S E D A R

Southeast Data, Assessment, and Review

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SEDAR 17
Data Workshop Report

South Atlantic Spanish Mackerel

July 2008

SEDAR is a Cooperative Initiative of:

The Caribbean Fishery Management Council
The Gulf of Mexico Fishery Management Council
The South Atlantic Fishery Management Council
NOAA Fisheries Southeast Regional Office
NOAA Fisheries Southeast Fisheries Science Center
The Atlantic States Marine Fisheries Commission
The Gulf States Marine Fisheries Commission

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Section II. Data Workshop Report

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1. Introduction

1.1 Workshop Time and Place

The SEDAR 17 Data Workshop was held May 19-23, 2008, in Charleston, SC.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition. Provide a map of species and stock distribution.

2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics, discard mortality rates); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.

3. Consider relevant fishery dependent and independent data sources to develop measures of population abundance. Document all programs used to develop indices; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop values by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision. Evaluate the degree to which available indices represent fishery and population conditions. Recommend which data sources should be considered in assessment modeling.

4. Characterize commercial and recreational catch, including both landings and discard removals, in pounds and number. Discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions of the catch. Provide maps of fishery effort and harvest.

5. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Recommend sampling intensity by sector (fleet), area, and season.

6. Develop a spreadsheet of assessment model input data that incorporates the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet within 6 weeks prior to the Assessment Workshop.

7. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report); prepare a list of tasks to be completed following the workshop, including deadlines and personnel assignments.

1.3 Participants

Appointee	Function	Affiliation
Coordination		
Dale Theiling	Chair and Chief Editor	SEDAR
Rachael Lindsay	Administrative Support	SEDAR
Data Management		
Rob Cheshire	Data Compiler	SEFSC
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Kate Andrews	Data Provider and Rapporteur	SEFSC
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Steve Brown	Data Provider	FL FWC
Julie Califf	Data Provider	GA DNR
Jack Holland	Data Provider	NC DMF
Robert Wiggers	Data Provider	SC DNR
Geoff White	Data Provider	ACCSP
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Recreational Statistics Workgroup		
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Beverly Sauls	Data Provider	FL FWC
Tom Sminkey	Data Provider	MRFSS (MRIP)
Ken Brennan	Data Provider	SEFSC/Headboats
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Pat Harris	Data Provider	MARMAP
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Kate Andrews	Data Provider	SEFSC

Analytical Team Representation

Kyle Shertzer	Vermilion Snapper Lead Analyst	SEFSC
Paul Conn	Spanish Mackerel Lead Analyst	SEFSC

Council Representation

Brian Chevront	Council Member	SAFMC
David Cupka	Council Member	SAFMC
Rick DeVictor	Vermilion Snapper Council Lead	SAFMC
Gregg Waugh	Spanish Mackerel Council Lead	SAFMC

Advisory Panel Representation

Ben Hartig	SAFMC AP Chair	FLA Commercial

Observers and Associates

Jeanne Boylan (SEAMAP)
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Acronyms
SEDAR 17 DW Attendance List

ACCSP	Atlantic Coastal Cooperative Statistics Program
AP	Advisory Panel
ASMFC	Atlantic States Marine Fisheries Commission
CCA	Coastal Conservation Association
CIE	Center for Independent Experts
FL FWC	Florida Fish and Wildlife Commission
FMP	Fishery Management Plan
GA DNR	Georgia Department of Natural Resources
MRFSS	Marine Recreational Fisheries Statistics System
MRIP	Marine Recreational Information Program
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
SAFMC	South Atlantic Fishery Management Council
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SC DNR	South Carolina Department of Natural Resources
SEDAR	Southeast Data, Assessment, and Review
SSC	Science & Statistics Committee, South Atlantic Fishery Management Council
TIP	Trip Interview Program, National Marine Fisheries Service

1.4 Workshop Documents

SEDAR 17
South Atlantic Vermilion Snapper and South Atlantic Spanish Mackerel
Data Workshop Document List

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR17-DW01	South Atlantic Vermilion Snapper Management Information Worksheet	J. McGovern (SERO) R. DeVictor (SAFMC)
SEDAR17-DW02	South Atlantic Spanish Mackerel Management Information Worksheet	J. McGovern (SERO) R. DeVictor (SAFMC)
SEDAR17-DW03	South Atlantic Vermilion Snapper Assessment History	D. Vaughan (SEFSC)
SEDAR17-DW04	South Atlantic Spanish Mackerel Assessment History	D. Vaughan (SEFSC)
SEDAR17-DW05	South Atlantic Vermilion Snapper Commercial Chapter	D. Vaughan (SEFSC)
SEDAR17-DW06	South Atlantic Spanish Mackerel Commercial Chapter	D. Vaughan (SEFSC)
SEDAR17-DW07	A review of Spanish mackerel (*Scomberomorus maculatus)* age data, 1987-2007, Atlantic collections only, from the Panama City Laboratory, SEFSC, NOAA Fisheries Service	C. Palmer, D. DeVries, C. Fioramonti and L. Lombardi-Carlson (SEFSC)
SEDAR17-DW08	Vermilion Snapper Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys in the South Atlantic, 2004 to 2007	B. Sauls, C. Wilson, D. Mumford, and K. Brennan (SEFSC)
SEDAR17-DW09	Development of Conversion Factors for Different Trap Types used by MARMAP since 1978.	P. Harris (MARMAP)
SEDAR17-DW10	Discards of Spanish Mackerel and Vermilion Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic	K. McCarthy (SEFSC)
SEDAR17-DW11	Standardized catch rates of vermilion snapper from the headboat sector: Sensitivity analysis of the 10-fish-per-angler bag limit	Sustainable Fisheries Branch (SEFSC)
SEDAR17-DW12	Estimation of Spanish mackerel and vermilion snapper bycatch in the shrimp trawl fishery in the South Atlantic (SA)	K. Andrews (SEFSC)
Documents Prepared for the Assessment Workshop		
SEDAR17-AW01	SEDAR 17 South Atlantic Vermilion Snapper Stock Assessment Model	To be prepared by SEDAR 17
SEDAR17-AW02	SEDAR 17 South Atlantic Spanish Mackerel Stock Assessment Model	To be prepared by SEDAR 17
Documents Prepared for the Review Workshop		

SEDAR17-RW01	SEDAR 17 South Atlantic Vermilion Snapper Document for Peer Review	To be prepared by SEDAR 17
SEDAR17-RW02	SEDAR 17 South Atlantic Spanish Mackerel Document for Peer Review	To be prepared by SEDAR 17
Final Assessment Reports		
SEDAR17-AR01	Assessment of the Vermilion Snapper Stock in the US South Atlantic	To be prepared by SEDAR 17
SEDAR17-AR02	Assessment of the Spanish Mackerel Stock in the US South Atlantic	To be prepared by SEDAR 17
Reference Documents		
SEDAR17-RD01	South Atlantic Vermilion Snapper Stock Assessment Report, SEDAR 2, 2003	SEDAR 2
SEDAR17-RD02	Update of the SEDAR 2 South Atlantic Vermilion Snapper Stock Assessment, 2007	SEDAR
SEDAR17-RD03	Fishery Management Plan for Spanish Mackerel, Atlantic States Marine Fisheries Commission, 1990	L. P. Mercer L. R. Phalen J. R. Maiolo
SEDAR17-RD04	Mitochondrial and nuclear DNA analysis of population subdivision among young-of-the-year Spanish mackerel (*Scomberomorus maculatus*) from the western Atlantic and Gulf of Mexico	V. P. Buonaccorsi E. Starkey J. E. Graves
SEDAR17-RD05	George Fishes MD TAFS 28 1-49	W. A. George
SEDAR17-RD06	Excerpt – Goode 1878 stats 7-1-99	Goode
SEDAR17-RD07	Excerpt – Henshall Comparative Excellence TAF 13 1-115	Henshall
SEDAR17-RD08	Stock Assessment Analyses on Spanish and King Mackerel Stocks, April 2003	Sustainable Fisheries Div, SEFSC
SEDAR17-RD09	Hooking Mortality of Reef Fishes in the Snapper-Grouper Commercial Fishery of the Southeastern United States	D.V. Guccione Jr.
SEDAR17-RD10	Effects of cryptic mortality and the hidden costs of using length limits in fishery management Lewis G Coggins Jr	L. G. Coggins Jr. and others
SEDAR17-RD11	Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA	P. J. Rudershausen and J. A. Buckel
SEDAR17-RD12	A multispecies approach to subsetting logbook data for purposes of estimating CPUE	A. Stephens and A. MacCall

SEDAR17-RD13	The 1960 Salt-Water Angling Survey, USFWS Circular 153	Clark, J. R.
SEDAR17-RD14	The 1965 Salt-Water Angling Survey, USFWS Resource Publication 67	Deuel, D. G. and J. R. Clark
SEDAR17-RD15	1970 Salt-Water Angling Survey, NMFS Current Fisheries Statistics Number 6200	Deuel, D. G.
SEDAR17-RD16	User's Guide: Delta-GLM function for the R Language /environment (Version 1.7.2, revised 07-06-2006)	Dick, E. J. SWFSC/NMFS
SEDAR17-RD17	Reproductive biology of Spanish mackerel, *Scomberomorus maculatus*, in the lower Chesapeake Bay. M.A. Thesis, Virginia Institute of Marine Science. (Selective pages)	Cooksey, C. L. 1996

2. Life History – Reply to TOR 1, 2, and 5. [Life History Workgroup]

2. 1 Overview - group membership, leader, and issues

Overview

The life history working group (LHG) reviewed information on stock structure, natural mortality, age, growth, movements, and reproduction of Atlantic stock Spanish mackerel: and age sampling, size and age composition, and discard mortality in the fisheries for this stock.

Group Membership

Jennifer Potts (Leader)…NMFS-Beaufort

Dan Carr……..NMFS-Beaufort

Chip Collier……..NC DMF

Doug DeVries……..NMFS-Panama City

Stephanie McInerny…..…NMFS-Beaufort

Paulette Mikell……SC DNR

Chris Palmer……NMFS-Panama City

Marcel Reichart……SC DNR

Jessica Stephen……SC DNR

David Wyanski……SC DNR

Issues

Some key issues discussed by the LHG included stock composition and possible mixing in the Florida Keys and the necessity of either constraining the von Bertalanffy parameter t_0 or increasing sample size of small age 0 individuals to more accurately model population growth parameters.

2. 2 Stock Definition and Description

Spanish mackerel are distributed throughout the US Atlantic coast and Gulf of Mexico (GoM) (Collette and Russo 1979, 1984). The majority of the population exists in Florida waters and they are targeted by both the recreational and commercial fishing sectors throughout their range (Trent and Anthony 1978). Amendment 2 to the Coastal Pelagics FMP delineated two groups of Spanish mackerel based on evidence from electrophoresis studies, distributional patterns, spawning areas, and the history of exploitation (Skow and Chittenden 1981; GMFMC and SAFMC 1987). The Dade/Monroe County, Florida boundary was accepted as a practical boundary, because both recreational and commercial catch data for the Gulf and Atlantic have used this boundary.

This species has been investigated for evidence of stock structure by multiple researchers with conflicting results. Early studies of morphometrics and meristics (Collette and Russo,

1984), a single allozyme study (Skow and Chittenden, 1981), and an electrophoresis study using 44 muscle enzyme loci (Nakamura, 1987) noted differences between Spanish mackerel in the Atlantic and GoM. More recent work using mitochondrial and nuclear DNA (Buonaccorsi et al., 2001) did not detect a difference between the Atlantic and GoM Spanish mackerel. Given the highly migratory nature of this species, possible mixing of pelagic eggs, and low number of individuals needed to homogenize the genetic signal, it is not surprising that mitochondrial and nuclear DNA differences were not detected; and the authors themselves noted that "From an ecological and fisheries management perspective, even a sensitive genetic analysis is not sufficient to determine that there is no difference among putative stocks. Migration on the order of tens of individuals per generation is sufficient to homogenize allele frequencies among genetic stocks for both markers." In the report of the life history workgroup from the recent data workshop on the closely related king mackerel (SEDAR 16), a discussion on stock structure noted that "a lack of a significant genetic difference in selectively neutral markers, such as mtDNA or nuclear DNA microsatellites, is not definitive evidence that interregional population structure does not exist (Nolan et al. 1991; Pruett et al. 2005)".

Additionally, the differences observed in morphometrics, meristics (Collette and Russo, 1984), and electrophoretic analyses (Nakamura, 1987) indicate separate stocks between the Atlantic and GoM Spanish mackerel. These stocks may have different demographic parameters (eg. length weight relationship, size at age, and fecundity), which will influence inputs and parameters for a stock assessment model. In the co-occurring king mackerel, for which there is ample evidence of movements and mixing between the Atlantic and GoM (Sutter et al. 1991), DeVries et al. (1997) reported significant differences in growth and size at age estimates between fish sampled in Atlantic waters off the SE U.S. and the eastern GoM. More recent studies of otolith shape and elemental composition (Clardy et al. 2008, Patterson and Shepard 2008) strongly supported the existence of separate Atlantic and eastern GoM stocks.

The consensus of the LHG was that the management units should remain distinct between the Atlantic and Gulf to remain consistent with Amendment 2 of the Fishery Mangement Plan for the Coastal Migratory Pelagic Resources (Mackerels) (GMFMC and SAFMC, 1987).

Recommendations for the AW:

1) Keep the status quo, i.e., one south Atlantic stock with a southern boundary at the Dade/Monroe County, Florida boundary.

2. 3 Natural Mortality

Consistent with the recommendations of previous SEDAR panels for other species, including king mackerel *Scomberomorus cavalla* in SEDAR 16, the group recommends modeling the natural mortality rate of Spanish mackerel as a declining 'Lorenzen' function of size (translated to age by use of a growth curve) (Lorenzen 1996). The Lorenzen curve should be scaled such that the average value of M over the range of fully-selected ages (in this case age 2 up to the maximum age) is the same as the point estimate from Hoenig's (1983) regression.

Application of that regression, based on fish data only, to the maximum age estimate of 12 yr from Nobel et al. (1992) suggests an average M value of 0.35 yr^{-1}, and the LHG recommends a sensitivity range of 0.32-0.38 to encompass the Hoenig estimate based on the maximum age of 11 reported in SEDAR 17-DW-07 and in Schmidt et al.(1993). Preliminary calculations of M based on the growth information available at the data workshop are shown in Figure 2.15.1.

Recommendations for the AW:

1) Model the natural mortality rate of Spanish mackerel as a declining Lorenzen function of size.

2) The Lorenzen function should be scaled to an M of 0.35 - the Hoenig estimate of M based on a maximum age of 12 yr from Noble (1992), with sensitivity runs between 0.32 and 0.38.

2. 4 Discard Mortality

Spanish mackerel are harvested by several gears, which have varying discard mortality rates. Currently, few data sets are published on discard mortality of Spanish mackerel (Harrington et al. 2005). Recently, the NOAA Southeast Fisheries Science Center commercial logbook program has provided discard rates for Spanish mackerel from 2002-2007. This program randomly samples 20% of commercial vessels operating in the South Atlantic and Gulf of Mexico. From the commercial logbooks, discard mortality rates can be estimated for gillnets, hook and line, and trolling (SEDAR17-DW10). The gillnet fisheries, including set gillnets, run around gillnets, and cast nets, should have a low number of releases due to gear selectivity for legal sized fish, but any under sized fish would have a high release mortality rate, most likely 100 % (Ben Hartig, personal communication). A discard mortality rate for Spanish mackerel in gillnets was estimated to be 93.4% (Hueter and Manire 1994). This estimate was based on a fishery independent study conducted in Florida for gillnets soaked one hour. The commercial logbooks estimated a gillnet discard mortality for Spanish mackerel at 100% (SEDAR17-DW10). Hook and line fisheries, which would include both recreational and commercial fisheries, were suggested to have a discard mortality of 25% or less (Ben Hartig, personal communication) and this estimate shows consistency with the king mackerel data workshop (SEDAR 16). However, estimates for Spanish mackerel from the commercial logbooks show a discard mortality of 80% for hook and line (SEDAR17-DW10). The MRFSS at-sea headboat observer survey noted very few Spanish mackerel releases (5 fish on >100 trips) and therefore no estimates were developed from this survey. Additionally, the headboats were recorded as drift fishing, which is not a typical manner used to harvest Spanish mackerel. Most recreational fishermen targeting Spanish mackerel troll (Mercer et al. 1990). Trolling appears to have high discard mortality rates similar to gillnets and resulted in 98% discard mortality based on commercial logbook data (SEDAR17-DW10). Since commercial landings for trolling and hook and line will be combined for use in the Spanish mackerel stock assessment, a combined discard mortality was calculated as a

mean mortality rate weighted by the percent of discards by gear. So the discard mortality rate for trolls and hook and line combined was estimated to be 88%.

A final component of discard mortality for Spanish mackerel would result from the shrimp trawl fishery. Sufficient data are not available to estimate the number of Spanish mackerel discarded in this fishery but any discarded would most likely have a high discard mortality rate around 100% (Pat Harris, personal communication). Observed shrimps trawl trips off South Carolina captured Spanish mackerel on 41% of the tows (Harris and Dean 1998). However, estimates of discards in shrimp trawls have been considered unreliable and, therefore, were not included in SEDAR 5 (SEDAR5-AW8). Since SEDAR 5, we are not aware of any new studies documenting bycatch in shrimp trawls.

Recommendations for the AW:

1) Use the following commercial and recreational discard mortality rates for the assessment of Spanish mackerel: gillnets 100%, shrimp trawls 100%, trolling 98%, hook and line 80%, and trolling/hook and line combined 88%.

2. 5 Age

The Panama City NMFS Laboratory initially provided age and length data on 13,405 Spanish mackerel collected in Atlantic waters north of Monroe County, Florida during 1987-2007 (Figure 2.15.2). Based on the disproportionate number of outliers in the 1987 (one of the earliest year's collections aged at the Panama City lab) size at age plot compared to that in the pooled data from all subsequent years (Figures 2.15.3 and 2.15.4), the LHG agreed that age data from that year (258 observations) should be excluded from any analyses for SEDAR 17. A description of the methods, information on quality control, and the distribution of age samples by year, sex, geographical location, gear, fishery, and collecting agency or program are detailed in SEDAR 17-DW-07. The large number of aged samples in 2002 was from a cooperative ageing study with the Virginia Institute of Marine Science.

SCDNR provided age and length data on 745 Spanish mackerel collected during 1986 – 1991 for use in SEDAR 17. Because only 2% of the fish in the NMFS data set were collected in South Carolina, the LHG agreed it was important to include as much of the SCDNR data as possible in the assessment. Although no reader comparison data between the SCDNR and NMFS labs were available, size at age plots were compared at the workshop and the results suggested the two groups aged fish similarly. The SCDNR data, however, only included annulus counts, not ages which could link a given fish with the correct year class (i.e., ages were not advanced for fish collected at the beginning of the calendar year before they had formed or completed forming a new annulus for the year). There were marginal increment measurements for some fish, but not all, and there was no way to ascertain if the measurement represented a large, small, or intermediate increment. Based on the marginal increment patterns observed in the much larger NMFS age data set, the LHG agreed the age of all SCDNR fish collected January – March would be calculated as the annulus count + one; for all fish collected July – December, age would equal the annulus count, i.e., they would not be advanced; and those collected April – June (the months when most fish complete annulus formation) would be excluded because there was no way to confidently

determine if the age should be advanced. Deleting the April-June collections left 596 observations, which were merged with the Panama City NMFS data set. Table 2.14.1 presents annual sample sizes of Spanish mackerel age data by state, and within Florida, by subregion.

Two other studies examined the age and growth in Spanish mackerel, one in North Carolina (Noble 1992) and the other in Chesapeake Bay (Gaichas 1997), but the raw data were not available to the LHG. The group did decide to utilize the maximum age from the Noble (1992) study for estimating M.

Recommendations for the AW:

1) Use the combined Panama City NMFS and SCDNR data set for ageing the catch.

2. 6 Growth

Issues discussed by the LHG regarding growth included whether to calculate unweighted or weighted von Bertalanffy curves, whether to constrain t_0, and whether to use sex-specific growth curves.

A comparison of the weighted versus the unweighted von Bertalanffy growth curves (Figure 2.15.5) showed very little difference in the two, so the consensus of the group was to use the unweighted.

Growth in Spanish mackerel, as it is in king mackerel *S. cavalla* (DeVries and Grimes 1997), is clearly sexually dimorphic, with females averaging larger than males at age and reaching larger maximum sizes (Figure 2.15.6) (Noble 1992, Schmidt et al. 1993). The group agreed that whenever possible and appropriate, sex-specific curves should be used in the assessment.

A comparison of growth parameters derived from fishery independent, fishery dependent commercial, and fishery dependent recreational samples showed some obvious differences, likely reflecting different selectivities in each (Figure 2.15.7). Not surprisingly, recreational samples tended to be larger at age, especially among the older ages.

There was considerable discussion within the group and during plenary sessions regarding the von Bertalanffy parameter t_0 – how the lack of small, young fish in the age/length data set results in more negative values, whether it is appropriate to constrain the parameter to 0 or -1, whether the purpose of the von Bertalanffy parameters is to describe the growth of the fish in the samples or the true growth of the population, and the effects changing t_0 can have on the strongly and negatively correlated K and L_∞ . The consensus of the workshop participants at the plenary session was that small, age 0 Spanish mackerel collected in the SEAMAP trawl survey should be incorporated in the age/length data base and used to calculate von Bertalanffy parameters, and that this would better anchor the curve and eliminate the need to constrain t_0. There was general agreement that given the clear modes in the seasonal length frequency data (Figure 2.15.8), age 0 individuals could be readily, confidently identified.

Because the SCDNR SEAMAP trawl survey Spanish mackerel data set contained almost 27,000 observations, only a random subsample of 250 assumed age 0 fish was incorporated in the age/length data set. Age 0 modal groups were most easily discerned in the spring and summer cruise length frequency distributions (Fig. 2.15.8), so random subsamples of 50

individuals 3-12 cm FL from the spring collections and 200 fish 3-26 cm FL from the summer cruises were drawn in proportion to the distribution of their sizes (Figure 2.15.9).

Von Bertalanffy parameters were estimated using nonlinear least squares regression, specifically, SAS's NLIN procedure (Marquardt method). Starting parameter values used for the overall and by sex estimates were $t_0 = -0.5$, K = 0.5563, and $L_\infty = 515$; while those used for the estimates by sample source (fishery independent, fishery dependent recreational, and fishery dependent commercial) were $t_0 = -0.5$, K = 0.4, and $L_\infty = 1000$. The unweighted von Bertalanffy parameters and 95% confidence limits (overall, by sex, and by source) are given in Table 2.14.2. The age 0 fish from the SEAMAP survey were included in the data sets used to calculate both the male and female parameters, as there was no way to assign sex to those observations, and sex-specific growth at that size and age is likely to be insignificant if it exists at all.

Recommendations for the AW:

1) Unweighted von Bertalanffy parameters should be used to model growth.

2) Represent growth in the Spanish mackerel population by sex where possible.

2. 7 Reproduction

The dataset from Schmidt et al. (1993), a life history study conducted by MARMAP, represents the most recent age-based information on the reproductive biology of Spanish mackerel along the Atlantic coast of the southeastern United States. These specimens were collected from 1983-1992, primarily with trawls (n = 1077; 94% fishery-independent) and gillnets (n = 507; 84% fishery-dependent; Table 14.2.3). Eighty-one percent of the trawl-caught specimens were collected by the SEAMAP program at S. Carolina Dept. of Natural Resources. Information below on spawning seasonality, sexual maturity, and sex ratio is based on the most accurate technique (histology) utilized to assess reproductive condition in fishes. Spanish mackerel do not change sex during their lifetime (gonochorism).

2.7.1. Spawning Seasonality

The spawning season of Spanish mackerel is progressively longer from north to south, primarily due to water temperature. In lower Chesapeake Bay, Cooksey (1996) found partially spent, gravid, and running ripe females from June through August. Off the Carolinas and Georgia, females spawn from May through August (Finucane and Collins 1986; Schmidt et al. 1993), perhaps as late as September based on the presence of larvae (Collins and Stender 1987). Off the Atlantic coast of Florida, spawning females have been collected during April through September (Beaumariage 1970; Powell 1975; Finucane and Collins 1986), and as late as October in some years (Klima 1959).

The gonadosomatic index of females is at a maximum during June in the lower Chesapeake (Cooksey 1996) and off southeast Florida (Finucane and Collins 1986).

Spawning appears to take place on the inner continental shelf, as females with "maturing" (hydrated) oocytes have been collected with gillnets near inlets and shoals along Florida's east coast (Powell 1975) and ripe females have been collected at depths of ca. 9 m from

Onslow Bay (North Carolina) through Georgia (Schmidt et al. 1993). The spatial distribution of Spanish mackerel larvae also indicates that spawning takes place on the inner shelf (Collins and Stender 1987).

2.7.2. Sexual Maturity

Maturity ogives in tabular format are available in the Data Workshop summary spreadsheet. This dataset was provided by MARMAP and represents a minor update of the data in Tables 3 and 4 in Schmidt et al. (1993); the numbers of females and males were increased by 32 and 20, respectively. The smallest mature male was 209 mm FL and the youngest was age 0; the size at 50% maturity was 239 mm FL (Logistic; 95% CI = 232-245). All males were mature at 351-375 mm FL and age 1. The smallest mature female was 288 mm FL, and the youngest was age 0; the size at 50% maturity was 353 mm FL (Normal; 95% CI = 349-358). All females were mature by 451-475 mm FL and age 2. Age at 50% maturity for females was 0.54 yr (Normal; 95% CI = 0.45-0.64) (Figure 2.15.10). No estimate of A_{50} could be calculated for males owing to the low number of immature specimens. Mature gonads were present in 85% of the males at age 0, and 100% at ages $\geq$1.

These results are in general agreement with other studies of sexual maturation. Using a histological method, Powell (1975) found vitellogenic and/or mature oocytes in >50% (vs. 94% in MARMAP data) of age-1 female Spanish mackerel sampled in Florida (Atlantic and Gulf coasts) during April through September. This percentage is conservative given that mature females may not be reproductively active throughout the entire spawning season; some may have become reproductively inactive (resting state). Klima (1959), using a macroscopic method, reported that females and males mature at ages 1-2; however, Powell (1975) concluded that the age data of Klima (1959) should be reduced by one year.

2.7.3. Sex ratio

The presence of strong sexual dimorphism in Spanish mackerel (females larger than males at ages 1-5; see Powell 1975; Fable et al. 1987; Schmidt et al. 1993) may result in skewed adult sex ratios when data are analyzed by gear type. In the MARMAP dataset, the percentage of females in samples from a 75 ft falcon trawl without a turtle excluder device was 28 % (n = 396) versus 62% (n = 373) in samples collected with gillnets. Each gear type exhibits evidence of size selectivity, the trawl for smaller specimens (mean FL=318 mm; predominantly males at FL $\leq$375 mm) and gillnets for larger specimens (mean FL=443 mm; predominantly females at FL >400 mm). The low percentage of females in the trawl data reflects the faster growth rate of females vs. males at younger ages and the resulting later sexual maturation of females (3% mature at age 0 vs. 85% for males). A highly skewed sex ratio (80% female, immature included) was also noted by Klima (1959) in recreational hook-and-line catches off southeast Florida. Klima speculated that the high percentage of females reflects their more aggressive feeding behavior, not the lack of males in the areas fished. A similar high percentage of females was noted in gillnet (67%; n = 495) samples of the MARMAP dataset if immature specimens were included.

In the MARMAP dataset, the subsample of specimens from gillnet samples that was assigned an age also revealed an adult sex ratio skewed toward females. The percentage of females in the subsample was 64% (n = 280), similar to the 62% value overall (specimens aged and

specimens not aged), but the percentage by age class was noticeably lower at age 0, the result of only 3% of females being mature at age 0 (Fig. 2.15.11). At the youngest ages represented by 100% maturity (ages 2-4), the percentage of females ranged from 64-73%. The percentage dropped to 38-50% at ages 5-7, but sample sizes were small (<40 per age class). Similar trends were noted in samples collected with trawls, even though the sample size was small (n = 77).

2.7.4. Spawning Frequency

No estimate of spawning frequency is available. Cooksey (1996) attempted to collect specimens over a 24-h period to determine the age of postovulatory follicles (POFs), but too few specimens were collected. She suggested that "almost-daily spawns" may be possible, as fresh POFs were observed in ovaries in which final oocyte maturation had begun.

2.7.5. Batch Fecundity

Batch fecundity (BF) vs. fork length (FL) and ovary-free weight (SW) were estimated for narrow ranges of length and weight by Cooksey (1996), but no estimate of batch fecundity vs. age is available.

BF = 610.17*FL – 159,198 (n = 13, r^2 = 0.59, FL = 335-439 mm)
BF = 160.33*SW – 8211 (n = 13, r^2 = 0.69, SW = 336-845 g)

Recommendations for the AW:

1) Consider using age-based sex ratio data in the model, given the uncertainty of the overall sex ratio in the population (consensus of the data workshop panel during plenary session 5/23/08).

2. 8 Movements and Migrations

The following is quoted from section 3.1 of the Atlantic States Marine Fisheries Commission's fishery management plan for Spanish mackerel (Mercer et al. 1990): "Spanish mackerel make seasonal migrations along the Atlantic coast and appear to be much more abundant in Florida during the winter. They move northward each spring to occur off the Carolinas by April or May, off Chesapeake Bay by May or June, and some years, as far north as Narragansett Bay by July (Berrien and Finan 1977)." In a tagging study in North Carolina, 1986-1990, by the NC Division of Marine Fisheries, fish were recaptured as far south as Sebastian Inlet, FL and as far north as the York River in Virginia (Noble 1992). The few fish recaptured in Florida were caught in winter and spring, confirming a southern movement during the fall, while those recaptured in Virginia were caught in summer and fall, supporting a northerly movement during that time of year (Phalen 1989, Noble 1992).

Recommendations for the AW:

None

2. 9 Meristics and Conversion Factors

Equations to make length-length and weight-length conversions were determined using the simple linear regression model and the power function, respectively (Tables 2.14.4 and 2.14.5). All weights are shown in grams and all lengths in millimeters. Coefficients of determination (r^2) ranged from 0.952 to 0.998 for these linear (length) and nonlinear (weight) regressions.

Recommendations for the AW:

1) Use the equations based on combined sources.

2.10 Adequacy of Data for Assessment Analyses

Included in individual sections above

2.11 Life History Research Recommendations

1) Ages provided for future assessments should be advanced when appropriate (i.e., during months when annuli are being formed) so fish can be assigned to the correct year class. If advanced ages cannot be provided, data should include assessment of otolith edge type. Classification schemes for edge type and quality of the otolith/section have been developed by the MARMAP program at SCDNR and are currently used by MARMAP and NMFS Beaufort.

2) Conduct inter-lab comparisons of age readings from test sets of otoliths in preparation for any future stock assessments.

3) Obtain adequate data to determine gutted to whole weight relationships.

4) Investigate the discard mortality of Spanish mackerel in the commercial and recreational trolling fishery, commercial gillnet fishery, and the shrimp trawl fishery.

6) To ensure more accurate estimates of t_0, increase efforts to collect age 0 specimens for use in estimating von Bertalanffy (VB) growth parameters.

2.12 Tasks for Completion following Data Workshop (Itemize and include completion dates and responsible parties.)

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2.14 Tables

Table 2.14.1. Annual numbers of Spanish mackerel from the Atlantic, 1986-2007, by state, and within Florida, by sub-region, aged by NMFS Panama City and SC DNR and included in final SEDAR 17 dataset. NEF = northeast Florida, EF = east Florida, SEF = southeast Florida, SF = south Florida.

Year	MA	VA	NC	SC	GA	NEF	EF	SEF	SF	Total
1986				26						
1987			67	50	59		104			258
1988			91	221	25		6			184
1989			7	185	171					208
1990	21		412	234	72		42			575
1991	40		328	39	210		60			649
1992	37		553	93	36		85			804
1993			268	31			164			463
1994			182				22			204
1995			171				165			336
1996			114				450			564
1997			403				280			683
1998			418				331			749
1999			273				459			732
2000		104	458				468			1,030
2001			485				315			800
2002		853	333			2	395			1,583
2003			318				328			646
2004			280				512	2		794
(blank)										
2005			285				413			698
2006			277				496	4		777
2007			295				368	4	1	668
Total	98	957	6018	879	573	2	5463	10	1	14001
% of Total	0.70	6.84	42.98	6.28	4.09	0.01	39.02	0.07	0.01	100

Table 2.14.2. Unweighted von Bertalanffy parameters for Spanish mackerel (Atlantic stock). Age 0 fish from the SEAMAP survey were used to estimate both the male and female parameters. Lengths (Lmax) are in millimeters fork length.

	N			Std. Error	Lower 95% CL	Upper 95% CL
All	14015	Lmax	606.6	3.7209	599.4	613.9
		K	0.3289	0.00735	0.3145	0.3433
		T_0	-1.6677	0.036	-1.7383	-1.5971
Males	5806	Lmax	520.5	3.1043	514.4	526.6
		K	0.4727	0.0123	0.4487	0.4967
		T_0	-1.2308	0.035	-1.2994	-1.1623
Females	8519	Lmax	628.7	4.165	620.5	636.8
		K	0.3599	0.00839	0.3434	0.3763
		T_0	-1.355	0.0325	-1.4186	-1.2913
FI includes age0 unk	790	Lmax	493	7.2415	478.8	507.2
		K	1.121	0.0626	0.9981	1.2439
		T_0	-0.3835	0.0227	-0.428	-0.339
FD Comm	8867	Lmax	597.8	5.0365	587.9	607.7
		K	0.3096	0.0104	0.2893	0.33
		T_0	-2.0329	0.0645	-2.1594	-1.9064
FD Rec	4068	Lmax	864.5	29.79	806.1	922.9
		K	0.129	0.00961	0.1102	0.1479
		T_0	-3.0332	0.1273	-3.2828	-2.7836

Table 2.14.3. Number of specimens of Spanish mackerel from Schmidt et al. (1993) for which sex and reproductive state were assessed histologically. Specimens were collected during 1983-92. HnL = hook and line

	Source		
Gear	**Fishery-dependent**	**Fishery-independent**	**Total**
Trawl	58	1012	1070
Gillnet	425	77	502
HnL	127	3	130
Stopnet		11	11
Trammel net		1	1
Unknown	104	9	113
Total	714	1113	1827

Table 2.14.4. Simple linear regressions (y = ax + b) to convert lengths of Spanish mackerel. **MARMAP** = Marine Resources Monitoring Assessment and Prediction Program at S.C. Dept. of Natural Resources, Charleston, SC; **SA** = South Atlantic headboat data from National Marine Fisheries Service. **State FL** = Florida.

Data Source	Dep. Variable	Ind. Variable	a	b	r^2	n	a SE	b SE	Ind. Range	Units
SA Headboat & State FL	TL	FL	1.0805	33.4862	0.9898	875	0.0037	1.7507	200-780	mm
	FL	TL	0.916	-25.9812	0.9898	875	0.0032	1.707	263-882	mm
	TL	SL	1.1116	43.0491	0.9888	128	0.0106	4.3925	212-730	mm
	FL	SL	1.0378	12.766	0.9907	142	0.0085	3.5645	212-730	mm
	SL	FL	0.9546	-8.3722	0.9907	142	0.0078	3.5011	232-767	mm
MARMAP	TL	FL	1.193	-1.873	0.9984	5009	0.0007	0.1752	47-730	mm
	FL	TL	0.8369	1.944	0.9984	5009	0.0005	0.1467	50-850	mm
	TL	SL	1.3222	-2.9617	0.9956	776	0.0032	0.6672	73-475	mm
	FL	SL	1.086	1.5427	0.9979	785	0.0018	0.3705	73-475	mm
	SL	FL	0.9186	-1.004	0.9979	785	0.0015	0.3426	82-513	mm
Combined	TL	FL	1.1574	5.2853	0.9969	5884	0.0008	0.2516	47-780	mm
	FL	TL	0.8614	-3.7294	0.9969	5884	0.0006	0.2197	50-882	mm
	TL	SL	1.1913	21.5975	0.9910	904	0.0038	0.9465	73-730	mm
	FL	SL	1.0569	7.0274	0.9979	927	0.0016	0.407	73-730	mm
	SL	FL	0.9441	-6.139	0.9979	927	0.0014	0.3936	82-767	mm

Table 2.14.5. Power function (Weight = a*(length)^b) to convert length of Spanish mackerel to weight. **MARMAP** = Marine Resources Monitoring Assessment and Prediction Program at S.C. Dept. of Natural Resources, Charleston, SC; **Panama City** = data from various sources provided by Panama City lab of National Marine Fisheries Service; **SA** = South Atlantic headboat data from National Marine Fisheries Service. **State FL** = Florida.

Data Source	Dep. Variable	Ind. Variable	a	b	r^2	n	Len SE	Wt SE	Length Range	Units
SA Headboat & State FL	Whole Weight	FL	1.935 e-5	2.869	0.9276	871	3.690 e-6	2.989 e-2	200-780	mm g
	Whole Weight	TL	4.851 e-6	3.0262	0.9156	880	1.093 e-6	3.432 e-2	263-882	mm g
Panama City (TIP, MRFSS, NCDMF, RECFIN)	Whole Weight	FL	1.305 e-5	2.9352	0.8992	2603	1.539 e-6	1.860 e-2	145-810	mm g
MARMAP	Whole Weight	FL	1.353 e-5	2.928	0.9835	4947	3.334 e-7	2.750 e-3	47-730	mm g
	Whole Weight	TL	3.590 e-6	3.061	0.9844	4853	1.414 e-7	6.210 e-3	50-850	mm g
Combined	Whole Weight	FL	1.523 e-5	2.909	0.9515	8421	8.176 e-7	8.517 e-3	47-810	mm g
	Whole Weight	TL	2.753 e-6	3.11	0.9657	5734	1.756 e-7	9.797 e-3	50-882	mm g

2.15 Figures

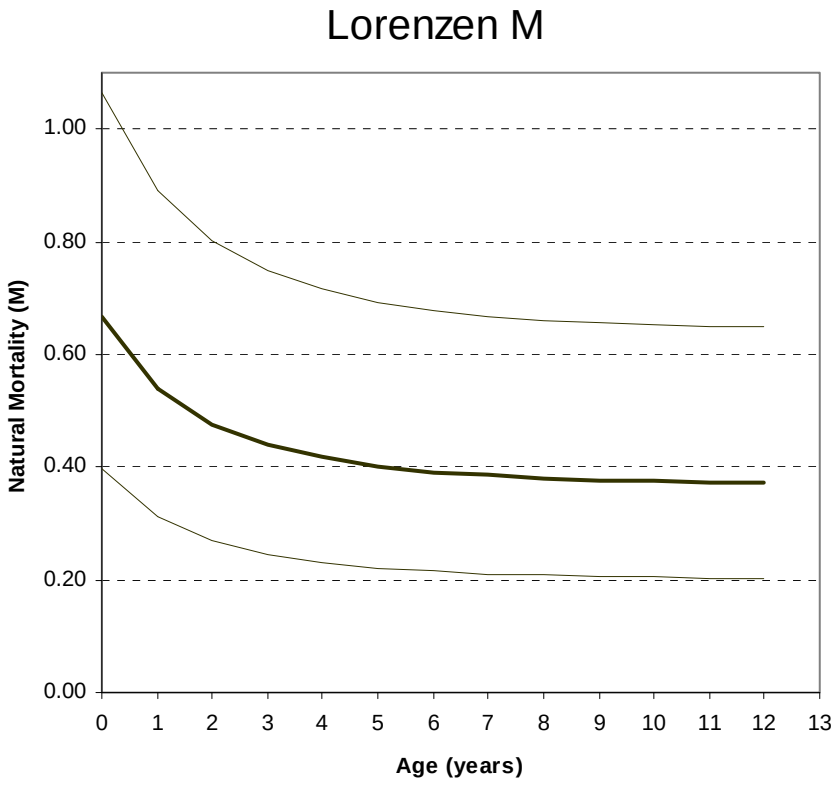

Figure 2.15.1. Unscaled age-varying instantaneous natural mortality (M) for Atlantic stock Spanish mackerel using the Lorenzen approach (Lorenzen 1996).

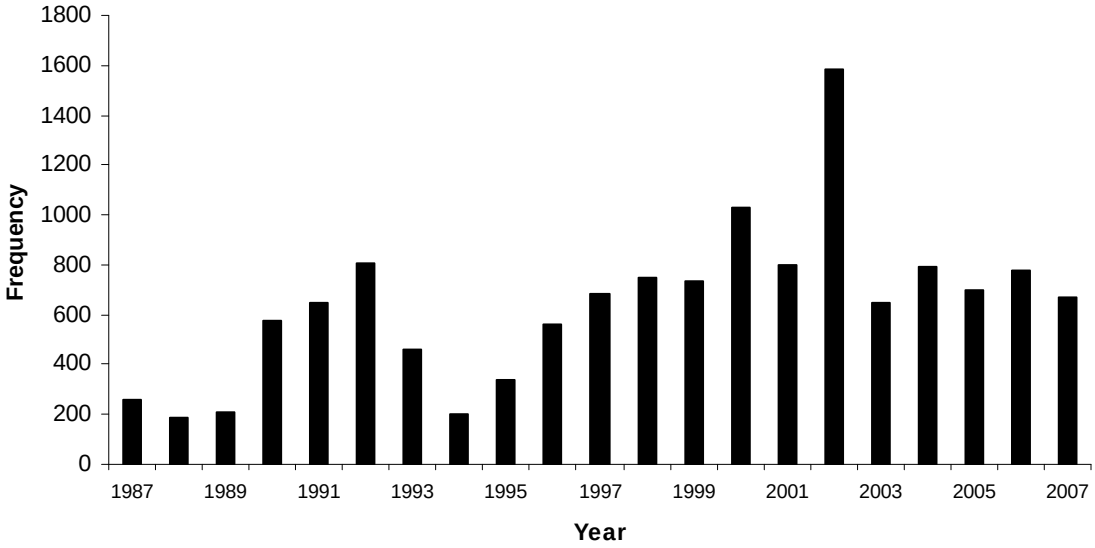

Figure 2.15.2. Annual numbers of Spanish mackerel (Atlantic stock) aged by the Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service, 1987-2007.

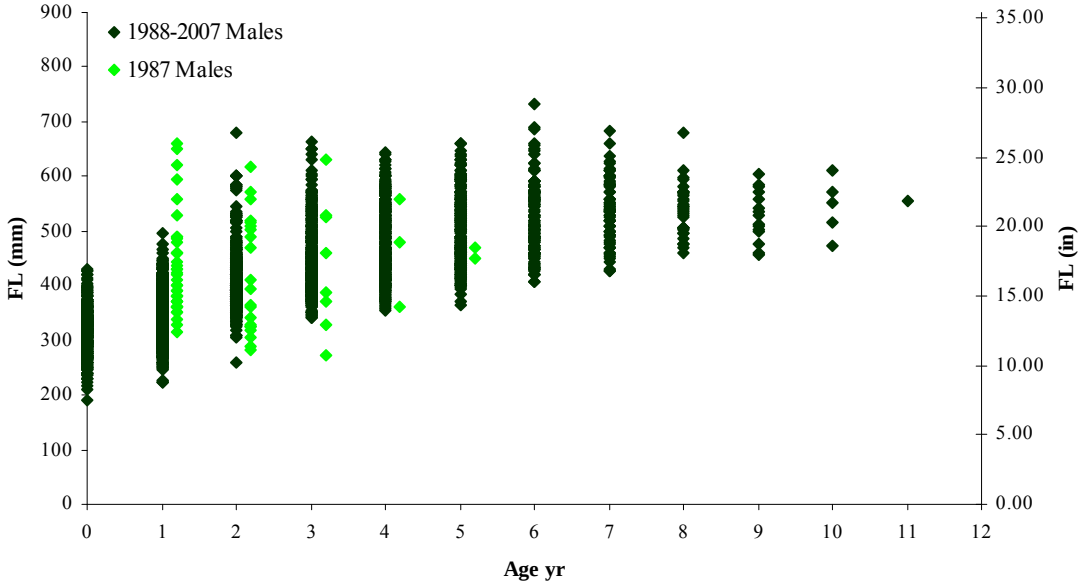

Figure 2.15.3. Length at age distributions of 1987 and 1988-2007 male Spanish mackerel from Atlantic waters aged by NMFS Panama City.

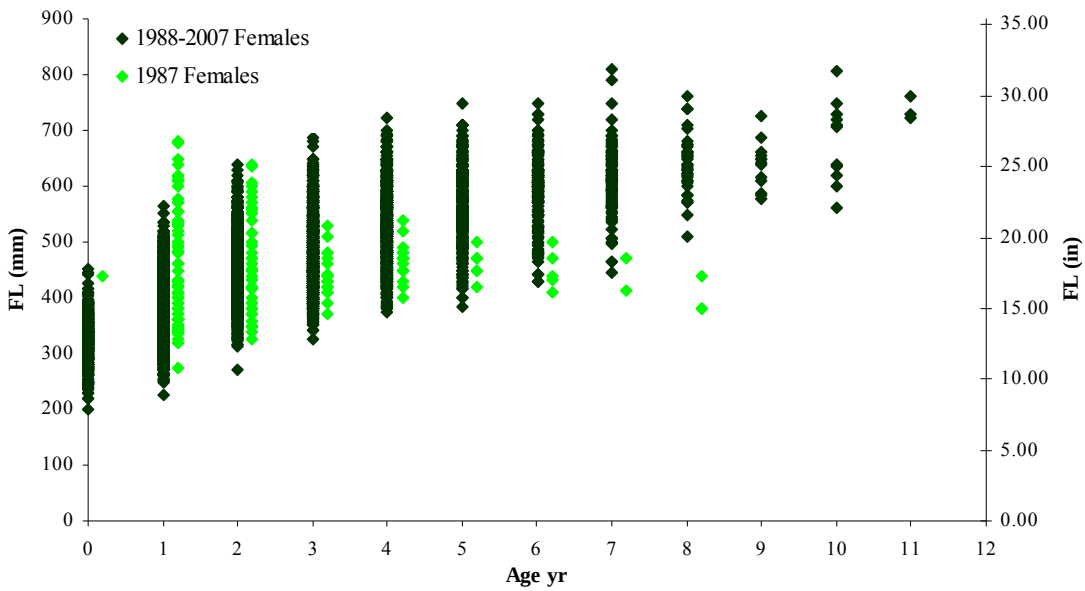

Figure 2.15.4. Length at age distributions of 1987 and 1988-2007 female Spanish mackerel from Atlantic waters aged by NMFS Panama City.

