Workgroup Report on the Selectivity of Red Snapper in the South Atlantic Region

South Atlantic Selectivity Workgroup

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By

South Atlantic Selectivity Workgroup

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Executive Summary

In the South Atlantic, the primary source of fishery-independent data for the assessment of reef fishes is the Southeast Reef Fish Survey (SERFS) chevron trap and underwater video survey. Historically, the selectivity of the chevron trap survey was modeled as being flat-topped, and subsequently age-composition data was considered representative for combined trap-video indices generated for assessment. However, results from a multi-gear selectivity study conducted by the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) in 2016 were presented to the SAFMC SSC in October 2018 indicating that selectivity of the chevron trap may be dome-shaped for some taxa. Based on these results, questions were raised over whether selectivity of chevron traps and video differ and, if so, whether it is appropriate to combine data during index development. In association with SEDAR 73 (South Atlantic Red Snapper), the South Atlantic Selectivity Workgroup was charged with critically evaluating results from the FWRI study as well as other relevant literature and data to provide recommendations as to the relative selectivity of chevron traps, video, and hook and line for reef fishes, how to best incorporate selectivity estimates into SEDAR 73 and other stock assessments, and what additional research may be required to more fully understand issues related to selectivity. Although the primary emphasis of the workshop was on Red Snapper, other species, including Black Sea Bass and Vermilion Snapper, were examined as time and data allowed.

Results from the FWRI selectivity study indicated that, for Red Snapper, chevron traps clearly exhibited dome-shaped selectivity relative to stereo-baited remote underwater video cameras (S-BRUV). Although some minor evidence of dome-shaped selectivity was also evident for hook-and-line gear relative to S-BRUV, this was only evident at the oldest age classes, indicating that differences from flat-topped selectivity were relatively minor. Additional age-structured analyses of the FWRI data for Red Snapper largely validated these results, where chevron traps exhibited a higher degree of doming relative to other gears. These analyses have the benefit of modeling selectivity in a way that may be informative to stock assessment models; however, selectivity results for all gears were extremely sensitive to the choice of F used. The workgroup concluded that the FWRI study was well-designed and provided valuable insight into the relative selectivity of multiple gears; however, concerns were raised as to what impacts temporal (the FWRI study was conducted in 2016 only) or spatial limitations of the study (the FWRI study was conducted off the coast of Florida in the center of distribution of Red Snapper and did not cover the full extent of the SERFS survey) may have on study outcomes. Questions were also raised as to whether the S-BRUV used in the FWRI study may have influenced fish behavior in and around the traps; although Red Snapper captured in coincident (limited to the same spatial and temporal extent as the FWRI study) SERFS traps were larger than those captured in the FWRI study, relative selectivity of the SERFS data in relation to the FWRI S-BRUV data was still dome-shaped. Results from a pilot study conducted by NMFS in 2019 to investigate the utility of stereo-cameras attached to chevron traps indicated that the length compositions from traps were smaller than those observed on stereo-video, although the degree of doming was less severe than that of the FWRI study. Catch curves were estimated based on length and age frequencies and

indicated that in the FWRI study on average traps caught smaller individuals than S-BRUV or hook and line. Additional catch curves were calculated using age composition data from SEDAR 41 and FWRI for multiple fleets (commercial handline, chevron trap, FWRI horizontal longline, FWRI hook and line, FWRI chevron trap, FWRI Z trap, FWRI vertical longline, general recreational and headboat) indicating the total mortality varied across time and gear. Although analyses were available from the FWRI study and other sources to examine the relative selectivity of multiple gears for both Black Sea Bass and Vermilion Snapper, there was insufficient time to critically evaluate these results, so no formal recommendations were made for these or other species.

