Influence of Food Web Dynamics on Mercury Bioaccumulation in Nesting Seabirds

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The Farallon Islands are located 28 miles west of San Francisco and support the largest colony of breeding seabirds in the contiguous United States; however, reproductive performance in many seabird species has been declining over the past several decades. Mercury remains one of the most pervasive contaminants along California's coast due to historic mining and atmospheric deposition. To investigate mercury bioaccumulation in seabirds we analyzed eggs from three species nesting on Southeast Farallon Island: Cassin's auklet (*Ptychoramphus aleuticus*), rhinoceros auklet (*Cerorhinca monocerata*) and pigeon guillemot (*Cepphus columba*). In addition to eggs, we analyzed a variety of fish and invertebrates that nesting seabirds feed on. To assess trophic position and feeding location egg and diet samples also underwent carbon and nitrogen stable isotope analysis. Results indicate both pigeon guillemot and rhinoceros auklet eggs have mercury concentrations that exceed the lowest observed adverse effects level of 0.50 µg/g (fresh wet weight) for impaired avian egg hatchability, suggesting that seabirds breeding on Southeast Farallon Island are being exposed to levels of mercury that could be contributing to observed population declines. Further, isotopic analysis indicates that mercury bioaccumulation in seabirds is impacted by both trophic position and feeding location.

Keywords: Mercury, Bioaccumulation, Stable Isotopes, Avian Egg

Poster Topic: Food Webs

In Situ Measurement of Ammonium Utilization by Phytoplankton to Determine the Impacts of Nutrient Loading on the Base of the Delta Food Web

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High concentrations of NH_4^+ in the San Francisco Bay-Delta Estuary have been hypothesized to inhibit the growth of larger phytoplankton such as diatoms, which are an important food source to zooplankton at the base of the pelagic food web. The primary goal of this research is to use stable isotope approaches to distinguish $NH_4^+$and NO_3^- utilization at the base of the food web in a range of habitats extending from fresh water portions of Sacramento River through San Pablo Bay. Preliminary results from transects sampled over a range of hydrologic conditions between 2007 and 2010 indicate shifts in the $\delta^{15}N$ composition of the bulk particulate organic matter (POM) where [NH_4^+] increases downstream of the SRWTP and again where [NH_4^+] decreases near the confluence of the Sacramento and San Joaquin Rivers. However, interpretation of $\delta^{15}N$ of bulk POM as a proxy for $\delta^{15}N$ of phytoplankton is complicated by the fact that the C:N ratios of bulk POM often increase to values greater than 8 downstream of the San Joaquin – Sacramento River confluence, suggesting that in this region of the estuary bulk POM includes a significant proportion of terrestrial detrital material. Given the interest in understanding nitrogen source utilization in this portion of the estuary, work is currently underway to isolate algae from bulk POM using flow cytometry prior to isotopic analysis. $\delta^{15}N$ values from isolated algal samples will allow downstream changes in nutrient source utilization to be distinguished from mixing of different POM sources. Because considerable bulk POM isotopic data have been collected over the last ten years, greater understanding of the relationship between $\delta^{15}N$-POM and $\delta^{15}N$ of isolated algal and terrestrial fractions will allow for improved use of the bulk POM isotope record to understand the potential link between historical changes in phytoplankton nutrient utilization and Delta POD.

Keywords: ammonium, nitrate, phytoplankton,

Poster Topic: Food Webs

Creating an Adaptive Management Decision-Making Framework to Address Uncertainties in Delta Habitat Restoration: Tidal Marsh Productivity Exports, Aquatic Food Webs, and Delta Smelt

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Restoring freshwater tidal marsh habitat in the Sacramento-San Joaquin Delta is likely to produce a multitude of ecosystem benefits, including creation of habitat for native terrestrial and aquatic species, many of which are federally or State-listed threatened or endangered. However, there is significant uncertainty associated with the relative magnitude of some of the key proposed benefits of restoring tidal marsh in the Delta, including its value to native fish for spawning, foraging, and rearing, and the timing and magnitude of the contribution of tidal marsh exports to the pelagic food web. There is critical need for an adaptive management strategy to guide planning for large-scale restoration targeted to benefit native fish species, including development of an experimental phased approach to implementation, to resolve uncertainties, and to use new knowledge to adjust our expectations and guide future actions.

We propose an adaptive management approach to implementing landscape-scale tidal marsh restoration, focused on resolving uncertainty related to tidal marsh contributions to the pelagic food web in support of delta smelt. We also propose key ecosystem monitoring metrics, outcome targets, and a decision-making process for responding to success or failure of pilot restoration projects.

Keywords: Adaptive management, delta smelt, food web, tidal marsh, restoration

Poster Topic: Food Webs

Comparing Copepod Adult and Naupliar Feeding using Epifluorescence Microscopy and a High-throughput Microplate Assay

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Despite extensive research on feeding by adult copepods, only a handful of studies have addressed feeding by nauplii, the smallest, larval stages of the copepod life cycle. In aquatic systems, copepod nauplii can outnumber adults by several orders of magnitude, and their high numerical abundance suggests that they play an underestimated role in aquatic food webs. We hypothesized that copepod nauplii eat different types and sizes of food particles, because they differ markedly from adults in size, morphology, and feeding and swimming behavior. We tested this using three very different copepod species: *Pseudodiaptomus marinus, Epilabidocera longipedata* and *Oithona davisae*. We offered nauplii and adults various types and sizes of phytoplankton, including a chlorophyte, haptophyte, cryptomonad, two diatoms, and two dinoflagellates. We then assessed the copepods' feeding capability on these prey by inspecting their guts under epifluorescence microscopy for evidence of chlorophyll pigment. For phytoplanktonthat were consumed, feeding rates were estimated for adults and nauplii using a high-sensitivity microplate-based chlorophyll assay we developed. Our results suggest both diet overlaps and contrasts between feeding capabilities of nauplii and adults. These differences in feeding appear to be related to the shape, motility, or size of prey particles and differences in the copepods' ability to ingest the prey during nauplius vs. adult life stages. Information gathered about naupliar feeding is useful for determining the relative impact that copepods have on foodwebs throughout their entire life cycle. Furthermore, methodologies developed during this project will be valuable for researchers interested in using rapid methods to measure feeding by zooplankton.

Keywords: Copepods, nauplii, larva,larvae, foodweb, foodwebs, epifluorescence microscopy, microplate reader, assay

Poster Topic: Food Webs