SEDAR

Southeast Data, Assessment, and Review

South Atlantic Gag Grouper
Stock Assessment Report

SECTION 2. DATA WORKSHOP

Prepared by the SEDAR10 Data Workshop Panel,
South Atlantic Panel

Final (Draft #5): June 5, 2006

REVISION HISTORY

Draft #1 – February 17, 2006

Initial draft prepared for review by Data Workshop participants.

Draft #2 – March 10, 2006

This revision includes major changes from the initial review.

Draft #3 – April 27, 2006

This revision includes correction to commercial landings (east coast of Florida); updating commercial and recreational length compositions; addition of commercial and recreational age compositions not previously included.

Draft #4 – May 12, 2006

This revision includes complete age compositions plots for both Recreational and Commercial fisheries (regardless of sample size); and the life history section was modified to reflect final values for release mortality used in the stock assessment.

Draft #5 – June 2, 2006

This revision incorporates results of two data decisions from the Assessment Workshop. The first concerns age-varying M based on Lorenzen (1996) (see Section 2.8). The second concerns interpolations of commercial diving landings for embedded years with no reported landings (1977-1978 and 1980) (see paragraph on p. II-40 in Section 3.2). Also, the commercial landings in numbers were miscopied from the excel spreadsheet when updating Table 3.8 for Draft #3 was corrected.

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1. Date Report Introduction

Fishery dependent and fishery independent data for U.S. South Atlantic gag grouper were assembled and analyzed for there usefulness in subsequent stock assessment.

1.1 Workshop Time and Place

The Data Workshop was convened in Charleston, SC, January 23-27, 2006. Data and analyses prepared for the workshop are documented in the SEDAR Working Paper Series (SEDAR10-DW-XX). Following the SEDAR approach, working groups were convened to address specific data issues: life history, commercial catch, recreational catch, and indices of abundance (both fishery dependent and independent). Groups were charged with developing preferred and alternative solutions to each issue, and presenting these solutions to the group for resolution. Groups were also charged with documenting all decisions and preparing report sections according to the SEDAR assessment report outline.

1.2 Terms of Reference, Data Workshop

1. Characterize stock structure and develop a unit stock definition.
2. Tabulate available life history information (e.g., age, growth, natural mortality, discard mortality, reproductive characteristics); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of life-history information for conducting stock assessments and recommend life history information for use in population modeling.
3. Provide measures of population abundance that are appropriate for stock assessment. Document all programs used to develop indices, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Consider fishery dependent and independent data sources; provide measures of abundance by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision. Provide analyses evaluating the degree to which available indices adequately represent fishery and population conditions.
4. Provide commercial and recreational catch, including both landings and discard removals, in pounds and numbers. Evaluate the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible.
5. Evaluate the adequacy of available data for estimating the impacts of past and current management actions.
6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.
7. Provide recommendations for future research and monitoring. Include specific guidance on sampling intensity and coverage where possible.

8. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report) and final datasets in a format accessible to all participants. Report and datasets are due no later than March 31, 2006.

1.3 Data Workshop Participants

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1.4 Data Workshop Working Papers

Document #	Title	Authors
Documents Reviewed at the Data Workshop		
SEDAR10-DW1	Metadata for gag tagging data	McGovern, J., P. Harris
SEDAR10-DW2	Age, Length, and Growth of Gag from the NE Gulf of Mexico 1979-2005	Lombardi-Carlson, L. A., G. R. Fitzhugh, B. A. Fable, M. Ortiz, C. Gardner
SEDAR10-DW3	Update of gag reproductive parameters: Eastern Gulf of Mexico	Fitzhugh, G. R., H. M. Lyon, L. A. Collins, W. T. Walling, L. Lombardi Carlson
SEDAR10-DW4	Standardized Catch Rates of Gag from the United States headboat fishery in the Gulf of Mexico during 1986-2004	Brown, C. A.
SEDAR10-DW5	Description of MARMAP sampling program	Harris, P.
SEDAR10-DW6	Analysis of Prelminary Results for the Release of Satellite-Tracked Drifters over Gag Spawning Sites	Lesher, A. T., G. R. Sedberry

SEDAR10-DW7	Preliminary Notes on FL Gag Data and Trip Ticket Map	Brown, S.
SEDAR10-DW8	Review of Tagging Data for gag grouper from the Southeastern Gulf of Mexico region 1985-2005	Ortiz, M. K. Burns, J. Sprinkel
SEDAR10-DW9	Standardized catch rates for gag grouper from the MRFSS	Ortiz, M.
SEDAR10-DW10	Standardized catch rates for gag grouper from the United States Gulf of Mexico handline fishery during 1993-2004	McCarthy, K. J.
SEDAR10-DW11	Estimates of gag grouper discard by vessels with Federal Permits in the Gulf of Mexico	McCarthy, K. J.
SEDAR10-DW12	NOAA Fisheries Reef Fish Video Surveys: Yearly indices of abundance for Gag	Gledhill, C. T., G. W, Ingram, K. R. Rademacher, P. Felts, B. Trigg.
SEDAR10-DW-13	Report of a gag age workshop	Reichert, M., G. Fitzhugh, J. Potts
SEDAR10-DW-14	QA/QC procedures used for TIP online data	Gloeckner, D.
SEDAR10-DW-15	Analytical report on the age, growth, and reproductive biology of gag from the Southeastern United States	Reichert, M. , D. Wyanski
SEDAR10-DW-16	Gag history of management in the Gulf of Mexico	Rueter, J.
SEDAR10-DW-17	Overview of gag material in Draft SAFMC Snapper-Grouper Amendment 13B	Waugh, G.
SEDAR10-DW-18	Standardized catch rate indices for gag grouper landed by the US Gulf of Mexico longline fishery during 1993-2004	Cass-Calay, S. L.
SEDAR10-DW-19	Standardized catch rates of gag from the commercial handline fishery off the Southeastern United States	Shertzer, K.
SEDAR10-DW-20	Standardized catch rates of gag from the headboat fishery off the Southeastern United States	Cheshire, R., K. Shertzer
SEDAR10-DW-21	Recreational landings and length data summary for South Atlantic gag (DELETED FOLLOWING WORKSHOP DUE TO INCLUSION OF CONFIDENTIAL DATA)	Cheshire, R, and D. Vaughan
SEDAR10-DW-22	Commercial landings and length data summary for South Atlantic gag. (DELEDTED FOLLOWING WORKSHOP DUE TO INCLUSION OF CONFIDENTIAL DATA	Gloeckner, D., D. Vaughan
SEDAR10-DW-	Effect of some variations in sampling	Chih, C-P

23	practices on the length frequency distribution of gag groupers caught by commercial fisheries in the Gulf of Mexico	
SEDAR10-DW-24	Estimation of species misidentification in the commercial landing data of gag groupers and black groupers in the Gulf of Mexico	Chih, C-P., S. Turner
SEDAR10-DW-25	Habitat use by juvenile gag in subtropical Charlotte Harbor, FL.	Casey, J. P., G. R. Poulakis, P. W. Stevens
SEDAR10-DW-26	Recreational survey data for gag and black grouper in the Gulf of Mexico.	Phares, P., V. Matter, S. Turner
SEDAR10-DW-27	Spatial distribution of headboat trips from the Florida Keys	Matter, V. M.
SEDAR10-DW-28	Species ID south atlantic – ETA 1 week post workshop	Chih
SEDAR10-DW-29	Council Boundaries	anon
SEDAR10-DW-30	Annual indices of abundance for gag from Florida Estuaries	Igram, W., T. Macdonald, L. Barbieri
SEDAR10-DW-31	Age composition information South Atlantic	Potts, J.
Research Documents		
SEDAR10-RD01	Exegeses on Linear Models	Venables, W.N.
SEDAR10-RD02 1977	A reformulation of Linear Models J. Royal Stat. Soc. A 140(1):48-77	Nelder, J. A.
SEDAR10-RD03 1999	Stock identification of gag along the Southeast coast of the United States Mar. Biotechnol. 1, 137-146.	Chapman, R. W., Sedberry, G. R. , C. C. Koenig, B. M. Eleby
SEDAR10-RD04 2005	A tag and recapture study of gag off the Southeastern US Bull Mar Sci 76(1)47-59.	McGovern, J. C.,et al
SEDAR10-RD05 1983	Empirical use of longevity data to estimate mortality rates FishBull 82(1)898-903	Hoenig, J.M.
SEDAR10-RD06 2005	Bycatch, discard composition, and fate in the snapper grouper commercial fishery, North Carolina NCSU/CMAST Proj 04-FEG-08	Rudershaussen, P. J., A. Ng, A. Ng, J. A. Buckel

1.5 Management History

This section consists of a series of tables that summarize various aspects of south Atlantic gag grouper management, including general management information (Table 1.1), specific management criteria (Table 1.2), stock rebuilding information (Table 1.3), stock projection information (Table 1.4), and regulatory history (Table 1.5).

Table 1.1. General Management Information

Species	Gag (*Mycteroperca microlepis*)
Management Unit	Southeastern US
Management Unit Definition	All waters within South Atlantic Fishery Management Council Boundaries
Management Entity	South Atlantic Fishery Management Council
Management Contact	Gregg Waugh/Rick DeVictor
Current stock exploitation status	Overfishing (Post-SFA)
Current stock biomass status	Not overfished (Pre-SFA); Unknown (Post-SFA)

Table 1.2. Specific Management Criteria

Current and proposed management criteria for the gag stock in the south Atlantic as specified by the Council. Snapper Grouper FMP Amendment 11 specified the current definitions for all the criteria. The 1998 assessment (Potts and Manooch, 1998 provided the value of M).

Criteria	Current		Proposed	
	Definition	Value	Definition	Value
MSST	$(1\text{-}M)B_{MSY}$	Not specified	$(1\text{-}M)B_{MSY}$*	UNK (SEDAR 10)
MFMT	$F_{30\%SPR} = F_{MSY}$	F=0.18	F_{MSY}	UNK (SEDAR 10)
MSY	Yield at F_{MSY}	Not Specified	Yield at F_{MSY}	UNK (SEDAR 10)
F_{MSY}	$F_{30\%SPR}$	F=0.18	F_{MSY}	UNK (SEDAR 10)
OY	Yield at F_{OY}	Not Specified	Yield at F_{OY}	UNK (SEDAR 10)
F_{OY}	$F_{45\%SPR}$	Not Specified	F_{OY} = 65%,75%, 85% F_{MSY}	UNK (SEDAR 10)
M	n/a	0.15	SEDAR 10	UNK (SEDAR 10)

Following SEDAR 10, the Council may want to consider alternative definitions of MSST. For example, if the assessment determines that M is very small, the Council may want to consider changing MSST to 0.75 B_{MSY}, 0.50* B_{MSY}, or some other definition.

Table 1.3. Stock Rebuilding Information

Rebuilding Parameter	Value
Rebuilding Plan Year 1	1991
Generation Time (Years)	UNK
Rebuilding Time (Years)	15*
Rebuilding Target Date	Dec. 31, 2006
$F_{rebuild}$	UNK
Time to rebuild @ F=0 (Years)	UNK

*The 15 year rebuilding schedule was established under Pre-SFA conditions.

Table 1.4. Stock projection information.

First Year of Management	2007
Projections for interim years should be based on	Exploitation rate
Projection criteria values for interim years should be determined from	Average of previous 3 years

Table 1.5. Regulatory History

Description	FMP/Amendment	Effective Date
4” Trawl mesh size	Snapper-Grouper FMP	8/31/1983
Prohibit trawls	Snapper Grouper Amend 1	1/12/1989
Required permit to fish for, land or sell snapper grouper species	Snapper Grouper Amend 3	1/31/1991
Prohibited gear: fish traps except bsb traps north of Cape Canaveral, FL; entanglement nets; longline gear inside 50 fathoms; bottom longlines to harvest wreckfish; powerheads and bangsticks in designated SMZs off S. Carolina. Established 20” TL minimum size and a 5 grouper bag limit.	Snapper Grouper Amend 4	1/1/1992
Oculina experimental closed area.	Snapper Grouper Amend 6	6/27/1994
Limited entry program; transferable permits and 225 lb non-transferable permits.	Snapper Grouper Amend 8	12/14/1998
24” TL size limit; no harvest or possession > bag limit, and no purchase or sale, during March and April. Vessels with longline gear aboard may only possess snowy grouper, warsaw grouper, yellowedge grouper, misty grouper, golden tilfefish, blueline tilefish, and sand tilefish.	Snapper Grouper Amend 9	2/24/1999
Approved definitions for overfished and overfishing. MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}. MFMT = F_{MSY}	Snapper Grouper Amend 11	12/2/1999
Extended for an indefinite period the regulation prohibiting fishing for and possessing snapper grouper species within the *Oculina* Experimental Closed Area.	Snapper Grouper Amend 13A	4/26/2004

References

Potts, J. C. and C. S. Manooch, III. 1998. Population assessment of the gag, *Mycteroperca microlepis*, from the southeastern United States. South Atlantic Fishery Management Council, Charleston. 73 p.

2. Life History

2.1. Mortality Estimates – Total, Natural, and Release

2.1.1. Juvenile (YOY)

Mortality rates of juvenile gag were examined in shallow seagrass beds located on the northwest coast of Florida using catch curve analysis (regression of CPUE over sampling period). Daily instantaneous mortality (Z) ranged from 0.0027 to 0.0032, suggesting that daily mortality was less than 1% per day at all sampling stations (Koenig and Coleman 1998). Similar to other early life estimates of mortality, early life estimates of Z may be affected by emigration or immigration from juvenile habitats. These juvenile Z values will be taken into account when analyzing data for age-varying M, such as the Lorenzen (1996) model.

2.1.2. Sub-adult/Adult

Maximum age of gag in Gulf of Mexico is 31 years (SEDAR10-DW2) while estimates in the South Atlantic range from 26 (SEDAR10-DW15) to 30 years (SEDAR10-DW31). Using this information, natural mortality (M) of gag was estimated using the regression model reported by Hoenig (1983) for teleosts: $\ln(M) = 1.46-1.01*\ln(t_{max})$. It should be noted that the Data Workshop (DW) did not use the alternative "rule of thumb" approach for estimating M from longevity ($M=2.98/t_{max}$, Quinn and Deriso 1999, Cadima 2003). Recent work by Hewitt and Hoenig (2005) recommend the regression model over the rule-of-thumb approach. Using Hoenig's regression approach, natural mortality of gag was slightly lower in the Gulf (M = 0.13) than the South Atlantic (M = 0.14-0.16). Natural mortality was also estimated using a variety of models based on von Bertalanffy growth or reproductive parameters (e.g., Jensen 1996). Using these alternative models, M ranged from 0.15-0.22 and 0.17-0.33 in the Gulf of Mexico and South Atlantic, respectively. Estimates of natural mortality recommended by the DW are consistent with recently published mortality data (e.g., McGovern et al. 2005) as well as those applied in the previous gag assessment.

Recommendations:

1.) Use a baseline estimate of 0.15 for the initial evaluations for both the Gulf of Mexico and South Atlantic.
2.) For sensitivity analysis, the DW recommended the following ranges of M: Gulf of Mexico (0.10 and 0.20) and South Atlantic (0.10 and 0.25). The upper range of M in the South Atlantic is higher due to estimates of M from models using the von Bertalanffy parameters.
3.) Following the DW, investigate age-varying M models and their appropriateness.

Estimates of total instantaneous mortality (Z) have been reported from recapture data and catch curves. McGovern et al. (2005) reported Z values of 0.38 (recapture data) and 0.40 (catch curves) for gag from the southeastern U.S. Using data in the

SEDAR10-DW2 document, the DW estimated Z values for a range of strong year classes or cohorts (1985 = 0.60, 1989 = 0.53, 1993 = 0.30, and 1996 = 0.52) in the Gulf of Mexico (based on individuals ~ 4-12 years). Catch curve estimates of Z ranged from 0.30-0.62 among individual cohorts. Combining all cohorts for the 4-12 year age interval, an overall Z of 0.52 was observed. A catch curve was also developed for gag 13-25 years, and Z (0.21) was markedly lower than the estimate for individuals in the 4-12 year age interval.

2.1.3. Release Mortality

A previous gag population assessment for the South Atlantic used release mortality rates of 20% and 50%. The first value was from surface observations of released fish on Headboat fishing trips, and the latter value was used because it was expected that mortality would be higher than what was observed at the surface (Robert Dixon, NMFS, Beaufort, NC, *pers. comm.*.; Potts and Manooch 1998). The 2001 Gulf of Mexico gag assessment used discard mortality rates of 20% for the recreational fishery and 30% for the commercial fishery based on different depths fished and an apparent increase in discard mortality rate with increasing depth (Turner et al. 2001). Recent work provides updated information on discard mortality in the South Atlantic and Gulf of Mexico. Discard mortality studies focusing on undersized gag utilized multiple techniques including observational indices (Rudershausen et al. 2005), tag release comparison (Burns et al. 2002; McGovern et al. 2005), and caging observations (Burns et al. 2002; Overton and Zabawski 2003).

A study by Rudershausen et al. (2005) reported pressure related effects, expressed as gastric distension and bleeding, on gag (n = 101) collected off North Carolina from depths ranging from 19-85 m (mean=29 m). Compared to five other species collected in the same study, gag exhibited the second highest rate of gastric distension (37.6%) and the highest occurrence of bleeding (16.8%). Of 29 gag released, all oriented and swam towards the bottom; only 5 were judged to swim in an erratic manner (condition 1 and 2; Patterson et al. 2000). However, gag with gastric distention or bleeding, if released, were expected to experience higher post-release mortality than predicted by the surface observations.

Improved estimates of post-release mortality were obtained through tag release and caging methods (Burns et al. 2002; Overton and Zabawski 2003; McGovern et al. 2005). Using these methods, mean mortality rates were estimated to be 21.2% for depths <35 m (Overton and Zabawski 2003), 23% over a variety of depths (McGovern et al. 2005), and 100% for depths >50 m (Wilson and Burns 1996).

Release mortality rates displayed a positive relationship (logistic regression) with depth, increasing from 14.2% at 15 m to 94.8% at 95 m with a 50% mortality rate at 45.5 m (McGovern et al. 2005). Burns et al. (2002) combined tag release comparison and caging observation methods to estimate discard mortality rate and found 50% mortality at a similar depth (47 m). The depth at 50% swimbladder rupture (47 m) was also similar to that for 50% mortality (Burns et al. 2002).

Vented gag showed increased survivorship compared to non-vented gag based on recapture data with all depths grouped. When recapture rates were stratified by depth, only the shallowest depth (0-12.2 m) had a significant difference between the vented and non-vented gag (Burns et al. 2002).

At depths less than 20 fm (37 m, inner shelf) where survival upon release is likely to be relatively high (about 50% or better survival with proper handling), ages and sizes of gag landed are consistently (in Gulf and SA) more truncated than at deeper depths (Figures 2.1-2.3). At depths greater than 40 fm, (73 m, outer shelf and upper slope) release mortality is likely to be quite high with little to no chance for survival. However, numbers of gag (in the compiled age-structure data) declines in this deepest zone compared to shallower depths; sizes and ages tend to increase compared to shallower depths (thus fewer potential discards, especially for the Gulf, Figure 3) and there appears to be a switch to landings dominated by long-line gear in the Gulf (Figure 2.4). Estimates of release mortality between the depths of 20-40 fm (37- 73 m, mid to outer shelf) are likely to be of *greatest concern* because this is the zone in which evident increases in release mortality (>50%) coincides with increasing depth. Also, compiled data from the Gulf and SA show that high numbers of gag from very broad age and size ranges can be harvested at 20-40 fm (Figures 2.1-2.3); thus undersized gag will be taken and will be at significant risk of mortality upon release. These suppositions are based upon example depth data accompanying biological samples. Conclusions may change when more complete landings data (by depth if available) are reviewed. The DW recognized that functional relationships of depth and release mortality potentially offers improved information over the use of simple point estimates of mortality representing broad depth intervals.

Recommendation:
The DW recommended further investigation into the practicality of applying depth-mortality functions as the assessment proceeds. Since discard mortality functions by depth were very similar between the Gulf of Mexico (Burns et al. 2002) and the South Atlantic (McGovern et al. 2005), a single function may apply to both unit stocks. Workgroup discussions then centered on the issue of whether it may be feasible to use age/length data and depths associated with discards or perhaps depth trends by fishery sector to estimate release mortality using these functions. Analysis is underway and will be made available to the assessment group prior to the Assessment Workshop. If a single function cannot be derived, then the group will further discuss options for release mortality values based on fishery sector.

If lack of adequate depth of fishing information from the various fisheries for gag in the South Atlantic makes the analysis difficult, the group recommended two values of release mortality. For the recreational fisheries (MRFSS and Headboat), release mortality should be set at 0.25. For the commercial fishery, release mortality should be set at 0.40. The group felt release mortality in the recreational fishery for gag would be lower than the commercial fishery because the recreational fishery tends to fish in shallower waters and inland than the commercial fishery. Also, handling and time spent by gag on deck in the commercial fishery may increase mortality of fish being released.

2.2 Age Data

2.2.1. Age Structure Samples

Three sets of age data were brought to the DW. Contributors included NMFS Panama City with data from the Gulf of Mexico commercial and recreational fisheries, NMFS Beaufort with data from the U.S. South Atlantic commercial and recreational fisheries, and SCDNR/MARMAP with data from the U.S. South Atlantic commercial and recreational fisheries and fishery-independent surveys, combining for a total of about 22,000 gag age estimates. Brief characterization of sampling and related issues follows:

Gulf of Mexico (SEDAR10-DW02)

Issues:
1.) Pre-1998 samples sizes of long-line collected otoliths were low compared to recent years.
2.) Throughout the time series the recreational industry, and in particular the private sector, was not well represented (n<200, 1991-2005). 3.) Fishery independent samples were also not well represented throughout the time series (n<500, 1991-2005).

Recommendations:
1.) Conduct further review of current sampling methodologies by sector, including detailed comparison of length data from otolith samples and from more expansive port-based length sampling (via TIP; see SEDAR10-DW24).
2.) Bring increased attention to the need for strategies to improve port sampling (representation of fishery sectors and random sampling)
3.) Increase the sampling of the recreational sector for biological samples throughout the docks and ports of Florida's west coast.
4.) Continue support of fishery-independent surveys including all gears (hand-line, long-line, and trap) throughout the west Florida shelf.
5.) Recognize that gag landings may be increasing elsewhere in the Gulf and bring increased attention to sampling the northern and western Gulf regions.

South Atlantic (SEDAR10-DW15, SEDAR10-DW31)

Issues:
Data collected by NMFS Beaufort was dominated by samples from the east coast of Florida from two major time periods (1976-1986; 1992-2004). The earlier time period collected mainly from the recreational sector whereas more recent years were from the commercial sector. Data were collected by SC-DNR throughout the region (NC through central FL), with most samples collected off the Carolinas. Most of these samples originated from the commercial sector during an intensive sampling period approximately every 10 years (1977-82, 1994-95, and 2004-05). In 2004-2005, SC-DNR employed commercial fishers under a special permit to collect all

sizes of fish (including undersized fish), and collections were made throughout the closed season.

The assignment of an otolith edge type, which allows estimates of annual (calendar) ages and biological (fractional) ages, has changed at SCDNR. Edge type are available for all aged fish collected after 1995, some edge types from samples collected in 1994-95 are available, and all samples collected after 1995 contain edge type information. This restricts the combination of data pre-1996.

Recommendations:
1.) The DW recommended combining the datasets from NMFS Beaufort and SCDNR to increase sample size, improve temporal coverage and growth pattern analysis.
2.) Continue with annual sampling for age structure with increased attention to representative sampling as above.
3.) SCDNR to include additional edge information based on available increment measurements to allow for age advancement, this will result in additional age data for 495 fish collected in 1976-1982, and for 763 fish collected in 1994-95 (this was completed post-DW and made available February16, 2006).
4.) SCDNR may be able to re-examine preparations to add edge information to allow for age advancement however, this will entail additional effort. (Data will be made available by February 17, 2006.)

2.2.2. Age Reader Precision

In September 2005, representatives of these three principal gag aging labs held a workshop to compare otolith interpretation, methods, and readings of gag otoliths for age estimates. Workshop results indicated that all labs use comparable procedures and methods for otolith examination. Furthermore, there was a high level of agreement and precision among readers from all labs and there was no appreciable reader bias evident from reader contrasts (SEDAR10-DW13).

Issue:
Differences in otolith interpretations and methodologies in the past have led, in some instances, to incompatible datasets.

Recommendation:
To continue exchanges of calibration otoliths sets and age workshops among state and federal agencies, and universities to continue improvements of data comparability and quality control.

2.2.3. Age Patterns

Gag year-class trends have been apparent for the Gulf of Mexico and the South Atlantic due to the ease of aging gag and the availability of a continuous series of age

structure sampling from 1991 to 2005 from the Gulf, and 1981 to 1986 and 1999 to 2003 from the Atlantic. Strong year classes evident in the Gulf of Mexico were 1985, 1989, 1993, 1996, 1999, and possibly 2000. Strong year classes in the U.S. South Atlantic were 1974, 1978, 1981, 1990, 1994 and 1996. The available overlapping years for the Gulf and South Atlantic revealed similar age progression and a relatively strong 1996 year class in both regions. This further suggests that annual recruitment trends may be similar in both regions. The DW recommends that age structure sampling continue on an annual basis for both regions.

Contributors of the three age data sets found similar age ranges – 1-31 years, 0-30 years and 1-26 years, (NMFS Panama City, NMFS Beaufort, and SCDNR/MARMAP, respectively) – but did note differences in size-at-age and different maximum size between the Gulf of Mexico and the U.S. South Atlantic (SEDAR10-DW2, SEDAR10-DW15, SEDAR10-DW31).

2.3. Growth

There have been several growth studies on gag in the Gulf of Mexico and South Atlantic (see citations within SEDAR10-DW2, SEDAR10-DW15, and SEDAR10-DW31). The updated data sets provided increased sample sizes for improved temporal coverage and contrasts. Growth models can be influenced by the use of size-biased samples, for example, due to minimum size-limits affecting fishery-dependent sampling. Thus, a modified von Bertalanffy growth model accounting for size limited data was used for the Gulf of Mexico (1991-2005, n=16,147) and South Atlantic (1976-2005, n=5,734; Diaz et al. 2004). Model fits used area, sector and temporal specific size-limits (GOM: 1990-2000 all sectors 20 inches, 2000-2005 recreational 22 inches, 2000-2005 commercial 24 inches; SA 1992-1998 all sectors 20 inches, 1999-2005 all sectors 24 inches).

The model was fit to observed lengths and fractional ages. Gag data from the entire time series were fit to the modified von Bertalanffy growth model (TL mm), separately by area (GOM, SA), to obtain population growth parameters for each area. The modified growth model resulted in an asymptotic length within the range of observed lengths (GOM: L_∞=1310 mm, TL range 245-1384 mm; SA L_∞=1051 mm, TL range 215-1300 mm), growth coefficients (GOM: k = 0.14 yr^{-1}; SA: k=0.24 yr^{-1}) and predicted t_o close to zero (GOM: t_o =-0.37 yr; SA: t_o =-0.48 yr).

Issues:
SCDNR analysis of size-at-age data and von Bertalanffy growth among the three periods (1979-82, 1994-95, and 2004-05) using increment counts and non-weighted data indicated possible temporal patterns in growth (SEDAR10-DW15, SEDAR10-DW31). However, data from NMFS-Beaufort did not show similar patterns.

Recommendations:
Analysis of combined South Atlantic datasets (SCDNR, NMFS Beaufort) for size-at-age and growth with various versions of the von Bertalanffy growth model using unweighted and weighted data will be completed prior to assessment workshop. (Data analysis will be made available by the end of February 2006.)

2.4. Reproduction

There have been several investigations of the reproductive biology of the gag in the U.S. South Atlantic and eastern Gulf of Mexico. Studies have addressed reproductive seasonality, spawning depth, sex ratio, sexual maturity, sexual transition (from female to male), aspects of the mating system, principal spawning habitats and regions, behavior, coloration, reproductive endocrinology, fecundity and spawning frequency (see citations within SEDAR10-DW3 and SEDAR10-DW15). The review below presents a summary of gag reproductive parameters that are most relevant for stock assessment. Topics are discussed jointly for U.S. South Atlantic and eastern Gulf of Mexico.

2.4.1. Spawning Seasonality

Spawning season in the South Atlantic was estimated to extend from mid-January to early May (with a peak in March-April), corresponding to a 114 d spawning duration (SEDAR10-DW15). In the eastern Gulf of Mexico the spawning season was estimated to extend from late January to mid-April (with a peak in March), corresponding to a 91 d spawning duration (SEDAR10-DW3). For both areas, delineation of the spawning season was based on the presence of females in spawning condition (i.e., ovaries containing hydrated oocytes or postovulatory follicles).

2.4.2. Sexual Maturity

Gag are known to be protogynous hermaphrodites (female first, changing to male later in life). Consequently, sexual maturity is reported for females only. Male sexual maturity is being addressed under "Sexual Transition" below.

Although data for the South Atlantic (mostly fishery-dependent) suggested temporal changes in size- and age-at-maturity (Table 2.1.; SEDAR10-DW15), discussion by the Life History Working Group could not resolve the issue of whether these changes were real or a reflection of temporal changes in size limits. Data from the Gulf of Mexico (collected during 1991-2002; SEDAR10-DW3) indicated no temporal changes in size- and age-at-maturity for gag. Size at maturity for Gulf of Mexico gag was 585 mm TL corresponding to an age-at-maturity of 3.7 yrs. These estimates are similar to, or perhaps slightly smaller than, size at maturity reported previously in US waters of the Gulf of Mexico.

Recommendations for South Atlantic:

1.) Provide an estimate of length and age at 50% maturity (L_{50} and A_{50}) for the entire time period (i.e., mean and variance for the data pooled over years). The pooled length and age at 50% maturity estimates are 648 mm TL (3.0 yr). Also, further analysis of data using a modified logistic model that takes into account minimum size regulations will be done following this workshop.

2.) Provide estimates of L_{50} and A_{50} for each of the time periods sampled. Estimates for the 3 separate time periods can be found in SEDAR10-DW15, as well as parameter estimates for each period and periods combined.

2.4.3. Sexual Transition

Similar to what we observed for "Sexual Maturity" data for the South Atlantic showed evidence of temporal change in size and age at sexual transition for gag. Histological examination of 1,128 sexually mature gag collected during 2004-05 revealed that the percentage of males and transitionals increased from 5.5% in 1994-95 (see McGovern et al. 1998, cited in SEDAR10-DW15) to 8.2%. The current percentage of males and transitionals is still much lower than the revised estimate of 19.4% for samples collected during 1977-82; McGovern et al. (1998) reported 21.1% males and transitionals in the 1976-82 samples. However, similar to the approach we took for "Sexual Maturity", we are providing a single estimate for size and age at transition: 1,025 mm TL for length at 50% transition and 10.5 yr for age at 50% transition. Estimates for the 3 separate time periods can be found in SEDAR10-DW15.

Data for the Gulf of Mexico (collected during 1991-2002, see SEDAR10-DW3) showed no evidence of temporal changes in size and age at transition (compared to Hood & Schlieder's data from 1977-80, cited in SEDAR10-DW3). Additionally, the histological and visual analyses of female size at transition to male (i.e., visual identification of "copperbellies") yielded very similar results. Based on histological criteria, size at 50% transition was 1100 mm TL, and based upon visual pigmentation size at 50% transition was 1085 mm TL. In both analyses, transition appeared to begin after 800 mm TL and nearly all gag had undergone transition upon reaching 1300 mm TL. Age at 50% transition was 10.8 years. Transition to "copperbelly" pigmentation began at age 7 and nearly all fish were pigmented after about 15 years of age.

2.4.4. Batch Fecundity

Very consistent parameter estimates were found for Gulf and South Atlantic stocks.

South Atlantic: Batch fecundity as a function of total length did not differ between the three time intervals (Jan-Feb, Mar, and Apr-May), as indicated by the lack of differences in slopes (F=0.05; P=0.956; df=2) and intercepts (F=2.62; P=0.078; df=2). Given the similarity of the equations, data from all time intervals were combined. Linear regression parameters for the relationships between BF and fish size and age can be found in SEDAR10-DW15.

Gulf of Mexico: Batch fecundity (BF) increased with age and length of females, ranging from 60 thousand to 1.7 million ova per batch with a mean of 422 thousand ova (sd = 295 thousand). Variation in batch fecundity was generally high among age and size classes but the variation explained by linear fits of batch fecundity regressed on age and size were similar (r^2 = 0.30 and 0.34 respectively). As is common among fishes, the batch fecundity relationship was best predicted by regression with (ovary free) body weight (r^2= 0.53). This is similar to results given in Collins et al. (1998) but expands the sample size of hydrated females. Linear regression parameters for the relationships between BF and fish size and age can be found in SEDAR10-DW3.

2.4.5. Spawning Frequency

South Atlantic: for a spawning season of 114 days the spawning frequency was estimated to be 1 spawn every 2.5 days (corresponding to 38 spawning events per season). See SEDAR10-DW15.
Gulf of Mexico: for a spawning season of 91 days the spawning frequency was estimated to be 1 spawn every 3.7-4.0 days (corresponding to 23-25 spawning events per season). See SEDAR10-DW3.

Recommendation:
Given that there is little evidence in both regions for an age effect on spawning frequency in both regions, annual fecundity at age would merely be the product of the expected number of spawns per female per season multiplied by batch fecundity at age.

2.5. Movements and migrations

The DW reviewed the results of two relatively large gag tagging studies. The objective was to gauge the degree of exchange between Atlantic and Gulf stock units. Approximately 6,500 gag were tagged primarily on the west Florida shelf, resulting in over 600 recaptures exhibiting limited movements (80% within a 9 km radius; SEDAR10-DW8). No movement was detected between the west Florida shelf and Atlantic stock units in this study. Most of these fish were recreational tag and recaptures and predominately showed ontogenetic movements from coastal to deeper waters of the shelf. In contrast, a South Atlantic tagging study (3,876 tags, 435 recaptures) reports a much higher proportion of fish moving a greater distance (23% over 185 km), primarily from the Carolinas towards the south to the Florida east coast (McGovern et al. 2005). There were several fish tagged in the South Atlantic that were recaptured from the Keys to the west Florida shelf.

Depth of tagging and size of fish appears to explain the different results from these two studies. In the Gulf tagging study, the modal size of tagged gag was approximately 400 mm. In the South Atlantic study, fish were tagged primarily from commercial boats across a broad depth range; fish were notably larger, ranging in mean size from 578-832 mm TL across 10-m depth categories. Mean distance moved was significantly greater for gag tagged in the 21-40 m depth range. It has also been reported that events such as hurricanes may cause large scale movements in shallow water groupers including gag. Gag were reported to be more abundant in Mississippi, Alabama and NW Florida after Hurricane Eloise in 1985 (Franks 2005).

In general, information suggests an ontogenetic movement to deeper waters; smaller gag (late juvenile to early adult) exhibit relatively high site fidelity with localized movements on the order of a few km. Gag then make larger along-shelf movements upon reaching depths of the mid to outer shelf (mature adults). There is some evidence that upon reaching older ages and outer shelf depths, associated with spawning habitats, gag again exhibit higher site fidelity (Coleman et al. 1996). Fish tagged and recaptured at the

deepest depths (41-80 m) did not exhibit movements as large as those tagged at inner to mid-shelf depths less than 40 m (McGovern et al. 2005). Also, ongoing work suggests copperbelly gag tagged in spawning areas exhibit relatively high site fidelity (Koenig pers.comm.)

Recommendation:
Current data are inconclusive as to whether stock transfer or exchange is taking place between the US South Atlantic and the Gulf of Mexico. Therefore, no rate of migration, stock transfer or exchange should be implemented into the assessment models, and council boundaries should rule as the dividing line of the two stocks.

2.6. Stock definition and recommendations for research

Gag has been managed as separate Atlantic and Gulf stock units, and the SEDAR workshop panel was instructed by the SAFMC and GMFMC to continue with the two US management units in SEDAR 10. However, it was acknowledged that this may change in future assessments. The DW discussed stock identification issues, acknowledging work underway, and made recommendations for further research.

2.6.1 .Otolith Chemistry

Chemical signatures in otoliths have been used recently to discriminate gag from different nursery habitats. Hanson et al. (2004) demonstrated that chemical signatures in otoliths of gag could be used to classify juveniles from four nursery areas along the west coast of Florida (note: classification success ranged 66-100%). Results indicate the approach has promise for determining population structure and the relative contribution of gag from different nurseries. To date, the DW is not aware of reports characterizing chemical signatures in the otoliths of gag from the South Atlantic. If otolith signatures from the Gulf of Mexico and South Atlantic nurseries differ, these natural markers will provide a means of predicting the nursery origin of sub-adult and adult gag (retrospective determination based on quantifying material in the otolith core of sub-adults and adults, which corresponds to the nursery period). In addition, estimates of nursery origin could also be used to characterize population structure and connectivity of the two stocks. The DW recommends continued research on the use of otolith chemistry to evaluate the population structure of gag.

2.6.2. Population genetics

Genetic studies can provide both long-term and short-term estimates of connectivity among regional populations of Gag. Previous studies (Chapman et al 1999) exhibited evidence for population structure among different regions of the Gulf coast and Atlantic coast (a noteworthy result considering the high dispersal potential associated with this species), but significant departures from Hardy-Weinberg equilibrium within these sample groups. These departures from what is considered to be a neutral state assumption could be caused by many different processes such as high variance in reproductive success in individuals from year-to-year or regionally differential reproductive success in a structured population. Research underway addresses these

questions and others associated with spatial and temporal population structure and their relationship to dispersal patterns, reproductive success, and effective population size (N. Jue, Florida State University). A recently funded Sea Grant proposal in South Carolina (Erik Sotka – PI, College of Charleston) will compare genetics of spawning gag captured in 2005 by commercial fishermen (sampled by MARMAP at SCDNR) to juveniles collected in North Carolina and South Carolina in subsequent months to determine the source of recruits, especially to North Carolina sounds. The DW recognizes the value of this research and that this type of genetics work can provide key insight into patterns in gag population structure. The DW further highly recommends every opportunity be taken to add Mexican (Campeche) samples to this analysis as these methods can be most informative in divining patterns of gene flow and population connectivity.

2.6.3. Demographic comparisons

Comparing estimates of growth, maturity, and sex-transition between Gulf and Atlantic management units provides inferences for stock connectivity. However, the DW recognized that subtle differences in methods of sampling, laboratory preparation and parameter estimation can obscure biological differences. The DW recognized that there have been recent workshops with productive outcomes on aging and reproductive assessments, targeting gag and similar species, and recommends that such workshops continue to be undertaken to eliminate potential methodological differences. The DW suggests that it may be particularly valuable to convene a workshop to address the potential non-random and non-representative sampling that hampers collection of small numbers of biological samples (relative to numbers of fish landed) which in turn are used for parameter estimates.

