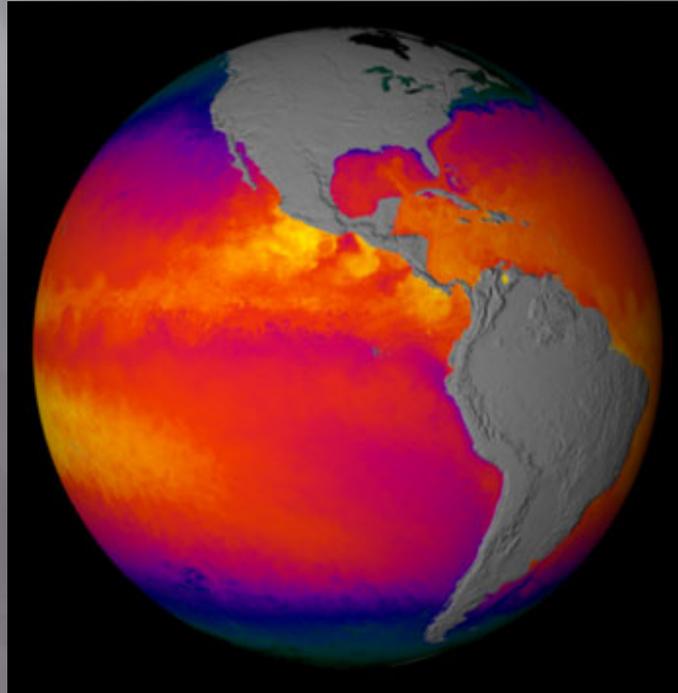


# SEA TO SKY: MARINE CLIMATE IMPACTS AND THE LAGUNA



**WILLIAM J. SYDEMAN**  
**FARALLON INSTITUTE**

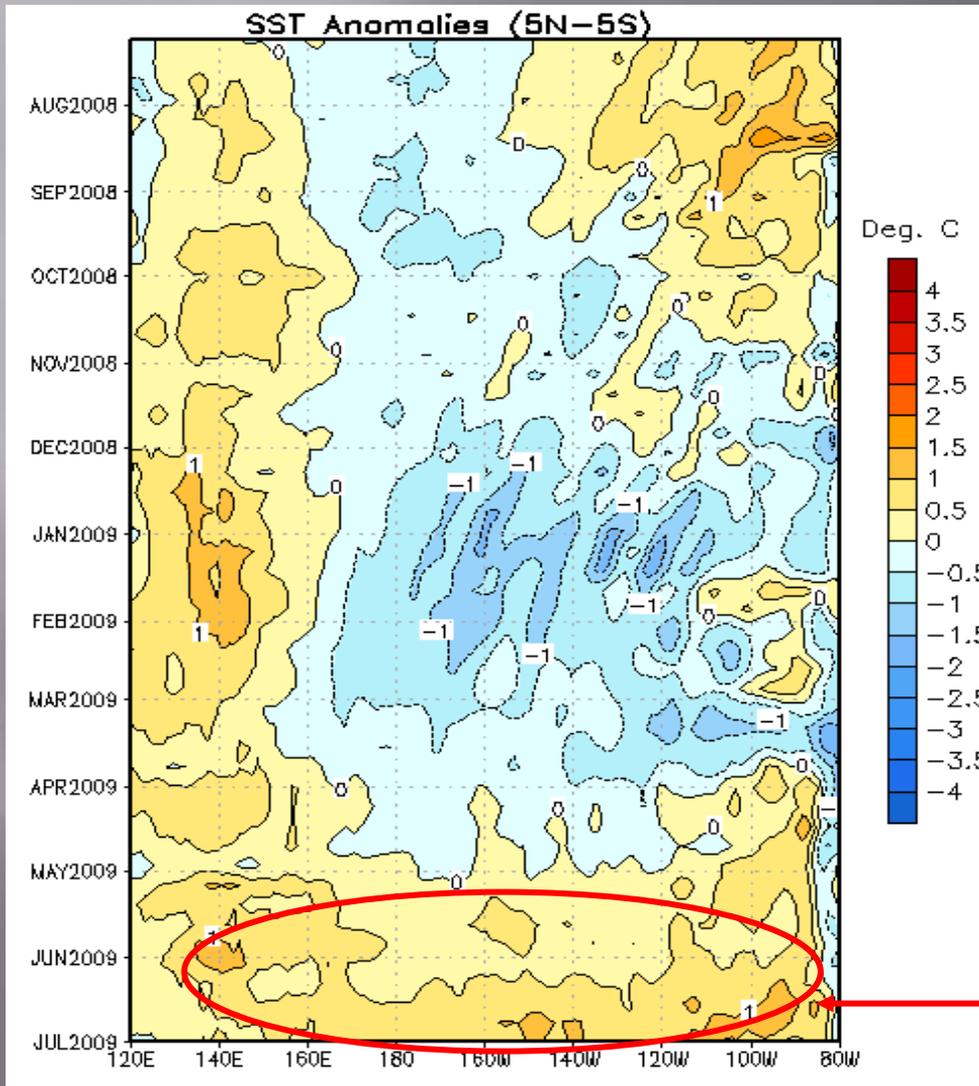
[WWW.FARALLONINSTITUTE.ORG](http://WWW.FARALLONINSTITUTE.ORG)



# Why is this Important?

- 71% of the earth is ocean
- 92% of all habitats on the planet are aquatic
- Of the 90,000 or so “time series” (data sets) used by the International Panel for Climate Change (IPCC) for the 4<sup>th</sup> Climate Change Assessment Report (2007), <1% came from aquatic ecosystems
- The pace of global warming likely to be much faster than previously predicted
- The 5<sup>th</sup> Climate Change Assessment Report will be released in 2014...but how will we enhance information base for aquatic systems?
- Water use, diversions, and salmonid ecosystems, Laguna is a part...

