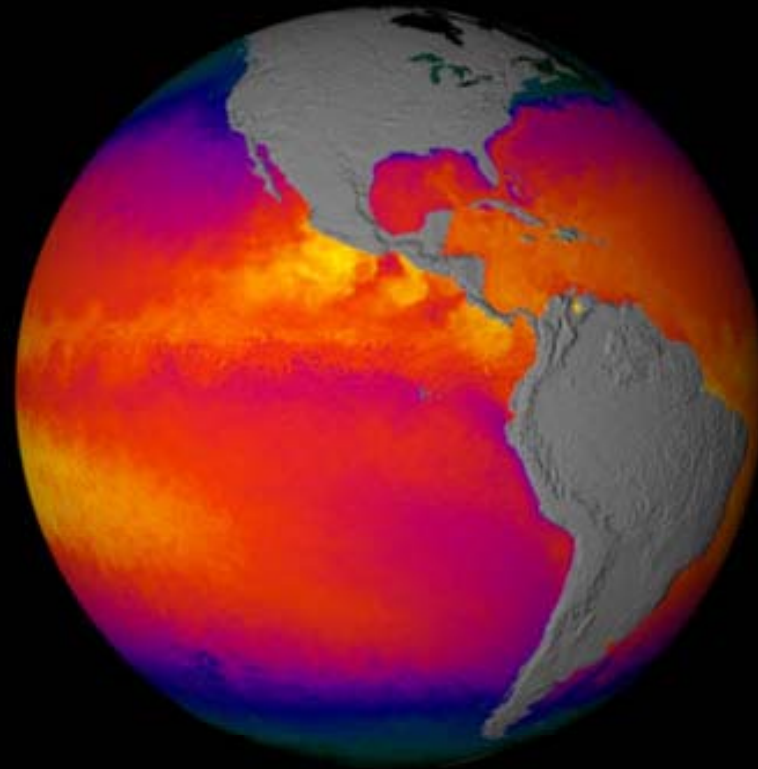


# Climate Change and North Pacific Marine Ecosystems: *What are the Seabirds Telling Us?*



William Sydeman, Kyra Mills (*Farallon Institute, USA*)

Vern Byrd, Heather Renner (*USFWS, USA*)

Yutaka Watanuki, Shoshiro Minobe (*Hokkaido U., Japan*)

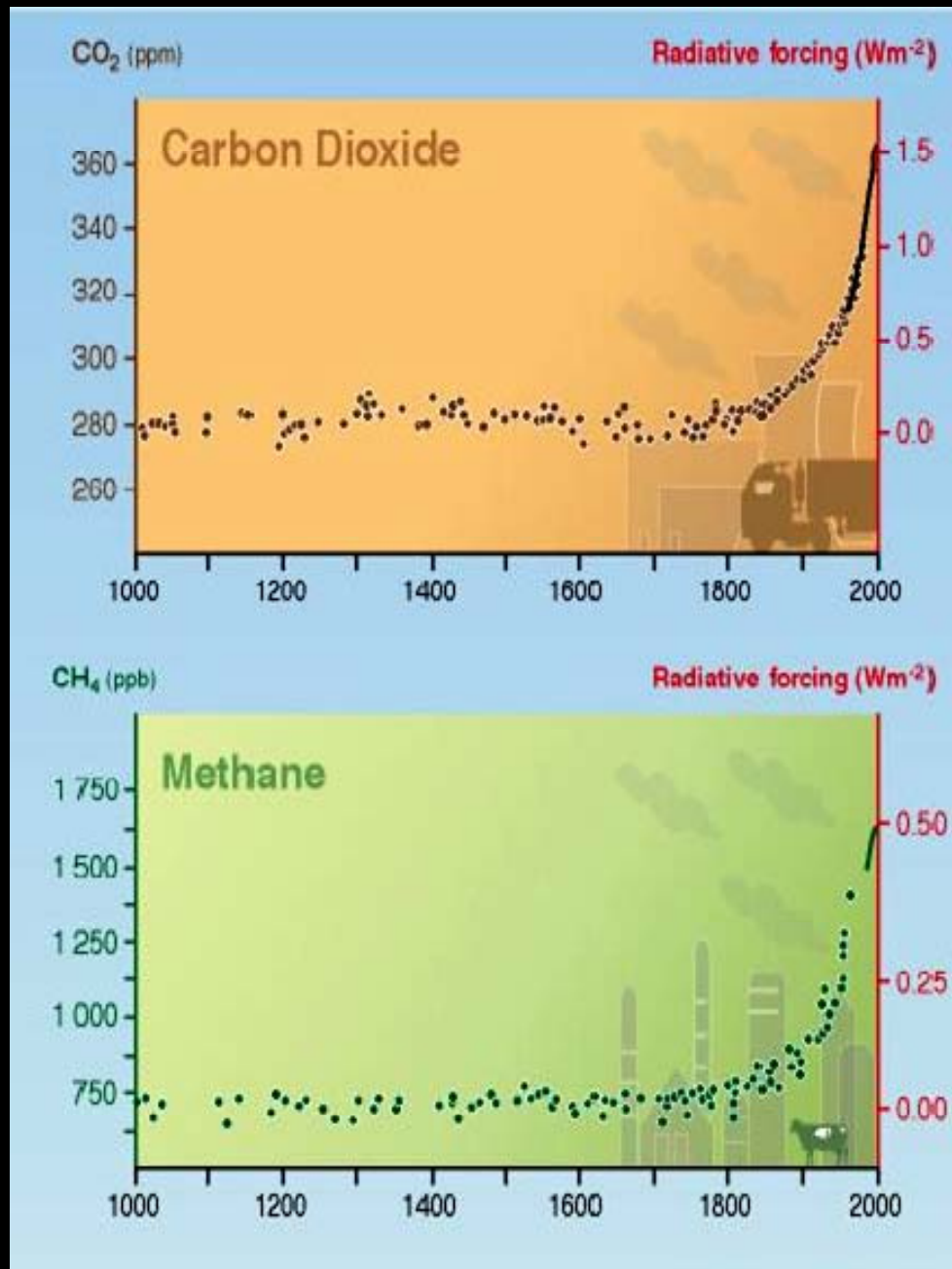
# Outline

- To understand climate change impacts requires that we know about how the ecosystems function (at least on some basic level..), and how the birds respond.
- Today: 3 seabird case studies
  - California (upwelling – “mechanism”)
  - Bering Sea (ice production)
  - Japan Sea (advection)

