SEDAR

Southeast Data, Assessment, and Review

SEDAR 48

Southeastern U.S. Black Grouper

Data Workshop Report

July 2017

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

EXECUTIVE SUMMARY

SEDAR 48 addressed the stock assessment for Southeastern U.S. black grouper. The assessment process was planned to consist of a Data Workshop, an Assessment workshop and several assessment webinars, and a Review Workshop.

The Data Workshop was held March 15-17, 2017 in St. Petersburg, Florida. During that workshop, a variety of issues were raised regarding the data inputs to be used in the assessment, particularly with regards to the landings data. The Florida Fish and Wildlife Commission (FWC)/ Fish and Wildlife Research Institute (FWRI), the lead agency for this assessment, discussed the data issues and determined the best course forward was to halt the assessment until the data issues could be resolved.

The FWC provided a memo to the SEDAR Steering Committee for their May 2017 meeting, informing them of the decision to terminate work on the SEDAR 48 assessment. FWC also provided a summary of the data that was reviewed at the Data Workshop which included the following summary:

> *After reviewing the data available for developing an assessment of Black Grouper, the life history information can be used straight away. The confusion of Black Grouper and Gag renders the landings data suspect before 2006 (2005 in the case of SRHS) and the high uncertainty in the MRFSS/MRIP estimates makes the MRFSS/MRIP catches almost meaningless. The commercial indices could not be updated because they are retained catch indices and IFQ, trip limits, and changes in minimum sizes. The age composition data are adequate for the commercial hook-and-line and longline but too sparse for the other fisheries and the length information coverage is better than that of ages but is light in many years especially for the headboat and commercial spearfishing. Overall, the landings data are the primary stumbling block for developing a credible stock assessment for Black Grouper. Landings scale the fishing mortality and natural mortality rates to the population size and, in turn, the biomass. Therefore, the high degree of uncertainty precludes determining the status of the stock.*

The SEDAR Steering Committee supported the decision of the FWRI to halt the assessment, and encouraged the development of the Data Workshop Report so the work completed to date would be documented and available for the next time black grouper is assessed. It was also noted that the FWC will continue to work on the solutions to these issues, and the Councils and Steering Committee will be kept informed on progress and developments.

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1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 48 Data Workshop was held March 15-17, 2017 in St. Petersburg, Florida.

1.2 TERMS OF REFERNCE

1. Review stock structure and unit stock definitions and consider whether changes are required.
    - Review available research and published literature
    - Make recommendations on biological stock structure and define the unit stock
    - Provide recommendations to address Council management jurisdictions to support management of the stock(s), and specification of management benchmarks and fishing levels, by Council jurisdiction (SAFMC/GMFMC)
    - Document discussions and recommendations pertaining to this term of reference in a separate working paper
2. Review, discuss, and tabulate available life history information.
    - Evaluate age, growth, natural mortality, and reproductive characteristics
    - Provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable
    - Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling
    - Provide estimates or ranges of uncertainty for all life history information
3. Recommend discard mortality rates.
    - Review available research and published literature
    - Consider research directed at black grouper, and other shallow water groupers, from the southeastern US Atlantic and Gulf of Mexico
    - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata
    - Include thorough rationale for recommended discard mortality rates
    - Provide justification for any recommendations that deviate from the range of discard mortality provided in the last benchmark or other prior assessment

4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant fishery-dependent and independent data sources
   - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics
   - Provide maps of fishery and survey coverage for each data source
   - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy
   - Discuss issues related to historical mis-labeling of gag as black grouper and adjustments made to correct the historical data.
   - Recommend which data sources are considered adequate and reliable for use in assessment modeling
   - Discuss the degree to which available indices adequately represent fishery and population conditions.
   - Rank the available indices with regard to their reliability and suitability for use in assessment modeling
5. Provide commercial catch statistics including landings and discards in both pounds and number of fish.
   - Evaluate and discuss the available data for accurately characterizing harvest and discard by species and fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest.
6. Provide recreational catch statistics including landings and discards in both pounds and number of fish.
   - Evaluate and discuss the available data for accurately characterizing harvest and discard by fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest in state and federal waters
7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
8. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II. of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Workshop Panel

Boo Muller, Lead Analyst .... FL FWC
Michelle Masi, Co-Lead Analyst .... FL FWC

Robert Ahrens .... SA SSC/UF
Carolyn Belcher .... SA SSC/GADNR
Chris Bradshaw .... FL FWC
Steve Brown .... FL FWC
Robert Ellis .... FL FWC
Martin Fisher .... RFAP
Kevin McCarthy .... NMFS Miami
Joe O'Hop .... FL FWC
Beverly Sauls .... FL FWC
Chris Stallings .... USF
Jessica Stephen .... NMFS SERO St. Pete
Phillip Stevens .... FL FWC
Ted Switzer .... FL FWC
Jim Tolan .... GM SSC/ TPWD
Steve Turner .... NMKFS Miami

Attendees
Tiffanie Cross .... FL FWC
Alisha Gray .... NMFS SERO St. Pete
Aimee Griffen .... FL FWC
Dominique Lazarre .... FL FWC

Staff
Julie Neer .... SEDAR
Mike Errigo .... SAFMC
Ryan Rindone .... GMFMC
Charlotte Schiaffo .... GMFMC

Additional Participants via Webinar
Larry Beerkircher .... NMFS Miami
Ken Brennan .... NMFS Beaufort
Kelly Fitzpatrick .... NMFS Beaufort
Dave Gloeckner .... NMFS Miami
Vivian Matter .... NMFS Miami
Refik Orhun .... NMFS Miami

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR48-DW-01	Standardized catch rates of Black Grouper, *Mycteroperca bonaci*, for	Robert G. Muller and Joe R. O'Hop	23 Feb 2017 Updated: 22

	the Southeast Regional Headboat Survey, 1986-2015		March 2017
SEDAR48-DW-02	Recent Black Grouper Publications (2010-2017)	James Tolan	9 March 2017
SEDAR48-DW-03	Standardized Reef Fish Visual Census index for the Florida reef track from Biscayne Bay through Florida Keys for 1997-2014	Robert G. Muller	14 March 2017
SEDAR48-DW-04	Black Grouper standardized catch rates from the Marine Recreational Fisheries Statistics Survey in south Florida, 1991-2015	Michelle Masi and Robert G. Muller	17 March 2017
SEDAR48-DW-05	Black Grouper Length and Weight Relationships for SEDAR 48	Joe O'Hop	27 March 2017
SEDAR48-DW-06	Using Trip Interview Program data to develop Black Grouper ratios to adjust commercial Black Grouper landings	Robert G. Muller and Steve Brown	24 April 2017
SEDAR48-DW-07	Southeastern Black Grouper Management History	GMFMC, SAFMC, and SERO Staff	February 2017
Reference Documents			
SEDAR48-RD01	Relative survival of gags Mycteroperca microlepis released within a recreational hook-and-line fishery: Application of the Cox Regression Model to control for heterogeneity in a large-scale mark-recapture study	Beverly Sauls	
SEDAR48-RD02	Update concerning species misidentifications in the commercial landing data of gag groupers and black groupers in the Gulf of Mexico (S33-DW-17)	Ching-Ping Chih	
SEDAR48-RD03	Estimation of species misidentification in the commercial landing data of gag groupers and black groupers in the Gulf of Mexico (S10-DW-24)	Ching-Ping Chih and Steve Turner	

2 LIFE HISTORY

2.1 OVERVIEW

The life history workgroup (LHW) reviewed and discussed data collected since the last South Atlantic and Gulf of Mexico Black Grouper stock assessment in 2010. Updated information was reviewed regarding meristics, age, growth, reproduction, mortality, and other topics from SEDAR 19 such as the approach used to model the effect of depth of capture by length, age, and gear on discard mortality. A summary of the discussions and recommendations made during the SEDAR 48 Data Workshop (DW) are presented below.

2.1.1 Life History Workgroup (LHW) members

Member Name	Affiliation
JNOe O'Hop (group leader)	FWC/FWRI
Rob Ahrens	UF
Carolyn Belcher	GADNR
Robert Ellis	FWC/FWRI
Phil Stevens	FWC/FWRI
Jim Tolan	TPWD

2.1.2 Taxonomy and identification

Black Grouper, *Mycteroperca bonaci* (Poey, 1860), are large groupers and members of the Family Serranidae (Eschmeyer et al. 2017, Page et al. 2013). While identification of this species is not overly difficult, the common name used for this species has also been used for several other groupers. This situation has caused confusion with the reporting of commercial and recreational landings. In some situations, fishers will refer to this species as "carberita", "carbos" or "true black grouper" to distinguish *M. bonaci* from Gag (*M. microlepis*). Observations by port samplers (NMFS Trip Interview Program; TIP) show that other species sometimes reported by fishermen and seafood dealers as "black grouper" are Scamp (*M. phenax*) and Yellowfin Grouper (*M. venenosa*), though this may be more out of convenience (e.g., no price differential) than by confusion. Observations by field samplers involved with the NMFS Marine Recreational Information Program (MRIP) and the NMFS Southeast Head Boat Survey (SRHS) in Florida also report that Gag are sometimes referred to as "black grouper" by recreational anglers, and charter and head boat captains, especially in areas of Florida where "true" Black Grouper are less common. To some extent, because the TIP, MRIP and SRHS employ field samplers for examining landed catch, the information from field sampling should be reliably identified. However, data reported on released fish from the MRIP survey should be treated cautiously especially in the early portion of the time series (i.e., 1981-1991). MRIP samplers are trained to question the identifications of species which may have local common names to try to reduce the effect of misidentification by anglers, but this training may not have been as effective to reduce confusion in the early portion of the time series with "black grouper" discards. Likewise, landings estimates from the SRHS generated from the vessel trip reports submitted by head boat captains should be carefully compared against dockside sampling to ensure that *M. bonaci* and *M. microlepis* were being properly distinguished on the vessel forms. Lastly, landings data for black grouper, gag, scamp, and yellowfin grouper from the commercial reporting systems (NMFS Accumulated Landings System, state trip ticket systems, and NMFS Coastal Fisheries Logbook Program) should be compared to the extent possible with the field sampling identifications from trip sampling in TIP.

2.2 REVIEW OF WORKING PAPERS

No working papers were submitted prior to the DW for the Life History Workgroup to discuss. Estimates and figures from a draft working paper on meristics and conversion factors were discussed during the session.

2.3 STOCK STRUCTURE

Currently, Black Grouper (*M. bonaci*) are managed as a single stock in the U.S. Southeastern Region (South Atlantic and Gulf of Mexico) based on our current understanding of the genetics of this species. The life history workgroup (LHW) discussed and reviewed the available stock structure information from SEDAR 19 (SEDAR 2010), and a literature search by Jim Tolan produced no new information relating to genetics studies of the stock structure of this species in U.S. waters.

Black Grouper (*M. bonaci*) are found from southeastern Brazil, throughout the Caribbean Sea and Gulf of Mexico, north to Massachusetts, and east to Bermuda. In waters of the southeastern U.S., they are most commonly found in the Florida Keys and southern Florida, though specimens caught from the west Florida shelf up to the Middle Grounds are not uncommon (Bullock and Smith, 1991). Black Grouper are found associated with rocky ledges and coral reefs, from 10-100 m in depth (Bullock and Smith 1991, Brulé et al. 2003). Generally, larger and older individuals are caught more often in deeper waters (O'Hop and Beaver 2009 [SEDAR 19-DW-09]; Brulé et al. 2003).

Recommendation

Given the lack of new information on the genetics and stock structure of Black Grouper in the U.S. Southeastern Region, the LHW recommends no changes to the fishery management region for this species. Given that this species appears to be a single population centered in south Florida and mostly in the Florida Keys, the assessment should treat the stock as a single unit rather than provide separate assessments for each of the two management units.

2.4 NATURAL MORTALITY

The LHW briefly and generally discussed various methods of estimating natural mortality (M), including calculations made during the Data Workshop for SEDAR 19 (2010). But, there being no major changes to the growth parameters or known maximum age for the species, the discussions centered around the use of a catch curve (which provides an estimate of total mortality, Z) for use as a potential upper limit for M, and the recommendations from Hoenig (1983), Hewitt and Hoenig (2005), and Then et al. (2015) which base M on the maximum age (t_{max}) of a species. There are several relationships given for M based on the maximum age observed in a wide variety of taxa (134 stocks of 79 species of fish, mollusks, and cetaceans) which were believed to be lightly exploited in Hoenig's (1983) original study. Hewitt and Hoenig (2005) compared the linear regression method (using the relationship for "all taxa") and the arbitrary "rule-of-thumb" method ($M \approx 3/t_{max}$). Hewitt and Hoenig (2005) recommended the use of $\widehat{M} \approx e^{1.44 - 0.982 \cdot (t_{max})}$ rather than the "rule-of-thumb" method. Then et al. (2015) revisited the datasets used in Hoenig's original study (denoted as "Hoenig_{lm}" or "linearized model") and additional data for other species and stocks. New relationships and regression methods were compared with Hoenig's (1983) and other methods of estimating M. Then et al. (2015) recommended the "Hoenig_{nls}" nonlinear regression to estimate parameters for relating M and maximum age.

The observed maximum age of Black Grouper is 33 years (three specimens) and the growth curve parameters (see Section 2.6) are like those used in SEDAR 19 (2010), so the recommendations made for M by the SEDAR 19 LHW are relevant. M in SEDAR 19 was estimated using the "$Hoenig_{lm}$" relationship as approximately $0.14y^{-1}$, and an age-specific relationship for M was developed using a modification of Lorenzen's (2005) method based on body length rather than body weight (Paul Medley, personal communication) and scaled over ages 3 to 33 (range of ages exploited) using the "target" M of $0.14y^{-1}$. The SEDAR 19 LHW originally recommended that sensitivity runs for M should be examined using values between 0.10 and $0.29y^{-1}$. Catch curve analyses using data from long line samples from the waters west of the Dry Tortugas (O'Hop and Beaver 2009) showed that estimates for total mortality (Z) ranged from $0.15y^{-1}$ (ages 15-33) to $0.29y^{-1}$ (ages 9-33); consequently, values for M above $0.15y^{-1}$ for the older individuals in the population may be too high. Using this information, the SEDAR 19 LHW modified their recommendation on sensitivity runs to vary M between 0.10 and $0.15y^{-1}$. Later, the Assessment Workshop panel modified that recommendation to examine the effect of M on the model outcomes using values between 0.10 and $0.20y^{-1}$.

The remaining items for this topic for the LHW to discuss was how the newer "$Hoenig_{nls}$" relationship (Then et al. 2015) might impact the levels of assumed M. The possible model(s) considered for use in the assessment and how estimates of M are treated in the model(s) (e.g., whether M would be a fixed constant or estimated) will affect the decisions used by analysts when incorporating these assumptions into the models. Depending upon the capabilities of the model(s) which may be used, priors for M on which a distribution and bounds should be specified, an age-specific M based on the average M estimate is typically incorporated into model calculations, and sensitivities runs for examining the effect of input M on model outputs are usually outlined by the LWH. The LWH briefly discussed methods for developing upper bounds on sensitivity runs such as catch curve analyses presented at the Data Workshop like those produced for SEDAR 19.

Catch curves (Chapman and Robson 1960) were developed, as in SEDAR 19 (O'Hop and Beaver 2009), from specimens sampled out of the long line catches west of the Dry Tortugas to provide an estimate of total mortality (Z) for that portion of the population containing the oldest known individuals (Figure 2.1). Among the assumptions made for catch curves is that total population size remains constant ("stationary"), that the age at which fish are fully available to the gear is known, the individual animals of age X are randomly and independently selected from the population, and that "there is some age X_0 such that for all ages $X \geq X_0$, the probability of selection is the same and the annual survival rate is the same" (Chapman and Robson 1960). The annual survival rate (S) is estimated using the independent observations of ages, which arise from the random sample of individuals from the population.

Typically for catch curves, the age at the peak of the curve is considered the age at which animals are nearly or fully vulnerable to the sampling gear (in this case, age 8 from long line gear). It is the usual practice to choose the age range beginning with the next age after the peak for catch curve calculations because there is no objective way in determining whether the age at the peak of the curve was completely or incompletely vulnerable to the gear (Chapman and Robson 1960). Because Black Grouper move into deeper areas as they age, and the deployment of long line gear is legal in waters 20 fathoms or deeper in the Gulf of Mexico (50 fathoms for the South Atlantic), not all ages of Black Grouper are equally available to this gear so vulnerability is a product of both the gear characteristics (selectivity) and the availability of ages in the habitats fished. The annual Z estimates are not only affected by fishing mortality from long line gear, but are also affected by fishing mortality from other fishing sectors (recreational fishing and other commercial gears). So, depending upon the age range chosen for analyses, Z will vary. The reasons for estimating Z for Black Grouper from this gear is that a greater range of ages is seen in catches of this species compared to catches from most other gears. Because Black Grouper move to deeper waters as they get older, the older ages do not appear to be vulnerable to most other gears because those gears are usually not used or fishermen are not fishing in those deeper areas where the older individuals tend to be. Overall, levels of fishing mortality of Black Grouper from long line gear appear to be lower than other gears used in shallower habitats, and that M may comprise a larger proportion of Z than F from this portion of the fishery. It may be possible to use estimates of Z from the long line fishery as a proxy for an upper bound on M. Catch curve estimates of Z from the long line samples were $0.22y^{-1}$ (ages 9-33), $0.20y^{-1}$ (ages 11-33), and 0.16 (ages 15-33) depending upon the age range considered (Figure 2.1). If the assumptions for catch curves produce reasonable values for Z, then M can be no larger than Z.

Then et al. (2015) provide the most recent recommendations for M from maximum age for the "$\text{Hoenig}_{\text{lm}}$" (updated as $M_{est} = \ e^{(1.717-1.01 \cdot \ln(t_{max}))}$) and a new estimator "$\text{Hoenig}_{\text{nls}}$" ($M_{est} = 4.899 \cdot \ t_{max}^{-0.916}$), and compared results with other estimators (Alverson and Carney (1975), Pauly

(1980), Pauly and Binohlan (1996)) and provided an updated Pauly M estimator without temperature (“$Pauly_{nls\text{-}T}$”) based solely on growth parameters as $M_{est} = 4.118K^{0.73}L_{\infty}^{-0.33}$. They preferred, based on their results, to use the “$Hoenig_{nls}$” if a reasonable estimate of the maximum age was available. Otherwise, if growth parameters were reasonable, they recommended the “$Pauly_{nls\text{-}T}$” estimator and cautioned against using other estimators which included temperature as a coefficient. They cautioned that M estimates used previously based on empirical relationships should be re-examined if those estimators performed poorly in their simulations, and against simple averaging of multiple M estimates derived from the various empirical relationships because those estimators are not equally reliable and some are not independent of others (i.e., they may include of similar quantities like growth parameters and maximum age).

The updated “$Hoenig_{lm}$” and “$Hoenig_{nls}$” estimators for SEDAR 48 (Figure 2.2; Then et al. 2015) estimated M at ≈ $0.16y^{-1}$ and $0.20y^{-1}$, respectively, of which the latter is at the upper end of the range for M used for sensitivity runs in SEDAR 19. The “$Pauly_{nls\text{-}T}$” estimate was ≈ 0.09 y^{-1}. Given that the newer M estimators are similar to the range for M recommended at the SEDAR 19 Assessment Workshop (0.10 – $0.20y^{-1}$), and that the catch curve estimated total annual mortality rate (Z) between 0.21-$0.23y^{-1}$, there is no reason to change the SEDAR 19 recommendation for the plausible range of M to be used in the SEDAR 48 assessment. The value to use as an estimate of the average value of M is more problematic. Given the current recommendation from Then et al. (2015) and the catch curve analyses, the average should be set to 0.2 and the distribution for M used by the model should not result in an M estimate (if M is a parameter estimated within the model) exceeding the catch curve Z. The lower limit for M is also problematic. The observed maximum age (33 years) would change if older specimens are found, and that would lower the estimated M using estimators based on t_{max}. Then et al. (2015) recommend use of the “$Pauly_{nls\text{-}T}$” estimator in cases when t_{max} is not known. Perhaps this M-estimator could serve as a plausible lower bound for M in models where this parameter is estimated. If M is not estimated internally (i.e., fixed) in the model, then sensitivity explorations should use a range of at least 0.1 to 0.2 y^{-1} for M (the same range used in SEDAR 19).

Rather than fixing M at an average value over all ages, it is common in SEDAR assessments to model natural mortality as power function of weight because research has demonstrated higher mortality rates for smaller-sized individuals than larger (and older) ones in natural and aquaculture systems (e.g., Lorenzen 1996). This relationship can be re-cast into age-specific M values for use in age-structured assessment models. The more common expressions for age-specific M in use in SEDAR are from Lorenzen (1996, 2005), and these relationships have been calculated externally to models usually as fixed terms using body weight and age from a growth curve, though body size and age have been used. Newer models which feature internal model estimation of M and age-specific M use a growth curve and length-weight relationship (e.g., Catch-free, Stock Synthesis) as starting priors to calculate age-specific M. Coefficients for age-specific M estimates are given in Lorenzen (1996; see Table 1 in that article), and common choices in SEDAR have used coefficients for "Ocean" and "Natural" ecosystems.

Examples of the predicted total length (TL, mm) and whole weight at age using the growth curve generated for SEDAR 19, and estimates of age-specific M at age on January 1 using the different estimators mentioned in the previous paragraph are in Table 2.1. Age-specific M is calculated from body length (Paul Medley, personal communication) averaged over ages 3-33. Black Grouper can become large enough under current size limits to be legally retained around age 2, but mostly they become vulnerable to exploitation at age 3. Of course, individuals are vulnerable to fishing gear at younger and smaller sizes. It is typical in SEDAR assessments to the adjust age-specific M rates for the range of ages vulnerable to retention in the fishery.

Recommendation

If possible, avoid fixing the overall level of M and allow the model to solve for this parameter. Use the "$\text{Hoenig}_{\text{nls}}$" estimator based on the maximum observed age, and construct an age-specific M (e.g., Table 2.1) based on the "$\text{Hoenig}_{\text{nls}}$" averaged over ages 3 to 33 to proportionately shift rates of natural mortality to small/younger individuals which are generally more vulnerable to predators than larger/older individuals. If priors can be specified, develop reasonable values for M and bound between 0.1 and $0.2y^{-1}$, or at least do not exceed the catch curve Z ($0.21\text{-}0.23y^{-1}$) estimated from long line specimens.

2.5 DISCARD MORTALITY

An ad-hoc working group was convened during the Data Workshop to discuss discard mortality. Participants in the discussion included: Beverly Sauls, Martin Fisher, Robert Ellis, Joe O'Hop, Rob Ahrons, Kevin McCarthy, Jessica Stephens, Mike Errigo, and James Tolan

Recommendations from SEDAR 19

The Data Workshop panel for the SEDAR 19 assessment recommended applying a 20% mortality rate to Black Grouper discard estimates for recreational hook-and-line fishery and commercial vertical line fishery, and a range of 10-30% for sensitivity analysis. For the commercial longline fishery, a higher rate of 30% with a range of 25-35% was recommended. The Assessment panel decided to support the point estimates and range of values recommended by the Data Workshop. At the time, no empirical data were available to support these estimates. The review panel for SEDAR 19 requested sensitivity runs that varied discard mortality from 10-90%; however, the panel did not find strong evidence that the value used for the assessment should be changed and recommended that attempts should be made in the future to obtain a more accurate estimate of both acute and chronic discard mortality.

Review of Available Literature

A review of available literature for shallow water groupers from the southeastern US Atlantic and Gulf of Mexico was conducted during the SEDAR 33 Data Workshop for the Gulf of Mexico Gag assessment (SEDAR 2013). Estimated discard mortality ranged from 0% to 100%; however, studies employed a range of methods (observational, cage, mark-recapture, barometric chamber), gear types (longline, vertical line, bandit reel, and recreational hook and line), hook types (circle hooks and J hooks), release methods (vented and unvented), and barotrauma exposures (0 to 100 meter depths). A meta-analysis approach was used to control for the variable effects of study type, gears, release methods, and sample sizes and evaluate the functional response between mortality and capture depth at 10 meter intervals (Figure 2.3). The model demonstrated a positive correlation between depth and mortality. A mark-recapture model using gag discards observed in the for-hire recreational fishery in the eastern Gulf of Mexico was also developed for SEDAR 33, and has since been published in peer-reviewed literature (Sauls 2014). No other studies have been published since the literature review that was conducted for SEDAR 33.

The SEDAR 33 Data Workshop Panel recommended using the depth-dependent discard mortality function developed from the meta-analysis of multiple studies combined for the commercial longline fishery. For the recreational hook-and-line fishery and the commercial vertical line fishery, the discard mortality model developed from mark-recapture data was recommended. At the assessment workshop, the mean depth for each fishery was calculated from available sources of data and this depth was used to assign one overall discard mortality rate from the fishery (Table 2.2).

Available Data for Black Grouper

Since 2005, the state of Florida has worked cooperatively with the for-hire industry to develop fishery observer programs for charter boat and headboats fleets (methods described in Sauls and Cermak 2013). Headboats typically carry groups of eleven or more anglers who pay individual fares to board the vessel, and charter boats cater to smaller groups that pay a single trip fare for a private fishing trip. A large portion of these trips target reef fish stocks that are federally managed in either the Gulf of Mexico or South Atlantic. During sampled trips, fishery observers accompany anglers and collect information from fish caught and released at-sea. Beginning in 2009, new procedures were implemented, which included collecting additional information from regulatory discards and marking individual fish with conventional tags prior to release. From this work, mark-recapture data have been used to develop a predictive model of survival for Gag grouper *Mycteroperca microlepis* (Sauls 2014), which was used in SEDAR 33. For this model, live gag discards were assigned to one of three release condition categories (Table 2.2), and estimated mortality percentages were applied to each group.

Due to low numbers of Black Grouper discards observed over this time-series, a separate mark-recapture model could not be produced for this species. Instead, Black Grouper that were observed in the for-hire fishery in Florida were placed in the same three condition categories described in Table 2.3, and mortality rates estimated for gag were applied to those observations (Table 2.4). This method resulted in an overall discard mortality estimate of 13.9%.

Recommendations

During the data workshop, it was recommended that depth dependent discard mortality functions developed for gag during SEDAR 33 be used as a proxy for Black Grouper. For commercial vertical lines and longlines, delayed mortality (red line in Figure 2.3) from the meta-analysis was recommended, since the analysis included studies from the commercial sector. For recreational hook-and-line fisheries, the tag-recapture model was recommended. Mean fishing depths for black grouper discards in the two fisheries were obtained from limited observer data available from the commercial and recreational fisheries in the Gulf of Mexico and South Atlantic (Table 2.5). The range of depths was used to choose the recommended range of discard mortality to apply to each fishery in SEDAR 48 (Table 2.5).

