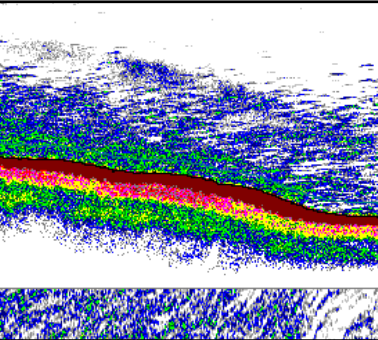




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# Krill and Krill-Predators: Habitat associations in the dynamic Gulf of the Farallones, California

J. Jahncke, B.L. Saenz, C. Rintoul and W.J. Sydeman

# Introduction



Euphausiids are a critical source of carbon in marine food webs.

Very little is known about their spatial and temporal distributions, abundance, and reproductive dynamics.



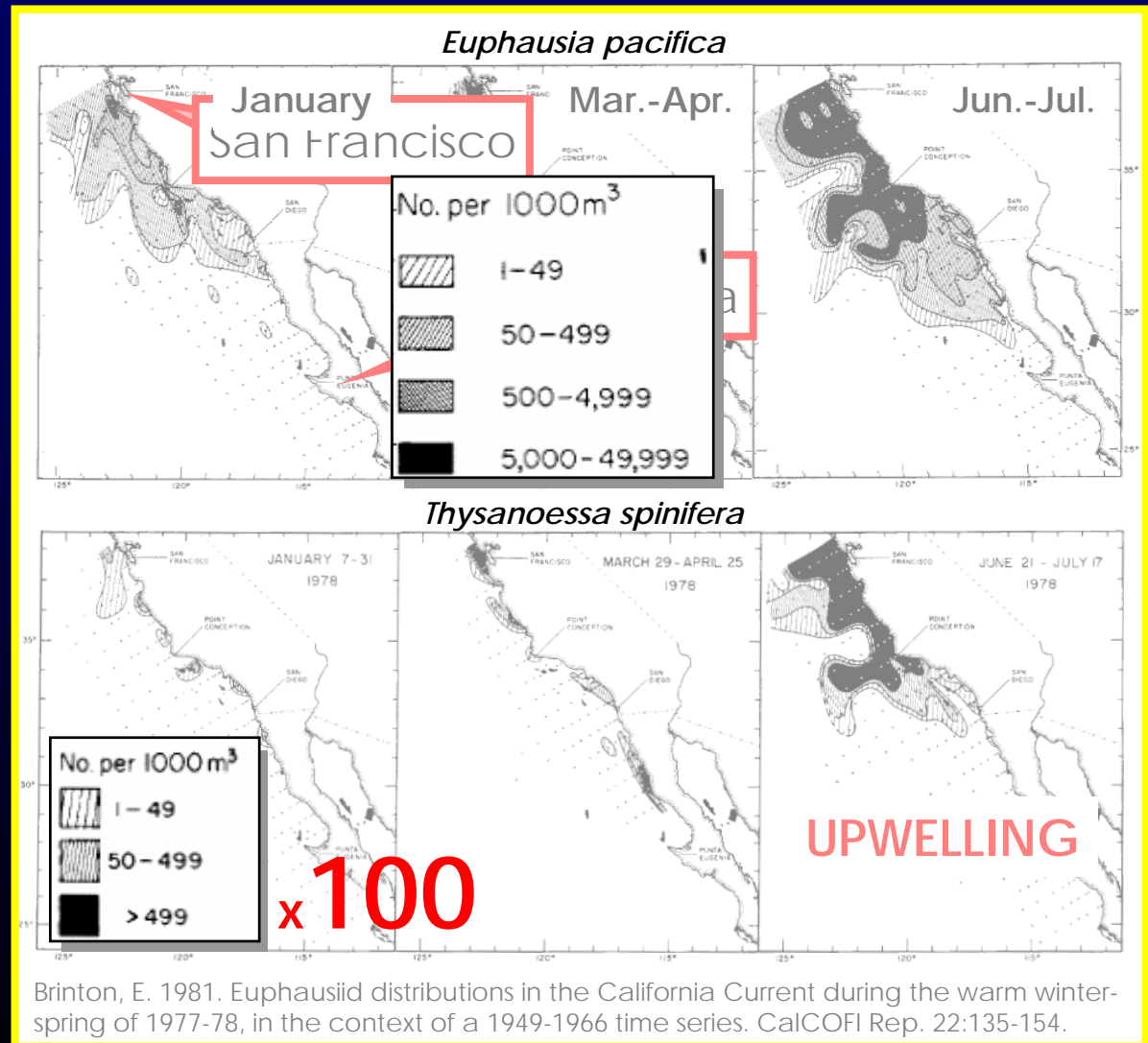
# Krill in the California Current

## *E. pacifica*

- More abundant
- Oceanic and shelf-break

## *T. spinifera*

- Less abundant
- Shelf



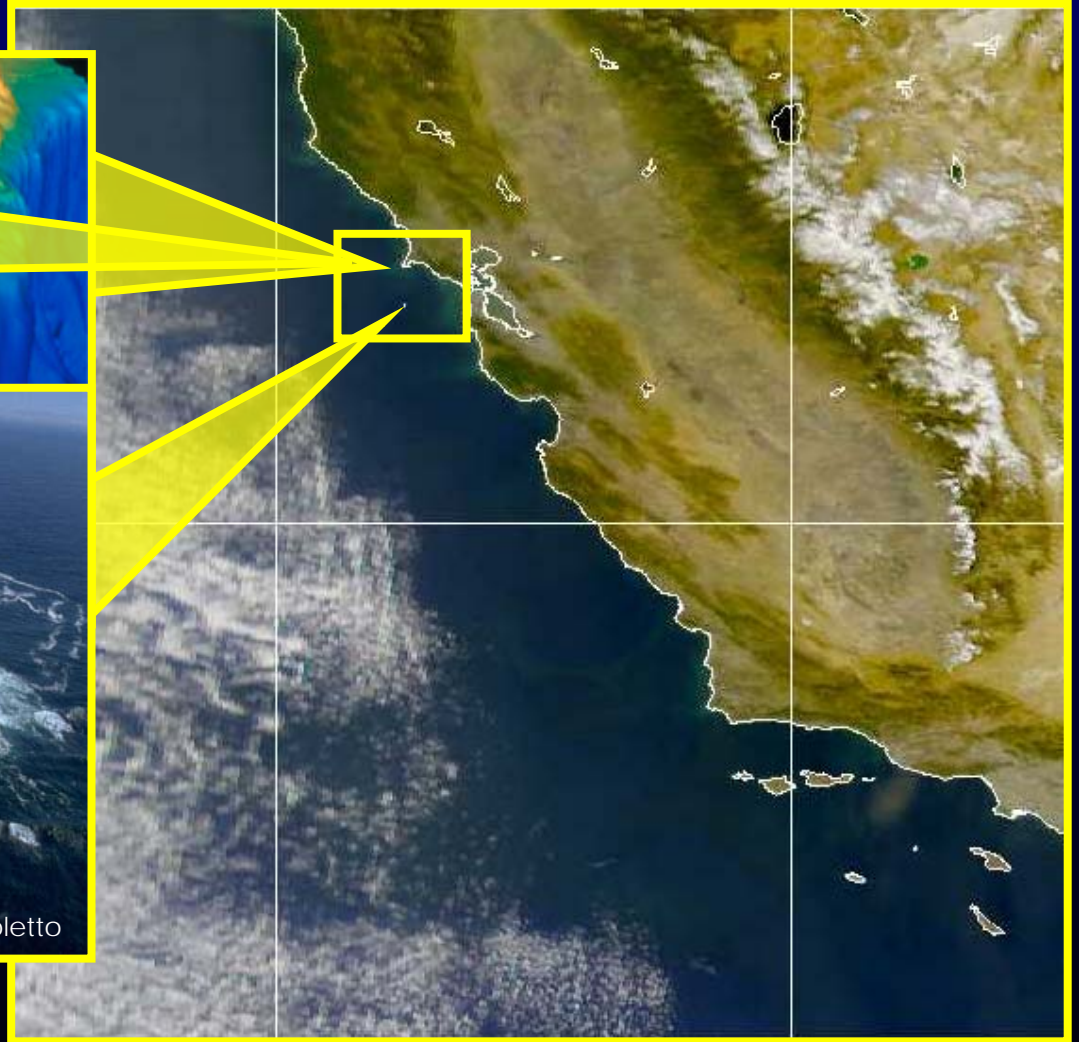
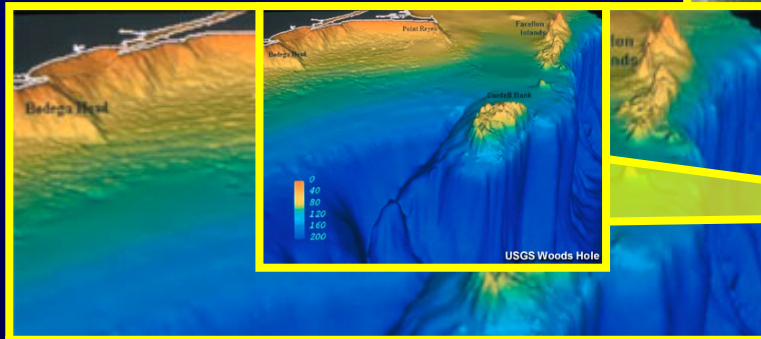
... there is great spatial and temporal variability in the relative abundance of these species.



