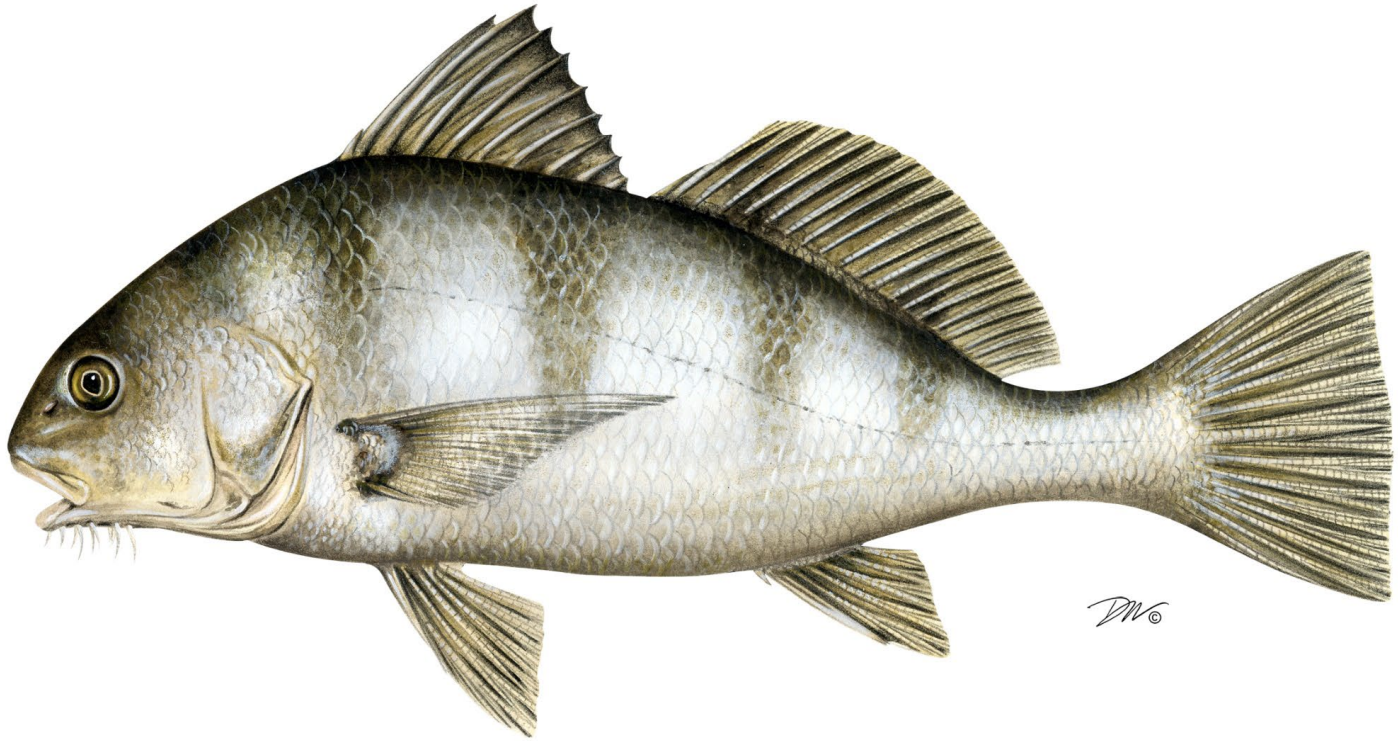
ASMFC Black Drum Stock Assessment: 2023



ASMFC Spring Meeting, May 1st 2023

Acknowledgements

ASMFC Black Drum Stock Assessment Sub-Committee

Chris McDonough (Chair), South Carolina Department of Natural Resources
Harry Rickabaugh, Maryland Department of Natural Resources
Margaret Conroy, Delaware Department of Natural Resources and Environmental Control
Hank Liao, Virginia Marine Resources Commission
Trey Mace, Maryland Department of Natural Resources
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Jeff Kipp, Atlantic States Marine Fisheries Commission

ASMFC Black Drum Technical Committee

Harry Rickabaugh (Chair), Maryland Department of Natural Resources
Chris McDonough, South Carolina Department of Natural Resources
Chris Stewart, North Carolina Division of Marine Fisheries
Craig Tomlin, New Jersey Department of Environmental Protection
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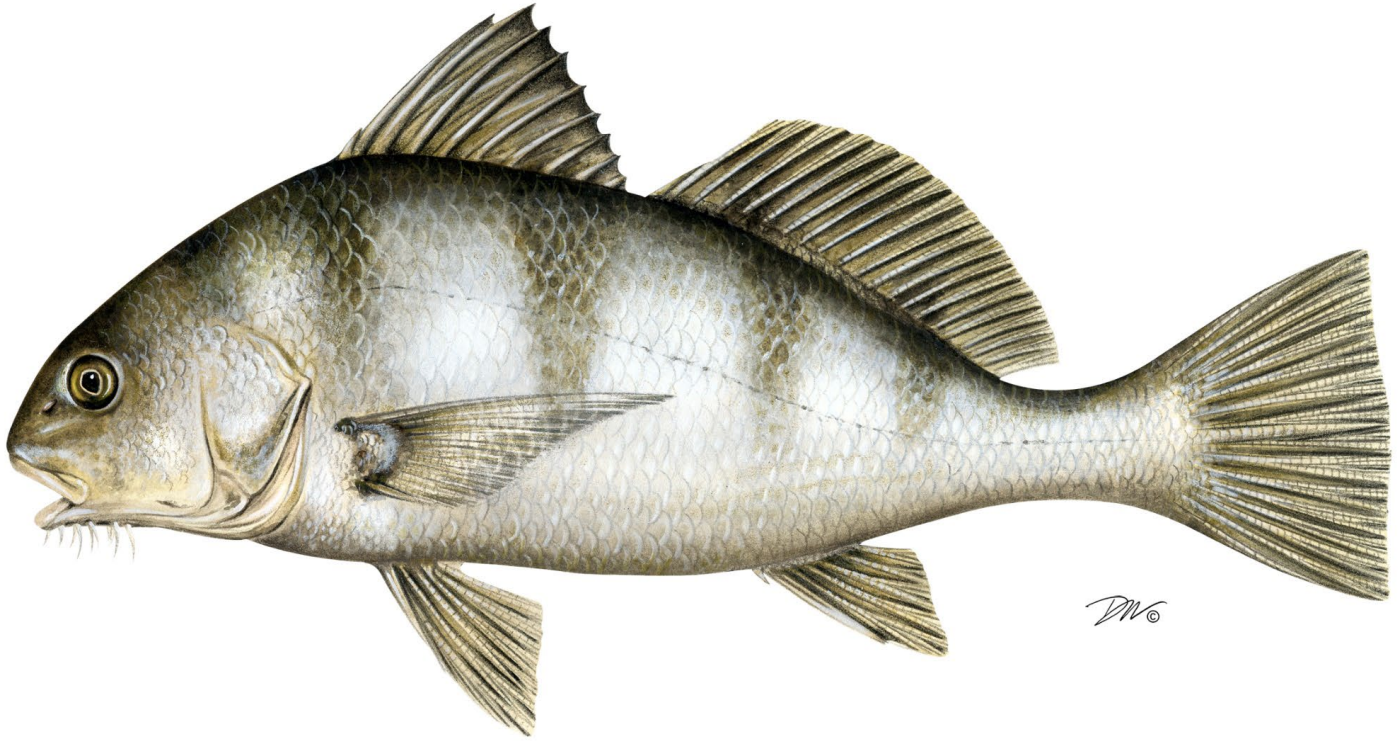
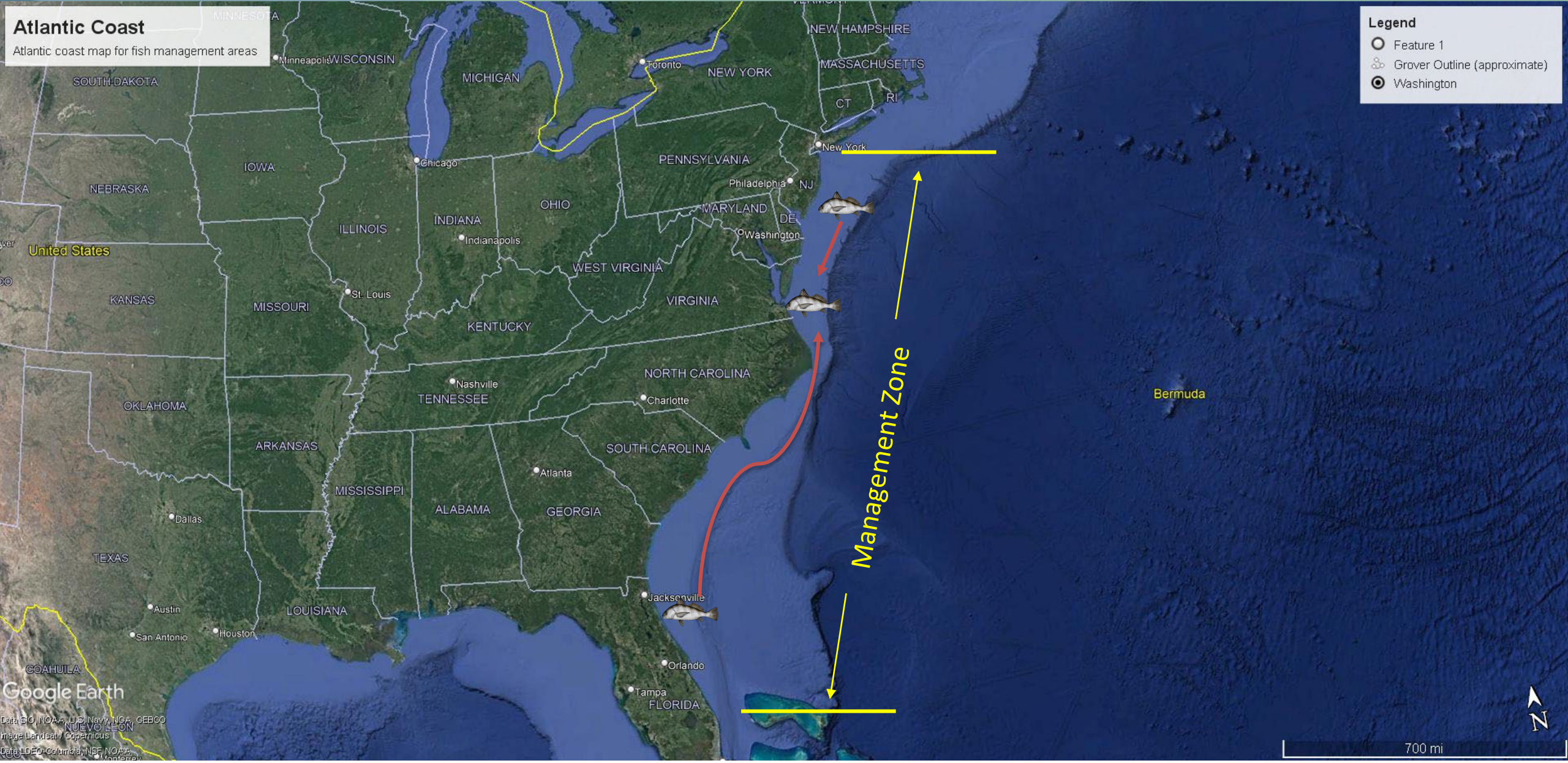
Jordan Zimmerman, Delaware Department of Natural Resources and Environmental Control
Ryan Harrell, Georgia Department of Natural Resources
Shanae Allen, Florida Fish and Wildlife Research Institute
Tracey Bauer, Atlantic States Marine Fisheries Commission
Jeff Kipp, Atlantic States Marine Fisheries Commission

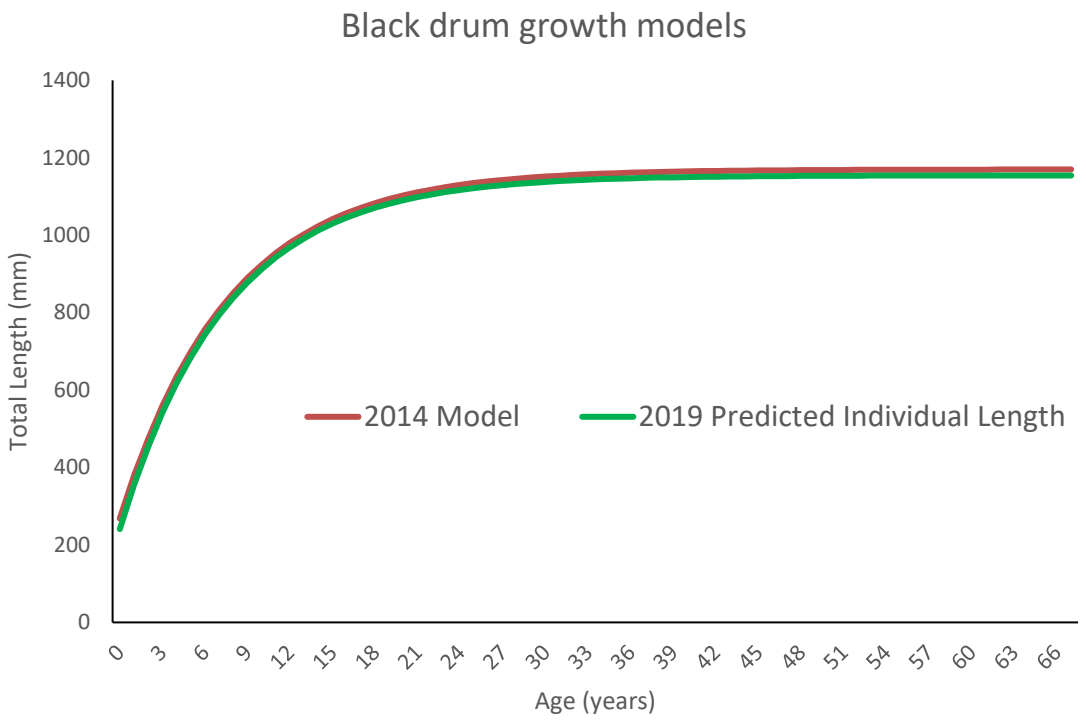
Black Drum: Life History

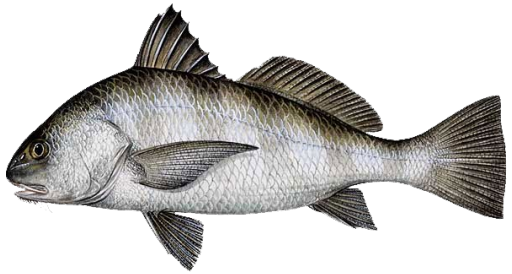




Migration has been documented from Florida north to the Chesapeake and from Delaware Bay to the south

Age & Growth

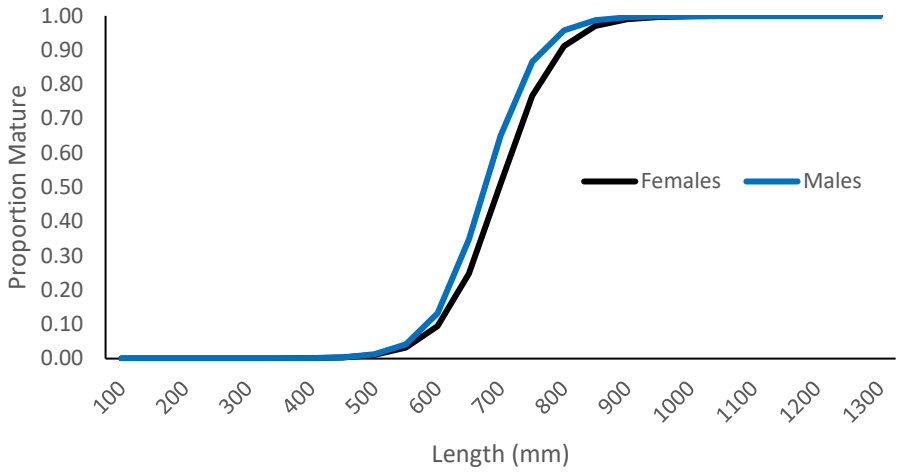




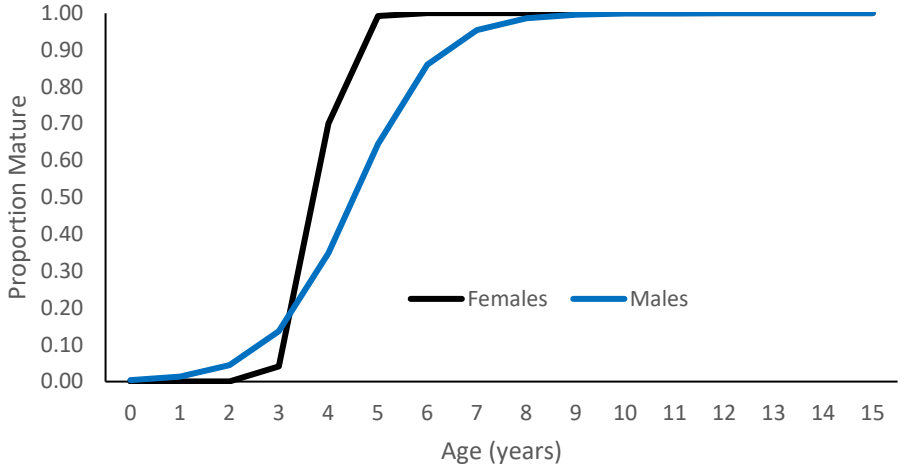
- Black drum are considered fast growing, reaching 80% of their growth potential in the first 20% of their lifespan
- Growth analysis did not detect any significant difference in growth between sexes or between regions (South Atlantic vs. Mid-Atlantic), supporting the use of a single growth function to describe black drum growth along the Atlantic coast
- There was very little difference in growth parameter estimates from the 2014 stock assessment and the current assessment using updated data sets

Reproduction and Maturity

Maturity at length by sex for black drum: composite data.



