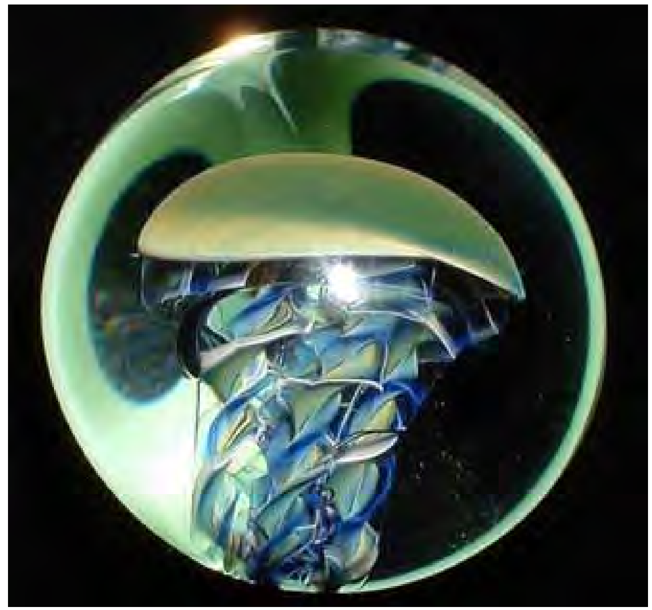
Insights into the eastern Bering Sea through a jellyfish lens: Recent trends & tests of predictive models



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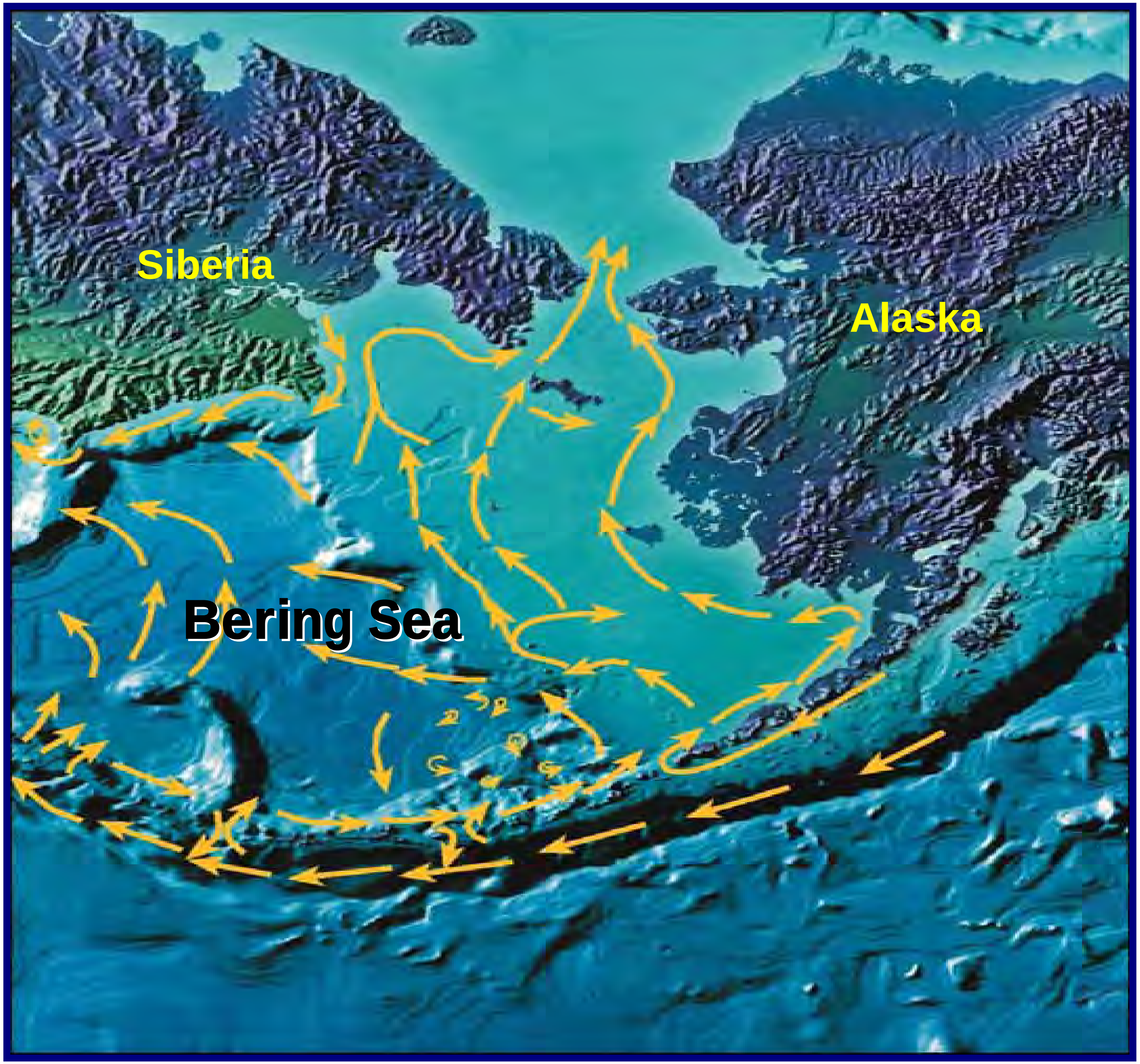
The Bering Sea