2.6.4. Age structure patterns

Gag year-class trends have been apparent for the Gulf of Mexico due to the ease of aging gag and the availability of a continuous series of age structure sampling from 1991 to 2005. The DW recommends that age structure sampling continue on an annual basis in the Gulf. Availability of age data in the South Atlantic is more episodic. The available overlapping years for the Gulf and South Atlantic revealed similar age progression and a relatively strong 1996 year class in both regions. This further suggests that annual recruitment trends are similar between regions. The DW recommends that long-term continuous monitoring of age structure be undertaken in the South Atlantic to test this hypothesis.

2.6.5. Larval transport and connectivity

It has been hypothesized that there are pathways for larval connectivity and transport from the Gulf to the Atlantic (Powles 1977, Fitzhugh et al. 2005). Exploration using a wind-driven 2-d transport model further supported this hypothesis but was unable to account for cross-shelf transport. In addition, there may be larval connectivity between the southern Gulf of Mexico (Campeche) and the west Florida shelf (Fitzhugh et al. 2005). The DW is aware that oceanographic modeling efforts are advancing (3-d models),and recommends that larval transport and modeling efforts

associated with development of an Integrated Coastal Ocean Observing System (ICOOS) is further supported.

2.6.6. Tagging

Tagging studies are needed to: 1) clarify the extent of movement between the Gulf and SA regions and within region, and 2) aid further development of age-specific estimates of depth-related mortality in the Gulf region. In the SA region, most of the tagging effort has been off South Carolina. Therefore, we recommend that additional tagging be completed off the east coast of Florida to examine the extent of northerly and southerly movements. In the Gulf region, the bulk of the tagging targeted juveniles and young adults in coastal areas, therefore we recommend that tagging effort be extended to the middle and outer shelf, perhaps with the assistance of cooperating commercial fishers, for the purpose of tagging adult gag. The DW recommends that future tagging studies should be done in a more coordinated manner between researchers in the Gulf and SA regions, particularly with respect to gear, fish size, and depth.

2.7. Meristic Conversions

Gulf of Mexico: Meristic relationships were calculated for gag caught in the Gulf of Mexico for length types (total and fork) and body weights (whole and gutted), (Table 2.2). Coefficients of determination were high for linear (length) and nonlinear (weight) regressions (r^2>0.96).

South Atlantic: Various fishery independent and dependent data sets were used to develop relationships among whole weight (WW), gutted weight (GW), total length (TL), fork length (FL), and standard length (SL). When relating among lengths or among weight no-intercept linear regressions were used (Table 2.3). A linearized regression (ln-ln) was used to relate whole weight to various length measurements (Table 4). Note that when retransforming back to arithmetic space from logarithmic space, a bias correction is necessary based on the mean squared error (MSE) from the regression (Beauchamp and Olson 1973, Sprugel 1983). Estimates for whole weight (WW) at length (L) are obtained from:

$$WW = \exp(\text{Intercept} + MSE/2 + \text{Slope}*\ln(L)).$$

If we let,

$$a = \exp(\text{Intercept} + MSE/2),$$

then

$$WW = a\,L^b.$$

These regressions were originally done by source for the South Atlantic, and ultimately summarized for the region as presented in the tables referenced. Fishery-independent data included whole weight, gutted weight, total length, fork length, and standard length from the SC DNR MARMAP program. These same data (less the gutted weight) were also available from FL FWCC. In recent years, the Headboat program has measured occasional fork lengths along with total lengths. Fishery dependent data for whole weight and lengths were available from headboat (TL), MRFSS (FL), and TIP (TL) for both coasts. All weights shown are in kilograms and all lengths are in millimeters.

2.8. Post Data Workshop: Natural Mortality Rate

An age-varying M (Lorenzen 1996) approach was developed subsequent to the SEDAR 10 DW. This approach inversely relates the natural mortality at age a (M_a) to mean weight at age (W_a) by the power function $M_a = \alpha W_a^{\beta}$, where α is a scale parameter and β is shape parameter (β > 0). Lorenzen (1996) provided point estimates and 90% confidence intervals of α and β for oceanic fishes, which were used for the initial parameterization. As in the SEDAR 04 AW, it was concluded during the SEDAR 10 AW that the Lorenzen (1996) approach is more biologically plausible than a fixed M for all ages. Also as in the SEDAR 04 assessment, the Lorenzen estimates were re-scaled to the oldest observed age (30) so that the cumulative natural morality through this age was equivalent to that of constant M (0.14) for all ages from the Hoenig (1983) method (Table 2.5 and Figure 2.4).

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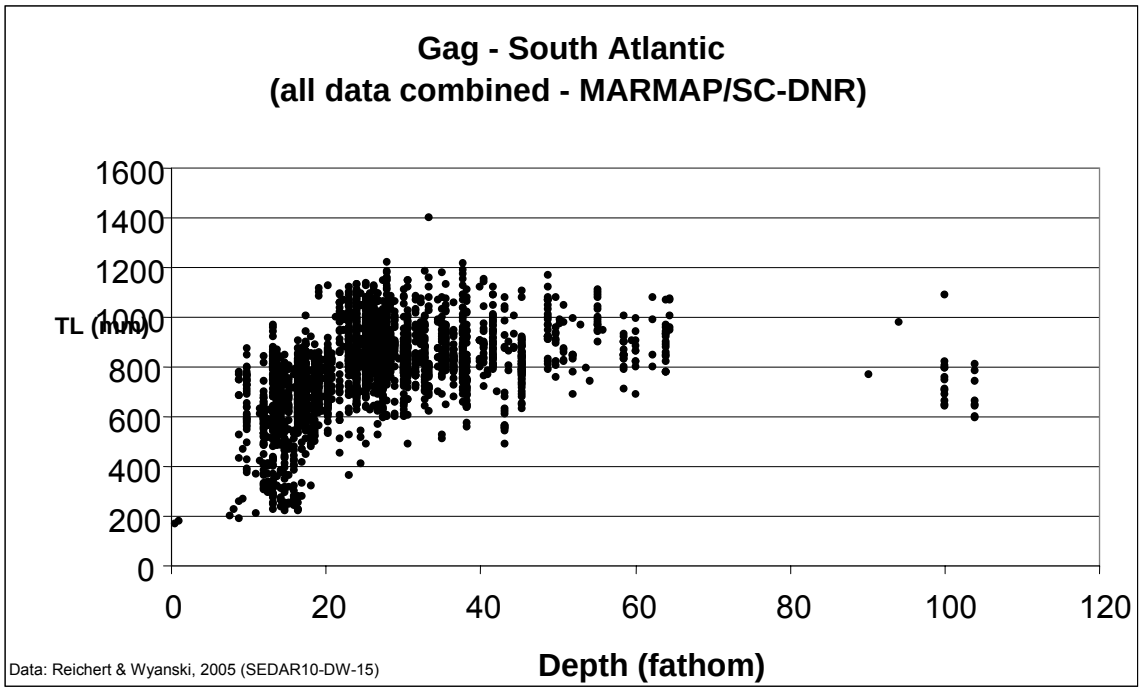

Figure 2.1. Gag total length (mm) plotted with depth (fm) for the South Atlantic. All gears were combined (fishery-independent and dependent) thus accounting for occurrences of undersized fish (below about 500 mm TL).

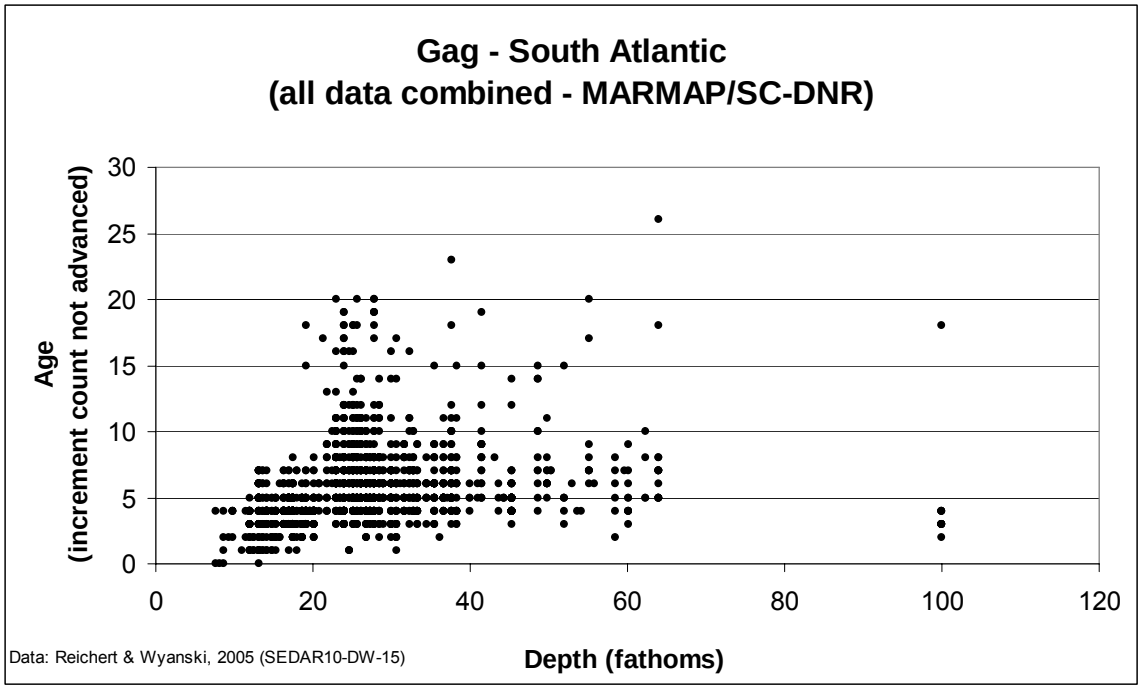

Figure 2.2. Gag age (increment count) plotted with depth (fm) for the South Atlantic. All gears combined (fishery-independent and dependent)

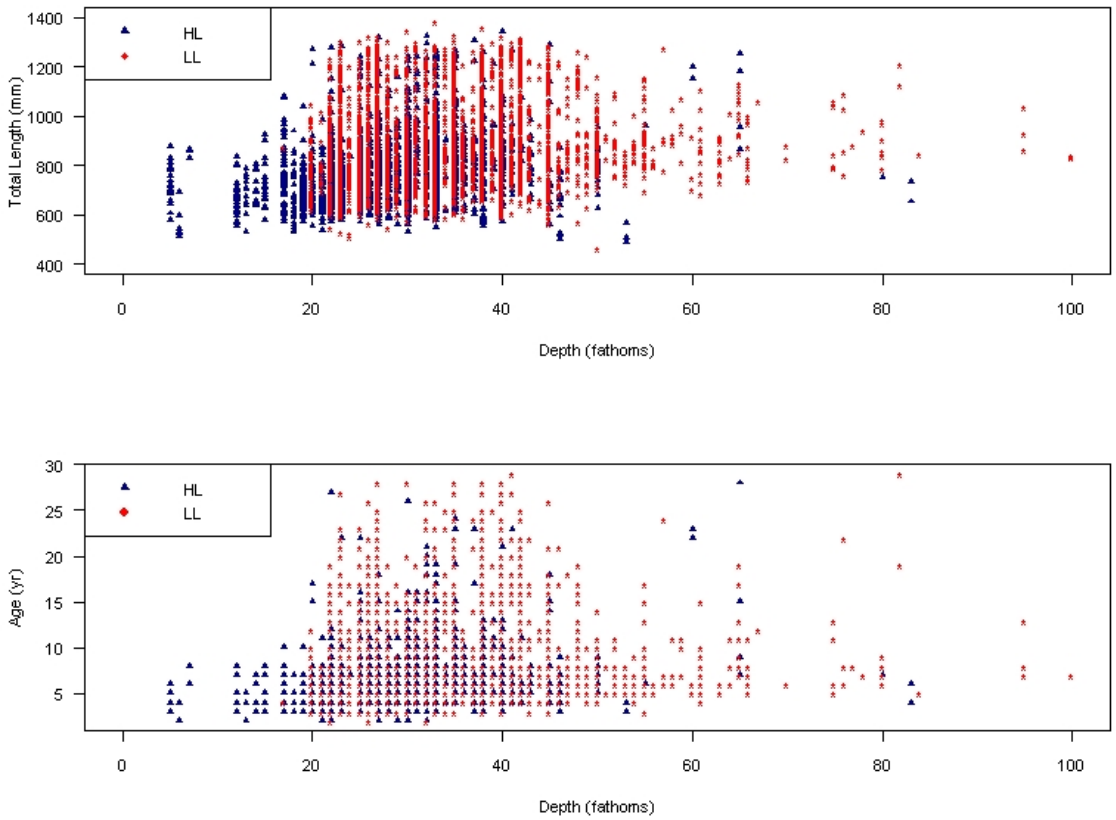

Figure 2.3. Age and length plotted with depth (fm) for the Gulf of Mexico for long-line (LL) and handline (HL) fisheries.

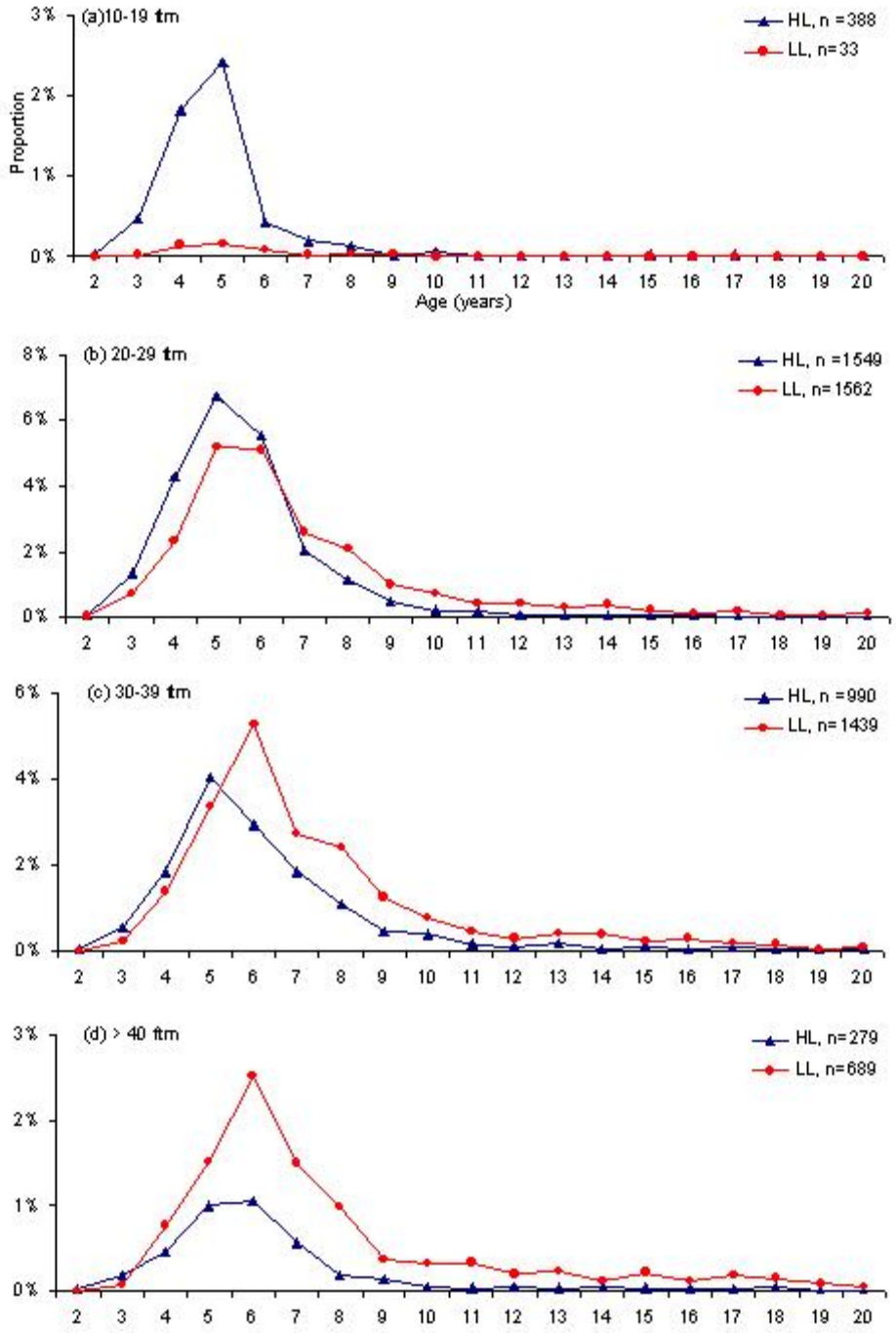

Figure 2.4. Age data proportioned to the depth (fm) fished and commercial gear type. Depth categories in 10-fm bins. Scales on y-axis vary.

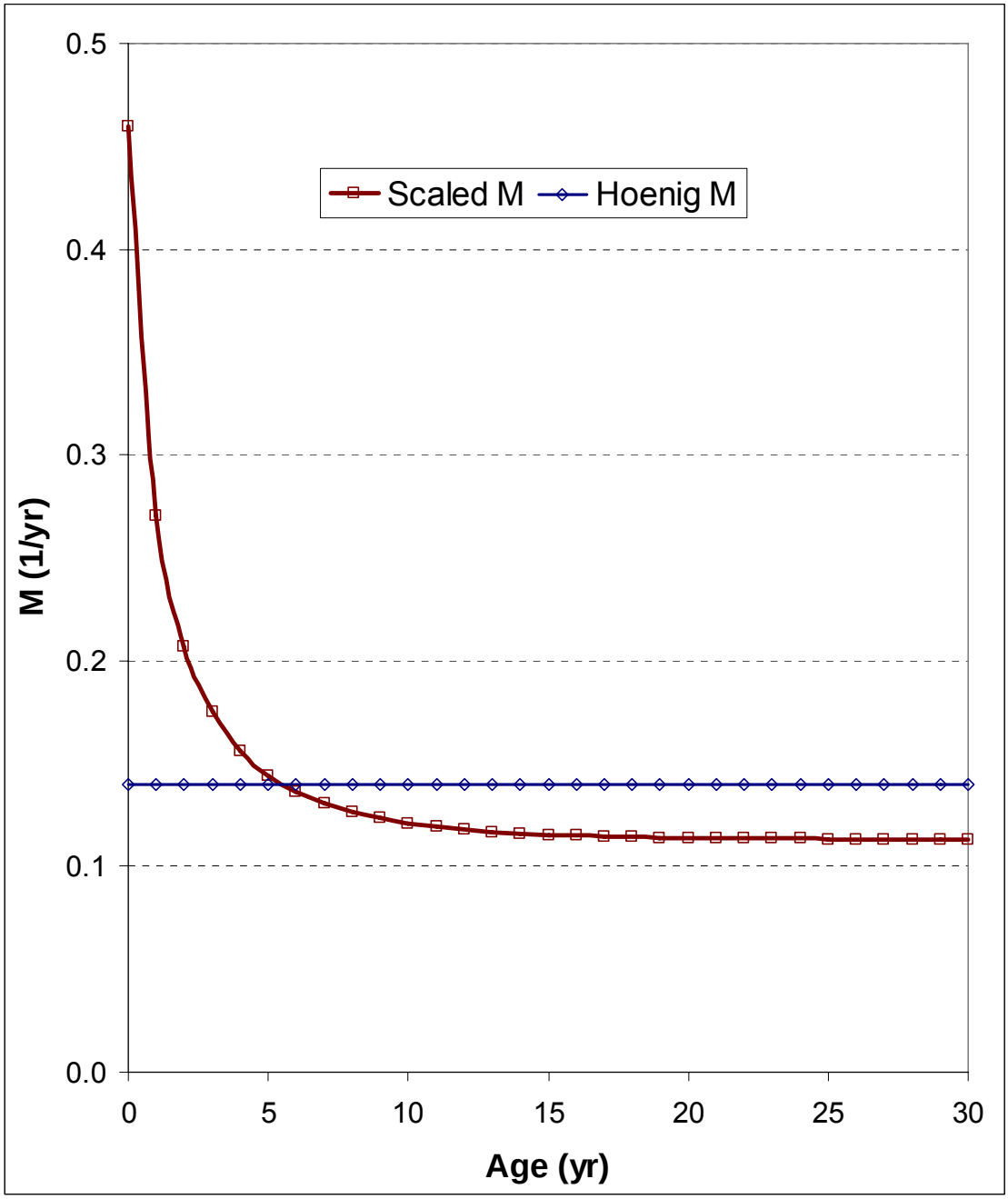

Figure 2.5. Age-varying estimates of South Atlantic gag grouper natural mortality based on Lorenzen's method (1996), re-scaled to 1.3% survival to oldest observed age (30), so as to be equivalent to the constant M (0.14 for maximum age of 30) from Hoenig (1983).

Table 2.1. Gag reproductive biology analysis – probit analysis – from the South Atlantic (SCDNR data – SEDAR10-DW15).

Analysis	Period	Cumul. Distrib.	N	Intercept	Standard Error	Independent variable	Standard Error
Age (count) at sex transition	1977-82	Normal	322	-3.37	0.41	0.287	0.047
	1994-95	Normal	1508	-4.26	1.03	0.406	0.129
	2004-05	Normal	1048	-4.60	0.28	0.474	0.036
	all	Normal	2878	-4.16	0.49	0.398	0.061
Total length at sex transition	1977-82	Logistic	501	-22.94	2.17	0.023	0.002
	1994-95	Normal	3836	-13.93	0.89	0.014	0.001
	2004-05	Logistic	1004	-29.45	3.82	0.028	0.004
	all	Logistic	5341	-19.29	0.60	0.018	0.001
Age (count) at maturity	1977-82	Logistic	329	-8.34	1.37	2.239	0.334
	1994-95	Logistic	1439	-6.42	0.77	2.442	0.227
	2004-05	Gompertz	1276	-5.41	0.48	1.594	0.136
	all	Logistic	3044	-7.68	0.81	2.529	0.240
Total length at maturity	1977-82	Gompertz	472	-9.60	1.37	0.015	0.002
	1994-95	Gompertz	3679	-12.68	1.01	0.020	0.002
	2004-05	Logistic	1239	-32.37	2.37	0.048	0.004
	all	Logistic	5390	-24.91	2.19	0.038	0.003

Table 2.2. Meristic regressions for gag from the Gulf of Mexico (1991-2005). Refer to SEDAR-10-DW-2, for details.

Gulf of Mexico

Conversion and Units	Equation	Sample Size	r^2 values	Data Ranges
FL (mm) to TL (mm)	TL = 1.03 * FL – 0.68	4999	0.99	TL (mm): 245 – 1360 FL (mm): 238 – 1321
TL (mm) to W. Wt (kg)	W. Wt = 1×10^{-08} * (TL^3.03)	4922	0.97	TL (mm): 245 – 1360 W. Wt (kg): 0.23 – 32.74
FL (mm) to W. Wt (kg)	W. Wt = 1×10^{-08} * (FL^3.02)	3809	0.97	FL (mm): 217 – 1321 W. Wt (kg): 0.13 – 32.74
TL (mm) to G. Wt (kg)	G. Wt = 1×10^{-08} * (TL^2.99)	527	0.96	TL (mm): 446 – 1295 G. Wt (kg): 0.99 – 27.02
FL (mm) to G. Wt (kg)	G. Wt = 9×10^{-9} * (FL^3.05)	2407	0.98	FL (mm): 432 – 1335 G. Wt (kg): 0.99 – 32.21
SL (cm) to TL (cm) *for age-0 gag only*	TL = 1.85 * SL – 0.23	165	0.99	SL (cm): 2.5-10.0 TL (cm): 3.1-12.1

Table 2.3. Length-length and weight-weight regressions (no-intercept) for gag from the South Atlantic.

Sources	Ind. Var.	Dep. Var.	N	Parameter	S.E.	Adj. R^2	Pr > F
Length-Length Regressions:							
FL FWCC (n=176), SC DNR (MARMAP; n=3301), Headboat (n=215)	TL (mm)	FL (mm)	3692	1.0341	0.00020	0.9999	<0.0001
FL FWCC (n=145) & SC DNR (MARMAP; n=3582)	TL (mm)	SL (mm)	3727	1.1908	0.00044	0.9999	<0.0001
Whole Weight (WW)-Gutted Weight (GW):							
SC DNR (MARMAP)	WW (kg)	GW (kg)	136	1.0585	0.0014	0.9998	<0.0001

Note: WW = whole weight; GW = gutted weight
TL = total length; FL = fork length; SL = standard length

Table 2.4. Linearized weight-length regressions for gag from the South Atlantic.

Source	Ind. Var.	Dep. Var.	N	Intercept	S.E. Int	Slope	S.E. Slope	MSE	Adj. R^2	Pr > F
SC DNR (MARMAP; n=4020), Headboat (n=11915), TIP (n=539)	ln(WW)	ln(TL)	16474	-17.843	0.040	2.943	0.006	0.047	0.933	<0.0001
SC DNR (MARMAP; n=2348), MRFSS (n=1334)	ln(WW)	ln(FL)	3682	-15.688	0.113	2.633	0.017	0.100	0.863	<0.0001
SC DNR (MARMAP)	ln(WW)	ln(SL)	2248	-17.332	0.066	2.949	0.010	0.020	0.9735	<0.0001

Note: WW = whole weight; TL = total length; FL = fork length; SL = standard length

Table 2.5. Summary of South Atlantic gag grouper life history values used in the statistical catch-at-age model. Lorenzen natural mortality (M) values are from Lorenzen (1996), while the scaled M are these values re-scaled to 1.3% surviving to age 30, and equivalent to the cumulative mortality from Hoenig (1983).

Age (years)	Total Length (mm)	Weight (kg)	Lorenzen M	Hoenig M		Scaled M
0	220.3	0.143	6.67	0.14		0.46
1	397.5	0.815	3.93	0.14		0.27
2	537.0	1.974	3.00	0.14		0.21
3	646.6	3.411	2.54	0.14		0.17
4	732.9	4.931	2.27	0.14		0.16
5	800.8	6.400	2.09	0.14		0.14
6	854.2	7.738	1.98	0.14		0.14
7	896.2	8.912	1.89	0.14		0.13
8	929.2	9.914	1.83	0.14		0.13
9	955.2	10.752	1.79	0.14		0.12
10	975.6	11.444	1.75	0.14		0.12
11	991.7	12.008	1.73	0.14		0.12
12	1004.4	12.464	1.71	0.14		0.12
13	1014.3	12.831	1.69	0.14		0.12
14	1022.1	13.125	1.68	0.14		0.12
15	1028.3	13.359	1.67	0.14		0.12
16	1033.1	13.545	1.67	0.14		0.11
17	1037.0	13.692	1.66	0.14		0.11
18	1040.0	13.809	1.66	0.14		0.11
19	1042.3	13.901	1.65	0.14		0.11
20	1044.2	13.974	1.65	0.14		0.11
21	1045.6	14.032	1.65	0.14		0.11
22	1046.8	14.077	1.65	0.14		0.11
23	1047.7	14.113	1.65	0.14		0.11
24	1048.4	14.141	1.64	0.14		0.11
25	1048.9	14.163	1.64	0.14		0.11
26	1049.4	14.181	1.64	0.14		0.11
27	1049.7	14.194	1.64	0.14		0.11
28	1050.0	14.205	1.64	0.14		0.11
29	1050.2	14.214	1.64	0.14		0.11
30	1050.4	14.220	1.64	0.14		0.11
			62.97	4.34	sum=	4.34
				0.013	exp(-sum)=	0.013

3 Commercial Fishery

3.1 Overview

A series of issues were discussed by the Commercial Working Group concerning stock boundaries between Gulf of Mexico and U.S. South Atlantic, the misidentification of gag as black grouper, and adjusting gag landings to include a portion of unclassified grouper species (primarily historical unclassified grouper landings prior to the mid-1980s). To adjust gag grouper for unclassified groupers, landings of all classified groupers are necessary (see grouper species codes in Table 3.1). Final adjusted commercial gag landings are then presented as a series of tables and figures for the U.S. South Atlantic gag grouper stock. Estimated discards are presented for recent years (2001-2004) subsequent to the last change in minimum size limit for the U.S. South Atlantic coast. The next section presents summaries of sampling intensity and annual length frequency distributions by gear. Several research recommendations are given.

3.2 Commercial Landings

The first discussion by the Commercial Working Group concerned the separation of stock boundary between U.S. South Atlantic and Gulf of Mexico waters. The Working Group decided to base it on the SAFMC-GMFMC boundary by using water body code designations found along the Florida Keys (Monroe County). Essentially, Florida Bay and waters north and west of the Florida Keys are designated in the Gulf of Mexico, while waters south and east of the Keys are designated in the South Atlantic. For historical landings data (1962-1992) from the Florida Atlantic (east) Coast, the water bodies are identified as 0010, 0019, 0029, 7200-7510, 7994, 7996, and also 0000, 9999 when the state was identified as code 10. Florida Gulf (west) Coast water bodies, specifically for the Florida Keys, are identified as 0011, 0018, 0020 and 0028 and a general Gulf of Mexico code of 5000. The data source for the water body allocations for Florida comes from the Florida General Canvass for the years 1977-1992. See maps showing shrimp statistical areas for the Gulf of Mexico and U.S. Atlantic coasts (Figure 3.1) and Florida statistical areas (Figure 3.2).

For the years 1993-2004 water body and jurisdiction allocations are based on water body ratios as reported in the Fishery Logbook data and applied to the total landings reported in the ALS data set for the state of Florida. 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 area of capture to catch.

The issue of misidentification of gag with black grouper was discussed by the Working Group at length. The discussions were based on the report SEDAR10-DW-24 for the Gulf of Mexico and following the Data Workshop a report was prepared for the U.S. South Atlantic: SEDAR10-DW-28). The following decisions were made by state. With minimal landings of black grouper reported for Georgia and South Carolina, no correction to gag grouper landings for black grouper misidentification was deemed

necessary. In most years North Carolina generally had minimal landings of black grouper. However, as later noted in SEDAR10-DW-28, there major exceptions; i.e., large reported landings of black grouper were found for 1981-1985 and 1992-1993. These were deemed anomalous by the Commercial Working Group and all black grouper landings for these years in North Carolina were assigned to gag grouper landings.

The proportion of gag grouper misidentified as black grouper were calculated from TIP observation weights for fish identified as gag by samplers, but identified by the dealer as black grouper in the TIP landings data (Table 3.2; Figure 3.3). The observation weight of the fish identified by dealers as black grouper were divided by the combined observation weight of fish identified by dealers as gag grouper and those identified by dealers as black grouper (comparable to Method 2 in SEDAR10-DW-28). The proportions were calculated from observations in kilograms whole weight. The proportions showed no defined trend over time, so the decision was made not to make any additional adjustments to gag grouper landings for misidentification in the South Atlantic, especially as regards Florida Atlantic Coast. In particular, there were only two counties for FL for which TIP data could be linked to Florida trip ticket data resulting in small sample size: 62 blacks in TIP of which 21 should have been gag for 1984-2003 data. As judged during the DW, this was insufficient to apply a correction to black grouper landings to be treated as gag landings.

The decision was made to present all landings in gutted weight. The standard conversion of groupers for Georgia and Florida from whole weight to gutted weight is by dividing whole weight by 1.18. South Carolina uses a conversion of 1.11, while North Carolina uses a conversion of 1.25. With landings data inputted to model in gutted weight, any conversions from gutted back to whole weight will be based on recent data from the South Carolina MARMAP program. Their data suggest a conversion of 1.0585 (SE = 0.0014) using a no-intercept regression with sample size of 136 (see Section 2).

Numerical gear codes for grouper (gag, unclassified, and other classified groupers) were divided into five categories: handline (600-660), longline (675-677), diving (760, 943), trawls (200-299), and other (remaining gear codes). Small amounts of unknown (999) landings have been proportioned among known gears for that year. Historical annual gear data from Florida were used to distribute Florida ALS landings among the various gears for 1976-1996.

With the adjustments to North Carolina for black grouper in 1981-1985 and 1991-1992 and distribution of unknown gear (999) for Florida during 1976-1996, tables of "unadjusted" gag landings were developed (Tables 3.3; Figures 3.4-3.5).

A proportion of the unclassified grouper landings (1410) were then converted to gag grouper. Annual proportions or ratios were developed for each gear and state by comparing gag grouper landings to all classified groupers (1411-1430). 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 the

early 1980s. Summaries of unclassified and classified groupers are shown in Figures 3.6-3.8.

When gag grouper are classified in the same year as unclassified grouper, we used that year's ratio of gag/total classified grouper landings to separate out gag from unclassified grouper. For earlier years (generally 1962-1980), the Working Group recommended use of the average proportion across years for each state and gear starting with the earliest year of classified gag grouper (generally 1981) through 1991 (management changed in 1992). When no classified grouper (including gag grouper) are given for a state, gear, year combination, then that value is treated as a missing value in calculating the average ratio.

Adjusted landings are presented summarized for the U.S. South Atlantic by gear in Table 3.4 and by gear and area in Figures 3.9-3.10. A comparison of unadjusted to adjusted gag grouper landings in the U.S. South Atlantic is presented in Figure 3.11. Lower and upper bounds on the adjusted gag landings were developed from the unclassified groupers converted to gag. These bounds are based on the mean ratios plus or minus twice the standard deviation applied to the historical conversions. The lower bound on adjusted gag grouper landings are presented in Table 3.5 and Figures 3.12-3.13, while the upper bound on adjusted gag grouper landings are presented in Table 3.6 and Figures 3.14-3.15. The range in adjusted gag grouper landings for the U.S. South Atlantic are shown in Figure 3.16.

One final modification was made to commercial landings as used in the assessment models during the Assessment Workshop. No landings were recorded for 1977-1978 and 1980 for diving gear, while positive landings were determined before and after these years (1976, 1979, 1981-2004). Thus an adjustment was deemed necessary by the Assessment Workshop group, who replaced the zero landings for commercial diving with a linear interpolation of adjusted landings for this gear based on landings recorded before and after. For the base landings (see Table 3.4), 0 landings for 1977 became 8,810 pounds gutted weight, for 1978 – 13,867 pounds, and for 1980 – 16,404 pounds.

A final adjustment made to commercial landings were to estimate gag landings in numbers based on average weight (gutted) from the TIP data based for each state, gear, and year. These data was generally available from 1984 to 2004 for handlines (1983 for NC, and 1985 for FL). Data for the remaining gears were sparse, with data available from longlines (1984-1998, 2002), diving (1986-1987, 1991-2004), and trawl (1984, 1986-1988) were available. For earlier years and missing later years, annual averages for each state and gear were used. When a single year was missing bounded by estimates, the average of these neighboring years was used. Average weights are summarized in Table 3.7, and gag landings in numbers are summarize in Table 3.8 and Figures 3.17-3.18.

For detailed description of the Accumulated Landing System (ALS), see addendum to this section.

3.3 **Commercial Discards**

In the south Atlantic, gag grouper trips were defined as handline trips where four or fewer lines were fished, with three or fewer hooks per line, the reported days at sea was eight or less, and the number of crew members was four or less. Data from all trips that reported to the coastal logbook discard program and that met these criteria were considered gag grouper trips. The number of gag grouper discards reported from those trips, including trips with no gag discards, was used to calculate the mean number of discards per trip. Similarly, trips reporting to the coastal logbook program that met the above criteria for a gag grouper trip were used to determine the total number of gag grouper trips taken in the Gulf of Mexico and south Atlantic.

Minimum size limit regulations came into effect in the south Atlantic in February 1999. As no size information is reported to the coastal logbook discard program, discard calculations were restricted to the period March 1999-December 2004 for the south Atlantic.

As in the Gulf of Mexico, GLM analyses of the proportion of successful trips (trips that discarded gag grouper) and the catch rates on successful trips were conducted. Significant factors included year, area fished, days at sea, number of crew, and discard period (August-December or January-July of each year). Subdividing the data by so many factors again resulted in many of the strata containing no observations. Only year, area fished, and number of crew could be used to stratify these data and still retain sufficient sample size for calculation of mean discards per stratum. Discard calculations were made by multiplying the total number of trips in a stratum by the mean number of discards from trips in the same stratum. Strata in the south Atlantic were year/area/crew combinations where area was defined as:

Area 24 = south Atlantic statistical grids greater than 2300 and less than 2600
Area 26 = south Atlantic statistical grids greater than 2600 and less than 3200
Area 32 = south Atlantic statistical grids greater than 3200 and less than 3300
Area 33 = south Atlantic statistical grids greater than 3300 and less than 3400
Area 34 = south Atlantic statistical grids greater than 3400 and less than 3700

The number of crew was divided into classes defined as: 1 = 1 crew member, 2 = 2 crew members, and 3 = 3-4 crew members.

Calculations of discards during the period 2001-2004 (the period when discards were reported to the coastal logbook program) are provided in Table 3.10 for the south Atlantic. Discard reporting began August 1, 2001. As was done for the Gulf of Mexico data, the discard calculation for 2001 uses the mean gag discards determined for the period August 1, 2001-December 31, 2001 multiplied by the total number of gag grouper trips reported to the coastal logbook program during 2001.

For the south Atlantic, numbers of gag discarded were also calculated for the two years prior to the beginning of the discard program (1999-2000) because the size limit

was the same in much of that period as it was in the period when discard reports were obtained. The mean number of discards for the entire period, 8/1/01-12/31/04, was determined for each area fished-crew size stratum. Those values were multiplied by the number of handline trips per year in the corresponding strata (Table 3.11). Yearly total numbers of discarded gag were calculated by summing all the calculated discards for each year (Tables 3.12).

South Atlantic discards were reported as "all alive" for approximately 53% of the gag released. Another 16% of gag were reported as "majority alive" at release. Only 0.25% of released gag were reported as "all dead", while 26.7% were reported as "majority dead". A further 3.7% of gag were reported as "kept, not sold". The final 0.5% of gag grouper were reported as "unable to determine" or the condition of the released fish was not reported. Most gag grouper discards (94.5%) were reported as "due to regulations" and 4.5% were reportedly discarded "due to market conditions".

3.4 Biological Sampling

A number of issues for developing length compositions were discussed by the Commercial Working Group. Lengths from Monroe County without identified water body were deleted. When gear code missing, the dominant gear for that cell was assigned. Fork lengths and standard lengths were converted to total lengths (see Section 2). We deleted any total lengths less than 30 cm TL (12" or 15 records) and any lengths greater than 150 cm TL (about 40 records). Length compositions are presented in 1 cm (10 mm) bin size.

3.4.1 Sampling Intensity Length

Sample sizes are summarized in Table 3.9 by gear, state and year for length data available for gag in the U.S. South Atlantic from the TIP data base.

