Rockfish, Seabirds, and the Importance of Wintertime Ocean Conditions in the California Current

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http://www.pfeg.noaa.gov

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- NOAA Fisheries and the Environment (FATE)
- California SeaGrant, Ocean Protection Council

MOTIVATION

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→ Indices of upwelling phenology (*last year*)





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→ Impacts on seabird reproduction, rockfish growth





DATA SETS

yelloweye rockfish
(piscivorous)

splitnose rockfish
(planktivorous)

→ growth-increment chronologies

common murre
(piscivorous)

Cassin's auklet
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Bryan Black
BIO-P-5884
Friday, 9:25 am

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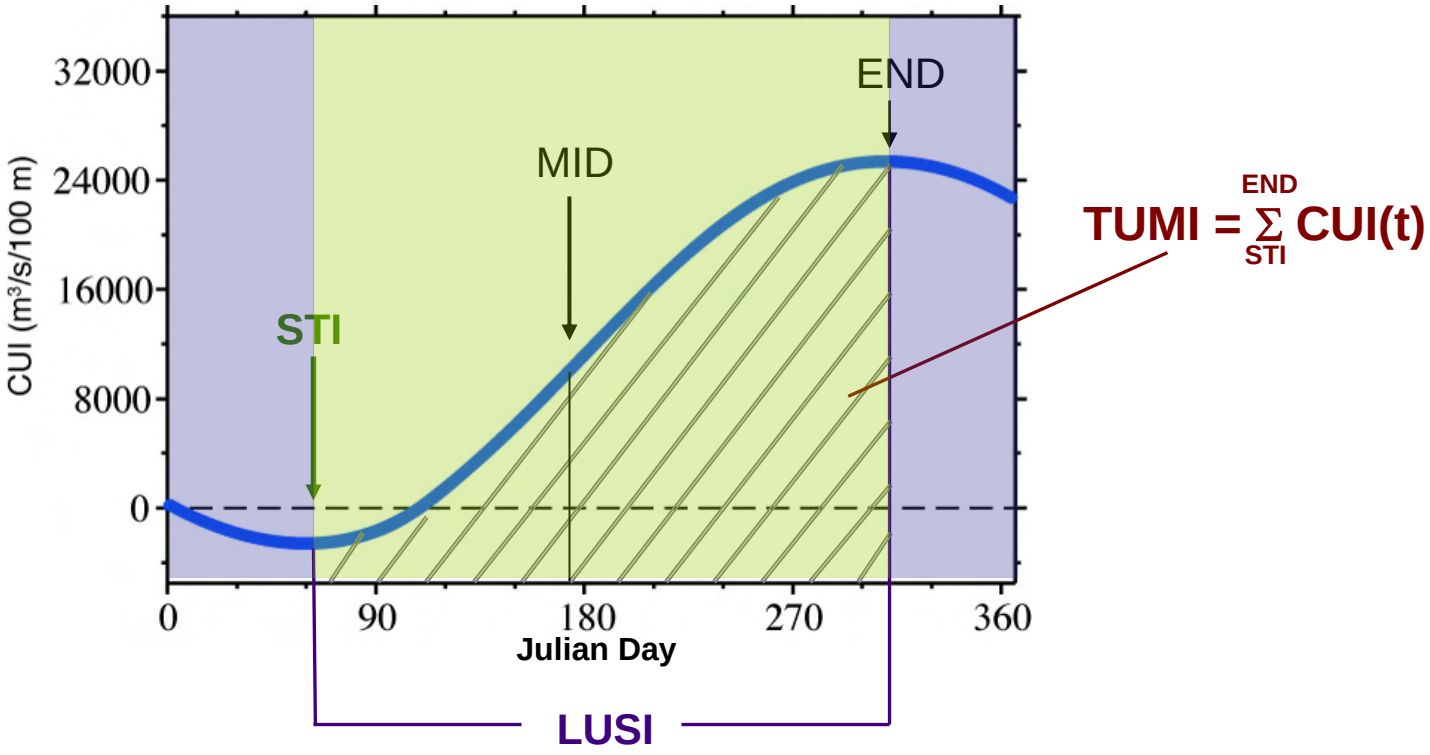
Question #1: How has timing, duration, intensity of coastal upwelling changed in the California Current?

INDICES of COASTAL UPWELLING: Timing, Duration, Intensity



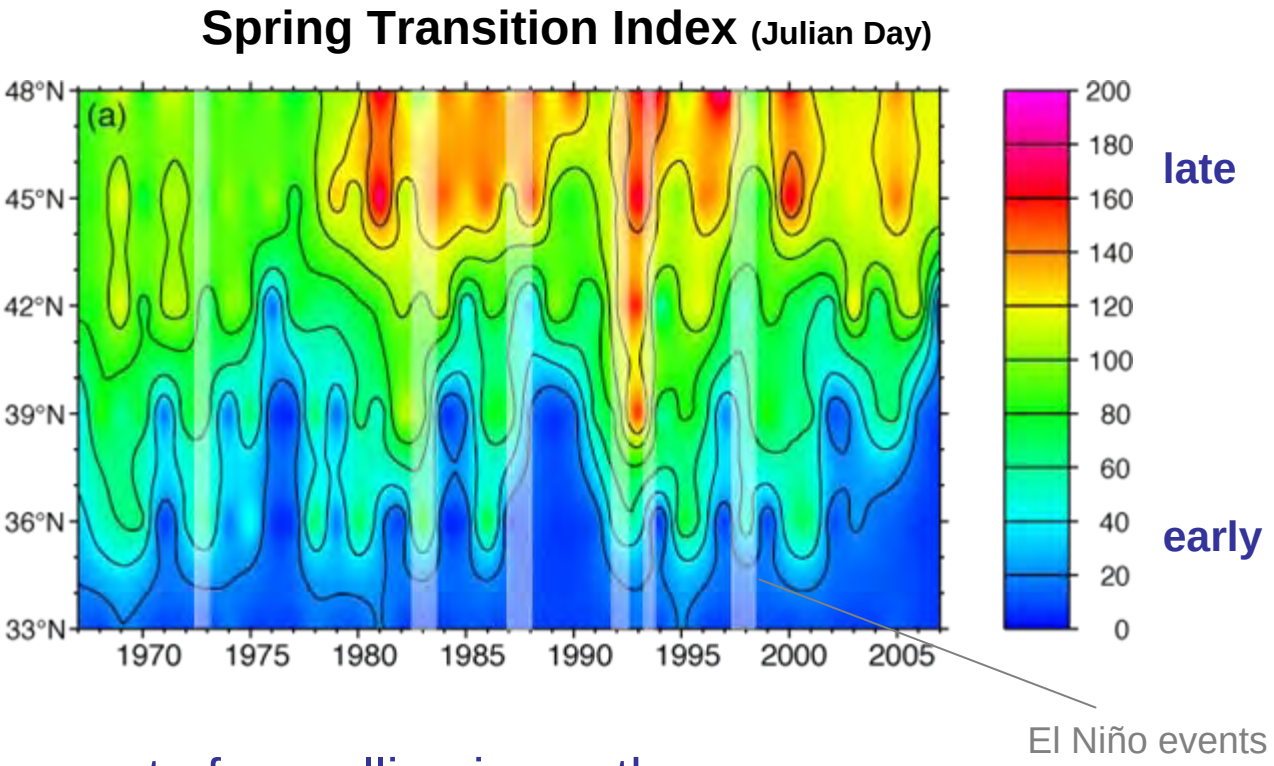
Spring Transition Index (STI) = Date of Minimum CUI

(END = Date of Maximum CUI)

