

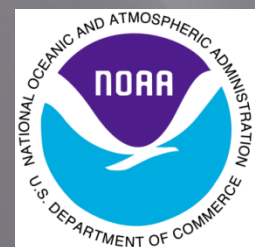
Integrating Indicators: A Progress Report

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Data Contributors: ³NOAA-ERD, ⁴NOAA-NMFS (NW and SW), ⁵Old Dominion University, USFWS (G. McChesney) & PRBO (R.W. Bradley and P. Warzybok), DFO-Canada (R.W. Tanasichuk, H. Freeland).



Project Goals/Deliverables

1. Integration: investigate co-variation in periodicities and amplitude in key time series datasets, from upwelling/advection to top predators.
2. Develop interpretable multivariate oceano-climatic ecological indicators for the northern California Current (MOCI)
 - emphasis: indices that reflect complex bio-physical interactions that drive variability in key fish and wildlife populations...
 - use: developing CCLME IEA efforts

Integrated Marine Ecological Database (IMED)

First step: amass data

54 "datasets" - ~160 time series:

- Atmospheric
- Oceanographic
- Primary Productivity
- Invertebrates (plankton)
- Forage Fish (landings and fishery independent)
- Salmon
- Seabirds
- Marine mammals

Integrating Indicators



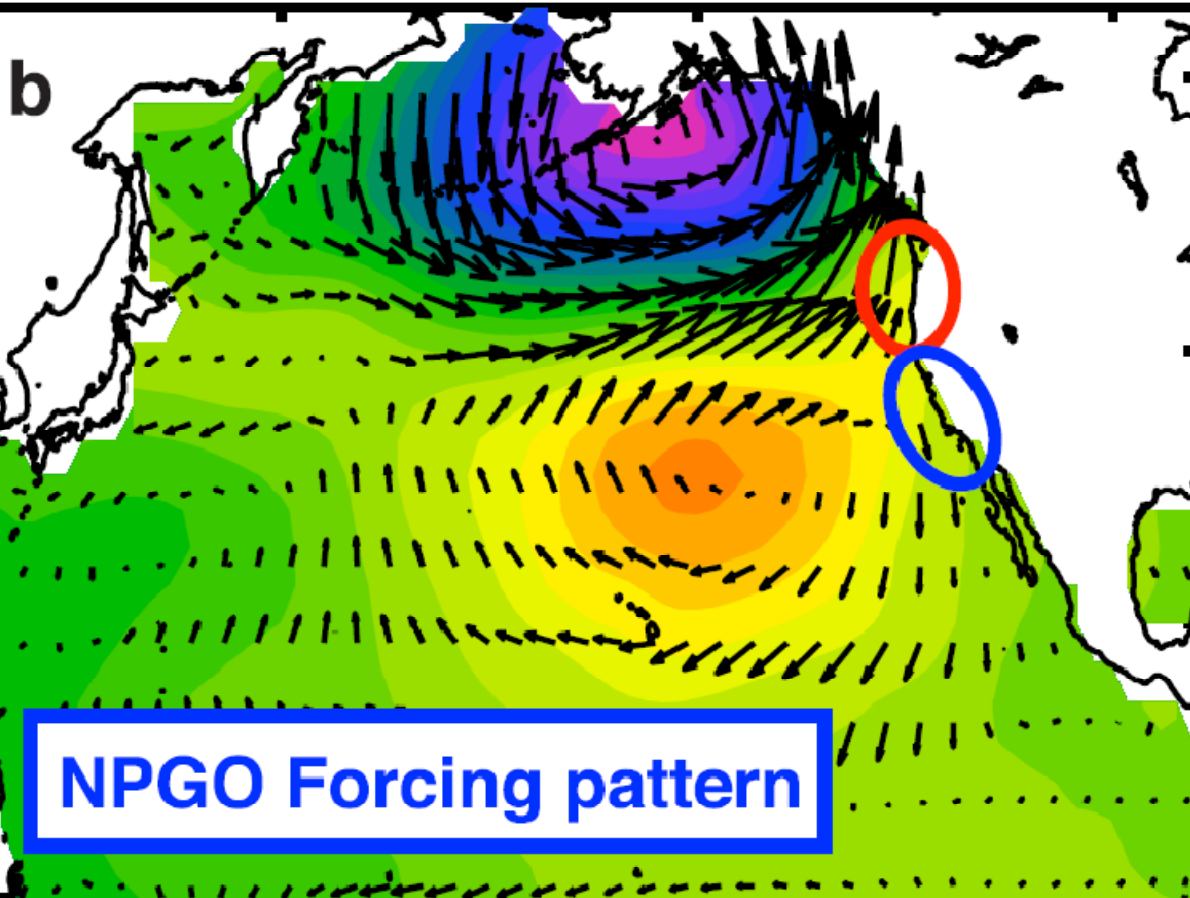
North Pacific Gyre Oscillation links ocean climate and ecosystem change

E. Di Lorenzo,¹ N. Schneider,² K. M. Cobb,¹ P. J. S. Franks,³ K. Chhak,¹ A. J. Miller,⁴ J. C. McWilliams,⁵ S. J. Bograd,⁶ H. Arango,⁷ E. Curchitser,⁷ T. M. Powell,⁸ and P. Rivière⁹

New big boy in town...