# Marine Climate Variability on Different Scales



Seasonal scale...

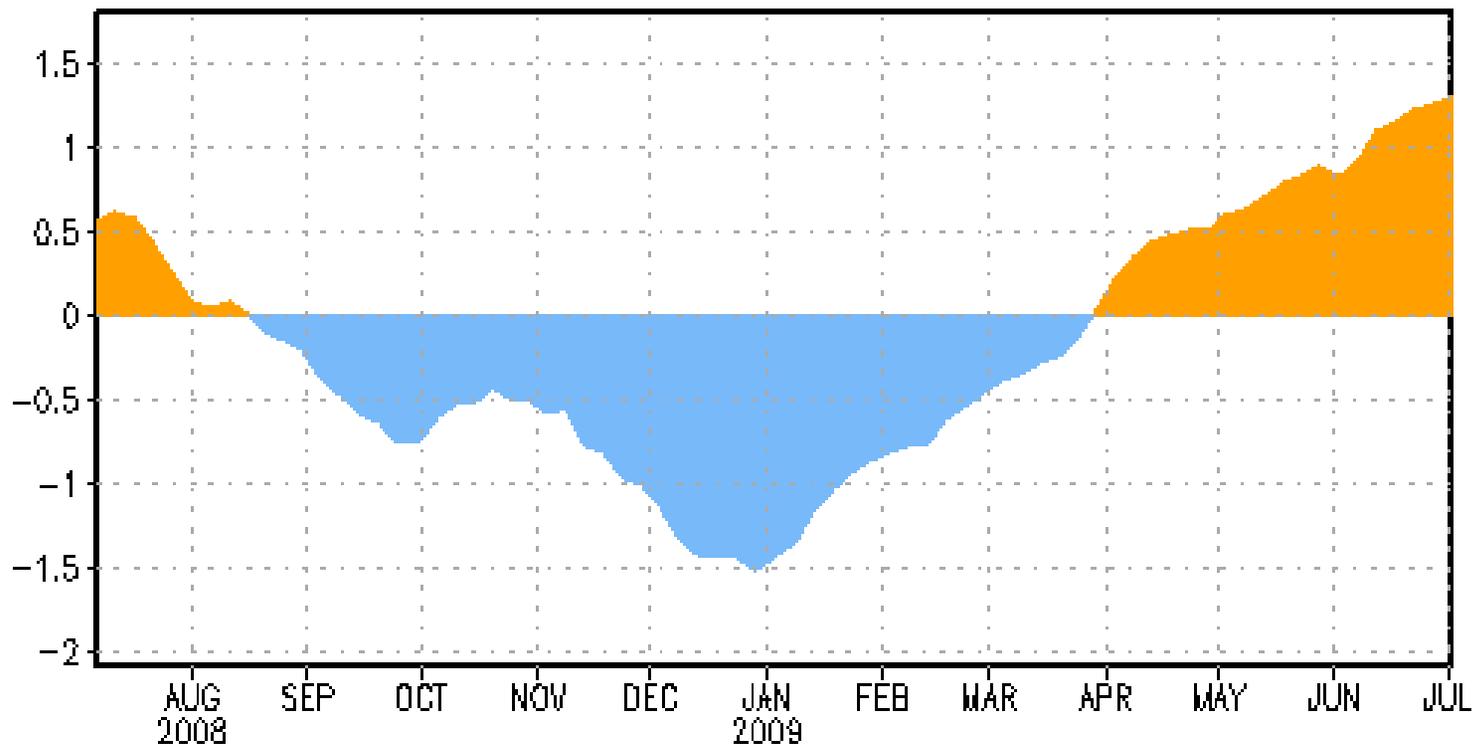
**During October 2008- February 2009, negative sea surface temperature (SST) anomalies dominated across the central and east-central equatorial Pacific Ocean.**

