EcoFOCI

Ecosystems & Fisheries-Oceanography Coordinated Investigations

NOAA's *Ecosystem and Climate Goal Teams*

A 25-year partnership between

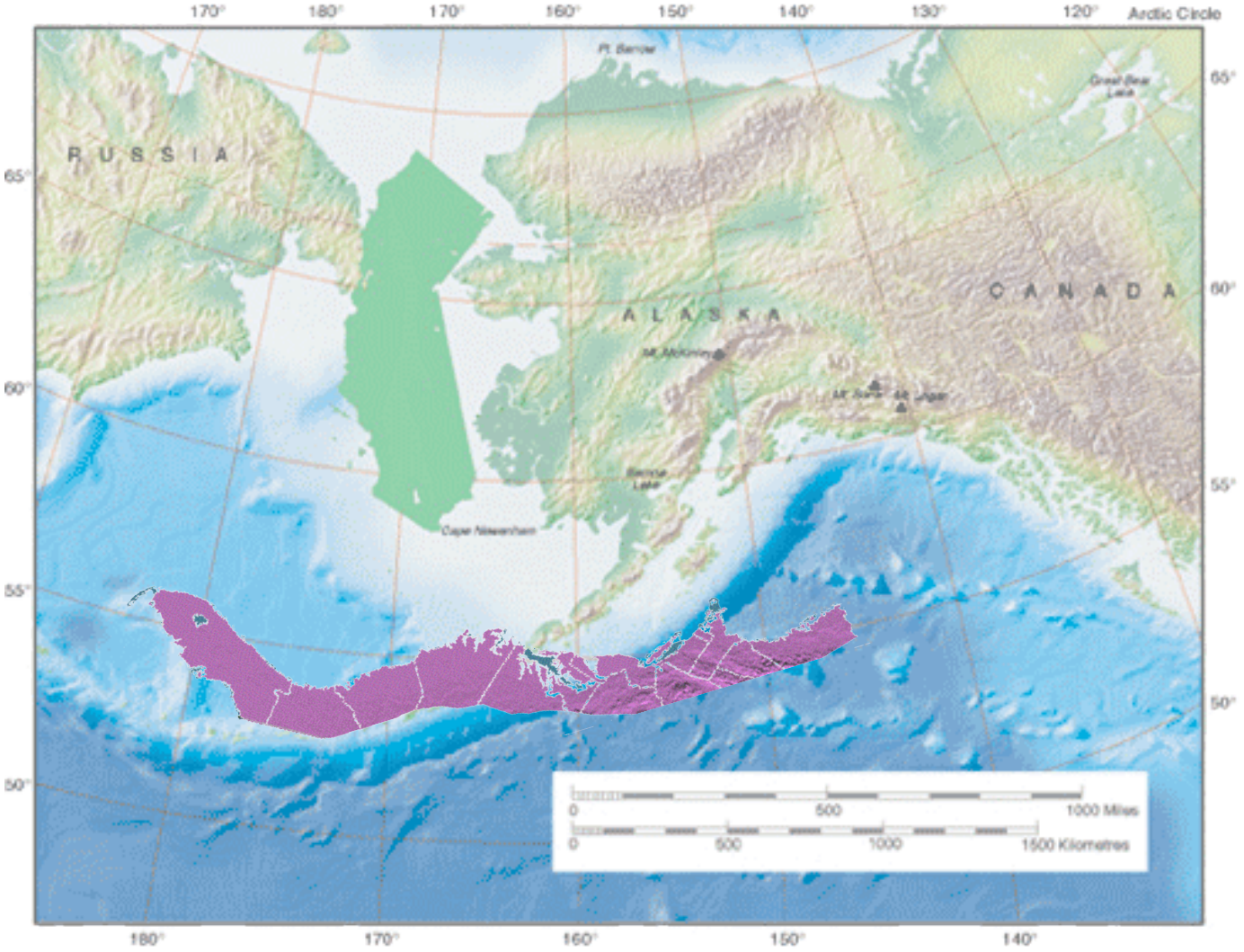
Pacific Marine
Environmental Laboratory

Alaska Fisheries
Science Center

Research Regions

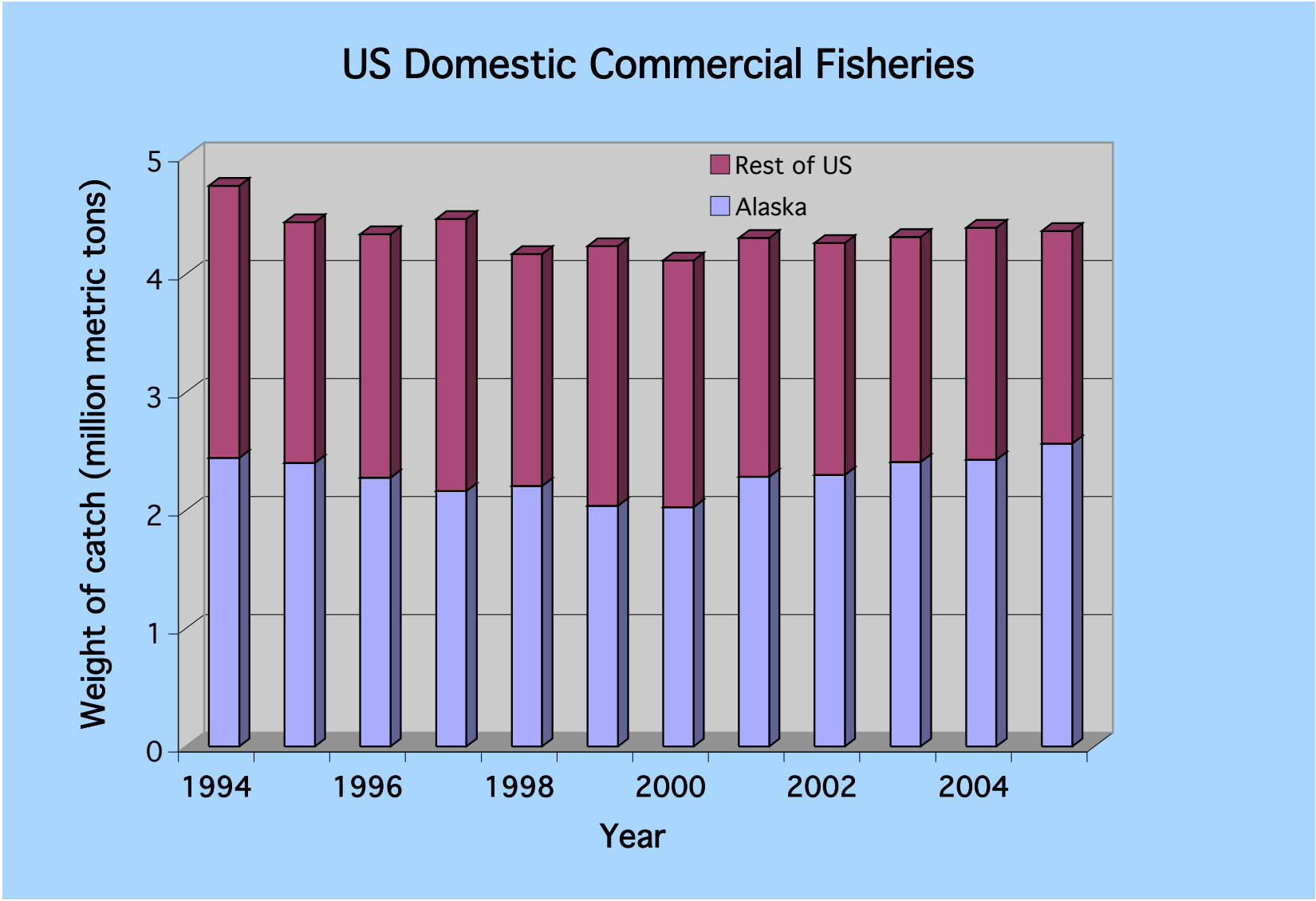
The Gulf of Alaska, the Bering Sea, the Aleutian Islands and the Alaskan Arctic

California fits into the Bering Sea

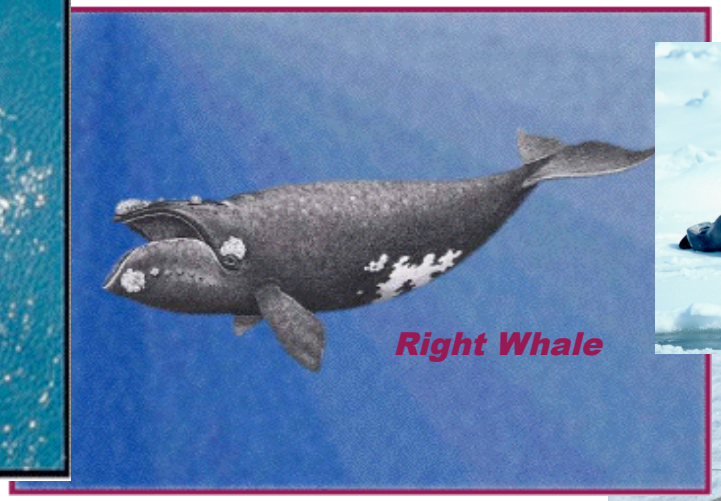


Economic and Societal Relevance

Alaska Feeds the Nation

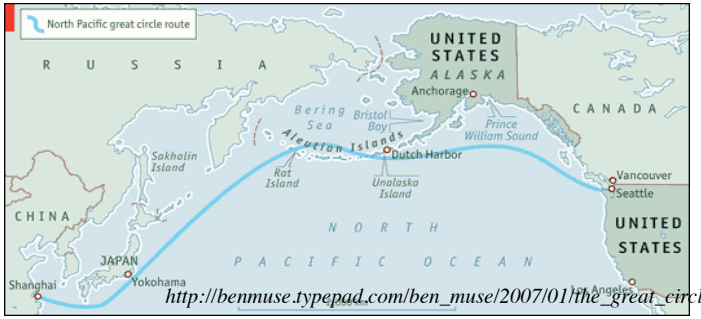


Protected, Endangered & Threatened Species

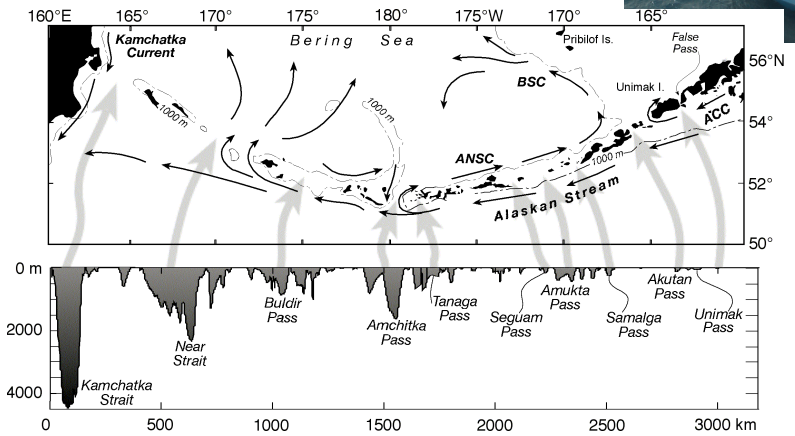


Marine Transportation, Oil and Gas Exploration and Production

http://geology.com/articles/northwest-passage.shtml



http://benmuse.typepad.com/ben_muse/2007/01/the_great_circl.html



Funding and Partnerships:

Evidence of Quality and Performance

Funding

NOAA base 40%, other NOAA 20%, Non NOAA 40%

External

AOOS *(Alaska regional component to OOS)* Received funding in 2005-2007 as part of AOOS and part of the present funding request

NEPGLOBEC *(NSF - NOAA partnership)* EcoFOCI scientists were PIs on 4 of the 6 synthesis proposal funded in fall 2005

NSF - Since 2004, EcoFOCI scientists have received funding from 5 NSF proposals

North Pacific Research Board - *(An Alaska organization supports* ***"…*** *research activities ... relating to the fisheries or marine ecosystems in [Alaskan waters] ... [with]...priority ... to address fishery management or marine ecosystem ... needs)* From 2004-2007 NPRB distributed $20.8M, EcoFOCI were on proposal totaling 15%.