... distribution responds to ENSO (Brinton 1981, Marinovic et al. 2002).

... abundance responds to PDO (Brinton and Townsend 2003).

# The Gulf of the Farallones



# Goal

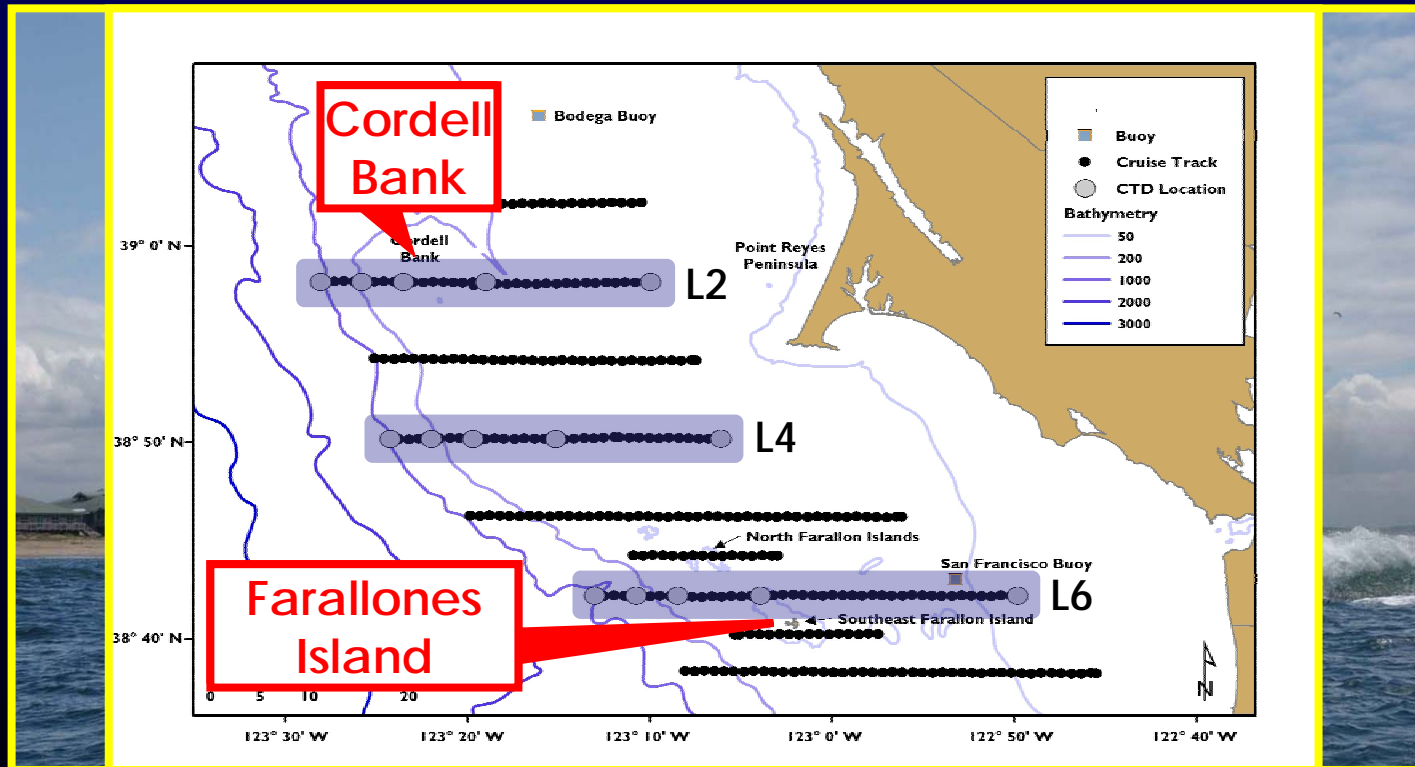
To determine how seasonal and interannual variability in oceanographic conditions affects the distribution and abundance of krill and krill-predators.

# Hypothesis

Krill and krill-predators aggregate at predictable locations in the continental shelf and slope waters of the Gulf of the Farallones

# Methods

- Research cruises onboard the R/V John H. Martin (MLML)
- Surveys from May to October 2004 and February to July 2005.
- Survey grid, 9 transects (total 300+ km), 3 oceanographic lines.