# Why is this Important?

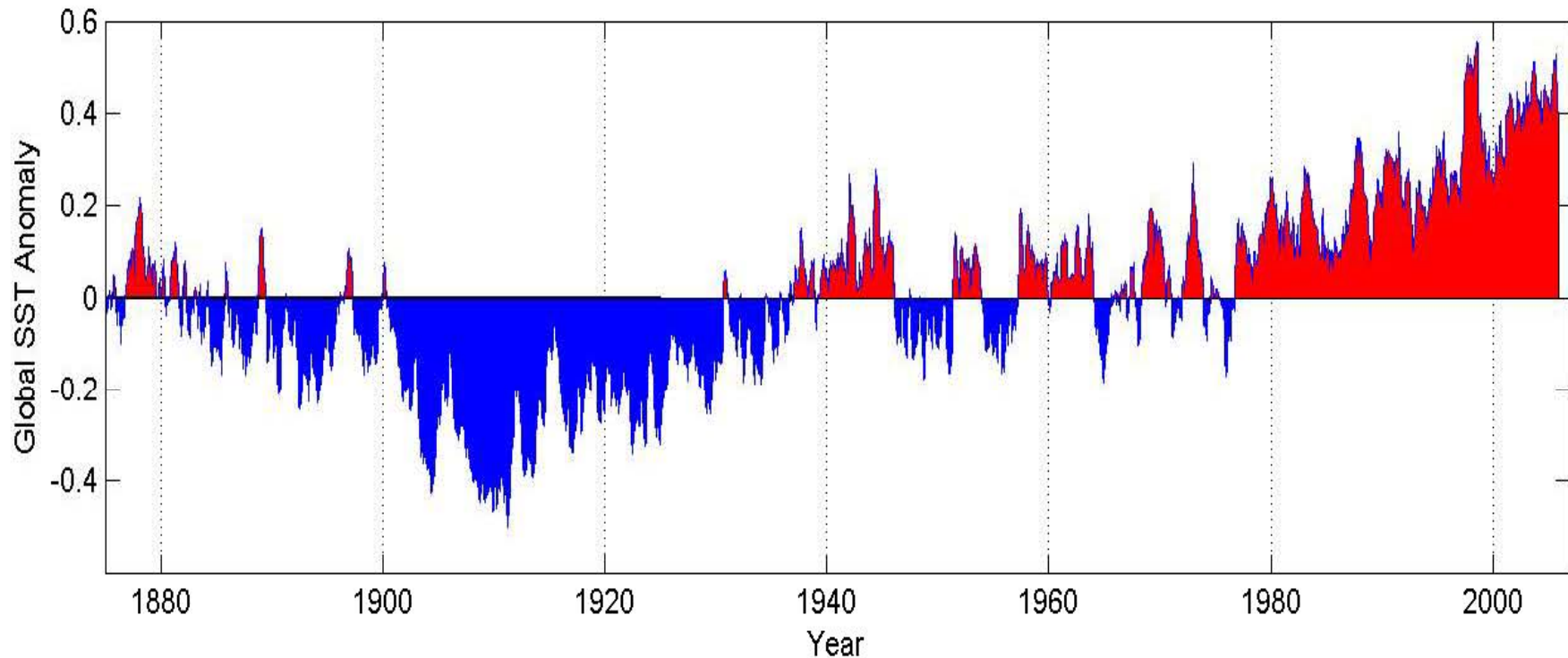
- 71% of the earth is ocean, with 92% of all habitats on the planet, marine
- Of the 90,000 or so “time series” (data sets) used by the International Panel for Climate Change (IPCC) for the 4<sup>th</sup> Climate Change Assessment Report (2007), <1% came from aquatic (water-based) ecosystems
- The pace of global warming likely to be much faster than previously predicted, particularly sea level rise
- The 5<sup>th</sup> Climate Change Assessment Report will be released in 2014...but how will we measure change in marine systems?
- Seabirds provide one answer: they are well studied and can be used as “sensors” of environmental change!

# Increasing "Greenhouse" Gases



(IPCC, 2001)

# Global Sea-Surface Temperature (1880-2005)



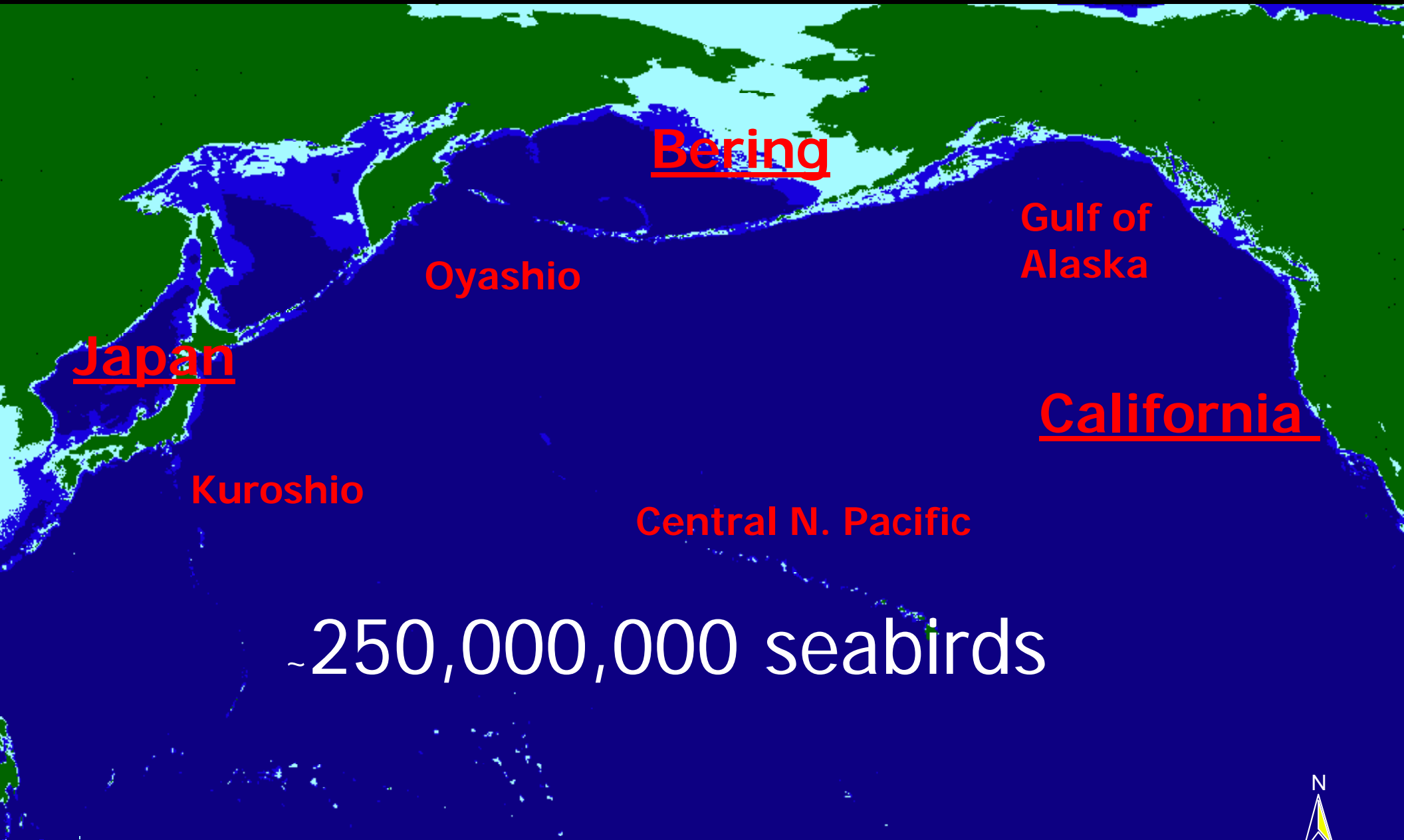
Courtesy Francisco Chavez, MBARI

# Potential Ecological Impacts

- Species range expansions/contractions
- Productivity and Physiology
- Recruitment
- Community Structure
- Timing of Biological Events

➤ *Complex ecological interactions*

# Major Ecosystems of the North Pacific



~250,000,000 seabirds



# Seabird Colonies are *Living Laboratories* :

On seabird colonies, we can study population changes, changes in production, and changes in food habits. We think climate change is altering seabird food chains in marine ecosystems.