P. Stabeno (PMEL, NOAA)

A Highly Productive Ecosystem

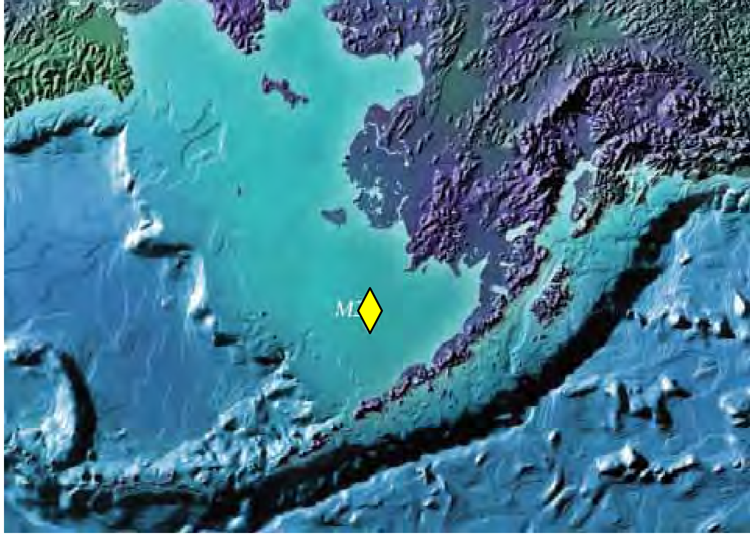
Photo: Mike Brittain

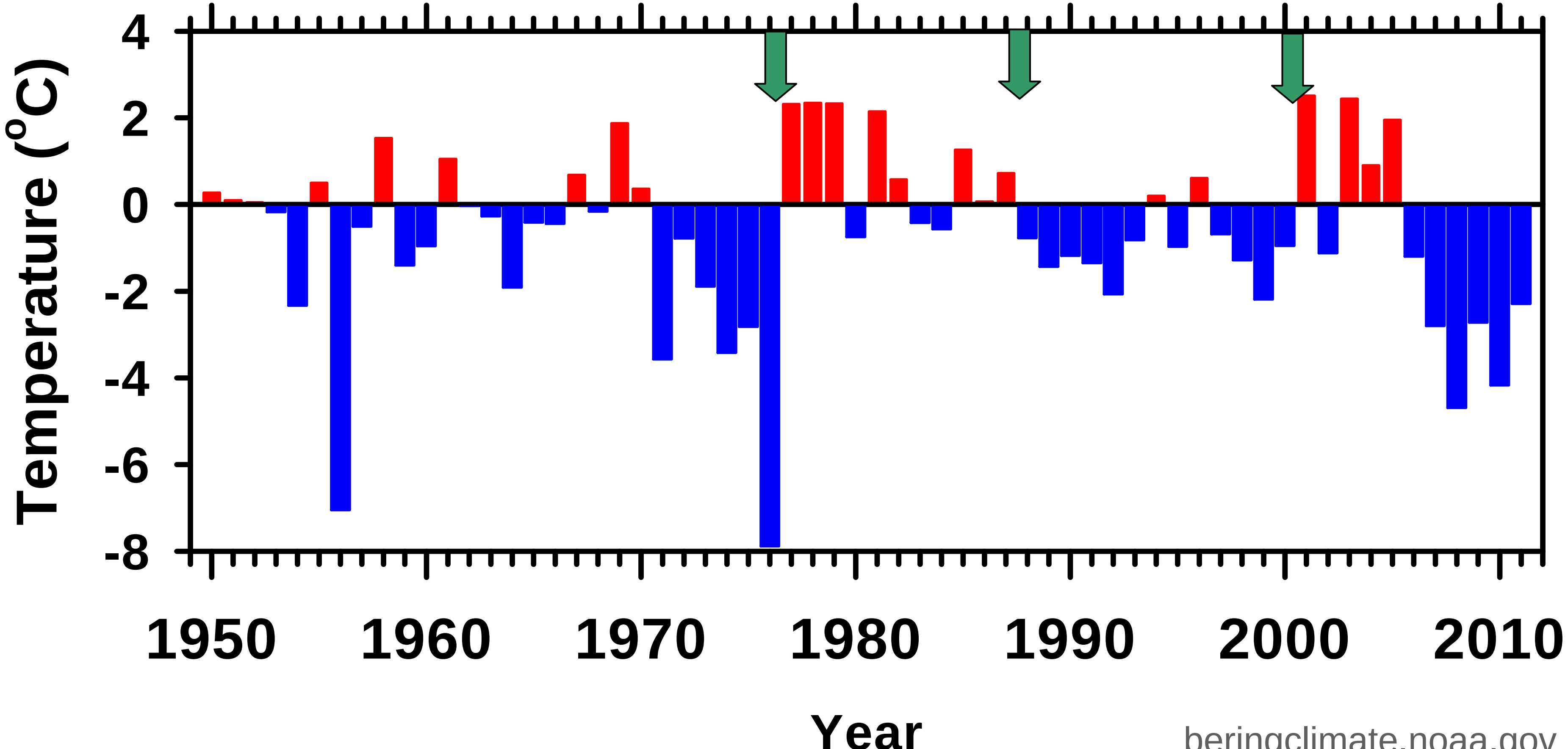
Evidence of Changes in the Eastern Bering Sea

- Changing Sea Water Temperatures
- Changing Seasonal Sea Ice Cover
- Changing Timing of Spring Primary Production
- Occurrence of Unusual Phytoplankton Blooms
- Fluctuating Summer Zooplankton Biomass
- Decreasing Seabird and Pinniped Populations
- Fluctuations in Jellyfish Biomass

Sea Surface Temperatures on Middle Shelf from January – April, 1950-2011

Climatic Regime Shifts





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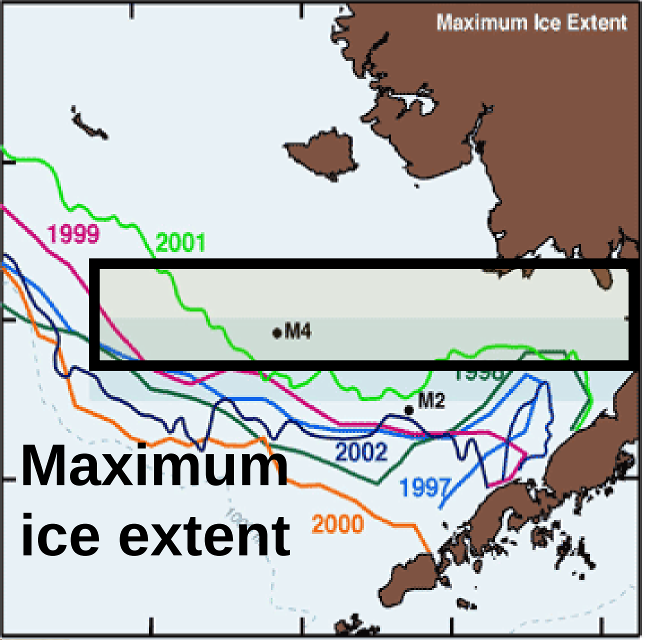
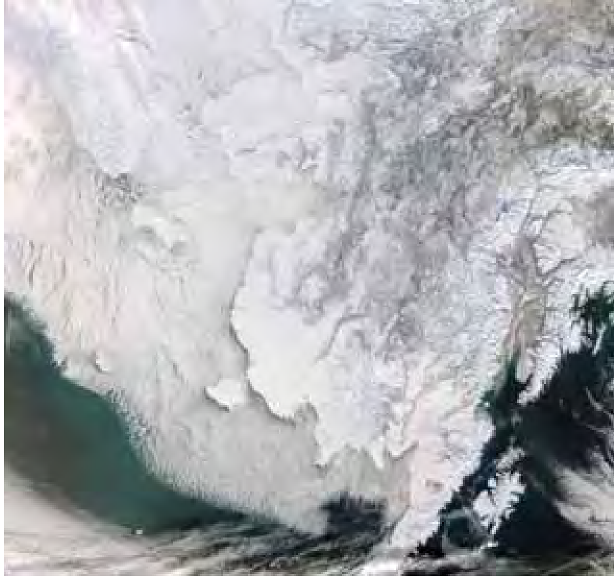
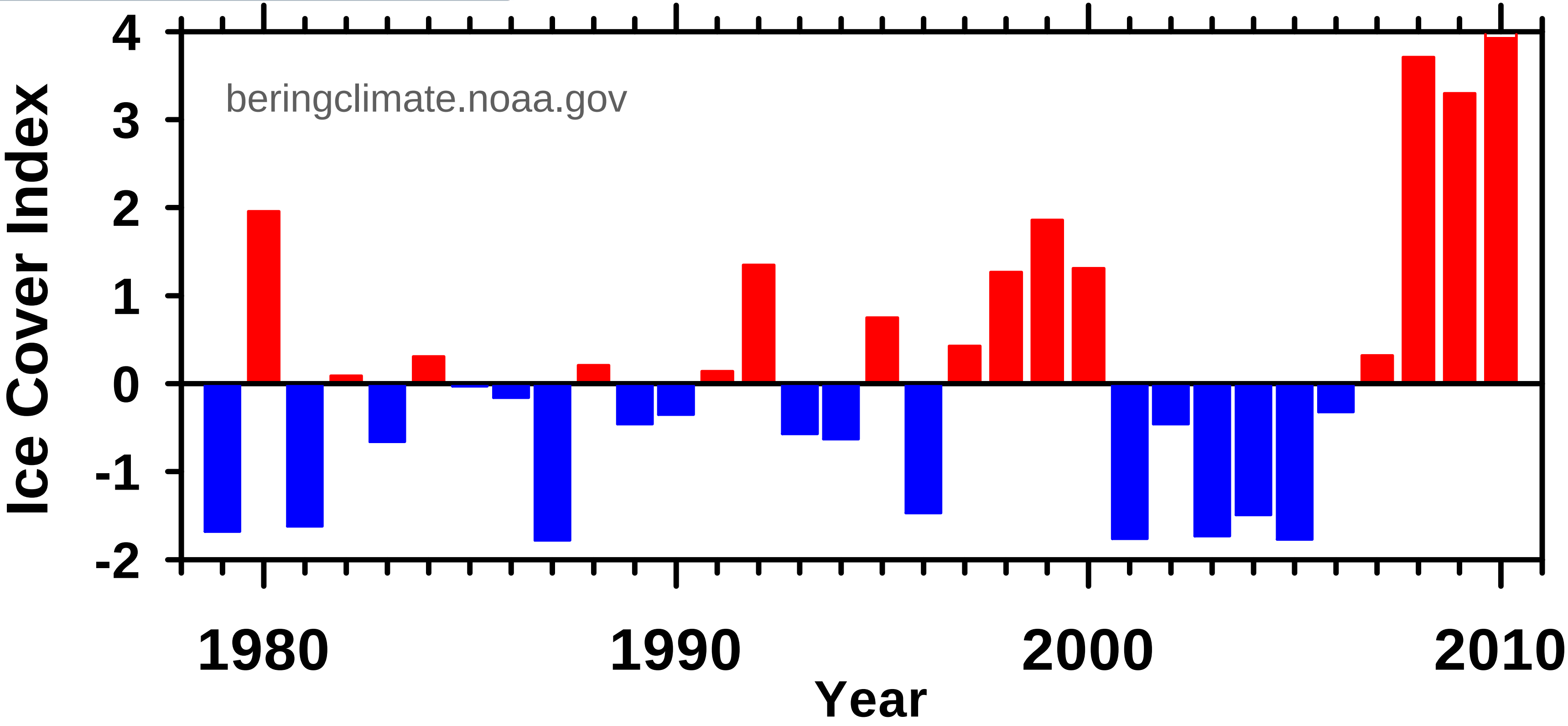