3.4.2 Length/Age Distribution

Annual length compositions are created for each commercial gear using the following approach for weighting lengths across individual trips and by state:

- Trips: expand lengths by trip catch in numbers,
- State: expand lengths by landings in numbers.

Annual length compositions for commercial handlines are shown weighting by the product of the landings in numbers and trip catch in numbers (Figure 3.19). Annual length compositions for commercial longline (Figure 3.20) and diving (Figure 3.21) are also summarized using weighting by landings in numbers and by trip catch in numbers.

Annual age compositions and sample sizes for commercial handlines are shown Figure 3.22 weighting by length compositions shown in Figures 3.19. This corrects for a sampling bias of age samples relative to length samples (SEDAR10-DW-23). Annual age compositions and sample sizes for commercial diving are shown in Figure 3.23. The bias noted in commercial handline age samples was not apparent for commercial diving age samples, so weighting was by state landings in numbers.

3.4.3 Adequacy for characterizing lengths

Generally sample sizes for length composition may be adequate for the handline component of the commercial fishery (Table 3.9). More limited length compositions are available for longline and diving, with minimal information for trawl. Handline length compositions may need to be used to represent length compositions for these other specified gears. Any representation of length composition for the 'other' gear category will be based on handline gear.

3.5 Research Recommendations

- Increase sampling for otoliths for aging
- Improve at-sea observation for discards
- Continued education of samplers for species identification
- Conversions needed for different market categories (gutted, headed, filleted, whole weight).

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Addendum to Commercial Landings (Section 3.2):

NMFS SEFIN Accumulated Landings (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected as early as the late1890s. Fairly serious collection activity began in the 1920s.
The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SEFIN database management system is a continuous data set that begins in 1962.

In addition to the quantity and value, information on the gear used to catch the fish, the area where the fishing occurred and the distance from shore are also recorded. Because the quantity and value data are collected from seafood dealers, the information on gear and fishing location are estimated and added to the data by data collection specialists. In some states, this ancillary data is not available.

Commercial landings statistics have been collected and processed by various organizations during the 1962-to-present period that the SEFIN data set covers. During the 16 years from 1962 through 1978, these data were collected by port agents employed by the Federal government and stationed at major fishing ports in the southeast. The program was run from the Headquarters Office of the Bureau of Commercial Fisheries in Washington DC. Data collection procedures were established by Headquarters and the data were submitted to Washington for processing and computer storage. In 1978, the responsibility for collection and processing were transferred to the SEFSC.

In the early 1980s, the NMFS and the state fishery agencies within the Southeast began to develop a cooperative program for the collection and processing of commercial fisheries statistics. With the exception of two counties, one in Mississippi and one in Alabama, all of the general canvass statistics are collected by the fishery agency in the respective state and provided to the SEFSC under a comprehensive Cooperative Statistics Program (CSP).

The purpose of this documentation is to describe the current collection and processing procedures that are employed for the commercial fisheries statistics maintained in the SEFIN database.

1960 - Late 1980s

Although the data processing and database management responsibility were transferred from the Headquarters in Washington DC to the SEFSC during this period, the data collection procedures remained essentially the same. Trained data collection personnel, referred to as fishery reporting specialists or port agents, were stationed at major fishing ports throughout the Southeast Region. The data collection procedures for commercial landings included two parts.

The primary task for the port agents was to visit all seafood dealers or fish houses within their assigned areas at least once a month to record the pounds and value for each species or product type that were purchased or handled by the dealer or fish house. The agents summed the landings and value data and submitted these data in monthly reports to their area supervisors. All of the monthly data were submitted in essentially the same form.

The second task was to estimate the quantity of fish that were caught by specific types of gear and the location of the fishing activity. Port agents provided this gear/area information for all of the landings data that they collected. The objective was to have gear and area information assigned to all monthly commercial landings data.

There are two problems with the commercial fishery statistics that were collected from seafood dealers. First, dealers do not always record the specific species that are caught and second, fish or shellfish are not always purchased at the same location where they are unloaded, i.e., landed.

Dealers have always recorded fishery products in ways that meet their needs, which sometimes make it ambiguous for scientific uses. Although the port agents can readily identify individual species, they usually were not at the fish house when fish were being unloaded and thus, could not observe and identify the fish.

The second problem is to identify where the fish were landed from the information recorded by the dealers on their sales receipts. The NMFS standard for fisheries statistics is to associate commercial statistics with the location where the product was first unloaded, i.e., landed, at a shore-based facility. Because some products are unloaded at a dock or fish house and purchased and transported to another dealer, the actual 'landing' location may not be apparent from the dealers' sales receipts. Historically, communications between individual port agents and the area supervisors were the primary source of information that was available to identify the actual unloading location.

Cooperative Statistics Program

In the early 1980s, it became apparent that the collection of commercial fisheries statistics was an activity that was conducted by both the Federal government and individual state fishery agencies. Plans and negotiations were initiated to develop a program that would provide the fisheries statistics that are needed

for management by both Federal and state agencies. By the mid- 1980s, formal cooperative agreements had been signed between the NMFS/SEFSC and each of the eight coastal states in the southeast, Puerto Rico and the US Virgin Islands.

Initially, the data collection procedures that were used by the states under the cooperative agreements were essentially the same as the historical NMFS procedures. As the states developed their data collection programs, many of them promulgated legislation that authorized their fishery agencies to collect fishery statistics. Many of the state statutes include mandatory data submission by seafood dealers.

Because the data collection procedures (regulations) are different for each state, the type and detail of data varies throughout the Region. The commercial landings database maintained in SEFIN contains a standard set of data that is consistent for all states in the Region.

A description of the data collection procedures and associated data submission requirements for each state follows.

Florida
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Prior to 1986, commercial landings statistics were collected by a combination of monthly mail submissions and port agent visits. These procedures provided quantity and value, but did not provide information on gear, area or distance from shore. Because of the large number of dealers, port agents were not able to provide the gear, area and distance information for monthly data. This information, however, is provided for annual summaries of the quantity and value and known as the Florida Annual Canvas data.

Beginning in 1986, mandatory reporting by all seafood dealers was implemented by the State of Florida. The State requires that a report (ticket) be completed and submitted to the State for every trip. Dealers have to report the type of gear as well as the quantity (pounds) purchased for each species. Information on the area of catch can also be provided on the tickets for individual trips. As of 1986 the ALS system relies solely on the Florida trip ticket data to create the ALS landings data for all species other than shrimp.

Georgia
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Prior to 1977, the National Marine Fisheries Service collected commercial landings data Georgia. From 1977 to 2001 state port agents visited dealers and docks to collect the information on a regular basis. Compliance was mandatory for the fishing industry. To collect more timely and accurate data, Georgia initiated a trip ticket program in 1999, but the program was not fully implemented to allow complete coverage until 2001. All sales of seafood products landed in Georgia must be recorded on a trip ticket at the time of the sale. Both the seafood dealer and the seafood harvester are responsible for insuring the ticket is completed in full.

South Carolina
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Prior to 1972, commercial landings data were collected by various federal fisheries agents based in South Carolina, either U.S. Fish or Wildlife or National Marine Fisheries Service personnel. In 1972, South Carolina began collecting landings data from coastal dealers in cooperation with federal agents. Mandatory monthly landings reports on forms supplied by the Department are required from all licensed wholesale dealers in South Carolina. Until fall of 2003, those reports were summaries collecting species, pounds landed, disposition (gutted or whole) and market category, gear type and area fished; since September 2003, landings have been reported by a mandatory trip ticket system collecting landings by species, disposition and market category, pounds landed, ex-vessel prices with associated effort data to include gear type and amount, time fished, area fished, vessel and fisherman information.

South Carolina began collecting TIP length frequencies in 1983 as part of the Cooperative Statistics Program. Target species and length quotas were supplied by NMFS and sampling targets of 10% of monthly commercial trips by gear were set to collect those species and length frequencies. In 2005, South Carolina began collecting age structures (otoliths) in addition to length frequencies, using ACCSP funding to supplement CSP funding.

North Carolina

The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

NMFS SEFIN Annual Canvas Data for Florida

The Florida Annual Data files from 1976 – 1996 represent annual landings by county (from dealer reports) which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents, which were assigned responsibility for the particular county, from interviews and discussions from dealers and fishermen collected through out the year. The estimates are processed against the annual landings totals by county on a percentage basis to create the estimated proportions of catch by the gear, area and distance from shore. (The sum of percentages for a given Year, State, County, Species combination will equal 100.)

Area of capture considerations:
ALS is considered to be a commercial landings data base which reports where the marine resource was landed. With the advent of some State trip ticket programs as the data source the definition is more loosely applied. As such one cannot assume reports from the ALS by State or county will accurately inform you of Gulf vs South Atlantic vs Foreign catch. In order to make that determination you must consider the area of capture.

Florida Annual Canvass 1976-1996 considerations:

1. 1976-1985 Data is as landed weight which was normally landed in a gutted condition. To convert to whole weight, a factor of 1.18 is universally applied.
2. State 00 and Grid 0000 in the data set are marine product landed else where and trucked into the State of Florida and are considered duplicated else where because they are theoretically reported back to the State of landing and are not included in the Florida totals.
3. State 12 is in the data set which represents Florida interior counties which were landed on Florida East Coast and not included in the Gulf catches.

Table 3.1. Grouper codes for general canvass and TIP data bases. Code 1410 is referred to as unclassified groupers. Remaining codes refer to classified groupers. As noted in text, codes 1850 and 4740 were not included with classified groupers.

Numeric Code	Common Name	Scientific Name
1410	GROUPERS	Serranidae
1411	HIND,SPECKLED	Epinephelus drummondhayi
1412	HIND,ROCK	Epinephelus adscensionis
1413	HIND,RED	Epinephelus guttatus
1414	GROUPER,SNOWY	Epinephelus niveatus
1415	GROUPER,YELLOWEDGE	Epinephelus flavolimbatus
1416	GROUPER,RED	Epinephelus morio
1417	GROUPER,MARBLED	Epinephelus inermis
1418	GROUPER,BROOMTAIL	Mycteroperca xenarcha
1419	GROUPER, TIGER	Mycteroperca tigris
1420	GROUPER,MISTY	Epinephelus mystacinus
1422	GROUPER,BLACK	Mycteroperca bonaci
1423	GROUPER,GAG	Mycteroperca microlepis
1424	SCAMP	Mycteroperca phenax
1425	GROUPER,YELLOWMOUTH	Mycteroperca interstitialis
1426	GROUPER,YELLOWFIN	Mycteroperca venenosa
1427	CREOLE-FISH	Paranthias furcifer
1428	GRAYSBY	Epinephelus cruentatus
1429	CONEY	Epinephelus fulvus
1430	GROUPER,NASSAU	Epinephelus striatus
1850	JEWFISH	Epinephelus itajara
4740	GROUPER,WARSAW	Epinephelus nigritus

Table 3.2. Proportion of gag grouper misidentified as black grouper by year and state in the South Atlantic, derived from TIP observation weights.

	FL		NC	
Year	Proportion by weight	Proportion by number	Proportion by weight	Proportion by number
1984	-	-	-	-
1985	-	-	-	-
1986	0.12	0.24	0.95	0.96
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	0.00	0.00	1.00	0.99
1994	-	-	-	-
1995	-	-	-	-
1996	0.00	0.00	0.98	0.96
1997	-	-	-	-
1998	0.01	0.01	0.42	0.31
1999	0.02	0.03	0.36	0.35
2000	-	-	-	-
2001	0.00	0.00	0.59	0.60
2002	-	-	-	-
2003	0.00	0.00	0.12	0.08
2004	0.11	0.20	0.66	0.65

Table 3.3. Unadjusted gag landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.

Year	Handline	Longline	Diving	Trawl	Other	Total
1962	0	0	0	0	0	0
1963	0	0	0	0	0	0
1964	0	0	0	0	0	0
1965	0	0	0	0	0	0
1966	0	0	0	0	0	0
1967	0	0	0	0	0	0
1968	0	0	0	0	0	0
1969	0	0	0	0	0	0
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	0	0	0	0	0	0
1973	0	0	0	0	0	0
1974	0	0	0	0	0	0
1975	0	0	0	0	0	0
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	97343	0	0	13438	0	110781
1981	376302	585	0	30557	0	407445
1982	446439	3821	0	39059	15	489335
1983	434380	38620	0	14285	40	487325
1984	499664	17391	168	8496	160	525878
1985	480070	2678	0	1851	0	484599
1986	677675	12450	5129	3796	221	699271
1987	654456	81787	18835	3145	701	758925
1988	450071	53576	12244	2299	1467	519656
1989	812541	13730	21217	0	8697	856185
1990	655525	20753	14651	0	7386	698314
1991	555877	9987	77745	0	31353	674962
1992	626150	5028	99684	0	261	731122
1993	690948	5317	74952	0	612	771829
1994	774301	3840	93297	0	5685	877124
1995	812289	3814	81806	0	2550	900459
1996	726243	3808	115318	0	3213	848582
1997	560531	4087	97981	0	3219	665817
1998	631418	5483	137973	1517	9175	785565
1999	525550	1758	113107	0	3803	644218
2000	424637	5065	62776	0	2973	495450
2001	438108	5843	82119	282	3245	529598
2002	439779	4570	84349	341	1897	530937
2003	437421	4488	117175	303	949	560337
2004	473521	1439	74794	0	801	550555

Table 3.4. Adjusted gag landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.

Year	Handline	Longline	Diving	Trawl	Other	Total
1962	150340	0	0	0	0	150340
1963	136532	445	0	0	0	136977
1964	128068	45	0	0	277	128391
1965	130127	0	0	0	277	130404
1966	98769	0	0	0	344	99112
1967	209806	0	0	0	1125	210931
1968	308423	0	0	0	1500	309923
1969	210436	57	0	0	6675	217169
1970	282848	0	0	0	16186	299034
1971	299860	0	0	0	6864	306724
1972	170659	0	0	0	33820	204479
1973	283839	0	0	332	6322	290493
1974	371185	0	0	0	1581	372766
1975	420101	0	0	1478	187	421765
1976	555369	0	3753	7846	1829	568797
1977	576162	0	0	45946	5463	627571
1978	946541	117	0	5158	15581	967398
1979	881766	0	18924	12988	12795	926473
1980	775295	1857	0	63167	5833	846152
1981	885267	1346	13883	85746	11627	997870
1982	968907	4653	15849	49581	4289	1043280
1983	1026062	39800	9077	32235	3004	1110179
1984	1057420	21899	18746	13870	14999	1126933
1985	848082	3790	11620	4267	9583	877341
1986	802913	12593	6342	4080	252	826180
1987	767155	86745	21931	3145	736	879712
1988	610624	56387	12961	3768	1608	685349
1989	943975	13797	22258	0	9242	989272
1990	755466	21392	19066	0	7441	803365
1991	613752	10216	85011	0	32462	741441
1992	686335	5041	106759	13	276	798424
1993	750575	5428	78151	0	623	834777
1994	790311	3958	97503	0	5762	897533
1995	833996	3862	83766	0	2570	924195
1996	744817	3856	118564	0	3224	870462
1997	600875	4121	98706	0	3223	706924
1998	638227	5506	138788	1517	9210	793247
1999	532500	1764	113495	0	3815	651573
2000	430165	5082	63024	0	2978	501250
2001	440693	5858	82299	282	3250	532382
2002	441514	4579	84525	341	1900	532860
2003	438153	4498	117412	303	950	561317
2004	474142	1443	74967	0	802	551354

Table 3.5. Lower bound of adjusted gag landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.

Year	Handline	Longline	Diving	Trawl	Other	Total
1962	41502	0	0	0	0	41502
1963	37694	0	0	0	0	37694
1964	35544	0	0	0	0	35544
1965	44476	0	0	59	0	44535
1966	28024	0	0	0	0	28024
1967	56533	0	0	0	0	56533
1968	97730	0	0	16057	43	113830
1969	59020	0	0	0	3190	62210
1970	77814	0	0	0	8320	86133
1971	84534	0	0	410	2931	87876
1972	48412	0	0	0	16518	64929
1973	98366	0	0	245	0	98611
1974	127097	0	0	0	684	127781
1975	125340	0	0	1091	0	126431
1976	202540	0	1617	2777	183	207117
1977	247436	0	0	23982	0	271418
1978	471228	0	0	2006	0	473234
1979	440701	0	8154	9588	0	458443
1980	550859	1278	0	55795	20	607953
1981	667469	585	5982	85746	0	759782
1982	750907	3849	6829	49581	15	811182
1983	745620	39246	3911	32235	56	821069
1984	803072	20833	8173	13870	400	846348
1985	684596	2856	5007	4267	0	696726
1986	802913	12593	6342	4080	252	826180
1987	767155	86745	21931	3145	736	879712
1988	610624	56387	12961	3768	1608	685349
1989	943975	13797	22258	0	9242	989272
1990	755466	21392	19066	0	7441	803365
1991	613752	10216	85011	0	32462	741441
1992	686335	5041	106759	13	276	798424
1993	750575	5428	78151	0	623	834777
1994	790311	3958	97503	0	5762	897533
1995	833996	3862	83766	0	2570	924195
1996	744817	3856	118564	0	3224	870462
1997	600875	4121	98706	0	3223	706924
1998	638227	5506	138788	1517	9210	793247
1999	532500	1764	113495	0	3815	651573
2000	430165	5082	63024	0	2978	501250
2001	440693	5858	82299	282	3250	532382
2002	441514	4579	84525	341	1900	532860
2003	438153	4498	117412	303	950	561317
2004	474142	1443	74967	0	802	551354

Table 3.6. Upper bound of adjusted gag landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.

Year	Handline	Longline	Diving	Trawl	Other	Total
1962	259178	0	0	0	0	259178
1963	235370	1970	0	0	0	237340
1964	220592	201	0	0	1226	222020
1965	215777	0	0	90	18866	234733
1966	169514	0	0	0	1646	171160
1967	363079	0	0	0	5459	368537
1968	519117	0	0	24660	6412	550189
1969	361853	169	0	0	17466	379488
1970	487882	0	0	0	36407	524289
1971	515186	0	0	630	19662	535478
1972	292906	0	0	0	43098	336005
1973	469312	0	0	376	14575	484263
1974	615272	0	0	0	3228	618500
1975	714862	0	0	1676	932	717470
1976	908199	0	5888	9056	7075	930218
1977	904888	0	0	52620	24162	981670
1978	1421855	353	0	5944	68891	1497043
1979	1322831	0	29693	14726	56572	1423822
1980	1092721	6429	0	64560	25801	1189512
1981	1103065	3958	21785	85746	51407	1265961
1982	1186908	7410	24869	49581	18913	1287680
1983	1306503	41700	14243	32235	13090	1407771
1984	1311767	25556	29320	13870	64945	1445457
1985	1011567	6994	18232	4267	42369	1083430
1986	802913	12593	6342	4080	252	826180
1987	767155	86745	21931	3145	736	879712
1988	610624	56387	12961	3768	1608	685349
1989	943975	13797	22258	0	9242	989272
1990	755466	21392	19066	0	7441	803365
1991	613752	10216	85011	0	32462	741441
1992	686335	5041	106759	13	276	798424
1993	750575	5428	78151	0	623	834777
1994	790311	3958	97503	0	5762	897533
1995	833996	3862	83766	0	2570	924195
1996	744817	3856	118564	0	3224	870462
1997	600875	4121	98706	0	3223	706924
1998	638227	5506	138788	1517	9210	793247
1999	532500	1764	113495	0	3815	651573
2000	430165	5082	63024	0	2978	501250
2001	440693	5858	82299	282	3250	532382
2002	441514	4579	84525	341	1900	532860
2003	438153	4498	117412	303	950	561317
2004	474142	1443	74967	0	802	551354

Table 3.7. Mean gutted weight (pounds) of fish by state and gear for the U.S. South Atlantic from the TIP data, 1962-2004.

	Florida (Atlantic)			Georgia				South Carolina				North Carolina	
Year	Handline	Longline	Diving	Handline	Longline	Diving	Trawl	Handline	Longline	Diving	Trawl	Handline	Longline
1983												12.6	
1984				15.4				17.3			10.5	13.3	23.3
1985	21.0	21.8		16.7				16.7	22.5			15.2	25.3
1986	19.0			14.7				17.7	24.3	10.4	16.4	10.2	
1987	10.7			16.5			7.5	17.1	20.2	12.0	19.6	10.2	22.7
1988	13.2			14.4				16.5	19.9		15.6	13.7	21.7
1989	15.3			16.5				15.3				12.5	17.7
1990	17.4							11.9	17.0			11.2	18.9
1991	15.6		12.6	15.8	10.4	5.3		11.4	21.0			11.5	19.6
1992	15.7	23.6	12.4	15.4				10.7		12.3		11.7	28.9
1993	17.6	20.1	15.6	15.4				9.7				11.4	16.5
1994	16.8	19.9	16.1	13.5	14.1	9.5		9.8				11.4	12.6
1995	19.5	23.0	13.4	16.6				11.5				11.9	21.5
1996	13.0	20.9	7.7	15.3				13.7		12.2		13.5	
1997	19.2	15.0	6.2	16.3				14.9				14.3	
1998	14.8	17.9	12.2	16.5				14.8	22.8			12.7	
1999	12.7		11.7					13.0				13.9	
2000	13.6		13.6	18.4				13.5				13.5	
2001	15.4		12.7	18.7				14.1				11.6	
2002	16.0	15.9	12.7	17.7				15.2				11.6	
2003	16.4		13.4	17.8				12.6				12.4	
2004	11.2			15.2				14.4		12.7		11.7	
Average	15.7	19.8	12.3	16.1	12.2	7.4	7.5	13.9	21.1	11.9	15.5	12.4	20.8

Table 3.8. Adjusted gag landings (numbers) by gear from the U.S. South Atlantic, 1962-2004.

Year	Handline	Longline	Diving	Trawl	Other	Total
1962	9576	0	0	0	0	9576
1963	8696	36	0	0	0	8732
1964	8165	4	0	0	18	8186
1965	8437	0	0	0	18	8454
1966	6329	0	0	0	23	6352
1967	13309	0	0	0	86	13395
1968	19958	0	0	0	96	20054
1969	13416	4	0	0	416	13835
1970	17996	0	0	0	1006	19002
1971	19171	0	0	0	428	19599
1972	10883	0	0	0	2149	13032
1973	18452	0	0	21	463	18936
1974	24333	0	0	0	105	24438
1975	27096	0	0	95	15	27206
1976	36264	0	190	494	116	37063
1977	38329	0	0	2921	348	41598
1978	66382	6	0	325	992	67705
1979	62392	0	956	837	815	64999
1980	55323	109	0	4051	372	59854
1981	63507	102	701	5500	740	70551
1982	69883	341	800	3190	273	74487
1983	72729	2817	458	2074	192	78270
1984	70002	1088	949	1311	960	74311
1985	49937	246	532	304	457	51476
1986	58849	541	340	253	14	59996
1987	59956	3988	1175	161	52	65331
1988	41737	2671	735	242	121	45506
1989	66044	784	1244	0	605	68678
1990	57449	1691	963	0	610	60713
1991	47921	664	4294	0	2348	55226
1992	56319	235	4955	1	18	61528
1993	64655	405	4064	0	37	69161
1994	68855	260	5291	0	454	74860
1995	63540	240	3796	0	184	67760
1996	54663	433	5736	0	241	61074
1997	38824	652	6570	0	212	46257
1998	45366	406	7778	92	644	54286
1999	39096	150	5746	0	299	45291
2000	31132	375	3195	0	219	34921
2001	32064	459	4235	15	217	36990
2002	32411	350	5374	19	124	38278
2003	33490	335	6266	17	59	40167
2004	36732	117	4099	0	71	41019

Table 3.9. Sample sizes for gag commercial length compositions by gear, state, and year from TIP data base for the U.S. South Atlantic, 1983-2004.

	DIVING			DIVING Total	Handline				Handline Total	Longline				Longline Total	TRAWL		TRAWL Total	Grand Total
Year	FLEC	GA	SC		FLEC	GA	NC	SC		FLEC	GA	NC	SC		GA	SC		
1983							116		116									116
1984						20	1206	1572	2798			42		42		16	16	2856
1985					509	105	906	1066	2586	68		31	4	103				2689
1986			32	32	66	118	877	357	1418				6	6		25	25	1481
1987			10	10	12	199	814	946	1971			131	2	133	10	11	21	2135
1988					27	121	508	474	1130			194	6	200		38	38	1368
1989					56	90	601	450	1197			44		44				1241
1990					79		491	180	750			39	19	58				808
1991	14	12		26	47	215	461	367	1090		2	32	2	36				1152
1992	28		24	52	426	102	303	377	1208	3		6		9				1269
1993	35			35	468	176	308	589	1541	22		5		27				1603
1994	33	4		37	156	123	541	374	1194	10	1	8		19				1250
1995	34			34	945	146	465	282	1838	55		36		91				1963
1996	43		32	75	361	137	204	901	1603	17				17				1695
1997	22			22	184	133	70	811	1198	20				20				1240
1998	11			11	146	115	139	883	1283	1			10	11				1305
1999	224			224	258		274	959	1491									1715
2000	198			198	387	9	365	830	1591									1789
2001	109			109	247	22	426	790	1485									1594
2002	59			59	67	63	311	587	1028	6				6				1093
2003	324			324	54	11	323	773	1161									1485
2004			78	78	10	76	890	645	1621									1699
Grand T	1134	16	176	1326	4505	1981	10599	14213	31298	202	3	568	49	822	10	90	100	33546

Table 3.10. Calculated numbers of gag grouper discards for the south Atlantic handline fishery by year, area fished, and number of crew. Mean gag discards per trip were calculated as the average discards reported for each year/area/crew size strata.

Year	Area	Crew	Handline Trips	Mean Gag Discards	Calculated Discards
2001	24	1	3072	0.002722	8
2001	24	2	3490	0.114141	398
2001	24	3	618	0.368182	228
2001	26	1	2370	0.041614	99
2001	26	2	1183	0	0
2001	26	3	645	0.6875	443
2001	32	1	14	2.5	35
2001	32	2	198	0.666667	132
2001	32	3	195	0.6	117
2001	33	1	121	5	605
2001	33	2	586	3.891304	2,280
2001	33	3	173	0	0
2001	34	1	188	12.5	2,350
2001	34	2	582	9.894073	5,758
2001	34	3	339	3.709667	1,258
2002	24	1	3116	0.054153	169
2002	24	2	3497	0.029955	105
2002	24	3	611	0.00974	6
2002	26	1	2711	0	0
2002	26	2	1256	0.897436	1,127
2002	26	3	565	0	0
2002	32	1	31	1	31
2002	32	2	187	2.04	381
2002	32	3	195	5.387097	1,050
2002	33	1	123	1.777778	219
2002	33	2	545	2.828519	1,542
2002	33	3	204	0	0
2002	34	1	231	3.273453	756
2002	34	2	812	6.410358	5,205
2002	34	3	393	3.356226	1,319
2003	24	1	3346	0.05947	199
2003	24	2	3452	0.061721	213
2003	24	3	675	0.109848	74
2003	26	1	2947	0	0
2003	26	2	1587	0.051613	82
2003	26	3	475	1.084507	515
2003	32	1	26	0	0
2003	32	2	201	0.866056	174
2003	32	3	90	6.443427	580
2003	33	1	164	0	0
2003	33	2	488	0.944444	461
2003	33	3	164	1.380952	226
2003	34	1	181	2.727273	494
2003	34	2	621	2.743199	1,704
2003	34	3	287	1.317485	378

Table 3.10. continued

Year	Area	Crew	Handline Trips	Mean Gag Discards	Calculated Discards
2004	24	1	2,664	0.098365	262
2004	24	2	3,525	0.143882	507
2004	24	3	549	0.235294	129
2004	26	1	2,784	0	0
2004	26	2	1,510	0.069547	105
2004	26	3	462	0.065574	30
2004	32	1	20	0	0
2004	32	2	145	1.5	218
2004	32	3	124	3.933333	488
2004	33	1	139	0	0
2004	33	2	627	2.863636	1,796
2004	33	3	213	1.6875	359
2004	34	1	215	2.833333	609
2004	34	2	548	4.925051	2,699
2004	34	3	239	0	0
Total			56,719		37,924

Table 3.11. Calculated numbers of gag grouper discards for the US south Atlantic handline fishery by year, area, and number of crew. Calculations for 1999 are for March-December, the period following imposition of a 24 inch minimum size limit for gag grouper. Mean gag discards per trip were calculated as the average discards reported for each area/crew size combination for the period August 2001-December 2004.

Year	Area	Crew	Handline Trips	Mean Gag Discards	Calculated Discards
1999	24	1	2,544	0.061875624	157
1999	24	2	3,406	0.089253029	304
1999	24	3	467	0.154778555	72
1999	26	1	2,090	0.001414064	3
1999	26	2	970	0.129894717	126
1999	26	3	430	0.470319635	202
1999	32	1	10	0.735294118	7
1999	32	2	148	1.38309202	205
1999	32	3	148	4.783180769	708
1999	33	1	92	2.885714286	265
1999	33	2	386	2.91621368	1,126
1999	33	3	162	0.8	130
1999	34	1	187	3.367712062	630
1999	34	2	581	5.038029619	2,927
1999	34	3	289	1.752192235	506
2000	24	1	2,954	0.061875624	183
2000	24	2	3,366	0.089253029	300
2000	24	3	509	0.154778555	79
2000	26	1	2,401	0.001414064	3
2000	26	2	1,072	0.129894717	139
2000	26	3	519	0.470319635	244
2000	32	1	23	0.735294118	17
2000	32	2	186	1.38309202	257
2000	32	3	178	4.783180769	851
2000	33	1	89	2.885714286	257
2000	33	2	491	2.91621368	1,432
2000	33	3	211	0.8	169
2000	34	1	199	3.367712062	670
2000	34	2	510	5.038029619	2,569
2000	34	3	340	1.752192235	596
Total					15,136

Table 3.12. Calculated yearly south Atlantic handline fishery gag grouper discards.

Year	Handline Trips	Calculated Discards
1999	11,910	7,369
2000	13,048	7,767
2001	13,774	13,712
2002	14,477	11,910
2003	14,704	5,100
2004	13,764	7,202
Total	81,677	53,060

Figure 3.1. Map of U.S. Atlantic and Gulf coast with shrimp area designations.

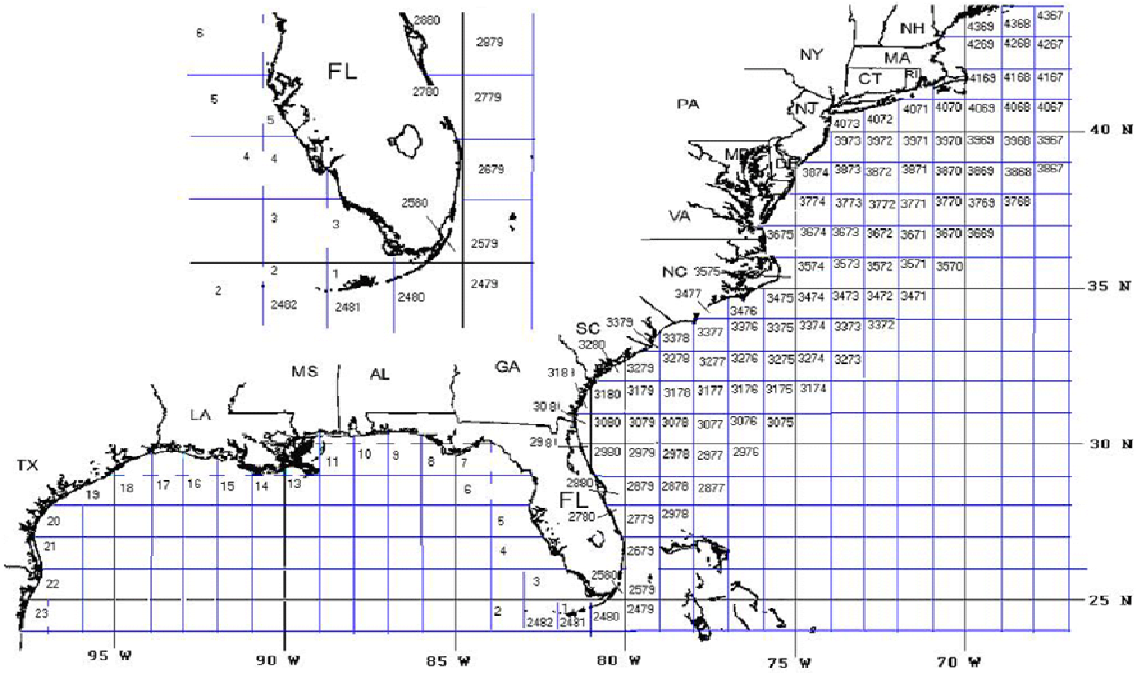


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

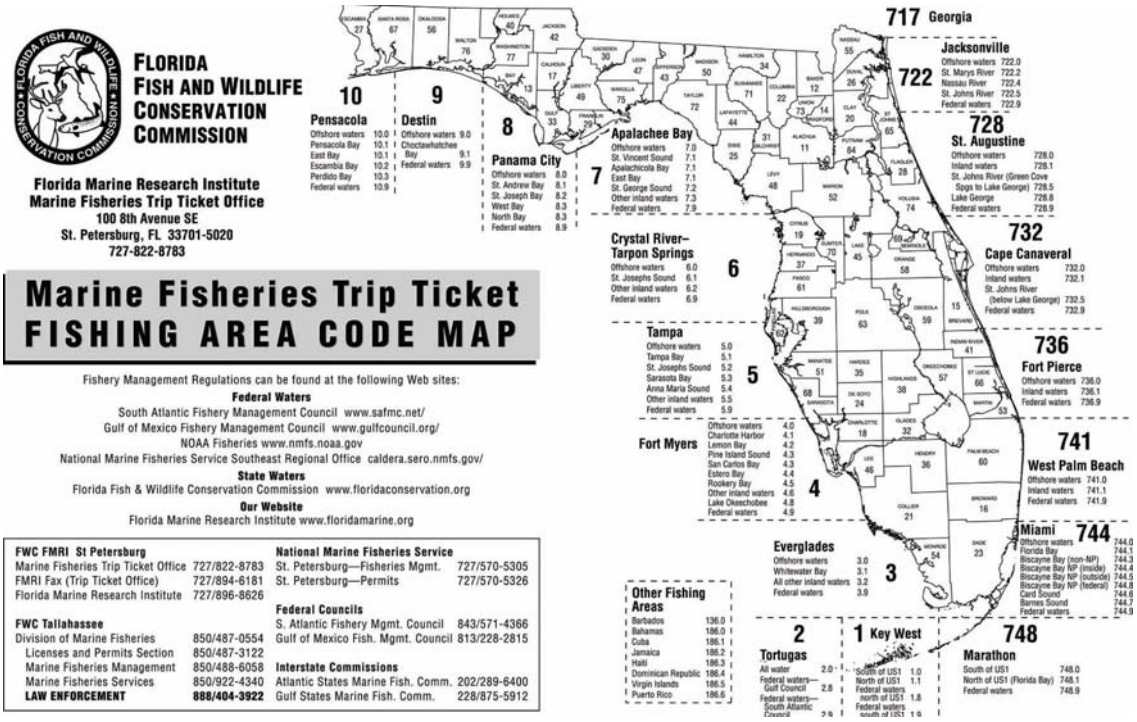


Figure 3.3. Proportion of gag misidentified as black grouper by seafood dealers in the South Atlantic by state and year, from TIP observation weight data.

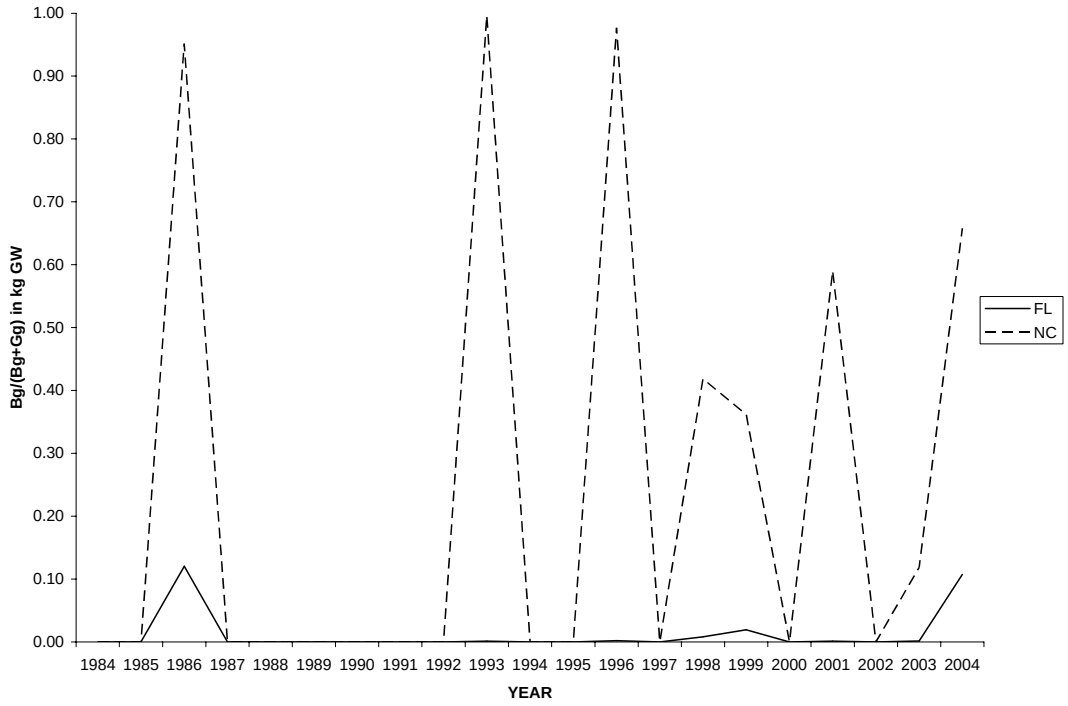


Figure 3.4. Unadjusted gag landings by gear for the U.S. South Atlantic, 1962-2004.