# Methods

- Birds/mammals (standardized strip and line transects)
- Zooplankton/fish (hydroacoustics and nets)
- Oceanography (CTD casts and continuous CT and fluorometry)



# Methods

## 4. Krill abundance and distribution

### **SIMRAD EK-60 with 38, 120, 200 kHz transducers**

Calculated Fiedlers et al.' (1998) index of krill abundance as follows:

$$\Delta S_{\text{Krill}} = 0.5 (S_{V120} + S_{V200}) - S_{V38}$$

$S_{\text{Krill}}$  not converted to biomass, sample analysis not completed.

$S_{\text{Krill}}$  integrated vertically (upper 50-m and 200-m).

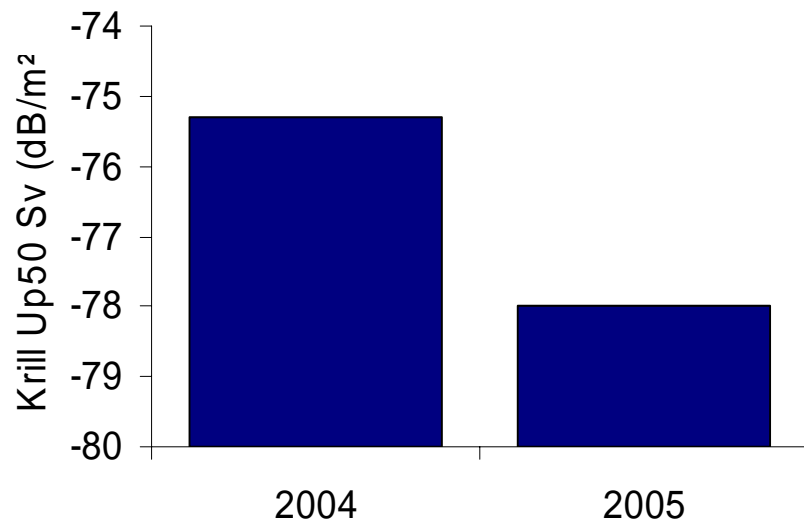
**We modeled 3 levels of krill and krill-predator abundance in 3-km bins (Log+1 transformed). Forward stepwise ordered logistic regression for the analysis (NS variables were dropped)**

# Results

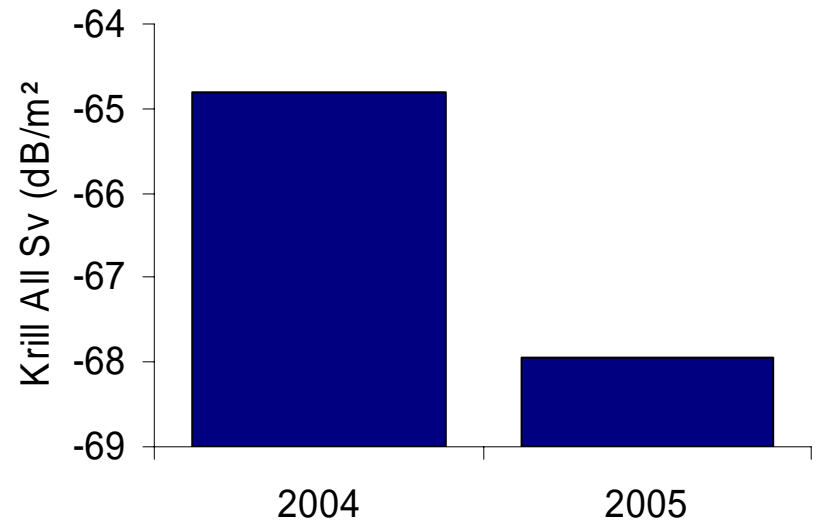
## More krill in 2004 than 2005

(Ordered Logistic Regression,  $p < 0.01$ )