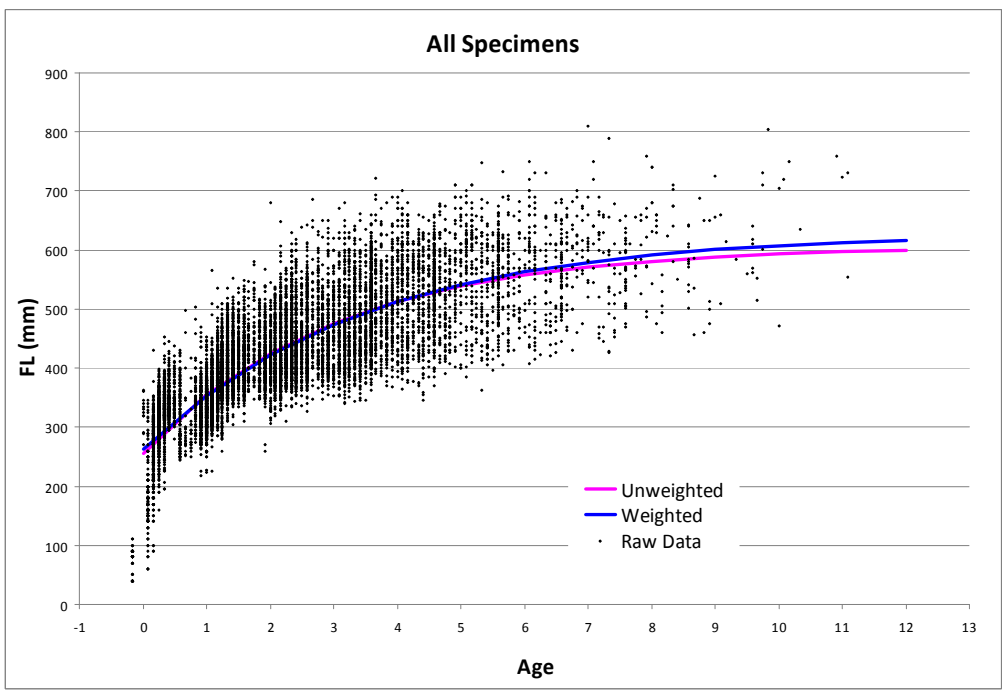

Figure 2.15.5. Overall weighted and unweighted von Bertalanffy growth curves and raw data from 1986-2007 for Atlantic stock Spanish mackerel.

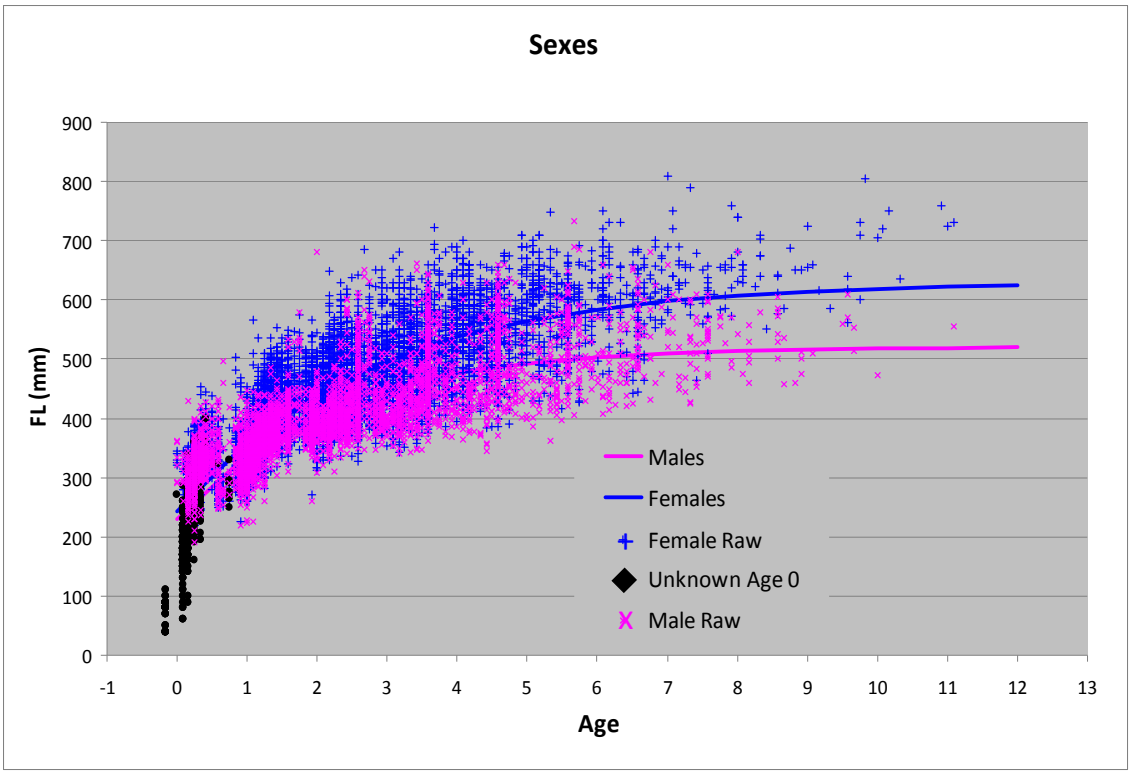

Figure 2.15.6. Unweighted von Bertalanffy growth curves and raw data from 1986-2007 for Atlantic stock Spanish mackerel by sex.

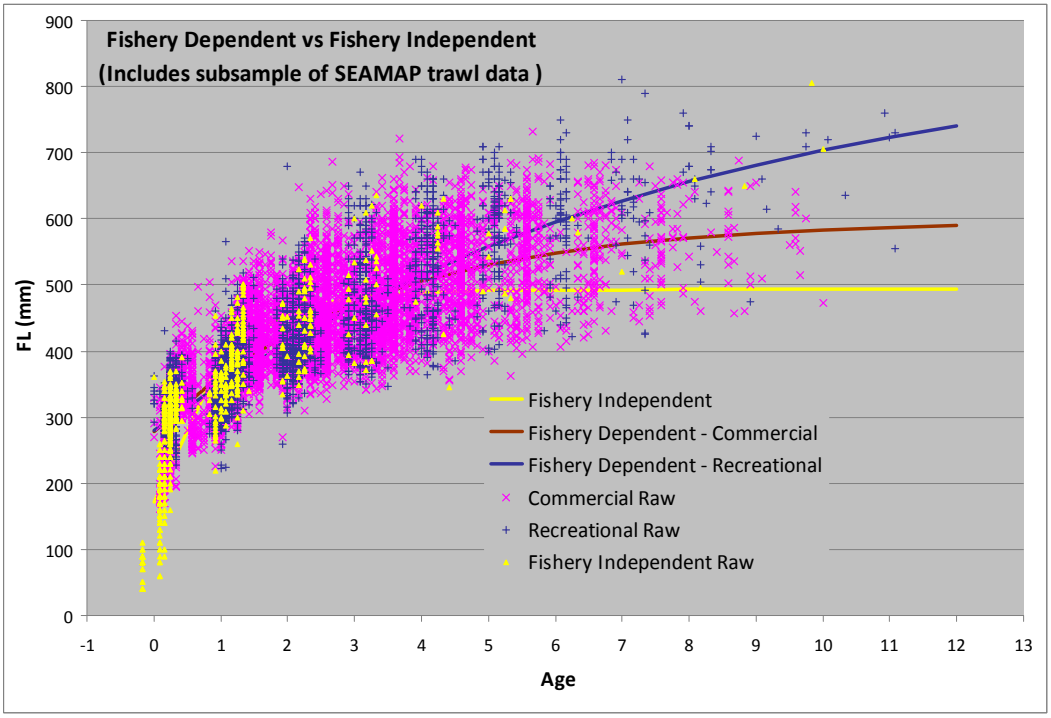

Figure 2.15.7. Von Bertalanffy growth curves and raw data for Atlantic stock Spanish mackerel from fishery independent, fishery dependent commercial, and fishery dependent recreational samples.

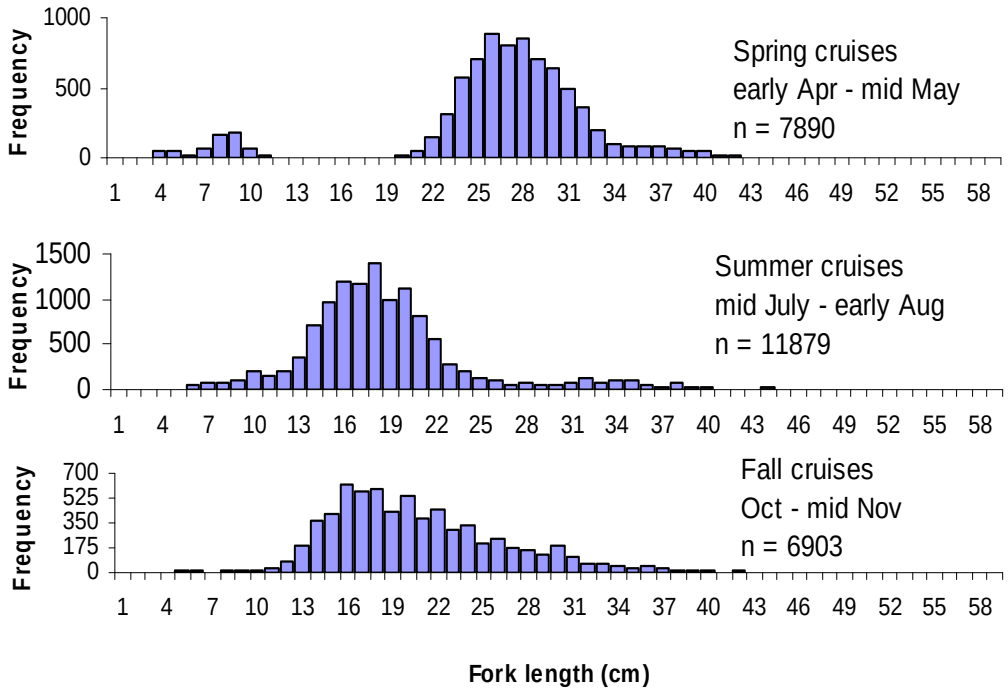

Figure 2.15.8. Size distributions of Spanish mackerel in SEAMAP trawl surveys, 1989-2007.

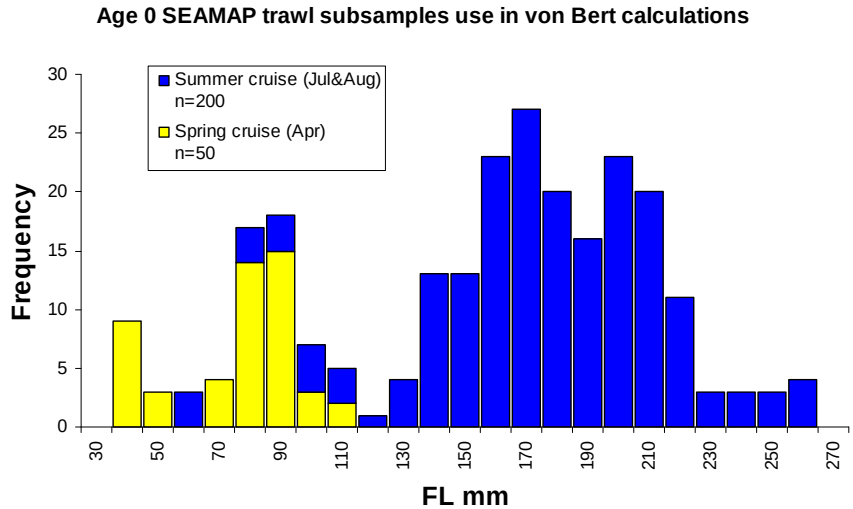

Figure 2.15.9. Size distribution of assumed age 0 Spanish mackerel subsampled from SEAMAP trawl data included in calculations of von Bertalanffy parameters.

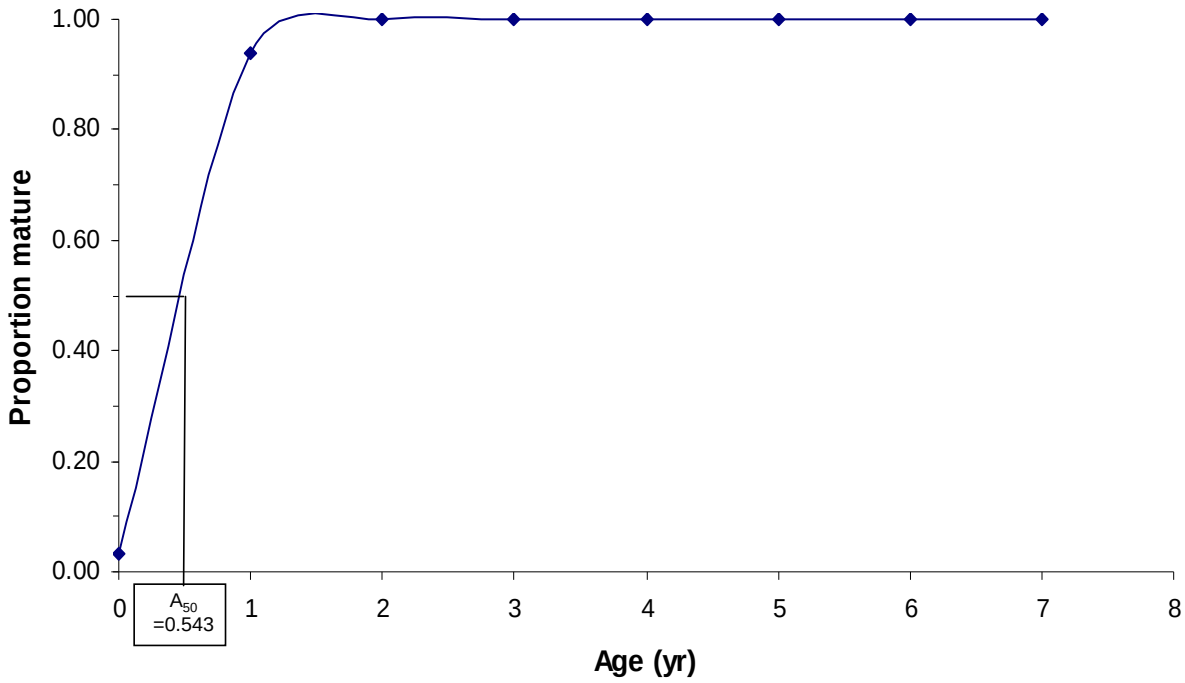

Figure 2.15.10. Proportions of mature female Spanish mackerel at age. A_{50} = age at 50% maturity. Data from Schmidt et al. (1993) plus 32 additional observations from subsequent MARMAP collections.

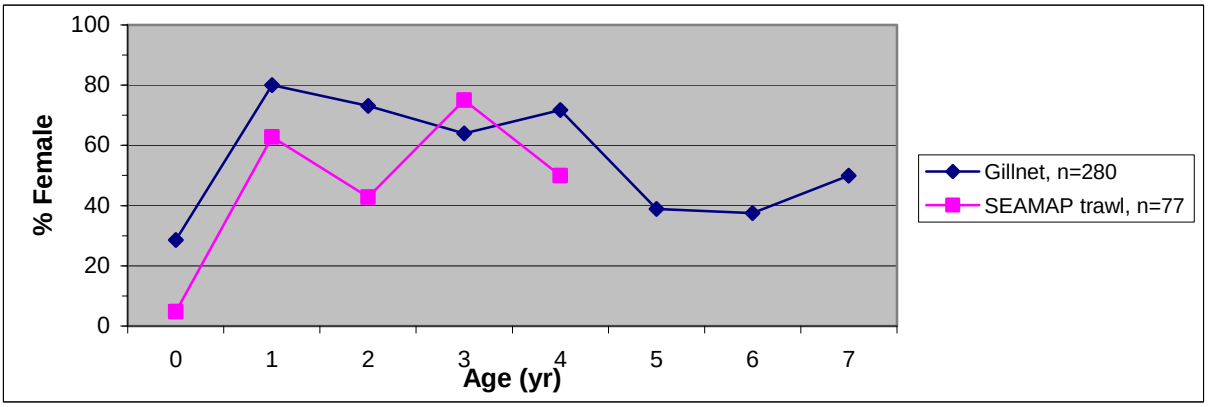

Figure 2.15.11. Percentage of adult female Spanish mackerel by age class in samples caught with gillnets and trawls (SEAMAP-SA program at S.C. Dept. of Natural Resources). Dataset is from life history study conducted by MARMAP.

3 Commercial Fishery

Chair: Douglas Vaughan (NMFS Beaufort); Rapporteur: Kate Andrews (NMFS Panama City); Members: Alan Bianchi (NC DMF), Jack Holland (NC DMF), Robert Wiggers (SC DNR), Julie Califf (GA DNR), Steve Brown (FL FWI), Dave Gloeckner (NMFS Beaufort), Kevin McCarthy (NMFS Miami), and Ben Hartig (FL Commercial Fisherman).

3.1 Overview

Historical commercial landings data for Spanish mackerel were explored to address several issues. These issues included: (1) geographic stock boundaries, (2) historical perspective of landings data (duration of data for stock assessment), (3) grouping of commercial gears for pooling landings, (4) mis-identification of species or need to expand unclassified mackerel landings (this species category does not exist), (5) final presentation of landings by gear in pounds (whole weight) and in numbers based on state and federal data, (6) estimates of discards in numbers from commercial logbooks and from shrimp trawls, (7) length and age compositions sampled from commercial fisheries, and (8) research needs.

3.2 Commercial Landings

3.2.1 NMFS Website for Commercial Landings

The NMFS website for commercial landings:

http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html

was queried for all Spanish mackerel landings along the Atlantic coast by state. This query produced annual landings by state and gear from 1950-2006 for Florida (east coast) to Maine. Commercial landings data from the NMFS website were split for Florida into the Florida East Coast (Atlantic) and Florida West Coast (Gulf of Mexico) based on county landed. Landings from the Atlantic coast counties from Dade and north were considered as Atlantic Florida.

Additionally, we queried the Standard Atlantic Fisheries Information System (SAFIS, Internet based data entry system developed by the ACCSP) for commercial landings of Spanish mackerel for Virginia and north. Estimates by month and state were obtained for 1980-2007. This latter data was used to replace data downloaded from the NMFS website for those states and years.

Decision 1. Because Spanish mackerel landings were reported as far north as Maine, the Workgroup recommended using commercial landings from along the entire US Atlantic coast to represent landings from the Atlantic Spanish mackerel stock.

Commercial landings data from the northern states (Virginia through Maine) were summarized by gear, to determine which gears are most important for landing Spanish mackerel from this region. Pound nets were found to be most important (69% of landings by weight), followed by gillnets (22.6%), and smaller amounts by haul seines (3.3%), trawls (3.0%) and other gears (2.3%).

Coastwide landings by state and gear for Spanish mackerel were reported consistently back to 1950 on the NMFS Website. These data prior to the ALS (1962) were believed to be valid, although with greater uncertainty associated with them. An expansion factor for Virginia and north was calculated by comparing landings for GA-NC to VA north for 1950-1969 (from the downloaded NMFS website data). Data gaps of varying duration occur prior to 1950, and minimal data is available prior to 1927. Also, landings were only reported for Florida (Atlantic) and North Carolina, and none for Georgia and South Carolina (presumed zero). No historical landings were available for Virginia and north prior to 1950.

Prior to 1950, landings were only reported for Florida (Atlantic) and North Carolina, and none for Georgia and South Carolina (presumed zero). No historical landings were available for Virginia and north prior to 1950. Because of differences in the seasonal distributional of commercial landings in Florida (Atlantic) and North Carolina, linear interpolations for missing years were applied separately by state. The workgroup then discussed application of an approach similar to that applied to red snapper (SEDAR 15) to develop historical landings for 1900-1949, and results are provided in this report for consideration by the Assessment Workshop. As with the red snapper assessment (SEDAR 15), the committee notes that historical data is reported fairly consistently back to 1927, with major gaps for World War II (1941-44) and post World War II (1946-1949). During SEDAR 15 (red snapper) discussions, it was suggested that the landings for 1941-44 were zero, but that a linear interpolation should be applied for 1946-49, using landings reported for 1945 and 1950. Other missing years occurred in 1933 and 1935, which were replaced with the average of the preceding and following years. Although there were occasional landings reported prior to 1927, these were few and far between (1923, 1918, 1908, 1902, and 1897). The approach chosen to fill in these early years was again similar to that applied to red snapper (SEDAR 15). For the years from 1901-1926, landings were linearly interpolated between assumed landings of zero in 1900, and the mean landings for 1927-29 used for “1927”.

Decision 2. With reasonably consistent data back to 1950, the Workgroup recommended that estimates of commercial landings be extended back to 1950.

3.2.2 **Accumulated Landings System (ALS)**

Historical commercial landings (1962 to present) for the US South Atlantic are maintained in the Accumulated Landings System (ALS) at the SEFSC. For detailed description of the Accumulated Landing System (ALS), see addendum to this section. These data were made available by Josh Bennett (NMFS Miami), and include landings

from North Carolina through the Gulf of Mexico. The boundary of the Atlantic stock with the Gulf of Mexico stock is defined [Amendment 2 to the Coastal Migratory Pelagic Resources (Mackerels) FMP] as "*The Dade/Monroe county line (25° 20.4' N. latitude in south Florida is to be the migratory group boundary for Spanish mackerel. Commercial fishery landings … have historically included Monroe County landings with the Gulf. There are few commercial landings of Dade and Palm Beach Counties and few ports available north of Marathon in Monroe County. Thus, there is a broad area of low catch on either side of this line which will facilitate enforcement.*" Rationale given in Amendment 2 was: "*While the stock identification for Spanish mackerel is not well defined, there is some evidence of Gulf and South Atlantic subpopulations with a mixing zone off south Florida, Williams, Murphy, and Muller (1985). The Councils' Stock Assessment Panel basing its recommendation on evidence from the electrophoresis studies, distributional patterns, spawning areas, and the history of exploitation suggested the Dade/Monroe County, Florida boundary as being a practical boundary because both recreational and commercial catch data for the Gulf and Atlantic have used this boundary. Dade County is the Miami area; while Monroe County includes the Florida Keys.*" This demarcation was implemented in the ALS database by using only landings, rather than catches, associated with the Atlantic coast of Florida (i.e., ALSSTATE = 10). 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).

Decision 3. The Workgroup recommends using the southern boundary in Amendment 2 to the Coastal Pelagics (Mackerels) FMP.

Florida's commercial fishery dominates the Atlantic coastal stock of Spanish mackerel, with 77.3% of the landings for the recent period 1997-2006 (their landings represented even higher percentages historically). The remaining south Atlantic states (Georgia-North Carolina) accounted for 17.4% (same time period), and more northern states (Virginia-Maine) accounted for the remaining 5.4%

The ALS database was then used to determine the importance of the different commercial gears to the Spanish mackerel landings from the US south Atlantic (Florida-North Carolina) for 1962-2007. About 88% of Florida's commercial landings were by gillnets (mostly gear code 475, "Runaround Drift Gillnets"), with lesser amounts from handlines (5.2%) and more recently castnets (6.8%). This latter category (code 735) shows up starting in 1995, with landings similar, or even exceeding, gillnets since 2003. This gear was apparently in response to Florida's net ban. For Georgia – North Carolina (mostly North Carolina), gillnets (dominated by gear 425, "Other Gillnets" – typically fixed or anchored) representing over 74% of the landings from this region, with significant landings by pound nets (11.4%), haul seines (8.2%), and handlines (4.3%).

Set gill net vs. runaround gillnet: When combining gear, it was suggested that we should not combine runaround gill net with set gill net as the selectivity may differ. We looked at the mean size of Spanish mackerel caught in each gear and found that set gill net had a mean length of 44 cm FL (SD = 8 cm FL), while runaround gill net had a mean

length of 45 cm FL (SD = 7 cm FL). These lengths are not considered different and it was decided to combine the set gill net lengths with runaround gill net lengths (Figure 3.3).

Decision 4. The Workgroup recommends that landings by fishing gear be reduced to four categories, gillnets, castnets, pound nets and handlines. The small percentage from miscellaneous other gears can be pooled with gillnets.

Because Atlantic Spanish mackerel management currently prescribes a fishing year from March 1 through February 28 [Amendment 15 to the Coastal Pelagic (Mackerel) FMP], the ALS database was used to investigate landings by month for the US South Atlantic. We considered monthly landings separately from Florida (monthly data available since 1977) and from the other southern states (Georgia-North Carolina; monthly data available since 1972) using the ALS database. Data for the northern states downloaded from the SAFIS were available by month since 1980.

Florida's commercial fishery is prosecuted primarily during the winter months, with few Spanish mackerel landed between May and September (Figure 3.4). Hence landings for Florida will be adjusted from calendar to fishing year. Data is available for Florida by month in the ALS since 1977. But with no monthly data prior to 1977, adjustments will be based on an average proportion caught in Jan-Feb versus Mar-Dec from subsequent years when monthly data is available (i.e., 1977-1985).

The fisheries to the north, both Georgia-North Carolina and Virginia-Maine, are prosecuted principally during the summer and early fall, with only trivial landings made during January and February (Figures 3.5 and 3.6). Although any adjustment in landings to fishing year from calendar year would be minuscule, such adjustments were made for Georgia-North Carolina based on monthly data from 1972-1980, and for Virginia and north from 1980-2007. For clarification, t*he fishing year runs from March 1 through the end of February the following year, but the fishing year denoted in this report refers to that portion of the year that includes March – December. For example, the fishing year running from March 1, 2005 through February 28, 2006, is denoted as fishing year 2005.*

Decision 5. The Workgroup recommended that commercial landings be aligned to the current fishing year definition, principally affecting landings from Atlantic Florida; and that fishing year runs from March 1 through February 28.

Although Spanish mackerel were landed in gutted form historically, they are now typically landed whole. It is also important to avoid confusion between reporting some landings in whole weight (typically recreational) and other landings in gutted weight (typically commercial). For Spanish mackerel, there appears to be no reason to report landings in gutted weight.

Decision 6. The Workgroup recommended reporting commercial landings in whole weight.

There was discussion about whether small king mackerel are mis-identified as Spanish mackerel, and vice versa. This was not thought to be an issue. The recent king mackerel assessment made a similar judgment in SEDAR 16 data workshop. There does not exist a landings category for unclassified mackerels. Further, Spanish mackerels have been identified as such historically back to the 1800s.

Decision 7. The Workgroup recommended no adjustments be made for either mis-identification or unclassified mackerels.

3.2.3 Commercial Landings Developed from State Databases

Commercial landings in whole weight were developed based on classified Spanish mackerel by the Working Group from each state by gear for fishing years 1950-2007 from state-specific data as augmented by NMFS data described above. Landings from 1962 up to the beginning of state specific landings were obtained from the ALS described above or from the NMFS website/SAFIS for Virginia and north. The NMFS website data was used for landings back to 1950.

Florida – Edited data from 1986-2007 were extracted and summarized by fishing year (March-February), county landed, gear, and fishery (species groups associated with Spanish mackerel trips) with whole pounds, gutted pounds, and number of trips from the Florida trip ticket database. Gears selected for summary were gill nets, cast nets, lines (rod & reel, long line, and electric reel combined) and other. Since gear was not on the trip ticket until late 1991, to fill in for missing gears from 1986-1991, we assigned gear to trips based on gears listed on the commercial fishers' annual license application. A hierarchy of these gear types, based on usage in later years, was used in combination with species composition on the trips to assign the most appropriate gear. Data were then summarized by fishing year and gear for Florida south Atlantic waters from Nassau to Miami-Dade counties from 1985-86 through 2007-08. It was decided that south Atlantic harvest could be adequately calculated using the Florida trip ticket data. In addition, to better estimate harvest from March-December of 1985 (since 1986 is the first official year for trip tickets), and January-February of 2008 (incomplete data), data for all years from 1985-2008 were summarized by each fishing year period (March-December and January-February). An average proportion for each period will then be applied to the appropriate periods from 1985 and 2008 to complete the landings. Finally, size/market data by fishing year were supplied to estimate length by size/market category from the biostatistical (TIP) data.

Georgia – Georgia had no reported Spanish mackerel landings for 1989 – 2007 fishing years.

South Carolina – South Carolina commercial landings data were reported by coastal dealers starting in 1972 through mandatory monthly landings reports required from all SC licensed wholesale dealers. These reports were summaries which collected species, pounds landed, catch disposition (gutted or whole), ex-vessel price and area

fished. In September 2003, South Carolina began collecting trip level information through mandatory trip tickets, which captures detailed effort information along with fisherman and vessel identifiers. The majority of commercial landings for Spanish mackerel are reported in whole weight, and in cases where they were reported as gutted weight, a conversion factor of 0.9 was used to determine whole weight. Landings were separated out by gear (hand lines, pound nets, gill nets and other) and by fishing year (1 March thru February 29). Spanish mackerel landings, as reported through monthly SC dealer summaries and trip tickets were documented starting in 1972. Overall, annual commercial landings are minimal, and the majority of landings can be attributed to bycatch from shrimp trawls and have been documented in the "Other" gear type category.

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. Annual landings of Spanish Mackerel were calculated for the SEDAR 17 Data Workshop for North Carolina. The annual landings are reported by fishing year, which runs from March to February. Data used to calculate the landings for North Carolina include the North Carolina Trip Ticket Program (1994 to 2008), landings from the ALS (1962 to 1993), and landings from historical data (prior to 1961). Prior to 1972, monthly landings were not recorded for North Carolina. Therefore, the proportion of landings of Spanish Mackerel from March to December and January to February by gear type were calculated across the years of 1972 to 2008. These proportions were then applied to the data that runs from 1950 to 1971 by gear type to determine the landings of Spanish Mackerel by fishing season.

Coastwide Landings in Pounds Commercial landings in pounds (whole weight) are summarized by region (Table 3.1 and Figure 3.7) and gear (Table 3.2 and Figure 3.8). Landings provided by the states were used preferentially to ALS (and in most cases was identical). As noted earlier based on the ALS data, landings are predominantly from Florida, followed by Georgia-North Carolina (mostly North Carolina), and Virginia-Maine. The dominant gear was gillnets, in turn dominated by runaround gillnets in Florida. Both gillnets and poundnets were important in North Carolina and further north. Handlines contribute landings up and down the coast (although mostly in Florida), while castnets have become very important in Florida since about 1995. Other than some peak landings in the latter half of the 1970s and early 1980s, Spanish mackerel commercial

landings have been relatively flat, averaging 3.9 million pounds (whole weight) between 1950 and 2007. This average declines to about 3.4 million pounds, by excluding the peak years 1975-1982.

Combined Landings in Numbers – Conversion of commercial landings in weight to numbers is based on mean weights obtained from TIP length sampling by state (as augmented by additional data provided by NC DMF, particularly for pound nets), gear and year. First sampled lengths are converted to weight using the weight length relation given in the Life History Section. When TIP length samples were inadequate (N<20) or non-existent, a weighted average of available weight was obtained by averaging across years, either prior to 1986 or 1986 and later (Table 3.3). The 1986 was selected because of the implementation of a minimum size limit the previous August 1985. Landings in numbers are summarized by region (Table 3.4 and Figure 3.9) and by gear (Table 3.5 and Figure 3.10). Where there were insufficient or no samples available prior to 1986, average weight from post-1986 was used.

Uncertainty in Commercial Landings - The Workgroup discussed the uncertainty that may be associated with the estimates of commercial landings. In past assessments this discussion was framed about coefficients of variation (CV = standard deviation/mean) and how CVs may have varied over time. The CV was thought to have been high in the early years prior to the start of the ALS in 1962. Meanwhile, the CV was thought to be relatively low in recent years, subsequent to North Carolina's trip ticket program in 1994. During the discussion, it was suggested that further improvements were associated with the transfer of responsibility for collection and processing to the SEFSC in 1978 and beginning of state-federal co-operation. Between the late 1970s and 1994, a series of improvements occurred, such as the Florida trip ticket in 1985/1986. Hence, a low CV of 10% was chosen for the recent period (1994-present), high CV of 40% for pre-ALS data, 30% for the early years of the ALS, and a linear interpolation from 30% to 10% form 1978-1994 (Figure 3.11). The Workgroup suggests that these CVs may serve as the basis for developing alternate landings streams for sensitivity model runs.

3.3. Commercial Price

Price per pound was estimated for Spanish mackerel sold in the South Atlantic states from the ALS database (Atlantic Florida – North Carolina) for the years 1962 through 2007. The Producer Price Index (PPI) for "*prepared fresh fish and other seafood*" was obtained from the U.S. Bureau of Labor Statistics website (data.bls.gov), and this index is available starting in 1965. The PPI, like the CPI, is an index that reflects inflation. But the difference here is that the PPI reflects the inflation in costs associated with bringing the product to market. In other words, this PPI reflects more closely the change in costs to fishermen and processors such as trip costs. Using the initial year available (1965) as base year (divide annual index value by the 1965 index value), observed price per pound was adjusted to obtain inflation-adjusted values for the price per pound. Unadjusted and adjusted price per pound are compared in Figures 3.12. The observed price the fishermen received noted a general upwards trend from approximately $0.10 on average in 1965 to

$0.82 per pound in 2007. These values were adjusted by dividing them by the PPI index, such that PPI-adjusted values ranges from $0.10 in 1965 to $0.06 in 2007. Over time, the PPI-adjusted values initially declined to a minimum of about $0.04 in 1987 and then increased gradually since then.

3.4. Commercial Discards

3.4.1 Discards in the Commercial Fishery from Logbooks

The report titled '***Discards of Spanish Mackerel and Vermilion Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic***' was prepared by Kevin McCarthy (**SEDAR 17-DW10**). A brief summary of the results and discussion for Spanish mackerel follows:

Calculated total discards for each year are provided in Table 3.6 for Spanish mackerel discarded from gillnet, handline and trolling vessels, respectively. Prior to 1998, vessels landing Spanish mackerel were not required to report to the coastal logbook program and the level of reporting and, therefore, effort was unknown. Discards of Spanish mackerel could not be reliably calculated for the years prior to 1998. Because landings by trolling are included in the landing category 'handline', discard estimates of handline and trolling are combined.

Relatively few Spanish mackerel were reported as discarded. For handline and trolling gear, fewer than 2,300 fish were discarded each year. Less than 14,000 Spanish mackerel were discarded annually from the gillnet fishery. Often the number of discards of the species was less than 10,000. The number of trips upon which the calculations were based, however, was very small. These results should be interpreted with caution.

A high percentage of Spanish mackerel were reported as "dead" or "kept" when released regardless of the gear used. The reason reported for discarding Spanish mackerel was most often given as "market conditions" for gillnet trips (95% of individuals) and trolling trips (73%). Regulations were cited in 47% of handline Spanish mackerel discards with another 39% discarded without a reason reported.

The number of trips reporting either Spanish mackerel in the US south Atlantic was very low and the number of individuals of those species reported as discarded was also low. Stratification of the available data was limited because of the small sample sizes and, therefore, likely does not capture much of the variation in numbers of discards within the Spanish mackerel fisheries. How that may affect the number of calculated discards (over or under estimate) is unknown.

The Commercial Workgroup discussed whether these discard estimates could be further extended back in time, possibly based on the average discard to landings ratios in numbers from 1998-2007 as applied to corresponding gillnet and handline landings back to 1986. With Amendment 1 to the Coastal Migratory Pelagic Resources (Mackerels) FMP, a 12" FL (or 14" TL) minimum size limit was implemented in August 1985. Prior

to this date, regulatory discarding was unlikely. The average discard to landings ratio was 0.6% for gillnets during 1998-2007 and 1.1% for handlines/trolling for the same time period. These ratios were applied to gillnet and handline landings for Florida – North Carolina for 1986-1997 to obtain estimates of discards from gillnets and handlines for 1986-1997, and are available for consideration by the Assessment Workshop Panel (Figure 3.13 and 3.14). Although uncertainty (as CV) is large for the estimates obtained from the logbooks back to 1998, the uncertainty associated with this additional extrapolation would likely be even larger.

Decision 8. The Workgroup accepted these estimates of Spanish mackerel discards from the gillnet and handline/trolling fisheries for 1998-2007, and offer an extension back to 1986 for use in sensitivity model runs.

3.4.2 Discards from the Shrimp Trawl Fishery

The report titled '***Estimation of Spanish mackerel and vermilion snapper bycatch in the shrimp trawl fishery in the US South Atlantic***' was prepared by Kate I. Andrews (**SEDAR 17-DW12**). A brief summary of the results and discussion for Spanish mackerel follows:

Estimates of Spanish mackerel bycatch in the shrimp trawl fishery was requested for the current SEDAR. Observer data are available, but sparse for the SA region. Effort data are available from representatives of each state (FL, GA, SC, and NC) and from the South Atlantic Shrimping System (SAS). The observer data were fit using a delta GLM model with a lognormal distribution. The resulting index was then scaled to an estimate of the number of fish caught using the average number of nets (from the observer data) and the effort in the SA.

There were historical data available (1972-1997) but there were so few occurrences of Spanish mackerel that the model threw those years out due to the lack of a model constraint (at least two positive tows in one year). The year 1980 had an inordinately large amount of Spanish mackerel caught that year in observed tows (19,000+), but the other years were incredibly small or non-existent. In fact the model threw out all years except 1979-1981 and 1984. The model then produced output too variable to create estimates, so the historical data bore no further investigation. There is no apparent pattern to where the Spanish mackerel were observed. Although there were not two positive tows in 2005 it is unlikely there were no Spanish mackerel caught in the shrimp fishery, but the model was unable to estimate a value for that year. The lognormal model performed better than the gamma model based on AIC scores, so the lognormal model is presented here. Interactions were considered, but no significant interactions were observed. The resulting index and estimates run from 1998-2006, with a missing year at 2005). The expanded estimates are provided for each state by year in the SA (Table 3.7).

Decision 9. The Workgroup considered these estimates of Spanish mackerel bycatch in the US South Atlantic shrimp trawl fishery for 1998-2004 and 2006, and recommended these estimates be carried forward.

3.5 Biological Sampling

3.5.1 Length Distributions

Length samples have been collected by the Trip Interview Program (TIP) and several state agencies since 1980. These samples are collected by port agents at docks where commercial catches are landed throughout the US South Atlantic coasts. Trips are randomly sampled to obtain trip, effort, catch and length frequency information. Occasionally there has been quota sampling to obtain age structures on fish that are rare in the catch (extremely large and small fish). These non-random samples are identified in the data to allow removal from analyses where non-random samples are not appropriate.

Sample data was obtained from the TIP sample data (NMFS/SEFSC), which is a data set from commercial, recreational and research programs. This data was merged with sample data from the inshore Spanish mackerel samples from NCDMF not contained in the data loaded to TIP. The combined dataset was censored to only include commercial samples identified as having no sampling bias, and where year, gear, and state could be assigned (Table 3.8).

Sample data were joined with landings data by year, gear and state. Landings data were also limited to those data that could be assigned a year, gear, and state. Landings and sample data were assigned a state based on landing and sample location.

Years were changed to fishing year by placing January and February in the previous year. Length data were converted to cm fork length and binned by one centimeter group with a floor of 0.5 cm and a ceiling of 0.4 cm. Length was converted to weight (whole weight in kg) using conversions provided by the life history group. The length data and landings data were broken into to two areas FL and NC-GA and five gears; castnet, gillnet, handline, poundnet and others. Length compositions were weighted by expanding the number of lengths in each strata (gear, area, year) by the landings in numbers (relative frequency in stratum x landings in numbers for the stratum).

Market category comparison: It was suggested that we use market category to obtain size trends in landings data. To accomplish this task we would need to allocate landings by size based on market grade. Market grade does vary between states.

Landings are available to varying degrees by market grade for Spanish mackerel for 1994-2007 (Figure 3.19). No landings were from Georgia, only a small amount of landings were from South Carolina and not by market grade, and landings from Virginia and north were not available by market grade. North Carolina landings were available mostly by market grade (about 10% were in the mixed category). Similarly, Florida landings were mostly be market grade (about 9% were 'mixed' or no information provided). Overall, about 62% of Spanish mackerel landings were available by market grade (generally small, medium and large).

However, of the 145,611 length samples obtained for Spanish mackerel, only 28,883 had a market category assigned. It was felt that having only 20% of the samples with market category was inadequate to allocate landings at size by market category.

3.5.2 Age Distributions

A review of the aging data for Spanish mackerel can be found in SEDAR 17 DW07, prepared by Chris Palmer, Doug DeVries, Carrie Fioramonti, and Linda Lombardi-Carlson. Sample size of Spanish mackerel ages from commercial landings in the US Atlantic are summarized by gear for fishing years1986-2007 (Table 3.9). A total of 8,868 aged Spanish mackerel are available for developing age compositions. Age compositions were developed for gillnets (Figure 3.20), castnets (Figure 3.21), handline (Figure 3.22), poundnets (Figure 3.23), and other (Figure 3.24) gear types. Age compositions are plotted for sample size 19 or greater. Weighting was initially by state landings in numbers, and then by length composition as shown in Figures 3.14 -3.18, respectively. This latter weighting is intended to correct for a potential sampling bias of age samples relative to length samples (see Section 3 in SEDAR10 for South Atlantic gag grouper).

3.5.3 Adequacy for characterizing lengths and ages

A total of 145,611 Spanish mackerel lengths were available for use in developing annual length compositions by gear (Table 3.8). Over half of these samples (74,286 fish lengths) were from gillnets collected primarily since 1984 (with the exception of 15 collected in 1982). Of these gillnet fish samples, 83% were collected in Atlantic Florida (compared to 79% of gillnet landings by weight since 1984). The remaining gillnet fish samples (12,514 fish lengths) were from Georgia-North Carolina. Fish samples from castnets, a Florida phenomena in this setting, are only available from Florida and almost entirely since 1996 (13,706 fish lengths, excluding 2 in 1993). Likewise, fish samples from poundnets, no landings from Florida, are only available from Georgia-North Carolina since 1982 (15,518 fish lengths, excluding 9 in 1980). Handline landings are predominantly from Florida (94% by weight), and so are sampled fish lengths (99%). Finally, fish lengths collected from other gears are distributed as 83% from Florida and 17% from Georgia-North Carolina (somewhat reflecting 76% of the landings from Florida). Note that there are no length samples available from Virginia and north (about 7% of the total landings). It is clear from the summary of samples for fish lengths, that there are gear/year combinations for which there may be inadequate samples, even though the overall sample size may appear adequate (Table 3.8). In certain years, post-stratification will be unable to adjust sample weights between Florida and GA-NC. In particular when there were no gillnet samples from GA-NC (1989, 1994, and 1996), or more recently when there were no gillnet samples from Florida (2004 and 2007).

There were two years for which the handline length composition contained a large proportion of fish greater than 70 cm FL, with about 30% in 1994 and over 87% in 1996. The data for these two years were limited to relatively few trips (9 in 1994 and 7 in 1996), and most of the sampled fish came from even fewer trips (2 trips in 1994 and 3

trips in 1996). This situation raises concerns about the representativeness of the handline length compositions for these two years. For other years, the fish lengths were better distributed among many more trips.

A minimum sample size of 20 ages was selected for developing age compositions. The largest sample sizes were associated with gillnets, the dominant gear. Of the 5,443 aged fish from gillnets, 3,847 were from Atlantic Florida, and 1,529 from North Carolina and South Carolina between 1986 and 1990. Ages from Florida gillnets were not available until 1991. All castnet ages were from Florida, while all pound net samples were from North Carolina, as expected. There was a mix of samples for handlines: 759 from Atlantic Florida, 302 from North Carolina and South Carolina. The age composition for handlines in 1990 would be problematic, because all 38 ages were from South Carolina. Less problematic would be that the 130 ages in 1999, 26 ages in 2002, and 25 ages in 2007 are only from Florida. Many of the age samples from "Other" gears were actually from unknown gears (1,052 out of 1,615). In particular, 853 of the 900 aged fish in 2002 were from VIMS (Virginia waters), all from unknown gears.

In general, the Workgroup suggested lumping landings from Other gears with the dominant gear (gillnets), and consequently not using length and age compositions from Other gears.

3.6 Research Recommendations for Spanish mackerel

- Need observer coverage for the fisheries for Spanish mackerel (gillnets, castnets (FL), handlines, poundnets and shrimp trawls for bycatch):
  - 5-10% allocated by strata within states
  - possible to use exemption to bring in everything with no sale
  - get maximum information from fish
- Expand TIP sampling to better cover all statistical strata
  - Predominantly from Florida and by gillnet & castnet gears
  - In that sense, we have decent coverage for lengths
- Trade off with lengths versus ages, need for more ages (i.e., hard parts)
- Need to address issue of fish retained for bait (undersized) or used for food by crew.(how to capture in landings)

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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 are 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
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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
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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 (see below).

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. To make that determination you must consider the area of capture.

Table 3.1. Spanish mackerel commercial landings (pounds whole weight) by region for the US Atlantic coast. Landings for Florida and Georgia – North Carolina are from the state representatives and augmented as needed with the SEFSC Accumulated Landings System (ALS). Landings for Virginia-Maine were downloaded from SAFIS for 1980-2007 and augmented with earlier data downloaded from the NMFS website. These landings are reported by fishing year (March-February), 1950-2007. Years prior to 1962 are all from NMFS website.

Fishing	US Atlantic Coast			
Year	Florida	Georgia-North Carolina	Virginia and North	Total
1950	2,860,384	147,497	13,457	3,021,338
1951	2,630,016	206,288	6,675	2,842,979
1952	3,499,943	174,268	2,801	3,677,013
1953	2,917,579	195,443	3,003	3,116,024
1954	2,610,245	329,463	3,514	2,943,222
1955	3,838,165	165,443	5,769	4,009,377
1956	4,418,105	346,581	16,647	4,781,333
1957	5,603,620	247,795	23,998	5,875,413
1958	5,088,283	216,285	7,970	5,312,538
1959	2,320,648	156,397	19,006	2,496,051
1960	2,674,347	124,500	20,551	2,819,399
1961	2,898,227	137,577	122,515	3,158,319
1962	2,327,143	96,511	15,008	2,438,662
1963	2,056,484	144,194	79,009	2,279,687
1964	2,498,386	81,310	33,461	2,613,157
1965	2,503,598	130,807	75,028	2,709,433
1966	1,971,607	80,787	141,692	2,194,085
1967	3,239,760	76,690	30,290	3,346,741
1968	3,275,934	70,502	60,704	3,407,139
1969	3,029,951	88,601	124,787	3,243,340
1970	3,026,370	63,727	200,657	3,290,754
1971	3,016,425	95,458	51,918	3,163,801
1972	3,277,349	105,992	23,371	3,406,712
1973	2,729,892	73,060	50,145	2,853,098
1974	3,891,305	77,191	26,065	3,994,561
1975	7,598,290	63,113	67,890	7,729,293
1976	11,466,317	36,896	81,618	11,584,832
1977	6,837,374	48,138	21,376	6,906,888
1978	6,253,326	40,670	1,793	6,295,789
1979	6,302,624	16,072	752	6,319,448
1980	6,343,536	82,566	604	6,426,706
1981	2,854,676	52,210	580	2,907,466
1982	6,891,817	191,043	288	7,083,148
1983	3,426,257	42,042	5,673	3,473,972
1984	3,609,012	128,902	103	3,738,017
1985	3,267,688	174,034	222	3,441,944

Table 3.1. (cont.)

