

Second U.S. Ocean Acidification Principal Investigators' Meeting
Gallaudet University's Kellogg Conference Center, Washington, DC
September 17-20 2013
Participant Bios

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- Collaborative research: Measuring the kinetics of CaCO_3 dissolution in seawater using novel isotope labeling, laboratory experiments, and in situ experiments

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- Development of a novel sensor for in situ measurements of carbonate ions in seawater
- Collaborative Research: Development of an in situ sensor for high-resolution measurements of total dissolved inorganic carbon
- Ocean Acidification: Collaborative Research: Investigation of seawater CO_2 system thermodynamics under high pCO_2 conditions

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- West Coast OA cruises Puget Sound
- OA observations
- Developing methods for estimating OA chemistry based on proxies

Alin, S.R., R.A. Feely, A.G. Dickson, J.M. Hernandez-Ayon, L.W. Jurinek, M.D. Ohman, and R. Goericke, 2012. Robust empirical relationships for estimating the carbonate system in the southern California Current System and application to CalCOFI hydrographic cruise data (2005–2011). *Journal of Geophysical Research–Ocean*, doi:10.1029/2011JC007511.

Feely, R.A., S.R. Alin, J. Newton, C.L. Sabine, M. Warner, C. Krembs, and C. Maloy, 2010. The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an

urbanized estuary. *Estuarine, Coast, and Shelf Science*, 88: 442–449,
doi:10.1016/j.ecss.2010.05.004.

Juranek, L.W., R.A. Feely, W.T. Peterson, S.R. Alin, J. Peterson, K. Lee, C.L. Sabine, and B. Hales, 2009.
Robust determination of aragonite saturation state seasonal evolution near Newport, Oregon
using simple algorithms with hydrographic data. *Geophysical Research Letters*, 36,
doi:10.1029/2009GL040778.

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- The effects of ocean acidification and rising sea surface temperatures on shallow-water benthic organisms in Antarctica
- Studies of the shell condition and composition in gastropods in the vicinity of a natural volcanic vent near Vulcano Island, Italy

McDonald, M.R., J.B. McClintock, C.D. Amsler, D. Rittschof, R.A. Angus, B. Oriheula, & K. Lutostanski. 2009. Effects of ocean acidification over the life history of the barnacle *Amphibalanus amphitrite*. *Marine Ecology Progress Series* 385: 179-187.

McClintock, J.B., R.A. Angus, M.R. McDonald, C.D. Amsler, S.A. Catledge, & Y.K. Vohra. 2009. Rapid dissolution of shells of weakly calcified antarctic benthic macroorganisms indicates high vulnerability to ocean acidification. *Antarctic Science* 21: 449-456.

McClintock, J.B., M.O. Amsler, R.A. Angus, R.C. Challener, J.B. Schram, C.D. Amsler, C.L. Mah, J. Cuce, & B.J. Baker. 2011. Mg-Calcite composition of Antarctic echinoderms: important implications for predicting the impacts of ocean acidification. *Journal of Geology* 119: 457-466.

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- World Data Center for Paleoclimatology (Director), the largest archive of paleo data on ocean acidification
- Coral reef paleoclimatology at Chuuk Atoll in Western Pacific

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- Bermuda ocean acidification and coral reef investigation: BEACON (NSF)
- Mg-calcite mineral dynamics in natural seawater systems: relevance to oceanic uptake of anthropogenic CO₂ and ocean acidification (NOAA)
- Biogeochemical modification of seawater CO₂ chemistry in near-shore environments: effect of ocean acidification (NSF CAREER)

Andersson, A. J., and Gledhill, D., 2013. Ocean acidification and coral reefs: Effects on breakdown, dissolution and net ecosystem calcification. *Annual Reviews*, 5, doi:10.1146/annurev-marine-121211-172241.

