Isotopic and Osteometric Evidence of Temporal Ecosystem Change in the Shelikof Strait from Archaeologically Deposited Harbor seal (*Phoca vitulina*) Remains.

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Abstract:

The Gulf of Alaska ecosystem has experienced dynamic variability over the past 6500 years. Subsistence resources have been greatly affected by ecosystem change and this is reflected in archaeological deposits. A wealth of faunal data remains in stratified datable layers at archaeological sites. Isotopic and osteometric data from these archaeologically deposited faunal remains provides a view of cultural and ecological change at large temporal scales. Harbor seal (*Phoca vitulina*) remains from the Mink Island archaeological site in Shelikof Strait have been analyzed for $\delta^{13}C$ and $\delta^{15}N$. The $\delta^{13}C$ values suggest patterns of variability in productivity from the mid-Holocene to present. The $\delta^{15}N$ values suggest shifts in trophic levels. Other faunal data, such as osteometrics, are compared with these proxies to better understand how ecological variability effects harbor seal and human populations in the Mink Island area.

Research Goals and Hypotheses:

Research Goals:
1) Investigate temporal changes in productivity in Shelikof Strait marine food webs from mid Holocene to present by analyzing stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios from archaeologically deposited seal bone collagen.
2) Evaluate if significant changes exist in the skeletal morphology (body size) of archaeologically deposited adult harbor seals from mid Holocene to present.
3) Identify if changes in ecosystem structure and function (isotope values) have a causal relationship with changes in skeletal morphology (osteometric measurements).

Hypotheses:
1) Ecosystem productivity has fluctuated over the past 6500 years in the Gulf of Alaska and will be exhibited by increases and decreases in $\delta^{13}C$ and $\delta^{15}N$ isotope values correlating with oceanographic and climatological changes.
2) Adult body size will be larger during periods of increased ecosystem productivity while smaller body sizes will correspond temporally to periods of decreased ecosystem productivity.

Methods:

1. Archaeofuanal samples assigned to stratigraphic levels during excavation from the Mink Island Archaeological Site, by Katmai National Park Archaeologists in 1998 (Hilton, 2002; Schaaf, 2002; Murray 2005).
2. Stratigraphic levels have been radiocarbon dated via Accelerated Mass Spectrometry (AMS) assays of charcoal from same level.
3. Archaeofauna identified to species, element, and side using a comparative collection at UAF Environmental Archaeology Laboratory, Fairbanks.
4. Collagen extracted from harbor seal humeri (n = 28) using methods outlined by Matheus (1997) and Hirons (pers. comm., 2006).
5. Isotopic assays obtained using an EA – IRMS system, calibrated with the standards VPDB for $\delta^{13}C$ and AIR for $\delta^{15}N$ at the UAF Alaska Stable Isotope Facility.
6. Osteometric measurements of humeri (n = 37) were collected with 150 mm digital calipers, using standards by Ericson and Storå (1999). Standard measurements taken from humeri included: smallest diagonal breadth of diaphysis (M6), and smallest height of diaphysis (M7) (Fig.1).
7. Linear regression used to analyze growth relationships between the different measurement locations for both elements (Fig. 3)
8. An index of body size was produced from multiplying the two measurements for each element (Fig. 4).
9. Body size index for each element is used to analyze continuity or change of mean body size for each age group in the lower midden (4370 to 6133 BP) and the upper midden (100 to 2010 BP) using two-way Analysis of Variance (ANOVA) tests (Fig. 4).

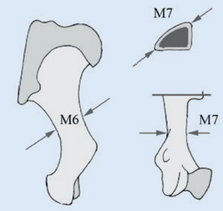


Figure 1. Location of Osteometric Measurements

Preliminary Results:

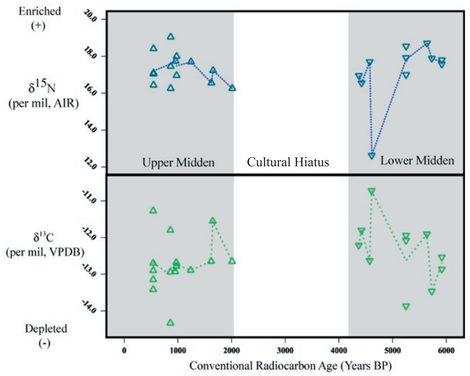


Figure 2. Stable Carbon and Ntirogen Values from harbor seal humeri bone collagen plotted against radiocarbon age before present (BP). $\delta^{13}C$ acts as a proxy for primary productivity within marine ecosystem.