### Upper 50-m



### Upper 200-m

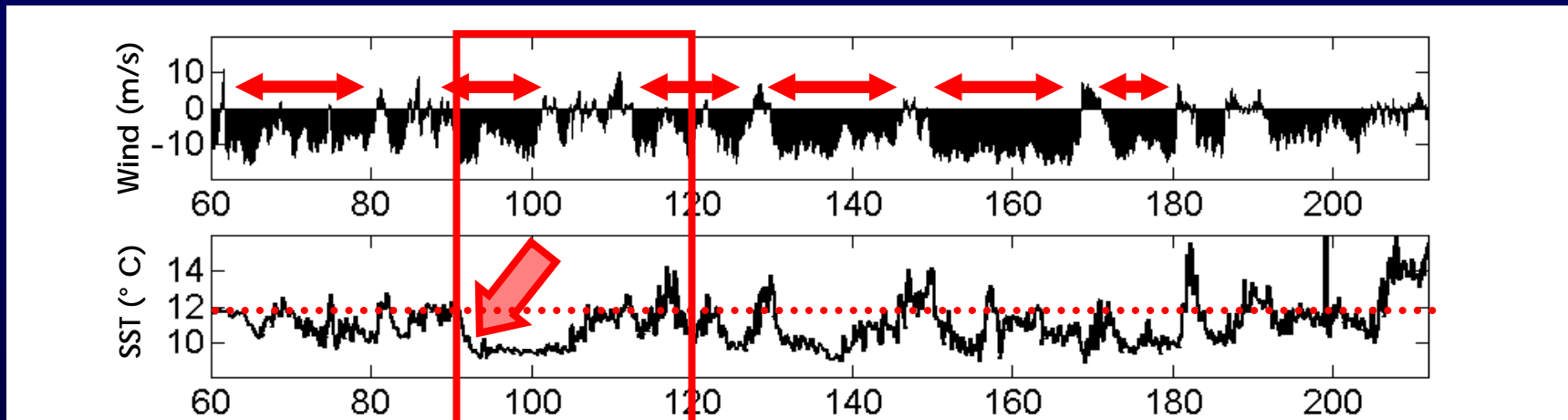


# Results

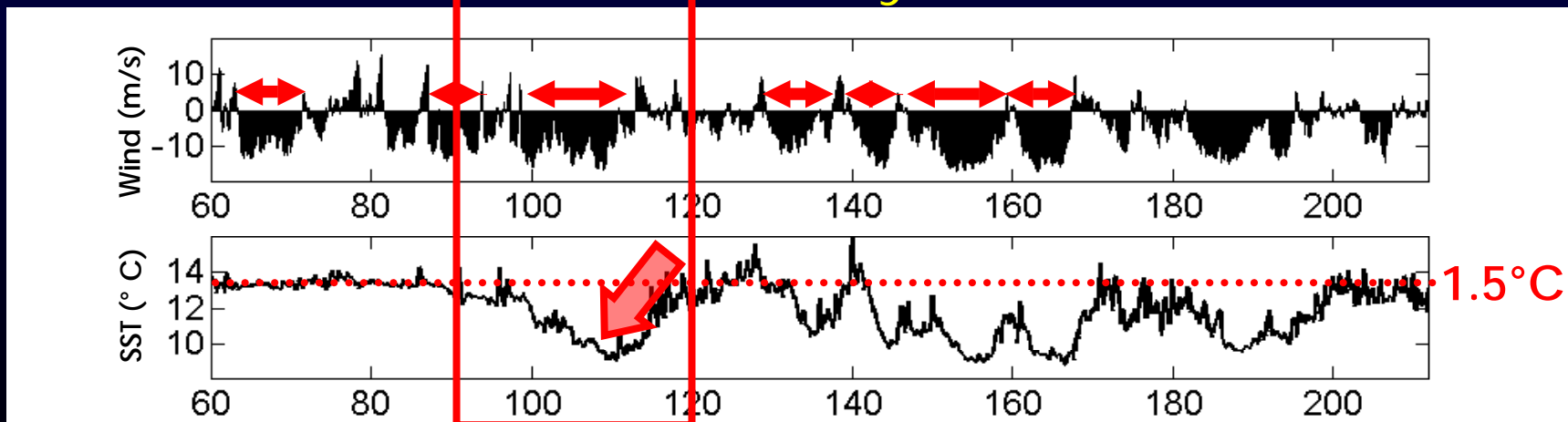
2004 and 2005  
were **very** different...

# Alongshore wind and SST; Bodega (46013)

March to July, 2004

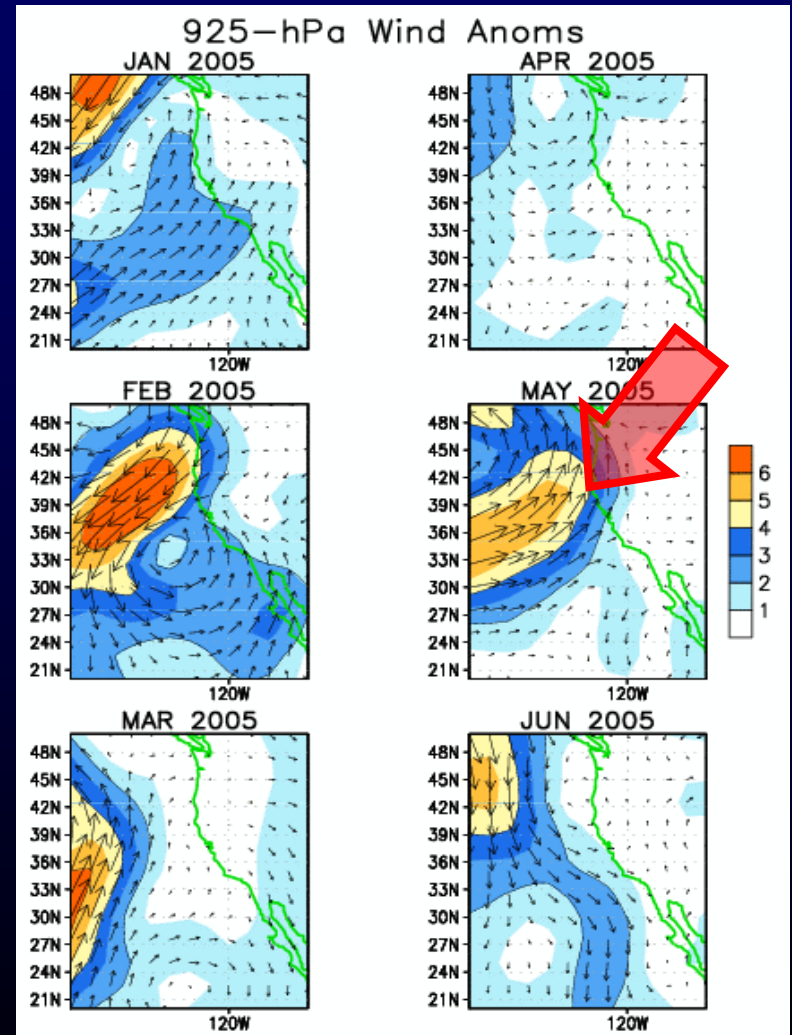
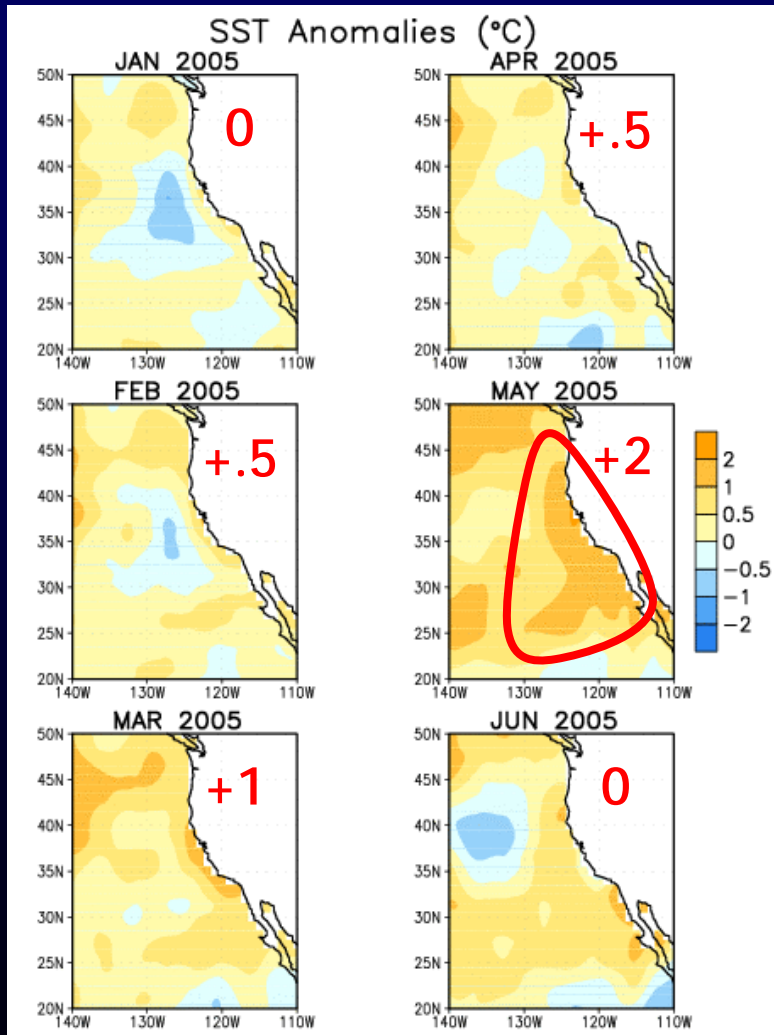


