NOAA FISHERIES

Southeast Fisheries Science Center

SSC Catch Level Projections Workgroup – Final Report

April 26, 2022

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Outline

- Background
  - Statement of work
  - Review of topic and literature
- Recommendations
  - General observations
  - Short-term forecasts
  - Long-term forecasts
  - Uncertainty and observations
  - Assessment report recommendations
  - Prioritized research recommendations

Background – Statement of Work

- Justification:
  - SSC has recently recommended different recruitment assumptions in catch level projections for different stocks
  - Requested an opportunity to review recent decisions and literature
  - **Develop recommendations on robust recruitment assumptions** for projections used to provide catch level recommendations
- Goal: Develop a set of recommendations for SSC consideration when making projection requests used to set catch levels.

Background – Statement of Work

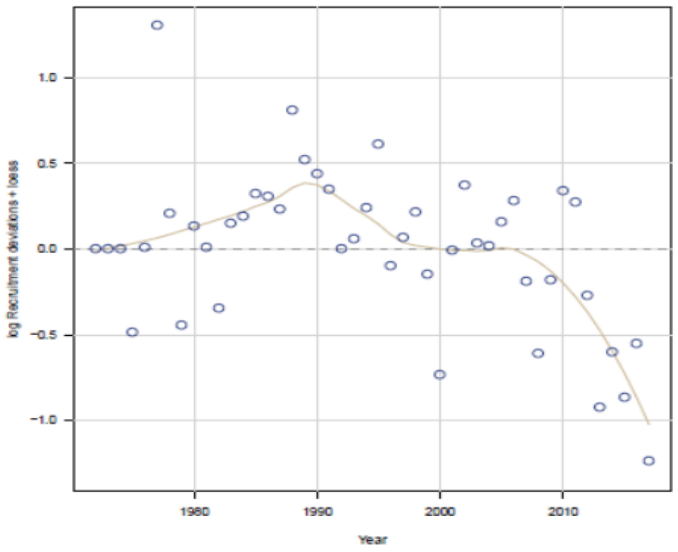
- Tasks:
  1. **Review recent literature** on recruitment assumptions and summarize key findings for the SSC
  2. **Summarize recent SSC decisions** regarding recruitment assumptions in projections used to set catch level recommendations. Case studies should include, but not be limited to, red grouper, red snapper, red porgy, golden tilefish, gag grouper, black sea bass, and snowy grouper
  3. With the assistance of the SEFSC, **explore the performance alternative recruitment assumptions** and summarize the impact on catch level advice for key example stocks.
  4. **Draft recommendations** for SSC consideration.

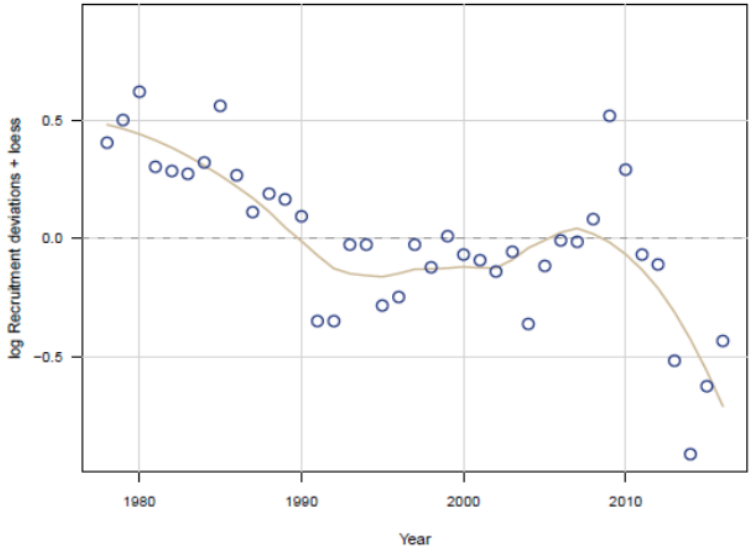
Background – Review of topic and literature

- Many federally managed South Atlantic stocks have estimates of recruitment during the most recent decade that are well below long-term averages
  - Recruitment overfishing caused by a reduction in spawning stock biomass
  - Changes to key environmental traits as a result of climate change
  - Combination of biotic and abiotic changes that could lead to a regime shift (e.g., **Klaer et al 2015**)
  - Misspecification of the stock assessment model or poor quantity/quality of input data

Background – Review of topic and literature

- Generally, the decisions regarding projections for recruitment in the South Atlantic have not been consistent across species, even with similar trajectories in stock status and estimated recruitment levels





Background – Review of topic and literature

- Other SSCs and Councils
  - Most regions have limited ability to adjust the scientific buffer between OFL and ABC based on environmental conditions
  - SSCs have adjusted ABCs when recruitment deviated from historic patterns as part of the scientific uncertainty
  - No consistent methods to adjust the ABCs or the time period for the new recruitment scenario
  - Typically, SSCs have adjusted the ABC downward associated with decreased recruitment
    - Few stocks have had increased recruitment like Red Snapper

