Stock Assessment of US Atlantic Wreckfish

Jeremy Collie, Consultant for Lynker Corporation

Introduction

This stock assessment is being conducted as part of a Climate Response Strategy for a Data-Limited Fishery. The last wreckfish stock assessment was based on data up to 2010 (Rademeyer & Butterworth 2014). The primary assessment tool was a statistical age/length model, with a dynamic production model used as a secondary tool. The current assessment will provide an update with 13 years of additional data.

Data sources

Landings

Most of the data used in the assessment come from the SAFIS database. These data files are up to date and have been validated by agency scientists. Landings data come from commercial trip reports and dealer reports, as no data are available on recreational catches or discards. These two components are assumed to be minor. The commercial landings data obtained from vessel trip reports are consistent with previously reported wreckfish landings (Fig. 1). Landings data from the most recent decade range between 70 and 180 tons.

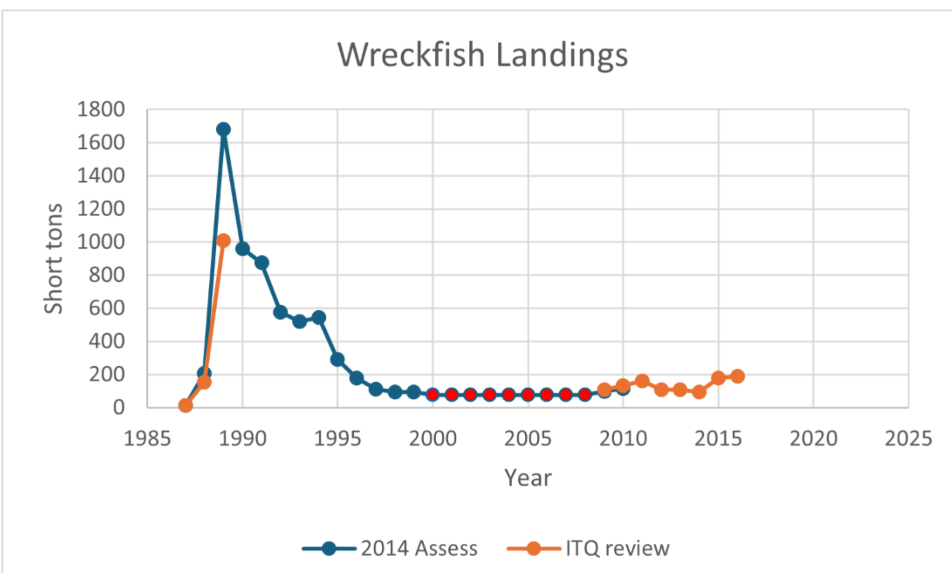

Figure 1. Commercial wreckfish landings reported by Rademeyer & Butterworth (2014, blue points) and by SAMFC (2019 orange points). Red points from 2000 to 2008 are the average for that period due to low number of participating vessels.

Wreckfish are not regularly caught by any of the NOAA Fisheries surveys, such that a survey abundance index is not available. Vessel trip reports contain measures of fishing effort that can be used to construct a catch-per-unit-effort (CPUE) index as well as covariates that may influence fishing success. A suite of Generalized Linear Models was fit to these data to generate a standardized CPUE index. Model selection was based on the Akaike Information Criterion (AIC) and model diagnostics. The final model was a Generalized Additive Model (GAM) with a smoothed spline relating catch to depth:

log(catch) ~ **gam**(lines + hooks per line + hours fished + **year** + area + s(depth))

where catch is the landings in mass units for a given trip. The number of fishing lines, hooks per line, and hours fished are treated as direct measures of fishing effort. The log link means these three variables have a multiplicative effect on catch, as would be expected. Fishing area and depth both had significant effects on the catch rate. Fishing location data confirm that the wreckfish fishery is concentrated off the coast of South Carolina and Florida. The GAM coefficients for the area term indicate highest fishing success off South Carolina.

Some of the fishing locations were obviously recorded in error, likely errors in single digits. The assessment team discussed several approaches for dealing with these reporting errors:

1. Use the areas as they are reported, given the small number of records;
2. Attempt to correct the area designation;
3. Omit records with incorrect area designation;
4. Don't include area as a factor in the gam, given that the fishery is highly concentrated.