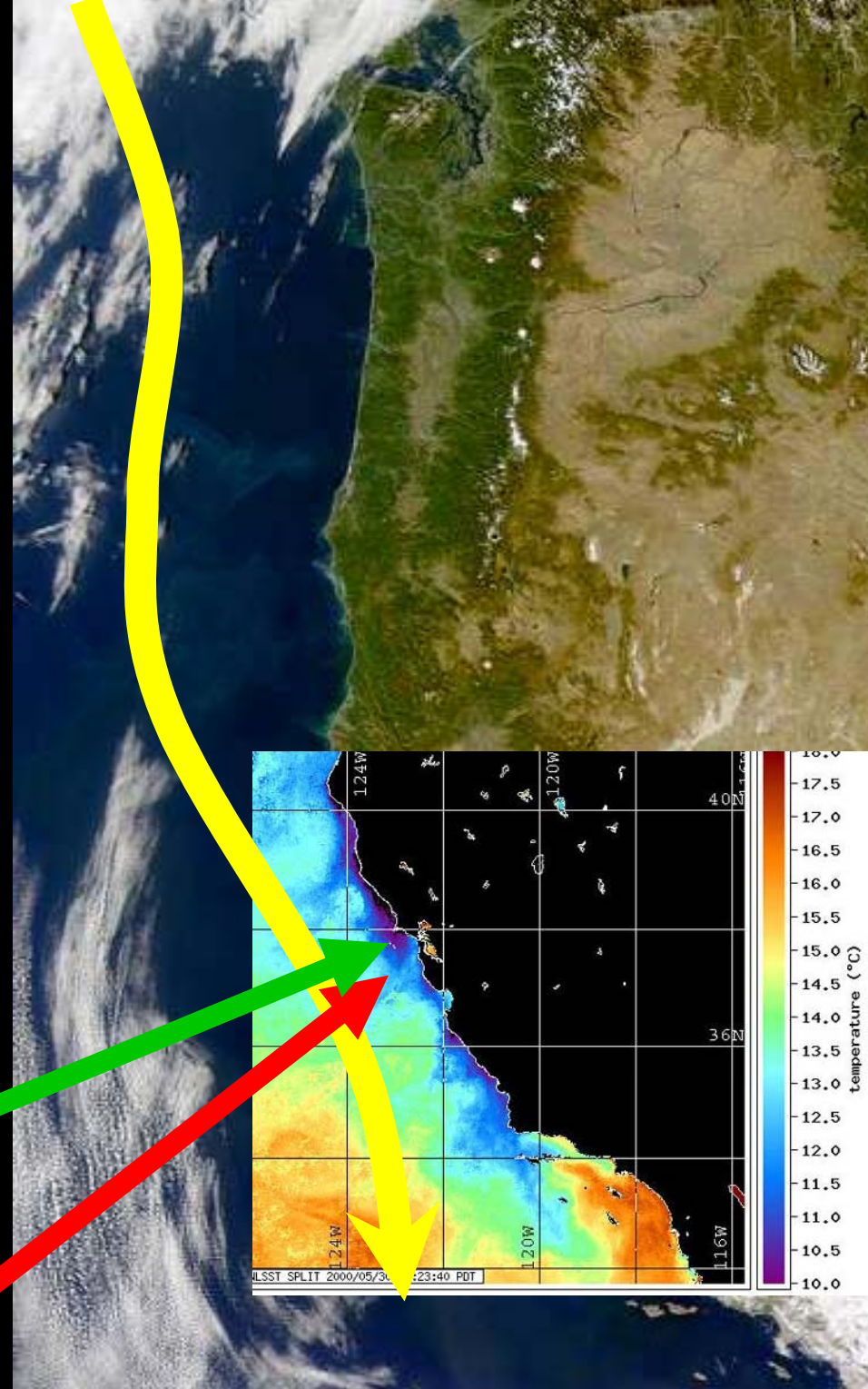
# The CA Current Large Marine Ecosystem: *How Does it Work?*

(1) California Current – offshore “river in the sea” – brings water from Gulf of Alaska

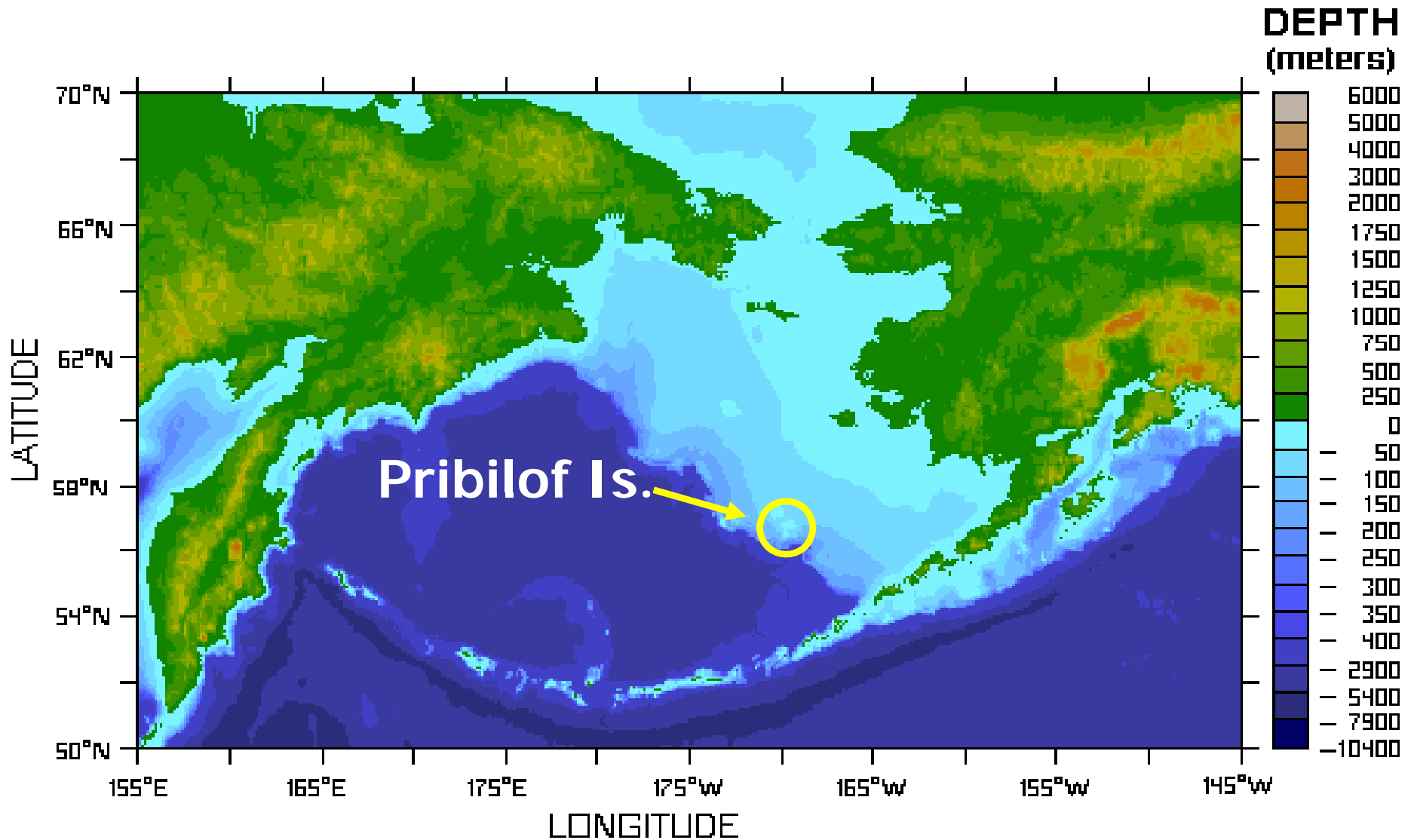
(2) Many promontories – sites of coastal “upwelling”