Background – Review of topic and literature

- Modeling and forecasting recruitment are fundamental to assessing the status of a stock and guiding management recommendations
- However, it is challenging to predict recruitment with the degree of accuracy needed for management purposes
- Approaches to forecast recruitment:
  - Functional stock-recruitment relationships
  - Sampling methods
  - Empirical dynamic modeling
  - Time-series analysis
  - Incorporation of environmental effects
- **Van Beveren et al 2021 paper**

General observations

- Current assumptions about fish population dynamics are based on
  - Populations experience short term fluctuations and long-term shifts
  - Tendency for ecosystem stability (or equilibrium)
  - Attraction point is basis for benchmarks and management targets
- We have seen situations in our stocks where short term (or recent) population dynamics differ from longer term dynamics

General observations

- When it comes to immediate future ABC determination, the more recent dynamics are likely the most relevant
- Long-term dynamics in fish populations tend to cycle around a central tendency
  - Cases of fish stocks reaching very low levels and then recovering
  - Mean condition may be surrounded by broad fluctuations, with the stock rarely settling into the specific central condition, but nonetheless this mean condition seems to exist in the sense of an attracting point to which the fluctuations return
  - Because of this likely condition in ecosystems, long-term forecasts should always consider the complete history of the stock

Short-term forecasts for ABC determination

1. **Short-term forecasts for ABC determination should be limited to 5 years** (post terminal year of the assessment, including interim years before management has taken effect)
   - Assessments should be done more frequently
   - If an analysis finds projections are accurate and performing well for a given species, then lengthening the projection time frame can be considered
   - Adjustment of P* should occur when projections go beyond the recommended years

Short-term forecasts for ABC determination

2. Short-term Forecasts should use recent mean recruitment

- Recommend default method for short-term forecasts should use recent mean recruitment
  - Van Beveren et al (2021) does not define recent recruitment, thus WG recommends recent mean recruitment be defined for each species on a case by case basis
- 3, 5, and 10 years were explored in Van Beveren paper
- Analysts can recommend a time period based on analyses of the species' data

Long-term forecasts

- ***Type A:* Forecast using average recruitment and historic variability**
  - The whole time series should be used as the default condition.
  - If evidence of regime shift (or other semi-permanent ecosystem change), then apply the average from the years under this condition. Rely on Klaer et al (2015) for guidance on how to define or detect regime shifts.

- ***Type B1*: Forecast using stock-recruit relationship and historic variability**
  - Provided a significant stock-recruit curve is detected.
  - Analysts and review bodies will determine the level of significance required.
  - The S-R curve can be fitted internally or externally to the assessment model.

Long-term forecasts

- ***Type B2*: Forecast using time series properties or environmental correlates**
  - Provided significant time series of correlates that affect longer term processes are detected.
  - Analysts and review bodies will determine the level of significance required.
  - As stated in the introduction above, literature and past experiences suggest these relationships often break down.
- ***Type C*: Forecast using S-R model, with time-series or environmental correlates that affect longer term processes included.**
  - Provided significant time series of correlates are detected.
  - Analysts and review bodies will determine the level of significance required.
  - It is a rarity for stocks to follow this type of predictive model. Caution as above applies in that correlates with recruitment often break down or become invalid.