1986	2,206,188	239,907	6,499	2,452,594
1987	2,307,282	505,279	68,170	2,880,731
1988	3,141,359	440,100	34,419	3,615,878
1989	2,877,585	590,865	423,607	3,892,057
1990	2,165,531	839,226	599,992	3,604,749
1991	2,982,448	859,224	765,365	4,607,037
1992	2,464,357	740,351	396,152	3,600,860
1993	4,043,268	590,334	412,715	5,046,317
1994	4,461,090	531,718	528,960	5,521,768
1995	1,260,161	402,709	227,732	1,890,602
1996	2,337,557	402,021	312,964	3,052,542
1997	2,108,989	766,931	211,015	3,086,935
1998	2,667,802	373,020	185,980	3,226,802
1999	1,607,051	459,094	339,902	2,406,047
2000	1,766,569	659,455	255,579	2,681,603
2001	2,193,722	653,176	243,680	3,090,578
2002	2,383,029	698,895	153,638	3,235,562
2003	3,158,137	456,938	133,285	3,748,360
2004	2,812,341	455,703	97,379	3,365,423
2005	3,167,532	445,963	59,157	3,672,652
2006	3,156,517	471,671	17,807	3,645,995
2007	2,508,404	487,200	25,141	3,020,745

Table 3.2. Spanish mackerel commercial landings (pounds whole weight) by gear for the US Atlantic coast. Landings for Florida and Georgia – North Carolina are from the state representatives and augmented as needed with the SEFSC Accumulated Landings System (ALS). Landings for Virginia-Maine were downloaded from SAFIS for 1980-2007 and augmented with earlier data downloaded from the NMFS website. These landings are reported by fishing year (March-February), 1950-2007. Years prior to 1962 are all from NMFS website.

Fishing	US Atlantic Coast					
Year	Gillnets	Castnets	Poundnets	Handlines	Other	Total
1950	2,979,370	0	13,457	0	28,512	3,021,338
1951	2,724,806	0	6,377	0	111,797	2,842,979
1952	3,578,614	0	2,601	0	95,797	3,677,013
1953	2,948,994	0	801	0	166,230	3,116,024
1954	2,666,626	0	3,514	0	273,081	2,943,222
1955	3,864,188	0	5,769	0	139,420	4,009,377
1956	4,481,198	0	15,945	0	284,190	4,781,333
1957	5,655,415	0	14,837	5	205,156	5,875,413
1958	5,132,174	0	5,650	9,999	164,715	5,312,538
1959	2,349,243	0	16,505	8,809	121,494	2,496,051
1960	2,694,147	0	20,551	24,997	79,703	2,819,399
1961	2,918,817	0	121,720	19,989	97,794	3,158,319
1962	2,255,134	0	14,083	75,627	93,818	2,438,662
1963	2,014,934	0	65,260	54,283	145,211	2,279,687
1964	2,415,377	0	32,386	103,222	62,171	2,613,157
1965	2,382,907	0	89,718	152,639	84,168	2,709,433
1966	1,854,689	0	111,249	172,538	55,608	2,194,085
1967	3,102,569	0	23,439	142,450	78,283	3,346,741
1968	3,139,402	0	73,217	123,104	71,416	3,407,139
1969	2,914,553	0	84,228	103,006	141,553	3,243,340
1970	2,938,042	0	104,466	127,184	121,062	3,290,754
1971	2,934,262	0	25,622	119,256	84,661	3,163,801
1972	3,181,305	0	22,975	134,127	68,306	3,406,712
1973	2,572,062	0	50,567	161,977	68,492	2,853,098
1974	3,638,193	0	25,477	283,203	47,688	3,994,561
1975	6,979,294	0	61,606	622,997	65,396	7,729,293
1976	10,891,776	0	76,705	581,893	34,457	11,584,832
1977	6,732,009	0	28,847	125,056	20,975	6,906,888
1978	6,239,821	0	2,396	43,874	9,698	6,295,789
1979	6,263,385	0	771	50,288	5,004	6,319,448
1980	6,356,694	0	4,015	49,685	16,312	6,426,706
1981	2,861,488	0	1,711	37,358	6,909	2,907,466
1982	6,969,239	0	10,825	91,009	12,075	7,083,148
1983	3,415,117	0	13,208	30,281	15,366	3,473,972
1984	3,638,444	0	14,270	50,140	35,163	3,738,017
1985	3,137,390	3,109	32,917	58,927	209,601	3,441,944

Table 3.2. (cont.)

1986	1,941,518	229	39,354	55,923	415,570	2,452,594
1987	1,771,923	759	235,061	115,831	757,157	2,880,731
1988	2,495,669	960	182,884	103,615	832,750	3,615,878
1989	2,354,637	8	504,557	141,772	891,083	3,892,057
1990	2,523,552	1,136	509,415	249,717	320,929	3,604,749
1991	3,625,062	319	468,247	285,484	227,925	4,607,037
1992	3,002,580	44	396,725	72,921	128,590	3,600,860
1993	4,585,016	36	328,326	60,917	72,022	5,046,317
1994	5,025,896	26	345,270	69,470	81,106	5,521,768
1995	1,375,791	34,114	207,390	199,656	73,651	1,890,602
1996	2,428,844	197,449	302,190	83,224	40,835	3,052,542
1997	2,659,955	76,470	207,649	92,925	49,937	3,086,935
1998	2,865,977	33,149	117,742	176,293	33,642	3,226,802
1999	1,532,370	345,491	301,805	201,662	24,720	2,406,047
2000	1,541,415	621,875	206,137	278,029	34,148	2,681,603
2001	1,483,788	934,494	221,644	419,494	31,159	3,090,578
2002	1,309,545	1,420,230	135,683	361,930	8,174	3,235,562
2003	943,902	2,270,236	111,397	416,038	6,786	3,748,360
2004	762,143	1,744,518	72,192	760,911	25,660	3,365,423
2005	1,197,040	1,716,393	49,540	697,521	12,157	3,672,652
2006	1,400,442	1,380,341	9,532	838,653	17,027	3,645,995
2007	1,690,573	548,723	13,614	753,181	14,654	3,020,745

Table 3.3. Spanish mackerel mean weights (in pounds, based on lengths from TIP/states and weight-length relation). Shaded numbers represent averages weighted by sample size across years; and where possible averages are separated prior to and including 1985 and 1986 and later. Mean weights for Georgia – North Carolina applied to landings in weights from Virginia and north.

Fishing	Florida				Georgia - North Carolina			
Year	Gillnets	Castnets	Handlines	Other	Gillnets	Poundnets	Handlines	Other
1950	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1951	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1952	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1953	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1954	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1955	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1956	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1957	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1958	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1959	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1960	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1961	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1962	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1963	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1964	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1965	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1966	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1967	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1968	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1969	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1970	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1971	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1972	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1973	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1974	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1975	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1976	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1977	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1978	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1979	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1980	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1981	2.235	2.002	2.487	1.563	3.799	0.626	4.755	1.019
1982	2.235	2.002	2.487	1.563	3.799	0.849	4.755	1.019
1983	2.235	2.002	2.487	1.563	3.799	0.671	4.755	1.019
1984	2.235	2.002	2.487	1.706	2.277	0.690	4.755	1.019
1985	2.235	2.002	2.487	1.495	5.963	0.403	4.755	0.721

Table 3.3. (cont.)

1986	2.057	2.002	2.487	2.209	1.858	0.736	5.470	0.401
1987	2.099	2.002	2.487	2.209	0.767	0.757	6.261	1.479
1988	2.499	2.002	2.487	2.209	1.023	0.782	4.755	1.539
1989	4.728	2.002	2.487	2.209	1.858	0.544	4.755	1.338
1990	3.343	2.002	2.487	2.209	1.662	0.550	5.287	0.996
1991	3.124	2.002	2.062	2.209	2.791	0.666	4.755	0.778
1992	2.870	2.002	3.674	2.877	1.768	0.807	4.755	1.045
1993	2.507	2.002	1.745	2.156	1.647	1.025	4.755	1.224
1994	2.359	2.002	3.605	2.840	1.858	0.664	4.755	0.884
1995	2.671	2.002	1.461	2.209	1.243	1.199	4.755	1.636
1996	1.961	2.002	11.507	2.209	1.858	1.216	4.755	1.424
1997	1.847	1.453	2.863	2.209	1.636	1.119	4.755	1.850
1998	1.653	2.002	2.661	2.209	2.158	1.271	4.755	1.889
1999	2.090	2.002	2.676	2.209	1.916	0.998	4.755	1.371
2000	1.840	2.182	2.121	2.209	1.931	1.408	4.755	1.204
2001	1.330	1.793	2.516	2.209	1.673	1.223	4.755	1.671
2002	1.376	1.887	2.399	2.209	1.687	1.221	4.755	1.532
2003	1.527	2.213	1.941	2.209	2.008	1.314	4.755	1.168
2004	2.410	2.744	3.460	2.044	2.130	1.331	4.755	2.092
2005	1.393	1.648	1.749	2.183	1.847	0.912	4.755	1.942
2006	1.592	2.067	2.460	2.681	2.006	1.290	4.755	1.636
2007	2.410	1.993	2.487	2.167	1.781	0.894	4.755	1.444

Table 3.4. Commercial landings of Spanish mackerel by region in numbers for fishing years, 1950-2007.

Fishing Year	US Atlantic Coast			
	Florida	Georgia-North Carolina	Virginia and North	Total
1950	1,280,054	59,317	21,493	1,360,864
1951	1,176,961	134,423	10,478	1,321,862
1952	1,566,264	114,568	4,351	1,685,183
1953	1,305,649	169,313	3,441	1,478,403
1954	1,168,114	282,955	5,612	1,456,681
1955	1,717,622	143,734	9,214	1,870,569
1956	1,977,151	294,939	26,156	2,298,247
1957	2,507,683	206,065	32,691	2,746,438
1958	2,277,064	173,097	11,301	2,461,462
1959	1,038,516	126,208	28,816	1,193,541
1960	1,196,800	88,722	32,824	1,318,346
1961	1,296,989	104,857	195,186	1,597,032
1962	1,038,231	91,286	23,401	1,152,919
1963	918,006	131,891	117,730	1,167,626
1964	1,114,016	69,292	47,551	1,230,859
1965	1,114,773	112,997	118,841	1,346,611
1966	876,758	36,010	206,894	1,119,662
1967	1,447,426	57,192	43,301	1,547,919
1968	1,465,599	75,332	88,900	1,629,831
1969	1,354,388	84,461	174,224	1,613,073
1970	1,353,194	57,621	221,709	1,632,525
1971	1,351,758	51,794	54,918	1,458,469
1972	1,467,347	52,146	36,500	1,555,993
1973	1,218,183	55,621	78,986	1,352,790
1974	1,731,622	44,107	40,023	1,815,753
1975	3,377,266	50,206	94,093	3,521,565
1976	5,108,216	23,938	122,402	5,254,557
1977	3,054,198	40,088	31,488	3,125,775
1978	2,796,627	18,365	2,343	2,817,335
1979	2,818,996	5,918	1,135	2,826,049
1980	2,837,528	35,668	880	2,874,076
1981	1,277,016	18,409	622	1,296,048
1982	3,083,676	61,845	316	3,145,837
1983	1,533,857	27,220	6,900	1,567,977
1984	1,617,686	69,224	45	1,686,955
1985	1,503,278	128,306	268	1,631,852

Table 3.4. (cont.)

1986	1,057,477	245,987	7,837	1,311,301
1987	1,079,386	558,072	63,267	1,700,725
1988	1,297,161	449,053	33,617	1,779,831
1989	817,821	548,527	676,278	2,042,625
1990	705,345	571,263	918,693	2,195,302
1991	996,308	504,459	758,321	2,259,089
1992	853,577	573,736	358,127	1,785,440
1993	1,622,336	394,580	340,471	2,357,387
1994	1,878,845	331,260	595,311	2,805,415
1995	538,191	321,827	178,081	1,038,099
1996	1,155,316	230,627	242,865	1,628,807
1997	1,135,303	482,378	168,974	1,786,655
1998	1,569,811	181,628	116,222	1,867,661
1999	755,634	263,684	300,786	1,320,104
2000	887,012	347,600	173,916	1,408,528
2001	1,324,771	391,426	186,899	1,903,096
2002	1,340,454	419,373	116,437	1,876,264
2003	1,549,041	229,160	95,043	1,873,244
2004	984,160	214,446	65,138	1,263,743
2005	1,980,069	241,537	58,162	2,279,768
2006	1,596,854	235,966	11,308	1,844,128
2007	1,079,181	274,353	20,861	1,374,394

Table 3.5. Commercial landings of Spanish mackerel by gear in numbers for fishing years 1950-2007.

Fishing Year	US Atlantic Coast					
	Gillnets	Castnets	Poundnets	Handlines	Other	Total
1950	1,311,378	0	21,493	0	27,993	1,360,864
1951	1,201,916	0	10,184	0	109,762	1,321,862
1952	1,586,974	0	4,154	0	94,054	1,685,183
1953	1,313,919	0	1,279	0	163,205	1,478,403
1954	1,182,957	0	5,612	0	268,112	1,456,681
1955	1,724,473	0	9,214	0	136,883	1,870,569
1956	1,993,761	0	25,467	0	279,018	2,298,247
1957	2,521,318	0	23,697	1	201,422	2,746,438
1958	2,288,618	0	9,023	2,103	161,718	2,461,462
1959	1,046,044	0	26,361	1,852	119,284	1,193,541
1960	1,202,013	0	32,824	5,257	78,252	1,318,346
1961	1,302,409	0	194,405	4,203	96,014	1,597,032
1962	1,008,367	0	22,493	30,354	91,705	1,152,919
1963	899,402	0	104,230	21,655	142,339	1,167,626
1964	1,078,844	0	51,726	39,589	60,700	1,230,859
1965	1,063,926	0	143,294	57,426	81,964	1,346,611
1966	826,308	0	177,683	62,019	53,652	1,119,662
1967	1,383,572	0	37,435	57,282	69,630	1,547,919
1968	1,402,505	0	116,938	49,445	60,943	1,629,831
1969	1,303,833	0	134,526	41,210	133,504	1,613,073
1970	1,304,592	0	166,848	49,977	111,108	1,632,525
1971	1,299,569	0	40,922	47,726	70,252	1,458,469
1972	1,410,583	0	36,694	53,571	55,145	1,555,993
1973	1,146,546	0	80,763	65,135	60,346	1,352,790
1974	1,620,008	0	40,691	113,573	41,480	1,815,753
1975	3,117,903	0	98,395	250,238	55,030	3,521,565
1976	4,870,599	0	122,510	233,194	28,254	5,254,557
1977	3,008,951	0	46,074	50,288	20,463	3,125,775
1978	2,786,729	0	3,827	17,548	9,231	2,817,335
1979	2,801,963	0	1,231	18,693	4,162	2,826,049
1980	2,834,589	0	6,413	17,945	15,129	2,874,076
1981	1,275,969	0	2,733	11,046	6,300	1,296,048
1982	3,097,602	0	12,756	25,382	10,097	3,145,837
1983	1,526,007	0	19,672	9,571	12,727	1,567,977
1984	1,627,658	0	20,691	13,636	24,969	1,686,955
1985	1,376,145	1,553	81,675	19,182	153,298	1,631,852

Table 3.5. (cont.)

1986	951,111	114	53,438	17,912	288,726	1,311,301
1987	992,175	379	310,479	32,401	365,290	1,700,725
1988	1,115,912	480	233,826	38,485	391,129	1,779,831
1989	619,448	4	927,325	54,936	440,912	2,042,625
1990	995,111	567	926,846	87,157	185,619	2,195,302
1991	1,195,102	159	703,409	116,157	244,262	2,259,089
1992	1,191,973	22	491,640	19,434	82,369	1,785,440
1993	1,956,146	18	320,241	30,051	50,931	2,357,387
1994	2,207,248	13	519,864	18,927	59,364	2,805,415
1995	668,828	17,042	173,005	135,808	43,415	1,038,099
1996	1,249,382	98,636	248,591	7,677	24,521	1,628,807
1997	1,490,599	52,635	185,636	31,647	26,138	1,786,655
1998	1,675,541	16,560	92,620	65,523	17,417	1,867,661
1999	753,648	172,591	302,434	74,388	17,044	1,320,104
2000	820,460	285,040	146,359	130,155	26,515	1,408,528
2001	1,018,608	521,271	181,256	163,607	18,355	1,903,096
2002	856,995	752,500	111,095	150,412	5,263	1,876,264
2003	543,997	1,025,831	84,785	213,812	4,820	1,873,244
2004	341,694	635,647	54,253	219,741	12,408	1,263,743
2005	780,529	1,041,278	54,299	397,719	5,943	2,279,768
2006	819,370	667,721	7,389	340,346	9,301	1,844,128
2007	772,475	275,374	15,220	302,125	9,199	1,374,394

Table 3.6a. Calculated yearly total discards of Spanish mackerel by gillnet vessels. Discards are reported in number of fish.

Year	Mean Discards per Square Yard Hour Fished	Discard Standard Deviation	Total Effort (net hours)	Calculated Discards
1998	0.000128	0.001248	68,319,392	8,755
1999	0.000128	0.001248	108,069,010	13,849
2000	0.000128	0.001248	78,265,803	10,030
2001	0.000128	0.001248	83,909,664	10,753
2002	0.000128	0.001248	94,771,378	12,145
2003	0.000128	0.001248	66,592,702	8,534
2004	0.000128	0.001248	51,634,828	6,617
2005	0.000128	0.001248	65,057,690	8,337
2006	0.000128	0.001248	55,474,032	7,109
2007	0.000128	0.001248	49,149,096	6,299

Table 3.6b. Calculated yearly total discards of Spanish mackerel by handline vessels. Discards are reported in number of fish.

Year	Mean Discards per Hook Hour	Discard Standard Deviation	Total Effort (Hook Hours)	Calculated Discards
1998	0.001781	0.048638	1,181,706	2,105
1999	0.001781	0.048638	975,510	1,737
2000	0.001781	0.048638	1,028,259	1,831
2001	0.001781	0.048638	1,081,936	1,927
2002	0.001781	0.048638	1,256,812	2,238
2003	0.001781	0.048638	1,111,641	1,980
2004	0.001781	0.048638	769,984	1,371
2005	0.001781	0.048638	720,595	1,283
2006	0.001781	0.048638	828,102	1,475
2007	0.001781	0.048638	878,993	1,565

Table 3.6c. Calculated yearly total discards of Spanish mackerel by trolling vessels. Discards are reported in number of fish.

Year	Mean Discards per Hook Hour	Discard Standard Deviation	Total Effort (Hook Hours)	Calculated Discards
1998	0.001781	0.048638	1,181,706	2,105
1999	0.001781	0.048638	975,510	1,737
2000	0.001781	0.048638	1,028,259	1,831
2001	0.001781	0.048638	1,081,936	1,927
2002	0.001781	0.048638	1,256,812	2,238
2003	0.001781	0.048638	1,111,641	1,980
2004	0.001781	0.048638	769,984	1,371
2005	0.001781	0.048638	720,595	1,283
2006	0.001781	0.048638	828,102	1,475
2007	0.001781	0.048638	878,993	1,565

Table 3.7. The catch index and estimated number of Spanish mackerel bycatch in the SA shrimp trawl fishery by year.

Year	Index	CV	Estimates
1998	0.176	0.461	417111
1999	2.990	0.284	7004988
2000	3.169	0.214	6340696
2001	0.993	0.507	1415705
2002	0.179	0.372	265600
2003	0.2639	0.414	362660
2004	0.110	0.783	129257
2005			
2006	0.100	0.553	115352
2007			

Table 3.8. Spanish mackerel lengths sampled from the commercial fishery and available in the TIP data base for fishing years 1980-2007. Also includes data provided from inshore fisheries by NC DMF.

	Cast Net		Gill Net		Pound Net		Handline		Other	
Year	FL	NC-GA	FL	NC-GA	FL	NC-GA	FL	NC-GA	FL	NC-GA
1980	0	0	0	0	0	9	0	0	0	2
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	15	0	259	0	0	0	7
1983	0	0	0	0	0	42	0	0	0	4
1984	0	0	900	68	0	56	0	11	695	1
1985	0	0	363	26	0	296	4	3	347	29
1986	0	0	1,469	48	0	181	4	20	0	65
1987	0	0	55	125	0	557	0	45	0	46
1988	0	0	1,232	278	0	666	0	0	0	285
1989	0	0	456	0	0	1,194	0	2	0	240
1990	0	0	3,401	84	0	1,189	9	24	0	948
1991	0	0	6,245	23	0	1,583	142	19	41	396
1992	0	0	9,417	516	0	2,206	162	40	52	299
1993	2	0	7,849	96	0	549	184	7	251	314
1994	0	0	7,536	0	0	510	73	0	0	166
1995	0	0	1,100	11	0	1,203	31	0	0	20
1996	50	0	2,951	0	0	531	102	0	0	155
1997	0	0	1,459	73	0	944	98	0	1	56
1998	4	0	6,293	25	0	827	774	1	9	142
1999	50	0	7,159	255	0	1,152	2,878	1	0	261
2000	3,360	0	2,042	1,681	0	133	2,506	1	11	286
2001	3,683	0	891	480	0	283	4,314	0	26	264
2002	1,967	0	341	600	0	438	3,229	1	22	86
2003	1,686	0	432	423	0	64	762	0	959	67
2004	893	0	0	1,089	0	56	225	0	3,473	21
2005	1,381	0	50	2,051	0	243	468	1	1,722	83
2006	577	0	131	2,495	0	143	84	8	6,127	86
2007	55	0	0	2,052	0	213	5	0	7,610	177

Table 3.9. Spanish mackerel ages sampled from the commercial fishery by gear and available from NMFS Panama City for fishing years 1986-2007.

Fishing Year	Gearname					Grand Total
	Gillnet	Castnet	Poundnet	Handline	Other	
1986	2				4	6
1988	72			9	49	130
1989	135			62	2	199
1990	216		6	38	19	279
1991	175			2	134	311
1992	250		28	79	129	486
1993	90			6	85	181
1994	23				16	39
1995	154		20	25	7	206
1996	417	34		41	34	526
1997	246		4	35	38	323
1998	363		50	84	83	580
1999	528	3	23	130	7	691
2000	539	110		93	58	800
2001	452		60	246	20	778
2002	376			26	900	1302
2003	323					323
2004	336	147	2	2	16	503
2005	249	212		5	12	478
2006	315	50		153	2	520
2007	182			25		207
Grand Total	5443	556	193	1061	1615	8868

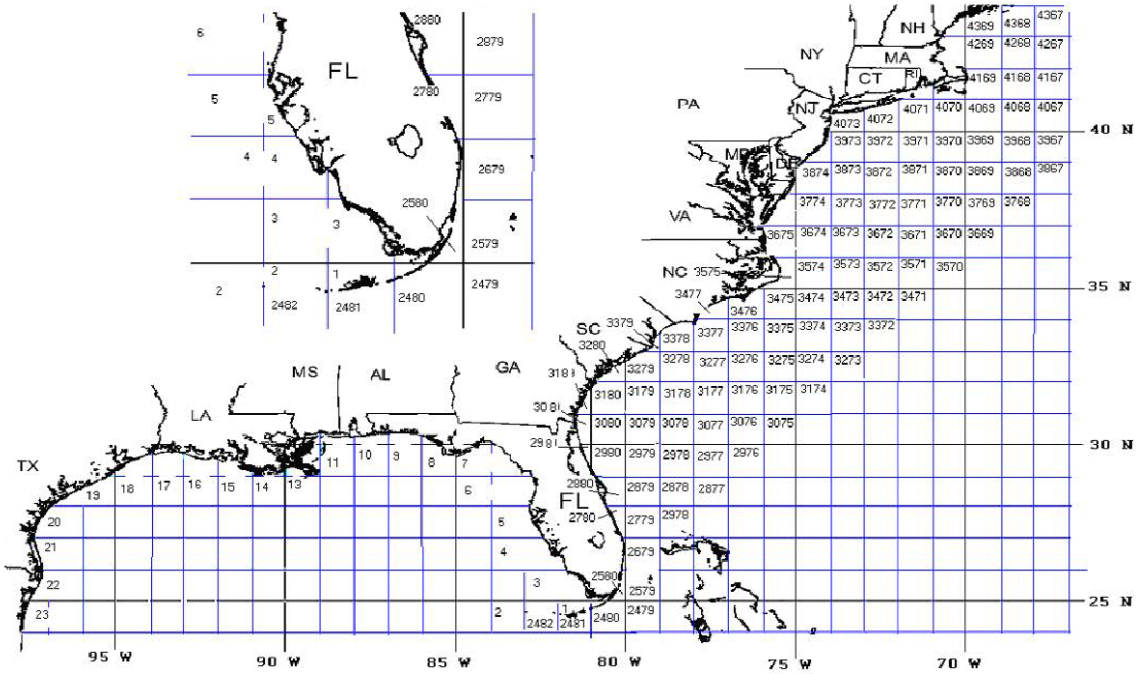


Figure 3.1. Map of U.S. Atlantic and Gulf coast with shrimp area designations.

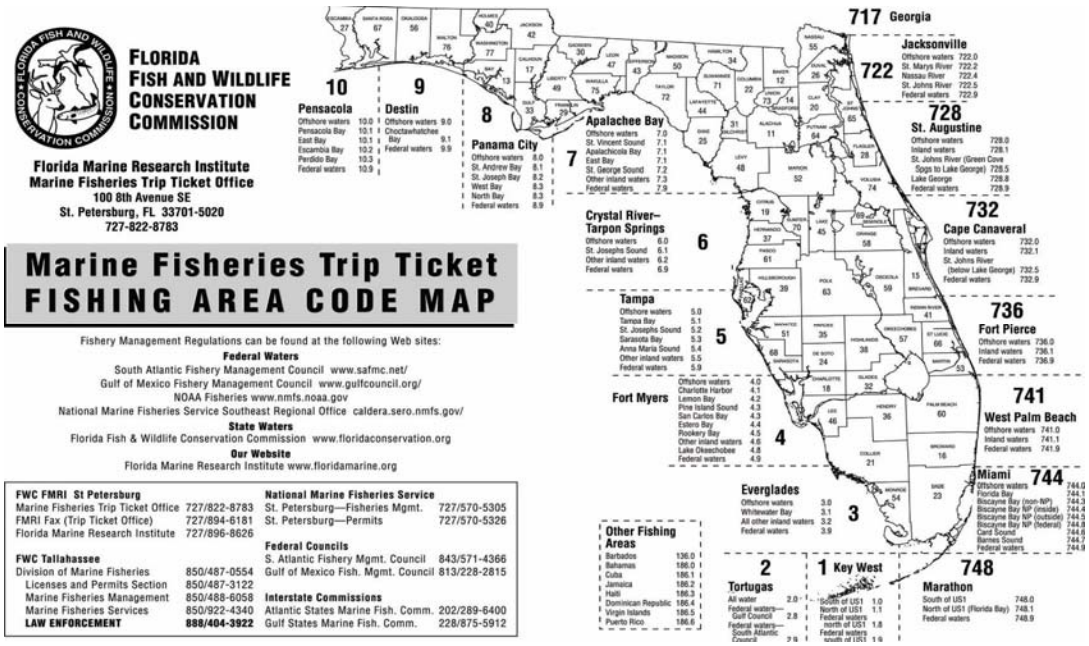


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

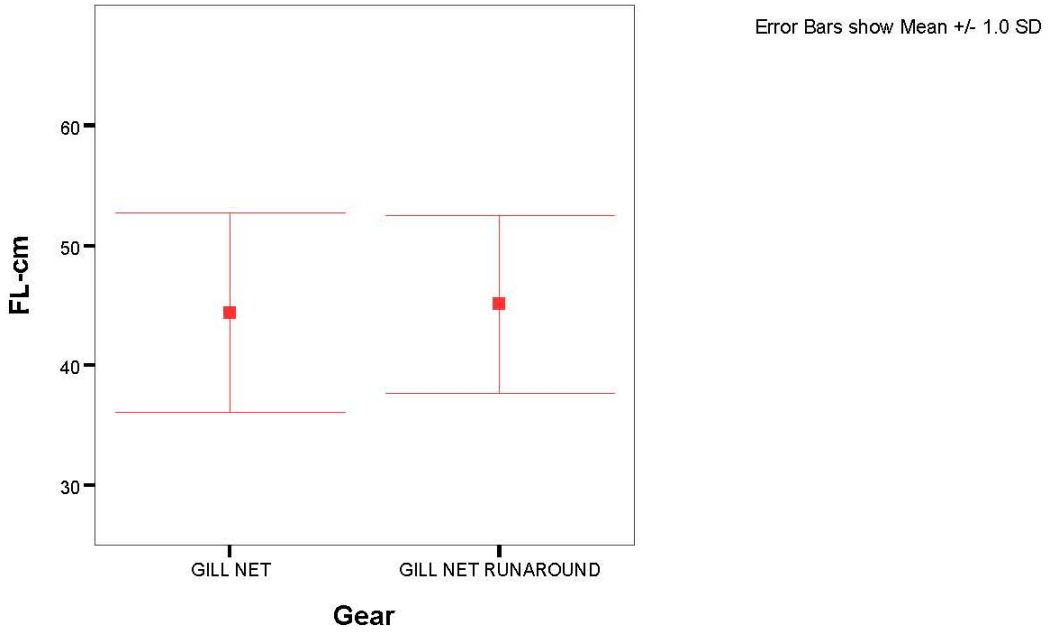


Figure 3.3. Comparison of mean lengths for Spanish mackerel caught with set gill net gear and runaround gill net gear.

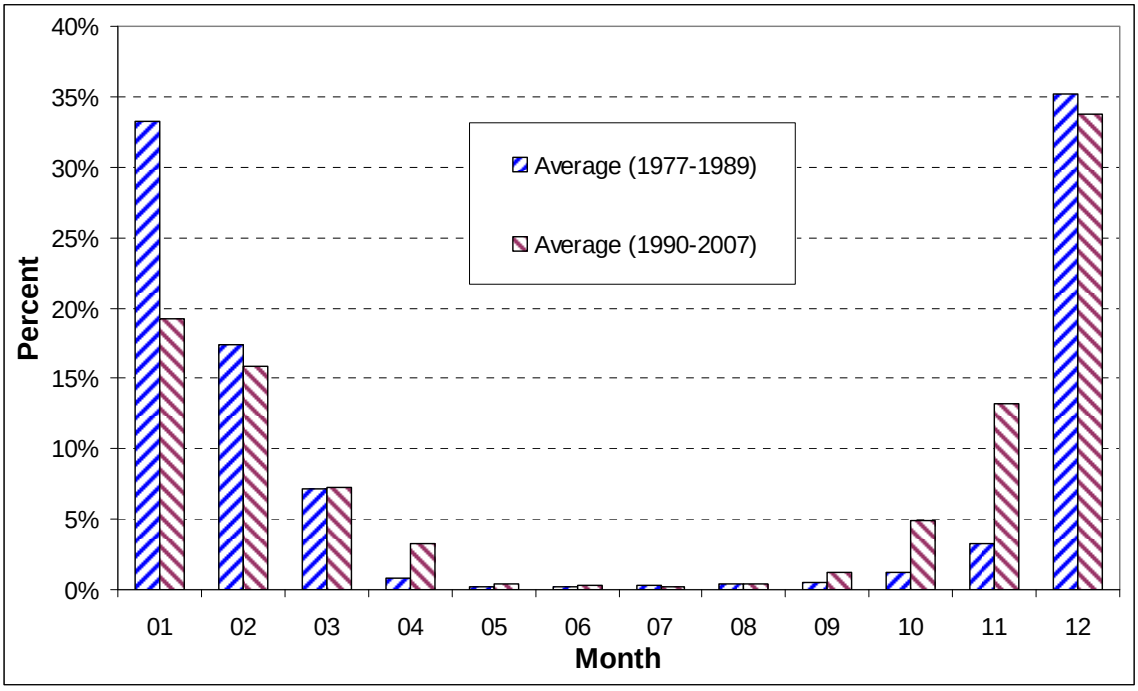


Figure 3.4. Spanish mackerel commercial landings by month from Atlantic Florida from ALS database, 1977-2007.

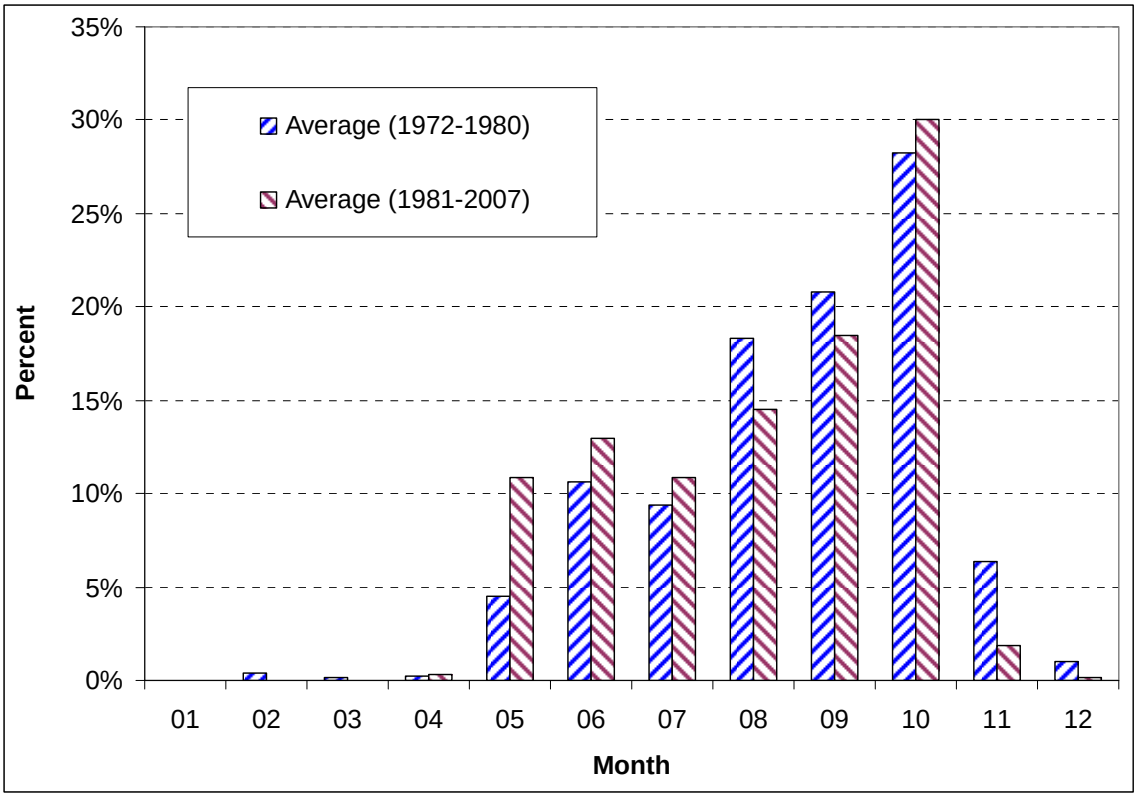


Figure 3.5. Spanish mackerel commercial landings by month from Georgia-North Carolina from ALS database, 1972-2007.

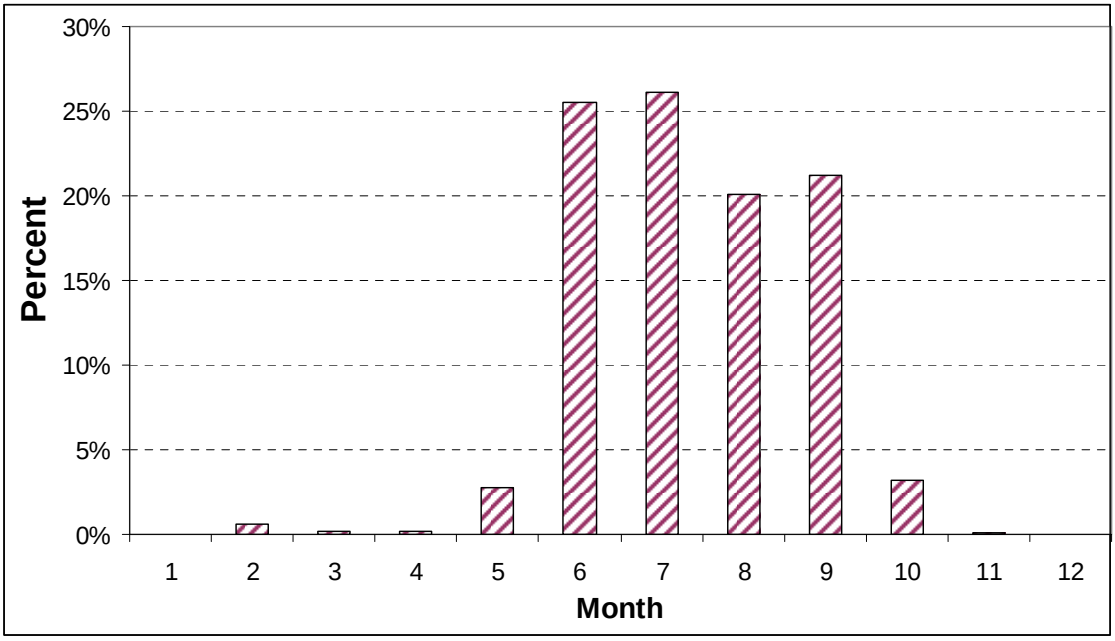


Figure 3.6. Spanish mackerel commercial landings by month from Virginia - Maine from SAFIS database, 1980-2007.

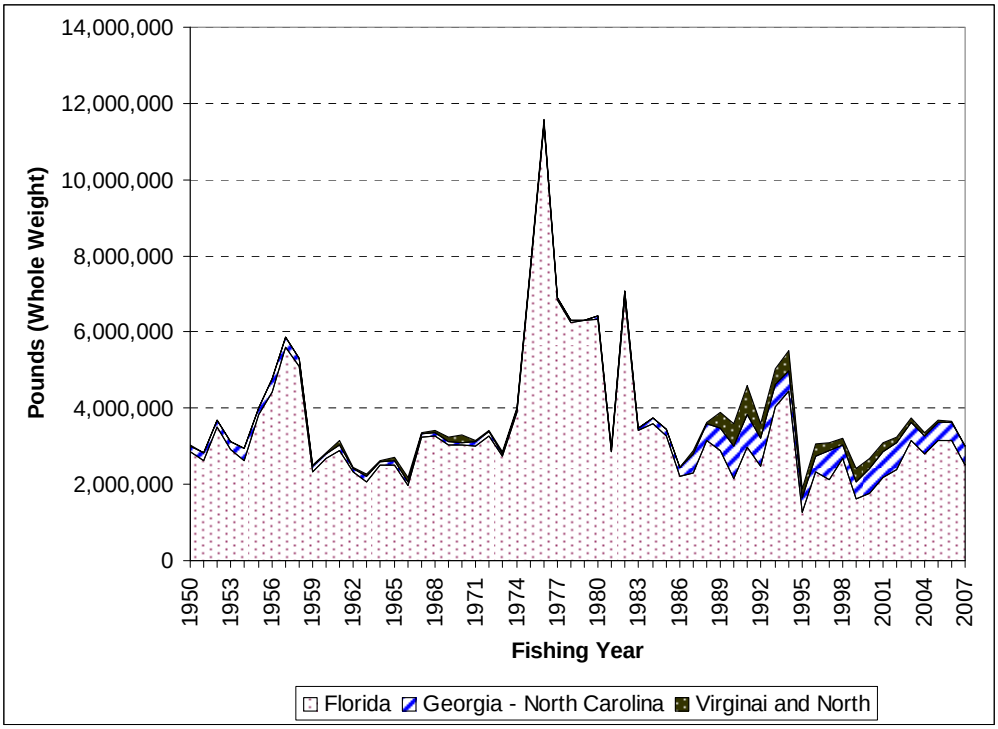


Figure 3.7. Spanish mackerel landings in pounds (whole weight) by region from the U.S. Atlantic coast, 1950-2007. (see text for data sources by state and temporal duration).

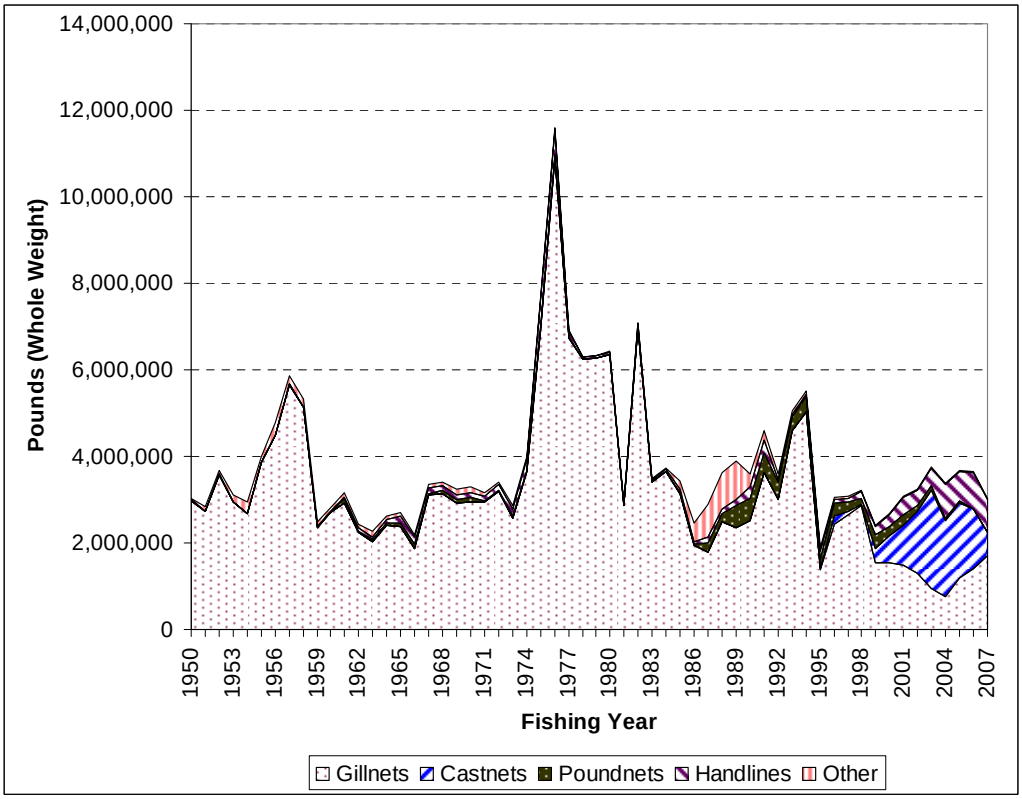


Figure 3.8. Spanish mackerel landings in pounds (whole weight) by gear from the US Atlantic coast, 1950-2007. (see text for data sources by state and temporal duration).

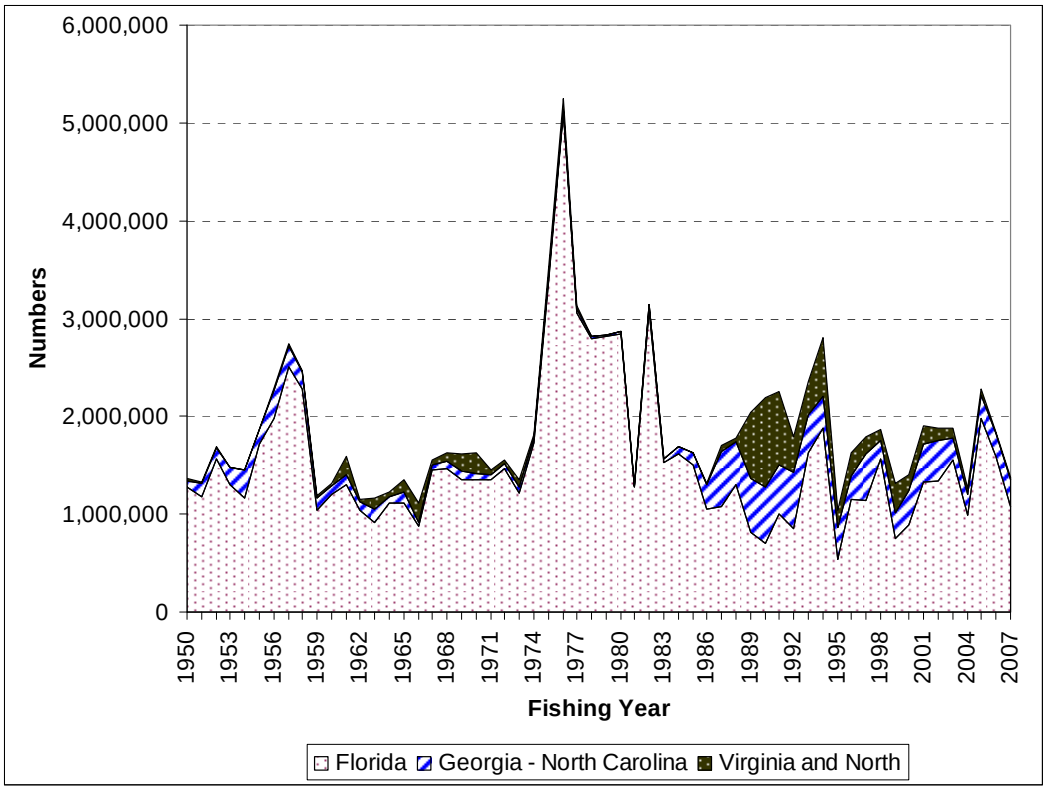


Figure 3.9. Spanish mackerel landings in numbers by region from the U.S. Atlantic coast, 1950-2007. (see text for data sources by state and temporal duration).