**During February- April 2009, negative SST anomalies weakened across the equatorial Pacific.**

**Since the beginning of May 2009, positive SST anomalies have increased across the equatorial Pacific.**

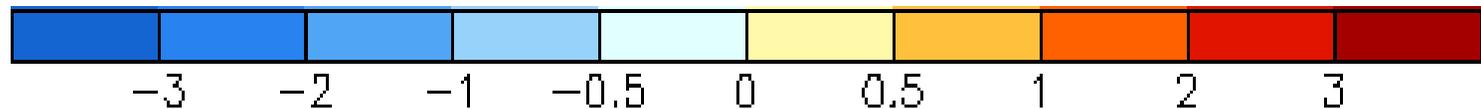
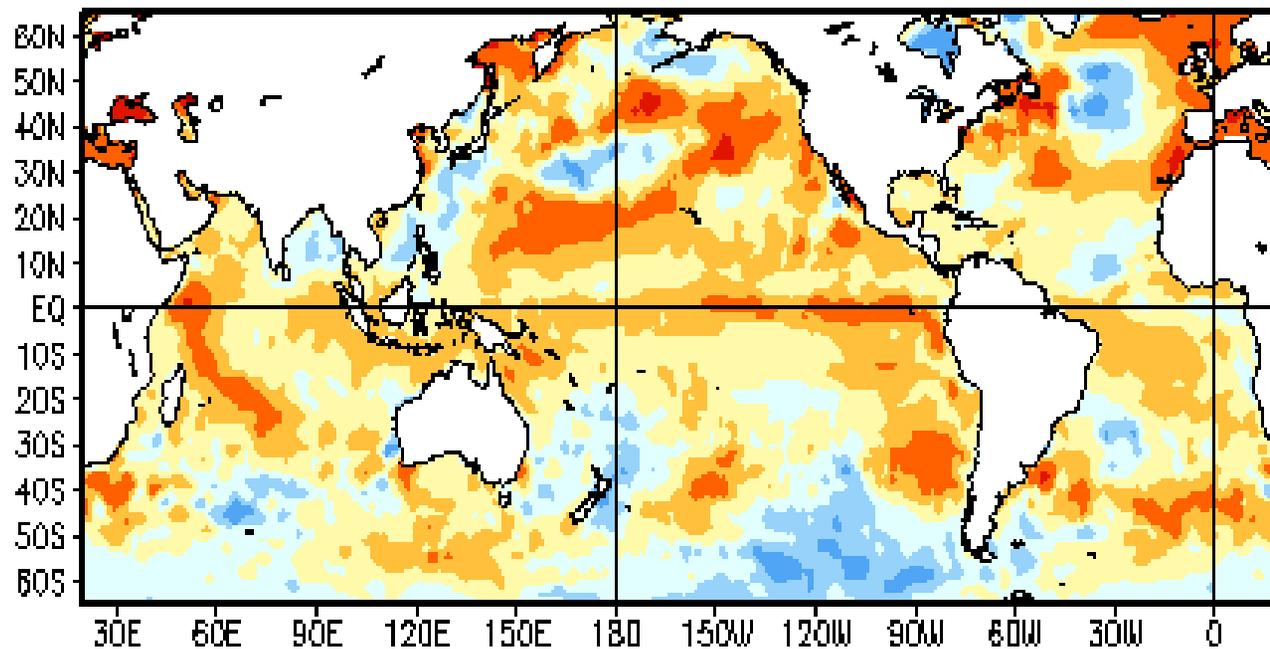
# Evolution of El Nino 2009-2010

