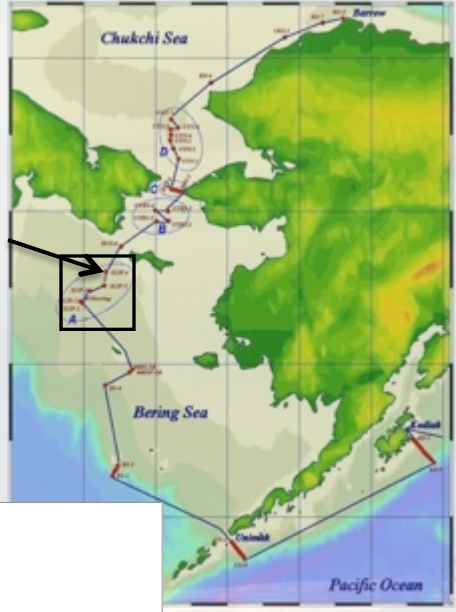
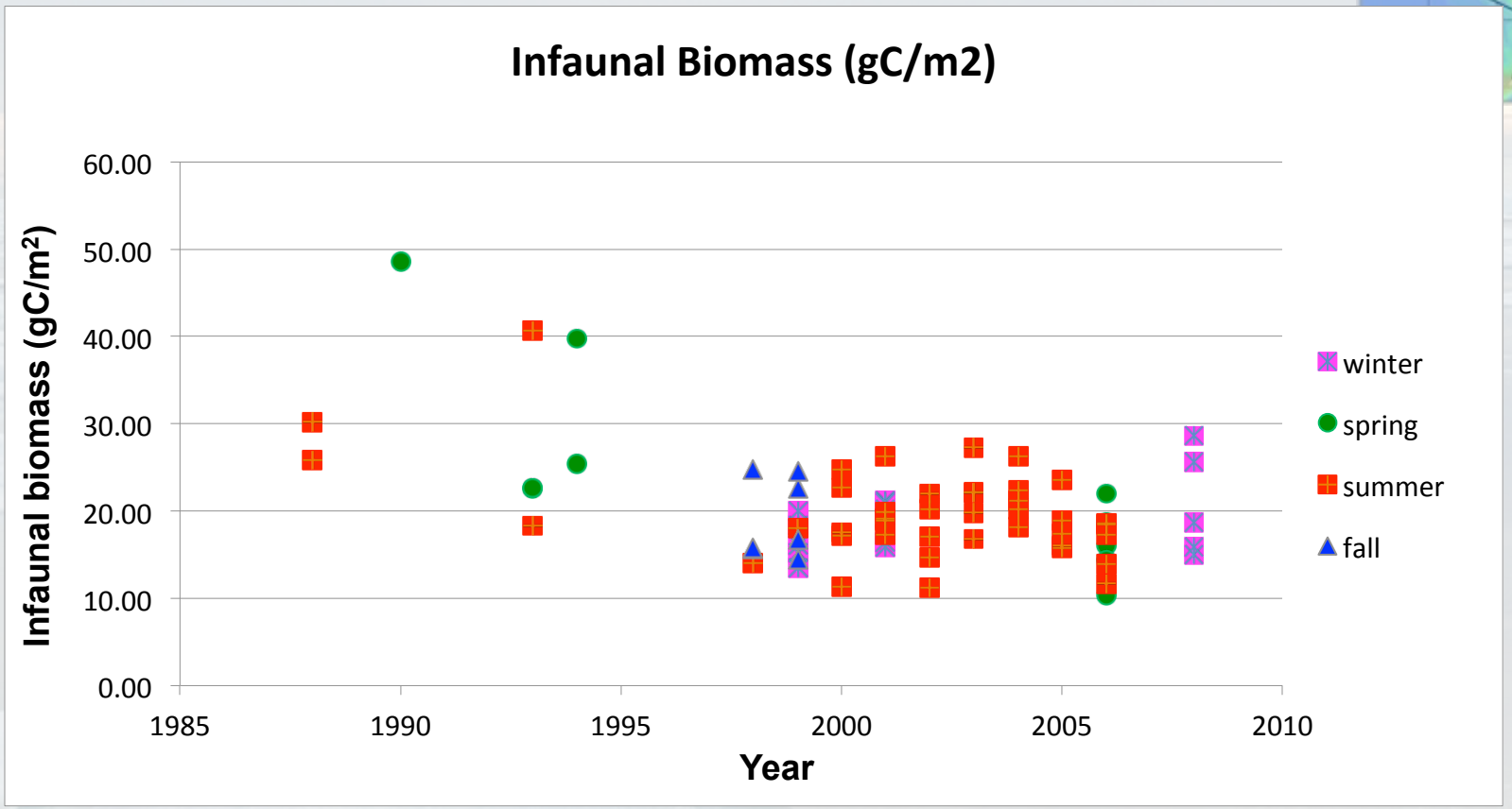
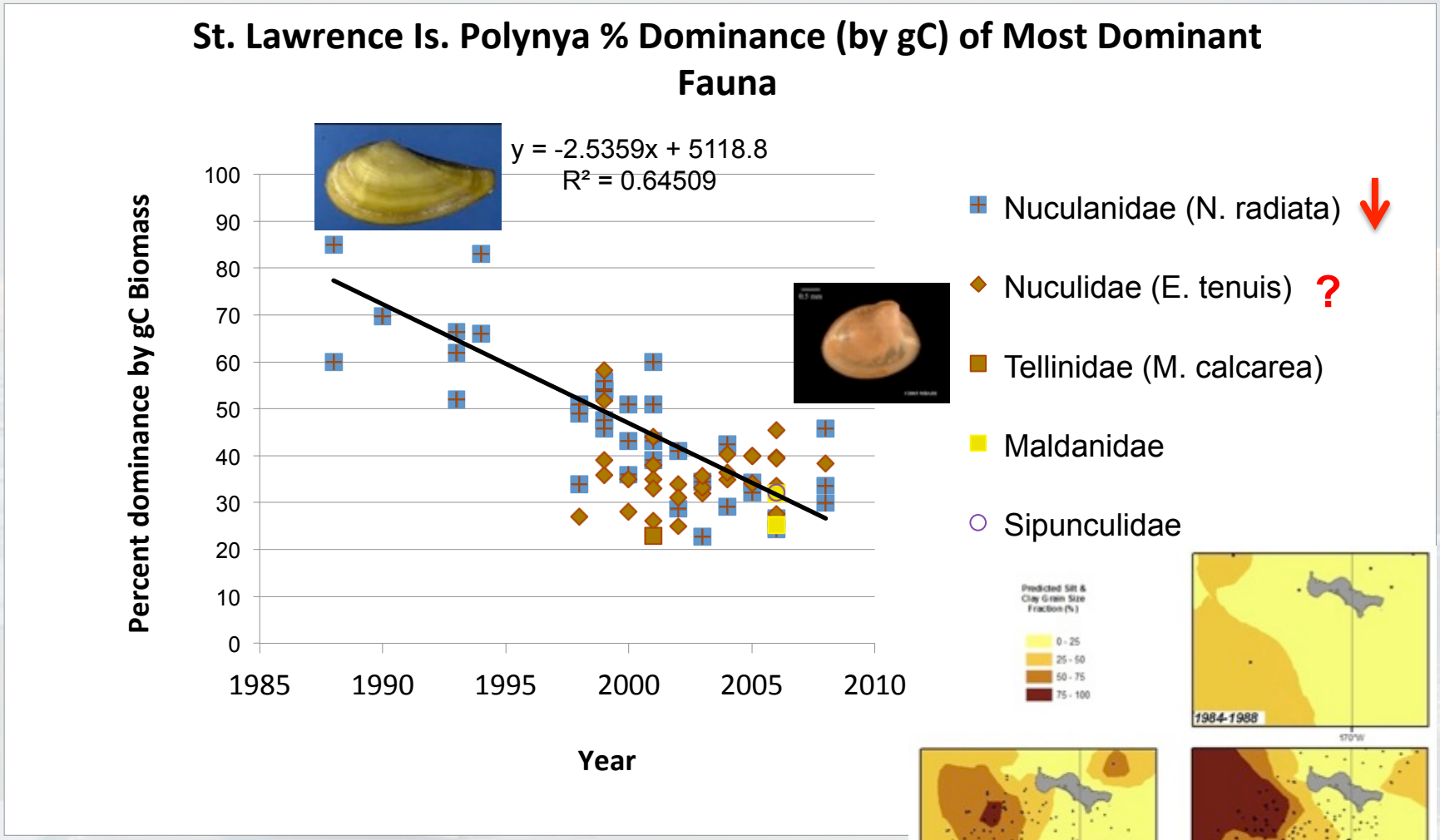
Benthic infaunal biomass 1990s-present over multiple seasons can act as integrator of multiple processes





