

KATHERINE R HEAL (SHE/HER)

School of Oceanography
University of Washington
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EDUCATION

- 2018 PhD in Chemical Oceanography
University of Washington
Advisor: Dr. Anitra Ingalls
“The power and promise of direct measurements of metabolites in marine systems”
- 2014 MS in Chemical Oceanography
University of Washington
Advisors: Dr. Anitra Ingalls and Dr. Allan Devol
- 2011 BA in Environmental Chemistry
The Colorado College
Advisor: Dr. Sally Meyer

RESEARCH EXPERIENCE

- 2019-present Simons Foundation Postdoctoral Fellow in Marine Ecology
University of Washington
Advisors: Dr. Randelle Bundy and Dr. Anitra Ingalls
- 2011-2018 Graduate Research Assistant
University of Washington
Advisors: Dr. Anitra Ingalls and Dr. Allan Devol
- 2010-2011 Summer Student Fellow and Visiting Scientist
Woods Hole Oceanographic Institution
Advisor: Dr. Daniel Repeta
- 2009-2010 Science Undergraduate Laboratory Internship
Oak Ridge National Laboratory
Advisor: Dr. Melanie Mayes

PEER REVIEWED PUBLICATIONS (14 total, 5 as first or co-first author)

- 2020 Dawson, H.M., **Heal, K.R.**, Boysen, A.K., Carlson, L.T., Ingalls, A.E., Young, J.N.,
Characterization of compatible solute use in a cultured sea-ice alga, *Nitzschia lecontei*, and in the environmental algal community of Utqiagvik, AK using a metabolomics approach. *Elementa*. 8, 25.
- 2019 Lu, X., **Heal, K.R.**, Ingalls, A.E., Doxey, A.C., Neufeld, J.D. Metagenomic and chemical evidence for cobalamin-based microbial niches across diverse soil

- biomes. *ISME Journal*. 14, 53–66
- 2019 **Heal, K.R.**, Kellogg, N.A., Carlson, L.T, Lionheart, R., Ingalls, A.E. Metabolic consequences of cobalamin scarcity in diatoms as revealed through metabolomics. *Protist*. 3, 328-348.
- 2019 Durham, B.P., Boysen A.K., Carlson, L.T, Groussman, R.D., **Heal, K.R.**, Cain, K.R., Coesel, S., Morales, R.L., Morris, R. M., Ingalls, A.E., Armbrust, E.V. Sulfonate-based networks between eukaryotic phytoplankton and heterotrophic bacteria in the surface ocean. *Nature Microbiology*. 4, 1706–1715.
- 2018 **Heal, K.R.***, Qin, W.*, Amin, S.A., Armbrust, E.V., Devol, A.H., Moffett, J.W., Stahl, D.A., Ingalls, A.E. Unexpected accumulation of NO₂-cobalamin in ammonia-oxidizing archaea and in the oxygen deficient zone of the Eastern Tropical North Pacific. *Environmental Microbiology Reports*. 2018, 10. ***equal contribution.**
- 2018 Boysen A.K.*, **Heal, K.R.***, Carlson, L.T, Ingalls A.E. Best-matched internal standard normalization in liquid chromatography-mass spectrometry as applied to environmental metabolomics. *Analytical Chemistry*. 2018, 90. ***equal contribution.**
- 2018 Horak, R.E.A., Qin, W., Bertagnolli, A.D., Nelson, A., **Heal, K.R.**, Han, H., Heller, M., Schauer, A., Jeffrey, W., Armbrust, E.V., Moffett, J.W., Ingalls A.E., Stahl, D.A., Devol, A.H. Relative impacts of light, temperature, and reactive oxygen on thaumarchaeal ammonia oxidation in the North Pacific Ocean. *Limnology and Oceanography*. 2018, 63.
- 2017 Qin, W., **Heal, K.R.**, Ramdasi, R., Kobelt, J., Martens-Habbena, W., Bertagnolli, A.D., Amin, S.A., Walker, C.B., Urakawa, H., Konneke, M., Devol, A.H., Moffett, J.W., Armbrust, E.V., Jensen, G.J., Ingalls A.E., Stahl, D.A. *Nitrosopumilus maritimus* gen. nov., sp. nov., *Nitrosopumilus cobalaminogenes* gen. nov., sp. nov., *Nitrosopumilus oxycliniae* gen. nov., sp. nov., and *Nitrosopumilus ureaphilus* gen. nov., sp. nov., four marine ammonia-oxidizing archaea of the phylum *Thaumarchaeota*. *International Journal of Systematic and Evolutionary Microbiology*. 2017, 12.
- 2017 Qin, W., Amin, S.A., Lundeen, R.A., **Heal, K.R.**, Martens-Habbena, W., Turkarslan S., Urakawa, H., Costa, K.C., Hendrickson, E.L., Wang, T., Beck, D.A.C., Tequia, S.M., Taub, F., Holmes, A.D., Vajjala, N., Berube, P.M., T.M., Moffett, J.W., Devol, A.H, Baliga, N.S., Arp, D.J., Sayavedra-Soto, Hackett, M., Armbrust, E.V., Ingalls, A.E, Stahl, D.A. Stress response analyses of a marine ammonia-oxidizing archaeon informs physiological status of environmental populations. *ISME Journal*. 2017, 12.
- 2017 **Heal, K.R.**, Qin, W., Ribalet, F., Bertagnolli, A.D., Coyotes-Maetstas, W., Hmelo, L.R., Moffett, J.W., Devol, A.H., Armbrust, E.V., Stahl, D.A., Ingalls, A.E. Two distinct pools of B₁₂ analogs reveal community interdependencies in the ocean. *Proceedings of the National Academy of Sciences*. 2017, 114.
- 2015 Amin, S.A., Hmelo, L.R., van Tol, H.M., Durham, B.P., Carlson, L.T., **Heal, K.R.**,