EQ. Upper-Ocean Heat Anoms. (deg C) for 180-100W

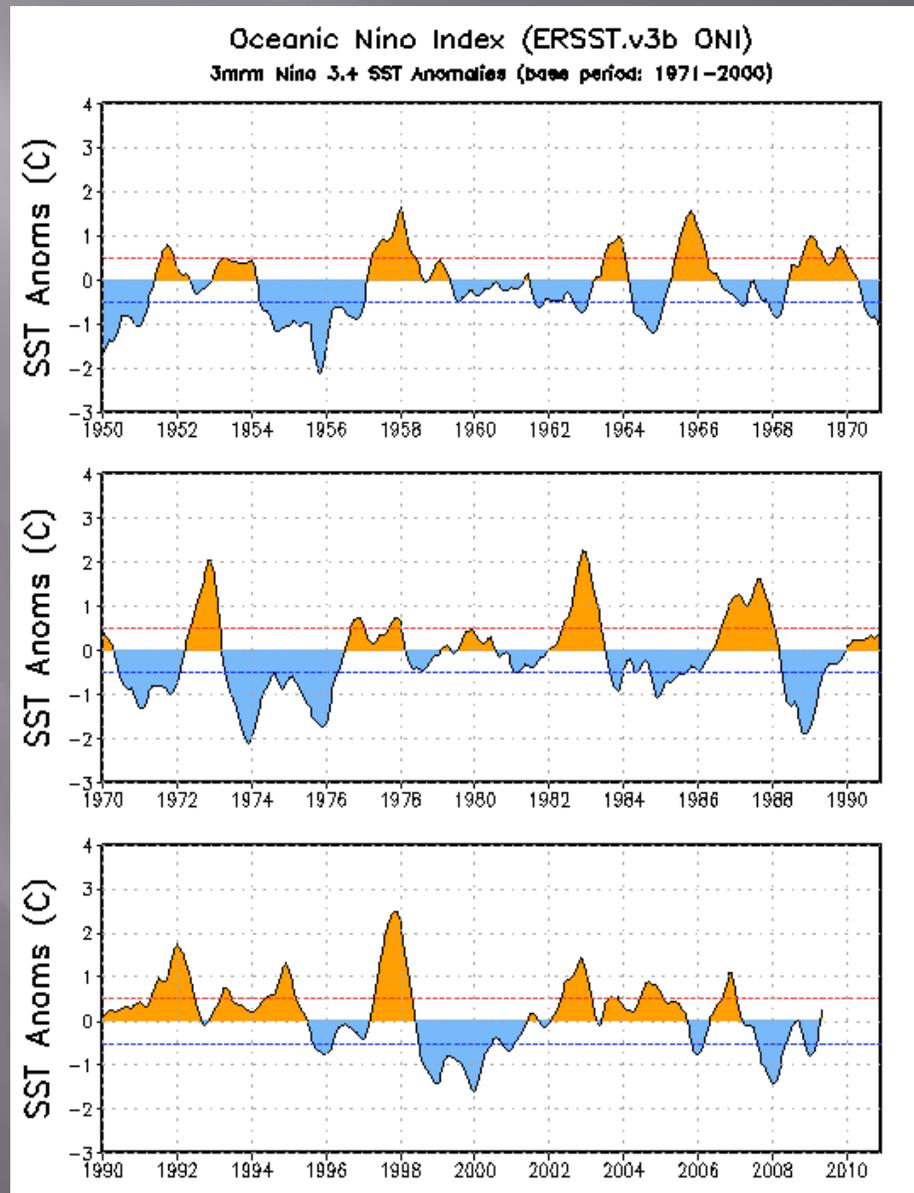


# Global Sea Temperatures, Summer 2009 (warmest on record, NOAA)

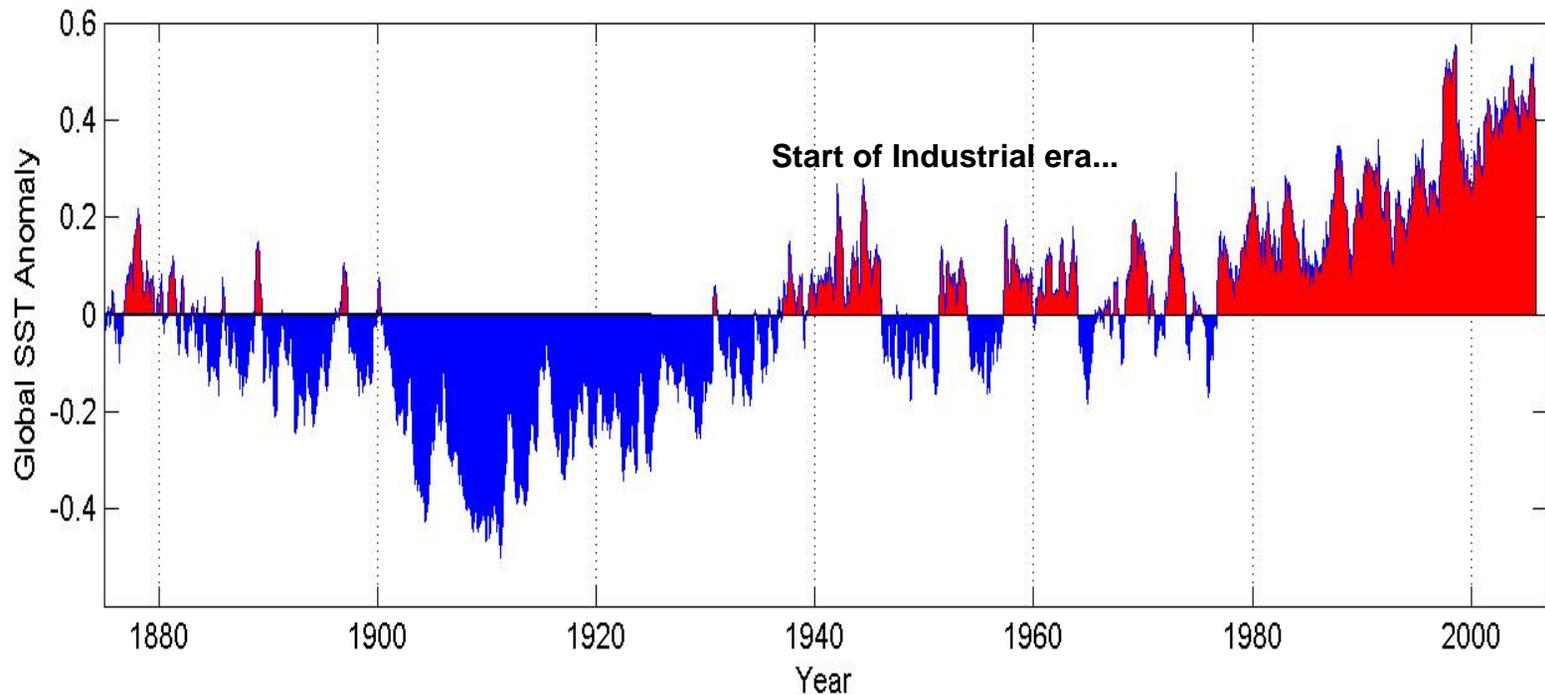
Average SST Anomalies  
7 JUN 2009 – 4 JUL 2009



