

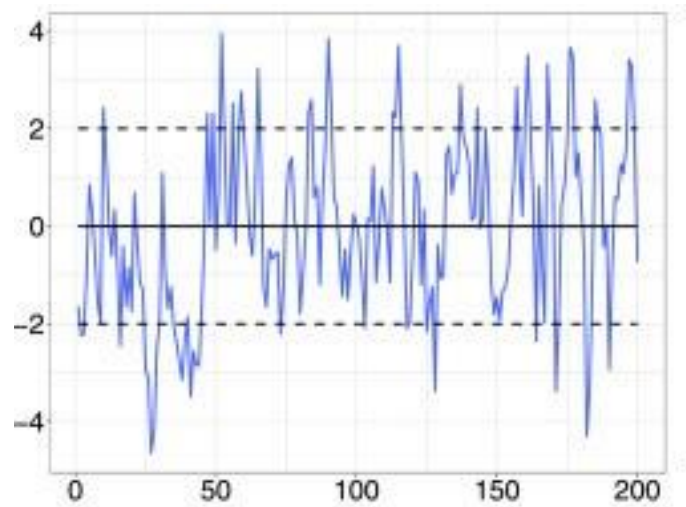
**NOAA
FISHERIES**

Harvest control rules in a changing environment: lessons for confronting non-stationarity in the U.S. Caribbean

Matt Damiano, Kyle Shertzer

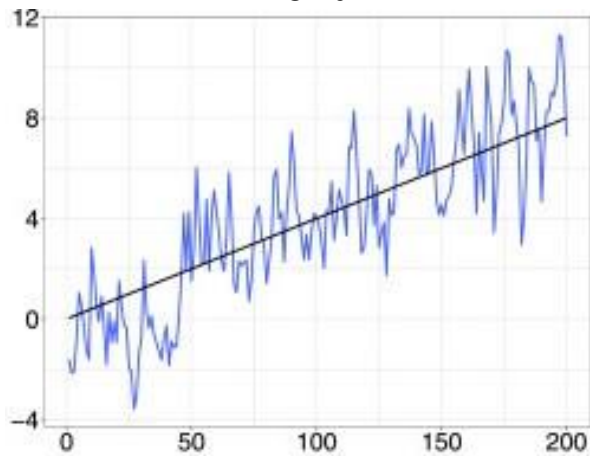
NOAA Fisheries, Southeast Fisheries Science Center