2.6 AGE AND GROWTH

There have been no new age and growth studies for *M. bonaci* in southeastern US waters since Crabtree and Bullock (1998). Collections of otoliths from fishery dependent and fishery independent sources has occurred, and these specimens have been used to provide updated growth parameter estimates for SEDAR 19 (SEDAR 2010) and SEDAR 48. Most specimens (73%) were from commercial vessels, and the long line fishery accounted for 48% of the ages available (Table 2.6). About 9% of the ages were from recreational vessels (head boats, charter boats, and private/rental boats), and about 15% were from fishery independent and special collections for a research study (Table 2.6). Fifty percent of the aged specimens were 6 years of age or younger (Table 2.7), and 95% were age 18 or younger. Annual samples for ages (Table 2.8) were low before the research study (Crabtree and Bullock 1998) began collecting otoliths and other samples of *M. bonaci* in 1994-1996 under grant funding from the National Marine Fisheries Service (Award NA57FF0060). The number of otoliths collected each year are relatively low and are mostly from commercial long line vessels from 1999-2015, though collections from head boats has recently increased during 2012-2015 (Table 2.8). *M. bonaci* are not particularly common in fishery catches especially under current management regulations, so the chances of field samplers encountering vessels with this species and being allowed to sample these fish is relatively low.

Annuli, based on marginal increment analyses (Crabtree and Bullock 1998), on the otoliths are not difficult to distinguish and reader agreement was 2.4% (Jessica Carroll, personal communication, FWRI Age and Growth Lab, St. Petersburg, FL). The counts of annuli determined by multiple readers is suitable for constructing an ageing error matrix if desired. Crabtree and Bullock (1998) used an average of 6 counts (2 readers) of annuli on each of the otoliths in their study. More recently, the annuli counts are adjusted for the degree of completeness of the marginal increment and the collection date, and nearly all of the otoliths from the Crabtree and Bullock (1998) study were re-read for SEDAR 19. Basically, either method provides very similar results, and the method of adjusted age using the marginal increment and collection date yields similar results as assigning a year class to the specimens. A von Bertalanffy (VB) growth model (von Bertalanffy 1938, Beverton and Holt 1957) was used to fit the adjusted ages and lengths of the specimens for SEDAR 19 and 48 (Table 2.9; PROC NLIN, SAS Institute Inc. 2015).

Individuals do not grow at the same rate, and it has been recognized (e.g., Diaz et al. 2004) that under size limit restrictions, faster growing fish grow into legal size at a younger age than slower or more average growing (and older) fish. This phenomenon can result in the skewing of age compositions and growth curves. We examined the average length at age (and coefficient of variation or "CV") from fishery dependent (FD) modes of fishing subject to size restrictions, and compared these to average length at age (and CV) from fishery independent (FI) and research collections (Figure 2.5). Average length at age for FI specimens was much smaller and more variable (higher CV) than FD length at age up to about age 5 where they became more equal. On this basis, we used FI specimens of all ages and excluded FD specimens less than age 5 (Figure 2.6) for estimating the parameters of the growth curve. Also, we entered the ages into the model as age plus the fraction of year elapsed after December 31, and censored any FD lengths below size limits prevailing over a period.

An additional variation on the VB growth model (Table 2.9) was constructed using the ages and lengths of the specimens and modeling the CV of length at age (PROC MODEL, SAS Institute Inc. 2011). For SEDAR 48, the CV was modeled as a decreasing linear function of age over ages 5 to 27 (ages from fishery dependent collections and sample sizes greater than 10; Table 2.7). This model is a typical VB growth curve with the additional feature of using the variability around length at age to decrease the contribution of unusually small or large lengths for an age to the likelihood in the fitting process. An additional term also allowed fishery dependent specimens below the prevailing size limits to be included in the fitting process.

There was very little difference between the parameters estimated for SEDAR 48 (Table 2.9) with the more usual VB growth curve than with the growth curve with modeled CV. The growth curve with modeled CV has more parameters than the usual VB growth curve (Figure 2.7) and does not offer a substantial difference in fit, so there is little to recommend it for use.

Recommendation

The recommended priors or bounds for growth parameters are listed in Table 2.9. While growth may be fixed in some models, growth rates in nature are not. We recommend allowing growth in the model to vary within reasonable bounds, and the parameter estimates and standard errors (Table 2.9) may be reasonable choices for priors.

2.7 REPORDUCTION

Black Grouper (*M. bonaci*) are monandric protogynous hermaphrodites (Sadovy and Shapiro, 1987, García-Cagide and García 1996, Crabtree and Bullock 1998, Renán et al. 2001, Brulé et al. 2003). Individuals are born as females, and mature females attaining larger size (and older ages) may transition to males. The physiological, behavioral, and environmental cues governing sexual change are not known, and because there are overlaps in size and age for females and males of this species the triggers for sexual change are not solely size- or age-related (Brulé et al. 2003). What has been observed is that males tend to attain larger average size than females, and larger individuals tend to be found in deeper habitats (Figure 2.8) resulting in skewed sex ratios – more females than males (15-76:1; García -Cagide and García 1996, Crabtree and Bullock 1998, Brulé et al 2003) particularly in shallower habitats.

This species aggregates to spawn in late winter to early spring (peak during January-March) in waters of the southeastern U.S., Cuba, and the southern Gulf of Mexico. The eggs of Epinepheline groupers are planktonic (Jory and Iversen 1989), but the larvae are not abundant in the plankton and newly settled young are "cryptic inhabitants of structurally complex bottoms and rarely collected by conventional sampling" (Keener et al. 1988). Keener et al. (1988) studying larval ingress of *Mycteroperca* (particularly Gag) in an inlet in South Carolina from early April to early July in 1981-1984 note finding several post-larvae (11-18mm SL; ages 31-57 days old) of *Mycteroperca bonaci* during April and May. Their back-calculation of fertilization dates (based on the daily rings in the lapillus otolith, plus a 6 day lag until formation of the first daily ring) estimates spawning to occur sometime from early March to early May in those waters.

Aggregations in the southeastern US have been documented by Eklund et al. (2000) at a site in the Upper Florida Keys in January to February of 1998 from the new moon to full moon. The site was characterized as forereef from 18-28 m in depth which sloped steeply to a sand plain. Several large caves in the fossilized reef may have provided shelter for large fish. Another aggregation site in the Florida Keys, based on underwater observations consistent with courtship behavior and passive acoustics in late April, 2010, is a 30 m deep site at Riley's Hump in the Tortugas South Ecological Reserve (Locasio and Burton 2016). There are other suspected aggregation sites based on local knowledge and oceanographic features (e.g., Sanchez et al. 2017) in the Florida Keys and elsewhere in the southeastern US that may warrant study. Sala et al. (2001) observed spawning *of M. bonaci* on one occasion at Glover's Reef [an elongate (32 km x 12 km), rectangular spur and groove coral atoll/shelf edge system offshore of Belize] which occurred shortly after sunset in January several days after the full moon at 25-45 m depth outside of a large channel through the crest of the reef. They observed a mix of 4 grouper species (Nassau, Tiger, Yellowfin, and Black Grouper) which became abundant on the spawning site within three days after the full moon.

2.7.1 Maturity

Crabtree and Bullock (1998) estimated female maturity (Table 2.10) in terms of length and age for *M. bonaci* using specimens from all months of the year. Brulė et al. 2003 examined female maturity in terms of length for specimens from the Campeche Banks (Mexican waters) from all months of the year. Hunter and Macewicz (1980, 2003) recommend using specimens only from the months prior to peak spawning activity to better assess maturity status. We restricted our analyses (Table 2.10, Figure 2.9) in SEDAR 19 to the months of January to March for this reason and excluded specimens that were in the "regenerating phase" (Brown-Peterson et al. 2011), also called "resting, regressed, recovering, or inactive" by other methods of classification, because of the difficulties in objectively distinguishing this phase from immature specimens. Because there were no new specimens for which histological samples were available after SEDAR 19, the length and age at which 50% of the females (logistic model, Quinn and Deriso 1999; PROC NLIN, SAS Institute Inc. 2015) were assessed to be mature is unchanged.

2.7.2 Sexual Transition

Crabtree and Bullock (1998) estimated the length and age for the proportion of males among their *M. bonaci* specimens (Table 2.11), as did Brulé et al. (2003) from their specimens from the Campeche Banks (Mexican waters). Both studies noted large differences in the sex ratio (male:female) of specimens from different water depths and that it was not possible to describe the overall sex ratio for the population because of the biases in sampling or catches. Many larger fish in the Crabtree and Bullock (1998) study had already been gutted and not possible to sex.

It is possible to examine the lengths and ages of these specimens and estimate the proportions of males (or females) at a given length or age using histological samples. A total of 55 males (and 835 females) were examined using histological methods by Crabtree and Bullock (1998). However, there were fewer (38 males, 694 females) to examine the age where 50% were males (Table 2.11, Figure 2.10). There were 225 males (895 females) in the Brulé et al. (2003) Campeche Banks study available for examining the length at which 50% of the specimens were male (Table 2.11).

After Crabtree and Bullock (1998), there have been no other published research in the US Southeast using histological examinations of *M. bonaci*. There were 55 additional macroscopic determinations of sex yielding a few additional males for examining the proportions of males at length and age for SEDAR 48 (Table 2.11). García-Cagide and García (1996) found that 13% of the macroscopic sex determinations for *M. bonaci* and *M. venenosa* (Yellowfin Grouper) were incorrect when compared to microscopic (histological samples) examinations. Brulé et al. (2003) noted that while males typically have jet black pigmentation on their pectoral, anal, and caudal fins, about 5% of the females (50-100 cm) also had this coloration. Therefore, caution should be used when including macroscopically determined sex for specimens for SEDAR 48. However, in these analyses (Table 2.11), there were only minor differences in the solutions (logistic model; Quinn and Deriso 1999; PROC NLIN, SAS Institute Inc. 2015) for the proportions at length or age where 50% of the specimens were male and either the SEDAR 19 or SEDAR 48 recommended solutions for these parameters are suitable.

2.7.3 Fecundity and spawning frequency

There are no published fecundity estimates for *M. bonaci*.

García-Cagide et al. (2001) describe the pattern of oocyte development in *M. bonaci* as "discontinuous asynchronous". Oocytes in this type of development will mature in batches ("discontinuous"), and an individual will spawn all batches in only one month. Because the ovaries contain vitellogenic oocytes in batches at different stages of maturation, maturation of oocytes in this species is "asynchronous". Crabtree and Bullock (1998) suggested that oocyte development in *M. bonaci* was more consistent with the pattern of oocyte maturation termed "group- synchronous" (Wallace and Selman 1981), which is described as a 'fairly synchronous population of larger oocytes (defined as a "clutch") and a more heterogeneous population of smaller oocytes from which the clutch is recruited.' Whether this type of pattern is "determinate fecundity" (all recruited primary growth oocytes undergo secondary growth for the upcoming spawning period) or "indeterminate fecundity" (primary growth oocytes undergo secondary growth throughout the spawning period) (see Lowerre-Barbieri et al. 2011) is not known. But, no matter the terminology used, *M. bonaci* appear to spawn multiple clutches of eggs over a short period most likely during late-winter and spring, probably with peak spawning during January-March in southeastern US waters and southern Gulf of Mexico judging by observed trends in the gonadosomatic index (Crabtree and Bullock 1998, Brulé et al. 2003).

Recommendation

The parameters for female maturity (Table 2.10) and proportions of males (Table 2.11) by length and age for suitable for use in SEDAR 48.

2.8 MOVEMENTS AND MIGRATIONS

2.8.1 Larval transport and connectivity

As noted previously, Keener et al. (1988) found young post-larvae (11-18mm SL; 31-57 days old) of *M. bonaci* brought into inlets in South Carolina on spring tides during April and May. But there is not much else known about connectivity among areas of the Gulf of Mexico and the South Atlantic where groupers are known to spawn. A Campeche Bank-based model by Donald Johnson (Gulf Coast Research Laboratory; SEDAR 2014) was used to explore possible connectivity of that area of the Southern Gulf of Mexico with the west Florida shelf for SEDAR 33. With aspects of Gag (*M. microlepis*) life history such as a January-March spawning period and a pelagic larval duration of 45 days, most Gag larvae were retained on the Mexican Shelf but some larvae (2%) could conceivably arrive in South Florida waters and potentially to the US South Atlantic. The life histories and pelagic duration of the larval stage of *M. microlepis* and *M. bonaci* are similar, so it seems possible that some viable larvae of *M. bonaci* may arrive in South Florida habitats from the Campeche Banks. It may be more likely that most recruitment, though, is local from spawning sites in the Florida Keys. Zatcoff (2001), using microsatellite DNA from specimens in the Florida Keys, Campeche Banks, Mexico, and Belize noted genetic homogeneity among these locations, with differentiation from specimens in Bermuda.

2.8.2 Habitat requirements

Post-larvae settle in estuarine habitats, but few juveniles have been found. There have been a few juveniles (~100 mm) captured in the Indian River Lagoon (Florida) in seines, but because this species prefers habitats difficult to sample with the types of fishery independent gears employed, it is not surprising that so few have been captured. Brulė et al. (2005) characterized the juvenile (105-455 mm TL) habitat of the north coast of the Yucatan peninsula as irregular hard bottom of limestone outcrops or rocks surrounded by sandy areas. There are many areas in the Florida Keys and southeastern coast of Florida with this type of habitat, and it is no accident that these areas are also the center of *M. bonaci* abundance in US waters. As *M. bonaci* mature, they move into deeper waters, preferring areas with high relief. Larger and older specimens are more often caught in deeper waters over 30 m (Figure 2.10).

2.8.3 Tagging, movements, and migrations

Burns et al. (2006) conducted a conventional tagging study of reef fish in the Florida Keys during 2004-2006, and tagged 126 *M. bonaci*. More than half of the Black Grouper that were tagged were caught in less than 20 m water depth. Anglers reported 6 recaptures of *M. bonaci* (1 of which was recaptured three times in the Dry Tortugas), most from fewer than 30 days after tagging. Distances traveled from tagging site to recapture was from only 1 fish and was 1.6 km.

A few *M. bonaci* have been acoustically tagged and monitored over short-term (4-8 months) studies in the Florida Keys (e.g., Lindholm et al. 2005, Farmer 2009). From the size of the fish tagged (469-889mm TL), most were probably immature females. During these studies, movements were relatively short (4 km or less) and site fidelity seemed to relatively high. Home range was estimated to be about 1.13 km^2 based on two fish (Farmer 2009). Because of the size (and assumed maturity status) of the fish tagged and short duration of the observations, it is likely that these documented movements are not generalizable to mature fish over the course of a year. Perhaps in the future there will be more acoustic data available for larger individuals over a longer period of observation.

Recommendation

There are no recommendations for this section.

2.9 MERISTICS AND CONVERSION FACTORS

Conversions between length measurement types taken by different sampling programs, and estimating weight from length (Table 2.12) are typically needed for assessments. Data from all fishery dependent and independent sources available from all years (1978-2013) were used for these relationships.

Recommendation

The relationships calculated for length-length and length-weight relationships (Table 2.12) are very similar to those estimated in SEDAR 19 (2010) and Crabtree and Bullock (1998). The new parameters are based on a slightly larger sample size which is generally preferable, but the ranges over which most were calculated were similar and therefore these relationships would provide similar guidance. The one exception is the relationship for estimating whole weight from fork length. Because of suspected outliers that were not detected during SEDAR 19, the relationship developed for SEDAR 48, if needed, should provide better estimates of average whole weight from fork length.

2.10 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

The life history data appear adequate for use in assessments. The LHW expressed a concern that there was a potential for sperm limitation if the number of males in the population was too low, but the amount of data available from field samples was probably not adequate to examine this aspect of the *M. bonaci* population.

2.11 RESEARCH RECOMMENDATIONS

Given that there may be some possible connectivity with the Campeche Banks, some genetic samples from *M. bonaci* from this area should be sought for comparison with specimens from the West Florida Shelf, the Florida Keys, and Southeast Florida. However, local recruitment is still thought to be the main contributor to the population in U.S. southeastern waters. Further genetic sampling of *M. bonaci* from the areas of the southeastern US (Texas to North Carolina) may be warranted to assess whether there is any genetic structuring in *M.bonaci* in U.S. southeastern waters.

2.12 DATA BEST PRACTICES COMMENTS AND SUGGESTIONS

The SEDAR Data Best Practices Living Document (SEDAR 2016, September) was used as a guide for structure and content for the LHW report. I found it helpful in organizing the biological information for a species into a more standardized format for SEDAR assessments.

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2.14 TABLES

Table 2.1. Black grouper total length and whole weight at age (January 1) using the SEDAR 19 growth curve, and examples of age-specific M (January 1) using different estimators.

Age	Total Length (mm)	Whole Weight (kg)[3]	$Hoenig_{nls}$[1]	$Hoenig_{lm}$[1]	$Hoenig_{lm}$[2]	$Pauly_{nls-T}$[1]
			M(y^{-1})	M(y^{-1})	M(y^{-1})	M(y^{-1})
4	161.8	0.05	0.953	0.78	0.652	0.444
1	318.2	0.41	0.579	0.474	0.396	0.27
2	453.8	1.26	0.434	0.355	0.297	0.202
3	571.2	2.61	0.357	0.292	0.244	0.166
4	673	4.39	0.31	0.253	0.212	0.144
5	761.2	6.5	0.278	0.227	0.19	0.129
6	837.7	8.8	0.255	0.209	0.174	0.119
7	903.9	11.21	0.238	0.195	0.163	0.111
8	961.3	13.63	0.225	0.184	0.154	0.105
9	1011.1	15.99	0.215	0.176	0.147	0.1
10	1054.2	18.26	0.207	0.169	0.142	0.096
11	1091.6	20.39	0.201	0.164	0.137	0.093
12	1123.9	22.38	0.195	0.16	0.134	0.091
13	1152	24.2	0.191	0.156	0.131	0.089
14	1176.3	25.86	0.187	0.153	0.128	0.087
15	1197.4	27.36	0.184	0.151	0.126	0.086
16	1215.6	28.7	0.182	0.149	0.124	0.085
17	1231.4	29.91	0.179	0.147	0.123	0.084
18	1245.1	30.97	0.178	0.145	0.121	0.083
19	1257	31.92	0.176	0.144	0.12	0.082
20	1267.3	32.76	0.175	0.143	0.119	0.081
21	1276.2	33.5	0.174	0.142	0.119	0.081
22	1284	34.15	0.173	0.141	0.118	0.08
23	1290.7	34.71	0.172	0.141	0.117	0.08
24	1296.5	35.21	0.171	0.14	0.117	0.08
25	1301.5	35.65	0.17	0.139	0.117	0.079
26	1305.9	36.03	0.17	0.139	0.116	0.079
27	1309.7	36.36	0.169	0.139	0.116	0.079
28	1312.9	36.65	0.169	0.138	0.116	0.079
29	1315.8	36.9	0.169	0.138	0.115	0.079
30	1318.2	37.12	0.168	0.138	0.115	0.078
31	1320.4	37.31	0.168	0.138	0.115	0.078
32	1322.2	37.48	0.168	0.137	0.115	0.078
33	1323.8	37.62	0.168	0.137	0.115	0.078
34	1325.2	37.75	0.168	0.137	0.115	0.078
35	1326.4	37.86	0.167	0.137	0.115	0.078

36	1327.4	37.95	0.167	0.137	0.114	0.078
37	1328.3	38.03	0.167	0.137	0.114	0.078
38	1329.1	38.1	0.167	0.137	0.114	0.078
39	1329.8	38.17	0.167	0.137	0.114	0.078
40	1330.4	38.22	0.167	0.137	0.114	0.078
41	1330.9	38.27	0.167	0.137	0.114	0.078
42	1331.3	38.31	0.167	0.137	0.114	0.078
43	1331.7	38.34	0.167	0.137	0.114	0.078
44	1332	38.37	0.167	0.136	0.114	0.078
45	1332.3	38.4	0.167	0.136	0.114	0.078
46	1332.6	38.42	0.167	0.136	0.114	0.078
47	1332.8	38.44	0.167	0.136	0.114	0.078
48	1333	38.46	0.167	0.136	0.114	0.078
49	1333.1	38.47	0.167	0.136	0.114	0.078
50	1333.3	38.48	0.167	0.136	0.114	0.078

[1] – Then et al. (2015)

[2] – Hoenig (1983), Hewitt and Hoenig (2005), differed slightly from mid-year calculation used in SEDAR 19 DW

[3] – with bias correction

[4] – assessment model (e.g., Stock Synthesis) will likely calculate Age0 quantities using a different method

Table 2.2. Calculated average depth of released Gag Grouper by fishing fleet and associated mortality assigned to discards during SEDAR33.

Fishing fleet	**Avg. depth (m)**	M (**SEDAR 33**)
Vertical line	31	0.27
Longline	58	0.27
Headboat	27	0.16
Charter boat	25	0.16
Private recreational	17	0.12

Table 2.3. Release condition categories used for gag, SEDAR33.

Condition category	**Description**
Good	Fish immediately submerged without the assistance of venting and did not suffer internal hook injuries or visible injury to the gills
Fair	Fish did not immediately submerge, or submerged with the assistance of venting, and did not suffer internal hook injuries or visible injury to the gills
Poor	Fish remained floating at the surface, suffered internal hook injuries, suffered visible injury to the gills, or any combination of the three impairments

Table 2.4. Black grouper discards by release condition category observed from charter and headboat trips in Florida, with mortality rates for Gag applied to estimate overall discard mortality.

Condition	**n**	**Mean length (ML mm)**	**Mean depth (m)**	**Gag survival rate (Sauls 2014)**	**Estimated M**
Good	146	391	11	0.925 (0.85, 1.0)	0.139 (0.01, 0.24)
Fair	24	490	29	0.664 (0.469, 0.940)	
Poor	13	441	14	0.506 (0.262, 0.978)	

Table 2.5. Mean fishing depths by fishery, based on available fishery observer data for black grouper discards, depth range, and discard mortality range recommended for use in SEDAR46.

Gear	Number of discards observed	Mean depth (m)	Depth range (m)	Recommended Mortality range
Bottom longline	8	57.3	36 to 85	0.25 to 0.50
Vertical line	29	20.6 (Gulf) 40.0 (Atlantic)	20 to 85	0.20 to 0.50
Recreational	183	13.6	1 to 50	0.09 to 0.26

Table 2.6. Number of *M. bonaci* specimens (otoliths) aged by mode/sector of fishing and gear /event, 1977 to 2015.

Fishing Mode/Sector	Hook and Line	Long Line	Haul Seines	Trawls	Spear	Traps	Unspec-ified Gear	Cold Kill	Total
Recreational - Head Boats	275	0	0	0	0	0	0	0	275
Recreational - Charter Boats	86	0	0	0	6	0	2	0	94
Recreational - Private/Rental Boats	11	0	0	0	4	0	0	0	15
Recreational - unclassified	2	0	0	0	0	0	3	0	5
Tournaments	8	0	0	0	38	0	0	0	46
Commercial vessels	531	2051	0	1	281	4	219	0	3087
Fishery Independent Surveys	10	0	16	3	0	10	0	0	39
Special Collections	1	0	0	0	616	2	0	1	620
Scientific Sampling	0	0	0	1	0	0	0	0	1
Unspecified	2	0	0	0	3	0	19	0	24
Total	926	2051	16	5	948	16	243	1	4206

Table 2.7. Number of *M. bonaci* specimens by age and fishing mode or collection type.

Age	Rec-HB	Rec-CH	Rec-PR	Rec-other	TR	CM	FI	SC	Cold Kill	Unspec.	Total
0	0	0	0	0	0	0	16	0	1	0	17
1	1	0	0	0	0	0	4	26	0	0	31
2	3	5	1	1	0	9	5	87	0	1	112
3	32	21	2	2	1	146	5	132	0	2	343
4	67	31	4	2	4	313	7	153	0	1	582
5	95	19	6	0	6	310	1	140	0	1	578
6	26	11	1	0	4	350	1	54	0	1	448
7	15	2	1	0	2	375	0	11	0	0	406
8	8	3	0	0	1	377	0	7	0	3	399
9	4	0	0	0	3	252	0	2	0	2	263
10	7	0	0	0	2	227	0	1	0	3	240
11	4	0	0	0	5	146	0	2	0	2	159
12	3	0	0	0	7	125	0	3	0	1	139
13	2	0	0	0	3	93	0	1	0	0	99
14	0	0	0	0	2	64	0	0	0	1	67
15	1	2	0	0	0	33	0	0	0	0	36
16	2	0	0	0	3	33	0	0	0	0	38
17	0	0	0	0	1	26	0	0	0	1	28
18	0	0	0	0	0	26	0	0	0	0	26
19	1	0	0	0	0	25	0	0	0	1	27
20	0	0	0	0	0	18	0	0	0	0	18
21	0	0	0	0	1	24	0	0	0	0	25
22	1	0	0	0	0	21	0	1	0	0	23
23	0	0	0	0	0	16	0	0	0	1	17
24	0	0	0	0	1	11	0	0	0	0	12
25	0	0	0	0	0	10	0	0	0	1	11
26	1	0	0	0	0	15	0	0	0	0	16
27	1	0	0	0	0	15	0	0	0	0	16
28	1	0	0	0	0	4	0	0	0	1	6
29	0	0	0	0	0	7	0	0	0	0	7
30	0	0	0	0	0	5	0	0	0	0	5
31	0	0	0	0	0	4	0	0	0	0	4
32	0	0	0	0	0	3	0	0	0	0	3
33	0	0	0	0	0	4	0	0	0	1	5
Total	275	94	15	5	46	3087	39	620	1	24	4206

[1] Rec=Recreational, HB=Head Boat, CH=Charter Boat, PR=Private/Rental Boat, TR=Tournament, CM=Commercial, FI=Fishery Independent Survey, SC=Special Collection, Unspec= Unspecified

Table 2.8. Number of aged specimens of *M. bonaci* by fishing mode or collection type.

Year	Rec-HB	Rec-CH	Rec-PR	Rec-other	TR	CM	FI	SC	Cold Kill	Unspec.	Total
1979	1	0	0	0	0	0	0	0	0	0	1
1980	17	0	0	0	0	0	0	0	0	0	17
1982	1	0	0	0	0	0	0	0	0	0	1
1984	2	0	0	0	0	1	0	0	0	1	4
1985	1	0	0	0	0	1	0	0	0	0	2
1986	3	1	0	0	0	0	0	0	0	0	4
1990	5	0	0	0	0	0	0	0	0	0	5
1991	5	0	0	0	1	1	0	0	0	0	7
1992	2	0	0	0	0	2	0	0	0	1	5
1993	5	0	0	0	0	7	1	0	0	1	14
1994	6	1	1	1	0	75	0	32	0	13	129
1995	5	0	1	0	0	145	0	350	0	3	504
1996	2	0	0	0	1	149	0	238	1	4	395
1997	1	0	0	0	0	2	2	0	0	0	5
1998	0	0	0	0	0	5	0	0	0	0	5
1999	0	5	0	0	0	15	2	0	0	0	22
2000	0	0	0	0	0	16	1	0	0	0	17
2001	2	3	1	4	2	51	0	0	0	1	64
2002	0	16	1	0	2	51	1	0	0	0	71
2003	1	11	6	0	0	100	0	0	0	0	118
2004	4	14	0	0	2	266	6	0	0	0	292
2005	3	0	0	0	0	350	0	0	0	0	353
2006	2	7	2	0	10	528	0	0	0	0	549
2007	8	8	0	0	2	351	6	0	0	0	375
2008	1	4	1	0	0	120	4	0	0	0	130
2009	3	9	1	0	0	108	3	0	0	0	124
2010	2	4	1	0	12	140	12	0	0	0	171
2011	8	0	0	0	8	105	1	0	0	0	122
2012	38	0	0	0	3	141	0	0	0	0	182
2013	36	4	0	0	2	93	0	0	0	0	135
2014	40	5	0	0	1	173	0	0	0	0	219
2015	71	2	0	0	0	91	0	0	0	0	164
Total	275	94	15	5	46	3087	39	620	1	24	4206

[1] Rec=Recreational, HB=Head Boat, CH=Charter Boat, PR=Private/Rental Boat, TR=Tournament, CM=Commercial, FI=Fishery Independent Survey, SC=Special Collection, Unspec= Unspecified

Table 2.9. Von Bertalanffy growth curve parameters and estimates (with standard errors) for *M. bonaci* in southeastern US waters.