Ice Cover Index Jan.-May, 1979-2010



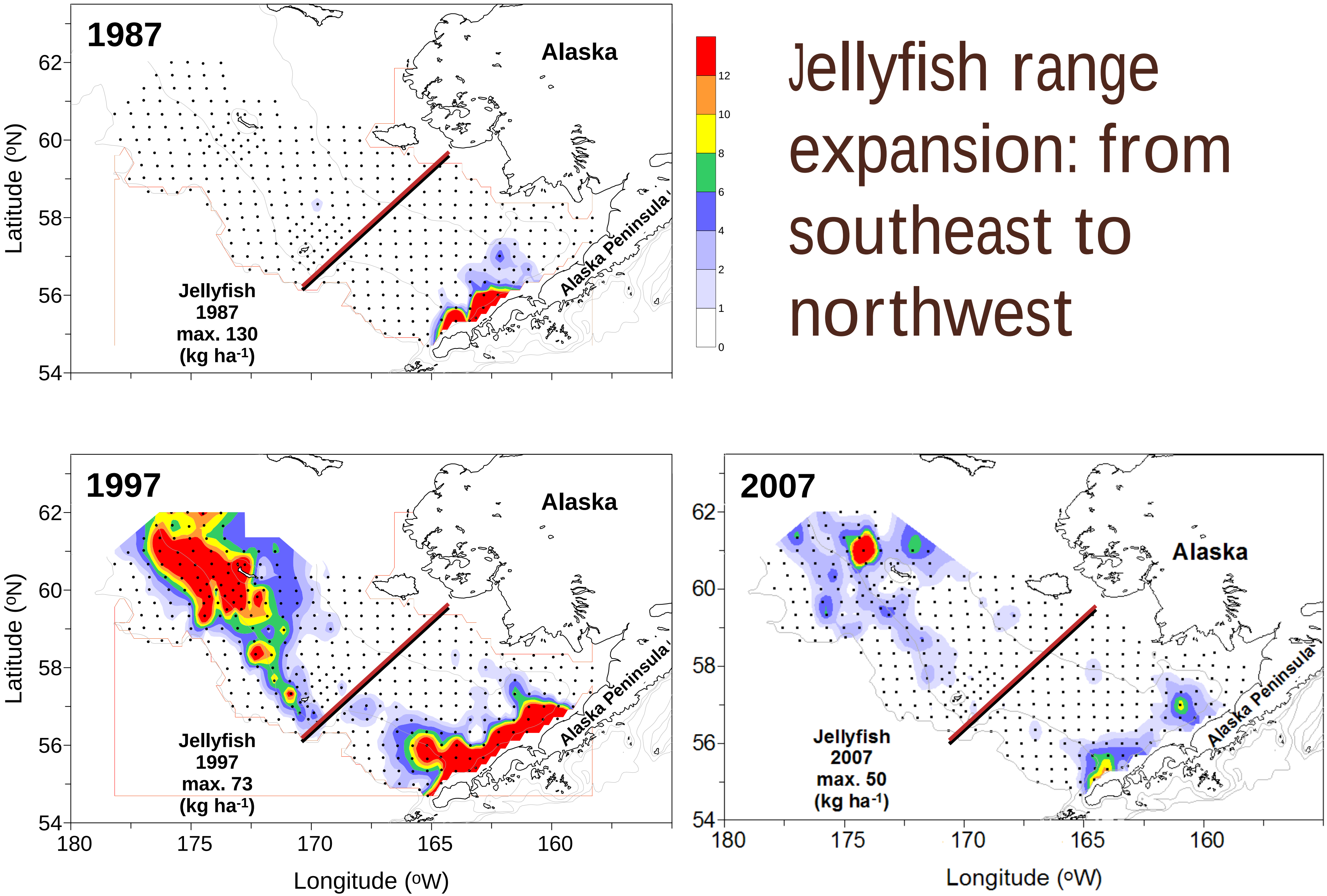


Eastern Bering Sea Shelf Groundfish Bottom Trawl Survey

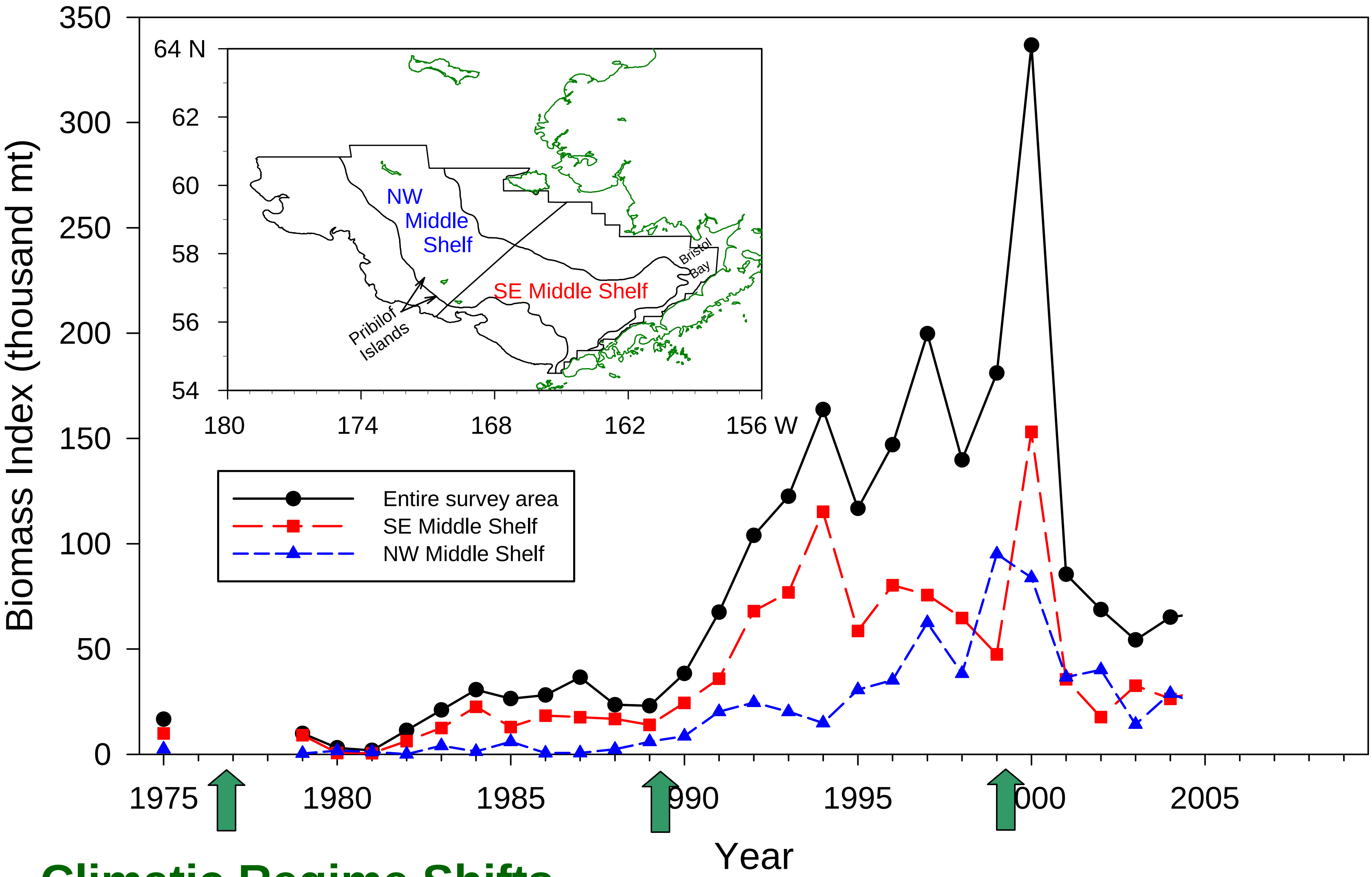
Jellyfish weighed, standardized to kg per hectare