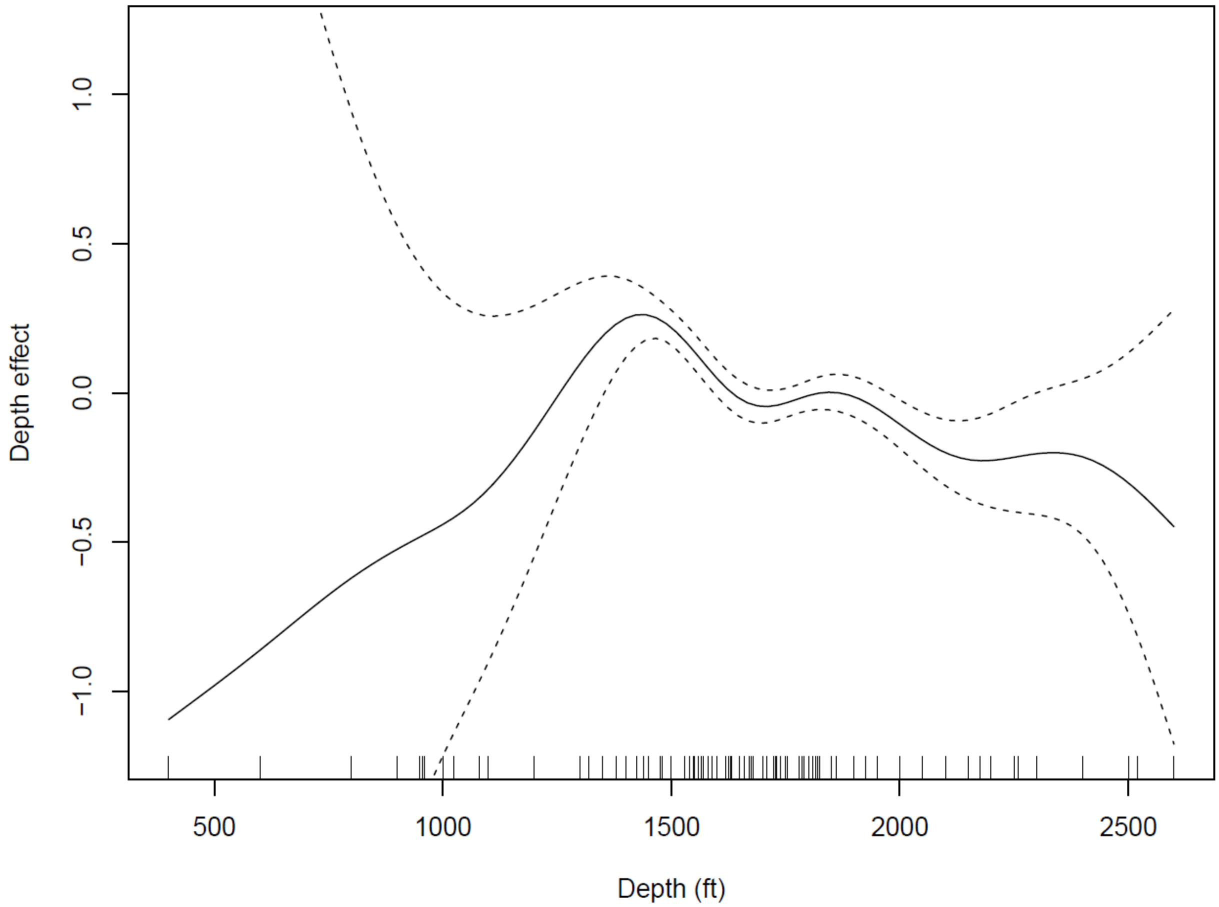

Figure 2. Depth effect on catch estimated with the GAM. The partial depth effect is calculated for constant values of the other independent variables. Solid line is the estimated effect and the dotted lines are ±2 times the standard error of the estimates. The rug plot at the bottom of the figure shows the distribution of sampled depths.

The depth variable shows the fishery to be concentrated between 1700 and 2000 ft with highest catch around 1500 ft (Fig. 2). The year variable can be interpreted as a standardized index of relative abundance in the sense that it reflects the catch with the effects of other variables removed (Fig. 3).