Overall, the workgroup concluded that there was sufficient evidence indicating that selectivity of chevron traps is dome-shaped relative to video gear for Red Snapper. However, there was insufficient information to explicitly define selectivity parameters for the SEDAR 73 assessment model. As an alternative, the workgroup recommended that analysts explore a range of selectivity functions in the upcoming assessment, including at a minimum flat-topped selectivity (similar to prior assessments), moderate dome-shaped selectivity (similar to that of the SERFS study), and severe dome-shaped selectivity (similar to that of the FWRI study). The workgroup also suggested that, since selectivity does appear to differ between the chevron trap and video gear, further research is required to determine the appropriateness of combining the traps and video into one index. Moving forward, the workgroup recognized that developing a better understanding of selectivity is critical to improving stock assessments for reef fishes in the South Atlantic. To accomplish this, the workgroup recommended that efforts similar to the FWRI study be conducted coastwide over multiple years to assess the relative selectivity for additional species because selectivity is likely species specific, and it is important to gain a better understanding of interannual variability in selectivity, especially in terms of potential recruitment variability. Efforts to better understand trap selectivity would also benefit from research that focuses on effects of baiting, soak time, and potential interactions among species of varying sizes (i.e., are some fish more aggressive towards bait). Finally, additional efforts examining potential sources of error or bias in stereo-video (e.g., aspect angle, potential for size sorting by school size, MaxN vs. MeanCount measurement protocols) would aid in better understanding the selectivity of stereo-video.

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Meeting Goal

The South Atlantic Selectivity Workgroup was charged with reviewing a selectivity study conducted by the Florida Fish and Wildlife Research Institute (FWRI) based on the terms of reference. The SSC reviewed preliminary study findings on selectivity for Red Snapper caught using traps, hook and line, and video at the October 2018 Meeting, considered them useful for consideration in the stock assessment, and indicated there was potential to also provide information on selectivity for Vermilion Snapper and Black Sea Bass. The FWRI study was finalized in 2018, and ages are available to better inform age-based selectivity. Other research in support of characterizing selectivity was developed for the workgroup meetings.

The workgroup discussed the findings of all relevant research conducted in the South Atlantic region on selectivity and addressed the terms of reference in a working paper for consideration in SEDAR 73 and future stock assessments.

Meeting Format

The Selectivity of Red Snapper in the South Atlantic Region was reviewed by the workgroup during discussions held in public meetings. All meetings were held via webinar from August through November.

Workgroup Discussion

Workgroup discussions were centered around the working papers provided to the group and the terms of reference. Below are discussions related to the terms of reference (italicized) which were used to create the executive summary.

Review the FWRI selectivity study and determine if the approaches are appropriate to characterize selectivity by gear

The Workgroup determined that the approach is appropriate to characterize selectivity by gear. However, there could be issues with spatial extent, temporal extent, and sample size that could hinder development of useful inference for selectivity in the assessment. When comparing selectivity across studies and gear types it is important to consider the spatial and temporal coverage as discussed below.

Spatial extent - The FWRI study was conducted in the core of the red snapper population in the South Atlantic region. Ideally, the study would have been conducted on a coastwide basis as habitat and environment along the South Atlantic coast are diverse and varies in species assemblage and abundance with latitude. However, there would be more concern if it was done outside of the core of the population. Density differences by area and small-scale spatial differences could influence the resultant selectivity forms. Many of the potential sampling stations are the same between the SERFS and FWRI study with 98% of the sampling frame overlapping off Florida. There was an attempt to expand the study coastwide but funding was limited. It was considered to add cameras onto the existing SERFS traps but there was concern that the size of the camera could alter the time series of the trap survey.

Temporal extent – Current research is looking into time of day influence on catches. Month, season, and year can lead to differences in species assemblage, abundance, and size distribution. Month is an important factor in developing selectivity based on differences observed in catch rates. Movement patterns are difficult to decipher, and tagging data would help to tease out some of the information. Multiple years of tagging data would be preferred since a single year could be impacted by year class strength. Selectivity likely varies from year to year. Other stock assessments have annually changing selectivity; however, a lot of high quality data are needed to estimate time varying selectivity. Also, doming and mortality are not separable unless you have an estimate of absolute abundance or scale.