Pt. Arena/Pt. Reyes Upwelling Cell

Farallon Archipelago



# Bering





Ice Edge

St. Paul



~100 km



St. George

~30 km

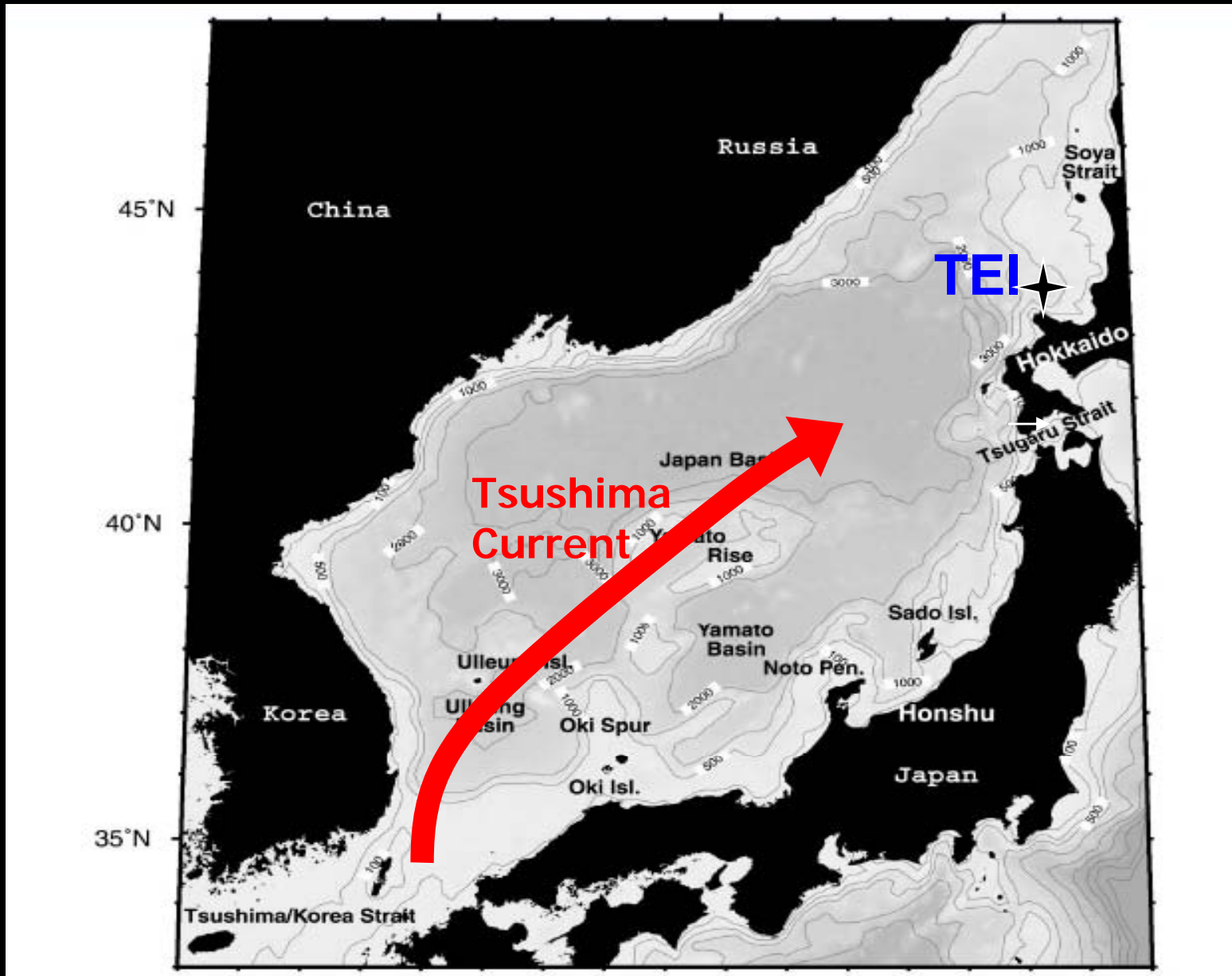


>70% of years ('72-'97)\*

\*Overland and Stabano 2004

Image from Google Earth

# Japan Sea and Teuri Island



30 km from mainland Hokkaido; 10 km east of shelf break

# Cassin's Auklet (California system)



Photo: Duncan Wright

# Red-Legged Kittiwake (Bering system)



Photo: Yuri Artukhin

# Rhinoceros Auklet (Japan system)



Photo: Frank Balthis

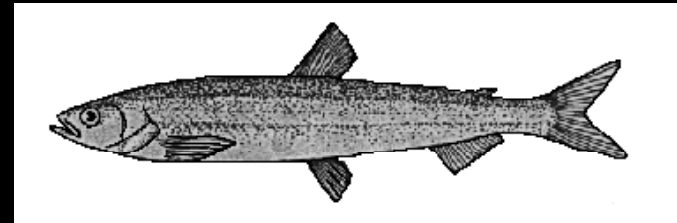
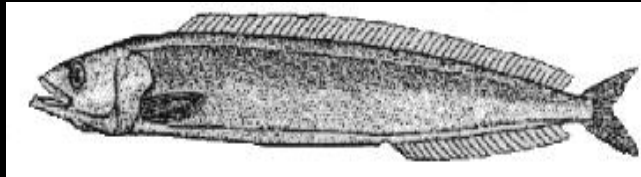
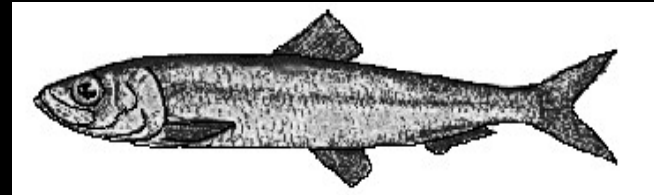
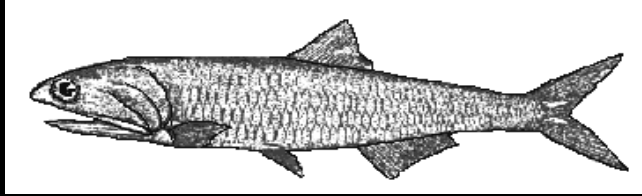
# "Krill" – (Euphausiacea)



Some climate change impacts occur through changes in the seabird's prey...like this plankton