Length of Upwelling Season Index (LUSI) = Total days between STI and END

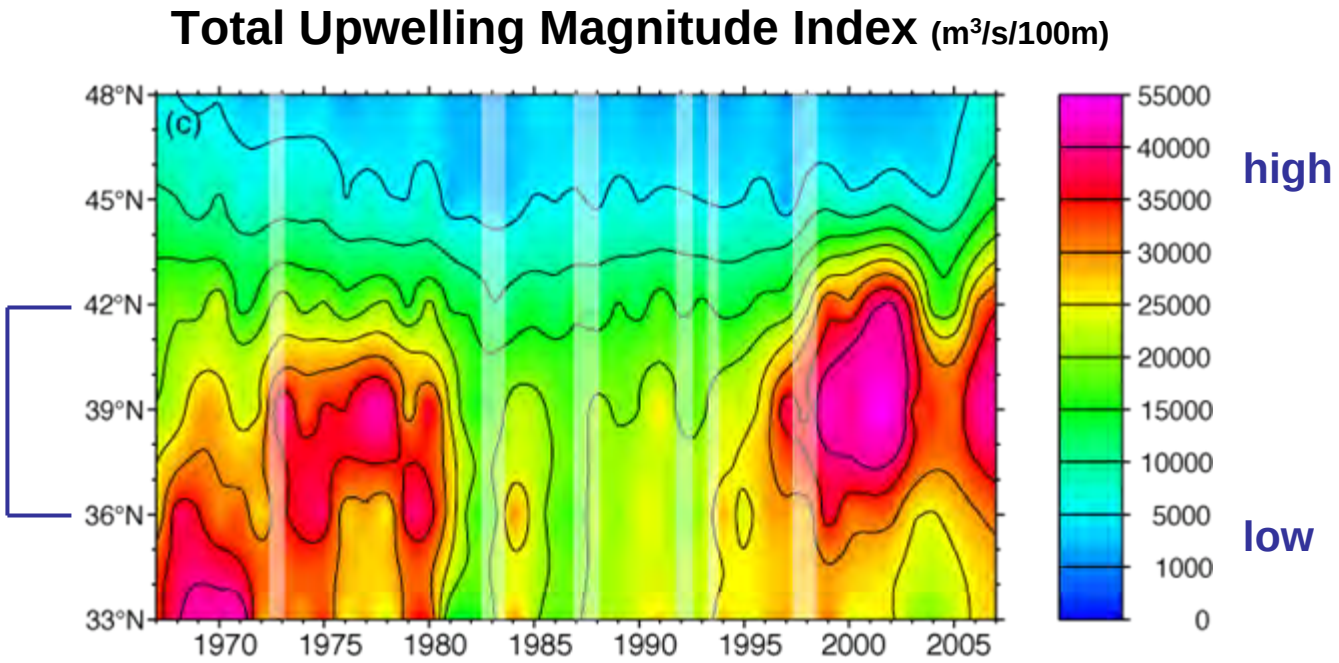
Total Upwelling Magnitude Index (TUMI) = CUI Integrated between STI and END

Interannual Variability in Upwelling: (1) Timing



- Earlier onset of upwelling in south
- Trend to later spring transition in north
- Delayed upwelling during El Niño events
- Upwelling “surplus” or “deficit” at climatological transition date

Interannual Variability in Upwelling: (2) Intensity



- High integrated upwelling in 1970s, 1998-2004
- Low integrated upwelling in 1980-1995
- 1998-2004: high TUMI, low LUSI --> intense upwelling
- 1980-1995: frequent El Niño events

Bograd et al. (2009)

Question #2: Does anomalous winter upwelling pre-condition the California Current ecosystem to higher productivity?

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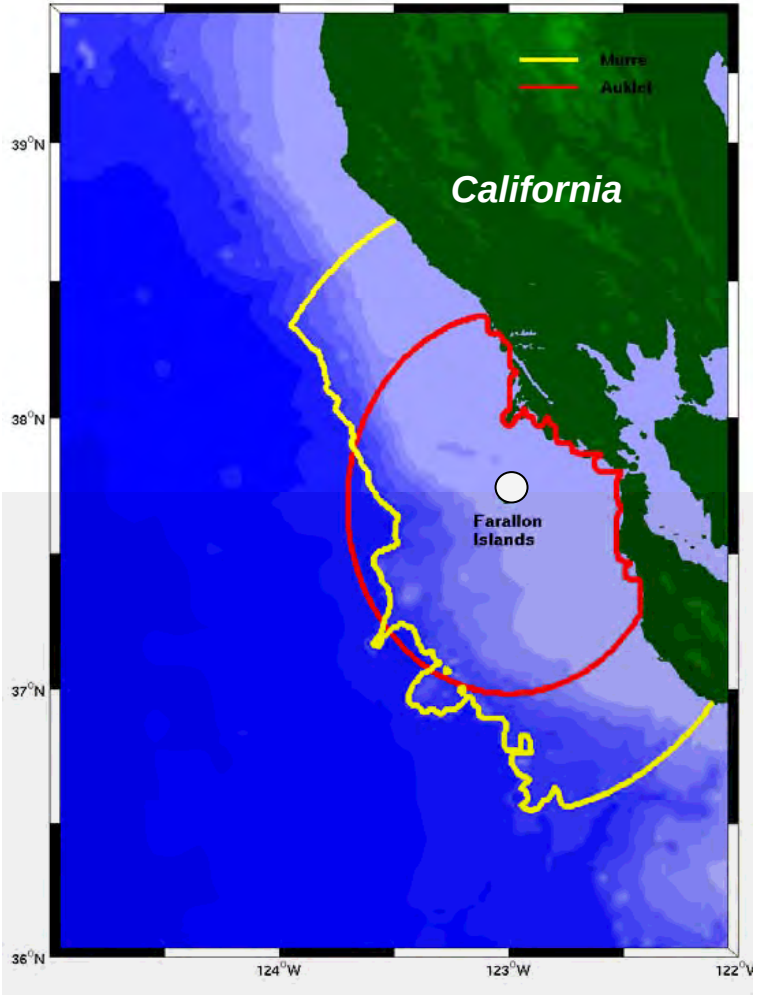
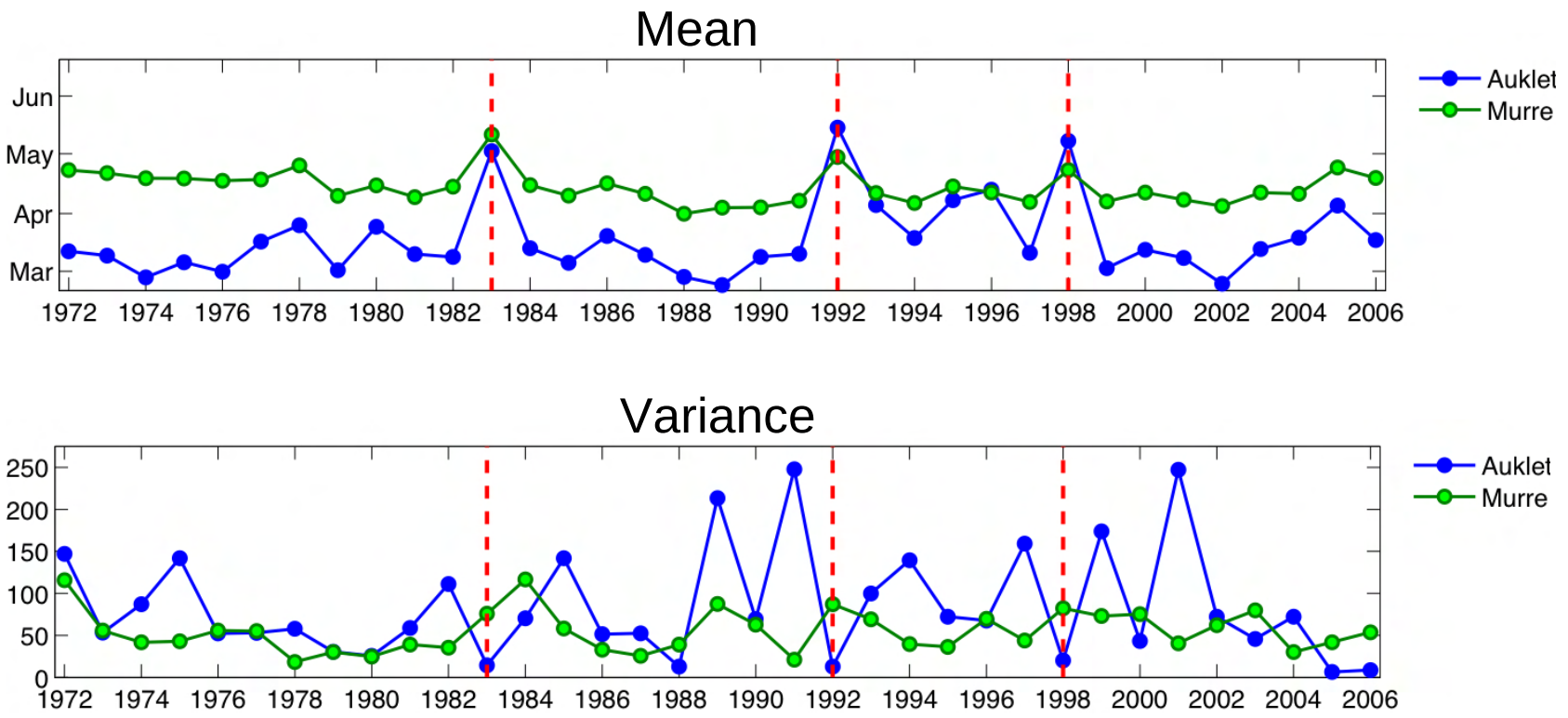
→ (a) enhanced seabird reproductive success?