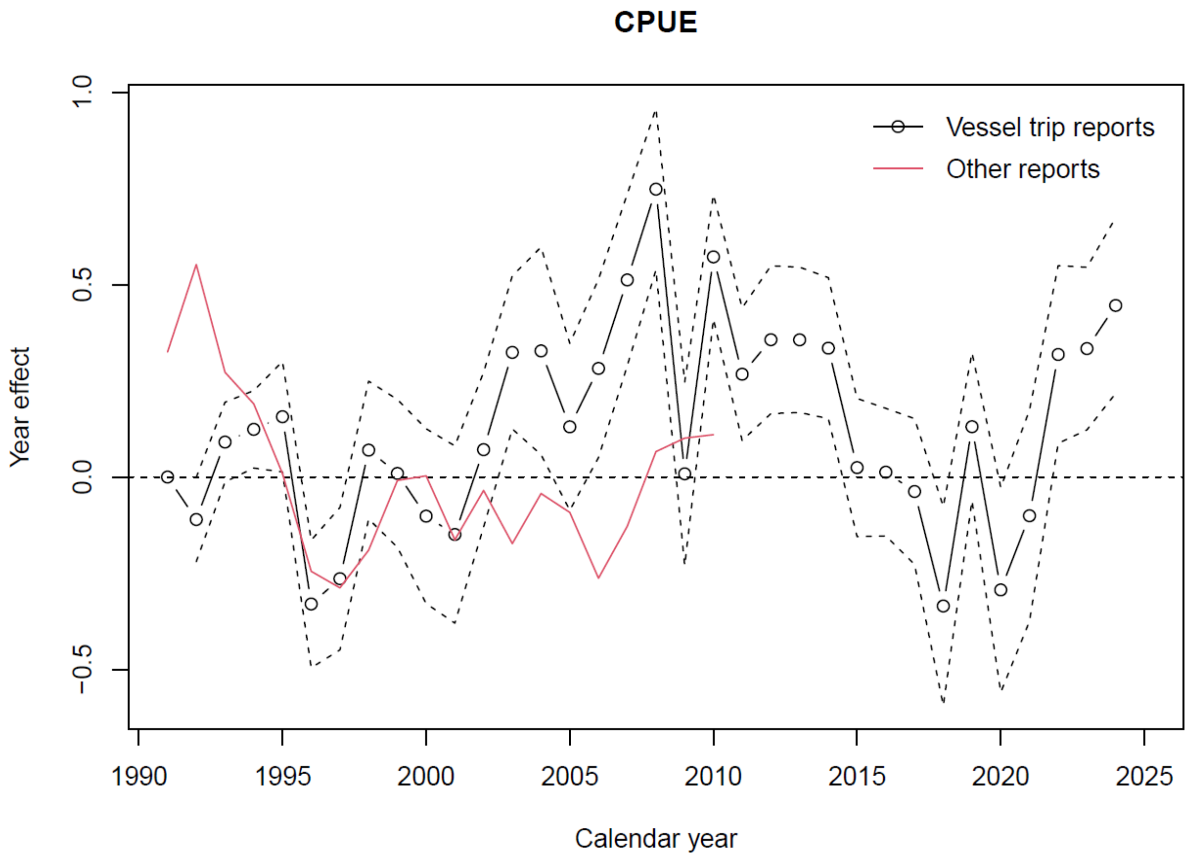

Figure 3. Year effect on catch estimated with the GAM.   Solid line with point is the estimated effect and the dotted lines are ±2 times the standard error of the estimates. For comparison the red line is the CPUE index used by Rademeyer & Butterworth (2014) standardized to mean 0.

The estimated year effects are well constrained by the data with a significant increase around 2010 followed by a decline around 2020 and increase since then. However, this year effect does not reflect the decline in catch success in the early 1990s that was estimated in previous assessments.

Fishing success is known to vary with individual fishing vessels and captains. Inclusion of a vessel effect in the GAM is complicated by the changing participation in the wreckfish fishery (Fig. 4). The team discussed possible ways to account for a vessel effect: 1) Estimate vessel effects for the top three participants, while aggregating the remaining vessels into an “other” category, or 2) calculating a CPUE index based on the top five vessels only (Vaughan et al. 2001).