Maturity at age for black drum by sex: composite data

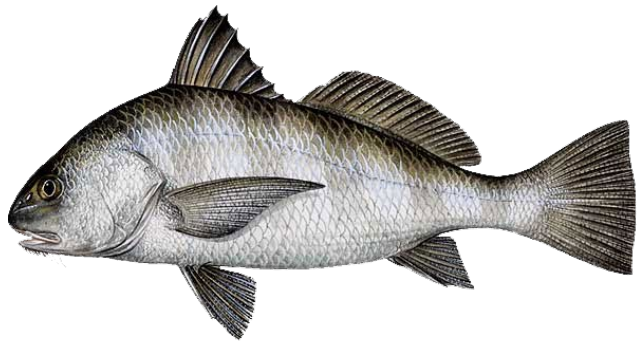


- The estimated length at 50% maturity was 675 mm TL with full maturity being reached at approximately 850 mm TL
- Both males and females reached 50% maturity at approximately age 4 with full maturity occurring at age 7
- Given their age range, black drum appear to mature relatively early and can have many years, if not decades of reproductive potential
- Spawning on the Atlantic coast ranges from November through June depending on region:
  - South Atlantic: Nov – April
  - Mid-Atlantic: April – June
- Total fecundity has been estimated from 5.5 to 26.6 million eggs per female in VA and is a function of fish size, length of the spawning season, spawning frequency and batch fecundity.

Natural Mortality

2014 Stock Assessment Estimates (report Table 59)				
Data Set	T_{max}	Hoenig (1983)	Hewitt & Hoenig (2005)	
DE DFW Biological Data	57	0.0740	0.0526	
ChesMMAP	55	0.0767	0.0545	
NC-DMF	60	0.0703	0.0500	
VMRC Data	67	0.0630	0.0448	****Estimate used in base DB-SRA model in 2014 assessment
SCDNR Data	46	0.0917	0.0652	

Updated 2022 Assessment		
Data Set	T_{max}	Then et al. (2015)
DE DFW Biological Data	57	0.1207
ChesMMAP	55	0.1247
NC-DMF	60	0.1152
VMRC Data	67	0.1041
SCDNR Data	47	0.1440



- **In the 2015 assessment, natural mortality was estimated using Hoenig (1983) and the maximum age observed coastwide of 67 years old (0.063)**
- **For this assessment, the TC decided to transition to the Then et al. (2015) non-linear least squares estimator of natural mortality**
- **The Then et al. (2015) estimator resulted in a higher estimate of natural mortality using the maximum age observed coastwide of 67 years old (0.1041)**

Habitat

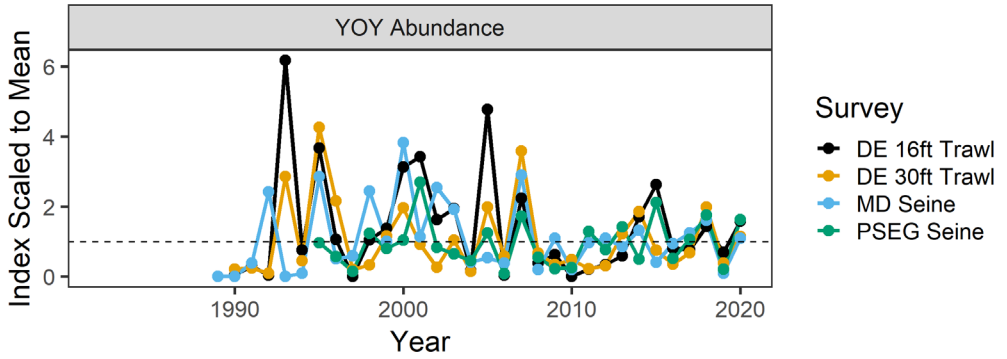
Spawning/Larval

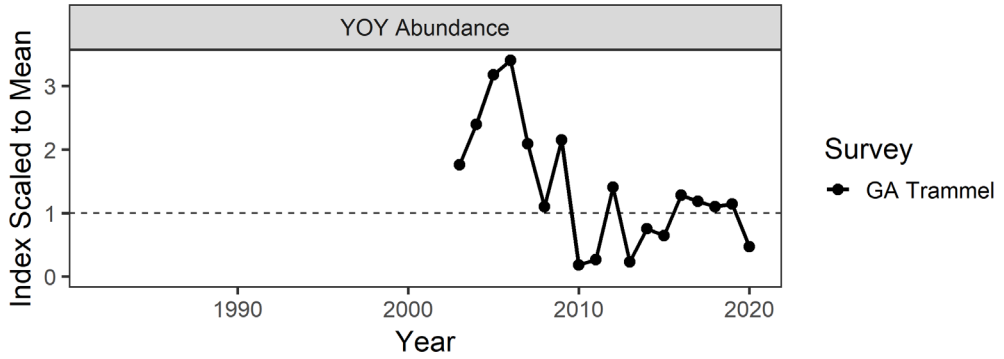
- Black drum spawn from April to June in the northern range in the mouth of the Chesapeake Bay and seaside inlets on the Eastern shore
- Evidence in Florida and the Carolinas suggests spawning occurs in deep waters inshore, from November through April, with peaks in February and March
- Larval black drum tend to settle in salt marshes and estuaries with salinities ranging from 22 – 30 ppt

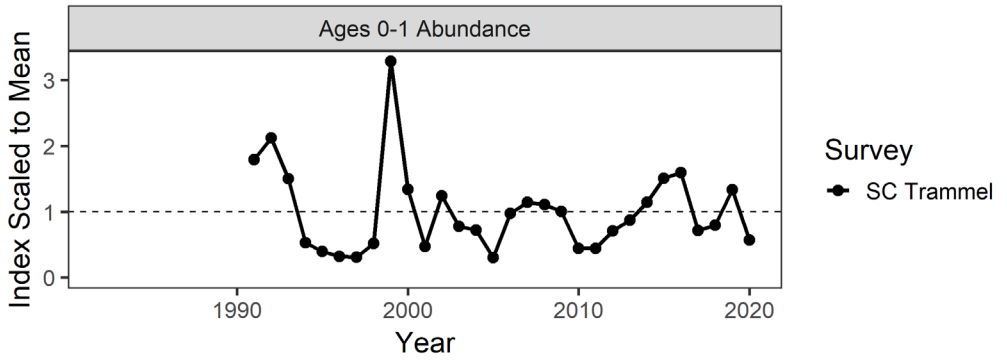
Juveniles/Adults

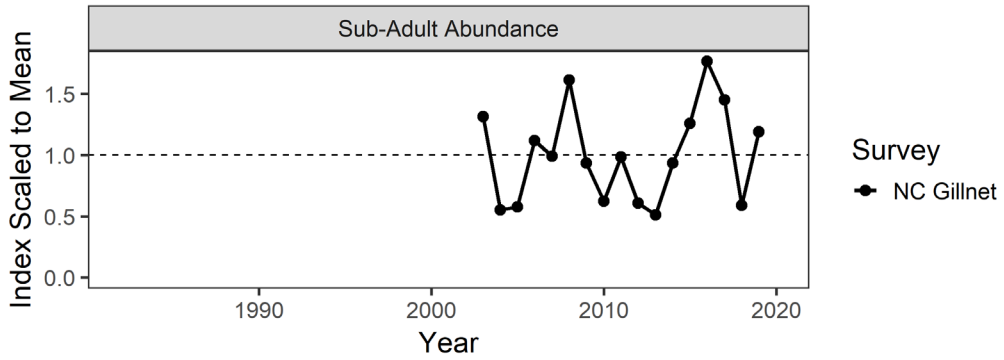
- Black drum juveniles have been found in salt marshes and estuaries along the coast, suggesting these areas serve as nurseries for sub-adults
- Juveniles tolerate a wide range of salinities and temperatures but have been found often in low to medium salinities and over unvegetated mud bottoms or near vertical structure
- Adults move between estuaries and nearshore shelf waters, although they tend to move to deeper channel areas as they grow and mature
- Evidence supports an age-specific migration in the Mid-Atlantic: northward and inshore in the spring; southward and offshore in the fall
- Black drum move offshore at sexual maturity and form large, offshore schools that can migrate extensively