SEABIRDS at the FARALLON ISLANDS



- Two bird species from same location but different life strategies
- Look at the timing of egg laying (mean, variance)

TIMING of SPRING EGG LAYING



- Early egg-laying = high reproductive success for both species
- High variance is good for Auklets, bad for Murres

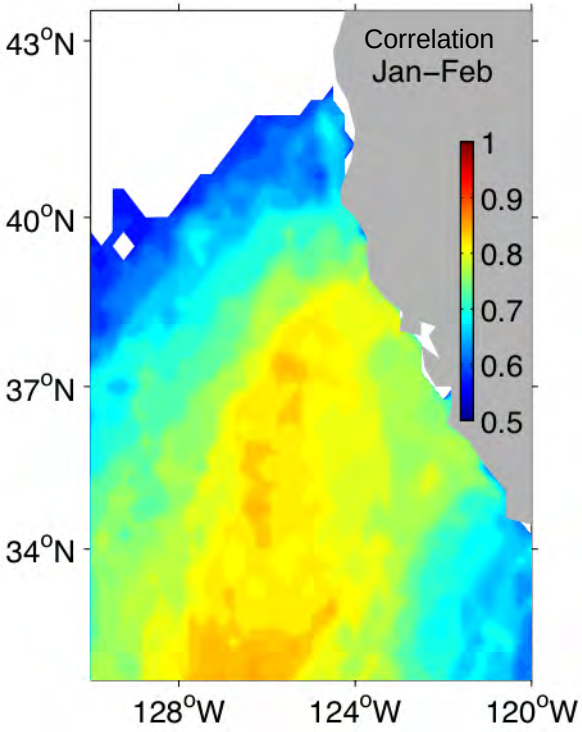
Abraham and Sydeman (2004); Reed et al (2008); PRBO (unpublished)

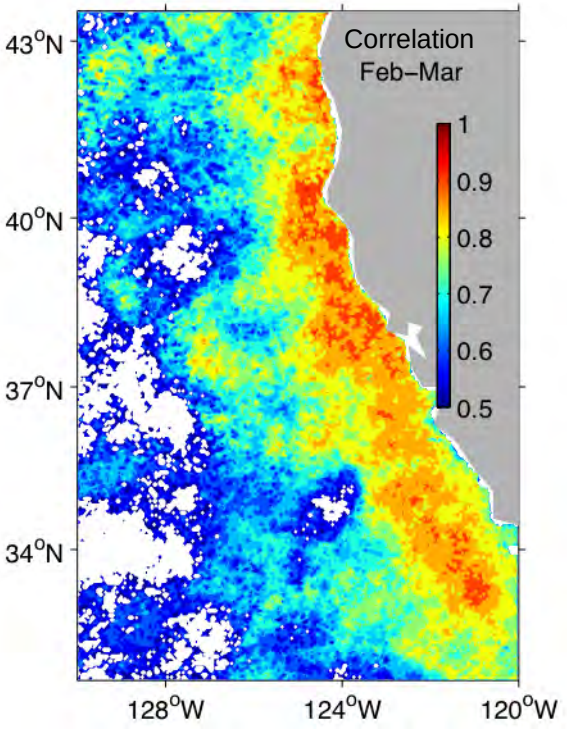
Egg-Laying Date vs. Upwelling Indices: Correlations

Egg-Laying Date	Cassin's Auklet	Common Murre
Spring Transition Date	0.46	0.46
Length of Upwelling Season	-0.52	-0.46

Early Upwelling → Early Egg-Laying (good)

Lagged Correlation Maps: Mean Lay Date vs. Winds, SST





+ correlation → northerly winds, cool SSTs → early lay date

Schroeder et al. (2009)

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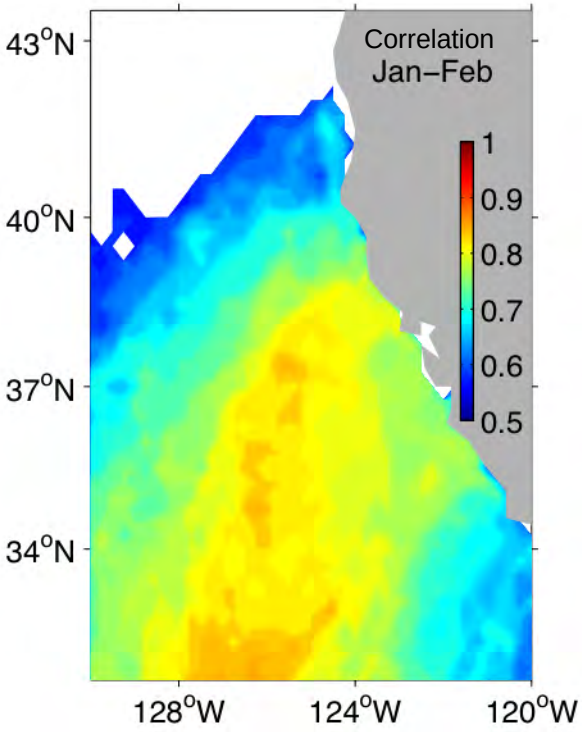