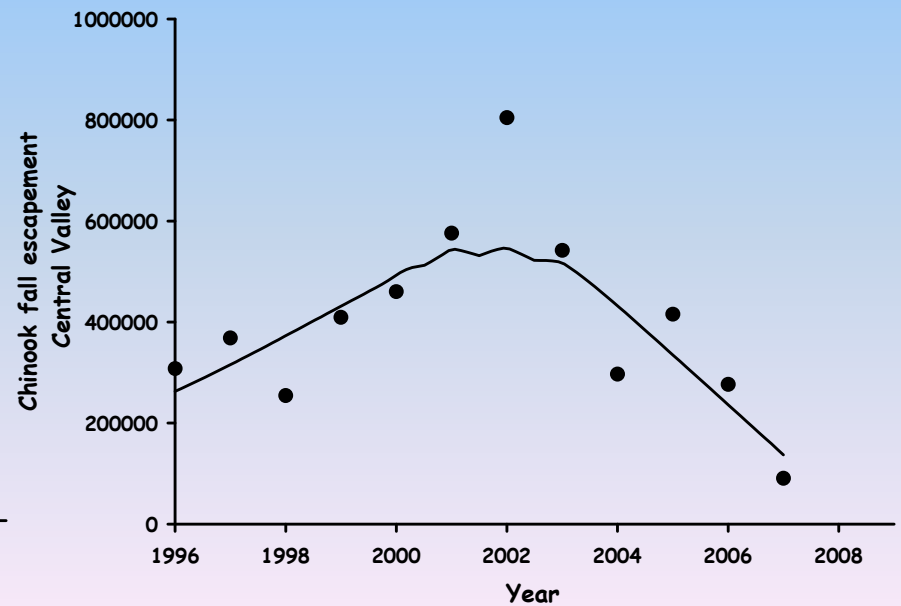
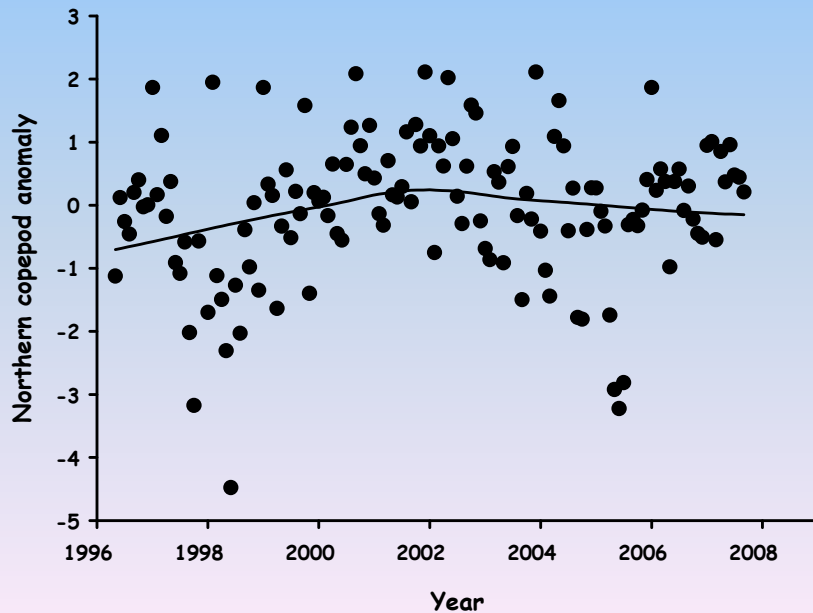
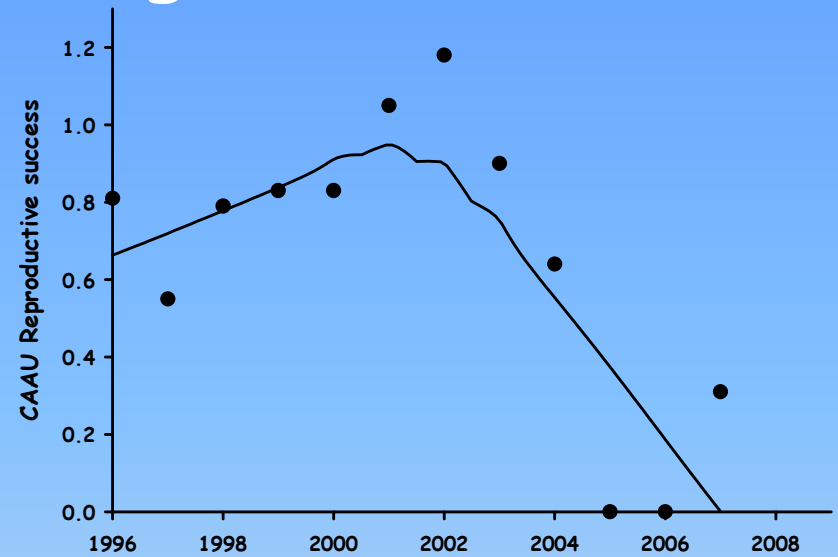
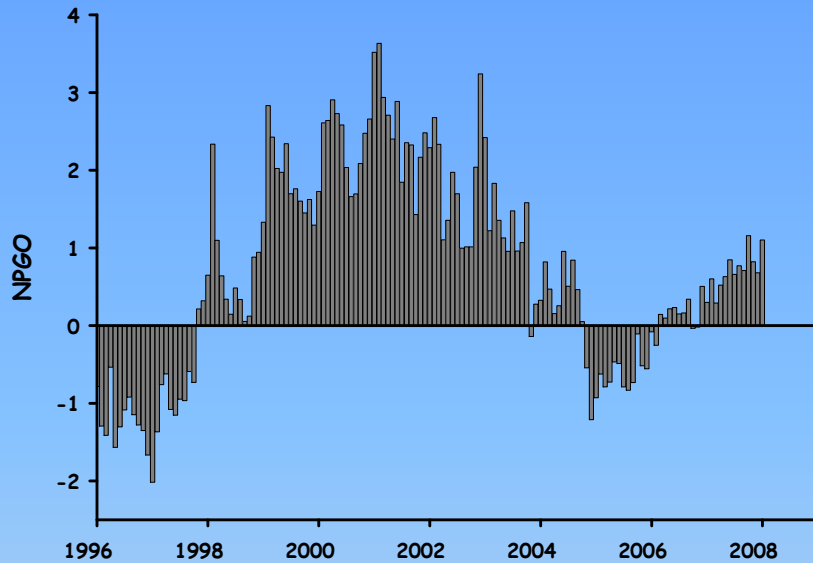
NPGO Pattern:

- 2 counter-rotating gyres in NE Pacific
- increased transport in California Current
- strong upwelling (at our latitude)
- low Sea Surface Temp (in E Pacific)
- what about position?



Vectors = wind stress Colors = sea level pressure

NPGO and some biological series



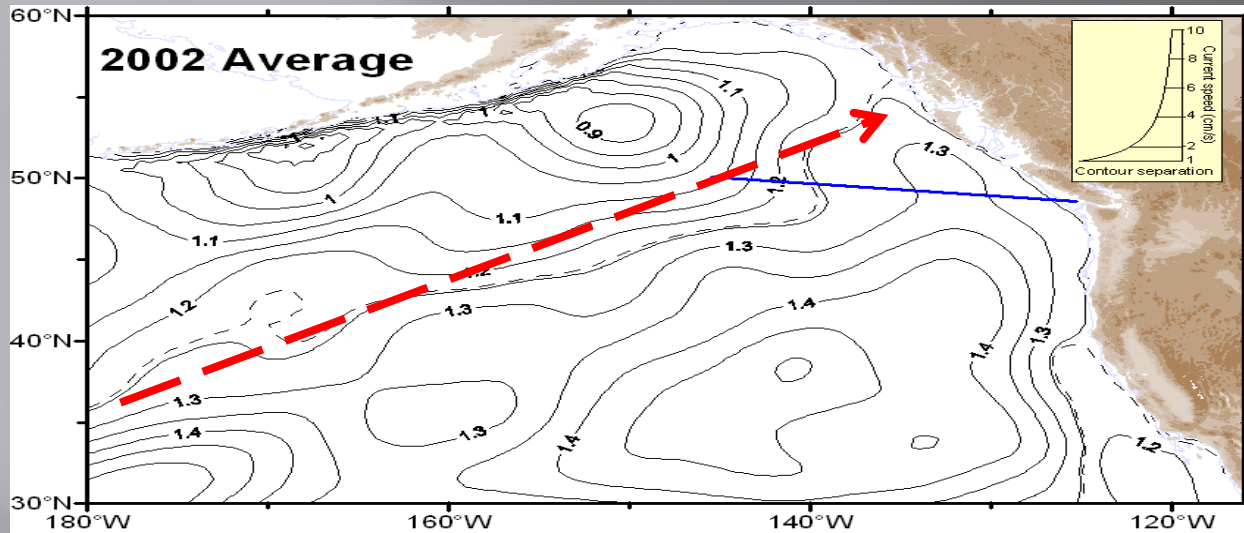