Data Source	L∞ (mm)	k (y^{-1})	t_0 (y)	MSE	n	Number of model parameters	a (cv intercept)	b (cv slope)
Manooch and Mason (1987)	1352	0.116	-0.927			3		
Crabtree and Bullock (1998)[1]	1306.2 (8.05)	0.169 (0.0037)	-0.768 (0.0640)	4211	927	3		
SEDAR 19 LHW[2,3,4], constant TL CV at age	1334.2 (9.56)	0.1412 (0.0023)	-0.9028 (0.0272)	6003	2271	4[1]	0.0989	
SEDAR 19 DW-09 and LHW[3,4]	1364.7 (7.94)	0.1348 (0.0025)	-1.0125 (0.0648)	5958.6	2271	3		
SEDAR 48 LHW[2,3,4,5], decreasing TL CV at age	1362.5 (5.41)	0.1346 (0.0014)	-0.4466 (0.0282)	6059.9	3518	5[1]	0.113 (0.0018)	-0.0025 (0.0001)
SEDAR 48 LHW[2,3,5], decreasing TL CV at age	1362.7 (5.42)	0.1345 (0.0014)	-0.4454 (0.0283)	6156.5	3524	5[1]	0.114 (0.0018)	-0.0026 (0.0001)
SEDAR 48 LHW[3,4,5,6]	1366.6 (6.87)	0.1338 (0.0022)	-0.4568 (0.0603)	5688.8	3518	3		

[1] Ages were average annuli counts for six reads

[2] Parameters added to include the CV of length-at-age in the model.

[3] Ages were annuli counts adjusted for margin code and date collected.

[4] Specimens from fisheries dependent modes of fishing with total lengths below prevailing size limits were excluded.

[5] Growth curves used ages for specimens collected during 1986-2015, and excluded specimens less than 5 years old from fishery dependent modes of fishing.

[6] ***Recommended for SEDAR 48.***

Table 2.10. Female maturity in *M. bonaci* in southeastern US waters. a) Length at maturity b) Age at maturity.

a. Female length at 50% maturity

Source	months	$TL_{50\%}$ (mm) (se)	slope (se)	MSE	n
Crabtree and Bullock (1998)	all months	825.3 (4.654)	0.0198 (0.00174)	0.0783	782
Brulé et al (2003)	all months	721			895
SEDAR 19 and 48 LHW[1]	January-March	855.6 (7.754)	0.0258 (0.0040)	0.0698	236

[1] ***recommended for SEDAR 19 and 48***

b. Female age at 50% maturity

Source	months	$Age_{50\%}$ (yr) (se)	Slope (se)	MSE	n
Crabtree and Bullock (1998)[2]	all months	5.202 (0.0779)	1.3724 (0.1340)	0.0876	617
SEDAR 19 LHW[3]	all months	5.741 (0.0938)	1.1754 (0.1144)	0.0922	617
SEDAR 19 LHW[3,4]	January-March	6.483 (0.1465)	1.6809 (0.3262)	0.077	190
SEDAR 48 LHW[3,5]	January-March	6.514 (0.1433)	1.8107 (0.3698)	0.078	193

[2] ages are average of annuli counts

[3] ages adjusted for margin code and specimen collection date

[4] ***recommended for SEDAR 19***

[5] ***recommended for SEDAR 48***

Table 2.11. Male maturity in *M. bonaci* in southeastern US waters. a) Length at maturity b) Age at maturity.

a. Length where 50% of specimens are male

Source	months	$TL_{50\%}$ (mm) (se)	Slope (se)	MSE	n
Crabtree and Bullock (1998)	all months	1214.4 (5.05)	0.016 (0.0013)		888
Brulé et al (2003)	all months	1114			1120
SEDAR 19 LHW[1]	all months	1213.7 (5.46)	0.0158 (0.0012)	0.0228	890
SEDAR 48 LHW[2]	all months	1208 (5.38)	0.0160 (0.0013)	0.0244	901

[1] ***recommended for SEDAR 19***

[2] ***recommended for SEDAR 48***

b. Age when 50% of specimens are male

Source	months	$Age_{50\%}$ (yr) (se)	Slope (se)	MSE	n
Crabtree and Bullock (1998)[3]	all months	15.55 (0.382)	0.355 (0.0287)		694
SEDAR 19 LHW[3]	all months	15.469 (0.3898)	0.3518 (0.0279)	0.0245	696
SEDAR 19 LHW[4,5]	all months	16.030 (0.3885)	0.3498 (0.0278)	0.0244	696
SEDAR 48 LHW[4,6]	all months	16.013 (0.3269)	0.3785 (0.0286)	0.0209	751

[3] ages are average of annuli counts

[4] ages adjusted for margin code and specimen collection date

[5] ***recommended for SEDAR 19***

[6] ***recommended for SEDAR 48***

Table 2.12. Length-length and length-weight relationships developed for Black Grouper (*Mycteroperca bonaci)*. Linear regressions are in the form Y = *a* + *b*X. SL: standard length (mm); FL: fork length (mm); TL: total length (mm); TW: total weight (kg), GW: gutted weight (kg).

a. LENGTH-LENGTH

Source	Y (mm)	*a*	*b*	X (mm)	*n*	Min X (mm)	Max X (mm)	Avg. X* (mm)	MSE*	r^2	Σx^2*	Σxy*	Σy^2*
SEDAR 48	SL	-24.681	0.883	FL[1]	1556	238	1495	776.44	46.880	0.99	88234626.27	77920795.14	68885409.52
	$TL_{natural}$[2]	8.429	1.011	FL	513	387	1347	725.86	81.574	0.99	7329205.89	7409609.11	7532578.56
	$TL_{natural}$	-2.886	0.993	TL_{max}	167	534	1270	725.11	37.916	0.99	1946234.06	1931882.26	1923892.36
	TL_{max}[3]	26.860	1.164	SL	1532	51.2	1260	663.74	81.923	0.99	71735840.75	83503806.48	97327599.60
	TL_{max}	-2.080	1.029	FL	1671	238	1495	777.00	22.834	0.99	91866919.09	94487308.81	97220551.61
Crabtree and Bullock 1998	SL	-23.712	0.883	FL	1134					0.99			
	TL_{max}	26.186	1.164	SL	1141					0.99			
	TL_{max}	-1.317	1.028	FL	1150					0.99			
Garciá-Cagide and Garciá 1996	TL	17.8	1.10	SL	209								

b. LENGTH-WEIGHT

Source	Ln (Y [kg])	Ln(a)	b	Ln (X[mm])	*n*	Min [mm]	Max [mm]	Avg. Ln (X[mm])	MSE	r^2	Σx^2	Σxy	Σy^2
SEDAR 48	TW[4]	-19.2391	3.1896	FL	2978	238	1495	6.493	0.01925	0.97	171.0718	545.6546	1797.7224
	TW	-18.5636	3.0722	$TL_{natural}$	1040	260	1600	6.536	0.01566	0.97	66.8133	205.2621	646.85420
	TW	-19.1945	3.1742	TL_{max}	976	63	1518	6.521	0.01023	0.99	114.1667	362.3831	1160.2217
	GW[4]	-18.8323	3.1217	FL	3375	327	1495	6.755	0.00782	0.99	240.0079	749.2236	2365.2037
	GW	-19.0112	3.1528	$TL_{natural}$	128	602	1184	6.575	0.00697	0.96	1.96605	6.198593	20.421136
	GW	-18.8867	3.1195	TL_{max}	1581	332	1518	6.707	0.00864	0.99	136.4381	425.6203	1341.3646
Crabtree and Bullock 1998	TW	-19.473[5]	3.218	TL_{max}	772	177	1518			0.99			

*Avg. X, MSE, Σx^2, Σxy, Σy^2 - Mean of independent variable (X), mean square error and corrected sums of squares (CSS) for the independent variable (X), corrected sum of cross-products for XY, and CSS for the dependent variable (Y); used for generating prediction intervals and for analysis of covariance (Zar 1996), and MSE also used for bias corrections for the means of log-transformed data [e.g., Haddon (2011)]. Usually, lengths were measured to the nearest millimeter, and weight to the nearest 0.02 kg. However, some data may have been taken using length measurements to the nearest 0.5 cm or in fractions of inches and weight measurements to the nearest 0.1 or 0.01 pound. Estimates derived from the above equations should be rounded to the nearest 0.5 centimeter and nearest 0.02 kg. The number of decimals shown in the table were meant solely to reduce rounding errors for calculation of prediction intervals and for generating sums of squares and cross-products needed for analysis of covariance.

[1] FL – Fork length (mm; in this species, the straight-line distance from the tip of the snout to the rear-center edge of the tail, also called a “mid-line” length).

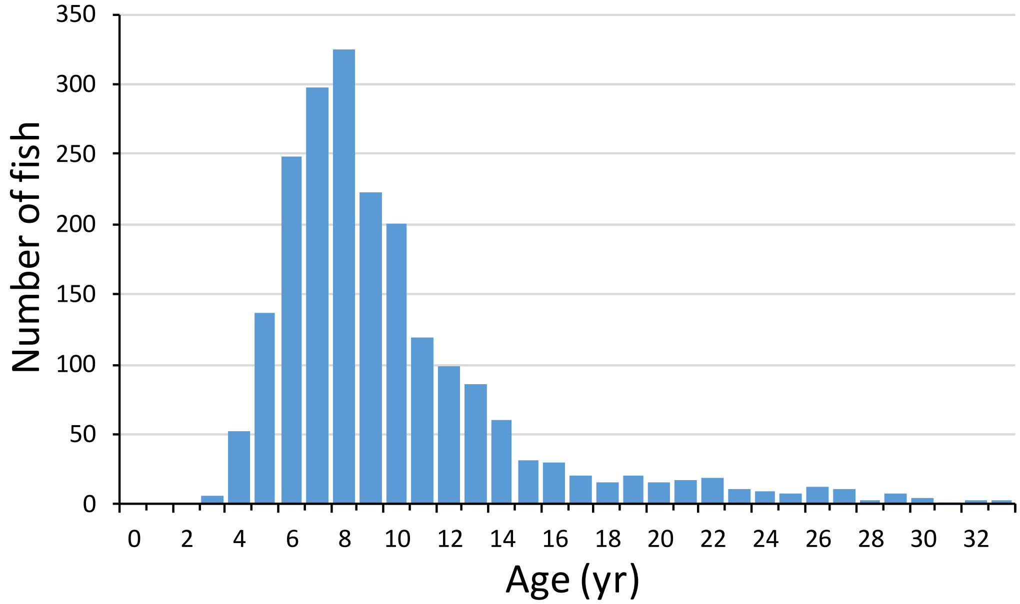
[2] $TL_{natural}$ - Tail flat (mm), in its natural state

[3] TL_{max} - Tail compressed to its maximum length (mm)

[4] TW=whole weight (kg), GW=gutted weight (kg)

[5] converted from common logarithms and weight in grams to natural logarithms and weight in kg

2.15 FIGURES



Catch curve estimates of annual survival rate

	ages 9-33	ages 11-33	ages 15-33
∑N	1027	605	242
T	4181	2771	1352
S	0.80	0.82	0.85
Z	0.22	0.20	0.16
Var_S	0.00003	0.00004	0.00008
$Std.Dev_S$	0.00551	0.00660	0.00898
Upper 95%	0.23	0.21	0.18
Lower 95%	0.21	0.18	0.14

Figure 2.1. Catch curve estimates (Robson and Chapman 1961) of total mortality (Z) for Black Grouper based upon long line specimens primarily from the Florida Keys from 2000-2015. The number of specimens (∑N) is for the age range considered, T is the product of sample size at age and zero-based count of ages starting with the first age considered. S is the annual survival rate, Z is annual total mortality rate, Var_S, $Std.Dev_S$, Upper and Lower 95% are the variance, standard deviation, and 95% confidence limits for S.

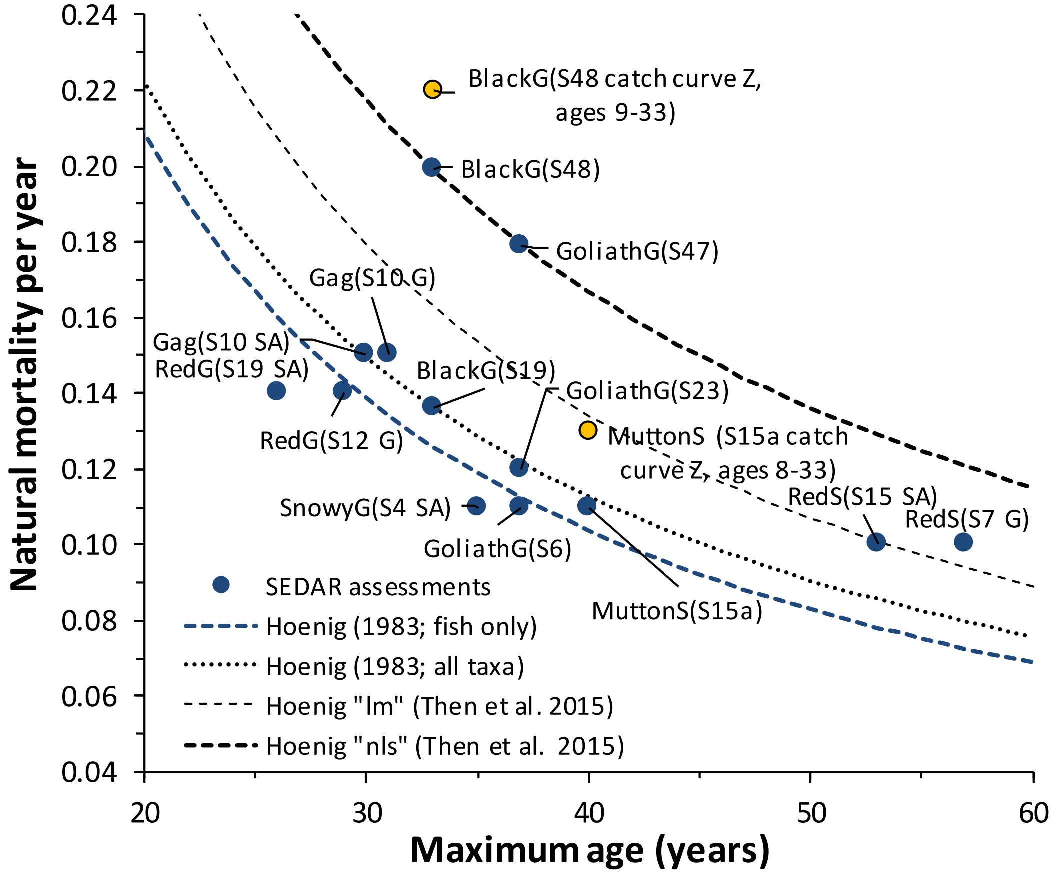


Figure 2.2. Estimates for natural mortality rates (M) used in various SEDAR assessments in relation to regression estimators based on maximum observed age (t_{max}). Two catch curve estimates (total mortality, Z; yellow dots) are shown for comparison to M estimates (blue dots). Species are Black, Gag, Goliath, Red, and Snowy Grouper, and Mutton and Red Snapper. In parentheses are the SEDAR assessment number and region (SA=South Atlantic assessment, G=Gulf of Mexico assessment). Combined South Atlantic and Gulf of Mexico assessment have no letters following the SEDAR number.

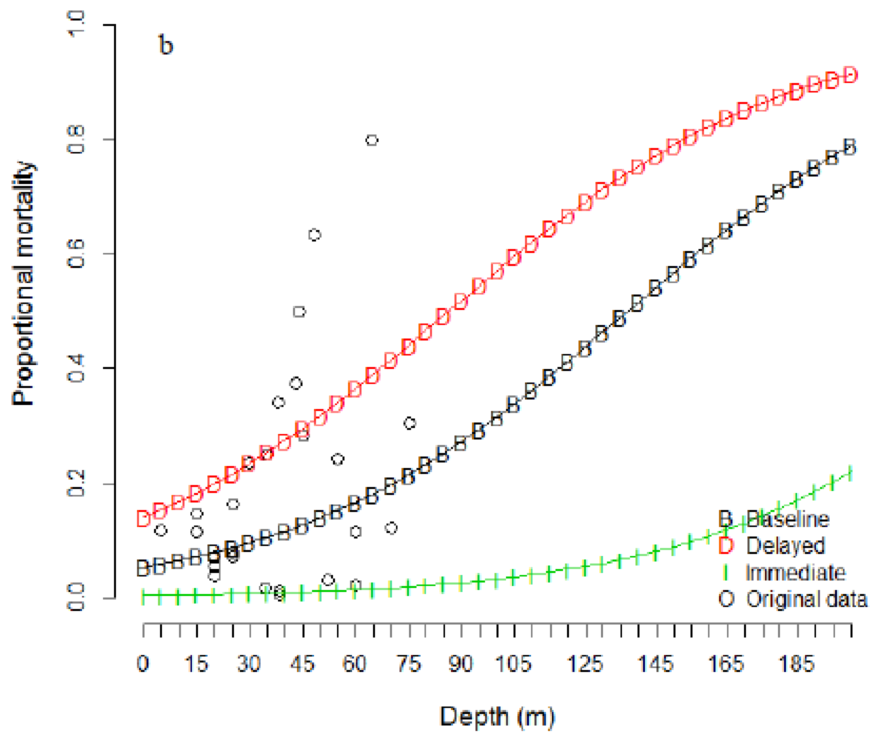


Figure 2.3. The depth-dependent discard mortality function derived from a meta-analysis for gag during SEDAR 33.

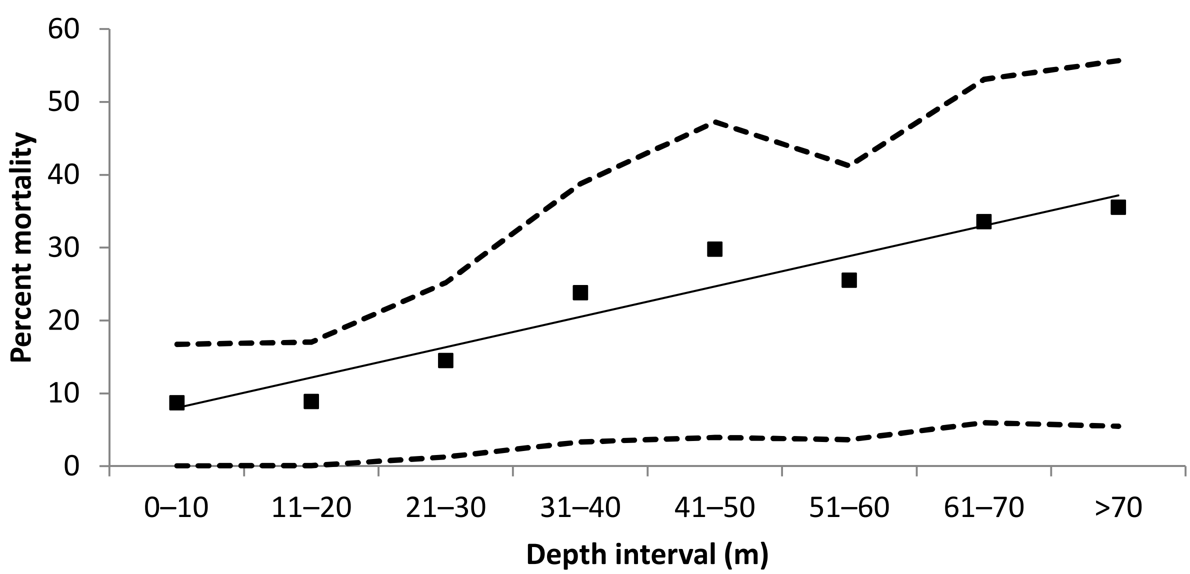
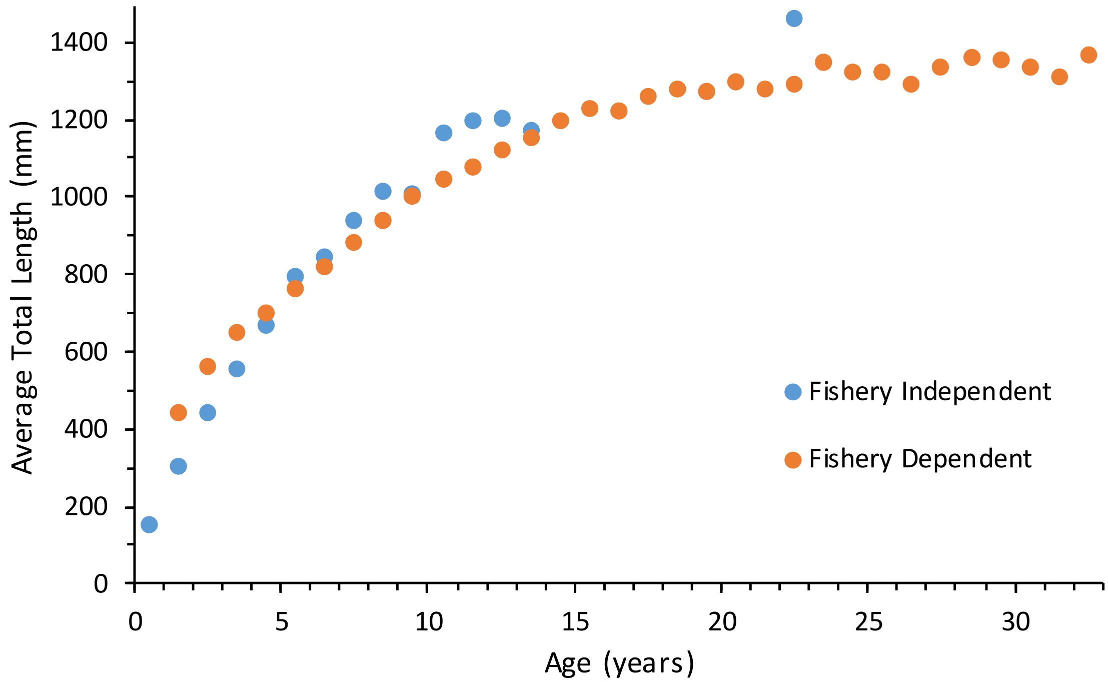


Figure 2.4. The depth-dependent discard mortality function derived from tag-recapture data for gag discards observed in the recreational for-hire fishery for SEDAR 33.

a. Average total length at age by specimen sources



b. Coefficient of variation of total length at age by specimen sources

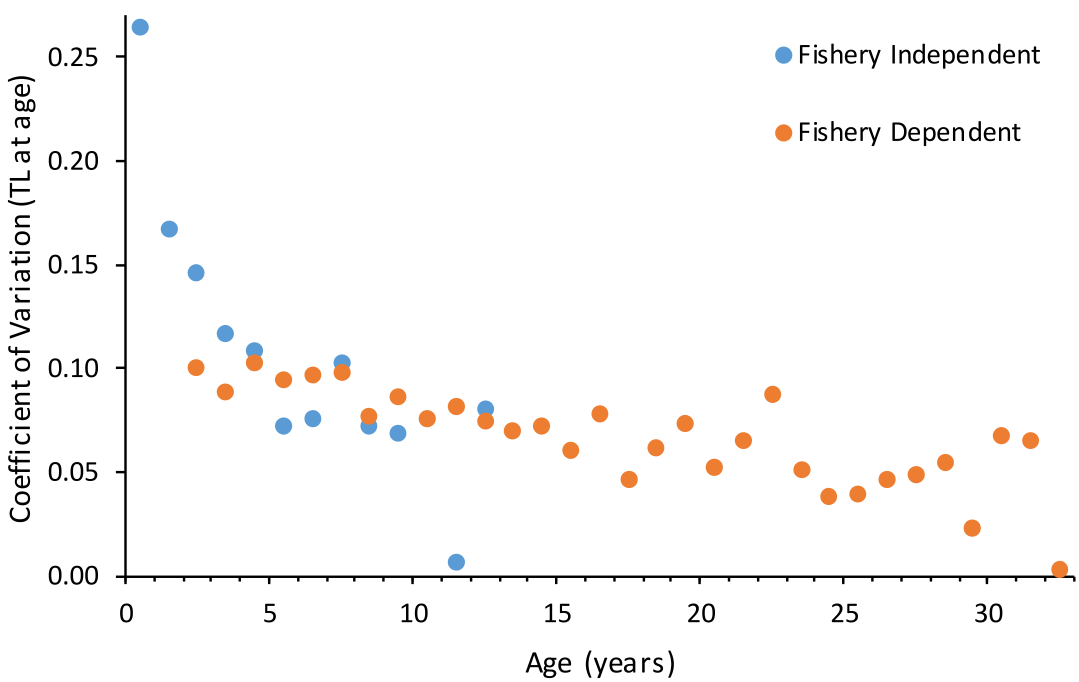
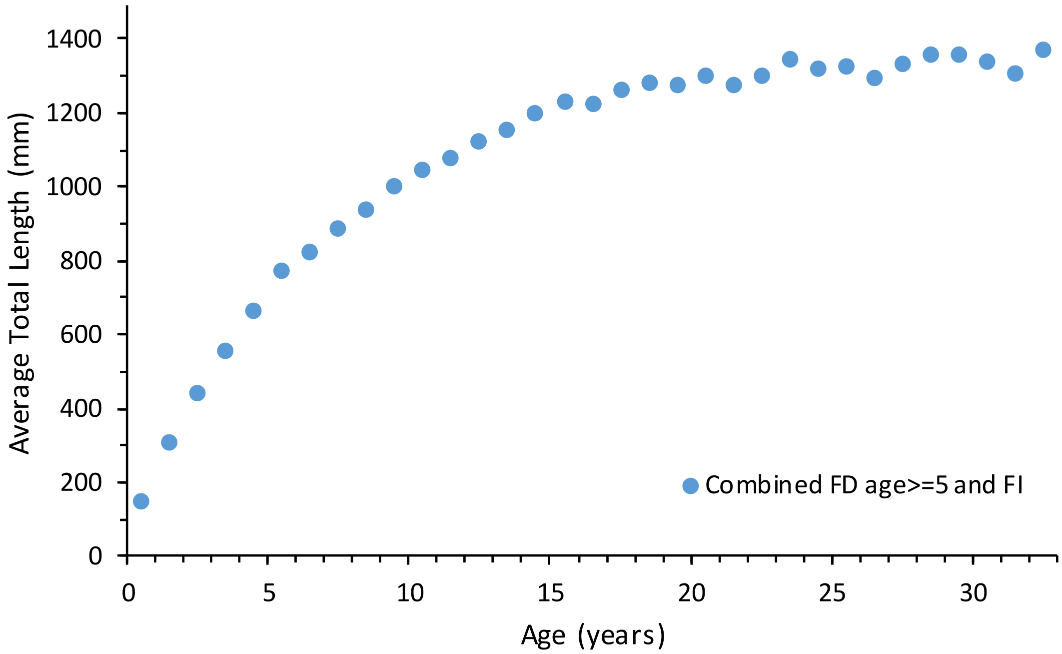


Figure 2.5. Comparison of total lengths at age for *M. bonaci* by general specimen sources. a.) average total lengths at age; b.) CV of total length at age.

a. Average total length at age for combined specimens



b. Coefficient of variation of total length at age for combined specimens

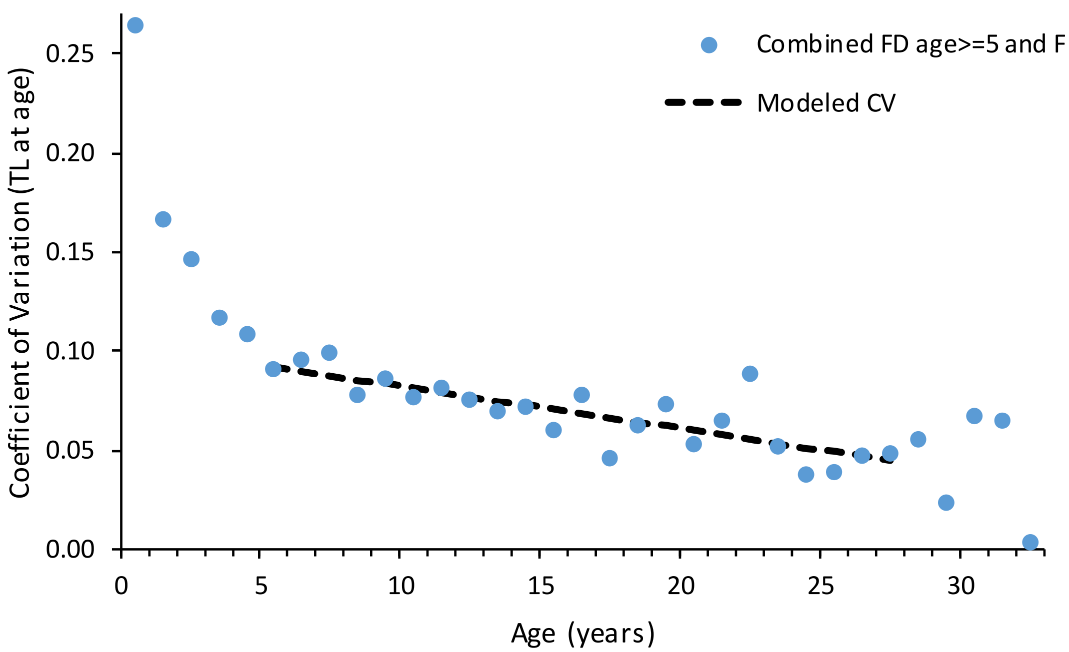


Figure 2.6. Total lengths at age for *M. bonaci* for combined fishery dependent specimens of age 5 or older and fishery independent specimens. a.) average total lengths at age; b.) CV of total length at age for the relatively linear portion of CV versus age for ages 5 to 27. Sample sizes for ages 28 to 33 were less than 10 for these ages and were not included in the regression.