Stationarity

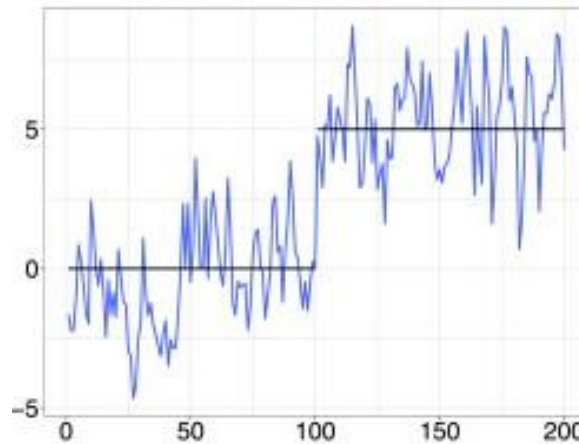


Nonstationarity

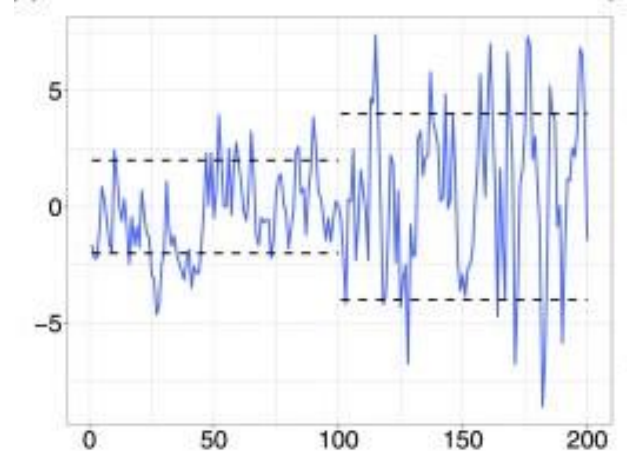
Trend



Shift in the mean

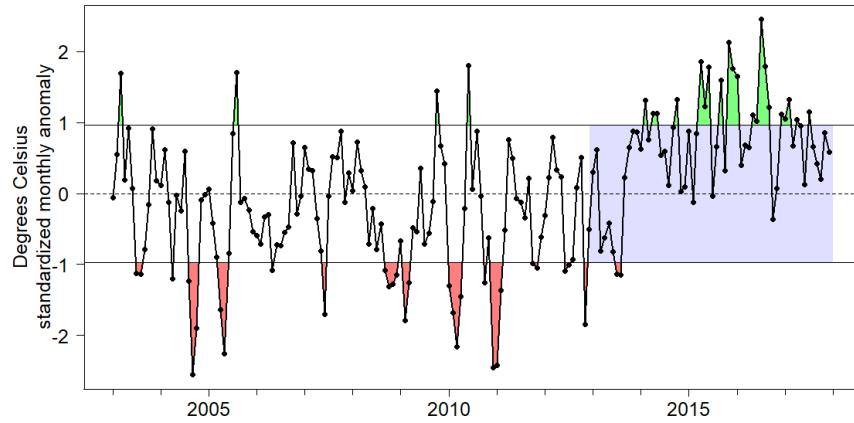


Shift in the variance

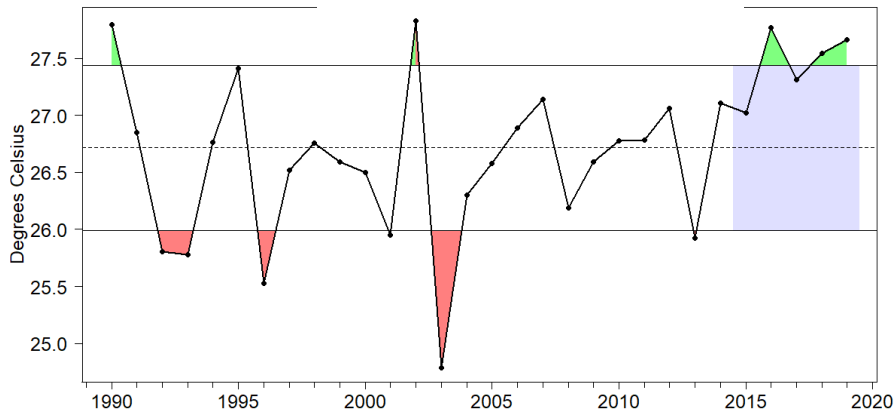