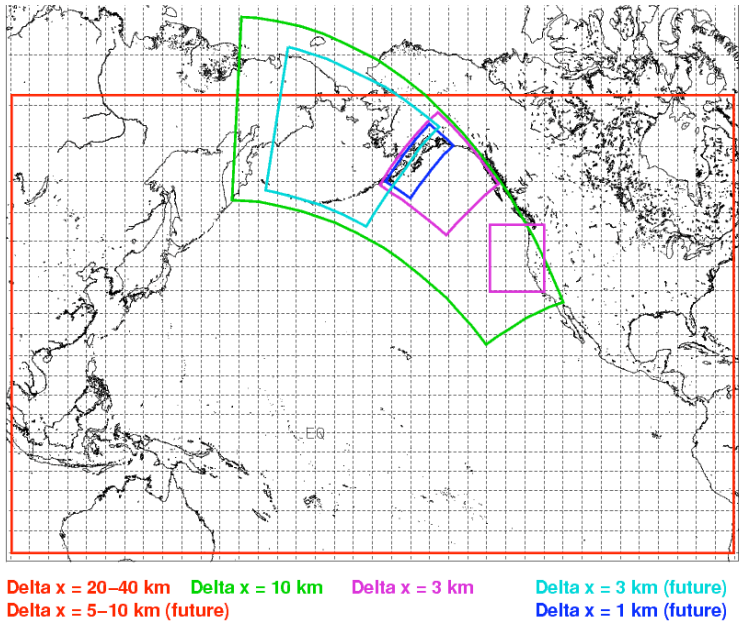
New NOAA Initiatives

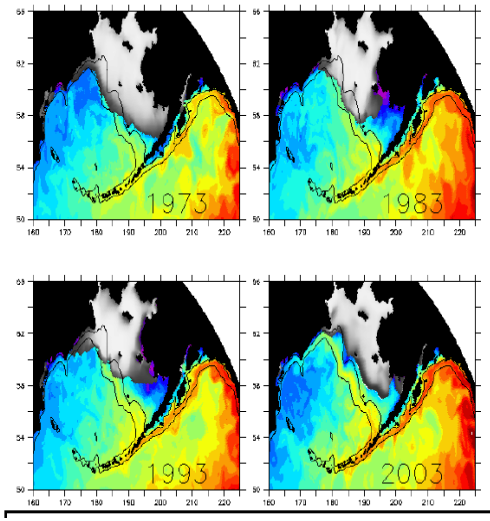
2004 - North Pacific Climate Regimes and Ecosystem Program (NPCREP)

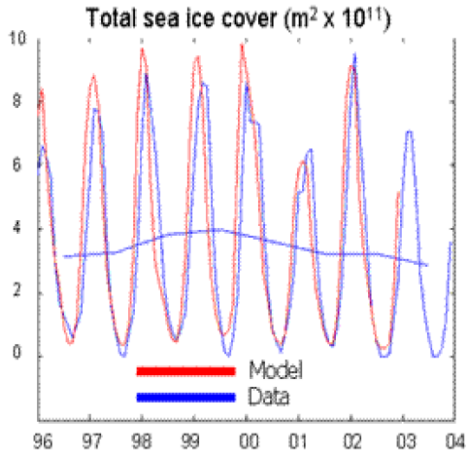
2009 - Loss of Sea Ice (LOSI)

Northeast Pacific GLOBEC

Regional Ocean Model System - ROMS





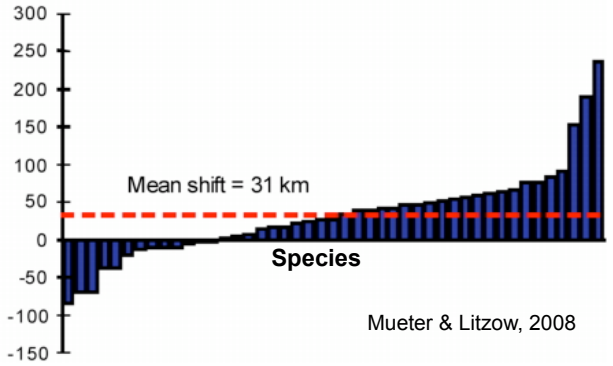


Development of ocean model of the North Pacific - *Impacts: Primary physical tool for recruitment studies (e.g. jellyfish, flatfish, pollock, snow crab, Tanner crabs, salmon); core of the ecosystem model (climate to humans) for Bering Sea Ecosystem study; and basis for future predictions within the planned Integrated Ecosystem Assessment.*

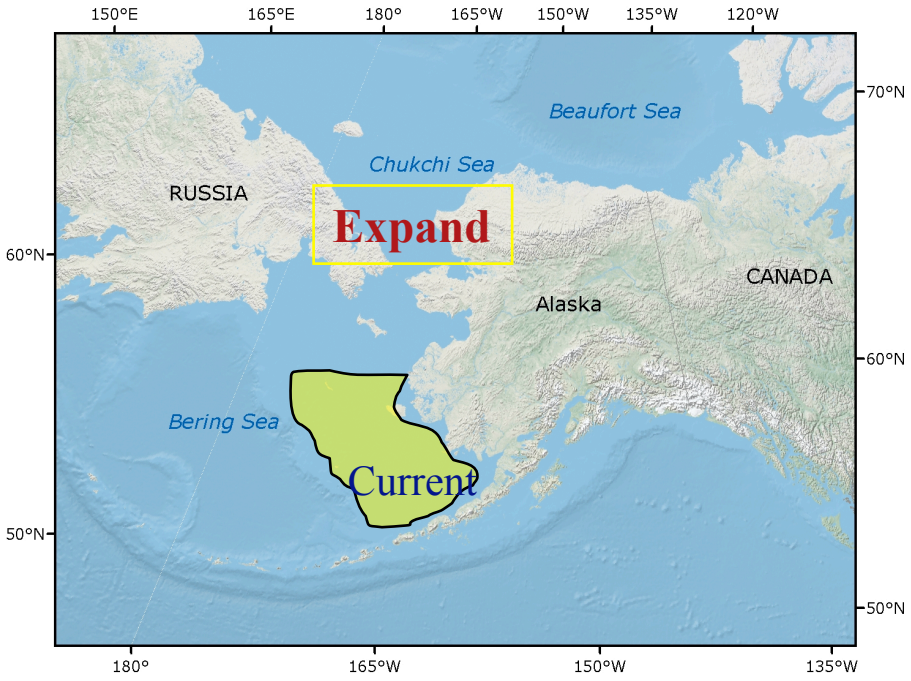
Loss of Sea Ice

(Beginning FY09)

Northward shift (km) in center of distribution of species (1982-2006)



Mueter & Litzow, 2008

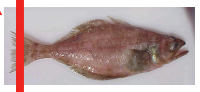


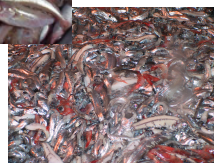
M. Cameron, AFSC

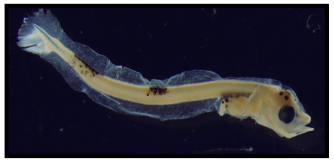
Purpose: Expand oceanographic, fish, cetaceans, and pinnipeds surveys; and understand these species' dependence on sea ice.

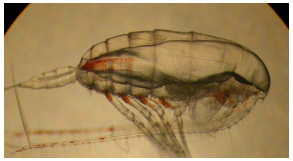
Bering Sea Integrated Ecosystem Study (BSIERP) and Bering Ecosystem Study (BEST)

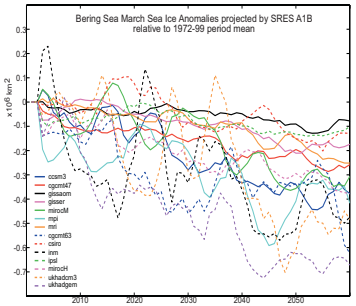
BSIERP/BEST











Humans

Humpback and fin whales

Commercial/subsistence fish: Pollock, cod, arrowtooth flounder

Kittiwakes and murres, fur seals, walrus

Forage species: Juvenile pollock, capelin, myctophids

NPZ: Ichthyoplankton, euphausiids, Copepods

Infauna: Bivalves, gastropods, polychaetes

Atmosphere/ocean

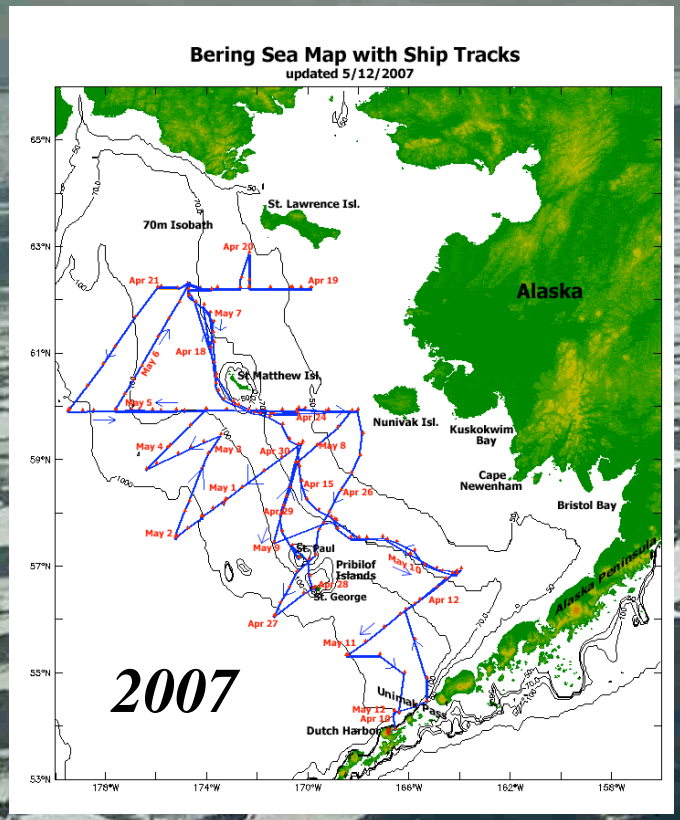
Climate Scenarios

Observations, Analyses and Applications

the path to

Integrated Ecosystem Assessment

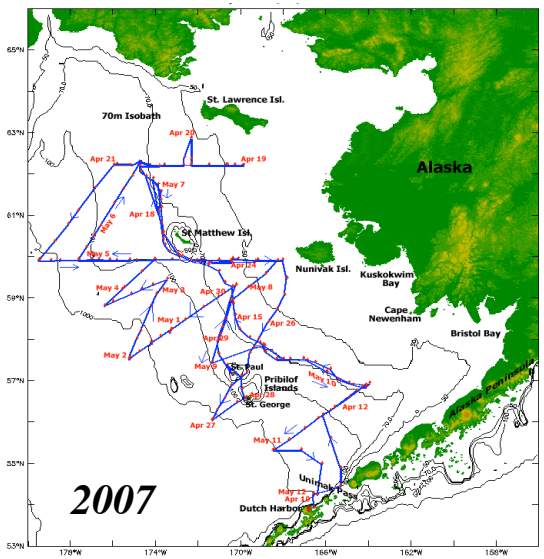
Observations



USCGC Healy

Aloft Conn 2007-04-30 23:00:01 | Lat: 58 13.0437 N | Long: 173 14.8248 W | Temp: 27 F

