

Seasonal Climate Predictions to Improve Fisheries Management Decisions

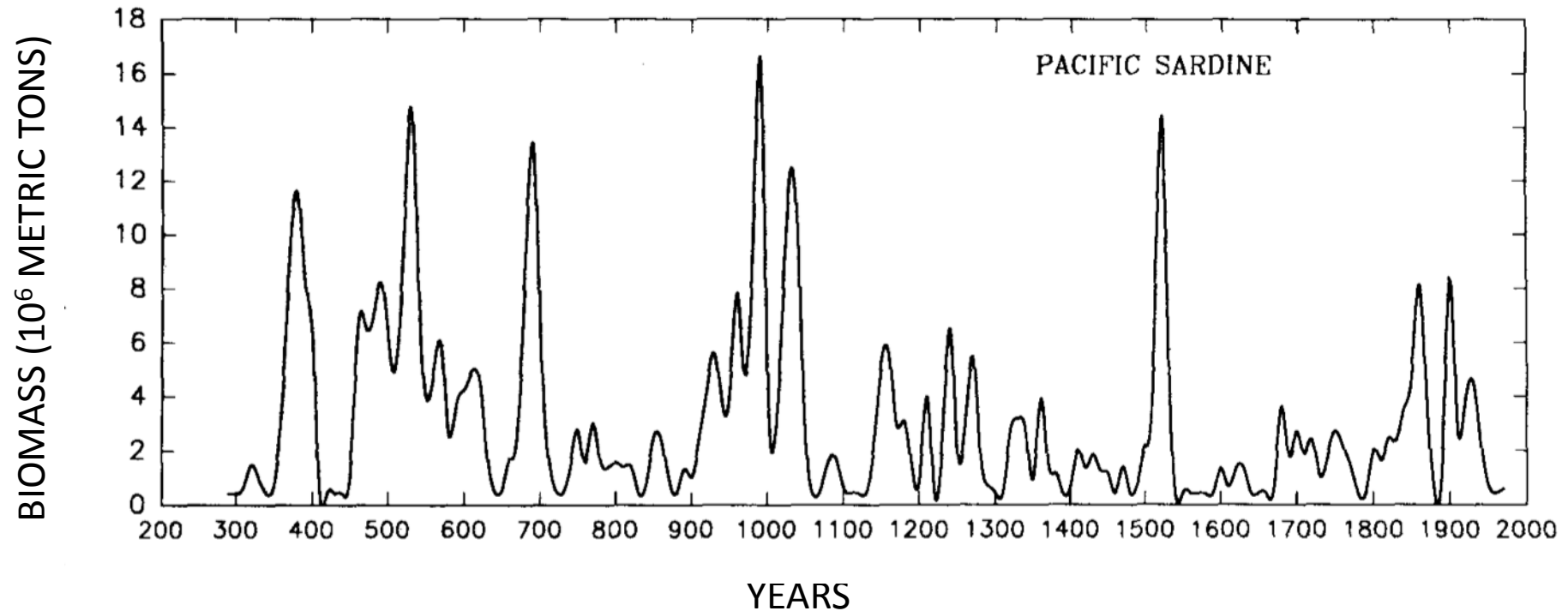
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Princeton University  NOAA Fisheries  NOAA GFDL



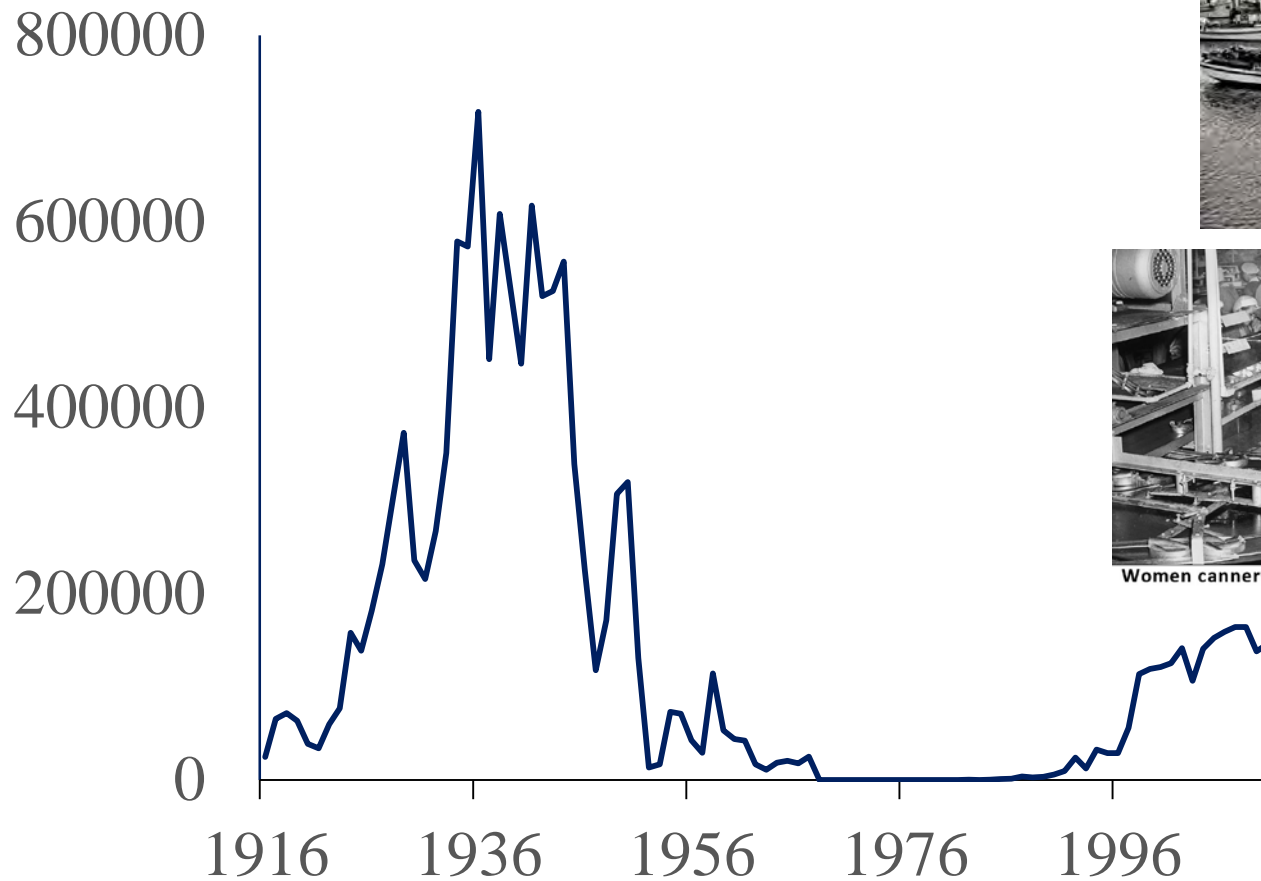
Climate variability affects fish dynamics