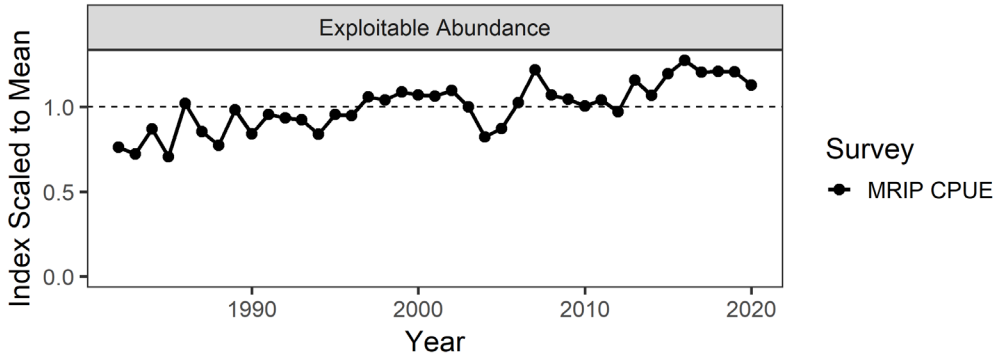
Abundance Data Sets/Stock Indicators



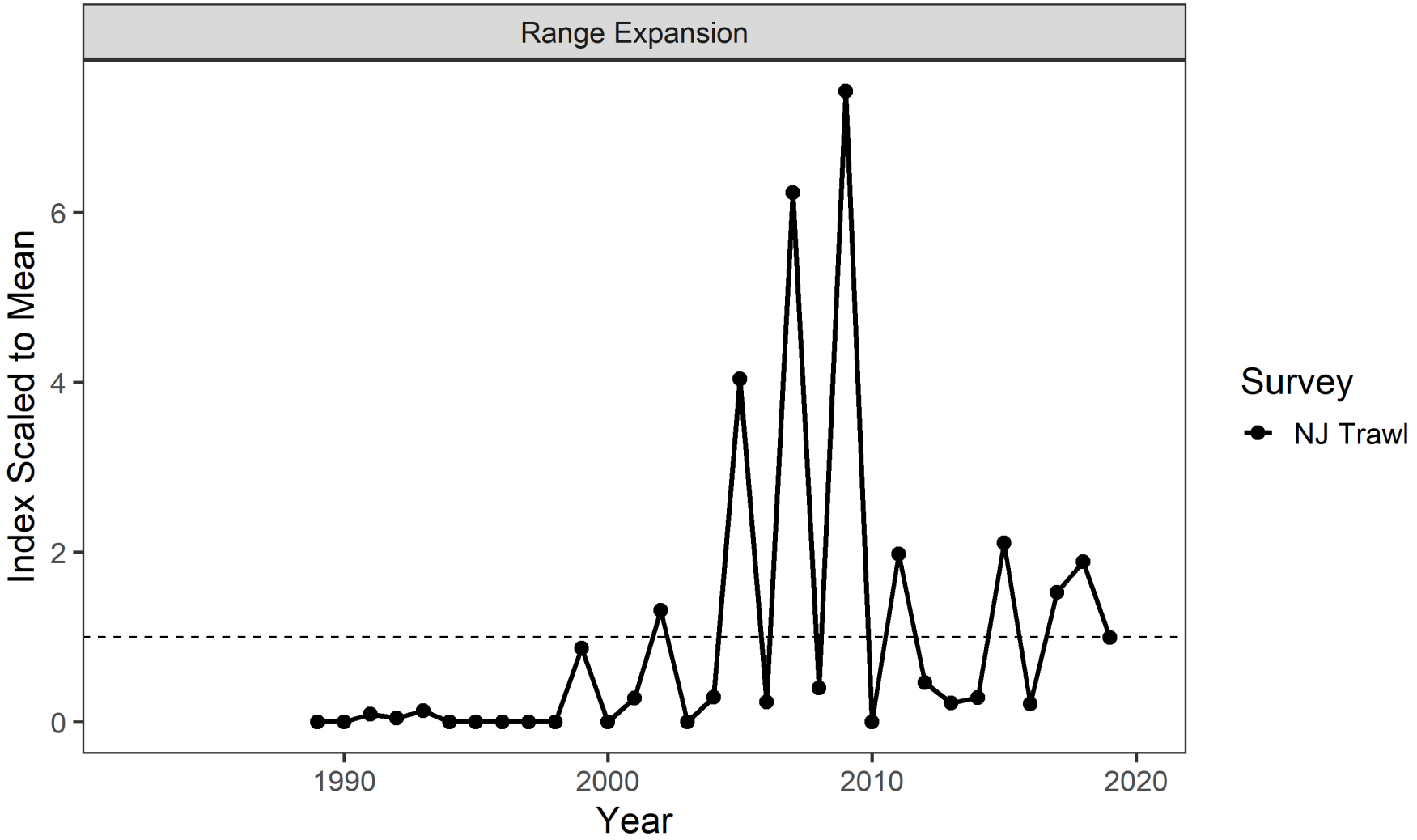




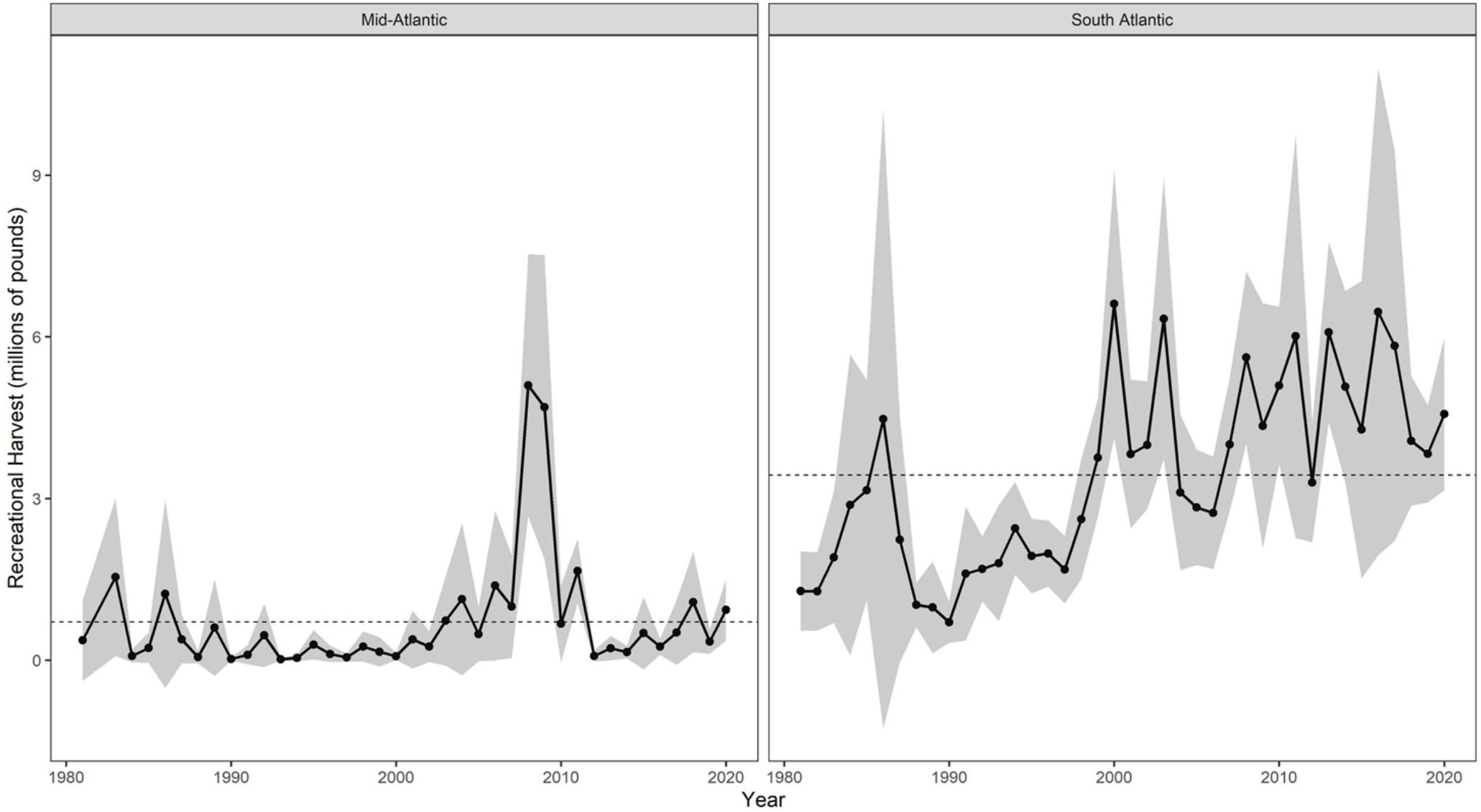




Range Expansion Data Set/Indicator



Fishery Characteristics Data Sets/Indicator



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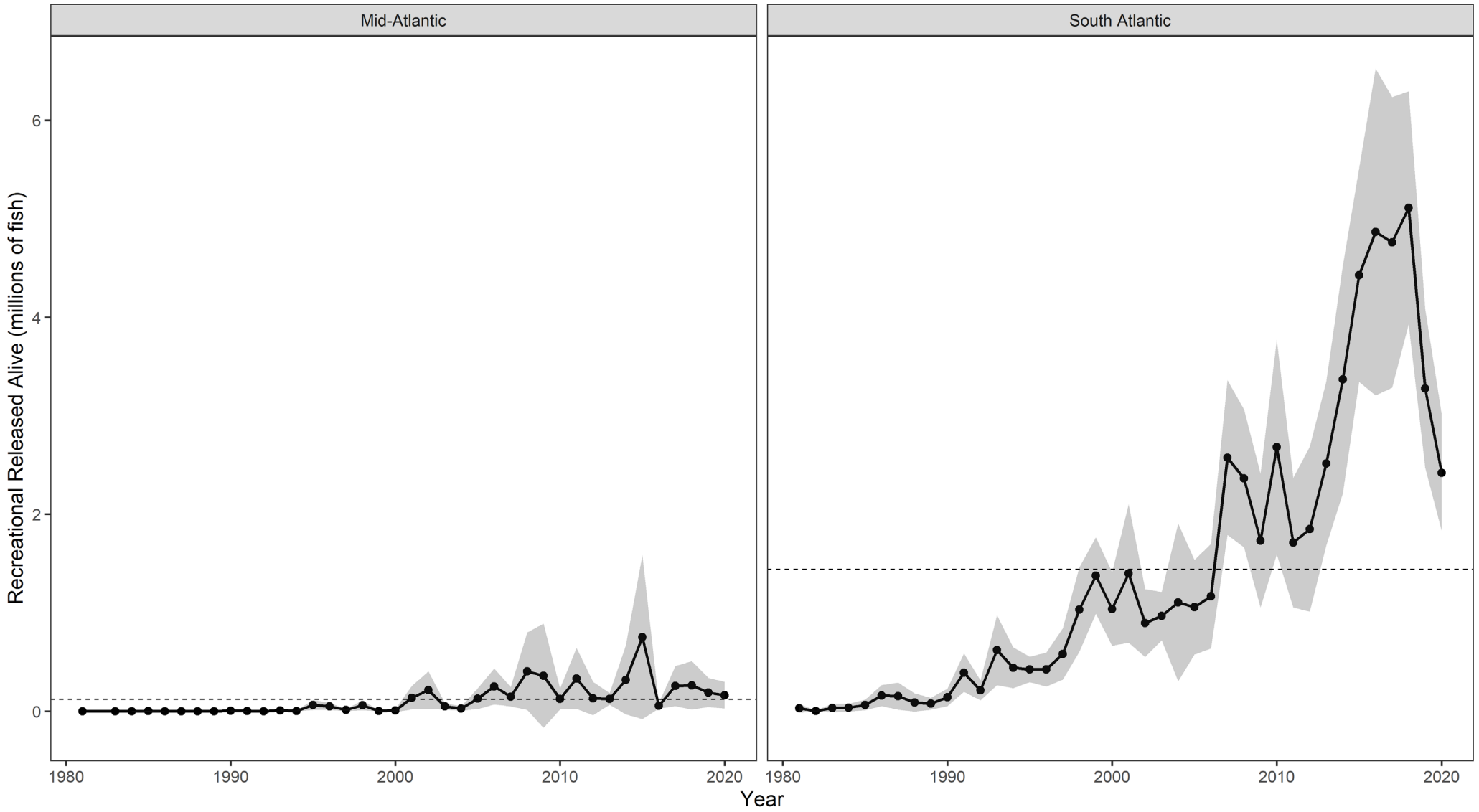

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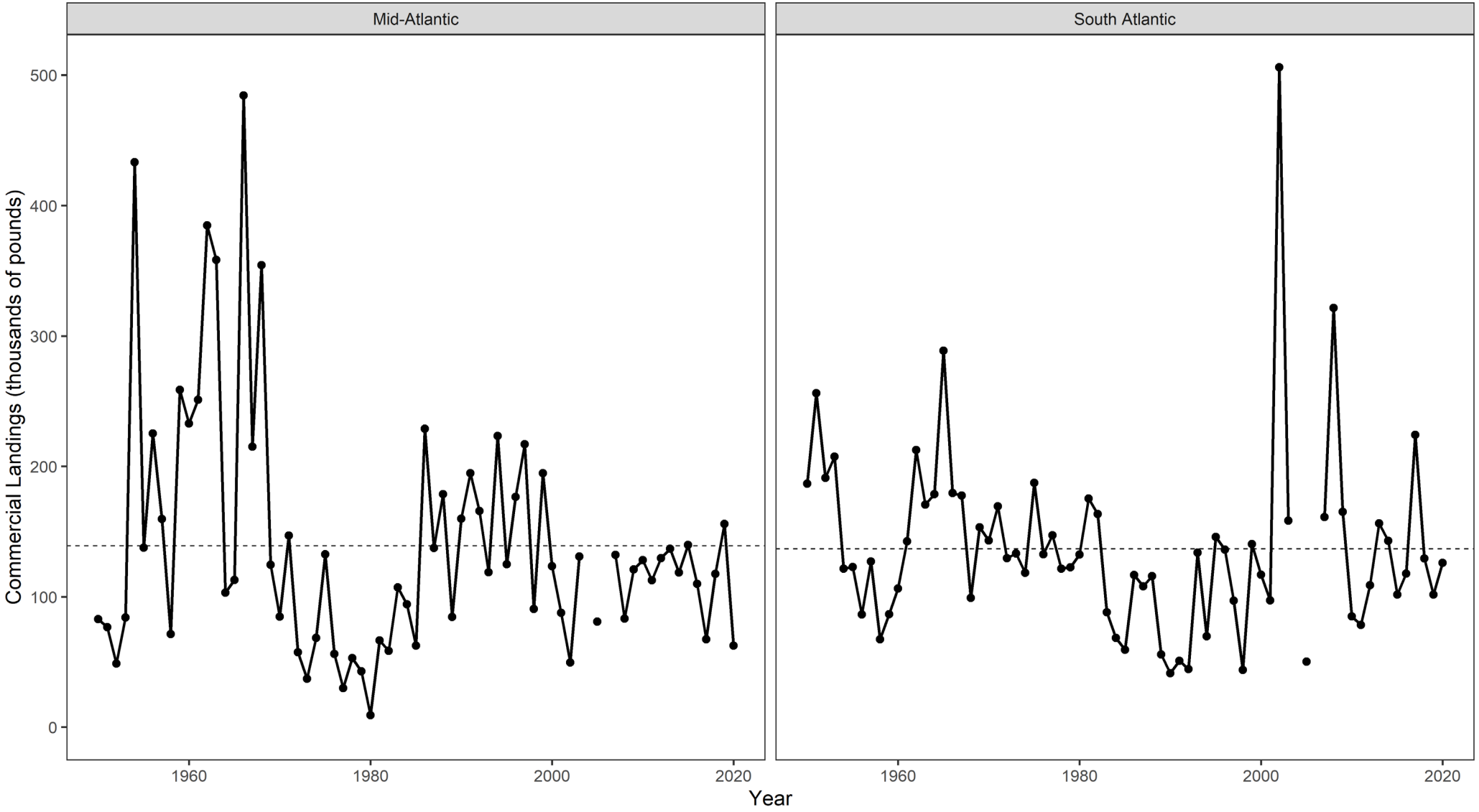
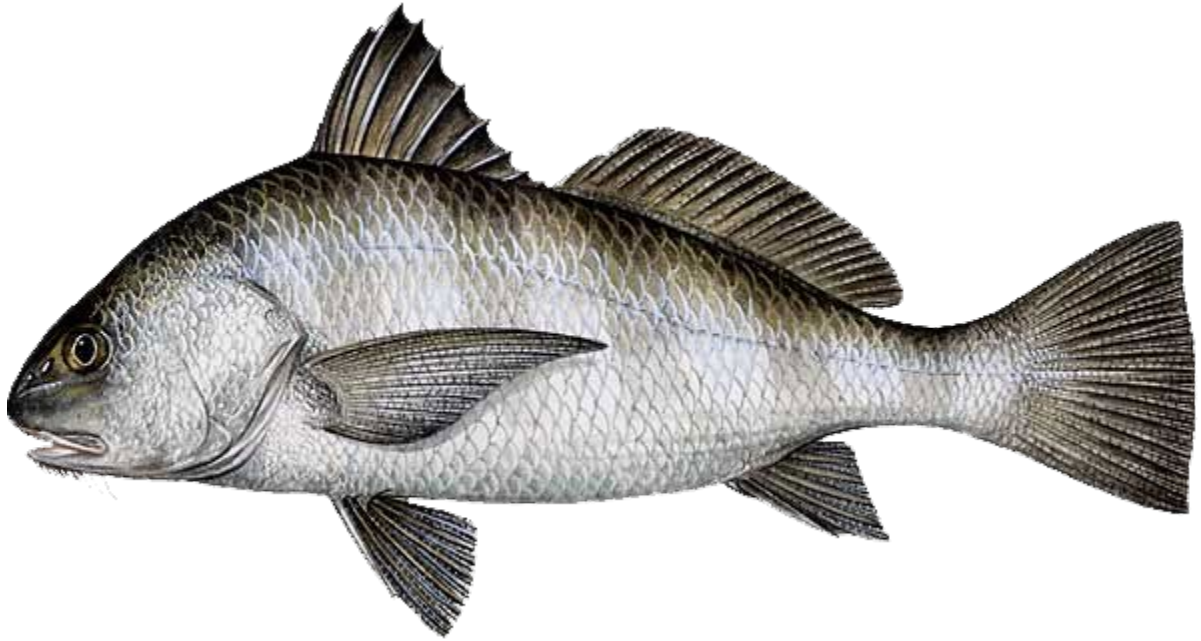


Black Drum: Methods & Model Preference



ASMFC Black Drum Stock Assessment 2023: Sciaenid Board Review

Models

Preferred

- JABBA-Select: Incorporates abundance information, differentiates between exploitable biomass and spawning biomass

Alternate Methods:

- Index Methods
  - Itarget: Complicated by one-way trip data sets, uncertainty in appropriate multiplier
  - Skate: Complicated by one-way trip data sets, uncertainty in appropriate reference period

- DB-SRA (previous preferred model): Does not incorporate abundance information from an index

- SSS: (DB-SRA type model in Stock Synthesis) Does not incorporate abundance information from an index

- Stock Synthesis: Needs further development in a future assessment

Index Methods

For Itarget method:

- Concerns with setting index multiplier value
  - Index multiplier at or near 1.0 justified for stock near carrying capacity
  - Higher index multiplier justified for more depleted stock
    - Depletion of Black Drum stock believed to be between 0.4 and 1
    - Higher multipliers set target catch levels at much lower levels than landings within the last decade.

