University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Some recent CBL blue crab research

M. Wilberg, D. Liang, G. Nesslage, T. Miller, R. Woodward, P. Huang, and D. Tomberlin

October 14, 2019

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Precautionary management

- Management often includes a buffer away from the "best" estimates as a form of precaution
- E.g., the blue crab target exploitation rate is 75% of the limit
- Is that amount of precaution too much or too little?

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Robust control for precautionary management

- Robust control is a way of making management decisions that plans for a poor outcome
- The goal is to make the best decision assuming you will be in a weak position
- E.g., what should your limit exploitation rate be if you assume productivity will be low?

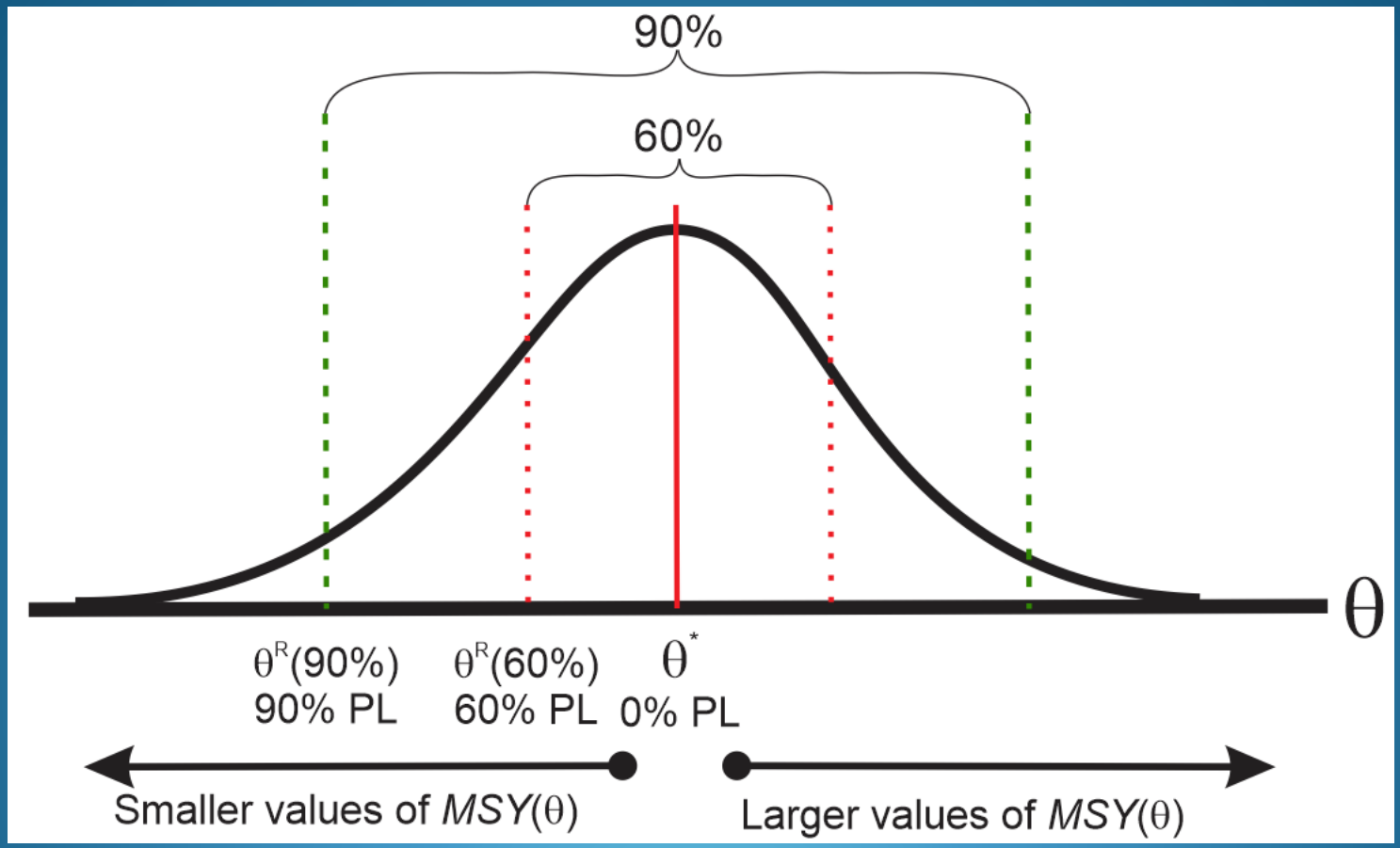
University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Robust control for precautionary management

