Projected Spatial Distributions for Eastern Bering Sea Arrowtooth Flounder Under Simulated Climate Scenarios, with Implications for Predation.

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Outline

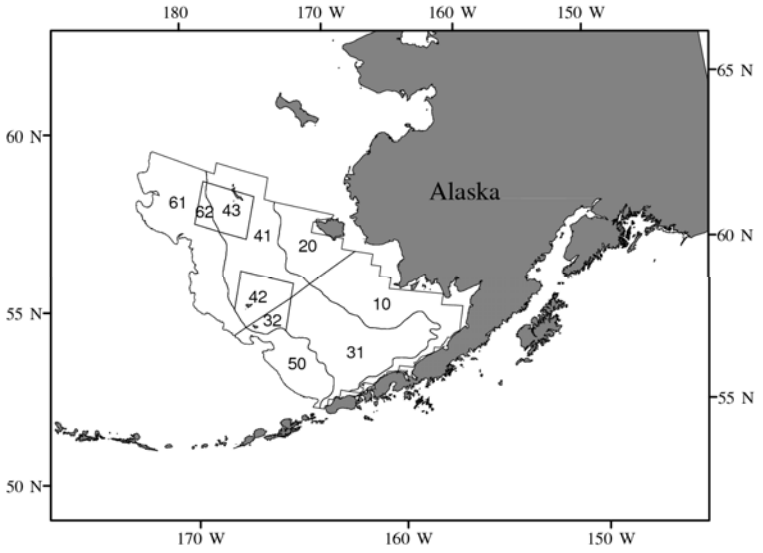
1) Description of study area and environmental variability

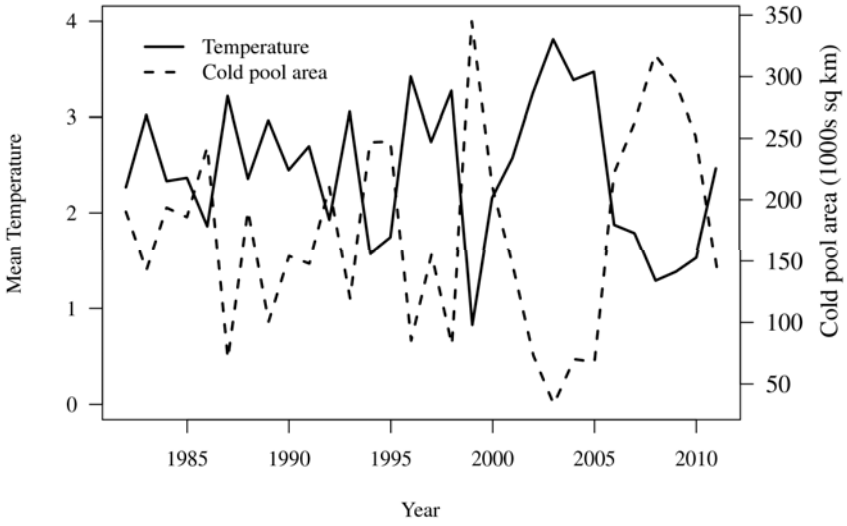
2) The influence of environmental variability on arrowtooth flounder and juvenile walleye pollock spatial distributions

3) Projections of future environmental conditions

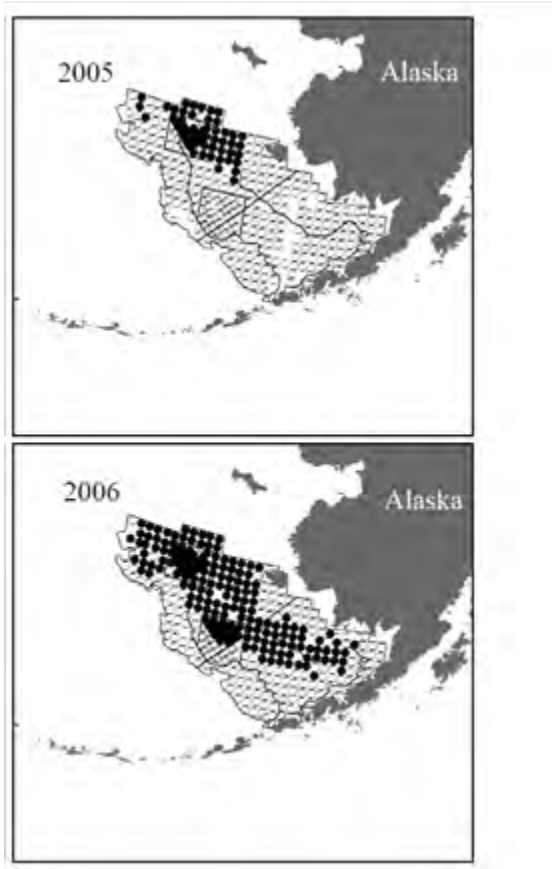
4) The influence of environmental conditions on pollock recruitment

