

Hypothesis-Driven Ecosystem Monitoring in the Gulf of Alaska

MONITOR Workshop:

Filling the gaps in the North Pacific Ecosystem Status Report

October 1, 2005

PICES XIV

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Gulf Ecosystem Monitoring Program

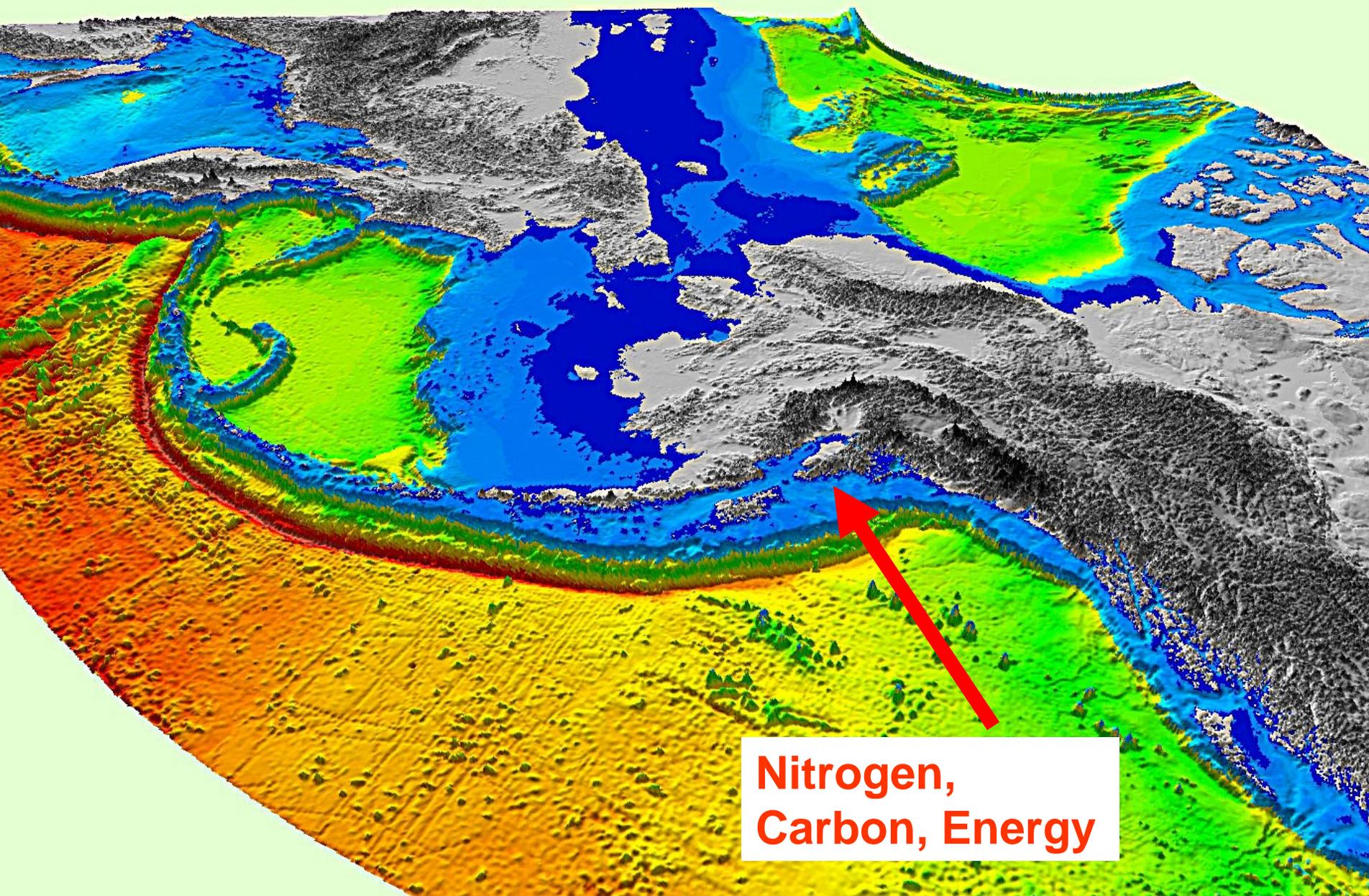
Implementation 2003 - 2007

- New Book: Biology and Oceanography of the Gulf of Alaska
 - Hypotheses on production of birds, fish and mammals
 - Background interdisciplinary atmosphere, oceans, biology
 - Status of birds, fish, mammals, human uses
 - Approaches to Modeling

Climate Driven Variability of Living Marine Resources

- Production of birds fish and mammals in the GOA depends on transport of nitrogen, N, carbon, C, and energy from deep waters, and from outside the Gulf
- Transport of N, C, and energy depends on basic physics (sun, moon, motion of earth) as altered by climate