SUBARCTIC WATER MASS INTRUSION, 2002

Bograd et al. 2003

Barth et al. 2003

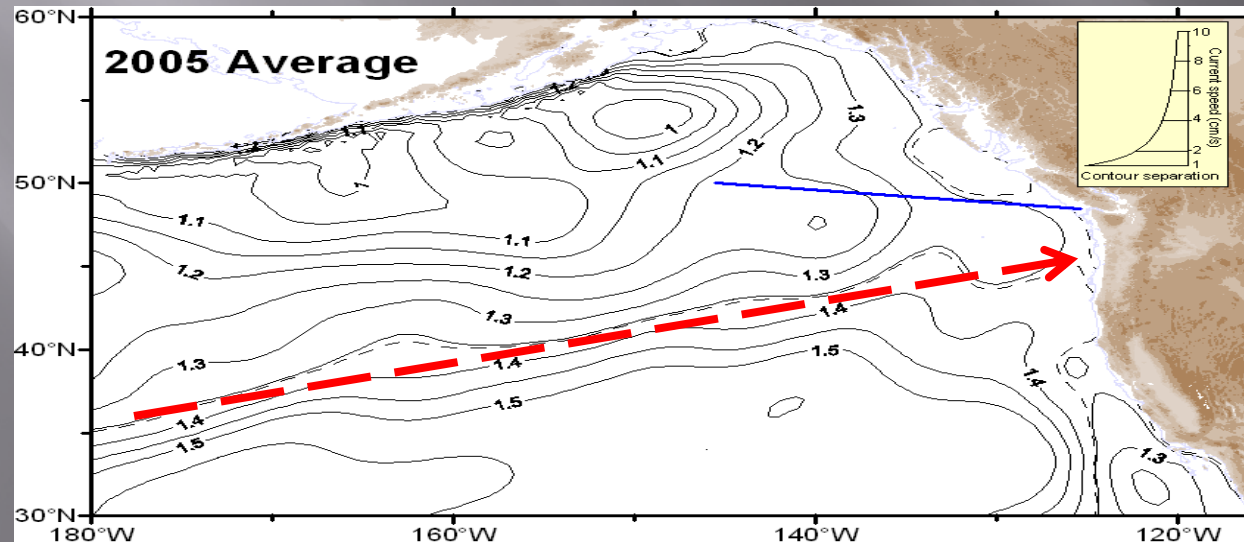
Wheeler et al. 2003

North Pacific Current, 2002 vs. 2005



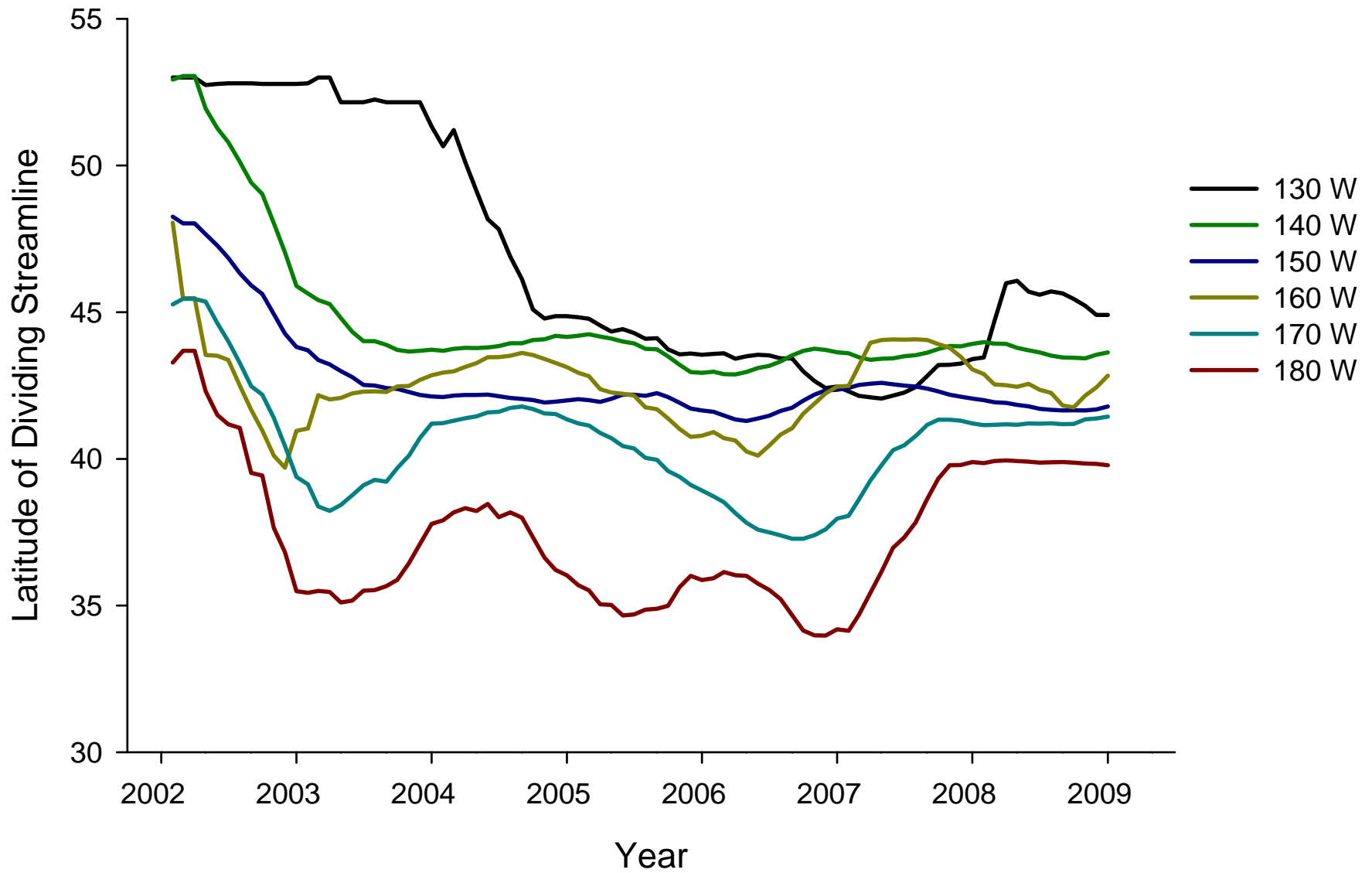
2002

- High salmon returns
- High bird success
- High rockfish success
- Boreal copepods
- NPC shifted north