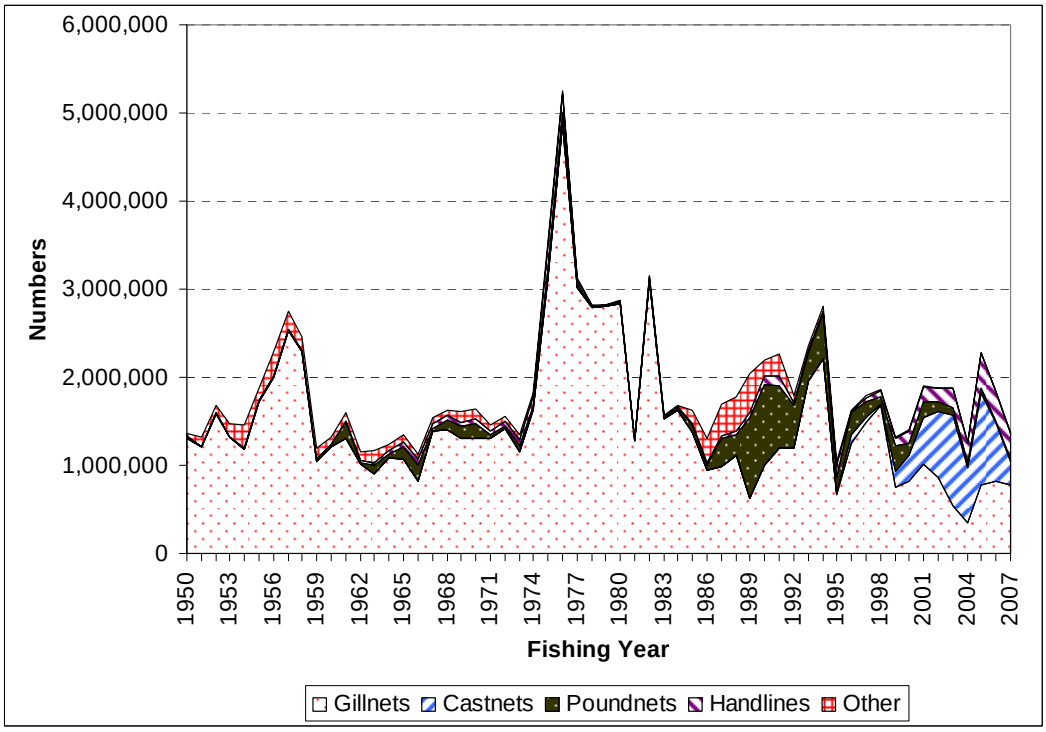


Figure 3.10. Spanish mackerel landings in numbers by gear from the US Atlantic coast, 1950-2007. (see text for data sources by state and temporal duration).

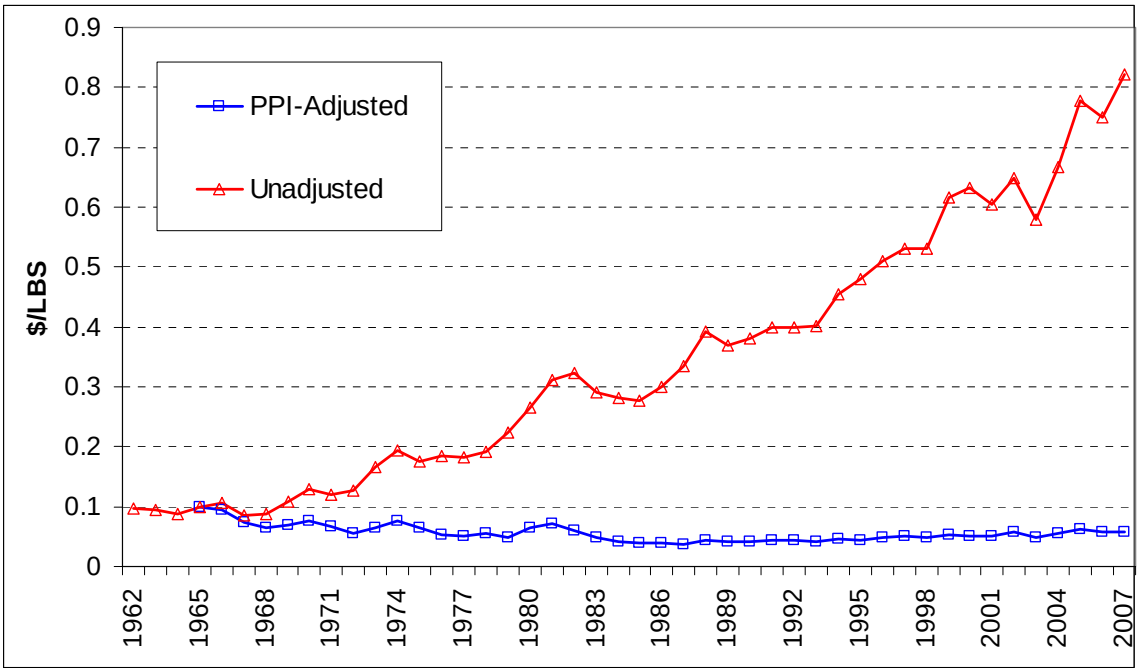


Figure 3.11. US South Atlantic Spanish mackerel, price per pound, unadjusted and adjusted for inflation from the SEFSC ALS database, 1962-2007. Price is adjusted by producer price index (PPI) using 1965 as base year.

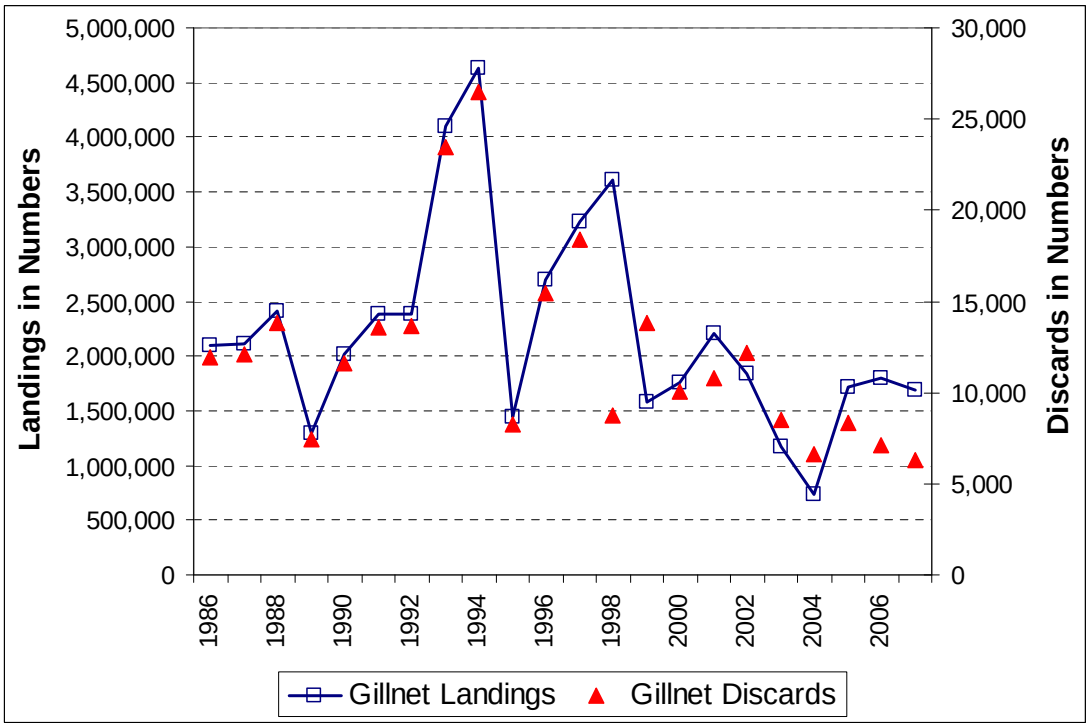


Figure 3.12. Comparison of commercial gillnet landings to discards for US South Atlantic Spanish mackerel (discard values prior to 1998 calculated as proportion of landings in numbers).

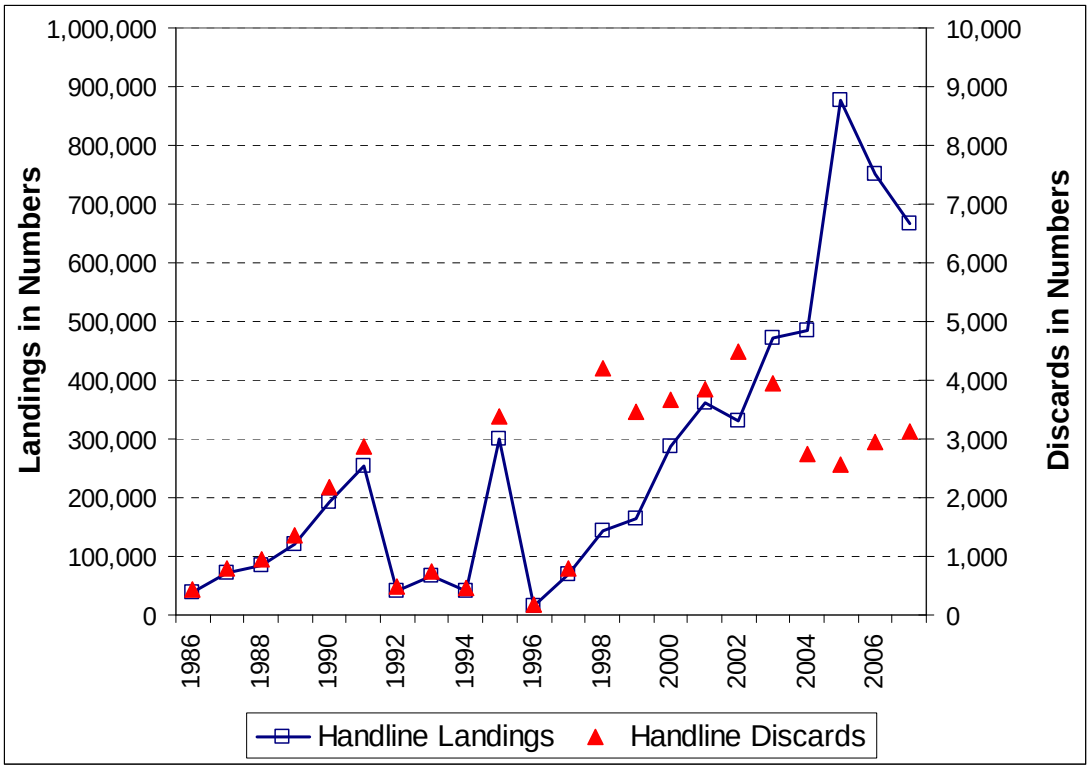


Figure 3.13. Comparison of commercial handline/trolling landings to discards for US South Atlantic Spanish mackerel (discard values prior to 1998 calculated as proportion of landings in numbers) (discard values prior to 1998 calculated as proportion of landings in numbers).

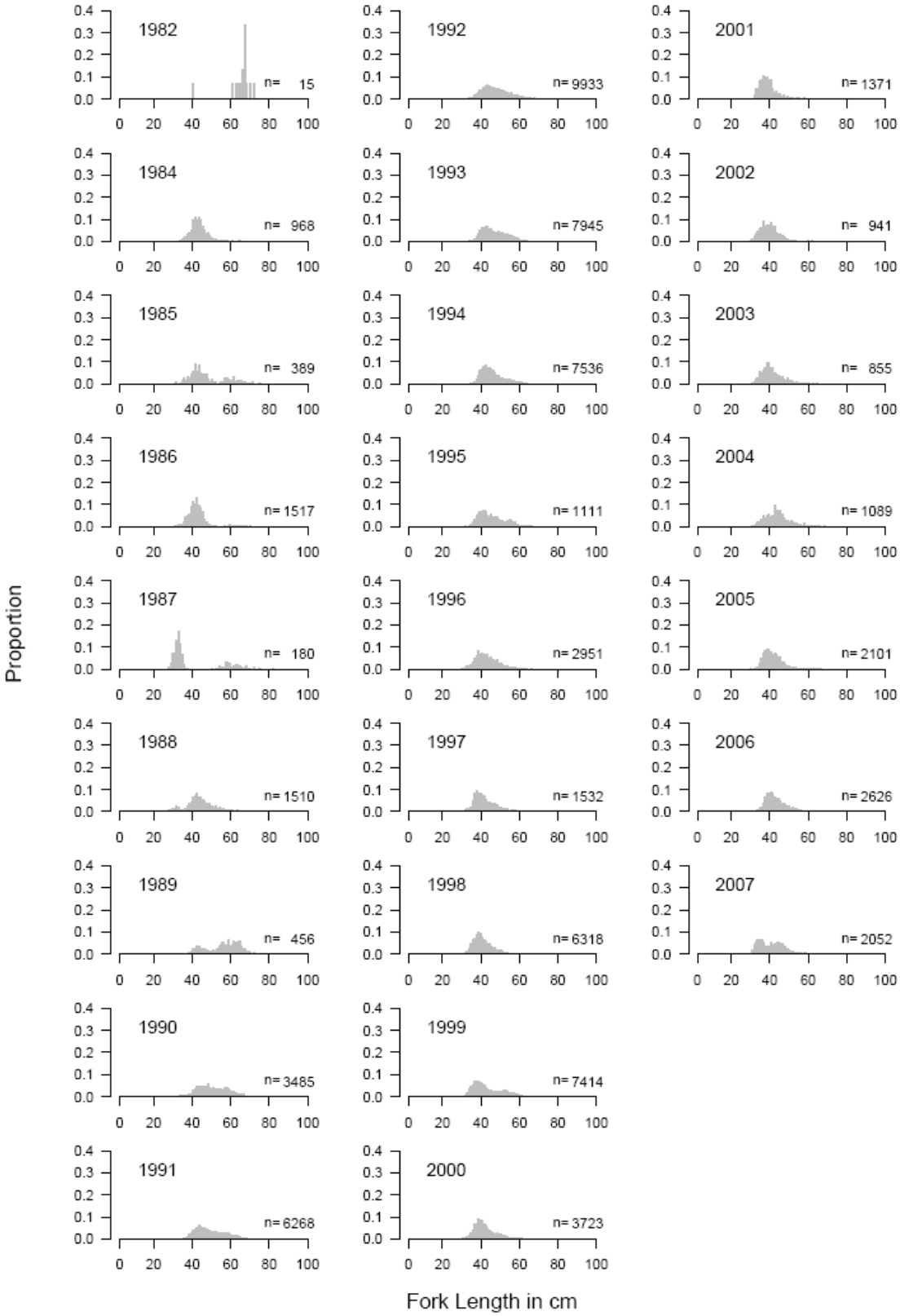


Figure 3.14. Spanish mackerel length composition (number at length, FL-cm) by year for commercial gillnet gear in the US South Atlantic.

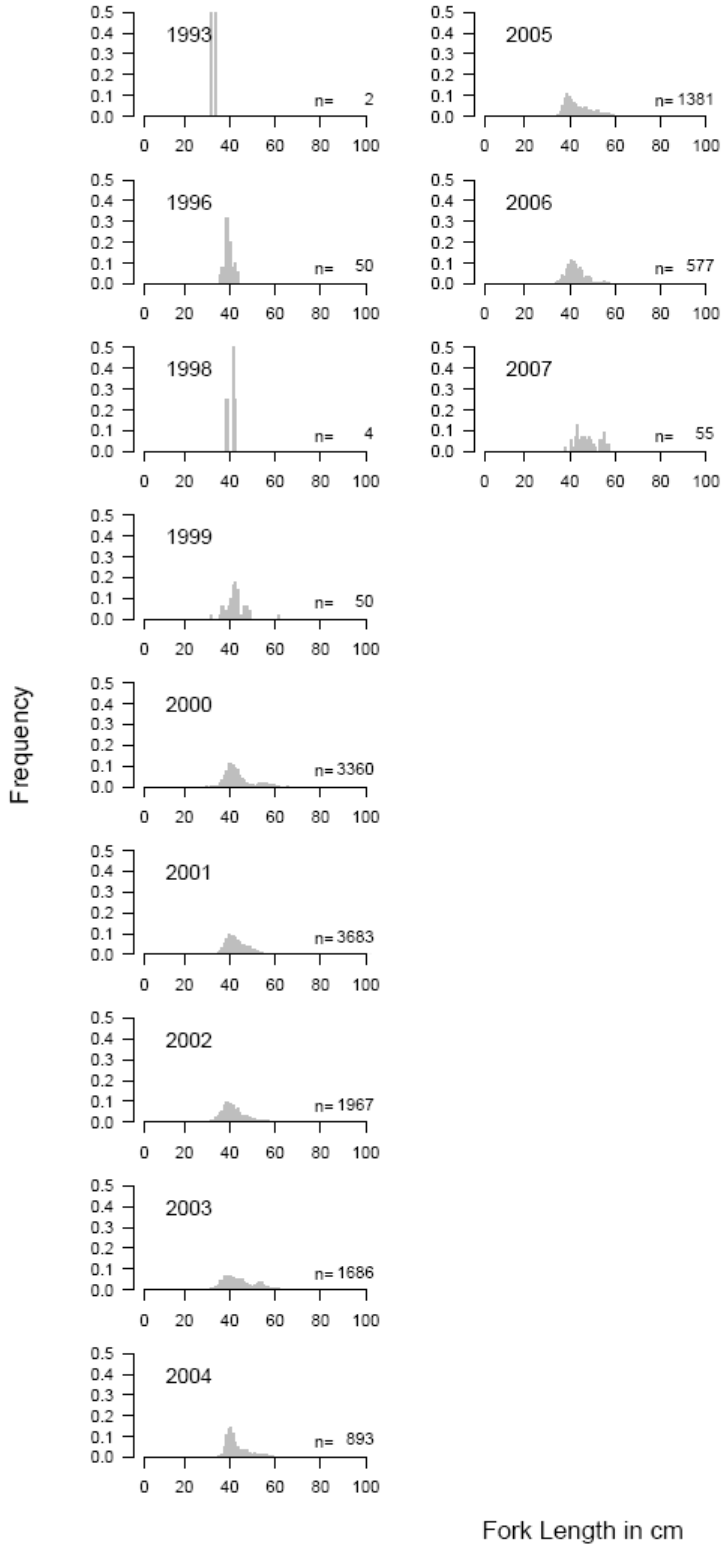


Figure 3.15. Spanish mackerel length composition (number at length, FL-cm) by year for commercial castnet gear in the US South Atlantic.

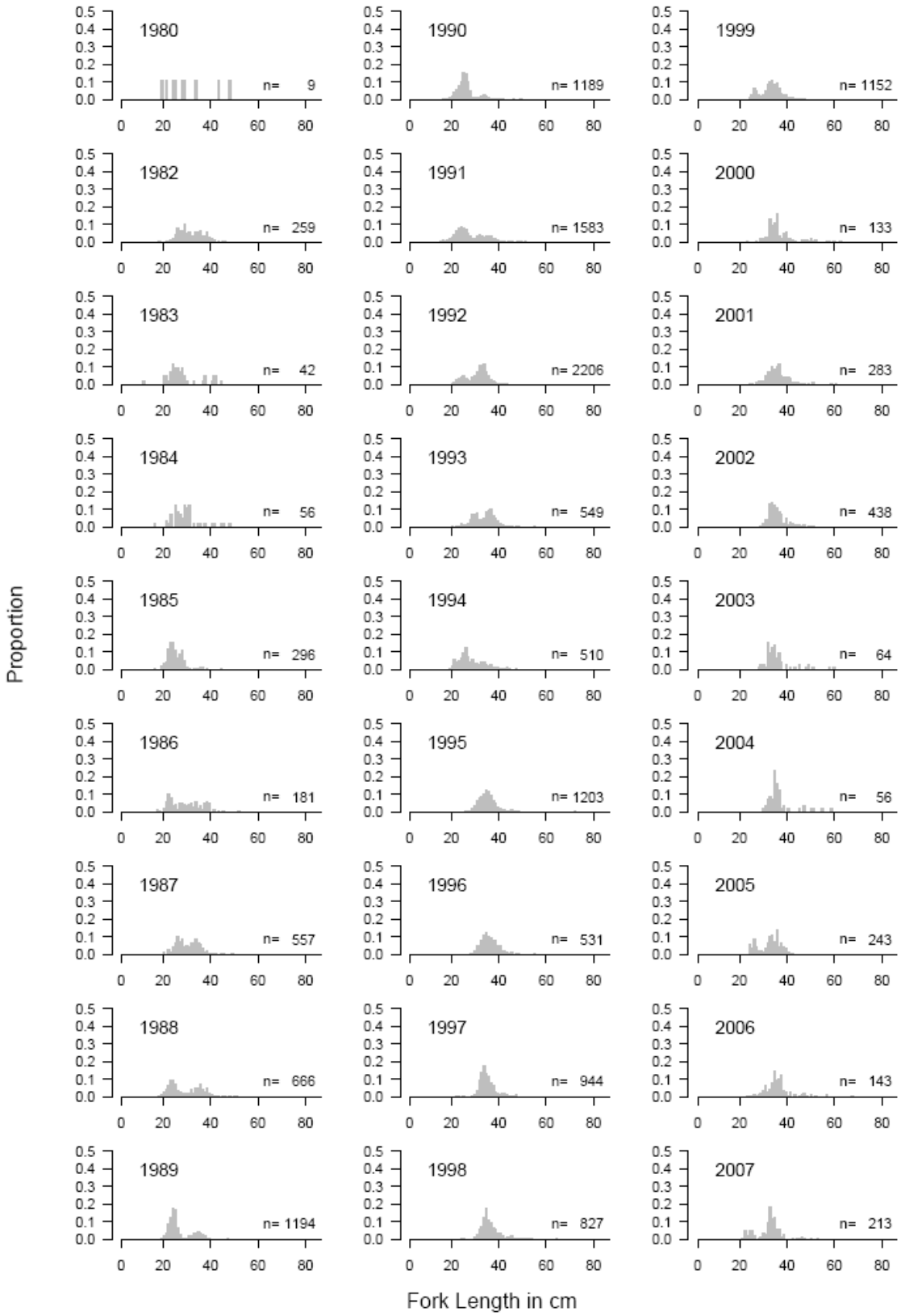


Figure 3.16. Spanish mackerel length composition (number at length, FL-cm) by year for commercial pound net gear in the US South Atlantic.

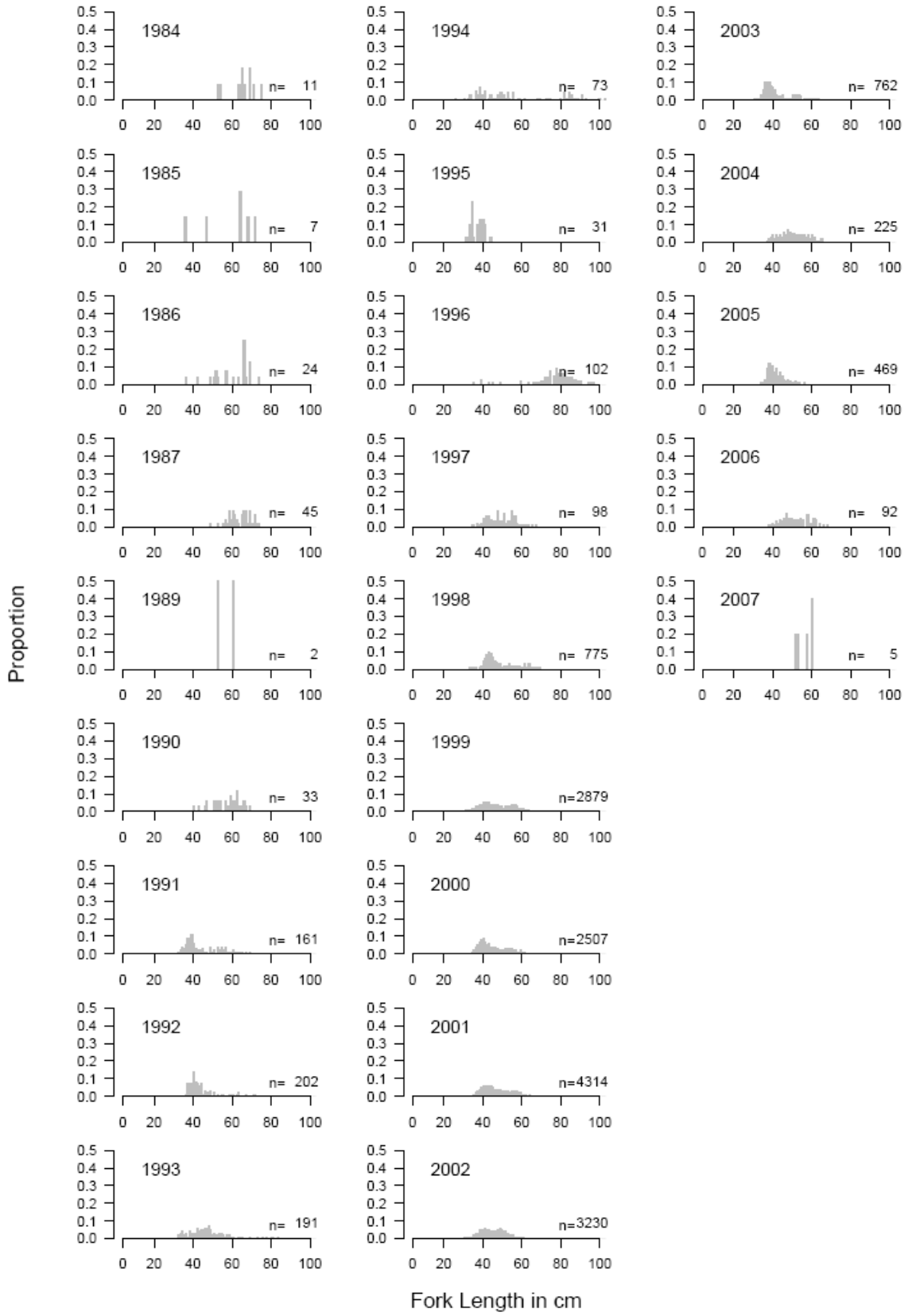


Figure 3.17. Spanish mackerel length composition (number at length, FL-cm) by year for commercial handline gear in the US South Atlantic.

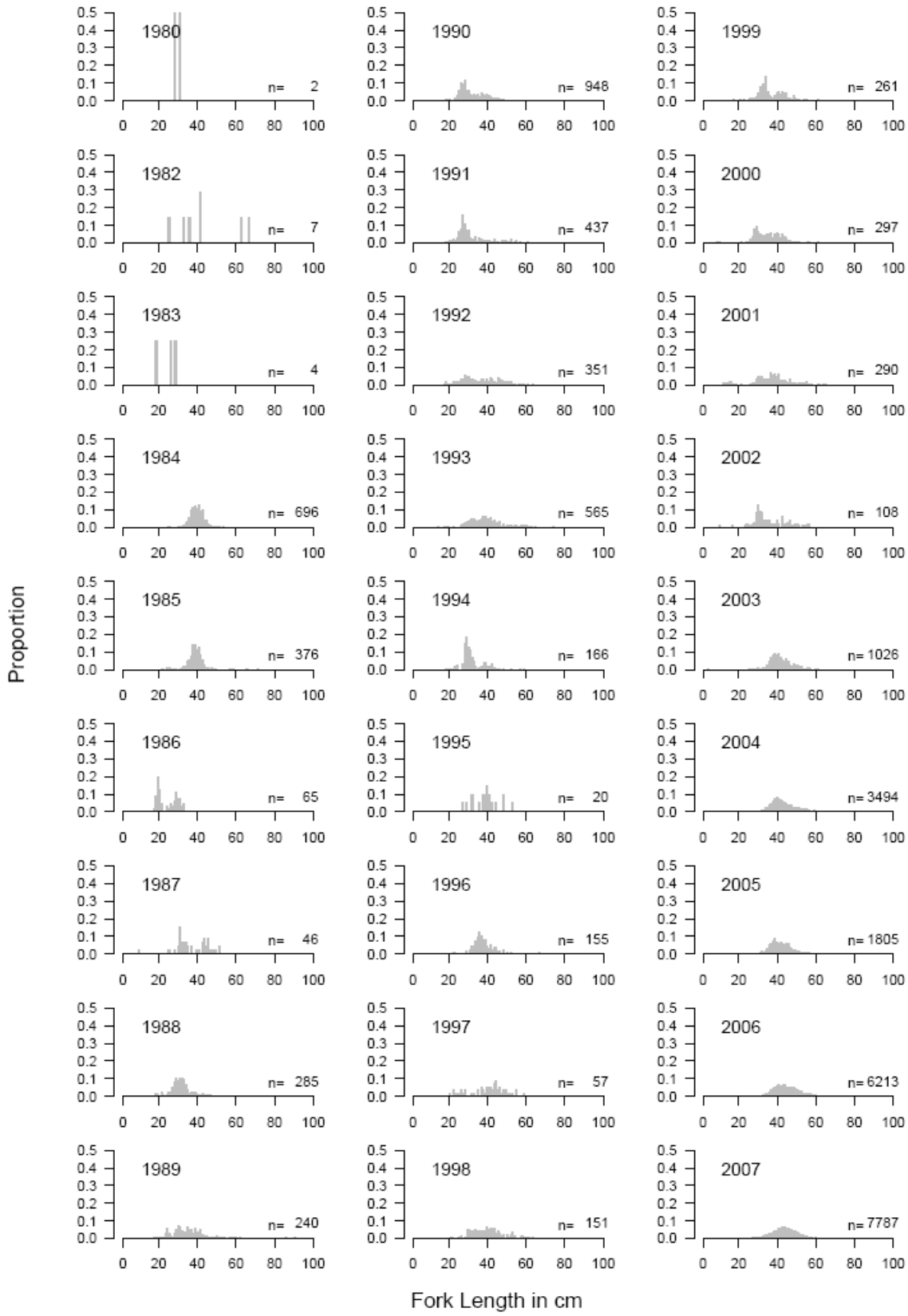


Figure 3.18. Spanish mackerel length composition (number at length, FL-cm) by year for other commercial gears in the US South Atlantic.

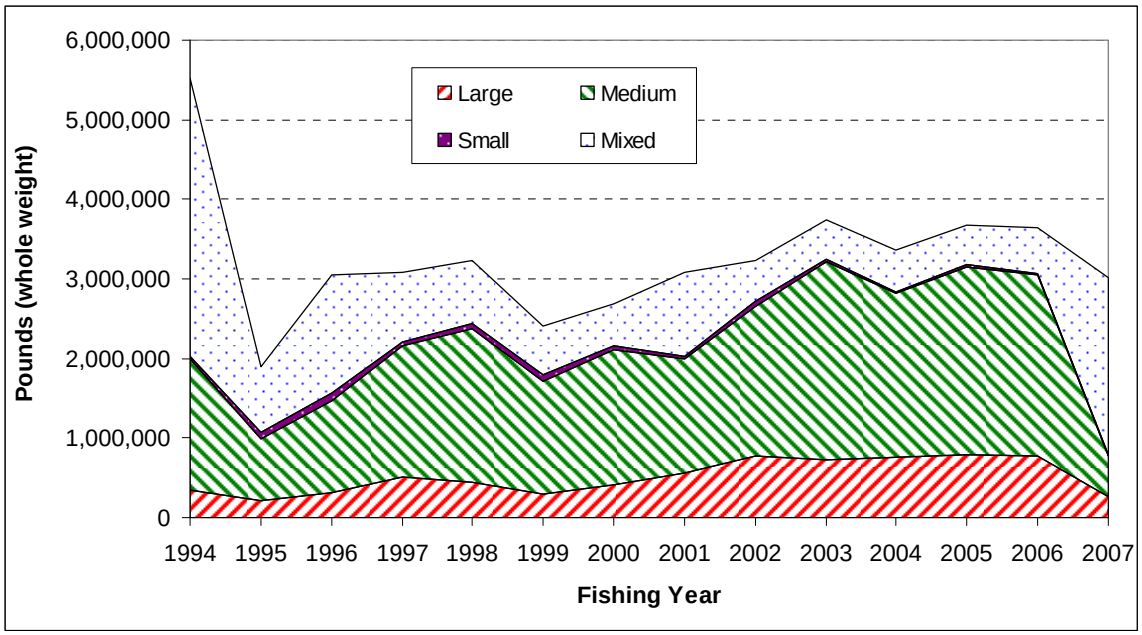


Figure 3.19. Commercial landings of Spanish mackerel by market grade, 1994-2007.

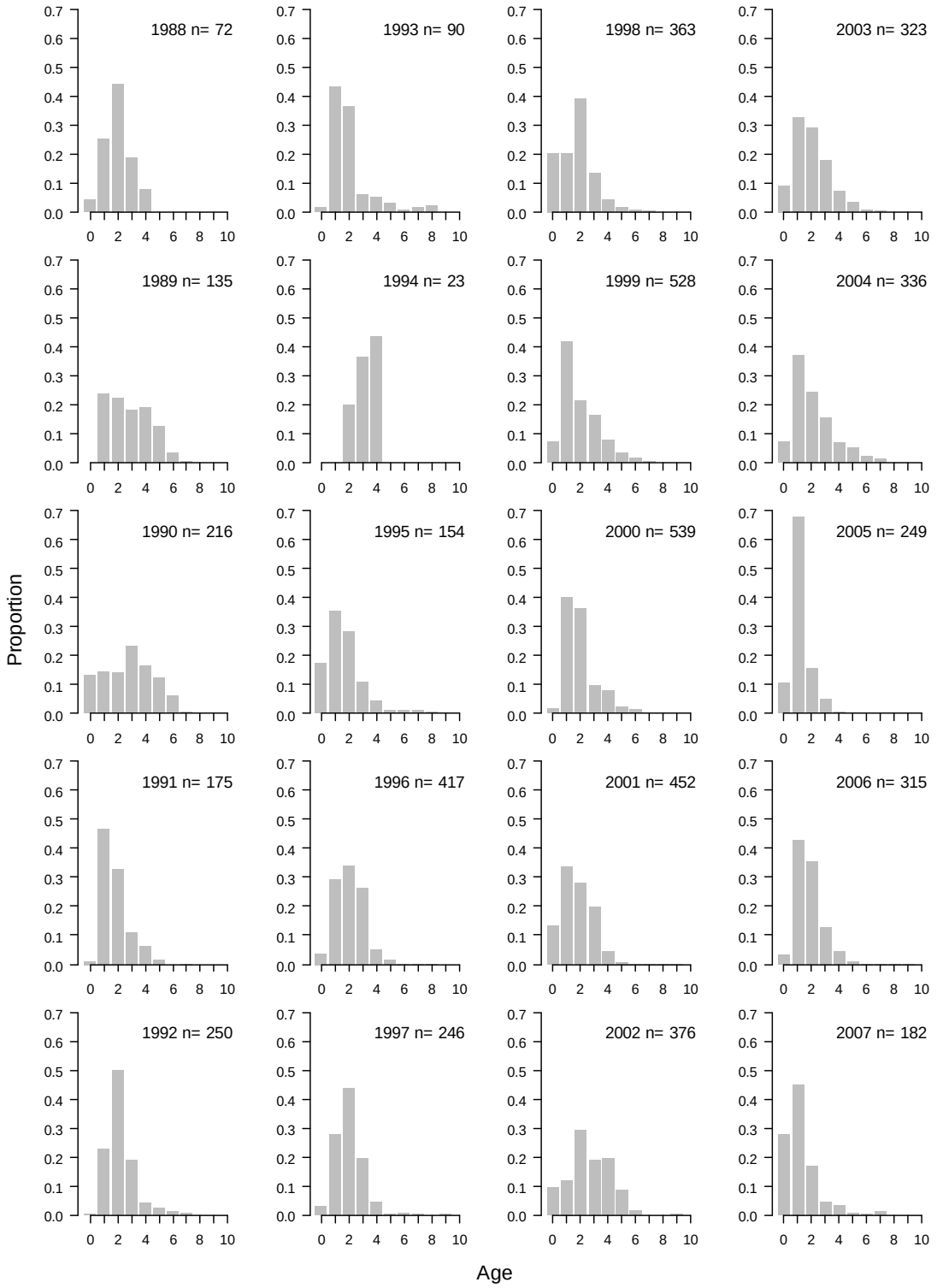


Figure 3.20. Spanish mackerel age frequencies by year for gillnet commercial gears in the US South Atlantic.

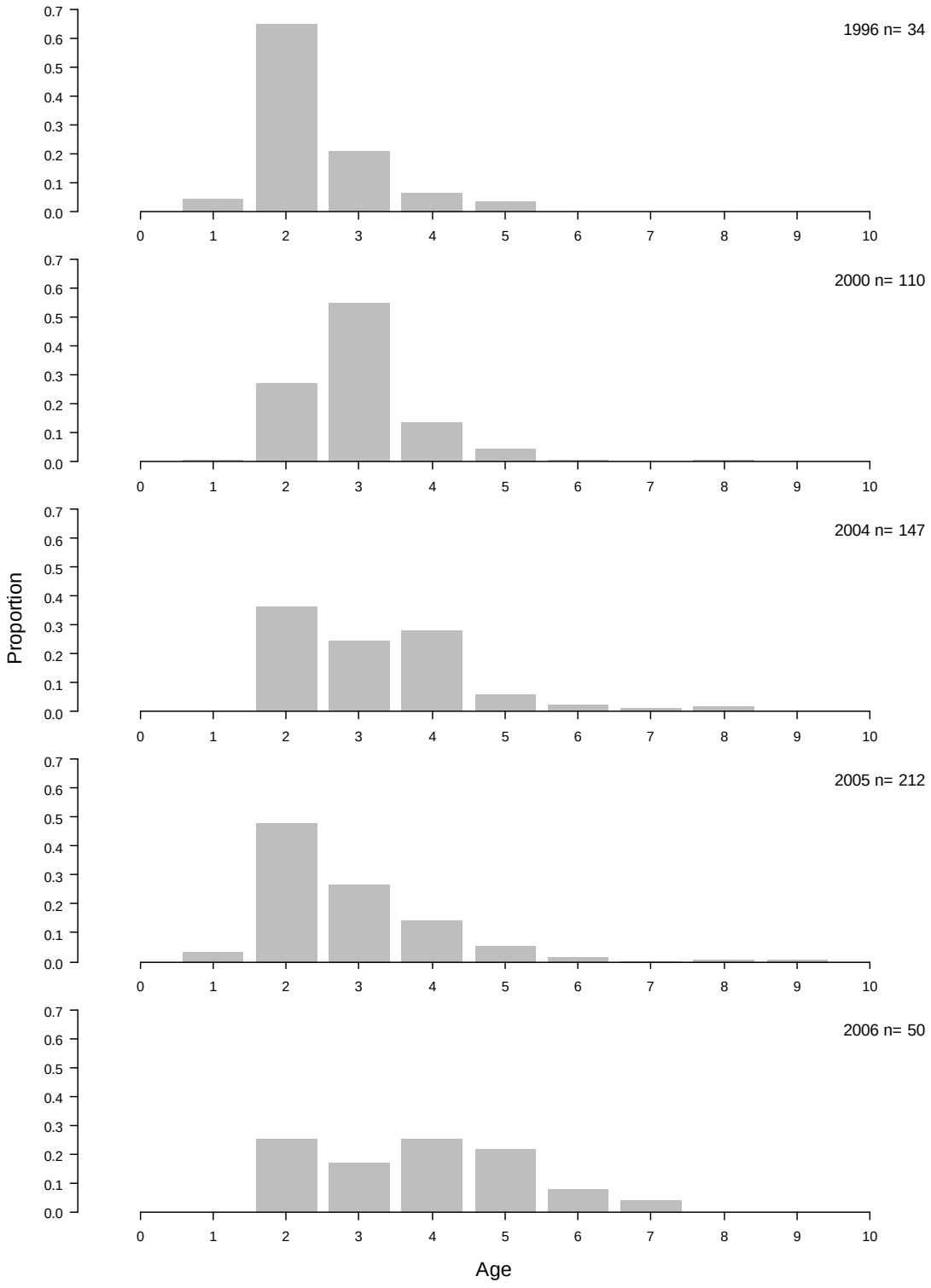


Figure 3.21. Spanish mackerel age frequencies by year for castnet commercial gears in the US South Atlantic.

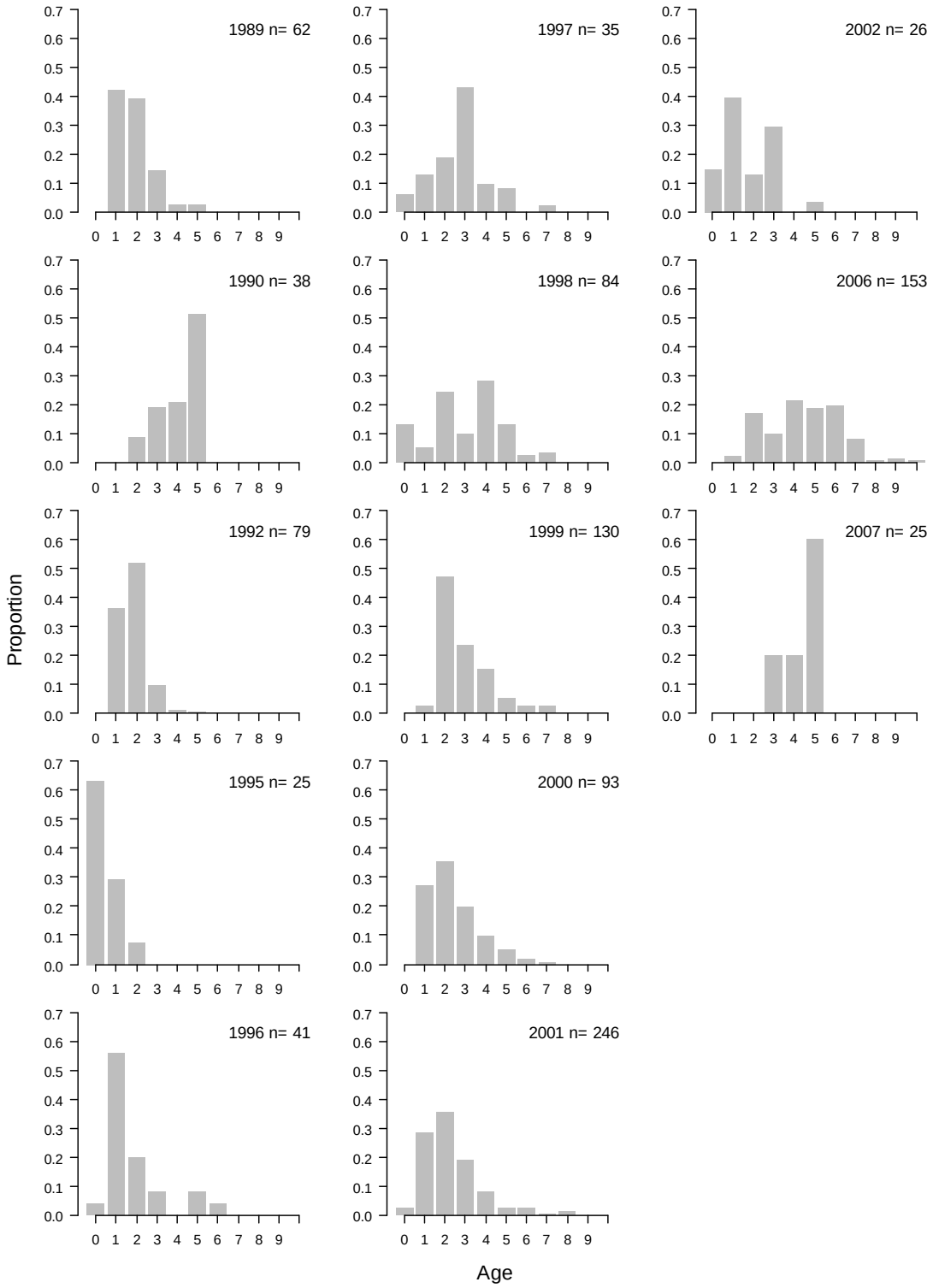


Figure 3.22. Spanish mackerel age frequencies by year for handline commercial gears in the US South Atlantic.

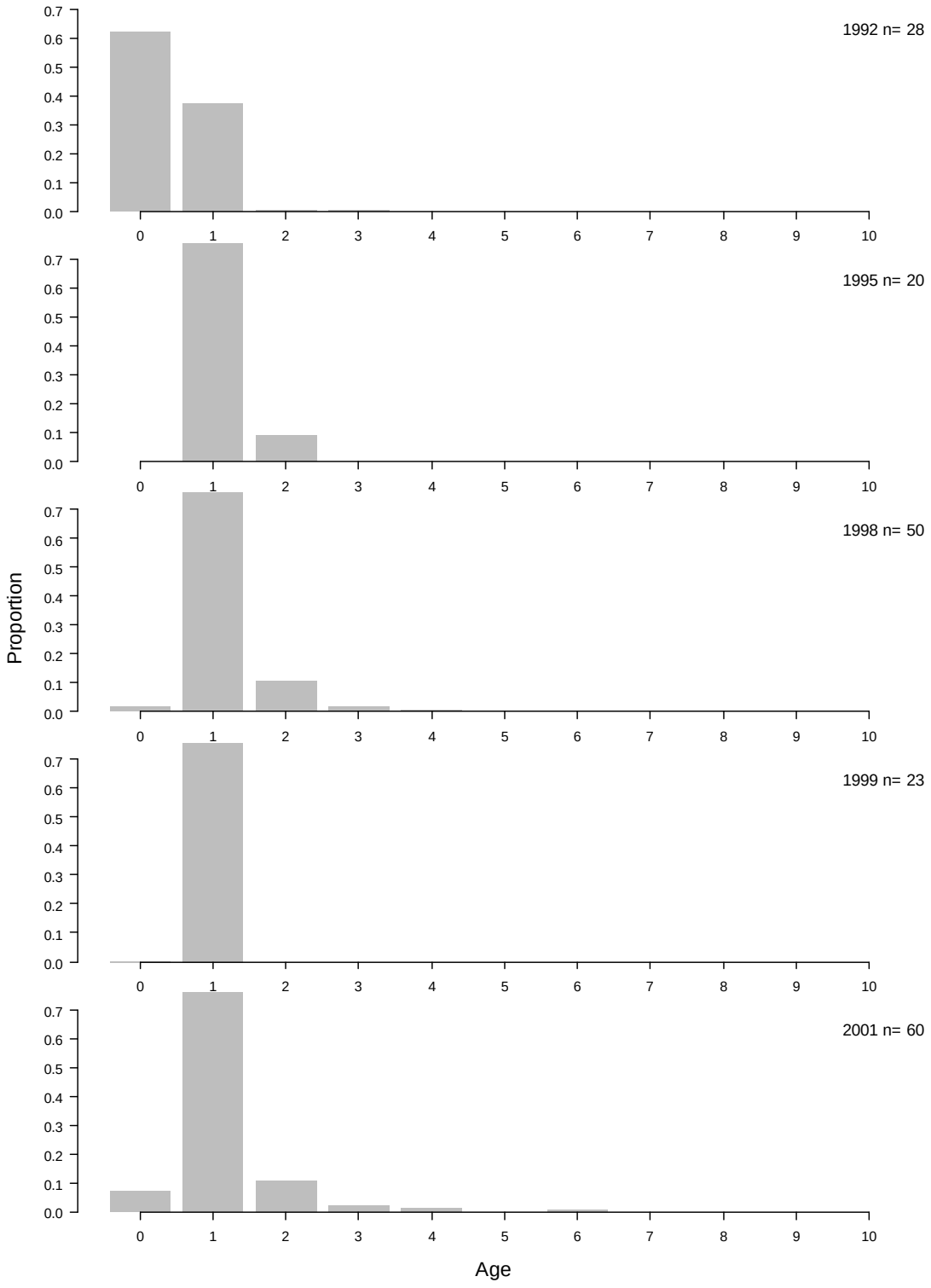


Figure 3.23. Spanish mackerel age frequencies by year for poundnet commercial gears in the US South Atlantic.