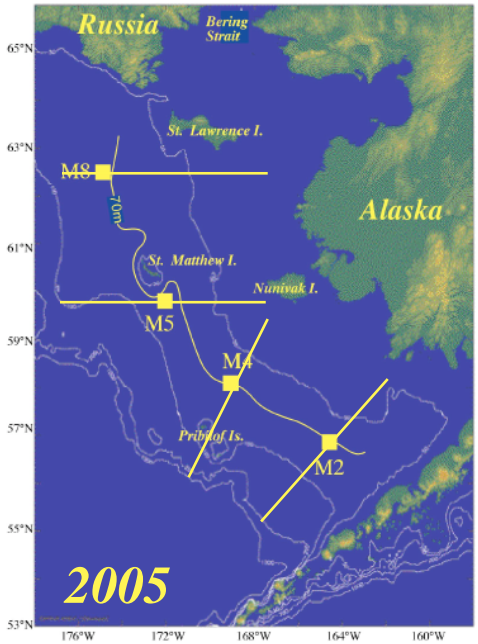
Shipboard Observations



The first NSF-BEST cruise

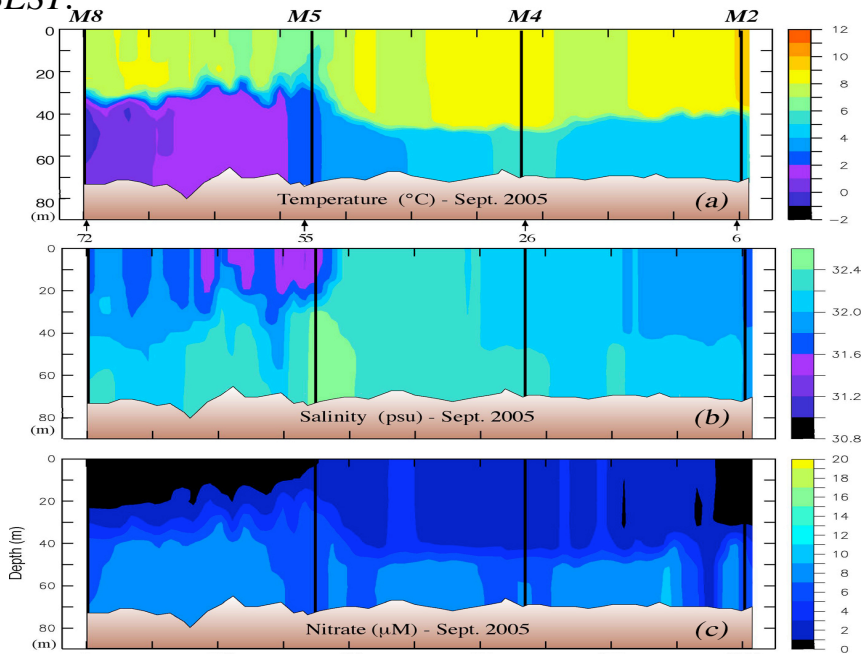
By 2000, EcoFOCI had identified locations for critical moorings (M2, M4, M5, and M8). In 2004, the primary long-term hydrography lines had been selected and occupied in 2005.

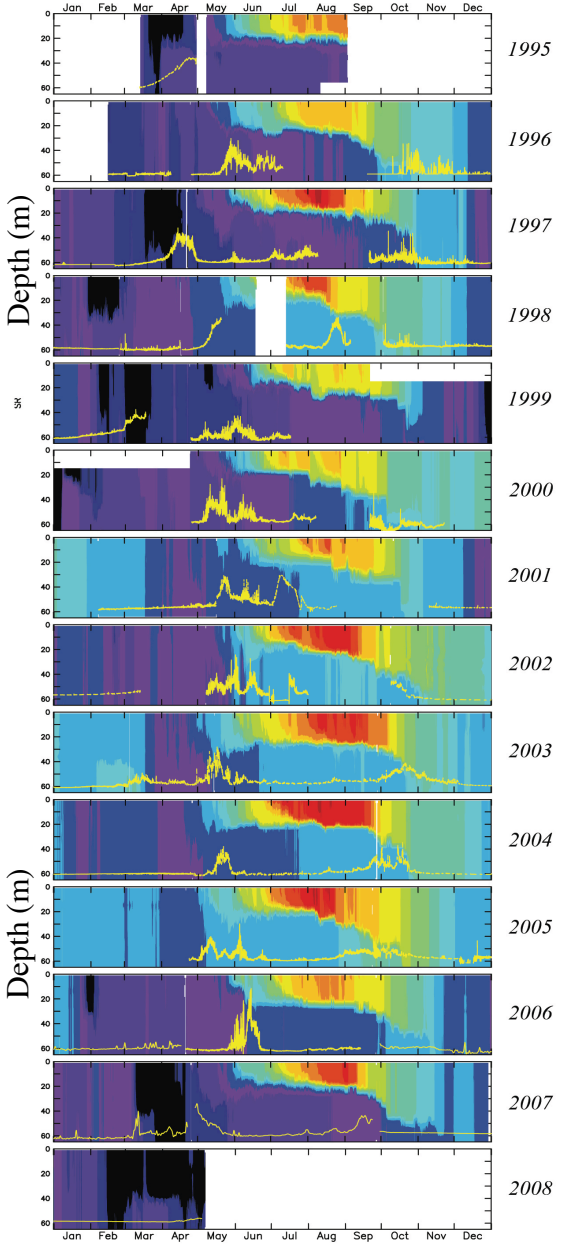
The 70-m isobath together with 4 cross shelf lines form primary sampling lines for BEST.



A few specific scientific observations:

- Even in warm years, ice persists over the northern shelf for 6 months.
- The northern shelf is colder and fresher than the southern shelf, and is dominated by benthic ecosystem rather than pelagic of the south
- Northern shelf has weaker tides and stronger low-frequency currents than southern shelf
- The dynamics of the northern shelf differ from those of the southern shelf and, as the Bering Sea warms, the ecosystem of the south will not be transferred northward unchanged.

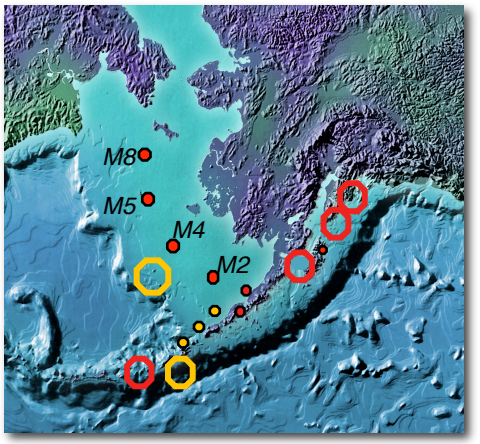




14 years at M2

Moorings

M2: Temperature, salinity, nutrients, currents, fluorescence, oxygen, nutrients, meteorological variables, zooplankton abundance (acoustic)



Moorings 2004-2008:
Yellow: < 4 years
Red: > 4 years

Platform "of opportunity"
(U. of Wash., Penn State, NMML, UAF, Scripps)

- Passive listening devices: PAL, HARPS, Haru Phone, Aural
- Water Column *Profiler*
- Nitrate sensors

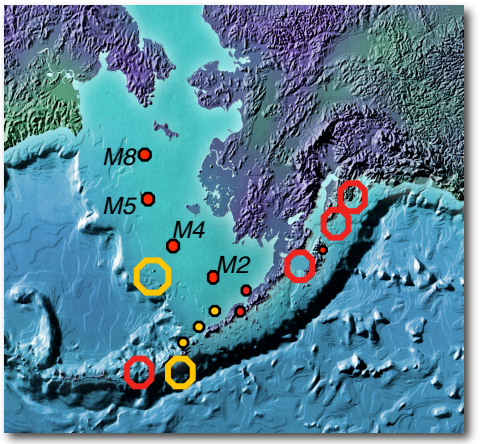
A few specific scientific contributions from M2:

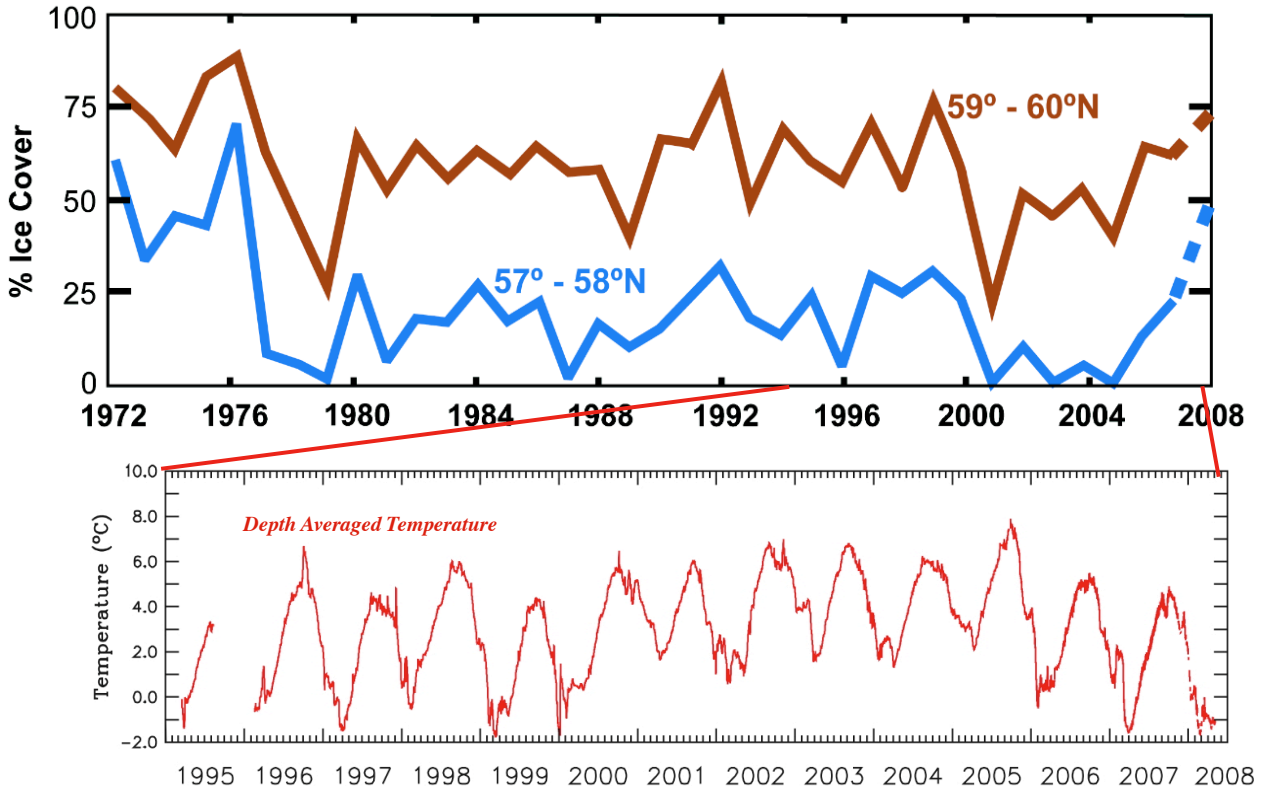
- Timing of spring bloom controlled by ice
- No long-term change in the pre-bloom concentration of nutrients on the southern shelf
- Identified NCEP downward short wave radiation was overestimated
- Sea-ice amplifies the oceanic response to atmospheric climate signal
- Fall phytoplankton bloom is typical
- Indices: summer bottom temperature, timing of the spring phytoplankton bloom, mixed layer depth, strength of stratification

Long-term, biophysical moorings on Bering Sea shelf - Impacts: Primary source of data for providing oceanographic indices, documenting decadal variability, validating biophysical models, and developing ecosystem hypotheses.