Photo: George Mobley

# Or Through Small Fish That The Birds Eat...

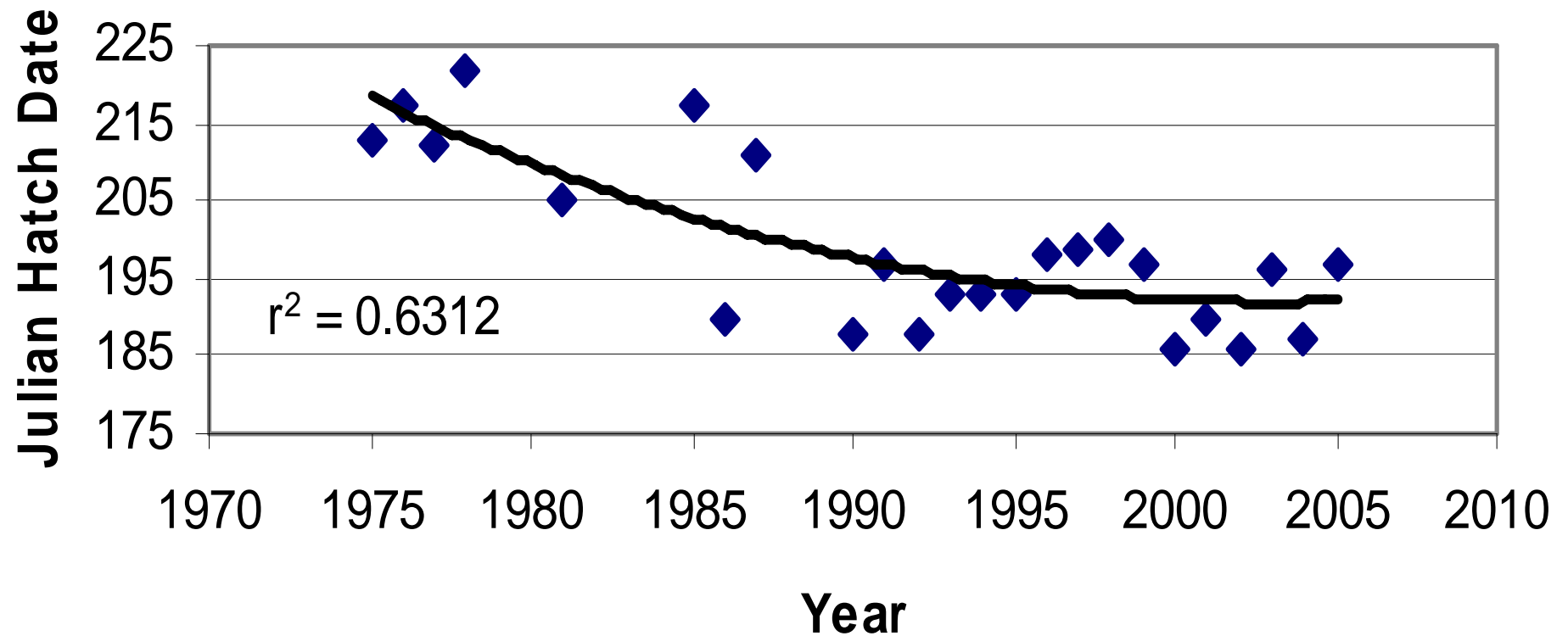


# Pattern: Cassin's Auklet (California) Breeding Success

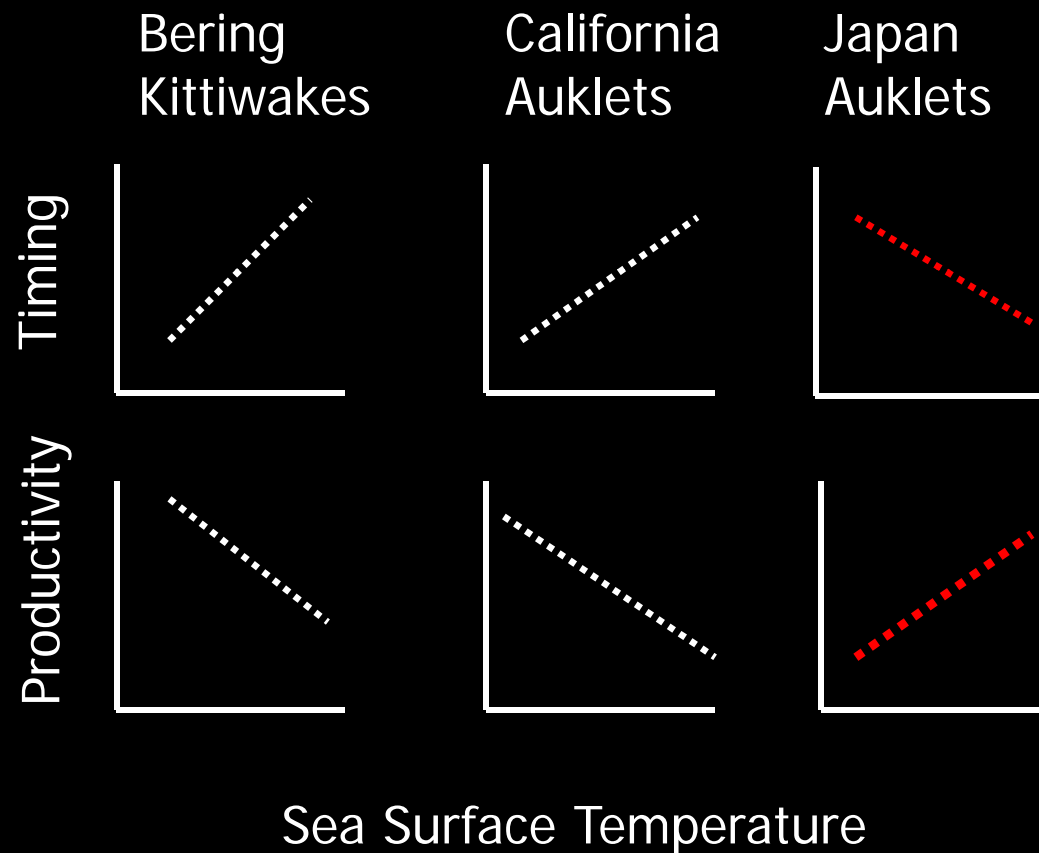
<u>Decade</u>	<u>Mean</u>	<u>CV(%)</u>
1971-1980	0.745	11.0
1981-1990	0.642	32.5
1991-2000	0.695	30.4
2001-2006	0.628	82.6