Mackenzie, F. T., and Andersson, A. J., 2013. The ocean CO₂-carbonic acid-carbonate system and acidification during Phanerozoic time. *Geochemical Perspectives*, vol. 2(1), 227 p.
<http://www.geochemicalperspectives.org/wp-content/uploads/2013/04/GPv2n1.pdf>

Andersson, A. J., and Mackenzie, F. T., 2012. Revisiting four scientific debates in ocean acidification research. *Biogeosciences*, 9, 1-13.

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- EPOCA. European Project on Ocean Acidification (EU FP7) June 2008-June 2012.
- UK Ocean Acidification: Sea Surface Consortium (NERC). Sept 2010-Sept 2013.
- Influence of Ocean Acidification on Biotic Controls of DMS Emissions (NSF) Oct 2013-Oct 2016

Archer SD, Hopkins FE, Kimmance SA, Stephens J, Hopkins FE, Bellerby RGJ, Schulz KG, Piontek J, Engel A (2013) Contrasting response of DMS and DMSP to ocean acidification in Arctic waters. *Biogeosciences* 10, 1893-1908. doi:10.5194/bg-10-1893-2013

Hopkins FE, Kimmance SA, Stephens J, Bellerby RGJ, Brussard CPD, Czerny J, Schulz KG, Archer SD (2013) Response of halocarbons to ocean acidification in the Arctic. *Biogeosciences*, 10: 2331-2345, doi:10.5194/bg-10-2331-2013

Carpenter LJ, Archer SD, Beale R (2012) Ocean-atmosphere trace gas exchange. Critical Review. *Chemistry Society Reviews*. 41: 6473-6506. doi:10.1039/c2cs35121h

Suzanne N Arnold

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- Development and dissemination of research priorities, monitoring options, and mitigation strategies related to ocean acidification in Maine



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- Characterization of coastal carbonate systems near natural and restored seagrasses meadows in the Chesapeake Bay (USA) and their potential for blue carbon sequestration. Utilization of portable real-time MarCOM underway systems. Collaboration with the Smithsonian Environmental Research Center initiated via a senior postdoctoral fellowship in 2011.
- Impacts of ocean acidification on the production of carbon-based secondary metabolites in aquatic vegetation from the Chesapeake Bay (USA), Moreton Bay (Australia), and Sicilian CO₂ vent sites (Italy). Utilizes F.O.C.E. technology. With the MedSeA program.
- Establishment of the Inga P. Stafford climate research facility and greenhouse at Dickinson College. Manager of \$1.5 million facility completed in January 2013. Construction of OA seawater system. Development of education modules via the Valley and Ridge program in environmental sustainability. Related to a current NSF TUES/CCLI award for the development of problem-based learning teaching modules and courses.

Arnold TM, Mealey C, Leahey H, Miller AW, Hall-Spencer J, Milazzo M, and Maers K (2012) Ocean acidification and the loss of phenolic substances in marine plants. *PLoS ONE*

www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0035107

Schultz JC, HM Appel, Ferrieri A, Arnold TM (in press) Flexible resource allocation during plant defense response. Invited review, submitted May 2013 to *Frontiers in Plant Science*.

Witter A, Arnold TM (2013) Nature's Medicine Cabinet: An Interdisciplinary Course Designed To Enhance Student Learning by Investigating the Ecological Roles of Natural Products. ACS Books. "Teaching Bioanalytical Chemistry" Symposium Series volume "Teaching Bioanalytical Chemistry."

Arnold TM, Appel H, and Schultz JC (2012) Is polyphenol induction simply a result of altered carbon and nitrogen accumulation? *Plant Signaling & Behavior* 7:11, 1-3.

