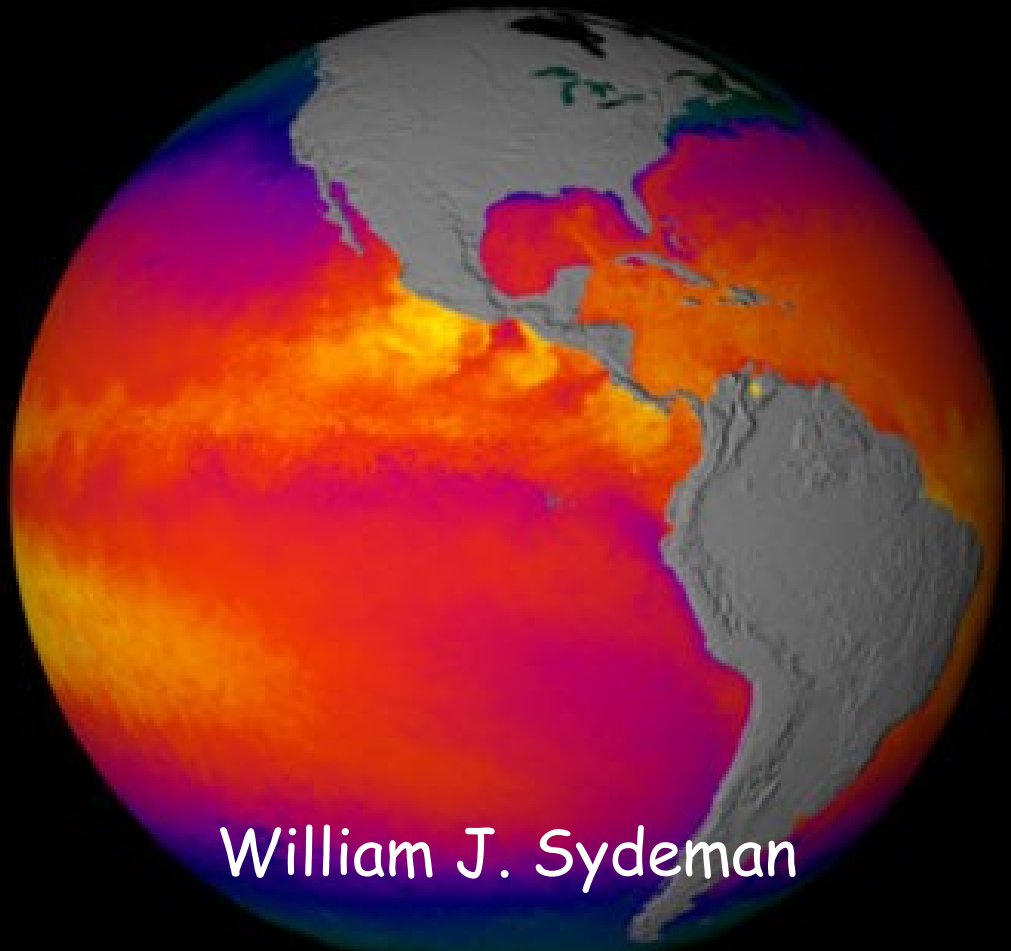
Ocean Observing, Climate Variability and Ecosystem Change