Temperature variability in the EBS shelf

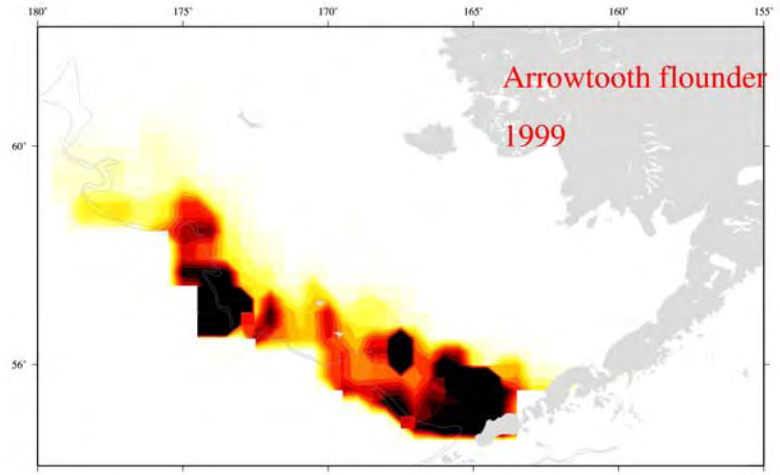


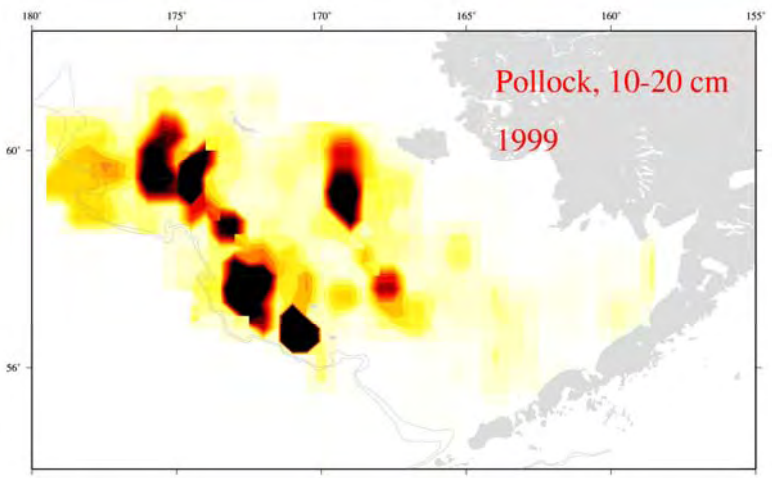


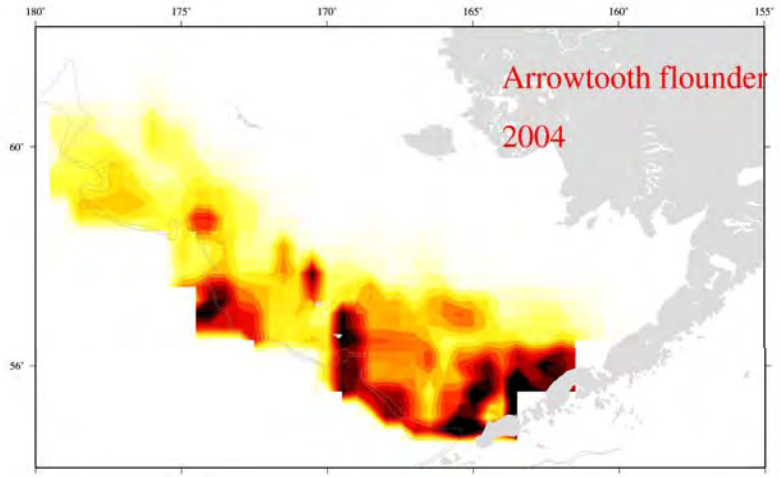
Annual bottom trawl survey with consistent methodology since 1982

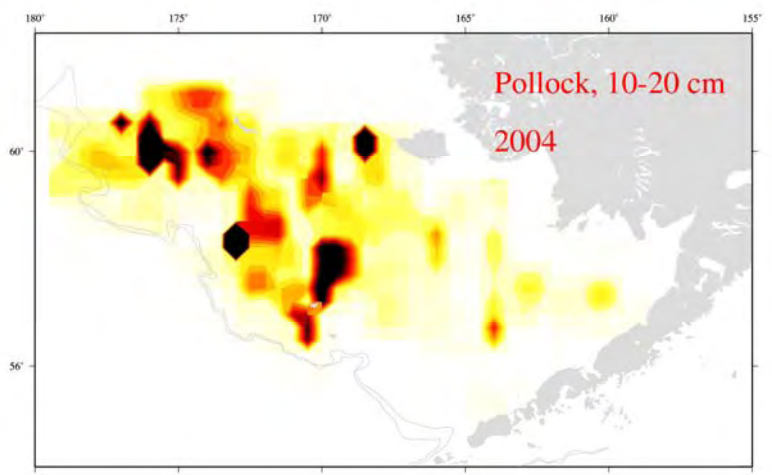


Arrowtooth flounder avoid the cold pool
Age 1 walleye pollock do not avoid the cold pool