Credit: Jonathan Heifetz, NOAA/NMFS/ABL/Juneau



**Nitrogen,
Carbon, Energy**

SeaWiFS
True Color
4/28/1998

Anchorage

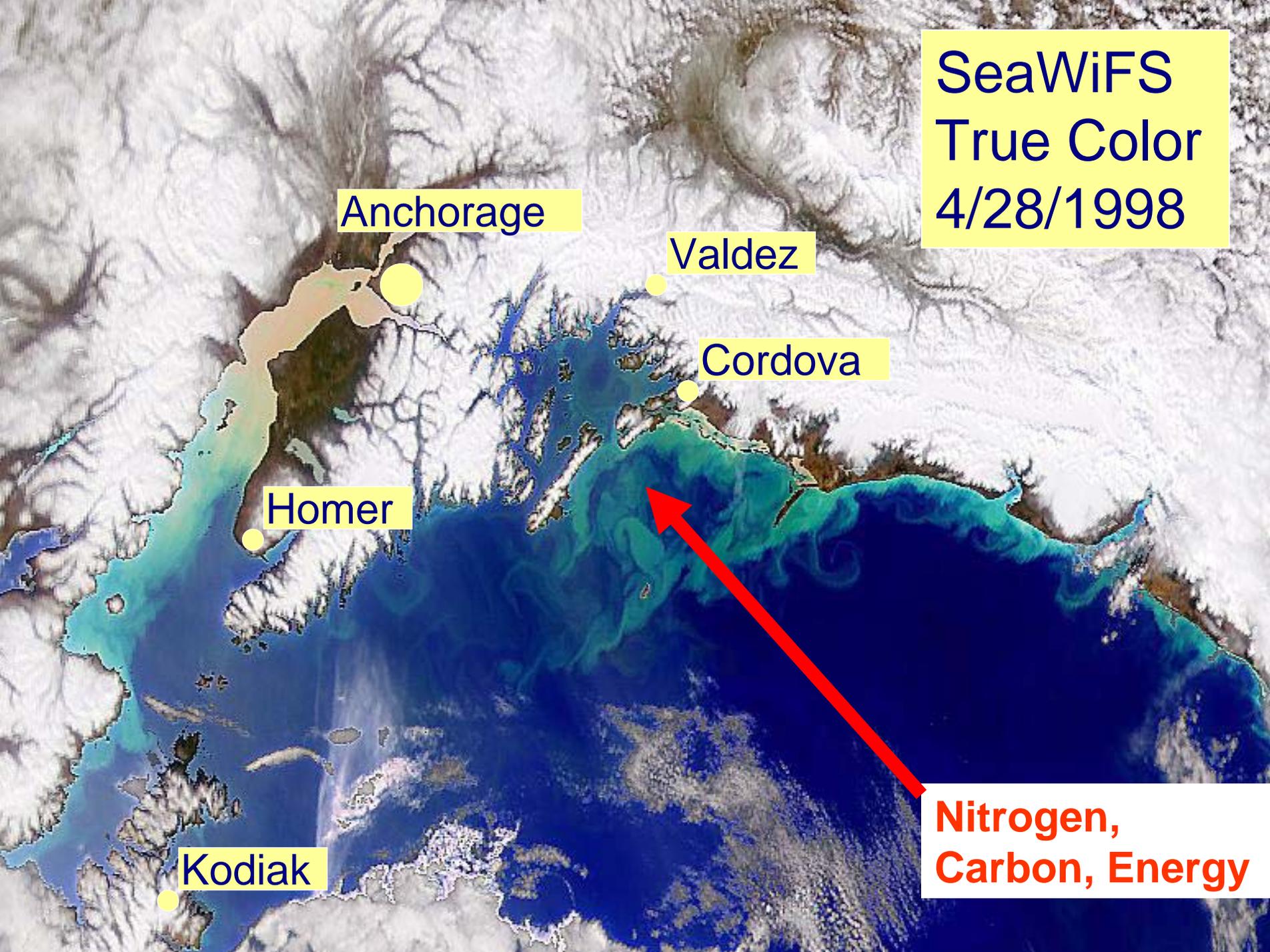
Valdez

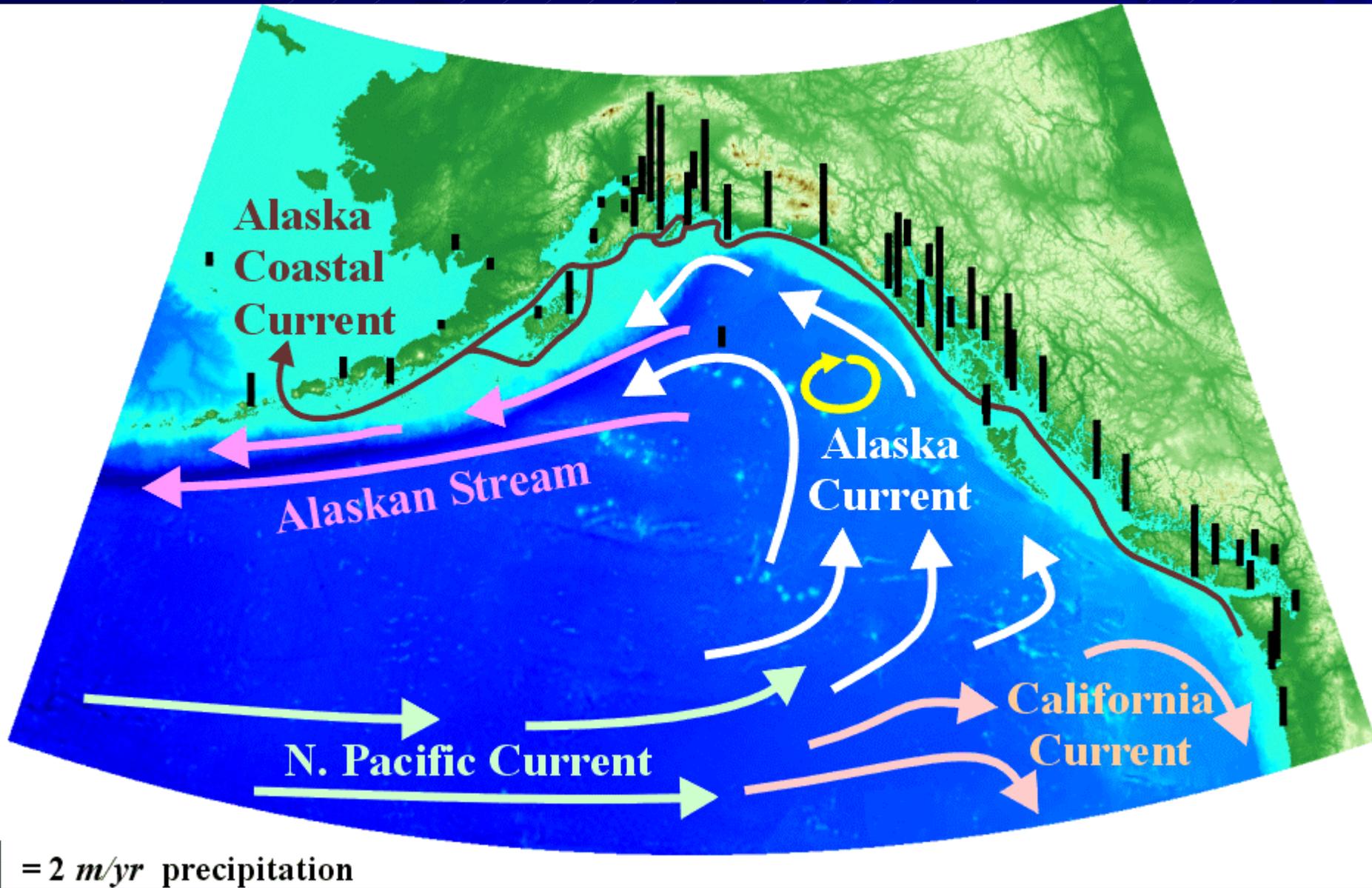
Cordova

Homer