# Interannual to Interdecadal Variability



# Secular Change - Sea-Surface Temperature over 125 years (1880-2005)

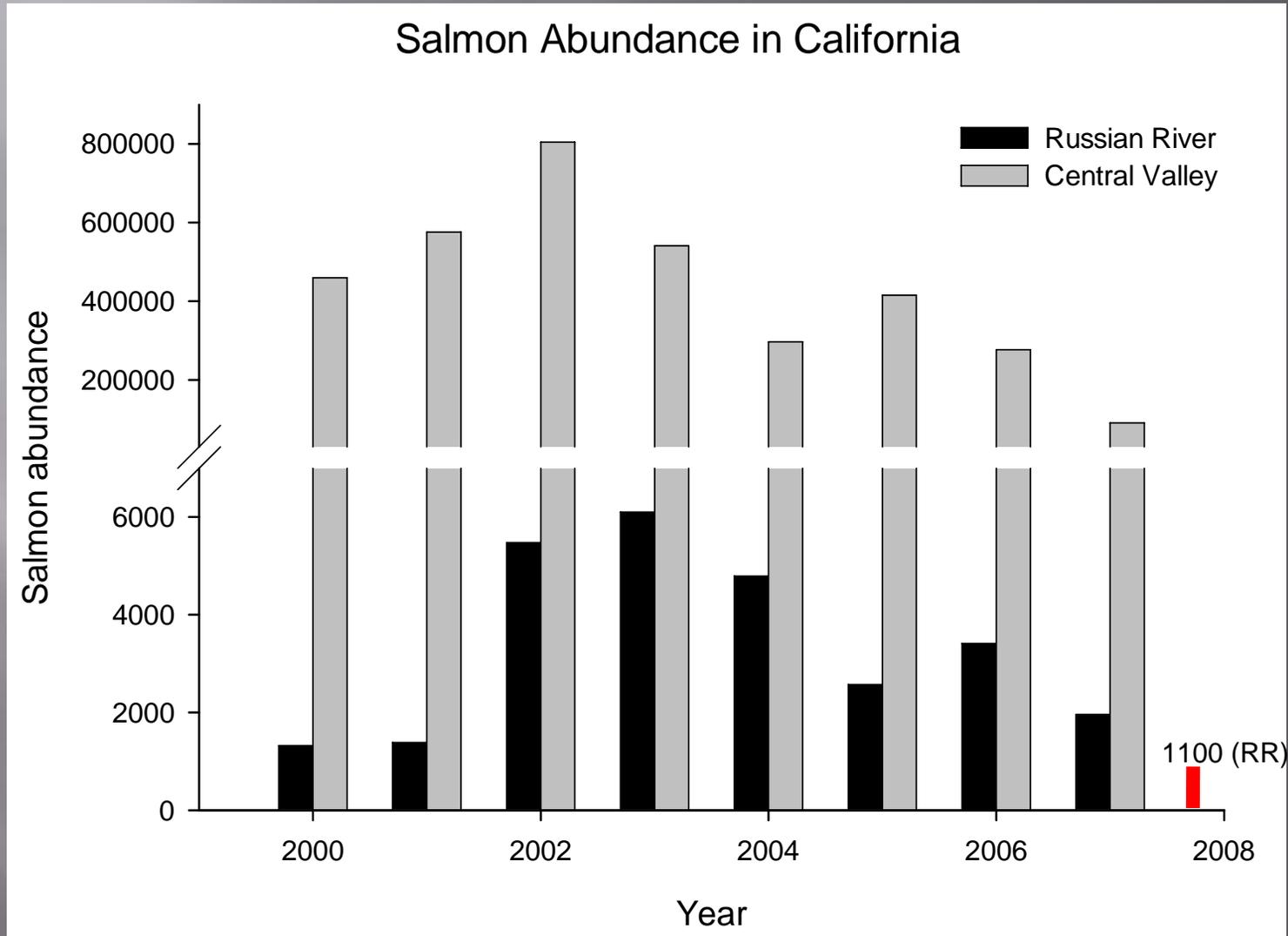


Courtesy Francisco Chavez, MBARI

# Potential Ecological Impacts

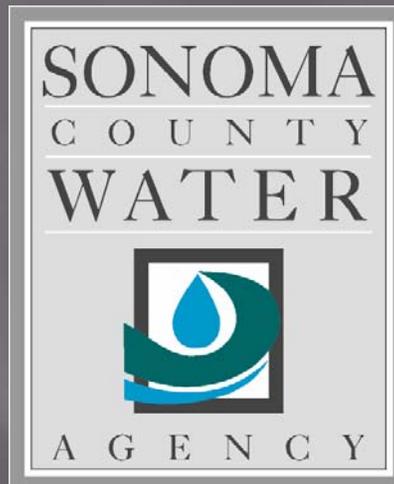
- ▣ Species range expansions/contractions
  - ▣ Change in productivity/physiology
  - ▣ Community structure
  - ▣ Timing of biological events
- *Complex ecological interactions*

