Port establishes habitat to reduce ocean acidification

Workers seeding oyster beds at Smith Cove.

The Port of Seattle, along with Puget Sound Restoration Fund and the Washington State Department of Natural Resources, are working on an innovative ‘Blue Carbon’ pilot program to establish habitat and a native oyster bed at the north end of Smith Cove in Seattle’s Elliott Bay. The purpose of these efforts is to create habitat, trap carbon in the environment, reduce ocean acidification and improve water quality, as oysters act as filter feeders, which remove pollution from the ocean.

“Creating the kelp, eelgrass and shellfish beds at Smith Cove is an exciting approach to slowing climate change while also fostering habitat for wildlife and fish, including Chinook salmon," said Port of Seattle Commissioner Fred Felleman. "This pilot program reflects the Port's commitment to addressing climate change and protecting the environment."

More than three tons of oysters have been planted in the intertidal area, covering about one-quarter acre. View map here.

"We thank the Port of Seattle for their environmental leadership and their commitment to restoring nearshore habitat," said Betsy Peabody of the Puget Sound Restoration Fund, a partner in the pilot project. "We look forward to great results from this pilot project, along with many more years of partnership in cleaning up our ocean water and habitat."

Blue carbon refers to carbon captured in ocean and nearshore environments, assimilated as biomass and stored in marine sediments. Blue carbon processes are critical to concerns for acidification of marine areas due to increases in atmospheric CO2. In Puget Sound, kelp, eelgrass, shellfish, and salt marsh are important elements in blue carbon processes, ensuring productive, resilient and carbon-rich marine conditions.

The pilot project to evaluate the ability to enhance blue carbon processes at Smith Cove includes the following:

CARBON SEQUESTRATION
Eelgrass, kelp and salt marsh vegetation sequester (or trap) dissolved carbon at a significant rate – as much as a ton of CO2 per acre annually. The Smith Cove project is expected to sequester 10 tons of carbon every year, or the equivalent of over 1,000 gallons of gasoline combustion.

FISH AND WILDLIFE HABITAT
In addition to sequestering carbon, eelgrass, kelp and salt marsh are the most biologically productive habitats in Puget Sound, supporting a wide variety of fish and wildlife species,

including life stages of endangered Chinook salmon.

WATER QUALITY IMPROVEMENT
The project includes establishment of a native oyster bed in Smith Cove, with a goal to support over 1 million oysters. A single oyster siphons up to 2 gallons of water per hour, removing particulate matter and contaminants. Introduced shellfish would filter up to 50 million gallons of Elliott Bay water per day.

OCEAN ACIDIFICATION REFUGIA
Acidification is one of the major threats facing Puget Sound. By removing dissolved carbon from the water, kelp, eelgrass and salt marsh buffer acidification, providing beneficial habitat for oysters and other pH sensitive species.

WAVE/CURRENT ATTENUATION
As sea level rises and storms intensify, our shorelines are becoming increasingly prone to erosion. Kelp, eelgrass, shellfish, salt marsh and riparian vegetation play an important role in stabilizing the shoreline, dissipating energy, and storing sediments.

SUSTAINABILITY
The project does not include structures or other components which require maintenance; if successful, it will be self-sustaining. The project also includes an experimental component that will test the viability of compost made with shellfish and kelp biomass. This marine-based organic compost will be studied and compared to conventional compost in a garden test plot at Centennial Park.

Peter McGraw, *Port of Seattle*, 31 October 2018. [Article](#).

Ocean warming, but not acidification, accelerates seagrass decomposition under near-future climate scenarios

