SEDAR
Southeast Data, Assessment, and Review

SEDAR 85
Stock Assessment Report

Gulf of Mexico Yellowedge Grouper

November 2023

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

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SEDAR

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SECTION I: Introduction

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Overview

SEDAR 85 addressed the stock assessment for Gulf of Mexico yellowedge grouper. The assessment process was completed inhouse by the SEFSC.

The Stock Assessment Report is organized into 2 sections. Section I – Introduction contains a brief description of the SEDAR Process, Assessment and Management Histories for the species of interest, and the management specifications requested by the Cooperator. Section II is the Assessment Process report. This section details the assessment model, as well as documents any data recommendations that arise for new data sets presented during this assessment process, or changes to data sets used previously.

The final Stock Assessment Report (SAR) for Gulf of Mexico yellowedge grouper was disseminated to the public in November 2023. The Council's Scientific and Statistical Committee (SSC) will review the SAR for its stock. The SSCs are tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch). The Gulf of Mexico Fishery Management Council's SSC will review the assessment at its February 2024 meeting, followed by the Council receiving that information at its April 2024 meeting. Documentation on SSC recommendations is not part of the SEDAR process and is handled through each Council.

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; a representative from the Highly Migratory Species Division of NOAA Fisheries, and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR workshops are public meetings organized by SEDAR staff and the lead Cooperator. 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.

2 MANAGEMENT OVERVIEW

2.1 Fishery Management Plans and Amendments

Original GMFMC FMP:

The Reef Fish Fishery Management Plan was implemented in November 1984. The regulations, designed to rebuild declining reef fish stocks, included: (1) prohibitions on the use of fish traps, roller trawls, and powerhead-equipped spear guns within an inshore stressed area; (2) a minimum size limit of 13 inches total length (TL) for red snapper with the exceptions that for- hire boats were exempted until 1987 and each angler could keep 5 undersize fish; and, (3) data reporting requirements.

GMFMC FMP Amendments affecting Yellowedge Grouper:

Description of Action	FMP/Amendment	Effective Date
Set an 11.0 million-pound commercial quota for groupers, with the commercial quota divided into a 9.2 million pound shallow-water grouper quota and a 1.6 million-pound deep-water grouper quota. Established a longline and buoy gear boundary and expanded the stressed area to the entire Gulf coast. Established a commercial reef fish permit.	Amendment 1	1990
Established a moratorium on the issuance of new reef fish permits for a maximum period of three years; established an allowance for permit transfers	Amendment 4	1992
Created an Alabama special management zone (SMZ) with fishing gear restricted to no more than three hooks within the SMZ, and a framework procedure for future specification of SMZs. Established restrictions on the use of fish	Amendment 5	1994

traps in the Gulf of Mexico EEZ, and implemented a three-year moratorium on the use of fish traps by creating a fish trap endorsement. Required that finfish be landed head and tails intact		
Established reef fish dealer permitting and record keeping.	Amendment 7	1994
Extended the reef fish permit moratorium through December 31, 1995 and allowed collections of commercial landings data for initial allocation of individual transferable quota (ITQ) shares. Established historical captain status for purposes of ITQ allocation.	Amendment 9	1994
Attempted to establish an ITQ system, which was then repealed by Congress	Amendment 8	1995
Implemented a new commercial reef fish permit moratorium for no more than five years or until December 31, 2000, permitted dealers can only buy reef fish from permitted vessels and permitted vessels can only sell to permitted dealers, established a charter and headboat reef fish permit.	Amendment 11	1996
Initiated a 10-year phase-out on the use of fish traps in the EEZ from February 7, 1997 to February 7, 2007, after which fish traps would be prohibited, and prohibited the use of fish traps west of Cape San Blas, Florida.	Amendment 14	1997
Prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps. Established 2-tier red snapper license system (Class 1 & 2).	Amendment 15	1998

(1) The possession of reef fish exhibiting the condition of trap rash on board any vessel with a reef fish permit that is fishing spiny lobster or stone crab traps is prima facie evidence of illegal trap use and is prohibited except for vessels possessing a valid fish trap endorsement; (2) that NOAA Fisheries establish a system design, implementation schedule, and protocol to require implementation of a vessel monitoring system (VMS) for vessels engaged in the fish trap fishery, with the cost of the vessel equipment, installation, and maintenance to be paid or arranged by the owners as appropriate; and, (3) that fish trap vessels submit trip initiation and trip termination reports. Prior to implementing this additional reporting requirement, there will be a one-month fish trap inspection/compliance/education period, at a time determined by the NOAA Fisheries Regional Administrator and published in the *Federal Register*. During this window of opportunity, fish trap fishermen will be required to have an appointment with NMFS enforcement for the purpose of having their trap gear, permits, and vessels available for inspection. The disapproved measure was a proposal to prohibit fish traps south of 25.05 degrees north latitude beginning February 7, 2001. The status quo 10-year phase-out of fish traps in areas in the Gulf EEZ is therefore maintained.	Amendment 16A	1998
Extended the commercial reef fish permit moratorium for another five years, from its previous expiration date of December 31, 2000 to December 31, 2005	Amendment 17	2000