Index Methods

For Skate method:

- Catch advice using full time series lower than actual landings over last 14 years
  - Conflicts with not overfishing determination using comparisons of previous and current index CVs
- Catch advice using only the time period from 2000 - 2012 yielded catch advice more closely aligned with catch history
  - No definitive explanation for change in exploitation after 1999
    - Exclusion of years before 2000 may be arbitrary decision

Index Methods

Both methods ultimately rejected

- Uncertainties related to the lack of a fisheries-independent index of relative abundance
- Specification of actual depletion status of the stock
- Defining the appropriate index multiplier for Itarget
- Conflicting signals of stock status between the index and catch history in Skate method

DB-SRA and Simple Stock Synthesis

- The DB-SRA model used in the previous assessment and the Simple Stock Synthesis model both assume the black drum population started at an unexploited state in 1900 and abundance was at 70%, on average, of the unexploited state at or near the end of the time series

- When combined with the increase in removals, especially in the last 20 years, and no information on abundance changes, this assumption and the structure of these two models results in a declining trend in abundance over time

- For both models, the lowest abundance occurred in 2020, the final year in the current assessment

- Neither of these models incorporated abundance information from an index

JABBA-Select Model: Preferred

- The JABBA-Select model links age-structured dynamics with per-recruit models to Pella-Tomlinson surplus production model parameters

- Uses the MRIP CPUE, removal data, life history characteristics, and selectivity information as inputs

- Incorporates uncertainty through prior distributions on influential parameters: stock-recruit relationship steepness (*h*) and natural mortality (*M*)

- JABBA-Select does not require the assumption that the modeled time series starts when the stock is unexploited and did not make an assumption about depletion at or near the end of the time series, but rather makes an assumption about depletion at the start of the time series (here 1982) with use of a prior distribution

JABBA-Select Model: Preferred

The JABBA-Select model:

1. Differentiates between exploitable biomass and spawning biomass, which are different for black drum due to life history and exploitation patterns, and accounts for this difference when estimating annual production as the ratio of these two biomasses changes

2. Requires one less assumption about biomass depletion than DB-SRA and Simple Stock Synthesis

3. Does not require use of early, uncertain catch data

4. Accounts for changes to fishery selectivity through time and resultant impacts to productivity

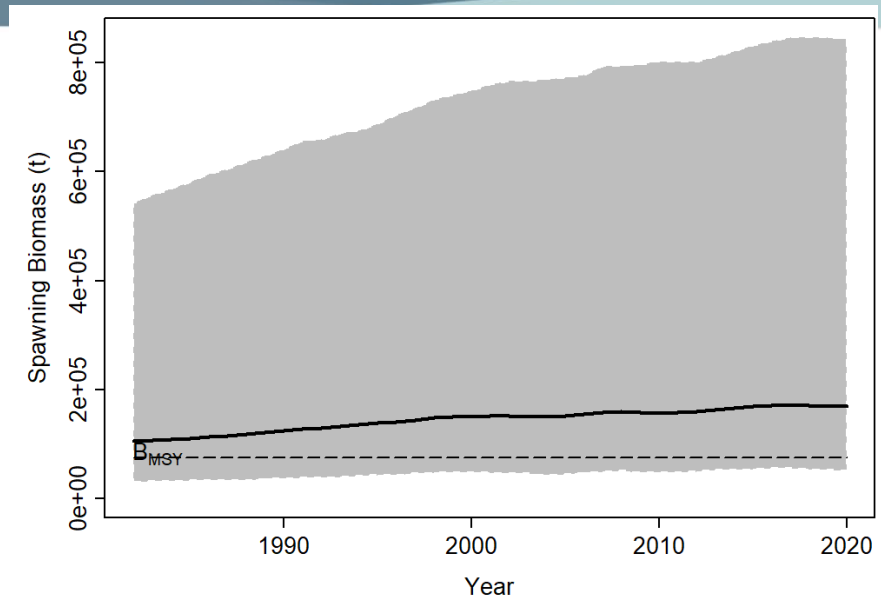
JABBA-Select Model Link

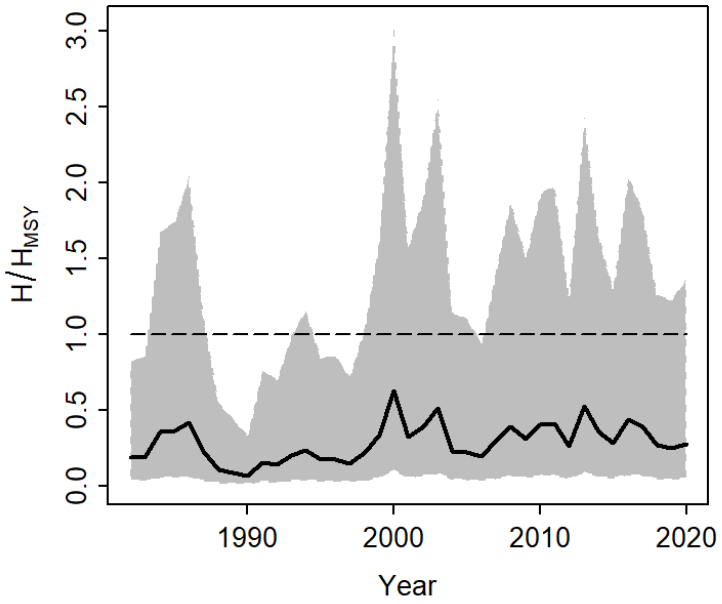
- Draws 1,000 iterations of M and h from prior distributions
- Solves for MSY, F_{MSY}, SB_{MSY} using per-recruit models
- Calculates SB_0 by setting F=0 in per-recruit models
- Uses these parameters to derive multivariate prior of surplus production parameters:
  - H_{MSY} (reparametrization of r)
  - m (shape of production curve)
- Fits surplus production model to MRIP CPUE and removals

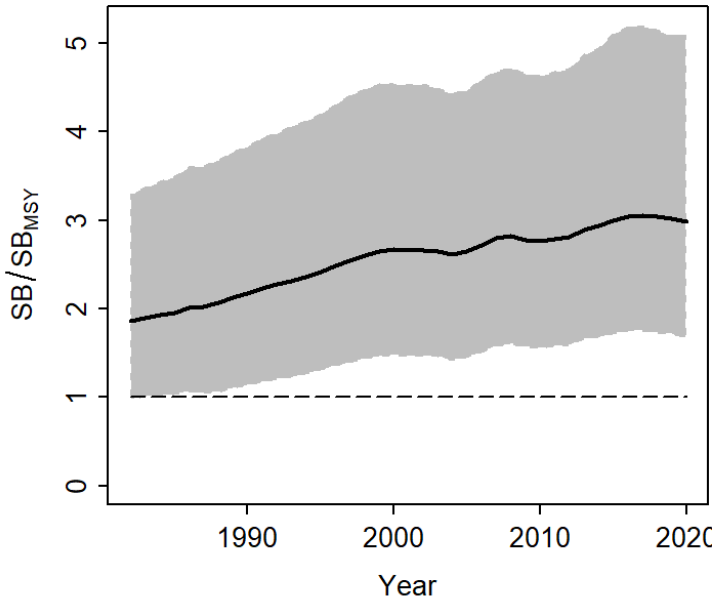
JABBA-Select Reference Points

- MSY-based reference points
  - SB_{MSY}
  - $H_{MSY} = MSY/SB_{MSY}$
  - MSY

JABBA-Select Base Model Results



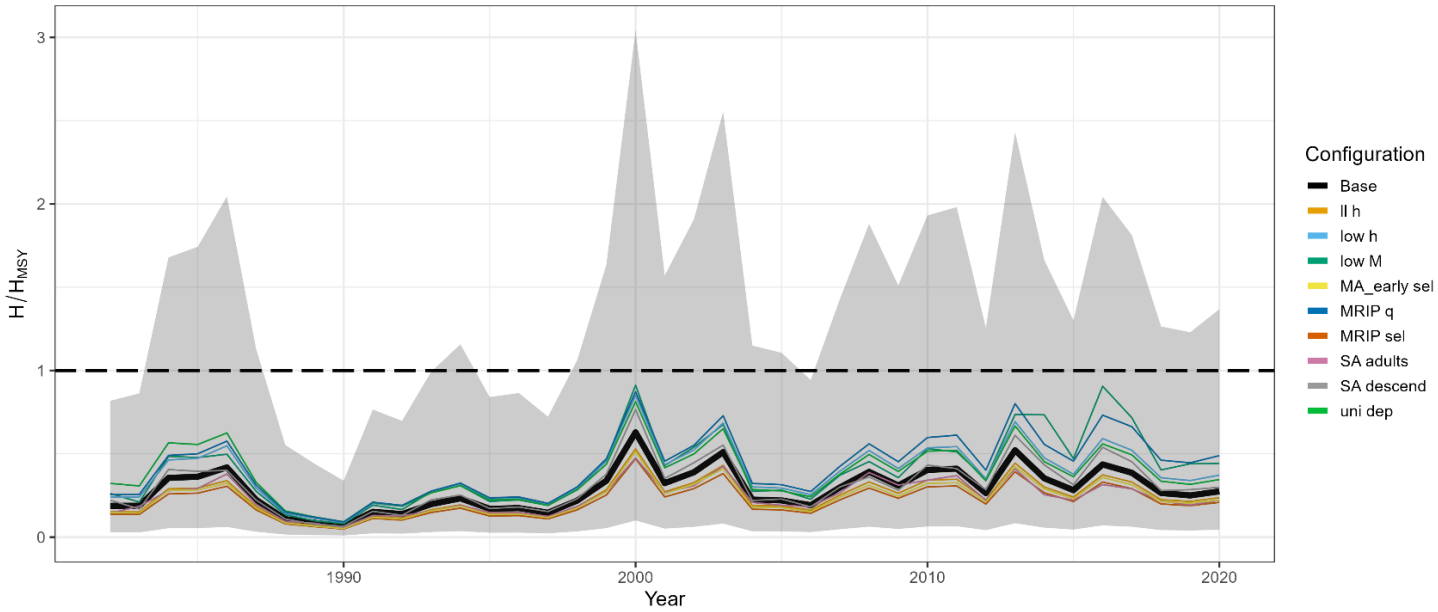


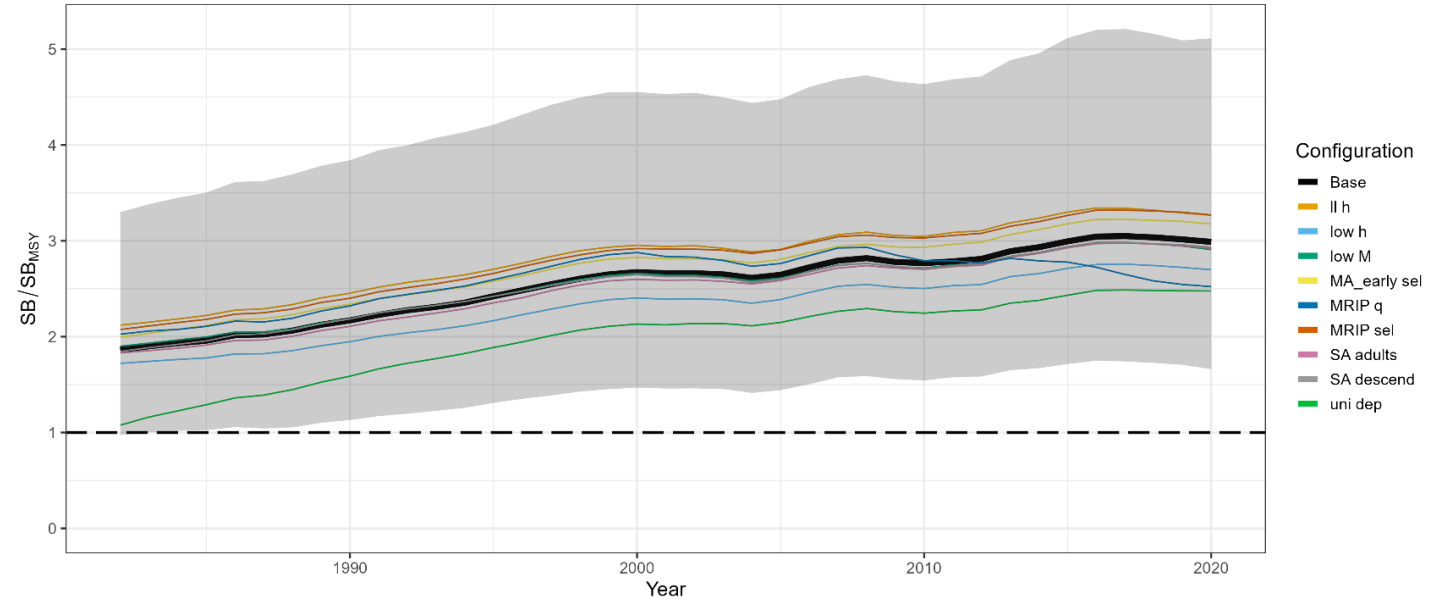


JABBA-Select Sensitivity Analysis

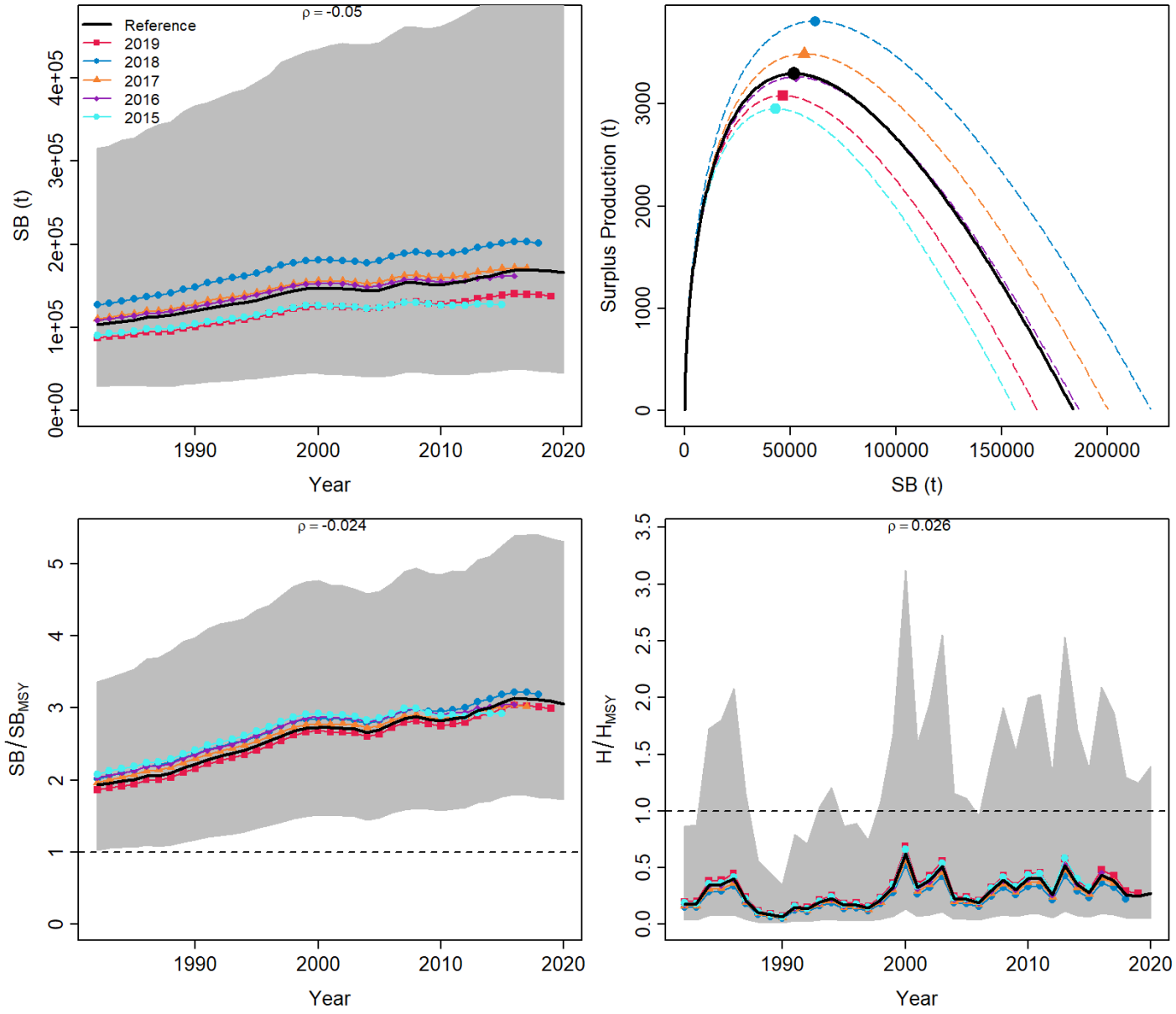
- low M: Decrease M to 0.068
- Hi h: Shertzer and Conn 2012 likelihood estimates
- low h: Decrease h by 0.1
- MRIP sel: Decrease large size selectivity to 0.1
- SA adults: Increase large size selectivity to 0.06
- SA descend: Shift descending selectivity to the right 100 mm
- MA_early sel: Shift selectivity right
- uni dep: Uniform depletion prior across range 0-1
- MRIP q: MRIP CPUE catchability change in 2016