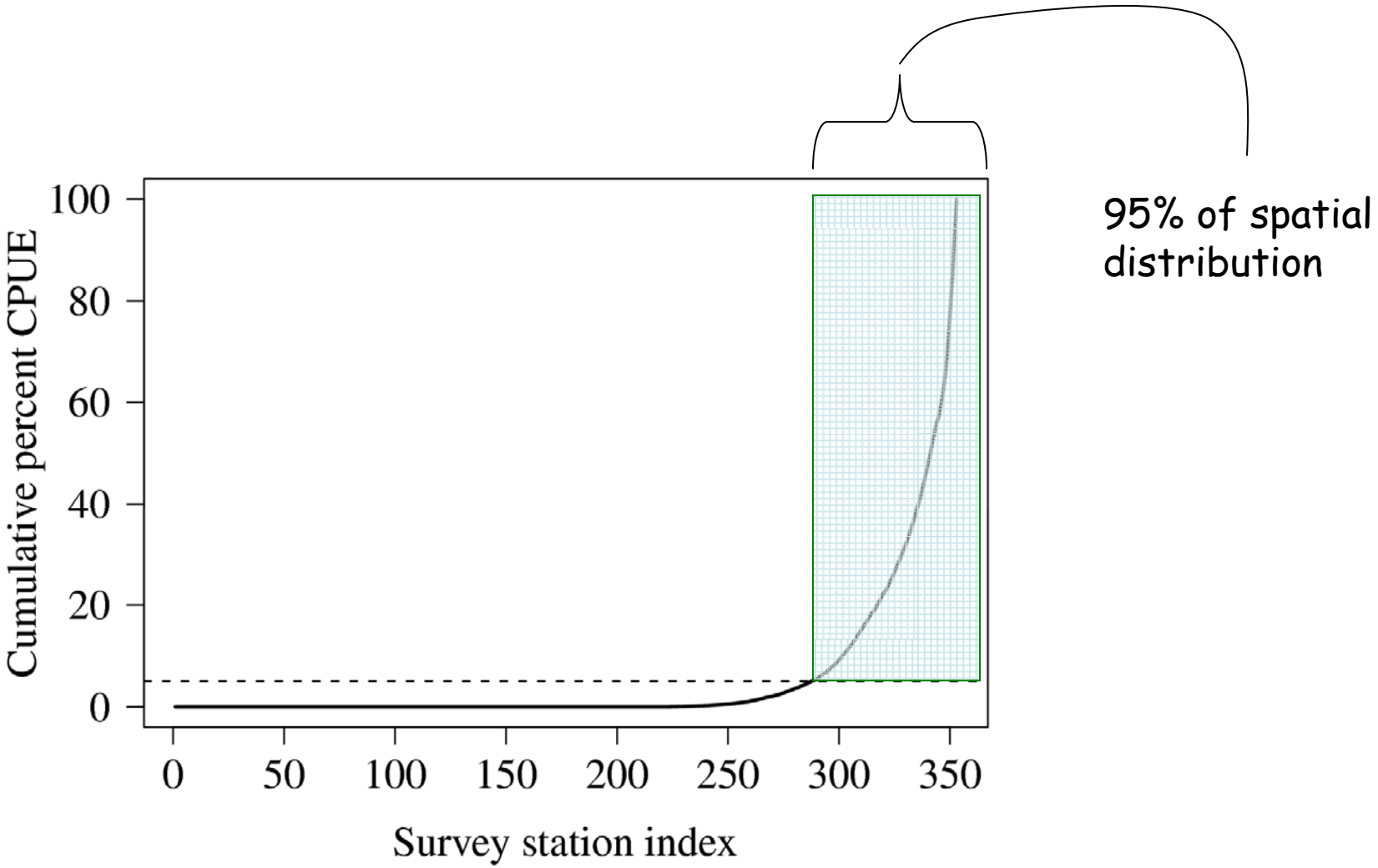


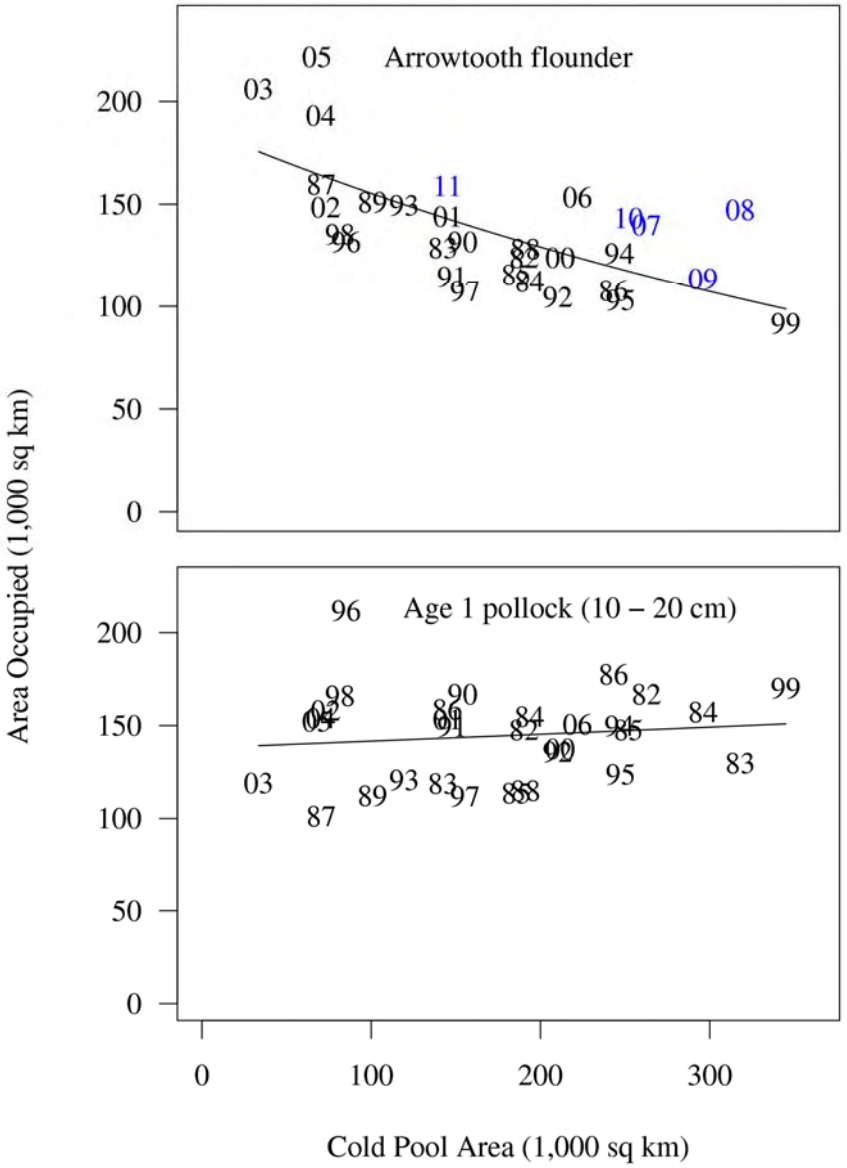






Estimation of minimum area occupied by 95% of the stock





Area occupied by arrowtooth flounder is inversely related to the area of cold pool