Arnold TM and Targett NM (2002) Review: Physiological basis of defense in marine macrophytes. *J. Chem. Ecol.* 28 (10): 1919-1934

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- Ocean Acidification Scientific Data Stewardship Program (NOAA-funded)

Arzayus et al., 2012. Towards and Ocean Acidification Data Stewardship System, NODC Earth System Monitor, 19:1. <http://www.nodc.noaa.gov/mobile/esm/esm19-1/#acid>

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- NSF Ocean Acidification-- Effects of ocean acidification on *Emiliania huxleyi* and *Calanus finmarchicus*; insights into the oceanic alkalinity and biological carbon pumps
- NSF Collaborative Research: The Great Southern Coccolithophore Belt
- NASA- "Land-to-sea carbon export from the northeast watersheds of North America to the northwest Atlantic Ocean" Sept 1, 2011 to Aug 31, 2014

Fabry, V.J., and W.M. Balch, 2010, Direct measurements of calcification rates in planktonic organisms, in Riebesell U., Fabry V. J., Hansson L. & Gattuso J.-P. (Eds.), 2010. Guide to best practices for ocean acidification research and data reporting, 260 p. Luxembourg: Publications Office of the European Union.

Balch, W., Utgoff, P., 2009. Potential interactions among ocean acidification, coccolithophores and the optical properties of seawater. *Oceanography* 22 (4), 146-159.

<http://dx.doi.org/10.5670/oceanog.2009.104#sthash.701LEbQT.dpuf>

Balch, W.M. and V. Fabry. 2008 Ocean acidification: documenting its impact on calcifying phytoplankton at basin scales. *Marine Ecology Progress Series*. 373: 239–247, doi: 10.3354/meps07801

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- On detail to the NOAA Ocean Acidification Program
- IWG-OA implementation plan

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- NSF-OCE #1129622: Will rising pCO₂ levels in the ocean affect growth and survival of marine fish early life stages? (Baumann and Gobler, 3y)

Baumann, H., Talmage, S.C., and Gobler, C.J. (2012). Reduced early life growth and survival in a fish as a direct response to elevated CO₂ levels. *Nature Climate Change* 2: 38-41.

<http://dx.doi.org/10.1038/NCLIMATE1291>

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- Ocean acidification along the California Current System (with PIs: Richard Feely, Jeremy Mathis and Mark Ohman)

N. Bednarsek et al., Extensive dissolution of live pteropods in the Southern Ocean. *Nature Geoscience* 5, 881-885 (2012).

N. Bednarsek et al., Description and quantification of pteropod shell dissolution: a sensitive bioindicator of ocean acidification. *Global Change Biology* 18, 2378-2388 (2012).

N. Bednarsek, et al., The global distribution of pteropods and their contribution to carbonate and carbon biomass in the modern ocean. *Earth System Science Data* 4 (2012).

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- Scientific coordination in the Southeast
- Coordination of unified OA communication and education effort
- Education implementation for NOAA OA Program

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- OA short course
- OA outreach activities
- OA website

Benway, H. M., S. R. Cooley, S. C. Doney (2010). A Catalyst for Ocean Acidification Research and Collaboration: Ocean Carbon and Biogeochemistry Short Course on Ocean Acidification; Woods Hole, Massachusetts, 2–13 November 2009. *Eos Trans. AGU* 91 (12).

Cooley, S. R., H. M. Benway (2010). Linking introductory chemistry and the geosciences through ocean acidification. *The Earth Scientist* (quarterly publication of the National Earth Science Teachers Association) 26(1), 39-42.

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- Ocean Acidification, Hypoxia and Warming: Experimental investigations into compounded effects of global change on benthic foraminifera

Bernhard JM, Barry JP, Buck KR, Starczak VR (2009a). Impact of intentionally injected carbon dioxide hydrate on deep-sea benthic foraminiferal survival. *Global Change Biology* 15: 2078-2088, DOI: 10.1111/j.1365-2486.2008.01822.x.

Bernhard JM, Mollo-Christensen E, Eisenkolb N, Starczak VR (2009b). Tolerance of allogromiid Foraminifera to severely elevated carbon dioxide concentrations: Implications to future ecosystem functioning and paleoceanographic interpretations. *Global and Planetary Change* 65: 107-114, DOI: 10.1016/j.gloplacha.2008.10.013.

McIntyre-Wressnig A, Bernhard JM, McCorkle DC, Hallock P (2013). Non-lethal effects of ocean acidification on the symbiont-bearing benthic foraminifer *Amphistegina gibbosa*. *Marine Ecology Progress Series* 472: 45-60, DOI: 10.3354/meps09918.