[updated from Grebmeier et al. Science 2006]

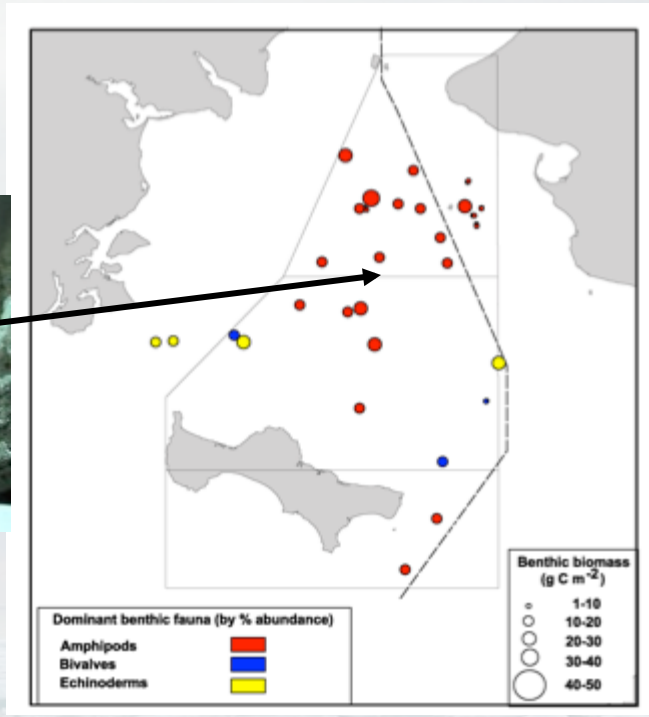
SLIP area decline in dominant bivalve (*N. radiata*), with possible shift to smaller bivalve (*E. tenuis*)