# Chinook Salmon Returns to the Sacramento and Russian Rivers, 2000-2007



# The North Coast Program: Integrated Ocean Observing for Salmon Management

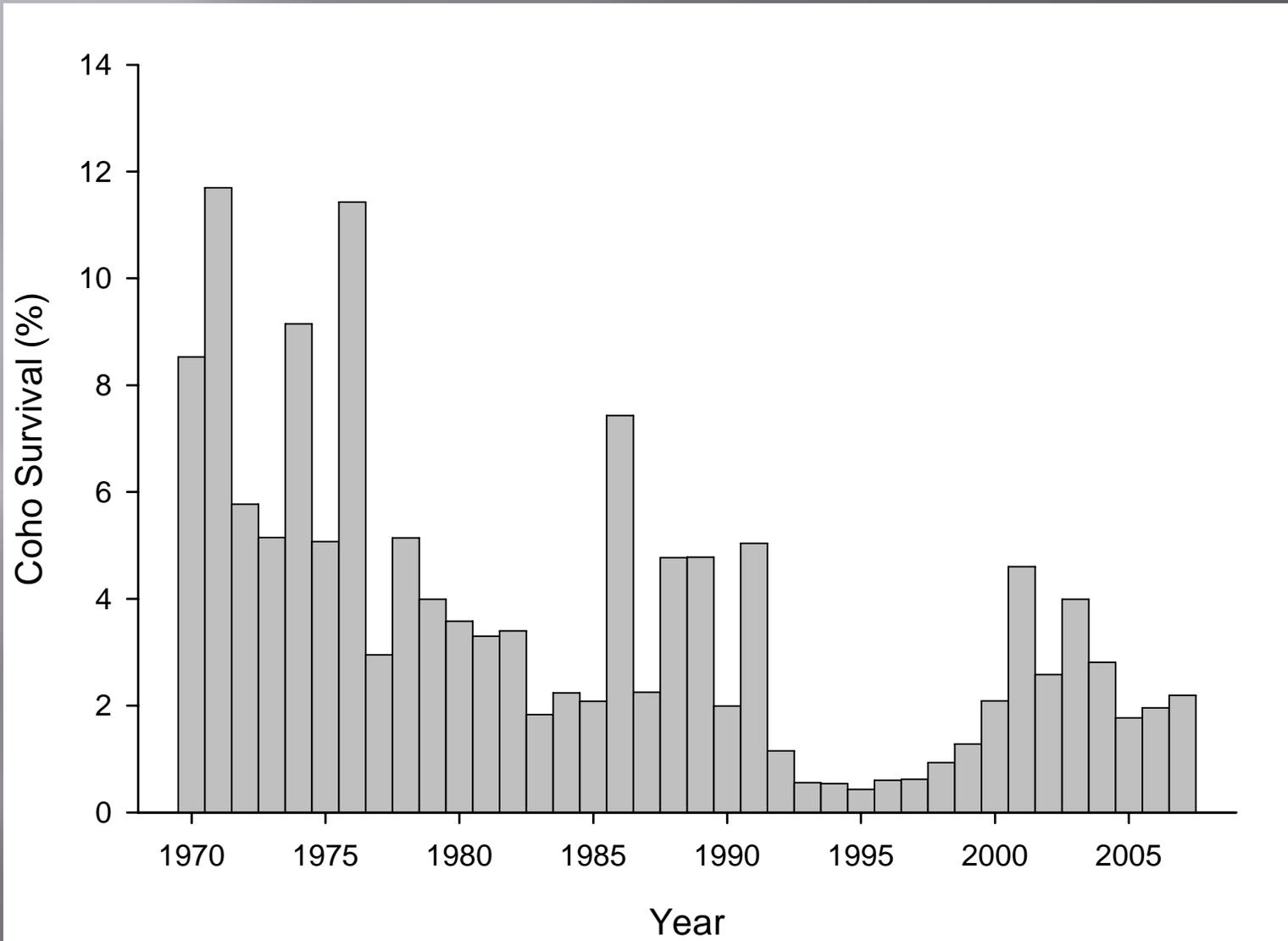
Strategy: *Coupled and integrated* physical and biological oceanographic monitoring is needed to move forward with salmon management in an ecosystem context during this period of substantial environmental change.



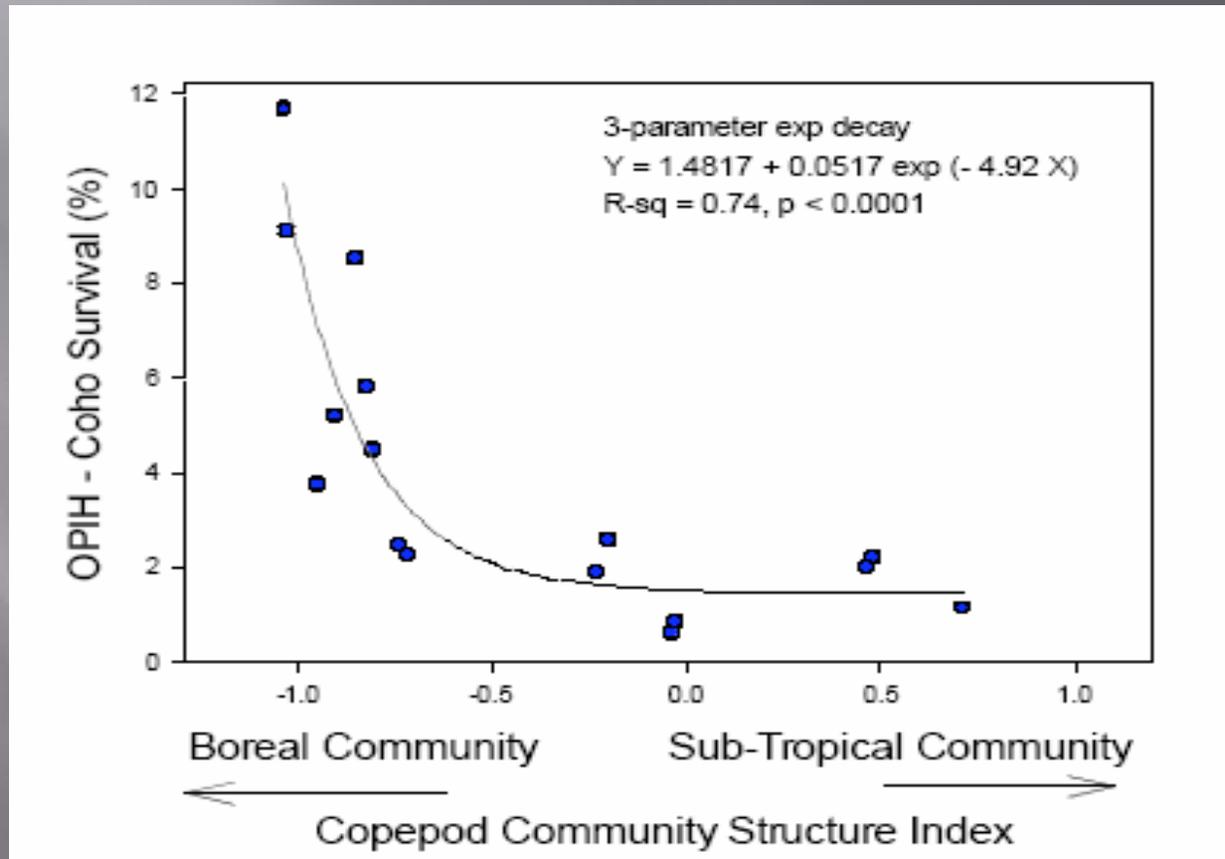
# Salmon Ocean Ecology – Predator-Prey Interactions