Examples of environmental nonstationarity in the SA

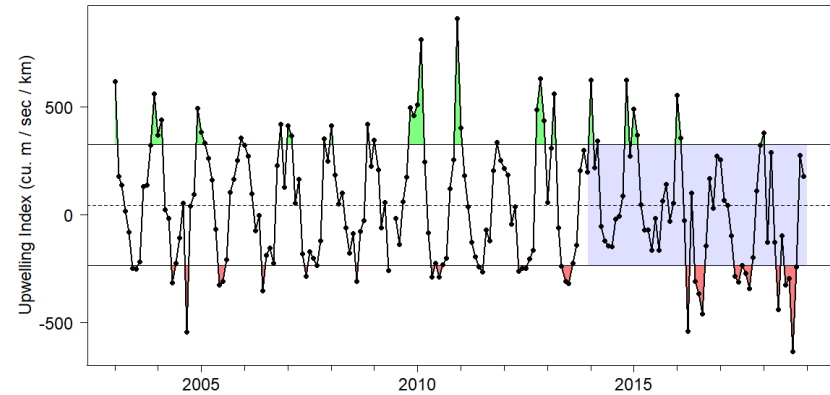
Sea Surface Temperature



Bottom Temperature



Upwelling



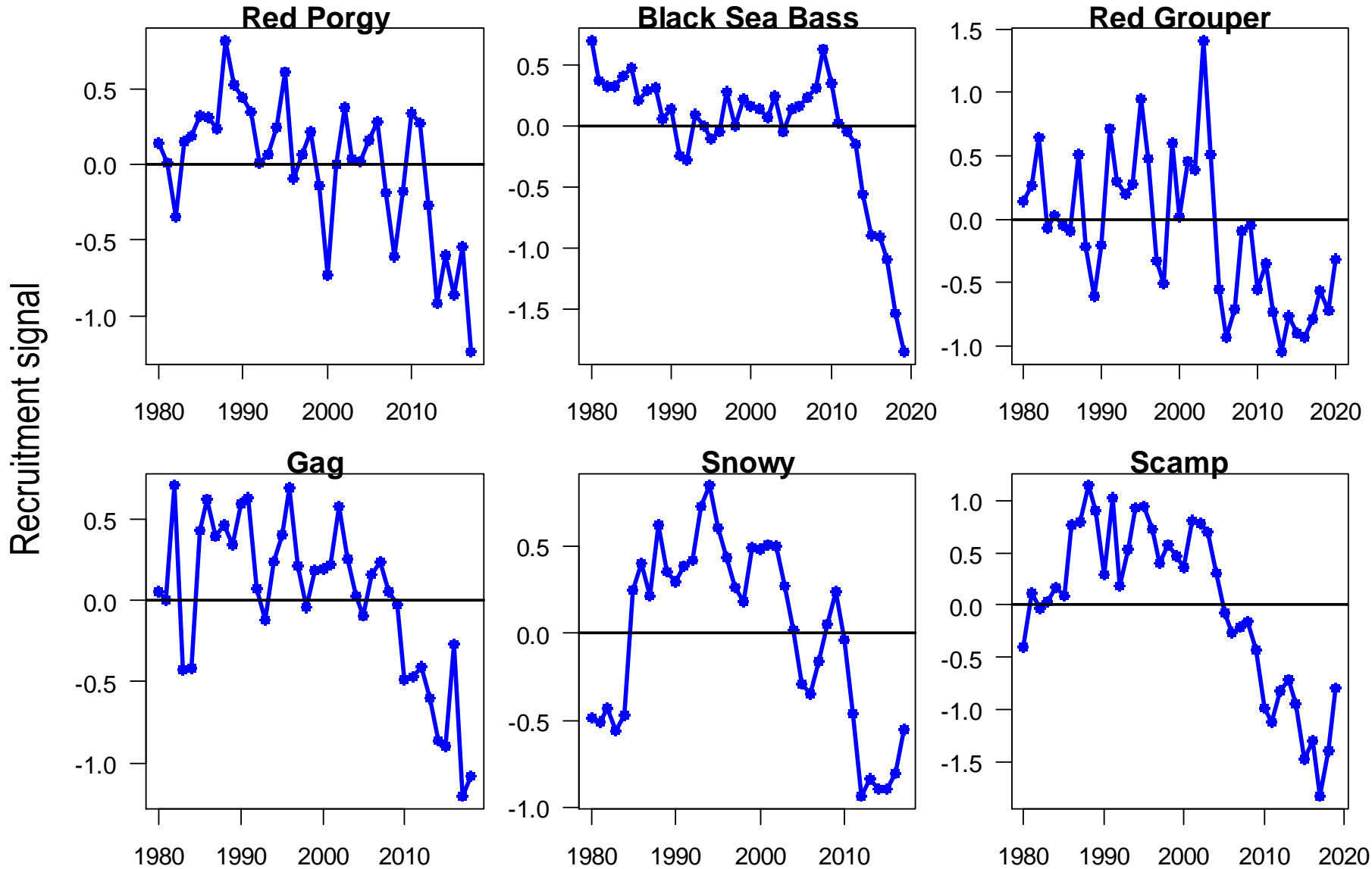
Environmental nonstationarity can affect fish populations