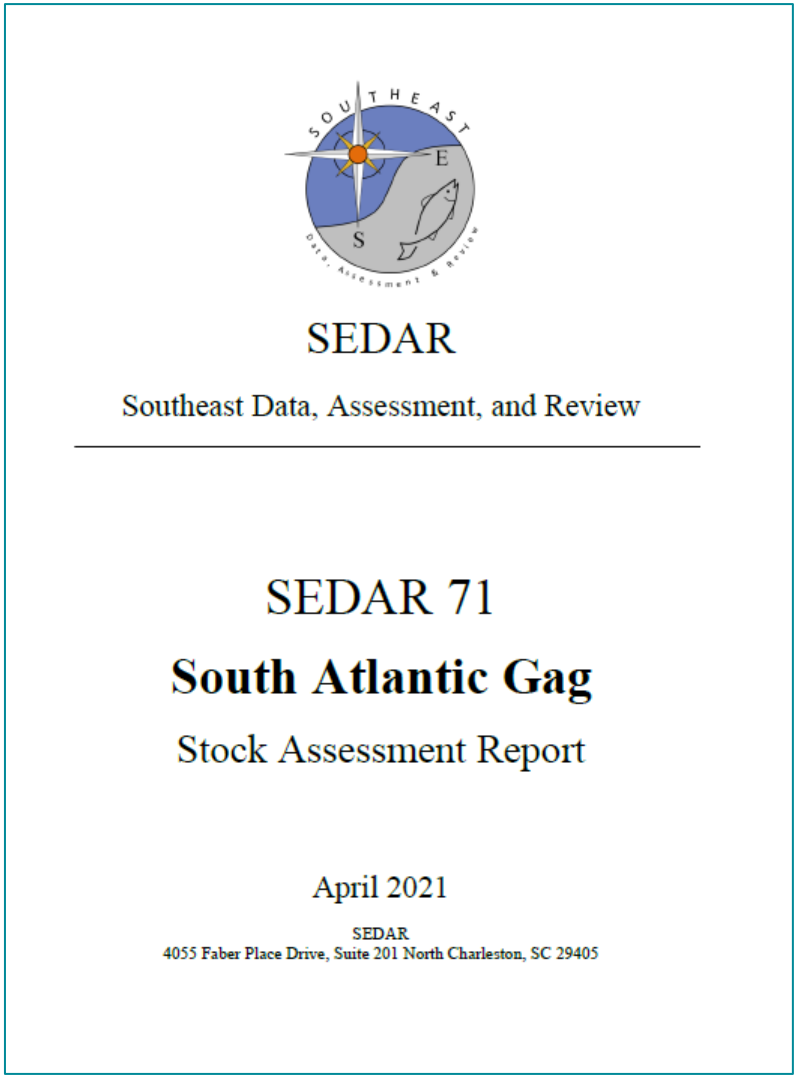
Uncertainty and observations

- Issues with short-term and long-term forecasts
  - Likely that short-term and long-term forecasts do not agree
  - Short-term dynamics may not be reflective of long-term shifts, changes, or equilibrium tendencies
  - Does not mean that either the rebuilding or short-term forecast is wrong, rather they are both correct but express different types of risks
  - Managers need to be aware of these risks and how their decisions affect the short-term and long-term goals for the fishery, fish stock, and ecosystem

- Uncertainty Assumptions in Forecast Models
  - Given uncertainties, it's imperative to provide managers with an accurate reflection of the unknowns, assumptions, and uncertainties in fish population forecasts
  - Major sources of uncertainty in stock assessment models include recruitment, natural mortality, and the S-R relationship (e.g., steepness)
  - Discards, abundance indices, and ageing accuracy

Assessment report recommendations

- A full description of the recruitment variance assumptions within the model
  - Inclusion of analyses of autocorrelation in recruitment
  - Provide a graph of the distribution of recruitment



SEDAR

Southeast Data, Assessment, and Review

SEDAR 71

South Atlantic Gag

Stock Assessment Report

April 2021

SEDAR
4055 Faber Place Drive, Suite 201 North Charleston, SC 29405

Assessment report recommendations

- **A full description of the data informing the estimation of recruitment deviations over time** including information on the quality of those data. Include any information regarding changes in the data over time that could be important such as changes in sampling frame (e.g., sampling frame of an index) or species compositions (e.g., mixed fisheries or not identifying to the species level until a given year)

- Inclusion of a sensitivity run removing the S-R curve (Maunder and Thorson 2019)

Assessment report recommendations

- Inclusion of a sensitivity run including ageing error
- A graph of the MCBE recruitment time series envelope of uncertainty with the base run recruitment overlaid
- A graph of the MCBE recruitment *deviations* time series envelope of uncertainty with the base run deviations overlaid
- Inclusion of hindcasting as described in Kell et al. (2016) in order to assess and improve the forecasting ability of assessments
- For research track assessments, provide an age structured production model - help with recruitment and index diagnosis

Prioritized research recommendations

- **Explore autocorrelation, proportional variability, and correlation in age at 50% maturity across species in the South Atlantic.** This recommended research is meant to specifically look at the factors from Van Beveren et al (2021) for the South Atlantic species in order to help determine the best methods of projection based on the species' characteristics.
  - With this research, scientists should be able to provide examples of the benefits and payoffs to things like increased or decreased catches, responsive management, and management tailored to species' characteristics.