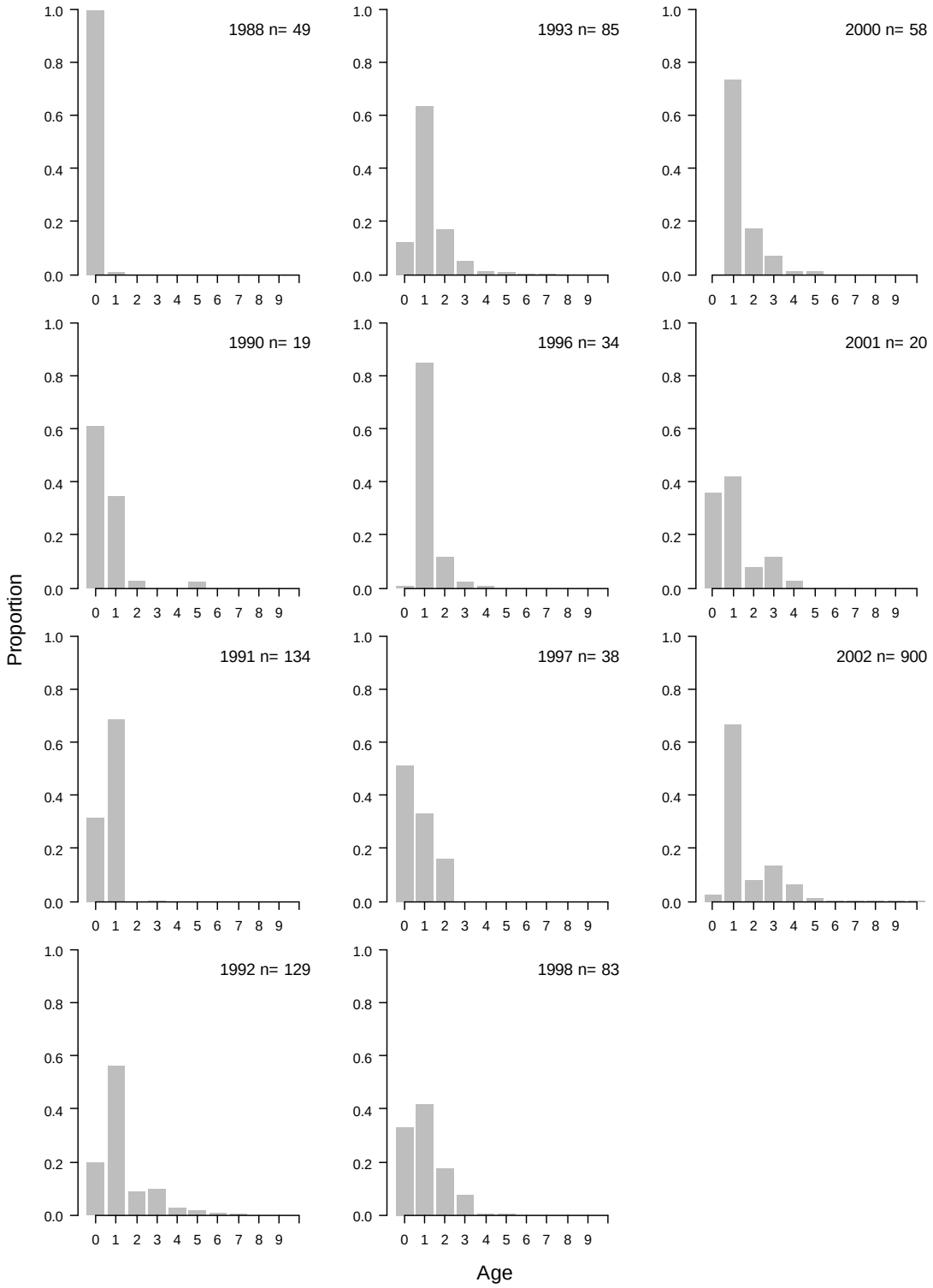


Figure 3.24. Spanish mackerel age frequencies by year for other commercial gears in the US South Atlantic. Note that this category includes a large fraction of unknown gears.

Spanish Mackerel

4. Recreational Fishery Statistics

4.1 Overview - group membership, leader, and issues

Chair: Erik Williams (NMFS Beaufort); Members: Tom Sminkey (NMFS Silver Spring), Ken Brennan (NMFS Beaufort), Rob Cheshire (NMFS Beaufort), Beverly Sauls (FWRC).

Issues:

(1) Only one working paper for the recreational workgroup was submitted, reflecting the relatively small amount of pre-workshop work completed for this workgroup.

(2) At the time of the data workshop the 2007 headboat data had not been through a full set of quality assurance and quality control checks. Key entry was finalized just days prior to the DW.

(3) Historic data, does it accurately reflect catch levels of the species reported?

4.2 Headboat Fishery

Historical accounts of headboat fishing in the South Atlantic for inshore and offshore species date back to the years immediately following World War II. The headboat fishery is a readily identifiable segment of the recreational fishery, and is responsible for a significant percent of the recreational landings for some species. Presently, the number of vessels in the headboat fleet fluctuates slightly from year to year as boats enter or leave the fishery, nonetheless, the relative size of the fleet is known, making it accessible to the Southeast Region 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. From 1981-present the Survey included all headboats operating in the southeastern U.S. EEZ, encompassing the areas shown in Figure 4.9.1.

4.2.1 Headboat Landings

Estimated headboat landings from the VA\NC boarder to Key Largo (1981-2007) for Spanish mackerel are based on the fishing year from March to February. Since landings are not available for 2008, a ratio was calculated from the sum of Jan-Feb (03-07) divided by the sum of Mar-Dec (02-06). This ratio was applied to both number and weight of the landings of Mar-Dec 2007 for all areas combined to derive total landings for Jan and Feb 2008. The totals from Mar-Dec 07 and Jan-Feb 08 were combined to give total landings for the 2007 fishing year (Tables 4.8.1 and 4.8.2).

Spanish mackerel are infrequently encountered in the headboat fishery compared to most bottom species that are targeted, which require anchoring the boat and fishing with bottom rigs. This is reflected in the relatively low numbers landed by headboats in the South Atlantic. Some areas such as South Carolina and southeast Florida account for higher percentage of the landings mostly due to the inshore fishery that mixes trolling with bottom fishing during the same trip.

4.2.2 Headboat Discards

The logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". This self-reported data is currently unvalidated within the Headboat Survey. The recreational working group compared vermilion snapper discard data from the MRFSS At-Sea Observer program to the Headboat Survey logbook and determined that the logbook discard data was representative of the fishery (See SEDAR17-DW08).

4.2.3 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 logbook data are used to calculate an estimate of total weight (kg) of reef fish landed in the headboat fishery.

4.2.3.1 Sampling Intensity Length/Age/Weight

The headboat sampling for lengths and weight was consistent throughout the time series with the exception of spatial coverage before 1978. The number of fish available to measure was patchy and represents localized effort over relatively small spatial and temporal scales. There are only a few years where the number of samples is high enough to provide information on the length composition of the fishery (See Table 4.8.3). However, even in years with good sample size the spatial differences in effort among years may erroneously indicate changes in the size distribution.

4.2.3.2 Length – Age Distributions

No length composition was generated from the headboat fishery due to the sampling problems discussed in Section 4.2.3.1. Headboat age samples (n=171, from 4 years) were included in the age composition for the general recreational fishery (see Section 4.3.3.2). SEDAR 17 DW participants headboat angling methods for Spanish mackerel were more consistent with charter boat fishing than with typical bottom fishing techniques employed on most headboats.

4.2.3.3 Adequacy for Characterizing Catch

Catch and effort data are reported on logbooks provided to all headboats in the Survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Each month port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is low in some areas for recent years, especially South Florida. Landings for these non-reporting vessels were

estimated from similar vessels adjusted using port sampler intercept data and estimates of the number of anglers.

4.2.3.4 Alternatives for Characterizing Discards

Based on the comparison of logbook data to the At-Sea Observer data, it was concluded that the logbook discard estimates for Spanish mackerel would be used for the available years back to 2004 for the South Atlantic headboat fishery. For years prior to the addition of the discard category on the logbook form, the recreational workgroup suggests using the average for 2004-2006 to interpolate discards. Further, the group recommends using the charter mode to calculate headboat discards for 1972-1998, since the discard rates from the longer time series of MRFSS reflect historic changes in discard rates. These rates include the impacts from changes in recreational size limits and bag limits for vermilion snapper over time.

4.2.4 Headboat Catch-at-Age/Length

Due to insufficient sample sizes, no length or age compositions were generated from the headboat fishery.

4.2.5 Headboat Effort

Headboat effort has changed only slightly in the past 10 years throughout the South Atlantic (Fig.4.9.2). The number of estimated trips in the headboat fishery has remained relatively constant during this period, with the only noticeable change occurring as effort peaked in GA and FL in 2000.

4.2.6 Comments on Adequacy of Headboat Data for Assessment Analyses

Catch and effort data are reported on logbooks provided to all headboats in the Survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Each month port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is low in some areas for recent years, especially South Florida. No other data sources were available to provide information on the headboat fishery sector.

4.3 General Recreational Fishery (aka MRFSS)

4.3.1 General Recreational Landings

The report, **SEDAR16-DW-21: Recreational Survey Data for King Mackerel in the Atlantic and Gulf of Mexico,** was presented at the recent King Mackerel Data Workshop (Feb. 2008) and describes the methodology used to produce the recreational catch estimates based on the traditional MRFSS, the Charter Boat estimates produced by the For-Hire Survey method (FHS) from 2004-2007, and the 'normalization' of the pre-FHS estimates of Charter Boat effort and inclusion in the total annual landings estimates. Correction factors to adjust historical estimates in the Atlantic to those which would have been expected had the new methodology been used were not available prior to that meeting. This computational normalization was only modeled for the southeast states, NC to FL, and followed a similar method used in the Gulf of Mexico by Diaz and Phares (2006). Included in this analyses and time-series of landings were both Spanish

Mackerel and Vermilion Snapper, where they occurred. The recreational fishery for Spanish mackerel, however, also produces significant landings from Virginia, which was not included in the earlier analyses.

For the "old estimation" methodology, the Marine Recreational Fishery Statistics Survey (MRFSS) collected fishing activity data using a telephone survey of households in coastal counties (CHTS) and fishing catch per trip data by interviewing anglers at fishing access sites. This complementary design survey began in 1981 and provides a time series of Spanish mackerel landings from 1981 - 2007 by state on the Atlantic Coast, U.S. To improve the effort estimation procedure for the charterboat mode, MRFSS tested and then implemented a new survey protocol of interviewing the charterboat operators directly (the For Hire Survey, or FHS). This survey became the official estimator of fishing effort for this mode in 2000 for the Gulf of Mexico, 2003 for East Florida, and 2005 for the rest of the Atlantic coast. The shift from one survey method to another in the time series can cause a shift in the trend of landings so it would be advantageous if the earlier effort estimates could be adjusted to more accurate annual numbers based on a relationship that could be modeled between the two surveys' results during the overlapping years. Such conversion (or "correction") factors had been developed for the Gulf of Mexico, where the FHS began earlier. Document **SEDAR16-DW-15** describes the results of this modeling for the South Atlantic.

The MRFSS CHTS pooled 3 years of charterboat trip data to produce an estimate of angler-trips per 2-month 'wave' due to a low frequency of contacts in most coastal zones. These aggregated estimates were more precise than estimates based on unpooled data, which would be highly variable and trends would be hard to recognize. However, to compare the two survey methods' results it was the unpooled estimates that were used in the first attempt at modeling originally presented to the Group. The results were reasonable but the method was questioned because it did not use the official estimates of charterboat angler effort (which were developed by pooling), which is ultimately what would need to be adjusted if a model could be described. The Group stressed that it was important that the methodology used to develop the conversion factors for the Gulf of Mexico be followed. Therefore, the entire GLM model was repeated using the CHTS 3-year pooled effort estimates and the FHS annual estimates of effort, as well as using the entire available time period of FHS data.

From 1981 to 1985, MRFSS considered charterboat and headboat as part of single mode (referred to as "party-charter", or "PC"). Thus, the conversion factors estimated with 2004-2007 charterboat data (used to calibrate 1986-2003 charterboat effort estimates) can not be used to calibrate the 1981-1985 estimates. To calibrate the 1981-1985 combined charterboat and headboat effort estimates, conversion factors will be estimated using 1986-1990 effort estimates instead of 2004-2007 to minimize possible effects of changes in the fishery over time. To do so, headboat (NMFS Headboat Survey) and original (MRFSS) charterboat effort estimates were combined (summed) into one estimate for each year and wave.

Conversion ratios were determined for the significant factors: sub-region (East Florida, North Carolina, or South Carolina & Georgia combined), area fished (Inland vs. Ocean waters), and 2-month wave (Mar.-Dec. north of FL, Jan-Dec for FL). The conversion ratios were then applied to the corresponding cell-level effort estimates (1986-2003) and the adjusted effort estimates were used to produce the adjusted king mackerel landings time series. Similarly, the PC landings estimates of king mackerel from the MRFSS, 1981-1985, were directly adjusted using the headboat + charterboat model ratios. The Group reviewed the modified document and the revised results, and recommended the use of these conversion factors (Table 4.8.4 and 4.8.5).

The final annual landings of Spanish mackerel on the Atlantic coast were adjusted for the fishing year of March 1 to February 28/29. For those landings estimated by MRFSS/FHS surveys north of Florida, no annual adjustments needed to be made because the recreational surveys are not conducted in Jan.-Feb., nor are landings estimated. Therefore, the estimated landings from Feb. - Dec. represent the fishing year. The Florida landings have been adjusted for annual totals by adding the Jan/Feb period landings estimates to the previous calendar-year's March-December landings.

4.3.1.1 Historical Recreational Landings

The workgroup was tasked with collecting any and all recreational landings for years prior to the start of modern data collections. Catch estimates from the MRFSS are not available from pre-1981, and for headboat logbook estimates, vermilion snapper landings are not available pre-1972 from North Carolina to South Carolina, and pre-1980 for Georgia through Florida.

The workgroup considered several historic data sets. The U.S. Fish and Wildlife Service conducted salt-water angling surveys in 1960, 1965, and 1970 (Clark 1962; Deuel and Clark 1968; Deuel 1973). These surveys resulted in estimates of the number of anglers and the number and weight of fish caught by region for all recreational fishing, including headboats. The Mid and South Atlantic regions were used for this assessment. In these surveys Spanish mackerel are reported at the species level (Table 4.8.6 and 4.8.7).

The workgroup noted that the salt-water angling survey estimates for Spanish mackerel are on the order of 6 times those in recent years. This raised some concerns, but after further review of other data sources, there was no evidence to suggest these estimates were incorrect. Old reports of recreational fishing in the state of Florida suggest these estimates may be fairly accurate. For example, according to Rosen and Ellis (1961) in 1958 about 13 percent of all fish kept by recreational anglers were Spanish mackerel. Ellis (1957) estimated that the total number of Spanish mackerel captured by charter boats in Florida was 65,971; this is 9 times higher than the recent Florida charter boat average of about 7,439.

Other data sources examined corroborate the estimates from the 1960, 1965, and 1970 salt-water angling surveys. Older reports from the state of Florida suggest the number of anglers estimated in these salt-water angling surveys is not too different (Ellis et al. 1958). Ellis et al. (1958) estimated 1,247,000 total number of salt and brackish water anglers in Florida in 1955, while the 1960 salt-water angling survey estimated 1,024,000 total anglers for the whole U.S. South

Atlantic. Considering the Ellis et al. (1958) estimate includes the west coast of Florida, while the 1960 survey includes Georgia, South Carolina, and North Carolina, these estimates are not too different.

The percent standard error (PSE) estimates in Table 4.8.7 were derived from a linear interpolation of tabled values provided in the U.S. Fish and Wildlife Service salt-water angling survey reports (Clark 1962; Deuel and Clark 1968; Deuel 1973).

4.3.2 General Recreational Discards

The access-point recreational fisheries surveys (angler intercept) ask anglers about any fish that were not landed or were landed, but not in the whole condition. Those that were not landed and were released alive were designated as discards and the raw reported data were expanded to the estimated totals following the same procedures as the landed fish. No size data were available for this class of catch (except for those headboat-caught fish on trips with an observer/interviewer on board - these are included in the headboat mode section) so catches of discards are reported by number only.

4.3.3 Biological Sampling

The only biological data collected during the routine MRFSS/FHS surveys are length of fish and weight of landed fish. Both are collected opportunistically but field interviewers are instructed to measure and weigh up to fifteen fish of each available species from each angler interviewed. The individual fish are to be selected from the total landed catch at random to avoid any size-bias in the resultant sample. Fish are measured to the nearest mm fork length (center-line total length in non-forked fish) and weighed to the nearest 1/8 or ½ kg, depending on scale precision. Annual sample sizes of fish measured are included on the length-frequency worksheet.

4.3.3.1 Sampling Intensity Length/Age/Weight

See length frequency sample sizes on annual length-frequency worksheet.

4.3.3.2 Length – Age Distributions

The general recreational length composition was created using data from the routine MRFSS/FHS surveys (Figure 4.9.3).

The general recreational age composition was created using data from charter vessels, headboats, and private vessels. The sampling shifts from primarily private vessels to charter vessels (see Table 4.8.8). Tournament vessels were not included because of the potential for bias in selectivity. Three samples removed from the analysis because recreational group members believed they were incorrect since Spanish mackerel were not caught in January in North Carolina in any years other than 2004. Most of the recreational age samples were from North Carolina (Table 4.8.9). All of the Georgia samples were from tournament fishing and were removed.

The recreational ages were weighted by the recreational length composition to overcome potential bias in selecting fish to age and to transfer the weighting given to the length

composition based on landings to the age composition. The weighting value for each age record was the proportion from the length composition corresponding to the year and length (1 cm bins) of the aged fish. The weighting values were then summed by age and year to determine the age composition of the fishery. Each value was normalized to sum to 1 across years by dividing each value by the sum for that year. General recreational age composition values were stored in the VS_DW_summary.xls workbook and are plotted in Figure 4.9.4.

4.3.3.3 Adequacy for Characterizing Catch

The samples of length/weight from the MRFSS/FHS surveys are stratified by year, wave, state, mode of fishing, and area fished (= cell) for purposes of estimating mean weight per fish and length frequency (weighted by catch). These cell samples are used to expand the cell catches in number to total kg and pounds landed, then are summed across cells to produce the annual statistics. Similarly, the length frequencies are expanded to counts per length group per cell, then are summed across cells to produce a single annual frequency distribution. If a cell is empty of sample, then a mode or state-level mean is substituted for mean weight. If the length frequency is absent from a cell but a catch number is estimated, then the cell is considered similar to the overall size-frequency distribution.

4.3.3.4 Alternatives for Characterizing Discards

Not addressed.

4.3.4 General Recreational Catch-at-Age/Length

Catch-at-age or length was not computed since age/length composition data is handled separately from catch estimates. For years in which adequate age/length sampling occurs, one could infer catch-at-age/length by multiplying the annual catch estimate by the annual age/length composition.

4.3.5 General Recreational Effort

Not addressed.

4.3.6 Comments on Adequacy of General Recreational Data for Assessment Analyses

Not addressed.

4.4 Recreational Workgroup Research Recommendations

There was insufficient time for this topic to be addressed by the workgroup during the data workshop.

4.5 Tasks for Completion following Data Workshop

Recreational workgroup things to be done post-DW:
(1) MRFSS landings for vermilion and Spanish from 1981-1985 (Tom Sminkey)
(2) Dig through some archives for more information on historic catch rates of Spanish mackerel (Beverly Sauls and Ken Brennan)
(3) Produce PSE's for historic and other landings time series (Erik Williams)
(4) Compute pre-2004 discards in headboat fishery from ratio of charter mode in MRFSS (Ken Brennan)

(5) Compile length composition data from headboat and MRFSS (Rob Cheshire)
(6) Submit all finalized data to Rob by June 13th (All)

4.8 Literature Cited

Clark, J.R. 1962. The 1960 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Circular 153, 36 pp.

Deuel, D.G. 1973. The 1970 Salt-Water Angling Survey. U.S. Department of Commerce, National Marine Fisheries Service, Current Fishery Statistics No. 6200, 54 pp.

Deuel, D.G. and J.R. Clark. 1968. The 1965 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Resource Publication 67, 51 pp.

Ellis, R.W. 1957. Catches of fish by charter boats on Florida's East Coast. Florida State Board of Conservation, Special Service Bulletin No. 14, 4 pp.

Ellis, R.W., A. Rosen, and A.W. Moffett. 1958. A survey of the number of anglers and of their effort and expenditures in the coastal recreational fishery of Florida. State of Florida, Board of Conservation, Technical Series No. 24, 50 pp.

Rosen, A. and R.W. Ellis. 1961. Catch and fishing effort by anglers in Florida's coastal and offshore waters. Florida State Board of Conservation, Special Service Bulletin No. 18, 9 pp.

4.8 Tables

Table 4.8.1. Total number of Spanish mackerel caught aboard headboats for fishing years 1981-2007 (March-February) by region; North Carolina (NC), South Carolina (SC), Georgia-North Florida (GA/NEFL), and Southeast Florida (SEFL).

Year	NC	SC	GA\NEFL	SEFL	Grand Total
1981	0	0	42	25471	25513
1982	0	0	25	3024	3049
1983	8	1	74	2416	2499
1984	0	134	65	393	592
1985	9	47	73	379	508
1986	33	198	164	2955	3350
1987	5	91	49	1328	1473
1988	83	33	60	324	500
1989	0	181	94	413	688
1990	13	232	231	264	740
1991	14	1099	315	480	1908
1992	38	303	258	442	1041
1993	5	271	85	302	663
1994	2	716	54	1805	2577
1995	5	63	49	484	601
1996	6	466	166	227	865
1997	106	1910	89	375	2480
1998	30	2073	56	231	2390
1999	197	5828	69	642	6736
2000	816	2529	54	363	3762
2001	30	3265	29	407	3731
2002	9	4072	165	397	4643
2003	47	1304	53	343	1747
2004	51	3445	50	1535	5081
2005	28	4707	39	708	5482
2006	11	2562	56	837	3466
2007	2	4637	57	928	5694

Table 4.8.2. Total weight (pounds) of Spanish mackerel caught aboard headboats for fishing years 1981-2007 (March-February) by region; North Carolina (NC), South Carolina (SC), Georgia-North Florida (GA/NEFL), and Southeast Florida (SEFL).

Year	NC	SC	GA\NEFL	SEFL	Grand Total
1981	0	0	115	73690	73805
1982	0	0	109	14254	14362
1983	13	2	119	3907	4040
1984	0	399	206	1555	2160
1985	31	161	269	1587	2048
1986	94	563	490	7891	9037
1987	13	235	127	3775	4150
1988	112	77	133	610	932
1989	0	487	295	692	1474
1990	14	273	771	856	1915
1991	30	1823	792	1304	3948
1992	53	422	630	1094	2199
1993	11	577	185	656	1428
1994	5	1755	135	4577	6472
1995	12	150	88	1321	1571
1996	15	1025	348	549	1937
1997	105	2417	212	1397	4131
1998	75	5180	190	845	6290
1999	202	5987	169	2954	9312
2000	818	1986	145	1077	4025
2001	81	9025	119	1738	10963
2002	8	3678	325	1592	5603
2003	51	1420	136	1014	2620
2004	186	10920	125	4497	15728
2005	65	8530	118	2185	10897
2006	11	2622	104	1838	4575
2007	2	4063	76	2384	6432

Table 4.8.3. Sample size of Spanish mackerel measured for length in the headboat program. NC=North Carolina, SC=South Carolina, NF=North Florida to Cape Canaveral, SF=South Florida from Cape Canaveral through the Florida Keys.

Year	NC	SC	NF	SF	Total
1974		1			1
1975					
1976					
1977					
1978				4	4
1979			2	4	6
1980				3	3
1981			3	11	14
1982	3			1	4
1983	2			65	67
1984			3	17	20
1985			3	10	13
1986		2	5	11	18
1987	1	4	1	115	121
1988	2	2	1	13	18
1989		2	6	1	9
1990	1	30	25	1	57
1991	2	23	9	11	45
1992	1	13	1	12	27
1993		3	4	3	10
1994			2	8	10
1995		4	3	19	26
1996		1	1	2	4
1997	28	16	8	22	74
1998	1	13	2	26	42
1999	1	9	10	14	34
2000	22	14	5	15	56
2001	5		1	16	22
2002	5	9	3	18	35
2003	32	21	2	45	100
2004	13	7	1	15	36
2005	10	8		11	29
2006	13	55		17	85
2007	22	41		19	82

Table 4.8.4. Predicted ratios and standard errors (in parenthesis) between FHS and MRFSS charterboat effort estimates (to be applied to 1986-2003) for the Mid-Atlantic states. Significant factors included state and wave.

	Wave				
	2	3	4	5	6
DE / MD	1.294 (0.52)	1.599 (0.54)	1.930 (0.54)	0.861 (0.52)	1.171 (0.56)
NJ	1.289 (0.36)	1.179 (0.34)	1.644 (0.34)	0.809 (0.34)	1.115 (0.36)
NY	1.187 (0.48)	2.048 (0.54)	2.665 (0.48)	1.210 (0.51)	0.617 (0.48)
VA	0.770 (0.25)	0.680 (0.21)	0.761 (0.21)	0.324 (0.22)	0.313 (0.22)

Table 4.8.5. Party/Charter (PC) mode Ratios for 1981-1985 Vermilion Snapper and Spanish Mackerel estimate adjustment for South Atlantic sub-region (both) and Mid-Atlantic sub-region (Spanish Mackerel only): Headboat (from logbook program: SEHB) plus Charterboat estimates (RDD-CHTS and FHS-GLM Ratio Adjusted) used to produce Party/Charter equivalent landings and adjustment ratios to be applied to the combined PC mode estimates produced by MRFSS using RDD-CHTS derived effort estimates. Significant factors included state and sub-region.

	STATE			
	NC	SC	GA	FL
Vermilion Snapper	1.082 (0.02)	1.082 (0.02)	NA	NA
Spanish Mackerel (south Atlantic)	1.518 (0.09)	2.031 (0.09)	NA	0.710 (0.10)
	ALL MID-ATLANTIC STATES (NY - VA)			
Spanish Mackerel (mid-Atlantic)	1.420 (--)			

Table 4.8.6. Estimates of the number of Spanish mackerel caught (1000s) in the recreational fisheries in the U.S. South and Mid Atlantic areas from the U.S. Fish and Wildlife Service salt-water angling surveys conducted in 1960, 1965, and 1970.

Region	**1960**	**1965**	**1970**
Mid-Atlantic		278	350
South Atlantic	7,380	7,548	4,967
Total	7,380	7,826	5,317

Table 4.8.7. Final estimates of caught Spanish mackerel from recreational anglers.

Year	**Landings (1000s)**	**PSE**
1960	7,380	36%
1965	7,826	46%
1970	5,317	57%

Table 4.8.8. Sample size from unfiltered Spanish mackerel age data from each of the fishing modes (CP=charter, HB=headboat, PR=private, TRN=Tournament). Tournament samples were not included in the age compositon.

Year	CP	HB	PR	TRN	Total
1988	6		109	62	177
1989			35	171	206
1990	66		205	110	381
1991	22		170	211	403
1992	182		16	42	240
1993	13		91	21	125
1994	171				171
1995	70				70
1996	73		5		78
1997	228		88		316
1998	165	31	23		219
1999	40		49	5	94
2000	76		54		130
2001	38		11		49
2002	161		43		204
2003	233		2	86	321
2004	97	135	7	2	241
2005	194	1	9		204
2006	240	4	11		255
2007	182			2	184
Total	2257	171	928	712	4068

Table 4.8.9. Sample size of aged Spanish mackerel by state.

Year	NC	SC	FL	Total
1988	88	14	6	108
1989	4	30	0	34
1990	253	18	0	271
1991	173	8	11	192
1992	161	33	0	194
1993	74	28	0	102
1994	171	0	0	171
1995	67	0	2	69
1996	76	0	1	77
1997	307	0	0	307
1998	214	0	0	214
1999	88	0	0	88
2000	129	0	0	129
2001	46	0	0	46
2002	161	0	42	203
2003	217	0	17	234
2004	220	0	10	230
2005	191	0	13	204
2006	247	0	4	251
2007	181	0	0	181

4.9 Figures

Figure 4.9.1. Reporting areas used in the Southeast Region Headboat Survey.

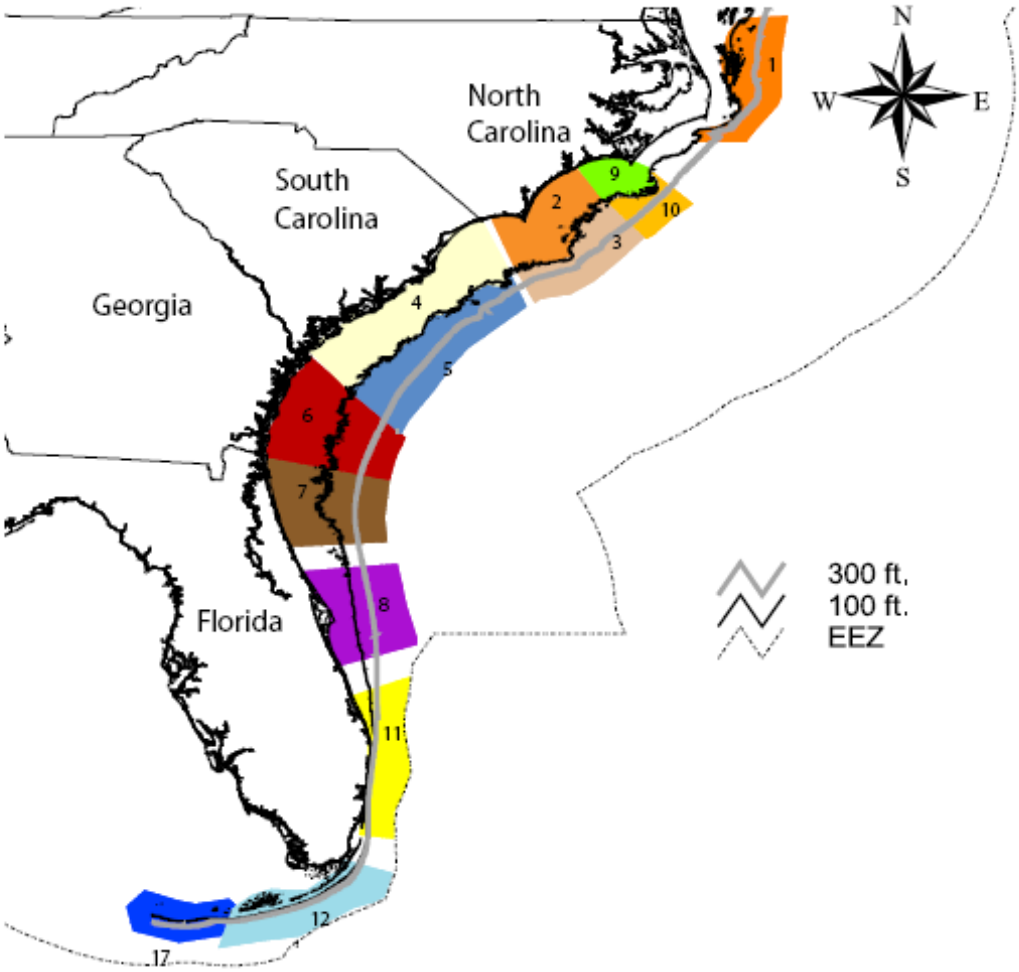


Figure 4.9.2. Number of headboat trips by region in the South Atlantic 1998-2007.

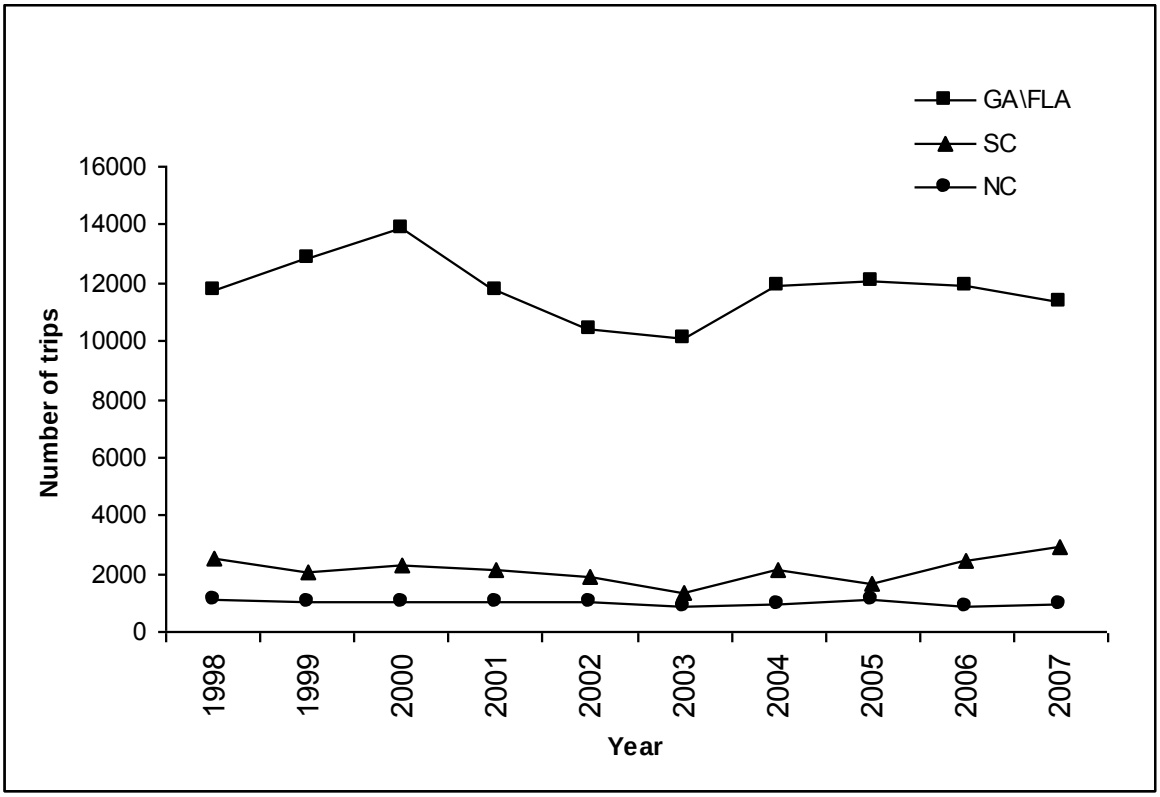


Figure 4.9.3. General recreational length composition from MRFSS data in 1 cm bins.

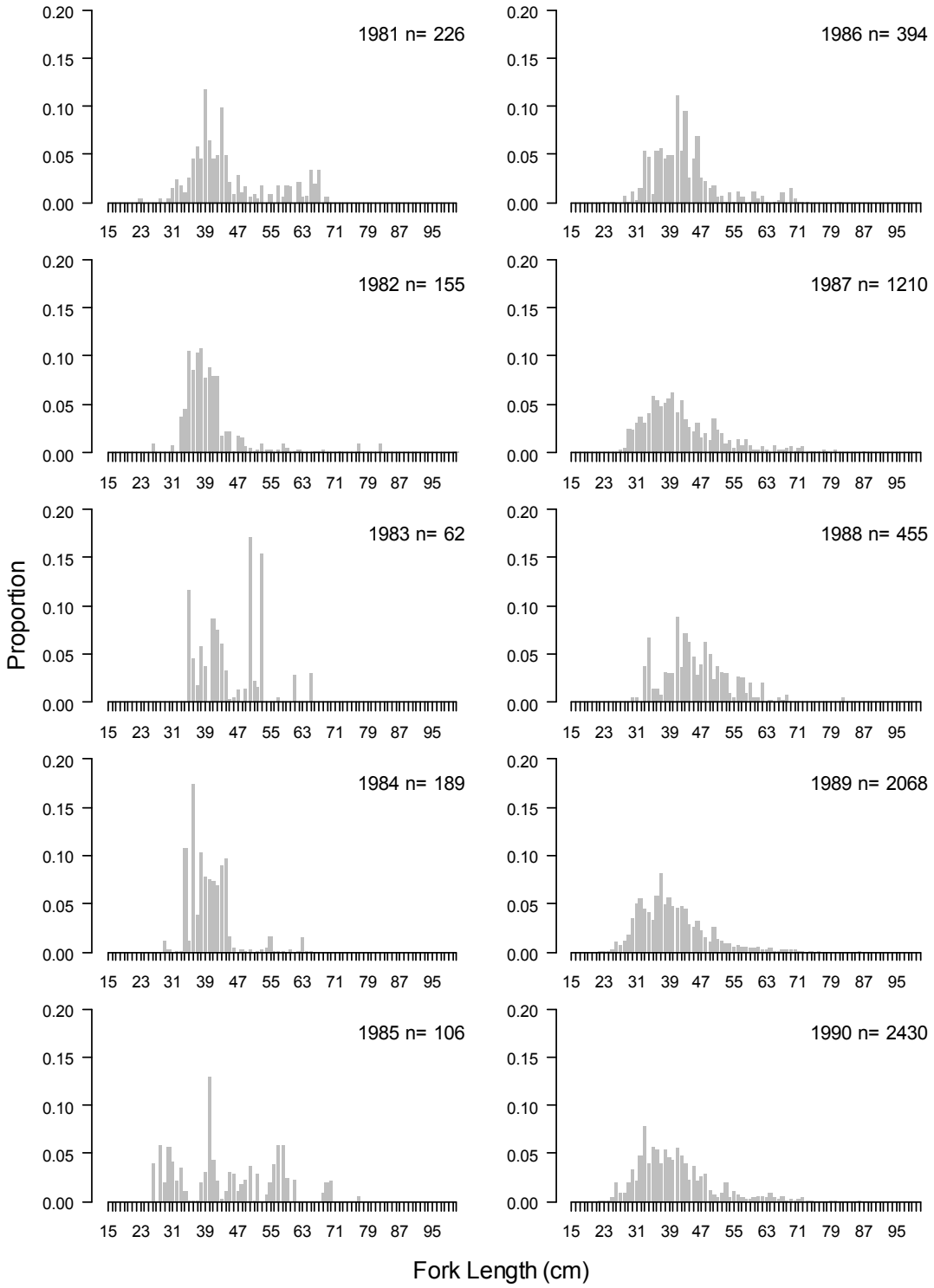


Figure 4.9.3 continued.

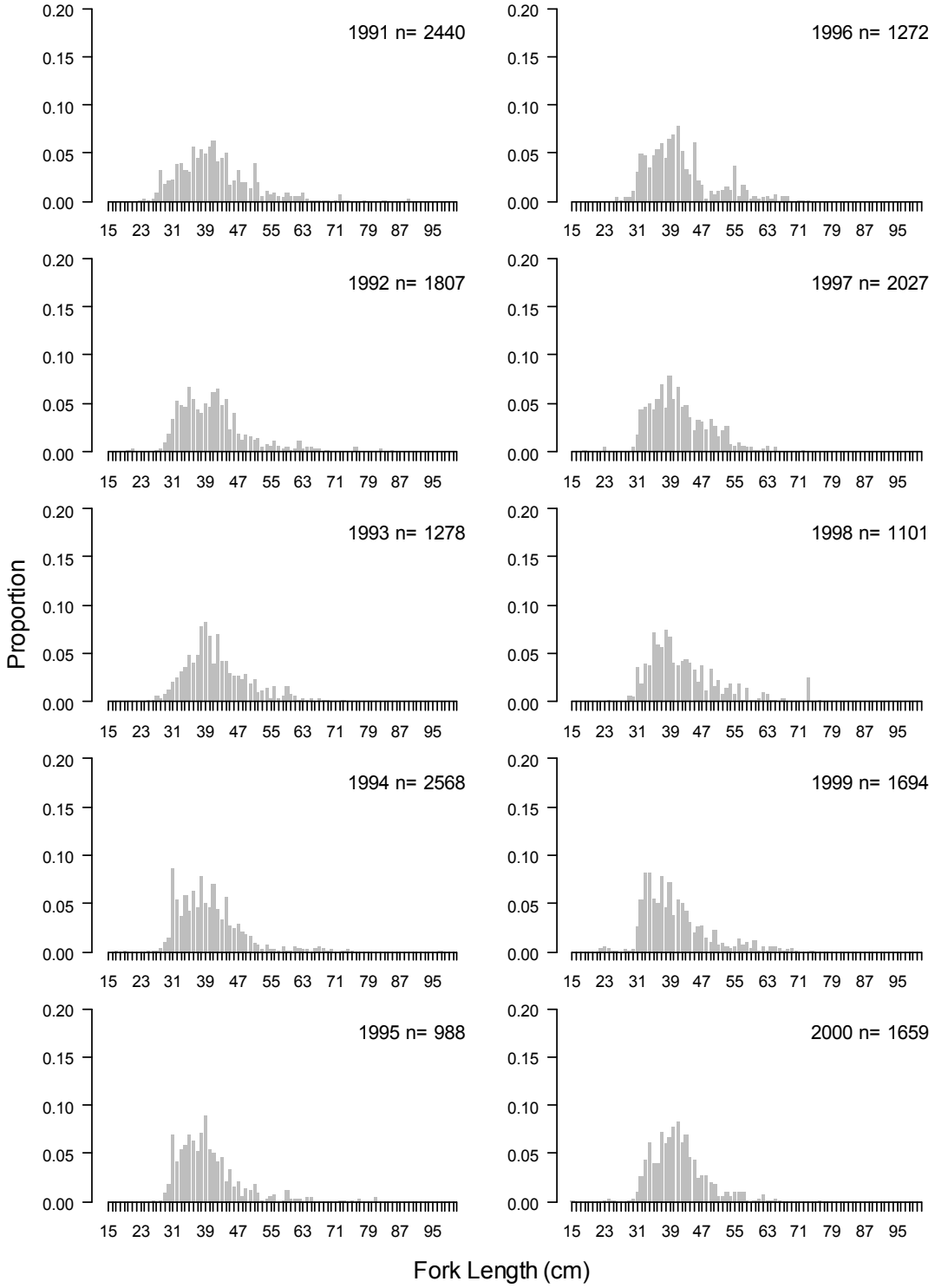


Figure 4.9.3 continued.

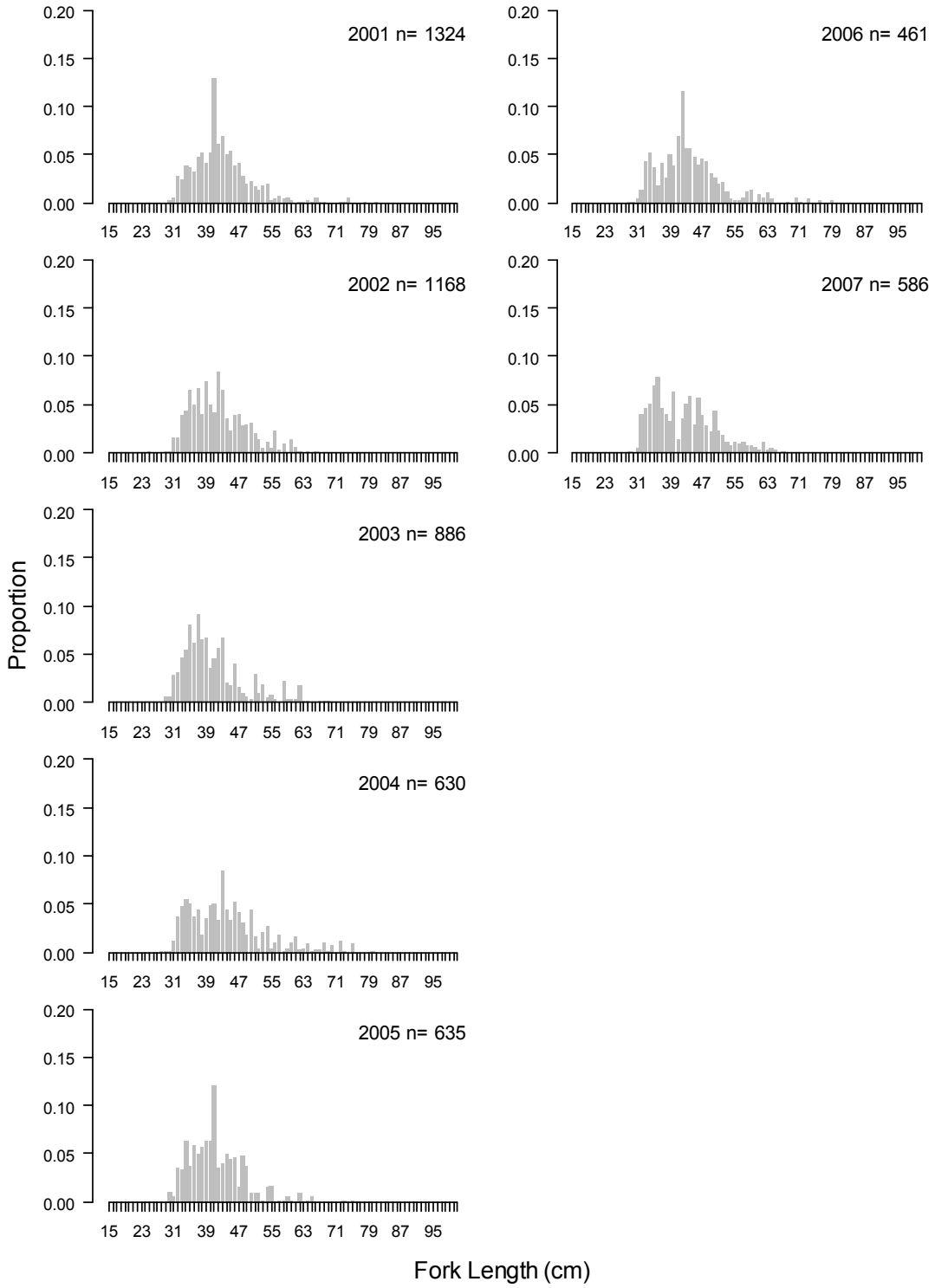
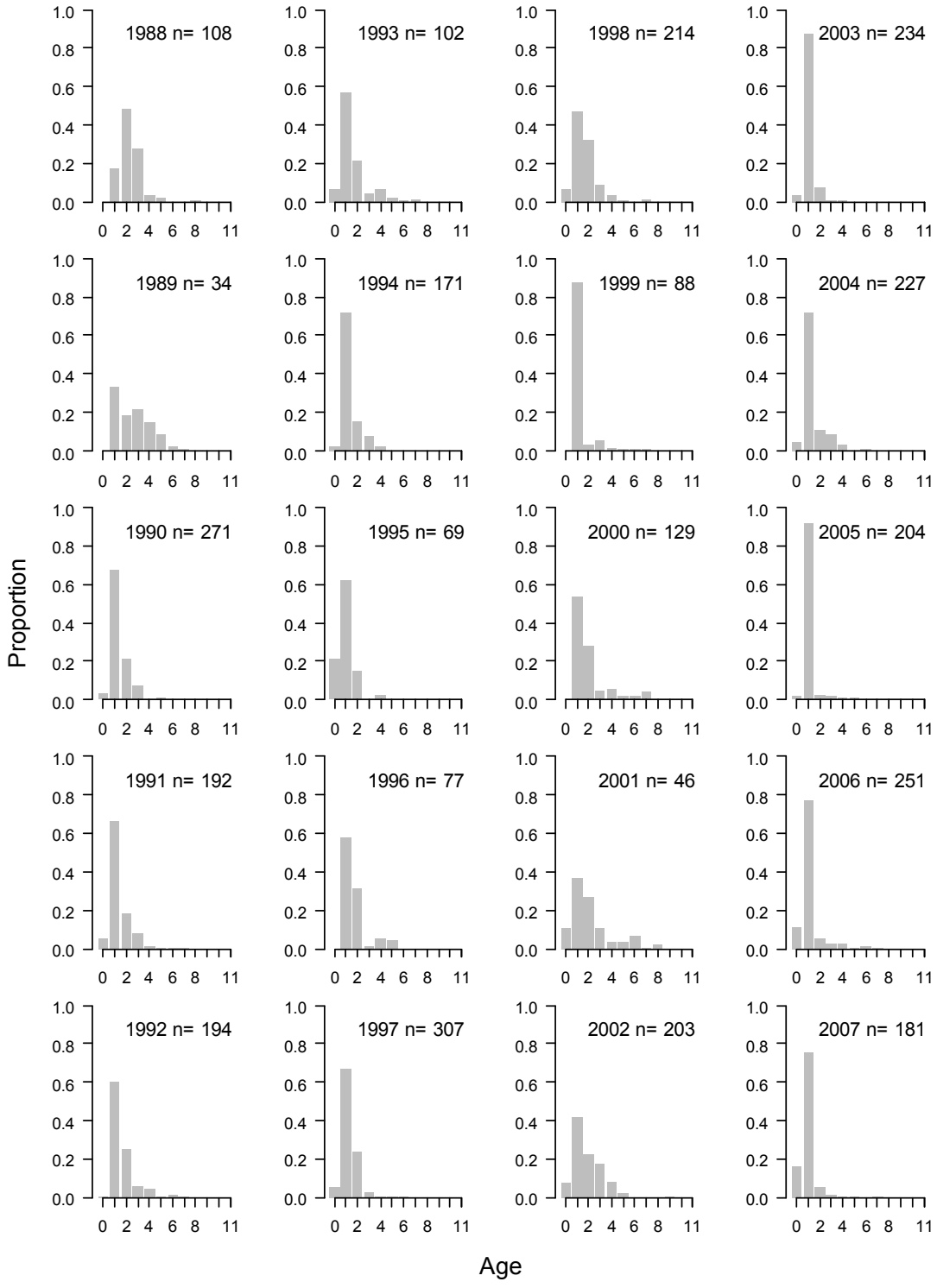


Figure 4.9.4. Age composition of Spanish mackerel from the general recreation fishery. Private, charter, and headboat samples are included. Samples from fishing tournaments were excluded.