Baumgartner et al. 1992

Often unable to set adequate coping strategies

Pacific sardine
Landings (mt)



Unloading sardines - 1920s



Women cannery workers on the line - 1949



End of an Era - Cannery Row.1950

Robust Pacific sardine-SST recruitment relationship

Recruitment Anomaly

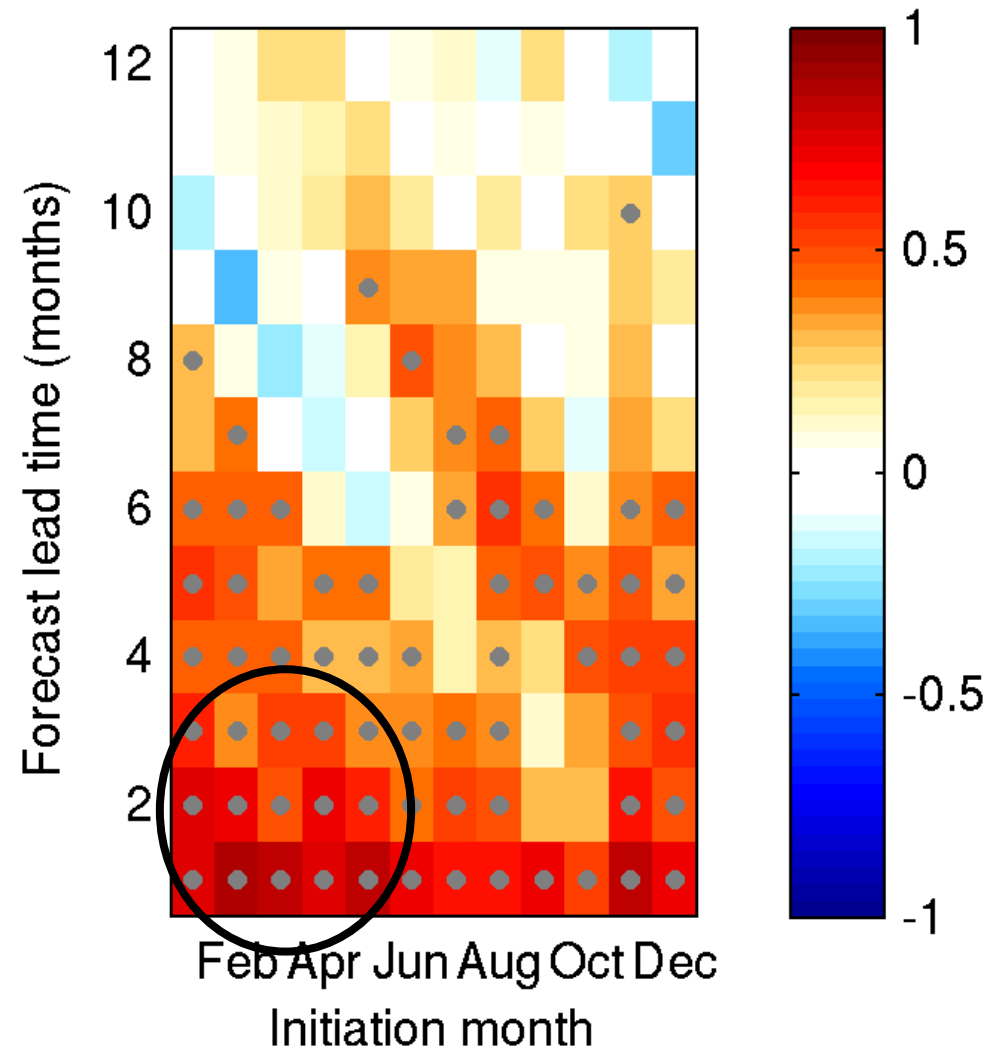
Poor recruitment of Pacific sardine when SST is low in southern California spawning grounds

SST

Lindegren and Checkley 2013

Skillful SST forecast at a fishery relevant scale

Anomaly Correlation
Coefficient
between observations and
GFDL FLOR model hindcast
(reforecast) from 1982-2008