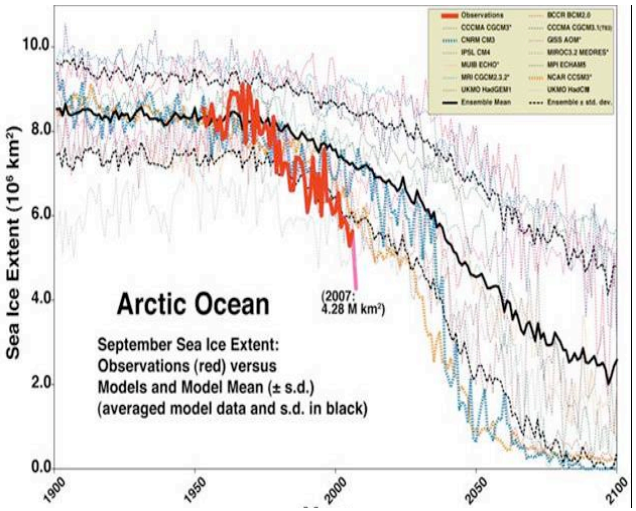
Moorings: Analysis

Decadal variability signal in ocean temperature

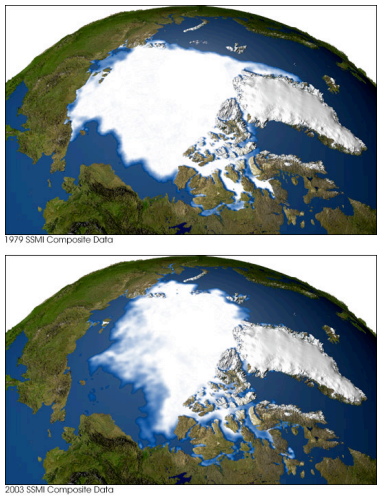


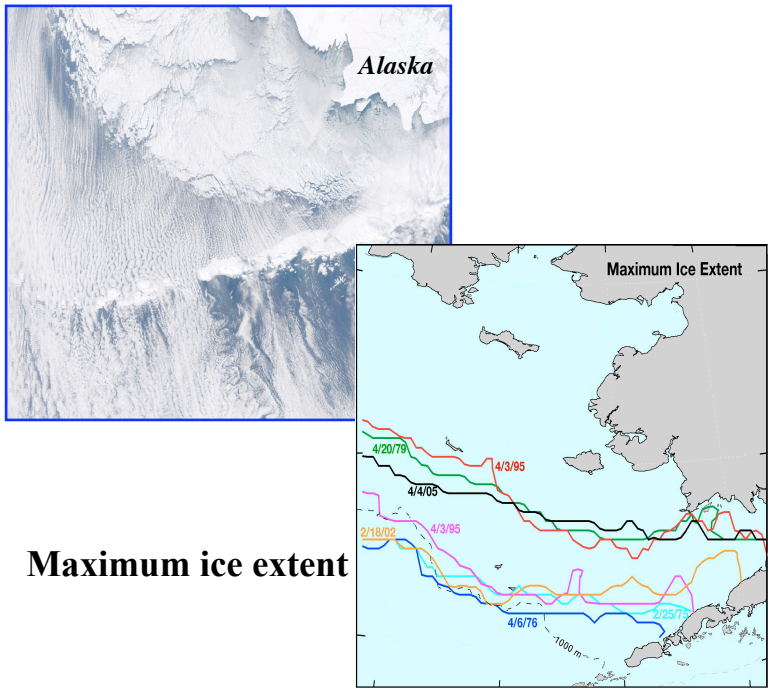


Sea-Ice Predictions from IPCC Analysis



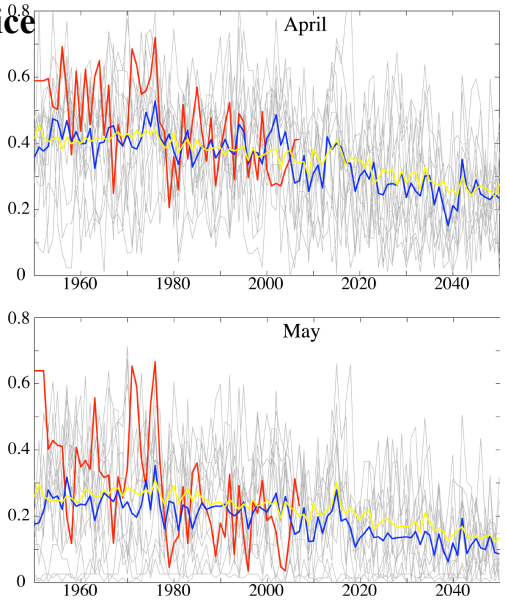
Prediction of minimum summer ice extent in the Arctic Ocean from selected IPCC runs and actual ice extent (red)



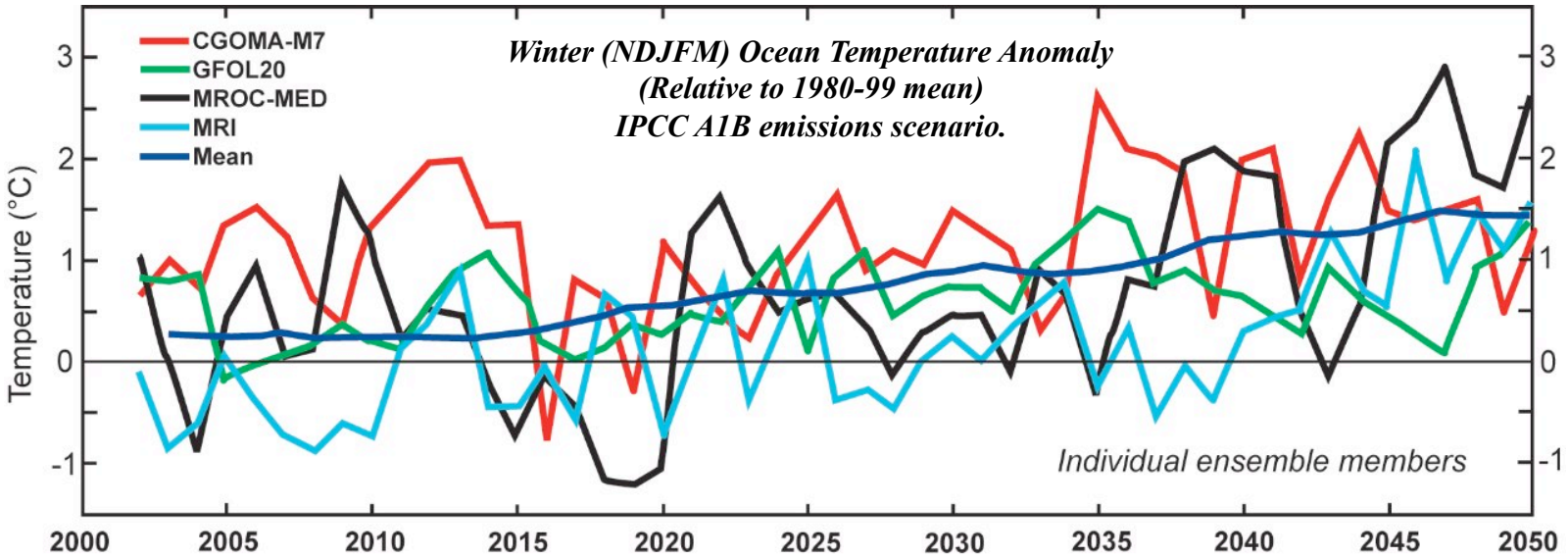


Maximum ice extent

Prediction of index of sea-ice cover over the Bering Sea from selected IPCC runs and actual ice extent (red)



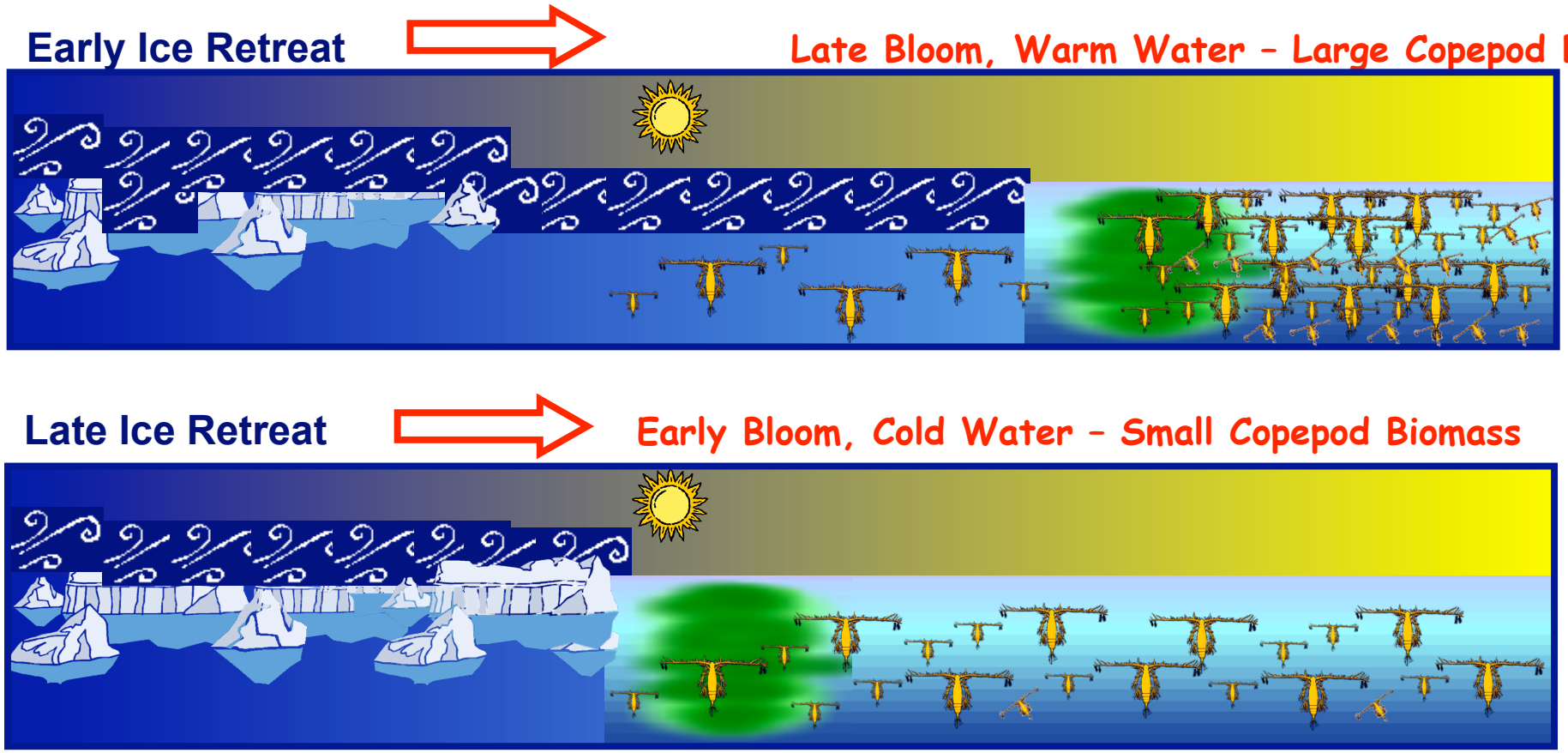
Temperature Predictions from selected IPCC Analysis



Evaluation climate runs - Impacts: Determination of the relative importance of interannual-decadal variability versus long-term warming; prediction of rate and variability of warming in the Bering Sea; and the climate component in evaluating ecosystem change (e.g. petition for endangered species status).