March to July, 2005



APRIL

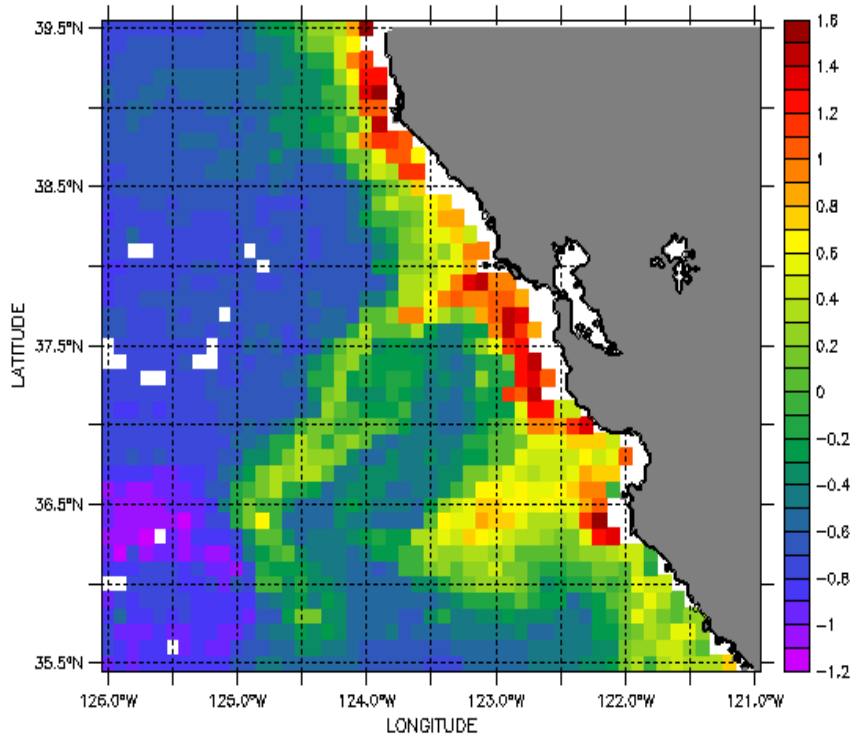
# SST and low-level wind anomalies; 2005



Figures: Vernon Kousky (vernon.kousky@noaa.gov)

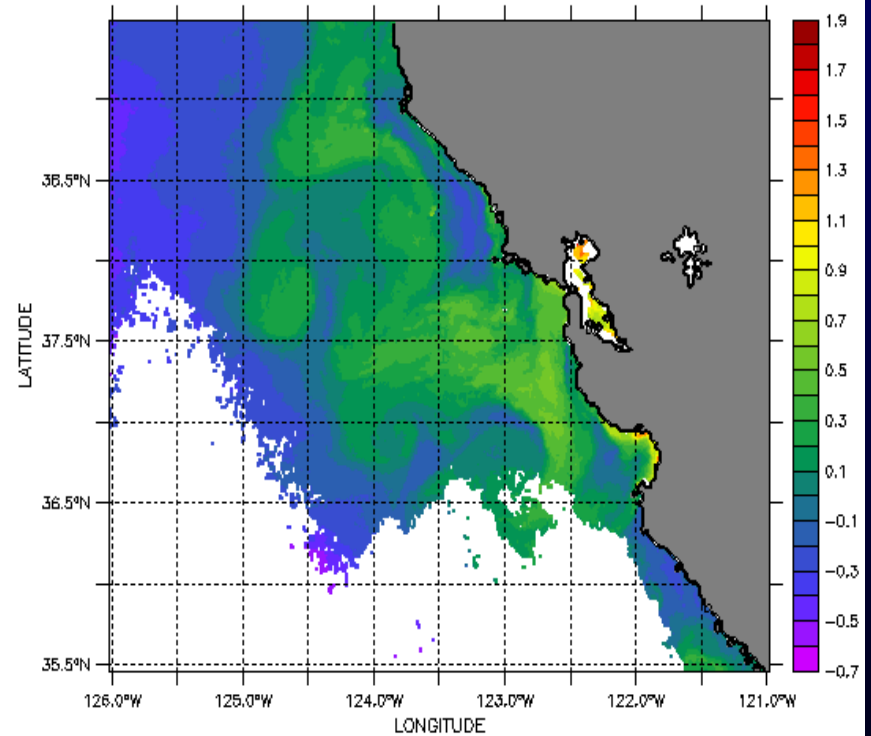
# Chlorophyll distribution along central CA

May 2004



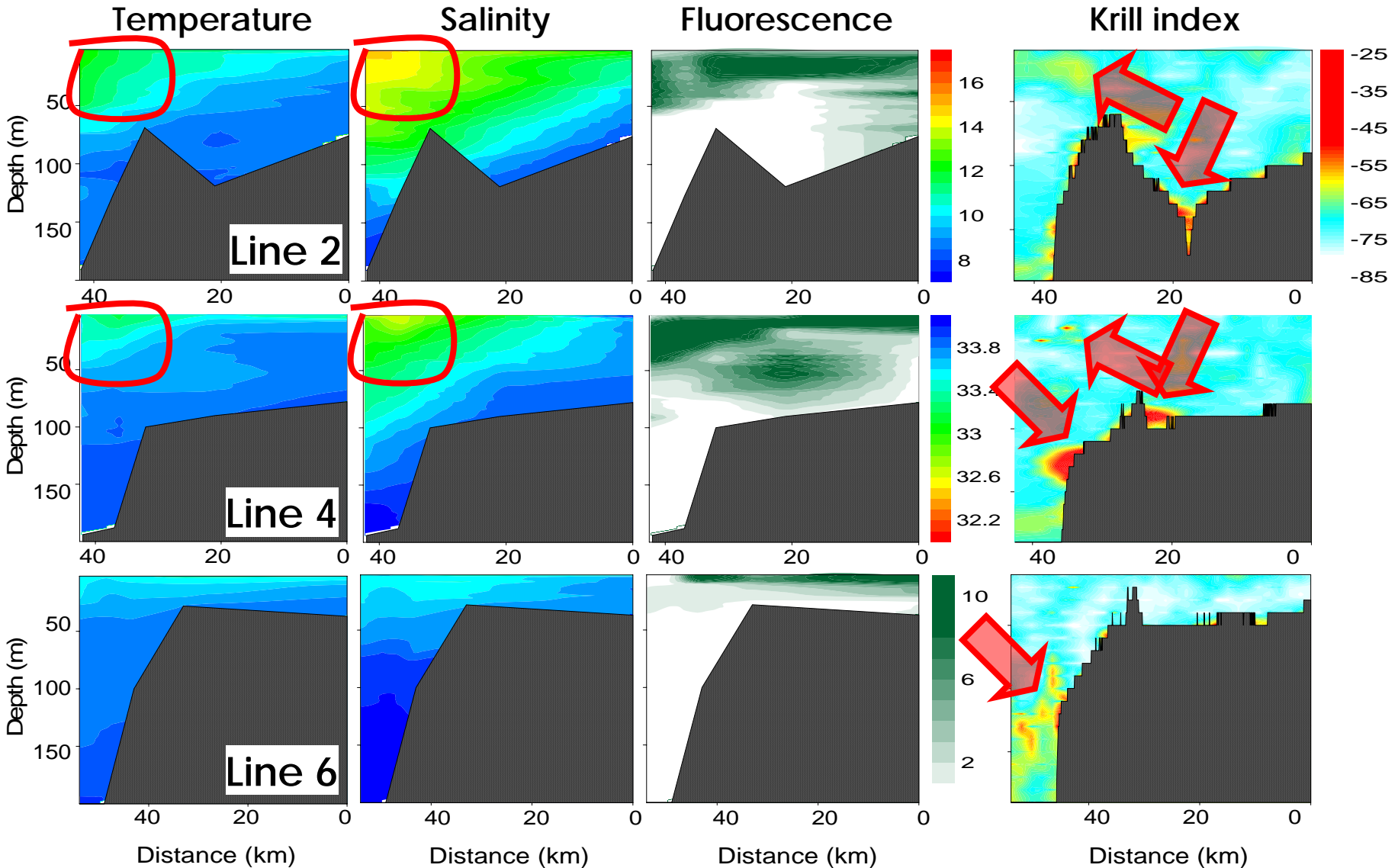
Chlorophyll a pigment concentration: 8-day ( $\text{mg m}^{-3}$ )