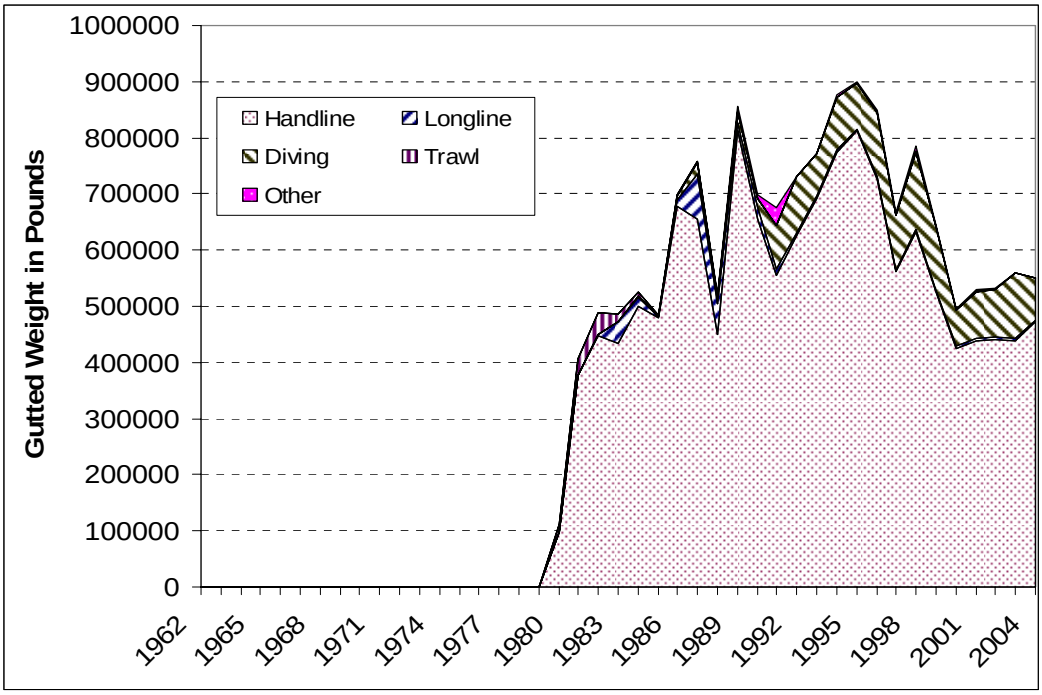


Figure 3.5. Unadjusted gag landings from the U.S. South Atlantic, 1962-2004.

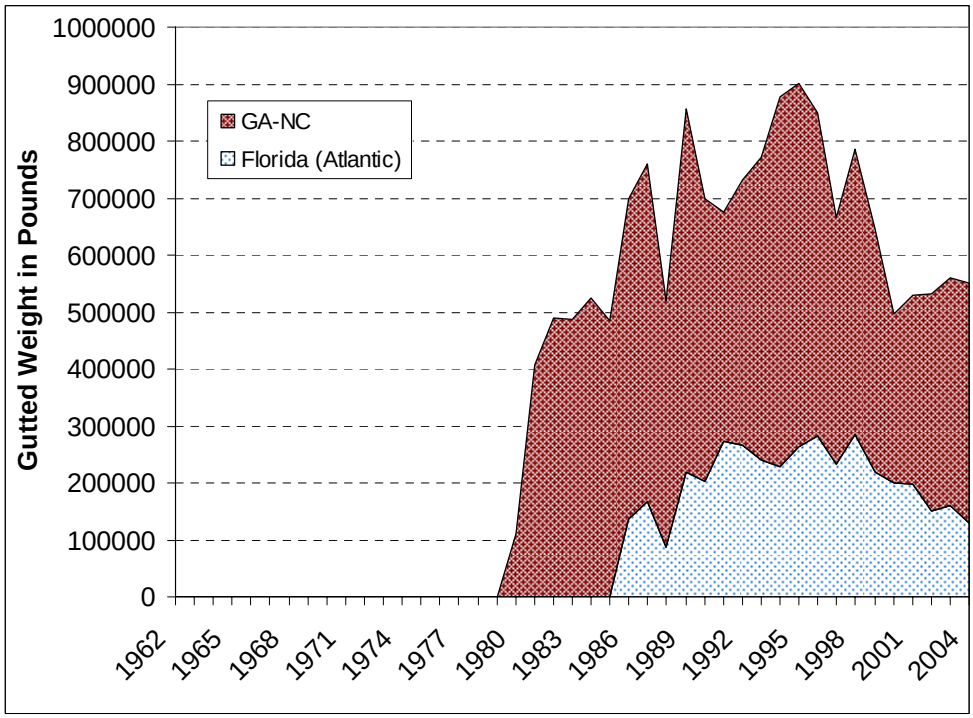


Figure 3.6. Unclassified grouper landings from the U.S. South Atlantic, 1962-2004.

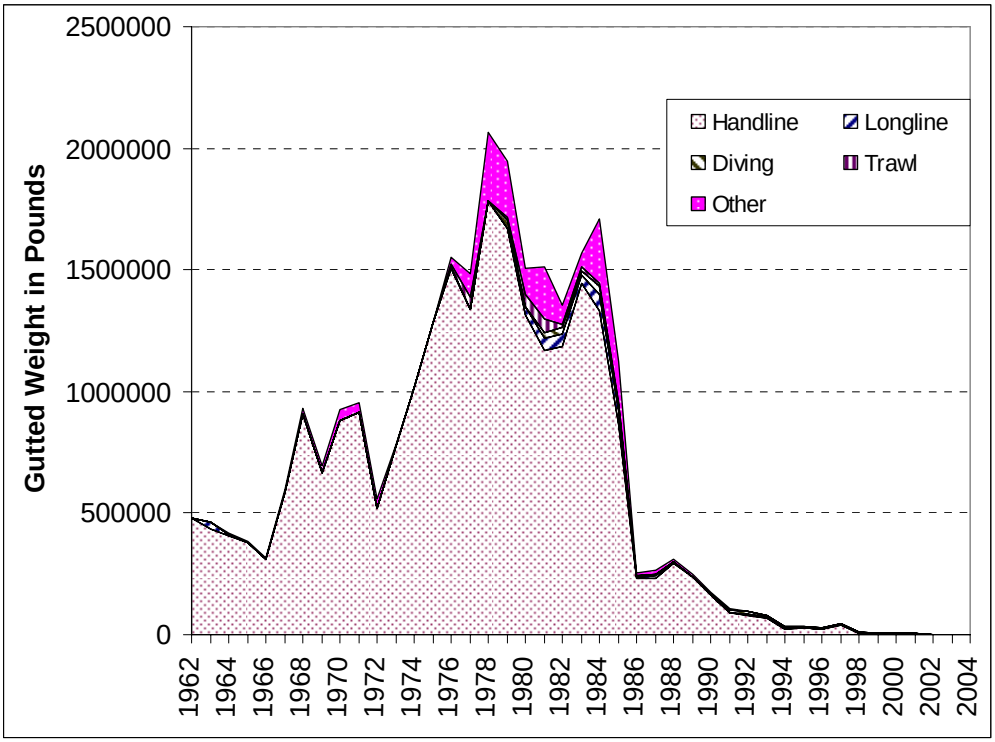


Figure 3.7. Classified grouper landings from the U.S. South Atlantic, 1962-2004.

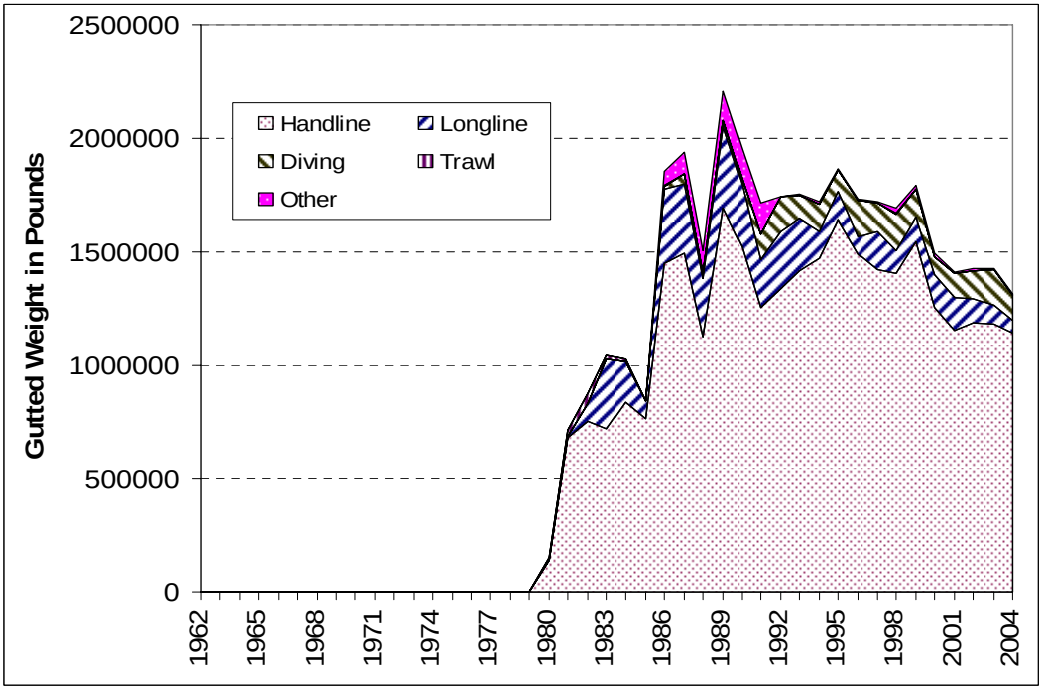


Figure 3.8. Classified versus unclassified grouper landings from the U.S. South Atlantic, 1962-2004.

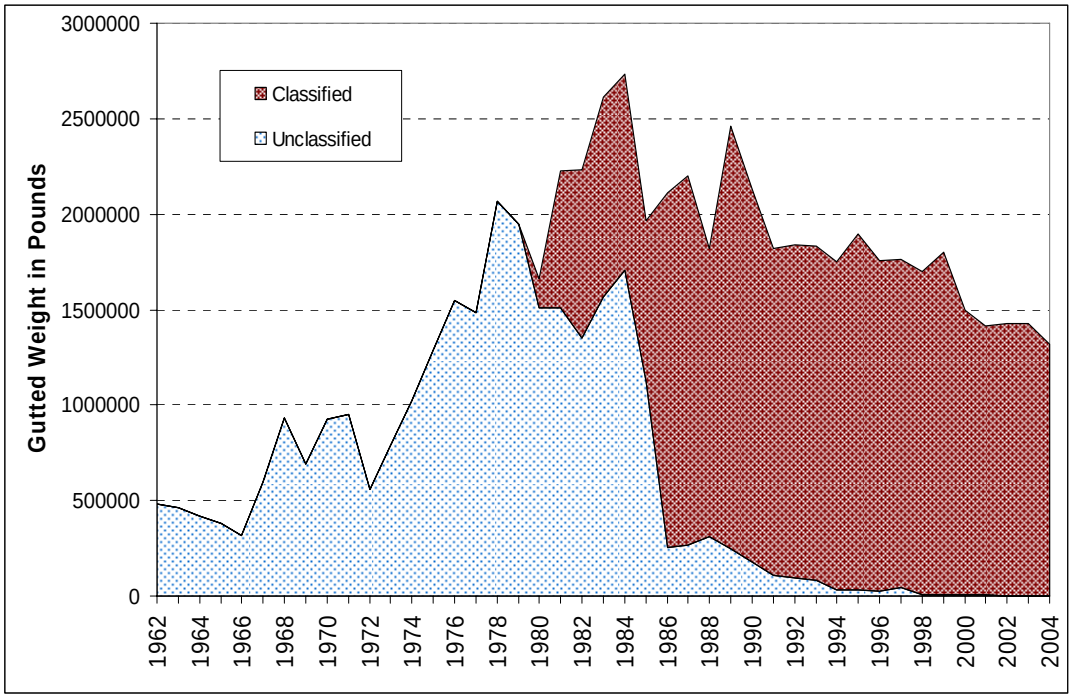


Figure 3.9. Adjusted gag grouper landings by gear from the U.S. South Atlantic, 1962-2004.

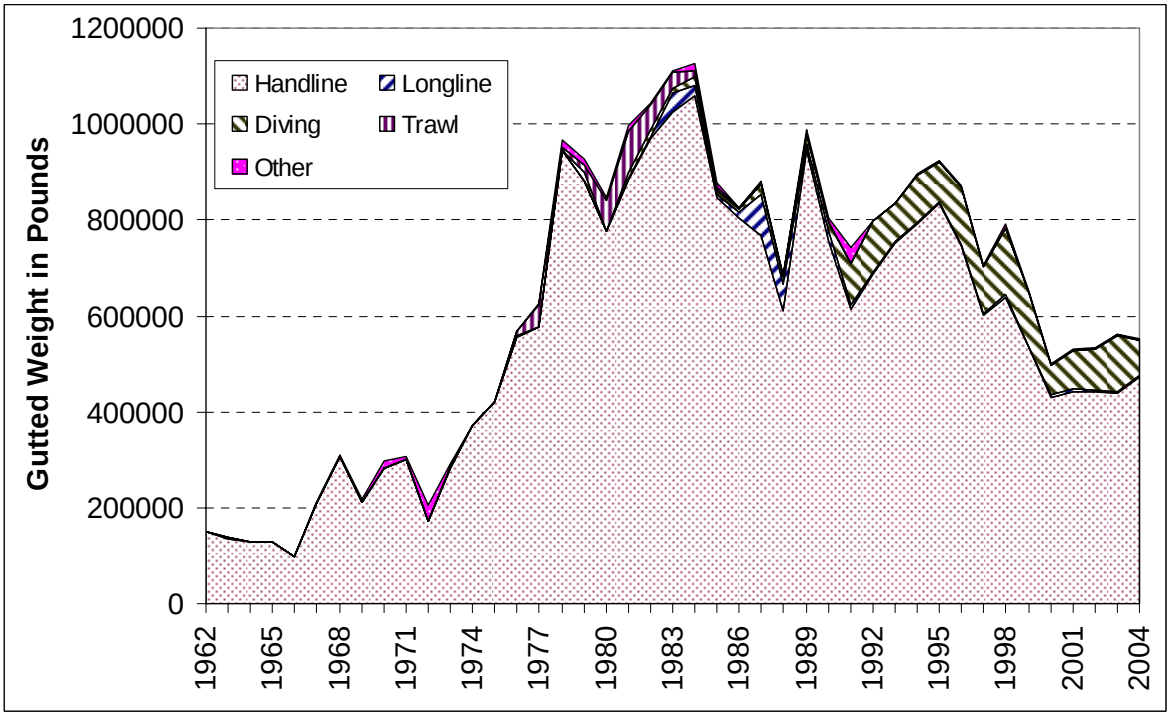


Figure 3.10. Adjusted gag grouper landings from the U.S. South Atlantic, 1962-2004.

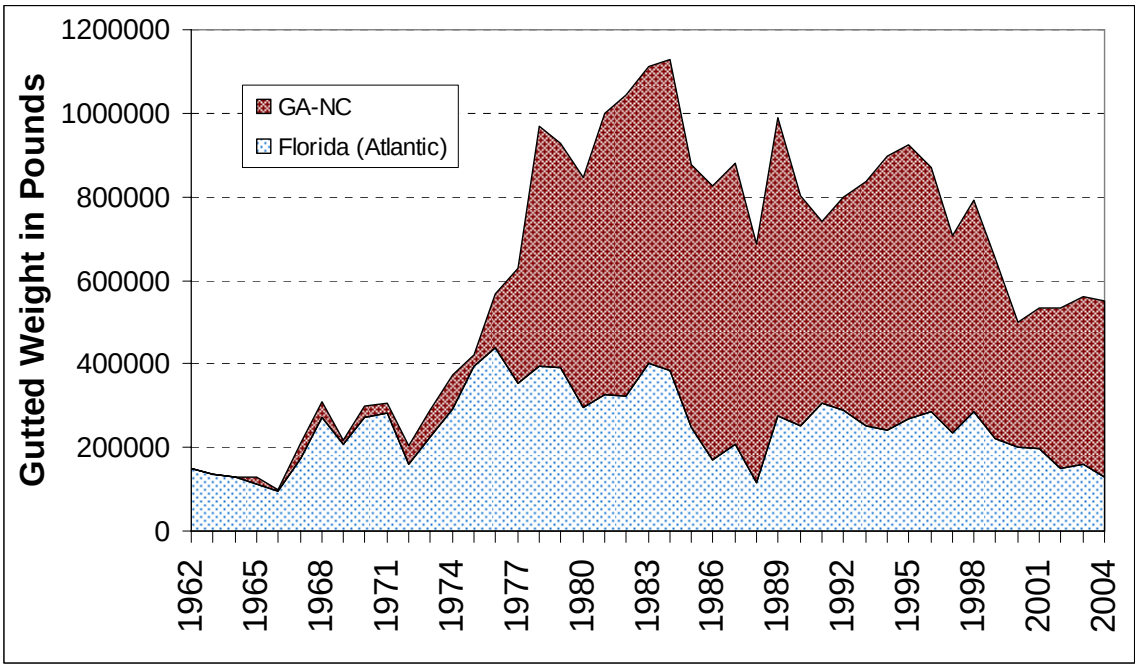


Figure 3.11. Comparison of unadjusted to adjusted gag grouper landings from the U.S. South Atlantic, 1962-2004.

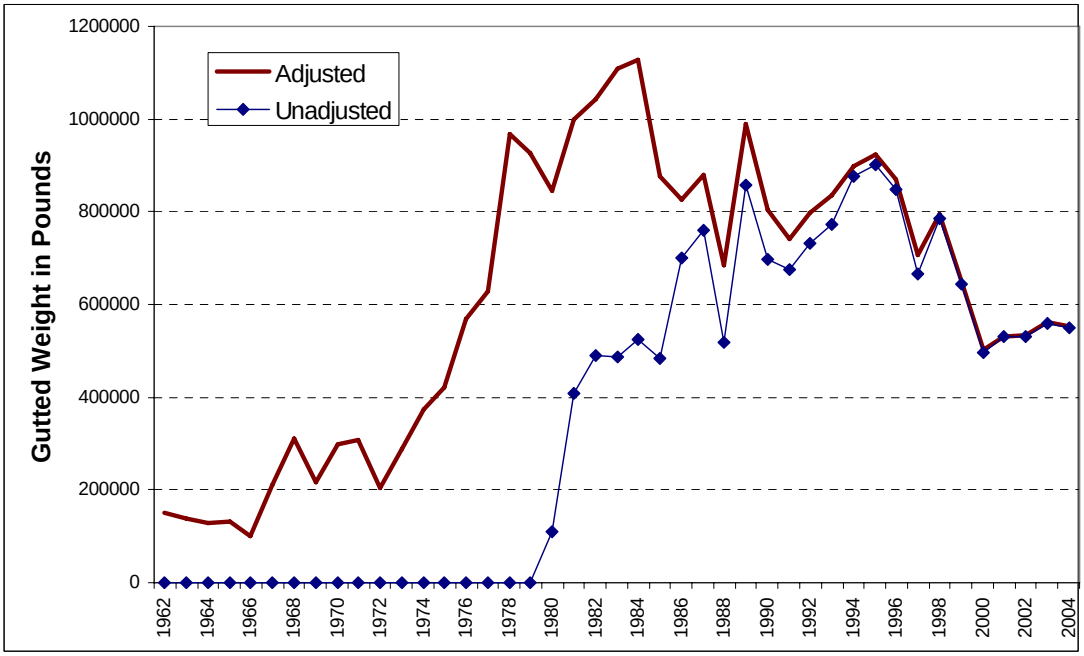


Figure 3.12. Lower bound on adjusted gag grouper landings by gear from the U.S. South Atlantic, 1962-2004

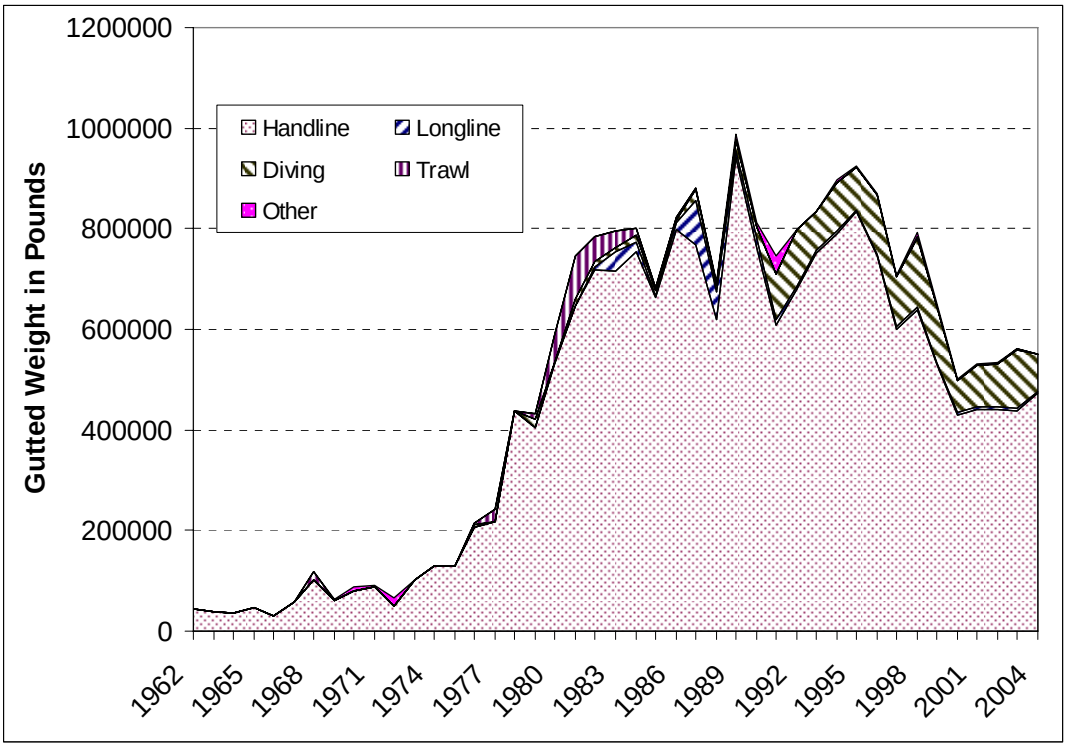


Figure 3.13. Lower bound on adjusted gag grouper landings from the U.S. South Atlantic, 1962-2004.

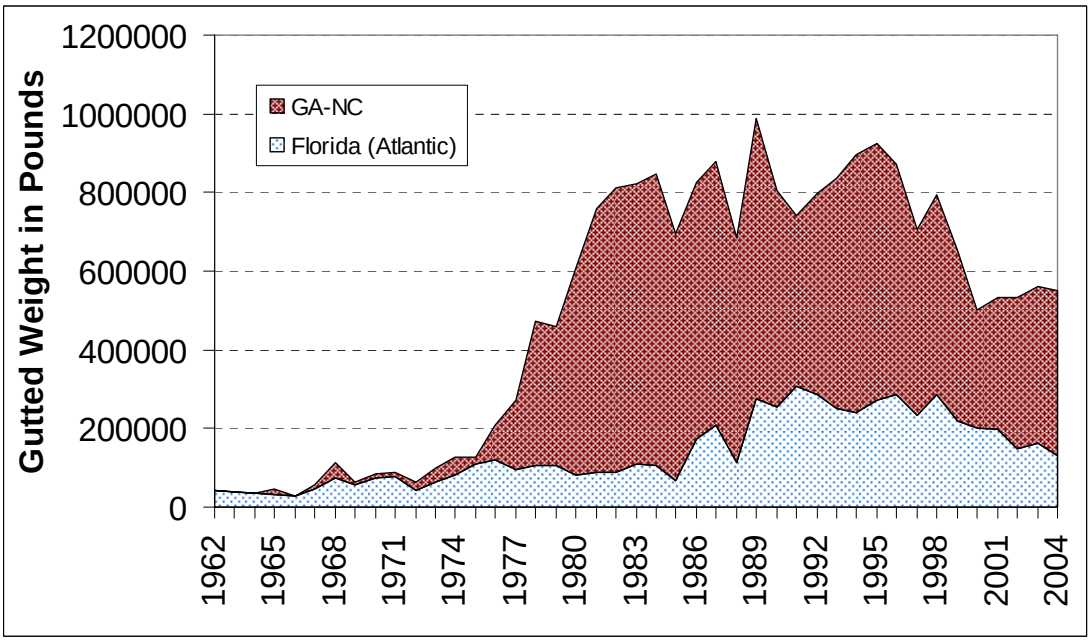


Figure 3.14.Upper bound on adjusted gag grouper landings by gear from the U.S. South Atlantic, 1962-2004.

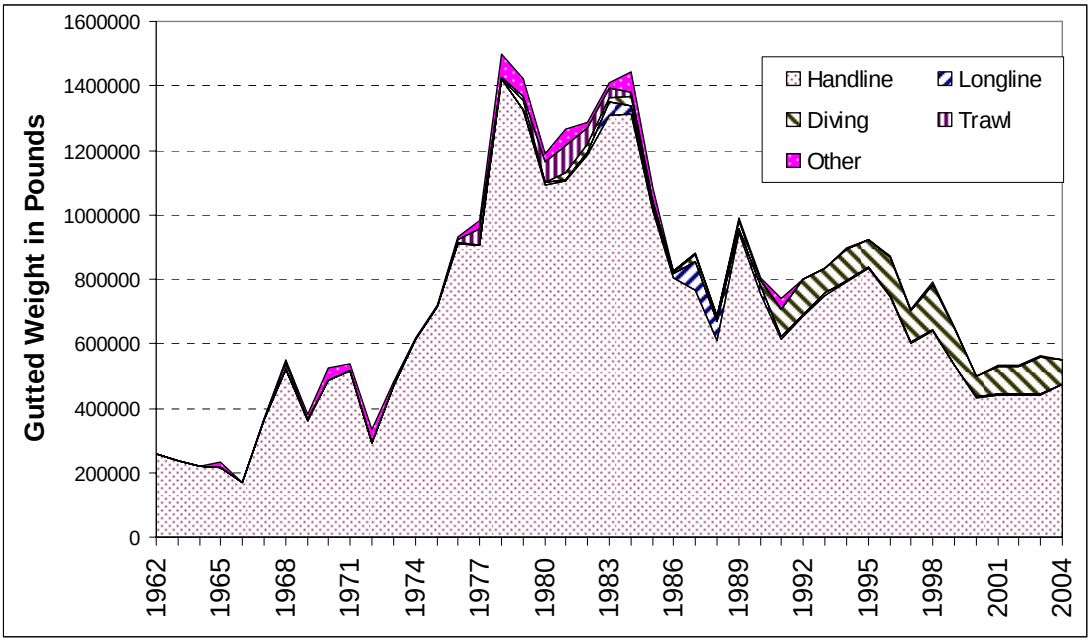


Figure 3.15. Upper bound on adjusted gag grouper landings from the U.S. South Atlantic, 1962-2004.

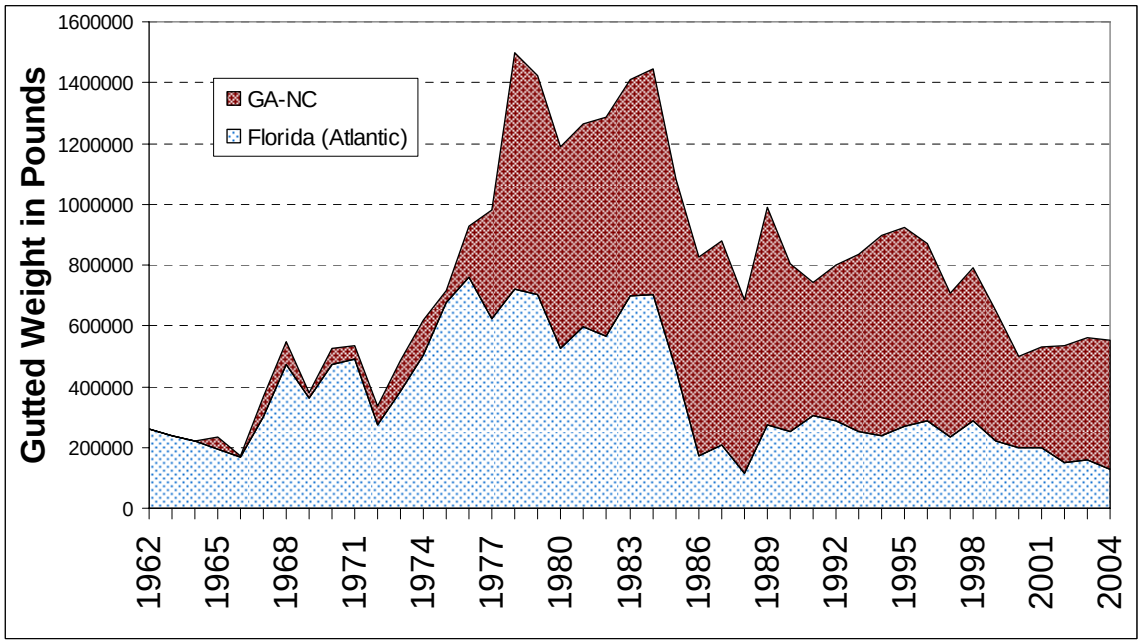


Figure 3.16. Range in adjusted gag grouper landings from the U.S. South Atlantic, 1962-2004.

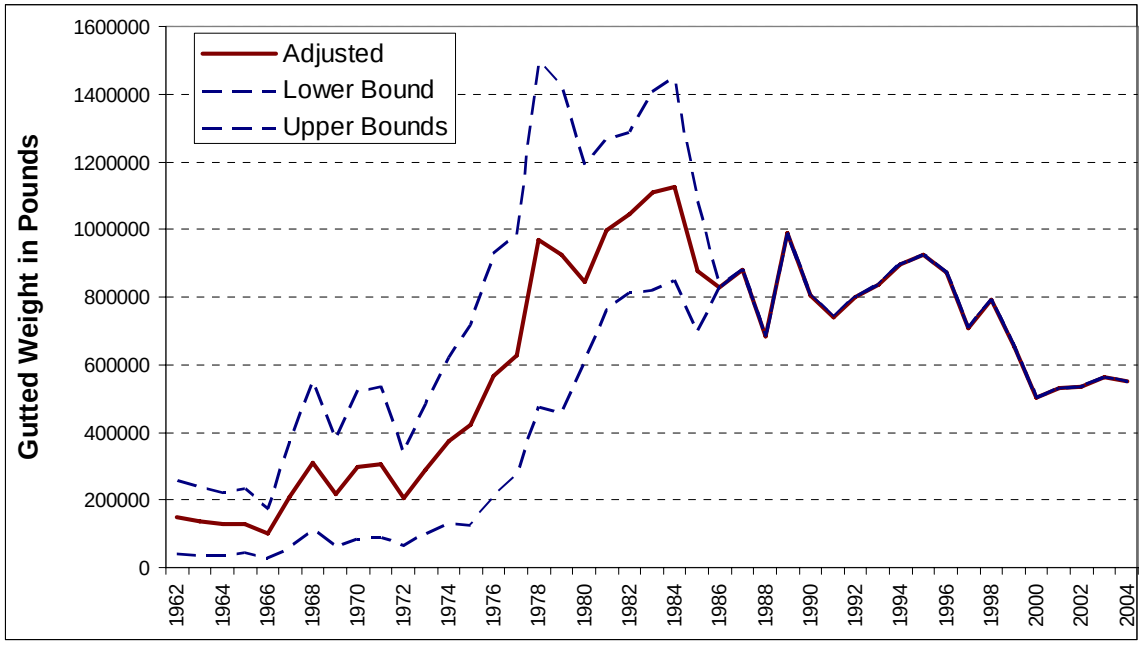


Figure 3.17. Adjusted gag grouper landings in numbers by gear from the U.S. South Atlantic, 1962-2004.

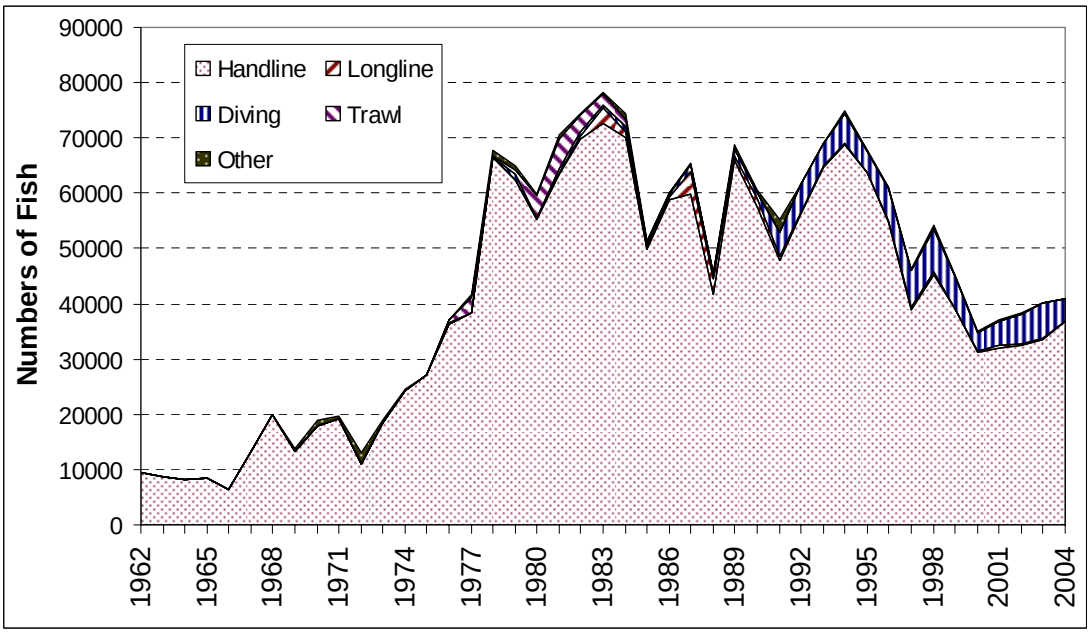


Figure 3.18. Adjusted gag grouper landings in numbers from the U.S. South Atlantic, 1962-2004.

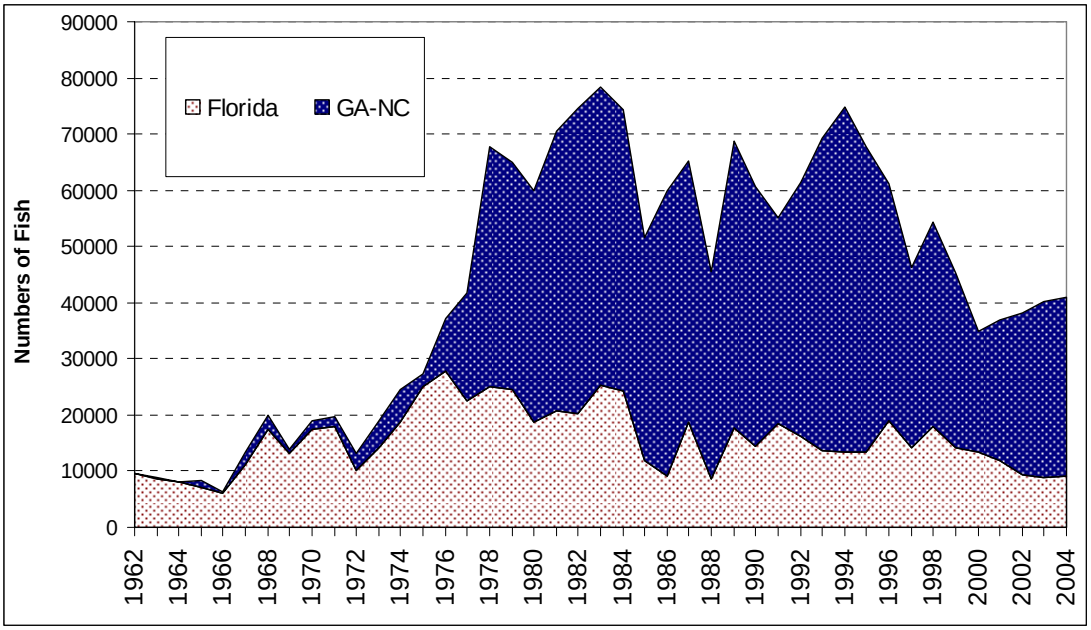


Figure 3.19. Length composition of gag grouper for commercial handline from TIP, 1983-2004. Weighting based on landings in numbers and trip catch in numbers.

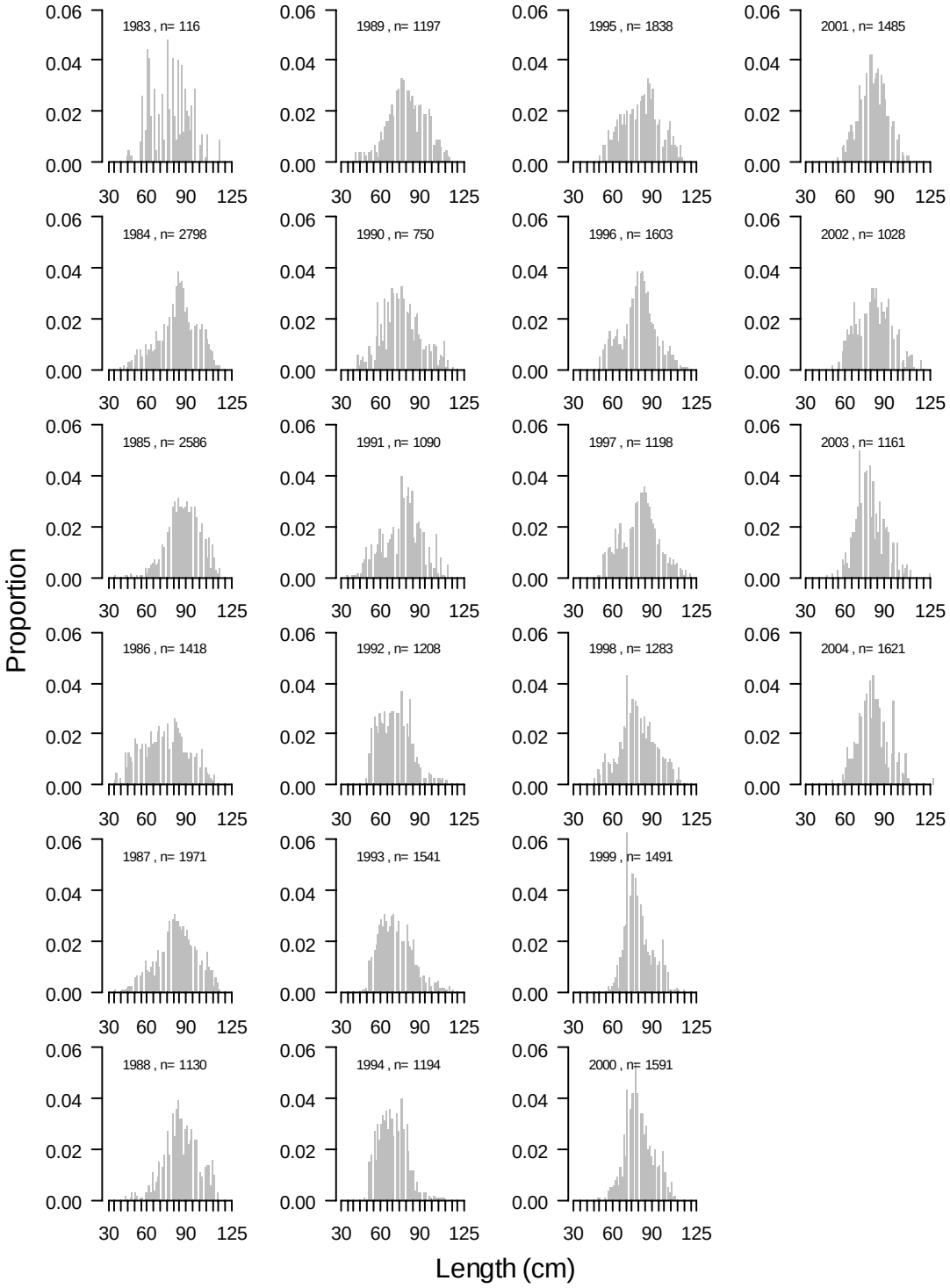


Figure 3.20. Length composition of gag grouper for commercial longline from TIP, 1984-1998, and 2002. Weighting based on landings in numbers and trip catch in numbers.