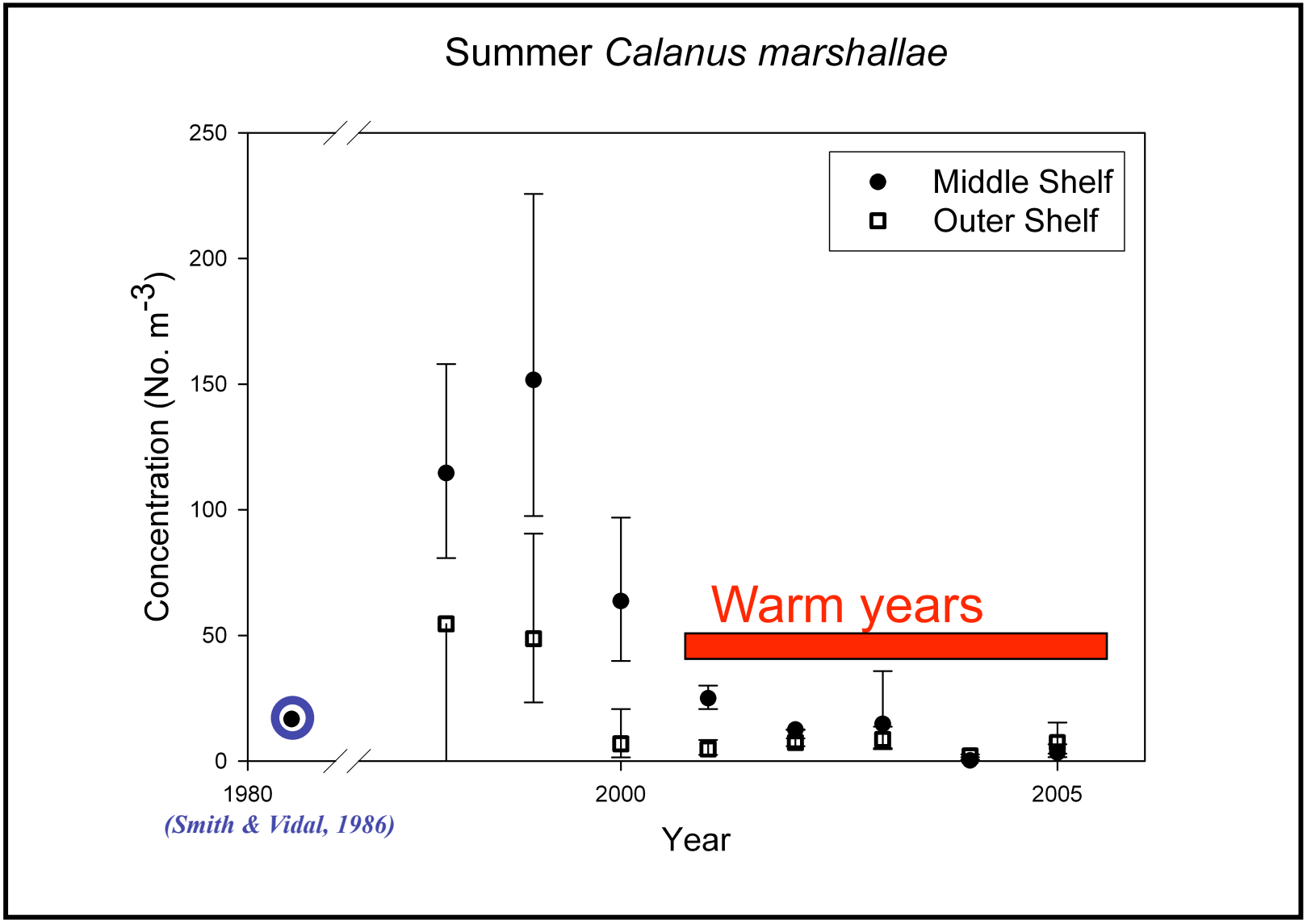
Ecosystem Impacts

Ice, Wind, Bloom and Copepods

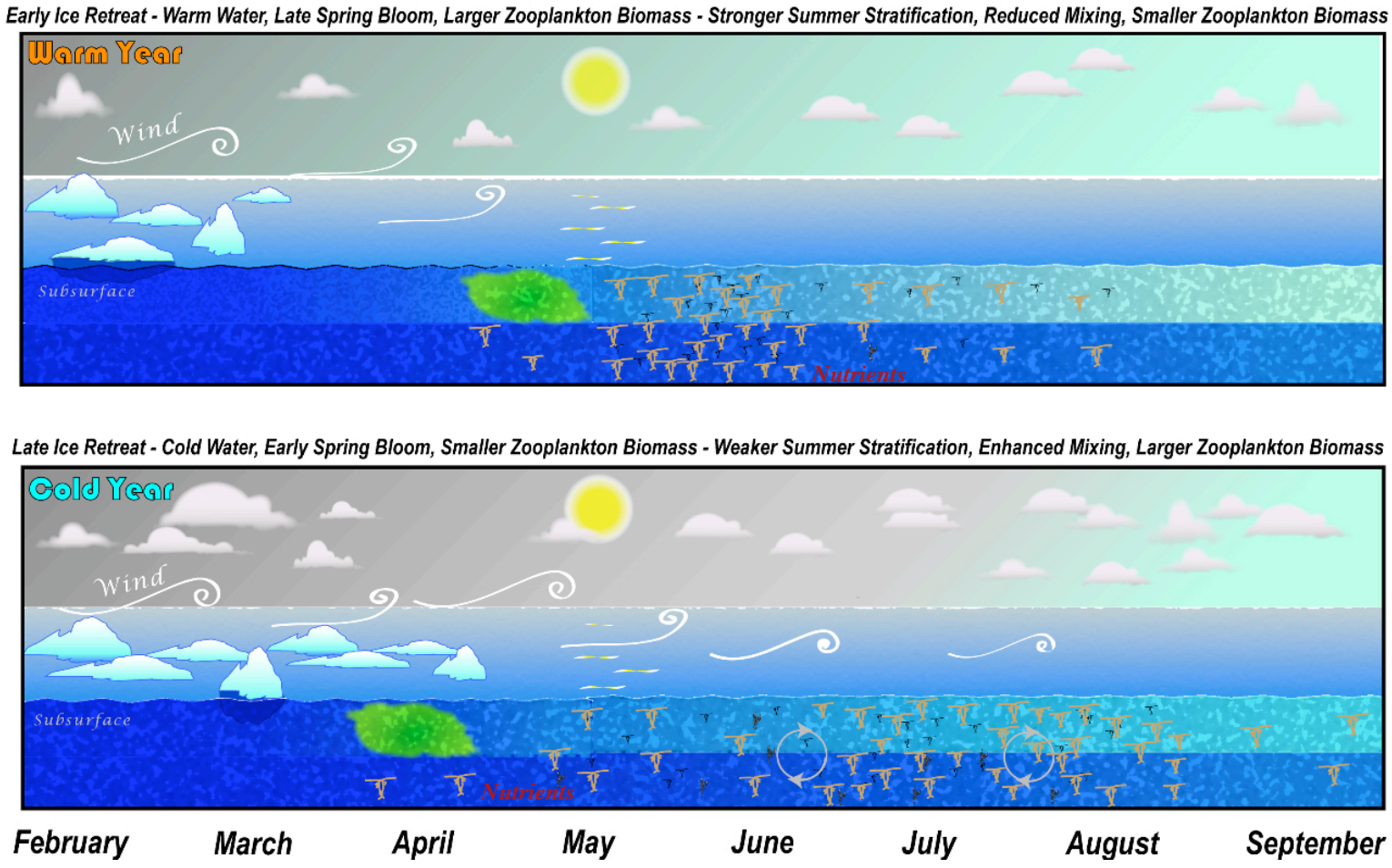


Hunt and Stabeno 2002

Summer Copepod Abundance



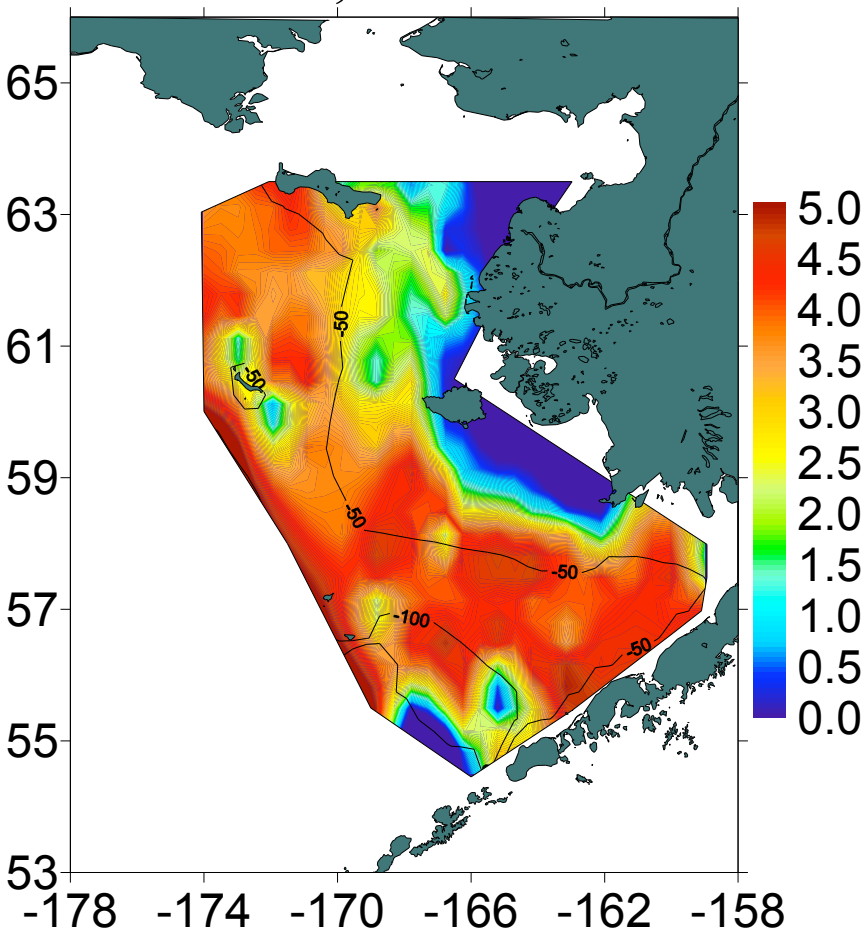
Continued production in summer and fall important – Winds renew nutrients depleted by spring bloom