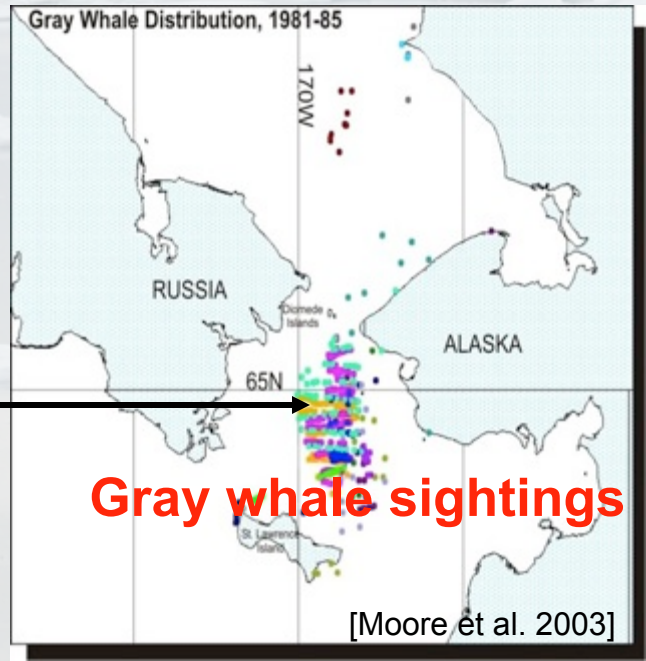
- Fining sediments over time →

Evidence for recent benthic change Chirikov Basin (DBO2)

- high amphipod populations in sediments in 1980's
- coincident large populations of migrating gray whales that feed on benthic amphipods

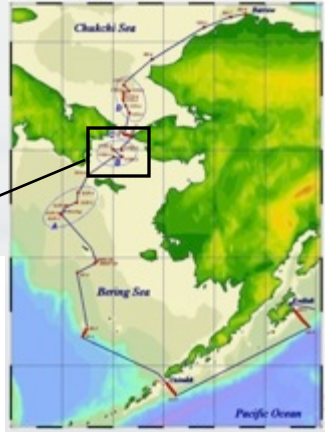


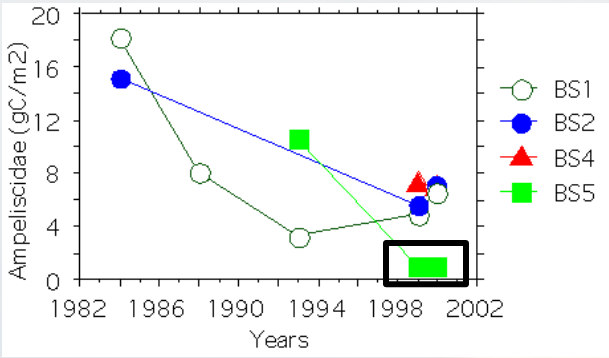
[Gray whale feeding movie]



Chirikov Basin: Drop in Benthic Productivity 1980s to 1990s

Time-series sites





- decline of ampeliscid amphipod biomass at 4 time series stations (Moore et al. 2003)

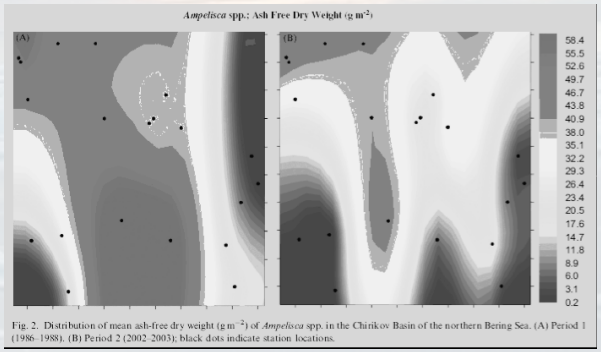
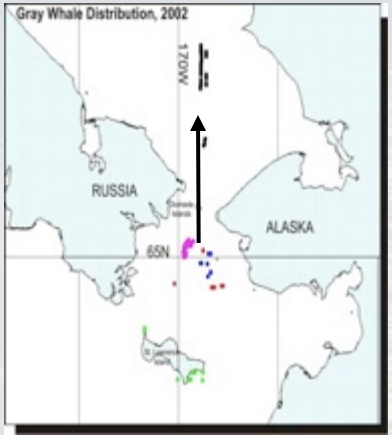