Prohibited vessels with commercial harvests of reef fish aboard from also retaining fish caught under recreational bag and possession limits. Vessels with both for-hire and commercial permits were limited to the minimum crew size outlined in its Certificate of Inspection when fishing commercially. Prohibited the use of reef fish other than sand perches for bait. Required commercially permitted reef fish vessels to be equipped with VMS.	Amendment 18A	2006
Established two marine reserve areas off the Tortugas area and prohibits fishing for any species and anchoring by fishing vessels inside the two marine reserves.	Amendment 19	2002
Established a 3-year moratorium on the issuance of new charter and headboat vessel permits in the recreational for hire fisheries in the Gulf EEZ. Allowed transfer of permits. Required vessel captains/owners to participate in data collection efforts.	Amendment 20	2002
Continues the Madison-Swanson and Steamboat Lumps marine reserves for an additional 6 years, until July 2010. Modified the fishing restrictions within the reserves to allow surface trolling during May – October.	Amendment 21	2004
Established bycatch reporting methodologies for the reef fish fishery.	Amendment 22	2005
Extended the commercial reef fish permit moratorium indefinitely. Established a permanent limited access system for the commercial fishery for Gulf reef fish. Permits issued under the limited access system are renewable and transferable.	Amendment 24	2005
Extended the recreational for-hire reef fish permit moratorium indefinitely. Established a limited access system on for-hire reef fish and CMP permits. Permits are renewable and transferable in the same manner as currently prescribed for such permits.	Amendment 25	2006
Requires all commercial and recreational reef fish fisheries to use non-stainless steel circle hooks when using natural baits, as well as venting tools and dehooking devices.	Amendment 27	2008

Established an individual fishing quota (IFQ) system for the commercial grouper and tilefish fishery, which began January 1, 2010.	Amendment 29	2009
Established annual catch limits (ACLs) and accountability measures (AMs) for the commercial and recreational fisheries. The Steamboat Lumps and Madison-Swanson fishing area restrictions were continued indefinitely. For the recreational sector, the amendment reduces the aggregate grouper bag limit from five fish to four. Finally, the amendment requires that all vessels with federal commercial or charter reef fish permits must comply with the more restrictive of state or federal reef fish regulations when fishing in state waters.	Amendment 30B	2009
Longline endorsement requirement - Vessels must have average annual reef fish landings of 40,000 pounds gutted weight or more from 1999 through 2007. The longline boundary in the eastern Gulf is extended from the 20-fathom depth contour to the 35-fathom depth contour from June - August. Vessels are limited to 1000 hooks of which no more than 750 of which can be rigged for fishing or fished.	Amendment 31	2010

GMFMC Regulatory Amendments:

August 1999:

Implemented June 19, 2000- Established two marine reserves (Madison-Swanson and Steamboat Lumps) on areas suitable for gag and other reef fish spawning aggregations sites that are closed year-round to fishing for all species under the Council’s jurisdiction. The two sites cover 219 square nautical miles near the 40-fathom contour, off west central Florida.

October 2005:

Implemented January 2006 – Established an aggregate commercial trip limit of 6,000 pounds gutted weight for deep-water grouper and shallow-water grouper combined.

March 2006:

Implemented July 2006 - Prohibits captain and crew of for-hire vessels from retaining grouper when under charter.

August 2010:

Effective January 2011- Provides a more specific definition of buoy gear by limiting the number of hooks, limiting the terminal end weight, restricting materials used for the line, restricting the length of the drop line, and where the hooks may be attached. In addition, the Council requested that each buoy must display the official number of the vessel (USCG documentation number or state registration number) to assist law enforcement in monitoring the use of the gear, which requires rulemaking.

2.2 Emergency and Interim Rules

December 17, 2002- The National Marine Fisheries Service published an emergency rule that extended certain permit-related deadlines contained in the final rule implementing the for-hire (charter vessel/headboat) permit moratorium for reef fish and coastal migratory pelagic fish in the Gulf of Mexico (Gulf). This emergency rule was implemented because the final rule implementing the for-hire permit moratorium contained an error regarding eligibility that needed to be resolved as soon as possible. In addition, the regulations that implemented the moratorium required all for-hire vessels operating in the Gulf reef fish or coastal migratory pelagic fisheries in federal waters to have a valid "moratorium permit," as opposed to the prior open access charter permit, beginning December 26, 2002.

