim. Cosmochim. Acta.* **186**: 1-12. 2016.
- Hansel, C.M., **Buchwald, C.**, Ossolinski, J. E., Dyhrman, S.T., and B. Van Mooy. Dynamics of extracellular superoxide production by Trichodesmium colonies from the Sargasso Sea. *Limnol. and Oceanogr.* doi: 10.1002/lno.10266. 2016.
- **Buchwald, C.**, Santoro, A.E., Stanley, R., and K. L. Casciotti. Nitrogen cycling in the secondary nitrite maximum of the eastern tropical North Pacific off Costa Rica. *Global Biogeochemical Cycles.* **29**: 2061-2081. 2015.
- Wankel, S.D., **Buchwald, C.**, Ziebis, W., Wenk, C. B., and M.F. Lehmann. Nitrogen cycling in the deep sedimentary biosphere: nitrate isotopes in porewaters underlying the oligotrophic North Atlantic. *Biogeosciences* **24**: 7483-7502. 2015.
- Stukel, M. R., Benitez-Nelson, C. R., Décima, M., Taylor, A. G., **Buchwald, C.**, and M. R. Landry. The biological pump in the Costa Rica Dome: an open-ocean upwelling system with high new production and low export. *J Plankton Res.* doi:10.1093/plankt/fbv097. 2015.
- **Buchwald, C.** and Casciotti, K. L. Isotopic ratios of nitrite as tracers of the source and age of oceanic nitrite. *Nature Geosci.* **6**: 308-313. 2013.
- Kong, L., Jing H., Kataoka, T., **Buchwald, C.** and H. Liu. Diversity and spatial distribution of hydrazine oxidoreductase (hzo) genes in the oxygen minimum zone off Costa Rica. *PloS ONE.* **8**: e78275. 2013.
- Casciotti, K. **Buchwald, C.** and McIlvin, M. R. Implications of nitrate and nitrite isotope measurements for the mechanisms of nitrogen cycling in the Peru oxygen deficient zone. *Deep Sea Res. I.* **80**: 78-93. 2013.
- Casciotti, K. L. and **Buchwald, C.** Insights on the microbial nitrogen cycle from isotopic approaches to nitrification. *Front. Microb.* **3**: 356. 2012.
- **Buchwald, C.**, Santoro, A. E., McIlvin, M. R., and Casciotti, K. L. Oxygen isotopic composition of nitrate and nitrite produced by nitrifying co-cultures and natural marine assemblages. *Limnol. Oceanogr.* **47**: 1361-1375. 2012.
- Santoro, A. E., **Buchwald, C.**, McIlvin, M. R., and Casciotti, K. L. Isotopic signature of N₂O produced by marine ammonia-oxidizing archaea. *Science.* **333**: 1282-1285. 2011.
- Casciotti, K. L., **Buchwald, C.**, Santoro, A. E. and Frame, C. Assessment of nitrogen and oxygen isotopic fractionation during nitrification and its expression in the marine environment. *Methods in Enzymol.* **486**: 253-275. 2011.
- **Buchwald, C.**, and Casciotti, K. L. Oxygen isotopic fractionation and exchange during bacterial nitrite oxidation. *Limnol. Oceanogr.* **55**: 1064-1074. 2010.
- Casciotti, K. L., McIlvin, M. R., and **Buchwald, C.** Oxygen isotopic exchange and fractionation during bacterial ammonia oxidation. *Limnol. Oceanogr.* **55**: 753-762. 2010.
- **Buchwald, C.** Tracking nitrogen's elusive trail in the ocean. *Oceanus.* 2008.

INVITED TALKS AND PROFESSIONAL MEETING PARTICIPATION

Feb, 2020 Old Dominion University, Norfolk, VA. *Invited talk.*

Feb, 2020 Ocean Sciences Meeting, San Diego, CA. Poster.

Mar, 2018 Mount Allison University, Sackville, NB. *Invited talk.*

Feb, 2018 Ocean Sciences Meeting, Portland, OR. Poster.

Mar, 2017 Bedford Institute of Oceanography, Halifax, NS. *Invited talk.*

Feb, 2017 ASLO Aquatic Sciences Meeting. Honolulu, HI. Poster.