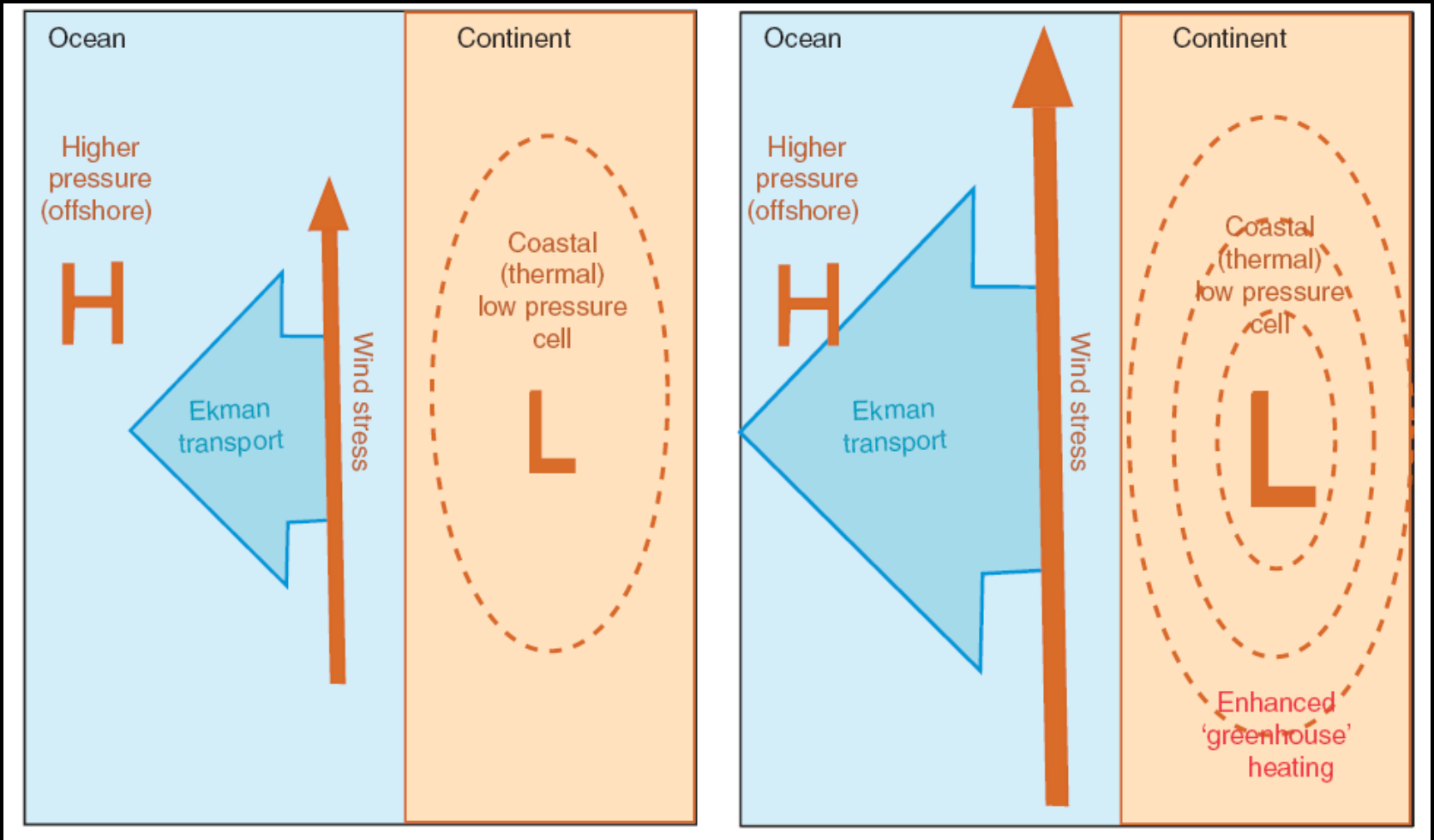


William J. Sydeman