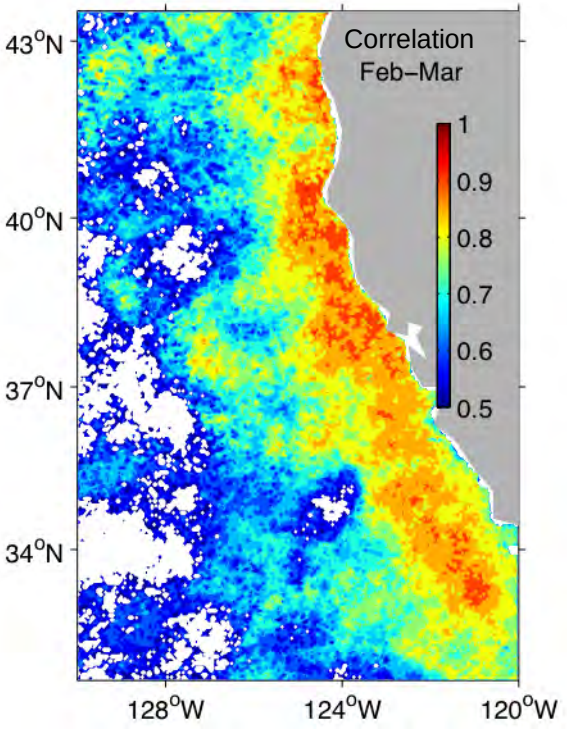

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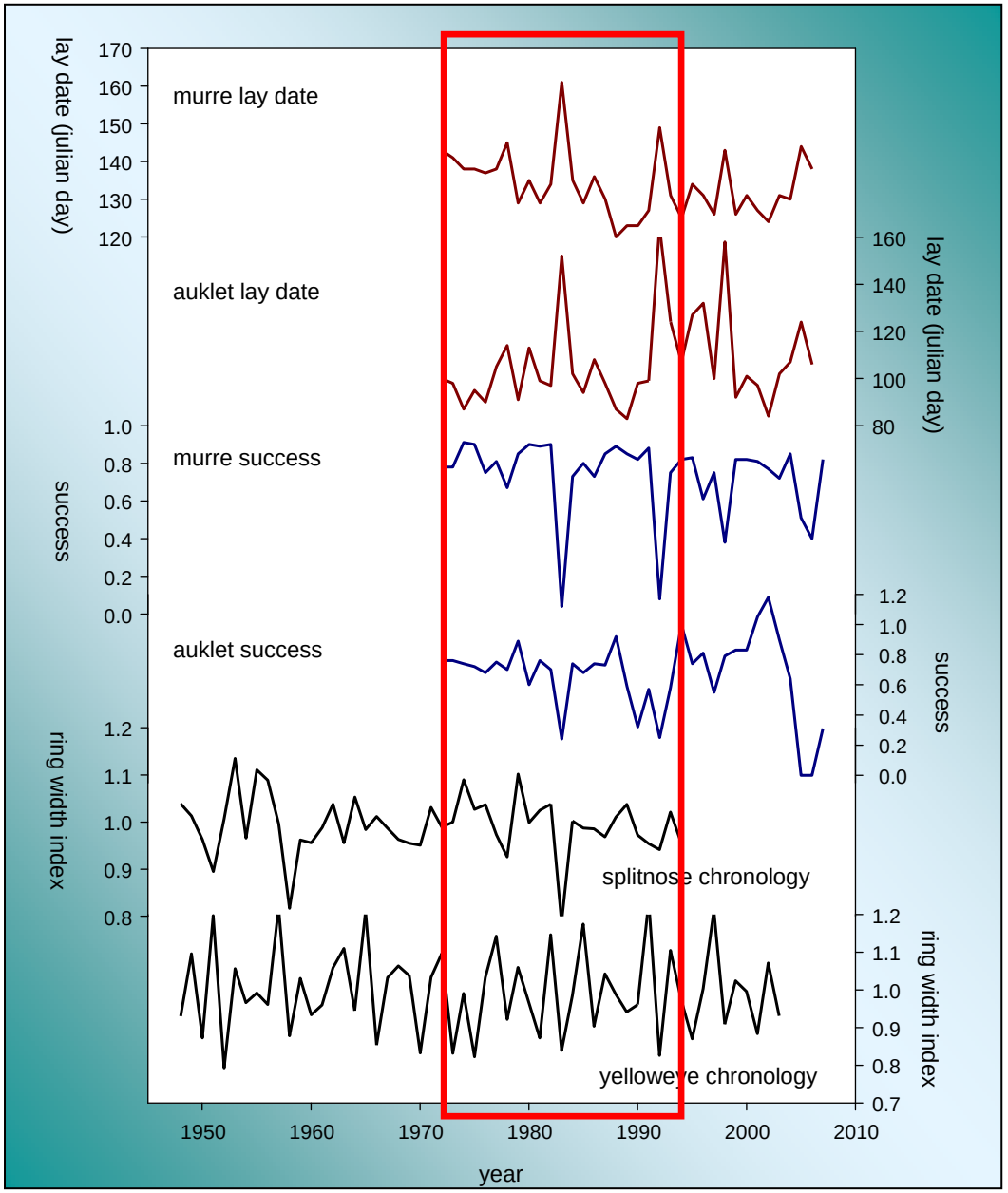


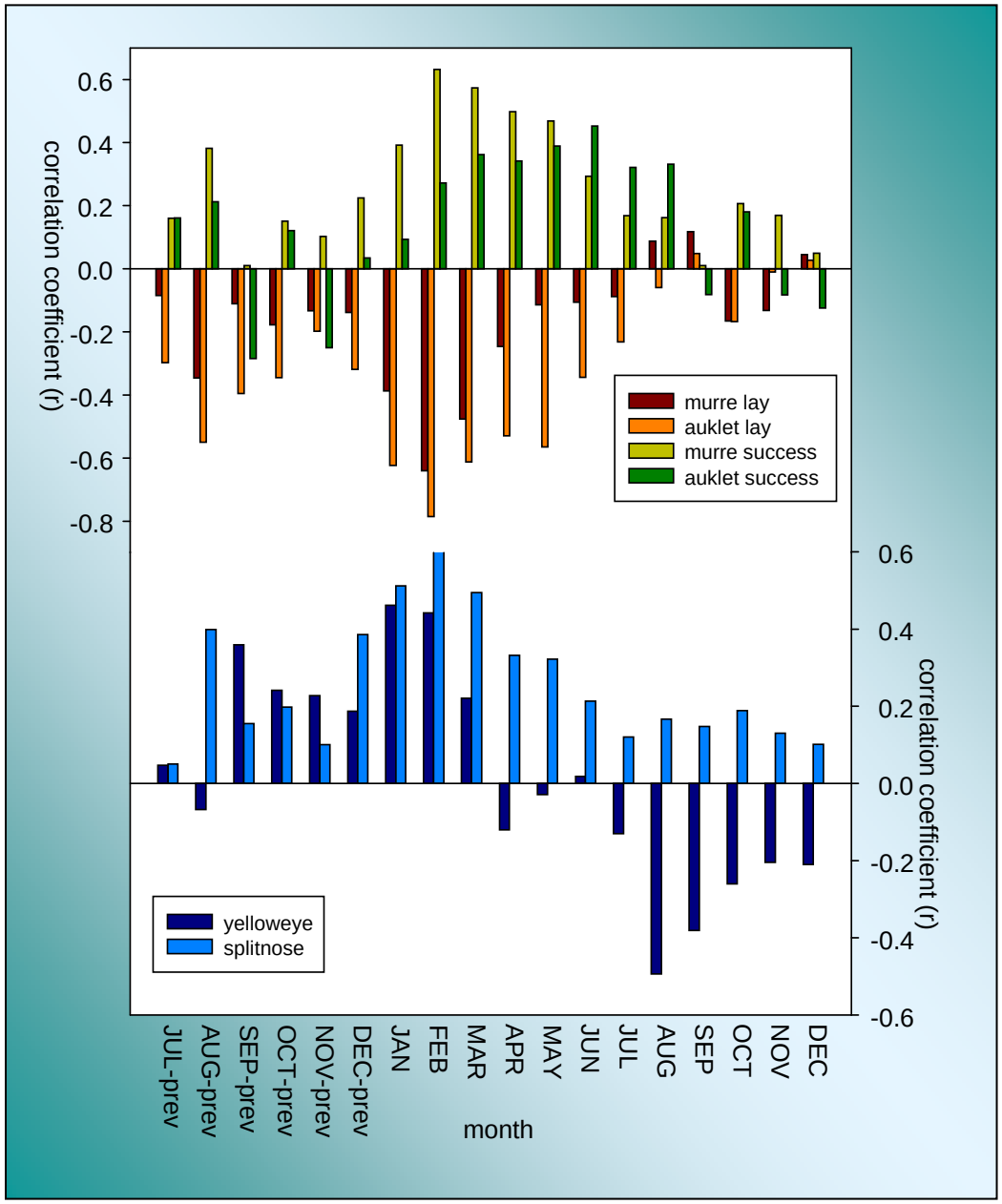
common period:
1972-1994

lay date
(seabirds)

fledgling success
(seabirds)

growth-increment
(rockfish)

Relationships with Upwelling (39° N)