Dec, 2016 International Symposium on Microbial Responses to Ocean Deoxygenation, Goa, India. *Invited talk*

Feb, 2016 Ocean Sciences Meeting, New Orleans, LA. Session organizer

Aug, 2015 Chemical Oceanography Gordon Conference, Holderness, NH. Poster

Oct, 2014 Columbia University Lamont-Doherty Earth Observatory, *Invited talk*

Apr, 2014 Princeton University Environmental Geology and Geochemistry Seminar, *Invited talk*
Feb, 2014 Ocean Sciences Meeting, Honolulu, HI. Session organizer
Aug, 2013 Goldschmidt Conference, Florence, Italy. *Invited talk*
Feb, 2013 ASLO Aquatic Sciences, New Orleans, LA. Oral Presentation
Feb, 2012 Stanford University Student Seminar. Talk
Feb, 2012 Ocean Sciences Meeting. Oral Presentation (Outstanding student presentation award)
Aug, 2011 Chemical Oceanography Gordon Conference, Andover, NH. Poster
Aug, 2010 International Society for Microbial Ecology (ISME) Conference, Seattle, WA. Poster
Aug, 2009 Chemical Oceanography Gordon Conference, Tilton, NH. Poster
Feb, 2009 ASLO Aquatic Sciences International Meeting, Nice, France. Poster

EDUCATIONAL AND COMMUNITY SERVICE

Manuscript reviewer- Nature Communications, Global Biogeochemical Cycles, ISME Journal, Biogeosciences, Journal of Geophysical Research- Oceans, Limnology and Oceanography, Environmental Science and Technology
Volunteer Marine Science Educator- Zephyr Marine Education, 2013-2016
Science Fair Judge- Falmouth Academy, 2014, 2015, 2016
Student Representative- Woods Hole Oceanographic Institution, 2010-2011
Student Mentor- Woods Hole Oceanographic Institution, 2009-2012

RESEARCH SUPPORT

- 2015 Canadian Foundation for Infrastructure, **\$275,300**
- 2017 NSERC Discovery Grant, *Using experiments and stable isotopes to track the fate of fixed nitrogen in the marine environment*, **\$125,000**
- 2018 OFI Seed Fund, *Determining the nutrient and carbon dioxide fluxes in local ecosystems due to kelp aquaculture*, **\$15,000**
- 2018 NSERC CRC stipend, **\$40,000**
- 2018 NSERC Discovery Grant Early Career Supplement, **\$12,500**
- 2018 Aquaculture Association of Nova Scotia Kelp Project Student Funding, **\$6,000**
- 2018 Aquatic Climate Change Adaptation Services Program, *Trends in nutrients and oxygen on the Scotian Shelf and changes during a recent warm period*, collaborator with DFO, **\$223,000**
- 2019- OFI International Postdoctoral Fellowship, *Controls on bioavailable nitrogen on the Scotian Shelf: Insights from the isotopic composition of nitrate and neodymium*, **\$150,000**
- 2019- OFI LRP, *The Northwest Atlantic as a Climate Ocean: Projecting Future Changes in Productivity and the Biological Carbon Pump (NWA BCP)*, **\$130,000**, **my portion, \$4,000,000 total**
- 2019- OFI Seed Fund, *Understanding the nitrogen isotope biogeochemistry of sewage wastewater for use as bioindicators in the marine environment*, collaborator, **\$26,700**
- 2020- OFI International Postdoctoral Fellowship, *Cryptic N cycling by a reversible enzyme: Implications for stable isotope systematics across redox gradients*, **\$150,000**

AWARDS AND FELLOWSHIPS

- Canada Research Chair Tier II in Ocean Chemistry (2016)
- Center for Dark Energy Biosphere Investigations (C-DEBI) Postdoctoral Fellowship (2014)
- The George P. Panteleyev Award, conferred annually on the MIT/WHOI student who best exemplifies the commitment to improving graduate education. *MIT/WHOI Joint Program in Oceanography* (2013)
- Outstanding student presenter award, *Ocean Sciences Conference, Salt Lake City, Utah* (2012)
- Coastal Ocean Institute graduate student award, *WHOI* (2011)
- MIT Presidential Fellowship, *MIT* (2007)
- WHOI Summer Student Fellow, *WHOI* (2006)
- NSF Research Experience for Undergraduates Fellowship, *University of Southern California* (2005)

CIRCUMSTANCES AFFECTING PRODUCTIVITY

Leave of Absence January, 2019 to January, 2020

- I was on maternity/parental leave for 52weeks
- During this time I was less productive in individual research and writing manuscripts. I was able to continue to advise my current students and postdoc on their research in my absence.

COVID 19 Closure of Daycare March to July, 2020

- My year old son was home with me for 3 months during the spring/summer 2020
- During this time I was solely responsible for watching my son, as my partner is an essential worker and working full time. I had very little time to devote to research in this time, except for checking in and managing trainee progress.