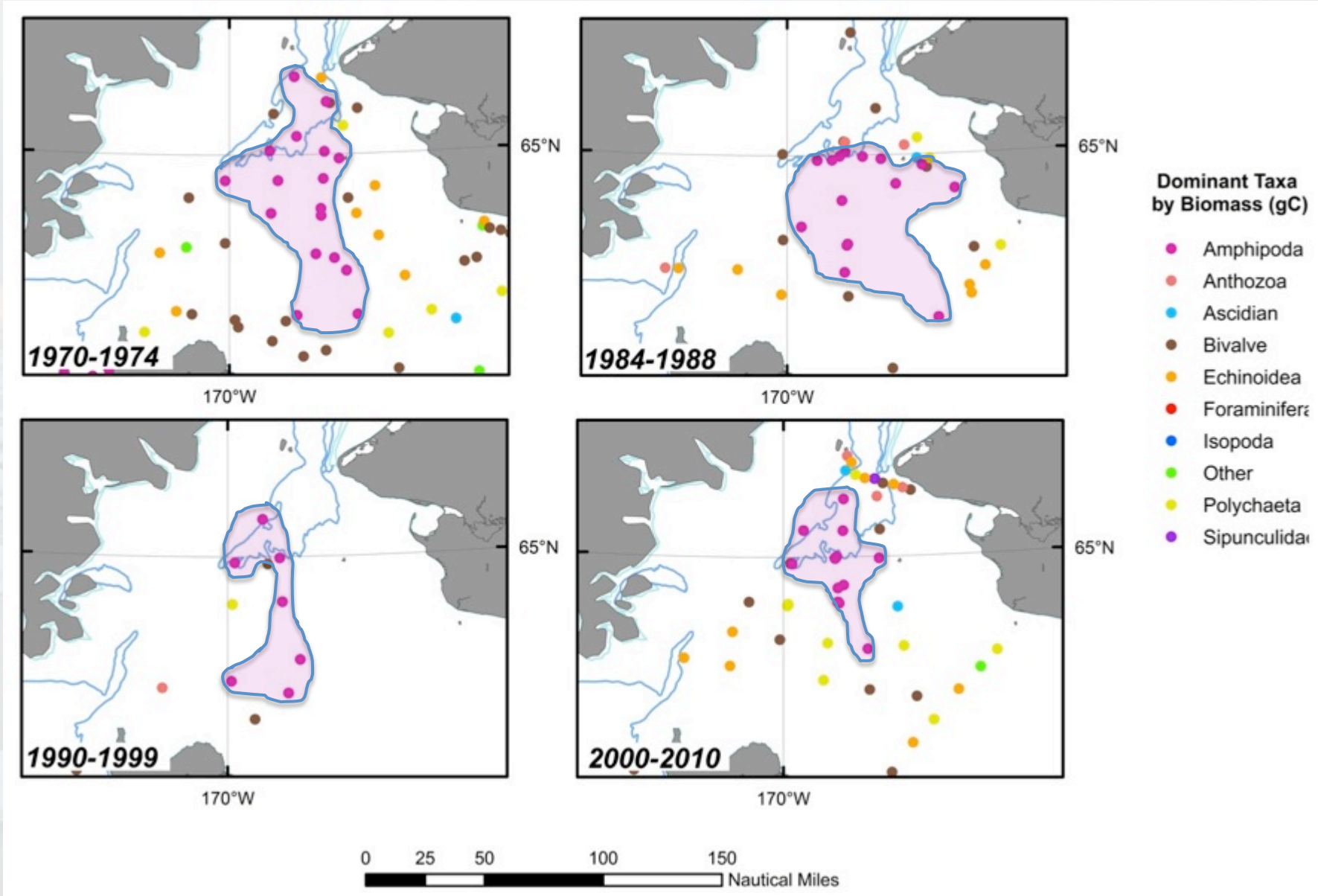
Fig. 2. Distribution of mean ash-free dry weight (g m^{-2}) of *Ampelisca* spp. in the Chirikov Basin of the northern Bering Sea. (A) Period 1 (1986–1988). (B) Period 2 (2002–2003); black dots indicate station locations.

- Highsmith and Coyle (1992) evidence of 30% benthic amphipod production downturn from 1986-88 and continued into the 2000s (Coyle et al. 2007)