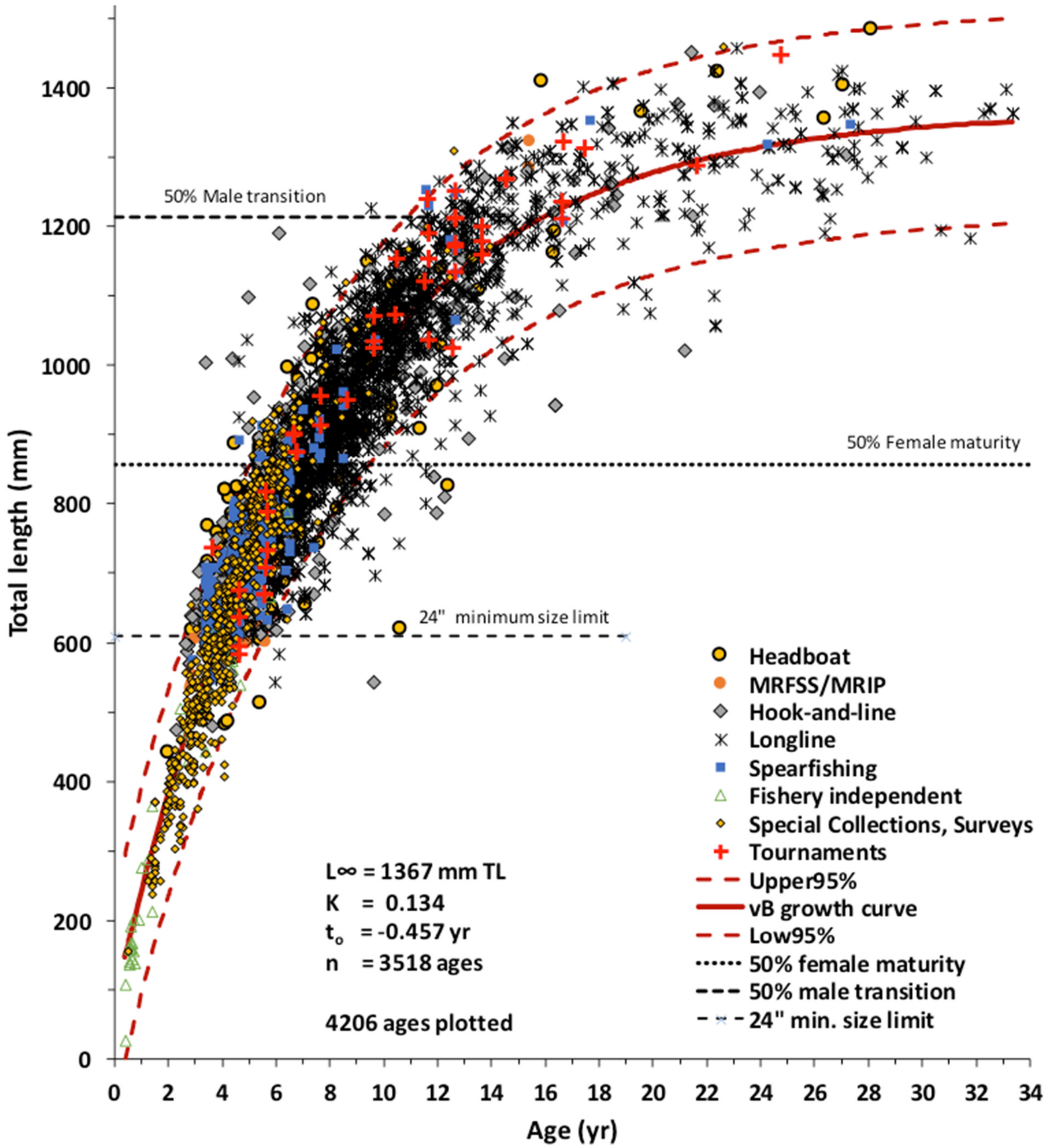


Figure 2.7. Growth curve for Black Grouper (*Mycteroperca bonaci*) in waters of the southeastern U.S. Fit excluded fishery dependent (commercial and recreational) specimens less than five years old and included all specimens collected by fishery independent surveys and special collection programs from 1986 to 2015. All specimens regardless of source and size/age were plotted in relation to the fitted curve.

a.) Specimens by total length (mm) and depth (m)

b.) Specimens by age (years) and depth (m)

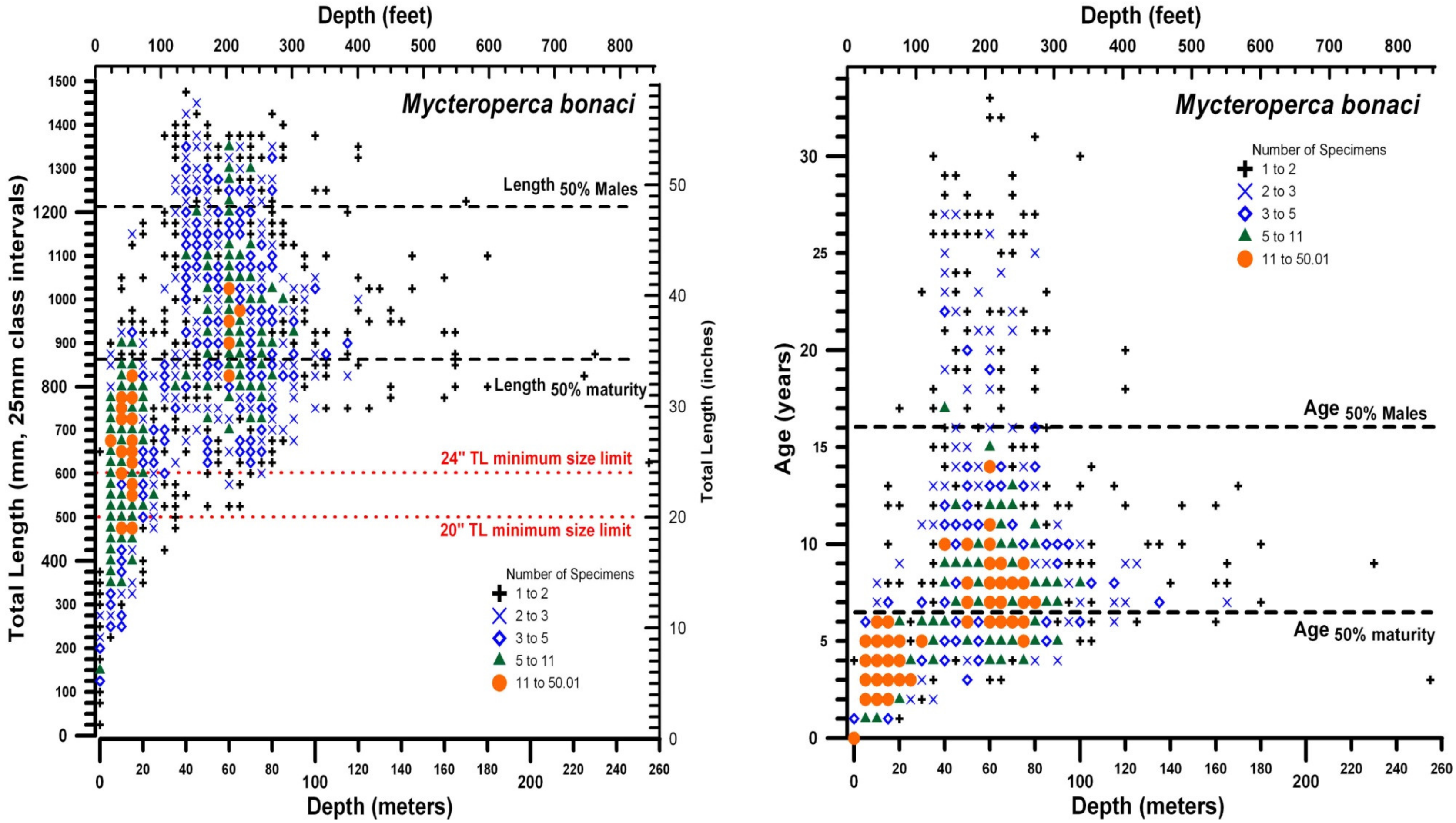
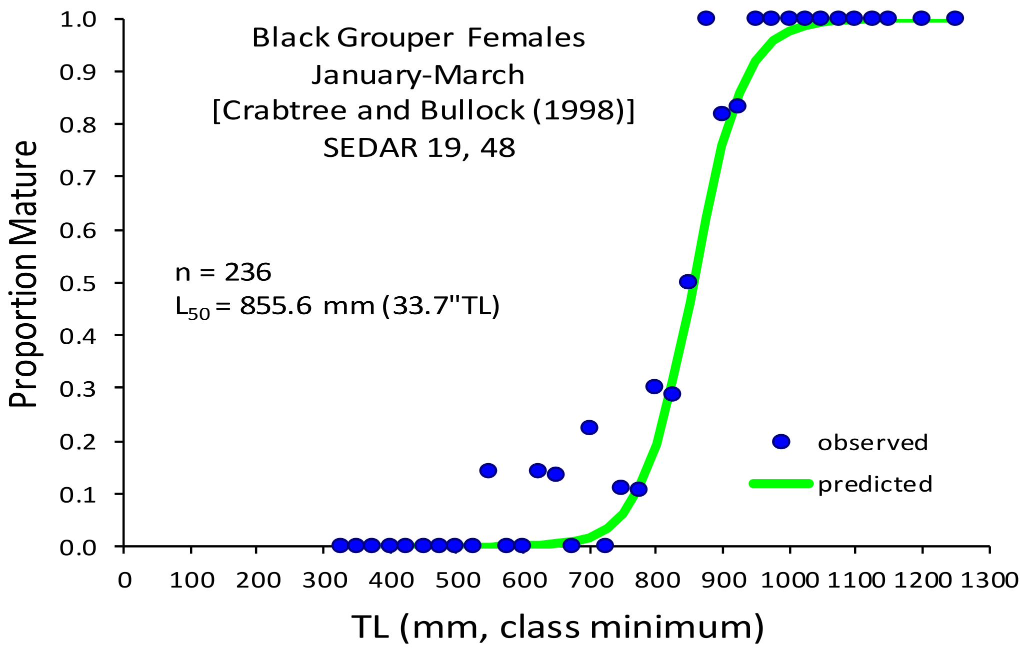


Figure 2.8. Black Grouper (*M. bonaci*) specimens by total length, age, and depth (meters) of catch, 1978-2008 (from SEDAR 19). a) total length and depth (meters); b) age and depth.

a. TL(mm) at 50% Female Maturity



b. Age at 50% Female Maturity

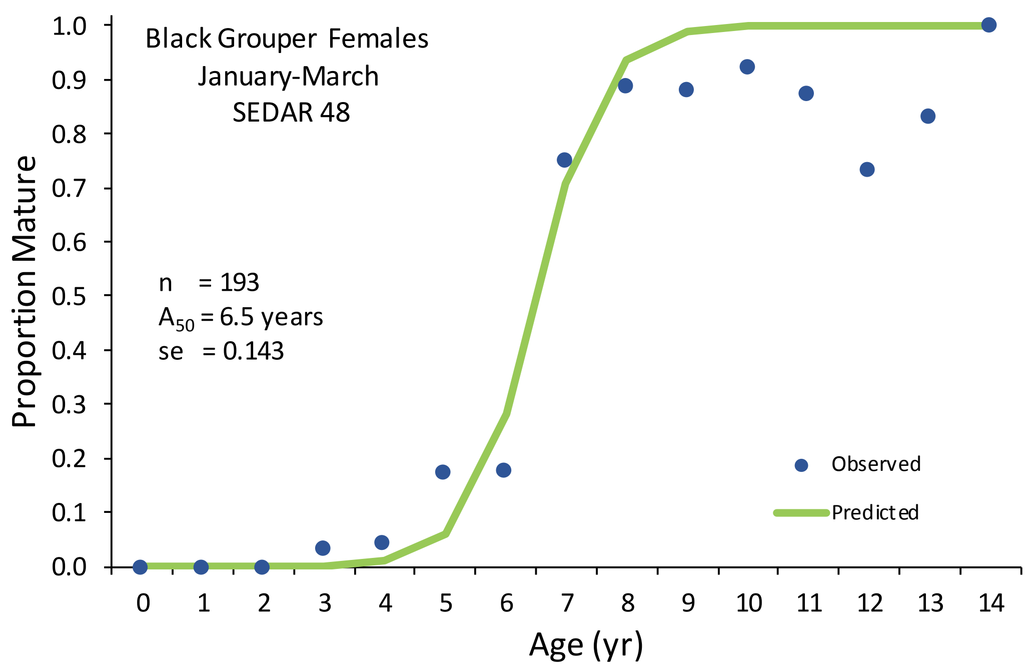
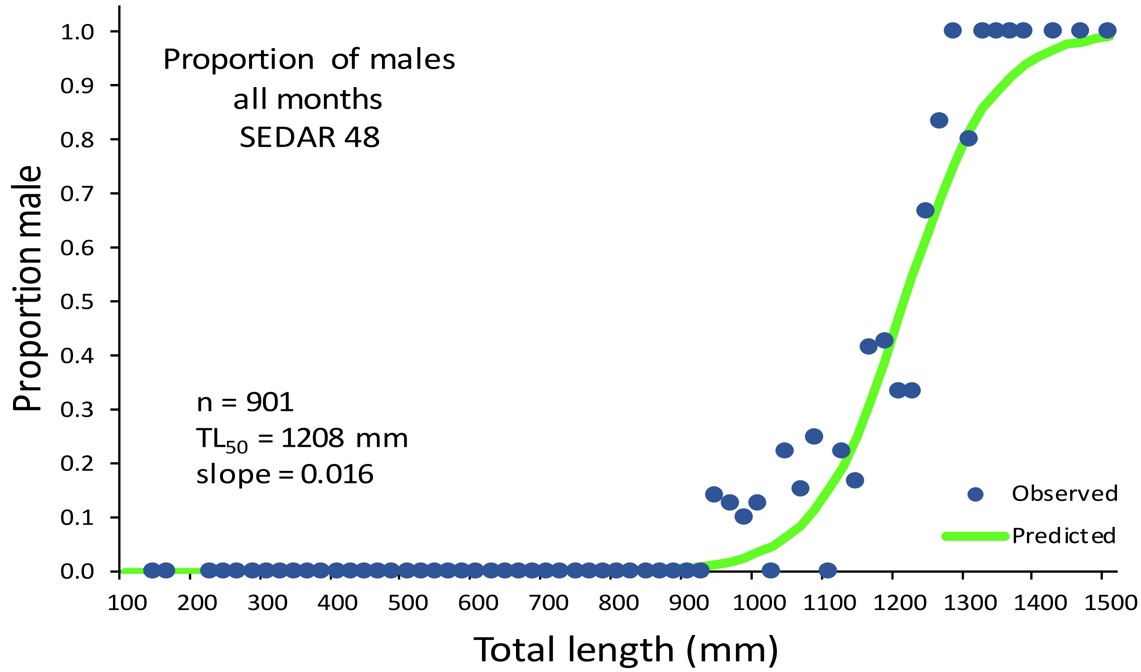


Figure 2.9. January to March female maturity (logistic model) in *M. bonaci*; a.) maturity versus total length; b.) maturity versus age in years.

a. TL(mm) at 50% male Maturity



b. Age at 50% male Maturity

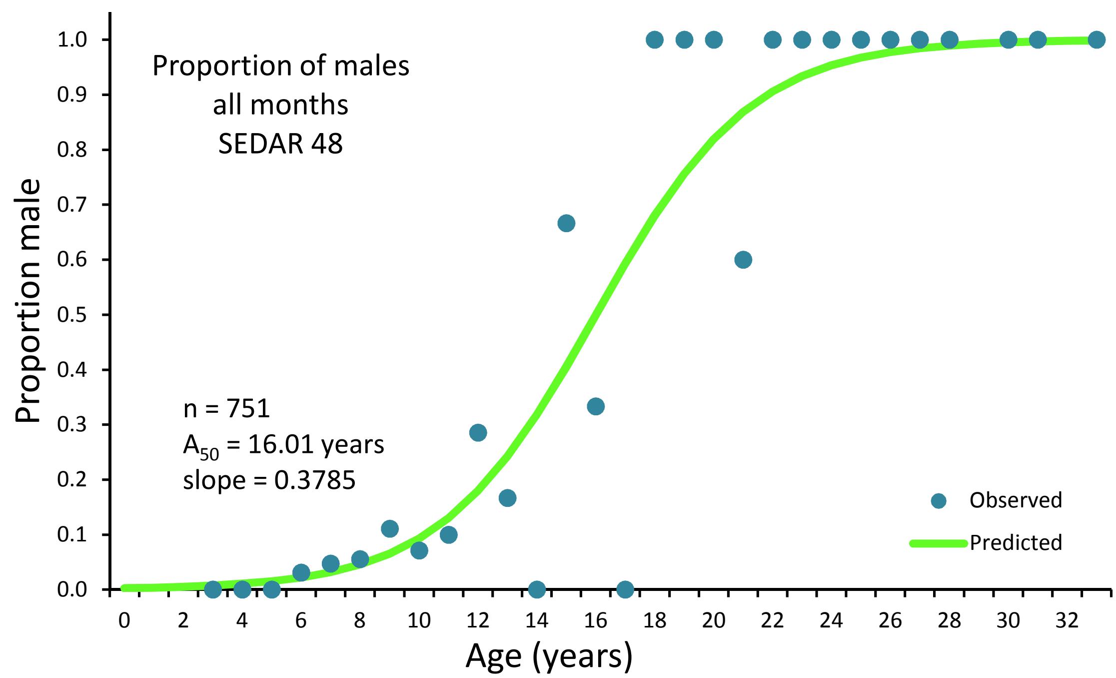


Figure 2.10. January to December proportion of male *M. bonaci*; a.) male maturity versus total length; b.) male maturity versus age in years.

3 COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

3.1.1. Commercial Workgroup Participants

Chair: Steve Brown (FWC), Bob Muller (FWC), Chris Bradshaw (FWC), Martin Fischer (Fisherman – St. Petersburg), Jessica Stephen (NOAA Fisheries), Jim Tolan (TPWD) Robert Ahrens (UF), Mike Errigo (SAFMC), and Kevin McCarthy (NOAA Fisheries).

3.1.2 Issues Discussed at the Data Workshop

Historical commercial landings data for black grouper were explored to address several issues. These issues included: (1) duration of data for the stock assessment, (2) northern boundary in the South Atlantic and western boundary in the Gulf of Mexico for the stock assessment, (3) methodology for proportioning Florida landings into regions of the South Atlantic and Gulf, (4) methodology for proportioning landings by gear, (5) methodology for proportioning unclassified' landings, (6) correction for misidentified black grouper, (7) commercial discards, (8) discard mortality, and (9) research needs.

3.2 REVIEW OF WORKING PAPERS

The workgroup reviewed two previous working papers (SEDAR10-DW24 and SEDAR33-DW17) by Ching-Ping Chi and Steve Turner that looked at estimation of misidentification of commercial black and gag groupers in the Gulf of Mexico. The methods described using commercial Trip Interview Program (TIP) sample data to calculate annual ratios of black and gag groupers from TIP sample data. The results showed large discrepancies in ratios of black and gag grouper between TIP and the Accumulate Landings System (ALS), indicating a likelihood of more accurate species identifications in the TIP data.

3.3 COMMERCIAL LANDINGS

3.3.1 Preliminary landings and discussion on methods

The Accumulated Landings System (ALS, 1962-2015), general canvass (1976-1996), and coastal logbook (1990-2015) data were provided by NOAA Fisheries SEFSC for all groupers. Additionally, trip ticket data were provided by the Florida Fish and Wildlife Conservation Commission (FWC) for all groupers from 1986-2015. Both ALS and logbook data included grouper landings from Florida, Georgia, South Carolina, North Carolina, Mississippi, Alabama, Louisiana, and Texas. The general canvass and Florida trip ticket data were for Florida grouper only. All data prior to 1986, other than Warsaw or Goliath, were unclassified groupers. This meant that proportioning of black from historical unclassified landings would be necessary, and since black and gag were often misidentified, those estimates may be suspect. Also, because black grouper landings are generally low as compared to other species like gag and red grouper, any error could dramatically affect the landings estimates.

Decision 1. Per SEDAR 19, because proportioning of historical unclassified grouper landings would be required, the group recommended that data prior to 1986 would not be included in the landings.

In SEDAR 19, no black grouper were reported north of North Carolina per NOAA Fisheries NEFSC commercial database. Additionally, North Carolina has indicated that only gag grouper, and not black, occur in their landings. And more recent analyses of landings data from Georgia to North Carolina show the proportion of gag to black is 98% and 2%, respectively, suggesting that any black grouper reported from this region are actually gag (Figure 3.1).

Decision 2. The commercial work group recommended using the Florida/Georgia line as the Northern boundary for the South Atlantic portion of the black grouper stock.

The Commercial Work Group also discussed the assignment of landings by MRIP region rather than by South Atlantic and Gulf of Mexico waters, and how to establish the regions. The main rationale is that black grouper in the U.S. are all from a single stock and a primary nursery area exists in Florida Bay which is partly state territorial waters and partly Gulf of Mexico federal waters. But as black groupers age, some of them move to the reef environment which is under South Atlantic federal waters jurisdiction. Black grouper movements become even more complex in the Dry Tortugas. From a stock viewpoint, the council boundaries are irrelevant to black groupers. As a result, area or water body data as reported in the landings could be used to establish the regions. Figure 3.2 shows the area maps and coding that would be used to establish the regions.

Also, occurrence of black grouper and fishing behavior seem to differ by region. Black grouper are most abundant in South Florida, and different gears are used in South Florida than in the other regions as you move north along both coasts. Dividing the landings into regions should more accurately represent the proportion of total black grouper landings in those regions.

Decision 3. The commercial work group recommended separating the landings into regions roughly based on MRIP regions by using water body, then county, then state, as applicable from the ALS landings, by the following definitions: 1=Texas through Levy county, Florida (TX-FL Panhandle); 2=Citrus through Sarasota counties (NW FL); 3=Charlotte through Collier counties (SW FL); 4=Monroe county (FL Keys); 5=Miami-Dade through Indian River counties (SE FL); 6=Brevard through Nassau counties (NE FL); 7=Georgia through North Carolina (GA-NC).

The workgroup also discussed the assignment of gear. Due to the uncertainty in dealer reported gear data, it was decided that such data should be allocated to gear based on NMFS Florida general canvass or coastal logbook data. The data source for the gear allocations comes from the general canvass for the years 1986-1992. In the northern Gulf of Mexico west through Texas, the Florida panhandle accounts for over 95% of black and gag landings from 1986-1992 (Figure 3.3). Because there were relatively few observations from other Gulf States during this time period, the gear proportions from the Florida general canvass could be applied to all ALS black and gag landings from the Florida panhandle to Texas. For the years 1993-2015, gear allocations are based on ratios as reported in the coastal logbook data and applied to the total landings reported in the ALS data set from Florida to Texas. The group consensus was data reported directly by fishermen in the logbook program versus data reported third person by dealers and associated staff submitted to the ALS would be more precise in assigning gear to the landings.

Decision 4. The work group decided to use NMFS Florida general canvass data to assign gear to the landings data from 1986- 1992, and to use NMFS logbook data from 1993-2015, by year and region.

The workgroup discussed presenting all landings in either whole or gutted weight. Although the same conversion of gutted to whole (1.18) is used from Florida to Texas, the standard condition of landing for groupers is in gutted weight.

Decision 5. The work group decided the data will be presented in gutted weight and any biological conversion can be applied in the model.

Probably the most significant commercial issue for this workshop was the problem of historical misidentification of black grouper and gag. In much of the Southeastern United States, the term 'black grouper' was used for gag, primarily for marketing reasons. This in turn resulted in inflated landings of black grouper as reported by both dealers and fishers going back to 1986 when both species began to be identified in the landings. As stated previously, all groupers accept for Warsaw and goliath were reported as unclassified prior to 1986.

