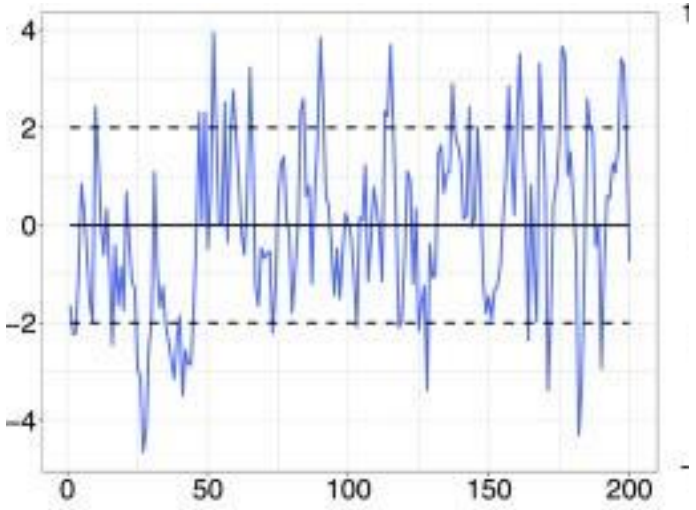
# Harvest control rules in a changing environment: lessons for confronting non-stationarity in the U.S. Caribbean

**Matt Damiano, Kyle Shertzer**

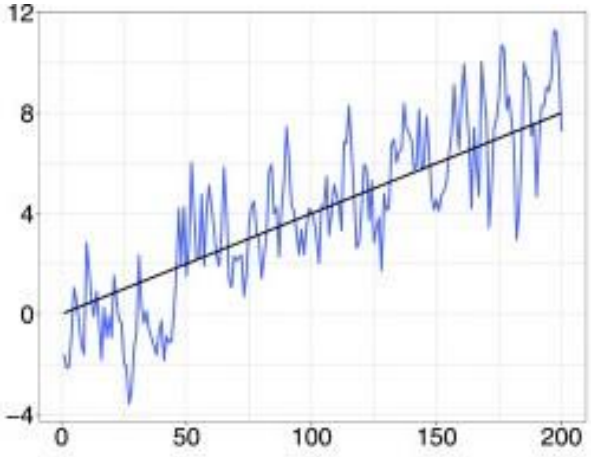
NOAA Fisheries, Southeast Fisheries Science Center

