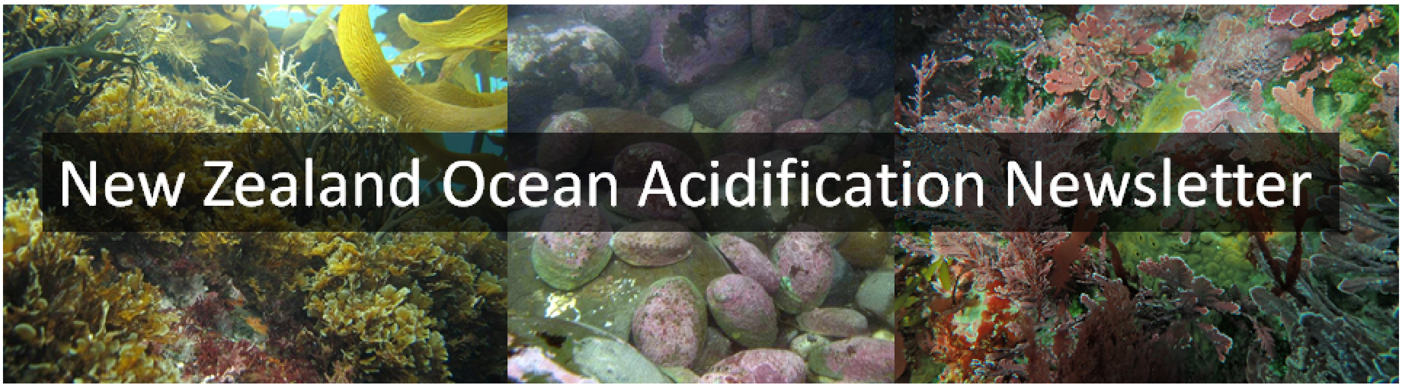
#66– August 2020 (http://nzoac.nz/)



Local News

14th annual New Zealand Ocean Acidification Conference – Dunedin Feb 2021

The 14th annual New Zealand Ocean Acidification Conference will be held in Dunedin during the week of February 8th (final dates TBC). We are aware that institutional restrictions on travel may limit the ability of some of our members to attend, so we are considering a mix of virtual and live sessions. To assist the NZOAC in planning, please send Christina McGraw (christina.mcgraw@otago.ac.nz) a short e-mail indicating whether you plan to attend in person or would prefer virtual options.

International News

Save the date: Ocean Acidification Week, 8-10 September 2020

Date: 8-10 September 2020
Description: A virtual multi-day forum to highlight different aspects of ocean acidification research and initiatives

The key goals of OA Week are to:

1. Engage the ocean acidification and broader oceanographic communities, raise awareness to the issue of ocean acidification, and bring attention to the global efforts being conducted related to monitoring, research, capacity building, capacity needs, and education.
2. Maintain momentum around the upcoming 5th International Symposium on the Ocean in a High CO_2 World, and share progress on GOA-ON's three High-level Goals.
3. Serve as the "kick off" to a new GOA-ON Webinar Series.

Each session will be hosted by a different GOA-ON regional hub and will be approximately 1 hour and 30 minutes. Each session will feature 3-5 short presentations that will be immediately followed by a live panel discussion and Q&A with the speakers. All sessions will be archived on the GOA-ON Youtube Channel.

More information.

Selection of recent papers

Inclusion of uncertainty in the calcium-salinity relationship improves estimates of ocean acidification monitoring data quality. The effects of Ocean Acidification (OA) and the resulting decrease of $CaCO_3$ saturation state (Ω) on marine organisms and biogeochemistry are observed through regionally dispersed monitoring programs. The standard of data collected by these programs is assessed based on the computed propagated uncertainties of $[CO_3^{2-}]$, with data quality regulated by thresholds defined by the Global Ocean Acidification Observing Network (GOA-ON). While these thresholds account for the adoption of lower-cost methods and technologies for carbonate parameter analysis (e.g. pH and total alkalinity), the impacts of salinity measurement and calcium concentration uncertainty on data quality are poorly understood. Currently, the publicly available marine carbonate chemistry uncertainty packages do propagate salinity uncertainty, but do not include $[Ca^{2+}]$ uncertainty. In this study, the uncertainty propagation methods in the R-based seacarb package were extended to include $[Ca^{2+}]$

uncertainty, and subsequently employed to examine the effects of uncertainty in salinity and [Ca2+] on carbonate system calculations. The results indicate that underestimation of uncertainty in [Ca2+] is of primary concern in variable coastal waters, where relatively small (<4%) deviations from the global [Ca2+]-salinity relationship leads to GOA-ON's quality standards being exceeded. In contrast, the uncertainty in salinity has a relatively minor impact on uncertainty in [CO32−] and Ω. Given the importance of Ω and its sensitivity to [Ca2+], coastal OA monitoring programs should consider whether their region conforms with the global [Ca2+]-salinity relationship, and if uncertain should directly measure [Ca2+] when calculating Ω.

Dillon D. N., Dillingham P. W., Currie K. I & McGraw C. M., in press. Inclusion of uncertainty in the calcium-salinity relationship improves estimates of ocean acidification monitoring data quality. *Marine Chemistry*. Article (subscription required).

