November 24, 2018

Dr. Donald R. Strong

Editor

Ecological Society of America

Dear Dr. Strong and Editorial Board Members,

Please find our attached manuscript entitled “Long-term salmon carcass manipulation enriches inorganic soil nitrogen: implications for marine derived nitrogen subsidies to riparian areas,” which we are submitting as an Article.

A major theme in ecosystem science is identifying important nutrient sources that support food webs and quantifying ecological responses to these sources. Using stable isotope analysis, it has been established anadromous, semelparous fish species contribute nutrients to direct terrestrial and aquatic consumers1, and that these nutrients can also be taken up by primary producers. In the terrestrial realm, many studies examine the contributions of these marine derived nutrients to vegetation without considering the effects on inorganic soil nitrogen pools, and the potential implications of biogeochemical pathways on stable isotope measurements2, 3.

In this manuscript we present the results of a 20-year salmon manipulation study by measuring the response of soil nitrogen pools, transformation rates, and stable isotope ratios. We also consider how biogeochemical pathways alter stable isotope signatures, and show previous studies likely overestimate percent marine derived nutrients for terrestrial producers, as they do not consider isotopic fractionation occurring in soils.

This paper contributes the following advances on the topic:

1. Few studies investigate the contributions of marine-derived nitrogen to inorganic nitrogen pools, the primary source of nitrogen for vegetation in many riparian systems. Of those studies, most focus on the importance of bear kills rather than ecosystem wide effects of salmon enhancement and depletion.
2. Most marine-derived nutrient research measures ecological responses to short-term manipulations, which may misrepresent the long-term persistence of observed phenomena. Despite this, few long-term experiments exist.
3. Multiple studies examining terrestrial producer response to salmon have acknowledged the need to consider biogeochemical pathways in soil that may alter stable isotope signatures4, but no study has quantified the effect of salmon on inorganic nitrogen pool stable isotope ratios.

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

1. We believe this study provides an important link between soil biogeochemistry literature and marine-derived nutrient research.
2. This 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.
3. This study examines a single ecosystem in Alaska, but we believe these results are applicable across salmon range. Specifically, we believe soil biogeochemical processes are likely altering isotopic signatures in other systems thus resulting in overestimates of marine-derived nutrient contributions to terrestrial producers.

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**

1. 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.

2. Hocking, M.D. and J.D. Reynolds. 2012. Nitrogen uptake by plants subsidized by Pacific salmon carcasses: a hierarchical experiment. *Canadian Journal of Forest Research* **42**: 908-917.

3. 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.

4.Helfield, J. M. and R. J. Naiman. 2002. Salmon and alder as nitrogen sources to riparian forests in a boreal Alaskan watershed. *Oecologia* **133**:573-582.