Diet Composition and Isotopic Signatures of Sentinel Species as Indicators of Climate Change

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Bottom-up Effects
(“Ecological Equivalents”)

Illustration by Soren Henrich

http://www.pncimamatters.ca
Top-Down Effects
Common Murre (*Uria aalge*)

- Chiefly piscivorous
- Dive up to 150 m
- Produce ≤ 1 chick per year

![Image of Common Murre birds](image)

**Timeline:**
- January
- March
- June
- September
- December

**Dave Pitkin, USFWS**
Objectives

➢ Determine whether variation in diets and isotopic signatures reflect local- or basin-scale physical variability.

➢ Decipher mechanisms by which physical forcing and biological production affects upper trophic level consumers.
Murre diets: digital photographs

- cod
- smelt
- herring or sardine
- Northern anchovy
- sand lance
- surfperch
- flatfish

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Murre Chick Diets

Murre Isotopes

\[ \delta^{15}N \]

\[ \delta^{13}C \]


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Local-Scale Drivers

1. Wind Stress
2. Upwelling Index
3. Water Temperature (upper water column)
4. Zooplankton Species Comp/Biomass (CCI & NCI)
5. Ichthyoplankton Species Comp/Biomass (WIC & WIB)
6. Spring Transition
Prey & Local-Scale Drivers

Upwelling Index (45° N) 
2004 - 2011
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Isotopes vs. Upwelling Index

Month 4, $r = -0.61$, $p = 0.11$

Months 5-6, $r = -0.92$, $p = 0.001$
Does Upwelling Affect Length of Food Chain?

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**Does Upwelling Affect Length of Food Chain?**

- **Months 5-6,** \( r = -0.92, p = 0.001 \)

- **Dinoflagellate**
  - 2005
  - 2010

- **Diatom**
  - 2006

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**Effects of variable oceanographic conditions on forage fish lipid content and fatty acid composition in the northern California Current**

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Isotopes vs. SST

Month 4-6, $r = 0.71$, $p = 0.047$

Month 3-5, $r = 0.45$, $p = 0.308$
Basin-Scale Drivers

1. Pacific Decadal Oscillation
2. Multivariate ENSO Index
3. Northern Oscillation Index
4. North Pacific Gyre Oscillation
Prey & Basin-Scale Drivers


Isotopes vs. NPGO

Month 1-5, $r = -0.89$, $p = 0.0035$

Month 1-5, $r = 0.1$, $p = 0.8083$
Isotopes vs. PDO

Month 5-7, $r = 0.93$, $p < 0.001$

Month 3-5, $r = 0.51$, $p = 0.24$
Isotopes vs. NOI

Month 5-7, $r = -0.67$, $p = 0.0674$

Month 1-2, $r = -0.65$, $p = 0.082$
Conclusions

- Murre diets reflected changes in local- and basin-scale biophysical drivers
- Murre $\delta^{15}$N may reflect upwelling driven changes in energy pathways in coastal food webs
- Murre $\delta^{13}$C appears to most strongly reflect variability in source water transport
Signals reflecting physical forcing and biological production regimes that propagate through the food web are measurable within a major, upper trophic level consumer on the Central Oregon Coast.
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