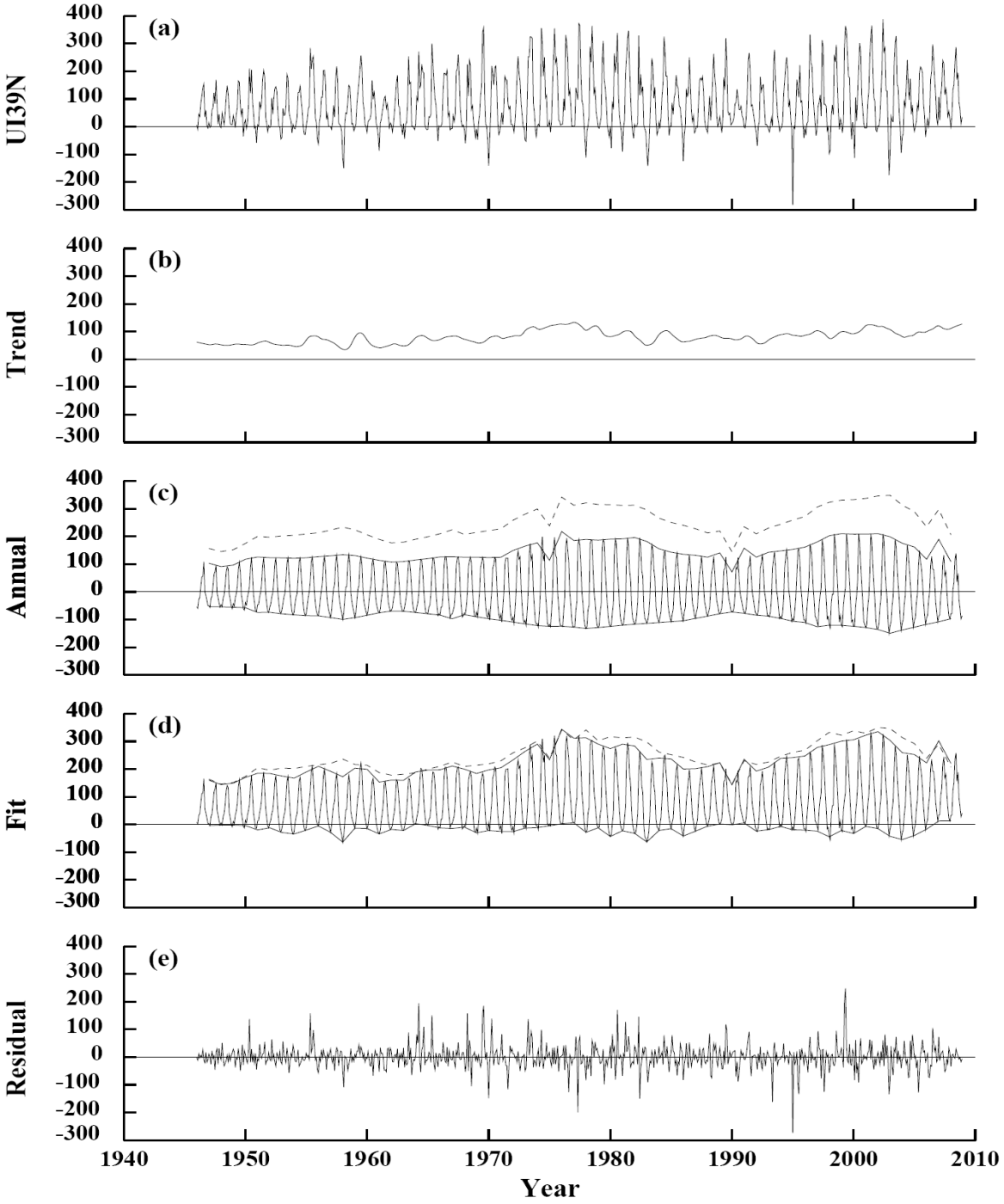
JSAC Meeting, 8 June 2010, Dana Point, CA