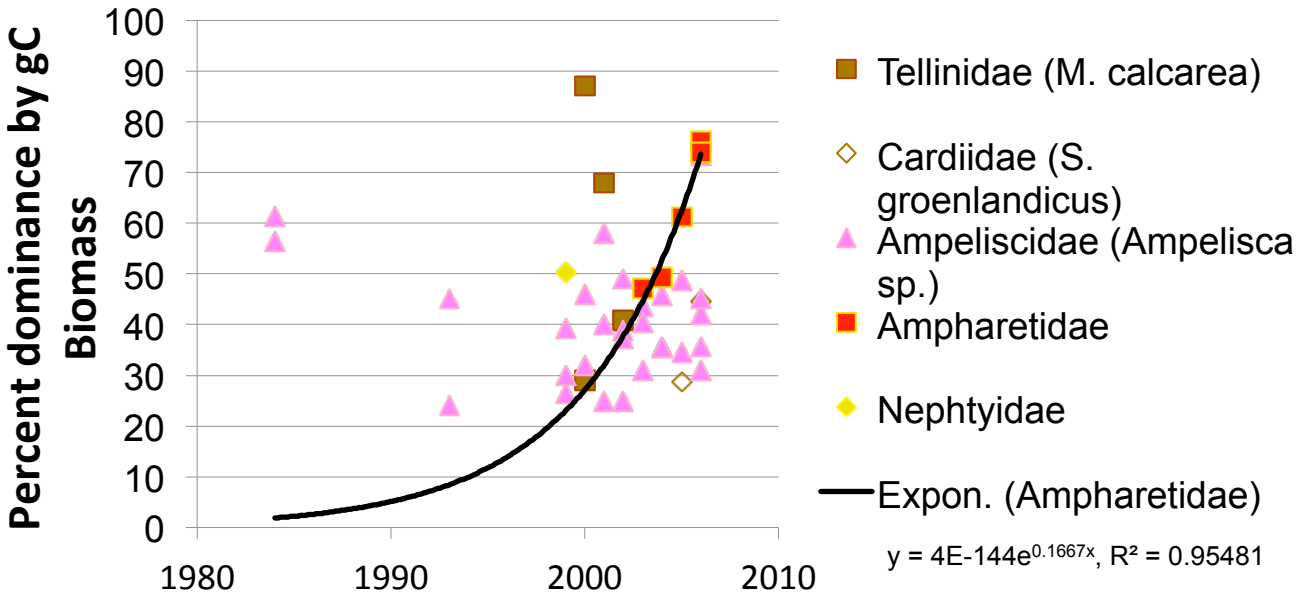


- Shift gray whales north of Bering Strait; prefer feeding in ice-free areas

“Footprint” of ampeliscid amphipod prey contracting spatially



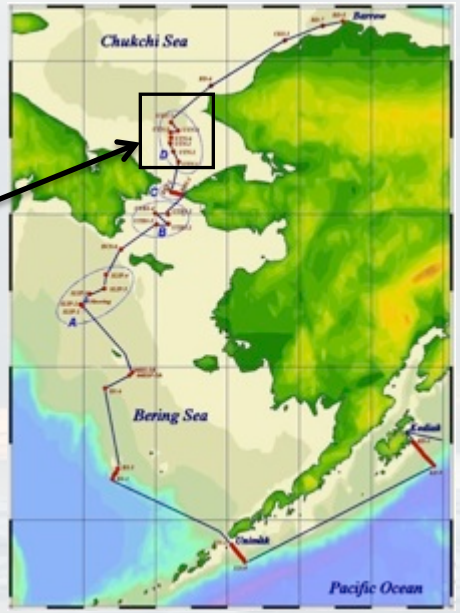
Northern Bering Sea (DBO2)-one station shifted from amphipods to polychaetes in 2003