seabirds

rockfish

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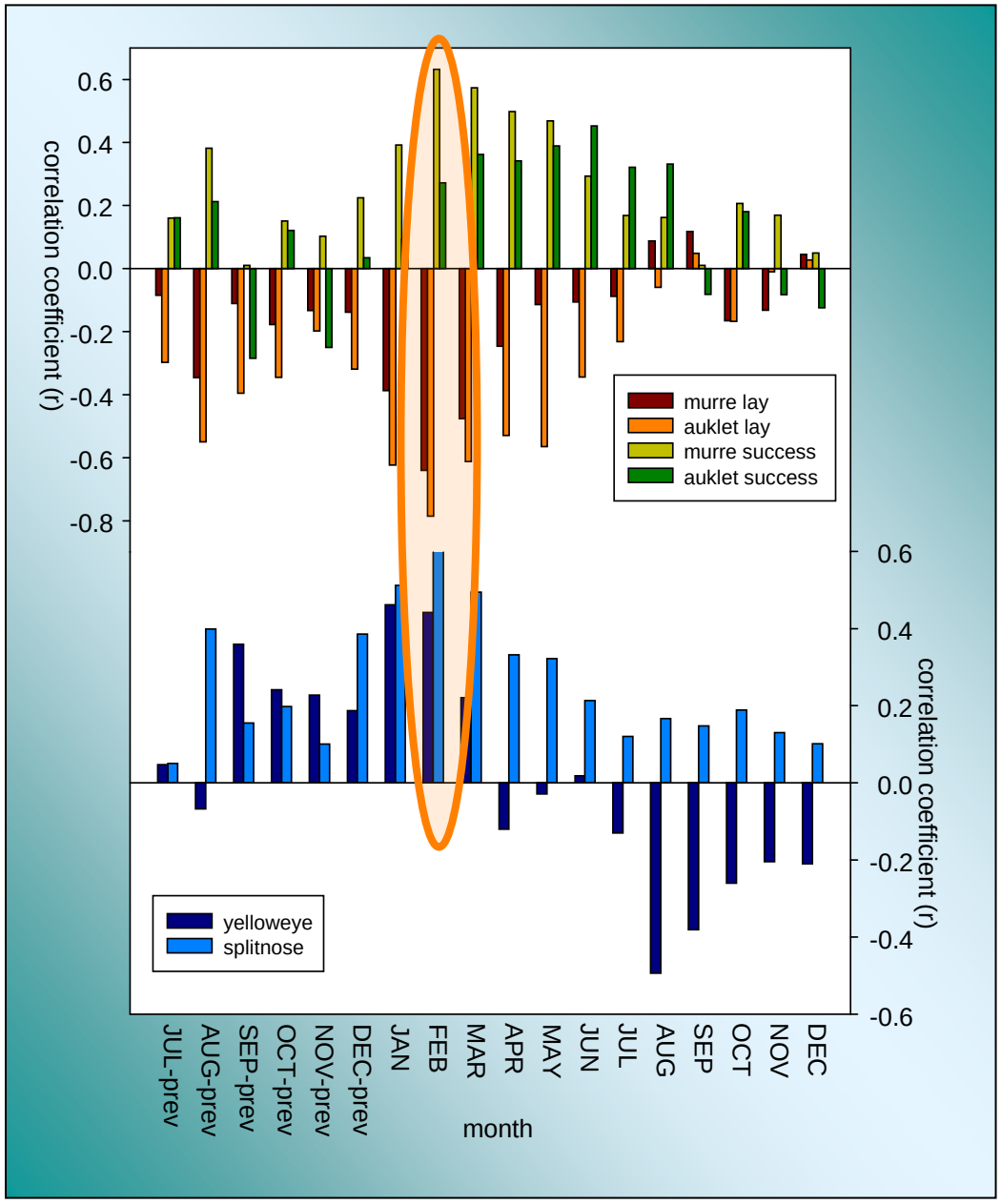
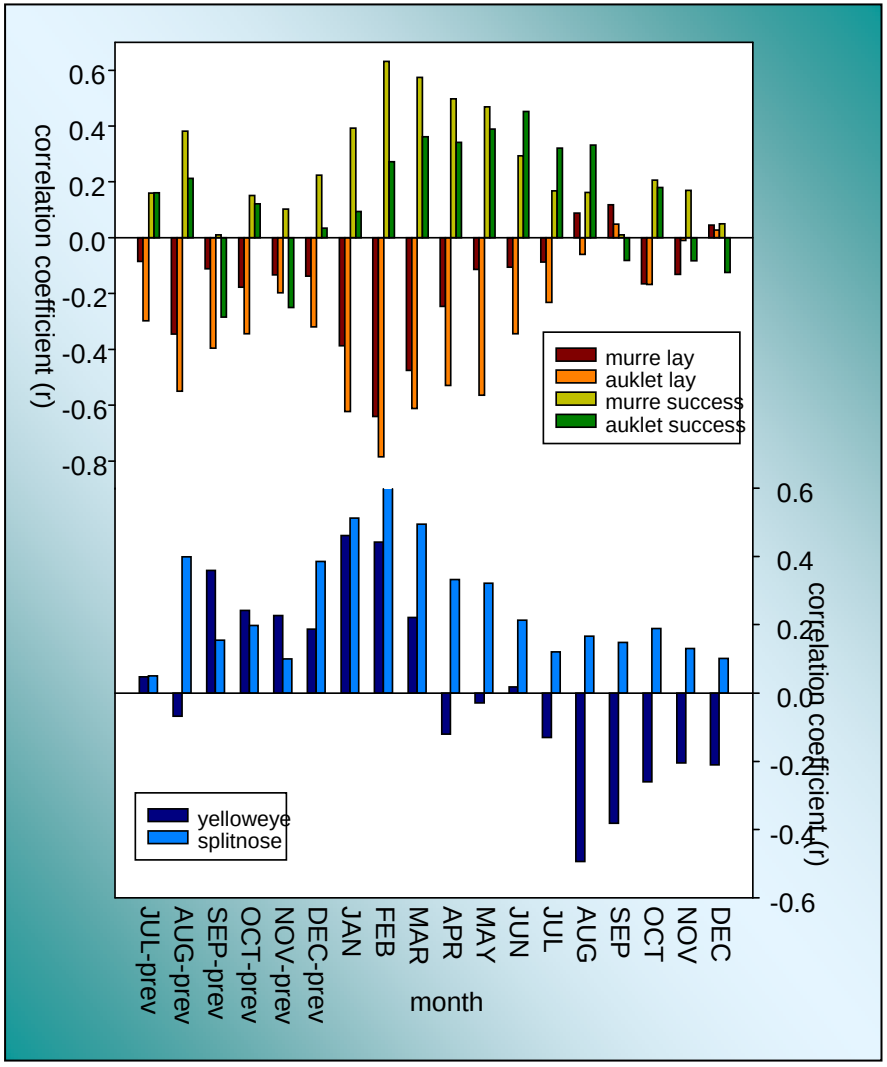


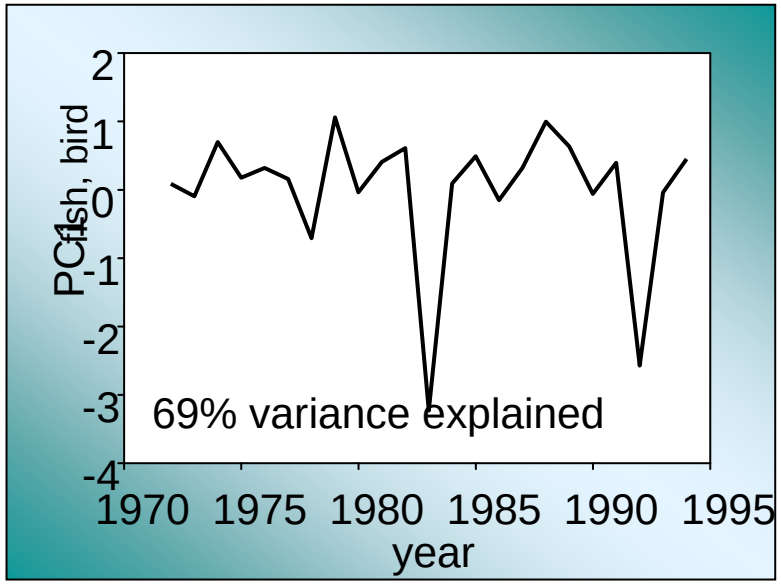
seabirds

rockfish

highest correlation in February

A California Current Ecosystem Indicator





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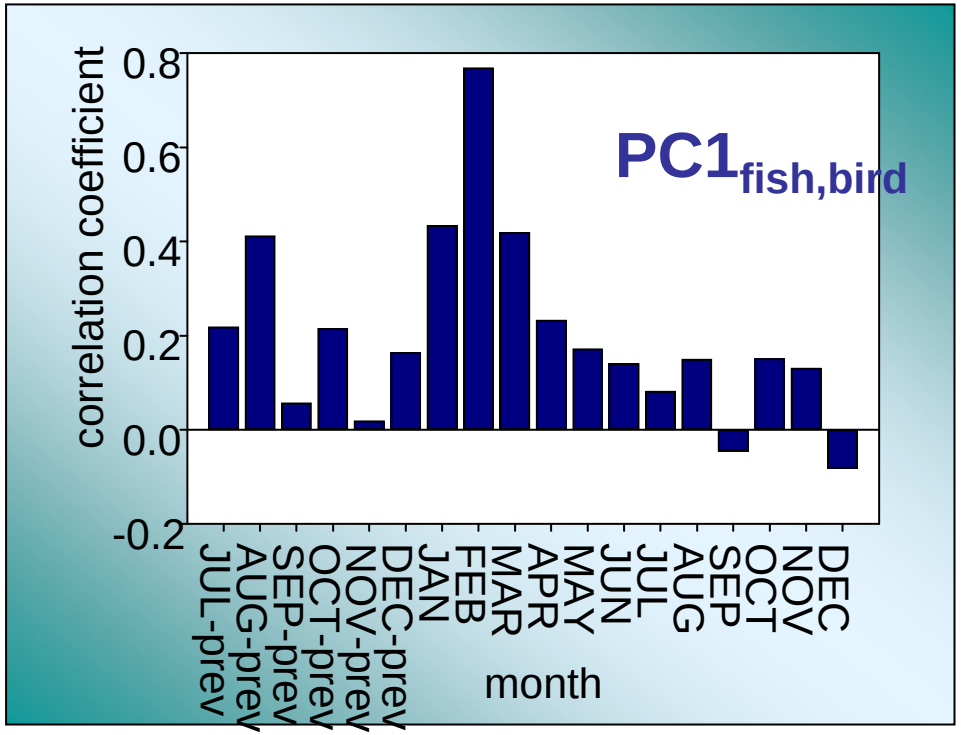