- We can combine this idea with the profile likelihood approach to find the option that maximizes long-term yield under a lower confidence interval for the estimated MSY

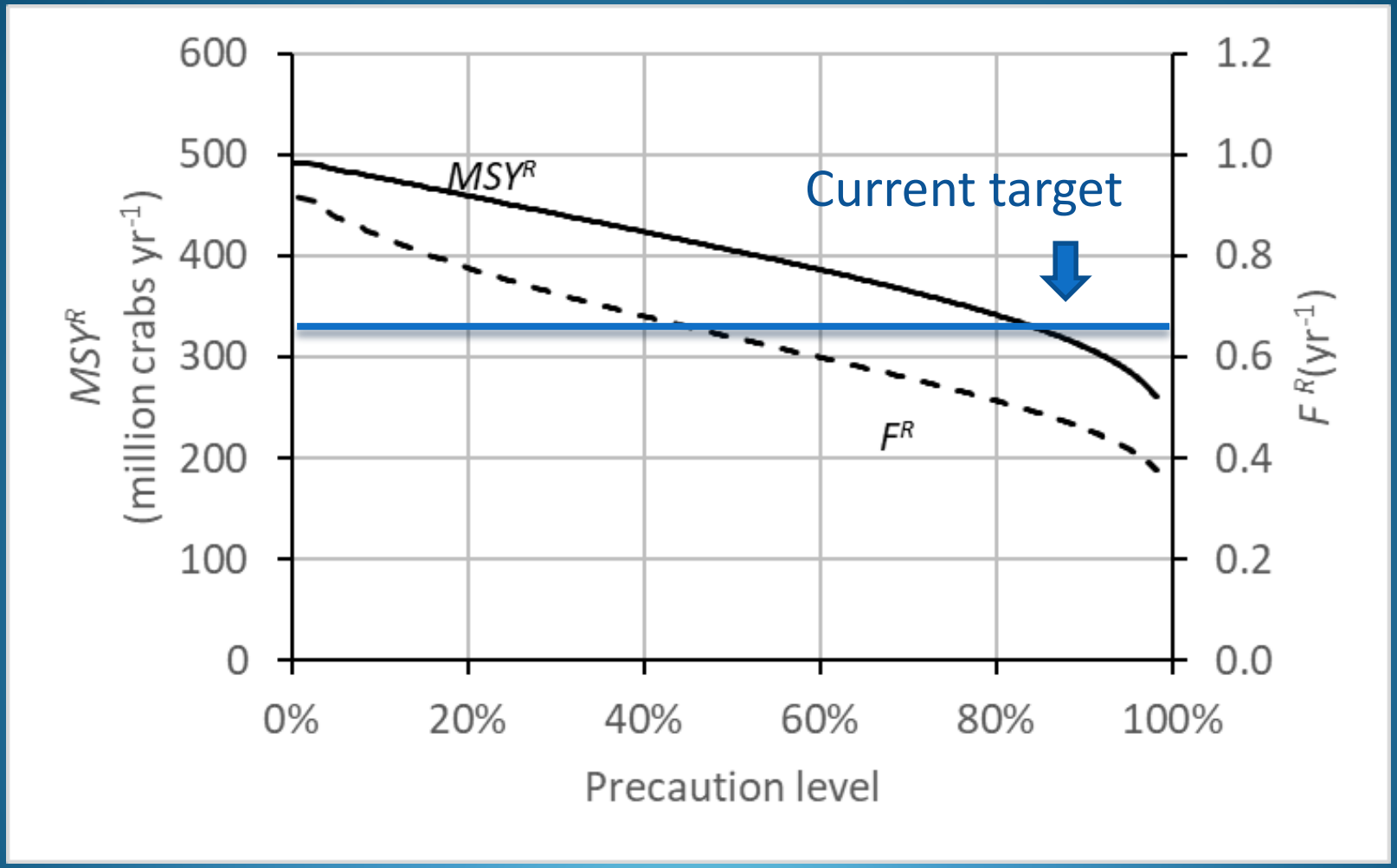
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Robust control example



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Results



University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Conclusions

- We have alternative approaches for setting precautionary buffers that allow for a more explicit inclusion of uncertainty
- Using robust control allows one to specify how much robustness is desired in management and uses that amount to find an optimal solution

University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Analysis of traditional survey

- Simple random surveys and stratified random surveys are robust statistical designs that lead to unbiased estimates of the mean and sampling variance
- But design based methods do not consider non-sampling variance and often ignore vast amounts of accessory data that are collected simultaneously with the sampling
- Can we use these data to improve estimates?