- Spatial distribution
- Growth rates
- Survival rates
- Recruitment ... *Maybe in the SA?...*

Evidence of recent poor recruitment in the SA

- Stock assessments: black sea bass, gag, scamp, red grouper, red porgy, snowy grouper
- SERFS trends reports: bank sea bass, knobbed porgy, sand perch, scup
- Peer-reviewed publications:
 - Scamp (*Bacheler & Ballenger 2018*)
 - Red porgy (*Bacheler et al. 2023*)
 - Multiple species (*Wade et al. 2023*)

Estimates of recruitment from stock assessments



Implications of recruitment nonstationarity

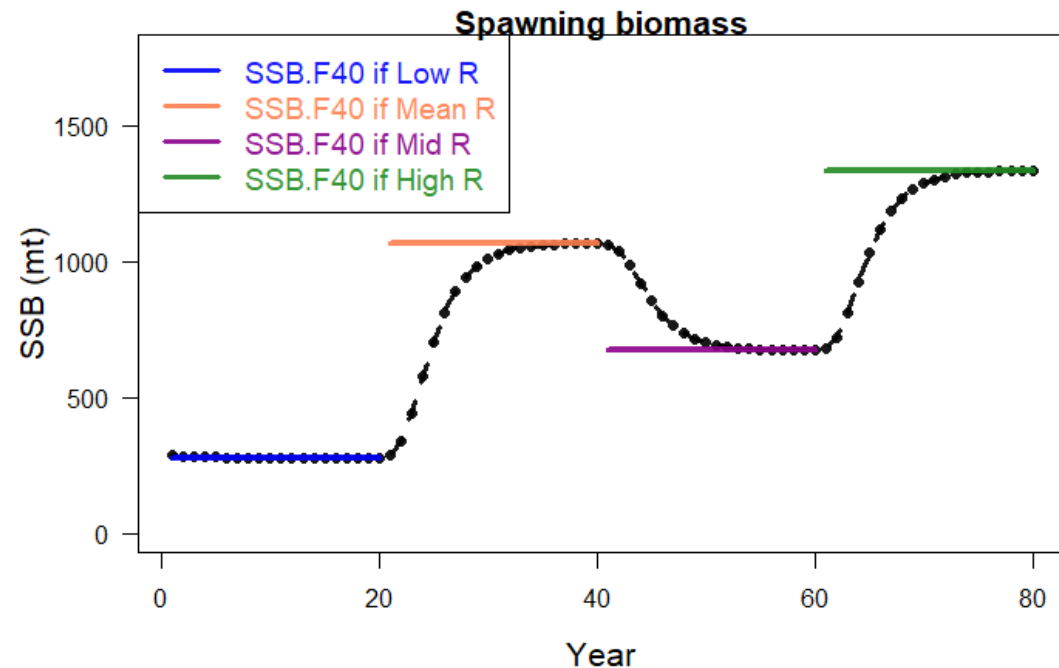
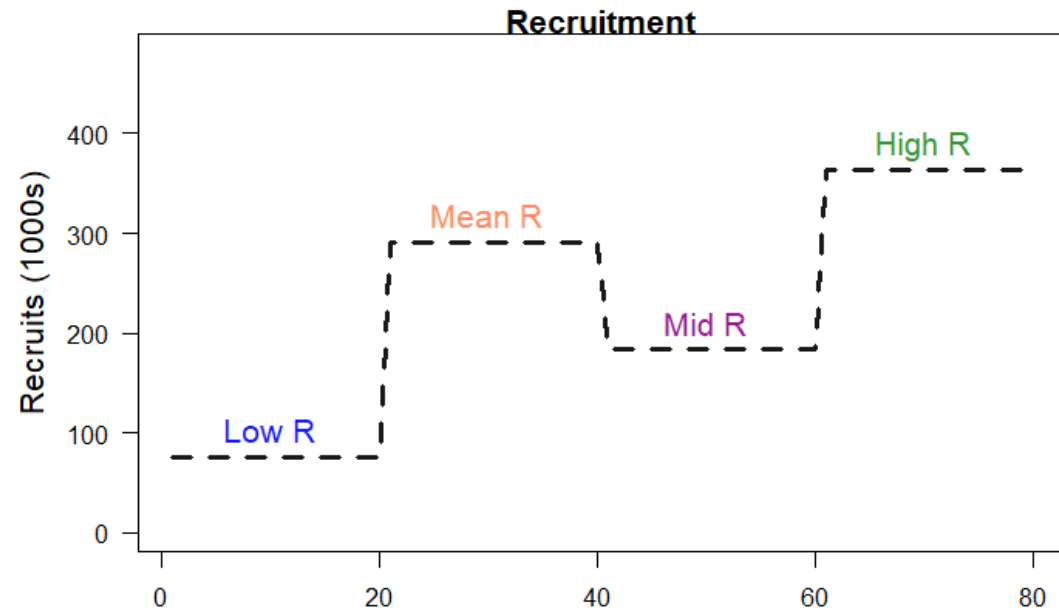
- Biomass benchmarks (e.g., B_{MSY}) are dynamic
 - Estimating stock status is challenging, especially in projections
- Rebuilding time frames are highly uncertain
 - Now the goalpost moves in ways we can't predict