5. INDICATORS OF POPULATION ABUNDANCE

5.1 OVERVIEW

Several Spanish mackerel indices of abundance were considered for use in the assessment model. These indices are listed in Table 5.8.1, with pros and cons of each in Table 5.8.2. The possible indices came from fishery dependent and fishery independent data. The DW recommended that six fishery dependent indices be used in the assessment: two from commercial logbook data (for gillnet and handline/trolling fisheries north of Florida), three from commercial trip tickets in Florida (corresponding to handline/trolling, gillnet, and castnet fisheries), and one from general recreational data (MRFSS) (Table 5.8.1, 5.8.2). The three Florida trip ticket indices were conditional on being able to adequately identify and remove records for which a substantial portion of the fishery exceeded trip limits. In addition, the DW recommended use of two fishery independent datasets, both derived from the SEAMAP survey. These included a young-of-year recruitment index derived from summer and fall trawl surveys as well as a one-year-old index from spring trawl surveys.

Membership of this DW working group included Paul Conn, Julie DeFilippi, Pat Harris, Kyle Shertzer (leader), Helen Takade, Elizabeth Wenner, and Geoff White. Ben Hartig (commercial fisherman) provided additional input.

5.2 FISHERY INDEPENDENT INDICES

5.2.1 SEAMAP

5.2.1.1 Background

The SEAMAP survey (Southeast Area Monitoring and Assessment Program) is a fishery independent trawl survey conducted three times a year from Cape Hatteras, NC down to Cape Canaveral, FL according to standardized protocol. This survey recorded a reasonable number of Spanish mackerel for the period 1989-2007; 26,017 fish were caught in a total of 4,872 trawls. In principle, annual changes of catchability should be minimized because the same gear and sample protocols were used throughout. In this regard, indices from SEAMAP are preferable to those from fishery dependent sources.

5.2.1.2 Survey Methods

The SEAMAP program conducts three seasonal trawl surveys each year, with reasonable sample sizes starting in 1989. Samples are taken by trawl from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida (Figure 5.9.1). Multi-legged cruises are conducted in spring (early April - mid-May), summer (mid-July - early August), and fall (October - mid-November). Stations are randomly selected from a pool of stations within each stratum. The number of stations sampled in each stratum is determined by optimal allocation. A total of 102 stations are sampled each season within twenty four shallow water strata, representing an increase from 78 stations previously sampled in those strata by the trawl survey (1990-2000). Strata are delineated by the 4 m depth contour inshore and the 10 m depth contour offshore. In previous years (1990-2000), stations were sampled in deeper strata with station depths ranging from 10 to 19 m in order to gather data on the reproductive condition of commercial penaeid shrimp. Those strata were abandoned in

2001 in order to intensify sampling in the shallower depth-zone. For purposes of index construction, only shallower depth zones were considered in order to maintain consistency in the survey.

The R/V *Lady Lisa*, a 75-ft (23-m) wooden-hulled, double-rigged, St. Augustine shrimp trawler owned and operated by the South Carolina Department of Natural Resources (SCDNR), is used to tow paired 75-ft (22.9-m) mongoose-type Falcon trawl nets (manufactured by Beaufort Marine Supply; Beaufort, S.C.) without turtle excluder devices. The body of the trawl is constructed of #15 twine with 1.875-in (47.6-mm) stretch mesh. The cod end of the net is constructed of #30 twine with 1.625-in (41.3-mm) stretch mesh and is protected by chafing gear of #84 twine with 4-in (10-cm) stretch "scallop" mesh. A 300 ft (91.4-m) three-lead bridle is attached to each of a pair of wooden chain doors which measured 10 ft x 40 in (3.0-m x 1.0-m), and to a tongue centered on the head-rope. The 86-ft (26.3-m) head-rope, excluding the tongue, had one large (60-cm) Norwegian "polyball" float attached top center of the net between the end of the tongue and the tongue bridle cable and two 9-in (22.3-cm) PVC foam floats located one quarter of the distance from each end of the net webbing. A 1-ft chain drop-back is used to attach the 89-ft foot-rope to the trawl door. A 0.25-in (0.6-cm) tickler chain, which is 3.0-ft (0.9-m) shorter than the combined length of the foot-rope and drop-back, is connected to the door alongside the foot-rope. Trawls are towed for twenty minutes, excluding wire-out and haul-back time, exclusively during daylight hours (1 hour after sunrise to 1 hour before sunset). Sampling during spring of 1989 was conducted at night, and thus was omitted from analysis. Each net is processed separately and assigned a unique collection number (port=odd, starboard=even); however, data from the paired trawls are pooled for analysis to form a standard unit of effort (tow), with the port (odd) collection number assigned to the tow. Contents of each net are sorted separately to species, and total biomass and number of individuals are recorded for all species.

5.2.1.3 Analysis methods

One issue that arises when exploring SEAMAP data is the sizes (and ostensibly ages) that are captured (Figure 5.9.2). In spring trawl surveys, almost all fish appear to be surviving members of the previous year's recruitment class, while summer and fall surveys primarily document young of year (YOY). For example, growth equations derived by Powell (1975) and Schmidt et al. (1993) point to an average size of around 27 inches for YOY, and 35 inches for 1 year olds. However, spawning occurs over a wide range of dates (April/May to August/September; Powell 1975, Schmidt et al. 1993), leading to a wide variety of sizes for a given year class.

For purposes of this stock assessment, we considered one index for young of the year, and one for 1-year-olds. The former appeared to be the primary group that was caught in Summer and Fall trawl surveys, although there were some one-year-olds mixed in. To limit mixing, we eliminated records of fish caught in summer and fall trawl surveys that were greater than 22 cm. An index of young-of year recruitment was then calculated as the average number of fish in this size range caught per summer and fall trawl per year, with sample standard errors used to calculate asymptotic 95% confidence intervals (± 1.96 SE; Figure 5.9.3, Table 5.8.3). Standard errors should be treated with

caution. The lengths of fishes in many of the trawls seemed to be correlated (e.g., when fish in a trawl were all of similar size), suggesting that individual trawls did not sample the population randomly.

The correlation between the YOY index and the index of one-year-olds in the following year was -0.26. The DW had hoped that joint modeling of both indices would allow for modeling of winter survival of recruits; however, this may not be possible given that the two do not appear to be related. If one of the indices had to be chosen over the other, the DW recommended using the YOY index because of greater temporal coverage and sample size. In addition, concerns were raised that an unknown proportion of one year olds may be unavailable for sampling due to growth past the selectivity range of the trawling gear. This recommendation was made with some reservation; if there is considerable variability in overwinter mortality of YOY, the one-year-old index may serve as a better recruitment index.

5.2.2 Other fishery independent sources

Other existing data sets (MARMAP survey, NEAMAP survey, N. C. Pamlico Sound trawl survey, Northeast Ground Trawl Survey, and diver reports (e.g., www.reef.com)) were considered for their potential as indices, but they sampled either no Spanish mackerel or insufficient numbers to be useful. The DW thus eliminated them from consideration.

5.3 FISHERY DEPENDENT INDICES

5.3.1 COMMERCIAL LOGBOOK

5.3.1.1 General description

The 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 the catch (Appendix 5.10.1). 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 with snapper-grouper permits were required to submit logs. For Spanish mackerel, mandatory reporting was required in 1998. Using these data, indices of abundance were computed for handline/trolling and gillnet fisheries for 1998–2007 for points north of Florida (Georgia – New York; 31° N ≤ latitude ≤ 40° N). The DW recommended using both indices, which had reasonable sample sizes and CV's (Table 5.8.5).

5.3.1.2 Issues discussed at the DW

Issue 1: Trip tickets vs. logbook

Option 1: Use trip tickets in NC and FL because they go back further in time (1985 for FL, 1996 for NC), thus increasing sample size. Trip tickets also sample more fishermen because only those with federal permits appear in the logbook survey.

Option 2: Use logbook because more precise information is available on effort and there is better spatial coverage (e.g., Georgia and South Carolina). However, logbook records are only required for Spanish since 1998.
Option 3: Use trip tickets for FL and logbook for the remaining states.
Decision: Option 3, because FL trip ticket gear types better correspond to summarized commercial landings (e.g., cast nets are broken out), which is needed for applying the correct selectivity curve in the assessment model. Records also span the period of apparent low abundance and the net ban. For NC, there is evidence that effort per trip (in terms of net-area-hours) has changed over time, which calls into question the use of NC trip ticket data for developing an index of abundance, because effort it in units of "trip" (Figure 5.9.4).

Issue 2: Gear selection
Option 1: Include separate gillnet and handline/trolling indices
Option 2: Include only gillnets
Decision: Option 1, because sample sizes were reasonable for both groups if all positive trips were included for the handline/trolling index

Issue 3: Defining which trips constitute effort
Option 1: Include only positive trips
Option 2: Use method of Stephens and MacCall (2004) to define effort that could have caught the focal species based on the composition of other species in the catch. This method would include trips with zero catch but positive effort.
Option 3: Include positive trips for the handline/trolling fishery and all trips for the gillnet fishery
Decision: Option 3, because federally licensed vessels are highly selective for Spanish when they are fishing for them. For handline/troll fishery this increases sample size to 1058 records, while applying the method of Stephens and MacCall (2004) to subset trips resulted in a total of 183 positive trips out of 972 trips that were selected as being likely to catch Spanish mackerel. For the gillnet fishery, 70% of trips were positive for Spanish mackerel, so including all of them was thought to be a reasonable indicator for effort.

Issue 4: Defining changes to catchability
Option 1: Include trends in catchability to reflect changes in technology.
Option 2: Do not include changes in catchability
Decision: Option 2, because coastal pelagics are not as susceptible to sonar, GPS, and other technologies that have ostensibly increased catchability in snapper-grouper fisheries.

5.3.1.3 Methods

The CPUE from commercial logbook data was computed in units of total pounds caught per hook-hour for the handline/troll fishery, and total pounds per net-area-hour for the gillnet fishery. The duration of the time series was 1998–2006, and included all records between 31° N and 40° N latitude (Figure 5.9.5; Table 5.8.5). Each record describes weight (total lb) of a single species caught on a single trip, along with

descriptive information of the trip, such as effort, date, and area fished (Appendix 5.10.1).

Of trips that caught Spanish mackerel, approximately 85% (6014 records) used gillnets, while most of the remainder used various forms of hook and line (electric reels, gear code E, 48 records; handline, gear code H, 157 records; trolling, gear code, TR, 864 records). Data from 4 positive trawls (gear code T) were deleted for analysis, with the remaining hook and line records combined for calculation of a hook and line index. Excluded were records suspected to be misreported or misrecorded, as in previous SEDAR assessments (e.g., SAFMC, 2006; SAFMC, 2007): The variable "fished" (number of hours fished) was constrained to less than 24 hours; the variable "numgear" (number of lines) to be an integer value; and the variable effort (# hooks/line or number of gillnets used) to be an integer value. All records that were missing *away, effort, fished, numgear, schedule,* or *species* fields were also deleted.

Prior to standardizing CPUE with generalized linear models, a number of outliers were noted, and the top one percent of CPUE records were deleted from both gear types (gillnet & hook-and-line) to remove them from analysis. Standardized catch rates were estimated using generalized linear models assuming either delta-lognormal or delta-gamma error structures (Lo et al., 1992; Dick 2004; Maunder and Punt, 2004), in which the binomial distribution describes positive versus zero CPUE, and the lognormal or gamma distribution describes positive CPUE. Explanatory variables considered, in addition to year (necessarily included), were geographic area, and gear type (handline/electric reels vs. trolling for the hook-and-line index). Geographic areas reported in the logbooks were pooled into two larger areas to provide adequate sample sizes for each level of this factor— GA & SC (31°N ≤ latitude ≤ 33°N), and NC up to NY (34°N ≤ latitude ≤ 40°N). Interactions with year effects were not considered, because there was no *a priori* reason to expect them and because such effects may be inseparable from annual changes in abundance.

Lognormal and gamma models were fitted to both datasets, and the error structure with the lowest AIC was selected (cf., Dick 2004; SEDAR17-RD16). In this case, the lognormal model was resoundingly selected for both indices (ΔAIC = 484.3 for hook & line; ΔAIC = 164.2 for gillnet). To put this in context, Burnham and Anderson (2002, pg 70) suggest that that a ΔAIC score of 10 or greater suggests essentially no support for the lower-ranked model. Delta-lognormal glms appeared to fit the CPUE data reasonably well, with neither normal quantile-quantile plots nor plots of standardized residuals against fitted values showing any serious trends (Appendix Figures 5.10.2.1, 5.10.2.2)

5.3.1.6 Catch Rates and Measures of Precision

Table 5.8.5 shows standardized CPUE series, standard errors (SE), and annual sample sizes (number of positive trips) for gillnet and hook& line fisheries. Figure 5.9.6 shows standardized and nominal CPUE, together with confidence intervals. Logbook indices were weakly (but positively) correlated with $\rho = 0.15$.

5.3.1.7 Comments on Adequacy for Assessment

The logbook index was recommended by the DW for use in the assessment. The DW, however, did express several concerns about this data set (Table 5.2). 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 logbook survey only obtains reports from federally permitted commercial fishermen. Since Spanish mackerel are often present in state waters, they can be targeted by commercial fishermen that do not have federal permits. Thus, the survey does not represent total effort for the commercial fishery. This could be problematic if there were partitioning of effort between the two groups such that federally permitted fishermen fished in areas further offshore. In this case, changes in CPUE may reflect changes in migratory pattern in addition to changes in abundance and/or catchability.

Second and probably foremost, the data are obtained from a directed fishery and therefore the index could be subject to problems associated with any fishery dependent index. Overall efficiency may have changed throughout the time series if fishermen of marginal skill have left or joined 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. In recent SAFMC assessments of reef fishes (e.g. SAFMC 2006, 2008), base model runs assumed catchability increased over in time in response to changes in technology. However, in the case of Spanish mackerel, the DW decided that the assumption of constant catchability was reasonable because recently developed technologies are not in general useful for locating coastal pelagics.

5.3.2 FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION (FWC) MARINE FISHERIES TRIP TICKET PROGRAM

5.3.2.1 General description

The FWC has recorded fisheries landings and effort data since November 1984. Since then, state law has required that all sales of seafood products from Florida waters be reported via a Marine Fisheries Trip Ticket (cf., http://floridamarine.org/features/view_article.asp?id=23423). Included in the trip ticket database are date of trip, total pounds landed, gear type, county, and areas fished (e.g. inshore, offshore, federal waters). Using these data, indices of abundance were calculated for three gear types: gillnet, castnet, and handline. The DW recommended use of all of these indices, although certain years and trips were to be omitted from analysis.

5.3.2.2 Issues discussed at the DW

Issue 1: What trips should be included given that trip limits changed over time?

Regulations for Spanish mackerel in Florida were changed frequently over the years, with a diverse array of trip limits and closures.

Option 1: Include all trips

Option 2: Only include data from April through October (regulations were reasonably constant during this time period)

Option 3: Include data from trips occurring on days and with gears unlikely to run up

against trip limits.

Decision: Option 3, because option 2 eliminates most trips (the primary fishery is in winter), and because option one may lead to problems with interpretability. If trips are constantly hitting up against trip limits, CPUE is unlikely to reflect abundance. In contrast, if we limit analysis to those where the probability of hitting up against a trip limit is relatively low (e.g., 5%), CPUE may better reflect abundance.

Issue 2: What defines effort?

For trip ticket data, the only reasonable proxy for effort is a trip. Examination of the logbook data from 1998-2007 indicated that effort decreased over time for the handline fishery (Figure 5.9.7), which may cast doubt on the utility of a trip as a unit of effort. However, there was some debate as to how primary gear types were assigned in the logbook database (e.g., castnets hardly ever appeared), and whether this decline really represented declining effort or whether it was more of a function of changing gear types. A Florida commercial fisherman present at the DW (Ben Hartig) suggested that due to the directed nature of the commercial fishery in Florida that all fishermen put in about the same amount of effort each time they go out, and that a 'trip' is about the best descriptor of effort one could hope for. The DW thus recommended using a 'trip' as a measure of effort.

Issue 3: What gears and time series should be considered?

Of the three primary gears used in Florida (castnet, gillnet, and handline), only handline has been consistently similar in method of operation throughout the course of the fishery. The gillnet fishery was largely unregulated until the late 1980's, with spotter planes being used to locate schools of fish and wrap around nets being used as the primary gear. Following a series of increasingly restrictive federal regulations in the early 1990's, a gillnet ban was put into effect in Florida state waters in 1995. These events dramatically altered the character of the fishery, with a large castnet fishery arising in the early 2000's. The DW agreed that if a gillnet index were to be used, it should be broken into two pieces: one prior to the net ban, and one after the net ban. Concerns were raised about anecdotal changes in migratory pattern of Spanish mackerel in recent years (2003-present), whereby Spanish were absent from traditional fishing locations and thus more susceptible to harvest by gillnets than by castnets or handlines. Thus, none of the indices alone would capture true abundance in the last few years prior to the assessment. Nonetheless, the DW agreed to pursue indices for all three gear types, with the thought that a compromise in model fit with all three indices included may best represent abundance in the areas where Spanish mackerel are most frequently landed.

Issue 4: Defining changes to catchability

Option 1: Include trends in catchability to reflect changes in technology.
Option 2: Do not include changes in catchability

Decision: Option 2, because coastal pelagics are not as susceptible to sonar, GPS, and other technologies that have ostensibly increased catchability in snapper-grouper fisheries.

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5.3.2.3 Methods

As a precursor to analysis, trips were screened to include only those that were unlikely to run up against a trip limit. To do so, a trip limit was assigned to each trip that was positive for Spanish mackerel by associating trip dates with corresponding regulations (some of which changed with day of the week). The percent of trips that met or exceed trip limits were then plotted by time according to gear and trip limit level (Figures 5.9.8-5.9.11). For gillnets and castnets, any trip limits under 3500 lb resulted in a large percent of trips meeting or exceeding trip limits, and so trips occurring on these days were censored from analysis. For the handline fishery, only 500 lb trip limits resulted in a large percentage of trips meeting or exceeding the trip limit; these were likewise omitted from analysis. After applying this approach, the number of trips included in analysis was somewhat reduced but still substantial (Tables 5.8.6-5.8.8). The following time series were considered as having large enough sample sizes for analysis:

- For gillnet, two time series: prior to FL state gillnet ban (1985-1994), after gillnet ban (1996-2007)
- For castnet, one time series (1999-2007)
- For handline, one time series (1985-2007)

For each such series, two generalized linear models (assuming either gamma or normal errors) were used to relate the log of catch/trip to predictor variables. In particular, categorical variables were specified for year, month, and county, and binary variables were assigned for whether other species had been caught. Six such binary variables were assigned, based on whether the other species caught were grouped as one of the following categories by Florida trip ticket personnel: “inshore pelagic,” “offshore pelagic,” “inshore bottom,” “offshore bottom,” “reef fish,” or “other species” (cf., Table 5.8.9). Akaike’s information criterion (AIC) was then used to select among error structures (gamma or normal).

The gamma error structure was selected as the most appropriate for the gillnet fishery prior to the gillnet ban (ΔAIC = 3400), while the normal error structure was selected for the remaining fisheries (ΔAIC = 2621, 7100, and 999, for the 1996-2007 gillnet, the castnet, and the hand lines fisheries, respectively). Standard diagnostic plots (Appendix Figures 5.10.2.3-5.10.2.6) indicated that error assumptions for GLMs were largely reasonable, except perhaps for the castnet fishery. A typical approach in this case would be to inflate the variance of the estimated CPUE trend with a variance inflation factor (cf. McCullough and Nelder 1989). However, the CV associated with trends are typically rescaled prior to assessments in the South Atlantic region, making variance inflation procedures redundant. Instead, one possible suggestion is to decrease the weight on the castnet index during fitting of the assessment model.

5.3.2.4 Sampling Intensity

The numbers of positive trips by year and gear are tabulated in Tables 5.8.6-5.8.8.

5.3.2.5 Size/Age Data

Sizes and ages of fish represented by these indices are the same as those sampled by commercial fisheries using the same gear (see chapter 3 of this DW report).

5.3.2.6 Catch Rates and Measures of Precision

Diagnostic plots of residuals from the GLM model fits are in Appendix 5.10.2. Table 5.8.10 shows nominal CPUE (total lb/trip), standardized CPUE, and coefficients of variation (CV). Figure 5.9.12 shows standardized and nominal CPUE for all Florida trip ticket indices.

5.3.2.7 Comments on Adequacy for Assessment

Trip ticket indices were recommended by the DW for use in the assessment. However, the DW did discuss several concerns (Table 5.2). One concern was that this index may contain problems associated with fishery dependent indices, such as density dependent changes in catchability and/or fish targeting. This was especially relevant given the number and frequency of regulation changes. Although these changes were accounted for in some way by censoring data or were controlled for in GLMs, changes in effort related to the timing of regulations could not be adequately addressed. For instance, if fishermen anticipated that a season would be closed (or if the fishery were opened at the start of a new fishing year), would they increase effort in months of the year where the fishery was not traditionally very active and/or successful? At least one member of the DW thought that these data should be omitted from consideration because of such concerns. However, a commercial fisherman present at the DW (Ben Hartig) provided ancillary information that the trends in the various fisheries were representative of what he was seeing on the water. Data workshop representatives ended by agreeing it was important to attempt to include commercial indices from the state of Florida, which has historically accounted for the vast majority of commercial landings of Spanish mackerel in the south Atlantic.

5.3.3 RECREATIONAL INTERVIEWS

5.3.3.1 General description

The general recreational fishery is sampled by the Marine Recreational Fisheries Statistics Survey (MRFSS). This general fishery includes all recreational fishing from shore, man-made structures, private boats, and charter boats (for-hire vessels that usually accommodate six or fewer anglers). Party boats were removed from this analysis because they are sampled by the headboat survey. Using the MRFSS data from the South Atlantic region, that is Currituck County, North Carolina through Miami-Dade County, Florida (Figure 5.9.13), an index of abundance was computed for 1987–2007.

5.3.3.2 Issues discussed at DW

Issue 1: Trip selection

Option 1: Select angler-trips based on the method of Stephens and MacCall (2004)

Option 2: Use MRFSS data on effective effort to select angler-trips: Apply proportion of intercepted trips that were "directed" [i.e., targeted or caught (A1+B1+B2)] to estimates of total marine recreational angler-trips.

Option 3: Use MRFSS data on effective effort to select angler-trips: Apply proportion of intercepted trips that were "directed" [i.e., targeted or harvested (A1+B1 only)] to estimates of total marine recreational angler-trips.

Decision: Option 2, because it is not clear how to implement the method of Stephens and MacCall (2004) given the MRFSS survey sampling design. Also, inclusion of B2's (discards) are useful for interpretation of CPUE as an index because of the high frequency of MRFSS trips bumping up against bag limits at the beginning of the time series (Figure 5.9.14).

Issue 2: First year of time series
Option 1: Start the time series in 1982, the first year of data collection.
Option 2: Start the time series in 1987, because of small sample sizes in 1982-1986.
Decision: Option 2. The DW decided to start the time series in 1987, when the sampling intensity increased substantially (Table 5.8.11).

Miscellaneous decisions
• A bag limit of 10/person/day was instituted for the recreational fishery in North Carolina, South Carolina and Georgia in 1987. A bag limit of 4/person/day was instituted for the recreational fishery in Florida in 1987. The bag limit in Florida was raised to 5/person/day in 1991 and 10/person/day in 1992. The bag limit for all four states was set at 15/person/day in 2000. The DW examined the occurrence of reaching and exceeding the bag limit and determined that it would not influence an index of abundance derived from recreational fishery data if discard data (B2's) were included in the analysis.
• Estimates of CV of the catch per effort are not obtainable, but instead were represented by proportional standard error (PSE) of total catch.

5.3.3.3 Methods

MRFSS CPUE
The CPUE was computed in units of number fish per angler-trip. The method chosen produced unbiased estimates of "directed" angler trips by applying the proportion of intercepted trips that were "directed" toward Spanish mackerel to estimates of total marine recreational angler trips. Directed trips were defined in two ways. First, directed trips were defined as those trips where Spanish mackerel was listed as targeted (under the variables "prim1" or "prim2") or caught (A1+B1+B2). Type B2 group catches (fish released alive) were assigned angler-trip values based on the leader with additional anglers acting as followers. Second, directed trips were defined as targeted (under the variables "prim1" or "prim2") or harvested (A1+B only). The proportion of directed trips was calculated based on the count of directed trips relative to all samples taken in a year/state/wave/mode/area strata. That proportion was then applied to the effort estimate for the same strata and summed up to the year/region level. The MRFSS data used included those areas ranging from North Carolina to the east coast of Florida excluding Monroe County. The directed trip analysis was obtained from the Atlantic Coastal Cooperative Statistics Program website (ACCSP, 2008).

BAG FREQUENCY DATA
Bag limits are typically analyzed as harvest. ACCSP pre-calculates the data from MRFSS intercept and effort estimate files and stores the output for online user queries. The code produces unbiased estimates of angler trips by catch frequency for harvest of a

species by state/mode/area/wave strata by applying proportion of intercepted trips that caught Spanish mackerel to estimates of total marine recreational angler trips.

5.3.3.4 Sampling Intensity
Sampling intensity (number of intercepted angler-trips) by state is shown in Table 5.8.11.

5.3.3.5 Size/Age Data
Sizes and ages of fish represented by this index are the same as those of the recreational fishery as sampled by the MRFSS (see chapter 4 of this DW report).

5.3.3.6 Catch Rates and Measures of Precision
Table 5.8.11 shows nominal CPUE (number/angler-trip) and estimates of precision, as does Figure 5.9.15.

5.3.4 Other Fishery Dependent Indices

Considerable effort was put towards developing an index from the headboat observer survey program database. However, a small percentage of boats – typically carrying 10 or fewer passengers – caught the majority of Spanish mackerel. Two approaches were considered. In the first, the method of Stephens and MacCall (2004) was used to subset trips by species composition. In the second, trips were subset to only include records from small vessels (≤10 anglers). In practice, both of these approaches resulted in inadequate sample sizes (e.g., 0-160 trips/year). As a result, the DW did not recommend indices developed from the headboat survey.

The Shrimp Fishery Observer Program was also considered, but dismissed by the DW because of low sample sizes (300 trips since the early 1970's) and extreme variability (see SEDAR17-DW12). The NC Citation program and online recreational reports were also considered but dismissed because they were voluntary and likely subject to reporting bias.

5.4 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

Two fishery independent indices based on the SEAMAP trawl survey were recommended for analysis, one of which represented young-of-year recruitment, while the other represented one-year-olds. Seven fishery dependent indices were recommended: commercial hook & line north of Florida (logbook), gillnet north of Florida (logbook), gillnet in Florida prior to state net ban (FL trip ticket; 1985-1994), gillnet in Florida after the net ban (FL trip ticket 1996-2007), Florida castnet (FL trip ticket), Florida handline (FL trip ticket), and MRFSS (Tables 5.1, 5.2). These indices are compared in Figure 5.9.17 and their correlations are in Table 5.8.12. It is noted that the correlations between indices are in many cases weak and often negative, indicating that none of the indices alone likely represents abundance well. Nevertheless, by using indices from different sectors of the fishery, one hopes to obtain a more complete picture of stock abundance over time.

5.5 RESEARCH RECOMMENDATIONS

1. Expand existing fishery independent sampling and/or develop new fishery independent sampling of the Spanish mackerel population off the southeastern U.S. Two ideas discussed were the following:
   - Collect age samples from SEAMAP
   - Fishery independent sampling of adults

2. Investigate whether catchability varies as a function of fish density and/or environmental conditions.

3. Investigate how temporal changes in migratory patterns may influence indices of abundance (for fishery dependent and fishery independent indices).

4. Investigate the possibility of using models that allow catchability to follow a random walk.

5.6 ITEMIZED LIST OF TASKS FOR COMPLETION FOLLOWING WORKSHOP

- Perform analysis of Florida trip ticket data
- Analyze logbook hook & line data for positive trips rather than using method of Stephens & MacCall
- Generate tables and figures
- Write chapter of DW report
- Submit data to Data Compiler

5.7 LITERATURE CITED

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5.8 Tables

Table 5.8.1. A summary of catch-effort time series available for the SEDAR 17 data workshop.

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Size Range	Issues	Use?
Recreational	Headboat	NC-FL	1976-2007	Number per angler-hr	Stephens and MacCall; delta-GLM	Same as fishery	Fishery dependent; small sample sizes	N
Commercial	Logbook - handline	NC-NY	1998-2007	Pounds per hook-hr	All positive trips	Same as fishery	Fishery dependent	Y
Commercial	Logbook – gillnet	NC-NY	1998-2007	Pounds per net-area-hr	All trips	Same as fishery	Fishery dependent	Y
Commercial	FL Trip Ticket Program - Castnet	FL	1985-2007	Pounds per trip	GLMs on positive trips	Same as fishery	Fishery dependent, only trip-level effort information	Y
Commercial	FL Trip Ticket Program - Gillnet	FL	1985-2007	Pounds per trip	GLMs on positive trips	Same as fishery	Fishery dependent, only trip-level effort information	Y
Commercial	FL Trip Ticket Program – Handline/ Trolling	FL	1985-2007	Pounds per trip	GLMs on positive trips	Same as fishery	Fishery dependent, only trip-level effort information	Y
Commercial	NC Trip Ticket Program	NC	1994-2007	Pounds per trip	—	Same as fishery	Fishery dependent, only trip level information	N
Commercial	Shrimp Fishery Observer Program	NC-FL	1998-2007	Pounds per tow	Delta-GLM (see SEDAR17-DW12)	Primarily young-of-year & 1-year-olds	Fishery dependent, Low sample sizes	N
Recreational	MRFSS	NC-FL	1987-2007	Number per angler-trip	Angler-trips included if species was targeted or caught (A+B1+B2); Nominal	Same as fishery	Fishery dependent	Y
Independent	MARMAP Chevron trap (extended)	NC-FL	1990-2007	Number per trap-hr	Nominal	—	Very low sample sizes	N
Independent	MARMAP Hook and line	NC-FL	1979-1998	Number per hook-hr	Nominal	—	Very low sample sizes	N
Independent	MARMAP Short longline	NC-FL	1980-2007	Number per hook-hr	Nominal	—	Very low sample sizes	N

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Size Range	Issues	Use?
Independent	SEAMAP	NC-FL	1990-2007	Number per hectare	Nominal	see Issues	Only contains ages 0 and 1	Y
Independent	NEAMAP	NY-Cape Hatteras	2006-2007	Number per hectare	Nominal	see Issues	Only contains ages 0 and 1, 2 year time series	N
Independent	NMFS Northeast Groundfish Trawl	ME – Cape Hatteras	1972-2007	Number per hectare	Nominal	—	Very low sample sizes	N
Independent	NC Pamlico Sound Survey	Pamlico Sound, NC	1987-2007	Number per tow	Nominal	—	Very low sample sizes	N
Independent	Diver Reports (Reef.org)	NC-FL	1990-2007	—	—	—	Voluntary reporting	N
Recreational	NC Citation Program	NC	19---2007	—	—	—	Voluntary reporting, variable publicity, target species may not be included in program	N
Recreational	Online recreational trip reporting (myfish.com)	NC-FL	2007	—	—	Same as fishery	Voluntary reporting, currently only on year of data available	N

Table 5.8.2. Issues with each data set considered for CPUE.

Fishery dependent indices

Commercial Logbook –

Gillnet, north of Florida (*Recommended for use*)

Pros: Complete census of federally permitted fishermen
Migrating stock; all individuals ostensibly subject to harvest
Large sample size
Better measures of effort than NC trip tickets

Cons: Fishery dependent
Will not contain all landings and effort (esp. non-federal)
Data are self-reported and largely unverified
Little information on discard rates
Catchability may vary over time and/or abundance

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

Handline & Trolling gears, north of Florida (*Recommended for use*)

Pros: Complete census of federally permitted fishermen
Migrating stock; all individuals ostensibly subject to harvest
Better measures of effort than NC trip tickets

Cons: Fishery dependent
Will not contain all landings and effort (esp. non-federal)
Data are self-reported and largely unverified
Little information on discard rates
Catchability may vary over time and/or abundance

Issues Addressed:
In some cases, self-reported landings have been compared to TIP data, and they appear reliable
Stephens and MacCall method resulted in sample sizes too small to be useful; due to directed nature of fishery, the DW suggested looking at all positive trips instead.

Recreational Headboat (*Not recommended for use*)

Pros: Complete census
Covers entire management area
Longest time series available
Data are verified by port samplers
Consistent sampling

Cons: Fishery dependent
Little information on discard rates
Catchability may vary over time and/or abundance
Spanish mackerel not a target species of many headboats
Low sample sizes

Issues Addressed:
Possible differences between trips carrying 10 or fewer anglers and trips carrying more than 10 anglers

MRFSS (*Recommended for use*)

Pros: Relatively long time series
Nearly complete area coverage (excluded Monroe County)
Only fishery dependent index to include discard information (A+B1+B2)

Cons: Fishery dependent
High uncertainty in MRFSS data
Targeted species (fields prim1 and prim2) are missing for many observations in the data set

Trip Ticket Program

Florida castnet (*Recommended for use*)

Pros: Will contain all landings and all effort
Longer time series than commercial logbook
Castnets can be broken out from gillnets, which is not possible in commercial logbooks
Nominal castnet trends reflect anecdotal reports

Cons: Fishery dependent
Effort only to the trip level
Subject to multiple changes in regulations, particularly trip limits

Issues Addressed: Changes in effort over time, with high variability but no trend in effort.

Florida gillnet (*Recommended for use*)

Pros: Will contain all landings and all effort
Longer time series than commercial logbook

Cons: Fishery dependent
Effort only to the trip level
Subject to multiple changes in regulations, particularly trip limits

Issues Addressed: Changes in effort over time, with high variability but no trend in effort. Need to break up index into two pieces to account for net ban in state waters that went into effect in 1995.

Florida handline/trolling (*Recommended for use*)

Pros: Will contain all landings and all effort
Longer time series than commercial logbook

Cons: Fishery dependent
Effort only to the trip level
Subject to multiple changes in regulations, particularly trip limits

Issues Addressed: Changes in effort over time, with a decreasing trend over time (as investigated with logbook data). Concern that logbook measures of effort misleading, with primary gear types poorly summarized. A trip in this case may be the best level of effort.

North Carolina gillnet (*Not recommended for use*)

Pros: Will contain all landings and all effort
Slightly longer time series than commercial logbook

Cons: Fishery dependent
Effort only to the trip level

Issues Addressed: Changes in effort over time, with a positive trend over time

North Carolina Citation Program (*Not recommended for use*)

Pros: May correlate with changes in size over time

Cons: No measure of effort
Fishery dependent
Limited geographic coverage
Not designed to provide information on abundance
Dependent on fishermen to call in and report citations

Online Recreational Reporting (*Not recommended for use*)

Pros: May contain more detailed trip-level information

Cons: Only contains one year of data
Program is completely voluntary

Shrimp boat observer program (*Not recommended for use*)

Pros: Reasonably long time series (1998-present)
Reasonable spatial coverage

Cons: Fishery dependent
Non-random observer placement
Bycatch estimates highly variable, do not correlate to SEAMAP

Fishery independent

MARMAP

Chevron Trap Index (*Not recommended for use*)

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

Cons: Low sample sizes.

Hook and Line Index (*Not recommended for use*)

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

Cons: Low sample sizes.

Short Bottom Longline Index (*Not recommended for use*)

Pros: Fishery independent

Cons: Low sample sizes.

Trawl Index (*Not recommended for use*)

Pros: Fishery independent

Cons: Low numbers of samples

NEAMAP (*Not recommended for use*)

Pros: Stratified random sample design
Fishery independent

Cons: Spanish mackerel only sampled if at northern end of their range
Only the last 1-2 years have adequate sample size

SEAMAP Trawl Survey (*Recommended for use*)

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

Cons: Limited depth coverage (shallow water survey)
Not all ages are represented in the survey

North Carolina Pamlico Sound Survey (*Not recommended for use*)

Pros: Stratified random sample design
Standardized sampling techniques

Cons: Not all ages are represented in the survey
Limited geographic coverage (Pamlico Sound only)
Low sample sizes

NE Groundfish Trawl Survey (*Not Recommended for use*)

Pros: Stratified random sample design

Standardized sampling techniques
Cons: Low sample sizes

Online Diver Reports (*Not recommended for use*)
Pros: May be able to separate observations by highly skilled divers
Cons: Low sample size
Voluntary reporting

Table 5.8.3. Numerical values, standard errors, and sample sizes (number of tows) associated with the SEAMAP summer/fall recruitment index. The index is scaled to it's mean.

Year	Index	SE	*N*
1989	1.04	0.39	106
1990	1.45	0.33	153
1991	1.94	0.41	155
1992	1.14	0.39	156
1993	0.69	0.11	156
1994	0.68	0.15	156
1995	1.21	0.21	156
1996	0.73	0.16	156
1997	0.26	0.08	156
1998	0.59	0.11	156
1999	0.79	0.19	156
2000	1.26	0.30	156
2001	1.86	0.56	204
2002	1.05	0.21	204
2003	0.54	0.13	204
2004	0.62	0.10	204
2005	0.91	0.18	204
2006	1.15	0.21	204
2007	1.11	0.18	204

Table 5.8.4. Numerical values, standard errors, and sample sizes (number of tows) associated with the SEAMAP spring index of one-year-olds. The index is scaled to it's mean.

Year	Index	SE	*N*
1990	0.93	0.29	78
1991	0.69	0.18	78
1992	1.78	0.27	78
1993	0.55	0.24	78
1994	1.16	0.20	78
1995	0.55	0.16	78
1996	1.02	0.30	78
1997	0.74	0.33	78
1998	2.39	1.52	78
1999	1.69	0.54	78
2000	1.83	0.43	78
2001	0.82	0.26	102
2002	0.60	0.15	102
2003	0.62	0.18	102
2004	0.86	0.25	102
2005	0.61	0.29	102
2006	1.14	0.35	102
2007	0.71	0.15	102

Table 5.8.5. Point estimates, jackknife standard errors (SE), and sample sizes (*N*; number of positive trips) associated with the gillnet and handline/trolling (H/T) logbook indices north of Florida. Both indices are scaled to their mean.

Year	Gillnet Index	Gillnet SE	Gillnet *N*	H/T Index	H/T SE	H/T *N*
1998	0.59	0.11	419	0.87	0.12	124
1999	0.79	0.19	509	1.12	0.17	146
2000	1.26	0.30	603	0.88	0.14	125
2001	1.86	0.56	556	0.97	0.15	99
2002	1.05	0.21	721	1.19	0.22	88
2003	0.54	0.13	680	0.93	0.18	75
2004	0.62	0.10	640	1.00	0.21	74
2005	0.91	0.18	578	0.86	0.12	135
2006	1.15	0.21	677	1.16	0.22	80
2007	1.11	0.18	631	0.80	0.12	112

Table 5.8.6 Number of Spanish mackerel trips reported in Florida trip ticket database by fishing year (April-March for 1984-2005; March-April 2006-2007) and trip limit type for the gillnet fishery. Darkly shaded cells were omitted from analysis because >5% of such trips met or exceeded trip limits, while lightly shaded cells were omitted because of possible irregularities at the beginning of the trip ticket program or because of implementation of the Florida state gillnet ban (1995). Total sample size used for analysis, *N*, is obtained by summing white entries across columns.

	Trip Limit					
Fishing Year	500 lb.	1000 lb	1500 lb	3500 lb	Unlimited	*N*
1984	0	0	0	0	272	
1985	0	0	0	0	3088	3088
1986	0	0	0	0	2916	2916
1987	0	0	0	0	3092	3092
1988	0	0	0	0	2663	2663
1989	0	0	0	0	3780	3780
1990	0	0	0	0	4357	4357
1991	0	0	0	0	6135	6135
1992	1335	1020	144	0	3262	3262
1993	1431	1756	3006	0	275	275
1994	105	2287	2668	0	611	611
1995	60	0	1230	0	226	
1996	65	0	771	0	275	275
1997	0	0	2085	0	68	68
1998	0	0	1798	0	346	346
1999	0	0	1262	0	263	263
2000	0	0	258	644	136	780
2001	0	0	68	717	255	972
2002	0	0	15	563	71	634
2003	0	0	16	379	19	398
2004	0	0	83	395	44	439
2005	0	0	51	786	86	872
2006	0	0	121	930	57	987
2007	0	0	20	985	224	1209

Table 5.8.7 Number of Spanish mackerel trips reported in Florida trip ticket database by year and trip limit type for the castnet fishery. Shaded cells were omitted from analysis because >5% of such trips often met or exceeded trip limits (dark gray) or because sample sizes were too low (light gray). Total sample size used for analysis, *N*, is obtained by summing white entries across columns.

	Trip Limit					
Fishing Year	500 lb.	1000 lb	1500 lb	3500 lb	Unlimited	*N*
1984	0	0	0	0	1	
1985	0	0	0	0	33	
1986	0	0	0	0	10	
1987	0	0	0	0	8	
1988	0	0	0	0	10	
1989	0	0	0	0	4	
1990	0	0	0	0	14	
1991	0	0	0	0	26	
1992	0	1	0	0	6	
1993	2	5	4	0	0	
1994	0	2	3	0	0	
1995	24	0	65	0	72	
1996	70	0	193	0	183	
1997	0	0	247	0	14	
1998	0	0	151	0	65	
1999	0	0	353	0	295	295
2000	0	0	193	95	674	769
2001	0	0	268	196	922	1118
2002	0	0	270	293	1393	1686
2003	0	0	640	486	1514	2000
2004	0	0	1412	402	636	1038
2005	0	0	291	155	1314	1469
2006	0	0	871	441	734	1175
2007	0	0	202	419	636	1055

Table 5.8.8 Number of Spanish mackerel trips reported in Florida trip ticket database by year and trip limit type for the hand line fishery. Shaded cells were omitted from analysis because >5% of such trips often met or exceeded trip limits (dark gray) or because sample sizes were too low (light gray). Total sample size used for analysis, *N*, is obtained by summing white entries across columns.

	Trip Limit					
Fishing Year	500 lb.	1000 lb	1500 lb	3500 lb	Unlimited	*N*
1984	0	0	0	0	22	
1985	0	0	0	0	644	644
1986	0	0	0	0	793	793
1987	0	0	0	0	817	817
1988	0	0	0	0	657	657
1989	0	0	0	0	825	825
1990	0	0	0	0	1128	1128
1991	0	0	0	0	1671	1671
1992	66	154	30	0	828	1012
1993	79	143	672	0	36	851
1994	33	134	605	0	87	826
1995	182	0	678	0	371	1049
1996	96	0	549	0	228	777
1997	0	0	1452	0	67	1519
1998	0	0	967	0	345	1312
1999	0	0	378	768	822	1968
2000	0	0	244	896	757	1897
2001	0	0	268	196	922	1386
2002	0	0	216	1074	844	2134
2003	0	0	307	854	568	1729
2004	0	0	930	1006	421	2357
2005	0	0	235	761	914	1910
2006	0	0	597	1544	747	2888
2007	0	0	438	1591	1353	3382

Table 5.8.9 A list of Florida Wildlife & Conservation Commission codes given to indicate whether species belong to "inshore bottom" (IB), "inshore pelagic" (IP), "offshore bottom" (OB), "offshore pelagic" (OP), or "reef fish" (RF) groups. If species other than those listed here were caught in the same trips as Spanish mackerel, they were given a code of "other species" (OS).