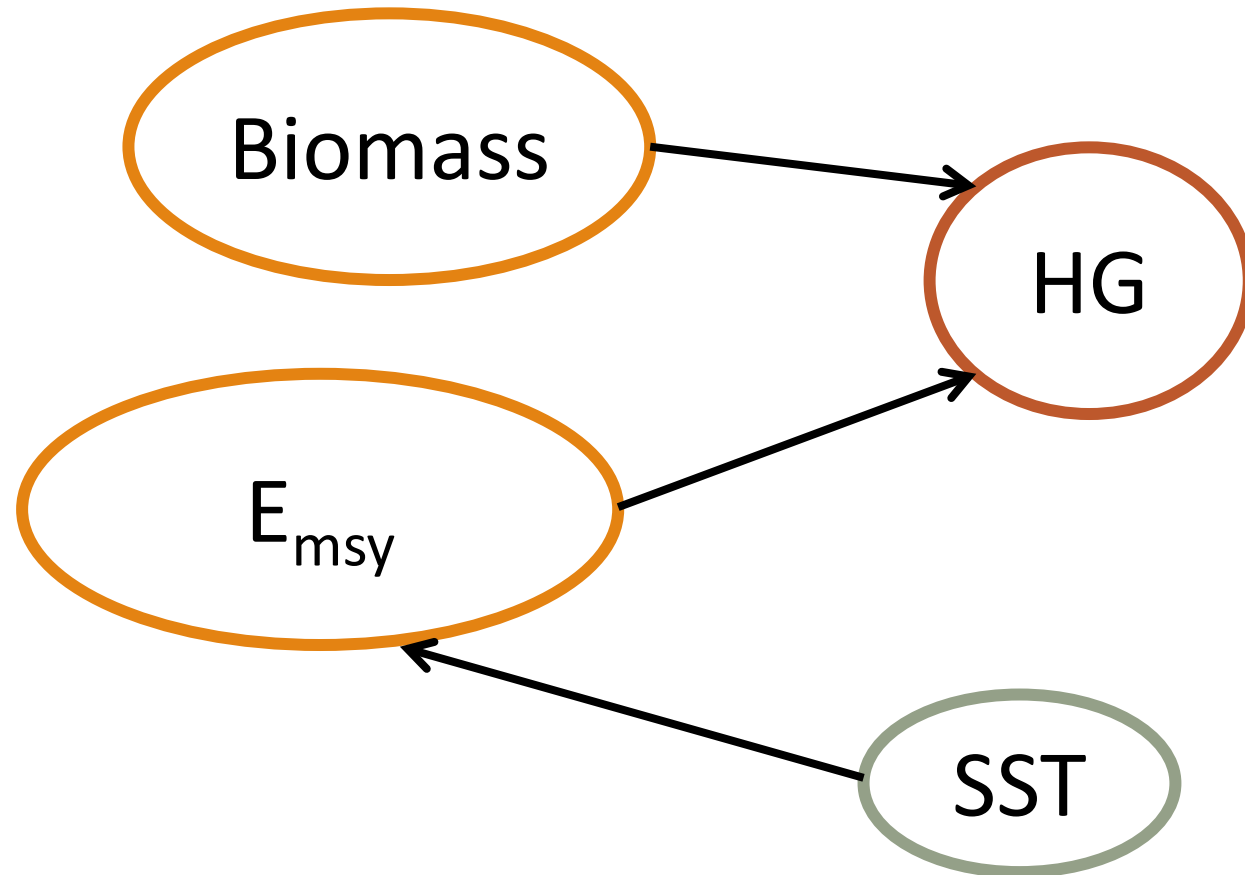
Can incorporation of climate predictions make management more effective?





How many sardines
will I allow to be
caught next year?

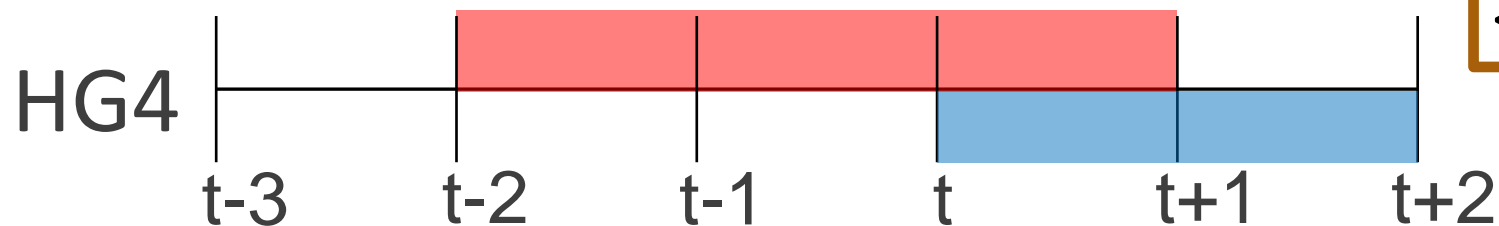
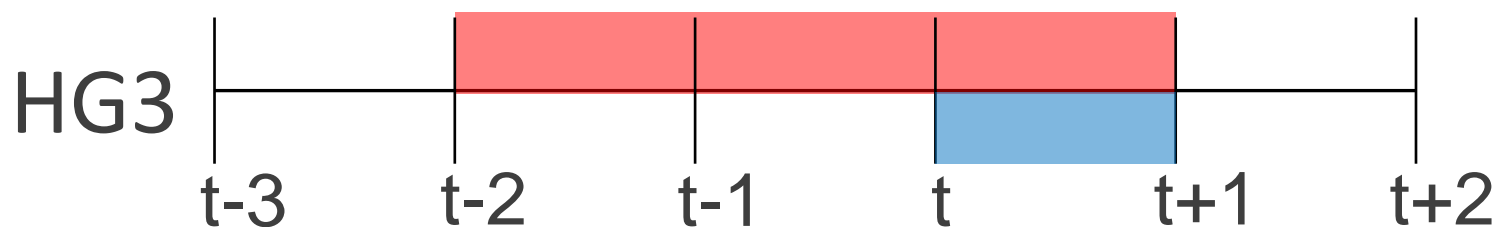
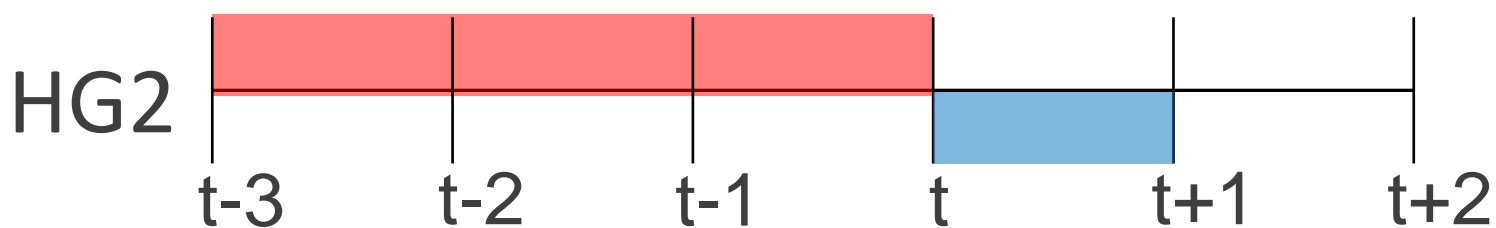
Set a Harvest Guideline (HG)



Compared effectiveness of four different HGs

Environmental Considerations

HG1 – constant E_{msy} of 0.18



SST averaging window for E_{msy}

Biomass

No harvest when biomass < 150,000 mt

Methods

- The effectiveness of HGs assessed through a **Management Strategy Evaluation (MSE)**
- Stock dynamics simulated from **1945-2008** to include low-productivity conditions, across **1000 realizations** of stochastic variability in recruitment and SST forecast error.