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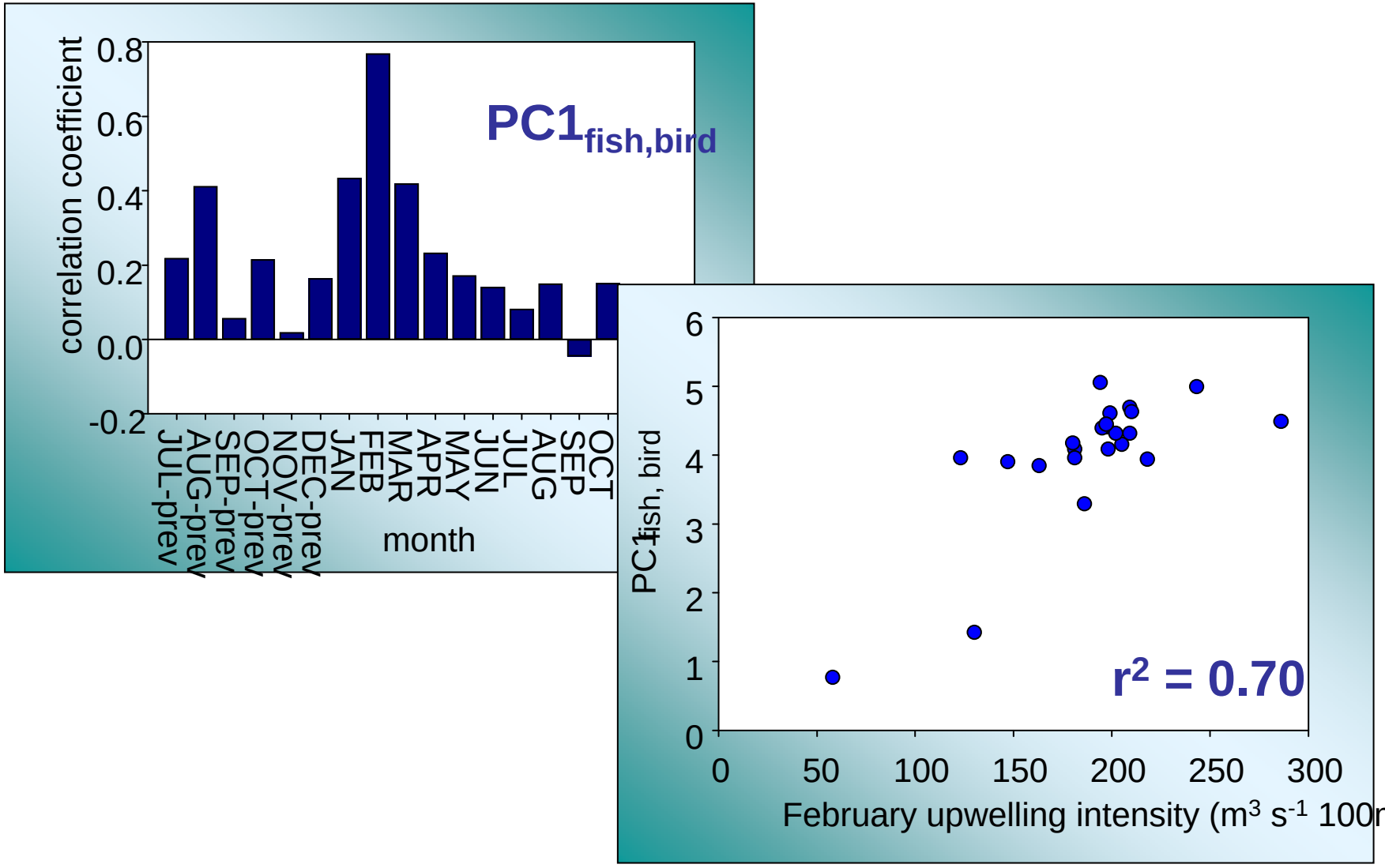
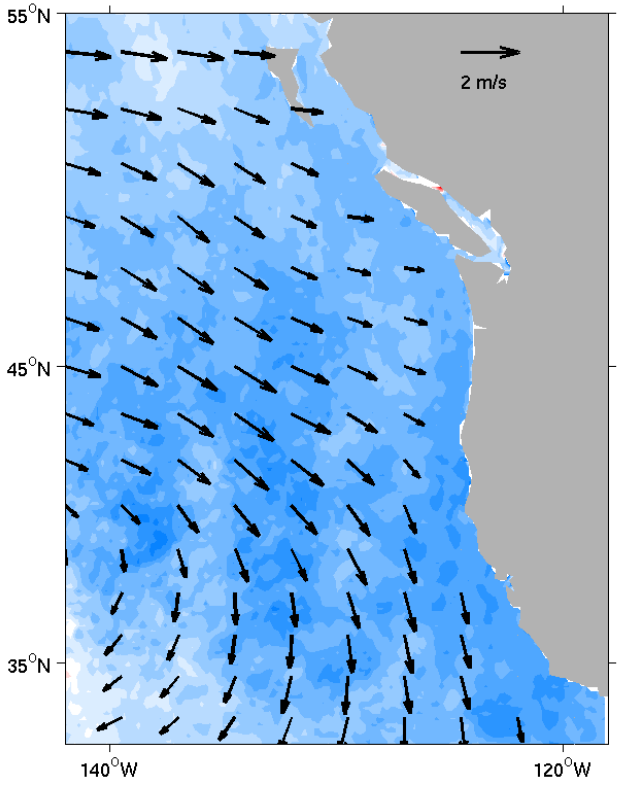


Black et al. (2009)

Good (Early) & Bad (Late) Years for Cassin's Auklet

Four earliest Auklet mean egg-laying years



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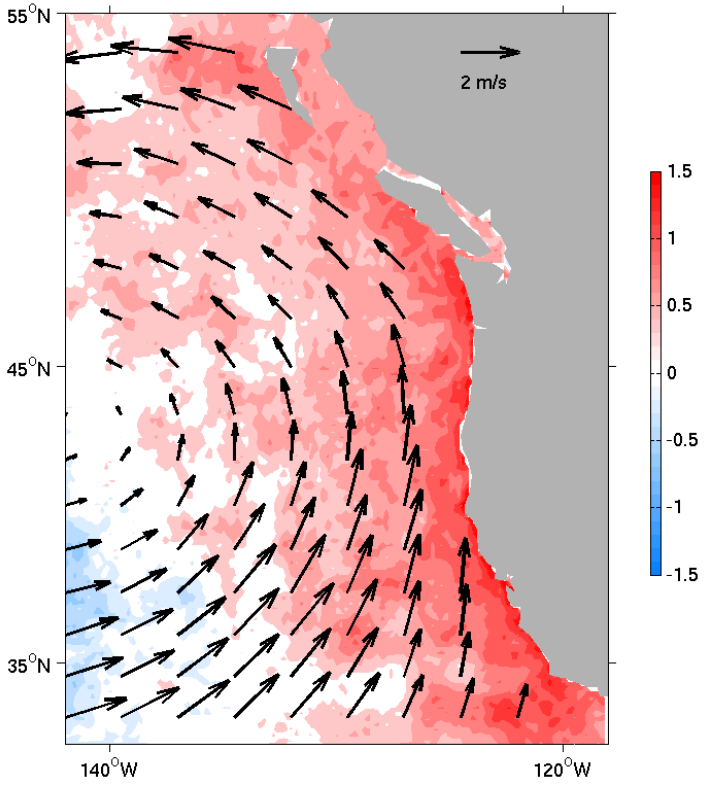

- Jan-Feb mean winds (vectors) & Feb-Mar mean SST (colors)
- Good years: strong H, anomalously strong upwelling, cool SSTs
- Bad years: weak H, anomalously weak upwelling, warm SSTs

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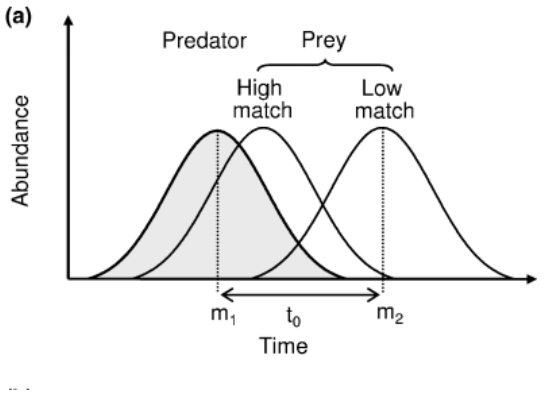

Durant et al. (2005)

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   c) Common sensitivity to early lower trophic production

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…….. February upwelling in California Current? … “Outlook”

THANK YOU!