The good news

- Fishing benchmarks (e.g., $F_{40\%}$) are robust to recruitment nonstationarity
- Short-term catch advice using recent recruitment is reliable
 - ✓ The SA SSC takes this approach
- The stock level should tend toward its target level, even if that level is unknown
 - ✓ Cartoon simulation using SA scamp, fishing at $F=F_{40\%}$...
 - ✓ SA black sea bass MSE

Cartoon simulation: SA scamp fished at $F=F_{40}$

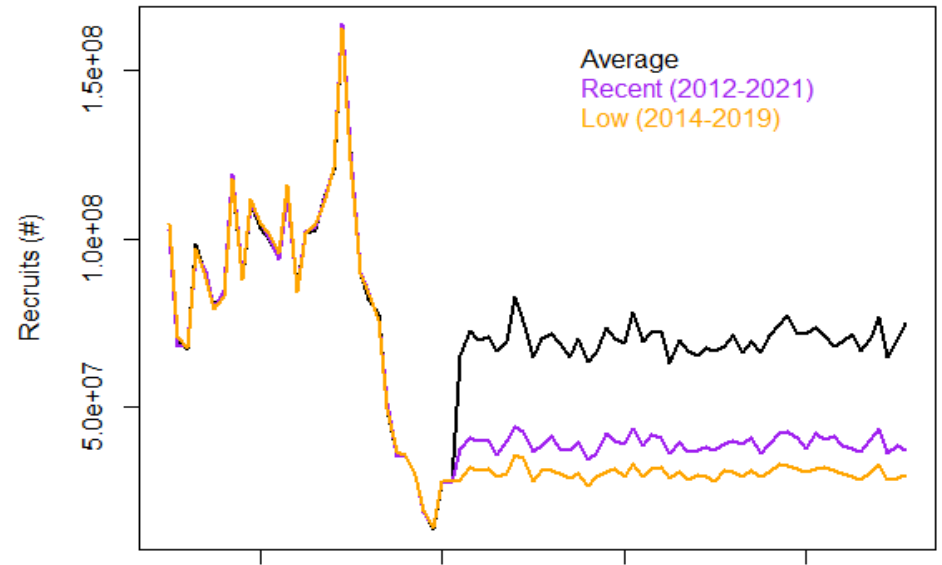
Take home message:
you do not need to
know SSB to know
the effect F_{40} will
have on the stock