# Stationarity

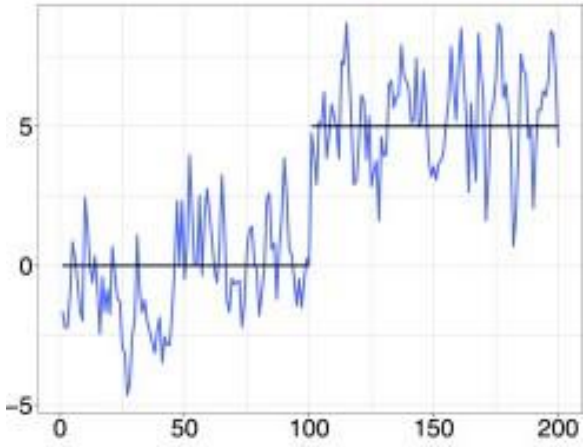



# Nonstationarity

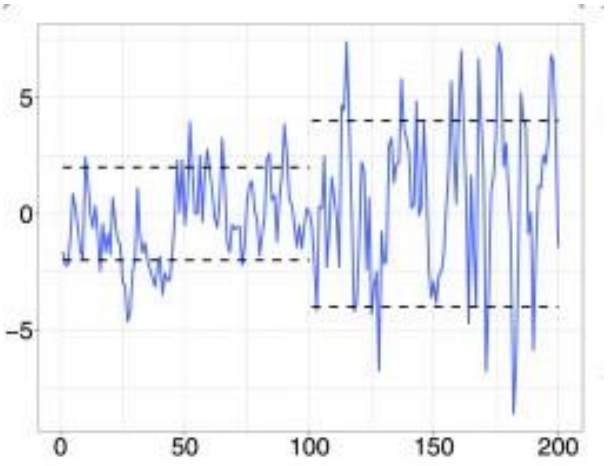
## Trend




## Shift in the mean



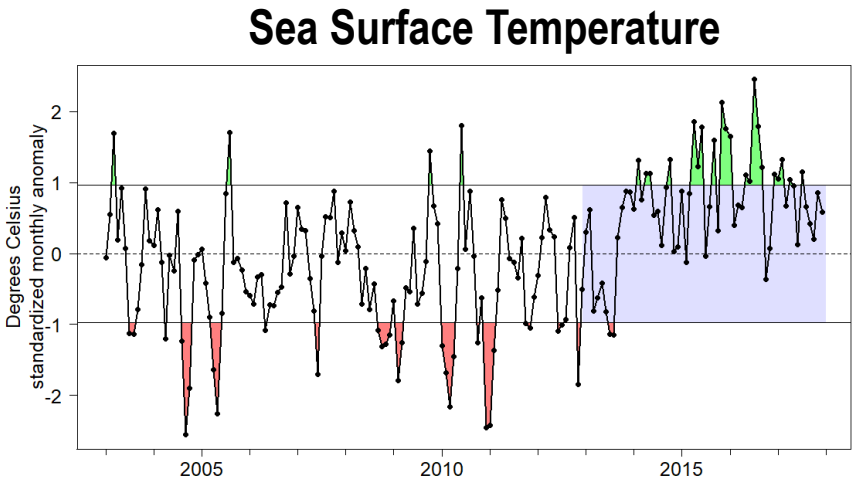

## Shift in the variance

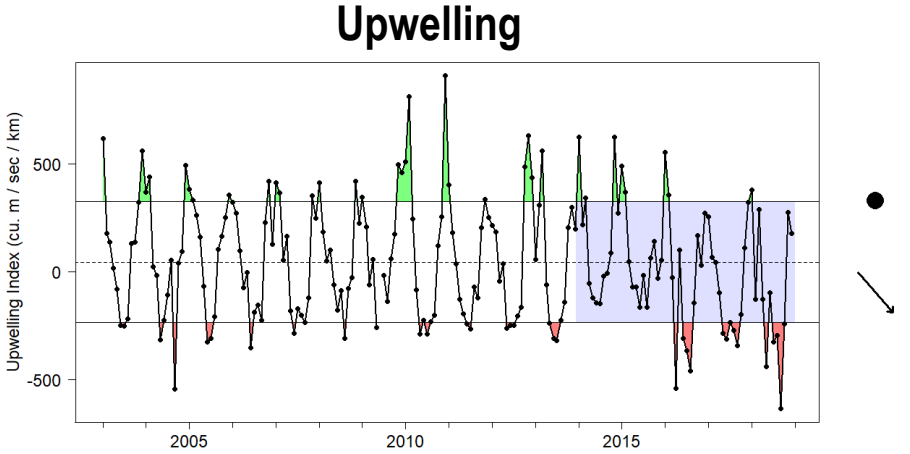


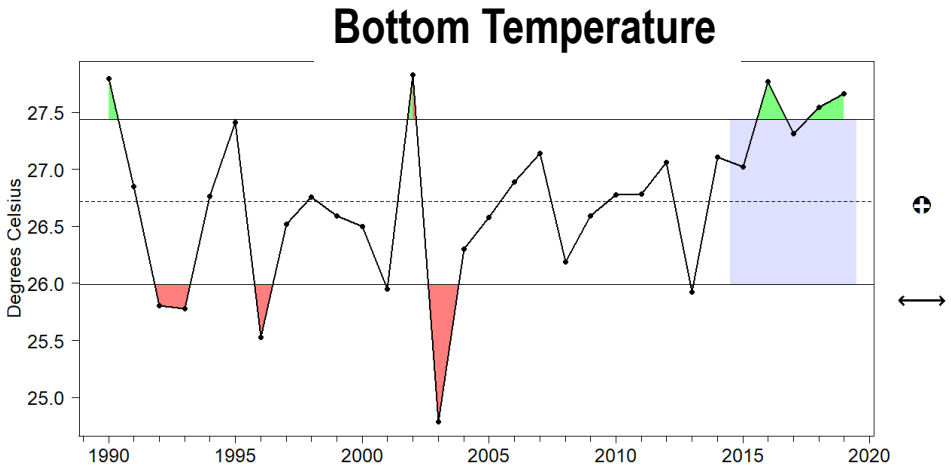