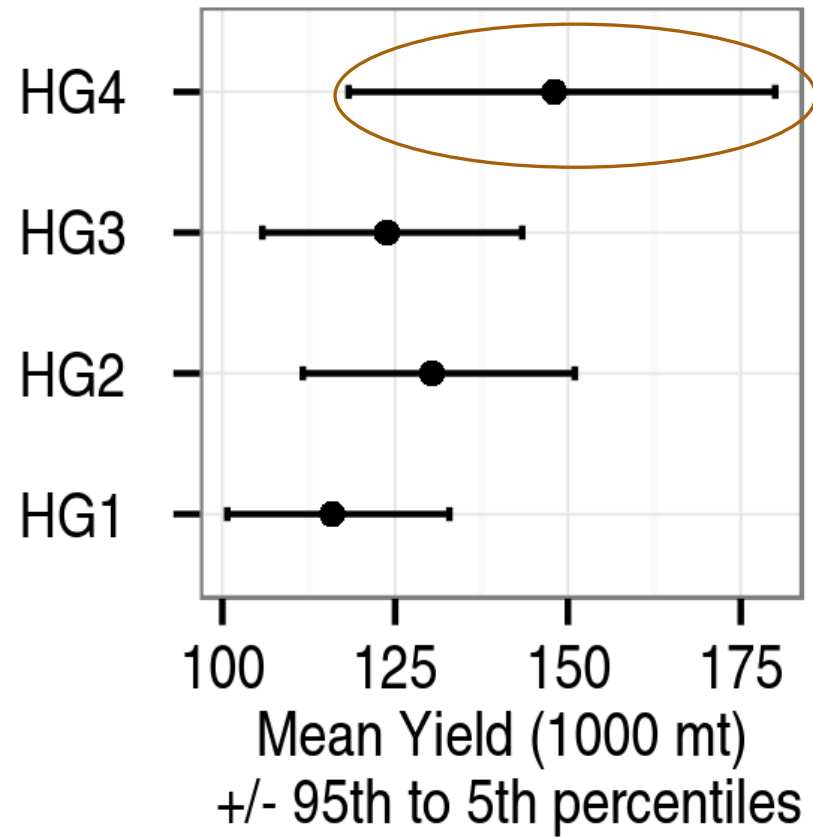
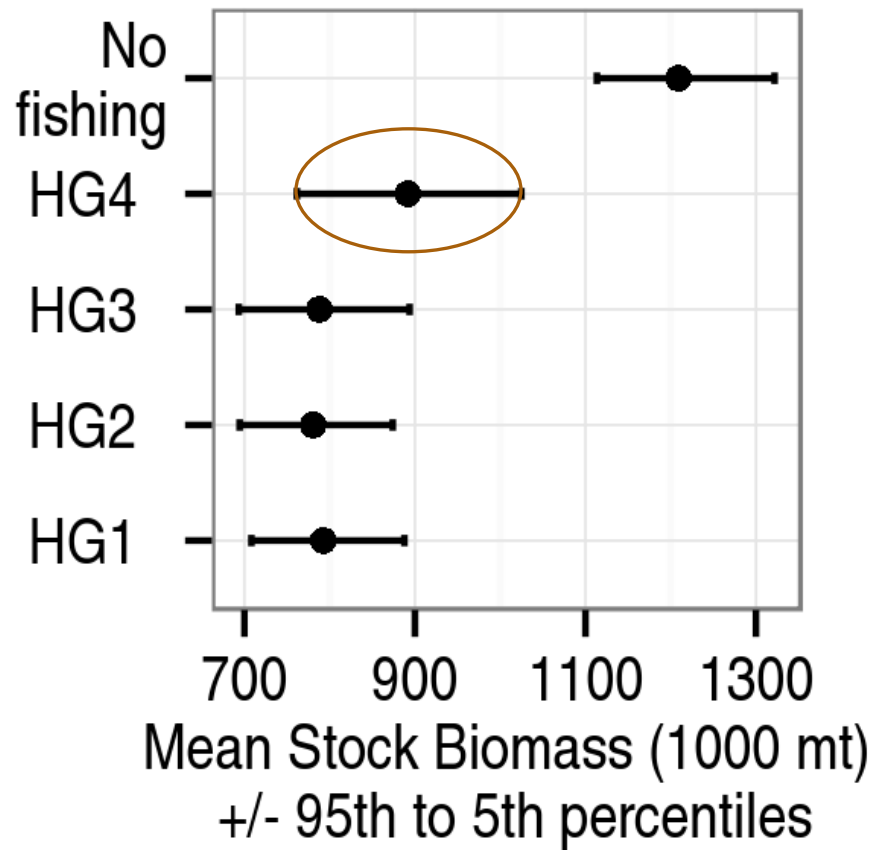


Management effectiveness evaluated through 6 performance metrics:

- Average and variability of the catch
- Average and variability of the stock biomass
- Probability of catch falling below 50,000 mt
- Probability of stock biomass falling below 400,000 mt