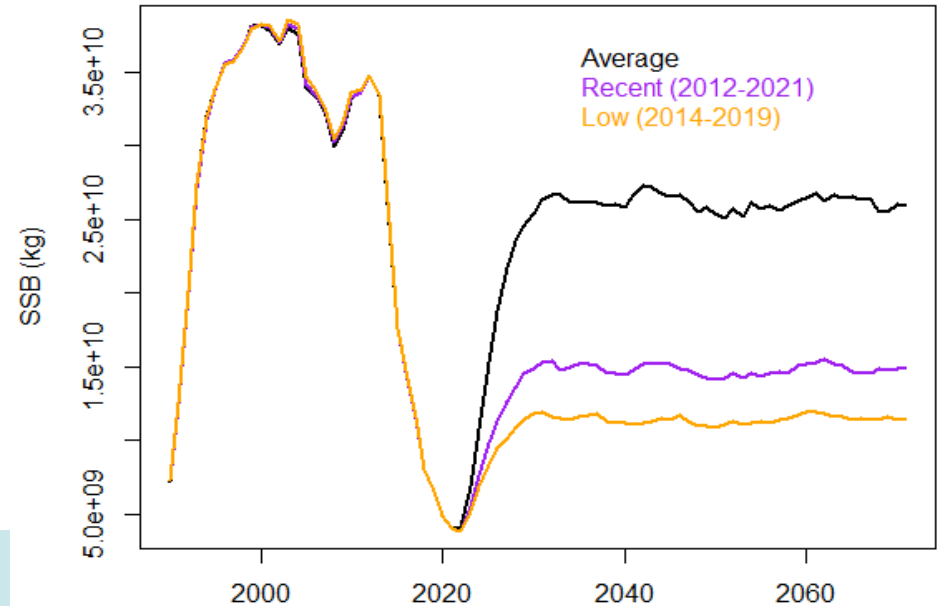
Management strategy evaluation: SA black sea bass fished at $F=F_{40}$

