Dr. Christina Frieder

Senior Scientist
Biogechemistry Department
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Education

Ph.D., Biological Oceanography, Scripps Institution of Oceanography, University of California San Diego, 2013

B.S, Aquatic Biology, University of California Santa Barbara, Distinction in Major, 2006

Professional Experience

Senior Scientist, Southern California Coastal Water Research Project, 2022-present

Scientist, Southern California Coastal Water Research Project, 2021-2022

Research Specialist and Postdoctoral Researcher, University of California, Irvine, 2018-2020

Postdoctoral Research Associate, University of Southern California, 2014-2018

Selected Presentations and Conference Proceedings

F Kessouri, CA Frieder, M Sutula, S Chu, CX Xiang. High-resolution modeling of Direct Ocean Capture in the southern California Current System. Oral presentation delivered at the Ocean Sciences Meeting, New Orleans, LA. February 2024.

Frieder CA, F Kessouri, M Sutula, K McLaughlin, D Feely, B Carter. Attribution of local-to-global stressors on pelagic calcifier habitat in the southern California Current System. Oral presentation delivered at the Ocean Sciences Meeting, New Orleans, LA. February 2024.

Frieder CA, F Kessouri, M Ho, N Bednarsek, M Sutula, K McLaughlin, D Bianchi, J McWilliams, P

Damien, E Howard, C Deutsch. Biological exposure to ocean acidification, hypoxia, and warming emerges from a confluence of ocean climate state and local stressors in the southern California Current System. Oral presentation delivered at the Ocean Sciences Meeting, Honolulu, HI, February 2022. (virtual)

Frieder CA, K Davis, M Chamecki, Y chao, J McWilliams, D Dauhajre, M Sutula, F Kessouri, R Kudela, M McPherson, J Infante. A Modeling platform to evaluate offshore macroalgal farming. Oral presentation delivered at the Ocean Sciences Meeting, San Diego, CA, February 2020.

Frieder CA, SL Applebaum, T-C F Pan and DT Manahan. Advancements in quantifying energy costs for organisms to respond to ocean change. Oral presentation delivered at the Ocean Sciences Meeting, Portland, OR, February 2018.

Frieder CA, SL Applebaum, T-C F Pan and DT Manahan. Metabolic costs of environmental stressors in feeding larval forms. Poster presented at the International Larval Biology Symposium, Honolulu, HI, August 2017.

Frieder CA, SL Applebaum, T-C F Pan, D Hedgecock and DT Manahan. Energy metabolism and shell formation in bivalve larvae under different environmental conditions. Oral presentation delivered at the Society for Integrative and Comparative Biology, New Orleans, LA, January 2017.

Frieder CA, T-C F Pan, SL Applebaum and DT Manahan. Ocean acidification causes increased calcium carbonate turnover during larval shell formation. Oral presentation delivered at the Ocean Sciences Meeting, New Orleans, LA, February 2016.

Frieder CA, SL Applebaum, T-C F PAN and DT Manahan. Characterization of coastal CO_2 dynamics and physiological responses of larval Pacific oyster to experimental ocean acidification. Poster presented at the National Shellfisheries Association meeting, Monterey, CA, March 2015.

Frieder CA and LA Levin. Macrofaunal biotic responses through the U.S. West Coast Oxygen Minimum Zone. Oral presentation delivered at the Coastal and Estuarine Research Federation meeting, San Diego, CA, November 2013.

Frieder CA and LA Levin. Larval responses of *Mytilus californianus* and *M. galloprovincialis* to low oxygen and/or high pCO_2. Poster presented at the Ocean in a High-CO_2 World, Monterey, CA, September 2012.

Frieder CA, MO Navarro and LA Levin. Continental shelf oxygen and pH dynamics: Implications for *Mytilus californianus* and *Doryteuthis opalescencs* early development. Oral presentation delivered at the National Shellfisheries Association meeting, Seattle, WA, March 2012. *Received Outstanding Student Oral Presentation.

Frieder CA and LA Levin. Macrofaunal diversity and community structure in the world's oxygen

minimum and carbon maximum zones. Oral presentation delivered at the Ocean Sciences meeting, Salt Lake City, UT, February 2012.

Frieder CA, TR Martz and LA Levin. Scales and sources of pH and dissolved oxygen variability in a shallow, upwelling-driven ecosystem, Oral presentation delivered at the American Geophysical Union annual meeting, San Francisco, CA, December 2011.

Frieder CA, TR Martz and LA Levin. Scales, sources and implications of short-term oxygen and pH variability on the continental shelf off southern California. Oral presentation delivered at the Eastern Pacific Ocean Conference, Tahoe, CA, October 2011.

Frieder CA and LA Levin. Present-day environmental pH windows experienced by marine larvae. Oral presentation delivered at Aquatic Sciences, San Juan, Puerto Rico, February 2011.