*Images from Salles et al. 2019*

# Examples of environmental nonstationarity in the SA






*Craig et al. 2021*

# Environmental nonstationarity can affect fish populations

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

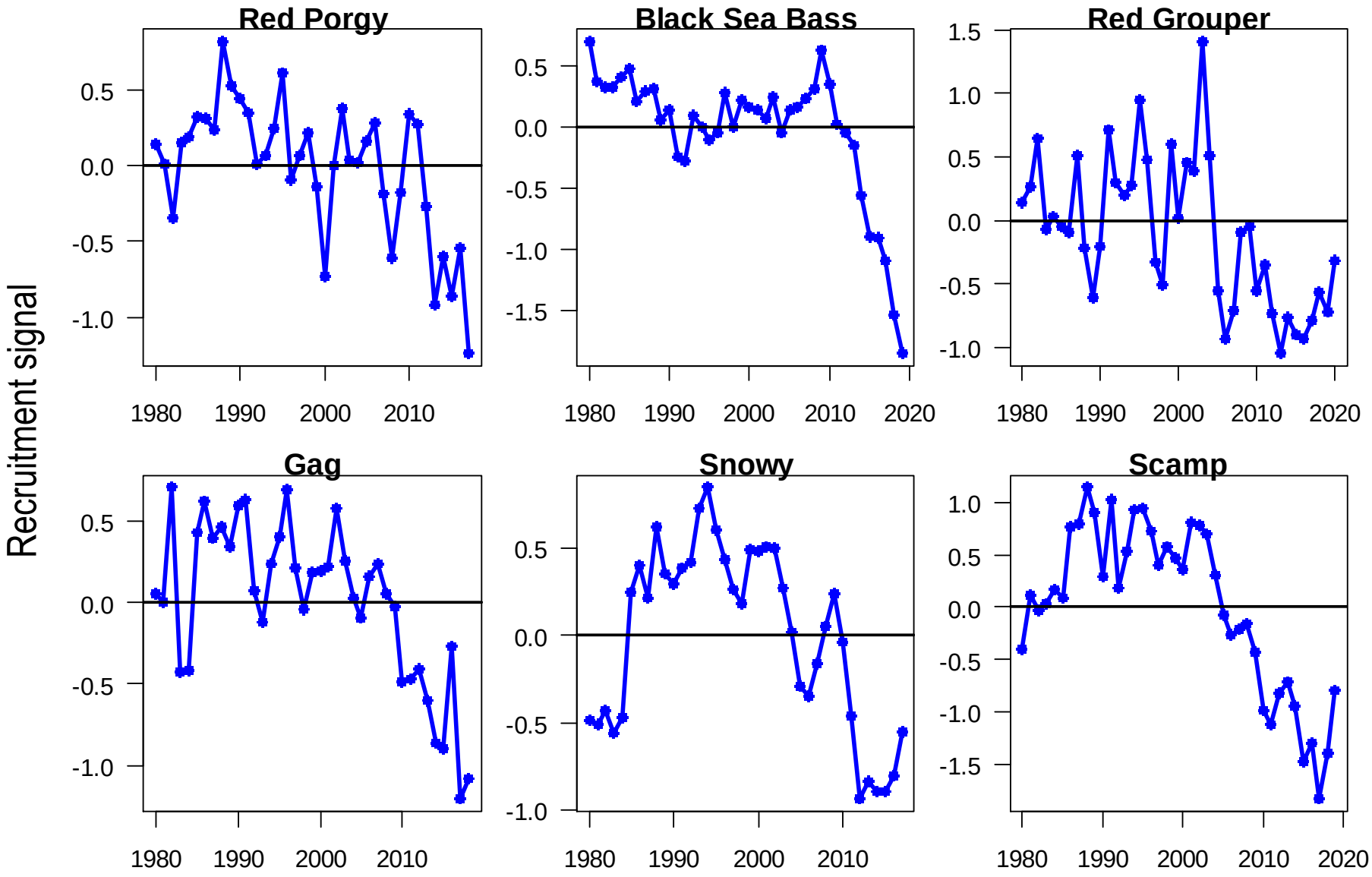
# Evidence of recent poor recruitment in the SA