2005

- Moderate returns (lag to 2007)
- Breeding failure
- Rockfish decrease
- Tropical copepods
- NPC shifted south



PCA on Latitude of WWD “SlipStream” Location

Latitude of dividing line @ w135 w140 w145 w150 w155 w160

(n=63 months from 2002-2006)

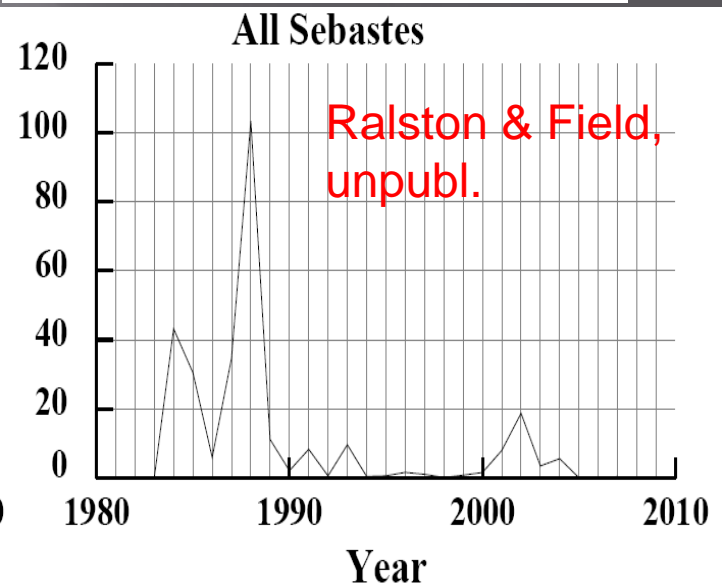
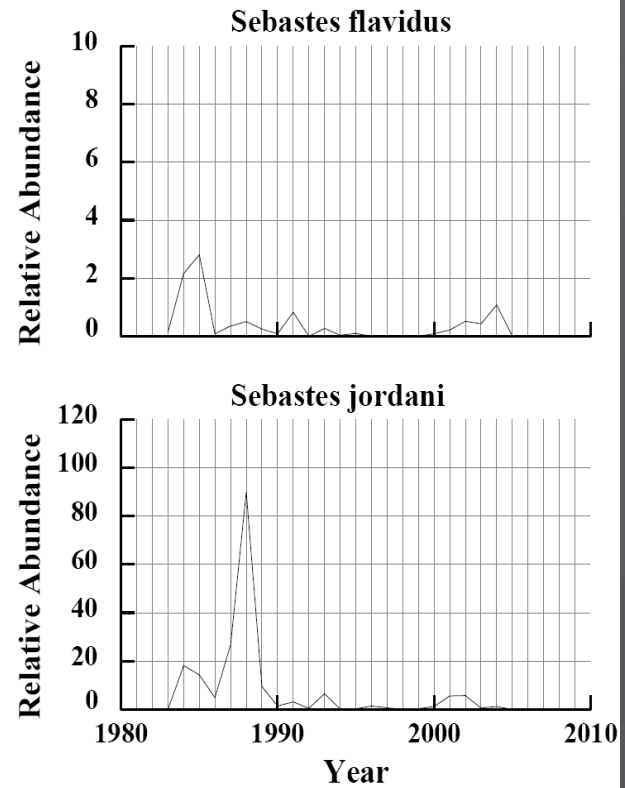
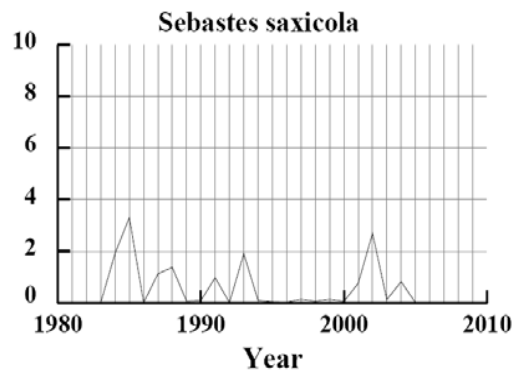