www.faralloninstitute.org

Global Warming - Upwelling Intensification Hypothesis



Bakun 1990 Science; Bakun et al. 2010 GCB



Decomposition Using STL

Results

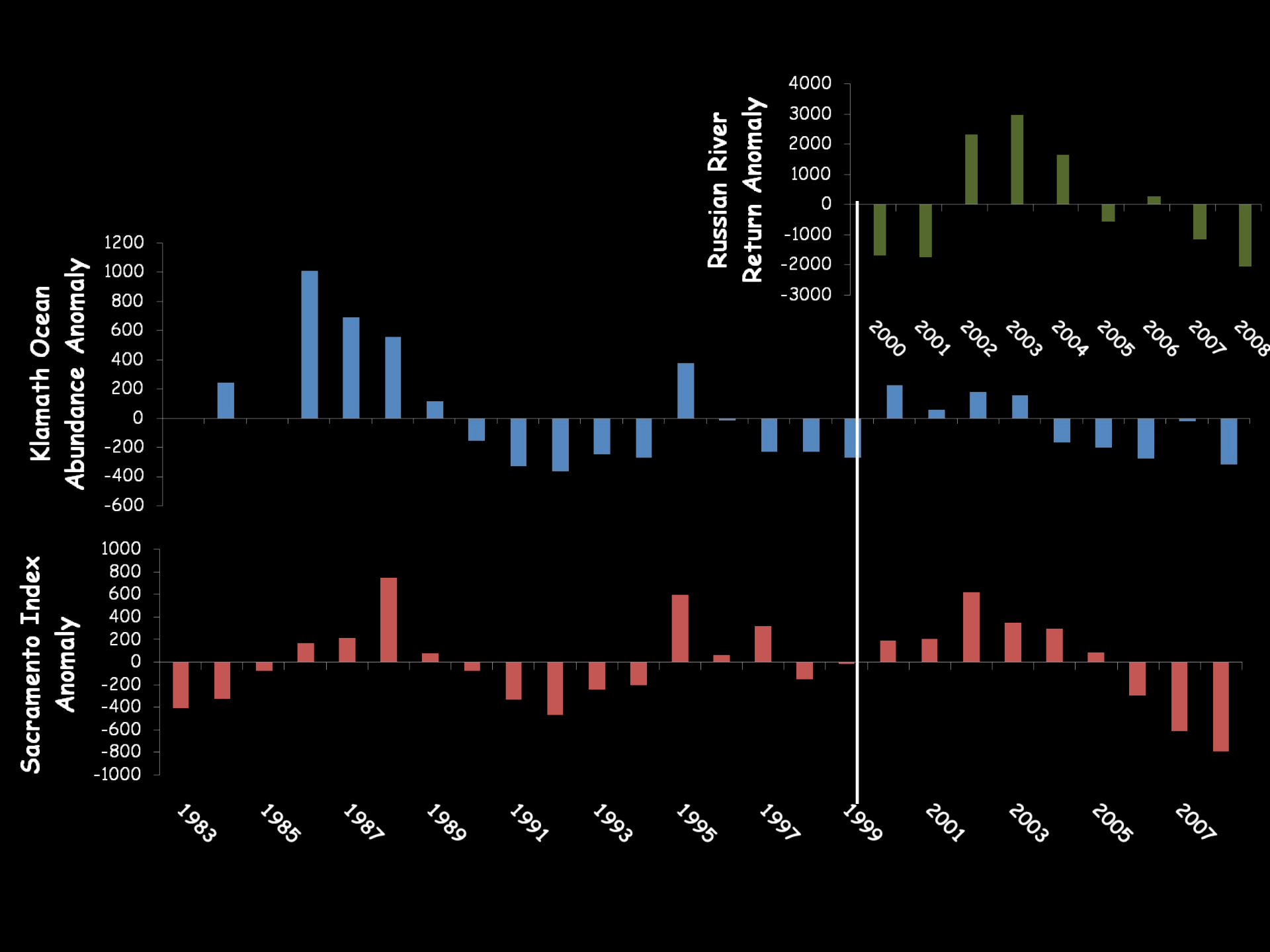
a) Upward trend accounts for small amount of variance (5.81%); varies little over 63 years.

b) Annual cycle is major (75.3% of the variance)

c) "fit" is combined trend+annual (81.1%); residual leftover (18.9%) and looks like white noise... indeed it is...

d) long-period amplitude modulation evident !

CLIMATE AND OCEAN ECOLOGY OF RUSSIAN RIVER CHINOOK SALMON


Russian River Return Anomaly
4000
3000
2000
1000
0
-1000
-2000
-3000
2000
2001
2002
2003
2004
2005
2006
2007
2008
Klamath Ocean Abundance Anomaly
1200
1000
800
600
400
200
0
-200
-400
-600
Sacramento Index Anomaly
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007

Path Analysis Approach

Response: Russian River Chinook adult returns

- Lagged 2 years (e.g. 2008 returns predicted by 2006 oceanographic and biological variables)