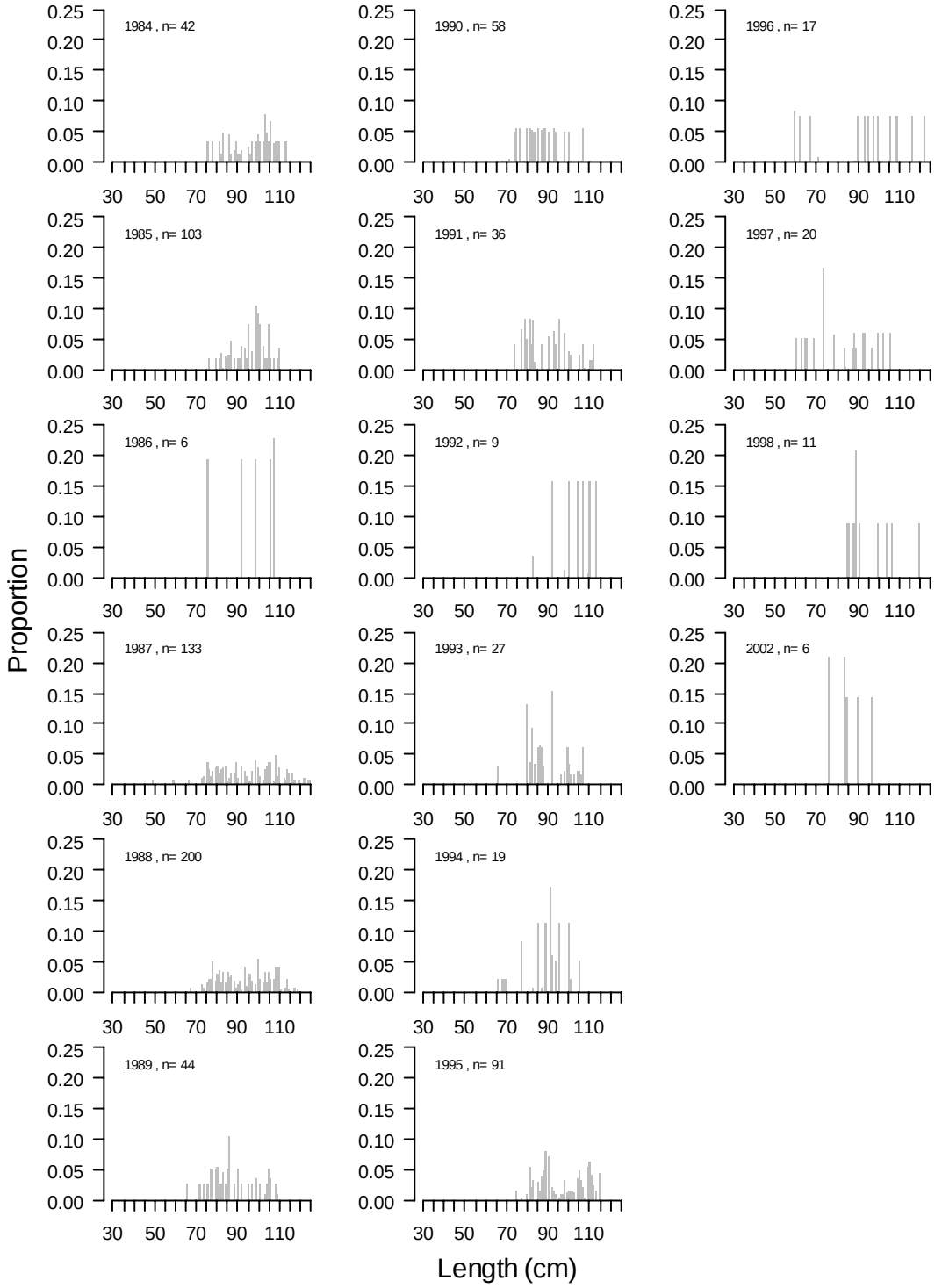


Figure 3.21. Length composition of gag grouper for commercial diving from TIP, 1986-1987, 1991-2004. Weighting based on landings in numbers and trip catch in numbers.

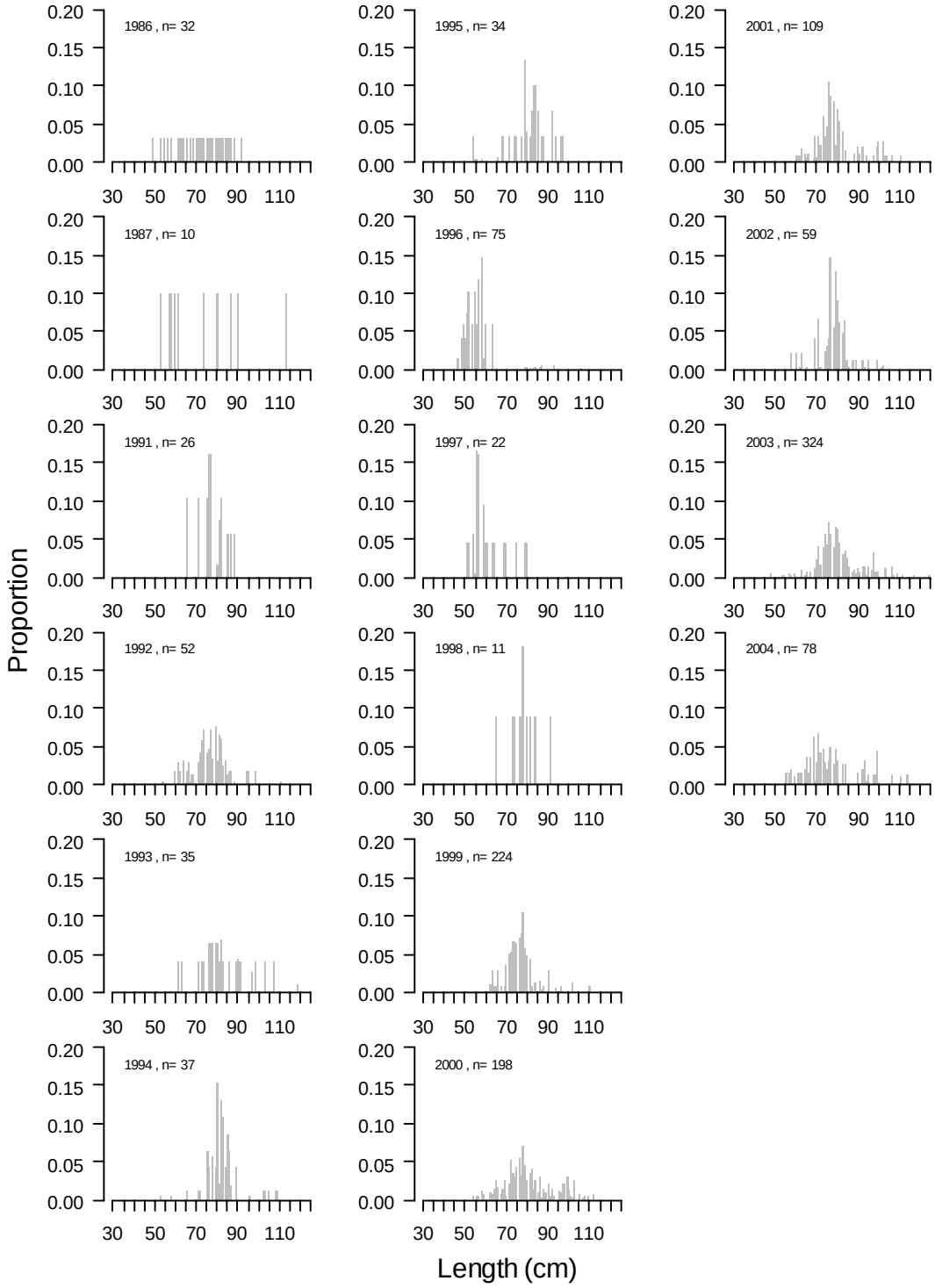


Figure 3.22. Age composition of gag grouper for commercial handline from TIP, 1979-1981, 1992-1997, 1999-2004. Weighting based on corresponding length composition available for 1992-2004.

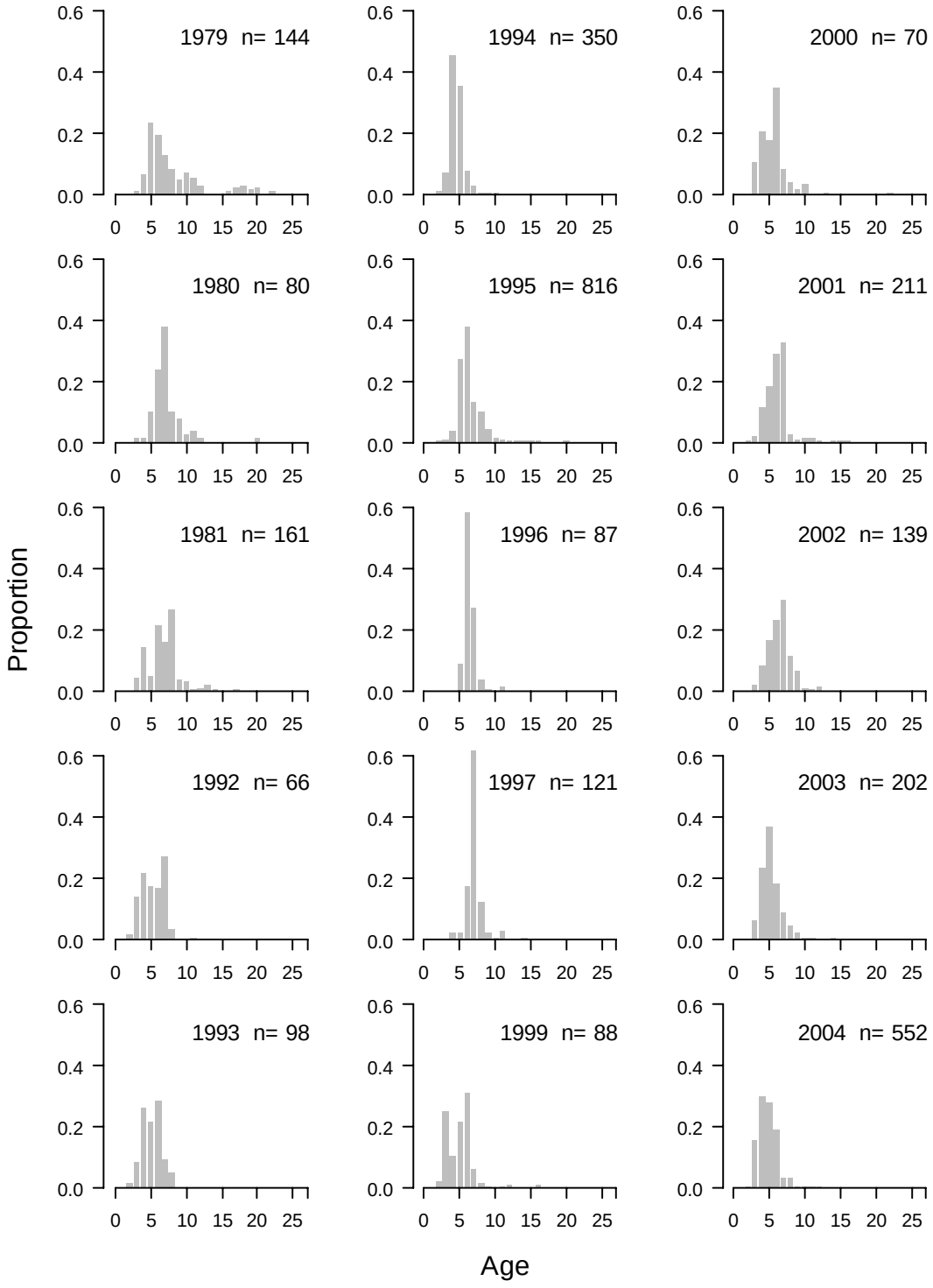
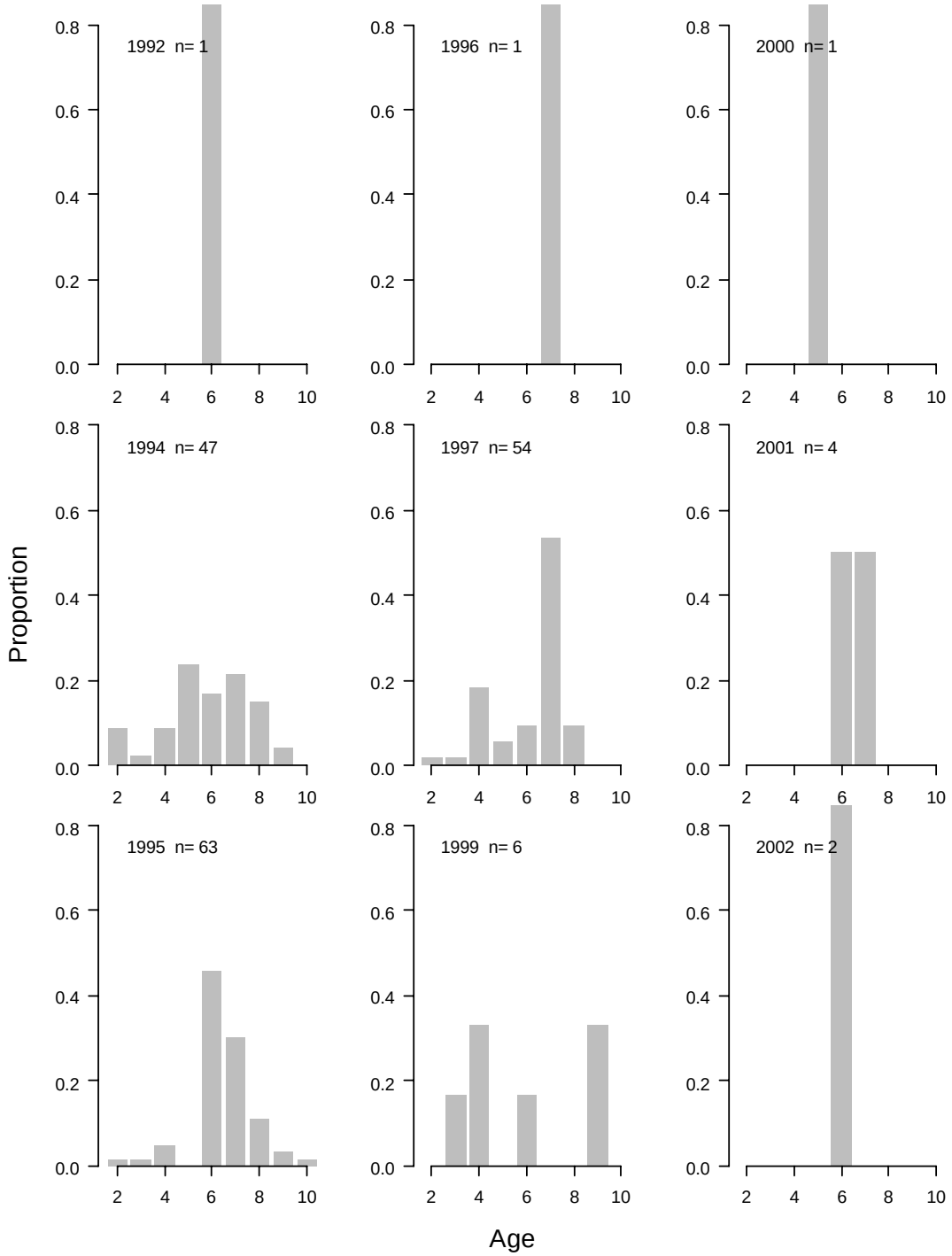


Figure 3.23. Age composition of gag grouper for commercial diving from TIP, 1992, 1994-1997, 1999-2002. Weighting based on landings in numbers by state.



4 Recreational Fisheries

4.1 Overview

Catch of gag, by recreational anglers in the southeastern U.S., can be estimated from at least two sources. The Southeast Region Headboat Survey, conducted by NOAA Fisheries Service at the NOAA Center for Coastal Fisheries and Habitat Research (CCFHR), collects catch and effort data from headboats that operate primarily in the offshore waters of the U. S. South Atlantic Ocean and Gulf of Mexico. Due to Coast Guard license differences, vessels operating in the Gulf of Mexico are defined, as headboats if licensed to carry 15 or more passengers, regardless of the method of payment, and primarily target reef fish. Vessels that operate in the U.S. South Atlantic Ocean are defined as headboats if they are licensed to carry over 6 anglers, regardless of method of payment. Catch and effort data are recorded by trip by the vessel crew. These trip reports are edited by port agents based on their recent sampling observations and after consultation with the crew member who completed the trip report. These trip reports are keyed into a database by a contracted company. The database is stored and summary reports generated at CCFHR. Total landings are estimated by expanding the reported data based on fishing effort information listed on vessel activity reports. In addition to catch and effort data, port agents collect length, weight, and biological materials from fish when the vessel returns to the dock.

The Marine Recreational Fishery Statistics Survey (MRFSS) conducts telephone and creel interviews from saltwater recreational fishermen throughout the US. Estimates of catch are then generated using census information to expand the reported trips and associated catch. Creel samplers also collect length and weight information.

4.2 Headboat Survey

4.2.1 Overview of Headboat Survey

The Southeast Region Headboat Survey included vessels only in North Carolina and South Carolina during the early part of the survey (1972-1975). The Survey expanded to northeast Florida in 1976, to southeast Florida in 1978, and finally to the Gulf of Mexico in 1986. Easily accessible, computer generated estimates are not available prior to 1981. From 1981-present the Survey included all headboats operating in the southeastern U.S. EEZ, encompassing the areas shown in Figure 1 .

4.2.2 Headboat Landings

Prior to 1981, landings estimates for Mycteroperca species were grouped into one landings estimate in the standard headboat data summaries. However, species specific landing estimates of gag were created for North Carolina and South Carolina from 1972-1980 for previous reports, and were digitized for this assessment. Trip reports for other areas began in 1976 and gradually increased so that all the currently sampled areas (NC to the Tortugas) were included by 1978. Landings for the non-coverage areas is discussed below presented with the estimates of landings in number and metric tons (see Table 1 and Table

2, and Figure 2). Landings estimates in gutted whole pounds were calculated using the conversion created for this assessment in the life history report (See Table 3).

1. ***Issue: Placement of landings from areas 12 and 17 corresponding to Southern Florida and the Tortugas. Should areas of South Florida, from Key Largo to Key West, and the Tortugas be placed in GMFMC or SAFMC jurisdiction***

   The data workshop recreational group decided that although some vessels were fishing in the Gulf of Mexico, the majority of the landings in these areas were in the Atlantic. The areas Northwest of the Florida Keys, primarily the waters of Florida Bay, are not deep enough, except in very small areas near channels and in the Intercoastal Waterway, to allow headboats to navigate. Headboat personnel at the workshop were not aware of any vessels in mid and upper Keys that operated in Florida Bay. The group discussed portioning the landings based on the location data in the trip reports. However, based on accuracy of the headboat location data and comments from the headboat personnel at the meeting, the group concluded the location information was insufficient to split the landings from these areas. Also, this decision was based on the time needed to re-estimate the landings if such a decision were made. This decision is consistent with previous SEDAR data workshop decisions regarding headboat landings in these areas.

2 ***Issue: Approach for extending landings for non–coverage areas.***

   To address these missing landings, we regressed landings of North Carolina and South Carolina catches combined against Georgia and Florida catches combined to predict landings for non-coverage areas from 1972–1980. The catch in numbers r-square value was 0.54 with $p<0.0001$. The catch in weight regression r-square value was 0.36 with $p<.0014$ (see Figure 3). Based on error estimates from this regression analysis, a lower and upper bound for the Georgia and Florida headboat landings were computed based on + and – 2 standard deviations and are given in Table 1 and Table 2 and in Figure 2

3 ***Issue: Approach for extending landings from 1971 through 1962.***

   Extending landings back to 1962. "From a stock assessment modeling perspective it is often desirable to extend landings estimates for primary fisheries as far back in time as is reasonable. Based on interviews with some headboat captains and a detailed report on the history of fishing in a town in South Carolina, it is clear that headboat fishing for offshore snapper-grouper species dates back to the years immediately following World War II. In fact many of the vessels employed as headboats were obtained as WWII surplus vessels. It is also well documented that commercial and recreational fishing efforts from large vessels was severely restricted during WWII. These facts confirm that headboat fishing was occurring as far back as the late 1940's and that headboat fishing was likely non-existent during the years of WWII. In an attempt to match commercial landings estimates which extend back to 1962, we examined two linear predictors for estimating historic headboat landings.

One approach involved regressing the headboat landings in 1972-2004 against the commercial landings for the same years. The regression of headboat landings without estimated released fish was significant at the 0.10 level using the robust linear model analysis (See Figure 4).

The other option considered for estimating historic headboat landings used the coastal human population estimates as a linear predictor. The results of this are shown in Figure 5.

There was no preferred recommendation from the data workshop panel on this issue. The SEDAR 10 Atlantic working group decided to use the regression equation of headboat landings against commercial landings to predict headboat landings from 1962–1971. (See Table 4).

4.2.3 Headboat Discards

Collection of discard data began in 2004 in the headboat survey, but were unavailable for this assessment. However, estimates of released(B2) fish from the MRFSS charter boat mode were used to estimate the proportion of released fish from the headboat fishery. (See Table 5) The charter boat mode is thought to most closely approximate fishing practices followed by headboats. The ratio of released:retained(A+B1) fish in the charter boat mode from MRFSS was averaged over regulation time periods (See Table 6 and Figure 6). These ratios were then applied to the headboat catch in numbers, providing estimates of the number of released fish in the headboat fishery. Prior to 1985, discards were assumed to be zero.

The 2004 headboat discard information was made available after the data workshop and was not reviewed by all workshop participants and therefore not available for the assessment workshop. However, releases of gag from the headboat survey in 2004 was estimated to be 83% which is very similar to the estimate of 90% from the most recent time period discussed above.

4.2.4 Biological Sampling

Length and weight measurements from fishes taken by anglers on headboats are collected by port agents throughout the coverage area. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely. Length-weight data are used to compute average weights for each species and to compute age frequencies and mortality rates. This information combined with catch record data are used to calculate an estimate of total weight (kg) of reef fish landed in the headboat fishery. Port agents are instructed to look for stringers with the less common species including groupers, red snapper, and unusual porgies. Common species are adequately represented because stringers with unusual fish usually include many of the common species.

If possible, ten or more fish of each species present in the total catch are weighed and measured for lengths. To avoid size- or species selectivity bias complete stringers of fish are measured.

After sampling is completed, data are electronically downloaded and edited for errors. It is also the responsibility of each sampler to review trip reports (catch records) for missing information and any other apparent errors, such as, coding errors, misidentification, or questionable weights and lengths.

Mean Weight

The plot of mean weight for North Carolina and South Carolina (Carolinas) and Georgia–Florida show similar trends with mean weight decreasing from the early 1970's to the mid 1980's and then increasing slightly. Implementation of size limits are likely responsible for the increases (see Figure 7).

Sampling Intensity

The number of length samples taken for gag has varied temporally and spatially. Changes in sampling intensity over time seem to follow the trend in landings as would be expected (see Table 7).

Length Compositions

Length compositions were created by assigning an estimated landings value to each fish length by year, state, and 4-month time interval. The estimated landings were summed by year and length (1cm bins). The proportion estimated landings for each length by year was calculated and reported as the annual weighted length composition (See Figure 8 and Figure 9).

Trends in the length composition data are difficult to examine in Figures 8 and 9, therefore we examined the data by year and length intervals (See Figures 10 and 11). Trends in these figures suggest that in the early years of the headboat fishery, there was a significant proportion of 95+ cm fish which disappeared by the early 1980s. This resulted in an increased proportion of smaller fish, which then began to drop out of the length composition data as size regulations came into place. The effects of the 20 and 24 inch minimum size limits can clearly be seen in the temporal changes occurring in the 30–50 and 51–60 cm length groups (See Figure 10 and 11).

Age Compositions

Recreational age data were available from charter boat and headboat collections. Most of the aged fish were from the headboat survey (91%). Headboat ages were weighted by the sum of the catch in each year, month (3 intervals), and area (North Carolina, South Carolina, and Georgia/Florida) in the headboat fishery associated with the sample. The charter boat ages were weighted using the same method with estimates of catch from the MRFSS. The combined headboat and charter boat age compositions are shown in Figures 12 and 13.

4.3 Adequacy of Data for Assessment Model

The data workshop concluded that the headboat landings data reported herein, represent the best available data and are adequate for use in the stock assessment model.

The data workshop concluded that the headboat discard data reported herein, represent the best available data and are adequate for use in the stock assessment model.

4.4 Recreational Survey(MRFSS)

4.4.1 Overview of Recreational Survey

(excerpt from MRFSS user's guide) The National Marine Fisheries Service (NMFS) initiated a series of surveys in 1979 to obtain standardized and comparable estimates of participation, effort, and catch by recreational anglers in the marine waters of the United States. Continued efforts to develop and maintain a comprehensive marine recreational fisheries data acquisition and analysis system implemented the first priority of the NMFS Marine Recreational Fisheries Policy established in 1981.

The primary MRFSS data files for this assessment are the landings estimated by year, wave (2–month intervals) and mode of fishing(charter boat, private vessel and shore-based) and creel interview data (MRFSS designated intercept–type 3). The intercept data includes biological information. Data from the MRFSS useful for the estimation of catch and effort for gag grouper begins in Wave 2 (March), 1981. In 2003 the MRFSS began new landings estimation methods (For Hire Survey method) to better estimate landings from charter vessels. Landings estimates for 2003–4 consistent with estimates prior to 2003 are available from the MRFSS by request.

4.4.2 Recreational Landings

A snapshot of the catch and intercept data was obtained from the MRFSS ftp: site on October 6, 2005. Catch estimates for 2003 and 2004 were requested using the estimation procedures as in 1981–2002 instead of the new For Hire Survey methods to maintain consistency. The types of catch are defined as:

Catch Type A
Fish brought to land and identified to species by the interviewer

Catch Type B1
Fish that were unavailable for verification by creel interviewer and were either used for bait, filleted, or consumed for some other use.

Catch Type B2
Fish that were unavailable for verification by the creel interviewer and were released alive.

4 ***Issue: Monroe County gag catches applied to GMFMC or SAFMC***

The MRFSS data are reported by regions, which includes regions for East Florida and West Florida. When creating these regions, MRFSS includes Monroe County, Florida in their estimates for the West Florida region. Monroe County, Florida includes the Florida Keys which form the boundary line for

the South Atlantic (SAFMC) and Gulf of Mexico (GMFMC) fishery management councils. The GMFMC territory to the Northwest of the Florida Keys is largely composed of the shallow waters of Florida Bay, unsuitable habitat for adult gag, but possibly suitable habitat for juvenile gag. It is likely that most of the catches of gag in Monroe County are from areas south of the Florida Keys in SAFMC jurisdiction. However, there still remains uncertainty about the catches of gag from Key West, Florida which may include angler trips in areas surrounding the Dry Tortugas, which may include both GMFMC and SAFMC jurisdictions. Ultimately it was decided at the data workshop that Monroe County should be included in the East Florida region, contributing to the U.S. South Atlantic totals. Staff at MRFSS provided a data query with separate catch estimates for Monroe County. This data was added into the total U.S. South Atlantic estimates.

5 ***Issue: Removal of headboat estimates from MRFSS for–hire vessel, charter and headboats,estimates in 1981-1985.***

From 1981-1985 the MRFSS included some headboats in their survey for the for–hire vessel estimates. The NMFS Headboat Survey was sampling these same vessels for those years. To avoid double counting landings estimates from headboats, the MRFSS headboat catches need to be removed. There is no distinction for these two types of vessels made for the catch estimates from MRFSS. However the intercept data does include an accounting of the number of each of these types of vessels. The data workshop decided to use the ratio of charter boats to headboats from the intercept data to create a correction factor for discounting the catch estimates, thereby removing the headboat catches from MRFSS.

The intercept data for headboats and charter boats in 1981-1985 are quite small. Annual correction factors could not be computed, but state specific correction factors were discussed as a possibility (see Table below). The preferred option decided upon by the data workshop was to use a single overall correction factor of 0.4138 to discount headboat catches.

State	Proportion Charter	Sample Size
NC	0.393	28
SC	0.333	9
GA	1	4
FL	0.353	17

6 ***Issue: Misreported gag grouper as black grouper***

In the Gulf of Mexico there were some known cases of gag samples being misreported as black grouper, owing to a common misnomer among the angling community. It was unclear if this same problem existed in the U.S. South Atlantic. We examined the ratios of gag to (gag + black grouper) by region. There was some slight indication that the ratio was lower in early years(See Figure 14),

which would have been consistent with the pattern found in the Gulf of Mexico, however, the pattern in the Gulf of Mexico was much more extreme . Furthermore, the Gulf of Mexico had a case of a known change in interviewer training, interviewer supervision, and contractor quality assurance and control implemented in 1990. This coincided with a rapid change in the reported ratio of gag:(gag + black grouper). Therefore it was decided by the data workshop to not make any adjustments to the East Florida MRFSS estimates.

The examination of the ratio of gag:(g ag + black grouper) for Georgia, South Carolina, and North Carolina did show some rapid changes in the ratio for some years (See Figure 14 and Table 8). Black grouper are known to occur in South Florida and there appearance north of Florida becomes increasingly rare. For this reason, it was decided that the reported black grouper in some years north of Florida were likely gag. The data workshop decided to include all reported black grouper catches north of Florida with gag for the U.S. South Atlantic.

7 ***Issue: Fill in estimates for Wave 1 in 1981.***

The MRFSS survey did not begin full operations in 1981 until March (Wave 2). The data workshop decided to estimate the missing Wave 1 estimates using a ratio of Wave 1 to Waves 2-6 for years 1982-1985. This ratio was then applied to the 1981 Wave 2-6 estimates to estimate Wave 1 in 1981. As it turns out, the only state with any Wave 1 estimates in 1982-1985 is Florida. Therefore the estimates of Wave 1 in 1981 are very minor; an addition of only 4,146 fish to the A+B1 category.

8 ***Issue: Estimate historic landings back to 1962***

From a stock assessment modeling perspective it is often desirable to extend landings estimates for primary fisheries as far back in time as is reasonable. In an attempt to match commercial landings estimates, which extend back to 1962, we examined two linear predictors for estimating historic MRFSS landings.

The first approach involved regressing the MRFSS landings in 1981-2004 against the commercial landings for the same years. The regression of MRFSS landings without estimated released fish was not significant using the linear model. However, the regression of MRFSS landings without released fish was significant using the robust linear model (See Figure 4).

The other option considered for estimating historic MRFSS landings used the coastal human population estimates as a linear predictor. The results of this are shown in Figure 5.

There was no preferred recommendation from the data workshop panel on this issue. The SEDAR 10 Atlantic working group decided to use the regression of headboat landings to commercial landings to predict headboat landings from 1962–1980. (See Table 4).

Landings in Numbers Landings in numbers are estimated in the MRFSS for three (3) landings categories: retained fish available for measurement (type A), retained fish unavailable for measurement (type B1), and released fish (type B2). Table 9 and Figure 15 summarize landings with percent standard error for private boats, charter boats, and shore-based fishing. Most landings represent two modes of fishing: private boats and charter boats. The latter are smaller for-hire vessels, not including headboats. Estimated total landings in numbers by state are also reported (see Table 10 and Figure 16).

Landings in Biomass

9 ***Issue: Use weight estimates or not.***

The MRFSS intercept samples with weight information is limited. Approximately 10% of the expansion cells have no information on weight. The data workshop discussed methods for borrowing weight estimates from neighboring cells to fill in missing weight samples. In addition, the records that do include weight may have been calculated using substitutions from other cells possibly based on only one fish. Ultimately, the data workshop decided not to use the weight estimates, since the assessment model was equipped to handle catch in numbers just as easily as catch in weight. Furthermore, the estimates of released fish do not have any weight estimates associated with them, suggesting MRFSS catches are best handled as numbers in the assessment model.

4.4.3 Recreational Discards

Discard data is collected during every MRFSS interview and has been collected consistently since the inception of the MRFSS. Anglers are asked to recall discards the day of their completed fishing trip by creel samplers during interviews. Early years of discard estimates are variable, probably due to low incidence of gag discards in the intercept sample, but variability has been reduced in more recent years with the an increase in the frequency of intercepts and a higher incidence of gag discards. (See Table 11)

4.4.4 Biological Sampling

Sampling Intensity There are limited length and weight samples from the MRFSS, especially in the first few years of the survey (see Table 12).

Length Compositions Length compositions were created by assigning an estimated landings value to each fish length by year, wave and fishing mode. The fork lengths were converted to total length using the conversion factor provided by the life history section for this assessment.

$$TotalLength = ForkLength * 1.034 \tag{1}$$

. The estimated landings associated with each fish were summed by year and fish length (1cm bins). The proportion estimated landings for each length by year was calculated and reported as the annual weighted length composition (see Figure 17 and Figure 18).

Tables

Table 1. Estimated numbers of gag landed from Headboat vessels in the Southeast US Atlantic. Fish in thousands of fish. The upper and lower 95% confidence intervals for predicted values of Georgia and Florida are reported.

Year	NC	SC	GA-FL	Lower	Upper	Total
1972	6.20	1.17	6.08	1.91	10.24	13.44
1973	8.25	2.00	7.74	3.50	11.98	17.99
1974	6.72	0.95	6.25	2.08	10.42	13.92
1975	2.92	1.36	4.29	0.10	8.49	8.57
1976	2.11	1.52	3.92	0.00	8.14	7.56
1977	3.31	0.91	4.26	0.07	8.45	8.48
1978	2.16	0.49	3.36	0.00	7.61	6.01
1979	4.07	0.82	4.65	0.47	8.83	9.55
1980	1.57	1.68	3.70	0.00	7.93	6.96
1981	3.42	1.39	9.05			13.86
1982	2.98	0.95	7.91			11.84
1983	3.44	3.90	9.12			16.46
1984	7.71	1.29	9.69			18.69
1985	6.90	1.61	7.62			16.13
1986	8.51	1.60	7.24			17.35
1987	10.60	2.50	11.00			24.09
1988	10.97	2.49	10.76			24.21
1989	12.58	1.88	7.95			22.42
1990	7.93	3.58	6.08			17.59
1991	5.46	3.50	4.59			13.55
1992	6.15	2.36	5.44			13.94
1993	4.84	1.79	5.16			11.80
1994	4.38	1.11	4.32			9.81
1995	4.26	0.88	5.40			10.54
1996	3.30	0.59	3.61			7.50
1997	2.67	0.39	3.80			6.85
1998	3.72	0.60	4.36			8.67
1999	1.28	0.91	3.14			5.34
2000	1.92	0.76	3.30			5.98
2001	1.74	1.21	2.17			5.12
2002	1.65	1.23	1.70			4.58
2003	1.66	0.25	1.36			3.27
2004	1.80	1.24	3.62			6.66

Table 2. Weights in metric tons of gag landed from Headboat vessels in the Southeast US Atlantic.

Year	NC	SC	GA-FL	Lower	Upper	Total
1972	44.71	9.43	52.99	24.19	81.78	107.12
1973	68.41	17.41	80.00	41.59	118.41	165.82
1974	55.57	10.26	62.96	31.08	94.84	128.79
1975	20.58	12.89	35.37	9.95	60.78	68.84
1976	15.21	10.92	29.10	4.08	54.12	55.22
1977	20.38	6.43	29.69	4.65	54.72	56.50
1978	16.16	2.74	22.95	0.00	48.03	41.85
1979	25.01	5.55	32.88	7.69	58.08	63.45
1980	8.62	10.93	23.49	0.00	48.55	43.03
1981	14.37	5.73	46.80			66.89
1982	12.94	3.75	41.32			58.01
1983	11.32	14.05	34.60			59.97
1984	27.10	6.54	59.88			93.52
1985	21.55	10.51	39.53			71.59
1986	23.19	8.18	29.46			60.84
1987	28.15	10.14	46.65			84.94
1988	30.30	8.41	52.56			91.27
1989	34.49	9.96	34.27			78.71
1990	23.44	17.09	22.38			62.91
1991	16.74	18.34	16.59			51.67
1992	18.56	9.92	27.99			56.47
1993	15.86	6.79	32.41			55.05
1994	14.77	5.89	22.39			43.05
1995	17.51	6.18	26.75			50.44
1996	9.92	3.53	16.65			30.09
1997	10.01	2.22	15.70			27.93
1998	13.34	3.89	14.92			32.15
1999	6.31	5.66	14.49			26.46
2000	9.58	4.37	13.67			27.63
2001	7.79	5.26	10.90			23.94
2002	5.94	6.44	10.55			22.93
2003	5.95	1.28	7.50			14.74
2004	8.43	5.59	23.30			37.31

Table 3. Weights in gutted whole pounds of gag landed from Headboat vessels in the Southeast US Atlantic.

Year	NC	SC	GA-FL	Lower	Upper	Total
1972	93113	19641	110360	50386	170334	223113
1973	142473	36265	166627	86628	246627	345365
1974	115742	21367	131129	64733	197525	268239
1975	42862	26851	73658	20732	126584	143370
1976	31673	22738	60609	8506	112712	115020
1977	42453	13392	61833	9694	113972	117678
1978	33666	5711	47789	0	100041	87166
1979	52097	11557	68491	16007	120976	132145
1980	17945	22759	48921	0	101121	89624
1981	29928	11932	97466			139327
1982	26947	7808	86062			120817
1983	23578	29258	72071			124908
1984	56436	13628	124724			194787
1985	44876	21884	82338			149098
1986	48302	17046	61367			126715
1987	58624	21122	97159			176905
1988	63106	17515	109474			190094
1989	71825	20734	71379			163938
1990	48819	35604	46608			131030
1991	34867	38205	34554			107627
1992	38649	20653	58305			117607
1993	33031	14140	67493			114665
1994	30761	12260	46641			89661
1995	36474	12870	55709			105053
1996	20655	7347	34674			62676
1997	20852	4632	32696			58180
1998	27782	8102	31075			66960
1999	13153	11793	30175			55121
2000	19960	9108	28474			57543
2001	16215	10948	22692			49856
2002	12375	13420	21969			47764
2003	12392	2675	15630			30697
2004	17548	11643	48527			77718

Table 4. Estimated numbers of gag landed from Headboat vessels and recreational anglers in the South Atlantic. Headboat and MRFSS (A+B1) landings are predicted from commercial landings for 1962–1971 and 1962–1980 respectively.