March 3, 2005 – An emergency rule established a commercial trip limit of 10,000 pounds for all grouper combined; reduce the trip limit to 7,500 pounds when 50 percent of either the shallow-water grouper or red grouper quota was reached; and reduce the trip limit to 5,500 pounds when 75 percent of either the shallow-water grouper or red grouper quota was reached. Fifty percent of the quota was reached on June 9 and trip limits were reduced to 7,500 pounds. The deep- water grouper quota was reached on June 23 and that component was closed.

April 1, 2005 - The National Marine Fisheries Service published an emergency rule to reopen the application process for obtaining Gulf charter vessel/headboat permits under moratorium. Permit owners who received their Gulf charter vessel/headboat permits under the moratorium, or a letter of eligibility for such a permit, need not reapply. This reopening is extended to historical participants in the fishery who, for whatever reason, failed to apply during the moratorium application period.

August 9, 2005 - NOAA's National Marine Fisheries Service (NMFS) published a temporary rule in the Federal Register implementing management measures for the recreational grouper fishery in the exclusive economic zone of the Gulf of Mexico, as requested by the Gulf of Mexico Fishery Management Council, to reduce overfishing of red grouper. This rule establishes a seasonal closure of the recreational fishery for all Gulf grouper species from November 1 through December 31, 2005 and reduces both the recreational bag limit for red grouper and the aggregate grouper bag limit. The intended effects are to reduce overfishing of red grouper in the Gulf of Mexico and to minimize potential adverse impacts on other grouper stocks that could result from a shift in fishing effort from red grouper to other grouper species. (A legal challenge resulted in a ruling that the November 1 through December 31 seasonal closure could, under an interim rule, only be applied to the stock that was undergoing overfishing, i.e., red grouper.)

January 1, 2009 - NOAA's National Marine Fisheries Service (NOAA Fisheries Service) has published a final rule implementing interim measures in the Gulf of Mexico reef fish fishery. The rule published in the Federal Register on December 2, 2008, and the measures are effective January 1, 2009. The Gulf of Mexico Fishery Management Council (Council) requested a temporary rule be effective at the beginning of 2009 to address overfishing of gag, as well as red snapper, greater amberjack, and gray triggerfish until more permanent measures can be implemented through Amendment 30B to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. The Council developed Amendment 30B to end overfishing of gag, revise shallow-water grouper management measures in light of new information on gag and red grouper stocks, and improve the effectiveness of federal management measures. NOAA Fisheries Service is presently reviewing Amendment 30B with subsequent rulemaking occurring later in 2009. New Management Measures The interim rule will: 1) Establish a two-fish gag recreational bag limit (recreational grouper aggregate bag limit will remain at 5 fish); 2) Adjust the recreational closed season for gag to February 1 through March 31 (the recreational closed season for red and black groupers will remain February 15 to March 15); 3) Establish a 1.32 million pound commercial quota for gag; and 4) Require operators of federally permitted Gulf of Mexico commercial and for-hire reef fish vessels to comply with the more restrictive of federal or state reef fish regulations when fishing in state waters for red snapper, greater amberjack, gray triggerfish, and gag.

May 18, 2009 - NOAA Fisheries Service implemented an emergency rule, effective May 18, 2009, through October 28, 2009, to reduce the sea turtle bycatch in the Gulf of Mexico bottom longline reef fish fishery. The emergency rule prohibits bottom longlining for Gulf reef fish east of 85^{o} 30'W longitude (near Cape San Blas, Florida) in a portion of the Exclusive Economic Zone shoreward of the 50-fathom depth contour. Once the deep-water grouper and tilefish quotas have been filled, the use of bottom longline gear to harvest reef fish in water of all depths east of

85^{o} 30'W longitude will be prohibited. During transit no reef fish may be possessed unless bottom longline gear is appropriately stowed meaning that a longline may be left on the drum if all gangions and hooks are disconnected and stowed below deck; hooks cannot be baited, and all buoys must be disconnected from the gear, but may remain on deck.