- 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

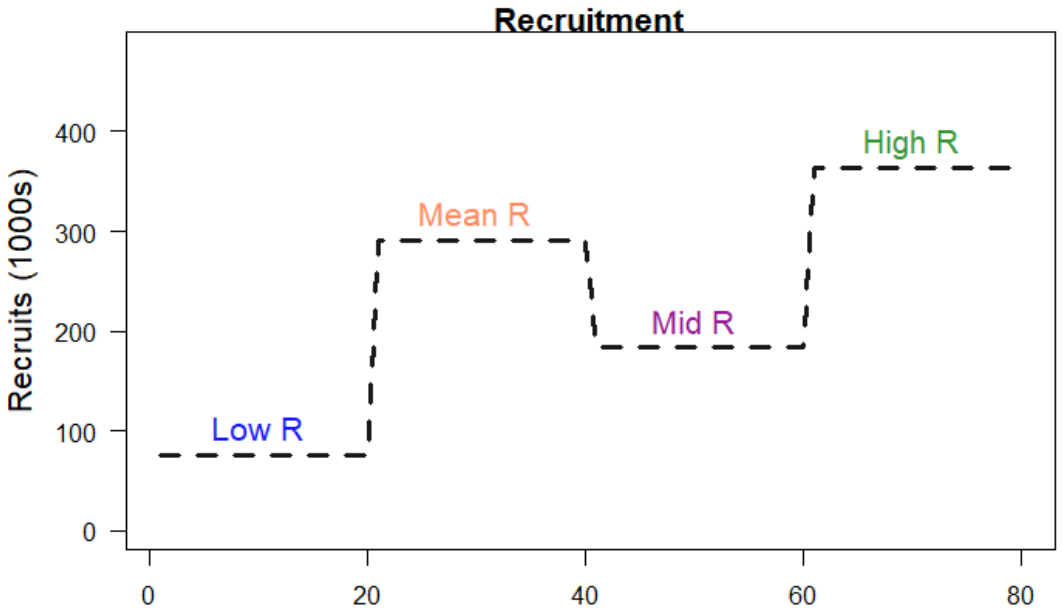
- Fishing benchmarks (e.g., F40%) are robust to recruitment nonstationarity

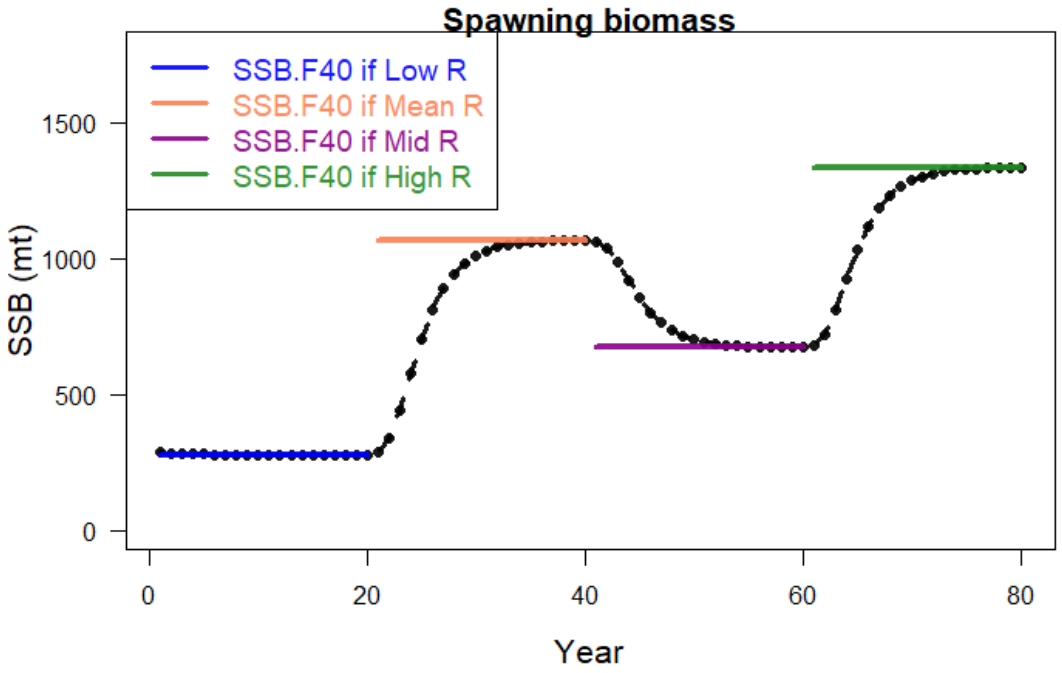
- Short-term catch advice using recent recruitment is reliable
  - ✓The SA SSC takes this approach

