

# Biology: Changes in distribution – is it temperature or is it food?

2000

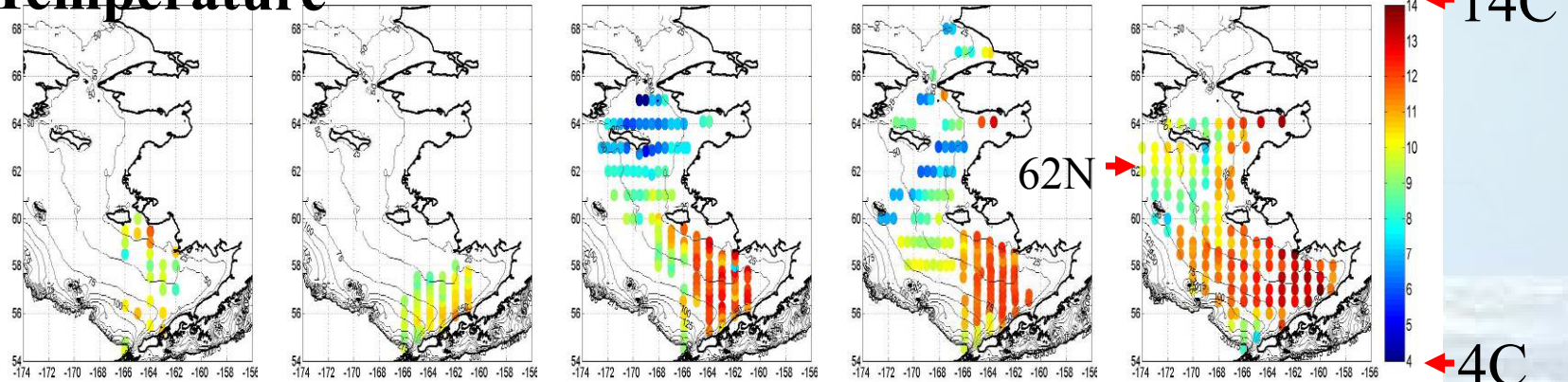
2001

2002

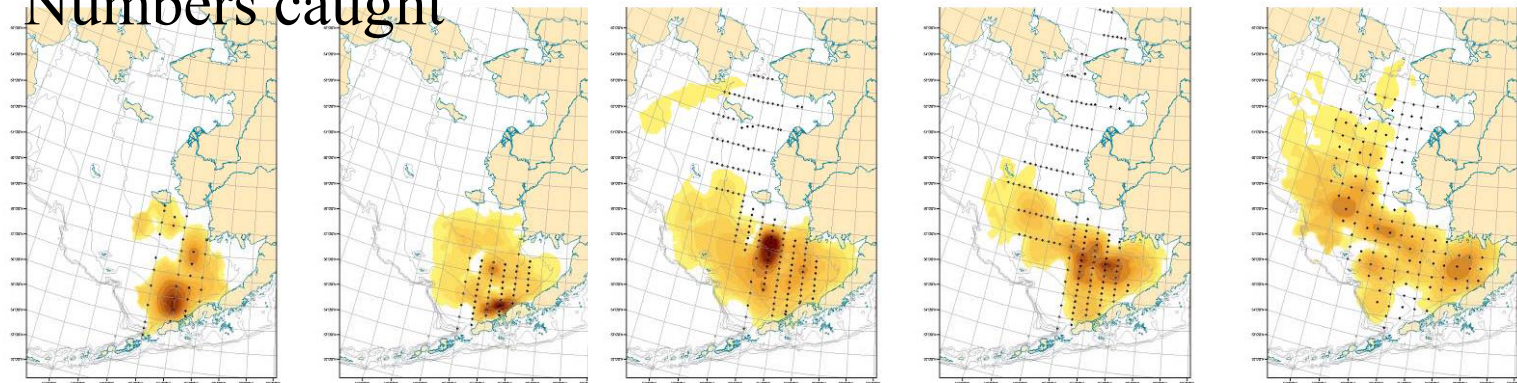
2003

2004

## Temperature

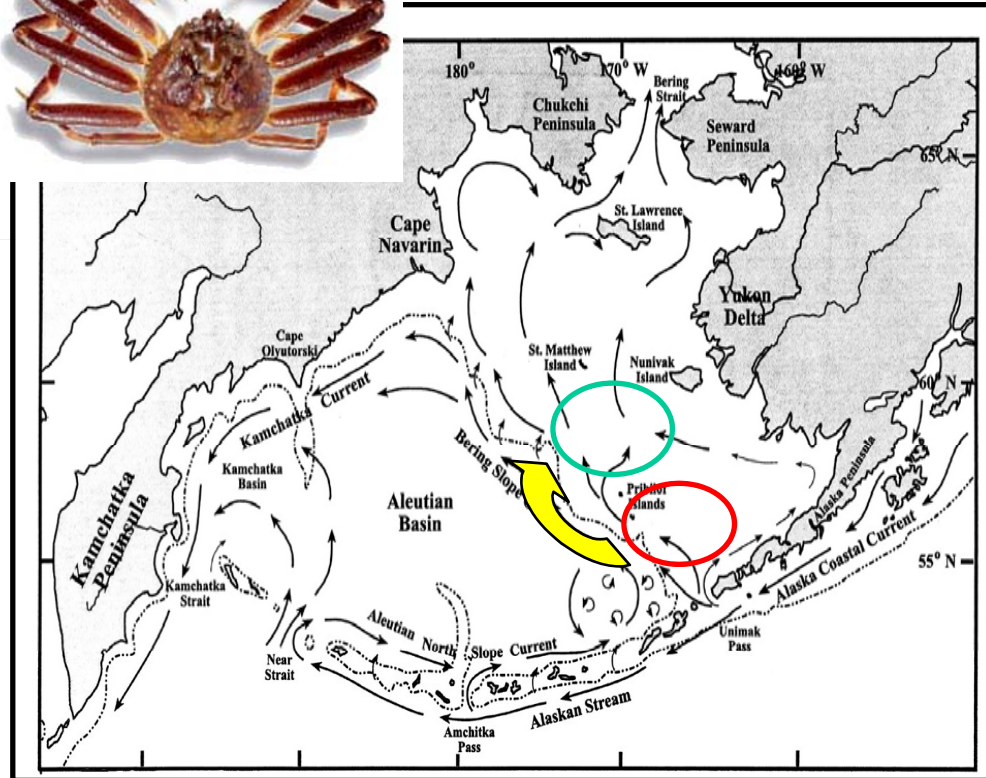


## Numbers caught

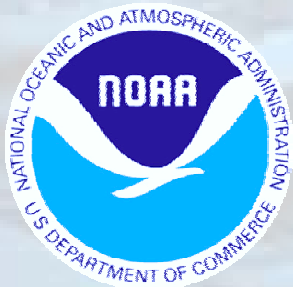


Juvenile sockeye salmon appear to respond to ocean temperature

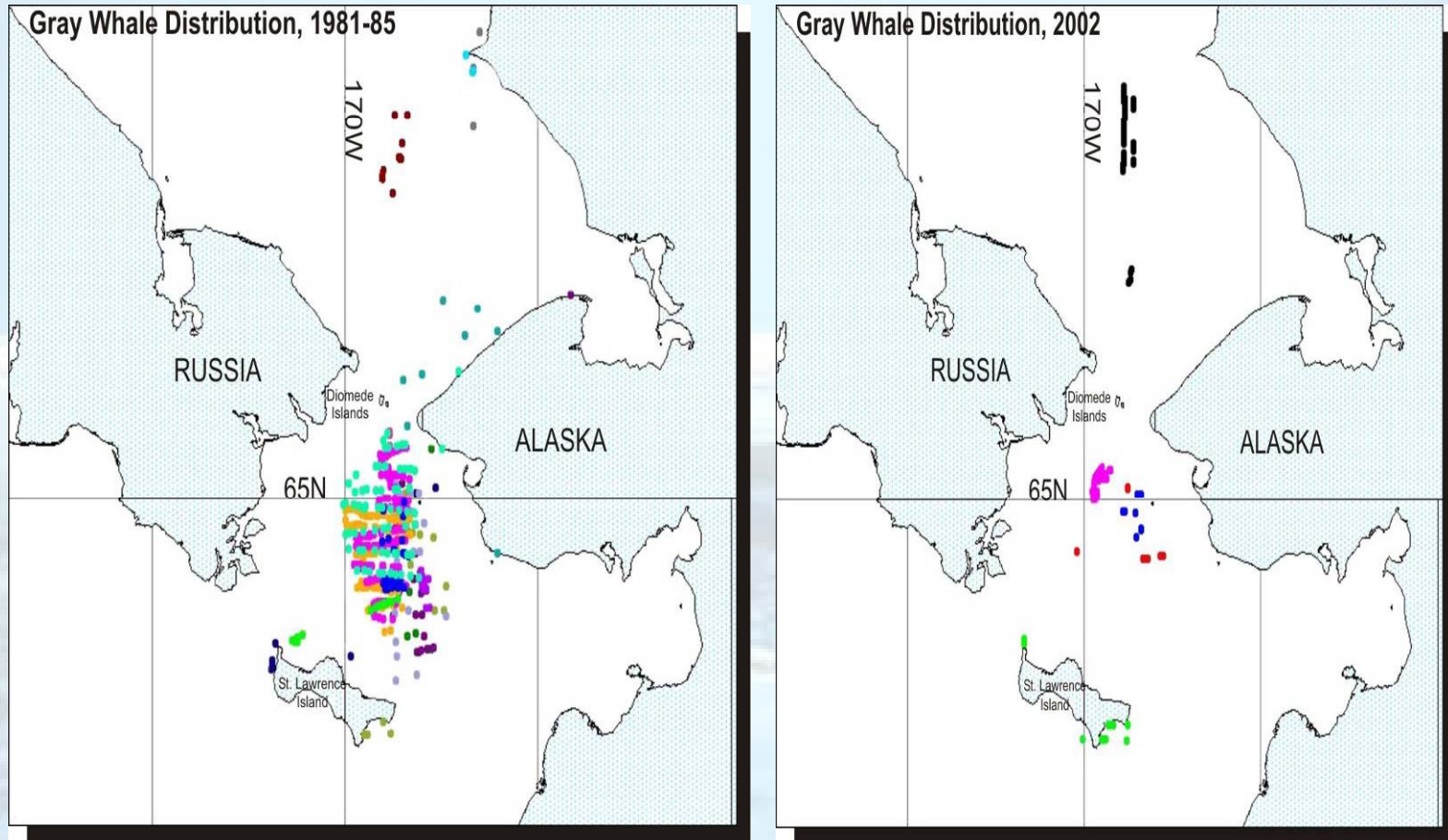
# Snow crab population has contracted north



Orensanz, J. L., B. Ernst, D. Armstrong, P. Stabeno, and P. Livingston. 2004. Contraction of the geographic range of distribution of snow crab (*Chionoecetes opilio*) in the eastern Bering Sea: An environmental ratchet? CalCOFI Rep. 45: 65-79.



## Gray whale feeding grounds have changed



Moore, S.E., Grebmeier, J.M., and Davies, J.R. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. *Can. J. Zool.* 81: 734-742.

# Ice-dependent seals

Ringed seals



Pups in under-snow lairs in coastal fast ice:  
feeds in water column/under ice

Bearded seals



Pups/feeds in pack ice zone over shelf,  
in areas of rich benthic productivity

Varying  
dependence  
on sea ice

Pups/molts in marginal ice  
zone, perhaps as a predator  
avoidance strategy



Ribbon seals

Pups in  
pack ice –  
uses land  
haulout  
sites during  
summer



Spotted seals

# Summary

- Pelagic vs. benthic production
- Trophic consequences
- Control Uncertainties
  - Bottom up
  - Top down