Area occupied by age 1 walleye pollock flounder is not related to the area of cold pool

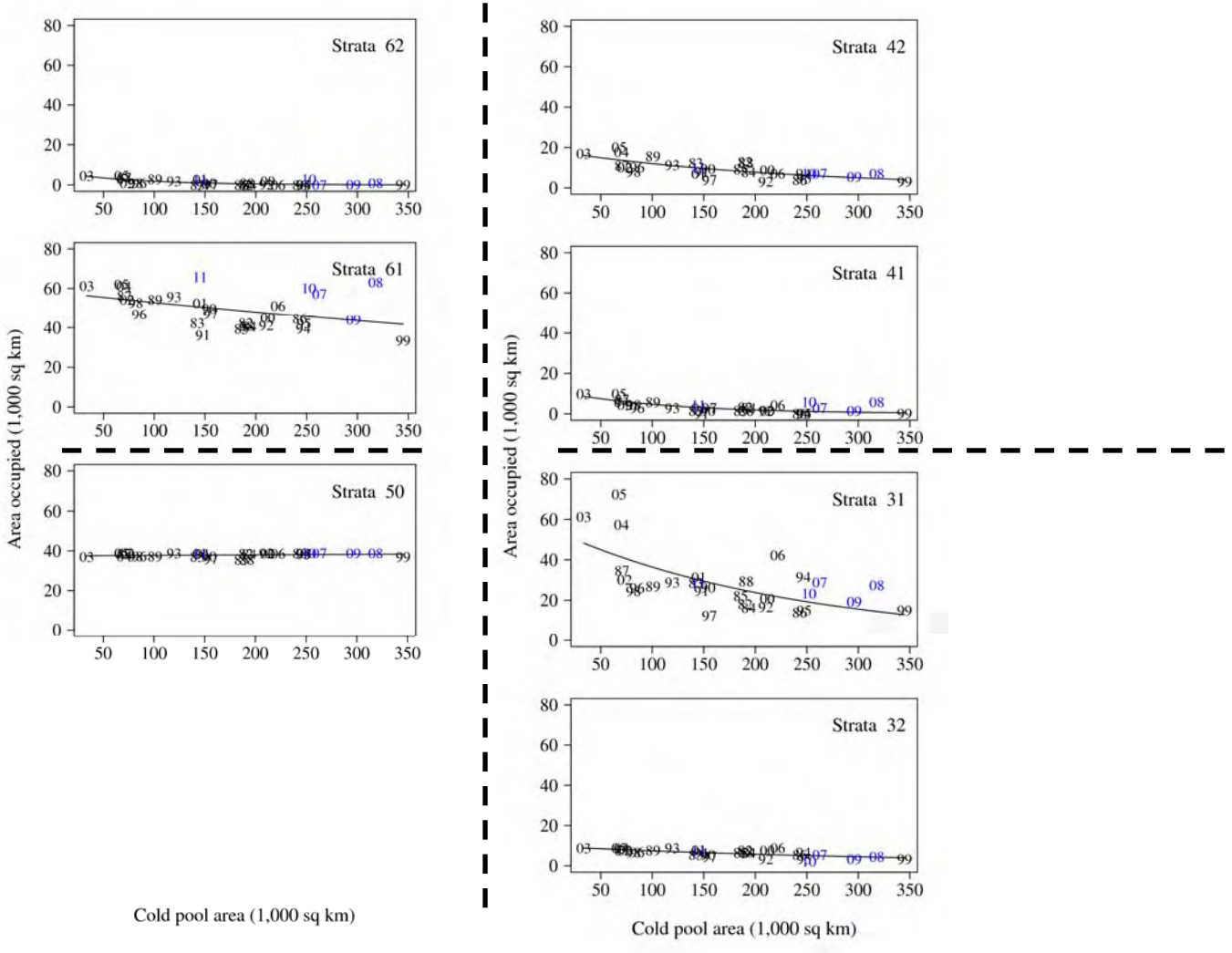
Changes in the area occupied occur primarily in the middle shelf