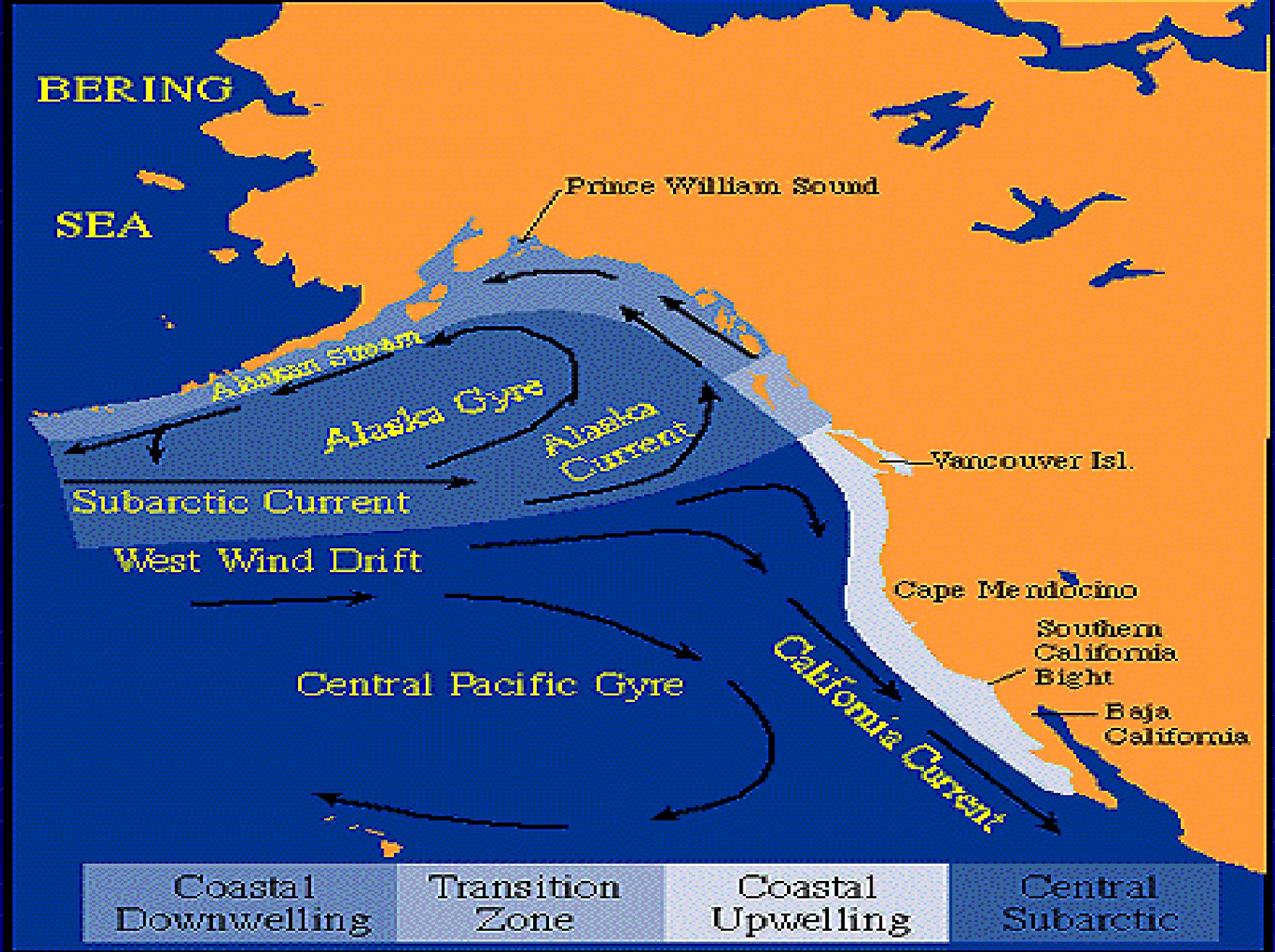
Kodiak

Nitrogen,
Carbon, Energy





Credit: Tom Weingartner and Seth Danielson, UAF IMS

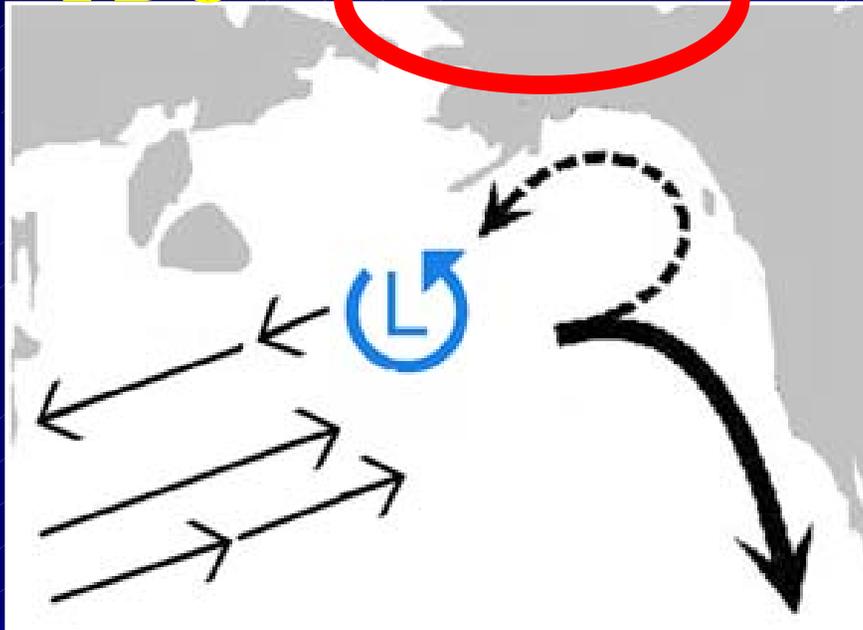


Credit: Ware and McFarlane 1989

The influence of Aleutian low on currents ...