JABBA-Select Sensitivity Analysis





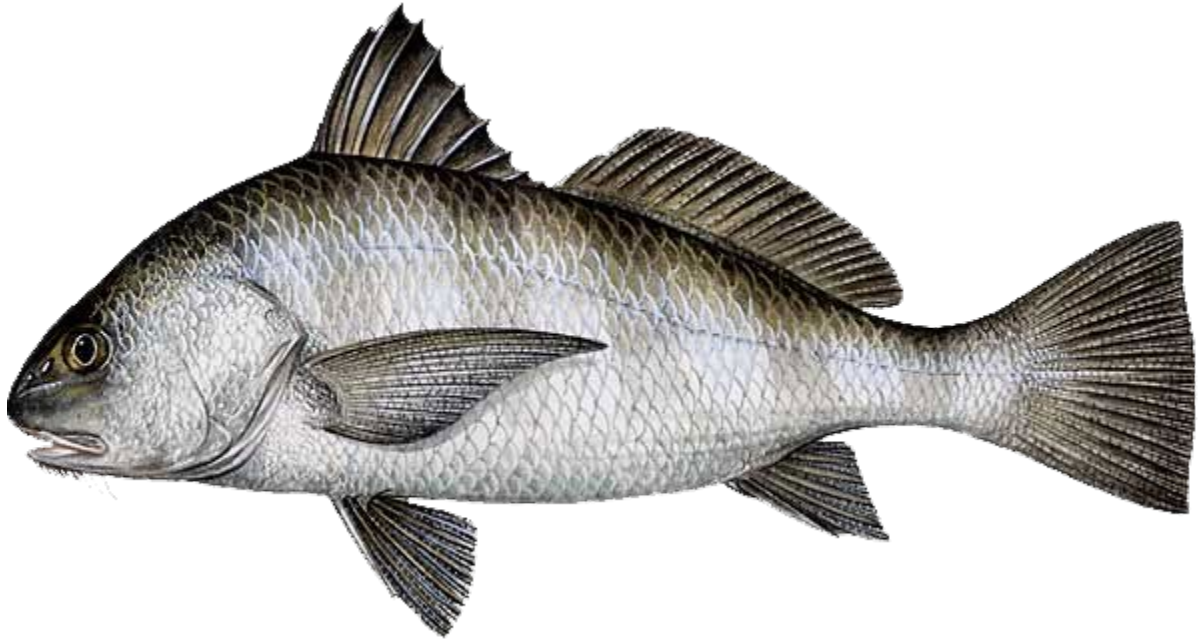
JABBA-Select Retrospective Analysis



JABBA-Select Conclusions

- Higher exploitation rates since 2000
- Increasing biomass followed be stabilizing trend at end of time series
- High uncertainty in absolute estimates
- Lower uncertainty in relative estimates with majority of credible intervals concentrated in final stock status region

Black Drum: Stock Status



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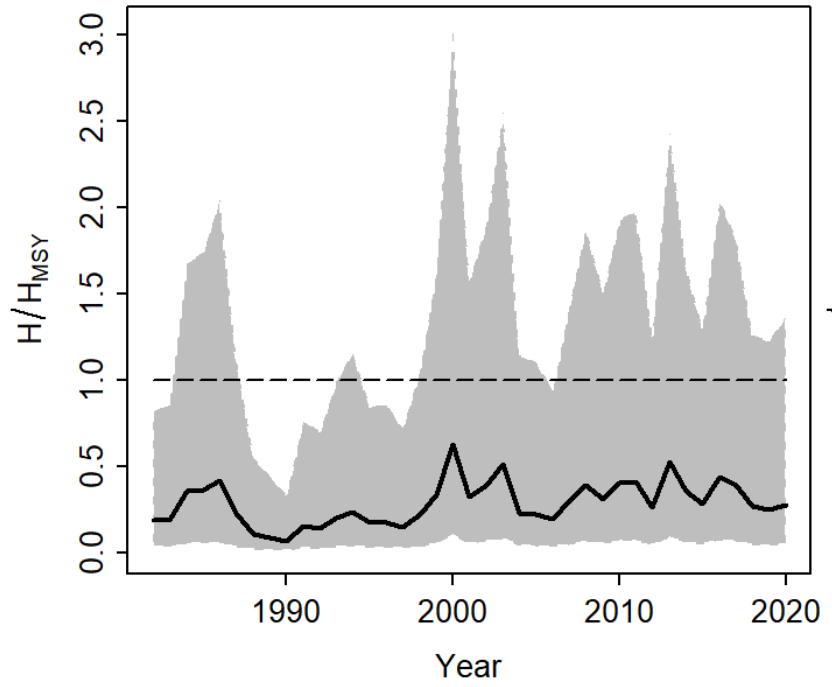
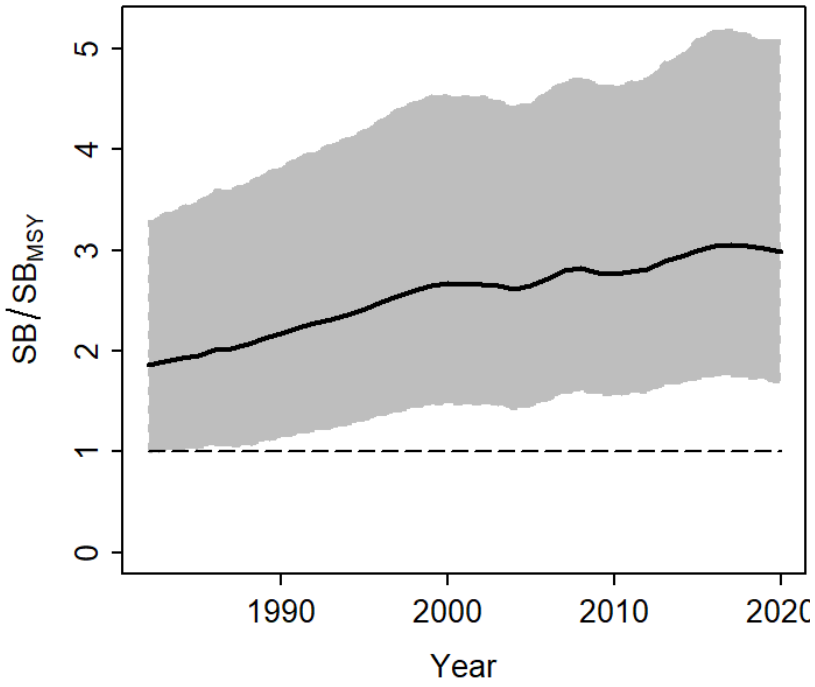
Stock Status

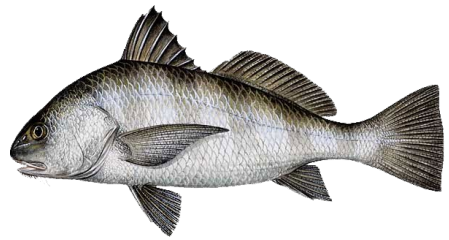
- Overfishing definition: $SB_y/SB_{MSY}<1$
  - Base model median estimate: $SB_{2020}/SB_{MSY} = 2.99$
  - Stock not overfished

Overfishing definition: $H_y/H_{MSY}>1$

- Base model median estimate: $H_{2020}/H_{MSY} = 0.28$
- Stock not experiencing overfishing







Additional Considerations

- Empirical indicators show increased fishery removals in the last twenty years and less frequent large recruitment events in the Mid-Atlantic in the last ten years
- There are no clear indications of a declining trend in recruitment or exploitable abundance from abundance indicators (exception: the anomalous GA trammel index)
- There is a declining trend in the final two years of the recreational discard time series that may be reflective of abundance in addition to other factors
- There is some indication of northern range expansion
- Overall, stock indicators do not appear negative at this time, but should be monitored closely for any sign of change

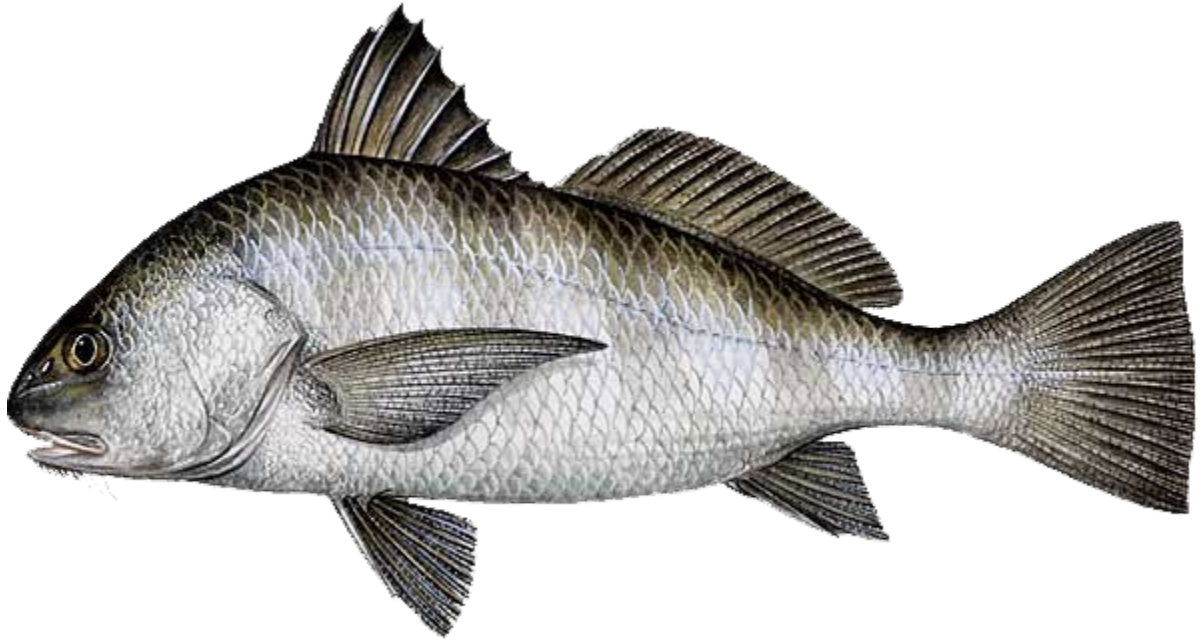
Additional Considerations

- The one-way trip increasing trend in both removals and the MRIP CPUE for the assessment time period may indicate that the stock either had been lightly exploited in the 1980s, which has allowed for the recent increase in exploitation of the predicted high biomass, or was overfished and rebuilding throughout the assessment time series

- However, it is also possible that recruitment overfishing is occurring or could begin to occur prior to detection with currently available data, due to sub-adult black drum accounting for the majority of removals and the lack of an index that solely tracks mature biomass

- With over 30 cohorts contributing to SSB, recruitment overfishing may not be evident within current data streams for an extended number of years, leading to an overfished state being reached prior to removals and the MRIP CPUE index indicating a sustained downward trend

Black Drum: Research Recommendations



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What has been accomplished since the last assessment (partially)

- Collect genetic material (i.e., create “genetic tags”) over a long time span to obtain information on movement and population structure, and potentially estimate population size.
  - ***See Section 2.1 and Leidig 2014.***

- Obtain better estimates of harvest from the black drum recreational fishery (especially in states with short seasons).
  - ***MRIP changes discussed in Section 4.2.1.1 were generally seen as improvements to catch estimates, though the exception remains nighttime fishery sampling identified as a moderate research recommendation above.***

- Collect information on the magnitude and sizes of commercial discards. Obtain better estimates of bycatch of black drum in other fisheries, especially juvenile fish in south Atlantic states.
  - ***An ongoing observer program now provides monitoring of the primary suspected commercial black drum discard fishery (Section 4.1.1.2). Recent estimates have been small in comparison to total fishery removals, but this source of catch should continue to be monitored in future stock assessments for signs of increase***

HIGH PRIORITY

- Evaluate use of MRIP site-use weighting factors to improve CPUE estimates. ***short-term***

- Skate and Itarget with their current data inputs should be evaluated as annual indicators to show current relationships between stock and removals (Itarget) and the ongoing trend of relative *F* (Skate). ***short-term***

- A process should be developed for appropriately combining MRIP and supplemental recreational sampling program data for characterizing the size structure of the recreational harvest. The process needs to consider spatial information, as there are likely spatial effects within states' supplemental sampling programs (e.g., VMRC Freezer Program representing Eastern Shore harvest). ***short-term***

HIGH PRIORITY

- Continue all current fishery-independent surveys recommended as stock indicators for black drum and collect biological samples for black drum on all surveys. ***long-term***

- Develop fishery-independent adult surveys to target black drum.
  - Collect age samples, especially in states where maximum size regulations preclude the collection of adequate adult ages. ***long-term***

- Conduct a high reward tagging program to obtain return rate estimates. Continue and expand current tagging programs to obtain total mortality, catch and release mortality, and growth information and movement-at-size data. ***long-term***

- Increase biological sampling in commercial fisheries, particularly gill nets in Virginia (see Section 4.4), to better characterize size and age composition of commercial landings. ***long-term***

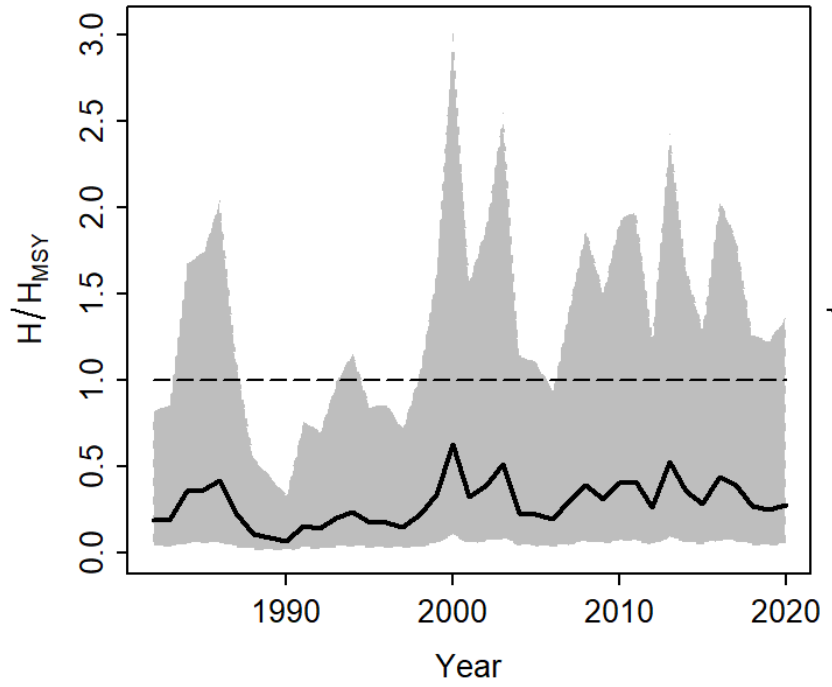
- Increase biological sampling in recreational fisheries, particularly harvest in the Mid-Atlantic region and releases coastwide (see Section 4.4), to better characterize size and age composition of recreational catch. ***long-term***

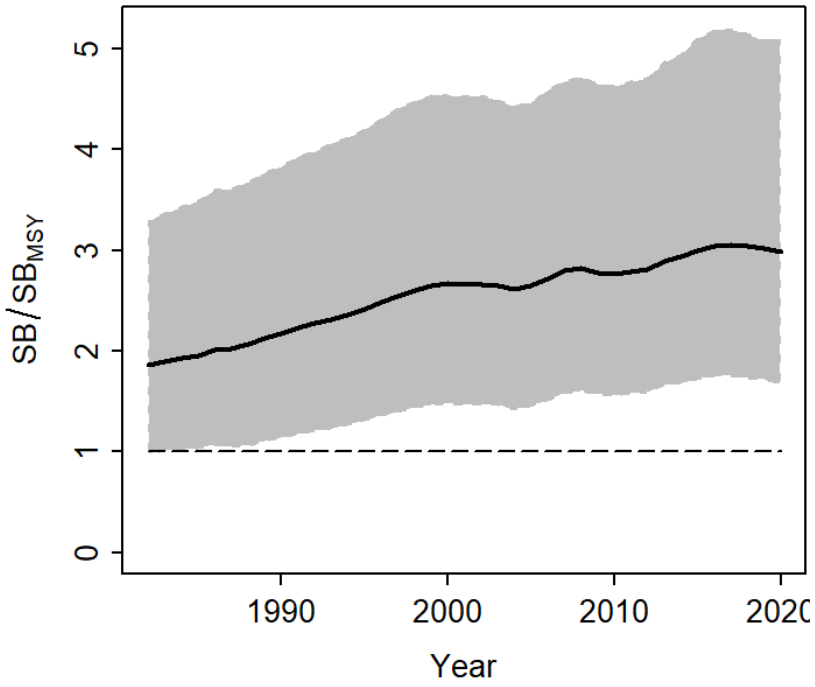
Questions?