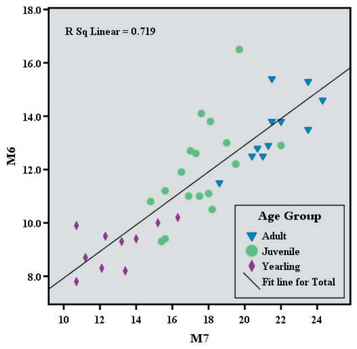


Figure 3. Osteometric measurements from humeri exhibiting stong positive linear growth relationship.

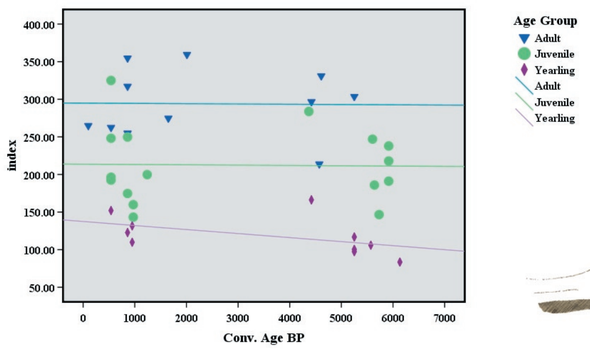
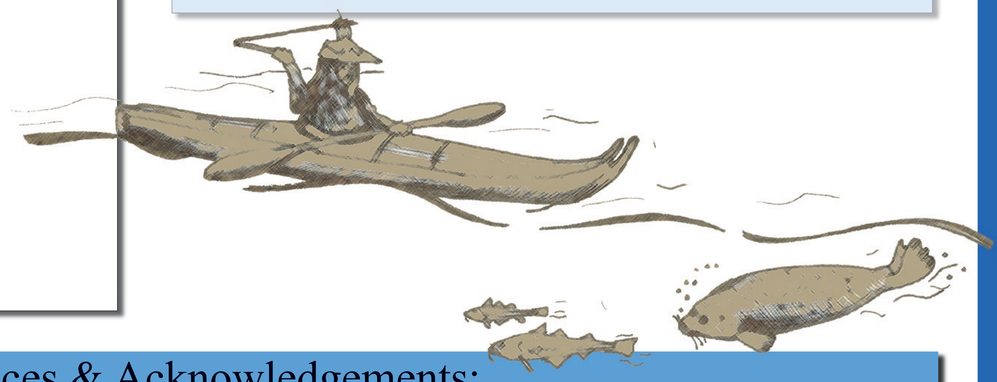


Figure 4. Body size index from multiplying osteometric measurements from humeri plotted against calibrated radiocarbon years before present (BP).



Discussion:

1. $\delta^{13}C$ isotopic evidence shows significant variation in primary productivity over the Holocene (Fry and Sherr, 1984; See Fig. 2)
2. $\delta^{15}N$ isotope values exhibit wider dietary breadth during periods of lower productivity and narrower dietary breadth during periods of higher productivity (Hirons et al., 1998; Hobson & Welch, 1992; See Fig. 2)
3. Changes in marine productivity may have affected adult harbor seal body size assuming that final body size is a reflection of nutritional inputs during nursing, weaning, and growth to skeletal maturity (Hammil et al., 1991; Le Boeff & Crocker, 2005; Woollett et al., 2000)
4. Comparison of humeri size index values for the lower midden (4370 to 6133 BP) and the upper midden (100 to 2010 BP) by age groups (two - way ANOVA) show that there is not a significant difference between the index values from each midden (p = .614; See Fig. 4)
5. Results Are Preliminary: More humeri will be analyzed for stable isotopes and osteometrics when all identification and cataloging of phocids from assemblage are finished.
6. Future research will look at the effects of ecosystem change on seal subsistence including changes in: season of harvest, harbor seal age classes, and human processing intensity as evidenced by archaeological assemblage.

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