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- OMEGAS: Ocean Margin Ecosystem Group for Acidification Studies. Focus integrates oceanography, ecology, physiology, genetics, and genomics in studies of mussels and sea urchins. Study includes quantification of pH and pCO₂ in intertidal and shallow subtidal region of inner shelf ranging from central Oregon to southern California [with Bruce Menge and collaborators]
- Collaboration with the CA Water Board: June 2012 - May 2013: Testing stability and reliability of in situ pH sensors [with Uta Passow and collaborators]
- Effective Practices for Ocean Acidification Communication [with staff from NOAA CINMS]

Hofmann, G.E., C.A. Blanchette, E.B. Rivest, and L. Kapsenberg. 2013. Taking the Pulse of Marine Ecosystems: The Importance of Coupling Long-Term Physical and Biological Observations in the Context of Global Change Biology. *Oceanography* 26(3):140–148,
<http://dx.doi.org/10.5670/oceanog.2013.56>.

Hofmann, G. E., T. G. Evans, M. W. Kelly, J. L. Padilla-Gamiño, C. A. Blanchette, L. Washburn, F. Chan, M. A. McManus, B. A. Menge, B. Gaylord, T. M. Hill, E. Sanford, M. LaVigne, J. M. Rose, L. Kapsenberg, and J. M. Dutton. 2013. Exploring local adaptation and the ocean acidification seascapes – studies in the California Current Large Marine Ecosystem. *Biogeosciences Discuss.*, 10, 11825-11856, 2013

Chan, F., J. Barth, C. Blanchette, F. Chavez, O. Cheriton, G. Friederich, B. Gaylord, T. Gouhier, T. Hill, G. Hofmann, M. McManus, B. Menge, A. Russell, E. Sanford, L. Washburn. 2013. Widespread detection of coastal ocean acidification across the California Current system in prep.

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- Controlled experimental aquarium system for multi-stressor investigation: carbonate chemistry, oxygen saturation, and temperature
- Filtration methods of discrete samples for carbonate chemistry analysis
- Various CO₂ sample analyses as well as Certified Reference Material (CRM) creation and proficiency testing

E. E. Bockmon, C. A. Frieder, M. O. Navarro, L. A. White-Kershek, and A. G. Dickson. Controlled experimental aquarium system for multi-stressor investigation: carbonate chemistry, oxygen saturation, and temperature. *Biogeosciences Discuss.*, 10, 3431-3453, doi:10.5194/bgd-10-3431-2013, 2013.

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- Program management of numerous ocean acidification-relevant topics.

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- Long-term monitoring of ecological/ecosystem impacts of ocean acidification on coral reefs, including carbonate chemistry, calcification and bioerosion rates, and biodiversity.
- Incorporating Considerations of Climate Change and Ocean Acidification into an Ecosystem Approach to Fisheries Management

Brainard RE, M Weijerman, CM Eakin, P McElhany, MW Miller, M Patterson, GA Piniak, MJ Dunlap, C Birkeland (In press, Cons. Bio.). Incorporating climate and ocean change into extinction risk assessments for 82 coral species.

Price, N, T Martz, RE Brainard, JE Smith (2012). Diel variability in seawater pH relates to calcification and benthic community structure on coral reefs. PLoS ONE 7(8): e43843.
doi:10.1371/journal.pone.0043843.

Heenan A, R Pomeroy, R Brainard, et al. (2013). Incorporating climate and ocean change into an Ecosystem Approach to Fisheries Management (EAFM) plan. Publication. Honolulu, Hawaii: The USAID Coral Triangle Support Partnership.