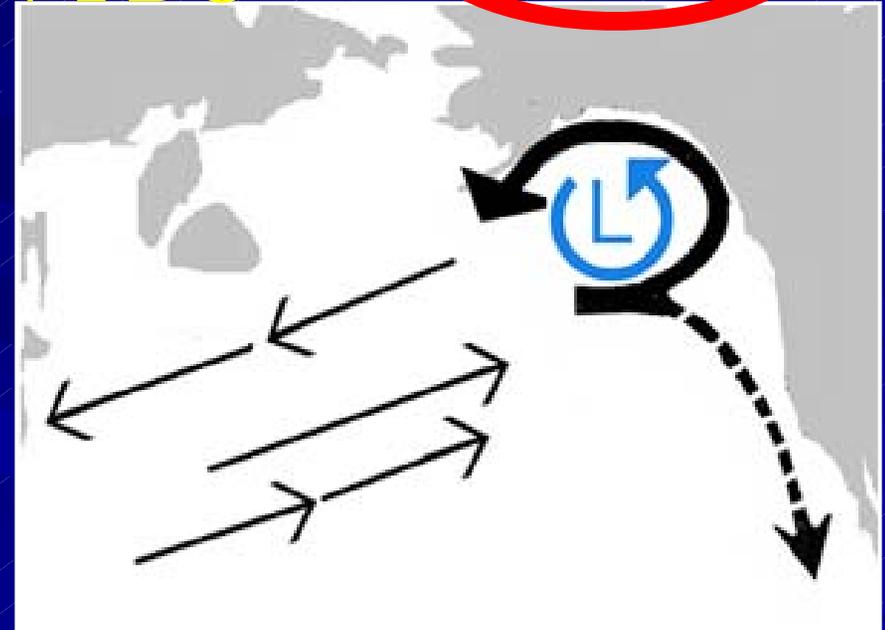
- PDO

AO



+ PDO

AO



Source: Hollowed and Wooster, 1992

... and the possible effect of the *Arctic Oscillation* on the Aleutian Low

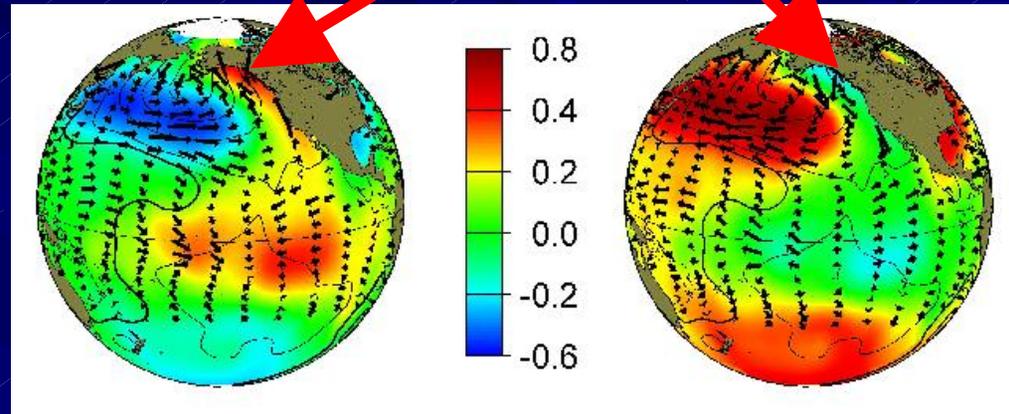
Climate is a major cause of change in the GOA

Pacific Decadal Oscill.
Anomaly Patterns

SST – colors

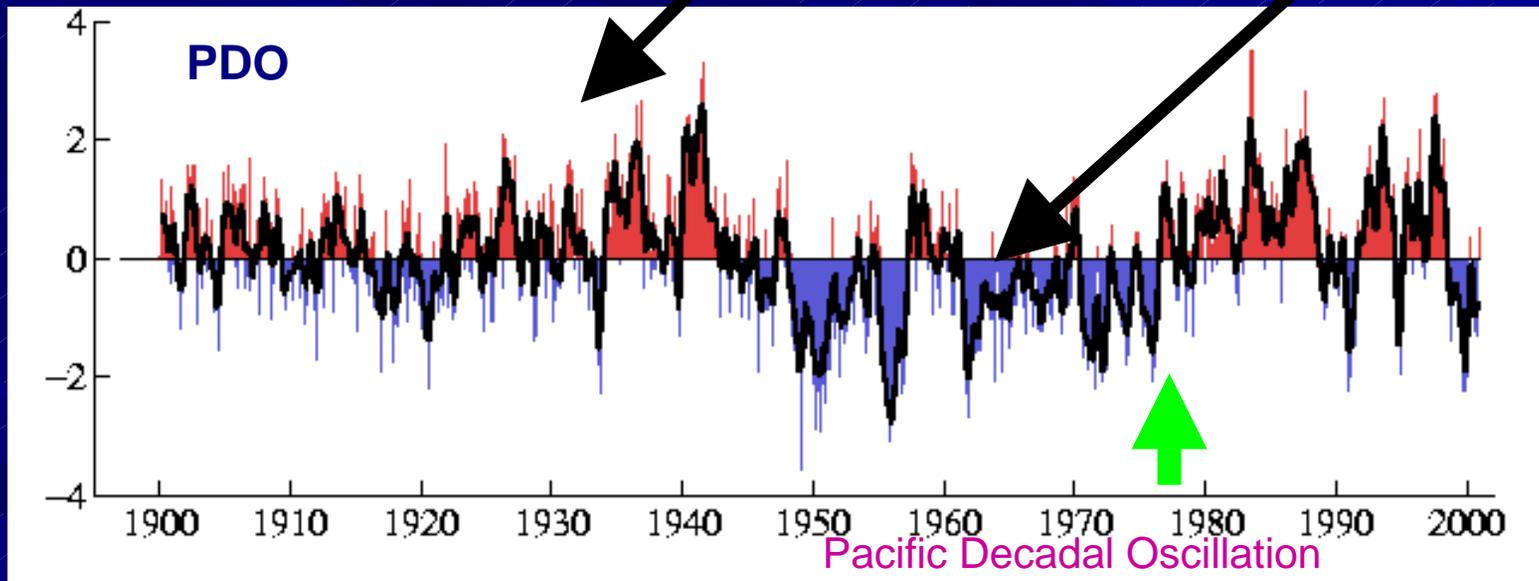
SLP – contours

Windstress - arrows



Warm

Cool



Credits: Hare, Mantua, Enfield

Regime Concept

Naturally caused
changes in abundance
and species composition
can be large and sudden