Inorganic carbon utilization of tropical calcifying macroalgae and the impacts of intensive mariculture-derived coastal acidification on the physiological performance of the rhodolith Sporolithon sp.. Fish farming in coastal areas has become an important source of food to support the world's increasing population. However, intensive and unregulated mariculture activities have contributed to changing seawater carbonate chemistry through the production of high levels of respiratory CO2. This additional CO2, i.e. in addition to atmospheric inputs, intensifies the effects of global ocean acidification resulting in localized extreme low pH levels. Marine calcifying macroalgae are susceptible to such changes due to their CaCO3 skeleton. Their physiological response to CO2-driven acidification is dependent on their carbon physiology. In this study, we used the pH drift experiment to determine the capability of 9 calcifying macroalgae to use one or more inorganic carbon (Ci) species. From the 9 species, we selected the rhodolith Sporolithon sp. as a model organism to investigate the long-term effects of extreme low pH on the physiology and biochemistry of calcifying macroalgae. Samples were incubated under two pH treatments (pH 7.9 = ambient and pH 7.5 = extreme acidification) in a temperature-controlled (26 ± 0.02 °C) room provided with saturating light intensity (98.3 ± 2.50 µmol photons m-2 s-1). After the experimental treatment period (40 d), growth rate, calcification rate, nutrient uptake rate, organic content, skeletal CO3-2, pigments, and tissue C, N and P of Sporolithon samples were compared. The pH drift experiment revealed species-specific Ci use mechanisms, even between congenerics, among tropical calcifying macroalgae. Furthermore, long-term extreme low pH significantly reduced the growth rate, calcification rate and skeletal CO3-2 content by 79%, 66% and 18%, respectively. On the other hand, nutrient uptake rates, organic matter, pigments and tissue C, N and P were not affected by the low pH treatments. Our results suggest that the rhodolith Sporolithon sp. is susceptible to the negative effects of extreme low pH resulting from intensive mariculture-driven coastal acidification.

Narvarte B. C. V., Nelson W. A. & Roleda M. Y., in press. Inorganic carbon utilization of tropical calcifying macroalgae and the impacts of intensive mariculture-derived coastal acidification on the physiological performance of the rhodolith Sporolithon sp.. *Environmental Pollution*. Article (subscription required).

Trophic pyramids reorganize when food web architecture fails to adjust to ocean change As human activities intensify, the structures of ecosystems and their food webs often reorganize. Through the study of mesocosms harboring a diverse benthic coastal community, we reveal that food web architecture can be inflexible under ocean warming and acidification and unable to compensate for the decline or proliferation of taxa. Key stabilizing processes, including functional redundancy, trophic compensation, and species substitution, were largely absent under future climate conditions. A trophic pyramid emerged in which biomass expanded at the base and top but contracted in the center. This structure may characterize a transitionary state before collapse into shortened, bottom-heavy food webs that characterize ecosystems subject to persistent abiotic stress. We show that where food web architecture lacks adjustability, the adaptive capacity of ecosystems to global change is weak and ecosystem degradation likely.

Nagelkerken I., Goldenberg S. U., Ferreira C. M., Ullah H. & Connell S. D., 2020. Trophic pyramids reorganize when food web architecture fails to adjust to ocean change. *Science* 369 (6505): 829-832. Article.

Effects of multiple drivers of ocean global change on the physiology and functional gene expression of the coccolithophore Emiliania huxleyi. Ongoing ocean global change due to anthropogenic activities is causing multiple chemical and physical seawater properties to change simultaneously, which may affect the physiology of marine phytoplankton. The coccolithophore Emiliania huxleyi is a model species often employed in the study of the marine carbon cycle. The effect of ocean acidification (OA) on coccolithophore calcification has been extensively studied; however, physiological responses to multiple environmental drivers are still largely unknown. Here we examined two-way and multiple driver effects of OA and other key environmental drivers—nitrate, phosphate, irradiance, and temperature—on the growth, photosynthetic, and calcification rates, and the elemental composition of E. huxleyi. In addition, changes in functional gene expression were examined to understand the molecular mechanisms underpinning the physiological responses. The single driver manipulation experiments suggest decreased nitrate supply being the most important driver regulating E. huxleyi physiology, by significantly reducing the growth, photosynthetic, and calcification rates. In addition, the interaction of OA and decreased nitrate supply (projected for year 2100) had more negative synergistic effects on E. huxleyi physiology than all other two-way factorial manipulations, suggesting a linkage between the single dominant driver (nitrate) effects and interactive effects with other drivers. Simultaneous manipulation of all five environmental drivers to the conditions of the projected year 2100 had the largest negative effects on most of the physiological metrics. Furthermore, functional genes associated with inorganic carbon acquisition (RubisCO, AEL1, and δCA) and calcification (CAX3, AEL1, PATP, and NhaA2) were most downregulated by the multiple driver manipulation, revealing linkages between responses of functional gene expression and associated physiological metrics. These findings together indicate that for more holistic projections of coccolithophore responses to future ocean global change, it is necessary to understand the relative importance of environmental drivers both individually (i.e., mechanistic understanding) and interactively (i.e., cumulative effect) on coccolithophore physiology.

Feng Y., Roleda M. Y., Armstrong E., Summerfield T. C., Law C. S., Hurd C. L. & Boyd P. W., in press. Effects of multiple drivers of ocean global change on the physiology and functional gene expression of the coccolithophore Emiliania huxleyi. *Global Change Biology*. Article (subscription required).