Stabeno and Napp

Young-of-the-year pollock abundance, BASIS survey

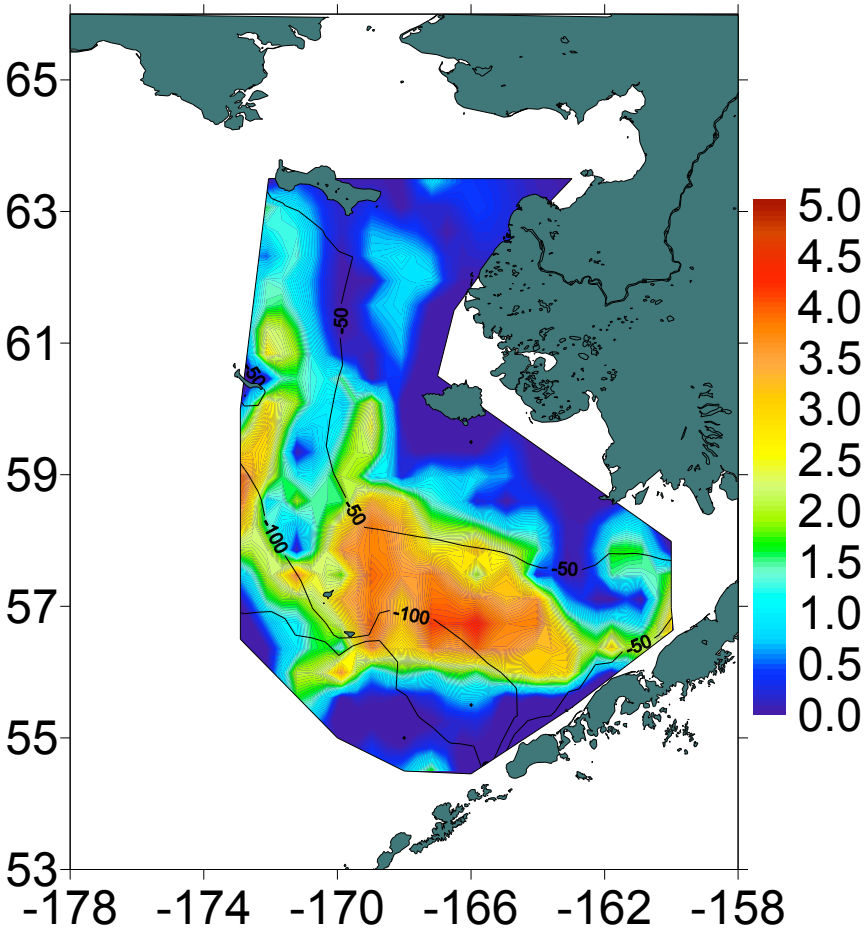
Warm, 2004-2005



Big fish, but not fat.

Cannibalism, small zooplankton.

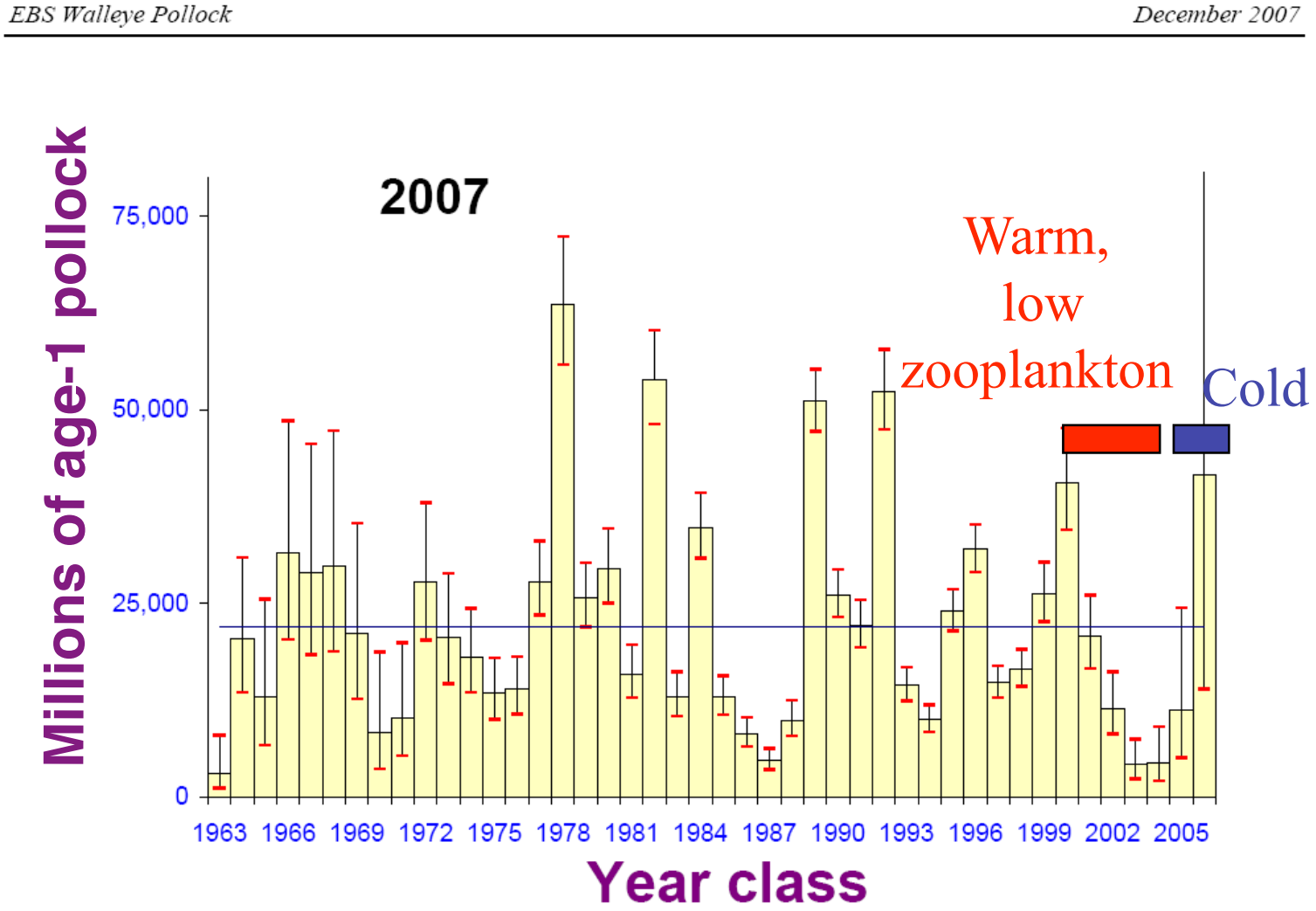
Cold, 2006-2007



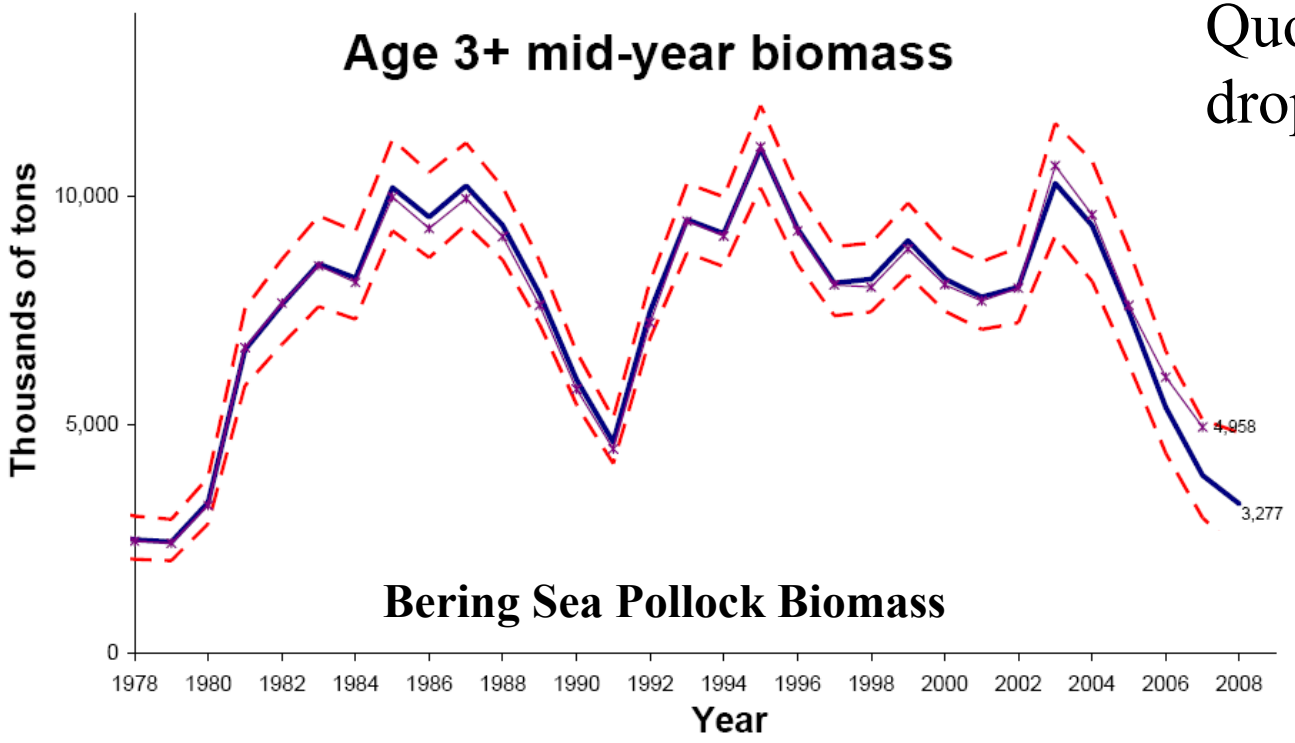
Small fish but fat.

Big zooplankton, euphausiids

Recent weak year classes



EcoFOCI impact on setting of pollock catch quota



Quota dropped 30%

In 2008 ecosystem information (climate and zooplankton abundance) was a major determinate in cutting total allowable catch.