# Pattern: Kittiwakes are Breeding Earlier, Bering Sea

## Red-legged Kittiwake, St. George



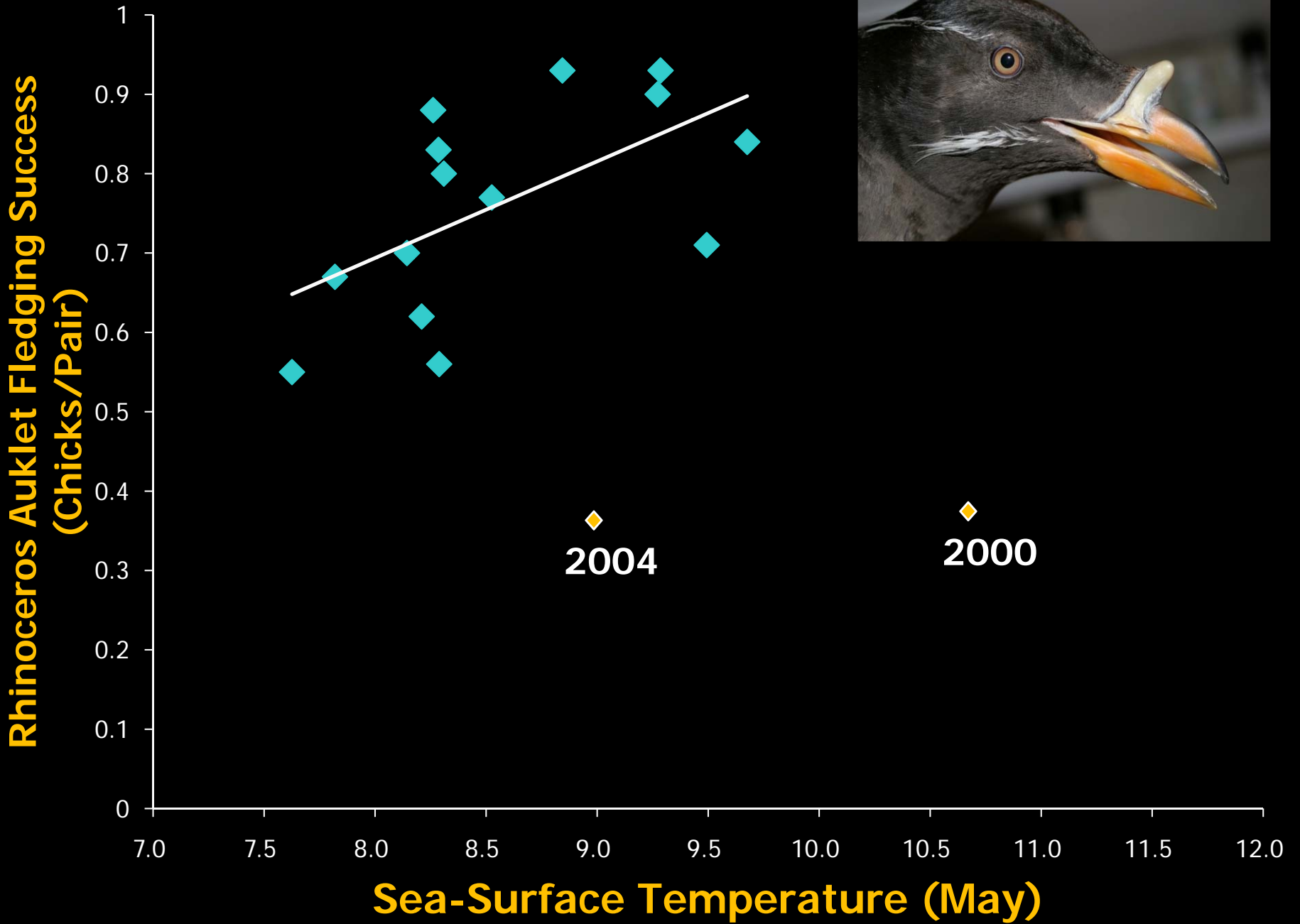
# Sea-Surface Temperature and Seabirds: Summary

