SEDAR 22 Gulf of Mexico Yellowedge Grouper and Tilefish

Guidelines for submitting written public comment

The intent of public comment is to allow interested parties the opportunity to address the draft reports of a SEDAR stock assessment before the report and assessment go to the Review Panel. Comments received will be reviewed by the appointed assessment panel and responded to as appropriate. The assessment panel reserves the right to make changes to the draft report in response to comments received. **These documents are a draft documents. Content and formatting may change between this draft and the version that will be released to the Review Panel on February 1st, 2011.**

The comment period will be open from 23 November 2010, to 14 December 2010. All comments must be in writing and submitted via US mail, fax, or by email to the appropriate address indicated below; comments sent by US mail must be postmarked by December 14, 2010. Comments will not be accepted by phone. Any comments received after **December 14, 2010** will not be forwarded to the panel. Please clearly indicate that you are commenting on the "SEDAR 22 Assessment reports" in your correspondence. Please indicate which species you are commenting on: yellowedge grouper or tilefish.

Comments for the SEDAR 22 Gulf of Mexico Yellowedge Grouper and Tilefish stock assessments may be submitted to the following:

Email: Sedar22comments@safmc.net Fax: (843) 769-4520

Address:
SEDAR 22 AW Comments -
4055 Faber Place Dr., Suite 201
North Charleston, SC 29405

When preparing comments for submission please keep the following guidelines in mind:

1. **Relevancy**. Please keep your comments concise and relevant to the assessment documents presented for comment.
   a) Target specific issues,
   b) Include data and facts with references,
   c) Propose specific ideas or suggestions for solving any problems you identify,
   d) Please comment on the assessment decisions and inputs that lead to the results, not on the results of the assessment.
2. **No personal or slanderous remarks**. Please be respectful and avoid personal attacks.
3. Comments should be directed to 'SEDAR 22 Assessment Panel' not to individual panel members.
4. You may submit comments anonymously.
5. All comments are considered public documents in compliance with open meeting and public record laws. All public documents will be available to the general public.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 22

Pre-Review Stock Assessment Report

Gulf of Mexico Yellowedge Grouper

November 2010

SEDAR

4055 Faber Place Drive, Suite 201

North Charleston, SC 29405

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Southeast Data, Assessment, and Review

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Gulf of Mexico Yellowedge Grouper

SECTION I: Introduction

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

1. SEDAR PROCESS DESCRIPTION

SouthEast Data, Assessment, and Review (**SEDAR**) is a cooperative Fishery Management Council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and US Caribbean. SEDAR seeks improvements in the scientific quality of stock assessments and the relevance of information available to address fishery management issues. SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments.

SEDAR is managed by the Caribbean, Gulf of Mexico, and South Atlantic Regional Fishery Management Councils in coordination with NOAA Fisheries and the Atlantic and Gulf States Marine Fisheries Commissions. Oversight is provided by a Steering Committee composed of NOAA Fisheries representatives: Southeast Fisheries Science Center Director and the Southeast Regional Administrator; Regional Council representatives: Executive Directors and Chairs of the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is organized around two workshops and a series of webinars. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. The second stage is the Assessment Process, which is conducted via a series of webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. Third and final is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products. The completed assessment, including the reports of all 3 workshops and all supporting documentation, is then forwarded to the Council SSC for certification as ‘appropriate for management’ and development of specific management recommendations.

SEDAR workshops are public meetings organized by SEDAR staff and the lead Council. Workshop participants are drawn from state and federal agencies, non-government organizations, Council members, Council advisors, and the fishing industry with a goal of including a broad range of disciplines and perspectives. All participants are expected to contribute to the process by preparing working papers, contributing, providing assessment analyses, and completing the workshop report.

SEDAR Review Workshop Panels consist of a chair, 3 reviewers appointed by the Center for Independent Experts (CIE), and three reviewers appointed from the SSC of the Council having jurisdiction over the stocks being assessed. The Review Workshop Chair is appointed by the Council from their SSC. Participating councils may appoint additional representatives of their SSC, Advisory, and other panels as observers.

2. MANAGEMENT OVERVIEW

2.1 *FISHERY MANAGEMENT PLAN AND AMENDMENTS*

The following summary describes only those management actions that likely affect yellowedge grouper fisheries and harvest

Original GMFMC FMP

The Fishery Management Plan (FMP) for the reef fish fishery of the Gulf of Mexico was implemented in November 8, 1984. This plan is for the management of reef fish resources under authority of the Gulf of Mexico Fishery Management Council Management Council. The plan considers reef fish resources throughout its range from Florida through Texas. The area which will be regulated by the federal government under this plan is confined to the waters of the fishery conservation zone (FCZ). The FCZ estimated area is 6.82 x 10^5 km ^{2} (263,525 square miles) and of that 12.4% of it is estimated as part of the continental shelf that is encompassed within the FCZ. Yellowedge grouper is one of the many species included in the fishery management unit. The four objectives of the FMP were: (1) to rebuild the declining reef fish stocks wherever they occur within the fishery, (2) establish a fishery reporting system for monitoring the reef fish fishery, (3) conserve reef fish habitats and increase reef fish habitats in appropriate areas and to provide protection for juveniles while protecting existing new habitats, (4) to minimize conflicts between user groupers of the resource and conflicts for space.

Measures in the original FMP that would have affected yellowedge grouper are maximum sustainable yield (MSY) and optimum yield (OY) estimates for all grouper and snapper species in aggregate, permits and gear specifications for fish traps along with a limit on the number of fish traps allowed per vessel, establishment of a stressed area within which the use of fish traps, roller trawls, and powerheads for the taking of reef fish was prohibited, and a prohibition on the use of poison or explosives for taking reef fish.

GMFMC FMP Amendments affecting yellowedge grouper

Description of Action	FMP/Amendment	Effective Date
Placed in the management unit/no regulations/Optimum Yield aggregate for groupers and snappers =45 mp.	Original FMP	1981

(1) Created deep-water and shallow-water aggregates (2) Set 1.8 mp (whole weight) deep-water grouper commercial quota (3) Allowed 2 day possession for charterboat/headboat (4) Established 20-50 fathom buoy/longline gear boundary (5) Established a commercial reef fish vessel permit (6) Established fish trap permits, 100 traps per person (7) Established fishing season January 1-December 31 (8)Established a framework for setting total allowable catch (9)Established a 5 grouper aggregate recreational bag limit	Amendment 1 (GMFMC 1990)	2/21/90
Changed TAC specification from April to August Set 1.8 mp (gutted weight) as the deep-water commercial quota. Scamp is shallow-water until closed then deep-water grouper -Set a three-year moratorium on issuance of new commercial reef fish permits	Amendment 4 (GMFMC 1992)	5/8/92
Grouper quotas were expressed in whole weight by multiplying the gutted weight by 1.18. This conversion factor was modified to 1.05 for deep-water and shallow-water groupers.	Supplemental Rule	5/22/92
Established reef fish dealer permitting and record keeping requirements, allowed transfer of fish trap permits, and endorsements between immediate family members during the fish trap moratorium, and allowed transfer of other reef fish permits or endorsements in the event of death or disability of the person who was the qualifier for the permit or endorsement.	Amendment 7 (GMFMC 1994)	2/7/94
(1) Limit sale of Gulf reef fish by permitted vessels to permitted reef fish dealers,(2) require that permitted reef fish dealers purchase reef fish caught in Gulf federal waters only from permitted vessels, (3) allow transfer of reef fish permits and fish trap endorsements in the event of death of disability, (4) implement a new reef fish permit moratorium for no more than 5 years or until 12/31/00, (5) allow permit transfers to other persons with vessels by vessel owners (not operators)	Amendment 11 (GMFMC 1996)	1/1/96

who qualified for their reef fish permit, and (6) allow a onetime transfer of existing fish trap endorsements to permitted reef fish vessels whose owners have landed reef fish from fish traps in federal waters, as reported on logbooks received by the science and research director of NMFS from 11/20/92 through 2/6/94.		
Ten year phase-out for the fish trap fishery in the EEZ; allowed transfer of fish trap endorsements for the first two years and thereafter only upon death or disability of the endorsement holder, to another vessel owned by the same entity, or to any of the 56 individuals who were fishing traps after 11/19/92 and were excluded by the moratorium; and prohibited the use of fish traps west of Cape San Blas, Florida.	Amendment 14 (GMFMC 1997)	4/24/97
Prohibit harvest of reef fish from traps other than permitted reef fish traps.	Amendment 15 (GMFMC 1998)	1/29/98
Prohibits the possession of reef fish exhibiting the condition of trap rash on board any vessel in the Gulf EEZ and that does not have a valid fish trap endorsement and requires fish trap owners or operators to provide trip initiation and termination reports and to comply with a vessel/gear inspection requirement.	Amendment 16A (GMFMC 2000)	1/10/00
Extended the commercial reef fish permit moratorium until December 31, 2005	Amendment 17 (GMFMC 2000)	8/2/00
1) Prohibits vessels from retaining reef fish caught under recreational bag/possession limits when commercial quantities of Gulf reef fish are aboard, (2) adjusts maximum crew size on charter vessels that also have a commercial reef fish permit, and (3) prohibits the use of reef fish for bait except for sand or dwarf sand perch.	Amendment 18A (GMFMC 2007)	5/6/07
Establish 3-year moratorium on issuance of charter and headboat permits for-hire reef fish	Amendment 20 (GMFMC 2001)	7/1/03

Continues the Steamboat Lumps and Madison-Swanson reserves for an additional six years, until June 2010.	Amendment 21 (GMFMC 2003)	6/3/04
Implemented specific bycatch reporting methodologies for logbooks and a mandatory commercial and for-hire (charter vessel/headboat) observer program for the reef fish fishery.	Amendment 22 (GMFMC 2004)	7/5/05
Replaced the commercial reef fish permit moratorium with a permanent limited access system	Amendment 24 (GMFMC 2005)	8/17/05
Replaced reef fish for-hire moratorium with limited access system	Amendment 25 (GMFMC 2005)	6/15/06
Requires the use of non-stainless steel circle hooks when using natural baits to fish for Gulf reef fish and the use of venting tools and dehooking devices when participating in the commercial or recreational reef fish fisheries.	Amendment 27 (GMFMC 2007)	6/1/08
Management of shallow water grouper (SWG) to achieve OY. (1) Establishes ACLs and AMs for the commercial and aggregate SWG fishery, (2) adjusts recreational grouper bag limits to 4 grouper/person/day and seasonal closures to all SWG closed 2/1 – 3/31 (3) adjusts commercial grouper season to "No Closed Season", instead a four month seasonal area closure at the Edges, (4) eliminates the end date for the Madison-Swanson and Steamboat Lumps marine reserves, and (5) requires that vessels with federal commercial or charter reef fish permits comply with the more restrictive of state or federal reef fish regulations when fishing in state waters	Amendment 30B (GMFMC 2008)	4/16/09
Proposes to rationalize effort and reduce overcapacity in the commercial grouper and tilefish fisheries in order to achieve and maintain OY. Several management alternatives including Individual Fishing Quota (IFQ) programs are developed to achieve these	Amendment 29 (GMFMC 2009)	1/1/10

objectives.		
Created season area closures for longline gear April through August from 35 fathoms shoreward, would establish an endorsement to use bottom longline gear to fish for reef fish in the eastern Gulf of Mexico greatly limiting the fishery, and created a gear limitation:1,000 hooks of which no more than 750 hooks are rigged for fishing or fished. Under this alternative all options for number of hooks per vessel are lower than the average number of hooks used by most commercial reef fish fishers in the bottom longline component of the fishery.	Amendment 31 (GMFMC 2009)	**IN NOAA REVIEW – REGULATIONS NOT ESTABLISHED**

*Yellowedge grouper stock assessment was conducted in 2002, but determined inconclusive. However it did extend the maximum age of yellowedge grouper from 35 to 85 years

Gulf Council Regulatory Amendments

An October 2005 regulatory amendment, implemented January 1, 2006, established a 6,000 pound GW aggregate deep-water (DWG) and shallow-water grouper (SWG) trip limit for the commercial grouper fishery, replacing the 10,000/7,500/5,500 step-down trip limit that had been implemented by emergency rule [70 FR 77057].

2.2. Emergency and Interim Rules

An emergency rule of February 17, 2005 that established trip limits for the commercial shallow-water and deep-water grouper fisheries in the Gulf of Mexico (EEZ) is in effect from March 3, 2005 through August 16, 2005 and was extended an additional 180 days by NMFS through February 12, 2006. The trip limit was initially set at 10,000 pounds gutted-weight (GW) for deep-water and shallow-water grouper combined. If on or before August 1 the fishery is estimated to have landed more than 50% of either the shallow-water grouper or the red grouper quota, then a 7,500 pound GW trip limit takes effect; and if on or before October 1 the fishery is estimated to have landed more than 75% of either the shallow-water grouper or red grouper quota, then a 5,500 pound GW trip limit takes effect [70 FR 8037].

An interim rule, published July 25, 2005, proposed for the period August 9, 2005 through January 23, 2006, a temporary reduction in the aggregate grouper bag limit from five to three grouper

per day, and a closure of the recreational fishery, from November-December 2005, for all grouper species. The closed season was applied to all grouper in order to prevent effort shifting from red grouper to other grouper species. This rule was challenged by organizations representing recreational fishing interests and on October 31, 2005 a U.S. District Court judge ruled that an interim rule could only be applied to the species undergoing overfishing. This resulted in the aggregate grouper bag limit and closed season for all grouper to be overturned [70 FR 42510].

An emergency rule effective May 18, 2009 moved the buoy/longline gear boundary line to 50 fathoms. That rule was replaced on October 16, 2009 by a rule under the Endangered Species Act moving the boundary to 35 fathoms and implementing 1,000 hooks of which no more than 750 hooks are rigged for fishing or fished.

2.3. Secretarial Amendments

Secretarial Amendment 1, implemented July 15, 2004, reduced the commercial quota from (1.6 mp whole weight) for deep-water grouper quota and reinstated gutted weight. The quota was reduced for deep-water grouper from 1.35 MP gutted weight to 1.02 mp gutted weight.

2.4. Control Date Notices

Notice of Control Date 11/1/89 54 FR 46755:

-Anyone entering the commercial reef fish fishery in the Gulf of Mexico after 11/1/89 may be assured of future access to the reef fish resource of a management regime is developed and implemented that limits the number of participants in the fishery.

Notice of Control Date 11/18/98 63 FR 64031:

-The Council considered whether there was a need to impose additional management measures limiting entry into the recreational-for-hire (i.e., charter vessel and headboat) fisheries for reef fish in the EEZ of the Gulf of Mexico and if needed what management measures should be imposed. Possible measures include the establishment of a limited entry program to control participation or effort in the recreational-for-hire fisheries for reef fish in the EEZ. In Amendment 20 to the Reef Fish FMP, a qualifying date of March 29, 2001 was adopted.

Notice of Control Date 7/12/00 65 FR 42978:

-The Council considered whether there was a need to limit participation by gear type in the commercial reef fish fisheries in the Gulf EEZ and if so what management measures should be imposed. Possible measures include modifications to the existing limited entry program to control fishery participation or effort, based on gear type, such as a requirement for gear endorsement on the commercial reef fish vessel permit for the appropriate gear. Gear types that may be included are longlines, buoy gear, handlines, rod-and-reel, bandit gear, spear fishing gear, and powerheads used with spears.

Notice of Control Date 10/15/04 69 FR 67106:

-The Council is considered the establishment of an IFQ to control participation or effort in the commercial grouper fishery of the Gulf of Mexico. The control data above would determine eligibility of catch histories in the commercial grouper fishery.

2.5. Management Program Specifications

Table 2.5.1. General Management Information

Species	Yellowedge grouper (*Epinephelus flavolimbatus*)
Management Unit	Gulf of Mexico
Management Unit Definition	All waters within the Gulf of Mexico Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	/ Carrie Simmons
Current stock exploitation status	Not yet determined
Current stock biomass status	Not yet determined

Table 2.5.2. Specific Management Criteria

Criteria	Gulf of Mexico – Current		Gulf of Mexico - Alternative	
	Definition	Value	Definition	Value
MSST	undefined*	To Be	MSST = [(1-M) or 0.5	SEDAR 22

		Determined (TBD)	whichever is greater]*B_{MSY}	
MFMT	F30%SPR	TBD	F_{MSY}	SEDAR 22
MSY	undefined**	TBD	Yield at F_{MSY}	SEDAR 22
F_{MSY}	no proxy defined	TBD	F_{MSY}	SEDAR 22
OY	undefined**	TBD	Yield at F_{OY}	SEDAR 22
F_{OY}	undefined***	TBD	F_{OY} =65%, 75%, 85% F_{MSY}	SEDAR 22
M	--	TBD	Instantaneous natural mortality	SEDAR 22
Probability value for evaluating status	50% Fcurr> MFMT = overfishing		Annual yield @ F_{MFMT}	

The Generic SFA Amendment (1999) states that MSST will be implemented by framework amendment for each stock as estimates of B_{MSY} and MSST are developed by NMFS, the Reef Fish Stock Assessment Panel, and Council. Thus, MSST is undefined until established following a stock assessment in which B_{MSY} or a proxy is determined. However, the Council has generally adopted (1-M)SSB_{MSY} as the MSST for stocks with stock assessments.

**Proposed SPR based proxies of MSY and OY in the Generic SFA Amendment were rejected by NMFS on the basis that such proxies must be biomass based.

*** The Council has typically used 75% of F_{MSY} (or F_{MSY} proxy) as its definition of F_{OY}. However, no generic definition of F_{OY} has been set, and it is therefore undefined for stocks without prior assessments.

Yields (MSY and OY) are in terms of pounds landed under prevailing selectivity's and after estimating and accounting for discards in the stock assessment.

NOTE: "Proposed" columns are for indicating any definitions that may exist in FMPs or amendments that are currently under development and should therefore be evaluated in the current assessment. "Current" is those definitions in place now. Please clarify whether landings parameters are 'landings' or 'catch' (Landings + Discard). If 'landings', please indicate how discards are addressed.

Stock Rebuilding Information

The current stock biomass is unknown; therefore, no rebuilding plan is required at this time.

Table 2.5.3. Stock projection information.

Requested Information	Value
First Year of Management	2013
Projection Criteria during interim years should be based on (e.g., exploitation or harvest)	Fixed exploitation at F_{OY} or Frebuilding as appropriate.
Projection criteria values for interim years should be determined from (e.g., terminal year, avg of X years)	Average of previous 3 years

First year of Management: Earliest year in which management changes resulting from this assessment are expected to become effective

interim years: those between the terminal assessment year and the first year that any management could realistically become effective.

Projection Criteria: The parameter which should be used to determine population removals, typically either an exploitation rate or an average landings value or a pre-specified landings target.

Table 2.5.4. Quota Calculation Details

There is currently not a quota specified for this stock, only a deep-water grouper quota = 1.02 mp gutted weight. The deep-water grouper includes scamp after the shallow-water grouper quota is filled. If a yellowedge grouper quota is established, the other remaining species would need to be considered: misty, snowy, and warsaw.

Current Quota Value	1.02 mp gutted weight
Next Scheduled Quota Change	None at this time
Annual or averaged quota ?	Annual

If averaged, number of years to average	
Does the quota include bycatch/discard?	Bycatch/discards incorporated into assessment

Commercial sector

The commercial deep-water grouper quota is 1.02 MP gutted weight and includes scamp after the shallow-water grouper quota is filled. This quota was implemented July 15, 2004 in Secretarial Amendment 1. An aggregate deep-water and shallow-water grouper trip limit of 6,000 pounds gutted weight was implemented on January 1, 2006. The deep-water quota is typically caught by June.

If a total allowable catch is established for yellowedge grouper, it will be necessary to establish commercial and recreational allocations so that the commercial shallow-water quota can be adjusted accordingly. There is currently no formal guidance for allocating grouper species other than red grouper and gag. If total allowable catch was developed for yellowedge grouper then it would be deducted from deep-water grouper quota.

Recreational Sector

The Amendment 30B proposed rule would establish new grouper bag limits and extend the Gulf grouper recreational closed season. These recreational measures are projected to reduce gag landings by 26% and increase red grouper landings by 17%. The aggregate grouper bag limit would be reduced from 5 fish to 4 fish per person per day. Within this aggregate bag limit, there is a 2 fish gag bag limit and a 2 fish red grouper bag limit per person per day. Lowering the aggregate grouper bag limit is intended to slow or prevent a shift in effort from gag to other shallow-water and deep-water grouper species as a result of actions to constrain the harvest of gag. Although deep-water grouper and shallow-water grouper species other than gag and red grouper represent a small portion of the recreational harvest, they could be significantly affected by shifts in fishing effort resulting from changes to gag and red grouper regulations [73 FR 68390].

If a yellowedge grouper total allowable catch and recreational allocation are established, it may be necessary to revise the recreational grouper harvest regulations to keep the recreational sector within its allocation. The determination of appropriate regulatory alternatives is beyond the scope of the SEDAR assessment.

Does the quota include bycatch/discard estimates? If so, what is the source of the bycatch/discard values? What are the bycatch/discard allowances?

Discard mortality estimates are to be estimated and incorporated into the assessment in order to estimate quotas and allocations in terms of landed catches that take into account discard mortality. Appropriate values for current levels of discards and discard mortality rates are to be determined and calculated as part of the Data and Assessment workshops using available data, research, and observations (both observer and anecdotal) to determine values that represent the best available scientific information.

In the recreational sector aggregate bag limits that pertain to all groupers except goliath grouper and Nassau grouper. No more than 2 gag grouper per person (counts as part of the 4 grouper aggregate bag limit), and no more than 2 red grouper per person (counts as part of the 4 grouper aggregate bag limit). Yellow-edge grouper are likely not landed frequently by recreational anglers. However, the reduction in the aggregate grouper bag limit may increase yellowedge grouper bycatch.

There is currently not a quota specified for this stock, only a deep-water grouper quota. If a yellowedge grouper quota is established, it will be taken from the other deep-water grouper allowance.

2.6. Management and Regulatory Timeline

The following tables provide a timeline of Federal management actions by fishery.

Table 2.6.1. Annual Commercial Yellowedge Grouper Regulatory Summary

Year	Fishing Year	Size Limit	Possession Limit
1983	Calendar Year	None	--
1984	Calendar Year	None	--
1985	Calendar Year	None	--
1986	Calendar Year	None	--
1987	Calendar Year	None	--
1988	Calendar Year	None	--
1989	Calendar Year	None	--
1990	Calendar Year	None	--
1991	Calendar Year	None	--
1992	Calendar Year	None	--
1993	Calendar Year	None	
1994	Calendar Year	None	
1995	Calendar Year	None	
1996	Calendar Year	None	
1997	Calendar Year	None	
1998	Calendar Year	None	"
1999	Calendar Year	None	"
2000	Calendar Year	None	
2001	Calendar Year	None	"
2002	Calendar Year	None	"
2003	Calendar Year	None	"
2004	Calendar Year	None	Commercial Fishery Closure for DWG June 23, 2005
2005	Calendar Year	None	The trip limit was initially set at 10,000 pounds gutted-weight (GW). If on or before 10/1 the fishery is estimated to have landed more than 75% of either SWG or red grouper quota then a 5,500 pound GW trip limit takes effect." Commercial Fishery Closure for DWG June 23, 2005
2006	Calendar Year		Established a 6,000 pound GW aggregate DWG and SWG trip limit Commercial Fishery Closure for DWG June 27, 2006
2007	Calendar Year		Commercial Fishery Closure for DWG June 2, 2007
2008	Calendar Year		Commercial Fishery Closure for DWG May 10,2008 The Commercial Fishery re-opened for DWG November 1-10, 2008
2009	Calendar Year		Commercial Fishery Closures for DWG June 27, 2009

Table 2.6.2. Annual Recreational Yellowedge Grouper Regulatory Summary

Year	Fishing Year	Size Limit	Bag Limit
1983[1]	Calendar Year	None	--
1984[1]	Calendar Year	None	--
1985[2]	Calendar Year	None	--
1986	Calendar Year	None	
1987	Calendar Year	None	
1988	Calendar Year	None	
1989	Calendar Year	None	
1990[3]	Calendar Year	None	5 grouper aggregate[1]/person/day
1991	Calendar Year	None	
1992	Calendar Year	None	
1993	Calendar Year	None	
1994	Calendar Year	None	
1995	Calendar Year	None	
1996	Calendar Year	None	
1997	Calendar Year	None	
1998	Calendar Year	None	
1999	Calendar Year	None	
2000	Calendar Year	None	
2001	Calendar Year	None	
2002	Calendar Year	None	
2003	Calendar Year	None	
2004	Calendar Year	None	
2005	Calendar Year	None	Published 7/05-Limited aggregate grouper bag limit from 5 to 3 grouper per day but, was overturned by 12/05
2006	Calendar Year	None	5 grouper aggregate[1]/person/day
2007	Calendar Year	None	
2008	Calendar Year	None	
2009	Calendar Year	None	4 grouper aggregate[1]/person/day

[1] The following species are included in the Gulf of Mexico grouper aggregate. The shallow-water grouper are defined as the following species: black grouper, gag (no more than 2 per person), red grouper (no more than 2 per person), yellowfin grouper, yellowmouth grouper, rock hind, red hind, speckled hind (1 per vessel), and scamp. Deep-water grouper are defined as misty grouper, snowy grouper, yellowedge grouper, warsaw grouper (1 per vessel), and scamp once the shallow-water grouper quota is filled. Recreational aggregate grouper bag limits apply to all groupers in aggregate.

2009-2010: For-hire captain and crew prohibited from retaining bag limits for any grouper while under charter. Federally permitted for-hire reef fish vessel must comply with the more restrictive of federal or state reef fish regulations when fishing for reef fish in state waters.

2.7 State Regulatory History

Florida:

Alabama: Recreational regulations

December 12, 1995-Established a grouper aggregate bag limit in Alabama waters of 5 fish per person for recreational fishermen

August 27, 2009 -Reduced the grouper aggregate bag limit to 4 fish for recreational fishermen

There are no regulations for commercial fishing for these species.

* Alabama Marine Resources is proposing regulations this year to the Conservation Advisory Board that will close Alabama waters at any time adjacent federal waters are closed to the taking of a specific reef fish species. These would include both the recreational fisheries and the commercial fisheries. We hope to have these regulations in place by May 2010.

Mississippi:

Historically Mississippi has followed the regulations set forth by the Gulf Council; however, we have not changed our regulations to reflect the regulations put into effect by the Gulf Council on July 29, 2009. We are still currently at a recreational five fish aggregate for the groupers.

Louisiana:

For Louisiana the only significant differences for these two species between federal and state management occurred in 2009, when modifications to include IFQ rules were not adopted, and rules on having charter vessels comply with more restrictive rules were also not adopted.

Texas: They do not have matching rules in Texas waters, but enforce federal rules under Joint Enforcement Agreements.

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GMFMC (Gulf of Mexico Fishery Management Council). 2003. Amendment 21 to the reef fish fishery management plan. Gulf of Mexico Fishery Management Council, Tampa, Florida. 143 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2004. Final Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to the following fishery management plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Stone Crab Fishery of the Gulf of Mexico, Coral and Coral Reef Fishery of the Gulf of Mexico, Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic, Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council, Tampa, Florida. 118 pp.

GMFMC (Gulf of Mexico Fishery Management Council). Corrected Amendment 20 for a Charter Vessel/Headboat Permit Moratorium Amending the FMPs for reef fish and Amendment 14 for Coastal Migratory Pelagics. 2003. Gulf of Mexico Fishery Management Council, Tampa, Florida. 165 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2004. Amendment 22 to the reef fish fishery management plan to set red snapper sustainable fisheries act targets and thresholds, set a rebuilding plan, and establish bycatch reporting methodologies for the reef fish fishery. Gulf of Mexico Fishery Management Council, Tampa, Florida 33607 350 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Amendment 18a to the Reef Fish FMP for resolving enforcement of regulations, for updating the framework procedure for setting total allowable catch, and to reduce bycatch mortality of incidentally caught endangered sea turtles and smalltooth sawfish. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 192 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Amendment 25 to the Reef Fish FMP and Amendment 17 for the Coastal Migratory Pelagics to for extend the charter vessel/headboat permit moratorium. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 80 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Final Regulatory Amendment to the Reef Fish Fishery Management Plan to Set Recreational Management Measures for Grouper Starting in 2006. Gulf of Mexico Fishery Management Council, Tampa, Florida. 124 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2007. Amendment 27 to the Reef Fish FMP and Amendment 14 to the Shrimp FMP to end overfishing and rebuild the red snapper stock. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 490 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2008. Amendment 30B to the Reef Fish FMP: Gag – End Overfishing and Set Management Thresholds and Targets, Red Grouper – Set Optimum Yield TAC and Management Measures, Time/Area Closures, and Federal Regulatory Compliance. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 462 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2009. Amendment 29 to the reef fish fishery management plan. Effort Management in the Commercial Grouper and Tilefish Fisheries. Gulf of Mexico Fishery Management Council, Tampa, Florida 33607. 300 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2009. Amendment 31 to the Fishery Management Plan for Reef Fish Resources in the Gulf of Mexico. Addresses bycatch of sea turtles in the bottom longline component of the Gulf of Mexico Reef Fish Fishery. Gulf of Mexico Fishery Management Council, Tampa, Florida 33607. 260 pp.

3. ASSESSMENT HISTORY AND REVIEW

The first assessment of yellowedge grouper was completed in 2002 (Cass-Calay and Bahnick 2002) but was inconclusive regarding the status of the stock. Estimates of initial spawning stock biomass were quite variable and extremely sensitive to initial inputs. Consequently any estimates of current stock status or MSY were also poorly determined. At the time it was felt that there was insufficient data to effectively model the population. In response to the absence of definitive stock status or quota advice, the reef fish stock assessment panel (GMFMC, 2002) recommended an allowable biological catch of 0.84 million lbs gutted weight (381) metric tons, commensurate with the historical average landings.

The 2002 assessment used an age-structured production model Porch (2002). The model included landings from 1986 to 2001 and standardized CPUE time series from the commercial handline and longline logbook program from 1993-2001 split into East and Western Gulf of Mexico. A species association statistic was used to subset the total logbook trips to identify trips targeting yellowedge grouper. The model used Bayesian priors on many of the key inputs (Table 22 in Cass-Calay and Bahnick 2002) and estimated M, R_0 (virgin recruitment), catchability and selectivity parameters. Of importance for the current assessment, the previous model used an initial estimate of M as 0.0533 based upon the maximum age of 85, logistic selectivity functions for the longline fishery and gamma functions for the handline fishery. Sensitivity analyses were conducted with ranges of steepness values of 0.7, 0.65 and 0.6 and with the removal of the 1990 and 1991 index values from one handline index.

In the interim between the 2002 assessment there have been a number of critical improvements in the information content for yellowedge grouper. These include substantial increases in the numbers of length and age composition samples from the fishery, the continuation of the NMFS bottom longline survey such that it now represents a 10 year time series of CPUE and age composition and, most notably, a massive effort to obtain and age archival otolith samples collected by Lew Bullock from the start of the fishery in the late 1970s. This set of initial age and length composition samples represents an unparalleled view of the size and age structure of the population in the first years of the fishery and may give substantial new insights. These additional sources of information coupled with substantial efforts to extend the time series of landings back to the 1970s give hope that the current assessment model will have much more informative data.

Cass-Calay, S.L., and M. Bahnick. 2002. Status of the yellowedge grouper fishery in the Gulf of Mexico. Sustainable Fisheries Division Contribution No. SFD-02/03-172. NMFS, Southeast Fisheries Science Center, Miami, FL.

4. REGIONAL MAPS

Figure 4.1. Gulf of Mexico management region including Council and EEZ Boundaries

5. **ASSESSMENT SUMMARY**

The Summary Report provides a broad but concise view of the salient aspects of the stock assessment. It recapitulates: (a) the information available to and prepared by the Data Workshop; (b) the application of those data, development and execution of one or more assessment models, and identification of the most reliable model configuration as the base run by the Assessment Process (AP); and (c) the findings and advice determined during the Review Workshop.

<u>TO BE COMPLETED FOLLOWING THE REVIEW WORKSHOP</u>

Stock Status and Determination Criteria

Table 1. Summary of stock status determination criteria.

Criteria	Recommended Values from SEDAR 22	
	Definition	Value
M (Instantaneous natural mortality; per year)	Average of Lorenzen M (if used)	
F_{2009} (per year)	Apical Fishing mortality in 2009	
$F_{current}$ (per year)	Geometric mean of the directed fishing mortality rates in 2007 - 2009	
F_{MSY} (per year)	F_{MSY}	
B_{MSY} (metric tons)	Biomass at MSY	
SSB_{2009} (metric tons)	Spawning stock biomass in 2009	
SSB_{MSY} (metric tons)	SSB_{MSY}	
MSST (metric tons)	(1-M)*SSB_{MSY}	
MFMT (per year)	F_{MSY}	
MSY (1000 pounds)	Yield at MSY	
OY (1000 pounds)	Yield at F_{OY}	OY (65% $F_{MSY)}$= OY (75% $F_{MSY)}$= OY (85% F_{MSY}=

F_{OY} (per year)	F_{OY} = 65%,75%, 85% F_{MSY}	65% F_{MSY}= 75% F_{MSY}= 85% F_{MSY}=
Biomass Status	SSB_{2009}/MSST	
Exploitation Status	$F_{current}/F_{MSY}$	

***All weights are whole weight

Stock Identification and Management Unit

Species Distribution:

Stock Life History - summary of life history characteristics of the stock under assessment

Assessment Methods

Assessment Data

Release Mortality

Catch Trends

Fishing Mortality Trends

Stock Abundance and Biomass Trends - summary of abundance, biomass, and recruitment over time

Projections - results of model runs conducted to estimate stock conditions under various potential future levels of fishing mortality

Scientific Uncertainty

Significant Assessment Modifications

Sources of Information

Tables

- Table 1: Summary of stock status and determination criteria (above)
- Table 2: Summary of life history parameters by age
- Table 3: Catch and discards by fishery sector
- Table 4: Fishing mortality estimates
- Table 5: Stock abundance and biomass
- Table 6: Spawning stock biomass and Recruitment

Figures

- Figure 1: Landings by fishery sector
- Figure 2: Discards by fishery sector
- Figure 3: Fishing Mortality
- Figure 4: Stock Biomass
- Figure 5: Abundance Indices
- Figure 6: Stock-Recruitment
- Figure 7: Yield per Recruit
- Figure 8: Stock Status and Control Rule
- Figure 9: Projections

Table 2: Summary of Life History Parameters:

Table 3: Catch and discards by fishery sector

Table 4: Fishing mortality estimates

Table 5: Stock abundance and biomass

Table 6: Spawning stock biomass and recruitment

Figure 1: Landings by fishery sector

Figure 2: Discards by fishery sector

Figure 3: Fishing Mortality

Figure 4: Stock Biomass

Figure 5: Abundance Indices

Figure 6: Stock-Recruitment

Figure 7: Yield per Recruit

Figure 8: Stock Status and Control Rule

Figure 9: Projections

SEDAR

Southeast Data, Assessment, and Review

SEDAR 22

Gulf of Mexico Yellowedge Grouper

SECTION II: Data Workshop Report

SEDAR
4055 Faber Place Drive, Suite 201
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Table of Contents

1. INTRODUCTION

1.1. *WORKSHOP TIME AND PLACE*

The SEDAR 22 Data Workshop was held March 15 - 19, 2010 in Tampa, Florida.

1.2. *TERMS OF REFERNCE*

1. Characterize stock structure and develop a unit stock definition. Provide maps of species and stock distribution.
2. Review, discuss and tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.
3. Provide measures of population abundance that are appropriate for stock assessment. Consider and discuss all available and relevant fishery dependent and independent data sources. Document all programs evaluated, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop CPUE and index values by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision and accuracy. Evaluate the degree to which available indices adequately represent fishery and population conditions. Recommend which data sources are considered adequate and reliable for use in assessment modeling.
4. Characterize commercial and recreational catch, including both landings and discard, in pounds and number. Provide estimates of discard mortality rates by fishery and other strata as appropriate or feasible. Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible. Provide maps of fishery effort and harvest.
5. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
6. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet by June 1.

7. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report). Develop a list of tasks to be completed following the workshop.

1.3. *LIST OF PARTICIPANTS*

Workshop Panel

Adam Pollack .... NMFS Pascagoula
Bob Spaeth .... GMFMC AP
Brad Kenyon .... GMFMC AP
Brian Linton .... NMFS Miami
Charlie Bergmann .... NMFS Pascagoula
Debbie Fable .... NMFS Panama City
Elbert Whorton .... GMFMC SSC
Gary Fitzhugh .... NMFS Panama City
Harry Blanchet .... GMFMC SSC/LADWLF
Hope Lyon .... NMFS Panama City
John Quinlan .... NMFS Miami
John Walter .... NMFS Miami
Kevin McCarthy .... NMFS Miami
Linda Lombardi .... NMFS Panama City
Martin Fisher .... GMFMC AP
Melissa Cook .... NMFS Panama City
Neil Baertlein .... NMFS Miami
Refik Orhun .... NMFS Miami
Richard Fulford .... GMFMC SSC/Univ of S. MS
Steve Turner .... NMFS Miami
Walter Ingram .... NMFS Pascagoula

CIE Reviewer

Yong Chen .... Univ. of Maine

Council Representation

Bob Shipp .... GMFMC

Observers

Greg Abrams ....

Staff

Carrie Simmons .... GMFMC Staff
Julie Neer .... SEDAR
Tina O'Hern .... GMFMC Staff

Patrick Gilles..NMFS Miami

1.4. LIST OF DATA WORKSHOP WORKING PAPERS AND REFERNCE DOCUMENTS

Document #	Title	Authors	Working Group
Documents Prepared for the Data Workshop			
SEDAR22-DW-01	Golden tilefish (*Lopholatilus chamaeleonticeps*) age, growth, and reproduction from the northeastern Gulf of Mexico: 1985,1997-2009	Linda Lombardi, Gary Fitzhugh, Hope Lyon	Life History
SEDAR22-DW-02	Commercial longline vessel standardized catch rates of yellowedge grouper in the Gulf of Mexico	Neil Baertlein and Kevin McCarthy	Indices
SEDAR22-DW-03	Golden tilefish and blueline tilefish standardized catch rates from commercial longline vessels in the Gulf of Mexico	Kevin McCarthy	Indices
SEDAR22-DW-04	Discards of yellowedge grouper, golden tilefish, and blueline tilefish from commercial fishing vessels in the Gulf of Mexico	Kevin McCarthy	Catch Statistics
SEDAR22-DW-05	Explorations of habitat associations of yellowedge grouper and golden tilefish	John F Walter, Melissa Cook, Brian Linton, Linda Lombardi, and John A. Quinlan	Life History
SEDAR22-DW-06	Abundance Indices of subadult Yellowedge Grouper, *Epinephelus flavolimbatus*, Collected in Summer and Fall Groundfish Surveys in the northern Gulf of Mexico	Adam G. Pollack and G. Walter Ingram, Jr.	Indices

SEDAR22-DW-07	Abundance Indices of Yellowedge Grouper and Golden Tilefish Collected in NMFS Bottom Longline Surveys in the northern Gulf of Mexico	G. Walter Ingram, Jr. and Adam G. Pollack	Indices
SEDAR22-DW-08	Yellowedge grouper (Epinephelus flavolimbatus) age, growth and reproduction from the northern Gulf of Mexico	Melissa Cook and Michael Hendon	Life History
SEDAR22-DW-09	Observed Length frequency distributions and otolith sampling issues for yellowedge groupers caught in the Gulf of Mexico from 1984 to 2009.	Ching-Ping Chih	Life History/ Catch Statistics
SEDAR22-DW-10	Observed Length frequency distributions and otolith sampling issues for tile fish caught in the Gulf of Mexico from 1984 to 2009	Ching-Ping Chih	Life History/ Catch Statistics
SEDAR22-DW-11	Length frequency distributions for blue line tile fish caught in the Gulf of Mexico from 1984 to 2009	Ching-Ping Chih	Life History/ Catch Statistics
SEDAR22-DW-12	Estimation of species misidentification in the commercial landing data of tile fish in the Gulf of Mexico from 1984 to 2009	Ching-Ping Chih	Catch Statistics
SEDAR22-DW-13	Estimation of species misidentification in the commercial landing data of yellowedge groupers in the Gulf of Mexico from 1984 to 2009	Ching-Ping Chih	Catch Statistics
SEDAR22-DW-14	Evidence of hermaphroditism in Golden Tilefish (*Lopholatilus chamaeleonticeps*) in the Gulf of Mexico	Hope Lyon	Life History
SEDAR22-DW-15	Recreational Survey Data for Yellowedge Grouper, Tilefish (golden), and Blueline Tilefish in the Gulf of Mexico	Vivian M. Matter	Catch Statistics
SEDAR22-DW-16	Estimated Recreational Catch in Weight: Method for Filling in	Vivian M. Matter	Catch

	Missing Weight Estimates from the Recreational Surveys		Statistics
SEDAR22-DW-17	Commercial Landings of Yellowedge Grouper, Golden Tilefish, and Blueline Tilefish from the Gulf of Mexico region	Refik Orhun	Catch Statistics

Reference Documents

SEDAR22-RD01	Lead-radium dating of golden tilefish (*Lopholatilus chamaeleonticeps*)	Allen Andrew
SEDAR22-RD02	Status of the yellowedge grouper fishery in the Gulf of Mexico	Shannon L. Cass-Calay and Melissa Bahnick
SEDAR22-RD03	Yellowedge grouper (*Epinephelus flavolimbatus*) and golden tilefish (*Lopholatilus chamaeleonticeps*) distributions, habitat preferences and available biological samples	Melissa Cook and Linda Lombardi-Carlson
SEDAR22-RD04	Validation of yellowedge grouper, *Epinephelus flavolimbatus*, age using nuclear bomb-produced radiocarbon	Melissa Cook & Gary R. Fitzhugh & James S. Franks
SEDAR22-RD05	Population dynamics structure, and per –recruit analyses of yellowedge grouper, *Epinephelus flavolimbatus* from the northern Gulf of Mexico	Melissa Cook
SEDAR22-RD06	Reproduction of yellowedge grouper *Epinephelus flavolimbatus*, from the eastern Gulf of Mexico	Bullock, L. H., M. F. Godcharles and R. E. Crabtree
SEDAR22-RD07	Burrow utilization by yellowedge grouper, *Epinephelus flavolimbatus*, in the northwestern Gulf of Mexico	Jones, R. S., E. J. Gutherz, W. R. Nelson and G. C. Matlock
SEDAR22-RD08	Age and growth of the yellowedge grouper, *Epinephelus flavolimbatus*, and the yellowmouth grouper, *Mycteroperca interstitialis*, off	Manickchand-Heileman, S. C. and D. A. T. Phillip

	Trinidad and Tobago	
SEDAR22-RD09	A descriptive survey of the bottom longline fishery in the Gulf of Mexico	Prytherch, H. F.

2. LIFE HISTORY

2.1. *OVERVIEW*

2.1.1. Life History Data Working group membership

Melissa Cook	SEFSC Panama City, DW leader and editor
Gary Fitzhugh	SEFSC, Panama City
Linda Lombardi-Carlson	SEFSC Panama City
Hope Lyon	SEFSC Panama City
Harry Blanchet	LDWF, GMFMC SSC
Brian Linton	SEFSC, Miami
Carrie Simmons	GMFMC, Staff lead

2.1.2. Issues

Issues discussed in the Life History Data Working Group (LH DW) for yellowedge grouper included the distribution (locations, depths) of catch, stock definition and population genetic analyses, identification of yellowedge grouper in the historical catch information, criteria used for age determinations, use of otolith weight-fish age relationship to estimate fish age, age and size at maturity, age and size at sex transition, construction of growth curves, movement and meristics (length-length and length-weight relationships). Estimates of natural mortality and discard mortality were discussed. The availability of aged fish collected at the beginning of commercial fishing provided estimates for the true value of natural mortality. Issues remaining at the end of the Data Workshop were related to the use of otolith weight to assign age for those fish that were not aged, primarily fish collected during 1982-1983 (the Johnson samples).

2.2. *REVIEW OF WORKING PAPERS*

Working papers were reviewed that were pertinent to the life history group. A central paper was SEDAR22-DW-08 which presented the age, growth and reproduction results for Gulf of Mexico

(GOM) yellowedge grouper, *Epinephelus flavolimbatus.* Working document SEDAR22-DW-05 presented Gulf habitat associations of tilefish and yellowedge grouper. Also reviewed was SEDAR22-DW-09 which presented comparisons of length data collected by the Trip Interview Program and reported hard part collection by port agents.

2.3. *STOCK DEFINITION AND DESCRIPTION*

Kingdom: Animalia (animals)

Phylum: Chordata (organisms with a notochord)

Subphylum: Vertebrata (animals with a backbone)

Class: Actinopterygii (ray-finned fishes)

Order: Perciformes

Family: Serranidae (sea basses and groupers)

Genus: Epinphelus

Species: flavolimbatus (Poey, 1865)

The common name for *Epinephelus flavolimbatus* is yellowedge grouper, however, commercially they are also commonly called and marketed as yellowfin grouper.

2.3.1 Stock structure and definition

Currently Gulf of Mexico (GOM) yellowedge grouper are classified as a single stock. Cass-Calay and Bahick (2002) assumed a single GOM stock for the 2002 yellowedge grouper assessment. Due to limited information on stock structure the LH DW recommends the assumption of a unit stock for the GOM.

2.3.2 Population genetics

Currently, there is no published information on the genetics of yellowedge grouper from the GOM. Preliminary genetic research noted a considerable amount of diversity within the 23 samples assayed. Samples were collected from the eastern and western GOM, Bay of Campeche and Atlantic. Certain haplotypes were unique to particular regions and there was a trend suggesting some measure of population differentiation (Joe Quattro, personal communication).

2.3.3 Tagging

Due to depths inhabited by yellowedge grouper no known tagging studies have been conducted.

2.3.4 Larval transport and connectivity

Eggs and larvae are pelagic and cannot be distinguished from larval snowy grouper, *Epinephelus niveatus,* therefore, no larval transport information is known for yellowedge grouper (Richards, 1999).

2.3.5 Distribution

Yellowedge grouper are found in the western Atlantic from North Carolina (Huntsman, 1976) to southern Florida, the entire Gulf of Mexico (GOM), Cuba (Smith, 1971), the West Indies, off the coasts of Central America, and the northern coast of South America to Brazil (Carpenter and Nelson, 1971; Smith, 1971; Heemstra and Randall, 1993; Carpenter, 2002) (Figure 1). Yellowedge grouper are primarily distributed between the 50 to 300 m depth contours throughout the GOM (Cook, 2007) (Figure 2). Smaller yellowedge grouper (<400 mm TL) were found in shallower depths between 35-125 m while larger fish were found in up to 300 m depths (Cook, 2007). Unlike most grouper, which are associated with reefs and structure, yellowedge grouper can be found in a variety of habitats. Adult yellowedge grouper prefer mostly soft substrate throughout the western and central GOM (Cook, 2007) and were observed in three distinct types of burrows, similar to those associated with tilefish, cut into cohesive mud-clay sediment in the western GOM (Jones et al., 1989). They have also been found at the shelf edge on mud, sand or sand-shell bottom (Jones et al., 1989; Heemstra and Randall, 1993). In the central GOM yellowedge grouper are associated with soft substrate near the Mississippi-Alabama pinnacles and also with patch reef areas within the pinnacles (Cook, 2007). The highest densities of yellowedge grouper collected on NMFS bottom longline surveys, from 1999-2004, were within a 45 km radius of the Naples sinkhole along the 100 Fathom Break (Cook, 2007). The area is composed of hard bottom, small cobble and rock outcrops < 1 meter high, and the surrounding substrate is flat with silty sand and rock talus (Reed et al., 2005).

2.4. *NATURAL MORTALITY*

The LH DW reviewed estimates of total (Z) and natural mortality (M) from catch curves and various equations (Table 1). The LH DW developed a table of estimated M values as informative priors for the assessment (Table 2). Natural mortality (M) estimates ranged from <0.0 to >0.3 based on maximum observed ages ranging from 46-85 depending on data set (Figure 3).

The base model to be used for analysis of yellowedge grouper in SEDAR 22 will be Stock Synthesis (Methot 2010). This model has the capacity to accept a distribution of informative priors, and estimate M within the model. That capacity reduces some of the need to specify a single estimate for M. However, other analytic methods that are intended to be run in the assessment process do require a specified value of M, or have difficulty in resolving M in some circumstances. Therefore, providing a good estimate of M for those cases will help evaluate the relative performance of the various models.

Several data sources, (1) Panama City Lab and (2) Bullock (see section 2.6 Age for further description of the data source), were utilized in order to develop the estimates presented here. A variety of data were required for the published methods to estimate M. Average water temperatures were obtained from NMFS longline cruise data where yellowedge grouper were collected. Age at maturity was derived from available literature on the species (Cook, 2007) and from SEDAR22 DW-08. Values for k, L_{inf} and t_{max} were obtained from fish aged using sectioned otoliths (SEDAR22 DW-08). The otoliths were aged by the same readers, using the same methodology. Details of the ageing process and methods of validation of otolith ageing are presented in SEDAR22-DW-08 and Cook (2007).

Disappearance rates were obtained through catch curve analysis, using data from different datasets, or from subsets of the data. Since protogyny is also present, one subset of the data was to consider females only, through those ages between full recruitment to longline gear and significant transition to males. Another case considered was to use all sexed fish, irrelevant of sex. Thirdly, all aged fish were considered. This last case increases the sample size significantly. In each case, the t_{max} associated with that dataset or subset was utilized for calculation of M.

The true value of Z should be considered as an upper limit of M, since with no fishing Z=M. Under fished conditions, Z=M+F, so some value of M below Z is reasonable. However negative estimates of M are not, since this would only be possible if there were contributions to the stock from some additional area. Catch curve analyses conducted by the LH DW showed negative slopes (positive M), so negative values for M should be discounted.

One of the caveats that should be mentioned here is that the species being assessed in SEDAR 22 are lower continental shelf / shelf break / continental slope species, while most of the published literature considers species that occur in more coastal zones. This may be pertinent to many aspects of the life history, since these deeper waters may be more constant in temperature and salinity than the coastal waters, and those factors may contribute to development of successful life history strategies.

The true value of M is rarely determined because it should be calculated from an unfished population, which requires sampling a population before the onset of fishing. The Bullock data set is comprised of yellowedge grouper harvested by the commercial longline and hand line fisheries during 1977-1984 which coincided with the beginning of the commercial fishery for yellowedge grouper. The LH DW divided the Bullock data into two subsets (1) 1977-1980 (majority of samples collected) and (2) 1977-1980 grids 4 and 5 only (to allow for comparison with recent Panama City Lab samples) and catch curves were constructed for each subset.

The LH WG recommended that catch curves constructed from the Bullock samples collected during 1977-1980 represent the best estimates for the true value of M; that is, the total mortality during this beginning period of the fishery was Z=0.078 (SE=0.009, 95% CI=0.060-0.096) (Figure 4). The bulk of commercially harvested yellowedge grouper continues to be harvested in statistical grids 4 and 5 (32% during 1999-2009). A comparison of the Bullock aged fish collected during 1977-1980 and Panama City Lab aged fish from 1998-2009 from grids 4 and 5 were used to compare calculations of M (Figure 5). Bullock catch curves (1977-1980, grids 4-5) estimated total mortality (Z) to be Z=0.068 (SE=0.018, 95% CI=0.032-0.105). In comparison, Panama City Lab (1998-2009, grids 4-5) current estimates of Z were Z=0.134 (SE=0.008, 95% CI=0.150-0.118).

The yellowedge grouper distribution of the functions of M includes estimates that are higher than current estimates of Z from catch curve calculations. We suggest that those estimates be discounted in development of any prior distributions of F. Table 2 and Figure 3 represent 140 estimates of M using different functions and sets of data. The LH WG recommends that the assessment incorporate a range of M estimates for sensitivity runs from 0.01 to 0.09 for yellowedge grouper. Choices of M based on catch curves constructed from the Bullock historical data for base runs is 0.068 and 0.078.

2.5. *DISCARD MORTALITY*

The Life History group noted that there was no information available regarding yellowedge grouper discard mortality. However, given the depths fished and common information regarding the condition of captured fish, the assumption is that discard mortality is equal to 100%.

2.6. *AGE*

Yellowedge grouper length and age data was available from three different data sources: (1) Panama City Lab – samples collected from 1979-2009, (2) Bullock – samples collected from 1977-1984, (3) Johnson – samples collected 1982-1983 (Table 3). A description of each data set is presented below.

(1) The Panama City Lab archive had a total of 10,417 yellowedge grouper collected and sampled from 1979-2009. A subsample of 8,197 otoliths was selected for ageing and 7,394 yellowedge grouper were successfully aged (SEDAR22 DW-08). Although yellowedge grouper were collected over a thirty year time period, sampling effort was not evenly distributed temporally, and varied considerably by sector and gear which made comparable comparisons over time difficult. Ninety-four percent of the yellowedge grouper otoliths were collected during the more recent years (1998-2009). The majority of samples came from the west coast of Florida (63%), followed by Louisiana (20%), Texas (15%), Mississippi (<1%) and Alabama (<1%). The bulk of samples were obtained from the trip interview program (TIP; 83%), fishery independent surveys (7%), cooperative research programs (5%) and scientific observer programs (4%). Yellowedge grouper otoliths were mainly collected from fish harvested in the commercial longline (76%) and hand line fisheries (16%), and scientific longline (6%) and trawl surveys (1%) (SEDAR22-DW-08).

Sectioned yellowedge grouper otoliths are difficult to interpret and age. Cook et al. (2009) used bomb-produced ^{14}C to validate observed ages. Yellowedge grouper otoliths were aged by two individual readers, a primary reader and a secondary reader aged at least 20% of otoliths aged by the primary reader. Indices of precision were calculated from otoliths aged by both readers (n = 2,108) with an overall average percent error of 9.07%, with percent agreement of 16.8% increasing to 91.9% ±5 years (S22-DW-08). The LH DW noted that these are reasonable results given the deeper water depth and generally slow growth of species with similar habitats affiliations and life history.

Yellowedge grouper ranged from 100-1,228 mm TL (mean=656, SE=1.82) (Figure 6 A) and ages 0-85 years (mean=14.9, SE=0.10) (Figure 6 B). The majority of the fish were 90-929 mm in length

(95%) and age 0-30 years (95%). A summary of descriptive statistics by time period): 1) 1979-1989, 2) 1991-1994 and 3) 1998-2009), sector and gear is presented in Table 4. Yellowedge grouper harvested using hand lines were slightly larger and older during 1991-94 (mean=684 mm TL, mean=18 years) than during 1998-2009 (mean=636 mm TL, mean=13 years) (SEDAR22 DW-08). Commercial longline gear captured larger and older fish (mean=661 mm TL, mean=15 years) than commercial hand line gear (mean=636 mm TL, mean=13 years) (SEDAR22 DW-08).

Some regional differences in demographics were noted; i.e., larger and older yellowedge grouper were sampled from the western GOM (Cook, 2007; S22-DW-08). Since commercial longline gear comprises the majority of the harvest, age and length data were evaluated by region (grids 1-11 were the eastern GOM, grids 12-21 were the western GOM, 1998-2009 data only). Mean lengths were significantly different between regions (ANOVA, $F_{(1,5288)} = 296.0$, $p < 0.0001$), yellowedge grouper from the western GOM (mean=721, SE=4.2) than from the eastern GOM (mean=642, SE=2.2). Mean ages were also significantly different between regions (ANOVA, $F_{(1,5288)} = 36.6$, $p < 0.0001$), with fish collected in the western GOM older (mean=16.6, SE=0.2) than in the eastern GOM (mean=14.7, SE=0.1).

(2) The Bullock data set is comprised of otoliths collected from commercial longline and hand lines sectors during 1977-1984 (the majority of otoliths were collected in 1977-1980). The objective was to describe yellowedge grouper life history. A description of yellowedge grouper reproduction was published by Bullock et al. (1996). However, the authors reported that the otoliths were difficult to age and no ages were reported. The otoliths were viewed again in early 2010 and ages were determined for 452 yellowedge grouper from the west Florida coast. The average size and age of yellowedge grouper collected during 1977-1984 was greater than observed during recent years. Yellowedge grouper ranged from 341-1,083 mm TL (mean=753.4, SE=2.07) (Figure 7 A) and ages 3-56 years (mean=18.9, SE=0.45) (Figure 7 B). The majority of the fish were 340-939 mm in length (95%) and age 3-37 (95%). Length data was collected for an additional 3,214 fish (Figure 8). The data set did not include gear information for individual fish; therefore, summaries could not be made by gear type.

(3) The Johnson data set is comprised of length data and otoliths obtained from 886 commercially harvested yellowedge grouper sampled in Treasure Island, FL (Pinellas County) from 1982-1983 by port sampler Lucius Johnson. There had been uncertainty about the source of these samples but recent discussions between SEFSC personnel recalled Johnson was collecting samples for the Prytherch study on the early long-line fishery and was recognized in the resulting report for his efforts (Prytherch 1983, submitted to SEDAR as reference document S22_RD09_TM_SEFC_122.pdf). It was noted by the LH WG that while the report refers to "yellowfin" grouper, the Johnson otoliths are distinct and identifiable as coming from yellowedge grouper and the (Beaufort SEFSC) codes Johnson used identified yellowedge grouper. Otoliths were not aged due to time constraints, however, the LH DW noted that the strong relationship observed between otolith weight and fish age (Cook et al. 2009) could be used to provide estimated ages for those fish. The estimated ages (as well as prediction error) will be used as inputs into SS3 to provide additional age and length data for the model since little data is available from the early 1980s. They will not be used to construct any additional growth curves or modify existing curves.

Differences in the relationship were observed over time; therefore the LH DW recommended a subsample of otoliths from this data set be used to construct the otolith weight – fish age equation used to assign predicted ages of the remaining samples. A subsample of 47 otoliths was used to construct the curve (Predicted age=8.8883*otolith weight+7.8178, SE=0.477, R^2=0.89, Figure 9). Predicted ages (n=807) ranged from 10-54 years which are reasonable based on previous age and growth research (Cook, 2007).

2.7. *GROWTH*

Yellowedge grouper ages and total lengths from the entire Panama City Lab time series (1979-2009) and subsamples of that time series were fit to von Bertalanfy growth functions (VBGF) (SEDAR22 DW-08). For all data: L_∞ = 1,004.5 mm, k = 0.059, t_o = -4.75 (Table 5). VBGF fits were also made by sex. The VBGF predicted the females to grow faster but obtain a smaller asymptotic size (male: L_∞ = 1043.2 mm, k = 0.054, t_o = -5.531; female: L_∞ = 843.0 mm, k = 0.095, t_o = -3.051). The smaller predicted asymptotic sizes for females is most likely because yellowedge grouper are protogynous hermaphrodites and few females are observed in the larger size classes and the maximum observed age of females was 36 years verses a maximum age of 70 years for males. An additional VBGF was conducted for the entire Bullock data set (1977-1984). Growth was predicted to be slower L_∞ = 1,042.5 mm, k = 0.048, t_o = -6.543 (Figure 10).

The LH DW noted data distribution issues that typically affect VBGF fits. In particular, the low number of samples of very young fish resulted in unrealistic fits of t_o. It was discussed that an iterative fitting process, allowing for sample size weighting by sex and region would be conducted within the assessment (e.g., by Stock Synthesis 3 model) and would correct this effect. However, the LH DW provided unconstrained estimates of VBGF as well as VGBF fits constrained to t_o = zero, needed to complete mortality equations and develop "prior values" to enter into the model (Table 2). It should be noted that in all unconstrained cases t_o was always less than zero. When t_o was constrained to equal zero, the growth coefficient increased.

2.8. *REPRODUCTION*

Female yellowedge grouper from the northern GOM exhibited a spawning season extending from February to November with peak development in March through September (SEDAR22-DW 08). Immature females ranged in size 141-650 mm TL and age 0-16 years old. Mature females ranged in size from 510 to 1,000 mm TL and age 6-36 (SEDAR22-DW-08). Based on logistic regression, size and age at 50% maturity for females in the GOM were 547 mm TL and age 8 years, respectively (Figure 11, 12). Yellowedge grouper are protogynous hermaphrodites. The size and age at 50% sexual transition for GOM yellowedge grouper was 815 mm TL and 22 years (Figures 13, 14). The overall sex ratio for yellowedge grouper sampled was 1:3.2 (male:female).

Based upon histologically sexed yellowedge grouper, 265 females were available to estimate average somatic weight at age (SEDAR22-DW-08, Figure 15). Active and spawning yellowedge grouper females ranged in age from 6-36 years old, the majority (87%) were twenty years old and younger. The relationships between hydrated and vitellogenic ovary weight and somatic weight were fairly proportional when graphically compared, these data (extrapolated to spawning stock biomass total, SSB) may be selected as the proxy for fecundity (Figure 16).

2.9. *MOVEMENTS AND MIGRATIONS*

Ontogenetic shifts have been observed for yellowedge grouper. Radiocarbon age validation of yellowedge grouper noted different ^{14}C signals throughout the life of a fish indicating that juvenile fish are found in shallower depths and move out to deeper water as they age (Cook et al. 2009). Cook (2007) noted that smaller, younger yellowedge grouper were found in shallower depths between 35-125 m while larger fish were found in up to 300 m depths. A large amount of variability was observed between length and depth, indicating that once a fish reached >400 mm TL they could be found at any depth between 125-300 m.

2.10. *MORPHOMETRICS AND CONVERSION FACTORS*

Conversions for length and weight were presented to the data workshop. Measurements of yellowedge grouper have been reported in terms of total length (TL), fork length (FL) and standard length (SL), whole weight (WW) and gutted weight (GW). Each metric is strongly correlated with the others and can easily be converted to another (Table 6).

2.11. *COMMETNS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES*

Aging: Difficulties determining ages from otolith sections were discussed. Validation studies usingbomb-produced ^{14}C were conducted and progress was noted over earlier studies. But there was less ageing precision than observed in some SEDARs for shallow water species. The LH DW noted that these are reasonable results given the deeper water depth and generally slow growth of species with similar habitats affiliations and life history. The LH DW noted that all yellowedge grouper otoliths, including the Bullock samples and subset of Johnson samples, were viewed by the same two readers which is beneficial because this eliminates the possibility of reader ageing differences over time. The LH DW recommended the strong relationship observed between otolith weight and fish age be used to provide estimated ages for un-aged Johnson fish from 1982-1983. The estimated ages (as well as prediction error) will be used as inputs into SS3 to provide additional age and length data for the model.

Biological sampling: The LH DW noted that age sampling levels from recent years were in general informative for assessment purposes. But there were sample size concerns (S22-DW-09); the LH WG recommends minimum otolith sampling levels (i.e., >= 500 per year per major strata) based upon GulfFIN guidelines. An increase in otolith sampling level is particularly needed for the western GOM.

Reproduction Parameters: Given that yellowedge grouper are protogynous, the LH DW recommends the use of SSB-total as the preferred form of reproductive potential following Brooks et al. (2008).

Natural Mortality: The LH DW panel recommends model sensitivity runs using M as an age-fixed value and as an age-variable value (Lorenzen M). As in earlier SEDARs, the panel believes an age-variable approach is more realistic and thus the preferred approach.

2.12. *ITEMIZED LIST OF TASKS FOR COMPLETION FOLLOWING WORKSHOP*

Complete age composition for use in auxiliary model runs (VPA, SRA). (John Walter, John Quinlan)

Investigate the use of otolith weight to age relationship to see if otolith weight can be used to assign ages for those fish that were not aged. (Melissa Cook).

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2.14. *TABLES*

Table 1. Equations for estimating natural mortality (M).

Method	Parameters	Authors & Parameter Explanations	Equation
Alverson & Carney	k, tmax	Quinn & Deriso (1999):	M = 3k/(exp(0.38*tmax*k)-1)
Beverton & Holt	k, am	Beverton and Holt (1956; a_m = age at 50% maturity)	M = 3k/(exp(a_m*k)-1)
Hoenig$_f$	tmax	Hoenig (1983; for fish)	M=exp(1.46 - 1.01*ln(tmax))
Hoenig$_c$	tmax	Hoenig (1983; fish plus other taxa)	M=exp(1.44-0.982*ln(tmax))
Pauly	Linf, k, T	Quinn & Deriso (1999):	M=exp(-0.0152+0.6543*ln(k)-0.279*ln(Linf, cm)+0.4634*lnT(°C))
		Pauly (1980):	M = 10^(-0.0066-0.279*(log(Linf))+0.6543*log(K)+0.4634*Log(T))
Pauly Method II (snappers and groupers)	Linf, k, T	Pauly and Binohlan (1996)	M=10^(-0.0636-0.279*(log(Linf)+0.6543*log(k)+0.4634*log(T))
			T=Average annual Sea Temperature at depth
Ralston	k	Ralston (1987)	M=0.0189 + 2.06*k
Ralston (geometric mean)	k	Ralston (1987)	M=-0.0666+2.52*k
Ralston Method II	k	Pauly and Binohlan (1996)	M=-0.1778+3.1687*k
Lorenzen Age-Specific	W at age	Lorenzen (1996; ocean)	M=3.69*W^(-0.305)
Jensen	k	Jensen (1996)	M = 1.5*K

Alagaraja	tmax, survivorship to tmax	Alagaraja (1984)	M=-ln[S(tmax)]/tmax; derived from S(tmax)=exp(-M*tmax)
Rule of thumb	tmax	Hewitt and Hoenig (2005)	M = 2.996/tmax

Table 2. Yellowedge Grouper Natural Mortality- shaded values are above estimated Z for combined information (sexes combined + unsexed) of 0.068 to 0.078 or Z<0.

Data Source	Observed Max Age (years)	Number of Fish Aged	Von Bert* Linf (mm)	Von Bert* k	Water Temp. (°C)	$Age_{.50Maturity}$	Alverson & Carney	Beverton & Holt	$Hoenig_f$	$Hoenig_c$	Pauly	(snappers and groupers)	Ralston	Ralston (geometric mean)	Ralston Method II	Jensen	Rule of thumb	Alagaraja 0.01	Alagaraja 0.02	Alagaraja 0.05
1999-2009 Female Age data without fixed T_0	36	712	843.03	0.10	16	8.2	0.107	0.242	0.115	0.125	0.222	0.194	0.215	0.173	0.124	0.143	0.083	0.128	0.109	0.083
1999-2009 Female age data WITH fixed T_0	36	712	762.55	0.16	16	8.2	0.059	0.174	0.115	0.125	0.324	0.284	0.355	0.344	0.339	0.245	0.083	0.128	0.109	0.083
1999-2009 Combined Sex Age data without fixed T_0 - UNCENSORED	70	933	1043.28	0.05	16	8.2	0.050	0.290	0.059	0.065	0.145	0.127	0.131	0.071	-0.005	0.082	0.043	0.066	0.056	0.043
1999-2009 Combined Sex age data WITH fixed T_0 - UNCENSORED	70	933	880.93	0.12	16	8.2	0.017	0.220	0.059	0.065	0.248	0.217	0.256	0.223	0.187	0.173	0.043	0.066	0.056	0.043
1999-2009 Combined Sex Age data without fixed T_0 – CENSORED	46	930	1043.28	0.05	16	8.2	0.103	0.290	0.090	0.098	0.145	0.127	0.131	0.071	-0.005	0.082	0.065	0.100	0.085	0.065
1999-2009 Combined Sex age data WITH fixed T_0 - CENSORED	46	930	880.93	0.12	16	8.2	0.053	0.220	0.090	0.098	0.248	0.217	0.256	0.223	0.187	0.173	0.065	0.100	0.085	0.065
1998-2009 Sexed + Unsexed Age data without fixed T_0	85	6942	1017.70	0.06	16	8.2	0.032	0.286	0.048	0.054	0.152	0.133	0.138	0.080	0.006	0.087	0.035	0.054	0.046	0.035

1998-2009 Sexed + Unsexed age data WITH fixed T_0	85	6942	883.29	0.11	16	8.2	0.010	0.229	0.048	0.054	0.236	0.207	0.239	0.203	0.161	0.161	0.035	0.054	0.046	0.035
Bullock 1977-1980 data, without T0 correction, Unsexed	56	437	1042.52	0.05	16	8.2	0.081	0.299	0.074	0.081	0.133	0.117	0.118	0.054	-0.026	0.072	0.054	0.082	0.070	0.053
Bullock 1977-1980 data, with T0 correction, unsexed	56	437	894.15	0.10	16	8.2	0.041	0.236	0.074	0.081	0.225	0.198	0.225	0.185	0.139	0.150	0.054	0.082	0.070	0.053

Censored data have excluded the oldest 3 fish (ages 50, 56, 70) in the sexed dataset, and only includes the data to 46 (last continuous age)

In the overall dataset (6942 samples) a single age of 85 was found in addition to one more fish of age 70. No other fish were over 56 years old.

H_2O temps - 18.5 ^{o}C from NMFS surveys - all historical incl. LL & groundfish, that caught YE grouper. 15.4 ^{o}C from BLL historic & current (2005) NMFS data. Source: Cook (2007)

Table 3. Summary of the number of yellowedge grouper otoliths aged by data source: Panama City Lab, Bullock and Johnson. Johnson otoliths were not aged but ages may be estimated using the otolith weight-age relationship. Years with zero samples are excluded from table.

Year	PC Lab aged fish	Bullock aged fish	Johnson available otoliths
1977		3	
1978		116	
1979	6	186	
1980		132	
1982	13	11	711
1983	25		175
1984	29	4	
1985	8		
1986	25		
1987	3		
1988	9		
1989	5		
1991	249		
1992	69		
1993	9		
1994	2		
1998	5		
1999	97		
2000	138		
2001	439		
2002	238		
2003	814		
2004	581		
2005	681		
2006	478		
2007	867		
2008	1274		
2009	1330		
Total	7394	452	886

Table 4. Summary of life history statistics for yellowedge grouper otoliths from the Panama City Lab archive. Yellowedge grouper were collected in 1979-1989 (*n*=123), 1991-1994 (*n*=327) and 1998-2009 (*n*=6,934) by head boat (HB), scientific survey (SS), commercial (CM) and charter party (CP) sectors using hand line (HL), bottom longline (LL), and trawl (TRW) gear types. Results include the sample size (*n*), range (minimum-maximum), mean, standard deviation and standard error for each parameter: total length (mm) and age (years).

Time Period	Mode Gear	Parameter	*n*	Range (Min-Max)	Mean	Standard Deviation	Standard Error
1979-1989	HB HL	Total Length	42	335-710	493.55	87.14	13.45
		Age	42	4-11	5.60	1.75	0.27
	SS LL	Total Length	81	488-1050	735.33	136.94	15.22
		Age	81	5-81	25.59	16.14	1.79
1991-1994	CM HL	Total Length	251	290-1110	684.47	162.61	10.26
		Age	251	2-70	17.86	13.76	0.87
	CM LL	Total Length	53	460-1100	706.81	138.09	18.97
		Age	53	3-50	14.83	8.19	1.13
	CP HL	Total Length	23	425-1160	789.57	173.86	36.25
		Age	23	5-77	22.96	20.55	4.28
1998-2009	CM HL	Total Length	963	262-1092	635.50	141.49	4.56
		Age	963	2-52	13.21	6.53	0.21
	CM LL	Total Length	5538	211-1178	660.72	147.74	1.99
		Age	5538	1-85	15.13	7.88	0.11
	SS LL	Total Length	350	322-1228	703.84	165.79	8.86
		Age	350	2-70	15.90	9.09	0.49
	SS TRW	Total Length	83	100-1075	219.54	157.47	17.28
		Age	83	0-38	2.70	6.03	0.66

Table 5. Results of yellowedge grouper von Bertalanffy growth curves from fish from the Panama City Lab archive (1979-2009, SEDAR 22-DW-08) and Bullock (1977-1984). Source refers to the data used in the analysis, predicted TL is total length, *n* is the number of samples, L_∞ is the maximum theoretical length, *K* is the growth coefficient, t_0 is the theoretical age at length zero, R^2 is the coefficient of determination.

Source	Size Range Examined (TL mm)	Age Range Examined (Years)	*n*	L_∞	*K*	t_0	R^2
All years	100-1,228	0-85	7394	1,004.5	0.059	-4.75	0.68
1979-1989	335-1,050	4-81	123	966.9	0.042	-11.87	0.67
1991-1994	290-1,160	2-77	329	969.8	0.059	-7.452	0.72
1998-2009	100-1,228	0-85	6942	1,017.7	0.058	-4.576	0.68
1977-1984	347-1,030	3-56	452	1,042.5	0.048	-6.543	0.81

Table 6. Equations used to convert various length and weight measurements of yellowedge grouper collected in the northern Gulf of Mexico. TL is total length (mm), FL is fork length (mm), SL is standard length (mm), WW is whole weight, GW is gutted weight (kg), R^2 is the coefficient of determination for the reported linear regression and N is the number of observations.

Equation	R^2	Size Range Examined	N
SL = 0.849*FL – 13.033	0.996	285-855 mm SL	1,331
SL = 0.791*TL + 1.295	0.993	285-855 mm SL	1,451
FL = 1.174*SL + 18.285	0.996	350-1033 mm FL	1,331
FL = 0.935*TL + 15.874	0.997	99-1174 mm FL	1,593
TL = 1.257*SL + 3.401	0.993	360-1083 mm TL	1,451
TL = 1.067*FL – 15.065	0.997	99-1174 mm TL	1,593
WW = 2.691 x 10^{-08} * ($TL^{\wedge 2.870}$)	0.979	99-1,228 mm TL 0.012-24.00 kg WW	1,722
GW = 2.106 x 10^{-08} * ($TL^{\wedge 2.910}$)	0.969	250-1,178 mm TL 0.22-22.40 kg GW	2,916
WW = 1.728 x 10-08 * (FL^2.956)	0.979	99-1,228 mm FL 0.012-24.00 kg WW	1,722
GW = 1.470 x 10-08 * (FL^2.984)	0.969	250-1,178 mm TL 0.22-22.40 kg GW	2,916

2.15. *FIGURES*

Figure 1. Estimated worldwide distribution for yellowedge grouper (Heemstra and Randall , 1993) and www.fishbase.org).

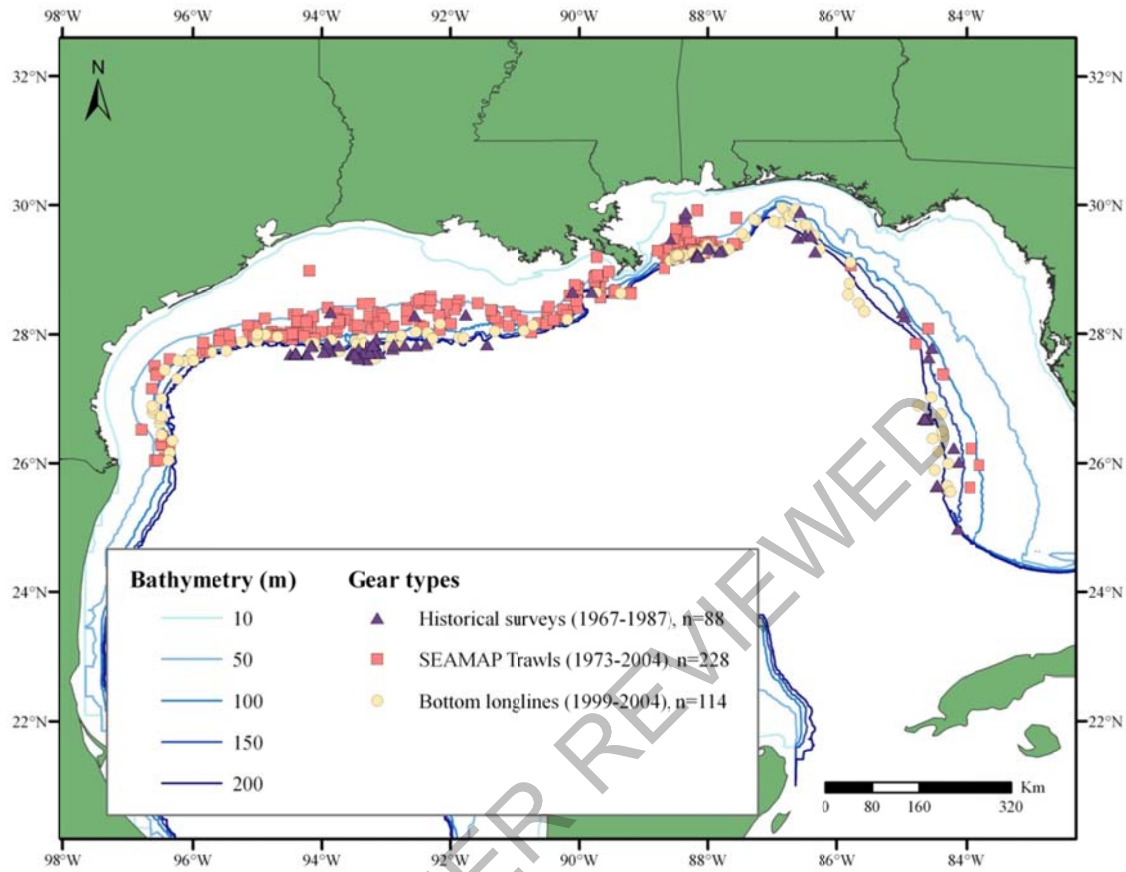


Figure 2. Locations of yellowedge grouper collected in the northern Gulf of Mexico on fishery independent surveys from 1967-2004. Gear types used include trawls (shrimp, fish, high opening bottom and mongoose), longlines (vertical, off-bottom and bottom) and fish traps. Data points indicate location of catch not number of fish collected. Figure reprinted from Cook (2007).

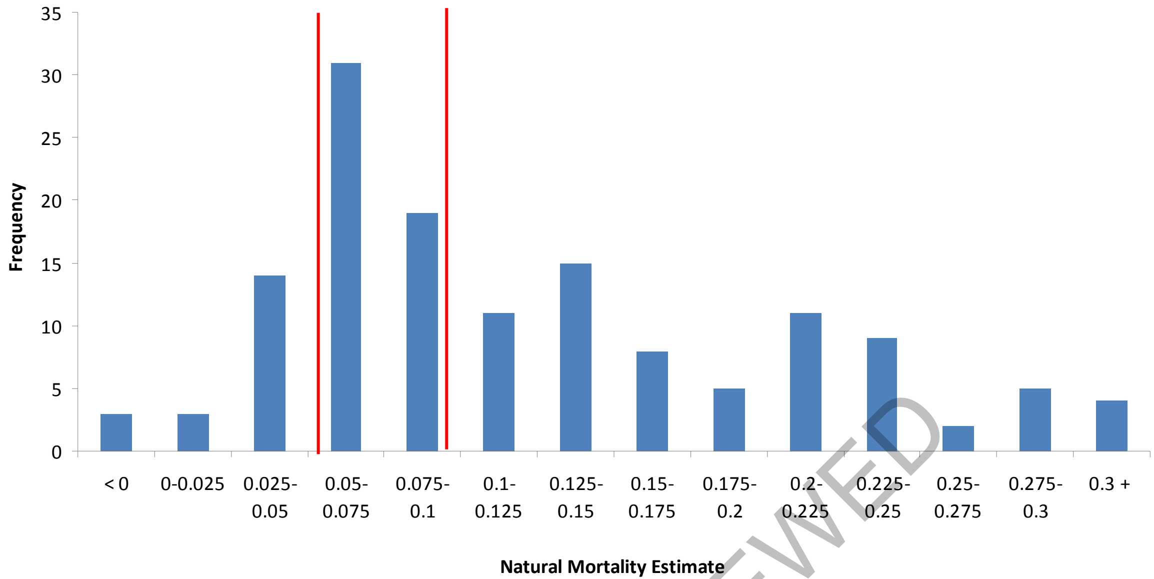


Figure 3. Distribution of estimates of natural mortality (M) for yellowedge grouper. Estimates of M (*n*=140) were based on various equations with varying input parameters (Table 1). Red lines indicate approximate minimum and maximum possible values of M, based on estimates of total mortality (Z) estimates (Z=0.068-0.078) from catch curve analysis.

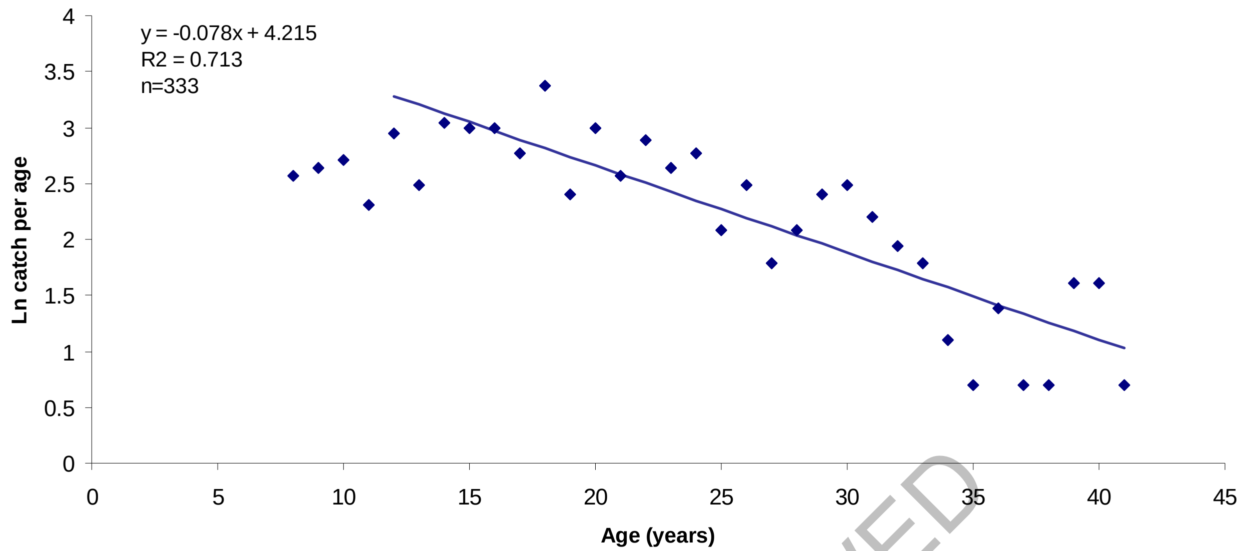


Figure 4. Estimate of total mortality (Z=0.078) for yellowedge grouper harvested during 1977-1980 by commercial longlines and hand lines (Bullock data set). Ages 12-41 years were used to construct the catch curve.

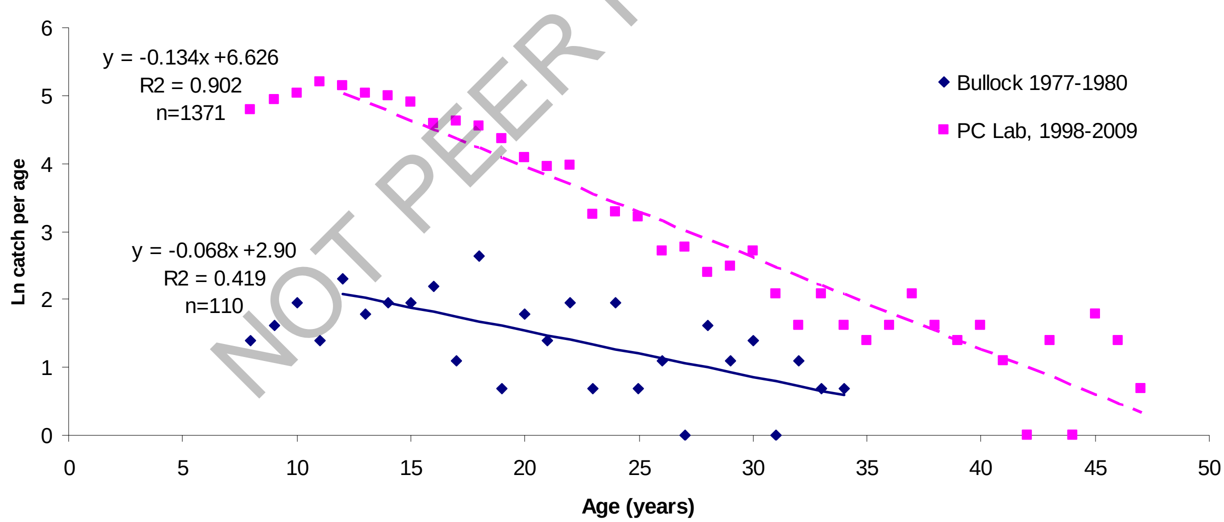


Figure 5. Estimates of total mortality (Z) for yellowedge grouper collected in statistical grids 4 and 5. Data were collected by Bullock (1977-1980) in western Florida and the Panama City Lab (1998-2009). Estimates of total mortality (Z) are (1977-80: Z=0.068, 1999-2009: Z=0.134). Ages 12-34 years (Bullock 1977-80) and 12-41 years (SEDAR 22 DW-08) were used to construct the catch curves.

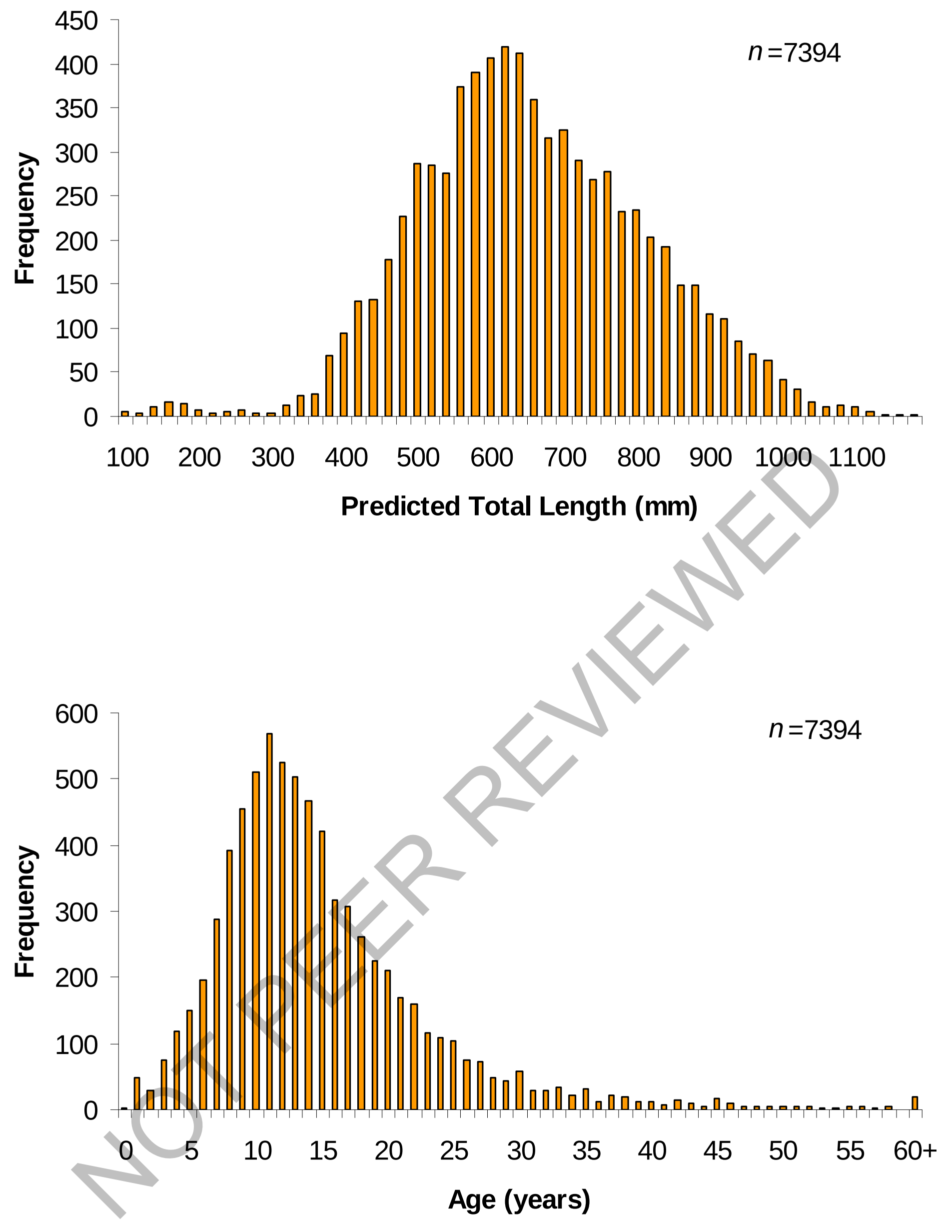


Figure 6. A) Length and B) age frequency distributions of yellowedge grouper collected during 1979-2009 by fishery dependent and independent sources using various gear types (bottom longline, hand line, trawls) in the northern Gulf of Mexico.

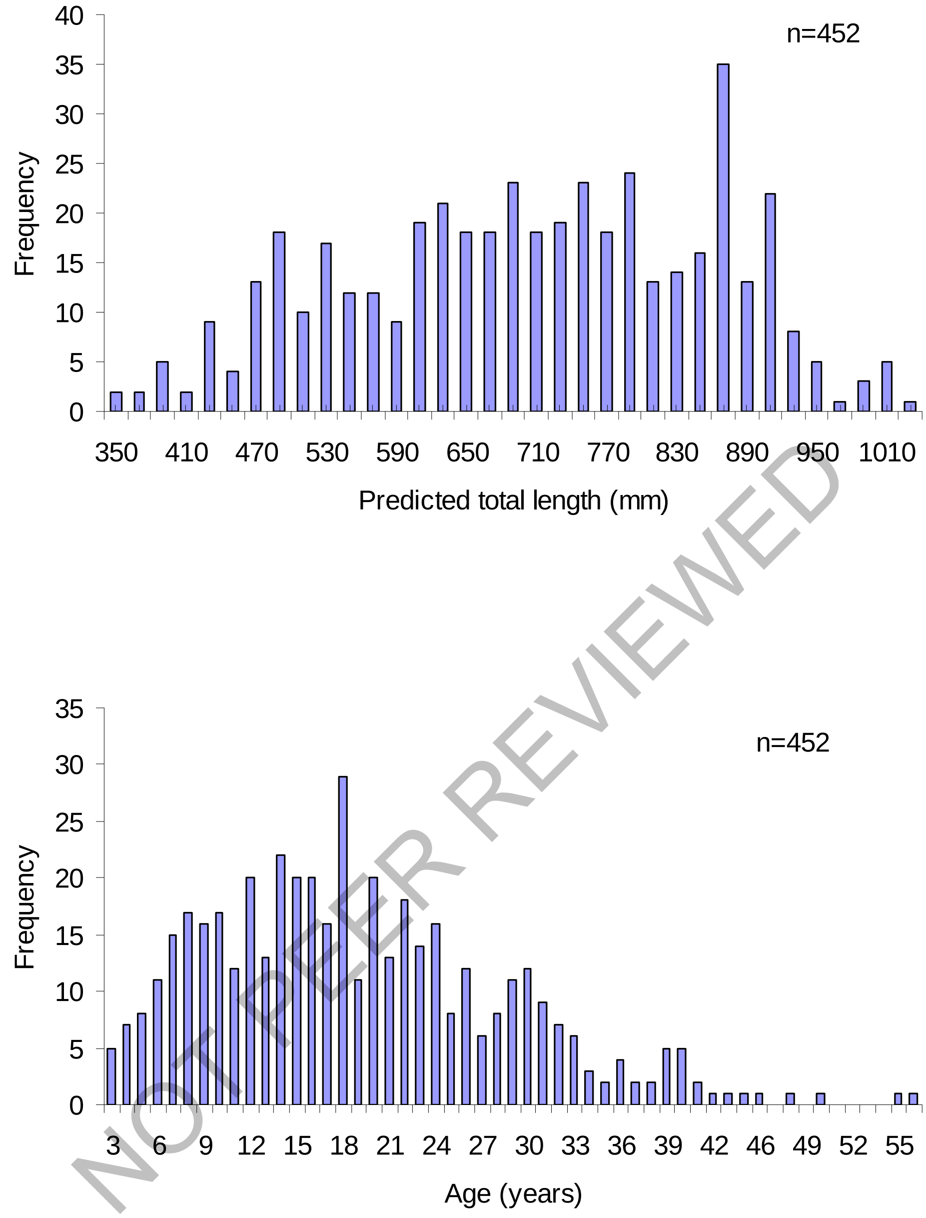


Figure 7. A) Length and B) age frequency distributions of aged yellowedge grouper collected during 1977-1984 (Bullock data set). Fish were collected from the commercial longline and hand line fisheries off the Florida west coast.

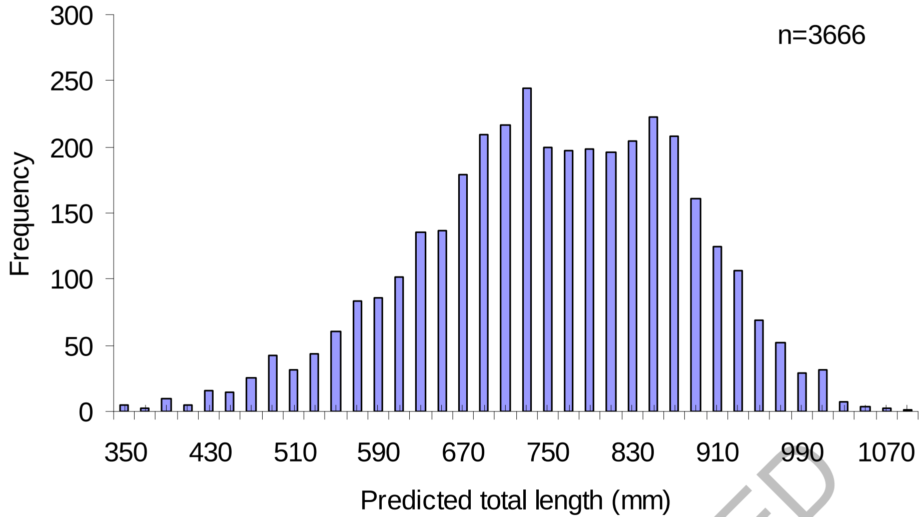


Figure 8. A) Length frequency distribution of yellowedge grouper collected during 1977-1984 (Bullock data set). Fish were collected from the commercial longline and hand line fisheries off the Florida west coast. Aged fish lengths (*n*=452) and length data only (*n*=3,214) combined.

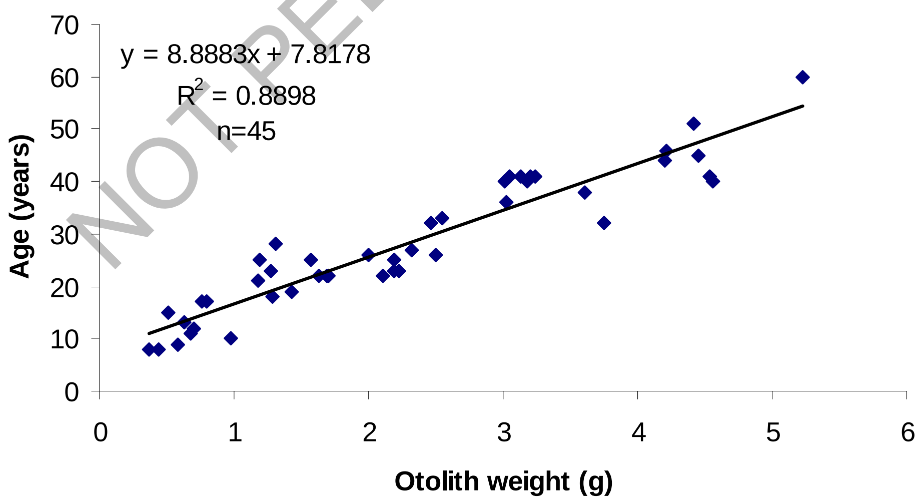


Figure 9. Otolith weight – age relationship of Johnson subsampled otoliths.

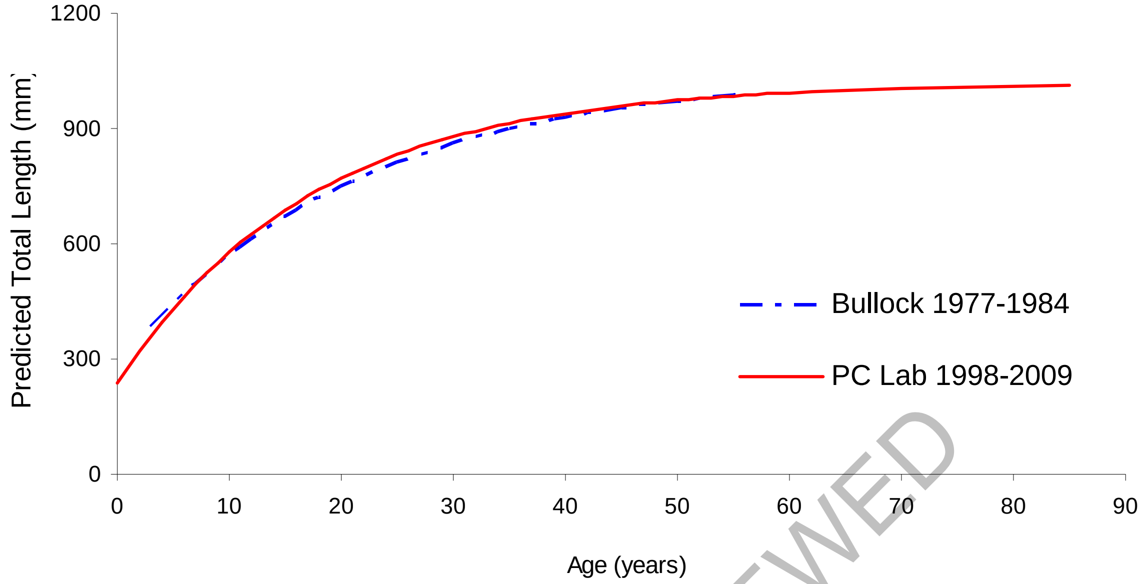


Figure 10. Results of von Bertalanffy growth curves for yellowedge grouper collected by the Panama City Lab during 1998-2009 (L_∞ = 1,017.7 mm, k = 0.058, t_o = -4.576) and by Bullock during 1977-1984 (L_∞ = 1042.5 mm, k = 0.048, t_o = -6.543).