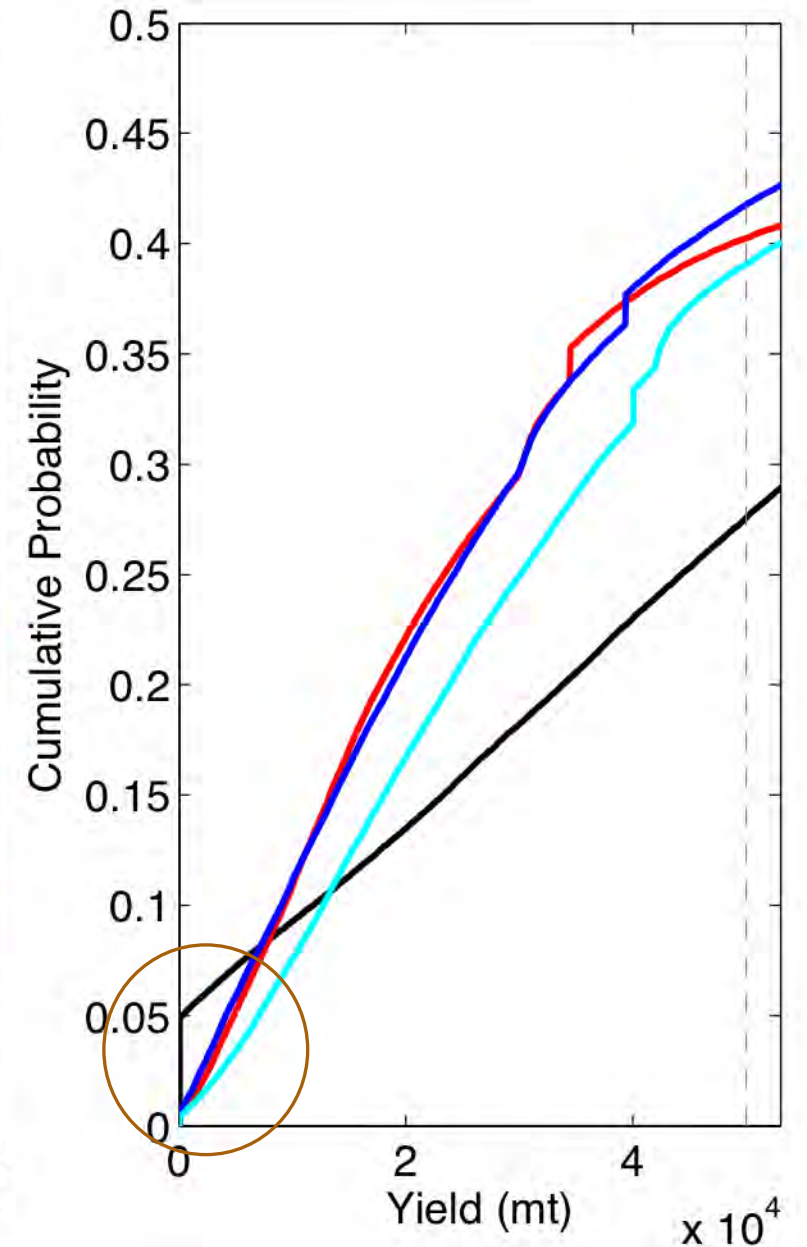
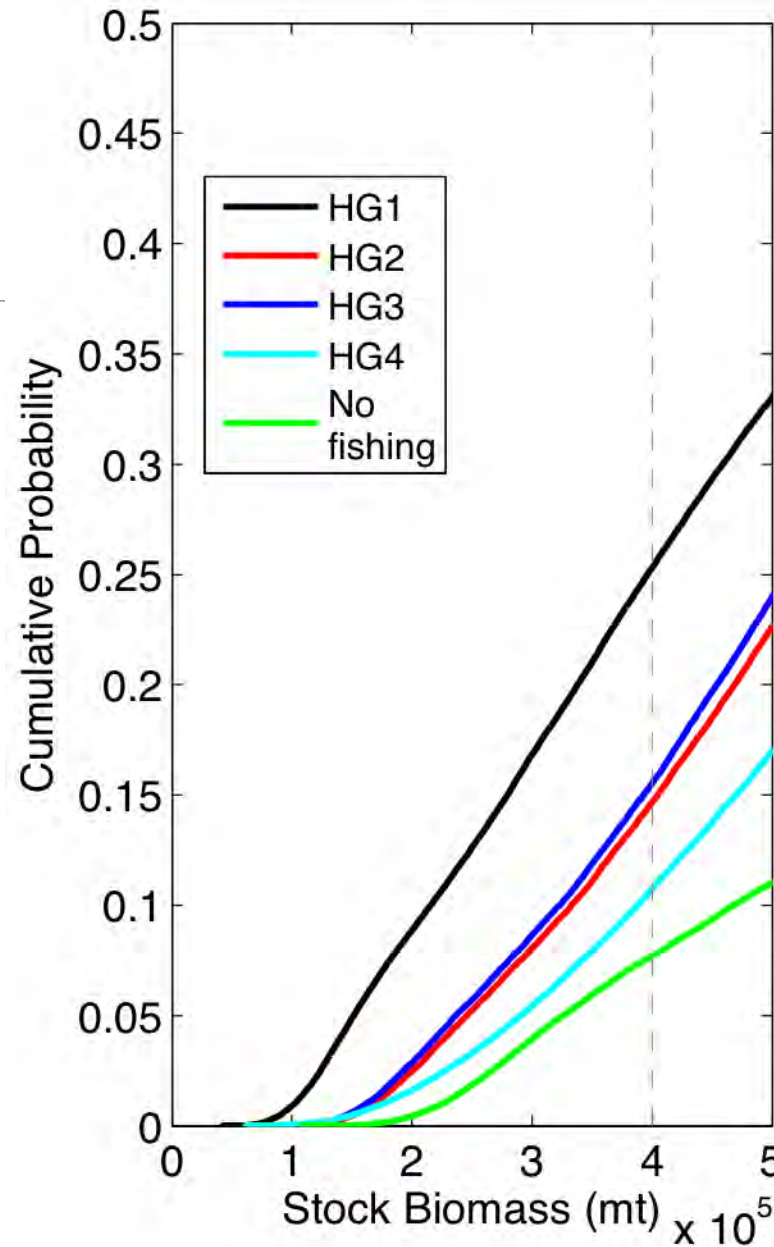


