Constraining coastal pollution using stable isotope systematics

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Organic pollutants and metals (Cu, Zn) released from net-pen fish farms have the potential to adversely affect local environmental health and the health of individuals who rely on these ecosystems for food. The local environmental impact of this pollution, including geographical extent, is not well understood. Organic pollutants released by fish farms (uneaten feed pellets, fish feces) drop out of the open net-pens, accumulate on the sea floor and in the water column, and then may be transported as suspended particles by water currents. In this study, we took advantage of bioaccumulation in passive suspension-feeding Manila clams and collected individuals at varying distances from a fish farm (Discovery Islands, British Columbia). Stable C and N isotope systematics were used to investigate the presence of organic waste from fish farms in the clams' diet.

Light stable isotope ratios can be used to determine the trophic level and dietary sources of organisms. A main ingredient of the excess food pellets released by fish farms is ground fish meal, which is enriched in the heavy isotopes of C and N when compared to clams' natural diet of algae and bacteria. Clams located within the areal extent of organic waste discharged by a fish farm are expected to exhibit anomalous C and N isotope ratios reflecting the effects of organic waste in their diets.

Samples were collected from a reference site on Penn Island, and from three sites in the Octopus Islands, 850m, 2100m, and 3000m north of the fish farm near Quadra Island. $\delta^{15}N$ gives on average 10.0 ± 1.3 with little variation between sites. In contrast, $\delta^{13}C$ shows significant variation, and is lowest at the reference site, -17.5 (on average), and highest at the site farthest from the fish farm, decreasing with proximity to the fish farm, from -14.3 to -16.7.

The fish farm may be a significant source of light isotope enriched organic matter if fractionation within the fish is responsible for low $\delta^{13}C$ feces released to the environment. Or an external source depleted in ^{13}C may be present to the north of the field site and overprint any organic pollution associated with fish farm. Cu-Zn concentrations of clam tissue will be used to support the light isotope study by evaluating the importance of the fish farm as a metal source; Pb isotopes will be analyzed to evaluate other local sources of pollutants.

A theoretical framework for understanding the capture and sequestration of atmospheric CO_2 by weak bases like water, ammonia and amines

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Although CO_2 is an acid anhydride it is only weakly reactive. Several procedures have been developed for reacting both weak and strong bases with CO_2, each process having its unique strengths and weaknesses. Reaction with a very weak base like water requires activation (by particle impact) and the product is stable only at low temperatures and in the absence of water. Reaction with weak bases like ammonia or amines may proceed with decrease of free energy at room temperature and the product may be sequestered (if the cost of the amine raw material is low enough) or decomposed at higher temperature (if the cost of heating the resultant solution can be sufficiently reduced). An important component in the stability of the carbamic acid products is the facile formation of dimers, verfied by comparison with vibrational spectroscopy. We will describe our search for amine species of low or negative costs (i.e. waste products) which can be reacted with CO_2 to produce stable or metastable products We will also describe new combinations of amine collectors and solvents which can reduce the energy cost of collector regeneration. Experimental data on reactions of CO_2 with ammonia and amines both in aqueous solutions and in cryogenic ices will be rationalized based on extensive state-of-the-art quantum mechanical calculations.