May 12, 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 harbor seals to ocean condition and prey availability during the past century,” which we are submitting as a Report.

A major theme in ecology is identifying how food web structure and predator populations are regulated by their environment (bottom-up control; sensu Estes). Many predator 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 responded in the climate in the past, to anticipate how predators may respond to ecological and environmental change in the future. 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 seal populations 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 (CSSIA) of amino acids from 153 museum specimens.

This paper contributes the following advances on the topic:

1. Harbor seal trophic ecology exhibits a delayed response to changes in ecological and environmental conditions on 1, 2, and 3, year timescales. This highlights the importance of considering delayed predator responses to bottom up forces.
2. Generalist predators exhibit dynamic responses to their ecological environment. Consideration for dynamic responses is likely important for prey consumption estimates, especially for predators consuming prey that are protected or considered economically or culturally valuable.
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 CSSIA studies.

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

1. While this study is specific to one species it our results show delayed trophic responses to environmental changes. This result and the methods used are highly transferable to pinnipeds more broadly and likely other terrestrial and marine species.
2. The dynamic response of harbor seals trophic ecology to their environmental and food web covariates is characteristic of most generalist predators. Consideration of dynamic foraging is relevant for systems that use consumption estimates as a tool for management of prey species and thus is not specific to harbor seals or Washington.
3. CSSIA is a rapidly growing laboratory technique in the field of ecology. This work has advanced the field of CSSIA by studies by applying a trophic position parameterization that improved results and would be applicable to all future CSSIA studies.

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.

**Scope and aims to highlight:**

- how it advances the field, while having broad appeal. If the manuscript relates to any previous submission to an ESA journal, that must be explained as well

- hat lead to an increased appreciation for the diversity of ecological phenomena

- that leads to generalizations potentially applicable to other species, populations, communities, or ecosystems.

- well grounded in ecological theory and have broad implications for environmental policy or resource management may be well suited for publication

We believe this work is well-suited for *Ecology* for the following reasons:

1. This study examines a single ecosystem in Alaska, but we believe these results are applicable in all salmon systems (Pacific, Atlantic, and Great Lakes).
2. This work is really the first large-scale experiment to examine soil responses to a salmon manipulation in detail. Given that soils have an essential mediating role in the transfer of salmon nutrients to plants, this has been a major gap in knowledge to date.
3. The manuscript provides additional insight into the salmon manipulation conducted in Quinn et al. 2018 (previously published by Ecology) by measuring separate but complimentary ecological responses thus providing a more complete understanding of salmon contributions to the entirety of riparian ecosystems.

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

**References**

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. *Fisheries* **24**: 6-15.

Helfield, J. M. and R. J. Naiman. 2002. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. *Ecology* **82**: 2403-2409.

Quinn, T.P., J. Helfield, C.S. Austin, R. Hovel, and A.G. Bunn. 2018. A multidecade experiment shows that fertilization by salmon carcasses enhanced tree growth in the riparian zone. *Ecology* **99**: 2433-2441.