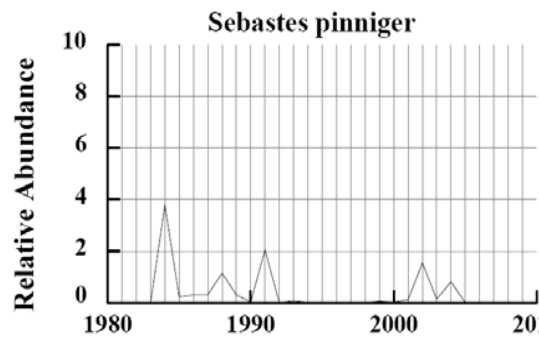
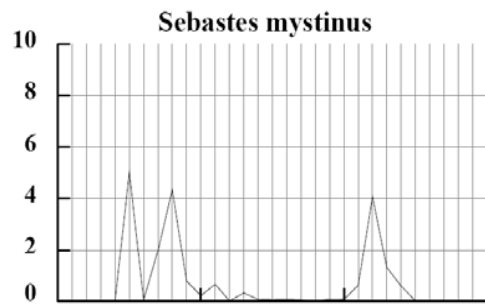
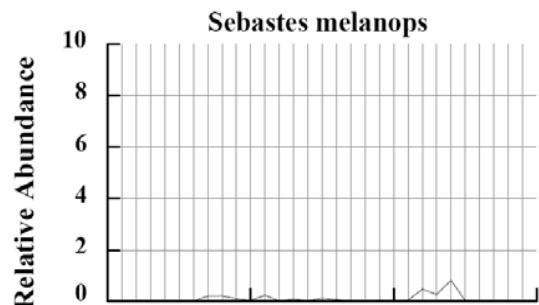
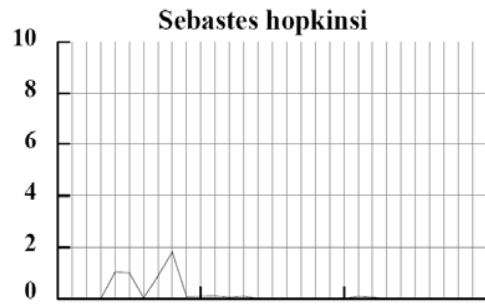
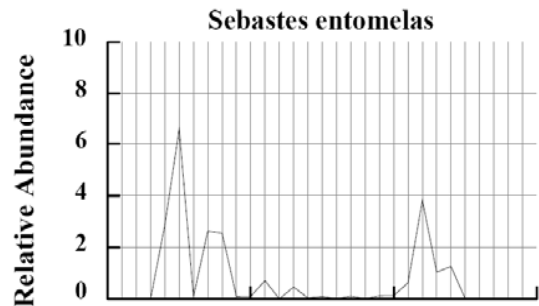
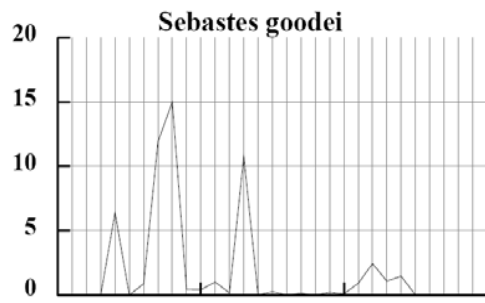
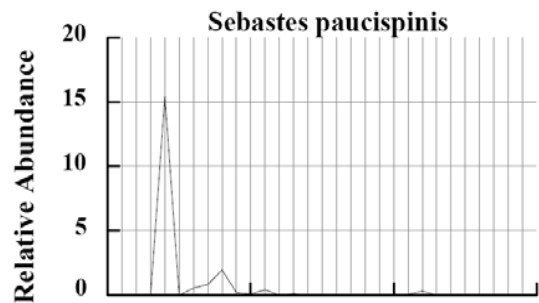
Component	Eigenvalue	Difference	Variance	Cum. Var.
1	4.23	2.79	0.7067	0.7067
2	1.44	1.30	0.2412	0.9479