Sample Size – Catch rates for trap catches and video are highly variable. It would be ideal to have a much larger sample size that is robust enough to sampling over the diverse habitats and environments.

a. *Consider sources and estimates of error, and limitations associated with video gear observations and measurements*
    i. Potential sources of error –
        1. Fish angle - fish at more extreme angles relative to the camera may be biased low
        2. schooling (small vs large fish) – small fish tend to be in larger schools
        3. measuring fish on max N vs mean count (see SAWG-02); preliminary results were compared in SAWG-10
        4. Range of possible measurements shrinks with poor water clarity
        5. Fish could be blocked from camera's view by larger fish or large schools

ii. QAQC is used to minimize sources of error. For example, FWRI removed fish images at extreme angle and measured with high root mean square error (RMSE) from analysis.
iii. Plotting the mean length as function of number observed may help address the schooling question.

b. *Consider sources and estimates of error, and limitations associated with trap gear observations and measurements*
   i. Species interaction (Aggressive species can influence catch and bait fish might attract fish)
   ii. Cameras could influence catchability, e.g. by altering trap entry behavior
   iii. Traps have physical limitation on number of fish that can fit in the trap
   iv. Soak time is standardized but could influence observations

c. *Consider sources and estimates of error, and limitations associated with hook and line gear observations and measurements*
   i. Species interactions (Aggressive species can influence catch and bait fish might attract fish)
   ii. Angler experience could influence catch on repetitive time drop (RTD) (red snapper, vermilion snapper, red grouper), but captain experience (vessel handling) was more important. FWRI only uses commercial or charter captains.
   iii. Hook and bait. Three hook sizes to catch a range of sizes. Mackerel, which is a good bait for red snapper, was used for bait. Bait size was proportional to hook size but standardized. Bait and hook size can influence species.
   iv. Currents at the site could influence catch
   v. Gangion and swivels did not seem to have an influence on catch (abundance and size)
   vi. Gear saturation for the RTD could occur because sampling is limited to 60 hooks (3 rods, 2 hooks, 10 drops)
   vii. Depredation on bait is an issue (bait stealers)
   viii. Longline, RTD, and short-bottom longline have some depredation. Gulf bandit gear becomes inefficient when sharks are present. The SCDNR procedure is to stop sampling and move when sharks move in (i.e., when multiple sharks are caught at a location). Bottlenose dolphin can shut charter fishing down in Gulf.

d. *Discuss the potential for density-dependent factors to influence selectivity estimates*
   i. Schooling – Big schools tend to be made up of smaller fish
   ii. Year classes could dominate a gear (not proportional to the size in the population)
   iii. Large year classes could reduce growth making the year class smaller at age compared to other year classes (resource competition). The opposite may be true for small year classes.
   iv. Potential positive feedback loop with fish in larger populations attacking bait more aggressively. Observed on oil platforms which tend to have 12- to 16-inch fish.

e. *Describe differences in age-based selectivity among gears (relative to gears used in study)*
    i. Traps seem to be dome shaped for red snapper relative to video data
    ii. Hook and line (RTD and unstandardized time drop (UTD)) have similar patterns for red snapper and more closely match video data with a shift away from smaller fish. There is evidence of slight dome shape selectivity for red snapper in this gear
    iii. Video data seem to be flat and broader in terms of size and age range for red snapper
f. *Identify which species evaluated in the study have sufficient data to reliably inform selectivity for use in stock assessments.*
    i. There seems to be sufficient information to inform selectivity for red snapper for traps, video, and hand line gears, but the degree of doming (selectivity parameters) cannot be defined based on the current information.
    ii. Potential to describe contact selectivity and availability for different years and gears.
    iii. Fish could enter trap before being observed on video, such as when the trap hits bottom and creates a plume, or before the camera is turned on or before or after the time the video examination occurs.
    iv. The selectivity is relative to the video gear
    v. Some preliminary data are available for black sea bass and vermilion snapper, but there was not enough data to determine the shapes of the selectivity curves for species other than red snapper. FWRI could not do all analyses due to limited data. However, black sea bass selectivity seems to be more flat-topped for trap gears and vermilion snapper appear more dome shaped for hook gears.
g. *Consider the spatio-temporal characteristics of the study compared to the fisheries and fishery-independent surveys*
    i. FWRI study worked in a subset of the area covered by SERFS and overlapped sampling stations. The FWRI study concentrated off Florida and SERFS covers from St. Lucie Inlet, FL to Cape Hatteras, NC. The FWRI study was conducted in the core area of abundance for red snapper, but it would be good to expand to the full region sampled by SERFS.
    ii. The temporal coverage of the FWRI study was good to compare with SERFS within the sample season.
    iii. Multiple years of this study would have been beneficial and allowed the investigation of the impact of year classes.
h. *Consider if catches in Chevron traps and observations from video on the trap should be combined into a single CPUE index*
    i. Selectivity of chevron traps and video are likely different enough to warrant additional investigation in the assessments for red snapper and other species. The conclusion for red snapper treatment of selectivities may only apply to red snapper.
    ii. This issue should be further investigated by the assessment team.