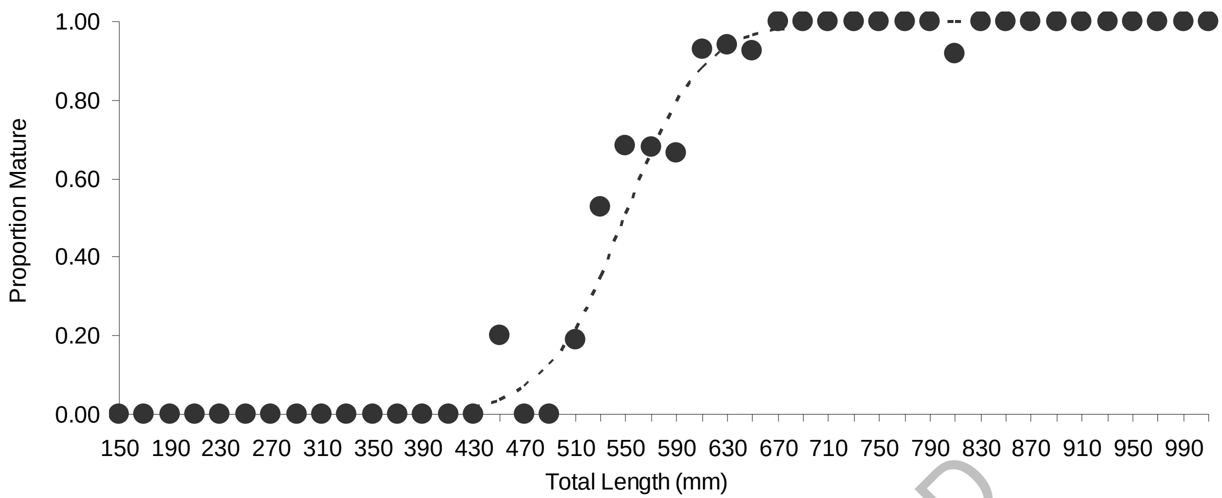


Figure 11. Length at maturity based on mature and immature female yellowedge grouper during all months of the year. Logistic regression function:

Proportion = 1/(1+EXP(-(-18.11 + 0.033*Length))), n=608, L50 maturity = 549 mm TL.

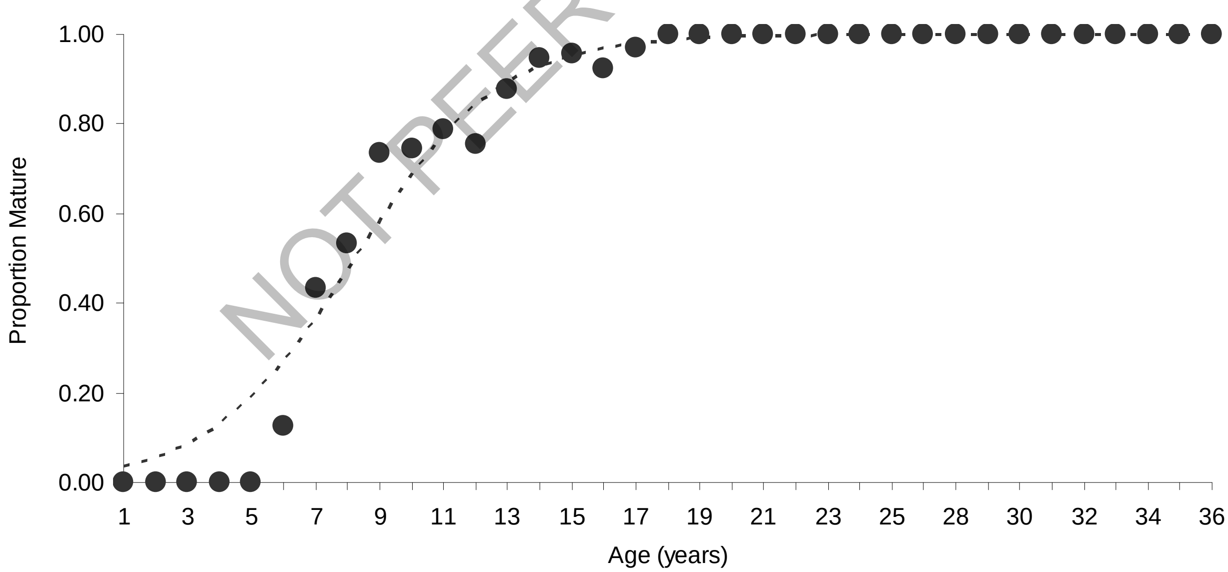


Figure 12. Age at maturity based on mature and immature female yellowedge grouper during all months of the year. Logistic regression function:

Proportion = 1/(1+EXP(-(-3.718 + 0.451*Age))), n=608, A50 maturity = 8.2 years.

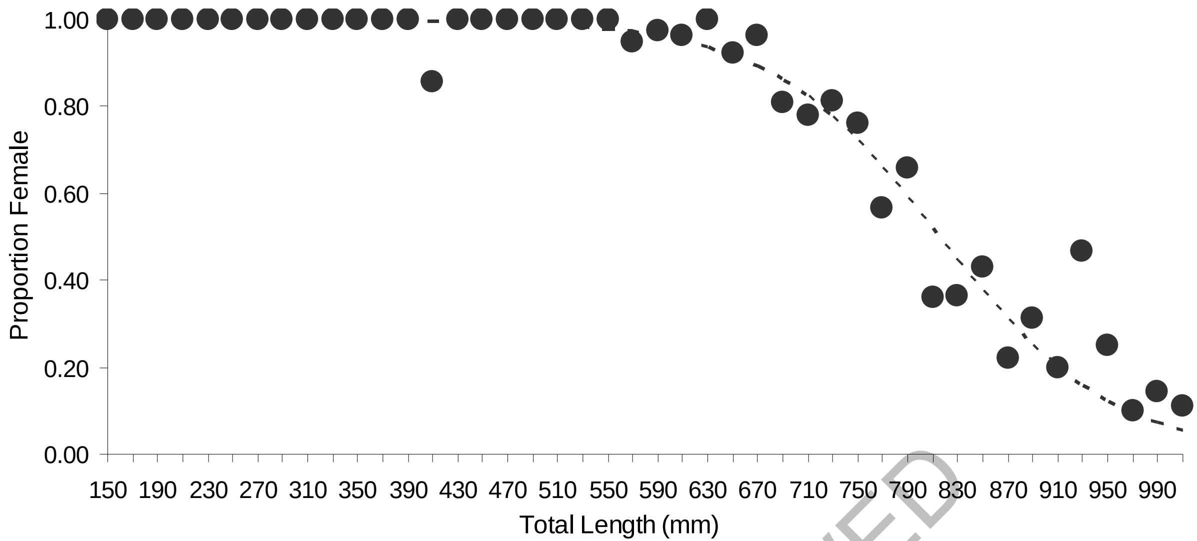


Figure 13. Proportion female by size, assessed histologically. Logistic regression function:

Proportion = 1/(1+EXP(-(-11.894 + 0.015*Length))), n=933, L50 transition = 815 mm TL.

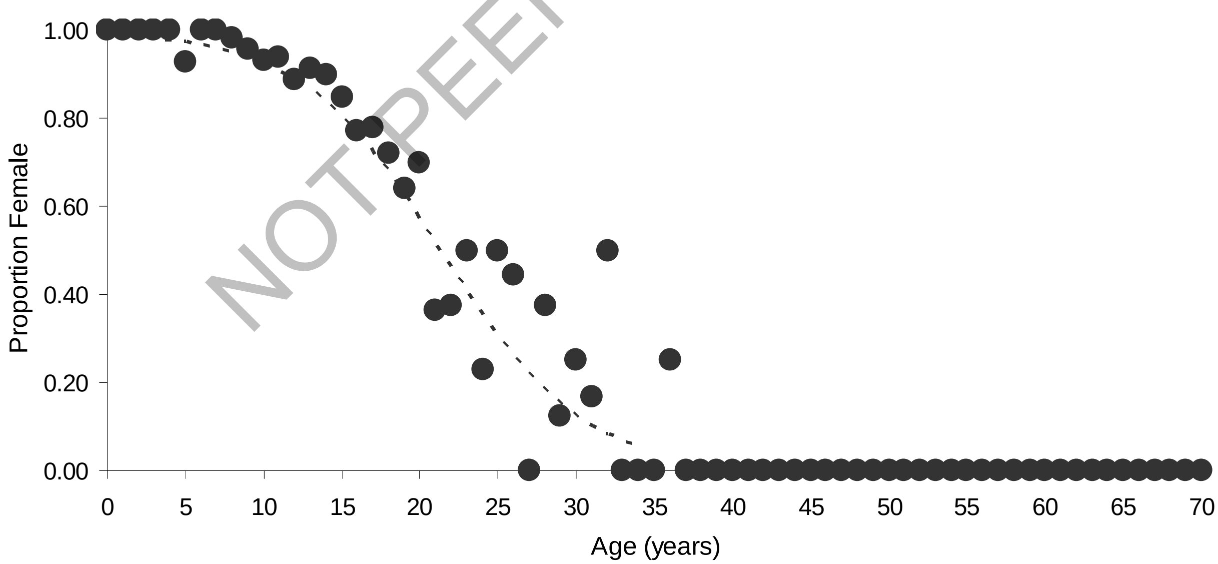


Figure 14. Proportion female by age, assessed histologically. Logistic regression function:

Proportion = 1/(1+EXP(-(-4.970 + 0.223*Age))), n=933, A50 transition = 22.3 years.

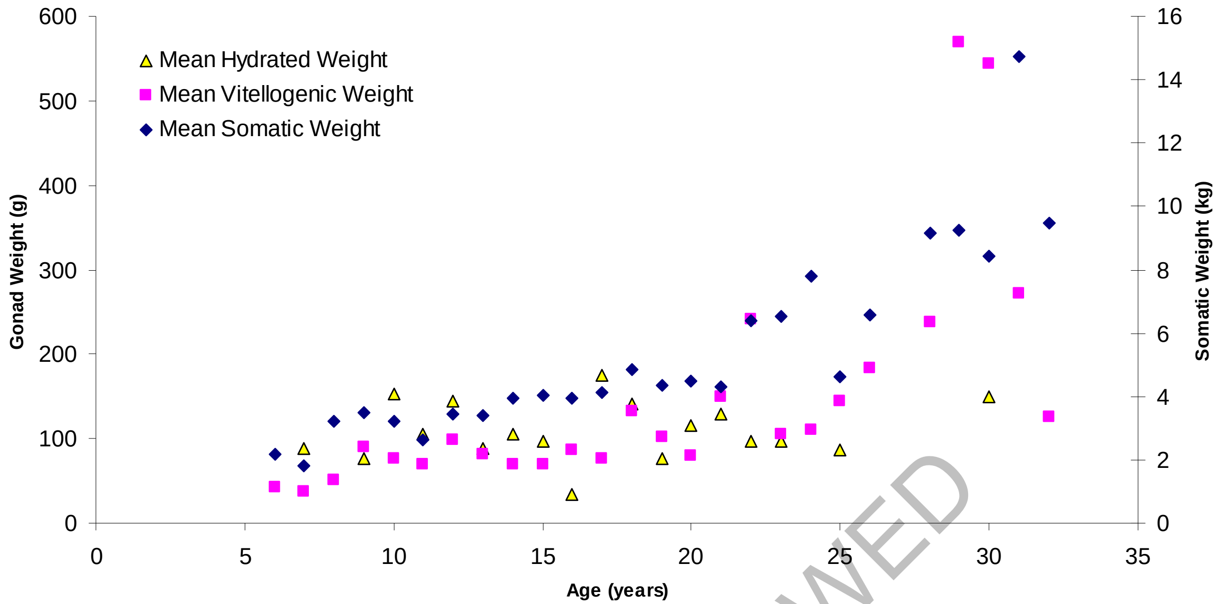


Figure 15. Mean gonad weight at age of yellowedge grouper females with vitellogenic or hydrated ova and mean somatic weight at age.

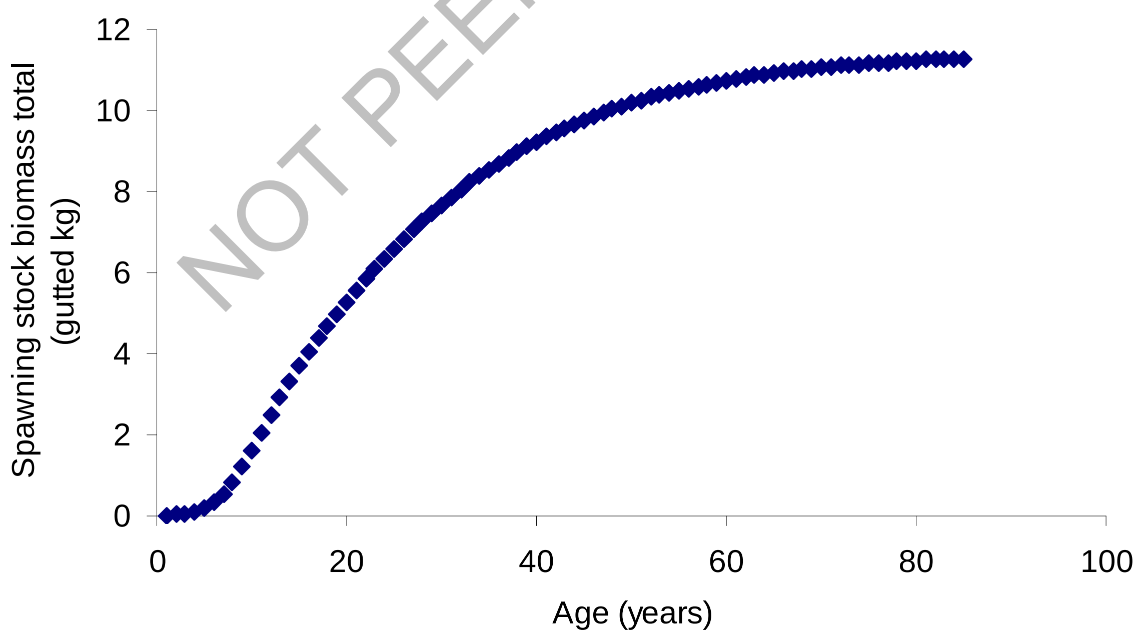


Figure 16. Spawning stock biomass total as the proxy for fecundity for yellowedge grouper.

3. COMMERCIAL FISHERY STATISTICS

3.1. *OVERVIEW*

The deepwater grouper-complex consists of eight species of fishes from 3 families of fishes, groupers (5 species), tilefishes (2 species) and a snapper species. The primary three species of importance and considered in the SEDAR 22 data workshop for stock assessment are the yellowedge grouper *Epinephelus flavolimbatus*; tilefish (often imprecisely called golden tilefish) *Lopholatilus chamaeleonticeps;* and blueline tilefish *Caulolatilus microps*. The other five secondary species also in the deep water grouper complex are warsaw grouper *Epinephelus nigritus*; snowy grouper *Epinephelus niveatus*; misty grouper, *Epinephelus mystacinus;* speckled hind *Epinephelus drummondhayi*; and queen snapper *Etelis oculatus*. These five secondary species were not considered in the data workshop, although commercial landings were presented.

3.1.1. Group membership

Refik Orhun (Group Leader) ....NMFS-Miami
Steve Turner...NMFS-Miami
Kevin McCarthy...NMFS-Miami
John Quinlan ....NMFS-Miami
Bob Spaeth ....
Commercial Fisheries
Martin Fisher.. Commercial Fisheries
Brad Kenyon ....Recreational Fisheries
Linda Lombardi ....NMFS-Panama City
Gary Fitzhugh ....NMFS-Panama City
Debbie Fable .... NMFS-Pascagoula
Charlie Bergmann .... NMFS-Pascagoula
Melissa Cook .... NMFS-Pascagoula
Richard Fulford..SSC - Univ. of Mississippi
Harry Blanchet...Louisiana Sea Grant
Yong Chen…………….... ....CIE Reviewer - Univ. of Maine

3.1.2. Issues

Commercial landings of yellowedge grouper were explored to address a variety of issues (listed below). Some are evident from the list of working papers presented and discussed (section 3.3).

Other issues included the historical onset and composition of the deep water grouper complex long line (LL) and vertical line (VL = hand and bandit or electric line) fisheries, with special attention given to identification of yellowedge grouper (YEG) from unclassified groupers:

(1) Commercial landings

(2) Discards

(3) Length Frequency Distribution of samples by gear

(4) Mis-identification

   a. Mis-identification or mis-labeling of yellowedge grouper as yellowfin grouper 1975-1990 Gulf of Mexico wide

(5) Onset of the LL fishery in the Gulf of Mexico as a pure deep water fishery targeting yellowedge grouper the fishery

(6) Partial switch of LL fishery to shallow water groupers and LL fishery mixed from 1982 onwards w/ a shallow water and a deep-water grouper complex fishery

(7) Proportion of unclassified groupers in the long line fishery to be attributed yellowedge grouper from the onset of LL fishery to the partial switch of the LL fishery to shallow water groupers until 1986 when grouper landings classification by species becomes regulation

(8) Year of onset of VL fishery and proportion of landings to be assigned to yellowedge grouper from unclassified groupers landings prior to 1986 when grouper landings classification by species becomes regulation

(9) Proportion of unclassified grouper landings (both LL and VL) to be attributed yellowedge grouper from 1986-2009

3.2. *REVIEW OF WORKING PAPERS (Author and Presenter)*

All SEDAR 22 Data Workshop (DW) working papers relevant to the commercial fisheries group were presented, reviewed, and discussed during the data workshop. The recommendations resulting from the discussion will be presented in each the relevant chapter, e.g. size distribution of landings samples by gear, misidentification, discards, effort, etc. Below is the list of the papers reviewed in the group

SEDAR **-22 DW-17:** Commercial Landings of Yellowedge Grouper, Golden Tilefish, and Blueline Tilefish from the Gulf of Mexico region (Refik Orhun)

SEDAR **-22-DW-15:** Recreational Survey Data for Yellowedge Grouper, Tilefish (Golden), and Blueline Tilefish in the Gulf of Mexico (Vivian Matter, Author; Richard Fulford, Presenter)

SEDAR **-22-DW-04:** Discards of Yellowedge Grouper, Golden Tilefish, and Blueline Tilefish from commercial fishing vessels in the Gulf of Mexico (Kevin McCarthy)

SEDAR**-22-DW-09:** Observed Length frequency distributions and otolith sampling issues for yellowedge groupers caught in the Gulf of Mexico from 1984 to 2009 (Ching-Ping Chih, author; John Quinlan, presenter)

SEDAR**-22-DW-13:** Estimation of species misidentification in the commercial landing data of yellowedge groupers in the Gulf of Mexico from 1984 to 2009 (Ching-Ping Chih, author; John Quinlan, presenter)

3.3. *COMMERCIAL LANDINGS*

3.3.1. Historical Catch Area

Prytherch (1983) divided the fishing grounds of the bottom longline fishery into three regions; Southern Gulf (SE), Northeastern Gulf (NE) and Western Gulf (W) (Figure 3.1.1). On the basis of similar landings species composition we propose a similar stratification of the 21 Gulf of Mexico 'shrimp grid' or '**statareas**' extending from statistical area 1 at the Southeastern edge of the Gulf of Mexico in Monroe county, North of the US 1 Line, to the West to statistical area 21 ending at the Texas US/Mexican Border (Figure 3.1.2) into three fishing regions. This classification differs from Prytherch only in that the Western Gulf region includes statistical areas 13-21 and the Northeastern Gulf encompasses stat areas 6-12. These regions also generally reflect similarities in the species composition of bottom longline trips from each of the three areas. These spatial classifications will be used in the assessment modeling as well. The general goal of these classifications is to partition the assessment into areas which have received fairly similar levels of overall fishing mortality over time, while maintaining enough aggregation of the data so that there are few missing cells for age composition, CPUE or landings.

Decision: Commercial landings for yellowedge grouper will be grouped by gear type into three geographical fishing areas based upon combining statistical areas as follows:
Southeastern Gulf SE statistical areas 1-5
Northeastern Gulf NE statistical areas 6-12
Western Gulf W statistical areas 13-21

3.3.2. Discussion of Methods to Calculate Historical Landings of Yellowedge Grouper

Landings of yellowedge grouper become available in 1986 with the onset of the grouper identification or classification requirement. Although classification of groupers began in 1986, unclassified groupers continued to be reported after 1985; a proportion of those unclassified groupers calculated to be yellowedge grouper (see below). These unclassified grouper landings 1986 and later were handled in the same way as had been done for gag and black grouper in the SEDAR 12 and 19, respectively. Prior to 1986 almost all grouper landings except warsaw grouper, Nassau grouper and goliath grouper (formerly jewfish) were recorded as unclassified grouper.

For the development of the historical landings record prior to 1986, commercial fishermen and dealers who had fished during that period from the mid-70's onward, Bob Spaeth, Martin Fisher, Gregg Abrams and others were asked to recollect the early fishery on yellowedge grouper and deepwater-complex fishery, e.g. snowy grouper, speckled hind, tilefish and blueline tilefish. Several fish houses were contacted by phone during the working group sessions and their comments were incorporated in the discussion and recommendations of the group.

The working group concluded that substantial landings of deep water groupers began in about 1975 and that they consisted primarily of yellowedge grouper as well as some snowy grouper and a few other deepwater species. It was noted that during the early part of the deep water fishery yellowedge was commonly referred to as yellowfin grouper even by some fisheries biologists (see below) until at least 1990. The commercial landings of the LL and VL fishery of unclassified groupers were substantial; the VL landings records date back to 1963 and the LL landings began in 1979. When the amount of pre-1986 unclassified groupers that might have been yellowedge was calculated, the two gear types (LL and VL) were treated separately. Both

LL and VL landings of unclassified groupers and the species composition of the respective fisheries are discussed below.

Yellowfin Grouper Landings. Historically, yellowedge groupers may have been reported as yellowfin grouper, *Mycteroperca venenosa,* from the onset of the fishery to about 1990. In fact, Prytherch (1983) makes no reference to yellowedge grouper in his report but rather refers to the dominant deepwater grouper species in the landings as yellowfin, demonstrating that the appellation ‘yellowfin’ was in widespread usage.

Yellowfin grouper inhabit shallower coral reef and hard bottom habitats than yellowedge grouper and are rarely caught in the current yellowedge fishery. During 1991 concerted efforts were made to have dealers report grouper landings by species (from 1986 to1990 distinguishing the only five primary species of groupers had been emphasized). Bob Spaeth suggested that those efforts coincided with concern about ciguatera toxin in some grouper species, including yellowfin grouper, which provided further incentive to properly distinguish the species.

The 1986-1990 yellowfin landings averaged 114,178 lbs per year with a peak of 358,654 lbs reported in 1986 (Tables 3.3.1.a and b., and Figure 3.3.1). In the five period after that (1991-1995) average landings were 8,818 lbs per year or only 7.7% of the landings from 1986-1990 (Table 3.3.1.b). Average landings per year of yellowfin grouper from 1996-2009 were 5,676 lbs. The working group concluded that landings well below 10,000 lbs per year probably more truly reflected the normal yellowfin landings in the Gulf and that the 1986-1990 landings reflected substantial mis-reporting of yellowedge as yellowfin.

The average percent of yellowfin grouper of the combined landings of yellowedge and yellowfin are about 9.6% in the years 1986-1990, whereas the average for 1991-2009 is 0.77% (Table 3.3.1.b), indicating a much higher level of misidentification in years prior to 1991. As a first approach the average yellowfin landings 1991-1995 were determined and compared relative to the average landings 1986-1990, the years with erroneous reporting. The landings 1991-1995 were on average only 7.7% of the landings 1986-1990, and following the logic, it was assumed that only 7.7% of yellowfin grouper landings 1986-1990 were actually yellowfin grouper landings and yellowfin grouper landings assigned to yellowedge grouper for 1986-1990 are shown in Table 3.3.1.c. After 1990, it was assumed that yellowfin grouper were properly identified in the ALS landings.

Decision: The majority of yellowfin grouper landings will be assumed as yellowedge grouper landings1986-1990. As a correction, 92.3% of yellowfin groupers landings will be assigned to yellowedge groupers in those years.

Historical Gulf of Mexico Long Line (LL) Fishery of Unclassified Groupers:

The grouper LL fishery begins in the ALS landing records in 1979 as unclassified groupers (Table 3.3.2 and Figure 3.3.2.a and b.). It was reported to the group by commercial fishermen representatives, is that the LL gear was introduced to the Gulf of Mexico by a group of fishermen from New England.

It was further reported that the LL fishery in the Gulf of Mexico began as a purely deep water fishery targeting yellowedge groupers from 1979 to 1981. The initial increase in landings coincides with the adoption of LL gear and is corroborated by notes from fish house interviews during the time. On August 10, 1981, Spence fish Co, Niceville, FL reported to have produced 800,000lbs of deepwater grouper from March-August of that year of which 90% were yellowedge grouper compared to only 50,000lbs in 1980 (Lew Bullock, 2010, field notes). Further, it was noted by several LL vessels that they fished off of Louisiana waters and landed in ports on the West Coast of Florida (Cortez).

In 1982, LL fishermen began shifting to inshore waters and targeting shallow water groupers with the newly acquired LL gear skills. By 1982, reportedly about more than half of the LL fishery in West Florida had shifted to shallow water grouper consisting mostly of red grouper (Prytherch 1983). Analysis of LL fishery grouper species composition by fishing region according to the Prytherch (1983) survey is shown in Tables 3.3.3.a.-c. Application of presumed yellowedge grouper proportion of unclassified groupers landings and calculated yellowedge LL landings 1979-1982 is shown Table 3.3.4.

Decision: Deepwater LL fishery began in 1979 in the Gulf of Mexico primarily targeting yellowedge grouper as reported in the ALS database. The proportion of unclassified grouper LL fishery assigned to yellowedge grouper will be classified according to the species composition of a Gulf wide LL grouper fishery survey report 1982 by Prytherch (1983).

The unclassified grouper landings will be grouped by three separate fishing areas of the Southeast (SE), Northeast (NE), and Western (West) Gulf. The proportion of yellowfin grouper LL landings (actually yellowedge grouper landings called yellowfin) will be applied to the years of unclassified grouper LL landings in 1979, 1980, 1981, and 1982 to calculate the landings for yellowedge grouper in those years.

Decision: LL fishery began targeting/shifting to shallow water groupers in1982 and remained a mixed fishery thereafter with both shallow water and deepwater components.

Decision: Information on assignment of unclassified grouper landings from 1983-1985 was not available, and the most sensible approach based on opinions of scientists and fishermen was to use region-specific linear interpolation to estimate annual landings between the estimated level of yellowedge grouper landings in 1982 and the calculated landings in 1986. This linear interpolation captures the shift in targeting from deepwater to shallow water groupers by the longline fishery.

Historical Gulf of Mexico Vertical Line (VL) Fishery of Unclassified Groupers:
Based upon two interviews with fishermen (Lew Bullock pers comm.), the VL species composition of the catch in 1986-1989 was reported to be similar to the species compostion in 1975-1985, or at least it did not undergo the same offshore/inshore shift as the longline fishery. Therefore the working group considered it reasonable to use the 1986-1989 VL species composition to calculate the amount of yellowedge grouper in the unclassified groupers vertical line landings from 1975-1985.

The reported average grouper species composition commercial landings of the VL fishery 1986-1989 was analyzed and calculated for the three fishing region (Table 3.3.5 and Figure 3.3.4.).

The combined proportion of yellowedge and yellowfin in the VL landings 1986-1989 was used to assign yellowedge grouper VL line proportions from unclassified grouper VL landings 1975 to 1985 by geographical fishing region.

Initial discussions regarding the yellowedge grouper landings with vertical line gear centered on the unusually high landings of 400,000-500,000 in 1986-1988, which some thought were too high with regards to long line landings in the same years as well as vertical line landings 1990-1994, which were 4-5 times less than the 1986-1988 landings. With the extension of the time series of VL landings back to 1975, these landings did not appear to be incongruously high, and further discussions with vertical line fishermen and dealers active in those years indicated that these landings levels were realistic.

From discussions conducted in the working group and from investigations done after the workshop, the yellowedge fishery began as a vertical line fishery and then transitioned rapidly after 1979 into a longline fishery. Some fishermen recalled landing a few yellowedge in the late 1960's and others not until the mid 1970's (Lew Bullock pers comm.). In either case, landings of yellowedge prior to 1975 appear to have been extremely low such that the fishery could be reasonably considered to have started in 1975.

Decisions Regarding Distribution of Unclassified Grouper Landings with vertical line gear

Decision: Vertical line landings of yellowedge will be assumed to have started in 1975 (zero landings in 1974).

Decision: Since VL fishery did not go through drastic changes as the LL fishery in the 1980’s, it was deemed reasonable to use yellowedge grouper species composition of VL landings from 1986-1989 to assign landings to Yellowedge from the unclassified grouper landings in the VL fishery for years prior to 1986 and back to 1975.

Calculated Yellowedge Grouper Landings:

Yellowedge grouper landing from 1986-2009 were compiled using methods similar to those used for red, gag and black grouper since 2005 (SEDAR 10). Proportions of a grouper species in the classified groupers, in this case yellowedge grouper, are calculated and applied to assign a proportion of unclassified groupers landings to the yellowedge landings by year, state, gear and statistical area (Figures 3.3.3 and 3.3.4).

The sum of reported yellowedge grouper and yellowedge grouper calculated from yellowfin grouper landings (1986-1990) and yellowedge grouper calculated from unclassified groupers from VL (1975-2009) and LL fishery (1979-2009) will be referred to as calculated yellowedge grouper landings. Estimated commercial landings of calculated yellowedge grouper by gear type and geographical fishing area, West, NE and SE Gulf, including a proportion of unclassified groupers from 1986 onwards are shown in Table 3.3.6 and Figure 3.3.5. These landings estimates were made using best available knowledge of scientists and differ from the estimated landings compiled for the previous yellowedge grouper stock assessment in 2002. Differences are attributable the current inclusion and assignment of yellowedge grouper landings from a proportion of unclassified groupers landings and a proportion of yellowfin grouper landings not considered in 2002 (Table 3.3.7.). In 2002, no yellowedge grouper landings were assigned from unclassified groupers or yellowfin grouper.

3.3.4 Mis-Identification

The working group reviewed two documents on mis-identification of yellowedge grouper and golden tilefish (see below). Members of the group had extensive discussions both during the workshop and after on ways of calculating quantities of mis-identified fish eventually concluding that with adequate sample size the two proposed methods yielded identical results (see below).

The group also concluded that in the years when sample sizes were adequate, the amounts of the total landings of yellowedge and golden tilefish which had been classified as other species (bony fish, unclassified grouper, …) was sufficiently low compared to the calculated total landings of yellowedge and golden tilefish, that it could be neglected.

***Mis-identification Sampling and Calculation*:**

The misidentification and improper allocation of fishes into (other species recorded as yellowedge) and out of (yellowedge recorded as other species) the yellowedge grouper landings estimates is discussed in SEDAR 22- DW-13. (Note: The same issue holds for tilefish as described in SEDAR 22 – DW 12.) The Data Workshop requested a secondary analysis of yellowedge misidentified as general grouper, bony fishes, and black grouper. The focus of this analysis was to examine the occurrence of misidentified yellowedge in those three landings categories. Rather than base this estimate on the number of yellowedge sampled as described in SEDAR 22 – DW 13, the Workshop recommended basing the calculations on the number of the general grouper, bony fishes, and black grouper sampled. This issue was thoroughly reviewed algebraically and through an examination of sampling protocols.

Algebraically, the DW-13 method simplifies to consideration of the reported landings and sampling data. The sampling data is used to generate estimates of the proportion of yellowedge grouper reported by dealers as some other species (bony fish, for instance). The sampling data also provides the total number of yellowedge grouper identified by the port agents. Note that these estimates are based on sampling of individual trips and the reports submitted by dealers. The ratio of these two estimates multiplied by the reported landings returns the number or weight of yellowedge grouper that must be added to the reported landings to estimate the true landings. If sample sizes are adequate, this method does correctly estimate the misidentified landings.

An examination of TIP sampling protocols indicates that implementing the methods suggested by the Data Workshop would greatly increase the uncertainties in the estimation of a misidentification rate. This is because dealers often categorize landings such as bony fish or unclassified grouper after TIP agents have already done their dock-site sampling. As a result, it is not feasible to conduct random sampling of fish that belong to bony fish or unclassified grouper landings. Consequently, estimation of species compositions for bony fish or unclassified grouper can be biased. Also, sampling for the dominant misidentification categories (bony fish, unclassified grouper, and black grouper) is inconsistent and of low intensity especially in the early years of the sampling program. Low intensity sampling in combination with low misidentification rates, can create biases which will exacerbate uncertainty issues.

Decision: Although the method suggested by the Data Workshop is mathematically valid, and perhaps conceptually cleaner, the sampling protocols of the TIP program were not structured to allow accurate estimation of misidentification rates by this method. The method suggested by the Data Workshop introduces an additional source of uncertainty because the exact landing categories often cannot be determined at the time of dock site sampling, and because the low sampling intensity common to general categories such as bony fish or unclassified grouper can result in biased estimates of misidentified landings for a target species.

Further, review of the methods specified in SEDAR 22 – DW 12 and SEDAR 22 – DW 13 indicates that, when sampling intensity is sufficient, they produce fully adequate, unbiased estimates of the number of fish misidentified and true landings. Given this, no change in the approach taken in documents SEDAR 22 – DW 12 and SEDAR 22 – DW 13 is recommended.

3.4. *COMMERCIAL DISCARDS*

Data from the SEFSC coastal fisheries self-reported logbook program were used to calculate the number and yellowedge grouper discarded during the period January 1, 1990 through December 31, 2009.A detailed description of the available data and methods used for calculating discards are available in SEDAR22-DW-04.

Due to the small number of trips reporting yellowedge grouper discards, the calculation of discards was limited to simple ratio estimation. For the years 2002-2009 when discard data were reported, all available data were pooled by gear (vertical line and logline only) and the mean discard rate for each year and deep-water grouper season (open or closed) was calculated. Mean discard rates were then applied to the yearly gear-specific effort for each deep-water grouper season. Effort for logline was defined as total hooks fished per year. Vertical line effort was total hook hours fished. Discards were calculated for years prior to 2002 by applying gear-specific mean discard rates calculated for deep-water grouper open season (there were no deep-water grouper closed seasons prior to 2004) for all years (2002-2009) to the year/deep-water grouper open season effort for each gear. Yearly yellowedge grouper discard totals for each gear are included in Table 3.4.1. Long line discards could not be calculated prior to 2002 because no open season discards were reported by logline vessels. Zero calculated discards appear in the table during years in which vessels submitted discard logbooks, but no yellowedge grouper discards were reported.

The release condition of reported discarded yellowedge grouper is provided in Table 3.4.2 for vertical line data reported yearly and for logline with all years combined due to small sample size. The majority (>87%) of vertical line discards and all logline discards were reported as due to regulatory restrictions (Table 3.4.3).Beginning in 2008, the discard reason categories were expanded to include “not legal size” and “out of season”. During both 2008 and 2009 over 90% of vertical line discards were reported as out of season.

The number of trips reporting yellowedge grouper and tilefish discards in the Gulf of Mexico was low. This was particularly true of the tilefish species and the deep-water grouper open season yellowedge grouper data. Given that the observed discard observations were so few, the discard rate of yellowedge grouper may be poorly characterized. Even with the limited available data, it does appear likely that the majority of yellowedge grouper discards occur during closed seasons and that yellowedge grouper discards are likely to be few. An additional concern associated with these data is the high percentage of trips that report “no discards”. Vessels selected to report discards must submit discard logbooks or report no discards to remain in permit compliance. The percentage of logline trips reporting no discards for a trip has ranged from 20 to 42 percent. Such high rates of “no discards” reports seem unlikely, suggesting that discards have been underreported in general. The calculated discards provided here should be used with caution, given the limitations and uncertainties of the available data.

3.5. *COMMERCIAL EFFORT*

Total effort reported to the coastal logbook program from the commercial golden tilefish, blueline tilefish, and yellowedge grouper fisheries is provided in Table 3.5.1. Effort of all trips reporting landings of one pound or more of those species was summed by year. Effort totals are provided for logline and vertical line (hand line and electric reel/bandit rig) vessels only. Very few landings of golden tilefish, blueline tilefish, or yellowedge grouper were reported from vessels fishing other gears. Total yearly logline and vertical line effort in the Gulf of Mexico is provided in Table 3.5.2 for comparison.

3.6. *BIOLOGICAL SAMPLING: SIZE COMPOSITION BY GEAR TYPE*

Length Composition Data from Trip Intercept Program:

Length measurements for individual Yellowedge grouper sampled in the Trip Intercept Program were examined to see if the length distributions from the handline and longline fisheries differed. Figure 3.6.1. shows the length frequency distributions for these two yellowedge grouper fisheries. Handline length frequency distributions were skewed to the left (smaller fish predominated). Longline length frequency distributions were more normal. To test whether or not the two fisheries produced the same length frequency distributions, a quantile-quantile plot was produced (Figure 3.6.2). This plot indicates that the two distributions differ from one another throughout most of the range of observations. The distribution-free two-sample Kolmogorov-Smirnov analysis was used to test whether or not the two data sets were drawn from the same distribution. This test indicated that the longline and handline length measurements were not drawn from the same distribution (p-value $\ll 0.05$).

Decision: Handline and longline fisheries for yellowedge grouper do not produce identical length frequency distributions. This can arise through differences in selectivity or through an interaction between the locations of the fisheries and the spatial distribution of the population of yellowedge grouper. Given these observations, handline and longline fisheries should be treated as different fleets in the assessment.

3.7. *COMPARISION BETWEEN TIP AND AGE & GROWTH LENGTH FREQUENCIES*

Two SEDAR 22 Data Workshop reports (S22-DW-09 and S22-DW–10) indicated that there were differences between the length frequencies derived from the length and otolith samples from the Trip Interview Program. The Data Workshop recommended a review of the issue. Subsequent review indicates that the length frequencies distributions of the two sample types are different in some years, particularly in the early years of the sampling programs (Figure 3.6.3). The length frequency distributions of the two sample types are reasonably similar in the more recent years of the sampling period. It is recommended that the assessment team adjust (reweight) the data used for determining the catch-at-age and growth relationships in the assessment model on a year-by-year basis. This will ensure that proper corrections are made when required, and that all the data will be handled in a consistent manner.

3.8. *COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES*

The commercial landings working group considered the yellowedge grouper landings data from 1986 to present to be relatively accurate. The group emphasizes that the 1975-1985 data are substantially more uncertain.

3.9. *TABLES*

Table 3.3.1.a. Total Gulf of Mexico yellowfin grouper landings 1986-2009 (in lbs gutted wt) for three geographical fishing areas SE=Southeastern Gulf Stat areas 1-5; NE=Northeastern Gulf (stat areas 6-12); W=Western Gulf (stat areas 13-21). LL = longline; VL = vertical line.

Year	W Gulf VL	W Gulf LL	NE Gulf VL	NE Gulf LL	SE Gulf VL	SE Gulf LL	Grand Total
1986	19,636		117,823	10,421	137,752	42,147	358,654
1987	3,775	186	15,636	1,679	397	3,002	27,386
1988	2,253	13,579	9,208	23	1,761	1,338	30,521
1989	15,453	70,599	486	472	43	291	120,592
1990	16,679	9,231	3,015	1,574	103	764	33,734
1991	312	478	421	799	2,894	168	7,223
1992	151	10	1,120	464	257	610	3,195
1993	846	170	551	60	1,767	42	3,729
1994	15,075	4,001	693	428	1,520	83	21,938
1995	2,786	719	3,250	488	589	58	8,004
1996	881	340	7,142	420	1,829	344	11,548
1997	1,313	556	1,908	81	175	94	4,540
1998	527	252	200	5	63	17	1,126
1999	3,506	1,218	421	53	6	2	5,290
2000	2,483	349	2,978	2,002	65	9	10,373
2001	550	773	8,197	1,396	83	122	11,210
2002	2,770	3,053	1,681	105	83	4	9,334
2003	848	1,705	1,511	107	25	3	4,311
2004		1,131	2,794	633	76	277	5,506
2005		2,461	1,011	15	1,992	12	5,813
2006		175	144	74	296	46	834
2007	1,154	4,146	550	73	56		6,031
2008	256	965	1	3		11	2,151
2009		1,264	56	11		4	1,402

Table 3.3.1.b. Total yellowfin and yellowedge grouper landings 1986-2009 from the Gulf of Mexico, percent of yellowfin grouper landings of combined yellowedge grouper and yellowfin grouper landings, average yellowfin grouper landings 1986-1990, 1991-1995 and 1996-2009.

YEAR	Yellowedge Grouper	Yellowfin Grouper	% Yellowfin/ Yellowfin+ Yellowedge	Average Landings	Comments
1986	1,114,903	358,654	24.3%		
1987	1,161,020	27,386	2.3%		
1988	1,620,333	30,521	1.8%		
1989	659,908	120,592	15.5%		
1990	847,079	33,734	3.8%	114,178 (100%)	1986-1990
1991	770,975	7,223	0.9%		
1992	1,041,905	3,195	0.3%		
1993	776,410	3,729	0.5%		
1994	1,069,729	21,938	2.0%		
1995	841,948	8,004	0.9%	8,818 (7.7%)	1991-1995
1996	529,862	11,548	2.1%		
1997	720,139	4,540	0.6%		
1998	683,466	1,126	0.2%		
1999	972,954	5,290	0.5%		
2000	1,091,339	10,373	0.9%		
2001	777,001	11,210	1.4%		
2002	785,154	9,334	1.2%		
2003	1,103,576	4,311	0.4%		
2004	925,347	5,506	0.6%		
2005	787,416	5,813	0.7%		
2006	745,337	834	0.1%		
2007	868,478	6,031	0.7%		
2008	819,040	2,151	0.3%		
2009	828,547	1,402	0.2%	5,676	1996-2009

Average percent yellowfin/(yellowfin + yellowedge) 1986-1990= 9.55 %
Average percent yellowfin/(Yellowfin + yellowedge) 1991-2009= 0.77%
Percentage of 1991-1995 yellowfin landings relative to 1986-1990 landings: 8,818/114,178= 7.7%

Table 3.3.1.c. 1986-1990 Yellowfin groupers landings (92. 3% of total landing estimated from comparison with landing from 1991-1995, see table 3.3.1.b.) from the Gulf of Mexico to be assigned as yellowedge grouper landings by gear and geographical fishing area. LL = longline; VL = vertical line.

YEAR	VL	LL	VL	LL	VL	LL	Grand Total
1986	18,120	-	108,724	9,616	127,114	38,893	330,956
1987	3,484	171	14,428	1,549	366	2,770	25,271
1988	2,079	12,530	8,497	21	1,625	1,235	28,164
1989	14,260	65,147	448	436	40	268	111,279
1990	15,391	8,518	2,782	1,452	95	705	31,129

Table 3.3.2. Total Gulf of Mexico unclassified grouper landings (in lbs gutted wt) 1962-2009 by gear for the three geographical fishing areas SE=Southeastern Gulf Stat areas 1-5; NE=Northeastern Gulf (stat areas 6-12); W=Western Gulf (sta tareas 13-21). LL = longline; VL = vertical line

Year	W Gulf VL	W Gulf LL	NE Gulf VL	NE Gulf LL	SE Gulf VL	SE Gulf LL	Grand Total
1963	550,868		1,406,955		4,075,622		6,033,444
1964	689,007		2,285,822		4,130,917		7,105,747
1965	708,995		2,464,618		4,626,236		7,799,850
1966	342,481		1,830,972		4,801,843		6,975,296
1967	355,184		1,278,364		4,150,710		5,784,258
1968	449,662		1,410,811		4,420,249		6,280,722
1969	356,194		1,438,688		5,333,632		7,128,514
1970	460,559		997,802		5,593,944		7,052,306
1971	548,815		2,287,056		3,684,350		6,520,221
1972	556,508		2,617,899		3,399,400		6,573,807
1973	398,694		1,919,237		2,967,498		5,285,429
1974	288,828		2,168,537		3,505,897		5,963,263
1975	300,480		2,766,810		4,083,071		7,150,361
1976	199,527		2,262,104		3,960,167		6,421,798
1977	157,758		1,777,216		3,054,883		4,989,858
1978	173,532		1,534,794		2,936,928		4,645,254
1979	194,303	46,031	2,704,454		3,518,285		6,463,073
1980	114,276	59,636	2,608,324	398,128	3,448,101	278,961	6,907,427
1981	597,194	871,308	2,443,510	1,208,488	2,953,030	1,549,005	9,622,535
1982	583,058	869,735	2,046,880	2,630,798	2,780,362	3,045,949	11,956,782
1983	303,982	414,480	1,652,489	1,593,880	2,788,655	2,558,046	9,311,532
1984	511,561	520,156	1,545,733	581,788	2,939,605	2,722,879	8,821,722
1985	543,726	966,810	2,018,635	844,243	3,594,329	1,988,387	9,956,130
1986	107,505	213,325	59,565	62,423	59,548	49,583	551,950
1987	120,153	245,869	61,411	45,606	96,718	71,237	640,993
1988	205,611	170,213	73,321	37,871	124,835	90,349	702,198
1989	195,445	172,651	75,308	5,943	28,871	17,138	495,355
1990	54,124	73,841	49,415	13,107	43,363	24,973	258,823
1991	39,260	49,717	29,121	38,112	8,393	19,251	183,855
1992	67,085	35,431	14,273	39,658	13,764	13,339	183,551
1993	30,182	69,362	10,620	28,053	5,258	26,780	170,255
1994	9,246	24,795	6,112	9,611	3,405	10,805	63,975
1995	8,268	39,338	3,829	8,017	2,174	5,892	67,518
1996	7,944	31,965	1,037	4,914	589	1,600	48,048
1997	11,244	33,424	1,240	17,186	440	2,990	66,523
1998	22,533	69,342	2,391	3,845	788	2,654	101,553
1999	6,607	52,614	3,061	7,016	1,025	3,840	74,163
2000	7,200	18,383	3,382	15,800	631	1,706	47,103
2001	8,871	36,999	4,068	11,915	239	708	62,801

2002	6,966	34,168	1,289	2,394	352	1,183	46,353
2003	2,713	20,653	951	1,397	257	1,034	27,005
2004	4,023	23,156	2,522	2,161	651	2,889	35,403
2005	5,677	13,631	1,552	1,085	60	180	22,186
2006	4,851	15,672	496	417	50	248	21,734
2007	90	189	390	314	16	76	1,074
2008	513	1,517	312	45	10	45	2,442
2009	470	1,177	292	69	1	1	2,011

Table 3.3.3. Species composition and landings of groupers sampled in 1982 during a long line survey of the commercial long line fishery in the Gulf Mexico conducted in three different geographical fishing grounds (after Prytherch 1983).

a. Long Line caught groupers - Western Grounds 1982

NMFS code	Species	% comp	(lbs)
1426	Yellowfin Grouper	**78.3%**	32,559
4740	Warsaw Grouper	18.3%	7,626
1411	Speckled Hind	0.9%	375
1424	Scamp Grouper	0.2%	67
1422	Black Grouper	0.8%	328
1416	Goliath Grouper	1.5%	640
1414	Snowy Grouper	0.0%	-

Total 41,595 lbs

Percent deep water species landings 1,035/41.595 = 97.5 %

b. Long Line caught groupers - Northern Grounds 1982

NMFS code	Species	% comp	(lbs)
1426	Yellowfin Grouper	**96.3%**	90,339
4740	Warsaw Grouper	3.2%	2,964
1411	Speckled Hind	0.4%	375
1424	Scamp Grouper	0.1%	67
1422	Black Grouper	0.1%	63
1416	Red Grouper	0.0%	-
1414	Snowy Grouper	0.0%	-

Total 93,808 lbs

Percent deep water species landings 93,678/93,808 = 99.9 %

c. Long Line caught groupers - Southern Grounds 1982

NMFS code	Species	% comp	(lbs)
1416	Red Grouper	34.9%	33,612
1414	Snowy	30.0%	28,860
1426	Yellowfin	**22.7%**	21,874
1422	Black	10.6%	10,191
4740	Warsaw	0.9%	883
1424	Scamp	0.4%	419
1411	Speckled	0.4%	375

Total 96,214 lbs

Percent deep water species landings 51,992/96,214 = 54.0 %

Table 3.3.4. Species composition and landings of unclassified groupers sampled in 1982 during a long line survey of the commercial Long Line fishery in the Gulf Mexico conducted in three different geographical fishing grounds (after Prytherch 1983). Note the Yellowfin in the original Prytherch (1983) report as evidence of wide spread mis-identification of yellowedge as Yellowfin.

Year	Deep water LL Landings	% Yellowfin West Gulf	% Yellowfin NE Gulf	% Yellowfin SE Gulf	LL Lands. Yellowedge West Gulf	LL Lands. Yellowedge NE Gulf	LL Lands. Yellowedge SE Gulf	LL Lands. Yellowedge Gulf Total
1979	46,031	78.3%	96.3%	22.7%	36,966	-	-	36,966
1980	736,725	78.3%	96.3%	22.7%	47,892	383,781	117,267	548,940
1981	3,628,801	78.3%	96.3%	22.7%	699,727	1,164,939	651,156	2,515,822
1982	6,546,482	78.3%	96.3%	22.7%	681,003	2,533,458	691,430	3,905,891

Table 3.3.5. Gulf Mexico of grouper species composition of the Vertical Line landings 1986-1989 by geographical fishing areas.

SE Gulf, Stat areas 1-5	**%**	**NE Gulf, Stat areas 6-12**	**%**	**West, Stat areas 13-21**	**%**
Red Grouper	73.2%	Red Grouper	55.3%	Yellowedge Grouper	27.4%
Black Grouper	8.9%	Black Grouper	18.5%	Warsaw Grouper	25.0%
Gag Grouper	8.8%	Gag Grouper	11.3%	Scamp	21.3%
Yellowedge Grouper	3.4%	Yellowedge Grouper	7.5%	Yellowfin Grouper	11.2%
Snowy Grouper	1.8%	Scamp	5.2%	Gag Grouper	5.8%
Scamp	1.7%	Warsaw Grouper	1.3%	Black Grouper	5.5%
Jewfish	1.2%	Snowy Grouper	0.5%	Snowy Grouper	2.1%
Yellowfin Grouper	0.5%	Jewfish	0.3%	Marbled Grouper	0.6%
Warsaw Grouper	0.4%	Yellowfin Grouper	0.2%	Jewfish	0.4%
Nassau Grouper	0.0%	Nassau Grouper	0.0%	Speckled Hind	0.3%
Speckled Hind	0.0%	Grand Total	100.0%	Red Grouper	0.2%
Grand Total	100.0%			Red Hind	0.0%
				Rock Hind	0.0%
				Yellowmouth Grouper	0.0%
				Graysby	0.0%
				Nassau Grouper	0.0%
				Misty Grouper	0.0%
				Grand Total	100.0%
Yellowedge+yellowfin	**3.9%**	Yellowedge+yellowfin	**7.6%**	Yellowedge+yellowfin	**38.7%**

Table 3.3.6. Calculated total Gulf of Mexico Yellowedge grouper landings 1974-2009 (in lbs gutted wt) for the three geographical fishing areas including mislabeled Yellowfin landing 1986-1990 and the unclassified grouper landings from 1975 onwards for vertical line (VL) and 1979 onwards for long line (LL) fisheries based grouper species composition found the Prytherch (1983) LL survey in 1982. SE=Southeastern Gulf Stat areas 1-5; NE=Northeastern Gulf (stat areas 6-12); W=Western Gulf (stat areas 13-21) based on the recommendations from the SEDAR 22 data workshop.

Year	W Gulf VL	W Gulf LL	NE Gulf VL	NE Gulf LL	SE Gulf VL	SE Gulf LL	Grand Total
1974	-		-		-		-
1975	116,156		210,370		160,238		486,764
1976	77,131		171,995		155,414		404,541
1977	60,985		135,128		119,887		315,999
1978	67,082		116,696		115,258		299,036
1979	75,112	36,031	205,629	-	138,073	-	454,845
1980	44,176	46,681	198,320	383,405	135,319	63,324	871,224
1981	230,857	682,027	185,788	1,163,798	115,890	351,624	2,729,985
1982	225,393	680,796	155,631	2,533,511	109,114	691,430	4,395,875
1983	117,510	646,674	125,644	1,928,289	109,439	547,917	3,475,474
1984	*	*	117,527	1,323,067	115,363	404,405	2,770,667
1985	*	*	153,484	717,845	141,057	260,892	2,061,894
1986	98,119	544,306	*	*	256,727	117,379	1,417,369
1987	63,191	437,827	257,166	212,141	88,382	125,081	1,183,788
1988	281,401	606,346	177,597	348,345	91,623	141,009	1,646,320
1989	49,078	351,233	*	*	18,278	22,137	740,507
1990	39,015	345,943	*	*	41,696	110,509	876,022
1991	*	*	28,930	175,356	50,047	159,430	770,975
1992	77,802	386,692	*	*	59,633	293,125	1,041,905
1993	*	*	21,096	171,418	11,410	176,582	776,410
1994	*	277,888	*	*	28,603	428,013	1,069,729
1995	*	372,383	*	180,655	8,984	234,634	841,948
1996	*	155,994	*	213,253	4,218	119,300	529,862
1997	*	*	6,097	230,134	9,286	331,465	720,139
1998	*	*	13,448	135,100	8,592	285,815	683,466
1999	37,094	274,224	18,581	196,148	9,553	437,354	972,954
2000	42,735	295,164	12,920	321,990	8,280	410,250	1,091,339
2001	22,893	197,259	9,338	241,112	5,693	300,705	777,001
2002	26,455	301,981	12,055	232,587	10,086	201,990	785,154
2003	33,021	363,051	14,611	340,073	10,124	342,695	1,103,576
2004	27,950	296,015	7,814	164,879	12,706	415,983	925,347
2005	23,365	268,662	12,184	133,541	3,953	345,710	787,416
2006	16,426	226,984	15,530	203,502	5,806	277,089	745,337
2007	27,529	137,744	6,550	277,070	3,964	415,622	868,478
2008	24,168	158,430	6,515	283,959	2,162	343,808	819,040
2009	43,453	210,874	11,989	201,355	8,410	352,466	828,547

Table 3.3.7. Calculated commercial landings of Gulf of Mexico yellowedge grouper 1986-2009 in lbs gutted wt and landings 1986-2001 used for 2002 stock assessment. Column on the far right shows the total difference between the 2010 and 2002 landings estimates. LL = longline; VL = vertical line

YEAR	Sedar 22 2010 LL	Sedar 22 2010 VL	Sedar 22 Total 2010	2002 LL	2002 VL	Total 2002	Difference 2010-2002 Total
1974			-				
1975	-	486,764	486,764				486,764
1976	-	404,541	404,541				404,541
1977	-	315,999	315,999				315,999
1978	-	299,036	299,036				299,036
1979	36,031	418,813	454,845				454,845
1980	493,410	377,814	871,224				871,224
1981	2,197,449	532,535	2,729,985				2,729,985
1982	3,905,738	490,137	4,395,875				4,395,875
1983	3,122,880	352,594	3,475,474				3,475,474
1984	2,340,023	430,645	2,770,667				2,770,667
1985	1,557,165	504,729	2,061,894				2,061,894
1986	774,308	643,061	1,417,369	579,094	334,705	913,799	526,362
1987	775,049	408,739	1,183,788	563,584	335,814	899,398	286,106
1988	1,095,699	550,621	1,646,320	881,810	419,475	1,301,285	346,993
1989	624,896	115,611	740,507	402,468	85,803	488,271	258,309
1990	719,189	156,833	876,022	612,863	129,621	742,484	135,719
1991	651,840	119,136	770,975	573,885	96,843	670,728	100,248
1992	897,826	144,078	1,041,905	669,869	124,944	794,813	247,091
1993	667,262	109,147	776,410	538,837	124,989	663,826	112,584
1994	976,362	93,367	1,069,729	935,979	55,620	991,598	78,131
1995	787,671	54,277	841,948	667,213	43,413	710,627	131,322
1996	488,547	41,315	529,862	435,372	41,919	477,291	52,571
1997	686,074	34,065	720,139	600,756	37,876	638,632	81,507
1998	635,949	47,517	683,466	524,021	35,161	559,182	124,284
1999	907,726	65,228	972,954	801,071	44,734	845,805	127,149
2000	1,027,404	63,935	1,091,339	909,811	53,883	963,693	127,646
2001	739,076	37,925	777,001	636,115	40,937	677,053	99,948
2002	736,558	48,595	785,154				
2003	1,045,820	57,756	1,103,576				
2004	876,877	48,470	925,347				
2005	747,913	39,503	787,416				
2006	707,574	37,763	745,337				
2007	830,435	38,043	868,478				
2008	786,197	32,844	819,040				
2009	764,695	63,852	828,547				

Table 3.4.1. Calculated yearly commercial vertical line and logline vessel yellowedge grouper discards by year. Discards are reported in number of fish.

Year	Vertical Line Discards	Logline Discards
1990	219	#
1991	700	#
1992	776	#
1993	305	#
1994	357	#
1995	428	#
1996	383	#
1997	587	#
1998	562	#
1999	641	#
2000	619	#
2001	618	#
2002	0	0
2003	*	0
2004	426	4,163
2005	892	0
2006	619	0
2007	4,435	*
2008	197	0
2009	21	0

#could not be calculated
*confidential data, but very few discards

Table 3.4.2. Percent of reported yellowedge grouper discards by estimated condition at release from commercial vessels.

Region	Year	All Dead	Majority Dead	All Alive	Majority Alive	Kept	Unknown	Unreported	N Fish
Vertical Line	2002	No discards reported							
	2003	Confidential data							
	2004	80.8%	15.3%	1.5%	0.6%	1.2%	0.6%	0.0%	339
	2005	83.9%	12.9%	0.7%	0.0%	2.6%	0.0%	0.0%	155
	2006	88.3%	10.1%	1.6%	0.0%	0.0%	0.0%	0.0%	248
	2007	44.2%	11.6%	9.1%	30.7%	0.2%	1.1%	3.2%	473
	2008	47.0%	12.9%	39.0%	1.1%	0.0%	0.0%	0.0%	549
	2009	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	137
	N Fish	1,227	223	267	153	10	7	15	1,902
Longline		0.0%	98.53%	0.0%	0.92%	0.0%	0.55%	0.0%	545

Table 3.4.3. Percent of reported yellowedge grouper discards by reason for discard from commercial vessels.

Region	Year	Not legal size	Out of season	Other regulations	Market conditions	Unreported	N Fish
Vertical Line	2002	No discards reported					
	2003	Confidential data not shown					
	2004	0.0%	0.0%	100.0%	0.0%	0.0%	339
	2005	0.0%	0.0%	94.8%	5.2%	0.0%	155
	2006	0.0%	0.0%	87.5%	0.0%	12.5%	248
	2007	0.0%	0.0%	100.0%	0.0%	0.0%	473
	2008	3.5%	92.5%	4.0%	0.0%	0.0%	549
	2009	0.0%	91.2%	2.9%	5.8%	0.0%	137
	N Fish	19	633	1,202	16	32	1,901
Longline		0.0%	0.0%	100.0%	0.0%	0.0%	545

Table 3.5.1. Reported golden tilefish, blueline tilefish, and yellowedge grouper total commercial fishing effort by year and gear fished in the Gulf of Mexico. Effort is defined as: logline – hooks fished and vertical line – hook hours fished. No trips reported blueline tilefish landings prior to 1993.

Year	Golden Tilefish		Blueline Tilefish		Yellowedge Grouper	
	Logline	Vertical line	Logline	Vertical line	Long line	Vertical line
1990	20,650	1,040			791,035	99,370
1991	108,500	5,400			2,522,020	441,027
1992	1,075,000	64,866			2,098,220	482,698
1993	2,594,250	135,590	2,005,250	567,496	4,571,870	956,650
1994	6,932,075	162,965	4,693,875	898,625	9,424,561	1,307,637
1995	6,236,350	123,126	3,490,965	969,045	9,089,235	1,277,702
1996	4,110,850	116,560	1,517,430	852,144	6,006,520	1,103,339
1997	5,888,940	542,766	4,538,250	1,242,228	10,807,900	2,050,354
1998	4,916,652	237,388	3,943,072	1,027,750	8,833,422	1,726,876
1999	5,673,450	430,605	3,006,200	843,317	10,646,450	1,898,750
2000	7,456,880	259,038	4,576,300	1,313,126	11,349,830	2,022,895
2001	5,922,225	164,764	3,551,050	1,028,506	9,779,535	1,918,324
2002	4,629,702	265,156	2,278,300	867,862	6,907,956	2,235,470
2003	6,613,000	312,199	3,536,280	771,210	11,584,630	2,177,766
2004	5,711,598	354,598	3,059,200	524,475	8,210,618	1,215,133
2005	4,583,876	285,094	1,903,716	417,132	6,177,386	945,872
2006	3,504,900	81,999	2,748,150	407,758	6,688,896	650,908
2007	3,339,650	191,992	2,076,950	347,626	6,977,050	784,539
2008	3,484,770	204,106	2,253,800	308,538	5,175,470	554,300
2009	2,866,200	173,140	1,854,650	299,472	5,202,350	804,327

Table 3.5.2. Total effort by year in the Gulf of Mexico reported to the coastal logbook program. Effort is defined as: logline – hooks fished and vertical line – hook hours fished.

Year	Long line	Vertical line
1990	2,860,561	523,538
1991	7,540,045	1,672,538
1992	6,534,972	1,854,139
1993	20,672,475	3,647,862
1994	25,182,372	4,264,703
1995	23,207,479	5,120,010
1996	19,824,375	4,578,622
1997	29,199,055	7,011,492
1998	27,203,196	6,717,985
1999	33,491,739	7,658,254
2000	28,375,357	7,396,677
2001	27,302,818	7,388,187
2002	22,980,633	7,606,856
2003	28,149,288	7,865,746
2004	26,832,283	6,536,835
2005	21,676,581	5,587,754
2006	24,766,701	5,262,599
2007	19,868,725	5,745,021
2008	17,834,960	5,008,894
2009	9,294,394	5,839,076

3.10. *FIGURES*

Figure 3.1.1. Historical Major Long line Fishing Grounds (Prytherch 1982).

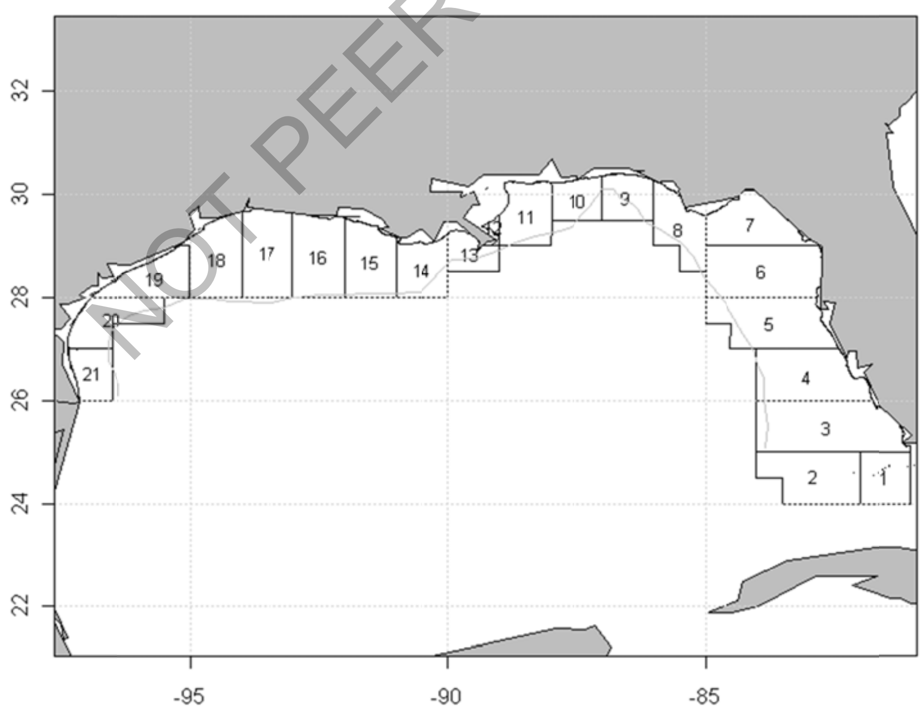


Figure 3.1.2. Statistical fishing or 'statareas' 1-21 in the Gulf of Mexico ranging from about Key West, FL in the Southeast to the Texas US/Mexican border in the Western Gulf.

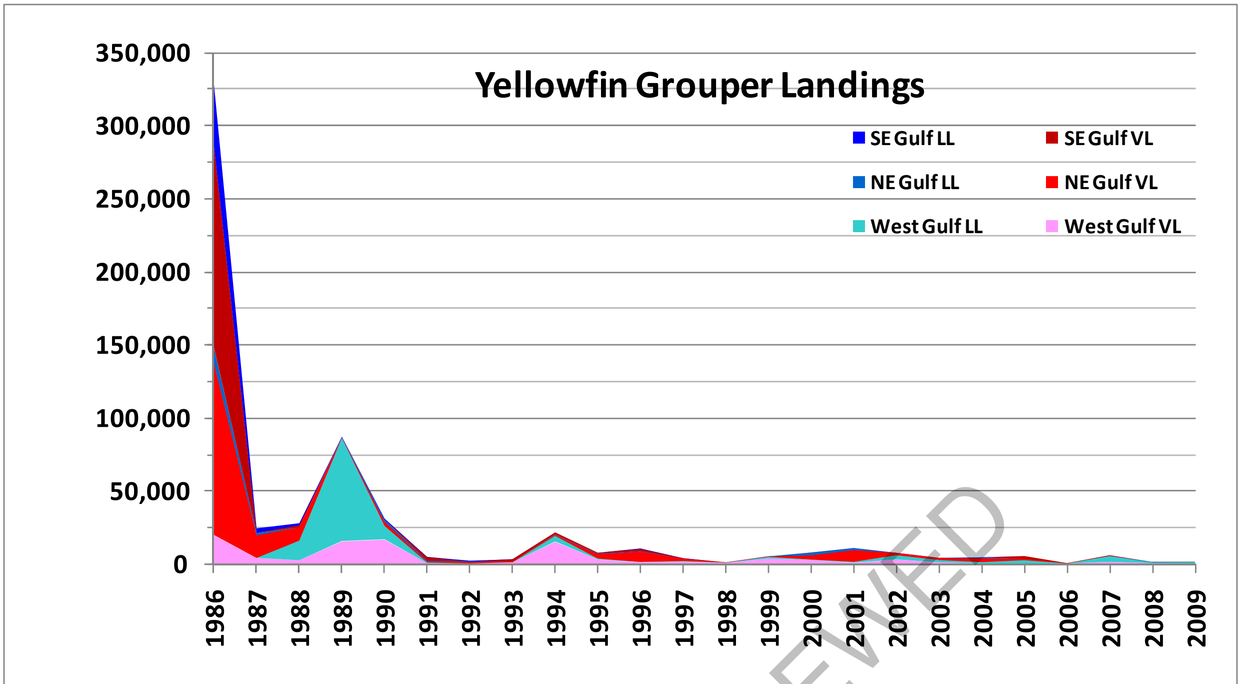
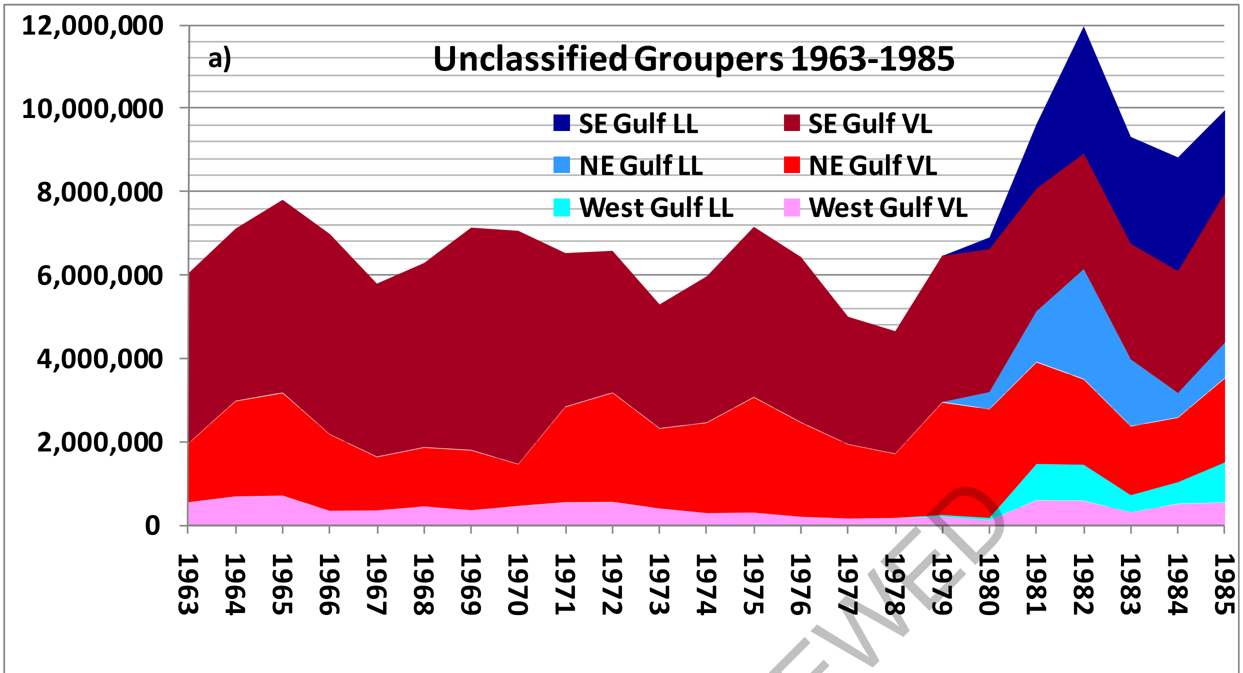


Figure 3.3.1. Preliminary commercial landings of Yellowfin grouper from the Gulf of Mexico management regions by geographical fishing area and gear type.SE=Southeastern Gulf Statareas 1-5; NE=Northeastern Gulf (statareas 6-12); W=Western Gulf (statareas 13-21).



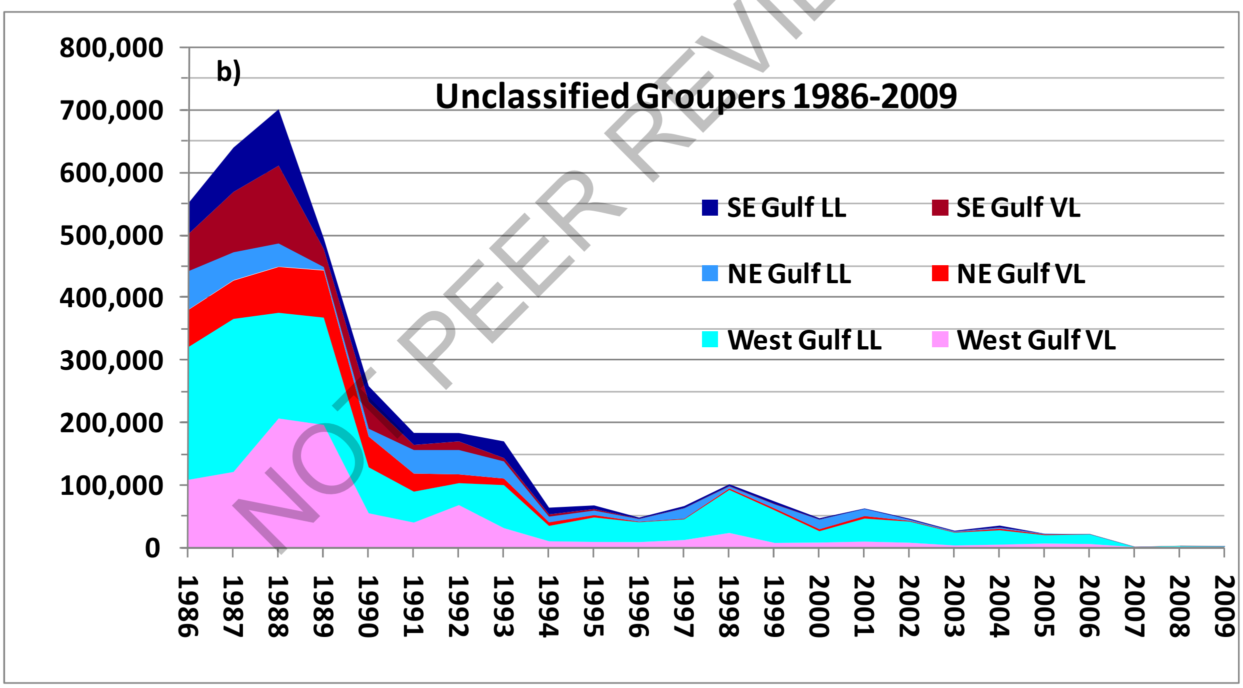


Figure 3.3.2. Commercial landings of unclassified groupers from the Gulf of Mexico management region by geographical fishing area and gear type.

a) 1963 – 1985 before the grouper classification requirement comes in effect in 1986
b) 1986 - 2009 after the grouper classification requirement comes in effect in 1986

SE=Southeastern Gulf Statareas 1-5; NE=Northeastern Gulf (statareas 6-12); W=Western Gulf (statareas 13-21) LL = long line, and VL = Vertical Line (hand and electric or bandit combined)

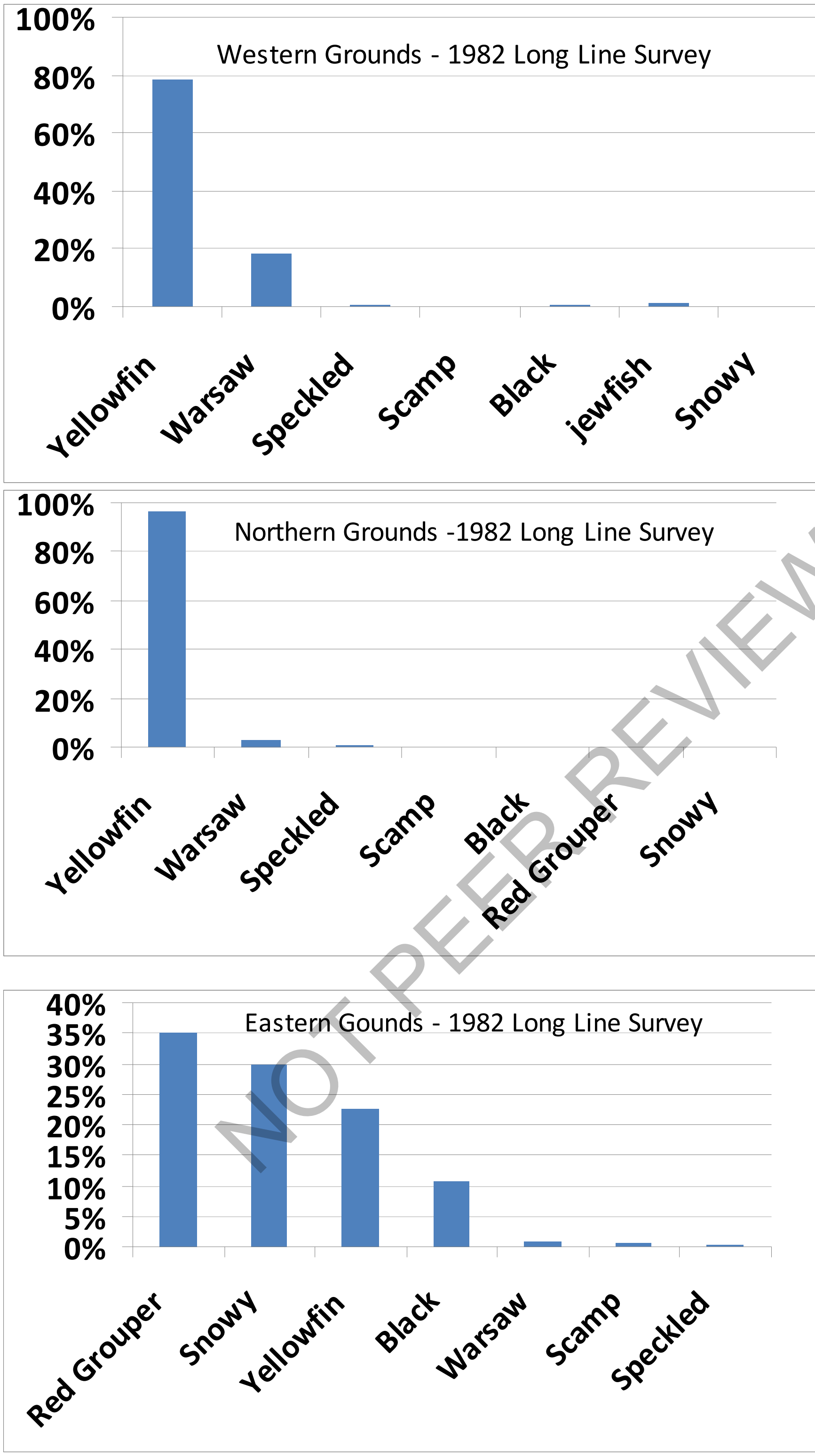


Figure 3.3.3. Percent species composition of grouper commercial long line fishery landings in 1982 for three different geographical fishing areas in the Gulf of Mexico after report by Prytherch (1983), see areas in Figure 3.3.1

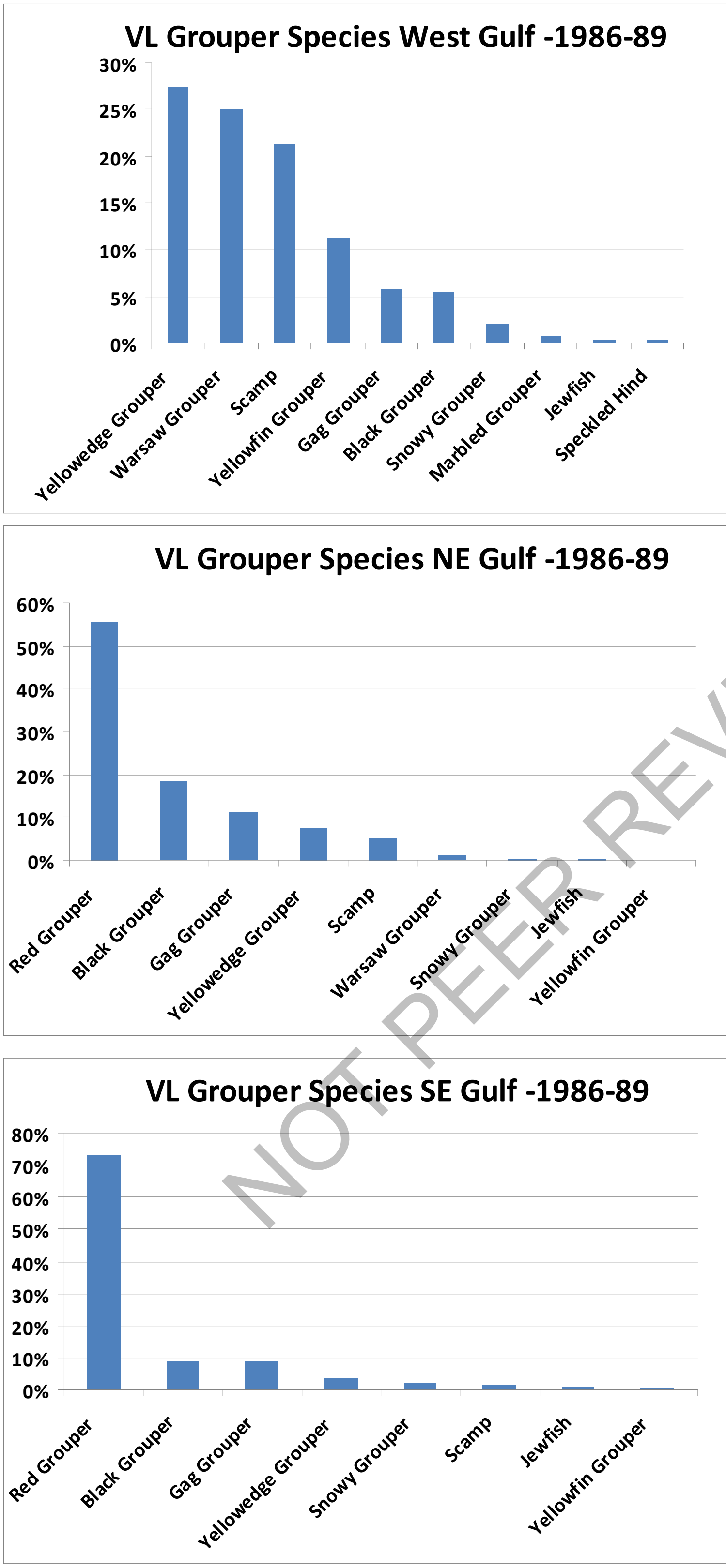


Figure 3.3.4. Percent species composition of grouper commercial vertical line landings from 1986 to 1989 for three different geographical fishing areas in the Gulf of Mexico. Note different axes between panels.

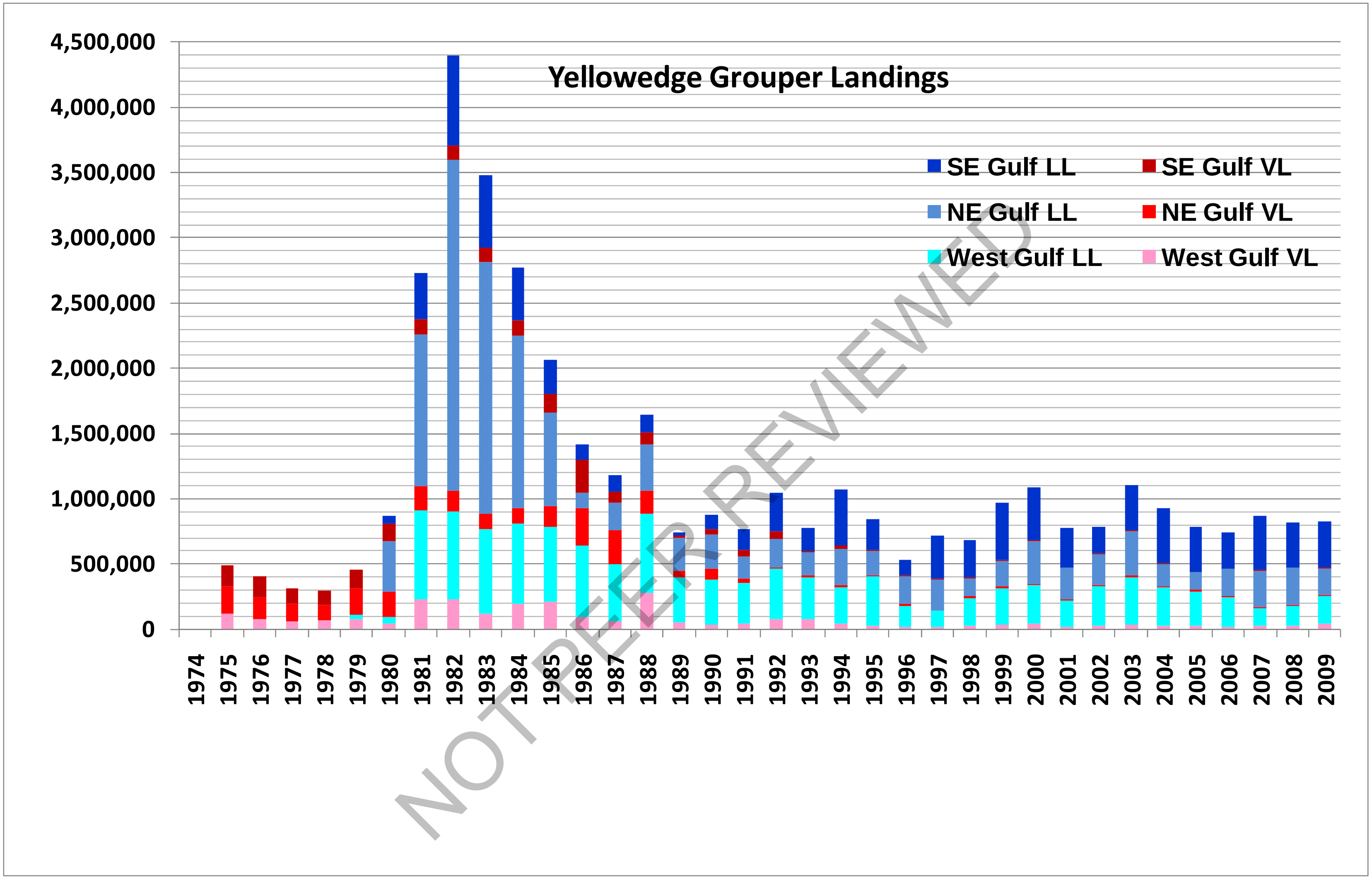


Figure 3.3.5. Updated calculated yellowedge grouper landings 1974-2009 (in lbs gutted wt) for three geographical fishing areas, including mislabeled Yellowfin landing 1975-1990 and unclassified grouper landings from 1979 onwards for the LL fishery and 1975 onwards for VL fishery. Analysis of grouper species compositions prior to 1986 for the LL fishery are shown in Table 3.3.3. and Figure 3.3.3 and for the VL fishery in Table 3.3.5. and Figure3.3.4.

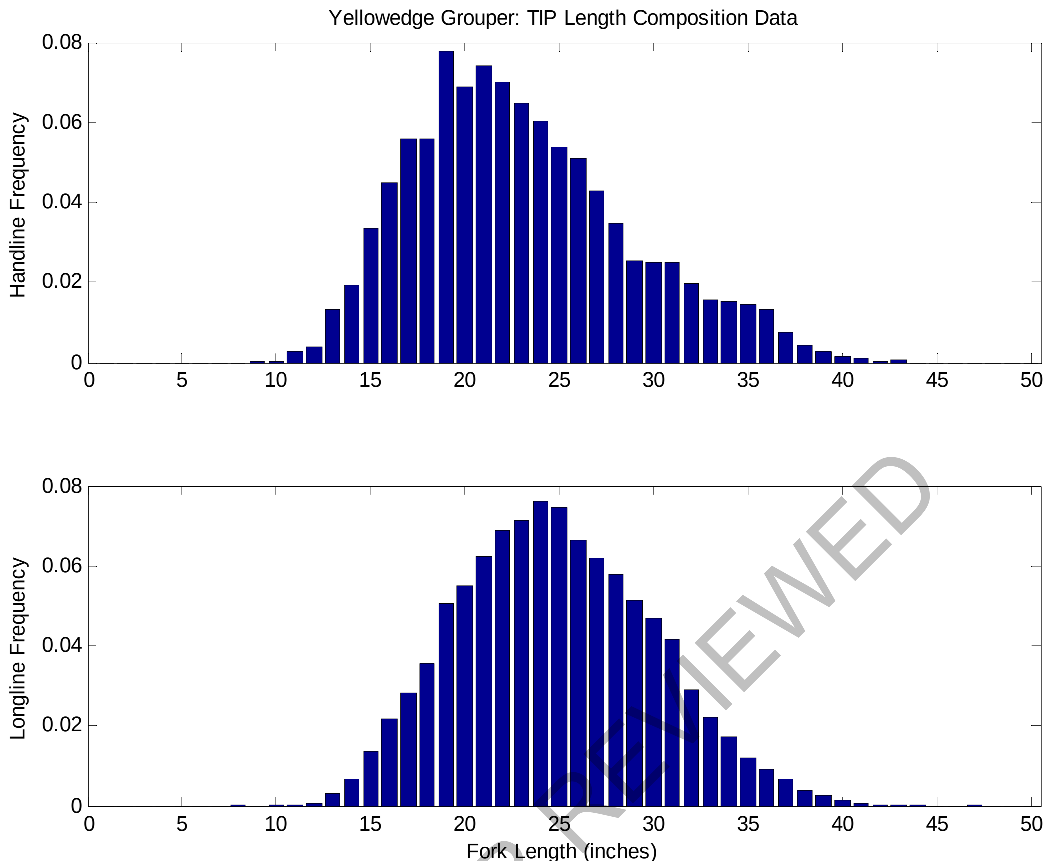


Figure 3.6.1. – Length frequency distributions for the yellowedge grouper handline (top panel) and longline (bottom panel) Trip Intercept Program data. There were 8,101 length observations from the handline fishery and 44,063 observations from the longline fishery.

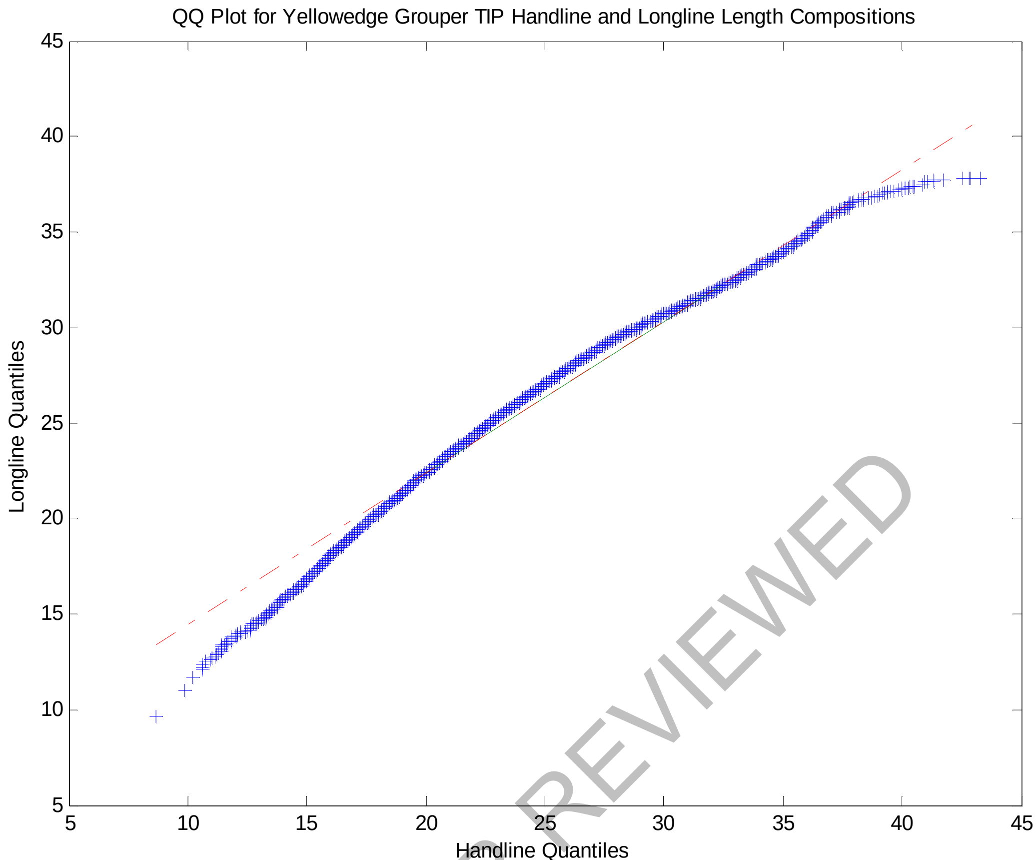


Figure 3.6.2. – Quantile-Quantile plot for the yellowedge grouper handline and long line length data measured by the Trip Intercept Program. This plot demonstrates deviations between the handline and longline length frequency distributions. Data drawn from identical distributions would fall along the red dotted line.

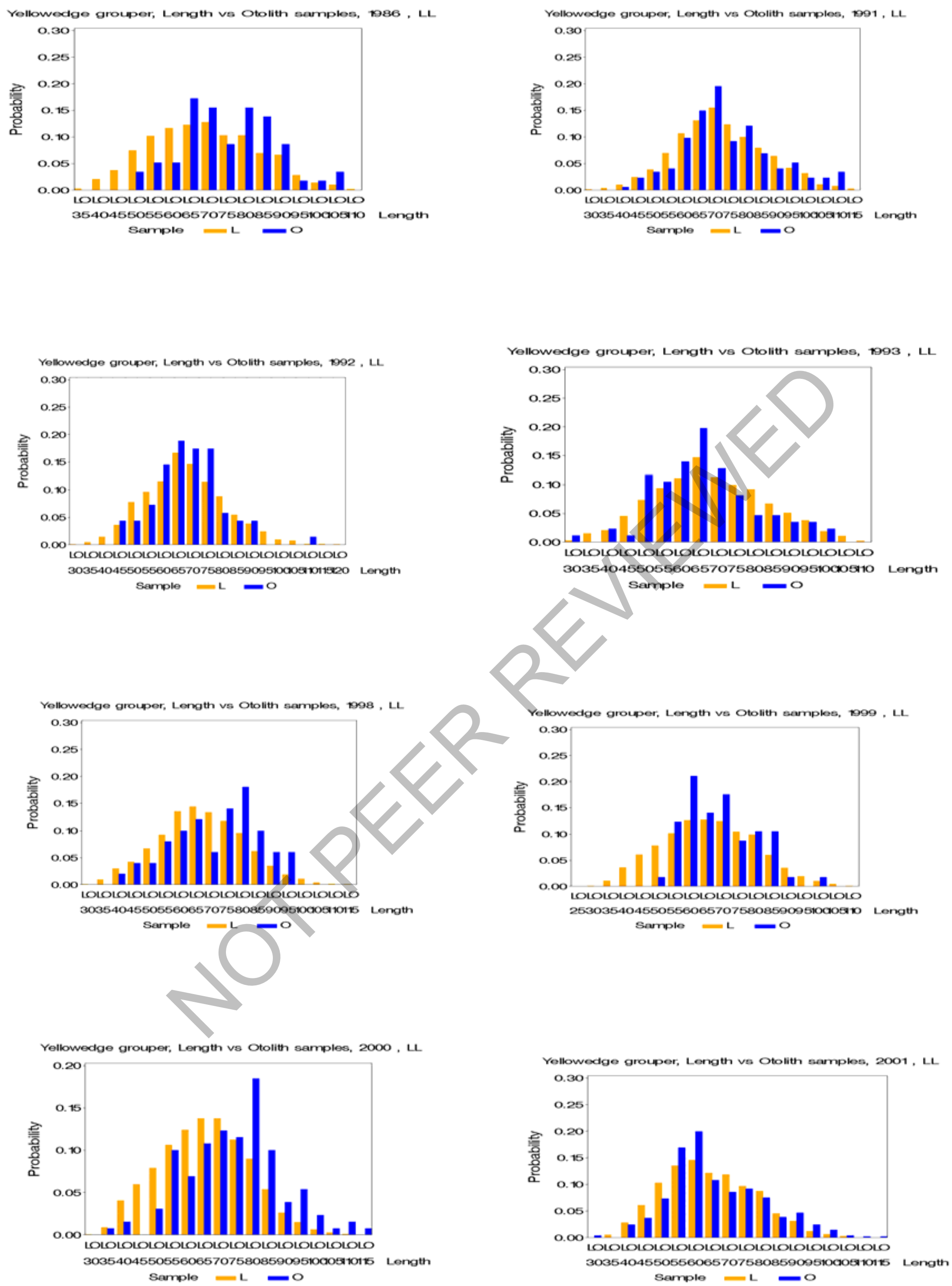


Figure 3.6.3. - Comparisons of yellowedge grouper length frequency distributions from TIP length and otolith samples from 1986- 2009. Orange bars indicate data derived from length samples, blue bars indicate data derived from otolith samples. Lengths (x-axis) are given in centimeters (cont'd next page.)

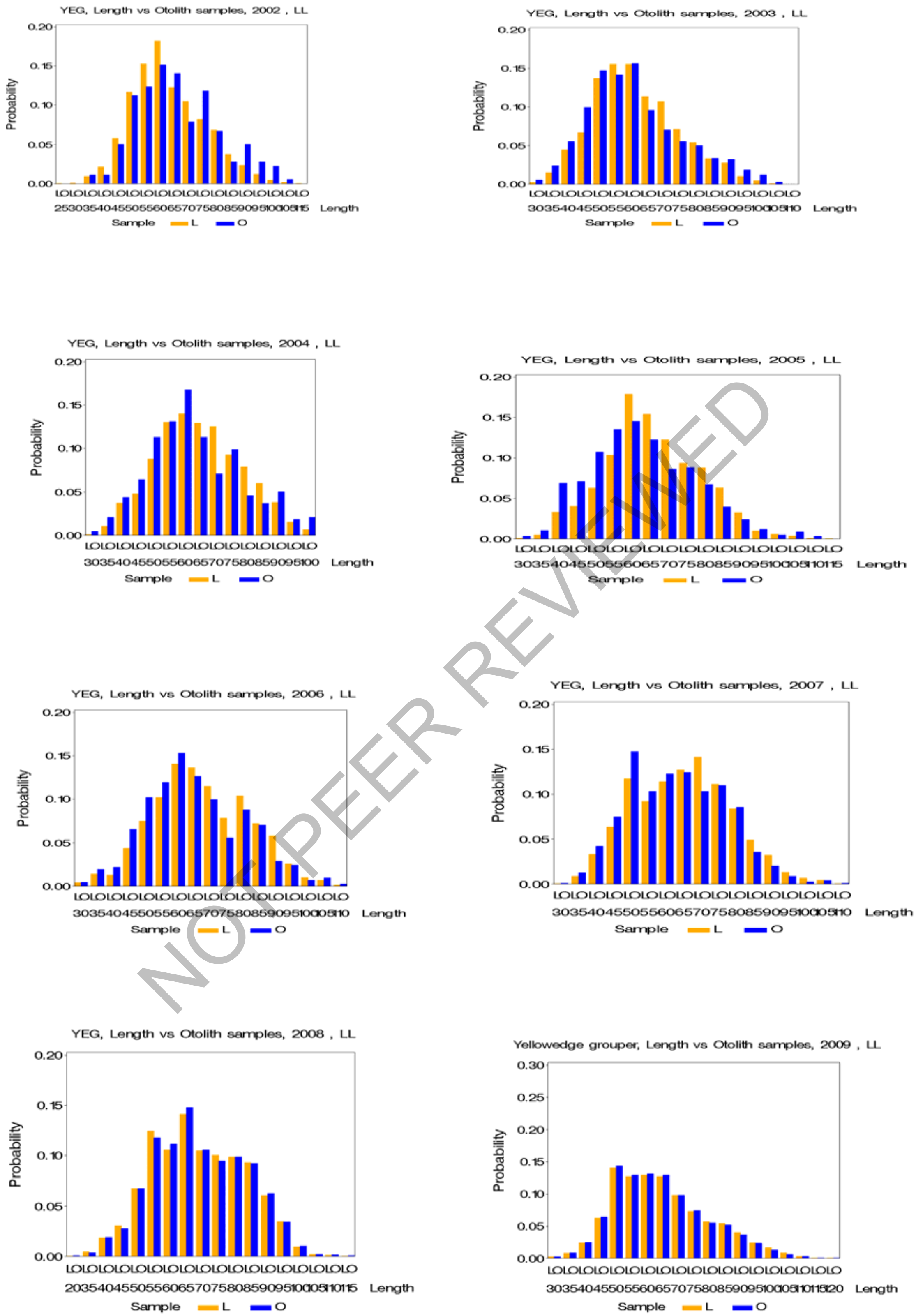


Figure 3.6.3. – Cont'd

4. RECREATIONAL FISHERY STATISTICS

4.1. *OVERVIEW*

The recreational landings for Yellowedge grouper in the Gulf of Mexico are small in comparison to landings in the commercial sector and for this reason the recreational and commercial landings groups were merged. The group membership is given in section 3.1.The primary issue with estimates of recreational landings of Yellowedge grouper are the validity of data for several years in which landings were abnormally high. This will be addressed below.

4.1.1. Group membership

Refik Orhun (Group Leader) ....NMFS-Miami
Steve Turner..NMFS-Miami
Kevin McCarthy..NMFS-Miami
John Quinlan ....NMFS-Miami
Bob Spaeth..Commercial Fisheries
Martin Fisher..Commercial Fisheries
Brad Kenyon..Recreational Fisheries
Linda Lombardi..NMFS-Panama City
Gary Fitzhugh..NMFS-Panama City
Debbie Fable..NMFS-Pascagoula
Charlie Bergmann..NMFS-Pascagoula
Melissa Cook..NMFS-Pascagoula
Richard Fulford..SSC - Univ. of Mississippi
Harry Blanchet..Louisiana Sea Grant
Yong Chen……………..CIE Reviewer - Univ. of Maine

4.2. *REVIEW OF WORKING PAPERS*

Two working papers were provided to the working group (DW-15 and 16).The first summarized estimates of recreational landings since 1982 based on three surveys: The MRFSS survey, the NMFS Headboat survey (HBT), and the Texas Parks and Wildlife Department recreational harvest survey. Data were given as number of fish landed per year estimated for each region or sector. The second working paper summarized an approach for filling in missing weight data when it was not provided as a part of the catch estimates.