Year	HB	HB +releases	MRFSS (A+B1)	MRFSS (A+B1+B2)
1962	8.41	8.41	6.17	6.17
1963	7.66	7.66	5.62	5.62
1964	7.18	7.18	5.27	5.27
1965	7.41	7.41	5.44	5.44
1966	5.58	5.58	4.09	4.09
1967	11.77	11.77	8.62	8.62
1968	17.72	17.72	12.98	12.98
1969	12.13	12.13	8.89	8.89
1970	16.66	16.66	12.20	12.20
1971	17.18	17.18	12.59	12.59
1972	13.44	13.44	8.37	8.37
1973	17.99	17.99	12.15	12.15
1974	13.92	13.92	15.68	15.68
1975	8.57	8.57	17.48	17.48
1976	7.56	7.56	23.77	23.77
1977	8.48	8.48	21.94	21.94
1978	6.01	6.01	37.54	37.54
1979	9.55	9.55	35.70	35.70
1980	6.96	6.96	35.39	35.39
1981	13.86	13.89	56.69	56.69
1982	11.84	11.86	17.85	22.17
1983	16.46	16.50	74.82	166.70
1984	18.69	18.72	153.25	165.20
1985	16.13	19.89	52.22	55.31
1986	17.35	21.40	46.78	59.26
1987	24.09	29.72	87.38	97.68
1988	24.21	29.86	62.07	77.08
1989	22.42	27.65	75.28	118.69
1990	17.59	21.70	52.20	63.66
1991	13.55	16.71	36.71	60.90
1992	13.94	21.68	49.32	87.98
1993	11.80	18.34	51.80	83.03
1994	9.81	15.26	56.22	124.51
1995	10.54	16.39	40.53	114.50
1996	7.50	11.66	43.92	86.92
1997	6.85	10.66	32.33	114.74
1998	8.67	13.49	40.32	72.54
1999	5.34	10.14	50.45	109.31
2000	5.98	11.36	29.87	156.50
2001	5.12	9.72	42.74	90.15
2002	4.58	8.70	24.03	109.76
2003	3.27	6.22	46.11	183.73
2004	6.66	12.66	46.25	135.79

Table 5. Percent gag released in the recreation angler fishery of the Southeast US Atlantic.

Charter Mode			
Year	B2	A+B1	B2/(A+B1)
1981	0	458	0%
1982	0	706	0%
1983	0	596	0%
1984	106	13382	1%
1985	1392	6449	22%
1986	749	718	104%
1987	0	4218	0%
1988	1793	22112	8%
1989	0	15564	0%
1990	1407	13445	10%
1991	1636	8730	19%
1992	9447	15899	59%
1993	12287	18666	66%
1994	11987	22303	54%
1995	13960	18213	77%
1996	2825	11822	24%
1997	6329	10521	60%
1998	3981	8168	49%
1999	5033	16913	30%
2000	7759	10666	73%
2001	2707	7968	34%
2002	4839	5857	83%
2003	19577	9152	214%
2004	8892	8270	108%

Table 6. Percent gag released in the recreation angler fishery of the Southeast US Atlantic averaged over each regulation period.

Charter Mode	
Regulation Period	B2/(A+B1)
1981–1984	0%
1985–1991	23%
1992–1998	55%
1999–2004	90%

Table 7. Frequency of headboat biological sampling of gag in the Southeast US Atlantic.

year	NC	SC	GA/FL	Total
1972	118	33		151
1973	124	116		240
1974	93	53		146
1975	180	53		233
1976	198	31	23	252
1977	271	36	73	380
1978	158	24	142	324
1979	91	16	180	287
1980	177	9	147	333
1981	94	1	361	456
1982	230	15	353	598
1983	283	67	551	901
1984	505	82	672	1259
1985	362	44	558	964
1986	325	27	319	671
1987	359	86	254	699
1988	323	60	161	544
1989	262	37	173	472
1990	166	27	173	366
1991	90	38	56	184
1992	123	71	82	276
1993	97	79	106	282
1994	71	123	94	288
1995	134	184	166	484
1996	76	42	105	223
1997	55	16	128	199
1998	77	20	270	367
1999	49	36	188	273
2000	40	3	154	197
2001	54	0	136	190
2002	37	8	61	106
2003	46	29	67	142
2004	55	7	47	109

Table 8. Percentage of MRFSS landings that were gag of the gag plus black grouper landings.

Year	North Carolina	South Carolina	Georgia	Florida
1981	100	0	20	57
1982	100	20	20	25
1983	0	0	100	33
1984	100	100	20	52
1985	100	100	100	75
1986	20	100	100	27
1987	100	100	100	76
1988	100	100	100	100
1989	100	95	100	82
1990	100	100	100	100
1991	100	100	100	100
1992	100	100	100	56
1993	100	100	100	100
1994	100	100	100	96
1995	100	100	100	70
1996	97	100	100	53
1997	100	20	100	64
1998	100	20	100	74
1999	50	100	100	90
2000	100	100	100	85
2001	100	100	100	83
2002	100	100	100	87
2003	100	100	100	84
2004	100	100	100	87

Table 9. MRFSS Estimates of numbers of gag landed by recreational anglers in the Southeast US Atlantic with percent standard error estimates (PSE). Landings are in thousands of fish.

	Private Boats		Charter Boats		Shore-based		Total	
Year	A + B1	PSE	A + B1	PSE	A + B1	PSE	A + B1	PSE
1981	0.46	100.00	50.53	50.98	5.71	71.50	56.69	46.51
1982	0.71	61.11	15.47	63.47	1.67	100.00	17.85	47.9
1983	0.60	77.38	74.23	52.77	0.00		74.82	52.32
1984	13.38	30.70	137.45	29.13	2.41	49.74	153.25	20.66
1985	6.45	37.31	37.90	44.18	7.87	56.38	52.22	29.78
1986	0.72	52.98	19.91	27.72	26.15		46.78	26.93
1987	4.22	29.18	80.78	38.82	2.38	73.39	87.38	35.81
1988	22.11	25.44	39.96	24.49	0.00		62.07	20.36
1989	15.56	24.51	55.29	22.39	4.43	100.00	75.28	17.49
1990	13.45	18.90	37.37	36.36	1.38	71.58	52.20	26.71
1991	8.73	17.20	23.85	24.36	4.13		36.71	19.05
1992	15.90	24.51	33.42	16.21	0.00		49.32	13.53
1993	18.67	26.66	32.75	28.68	0.38	70.94	51.80	20.43
1994	22.30	20.97	32.27	26.10	1.64	66.67	56.22	17.2
1995	18.21	33.16	19.04	26.97	3.28	100.00	40.53	20.82
1996	11.82	30.67	31.33	26.93	0.77	99.04	43.92	20.48
1997	10.52	35.79	21.81	25.79	0.00		32.33	21.86
1998	8.17	38.77	32.15	33.49	0.00		40.32	29.44
1999	16.91	20.51	33.08	31.70	0.46	100.00	50.45	22.25
2000	10.67	25.69	19.21	20.80	0.00		29.87	16.24
2001	7.97	18.98	31.93	22.55	2.84	71.13	42.74	18.1
2002	5.86	18.59	18.18	24.99	0.00		24.03	19.36
2003	9.15	35.14	36.96	17.58	0.00		46.11	15.73
2004	8.27	18.15	37.99	20.00	0.00		46.25	17.14

Table 10. MRFSS Estimates gag landings by recreational anglers in the Southeast US Atlantic by state with associated percent standard error(PSE). Landings are in thousands of fish.

	North Carolina		South Carolina		Georgia		Florida		Total	
YEAR	A+B1	PSE	A+B1	PSE	A+B1	PSE	A+B1	PSE	A+B1	PSE
1981	4.07	71.50	0.16				52.47	50.33	56.69	55.64
1982	3.35	59.14	0.00				14.50	61.11	17.85	
1983	47.37		0.18		0.41	49.87	26.85	53.69	74.82	60.65
1984	9.29	37.94	3.35	38.90	0.00		140.61	27.01	153.25	43.47
1985	9.23	46.34	5.56	46.49	1.42	34.91	36.00	44.89	52.22	41.39
1986	0.00		8.20	40.56	1.42	41.74	37.16	40.03	46.78	63.16
1987	32.01	78.74	4.34	46.08	0.42	50.93	50.60	30.35	87.38	34.34
1988	17.43	22.52	3.16	40.23	0.57	100.00	40.91	32.38	62.07	35.25
1989	23.84	26.66	8.10	33.58	0.47	69.11	42.87	29.24	75.28	34.05
1990	38.23	33.96	2.59	45.15	0.00		11.38	38.00	52.20	55.51
1991	13.57	31.61	8.56	42.46	1.57	63.10	13.01	30.97	36.71	30.44
1992	12.13	18.91	8.42	41.54	3.58	34.94	25.19	20.13	49.32	24.2
1993	13.47	59.61	7.85	49.11	9.97	31.43	20.50	21.98	51.80	25.02
1994	7.05	20.53	1.41	44.68	13.89	30.27	33.87	25.53	56.22	31.2
1995	7.34	49.90	4.96	79.63	5.33	28.95	22.91	27.14	40.53	30.15
1996	1.99	32.53	3.66	71.99	5.50	28.82	32.78	27.04	43.92	33.57
1997	3.77	48.48	0.76	100.00	2.73	42.91	25.06	27.68	32.33	37.34
1998	1.93	44.03	0.00		0.70	45.40	37.69	31.80	40.32	30.37
1999	5.00	46.90	5.51	39.54	0.25	68.52	39.69	26.17	50.45	25.69
2000	2.31	45.65	1.97	24.89	0.08	58.35	25.52	18.48	29.87	18.76
2001	4.05	38.88	1.03	67.86	0.10	55.22	37.55	20.11	42.74	21.96
2002	3.61	61.14	1.07	74.10	0.01	95.27	19.34	20.60	24.03	23.56
2003	7.65	49.20	3.88	56.81	0.02	99.04	34.57	16.42	46.11	21.29
2004	14.82	41.22	2.78	35.72	1.49	42.29	27.17	17.22	46.25	19.08

Table 11. MRFSS Estimates of released gag by recreational anglers in the Southeast US Atlantic with associated percent standard error(PSE). Releases are estimates of individual fish.

	Private Boats		Charter Boats		Shore-based	
YEAR	B2	PSE	B2	PSE	B2	PSE
1981	0	–	0	–	12444	100
1982	1461	100	0	–	1671	100
1983	1812	100	0	–	–	–
1984	4122	71	256	100	0	–
1985	1697	53	3526	61	11809	76
1986	24158	36	1220	53	–	–
1987	14727	39	0	–	8253	100
1988	13217	83	0	–	–	–
1989	67337	24	0	–	0	–
1990	22012	37	0	–	0	–
1991	27682	26	1636	74	0	–
1992	27675	27	5074	40	–	–
1993	20081	34	11800	90	3405	48
1994	68070	25	1416	45	12504	69
1995	61110	20	11120	30	17452	44
1996	55905	18	4179	36	4080	58
1997	63123	18	791	52	2395	100
1998	31587	25	1036	100	1310	100
1999	47226	15	2276	34	4596	47
2000	114400	30	6713	26	9568	67
2001	74727	15	1924	51	3308	65
2002	121940	14	4673	22	3348	52
2003	124300	13	6389	33	23406	29
2004	94128	14	3715	26	1372	72

Table 12. Sample sizes of gag weights and lengths collected by MRFSS.

	Number of Gag Weighed			Number of Gag Measured		
Year	Charter Boats	Private Boats	Shore-based	Charter Boats	Private Boats	Shore-based
1981	1	7	2	1	7	2
1982	1	1	1	1	1	1
1983	1	7	–	1	7	–
1984	25	11	1	26	14	1
1985	11	15	6	11	15	6
1986	1	14	–	1	14	–
1987	22	24	1	24	35	1
1988	24	13	–	55	13	–
1989	26	14	1	66	24	1
1990	55	12	2	94	21	2
1991	15	24	3	27	25	3
1992	54	26	–	63	28	–
1993	37	29	1	38	31	1
1994	62	16	1	79	17	1
1995	37	19	1	54	20	1
1996	21	5	1	29	11	1
1997	18	8	–	19	8	–
1998	21	18	–	23	20	–
1999	47	32	–	54	35	–
2000	73	23	–	75	26	–
2001	67	29	–	71	30	–
2002	74	15	–	76	18	–
2003	51	17	–	53	23	–
2004	52	22	–	65	25	–

Figures

Figure 1. Areas sampled by the headboat survey in the Southeast US Atlantic.

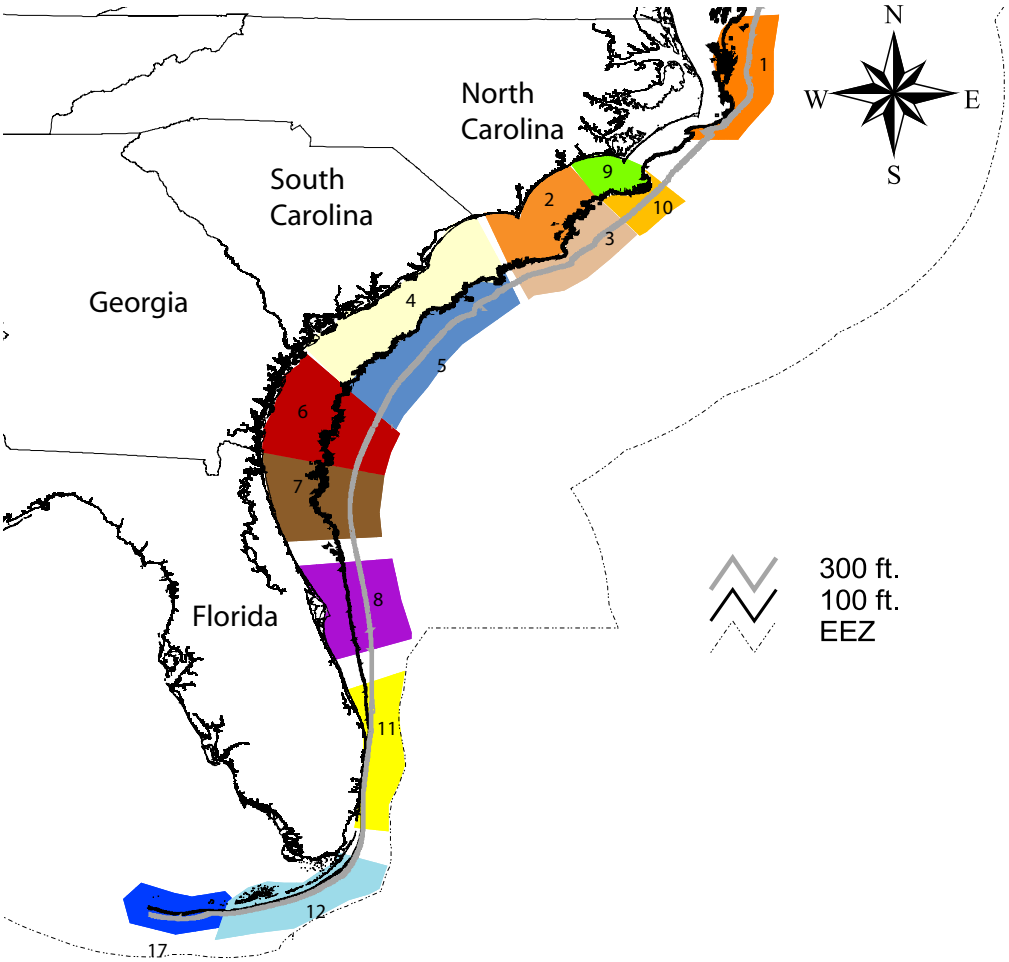


Figure 2. Landings of gag from the headboat survey by area in thousands of fish and in metric tons. The 95% confidence intervals are displayed for predicted landings from Georgia and Florida from 1972–1980

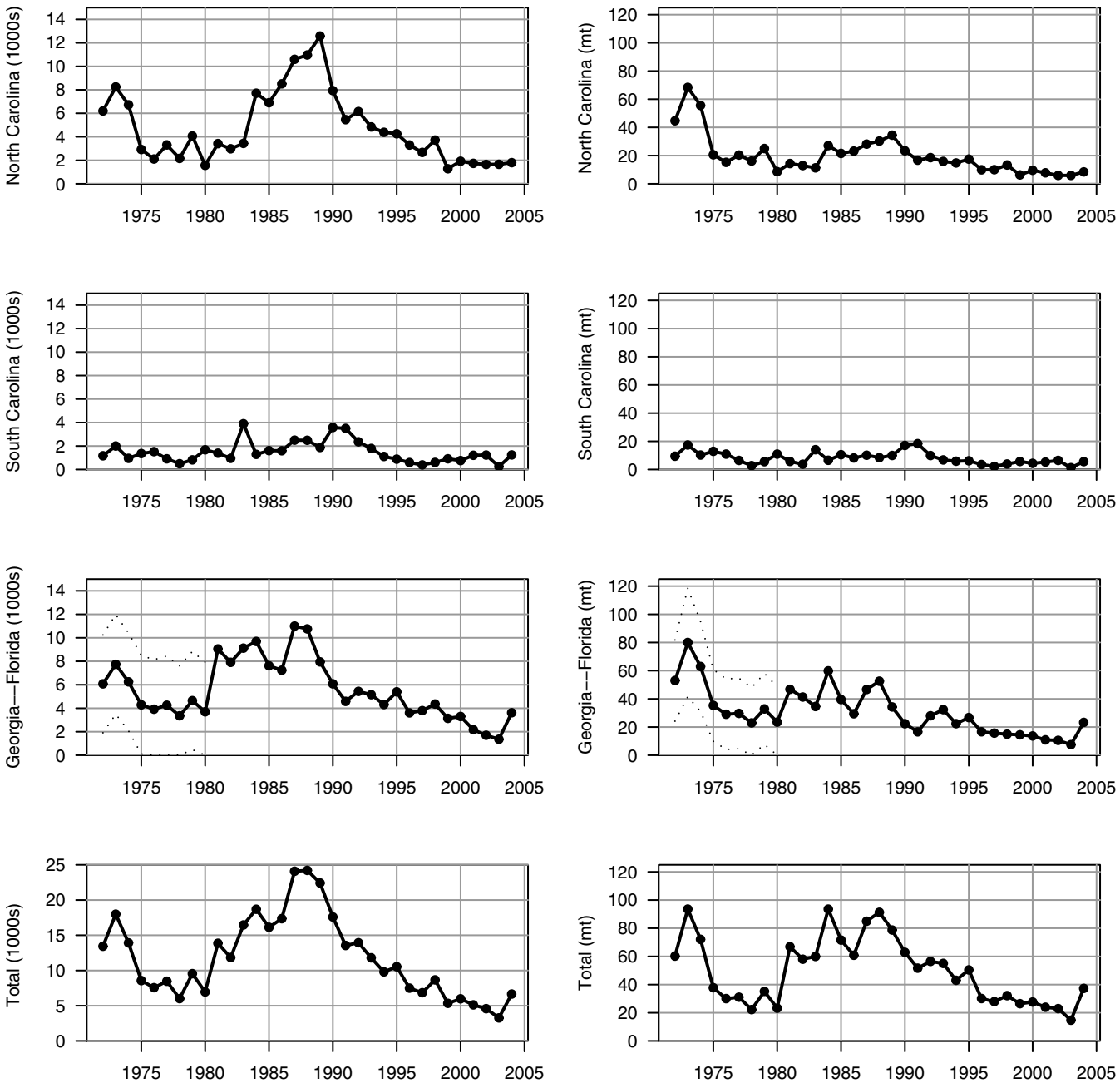
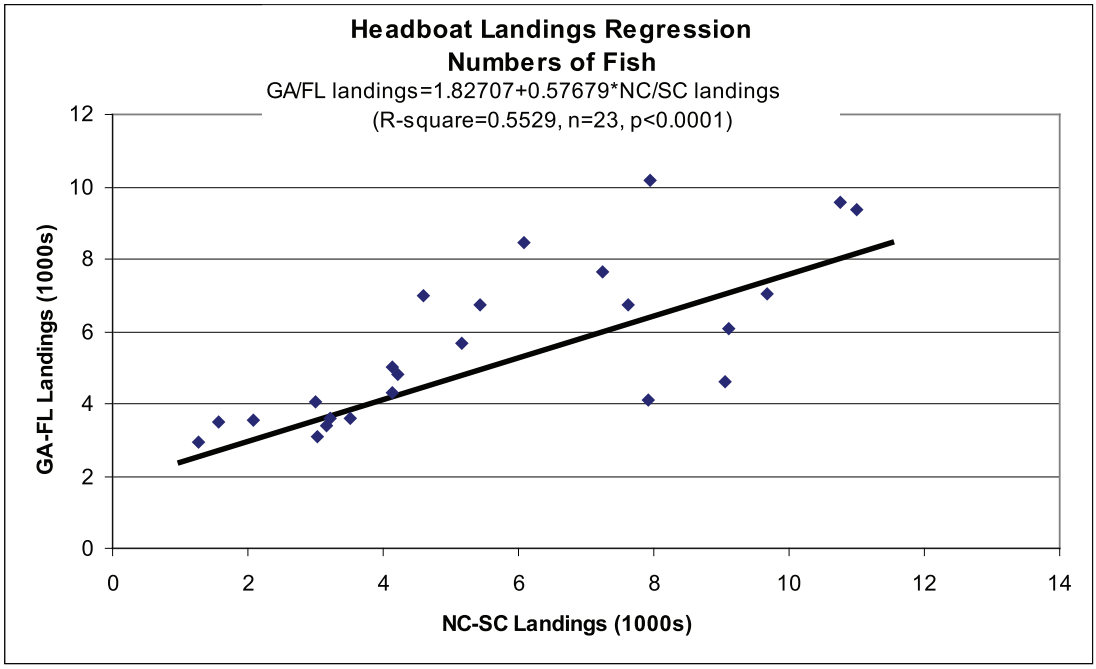


Figure 3. Landings and predicted landings of gag from the Headboat Survey in thousands of fish (A) and metric tons (B).



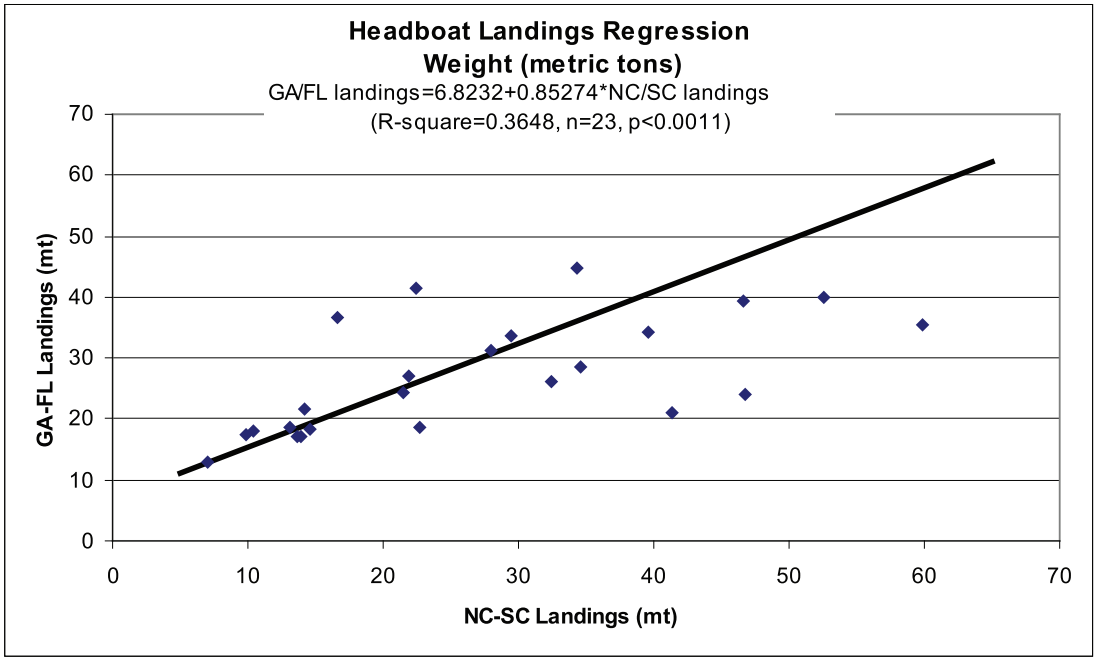


Figure 4. Linear model and Robust Linear Model regressions of gag landings from the recreational data sources against commercial landings for all years where both occurred.

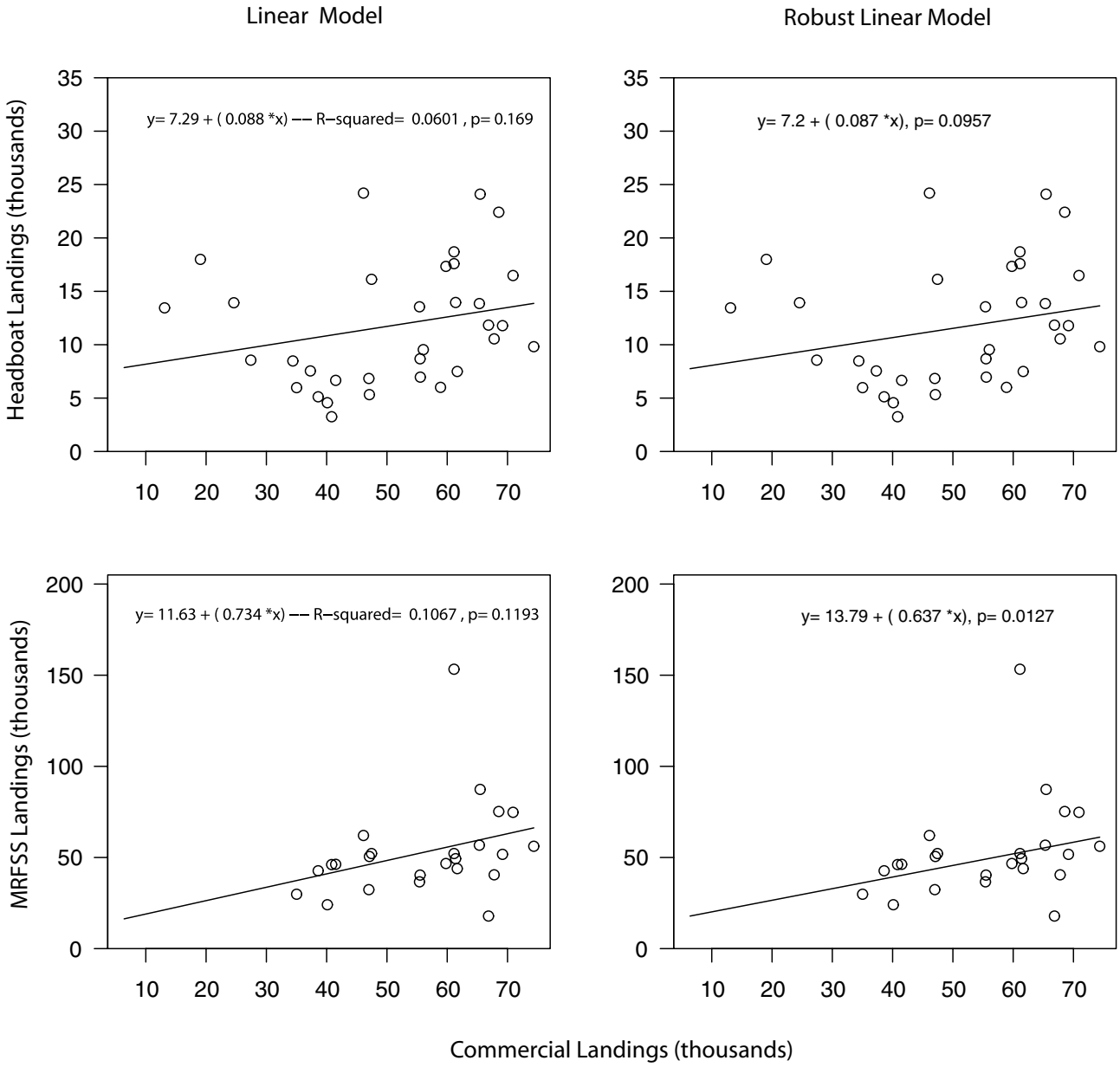


Figure 5. Regressions of headboat(A) and MRFSS (B) landings in number against coastal human population. Population trends by state displayed (C).

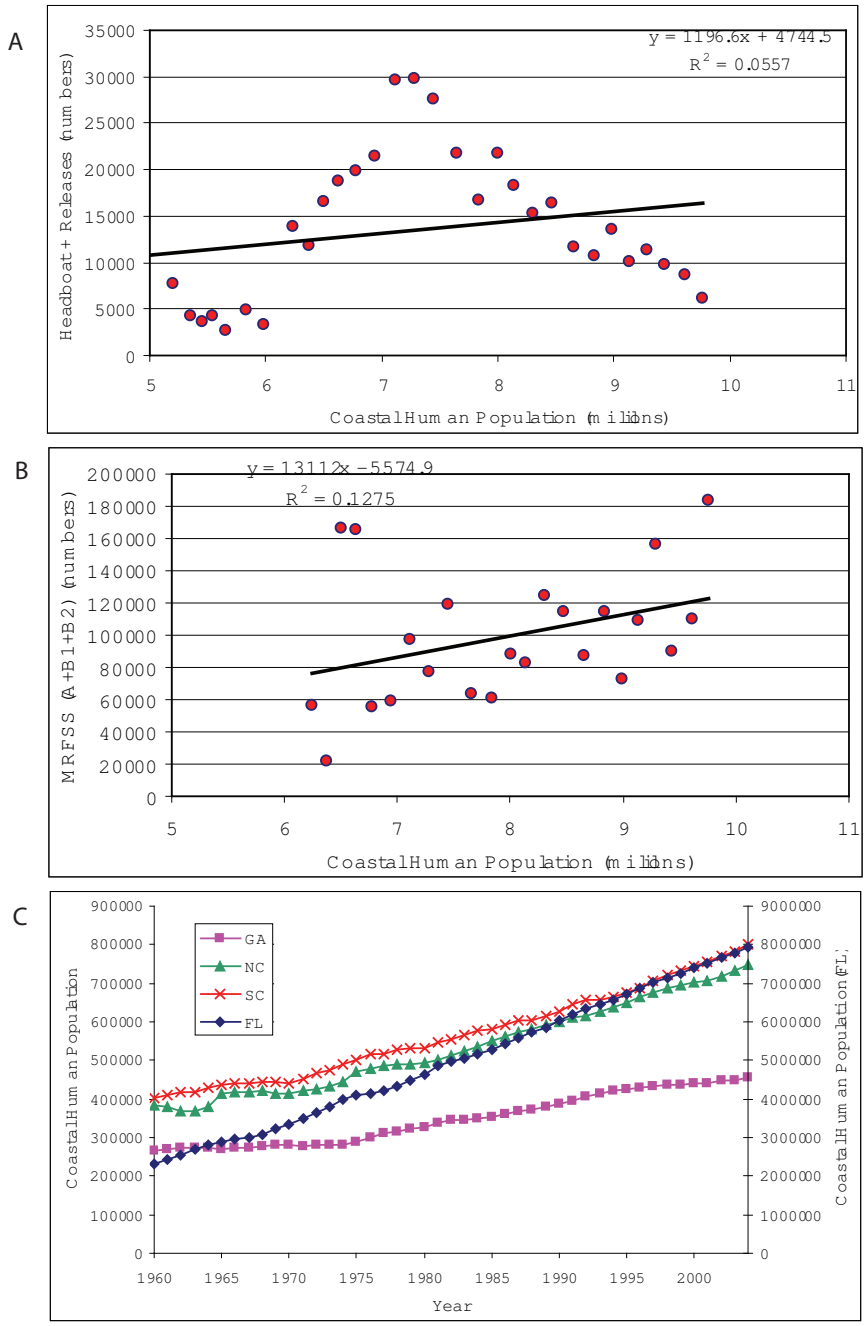


Figure 6. Release rates of gag used to predict headboat releases.

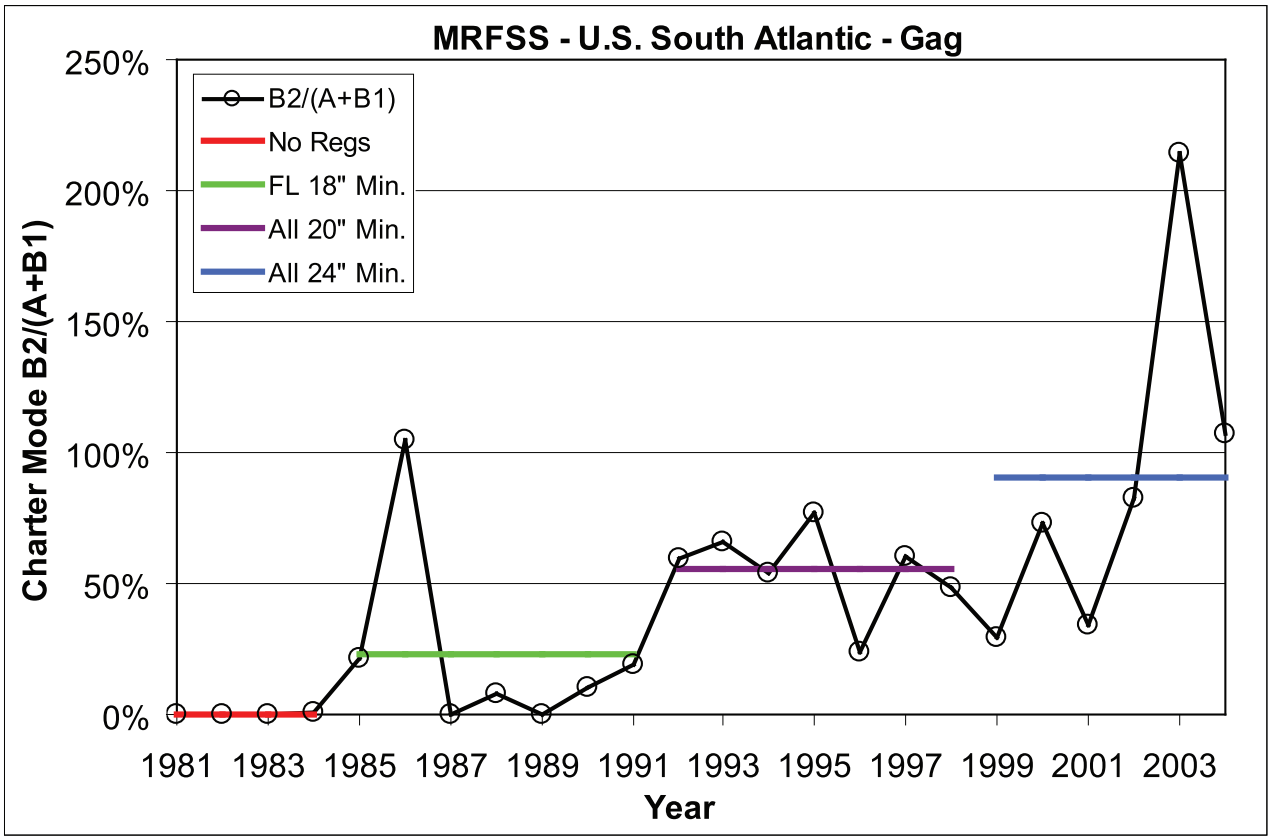


Figure 7. Mean weight in kg for North and South Carolina (Carolinas) and Georgia and Florida (GA/FL).

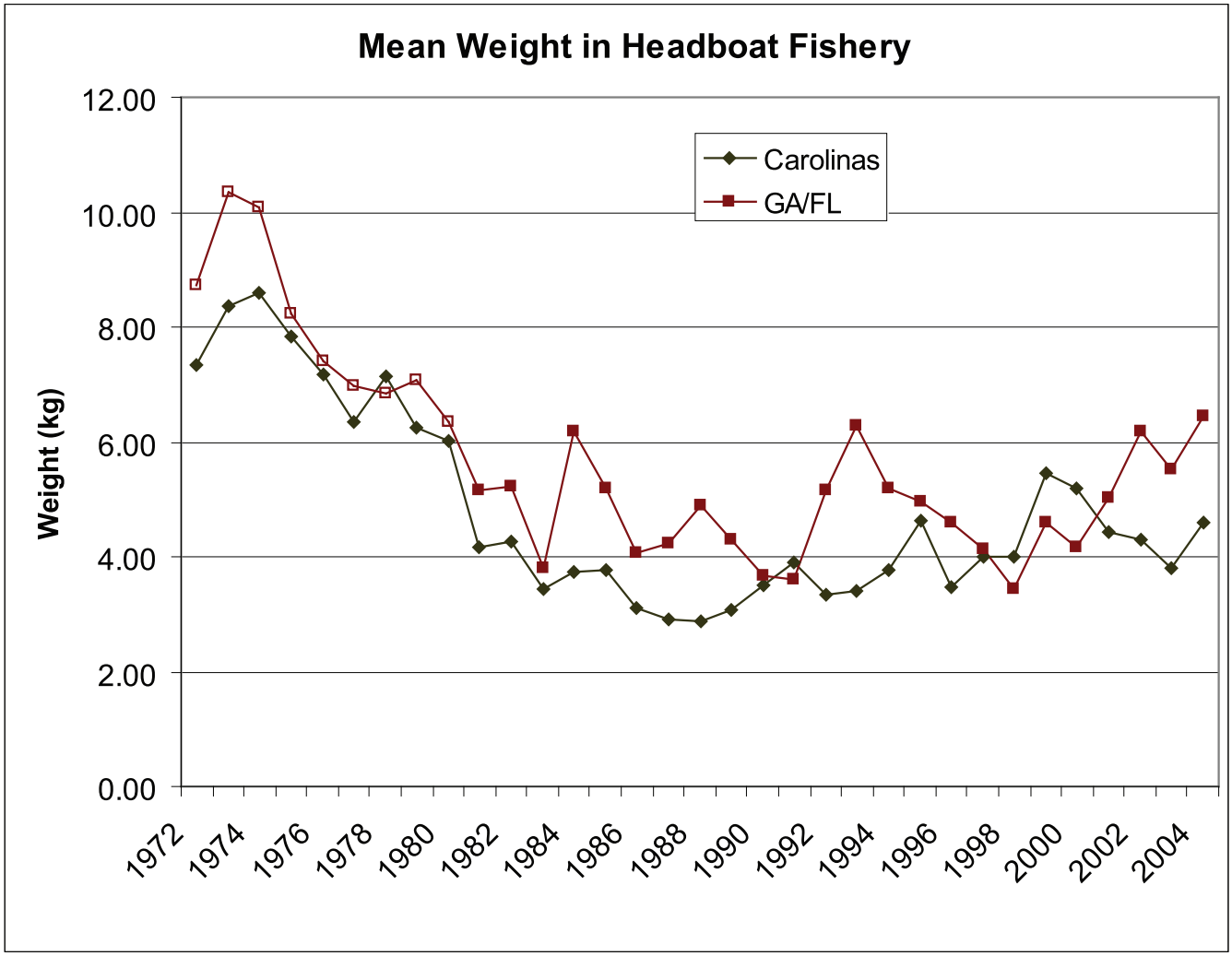


Figure 8. Length composition of gag from the headboat survey for 1972 to 1989. Lengths are in 1 cm bins from 20 cm to 125 cm.