May 2005



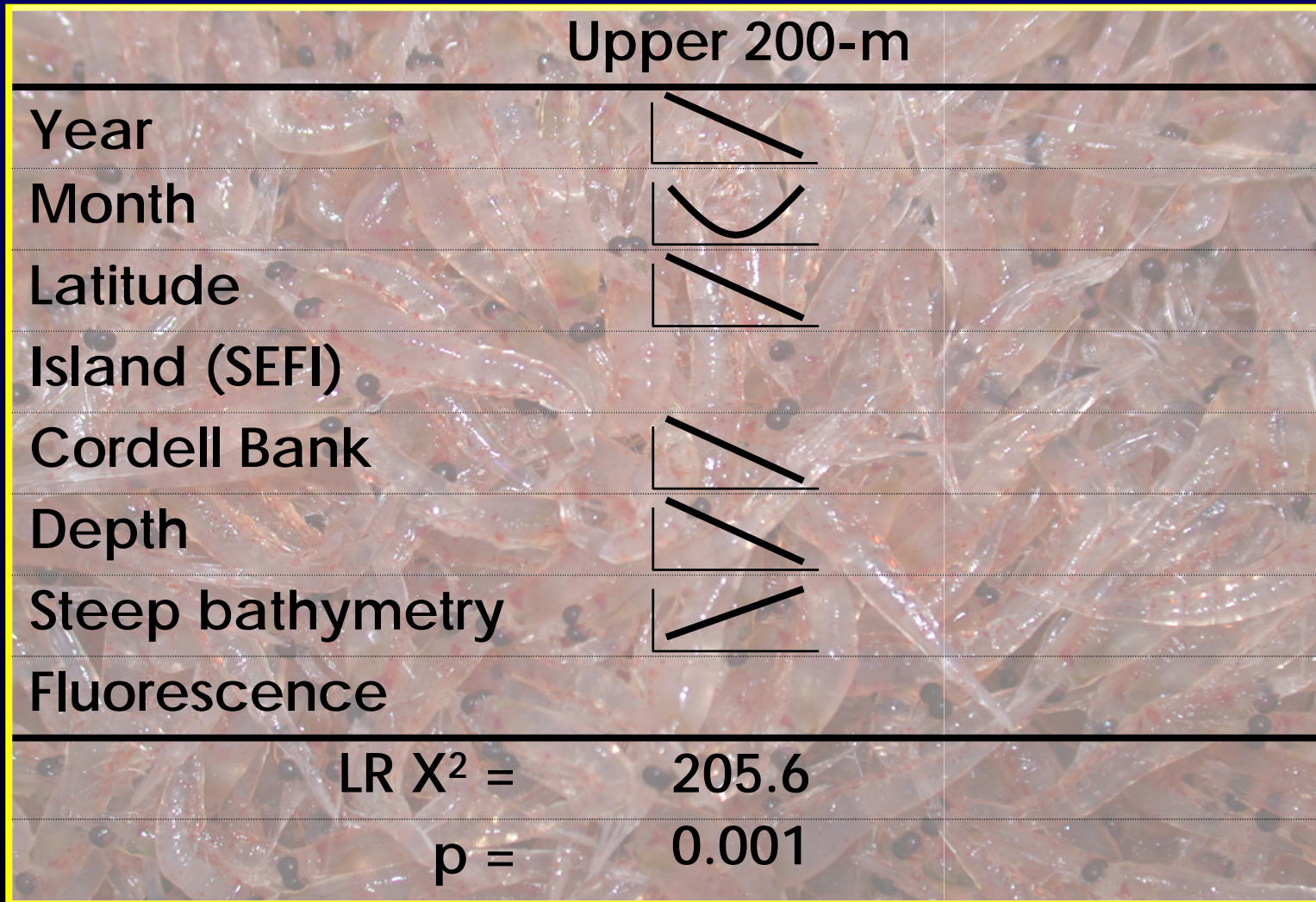
Chlorophyll a 3-day ( $\text{mg m}^{-3}$ )

