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Determining Pacific Northwest Seabird Diet Using Stable Isotopes

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INTRODUCTION

Seabirds have often been used as gauges of conditions in marine environments, as changes in their breeding and health can indicate the state of marine ecosystems with regard to pollution and prey population sizes.[1] Northern fulmars are one such indicator species. These generalists—feeding on whatever is near the surface— are particularly susceptible to ingesting and retaining marine debris. This study investigated diets of 15 fulmars, 6 western grebes, and 6 common murres found dead on the outer coast of Washington during the fall of 2009 using stable isotope analysis. This technique allowed us to determine diet at an individual level and gain insight into the trophic structure of Washington seabirds.

METHODS

I. Collection of muscle tissue and bone from fulmars (n=15), western grebes (n=6), and murres (n=6)
II. Chemical preparation of tissues and weighing of samples
III. Analysis of samples at stable isotope lab at UC Santa Cruz

PART I. SEABIRD COMMUNITY FOOD WEB

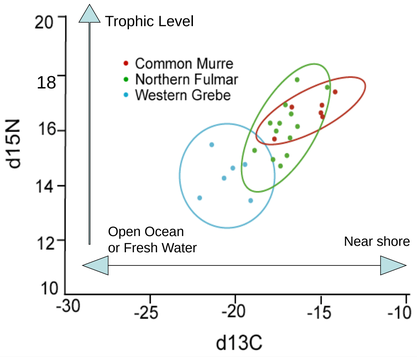

Figure 1. Isotopic data from seabird bone collagen. Ellipses indicate a 95% confidence interval. Trophic level and prey size increase with increased $\delta^{15}N$. Lower $\delta^{13}C$ values indicate open ocean feeding whereas higher $\delta^{13}C$ indicates near shore feeding. $\delta^{13}C$ values of western grebes suggest fresh water feeding. Fulmars show a wide spread in the trophic level at which they are feeding. Paired post hoc species comparisons showed all species significantly different feeding ecologies ($_{approx}F_{4,44}$= 6.64, p= 0.0003).

Northern Fulmar (above right), Western Grebe (bottom right), Common Murre (above). Photographs courtesy of Paul Higgins, Earl Orf, and Kate Sutherland

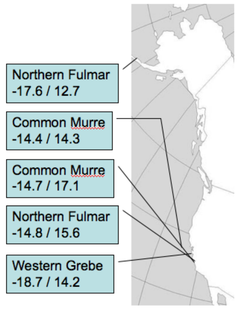

Figure 2. Average isotopic bone collagen values from various studies and locations. $\delta^{13}C$ and $\delta^{15}N$ values decrease with increases in altitude. Locations were Monterey, CA (Fox-Dobbs, 2006; Schoeninger, 1984), the Gulf of Farallones (Sydeman, 1997), and the Aleutian archipelago (Ricca, 2007).

Summary

- Isotopic data affirms that fulmars are generalists and off shore feeders.
- Grebes (fresh water breeders) show mixed fresh water & marine signature.
- Murres appear to feed more discriminately on prey items of similar size.
- Isotopes show significantly different feeding ecologies between 3 species.

PART II. FULMARS & PLASTICS

Many seabirds mistake plastic for food and end up consuming a great deal of it. Fulmars are unable to regurgitate plastics and thus, retain these indigestible objects in their stomachs.[1] For example, in one study, between 62-84% of fulmars sampled contained plastic in their guts.[2]

Of five birds we dissected, all contained plastics. It was observed that fragments tended to be red or white.

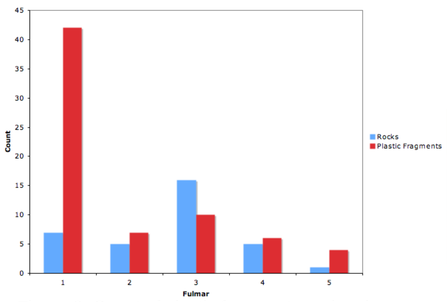

Figure 3. Count of plastic fragments and rocks found in five Washington fulmar stomachs. The most impacted stomach contained 42 plastic fragments.

Fulmar stomach full of plastics (Top), fulmar dissection in (Below). Photos by Susin Olszewski.