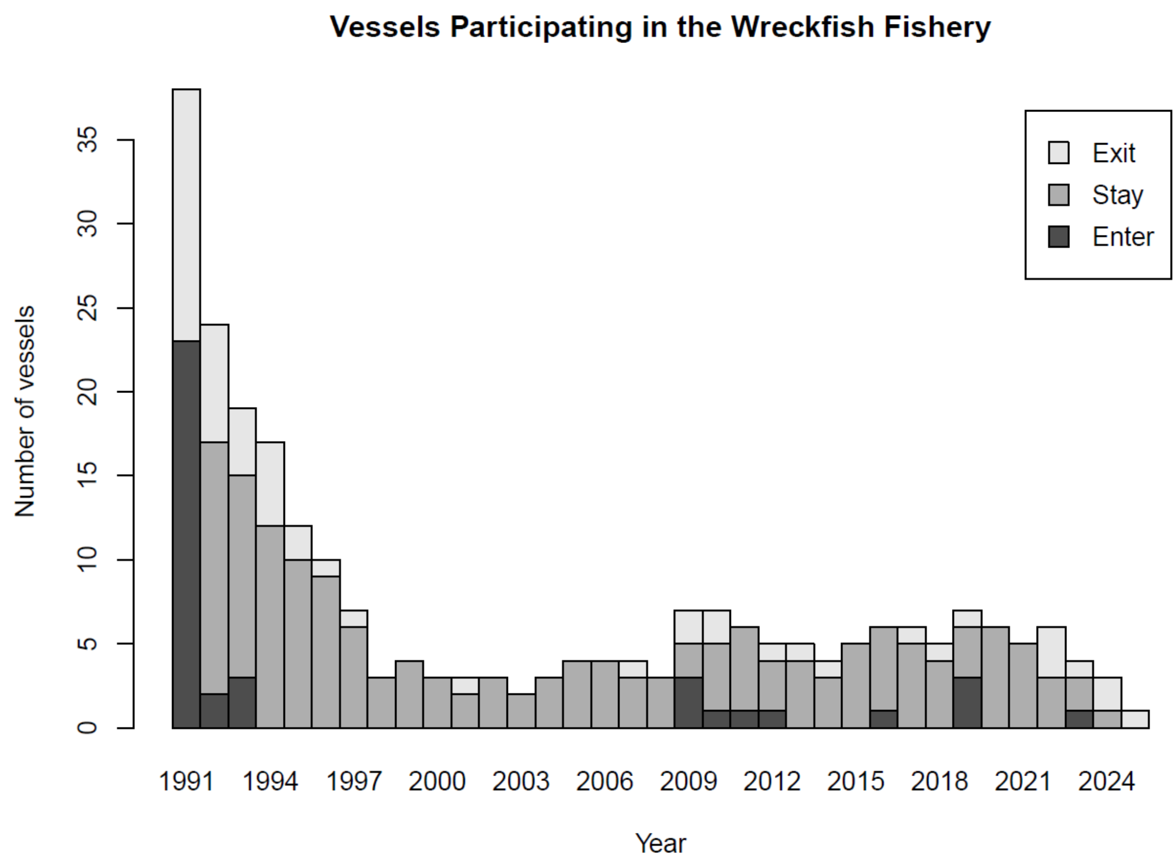

Figure 4. Participation in the wreckfish fishery. Bars at the start and end of the series need special interpretation. Some of the "entrants" in 1991 likely participated in 1990. Data for 2025 are preliminary and can't anticipate vessels that will remain in the fishery.

Size Composition

As an overall measure of size distribution, total numbers landed were divided by landing weight to obtain the mean weight per trip. Mean weight per trip was fairly steady around 32 lbs with low variation between 1991 and 2008 (Fig. 5). There was increased variability in mean weight from 2009 and on, with a pronounced decrease from 2015 to 2021. The team considered several hypotheses to explain the increased variance and lower mean weights during that period:

1. Less precision is reporting numbers than weight landed;
2. Fishing in shallower areas;
3. Fishing in a nursery area;
4. Recruitment of small individuals from outside the main fishing ground.