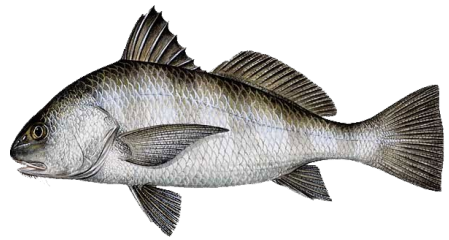
- Overfishing definition: $SB_y/SB_{MSY}<1$
  - Base model median estimate: $SB_{2020}/SB_{MSY} = 2.99$
  - Stock not overfished

Overfishing definition: $H_y/H_{MSY}>1$

- Base model median estimate: $H_{2020}/H_{MSY} = 0.28$
- Stock not experiencing overfishing







Backups

MODERATE PRIORITY

- Age otoliths that have been collected and archived (≈ 500 sub-adults samples from GA). ***short-term***

- Improve sampling of concentrated, targeted nighttime fisheries in the Mid-Atlantic region (e.g., Delaware Bay). ***long-term***

- Conduct tagging study to determine survival, migration, and contribution of YOY fish spawned in the Mid-Atlantic to the overall sub-adult stock. ***long-term***

- The recreation released alive trend and harvest trend provided a mixed signal. However, such an analysis may provide limited information on fishing behavior change, therefore, we recommend to directly collect such information via a one-time pilot study (≈three years) during existing creel surveys (e.g., MRIP APAIS). Such information may potentially provide better information to understand drivers of these trends in the future stock assessment. ***short-term***

LOW PRIORTY

- Expand simulation-based power analysis to other index data sets used for stock indicators of black drum. ***short-term***

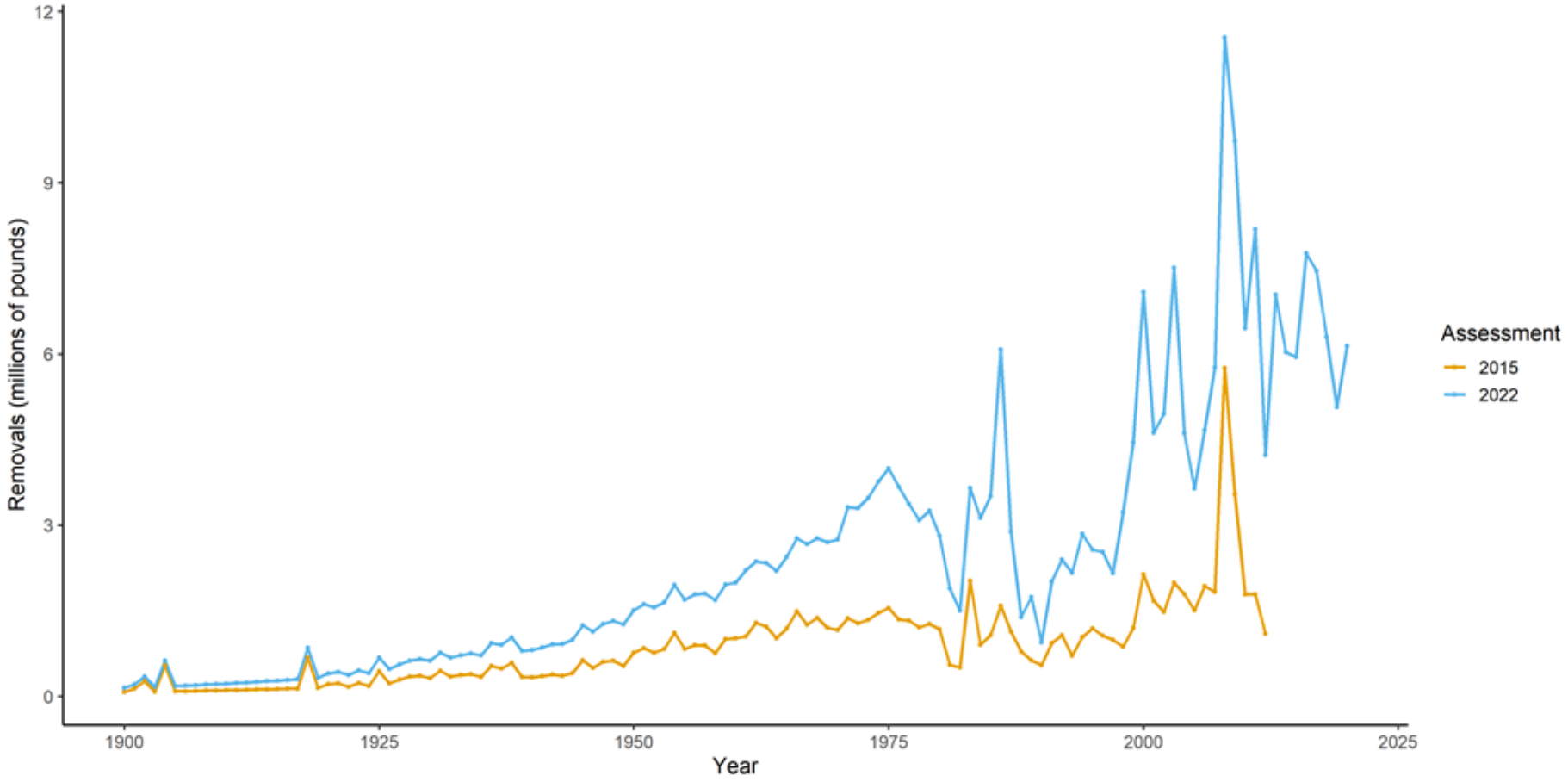
- Conduct reproductive studies that provide updated estimates and an expanded spatial coverage, including: age and size-specific fecundity, spawning frequency, spawning behaviors by region, and movement and site fidelity of spawning adults. ***long-term***

- There is uncertainty about selectivity between gill net types fished (anchor and drift) in Virginia and the appropriateness of combining these gears into a fleet. There are no composition data collected from drift gill nets, so this remains an uncertainty that should be researched in the future. ***short-term***

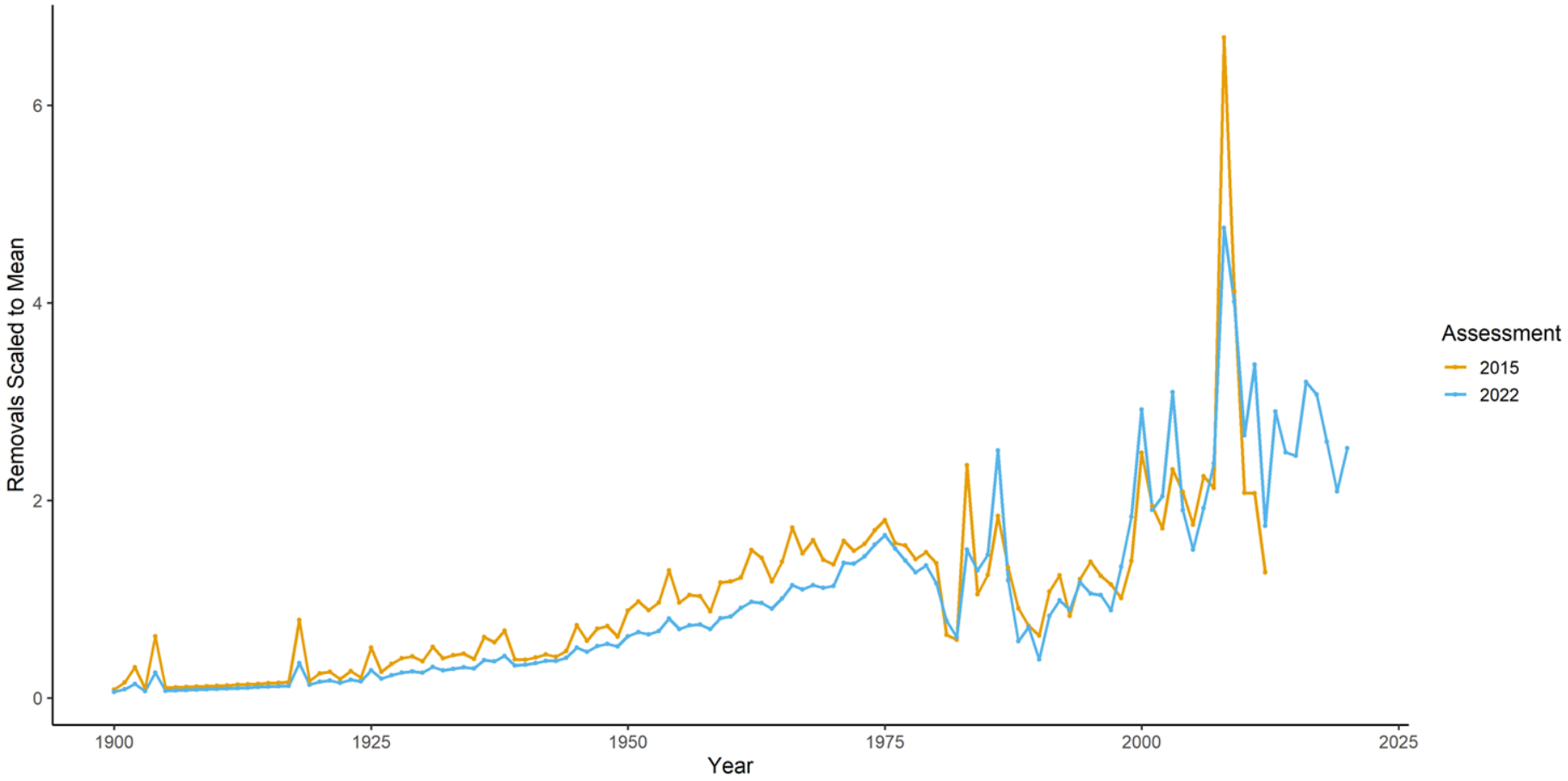
Updated DB-SRA

- Preferred model from previous assessment
- Included as continuity model and candidate for preferred model in this assessment
- Two runs to isolate changes
  - Updated MRIP estimates (***New_Catch***)
  - Updated MRIP estimates with Then et al. 2015 M estimator (***Then_M***)