4.3. *RECREATIONAL LANDINGS*

Recreational landings of were sporadic and low as reported in the three recreational surveys; typically less than 5,000 lbs in all years except 1982 and 2005.The data as originally presented in DW-15 reported landings of over 16,000 fish in 1982 and over 5,000 fish in 2005.It was the consensus of the data workshop panel, particularly members from the fishing community that estimates for these years were overestimates most likely due to misallocation of catch from the Atlantic side of Florida that was landed in Monroe Co. The group recommended that the recreational catch data be recalculated after all intercept and effort data for Monroe Co., Fl was removed. Recalculated, recreational landings in number of fish and weight are shown in Tables 4.3.1.

4.4. *RECREATIONAL DISCARDS*

Recreational discards were reported only for the MRFSS survey and were given by year in DW-15.It was the consensus of the Data workshop panel that these data be recalculated as described in section 4.3. Recreational discards for yellowedge grouper from 1982 to 2009 are shown in Table 4.3.2.

4.5. *BIOLOGICAL SAMPLING*

Due to very low amount of recreational landings and its accordingly very low impact on the stock assessment process, biological sampling was not considered in the data workshop.

4.6. *RECREATIONAL CATCH-AT-AGE/LENGTH*

Due to very low amount of recreational landings and its accordingly very low impact on the stock assessment process, sampling of recreational catch-at-age/length was not considered in the data workshop.

Directed and discard –.The removal of data for Monroe Co., FL did not completely eliminate the anomalous landings data for 1982 and 1987.Discussion regarding the overall validity of existing surveys (particularly MRFSS) for providing estimates of recreational catch led the group to recommend that estimates of recreational landings by year be based on …….

4.7. RECREATIONAL EFFORT

Estimates of recreational effort were not provided to the working group but they were included in the conversion of recreational survey data to total catch. There were some questions regard the effort data used to make this conversion as Yellowedge grouper are not a commonly targeted species for recreational anglers due to depth and distance from shore. No recommendations were made by the working group regarding the estimation of recreational effort for Yellowedge grouper.

4.8. COMMENTS ON THE ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Members of the working group expressed concern regarding the validity of the estimates for 1982 and 2005.The overall reliability of the recreational data is not known as the nature of the effort calculation was not described. The consensus of the group was that recreational landings for yellowedge grouper are small in comparison to commercial landings and should not therefore overly influence the assessment. For this reason, summary estimates of landings across years are being considered for generating a final estimate of total landings for the assessment model. Given that the total commercial landings in 1982 (~4 million lbs) appear to be far greater than the recreational landings, it is likely that including these numbers will have little effect upon the assessment.

4.9. LITERATURE CITED

Prytherch, H.F. (1983). A descriptive survey of the bottom long line fishery in the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-122. 33p.

4.10. TABLES

Table 4.3.1. Recreational Landings of yellowedge grouper from 1982 to 2009 collected by three data sampling survey sources, Headboat, MRFSS and Texas Parks and Wildlife (TPWD). Landings exclude Monroe County and are in numbers of fish and lbs gutted weight.

Year	Headboat (#)	MRFSS (#)	TWPD (#)	Headboat (lb)	MRFSS (lb)	TWPD (lb)
1982		13,146			130,570	
1984			21			209
1986	121		44	457		437
1987	497			1,103		
1988	949			2,178		

1989	325	1,668		734	16,570	
1990	599			1,643		
1991	364	0		1,331	0	
1992	130			489		
1993	84	311		333	3,090	
1994	57	0		423	0	
1995	101			605		
1996	26	0		180	0	
1997	73	92		369	1,226	
1998	63	346		445	7,483	
1999	6	125		53	624	
2000	6			37		
2001	6	222		50	1,373	
2002	4	415		29	3,808	
2003	11	32		91	299	
2004	10	126		69	1,143	
2005	32	6,160		142	56,460	
2006	21	223		207	2,568	
2007	43	25		202	250	
2008	43	62		202	613	
2009		567			4,944	

Table 4.3.2. Recreational discards of yellowedge grouper from 1982 to 2009 collected by three data sampling survey sources, Headboat, MRFSS, and Texas Parks and Wildlife (TPWD). Landings exclude Monroe County and are in numbers of fish.

Year	Headboat (#)	MRFSS (#)	TWPD (#)
1982		0	
1984			
1986			
1987			
1988			
1989		0	
1990			
1991		11,139	
1992			
1993		0	
1994		322	
1995			
1996		876	
1997		1,144	
1998		0	

1999		219	
2000			
2001		0	
2002		0	
2003		0	
2004		0	
2005		0	
2006		0	
2007		0	
2008		0	
2009		0	

5. MEASURES OF POPULATION ABUNDANCE

5.1. *OVERVIEW*

Several indices of abundance were considered for use in the assessment model. These indices came from both fishery independent and dependent data sources. The DW recommended the use of three fishery independent indices (two from NOAA Fisheries SEAMAP groundfish survey and NOAA Fisheries bottom longline survey) and one fishery dependent indices (commercial logbook data).

5.1.1. Group Membership

Membership of this DW working group included Neil Baertlein, Walter Ingram (leader), Kevin McCarthy, Adam Pollack, John Walter and Elbert Whorton, with assistance from Melissa Cook and Linda Lombardi.

5.2. *REVIEW OF WORKING PAPERS*

The working group reviewed a three working papers and reference documents describing index construction, including:

SEDAR22-DW-02 (Commercial logbook)
SEDAR22-DW-06 (NOAA Fisheries groundfish)
SEDAR22-DW-07 (NOAA Fisheries bottom longline)

Several improvements to analyses were identified. In some cases these modifications are described in appendices to original working documents; otherwise, they are reported here. We refer the reader to the original working documents for further details on exploratory data analysis, technical analysis, and diagnostics.

5.3. *FISHERY INDEPENDENT INDICES*

5.3.1. NOAA Fisheries SEAMAP Groundfish Survey (SEDAR22-DW-06)

5.3.1.1 General Description

The National Oceanic and Atmospheric Administration (NOAA) Fisheries has been conducting groundfish surveys in the northern Gulf of Mexico since fall, 1972 (Nichols and Pellegrin 1989). Initially the survey (Fall Groundfish Survey) was centered in the north-central Gulf of Mexico (Atchafalaya Bay, Louisiana to Mobile Bay, Alabama) and was designed to address a decline in finfish stocks that supported the pet food industry. Starting in 1981, a Summer Groundfish Survey was added to investigate brown shrimp stocks in the northern Gulf of Mexico. Even though the two surveys employed the same gear, a 40 foot shrimp trawl, they employed slightly differing sampling protocols in order to address specific requirements for their respective study. Beginning in 1987, a standardized SEAMAP protocol was used for both surveys to ensure compatibility of the data. This survey was conducted as a component of the Southeast Area Monitoring and Assessment Program (SEAMAP) (Rester *et al.* 2002).

5.3.1.2. Issues Discussed at the DW

Issue 1: Years to Include in Final Model

The groundfish survey has not always covered the current sampling area of Brownsville, TX to Mobile Bay, AL. During the early years of the groundfish survey (1972-1980), sampling was concentrated in the north central Gulf of Mexico (shrimp statistical zones 11-15). It was not until later years (1982-present) that the survey was expanded to cover most of the northern Gulf of Mexico (shrimp statistical zones 11-21). During the early years of the expanded survey, coverage was spotty (see SEDAR22-DW-06 Appendix). In 1987, a change in survey design was implemented and coverage became more consistent between shrimp statistical zones. The problem was there were large gaps in data for the early years forcing the models to try to fill in these gaps.

Option 1: Use data from 1972-2008 to model abundance for entire coverage area
Option 2: Use data from 1987-2008 to model abundance for entire coverage area
Option 3: Use data from 1972-2008, but only from shrimp statistical zones 11-15
Option 4: Use data from 1982-2008, but only from shrimp statistical zones 16-21

Decision: Both Option 2 and Option 3 because this survey represents an index value that is heavily centered on subadult yellowedge grouper. Option 3 allows for use of an index that may be representative of a virgin stock (major fishery started in the late 1970s) and has full coverage of the given area throughout the time series. Option 2 because it represents a subadult index that covers most of the northern Gulf of Mexico.

Miscellaneous Decisions

- The DW acknowledged that based on the length frequency distribution and age distribution (see SEDAR22-DW-06) that these indices do represent the subadult yellowedge grouper.
- The DW acknowledged that there may be some underlying cause that is behind the erratic changes in abundance in the early years when compared to later years of the survey.

5.3.1.3. Analysis Methods

Available catch per unit effort (CPUE) data from NOAA Fisheries SEAMAP groundfish survey from 1972-2008 was used to develop indices of abundance for subadult yellowedge grouper. Standardized indices of abundance were constructed using a delta lognormal modeling approach (Lo *et al.* 1992). Seven factors were considered for inclusion in the binomial submodel that models the proportion of stations where a yellowedge grouper were captured. These factors were year, depth zone, shrimp statistical zone, season, bottom type, time of day and fish time. All factors, except fish time, were included in the positive catch submodel which modeled effects on the number of yellowedge captured. A complete description of the methodology and results are presented in SEDAR22-DW-06.

5.3.1.4. Sampling Intensity

A map of survey coverage is provided in Figure 5.9.1. For annual maps of survey coverage, see SEDAR22-DW-06.

5.3.1.5. Size/Age Data

Length data for yellowedge grouper captured in NOAA Fisheries groundfish trawls are available from 1985-2008. This data indicates that most fish captured are subadults (>600 mm total length), with only a 4 individuals out of the 138 measured being larger than 600 mm. Age data is available for yellowedge grouper captured from 2000-2008 with most fish at age 1 and the majority falling between ages 1 and 4.

5.3.1.6. Catch Rates and Measures of Precision

Catch rates (CPUE) are presented in number of fish per trawl-hour and have been standardized as aforementioned in Analysis Methods. Measures of precision are presented as coefficients of variation (CV). The standardized and nominal CPUE as well as the CV are presented in Tables 5.8.1 and 5.8.2.

5.3.1.7 Comments on Adequacy for Assessment

The DW recommended using the two models for the assessment. The short time series (1987-2008) should be used as a base run and the longer (1972-2008) centralized model should be used as a sensitivity run. These decisions will allow for the use of the full time series and account for some of the survey design changes implemented throughout the time frame of the groundfish survey.

5.3.2 NOAA Fisheries Bottom Longline Survey (SEDAR22-DW-07)

5.3.2.1 General Description

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories has conducted standardized bottom longline surveys in the Gulf of Mexico, Caribbean, and Western North Atlantic since 1995. The objective of these surveys is to provide fisheries independent data for stock assessment purposes for as many species as possible. These surveys are conducted annually in U.S. waters of the Gulf of Mexico (GOM) and/or the Atlantic Ocean, and they provide an important source of fisheries independent information on large coastal sharks, snappers and groupers from the GOM and Atlantic.

5.3.2.2 Analysis Methods & Issues Discussed at the DW

For the SEDAR 22, we used the time series of data between 2000 and 2009 to develop abundance indices for yellowedge grouper. Due to the effects of Hurricane Katrina on the distribution of effort, the 2005 survey was dropped. Only data from stations within the depth range of capture for yellowedge grouper (i.e. 70 – 365 m) were used in development of annual indices for this species. Standardized indices of abundance, based on CPUE (number of yellowedge grouper per 100 hook hours) were constructed using a delta lognormal modeling approach (Lo *et al.* 1992). Initially, three factors were considered for inclusion in the binomial and lognormal submodels: water depth, survey area (three demarcations in the GOM: Eastern Gulf (east of 88^o west longitude); Central Gulf (between 88^o and 93^o west longitude); and Western Gulf (west of 93^o west longitude) and year. A backward selection procedure was used to determine which variables were to be included into each submodel based on type 3 analyses with a level of significance for inclusion of $\alpha = 0.05$. If year was not significant then it was forced into each submodel in order to estimate least-squares means for each year. The findings of this initial model run are described in SEDAR22-DW-07.

During the workshop I was asked to incorporate sediment data into the delta-lognormal model. This data is summarized by Rester (2009). The variables included for testing, along with those listed above, were the amounts of mud, clay, and carbonate in core samples taken nearest to the station location and the linear critical sheer stress and sorting factor of the sediment in said core sample. Modeling methods were conducted as described above. The findings of this second model run are described in Addendum 1 of SEDAR22-DW-07.

Finally, during the data workshop, I was also asked by the stock assessment scientist to develop indices for three areas of the Gulf. These areas were based on the NMFS shrimp statistical zones, employed in many fishery independent survey designs: southwest Florida (SWFLA), zones 2-5;

northwest Florida (NWFLA), zones 6-11; and the western Gulf (WEST), zones 13-21. This area variable and a variable denoting the interaction of this area and year were forced into the models developed for each species in Addendum 1 of SEDAR22-DW-07. The Table 5.8.3 and Figure 5.9.3 summarize these area-specific abundance indices and summaries of Type 3 tests for model inclusion.

5.3.2.3. Sampling Intensity

The positions of all stations, within the depth range yellowedge grouper were collected (i.e. 70 – 365 m), and positions of stations where yellowedge grouper were captured were plotted for all survey years combined (Figure 5.9.4). Survey coverage area varied during the time series due to weather or mechanical problems. For annual maps of survey coverage, see SEDAR22-DW-07.

5.3.2.4 Size/Age Data

Length data was collected on specimens throughout the time series whenever possible. Yellowedge grouper range from 300 to 1250 mm total length, with an average total length of 707 mm.

5.3.2.5 Catch Rates and Measures of Precision

Catch rates (CPUE) are presented as number of yellowedge grouper per 100 hook hours and have been standardized as aforementioned in Analysis Methods. Measures of precision are presented as coefficients of variation (CV). The standardized and nominal CPUE as well as the CV are presented in Table 5.8.3.

5.3.2.6 Comments on Adequacy for Assessment

The workshop group recommends using this index for the assessment.

5.4. *FISHERY DEPENDENT INDICES*

5.4.1 Commercial Logbook (Longline) (SEDAR22-DW-02)

5.4.1.1 General Description & Issues Discussed at the DW

Using the Southeast Fisheries Science Center's Coastal Fisheries Logbook Program (CFLP) available commercial longline data, an index of abundance was created for yellowedge grouper in the Gulf of Mexico. An initial index of abundance was created (SEDAR22-DW-02), however during the data workshop it was recommended that the unusually high amount of yellowfin grouper (*Mycteroperca venenosa)* landings be reclassified as yellowedge grouper. That decision was based upon consultation with the panel's fishermen and other members. The results below are from the yellowedge-yellowfin landing adjustment dataset and are fully described in the SEDAR22-DW-02 Addendum.

5.4.1.2 Analysis Methods & Sampling Intensity

For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear specific fishing effort, species caught and weight of the landings. Fishing effort data available for longline included number of sets and number of hooks fished per set. Clear outliers in the data, i.e. effort values falling outside the 99.5 percentile of the data, were also excluded from the analyses. Data were further restricted to include only those trips with landings and effort data received by the CFLP within 45 days of the completion of the trip.

Yellowedge grouper trips were identified using a data subsetting technique (modified from Stephens and MacCall, 2004) intended to restrict the data set to trips with fishing effort in yellowedge grouper habitat. Targeted trips were identified independently for the eastern Gulf of Mexico (statistical areas 2-7) and the western Gulf (statistical areas 8-21). Figure 5.9.5A and 5.9.5B provide species-specific regression coefficients. The magnitude of the coefficients indicates the predictive impact of each species.

CPUE was defined as gutted pounds of yellowedge grouper per hook. The effects of area, days at sea, distance between hooks, number of crew, season, total hooks fished, and longline length were tested. The delta lognormal model approach (Lo et al. 1992) was used to construct a standardized index of abundance. This method combines separate general linear model (GLM) analyses of the proportion of successful trips (trips that landed yellowedge grouper) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing

YEAR which were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

5.4.1.3 Results & Discussion

The final models for the binomial on proportion positive trips (PPT) and the lognormal on CPUE of successful trips were:

PPT = Area + Days at sea + Year

LOG(CPUE) = Area + Distance between Hooks + Year + Year*Area

The linear regression statistics and analysis of the mixed model formulations of the final models are summarized in the addendum to SEDAR22-DW-02. Plots of annual trends for proportion positive trips and nominal CPUE, as well as diagnostic plots for the binomial and lognormal components of the analyses, can also be found in the SEDAR22-DW-02 addendum.

Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Table 5.8.4 for the vertical line model. The delta-lognormal abundance index developed, with 95% confidence intervals, is shown in Figure 5.9.6

5.4.1.4 Comments on Adequacy for Assessment

The workshop group recommends using this index for the assessment.

5.5. *CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS*

The workshop group recommends using the indices described above as inputs into the assessment model. Figure 1.5 illustrates linear coverage of specific abundance indices along the coast of the Gulf of Mexico.

5.6. *ITEMIZED LIST OF TASKS FOR COMPLETION FOLLOWING WORKSHOP*

The group was tasked with developing an extended time series for yellowedge grouper, which included data from historic exploratory fishing surveys conducted by NMFS, the current NOAA

Fisheries bottom longline (SEDAR22-DW-07), and current observer data from the commercial bottom longline fishery.

The tasks to be completed for all fisheries dependent bottom longline indices are as follows:
1.) Define all yellowfin grouper landings as yellowedge grouper except for when both species were reported on a trip.
2.) Rerun Stevens-McCall data subsetting procedure after completion #1.

3.) Construct 3 separate indices for yellowedge grouper for three regions in the Gulf of Mexico (areas 2-5, 6-11, & 13-21).

The results of these tasks will be submitted as documents for the upcoming Assessment Workshop.

5.7. *LITERATURE CITED*

Lo, N.C.H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. *Canadian Journal of Fisheries and Aquatic Science* 49:2515-2526.

Nichols S. and G.J. Pellegrin, Jr. 1989. Trends in catch per unit effort for 157 taxa caught in the Gulf of Mexico fall groundfish survey 1972 to 1988. National Marine Fisheries Service, Southeast Fisheries Center, Pascagoula, Mississippi.

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Rester, J.K., D. Hanisko, N. Sanders, Jr. and B. Pellegrin. 2002. SEAMAP Environmental and Biological Atlas of the Gulf of Mexico, 2000. Gulf States Marine Fisheries Commission. Ocean Springs, MS. Number 101. 264pp.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70:299-310.

5.8. *TABLES*

Table 5.8.1: Indices of yellowedge grouper developed using the delta-lognormal model for 1987-2008. The nominal CPUE, nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Nominal CPUE	Frequency	N	DL Index	Scaled Index	CV	LCL	UCL
1987	0.00000	0.00000	76	0.00000	0.00000			
1988	0.01854	0.02041	98	0.01613	0.28347	2.37249	0.01811	4.43667
1989	0.00439	0.01149	87	0.01029	0.18089	4.01535	0.00622	5.26367
1990	0.08619	0.04000	100	0.07165	1.25953	0.96890	0.24744	6.41133
1991	0.06488	0.03636	110	0.05424	0.95344	1.11989	0.15712	5.78579
1992	0.07283	0.03670	109	0.03806	0.66896	1.20086	0.10108	4.42722
1993	0.03750	0.04902	102	0.03718	0.65360	1.12655	0.10692	3.99541
1994	0.07402	0.03636	110	0.06173	1.08509	1.02027	0.20037	5.87635
1995	0.02923	0.02041	98	0.03386	0.59525	1.75882	0.05540	6.39541
1996	0.27642	0.09615	104	0.11453	2.01325	0.58552	0.67969	5.96330
1997	0.09401	0.04082	98	0.04334	0.76190	1.17310	0.11853	4.89735
1998	0.04287	0.01923	104	0.02201	0.38698	2.10338	0.02872	5.21363
1999	0.02171	0.02752	109	0.01140	0.20037	2.28525	0.01341	2.99402
2000	0.09021	0.06186	97	0.04937	0.86788	0.96439	0.17145	4.39333
2001	0.07693	0.05952	84	0.03451	0.60668	1.17456	0.09424	3.90568
2002	0.11284	0.08491	106	0.11324	1.99055	0.59606	0.66078	5.99641
2003	0.11381	0.09474	95	0.09128	1.60458	0.65687	0.48434	5.31592
2004	0.12907	0.10753	93	0.08996	1.58142	0.62053	0.50502	4.95203
2005	0.15433	0.08537	82	0.07370	1.29548	0.76691	0.33242	5.04872
2006	0.21166	0.07368	95	0.10546	1.85382	0.67683	0.54282	6.33103
2007	0.12122	0.06250	80	0.05903	1.03761	0.95042	0.20855	5.16238
2008	0.12627	0.06024	166	0.06367	1.11925	0.68497	0.32373	3.86963

Table 5.8.2: Indices of yellowedge grouper developed using a binomial model for 1972-2008. The nominal CPUE, nominal frequency of occurrence, the number of samples (*N*), the Index (frequency of occurrence), the indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV) are listed.

Survey Year	Nominal CPUE	Frequency	N	Index	Scaled Index	CV
1972	0.00000	0.00000	71	0.00000	0.00000	
1973	0.00000	0.00000	82	0.00000	0.00000	
1974	0.00971	0.00485	206	0.00621	0.20357	1.02076
1975	0.01667	0.00833	120	0.01255	0.41125	1.01737
1976	0.25600	0.04800	125	0.06727	2.20433	0.42036
1977	0.18182	0.03030	99	0.03658	1.19879	0.59099
1978	0.08602	0.01075	93	0.01430	0.46865	1.02146
1979	0.00000	0.00000	89	0.00000	0.00000	
1980	0.18182	0.05194	77	0.08534	2.79652	0.50322
1981	0.16071	0.06250	64	0.08521	2.79206	0.50076
1982	0.03571	0.01785	112	0.02642	0.86569	0.72286
1983	0.00000	0.00000	70	0.00000	0.00000	
1984	0.00000	0.00000	84	0.00000	0.00000	
1985	0.12155	0.03947	76	0.04383	1.43625	0.61785
1986	0.00000	0.00000	39	0.00000	0.00000	
1987	0.00000	0.00000	31	0.00000	0.00000	
1988	0.00000	0.00000	33	0.00000	0.00000	
1989	0.00000	0.00000	34	0.00000	0.00000	
1990	0.07908	0.02127	47	0.00836	0.27396	1.07260
1991	0.00000	0.00000	44	0.00000	0.00000	
1992	0.00000	0.00000	45	0.00000	0.00000	
1993	0.00906	0.02325	43	0.00919	0.30141	1.11295
1994	0.05050	0.02272	44	0.00934	0.30630	1.07189
1995	0.00000	0.00000	37	0.00000	0.00000	
1996	0.37330	0.09756	41	0.05472	1.79304	0.56820

1997	0.04762	0.02777	36	0.00816	0.26743	1.12227
1998	0.00000	0.00000	38	0.00000	0.00000	
1999	0.00000	0.00000	40	0.00000	0.00000	
2000	0.00000	0.00000	37	0.00000	0.00000	
2001	0.02052	0.02941	34	0.01203	0.39427	1.10039
2002	0.00000	0.00000	41	0.00000	0.00000	
2003	0.14694	0.09090	33	0.04573	1.49860	0.66044
2004	0.03563	0.02777	36	0.01173	0.38454	1.07021
2005	0.00000	0.00000	31	0.00000	0.00000	
2006	0.09183	0.02777	36	0.01229	0.40299	1.08513
2007	0.00000	0.00000	23	0.00000	0.00000	
2008	0.00000	0.00000	70	0.00000	0.00000	

Table 5.8.3: Area-specific abundance indices and summaries of Type 3 tests for model inclusion.

Table 5.8.3.a: *Type 3 Tests of Fixed Effects for the Binomial Submodel for Yellowedge Grouper*

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
YEAR	8	579	6.67	0.83	0.5724	0.5729
Area	2	579	0.44	0.22	0.8015	0.8016
sta_dpth	1	579	4.49	4.49	0.0340	0.0344
Carbonate	1	579	1.50	1.50	0.2204	0.2209
lCritShStrs	1	579	5.22	5.22	0.0223	0.0227
*YEAR*Area*	13	579	6.24	0.48	0.9371	0.9361

Table 5.8.3.b: *Type 3 Tests of Fixed Effects for the Lognormal Submodel for Yellowedge Grouper*

Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	8	121	1.25	0.2745
Area	2	121	0.75	0.4734
*YEAR*Area*	13	121	0.96	0.4976

Table 5.8.3.c: *Abundance Indices and Variability*

Survey Year	*Area*	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2000	NWFLA	0.28571	7	0.24922	0.51119	0.86261	0.11502	2.27188
2001	NWFLA	0.17241	29	0.22536	0.46225	0.56739	0.16070	1.32966
2002	NWFLA	0.33333	15	0.42259	0.86681	0.51609	0.32798	2.29090
2003	NWFLA	0.25000	28	0.50848	1.04299	0.45763	0.43604	2.49477
2004	NWFLA	0.19048	20	0.39862	0.81763	0.61117	0.26498	2.52286
2006	NWFLA	0.42857	7	1.15009	2.35903	0.64875	0.72100	7.71846
2007	NWFLA	0.21429	14	0.45707	0.93752	0.72390	0.25595	3.43401
2008	NWFLA	0.10000	10	0.21671	0.44451	1.24105	0.06445	3.06569
2009	NWFLA	0.37500	16	0.75411	1.54680	0.45852	0.64567	3.70562
2001	SWFLA	0.00000	19	0.00000	0.00000	.	.	.
2003	SWFLA	0.21875	32	0.76688	1.57299	0.46283	0.65172	3.79657
2004	SWFLA	0.16667	30	0.46950	0.96302	0.55196	0.34333	2.70126
2006	SWFLA	0.26316	19	0.41394	0.84906	0.54312	0.30713	2.34717
2007	SWFLA	0.31579	19	0.80989	1.66122	0.51044	0.63455	4.34896
2008	SWFLA	0.09091	11	0.30008	0.61551	1.24194	0.08917	4.24889
2009	SWFLA	0.25000	20	0.70607	1.44827	0.52878	0.53649	3.90965
2000	WEST	0.24242	66	0.42160	0.86478	0.30227	0.47871	1.56219
2001	WEST	0.26087	46	0.43616	0.89463	0.35504	0.44912	1.78207
2002	WEST	0.26471	68	0.45864	0.94076	0.28859	0.53433	1.65633
2003	WEST	0.25000	32	0.36234	0.74323	0.42124	0.33119	1.66790
2004	WEST	0.21875	32	0.39667	0.81364	0.49316	0.32001	2.06871
2006	WEST	0.27586	29	0.59795	1.22650	0.42760	0.54043	2.78354
2007	WEST	0.09091	22	0.31664	0.64949	0.90307	0.13861	3.04331
2008	WEST	0.20000	10	0.42392	0.86953	0.89709	0.18701	4.04301
2009	WEST	0.20588	34	0.43811	0.89865	0.46790	0.36908	2.18808

Table 5.8.4. Longline relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for yellowedge grouper (1992-2009) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1991	2.763221	116	0.922414	1.516128	0.984288	2.335337	0.218542
1992	1.562496	123	0.918699	1.449104	0.937928	2.238874	0.220112
1993	0.804279	174	0.867816	0.621648	0.389431	0.992335	0.237077
1994	0.812022	326	0.868098	0.912207	0.642000	1.296140	0.177003
1995	1.189826	344	0.848837	0.814693	0.563764	1.177309	0.185658
1996	0.701543	204	0.872549	0.668300	0.439352	1.016554	0.212045
1997	0.733037	367	0.901907	0.868919	0.625398	1.207265	0.165549
1998	0.630989	331	0.851964	0.747721	0.518602	1.078065	0.184488
1999	0.862710	389	0.858612	0.823427	0.576316	1.176493	0.179838
2000	0.868600	429	0.892774	0.835222	0.597652	1.167228	0.168523
2001	0.823798	408	0.906863	0.805724	0.577871	1.123420	0.167350
2002	0.740617	354	0.875706	0.783833	0.549460	1.118179	0.179041
2003	0.726188	440	0.925000	0.921541	0.670646	1.266299	0.159912
2004	0.706083	306	0.908497	0.854458	0.603201	1.210375	0.175437
2005	0.847371	279	0.892473	1.136052	0.806778	1.599713	0.172393
2006	0.863297	267	0.928839	1.220332	0.881659	1.689099	0.163616
2007	1.067990	258	0.980620	1.289692	0.947675	1.755143	0.154992
2008	1.248652	229	0.930131	1.485238	1.068224	2.065045	0.165914
2009	1.047280	223	0.946188	1.245760	0.889774	1.744171	0.169465

5.9. *FIGURES*

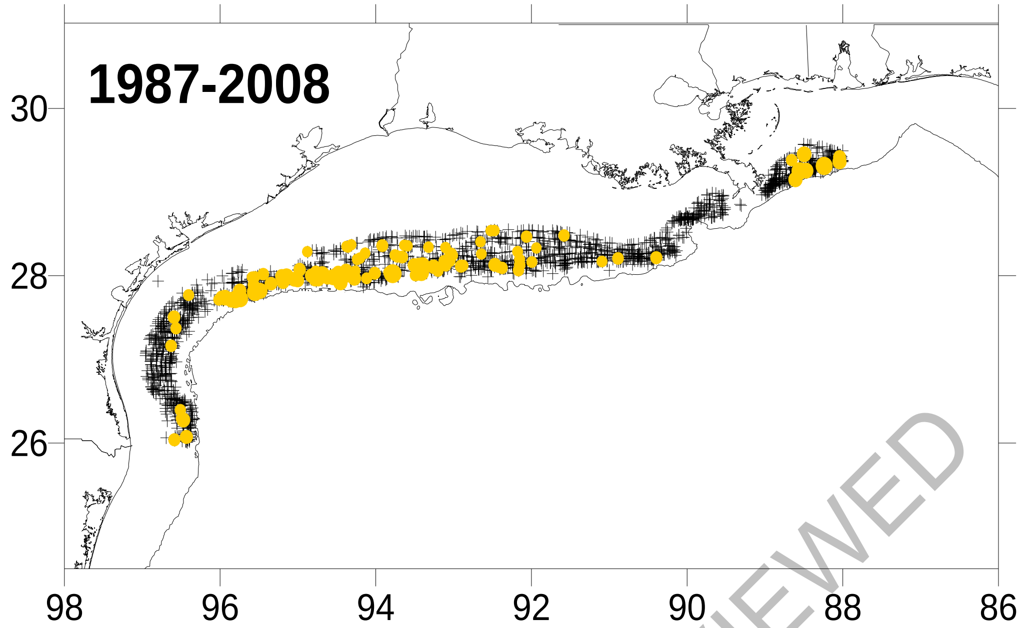


Figure 5.9.1: Overview of locations of groundfish survey trawls in the northern Gulf of Mexico conducted between 1987 and 2008. Each + indicates the starting point of a trawl station and the circle represents where yellowedge grouper were captured and the CPUE. The smallest circle represents a CPUE of 0.25 fish per hour, while the largest circle represents a CPUE of 6 fish per hour.

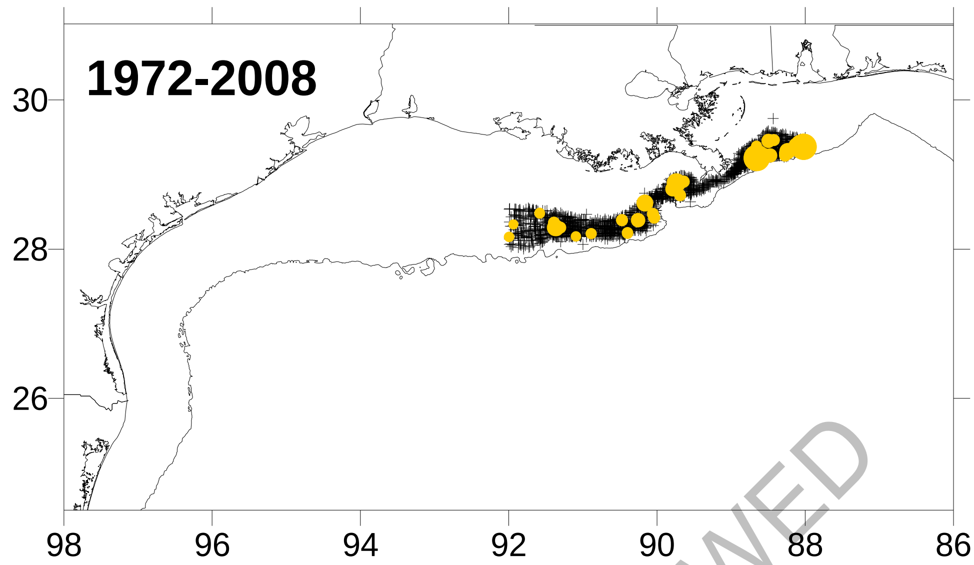


Figure 5.9.2: Overview of locations of groundfish survey trawls in the northern Gulf of Mexico conducted between 1972 and 2008. Each + indicates the starting point of a trawl station and the circle represents where yellowedge grouper were captured and the CPUE. The smallest circle represents a CPUE of 0.38 fish per hour, while the largest circle represents a CPUE of 14 fish per hour.

Figure 5.9.3: Area-specific abundance indices for yellowedge grouper

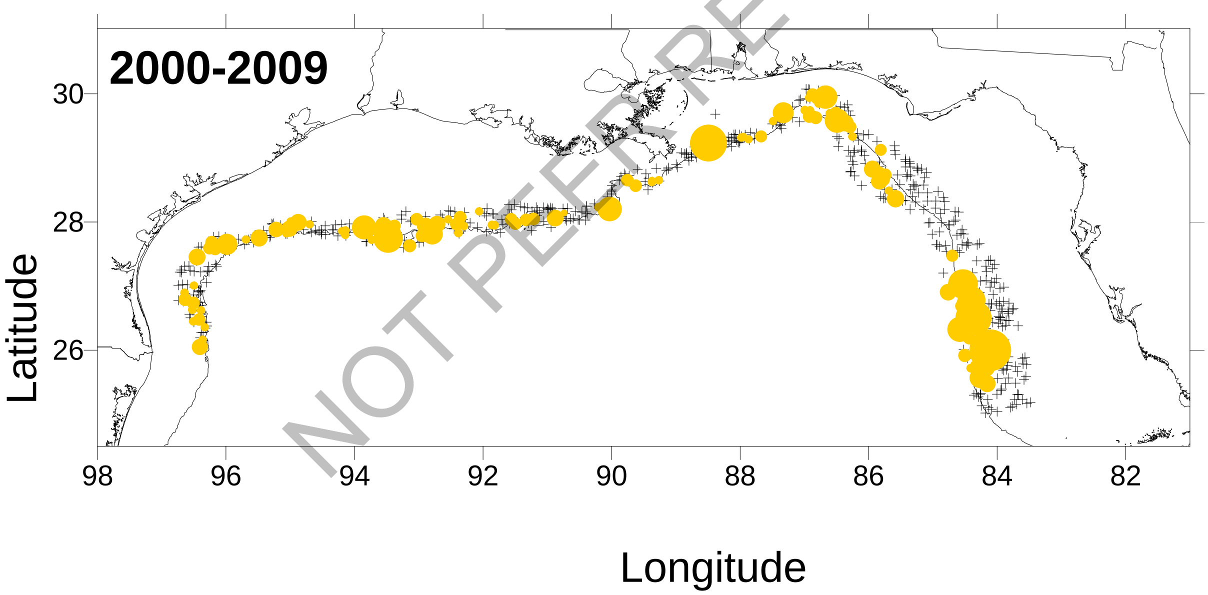
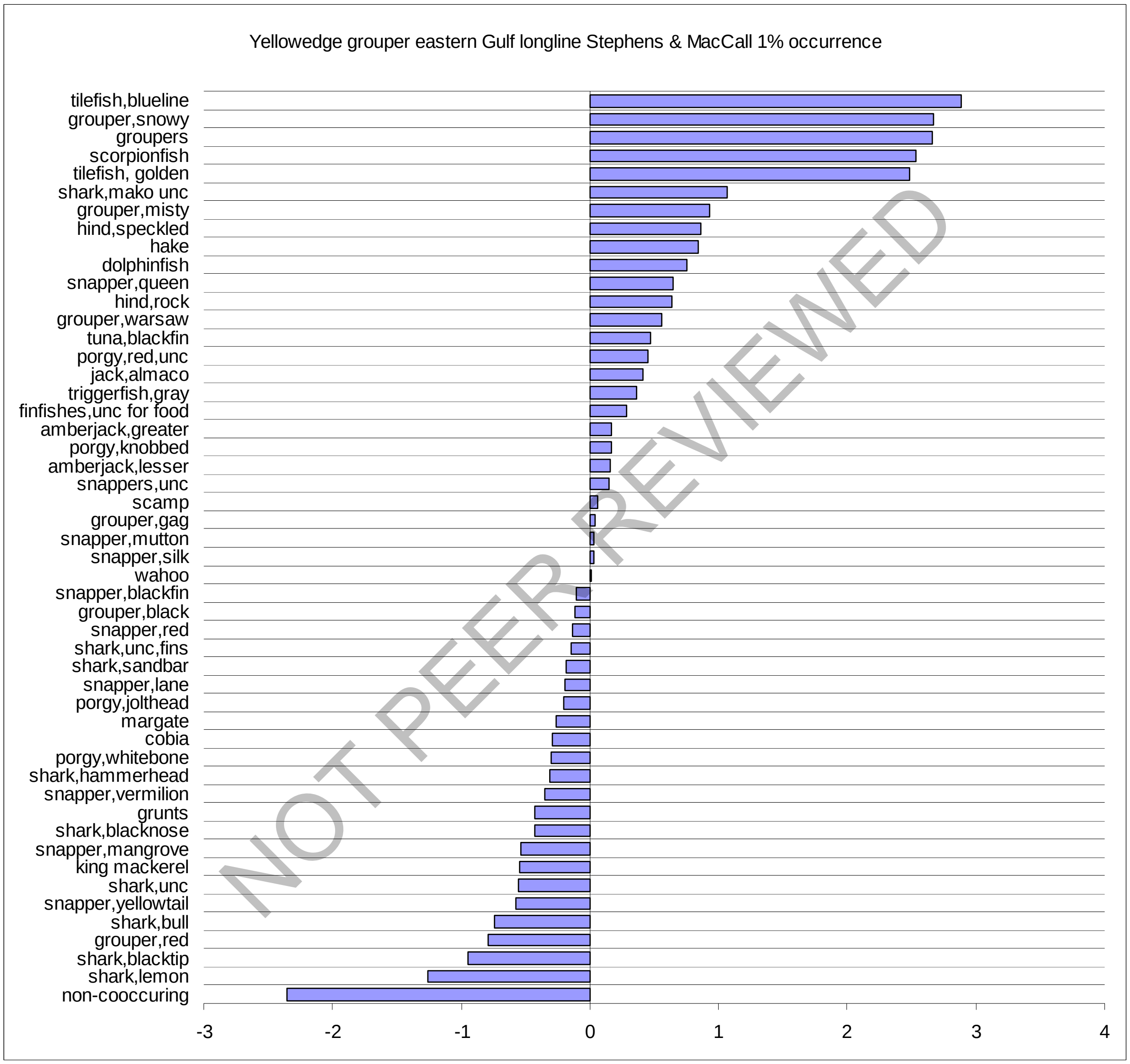
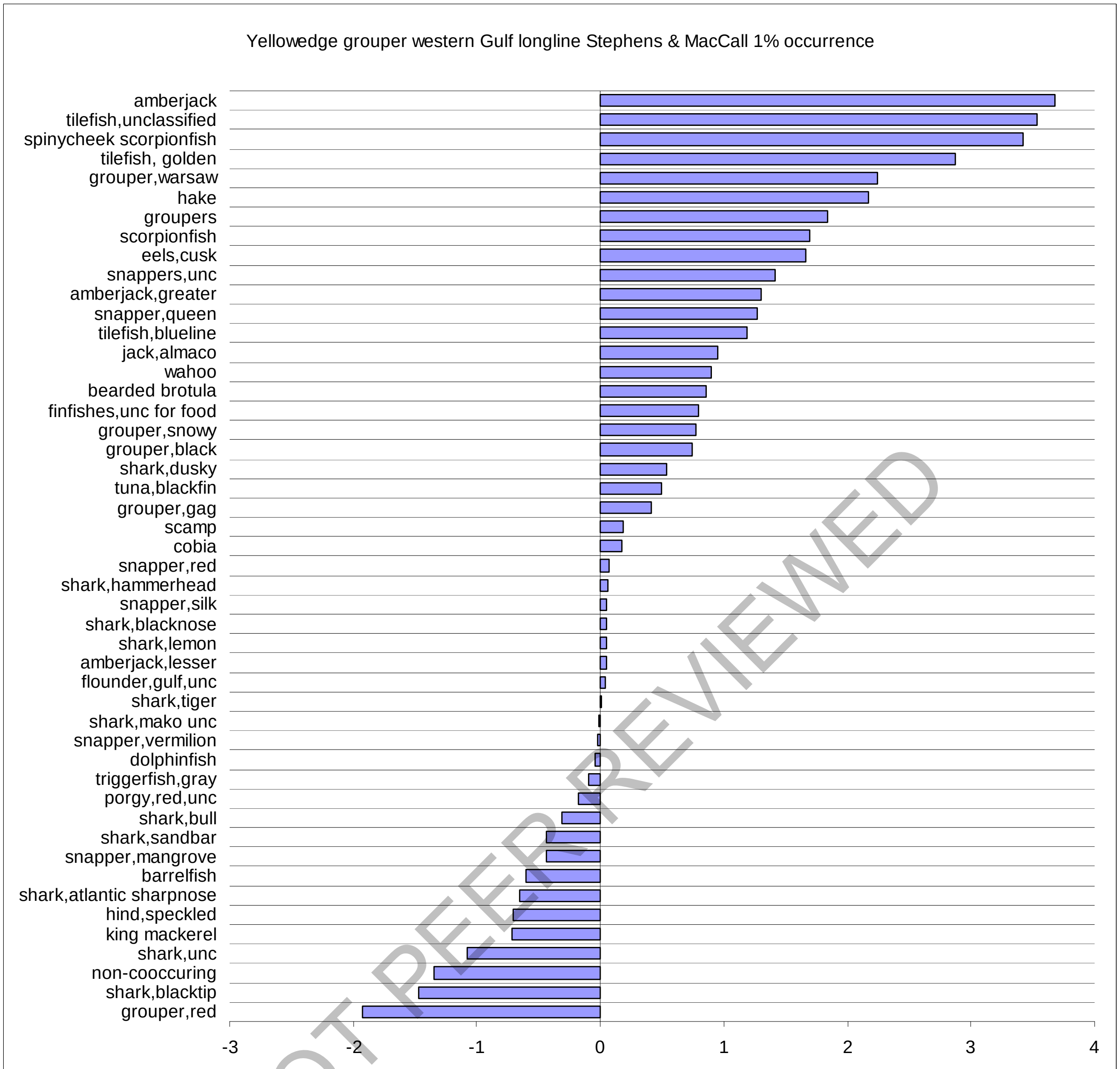


Figure 5.9.4: Survey effort included in analyses and CPUE of yellowedge grouper from 2000 through 2009 in the Gulf of Mexico. Crosses indicate effort with no catch. The size of yellow circles is linearly related to positive CPUE (range: 0.4 – 9 yellowedge grouper per 100 hook hours).

Figure 5.9.5: Regression coefficients from the Stephens & MacCall analyses. Positive coefficients signify species that had positive associations with the target species. The magnitude of the coefficients indicates the predictive impact of each species. The value for "non-coocurring" is the regression intercept and denotes the probability a trip was fishing in the target species' habitat, but did not report any of the listed species. Species included were reported on at least one percent of longline trips in the eastern or western Gulf of Mexico.



5.9.5.A. Yellowedge grouper eastern Gulf of Mexico longline



5.9.5.B. Yellowedge grouper western Gulf of Mexico longline

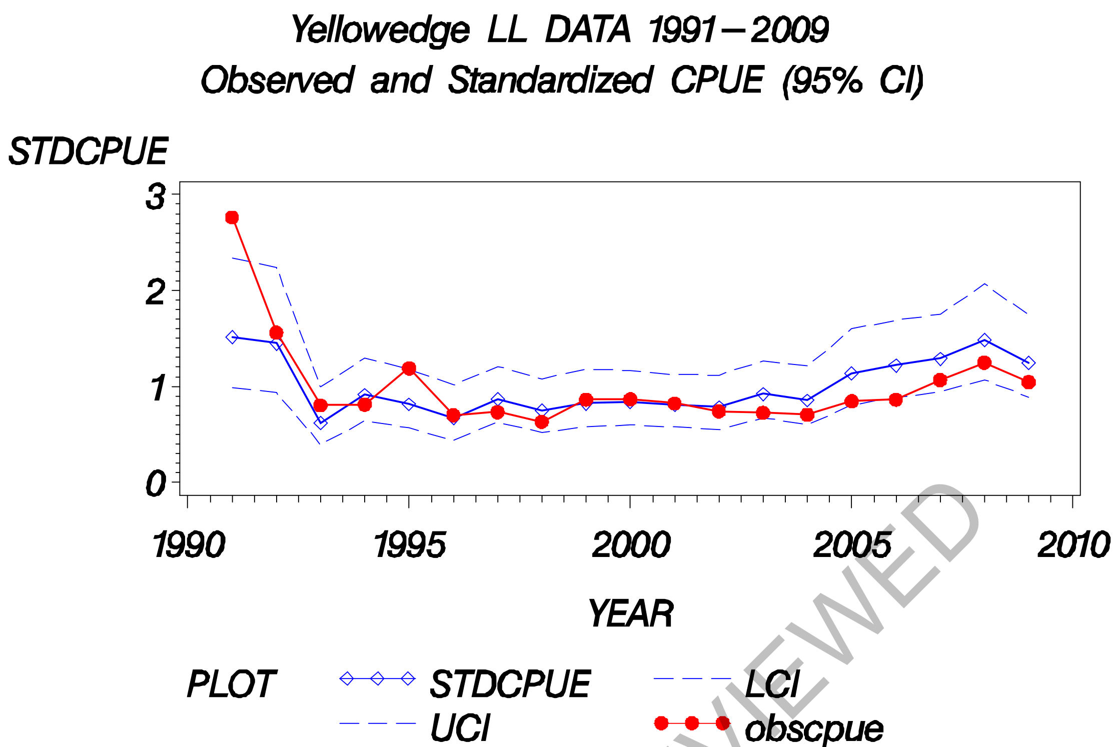


Figure 5.9.6: Yellowedge grouper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for vessels fishing longline gear in the Gulf of Mexico.

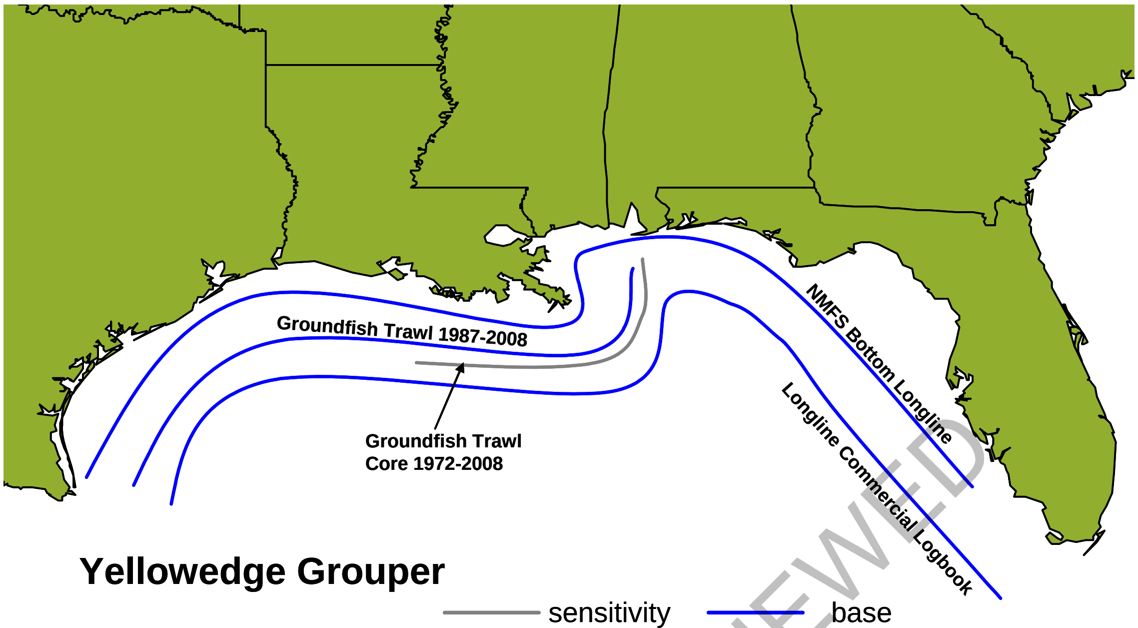


Figure 5.9.7: Linear coverage of specific abundance indices along the coast of the Gulf of Mexico.

6. ANALYTIC APPROACH

6.1. *SUGGESTED ANALYTIC APPROACH GIVEN THE DATA*

Stock Synthesis III (SSIII, Methot 2000) will be the first assessment modeling approach for both yellowedge grouper (YEG) and tilefish. SSIII is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world. SSIII takes relatively unprocessed input data and incorporates many of the important processes (mortality, selectivity, growth, etc) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. In addition, SSIII can incorporate time series of environmental data. Because many of these inputs are correlated, the concept behind SSIII is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SSIII has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time period for which indices and length and age observations are available. Such a situation exists for both YEG and tilefish, however both fisheries are rather short (~40 years) and for YEG we have the benefit of substantial age composition data from fairly early in the fishery. However, in either case, there is evidence of substantial landings prior to the routine collection of age composition data from throughout the spatial distribution of the stock.

As a second assessment modeling approach, stochastic stock reduction analysis (SRA, Walters et al. 2005) will also be applied to both species. SRA is a less data-intensive method which can help to determine how large the stock needed to be to have produced the time series of observed landings. This will provide a necessary check on the SSIII results and may be very useful in determining stock status relative to the initial population size. SRA has been applied to several other Gulf of Mexico species including gag and red grouper and red snapper.

For both species, there are sources of uncertainty which will have to be incorporated within the modeling framework or through sensitivity analyses. Uncertainties in assigned ages created by aging error, changing growth rates and unknown M can be incorporated within the SSIII framework. Given the complex reproductive biology of YEG and tilefish, the most effective proxy for spawning stock biomass is another source of uncertainty and will have to be considered in some manner as well. Unfortunately, the greatest uncertainties in either of these two assessments are in the actual landings levels themselves, because of a lack of historical identification of groupers and tilefishes to species. Very few modeling approaches can deal with large uncertainties in total catch, so these may have to be considered through sensitivity runs with both SRA and SSIII.

6.2. *REFERENCES*

Walters, C. J., S. J.D. Martell, and J. Korman 2006. A stochastic approach to stock reduction analysis. Can. J. Fish. Aquat. Sci. 63: 212–223.

Methot, R.D. 2000. Technical description of the stock synthesis assessment program. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-43, 4

Appendix 1: Indices Worksheets

Evaluation of Abundance Indices of Yellowedge Grouper: Commercial Logbook (Longline) (SEDAR22-DW-02)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.	✓			
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.		✓		

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

No minimum size regulation, but size/age range unknown.

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).			✓	
B. Describe the effects (if any) of management regulations on CPUE		✓		
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).		✓		
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

-Data from closed seasons were excluded. Effects for trip limits were examined and appeared to have little effect. Results were not included in the document. There is no minimum size in the regulations.

Number of observations by factors and interaction terms were examined, but were not included in the document due to confidentiality concerns.

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Include plots of the chi-square residuals by factor.				✓	
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).		✓			

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.		✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓			
F. Include plots of the residuals by factor				✓	

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				*The feasibility of this diagnostic is still under review.*

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	3/17/10	Accept with revisions		
Revision	4/9/10 (Addendum)			

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

Workshop recommendations:
-Yellowfin grouper should be assumed to be yellowedge grouper except in the case where both species were reported on a trip. The yellowfin/yellowedge adjustment affected the Stevens-McCall trip selection, but change to the index was was minimal.

Working group recommendations:
-Following the workshop, it was recommended by the assessment biologists and indices work group that separate indices be created for Gulf of Mexico areas 2-5, 6-11, and 13-21. Results of these analyses will be disseminated in a working paper prior to the assessment workshop/webinar (by 5/10/10).

Evaluation of Abundance Indices of Yellowedge Grouper: SEAMAP Groundfish Survey (SEDAR22-DW-06)

DESCRIPTION OF THE DATA SOURCE

	Not Applicable	Absent	Incomplete	Complete
1. Fishery Independent Indices				
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.				✓
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)				✓
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)				✓
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).				✓
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓
2. Fishery Dependent Indices				
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).	✓			
B. Describe any changes to reporting requirements, variables reported, etc.	✓			
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

	Not Applicable	Absent	Incomplete	Complete
1. Data Reduction and Exclusions				
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?		✓		

Working Group Comments:

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).	✓			
B. Describe the effects (if any) of management regulations on CPUE	✓			
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.	✓			

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.			✓	
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?		✓		
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.		✓			
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓	
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓			
F. Include plots of the residuals by factor			✓		
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).			✓	

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	3/15/10	Accept with revisions		
Revision	4/12/10 (Addendum)	Accept		

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

Revisions described in Section 1.3.1.2

Evaluation of Abundance Indices Yellowedge Grouper: NOAA Fisheries Bottom Longline Survey (SEDAR22-DW-07)

Working Group Comments:

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.				✓
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)				✓
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)				✓
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).				✓
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).	✓			
B. Describe any changes to reporting requirements, variables reported, etc.	✓			
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?		✓		

Working Group Comments:

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).	✓			
B. Describe the effects (if any) of management regulations on CPUE	✓			
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.	✓			

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.			✓	
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?		✓		
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.		✓		
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓		
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓

2. Lognormal/Gamma Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓		
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓		
F. Include plots of the residuals by factor			✓	

3. Poisson Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

4. Zero-inflated model

Item	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).			✓	

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	3/15/10	Accept with revisions		
Revision	4/12/10 (Addendum)	Accept		

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

Revisions described in Section 1.3.2.2

SEDAR

Southeast Data, Assessment, and Review

SEDAR 22

Gulf of Mexico Yellowedge Grouper

SECTION III: Assessment Process Report

November 2010

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

Table of Contents

1. WORKSHOP PROCEEDINGS

1.1. *INTRODUCTION*

1.1.1. Workshop time and Place

The SEDAR 22 Assessment Process was held via a series of webinars between May and September 2010.

1.1.2. Terms of Reference

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data and recommend which model and configuration is deemed most reliable or useful for providing advice. Document all input data, assumptions, and equations.
3. Provide estimates of stock population parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values, considering components such as input data, modeling approach, and model configuration. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
5. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, including figures and tables of complete parameters.
6. Provide estimates for SFA criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards. This may include: evaluating existing SFA benchmarks, estimating alternative SFA benchmarks; and recommending proxy values. **In addition, specify OFL, and recommend a range of ABC for review by the SSC in compliance with ACL guidelines.**
7. Provide declarations of stock status relative to SFA benchmarks.
8. Perform a probabilistic analysis of proposed reference points and provide the probability of overfishing at various harvest or exploitation levels.
9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:
   - A) If stock is overfished:
     - F=0, F=current, F=Fmsy, Ftarget (OY),
     - F=Frebuild (max that rebuild in allowed time)
   - B) If stock is overfishing
     - F=Fcurrent, F=Fmsy, F= Ftarget (OY)
   - C) If stock is neither overfished nor overfishing
     - F=Fcurrent, F=Fmsy, F=Ftarget (OY)
10. Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

11. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity and emphasize items which will improve future assessment capabilities and reliability.
12. Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.
13. Complete the Assessment Workshop Report (Section III of the SEDAR Stock Assessment Report).

1.1.3. List of Participants

SEDAR 22 ASSESSMENT WEBINARS ATTENDANCE REPORT

x = present

First	Last	Web1 13-May	Web2 1-Jul	Web3 21-Jul	Web4 12-Aug	Web4 cont 13-Aug	Web5 23-Aug	Web6 1-Sep	Web7 4-Oct	Web8 3-Nov
PANELISTS										
Brian	Linton	x	x	x	x	x	x	x	x	x
John	Walter	x	x	x	x	x	x	x	x	x
John	Quinlan	x		x	x		x		x	
Linda	Lombardi	x	x	x	x	x	x	x	x	x
Harry	Blanchet	x	x	x	x		x	x	x	
Shannon	Cass-Calay		x	x	x	x	x	x	x	x
Richard	Fulford		x	x	x	x	x			x
Joe	Powers									
Will	Patterson	x	x	x				x	x	
Robert	Allman	x	x	x			x	x		
Irby	Basco									
Bob	Spaeth									
Martin	Fischer									
TJ	Tate									
Neil	Baertein									
COUNCIL REPRESENTATION										
Bob	Shipp				x		x			x
STAFF										
Julie	Neer	x	x	x	x	x	x	x	x	x
Carrie	Simmons		x	x	x	x	x	x	x	
John	Froeschke	x								
Kari	Fenske				x					
John	Carmichael				x					
OBSERVERS										
Clay	Porch	x					x	x		

Nancy	Cummings	x	x	x				x		
Nick	Farmer				x	x	x	x	x	x
Rich	Malinowski							X		
Todd	Gedamke		x							

1.1.4. List of Assessment Process Working and Reference Papers

Documents Prepared for the Assessment Workshop		
SEDAR22-AW-01	United States Commercial Longline Vessel Standardized Catch Rates of Golden and Blueline Tilefish in the Gulf of Mexico, 1992-2009: Revised	Kevin McCarthy
SEDAR22-AW-02	United States Commercial Longline Vessel Standardized Catch Rates of Yellowedge Grouper (*Epinephelus flavolimbatus*) for Three Regions in the Gulf of Mexico, 1991-2009	Neil Baertlein and Kevin McCarthy
Reference Documents		
SEDAR22-RD10	Comparison of Two Techniques for Estimating Tilefish, Yellowedge Grouper, and Other Deepwater Fish Populations	Matlock, Gary C., Walter R. Nelson, Robert S. Jones, Albert W. Green, Terry J. Cody, Elmer Gutherz, and Jeff Doerzbacher
SEDAR22-RD11	Deep-water sinkholes and biotherms of South Florida and the Pourtales Terrace – Habitat and Fauna	John K. Reed, Shirley A. Pomponi, Doug Weaver, Charles K. Paull, and Amy E. Wright
SEDAR22-RD12	Tilefishes of the genus *Caulolatilus* construct burrows in the sea floor	K.W. Able, D.C. Twichell, C.B. Grimes, and R.S. Jones
SEDAR22-RD13	Spawning Locations for Atlantic Reef Fishes off the Southeastern U.S.	GEORGE R. SEDBERRY, O. PASHUK, D.M. WYANSKI, J.A. STEPHEN, and P. WEINBACH
SEDAR22-RD14	Trends in tilefish distribution and relative abundance off South Carolina and Georgia	Charles A. Barnes and Bruce W. Stender
SEDAR22-RD15	Age, growth, and reproductive biology of blueline tilefish along the Southeastern coast of the United	Patrick J. Harris, David M. Wyanski, and Paulette T. Powers

	States, 1982-1999	Mikell
SEDAR22-RD16	Temporal and spatial variation in habitat characteristics of tilefish (Lopholatilus chamaeleonticeps) off the east coast of Florida	Kenneth W. Able, Churchill B. Grimes, Robert S. Jones and David C. Twichell
SEDAR22-RD17	The Complex Life History of Tilefish *Lopholatilus chamaeleonticeps* and Vulnerability to Exploitation	Churchill B. Grimes and Stephen C. Turner
SEDAR22-RD18	The fishery for tilefish, *Lopholatilus chamaeleonticeps*, off South Carolina and Georgia	Bob Low, Glenn Ulrich, and Frank Blum
SEDAR22-RD19	Tilefish off South Carolina and Georgia	R.A. Low, Jr., G.F. Ulrich, and F. Blum
SEDAR22-RD20	Spawner-recruit relationships of demersal marine fishes: Prior distribution of steepness for possible use in SEDAR stock assessments	SEDAR 24−AW−06 - Sustainable Fisheries Branch

1.2. *PANEL RECOMMENDATIONS AND COMMENT*

1.2.1. Term of Reference 1

Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.

1.2.2. Term of Reference 2

Develop population assessment models that are compatible with available data and recommend which model and configuration is deemed most reliable or useful for providing advice. Document all input data, assumptions, and equations.

1.2.3. Term of Reference 3

Provide estimates of stock population parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates.

1.2.4. Term of Reference 4

Characterize uncertainty in the assessment and estimated values, considering components such as input data, modeling approach, and model configuration. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.

1.2.5. Term of Reference 5

Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, including figures and tables of complete parameters.

1.2.6. Term of Reference 6

Provide estimates for SFA criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards. This may include: evaluating existing SFA benchmarks, estimating alternative SFA benchmarks; and recommending proxy values. In addition, specify OFL, and recommend a range of ABC for review by the SSC in compliance with ACL guidelines.

1.2.7. Term of Reference 7

Provide declarations of stock status relative to SFA benchmarks.

1.2.8. Term of Reference 8

Perform a probabilistic analysis of proposed reference points and provide the probability of overfishing at various harvest or exploitation levels.

1.2.9. Term of Reference 9

Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time.

1.2.10. Term of Reference 10

Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

1.2.11. Term of Reference 11

Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity and emphasize items which will improve future assessment capabilities and reliability.

2. DATA REVIEW AND UPDATE

Early in the SEDAR process for yellowedge grouper there was an effort to partition the assessment model into three regions (West – statistical grids 13 to 21; Northeast – statistical grids 6 to 12; and Southeast – statistical grids 1 to 5). These divisions would provide more appropriate treatment of the various habitat types across the Gulf of Mexico, but was also supported by the work of Prytherch (1983) who identified three primary fishing areas (West, middle, Southeast) of relevance to this assessment. This three region approach was initially adopted by the assessment workshop panel (AWP).

However this spatial partitioning appeared to present some modeling problems most likely due to the fact that the deepwater fishery for YEG in the northeastern Gulf of Mexico between stat areas 5 and 8 is not well differentiated. Prytherch (1983) states that vessels fishing from St. Petersberg, FL could see the lights of the vessels from Panama City, indicating that, at least on the fishing grounds, there was little separation between fish from the South and fish from the Central region, as the three area partition originally separated them.

On this basis the model was condensed into two regions; East (statistical grids 1 to 12) and West (grids 13 to 21). Subdivision beyond this, which was desirable as this long-lived species could be vulnerable to serial local depletion, simply could not be supported by the available data.

2.1. ***COMMERCIAL LANDINGS DATA***

The commercial landings shown in Table 2.1 were reconstructed back to 1975 via the reconciliation of several lines of evidence which are discussed below. The color coding in Table 2.1 will assist with interpretation of the following paragraphs.

The unshaded landings from 1991 onward (Table 2.1) were compiled directly from the SEFSC Accumulated Landings System (ALS) (Orhun 2010). The data prior to 1991 required several corrections.

First, before 1986 identification of grouper landings to species was not required except for warsaw and goliath groupers. This resulted in a significant ALS record, extending from 1975 to 1985, of 'unclassified grouper', some of which were yellowedge grouper. These landings were accounted for in this assessment. The vertical line landings from 1975 to 1985 (purple shading in Table 2.1) were estimated by multiplying the fishing area-specific unclassified grouper landings by the fraction of known yellowedge and yellowfin vertical line landings from 1986 to 1989 (blue shading in Table 2.1). This action requires an assumption here that the ratio of yellowedge and yellowfin to other groupers was constant from 1975 to 1989. Yellowfin were included because there is clear evidence that yellowedge were misclassified as yellowfin in early reporting.

In the original data, there existed a sharp transition between high landings of 1981-1982 and the relatively lower landings of 1986 on. This transition was viewed by the SEDAR Data Workshop as unrealistic. To correct this, the longline landings between 1983 and 1985 (green shading in Table 2.1) were estimated by linearly interpolation, by fishing area, between the 1982 and 1986 landings.

The misclassification of yellowedge as yellowfin, which was more common in the western Gulf than in the East, also needed to be addressed. To correct this, the data collected by Prytherch (1983) was reanalyzed and compared with existing ALS data. Area-specific corrections were developed that reclassified a fraction of the yellowfin landings from 1986 to 1990 as yellowedge (blue shading in Table 2.1).

The last major data decision required partitioning the unclassified groupers landing by longlines between 1979 and 1982 (orange shading). These unclassified grouper were partitioned according to the fraction of yellowedge to total groupers recorded by Prytherch (1983) from the deepwater longline fishery during 1982. In the original three-area partitioning, 26% of unclassified grouper in the South region (stat areas 1-5) assigned as yellowedge. For the Central (6-12) region 96% were assigned to be YEG, on the basis of the Prytherch study.

Condensing of the model into two areas initiated a re-evaluation of some of the decisions regarding the spatial allocation of historical landings of YEG. The key re-evaluation is the large quantity of unclassified groupers captured on longlines in statistical areas 6 and 7 which were over 2 million pounds in 1982. However these stat areas are largely, if not entirely in shallower water than where YEG are found and are substantial areas for red grouper (Figure 2.2). Thus it is highly likely that many or all of the fish in stat area 7 were red grouper in these early years. It also might be likely that the composition of unclassified groupers in stat area 6 would have been similar to that of stat area 5, which would mean that they would be less than 96% YEG.

To construct an alternative landings history which could be considered the ‘low’ or perhaps the lower bound on the historical landings, all unclassified groupers in stat area 7 were removed and the percentage of YEG in stat area 6 was changed from 23% to 96%. Given the high landings of unclassified grouper in stat area 6, this resulted in a reduction in total YEG landings in the years 1980-1985 (Table 2.2, Figure 2.3). The following short table shows this reallocation:

Year	Low: Stat area 6 is 23%, none in 7	High: Stat area 6/7 are 96% YEG	Difference
1980	792,909	871,224	78,316
1981	2,043,982	2,729,985	686,003
1982	2,713,687	4,395,875	1,682,188
1983	2,213,833	3,475,474	1,261,641
1984	1,929,573	2,770,667	841,094
1985	1,641,347	2,061,894	420,547

This resulted in a substantial reduction of YEG landings in 1980-1985.

To obtain total removals, commercial discards were added to the appropriate fleet landings, assuming that all discards were dead. A weight of 2.8 lbs (1/2 the average weight of landed yellowedge grouper from the headboat fishery) was used to multiply the discards in numbers to obtain discards in weight. Commercial discards were split evenly between the east and west region.

2.2. ***RECREATIONAL LANDINGS AND DISCARDS***

The recreation landings were considered to be too minor to necessitate treatment as a separate fishing fleet (Table 2.3) and were added to the vertical line commercial landings. Landings in pounds (Matter 2010) and discards in number, converted to pounds with an average weight of 2.8 pounds (1/2 the average weight of landed yellowedge grouper from the headboat fishery), under the assumption that all discarded YEG died were summed. Then all recreational landings and discards were added to the commercial handline fisheries in equal proportions East and West, though all of Texas Parks and Wildlife (TPWD) landings were allocated to the West handline.

2.3. ***COMMERCIAL DISCARDS***

Commercial discards were determined by the SEDAR Data Workshop (SEDAR22-DW-04, McCarthy 2010) to be very small, though possibly underreported. Yellowedge longline discards could be calculated for only one year. Similar to the recreational discards, commercial discards were assumed to weigh 2.8 pounds (1/2 the average weight of landed yellowedge grouper from the headboat fishery and added to the appropriate fishery, split evenly East and West. Both commercial discards and recreational landings usually were less than 1% of the total landings almost every year so any alternative treatment of this set of data would be unlikely to substantively alter model results and advice.

2.4. ***AGE COMPOSITION DATA***

Age composition data comes from four sources (Table 2.4, Figures 2.4-2.10):

1) Aged fish obtained from fishery dependent sampling and aged by otolith readings (1984-2009).

2) Pre-TIP age composition sampling conducted by the State of Florida collected by Lew Bullock, Mark Godcharles and Lucious Johnson. For some fish obtained in 1982-1983, otoliths were weighed and ages obtained from an otolith age-otolith weight regression. These fish were not used in the final analysis, however.

3) NFMS bottom longline survey, fish aged by otoliths

4) SEAMAP bottom trawl survey, fish aged by otoliths. These length and age composition samples are quite important for growth modeling as they represent the only age 0 and most of the age 1 and 2 fish in assessment.

2.4.1. Aging error

Two aging error matrices were used, one from the otolith weight-otolith age relationship derived for fish collected from the commercial fishery in 1982-1983 and one from the standard Panama City Lab aging precision error (Table 2.6). Originally both sets of age composition data were considered however, in subsequent assessment iterations the otolith weight-otolith age data provided anomalous fits to the age composition data and were removed from consideration.

2.5. ***LENGTH COMPOSITION DATA***

Length composition data comes from four sources (Table 2.5 , Figures 2.11-2.14):

1) TIP measured lengths (1984-2009)

2) Pre-TIP length and age composition sampling conducted by the State of Florida collected by Lew Bullock, Mark Godcharles and Lucious Johnson. (1977-1983)

3) NFMS bottom longline survey, all fish measured.

4) NMFS bottom trawl survey, all fish measured.

For all length composition the absolute sample size input to SS3 was capped at a maximum of 200.

2.6. ***INDICES***

Two commercial longline (SEDAR22-DW-02) indices and two NMFS bottom longline survey indices were used (Table 2.7, Figure 2.15). Juvenile abundance indices from the NMFS trawl survey (SEDAR22-DW-06) were considered for inclusion but given the extremely low sample sizes they were not used. Indices were constructed after the DW workshop specifically for the East (stat areas 1-12) and the West (stat areas 13-21). For the three-area model indices were constructed for the South (grids 1-5), Central (grids (6-12) and West (13-21) (Table 2.8) but these were only used in one run presented in this document.

The coefficient of variation (CV) associated with the standardized indices were converted to log-scale standard errors by:

$$\log(SE) = \sqrt{\log_e\left(1 + CV^2\right)},$$

for input into SS3.

2.7. ***LIFE HISTORY***

Inputs for many life history parameters are discussed below in *Model configuration*. A fixed vector of maturity at age, and a fixed length-weight relationship was used for weight at age and fecundity at age for both males and females (Table 2.9). Figure 2.16 depicts the derivation of the input hermaphroditism parameters and will be discussed in section 3.

2.8. ***TABLES***

Table 2.1. Commercial landings in gutted pounds.

	Western Gulf		Eastern Gulf		
Year	**Vertical Line**	**Longline**	**Vertical Line**	**Longline**	**Total**
1974	-	-	-	-	-
1975	113,454	-	351,630	-	465,083
1976	74,084	-	296,289	-	370,374
1977	60,985	-	255,015	-	315,999
1978	67,082	-	231,954	-	299,036
1979	75,112	36,031	343,702	-	454,845
1980	44,176	46,681	333,638	446,729	871,224
1981	230,857	682,027	301,678	1,515,422	2,729,985
1982	225,393	680,796	264,745	3,224,942	4,395,875
1983	117,510	646,674	235,083	2,476,207	3,475,474
1984	197,754	612,551	232,890	1,727,472	2,770,667
1985	210,188	578,428	294,541	978,737	2,061,894
1986	98,119	544,306	544,942	230,002	1,417,369
1987	63,191	437,827	345,548	337,222	1,183,788
1988	281,401	606,346	269,219	489,354	1,646,320
1989	49,078	351,233	66,533	273,663	740,507
1990	39,015	345,943	117,818	373,245	876,022
1991	40,159	317,054	78,977	334,785	770,975
1992	77,802	386,692	66,276	511,134	1,041,905
1993	76,642	319,263	32,506	348,000	776,410
1994	42,398	277,888	50,969	698,474	1,069,729
1995	30,945	372,383	23,332	415,288	841,948
1996	19,477	155,994	21,838	332,554	529,862
1997	18,681	124,475	15,384	561,599	720,139
1998	25,478	215,034	22,040	420,914	683,466
1999	37,094	274,224	28,134	633,502	972,954
2000	42,735	295,164	21,200	732,240	1,091,339
2001	22,893	197,259	15,031	541,818	777,001
2002	26,455	301,981	22,141	434,577	785,154
2003	33,021	363,051	24,735	682,769	1,103,576
2004	27,950	296,015	20,520	580,862	925,347
2005	23,365	268,662	16,138	479,251	787,416
2006	16,426	226,984	21,337	480,590	745,337
2007	27,529	137,744	10,514	692,691	868,478
2008	24,168	158,430	8,676	627,767	819,040
2009	43,453	210,874	20,399	553,821	828,547

Table 2.2. Table of high and low landings scenarios. Landings are in metric tons as input to SS3, except for the totals in pounds.

High landings							Low Landings					
East HL+rec landings and discards	West HL+rec landings and discards	East LL+ discards	West LL+ discards	Total	Total lbs (1000s)	Year	East HL+rec landings and discards	West HL+rec landings and discards	East LL+ discards	West LL+ discards	total	total lbs (1000s)
0	0	0	0	0	0.00	1974	0	0	0	0	0	0.00
159.5	51.46	0	0	210.96	465.09	1975	159.5	51.46	0	0	210.96	465.09
134.39	33.6	0	0	168	370.38	1976	134.39	33.6	0	0	168	370.38
115.67	27.66	0	0	143.33	315.99	1977	115.67	27.66	0	0	143.33	315.99
105.21	30.43	0	0	135.64	299.04	1978	105.21	30.43	0	0	135.64	299.04
155.9	34.07	0	16.34	206.31	454.84	1979	155.9	34.07	0	16.34	206.31	454.84
151.34	20.04	202.63	21.17	395.18	871.22	1980	151.34	20.04	167.11	21.17	359.66	792.91
136.84	104.72	687.38	309.36	1238.3	2729.98	1981	136.84	104.72	376.22	309.36	927.13	2043.97
149.7	131.85	1462.81	308.8	2053.16	4526.44	1982	120.09	102.24	699.78	308.8	1230.91	2713.69
106.63	53.56	1123.19	293.33	1576.71	3476.05	1983	106.63	53.3	550.92	293.33	1004.18	2213.84
105.66	90.27	783.57	277.85	1257.35	2771.98	1984	135.25	119.31	402.05	277.85	934.47	2060.15
133.71	95.45	443.95	262.37	935.48	2062.38	1985	133.6	95.6	253.19	262.37	744.76	1641.91
247.4	44.72	104.33	246.89	643.34	1418.32	1986	247.21	45.08	104.33	246.89	643.51	1418.70
160.57	32.49	152.96	198.59	544.62	1200.68	1987	156.85	28.78	152.96	198.59	537.18	1184.28
122.25	127.78	221.97	275.03	747.03	1646.92	1988	122.33	127.86	221.97	275.03	747.19	1647.27
37.21	29.3	124.13	159.32	349.96	771.53	1989	34.01	26.09	124.13	159.32	343.55	757.40
53.61	17.87	169.3	156.92	397.69	876.76	1990	53.72	17.97	169.3	156.92	397.91	877.24
36.99	19.38	151.86	143.81	352.04	776.12	1991	43.3	25.7	151.86	143.81	364.67	803.96
30.77	36	231.85	175.4	474.01	1045.01	1992	30.58	35.81	231.85	175.4	473.64	1044.20
14.96	34.98	157.85	144.82	352.61	777.37	1993	15.66	35.68	157.85	144.82	354	780.44
23.9	20.01	316.82	126.05	486.78	1073.17	1994	23.56	19.67	316.82	126.05	486.1	1071.67
11.86	15.32	188.37	168.91	384.46	847.59	1995	10.88	14.33	188.37	168.91	382.49	843.25
11.86	10.79	150.84	70.76	244.25	538.48	1996	10.7	9.63	150.84	70.76	241.93	533.36
7.63	9.13	254.74	56.46	327.95	723.01	1997	8.36	9.86	254.74	56.46	329.41	726.22
10.36	11.91	190.92	97.54	310.73	685.04	1998	12.07	13.62	190.92	97.54	314.15	692.58
13.48	17.55	287.35	124.39	442.76	976.12	1999	13.45	17.51	287.35	124.39	442.7	975.99
10.87	20.64	332.14	133.88	497.54	1096.89	2000	10.01	19.78	332.14	133.88	495.81	1093.07
7.28	10.85	245.76	89.48	353.37	779.05	2001	7.52	11.09	245.76	89.48	353.85	780.11
10.3	12.26	197.12	136.98	356.66	786.30	2002	10.91	12.86	197.12	136.98	357.87	788.97
24.03	27.79	309.7	164.68	526.2	1160.07	2003	11.29	15.05	309.7	164.68	500.71	1103.88
10.17	13.54	266.12	136.91	426.73	940.78	2004	9.84	13.21	266.12	136.91	426.08	939.35
7.95	11.23	217.38	121.86	358.43	790.20	2005	20.7	23.98	217.38	121.86	383.92	846.40
10.22	7.99	217.99	102.96	339.16	747.72	2006	10.66	8.43	217.99	102.96	340.04	749.66
8.71	16.42	314.2	62.48	401.81	885.84	2007	7.65	15.37	314.2	62.48	399.7	881.19
4.21	11.24	284.75	71.86	372.06	820.25	2008	4.21	11.24	284.75	71.86	372.06	820.25
10.39	20.84	251.21	95.65	378.09	833.55	2009	10.39	20.84	251.21	95.65	378.09	833.55

Table 2.3 Recreational landings in gutted lbs.

Year	Recreational Landings		
	Headboat	MRFSS	TPWD
1982		130,570	
1984			209
1986	457		437
1987	1,103		
1988	2,178		
1989	734	16,570	
1990	1,643		
1991	1,331	0	
1992	489		
1993	333	3,090	
1994	423	0	
1995	605		
1996	180	0	
1997	369	1,226	
1998	445	7,483	
1999	53	624	
2000	37		
2001	50	1,373	
2002	29	3,808	
2003	91	299	
2004	69	1,143	
2005	142	56,460	
2006	207	2,568	
2007	202	250	
2008	202	613	
2009		4,944	

Table 2.4. Age composition sample sizes.

	East														West													total
	F				M				U						F				M				U					
YEAR	HL	LL	SSLL	SS TRW	HL	LL	SSLL	SS TRW	HL	LL	SSLL	SS TRW	E Total		HL	LL	SSLL	SS TRW	HL	LL	SSLL	SS TRW	HL	LL	SSLL	SS TRW	W Total	
1977	1				3								4															4
1978	88				17				2				107		7												7	114
1979	118	1			44	1			19		6		189										2				2	191
1980	40	44			26	17			1	2			130															130
1981																												
1982										683	13		696															696
1983										169			169												50		50	219
1984										4			4												58		58	62
1985											8		8															8
1986									4				4										21				21	25
1987																							3				3	3
1988																							9				9	9
1989																							5				5	5
1990																												
1991																							237	12			249	249
1992										11			11										31	27			58	69
1993																							6	3			9	9
1994																							2				2	2
1995																												
1996																												
1997																												
1998										5			5															5
1999			34				6		1	55	1		97															97
2000			8				1		13	85			107				30				8			5	2	6	51	158
2001	4		6		1		1		31	350		3	396				22				18		16		2	5	63	459

2002			12	4			5		20	150	1	1	193			34				8		19	2	2	1	66	259
2003		140	34			39	6		37	513	4	2	775			18	5			4		10	11			48	823
2004	3	76	18			26	4		19	350			497			18	3			6		19	41	6	6	99	596
2005		44	6			18	3		7	460			538			2						71	49		11	133	671
2006			8				6		8	277	3	1	303			24				10		46	99		13	192	495
2007		21	17			9	4		21	454	3	1	530			8				6		95	230			339	869
2008		138	2			46	1		50	413	2		652			6				2		193	412		7	620	1272
2009		14	19			2	4		6	519			564			18				8		275	475		3	779	1343
total	254	478	164	4	91	158	41	1	239	4500	41	8	5979	7		180	8	0	0	70	0	1060	1366	120	52	2863	8842

Table 2.5. Length composition sample sizes.

	East														West												total
	Female				Male				Unknown				Total	Female				Male				Unknown				W Total	
YEAR	HL	LL	SSLL	TRW	HL	LL	SSLL	TRW	HL	LL	SSLL	TRW		HL	LL	SSLL	TRW	HL	LL	SSLL	TRW	HL	LL	SSLL	TRW		
1977					3								3														3
1978	88				17				2				107	7												7	114
1979	118	1			44	1			19		6		189									2				2	191
1980	40	44			26	17			1	2			130														130
1982										683	13		696														696
1983										169			169											25		25	194
1984									71	552			623	40	26			1				54	493	29		643	1266
1985									19	469	8		496	83	84			1				494	1441			2103	2599
1986									4	598			602									370	509			879	1481
1987									39	617			656									62	197			259	915
1988									25	192			217									114	31			145	362
1989									4	214			218									86	28			114	332
1990									37	658			695									364	263			627	1322
1991	5	1							26	757			789	25	46			3	17			716	662			1469	2258
1992	28								59	896			983	1	14			1	1			837	680			1534	2517
1993	2	27			1	2			129	436			597									176	530			706	1303
1994	15	15			4				296	1347			1677	1	3							366	327			697	2374
1995	27					9			316	1420			1772		1							180	157			338	2110
1996									506	608			1114	1	2							96	115			214	1328
1997	12	9							231	1378			1630									169	20			189	1819
1998						26			227	2667			2920									56	101			157	3077
1999			34				6		188	3088	1		3317									49	162			211	3528
2000	17		8				1		96	5271			5393			15				4		2	335	1	6	363	5756
2001			6			25	1		67	2746		3	2848			11				9		20	24	1	5	70	2918
2002	20		12	4	2		5		41	1554	1	1	1640			17				4		31	3	1	1	57	1697

2003			34			36	6		50	2476	4	2	2608			9	5			2		24	18			58	2666
2004	3		18				4	1	60	2007			2093			9	3			3		24	43	3	6	91	2184
2005	7	11	6				3		48	1623			1698			1						84	60		11	156	1854
2006			8				6		64	576	3	1	658			12				5		53	115		13	198	856
2007	9	4	17				4		16	1468	3	1	1522			4				3		112	273			392	1914
2008	4	5	2				1		99	755	2		868			3				1		190	483		7	684	1552
2009	3	1	19				4		21	1343			1391	1		9				4		316	567		3	900	2291
total	398	118	164	4	97	116	41	1	2761	36570	41	8	40319	159	176	90	8	6	18	35		5047	7637	60	52	13288	53607

Table 2.6. Aging error vectors.

Mean age	otolith reading standard error	otolith weight/otolith age prediction standard error	Mean age	otolith reading standard error	otolith weight/otolith age prediction standard error
0.5	1.1	4.5	21.5	3.7	4.3
1.5	1.0	4.5	22.5	3.9	4.3
2.5	1.2	4.5	23.5	4.1	4.3
3.5	1.3	4.5	24.5	4.3	4.3
4.5	1.8	4.5	25.5	4.4	4.3
5.5	1.9	4.5	26.5	4.6	4.3
6.5	2.6	4.5	27.5	4.8	4.3
7.5	2.2	4.4	28.5	5.0	4.3
8.5	2.5	4.4	29.5	5.2	4.3
9.5	2.6	4.4	30.5	5.4	4.3
10.5	2.6	4.4	31.5	5.6	4.3
11.5	2.7	4.4	32.5	5.7	4.3
12.5	2.3	4.4	33.5	5.9	4.3
13.5	3.1	4.4	34.5	6.1	4.3
14.5	3.2	4.4	35.5	6.3	4.3
15.5	2.8	4.4	36.5	6.5	4.3
16.5	2.5	4.3	37.5	6.7	4.3
17.5	3.2	4.3	38.5	6.9	4.3
18.5	3.0	4.3	39.5	7.1	4.4
19.5	3.3	4.3	40.5	7.2	4.4

Table 2.7 Indices used in two-area SS3 model

	CM LL E		CM LL W		NMFS BLL E		NMFS BLL W	
	std index	log SE	std index	log SE	std index	log SE	std index	log SE
1991	1.749	0.281	1.706	0.180	-	-	-	-
1992	1.450	0.292	1.086	0.270	-	-	-	-
1993	0.375	0.234	1.238	0.230	-	-	-	-
1994	0.760	0.175	1.192	0.230	-	-	-	-
1995	0.735	0.185	1.006	0.270	-	-	-	-
1996	0.742	0.199	0.462	0.530	-	-	-	-
1997	0.927	0.162	0.573	0.440	-	-	-	-
1998	0.636	0.174	0.961	0.280	-	-	-	-
1999	0.775	0.178	0.868	0.300	-	-	-	-
2000	0.963	0.166	0.627	0.400	1.086	0.338	0.574	0.526
2001	0.703	0.166	0.894	0.300	0.989	0.367	0.312	0.540
2002	0.828	0.171	0.593	0.430	0.825	0.360	1.399	0.334
2003	0.980	0.161	0.856	0.320	0.819	0.440	1.336	0.314
2004	0.846	0.173	0.878	0.320	0.921	0.517	0.934	0.390
2005	1.109	0.176	1.463	0.210	-	-	0.492	0.668
2006	1.225	0.170	1.206	0.250	1.350	0.445	1.397	0.394
2007	1.413	0.163	0.816	0.370	0.809	0.948	1.448	0.387
2008	1.643	0.177	1.094	0.270	1.253	0.910	0.519	0.839
2009	1.141	0.175	1.482	0.210	0.949	0.496	1.589	0.333

Table 2.8. Indices used in three-area SS3 model

	CM LL Central		CM LL South		CM LL W		NMFS BLL Central		NMFS BLL South		NMFS BLL West	
	std index	log SE	std index	log SE	std index	log SE	std index	log SE	std index	log SE	std index	log SE
1991	1.5718	0.21	1.784	0.21	1.706	0.18	-	-	-	-	-	-
1992	1.4906	0.19	1.3356	0.32	1.086	0.27	-	-	-	-	-	-
1993	0.4888	0.46	0.2793	0.88	1.238	0.23	-	-	-	-	-	-
1994	0.9426	0.23	0.6014	0.41	1.192	0.23	-	-	-	-	-	-
1995	0.8243	0.26	0.5919	0.45	1.006	0.27	-	-	-	-	-	-
1996	0.9664	0.23	0.4618	0.6	0.462	0.53	-	-	-	-	-	-
1997	1.038	0.21	0.8105	0.31	0.573	0.44	-	-	-	-	-	-
1998	0.6348	0.32	0.6191	0.41	0.961	0.28	-	-	-	-	-	-
1999	0.866	0.25	0.6746	0.38	0.868	0.3	-	-	-	-	-	-
2000	1.0625	0.2	0.8053	0.33	0.627	0.4	0.511	0.9	-	-	-	-
2001	0.6946	0.3	0.7193	0.35	0.894	0.3	0.462	0.76	-	-	0.8648	0.29
2002	0.8188	0.25	0.8989	0.31	0.593	0.43	0.867	0.45	-	-	0.8946	0.33
2003	1.0891	0.19	0.8608	0.3	0.856	0.32	1.043	0.35	1.573	0.25	0.9408	0.26
2004	0.8815	0.24	0.8057	0.33	0.878	0.32	0.818	0.52	0.963	0.43	0.7432	0.43
2005	0.9729	0.23	1.2435	0.22	1.463	0.21	-	-	-	-	0.8136	0.45
2006	1.1739	0.19	1.2832	0.21	1.206	0.25	2.359	0.22	0.849	0.47	1.2265	0.29
2007	1.2397	0.18	1.7197	0.16	0.816	0.37	0.938	0.53	1.661	0.25	0.6495	0.78
2008	1.4818	0.16	1.8122	0.15	1.094	0.27	0.445	1.15	0.616	0.94	0.8695	0.63
2009	0.7618	0.29	1.6932	0.16	1.482	0.21	1.547	0.25	1.448	0.29	0.8987	0.4

Table 2.9. Maturity, weight and fecundity input.

	Proportion Mature at Length mat=1/(1 + exp(slope*(<size @ inflection)))	**Weight at length (kg) GW = 2.106 x 10-08 * (TL^2.910)**
	size at inflection = 54.9	a = 0.00002106
	slope = -0.33	b = 2.91
length (cm TL)	Maturity	Weight (kg, gutted)
9	0.0000	0.013
13	0.0000	0.037
17	0.0000	0.080
21	0.0000	0.148
25	0.0001	0.246
29	0.0002	0.379
33	0.0007	0.553
37	0.0027	0.771
41	0.0101	1.039
45	0.0367	1.362
49	0.1249	1.746
53	0.3482	2.193
57	0.6666	2.711
61	0.8822	3.302
65	0.9655	3.972
69	0.9906	4.726
73	0.9975	5.568
77	0.9993	6.503
81	0.9998	7.536
85	1	8.671
89	1	9.913
93	1	11.265
97	1	12.734
101	1	14.323
105	1	16.037
109	1	17.880
113	1	19.857
117	1	21.972
121	1	24.231
125	1	26.636
129	1	29.193

2.9. ***FIGURES***

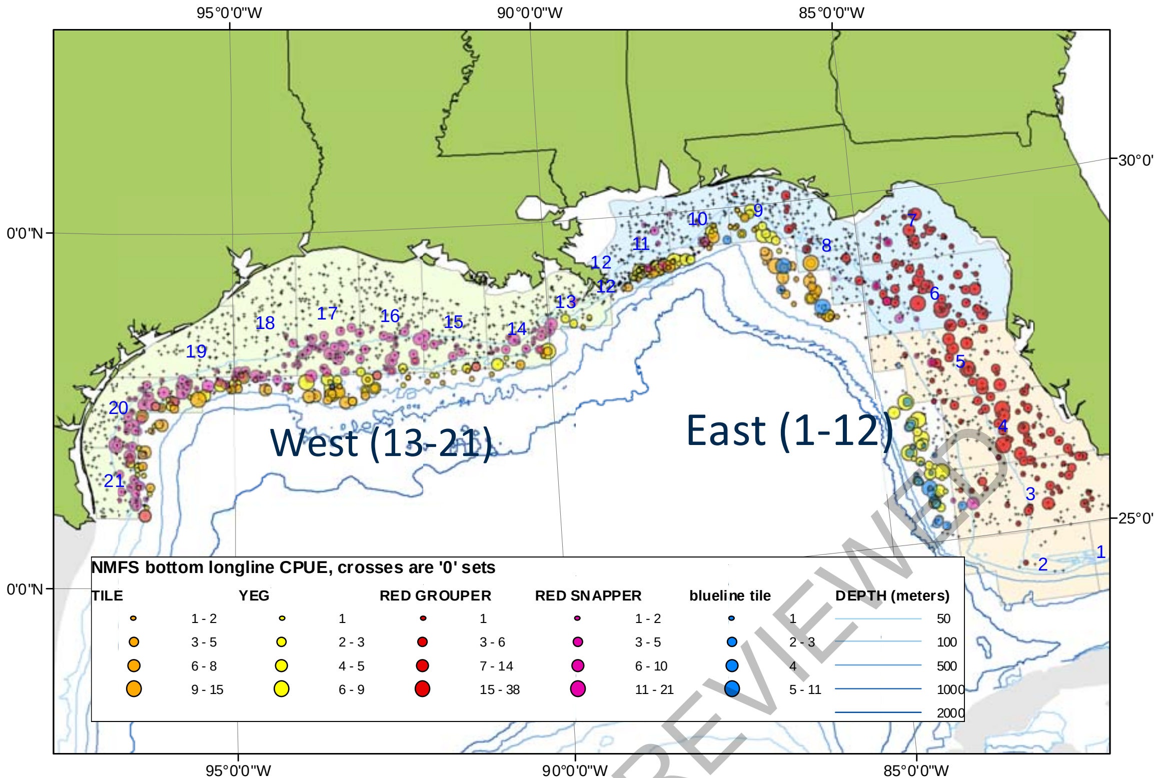


Figure 2.1. Spatial partitioning of YEG assessment model into East and West regions. Data represents NMFS bottom longline catch rates for five predominant teleosts. Dots are locations with no catch of any of the 5 species.

Figure 2.2. Spatial representation of fishing locations for the early (1982-1983) deepwater longline fleet (Prytherch 1983). A key point is the lack of separation between the "Northern" and "Eastern" grounds.

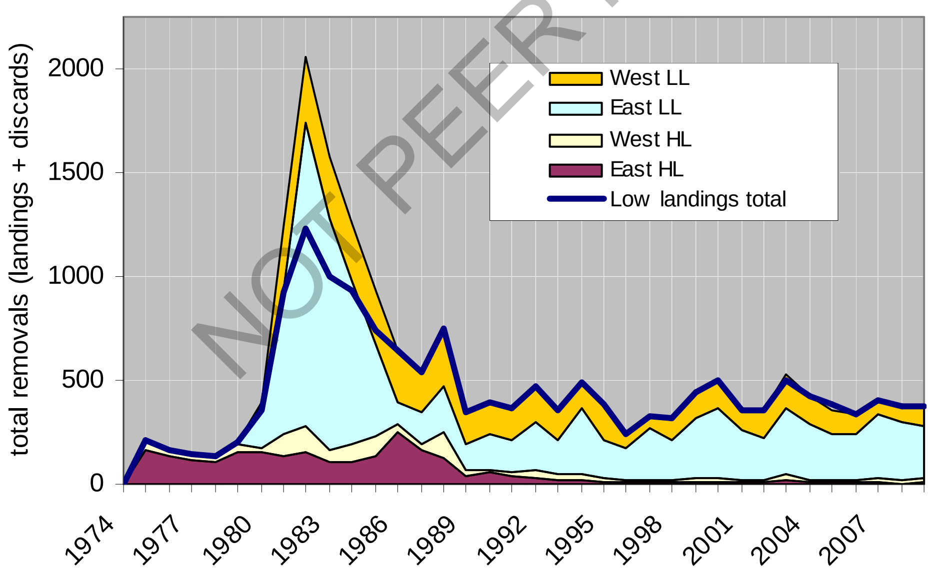


Figure 2.3. "Low" and "High" landings scenarios. Removals by fleet are shown for the high scenario where unclassified longline caught grouper in stat areas 6 and 7 are assumed 96% YEG. Only the total removals are shown for the low landings scenario where unclassified longline caught grouper in stat area 6 are assumed to be 23% YEG. The differences only apply to the longline fishery and only over the years 1980-1985.

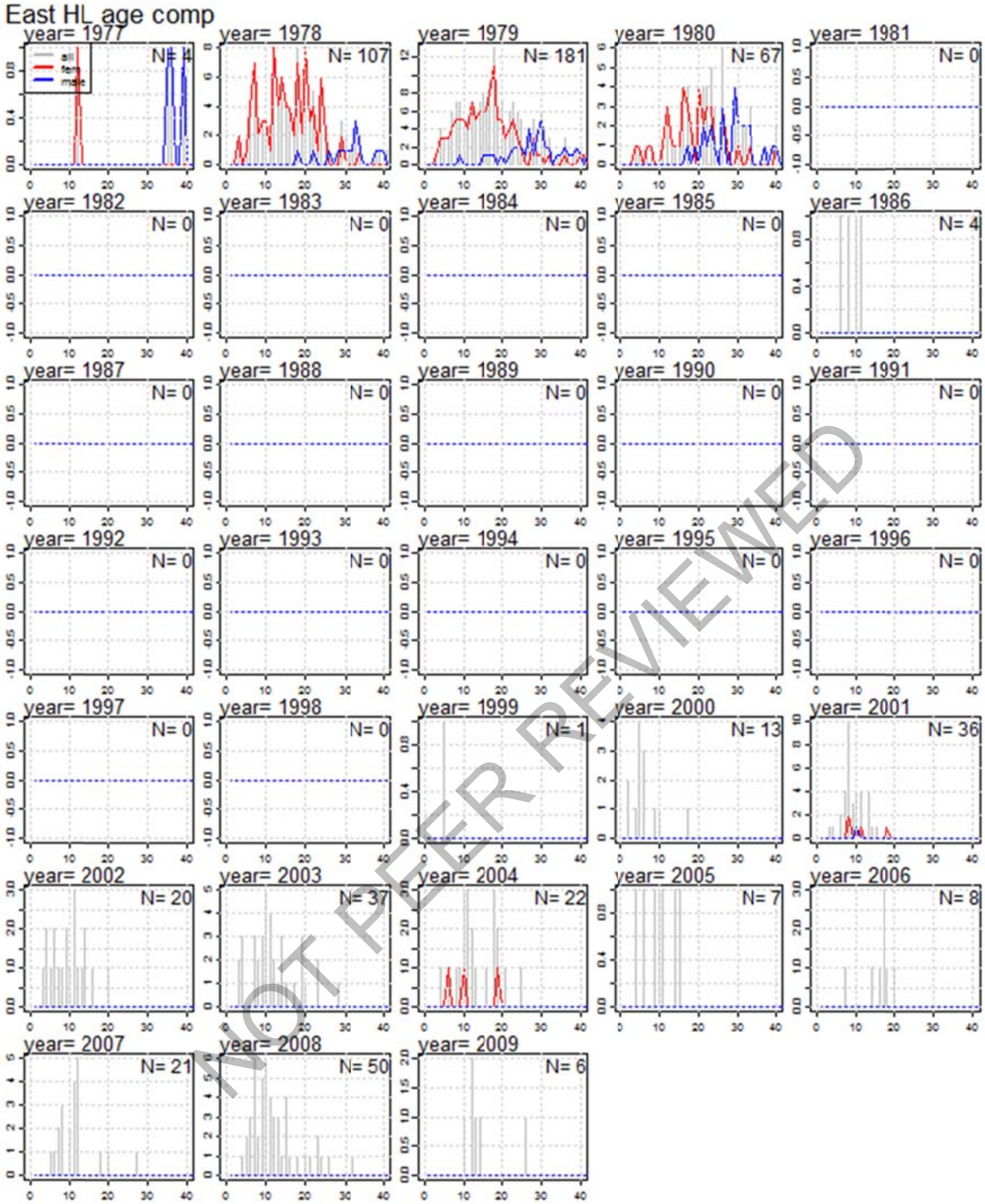


Figure 2.4. Commercial handline East age composition. Red lines are females, blue are males. Shaded bars are both or unknown sex.