- Morales, R.L., Berthiaume, C.T., Parker, M.S., Djunaedi, B., Ingalls, A.E., Parsek, M.R., Moran, M.A., Armbrust, E.V. Interaction and signalling between a cosmopolitan phytoplankton and associated bacteria. *Nature*. 2015, 98.
- 2014 **Heal, K.R.**, Carlson, L.T., Devol, A.H., Armbrust, E.V., Moffett, J.W., Stahl, D.A., Ingalls, A.E. Determination of four forms of vitamin B₁₂ and other B vitamins in seawater by liquid chromatography/tandem mass spectrometry. *Rapid Communications in Mass Spectrometry*. 2014, 28.
- 2013 Martin, M.Z., Mayes M.A., **Heal, K.R.**, Brice, D.J., Wulfschleger, S.D. Investigation of laser-induced breakdown spectroscopy and multivariate analysis for differentiating inorganic and organic C in a variety of soils. *Spectrochimica Acta Part B*. 2013, 87.
- 2012 Mayes, M.A., **Heal, K.R.**, Brandt, C.C., Phillips, J.R., Jardine, P.M. Relation between soil order and sorption of dissolved organic carbon in temperate subsoils. *Soil Science Society of America Journal*. 2012, 76.

SUBMITTED MANUSCRIPTS (drafts available on request)

- In Review Biller, S.J., Lundeen, R.A., Hmelo, L.R., Becker, K.W., Arellano, A., Dooley, K., Carlson, L.T., **Heal, K.R.**, Van Mooy, B.A.S., Ingalls, A.E., Chisholm, S. Bacterial extracellular vesicles and the molecular marketplace of the sea: Insights through *Prochlorococcus*. Submitted to *ISME Journal*.
- In Review Boysen, A.K., Carlson, L.T., Durham, B.P., Groussman, R.D., Aylward, F.O., Ribalet, F., **Heal, K.R.**, DeLong, E.F., Armbrust, E.V., Ingalls, A.E. Diel oscillations of particulate metabolites reflect synchronized microbial activity in the North Pacific Subtropical Gyre. Submitted to *ISME Journal*.
<https://www.biorxiv.org/content/10.1101/2020.05.09.086173v1>
- In Review Dawson, H.M., **Heal, K.R.**, Torstensson, A., Carlson, L.T., Ingalls, A.E., Young, J.N. Large diversity in nitrogen- and sulfur-containing compatible solute profiles in sea-ice diatoms suggest different adaptive strategies that have potential to impact polar biogeochemical cycles. Submitted to *Integrative and Comparative Biology*.