The majority of marine macrophyte production is not consumed by herbivores but instead is channeled into detrital pathways where it supports biodiversity and drives coastal productivity, nutrient cycling and blue carbon sequestration. While it is clear that detrital pathways will be affected by ocean climate change, the relative importance of changing temperature or pH, or their interactions, has not been assessed. We used outdoor mesocosm experiments to assess the relative importance of ocean warming, acidification and latitude of litter origin on the decomposition and biomechanical properties of seagrass Zostera muelleri. Seagrass, collected from 2 sites at each of 2 latitudes (29° and 35°S), was subjected to an orthogonal combination of current and predicted future ocean warming (+3°C) and acidification (-0.3 pH unit). Elevated temperatures resulted in a 15% greater loss of seagrass detrital mass. Mass loss of seagrass detritus was also greater in seagrass from higher than from lower latitudes. The stiffness (Young's modulus) of decomposing seagrass was greater at 22°C than at 25°C. Elevated sea temperatures also weakened decomposing seagrass, but the magnitude of these effects was greater for Z. muelleri originating from higher than from lower latitudes. Overall, ocean warming is likely to have a much larger influence on seagrass decomposition than ocean acidification. As climate changes, however, if seagrass from higher latitudes takes on similar characteristics to seagrass currently growing at lower latitudes, there may be a negative feedback against the impacts of ocean warming on decomposition, moderating changes in associated primary and secondary productivity that supports coastal fisheries and ecosystem processes.

Kelaher B. P., Coleman M. A. & Bishop M. J., 2018. Ocean warming, but not acidification, accelerates seagrass decomposition under near-future climate scenarios. *Marine Ecology Progress Series* 605: 103-110. [Article](#) (subscription required).

Original post: https://news-oceanacidification-icc.org/

Quantifying sensitivity and adaptive capacity of shellfish in the Northern California Current Ecosystem to increasing prevalence of ocean acidification and hypoxia

The severity of carbonate chemistry changes from ocean acidification is predicted to increase greatly in the coming decades, with serious consequences for marine species-especially those reliant on calcium carbonate for structure and function (Fabry et al. 2008). The Northern California

Current Ecosystem off the coast of US West Coast experiences seasonal variations in upwelling and downwelling patterns creating natural episodes of hypoxia and calcite/aragonite undersaturation, exacerbating global trends of increasing ocean acidification and hypoxia (OAH) (Chan et al. 2008) (Gruber et al. 2012). The goal of these experiments was to identify thresholds of tolerance and attempt to quantify a point at which variance in responses to stress collapses. This study focuses on two species: Cancer magister (Dungeness crab) and Haliotis rufescens (red abalone). These species were selected for this study based on their economic and ecological value, as well as their taxonomic differences. Respirometry was used as a proxy for metabolic activity at four different scenarios mimicking preindustrial, upwelling, contemporary upwelling, and distant future conditions by manipulating dissolved oxygen and inorganic carbon (DIC) concentrations. Both species showed a decrease in mean respiration rate as OAH stressors increase, including an effect in contemporary upwelling conditions. These results suggest that current exposure to ocean acidification (OA) and hypoxia do not confer resilience to these stressors for either taxa. In teasing apart the effects of OAH as multiple stressors, it was found that Dungeness crab response was more strongly driven by concentration of dissolved oxygen, while red abalone data suggested a strong interactive effect between OA and hypoxia. Not only did these two different taxa exhibit different responses to a multiple stressors, but the fact that the Dungeness crab were secondarily impacted by acidification could suggest that current management concerns may need to be focus more strongly on deoxygenation.

Gossner H. M., 2018. *Quantifying sensitivity and adaptive capacity of shellfish in the northern California current ecosystem to increasing prevalence of ocean acidification and hypoxia*. MSc thesis, Oregon State University, 104 p. Thesis.

Original post: https://news-oceanacidification-icc.org/

Alterations to seabed raise fears for future

The ocean floor as we know it is dissolving rapidly as a result of human activity.

Normally the deep sea bottom is a chalky white. It's composed, to a large extent, of the mineral calcite ($CaCO_3$) formed from the skeletons and shells of many planktonic organisms and corals. The seafloor plays a crucial role in controlling the degree of ocean acidification. The dissolution of calcite neutralizes the acidity of the CO_2, and in the process prevents seawater from becoming too acidic. But these days, at least in certain hotspots such as the Northern Atlantic and the southern Oceans, the ocean's chalky bed is becoming more of a murky brown. As a result of human activities the level of CO_2 in the water is so high, and the water is so acidic, that the calcite is simply being dissolved.

The McGill-led research team who published their results this week in a study in PNAS believe that what they are seeing today is only a foretaste of the way that the ocean floor will most likely be affected in future.