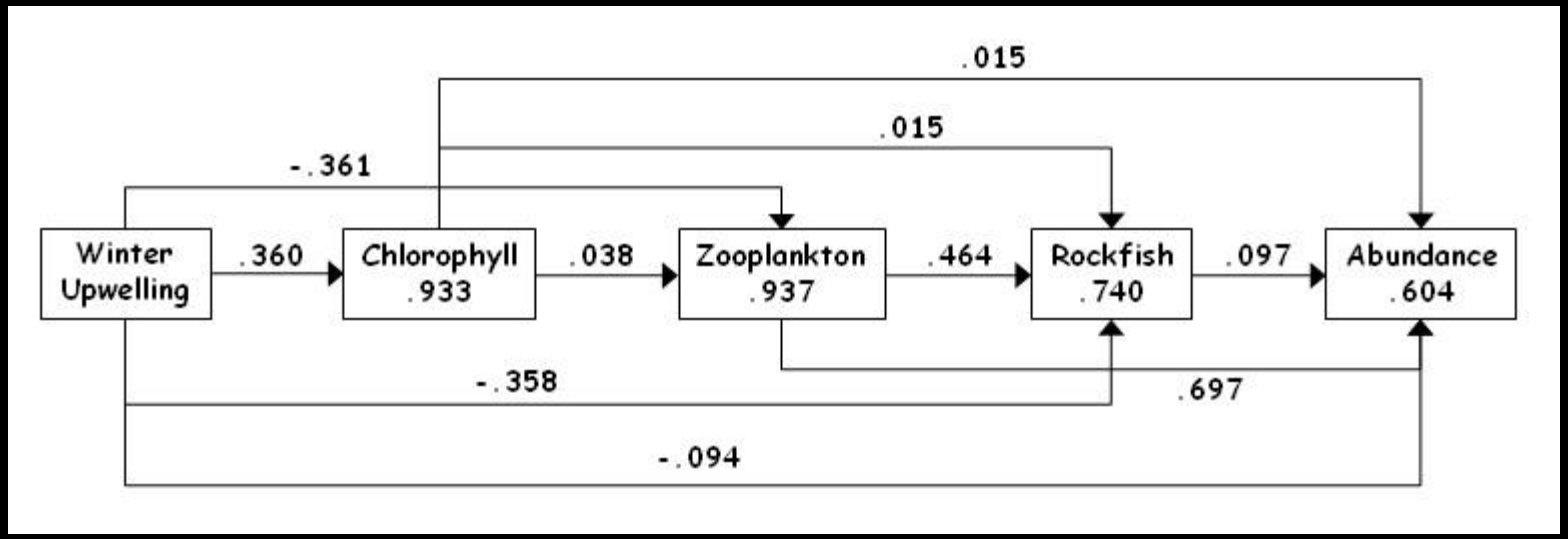
Oceanographic predictors: Seasonal Upwelling "modes"

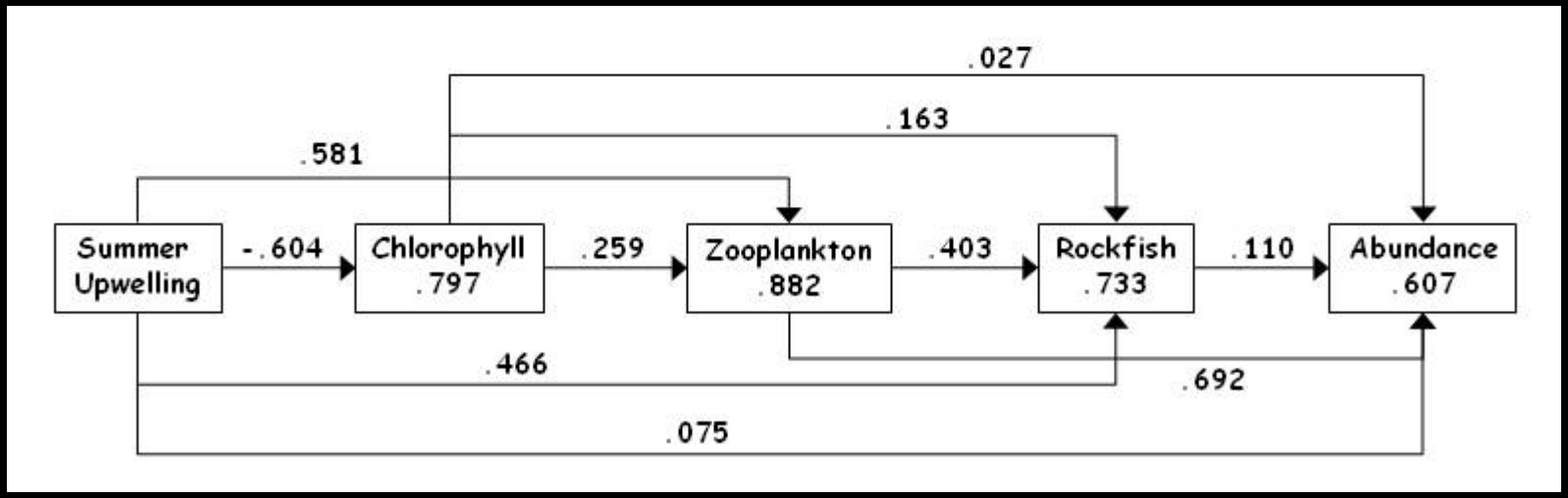
- First principal component: summer upwelling
- Second principal component: winter upwelling