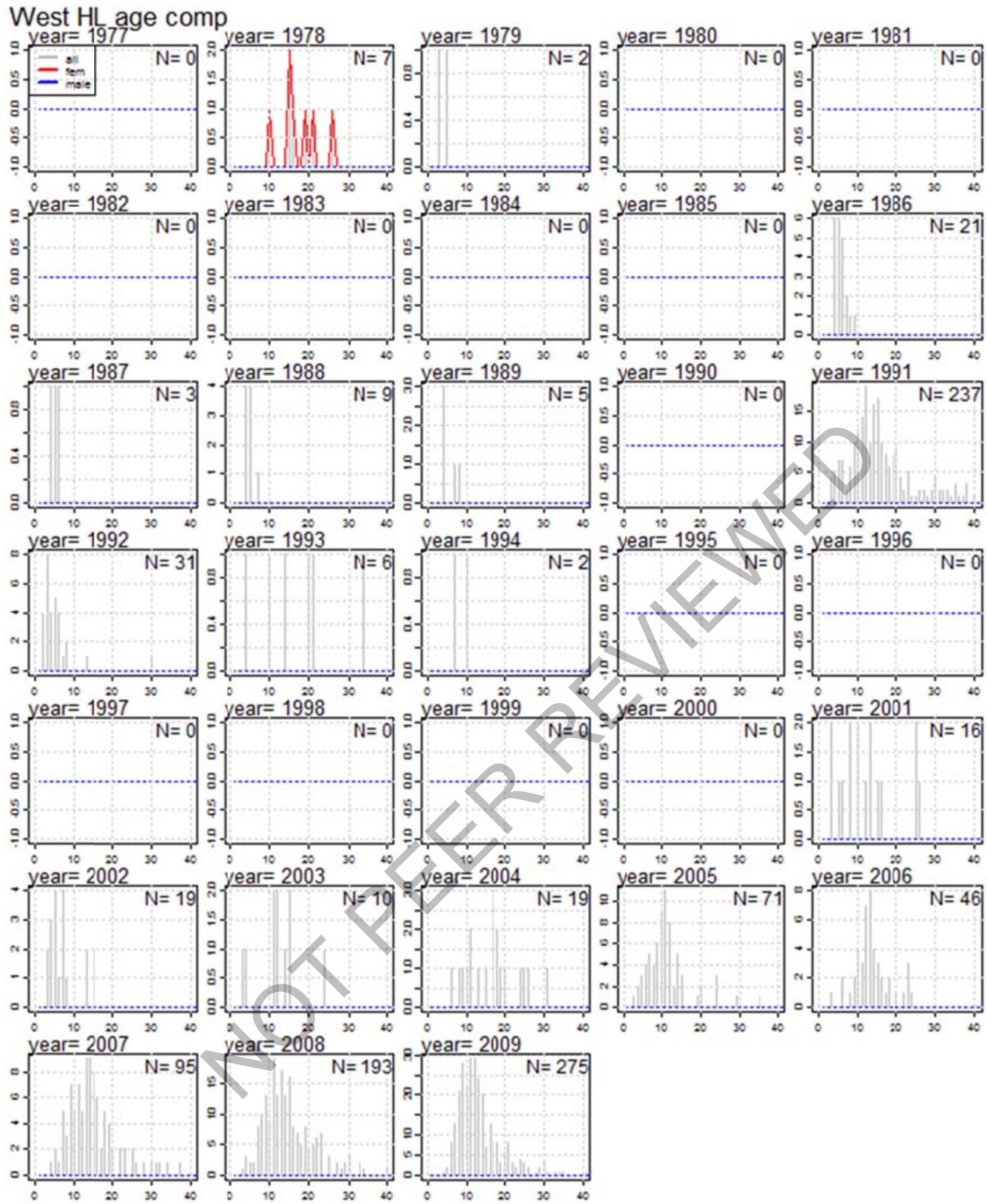


Figure 2.5. Commercial handline West age composition. Red lines are females, blue are males.

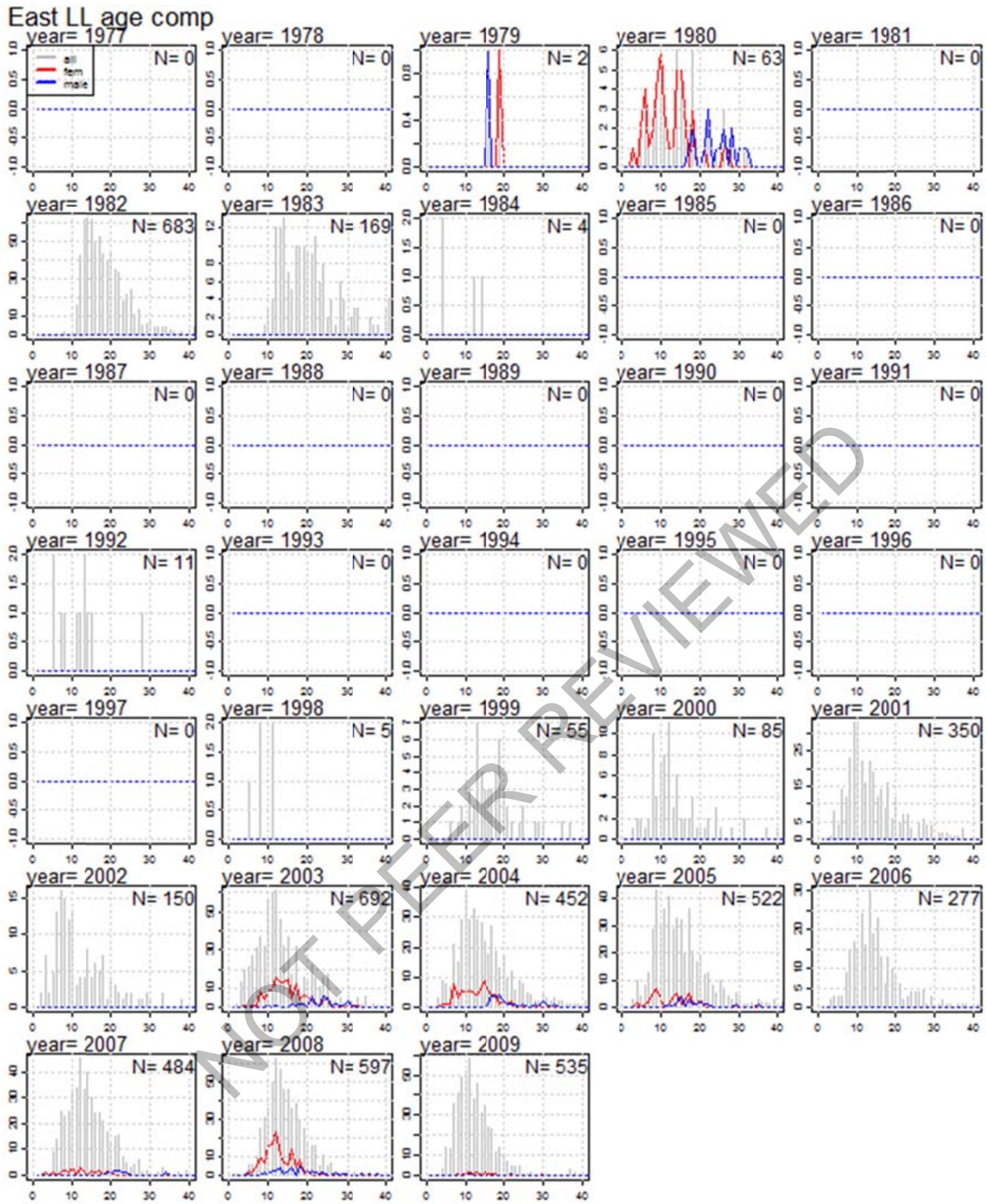


Figure 2.6. Commercial longline East age composition. Red lines are females, blue are males.

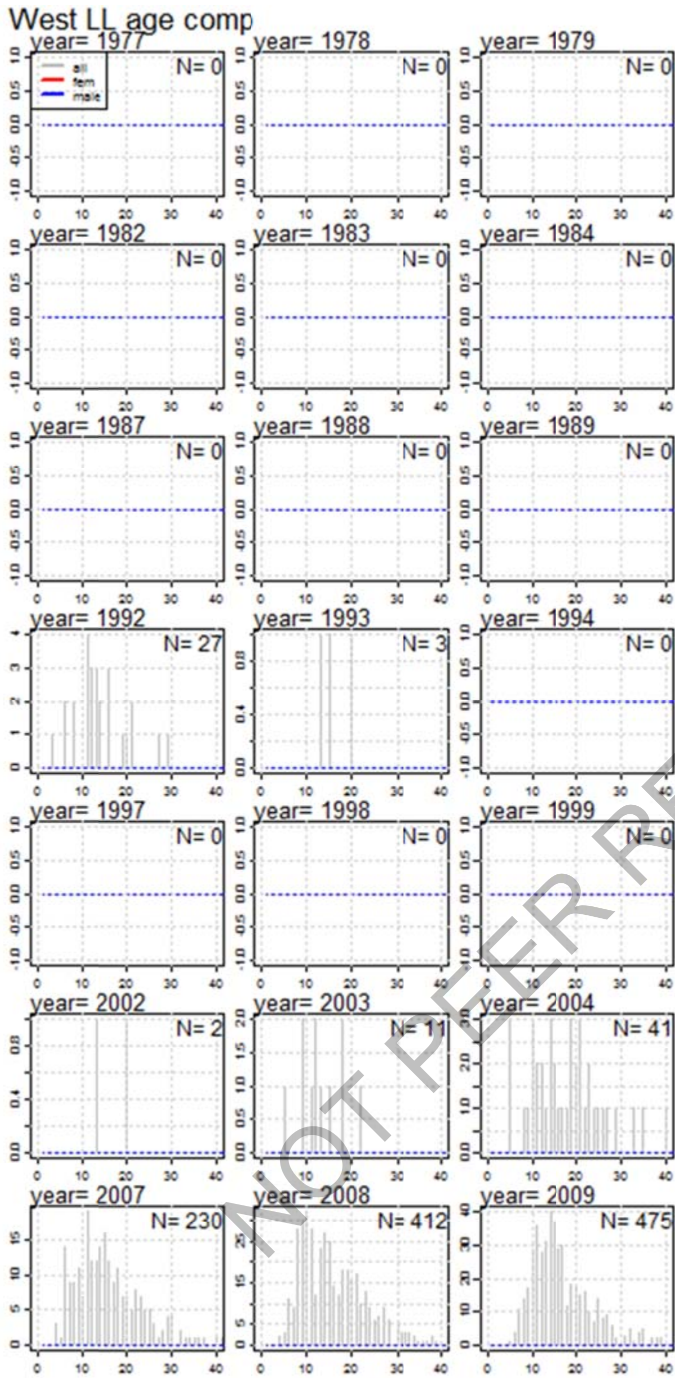


Figure 2.7. Commercial longline West age composition. Red lines are females, blue are males.

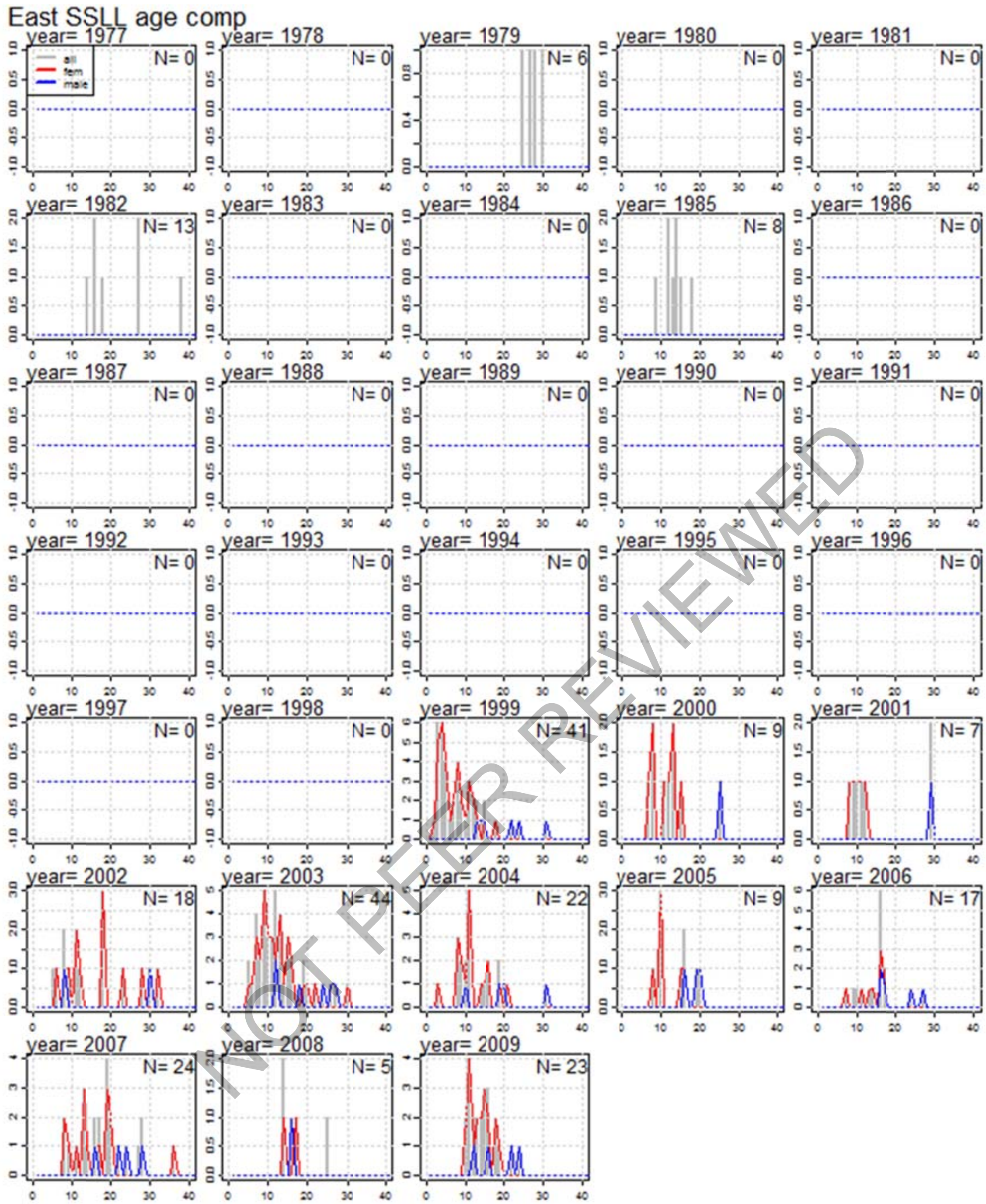


Figure 2.8. NMFS bottom longline East age composition. Red lines are females, blue are males.

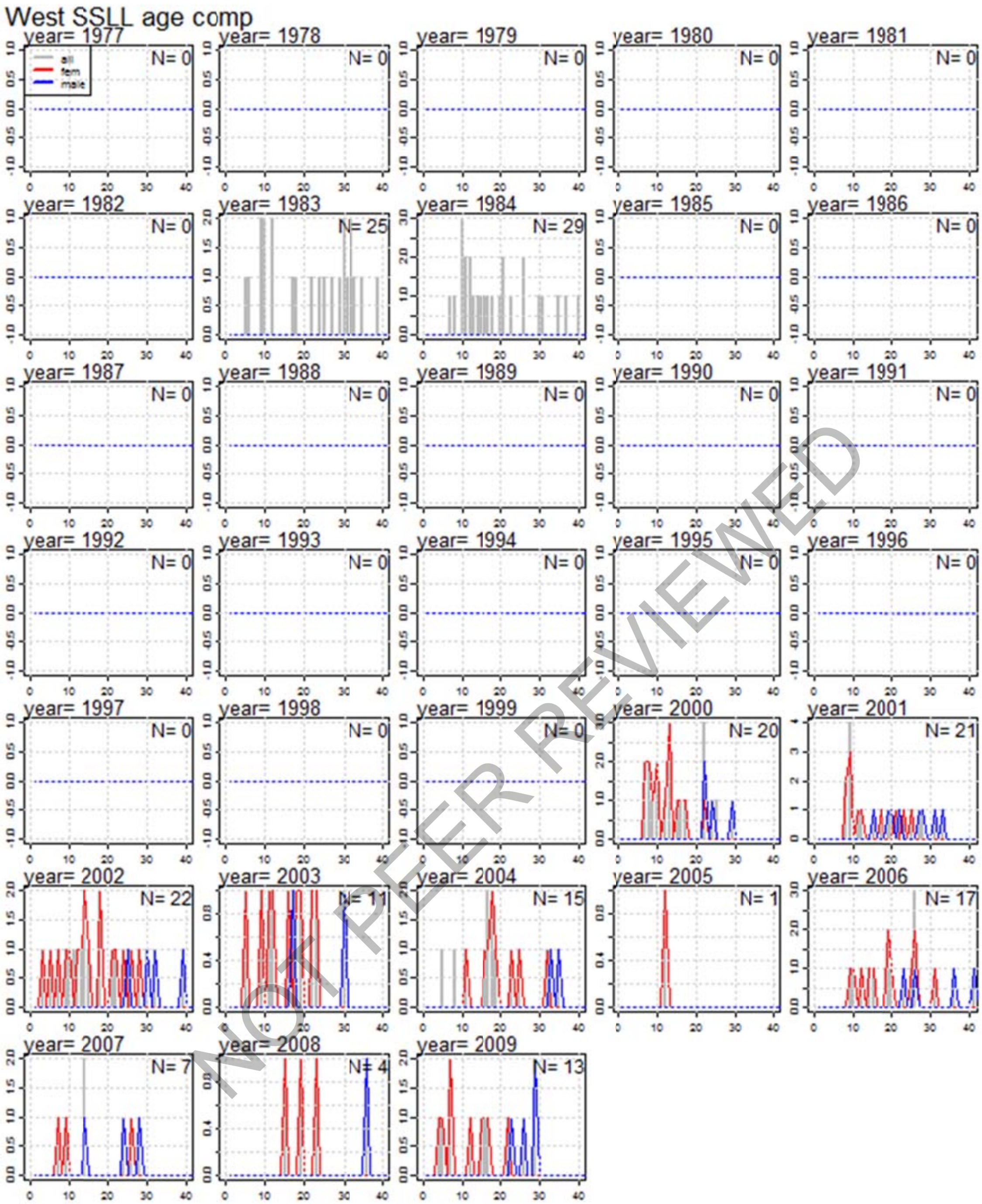


Figure 2.9. NMFS bottom longline West age composition. Red lines are females, blue are males.

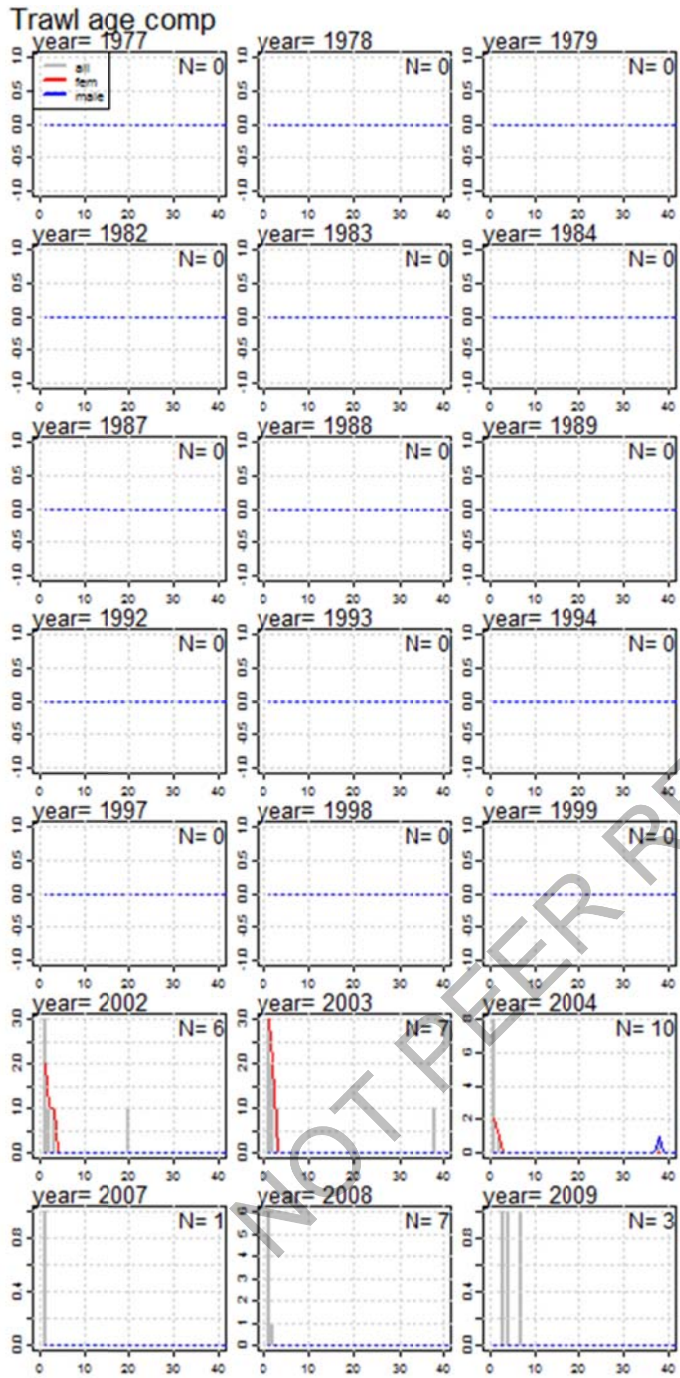


Figure 2.10. SEAMAP trawl East and West age composition. Red lines are females, blue are males.

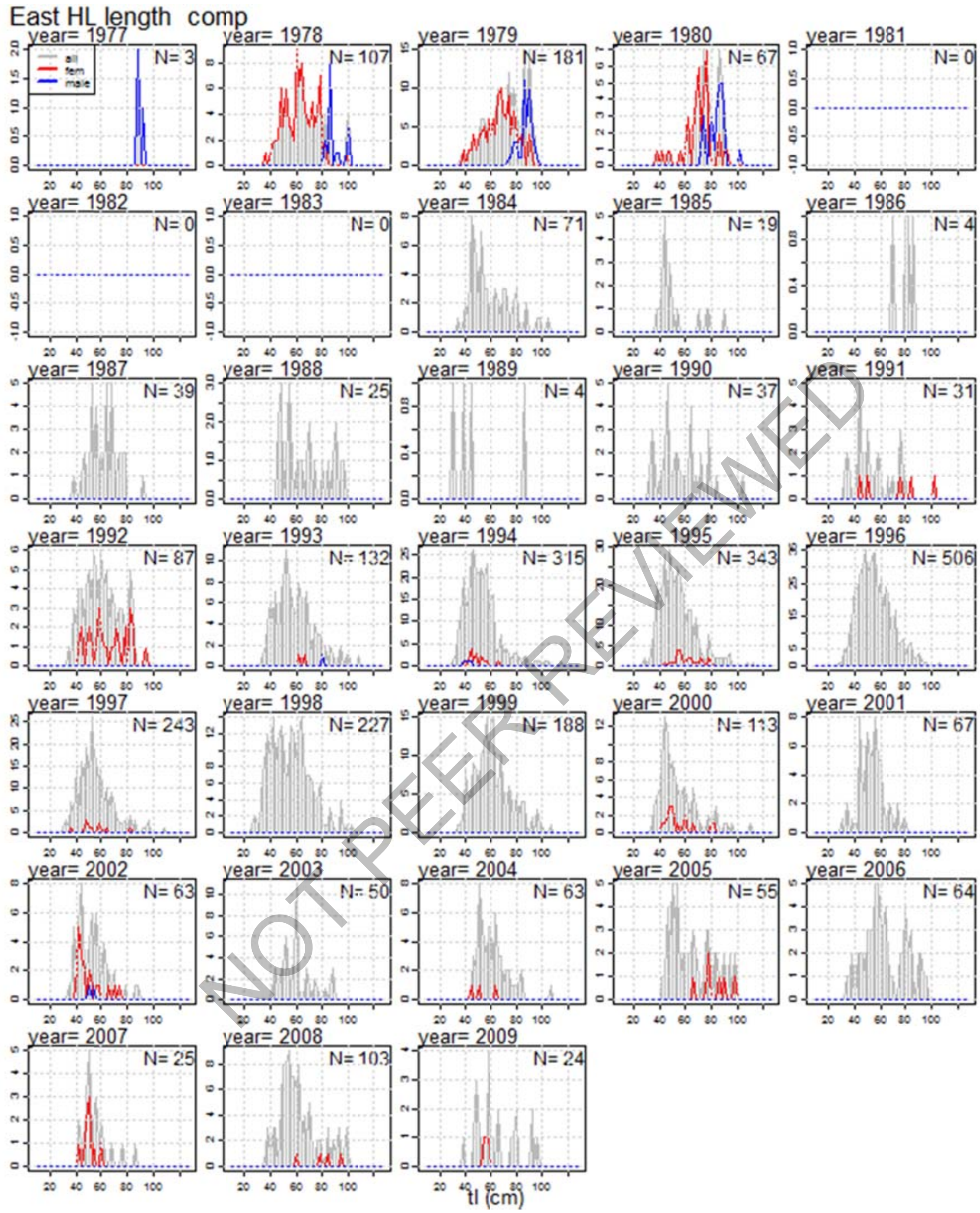


Figure 2.11.Commercial handline East length composition. Red lines are females, blue are males. Shaded bars are both or unknown sex.

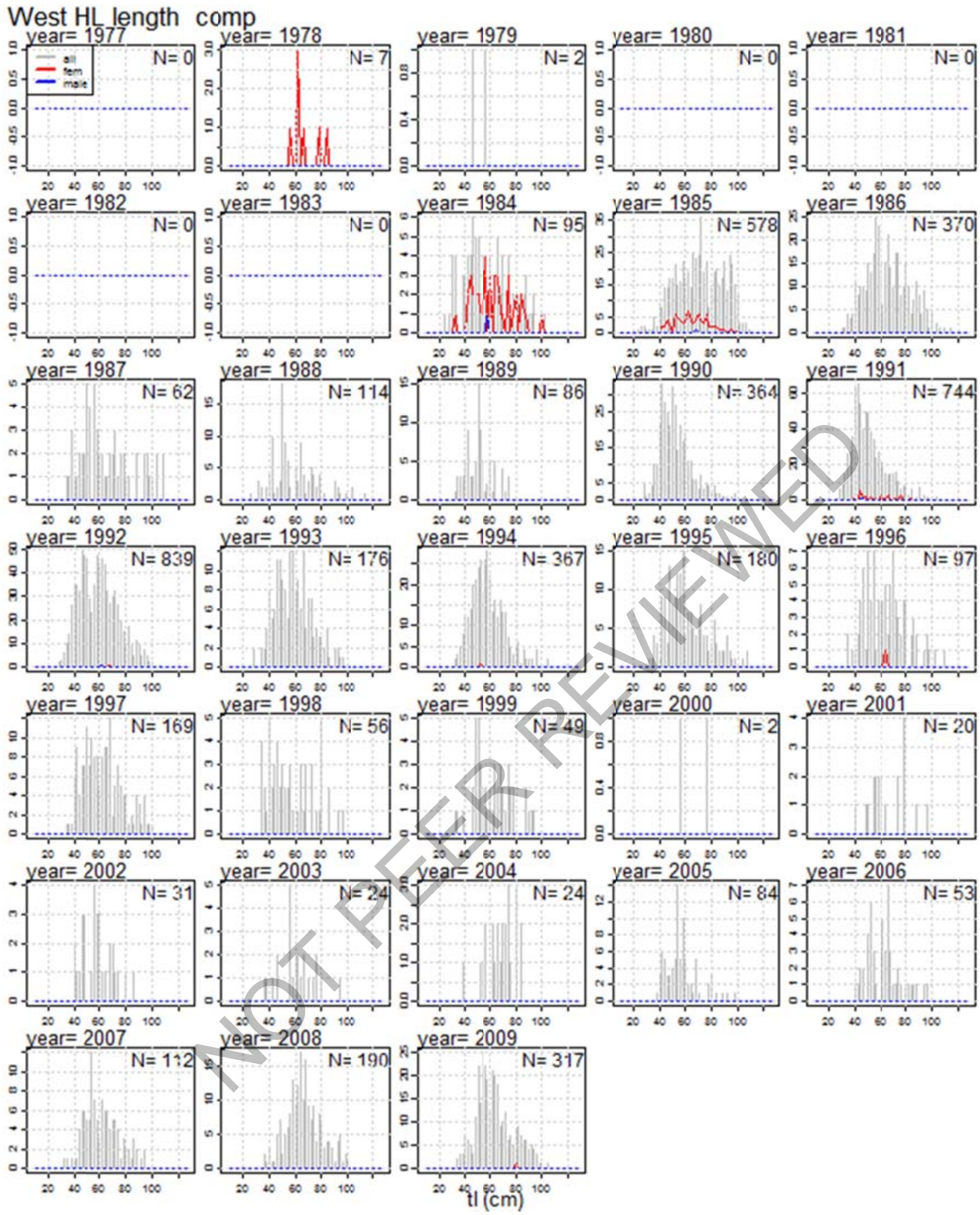


Figure 2.12.Commercial handline West length composition. Red lines are females, blue are males. Shaded bars are both or unknown sex.

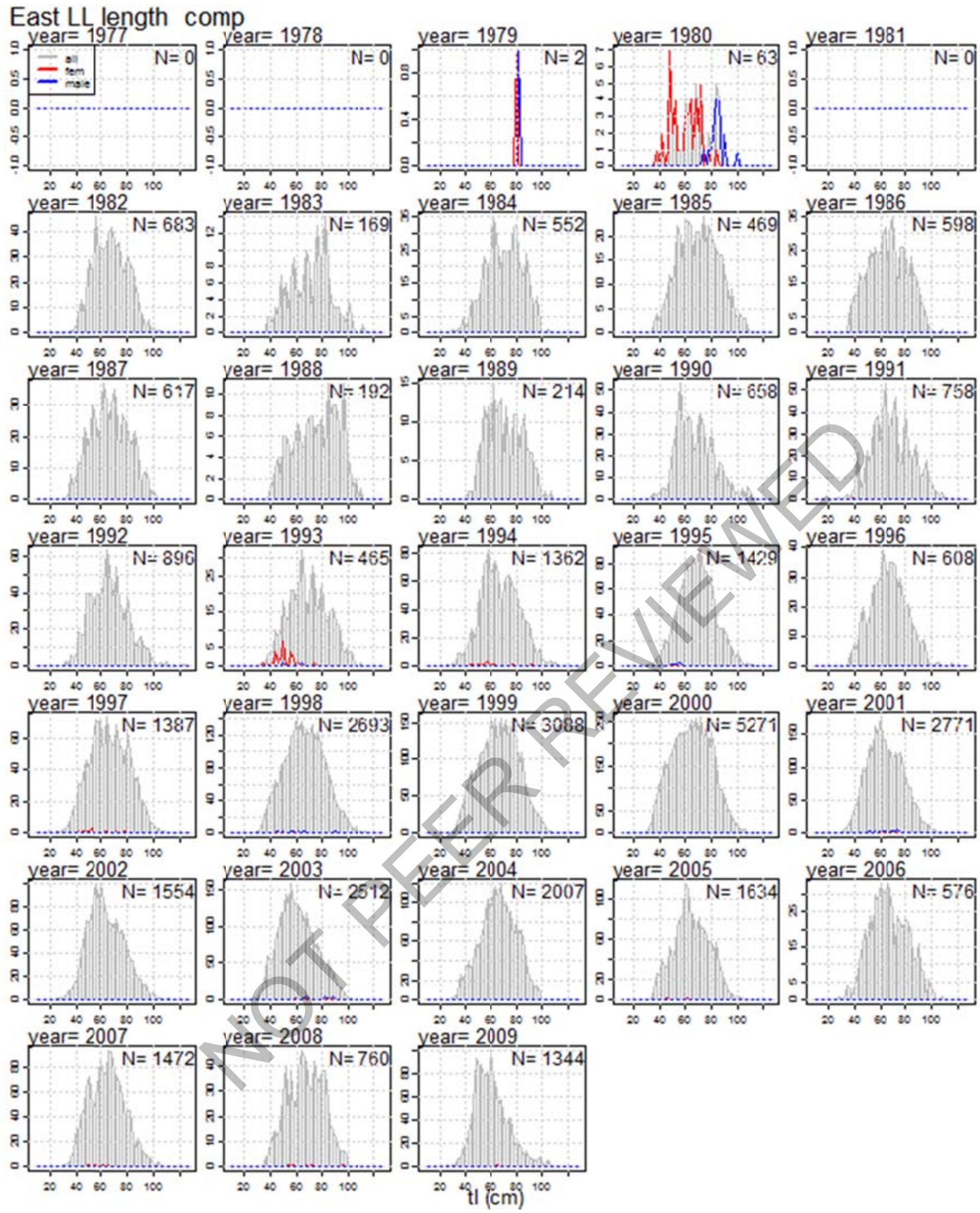


Figure 2.13.Commercial longline East length composition. Red lines are females, blue are males. Shaded bars are both or unknown sex.

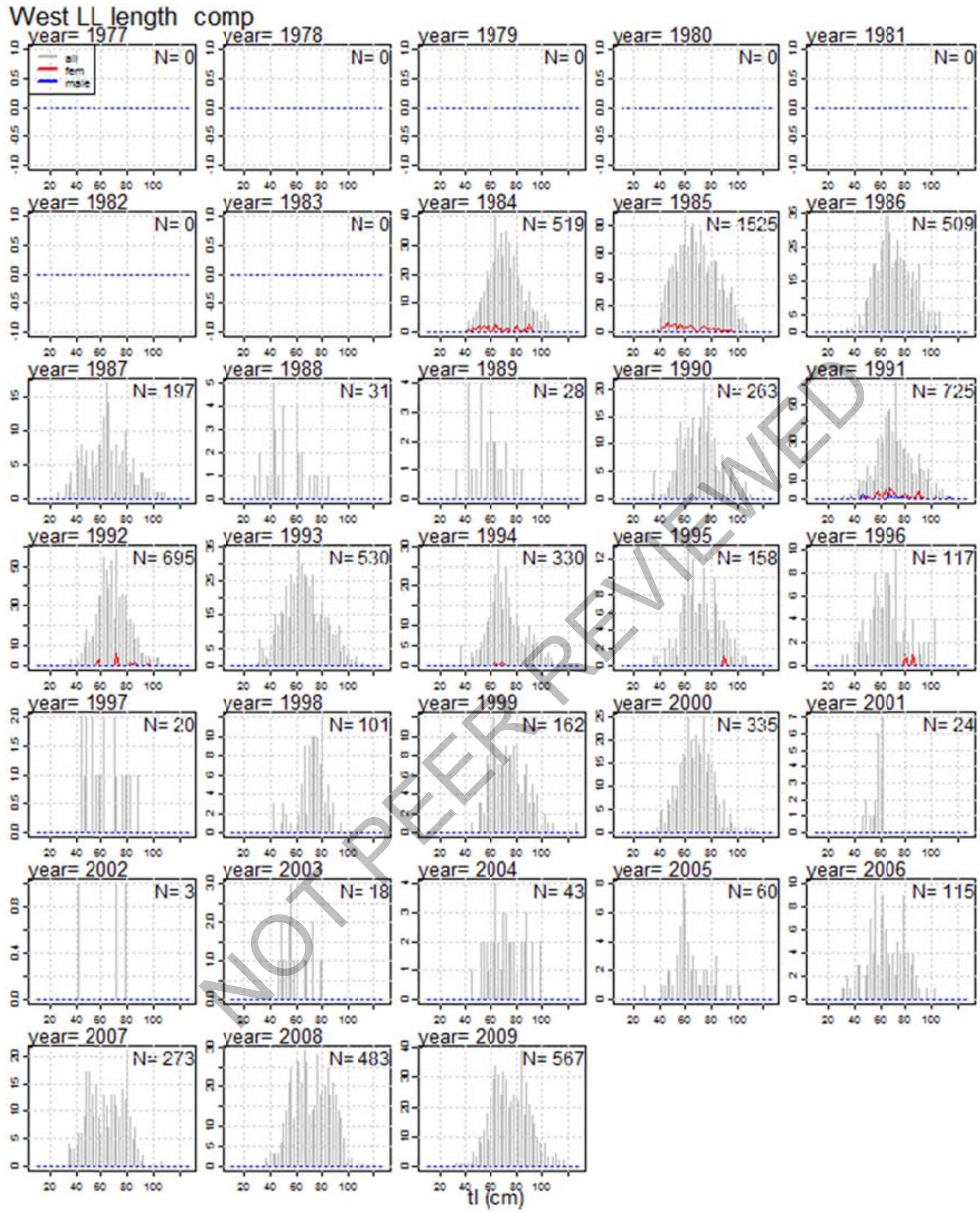


Figure 2.14.Commercial longline West length composition. Red lines are females, blue are males. Shaded bars are both or unknown sex.

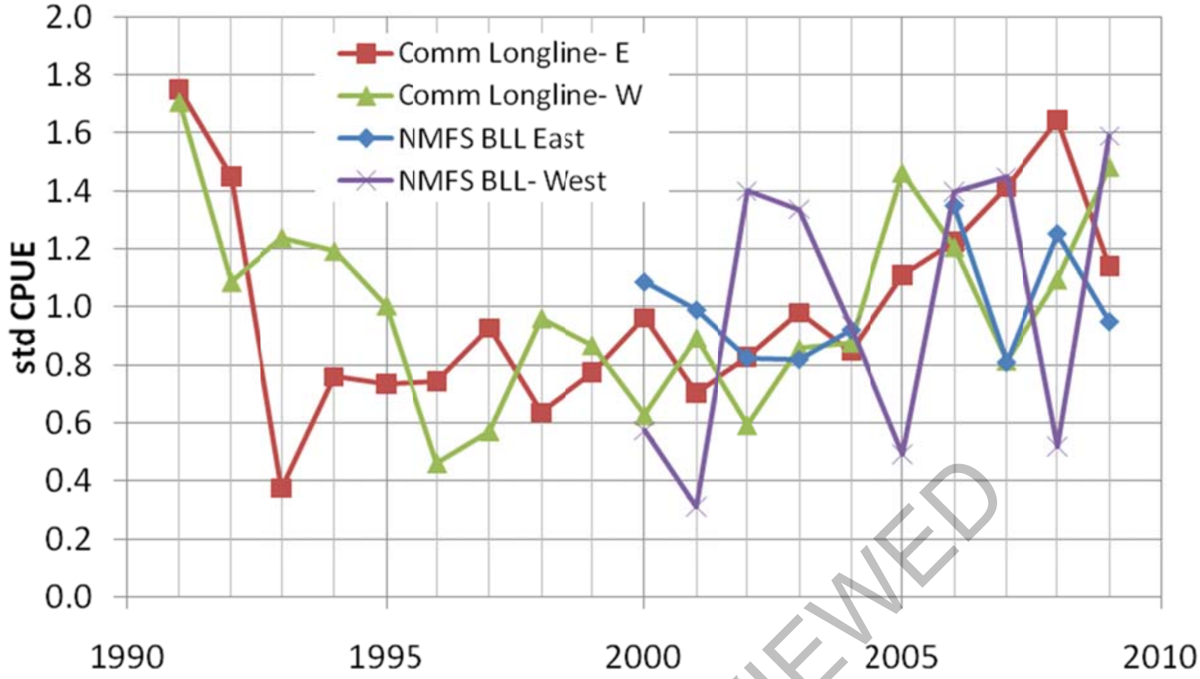


Figure 2.15. Indices used in YEG assessment.

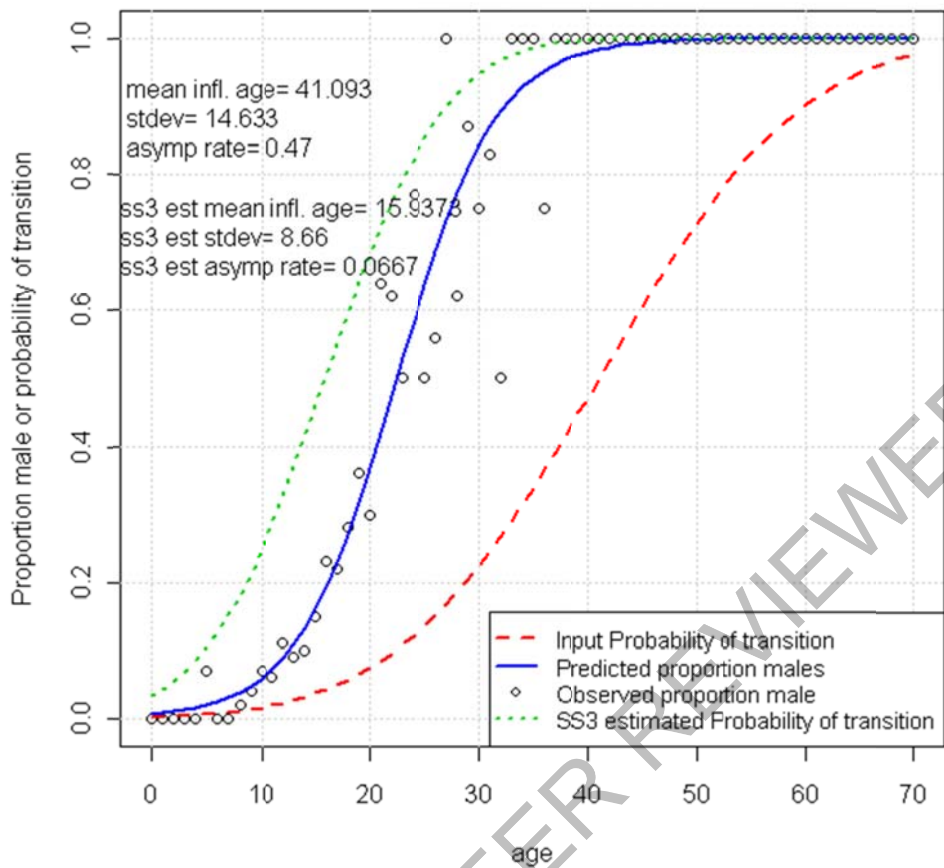


Figure 2.16. Hermaphrodite transition probability. The red dashed line is the input probability of transitioning to male at age, which increases up to an asymptotic rate. Parameter input to SSIII is as three parameters of a cumulative normal curve defining the probability of transitioning to male at age. Black points are observed proportion male at age and the blue line is a logistic model fit. The green line is the SS3 estimated transition parameters.

3. STOCK ASSESSMENT MODELS AND RESULTS

3.1. *MODEL 1: STOCHASTIC STOCK REDUCTION ANALYSIS*

3.1.1. Model 1 Methods

3.1.1.1. Overview

Stochastic stock reduction analysis (SRA) was applied to yellowedge grouper (*Epinephelus flavolimbatus*) from the Gulf of Mexico. Stochastic SRA (Walters et al. 2006) is a deterministic age structured population model with Beverton-Holt stock-recruitment function that estimates forward in time. SRA uses maximum sustainable yield (MSY) and exploitation at MSY (Umsy) as leading parameters, and given these parameters the model simulates changes in biomass by subtracting estimates of mortality and adding recruits. A single trajectory of biomass over time is produced, as well as, estimates of MSY, Umsy, Ucurrent, Goodyear's Compensation Ratio (recK), and stock status. SRA is a less data-intensive method which can help to determine how large the stock needed to be to have produced the time series of observed landings. SRA should not be a replacement for more computational complex assessment models (such as stock synthesis, referred to as SS) but used more as a tool to make possible conclusions of stock status based on historical catches and recent abundances. SRA has been applied to several Gulf of Mexico species including red snapper (*Lutjanus campechanus*, SEDAR 2005), gag (*Mycteroperca microlepis*, SEDAR 2006a), and red grouper (*Epinephelus morio*, SEDAR 2006b).

3.1.1.2. Data Sources

Stochastic SRA inputs were obtained through SEDAR 22 Data Workshop documents:

Document Reference	Parameter(s)
S22_yellowedge_DW_Final.pdf, Chapter 2 Life History	Growth parameters*
	Natural mortality
	Length at Maturity
	Weight at 100 cm
S22_yellowedge_DW_Final.pdf, Chapter 3 Commercial Statistics	Catch histories
S22_yellowedge_DW_Final.pdf, Chapter 5 Measures of Population Abundance	Indices of Abundance*

*East region designation was established after these reports were written, therefore growth parameters and indices for this region appear first in the assessment report.

3.1.1.3. Model Configuration and Equations

Stochastic SRA (Walters et al. 2006) is an age structured population model with Beverton-Holt stock-recruitment function that simulates biomass forward in time from the start of the fishery, with exploitation rates calculated each year from observed catch divided by modeled vulnerable population (sum of vulnerabilities at age multiplied by modeled numbers at age). In Stochastic

SRA, recruitment is assumed to have had lognormally distributed annual anomalies (with variance estimated from VPA estimates of recent recruitment variability), and to account for the effects of these a very large number of simulation runs is made with anomaly sequences chosen from normal prior distributions (with or without autocorrelation). The resulting sample of possible historical stock trajectories is re-sampled using Markov Chain Monte Carlo integration (MCMC). Summing frequencies of occurrence of different values of leading population parameters over this sample amounts to solving the full state space estimation problem for the leading parameters (i.e. find marginal probability distribution for the leading population parameters integrated over the probability distribution of historical state trajectories implied by recruitment process errors and by the likelihood of observed population trend indices).

The stochastic SRA is parameterized by taking Umsy (annual exploitation rate producing MSY at equilibrium) and MSY as leading parameters, then calculating the Beverton-Holt stock-recruit parameters from these parameters and from per-recruit fished and unfished eggs and vulnerable biomasses. Under this parameterization, we effectively assume a uniform Bayes prior for Umsy and MSY, rather than a uniform prior for the stock-recruitment parameters. This is an age-structured version of the stock-recruitment parameterization in terms of policy parameters suggested by Schnute and Kronlund (1996).

Natural mortality rate was treated as age-independent, and was sampled for each simulation trial from a uniform prior distribution with M ranging from 0.08-0.10.
Vulnerabilities at age were provided from SS from logistic functions of age selectivities given size selectivities and size-at-age data (SS, Asel2). Fecundity was assumed to be proportional to the differences between age-specific body weight and weight at maturity calculated from input parameters.

SRA provides probability distributions of leading parameters (Umsy, MSY) and other population parameters (vulnerable biomass, catch, exploitation), as well as the probability of the population being overfished or undergoing overfishing based on a 40/10 rule. Each of these parameters is reported with a level of uncertainty determined through MCMC resampling.

3.1.1.4. Uncertainty and Measures of Precision

Stochastic SRA uses a Monte Carlo approach, as well as Bayesian and likelihood approaches for estimating leading parameters.

3.1.1.5. Benchmark / Reference points methods

Stochastic SRA estimates benchmark for probability of overfished as the ratio of Biomass current/Biomass MSY less than 40% and the benchmark for probability of overfishing as the ratio of Exploitation current/Exploitation MSY greater than 1.

3.1.1.6. Projection methods

Stock status is projected with an exploitation rate of 0.2. This exploitation rate is roughly double the estimated exploitation rate at MSY and was used only as a placeholder rather than a meaningful projection of future fishing mortality. Stochastic SRA obtains probability distributions for future stock status using Markov Chain Monte Carlo methods.

3.1.2. Model 1 Results

Stochastic SRA model was applied to yellowedge grouper life history parameters (Table 3.1) and catch history (Table 3.2) by region (East and West of Mississippi River) in the Gulf of Mexico. Vulnerabilities at age were provided from SS from logistic functions of age selectivities given size selectivities and size-at-age data (SS, Asel2) and were the same in both regions (Table 3.3). Commercial longline indices by region were used with varying degrees of uncertainty (index standard error) and the default value for recruitment anomalies was used (1.0)(Table 3.4). An increase in the uncertainty (1.96 * CV for all years) was necessary in the commercial longline index for all data combined for a satisfactory number of model iterations. Each model was manually ceased after several million MCMC iterations (all data, 4.2 10^6; east, 4.0 x 10^6; west, 3.9 10^6).

3.1.2.1. Measures of Overall Model Fit

Stochastic SRA does not provide measures of overall model fit.

3.1.2.2. Parameter estimates & associated measures of uncertainty

Stochastic SRA model provided estimates of population parameters such as vulnerable biomass, maximum sustainable yield, exploitation (current and at maximum sustainable yield), and Goodyear's compensation ratio for each MCMC iteration. Summary statistics were calculated for these parameters given combinations of Umsy and MSY that yielded positive Goodyear's compensation ratio (recK) values.

- The eastern region of the Gulf of Mexico yielded a higher carrying capacity of yellowedge grouper compared to the western region given the historical catches (Figure 3.1, Table 3.5). Historical exploitation levels were higher in the east during the earliest years of the fishery and the west region was predicted to have higher exploitation since the mid-1980s (Figure 3.2).
- SRA model estimated maximum sustainable yield (MSY) to be higher in the east region with central tendency of MSY at 209,642 kg compared to 102,000 kg in the west (Figure 3.3).
- Exploitation at MSY was predicted higher in the western region (0.07 ± 0.01 and 0.10 ± 0.1, east and west respectively) (Figure 3.4).
- The central tendencies of current exploitation were higher in the western region (Ucurrent 0.06 ± 0.02 and 0.09 ± 0.02, east and west respectively).
- The eastern region has a narrower sample distribution of MSY values given a wider distribution of MSY and the same distribution of Umsy values as the west (Figure 3.5). Given the sample distribution of MSY and Umsy, there is a high probability that recent catches have been at MSY in the west and below MSY in the east.
- The east region had a lower Goodyear's recruitment compensation ratio (East, recK = 41.86; West, recK = 52.59).

3.1.2.3. Stock Abundance and Recruitment

Stochastic SRA does not provide measures of stock abundance. Recruitment for yellowedge grouper from each region was modeled using the default value of 0.5 for the standard deviation of recruitment without autocorrelation. Normally distributed recruitment anomalies were predicted for each region, with both regions having similar recruitment anomalies throughout the time series (Figure 3.6).

3.1.2.4. Stock Biomass (total and spawning stock)

Stochastic SRA does not provide measures of spawning stock biomass. Total egg production was calculated as a proxy for stock biomass.

3.1.2.5. Fishery Selectivity

Stochastic SRA does not provide measures of fishery selectivity.

3.1.2.6. Fishing Mortality

Stochastic SRA does not provide measures of fishing mortality.

3.1.2.7. Stock-Recruitment Parameters

Stochastic SRA does provide measures of Goodyear's Recruitment Compensation Ratio (recK) which is comparable to the steepness of the stock-recruitment curve. The east region had a lower Goodyear's recruitment compensation ratio (east, recK = 41.86; west, recK = 52.59), these recK values are analogous to steepness values of 0.91 and 0.93, respectively.

3.1.2.8. Evaluation of Uncertainty

Stochastic SRA does not provide other evaluations of uncertainty than those presented in 3.1.2.2.

3.1.2.9. Benchmarks / Reference Points / ABC values

The default benchmark for overfishing and overfished status in the SRA program employs the Pacific Fisheries Management Council 40:10 rule and is not directly comparable to the benchmarks employed by the Gulf of Mexico Fisheries Management Council. Furthermore, the benchmark used here is 40% of virgin biomass, rather than and SPR proxy, so the results are not exactly comparable to the SS3 status determination. The probability of overfishing shown in the figures and calculated here comes from the PFMC 40:10 rule whereby F is targeted to be decremented below F_{msy} when the stock is less than 40% of B_0, and F is targeted at 0 when the stock is less than or equal to 10% of B_0. This rule is shown as the diagonal line on Figure 7.Under this rule, SRA results predict yellowedge grouper in the Gulf of Mexico to be experiencing overfishing (prob. overfishing: east 68%, west 94%) and overfished (prob. overfished: east 87%, west 99%) conditions in the both regions (Figure 3.7).

3.1.2.10. Projections

Stochastic SRA projections were at a fishing mortality rate that was extremely high and unsustainable. Thus the projections indicate a stock decline, and are not particularly useful. If SRA was chosen for base model results it would be necessary to project under more realistic fishing mortality rate or TAC conditions.

3.1.3. References

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3.2. ***MODEL 2: STOCK SYNTHESIS***

3.2.1. Model 2: Methods

Stock Synthesis III (SSIII, Methot 2000) is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world. SSIII takes relatively unprocessed input data and incorporates many of the important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. In addition, SSIII can incorporate time series of environmental data. Because many of these inputs are correlated, the concept behind SSIII is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SSIII has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time period for which indices and length and age observations are available. For YEG we have the benefit of substantial age composition data from fairly early on in the fishery.

3.2.1.1. Data sources

Data sources are described above in section 2.

3.2.1.2. Model configuration and equations

Note that specific equations can be found in the technical description of stock synthesis (Methot 2000) and are not reproduced here.

Initial fishing mortality

Substantial work was conducted to track landings of YEG back to the beginning of the deep-water fishery. Based on discussions at the DW and subsequent discussions and interviews with fishermen, it appears that the deep-water fishery generally began in the mid to late 1970's. Based on this input an initial equilibrium F of zero was assumed for all fleets, under the assumption that the population started in 1974 under close to virgin fishing conditions.

Temporal domain

The model begins in 1974 under the assumption of an unfished condition. The first year of catch and data is 1975 and the modeling time period extends until 2009. Model projections were run to 2029.

Spatial resolution

Yellowedge grouper are not believed to exhibit high movement rates. This low probability of movement, coupled with their longevity and low population growth rates increases the potential that highly concentrated fishing effort can serially deplete different local concentrations, while overall catch rates and age composition fail to reflect overall population declines. To ward against such serial depletion we desired to incorporate as much spatial resolution as possible while maintaining adequate sample sizes and balance.

Furthermore there are substantial differences in habitat type between the Eastern and Western Gulf of Mexico. The Eastern gulf is dominated more by hard bottom habitats while the Western gulf has less hard structure. Yellowedge grouper utilize both rocky hard-bottom habitats as well as soft-sediment habitats and, in particular, sediments with tilefish burrows (Jones et al. 1989, Cook 2007).

Originally the model was set up to include three spatial regions (shaded areas in Figure 2.1), however, difficulties related to the assignation of age composition data and landings to the correct NMFS shrimp grid necessitated the condensing the spatial domain into Eastern (shrimp grids 1-12) and a Western (shrimp grids 13-21) regions (Figure 2.1). The three-region model also exhibited extremely poor fits to the CPUE time series as well as anomalous recruitment deviations, likely caused by the substantial mismatch between the early age composition data, much of which was believed to come from shrimp grids 4 and 5 and the historical landings which largely came from shrimp grids 5 and 6. This mis-match may have been caused by forcing the partitioning of landings between the South and a Central region when it may not be simple to partition these landings spatially given that the historical fishing grounds actually cover both locations (Figure 2.2). The most expedient solution was to combine the two areas into one.

<u>*Plus group decisions*</u>

The plus group was set at 40 for the purpose of the assessment as age and length composition information was relatively sparse with only 186 out of 8655 or 2.1% of all aged fish between 40-85 years old, growth was generally linear and size at age appears to approach the asymptotic L_{max} near age 40. Furthermore, there was little evidence of changes in selectivities from ages 39 to 40 and above.

<u>*Natural mortality*</u>

Natural mortality was initially fixed within the model to a value of 0.073 commensurate with the mean value of the most likely ranges of M based upon catch curves, maximum age- mortality regressions and other life-history-based proxies for M (SEDAR22 DW report). Within SS3, a Lorenzen scaling function was used with a reference age (the age where the input value of 0.073 was assumed to apply) was set at 15. This Lorenzen function scales M according to the growth curve, so the actual scaling of M varies between males and females and according to the growth rates in the different regions.

<u>*Growth modeling*</u>

Growth rates were estimated separately for each region and for each sex. Growth was modeled with a three parameter (L_{min}, L_{max} and K) Von Bertalannfy function. The highly variable estimation of Lmin due to very few age 0 and 1 fish caused this parameter to vary greatly which had an undesirable consequence of creating great disparity in estimated values for age 0 and 1 natural mortality due to the Lorenzen scaling according to the growth curve. For this reason the AW panel agreed that Lmin should be fixed at the mean value estimated from the separately estimated 3-parameter growth curves. This size (5 cm) was then used for all growth modeling, thus reducing the number of parameters to two (L_{max} and K) and the moderating the wild fluctuations in M for ages 0 and 1. For both sexes and for all growth curves fixed CVs of 0.1626 and 0.1165 were used for young (age<= 0) and old (age>= age at L_{max}) which generally corresponded to the CV of length at age for young and old fish. For intermediate ages a linear interpolation of the CV on mean size-at-age is used.

Maturity, fecundity and length-weight relationships

For both males and females a fixed length-weight relationship was used to obtain biomass and fecundity (Table 2.9). Fecundity was assumed to be proportional to male and female biomass. Maturity was input as fixed slope and size of inflection parameters of a logistic function of length where maturity = 1/(1 + exp(slope*(inflection))). Length weight relationships and maturity at size relationships were developed by the DW.

Recruitment partitioning, stock recruitment and recruitment deviations

A Beverton-Holt stock recruitment relationship was fit within SS3. Spawning stock was assumed to be the total spawners in all regions and a single parameter defining the fractional allocation of age 0 recruits was estimated. Recruits were then allocated to both regions based upon this estimated fraction. In the three region model, two parameters were estimated.

Two parameters of the stock recruitment relationship were estimated; R_0 or the virgin recruitment level and steepness. A third parameter, sigmaR or the standard deviation in recruitment was input as a fixed value for reasons that will be described below. Rarely is sigmaR directly estimable from the given data and hence it is often necessary to input it as a fixed parameter.

Recruitment deviations were estimated starting in 1967 and ending in 2000, as this is the last year that reliable age or length composition would give information on recruitment deviations. I began the early recruitment deviations prior to the start of the model because the initial age and length samples contain signals of recruitment several years prior. A ramp in recruitment bias adjustment was initiated in 1967 ramped to the full bias adjustment of 1 in 1977, kept at 1 until 1999 and ramped down to zero in 2000. No forecast recruitment deviations were estimated.

In theory the SEAMAP trawl survey length composition samples should provide some recruitment signal, however the very small samples sizes gave very odd, and, likely spurious, recruitment patterns. I deemed it not prudent to allow one or two fish to constitute all of the evidence for or against a recruitment deviation. This logic is similar to the logic that lead the DW panel not to recommend using the trawl survey index in the model due to low numbers of fish and low likelihood that the survey adequately captures a recruitment signal.

Modeling conditional age at length

SS3 provides the option to model the age composition as a set of conditional ages at length. This modeling framework operates similarly to an age length key where a distribution of ages is input for a given length bin. This modeling approach is recommended (Methot 2010) and avoids double use of fish for both age and size information because the age information is considered conditional on the length information, contains more detailed information on the variance of size-at-age and provides better ability to estimate growth parameters and the age composition need not be selected completely at random. Thus data collected in a length-stratified program can be incorporated, provided there is no bias for a particular age within a length bin (such as might occur if fish only are captured when they mature). This was particularly useful due to the potential for biased sampling of larger fish for otolith aging identified in SEDAR22-DW-09. The age composition data was input in this manner with ages assigned to 2 cm length bins with the length bins ranging from 8 to 128 cm and the ages from 1-40 where 40 represents a plus group age.

Selectivity modeling

For all fleets, only length based selectivity was estimated and selectivities within a fleet or survey for both areas were mirrored. This means that a single selectivity was estimated for the handline fishery for both East and West regions. The handline fishery and the NMFS trawl survey selectivity were modeled with 6 parameter double normal functions (option 24 in SS3), which allow for either asymptotic or dome-shaped selectivity. A dome-shape could be possible for the handline which could be limited by maximum depth but the double-normal function does not necessarily pre-suppose a dome-shape to be the case. A dome-shape is most likely the case for the trawl survey which fishes at the shallowest depths inhabited by YEG and rarely captures large fish either due to gear avoidance, depth or movement of YEG into untrawlable habitat. For the handline fishery the initial selectivity parameter (selectivity at the smallest length) was fixed to a very low value as fish below 30 cm were never captured. This reduced the number of estimated selectivity parameters for this fleet to 5.

For the commercial longline fishery and the NMFS bottom longline fishery selectivity was modeled with a two parameter logistic function. No parametric prior distributions were used for the selectivity modeling other than for the time block estimates. Only likely min and maximum values were given for other parameters.

The longline fishery selectivity was modeled with two time blocks: 1975-1985 and 1986-2009. These time blocks were designed to account for the beginnings of the longline fishery when vessels often carried both longline and handline gear (Prytherch 1983) and used both interchangeably and a later period reflecting the more recent specialized deep-water longline fishery. During that early time period the length composition of the longline caught fish closely resembled those caught on handlines (Figure 32 in Bullock and Smith 1991). One sensitivity run examines the impact of using a single selectivity for the commercial longline.

Age-based selectivities were not estimated. The ‘realized’ selectivity for a fish of a given age was then assumed to be only a function of its size. As the apparent selectivity is the vector product of age and size selectivity, we assumed that the modeled size of the animal already incorporated all age-based factors. We feel that there is no clear rationale for modeling age-based selectivity in addition to length-based selectivity. This is consistent with the assumption that most of the factors that affect selectivity (hook size, fishing location, fishing method) operate largely upon size or length rather on fish age.

Hermaphroditism

Within SS3, sex change is modeled with 3 parameters (inflection age, standard deviation and an asymptotic rate) that define a cumulative normal distribution for the probability of transition of females to males as a function of age. Initially the three input parameters were estimated externally from the observed sex ratios (Figure 2.13) but then were allowed to be estimated within the assessment model from sex-specific age and length composition data.

3.2.1.3. Parameters estimated and prior distributions

A total of 73 parameters were estimated for the 'base' model (Table 3.6, Figure 3.9, though the recruitment deviations are not shown on the plot) with specific sensitivity runs adding other or removing other parameters. Table 3.6 provides a table of parameter and their estimates from the base model run, starting values, minimum and maximum values, parameter estimates for the base model and as well as asymptotic standard deviations.

Steepness and the selectivity block multipliers for the commercial longline selectivity were the only parameters given prior distributions. Steepness was given a symmetric beta distribution with a min and max between 0.4 and 0.99, a central tendency of 0.7 and a standard deviation of 2. The symmetric beta distribution penalizes departures from central tendency with a penalty proportional to the standard deviation (Figure 3.9). In this case the prior distribution for steepness is relatively non-constraining except at the boundaries of the distribution. For the selectivity block multipliers a standard deviation of 0.2 was used which represents a very diffuse prior on the estimated change in selectivity. The selectivity change parameter is estimated as an offset from the initial baseparm where the selectivity parameter = baseparm * exp(blockparm).

3.2.1.4. Uncertainty and measures of precision

Uncertainty of parameter estimates was evaluated in two ways, first by obtaining the asymptotic estimates of variance by inverting the information matrix (hessian or the matrix of second derivatives) and second through Markov Chain Monte-Carlo (MCMC) estimation within the SS3 model. For derived parameters such as spawning stock biomass the variance is calculated through the delta method.

3.2.1.5. Benchmark and reference point methods

Benchmarks were calculated at Fmsy, F at 40% spawning potential ratio (F_{SPR40}), F at 30% spawning potential ratio (F_{SPR30}),and F at 40% of virgin biomass ($F_{40virgin}$). Fishing mortality was calculated as the exploitation rate in biomass. This value represents a useful proxy for an instantaneous fishing mortality rate when there are multiple areas, and multiple fisheries with different selectivity patterns. As the above reference points are all calculated with respect to this F proxy, they scale appropriately. For spawning stock biomass, both males and females are included according to recommendations in Brooks et al. (2007) that when the potential for decreased fertilization is moderate or unknown spawning stock biomass of both males and females should be used. For determination of current status F and SSB in 2009 are both used rather than some average over several years.

3.2.2. Model 2 Results

3.2.2.1. Sensitivity analyses on inputs (scoping and profiling for stp, Ro, etc)

<u>*General description*</u>

The basic modeling strategy presented here begins with a series of scoping or ranging model runs to define the range and sensitivity to some basic inputs. The model runs are organized in Table 3.7. The first model results (3.1.2.8.1) presented are a series of 'scoping' runs or sensitivity runs that are critical for determining appropriate input parameters as well as determining the estimability of several critical inputs. The first series of runs evaluate the value of sigma R, or the standard deviation of recruitment. Methot and Taylor (unpublished ms) advise testing the sensitivity of the root mean square error (RMSE) of the recruitment deviations to a range of values of sigma R with the goal of achieving an RMSE that is slightly less than the input value of sigmaR. Rarely is sigma R directly estimable from the data, so it is rather critical to specify an appropriate value of sigma R.

The second run involved exploring the likelihood to various levels of reference age for the Lorenzen natural mortality scaling. As this reference age is chosen so that the 'target' M corresponds to the chosen age, this choice could be perceived as arbitrary, and the resulting choice could drive the assessment outcome. Setting the target age to a young age effectively drives down the natural mortality, setting it to an old age drives up the overall M. Thus exploring the sensitivity of the likelihood can help to determine the most appropriate age.

The third scoping run is to determine the estimability of the steepness parameter. Often without strong contrast in spawning stock and clear recruitment signals, it may be difficult to estimate steepness. Overall likelihoods for models with different levels of steepness will have similar values resulting in a shallow or smooth likelihood profile. In these situations, it may be necessary to input a tighter Bayesian prior on steepness, to fix a value of steepness to some desired level or, ultimately, to abandon the hope of estimating an appropriate steepness and to employ proxies for MSY when the stock-recruitment relationship is poorly determined (Restrepo et al 1998). Thus the main goal here is to determine whether we can properly estimate the stock-recruitment relationship, or if our input values wholly determine the outcome.

The last scoping run was similar in that evaluates the likelihood at various levels of virgin recruitment (R0) to determine the shape of the likelihood surface to various levels of virgin recruitment. The concept here is similar to the likelihood profiling on steepness to determine whether we can properly estimate the level of virgin recruitment or if our input values wholly determine the outcome.

Scoping on sigma R

Values of sigma R above 0.3 all lead to estimated RMSE > sigma R (Table 3.8). In these cases, the input value of sigma R creates recruitment variability not necessarily observed in the data. It appears that there is rather little information in the data on recruitment variability as when estimated sigmaR is 0. Given the recommendations of Methot and Taylor (unpublished ms) to choose a sigmaR >= RMSE, or conversely to explore a range of sigmaR until it meets the above condition, the recommended value is 0.2. Derived and estimated benchmarks for different values of sigmaR clearly show that setting this value can have a substantial impact upon the assessment (Table 3.9). But if we assume that values of sigmaR for which sigmaR < RMSE represent situations where the input value is creating spurious recruitments we can rule out these runs. In addition we can likely use the lowest value of sigmaR as some indicator of stock results in the absence of recruitment deviations, which, in this case, appear to be a worst case scenario over all values of sigmaR.

Profile for reference age (5,15,20, 25) for natural mortality scaling

The choice of a reference age for the natural mortality scaling is, unfortunately, not a neutral decision and it may not be possible to rely solely upon the data to determine the appropriate age. As the reference age increases we obtain a lower likelihood and better fit (Table 3.10) , however the practical result is that of increasing the total mortality experienced, in the same manner as actually increasing or decreasing the reference M (Figure 3.10). To choose the reference age I derived the Lorenzen curve with initial estimated of the growth curves from SS3 and a target M of 0.073. On the basis of the function, the age which corresponded to M=0.073 was 15 and this was the input value to for SS3. However, this decision represents an assessment uncertainty. Given the direct scaling of M which occurs with different reference ages, this uncertainty in the reference age will likely be very similar to the sensitivity runs that scale the actual value of M.

Scoping on steepness

These runs evaluate the likelihood components for various input values of steepness to determine the direction that the model estimates steepness (Table 3.11). Without substantial contrast in stock and clear evidence of recruitments, it may be unlikely that steepness can be estimated well. It appears that the model tends to estimate very high values of steepness, but there is very little contrast between values of 0.7 and 0.99. Because of this the AW panel recommended employing proxy benchmarks which avoid the explicitly modeling or choosing of a value for steepness. These proxy benchmarks will be discussed in a following section.

3.2.2.2 Base model results

General description

This set of model results (3.1.2.8.2.) is the 'Base' or most likely model formulation based upon the previous scoping runs and decisions made by the AW panel. Key characteristics of the model are as follows:

- 2 areas, East and West
- Separate sexes, with estimated sex transition from female to male
- 4 estimated growth rates (male, female, East and West)
- single input mortality rate, scaled with the Lorenzen function
- 4 fleets: Commercial Longline, E and W Commercial handline, E and W

- 4 indices: Commercial Longline, E and W and NMFS bottom longline, E and W
- 2 Surveys: NMFS bottom longline, SEAMAP trawl survey
- 4 Estimated selectivities: Commercial Longline: Logistic

  Commercial Handline: double normal

  NMFS bottom Longline: Logistic

  SEAMAP trawl: double normal
- 73 estimate parameters

Measures of overall model fit

Overall the model fit to the CPUE indices is rather poor. The model fails to fit the increases int commercial longline index in the East but does at least fit the West index somewhat. The CVs on all indices were quite high so the model is not terribly restricted to fit the indices. Furthermore the indices only contribute a small amount to the total likelihood (-23.7) indicating that they are not terribly influential on the overall results (Table 3.12). Note that the negative value indicates that fitting the index improves the likelihood (subtracts from the overall likelihood). In contrast, the likelihood components for the age (9317) and length composition (4170) indicate that these components have the greatest influence on the model.

The fits to the length composition are relative good, for the cell (year, region, fleet, sex) combinations that have adequate data (Figures 3.12-3.35). Fits to the length composition data can also be evaluated by plots of the Pearson residuals (Figures 3.36-3.54). The residual are plotted as with solid circles as positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed). There are few strong patterns in the residuals other than what appear to be small clumps of missing or higher than predicted numbers of fish in certain lengths. These may be a function of the patchy distribution of the fish and the fact that length composition samples might be more of a cluster sample than actually independent samples.

Fits to the conditional age at length can be evaluated by looking at the Pearson residuals to the age at length fits (Figures 3.55-3.76). Generally, where there are sufficient samples, the plots should represent random variability around the population growth curve. As an example of a poor and highly problematic fit, I have included the residuals around the fits to the ages obtained from the 1982-83 otolith weight-otolith age regression (Figure 3.77). Clearly these did not fit the population growth curve and the result of including these data points was that the model created entirely spurious early recruitment deviations to fit them. Growth curve fits and the Lorenzen M scaling are shown in Figure 3.78. The growth curve fits reflect documented spatial variation in growth rates with fish in the East, or at least in the South, being smaller at age than in the West. The growth curves differ substantially at young ages from growth curves brought to the data workshop because of the strong influence of the estimated selectivities upon the observed sizes at ages. It is likely that these growth curves better represent the population, to the extent that the estimated selectivities provides a scaling factor between the observed size at age and the population size at age.

The fraction of males at length and age obtained by estimated the probability of transition are shown in Figure 3.79. The fraction of males-at-length indicate a higher fraction of males at length between 60 and 80 cm and a lower fraction of males between 80 and 120 cm than in the observed input data. In addition the fraction of males-at-age are lower than the observed data. These differences are most likely attributable to the joint estimation of growth and selectivity and to the different data sets used for to empirically estimate the sex ratios versus the data in the assessment. The observed data comes from 712 female and 221 male fish obtained from 1999-2009 whereas the sex composition data in the assessment includes the fish from prior to 1999 as well as the fish measured and sexed in the TIP program. As the actual sex ratios are an source of uncertainty, one of the sensitivity runs uses just the input probabilities rather than estimating them.

Parameter estimates and asymptotic standard errors for are given in Table 3.6. The standard errors appear quite low on all parameters, except they are very high for the recruitment deviations, indicating that the recruit deviations are quite poorly estimated. This is likely due to an absence of clear and identifiable cohorts in either the age or length composition, with the exception of the 1993 year class which might actually appear as a cohort in the age comp (Figures 2.6 and 2.7).

Stock abundance, stock biomass (total and spawning stock)

Predicted total biomass (mt), spawning biomass (mt), age-0 recruits (thousand fish), and fishing mortality for are given in Table 3.13. Total biomass, spawning depletion (relative to virgin biomass and region-specific total and spawning biomass are plotted in Figure 3.80. The general biomass trend is a steep decline starting in the early 1980s, commensurate with a dramatic increase in F, then a leveling off since around 1993 (Figure 3.81). This generally matches the rapid expansion of the deep-water longline fishery in the early 1980's and its rapid movement inshore to target red grouper. It is likely that there would have been an extremely strong decline in CPUE during this time, but unfortunately we do not have any indices from before 1995. The time period covered by the indices is largely after most of the major population changes predicted by the model.

These population changes can be seen in the plots of the numbers at age by year for both sexes in the East and West (Table 3.14 and Figure 3.82). The estimated strong cohorts are also clearly visible on this plot.

Spawning stock and recruitment, stock-recruitment parameters

The estimated Beverton-Holt stock recruitment relationship appears quite poorly estimated (Figure 3.83). There are very few observations at lower stock sizes and very little evidence of a stock-recruitment relationship. This could largely be a function of the spawning stock being estimated to have been constant for the past 15 years, while estimated recruitment has fluctuated.

Steepness is estimated to be 0.95, virgin recruitment 824,700 age 0 recruits and the RMSE on recruitment deviations 0.189. The recruitment deviations show some rather strange behavior in the early years, 1967-1973. I do not know what is creating these deviations and they may influence upon future abundance because of the delayed entry of recruits into the fishery (fish generally do not recruit to the fishery until ~ age 10).

The partitioning of recruits by area was relatively 2:1 which matches the allocation of habitat area with the East being approximately twice the area of inhabitable habitat for YEG of that of the West (Walter et al. 2010).

Fishery Selectivity

Fishery and survey selectivity patterns for the commercial handline East and West (HLE, HLE) and SEAMAP trawl surveys East and West (TRWE, TRWW) were both modeled with a double normal selectivity pattern (Figure 3.84) which allows both logistic or dome-shaped selectivities. For the handline fishery, the estimated selectivity was nearly asymptotic with a sharp falling off at the largest size bins. This could be a strange pattern resulting from very few large fish to estimate selectivity at these lengths.

Early (1975-1985) and late (1986-2009) selectivity vectors were modeled separately for the commercial longline. Early selectivity (solid lines) appears clearly shifted towards smaller fish which likely reflects the mixed handline and longline nature of the early longline fishery. The more recent selectivity vector (dotted lines) indicate a shifting towards larger fish.

The NMFS bottom longline survey shows a selectivity pattern that is focused very much on large fish, and larger fish than the commercial longline. The SEAMAP trawl survey shows as selectivity pattern strongly focused on extremely small fish, which reflects both the shallower location of these tows in areas separated from the distribution of larger fish and the potential that larger fish avoid the trawl.

Fishing Mortality

Fleet-specific patterns of instantaneous F show different trends from the overall pattern (Figure 3.85). The East fishing mortality spiked in the early 1980s, then declined and now appears to be slightly increasing since the mid-1990s. The West fishing mortality has been on a slight decline over the last 20 years after peaking between 1983-1995. Current fishing mortality rates in the East appear to be twice that of the West (Table 3.15) which largely reflect that fact that in the East are much higher than that of the West.

Given the selectivity patterns estimated above and the dominance of the longline fishery, the fishing mortality at age is concentrated on the older fish and is relatively constant for ages 20-40+ (Table 3.16).

Evaluation of Uncertainty

Standard deviations of the estimated parameters are given in Table 3.6. These provide some measure of the uncertainty around a particular estimate but do not necessarily capture all of the sources of uncertainty. For this reason MCMC runs were performed on the base model. At the present time only 100,000 MCMC runs have been completed so these results are preliminary and may be further updated with MCMC results from other model constructions. For these preliminary runs, the 100000 runs were thinned twice, once at every 100th run, then the first 10 of these was removed as a burn in and the every other of these runs were saved to give 495 total retained MCMC runs. Plots of the individual points and cumulative means (Figure 3.86) appear that they most estimated or derived parameters reached convergence, though the parameters that depend upon the stock recruitment relationship (MSY-related parameters) do show some tendency for trend. This might necessitate a greater number of MCMC runs, but, in general these runs appear to capture the range of uncertainty that can be obtained with the MCMC approach.

3.2.2.3 Sensitivity analyses (Alternate model runs or configurations)

General description

This set of model results describes several sensitivity results run on various model scenarios. The first is a run designed to mimic the 2002 assessment run by using only data from 1986-2009. The second run includes no recruitment deviations, such that recruitment comes strictly off of the stock recruitment relationship. The third model is the three-area model, exactly the same as the base model, above but with three areas; South, Central and West. The fourth model has no selectivity time-blocks implemented for the commercial longline fishery. The fifth model allows M to be estimated and the last model uses a fixed value of 0.7 for steepness which contrasts with the high values (~0.94) generally estimated in all other models. The last model did not estimate the 3 parameters defining the transition rate from females to males. Likelihood fits for sensitivity runs are given in Table 3.12, parameter estimates in Table 3.17 and derived quantities and benchmarks in Table 3.18. Overall SSB, recruits and F trajectories for the sensitivity runs are shown in Figures 3.87 and 3.88.

Update 2002 model (1986-2009), assume zero equilibrium catch, and assume five year average equilibrium catch

These models mimic strict updates to the 2002 assessment and largely reach the same conclusion: current stock status depends largely upon the assumed level of fishing prior to the start of the model since there is no contrast in the data during the 1986-2009 time period.

Model with no recruitment deviations (Null deviation model)

This model is instructive as it appears to represent the most 'pessimistic' version of the base model. If the recruitment deviations are entirely spurious and not to be trusted, then not estimating them could be considered prudent and it appears that, if this causes a bias, the bias is in the direction of a more pessimistic stock status.

Three-area model

This model displays a highly divergent fit to the longline CPUE index in the south (Figure 3.89) which indicates that, despite the index increasing, the stock is plummeting over the 1986-2009 time period. Time series of biomass indicate that the South region has been declining continuously while F goes extremely high due to recent increases in landings (Figure 3.90). Such an extreme increase in F does not appear in the age composition. I believe that these trends are caused by simple mismatch of the landings with the age composition caused by an imprecise allocation of substantial early landings to the central region. Most of the early age composition comes from the South, yet most of the landings from the same time period were put in the central region (Figure 3.90). The end result of this mismatch is a) high recruitment deviations, b) the model has to give the South a very low amount of total recruitment, and say that it is a much smaller initial population than the central and west and b) given the recent increases in landings in South, these are having a drastic negative impact upon this region. As long as we can generally rule out the possibility that the population is collapsing (we should see a severe truncation of the age structure), then it is more likely that these patterns are spurious and a simple solution was to combine the South and the Central regions.

No selectivity time-blocks

This modification has very little effect other than to somewhat ameliorate the early erratic recruitment deviations.

Estimate M

This model estimates two separate M values, East= 0.088 and West = 0.110. It has substantially improved fits to the indices (Figure 3.91) and a much more optimistic stock status commensurate with increasing natural mortality. The estimated M values are, however, substantially higher than those estimated by the catch curves at the data workshop for the early time period, and the estimate of M for the West is among the higher of those calculated at the DW. Because there is a direct tradeoff between natural mortality and fishing mortality, allowing M to be estimated higher will reduce the apparent F.

Low value of steepness (0.7)

This run was requested to determine benchmarks and stock status for a fixed steepness of 0.7. The greatest impact would be to bring Fmsy between the two proxies of FSPR30 and FSPR40, indicating that the two proxies would likely serve to as relatively similar proxies for Fmsy if the true steepness is close to 0.7.

Hermaphroditism parameters not estimated

Originally the hermaphroditism parameters were input as fixed values. However just as selectivity can bias estimation of growth rates, it may also influence the observed sex ratio at size and hence one may want to estimate these parameters in the integrated model. When estimated, the parameters diverge substantially from the input values and the modeled sex ratio has a lower proportion of male fish at age than the input data (Figure 3.92). These differences and the adequacy of the age and length composition data to estimate the herm parms should be further explored but they actually make little difference to the current assessment (Table 3.18) as spawning stock biomass calculated as both males and females. If SSB was taken to be just females, then this could have a larger impact.

3.2.2.4. Sensitivity analyses around true uncertainty in base model

General description

These model runs represent a range of uncertainties around the base model. For the purposes of characterizing uncertainty they could be considered runs that bound the ranges of plausibility for natural mortality (M varied from 0.055-0.9) or on historical landings (high or low landings scenario).

1. Alternative partitioning of landings in statistical area 6

This represents one of the greatest uncertainties and has a very direct impact upon the assessment in that it scales the population size and downwards as SSB benchmarks and the potential yield. It basically says that if these landings had not been taken, the stock has always been smaller and MSY and proxies for it scale downward. This partitioning of landings may be the more realistic partitioning given that the difference between the high and low landings scenario hinged upon the partitioning of unclassified grouper in stat area 6. If 96% of these early grouper were YEG, then the high landings scenario is most plausible. If 23% is a more likely percentage for stat area 6 in 1982, then the low scenario is most plausible.

The fits to the CPUE indices do, however degrade substantially in moving to the low landings scenario and there may be some other inconsistency in the model causing this (Figure 3.93).

2. Low M (0.055) and High M (0.099)

Both of these have the anticipated effect of scaling estimated parameters and stock status up and down with M. They bracket a 25% increase and a 25% decrease in natural mortality from the base value of 0.073.

3.2.2.5. Sensitivity analyses (retrospectives on Base model)

General description

These model runs are 5-year retrospective analyses of the base model, i.e., run the same model but remove 1, 2, etc.,… years of data to see whether there is a pattern in the terminal year estimates of SSB, fishing mortality rate and other parameters. Severe biases (as opposed to random fluctuations) represent problematic retrospective patterns.

Five-year retrospective patterns

Retrospective patterns were explored by peeling 10 years of data from the base model (Figure 3.94). The retrospective patterns for biomass and for recruitment are showns and do not appear to had a particularly problematic pattern.

3.2.2.6. Projections

Projections were run according to two fishing mortality scenarios, F_{SPR30} and F_{SPR40} from 2010 to 2029. The final year partitioning of relative F was used to allocate F among the four fleets.

Stock status and outlook

Table 3.20 provides the required SFA and MSRA evaluations using SPR 40% and SPR 30% reference points for Gulf of Mexico yellowedge grouper BASE, low M, high M and low landings runs. Depending upon the proxy for MSY (SPR 40% or SPR 30%), the stock status using the base run ranges from overfished and overfishing to not overfished, slightly overfishing (Figure 3.95). This does not incorporate uncertainties related to landings histories or any other uncertainty explored in the sensitivity runs.

Projected yields in 2011 at the $F_{40\%SPR}$ range from 310-1100 thousand pounds of YEG. Yields at $F_{30\%SPR}$ range from 460-1550 thousand pounds of YEG (Figure 3.97). Recent catches in the past five years have averaged ~860,000lbs which is 50,000lbs higher that than the OFL for 2011 at $F_{30\%SPR}$. Spawning stock biomass would be projected to increase under most $F_{SPR40\%}$ projections but would be actually need to reduced to reach the desired target level under high mortality scenario for both F targets (Figure 3.96).

Short term projected yields under the high M scenario would be substantially (F30%SPR) or moderately (FSPR40%) higher than actual landings from 1986-2009. In contrast the base model under the F30%SPR would be almost the same as the landings from the last several years (Figure 3.97).

Projections with decremented recruitment

To evaluate the potential impact of the reductions in recruitment due to the Deepwater Horizon oil spill in 2010 on the population and on projected yields I decremented 2010 recruitment by 25%, 50%, 75% and 100% (total failure). Projections under these scenarios were performed for the base model with F at $F_{SPR30\%}$. Spawning stock biomass shows a very slight impact of the recruitment declines and then only 7-8 years into the future (Figures 3.98 and 3.99). The long-term impact appears to be approximately a 5% reduction in SSB in year 2029 for a recruitment failure in 2010. This result is not surprising given that the stock recruitment relationship does not have a high correlation between stock and recruitment (Steepness=0.95). Further, the YEG population is maintained by high spawning stock biomass, rather than supported solely by annual recruitments as would be the case for a species with a much shorter lifespan and greater reliance on annual recruitments. The greater danger for this stock is that the spawning stock could be damaged, which, given the low natural mortality rates, even a small reduction in spawning stock could have substantial population level consequences.

As alteration of the fishing mortality rate is the only management action that can be taken in the face of an episodic mortality event, it is necessary to see whether reductions in TAC would be warranted, given a reduction in 2010 recruitment. Projected yields at $F_{SPR30\%}$ indicate that any reductions in TAC would not be warranted until 2015, and even then the most severe reductions would be on the order of 5% (Figure 3.100). So, again, a single year reduction in recruitment would have minimal impact and there would be minimal management response under the current management scenario. However, direct impacts on the spawning stock are unknown and unquantified. The AW considered impacts on the spawning stock but was not comfortable modeling these at the present time.

3.2.3. Discussion

Overall substantial progress has been made in the assessment of yellowedge grouper relative to the last assessment in 2002. Three critical pieces of information now exist that substantially improve our ability to assess the stock. First we now have a 10-year time series of survey index and size and age composition from the NMFS bottom longline survey. Second, we have reclaimed a vast archive of historic age and length composition data from the beginning of the fishery. Third we have been able to push the landings history back to approximately the start of the fishery in 1975. These additions should make the determination of stock status, productivity and consequent management advice much better determined than in 2002.

Notwithstanding these changes, several key uncertainties and issues remain. The primary uncertainty is in the magnitude of the historic landings of yellowedge from within the mass of unclassified groupers during the 1980-1986 time period at the initiation of the deepwater longline fishery. The high and low landings trajectories give, not surprisingly, high and low yields at all benchmarks. The two landings time series span two likely ranges of the landings and could be considered jointly. It may be likely that landings from stat area 6 were more likely to be red grouper in the early longline fishery but it could also be likely that landings from stat area 5 in this early fishery were higher than 26% yellowedge. However this uncertainty is far less than the uncertainty of either not considering landings prior to 1986 or having to estimate some level of landings prior to 1986.

A second source of uncertainty is in the natural mortality rates, which, again, have direct impact upon the benchmarks. It is informative, in this regard, to consider the catch curves derived from the early (1977-1980) age composition and the current catch curves (Figures 3.101 and 3.102). If we assume constant recruitment, which actually the SS3 model could not refute, when allowed to estimated sigma R (it estimated a value of 0, or constant recruitment) then the total mortality estimates from these early catch curves are 0.075 -0.0943 for females and males in the South region (stat areas 1-5) for 1977-1980. Similar values were estimated in the DW with slightly different partitioning of the data. Recent values are between 0.13-0.15 indicating a potential doubling, likely commensurate fishing. These catch curves give us a fairly strong basis for the assumed M~0.073, at least in the South or East region. When estimated, M in the East was 0.088 and in the West 0.11. Unfortunately we do not have age composition from the beginning of the fishery in the West to document such a large difference in natural mortality rates. Furthermore, we might want there to be a fairly strong biological basis for such a large difference in M because, within the integrated modeling approach, many factors interact and fitting a higher M in the West might be due to an interaction with growth rates or recruitment. So, in conclusion, there is some evidence from catch curves that M might be slightly greater than 0.073, at least for males but we have little evidence to say that it is substantially higher in the West versus the East.

Another unresolved issue is the discrepancy between the input and the estimated probability of transition to male. The estimated transition rate of females to males gives a different sex ratio at age than that of the input data. This is odd but the estimated stock benchmarks, stock status and projected yields (Table 3.18 and Figure 3.95) are virtually indistinguishable between the base model that estimated these parameters and the sensitivity run that used fixed values. This is likely because of using both males and females in SSB. If further explorations of model runs with different metrics for SSB are to be considered, then the issue of sex transition probabilities and the adequacy of the data to estimate these would need to be explored. But for the purposes of providing advice with the current metric for SSB, this discrepancy is inconsequential.

Lastly, uncertainties regarding the stock-recruitment relationship exist. When estimated, the SRR shows a tendency towards high values of steepness. These values appear very high for a fish with such a long lifespan and low maturity but higher values may actually have some biological realism. Demersal fish tend to show fairly high levels of Goodyear's (Goodyear 1993) compensation ratio (Goodwin 2006) which correspond to relatively high levels of steepness. This is generally thought to occur whereby recruitment is largely habitat limited and strong density dependence in early life history occurs. As the stock is fished, number of available niches opens allowing for a substantial increase in juvenile survival as the stock gets fished down, resulting in high compensation ratios and high steepness in the SRR. Such a situation could exist for YEG.

Nevertheless, we can have very little confidence in the estimated stock recruitment relationship and hence it is recommended to use a proxy for MSY such as and SPR-based value.

What we can have confidence in this assessment is that the landings have been more or less stable for the past 20 years and that this stability appears to be due to harvests close to only slightly higher than yields at SPR30% and close to the yields at MSY. Our confidence in this statement comes largely from two pieces of evidence. One, the early and late age composition provides strong information on natural mortality and a good ability to evaluate the effects of this harvest history on the current age composition. Second, the extremely high landings in 1981-1985, regardless of the high or low scenarios, give substantial insight into the inherent productivity of the stock, even if we do not know the nature of the stock recruitment relationship.

3.2.4. References

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3.3. ***COMPARISON OF SRA AND SS3***

Comparison of SRA and SS3 models provides analyses from two different assessment models; one with a high level of inputs and model complexity (SS3) and another with very low level of complexity (SRA).

The two models have very similar trajectories of biomass and fishing mortality over time (Figures 3.103 -3.105; Table 3.21). For SRA exploited biomass is plotted, while for SS3 the total biomass is shown which will tend to lead to slightly higher plotted values for SS3 versus SRA, though the general patterns should be comparable. For overall biomass, SRA and SS3 have very similar trajectories (Figure 3.103); the main difference is that the biomass estimated by SRA in the West is much lower than for SS3 (Figure 3.104) leading to lower total biomass.

Furthermore, trajectories of fishing mortality (here quantified as exploitation rates) are quite similar, and show the exact same pattern but with only slight scaling differences. These scaling differences in exploitation level are likely due to the signal that SS3 gets from age and length composition which suggests a slightly lower level of exploitation. In response, the SS3 model likely matches this lower level of exploitation through recruitment deviations. When recruitment deviations were turned off in SS3, the absolute levels for current exploitation rate come very close to the SRA estimates (green line in Figure 3.105).

Benchmark levels are also fairly similar between the two models. SRA does not calculate the same $SPR_{30\%}$ or $SPR_{40\%}$ metrics, and so we compare metrics related to 40% of virgin biomass. Notwithstanding the slight differences between total biomass and vulnerable biomass, the virgin biomass levels are similar, as well as the biomass levels at 40% of unfished status. $SSB/SSB_{40\%virgin}$ is 0.75 for SS3 versus 0.798 for SRA. Estimated values for MSY are also fairly similar between the two models though SS3 estimates higher MSY (SRA MSY = 340 MT; SS3 MSY = 375 MT). Exploitation at MSY is higher for SS3 (0.098) than for SRA (0.077) which could lead to the differences in estimated MSY values and to a rather substantial difference in the F/Fmsy. Since AW panel has chosen to use proxy benchmarks rather than MSY-related benchmarks for fishing status, the differences in F_{MSY} are not a substantial issue.

There are several differences in the basic inputs between SRA and SS3. SRA also only uses a single index for each model, whereas SS3 uses four separate indices. These differences in index trend would clearly lead to some differences in model results.

A primary difference is in the landings history input between the current SRA models and the SS3 model. SRA uses only the landings history coming from the commercial longline fishery. Thus neither the early (1975-1979) landings by the handline fishery nor the relatively high handline landings during 1980-1990 were included in the SRA model. The SRA model begins in 1980, under assumption of a virgin, unfished stock, whereas SS3 begins with the same assumption but five years earlier, in 1975. These differences likely lead to some of the differences in benchmarks, particularly in MSY and it is likely that inclusion of higher earlier removals would have lead to a higher value of MSY for SRA. In addition inclusion of the handline removals would likely increase the total population size in the West because handline landings represented between 15-30% of the total Western landings during the time period 1980-1990. Including these landings would likely make the results even closer to that of SS3.

In conclusion, while there are some differences in benchmarks and in some of the basic inputs, the models still have quite similar results and appear to generally corroborate each other, or at least share the same biases.

3.4. ***TABLES***

Table 3.1. Life history parameter input values for the Stochastic SRA model for yellowedge grouper from the Gulf of Mexico.

Parameter	Definition	All	East	West
# ages	Number of age classes	85	85	85
Bhat 2009	Biomass in the last year	6.0E+06	6.0E+06	6.0E+06
SD Bhat	Standard Deviation Bhat	1.0E+08	1.0E+08	1.0E+08
Uhat 2009	Exploitation for the last year	0.10	0.10	0.10
SD Uhat	Standard Deviation of Uhat	0.02	0.02	0.02
SD rec	Standard Deviation of RecK	0.50	0.50	0.50
Rec rho	Recruitment Residuals	0	0	0
Future Catch	Amount of future landings (catch, kg)	NA	NA	NA
Ufuture	Future exploitation	0.2	0.2	0.2
growth von B K	von Bertalanffy growth coefficient	0.06	0.04	0.08
growth Linfinity (cm)	von Bertalanffy asymptotic length	100.5	109.3	95.7
CV length age	Variation of length at age	0.08	0.08	0.08
length maturity (cm)	Length at maturity	55	55	55
wt (kg) at 100 cm	Size (weight) of fish at 100 cm	11	11	11
growth tzero	Size (length, cm) at time zero			
MSY min	Minimum Maximum Sustainable Yield	10,000	10,000	10,000
MSY max	Maximum Maximum Sustainable Yield	1,000,000	1,000,000	300,000
Umsy min	Minimum Exploitation at MSY	0.01	0.01	0.01
Umsy max	Maximum Exploitation at MSY	0.20	0.20	0.20
S min	Minimum Survivalship (S-0.2)	0.90	0.90	0.90
S max	Maximum Survivalship (S+0.2)	0.94	0.94	0.94

Table 3.2. Commercial longline catch histories (gutted kilograms) for yellowedge grouper by region (East and West of Mississippi River) in the Gulf of Mexico.

Year	All	East	West
1980	223,807	202,633	21,174
1981	996,747	687,384	309,362
1982	1,771,613	1,462,809	308,804
1983	1,416,515	1,123,189	293,326
1984	1,061,417	783,568	277,848
1985	706,318	443,948	262,371
1986	351,220	104,327	246,893
1987	351,557	152,962	198,595
1988	497,001	221,967	275,034
1989	283,448	124,132	159,316
1990	326,591	169,301	157,290
1991	296,973	151,856	145,117
1992	408,692	231,847	176,845
1993	303,195	157,850	145,345
1994	443,527	316,823	126,704
1995	358,147	188,372	169,776
1996	222,303	150,844	71,459
1997	312,308	254,737	57,571
1998	289,541	190,924	98,617
1999	412,946	287,352	125,594
2000	467,204	332,139	135,065
2001	336,444	245,764	90,680
2002	334,097	197,121	136,977
2003	474,376	309,699	164,677
2004	407,846	272,714	135,132
2005	341,034	217,385	123,650
2006	322,181	217,992	104,189
2007	384,743	314,200	70,543
2008	356,987	284,750	72,237
2009	346,897	251,209	95,688

Table 3.3. Yellowedge grouper vulnerabilities at age were provided from SS3 from logistic functions of age selectivities given size selectivities and size-at-age data (SS, Asel2). The same age vulnerabilities were used for all data combined and for each region. Vulnerabilities for age 41-85 were 0.9999.

Age	Vulnerability	Age	Vulnerability
1	0.00789	21	0.97585
2	0.01530	22	0.97600
3	0.02947	23	0.98261
4	0.05600	24	0.98760
5	0.10380	25	0.98750
6	0.15923	26	0.99000
7	0.23978	27	0.99103
8	0.34110	28	0.99000
9	0.46145	29	0.99357
10	0.58594	30	0.99000
11	0.66427	31	0.99000
12	0.73451	32	0.99000
13	0.79459	33	0.99000
14	0.84396	34	0.99000
15	0.88321	35	0.99000
16	0.91360	36	0.99000
17	0.93665	37	0.99000
18	0.94000	38	0.99000
19	0.95386	39	0.99000
20	0.96656	40	0.99000

Table 3.4. Commercial longline indices and coefficient of variation (CV) for yellowedge grouper. An increase in the uncertainty (1.96 * CV for all years) was necessary in the commercial longline index for all data combined for a satisfactory number of model iterations.

Year	All Index	All CV	East Index	East CV	West Index	West CV
1991	1.5161	0.22	1.7492	0.28	1.7058	0.18
1992	1.4491	0.22	1.4498	0.29	1.0857	0.27
1993	0.6216	0.24	0.3746	0.23	1.2382	0.23
1994	0.9122	0.18	0.7595	0.17	1.1920	0.23
1995	0.8147	0.19	0.7353	0.18	1.0055	0.27
1996	0.6683	0.21	0.7424	0.20	0.4616	0.53
1997	0.8689	0.17	0.9267	0.16	0.5727	0.44
1998	0.7477	0.19	0.6363	0.17	0.9614	0.28
1999	0.8234	0.18	0.7754	0.18	0.8682	0.3
2000	0.8352	0.17	0.9626	0.17	0.6273	0.4
2001	0.8057	0.17	0.7028	0.17	0.8941	0.3
2002	0.7838	0.18	0.8277	0.17	0.5931	0.43
2003	0.9215	0.16	0.9796	0.16	0.8562	0.32
2004	0.8545	0.18	0.8465	0.17	0.8778	0.32
2005	1.1361	0.17	1.1089	0.18	1.4626	0.21
2006	1.2203	0.16	1.2253	0.17	1.2059	0.25
2007	1.2897	0.16	1.4135	0.16	0.8155	0.37
2008	1.4852	0.17	1.6429	0.18	1.0943	0.27
2009	1.2458	0.17	1.1410	0.18	1.4820	0.21

Table 3.5. Vulnerable biomass (gutted kilograms) trajectories by region for yellowedge grouper.

Year	All	East	West
1980	13,260,869	8,506,585	3,453,289
1981	12,691,384	8,132,669	3,385,578
1982	11,308,349	7,571,795	3,069,591
1983	9,599,893	6,169,611	2,821,315
1984	7,972,793	4,954,385	2,482,757
1985	6,671,112	4,300,032	2,234,481
1986	5,776,207	3,739,158	2,008,776
1987	5,206,722	3,832,637	1,783,071
1988	4,799,947	3,739,158	1,579,936
1989	4,230,461	3,645,679	1,376,802
1990	4,149,106	3,645,679	1,241,379
1991	3,905,041	3,645,679	1,173,667
1992	3,823,686	3,552,200	1,060,814
1993	3,579,621	3,458,721	947,962
1994	3,416,911	3,458,721	902,821
1995	3,254,201	3,271,763	812,539
1996	3,254,201	3,271,763	722,257
1997	3,416,911	3,271,763	722,257
1998	3,416,911	3,271,763	789,968
1999	3,498,266	3,271,763	789,968
2000	3,579,621	3,458,721	789,968
2001	3,498,266	3,365,242	744,827
2002	3,498,266	3,365,242	835,109
2003	3,660,976	3,458,721	857,680
2004	3,823,686	3,645,679	857,680
2005	3,823,686	3,458,721	880,250
2006	3,905,041	3,552,200	857,680
2007	4,149,106	3,552,200	902,821
2008	4,149,106	3,739,158	947,962
2009	4,230,461	3,458,721	1,015,673

Table 3.6. List of the parameters (72) estimated in SS3 YEG model runs, initial guess estimates, low and upper bounds, and phase of estimation.