Journal Articles

Frieder, C.A., T.W. Bell, H. Berry, K. Cavanaugh, D.C. Claar, J. Freiwald, B. Grime, S. Hamilton, H.F. Houskeeper, N. Lombardo, S. Marion, T.A. McHugh, G. McKenna, P.E. Parnell, P. Spector, S.B. Weisberg. 2025. Developing a Status and Trends Assessment for Floating Kelp Canopies across Large Geographic Areas. *Environmental Science & Technology* DOI:10.1021/acs.est.5c07501.

Hoel, P., D. Bianchi, K.C. Cavanaugh, C.A. Frieder, F. Kessouri. 2025. Influence of anthropogenic nutrient sources on kelp canopies during a marine heat wave. *Marine Pollution Bulletin* 216:117788.

Frieder, C.A., F. Kessouri, M. Ho, M. Sutula, D. Bianchi, J.C. McWilliams, C. Deutsch, E. Howard. 2024. Effects of urban eutrophication on pelagic habitat capacity in the Southern California Bight. *Frontiers in Marine Science* 11:1392671.

Bo, T., J.C. McWilliams, C.A. Frieder, K.A. Davis, M. Chamecki. 2024. Nutrient Replenishment by Turbulent Mixing in Suspended Macroalgal Farms. *Geophysical Research Letters* DOI:10.1029/2024GL109128.

Kessouri, F., M. Sutula, D. Bianchi, M. Ho, P. Damien, J.C. McWilliams, C.A. Frieder, L. Renault, H. Frenzel, K. McLaughlin, C. Deutsch. 2024. Cross-shore transport and eddies promote large scale response to urban eutrophication. *Scientific Reports* 14:7240.

Ho, M., F. Kessouri, C.A. Frieder, M. Sutula, D. Bianchi, J.C. McWilliams. 2023. Effect of ocean outfall discharge volume and dissolved inorganic nitrogen load on urban eutrophication outcomes in the Southern California Bight. *Scientific Reports* 13:22148.

Arzeno-Soltero, I.B., B.T. Saenz, C.A. Frieder, M.C. Long, J. DeAngelo, S.J. Davis, K.A. Davis. 2023. Large global variations in the carbon dioxide removal potential of seaweed farming due to biophysical constraints. *Communications Earth and Environment* 4:185.

DeAngelo, J., B.T. Saenz, I.B. Arzeno-Soltero, C.A. Frieder, M.C. Long, J. Hamman, K.A. Davis, S.J. Davis. 2023. Economic and biophysical limits to seaweed farming for climate change mitigation. *Natural Plants* 9:45-57.

Frieder, C.A., C. Yan, M. Chamecki, D. Dauhajre, J.C. McWilliams, J. Infante, M.L. McPherson, R.M. Kudela, F. Kessouri, M. Sutula, I.B. Arzeno-Soltero, K.A. Davis. 2022. A Macroalgal Cultivation Modeling System (MACMODS): Evaluating the Role of Physical-Biological Coupling on Nutrients and Farm Yield. *Frontiers in Marine Science* DOI:10.3389/fmars.2022.752951.

Frieder, CA, Yan, C, Chamecki, M, Dauhajre, D, McWilliams, J C, Infante, J, ... & Davis, K. (2022) A macroalgal cultivation modeling system (MACMODS): Evaluating the role of physical-biological coupling on nutrients and farm yield. Frontiers in Marine Science, 214.

Ern R, D Chung, CA Frieder, N Madsen and B Speers-Roesch (2020) Oxygen-dependence of upper thermal limits in crustaceans from different thermal habitats. Journal of Thermal Biology 93, 102732.

Breitburg DL, H Baumann, IM Sokolova and CA Frieder (2019) Chapter 6. Multiple stressors - forces that combine to worsen dioxygen and its effects. In: Ocean deoxygenation: Everyone's problem. Causes, impacts, consequences and solutions. International Union for Conservation of Nature (IUCN) Report xxii, 562 pp.

Frieder CA, SL Applebaum, T-CF Pan and DT Manahan (2018) Shifting balance of protein synthesis and degradation sets a threshold for larval growth under environmental stress. The Biological Bulletin 234, 45-57.

Pan T-CF, SL Applebaum, CA Frieder, and DT Manahan (2018) Biochemical bases of growth variation during development: a study of protein turnover in pedigreed families of bivalve larvae (Crassostrea gigas). Journal of Experimental Biology 221:jeb171967 *selected as Editor's Choice and 2018 JEB Outstanding Paper

Frieder CA, SL Applebaum, T-CF Pan, D Hedgecock and DT Manahan (2017) Metabolic cost of calcification in bivalve larvae under experimental ocean acidification. ICES Journal of Marine Science 74, 941-954. *selected as Editor's Choice

Sweetman AK, AR Thurber, CR Smith [et al., including CA Frieder] (2017) Global climate change effects on deep seafloor ecosystems. Elementa: Science of the Anthropocene 5, 4.