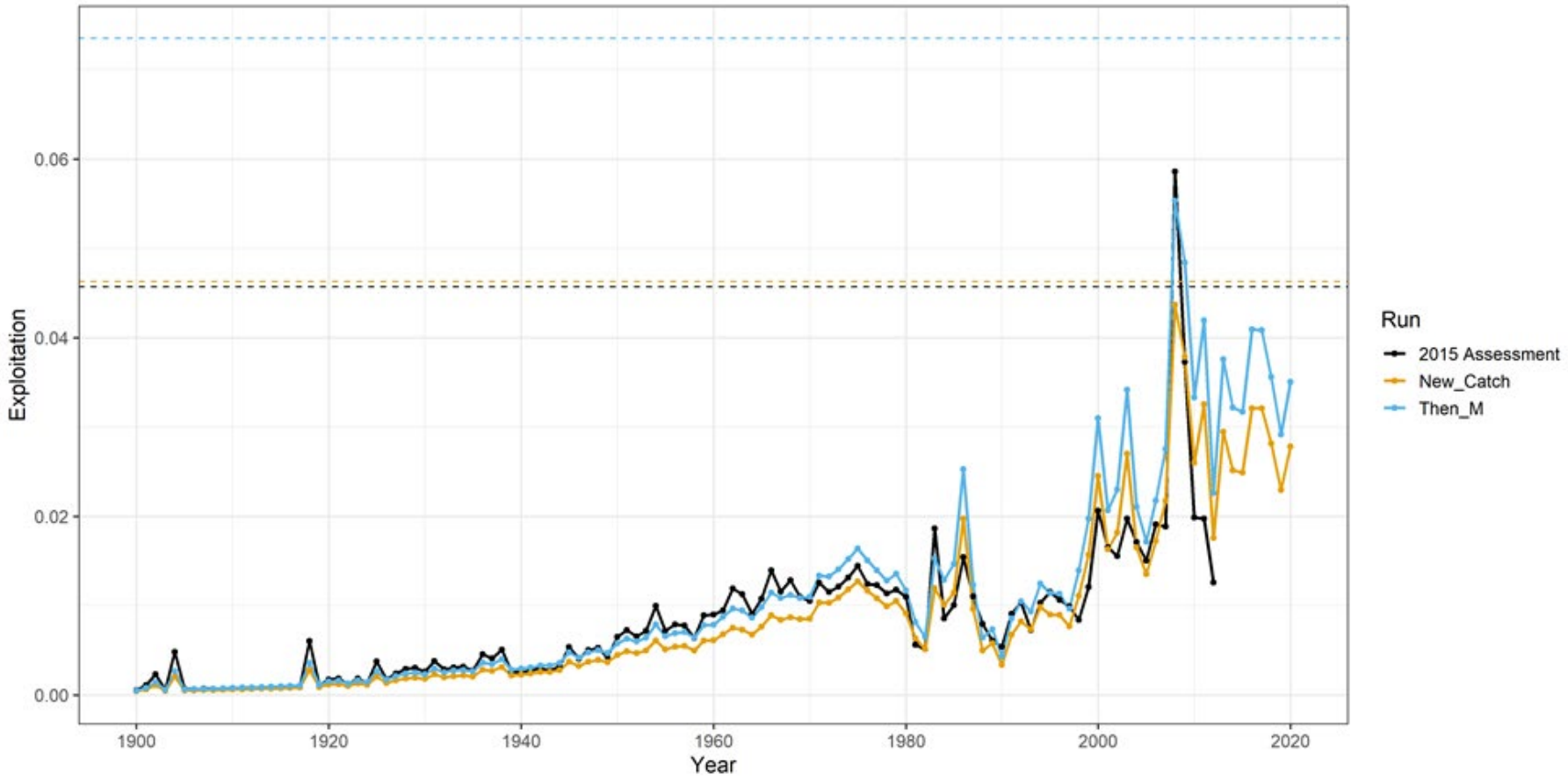
DB-SRA Data Input



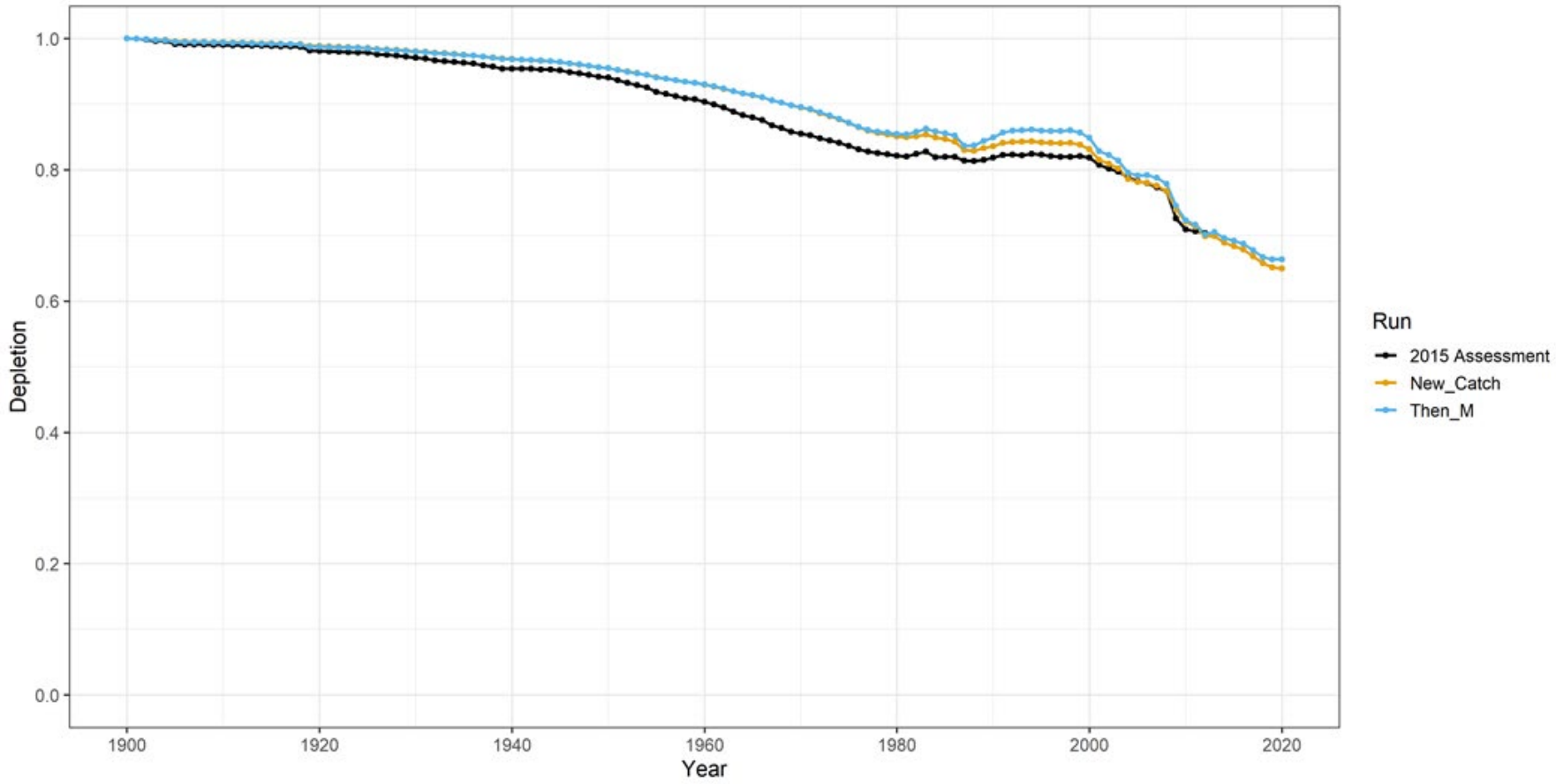
DB-SRA Data Input



DB-SRA Results: Exploitation



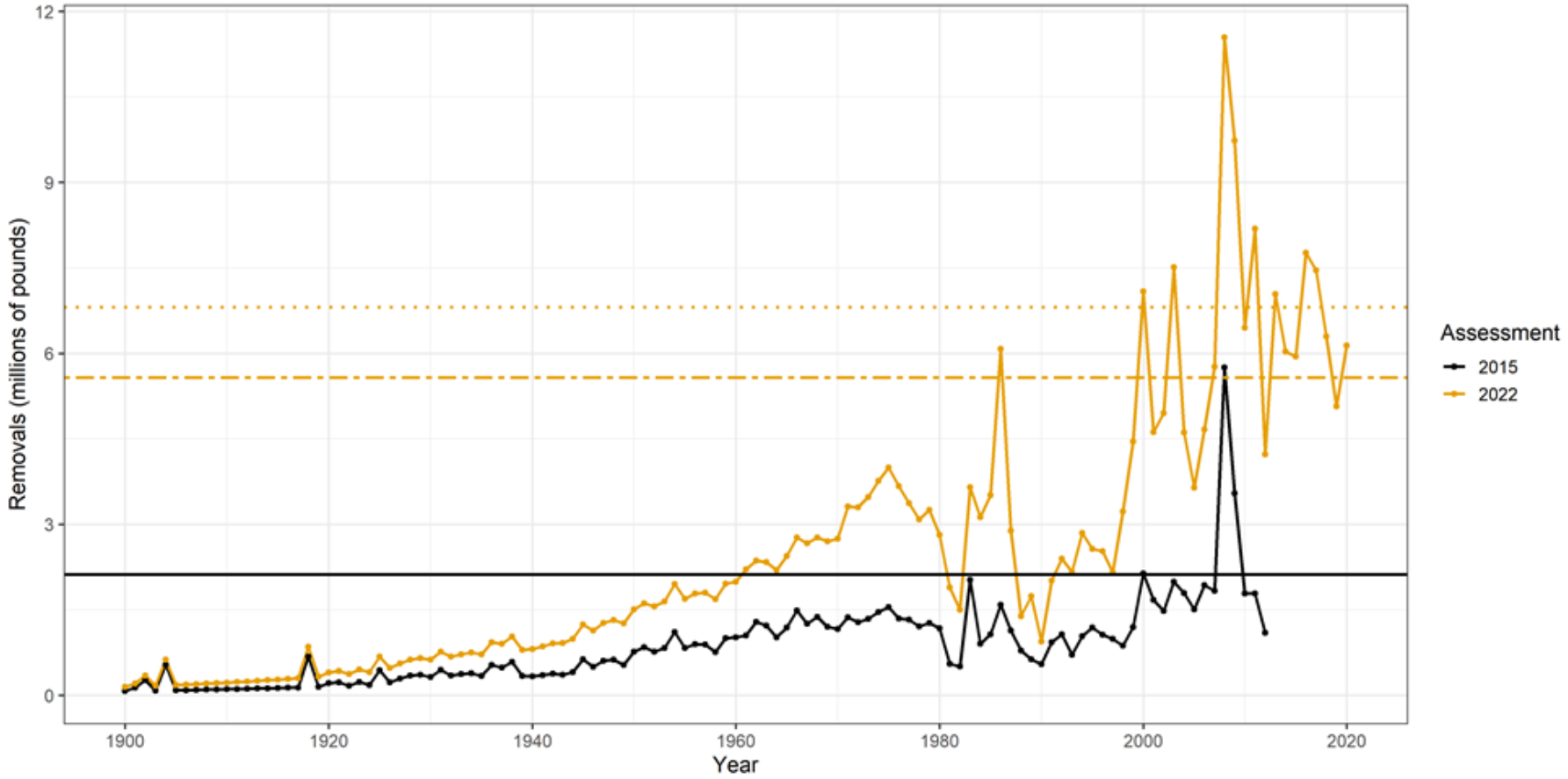
DB-SRA Results: Depletion



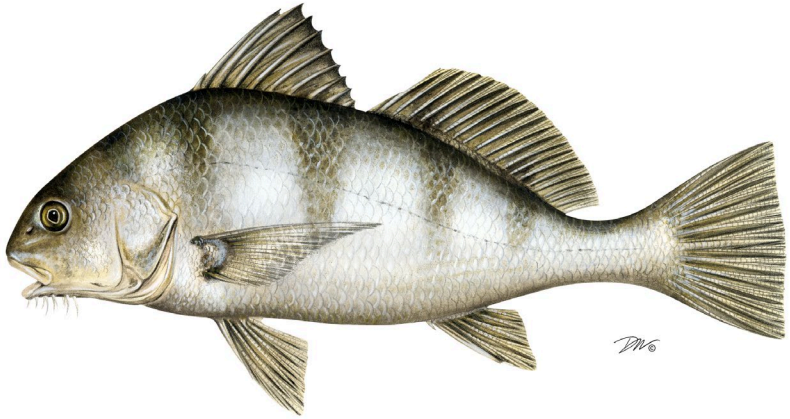
DB-SRA Results: Catch

- Reference points:
  - Catch target = MSY
  - Catch threshold = OFL

Quantity	Run	Estimate Quantile		
		25%	50%	75%
2012 OFL	2015 Assessment	2.60	4.12	6.98
	New_Catch	6.99	10.80	18.34
	Then_M	8.62	13.34	22.95
2020 OFL	New_Catch	6.16	9.97	17.60
	Then_M	7.80	12.60	22.25



Black Drum Stock Assessment Peer Review Report



Sciaenids Fishery Management Board

May 1, 2023

Stock Assessment Peer Review Process

- Black Drum Technical Committee and Stock Assessment Subcommittee developed new stock assessment.

- Review Workshop: January 18-20, Arlington, VA.

- Scientific review focused on data inputs, models, results, sensitivity analyses, and overall quality of stock assessment.

Products

- ASMFC Stock Assessment and Review Report. www.asmfc.org/species/black-drum

Peer Review Process

Scientific Peer Review Panel

Chair + 2 additional Technical Reviewers, with expertise in

- Black Drum ecology and population dynamics,
- MRIP data, indices, and other relevant assessment data,
- Stock assessment modeling,
- Uncertainty analyses.

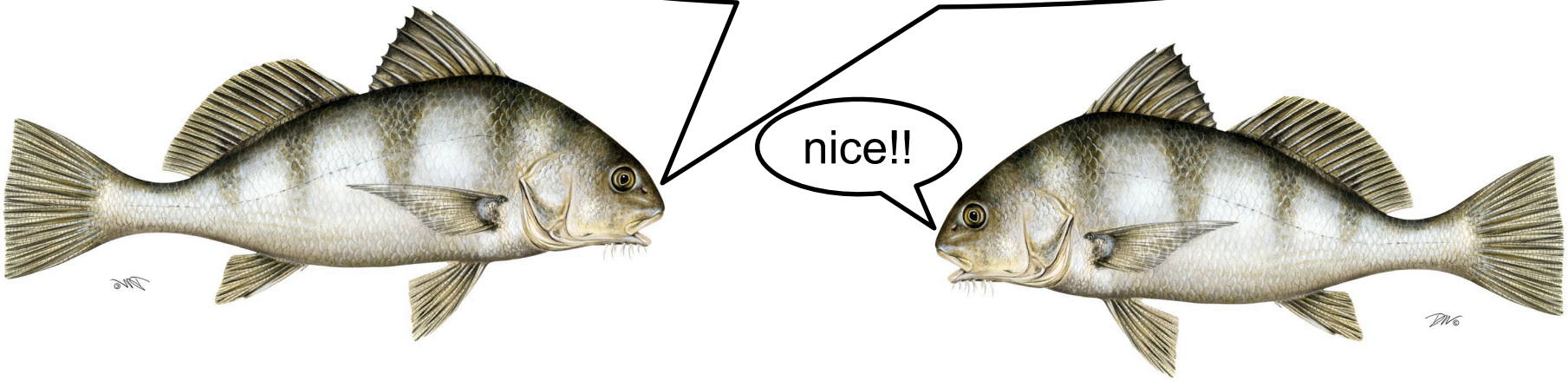
Marcel Reichert, PhD (Chair), South Carolina Department of Natural Resources (retired)

Maia Sosa Kapur, Alaska Fisheries Science Center, National Marine Fisheries Service

Gary Nelson, PhD, Massachusetts Division of Marine Fisheries

Review Panel Overall Findings

- Assessment was thorough and well documented.
- All potential data sources were appropriately explored, analyzed, and description was excellent.
- Exploration of potential models was very good and selected model (JABBA-Select) was appropriate given the available data.
- Stock status: **not overfished and not overfishing**



Review Findings

✓ **ToR 1:** Evaluate the data used in the stock assessment

Panel Conclusions and Recommendations

- Available data thoroughly explored and well described.
- Use of data was appropriate.
- Black Drum remains relatively data poor.
- Key points:

  Harvest: Mostly recreational.

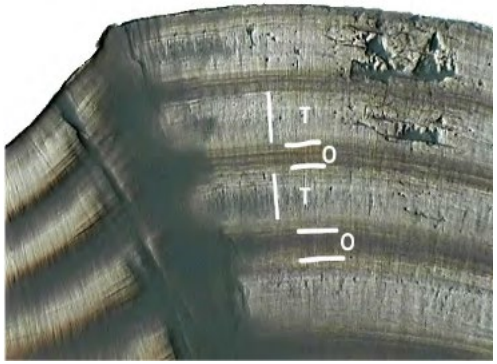
  Discards: Information sparse.

  Life history: Need for more age data.

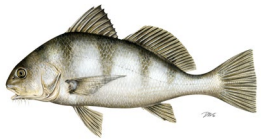
  Indices: No coast-wide index available.

  Recreational index (MRIP) important.

  Investigate catchability GA trammel net.



Black drum otolith, C. Jones, ODU



Review Findings

✓ **ToR 2:** Evaluate empirical indicators for the stock and fishery

Panel Conclusions and Recommendations

- **Indices**:
  - Fishery-Independent preferred.
  - Monitor existing surveys (changes to the population).
  - Areas with largest harvest especially informative.
  - MRIP index used in model: recreational data beneficial.
- Trends in **harvest** (incl. effort & discards) important to monitor.
  - especially in recreational fisheries
- **Age/length** information can be important interim data source.
  - Indicator of recruitment and overall population structure.

Review Findings

✓ **ToR 3:** Evaluate the methods and models

Panel Conclusions and recommendations:

- RP agreed with AT: JABBA-Select model preferred.
- Three key discussion points, none alarming enough to change base model, with one exception.

I) **Fleet specification and selectivities**

a) "Area-as-fleet" => selectivity is combination of gear selectivity and species availability => difficult to separate.

b) Selectivity parameter selection not fully clear.
Recommend: more rigorous selectivity approach in next assessment.

c) Two Mid-Atlantic fleets with yearly time steps overcomplicated model.
Recommendation: **new base run** for this assessment with combined Mid-Atlantic fleets =>
More parsimonious & single time step.

Review Findings

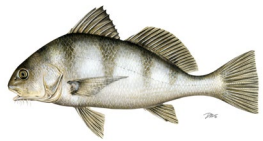
✓ **ToR 3:** Evaluate methods and models.