Climate forced change occurs across wide geographic range and different species

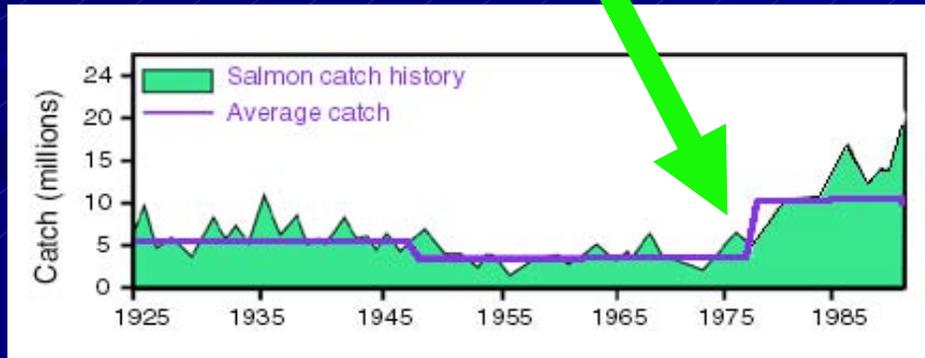


Early '70s



Late '70s

Source: Francis and Hare 1994



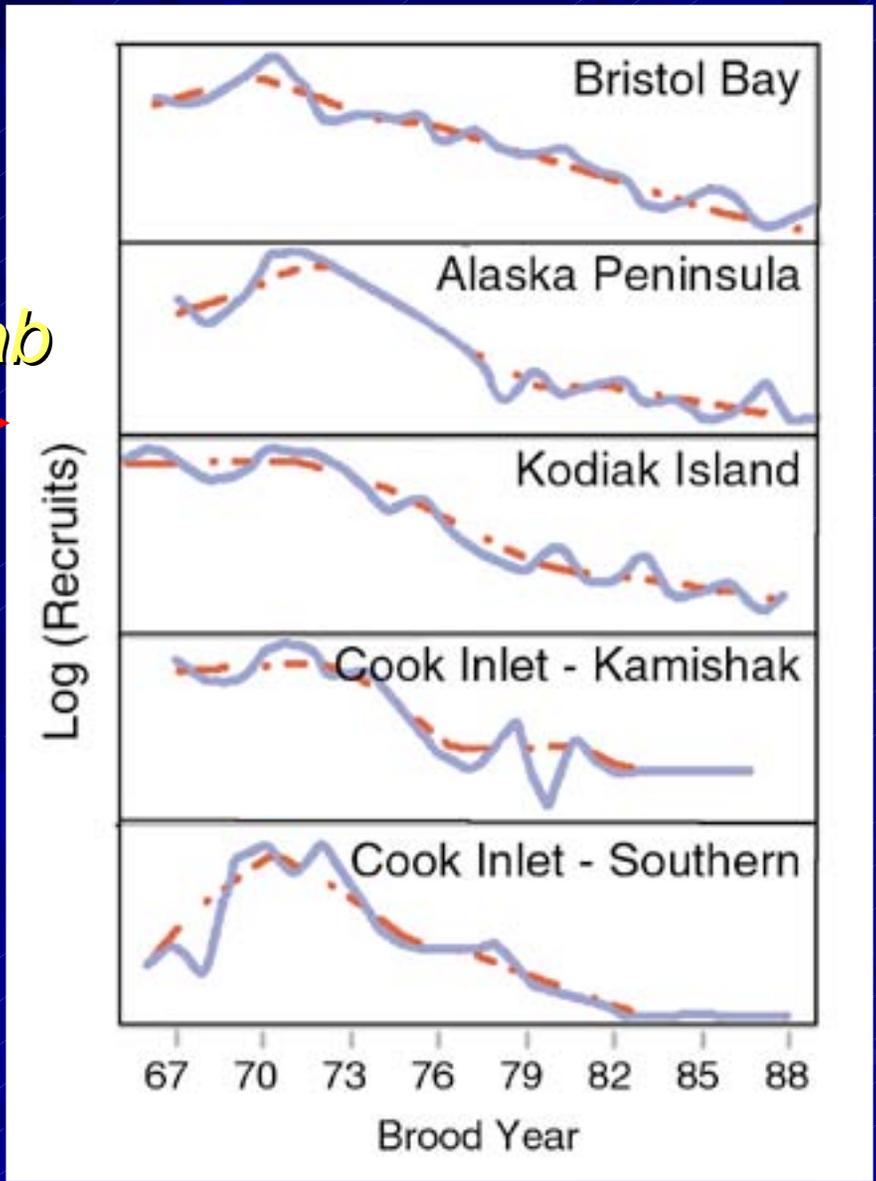
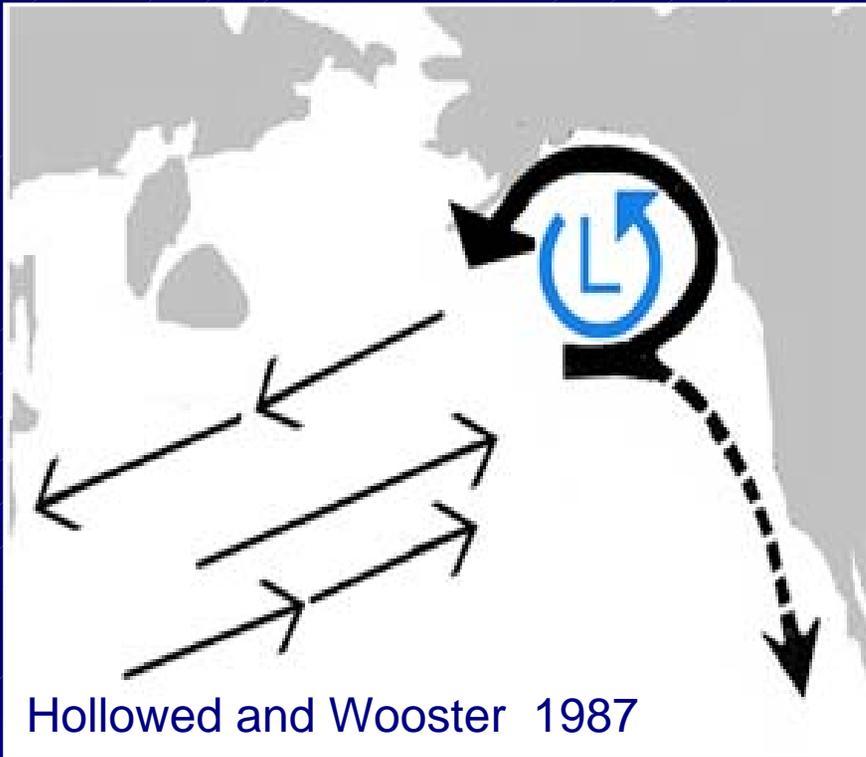
Central Alaska Sockeye catches