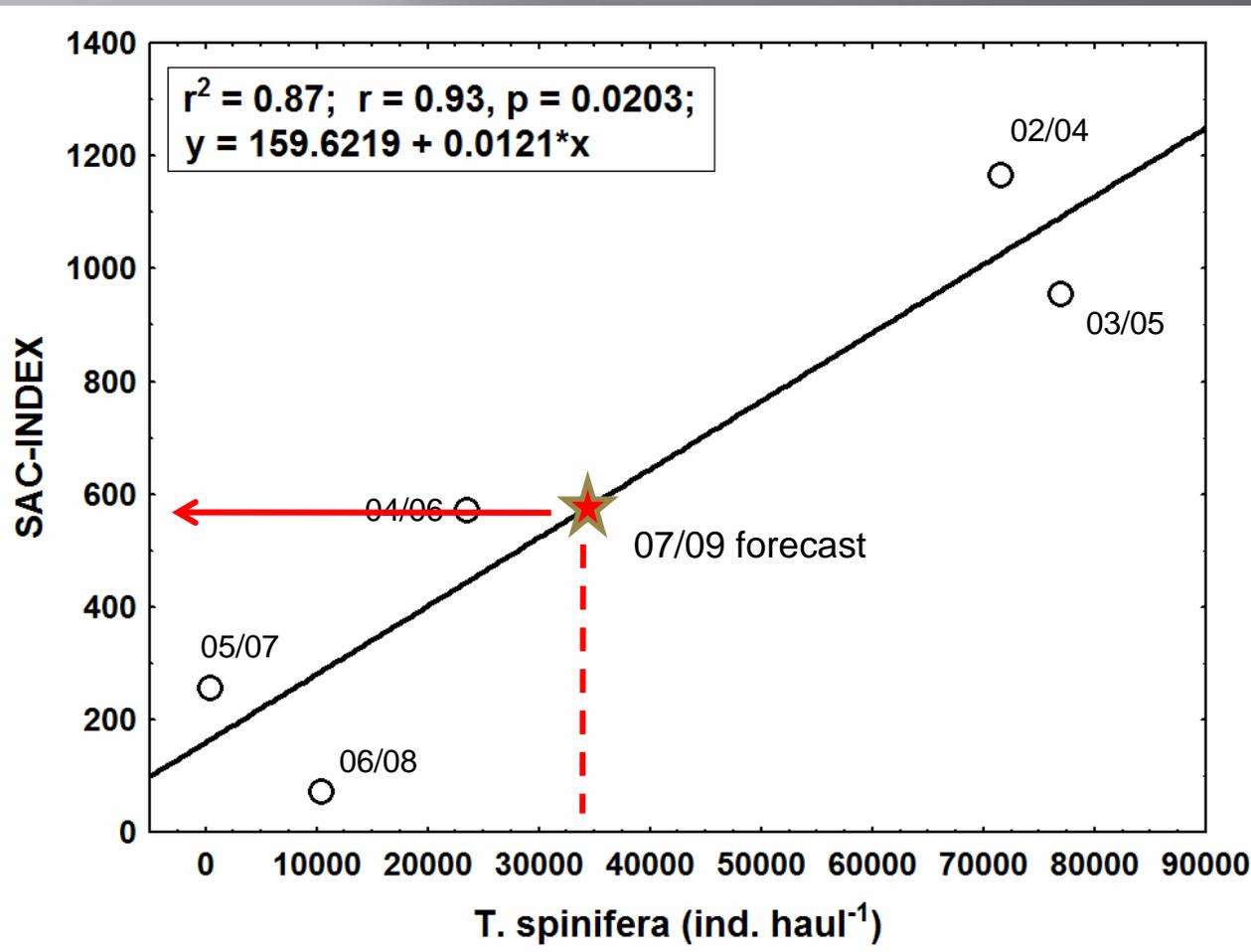
# Oregon Coho Marine Survival, 1969-2007



# PETERSON'S FORECASTING MODEL (OREGON COHO SURVIVAL & COPEPODS)



# Chinook Salmon and *Thysanoessa spinifera*



6 stations in Gulf of Farallones – outside Golden Gate

Lagged relationship Of *Tspin* CPUE in Year<sub>x</sub> (May-Jun) against run size of Chinook in Year<sub>x+2</sub> (fall)

2002/2006 *Tspin* CPUE aligned with 2004/2008 run size

87% of variance in run size explained

Sydeman et al. unpubl.

# Coastal Influences - Yesterday

San Francisco Bay Area — News, Sports, Business, Entertainment, Classifieds: SFGate - Mozilla Firefox

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http://www.sfgate.com/

National Weather Service - NWS San Fr... San Francisco Bay Area — News, ...

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## Storm wallops Bay Area; Hwy. 1 closed at Devil's Slide



First significant storm of the season hits with major flooding, bringing high winds and flash flooding around the region.