Factor Loading
Variable | PC1

w135		0.44
w140		0.47
w145		0.44
w150		0.47
w155		0.35
w160		0.22

Biological variables:

- May-September Northern Copepod Index (Newport, OR)
- M-S Copepod species richness (Newport, OR)
- *Thysanoessa spinifera* adult abundance (Vancouver Is.)
- *Euphausia pacifica* adult abundance (Vancouver Is.)
- Rockfish reproductive success (central-northern CA)
- Auklet reproductive success/timing of breeding (northern CA)
- Murre reproductive success/timing of breeding
- Coho salmon smolt-adult return (OPI)
-



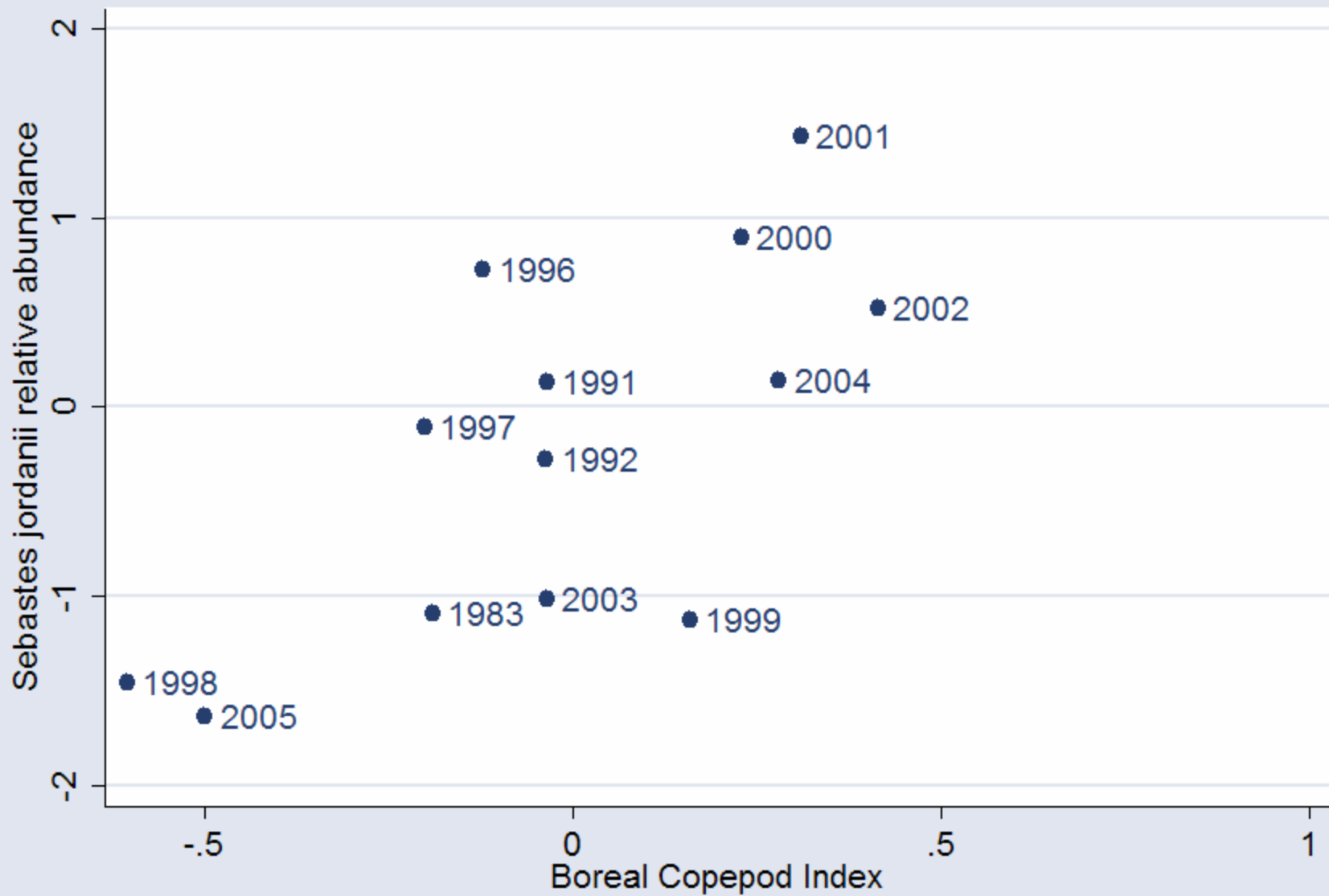
Rank Correlation at zero lag between bird indices and
the (Probability) that the correlation is due to chance.
Probability has been rounded to three significant figures.
The time series have been detrended.

	CAAU Laydate	WEGU R. S.	BRAC R. S.	COMU R. S.	PIGU R. S.	PECO R. S.	CAAU R. S.	ASSP R. S.	RHAU R. S.
COMU Laydate	0.769** (<0.0001)	-0.381* (0.022)	-0.220 (0.198)	-0.457** (0.005)	-0.219 (0.200)	-0.212 (0.215)	0.010 (0.954)	-0.099 (0.564)	-0.151 (0.503)
CAAU Laydate		-0.472** (0.004)	-0.249 (0.144)	-0.497** (0.002)	-0.406* (0.014)	-0.344* (0.040)	-0.166 (0.333)	0.113 (0.512)	-0.377 (0.084)
WEGU R. S.			0.318 (0.055)	0.415* (0.012)	0.290 (0.081)	0.160 (0.346)	-0.073 (0.668)	-0.103 (0.544)	0.117 (0.605)
BRAC R. S.				0.463** (0.005)	0.579** (<0.0002)	0.431** (0.008)	0.341* (0.039)	-0.097 (0.568)	0.233 (0.296)
COMU R. S.					0.572** (<0.0003)	0.450** (0.006)	0.239 (0.161)	0.035 (0.841)	0.504* (0.017)
PIGU R. S.						0.855** (<0.00001)	0.450** (0.005)	-0.109 (0.521)	0.407 (0.060)
PECO R. S.							0.609** (<0.0001)	0.020 (0.905)	0.310 (0.160)
CAAU R. S.								-0.066 (0.697)	0.293 (0.186)
ASSP R. S.									-0.283 (0.202)

R. S. denotes Reproductive Success.

Boldface and ** identifies correlations that have an associated probability < 0.01 .

Boldface and * identifies correlations that have an associated probability > 0.01 but < 0.05 .





