

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

PRIMARY RESEARCH INTERESTS

Microbial control on biogeochemical cycling
Ecophysiology of marine microbes
Development and application of mass spectrometry techniques within microbial ecology

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 (13 total, 5 as first or co-first author)

- 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. In press at *ISME Journal*.
- 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. In press at *Protist*.
- 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. In press at *Nature Microbiology*.
- 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-Habben, 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-Habben, 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.

MANUSCRIPTS SUBMITTED AND IN PREPARATION (drafts available on request)

- In prep 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*. In preparation for *ISME Journal*.
- In prep Dawson, H.M., Boysen, A.K., **Heal, K.R.**, 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. In preparation for *New Phytologist*.

FELLOWSHIPS AND GRANTS

- 2018 Postdoctoral Fellowship in Maine 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)
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

- 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

- 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. Oral presentation at Princeton University. Princeton, New Jersey.
- 2018 **Heal, K.R.** Power and promise of direct measurements of metabolites in marine systems. Invited 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)

- 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. 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 Instructor

	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

2018-	Aaron Cheah
	Biochemistry undergraduate at University of Washington
2016-2018	Natalie Kellogg
	Current graduate student at University of Washington
2015-2017	Regina Lionheart
	Current research consultant at University of Washington
2015-2017	Alexandra Weid
	Currently teaching English in Ecuador
2013-2014	Willow Coyote-Maestes
	Current graduate student at the University of Minnesota
2012-2014	Davey French
	Current graduate student at the University of Washington

OCEANOGRAPHIC SHIPBOARD EXPERIENCE

2019	Honolulu to Honolulu on <i>R/V Kilo Moana</i> , 8 days
2019	Honolulu to Honolulu on <i>R/V Kilo Moana</i> , 25 days
2017	Honolulu to Honolulu on <i>R/V Langseth</i> , 19 days
2015	Portland to Honolulu on <i>R/V Kilo Moana</i> , 10 days
2013	Seattle to Honolulu on <i>R/V Kilo Moana</i> , 30 days
2013	Hood Canal on <i>R/V Barnes</i> , 7 days
2013	Strait of Juan de Fuca, <i>R/V Thompson</i> , 2 days
2012	Hood Canal on <i>R/V Barnes</i> , 7 days
2012	Hood Canal on <i>R/V Barnes</i> , 7 days
2012	Station ALOHA on <i>R/V Kilo Moana</i> , 10 days
2012	Seattle to Seattle on <i>R/V Thompson</i> , 7 days
2012	Hood Canal on <i>R/V Barnes</i> , 7 days
2011	Hood Canal on <i>R/V Barnes</i> , 5 days
2011	Hood Canal on <i>R/V Barnes</i> , 5 days

2010 Arica, Chile to Easter Island 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 Hawaii

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 (1), Applied and
 Environmental Microbiology (1), Environmental Microbiology (1), NSF
 Chemical Oceanography proposals (1)
 2019 Co-chair of session at ASLO "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 Graduate student representative on faculty hiring committee
 2012 Co-chair of the University of Washington's School of Oceanography All
 Student Educational Retreat