CODE	*SPECIES*
IB	CATFISH
IB	CROAKER
IB	CROAKER (NUMBERS)
IB	GOATFISHES
IB	GRUNTS
IB	GRUNTS (NUMBERS)
IB	LIZARDFISH (SNAKEFISH)
IB	MOJARRA
IB	MOJARRA, IRISH POMPANO
IB	MULLET, BLACK (LISA)
IB	MULLET, BLACK, (RED ROE)
IB	MULLET, BLACK, (WHITE ROE)
IB	MULLET, FINGERLING (NUMBERS)
IB	MULLET, FINGERLING (POUNDS)
IB	MULLET, ROE ONLY (W/R)
IB	MULLET, SILVER
IB	MULLET, SILVER (NUMBERS)
IB	PORGY, GRASS
IB	RAYS
IB	SAND PERCH (NUMBERS)
IB	SAND PERCH (SERRANIDAE)
IB	SEAROBINS
IB	SEATROUT, GREY (WEAKFISH, EAST COAST)
IB	SEATROUT, SAND
IB	SEATROUT, SILVER
IB	SEATROUT, SPOTTED
IB	SHEEPSHEAD
IB	SPADEFISH
IB	SPOT
IB	SPOT (NUMBERS)
IB	TILAPIA (NILE PERCH)
IB	WHITING
IP	BLUE RUNNER
IP	BLUE RUNNER (NUMBERS)
IP	BLUEFISH
IP	COBIA
IP	JACK, ATLANTIC BUMPER
IP	JACK, ATLANTIC MOONFISH
IP	JACK, BAR
IP	JACK, BAR (NUMBERS)
IP	JACK, CREVALLE
IP	JACK, HORSE-EYE
IP	JACK, LOOKDOWN

IP	JACK, MIXED
IP	JACK, OTHER
IP	JACK, YELLOW
IP	LADYFISH (HEADED & GUTTED)
IP	LADYFISH (SKIPJACK)
IP	MACKEREL, CERO
IP	MACKEREL, SPANISH
IP	MACKEREL, SPANISH (NUMBERS)
IP	PERMIT
IP	POMFRET (BIG SCALE)
IP	POMFRET (OTHER)
IP	POMPANO
IP	POMPANO, AFRICAN
IP	SHARK, BLACKNOSE
IP	SHARK, BONNETHEAD
IP	SHARK, FINETOOTH
IP	STURGEON
OB	BASS, LONGTAIL
OB	BROTULA ("HAKE")
OB	DRUM, BLACK
OB	EEL, CONGER
OB	EEL, CUSK
OB	FLOUNDER, GULF
OB	FLOUNDER, SOUTHERN
OB	FLOUNDER, SUMMER
OB	FLOUNDERS
OB	HAKE (SOUTHERN,GULF,SPOTTED)
OB	SHARK, ANGEL
OB	SHARK, SAND TIGER
OB	SHARK, SANDBAR
OB	TILEFISH (GOLDEN)
OB	TILEFISH, ANCHOR
OB	TILEFISH, BLACKLINE
OB	TILEFISH, BLUELINE (GRAY)
OB	TILEFISH, GOLDFACE
OB	TILEFISH, SAND
OB	WRECKFISH
OB	WRECKFISH ROE
OP	BARRELFISH
OP	BUTTERFISH
OP	CUTLASSFISH
OP	CUTLASSFISH (NUMBERS)
OP	DOLPHIN
OP	ESCOLAR
OP	HARVESTFISH
OP	MACKEREL, CHUB
OP	MACKEREL, KING (KINGFISH)
OP	MARLIN, BLUE
OP	MARLIN, WHITE
OP	OIL FISH

OP	OPAH
OP	RUDDERFISH, BANDED (AMBERINA)
OP	RUDDERFISH, BANDED (AMBERINA; CORES)
OP	SHARK
OP	SHARK FINS
OP	SHARK, ATLANTIC SHARPNOSE
OP	SHARK, BLACKTIP
OP	SHARK, BULL
OP	SHARK, DUSKY
OP	SHARK, GREAT WHITE
OP	SHARK, HAMMERHEAD
OP	SHARK, LEMON
OP	SHARK, MIXED (LARGE COASTALS)
OP	SHARK, MIXED (SMALL COASTALS)
OP	SHARK, OTHER
OP	SHARK, SHORTFIN MAKO
OP	SHARK, SILKY
OP	SHARK, SPINNER
OP	SHARK, THRESHER
OP	SHARK, TIGER
OP	SHARK,BIGNOSE
OP	SPEARFISH, LONGBILL
OP	SWORDFISH
OP	TRIPLETAIL
OP	TUNA, ALBACORE
OP	TUNA, BIGEYE
OP	TUNA, BLACKFIN
OP	TUNA, BLUEFIN
OP	TUNA, MIXED
OP	TUNA, SKIPJACK
OP	TUNA, YELLOWFIN
OP	TUNNY, LITTLE (BONITO)
OP	TUNNY, LITTLE (BONITO; NUMBERS)
OP	WAHOO
RF	AMBERJACK
RF	AMBERJACK, GREATER (CORES)
RF	AMBERJACK, LESSER
RF	AMBERJACK, LESSER (CORES)
RF	ANGELFISH
RF	BARRACUDA
RF	BIGEYE (TORO SNAPPER)
RF	EEL, MORAY
RF	GROUPER, BLACK (CARBERITA)
RF	GROUPER, CONEY
RF	GROUPER, GAG
RF	GROUPER, GOLIATH
RF	GROUPER, GRAYSBY
RF	GROUPER, HIND, ROCK
RF	GROUPER, MARBLED
RF	GROUPER, MISTY

RF	GROUPER, MIXED
RF	GROUPER, NASSAU
RF	GROUPER, OTHER
RF	GROUPER, RED
RF	GROUPER, RED HIND
RF	GROUPER, SCAMP
RF	GROUPER, SNOWY
RF	GROUPER, SPECKLED HIND (KITTY MITCHELL)
RF	GROUPER, TIGER
RF	GROUPER, WARSAW
RF	GROUPER, YELLOWEDGE
RF	GROUPER, YELLOWFIN
RF	GROUPER, YELLOWMOUTH
RF	HOGFISH (HOG SNAPPER)
RF	JACK, ALMACO
RF	JACK, ALMACO (CORES)
RF	MARGATES
RF	PARROTFISH
RF	PORGIES, UNCL.
RF	PORGY, JOLTHEAD
RF	PORGY, KNOBBED
RF	PORGY, LITTLEHEAD
RF	PORGY, LONGSPINE
RF	PORGY, RED
RF	PUFFERS
RF	ROSEFISH, BLACK BELLY
RF	SCORPIONFISH
RF	SEA BASS, BANK
RF	SEA BASS, BLACK
RF	SEA BASS, ROCK
RF	SEA BASS, UNCL.
RF	SNAPPER, BLACK
RF	SNAPPER, BLACKFIN (HAMBONE)
RF	SNAPPER, CARIBBEAN RED
RF	SNAPPER, CUBERA
RF	SNAPPER, DOG
RF	SNAPPER, GRAY (MANGROVE)
RF	SNAPPER, LANE
RF	SNAPPER, MAHOGONY
RF	SNAPPER, MIXED
RF	SNAPPER, MUTTON
RF	SNAPPER, OTHER
RF	SNAPPER, QUEEN (BALLBAT)
RF	SNAPPER, RED
RF	SNAPPER, SCHOOLMASTER
RF	SNAPPER, SILK (YELLOWEYE)
RF	SNAPPER, VERMILION (B-LINER)
RF	SNAPPER, WENCHMAN
RF	SNAPPER, YELLOWTAIL
RF	SQUIRRELFISH

RF	SURGEONFISH
RF	TRIGGERFISH

Table 5.8.10. Nominal and GLM-based CPUE (total lb/trip) as estimated from Florida trip ticket data, together with a bootstrap-based coefficient of variation (CV). The suffixed number represents a particular index (1-gillnet prior to net ban; 2-gillnet after net ban; 3-castnet; 4-hook & line). Sample sizes are given in Tables 5.8.6-5.8.8.

Year	GLM1	CV1	Nom1	GLM2	CV2	Nom2	GLM3	CV3	Nom3	GLM4	CV4	Nom4
1985	0.46	0.07	0.71							0.69	0.08	0.38
1986	0.59	0.07	0.32							0.94	0.08	0.26
1987	0.83	0.07	0.34							1.03	0.08	0.43
1988	0.64	0.07	0.49							1.21	0.08	0.65
1989	0.93	0.07	0.38							1.16	0.07	1.13
1990	0.79	0.06	0.26							1.12	0.07	1.03
1991	0.65	0.06	0.32							0.87	0.06	0.84
1992	0.63	0.07	0.25							0.85	0.07	0.38
1993	2.10	0.19	4.78							0.87	0.08	0.36
1994	2.40	0.12	2.13							0.68	0.07	0.47
1995										0.69	0.07	1.11
1996				1.25	0.17	2.40				0.63	0.08	0.56
1997				0.77	0.34	2.68				0.67	0.07	0.46
1998				1.05	0.17	1.74				0.95	0.06	0.81
1999				1.05	0.17	1.07	0.77	0.15	0.86	0.82	0.07	0.74
2000				1.09	0.14	0.65	0.77	0.13	0.95	0.92	0.06	1.04
2001				0.88	0.14	0.47	0.83	0.13	0.97	1.40	0.07	1.46
2002				0.85	0.15	0.49	0.95	0.12	1.08	0.85	0.06	1.10
2003				0.94	0.15	0.58	1.39	0.12	1.35	1.22	0.07	1.72
2004				0.62	0.15	0.35	1.48	0.13	1.15	1.52	0.06	2.49
2005				1.11	0.14	0.46	1.17	0.12	1.16	1.22	0.07	2.03
2006				1.17	0.14	0.52	0.86	0.13	0.88	1.46	0.06	2.00
2007				1.21	0.13	0.59	0.78	0.13	0.59	1.22	0.06	1.53

Table 5.8.11 Nominal CPUE (number/angler-trip) and estimates of precision for two methods of summarizing CPUE. The first, 'Total Catch', uses estimates of discards (B2's) while the second (Harvest) does not. The DW selected the former as the most appropriate to use in this assessment, selecting 1987-2007 as having reasonable sample sizes.

Year	TotCatch CPUE	Total Catch PSE	Directed TotCatch Interviews	Harvest CPUE	Harvest PSE	Directed Harvest Interviews
1982	2.72	29.2	195	2.72	29.4	192
1983	0.57	24.1	156	0.56	25.0	152
1984	2.83	31.1	256	2.80	32.0	253
1985	1.67	19.7	232	1.59	21.1	221
1986	4.33	15.7	543	3.25	12.9	522
1987	1.68	7.3	1776	1.64	7.5	1740
1988	2.35	6.4	1895	2.32	6.5	1868
1989	2.01	7.6	2353	1.68	7.1	2327
1990	1.81	6.2	2664	1.65	6.7	2627
1991	1.55	5.4	2991	1.29	5.9	2922
1992	1.67	4.3	2508	1.36	4.8	2435
1993	1.33	5.6	1687	1.12	6.3	1647
1994	2.03	5.9	2567	1.31	5.4	2436
1995	1.63	7.8	1600	1.13	10.0	1531
1996	2.13	6.7	1804	1.62	8.5	1700
1997	2.18	5.8	2141	1.71	7.0	2023
1998	1.86	7.1	1435	1.55	8.8	1322
1999	2.33	5.7	1981	1.74	6.9	1796
2000	2.14	6.0	2011	1.51	7.5	1850
2001	2.26	6.6	1837	1.76	7.1	1730
2002	2.72	7.3	2070	1.91	8.2	1886
2003	2.39	7.7	1735	1.51	7.6	1594
2004	1.98	7.3	1419	1.49	8.8	1316
2005	2.58	7.1	1249	1.82	8.3	1121
2006	1.65	7.1	1152	1.29	8.7	1048
2007	1.76	6.3	1493	1.31	8.2	1366

Table 5.8.12 A correlation matrix for all indices recommended for use in the SEDAR 17 assessment of Spanish mackerel. Included are the 1985-1994 FL trip ticket gillnet index (GN_FL1), the 1996-2007 FL trip ticket gillnet index (GN_FL2), the FL trip ticket castnet index (CN_FL), the FL trip ticket hook & line index (HL_FL), the MRFSS index, the logbook survey gillnet index north of FL (GN_LB), the logbook survey handline index north of FL (HL_LB), the SEAMAP young-of-year index (SMAP_YOYa), a one year lagged version of the young-of-year index (SMAP_YOYb), and the SEAMAP 1-year-old index (SMAP_1YR). The lagged version of the YOY index, SMAP_YOYb, was not recommended for use but is included in this table for correlation comparison.

	GN_FL1	GN_FL2	CN_FL	HL_FL	MRFSS	GN_LB	HL_LB	SMAP_YOYa	SMAP_YOYb	SMAP_1YR
GN_FL1	1.00	NA	NA	-0.37	-0.16	NA	NA	-0.79	-0.73	-0.12
GN_FL2	NA	1.00	-0.63	-0.19	-0.28	-0.64	-0.29	0.22	0.03	0.27
CN_FL	NA	-0.63	1.00	0.44	0.19	0.28	-0.11	-0.67	-0.25	-0.51
HL_FL	-0.37	-0.19	0.44	1.00	0.08	0.27	-0.08	0.22	-0.10	-0.18
MRFSS	-0.16	-0.28	0.19	0.08	1.00	0.14	0.21	-0.22	-0.03	-0.06
GN_LB	NA	-0.64	0.28	0.27	0.14	1.00	0.15	0.19	0.68	-0.55
HL_LB	NA	-0.29	-0.11	-0.08	0.21	0.15	1.00	0.06	0.38	-0.11
SMAP_YOYa	-0.79	0.22	-0.67	0.22	-0.22	0.19	0.06	1.00	0.44	-0.11
SMAP_YOYb	-0.73	0.03	-0.25	-0.10	-0.03	0.68	0.38	0.44	1.00	-0.26
SMAP_1YR	-0.12	0.27	-0.51	-0.18	-0.06	-0.55	-0.11	-0.11	-0.26	1.00

5.9 FIGURES

Figure 5.9.1. Strata sampled by the SEAMAP Coastal Survey.

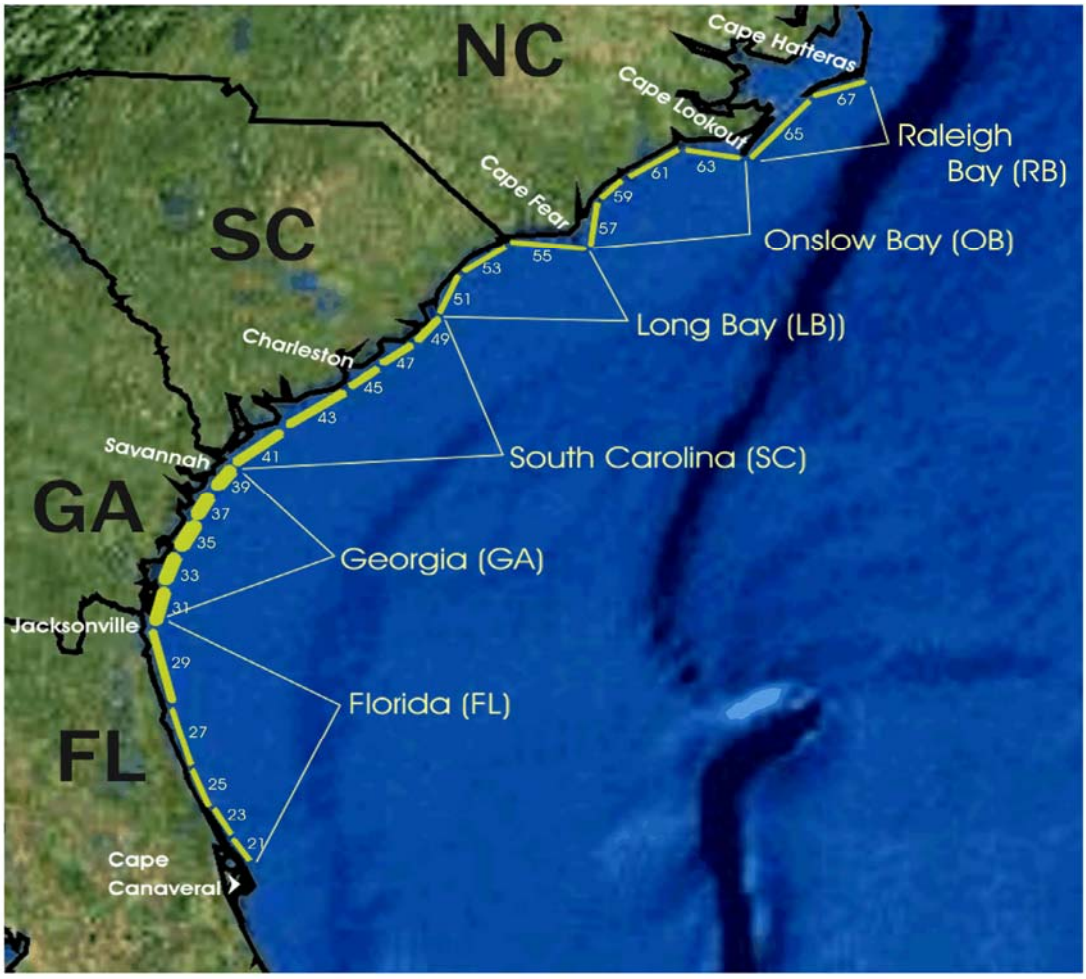


Figure 5.9.2 Length compositions of Spanish mackerel in SEAMAP trawls, 1989-present by season.

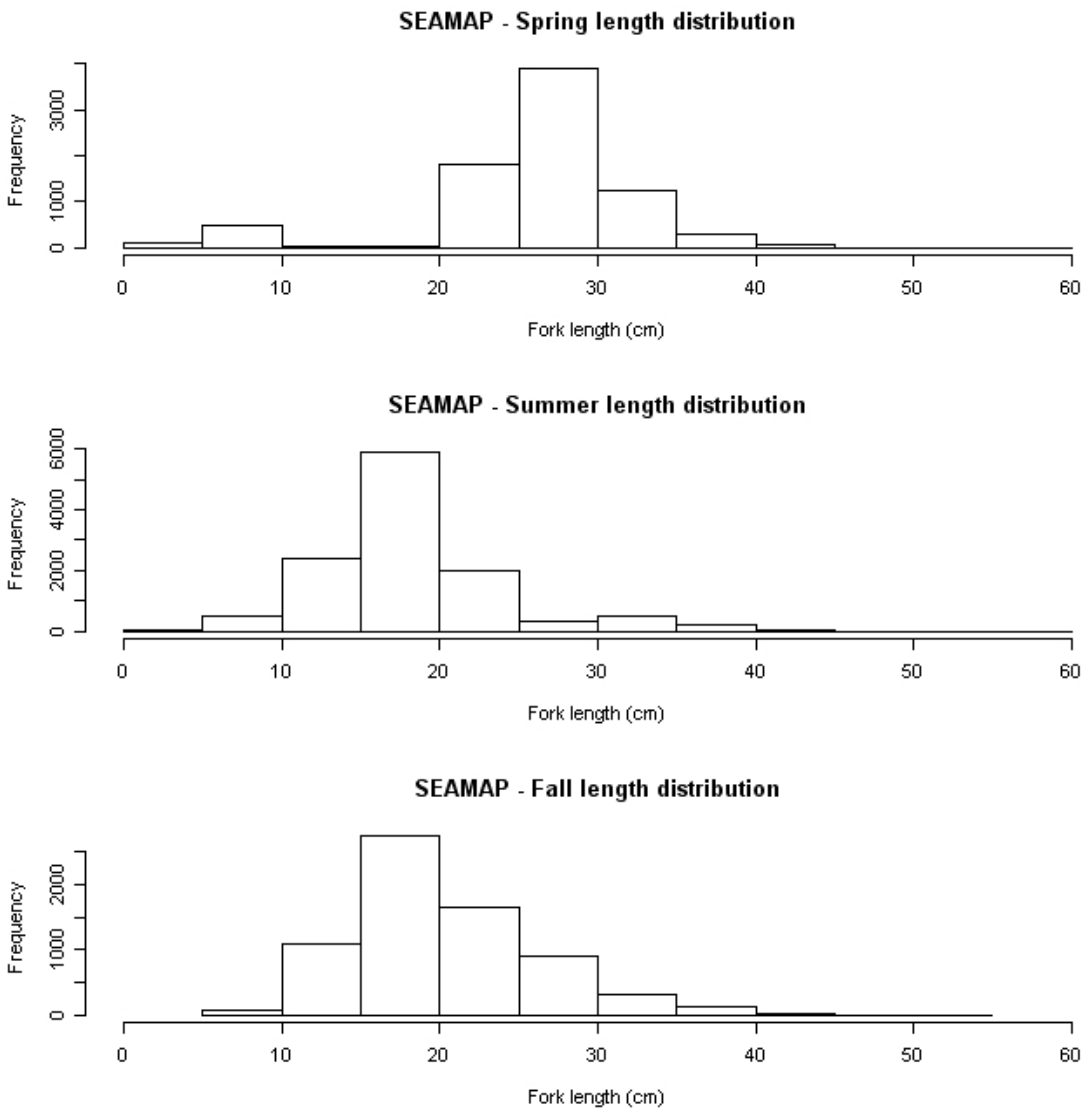
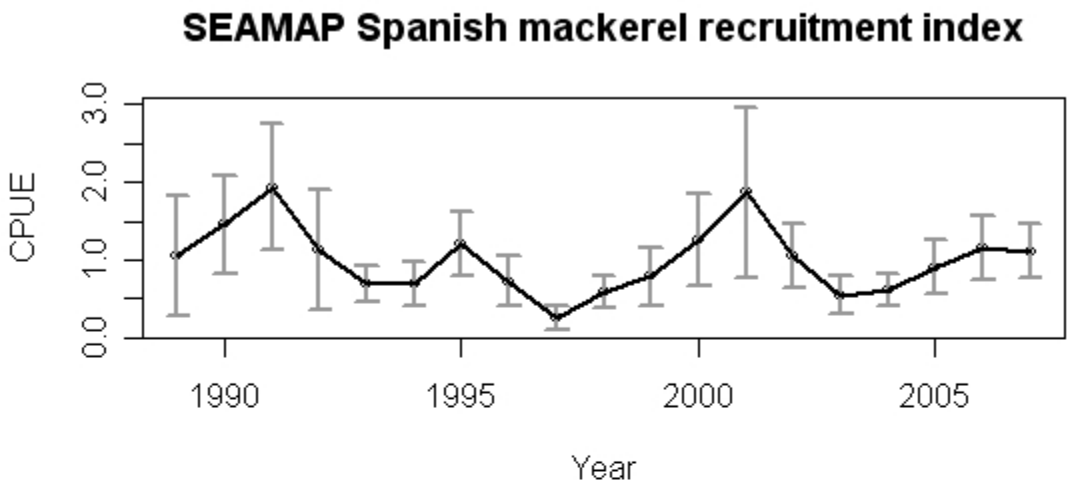


Figure 5.9.3 Indices of young-of-year and one year old south Atlantic Spanish mackerel (U.S.) derived from summer/fall and spring SEAMAP trawl surveys, respectively. Error bars represent 95% asymptotic confidence intervals. Indices are scaled to their mean.



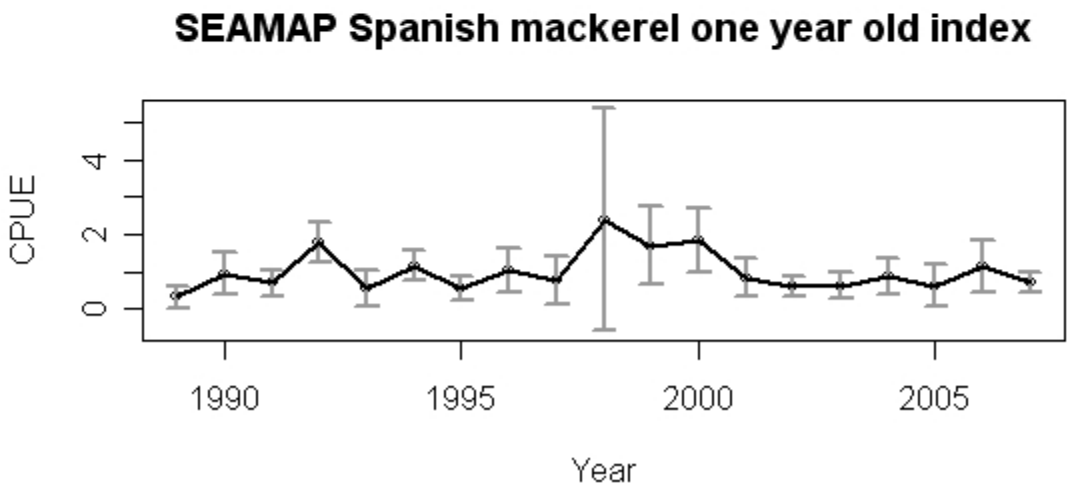


Figure 5.9.4 Net area-hours for the gillnet fishery as calculated from logbook data north of Florida as a function of year. The amount of effort per trip appears to be increasing over time, a feature which may call into question the utility of a 'trip' as a reasonable proxy for effort.

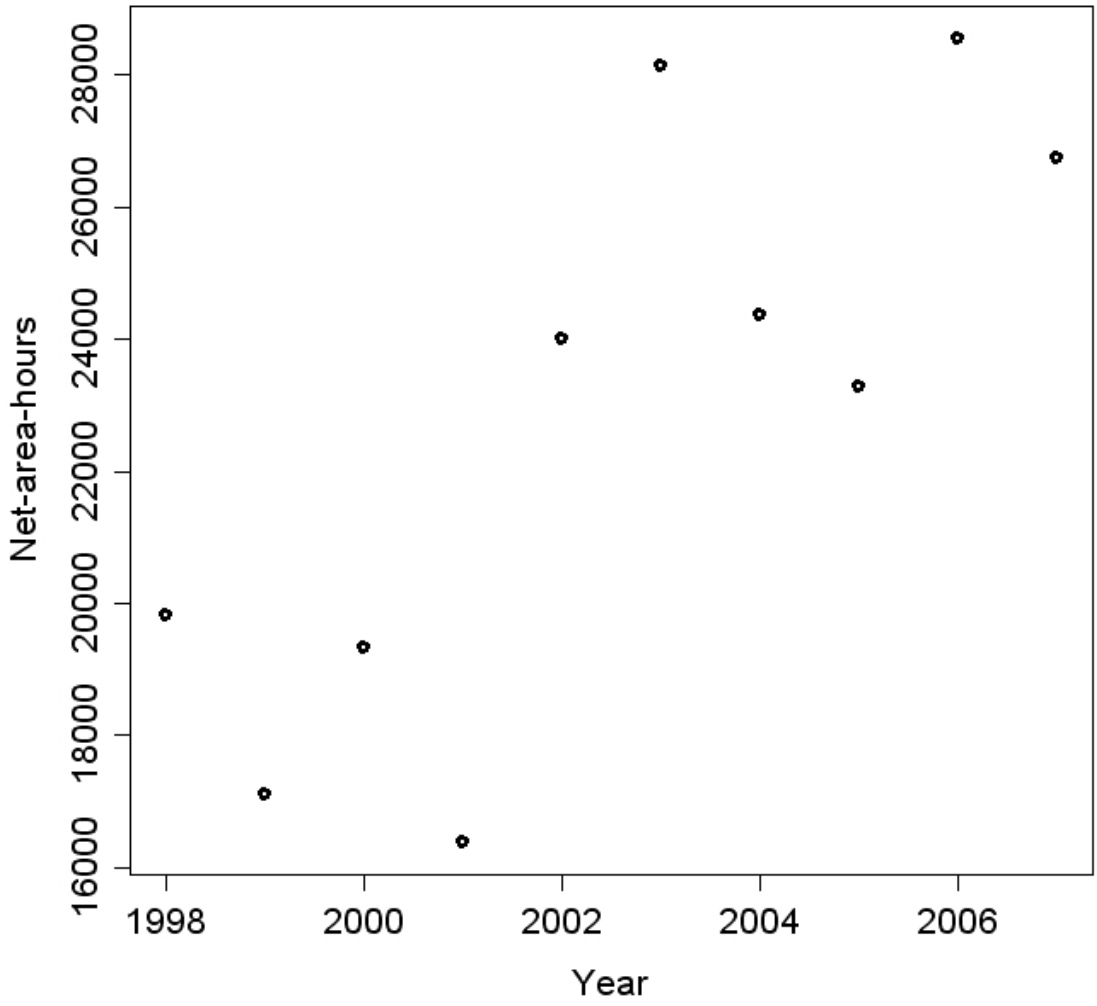


Figure 5.9.5. Areas reported in commercial logbooks. First two digits signify degrees latitude, second two degrees longitude. Areas were excluded from the analysis if south of 31 degree latitude.

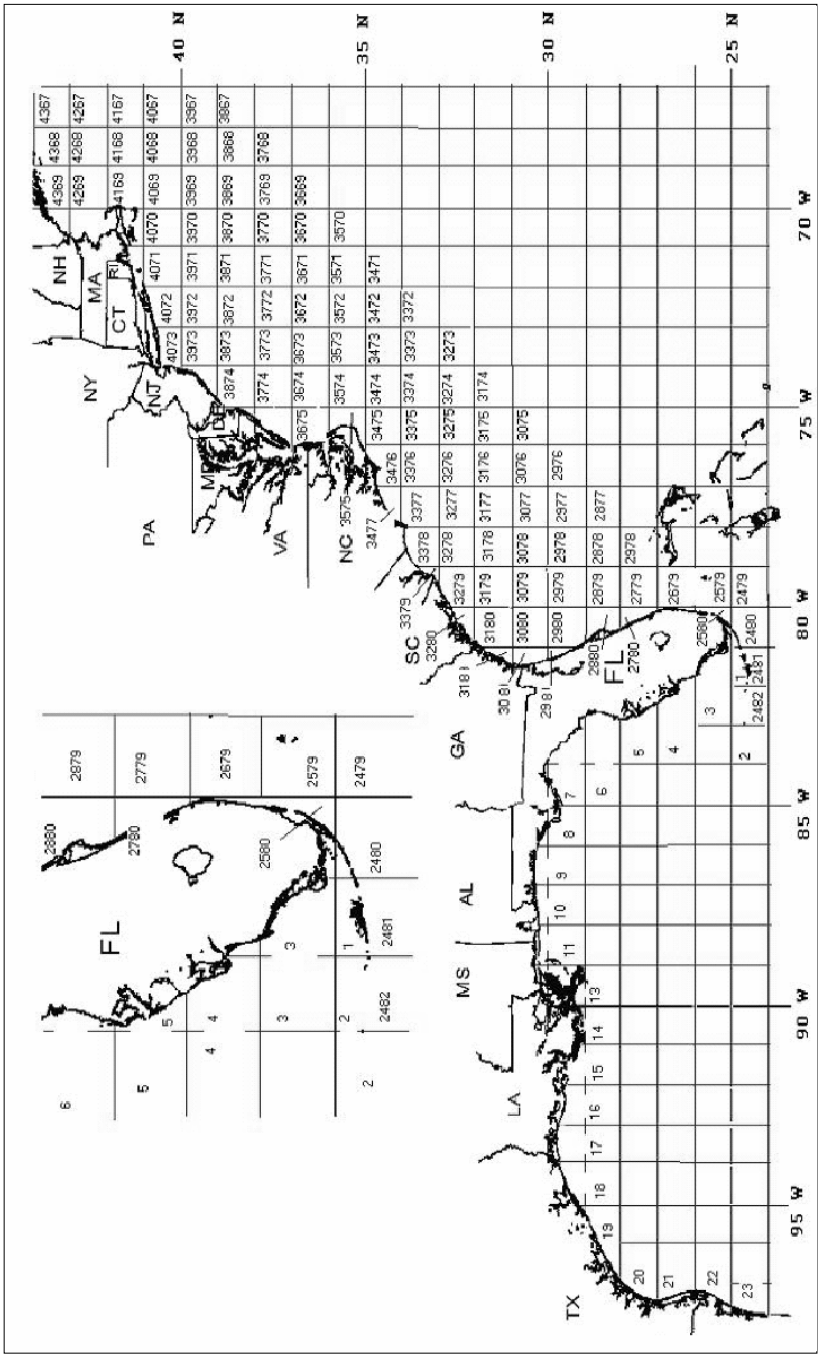


Figure 5.9.6 Standardized (solid line) and nominal (dashed line) catch per unit effort over time for the logbook survey. Error bars give 95% asymptotic confidence intervals.

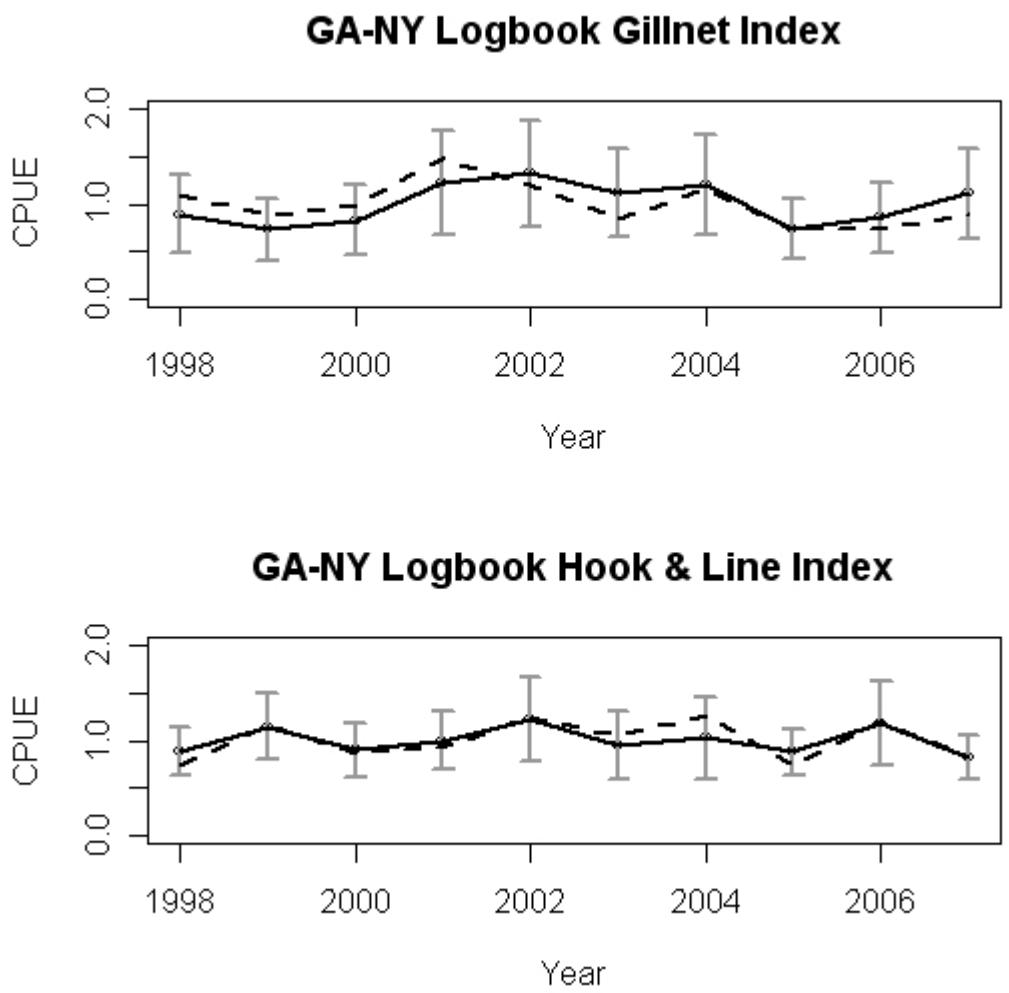


Figure 5.9.7 A plot of the average number of hook-hrs per trip for Florida trips that were classified with gear code 'H' (hand lines) in the commercial logbook survey database. A decrease in average number of hook-hrs over time casts some doubt on the utility of using a 'trip' as a unit of effort.

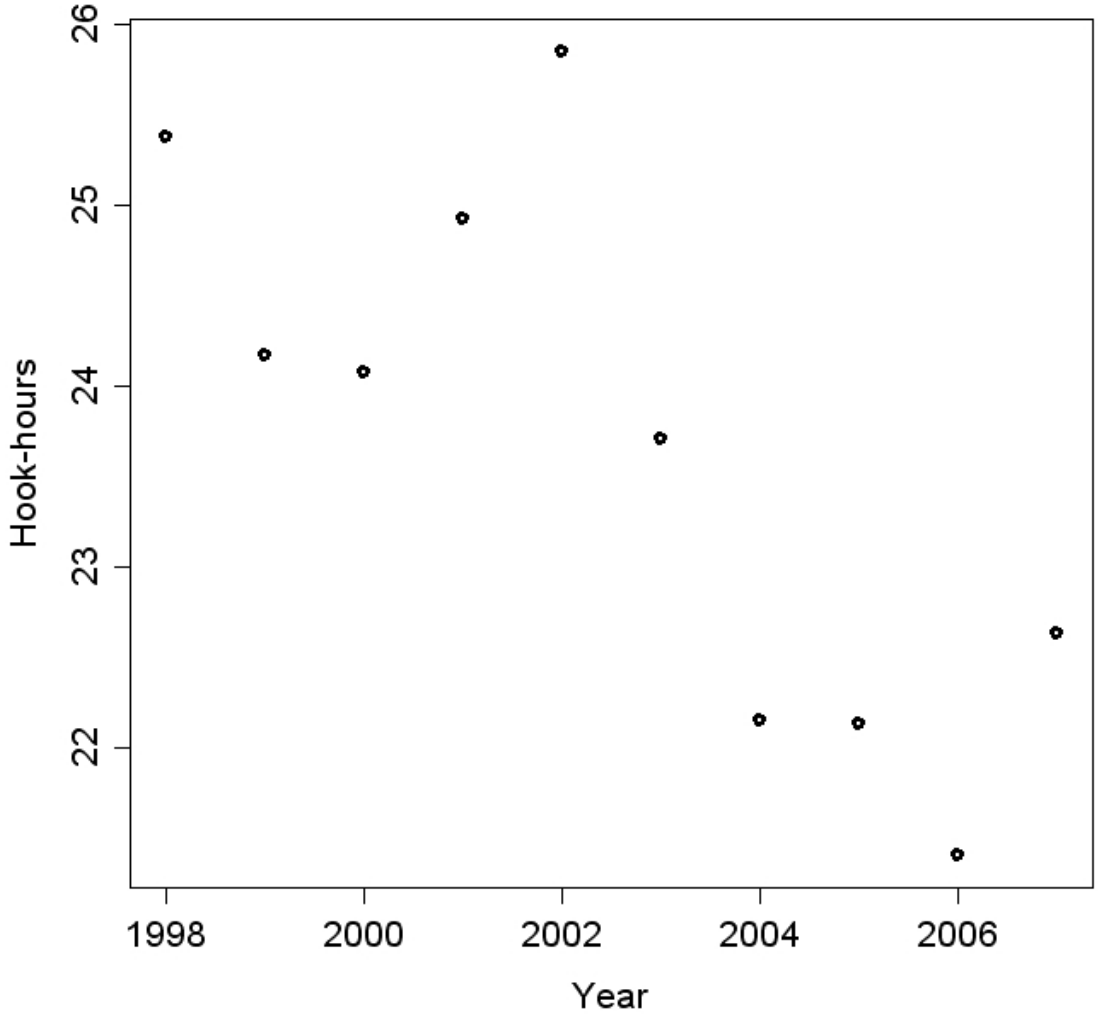


Figure 5.9.8 Percent of Spanish mackerel trips meeting or exceeding the trip limit when the trip limit was 500 lb. When trip limits were exceeded more that 5% of the time (dashed line), the relationship between CPUE and abundance was thought to be questionable. Trips occurring on days where the trip limit was 500 lb were thus censored from analysis.

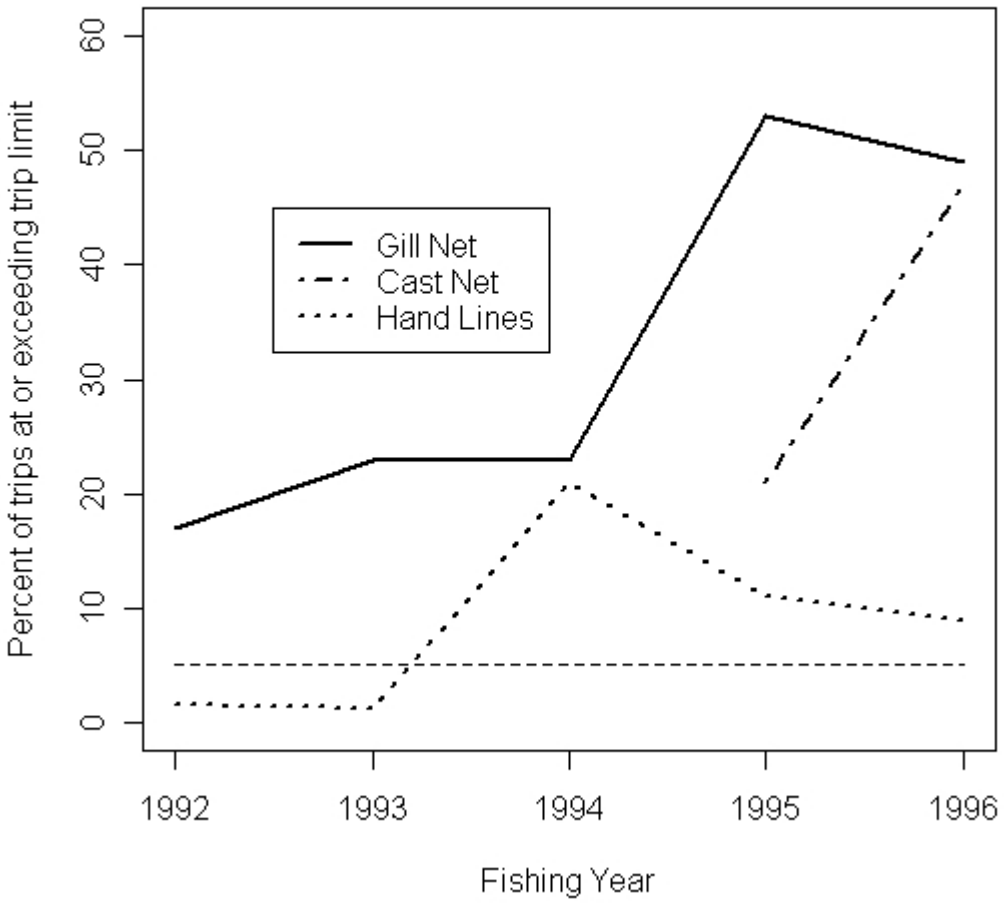


Figure 5.9.9 Percent of Spanish mackerel trips meeting or exceeding the trip limit when the trip limit was 1000 lb. When trip limits were exceeded more that 5% of the time (dashed line), the relationship between CPUE and abundance was thought to be questionable. Trips occurring on days where the trip limit was 1000 lb in the gillnet fishery were thus censored from analysis. Such trips were also eliminated for the cast net fishery because of small sample sizes.

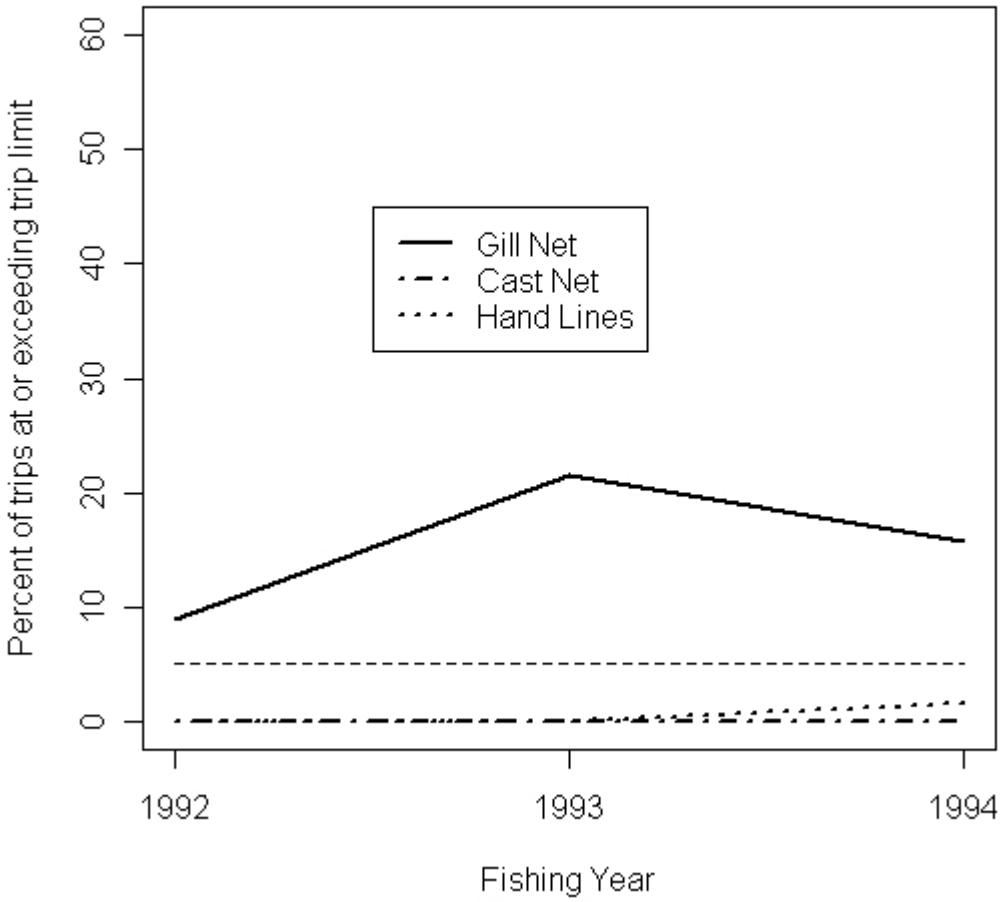


Figure 5.9.10 Percent of Spanish mackerel trips meeting or exceeding the trip limit when the trip limit was 1500 lb. When trip limits were exceeded more that 5% of the time (dashed line), the relationship between CPUE and abundance was thought to be questionable. Trips occurring on days where the trip limit was 1500 lb in the gill net and cast net fisheries were thus censored from analysis, but retained for hand line fisheries.