Relative biomass on annual basis since 1979

Jellyfish range expansion: from southeast to northwest



Jellyfish Biomass in the Eastern Bering Sea, 1975-2004



Climatic Regime Shifts

Brodeur *et al.* (2008)

Previous Analyses

Methods:

- Examine interannual trends in jellyfish biomass, 1982-2004, separately for 2 regions
- Examine abiotic and biotic correlates of jellyfish biomass
- Construct GAM models for best fitting variables

Brodeur *et al.* (2008)

Generalized Additive Modeling (GAM)

1) GAMs: non-linear regressions; nonparametric smooth functions are determined from the data

2) Constructed separate models for SE and NW using Log (CPUE) as dependent variable

3) Forward stepwise selection strategy, limiting degrees of freedom to 4

4) Minimize Generalized Cross Validation (GCV)

5) Variables could be dropped if addition of subsequent variables decreased significance

Brodeur *et al.* (2008)

Variable names

sebiom, nwbiom	Jellyfish biomass, CPUE (catch per unit effort)
sesprtemp	March-May SST in southeast region
nwsprtemp	March-May SST in northwest region
sesumtemp	June-August SST in southeast region
nwsumtemp	June-August SST in northwest region
wstressna	Wind stress, November-April
wstressmj	Wind stress, May-June
wmixmay	Wind mixing index, May
wmixjj	Wind mixing index, June-July
current	Distance OSCURS model drifters traveled
icecover	Sea ice cover index
iceretreat	Number of days with ice cover after March 15
mszoop	Middle Shelf zooplankton biomass
oszoop	Outer Shelf zooplankton biomass
pollock	Juvenile walleye pollock CPUE
forage	Herring, eulachon and capelin CPUE

Brodeur *et al.* (2008) PiO

Generalized Additive Modeling (GAM)

Best SE Model

$$\log(CPUE) = \beta_o + s(sebiomlag) + s(sesprtemp) + s(wmixmay) + s(sepollock) + s(icecover)$$

R^2 (%) = 89.6 GCV = 0.356

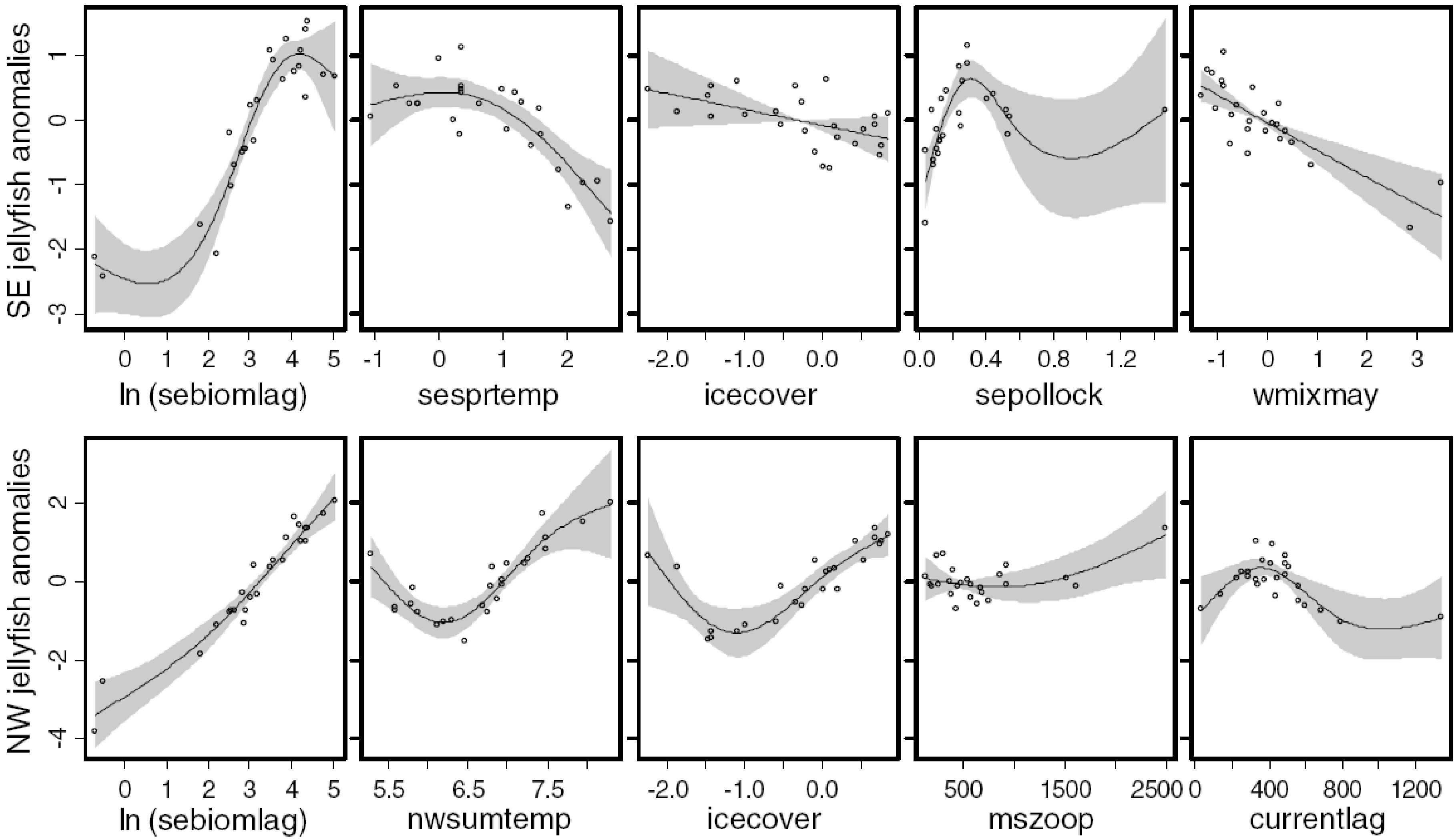
Best NW Model

$$\log(CPUE) = \beta_o + s(sebiomlag) + s(nwsumtemp) + s(icecover) + s(mszoop) + s(currentlag)$$