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- CHRP:Shallow water hypoxia - Tipping the balance for individuals, populations and ecosystems (effects of diel-cycling hypoxia and acidification on disease dynamics, fish and oyster growth and food web structure in Chesapeake Bay)
- Ecology of an extreme environment: Shallow mangrove ponds (mangrove ponds as a natural model system to examine effects of hypoxia and acidification)

Breitburg, Denise L., Hondorp, Darryl W., Davias, Lori A. and Diaz, Robert J. 2009. Hypoxia, Nitrogen, and Fisheries: Integrating Effects Across Local and Global Landscapes. Annual Revue of Marine Science, 1(1): 329-349. doi:10.1146/annurev.marine.010908.163754

Breitburg, Denise L., Craig, J. K., Fulford, Richard S., Rose, K. A., Boynton, W. R., Brady, D. C., Ciotti, B. J., Diaz, R. J., Friedland, K. D., Hagy, J. D., III, Hart, D. R., Hines, Anson H., Houde, E. D., Kolesar, S. E., Nixon, S. W., Rice, J. A., Secor, D. H. and Targett, T. E. 2009. Nutrient enrichment and fisheries exploitation: interactive effects on estuarine living resources and their management. Hydrobiologia, 629(1): 31-47. doi:10.1007/s10750-009-9762-4

Breitburg, Denise L. and Riedel, Gerhardt. 2005. Multiple stressors in marine systems. In: Crowder, L. E., Marine Conservation Biology: the Science of Maintaining the Sea's Biodiversity. Washington, D.C.: Island Press, pp.167-182. (http://books.google.com/books?hl=en&lr=&id=J-2IcCC_Yn0C&oi=fnd&pg=PA167&dq=breitburg+multiple+stressors&ots=pZ5FH2e4yI&sig=h8lvxKPVyD0qTnMvDTN_C8VYu9I#v=onepage&q=breitburg%20multiple%20stressors&f=false)

Breitburg, D. S. Seitzinger and J. Sanders, editors. 1999. The effects of multiple stressors on freshwater and marine ecosystems. Limnology and Oceanography special issue 44:3 part 2: 739-932. http://aslo.org/lo/toc/vol_44/issue_3_part_2/index.html

Breitburg, Denise L., Baxter, J., Hatfield, C., Howarth, R. W., Jones, C. G., Lovett, G. M. and Wigand, C. 1998. Understanding effects of multiple stressors: ideas and challenges. In: Pace, M. and Groffman, P., Successes, Limitations and Frontiers in Ecosystem Science. New York: Springer, pp.416-431.

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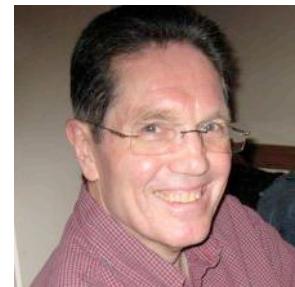
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- Synergistic effects of iron, carbon dioxide and temperature on the fate of nitrate: Implications for future changes in export production in the Southern Ocean

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- Establish ocean and coastal technical workgroup in response to request from State of Washington

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- Prize lead for the Wendy Schmidt Ocean Health X PRIZE, a \$1.5M global competition for the development of accurate, robust, and affordable pH sensors to profoundly improve our understanding of ocean acidification.

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- Vulnerability assessment of California Current food webs and economics to ocean acidification
- Laboratory studies on the response of economically and ecologically important North Pacific species to ocean acidification
- Incorporating climate change and ocean acidification in actions related to management and listing of species under the US Endangered Species Act

Busch, D. S., C. Harvey, P. McElhany. In press. Potential impacts of ocean acidification on the Puget Sound food web. ICES Journal of Marine Science.

McElhany, P., D. S. Busch. 2012. Appropriate pCO₂ treatments in ocean acidification experiments. Marine Biology. doi: 10.1007/s00227-012-2052-0

Ainsworth, C., J. Samhouri, D. S. Busch, W. Cheung, J. Dunne, T. Okey. 2011. Potential impacts of climate change on Northeast Pacific marine fisheries and food webs. ICES Journal of Marine Science 68: 1217-1229. doi: 10.1093/icesjms/fsr043

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- (NSF) Ocean Acidification: Collaborative Research: Investigation of seawater CO₂ system thermodynamics under high pCO₂ conditions.
- (NOAA) Time Series and Underway Assessments of Ocean Acidification and Carbon System Parameters in Coastal Waters.
- (NSF) Purification and Calibration of Indicators for Measurement of Seawater pH.