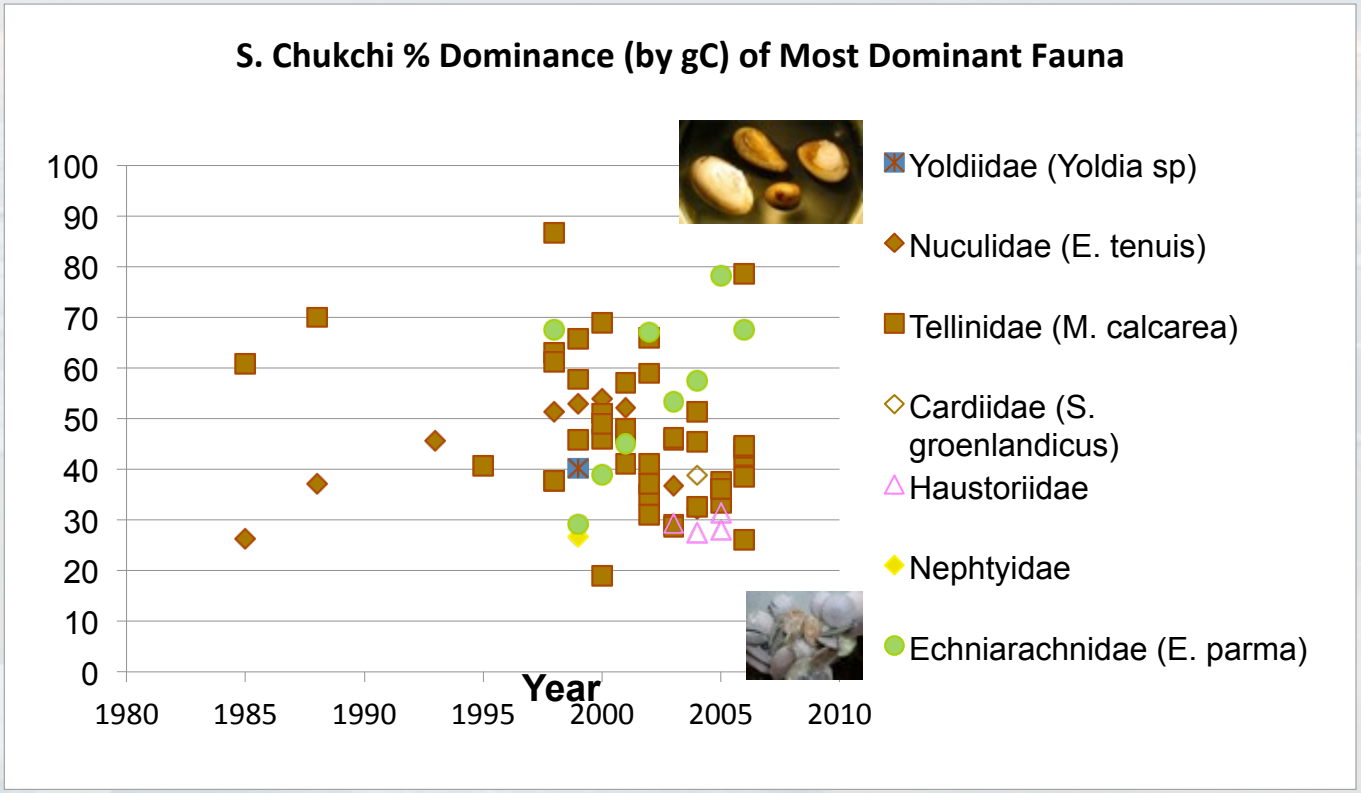


- shift in dominance at SW Chirikov site in 2000s from ampeliscid amphipods (gray whale food) to ampharetid polychaetes (sculpin food)
- change to ampharetid polychaetes coincident with increase in silt and clay content of sediments

SE Chukchi Sea-no clear trend in benthic faunal response

- area is area of high export carbon to sediments
- depocenter for both advected carbon from the south and *in situ* production





Benthic Foragers: respond to changes in sea ice

Gray whales = shifts in distribution reflects sea-ice related prey decline

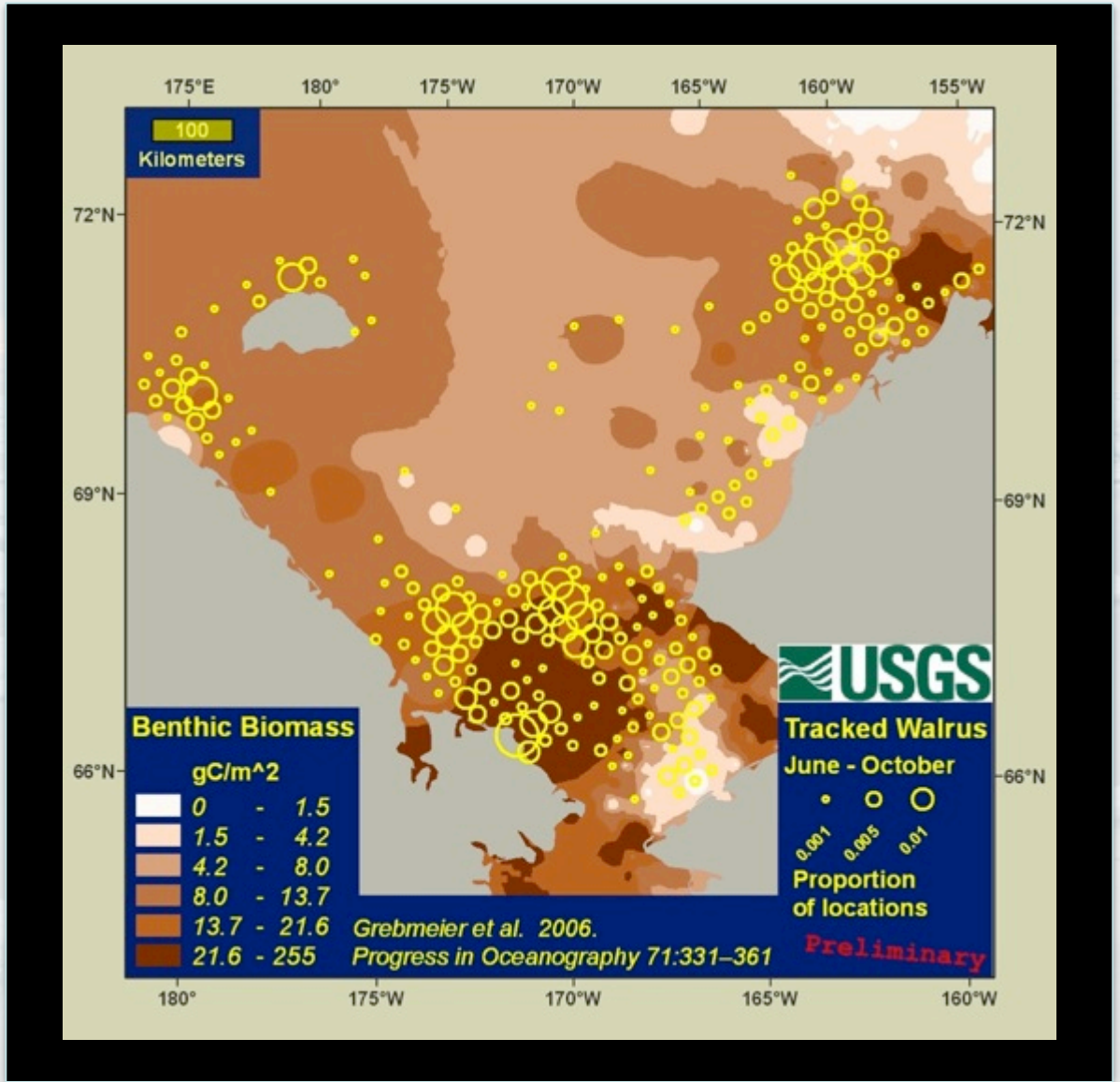
(amphipods: time and space) & over-wintering opportunity feed euphausiids;

staying longer north to feed


[courtesy Kate Stafford]