R^2 (%) = 93.8 GCV = 0.463

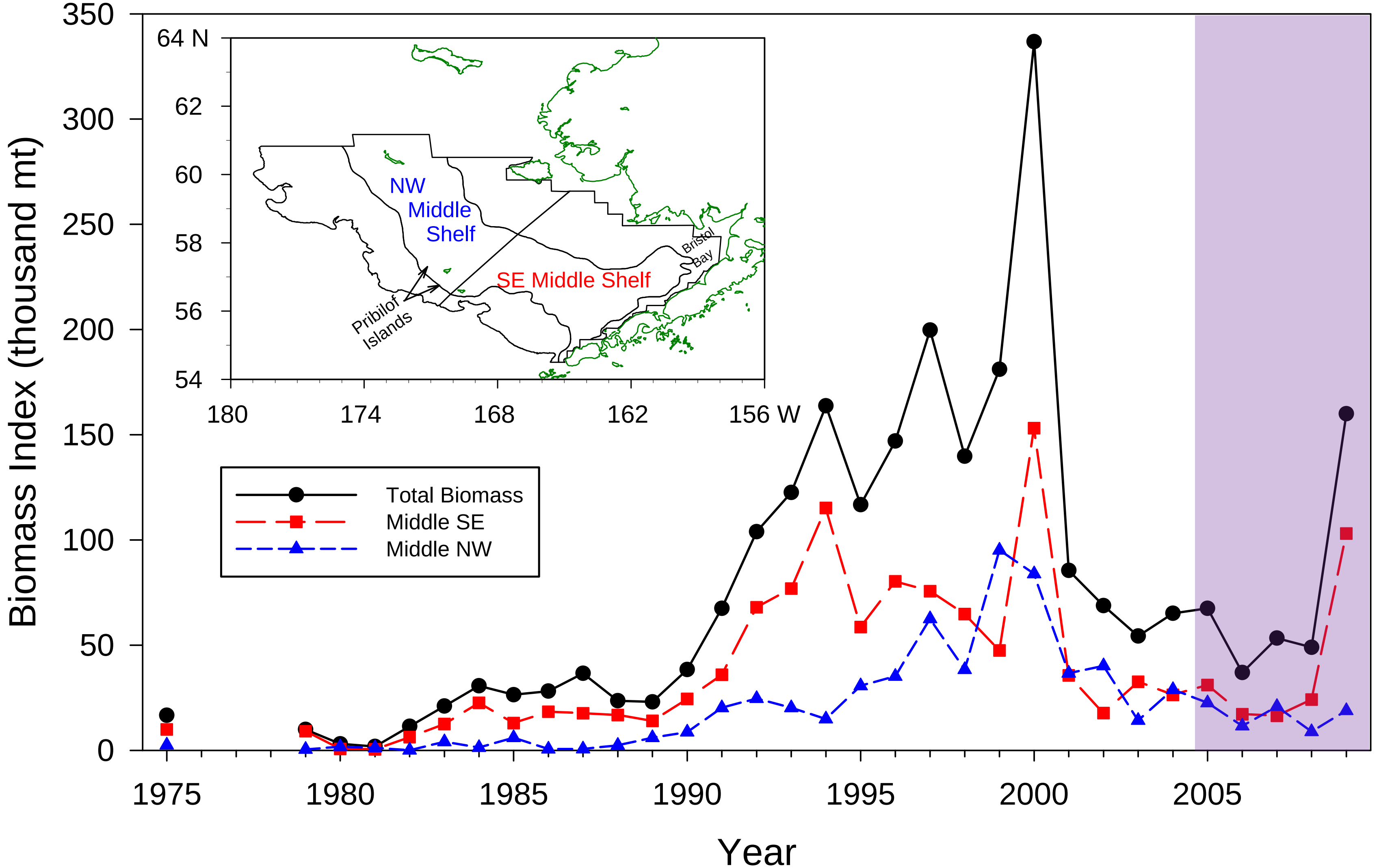
Brodeur *et al.* (2008)

Additive effects of significant covariates in the SE and NW jellyfish biomass models.



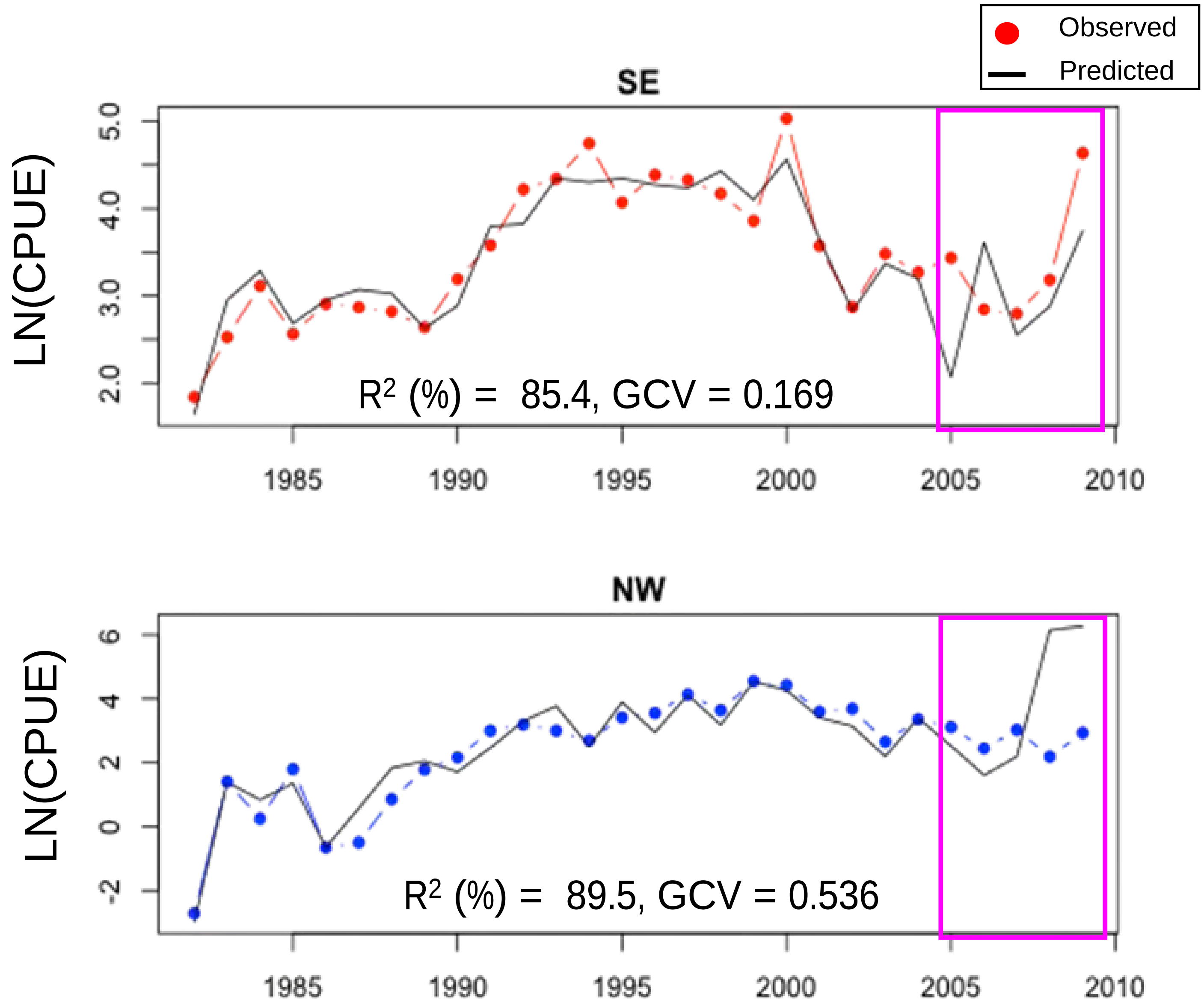
Brodeur *et al.* (2008)