Outer shelf

Middle shelf

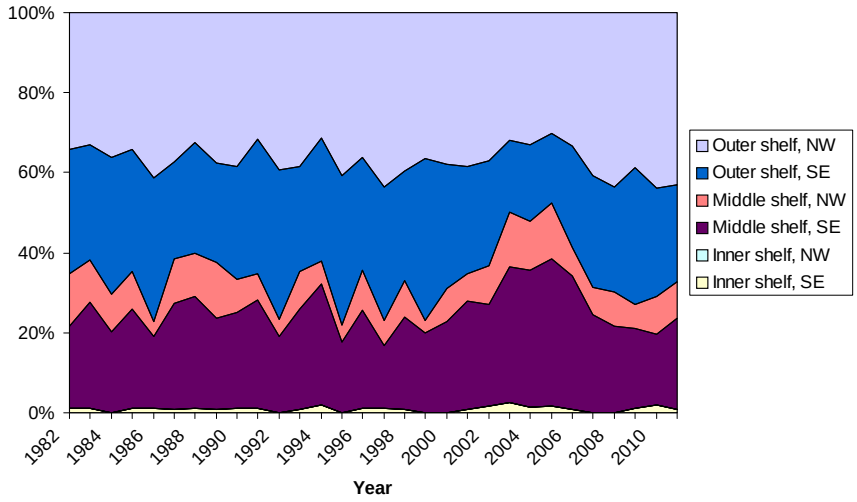
Northwest shelf

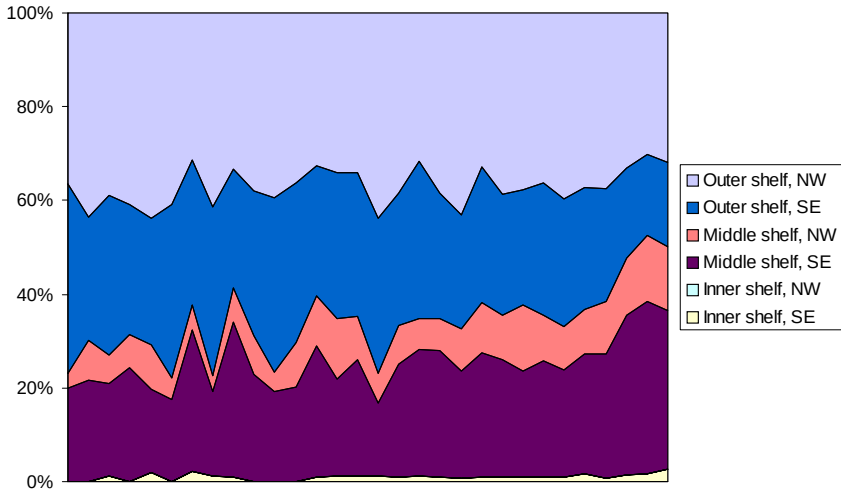
Southeast shelf



Relative distribution across strata

Arrowtooth flounder



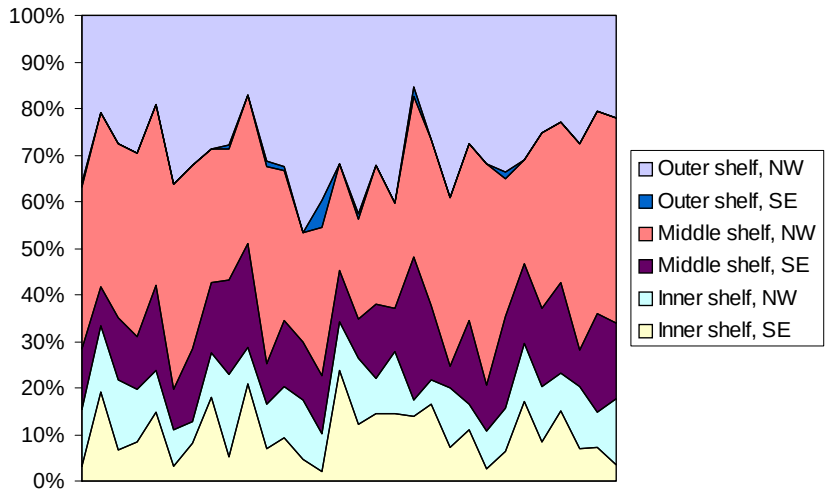


Large

Small

Cold pool

Age 1 walleye pollock

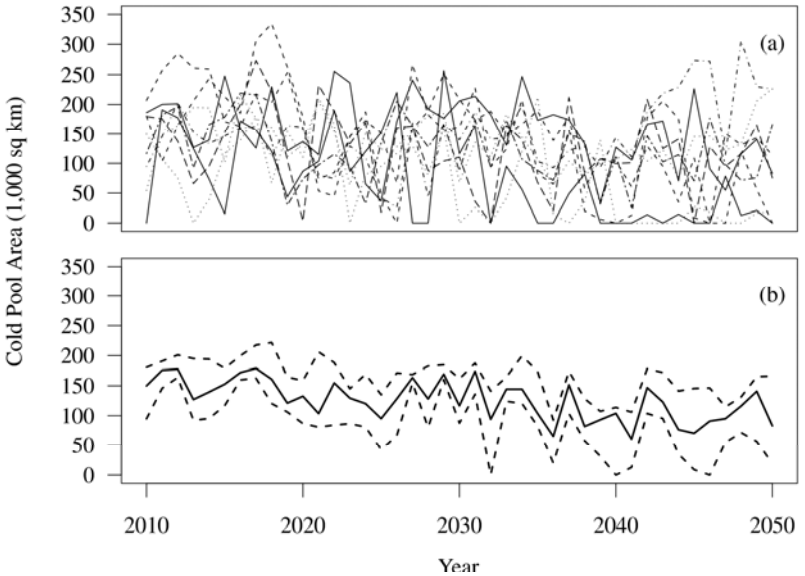


Large

Small

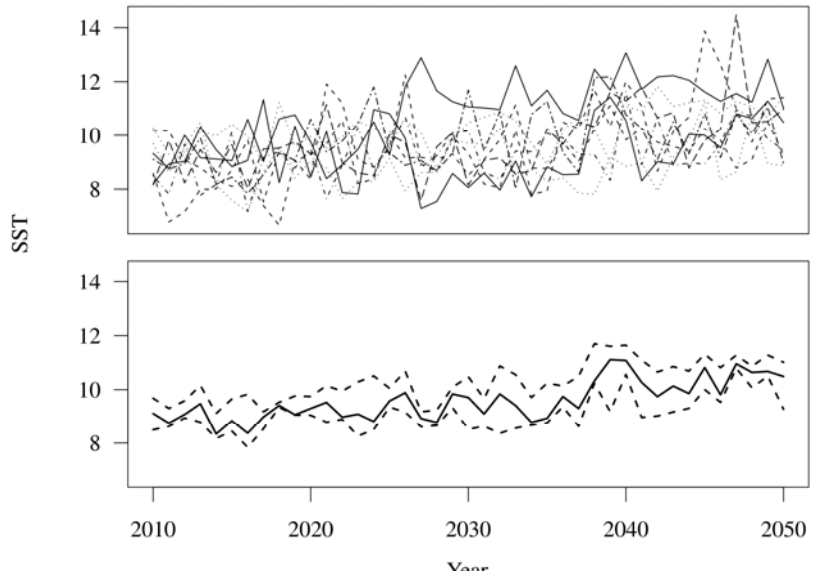
Cold pool