iii. It is not clear if we should combine two datasets with different selectivity. However, if there is no way to combine the gears, we also have to consider that the two indices are not independent.
iv. If separated, there are no size data for the video index except for limited data in 2019. Use ages from trap on the ascending limb to represent age for video gear
v. The ascending portion of the curves seem to behave similarly in the trap and video gears.
vi. Utilizing the video and trap data, indices of abundance could include the following options:
    1. Video and trap could get equal weight (or weighted) and combined in an index, e.g. by using the Conn method,
    2. Indices kept separate – however, this creates an issue with over weighting data and dependence,
    3. two different indices without overlap in time and don't use trap data (1990) after video sampling starts in 2011 – need to borrow length data from another gear
    4. Only use the video or trap data through the entire series
        a. Still need choices on species by species basis
vii. Overall, the workgroup noted that we have indications that selectivity for red snapper is different enough that they need to be handled separately and the preferred method would not combine the indices as a single index.

i. Provide selectivity estimates or guidance for these species

i. There is not sufficient information to develop selectivity parameters for an assessment model but can describe the general shape for red snapper.
    1. Traps are dome shaped relative to video gear
    2. Range of doming for the assessment to consider
        a. Could be used in uncertainty analysis to provide reasonable range
        b. The workgroup recommends flat-topped (no doming) to FWRI (severe doming) for sensitivity runs
        c. The workgroup recommends the SERFS shape (moderately domed or estimated in the assessment model) be the base run
        d. This is focused on contact selectivity, but assessment will use contact selectivity and abundance
ii. The doming in the trap gear indicated selectivity for red snapper should be different for trap and video gears in the assessment.
iii. Not sufficient data for vermilion snapper and black sea bass

2. *Review other relevant data and research on selectivity for Red Snapper and other species.*

a. Consider all potential sources of error and bias in the data or research

i. The review has covered the available relevant data. (See abstracts below.)

b. Determine useful information that could be used to inform selectivity of Red Snapper and other species.

i. The workgroup suggests the assessment team review information/methods included in this report as a starting point to inform selectivity
ii. The selectivity of video gear is assumed to be flat-topped. This assumption should be tested

3. *Provide recommendations on appropriate methods to incorporate selectivity estimates from the FWRI study and other relevant data and research into SEDAR 73 and other stock assessments.*
    a. *Discuss methods for estimating selectivity inside or outside of the stock assessment model*
        i. This should be done by the assessment team. See recommendations above.
4. *Provide recommendations for research needs to improve selectivity estimates for species in the South Atlantic region.*
        i. It is important to look at selectivity independently for all gears and species. This working group focused on RTD, trap, and video gears for red snapper.
        ii. What are important factors that impact selectivity for reef fish (snapper grouper complex) for all gears and relevant species?
        iii. Gear configuration could influence selectivity and should be considered when developing research projects.
        iv. Regional-scale workshop or meta-analysis would be very beneficial to develop assessment best practices to develop selectivity estimates. What is a better default assumption for selectivity shape? This could theoretically be addressed by the three options below but data need to be collected before selectivity discussions occur.
            1. The shape of the selectivity curve could be tested in a research track assessment for a single species assessment,
            2. reviewed by topical workgroup for a single species in an operational assessment, or
            3. a topical research track assessment that is focused on selectivity.
        v. When possible, when research like FWRI's is done, it would be good that it be done on the SERFS platform, so it is more compatible across long-term survey gears.
5. *Develop a report to discuss the findings of the workgroup and address the TORs.*
        i. This document constitutes the report of the Selectivity Workgroup.
6. *List future research, guidance and best practice recommendations for selectivity modeling in stock assessments.*
        i. Explore expanding the FWRI study coastwide and the potential impact of mounted cameras on the existing Chevron video trap time series.
        ii. There is a critical need to determine fish lengths in the video recordings from the SERFS chevron video traps using stereo cameras or other methods.
        iii. Investigate potential sources of error associated with video camera sampling, including:
            1. fish angle,
            2. schooling by fish size,