Num	Label	Value	phase of est	Min	Max	Init	Prior	PR type	Pr SD	Parm St Dev
1	NatM_p_1_Fem_GP_1	0.073	_	0.02	0.15	0.073	0.073	_	0.2	_
2	L_at_Amin_Fem_GP_1	5	_	0	40	5	5	_	0.8	_
3	L_at_Amax_Fem_GP_1	90.3104	3	70	120	84.3	84.3	_	0.8	1.02148
4	VonBert_K_Fem_GP_1	0.0781804	3	0.02	0.15	0.059	0.059	_	0.8	0.00175
5	CV_young_Fem_GP_1	0.1626	_	0.05	0.5	0.1626	0.1626	_	0.1	_
6	CV_old_Fem_GP_1	0.1165	_	0.05	0.5	0.1165	0.1165	_	0.1	_
7	NatM_p_1_Fem_GP_2	0.073	_	0.02	0.15	0.073	0.073	_	0.2	_
8	L_at_Amin_Fem_GP_2	5	_	0	40	5	5	_	0.8	_
9	L_at_Amax_Fem_GP_2	90.0159	3	70	120	84.3	84.3	_	0.8	1.35745
10	VonBert_K_Fem_GP_2	0.088926	3	0.02	0.15	0.059	0.059	_	0.8	0.00281
11	CV_young_Fem_GP_2	0.1626	_	0.05	0.5	0.1626	0.1626	_	0.1	_
12	CV_old_Fem_GP_2	0.1165	_	0.05	0.5	0.1165	0.1165	_	0.1	_
13	NatM_p_1_Mal_GP_1	0.073	_	0.02	0.15	0.073	0.073	_	0.2	_
14	L_at_Amin_Mal_GP_1	5	_	0	40	5	5	_	0.8	_
15	L_at_Amax_Mal_GP_1	91.5031	3	70	130	100.45	100.45	_	0.8	0.67957
16	VonBert_K_Mal_GP_1	0.091565	3	0.02	0.15	0.059	0.059	_	0.8	0.00308
17	CV_young_Mal_GP_1	0.1626	_	0.05	0.5	0.1626	0.1626	_	0.1	_
18	CV_old_Mal_GP_1	0.1165	_	0.05	0.5	0.1165	0.1165	_	0.1	_
19	NatM_p_1_Mal_GP_2	0.073	_	0.02	0.15	0.073	0.073	_	0.2	_
20	L_at_Amin_Mal_GP_2	5	_	0	40	5	5	_	0.8	_
21	L_at_Amax_Mal_GP_2	90.2071	3	70	130	100.45	100.45	_	0.8	0.87666
22	VonBert_K_Mal_GP_2	0.103095	3	0.02	0.15	0.059	0.059	_	0.8	0.00527
23	CV_young_Mal_GP_2	0.1626	_	0.05	0.5	0.1626	0.1626	_	0.1	_
24	CV_old_Mal_GP_2	0.1165	_	0.05	0.5	0.1165	0.1165	_	0.1	_
25	Wtlen_1_Fem	2.11E-05	_	1.8E-05	3.0E-05	2.1E-05	2.1E-05	_	0.2	_
26	Wtlen_2_Fem	2.91	_	2.5	3.8	2.91	2.91	_	0.2	_
27	Mat50%_Fem	55	_	54.2738	61.3098	55	55	_	0.8	_
28	Mat_slope_Fem	-0.33	_	-0.35	-0.15	-0.33	-0.33	_	0.8	_
29	Eggs_scalar_Fem	2.11E-05	_	1.8E-05	3.0E-05	2.1E-05	2.1E-05	_	0.2	_
30	Eggs_exp_len_Fem	2.91	_	2.5	3.8	2.91	2.91	_	0.2	_
31	Wtlen_1_Mal	2.11E-05	_	1.8E-05	3.0E-05	2.1E-05	2.1E-05	_	0.2	_
32	Wtlen_2_Mal	2.91	_	2.5	3.8	2.91	2.91	_	0.2	_
33	Herm_Infl_age	14.7895	4	12	70	41	41	_	0.0	2.51934
34	Herm_stdev	8.13726	4	5	20	14.63	14.63	_	0.0	2.13958
35	Herm_asymptote	0.0593376	4	0.04	0.8	0.470231	0.470231	_	0.0	0.01277
36	RecrDist_GP_1	0	_	-4	4	0	0	_	99.0	_
37	RecrDist_GP_2	0	_	-4	4	0	0	_	99.0	_
38	RecrDist_Area_1	1.70597	2	-5	4	1	1	_	0.0	0.0224
39	RecrDist_Area_2	1	_	-5	4	1	1	_	0.0	_
40	RecrDist_Seas_1	1	_	-4	4	1	1	_	0.0	_
41	CohortGrowDev	1	_	1	1	1	1	_	0.0	_
42	SR_R0	6.7221	1	4.5	16.5	8.5	8.5	_	0.8	0.01502
43	SR_steep	0.953466	1	0.4	0.99	0.6	0.8	sym beta	2.0	0.02474
44	SR_sigmaR	0.2	_	0	2	0.2	0.2	_	50.0	_
45	SR_envlink	0	_	-5	5	0	0	_	50.0	_
46	SR_R1_offset	0	_	-5	5	0	0	_	50.0	_
47	SR_autocorr	0	_	0	0.5	0	0	_	50.0	_
48	Main_InitAge_8	-0.361037	_	_	_	_	_	_	_	0.18686
49	Main_InitAge_7	-0.334663	_	_	_	_	_	_	_	0.19009
50	Main_InitAge_6	-0.280285	_	_	_	_	_	_	_	0.19519

51	Main_InitAge_5	-0.209984	_	_	_	_	_	_	_	0.20142
52	Main_InitAge_4	-0.135174	_	_	_	_	_	_	_	0.20751
53	Main_InitAge_3	-0.069856	_	_	_	_	_	_	_	0.21428
54	Main_InitAge_2	-0.017798	_	_	_	_	_	_	_	0.21919
55	Main_InitAge_1	-0.015861	_	_	_	_	_	_	_	0.22028
56	Main_RecrDev_1975	0.0043554	_	_	_	_	_	_	_	0.22123
57	Main_RecrDev_1976	-0.005954	_	_	_	_	_	_	_	0.21936
58	Main_RecrDev_1977	0.0275768	_	_	_	_	_	_	_	0.21986
59	Main_RecrDev_1978	0.0466933	_	_	_	_	_	_	_	0.21942
60	Main_RecrDev_1979	0.0822629	_	_	_	_	_	_	_	0.21555
61	Main_RecrDev_1980	0.0071192	_	_	_	_	_	_	_	0.21199
62	Main_RecrDev_1981	0.0391472	_	_	_	_	_	_	_	0.20674
63	Main_RecrDev_1982	-0.038168	_	_	_	_	_	_	_	0.20192
64	Main_RecrDev_1983	-0.064913	_	_	_	_	_	_	_	0.20155
65	Main_RecrDev_1984	0.0084711	_	_	_	_	_	_	_	0.2138
66	Main_RecrDev_1985	0.309394	_	_	_	_	_	_	_	0.21294
67	Main_RecrDev_1986	0.144204	_	_	_	_	_	_	_	0.21777
68	Main_RecrDev_1987	-0.090458	_	_	_	_	_	_	_	0.19578
69	Main_RecrDev_1988	-0.106895	_	_	_	_	_	_	_	0.18928
70	Main_RecrDev_1989	-0.058009	_	_	_	_	_	_	_	0.1871
71	Main_RecrDev_1990	-0.147741	_	_	_	_	_	_	_	0.19434
72	Main_RecrDev_1991	0.137369	_	_	_	_	_	_	_	0.20512
73	Main_RecrDev_1992	0.182089	_	_	_	_	_	_	_	0.24452
74	Main_RecrDev_1993	0.613172	_	_	_	_	_	_	_	0.22188
75	Main_RecrDev_1994	0.168829	_	_	_	_	_	_	_	0.242
76	Main_RecrDev_1995	-0.094834	_	_	_	_	_	_	_	0.20504
77	Main_RecrDev_1996	0.0591926	_	_	_	_	_	_	_	0.21422
78	Main_RecrDev_1997	0.351558	_	_	_	_	_	_	_	0.2128
79	Main_RecrDev_1998	0.0846531	_	_	_	_	_	_	_	0.21832
80	Main_RecrDev_1999	0.0107934	_	_	_	_	_	_	_	0.18892
81	Main_RecrDev_2000	-0.245251	_	_	_	_	_	_	_	0.16967
91	InitF_1COMMHL_E	0	_	0	1	0	0.01	_	99.0	_
92	InitF_2COMMHL_W	0	_	0	1	0	0.01	_	99.0	_
93	InitF_3COMMLL_E	0	_	0	1	0	0.01	_	99.0	_
94	InitF_4COMMLL_W	0	_	0	1	0	0.01	_	99.0	_
95	Q_base_1_COMMHL_E	-8.59974	1	-50	50	-8.6	-8.6	_	10.0	343094
96	Q_base_2_COMMHL_W	-8.59974	1	-50	50	-8.6	-8.6	_	10.0	343094
97	Q_base_3_COMMLL_E	-7.73004	1	-50	50	-8.6	-8.6	_	10.0	0.06575
98	Q_base_4_COMMLL_W	-7.23648	1	-50	50	-8.6	-8.6	_	10.0	0.08285
99	Q_base_5_NMFSBLL_E	-5.71696	1	-50	50	-8.6	-8.6	_	10.0	0.17863
100	Q_base_6_NMFSBLL_W	-5.44824	1	-50	50	-8.6	-8.6	_	10.0	0.18902
101	Q_base_7_NMFSTRW_E	-8.59974	1	-50	50	-8.6	-8.6	_	10.0	343094
102	Q_base_8_NMFSTRW_W	-8.59974	1	-50	50	-8.6	-8.6	_	10.0	343094
103	SizeSel_1P_1_COMMHL_E	51.1004	2	30.3	119.79	49.5	49.5	_	0.1	0.57439
104	SizeSel_1P_2_COMMHL_E	1.63588	2	-5	3	-1	-1	_	0.1	0.74686
105	SizeSel_1P_3_COMMHL_E	4.84476	2	-4	12	7.2	7.2	_	0.1	0.074
106	SizeSel_1P_4_COMMHL_E	-1.3684	2	-2	6	5.9	5.9	_	0.1	12.6528
107	SizeSel_1P_5_COMMHL_E	-6.6	_	-15	5	-6.6	-6.6	_	0.1	_
108	SizeSel_1P_6_COMMHL_E	-5.78729	2	-6	5	-0.9	-0.9	_	0.1	6.01217
109	SizeSel_2P_1_COMMHL_W	1	_	1	80	1	1	_	0.1	_
110	SizeSel_2P_2_COMMHL_W	-1	_	-1	80	-1	-1	_	0.1	_
111	SizeSel_3P_1_COMMLL_E	40	_	30	80	40	40	_	40.0	_
112	SizeSel_3P_2_COMMLL_E	20	_	10	30	20	20	_	20.0	_
113	SizeSel_4P_1_COMMLL_W	1	_	1	80	1	1	_	0.1	_
114	SizeSel_4P_2_COMMLL_W	-1	_	-1	80	-1	-1	_	0.1	_
115	SizeSel_5P_1_NMFSBLL_E	63.615	2	30	100	47.7058	47.7058	_	5.0	2.39521
116	SizeSel_5P_2_NMFSBLL_E	21.9002	2	10	50	10.5888	10.5888	_	5.0	2.10364

117	SizeSel_6P_1_NMFSBLL_W	1	_	1	80	1	1	_	0.1	_
118	SizeSel_6P_2_NMFSBLL_W	-1	_	-1	80	-1	-1	_	0.1	_
119	SizeSel_7P_1_NMFSTRW_E	14.7904	2	11	50	15	15	_	0.1	1.72637
120	SizeSel_7P_2_NMFSTRW_E	-9.60198	2	-10	3	-3.25	-3.25	_	0.1	10.6897
121	SizeSel_7P_3_NMFSTRW_E	3.14353	2	-7	12	2.5	2.5	_	0.1	1.73029
122	SizeSel_7P_4_NMFSTRW_E	4.40572	2	-3	8	5	5	_	0.1	0.42333
123	SizeSel_7P_5_NMFSTRW_E	-3.71177	2	-15	5	-3	-3	_	0.1	1.03631
124	SizeSel_7P_6_NMFSTRW_E	-3.77637	2	-10	1	-8	-8	_	0.1	0.6194
125	SizeSel_8P_1_NMFSTRW_W	1	_	1	80	1	1	_	0.1	_
126	SizeSel_8P_2_NMFSTRW_W	-1	_	-1	80	-1	-1	_	0.1	_
127	AgeSel_1P_1_COMMHL_E	0	_	0	40	0	5	_	99.0	_
128	AgeSel_1P_2_COMMHL_E	40	_	0	40	40	6	_	99.0	_
129	AgeSel_2P_1_COMMHL_W	0	_	0	40	0	5	_	99.0	_
130	AgeSel_2P_2_COMMHL_W	40	_	0	40	40	6	_	99.0	_
131	AgeSel_3P_1_COMMLL_E	0	_	0	40	0	5	_	99.0	_
132	AgeSel_3P_2_COMMLL_E	40	_	0	40	40	6	_	99.0	_
133	AgeSel_4P_1_COMMLL_W	0	_	0	40	0	5	_	99.0	_
134	AgeSel_4P_2_COMMLL_W	40	_	0	40	40	6	_	99.0	_
135	AgeSel_5P_1_NMFSBLL_E	0	_	0	40	0	5	_	99.0	_
136	AgeSel_5P_2_NMFSBLL_E	40	_	0	40	40	6	_	99.0	_
137	AgeSel_6P_1_NMFSBLL_W	0	_	0	40	0	5	_	99.0	_
138	AgeSel_6P_2_NMFSBLL_W	40	_	0	40	40	6	_	99.0	_
139	AgeSel_7P_1_NMFSTRW_E	0	_	0	40	0	5	_	99.0	_
140	AgeSel_7P_2_NMFSTRW_E	40	_	0	40	40	6	_	99.0	_
141	AgeSel_8P_1_NMFSTRW_W	0	_	0	40	0	5	_	99.0	_
142	AgeSel_8P_2_NMFSTRW_W	40	_	0	40	40	6	_	99.0	_
143	SizeSel_3P_1_COMMLL_ E BLK1mult_1975	0.222452	3	-15	1	0.1	0.1	sym beta	0.2	0.0135
144	SizeSel_3P_1_COMMLL_E BLK1mult_1986	0.351569	3	-15	1	0.1	0.1	sym beta	0.2	0.00802
145	SizeSel_3P_2_COMMLL_E BLK1mult_1975	-0.634473	3	-15	1	0.1	0.1	sym beta	0.2	0.08078
146	SizeSel_3P_2_COMMLL_E BLK1mult_1986	-0.140539	3	-15	1	0.1	0.1	sym beta	0.2	0.02413

Table 3.7. Description of model runs.

Type	number	RUN	Key characteristics	Key Result
scoping runs	1	Scoping sigma R	8 fixed values of sigma R (0.1-0.9), one free estimation	sigma R input should be ~0.2
	2	Profile on ref. age	4 fixed value for reference age (5,15, 20, 25) for Lorenzen M scaling	Reference age is sensitive; same as scaling M
	3	Scoping steepness	8 fixed values of steepness (0.3-0.99)	Model estimates steepness >0.9
Base and sensitivity runs	4	Base model results	4 growth curves, 4 fleets, 4 surveys, 2 sexes, 2 areas	presented in detail
	5	Update 2002 model	(1986-2009), assume zero equilibrium catch.	Results depend upon initial F
	6	Update 2002 model	(1986-2009), assume five year average equilibrium catch.	Results depend upon initial F
	7	no recruitment devs		Poorer fit due to no rec devs
	8	Three-area model	Originial three area, 6 growth curve model	Poor fit to CPUE, F is extremely high in South
	9	No sel.time-blocks	Single selectivity for comm LL	Poorer fit to model
	10	Estimate M	Estimate M for East and West	Better fit, model estimates M of 0.087 in East, 0.11 in West
	11	Low steepness (0.7)	input fixed steepness of 0.7	More pessimistic stock status
	12	no est. herm. parms	Fixed input herm parms	Poor model fit
sensitivity around base model	14	Low landings	Alternative partitioning of 1981-1985 landings in statistical area 6 and 7	Lower overall MSY, and other yields
	15	Low M	M=0.055	Poorer model fit, Lower MSY
	16	High M	M=0.099	Better model fit, Higher MSY

Table 3.8. Root mean square error versus input sigma R. The recommendation is to choose an input value of sigma R >= RMSE, hence the shaded region is the recommended value.

Inout sigma R	Estimated Root Mean Square Error (RMSE) of recruitment deviations	RMSE / sigmaR
estimated	0	0
0.1	0.082	0.677
0.2	0.186	0.867
0.3	0.344	1.312
0.4	0.547	1.868
0.5	0.779	2.429
0.6	0.893	2.217
0.8	1.189	2.21
0.9	1.189	2.21

Table 3.9. Derived quantities for sigmaR scoping runs.

	Est	sigr.1	sigr.2	sigr.3	sigr.4	sigr.5	sigr.6	sigr.8	sigr.9
TotBio_Unfished	13615	14644	14872	15207	15019	13965	14239	13351	13552
SPB_Virgin	12140	13029	13231	13547	13389	12452	12708	11932	12105
Recr_Virgin	847	829	840	864	855	781	805	740	758
SSB_B40%virgin	4856	5211	5292	5419	5356	4981	5083	4773	4842
SSB_SPR40%	4817	5136	5201	5294	5183	4795	4829	4474	4468
MSST	4465	4761	4821	4907	4805	4445	4476	4147	4142
SSB_MSY	1695	2290	2389	2576	2713	2589	2814	2765	2940
SPB_2009	1880	3522	3836	4400	4945	4980	5517	5654	6028
SSB/B40%virgin	0.387	0.676	0.725	0.812	0.923	1.000	1.085	1.185	1.245
SSB/SPR40%	0.390	0.686	0.737	0.831	0.954	1.039	1.142	1.264	1.349
SSB/MSST	0.421	0.740	0.796	0.897	1.029	1.120	1.232	1.363	1.455
SSB/MSY	1.109	1.538	1.606	1.708	1.823	1.923	1.960	2.045	2.050
Fstd_B40%virgin	0.041	0.047	0.047	0.047	0.046	0.046	0.045	0.044	0.043
Fstd_SPR40%	0.041	0.048	0.048	0.048	0.048	0.048	0.048	0.047	0.048
Fstd_MSY	0.108	0.102	0.099	0.094	0.088	0.086	0.080	0.075	0.071
F_2009	0.123	0.077	0.072	0.064	0.058	0.058	0.053	0.052	0.049
Yield B40%virgin	255	318	322	325	316	290	290	264	264
Yield_SPR40%	256	320	324	328	321	295	296	270	272
Yield_MSY	309	369	372	372	358	327	323	291	288

Table 3.10. Likelihood components for reference age for Lorenzen M scaling.

likelihood component	BaseRefAge5	BaseRefAge15	BaseRefAge20	BaseRefAge25
TOTAL	13846.8	13484.7	13436.5	13416.4
Catch	0	0	0	0
Equil_catch	0	0	0	0
Survey	-0.01	-22.63	-27.21	-29.21
Length_comp	4316.39	4223.96	4195.55	4181.48
Age_comp	9440.79	9308.43	9297.09	9293.67
Recruitment	83.28	-29.79	-32.9	-33.1
Forecast_Recruitment	0	0	0	0
Parm_priors	6.37	4.7	3.98	3.52
Parm_softbounds	0.01	0.01	0.01	0.01
Parm_devs	0	0	0	0
Crash_Pen	0	0	0	0

Table 3.11. Likelihood components for input values of steepness.

likelihood	Stp0.3	Stp0.4	Stp0.5	Stp0.6	Stp0.7	Stp0.8	Stp0.9	Stp0.99
TOTAL	13609.3	13562.2	13521.3	13494.7	13482.3	13474	13481.4	13479.5
Catch	0	0	0	0	0	0	0	0
Equil_catch	0	0	0	0	0	0	0	0
Survey	30.87	14.64	3.01	-7.49	-14.2	-18.86	-20.61	-24.14
Length_comp	4181.65	4186.01	4199.5	4194.03	4196.46	4197.63	4222.6	4201.41
Age_comp	9355.17	9341.17	9326.8	9326.98	9323.69	9321.47	9305.02	9317.05
Recruitment	38.33	4.11	-10.82	-20.68	-25.32	-28.11	-28.62	-31.06
Forecast_Rec	0	0	0	0	0	0	0	0
Parm_priors	3.25	16.22	2.78	1.85	1.63	1.9	2.97	16.23
Parm_softbounds	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Parm_devs	0	0	0	0	0	0	0	0
Crash_Pen	0	0	0	0	0	0	0	0

Table 3.12. Likelihood components for base and sensitivity runs.

component	YEG BASE Oct20	Update 86_09	Update 86_09 zeroeq	No Rec Devs	Three Area	No Sel Blocks	Est. M	Low Stp 0.7	No Est Herm Parms	BASE low Landing	LowM	HighM
TOTAL	13439	11582	11913	13507	15182	13471	13353	13442	13485	13445	13634	13375
Catch	0	0	0	0	0	0	0	0	0	0	0	0
Equil_catch	0	1.44	0	0	0	0	0	0	0	0	0	0
Survey	-23.7	-22.2	25.86	-14	-9.79	-21.7	-29.3	-15.5	-22.6	-7.01	-6.24	-30.4
Length_comp	4170	3399	3488	4172	4800	4197	4110	4150	4224	4146	4242	4133
Age_comp	9317	8196	8333	9344	10375	9319	9300	9330	9308	9318	9378	9300
Recruitment	-28.9	1.37	63.78	0	10.87	-26.9	-29.8	-24.4	-29.8	-17.6	14.85	-30.6
Forecast Rec.	0	0	0	0	0	0	0	0	0	0	0	0
Parm_priors	4.57	5.45	1.67	5.42	5.52	3.42	2.44	1.64	4.7	4.92	6.16	3.01
Parm bounds	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Parm_devs	0	0	0	0	0	0	0	0	0	0	0	0
Crash_Pen	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.13. Predicted total biomass (mt), spawning biomass (mt), age-0 recruits (thousand fish), and fishing mortality for Gulf of Mexico YEG from the base model, asymptotic standard deviations based on inverting the hessian matrix are given in parentheses.

year	Total abundance (gutted MT)	Spawning biomass (gutted MT, males and females)	Recruitment (1000s)	Overall F
1975	15003	13288 (169.58)	814.99 (179.778)	0.014 (0.0002)
1976	15003	13058 (167.18)	804.93 (176.219)	0.012 (0.0001)
1977	14764	12856 (164.29)	830.37 (182.149)	0.01 (0.0001)
1978	14508	12669 (161.04)	845.97 (185.155)	0.01 (0.0001)
1979	14302	12486 (157.47)	876.22 (188.354)	0.015 (0.0002)
1980	14126	12242 (153.5)	812.65 (172.159)	0.029 (0.0003)
1981	13967	11831 (149.11)	838.33 (173.065)	0.093 (0.001)
1982	13746	10653 (144.11)	774.96 (156.48)	0.164 (0.002)
1983	13355	8815 (138.66)	752.44 (151.862)	0.154 (0.0021)
1984	12160	7416 (133.39)	807.13 (172.981)	0.142 (0.0022)
1985	10273	6356 (128.58)	1084.86 (230.374)	0.121 (0.0021)
1986	8844	5629 (124.53)	916.99 (199.478)	0.092 (0.0017)
1987	7770	5197 (121.36)	723.63 (142.016)	0.081 (0.0016)
1988	7038	4887 (119)	710 (134.706)	0.118 (0.0025)
1989	6621	4416 (117.04)	742.38 (139.234)	0.057 (0.0013)
1990	6334	4323 (116.27)	678.54 (132.355)	0.069 (0.0016)
1991	5866	4200 (115.98)	900.98 (185.271)	0.061 (0.0015)
1992	5808	4139 (116.47)	943.25 (231.291)	0.084 (0.0021)
1993	5707	3995 (117.57)	1441.31 (319.096)	0.064 (0.0017)
1994	5660	3969 (119.65)	928.71 (225.462)	0.089 (0.0024)
1995	5516	3845 (122.24)	712.43 (147.402)	0.071 (0.002)
1996	5494	3807 (125.6)	830.32 (179.063)	0.045 (0.0013)
1997	5372	3891 (129.62)	1111.61 (237.607)	0.06 (0.0018)
1998	5362	3906 (134.03)	854.06 (188.006)	0.056 (0.0018)
1999	5497	3942 (139.18)	793.92 (152.307)	0.078 (0.0026)
2000	5557	3886 (145.31)	627.24 (108.941)	0.088 (0.0031)
2001	5641	3806 (152.77)	799.4 (18.2768)	0.064 (0.0024)
2002	5606	3860 (161.59)	799.87 (18.1457)	0.064 (0.0025)
2003	5524	3919 (171.26)	800.37 (18.0088)	0.089 (0.0036)
2004	5569	3862 (181.46)	799.89 (18.2821)	0.076 (0.0033)
2005	5605	3868 (192.47)	799.94 (18.3403)	0.065 (0.003)
2006	5504	3922 (204.12)	800.39 (18.236)	0.062 (0.0029)
2007	5472	3984 (216.00)	800.9 (18.1072)	0.071 (0.0035)
2008	5494	3991 (227.56)	800.95 (18.1708)	0.068 (0.0034)
2009	5530	4002 (238.53)	801.05 (18.214)	0.068 (0.0036)

Table 3.14. Estimated numbers at age and sex by region, in thousands.

Region	sex	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
East	Fem.	1975	546.7	348.2	263	202.2	159.3	127.4	104	87.22	75.82	97.09	87	79	71	64	58	52	47	43	38	34	31	28	25	22	20	18	16	14	12	11	9.9	8.8	7.8	6.9	6.2	5.5	4.9	4.3	3.9	3.4	28
East	Fem.	1976	539.9	354.6	262.9	212.5	169.6	136.8	110.9	91.25	76.88	67.03	86	77	70	63	57	51	46	42	38	34	30	27	24	22	19	17	15	14	12	11	9.7	8.6	7.7	6.8	6.1	5.4	4.8	4.3	3.8	3.4	29
East	Fem.	1977	557.0	350.2	267.8	212.5	178.3	145.6	119.1	97.41	80.55	68.08	59	76	69	62	56	51	46	41	37	33	30	27	24	21	19	17	15	14	12	11	9.6	8.5	7.6	6.7	6	5.3	4.7	4.2	3.7	3.3	30
East	Fem.	1978	567.5	361.3	264.5	216.4	178.3	153.1	126.9	104.7	86.07	71.43	61	53	68	61	55	50	45	41	37	33	30	26	24	21	19	17	15	13	12	11	9.4	8.4	7.5	6.6	5.9	5.2	4.7	4.1	3.7	3.3	31
East	Fem.	1979	587.7	368.1	272.8	213.7	181.6	153.1	133.4	111.6	92.57	76.39	64	54	47	61	55	49	45	40	36	33	29	26	23	21	19	17	15	13	12	10	9.3	8.3	7.4	6.6	5.8	5.2	4.6	4.1	3.6	3.2	32
East	Fem.	1980	545.1	381.2	278	220.5	179.3	155.9	133.2	117	98.28	81.78	68	56	48	42	54	49	44	39	36	32	29	26	23	21	18	16	15	13	12	10	9.1	8.1	7.2	6.4	5.7	5.1	4.5	4	3.6	3.2	33
East	Fem.	1981	562.3	353.6	287.9	224.6	185	153.9	135.5	116.6	102.5	86.05	71	59	49	42	36	47	42	38	34	31	27	25	22	20	18	16	14	12	11	9.8	8.8	7.8	6.9	6.2	5.5	4.9	4.3	3.8	3.4	3	33
East	Fem.	1982	519.8	364.7	267	232.6	188.4	158.6	133.5	117.8	100.7	87.69	73	60	49	40	34	30	38	34	31	27	25	22	20	18	16	14	12	11	9.9	8.8	7.8	7	6.2	5.5	4.9	4.3	3.9	3.4	3.1	2.7	30
East	Fem.	1983	504.7	337.2	275.5	215.7	195.1	161.4	136.9	114.4	98.76	81.91	69	56	45	36	29	24	21	27	24	21	19	17	15	14	12	11	9.7	8.6	7.7	6.8	6.1	5.4	4.8	4.3	3.8	3.4	3	2.7	2.4	2.1	24
East	Fem.	1984	541.4	327.4	254.6	222.5	180.9	167.1	139.3	117.3	95.93	80.38	65	53	42	33	26	21	17	15	19	17	15	13	12	11	9.5	8.4	7.5	6.7	6	5.3	4.7	4.2	3.7	3.3	2.9	2.6	2.3	2.1	1.8	1.6	19
East	Fem.	1985	727.7	351.2	247.2	205.7	186.6	154.9	144.2	119.5	98.8	78.71	64	50	40	31	24	19	15	13	11	14	12	11	9.6	8.6	7.6	6.8	6	5.4	4.8	4.2	3.8	3.3	3	2.6	2.3	2.1	1.9	1.7	1.5	1.3	16
East	Fem.	1986	615.1	472.0	265.2	199.7	172.5	159.8	133.8	124	101.4	82.26	64	52	40	32	24	19	15	12	9.7	8.3	10	9.2	8.2	7.3	6.5	5.7	5.1	4.5	4	3.6	3.2	2.8	2.5	2.2	2	1.8	1.6	1.4	1.2	1.1	14
East	Fem.	1987	485.4	398.9	356.4	214.2	167.4	147.4	137.4	114.6	105.4	85.36	69	53	43	33	26	20	15	12	9.6	7.9	6.7	8.4	7.4	6.6	5.8	5.2	4.6	4.1	3.6	3.2	2.9	2.5	2.3	2	1.8	1.6	1.4	1.2	1.1	1	13
East	Fem.	1988	476.3	314.8	301.3	287.9	179.6	143.3	127.3	118.7	98.47	89.95	72	58	45	36	27	22	16	13	9.8	7.8	6.4	5.4	6.8	6	5.3	4.7	4.1	3.7	3.3	2.9	2.6	2.3	2	1.8	1.6	1.4	1.3	1.1	1	0.9	11
East	Fem.	1989	498.0	308.9	237.7	243.3	241.3	153.7	123.8	110.1	102.1	84.09	76	61	48	37	29	22	17	13	10	7.8	6.2	5.1	4.3	5.3	4.7	4.1	3.7	3.2	2.9	2.5	2.3	2	1.8	1.6	1.4	1.2	1.1	1	0.9	0.8	10
East	Fem.	1990	455.2	323.0	233.3	192.1	204.1	207.1	133.8	108.5	96.8	89.8	74	67	53	42	32	25	19	15	11	8.6	6.7	5.2	4.3	3.6	4.5	3.9	3.5	3.1	2.7	2.4	2.1	1.9	1.7	1.5	1.3	1.2	1	0.9	0.8	0.7	9.8
East	Fem.	1991	604.4	295.2	243.9	188.4	161.1	175	179.8	116.8	94.79	84.32	78	64	57	45	36	27	21	16	12	9.4	7.1	5.5	4.3	3.5	2.9	3.7	3.2	2.8	2.5	2.2	2	1.7	1.5	1.4	1.2	1.1	1	0.8	0.8	0.7	9.1
East	Fem.	1992	632.7	392.0	222.9	197.1	158.1	138.2	152.2	157.4	102.4	83.04	74	68	55	49	39	30	23	18	13	10	7.8	5.9	4.6	3.6	2.9	2.4	3	2.7	2.3	2.1	1.8	1.6	1.4	1.3	1.1	1	0.9	0.8	0.7	0.6	8.5
East	Fem.	1993	966.8	410.4	296	180.1	165.2	135.5	120.1	133	137.6	89.21	72	63	58	47	41	32	25	19	15	11	8.4	6.3	4.8	3.7	2.9	2.3	1.9	2.4	2.1	1.9	1.6	1.4	1.3	1.1	1	0.9	0.8	0.7	0.6	0.6	7.7
East	Fem.	1994	623.0	627.1	309.9	239.1	151.1	141.8	118	105.3	117.1	121.1	78	63	55	50	40	35	27	21	16	12	9.2	7.1	5.3	4	3	2.4	1.9	1.6	2	1.7	1.5	1.4	1.2	1.1	0.9	0.8	0.7	0.7	0.6	0.5	7.3
East	Fem.	1995	477.9	404.1	473.5	250.3	200.5	129.5	123.1	102.9	91.74	101.3	104	66	53	45	41	32	28	22	17	13	9.6	7.2	5.5	4.1	3.1	2.4	1.8	1.5	1.2	1.5	1.3	1.2	1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	6.3
East	Fem.	1996	557.0	310.0	305.1	382.5	210	172.1	112.7	107.9	90.47	80.54	89	90	57	45	39	35	27	24	18	14	10	7.9	5.9	4.5	3.4	2.5	1.9	1.5	1.2	1	1.2	1.1	1	0.8	0.7	0.7	0.6	0.5	0.5	0.4	5.8
East	Fem.	1997	745.6	361.3	234.1	246.5	320.9	180.2	149.8	98.96	95.13	79.73	71	78	79	50	39	33	30	23	20	15	12	8.7	6.6	4.9	3.8	2.8	2.1	1.6	1.2	1	0.8	1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	5.5
East	Fem.	1998	572.9	483.6	272.8	189.1	206.7	275.3	156.7	131.2	86.76	83.13	69	61	66	66	42	32	27	24	19	16	12	9.5	7	5.3	3.9	3	2.2	1.7	1.3	1	0.8	0.7	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	4.9
East	Fem.	1999	532.5	371.6	365.2	220.4	158.6	177.4	239.6	137.5	115.4	76.19	73	60	53	57	57	35	27	23	20	16	14	10	7.8	5.7	4.4	3.2	2.5	1.8	1.4	1	0.8	0.6	0.5	0.7	0.6	0.5	0.4	0.4	0.3	0.3	4.6
East	Fem.	2000	420.7	345.4	280.6	295	184.8	136	154.2	209.4	120.2	100.4	66	62	51	44	47	47	29	22	19	16	13	11	8.1	6.2	4.5	3.4	2.5	1.9	1.4	1.1	0.8	0.6	0.5	0.4	0.5	0.5	0.4	0.3	0.3	0.3	4
East	Fem.	2001	536.2	272.9	260.8	226.6	247.3	158.4	118.1	134.6	182.6	104.1	86	56	52	42	36	38	37	23	17	15	13	9.7	8.3	6.3	4.7	3.5	2.6	1.9	1.5	1.1	0.8	0.6	0.5	0.4	0.3	0.4	0.3	0.3	0.3	0.2	3.5
East	Fem.	2002	536.5	347.8	206.1	210.7	190.1	212.2	137.8	103.4	118	159.6	90	74	47	44	35	30	31	31	19	14	12	10	7.8	6.6	5	3.8	2.8	2.1	1.5	1.2	0.9	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.2	0.2	3.1
East	Fem.	2003	536.9	348.0	262.6	166.5	176.7	163.1	184.6	120.8	90.86	103.5	139	78	64	41	37	30	25	26	25	15	12	9.6	8.3	6.4	5.4	4.1	3.1	2.2	1.7	1.2	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.3	0.2	0.2	2.8
East	Fem.	2004	536.5	348.2	262.8	212.2	139.6	151.5	141.7	161.3	105.4	78.86	89	118	66	53	33	30	24	20	21	20	12	9.1	7.5	6.5	5	4.2	3.1	2.4	1.7	1.3	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	2.5
East	Fem.	2005	536.6	348.0	263	212.3	177.9	119.7	131.7	123.9	141.2	91.91	68	76	101	55	44	28	25	19	16	17	16	9.7	7.2	6	5.1	3.9	3.3	2.5	1.9	1.3	1	0.7	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.2	2.2
East	Fem.	2006	536.9	348.0	262.8	212.4	178	152.6	104.2	115.4	108.8	123.7	80	59	65	86	47	37	23	21	16	13	14	13	7.9	5.9	4.8	4.1	3.2	2.7	2	1.5	1.1	0.8	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	2
East	Fem.	2007	537.2	348.2	262.8	212.3	178.2	152.8	132.8	91.27	101.3	95.33	108	69	51	56	72	39	31	19	17	13	11	11	11	6.4	4.8	3.9	3.3	2.5	2.1	1.6	1.2	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	1.8
East	Fem.	2008	537.3	348.4	263	212.3	178	152.8	132.7	116.1	79.77	88.09	82	92	58	42	46	59	32	25	15	13	10	8.6	8.7	8.3	5	3.7	3	2.6	2	1.7	1.2	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	1.5
East	Fem.	2009	537.3	348.5	263.1	212.4	178	152.7	132.8	116.1	101.6	69.51	76	70	78	49	35	38	48	26	20	12	11	8.3	6.8	6.9	6.5	3.9	2.9	2.4	2	1.5	1.3	1	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	1.3
East	Male	1975	0.0	0.0	0.17	0.424	0.721	1.037	1.368	1.729	2.154	3.805	4.6	5.4	6.2	7.1	7.9	8.8	9.6	10	11	12	12	13	13	13	14	14	14	14	14	14	13	13	13	12	12	12	11	11	11	10	202
East	Male	1976	0.0	0.0	0.17	0.445	0.768	1.112	1.456	1.804	2.178	2.621	4.5	5.3	6.1	7	7.8	8.6	9.4	10	11	11	12	12	13	13	13	13	14	14	13	13	13	13	13	12	12	12	11	11	10	10	197
East	Male	1977	0.0	0.0	0.173	0.445	0.807	1.184	1.563	1.923	2.278	2.658	3.1	5.2	6	6.9	7.7	8.5	9.3	10	11	11	12	12	13	13	13	13	13	13	13	13	13	13	12	12	12	11	11	11	10	9.9	192
East	Male	1978	0.0	0.0	0.171	0.453	0.807	1.245	1.666	2.068	2.433	2.786	3.2	3.6	6	6.8	7.6	8.4	9.2	9.9	11	11	12	12	13	13	13	13	13	13	13	13	13	12	12	12	12	11	11	11	10	9.8	188
East	Male	1979	0.0	0.0	0.176	0.448	0.822	1.245	1.751	2.204	2.618	2.979	3.3	3.7	4.1	6.7	7.5	8.3	9.1	9.8	10	11	12	12	12	13	13	13	13	13	13	13	13	12	12	12	11	11	11	10	10	9.7	184
East	Male	1980	0.0	0.0	0.18	0.462	0.811	1.267	1.748	2.309	2.777	3.187	3.5	3.8	4.2	4.6	7.4	8.2	8.9	9.6	10	11	11	12	12	12	13	13	13	13	13	13	12	12	12	12	11	11	11	10	9.9	9.5	180
East	Male	1981	0.0	0.0	0.186	0.471	0.837	1.251	1.776	2.294	2.885	3.338	3.7	4	4.3	4.6	5	7.8	8.5	9.2	9.8	10	11	11	12	12	12	12	12	12	12	12	12	12	11	11	11	10	10	9.8	9.4	9.1	171
East	Male	1982	0.0	0.0	0.173	0.487	0.852	1.288	1.744	2.301	2.801	3.352	3.7	4	4.2	4.4	4.6	4.9	7.7	8.3	8.8	9.3	9.7	10	10	11	11	11	11	11	11	11	11	10	10	9.9	9.6	9.3	9	8.7	8.4	8.1	152
East	Male	1983	0.0	0.0	0.178	0.452	0.882	1.308	1.777	2.199	2.675	3.03	3.4	3.6	3.7	3.8	3.9	4	4.2	6.4	6.8	7.2	7.5	7.8	8	8.2	8.3	8.4	8.4	8.4	8.4	8.3	8.2	8	7.8	7.6	7.4	7.2	7	6.8	6.5	6.3	117
East	Male	1984	0.0	0.0	0.165	0.466	0.818	1.354	1.805	2.246	2.572	2.921	3.1	3.4	3.4	3.4	3.4	3.4	3.4	3.6	5.4	5.7	5.9	6.1	6.3	6.4	6.5	6.5	6.6	6.6	6.5	6.4	6.3	6.2	6.1	5.9	5.8	5.6	5.4	5.3	5.1	4.9	90
East	Male	1985	0.0	0.0	0.16	0.431	0.844	1.256	1.871	2.292	2.652	2.854	3.1	3.1	3.3	3.2	3.2	3.1	3	3	3.1	4.6	4.7	4.9	5	5.1	5.2	5.2	5.3	5.2	5.2	5.1	5.1	5	4.9	4.7	4.6	4.5	4.3	4.2	4	3.9	72
East	Male	1986	0.0	0.0	0.171	0.418	0.78	1.295	1.738	2.391	2.746	3.014	3.1	3.2	3.2	3.2	3.1	3	2.9	2.8	2.7	2.7	4.1	4.2	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.2	4.1	4	3.9	3.8	3.7	3.5	3.4	3.3	60
East	Male	1987	0.0	0.0	0.23	0.449	0.757	1.194	1.786	2.222	2.894	3.191	3.4	3.4	3.5	3.4	3.3	3.1	3	2.8	2.7	2.6	2.6	3.8	3.9	3.9	4	4	4	4	3.9	3.9	3.8	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	2.9	53
East	Male	1988	0.0	0.0	0.195	0.603	0.812	1.161	1.657	2.308	2.721	3.398	3.6	3.8	3.7	3.7	3.5	3.4	3.1	2.9	2.7	2.6	2.5	2.4	3.5	3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.4	3.4	3.3	3.2	3.1	3	2.9	2.8	2.7	2.6	48
East	Male	1989	0.0	0.0	0.154	0.51	1.091	1.247	1.613	2.143	2.824	3.183	3.8	4	4	3.8	3.7	3.5	3.3	3	2.8	2.5	2.4	2.2	2.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3	3	2.9	2.8	2.7	2.7	2.6	2.5	2.4	2.3	42
East	Male	1990	0.0	0.0	0.151	0.402	0.924	1.683	1.752	2.129	2.7	3.427	3.7	4.4	4.4	4.4	4.1	3.9	3.6	3.4	3.1	2.8	2.5	2.3	2.2	2.1	3	3	3	3	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.5	2.4	2.3	2.3	2.2	39
East	Male	1991	0.0	0.0	0.158	0.395	0.729	1.422	2.355	2.293	2.65	3.227	4	4.2	4.8	4.8	4.6	4.3	4	3.6	3.4	3	2.7	2.4	2.2	2	2	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.2	2.1	2.1	2	35
East	Male	1992	0.0	0.0	0.144	0.413	0.715	1.123	1.994	3.095	2.869	3.188	3.8	4.5	4.6	5.2	5	4.8	4.4	4.1	3.6	3.3	2.9	2.6	2.3	2.1	1.9	1.8	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2	2	1.9	1.8	33
East	Male	1993	0.0	0.0	0.191	0.377	0.748	1.101	1.572	2.612	3.848	3.418	3.7	4.2	4.9	4.9	5.4	5.1	4.8	4.3	4	3.5	3.2	2.8	2.4	2.1	1.9	1.7	1.7	2.3	2.3	2.2	2.2	2.1	2.1	2	2	1.9	1.8	1.8	1.7	1.6	29
East	Male	1994	0.0	0.0	0.2	0.501	0.684	1.153	1.547	2.073	3.282	4.652	4	4.2	4.6	5.3	5.2	5.6	5.3	4.9	4.3	3.9	3.4	3.1	2.7	2.3	2	1.8	1.6	1.5	2.1	2.1	2	2	1.9	1.9	1.8	1.8	1.7	1.6	1.6	1.5	27
East	Male	1995	0.0	0.0	0.306	0.524	0.907	1.052	1.612	2.019	2.56	3.867	5.3	4.4	4.4	4.8	5.3	5.2	5.4	5	4.6	4	3.6	3.1	2.7	2.4	2	1.8	1.5	1.4	1.3	1.8	1.8	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3	23
East	Male	1996	0.0	0.0	0.197	0.802	0.95	1.399	1.477	2.123	2.532	3.084	4.5	5.9	4.8	4.7	5	5.5	5.3	5.5	5	4.5	3.9	3.4	2.9	2.6	2.2	1.9	1.6	1.4	1.3	1.2	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	21
East	Male	1997	0.0	0.0	0.151	0.517	1.452	1.466	1.966	1.949	2.671	3.066	3.6	5.1	6.6	5.2	5.1	5.3	5.7	5.4	5.5	5	4.4	3.8	3.3	2.8	2.5	2.1	1.8	1.5	1.3	1.2	1.1	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	19
East	Male	1998	0.0	0.0	0.176	0.396	0.935	2.238	2.055	2.581	2.43	3.188	3.5	4	5.6	7	5.4	5.1	5.3	5.6	5.2	5.3	4.7	4.1	3.5	3	2.6	2.2	1.9	1.6	1.3	1.2	1	1	1.3	1.3	1.2	1.2	1.1	1.1	1	1	17
East	Male	1999	0.0	0.0	0.236	0.462	0.718	1.442	3.142	2.706	3.235	2.926	3.7	4	4.4	6	7.4	5.6	5.2	5.3	5.5	5.1	5.1	4.5	3.9	3.3	2.8	2.4	2	1.7	1.4	1.2	1	0.9	0.9	1.2	1.1	1.1	1	1	0.9	0.9	16
East	Male	2000	0.0	0.0	0.181	0.618	0.836	1.105	2.02	4.114	3.359	3.839	3.3	4.1	4.3	4.6	6.1	7.4	5.5	5.1	5	5.2	4.7	4.7	4.1	3.5	2.9	2.5	2.1	1.8	1.5	1.2	1	0.9	0.8	0.7	1	0.9	0.9	0.9	0.8	0.8	14
East	Male	2001	0.0	0.0	0.169	0.475	1.119	1.287	1.546	2.639	5.088	3.962	4.3	3.6	4.3	4.4	4.6	6	7.1	5.2	4.7	4.6	4.7	4.2	4.2	3.6	3.1	2.6	2.2	1.8	1.5	1.3	1	0.9	0.7	0.7	0.6	0.8	0.8	0.7	0.7	0.7	12
East	Male	2002	0.0	0.0	0.133	0.441	0.86	1.725	1.805	2.031	3.293	6.084	4.6	4.8	3.9	4.6	4.5	4.7	6	7	5	4.5	4.4	4.4	3.9	3.8	3.3	2.8	2.3	1.9	1.6	1.3	1.1	0.9	0.8	0.6	0.6	0.5	0.7	0.7	0.6	0.6	10
East	Male	2003	0.0	0.0	0.17	0.349	0.8	1.326	2.421	2.376	2.544	3.962	7.1	5.2	5.3	4.2	4.8	4.7	4.8	6	6.9	4.9	4.3	4.2	4.1	3.7	3.5	3	2.5	2.1	1.8	1.4	1.2	1	0.8	0.7	0.6	0.5	0.5	0.6	0.6	0.6	9.3
East	Male	2004	0.0	0.0	0.17	0.445	0.631	1.231	1.855	3.166	2.942	3.008	4.5	7.8	5.5	5.5	4.3	4.8	4.5	4.6	5.6	6.4	4.5	3.9	3.7	3.7	3.2	3.1	2.6	2.2	1.8	1.5	1.2	1	0.8	0.7	0.6	0.5	0.4	0.4	0.5	0.5	8
East	Male	2005	0.0	0.0	0.17	0.445	0.805	0.973	1.726	2.434	3.941	3.506	3.5	5	8.4	5.8	5.7	4.3	4.7	4.4	4.4	5.3	6	4.2	3.6	3.4	3.3	2.9	2.7	2.3	1.9	1.6	1.3	1.1	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.4	7
East	Male	2006	0.0	0.0	0.17	0.445	0.806	1.241	1.366	2.27	3.045	4.731	4.1	3.9	5.5	8.9	6	5.8	4.4	4.7	4.3	4.2	5.1	5.6	3.9	3.3	3.1	3	2.6	2.5	2.1	1.7	1.4	1.2	0.9	0.8	0.6	0.5	0.4	0.4	0.3	0.3	6.3
East	Male	2007	0.0	0.0	0.17	0.445	0.806	1.242	1.741	1.795	2.838	3.652	5.5	4.6	4.2	5.8	9.3	6.2	5.9	4.3	4.6	4.2	4.1	4.8	5.3	3.6	3.1	2.9	2.8	2.4	2.2	1.9	1.5	1.2	1	0.8	0.7	0.5	0.4	0.4	0.3	0.3	5.6
East	Male	2008	0.0	0.0	0.17	0.445	0.805	1.242	1.739	2.279	2.227	3.361	4.2	6	4.9	4.4	5.9	9.3	6	5.6	4.1	4.3	3.9	3.7	4.3	4.7	3.2	2.7	2.5	2.4	2	1.9	1.6	1.3	1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	4.8
East	Male	2009	0.0	0.0	0.17	0.445	0.805	1.241	1.74	2.28	2.836	2.65	3.8	4.6	6.5	5.1	4.5	5.9	9.1	5.8	5.4	3.8	4	3.6	3.4	3.9	4.2	2.8	2.4	2.2	2.1	1.8	1.6	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	4.2
West	Fem.	1975	268.3	171.8	130.8	101.3	80.27	64.48	52.83	44.45	38.74	49.71	45	40	37	33	30	27	24	22	20	18	16	14	13	11	10	9	8	7.1	6.3	5.6	5	4.4	3.9	3.5	3.1	2.8	2.4	2.2	1.9	1.7	14
West	Fem.	1976	265.0	175.0	130.8	106.4	85.44	69.22	56.35	46.55	39.38	34.46	44	40	36	33	30	27	24	22	20	18	16	14	13	11	10	8.9	8	7.1	6.3	5.6	5	4.4	3.9	3.5	3.1	2.7	2.4	2.1	1.9	1.7	14

West	Fem.	1977	273.4	172.8	133.2	106.4	89.8	73.71	60.55	49.74	41.35	35.13	31	40	36	32	29	26	24	22	19	17	16	14	13	11	10	8.9	7.9	7	6.2	5.5	4.9	4.4	3.9	3.4	3.1	2.7	2.4	2.1	1.9	1.7	15
West	Fem.	1978	278.5	178.3	131.6	108.4	89.8	77.48	64.51	53.49	44.22	36.92	31	28	36	32	29	26	24	21	19	17	16	14	12	11	9.9	8.8	7.9	7	6.2	5.5	4.9	4.3	3.9	3.4	3	2.7	2.4	2.1	1.9	1.7	16
West	Fem.	1979	288.5	181.6	135.7	107	91.46	77.48	67.8	56.96	47.53	39.47	33	28	25	32	29	26	24	21	19	17	15	14	12	11	9.8	8.8	7.8	6.9	6.2	5.5	4.9	4.3	3.8	3.4	3	2.7	2.4	2.1	1.9	1.7	16
West	Fem.	1980	267.5	188.1	138.3	110.4	90.32	78.89	67.76	59.8	50.52	42.31	35	30	25	22	29	26	23	21	19	17	15	14	12	11	9.7	8.7	7.7	6.9	6.1	5.4	4.8	4.3	3.8	3.4	3	2.6	2.3	2.1	1.9	1.6	17
West	Fem.	1981	276.0	174.5	143.2	112.5	93.19	77.95	69.05	59.84	53.13	45.06	38	32	26	23	20	26	23	21	19	17	15	14	12	11	9.6	8.6	7.6	6.8	6	5.4	4.8	4.2	3.8	3.3	3	2.6	2.3	2.1	1.8	1.6	17
West	Fem.	1982	255.1	180.0	132.8	116.5	94.85	80.1	67.45	59.59	51.23	45.06	38	32	26	22	19	16	21	19	17	15	14	12	11	9.8	8.8	7.8	7	6.2	5.5	4.9	4.3	3.8	3.4	3	2.7	2.4	2.1	1.9	1.7	1.5	16
West	Fem.	1983	247.7	166.4	137	108.1	98.23	81.5	69.24	58.07	50.82	43.23	38	31	26	22	18	15	13	17	15	14	12	11	9.9	8.9	7.9	7	6.3	5.6	5	4.4	3.9	3.5	3.1	2.7	2.4	2.1	1.9	1.7	1.5	1.3	15
West	Fem.	1984	265.7	161.6	126.7	111.5	91.13	84.51	70.68	59.93	49.86	43.21	36	32	26	22	18	15	13	11	14	13	11	10	9	8.1	7.2	6.4	5.7	5.1	4.5	4	3.5	3.1	2.8	2.5	2.2	2	1.7	1.5	1.4	1.2	14
West	Fem.	1985	357.2	173.3	123	103	93.97	78.27	72.99	60.74	50.95	41.89	36	30	26	21	18	14	12	10	8.9	11	10	9.1	8.1	7.2	6.4	5.7	5.1	4.5	4	3.6	3.2	2.8	2.5	2.2	2	1.7	1.5	1.4	1.2	1.1	13
West	Fem.	1986	301.9	232.9	131.9	100	86.85	80.66	67.48	62.52	51.4	42.56	35	29	24	21	17	14	12	9.6	8.1	7.1	9	8.1	7.2	6.4	5.7	5.1	4.5	4	3.6	3.2	2.8	2.5	2.2	2	1.7	1.5	1.4	1.2	1.1	1	12
West	Fem.	1987	238.2	196.9	177.3	107.3	84.32	74.66	69.97	58.63	54.13	44.21	36	29	25	20	17	14	12	9.5	7.8	6.6	5.7	7.3	6.5	5.7	5.1	4.5	4	3.6	3.2	2.8	2.5	2.2	2	1.8	1.6	1.4	1.2	1.1	1	0.9	11
West	Fem.	1988	233.7	155.4	149.9	144.2	90.45	72.55	64.91	61.04	51.06	46.92	38	31	25	21	17	14	12	9.6	7.8	6.4	5.4	4.7	5.9	5.3	4.7	4.1	3.7	3.3	2.9	2.6	2.3	2	1.8	1.6	1.4	1.3	1.1	1	0.9	0.8	9.8
West	Fem.	1989	244.4	152.4	118.3	121.9	121.4	77.31	62.06	55.05	51.09	42.13	38	31	25	20	16	13	11	9	7.3	5.9	4.8	4	3.5	4.4	3.9	3.5	3.1	2.7	2.4	2.1	1.9	1.7	1.5	1.3	1.2	1	0.9	0.8	0.7	0.6	8.3
West	Fem.	1990	223.4	159.4	116	96.18	102.7	104.4	67.24	54.17	47.99	44.34	36	33	26	21	16	14	11	9.2	7.5	6	4.9	4	3.3	2.8	3.6	3.2	2.8	2.5	2.2	2	1.7	1.5	1.4	1.2	1.1	0.9	0.8	0.7	0.7	0.6	7.7
West	Fem.	1991	296.6	145.7	121.3	94.37	81.09	88.42	90.87	58.73	47.26	41.67	38	31	28	22	18	14	11	9.1	7.6	6.1	4.9	4	3.2	2.7	2.3	2.9	2.6	2.3	2	1.8	1.6	1.4	1.2	1.1	1	0.9	0.8	0.7	0.6	0.5	7.1
West	Fem.	1992	310.5	193.4	110.9	98.69	79.57	69.8	76.94	79.39	51.25	41.07	36	33	27	24	19	15	11	9.4	7.6	6.3	5.1	4.1	3.3	2.6	2.2	1.9	2.4	2.1	1.8	1.6	1.4	1.3	1.1	1	0.9	0.8	0.7	0.6	0.5	0.5	6.6
West	Fem.	1993	474.5	202.5	147.3	90.19	83.16	68.37	60.48	66.72	68.52	43.9	35	30	27	22	19	15	12	9.3	7.6	6.1	5	4	3.2	2.6	2.1	1.7	1.5	1.9	1.6	1.5	1.3	1.1	1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	5.9
West	Fem.	1994	305.8	309.5	154.2	119.8	76.01	71.48	59.28	52.52	57.73	58.92	37	30	25	23	18	16	12	9.7	7.5	6.1	4.9	4.1	3.2	2.6	2.1	1.7	1.4	1.2	1.5	1.3	1.2	1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	5.3
West	Fem.	1995	234.5	199.4	235.6	125.4	101	65.41	62.17	51.75	45.78	50.11	51	32	25	22	19	15	13	10	8.1	6.2	5	4	3.3	2.6	2.1	1.7	1.4	1.1	1	1.2	1.1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.4	4.9
West	Fem.	1996	273.4	153.0	151.8	191.6	105.7	86.85	56.84	54.15	44.92	39.45	43	43	27	21	18	16	12	11	8.3	6.5	5	4	3.2	2.6	2.1	1.7	1.3	1.1	0.9	0.8	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.4	0.3	4.4
West	Fem.	1997	366.0	178.3	116.4	123.5	161.6	91.09	75.82	49.96	47.71	39.57	35	38	38	23	18	15	14	11	9.3	7.1	5.5	4.2	3.4	2.7	2.2	1.8	1.4	1.1	0.9	0.7	0.6	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	4.2
West	Fem.	1998	281.2	238.7	135.7	94.73	104.2	139.3	79.58	66.73	44.12	42.17	35	31	33	33	20	16	13	12	9.2	8	6.1	4.8	3.6	2.9	2.3	1.9	1.5	1.2	1	0.8	0.6	0.5	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	4.1
West	Fem.	1999	261.4	183.4	181.7	110.4	79.89	89.73	121.5	69.78	58.57	38.65	37	30	26	28	28	17	13	11	10	7.8	6.7	5.1	4	3	2.4	1.9	1.6	1.3	1	0.8	0.6	0.5	0.4	0.6	0.5	0.4	0.4	0.3	0.3	0.3	3.8
West	Fem.	2000	206.5	170.5	139.6	147.8	93.08	68.77	78.09	106.1	60.91	50.93	33	32	26	22	24	24	15	11	9.4	8.2	6.4	5.5	4.2	3.3	2.5	2	1.6	1.3	1	0.8	0.6	0.5	0.4	0.4	0.5	0.4	0.4	0.3	0.3	0.2	3.5
West	Fem.	2001	263.2	134.7	129.8	113.5	124.6	80.09	59.8	68.13	92.46	52.8	44	29	27	22	19	20	20	12	9.2	7.7	6.7	5.2	4.5	3.4	2.6	2	1.6	1.3	1	0.8	0.6	0.5	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.2	3.2
West	Fem.	2002	263.3	171.6	102.5	105.5	95.75	107.4	69.87	52.48	59.9	81.17	46	38	25	23	19	16	17	17	10	7.8	6.5	5.7	4.4	3.8	2.9	2.2	1.7	1.3	1.1	0.9	0.7	0.5	0.4	0.3	0.3	0.2	0.3	0.3	0.2	0.2	3.1
West	Fem.	2003	263.5	171.7	130.7	83.38	88.99	82.44	93.47	61.09	45.85	52.09	70	40	33	21	20	16	13	14	14	8.5	6.4	5.3	4.6	3.6	3.1	2.3	1.8	1.4	1.1	0.9	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.8
West	Fem.	2004	263.3	171.8	130.7	106.3	70.29	76.57	71.67	81.48	53.11	39.6	45	60	33	27	17	16	13	11	12	11	6.8	5.2	4.3	3.7	2.9	2.4	1.9	1.4	1.1	0.9	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.5
West	Fem.	2005	263.4	171.7	130.8	106.3	89.59	60.51	66.66	62.65	71.16	46.18	34	38	51	28	23	15	13	11	9.1	9.5	9.2	5.6	4.2	3.5	3	2.3	2	1.5	1.2	0.9	0.7	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.2	2.3
West	Fem.	2006	263.5	171.8	130.7	106.4	89.66	77.16	52.72	58.36	54.85	62.08	40	30	33	43	24	19	12	11	8.9	7.5	7.9	7.6	4.6	3.5	2.9	2.5	1.9	1.6	1.2	0.9	0.7	0.6	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.1	2.1
West	Fem.	2007	263.7	171.9	130.7	106.3	89.73	77.26	67.31	46.27	51.29	48.1	54	35	26	28	37	20	16	10	9.5	7.5	6.3	6.6	6.4	3.8	2.9	2.4	2.1	1.6	1.3	1	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	2
West	Fem.	2008	263.7	172.0	130.8	106.4	89.7	77.35	67.45	59.18	40.8	45.25	42	48	31	22	25	32	18	14	9	8.2	6.5	5.4	5.6	5.4	3.3	2.5	2	1.7	1.3	1.1	0.9	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.1	0.1	1.9
West	Fem.	2009	263.7	172.0	130.9	106.4	89.72	77.32	67.53	59.3	52.17	35.98	40	37	42	27	19	21	28	15	12	7.7	7	5.5	4.6	4.8	4.6	2.8	2.1	1.7	1.5	1.1	1	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	1.8
West	Male	1975	0.0	0.0	0.085	0.212	0.363	0.525	0.695	0.881	1.101	1.948	2.3	2.8	3.2	3.6	4.1	4.5	4.9	5.3	5.7	6	6.3	6.5	6.7	6.9	7	7	7	7	7	6.9	6.8	6.6	6.5	6.3	6.1	5.9	5.7	5.5	5.3	5.1	96
West	Male	1976	0.0	0.0	0.085	0.223	0.387	0.563	0.741	0.922	1.118	1.35	2.3	2.7	3.2	3.6	4	4.5	4.9	5.3	5.6	5.9	6.2	6.5	6.7	6.8	6.9	6.9	7	6.9	6.9	6.8	6.7	6.6	6.4	6.2	6.1	5.9	5.7	5.5	5.3	5.1	95
West	Male	1977	0.0	0.0	0.086	0.223	0.407	0.6	0.796	0.985	1.173	1.375	1.6	2.7	3.2	3.6	4	4.4	4.9	5.2	5.6	5.9	6.2	6.4	6.6	6.7	6.8	6.9	6.9	6.9	6.8	6.8	6.6	6.5	6.4	6.2	6	5.8	5.6	5.4	5.2	5	93
West	Male	1978	0.0	0.0	0.085	0.227	0.407	0.631	0.848	1.059	1.254	1.445	1.6	1.9	3.1	3.6	4	4.4	4.8	5.2	5.6	5.9	6.2	6.4	6.6	6.7	6.8	6.9	6.9	6.9	6.8	6.7	6.6	6.5	6.3	6.2	6	5.8	5.6	5.4	5.2	5	92
West	Male	1979	0.0	0.0	0.088	0.224	0.414	0.63	0.891	1.128	1.348	1.544	1.7	1.9	2.2	3.5	4	4.4	4.8	5.2	5.5	5.8	6.1	6.3	6.5	6.7	6.8	6.8	6.8	6.8	6.8	6.7	6.6	6.4	6.3	6.1	5.9	5.8	5.6	5.4	5.2	5	91
West	Male	1980	0.0	0.0	0.089	0.231	0.409	0.642	0.89	1.183	1.432	1.655	1.8	2	2.2	2.5	3.9	4.3	4.7	5.1	5.5	5.8	6	6.3	6.5	6.6	6.7	6.7	6.8	6.7	6.7	6.6	6.5	6.4	6.2	6	5.9	5.7	5.5	5.3	5.1	4.9	89
West	Male	1981	0.0	0.0	0.093	0.236	0.422	0.634	0.908	1.184	1.506	1.762	2	2.2	2.3	2.5	2.7	4.3	4.7	5.1	5.4	5.7	6	6.2	6.4	6.5	6.6	6.7	6.7	6.7	6.6	6.5	6.4	6.3	6.2	6	5.8	5.6	5.5	5.3	5.1	4.9	88
West	Male	1982	0.0	0.0	0.086	0.244	0.429	0.65	0.881	1.168	1.436	1.743	2	2.2	2.3	2.4	2.6	2.8	4.3	4.6	4.9	5.2	5.5	5.7	5.8	5.9	6	6.1	6.1	6.1	6	5.9	5.8	5.7	5.6	5.4	5.3	5.1	5	4.8	4.6	4.4	79
West	Male	1983	0.0	0.0	0.089	0.226	0.444	0.661	0.902	1.132	1.413	1.657	1.9	2.1	2.3	2.4	2.5	2.6	2.7	4.2	4.5	4.7	4.9	5.1	5.2	5.4	5.4	5.5	5.5	5.5	5.4	5.4	5.3	5.2	5	4.9	4.8	4.6	4.5	4.3	4.1	4	71
West	Male	1984	0.0	0.0	0.082	0.234	0.412	0.686	0.922	1.168	1.382	1.647	1.9	2.1	2.3	2.4	2.4	2.5	2.5	2.7	4.1	4.3	4.5	4.6	4.8	4.9	4.9	5	5	5	4.9	4.9	4.8	4.7	4.6	4.5	4.3	4.2	4.1	3.9	3.8	3.6	64
West	Male	1985	0.0	0.0	0.079	0.216	0.425	0.635	0.951	1.182	1.409	1.592	1.8	2	2.2	2.3	2.4	2.4	2.4	2.5	2.5	3.8	4	4.1	4.3	4.4	4.4	4.4	4.5	4.4	4.4	4.3	4.3	4.2	4.1	4	3.9	3.7	3.6	3.5	3.4	3.2	57
West	Male	1986	0.0	0.0	0.085	0.21	0.393	0.654	0.878	1.214	1.419	1.614	1.8	2	2.1	2.3	2.3	2.3	2.3	2.3	2.3	2.4	3.6	3.7	3.8	3.9	3.9	3.9	4	3.9	3.9	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3	2.9	50
West	Male	1987	0.0	0.0	0.115	0.225	0.381	0.606	0.914	1.144	1.5	1.677	1.8	1.9	2.1	2.2	2.3	2.3	2.3	2.3	2.2	2.2	2.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.3	3.2	3.2	3.1	3	2.9	2.8	2.7	2.6	44
West	Male	1988	0.0	0.0	0.097	0.302	0.409	0.589	0.849	1.196	1.423	1.788	1.9	2	2.1	2.2	2.3	2.4	2.3	2.3	2.2	2.2	2.1	2.1	3.1	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3	2.9	2.9	2.8	2.7	2.6	2.5	2.4	2.3	40
West	Male	1989	0.0	0.0	0.076	0.255	0.549	0.626	0.807	1.072	1.416	1.6	1.9	2	2.1	2.1	2.1	2.1	2.2	2.1	2.1	2	1.9	1.8	1.8	2.6	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2	1.9	33
West	Male	1990	0.0	0.0	0.075	0.202	0.465	0.848	0.878	1.059	1.335	1.69	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2	1.9	1.8	1.7	1.7	2.4	2.5	2.4	2.4	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2	2	1.9	1.8	1.8	30
West	Male	1991	0.0	0.0	0.078	0.198	0.367	0.718	1.19	1.152	1.318	1.592	1.9	2.1	2.3	2.3	2.3	2.2	2.2	2.1	2.1	2	1.9	1.8	1.7	1.6	1.6	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2	2	1.9	1.9	1.8	1.7	1.7	1.6	27
West	Male	1992	0.0	0.0	0.072	0.207	0.36	0.567	1.008	1.559	1.433	1.573	1.8	2.2	2.2	2.5	2.4	2.4	2.2	2.2	2.1	2.1	1.9	1.8	1.7	1.6	1.5	1.4	2.1	2	2	2	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.5	1.5	25
West	Male	1993	0.0	0.0	0.095	0.189	0.376	0.555	0.791	1.307	1.913	1.679	1.8	2	2.3	2.3	2.5	2.4	2.3	2.2	2.1	2	1.9	1.8	1.7	1.5	1.4	1.3	1.3	1.8	1.8	1.8	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3	22
West	Male	1994	0.0	0.0	0.1	0.251	0.344	0.58	0.775	1.029	1.611	2.254	1.9	2	2.2	2.4	2.4	2.6	2.4	2.3	2.1	2	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	19
West	Male	1995	0.0	0.0	0.152	0.263	0.457	0.531	0.814	1.015	1.279	1.92	2.6	2.1	2.1	2.3	2.5	2.5	2.6	2.4	2.2	2	1.9	1.8	1.7	1.6	1.4	1.3	1.2	1.1	1	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1	18
West	Male	1996	0.0	0.0	0.098	0.401	0.478	0.706	0.744	1.061	1.253	1.508	2.2	2.8	2.3	2.2	2.3	2.5	2.4	2.5	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.1	1	1	0.9	1.3	1.2	1.2	1.2	1.1	1.1	1	1	1	0.9	16
West	Male	1997	0.0	0.0	0.075	0.259	0.731	0.741	0.994	0.983	1.338	1.522	1.8	2.5	3.2	2.5	2.4	2.5	2.7	2.5	2.6	2.3	2.1	1.9	1.7	1.6	1.5	1.3	1.2	1.1	1	0.9	0.8	1.2	1.1	1.1	1.1	1	1	1	0.9	0.9	15
West	Male	1998	0.0	0.0	0.088	0.199	0.471	1.133	1.045	1.316	1.242	1.63	1.8	2	2.8	3.5	2.7	2.6	2.6	2.8	2.6	2.6	2.3	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1	0.9	0.8	0.8	1.1	1.1	1	1	1	0.9	0.9	0.8	14
West	Male	1999	0.0	0.0	0.117	0.231	0.362	0.73	1.593	1.375	1.648	1.494	1.9	2	2.3	3.1	3.8	2.8	2.6	2.7	2.8	2.6	2.6	2.3	2	1.8	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.8	0.7	1	1	0.9	0.9	0.9	0.8	0.8	13
West	Male	2000	0.0	0.0	0.09	0.31	0.421	0.559	1.023	2.088	1.709	1.963	1.7	2.1	2.2	2.4	3.2	3.9	2.9	2.6	2.6	2.7	2.5	2.5	2.2	1.9	1.7	1.5	1.3	1.2	1.1	1	0.8	0.8	0.7	0.6	0.9	0.8	0.8	0.8	0.8	0.7	12
West	Male	2001	0.0	0.0	0.084	0.238	0.564	0.651	0.783	1.338	2.589	2.03	2.2	1.9	2.3	2.3	2.5	3.2	3.9	2.8	2.6	2.5	2.6	2.3	2.3	2	1.8	1.5	1.4	1.2	1.1	1	0.9	0.8	0.7	0.6	0.6	0.8	0.7	0.7	0.7	0.7	11
West	Male	2002	0.0	0.0	0.066	0.221	0.433	0.873	0.916	1.033	1.681	3.127	2.4	2.6	2.1	2.5	2.5	2.6	3.4	4	2.9	2.6	2.5	2.5	2.3	2.2	1.9	1.7	1.4	1.3	1.1	1	0.9	0.8	0.7	0.6	0.6	0.5	0.7	0.7	0.6	0.6	10
West	Male	2003	0.0	0.0	0.084	0.175	0.403	0.67	1.225	1.201	1.285	2.003	3.6	2.6	2.8	2.3	2.6	2.6	2.6	3.3	3.9	2.8	2.5	2.4	2.4	2.1	2.1	1.8	1.5	1.3	1.2	1	0.9	0.8	0.7	0.6	0.5	0.5	0.5	0.6	0.6	0.6	9.1
West	Male	2004	0.0	0.0	0.084	0.223	0.318	0.622	0.938	1.599	1.485	1.518	2.3	4	2.8	2.9	2.3	2.6	2.5	2.6	3.2	3.7	2.6	2.3	2.2	2.2	1.9	1.8	1.6	1.4	1.2	1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.5	0.5	8.1
West	Male	2005	0.0	0.0	0.085	0.223	0.405	0.492	0.873	1.23	1.991	1.771	1.7	2.5	4.3	3	3	2.4	2.6	2.5	2.5	3.1	3.5	2.5	2.2	2	2	1.8	1.7	1.4	1.2	1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.5	7.4
West	Male	2006	0.0	0.0	0.084	0.223	0.406	0.627	0.691	1.147	1.536	2.385	2	2	2.8	4.6	3.2	3.1	2.4	2.6	2.5	2.5	3	3.4	2.4	2	1.9	1.9	1.6	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	6.8
West	Male	2007	0.0	0.0	0.084	0.223	0.406	0.628	0.883	0.911	1.439	1.852	2.8	2.3	2.2	3	4.9	3.3	3.2	2.4	2.7	2.5	2.4	2.9	3.3	2.3	1.9	1.8	1.8	1.5	1.4	1.2	1	0.9	0.8	0.6	0.6	0.5	0.4	0.4	0.3	0.3	6.2
West	Male	2008	0.0	0.0	0.085	0.223	0.406	0.629	0.885	1.167	1.149	1.749	2.2	3.2	2.6	2.4	3.3	5.2	3.5	3.4	2.5	2.7	2.5	2.4	2.9	3.2	2.2	1.9	1.7	1.7	1.4	1.4	1.1	1	0.8	0.7	0.6	0.5	0.5	0.4	0.3	0.3	5.9
West	Male	2009	0.0	0.0	0.085	0.223	0.406	0.629	0.886	1.17	1.47	1.394	2.1	2.5	3.6	2.9	2.6	3.5	5.5	3.6	3.4	2.5	2.7	2.5	2.4	2.8	3.1	2.1	1.8	1.6	1.6	1.4	1.3	1.1	0.9	0.7	0.6	0.6	0.5	0.4	0.4	0.3	5.5

Table 3.15. Fleet specific instantaneous fishing mortality rates. Fishing mortality rates are the apical instantaneous fishing mortality rate. For the longline fishery, and for the most recent years where the fishery is mostly longlines, apical F is generally the F on ages 20-40+ due to the logistic selectivity.

Year	F Comm HLE	F Comm HLW	F Comm LLE	F Comm LLW	Apical F East (~sum of HL and LL)	Apical F West (~sum of HL and LL)
1975	0.018	0.010	0.000	0.000	0.018	0.010
1976	0.015	0.007	0.000	0.000	0.015	0.007
1977	0.013	0.006	0.000	0.000	0.013	0.006
1978	0.012	0.006	0.000	0.000	0.012	0.006
1979	0.018	0.007	0.000	0.004	0.018	0.011
1980	0.019	0.004	0.026	0.005	0.044	0.009
1981	0.018	0.023	0.095	0.072	0.112	0.095
1982	0.019	0.025	0.239	0.079	0.257	0.104
1983	0.021	0.014	0.232	0.083	0.252	0.097
1984	0.025	0.026	0.200	0.086	0.224	0.112
1985	0.037	0.031	0.133	0.090	0.169	0.120
1986	0.074	0.016	0.038	0.101	0.111	0.115
1987	0.049	0.011	0.060	0.088	0.108	0.097
1988	0.040	0.053	0.094	0.135	0.132	0.185
1989	0.010	0.010	0.054	0.087	0.064	0.095
1990	0.018	0.008	0.075	0.090	0.092	0.096
1991	0.012	0.009	0.068	0.086	0.079	0.093
1992	0.010	0.018	0.105	0.109	0.114	0.125
1993	0.005	0.018	0.072	0.095	0.076	0.111
1994	0.008	0.010	0.147	0.085	0.153	0.094
1995	0.004	0.008	0.089	0.118	0.091	0.123
1996	0.003	0.005	0.070	0.050	0.073	0.054
1997	0.002	0.005	0.118	0.039	0.119	0.043
1998	0.003	0.006	0.089	0.066	0.091	0.071
1999	0.004	0.009	0.134	0.084	0.136	0.091
2000	0.003	0.010	0.159	0.091	0.160	0.099
2001	0.002	0.005	0.120	0.060	0.120	0.064
2002	0.003	0.006	0.095	0.091	0.097	0.095
2003	0.004	0.008	0.149	0.110	0.150	0.116
2004	0.003	0.006	0.128	0.090	0.129	0.095
2005	0.003	0.005	0.104	0.082	0.105	0.086
2006	0.003	0.004	0.103	0.068	0.104	0.071
2007	0.002	0.006	0.149	0.040	0.148	0.046
2008	0.001	0.005	0.137	0.045	0.136	0.050
2009	0.003	0.010	0.122	0.059	0.123	0.067

Table 3.16. Age specific instantaneous fishing mortality rates, East and West.

Region	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	avg 20-40	Apical
East	1975	0.000	0.000	0.000	0.000	0.001	0.003	0.007	0.010	0.013	0.015	0.016	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018
East	1976	0.000	0.000	0.000	0.000	0.001	0.003	0.006	0.009	0.011	0.013	0.014	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
East	1977	0.000	0.000	0.000	0.000	0.001	0.003	0.005	0.008	0.010	0.011	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
East	1978	0.000	0.000	0.000	0.000	0.001	0.002	0.005	0.007	0.009	0.010	0.011	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
East	1979	0.000	0.000	0.000	0.000	0.001	0.004	0.007	0.011	0.014	0.016	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
East	1980	0.000	0.000	0.000	0.000	0.002	0.005	0.010	0.016	0.023	0.028	0.033	0.036	0.039	0.040	0.042	0.042	0.043	0.043	0.044	0.044	0.044	0.044
East	1981	0.000	0.000	0.000	0.000	0.002	0.007	0.016	0.030	0.047	0.062	0.075	0.086	0.093	0.099	0.103	0.106	0.107	0.109	0.110	0.110	0.112	0.112
East	1982	0.000	0.000	0.000	0.001	0.003	0.012	0.031	0.061	0.098	0.135	0.166	0.191	0.210	0.224	0.233	0.240	0.245	0.248	0.251	0.252	0.257	0.257
East	1983	0.000	0.000	0.000	0.001	0.004	0.012	0.031	0.061	0.097	0.133	0.164	0.188	0.207	0.220	0.229	0.236	0.240	0.244	0.246	0.248	0.252	0.252
East	1984	0.000	0.000	0.000	0.001	0.004	0.012	0.029	0.057	0.089	0.120	0.147	0.169	0.185	0.196	0.204	0.210	0.214	0.217	0.219	0.220	0.224	0.224
East	1985	0.000	0.000	0.000	0.001	0.004	0.012	0.027	0.049	0.074	0.097	0.116	0.131	0.142	0.150	0.156	0.159	0.162	0.164	0.165	0.166	0.169	0.169
East	1986	0.000	0.000	0.000	0.001	0.006	0.016	0.031	0.047	0.062	0.073	0.082	0.088	0.093	0.097	0.100	0.102	0.104	0.105	0.106	0.107	0.110	0.110
East	1987	0.000	0.000	0.000	0.001	0.004	0.012	0.023	0.036	0.048	0.059	0.068	0.075	0.081	0.086	0.091	0.094	0.097	0.099	0.101	0.102	0.107	0.107
East	1988	0.000	0.000	0.000	0.001	0.004	0.011	0.022	0.035	0.048	0.061	0.072	0.082	0.091	0.099	0.105	0.110	0.114	0.117	0.120	0.122	0.130	0.130
East	1989	0.000	0.000	0.000	0.000	0.001	0.004	0.008	0.013	0.018	0.024	0.030	0.035	0.040	0.044	0.048	0.051	0.053	0.055	0.057	0.058	0.062	0.062
East	1990	0.000	0.000	0.000	0.001	0.002	0.006	0.012	0.020	0.028	0.037	0.045	0.052	0.059	0.065	0.070	0.074	0.077	0.080	0.082	0.084	0.090	0.090
East	1991	0.000	0.000	0.000	0.001	0.002	0.005	0.009	0.015	0.022	0.030	0.037	0.044	0.050	0.055	0.059	0.063	0.066	0.068	0.070	0.072	0.077	0.077
East	1992	0.000	0.000	0.000	0.001	0.002	0.005	0.011	0.019	0.028	0.039	0.049	0.059	0.068	0.076	0.083	0.089	0.093	0.097	0.100	0.103	0.111	0.111
East	1993	0.000	0.000	0.000	0.001	0.001	0.003	0.007	0.012	0.018	0.025	0.032	0.039	0.045	0.050	0.055	0.059	0.062	0.065	0.067	0.068	0.074	0.074
East	1994	0.000	0.000	0.000	0.001	0.003	0.006	0.013	0.022	0.035	0.049	0.063	0.077	0.090	0.101	0.110	0.118	0.124	0.129	0.134	0.137	0.149	0.149
East	1995	0.000	0.000	0.000	0.001	0.002	0.004	0.007	0.013	0.020	0.028	0.037	0.046	0.053	0.060	0.066	0.070	0.074	0.077	0.080	0.082	0.089	0.089
East	1996	0.000	0.000	0.000	0.000	0.001	0.003	0.006	0.011	0.016	0.023	0.030	0.036	0.042	0.048	0.052	0.056	0.059	0.061	0.063	0.065	0.071	0.071
East	1997	0.000	0.000	0.000	0.001	0.002	0.004	0.009	0.016	0.025	0.036	0.047	0.058	0.068	0.077	0.084	0.091	0.096	0.100	0.103	0.106	0.116	0.116
East	1998	0.000	0.000	0.000	0.001	0.002	0.004	0.007	0.013	0.020	0.028	0.037	0.045	0.053	0.059	0.065	0.070	0.073	0.077	0.079	0.081	0.088	0.088
East	1999	0.000	0.000	0.000	0.001	0.002	0.005	0.011	0.019	0.029	0.042	0.055	0.067	0.079	0.089	0.097	0.104	0.110	0.115	0.119	0.122	0.133	0.133
East	2000	0.000	0.000	0.000	0.001	0.003	0.006	0.012	0.021	0.034	0.048	0.063	0.078	0.092	0.104	0.114	0.122	0.129	0.135	0.139	0.143	0.156	0.156
East	2001	0.000	0.000	0.000	0.001	0.002	0.004	0.009	0.016	0.025	0.036	0.047	0.059	0.069	0.078	0.085	0.092	0.097	0.101	0.105	0.107	0.117	0.117
East	2002	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.013	0.021	0.030	0.039	0.048	0.056	0.063	0.069	0.074	0.078	0.082	0.084	0.087	0.094	0.094
East	2003	0.000	0.000	0.000	0.001	0.002	0.006	0.011	0.020	0.032	0.045	0.060	0.074	0.086	0.097	0.107	0.115	0.121	0.126	0.131	0.134	0.146	0.146
East	2004	0.000	0.000	0.000	0.001	0.002	0.005	0.010	0.017	0.027	0.039	0.051	0.063	0.074	0.084	0.092	0.098	0.104	0.108	0.112	0.115	0.125	0.125
East	2005	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.014	0.022	0.032	0.042	0.051	0.060	0.068	0.075	0.080	0.085	0.089	0.092	0.094	0.102	0.102
East	2006	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.014	0.023	0.032	0.042	0.052	0.060	0.068	0.075	0.080	0.085	0.088	0.091	0.094	0.102	0.102
East	2007	0.000	0.000	0.000	0.001	0.002	0.005	0.011	0.019	0.030	0.044	0.058	0.072	0.084	0.095	0.105	0.113	0.119	0.124	0.129	0.132	0.144	0.144
East	2008	0.000	0.000	0.000	0.001	0.002	0.005	0.010	0.017	0.028	0.040	0.053	0.066	0.077	0.088	0.096	0.104	0.110	0.114	0.118	0.122	0.133	0.133
East	2009	0.000	0.000	0.000	0.001	0.002	0.005	0.009	0.017	0.026	0.037	0.049	0.061	0.071	0.080	0.088	0.094	0.100	0.104	0.107	0.110	0.120	0.120
West	1975	0.000	0.000	0.000	0.000	0.001	0.003	0.006	0.008	0.009	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
West	1976	0.000	0.000	0.000	0.000	0.001	0.002	0.004	0.005	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
West	1977	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
West	1978	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
West	1979	0.000	0.000	0.000	0.000	0.001	0.003	0.005	0.007	0.008	0.009	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
West	1980	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.005	0.006	0.007	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
West	1981	0.000	0.000	0.000	0.001	0.005	0.013	0.027	0.042	0.057	0.068	0.077	0.083	0.087	0.090	0.091	0.093	0.093	0.094	0.094	0.095	0.095	0.095
West	1982	0.000	0.000	0.000	0.001	0.005	0.014	0.029	0.046	0.062	0.075	0.084	0.090	0.095	0.098	0.100	0.101	0.102	0.103	0.103	0.103	0.104	0.104
West	1983	0.000	0.000	0.000	0.001	0.004	0.011	0.024	0.039	0.054	0.067	0.076	0.083	0.087	0.090	0.092	0.094	0.094	0.095	0.096	0.096	0.097	0.097
West	1984	0.000	0.000	0.000	0.001	0.005	0.015	0.031	0.049	0.066	0.080	0.090	0.097	0.102	0.105	0.107	0.109	0.110	0.110	0.111	0.111	0.112	0.112
West	1985	0.000	0.000	0.000	0.001	0.006	0.017	0.034	0.054	0.072	0.087	0.097	0.105	0.110	0.113	0.115	0.117	0.118	0.118	0.119	0.119	0.120	0.120
West	1986	0.000	0.000	0.000	0.001	0.005	0.011	0.020	0.031	0.043	0.055	0.065	0.075	0.083	0.089	0.094	0.098	0.102	0.104	0.106	0.108	0.113	0.113
West	1987	0.000	0.000	0.000	0.001	0.004	0.008	0.016	0.025	0.035	0.045	0.054	0.062	0.069	0.075	0.079	0.083	0.086	0.088	0.090	0.091	0.096	0.096
West	1988	0.000	0.000	0.001	0.003	0.010	0.025	0.044	0.065	0.085	0.102	0.118	0.131	0.142	0.151	0.158	0.163	0.168	0.171	0.174	0.176	0.183	0.183
West	1989	0.000	0.000	0.000	0.001	0.003	0.008	0.015	0.024	0.034	0.044	0.053	0.061	0.067	0.073	0.077	0.081	0.084	0.086	0.087	0.089	0.094	0.094
West	1990	0.000	0.000	0.000	0.001	0.003	0.008	0.015	0.023	0.033	0.043	0.053	0.061	0.068	0.073	0.078	0.082	0.084	0.087	0.088	0.090	0.095	0.095
West	1991	0.000	0.000	0.000	0.001	0.003	0.008	0.014	0.023	0.032	0.042	0.051	0.059	0.066	0.071	0.075	0.079	0.081	0.084	0.085	0.087	0.091	0.091
West	1992	0.000	0.000	0.000	0.002	0.005	0.012	0.022	0.034	0.047	0.060	0.071	0.082	0.090	0.097	0.103	0.107	0.111	0.113	0.115	0.117	0.123	0.123
West	1993	0.000	0.000	0.000	0.001	0.005	0.011	0.020	0.032	0.043	0.054	0.065	0.073	0.081	0.087	0.092	0.096	0.099	0.101	0.103	0.104	0.110	0.110
West	1994	0.000	0.000	0.000	0.001	0.003	0.008	0.015	0.024	0.034	0.043	0.052	0.060	0.067	0.072	0.076	0.080	0.083	0.085	0.086	0.088	0.092	0.092
West	1995	0.000	0.000	0.000	0.001	0.004	0.009	0.017	0.028	0.041	0.054	0.066	0.077	0.086	0.093	0.099	0.104	0.108	0.111	0.113	0.115	0.121	0.121
West	1996	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.013	0.019	0.024	0.030	0.034	0.038	0.041	0.044	0.046	0.047	0.049	0.050	0.050	0.053	0.053
West	1997	0.000	0.000	0.000	0.001	0.002	0.004	0.007	0.011	0.015	0.020	0.024	0.027	0.030	0.033	0.035	0.036	0.038	0.039	0.039	0.040	0.042	0.042
West	1998	0.000	0.000	0.000	0.001	0.002	0.006	0.011	0.017	0.024	0.032	0.039	0.045	0.050	0.054	0.057	0.060	0.062	0.064	0.065	0.066	0.070	0.070
West	1999	0.000	0.000	0.000	0.001	0.003	0.007	0.014	0.023	0.032	0.041	0.050	0.058	0.064	0.070	0.074	0.077	0.080	0.082	0.084	0.085	0.090	0.090
West	2000	0.000	0.000	0.000	0.001	0.004	0.008	0.016	0.025	0.035	0.045	0.055	0.063	0.070	0.076	0.081	0.084	0.087	0.089	0.091	0.093	0.098	0.098
West	2001	0.000	0.000	0.000	0.001	0.002	0.005	0.010	0.015	0.022	0.029	0.035	0.041	0.045	0.049	0.052	0.054	0.056	0.058	0.059	0.060	0.063	0.063
West	2002	0.000	0.000	0.000	0.001	0.003	0.007	0.013	0.022	0.032	0.042	0.051	0.059	0.066	0.072	0.077	0.080	0.083	0.086	0.087	0.089	0.094	0.094
West	2003	0.000	0.000	0.000	0.001	0.004	0.009	0.016	0.027	0.039	0.051	0.062	0.072	0.081	0.088	0.093	0.098	0.101	0.104	0.106	0.108	0.114	0.114
West	2004	0.000	0.000	0.000	0.001	0.003	0.007	0.014	0.022	0.032	0.042	0.051	0.060	0.066	0.072	0.077	0.080	0.083	0.086	0.087	0.089	0.094	0.094
West	2005	0.000	0.000	0.000	0.001	0.003	0.006	0.012	0.020	0.028	0.037	0.046	0.053	0.060	0.065	0.069	0.072	0.075	0.077	0.079	0.080	0.084	0.084
West	2006	0.000	0.000	0.000	0.001	0.002	0.005	0.010	0.016	0.023	0.031	0.038	0.044	0.049	0.053	0.057	0.060	0.062	0.063	0.065	0.066	0.070	0.070
West	2007	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.012	0.017	0.022	0.026	0.030	0.033	0.036	0.038	0.039	0.041	0.042	0.042	0.043	0.045	0.045
West	2008	0.000	0.000	0.000	0.001	0.002	0.004	0.008	0.013	0.018	0.023	0.028	0.032	0.035	0.038	0.040	0.042	0.044	0.045	0.046	0.046	0.049	0.049
West	2009	0.000	0.000	0.000	0.001	0.003	0.006	0.012	0.018	0.025	0.032	0.039	0.044	0.049	0.052	0.055	0.058	0.060	0.061	0.062	0.063	0.066	0.066

Table 3.17. Input and estimated parameters for sensitivity runs.

num	parameter	YEG BASE	Update 86_09	No Rec Devs	No Sel Blocks	Est. M	Low Stp 0.7	No Est Herm Parms	BASE low Land.	LowM	HighM
1	NatM_p_1_Fem_GP_1	0.073	0.073	0.073	0.073	0.088	0.073	0.073	0.073	0.055	0.090
2	L_at_Amin_Fem_GP_1	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
3	L_at_Amax_Fem_GP_1	90.310	99.088	92.320	91.209	92.554	91.213	93.295	89.100	87.349	93.323
4	VonBert_K_Fem_GP_1	0.078	0.067	0.075	0.077	0.074	0.077	0.074	0.080	0.084	0.073
5	CV_young_Fem_GP_1	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
6	CV_old_Fem_GP_1	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
7	NatM_p_1_Fem_GP_2	0.073	0.073	0.073	0.073	0.110	0.073	0.073	0.073	0.055	0.090
8	L_at_Amin_Fem_GP_2	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
9	L_at_Amax_Fem_GP_2	90.016	98.114	92.427	90.590	95.200	91.457	93.806	90.278	86.268	93.730
10	VonBert_K_Fem_GP_2	0.089	0.077	0.085	0.088	0.080	0.087	0.083	0.089	0.097	0.083
11	CV_young_Fem_GP_2	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
12	CV_old_Fem_GP_2	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
13	NatM_p_1_Mal_GP_1	0.073	0.073	0.073	0.073	0.000	0.073	0.073	0.073	0.055	0.090
14	L_at_Amin_Mal_GP_1	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
15	L_at_Amax_Mal_GP_1	91.503	98.368	90.956	91.894	92.311	90.701	90.820	90.741	90.084	92.280
16	VonBert_K_Mal_GP_1	0.092	0.074	0.094	0.091	0.089	0.095	0.092	0.095	0.098	0.089
17	CV_young_Mal_GP_1	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
18	CV_old_Mal_GP_1	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
19	NatM_p_1_Mal_GP_2	0.073	0.073	0.073	0.073	0.000	0.073	0.073	0.073	0.055	0.090
20	L_at_Amin_Mal_GP_2	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
21	L_at_Amax_Mal_GP_2	90.207	99.721	89.345	90.911	93.573	89.232	89.437	91.234	89.605	91.188
22	VonBert_K_Mal_GP_2	0.103	0.073	0.108	0.102	0.087	0.108	0.103	0.100	0.113	0.097
23	CV_young_Mal_GP_2	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
24	CV_old_Mal_GP_2	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
25	Wtlen_1_Fem	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Wtlen_2_Fem	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910
27	Mat50%_Fem	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000
28	Mat_slope_Fem	-0.330	-0.330	-0.330	-0.330	-0.330	-0.330	-0.330	-0.330	-0.330	-0.330
29	Eggs_scalar_Fem	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Eggs_exp_len_Fem	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910
31	Wtlen_1_Mal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	Wtlen_2_Mal	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910	2.910
33	Herm_Infl_age	14.790	50.859	16.618	15.669	21.040	15.966	41.000	14.574	12.000	19.560
34	Herm_stdev	8.137	20.000	8.666	8.677	10.630	8.797	14.630	8.310	7.225	9.957
35	Herm_asymptote	0.059	0.382	0.072	0.065	0.105	0.067	0.470	0.057	0.042	0.095
36	RecrDist_Area_1	1.706	1.237	1.687	1.703	0.568	1.689	1.702	1.494	1.727	1.675
37	RecrDist_Area_2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
38	SR_R0	6.722	7.111	6.720	6.714	7.934	6.767	6.726	6.574	5.869	7.544
39	SR_steep	0.953	0.978	0.967	0.954	0.862	0.700	0.956	0.960	0.974	0.902
40	SR_sigmaR	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
41	Main_InitAge_8	-0.361	-0.254	0.000	-0.411	-0.144	-0.396	-0.334	-0.527	-0.643	-0.194
42	Main_InitAge_7	-0.335	-0.178	0.000	-0.377	-0.179	-0.372	-0.311	-0.483	-0.571	-0.218

43	Main_InitAge_6	-0.280	-0.081	0.000	-0.312	-0.182	-0.320	-0.259	-0.412	-0.465	-0.213
44	Main_InitAge_5	-0.210	-0.276	0.000	-0.229	-0.166	-0.250	-0.189	-0.323	-0.332	-0.190
45	Main_InitAge_4	-0.135	0.096	0.000	-0.134	-0.141	-0.172	-0.111	-0.230	-0.188	-0.156
46	Main_InitAge_3	-0.070	-0.114	0.000	-0.041	-0.117	-0.100	-0.040	-0.146	-0.065	-0.121
47	Main_InitAge_2	-0.018	0.863	0.000	0.050	-0.108	-0.038	0.019	-0.072	0.032	-0.095
48	Main_InitAge_1	-0.016	-0.112	0.000	0.086	-0.144	-0.030	0.014	-0.040	0.064	-0.112
49	Main_RecrDev_1975	0.004	-0.253	0.000	0.126	-0.163	-0.014	0.026	0.016	0.249	-0.115
50	Main_RecrDev_1976	-0.006	-0.114	0.000	0.087	-0.178	-0.038	0.010	0.025	0.146	-0.125
51	Main_RecrDev_1977	0.028	0.692	0.000	0.066	-0.150	-0.020	0.041	0.078	0.199	-0.096
52	Main_RecrDev_1978	0.047	-0.139	0.000	0.014	-0.121	-0.008	0.051	0.100	0.108	-0.071
53	Main_RecrDev_1979	0.082	0.173	0.000	0.008	-0.081	0.031	0.083	0.146	0.457	-0.035
54	Main_RecrDev_1980	0.007	-0.302	0.000	-0.051	-0.102	-0.031	0.015	0.060	-0.023	-0.069
55	Main_RecrDev_1981	0.039	0.000	0.000	0.030	-0.066	0.006	0.052	0.147	0.300	-0.045
56	Main_RecrDev_1982	-0.038	0.000	0.000	-0.019	-0.101	-0.069	-0.031	0.049	0.058	-0.096
57	Main_RecrDev_1983	-0.065	0.000	0.000	-0.047	-0.105	-0.096	-0.064	-0.012	-0.098	-0.104
58	Main_RecrDev_1984	0.008	0.000	0.000	0.015	-0.009	-0.013	0.029	0.019	-0.251	-0.008
59	Main_RecrDev_1985	0.309	0.000	0.000	0.336	0.185	0.323	0.337	0.458	0.930	0.206
60	Main_RecrDev_1986	0.144	0.000	0.000	0.153	0.088	0.182	0.117	0.212	-0.059	0.097
61	Main_RecrDev_1987	-0.090	0.000	0.000	-0.086	-0.078	-0.051	-0.108	-0.043	-0.071	-0.084
62	Main_RecrDev_1988	-0.107	0.000	0.000	-0.099	-0.097	-0.051	-0.114	-0.045	-0.005	-0.101
63	Main_RecrDev_1989	-0.058	0.000	0.000	-0.049	-0.052	0.013	-0.062	0.018	0.148	-0.055
64	Main_RecrDev_1990	-0.148	0.000	0.000	-0.152	-0.102	-0.090	-0.168	-0.118	-0.134	-0.111
65	Main_RecrDev_1991	0.137	0.000	-8.595	0.136	0.170	0.201	0.132	0.186	0.146	0.158
66	Main_RecrDev_1992	0.182	0.000	-8.595	0.163	0.293	0.206	0.175	0.115	-0.229	0.274
67	Main_RecrDev_1993	0.613	0.000	-7.690	0.628	0.552	0.744	0.586	0.772	1.126	0.556
68	Main_RecrDev_1994	0.169	0.000	-7.247	0.146	0.279	0.189	0.132	0.085	-0.232	0.264
69	Main_RecrDev_1995	-0.095	0.000	-5.697	-0.117	0.041	-0.069	-0.131	-0.145	-0.307	0.018
70	Main_RecrDev_1996	0.059	0.000	-5.480	0.037	0.181	0.089	0.029	0.022	-0.164	0.158
71	Main_RecrDev_1997	0.352	0.000	-8.595	0.338	0.394	0.402	0.336	0.396	0.649	0.376
72	Main_RecrDev_1998	0.085	0.000	-8.595	0.042	0.225	0.090	0.049	0.035	-0.164	0.194
73	Main_RecrDev_1999	0.011	0.000	51.966	-0.039	0.186	0.011	-0.018	-0.034	-0.155	0.153
74	Main_RecrDev_2000	-0.245	0.000	-1.525	-0.300	-0.006	-0.258	-0.293	-0.311	-0.454	-0.044

Table 3.18. Derived quantities for base and sensitivity runs. Reference points and benchmarks from sensitivity runs for Gulf of Mexico tilefish. Benchmarks are reported for four reference points : 1) SPR40%. 2) SPR30%, 3) SSB at MSST which (1-M)*$SSB_{SPR40\%}$ and 4) SSB_{MSY}.

estimate/ benchmark	YEG BASE	Update 86_09	Update 86_09 zeroeq	No Rec Devs	Three Area	No Sel Blocks	Est. M	Low Stp0.7	NoEst Herm Parms	low Land-ing	LowM	HighM
TotBio_Unfished	15120	23851	9935	14821	15599	15082	18583	15673	14749	13165	14288	17103
SPB_Virgin	13423	21636	8839	13176	13978	13417	15470	13923	13122	11686	13172	14541
Recr_Virgin	831	1226	559	829	881	824	2791	869	834	716	354	1889
SSB_B40%virgin	5369	8654	3536	5270	5591	5367	6188	5569	5249	4674	5269	5817
SSB_SPR40%	5270	8579	3371	5202	5494	5268	5801	4567	5157	4600	5216	5573
SSB_SPR30%	3911	6403	2460	3873	4080	3910	4190	3007	3863	3449	4013	4113
MSST_SPR40%	4885	7953	3125	4822	5093	4884	5378	4233	4780	4264	4835	5166
SSB_MSY	2401	3552	1926	2247	2513	2396	3127	4072	2371	2012	2377	2853
SPB_2009	4026	8090	3496	3489	6105	3982	7883	3606	3812	3486	2562	6710
SSB/B40%virgin	0.750	0.935	0.989	0.662	1.092	0.742	1.274	0.647	0.726	0.746	0.486	1.154
SSB/SPR40%	0.764	0.943	1.037	0.671	1.111	0.756	1.359	0.790	0.739	0.758	0.491	1.204
SSB/SPR30%	1.030	1.263	1.421	0.901	1.496	1.018	1.881	1.199	0.987	1.011	0.638	1.632
SSB/MSST_SPR40%	0.824	1.017	1.119	0.724	1.199	0.815	1.466	0.852	0.797	0.817	0.530	1.299
SSB/MSY	1.677	2.278	1.815	1.553	2.430	1.662	2.521	0.885	1.608	1.733	1.078	2.352
Fstd_B40%virgin	0.047	0.043	0.045	0.047	0.047	0.046	0.049	0.039	0.047	0.046	0.040	0.051
Fstd_SPR40%	0.048	0.043	0.047	0.048	0.048	0.047	0.053	0.048	0.048	0.047	0.040	0.053
Fstd_SPR30%	0.066	0.060	0.065	0.066	0.067	0.065	0.073	0.066	0.067	0.066	0.057	0.073
Fstd_MSY	0.099	0.099	0.080	0.103	0.101	0.098	0.091	0.053	0.099	0.102	0.087	0.097
F_2009	0.068	0.037	0.086	0.077	0.049	0.070	0.035	0.078	0.072	0.079	0.108	0.041
Yield B40%virgin	323	457	200	318	328	317	436	271	319	279	249	413
Yield_SPR40%	326	459	204	320	331	319	448	282	322	281	250	421
Yield_SPR30%	358	504	219	353	365	351	448	275	356	312	285	463
Yield_MSY	375	532	222	371	382	367	498	283	369	325	288	472

Table 3.19. Uncertainty in management benchmarks with the base model. Maximum likelihood estimates and asymptotic standard deviations are and median and standard deviations from the MCMC runs are shown.

estimate/ benchmark	MLE	asymptotic stdev	MCMC median	StDev MCMC
SPB_Virgin	13423.00	173.33	13209.90	192.84
Recr_Virgin	831.00	12.47	820.72	13.23
SSB_SPR40%	5270.00	86.31	5148.85	100.91
SSB_MSY	2401.00	233.03	2476.74	227.39
SPB_2009	4026.00	239.89	3955.53	261.86
Fstd_SPR40%	0.0480	0.0004	0.0478	0.0003
Fstd_MSY	0.0990	0.0088	0.0948	0.0082
F_2009	0.0680	0.0036	0.0692	0.0041
SSB/SPR40%	0.764	0.000	0.768	0.039
SSB/MSY	1.677	0.036	1.597	0.191
Fstd/F_SPR40%	1.42	0.01	1.45	0.09
Fstd/Fstd_MSY	0.69	0.01	0.73	0.09
Yield B40%virgin	323.00	6.80	315.18	7.63
Yield_SPR40%	326.00	5.93	318.45	6.61
Yield_MSY	375.00	12.94	363.21	13.70

Table 3.20. Required SFA and MSRA evaluations using SPR 40% and SPR 30% reference points for Gulf of Mexico yellowedge grouper BASE, low M, high M and low landings runs. Biomass units are 1000lbs, gutted weight (SSB, MSST, and MSY).