Eastern Bering Sea Jellyfish Biomass, 1975-2009

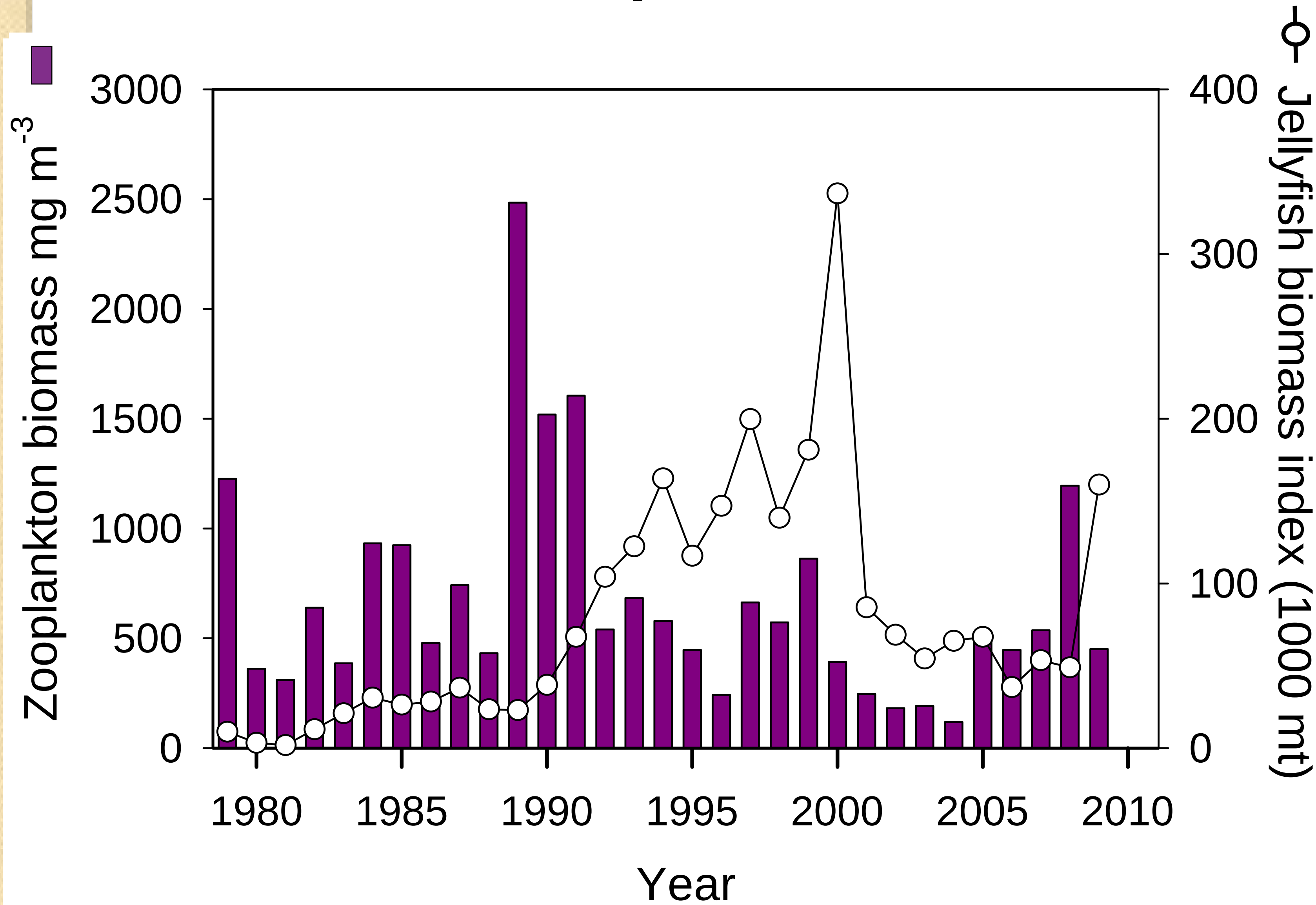


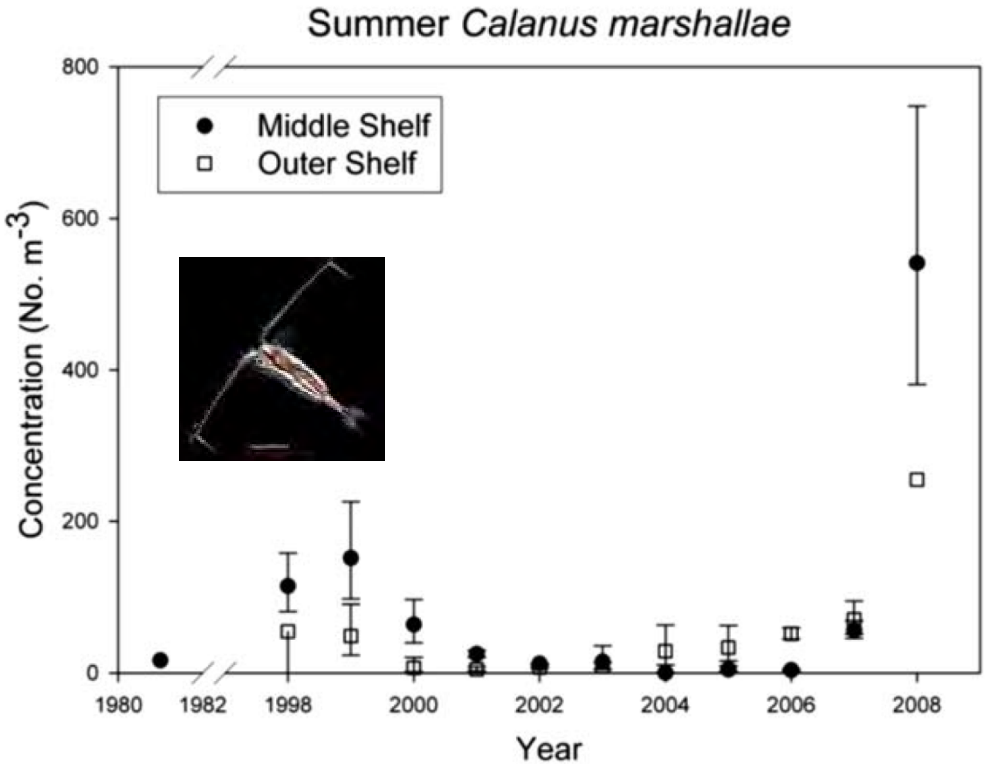
Can we use our previous GAM models to 'hindcast' the observed jellyfish biomass for 2005-2009?