3. measuring fish based on Max N or mean count,
4. visibility.

iv. Investigate the effect of soak time on size of fish captured.
v. Evaluate impact of fish size relative to bait for hook and line, i.e., are some sized fish more aggressive toward bait, given this study observed primarily 12-16" fish, rather than larger fish.
vi. Evaluate availability as a source of error and/or bias in the study.
vii. Evaluate the impact baiting traps and size/type of bait have on trap selectivity.
viii. Examine whether video gear selectivity is flat-topped.
ix. Recommendations are provided by the working group, but some flexibility needs to be given to the assessment team.
x. Length compositions need accurate age compositions for the gear to accurately reflect the age structure of the removals
    1. Age compositions are more direct than length comps.
    2. Length compositions infer age, although some species exhibit high variability in size at age.
xi. Selectivity is extremely important for providing management advice. It is used to develop reference points, and good estimates of selectivity help to minimize uncertainty in the assessment. Selectivity, along with good estimates of natural mortality and adequate age compositions have been identified as the three most important factors in the quality of stock assessments.

Abstracts for working papers presented to the workgroup

SAWG-01 FWRI First Direct Assessment of Size Selectivity 2018

The ongoing prohibition of commercial and recreational harvest of Red Snapper in the United States South Atlantic (aside from very limited seasons), has dramatically eroded the utility of fishery-dependent data for assessing Red Snapper stock status. To address this loss of information, there have been several efforts to improve fishery-independent data streams. Most notably, the long-term chevron trap survey was modified to incorporate a video component and expand spatial coverage, while the Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute (FWRI) has developed a standardized, fishery-independent hooked-gear survey. Despite these efforts, important questions remain as to the selectivity of these sampling gears. We assessed size-selectivity of chevron trap, fisheries-independent hooked-gear, and fisheries-dependent hooked-gear surveys by pairing capture gears with underwater stereoscopic cameras. In 2016, a total of 93 stations were sampled from Cape Canaveral, Florida to the Florida/Georgia border. Based on available data, we assessed the size-selectivity of capture gears for three managed reef fishes: Red Snapper, *Lutjanus campechanus* (all gears); Black Sea Bass, *Centropristis striata* (all gears); and Vermilion Snapper, *Rhomboplites aurorubens* (all gears except chevron traps). For Red Snapper, size composition from all three capture gears differed significantly from that obtained from corresponding stereo-

video surveys. There was strong evidence for dome-shaped selectivity for Red Snapper captured in chevron traps as the average length was smaller than those observed on stereo-video; this was largely attributable to decreasing capture probability for individuals over ~500 mm FL. For both hooked gears, there was evidence of slight doming as stereo video observed the largest fish however, Red Snapper were larger on average on hooked gears than were observed on stereo-video. Overall, sample sizes were lower for both Black Sea Bass and Vermilion Snapper, however there was evidence of flat-topped selectivity for Black Sea Bass in all three capture gears. Mean length of Black Sea Bass was lower for individuals captured in traps, and higher for individuals captured in hooked-gear surveys, than was observed on stereo-video. Insufficient numbers of Vermilion Snapper were captured in traps for selectivity analyses; however, hooked-gears had dome-shaped selectivity curves capturing larger vermilion snapper than were observed on stereo-video.

SAWG-02 SEFIS Stereo-Video Methods

The Southeast Reef Fish Survey (SERFS) has collected videos using cameras attached to baited chevron traps since 2010. Indices of abundance have been developed from chevron trap catches and video counts, and these separate indices of abundance have typically been combined into a single fishery-independent trap-video index of abundance for use in recent SEDAR stock assessments. This combination tacitly assumes that selectivities from traps and videos are the same, but recent evidence suggests this may not be correct. Results are presented in SAWG-10.