# Krill aggregations (... an example)





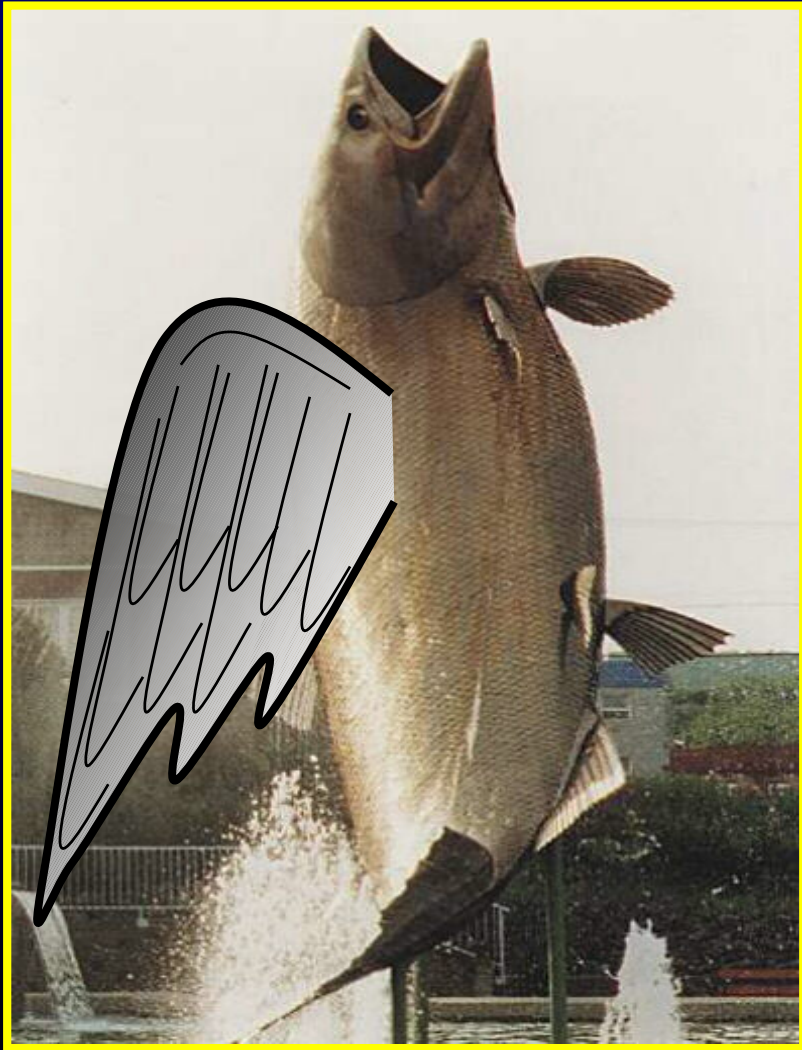
# Krill habitat associations



A large school of silver fish swimming in clear blue water. The fish are densely packed and appear to be moving in a coordinated pattern. The water is a vibrant blue, and the fish are silvery with some darker spots. The overall scene is dynamic and captures a moment of collective movement in nature.

**Well... so what???**

# Salmon with wings (i.e, Cassin's Auklets)



Small birds (23 cm; 150-200 g)

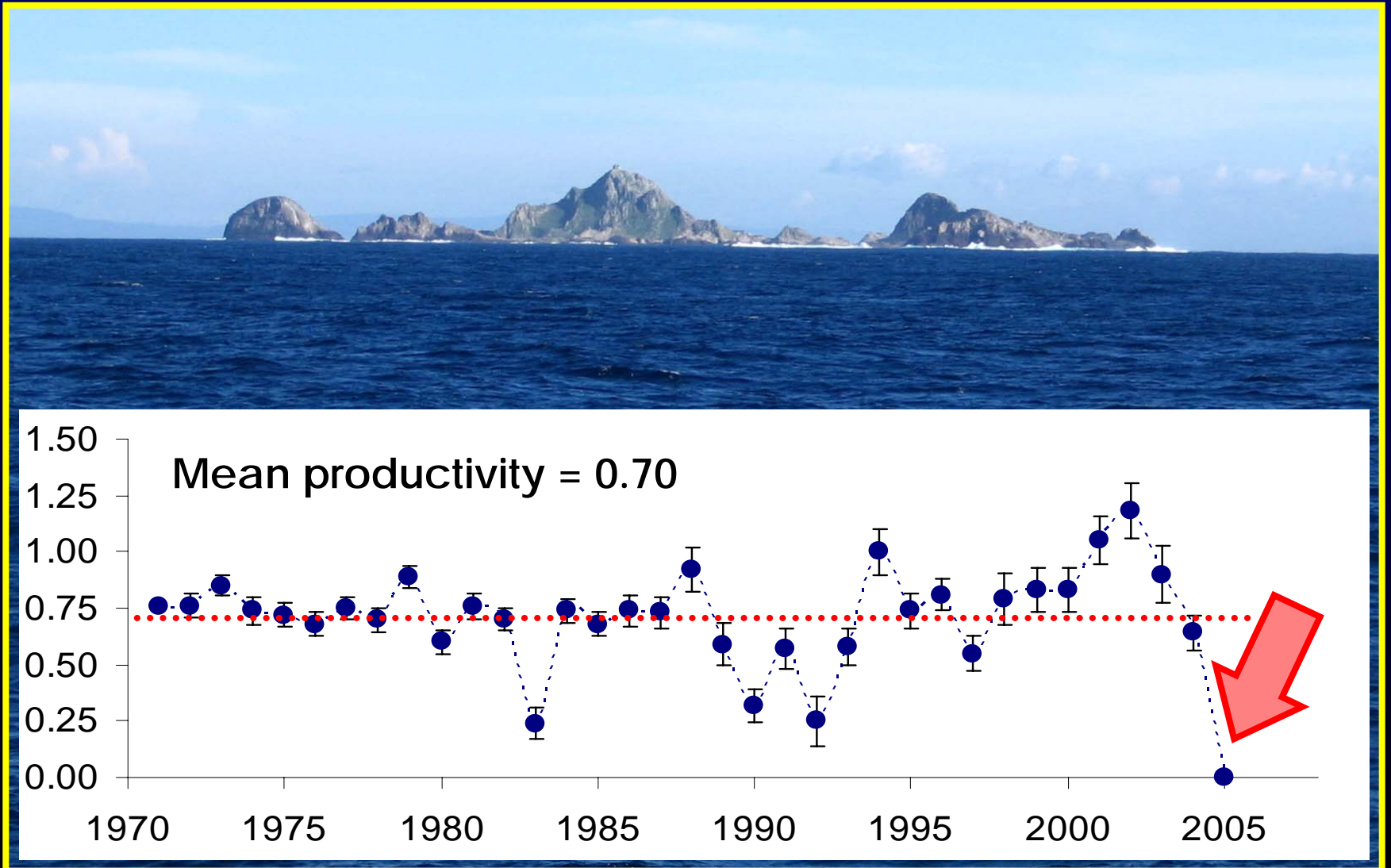
Dive 40 m (20-80 m)