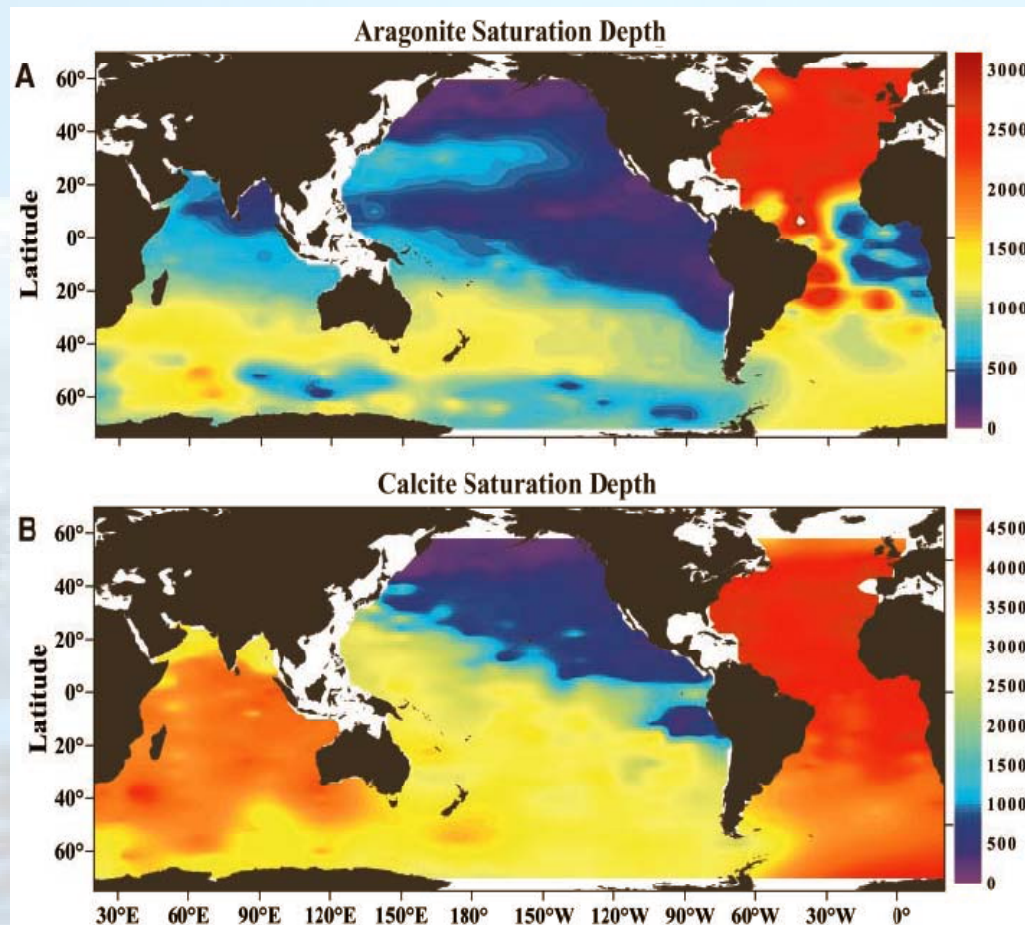


P. Malecha, AFSC



# Ocean Chemistry Change - Ocean Acidification

Calcium carbonate saturation horizons are relatively shallow in the North Pacific Ocean; thus this ocean is a sentinel for ocean acidification effects.



Feely et al. 2004. Impact of anthropogenic CO<sub>2</sub> on the CaCO<sub>3</sub> in the oceans. Science 305: 362-366.

# Ocean Acidification - Potential Fishery Effect

- Larval blue king crab, Kodiak Alaska, pilot experiment
- Tested range of projected global ocean pH change over the current century.
- ~15% reduction in growth and ~67% reduction in survival when pH was reduced 0.5 units.