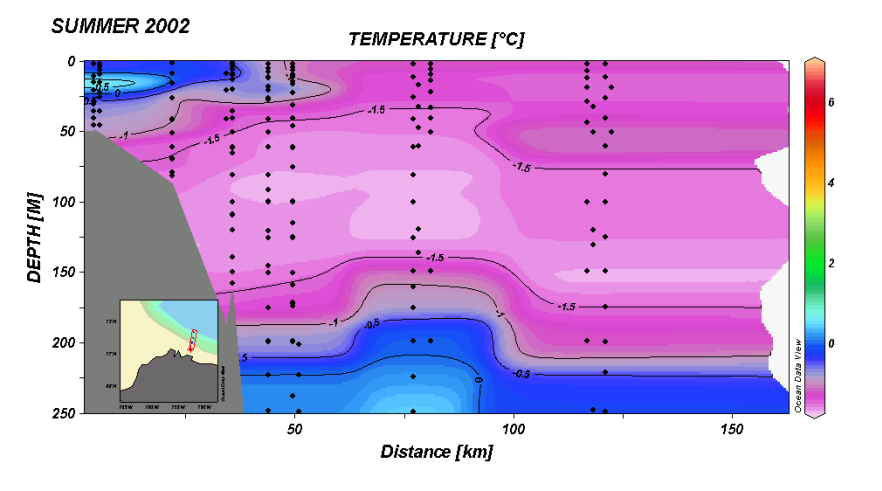
Walrus = loss of sea ice platform for riding, resting, nursing calves & <u>access</u> to Chukchi shelf feeding areas

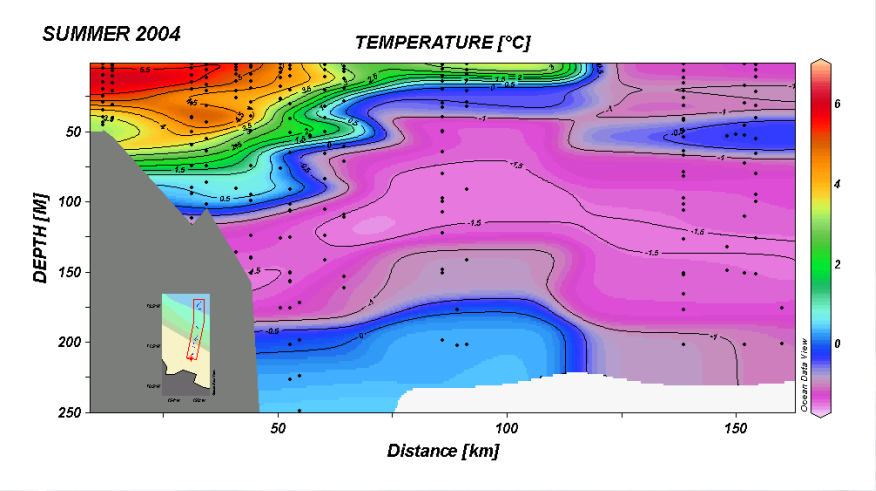
Walrus location and benthic infaunal prey biomass (Jay and Fischbach unpubl.)

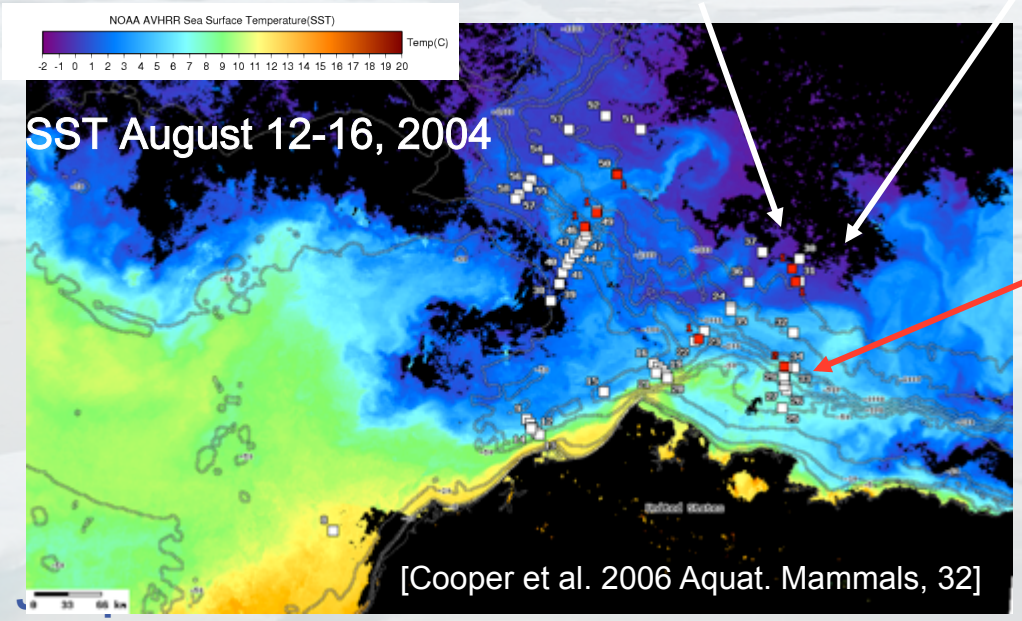


- walrus feeding in areas of ice and rich underlying benthic infauna
- issue of higher energy expenditure if have to haul-out on land