May 2, 2010 - NOAA Fisheries Service is enacting emergency regulations to close a portion of the Gulf of Mexico (Gulf) exclusive economic zone (EEZ) to all fishing, in response to the Deepwater Horizon oil spill. The closure will be in effect for 10 days, from May 2, 2010, through 12:01 a.m. local time May 12, 2010, unless conditions allow NOAA Fisheries Service to terminate it sooner. NOAA Fisheries Service will continue to monitor and evaluate the oil spill and its impacts on Gulf fisheries and will take immediate and appropriate action to extend or reduce this closed area. This closure is implemented for public safety (subsequent frequent adjustments were made to the closed area during the summer of 2010).

2.3 Secretarial Amendments

Secretarial Amendment 1 (2004)

Implemented July 15, 2004- Changed the quota for deep-water grouper from 1.6 million pounds whole weight (equal to 1.35 million pounds landed weight) to a gutted weight quota of 1.02 million pounds (equal to the average annual harvest 1996-2000.

2.4 Control Date Notices

Control date notices are used to inform fishermen that a license limitation system or other method of limiting access to a particular fishery or fishing method is under consideration. If a program to limit access is established, anyone not participating in the fishery or using the fishing method by the published control date may be ineligible for initial access to participate in the fishery or to use that fishing method. However, a person who does not receive an initial eligibility may be able to enter the fishery or fishing method after the limited access system is established by transfer of the eligibility from a current participant, provided the limited access system allows such transfer. Publication of a control date does not obligate the Council to use that date as an initial eligibility criteria. A different date could be used, and additional qualification criteria could be established. The announcement of a control date is primarily intended to discourage entry into the fishery or use of a particular gear based on economic speculation during the Council's deliberation on the issues. The following summarizes control dates that have been established for the Reef Fish FMP. A reference to the full *Federal Register* notice is included with each summary.

November 1, 1989:

Anyone entering the commercial reef fish fishery in the Gulf and South Atlantic after November 1, 1989, may not be assured of future access to the reef fish resource if a management regime is developed and implemented that limits the number of participants in the fishery [54 FR 46755].

November 18, 1998:

The Council is considering whether there is a need to impose additional management measures limiting entry into the recreational-for-hire (i.e., charter vessel and headboat) fisheries for reef fish and coastal migratory pelagic fish in the EEZ of the Gulf and, if there is a need, 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 and coastal migratory pelagic [63 FR 64031] (In Amendment 20 to the Reef Fish FMP, a qualifying date of March 29, 2001, was adopted).

July 12, 2000:

The Council is considering whether there is a need to limit participation by gear type in the commercial reef fish fisheries in the exclusive economic zone of the Gulf and, if there is a need, what management measures should be imposed to accomplish this. 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 a gear endorsement on the commercial reef fish vessel permit for the appropriate gear. Gear types which may be included are longlines, buoy gear, handlines, rod-and-reel, bandit gear, spear fishing gear, and powerheads used with spears [65 FR 42978].

October 15, 2004:

The Council is considering the establishment of an individual fishing quota program to control participation or effort in the commercial grouper fisheries of the Gulf. If an individual fishing quota program is established, the Council is considering October 15, 2004, as a possible control date regarding the eligibility of catch histories in the commercial grouper fishery [69 FR 67106].

December 31, 2008:

The Council voted to establish a control date for all Gulf commercial reef fish vessel permits. The control date will allow the Council to evaluate fishery participation and address any level of overcapacity. The establishment of this control date does not commit the Council or NOAA Fisheries Service to any particular management regime or criteria for entry into this fishery.

Fishermen would not be guaranteed future participation in the fishery regardless of their entry date or intensity of participation in the fishery before or after the control date under consideration. Comments were requested by close of business April 17, 2009 [74 FR 11517].

2.5 Management Program Specifications

Table 2.5.1. General Management Information Gulf of Mexico

Species	Yellowedge Grouper
Management Unit	Gulf of Mexico
Management Unit Definition	Gulf of Mexico EEZ
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	Peter Hood / Ryan Rindone
Current stock exploitation status	Unknown
Current spawning stock biomass status	Unknown

Table 2.5.2. Specific Management Criteria

Criteria	Gulf of Mexico - Proposed	
	Definition (SEDAR 22)	Value
MSST	1-M*SSB_{MSY}	SEDAR 85
SSB_{MSY}	Equilibrium SSB @ $F_{30\%SPR}$	SEDAR 85
$SSB_{Current}$	SSB_{2021}	SEDAR 85
MFMT	F_{MSY}	SEDAR 85
MSY	F_{MSY}	SEDAR 85
FMSY	$F_{30\%SPR}$	SEDAR 85
$F_{Current}$	Geom. mean of last 3 fishing years	SEDAR 85
OY	Equilibrium yield at F_{OY}	SEDAR 85
FOY	75% of $F_{30\%SPR}$	SEDAR 85
M	0.13	SEDAR 85

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

Gulf of Mexico yellowedge grouper is not currently under a rebuilding plan.