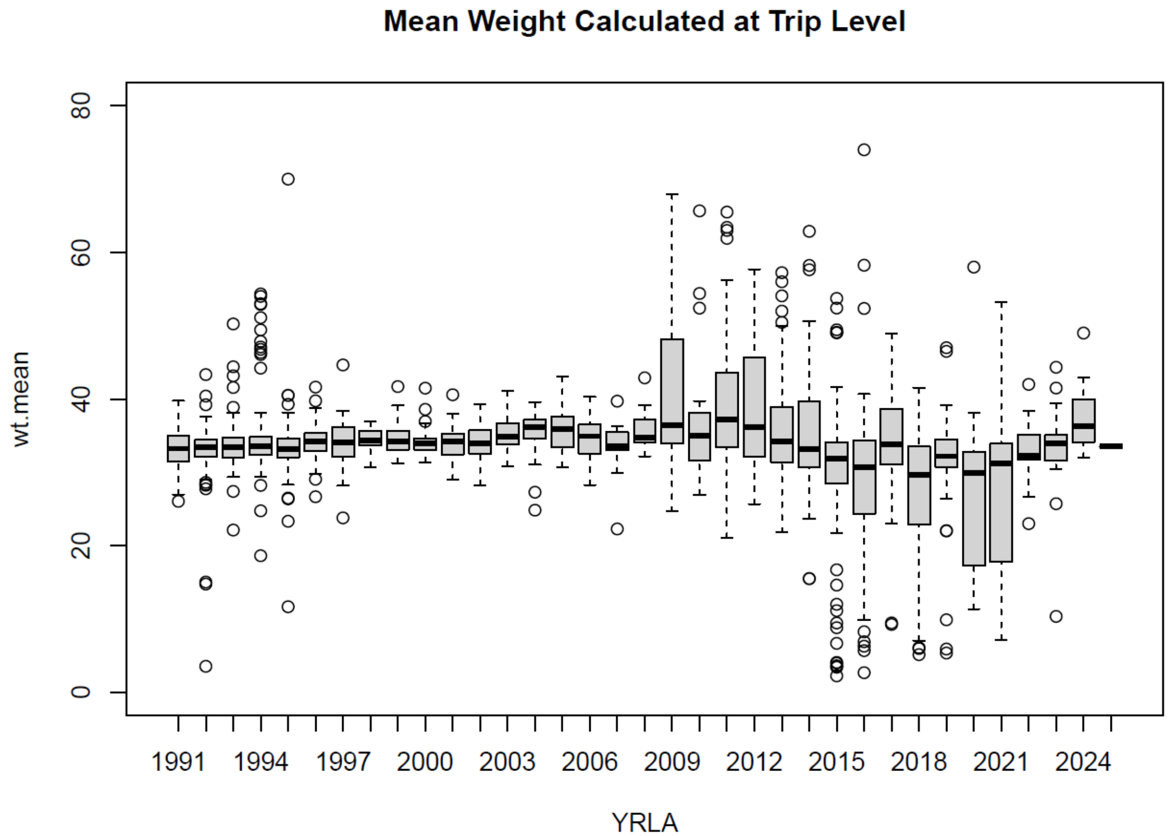

Figure 5. Mean weight (lbs) calculated as reported numbers divided by reported weight. Box plots show the median (black line) interquartile ranges (boxes), range (dashed lines), and outliers (points).

Hypothesis two was not supported because the low mean weights were reported at intermediate depths (Fig. 6). The project team suggested looking to see if these smaller fish were apparent in length distribution data.