To establish a method of proportioning black grouper from the misidentified landings, the workgroup discussed a few different data sources, but focused primarily on the Trip Interview Program (TIP) data that was used previously for proportioning Gag in SEDAR 10 (Chih and Turner, 2006), and in SEDAR 33 (Chih, 2013). But unlike the previous methods for gag, the group decided there was a need to break out these data by gear and time period as well as region. As a result, the group thought it would be necessary to reexamine the TIP data for that purpose.

Initial analyses revealed that the TIP data were too sparse to calculate annual ratios, so it was proposed to divide the data into 5-year time periods. Also, because of low sample sizes for some gears (traps, other), it was proposed to include data from traps and other into hand lines, and develop final ratios for hand lines, long lines, and diving.

Decision 6. The work group decided to calculate the ratio of black grouper to black grouper+gag from the TIP data by 5-year period, region, and gear.

After the discussions and preliminary analyses of the TIP data, it was decided to use hand lines, long lines, and diving as the gear groupings for the final landings.

Decision 7. The group decided to use hand lines, long lines, and diving as the gear groupings.

The group also discussed proportioning unclassified groupers into combined black and gag grouper. A proportion of the unclassified grouper landings were converted to black and gag grouper. When black and gag grouper are classified in the same year as unclassified grouper, we used that year's ratio of black and gag to total classified grouper landings to separate out the proportion of unclassified which may have been black and gag. Annual proportions or ratios were developed for each region. Warsaw and goliath groupers were not included among classified groupers because they were identified historically back to 1962, while other groupers were classified beginning in 1986.

Decision 8. The group decided to proportion unclassified grouper landings into black+gag grouper landings for 1986-2015 from Florida to Texas.

3.3.2 Final methods used to develop annual commercial landings by year, region, and gear

ALS data from FL-TX were used as the base landings from 1986-2015. The assignment of landings to previously defined regions was based on water body as reported in the ALS landings data. If water body was missing, then county landed or state landed were used to assign data to a region. Table 3.1 shows commercial black grouper landing as originally reported by year, region, and gear.

Unclassified groupers were proportioned into black+gag grouper. A proportion was calculated by dividing the total amount of black+gag into total identified groupers. That proportion was then applied to the unclassified groupers with the resulting landings added to the original black+gag landings by year and region.

Gear was assigned to the adjusted black+gag landings based on logbook data (1993-2015) or General Canvass data (1986-1992). A proportion of each gear type was calculated for each year and region. Those proportions were then applied to the total landings for each year and region to get landings by gear.

Additionally, a correction for misidentification was developed and applied to the adjusted black+gag landings based on TIP ratios of black to black+gag by 5-year period, region, and gear. The adjustments were based on actual species compositions by trained samplers from TIP. Final adjusted black grouper landings are shown in table 3.2. The methods are described in working paper S48-DW-06 by Muller and Brown.

3.4 COMMERCIAL DISCARDS

Due the issues discovered regarding the commercial and recreational landings, the assessment was halted at the data workshop stage, prior to the development of the commercial discards.

3.5 COMMERCIAL EFFORT

Due the issues discovered regarding the commercial and recreational landings, the assessment was halted at the data workshop stage, prior to the development of the commercial effort series.

3.6 BIOLOGICAL SAMPLING

Biostatistical samples (length, weight, sex, hard parts, etc.) have been collected by the Trip Interview Program (TIP) and several state agencies since 1981. These samples are collected by port agents at docks where commercial catches are landed throughout the southeast US coast. Trips are randomly sampled to obtain trip, effort, catch, length frequency, and age information. Biological sample data were obtained from the TIP sample data (NMFS/SEFSC). A subset of these data were used for analyses, which contained commercial samples that were identified as having no sampling bias. These data were further limited to those that could be assigned to a year, gear, and region. Biological data were joined with landings data by 5-year period, gear, and region.

3.6.1 Length Samples

The number of fish sampled ranged from a high of 477 for long line gear in 1999 to a low of zero for a few early years by diving (Table 3.3). From 1986-2015, the average number of fish sampled per year was 157 for hand line gear, and 176 fish per year for long line. Diving averaged less than 30 fish per year.

3.6.2 Age samples

The number of aging samples (otoliths) collected ranged from zero to 64 for hand line, zero to 480 for long, and zero to 130 for diving (Table 3.4). Hand line samples were consistently less than 60 samples per year. Long line samples had greater than 100 ages collected for 1995-1996 and 2004-2007. Half of the years for diving showed zero and other years with samples were much lower than the max year.

3.6.3 Length distributions

Length data were converted to cm total length and binned into two centimeter increments with a range of 18 cm to 154 cm. If a length measurement had no corresponding sample weight, gutted weight was calculated from the measured lengths in the TIP Observation file. Lengths were standardized to maximum total length in millimeters where necessary using length-length conversion equations and the maximum total length was used to estimate the fish's gutted weight in pounds. The length data were divided into hand line, long line, and diving.

3.6.4 Age Distributions

Ages for black grouper were compiled into annual bins by year and gear. Over all gears, sampled ages ranged from 2 to 33 years. Ages by gear ranged from 2 to 27 years for hand lines, 3 to 33 years for longline, and 2 to 27 years for diving.

3.6.5 Adequacy for characterizing catch

This topic was not discussed.

3.6.6 Alternatives for characterizing discard length/age

This topic was not discussed.

3.7 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

While combined black and gag landings may be reliable since the beginning of the trip ticket programs, the issues of proportioning of unclassified grouper landings to black grouper, proportioning of gear and area, and correcting for misidentification creates errors in these estimates of black grouper landings.

3.8 POST-WORKSHOP TASKS

Any additional work toward an assessment has been canceled due to the high uncertainty in the ability to accurately characterize commercial South Atlantic and Gulf of Mexico black grouper landings.

3.9 RESEARCH RECOMMENDATIONS

- • More observer coverage for the snapper-grouper fishery
- • Expand TIP sampling to better cover all statistical strata
- • Trade off with lengths versus ages, need for more ages (i.e., hard parts)
- • Historical species identification (mis-identification and unclassified)

3.10 LITERATURE CITED

Chih, C. and S.C. Turner. 2006. Estimation of species misidentification in the commercial landing data of gag groupers and black groupers in the Gulf of Mexico. SEDAR10-DW-24.

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3.11 TABLES

Table 3.1 Commercial black grouper landings by year, region, and gear as reported in ALS.

Year	Region	Hand Lines	Longline	Diving
1986	1-TX-FL Panhandle	887,428	1,141,880	356
	2-NW FL	3,047,069	1,865,864	18
	3-SW FL	1,475,031	879,897	20,124
	4-FL Keys	733,794	556,195	31,066
	5-SE FL	271,914	77,303	6,320
	6-NE FL	380,431	88,764	
	7-GA-NC	1,093,896	149,124	4,937
1987	1-TX-FL Panhandle	911,283	1,068,731	2,638
	2-NW FL	2,055,838	2,324,269	
	3-SW FL	1,119,331	1,317,710	20,586
	4-FL Keys	968,580	872,503	43,360
	5-SE FL	260,769	40,628	32,016
	6-NE FL	451,439	69	
	7-GA-NC	1,040,555	267,769	12,748
1988	1-TX-FL Panhandle	1,690,403	1,266,185	3,495
	2-NW FL	1,487,347	1,113,547	
	3-SW FL	937,310	975,358	57,627
	4-FL Keys	568,855	643,032	18,334
	5-SE FL	182,613	16,404	6,948
	6-NE FL	383,465	432	2,353
	7-GA-NC	968,078	213,700	11,015
1989	1-TX-FL Panhandle	2,333,855	966,703	1,012
	2-NW FL	2,574,275	1,535,208	
	3-SW FL	1,174,198	1,083,836	38,796
	4-FL Keys	670,181	827,370	15,255
	5-SE FL	138,517	13,937	20,364
	6-NE FL	453,849		4,028
	7-GA-NC	1,305,799	169,759	7,870
1990	1-TX-FL Panhandle	2,133,569	847,980	1,562
	2-NW FL	1,780,026	1,160,576	2,080
	3-SW FL	621,647	672,405	4,861
	4-FL Keys	443,960	731,898	8,724
	5-SE FL	135,265	16,391	8,841
	6-NE FL	358,512	9,201	16,591
	7-GA-NC	1,293,168	243,164	86
1991	1-TX-FL Panhandle	1,195,452	403,454	1,853
	2-NW FL	2,144,901	1,832,529	33,763
	3-SW FL	740,256	1,400,136	3,766

	4-FL Keys	275,106	271,355	16,591
	5-SE FL	154,203	16,625	49,144
	6-NE FL	237,962	43,525	62,919
	7-GA-NC	1,035,840	150,034	4,329
1992	1-TX-FL Panhandle	1,135,167	391,469	1,444
	2-NW FL	1,877,669	2,349,954	17,521
	3-SW FL	730,075	939,047	6,285
	4-FL Keys	306,317	277,642	24,754
	5-SE FL	120,945	23,194	53,657
	6-NE FL	229,828	53,605	85,944
	7-GA-NC	1,081,722	176,788	13,292
1993	1-TX-FL Panhandle	1,120,224	766,990	
	2-NW FL	2,059,594	3,361,610	24,782
	3-SW FL	656,477	1,154,209	3,811
	4-FL Keys	355,255	250,095	31,223
	5-SE FL	113,946	15,783	52,852
	6-NE FL	241,841	36,719	46,819
	7-GA-NC	1,152,181	113,314	6,750
1994	1-TX-FL Panhandle	1,328,931	822,670	
	2-NW FL	1,772,953	2,077,058	25,053
	3-SW FL	631,089	1,005,202	2,347
	4-FL Keys	331,083	182,679	19,589
	5-SE FL	67,887	5,886	54,914
	6-NE FL	183,529	24,982	73,878
	7-GA-NC	1,180,497	67,244	16,317
1995	1-TX-FL Panhandle	1,674,190	420,982	4,320
	2-NW FL	1,817,470	1,707,170	21,230
	3-SW FL	775,369	997,516	1,209
	4-FL Keys	267,437	74,706	33,317
	5-SE FL	96,653	14,997	26,549
	6-NE FL	288,427	57,280	63,286
	7-GA-NC	1,230,228	39,819	9,714
1996	1-TX-FL Panhandle	1,190,017	366,197	1,326
	2-NW FL	1,364,003	2,446,509	43,843
	3-SW FL	570,045	730,472	243
	4-FL Keys	228,861	100,922	39,969
	5-SE FL	134,100	15,192	50,853
	6-NE FL	229,215	62,247	53,324
	7-GA-NC	1,103,669	28,044	3,386
1997	1-TX-FL Panhandle	1,262,181	452,411	7,514
	2-NW FL	1,509,733	2,562,790	33,065
	3-SW FL	644,300	932,536	604
	4-FL Keys	261,973	155,175	27,192

	5-SE FL	136,581	10,414	40,289
	6-NE FL	221,396	76,675	55,000
	7-GA-NC	1,019,970	90,441	3,993
1998	1-TX-FL Panhandle	1,590,298	394,789	
	2-NW FL	1,475,885	2,242,042	41,172
	3-SW FL	463,526	942,892	321
	4-FL Keys	253,506	278,031	22,599
	5-SE FL	108,332	6,156	51,136
	6-NE FL	199,010	56,406	68,874
	7-GA-NC	1,092,220	42,343	1,236
1999	1-TX-FL Panhandle	1,498,839	533,878	1,948
	2-NW FL	1,840,524	3,367,753	41,095
	3-SW FL	599,085	1,305,900	1,175
	4-FL Keys	220,755	206,143	15,749
	5-SE FL	74,594	9,053	18,579
	6-NE FL	166,560	38,086	105,907
	7-GA-NC	1,239,064	54,649	1,715
2000	1-TX-FL Panhandle	1,675,890	680,142	2,476
	2-NW FL	2,067,651	2,916,912	49,842
	3-SW FL	965,461	1,060,761	679
	4-FL Keys	240,045	111,978	26,111
	5-SE FL	76,822	8,172	9,628
	6-NE FL	168,286	59,090	71,682
	7-GA-NC	958,704	63,618	862
2001	1-TX-FL Panhandle	2,092,217	672,865	9,737
	2-NW FL	1,976,775	3,385,056	42,295
	3-SW FL	683,284	1,159,542	384
	4-FL Keys	245,008	222,560	30,152
	5-SE FL	88,026	11,097	24,830
	6-NE FL	139,018	33,225	68,169
	7-GA-NC	784,584	18,272	3,742
2002	1-TX-FL Panhandle	2,238,008	775,884	4,580
	2-NW FL	1,887,707	3,083,836	38,557
	3-SW FL	744,938	1,064,911	658
	4-FL Keys	280,961	191,546	24,205
	5-SE FL	68,659	6,219	20,067
	6-NE FL	100,435	24,000	65,764
	7-GA-NC	875,979	29,503	3,934
2003	1-TX-FL Panhandle	1,662,315	767,186	4,236
	2-NW FL	1,447,481	2,953,482	45,343
	3-SW FL	754,878	1,324,458	814
	4-FL Keys	239,691	218,751	18,200
	5-SE FL	76,827	6,924	31,903

	6-NE FL	62,658	11,347	73,762
	7-GA-NC	898,321	19,961	7,237
2004	1-TX-FL Panhandle	1,943,503	632,114	6,481
	2-NW FL	1,667,024	3,137,044	45,981
	3-SW FL	839,068	1,388,425	942
	4-FL Keys	243,980	412,044	24,755
	5-SE FL	75,545	1,628	17,545
	6-NE FL	90,562	7,697	43,466
	7-GA-NC	925,864	45,913	23,419
2005	1-TX-FL Panhandle	1,849,610	643,837	6,519
	2-NW FL	1,512,084	2,829,774	41,155
	3-SW FL	721,152	1,232,038	205
	4-FL Keys	170,392	341,714	29,865
	5-SE FL	56,336	1,459	11,275
	6-NE FL	110,657	3,912	23,529
	7-GA-NC	957,955	34,386	13,371
2006	1-TX-FL Panhandle	1,302,058	726,386	6,751
	2-NW FL	1,255,815	2,196,656	35,585
	3-SW FL	604,099	1,164,082	443
	4-FL Keys	161,310	410,137	18,754
	5-SE FL	36,461	2,760	15,081
	6-NE FL	73,529	4,650	28,825
	7-GA-NC	1,125,588	39,614	19,140
2007	1-TX-FL Panhandle	1,500,081	580,705	2,964
	2-NW FL	959,168	1,591,873	34,728
	3-SW FL	235,764	1,141,727	473
	4-FL Keys	145,164	261,655	24,950
	5-SE FL	44,062	1,631	15,155
	6-NE FL	154,253	2,497	48,897
	7-GA-NC	1,278,871	1,625	10,187
2008	1-TX-FL Panhandle	1,715,578	847,430	4,060
	2-NW FL	1,169,408	2,272,905	39,425
	3-SW FL	261,627	949,014	2,151
	4-FL Keys	91,732	130,394	14,908
	5-SE FL	24,297	1,191	19,567
	6-NE FL	110,890	5,258	28,593
	7-GA-NC	1,154,907	7,097	12,372
2009	1-TX-FL Panhandle	1,359,238	484,434	3,195
	2-NW FL	1,454,681	1,142,592	44,147
	3-SW FL	457,936	697,970	2,261
	4-FL Keys	98,012	82,614	11,590
	5-SE FL	27,566	635	20,044
	6-NE FL	83,936	2,384	26,239

	7-GA-NC	928,067	7,584	26,941
2010	1-TX-FL Panhandle	710,669	248,879	5,208
	2-NW FL	817,453	1,232,395	35,642
	3-SW FL	312,992	730,519	6,168
	4-FL Keys	84,389	57,756	11,316
	5-SE FL	26,755	214	19,866
	6-NE FL	58,157	853	37,495
	7-GA-NC	765,119	5,980	36,078
2011	1-TX-FL Panhandle	963,732	535,676	8,159
	2-NW FL	795,047	1,841,069	41,950
	3-SW FL	410,611	1,220,297	4,291
	4-FL Keys	73,049	131,366	20,215
	5-SE FL	31,052	123	20,052
	6-NE FL	50,953	121	22,052
	7-GA-NC	644,033	18,917	40,280
2012	1-TX-FL Panhandle	1,342,065	484,687	8,033
	2-NW FL	1,153,058	2,039,992	56,423
	3-SW FL	519,648	1,108,725	2,080
	4-FL Keys	83,147	145,977	21,733
	5-SE FL	36,103	343	18,152
	6-NE FL	78,087	1,498	36,855
	7-GA-NC	528,815	2,708	30,953
2013	1-TX-FL Panhandle	932,041	658,627	1,830
	2-NW FL	915,855	1,774,164	39,370
	3-SW FL	444,808	1,315,243	3,759
	4-FL Keys	82,932	144,265	32,035
	5-SE FL	28,509	386	10,908
	6-NE FL	80,629	4,564	23,328
	7-GA-NC	479,775	10,203	28,529
2014	1-TX-FL Panhandle	913,310	474,050	12,948
	2-NW FL	986,770	2,035,741	56,282
	3-SW FL	790,373	1,831,353	6,616
	4-FL Keys	126,242	263,000	32,126
	5-SE FL	38,784	186	7,119
	6-NE FL	82,674	2,131	6,031
	7-GA-NC	465,280	26,359	36,714
2015	1-TX-FL Panhandle	510,388	698,672	8,903
	2-NW FL	883,936	1,685,188	38,456
	3-SW FL	836,505	1,572,137	12,782
	4-FL Keys	116,481	170,896	42,952
	5-SE FL	30,173	82	2,157
	6-NE FL	68,913	7,315	24,460

7-GA-NC	397,053	18,096	31,162

Table 3.2 Final adjusted black grouper landings by year, region, and gear.

Year	Region	Handlines	Longline	Diving
1986	1-TX-FL Panhandle	2741	0	17
1986	2-NW FL	34429	10848	0
1986	3-SW FL	8652	2058	209
1986	4-FL Keys	43835	21263	5893
1986	5-SE FL	0	23879	595
1986	6-NE FL	75589	0	0
1986	7-GA-NC	0	0	0
1987	1-TX-FL Panhandle	2676	0	20
1987	2-NW FL	18454	11204	0
1987	3-SW FL	8869	2571	113
1987	4-FL Keys	80730	30267	11508
1987	5-SE FL	0	8542	3485
1987	6-NE FL	86419	0	0
1987	7-GA-NC	11706	0	0
1988	1-TX-FL Panhandle	3330	0	25
1988	2-NW FL	15580	7916	0
1988	3-SW FL	5523	1346	174
1988	4-FL Keys	52136	25507	3741
1988	5-SE FL	0	2325	820
1988	6-NE FL	64410	0	0
1988	7-GA-NC	9752	0	0
1989	1-TX-FL Panhandle	4769	0	10
1989	2-NW FL	30271	8971	0
1989	3-SW FL	5344	1149	1702
1989	4-FL Keys	83112	26233	1860
1989	5-SE FL	0	153	2625
1989	6-NE FL	78525	0	0
1989	7-GA-NC	12158	0	0
1990	1-TX-FL Panhandle	4318	0	9
1990	2-NW FL	23135	10878	49
1990	3-SW FL	5732	1341	1570
1990	4-FL Keys	68828	33920	1978
1990	5-SE FL	0	1590	916
1990	6-NE FL	61317	0	35
1990	7-GA-NC	9420	0	0
1991	1-TX-FL Panhandle	13553	208	0
1991	2-NW FL	11214	13459	692
1991	3-SW FL	14316	12550	802

1991	4-FL Keys	79730	12387	7317
1991	5-SE FL	615	644	0
1991	6-NE FL	1284	1	231
1991	7-GA-NC	3432	0	0
1992	1-TX-FL Panhandle	10256	158	0
1992	2-NW FL	12775	20162	1621
1992	3-SW FL	12994	8865	1233
1992	4-FL Keys	88519	18380	17617
1992	5-SE FL	528	429	0
1992	6-NE FL	1153	9	285
1992	7-GA-NC	4037	0	0
1993	1-TX-FL Panhandle	12843	121	0
1993	2-NW FL	16443	16062	3129
1993	3-SW FL	13361	6459	461
1993	4-FL Keys	96870	9882	33234
1993	5-SE FL	559	446	0
1993	6-NE FL	1052	37	135
1993	7-GA-NC	4357	23	0
1994	1-TX-FL Panhandle	16698	105	0
1994	2-NW FL	11625	9541	3778
1994	3-SW FL	13521	6364	320
1994	4-FL Keys	91135	7736	18936
1994	5-SE FL	375	475	0
1994	6-NE FL	1033	37	198
1994	7-GA-NC	4970	7	0
1995	1-TX-FL Panhandle	21643	362	0
1995	2-NW FL	10060	8501	2742
1995	3-SW FL	7925	5812	629
1995	4-FL Keys	80188	6666	23614
1995	5-SE FL	384	407	0
1995	6-NE FL	1404	43	193
1995	7-GA-NC	4805	8	0
1996	1-TX-FL Panhandle	1834	0	0
1996	2-NW FL	4553	11267	0
1996	3-SW FL	5032	6611	319
1996	4-FL Keys	45655	8168	17506
1996	5-SE FL	22818	0	0
1996	6-NE FL	1594	580	116
1996	7-GA-NC	9788	0	0
1997	1-TX-FL Panhandle	1798	0	0
1997	2-NW FL	4426	10497	0
1997	3-SW FL	5122	6893	356
1997	4-FL Keys	41852	9340	15063

1997	5-SE FL	15633	0	0
1997	6-NE FL	1317	1159	87
1997	7-GA-NC	7576	0	0
1998	1-TX-FL Panhandle	3398	0	0
1998	2-NW FL	7339	15258	0
1998	3-SW FL	6662	9954	163
1998	4-FL Keys	41859	17949	16005
1998	5-SE FL	17028	0	0
1998	6-NE FL	1417	876	127
1998	7-GA-NC	8719	0	0
1999	1-TX-FL Panhandle	2340	0	0
1999	2-NW FL	6486	17317	0
1999	3-SW FL	4434	10909	84
1999	4-FL Keys	30744	21672	8418
1999	5-SE FL	10317	0	0
1999	6-NE FL	1274	395	137
1999	7-GA-NC	7359	0	0
2000	1-TX-FL Panhandle	2739	0	0
2000	2-NW FL	6306	18252	0
2000	3-SW FL	6594	10244	528
2000	4-FL Keys	33449	14766	14526
2000	5-SE FL	11145	0	0
2000	6-NE FL	1521	414	77
2000	7-GA-NC	4999	0	0
2001	1-TX-FL Panhandle	2633	1037	0
2001	2-NW FL	11222	26464	0
2001	3-SW FL	11208	18036	400
2001	4-FL Keys	47193	20742	22160
2001	5-SE FL	6687	560	1155
2001	6-NE FL	2756	0	2866
2001	7-GA-NC	4743	248	0
2002	1-TX-FL Panhandle	2699	1029	0
2002	2-NW FL	7744	27384	0
2002	3-SW FL	12094	23580	356
2002	4-FL Keys	59249	18456	28586
2002	5-SE FL	5025	649	755
2002	6-NE FL	1909	0	2800
2002	7-GA-NC	6036	0	0
2003	1-TX-FL Panhandle	1874	703	0
2003	2-NW FL	6886	30371	0
2003	3-SW FL	11807	28409	282
2003	4-FL Keys	53486	28369	26387
2003	5-SE FL	4581	403	2091

2003	6-NE FL	1133	0	2736
2003	7-GA-NC	6387	20	0
2004	1-TX-FL Panhandle	2482	898	0
2004	2-NW FL	7835	26536	0
2004	3-SW FL	10023	28326	182
2004	4-FL Keys	56389	34967	32190
2004	5-SE FL	4381	194	1184
2004	6-NE FL	1664	0	1877
2004	7-GA-NC	7618	0	0
2005	1-TX-FL Panhandle	2054	893	0
2005	2-NW FL	6672	21872	0
2005	3-SW FL	10929	22482	167
2005	4-FL Keys	48211	19416	31464
2005	5-SE FL	4583	57	600
2005	6-NE FL	1667	0	2004
2005	7-GA-NC	8034	108	0
2006	1-TX-FL Panhandle	3633	0	72
2006	2-NW FL	13525	22073	13536
2006	3-SW FL	15189	28757	103
2006	4-FL Keys	41105	47183	14932
2006	5-SE FL	23025	37	1546
2006	6-NE FL	314	0	57
2006	7-GA-NC	10180	0	1221
2007	1-TX-FL Panhandle	4679	0	44
2007	2-NW FL	9337	18549	10357
2007	3-SW FL	7851	27715	1705
2007	4-FL Keys	35652	25567	22204
2007	5-SE FL	23009	90	1971
2007	6-NE FL	654	0	118
2007	7-GA-NC	10172	0	1469
2008	1-TX-FL Panhandle	6402	0	66
2008	2-NW FL	9841	17045	10585
2008	3-SW FL	5402	13143	1129
2008	4-FL Keys	18375	5140	16273
2008	5-SE FL	9970	0	2460
2008	6-NE FL	393	0	91
2008	7-GA-NC	8151	0	1416
2009	1-TX-FL Panhandle	3071	0	36
2009	2-NW FL	9306	7410	10495
2009	3-SW FL	4923	7155	1779
2009	4-FL Keys	13141	5943	10502
2009	5-SE FL	12616	18	2758
2009	6-NE FL	303	0	66

2009	7-GA-NC	7746	0	1717
2010	1-TX-FL Panhandle	1649	0	61
2010	2-NW FL	7061	5295	10525
2010	3-SW FL	6496	5435	1708
2010	4-FL Keys	8312	3895	13205
2010	5-SE FL	12155	0	2496
2010	6-NE FL	161	0	76
2010	7-GA-NC	7154	0	2041
2011	1-TX-FL Panhandle	1064	70	0
2011	2-NW FL	1133	5076	571
2011	3-SW FL	7984	6251	1920
2011	4-FL Keys	20958	5676	18526
2011	5-SE FL	9517	0	573
2011	6-NE FL	25	0	163
2011	7-GA-NC	3007	0	406
2012	1-TX-FL Panhandle	1844	111	0
2012	2-NW FL	2016	7826	828
2012	3-SW FL	11818	10104	1659
2012	4-FL Keys	14870	5163	19912
2012	5-SE FL	8270	0	382
2012	6-NE FL	41	0	200
2012	7-GA-NC	2235	0	268
2013	1-TX-FL Panhandle	2011	181	0
2013	2-NW FL	2150	8632	562
2013	3-SW FL	10145	15138	1899
2013	4-FL Keys	15419	12131	23615
2013	5-SE FL	7346	0	248
2013	6-NE FL	43	0	163
2013	7-GA-NC	2452	222	260
2014	1-TX-FL Panhandle	1634	89	0
2014	2-NW FL	1890	9672	1031
2014	3-SW FL	11616	21555	2777
2014	4-FL Keys	23980	16572	36079
2014	5-SE FL	13655	41	271
2014	6-NE FL	28	0	146
2014	7-GA-NC	2229	841	280
2015	1-TX-FL Panhandle	1251	170	0
2015	2-NW FL	1385	11613	1026
2015	3-SW FL	10592	23466	4757
2015	4-FL Keys	19605	16717	37705
2015	5-SE FL	8533	0	214
2015	6-NE FL	29	0	160

2015	7-GA-NC	1714	0	283

Table 3.3 Number of commercial length samples for black grouper.