		40%SPR				30%SPR			
Criteria	Definition	BASE	Low M	High M	Low Land	BASE	Low M	High M	Low Land
	Mortality Rate Criteria								
$F_{MSY\ or\ proxy}$	$F_{SPRtgt\%}$	0.048	0.040	0.053	0.000	0.066	0.057	0.073	0.066
MFMT	$F_{SPR40\%}$	0.048	0.040	0.053	0.047	0.066	0.057	0.073	0.066
F_{OY}	75% of $F_{SPRtgt\%}$	0.036	0.030	0.040	0.035	0.050	0.042	0.055	0.049
$F_{CURRENT}$	F_{2009}	0.068	0.108	0.041	0.079	0.068	0.108	0.041	0.079
$F_{CURRENT}$/MFMT	F_{2009}	1.432	2.702	0.767	1.666	1.032	1.910	0.559	1.201
Base M	**Biomass Criteria**								
SSB_{MSY} (1000lbs)	Equilibrium SSB @ $F_{SPRtgt\%}$	11614.3	11496.4	12282.6	10139.1	8619.4	8843.8	9064.8	7600.9
MSST (1000lbs)	(1-M)*$SSB_{SPRtgt\%}$ M=0.073 or 0.055 or 0.09 for low and high	10766.5	10864.1	11177.1	9399.0	3625.3	3791.9	3742.7	3196.9
$SSB_{CURRENT}$	SSB_{2009}	8873.7	5646.3	14789.3	7683.2	4026.2	2561.8	6710.2	3486.0
$SS_{CURRENT}$/MSST	SSB_{2009}	0.824	0.520	1.323	0.817	1.111	0.676	1.793	1.090
Equilibrium MSY	Equilibrium Yield @ $F_{SPRtgt\%}$	717.77	551.56	926.78	619.74	789.32	628.22	1019.45	687.47
Equilibrium OY	Equilibrium Yield @ F_{OY}	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
OFL (1000lbs)	Annual Yield @ FMFMT								
	OFL 2010	552.37	296.30	1142.37	475.61	820.44	437.39	1694.79	718.76
	OFL 2011	565.74	309.93	1131.74	486.15	818.75	448.32	1625.15	712.17
	OFL 2012	578.21	323.75	1119.34	496.35	816.47	459.37	1558.60	706.37
	OFL 2013	589.87	337.66	1105.90	506.24	813.93	470.49	1496.23	701.47
	OFL 2014	600.76	351.52	1092.04	515.78	811.35	481.55	1438.82	697.49
	OFL 2015	610.93	365.22	1078.26	524.92	808.86	492.42	1386.81	694.33
Annual OY (ACT)	Annual Yield @ F_{OY}								
	OY 2010	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	OY 2011	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	OY 2012	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	OY 2013	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	OY 2014	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	OY 2015	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Annual Yield (2011) @ 65% FMFMT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Alternative ACT:	Annual Yield (2011) @ 75% FMFMT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Annual Yield (2011) @ 85% FMFMT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Generation									

Time									
Rebuild Time	(if B_{2009}<MSST)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Tmin	@ F=0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Midpoint	mid of Tmin, Tmax	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	if Tmin>10y, Tmin + 1								
Tmax	Gen	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ABC	Recommend Range	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Table 3.21. Comparison of estimated quantities and benchmarks between SRA and SS3.

estimate/ benchmark	YEG BASE	SRA ALL	SRA EAST	SRA WEST
TotBio_Unfished	15119.90	NA	NA	NA
Vulnerable biomass, unfished	NA	13260.87	8506.59	3453.29
SPB_Virgin	13422.80	NA	NA	NA
Recr_Virgin	830.56	NA	NA	NA
SSB_B40%virgin	5369.14	NA	NA	NA
Vulnerable biomass @40%virgin	NA	5304.35	3402.63	1381.32
SSB_2009	4026.17	NA	NA	NA
VulnB_2009	NA	4230.46	3458.72	1015.67
SSB/SSB40%virgin	0.750			
VulnB_2009/VulnB40%virgin		0.798	1.016	0.735

3.5. ***FIGURES***

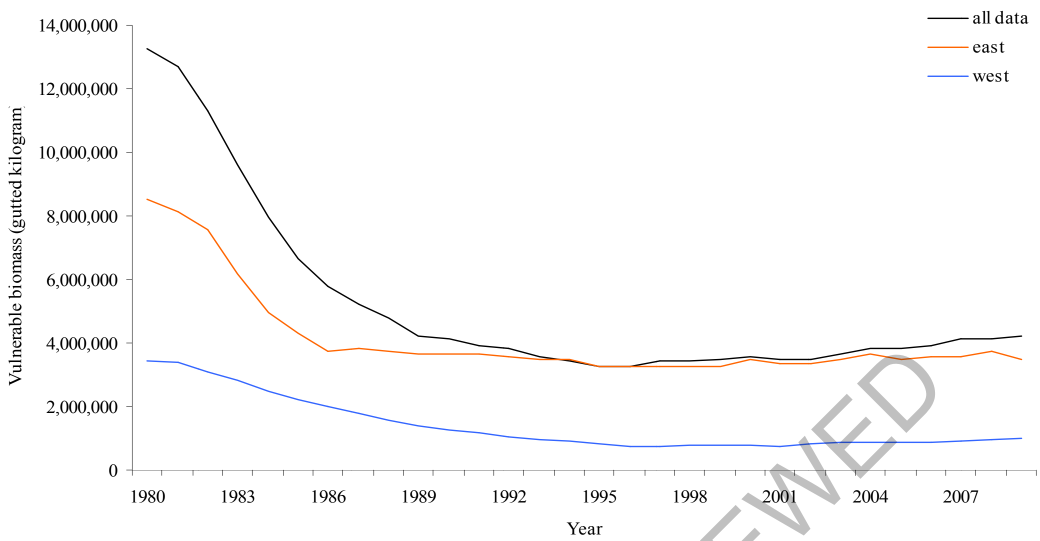


Figure 3.1. Estimates of vulnerable biomass for yellowedge grouper by region (east and west of the Mississippi River) and all data combined in the Gulf of Mexico for the time period catch histories exist. Note that the 'all data' model is an independent model and not the sum of the East and West biomass.

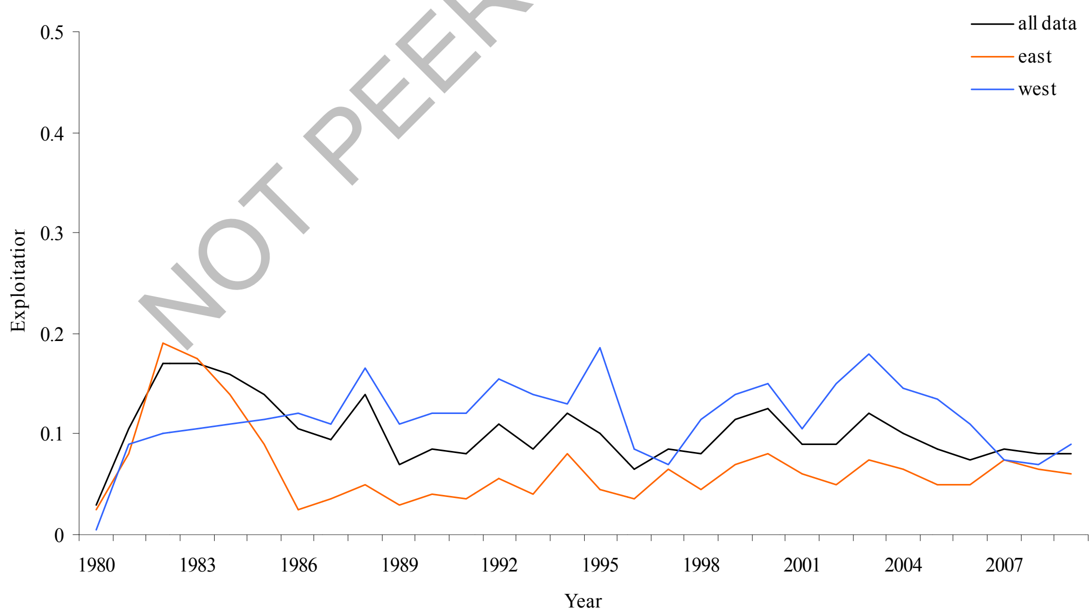
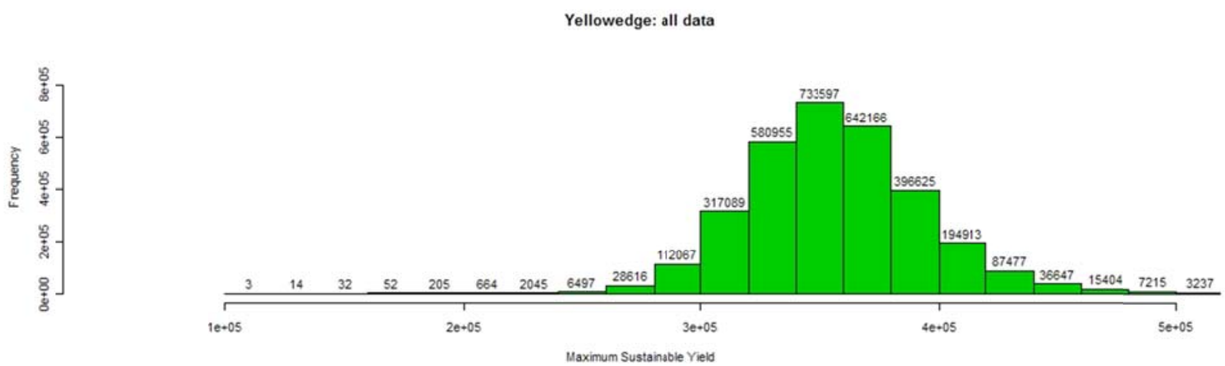
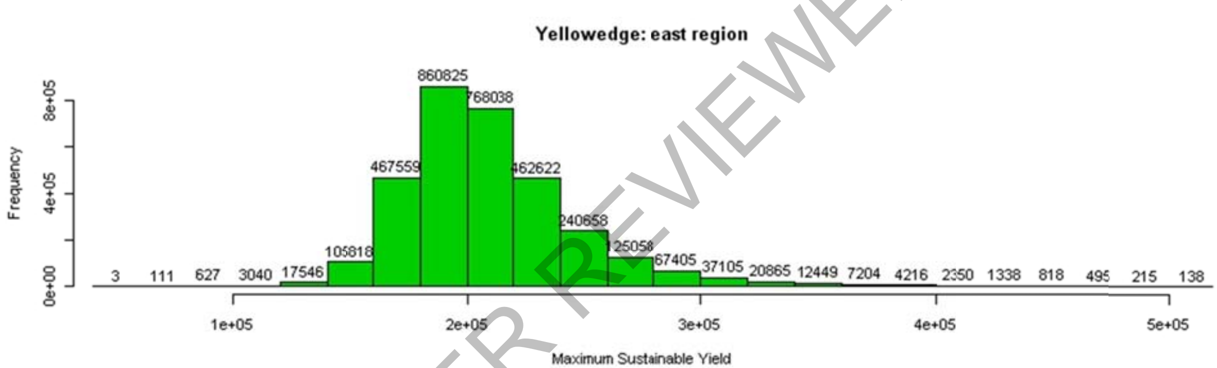


Figure 3.2. Estimates of exploitation for yellowedge grouper by region (east and west of the Mississippi River) and all data combined in the Gulf of Mexico for the time period catch histories exist.

a.



b.



c.

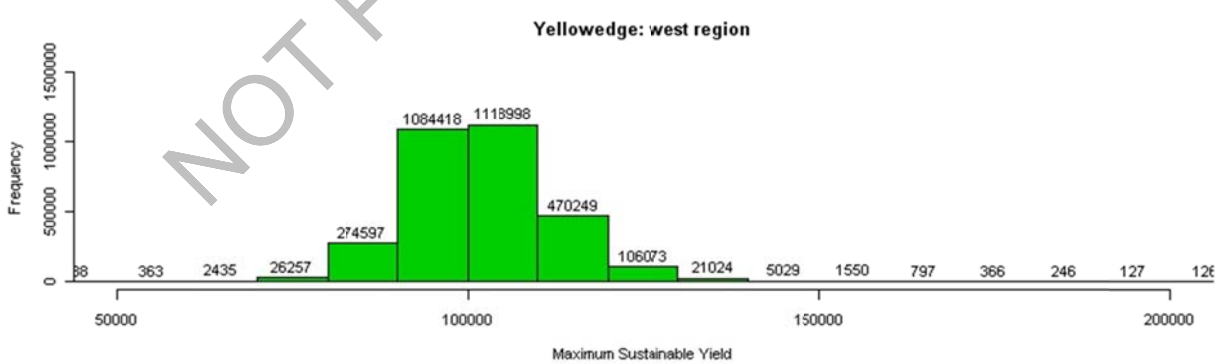
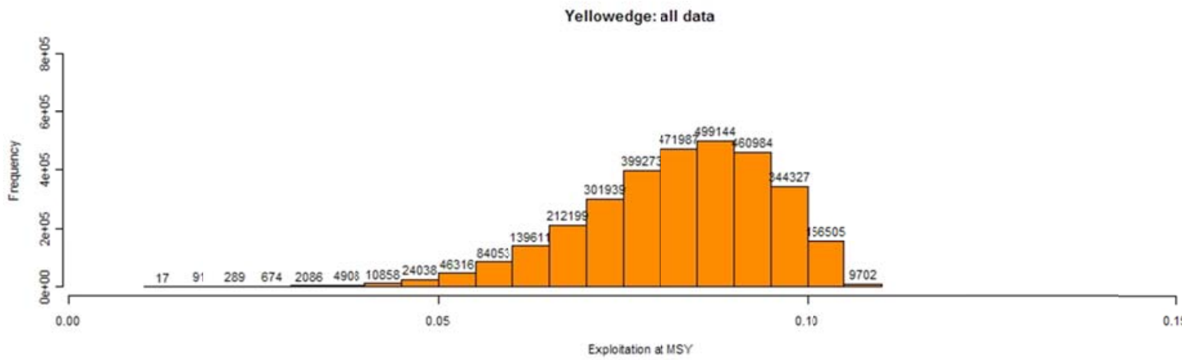
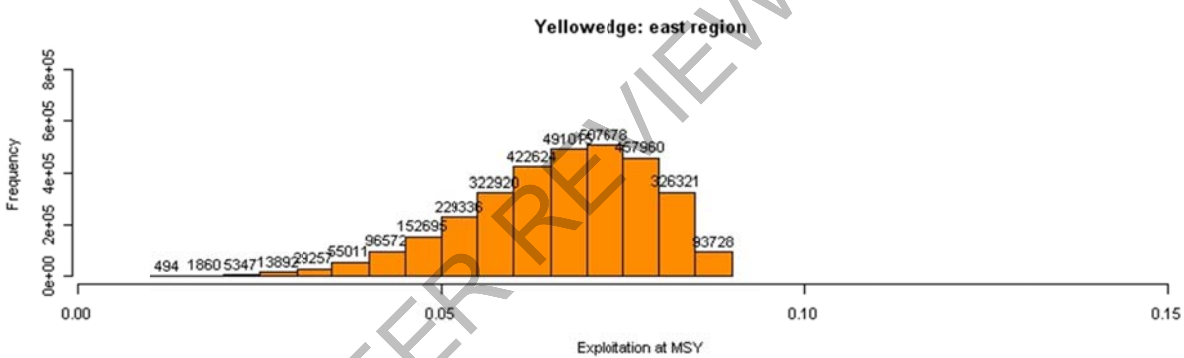


Figure 3.3. Distribution of maximum sustainable yield values for (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico for yellowedge grouper. Sample sizes per size bin are above each respective column. Note, figure (c) not drawn on the same x-axis or y-axis.

a.



b.



c.

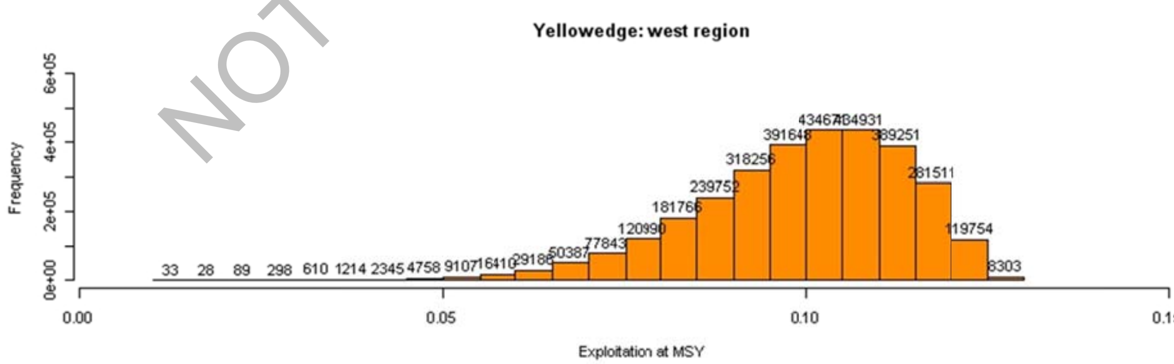
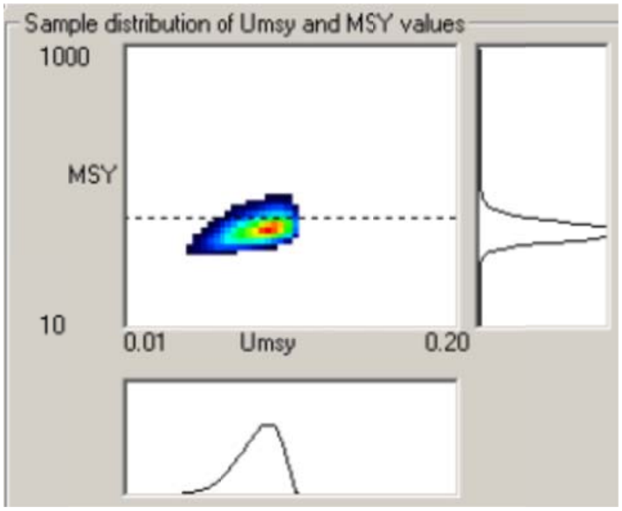
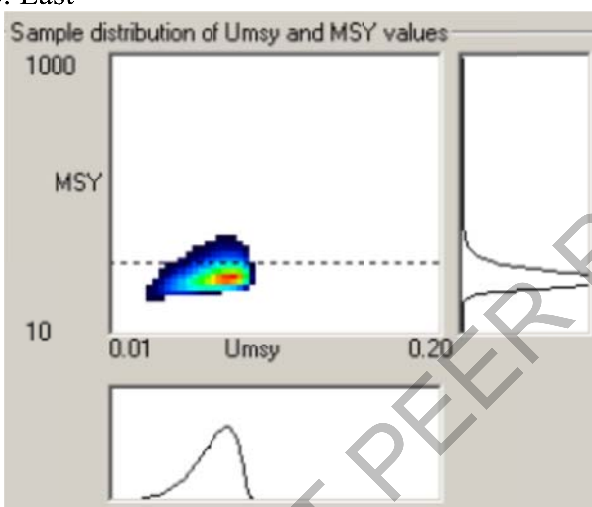


Figure 3.4. Distribution of exploitation at maximum sustainable yield (MSY) values (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico for yellowedge grouper. Sample sizes per size bin are above each respective column.

a. All data



b. East



c. West

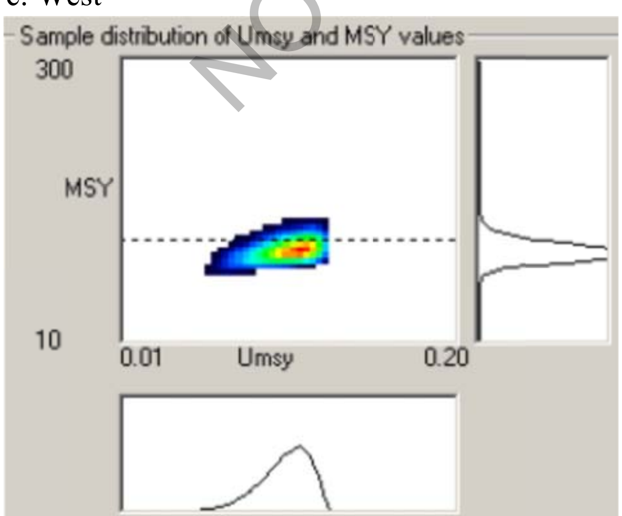


Figure 3.5. Sample distributions of maximum sustainable yield (MSY) given the sample distribution of exploitation at maximum sustainable yield (Umsy) for (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico for yellowedge grouper. Dotted line indicate the average catch for the given time series for either region. Note: range of MSY and Umsy differ for each figure.

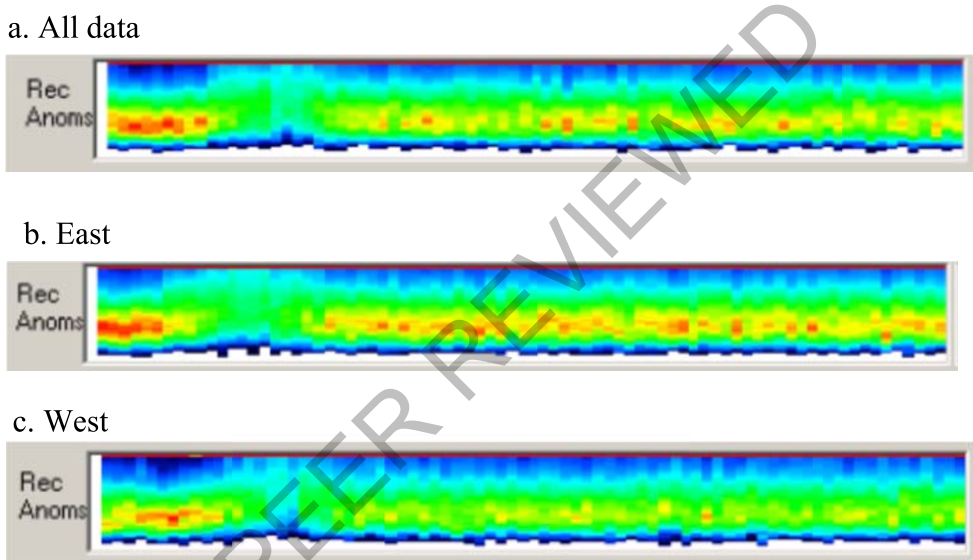


Figure 3.6. Recruitment anomalies for the historical and future projection time periods for yellowedge grouper for (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico.

a. All data b. East c. West

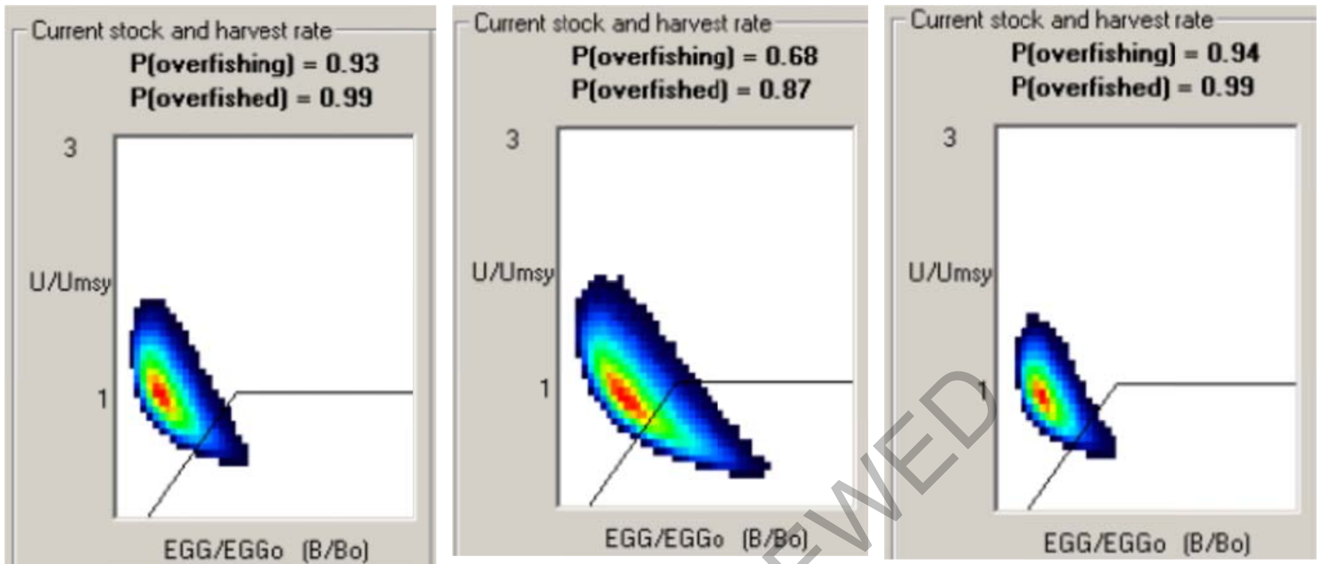


Figure 3.7. Current stock status and harvest rate for yellowedge grouper for (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico. Note that the probabilities of overfishing and of being overfished are calculated according to the Pacific Fisheries Management Council 40/10 rule and are not the same as the GMFMC rules.

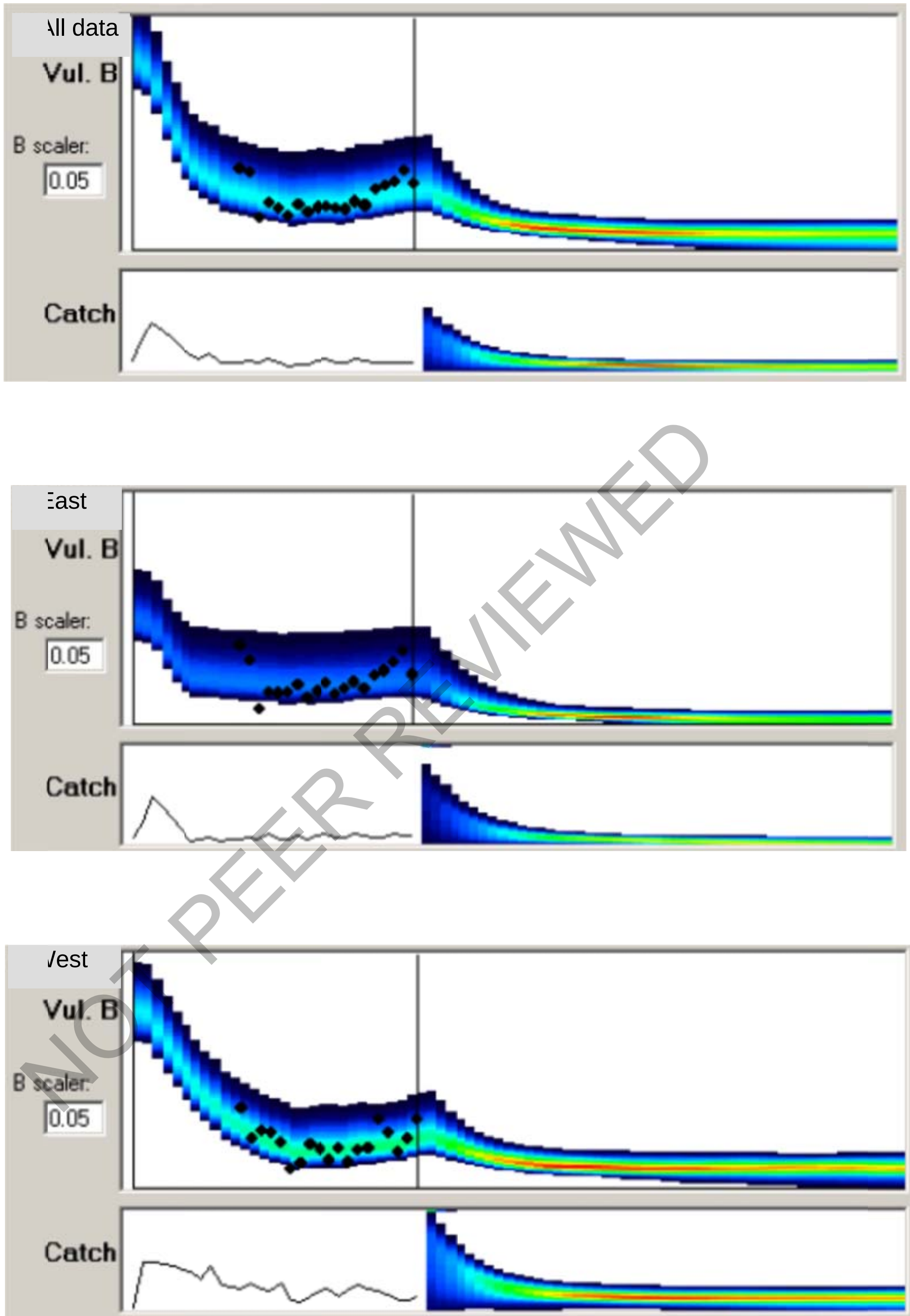


Figure 3.8. Future projections at an exploitation rate of 0.2 (approximately double the rate at MSY) of catch and vulnerable biomass for yellowedge grouper for (a) all data combined, (b) East Gulf of Mexico and (c) West Gulf of Mexico. The vertical line indicates the last year of data, 2009. Black dots represent the respectively commercial longline index.

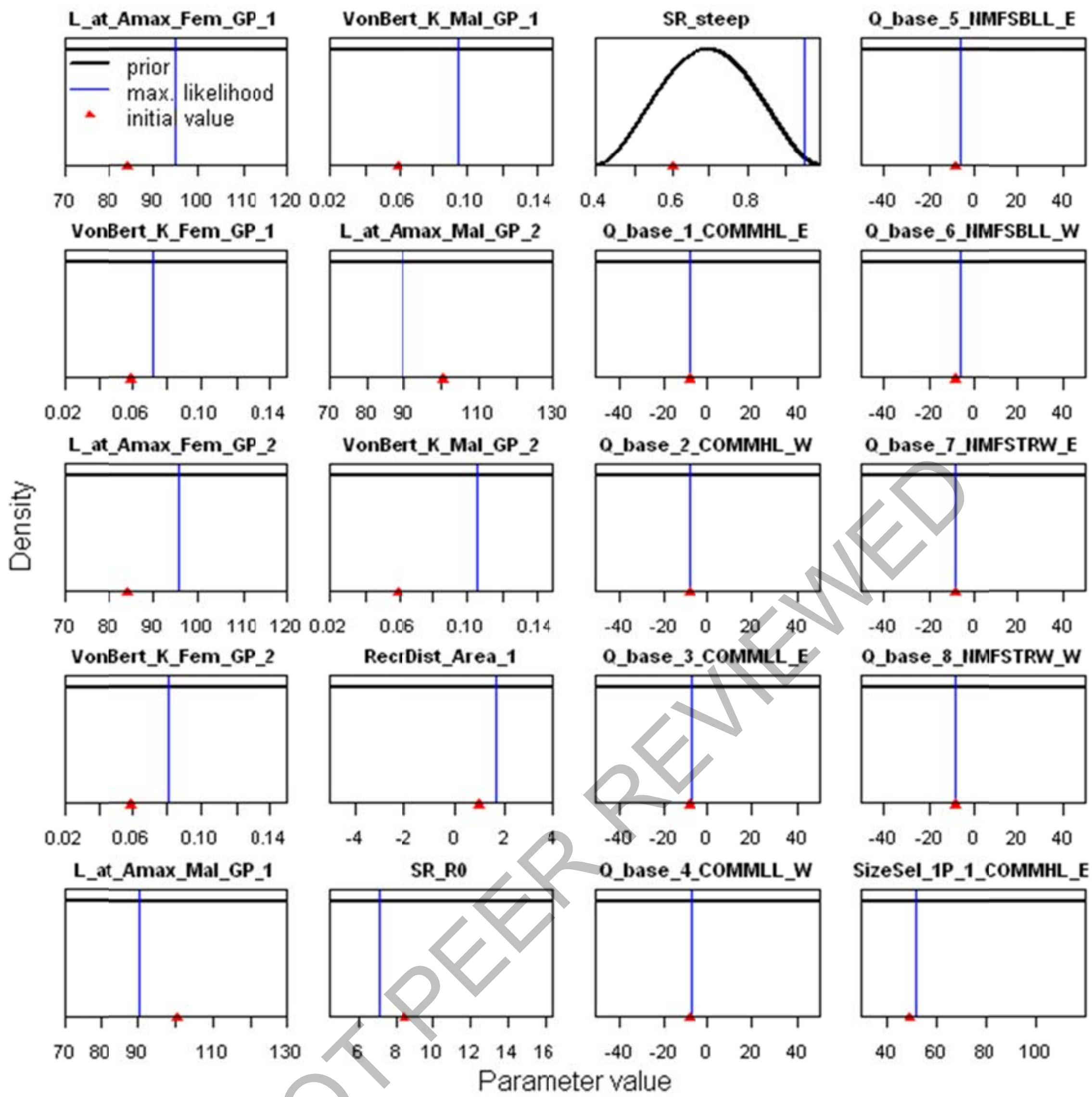


Figure 3.9. Input parameters, priors, maximum likelihood and starting values.

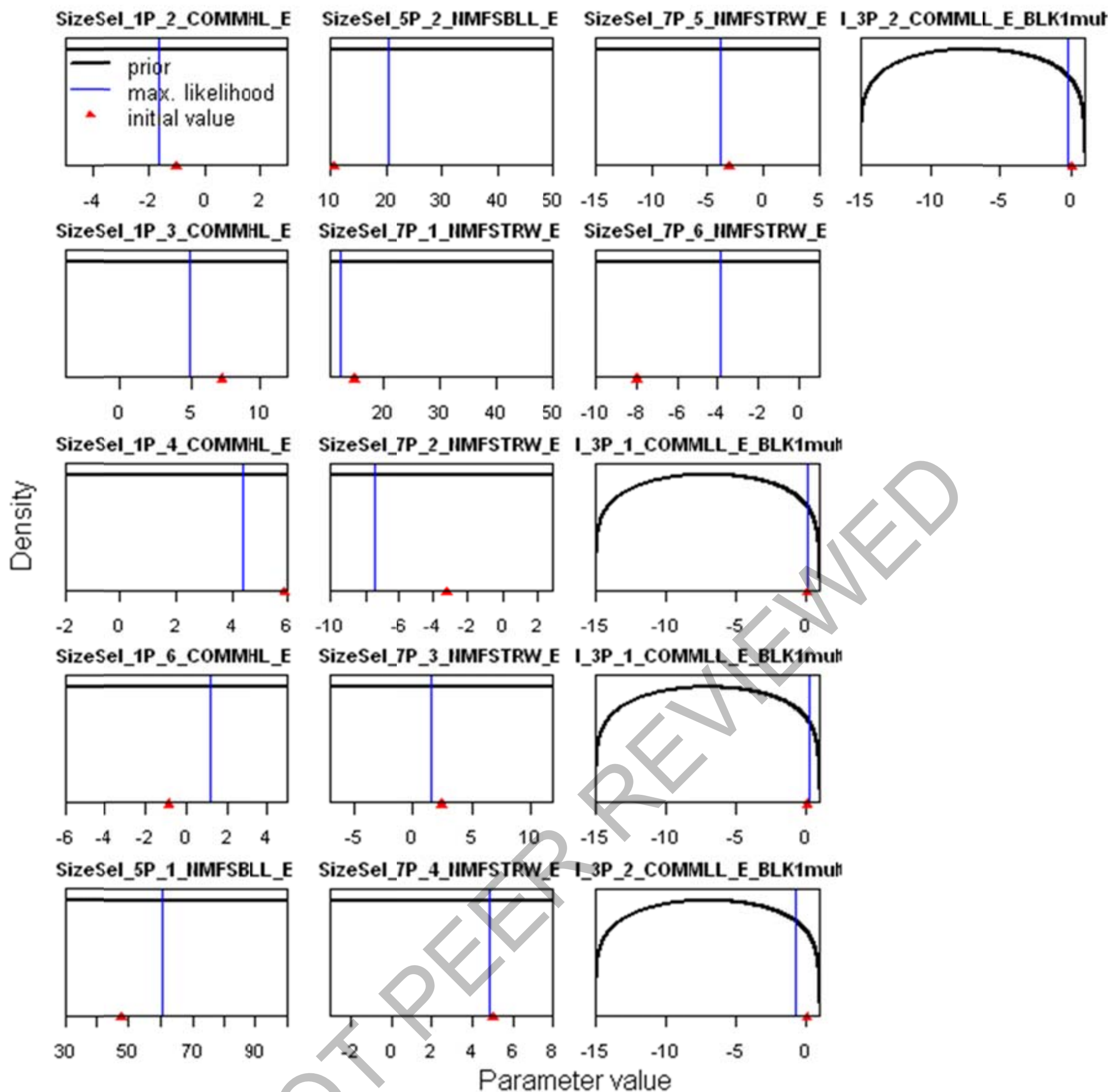


Figure 3.9. continued.

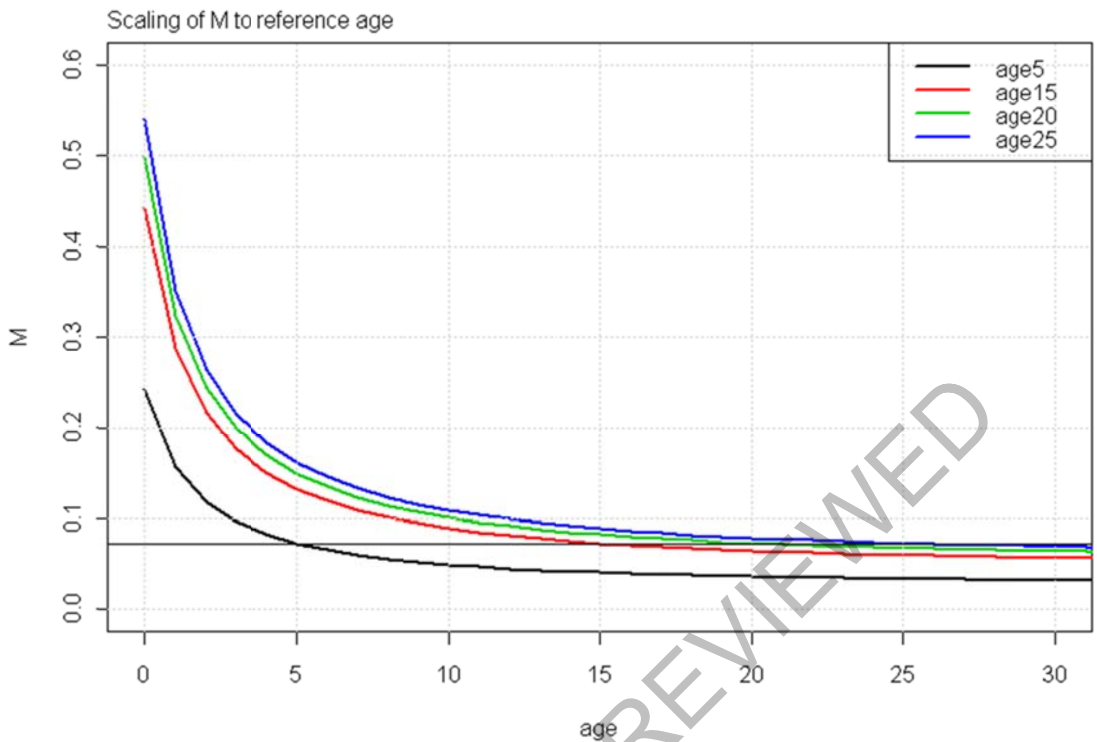


Figure 3.10. Scaling of mortality at age according to the reference age. Only mortality for females of growth morph 1 (East) are shown. Not the increase in total mortality that occurs with an increase in the reference age. The solid line is the target M of 0.073.

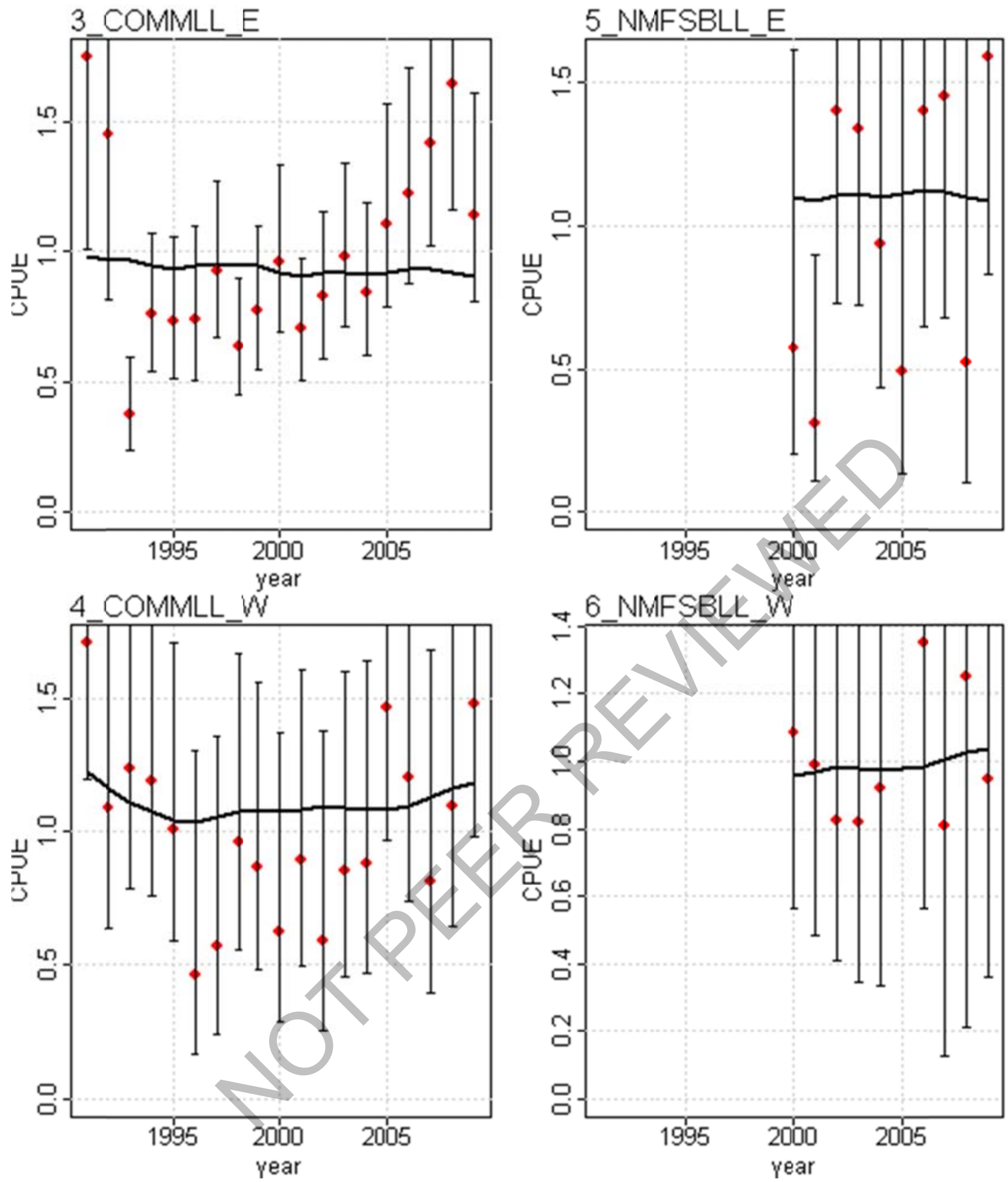


Figure 3.11. Base model fits to the CPUE indices.

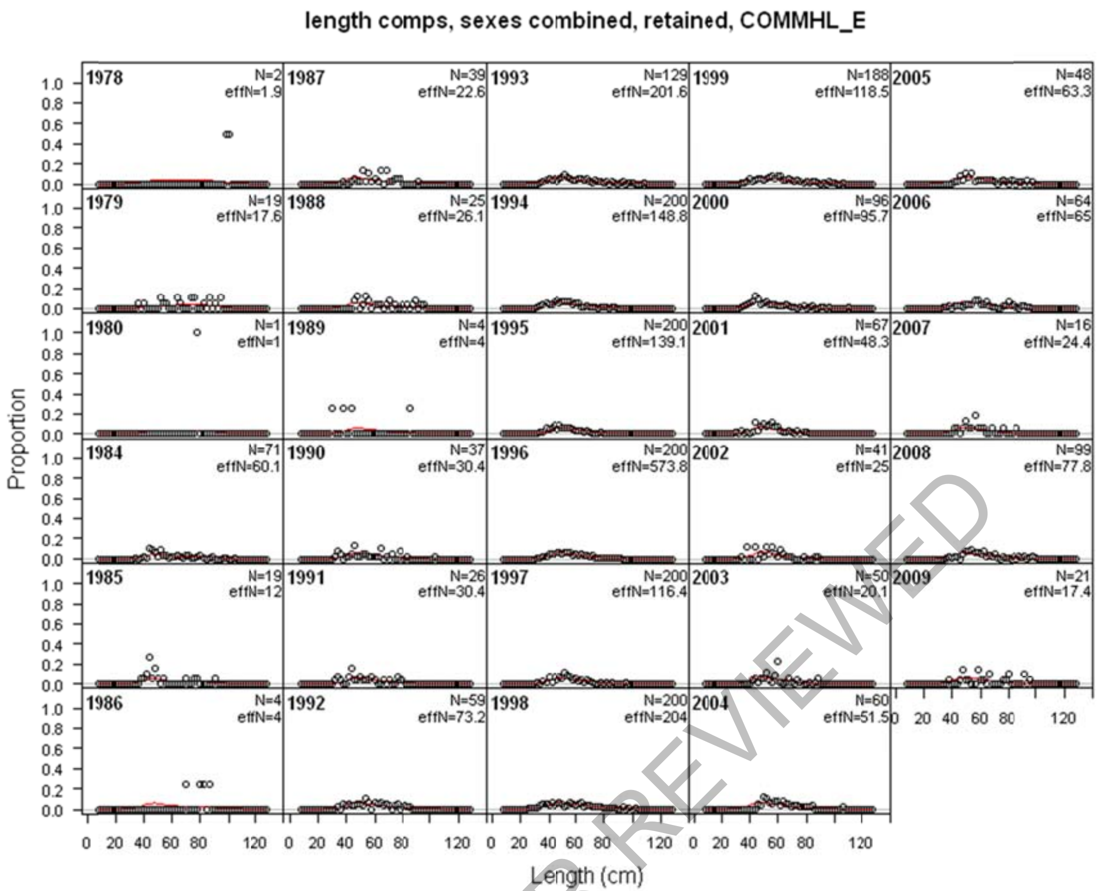


Figure 3.12. Length composition fits, commercial handline East, both sexes not differentiated.

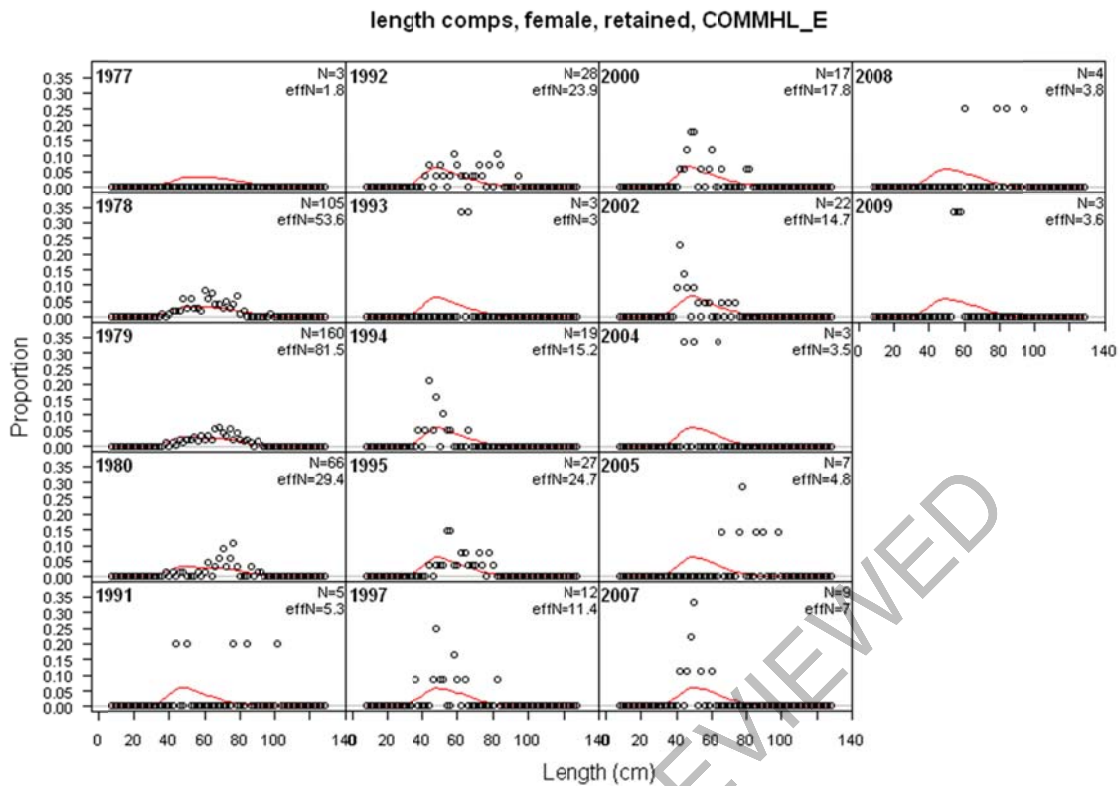


Figure 3.13. Length composition fits, commercial handline East, female

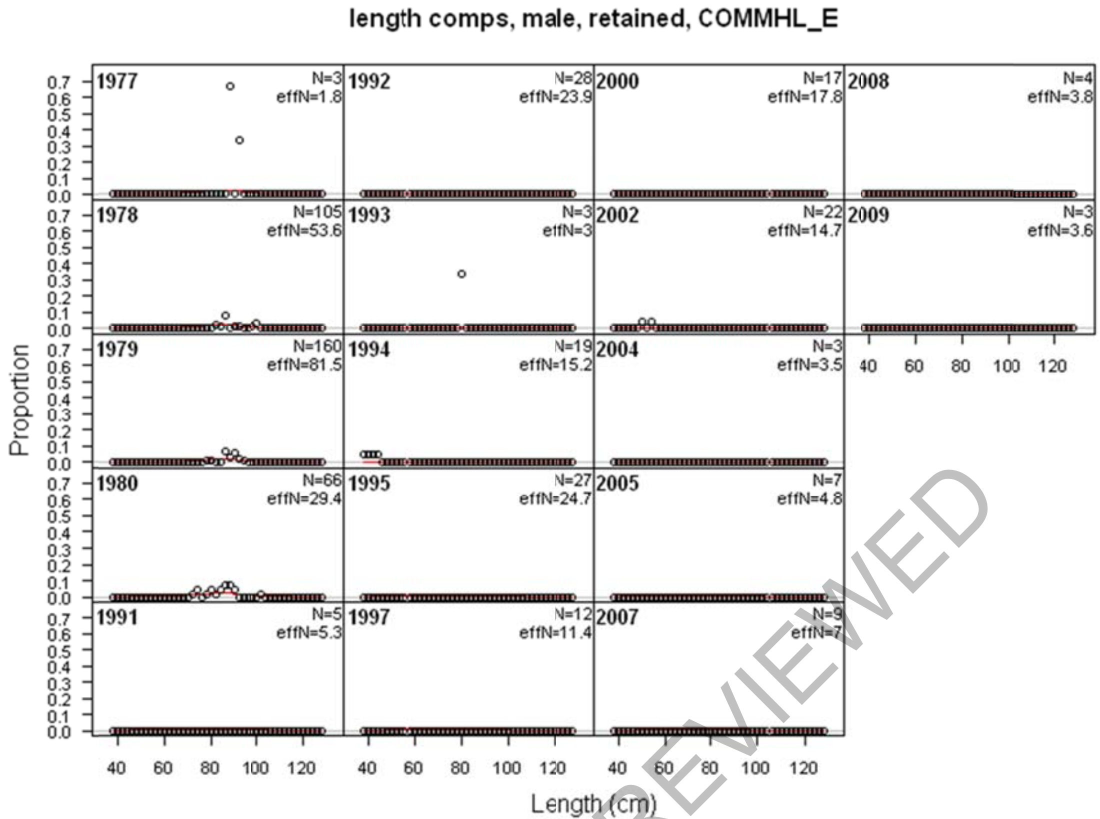


Figure 3.14. Length composition fits, commercial handline East, male.

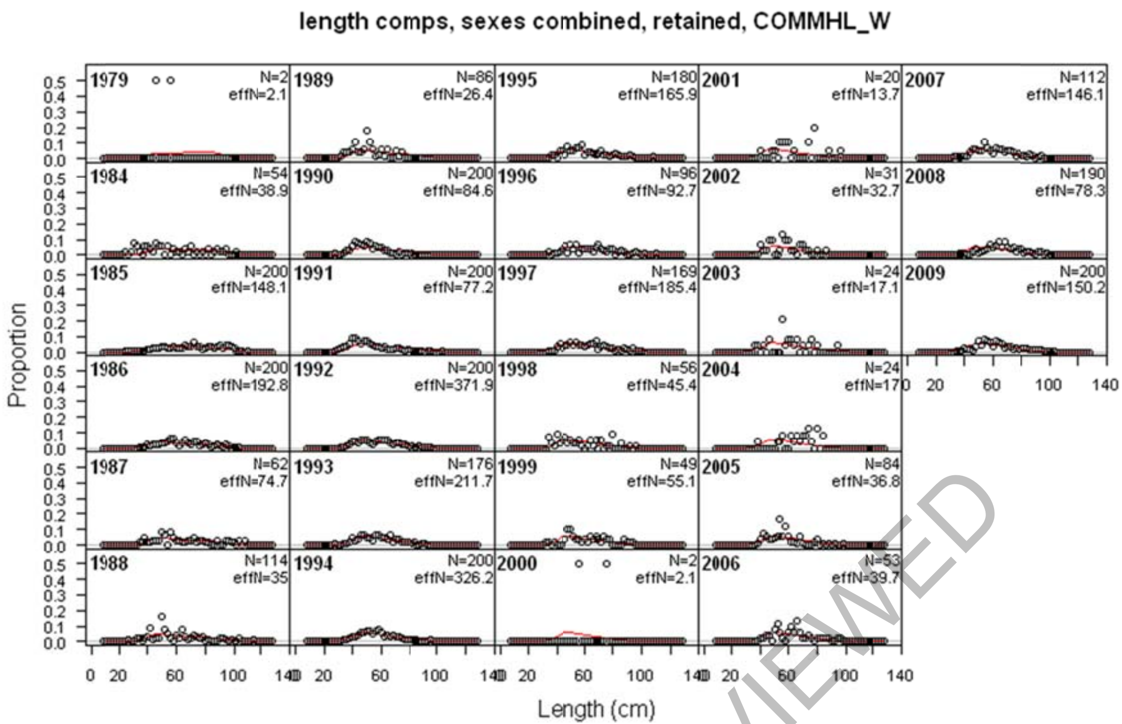


Figure 3.15. Length composition fits, commercial handline West, both sexes combined.

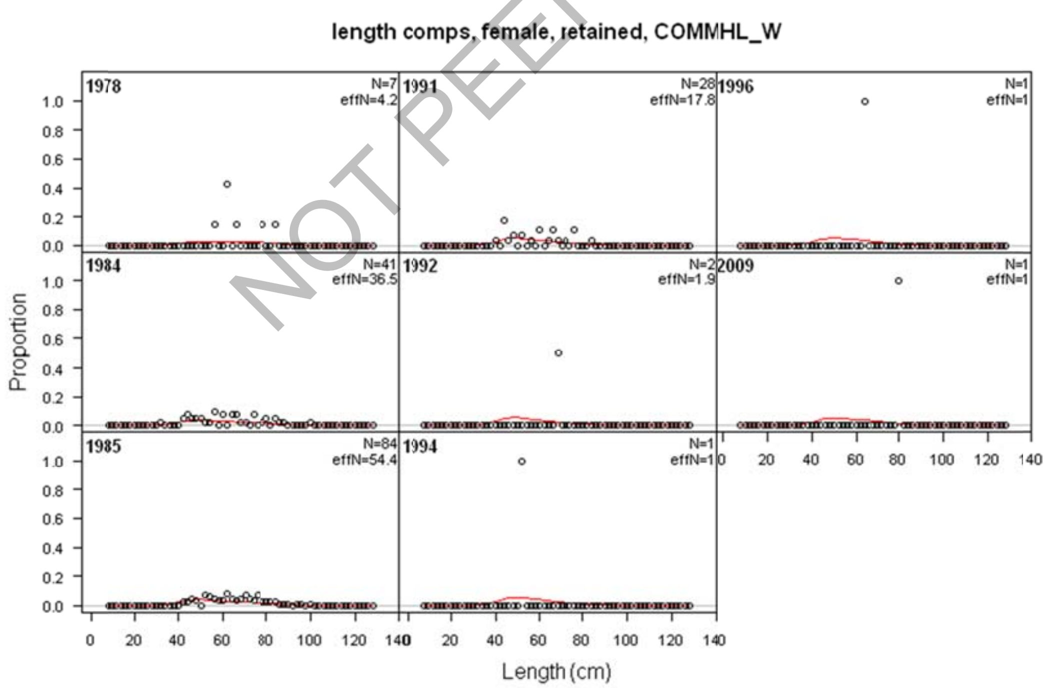


Figure 3.16. Length composition fits, commercial handline West,females.

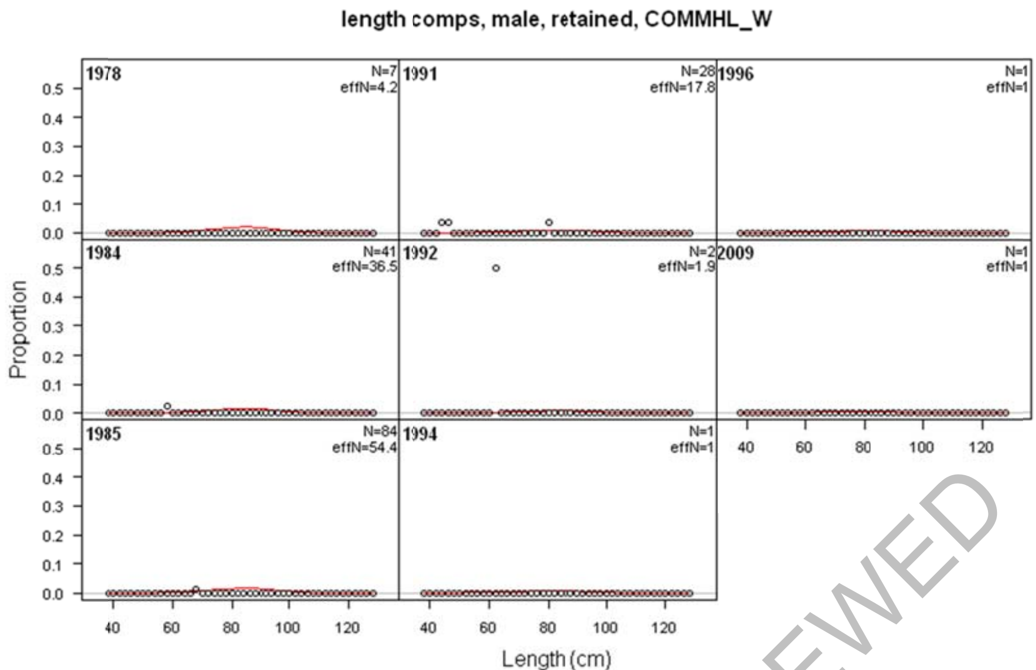


Figure 3.17. Length composition fits, commercial handline West, males.

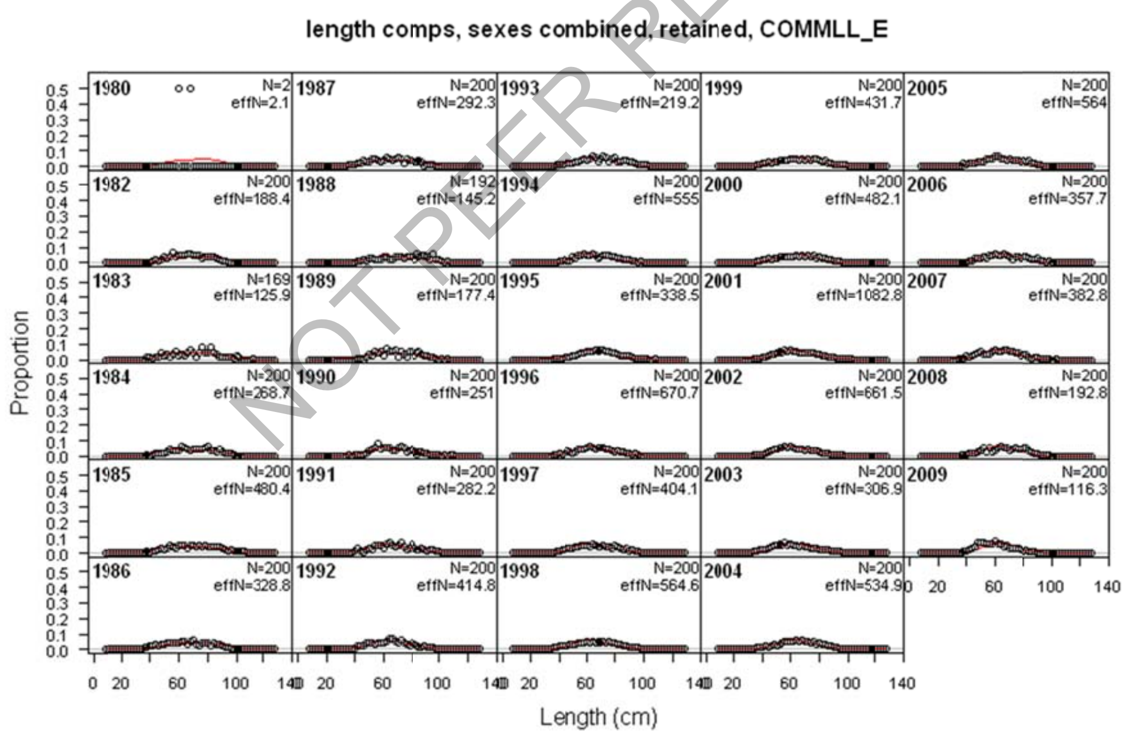


Figure 3.18. Length composition fits, commercial longline East, sexes not differentiated

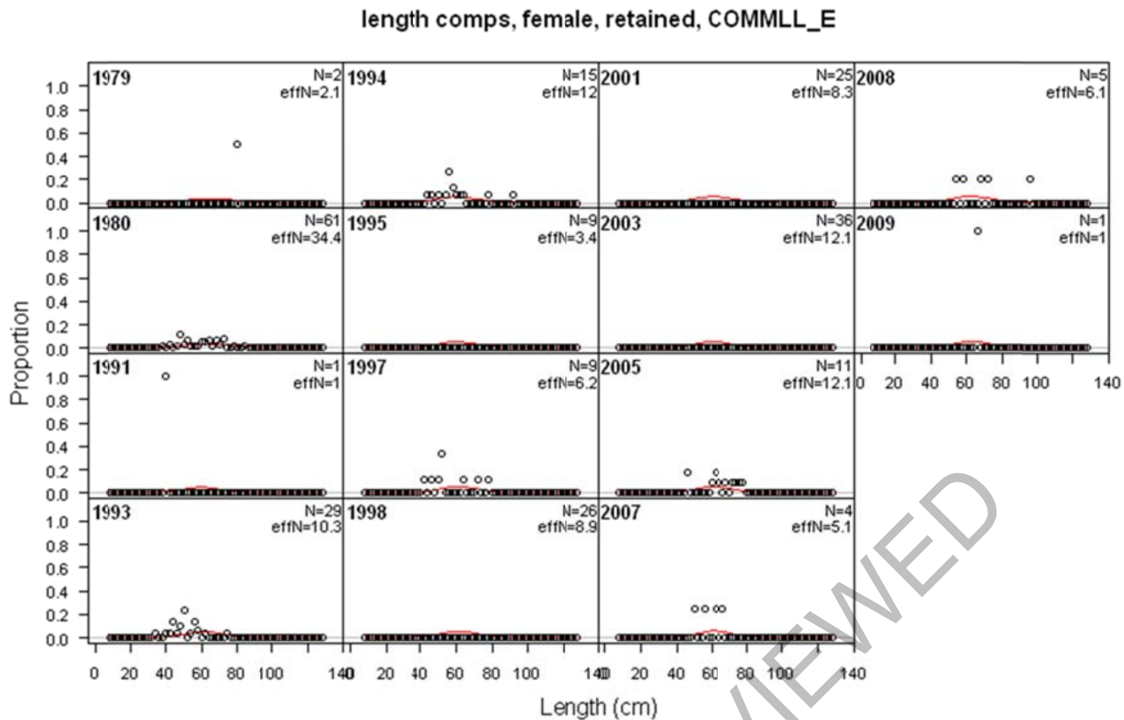


Figure 3.19. Length composition fits, commercial longline East, females.

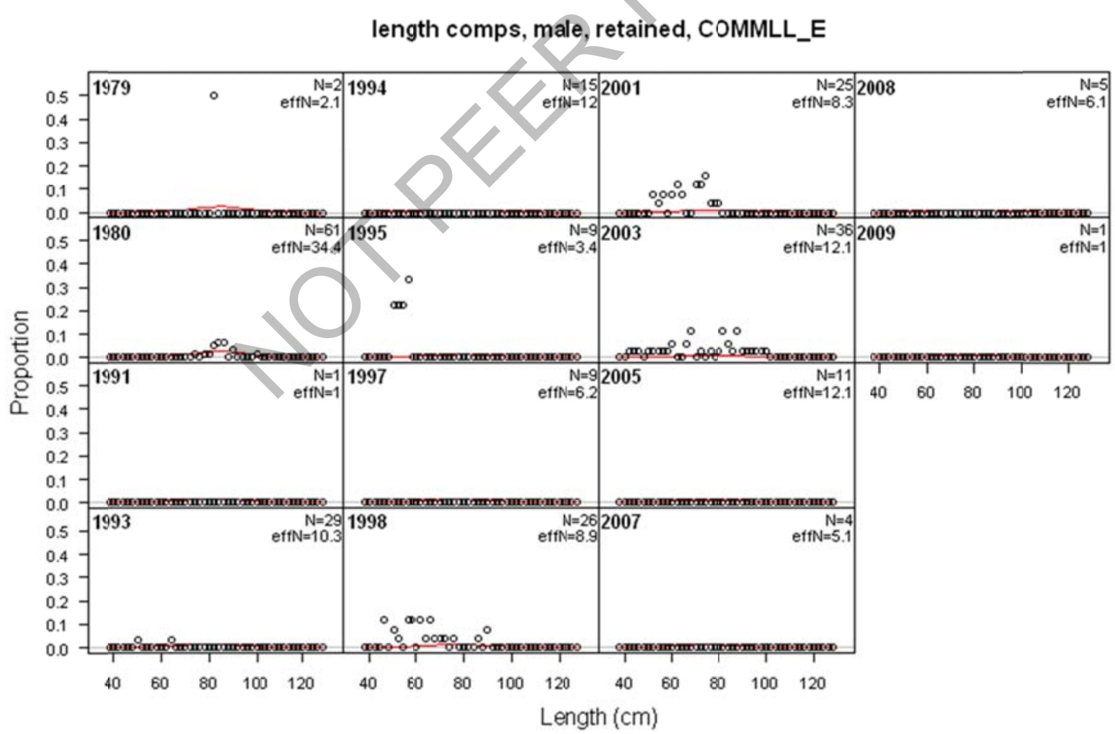


Figure 3.20. Length composition fits, commercial longline East, males.

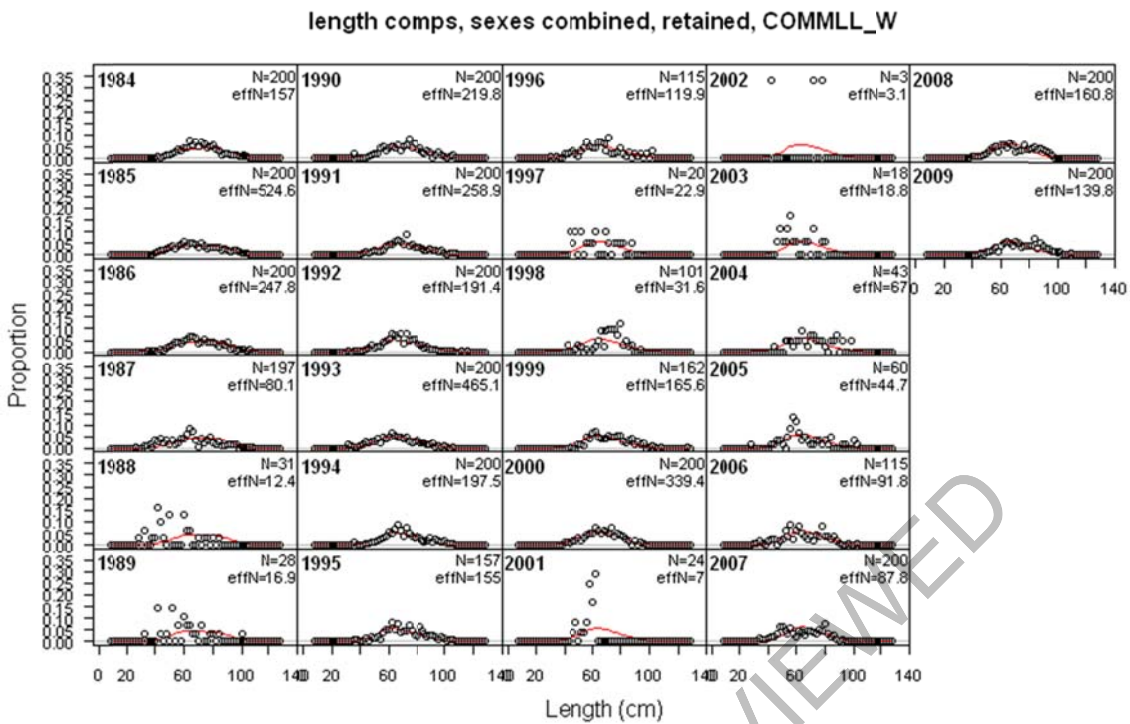


Figure 3.21. Length composition fits, commercial longline West, sexes not differentiated.

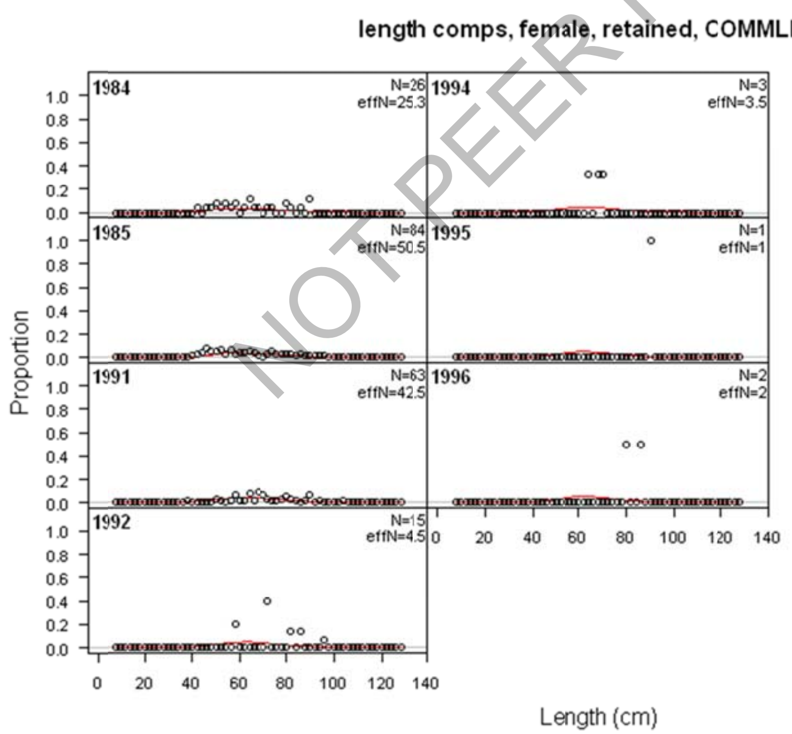


Figure 3.22. Length composition fits, commercial longline West, females.

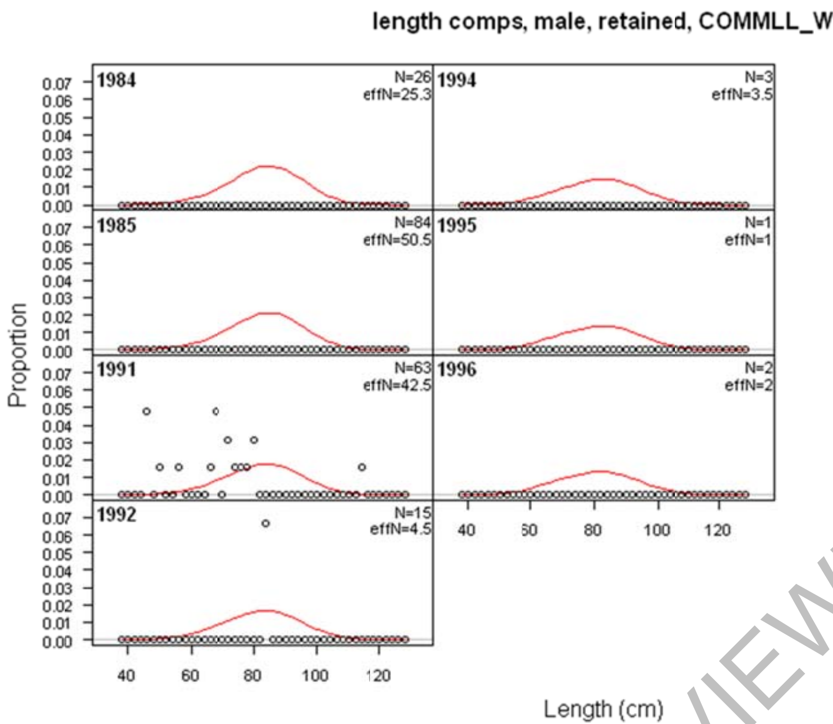


Figure 3.23. Length composition fits, commercial longline West, males.

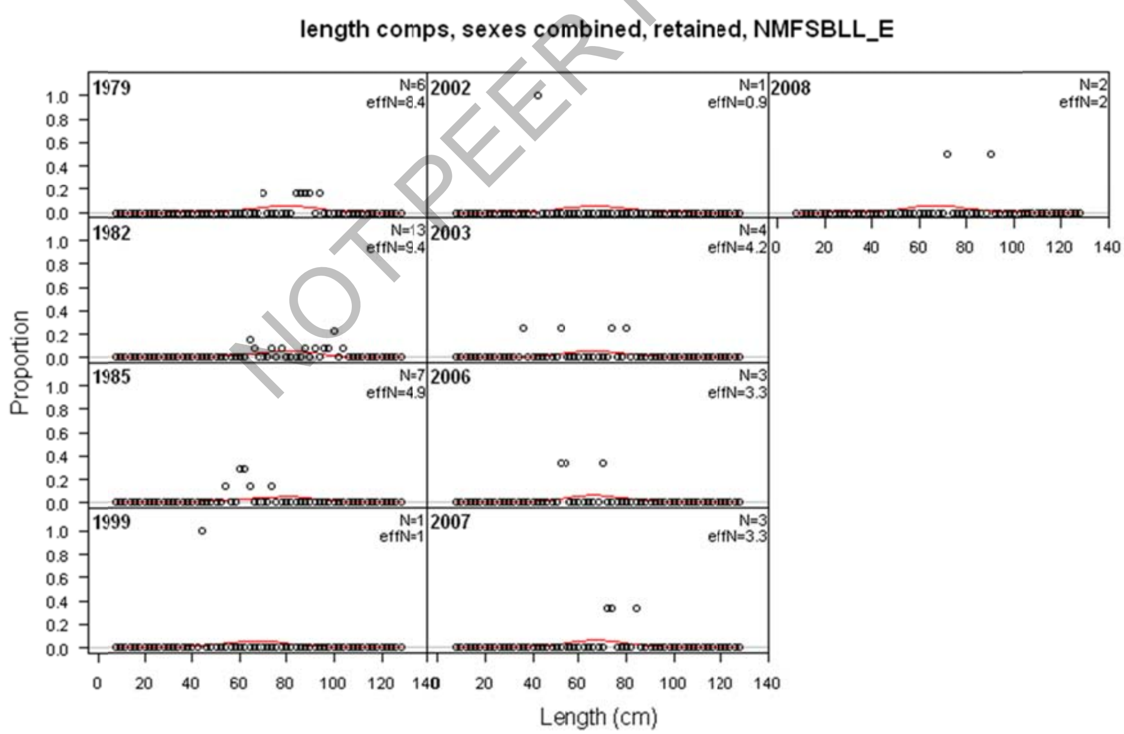


Figure 3.24. Length composition fits, NMFS bottom longline East, sexes not differentiated.

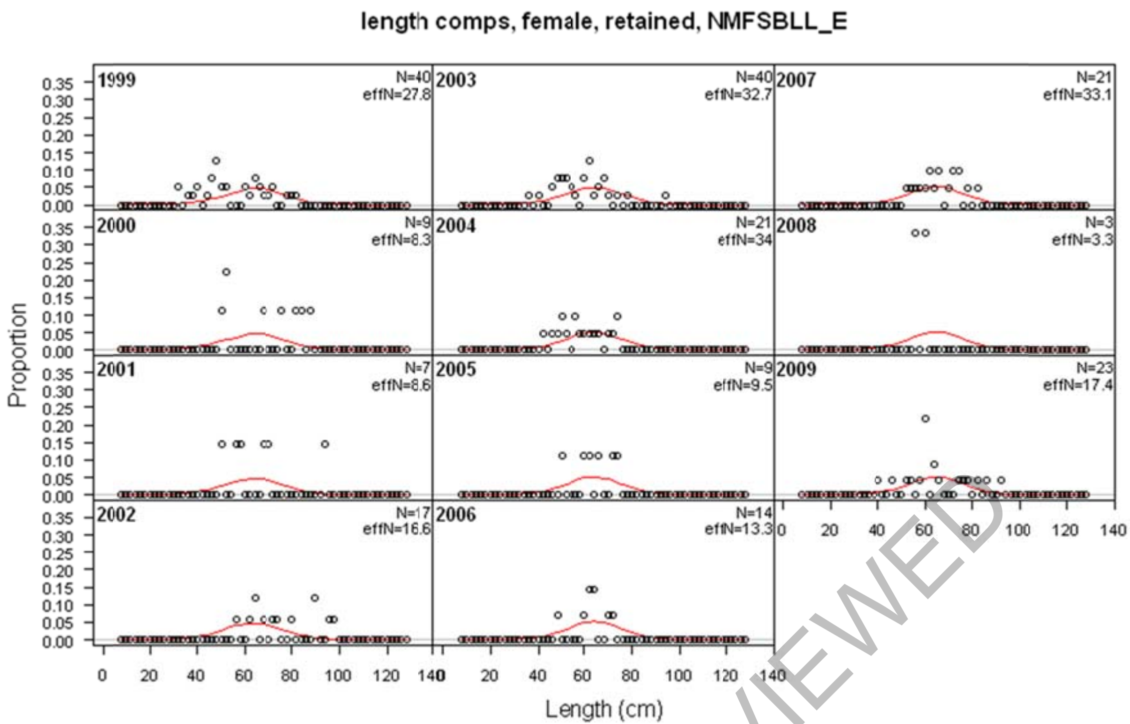


Figure 3.25. Length composition fits, NMFS bottom longline East, females.

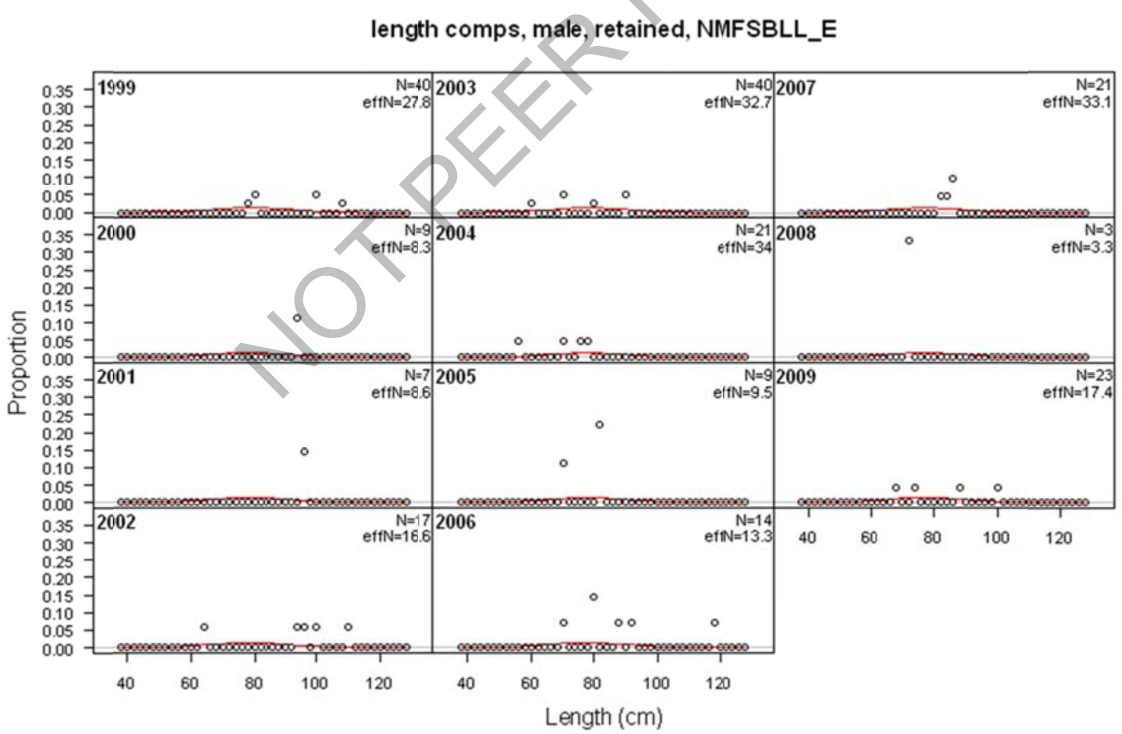


Figure 3.26. Length composition fits, NMFS bottom longline East, males.

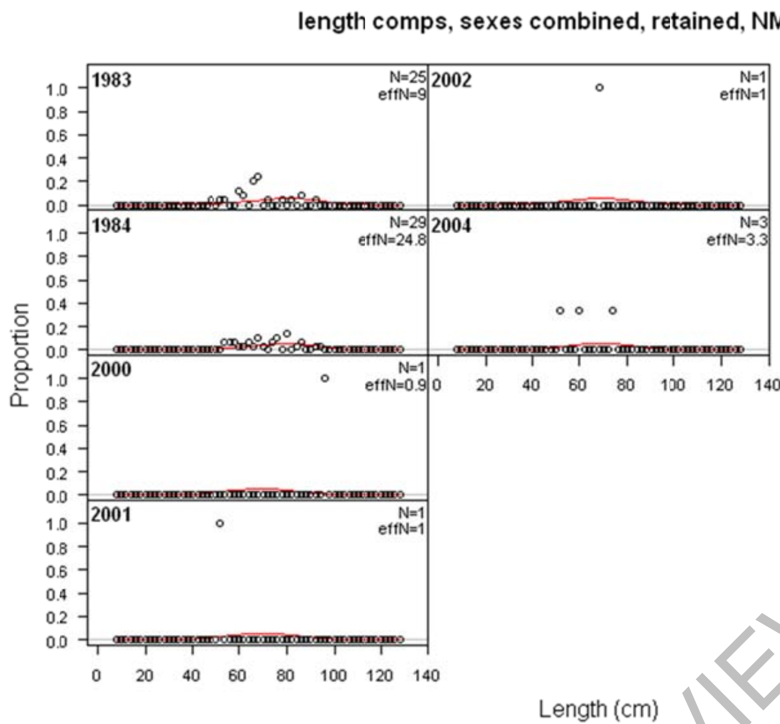


Figure 3.27. Length composition fits, NMFS bottom longline West, sexes not differentiated.

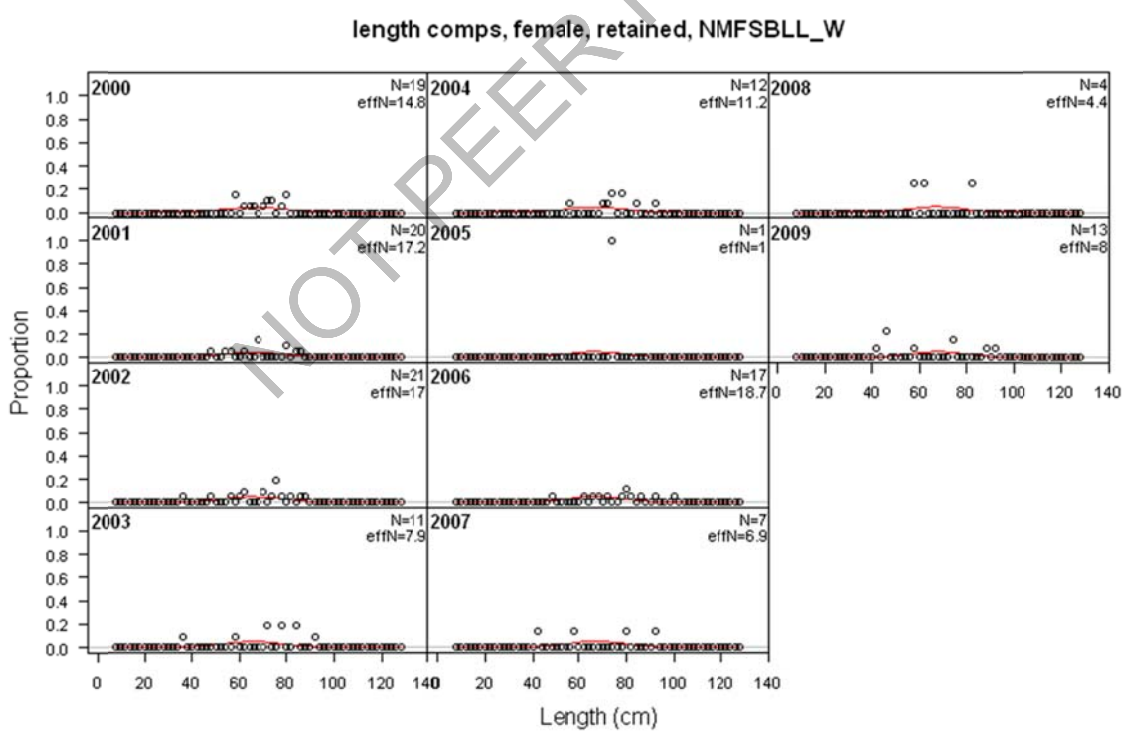


Figure 3.28. Length composition fits, NMFS bottom longline West, females.

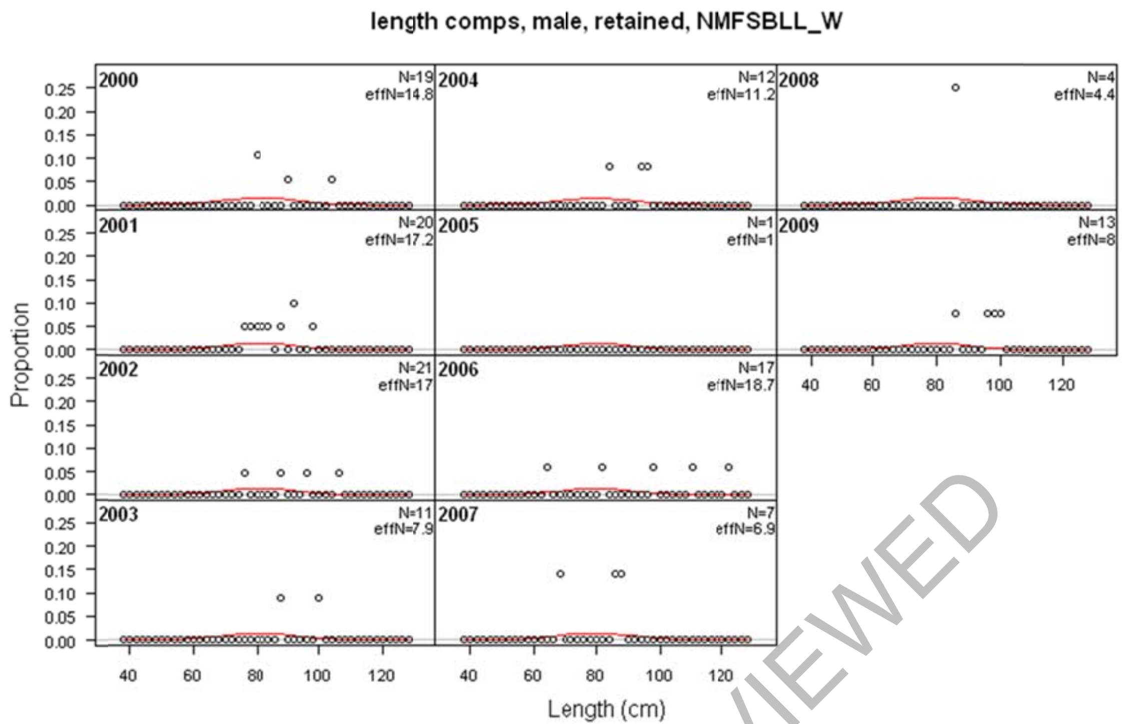


Figure 3.29. Length composition fits, NMFS bottom longline West, males.

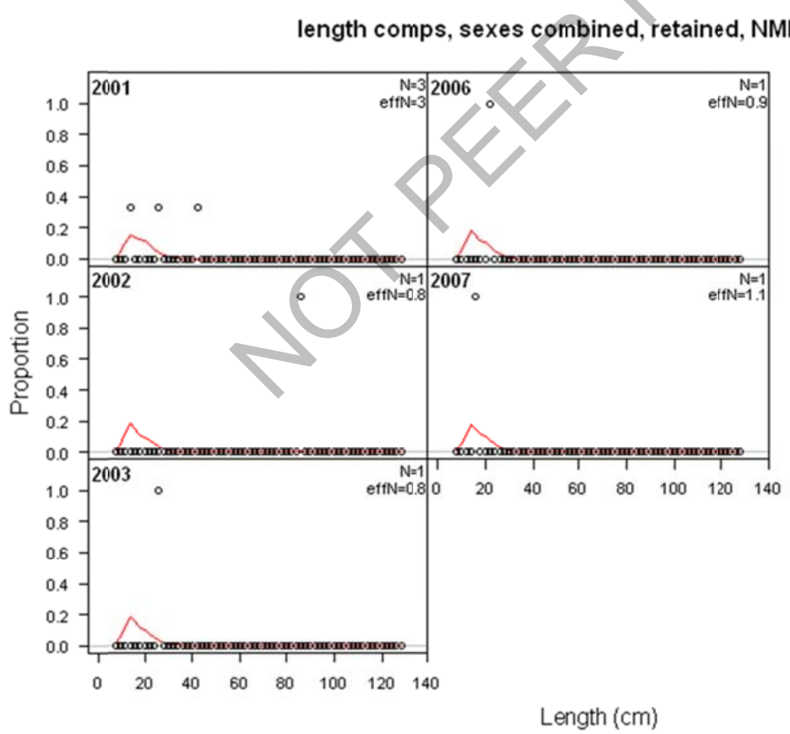


Figure 3.30. Length composition fits, SEAMAP trawl East, sexes not differentiated.

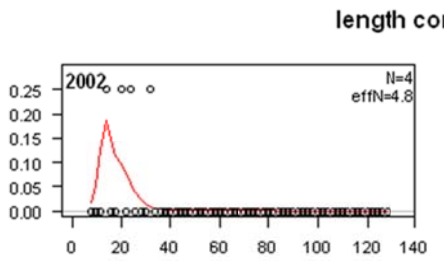


Figure 3.31. Length composition fits, SEAMAP trawl East, females.

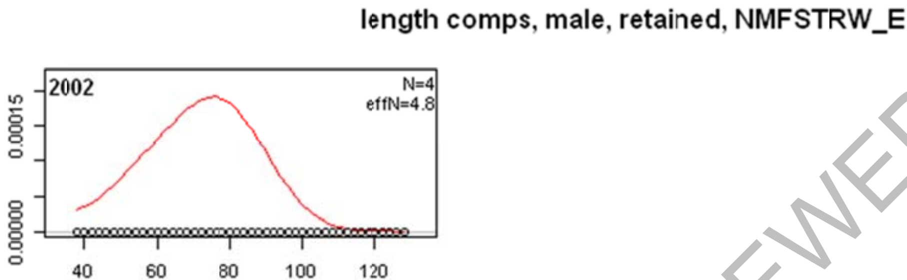


Figure 3.32. Length composition fits, SEAMAP trawl East, males.

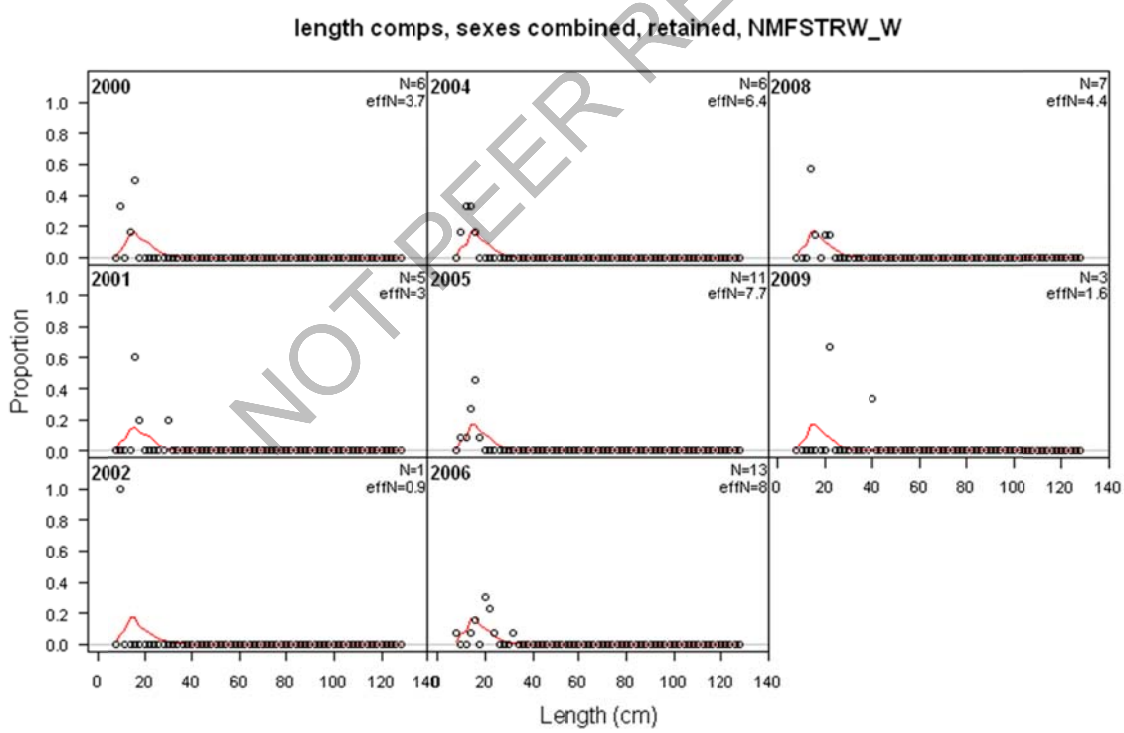


Figure 3.33. Length composition fits, SEAMAP trawl West, sexes not differentiated.