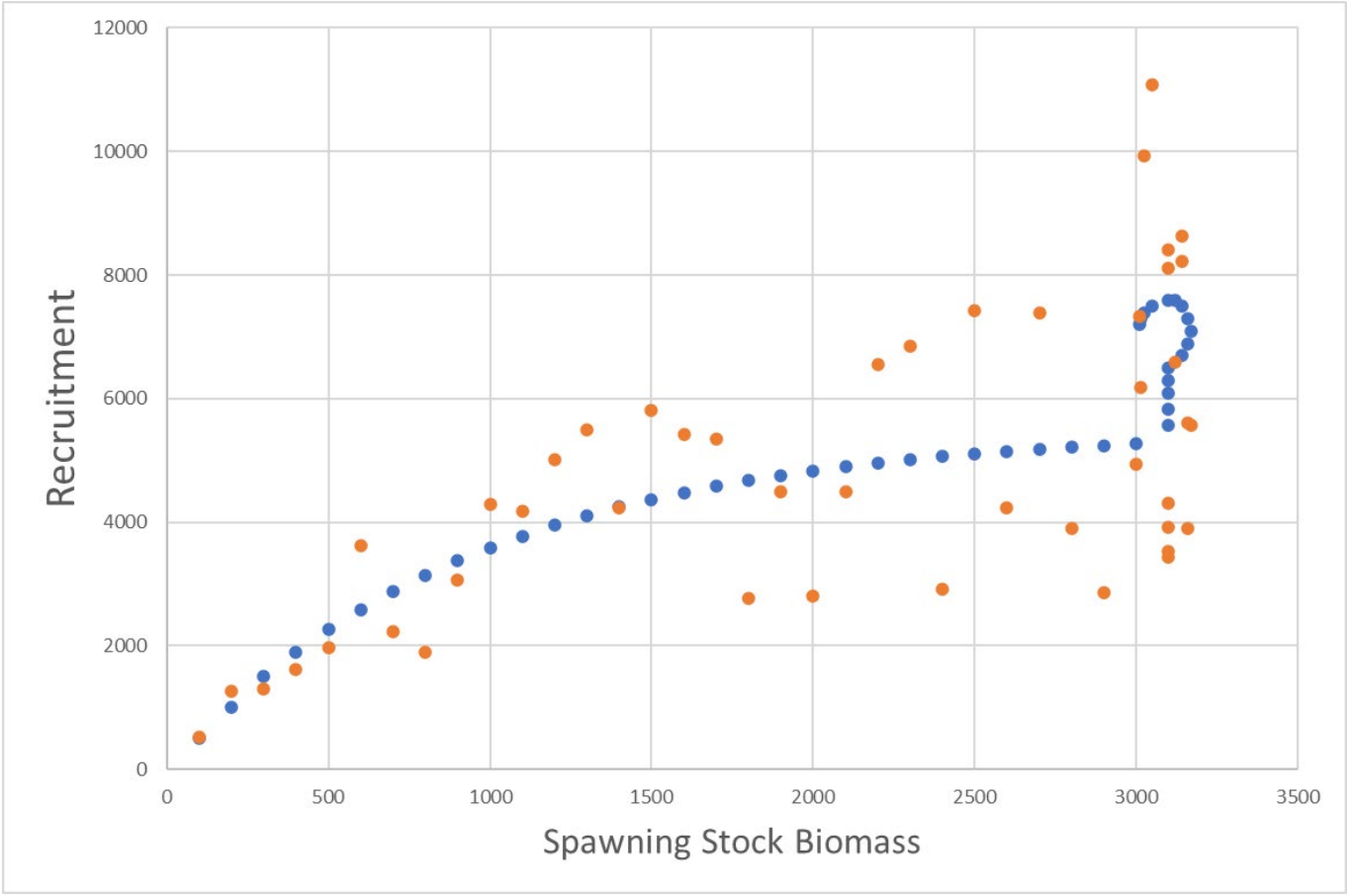
Prioritized research recommendations

- (*Work has started*) **Analysis of recruitment patterns across multiple species in the South Atlantic. Include time series analyses, trend analyses, correlation between the recruitment time series of two or more species.** This would help to answer questions such as: Is more recent recruitment a better predictor of short-term future recruitment? Is there a systemic pattern in recruitment and can it be used to aid in prediction? Do the recruitment time series of two or more species move together, so that looking at them jointly might help predict each individually? Are systemic recruitment patterns driven by environmental factors?
  - Where correlations exist between the recruitment time series of two species, or between the recruitment of a species and an environmental factor, methods of conditioning and conditional forecasting might be used to decrease the variance of recruitment forecasts
  - Where recruitment of one species is part of the recruitment of a larger aggregation of species, and the covariance between recruitment of the single species and aggregate recruitment is relatively large, control variate methods might help to reduce the variance of recruitment forecasts
  - Where the time series of recruitment deviations for two or more species are contemporaneously correlated, then analyzing the recruitment time series of both species together can reduce the error envelope around predictions of recruitment

Prioritized research recommendations

- **Analysis of the performance of projections in current assessment models.** We have nearly 20 years of stock assessments in the South Atlantic that have produced forecast predictions. How well have they performed? What are the biggest sources of error?
- Implementation of collection surveys for independent sources of data to help provide independent estimates of recruitment.
- Analyze the value of investing in pre-recruit surveys such as ECOMON and MARMAP data.
- Analysis of best leading indicators of recruitment to use after the stock assessment terminal year for forecasting R. Update interim analysis to reflect this.
- Analysis of possible environmental correlates with recruitment for specific species.

Questions?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