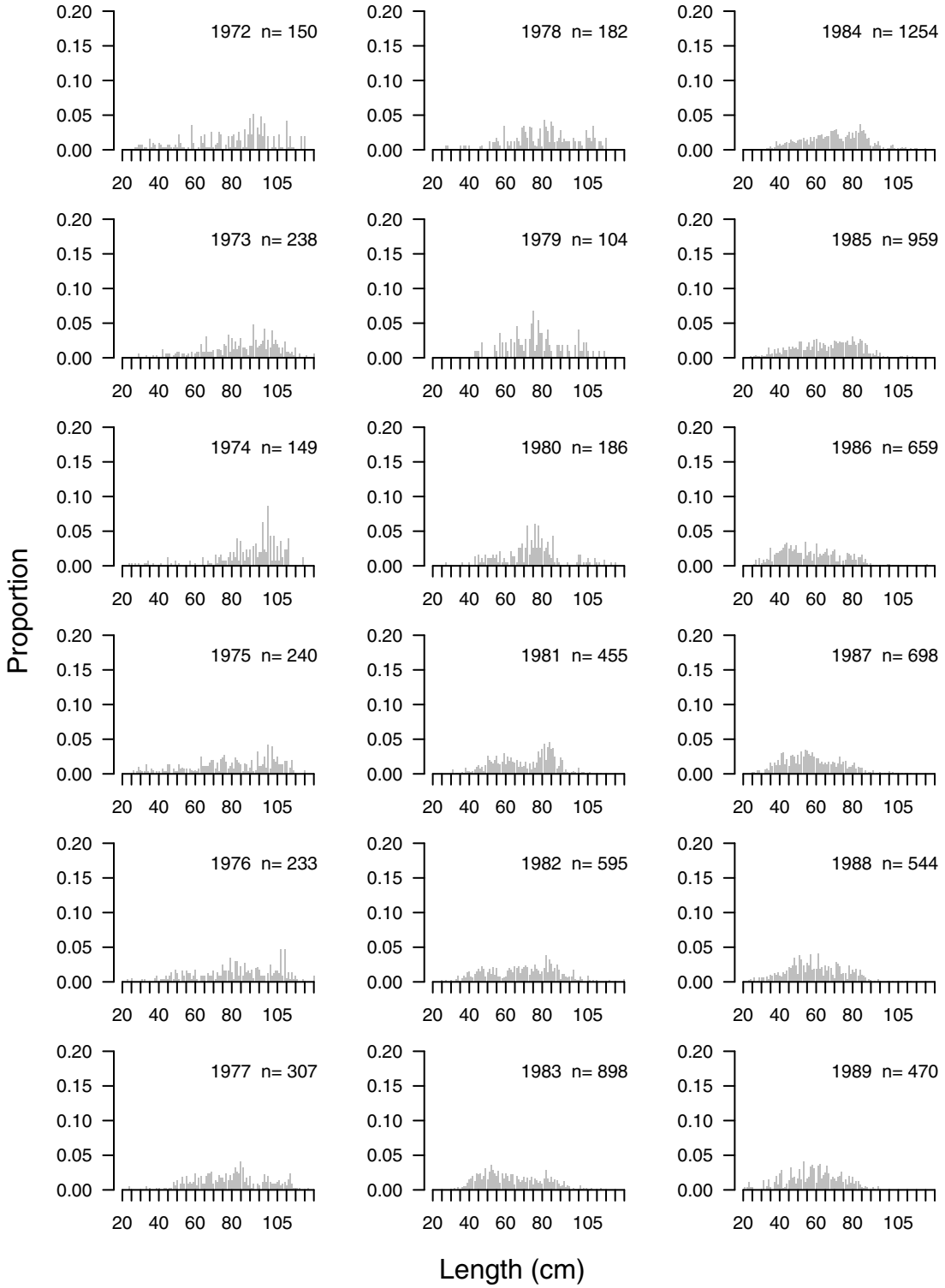


Figure 9. Length composition of gag from the headboat survey for 1990 to 2004. Lengths are in 1 cm bins from 20 cm to 125 cm.

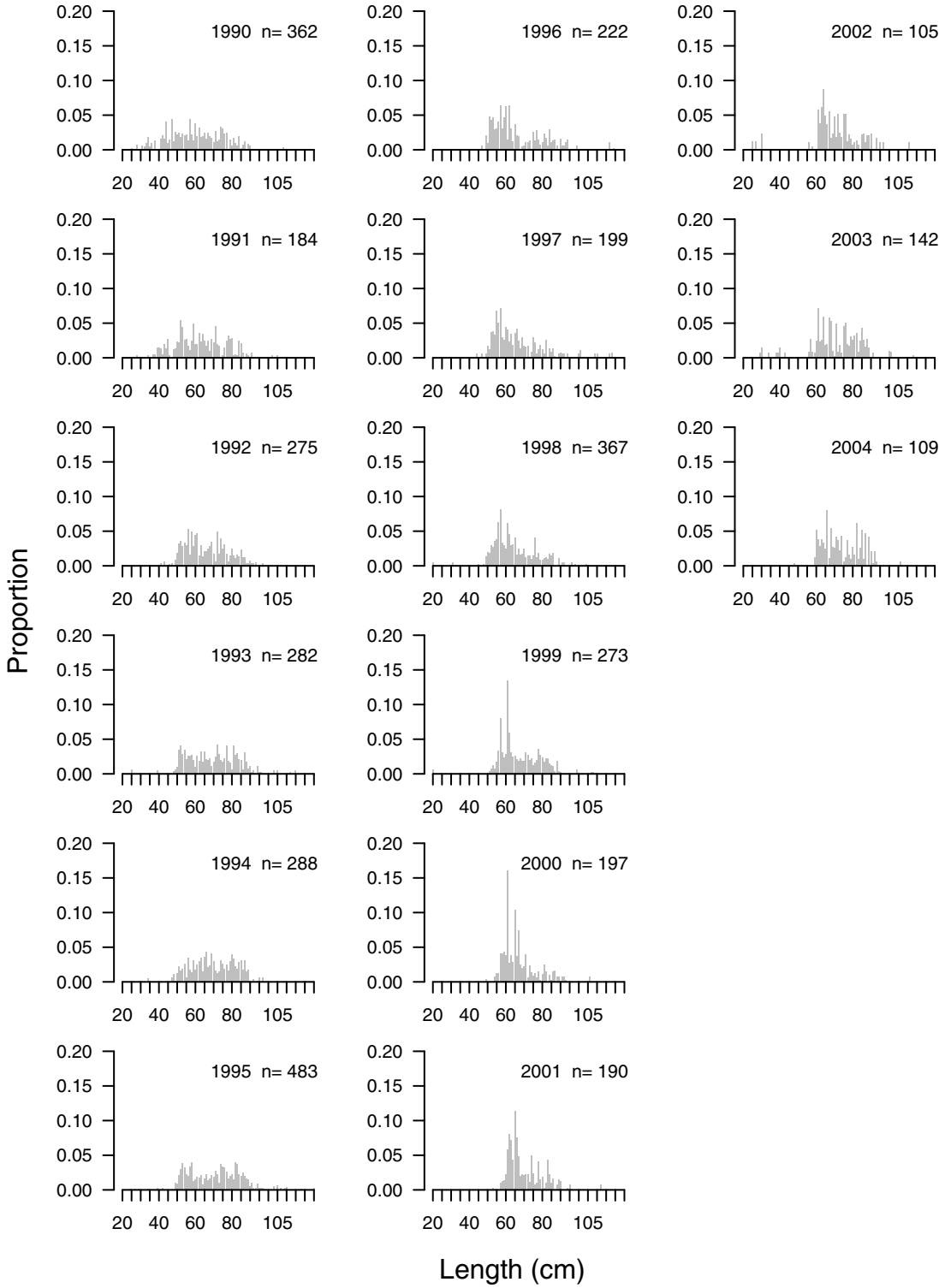
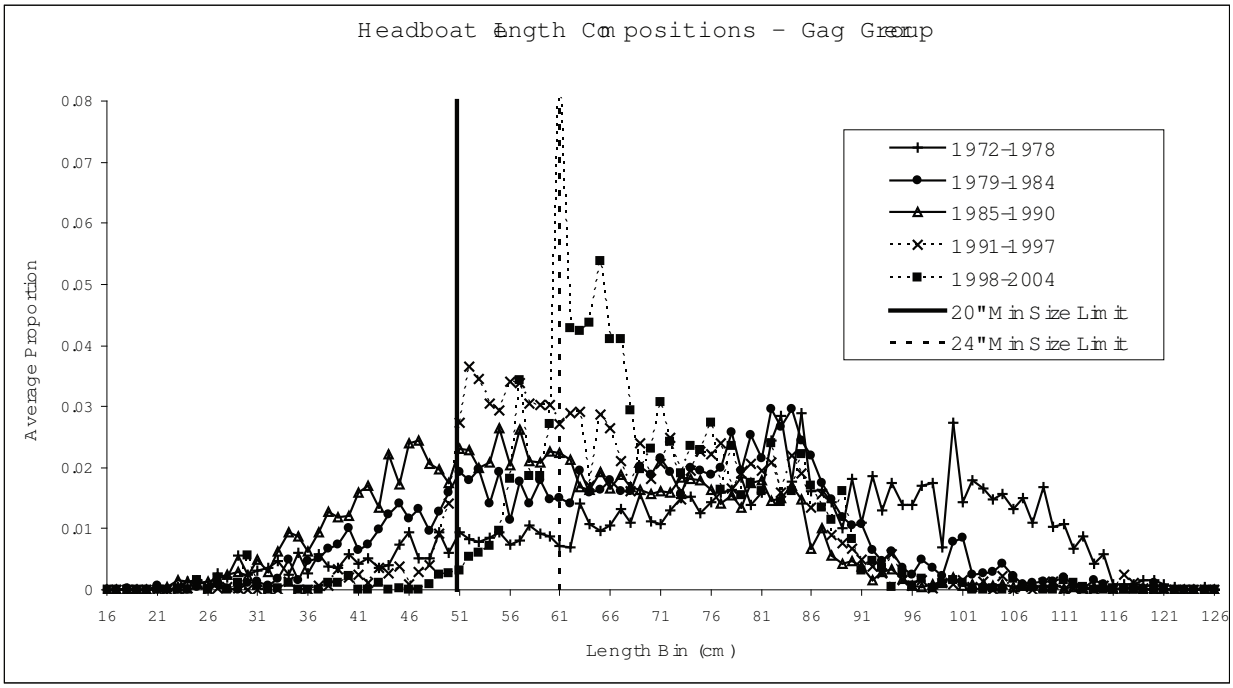


Figure 10. Analysis of changes in lengths of gag over time in the headboat survey.

A



B

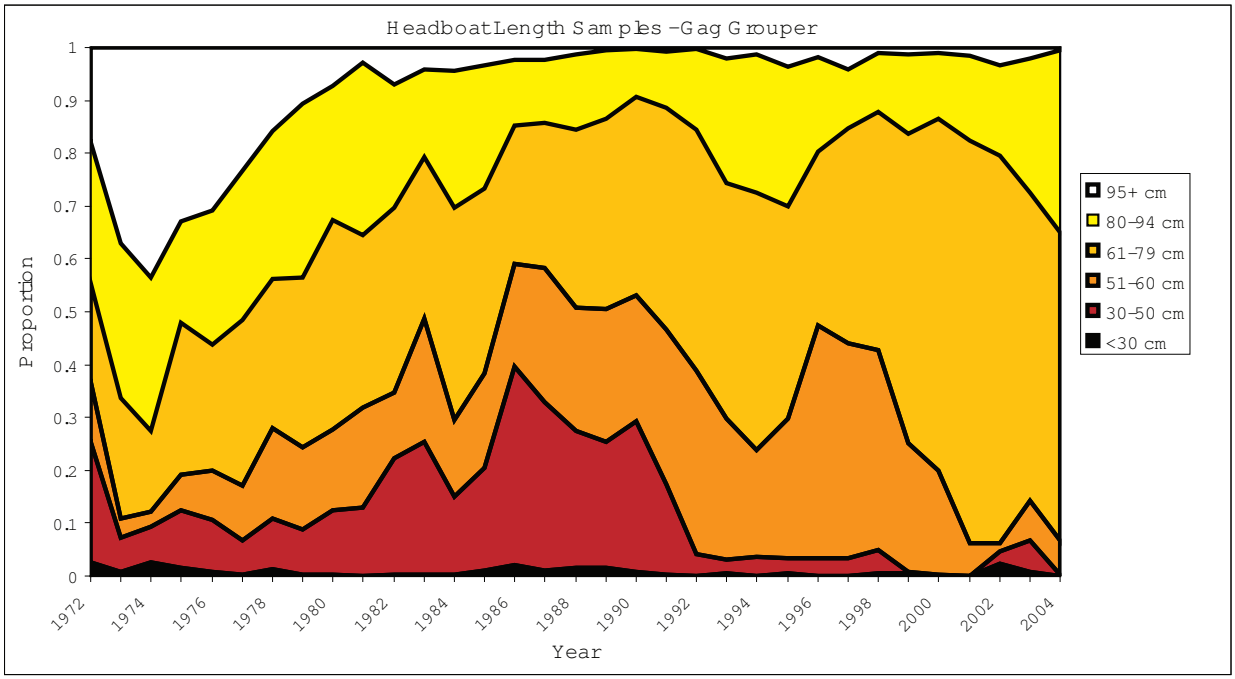


Figure 11. Analysis of changes in lengths of gag over time in the headboat survey.

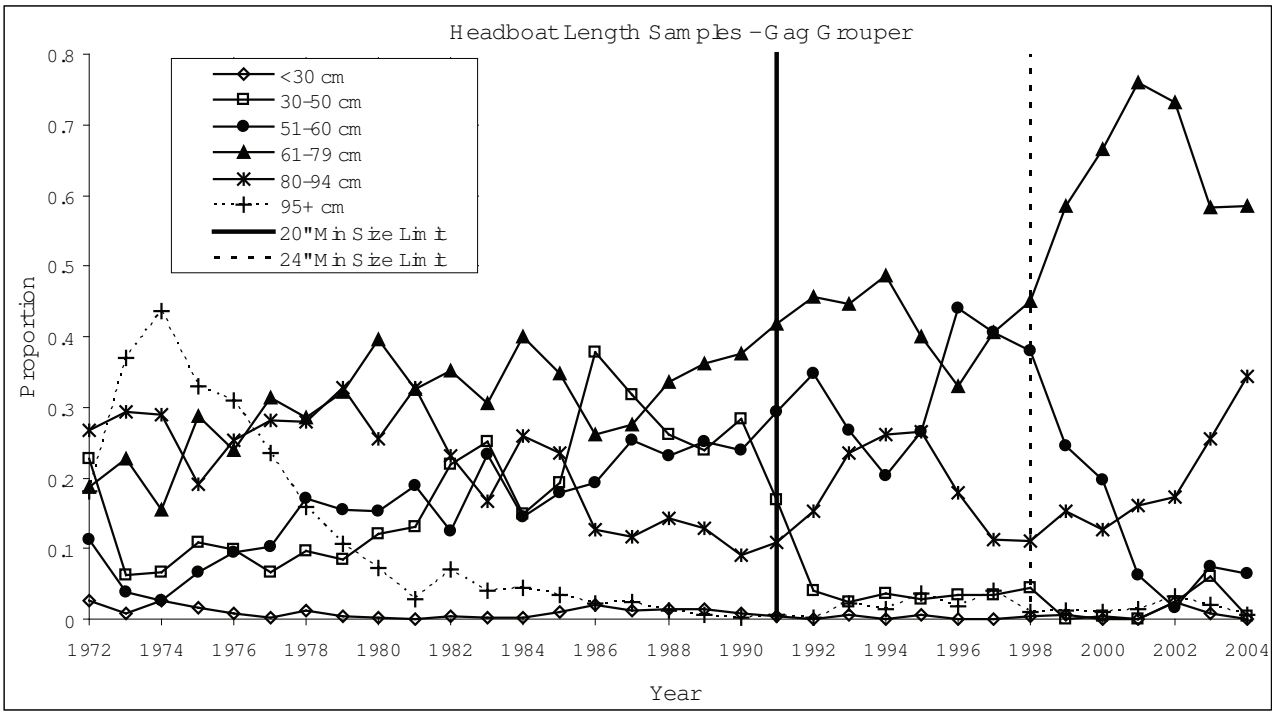


Figure 12. Age compositions of gag from the recreational data (headboat and charter vessel) for 1975-1990.

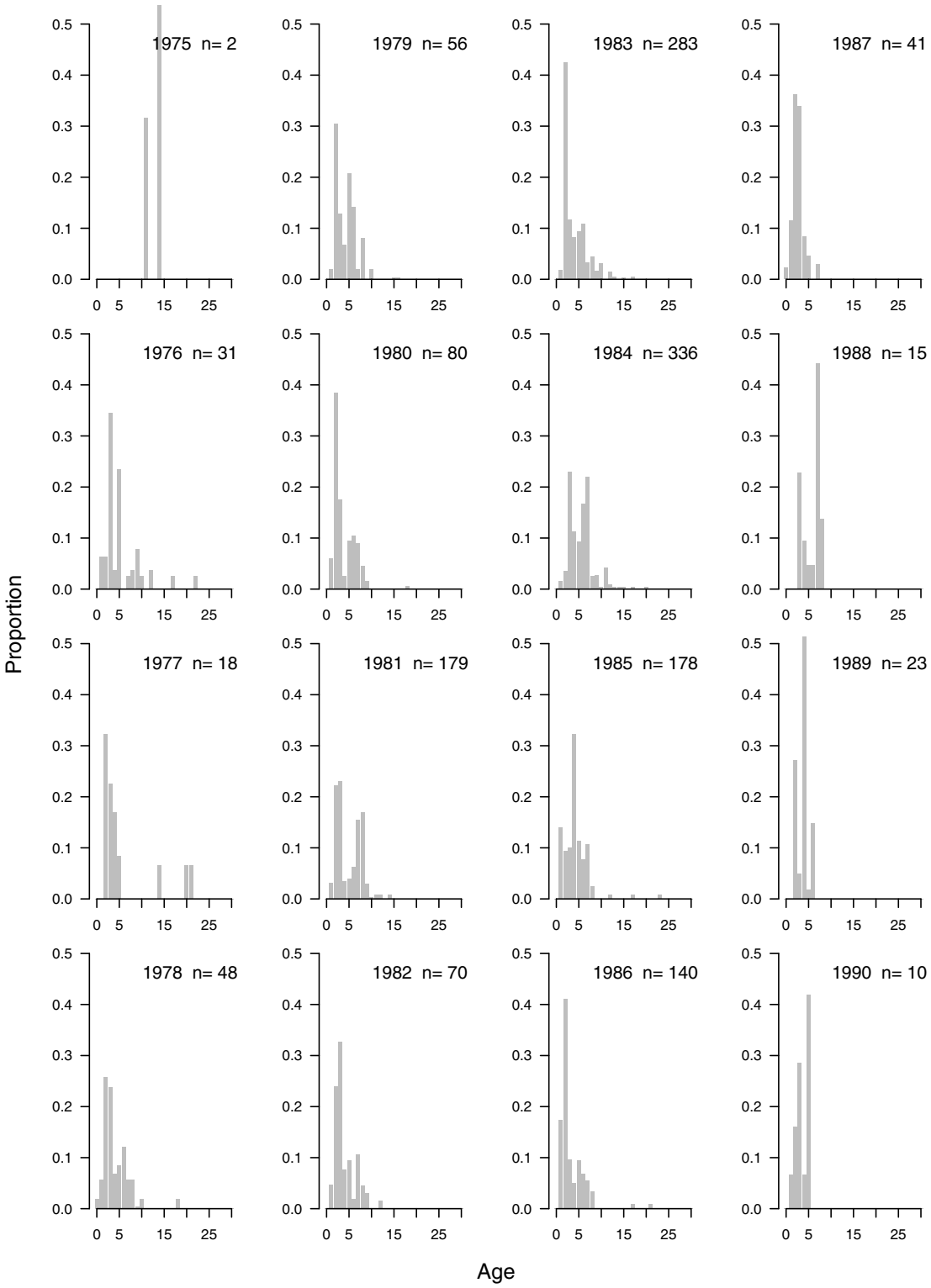


Figure 13. Age composition of gag from the recreational data (headboat and charter vessel) for 1991-2004, no ages were available from 1999 or 2000.

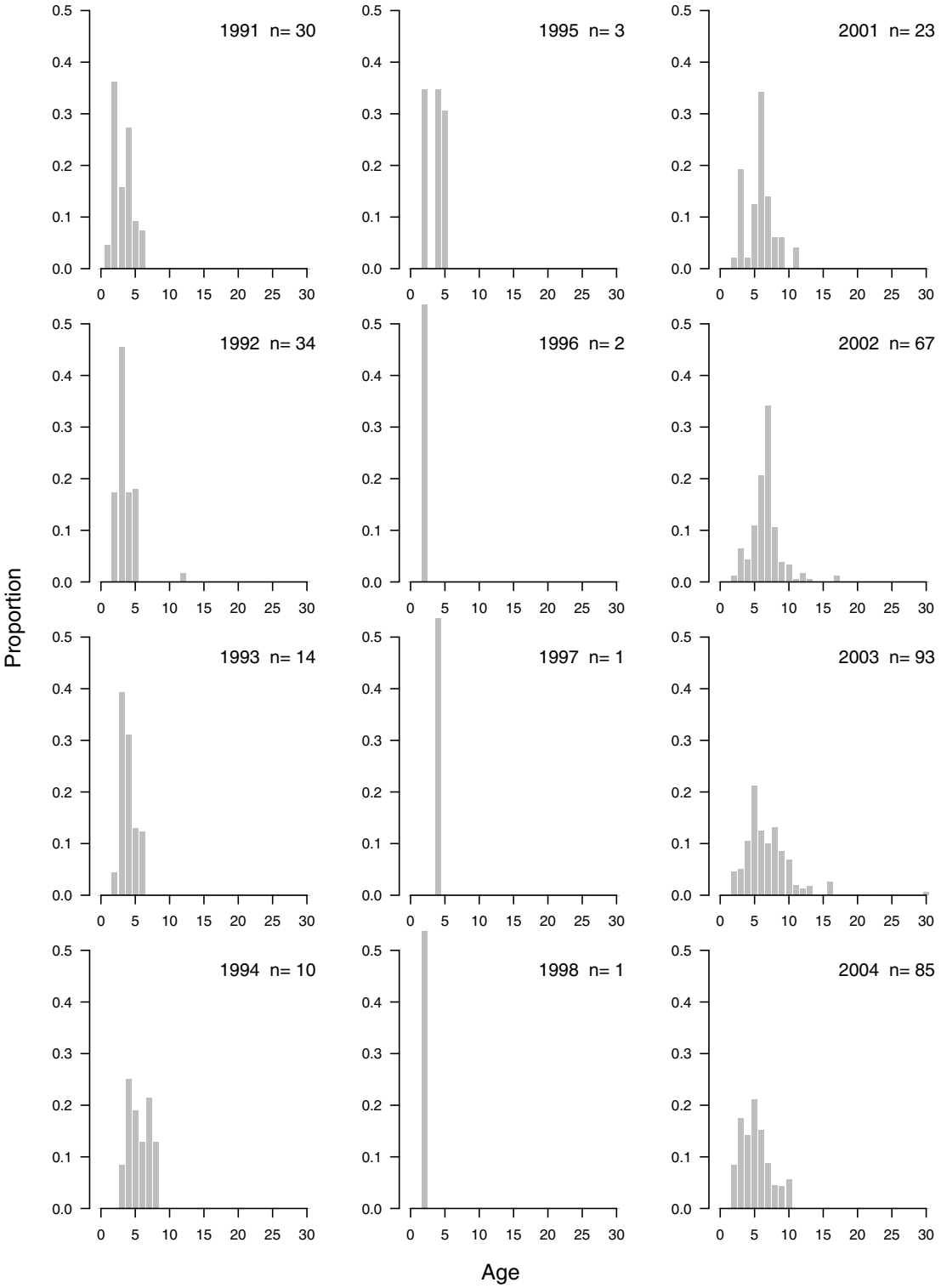


Figure 14. Percent of MRFSS landings in Number that were gag of total gag and black grouper.

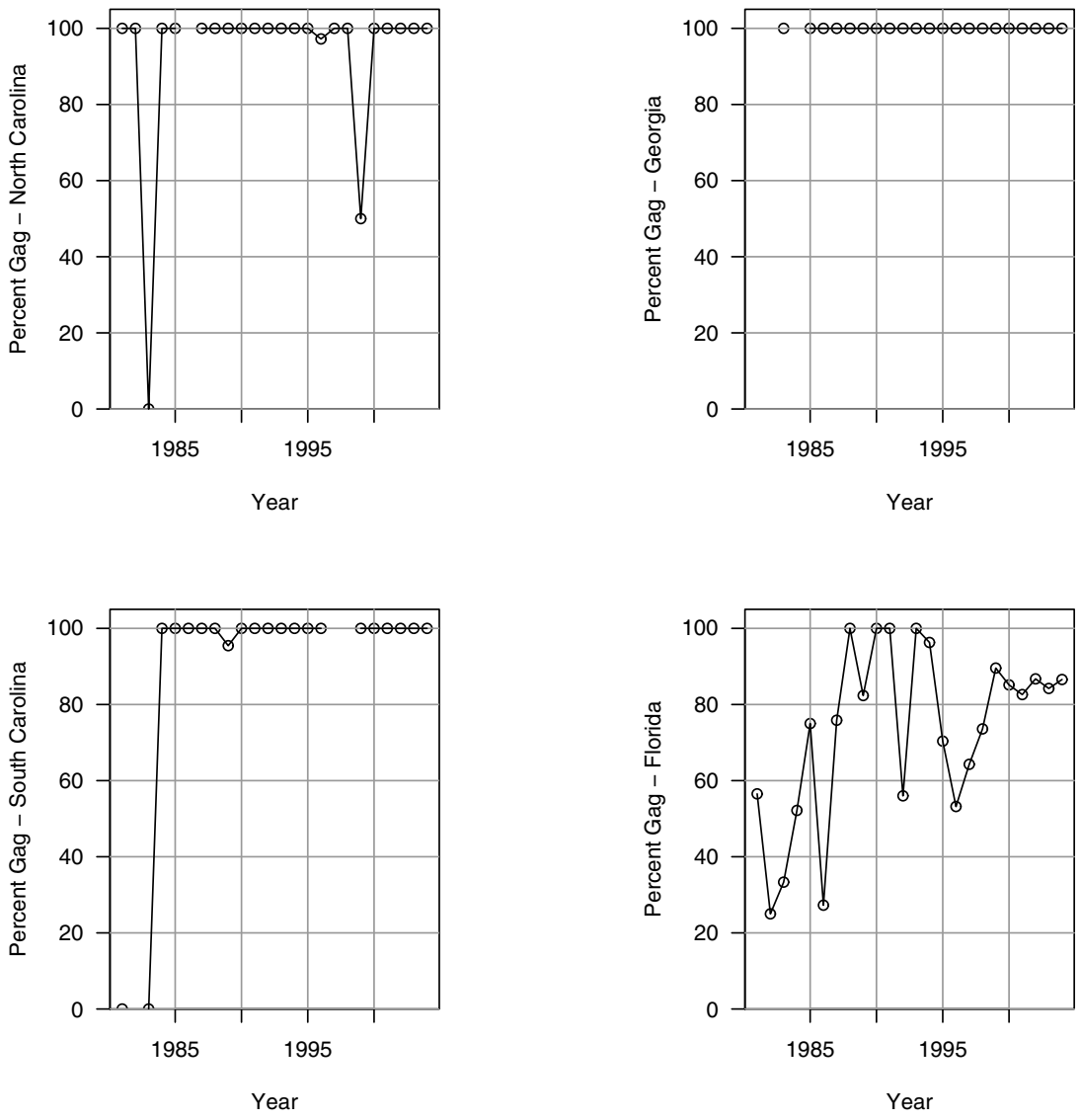


Figure 15. Landings in thousands of fish of gag from the MRFSS by fishing mode.

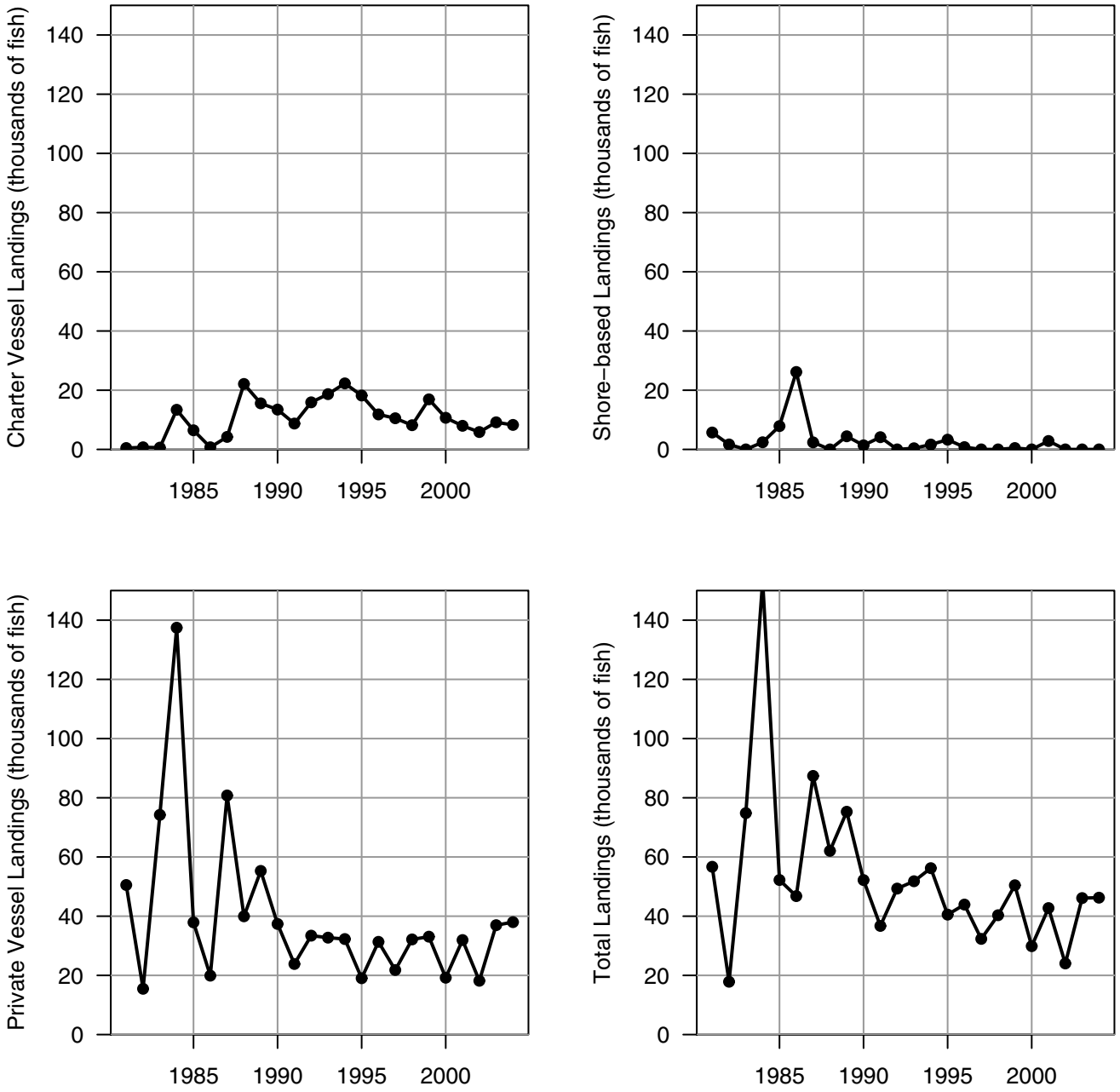


Figure 16. Landings of gag from MRFSS by state in thousands of fish.

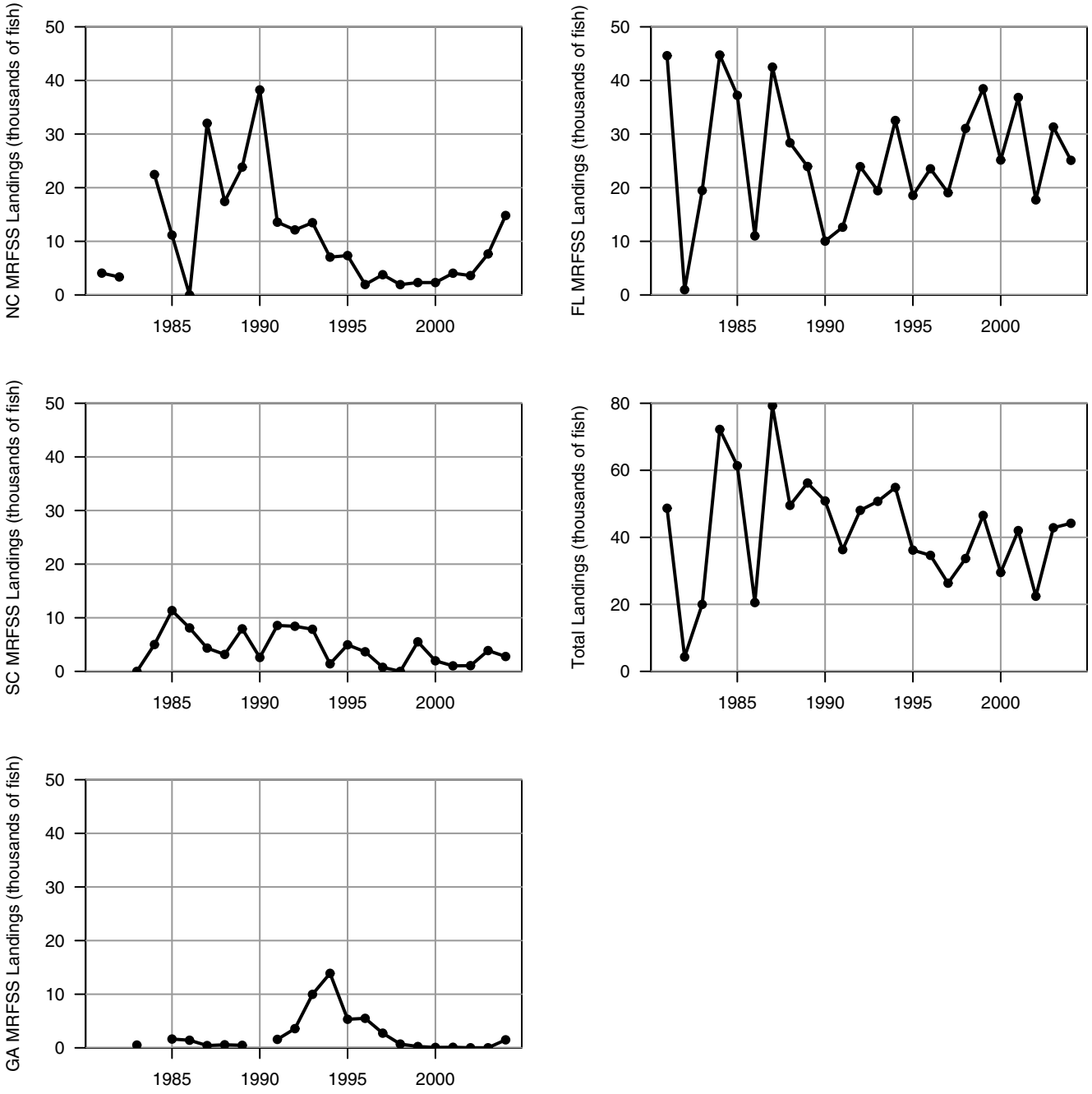


Figure 17. Length composition of gag from the MRFSS for 1981 to 1992. Lengths are in 1 cm bins from 20 cm to 125 cm.