Year	Hand Lines	Longline	Diving
1986	138	177	0
1987	250	90	10
1988	251	53	0
1989	253	55	0
1990	460	53	1
1991	155	80	2
1992	206	76	30
1993	274	47	40
1994	98	40	19
1995	126	71	2
1996	131	58	3
1997	164	128	11
1998	153	351	13
1999	178	477	8
2000	160	364	8
2001	296	278	11
2002	201	289	23
2003	149	460	8
2004	94	312	5
2005	138	328	50
2006	65	386	14
2007	123	179	10
2008	59	107	20
2009	70	76	28
2010	49	140	26
2011	66	113	13
2012	115	98	43
2013	76	158	54
2014	122	126	217
2015	96	124	167

Table 3.4 Number of commercial age samples for black grouper.

Year	Hand Lines	Longline	Diving
1986	0	0	0
1987	0	0	0
1988	0	0	0
1989	0	0	0
1990	0	0	0
1991	1	0	0
1992	2	0	0
1993	5	0	0
1994	5	11	0
1995	5	109	3
1996	8	105	2
1997	1	0	1
1998	5	0	0
1999	11	3	0
2000	9	7	0
2001	16	34	1
2002	11	37	0
2003	14	85	0
2004	16	229	4
2005	35	312	0
2006	38	480	9
2007	64	272	3
2008	28	78	14
2009	34	63	11
2010	36	85	18
2011	27	67	11
2012	51	45	18
2013	33	28	9
2014	38	2	130
2015	24	1	66

3.12 FIGURES

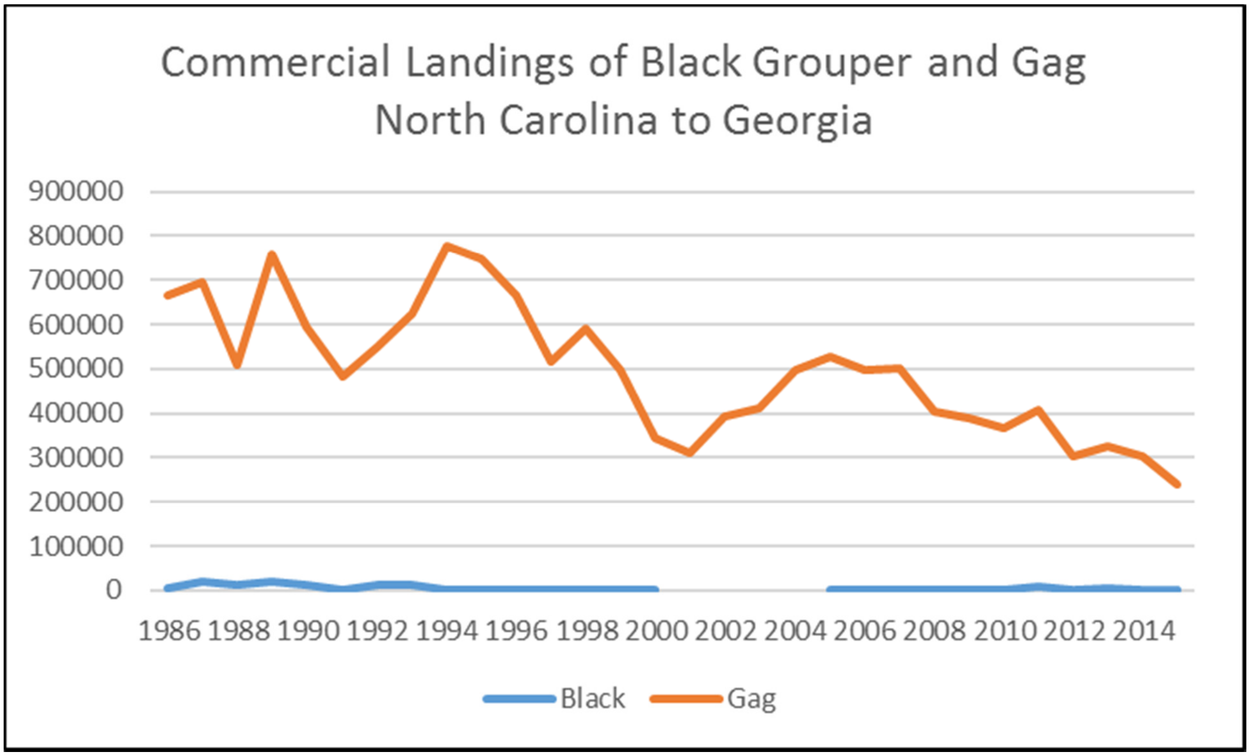

Figure. 3.1. ALS commercial landings of black grouper and gag from North Carolina to Georgia, 1986-2015.

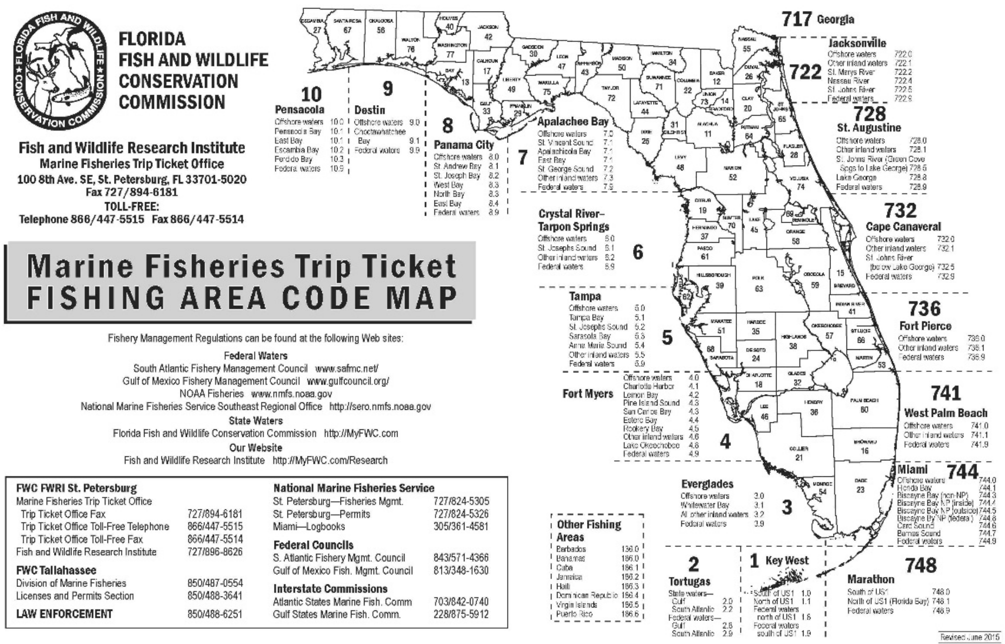

Figure 3.2a. Florida trip ticket area-county map.

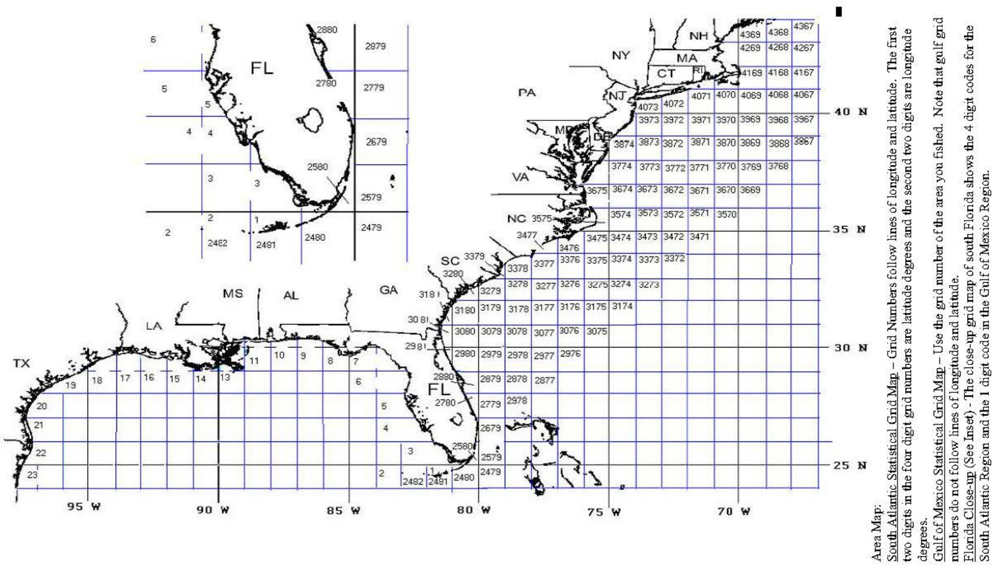

Figure 3.2b. NMFS statistical grid area map.

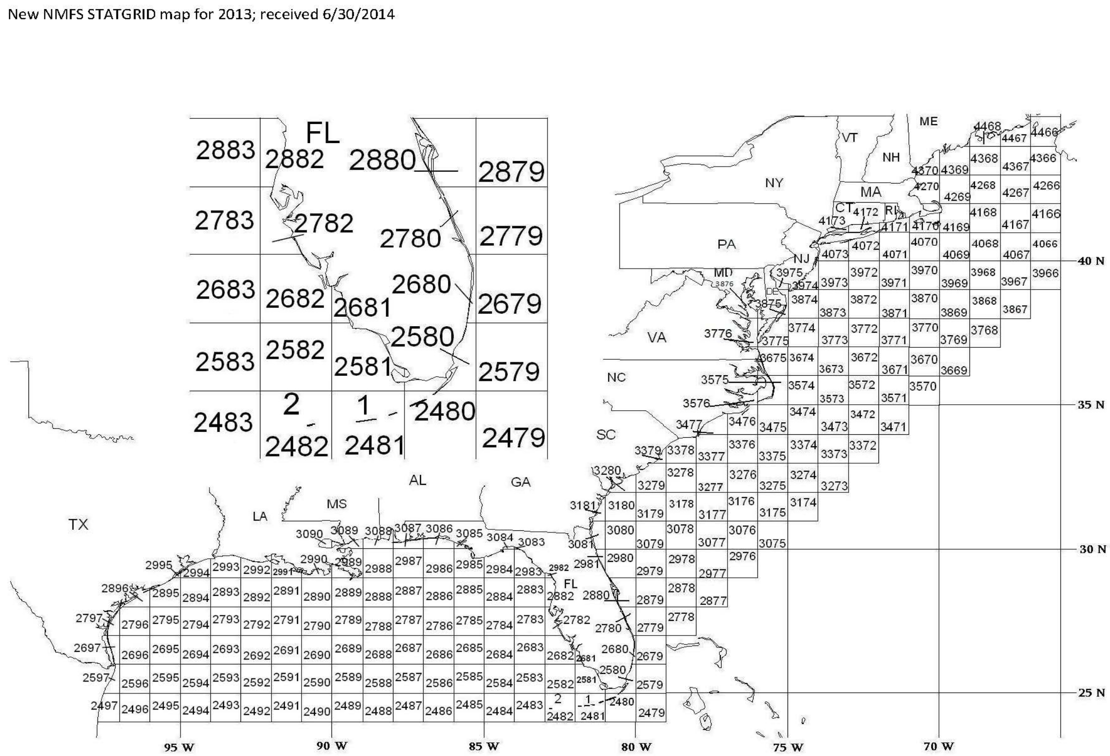

Figure 3.2c. NMFS statistical grid area map revised in 2013.

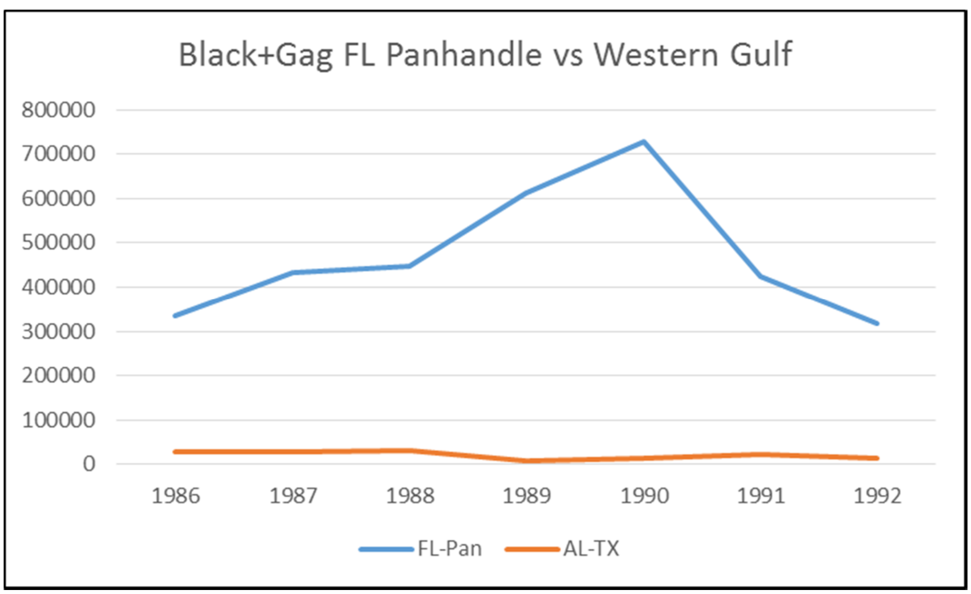

Figure 3.3. ALS commercial landings of black grouper and gag from the Florida Panhandle as compared to the other Gulf States combined from 1986-1992.

4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

4.1.1 Recreational Workgroup (RWG) Members

This Working Group did not meet during the Data Workshop. Recreational data was reviewed during the post-Data Workshop Webinar.

4.2 REVIEW OF WORKING PAPERS

No working papers were provided.

4.3 RECREATIONAL LANDINGS

4.3.1 Marine Recreational Information Program (MRIP) and Texas Parks and Wildlife Division (TPWD) Estimates

Introduction

The recreational charter, private, and shore landings for black grouper were obtained from the following separate sampling programs:

1) Marine Recreational Fisheries Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP)- charter, private, shore, and headboat 1981-1985
2) Texas Parks and Wildlife Department (TPWD)- charter and private

MRFSS/MRIP provides a long time series of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. MRFSS/MRIP provides estimates for three recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (CH). When the survey first began in Wave 2 (Mar/Apr), 1981, headboats were included in the for-hire mode, but were excluded after 1985 in the South Atlantic and Gulf of Mexico to avoid overlap with the Southeast Region Headboat Survey (SRHS) conducted by the NMFS Beaufort, NC lab. The MRFSS/MRIP survey covers coastal Atlantic states from Maine to Florida and coastal Gulf of Mexico states from Florida to Louisiana. The LA Creel survey provides landing estimates for Louisiana when the MRIP survey was not conducted in the state in 2014; however, no estimates for black grouper were available. The state of Texas was included in the survey from 1981-1985, although not all modes and waves were covered.

The TPWD Sport-boat Angling Survey was implemented in May 1983 and samples fishing trips made by sport-boat anglers fishing in Texas marine waters. All sampling takes place at recreational boat access sites. The raw data include information on catch, effort and length composition of the catch for sampled boat-trips. These data are used by TPWD to generate recreational catch and effort estimates. The survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). In SEDAR 16 TPWD seasonal data was disaggregated into months. Since then SEFSC personnel has disaggregated the TPWD seasonal estimates into waves (2 month periods) using the TPWD intercept data. This was done to make the TPWD time series compatible with the MRFSS/MRIP time series. TPWD surveys private and charterboat fishing trips. While TPWD samples all trips (private, charterboat, ocean, bay/pass), most of the sampled trips are associated with private boats fishing in bay/pass, as these trips represent most of the fishing effort. Charterboat trips in ocean waters are the least encountered in the survey.

Adjustments and modifications

MRIP adjustments were applied in the following order, with each step described below:

1. FHS calibration
2. Separate Monroe County
3. MRIP APAIS adjustment (regular black grouper factors) <2004
4. MRIP APAIS adjustment (combined gag/black grouper factors- GOM <1990) and species ID fixes
5. Weight estimation
6. Fill in 1981, wave 1

1: FHS Calibration:

The For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. Conversion factors have been estimated to calibrate the traditional MRFSS charter boat estimates with the FHS for 1986-2003 in the South Atlantic (SEDAR25-Data Workshop Report) and 1986-1997 in the Gulf of Mexico (SEDAR7-AW-03). To calibrate the MRFSS combined charter boat and headboat mode effort estimates in 1981-1985, conversion factors were estimated using 1986-1990 effort estimates from both modes, in equivalent effort units, an angler trip (SEDAR28-DW-12).

2: Separate Monroe County:

Monroe County MRFSS landings from 1981 to 2003 can be post-stratified to separate them from the MRFSS West Florida estimates. Originally, during the first MRIP re-estimation, Monroe County landings (2004+) could be estimated separately from the remaining West Florida estimates using domain estimation. The Monroe County domain includes only intercepted trips returning to that county as identified in the intercept survey data. Estimates are then calculated within this domain using standard design-based estimation which incorporates the MRIP design stratification, clustering, and sample weights. However, the new MRIP APAIS calibration does not allow for domain estimation at this time for adjusted estimates from 2004 to 2012. The approach used for this update is to use the annual proportions from the original MRIP domain estimates (panhandle and peninsula over total FLW) and apply those proportions to the new West Florida MRIP APAIS estimates in order to remove Monroe County. This approach was also used in SEDAR 42, Gulf of Mexico red grouper. Traditional MRIP domain estimation is available for estimates 2013+ and is used in this update to exclude Monroe County for that time period.

3: MRIP APAIS adjustment (regular black grouper factors) <2004:

The Marine Recreational Information Program (MRIP) was developed to generate more accurate recreational catch rates by re-designing the MRFSS sampling protocol to address potential biases including port activity and time of day. Starting in 2013, wave 2, the MRIP Access Point Angler Intercept Survey (APAIS) implemented a revised sampling design. As new MRIP APAIS estimates are available for a portion of the recreational time series that the MRFSS covers, conversion factors between the MRFSS estimates and the MRIP APAIS estimates were developed in order to maintain one consistent time series for the recreational catch estimates. Ratio estimators, based on the ratios of the means, were developed for Gulf of Mexico black grouper to hind-cast catch and variance estimates by fishing mode. In order to apply the charter boat ratio estimator back in time to 1981, charter boat landings were isolated from the combined charter boat /headboat mode for 1981-1985. The MRFSS to MRIP APAIS calibration process is the same as the original MRFSS to MRIP adjustment that has been used since 2012, which is detailed in SEDAR31-DW25 and SEDAR32-DW02. In SEDAR 48, MRIP estimation adjustment factors were used to maintain a consistent time series of recreational catch. The MRIP APAIS adjustment factors for black grouper, and associated c.v.s, are provided in Tables 1 and 2.

4: MRIP APAIS adjustment (combined gag/black grouper factors- GOM <1990) and species ID Fixes:

Gag grouper (*Mycteroperca microlepis*) and black grouper (*Mycteroperca bonaci*) look similar and in parts of the Gulf, *M. microlepis* has traditionally been called black grouper. This issue was investigated and discussed in SEDAR 10 and 33 (Gulf of Mexico gag) and it was found that many gag landings were misreported as black grouper landings prior to 1990. The problem was apparently corrected with updated interviewer training, interview supervision, and contractor QA/QC work in the 1990 MRFSS contracts.

As was done in the previous gag assessments, catches from the Gulf of Mexico (not including the Keys) were adjusted prior to 1990 to correct for this misidentification. The average ratios of gag to the sum of gag and black grouper for 1990 to 2012 were calculated by state and applied to the sum of gag and black grouper landings from 1981 to 1989 (0.974 for LA, 1 for MS and AL, and 0.993 for FLW- SEDAR33). The MRIP APAIS adjustment factors for combined gag and black grouper landings in the Gulf, and associated c.v.'s, are provided in Table 3.

In the South Atlantic, all black grouper north of Florida were considered to be gag (SEDAR 10).

5: Weight Estimation:

The MRFSS and the MRIP surveys use different methodologies to estimate landings in weight. To apply a consistent methodology over the entire recreational time series, the Southeast Fisheries Science Center (SEFSC) implemented a method for calculating average weights for the MRIP (and MRIP adjusted) landings. This method is detailed in SEDAR32-DW-02. The length-weight equation from SEDAR 48 (W=exp(-19.2391 + 3.1896*log(L)) was used to convert black grouper sample lengths into weights, when no weight was recorded. W is whole weight in kilograms and L is fork length in millimeters. This method was used to calculate landings estimates in weight from the MRIP and TPWD.

6: Fill in Wave 1, 1981:

Missing estimates from MRIP 1981, wave 1 have been filled in using the proportion of catch in wave 1 to catch in all other waves for 1982-1984 by fishing mode and area.

Variances are provided by MRFSS/MRIP for their recreational catch estimates. Variances are adjusted to take into account the variance of the conversion factor when an adjustment to the estimate has been made (FHS and MRIP conversions). However, the variance estimates of the charter and headboat modes in 1981-1985 are missing. This is due to the MRIP calibration procedure, which requires the combined charter/headboat mode to be split in order to apply the MRIP adjustment to the charter mode back to 1981. In addition, variance estimates are not available for weight estimates generated through the SEFSC method described above.

The adjusted landings PSE values for Black Grouper were above 100% for 1981-2003 and 33% to 93% for 2004-2015 (Table 4). The ACCSP held a workshop examining the effects of PSE values (low to high) on the stability of stock assessment results and concluded “In general, model estimates are more reliable (unbiased) for input data with PSEs up to 40-60%. Higher values (>=60%) of recreational data precision were tolerated for species with a shorter life history and smaller recreational fishery component.” The maximum observed age of Black Grouper is 33 years and 6 of the 36 years had PSE values <= 60% for landings and 11 of 36 years had PSE values <= 60% for discards. Since commercial and headboat landings were smaller than the estimated MRFSS/MRIP estimates, the MRFSS/MRIP estimates do not meet the ACCSP recommendations and are deemed too uncertain to yield stable assessment results.

4.3.2 Southeast Region Headboat Survey (SRHS)

Introduction

The Southeast Region Headboat Survey estimates landings and effort for headboats in the South Atlantic and Gulf of Mexico. The Headboat Survey began in 1972 in the South Atlantic and covers from the VA/NC border to Key West, FL. The Gulf of Mexico headboat survey followed, starting in 1986 from Naples, FL to South Padre Island, TX. The South Atlantic and Gulf of Mexico Headboat Surveys generally include 70-80 vessels participating in each region annually.

The Headboat Survey incorporates two components for estimating catch and effort. 1) Biological information: size of the fish landed are collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate mean weights for all species by area and month. Port samplers also collect otoliths for ageing studies during dockside sampling events. 2) Information about total catch and effort are collected via the logbook, a form filled out by vessel personnel and containing total catch and effort data for individual trips. These logbooks are summarized by vessel to generate estimated landings by species, area, and time strata.

The SRHS was inconsistent in LA in 2002-2005. There were no trip reports collected in LA in 2002. Trip reports from 2001 were used (by the HBS) as a substitute to generate estimates numbers caught (though there are some minor differences between the resulting estimates for the two years). In 2003, there were only a few trip reports but they were still used to generate the estimates. From 2004 to 2005 there were no trip reports or fish sampled, and no substitutes were used, so there are no estimates or samples from 2004 to 2005 due to funding issues and Hurricane Katrina. However, the MRFSS/MRIP For-Hire Survey included the LA headboats in their charter mode estimates for these years thereby eliminating this hole in the headboat mode estimates.

Variances

Variances estimates are not currently available for the SRHS catch estimates. Further research is required to develop a suitable method to calculate variance.

Estimated catch

Due to vessel confidentiality concerns landings of black grouper are reported by region. Estimated landings of black grouper in the South Atlantic and Gulf of Mexico (number and pounds) are reported in Table 5.

4.4 RECREATIONAL DISCARDS

4.4.1 MRIP and TPWD Discard Estimates

Discarded live fish are reported by the anglers interviewed by the MRIP/MRFSS. Consequently, neither the identity nor the quantities reported are verified. MRFSS/MRIP estimates of live released fish (B2 fish) were adjusted in the same manner as the landings (i.e., using charter boat calibration factors, MRIP adjustment, substitutions, etc. described in section above).

TPWD does not estimate discards. Due to extremely low catches of black grouper, TPWD discards were assumed to be zero.

4.4.2 Headboat Logbook Discards

The Southeast Region Headboat Survey logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". As of Jan 1, 2013 the SRHS began collecting logbook data electronically. Changes to the trip report were also made at this time, one of which removed the condition category for discards i.e., released alive vs. released dead. From 2013 on all discards are recorded as released alive.

Due to vessel confidentiality concerns discards of black grouper are reported by region. Estimated landings of black grouper in the South Atlantic and Gulf of Mexico (number) are reported in Table 6.

4.5 BIOLOGICAL SAMPLING

4.5.1 Private Recreational Fishery and Charter Fishery

A total of 1779 Black Grouper lengths were measured by MRFSS/MRIP samplers from 1981 through 2015 in the Southeast US from charterboat and private/rental boat anglers (Table 6). Prior to 1986, the charterboat mode was combined with the headboat mode (155 fish). MRFSS/MRIP samplers measure the mid-line length or fork length in mm and, whenever possible, the samplers obtain a weight. The weights are standardized to kilograms. Rarely are otoliths collected under the current sample design.

4.5.2 Headboat Survey Biological Sampling

Lengths were collected from 1972 to 2015 by headboat dockside samplers. From 1972 to 1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida were sampled beginning in 1976. The Southeast Region Headboat Survey conducted dockside sampling for the entire range of Atlantic waters along the southeast portion of the US from the NC-VA border through the Florida Keys beginning in 1978. The Gulf of Mexico, excluding Mississippi, was added to the dockside sampling program in 1986. Mississippi was added in 2010. Weights are typically collected for the same fish measured during dockside sampling. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely and processed for aging, diet studies, and maturity studies.

Due to vessel confidentiality concerns the number of measurements of black grouper and trips with measured fish are reported by region (Table 7).

4.6 RECREATIONAL EFFORT

4.6.1 Headboat Effort

Catch and effort data are reported on logbooks provided to all headboats in the survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Data on effort are provided as number of anglers on a given trip. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to "angler days" (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Each month, port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for non-reporting, a correction factor is developed based on sampler observations, angler numbers from office books and all available information. This information is used to provide estimates of total catch (expanded or corrected for non-reporting) by month and area, along with estimates of effort. Estimated headboat angler days showed a noticeable decreased in the South Atlantic and Gulf of Mexico from 2008-2011. The most obvious factor which impacted the headboat fishery in both the Atlantic and South Atlantic and Gulf of Mexico was the high price of fuel. This, coupled with the economic down turn starting in 2008 resulted in a marked decline in angler days in the South Atlantic and Gulf of Mexico headboat fishery. Reports from industry representatives and port agents indicated fuel prices, the economy and fishing regulations as the factors that most affected the amount of trips, number of passengers, and overall fishing effort. Also important to note, is the decrease in effort in the South Atlantic and Gulf of Mexico in 2010, the year of the Deepwater Horizon oil spill. Estimated angler days have risen in recent years (2012-2015) possibly due to the decrease in fuel price and an improving economy (Table 8).