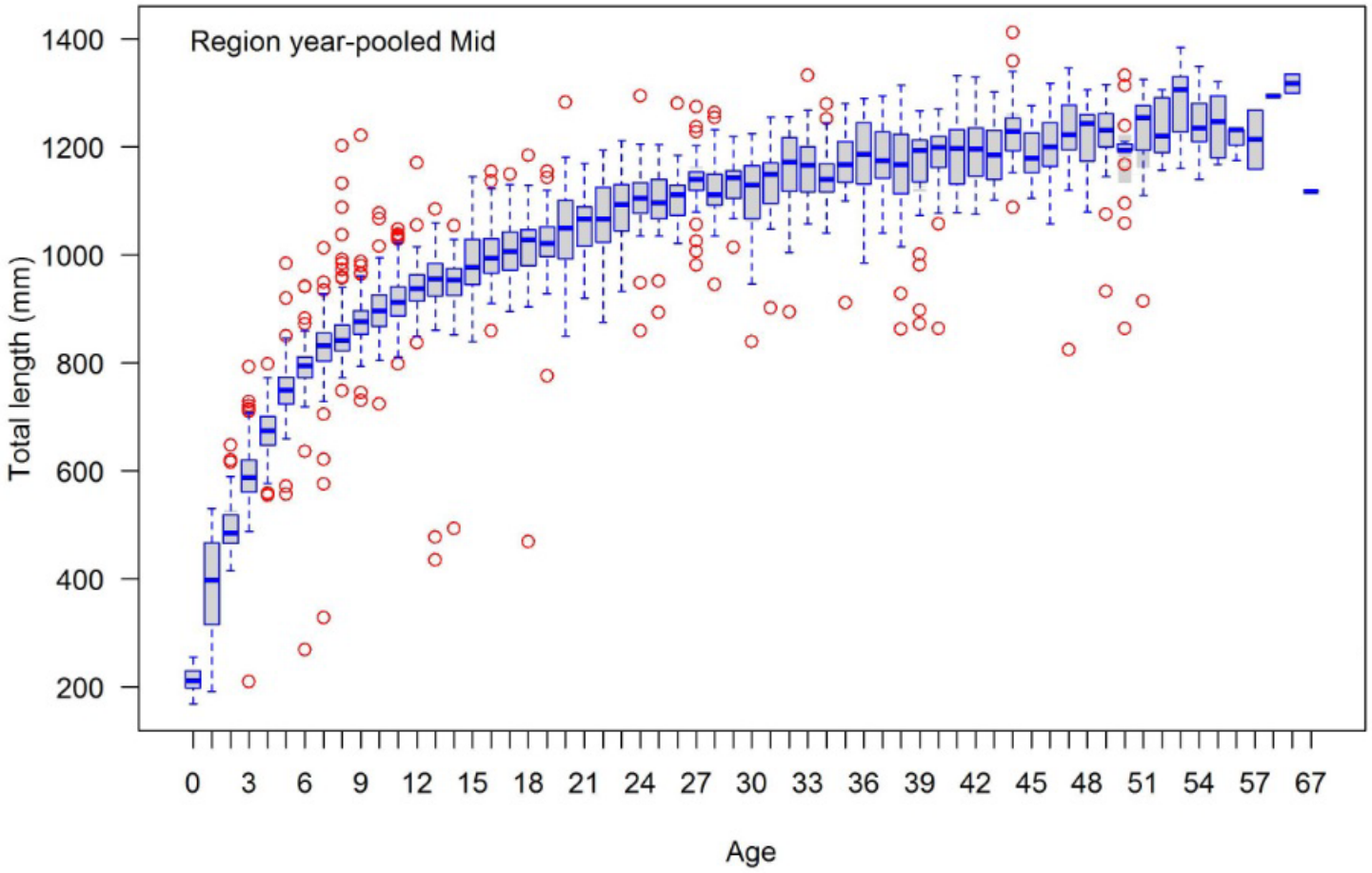
<u>Panel Conclusions and recommendations:</u>

II) **Growth curves**

- Confirm sexual dimorphic growth.
- Base growth parameter estimates on individual length-at-age by sex without extensive filtration or averaging.
- Consider how to incorporate uncertainty in growth curve.
- Possibly include sensitivities with “high” and “low” growth.

Not possible to review impact of this uncertainty within scope of review, but important for **next assessment**.




Region year-pooled Mid
Total length (mm)
1400
1200
1000
800
600
400
200
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 67
Age

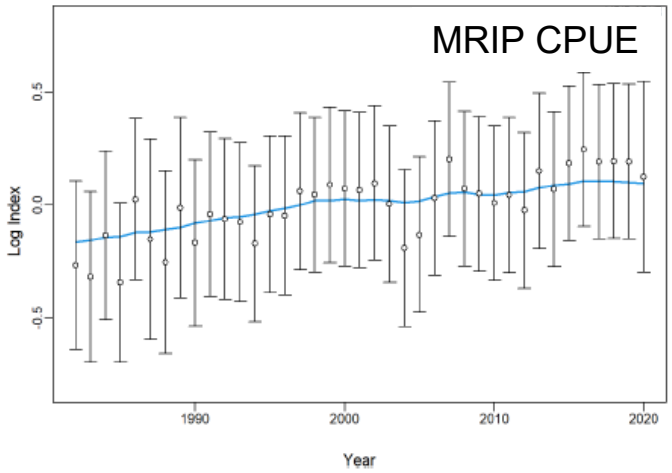
Review Findings

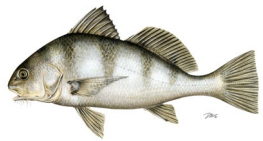
✓ **ToR 3:** Evaluate the methods and models

Panel Conclusions and recommendations:

III) **Observation uncertainty MRIP index.**

Recommendation for **future assessment**:
Investigate alternative approaches to specifying the input Standard Error for the index.





Review Findings

✓ **ToR 4:** Evaluate the sensitivity and retrospective analyses

Panel Conclusions and recommendations:

- Choice of **sensitivity runs** was appropriate.
  - Explored critical parameter choices.
  - RP requested 3 additional runs:
    1) Mid-Atlantic early and late fleets as single fleet,
    2) No additive SE in MRIP CPUE index,
    3) Logistic selectivity for the South Atlantic early and late fleets.
  - Did not significantly change qualitative stock status.

- **Retrospective analysis** did not show a concerning pattern.

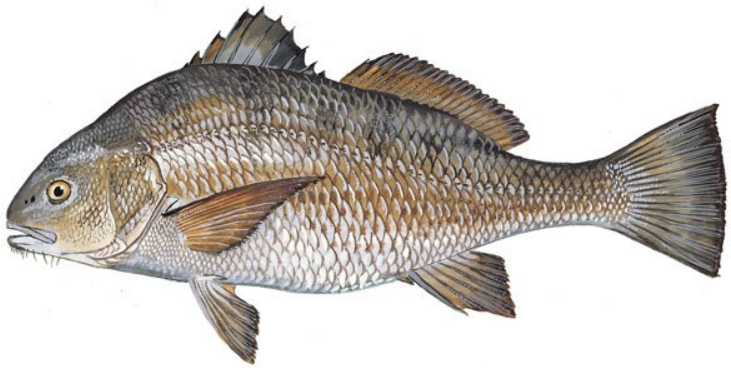
- **Modify current base model:** single, combined Mid-Atlantic fleet.

Review Findings

✓ **ToR 5:** Evaluate the methods used to characterize uncertainty

<u>Panel Conclusions and Recommendations:</u>

- **Uncertainty** thoroughly explored through sensitivity runs, Bayesian statistics, and other diagnostics.
- RP satisfied with extent of uncertainty characterization.
- Specification of the **shape and parameterization of selectivities** is likely a chief uncertainty.



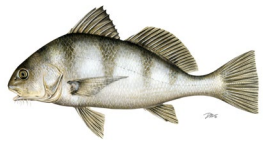
Review Findings

✓ **ToR 6:** Recommend best estimates of stock biomass, abundance, and exploitation

Panel Conclusions and Recommendations:

- Given available data, the **JABBA-Select** model provides best, most robust estimates for relative stock biomass and fishing mortality estimates, and is **appropriate for use in management**.

- Stock status determination using JABBA-Select model generally agreed with results from updated DB-SRA model used in previous assessment.



Review Findings

✓ **ToR 7:** Evaluate reference points and stock status determination

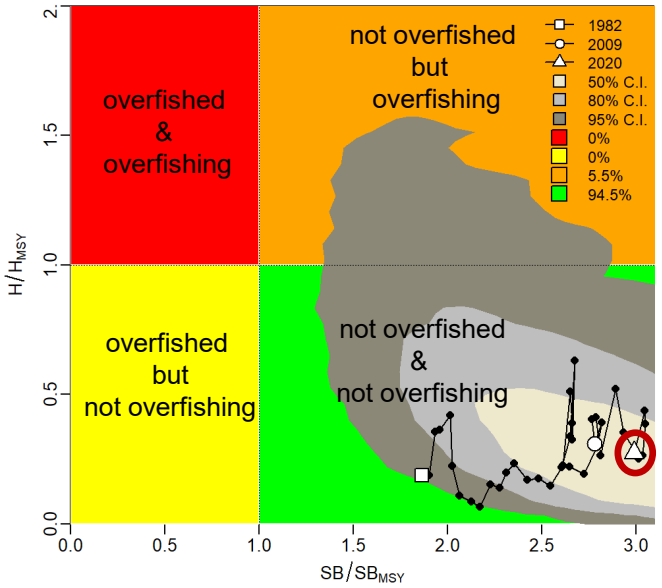
Panel Conclusions and Recommendations:

- Reference points and estimation methods appropriate given the data and recommended JABBA-Select model.
- Using updated base run:

  SB_{2020}/SB_{MSY} = 2.99 => **not overfished** (terminal year)

  H_{2020}/H_{MSY} = 0.28 => **not overfishing** (terminal year).
- Assessment results

  robust for **biomass status** (not overfished), **robust** for **exploitation status** (not overfishing), but with higher uncertainty.
- Results **appropriate for use in management**, but uncertainties should be taken into account in terms of management risk.



Review Findings

✓ **ToR 8:** Review and prioritize the research recommendations

<u>Panel Conclusions and Recommendations</u>

The RP agreed with research recommendation in Assessment Report and added 3.

RP emphasized:

- Increase biological sampling in fisheries, in particular representative age samples.
- Develop additional fishery-independent indices, especially coast-wide.
- Improve coast-wide discard data (incl. biological data and discard mortality), especially in recreational fishery.
- Explore reduction in large recruitment events.
- Region-specific reproductive information.
- Investigate GA trammelnet.

Review Findings

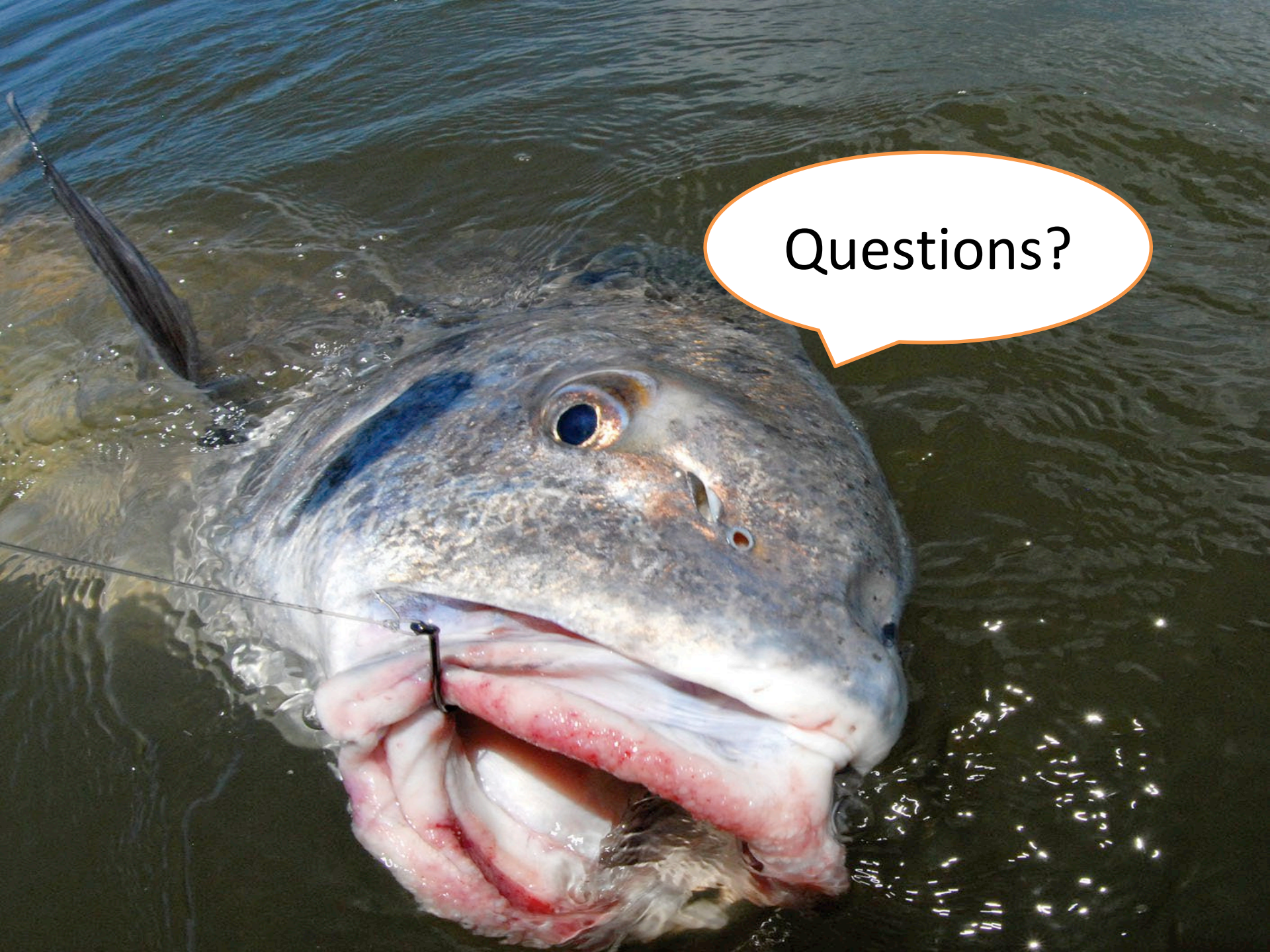
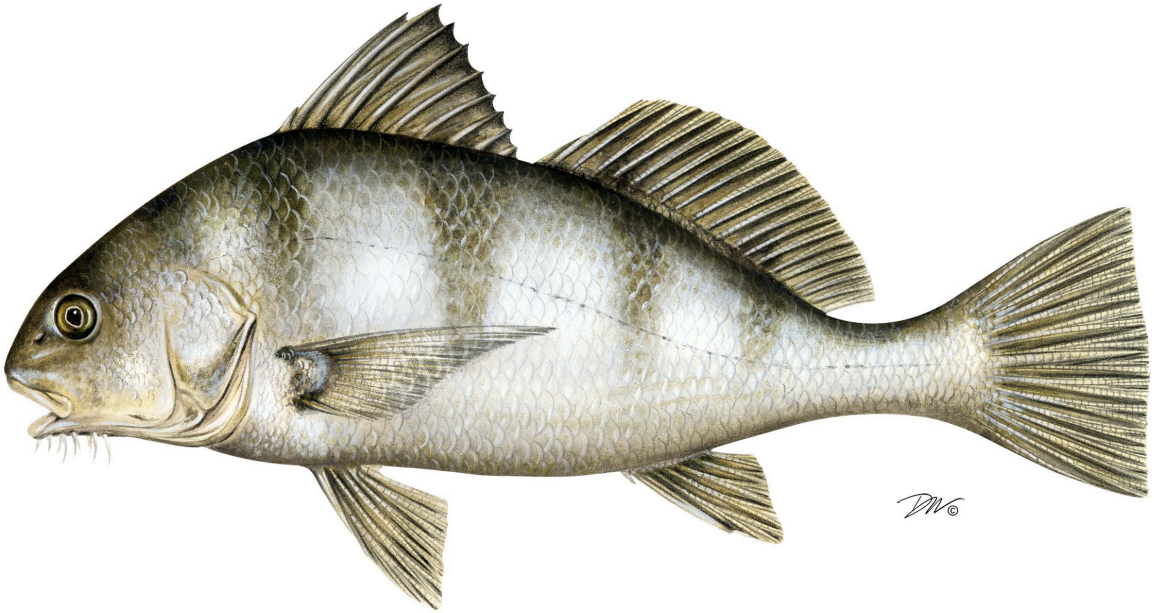
✓ **ToR 9:** Recommend timing of the next stock assessment

Panel Conclusions and Recommendations

- Next benchmark assessment in **5 years**.
- Justification include: uncertainty in the model and age structure, incl. max. age of 67yrs.
- Annual monitoring of the population using recommended stock indicators (see slide 6).

Review Panel Conclusions

- Black Drum is still **relatively data poor**.
- **JABBA-Select most appropriate model**,
  but RP **requested new base run**.
- Stock status: **Not overfished and not overfishing**
- Assessment robust and **appropriate for management**.
- Given stock status (incl. uncertainty), harvest trends,
  abundance indices, and nature of fishery (mostly by-catch):
  recent harvest is likely sustainable.
- However, harvest, abundance, and recruitment
  should be monitored.
- New assessment in **5 years**.


Questions?