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- Collaborative Research - Ocean Acidification Category 1: Interactive Effects of Temperature, Nutrients, and Ocean Acidification on Coral Physiology and Calcification, with Andrea Grottoli and Mark Warner (9/10-9/13).
- NOAA Ocean Acidification Program Theme 1 Oceanic, Coastal and Estuarine Observing Networks: North Atlantic Ocean, East and Gulf Coast.

- Cai, W.-J. X. Hu, W. Huang, M. C. Murrell, J. C. Lehrter, S.E. Lohrenz, W.-C. Chou, W. Zhai, J.T. Hollibaugh, Y. Wang, P. Zhao, X. Guo, K. Gundersen, M. Dai and G.-C. Gong. 2011. Acidification of subsurface coastal waters enhanced by eutrophication. *Nature Geoscience* 4, 766-770, doi:<http://www.nature.com/ngeo/journal/v4/n11/abs/ngeo1297.html#supplementary-information> (2011).
- Hu, X. and Cai, W.-J. 2011. The impact of denitrification on the atmospheric CO₂ uptake potential of seawater. *Marine Chemistry* 127:192-198, doi:10.1016/j.marchem.2011.09.008.
- Hu, X. and Cai, W.-J., 2011. An assessment of ocean margin anaerobic processes on oceanic alkalinity budget. *Global Biogeochemical Cycles* 25, GB3003, doi: 10.1029/2010GB003859.
- Jiang, L.-Q., Cai, W.-J., Feely, R., Wang, A. Y., X. Guo, Gledhill, D. K., Hu, X., Arzayus, F., Chen, F., Hartmann, J., and Zhang, L. 2010. Carbonate mineral saturation states along the U.S. east coast. *Limnology and Oceanography*, 55(6), 2010, 2424-2432, DOI: 10.4319/lo.2010.55.6.2424.
- Sunda, W. G., and W.-J. Cai. 2012. Eutrophication Induced CO₂-Acidification of Subsurface Coastal Waters: Interactive Effects of Temperature, Salinity, and Atmospheric pCO₂. *Environmental Science & Technology*. DOI: 10.1021/es300626f.
- Wang, Z. A., Wanninkhof, R., Cai, W.-J., Byrne, R.H., Hu, X., Peng, T.-H., Huang, W.J. The marine inorganic carbon system along the Gulf of Mexico and Atlantic coasts of the United States: Insights from a transregional coastal carbon study. 2013. *Limnology and Oceanography* 58 (1): 325-342. DOI: 10.4319/lo.2013.58.1.032.

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- Effects of CO₂ and temperature on early life-stages of Winter Flounder and Summer Flounder of the northeast Atlantic coast

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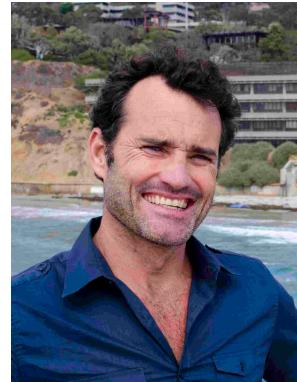
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- Geochemistry of calcification: Coral biomineralization in a changing ocean



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- Oversight and coordination of the ocean acidification monitoring requirements being advanced through CRCP National Coral Reef Monitoring Strategy as leveraged by OAP investments.

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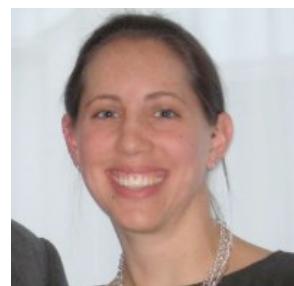
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- Genetic response of diatoms to CO₂/pH



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- Impacts of OA on open-coast and estuarine foundation species in a California upwelling zone [with Eric Sanford, Brian Gaylord, Tessa Hill, and Ann Russell; UC Davis/Bodega Marine Laboratory].