SAWG-03 Length and Age Data

This working paper includes length and age data available for the selectivity workgroup to use in analysis and discussion of selectivity in the South Atlantic region.

SAWG-04 FWRI Additional Data

As requested by several workgroup panelists, several additional details on the measurement protocols for the FWRI selectivity study using stereo-remote baited underwater video (S-BRUV) were summarized. FWRI S-BRUV measurement protocols preclude the measurement of any fish that is visually assessed to be at an angle of >45° to the camera. After further exploration, it appears that the output from the SeaGIS software is not directly comparable to the true angle of the fish and therefore cannot be used to quantify the angle each fish was measured at. Fish are measured at the time when the greatest number of fish can be measured in a single screen, although the determination of the percentage of length samples obtained at time of MaxN versus at an alternative time in the video obtained would require each video to be reexamined. The total number of sampling sites where Red Snapper were captured were compared for each gear pairing. For Traps/S-BRUVs the highest number of Red Snapper occurrences were recorded on S-BRUV but not captured in traps. For both hooked gears the highest number of Red Snapper occurrences at sampling sites where Red Snapper were recorded both by the capture gear and S-BRUV. For all three gear pairs the highest number of measured fish occurred when both gears captured Red Snapper at a site. Generally, there was no clear relationship between the number of Red Snapper observed by S-BRUV and the number of fish captured by the capture gears.

SAWG-05 SERFS FWC Trap Comparison

During the review of the FWRI selectivity study, a question was raised as to whether the trap-mounted stereo camera may have influenced fish behavior. To explore this issue further, data from the FWRI chevron trap survey were compared to similar data from the SERFS Chevron traps survey collected in 2016. To ensure comparability of data between the two surveys, the SERFS data were limited to overlapping geographical regions where the FWRI study occurred. In terms of seasonality of sampling, the FWRI study was conducted April – August 2016, whereas the SERFS sampling occurred in May, August, and September of that year. As there was no FWRI sampling conducted in September and the September size composition of the SERFS data differed markedly from that observed in May and August, September data were excluded from subsequent analyses, resulting in the exclusion of almost 75% of available size composition data for Red Snapper from the SERFS survey. The FWRI survey primarily captured individuals < 500 mm, while the SERFS survey was bimodal with peaks occurring at ~425 mm and a smaller peak at ~725 mm. Most individuals > 500 mm were captured in < 30 m and in Zones 728 and 732 for both surveys. The highest CPUE for both surveys occurred in > 30 m and in Zone 732. For the FWRI survey the lowest CPUE occurred in < 30 m in Zone 722, while for the SERFS survey > 30 m in Zones 722 and 728 had the lowest CPUE. Nevertheless, analyses of relative selectivity of the SERFS trap survey by comparing relative frequency with that of the FWRI S-BRUV survey still indicate that the selectivity curve for chevron traps is likely dome-shaped.

SAWG-06 FWRI Catch Curves Revised

Two catch curves for Red Snapper were estimated using the length data from the FWRI fishery independent surveys in the South Atlantic. The first data set is from the selectivity study conducted between April-August 2016, where size selectivity was assessed by comparing three capture gears (chevron traps, repetitive timed-drop [RTD], and unstandardized hook and line [UHL]) to paired stereo-baited remote underwater video (S-BRUV). All fish collected were identified and measured (mm) as standard length (SL), fork length (FL) and total length (TL). Individuals observed by S-BRUV were measured to the nearest mm FL using stereo still images and SeaGIS® software and converted to TL. The second set of available data is from RTD sampling that occurred in 2012, 2014, 2016, 2017 and 2018. Life history growth parameters used in this analysis were L_{inf}=911.36, k=0.24, and t_0= -0.33 based on parameters used for the most recent Red Snapper stock assessment. On average traps caught smaller individuals than either hooked gear or S-BRUVs. Hooked gears tended to catch larger fish than trap or SBRUVs. This trend is supported by the capture of fish >500 mm in all years the RTD survey was conducted. Length based catch curves for traps had the highest Z, while the S-BRUV had the lowest Z. The Z varied for RTD with year but overall was always lower than traps.