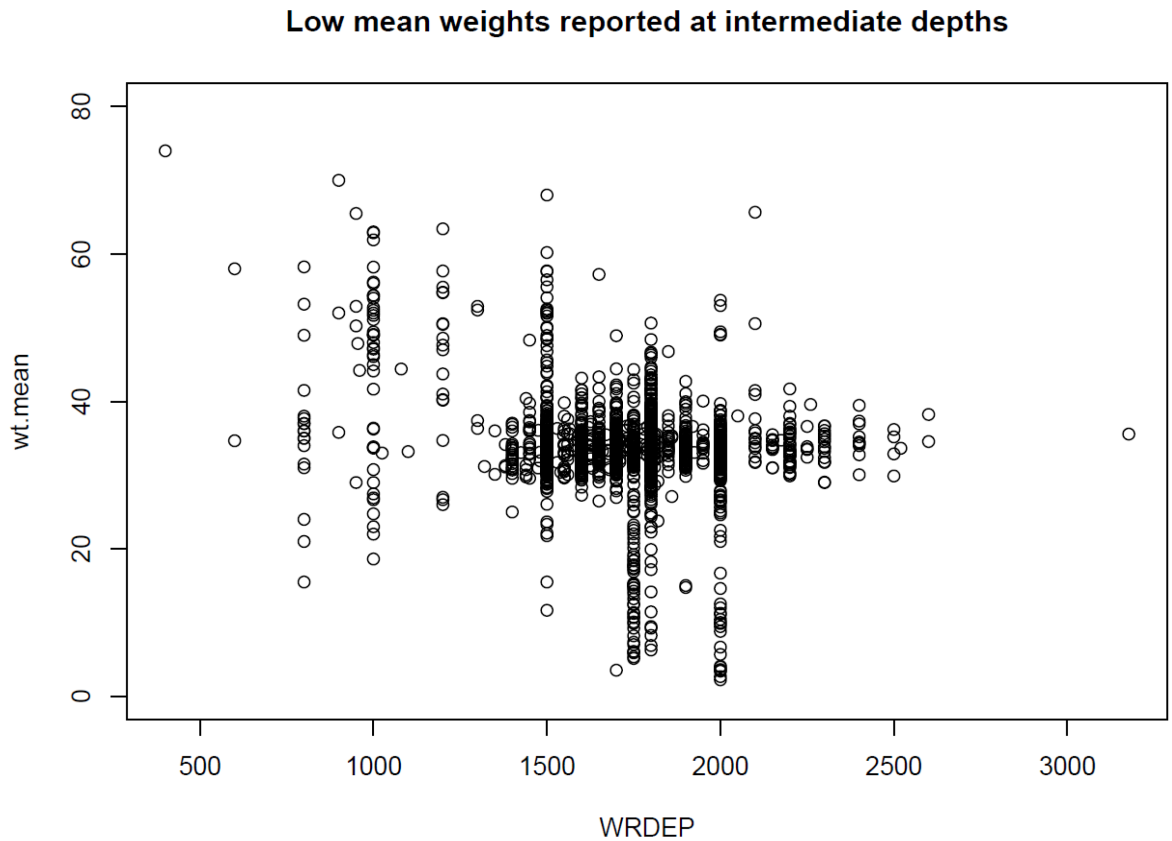

Figure 6. Mean weight (lbs) per trip plotted against fishing depth (ft). Each point represents one fishing trip.

Length data are available from 1984 until 2023. During these years, 20,485 length measurements were reported from 773 trips. For consistency, standard lengths and total lengths were converted to fork lengths with the conversions provided by Bubley et al. (2025). Length distributions have been weighted by the total landings in each trip containing length samples.

Most of the reported lengths are between 80 and 110 cm. Smaller fish were reported in 1984 but this was a small sample (n=7) during the very early years of the fishery. There were also smaller fish (<60cm) in 2006 but not in the years 2015 to 2021 (Fig. 7). Larger wreckfish were reported in 1987, but overall, the length distributions have remained stable over time and consistent with the previous assessment.