1980s-'90s

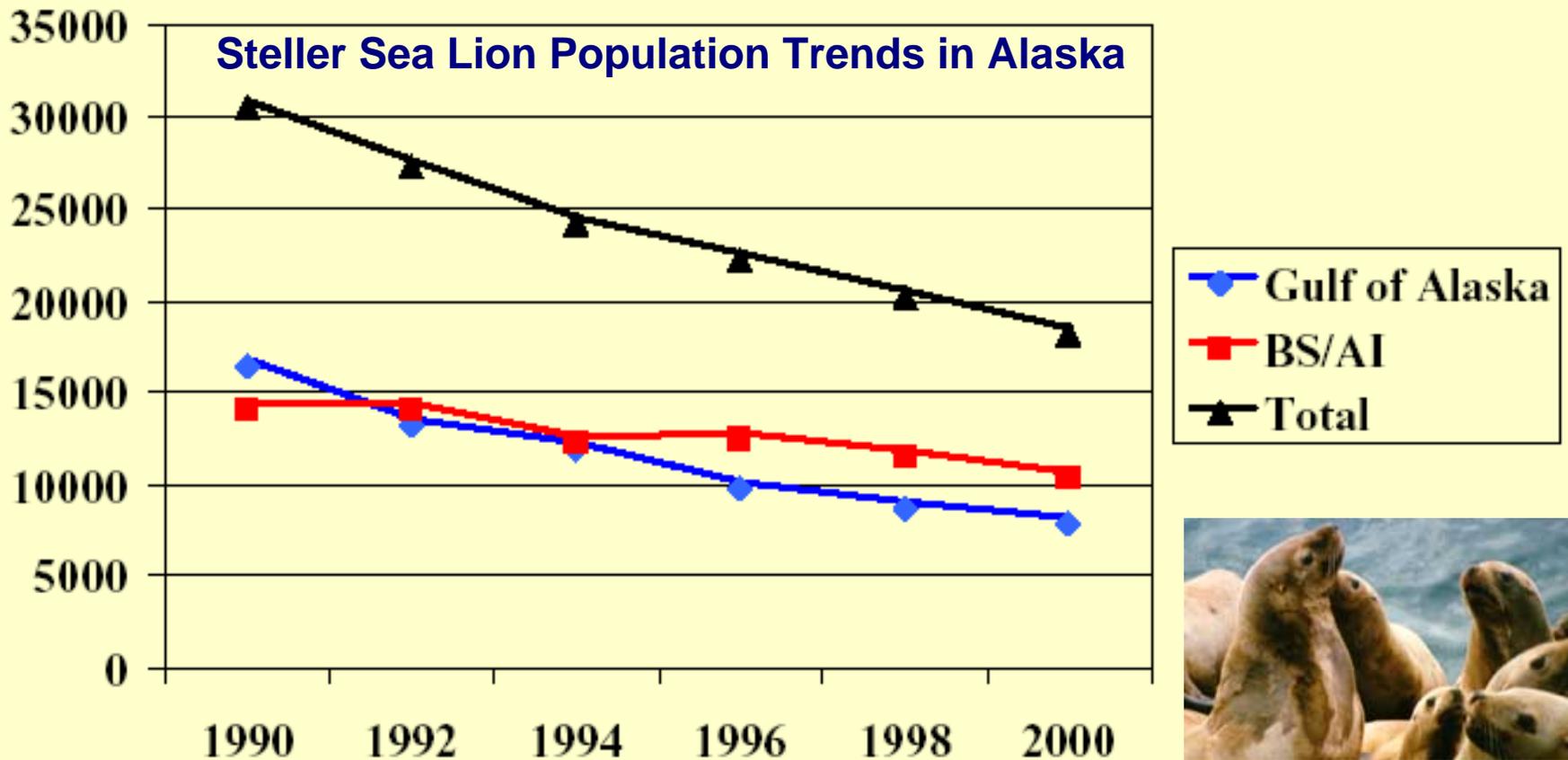
Natural resources are subject to long-term weather patterns, i.e.

Recruitment of red king crab



Source: Zheng and Kruse, 2000

Marine mammal populations show long downward trends in broad areas ...