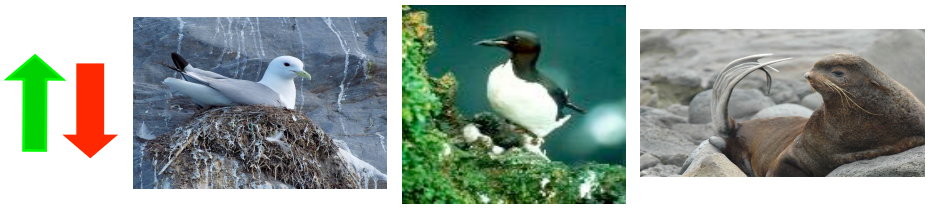
Bering Sea Conclusions

- NOAA responsibility
- Extremely valuable ecosystem
- Northern and southern shelves are dissimilar, unique habitats
- Impacts of climate warming -
  - Reduction in sea ice
  - Warmer and saltier ocean
  - Timing of spring phytoplankton bloom
  - Reduction in summer zooplankton
  - Northward displacement of subarctic species
  - Loss of habitat for seals and walrus
  - Not a simple shift of the southern ecosystem northward

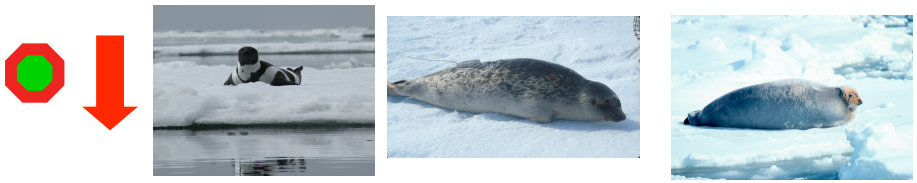
Predictions Regarding Health and Function of Ecosystem:
A Warming Scenario

Fish abundance will decline because of decrease in summer zooplankton.

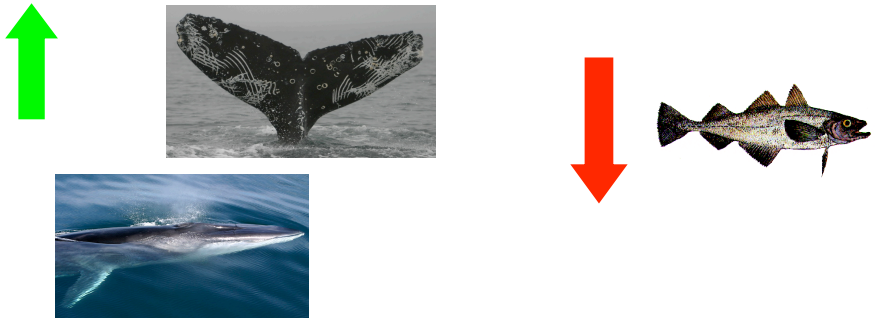
Murres, kittiwakes and fur seals populations will vary because of reduced competition with fish and decrease in food



Bearded seal population will decrease and ribbon population will remain unchanged because of reduction in spring and summer ice extent.

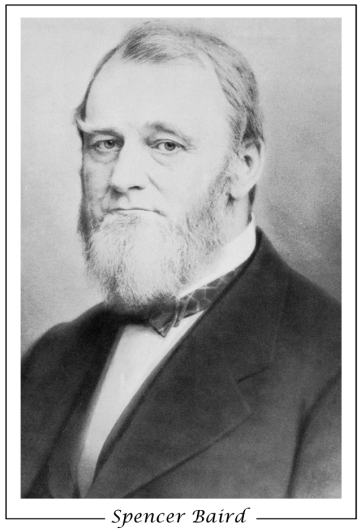


Growing populations of baleen whales will both consume and compete with forage fish (including juvenile pollock) for zooplankton.

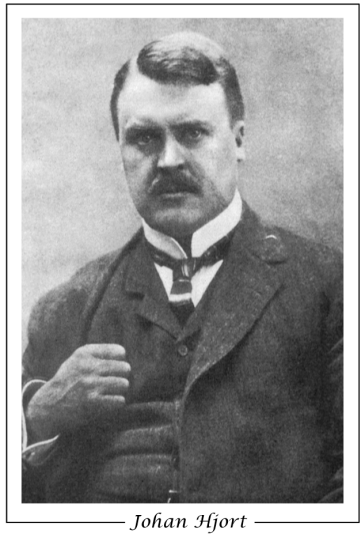


Fishery Oceanography

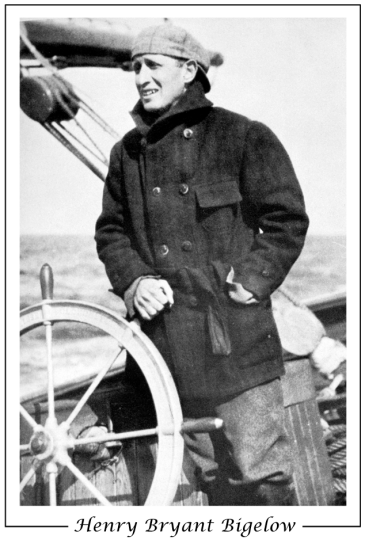
- Established early 1900s
- Not an oxymoron
- Interdisciplinary from the start



Spencer Baird



Johan Hjort



Henry Bryant Bigelow

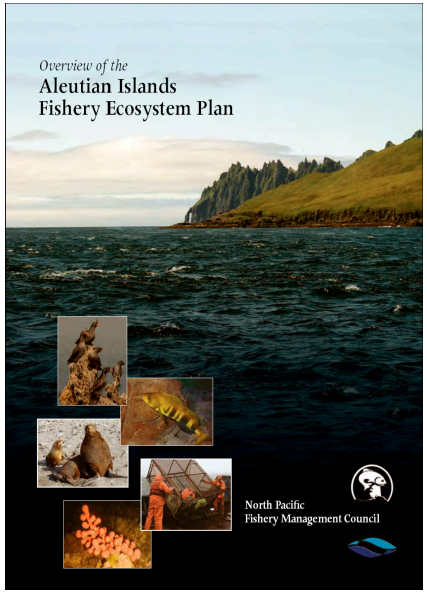
Kendall & Duker, 1998

EcoFOCI (PMEL & AFSC) Contributions

- 25 years of significant scientific contributions to fisheries oceanography
- 3 NOAA Bronze Awards
- 422 refereed publications
- 1 special issue in *Fisheries Oceanography (*FOCI*)*
  + contributions to:
    - 2 *Deep-Sea Research II special issues*
    - 1 *Progress Oceanography special issue*
    - 1 *Fisheries Oceanography special issue*
- 16 years of annual recruitment forecasts
- Assistance and advice to other national and international programs

Ecosystems Approach to Management

- Historical use of an "ecosystems" approach
- Contributing indices to the Ecosystems Status Report and the PICES Marine Ecosystems of the North Pacific
- Improving predictors / indices
- Improving data delivery
- Improving models
- Constructing Fishery Ecosystem Plans




November 2004 Ecosystem Considerations

APPENDIX C

Ecosystem Considerations for 2005

Reviewed by
The Plan Teams for the Groundfish Fisheries
of the Bering Sea, Aleutian Islands, and Gulf of Alaska

Edited by
Jennifer Boldt
Alaska Fisheries Science Center
7600 Sand Point Way NE
Seattle, WA 98115

With contributions from
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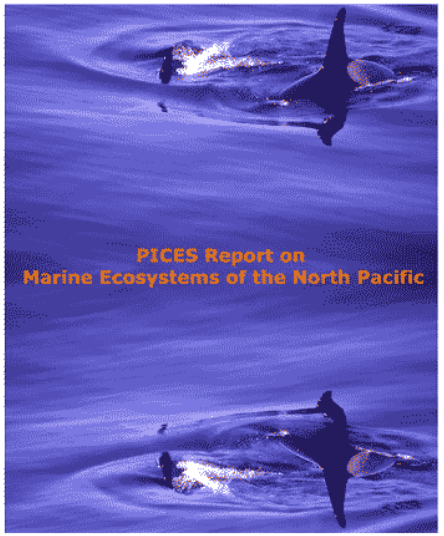
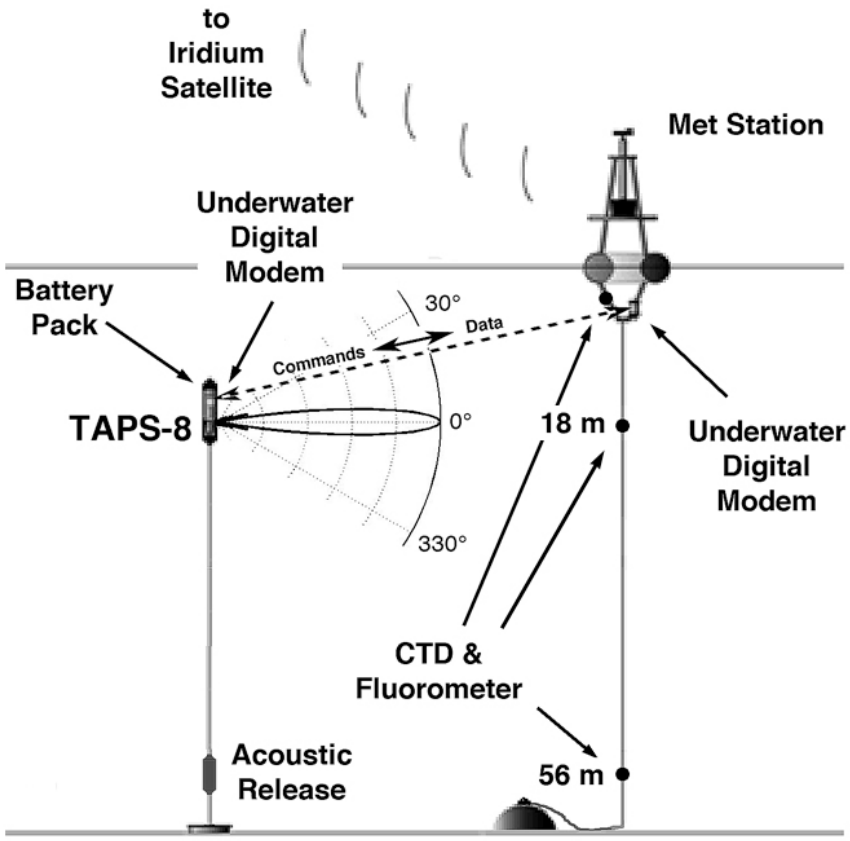
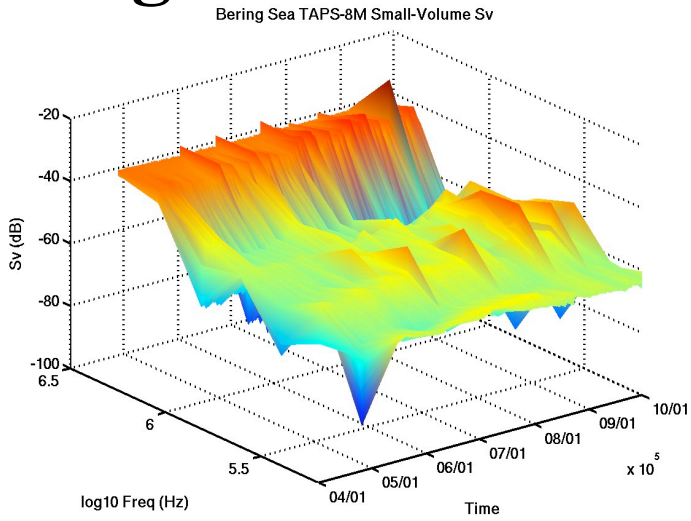
November 2004
North Pacific Fishery Management Council
605 W. 4th Avenue, Suite 306
Anchorage, AK 99501