SAWG-07 Red Snapper Catch Curves

Catch curves were developed for Red Snapper using the age composition from SEDAR 41, FWRI from 2012 to 2018, and SCDNR chevron trap data 2014 to 2019. The catch curves were analyzed using a custom catch curve analysis created by the NMFS Beaufort Lab implemented in R. Catch curves are estimated for age classes from the approximate peak in the age distribution for each fleet, up to but not including the plus group. The total mortality was variable by year and gear. The estimate of Z from the 2016 FWRI was higher than most other gears and gears

and was substantially higher than other gears with an estimate of Z. No trends in Z were observed among gears.

SAWG-08 Estimation of Gear Selectivity Using an Equilibrium Age-Structured Analysis of FWRI Red Snapper Data Collected in 2016

An equilibrium age-structured analysis was implemented in Excel to estimate selectivity patterns based on fits to single-year age and length composition data. The analysis relies on species specific life-history and fishery settings. Natural mortality, age-length growth (including variability of length at age), fishery selectivity, and total fishing mortality were set based on SEDAR 41 Red Snapper stock assessment. The FWRI data from 2016 included length composition data from stereo video cameras, repeated time drop hook-and-line gear, unstandardized, Captain's choice hook and-line gear, and chevron trap.

An equilibrium age-structured model was constructed using ages 0-20+. The model is "equilibrium" because it assumes no recruitment variability in computing the population age structure. Lengths were binned by both 25 and 50 mm bins to determine if binning had an effect on the results. From this estimated per-recruit population age vector, both age and length composition vectors were estimated based on an estimated selectivity curve. Thus, predicted age and length compositions are computed by manipulating the four parameters of a double-logistic selectivity function, which can take the form of a flat-topped or dome-shaped selection curve. These predicted compositions are then compared to observed vectors through a likelihood function to optimize the selectivity parameters for the best fit to observed data. The likelihood function used in this fitting process was a simple sum of squares of positive values only, leaving out zero values. With this estimation model, observed age and length composition data can be fit by optimizing the gear selectivity parameters for the minimum sum of squares value. The fishing mortality rate input for the fishery is an influential parameter and confounded with the degree of doming, thus various values of F were examined (F=0, F=F from assessment, F=2xF from assessment).

Although the fits to the data were adequate, the results from this analysis are most likely limited to relative selectivity shape conclusions between paired gear types and not absolute estimates of selectivity for use in stock assessment. The results are susceptible to bias from variability in year-class strength because the analysis assumes equilibrium age structure and only includes one year of data. Another point of uncertainty for this analysis and for the inferences from the results is the spatial and temporal limitations of the data.

Despite these data and analysis caveats, the general pattern of results indicates that the stereo video data is capturing a wide range of sizes, as indicated by largely flat-topped selectivity estimates. The results indicate that the hook gear is capturing fewer large fish relative to the video data, and the Chevron trap is capturing an even smaller range of fish relative to video and hook gears. It is unclear how much different the hook gear and video gear selectivities may be, as some of the results suggest they are quite similar. The Chevron trap data seem to strongly suggest a dome-shaped selectivity pattern.

SAWG-09 Catch Curves for Black Sea Bass Collected by NCDMF

Black Sea Bass are an important component of the commercial snapper grouper fishery off North Carolina. Age data was provided by the North Carolina Division of Marine Fisheries for Black

Sea Bass caught off North Carolina in bandit reel, electric reel and rod and reel, and pot gears. Catch curves were developed by year and gear based on the length and age frequencies using TropFishR implemented in R software. Lengths ranged from 275 to 500 mm total length and ages ranged from 1 to 10 years old. Fish pots tended to catch the smallest fish. Bandit reels tended to catch larger fish than electric/rod and reel and pots gears. Although bandit reels caught the largest Black Sea Bass, the ages of the fish were shifted toward younger ages (age 2 and age 3).

The estimate of total mortality varied across time and gear. The total mortality for length-based catch curves was lower than the mortality for age-based catch curves. The age-based catch curves had higher total mortality from 2012 to 2015 compared to 2016 and 2017, but the length-based catch curves were similar across the period analyzed. The highest mortality rate was observed in fish pots for both age- and length-based catch curves.