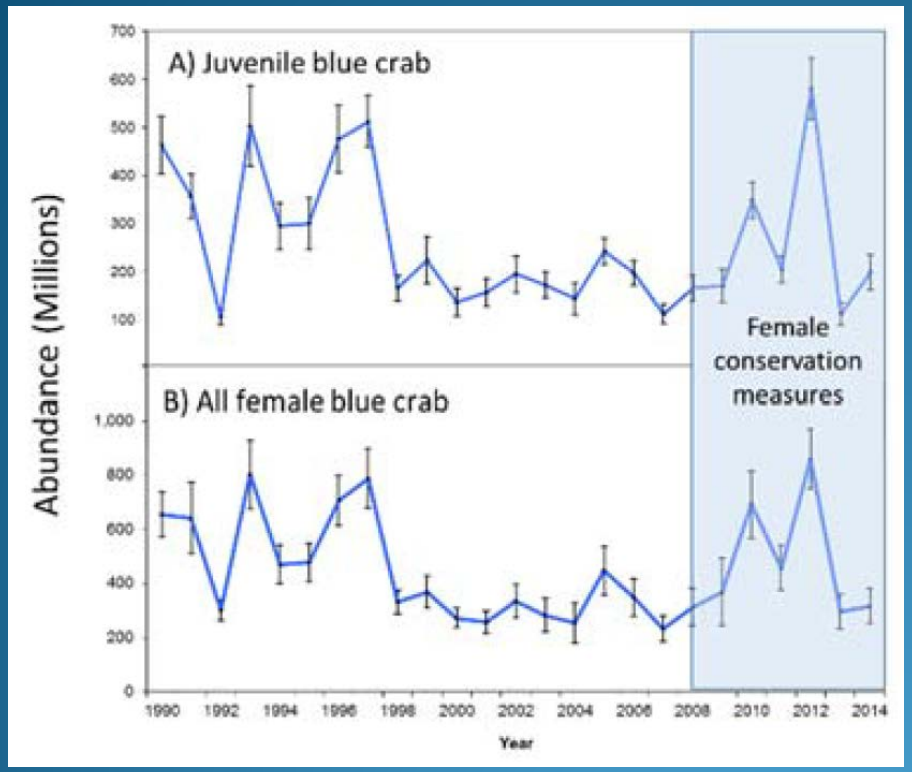
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

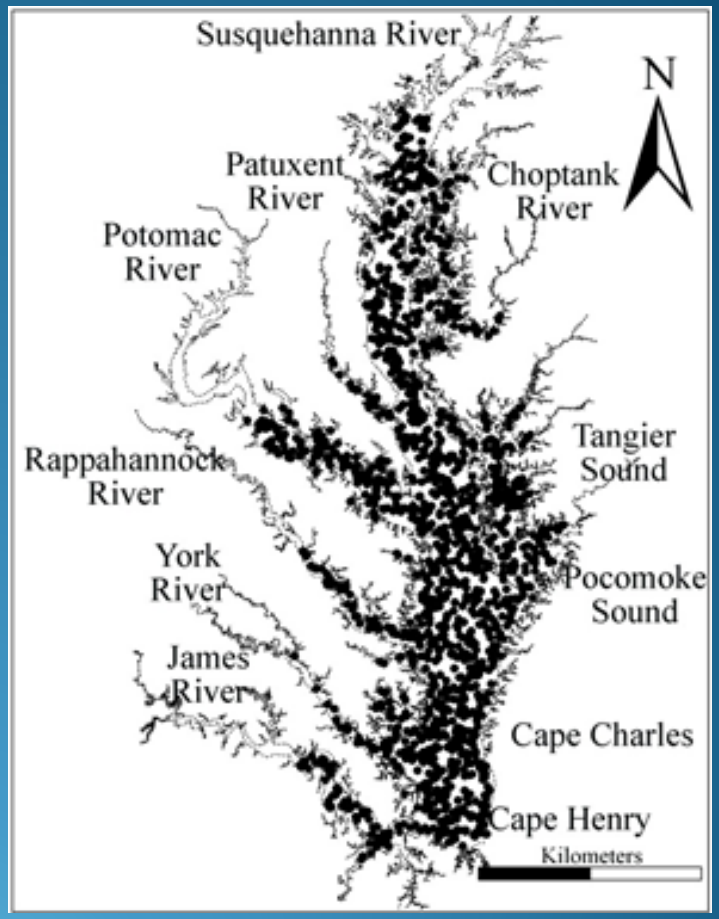
Model assisted estimation

- Locational information is routinely collected during fisheries surveys.
- Fisheries catch data are sometimes zero-inflated and spatially auto-correlated.
- Can locational information collected by surveys be used to enhance abundance and standard error estimates?