Increased seawater temperature from 2002 to 2004 coincided with high sea ice retreat; abandoned baby walruses observed in 2004







Red squares: abandoned walrus pups with rapid ice retreat

Calf strandings predicted by B. Kelly, 1998

Loss of Feeding/Resting Platform in Chukchi Sea

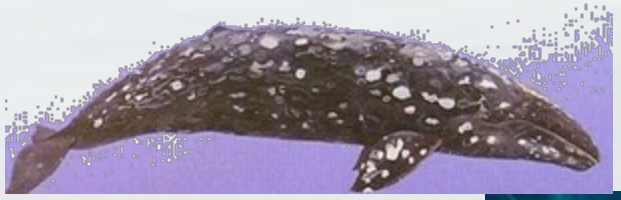
- USGS* tagged walrus in 2007-10 <usgs.web>
- Walrus swim to small ice floes & land as ice retreats
- Massive haul-outs in 2007, 2009, and 2010 = stampedes & *shift to 'central-place' foragers?*
- 2009 calf mortalities near Icy Cape (X, Fischbach et al. 2009) and Pt. Lay (X, 2010)

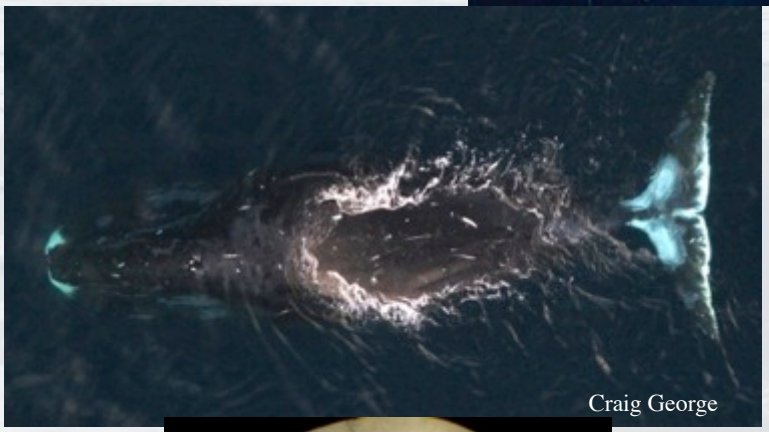
*Chad Jay & team

Ice Associated and Seasonally Migrant Species = Pelagic sentinels?

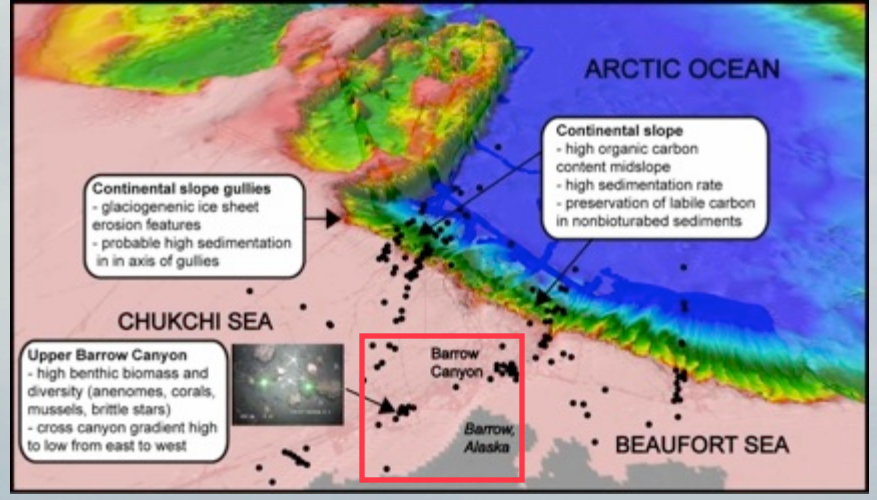
Is a change in bowhead & gray whale numbers & phenology (timing of migration) since the 1980s…

- Reflecting a shift in prey composition? Gray whales consume benthic amphipods and pelagic euphausiids
- Resulting in competition for prey near Barrow?
- Influencing Inuit hunting?





[courtesy Sue Moore]



High epifaunal biodiversity and biomass in upper Barrow Canyon off Alaska, USA

[SWL 2007 C30 epibenthic video]

- also upper Barrow Canyon “hotspot” for infaunal mussels, highest overall biomass for total Chukchi Sea due to large amount of organic carbon in bottom waters

Summary

- decreasing sea ice, increasing heat and freshwater transport in the Pacific Arctic are key factors for change in marine ecosystem dynamics and biodiversity

- continental shelf regions in the northern Bering and Chukchi Seas are experiencing earlier spring and/or later fall transition between ice-covered and ice-free conditions and increasing seawater temperatures

- changes in the timing of primary productivity and zooplankton grazing over shelf and slope regions will change trophic structure and carbon use and transport from shelf to basin in the Pacific Arctic region

- tracking status and trends in the time-series sites are critical for identifying ecosystem status and response to environmental change

Thank you. Any questions?

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[photo courtesy Karen Frey]