Effect of environmental variation on diets and stable isotope signatures of a piscivorous seabird in a coastal upwelling system

Robert M. Suryan, Amanda J. Gladics
Northern California Current

(Schwing et al. 2006)
Coastal Upwelling

Water moving offshore due to Coriolis effect

Wind from north
Marine Food Web

Illustration by Soren Henrich
http://www.pncimamatters.ca
Emergence of Anoxia in the California Current Large Marine Ecosystem

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Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current

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A new climate regime in northeast pacific ecosystems

William T. Peterson1 and Franklin B. Schwing2

Planktivorous auklet Ptychoramphus aleuticus responses to ocean climate, 2005: Unusual atmospheric blocking?

William J. Sydeman,1 Russell W. Bradley,1 Pete Warzybok,1 Christine L. Abraham,1 Jaime Jahncke,1 K. David Hyrenbach,2 Vernon Kousky,3 J. Mark Hipfner,4 and Mark D. Ohman§

Anomalous pelagic nekton abundance, distribution, and apparent recruitment in the northern California Current in 2004 and 2005

Richard D. Brodeur,1 Stephen Ralston,2 Robert L. Emmett,1 Marc Trudel,3 Toby D. Auth,4 and A. Jason Phillips4
Common Murre (*Uria aalge*)

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

- Determine whether variation in isotopic signatures of common murres reflect variation in coastal upwelling conditions and summer diet
- Decipher mechanisms by which physical forcing and biological production affects upper trophic level consumers
Murre Diets: stable isotope analysis
2004-2011

Introduction
Objectives
Methods
Results
Conclusions
Murre Diets: digital photographs
2007-2011

Spotting scope

Digital SLR camera
Murre diets: digital photographs

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

Introduction
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Murre Chick Diets

Introduction

Objectives

Methods

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Prey Gradients

Herring in warmer years (+ SST, + PDO)
Herring in years with weaker N Pacific High (- NOI)
Smelts in years with a stronger N Pacific High (+ NOI)

Gladics et al. 2012, ms
Upwelling Index (45° N)
2004 - 2011

Upwelling Index (m³ s⁻¹ 100 m⁻¹)

Month

Introduction
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Murre Isotopes vs. Upwelling Index

![Graph showing correlation coefficient over months (Month 1 to 7). The x-axis represents months, and the y-axis represents correlation coefficient. The graph compares d13C (blue line) and d15N (red line).]
Isotopes vs. Upwelling Index

Month 4, \( r = -0.61, p = 0.11 \)

Months 5-6, \( r = -0.92, p = 0.001 \)
Isotopes vs. Upwelling Index

Months 5-6, $r = -0.92$, $p = 0.001$

Dinoflagellate: 2005, 2010
Diatom: 2006

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

Marisa N. C. Litz¹*, Richard D. Brodeur², Robert L. Emmett², Selina S. Heppell³, Rosalee S. Rasmussen⁴, Linda O’Higgins¹, Matthew S. Morris⁵
Ecosystem Impacts

Biological and Chemical Response of the Equatorial Pacific Ocean to the 1997–98 El Niño

F. P. Chavez,1* P. G. Strutton,1 G. E. Friederich,1 R. A. Feely,2
G. C. Feldman,3 D. G. Foley,4 M. J. McPhaden2

Environmental forcing on life history strategies: Evidence for multi-trophic level responses at ocean basin scales

Robert M. Suryan,1*, Vincent S. Saba2, Bryan P. Wallace3, Scott A. Hatch4, Morten Frederiksen5, Sarah Wanless1
Prey Species vs. Stable Isotopes

**Introduction**

**Objectives**

**Methods**

**Results**

**Conclusions**

**Clupeidae (herring/sardines) r = 0.87, p = 0.05**

*Clupeidae r = 0.83899 p = 0.075658*

**Osmeridae (smelts) r = 0.87, p = 0.05**

*Osmeridae (smelts) r = 0.87, p = 0.05*
Prey Species PCA

The graph shows the variance explained by each principal component. The first principal component explains the highest variance, followed by the second and then the third. The variance explained by the first principal component is approximately 50%, while the second and third components explain 30% and 20% respectively. The cumulative variance increases with each principal component.
Prey Species vs. Stable Isotopes

PC 1, $r = -0.88$, $p = 0.05$

PC 1 vs. $\delta^{13}C$

$PC1 vs. \delta^{15}N$

$r = -0.009$, $p = 0.989$
Prey Species vs. Stable Isotopes

PC 2, $r = 0.88$, $p = 0.05$

PC2 of diet vs. $\delta^{13}C$
$r = 0.082$, $p = 0.896$
Stable Isotopes vs. Reproductive Success

$\delta^{15}$N vs. Repro. Succ: $r = -0.256$, $p = 0.678$

$\delta^{13}$C vs. Repro. Succ: $r = -0.460$, $p = 0.436$
Stable Isotopes vs. Reproductive Success

δ^{15}N vs. Repro. Succ: r = -0.256, p = 0.678

δ^{13}C vs. Repro. Succ: r = -0.460, p = 0.436

Roy Lowe, USFWS
Conclusions

- Variation in upwelling and diet affects the isotopic signature of murre diets during the summer breeding season.
- Murre $\delta^{15}N$ values can vary by 1 trophic level among years, even though their diet is strictly forage fishes.
- $\delta^{15}N$ correlated most strongly with physical forcing (upwelling).
- $\delta^{13}C$ correlated most strongly with prey species consumed (spatial and source water variability?).

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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