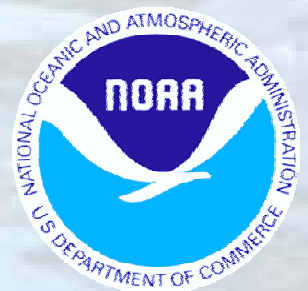
M. Litzow and J. Short, AFSC



- The End



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





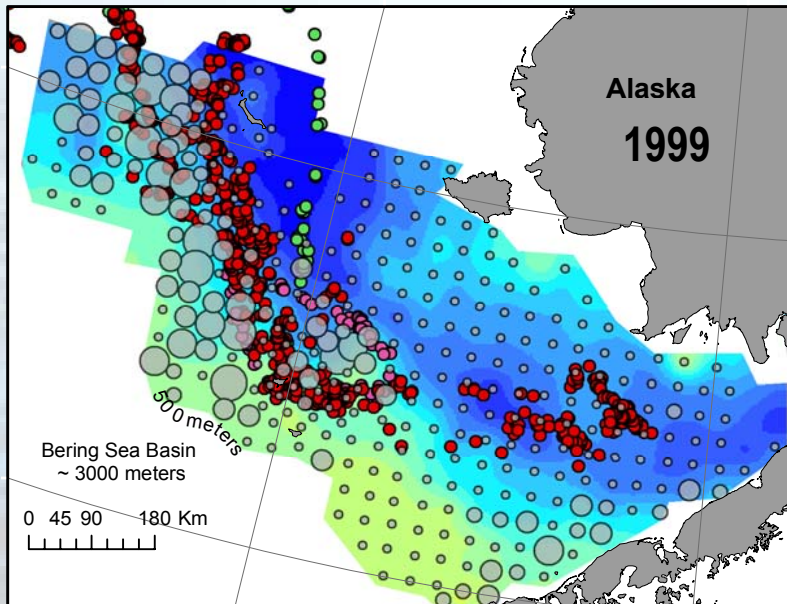
# Place-based foragers

Hot spot foragers

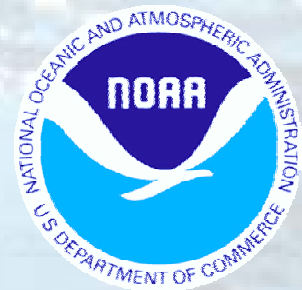


M. Sigler, AFSC

Central place foragers



J. Sterling, AFSC



# Existing & Proposed Sentinel Programs for Climate Change

North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) Picket fence of biophysical moorings Spring and late summer ichthyoplankton surveys

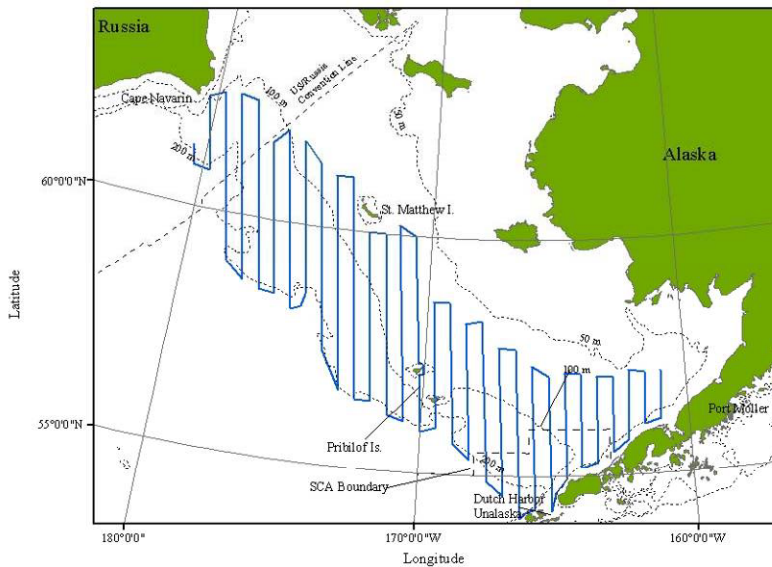
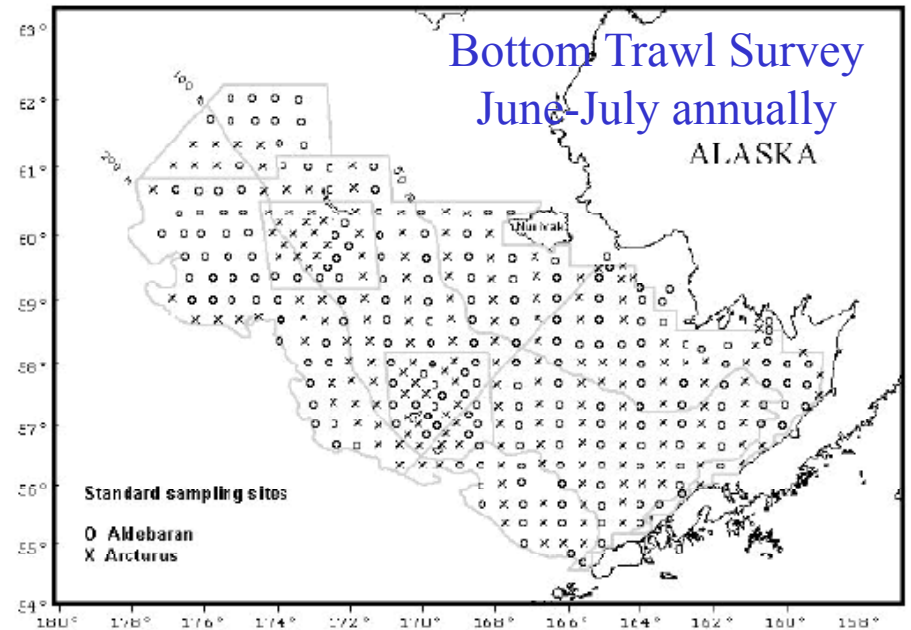
## Bering Sea Loss of Sea Ice (LOSI)