Results



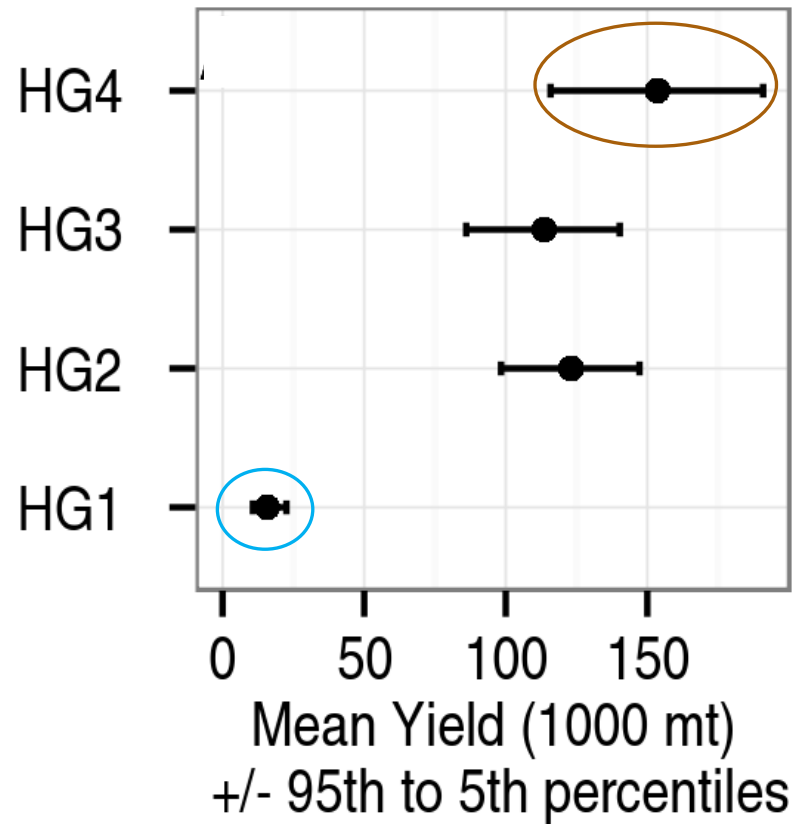
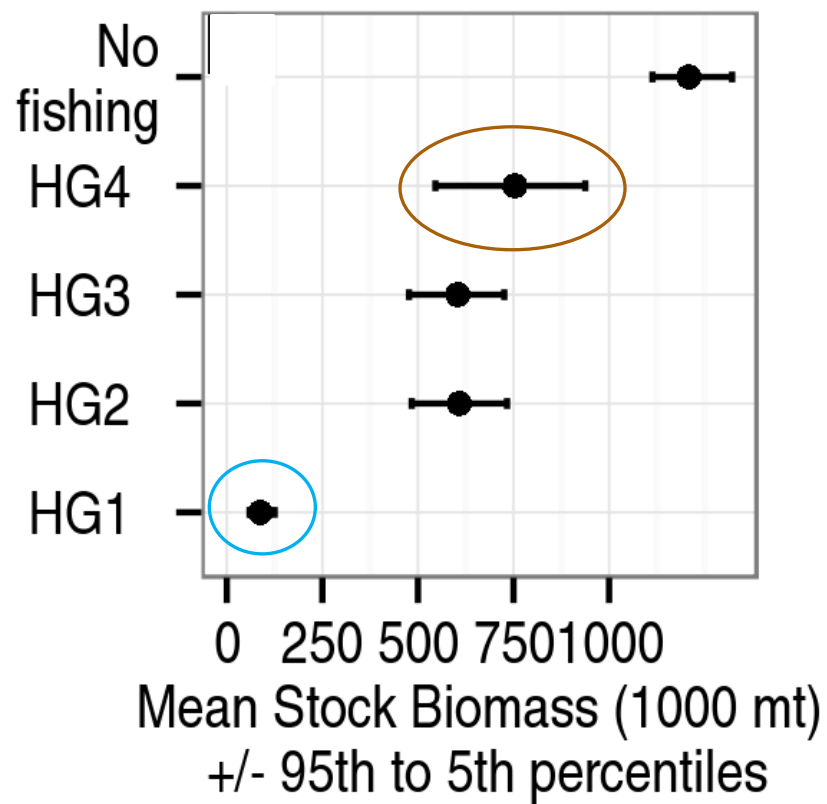
HG1 = no SST
HG2 = past SST
HG3 = forecast SST
for fishing rate
HG4 = forecast SST for
fishing rate and
biomass forecast