Sperling EA, CA Frieder and LA Levin (2016) Biodiversity response to natural gradients of multiple stressors on continental margins. Proceedings of the Royal Society B 283, 20160637.

Grupe BM, ML Krach, AL Pasulka, JM Maloney, LA Levin, CA Frieder (2015) Methane seeps enhance continental margin ecosystem services: Evidence from a recently discovered southern California seep. Marine Ecology 36, 91-108.

Levin LA, B HÃ□Â□Ã□Â□Ã□Â□Ã□Â¶nisch and CA Frieder (2015) Geochemical proxies for estimating faunal exposure to ocean acidification. Oceanography 28(2), 62-73.

Maloney JM, BM Grupe, AL Pasulka, KS Dawson, DH Case, CA Frieder, LA Levin, NW Driscoll (2015) Transpressional segment boundaries in strike-slip fault systems offshore southern California: Implications for fluid expulsion and cold-seep habitats. Geophysical Research Letters doi:10.1002/2015GL063778.

Nam SH, Y Takeshita, CA Frieder, T Martz and J Ballard (2015) Seasonal advection of Pacific Equatorial Water alters oxygen and pH in the Southern California Bight. Journal of Geophysical Research: Oceans doi:10.1002/2015JC010859.

Takeshita Y, CA Frieder, TR Martz, JR Ballard, RA Feely, S Kram, S Nam, MO Navarro, NN Price and JE Smith (2015) Including high-frequency variability in coastal ocean acidification projections. Biogeosciences 12, 5853-5870.

Frieder CA (2014) Present-day nearshore pH differentially depresses fertilization in congeneric sea urchins. Biological Bulletin 226(1), 1-7.

Frieder CA, JP Gonzalez, EE Bockmon MO Navarro and LA Levin (2014) Can variable pH and low oxygen moderate ocean acidification outcomes for mussel larvae? Global Change Biology 20(3), 754-764.

Frieder CA, JP Gonzalez and LA Levin (2014) Uranium in larval shells as a barometer of molluscan ocean acidification exposure. Environmental Science & Technology 48, 64016408.

Navarro MO, EE Bockmon, CA Frieder, JG Gonzalez and LA Levin (2014) Environmental pH, O2, and capsular effects on the geochemical composition of statoliths of embryonic squid Doryteuthis opalescens. Water 6(8), 2233-2254.

Pfister CA, A Esbaugh, CA Frieder, et al. (2014) Detecting the unexpected: A research framework for ocean acidification. Environmental Science & Technology 48, 9982-9994.

Bockmon EE, CA Frieder, MO Navarro, LA White-Kershek and AG Dickson (2013) Technical note: Controlled experimental aquarium system for multi-stressor investigation of carbonate chemistry, oxygen saturation, and temperature. Biogeosciences 10, 59675975.

Sperling EA, CA Frieder, AV Raman, PR Girguis, LA Levin and AH Knoll (2013) Oxygen, ecology, and the Cambrian radiation of animals. Proceedings of the National Academy of Sciences USA 110, 13446-13451. *PNAS cover image

Frieder CA, SH Nam, TR Martz and LA Levin (2012) High temporal and spatial variability of dissolved oxygen and pH in a nearshore California kelp forest. Biogeosciences 9, 39173930.

Hofmann GE, JE Smith, KS Johnson, [et al., including CA Frieder] (2011) High-frequency dynamics of ocean pH: A multi-ecosystem comparison. PLoS ONE 6(12), e28983.

Technical Reports

Patin, N., M. Sutula, C.A. Frieder, S. Theroux. 2026. Best practices for monitoring biological effects of ocean acidification with environmental DNA (eDNA) and other 'Omics approaches: March 17-18, 2025, Workshop Proceedings. Technical Report 1461. Southern California Coastal Water Research Project. Costa Mesa, CA.

Sutula, M., F. Kessouri, C.A. Frieder, N. Lombardo. 2026. Quantifying Uncertainty in Oxygen Predictions of an Ocean Numerical Model: A Case Study for Application to Anthropogenic Nutrient Effect Assessment. Technical Report 1445. Southern California Coastal Water Research Project. Costa Mesa, CA.

Sutula, M., F. Kessouri, M. Ho, C.A. Frieder. 2026. Numerical Simulation of Potential Eutrophication Effects of Oil and Gas Produced Water Discharges on the Southern California Bight. Technical Report 1446. Southern California Coastal Water Research Project. Costa Mesa, CA.

Sutula, M., F. Kessouri, C.A. Frieder, N. Lombardo. 2025. Quality Control Procedures for the Development, Validation and Science Applications of the Regional Ocean Modeling System with Biogeochemical Elemental Cycling Model (2019-2026). Technical Report 1444. Southern California Coastal Water Research Project. Costa Mesa, CA.