OTHER PUBLICATIONS (NOT PEER REVIEWED)

- 2020 Heal, K.R. "Biological Pump" Climate Science for the Classroom, edited by Bertram and Biyani. <https://uw.pressbooks.pub/climate/chapter/biological-pump/>

FELLOWSHIPS AND GRANTS

- 2018 Postdoctoral Fellowship in Marine Microbial Ecology (\$261,000)
Simons Foundation
- 2016 Travel grant to attend Ocean Science Meeting (\$500)
College of the Environment, University of Washington
- 2012 Program Climate Change Grad Fellowship (1 yr tuition and stipend)

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| | University of Washington |
| 2012 | Graduate Research Fellowship (3 yr tuition and stipend) National Science Foundation |
| 2012 | Collaborative research travel grant (\$5,000) Burroughs Wellcome Fund |
| 2011 | Top Scholar – Egtvedt Grad Fellowship (1 yr tuition and stipend) University of Washington |
| 2011 | Travel grant to attend American Society of Limnology and Oceanography annual meeting National Science Foundation Research Experience for Undergraduates |
| 2010 | Guest Student Honorarium (\$1,000) Woods Hole Oceanographic Institution |
| 2010 | Science and Energy Research Challenge (\$2,000) Department of Energy Office of Science |
| 2010 | Venture grant recipient (\$1,000) The Colorado College |
| 2010 | Washington State University REU (declined) National Science Foundation |
| 2010 | Marine Physical Lab Summer Fellowship (declined) Scripps Oceanographic Institution |
| 2006-2008 | Iron Range Scholarship (\$4,000 per yr) The University of Minnesota |

AWARDS AND HONORS

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| 2019 | Selected Participant UNOLS Early Career Chief Scientist Training Program |
| 2018 | Selected Participant Dissertations Symposium in Chemical Oceanography XXVI |
| 2017 | College of the Environment Graduate Dean's Medalist University of Washington |
| 2011 | Graduated cum laude with departmental distinction The Colorado College |
| 2011 | Graduate Research Fellowship Honorable Mention National Science Foundation |

INVITED PRESENTATIONS

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| 2020 | Heal, K.R. , Durham, B.P., Boysen, A.K., Carlson, L.T., Groussman, R., Bundy, R., Armbrust, E.V., Ingalls, A.E. Patterns in metabolite pools show that phytoplankton leave a taxon-specific signature on labile carbon in the surface ocean. Marine Chemistry and Geochemistry seminar, Woods Hole Oceanographic Institute. Remote seminar. |
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- 2019 **Heal, K.R.** Evidence and implications of arsenic removal from the surface ocean via complex biomolecules. Seminar at University of Rhode Island Graduate School of Oceanography. Narragansett, Rhode Island.
- 2018 **Heal, K.R.**, Carlson, L.T., Boysen, A.K., Durham, B.P., Groussman, R., Armbrust, E.V., Ingalls, A.E. New insights into microbial carbon exchange through metabolomics. Environmental Geology and Geochemistry Seminar at Princeton University. Princeton, New Jersey.
- 2018 **Heal, K.R.** Power and promise of direct measurements of metabolites in marine systems. Oral presentation at Dissertations Symposium in Chemical Oceanography XXVI. Kona, Hawai'i.
- 2017 **Heal, K.R.**, Qin, W., Ribalet, F., Bertagnolli, A.D., Amin, S., Coyotes-Maetstas, W., Hmelo, L.R., Moffett, J.W., Devol, A.H., Armbrust, E.V., Stahl, D.A., Ingalls, A.E. Insights into the sources and metabolic underpinnings of vitamin B₁₂ in the ocean as revealed through liquid-chromatography mass spectrometry. Oral presentation at Gordon Research Seminar in Chemical Oceanography, New London, NH.