Further demonstrates the same take home message

Recruitment

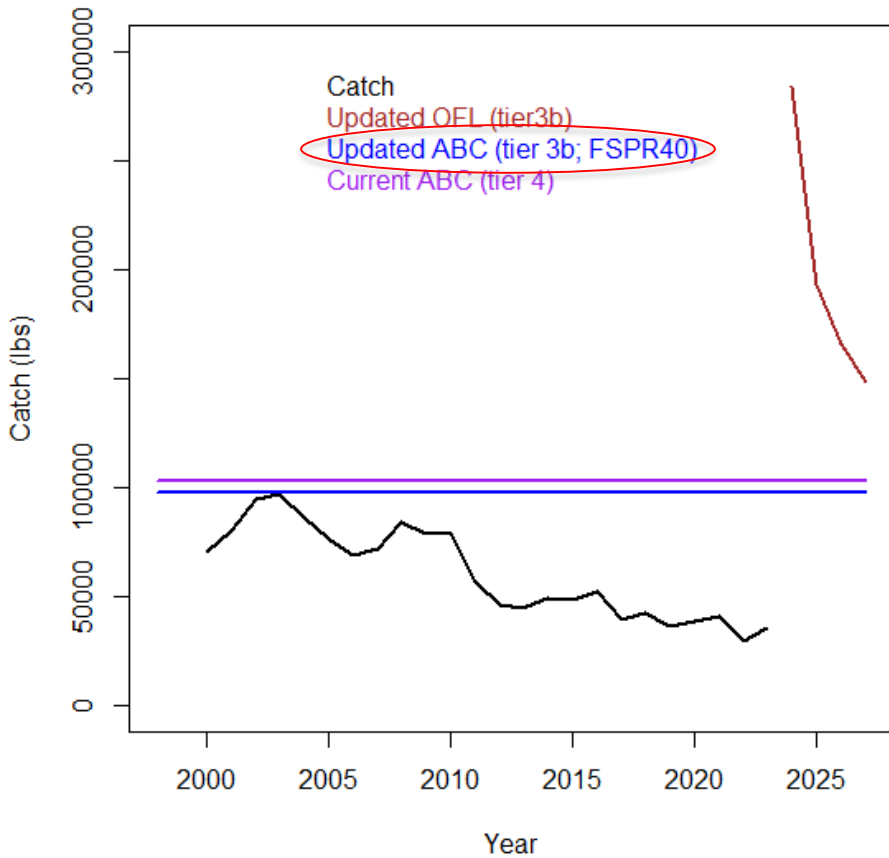


Spawning stock biomass

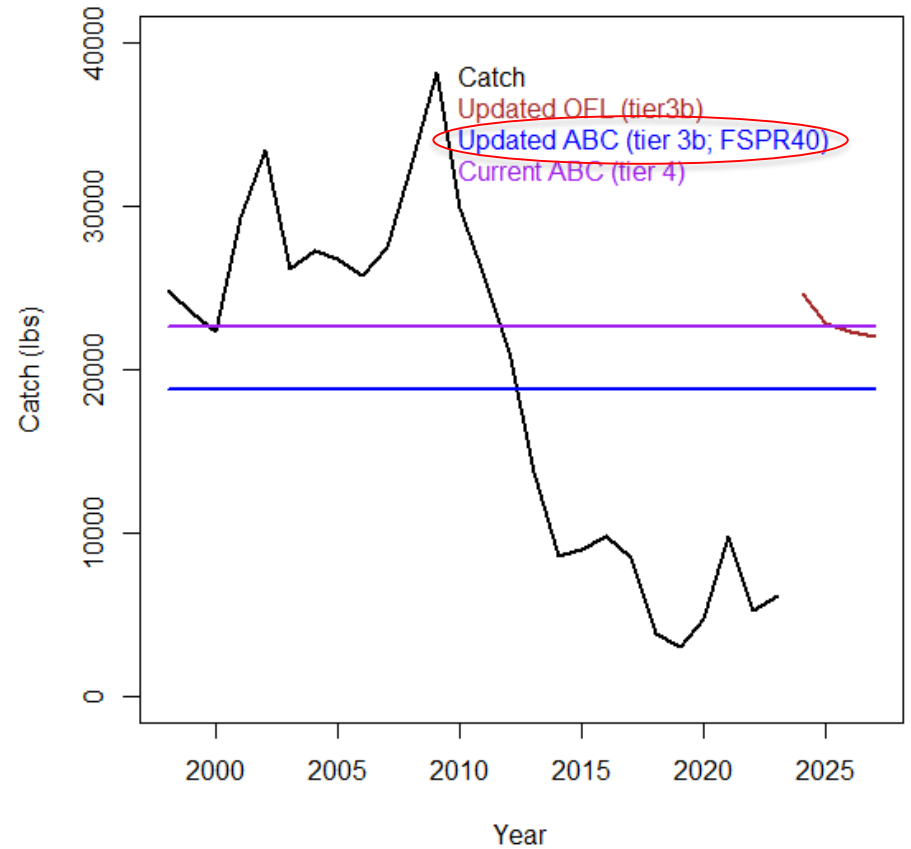


SSC's ABC recommendation for SEDAR 80

STTJ Reported Catch (commercial, all)