OREGON STATE UNIVERSITY
CENTER
Hatfield Marine Science Center
NEWPORT, OREGON


Farallon Institute
Advanced Ecosystem Research


NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE


Sea Grant
California
Coastal Science
Serving California


CALIFORNIA OCEAN
PROTECTION COUNCIL

PHENOLOGICAL CONSEQUENCES:
Seabird Reproduction

Sydeman et al (2006); Peterson et al (2007); PRBO (unpublished)

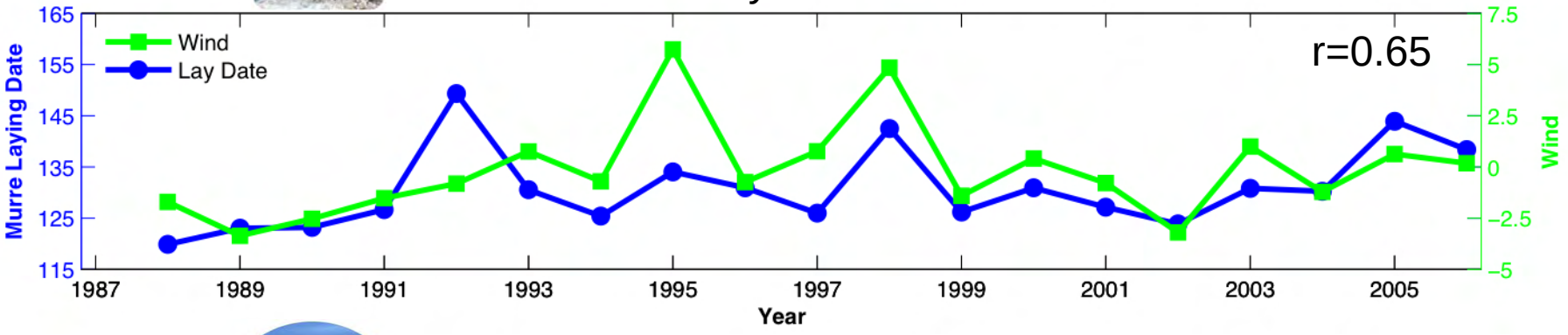
ENVIRONMENTAL DATA

Use satellite winds and SST to describe variations in upwelling:

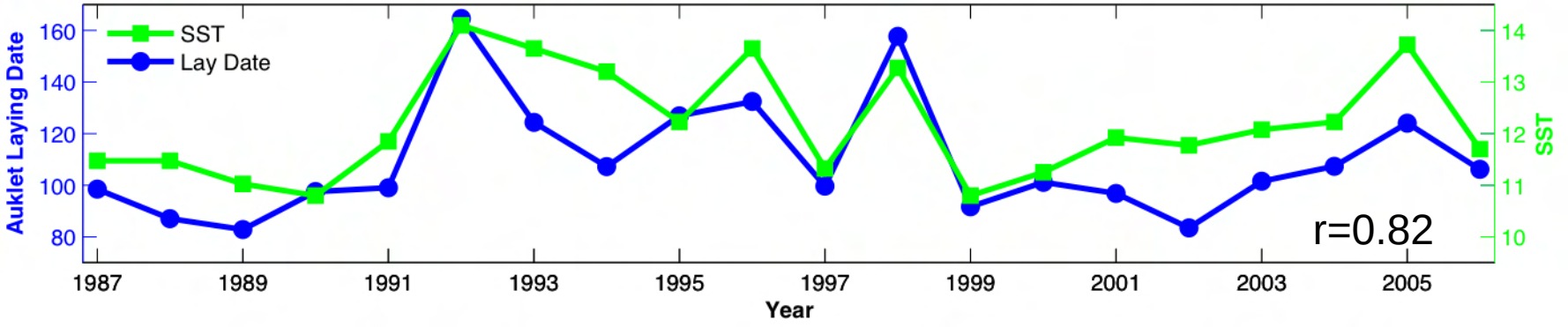
- Northeast Pacific domain: ~ 120˚ -145˚ W, 30˚ -55˚ N
- NOAA/NCDC blended wind product: 25 km grid
- Pathfinder SST: 4.4 km grid
- Monthly means for 1987-2006

Lagged Correlations at 37.5°N - 123°W (example)

Murre's Mean Lay Date & Jan Wind

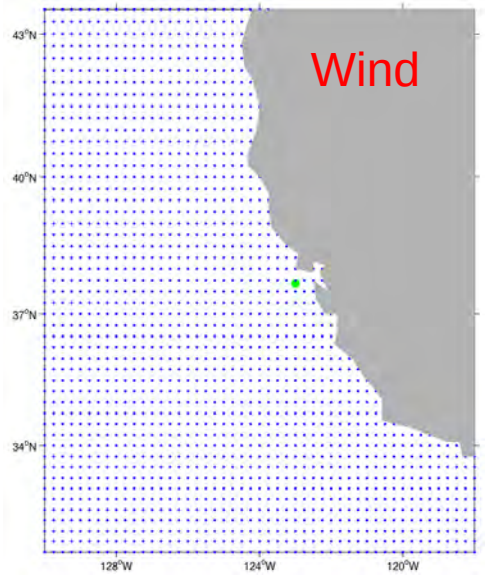


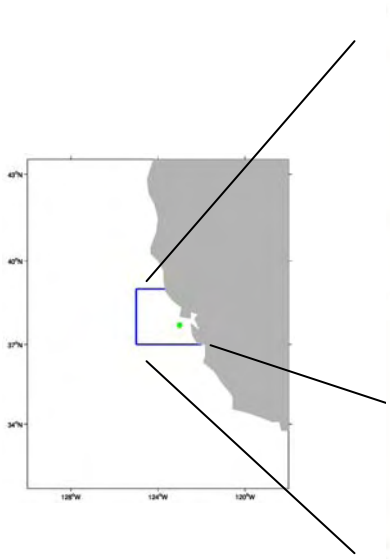
Auklet's Mean Lay Date & March SST

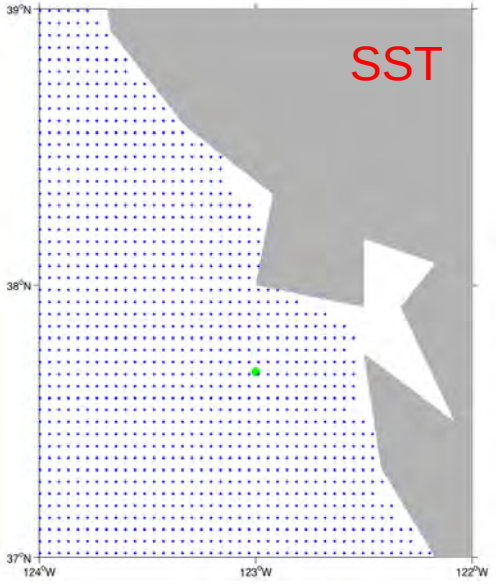


CORRELATION MAPS

- Compute correlations at all grid locations
- For SST and Alongshore Wind (V)
- For Murre and Auklet egg-laying date: mean and variance
- Monthly for September - April
- Different lags between environment and egg-laying