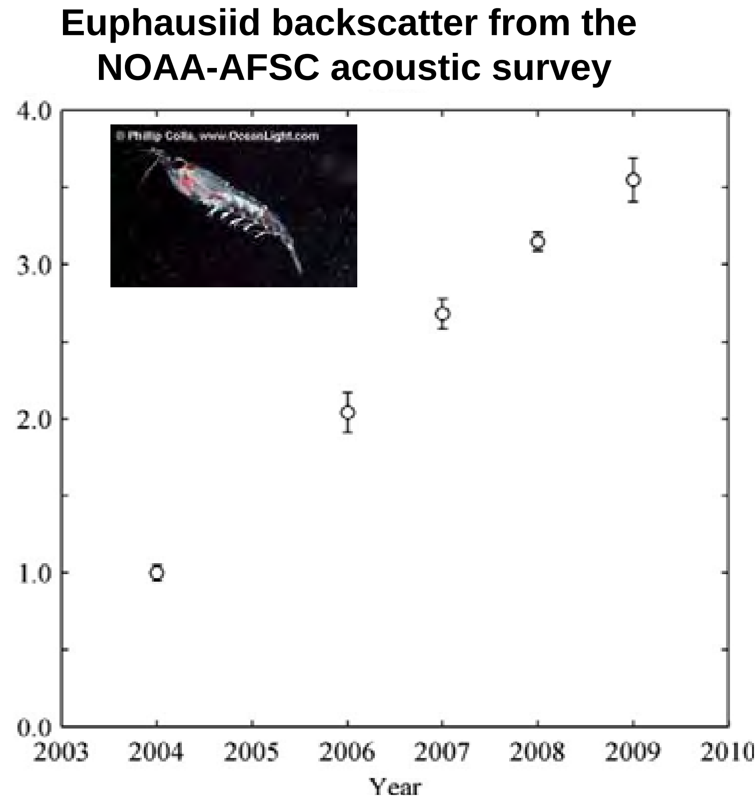
We “hindcasted” our models using new environmental data from 2005-2009