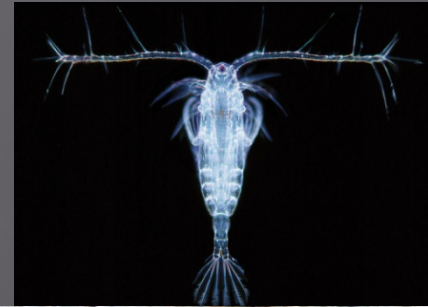
PCA on Biological Indicators

Copepods (Oregon), Euphausiids (B.C.), Salmon (Oregon), Birds (Northern CA), Rockfish (Northern CA)

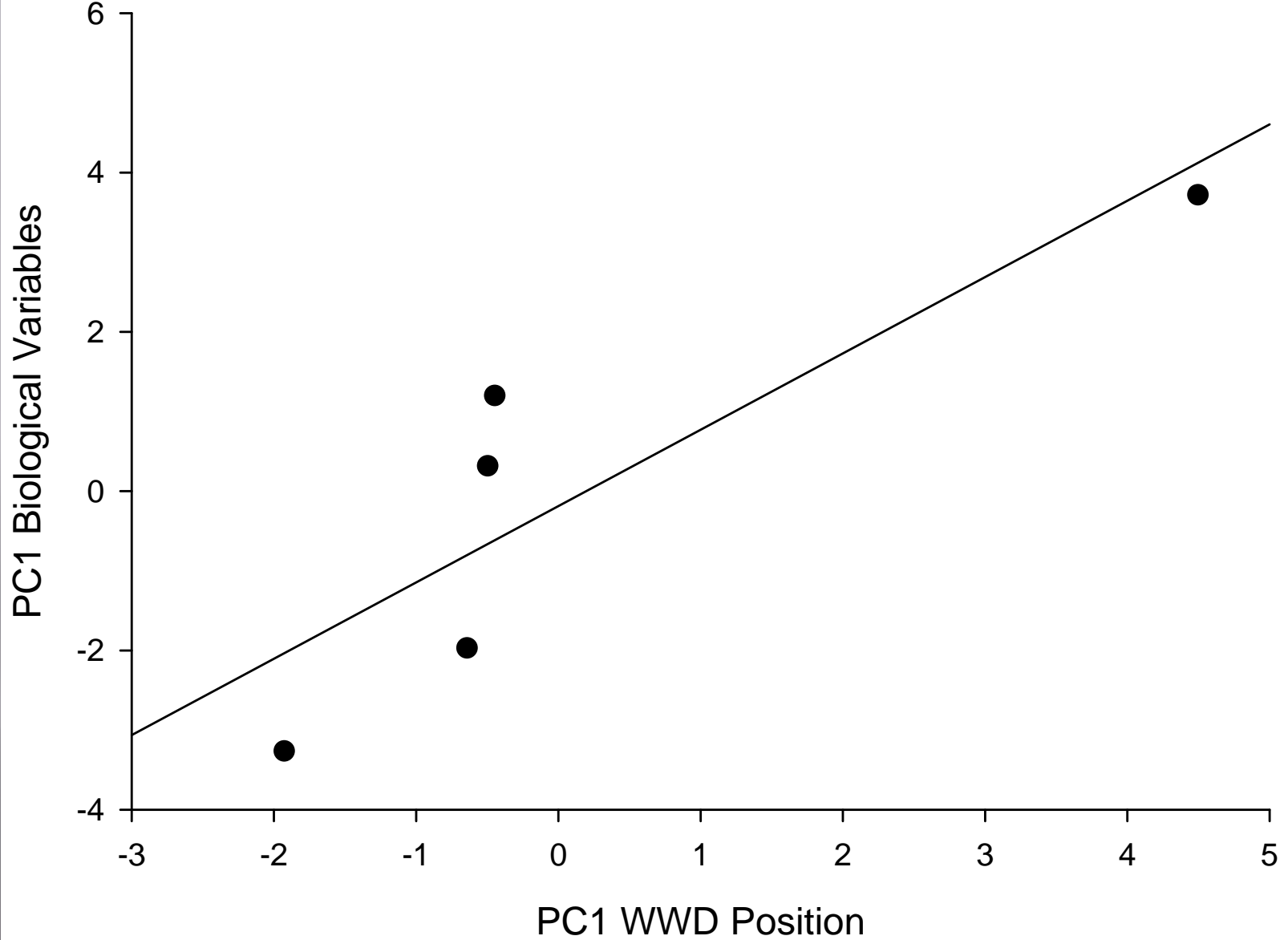
(n=5 years)

Component	Eigenvalue	Difference	Proportion	Cumulative
1	7.47	5.98	0.75	0.75
2	1.48	0.74	0.15	0.90

Variable	PC1
NCI_ms	0.30
cope_rich	-0.36
caau_rep	0.34
caau_el	-0.32
comu_rep	0.29
comu_el	-0.36
tspin_ads	0.30
epac_ads	0.32
coho_sar	0.18
Rockfish	0.33



pc1_wwd | pc1_bio: Beta=.958, s.e.=.314, t=3.05, p=0.055, r2=.76



Where are we?

- ▣ NPGO important index for biology

Appears to relate to more active transport in the CCE

Appears to relate to more active upwelling in CCE

- ▣ North Pacific Current location probably important to NPGO- related changes in physical drivers

Biological populations (indices) from zooplankton to birds and salmon appear to respond to this variability.

ARGO tool, should be examined more closely.

Looking Forward

- Analyses
 - Spectral Analyses on Physics and Biology
 - Wavelet Analyses (localizes modulations in time)
Are signals showing the same spectra?
- Multivariate Indicators
- IEA