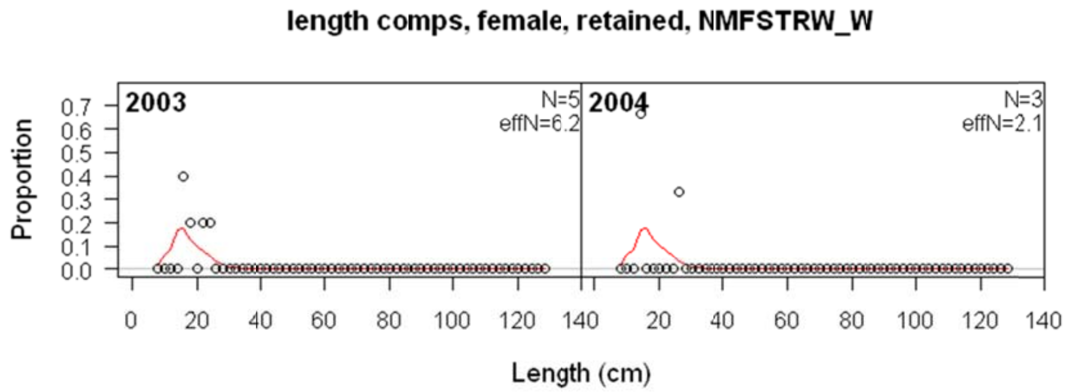


Figure 3.34. Length composition fits, SEAMAP trawl West, females.

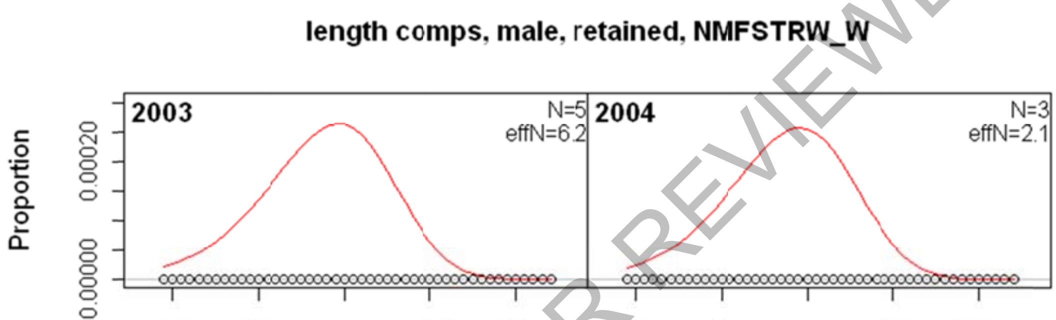


Figure 3.35. Length composition fits, SEAMAP trawl West, males.

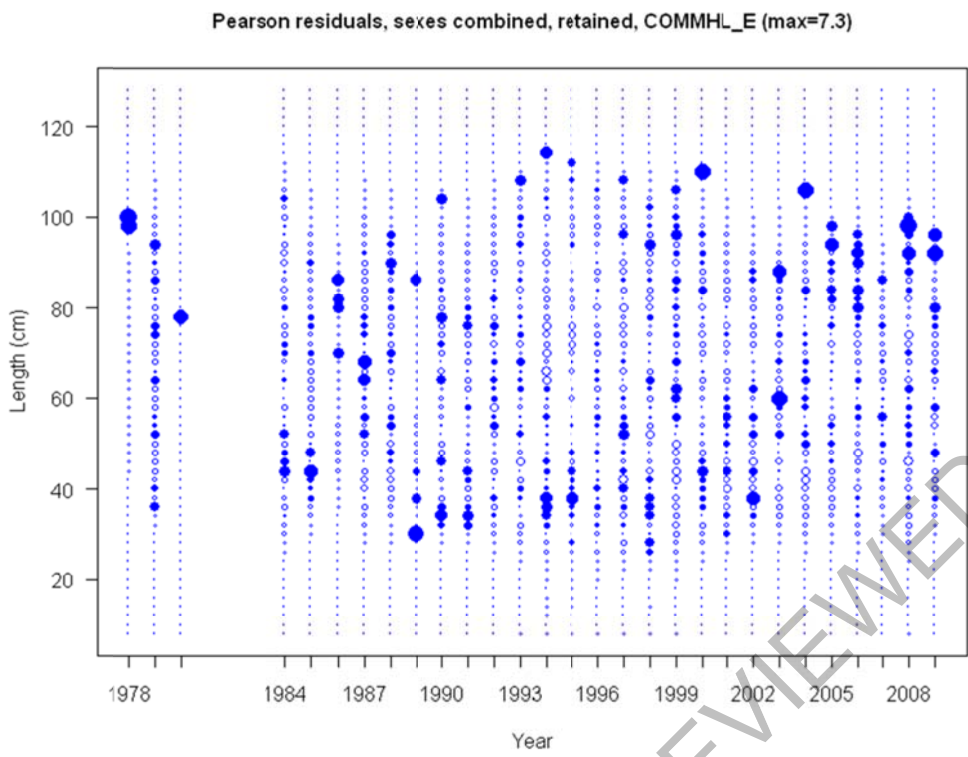


Figure 3.36. Pearson residuals commercial handline East, sexes not differentiated. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

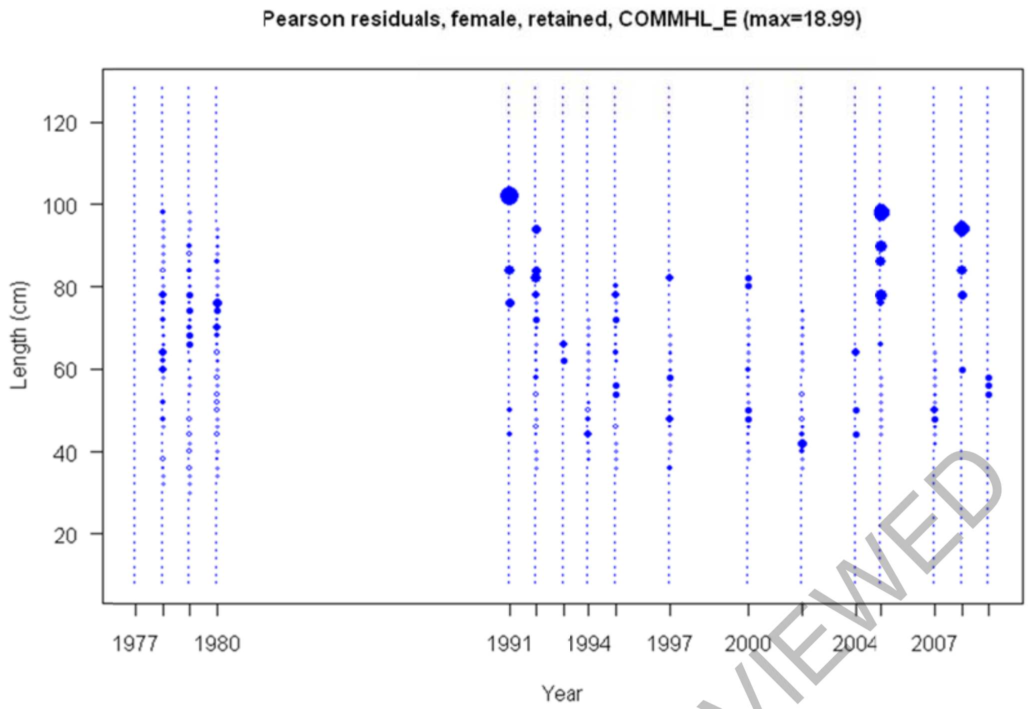


Figure 3.37. Pearson residuals commercial handline East, females.

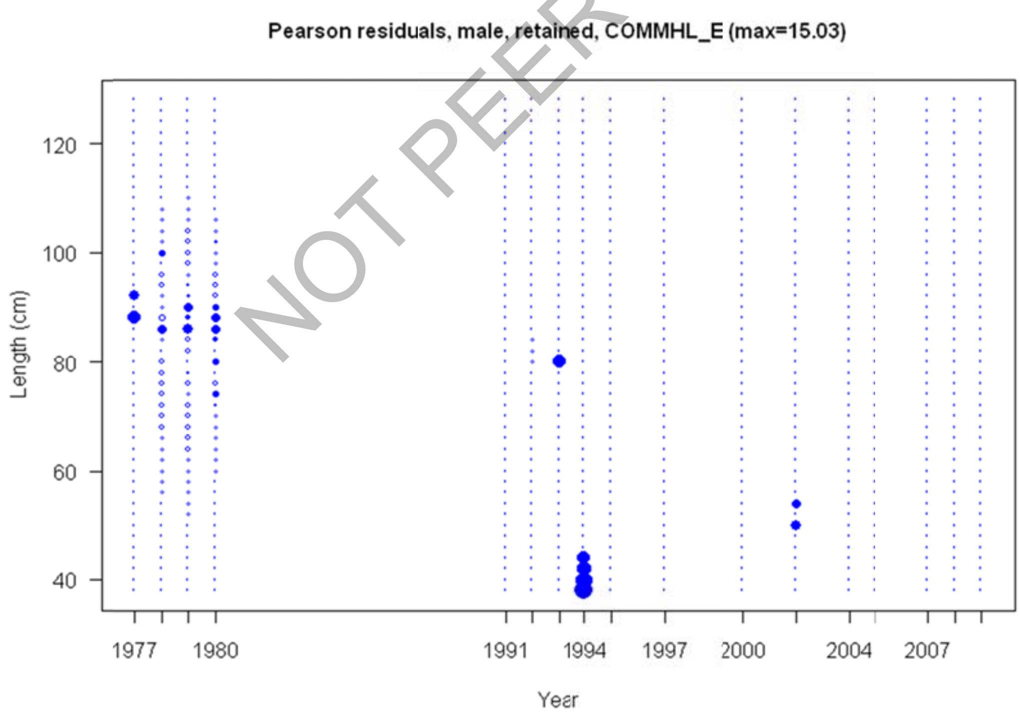


Figure 3.38. Pearson residuals commercial handline East, males.

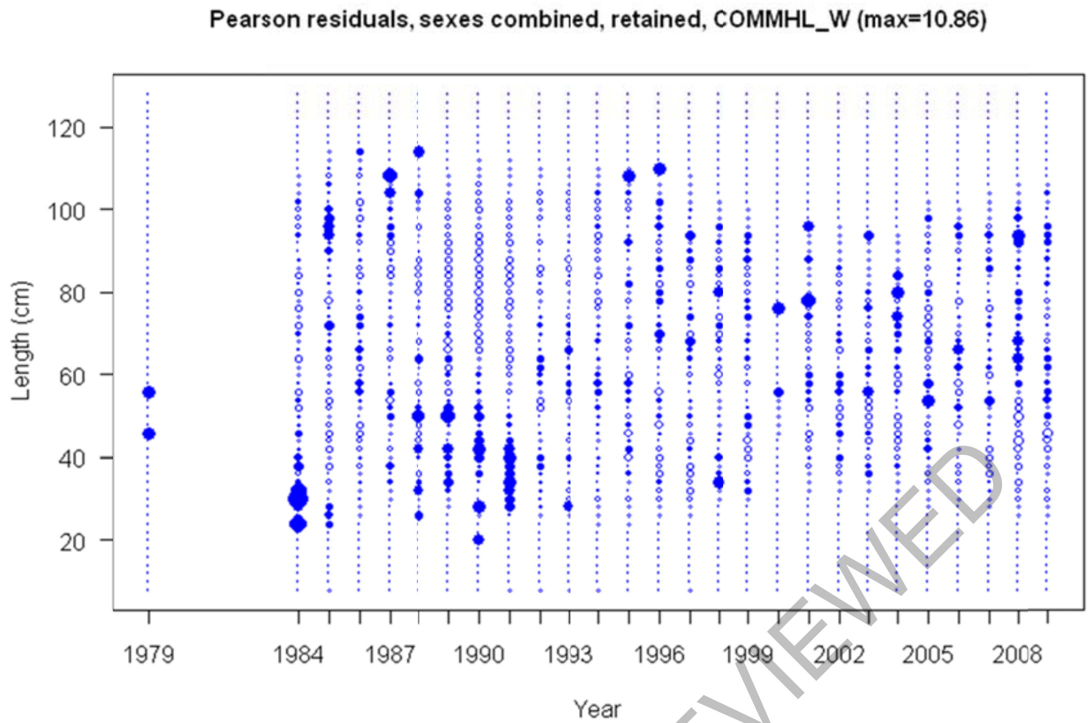


Figure 3.39. Pearson residuals commercial handline West, sexes not differentiated.

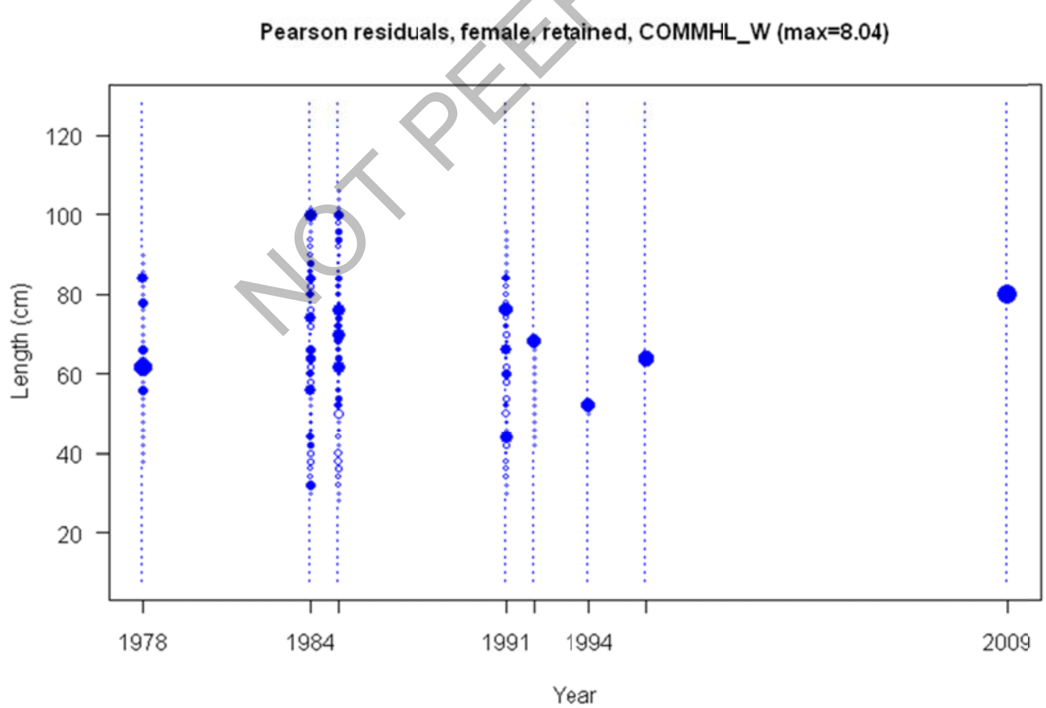


Figure 3.40. Pearson residuals commercial handline West, females.

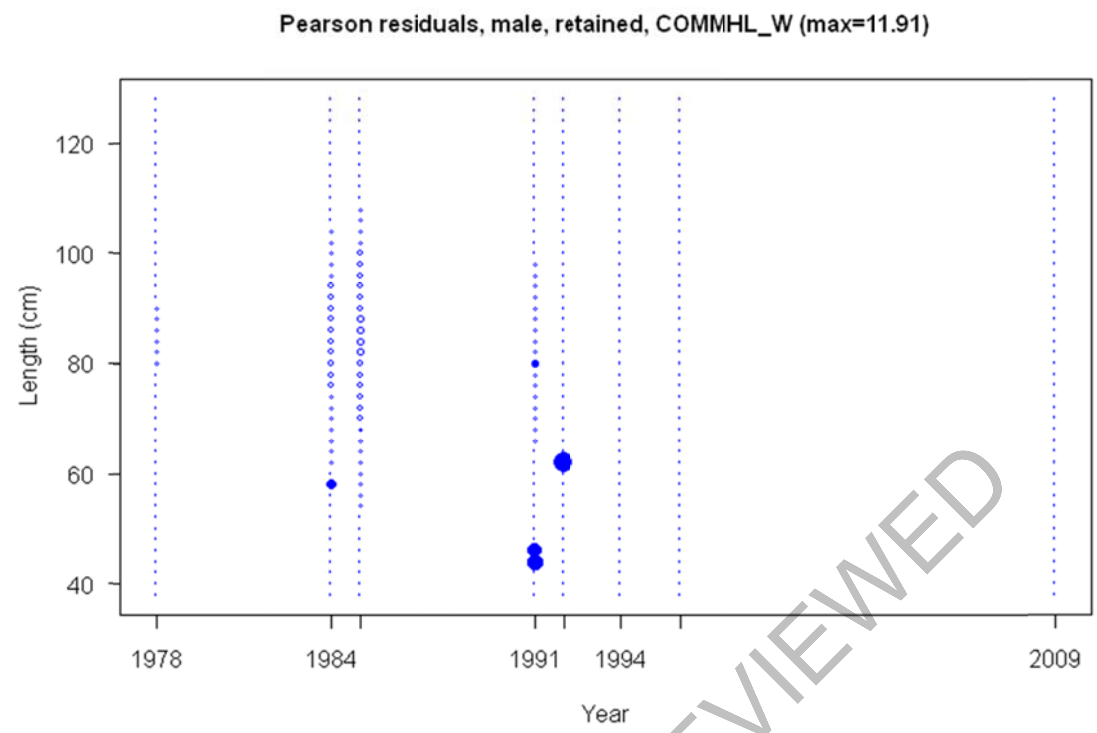


Figure 3.41. Pearson residuals commercial handline West, males.

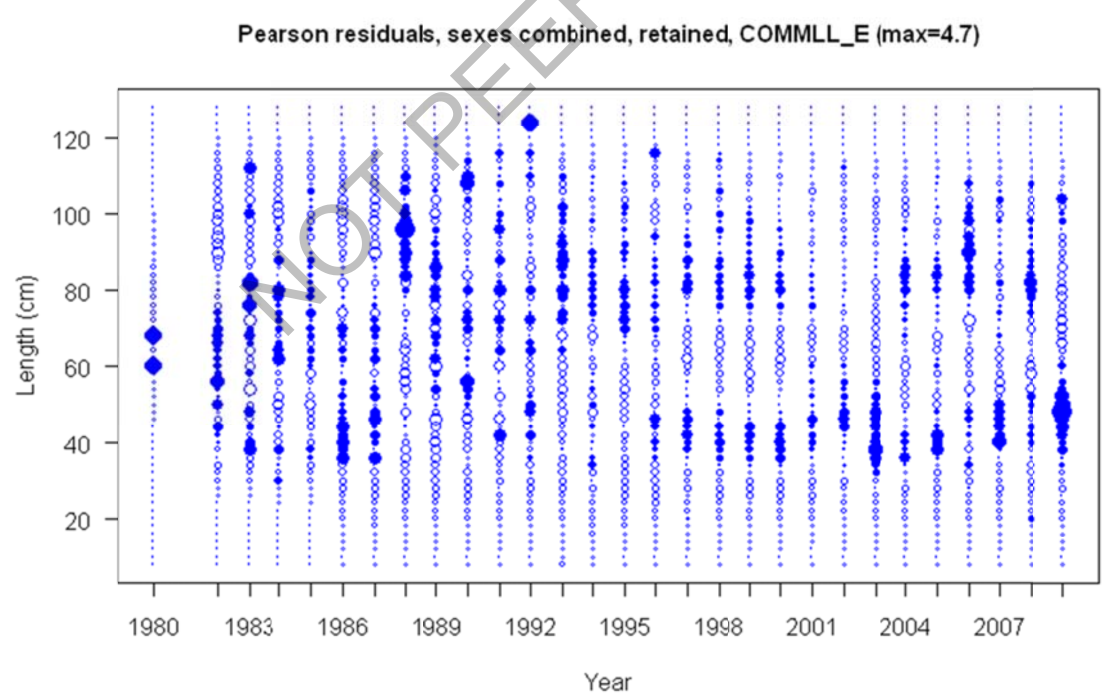


Figure 3.42. Pearson residuals commercial longline East, sexes not differentiated.

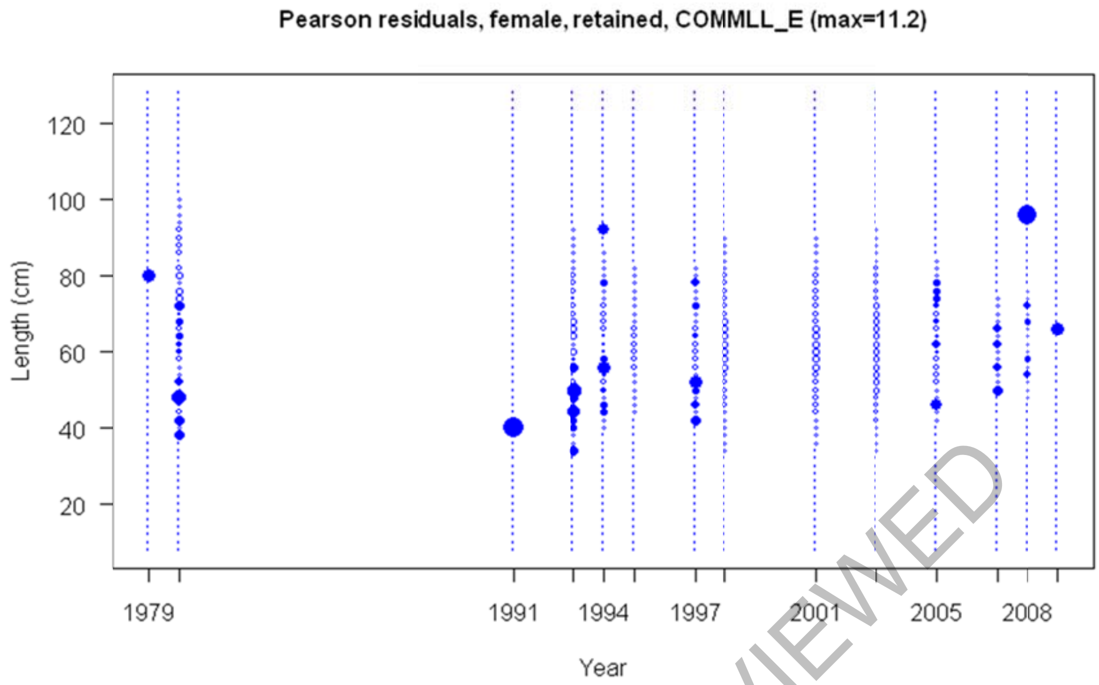


Figure 3.43. Pearson residuals commercial longline East, females.

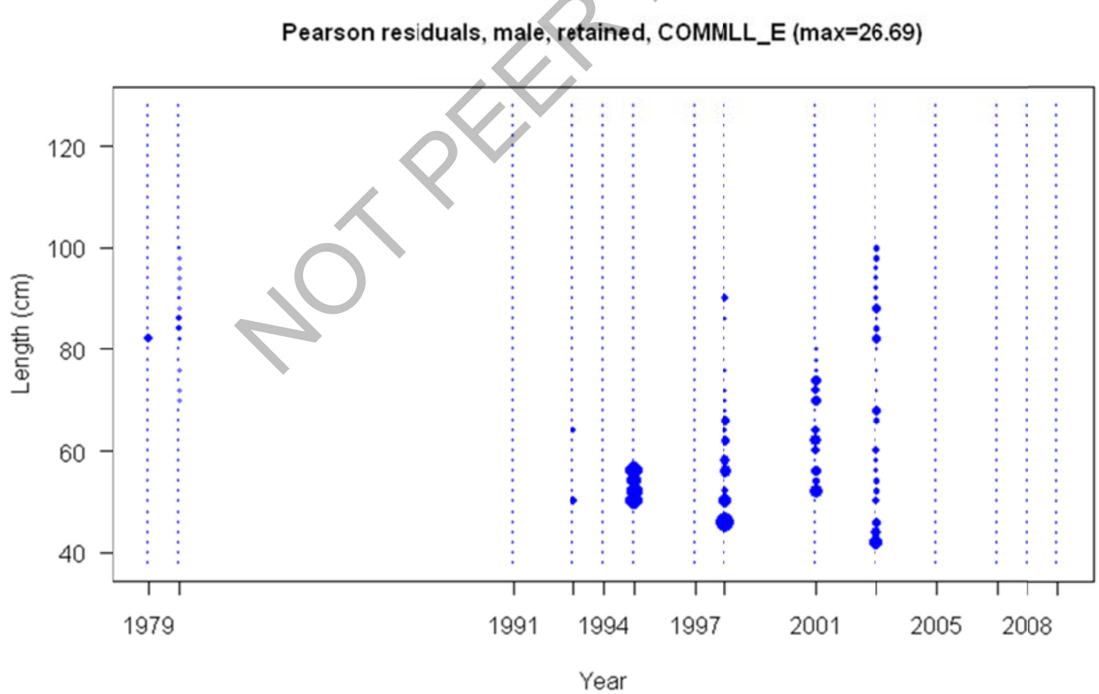


Figure 3.44. Pearson residuals commercial longline East, males.

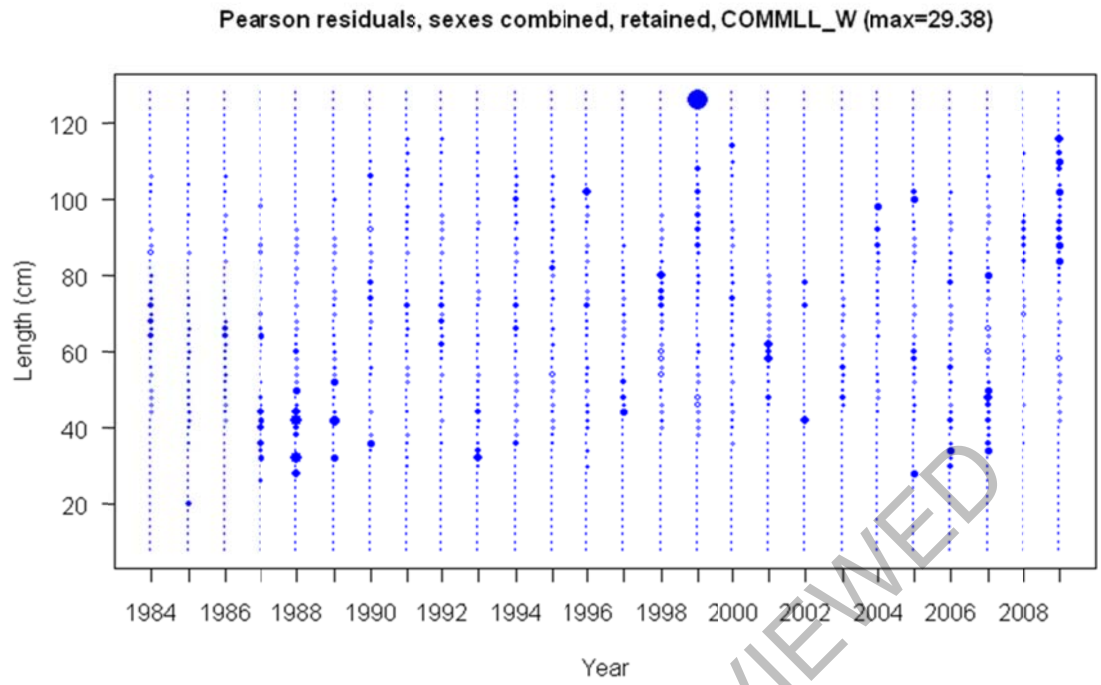


Figure 3.45. Pearson residuals commercial longline West, sexes not differentiated.

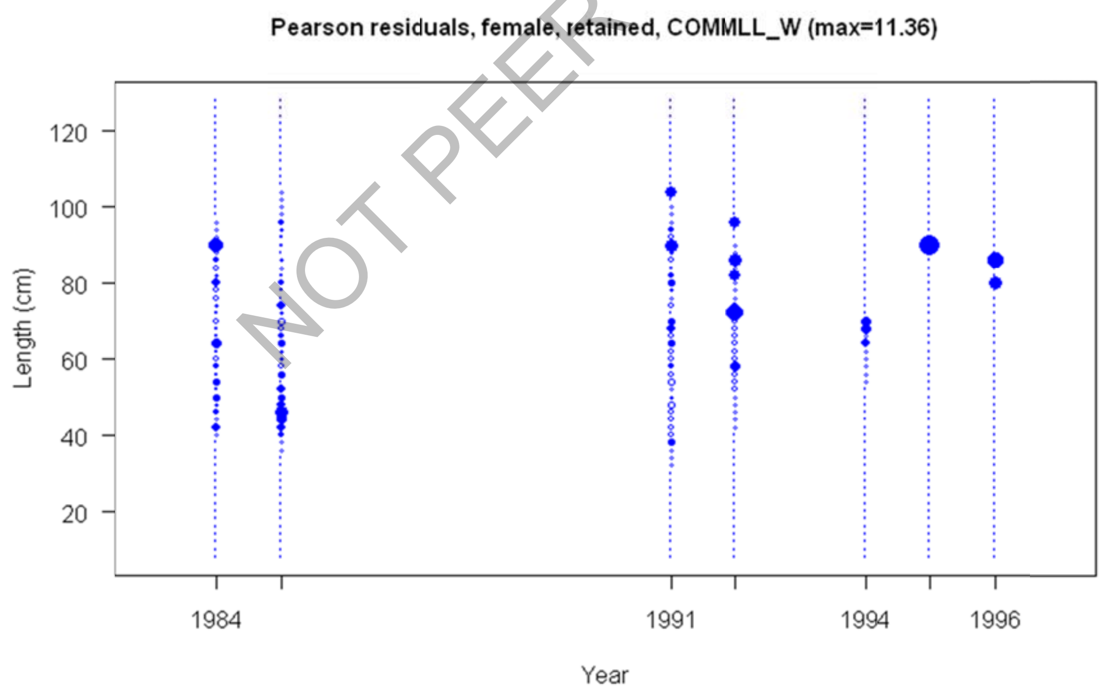


Figure 3.46. Pearson residuals commercial longline West, females.

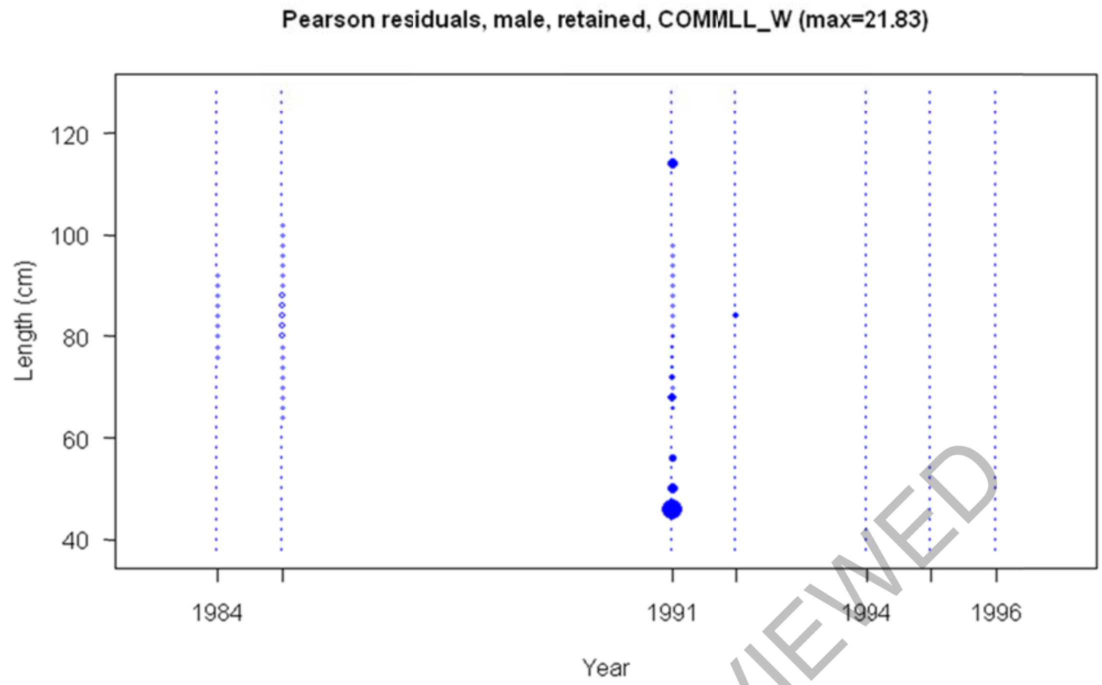


Figure 3.47. Pearson residuals commercial longline West, males.

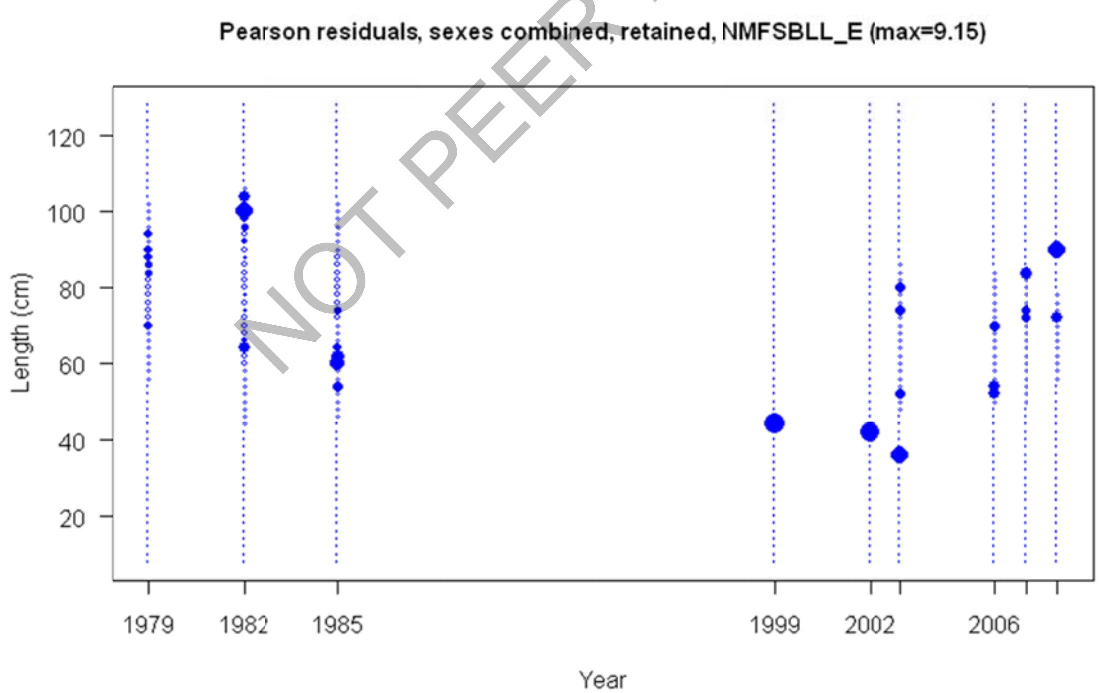


Figure 3.48. Pearson residuals NMFS bottom longline East, sexes not differentiated.

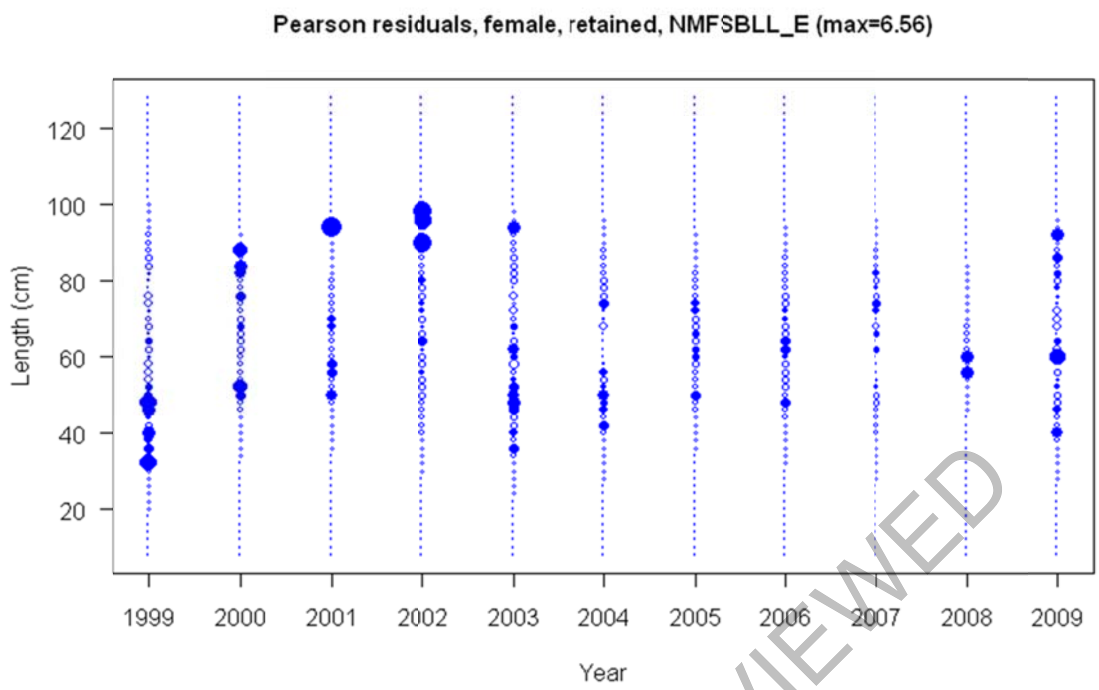


Figure 3.49. Pearson residuals NMFS bottom longline East, females.

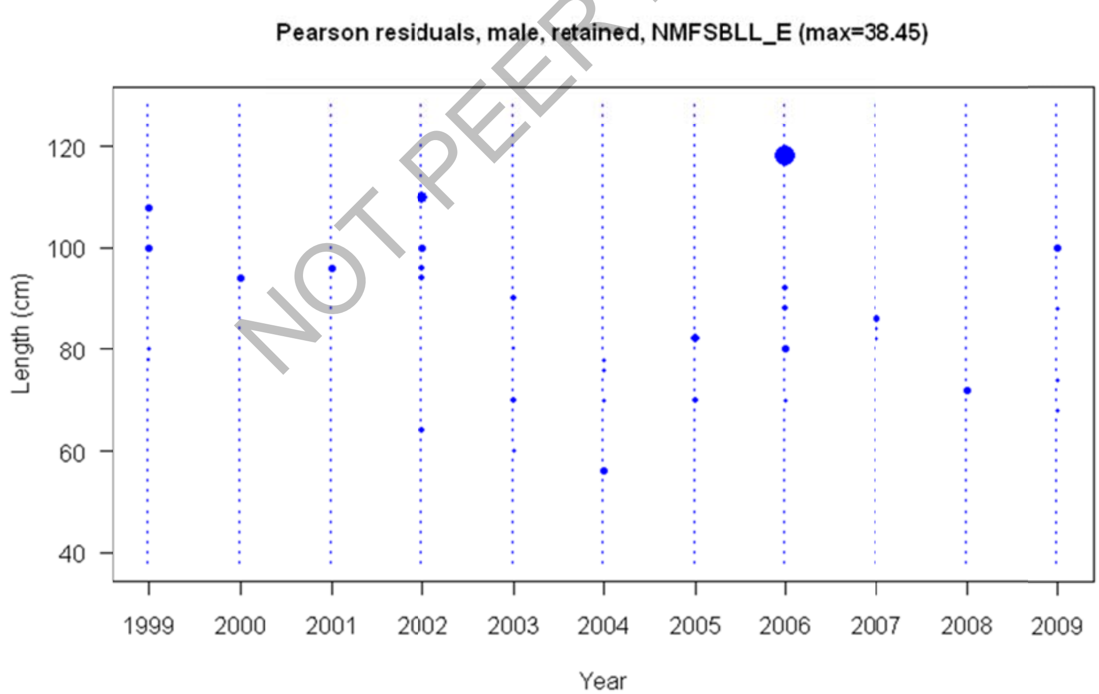


Figure 3.50. Pearson residuals NMFS bottom longline East, males.

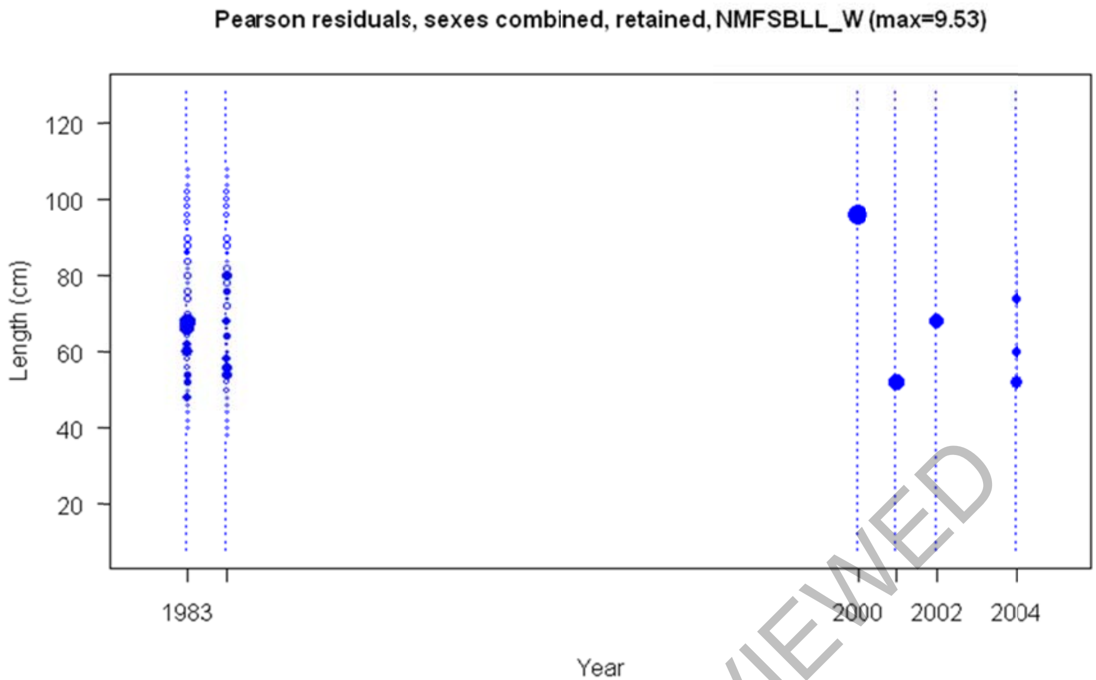


Figure 3.51. Pearson residuals NMFS bottom longline West, males.

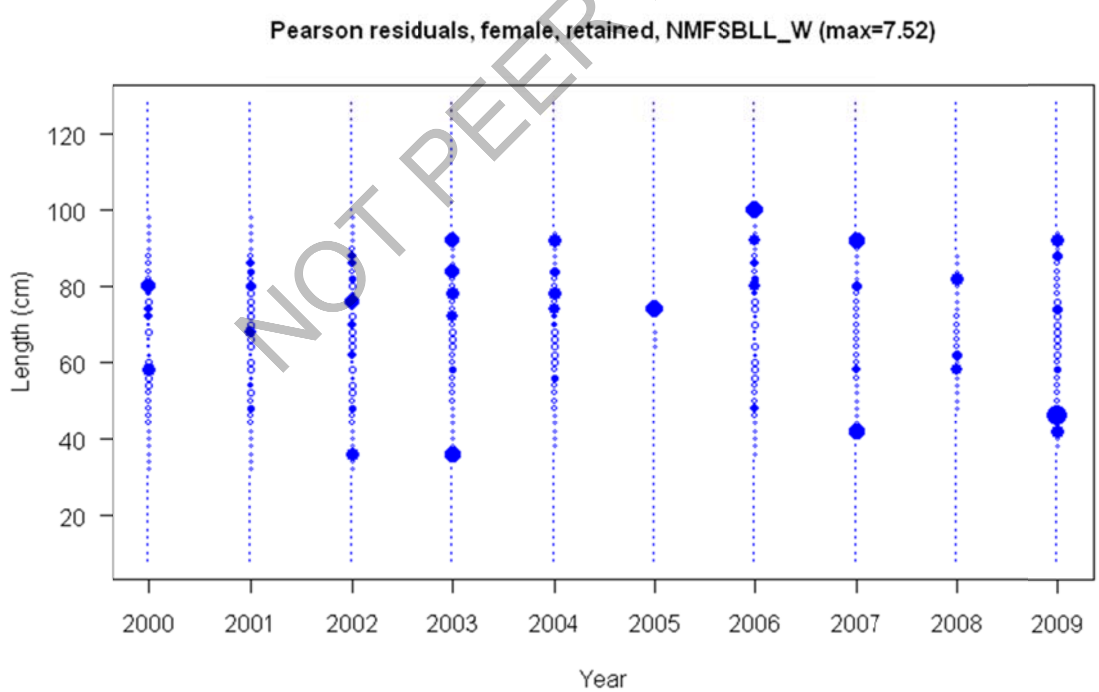


Figure 3.52. Pearson residuals NMFS bottom longline West, females.

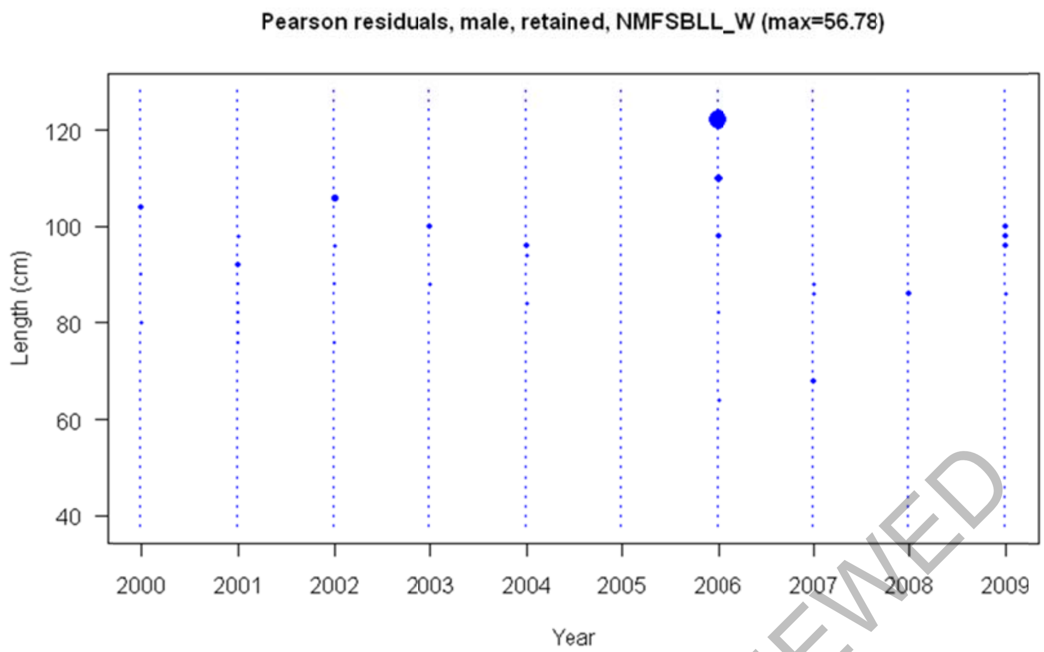


Figure 3.53. Pearson residuals NMFS bottom longline West, males.

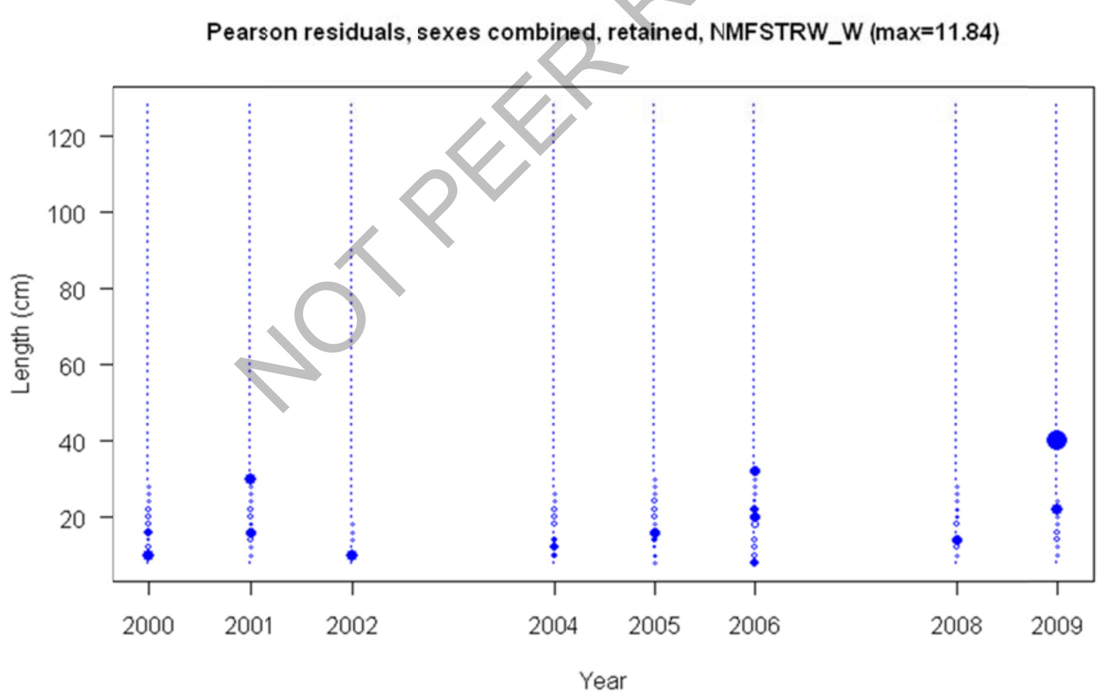


Figure 3.54. Pearson residuals SEAMAP trawl West, sexes not differentiated. All other Pearson residual plots for the males, females and for the East are uninformative as they have only a few fish.

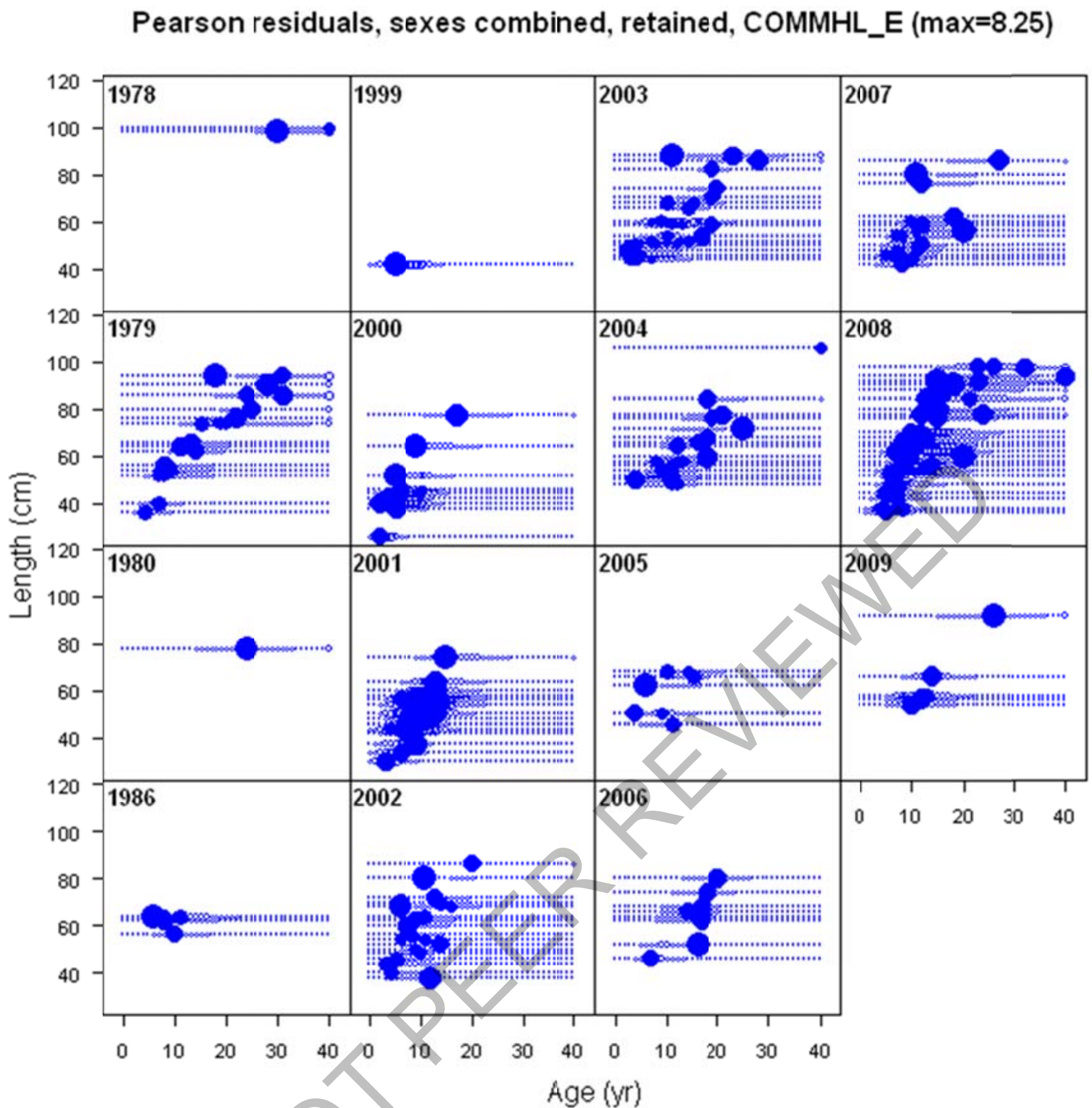


Figure 3.55. Pearson residuals for fits to conditional age at length, commercial handline East, both sexes combined.

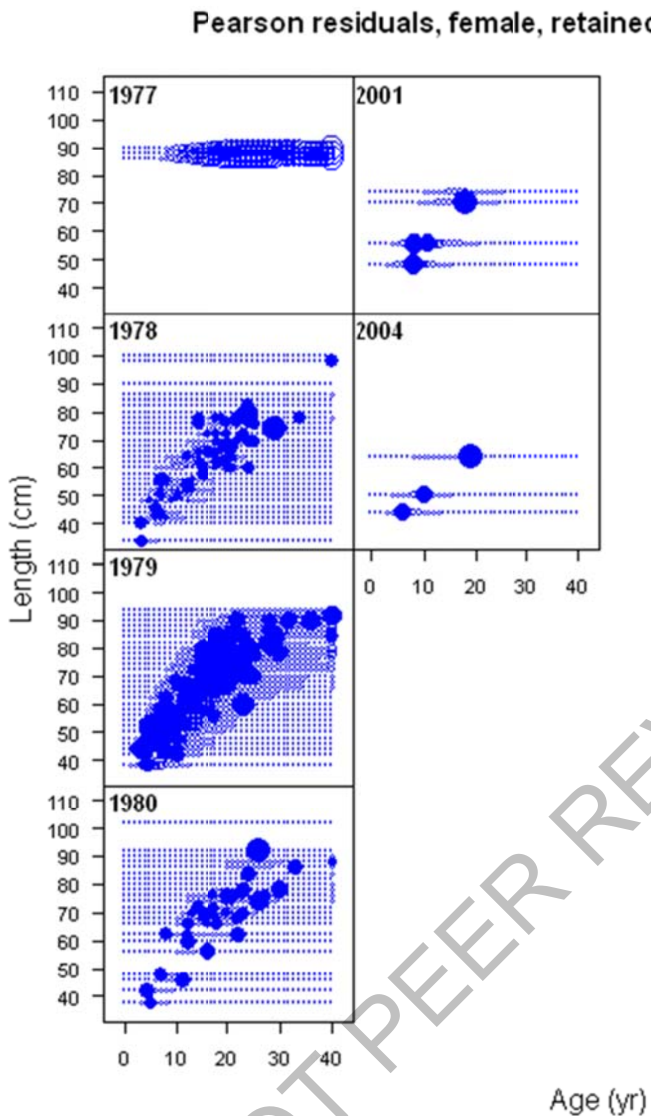


Figure 3.56. Pearson residuals for fits to conditional age at length,commercial handline East, females

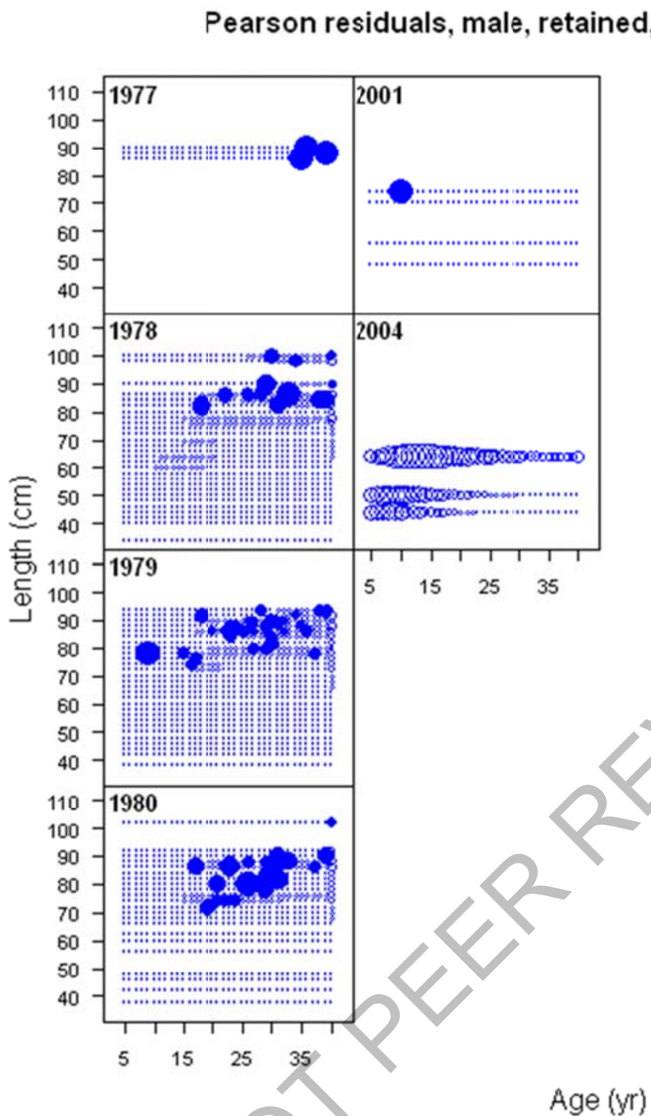


Figure 3.57. Pearson residuals for fits to conditional age at length, commercial handline East, males

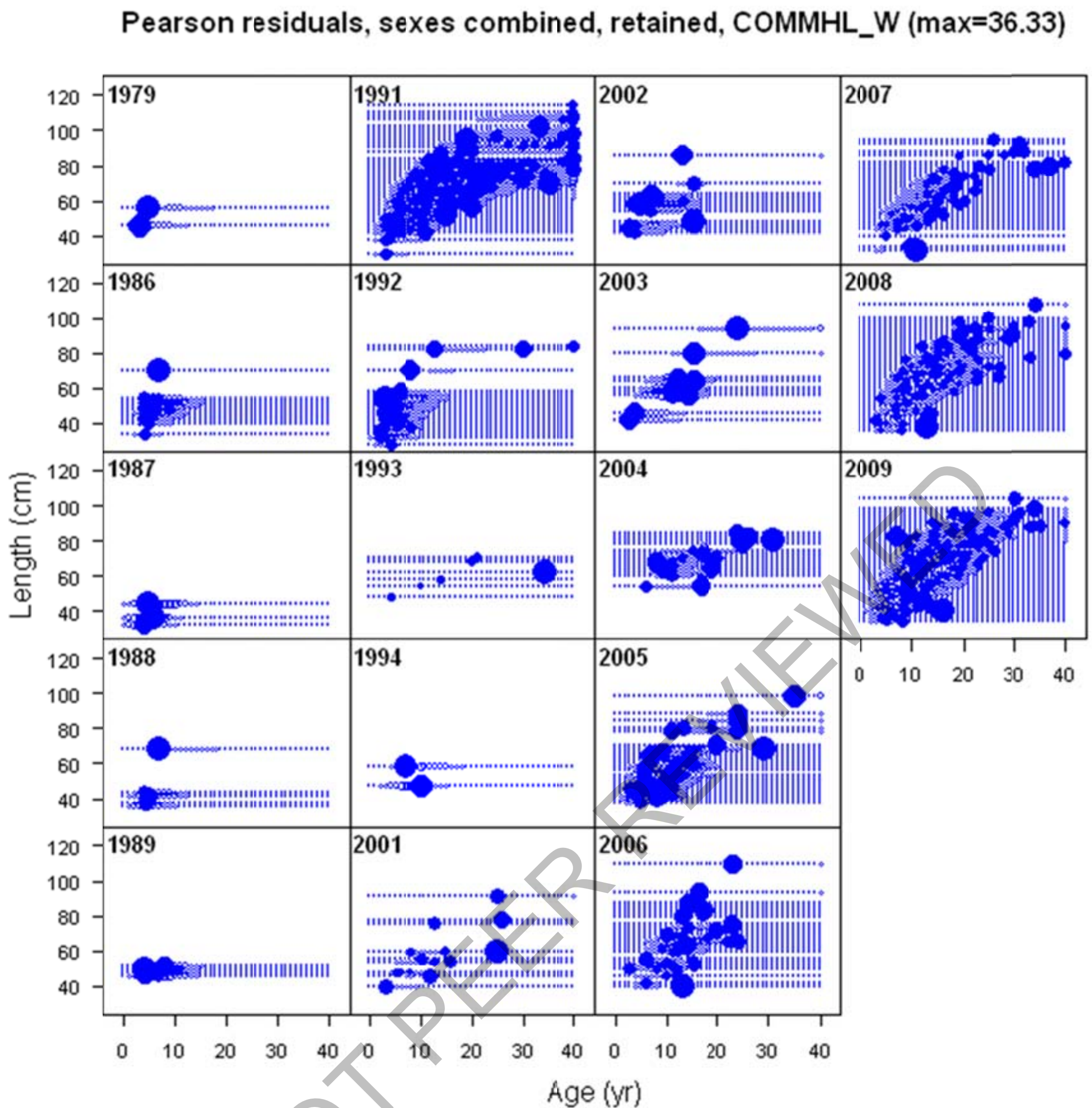


Figure 3.58. Pearson residuals for fits to conditional age at length, commercial handline West, both sexes.

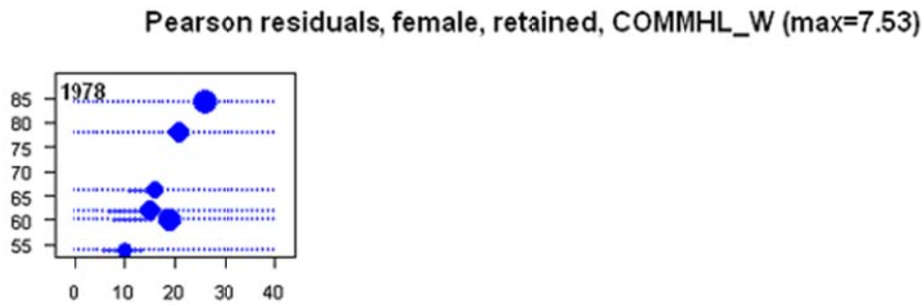


Figure 3.59. Pearson residuals for fits to conditional age at length, commercial handline West, females.

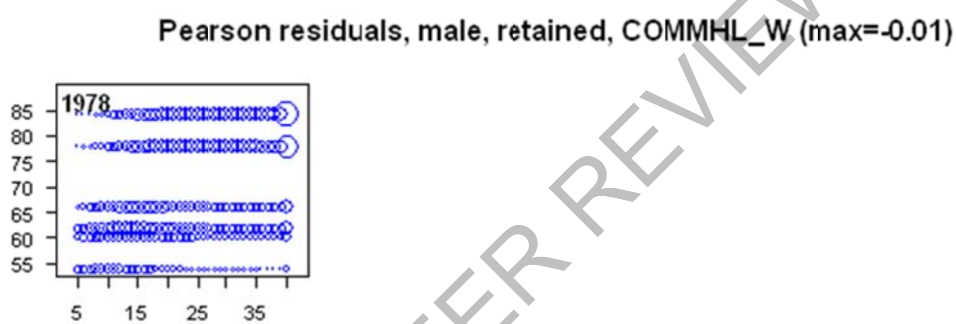


Figure 3.60. Pearson residuals for fits to conditional age at length, commercial handline West, males.

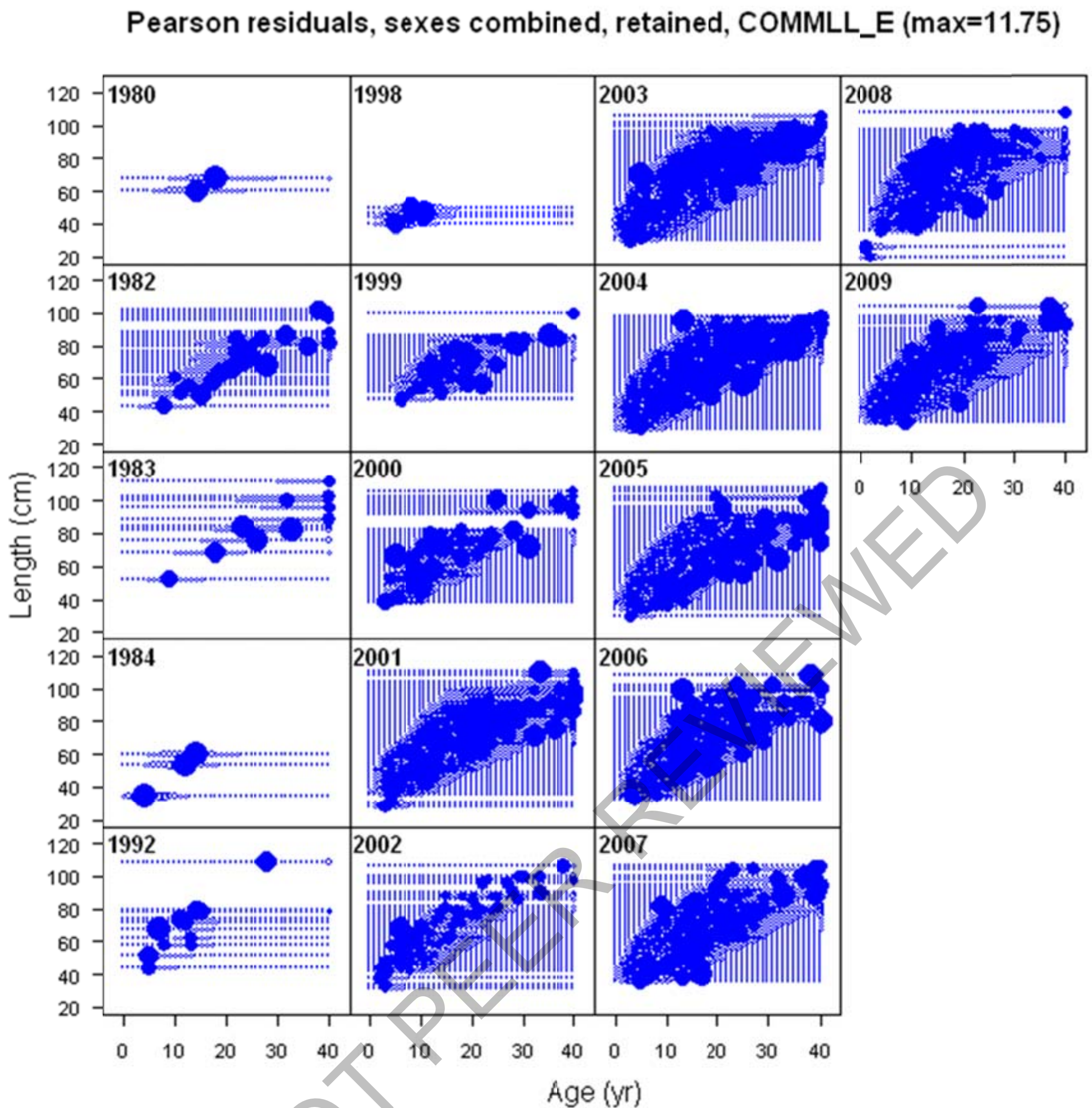


Figure 3.61. Pearson residuals for fits to conditional age at length, commercial longline East, sexes combined.

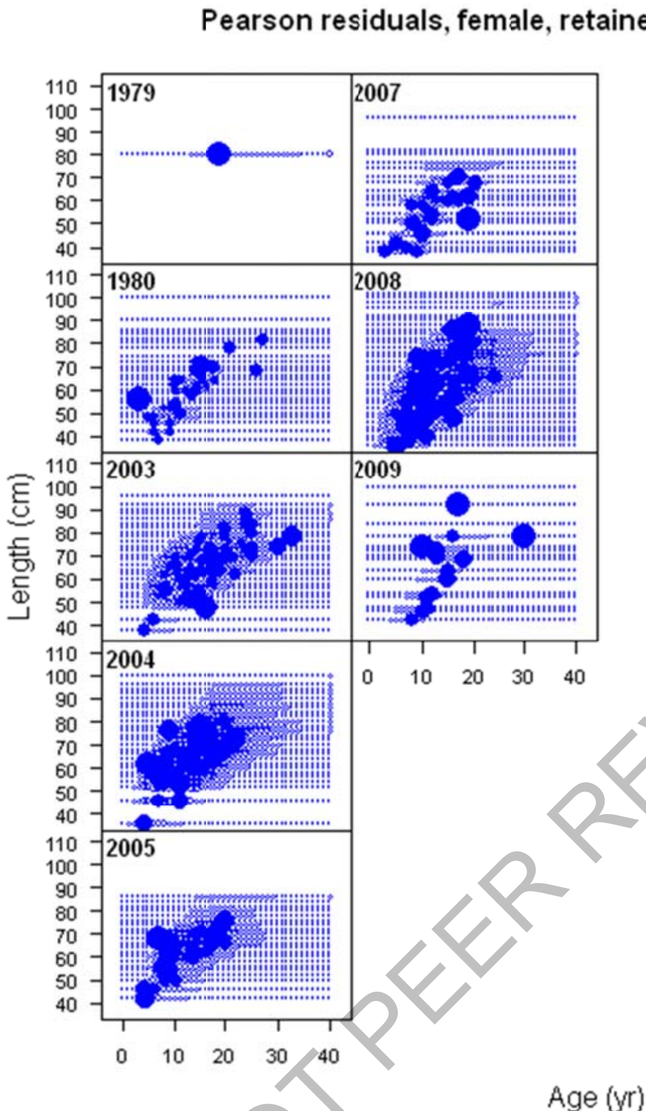


Figure 3.62. Pearson residuals for fits to conditional age at length, commercial longline East, females.

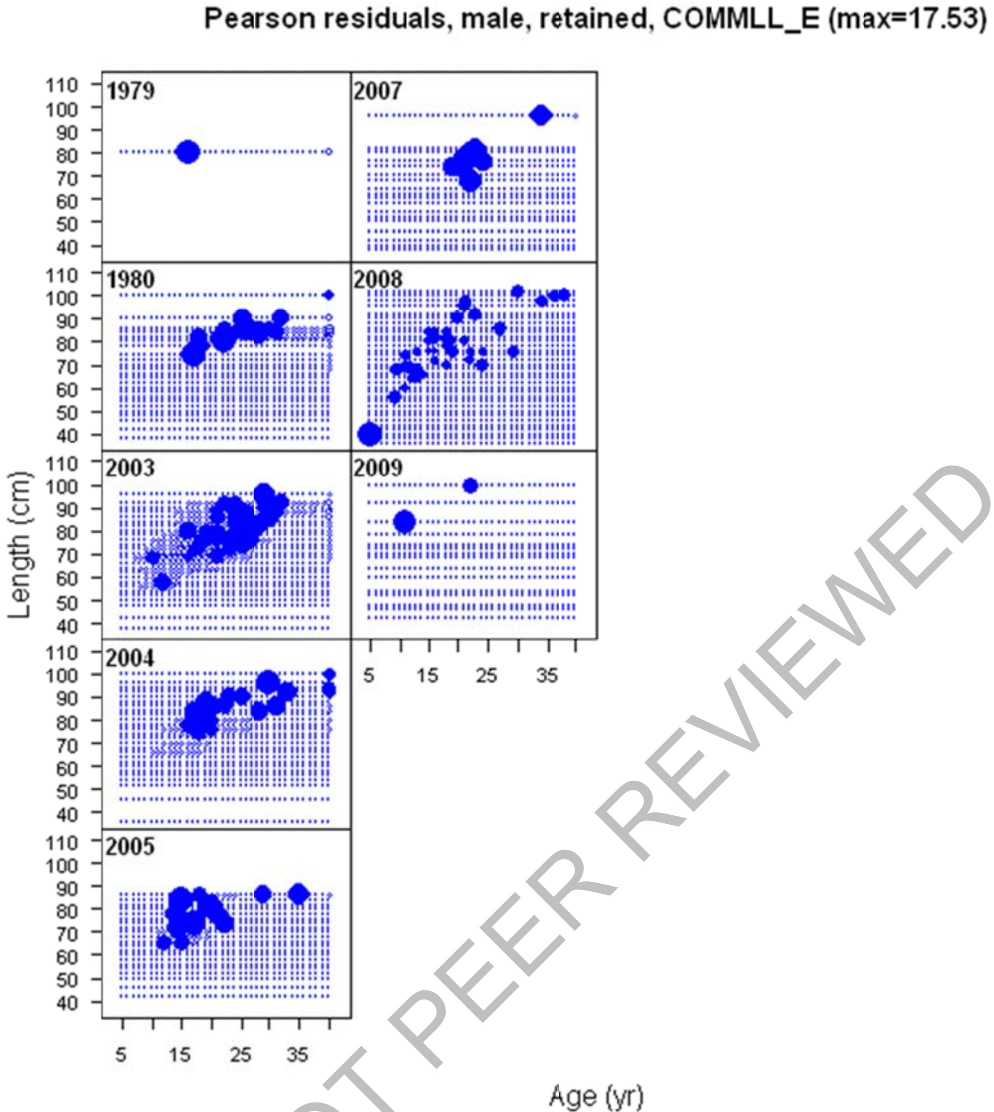


Figure 3.63. Pearson residuals for fits to conditional age at length, commercial longline East, males.

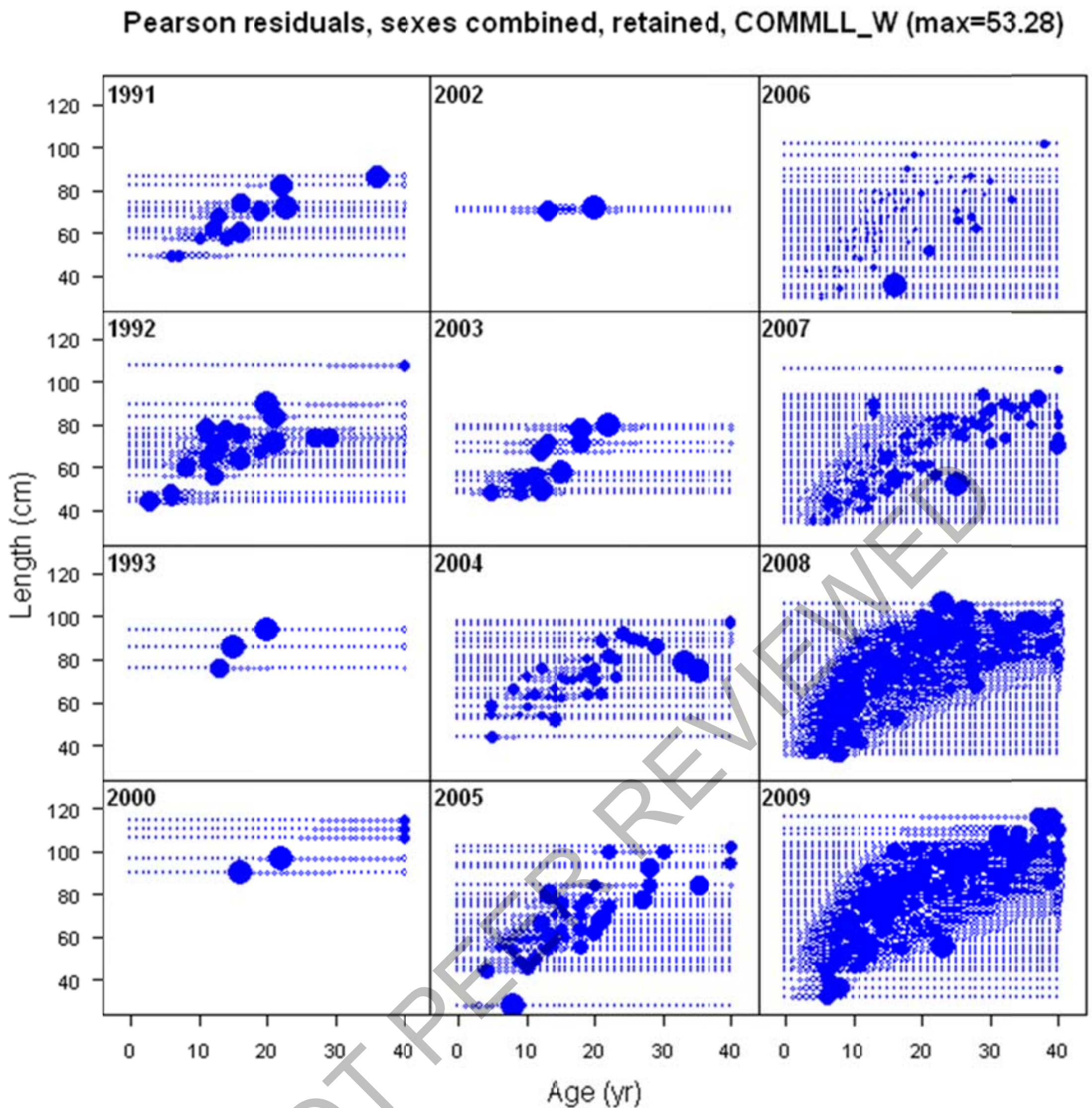


Figure 3.64. Pearson residuals for fits to conditional age at length, commercial longline West, sexes combined. No similar plot exists for males or females separately.

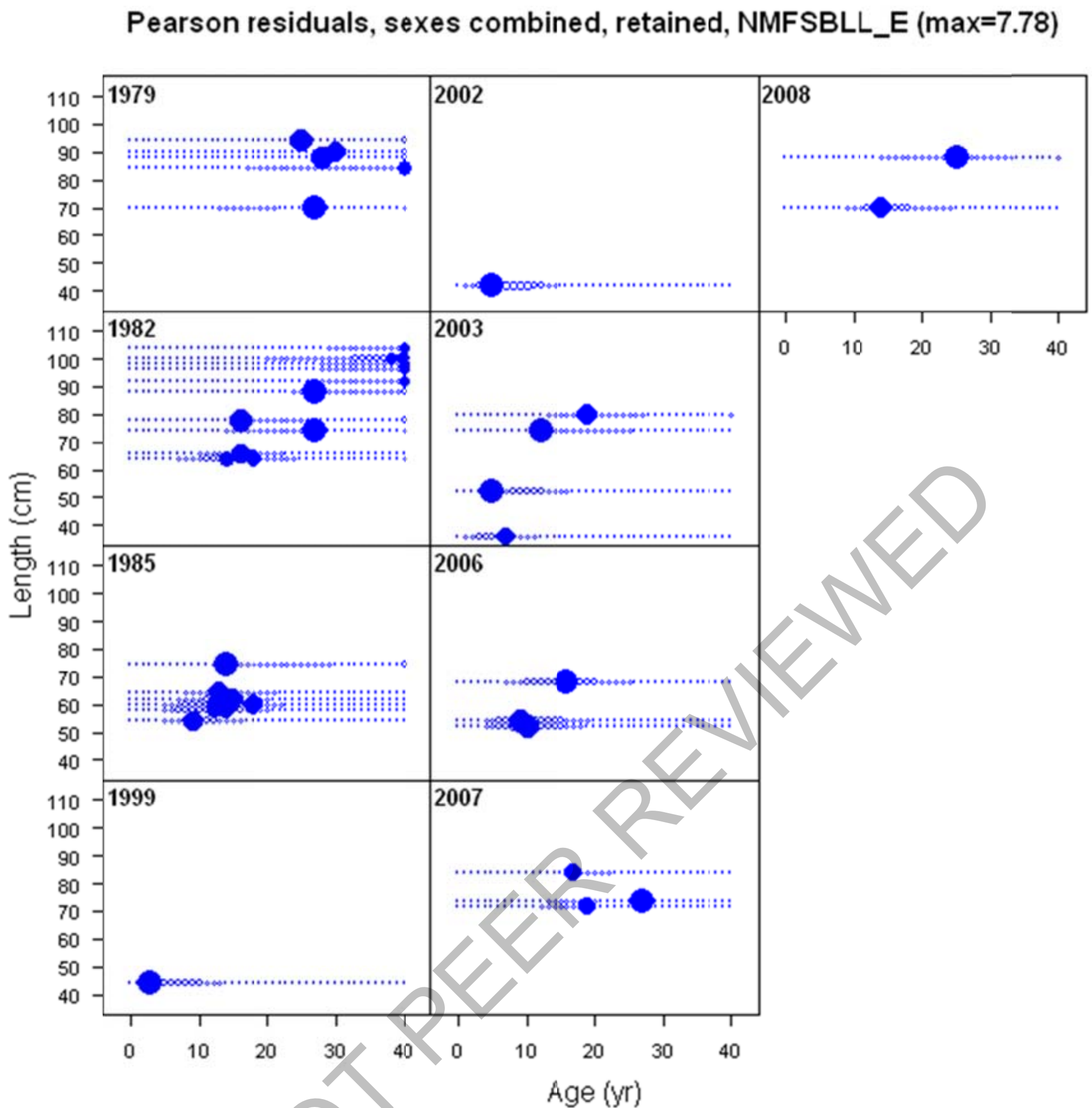


Figure 3.65. Pearson residuals for fits to conditional age at length, NMFS BLL West, both sexes.

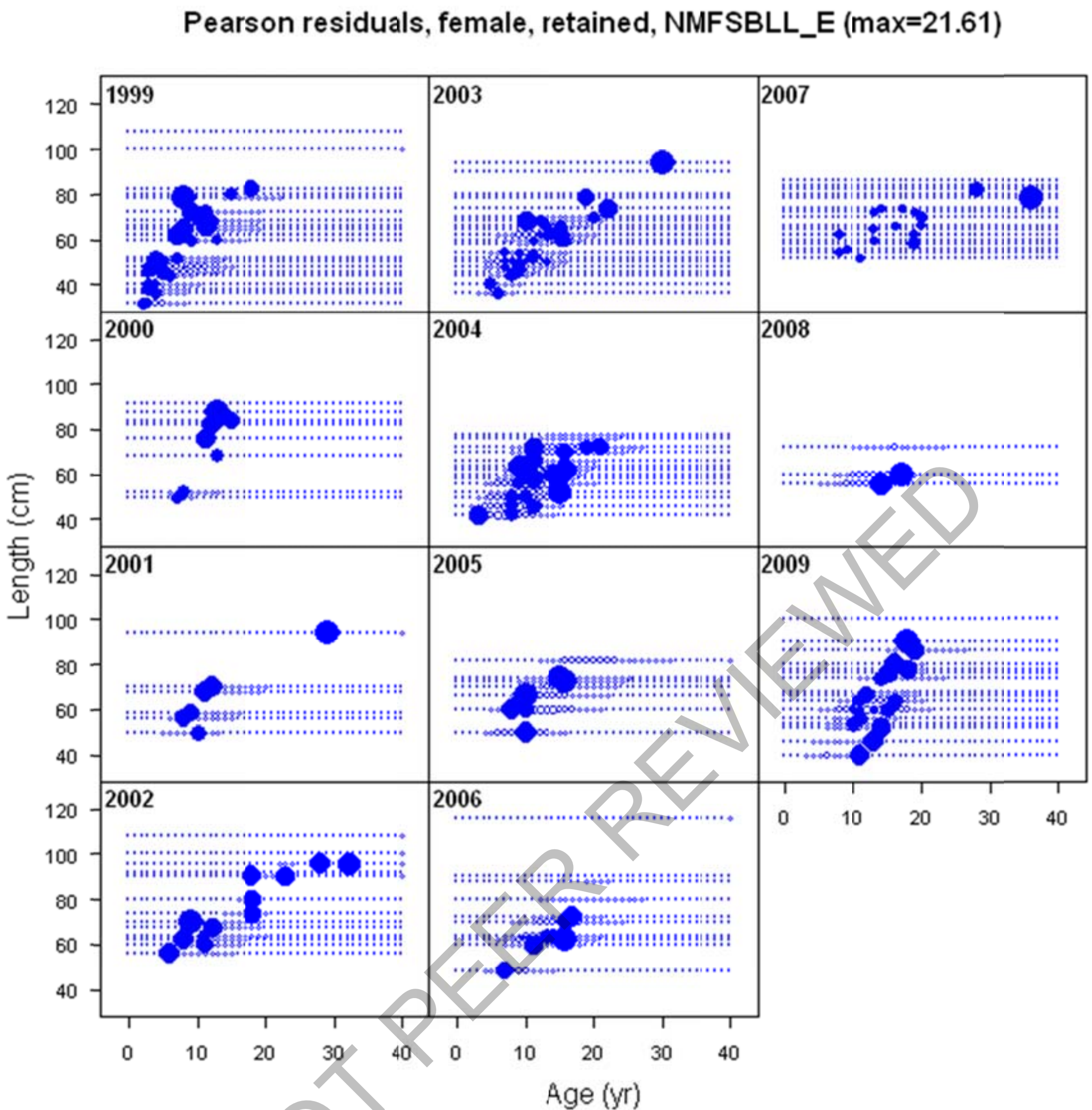


Figure 3.66. Pearson residuals for fits to conditional age at length, NMFS BLL West, females.

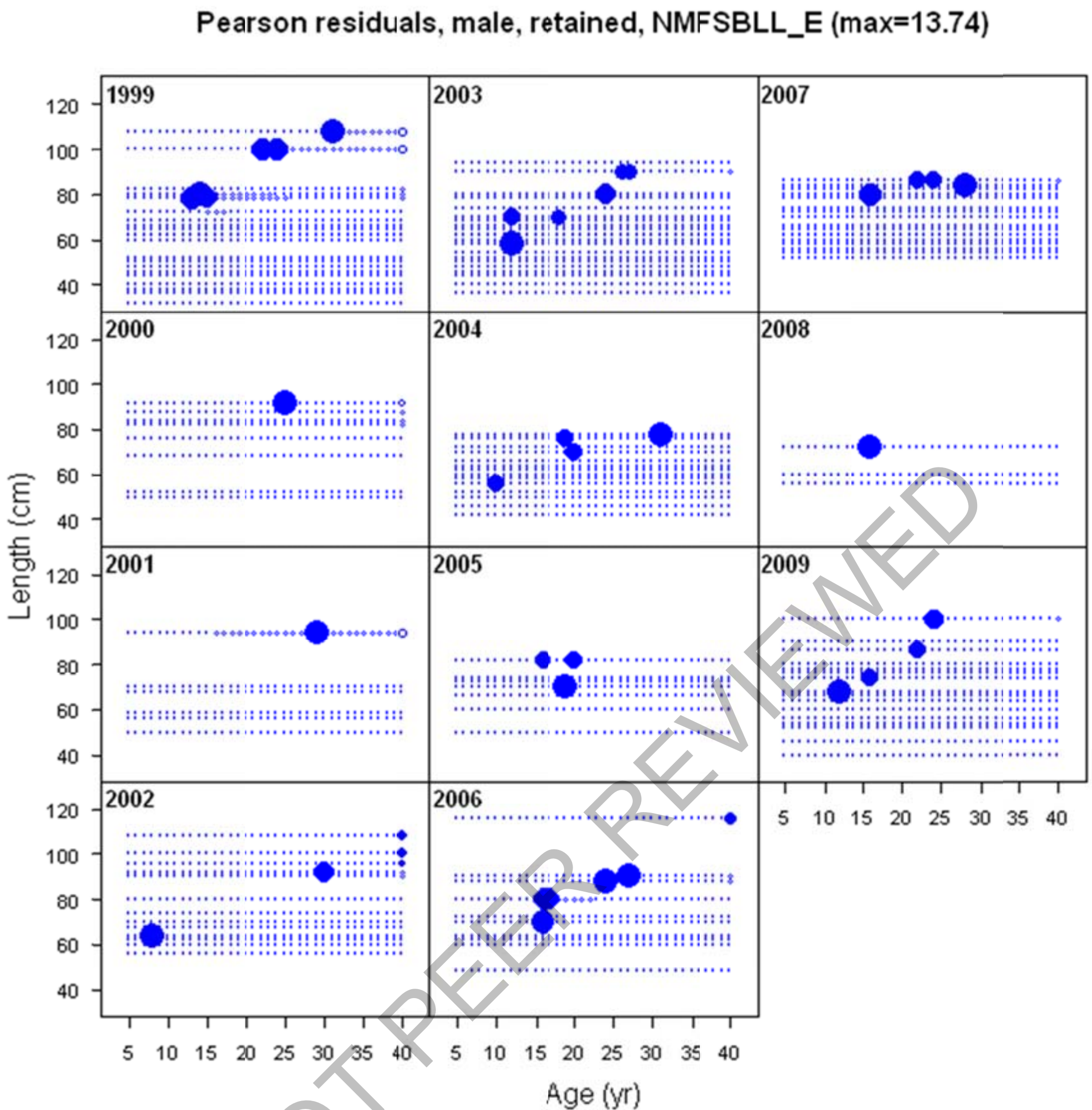


Figure 3.67. Pearson residuals for fits to conditional age at length, NMFS BLL East, males.

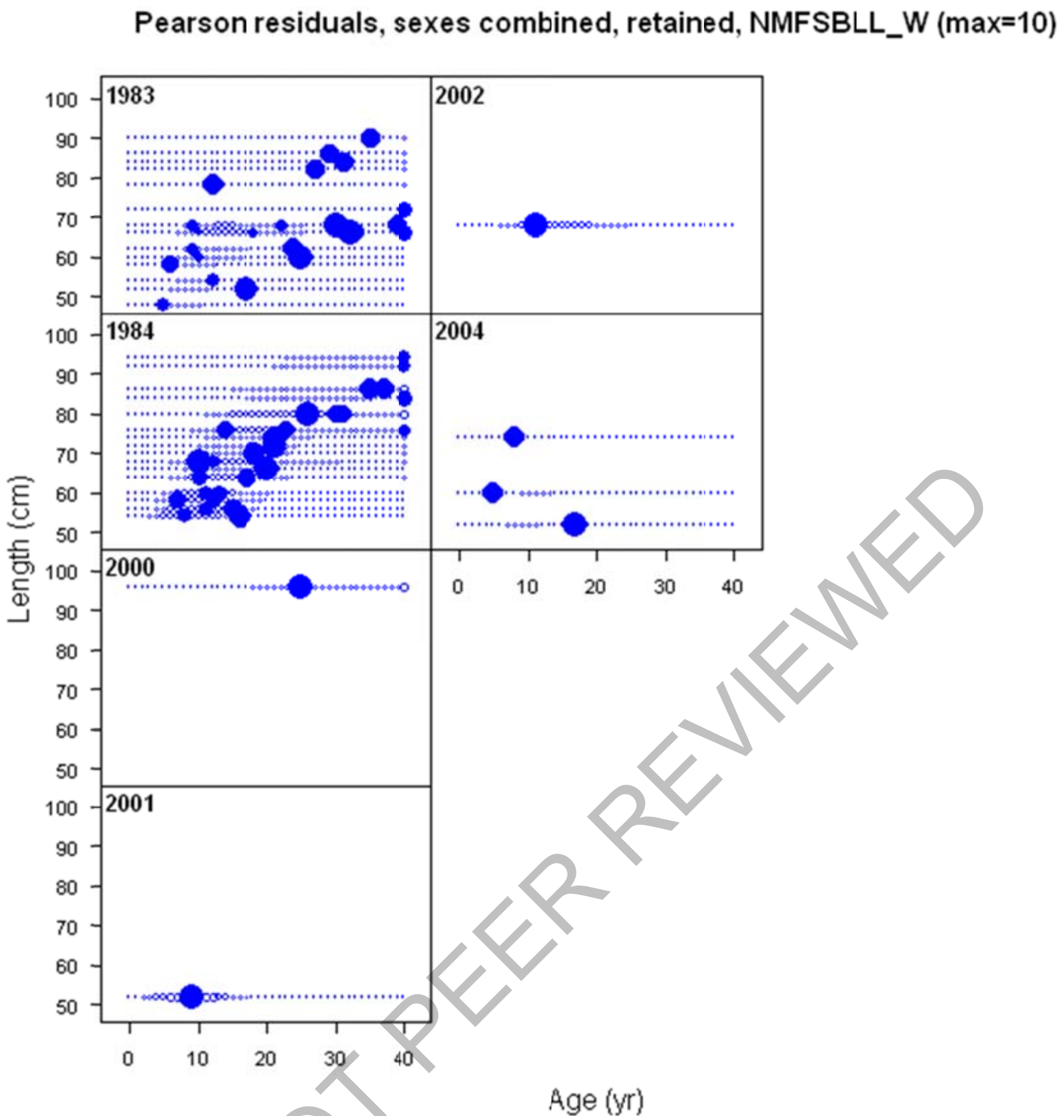


Figure 3.68. Pearson residuals for fits to conditional age at length, NMFS BLL West, both sexes.

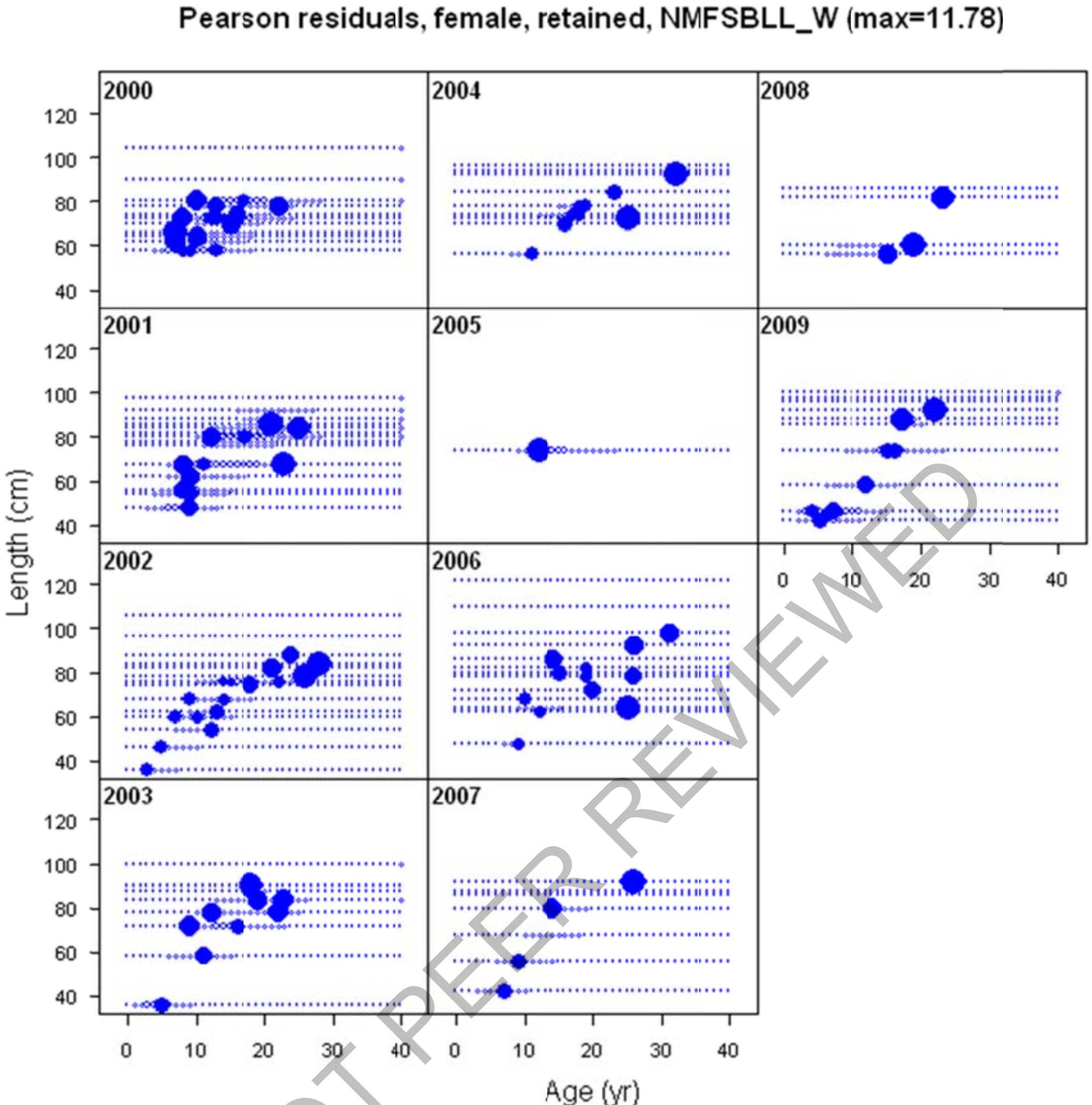


Figure 3.69. Pearson residuals for fits to conditional age at length, NMFS BLL East, females.

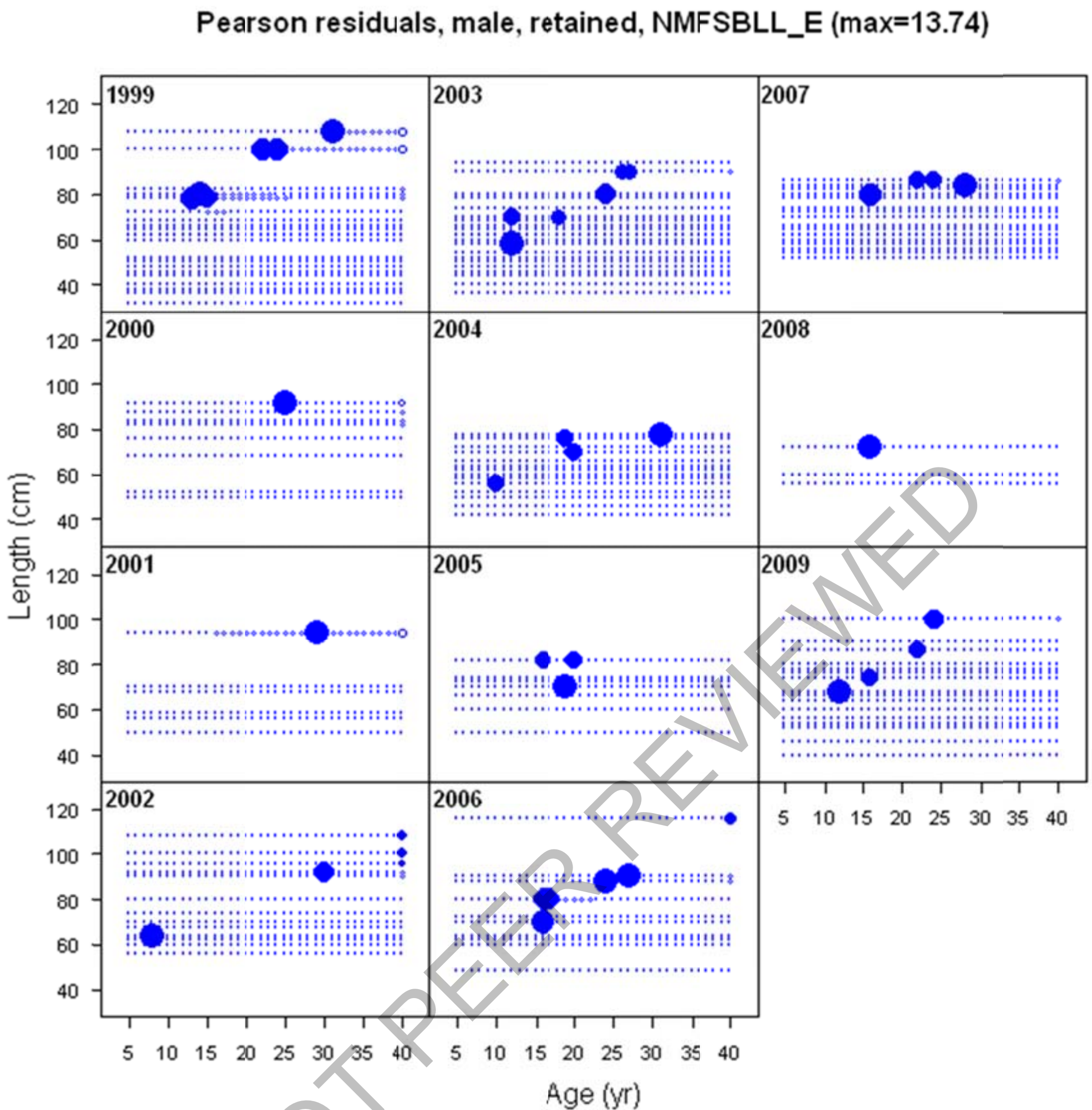


Figure 3.70. Pearson residuals for fits to conditional age at length, NMFS BLL East, males.