Biological predictors:

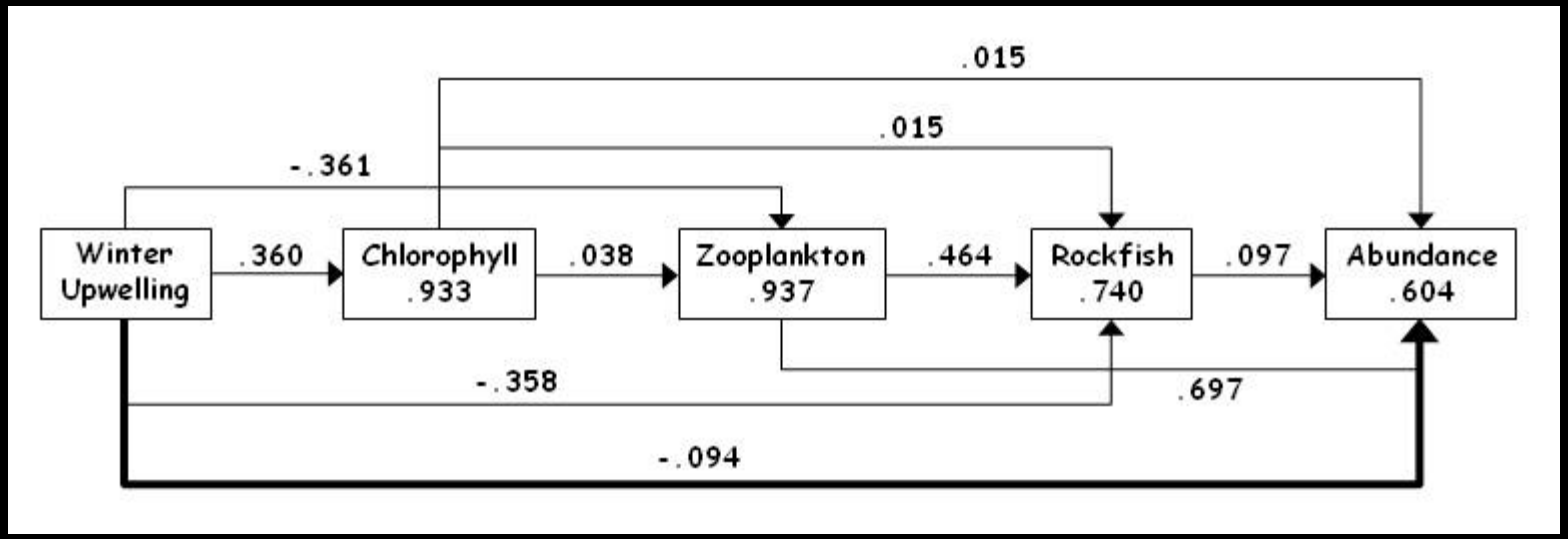
- Chlorophyll concentrations
  - Farallon Islands and Bodega Bay
    - First principal component (PC1)
- Zooplankton
  - Copepod biomass
  - Copepod community index
  - Euphausiid (*Thysanoessa spinifera*) abundance (% of auklet diet)
    - First principal component (PC1)
- Juvenile rockfish abundance
  - % of common murre diet