SAWG-10 Length Comparison from SERFS chevron trap and stereo-video sampling

This working paper explores two concepts related to length compositions from SERFS chevron traps and stereo-video sampling. The first is a qualitative comparison of red snapper length compositions observed when the two gears are paired, with the goal to explore relative selectivities of the two gears. The second compares lengths derived from the MinCount versus MeanCount approaches. We explored this empirically using SERFS data and through simulation analysis.

Results of the gear comparison are consistent with previous findings (SAWG-01), that length compositions from traps comprise smaller fish than those from video. This suggests that chevron trap gear is dome-shaped. Exploration of the MinCount versus MeanCount approaches was inconclusive. The empirical examination suggested that the MinCount approach selects smaller fish than the MeanCount approach; however, the simulation analysis favored either or neither approach, depending on the stochastic nature of schooling behavior.

SAWG-11 Black Sea Bass Catch Curves

Catch curves were developed for Black Sea Bass using the age composition from SEDAR 56. The catch curves were analyzed using a custom catch curve analysis created by the NMFS Beaufort Lab implemented in R. Catch curves are estimated for age classes from the approximate peak in the age distribution for each fleet, up to but not including the plus group. Commercial pots had the highest or second highest Z from 2008 to 2016 while chevron traps had the lowest Z from 2007 to 2011 and second lowest Z for four years from 2012 to 2016. Additional research into selectivity will be needed to determine if there are differences among gears.

SAWG-12 Vermilion Snapper Catch Curves

Catch curves were developed for Vermilion Snapper using the age composition from SEDAR 55. The catch curves were analyzed using a custom catch curve analysis created by the NMFS Beaufort Lab implemented in R. Catch curves are estimated for age classes from the approximate peak in the age distribution for each fleet, up to but not including the plus group. The estimate of total mortality was highest in the headboat from 2010 to 2016 (except

2013) while the estimates of total mortality for chevron traps tended to be lower than most other gears from 2010 to 2016. Additional research into selectivity will be needed to determine if there are differences among gears but this comparison does not indicate chevron traps are domed shaped for Vermilion Snapper.

Appendix 1.

Terms of Reference

Workgroup Terms of Reference

1. Review the FWC selectivity study and determine if the approaches are appropriate to characterize selectivity by gear
    a. Consider sources and estimates of error, and limitations associated with video gear observations and measurements
    b. Discuss the potential for density-dependent factors to influence selectivity estimates
    c. Describe differences in age-based selectivity among gears
    d. Identify which species evaluated in the study have sufficient data to reliably inform selectivity for use in stock assessments.
    e. Consider the spatio-temporal characteristics of the study compared to the fisheries and fishery-independent surveys
    f. Consider if catches in Chevron traps and observations from video on the trap should be combined into a single CPUE index
    g. Provide selectivity estimates or guidance for these species
2. Review other relevant data and research on selectivity for Red Snapper and other species.
    a. Consider all potential sources of error and bias in the data or research
    b. Determine useful information that could be used to inform selectivity of Red Snapper and other species.
3. Provide recommendations on appropriate methods to incorporate selectivity estimates from the FWC study and other relevant data and research into SEDAR 73 and other stock assessments.
    a. Discuss methods for estimating selectivity inside or outside of the stock assessment model
4. Provide recommendations for research needs to improve selectivity estimates for species in the South Atlantic region.
5. Develop a report to discuss the findings of the workgroup and address the TORs.
6. List future research, guidance and best practice recommendations for selectivity modeling in stock assessments.

Briefing Materials

Briefing materials were developed and compiled prior to the workshop, including age data collected in the South Atlantic region. The overview documents included a brief explanation of the workgroup tasks, agenda for the meeting, issues to be addressed, and a list of additional resources where more detailed information can be found on the issue or potential solutions. Documents were submitted to SAFMC staff who developed a document list and made all documents available via SAFMC's Other Meetings webpage (https://safmc.net/safmc-meetings/other-meetings/). The public was provided an opportunity to comment during each meeting.