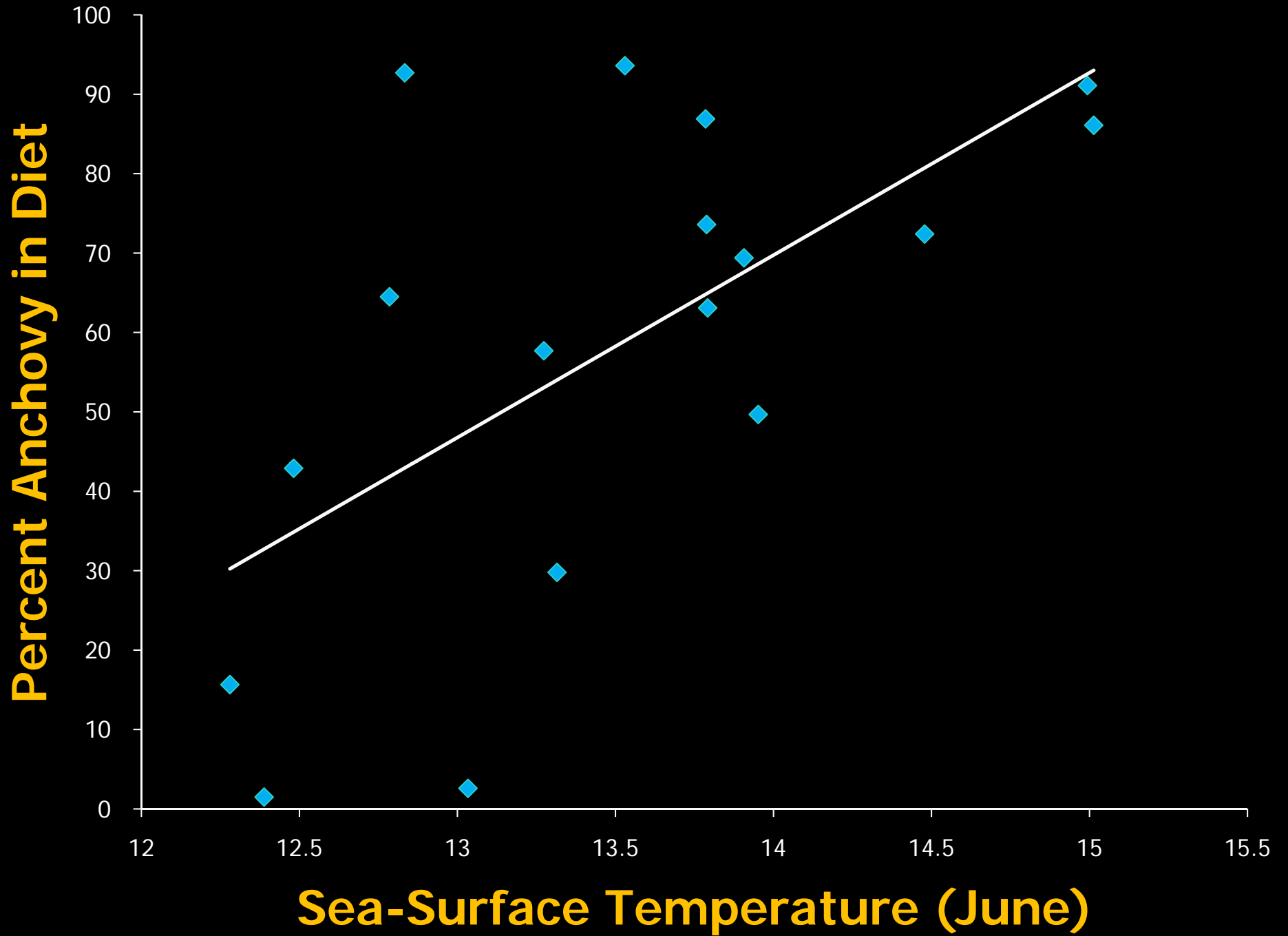


➤ In Bering and California, breed later when warmer, but in Japan, breed earlier

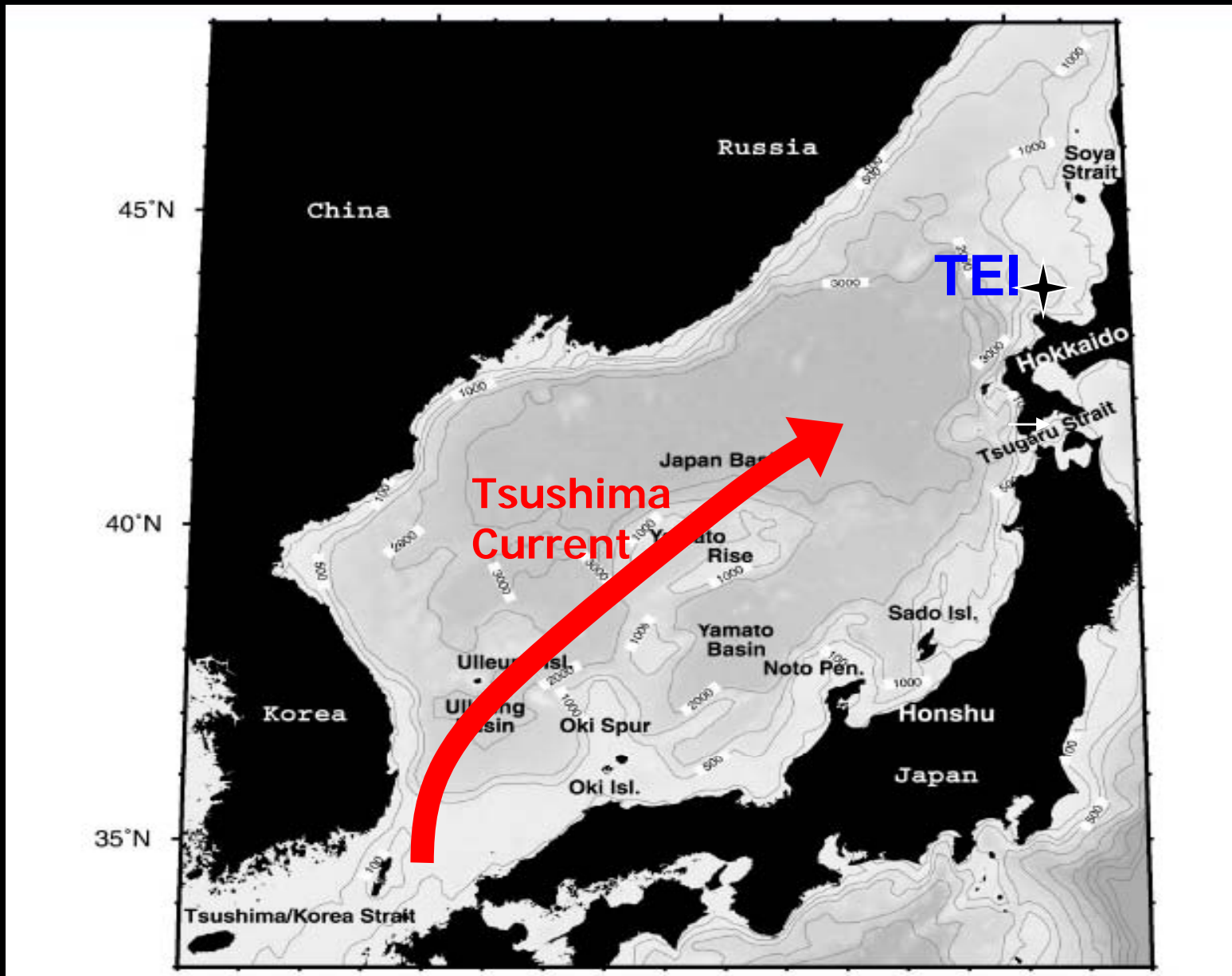
➤ Lower productivity when warmer in California and Bering Sea; higher with warmer temperatures in Japan Sea

- let's look at this in more detail...





# Japan Sea and Teuri Island



30 km from mainland Hokkaido; 10 km east of shelf break

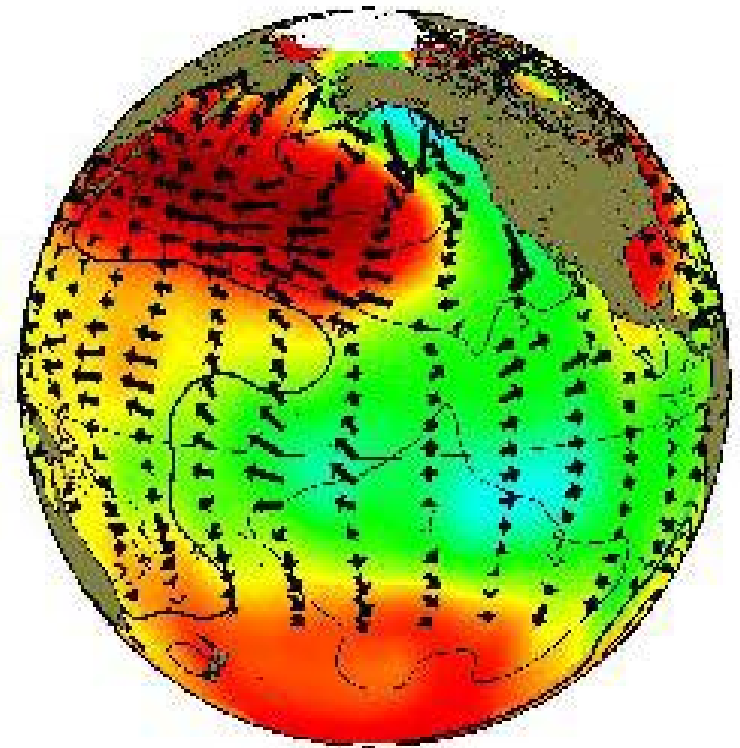
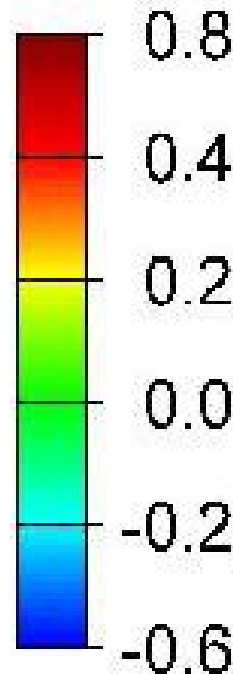
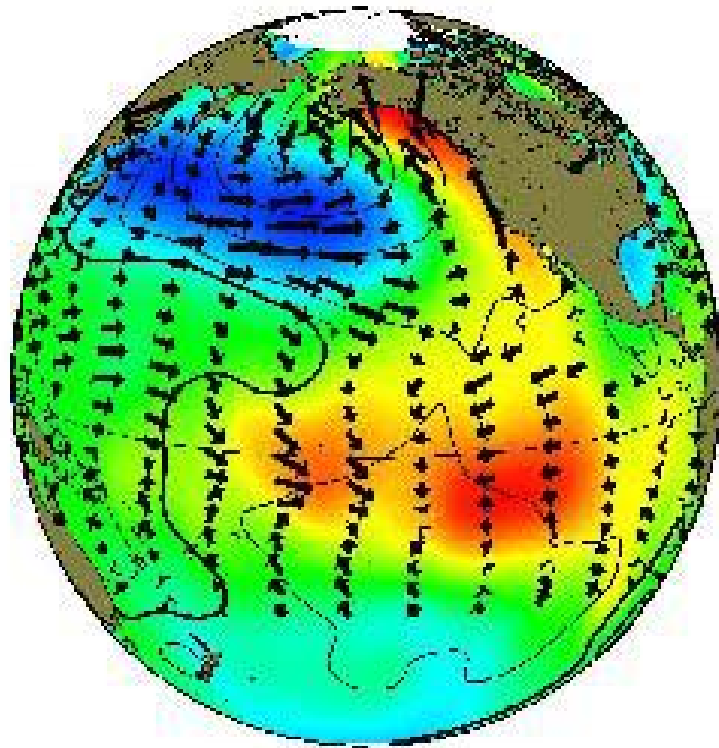
# Summary