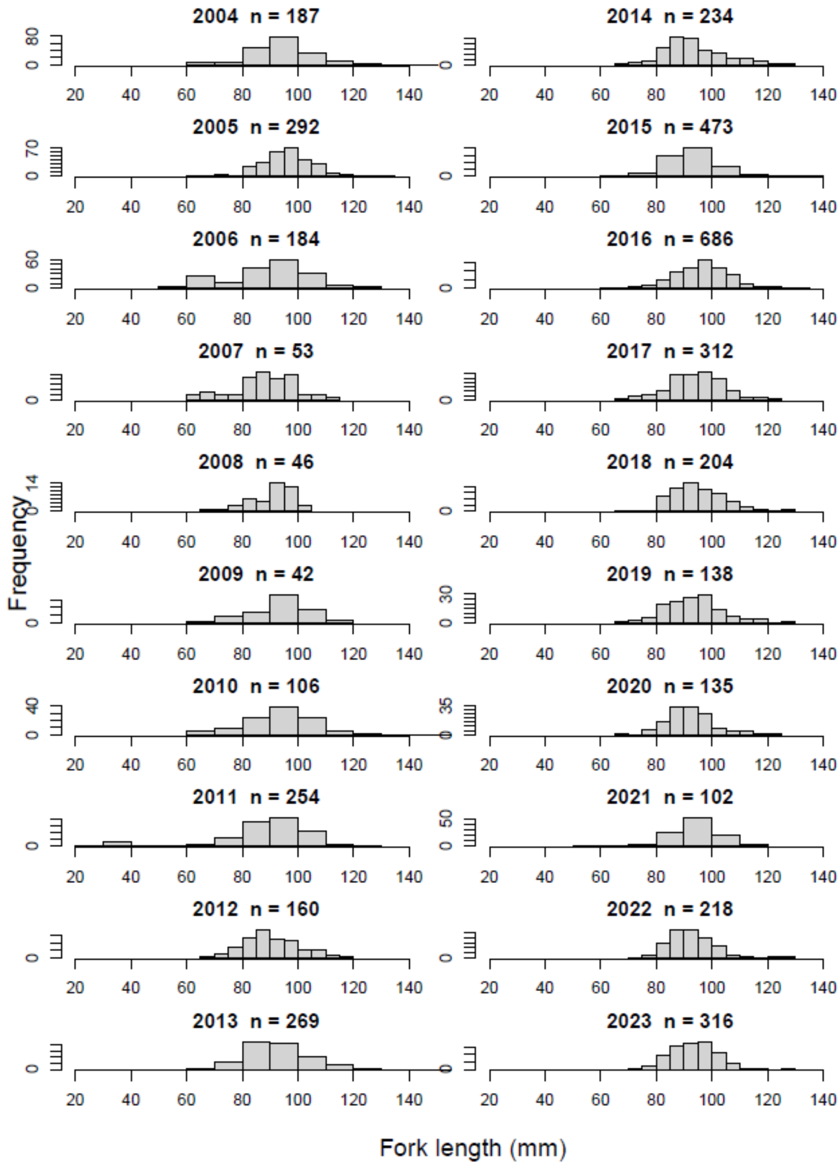

Figure 9. Length-frequency distributions from 2004 to 2023. Sample size "n" is the number of length measurements reported each year.

Life History Data

The life-history information and allometric relationships data needed for the stock assessment are listed in Table 1. The uncertainty in these parameters will be retained for sensitivity analyses.

Table 1. Demographic parameters and relationships obtained from Rademeyer & Butterworth (2014) and Bubley et al. (2025).

Relationship/parameter				
Natural mortality rate	M	0.037 (yr^{-1})	SD = 0.00407	
Von Bertalanffy growth equation	L_∞ (cm)	K (yr^{-1})	t_0 (yr)	
Female	102.6	0.10	-5.30	
Male	94.9	0.11	-5.40	
Maturity	$L_{50\%}$	76.8 (cm)	$L_{90\%}$	860.2 (cm)
Stock-recruitment relationship	Steepness (h)	0.75		
Length-weight relationship	a	0.0000208	b	3.017

Assessment model

The Stock Assessment Continuum Tool (Cope 2024) has been chosen as the primary assessment method for this project. This tool provides a Shiny App interface to the powerful Stock Synthesis assessment program. The continuum tool can fit models of varying complexities depending on data availability. The model continuum ranges from catch-only models for data-limited stocks to fully age-structured models. The Stock Synthesis Catch Length (SS-CL) module is appropriate for a data-moderate stock such as wreckfish. A relative abundance index (e.g. CPUE) can also be incorporated but is not necessary.

Several model variants will be considered:

1. Asymptotic or dome-shaped selectivity of the commercial fishery;
2. Different possible start years for the assessment (e.g. 1988 or 1991);
3. Selectivity analyses on key life-history parameters.

A production model was proposed as a secondary assessment method. The production model is given lower priority because it doesn't make use of the length distribution data and instead relies heavily on the CPUE index.

References

Cope, J. 2024. Stock Assessment Continuum Tool (Version 1.1.0) [Computer software]. https://github.com/shcaba/SS-DL-tool

Rademeyer, R.A. & Butterworth, D.S. 2014. Assessment of the US South Atlantic Wreckfish using primarily Statistical Catch-at-Age Assessment Methodology following the Recommendations of the November 2013 SAFMC SSC Wreckfish Assessment Workshop.

SAMFC 2019. Review of the Wreckfish Individual Transferable Quota Program of the South Atlantic Fishery Management Council. NOAA Award Number FNA10NMF4410012.

Vaughan, D.S., Manooch III, C.S. and Potts, J.C. 2001. Assessment of the wreckfish fishery on the Blake plateau. Pgs 105-122 in G.R. Sedberry, ed. Island in the stream: oceanography and fisheries of the Charlestown Bump. AFS, Symposium 25, Bethesda, MD.