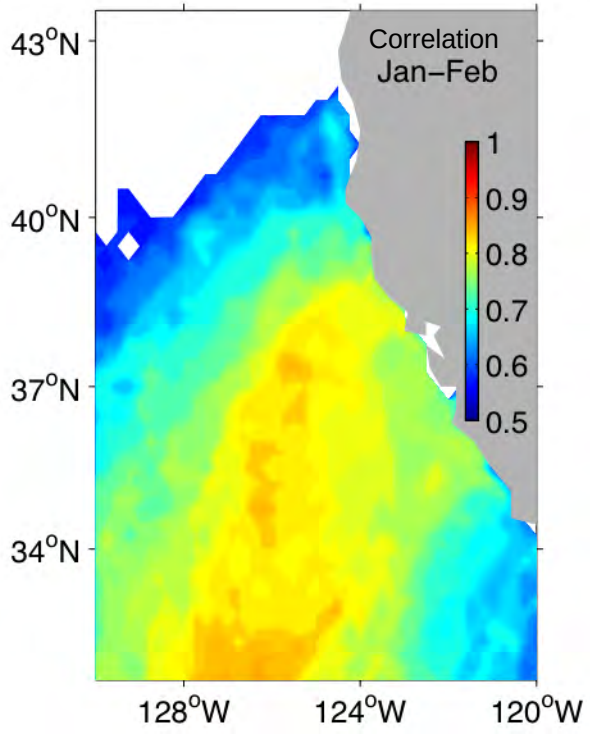


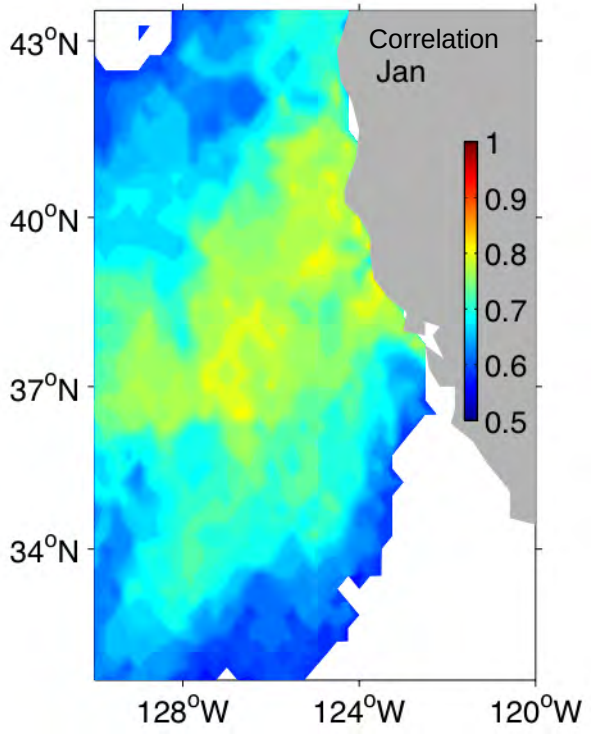


Lagged Correlation Maps: Mean Lay Date vs. Alongshore Wind

+ correlation

Northerly winds =
Early egg-laying

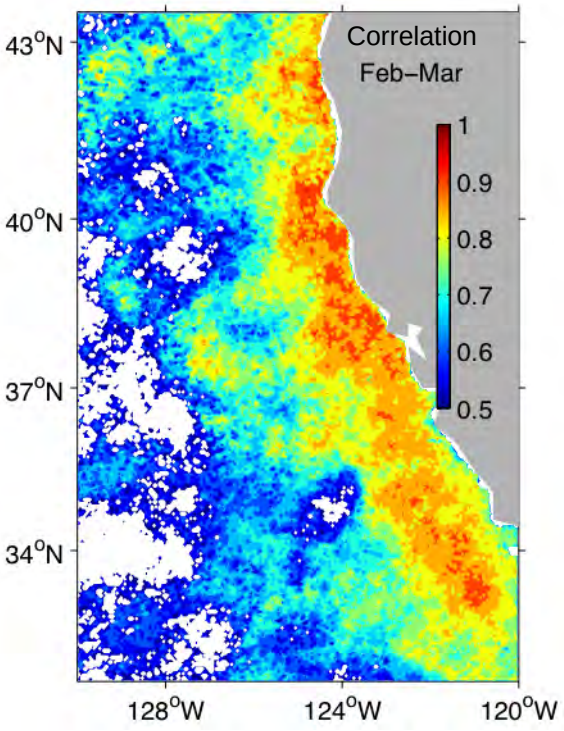


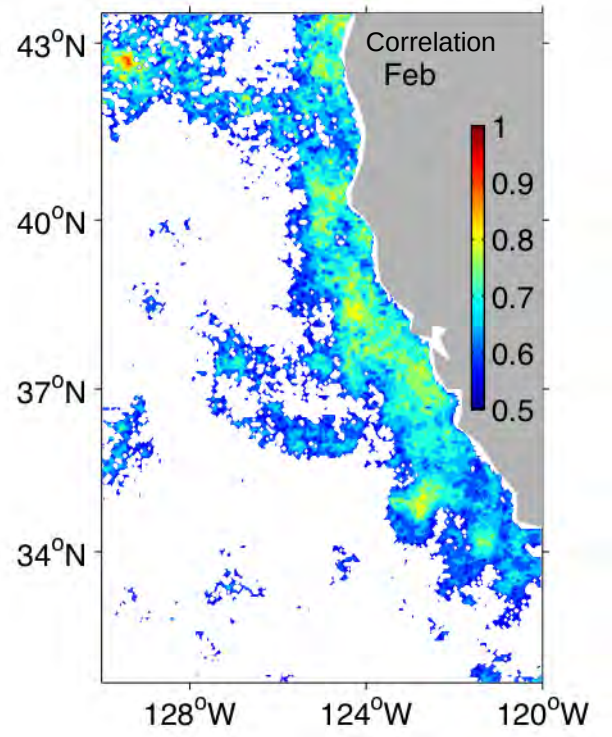


Lagged Correlation Maps: Mean Lay Date vs. SST

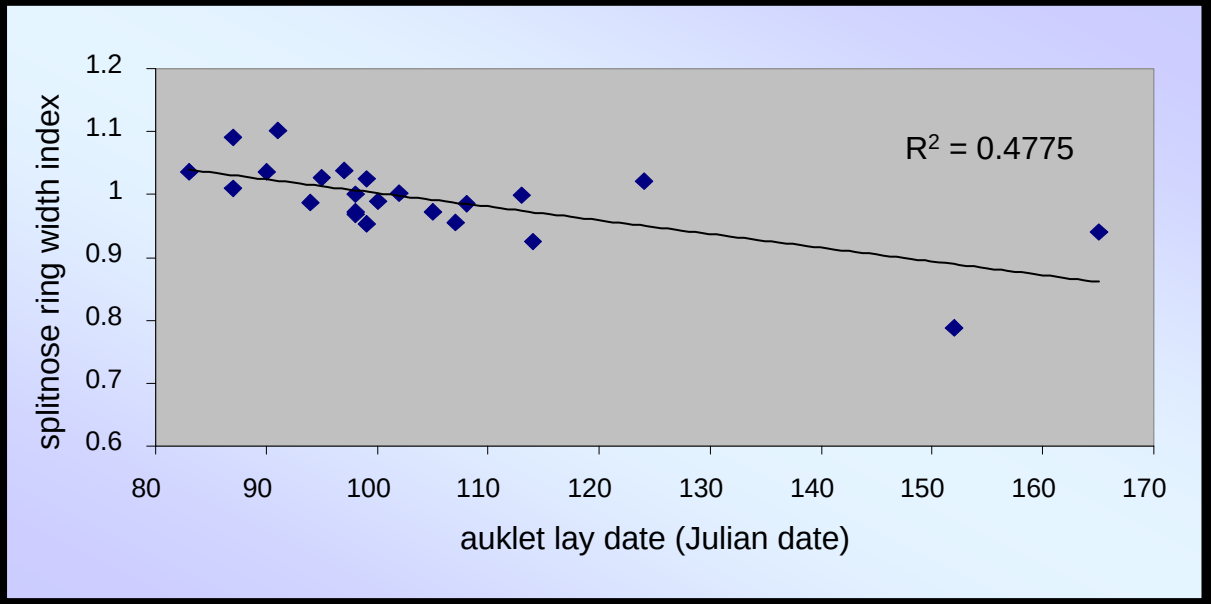
+ correlation

Cool SSTs =
Early egg-laying





Fish growth and bird reproduction linked



favorable ocean conditions = early lay date, wide growth incre