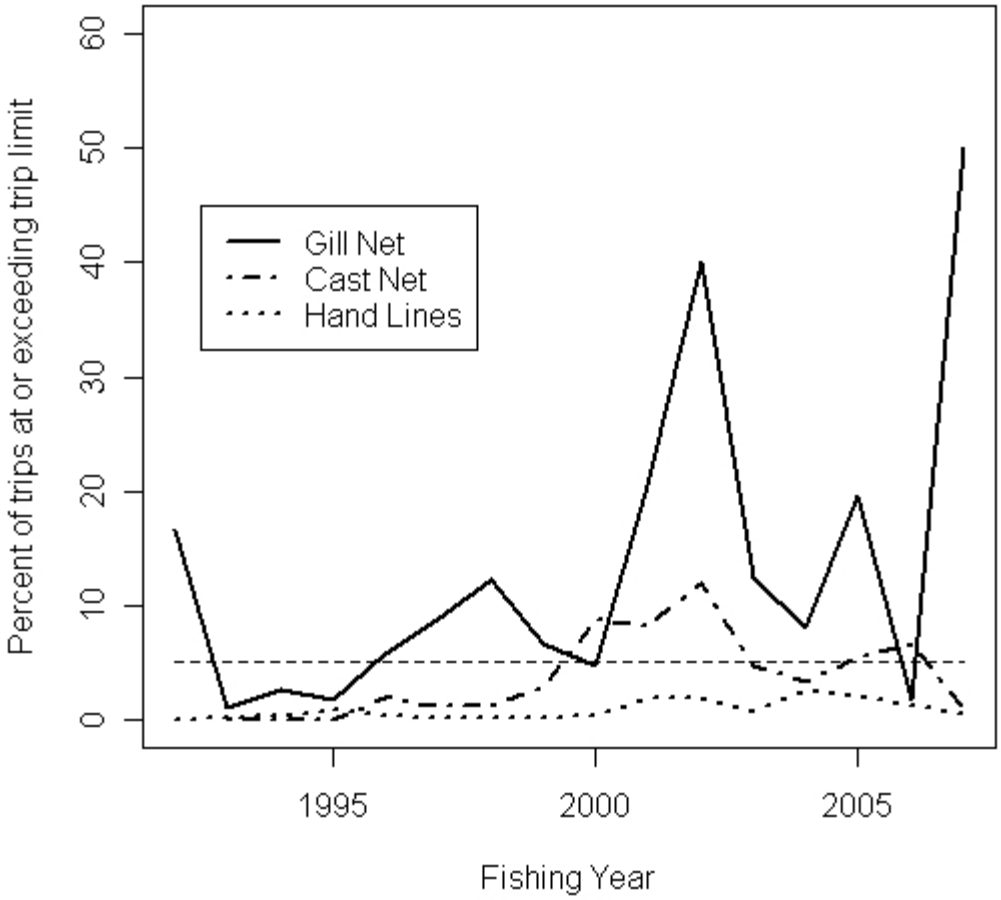
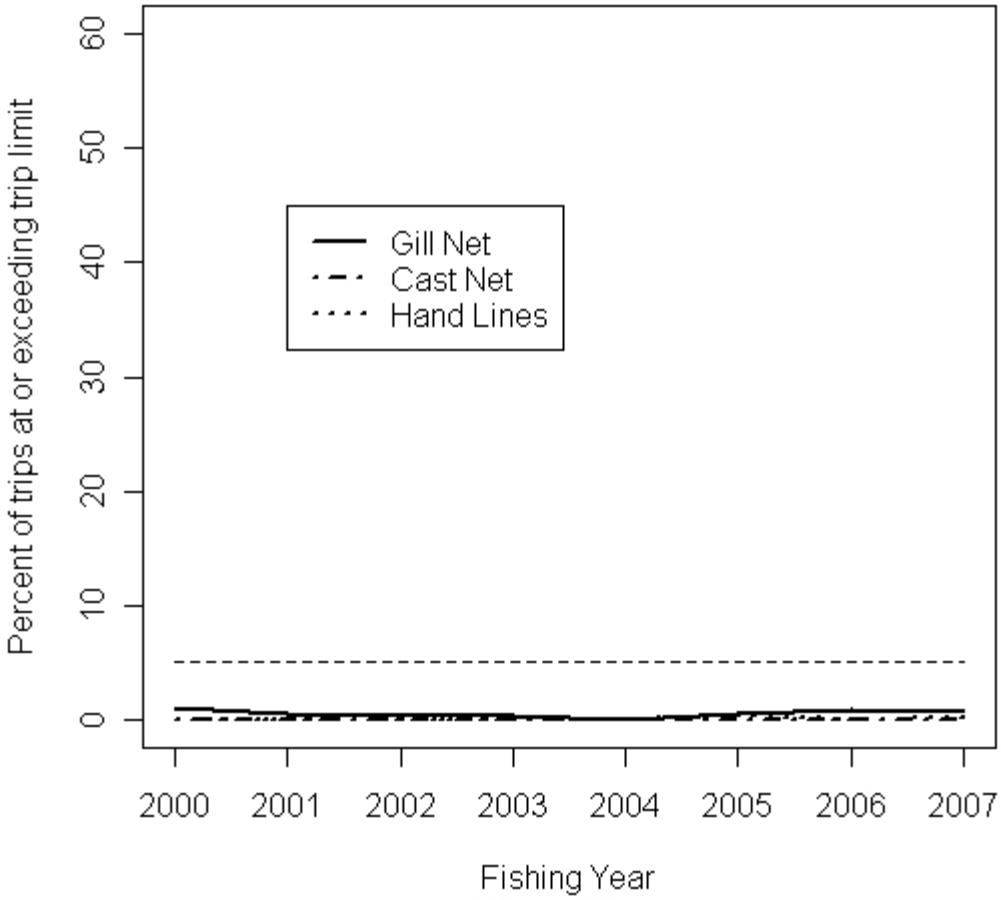


Figure 5.9.11 Percent of Spanish mackerel trips meeting or exceeding the trip limit when the trip limit was 3500 lb. When trip limits were exceeded more that 5% of the time (dashed line), the relationship between CPUE and abundance was thought to be questionable. This threshold was never exceeded so all such trips were retained for analysis.



5.9.12 Estimated CPUE indices of total catch for Florida trip ticket data. The two upper panels give standardized CPUE for the gillnet fishery pre- and post-Florida gillnet bans, as output from GLMs and as calculated directly from data ("Nominal"). The bottom panels give estimated CPUE for castnet and hand line fisheries. Large differences in nominal and GLM CPUE's result mainly from fishery closures.

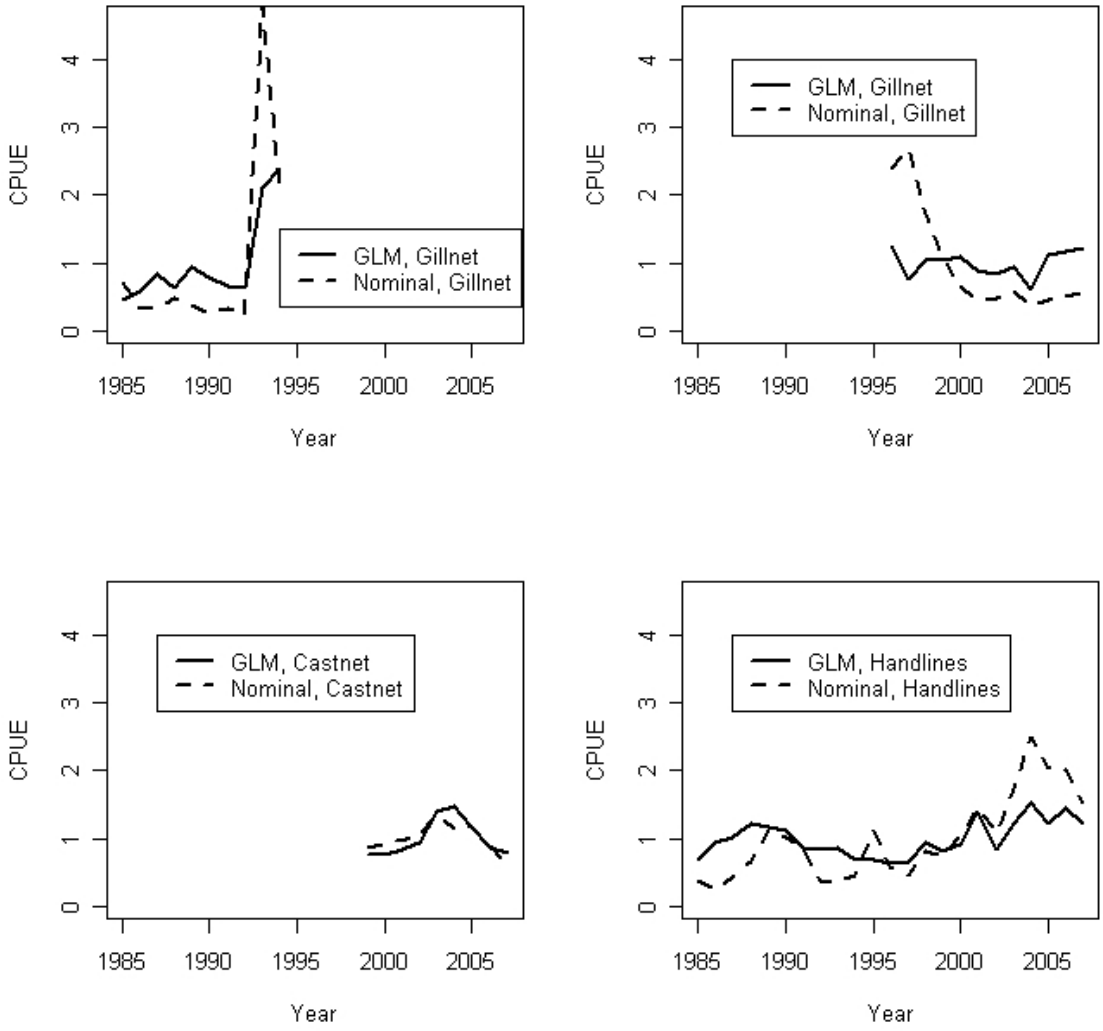


Figure 5.9.13 Counties sampled by the MRFSS, as used to compute the index of abundance, included those along the coast from Currituck County, NC through Miami-Dade County, FL.

Figure 5.9.14 The ratio of MRFSS trips that met or exceeded the bag limit to the total number of trips by year. The blue line (diamonds) gives the ratio including discards (A+B1+B2), while the pink line (squares) gives the ratio with respect to number harvested (A+B1).

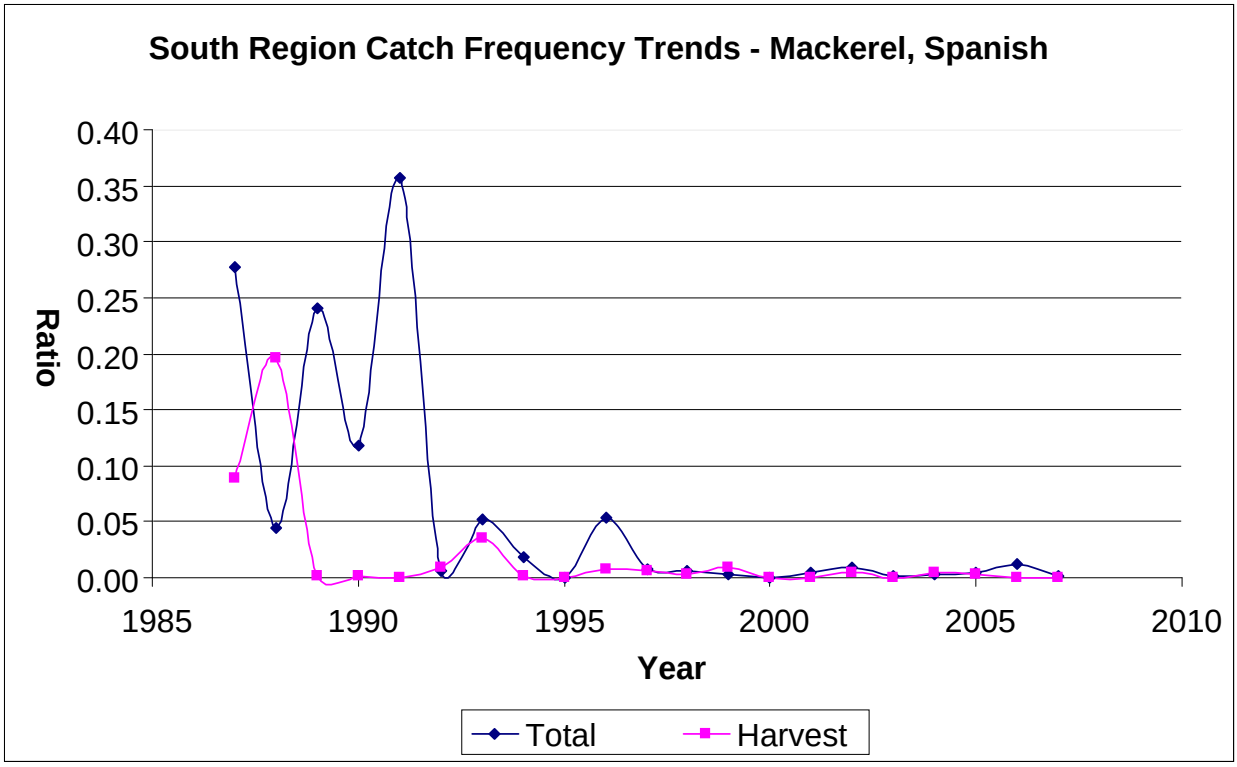


Figure 5.9.15. Spanish mackerel CPUE from the MRFSS survey. The blue line (diamonds) gives the ratio including discards (A+B1+B2), while the pink line (squares) gives the ratio with respect to number harvested (A+B1). The DW selected the former (blue line) as most appropriate for use in the assessment, specifying that the time series begin in 1987 to provide adequate sample sizes.

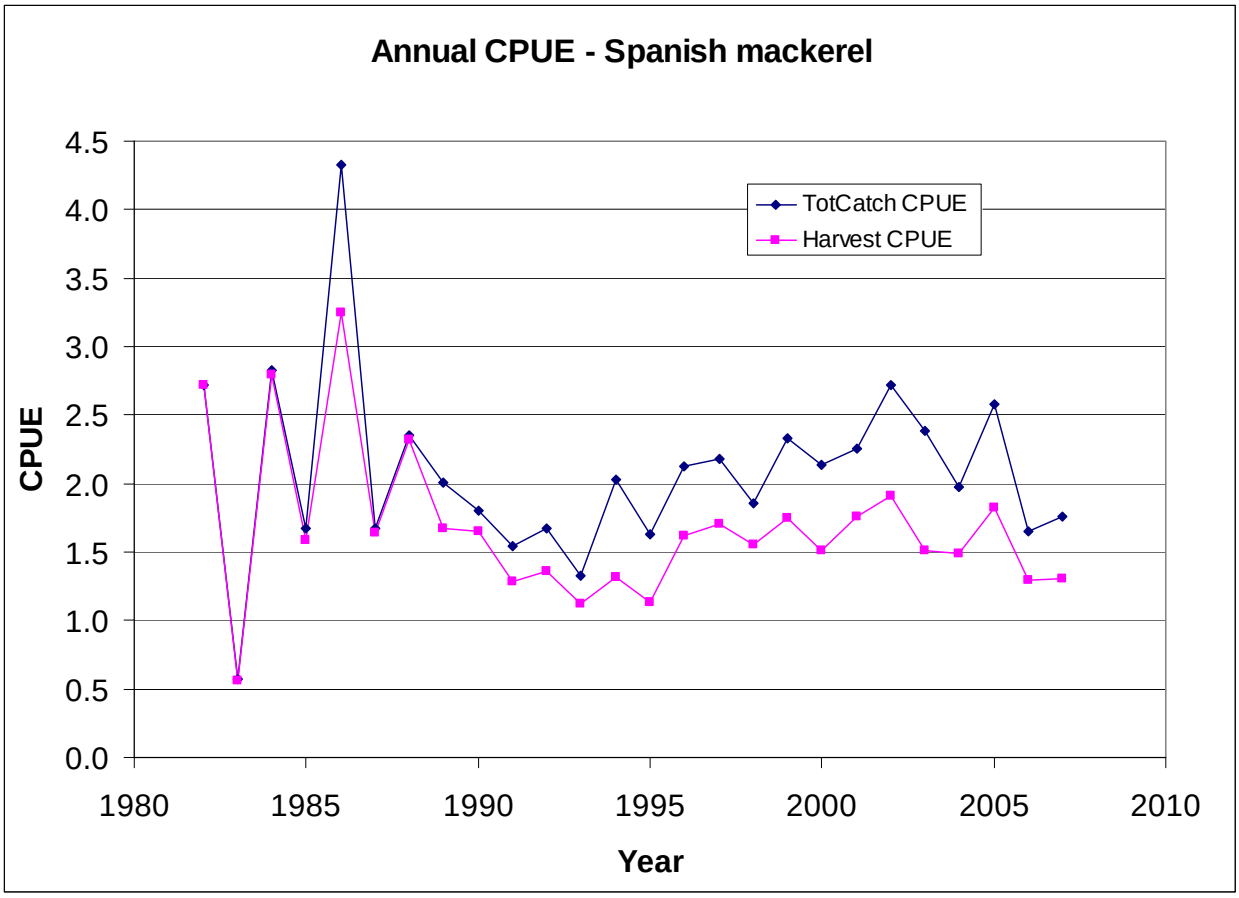
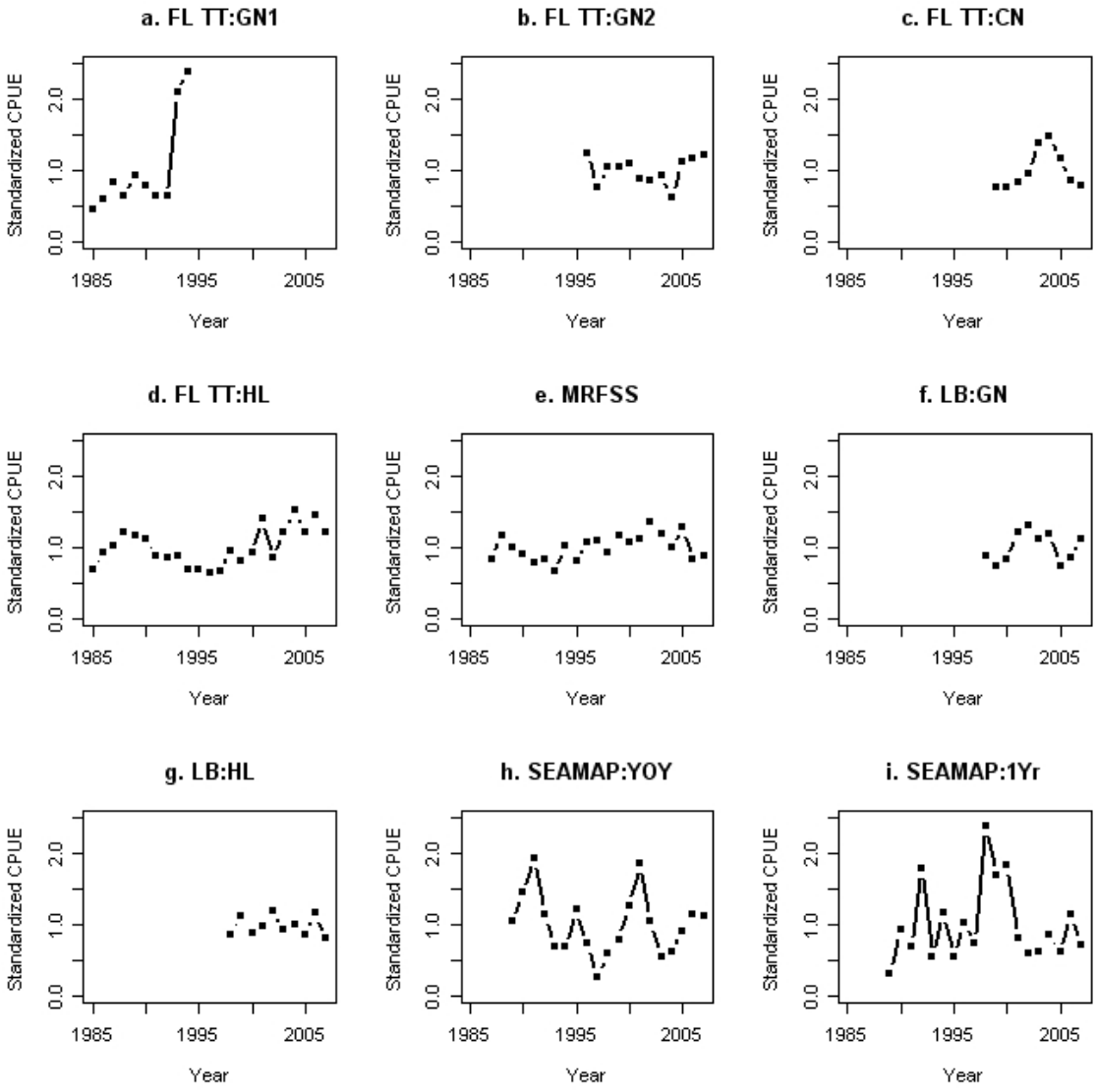


Figure 5.9.16. A plot of all indices recommended for use in the SEDAR 17 assessment of Spanish mackerel. Those included are a) a Florida trip ticket gillnet index prior to the FL state gillnet ban ("FL TT:GN1"), b) a FL trip ticket gillnet index after the FL state gillnet ban ("FL TT:GN2"), c) a Florida trip ticket castnet index ("FL TT:CN"), d) a Florida trip ticket hook & line index ("FL TT:HL"), e) the MRFSS index, f) a gillnet index using logbook survey data north of Florida ("LB:GN"), g) a hook & line index using logbook data north of Florida ("LB:HL"), h) a young-of-year index using summer and fall SEAMAP trawls (SEAMAP:YOY), and i) an index of one-year-olds from SEAMAP spring trawls ("SEAMAP-1Yr"). Each index is scaled to it's mean.



5.10 APPENDICES

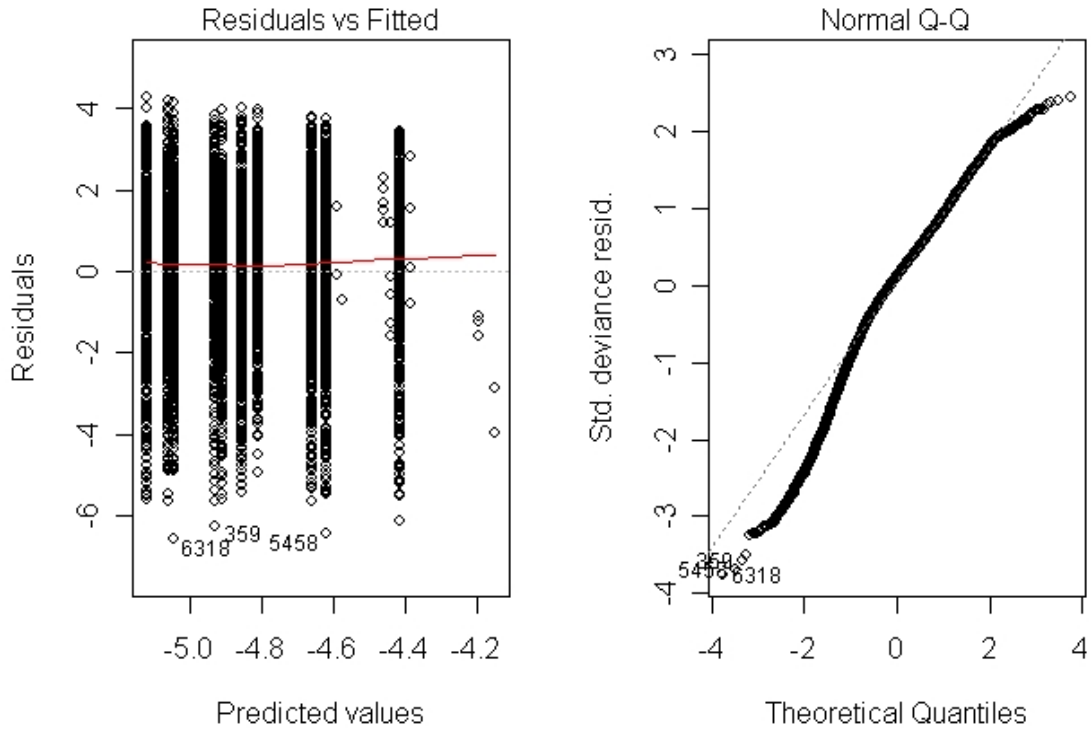
Appendix 5.10.1 Information contained in the commercial logbook data set (all variables are numeric unless otherwise noted):

schedule: this is a unique identifier for each fishing trip and is a character variable
species: a character variable to define the species
gear: a character variable, the gear type, multiple gear types may be used in a single trip, L = longline, H = handline, E = electric reels, B = bouy gear, GN = gill net, P = diver using power head gear, S = diver using spear gun, T = trap, TR = trolling
area: area fished, in the south Atlantic these codes have four digits- the first two are degrees of latitude and the second two are the degrees of longitude
conversion: conversion factor for calculating total pounds (totlbs) from gutted weight
gutted: gutted weight of catch for a particular species, trip, gear, and area
whole: whole weight of catch for a particular species, trip, gear, and area
totlbs: a derived variable that sums the gutted (with conversion factor) and whole weights, this is the total weight in pounds of the catch for a particular species, trip, gear, and area
length: length of longline (in miles) or gill net (in yards)
mesh1 – mesh4: mesh size of traps or nets
numgear: the amount of a gear used, number of lines (handlines, electric reels), number of sets (longlines), number of divers, number of traps, number of gill nets
fished: hours fished on a trip, this is problematic for longline data as discussed later
effort: like numgear, the data contained in this field depends upon gear type; number of hooks/line for handlines, electric reels, and trolling; number of hooks per longline for longlines; number of traps pulled for traps; depth of the net for gill nets, this field is blank for divers
source: a character variable, this identifies the database that the record was extracted from, sg = snapper grouper, grf = gulf reef fish, all records should have this source code
tif_no: a character variable, trip identifier, not all records will have a tif_no
vesid: a character variable, a unique identifier for each vessel
started: numeric (mmddyy8) variable, date the trip started
landed: numeric (mmddyy8) variable, date the vessel returned to port
unload: numeric (mmddyy8) variable, date the catch was unloaded
received: numeric (mmddyy8) variable, date the logbook form was received from the fisherman
opened: numeric (mmddyy8) variable, date the logbook form was opened and given a schedule number
away: number of days at sea, this value should equal (landed-started+1)
crew: number of crew members, including the captain

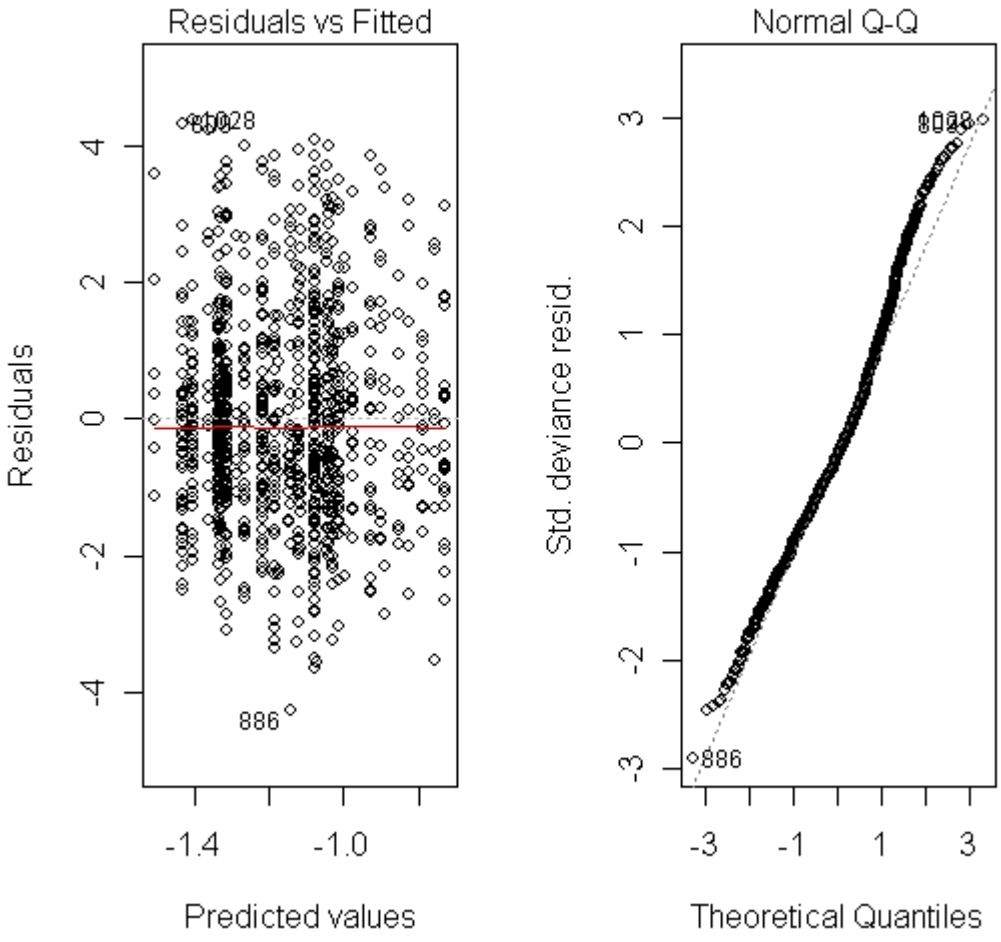
dealer: character variable, identifier for the dealer who bought the catch, in some cases there may be multiple dealers for a trip
state: character variable, the state in which the catch was sold
county: character variable, the county in which the catch was sold
area1 – area3: areas fished, if the trip included catch from multiple areas, those areas will be listed here
trip_ticket: character variable, trip ticket number, a unique identifier for each trip not all trips have this identifier

Appendix 5.10.2 Diagnostic plots for generalized linear models used to construct indices.

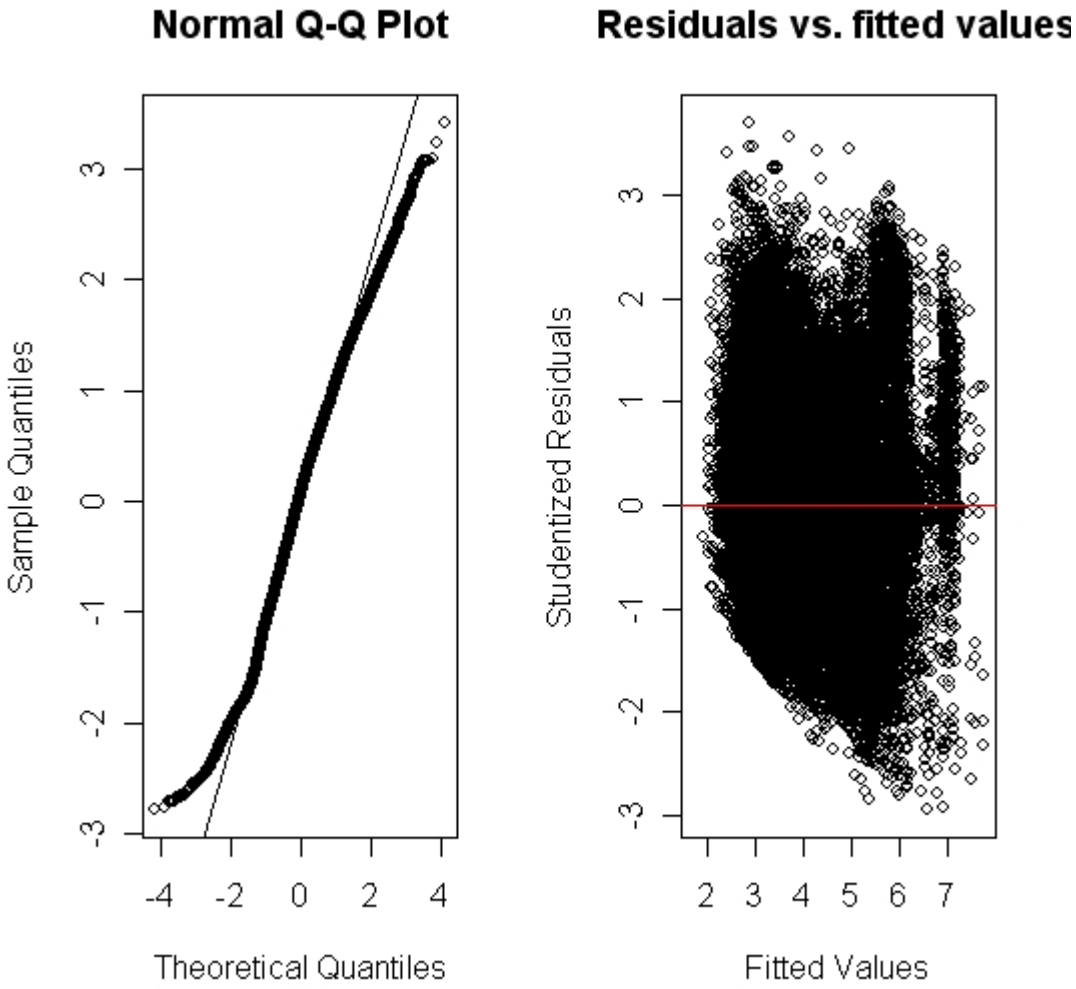
Appendix Figure 5.10.2.1. Regression diagnostics for the lognormal part of the delta-lognormal model for gillnet CPUE data from the logbook survey. The first panel gives a plot of fitted values against studentized residuals, indicating that residual variance is roughly constant across the range of fitted values. The second panel gives a normal quantile-quantile plot, where quantiles of residuals are close to being normally distributed (i.e., falling on the dotted line), with slight over-dispersion apparent in large CPUE observations and slight under-dispersion in small values of CPUE.



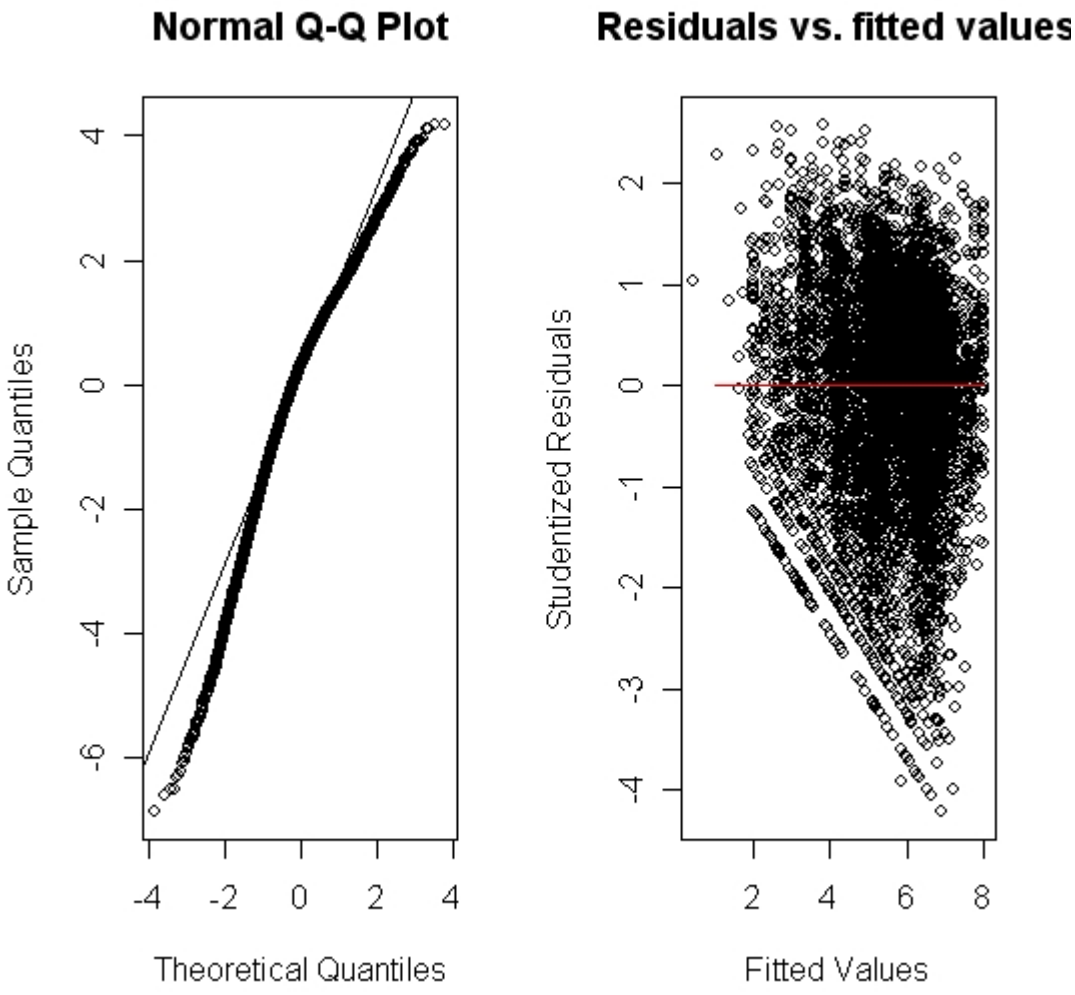
Appendix Figure 5.10.2.2 Regression diagnostics for the lognormal part of the delta-lognormal model for hook&line CPUE data from the logbook survey. The first panel gives a plot of fitted values against studentized residuals, indicating that residual variance is roughly constant across the range of fitted values. The second panel gives a normal quantile-quantile plot, where quantiles of residuals are close to being normally distributed (i.e., falling on the dotted line).



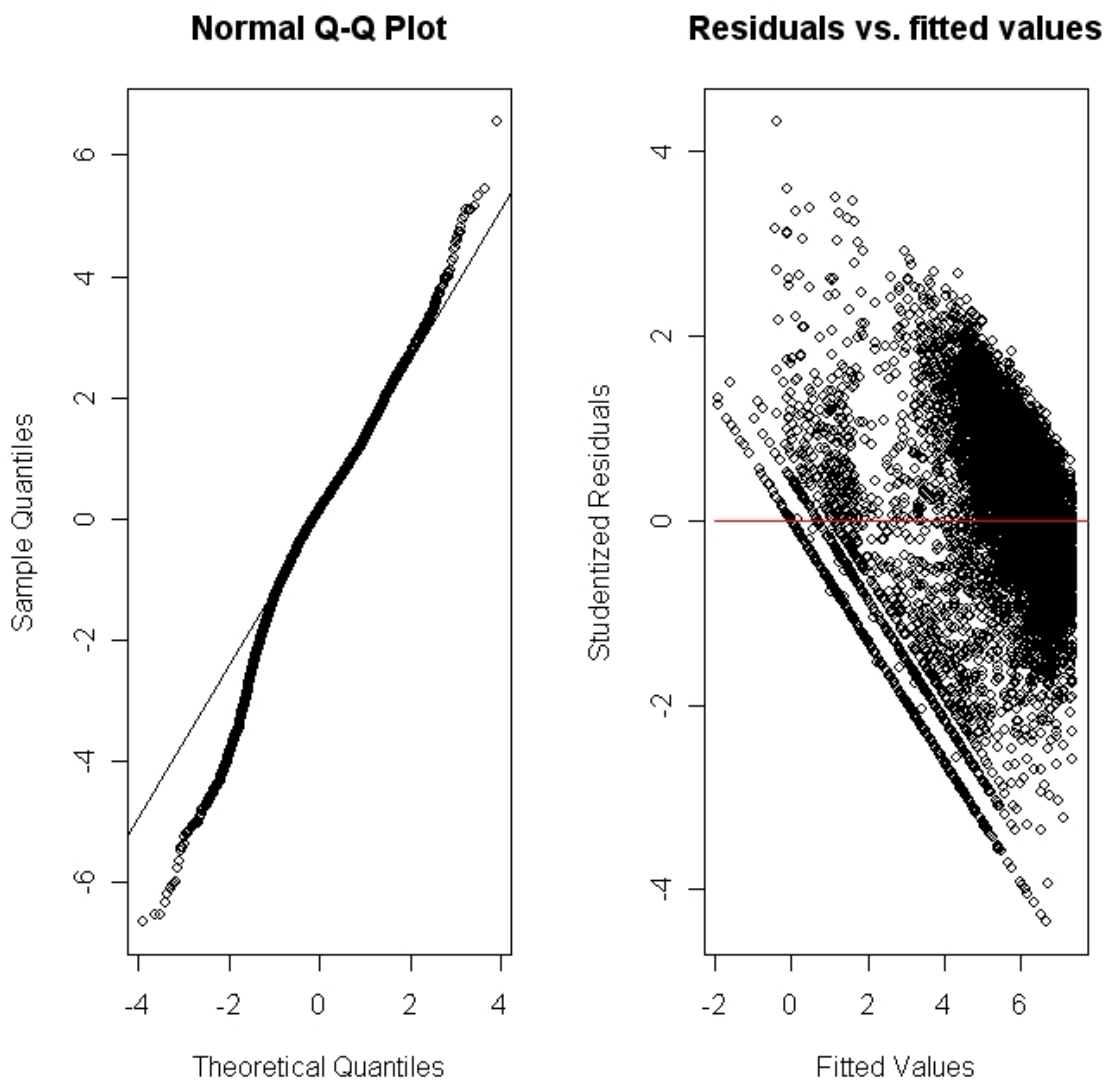
Appendix Figure 5.10.2.3. A normal quantile plot of randomized quantile residuals (cf. Dunn and Smyth 1995), together with a plot of studentized randomized quantile residuals vs. fitted values for the generalized linear model fit to 1985-1994 Florida trip ticket gillnet CPUE data. The normal quantile-quantile plot reveals that the fitted model has residuals that are somewhat underdispersed in comparison to the fitted gamma model. Residual variance appears roughly constant across the range of fitted values.



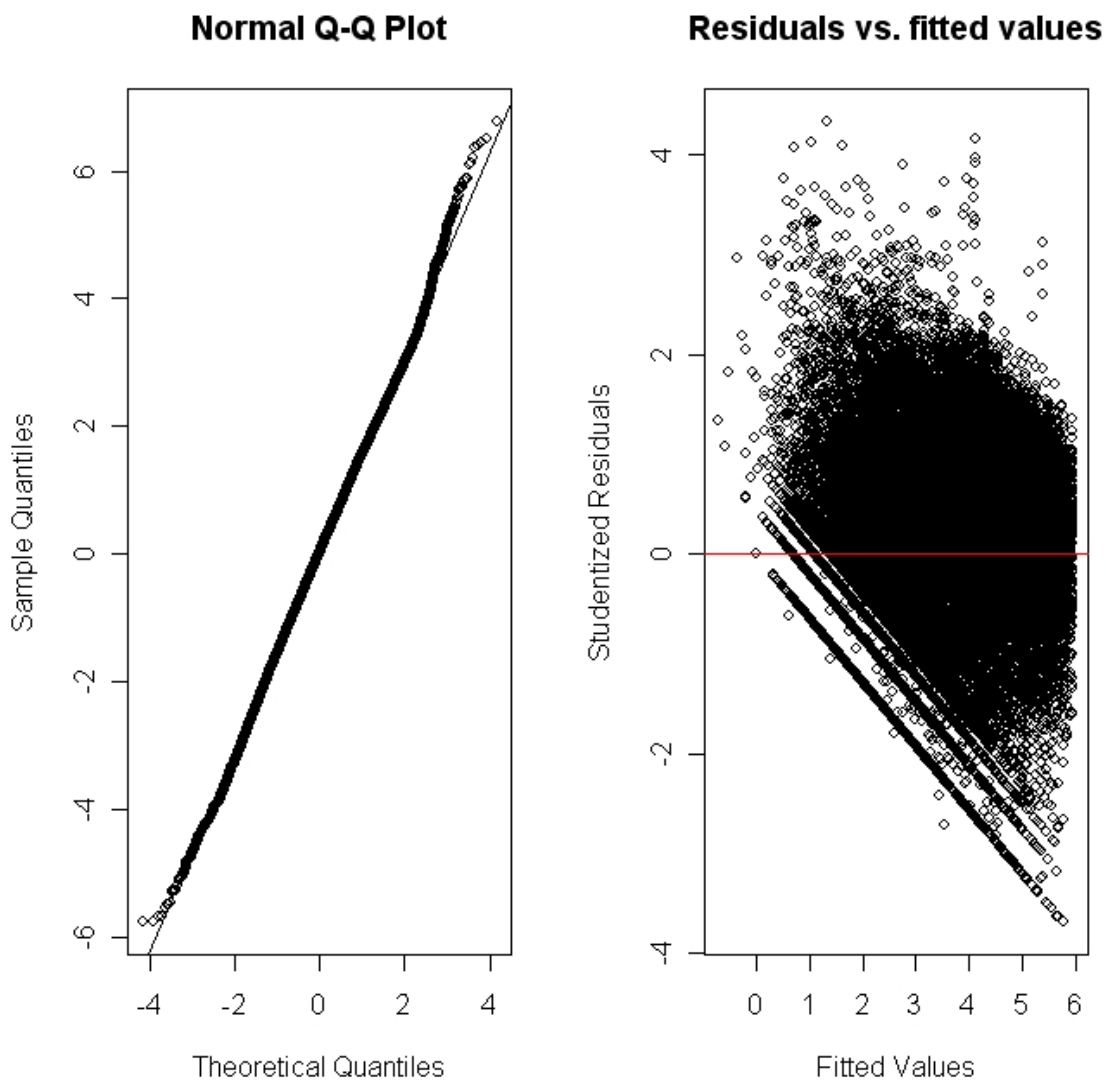
Appendix Figure 5.10.2.4. A normal quantile plot of residuals, together with a plot of studentized residuals vs. fitted values for the generalized linear model fit to 1996-2007 Florida trip ticket gillnet CPUE data. The normal quantile-quantile plot reveals that CPUE is overdispersed in comparison to the normal model at lower values, but somewhat underdispersed at higher values. Residual variance appears roughly constant across the range of fitted values. The absence of values in the lower left quadrant is related to the lower boundary of observations (1 lb).



Appendix Figure 5.10.2.5. A normal quantile plot of residuals, together with a plot of studentized residuals vs. fitted values for the generalized linear model fit to 1999-2007 Florida trip ticket castnet CPUE data. The normal quantile-quantile plot reveals extreme overdispersion in relation to the normal model, while the second panel reveals that residual variance decreases as the fitted value increases. The absence of values in the lower left quadrant is related to the lower boundary of observations (1 lb).



Appendix Figure 5.10.2.6. A normal quantile plot of residuals, together with a plot of studentized residuals vs. fitted values for the generalized linear model fit to 1985-2007 Florida trip ticket hook & line CPUE data. The normal quantile-quantile plot reveals that residuals are roughly normally distributed, while panel 2 indicates that residual variance is roughly constant across the range of fitted values. The absence of values in the lower left quadrant is related to the lower boundary of observations (1 lb).



6. Submitted Comments