SELECTED PRESENTATIONS (* = undergraduate mentee)

- 2020 **Heal, K.R.**, Boysen, A.K., Durham, B.P., Carlson, L.T., Armbrust, E.V., Ingalls, A.E., Bundy, R.M. Chemical and genetic evidence point to arseno-metabolites underpinning the marine arsenic cycle. Oral presentation at Ocean Sciences Meeting. San Diego, CA.
- 2019 **Heal, K.R.**, Carlson, L.T., Boysen, A.K., Durham, B.P., Groussman, R.G., Armbrust, E.V., Ingalls, A.E. Environmental metabolomics across natural oceanographic gradients expose under-appreciated compounds engaged in multiple elemental cycles. Oral presentation at American Society of Limnology and Oceanography in San Juan, PR.
- 2018 **Heal, K.R.**, Carlson, L.T., Boysen, A.K., Durham, B.P., Kellogg*, A.K., Lionheart*, R.M., Armbrust, E.V., Ingalls, A.E. Metabolite pools across a basin-wide oceanographic gradient in the North Pacific. Poster presentation at Ocean Sciences Meeting. Portland, OR.
- 2017 **Heal, K.R.**, Carlson, L.T., Boysen, A.K., Lionheart*, R.M., Kellogg*, N.A., Ingalls, A.E. Metabolic consequences of cobalamin starvation in marine microbes revealed through metabolomics. Oral presentation at American Society of Limnology and Oceanography in Honolulu, HI.
- 2016 **Heal, K.R.**, Qin, W., Ribalet, F., Bertagnolli, A.D., Coyotes-Maetstas*, W., Hmelo, L.R., Moffett, J.W., Devol, A.H., Armbrust, E.V., Stahl, D.A., Ingalls, A.E. Cobalamin and cobalamin-like compounds in the sunlit ocean: Inter-phyla mutualism or competition? Oral presentation at Ocean Science Meeting in New Orleans, LA.
- 2015 **Heal, K.R.**, Coyotes-Maetstas*, W., Armbrust, E.V., Stahl, D.A., Devol, A.H., Moffett, J.W., Ingalls, A.E. Using targeted metabolomics to assess cobalamin

- demand in simple and natural marine systems. Poster presentation at Gordon Conference in Chemical Oceanography, NH.
- 2014 **Heal, K.R.** L. Truxal Carlson, W. Coyote-Maestas*, D.A. Stahl, W. Qin, E. V. Armbrust, J. Moffet, A. Devol, and A. E. Ingalls. Microbial contribution to the dissolved B₁₂ pool in coastal Washington. Poster presentation at Ocean Science Meeting in Honolulu, HI.
- 2014 Coyote-Maestas*, W., **Heal, K.R. L.** Truxal Carlson, D.A. Stahl, W. Qin, E. V. Armbrust, J. Moffet, A. Devol, and A. E. Ingalls. A quantitative analysis and comparison of B₇ and several forms of B₁₂ between coastal, sub arctic gyre and oligotrophic gyre regimes. Poster presentation at Ocean Science Meeting in Honolulu, HI.
- 2013 **Heal, K.R.** Embracing social media to teach introductory oceanography. Poster presentation at American Society of Limnology and Oceanography in New Orleans, LA.
- 2010 **Heal, K.R.**, Mayes, M., Phillips, J. Sorption of dissolved organic carbon onto subsurface soil. Oral presentation at Goldschmidt Geochemistry conference in Knoxville, TN.