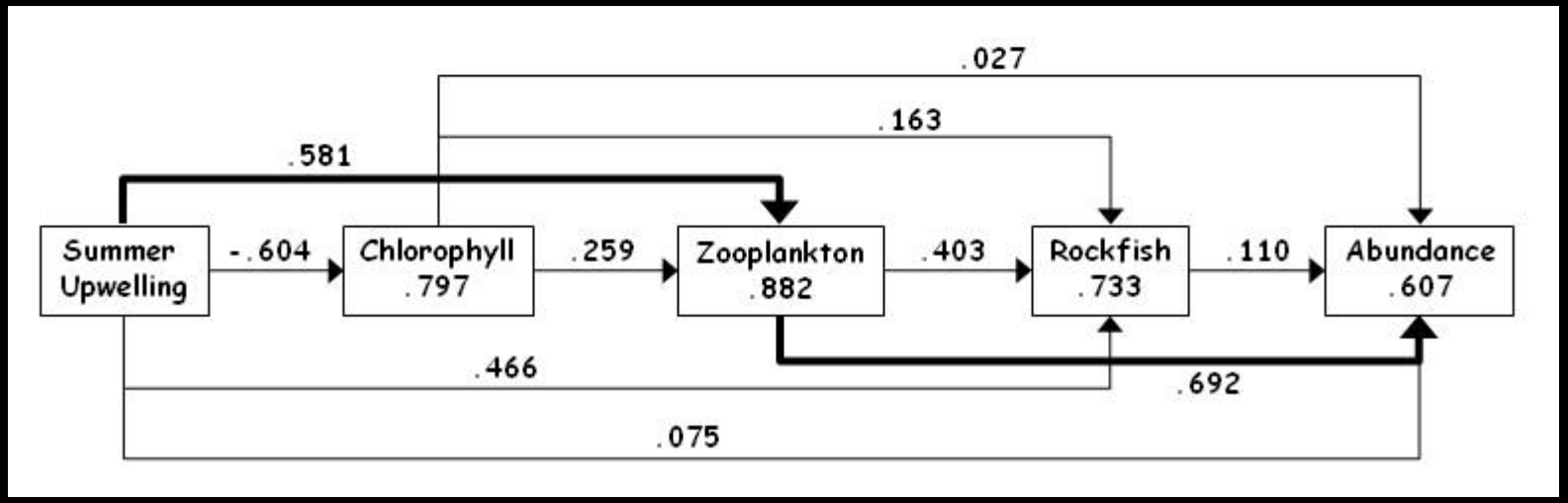
Path Analysis Diagrams





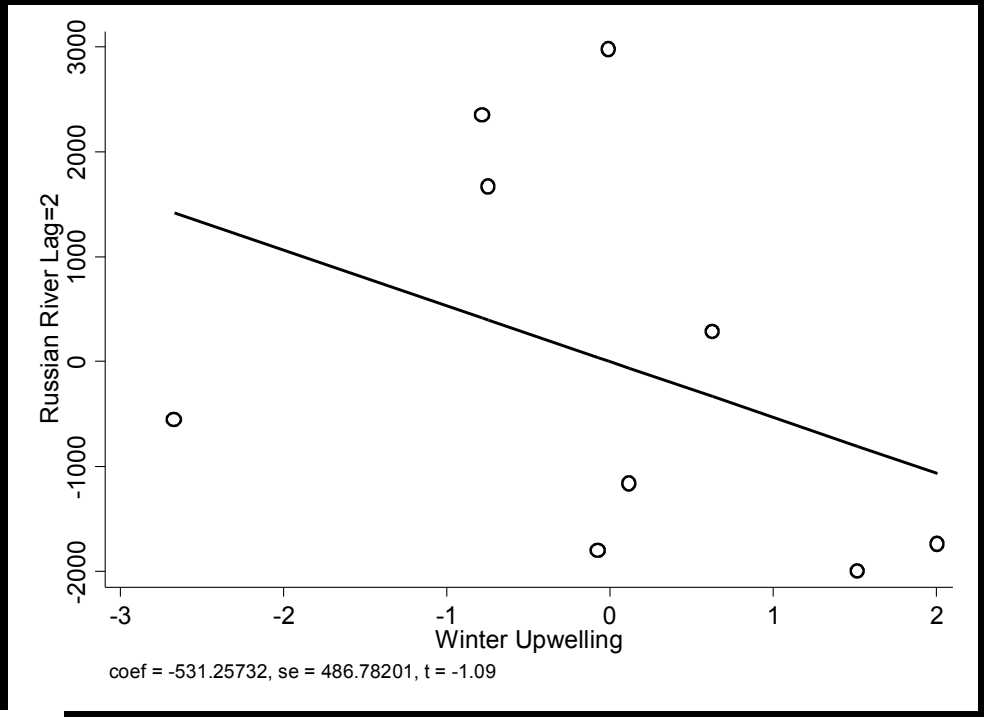
Path Analysis Diagrams

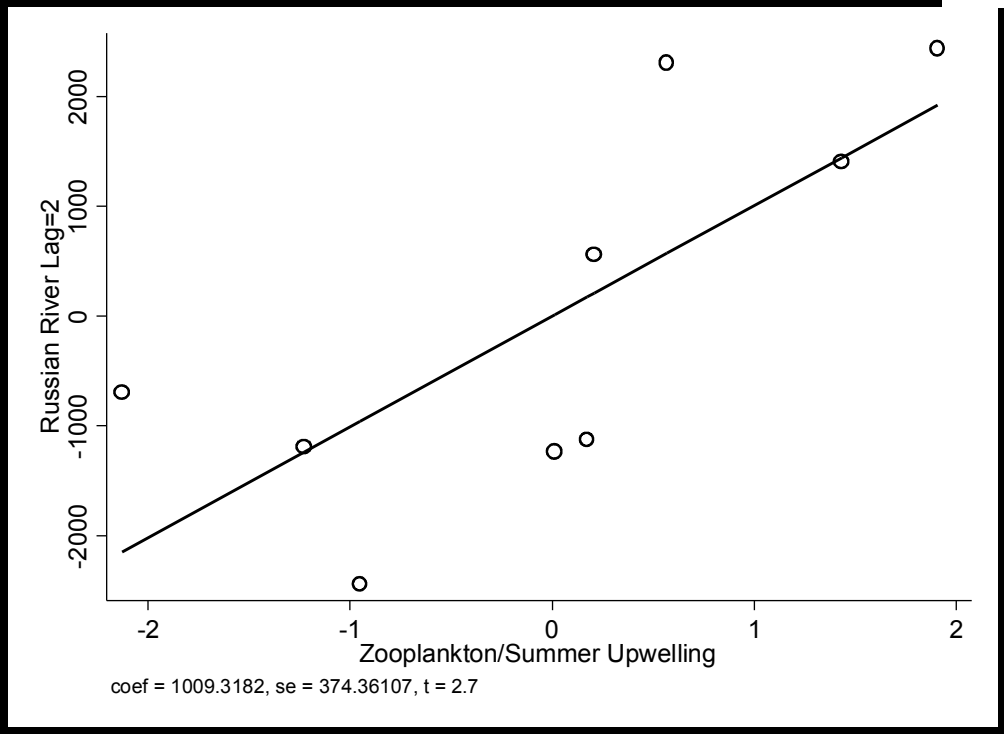




Winter Upwelling: direct

- Spearman correlation:
  - Rho=-0.4833, p=0.1875
- Regression:
  - Model R^2=0.1454, p=0.3112





Summer Upwelling: indirect

- Zooplankton intermediate
- Spearman correlation:
  - Rho=0.4176, p=0.2646
- Multiple regression:
  - Model R^2=0.6243, p=0.0530
  - Zooplankton t=2.70, p=0.036

Forecasting Ecosystem Productivity