Projected environmental conditions from statistical downscaling



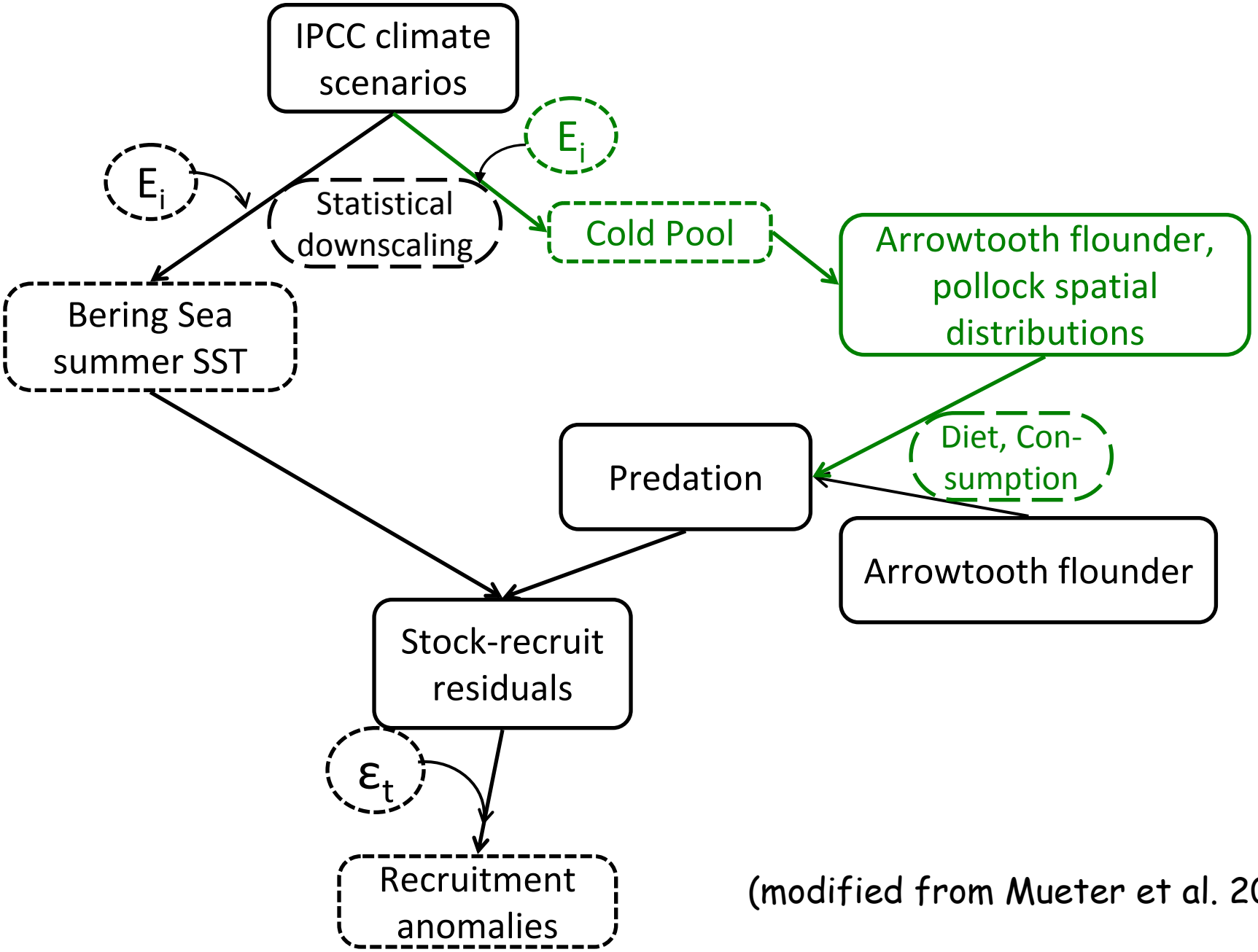
Decrease in cold pool area

Median cold pool area in 2045-2050 is 32% lower than median from 2011-2015



Increase in sea surface temperature

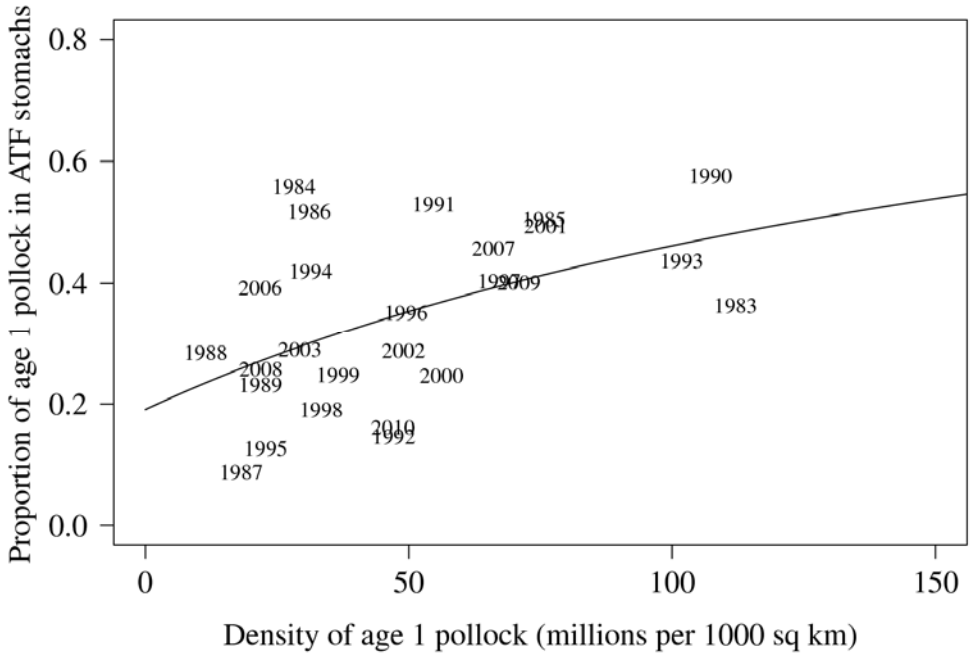
Median SST in 2045-2050 is 17% higher than median from 2011-2015



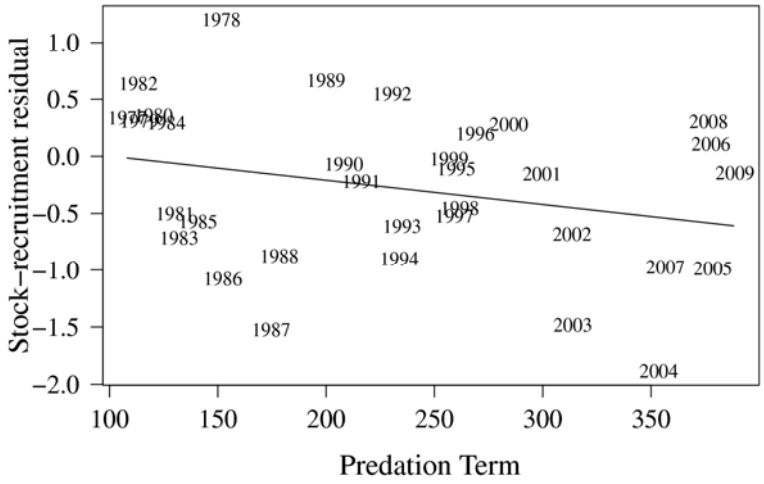