- Photos Video
- Devil's Slide fatality closes
- Thousands without power (
- Major delays at SFO (CBS5
- Weather | Traffic | Radar
- Post your weather photos

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## Power outages, flooding across North Bay



(Kent Porter / Press Democrat) 2009

NEW Man dies after Taser in Mendocino County 54 min ago

Voters sour on Schwarzenegger 7:52 AM

Flights delayed at SFO; Oakland, Santa Rosa OK 7:19 AM

Nobel jury defends Obama decision 7:29 AM

Schwarzenegger signs flurry of bills, rejects others

## Flooding snarls 101 traffic



Done

## Concluding remarks...



# NCP PARTNERS

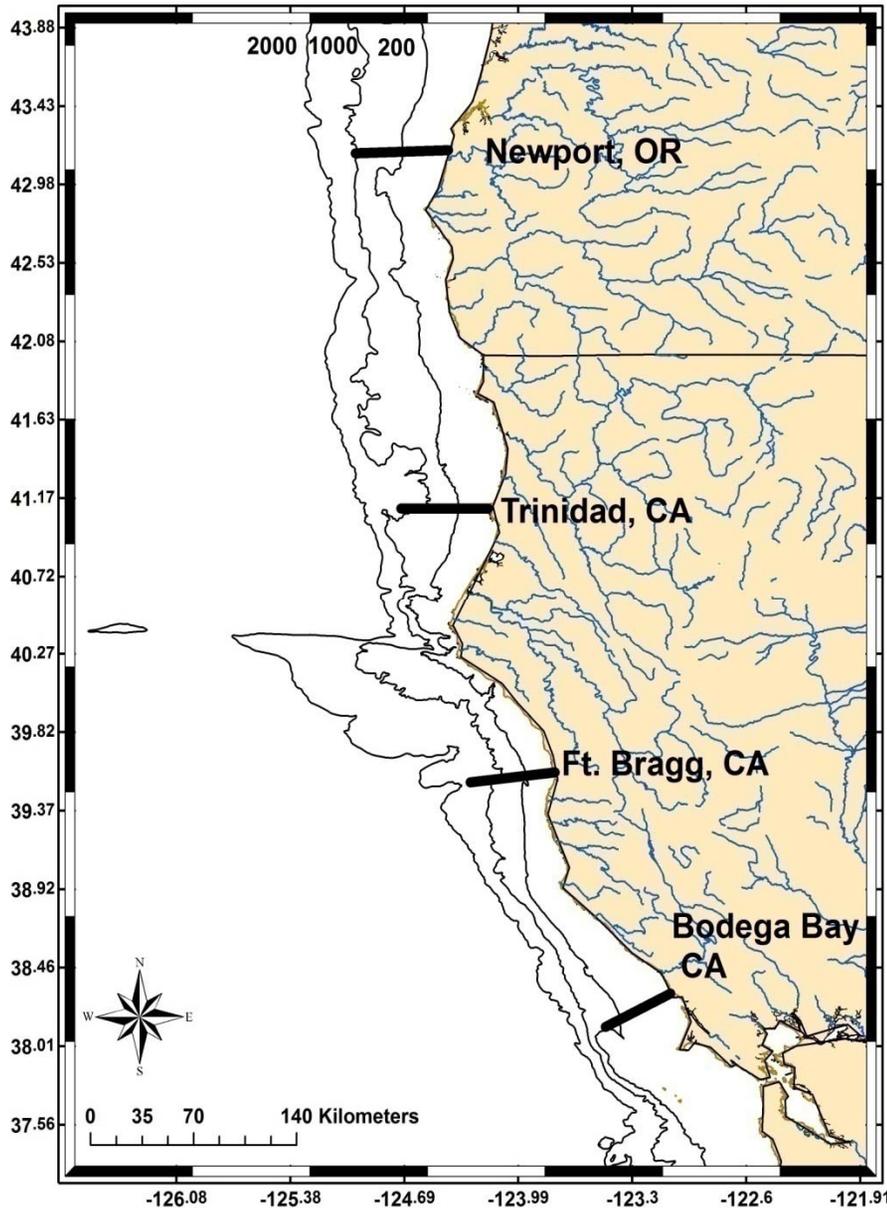
- Sonoma County Water Agency
- California Coastal Conservancy
- Central and Northern California Ocean Observing System
  - Humboldt State University
  - Monterey Bay Aquarium Research Institute
    - Bodega Marine Laboratory/UC Davis
  - Farallon Institute for Advanced Ecosystem Research
    - NOAA-National Marine Fisheries Service
    - California Ocean Science Applications
  - NOAA/Integrated Ocean Observing System

Research Team: Eric Bjorstedt, Francisco Chavez, John Field, Heather Kerkering, John Largier, David Manning, Kyra Mills, Steven Morgan, Bill Peterson, Jonathon Phinney, Steve Ramp, Steve Ralston, Jarrod Santora, Paul Siri, Bill Sydeman, Sarah Ann Thompson et al.

## *The North Coast Program*

- 4 coastal lines (3 active)
- Near active fishing ports, for Collaborative Fisheries Research (CFR) programs
- Academic, NGO, and Government, Industry partnership
- Cover shelf habitat where juvenile chinook and coho Reside

Cost estimate: ~ \$1M/year – 5 year program





Catching a haul of chinook, or king, salmon off Point Reyes, Calif.

# The CA Current Large Marine Ecosystem: *How Does it Work?*

1. California Current – offshore “river in the sea” – brings water from Gulf of Alaska
2. Davidson Current – inshore – brings water from subtropics
3. Coastal promontories – sites of localized coastal “upwelling”

Pt. Arena/Pt. Reyes Upwelling Cell  
(upwelling promotes primary productivity/greening of the ocean)