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- Field monitoring of coral and CCA calcification rates
- Paleorecord of coral growth and temperature • Proxy development and calibration for environmental variables

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- Horizontal and Vertical Distribution of Thecosome Pteropods in Relation to Carbonate Chemistry (NSF OA; co-PIs Aleck Wang, Andone Lavery, Peter Wiebe)
- Acidification of the Coastal Ocean: Are Deep Waters of the Gulf of Maine already Corrosive to Pteropods? (WHOI funds; co-PI Aleck Wang)
- Ocean Acidification: Seasonal and Ontogenetic Effects of Ocean Acidification on Pteropods in the Gulf of Maine (NSF OA; co-PIs Amy Maas, Ann Tarrant)

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- Development of geochemical proxies to evaluate larval pH and O₂ exposure history
- Macrophyte-induced variability in coastal ocean pH and consequences for invertebrate larvae
- Disentangling effects of low O₂ and low pH in upwelling regions.

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- Effects of ocean acidification on king and Tanner crabs.

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- Planktonic interactions in a changing ocean: Biological responses of *Emiliania huxleyi* to elevated pCO₂ and their effects on microzooplankton
- Exploratory project on the effects of eel grass beds on pCO₂ on diurnal and tidal time scales in Padilla Bay, WA

Effects of Elevated pCO₂ on the Calcification and Morphological Characteristics of the Coccolithophore *Emiliania huxleyi*, in prep, Christina Goethel, Anna Hildebrandt, Brooke Love, Brady Olson, Kasey Kendall.

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- G.L. Lawson, A.E. Maas, A.M. Tarrant "Ocean Acidification: Seasonal and ontogenetic effects of acidification on pteropods in the Gulf of Maine" (NSF - OA 2013).
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- Proteomic, genomic, and elemental characterization of photosynthetic strategies in picocyanobacteria

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- Predicting "Winners and Losers" to ocean acidification: a physiological genomic study of genetically-determined variance during larval development

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- Development and application of the COMBO model, which estimates impacts of future climate change on coral reefs by combining effects from long-term changes in average sea surface temperature (SST) and ocean acidification with impacts from episodic high temperature mortality (bleaching) events.

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- Development of SeaFET, SeapHOx, and Deep-Sea Durafet sensors
 Modification of CROSS system to study alkalinity flux on reef systems
 development of technologies for pH and DIC on profiling floats

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- The impacts of ocean acidification and rising temperatures on Antarctic calcified algae and invertebrates (with C. Amsler and R. Angus)
- The impacts of hypercapnic conditions on echinoids in land based aquaculture (with R. Challener)
- The magnesium-calcite levels of skeletal elements of echinoderms in polar, temperate and tropical latitudes as they relate to vulnerability to ocean acidification Studies of the shell condition and composition for a suite of limpets and gastropods occurring in the vicinity of a natural volcanic vent near Vulcano Island, Italy (with A. Duquette, C. Amsler, J. Ries)

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- Time-series measurements of coastal carbonate chemistry
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- Coral community calcification rate studies

*White, M.M., D.C. McCorkle, L.S. Mullenax, and A.L. Cohen (2013) Early exposure of bay scallops (*Argopecten irradians*) to high CO₂ causes initial decrease in shell growth resulting in persistent smaller larval size. PLoS ONE 8(4): e61065.doi:10.1371/journal.pone.0061065.

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- Species OA exposure experiments
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- Carbonate preservation in pelagic sediments: Developing a new aragonite preservation proxy
- A Multi-Proxy Search for the Deglacial Deep Sea Carbonate Preservation Maximum.

- Quantifying Calcite Flux and the Organic Carbon to Calcite Flux Ratio in the Tropical and Subtropical World Ocean

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- ACIDIC: Algal Communities in Distress: Impacts and Consequences. Focus on linking oceanography, ecology, and physiology in study of coralline algal and associated species response to OA in field and lab mesocosm settings in Oregon and northern California.