(modified from Mueter et al. 2011)

Model of predation impact

$$pred = \sum_{i=1}^{strata} \left(\frac{Q}{B} \right) B_i \, p_i$$



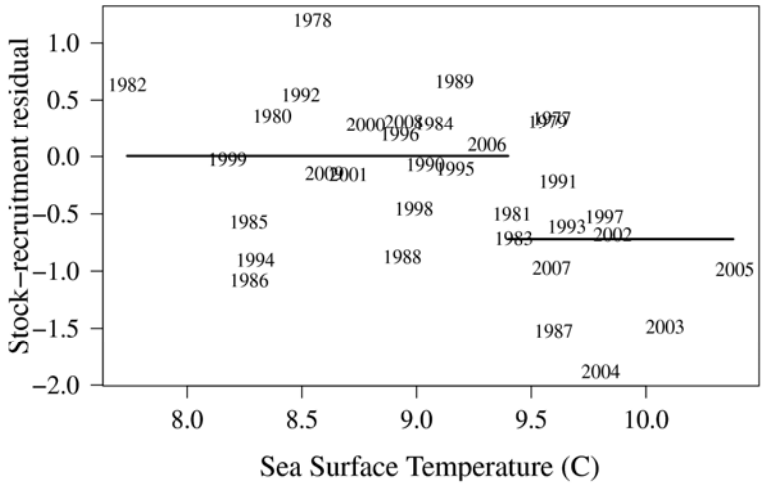
Model of recruitment residuals



SST >= 9.4 C

SR residual =

0.500 -0.002*Pred(lag 1) -0.725



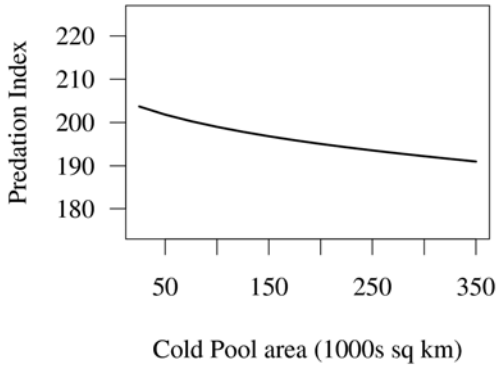
SST < 9.4 C

SR residual =

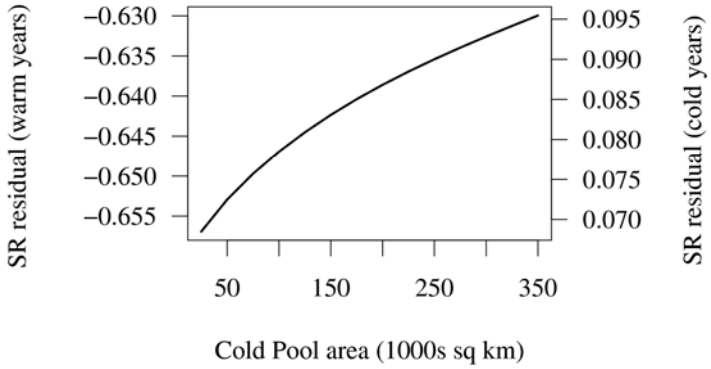
0.500 -0.002*Pred(lag 1)