- The stock level should tend toward its target level, even if that level is unknown
  - ✓Cartoon simulation using SA scamp, fishing at F=F40…
  - ✓SA black sea bass MSE

# Cartoon simulation: SA scamp fished at F=F40

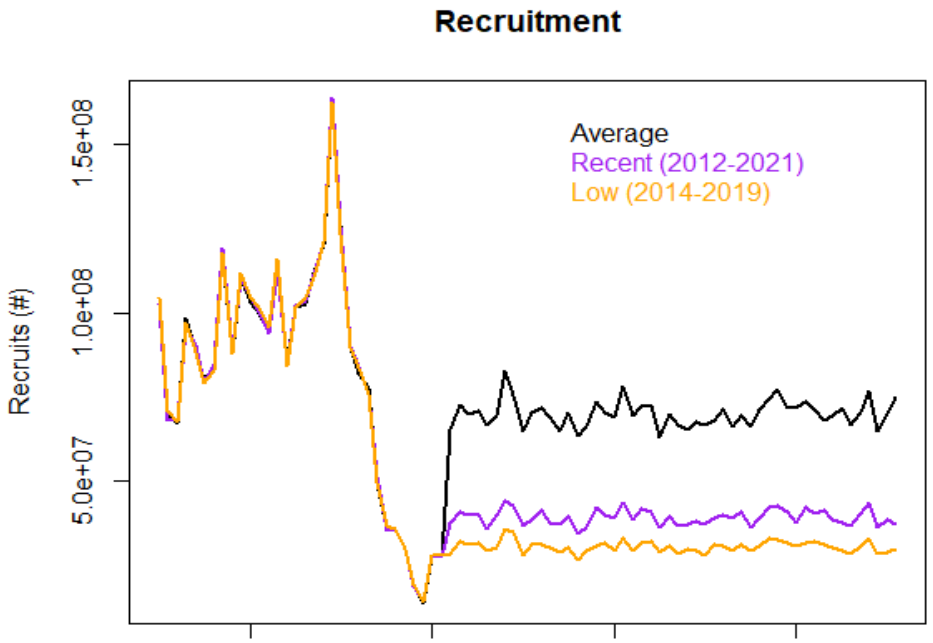
Take home message: you do not need to know SSB to know the effect F40 will have on the stock