Source: NOAA/NMFS DeMaster 2001

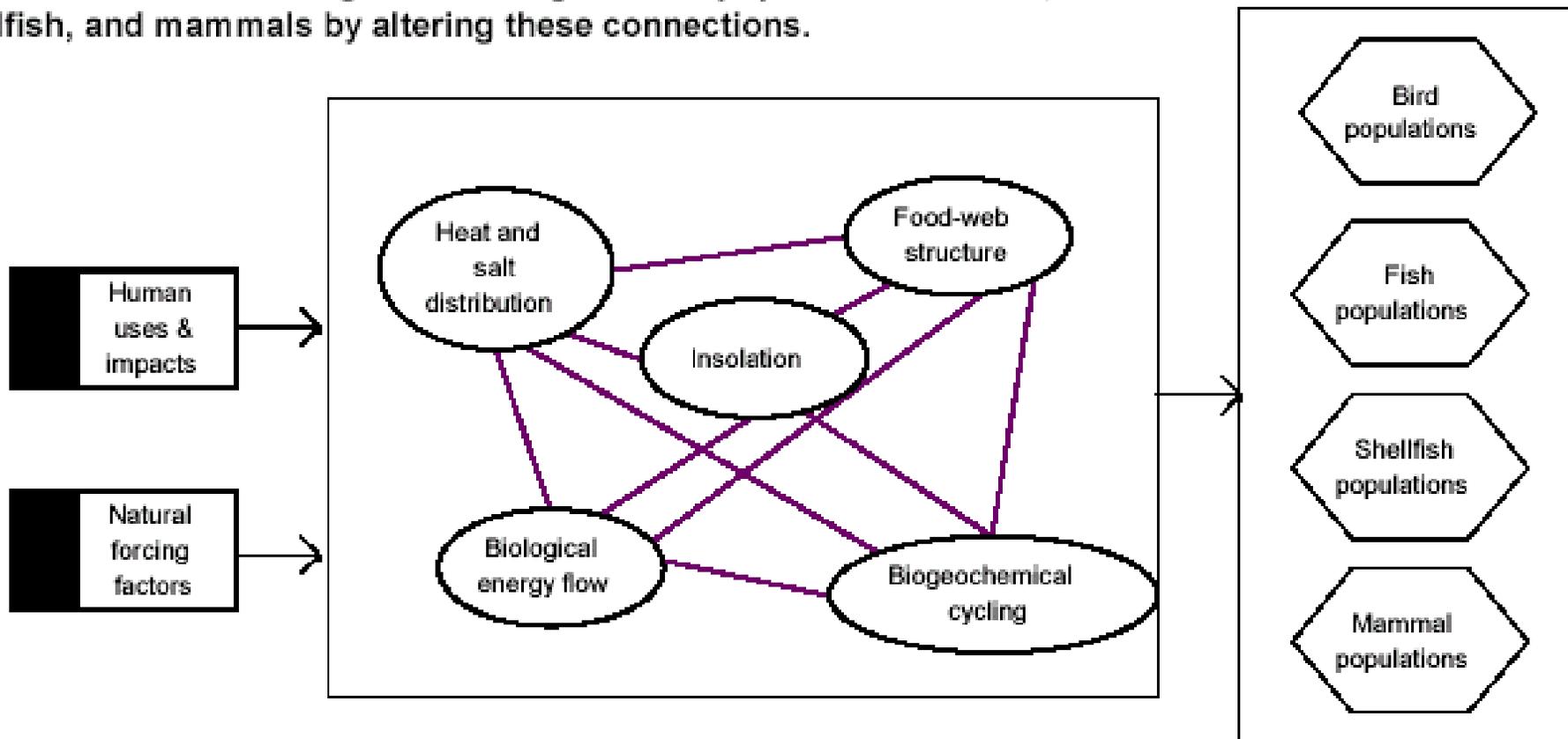
GEM Central Hypothesis

The “Committee” Version

Natural forces and human activities working over global to local scales bring about short term and long lasting changes in the biological communities that support birds, fish, shellfish and mammals. Natural forces and human activities bring about change by altering relationships among defining characteristics of habitats and ecosystems such as heat and salt distribution, insolation, biological energy flow, freshwater flow, biogeochemical cycles, food web structure, fishery impacts, and pollutant levels.

GEM Central Hypothesis

The marine ecosystem in the northern Gulf of Alaska (GOA) depends on a mixture of connections between heat and salt distribution, insolation, energy flow, biogeochemical cycling, and food-web structure. Natural and human activities bring about changes in the populations of birds, shellfish, and mammals by altering these connections.



Modeling

- Need Verbal Models of mechanisms of marine production to guide monitoring and quantitative modeling exercises
- Statistical Models (correlative) are precursors to deterministic models
- Do not have the right data to effectively produce coupled biophysical models – need to fill these gaps

Universal Question: What causes change, and how do we measure it?

- Natural variability in the physical environment causes shifts in trophic (food web) structure and changes in the overall productivity
.... Human impacts ... may trigger changes in species composition and abundance.

International GLOBEC 1991 = NEP GLOBEC

Alaska Regional Marine Research Plan 1992

Bering Sea Ecosystem Plan 1998

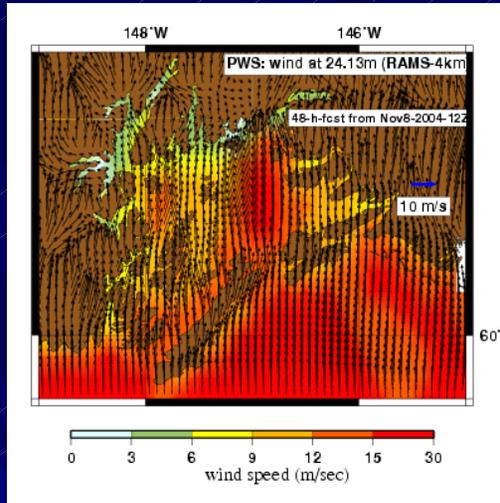
GEM Program 2001

BEST (Hunt, Stabeno et al.) 2004

What do we measure to understand change?