Results



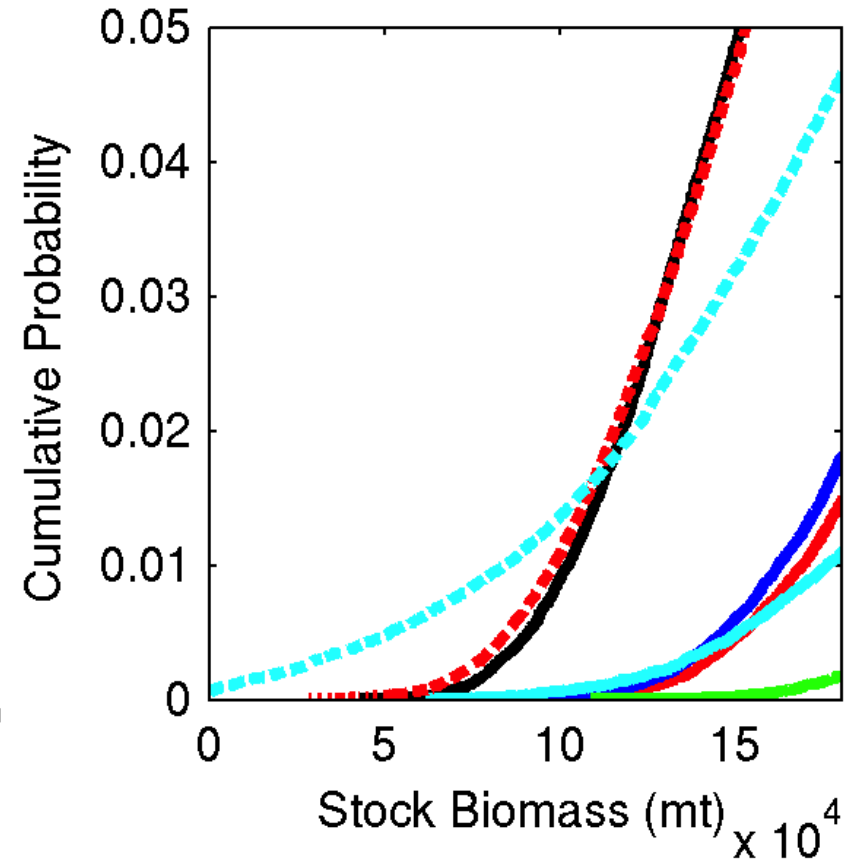
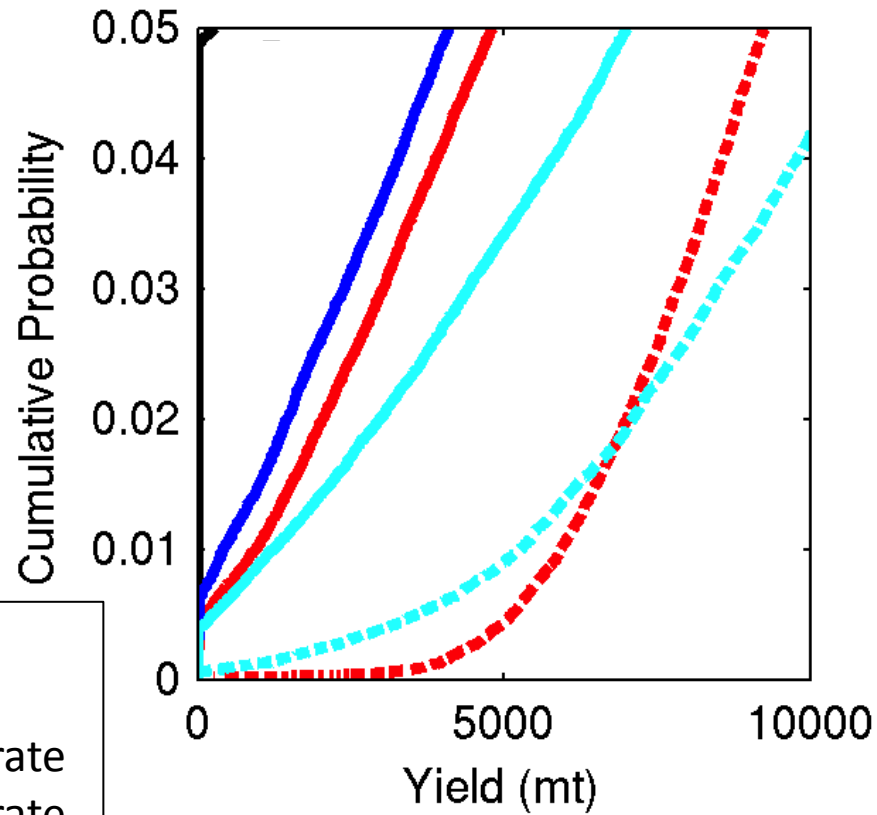
HG1 = no SST
HG2 = past SST
HG3 = forecast SST for fishing rate
HG4 = forecast SST for fishing rate and biomass forecast

Tested robustness of results to removal of harvest cutoff



HG1 = no SST
HG2 = past SST
HG3 = forecast SST
for fishing rate
HG4 = forecast SST for
fishing rate and
biomass forecast