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Winter Dredge Survey





- What is the fate of the 2011 year class?

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

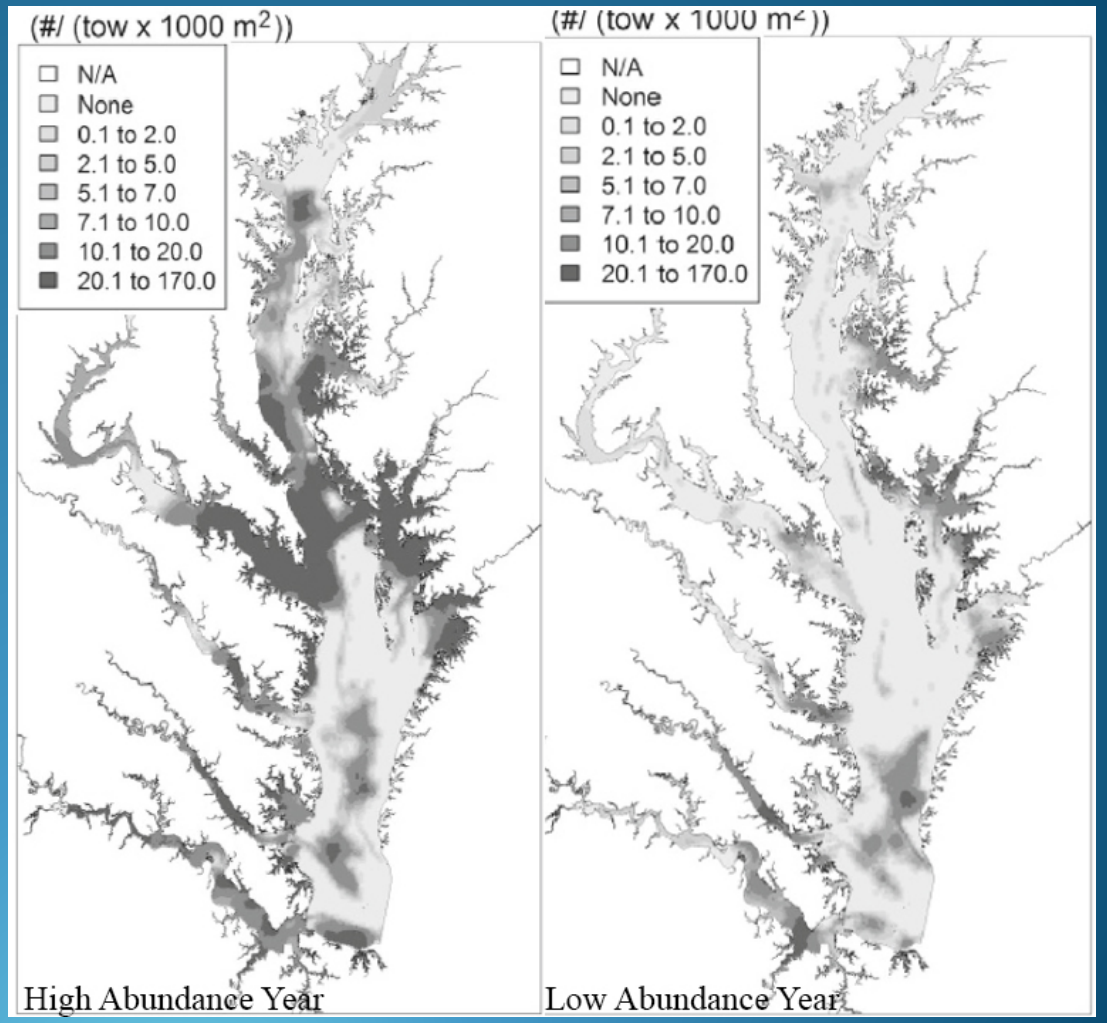
Approach

- Develop a geostatistical and zero-inflated model of catch.
- Use predicted (Kriging) catch as an auxiliary variable to calibrate abundance index estimate.
- Use Bayesian methods to estimate abundance and standard error.
- Conduct simulation studies to investigate the performance of the proposed estimator.