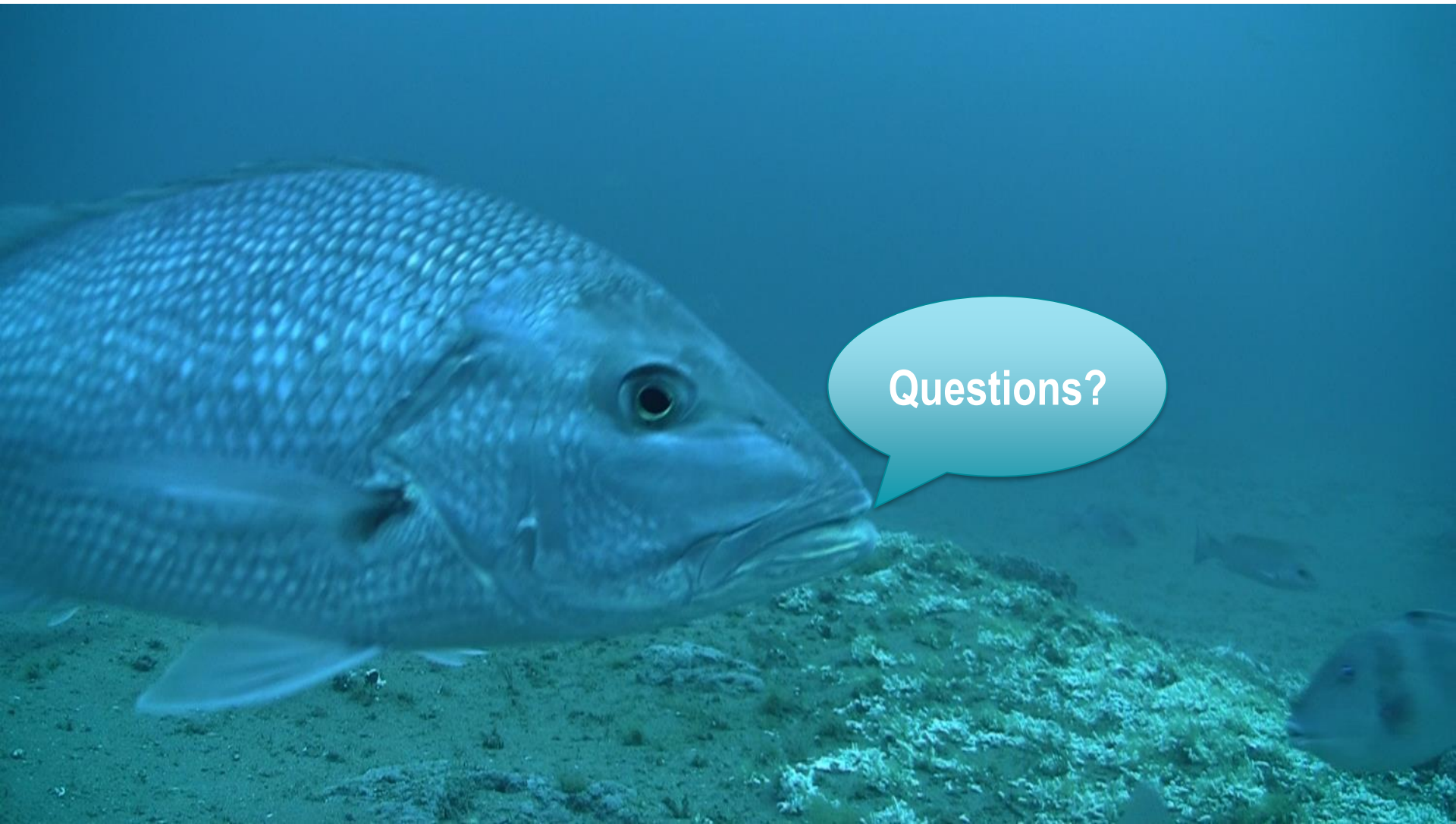


STX Reported Catch (commercial, all)



Need for further research

- Increased temperature = distribution shifts? Not always the case, so spatial management may not meet objectives (Cao et al., in press)
- Correlations b/w ecosystem indicators (like CPUE) and large-scale oceanographic processes may lend insight (Karnauskas et al. 2015)
- MSE and simulation studies are useful to test an HCR's robustness to non-stationarity in population dynamics, e.g., recruitment (Damiano et al., *in press*), but also growth, survival, etc.



Questions?