TEACHING EXPERIENCE

- 2019 Co-Instructor of Record
Chemistry of Marine Organic Carbon
University of Washington
- 2015 Teaching Assistant (course development and implementation)
Chemistry of Marine Organic Carbon
University of Washington
- 2013 Teaching Assistant
Chemical Oceanography
University of Washington
- 2008-2011 Teaching Assistant – 5 courses total
Introductory Chemistry I and II, Organic Chemistry I, Atmospheric
Physics and Chemistry, Human Impacts on Biogeochemical Cycles
The Colorado College

MENTORSHIP EXPERIENCE

- 2019-present Founder and peer mentor for early career women and trans people in geosciences (anonymous group)
- 2019-2020 Alec Myers, post baccalaureate research assistant
- 2018-2019 Aaron Cheah, biochemistry undergraduate researcher
- 2016-2018 Natalie Kellogg, undergraduate researcher, post baccalaureate research assistant
- 2015-present Regina Lionheart, undergraduate researcher, post baccalaureate research assistant, research consultant

2015-2017 Alexandra Weid, undergraduate researcher
 2013-2014 Willow Coyote-Maestes, undergraduate researcher
 2012-2014 Davey French, undergraduate researcher, post baccalaureate research assistant

OCEANOGRAPHIC SHIPBOARD EXPERIENCE

2019 Honolulu to Honolulu on *R/V Kilo Moana*, 8 days
 2019 Honolulu to Honolulu on *R/V Kilo Moana*, 25 days
 2017 Honolulu to Honolulu on *R/V Langseth*, 19 days
 2015 Portland to Honolulu on *R/V Kilo Moana*, 10 days
 2013 Seattle to Honolulu on *R/V Kilo Moana*, 30 days
 2013 Hood Canal on *R/V Barnes*, 7 days
 2013 Strait of Juan de Fuca, *R/V Thompson*, 2 days
 2012 Hood Canal on *R/V Barnes*, 7 days
 2012 Hood Canal on *R/V Barnes*, 7 days
 2012 Station ALOHA on *R/V Kilo Moana*, 10 days
 2012 Seattle to Seattle on *R/V Thompson*, 7 days
 2012 Hood Canal on *R/V Barnes*, 7 days
 2011 Hood Canal on *R/V Barnes*, 5 days
 2011 Hood Canal on *R/V Barnes*, 5 days
 2010 Arica, Chile to Easter Island, Chile on *R/V Melville*, 28 days

NONTRADITIONAL EDUCATION AND TRAINING

2019 UNOLS Early Career Chief Scientist Training Program
 2018 An Introduction to Evidence-Based Undergraduate STEM Teaching
 Ten-week online course through EdX
 2015 Graduate Student Certificate on Climate Change
 University of Washington's Program on Climate Change
 Earned certificate in 2015, active member 2011-2018
 2012-2016 Program on Climate Change Summer Institutes (4)
 Four-day workshops on varied topics of climate change
 2012 Center for Microbial Oceanography Research and Education: From
 Genomes to Biomes Summer Course
 Six-week immersive program at the University of Hawai'i

UNIVERSITY AND ACADEMIC SERVICE

ad hoc Reviewer for *Limnology and Oceanography* (1), *Limnology and Oceanography Methods* (2), *Geochimica et Cosmochimica Acta* (1), *Analytical Chemistry* (1), *Aquatic Microbial Ecology* (2), *Applied and Environmental Microbiology* (2), *Environmental Microbiology* (1), NSF Chemical Oceanography proposals (2)

- 2020-present UW School of Oceanography Committee on Diversity, Equity, and Inclusion
- 2020-present Postdoc representative at faculty meetings
- 2019 Co-chair of session at ASLO meeting “New views on the biological transformation of metals in the marine environment”
- 2019 Mentor at ASLO meeting for two undergraduate students
- 2013-2017 Peer reviewer for NSF Graduate Research Fellowship Program applications
- 2016 Co-chair of the John Hedges Visiting Scholar committee
- 2016 Search committee member for Chemical Oceanography faculty hire
- 2012 Co-chair of the University of Washington’s School of Oceanography All Student Educational Retreat

PROFESSIONAL MEMBERSHIPS

- 2011-present American Society of Limnology and Oceanography
- 2018-present Society for Women in Marine Science
- 2018-present Metabolomics Society
- 2019-present Earth Science Women’s Network
- 2019-present Phycological Society of America
- 2020-present National Association of Geoscience Teachers