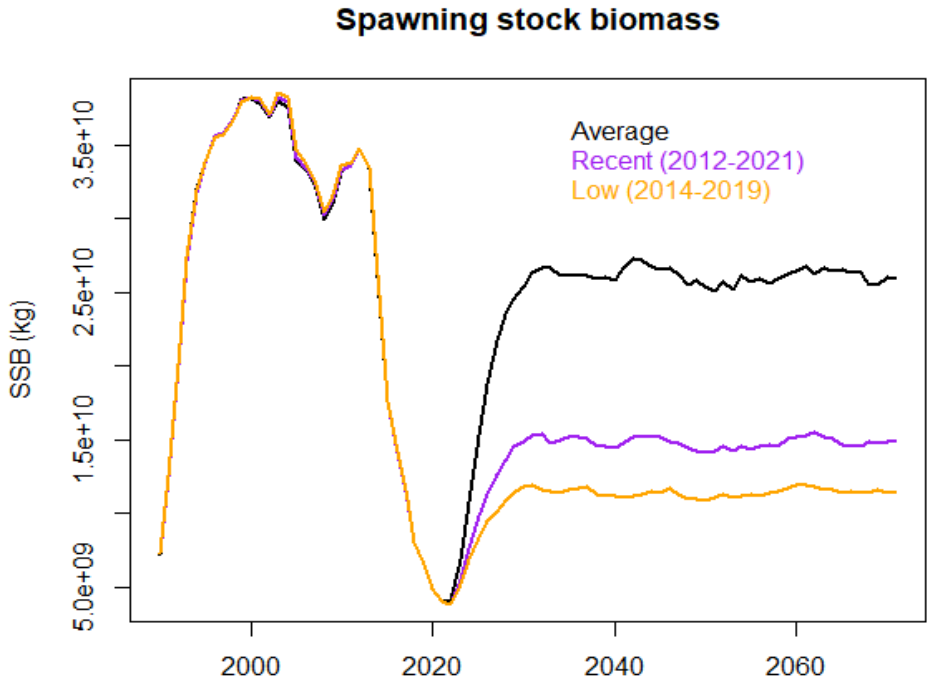


# Management strategy evaluation: SA black sea bass fished at F=F40

Further demonstrates the same take home message



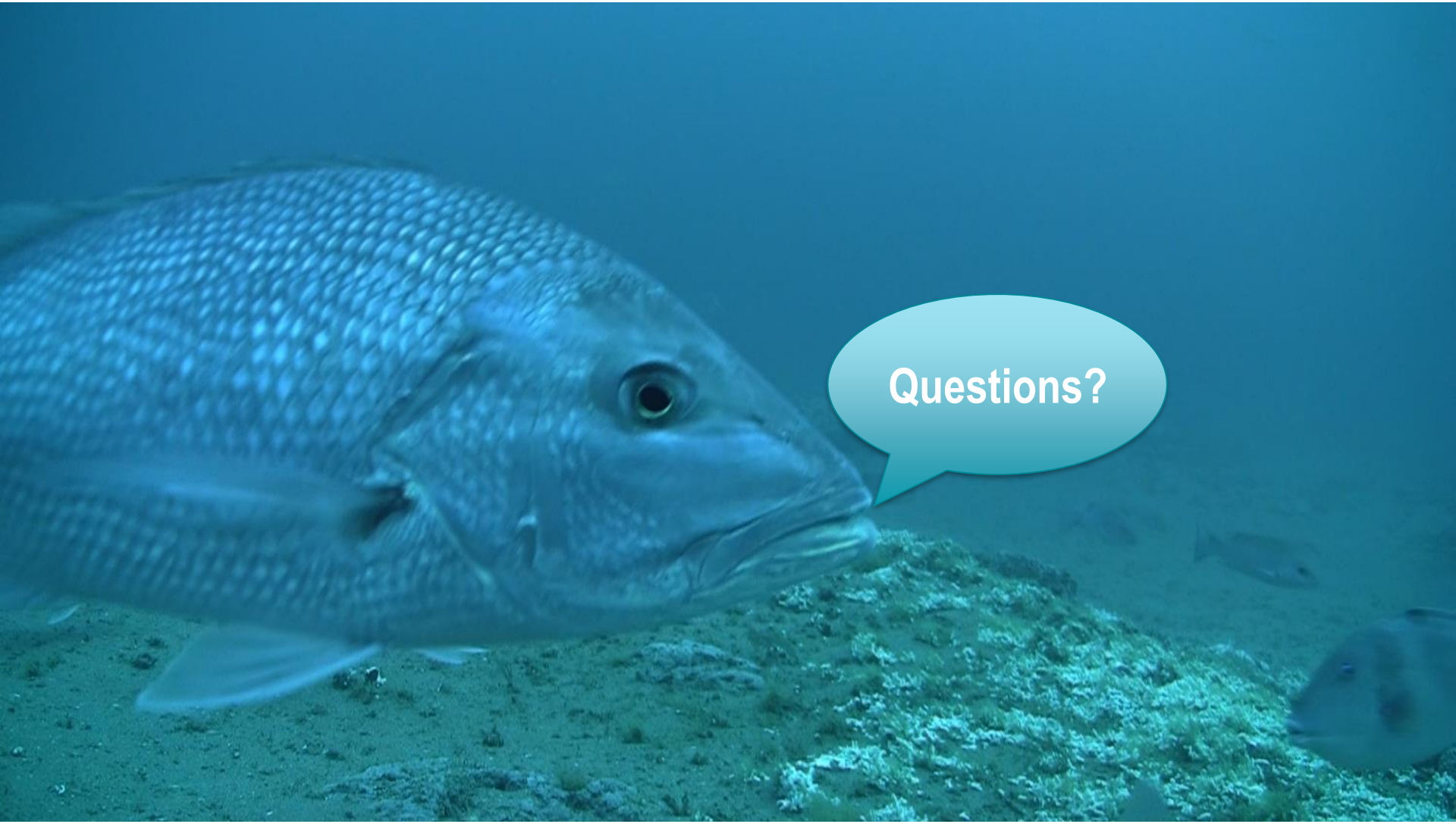



# Need for further research

- 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 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 review), but also growth, survival, etc.


Questions?