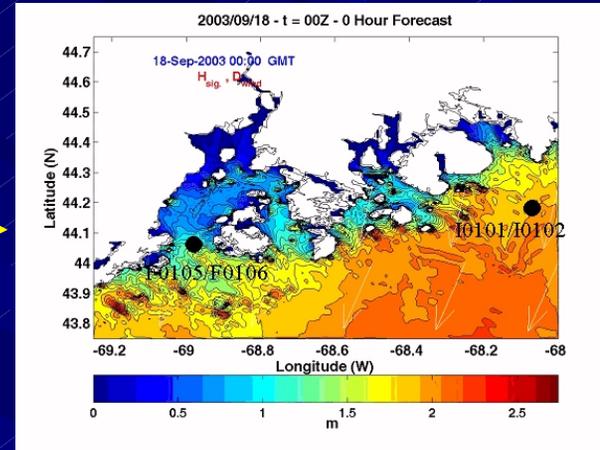
- T,S relevant to biological populations
- Data to estimate parameters of models of atmospheric and oceanic circulation relevant to biological populations
- Transport of Nitrates to areas of biological production (shelf areas, and other photic zone)
- Indicator species – commercial and lower trophic level

PWS Observing System Products



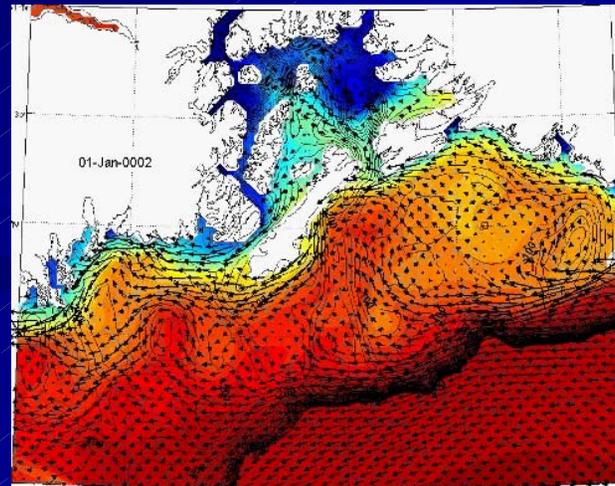
Weather
Forecasts

1. Wind velocity
2. Wind direction
3. Precipitation



Wave
Forecasts

1. Wave heights
2. Nearshore currents
3. Turbulent mixed depth



Circulation
Forecasts

1. Current velocity
2. Current direction
3. Stratification
4. Upwelling centers
5. Fronts

■ The End

Thanks to NOAA, National
Marine Fisheries Service,
Alaska Fisheries Science
Center for supporting this
presentation



List of Comments

Slide 5

From Dede Bohn 10/19/99: Several of us DOI folks met with Marilyn Heiman, DOI Trustee, yesterday, to brief her on the GEM plan. I'll copy below the points I tried to make, and the people who attended, FYI. Marilyn was quite interested in the briefing, overall. In particular, she wishes to hear more about how GEM will cover not only coastal areas but also especially the immediate onshore areas, including mouths of river drainages. She remarked that she knows those pieces of land are of particular interest to the State. She also hopes to find human interests well represented. **EVOS BRIEFING WITH MARILYN, Oct. 18 at 1:30** Attendees: USGS: Dede Bohn, EVOS Liaison, Bill Seitz, Director, Alaska Science Center, Jim Bodkin, Wildlife Biologist_Sea otters, FWS: Catherine Berg, EVOS Liaison, Kent Wohl, Nongame Migratory Bird Coordinator for Refuges and Wildlife, Dave Irons, Wildlife Biologist--Seabirds, NPS: Bud Rice, EVOS Liaison

Gulf Ecosystem Monitoring (GEM) Program status and DOI Perspective 10/18/99

Scientific Program, not yet a Plan, · Intended to connect the dots between existing efforts · Competitive proposal process · Current emphasis on lingering effects of oil spill will begin to shift to maintaining health of ecosystem. **Points of Interest:** · Preserves Trustee Council structure; continue making decisions by consensus · **Probable Trustee Council actions:** authorize dollars to fund activities, vote on research and funding priorities, evaluate how this plan fits with existing efforts, react to National Research Council review of the Plan, expected, between January-March 2001, determine role and structure of Public Advisory Group(s), determine if we need a formal Scientific Advisory Group

Anticipate feedback: Community Involvement_requested \$20M of \$115M, University_request for Endowment(s), · Science Coordinator position may eventually absorb role of Executive Director, Geographic scope: probably larger coverage than current workplans, **How does DOI fit in to the Plan?** NPS (coastal issues), USGS (DOI Trust species, research, development of scientific capabilities, monitoring protocols, FWS: DOI Trust species, research, inventorying and monitoring Future Issues: Keep careful watch during next year on setting of research priorities for the plan, Open process, DOI Interests represented.

Slide 7

The Gulf of Alaska and its salmon super highways provide habitat for salmon from SE Alaska, North America and Asia.

GOA is the cross roads of the world for Pacific salmon. In the winter, many of the salmon in the Gulf of Alaska are from Asia and western Alaska. Salmon from Canada and the lower 48 cruise the coastal and offshore waters of the Gulf.

Slide 9

Long-standing weather patterns can lead to decades of unusually warm or unusually cold sea-surface temperatures in the Gulf of Alaska and adjacent areas that is marked by opposite patterns of sea-surface temperatures to the west. A very marked change in these patterns occurred in 1977- 1978, see the green arrow.

Slide 11

Changes in the species composition of small mesh trawl surveys on the Alaskan Peninsula from shrimp and smaller forage fish species in the early 1970's to a predominance of flatfish and cod-like species in the 1980's were accompanied by changes in salmon abundance in many parts of Alaska. Annual changes in Alaskan salmon abundance have been related to changes in annual growth rings of trees in Alaskan and Canadian coastal forests. Declines in crab populations over much of Alaska followed a similar time schedule. The responses of so many different species over so large an area appear to be the effect of the large-scale forces of atmosphere and oceans.

Slide 15

What are the relative roles of natural forces and human activities, as distant and local factors, in causing short-term and long-lasting changes in the biological communities that support birds, fish, shellfish, and mammals in the four key habitats of the GOA?

Slide 18

Explanations of what causes change in valued natural resources are very much the same all over the world. They all tend toward the concept that natural variability combines with human actions to trigger changes in species composition and abundance of individual species. The scientific theories about what causes change appear to be well developed, along the following lines.