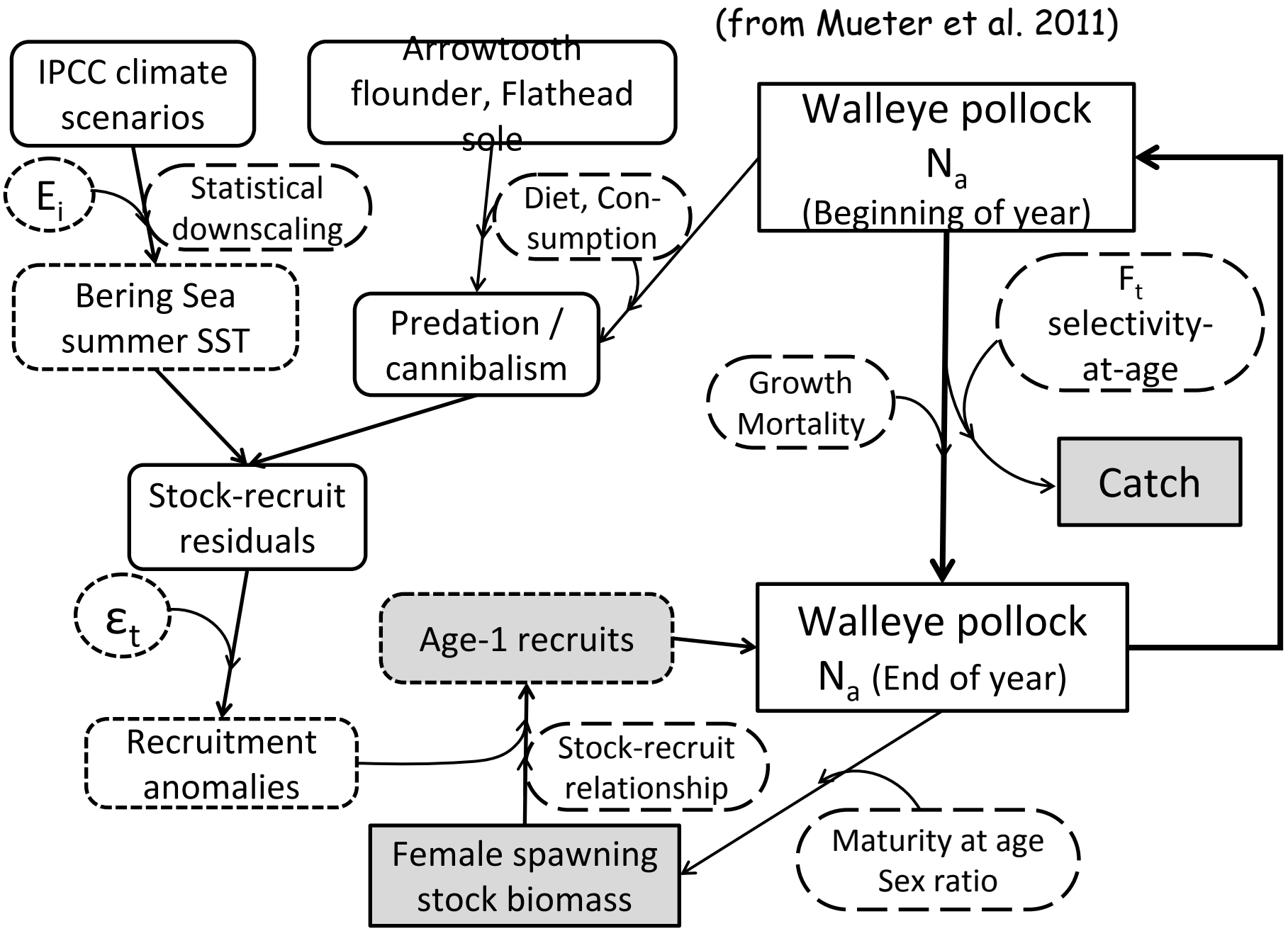
How sensitive are the predation index and stock-recruitment residuals to changes in the cold pool?

(Assume constant arrowtooth and pollock prey biomass)



~ 6% reduction in predation index over this range of cold pool area




(from Mueter et al. 2011)
IPCC climate scenarios
Arrowtooth flounder, Flathead sole
Walleye pollock N_a (Beginning of year)
E_i
Statistical downscaling
Diet, Con-sumption
Bering Sea summer SST
Predation / cannibalism
F_t selectivity-at-age
Growth Mortality
Catch
Stock-recruit residuals
ε_t
Age-1 recruits
Walleye pollock N_a (End of year)
Recruitment anomalies
Stock-recruit relationship
Female spawning stock biomass
Maturity at age Sex ratio

Conclusions

1) The spatial distributions of arrowtooth flounder are more sensitive to variations in the cold pool than those of age 1 walleye pollock, resulting in variable overlap in the middle shelf.

2) Changes in the area occupied by arrowtooth flounder occur primarily in the southeast middle shelf, which contributes a relatively small portion of the age 1 pollock spatial distribution.

3) Stock-recruitment residuals are more strongly influenced by SST than by the predation index.

4) Future work will evaluate modeling the predation mortality.