Coordinated with  
NPRB-BSIERP  
NSF-BEST  
AOOS

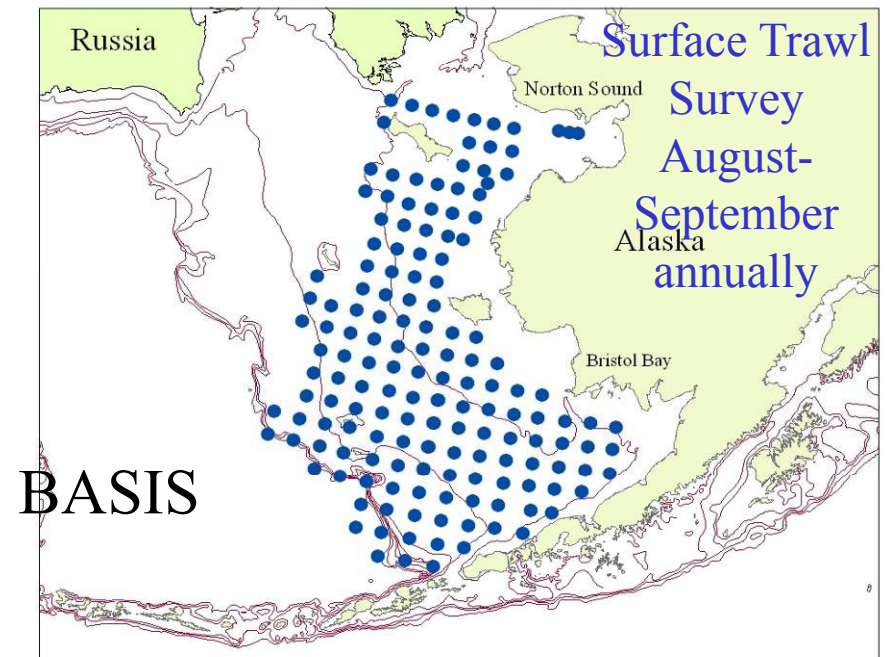
- Expand surveys northward
- Assess ice-dependent seals
- Estimate socioeconomic impacts

# Existing Sentinel Programs for Climate Change

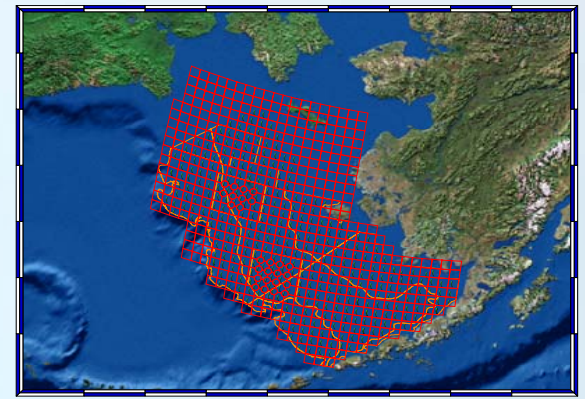
## Standard Surveys



Hydroacoustic Survey, June-July biennially



# Proposed Sentinel Programs for Climate Change



## Bering Sea Loss of Sea Ice (LOSI)

- Expand surveys northward
- Assess ice-dependent seals
- Estimate socioeconomic impacts

M. Jones, NMFS



M. Cameron, AFSC