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- Impact of ocean acidification on the early life stages of surfclams and sea scallops.



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- Ocean Acidification: Examining impacts on squid paralarval development, behavior, and survival
- The I-TAG (Invertebrate Tag): Coordinated measures of invertebrate behavior and their natural environment using novel "eco-sensors"

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- Economic Impacts of Ocean Acidification

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- Effects of pCO₂ and pH on photosynthesis, respiration and growth in marine phytoplankton (NSF).
- EFFECTS OF OCEAN ACIDIFICATION ON NUTRIENT AVAILABILITY AND REQUIREMENTS IN PHYTOPLANKTON (NSF).

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- NANOOS-IOOS observations in support of NOAA OAP
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- Global OA Observing Network

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O'Donnell, M.J., George, M.N., Carrington, E. (2013) Mussel byssus attachment weakened by ocean acidification. *Nature Climate Change*. DOI 10.1038/NCLIMATE1846.
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- Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System

- Emergent effects of ocean acidification on ecosystem function in Ischia, Italy
- How marine species affect ocean acidification: ecosystem engineering and mitigation on coral reefs

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- OCE-1041038: 10/1/10-9/31/14 Will high CO₂ conditions affect production, partitioning and fate of organic matter?
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- The patterns of carbon cycle change along the Washington state shore.
- The ancient and recent history of isotopic and elemental analyses of mussel shells.
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- Nutrient and carbon chemistry associated with the Hudson-Raritan Bay Estuary and the upwelling centers off the New Jersey coast.

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- (Moore Foundation) Population and community ecological responses to natural variation in the carbonate system on remote coral reefs [with J. Smith, R. Dunbar, and T. Martz],
- (CA Seagrant) Physiological response of seaweeds to warming and OA [with J. Smith, S. Hamilton, and M. Graham],
- (NSF) Quantifying biogeochemical feedbacks (H and O₂ flux) on tropical coral reefs using a modified CROSS system [with J. Smith, T. Martz, and W. McGillis]

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- Tracking and assisting projects aiming to advance the understanding of the role of land-based sources (e.g., nutrients) in contributing to coastal acidification and its impact on shellfish populations.
- Evaluating ocean and coastal acidification research to assist in the development of approaches to address ocean acidification-related impairments in coastal waters through the Clean Water Act Section 303(d) Listing of Threatened and Impaired Waters and Total Maximum Daily Load (TMDL) programs.

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- Feeding and nutrient excretion of adult Antarctic krill, *Euphausia superba*, exposed to enhanced CO₂ (Funded by Moore Foundation grant #1859 and Palmer LTER: NSF# ANT-0823101)
- Effects of enhanced CO₂ on Antarctic plankton community structure and biogeochemical cycles (Funded by Moore Foundation grant #1859, New Jersey Agricultural Experiment Station (NJAES) Competitive Intramural Research Awards Program Palmer LTER: NSF# ANT-0823101)

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- Impacts of ocean acidification on open-coast and estuarine foundation species (mussels and oysters) in a California upwelling zone [with Brian Gaylord, Tessa Hill, and Ann Russell; UC Davis/Bodega Marine Laboratory].

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Tatters A.O., Roleda M.Y., Schnetzer A., Fu F., Hurd C., Boyd P.W., Caron D.A., Lie A., Hoffmann L. and Hutchins D.A. (in revision) Adaptation of a Temperate Marine Diatom Community to a Global Change Matrix - *Philosophical Transactions B*
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- Ocean Acidification: Oxygen-limited CO₂ tolerance in Squids

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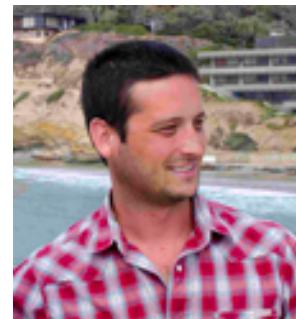


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