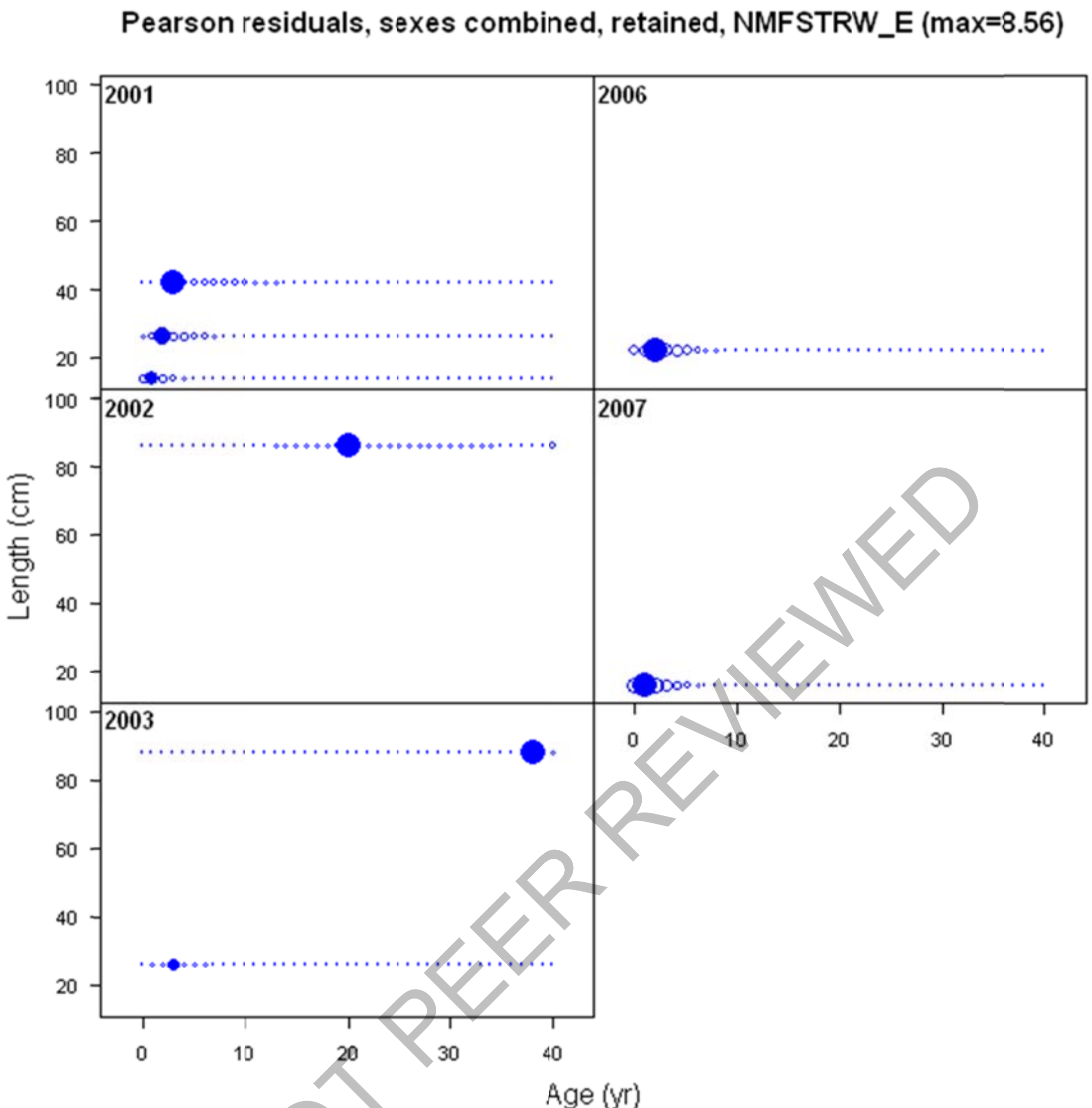


Figure 3.71. Pearson residuals for fits to conditional age at length, NMFS BLL East, both sexes.

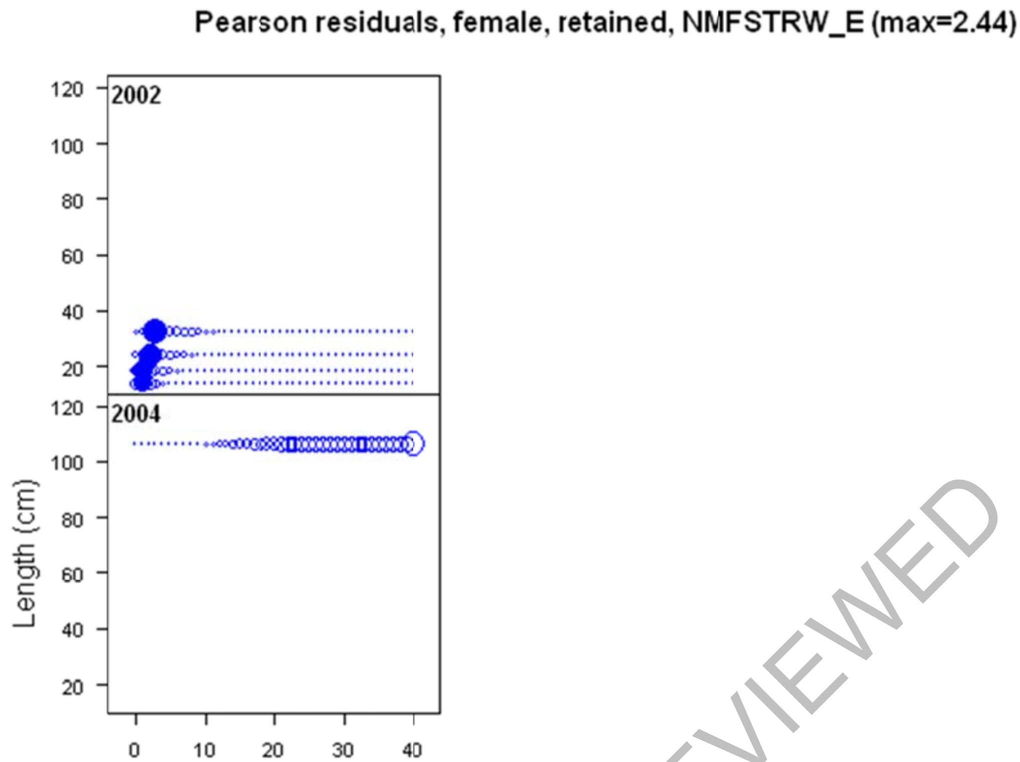


Figure 3.72. Pearson residuals for fits to conditional age at length, NMFS BLL East, females.

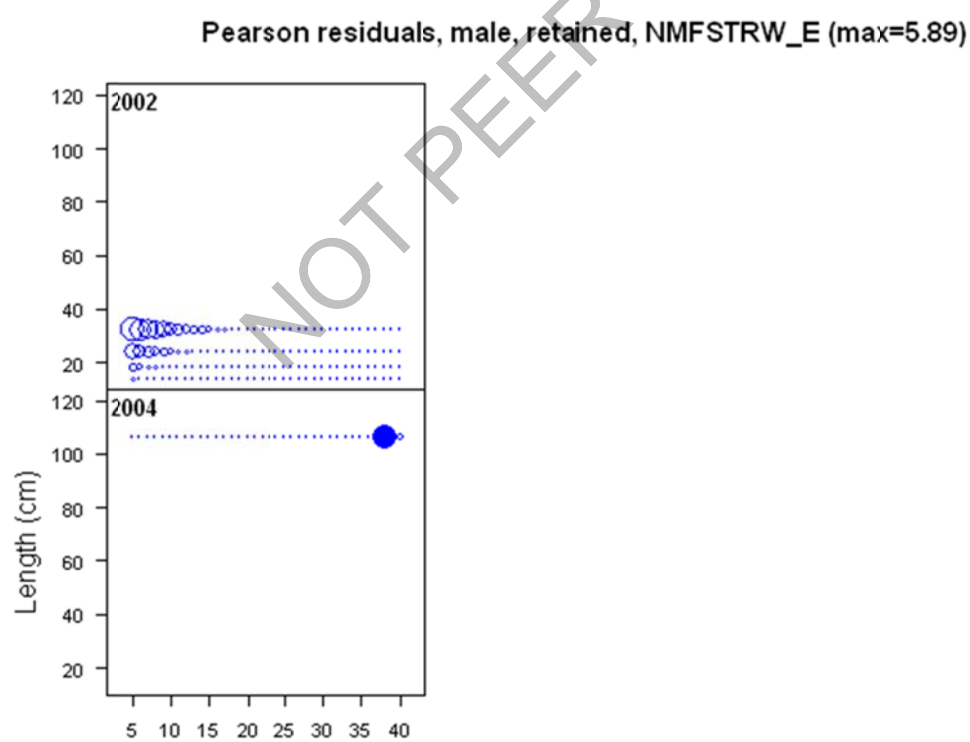


Figure 3.73. Pearson residuals for fits to conditional age at length, NMFS BLL East, males.

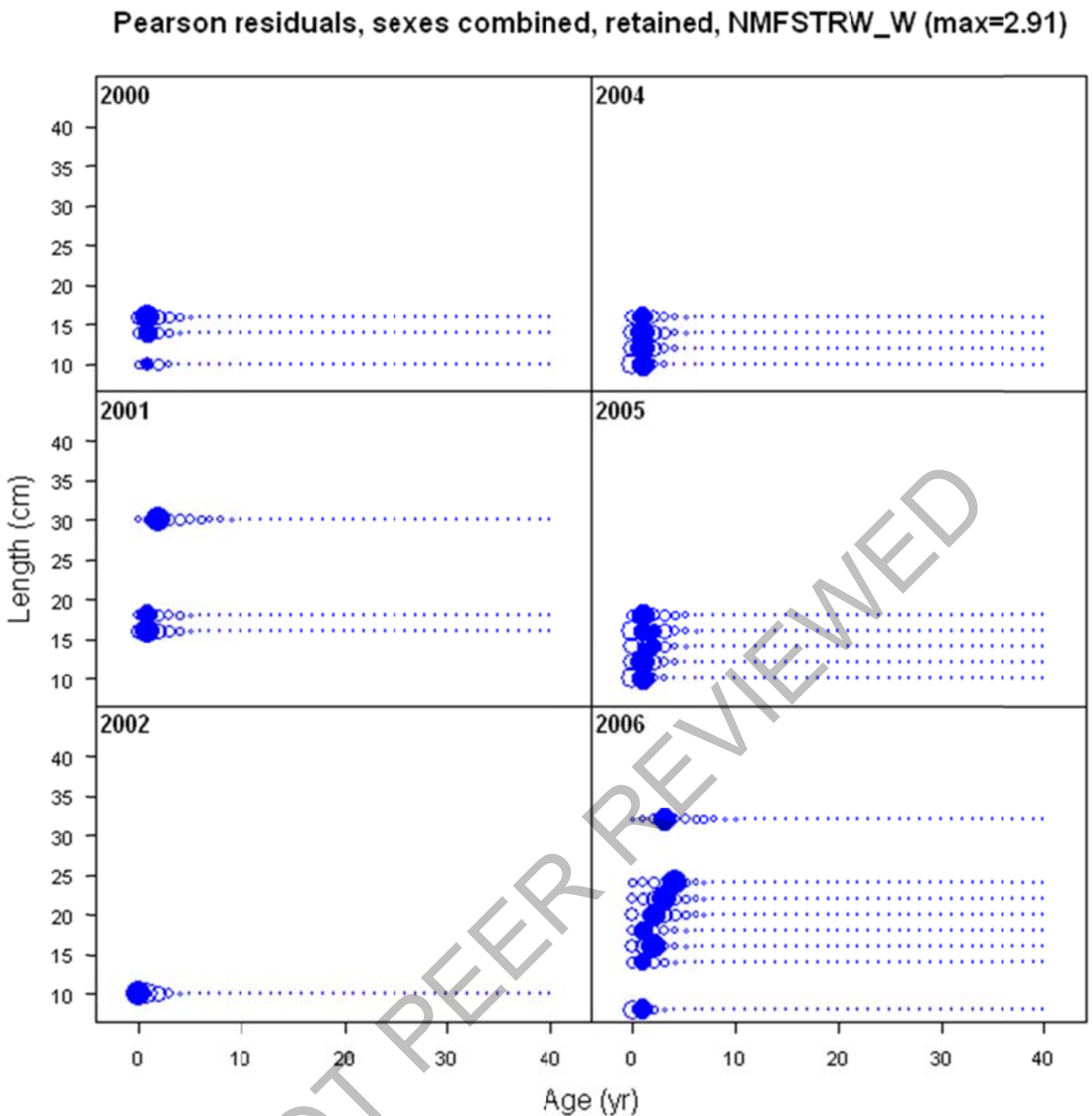


Figure 3.74. Pearson residuals for fits to conditional age at length, NMFS BLL West, both sexes.

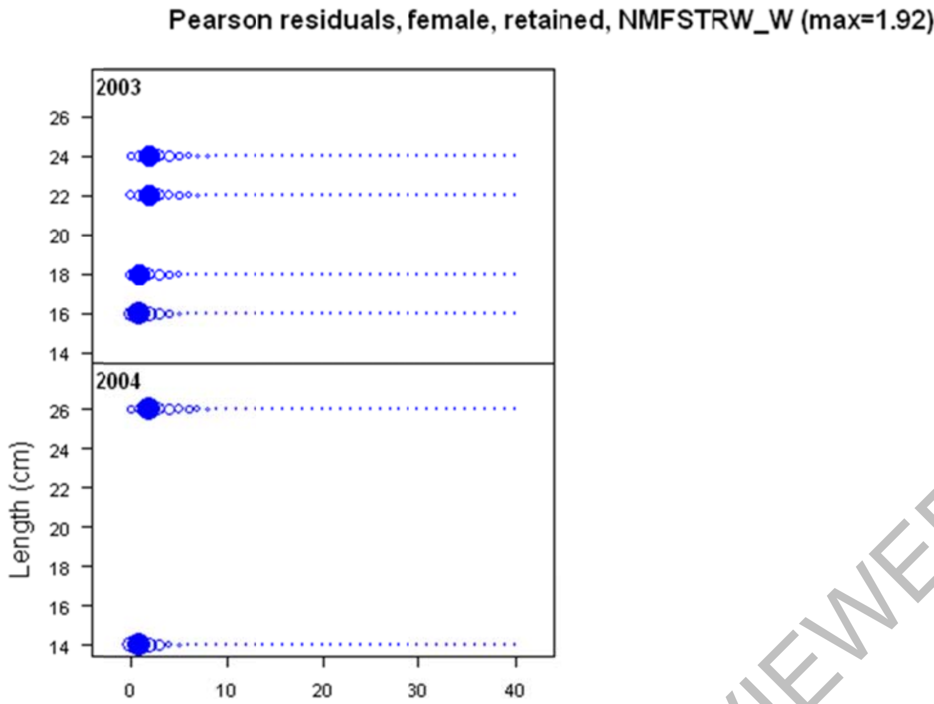


Figure 3.75. Pearson residuals for fits to conditional age at length, NMFS BLL West, females.

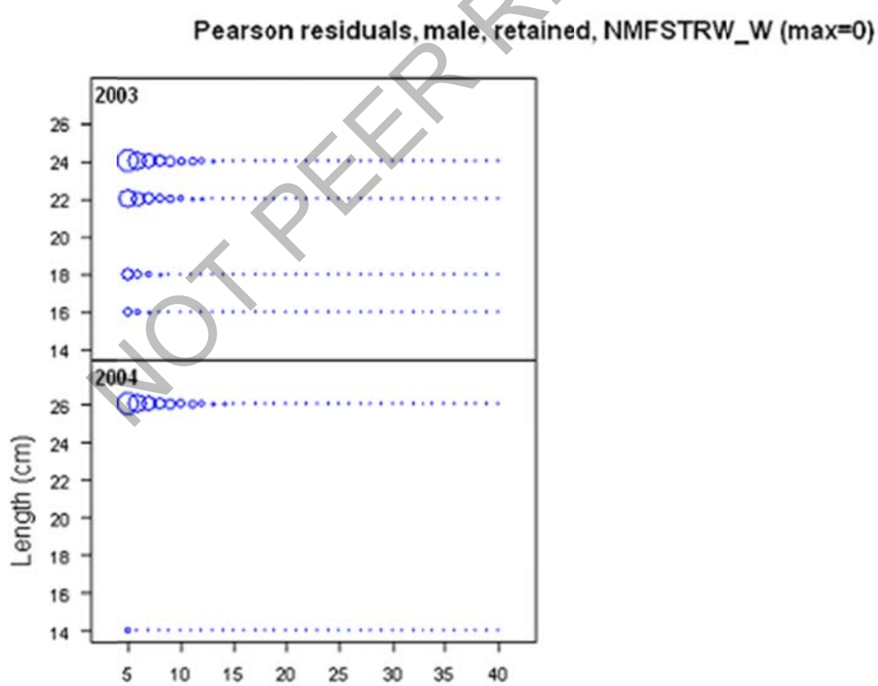


Figure 3.76. Pearson residuals for fits to conditional age at length, NMFS BLL West, males. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

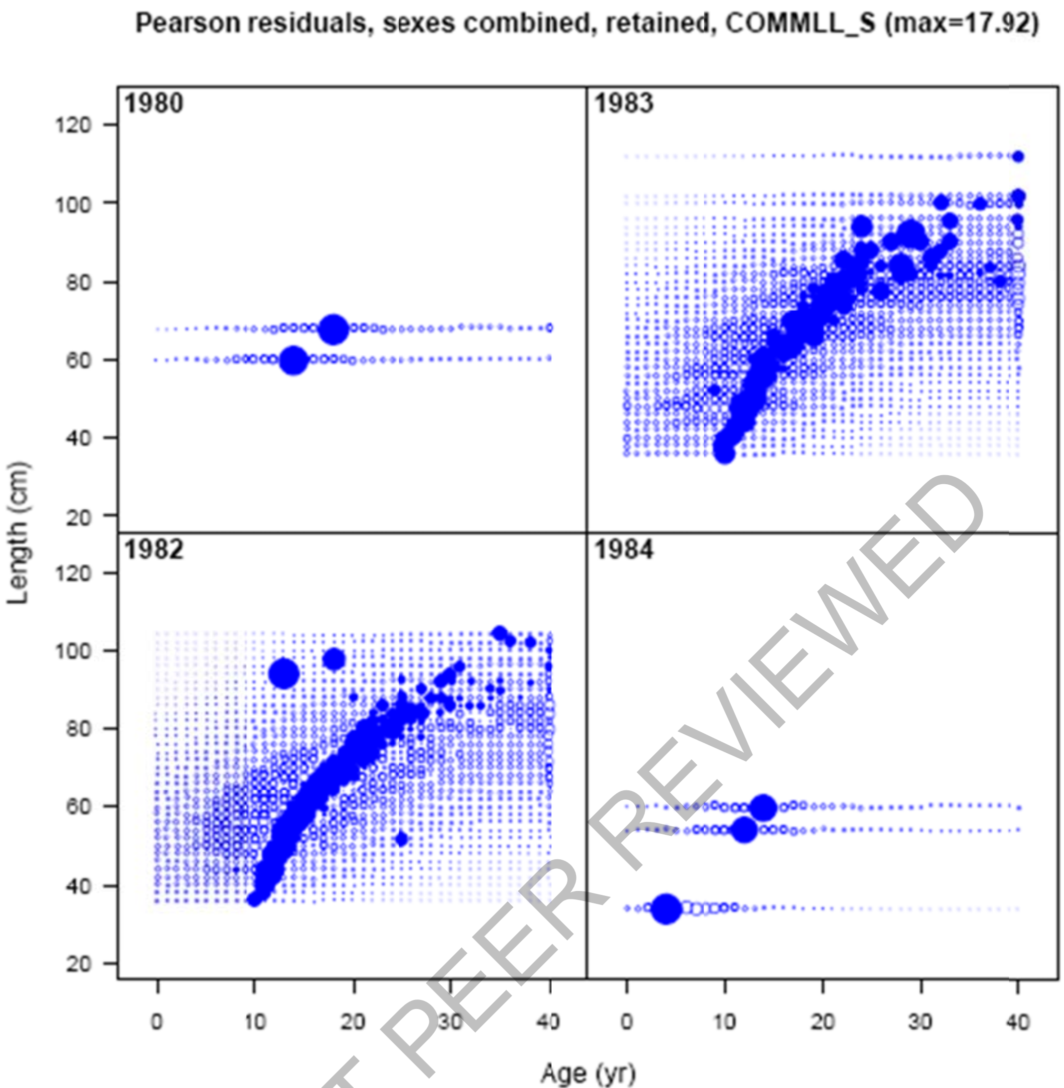


Figure 3.77. Pearson residuals to fits to 1982-83 otolith weight – otolith age regression predicted ages indicated an extremely biased fit.

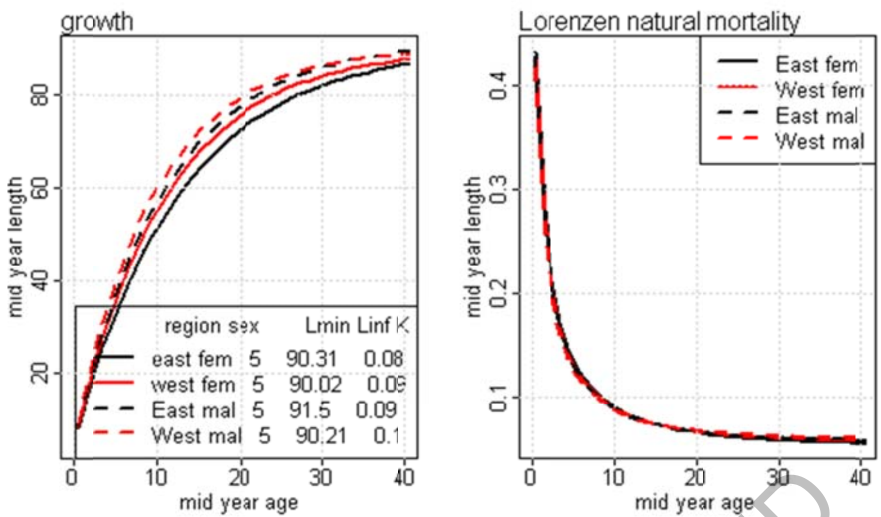


Figure 3.78. Base model estimated growth curves and Lorenzen M curves.

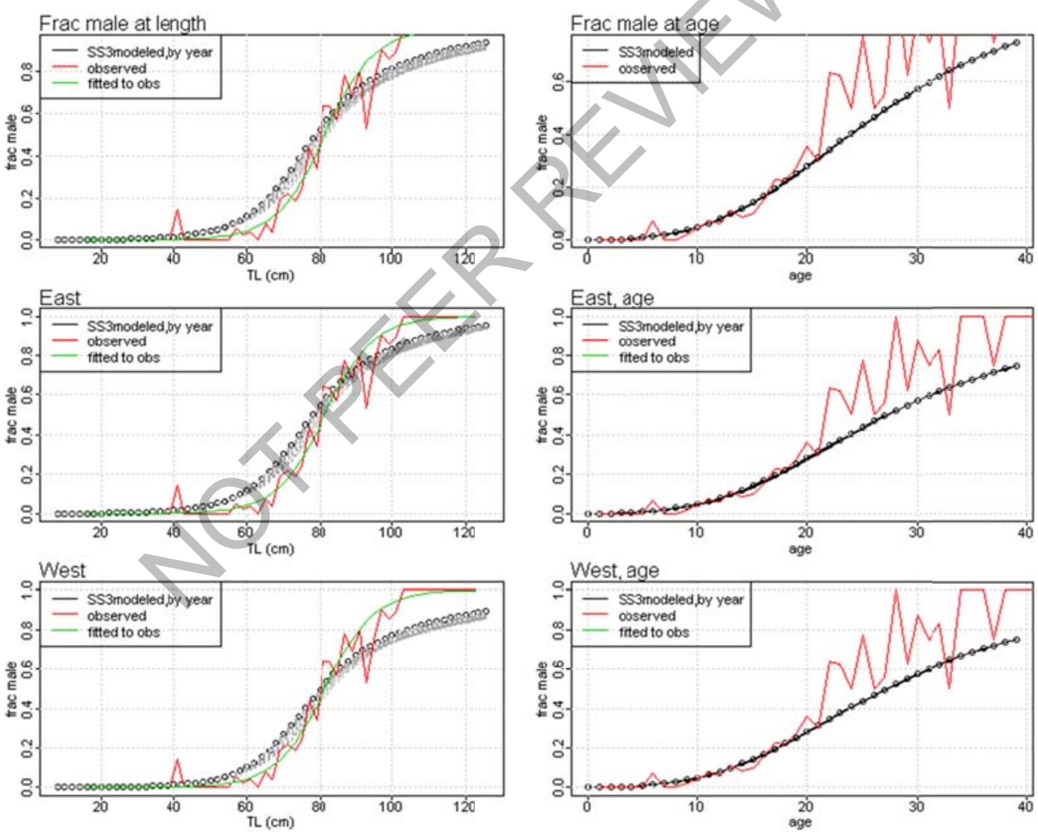


Figure 3.79. Empirically observed fraction male at length and age (Red) and SS3 estimated fraction (gray). The green lines is a fit conducted to the observed fraction male at length but not used in SS3 modeling. The transition probabilities are only estimated as a function of age within SS3. The top row is the combined data.

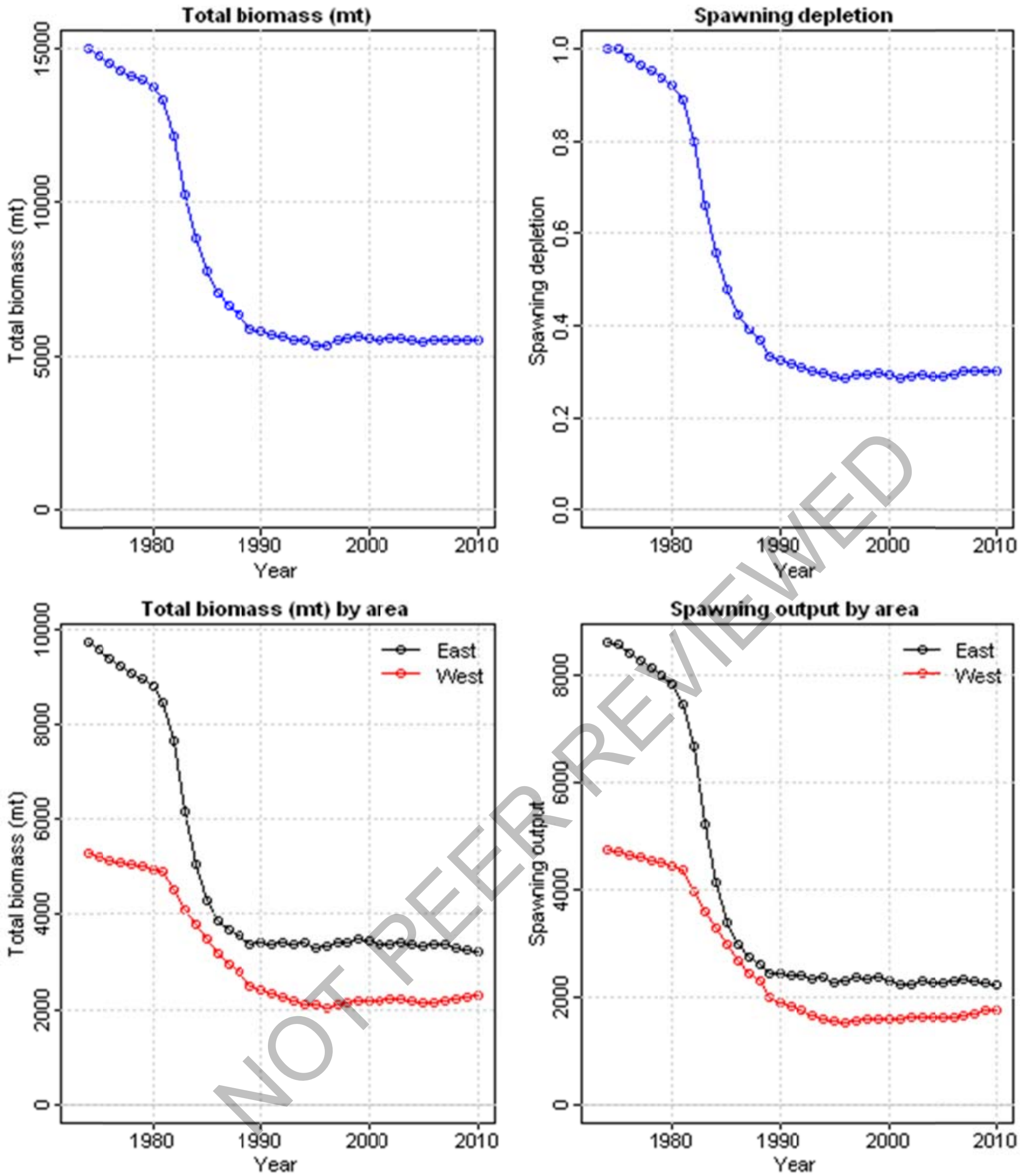


Figure 3.80. Stock Biomass (total and spawning stock).

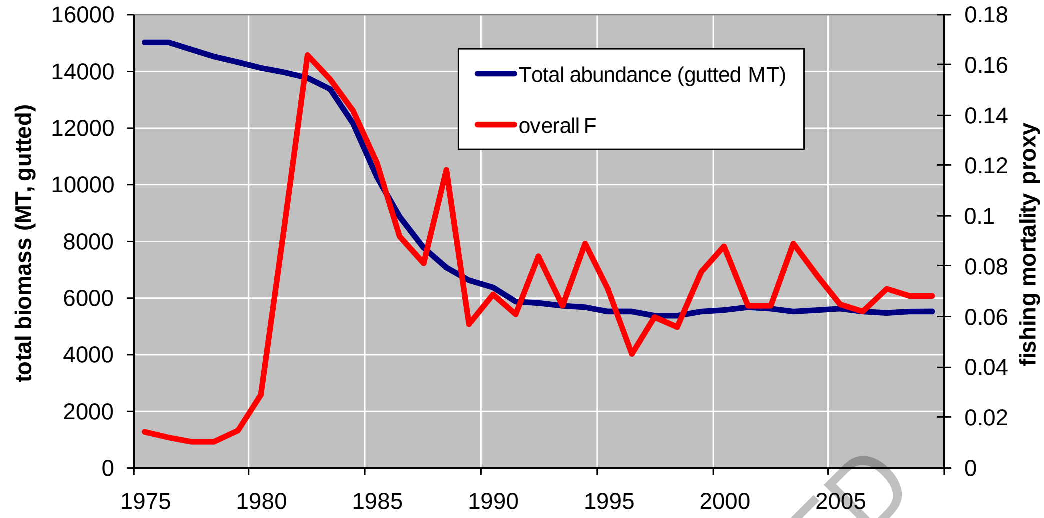


Figure 3.81. Total estimated biomass and fishing mortality, YEG base model.

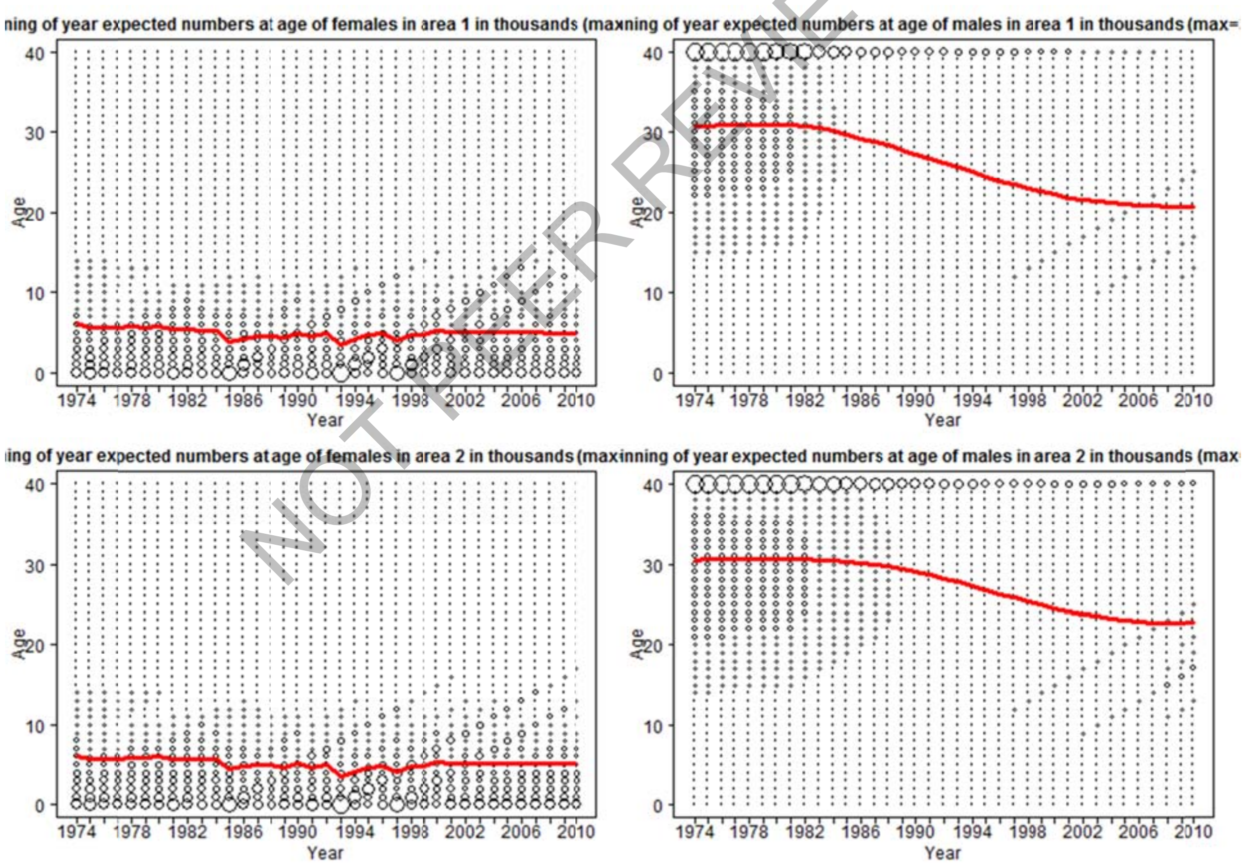


Figure 3.82. Numbers by year and age for females (left) and males (right) and for East (top) and West (bottom). Red line is the mean age. Note that this is from a previous version of the base model and the absolute numbers may be different but the pattern is largely the same.

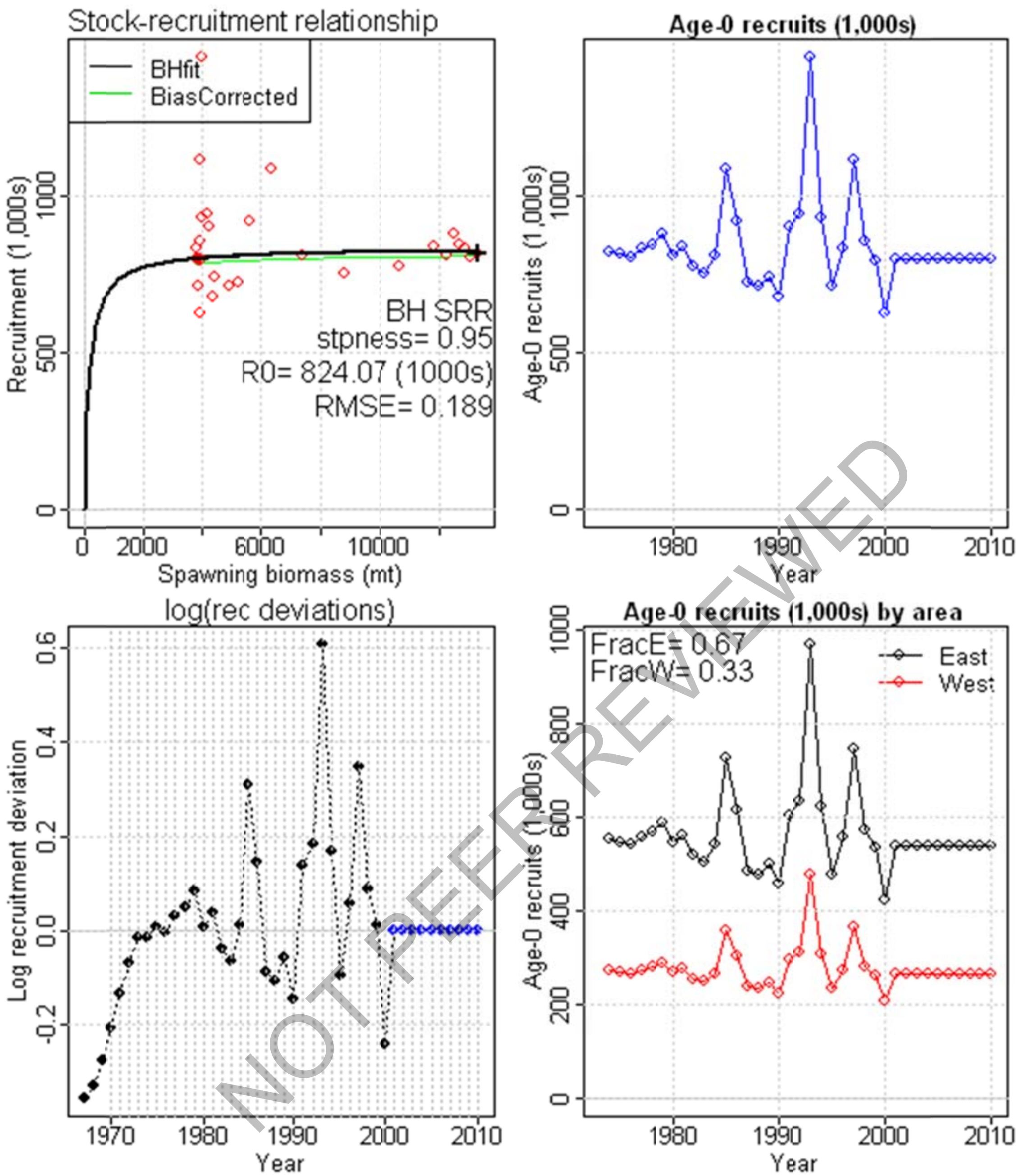


Figure 3.83. Base model stock recruit relationship, recruits, recruitment deviations and recruits by region.

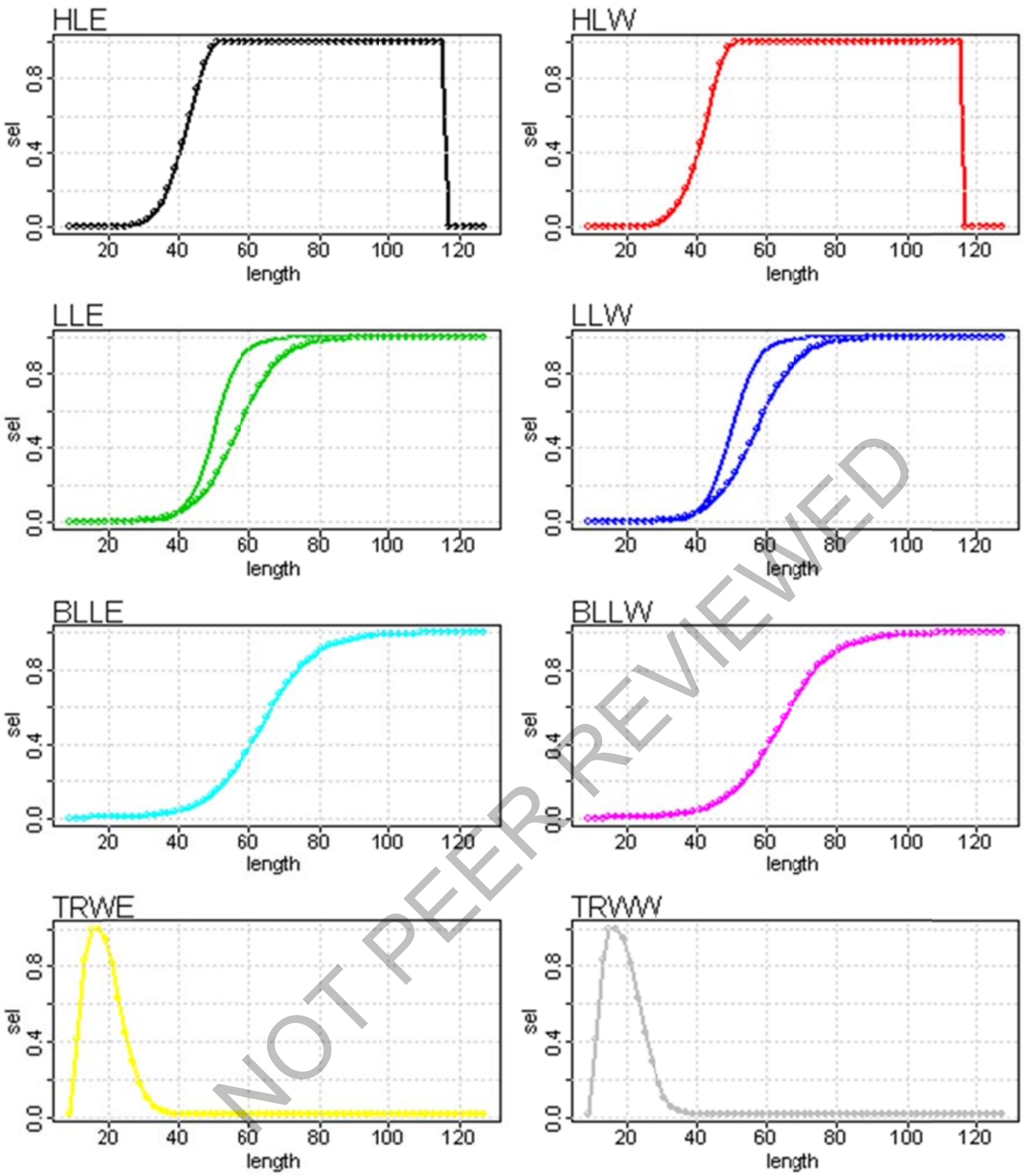


Figure 3.84. Fishery and survey selectivity patterns. Commercial handline East and West (HLE, HLE) and SEAMAP trawl surveys East and West (TRWE, TRWW) were both modeled with a double normal selectivity pattern. Commercial longline East and West, NMFS bottom longline East and West were both modeled with logistic functions. For each fleet or survey selectivity patterns were mirrored so they were jointly estimated. For the commercial longline indices, the solid lines are the 1975-2005 vectors and the dotted lines are the 1986-2009 vectors.

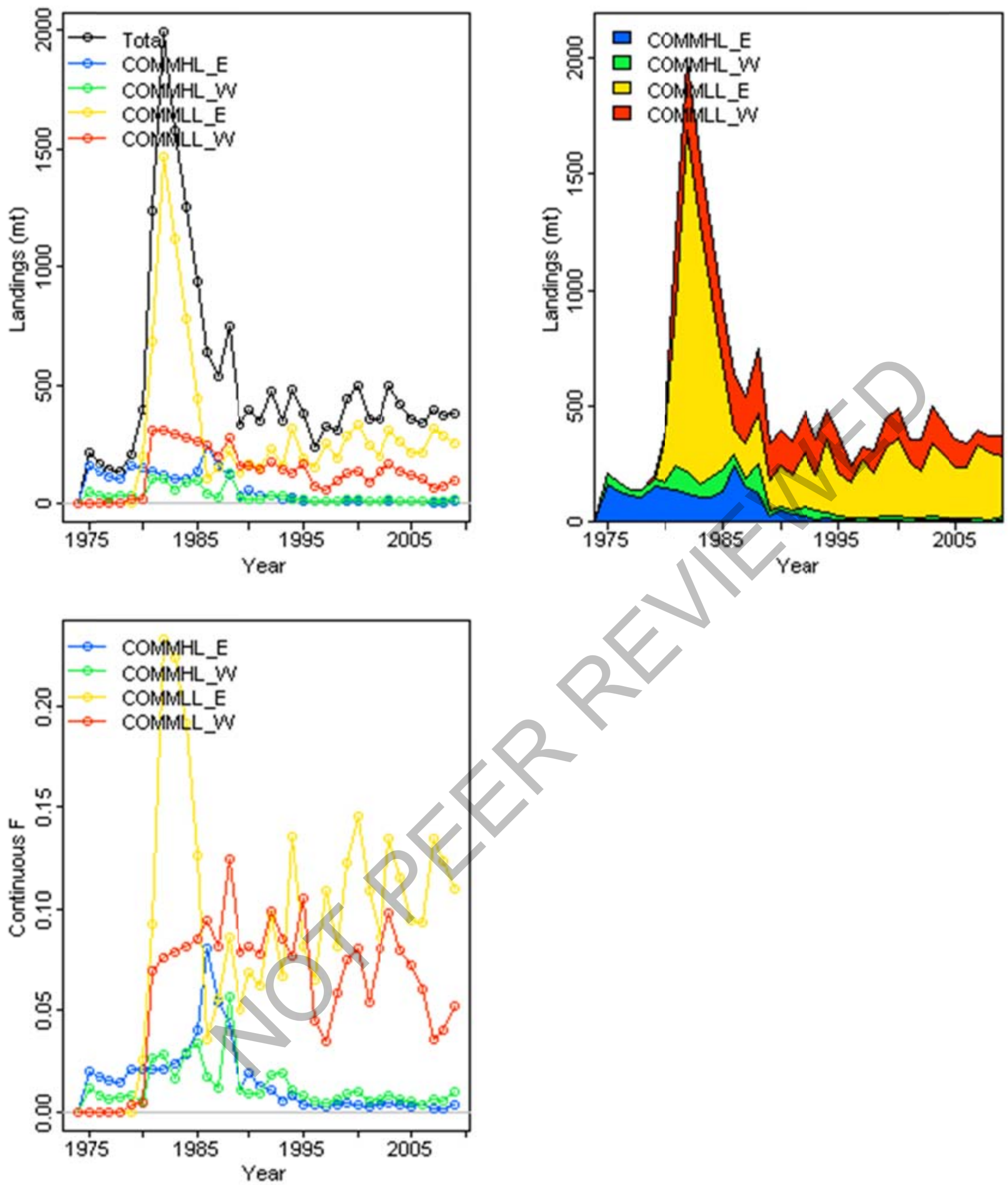


Figure 3.85. Base model landings and estimated fleet specific fishing mortality rates.

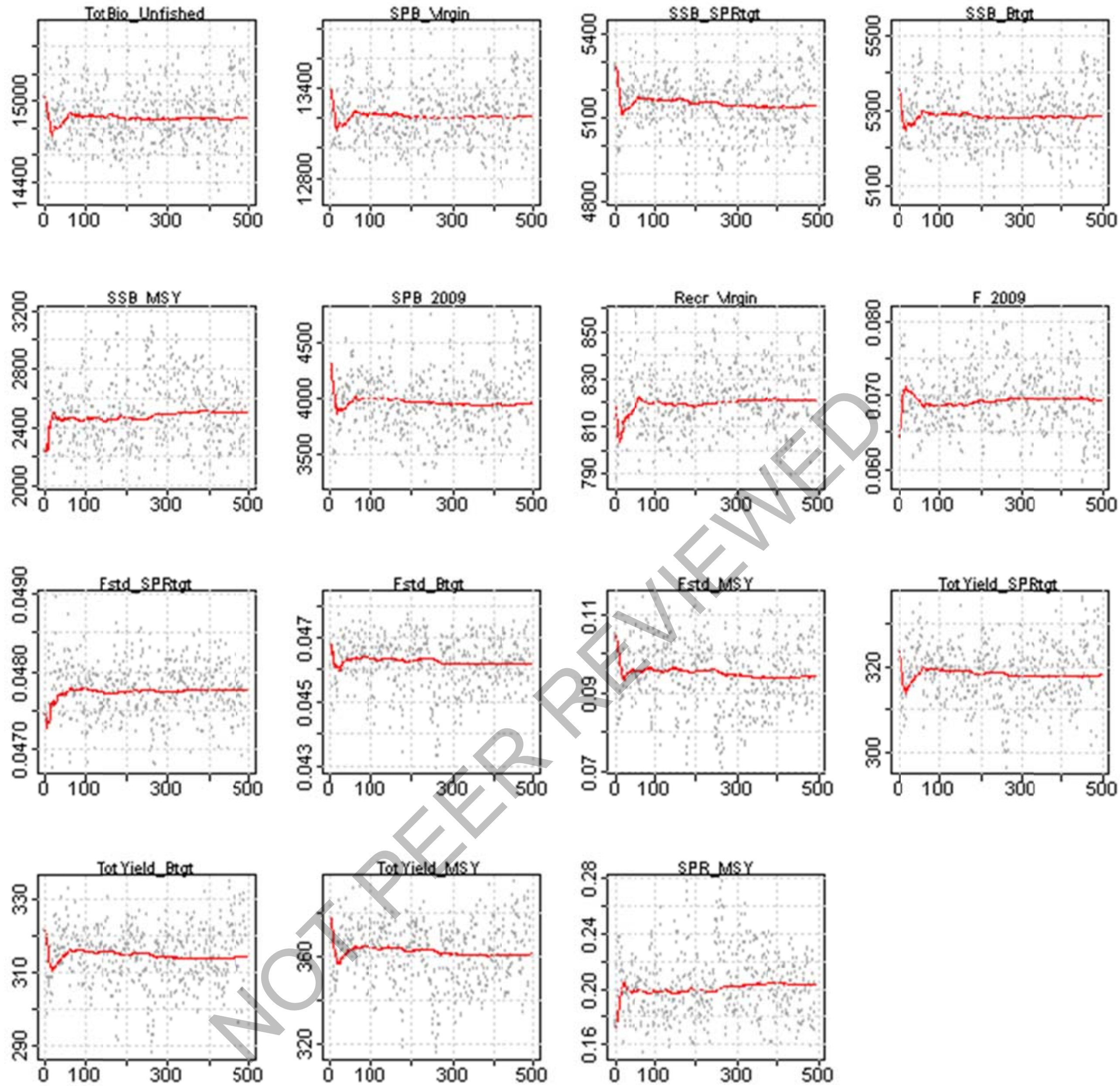


Figure 3.86. Individual points and cumulative means from MCMC runs for the BASE model. The SPR40% is the SPR reference for these runs.

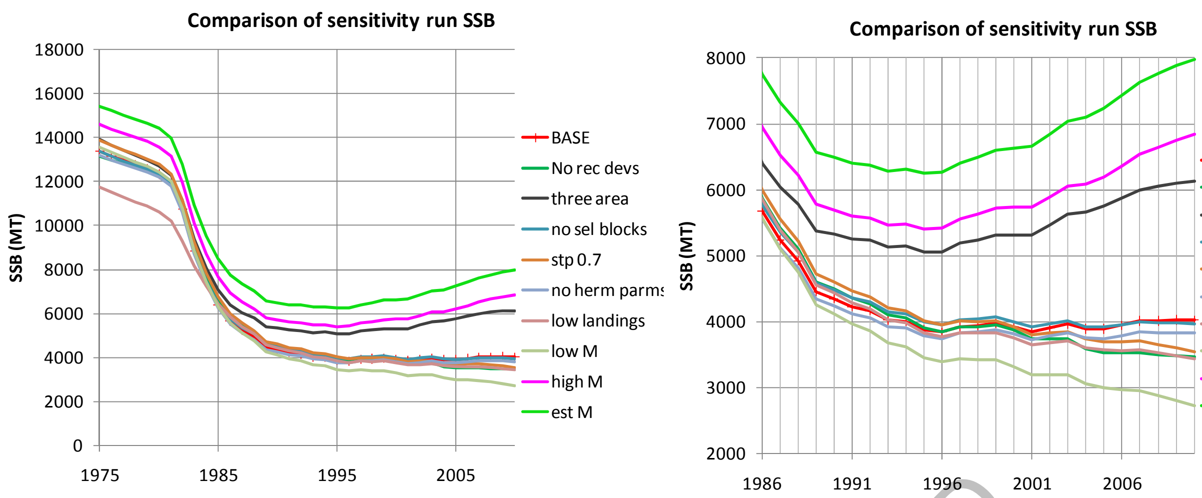


Figure 3.87. Comparison of SSB trajectories for 9 sensitivity runs.

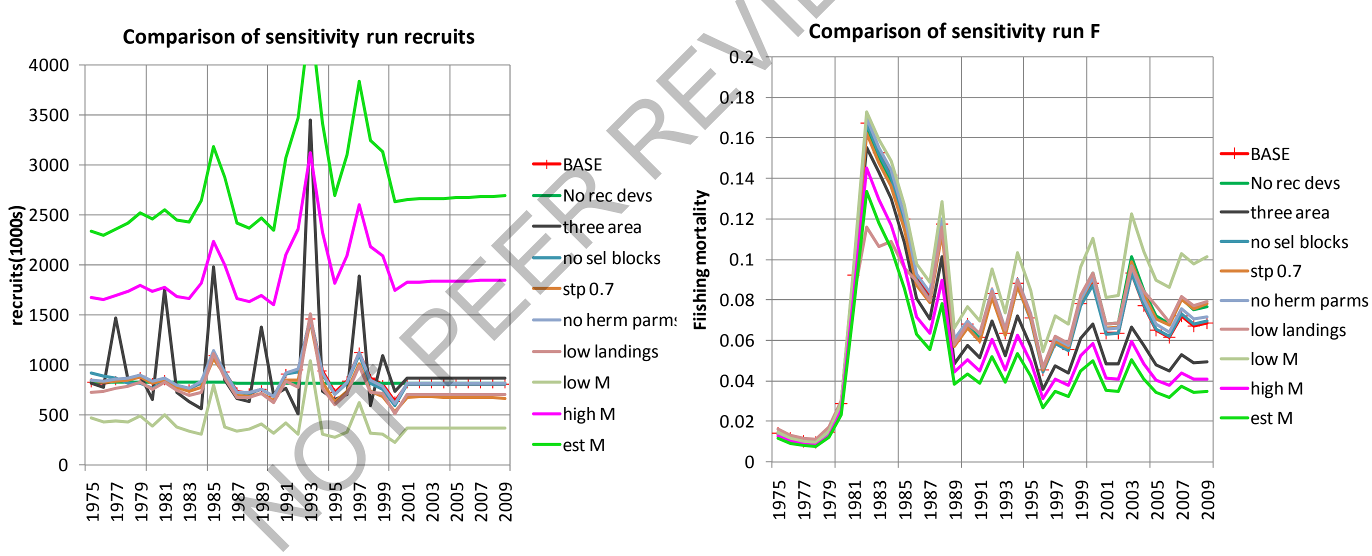


Figure 3.88. Comparison of recruitments and F trajectories for 9 sensitivity runs.

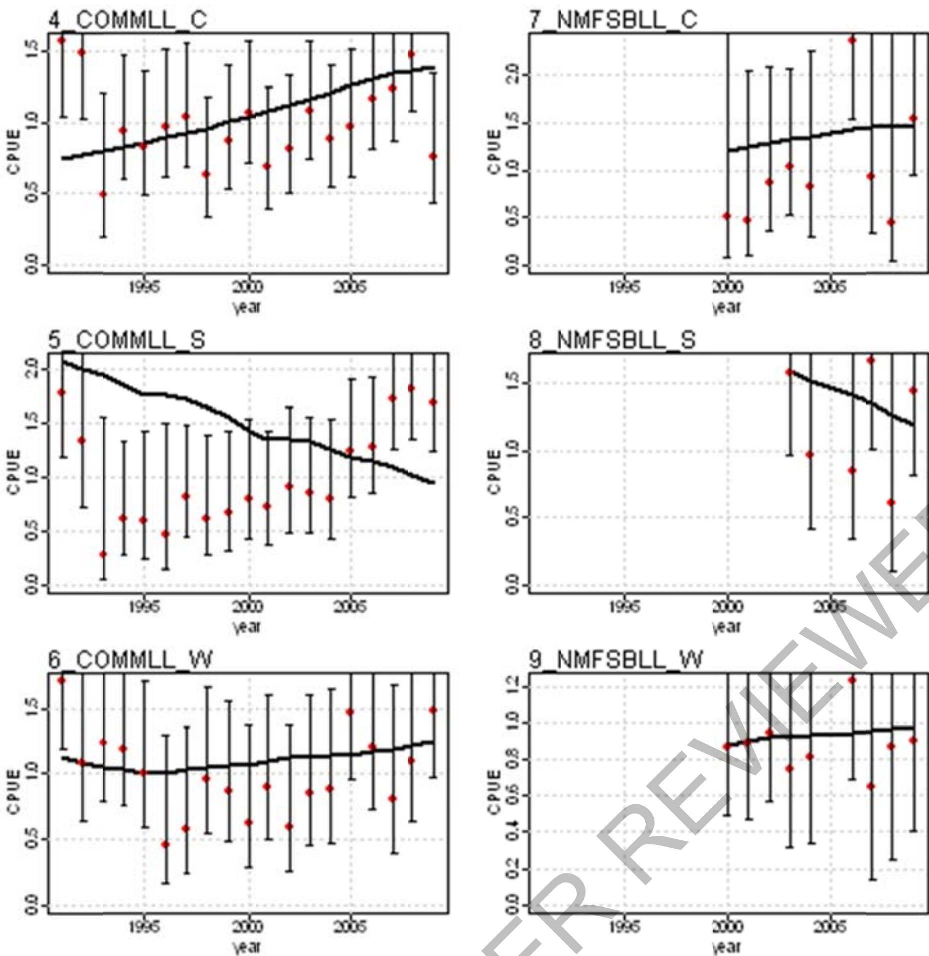


Figure 3.89. Fits to CPUE indices for the three area sensitivity run.

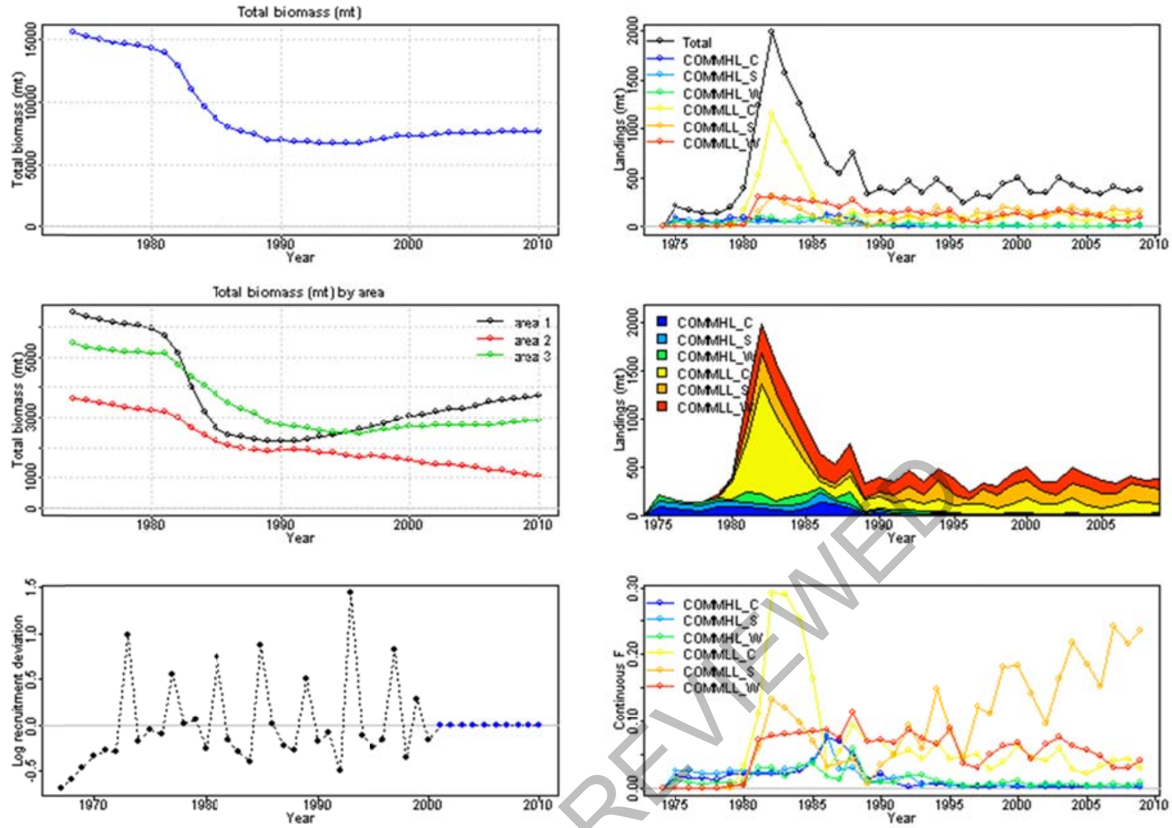


Figure 3.90. Total biomass, biomass by area, recruitment deviations, landings and instantaneous F for the three-area model.

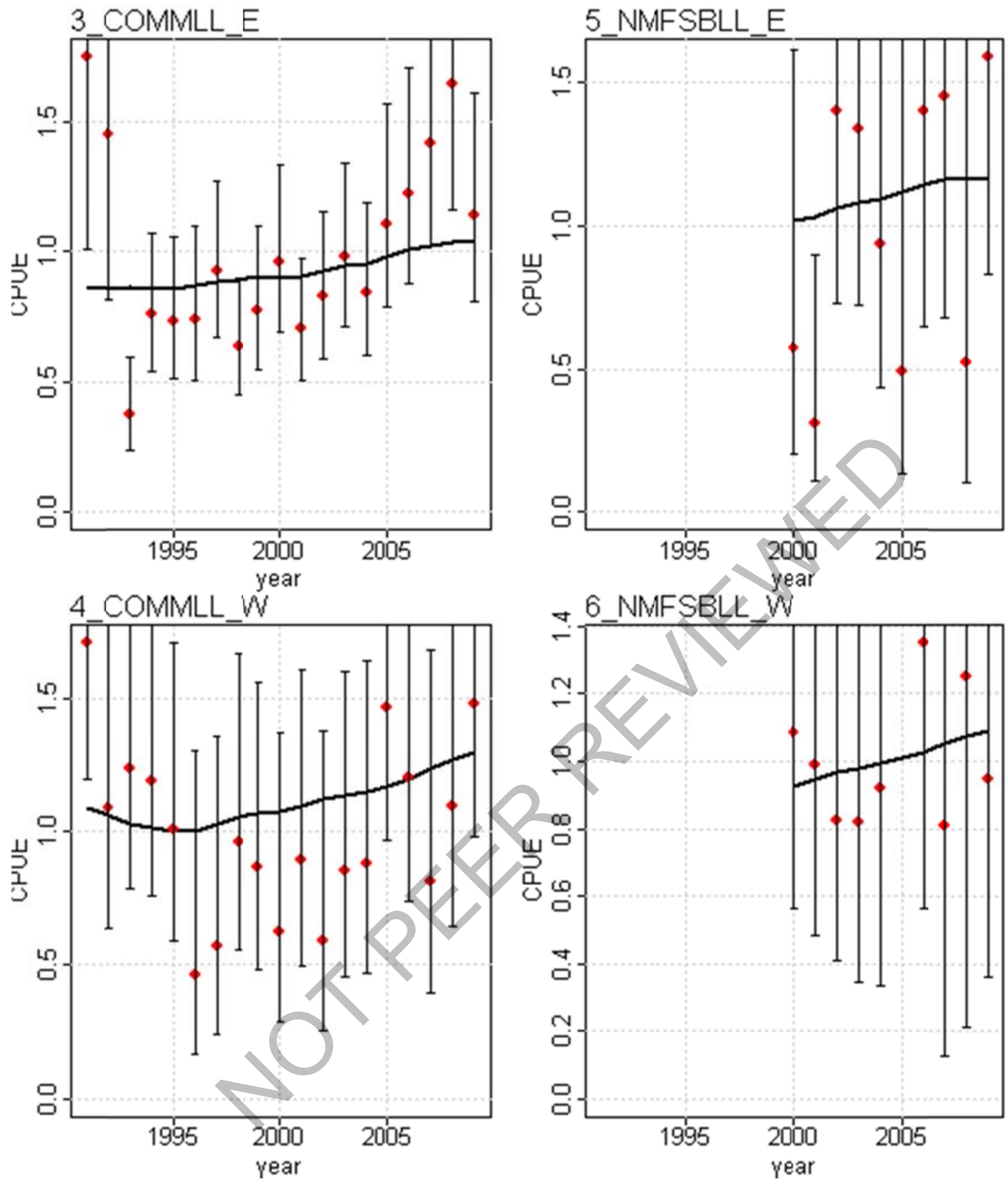


Figure 3.91. Fits to CPUE indices for the estimate M sensitivity run.

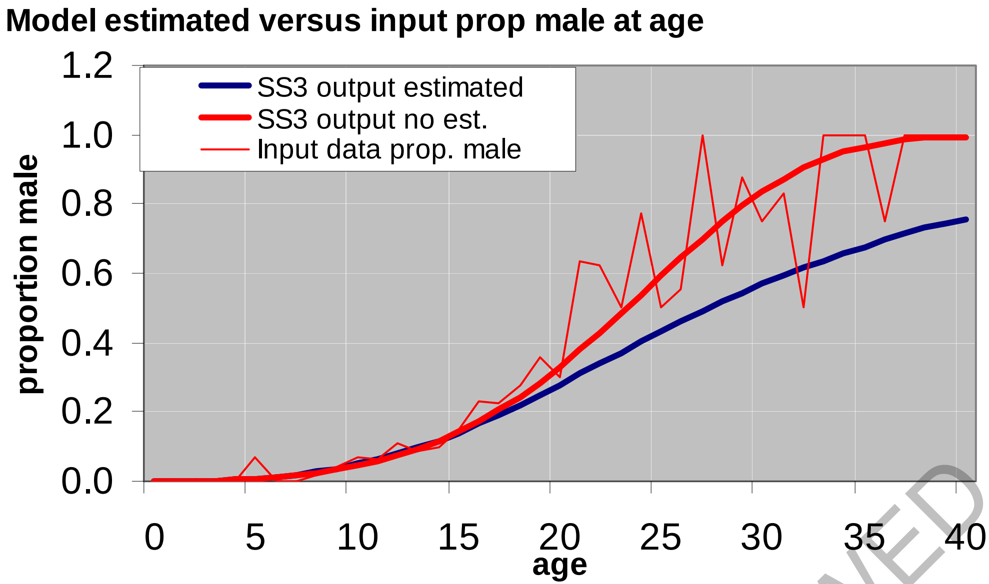


Figure 3.92. SS3 model estimated proportion of males at age (blue) versus the proportion estimated at the data workshop as initial input.

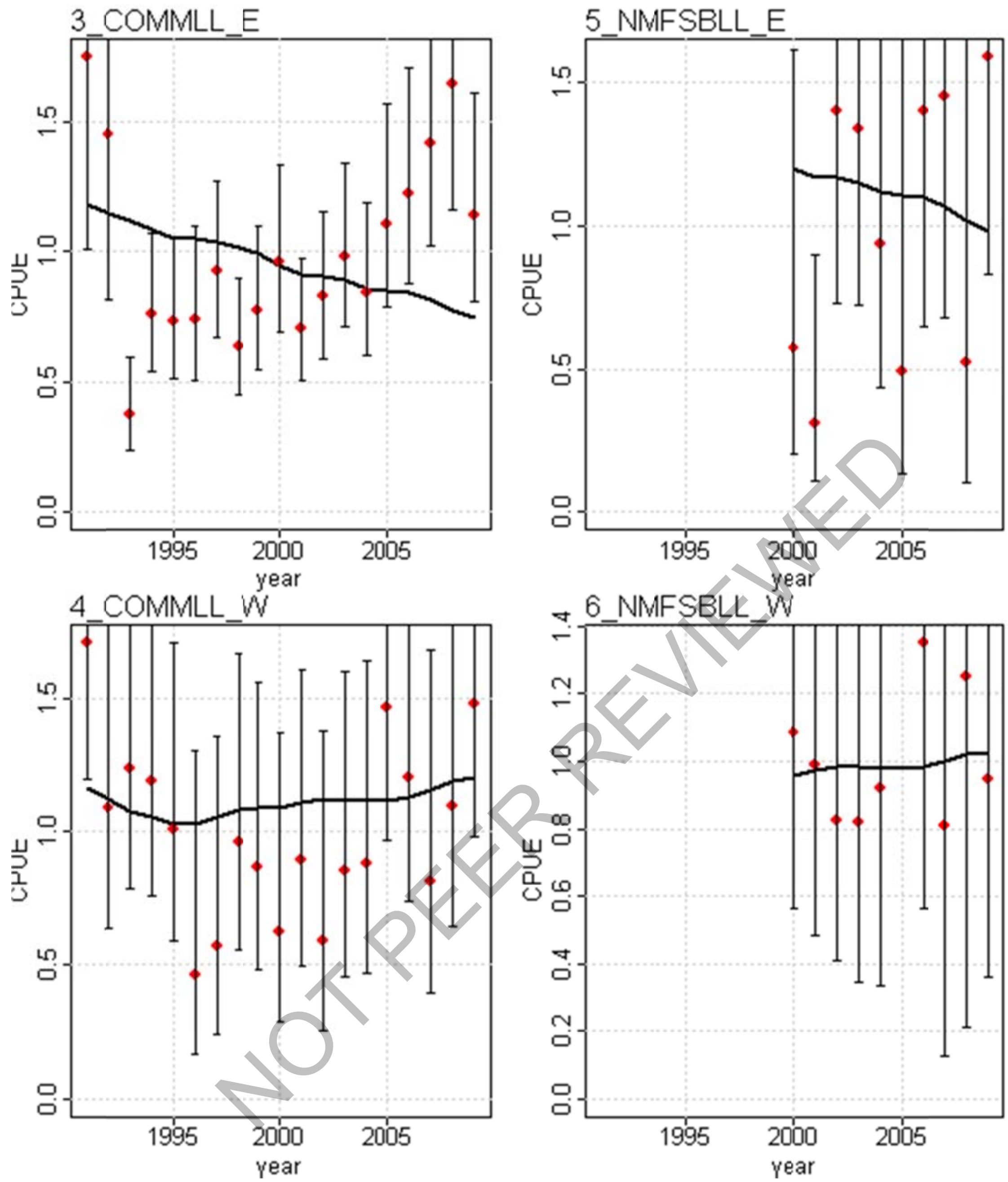


Figure 3.93. CPUE fits for sensitivity run incorporating low landings history.

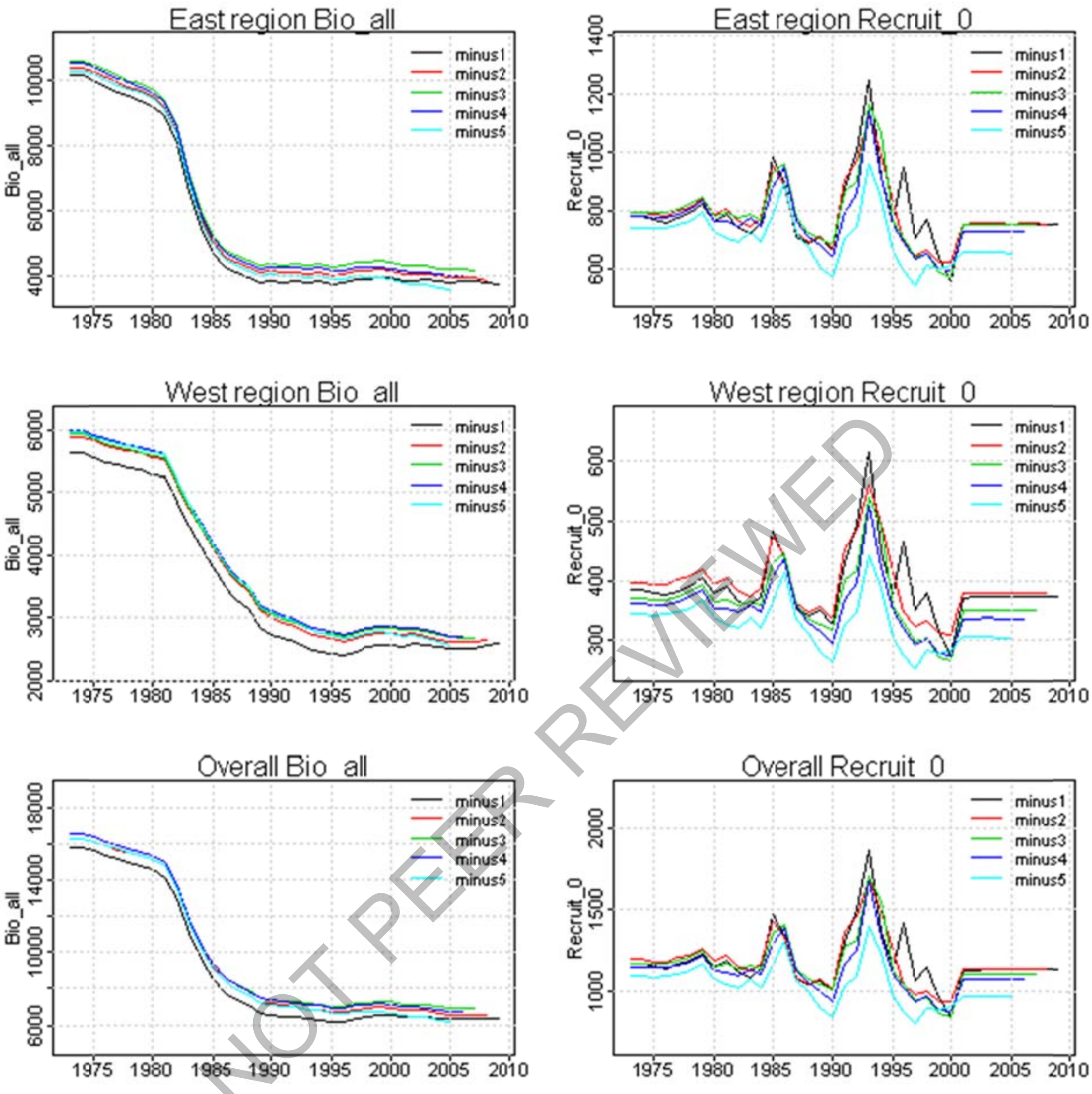


Figure 3.94. Retrospective patterns for total biomass and estimated recruits for the base model.

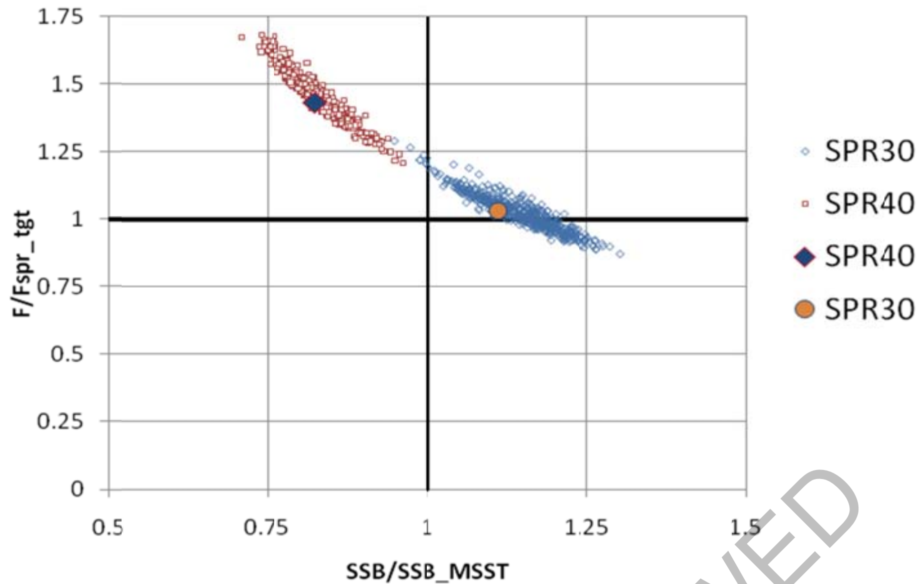


Figure 3.95. Base model uncertainty in stock status from trimmed MCMC runs (495 trimmed from 100000). Fishing mortality rate is calculated is the deterministic F2009/$F_{SPR30\%}$ or $F_{SPR40\%}$. SSB status is calculated as the deterministic SSB2009/SSB_MSST where SSB_MSST is (1-M)*$SSB_{SPR30\%}$ or $SSB_{SPR40\%}$ and M=0.073.

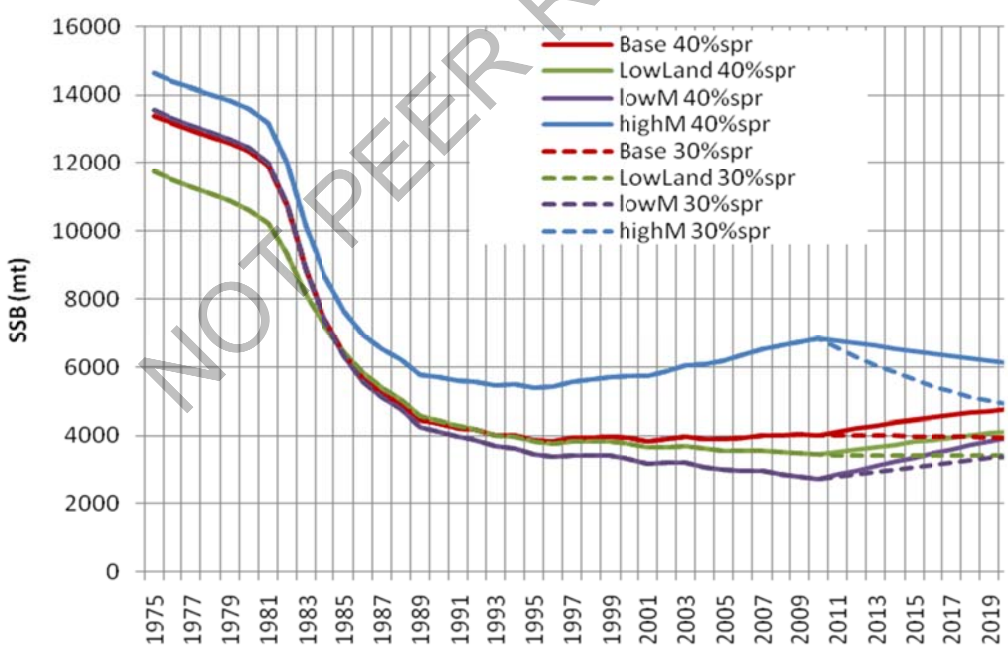


Figure 3.96. Historic and projected spawning stock biomass under for four model configurations under FSPR30 and FSPR40%. Models shown are the base model, the low landings model and the high and low M models.

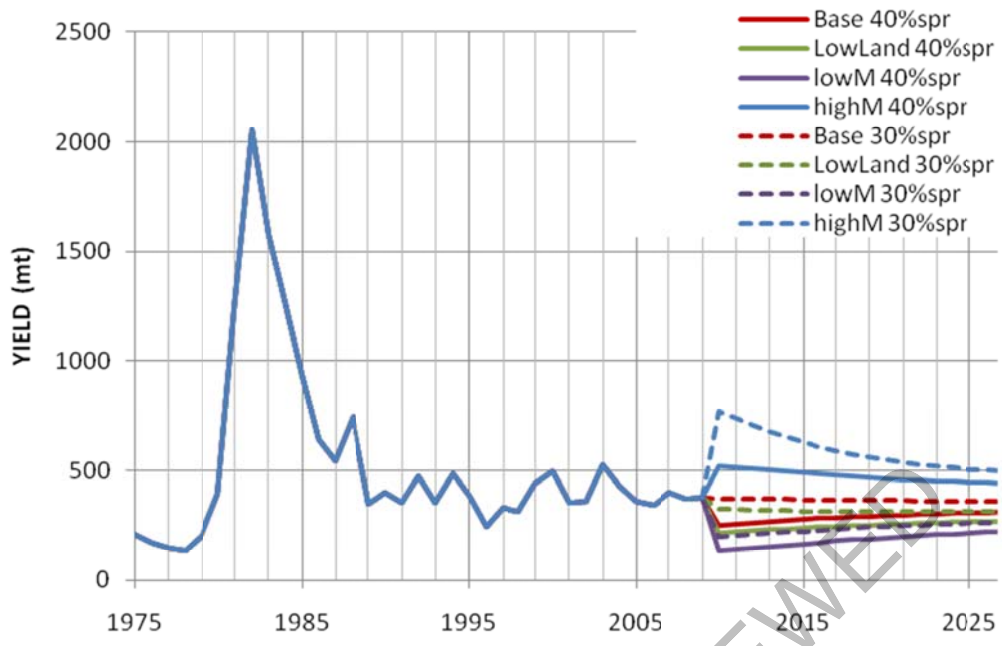


Figure 3.97. 1970-2029 historic and projected yield for four model configurations under $F_{SPR30\%}$ and $F_{SPR40\%}$. Models shown are the base model, the low landings model and the high and low M models.

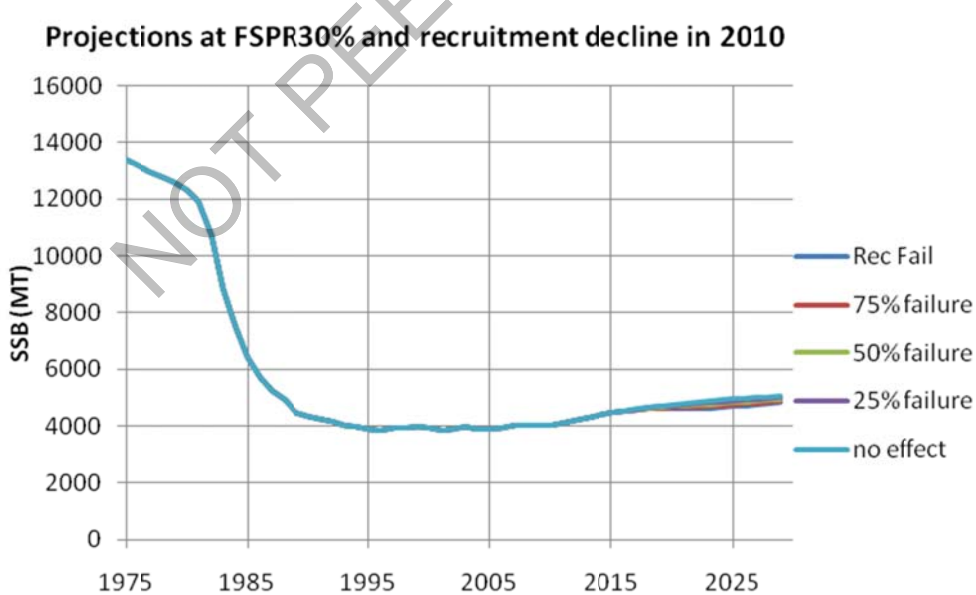


Figure 3.98. Base model projections of SSB when fished at Fspr30% and the base model under recruitment decline in 2010 scenarios.

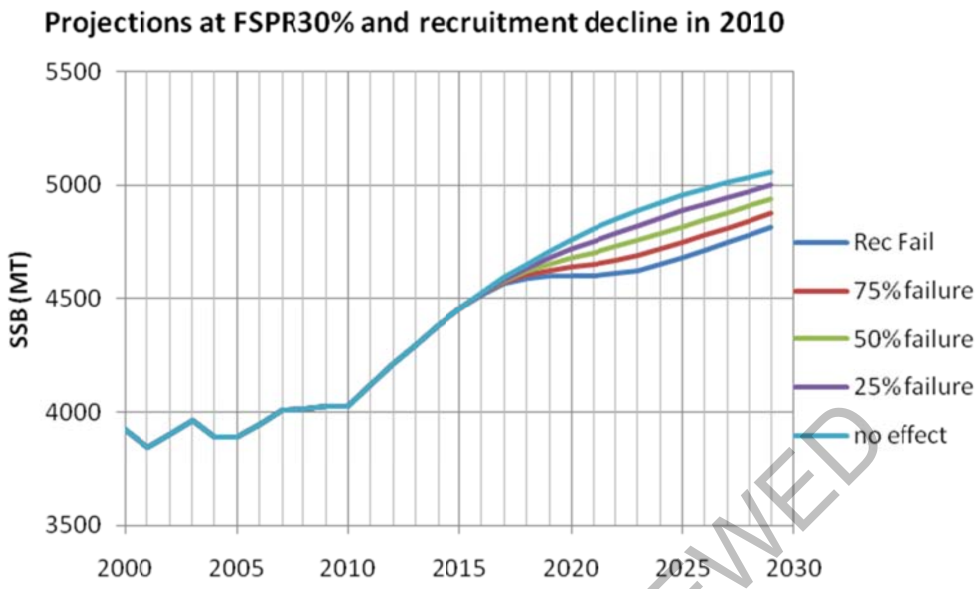


Figure 3.99. Base model projections of SSB when fished at Fspr30% under recruitment decline in 2010 scenarios, years expanded.

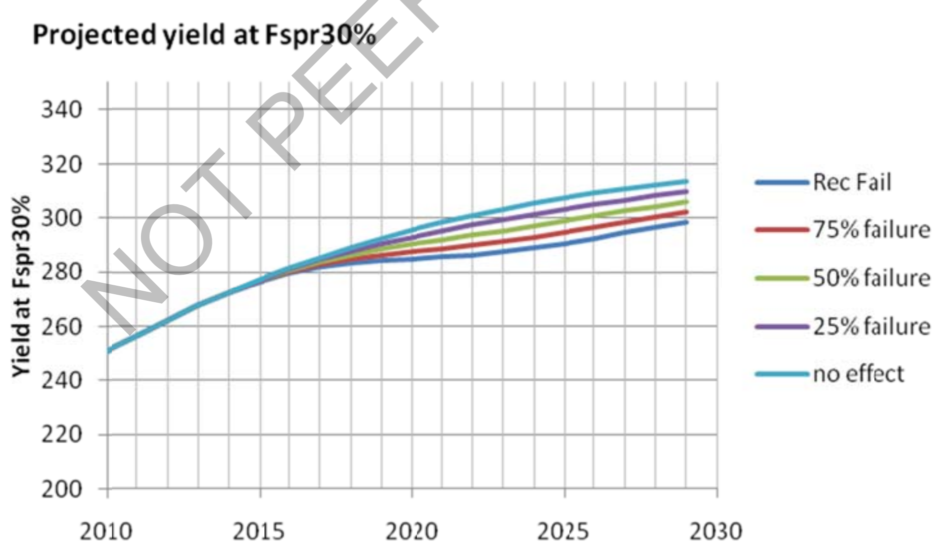


Figure 3.100. Base model projected yield at Fspr30% and the base model under recruitment decline in 2010 scenarios, years expanded.

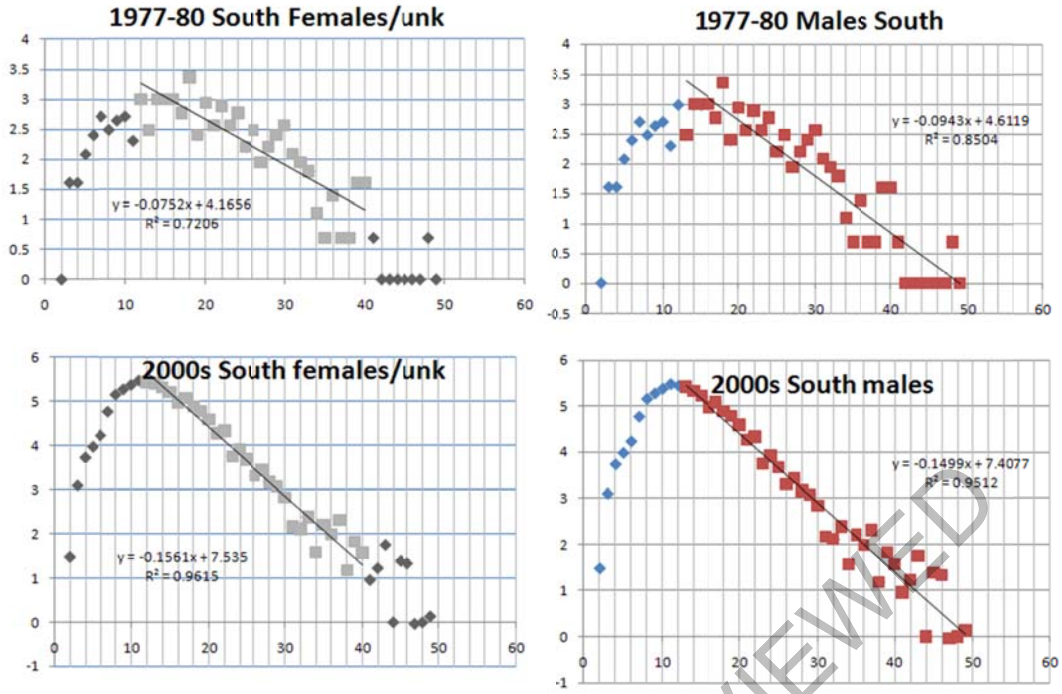


Figure 3.101. Cross-sectional catch curves for early (1977-1980) and recent (2000s) yellowedge grouper for the South region YEG for South females and unknown sex 1977-1980

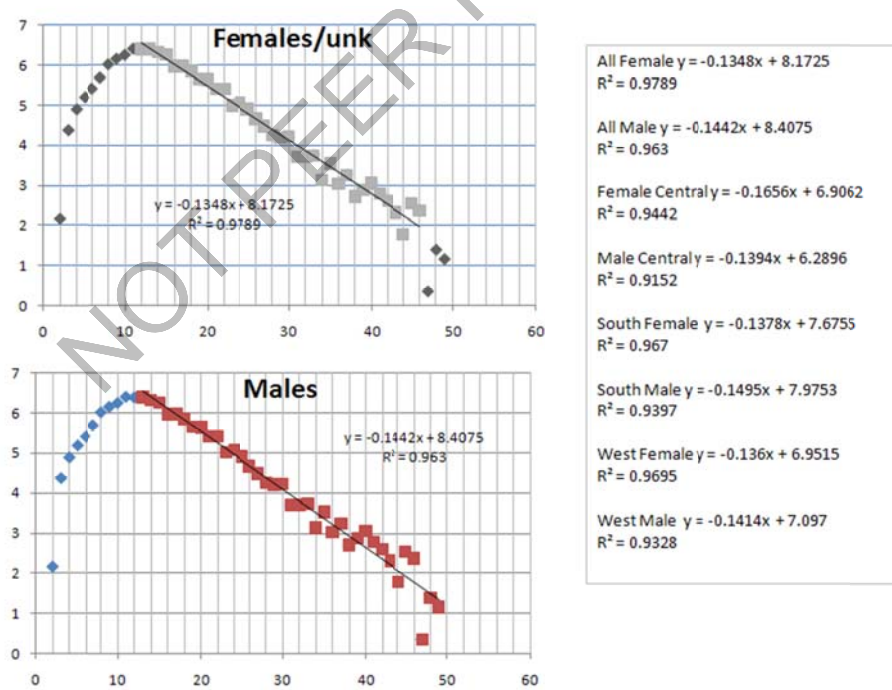


Figure 3.102. Cross-sectional catch curves for early (1977-1980) and recent (2000s) yellowedge grouper for the South region YEG for South females and unknown sex 1977-1980 Recent (2000s) catch curves

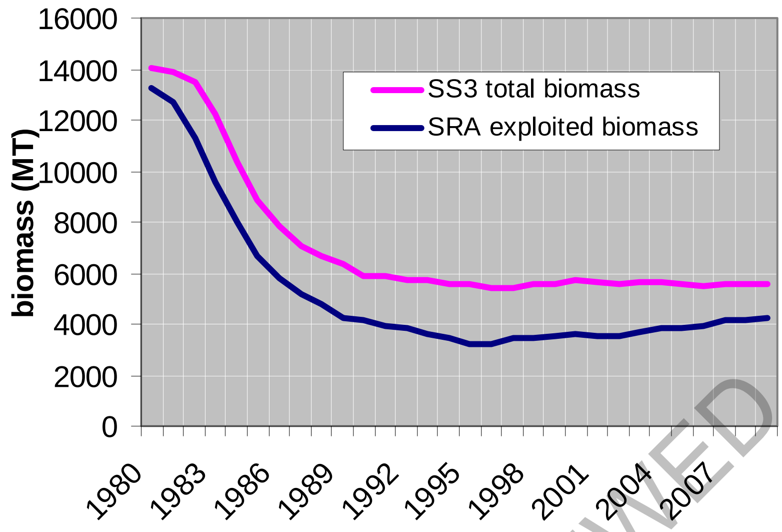


Figure 3.103. Comparison of biomass trajectories.

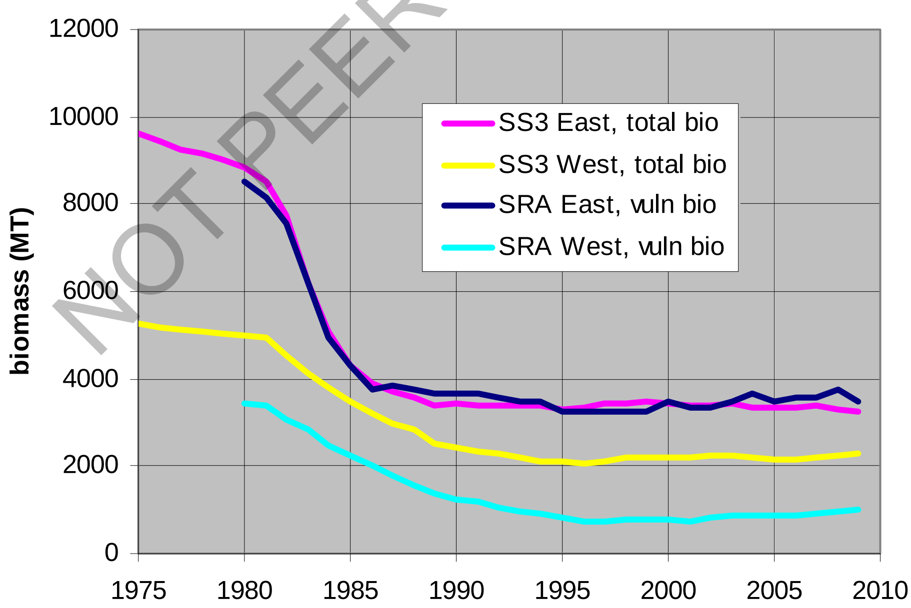


Figure 3.104. Comparison of biomass trajectories by region.

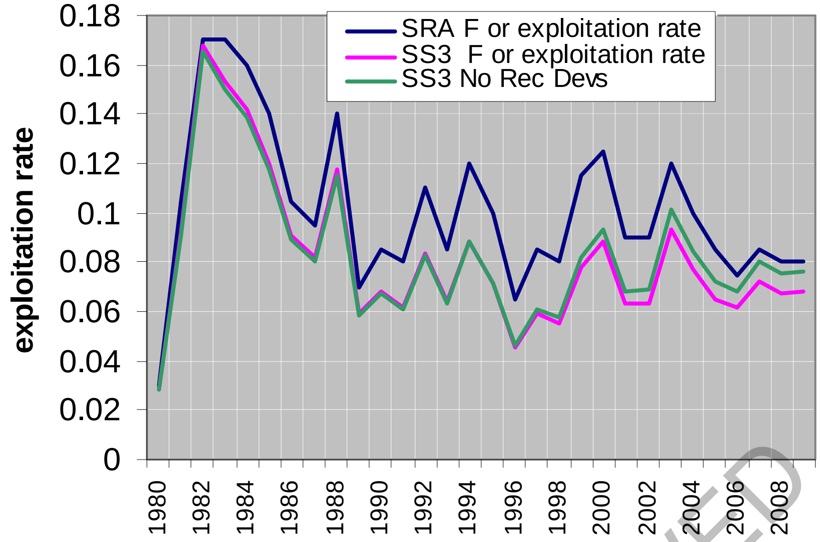


Figure 3.105. Estimated overall exploitation rates for SRA (all area model) and SS3 (combined across both areas).

SEDAR

Southeast Data, Assessment, and Review

SEDAR 22

Gulf of Mexico Yellowedge Grouper

SECTION IV: Research Recommendations

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

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY WORKING GROUP

- The LH DW recommends directed studies for better estimation of onset of maturity, batch fecundity by age, spawning frequency by age, and spawning duration by age.
- Recommend the fishery-independent longline survey enhance collection of sediment/habitat data to allow post-stratification. Increased resolution of spatial population structure is important given the demographic differences (east and western GOM) noted. There is the potential for over-exploitation of sub-populations within the larger GOM stock.
- Monitor for possibility of increased discards/high-grading as ITQs (catch shares) is undertaken as management approach.
- Since preliminary genetic research and demographic comparisons by Cook (2007) found differences between regions in the GOM the LH DW recommends additional genetic research on population genetics throughout the GOM be conducted.
- Improve information on stock structure/rates of possible exchange between Gulf and Atlantic, including pathways for larval transport.
- Age Johnson historical otoliths collected off Florida during 1982-1983. Use otolith age results to support ages determined using otolith weight to predict age.

1.2 COMMERCIAL STATISTICS WORKING GROUP

No recommendations were provided.

1.3 RECREATIONAL STATISTICS WORKING GROUP

No recommendations were provided.

1.4 INDICES OF ABUNDANCE WORKING GROUP

In both the fishery-independent surveys presented above, precision in abundance indices could be improved by increasing the number of samples at least two- to three-fold.

<u>Research recommendations for fishery dependent data:</u>

1.) Expand observer coverage to provide a subsample adequate to construct indices of abundance (Pelagic Longline Observer Progam has 5-8% coverage). Observer data provides finer spacial resolution and a more accurate measure of CPUE. It also provides size frequency and discard information that is currently unavailable in the self-reported dataset. Current observer coverage is inadequate for the construction of indices of abundance.

2.) Self logbook data should be restructured to collect data on a per set basis rather than per trip. This would allow for a more accurate calculation of CPUE. Data subsetting (determining targeting) would be vastly improved with set-based data.

2. ASSESSMENT WORKSHOP RESEARCH RECOMMENDATIONS

No specific research recommendations were provided.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

To be added following the Review Workshop.