4.7 LITERATURE CITED

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4.8 TABLES

Table 1. South Atlantic black grouper ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP APAIS numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

	Numbers Ratio Estimator		Variance of Numbers Ratio Estimator		Variance Ratio Estimator	
MODE	AB1	B2	AB1	B2	AB1	B2

Charter boat	1.08605876	0.525632331	0.123055603	0.019487129	6.305154145	0.45296732
Private	4.683779506	4.097540802	0.231912873	0.080953305	89.77768754	116.1885628
Shore		0.618678202		0.023859851		0.525402688
All	4.356413071	3.454944049	0.19571174	0.040575099	88.73319557	61.20188289

Table 2. Gulf of Mexico black grouper ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP APAIS numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

	Numbers Ratio Estimator		Variance of Numbers Ratio Estimator		Variance Ratio Estimator	
MODE	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**
Charter boat	0.975626008	1.120843789	0.000917099	0.007318014	1.938348696	5.579135031
Private	1.772745534	1.245156495	0.555762278	0.042563263	9.559834005	3.721089962
Shore		2.705514573		0.75567715		18.55911818
All	1.519049111	1.330620109	0.22996107	0.024632475	9.377341154	5.018988006

Table 3. Gulf of Mexico gag and black grouper combined ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP APAIS numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

	Numbers Ratio Estimator		Variance of Numbers Ratio Estimator		Variance Ratio Estimator	
MODE	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**
Charter boat	1.156663	1.06519	0.008743	0.003029	19.83885	5.565203
Private	1.169833	1.191601	0.002954	0.000531	6.967189	10.46233
Shore	1.282907	1.8422	0.091118	0.010574	4.398622	23.8935

Table 4. Calibrated MRIP landings and associate coefficient of variation (c.v.).

Year	Numbers	C.V.
1981	187,101	2.28
1982	159,423	3.10
1983	105,588	3.16
1984	146,830	1.20
1985	115,316	1.75
1986	159,906	1.57
1987	140,117	1.33
1988	48,996	1.02
1989	65,655	2.07
1990	47,618	1.43
1991	64,389	1.94
1992	66,404	1.12
1993	43,566	0.60
1994	34,470	1.19
1995	60,383	2.09
1996	109,531	1.68
1997	95,899	1.78
1998	63,889	1.85
1999	16,797	2.14
2000	20,966	2.68
2001	32,056	2.60
2002	29,116	2.67
2003	38,974	2.05
2004	70,410	0.53
2005	30,364	0.60
2006	11,180	0.61
2007	25,022	0.65
2008	24,768	0.70
2009	32,326	0.80
2010	11,174	0.93
2011	12,359	0.89
2012	26,631	0.68
2013	9,228	0.49
2014	6,155	0.36
2015	10,748	0.33

Table 5. Estimated headboat landings and discards of black grouper in the South Atlantic and the Gulf of Mexico, 1981-2015.

	South Atlantic				Gulf of Mexico			
Year	Number	Pounds	Released dead (n)	Released live (n)	Number	Pounds	Released dead (n)	Released live (n)
1981	1,664	15,391						
1982	1,884	27,107						
1983	4,257	56,738						
1984	1,381	11,288						
1985	1,227	11,469						
1986	1,294	14,934			8,064	10,081		
1987	1,831	26,496			5,678	92,225		
1988	2,290	20,620			766	3,669		
1989	687	5,863			1,397	23,909		
1990	392	3,412			1,529	14,353		
1991	395	4,464			1,308	10,914		
1992	832	8,727			1,714	12,238		
1993	1,150	12,698			990	12,583		
1994	1,164	10,949			1,310	13,104		
1995	1,006	7,411			3,519	24,350		
1996	948	10,548			1,963	26,065		
1997	547	7,083			3,216	41,192		
1998	677	8,123			5,445	76,862		
1999	654	9,243			1,713	22,629		
2000	587	10,365			478	4,753		
2001	504	7,540			1,569	23,473		
2002	535	7,574			585	7,698		
2003	610	7,580			660	4,360		
2004	1,100	14,341	0	514	513	4,073	0	184
2005	1,766	22,912	24	1074	234	2,821	3	96
2006	1,042	16,471	7	587	88	1,391	0	2
2007	1,199	16,865	12	739	83	963	0	26
2008	261	3,165	14	819	78	765	0	288
2009	233	2,478	16	880	38	186	0	74
2010	242	2,904	12	1309	31	349	0	37
2011	387	3,730	1	1743	39	596	0	127
2012	333	4,940	2	1805	33	1,239	0	61
2013	491	6,857	0	968	69	2,280	0	106
2014	948	10,548	0	1106	19	786	0	14
2015	461	6,809	0	602	27	1,124	0	27

Table 6. Annual numbers of Black Grouper by fishing mode measured by MRFSS/MRIP samplers.

	Fishing mode			
Year	Headboat/ Charterboat	Charterboat	Private/rental	Total
1981	27		65	92
1982	12		65	77
1983	25		49	74
1984	57		33	90
1985	34		37	71
1986		88	55	143
1987		66	97	163
1988		30	89	119
1989		4	19	23
1990		0	3	3
1991		6	4	10
1992		8	14	22
1993		6	20	26
1994		16	6	22
1995		7	14	21
1996		10	28	38
1997		36	13	49
1998		83	14	97
1999		59	15	74
2000		65	4	69
2001		75	7	82
2002		51	8	59
2003		74	4	78
2004		44	5	49
2005		29	5	34
2006		15	2	17
2007		39	7	46
2008		26	1	27
2009		2	12	14
2010		5	0	5
2011		5	1	6
2012		12	4	16
2013		6	6	12
2014		10	10	20
2015		23	8	31
Total	155	900	724	1779

Table 7. Number of black grouper measured and number of trips with measured fish in the Southeast Region Headboat Survey in the South Atlantic and Gulf of Mexico, 1972-2015.

	Fish(n)		Trips(n)	
YEAR	South Atlantic	Gulf of Mexico	South Atlantic	Gulf of Mexico
1972	4		3	
1973				
1974				
1975				
1976				
1977	2		1	
1978	10		8	
1979	29		22	
1980	47		32	
1981	70		52	
1982	42		36	
1983	34		30	
1984	49		44	
1985	61		44	
1986	54	4	35	4
1987	28		20	
1988	17	1	15	1
1989	20	7	15	4
1990	14	11	12	3
1991	10		4	
1992	11		11	
1993	18		15	
1994	18		17	
1995	13		13	
1996	16	1	14	1
1997	23	1	22	1
1998	24	1	22	1
1999	11	2	7	2
2000	7	1	5	1
2001	9	1	9	1
2002	9		7	
2003	8		7	
2004	6		6	
2005	5	2	4	2
2006	9	1	9	1
2007	10	1	8	1
2008	2		2	
2009	3	3	3	3
2010	5		5	
2011	19		15	
2012	54	7	25	6
2013	68	4	32	3
2014	51	27	30	5
2015	94	4	28	3

Table 8. Headboat estimated angler days by year and state, 1981-2015.

Year	GA/FLE	NC	SC	South Atlantic	FLW/AL	LA/MS	TX	Gulf of Mexico
1981	298,883	19,374	59,030	377,287				
1982	293,133	26,939	67,539	387,611				
1983	277,863	23,830	65,733	367,426				
1984	288,994	28,865	67,314	385,173				
1985	280,845	31,384	66,001	378,230				
1986	317,058	31,187	67,227	415,472	240,077	5,891	56,568	302,536
1987	333,041	35,261	78,806	447,108	217,049	6,362	63,363	286,774
1988	301,775	42,421	76,468	420,664	195,948	7,691	70,396	274,035
1989	316,864	38,678	62,708	418,250	208,325	2,867	63,389	274,581
1990	322,895	43,240	57,151	423,286	213,906	6,898	58,144	278,948
1991	280,022	40,936	67,982	388,940	174,312	6,373	59,969	240,654
1992	264,523	41,176	61,790	367,489	184,802	9,911	76,218	270,931
1993	236,973	42,786	64,457	344,216	207,898	11,256	80,904	300,058
1994	242,781	36,691	63,231	342,703	204,562	12,651	100,778	317,991
1995	210,714	40,295	61,739	312,748	182,410	10,498	90,464	283,372
1996	199,857	35,142	54,929	289,928	154,913	10,988	91,852	257,753
1997	173,273	37,189	60,150	270,612	149,442	9,008	82,207	240,657
1998	155,341	37,399	61,342	254,082	185,331	7,854	77,650	270,835
1999	164,052	31,596	55,499	251,147	176,117	8,026	58,235	242,378
2000	182,249	31,351	40,291	253,891	159,331	4,952	58,395	222,678
2001	163,389	31,779	49,265	244,433	157,243	6,222	55,361	218,826
2002	151,546	27,601	42,467	221,614	141,831	6,222	66,951	215,004
2003	145,011	22,998	36,556	204,565	144,211	6,636	74,432	225,279
2004	175,400	27,255	48,763	251,418	158,430		64,990	223,420
2005	172,839	31,573	34,036	238,448	130,233		59,857	190,090
2006	175,522	25,736	56,074	257,332	124,049	5,005	70,789	199,843
2007	157,150	29,002	60,729	246,881	136,880	2,522	63,764	203,166
2008	123,943	17,158	47,287	188,388	130,176	2,945	41,188	174,309
2009	136,420	19,468	40,919	196,807	142,438	3,268	50,737	196,443
2010	123,662	21,071	44,951	189,684	111,018	715	47,154	158,887
2011	132,492	18,457	44,645	195,594	157,025	3,657	47,284	207,966
2012	147,699	20,766	41,003	209,468	161,975	3,680	51,776	217,431
2013	165,679	20,547	40,963	227,189	174,731	3,406	55,749	233,886
2014	195,890	22,691	42,025	260,606	191,365	3,257	51,231	245,853
2015	194,979	22,716	39,702	257,397	194,383	3,587	55,135	253,105

4.9 FIGURES

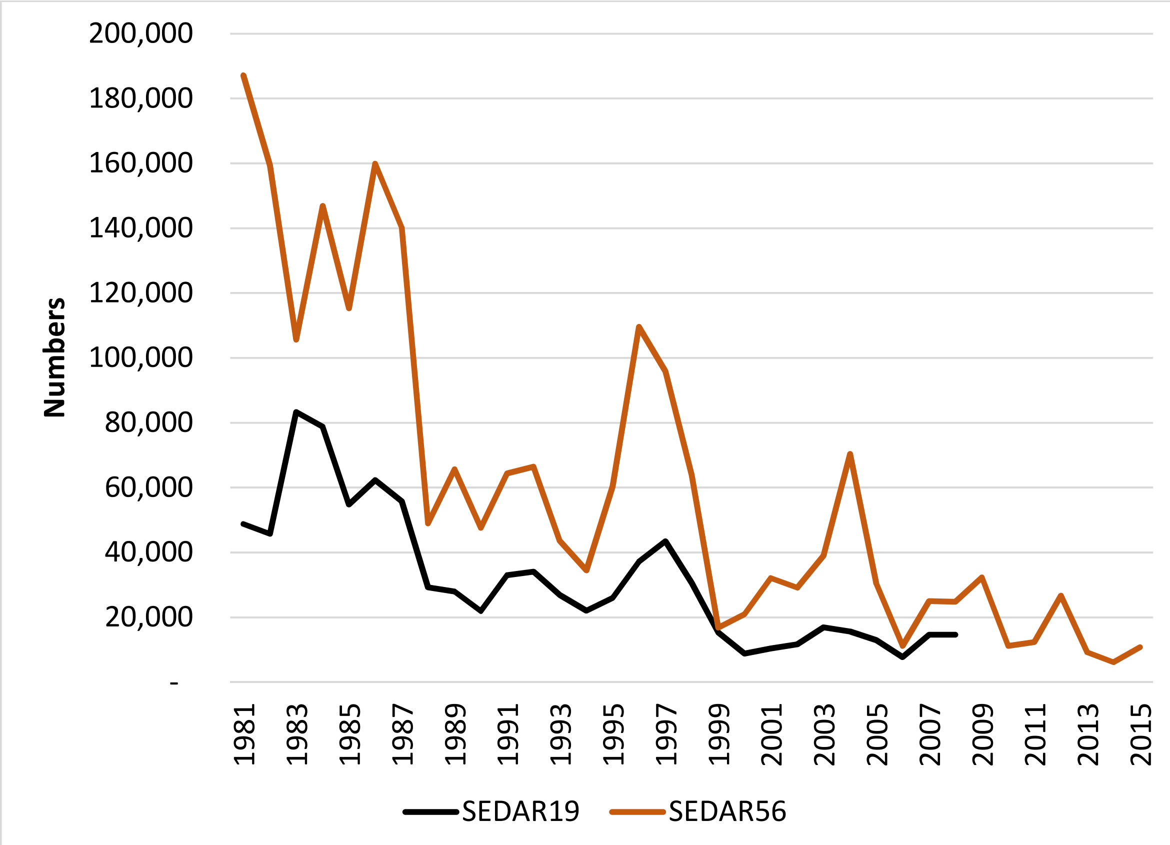

Figure 1. Estimated landings (not including Texas) in numbers. Values from SEDAR19 were generated from the Marine Recreational Fisheries Statistics Survey (MRFSS), and values for SEDAR56 are calibrated Marine Recreational Information Program (MRIP) estimates. Ratio estimators for calibrations and associated c.v.'s are provided in Tables 1-3.

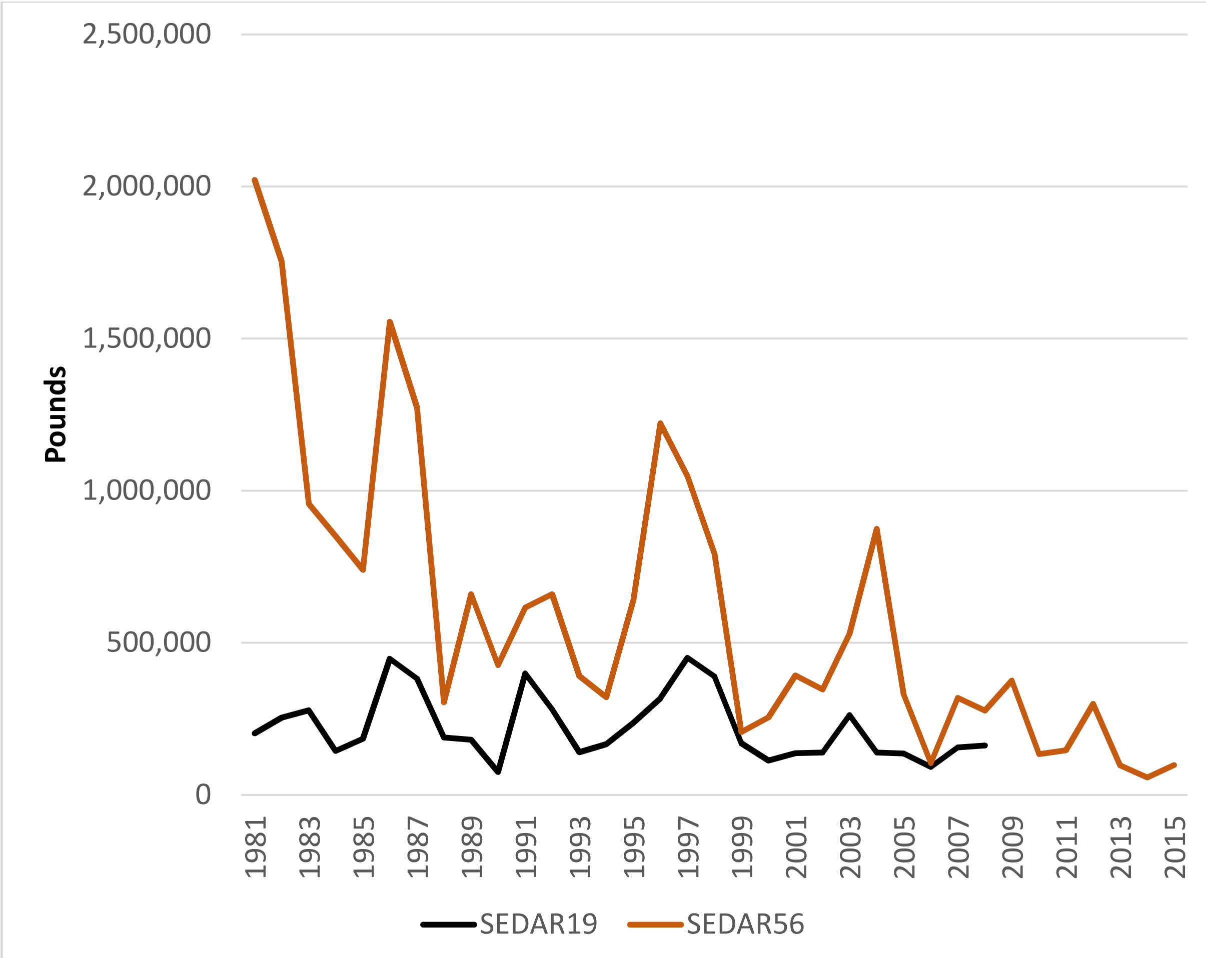

Figure 2. Estimated landings, in pounds. Ratio estimators and associated c.v.'s are provided in Tables 1-3.

5 MEASURES OF POPULATION ABUNDANCE

5.1 OVERVIEW

5.1.1 Group Membership

The index working group consisted of Rob Aherns, Carolyn Belcher, Mike Errigo, Martin Fischer, Michelle Masi, Kevin McCarthy, Bob Muller, Joe O'Hop, Bev Sauls, Jessica Stephen, and Ted Switzer

5.2 REVIEW OF WORKING PAPERS

The workgroup reviewed three working papers (SEDAR 48-DW-01, SEDAR 48-DW-03, and SEDAR 48-DW-04), details of which follow below.

5.3 FISHERY INDEPENDENT SURVEYS

Preliminary data inquiries were made of all fishery-independent surveys conducted in the region. Black grouper were infrequently captured in most of these surveys (e.g., FWRI estuarine surveys, FWRI baitfish trawl survey, SEAMAP summer and fall groundfish trawl surveys, NMFS bottom longline survey, NMFW ichthyoplankton surveys, and FWRI/NMFS-Pascagoula/NMFS-Panama City video surveys), and so no formal indices were developed. Accordingly, the only fishery-independent index developed was for the reef fish visual census.

5.3.1 Reef Fish Visual Census

The Reef fish Visual Census (RVC) began in 1979 with SCUBA divers counting fish along the Florida reef track following a two-stage stratified random survey design (Bohnsack and Bannerot 1986; Bohnsack et *al.* 1999; and Ault et *al.* 2001). A list of habitat sampling strata was created by dividing the Florida reef track into 200 m x 200 m blocks and tallying the habitats in each block. Annually (biennially after 2012), blocks were randomly selected by habitat and then divers (usually two) were deployed at each of two randomly located stations within the block. The divers identified and counted the fish within an imaginary cylinder with a 7.5 m radius. The RVC sampling protocols have evolved over time but have been stable since 1997 when the Florida Keys National Marine Sanctuary set aside Sanctuary Protected Areas (SPAs) which the RVC accommodated by recording whether the station was in a SPA or not. Florida Fish and Wildlife Conservation Commission (FWC) began a similar visual survey in 1999 and the two surveys were combined in 2009.

5.3.1.1 Methods, Gears, and Coverage

RVC station point count data were extracted for the Florida Keys for the 1997-2014 time period; there was no sampling in 2013 due to the biennial sampling schedule and the 2016 data will be available in late March 2017. The 1997 and 1998 data lacked three fields when compared to the later data (whether the dive location was in a SPA, the stratum being sampled based on zone and habitat, and region which was based on the subregion of the Florida Keys), but these fields could be constructed from other reported information. Additional data filtering included deleting the experimental winter surveys that were conducted in 2004/2005, accepting only stations with underwater visibility of 7.5 m or greater, and removing stations that were conducted in sand, seagrass, mud, or artificial habitats because these habitats were not part of the RVC domain. The basic observation is the average number of fish observed by the divers at a station. Additional surveys have been conducted in the waters surrounding the Dry Tortugas National Park in some years but those stations were not included in these analyses. The final dataset consisted of 8,450 station samples.

Similar to the approach that Ingram and Harper (2009) used, the index was standardized with the hurdle approach which splits the process into two generalized linear submodels (Lo *et al.* 1992): a submodel to estimate the proportion of positive stations with a binomial distribution that used a logit link and a submodel to estimate the mean number of Black Grouper caught at a positive station with a gamma distribution using a log link. Ingram and Harper (2009) used a Poisson distribution for the number of Black Grouper observed at positive stations. The Poisson and the lognormal distributions were evaluated as well as the gamma distribution for the number of Black Grouper observed at positive stations and the selection of the distribution in the final configuration was based on the extent of the reduction in the mean deviance. The annual index is the product of the proportion of positive stations (***Prop***) and the mean number of Black Grouper seen per station ($\hat{\boldsymbol{Y}}$) by year after they each have been back-calculated from their linear forms (for the logit link, the transform was $\Pr op = \frac{e^{f(x1+x2+..)}}{1+e^{f(x1+x2+...)}}$ and for the gamma, the transform was $\hat{Y} = e^{g(x1+x2+...)}$ where the *x1, x2,…* refer to the variables included in the final, respective linear submodels).

Potential explanatory variables included year (1997 to 2014), season (Apr-Jun, Jul-Sep, Oct-Dec), sub-regions of the reef track (Biscayne, Upper Keys, Middle Keys, Lower Keys), Sanctuary Protected Area (yes, no), strata (inshore patch reef, mid-channel patch reef, offshore patch reef, high relief reef, shallow forereef, mid-depth forereef , deep forereef), depth (5m categories with 25 m +), and underwater visibility (5m categories with 20 m +). All of the potential, explanatory variables were treated as categorical variables partially to account for non-linearity.

The submodels used a forward stepwise process starting with the null model to identify which variables should be included in the respective submodels. Variables to be included in the final submodel had to meet two criteria: the variable had to be statistically significant at the 0.05 level (the probability of rejecting the null hypothesis) and its inclusion had to reduce the deviance (a measure of the variability) by at least 0.5%.

To calculate the variability in the annual indices, a Monte Carlo simulation approach was used with 10,000 iterations that used the least-squares mean estimates and their standard errors from the two GLIM submodels. Each iteration used the annual least-squares mean estimate on the linear scale and added uncertainty that was calculated by multiplying the standard error by a random normal deviate ($\mu=0$, $\sigma=1$). As described above, these values were converted back from their linear scales and multiplied together.

5.3.1.2 Sampling Intensity and Time Series

Data were extracted for the Florida Keys for the 1997-2014 time period; there was no sampling in 2013 due to the biennial sampling schedule and the 2016 data will be available in late March 2017 (Table 5.8.1). The final dataset consisted of 8,450 station samples.

5.3.1.3 Size/Age Data

Although the reviewers for SEDAR 19 recommended only using the age-1 index from FWC, the change of assessment models now allows for the use of a length-based selectivity instead of age-based (Figure 5.9.1). Being a non-destructive sampling method, the RVC does not collect any age information; thus in SEDAR 19, the fish's length had to be converted to age using an age-length key from different sources which introduced additional uncertainty into the analyses. Therefore, the change in assessment models means that the RVC index can include all of the Black Grouper observed during the surveys instead of just those Black Grouper with lengths believed to represent age-1. Black Grouper observed by the divers at the depths sampled (1 to 33 m) were mostly sub-adults, likely due to a combination of fishing pressure and natural ontogenic distribution of the species. Accordingly, only about 3% were at or greater than the total length at which 50% of the female fish were mature [82.6 cm], so this index should use a length-based dome-shaped selectivity curve.

5.3.1.4 Catch Rates – Number and Biomass

Standardized catch rates are presented in Table 5.8.1 and Figures 5.10.2 and 5.10.3. The Reef Fish Visual Census index was stable but variable from 1997 until 2005 and then declined to a lower level with high values in 2011 and a low value in 2014. The nominal index had a similar shape as the standardized RVC index.

5.3.1.5 Uncertainty and Measures of Precision

Annual coefficients of variation are presented in Table 5.8.1. The coefficients of variation were reasonable ranging from 0.086 to 0.208.

5.3.1.6 Comments on Adequacy for Assessment

Being the only fishery-independent index available for Black Grouper, this index should be useful in the assessment. However, it should be noted that this index, based on stations in shallow waters, is primarily a sub-adult index and does not provide guidance on adult fish or spawning biomass.

5.4 FISHERY-DEPENDENT MEASURES

Several fishery-dependent indices were considered at the data workshop. Ultimately, two fishery-dependent indices were developed for Black Grouper: MMRIP, and the Southeast Headboat survey. Various potential commercial longline and commercial vertical line indices were discussed. In terms of commercial longline data, the development of a South Atlantic index was not recommended due to depth and catch retention restrictions. The development of a western Gulf of Mexico index was also not recommended due to insufficient data. A potential eastern Gulf of Mexico commercial longline index was discussed, although there were concerns with post IFQ data (2010+), the potential for increased pre-closure effort in 2009, seasonal closures (February – March since 2001 as well as late-season quota closures in 2004 and 2005), that would require extensive filtering of the commercial longline data prior to analysis. In terms of commercial vertical line data, no western Gulf of Mexico index was recommended, again due to insufficient data. The development of an eastern Gulf of Mexico commercial vertical line index was considered, with similar concerns/restrictions as were mentioned for the commercial longline index. In addition, the panel thought a South Atlantic commercial vertical line index might be worth pursuing, with the consideration of spawning season closures (January – April 2010+) and potential implications of gag quota. Ultimately, no commercial indices were developed because of concerns with how to appropriately partition reported Black Grouper catch between Gag and Black Grouper.

5.4.1 Marine Recreational Fisheries Statistics Survey of South Florida

Recreational anglers catch Black Grouper, *Mycteroperca bonaci*, primarily in southern Florida from Tampa Bay to Cape Canaveral in the private/rental boat and charterboat fishing modes. While the Marine Recreational Information Program, formerly known as the Marine Recreational Fisheries Statistics Survey (MRFSS/MRIP) is a fishery dependent survey, total catch including discards is reported in the intercepts and total catch rates can provide an indication of changes in the underlying population because they are less affected by changes in management regulations. In 1991, MRFSS/MRIP made several improvements to the survey and one of which was the linking of ancillary intercepts from the same fishing trip together and recording the total number of anglers in the party. MRFSS/MRIP also improved the training of field samplers which was particularly important for Black Grouper which is frequently confused with Gag, *Mycteroperca microlepis*. Therefore, the data for this analysis were constrained to MRFSS/MRIP intercepts from the 1991-2015 period in the private/rental boat and charterboat modes in offshore waters from southern Florida, Tampa Bay on the Gulf coast through to Cape Canaveral on the Atlantic coast of Florida (i.e., from Pinellas through Indian River counties). Initial analyses included both hook-and-line and spearfishing trips. Due to concerns that spearfishing may have increased in recent years, a revised index was developed using only hook-and-line trips.