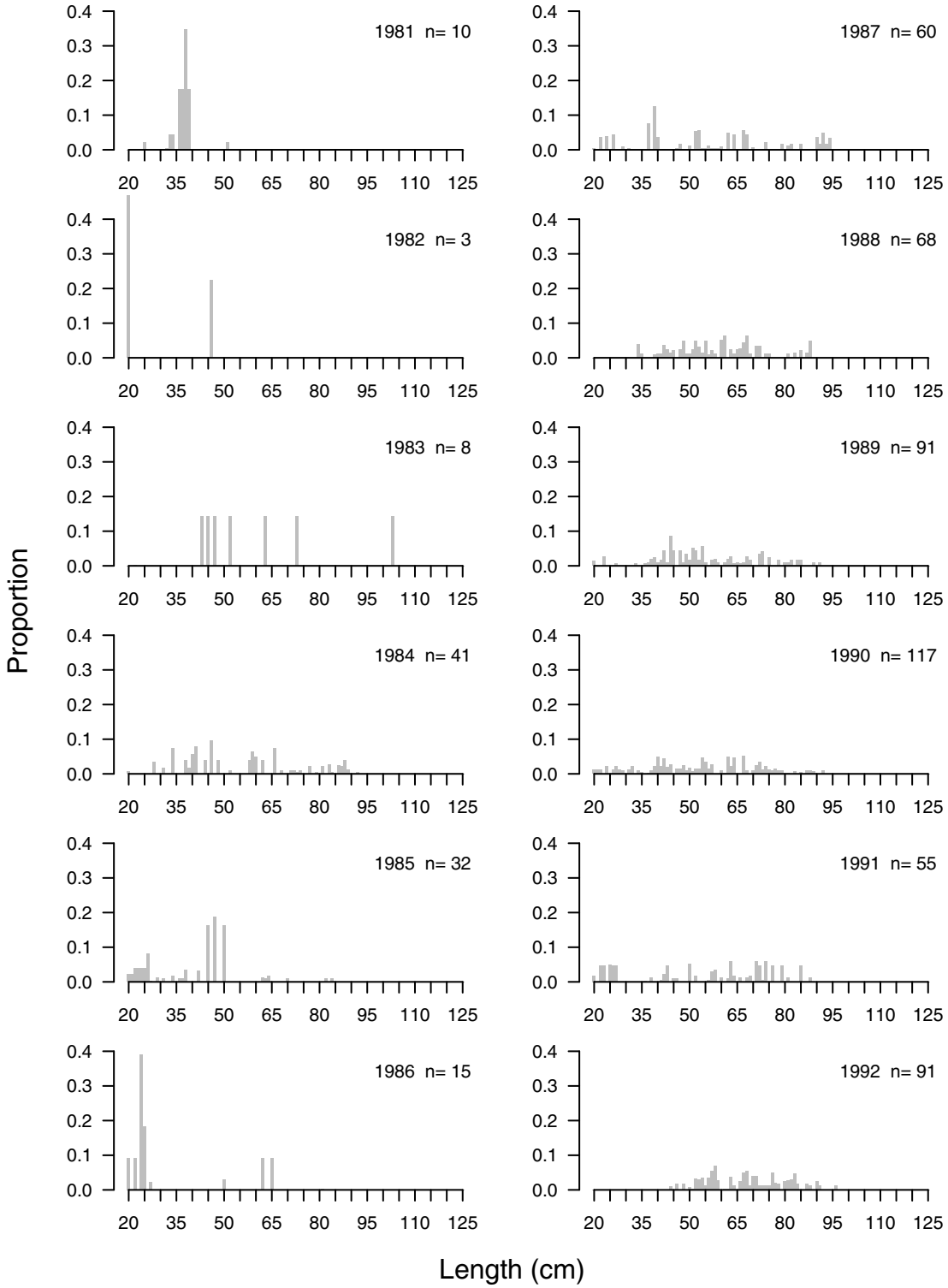
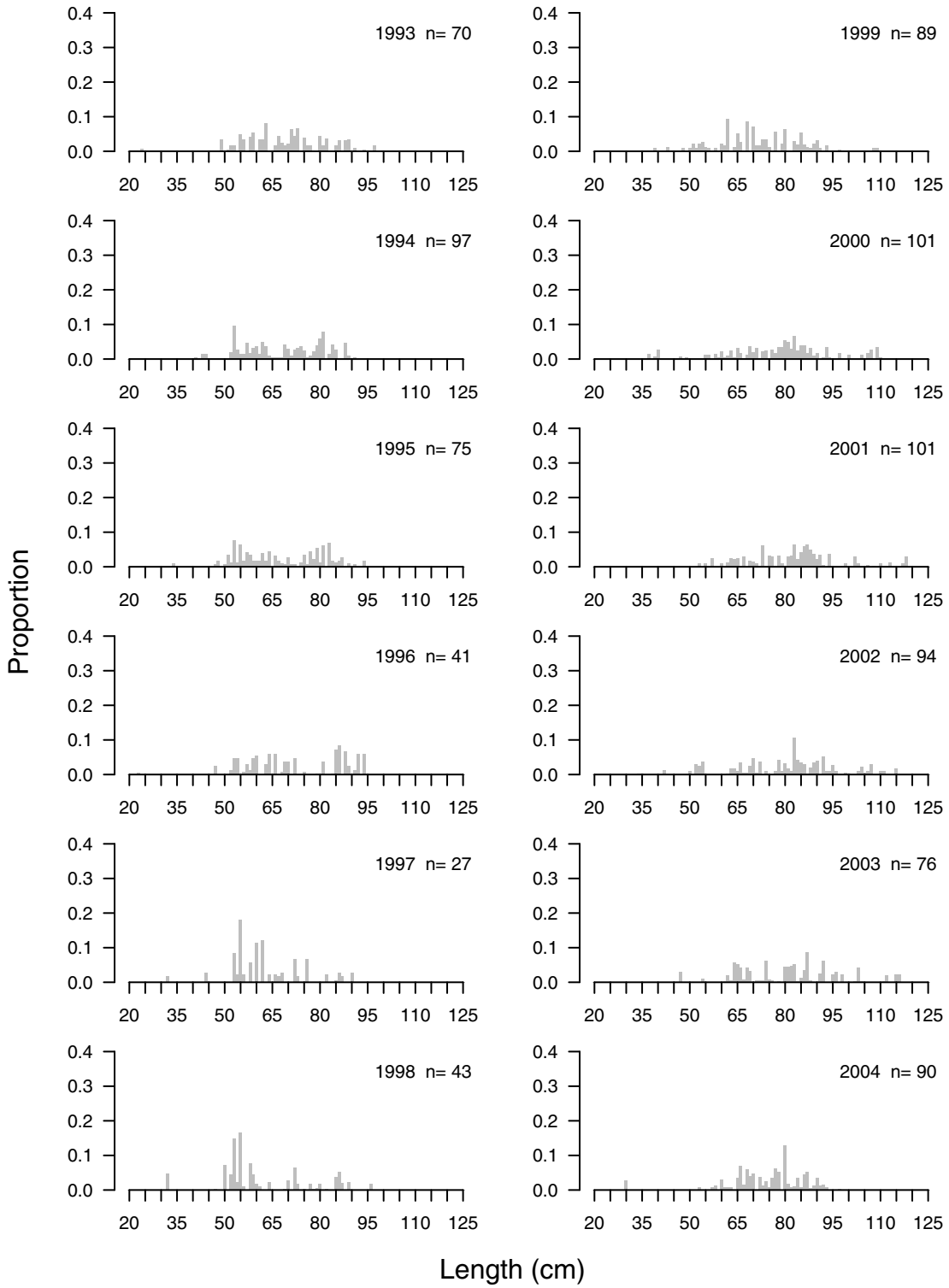


Figure 18. Length composition of gag from the MRFSS for 1993 to 2004. Lengths are in 1 cm bins from 20 cm to 125 cm.



5. INDICES OF ABUNDANCE

Several indices of abundance were considered for use in the assessment model. These indices are listed in Table 5.1, with pros and cons of each in Table 5.2. The possible indices came from fishery-dependent and fishery-independent data. The DW recommended that three fishery-dependent indices be used – one from commercial logbook data, one from headboat data, and one from general recreational data (Figure 5.1, Table 5.6). The DW did not recommend using any of the fishery-independent indices, due to inadequacies in the data.

5.1 INDEX FROM COMMERCIAL LOGBOOK (HANDLINE)

5.1.1 General description

NMFS collects catch and effort data by trip from commercial fishermen who participate in fisheries managed by the SAFMC. For each fishing trip, data collected include date, gear, fishing area, days at sea, fishing effort, species caught, and weight of catch. The logbook program in the Atlantic started in 1992. In that year, logs were collected from a random sample representing 20% of vessels; starting in 1993, all vessels were required to submit logs. Using these data, an index of abundance was computed for 1992–2004 (SEDAR10-DW-19).

5.1.2 Issues discussed at DW

Issue 1: Trip selection using method of Stephens and MacCall (2004)

Option 1: Include all positive trips and use Stephens and MacCall method to identify zero trips only.

Option 2: Include only those trips with associated probability of catching gag above the threshold probability, as in Stephens and MacCall (2004).

Decision: Option 2, to be consistent with the published method and to exclude trips with incidental catches of gag.

Issue 2: Misidentification of gag as black grouper

Option 1: Use data as reported

Option 2: Devise a correction method to achieve landings consistent with proportions of species as indicated by TIP data. The method would need to be applied on a trip by trip basis.

Option 3: Exclude problematic areas. For other areas where black grouper are known to be rare, convert all landings reported as black grouper to gag.

Decision: Option 3. Much effort was devoted to achieving option 2, however, an acceptable method for correcting the landings could not be developed during the DW given available data. Option 3 was chosen because it corrects many records believed to be in error (SEDAR10-DW-19 SEDAR10-DW-28), with little chance of introducing new errors (i.e., converting black grouper to gag incorrectly). Option 3 was implemented by excluding areas south of 29 degrees latitude (near Cape Canaveral) and converting all reported black grouper to gag in areas equal to and north of 29 degrees.

Issue 3: Interaction terms in the delta-GLM

Option 1: Include only main effects

Option 2: Investigate interaction terms
Decision: Option 2. Investigate interaction terms. The group decided not to include interactions with year effects, because such effects may be inseparable from annual changes in abundance.

Miscellaneous decisions

- Exclude months of March and April from all years in the analysis, because of bag limits that started midway through the time series, in 1999.
- Include areas 2482 and 2382 in the Atlantic, because of council boundaries. Due to the decision on issue 2 (above), however, these areas were not used in the analysis, because they are south of 29 degrees latitude.

5.1.3 Methods

Standardized catch rates were estimated using a generalized linear model assuming delta-lognormal error structure (Lo et al., 1992, Can. J. Fish. Aquat. Sci., 49:2515-2526), in which the binomial distribution describes positive versus zero CPUE, and the normal distribution describes the log of positive CPUE. Explanatory variables considered, in addition to year (necessarily included), were month, geographic area, and month*area interaction. A forward stepwise approach was used to construct each GLM (SEDAR DW-19). The approach identified area as the only factor other than year to be used in the binomial GLM, and it identified area, month, and area*month interaction as factors to be used in the lognormal GLM. The CPUE was in units total pounds caught per hook-hour.

Effective effort was based on those trips that caught gag (positive CPUE) and those that *could* have caught gag (zero catch, but positive effort). Positive catches are readily available from the data, but without information on targeting by fishermen, zero catches must be inferred. To do so, we applied the method of Stephens and MacCall (Stephens and MacCall, 2004, Fish. Res. 70:299-3210). In essence, the method uses multiple logistic regression to estimate a probability for each trip that gag was caught, given other species caught in that trip. Species used as factors in the regression were selected as those caught in at least 5% of trips. This cutoff simplifies the regression, by excluding rarely caught species; however, preliminary analyses indicated results were insensitive to the value of the cutoff (examined over a range of 0% to 10%). Trips were included if their associated probability was higher than a threshold probability. The threshold's value was defined as that which results in the same number of predicted and observed positive trips, as in Stephens and MacCall (2004).

5.1.4 Results

Estimates of CPUE (pounds/hook-hr) and CV are presented in Table 5.3 and in Figure 5.1.

5.1.5 Discussion

The logbook index was recommended by the DW for use in the assessment (Table 5.2). The DW, however, did express several concerns about this data set. It was pointed out that there are problems associated with any abundance index and that convincing counter-evidence needs to be presented to not use the logbook data.

Two concerns merit further description. First, the data are self-reported and largely unverified. Some attempts at verification have found the data to be reliable, but clearly problems remain, as demonstrated by the misidentification of gag as black grouper.

Second and probably foremost, the data are obtained from a directed fishery and therefore the index could contain problems associated with any fishery-dependent index. Fishing efficiency of the fleet has likely improved over time due to improved electronics. In addition, overall efficiency may have changed throughout the time series if fishermen of marginal skill have left the fishery at a greater rate than more successful fishermen. Also of concern is whether catch rates in a directed fishery are density-dependent. As fish abundance decreases, fishermen may maintain relatively high catch rates, and as fish abundance increases, catch rates may saturate. The DW discussed how the assessment might attempt to account for changes in catchability over time. Constant catchability, though commonly assumed, would not be an appropriate assumption in this fishery, as the DW generally believed that catchability has increased with improvements in fishing gear and technology.

5.2 INDEX FROM HEADBOAT SURVEY

5.2.1 General description

The headboat fishery is sampled separately from other recreational fisheries. The headboat fishery comprises large, for-hire vessels that generally charge a fee per angler. Using the headboat data, an index of abundance was computed for 1973–2004 (SEDAR10-DW-20).

5.2.2 Issues discussed at DW

Issue 1: Trip selection using method of Stephens and MacCall (2004)

Option 1: Include all positive trips and use Stephens and MacCall method to identify zero trips only.

Option 2: Include only those trips with associated probability of catching gag above the threshold probability, as in Stephens and MacCall (2004).

Decision: Option 2, to be consistent with the published method and to exclude trips with incidental catches of gag.

Issue 2: Interaction terms in the delta-GLM

Option 1: Include only main effects

Option 2: Investigate interaction terms

Decision: Option 2. Investigate interaction terms. The group decided not to include interactions with year effects, because such effects may be inseparable from annual changes in abundance.

Issue 3: Include/exclude years prior to full area or vessel coverage

Early years of headboat sampling did not have full area coverage. All headboats from North Carolina and South Carolina were sampled starting in 1973. Headboats from Georgia and northern Florida were sampled starting in 1976, but without a complete census. All headboats across all states were sampled starting in 1978.

Option 1: Exclude early years, starting the time series in either 1976 (full area coverage) or 1978 (full vessel coverage).
Option 2: Include early years, unless there is compelling empirical reason not to.
Decision: Option 2. The DW decided to include the early years, starting in 1973, because the sampling covered a substantial proportion of the geographic area, and because the GLM accounts for area as a factor. Exploratory data analysis revealed nothing to suggest data in those early years were flawed.

Miscellaneous decisions

- Landings in 2004 from vessel #308 were apparently reported incorrectly. These landings were corrected for computing CPUE, as they were for computing headboat landings.

5.2.3 Methods

Standardized catch rates were estimated using a generalized linear model assuming delta-lognormal error structure (Lo et al., 1992, Can. J. Fish. Aquat. Sci., 49:2515-2526), in which the binomial distribution describes positive versus zero CPUE, and the normal distribution describes the log of positive CPUE. Explanatory variables considered, in addition to year (necessarily included), were month, geographic area, trip type, and interaction terms. A forward stepwise approach was used to construct each GLM (SEDAR DW-20). For the binomial GLM, the stepwise approach identified all main effects—area, month, and trip type—for inclusion in the analysis. For the lognormal GLM, it identified all main effects plus the area*trip type interaction for inclusion. The CPUE was in units number caught per angler-hour.

Effective effort was based on those trips that caught gag (positive CPUE) and those that *could* have caught gag (zero catch, but positive effort). Positive catches are readily available from the data, but without information on targeting by fishermen, zero catches must be inferred. To do so, we applied the method of Stephens and MacCall (Stephens and MacCall, 2004, Fish. Res. 70:299-3210). In essence, the method uses multiple logistic regression to estimate a probability for each trip that gag was caught, given other species caught in that trip. Species used as factors in the regression were selected as those caught in at least 5% of trips. This cutoff simplifies the regression, by excluding rarely caught species; however, preliminary analyses indicated results were insensitive to the value of the cutoff (examined over a range of 0% to 10%). Trips were included if their associated probability was higher than a threshold probability. The threshold's value was defined as that which results in the same number of predicted and observed positive trips, as in Stephens and MacCall (2004).

5.2.4 Results

Estimates of CPUE (number/angler-hr) and CV are presented in Table 5.4 and in Figure 5.1.

5.2.5 Discussion

The headboat index was recommended by the DW for use in the assessment (Table 5.2). One concern was that this index may contain problems associated with fishery-dependent indices, as described in section 5.1.5. The DW, however, did note that

the headboat fishery is not a directed fishery for gag. Rather, it more generally fishes a complex of snapper-grouper species, and does so with only limited search time. Thus, the headboat index may be a more reliable index of abundance than one developed from a fishery that targets gag specifically.

The DW discussed a perceived shift in headboat effort during the 1980s, from full day trips to half day trips nearer shore. However, analysis of positive gag trips reveals that no such shift occurred during the 1980s (Figure 5.2). Half-day trips were initiated during the mid- to late-1970s, but since have shown no striking trends. Similar analyses of all headboat trips, by state and overall, revealed similar patterns. The DW noted that if there were a shift in trip type, it would be accounted for by the GLM, because trip type (half day, full day, full plus) is used as a factor.

The DW discussed how the assessment might attempt to account for changes in catchability over time. Constant catchability, though commonly assumed, would not be an appropriate assumption in this fishery, as the DW generally believed that catchability has increased with improvements in fishing gear and technology.

5.3 INDEX FROM MRFSS DATA

5.3.1 General description

The general recreational fishery is sampled by MRFSS. This general fishery includes all recreational fishing from shore, private boats, and charter boats (for-hire vessels that usually accommodate six or fewer anglers). Using the MRFSS data, an index of abundance was computed for 1981–2004 (SEDAR10-DW-09).

5.3.2 Issues discussed at DW

Issue 1: Trip selection

Option 1: Method of Stephens and MacCall (2004)

Option 2: Use guild – reef, non-reef, or pelagic – as reported in the MRFSS.

Decision: Option 2. Option 2 selected trip/interview records for which the angler reported targeted species from guilds. Given direct information on targeting, sub-setting trips via the method of Stephens and MacCall is unnecessary. That method, however, was still investigated, but the regression failed to converge.

Miscellaneous decisions

The group acknowledged the possibility that some gag were misreported as black grouper. In states north of Florida, the ratio of gag:gag+grouper was near one in most years. In Florida, the ratio was lower; however, the data were insufficient to make any corrections. Therefore the MRFSS data were used as reported. This approach assumes that if gag were misreported, the misreporting was not systematic, such that the gag reported could be considered a random sample of all gag caught.

5.3.3 Methods

The MRFSS data include only the areas between North Carolina and Florida east coast, including the Monroe County in the Florida Keys. No recreational catches of gag have ever been reported in the New England region. Gag nominal catch rates (number of fish caught AB1B2 per number of angler-hours) were standardized following a delta

modeling approach as the proportion of trip/interviews that reported gag catches were low (~ 1%). The model assumed a binomial distribution for the proportion of positive trips and a lognormal distribution for the catch rates of positive gag trips. Factors evaluated in the model were mode (shore, charter, private/rental), area (inshore, ocean < 3 miles, 3 < ocean < 10 miles, ocean > 10 miles), region (Florida east coast, Georgia-North Carolina), season (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec), and guild (inshore species, reef species, non-reef species, and pelagic species, unclassified). The last factor guild, classified trips according to the intended target species of the trip declared by the angler, if no target was defined then the trip was assigned as unclassified. The standardization model also evaluated interactions between factors.

5.3.4 Results

The results show no discernible trend for the Atlantic gag standardized catch rates between 1981 and 2004 (Fig 16 SEDAR DW-09). Estimated 95% confidence bounds were wide and overlapped any estimate-point trend; average estimated coefficient of variance was 63%. Estimates of CPUE (number/1000 angler-hr) and CV are presented in Table 5.5 and in Figure 5.1.

5.3.5 Discussion

The MRFSS index was recommended by the DW for use in the assessment (Table 5.2). One concern was that this index may contain problems associated with fishery-dependent indices, as described in section 5.1.5. Another concern was the large uncertainty in MRFSS estimates.

5.4 FISHERY-INDEPENDENT INDICES

5.4.1 Fishery-independent indices of adult abundance

Gag have been sampled in low numbers with a variety of gear types since the inception of MARMAP (described in working paper SEDAR10-DW-05), including chevron traps (n=103), Florida traps (n=10), blackfish traps (n=14), hook and line (n=53), vertical longline (n=6) and several other experimental gear types (n=39). The DW considered indices from two gear types: the chevron trap (1990-2004) and hook and line (1979-2004).

5.4.1.1 MARMAP Chevron trap:

The DW did not recommend using an index developed from MARMAP chevron trap samples. The percentage of traps each year that captured gag was extremely low, in spite of relatively extensive regional coverage. As gag is one of the most commonly captured species in the region, the group was concerned that the low frequency of occurrence of gag in chevron traps demonstrated some level of trap avoidance by gag. Trap avoidance may have occurred if soak time was insufficient for gag to enter the trap, if the presence of other species in the trap deterred the entrance of gag, or for unknown reasons. The group concluded there was a strong possibility that the chevron trap samples did not provide an index of abundance for gag off the Southeastern U.S.

5.4.1.2 MARMAP hook and line:

The DW did not recommend using an index from MARMAP hook and line samples as an index of abundance for the following reasons:
i) Approximately 50% of years sampled had zero catches.
ii) Changes in personnel and level of effort have changed over time, compromising the utility of the hook and line survey as an index.
iii) Much of the hook and line effort was conducted over mid-shelf depths, and as such may not provide an adequate representation of the complete range of gag.

5.4.2 Indices of juvenile abundance

5.4.2.1 Charleston, SC survey:

A survey of juvenile gag was conducted by SCDNR scientists near Charleston, SC SEDAR 10 DW05). The limited nature of the data generated by the study meant its utility as an index of juvenile abundance or recruitment was extremely low. The study lasted only three years, and only one site provided data for all three years. The limited geographic range of sampling and the low number of years sampled led the DW to reject the juvenile gag survey for inclusion as either a recruitment index or abundance index in the gag stock assessment.

5.4.2.2 SEAMAP trawl survey:

SEAMAP-SA is a random stratified shallow water sand bottom trawl survey from Onslow Bay, NC to Cape Canaveral FL from 1990 to the present. However, only three gag have been reported from the survey – two in 1990, and one in 1993. The potential of the SEAMAP survey as an index of abundance for gag was rejected by the DW due to the almost non-existent samples of gag collected in the survey.

5.4.2.3 FMRI estuarine survey:

Gag abundance and habitat data were collected throughout Florida estuaries [Southern Indian River Lagoon, Northern Indian River Lagoon, and Northeast Florida (St. Johns, Nassau, and St. Marks Rivers)] by the Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute's Fisheries-Independent Monitoring program from 1996 to 2004 (SEDAR10-DW30). Monthly stratified-random sampling was conducted during the day by using three different seines. Estuaries used in the study were adequately sampled; however, few gag were caught in the Northeast Florida estuary. The DW questioned whether recruitment in two Florida estuaries could be used to infer recruitment across the entire assessment region (FL, GA, SC, and NC). Because of the strong possibility that observed recruitment was localized, the DW did not recommend use of the index from the FMRI survey.

5.5 RESEARCH RECOMMENDATIONS

1) Investigate further the issue of misidentification between black grouper and gag. Develop a suitable method to correct misidentifications on a trip by trip basis. This issue will also be of concern when assessing black grouper. The catches of gag grouper misidentified as black is likely a substantial proportion of reported black grouper landings.

2) We recognize that many valuable and well designed fishery-independent sampling programs have been underfunded or discontinuously funded, resulting in low sample sizes, variable sampling effort (in time and space), discontinuous time series, and poorly stratified designs. The group strongly recommends increased funding toward developing and maintaining fishery-independent sampling programs, and stresses that quality indices require continuous funding over meaningful time periods (ideally decades).

3) It was proposed that the index working group examine the possibility of including environmental variables in computation of indices. Variables discussed included wave height, sea surface temperature, surface currents and hurricane impact. The group considered that other model parameters, particularly the spawner-recruit relationship, might be a meaningful way to include environment variables in assessment models.

4) Examine methods to account for changes in catchability over time of abundance. This is of particular importance when considering fisheries-dependent indices.

5) Develop coast-wide sampling of larval and juvenile abundance.

Table 5.1
Table . A summary of catch series from the Atlantic available for the SEDAR10 data workshop.

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Size Range	Issues	Use?
Recreational	Headboat	Atlantic	1973-2004	Number per angler-hr	Stephens and MacCall; delta-lognormal GLM	Same as fishery	Fishery-dependent	Y
Commercial	Handline	Atlantic	1992-2004	Pounds per hook-hr)	Stephens and MacCall; delta-lognormal GLM	Same as fishery	Fishery-dependent	Y
Recreational	MRFSS	Atlantic	1981-2004	Number per 1000 hours	Trips included by guild composition, delta-lognormal GLM	Same as fishery	Fishery-dependent	Y
Independent	Juvenile Gag Survey	Charleston/ close by locales	1981, 1995-1997	Number per Witham Collector	Nominal	Larvae/Juvenile	Low sample size; localized	N
Independent	MARMAP:trap	Atlantic					Trap avoidance suspected	N
	Florida trap		1983-1987	Number per trap-hr	Nominal	31 to 73 cm n=10		
	Chevron		1990-2004			22 to 93 cm n=103		
Independent	MARMAP; hook and line	Atlantic	1979-present	Number per hook-hr	Nominal		Low sample sizes; freq. annual zeros	N
Independent	SEAMAP	Atlantic	1990	Number per hectacre	Nominal		Low samples sizes	N
Independent	FMRI Estuarine Survey	Both coasts (FL)	1996-2004		Delta-lognormal GLM	Juvenile		N

Table 5.2 Issues of each data set considered for CPUE, as discussed by the DW.

Fishery-dependent Indices

Commercial Logbook – Handline (*Recommended for use*)

Pros: Complete census
Covers broad geographical area
Continuous, 13-year time series

Cons: Unknown if catch rates are proportional to abundance; however could be accounted for in the assessment
Data are self-reported and largely unverified
Lacks information on discard rates
Variability in fishing practices at vessel level
Catchability may vary over time

Issues Addressed:
In some cases, self-reported landings have been compared to TIP data, and they appear reliable

Recreational Headboat (*Recommended for use*)

Pros: Complete census
Cover complete area
Long time series
Data are verified by port samplers
Consistent sampling
Large sample size
Non-targeted for gag

Cons: Unknown if catch rates are proportional to abundance; however could be accounted for in the assessment
Lacks information on discard rates until 2004
Variability in fishing practices at vessel level
Catchability may vary over time

Issues Addressed:
Possible shift in fisherman preference (Stephens and McCall approach)
Perception that trip duration has shifted toward half-day trips (Exploratory data analysis reveals no such shift, on positive gag trips or on headboat trips overall; Trip duration is a factor in GLM)

MRFSS (*Recommended for use*)

Pros: Methods are statistically valid
Long time series
Complete area coverage
Only FD index that includes discard information (AB1B2)

Cons: High PSE's for grouper species
Unknown if catch rates are proportional to abundance; however could be accounted for in the assessment

Table 5.2 (cont.)

Fishery-independent

MARMAP

Chevron Trap Index (Not recommended for use)

Pros: Fishery independent random hard bottom survey
Adequate regional coverage
Standardized sampling techniques

Cons: Trap avoidance is suspected due to low percent occurrence relative to total sample set
High standard errors

Hook and Line Index (Not recommended for use)

Pros: Fishery independent random hard bottom survey
Adequate regional coverage
Standardized sampling techniques

Cons: In ~50% of years there are zero catches. In other years the highest observed number of fish is 10. Generally less than 5 were observed
Primarily midshelf sampled
High standard errors
Ability of samplers may have decreased over time
Level of effort has decreased over time

Charleston, SC Juvenile Gag Survey (not recommended for use)

Pros: Fishery-independent attempt to monitor abundance of gag

Cons: Limited geographic range (4 sites – 3 in SC, one in NC)
Limited time frame (3 years for 1 SC site, 2 years 2 SC sites, 1 year for NC site)
Observed only 103 specimens over all sites, gears, for all years

SEAMAP Trawl Survey (Not Recommended for use)

Pros: stratified random sample design
Adequate regional coverage
Standardized sampling techniques

Cons: Sand bottom survey
Only captured 3 gag since program inception (1990)

FMRI Estuarine Survey (Not recommended for use)

Pros: Stratified random sample design
Adequate coverage of estuaries sampled (3 sites in FL)
Standardized sampling techniques

Cons: Could not conclude that estuaries sampled represented entire assessment region (FL, GA, SC, and NC)
Low frequency of occurrence of gag

Table 5.3. Estimated CPUE (lb/hook-hr) of gag off the Southeastern U.S., including lower (LCI) and upper (UCI) 95% confidence intervals and CV. Estimates based on handline gear reported in commercial logbooks.

YEAR	CPUE (lb/hook-hr)	Relative CPUE	LCI	UCI	CV
1992	1.505	0.908	0.797	1.034	6.53%
1993	1.566	0.944	0.868	1.027	4.22%
1994	1.505	0.907	0.835	0.986	4.13%
1995	1.553	0.937	0.862	1.017	4.13%
1996	1.660	1.001	0.924	1.085	4.02%
1997	1.274	0.768	0.703	0.839	4.41%
1998	1.577	0.951	0.872	1.037	4.32%
1999	1.686	1.017	0.926	1.116	4.66%
2000	1.512	0.912	0.823	1.009	5.09%
2001	1.438	0.867	0.791	0.951	4.60%
2002	1.668	1.006	0.917	1.103	4.62%
2003	2.226	1.342	1.223	1.473	4.65%
2004	2.388	1.440	1.313	1.579	4.62%

Table 5.4 Estimated CPUE (number/angler-hr) of gag off the Southeastern U.S., including lower (LCI) and upper (UCI) 95% confidence intervals and CV. Estimates based on data from the headboat fishery.

YEAR	CPUE (number/angler-hr)	Relative CPUE	LCI	UCI	CV
1973	0.027	2.486	1.452	4.256	27.37%
1974	0.019	1.762	0.956	3.247	31.29%
1975	0.010	0.925	0.397	2.154	44.20%
1976	0.007	0.659	0.270	1.609	46.97%
1977	0.007	0.678	0.280	1.642	46.47%
1978	0.007	0.689	0.335	1.418	37.30%
1979	0.011	1.037	0.589	1.826	28.87%
1980	0.013	1.198	0.732	1.958	24.97%
1981	0.011	1.064	0.607	1.866	28.66%
1982	0.011	1.040	0.625	1.733	25.92%
1983	0.012	1.150	0.723	1.829	23.52%
1984	0.012	1.168	0.718	1.901	24.71%
1985	0.011	0.985	0.601	1.613	25.06%
1986	0.011	1.006	0.614	1.649	25.09%
1987	0.012	1.084	0.690	1.705	22.92%
1988	0.013	1.231	0.819	1.850	20.59%
1989	0.012	1.166	0.705	1.928	25.55%
1990	0.012	1.122	0.682	1.846	25.30%
1991	0.012	1.098	0.664	1.818	25.60%
1992	0.012	1.143	0.712	1.835	24.02%
1993	0.011	1.050	0.615	1.793	27.26%
1994	0.009	0.872	0.488	1.560	29.68%
1995	0.010	0.914	0.515	1.624	29.34%
1996	0.008	0.769	0.380	1.555	36.35%
1997	0.009	0.821	0.379	1.780	40.18%
1998	0.010	0.977	0.564	1.690	27.96%
1999	0.007	0.670	0.320	1.402	38.26%
2000	0.008	0.713	0.341	1.487	38.07%
2001	0.007	0.658	0.306	1.414	39.69%
2002	0.008	0.708	0.333	1.503	39.03%
2003	0.006	0.522	0.190	1.429	53.76%
2004	0.007	0.637	0.290	1.400	40.95%

Table 5.5 Estimated CPUE (number/1000 angler-hr) of gag off the Southeastern U.S., including lower (LCI) and upper (UCI) 95% confidence intervals and CV. Estimates based on data from the MRFSS.

YEAR	CPUE (number/1000 angler-hr)	Relative CPUE	LCI	UCI	CV
1981	0.784	0.590	0.083	4.219	127.69%
1982	0.646	0.487	0.071	3.323	123.14%
1983	0.593	0.446	0.086	2.322	98.66%
1984	0.773	0.582	0.128	2.648	87.98%
1985	1.719	1.294	0.336	4.992	75.97%
1986	1.669	1.257	0.376	4.199	66.24%
1987	1.337	1.007	0.297	3.414	67.22%
1988	0.817	0.615	0.173	2.193	70.52%
1989	2.631	1.982	0.628	6.249	62.51%
1990	1.042	0.784	0.221	2.786	70.28%
1991	1.352	1.018	0.313	3.313	64.54%
1992	1.462	1.101	0.342	3.538	63.72%
1993	1.473	1.110	0.343	3.585	64.06%
1994	1.376	1.036	0.322	3.335	63.82%
1995	2.047	1.542	0.486	4.885	62.82%
1996	1.120	0.843	0.256	2.780	65.37%
1997	1.165	0.877	0.246	3.126	70.54%
1998	0.458	0.345	0.091	1.303	74.52%
1999	2.316	1.744	0.543	5.606	63.73%
2000	1.183	0.891	0.271	2.927	65.16%
2001	0.935	0.704	0.215	2.306	64.92%
2002	1.589	1.196	0.374	3.828	63.42%
2003	1.318	0.992	0.303	3.250	64.94%
2004	2.067	1.556	0.500	4.842	61.63%

Table 5.6 Correlation among indices (Pearson correlation coefficient).

	Headboat	MRFSS	Comm. logbook
Headboat	1.00	-0.24	-0.54
MRFSS	-0.24	1.00	0.37
Comm. logbook	-0.54	0.37	1.00

Figure 5.1 Fishery-dependent indices of abundance for gag off the southeastern U.S.

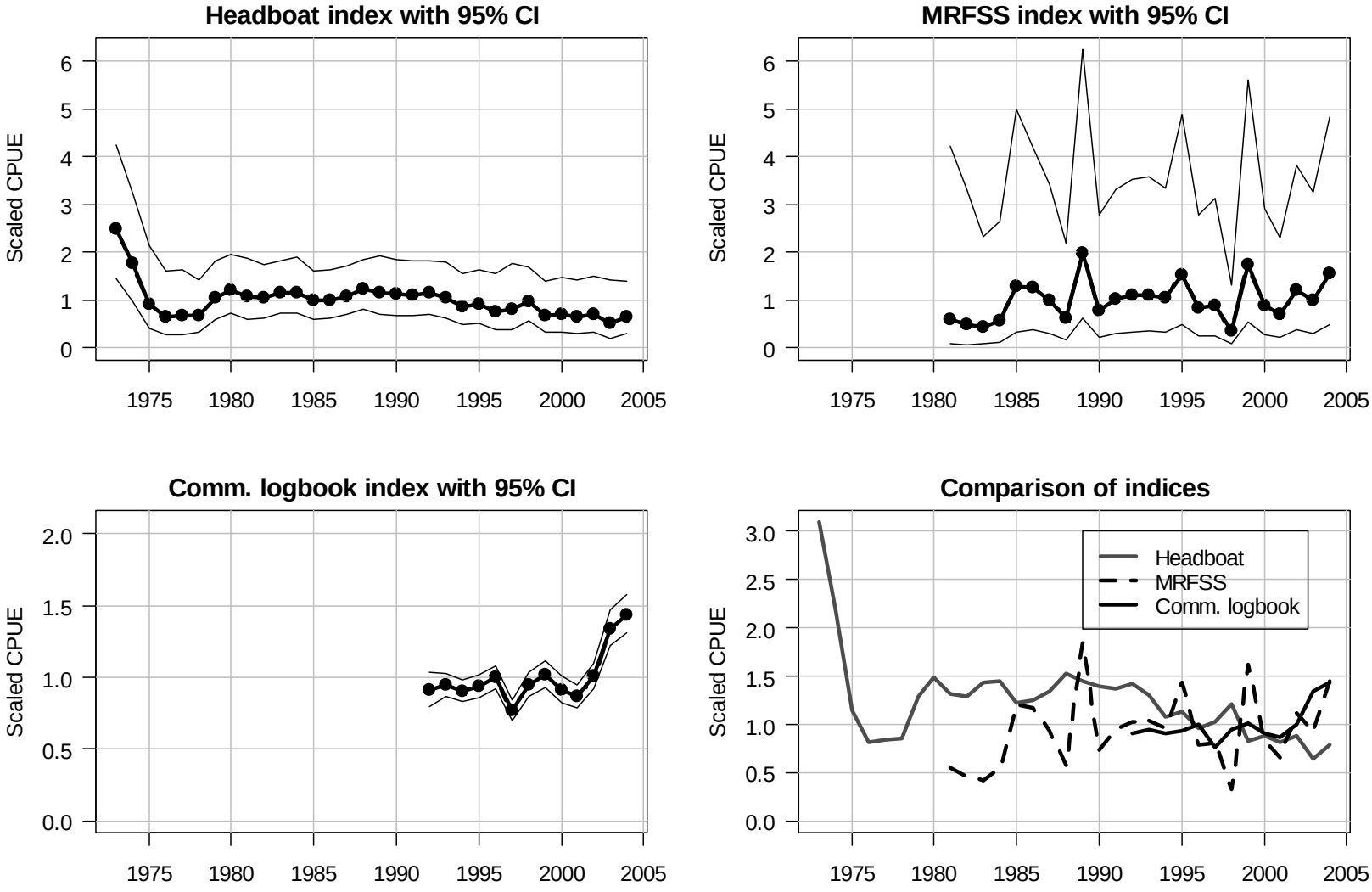
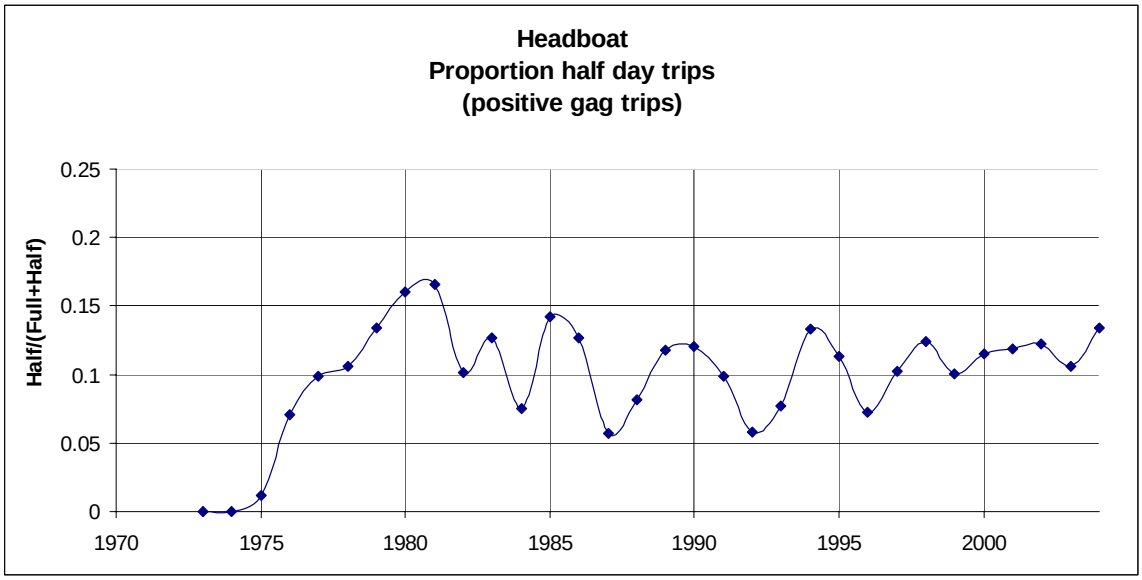



Figure 5.2. Proportion of positive gag headboat trips that are half day trips.