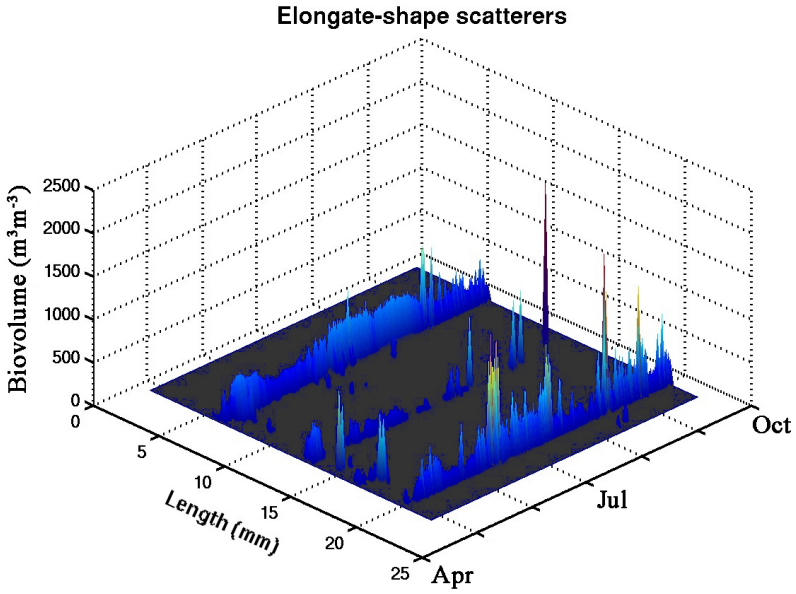
1 NPFMC Bering Sea/Aleutian Islands and Gulf of Alaska SAFE



Integrating Physical and Biological Observations

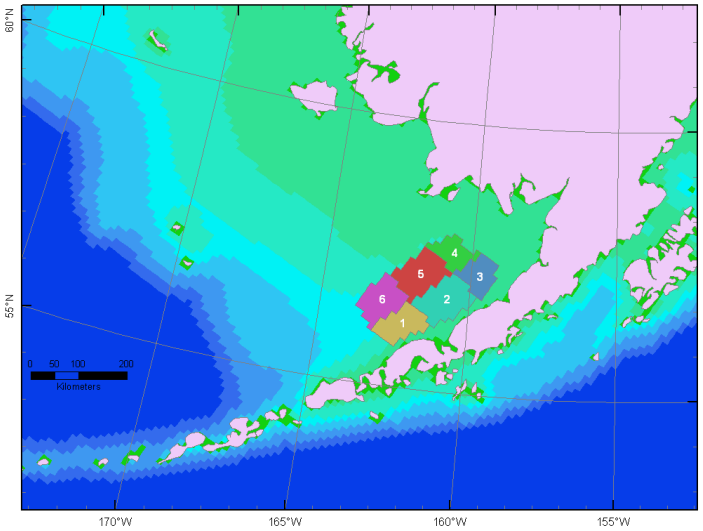




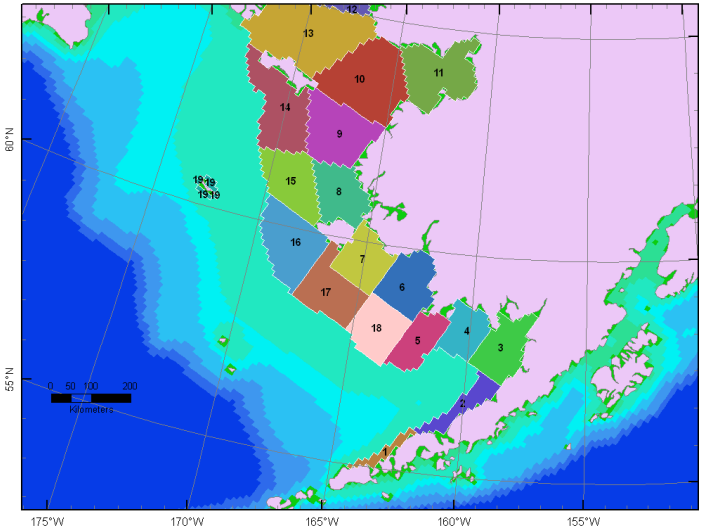


Integrating Physical and Biological Modeling and Process Research

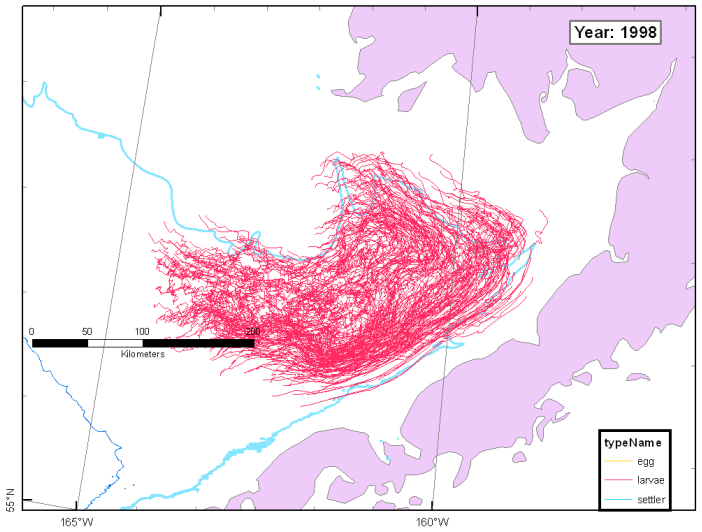
Source areas



Settlement areas



Alaska plaice (*Pleuronectes quadrituberculatus*)

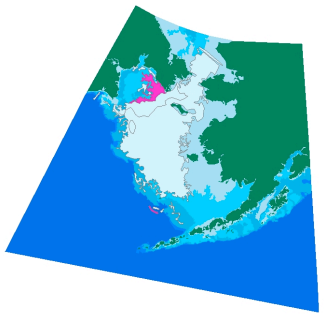


Optimal Settlement Areas (0-2 °C):

Warm years: smaller, more to northwest

Cold years: larger, extend more to south

1979



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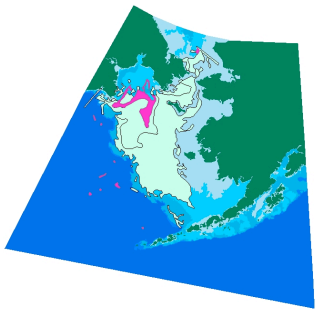

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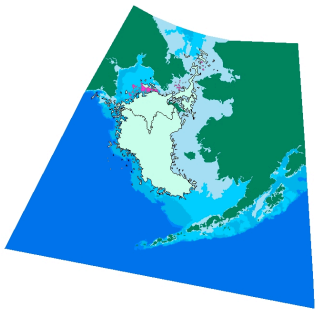

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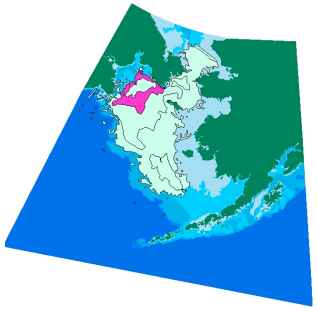

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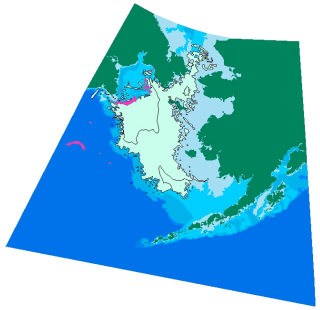

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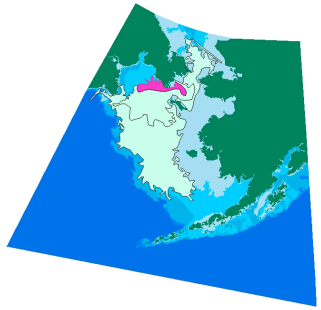

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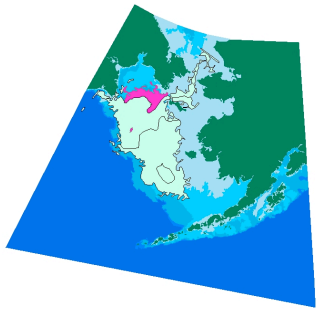

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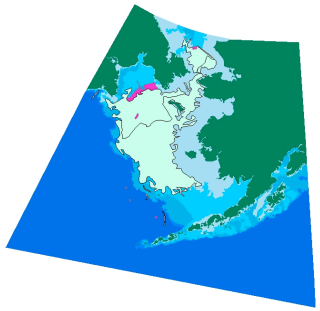

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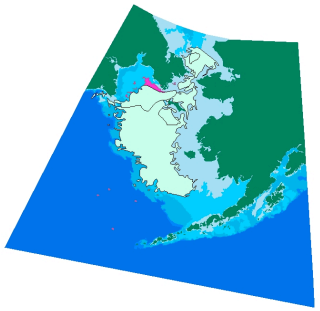

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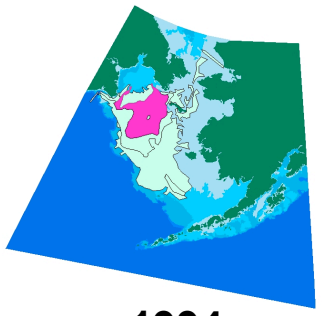

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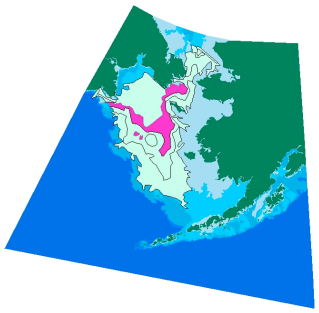

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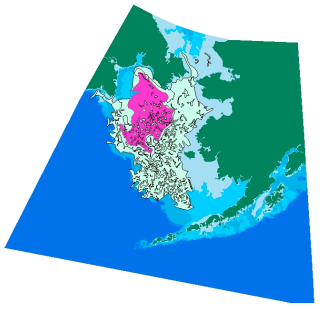

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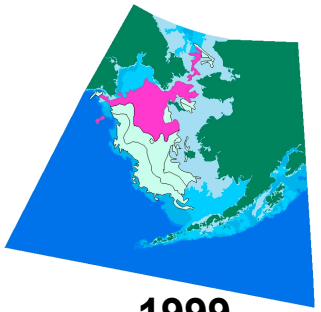

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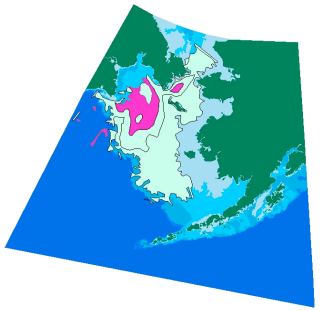

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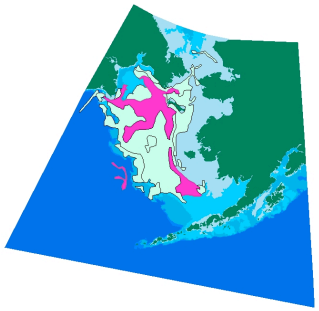

Our Collaborative Future

- Contribute to Integrated Ecosystem Assessments
  - Application of BSIERP-like recommendations
  - Comparative ecosystem approach
- Operational oceanography to forecast annual survival of commercially valuable species.
  - Flatfish community forecast
  - Pollock
- Predict climate-mediated impacts on ecosystems to enable long-term planning and mitigation.
  - Ocean Acidification
  - Loss of Sea Ice