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

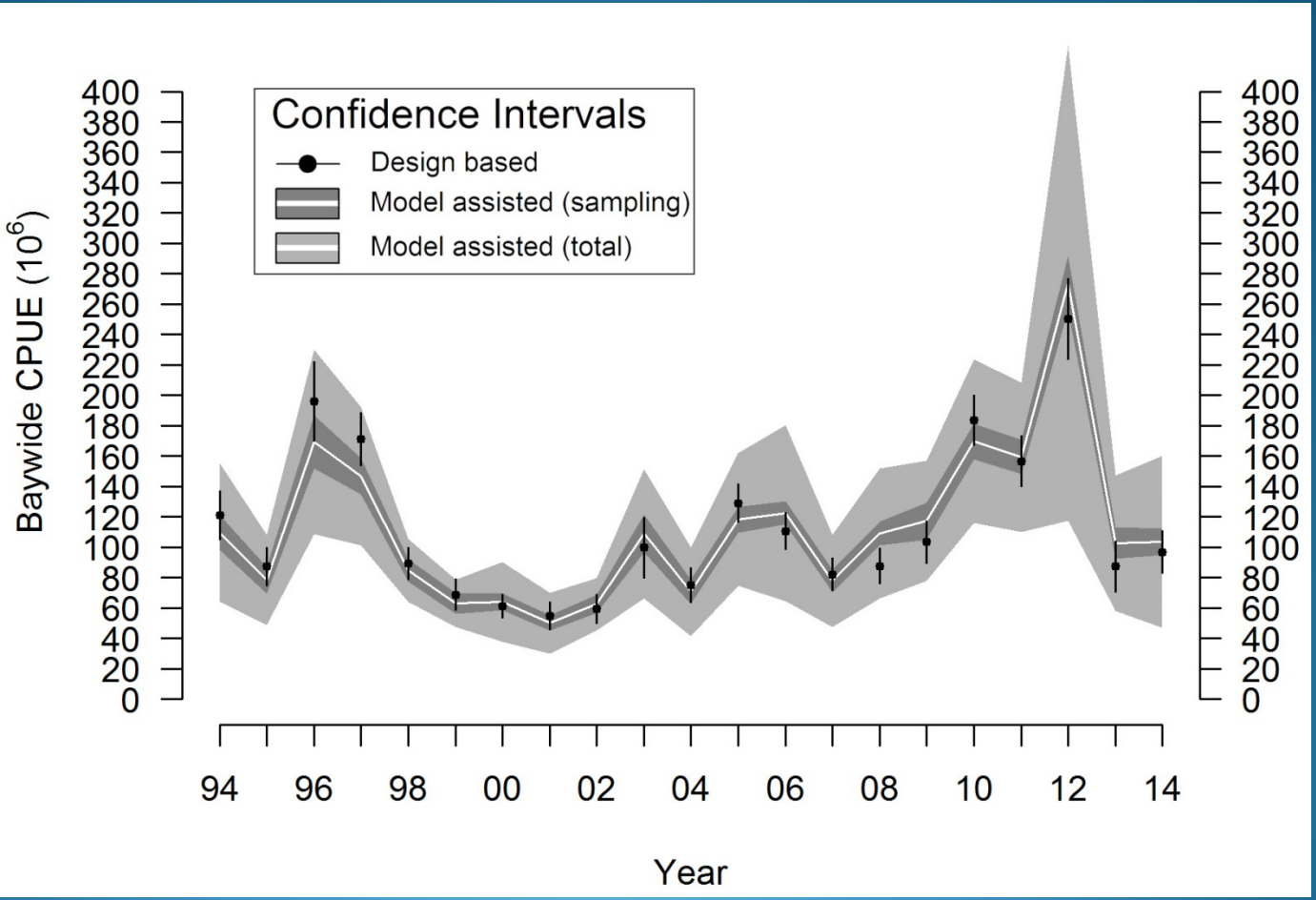
Maps of winter distribution

- Spatial patterns of blue crab distribution were consistent across year.
- High densities occurred in lower Bay tributaries and eastern shore embayments.



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Bayesian calibration estimates



Liang, D., Nesslage, G., Wilberg, M., & Miller, T. (2017), JABES

University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Conclusion

- The 2011 year class had a high point estimate, but when total standard error was considered, was not significantly different from adjacent years.
  - The year class may not be as strong as initially thought.
- Variance due to non-sampling factors is important to consider in the analyses of probabilistic surveys.
- Bayesian calibration based on the posterior distribution generated unbiased estimates of abundance and variance.

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Funding and prioritization

- The robust control project was funded by Maryland Sea Grant as a way to include more social science in ecosystem-based management
- The Bayesian calibration project was funded by the CB Trust and was a priority identified by CBSAC and the Fish GIT