- Climate change is global, but effects are local.
- In California, colder temperatures are generally better
- In Bering, colder - moderate is better
- In Japan, warmer is better, at least up to a point...
- Why is this?

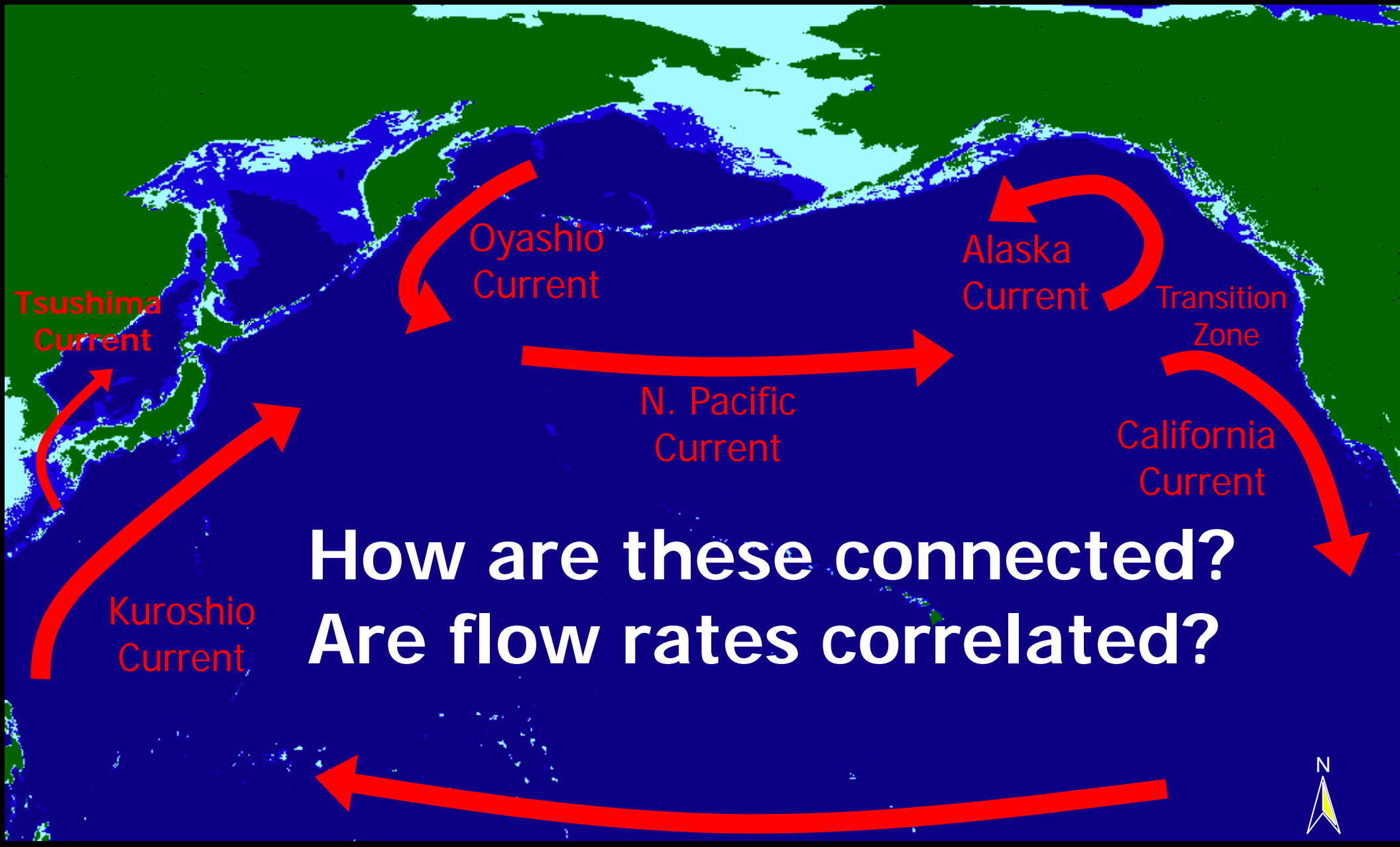
# Differences in Temperature Between Eastern and Western North Pacific

“Phase A” = Bad

“Phase B” = Good



# Major Currents of the North Pacific



How are these connected?  
Are flow rates correlated?



**We must work together,  
across disciplines and study areas...**



**Watanuki-san  
Seabird Ecology**

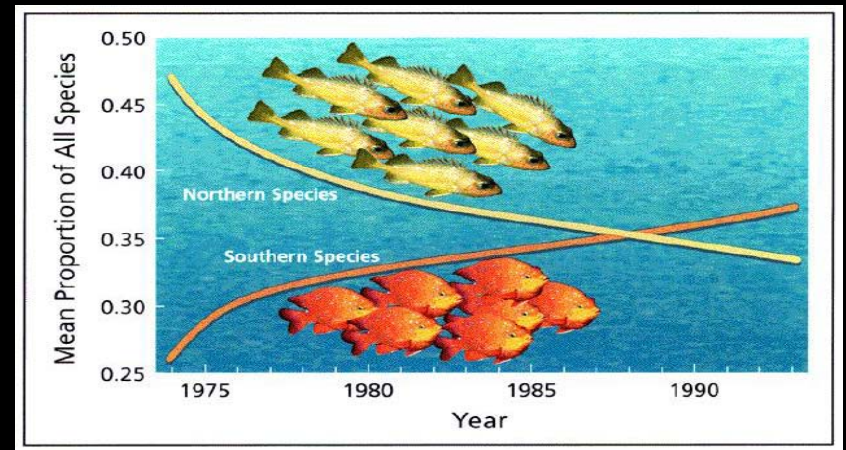
**Minobe-san  
Climatology**

## What PSG can do...



- Center of Excellence in Seabird Ecosystems Science (arctic, sub-arctic tropical...)
- Document and Communicate (IPCC, etc.)
- Develop Recommendations (e.g., climate may increase competition between societies (fisheries) and seabirds...)

# What you can do...



- Support/fund seabird ecosystem research
- Talk about it. Environmental changes now.
- Ask for more government funding and approaches to conservation (“endangered ecosystems”)
- Ask are these environmental changes acceptable? Get involved.

# Thank you for listening