Zooplanktivorous **80% krill**

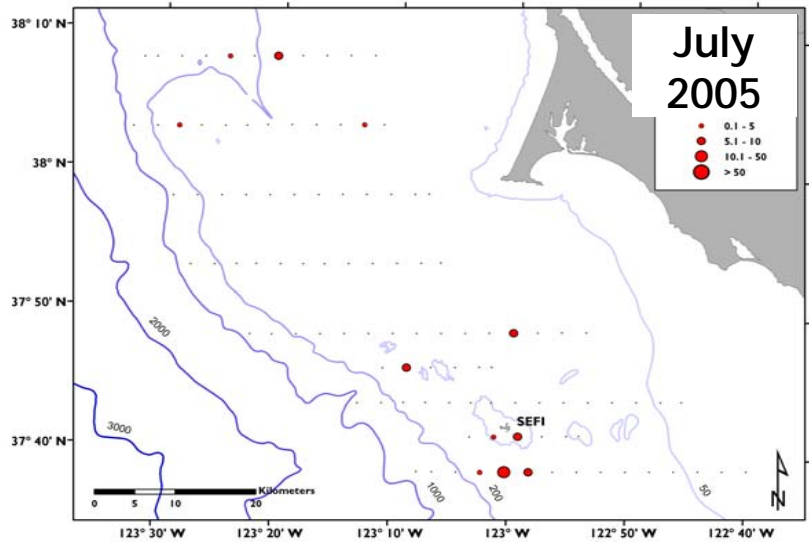
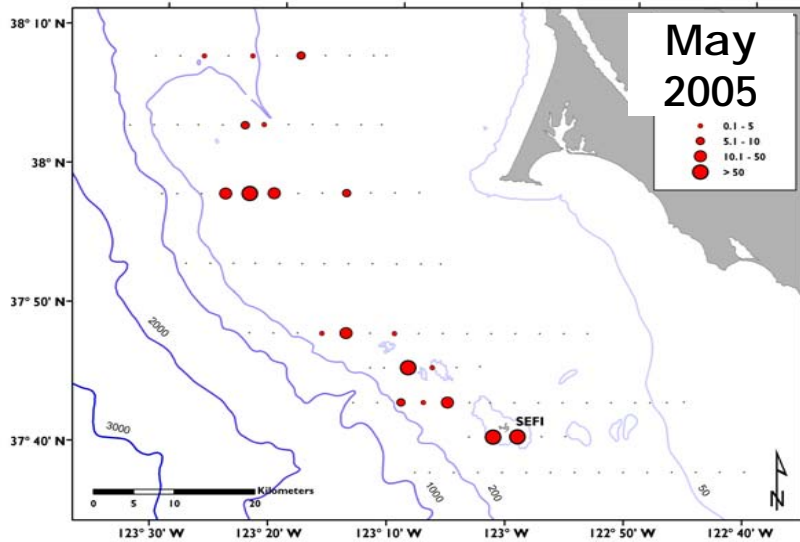
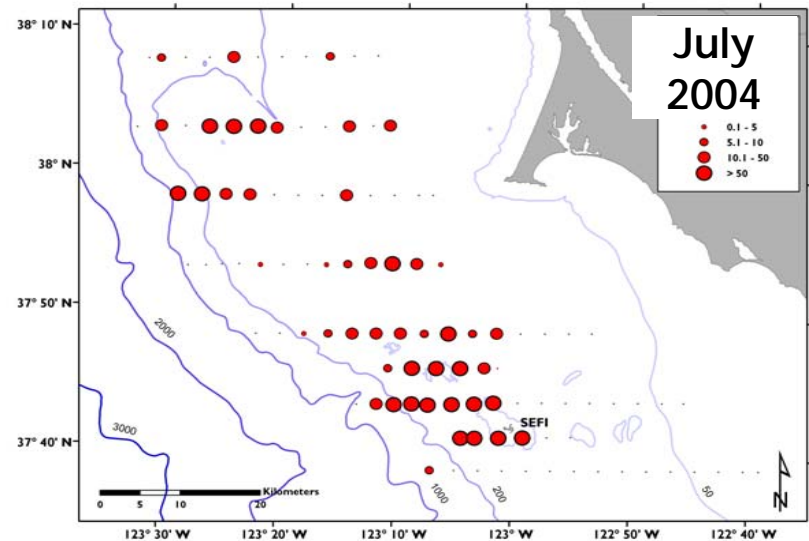
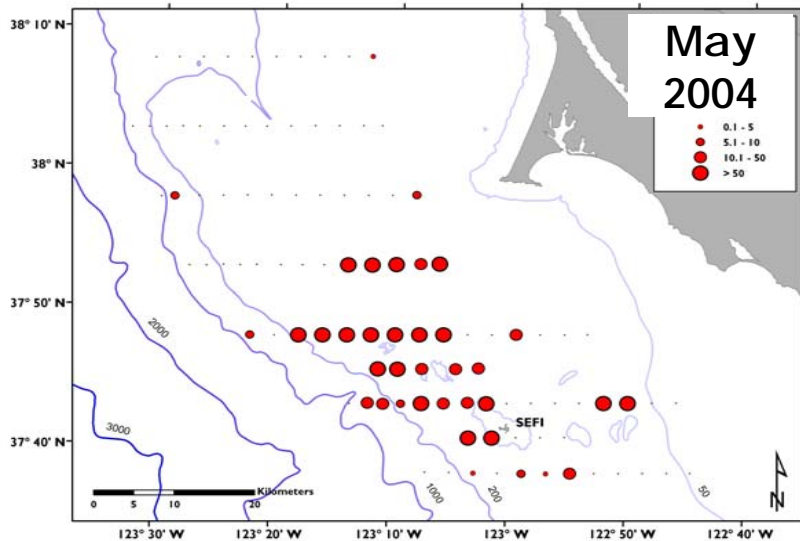
**Bird productivity is correlated  
with krill abundance**

(Abraham and Sydeman 2004)

# Worst year on record for auklets on SEFI



# Cassin's auklets distribution



# Krill / krill-predator habitat associations

	Upper 200-m	Auklets
Year		
Month		
Latitude		
Island (SEFI)		
Cordell Bank		
Depth		
Steep bathymetry		
Fluorescence		
LR $X^2 =$	205.6	54.6
$p =$	0.001	0.001

# Conclusions

1. Unusual weather conditions in 2005 (warmer SST, decreased winds) resulted in low krill and krill predator abundance off central California in 2005 than 2004.
  2. Krill and krill predators aggregated at predictable locations near Cordell Bank and other areas of rough topography such as the shelf break and submarine canyons.
- This is a work in progress... (15 cruises, next 3 years)

# Acknowledgements

Sue Abbott, Jamie Hall, Dave Johnston, Brandy Johnson,  
Carol Keiper, Brenna Langabeer, Derek Lee, Shanon Lyday,  
Jason Yakich, Pete Warzybok, Sophie Webb

Lee Bradford and Kurt Brown, R/V John H. Martin

Bay Model, US Army Corps of Engineers  
Lifeboat Station, Point Reyes National Seashore  
Spud Point Marina, Sonoma County Regional Park  
Mr. George Nunez, Point St. Joseph Fish Company

Jan Roletto, Gulf of the Farallones National Marine Sanctuary  
Dan Howard, Cordell Bank National Marine Sanctuary

Nina Karnovsky, Pomona College  
Nancy B. Kachel, PMEL/NOAA  
Mariano Gutierrez, IMARPE

Krill images provided by [GoldenStateImages.com](http://GoldenStateImages.com), (C) Randy Morse

Moore Family Foundation  
Resources Legacy Fund Foundation





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