August 2, 2021

Dr. Donald R. Strong

Editor

Ecological Society of America

Dear Dr. Strong and Editorial Board Members,

Please find our attached manuscript entitled “Delayed trophic response of a marine predator to ocean condition and prey availability during the past century,” which we are submitting as an Article.

A major theme in ecology is identifying how food web structure and predator populations are regulated by their environment (bottom-up control; sensu Estes et al. 1998). Many species exhibit delayed responses to their environment creating challenges for short-term studies and highlighting the importance of long-term datasets for linking food web responses to previous environmental conditions. Given global, large scale, changes in climate conditions, historic datasets are important for understanding how predators have responded to climate in the past in order to anticipate future responses. Understanding predator responses to ecological and environmental change, and the time scales over which these responses can be observed, is important for managing ecosystems in a changing world.

In this manuscript we analyze how the trophic ecology of harbor seals in Washington state has responded to major changes in prey (i.e., endangered Chinook salmon) and ocean condition (i.e., sea surface temperature). The data presented are derived from a century of compound specific stable isotope analysis (CSIA) of amino acids from 153 museum specimens.

This paper contributes the following advances on the topic:

1. Based on our findings, nearshore marine predators exhibit delayed trophic response to ocean conditions and prey availability on multiple temporal scales, as different perturbations propagate through the food web at different rates.
2. The utility of monitoring marine predator responses to manage for ecological change has focused on immediate responses (Hazen et al. 2019). However, understanding both immediate and temporally delayed predator responses will be useful for anticipating long-term ecological consequences in response to future climate perturbations, especially as extreme climate events become more frequent and severe.
3. The parameterization of the trophic position equation applied in this analysis (multi-amino acid, multi-trophic enrichment factors, weighted beta) improved trophic position estimates which tend to be underestimated relative to ecologically realistic values in CSIA studies.
4. Spatially distinct management strategies that are reevaluated in the context of changing ecological conditions will likely be important for managing harbor seal prey given their dynamic foraging strategies.

We have decided to publish this work in Ecology for the following:

1. While this study is specific to one species our results show delayed trophic responses to environmental change over the past century. This result is highly transferable to pinnipeds more broadly and likely other terrestrial and marine consumers.
2. The regulation of food web structure by resources (bottom-up control) and the presence of top predators (top-down control) is fundamental for understanding food web responses to environmental, ecological, and anthropogenic change. How marine predators respond to multiple types of bottom-up drivers (i.e., ocean condition, prey availability), and the different temporal scales over which they respond, is crucial for understanding community stability and resistance to change.
3. CSIA is a rapidly growing laboratory technique in the field of ecology particularly for retrospective analyses examining food web forcing. Applications of CSIA require careful consideration of physiological and ecological processes (i.e., variability of trophic enrichment factors, primary production pathways, tissue turnover times, and ecological delays). We anticipate this work will advance the field of CSIA by providing a framework for retrospective analyses that considers both physiological and ecological dynamics of a given system.

This manuscript has been approved for submission by all authors and is not being considered for publication elsewhere. Please address correspondence to me at: University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA 98195. Email: mfeddern@uw.edu; Phone: (603) 651-6802.

Please contact me with any questions.

Sincerely,

Megan Feddern