Long-lasting repercussions

"Because it takes decades or even centuries for CO_2 to drop down to the bottom of the ocean, almost all the CO_2 created through human activity is still at the surface. But in the future, it will invade the deep-ocean, spread above the ocean floor and cause even more calcite particles at the seafloor to dissolve," says lead author Olivier Sulpis who is working on his PhD in McGill's Dept. of Earth and Planetary Sciences. "The rate at which CO2 is currently being emitted into the atmosphere is exceptionally high in Earth's history, faster than at any period since at least the extinction of the dinosaurs. And at a much faster rate than the natural mechanisms in the ocean can deal with, so it raises worries about the levels of ocean acidification in future."

In future work, the researchers plan to look at how this deep ocean bed dissolution is likely to evolve over the coming centuries, under various potential future CO2 emission scenarios. They believe that it is critical for scientists and policy makers to develop accurate estimates of how marine ecosystems will be affected, over the long-term, by acidification caused by humans.

How the work was done

Because it is difficult and expensive to obtain measurements in the deep-sea, the researchers created a set of seafloor-like microenvironments in the laboratory, reproducing abyssal bottom currents, seawater temperature and chemistry as well as sediment compositions. These experiments helped them to understand what controls the dissolution of calcite in marine sediments and allowed them to quantify precisely its dissolution rate as a function of various environmental variables. By comparing pre-industrial and modern seafloor dissolution rates, they were able to extract the anthropogenic fraction of the total dissolution rates.

The speed estimates for ocean-bottom currents came from a high-resolution ocean model developed by University of Michigan physical oceanographer Brian Arbic and a former postdoctoral fellow in his laboratory, David Trossman, who is now a research associate at the University of Texas-Austin.

“When David and I developed these simulations, applications to the dissolution of geological material at the bottom of the oceans were far from our minds. It just goes to show you that scientific research can sometimes take unexpected detours and pay unexpected dividends,” said Arbic, an associate professor in the University of Michigan Department of Earth and Environmental Sciences.

Trossman adds: “Just as climate change isn’t just about polar bears, ocean acidification isn’t just about coral reefs. Our study shows that the effects of human activities have become evident all the way down to the seafloor in many regions, and the resulting increased acidification in these regions may impact our ability to understand Earth’s climate history.”

“This study shows that human activities are dissolving the geological record at the bottom of the ocean,” says Arbic. “This is important because the geological record provides evidence for natural and anthropogenic changes.”

McGill University (via *SienceDaily*), 29 October 2018. Article.

Original post: https://news-oceanacidification-icc.org/2

Current CaCO3 dissolution at the seafloor caused by anthropogenic CO2

Oceanic uptake of anthropogenic CO2 leads to decreased pH, carbonate ion concentration, and saturation state with respect to CaCO3 minerals, causing increased dissolution of these minerals at the deep seafloor. This additional dissolution will figure prominently in the neutralization of man-made CO2. However, there has been no concerted assessment of the current extent of anthropogenic CaCO3 dissolution at the deep seafloor. Here, recent databases of bottom-water chemistry, benthic currents, and CaCO3 content of deep-sea sediments are combined with a rate model to derive the global distribution of benthic calcite dissolution rates and obtain primary confirmation of an anthropogenic component. By comparing preindustrial with present-day rates, we determine that significant anthropogenic dissolution now occurs in the western North Atlantic, amounting to 40–100% of the total seafloor dissolution at its most intense locations. At these locations, the calcite compensation depth has risen ~300 m. Increased benthic dissolution was also revealed at various hot spots in the southern extent of the Atlantic, Indian, and Pacific Oceans. Our findings place constraints on future predictions of ocean acidification, are consequential to the fate of benthic calcifiers, and indicate that a by-product of human activities is currently altering the geological record of the deep sea.

Sulpis O., Boudreau B. P., Mucci A., Jenkins C., Trossman D. S., Arbic B. K. & Key R. M., 2018. Current CaCO3 dissolution at the seafloor caused by anthropogenic CO2. *Proceedings of the National Academy of Science*: 201804250. doi: 10.1073/pnas.1804250115. Article (subscription required).