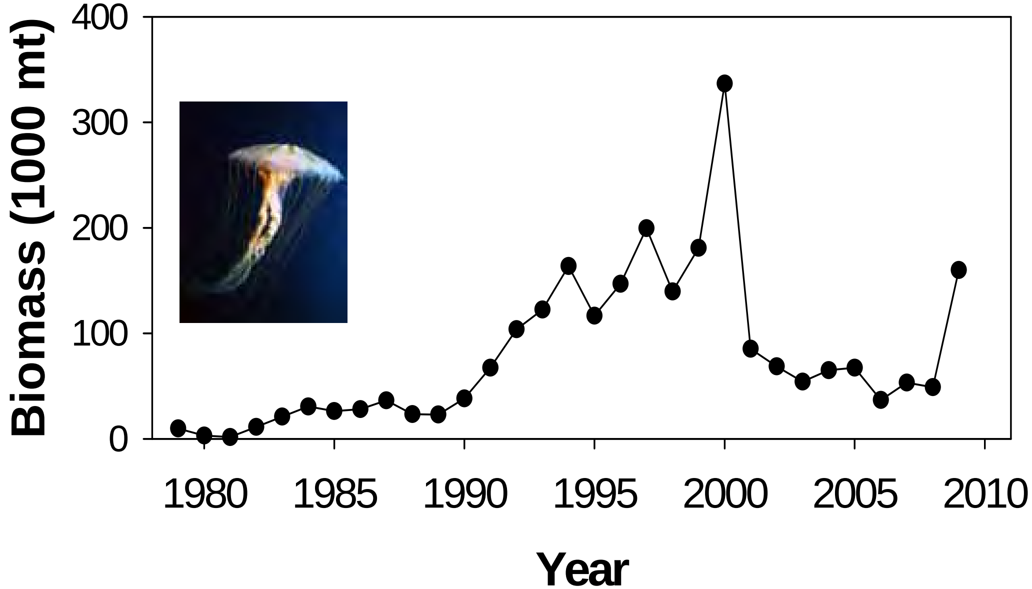


Middle Shelf Zooplankton Biomass





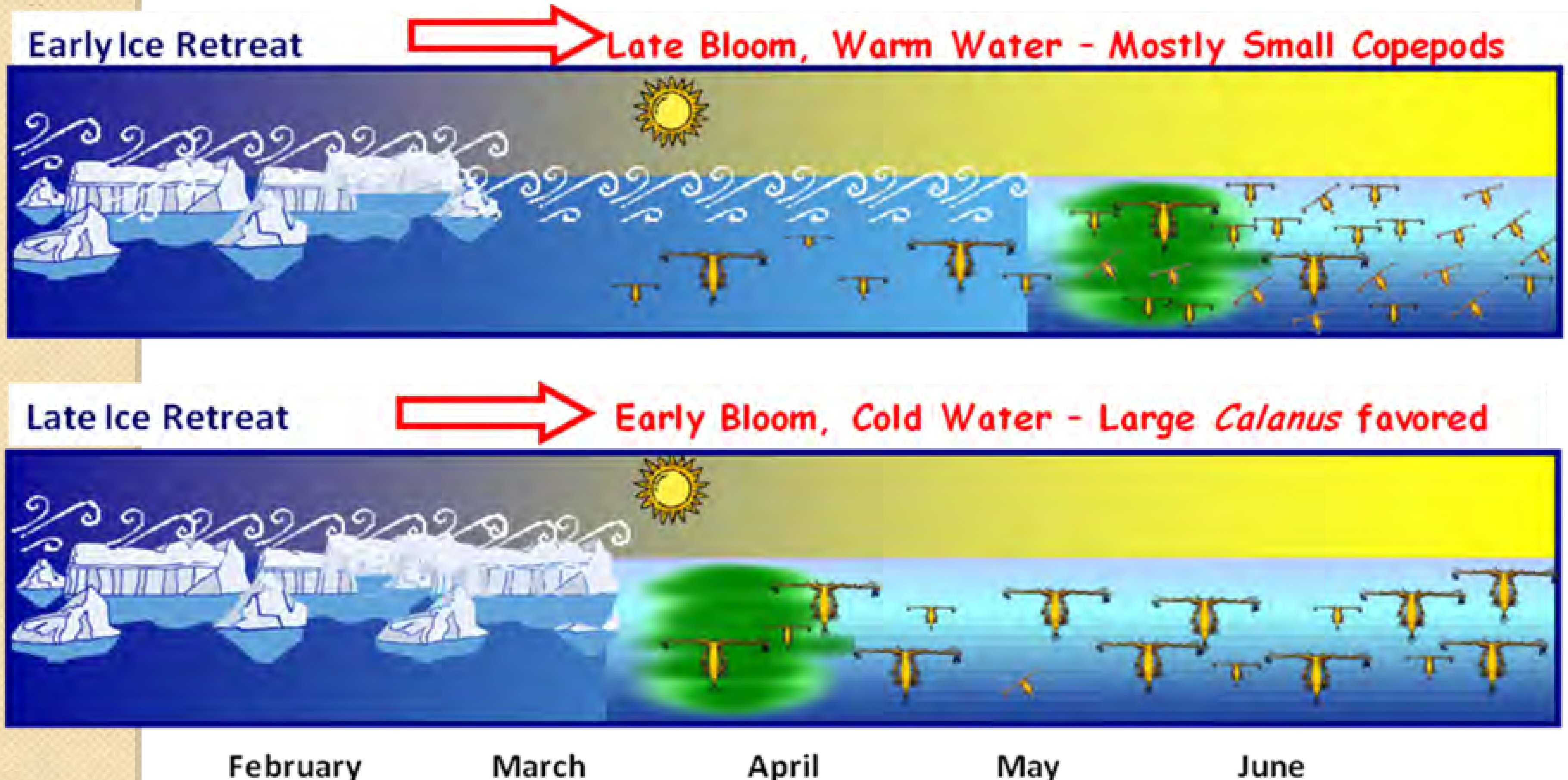




Hunt *et al.* (2011) IJMS

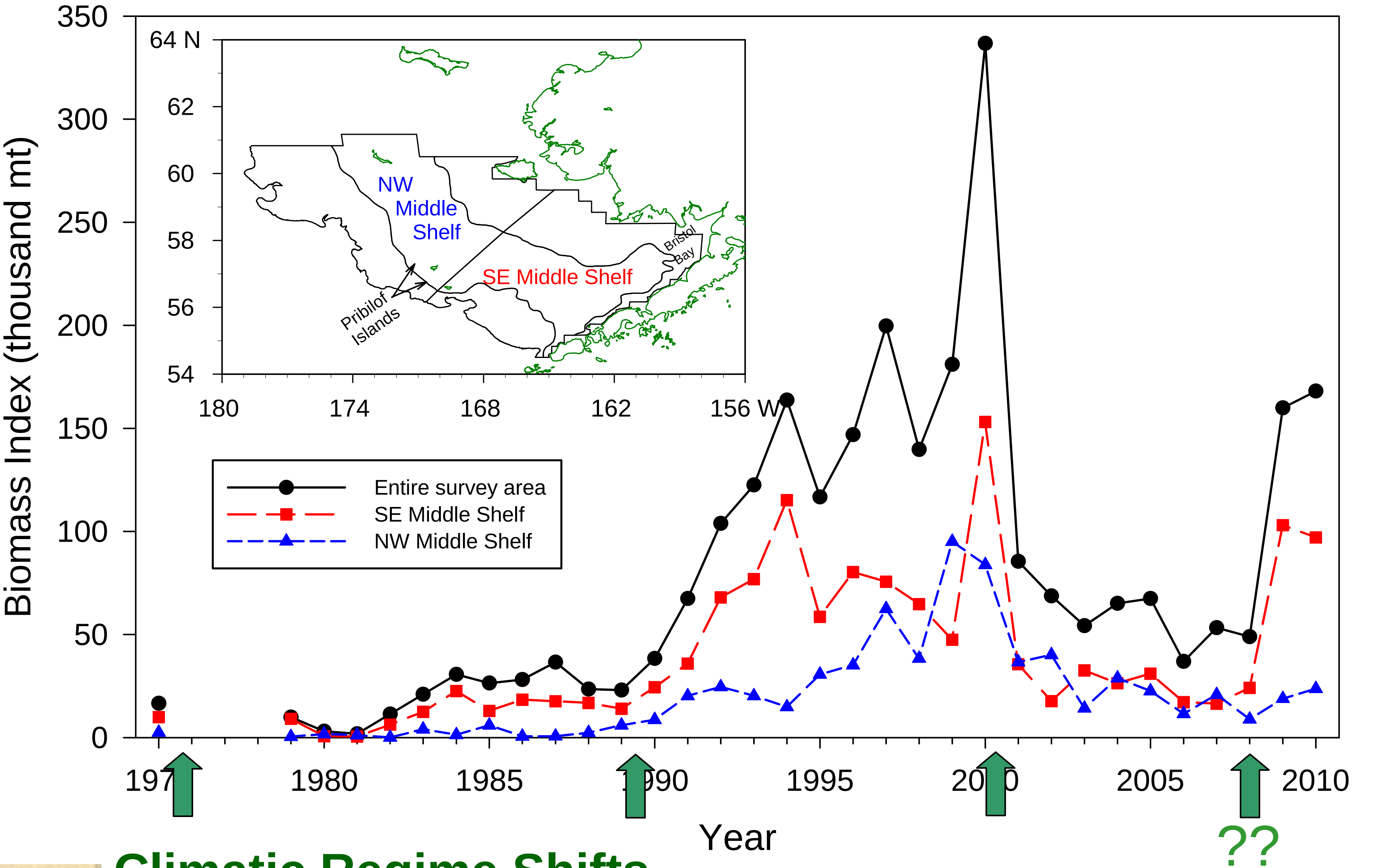
Evidence for increasing biomass of plankton in since 2008

Timing of ice retreat affects the bloom and the production of copepods of different size classes



Hunt *et al.* (2011) IJMS

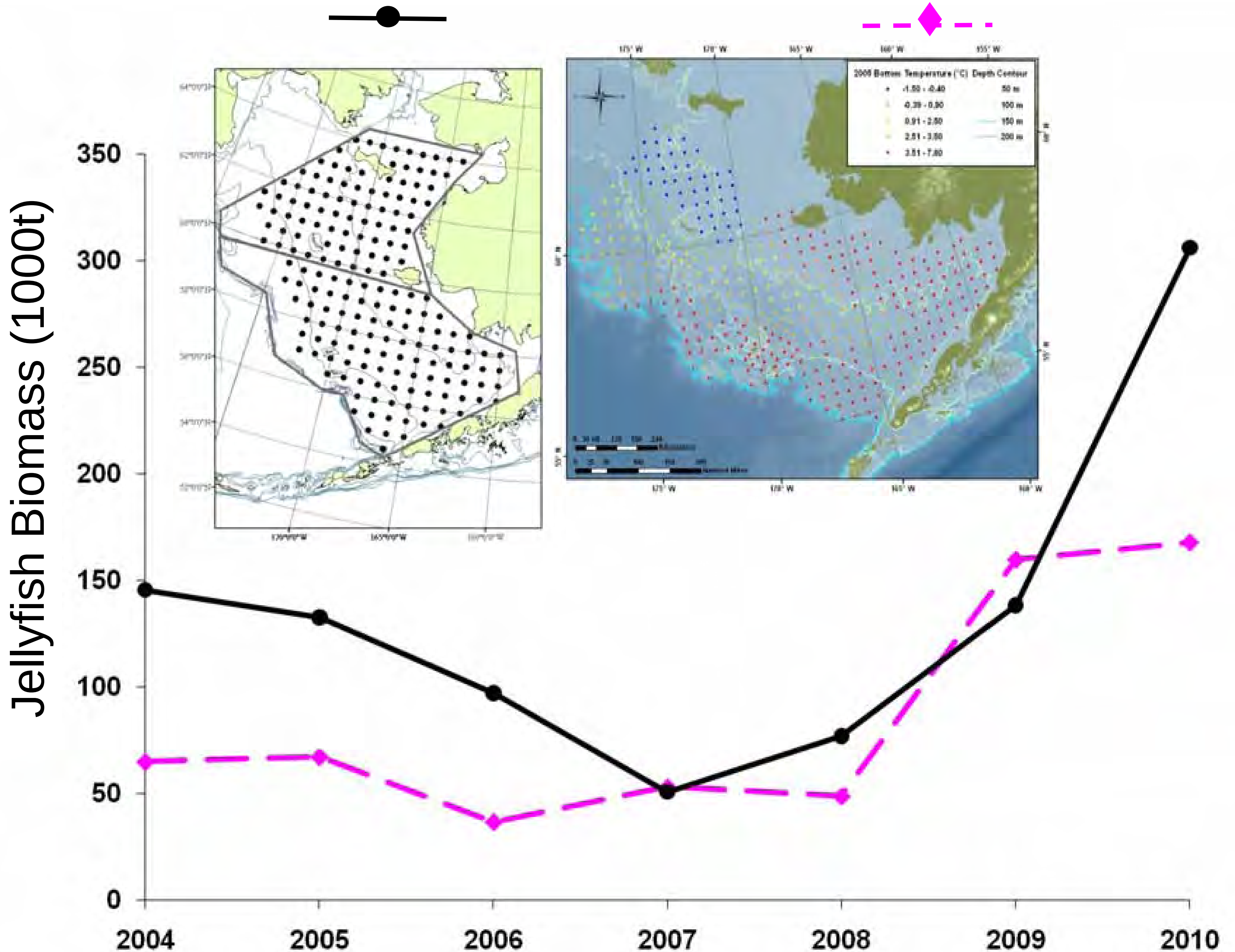
Jellyfish Biomass in the Eastern Bering Sea, 1975-2010



Climatic Regime Shifts

Decker *et al*. (in prep.)

Surface Trawl (BASIS) vs. Bottom Trawl (RACE)



Conclusions

- Jellyfish in SE Bering Sea continue to show fluctuations in biomass and a northward shift in distribution.
- Jellyfish biomass during 1982-2004 is influenced regionally by interacting variables (e.g., sea ice cover, SST, currents, wind mixing and food availability.
- Models "hindcasted" with 2005-2009 environmental data estimate recent trends in Bering Sea jellyfish.
- Large zooplankton may be a key factor fueling jellyfish biomass.
- Models that predict jellyfish biomass may help understand ecosystem changes.

Acknowledgements

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Thank you!