5.4.1.1 Methods, Gears, and Coverage

A similar process was used similar to that used in SEDAR 19 to estimate the recreational CPUE indices of abundance based on MRFSS/MRIP data. First, a hierarchical cluster analysis (Shertzer and Williams 2008) was performed on presence-absence data of the landings (recreational landings in numbers) to identify those species caught in association with Black Grouper to include trips which potentially could have caught Black Grouper. In this analysis, landings data were limited to trips made in the Keys only, as few positive trips were found in other regions. Also, Type A (retained) catch was used here (to avoid misidentification issues in reported landings and releases) and pulled landings data from May through December (i.e., there should be few, if any, positive trips during the closed season- January through April). Intercepts from the same fishing trip that caught fish were linked back to the main intercept for the party to form a unique trip identifier. The hierarchical clustering procedure was used because it does not require the analyst to define the number of clusters in the data, and a Bray-Curtis measure of similarity was used which is appropriate for presence-absence data.

Once the species caught in association with Black Grouper were identified (Red Grouper, *Epinephelus morio*, and Mutton Snapper, *Lutjanus analis*), all trips were extracted that caught (retained or released) any of the three species from any month, Pinellas County on the Gulf coast around to Indian River County on the Atlantic coast using trips from the Charterboat and Private/Rental boat modes in nearshore (state) and offshore (federal) waters.

After the recreational trip data were extracted, a hurdle approach was used with two generalized linear submodels (binomial and gamma distributions) to fit the data and produce an index of abundance time-series (Lo *et al.* 1992). The hurdle approach is the same method that was applied to the MRFSS index in SEDAR 19 (Muller 2009, SEDAR 19 DW-01). The index is the product of the probability that a Black Grouper was caught on a recreational trip and the number of Black Groupers that are caught on positive trips. The probability submodel used a binomial distribution with a logit link and the submodel for the number of Black Grouper caught on positive trips used a gamma distribution (with a log link). For these analyses, potential explanatory variables were the region of Florida, year, two-month wave, fishing mode, whether nearshore or offshore, day or night fishing, hours fished, number of anglers, and the number of fishing trips in the past two months (avidity) and each was evaluated for inclusion in the final model. The variable selection process used a forward selection procedure starting with the null model to identify which combination of variables reduced the deviance (a measure of uncertainty) the most. To be included, a variable had to be statistically significant ($\alpha <= 0.05$), and the variable had to reduce the mean deviance by at least 0.5%.

We used a Monte Carlo simulation approach to calculate the variability in the annual indices. Each iteration used the annual least-squares mean estimates on their linear scale and added uncertainty that was calculated by multiplying the standard error by a random normal deviate (μ=0, σ=1). As described above, these values were converted back from their linear scales and multiplied together and this product was repeated 10,000 times to produce an empirical distribution for the index.

5.4.1.2 Sampling Intensity and Time Series

Final data were available for the 1991-2015 time period (Table 5.8.2). The final dataset consisted of 13,443 trips.

5.4.1.3 Size/Age Data

No size or age data were available, although the analyses were restricted to harvested (legal-sized) catch.

5.4.1.4 Catch Rates – Number and Biomass

Standardized catch rates are presented in Table 5.8.2 and Figures 5.9.4 and 5.9.5. The MRFSS index showed an increasing trend from 1996 – 2004, and declining in 2005 to a low in 2006. In 2007, the index increased again, but then declined through 2009, where it reached levels like those seen in the early 1990s. The nominal index had a similar shape to the standardized index.

5.4.1.5 Uncertainty and Measures of Precision

Annual coefficients of variation are presented in Table 5.8.2. The coefficients of variation were reasonable ranging from 0.12 to 0.30.

5.4.1.6 Comments on Adequacy for Assessment

This index was recommended for use in the assessment.

5.4.2 Southeast Regional Headboat Survey

In SEDAR 19, standardized catch rates for Black Grouper for the Southeast Regional Headboat Survey, hereafter called the headboat survey, were calculated from 1979 through 2008. Because the measure of the index was the number of fish landed and not the total catch, the index was broken into two time periods reflecting different size regulations. Because of the switch to Stock Synthesis 3, which allows for indices on the retained catch, there is no longer a need to partition the index. The reviewers also recommended using a single index for the entire time period; therefore, the headboat index is a single index using data from 1986 through 2015. In SEDAR 41 DW46, it was recommended that the potential vessels be evaluated following criteria outlined below before being included in the data set used to calculate the headboat index.

5.4.2.1 Methods, Gears, and Coverage

The headboat captain's logbook dataset was used, which contains the trip date, collection number, area, vessel, vessel type, trip type, number of anglers, species, number of fish landed, number fish released, and weight landed in kg. To identify headboat trips that had the potential to catch Black Grouper, headboat logbook records (vestype = 1) from 1986 through 2015 were extracted from the center of the Black Grouper distribution (areas 11 -- Fort Pierce and 12 -- the Florida Keys and Dry Tortugas). These data were also filtered to remove records with species codes of 0, 999, and missing species codes and trips from January through April. After tallying the records by trip and species, there were 446,705 species records from 47,380 headboat trips and anglers on 4,040 trips that landed Black Grouper.

Originally, the headboat data were restricted to vessels that had been in the headboat fishery for three or more years and caught Black Grouper every year. It was pointed out during discussion of the headboat index that the turnover in captains within the fleet nullified the underlying assumption that a vessel was fished in a similar manner from year to year; therefore, vessels were not considered further in the analyses.

As before, additional headboat trips that had the potential to catch Black Grouper were identified using the same Stephens and MacCall (2004) multiple logistic regression technique that we used in the SEDAR 48 DW-01A Addendum Headboat Index 2 original standardization (Muller and O'Hop 2017) and Conn (2009) used In SEDAR 19 (DW04) to predict whether Black Grouper could have been caught on a trip. Of the 69 species that were included in the full model, only 43 species had coefficients that were statistically significant at an alpha level of 0.05. Possible threshold values over the range of 0 to 1 were evaluated with regard to locating the minimum difference between the observed number of positive trips and the predicted number of positive trips. The threshold value of 0.263 had the lowest absolute difference (4 trips); thus, trips with a probability greater than 0.263 were included to minimize the number of false positives (trips predicted to have landed Black Grouper that did not actually land Black Grouper) and false negatives (trips predicted not to have landed Black Grouper but did actually land Black Grouper) in the standardization analysis.

The standardized mean number of Black Grouper per trip was estimated with a delta-gamma model (Lo et al. 1992) that involved two generalized linear submodels (GLIM). The first submodel estimated the probability that a headboat trip would catch a Black Grouper with a binomial distribution (logit link) and the second submodel estimated the number of Black Grouper caught on successful trips using a gamma distribution (log link). The annual index is the product of these two terms by year after they each have been back-calculated from their linear forms (for the logit link, the transform was

$$\Pr op = \frac{e^{f(x1+x2+..)}}{1+e^{f(x1+x2+...)}}$$ and for the gamma, the transform was $$Y = e^{g(x1+x2+...)}$$

where the x1, x2,… refer to the variables included in the respective linear models). Potential variables to be included in the models were year, month, area (Southeast Florida or the Florida Keys), adjusted trip type, and the number of anglers. The number of anglers was subdivided into 5-angler bins and then by 10 anglers per bin. However, there were only two trips in the 70-79 angler bin and so that bin was grouped into a 60+ angler bin. Time fished is not recorded for each headboat trip, but the trip type contains the trip duration in hours; half day trips were assumed to have fished five hours, three-quarter day trips fished seven hours, full day trips fished for nine hours, and multi-day trips fished for 12 hours per day. The use of categories can account for non-linearity in the catch-rate response. In SEDAR 19, the response variable was the number fish per trip per angler-hour while in the current analysis, the response variable is the number of Black Grouper per trip and the components of effort (the number of anglers and time) are included in the model only if they meet the criteria for including variables given below.

The submodels used a forward stepwise process to identify which variables to include in the respective submodels. For a variable to be included in the final model, the variable had to meet two criteria: the variable had to be statistically significant at the 0.05 level (chance of observing value if its actual value was zero) and it had to reduce the deviance (a measure of the variability) by at least 0.5%.

To calculate the year-specific index and its variability, a Monte Carlo simulation approach was used with 10,000 iterations that used the least-squares mean estimates and their standard errors from the GLIM models. Each iteration used the annual least-squares mean catch rate and added uncertainty that was calculated by multiplying the standard error by a random normal deviate (μ=0, σ=1). As described above, these values were converted back from their linear scale and multiplied together.

5.4.2.2 Sampling Intensity and Time Series

Final data were available for the 1986-2015 time period (Table 5.8.3). There were 4,040 headboat trips in Southeastern Florida, the Florida Keys, and the Dry Tortugas that landed Black Grouper out of 47,380 trips. The Stephens and MacCall process selected 4,033 trips and of those trips, anglers on 1,554 trips landed Black Grouper (an average of 39%). Thus, the estimated effort for Black Grouper was almost three times that of the trips landing Black Grouper confirming that just using Black Grouper trips would have underestimated that effort that was expended for Black Grouper.

5.4.2.3 Size/Age Data

No size or age data were available, although the analyses were restricted to retained (legal-sized) catch.

5.4.2.4 Catch Rates – Number and Biomass

Standardized catch rates are presented in Table 5.8.3 and Figures 5.9.6 and 5.9.7. Catch rates were variable and without trend.

5.4.2.5 Uncertainty and Measures of Precision

Annual coefficients of variation are presented in Table 5.8.3. The coefficients of variation were reasonable ranging from 0.10 to 0.23, with the exception of 1990 (2.75) where only three trips were included in the analysis.

5.4.2.6 Comments on Adequacy for Assessment

This index was recommended for use in the assessment.

5.5 RESEARCH RECOMMENDATIONS

Only one fishery-independent index was available for Black Grouper (Reef Visual Census), and that index may suffer from hyperstability because it is limited primarily to the center of distribution for Black Grouper in the region. Accordingly, the index working group recommends that additional fishery-independent survey effort would be extremely valuable in assessing trends in population abundance of Black Grouper. Such efforts would include an expansion of survey effort beyond the core distribution of the species, including better coverage of the spawning-capable portion of the stock (potentially through the use of expanded underwater video surveys), and efforts to characterize juvenile recruitment.

5.6 DATA BEST PRACTICES COMMENTS AND SUGGESTIONS

None noted.

5.7 LITERATURE CITED

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5.8 TABLES

Table 5.8.1. The Reef Fish Visual Census index, its coefficient of variation, the number of stations sampled, the number of stations where Black Grouper were observed, the RVC index scaled to its mean, nominal index, and the nominal index scaled to its mean.

Year	Number per station	Coefficient of variation	Number of stations	Number of stations with Black Grouper	Index scaled to mean	Nominal index	Nominal index scaled to mean
1997	0.074	0.177	408	43	0.328	0.067	0.412
1998	0.107	0.147	461	64	0.474	0.091	0.557
1999	0.163	0.132	440	76	0.720	0.136	0.829
2000	0.284	0.111	513	104	1.257	0.231	1.411
2001	0.252	0.093	742	155	1.116	0.188	1.151
2002	0.426	0.085	578	142	1.882	0.262	1.601
2003	0.245	0.132	300	59	1.083	0.151	0.923
2004	0.356	0.136	208	52	1.573	0.240	1.469
2005	0.313	0.114	358	85	1.385	0.249	1.519
2006	0.192	0.139	404	59	0.850	0.126	0.771
2007	0.233	0.116	494	91	1.031	0.170	1.039
2008	0.192	0.105	635	111	0.848	0.132	0.803
2009	0.127	0.111	829	113	0.564	0.096	0.586
2010	0.183	0.116	554	91	0.808	0.133	0.811
2011	0.324	0.082	643	175	1.432	0.239	1.459
2012	0.227	0.099	543	118	1.003	0.159	0.973
2013							
2014	0.201	0.140	340	56	0.887	0.142	0.898

Table 5.8.2. The MRFSS/MRIP index, its coefficient of variation, the number of intercepts, the proportion of positive trips (catching Black Grouper), the MRFSS/MRIP index scaled to its mean, nominal index, and the nominal index scaled to its mean.

Year	MRFSS /MRIP Index	Coefficient of Variation	Number of Trips	Proportion of Positive Trips	Index Scaled to Mean	Nominal Index	Nominal Index Scaled to Mean
1991	0.16	0.30	160	20	0.89	0.28	0.83
1992	0.09	0.24	393	32	0.51	0.15	0.46
1993	0.09	0.26	299	28	0.48	0.18	0.53
1994	0.16	0.24	266	32	0.88	0.33	1.01
1995	0.13	0.27	257	26	0.73	0.25	0.74
1996	0.23	0.20	291	48	1.23	0.58	1.74
1997	0.16	0.18	348	62	0.88	0.48	1.44
1998	0.22	0.15	494	83	1.19	0.38	1.15
1999	0.35	0.12	739	132	1.87	0.48	1.45
2000	0.23	0.12	645	134	1.26	0.44	1.32
2001	0.27	0.12	679	138	1.47	0.47	1.40
2002	0.18	0.13	747	119	0.99	0.39	1.19
2003	0.29	0.12	735	152	1.59	0.58	1.76
2004	0.28	0.13	840	127	1.54	0.42	1.25
2005	0.23	0.14	666	96	1.22	0.29	0.87
2006	0.12	0.17	396	62	0.64	0.28	0.84
2007	0.15	0.15	468	89	0.84	0.40	1.21
2008	0.13	0.14	712	100	0.71	0.30	0.91
2009	0.10	0.20	565	44	0.54	0.15	0.45
2010	0.12	0.17	573	61	0.66	0.23	0.68
2011	0.22	0.17	479	67	1.21	0.40	1.21
2012	0.16	0.15	586	88	0.88	0.28	0.84
2013	0.09	0.18	554	57	0.47	0.18	0.53
2014	0.12	0.19	816	52	0.65	0.16	0.49
2015	0.09	0.19	735	49	0.48	0.13	0.40

Table 5.8.3. Standardized headboat index (catch rates), their coefficient of variation, number of trips, and number of positive trips by year.

Year	Index Number per trip	CV	Index Scaled to mean	Number of trips	Number of positive trips
1986	1.96	0.076	1.09	314	143
1987	1.83	0.081	1.01	224	111
1988	1.31	0.126	0.72	94	39
1989	2.14	0.190	1.19	41	19
1990	1.75	0.398	0.97	10	5
1991	1.85	0.106	1.03	101	53
1992	1.89	0.075	1.05	263	138
1993	2.33	0.084	1.29	176	94
1994	1.78	0.097	0.98	193	77
1995	1.88	0.090	1.04	174	83
1996	1.44	0.125	0.80	81	38
1997	1.39	0.096	0.77	158	71
1998	1.79	0.133	0.99	66	32
1999	1.90	0.127	1.05	55	33
2000	1.45	0.118	0.80	73	39
2001	1.78	0.108	0.99	70	48
2002	1.56	0.147	0.86	31	24
2003	1.50	0.148	0.83	32	23
2004	1.95	0.099	1.08	85	56
2005	2.17	0.079	1.20	151	112
2006	1.64	0.085	0.91	124	81
2007	1.63	0.089	0.90	110	76
2008	1.66	0.082	0.92	168	93
2009	1.12	0.135	0.62	139	50
2010	1.76	0.078	0.97	230	117
2011	2.27	0.076	1.26	246	128
2012	1.84	0.067	1.02	434	212
2013	1.73	0.177	0.96	47	29
2014	1.31	0.132	0.72	75	44
2015	1.89	0.144	1.05	60	40
				4025	2108

5.9 FIGURES

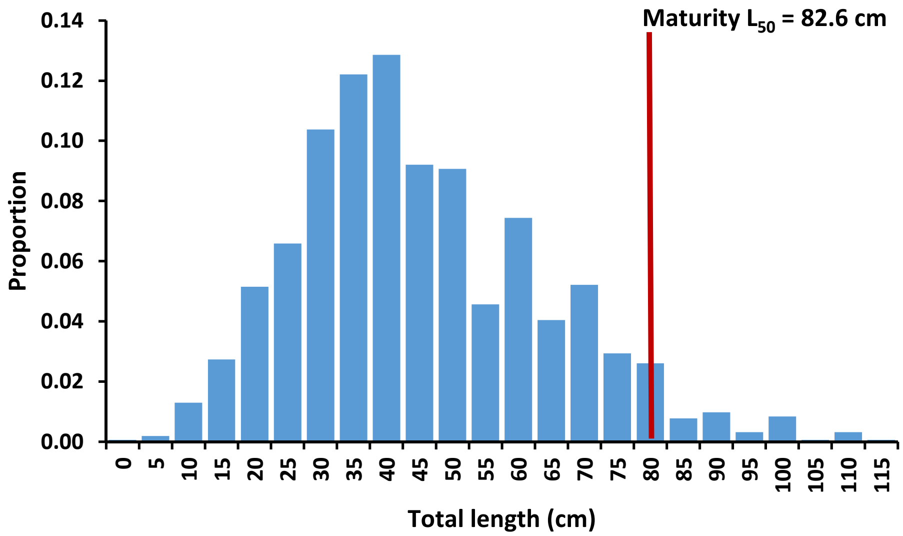

Figure 5.9.1. The distribution of total lengths of Black Grouper estimated *in situ* by Reef Fish Visual Survey divers along the Florida reef track.

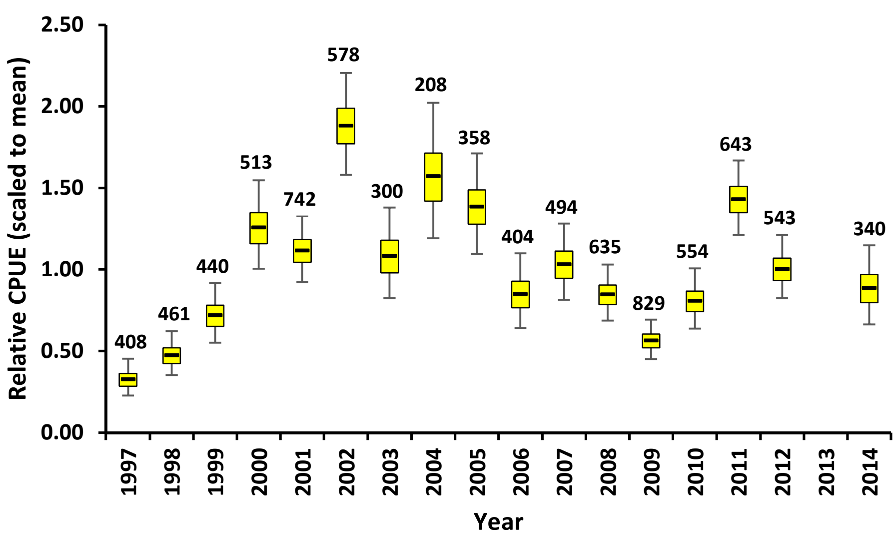

Figure 5.9.2. A box-whisker plot of the Reef Fish Visual Census index by year. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of stations sampled each year is shown above the confidence interval.

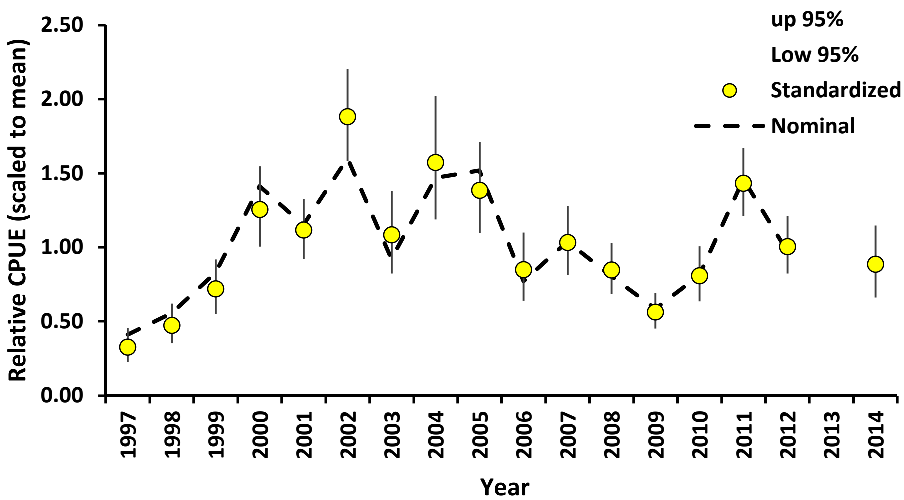

Figure 5.9.3. Comparison of standardized catch rates with their confidence intervals and nominal catch rates by year for the Reef Fish Visual Census index.

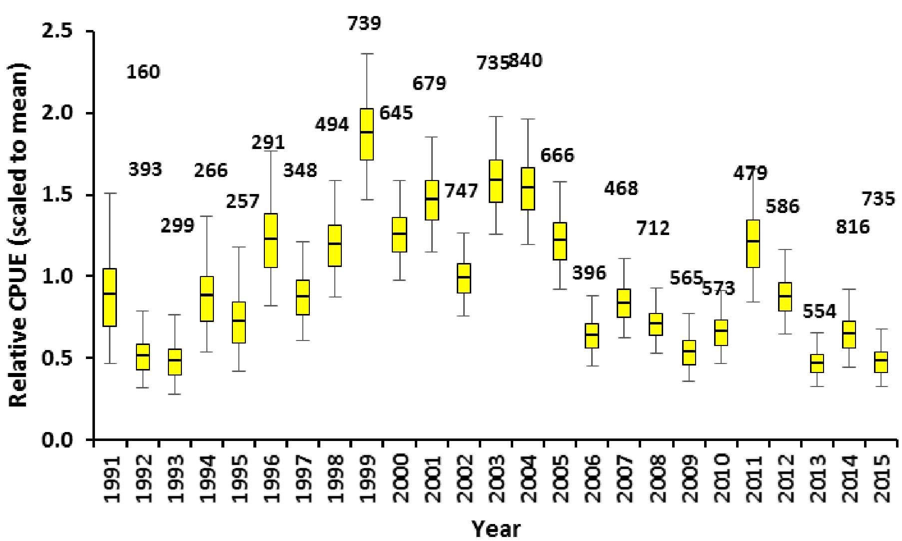

Figure 5.9.4. A box-whisker plot of the MRFSS/MRIP index by year. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of interviews conducted each year is shown above the confidence interval.

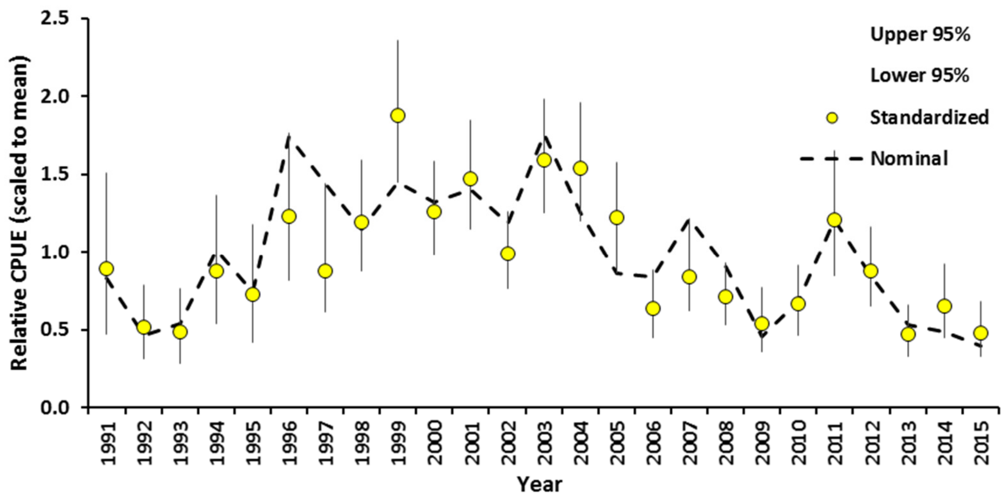

Figure 5.9.5. Comparison of standardized catch rates with their confidence intervals and nominal catch rates by year for the MRFSS/MRIP index.

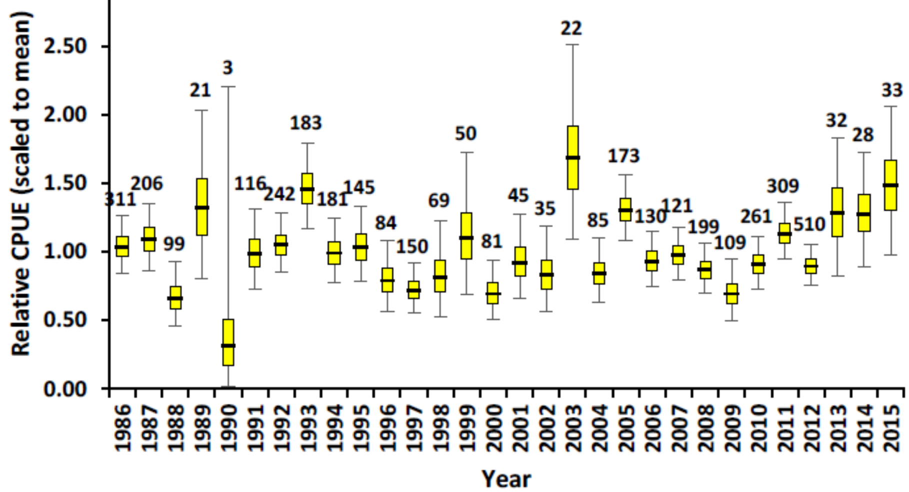

Figure 5.9.6. Box plot of the standardized Black Grouper headboat catch rates. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of trips by year is shown above the confidence interval.

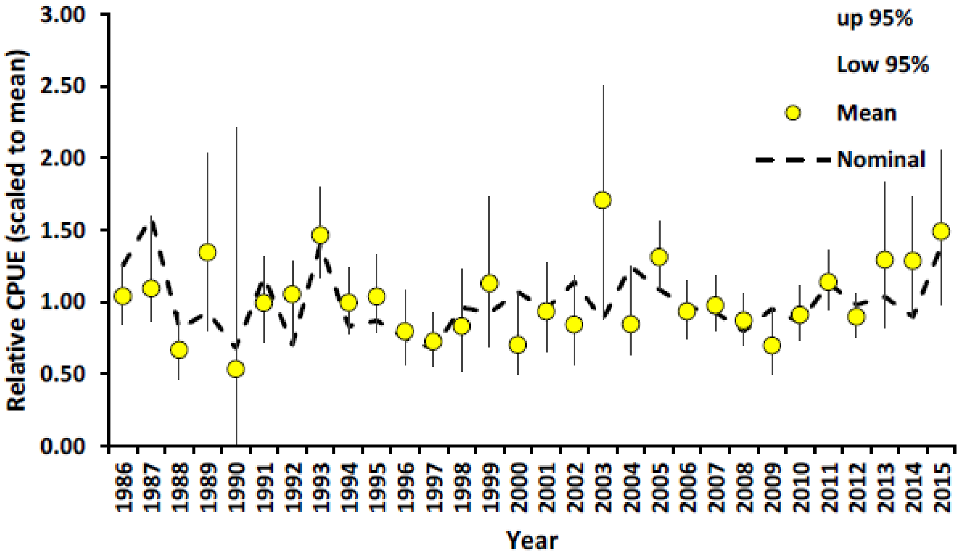

Figure 5.9.7. Comparison of standardized catch rates with their confidence intervals and nomin