PART III. WASHINGTON FULMAR COMMUNITY

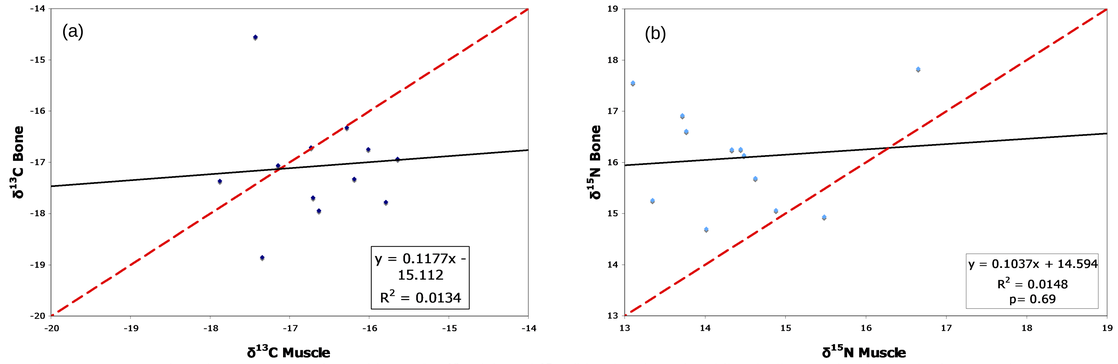

Figure 4. Regressions between muscle and bone for ^{13}C (a) and ^{15}N (b). The dotted red line indicates the theoretical regression. There was no correlation at the individual level for ^{13}C (r^2= 0.0134, p= 0.71). ^{15}N also lacked correlation between muscle and bone (r^2= 0.0148, p=0.69).

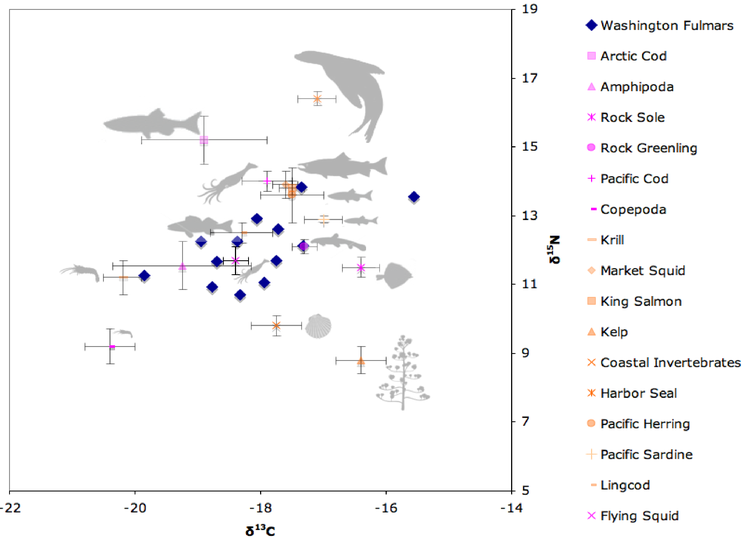

Figure 5. Washington fulmars compared with the muscle of potential prey. Isotopic data gathered from the Aleutian Islands are shown in pink and data from the California coast are shown in orange. Error bars indicate standard deviation. List of reference literature available upon request.

Summary

- Lack of correlation at the individual level in Figure 4 (a & b) reflects several possible factors impacting muscle:
  1. Migration
  2. Starvation
  3. Variation in time spent in WA before death
- Isotopic data agrees with biological knowledge of diet, such that components of the fulmar diet are:
  1. Amphipods
  2. Squid
  3. Small Fish
  4. Krill

Future Work

- Explore the ingested plastics in fulmars with increased sample size looking for trends in age, fragment size, and color.
- Gain isotopic data from prey items specifically from the outer coast of Washington.
- Utilize isotopic mixing models to determine the contribution of movement verses diet to the isotopic signal, using murres as a proxy.

ACKNOWLEDGEMENTS & LITERATURE CITED

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2. Provencher J. F., A. J. Gaston, and M. L. Mallory. 2009. Evidence for increased ingestion of plastics by northern fulmars (Fulmarus glacialis) in the Canadian Arctic. Marine pollution bulletin **58**:1092-1095.