Tested robustness of results to removal of harvest cutoff



HG1 = no SST
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Conclusions



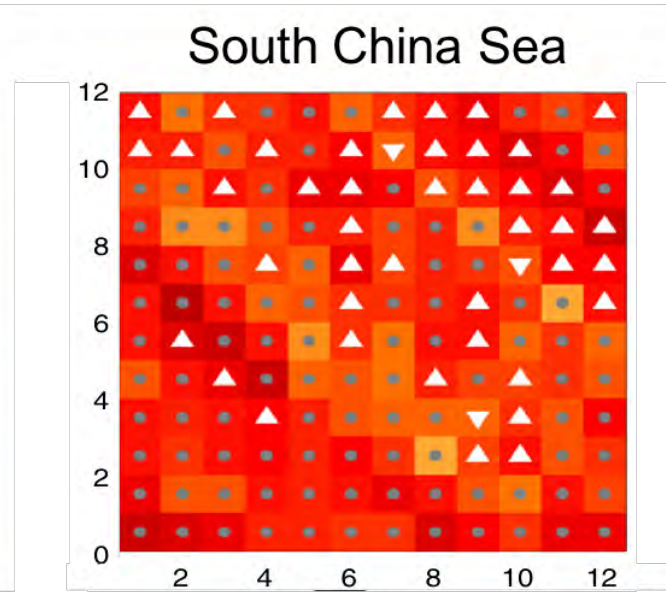
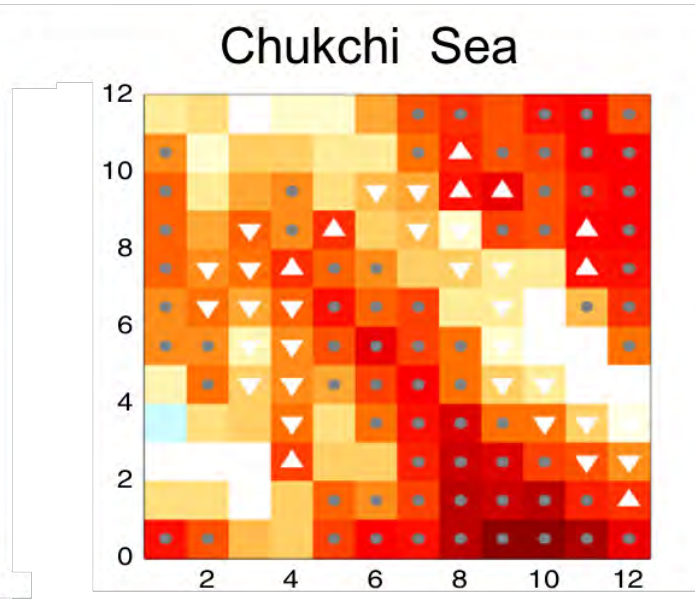
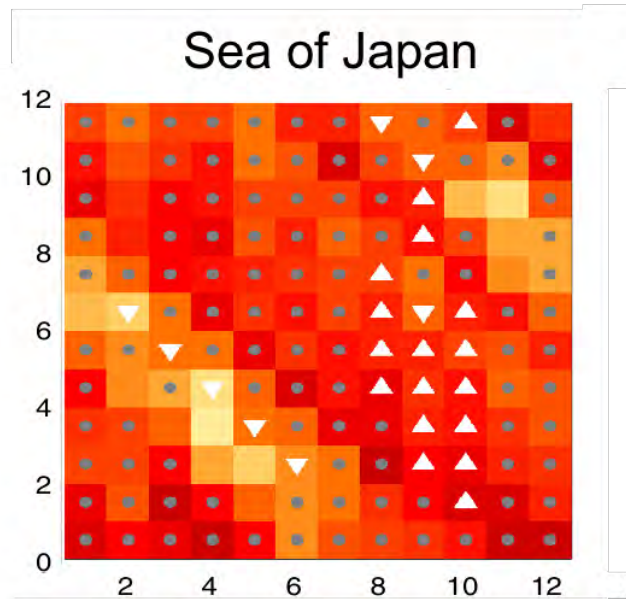
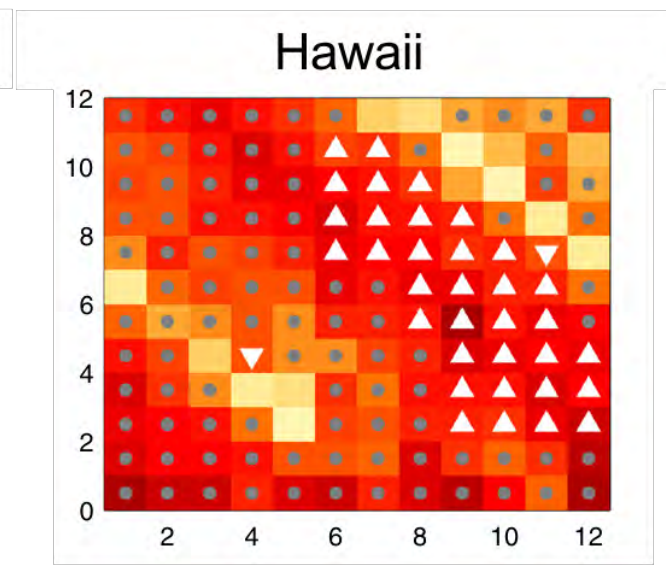
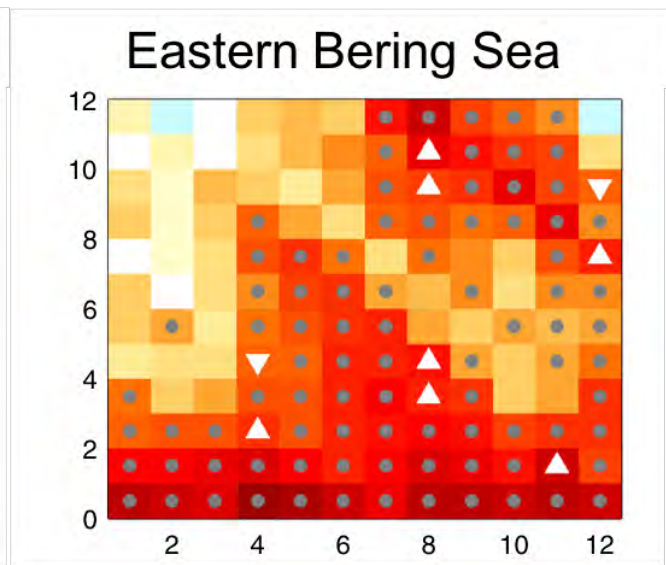
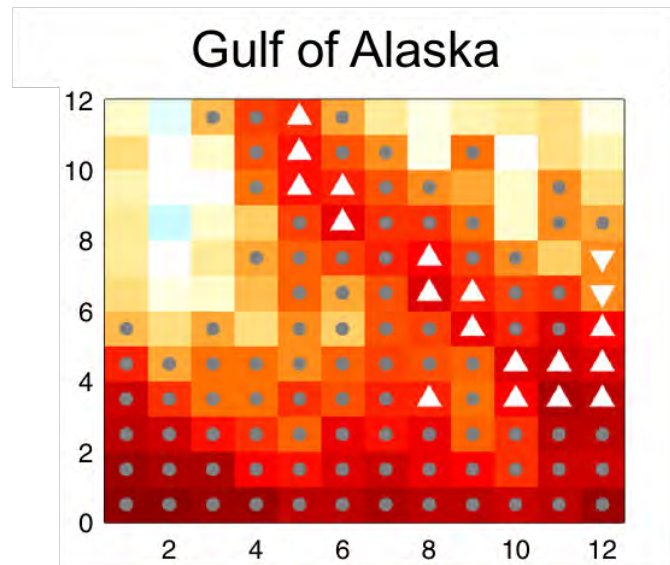
- Using SST predictions to anticipate short-term changes in stock biomass leads to more effective catch targets.
- The forecast-informed HG has to be combined with a harvest cutoff at low biomass to mitigate the risk of collapse in the event of an erroneous forecast

Future Work

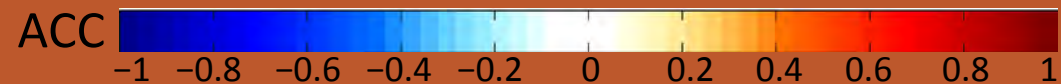
- Include full stock assessment model
- More mechanistic recruitment model
- Human dimension
- Upper trophic levels
- Apply to other species



SST Forecast lead (months)



Initialization month



Thank you!

For more information:

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Tommasi et al., 2017. Improved management of small pelagic fisheries through seasonal climate prediction. *Ecological Applications*, doi: 10.1002/eap.1458



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