Table 2.5.4. Stock projection information

(This provides the basic information necessary to bridge the gap between the terminal year of the assessment and the year in which any changes may take place or specific alternative exploitation rates should be evaluated)

Gulf of Mexico

Requested Information	Value
First Year of Management	2023
Projection Criteria during interim years should be based on (e.g., exploitation or harvest)	Fixed Exploitation
Projection criteria values for interim years should be determined from (e.g., terminal year, average of X years)	Actual or preliminary landings; else, average of previous 3 years

*Fixed Exploitation would be $F=F_{MSY}$ (or $F<F_{MSY}$) that would rebuild overfished stock to B_{MSY} in the allowable timeframe. Modified Exploitation would allow for adjustment in $F<=F_{MSY}$, which would allow for the largest landings that would rebuild the stock to B_{MSY} in the allowable timeframe. Fixed harvest would be maximum fixed harvest with $F<=F_{MSY}$ that would allow the stock to rebuild to B_{MSY} in the allowable timeframe.

Project future stock conditions and develop rebuilding schedules if warranted, including estimated generation time. Develop stock projections in accordance with the following:

A) If stock is overfished:
   $F=0$, $F_{Current}$, F_{MSY}, F_{OY}
   $F=F_{Rebuild}$ (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:
   $F= F_{Current}$, F_{MSY}, F_{OY}

C) If stock is neither overfished nor undergoing overfishing:
   $F= F_{Current}$, F_{MSY}, F_{OY}

D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

Table 2.5.5. Quota Calculation Details

If the stock is managed by quota, please provide the following information

Current Quota Value (DWG)	1.024 mp gw
Next Scheduled Quota Change	2023
Annual or averaged quota?	Annual
If averaged, number of years to average	-
Does the quota include bycatch/discard?	No

2.6 Federal Management and Regulatory Timelines for Yellowedge Grouper

Harvest Restrictions: Trip Limits (Trip limits do not apply during closures: if season is closed, then trip limit is 0)

First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Fishery	Bag Limit Per Person/Day	Trip Limit Per Boat/Day	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type
2005	2005	3/3/05	6/8/05	Com	NA	10,000 lbs gw; DWG[1]	Gulf of Mexico EEZ	70 FR 8037	622.44	Emergency Rule
2005	2005	6/9/05	12/31/05	Com	NA	7,500 lbs gw; DWG[1]	Gulf of Mexico EEZ	70 FR 33033	622.44	Temporary Rule
2006	2009	1/1/06	12/31/09	Com	NA	6,000 lbs gw; DWG[1]	Gulf of Mexico EEZ	70 FR 77057	622.44	Reef Fish Regulatory Amendment
2010	Ongoing	1/1/10	Ongoing	Com	NA	IFQ	Gulf of Mexico EEZ	74 FR 44732	622.2	Reef Fish Amendment 29
1990	2004	4/23/90	7/14/04	Rec	5 grouper aggregate	NA	Gulf of Mexico EEZ	55 FR 2078	641.24	Reef Fish Amendment 1
2004	2005	7/15/04	8/8/05	Rec	5 grouper aggregate	NA	Gulf of Mexico EEZ	69 FR 33315	622.39	Secretarial Amendment 1
2005	2006	8/9/05	1/23/06	Rec	3 grouper aggregate	NA	Gulf of Mexico EEZ	70 FR 42510	622.39	Temporary Rule
2006	2009	1/24/06	5/17/09	Rec	5 grouper aggregate	NA	Gulf of Mexico EEZ	71 FR 3018 71 FR 34534	622.39	Temporary Rule Reef Fish Regulatory Amendment
2009	Ongoing	5/18/09	Ongoing	Rec	4 grouper aggregate	NA	Gulf of Mexico EEZ	74 FR 17603	622.39	Reef Fish Amendment 30B

[1]DWG: deep-water grouper (misty grouper, snowy grouper, yellowedge grouper, warsaw grouper, and speckled hind)

Harvest Restrictions: Size Limits (Size limits do not apply during closures)

First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type
1990	Ongoing	2/21/90	Ongoing	Both	None	Gulf of Mexico EEZ	55 FR 2078	622.37	Reef Fish Amendment 1

Harvest Restrictions: Fishery Closures (*Area specific regulations are documented under spatial restrictions)

First Yr In Effect	Last Year in Effect	Effective Date	End Date	Fishery	Closure Type	First Day Closed	Last Day Closed	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type	Species Associated with Closure
2005	2005	8/9/05	1/23/06	Rec	Seasonal	1-Nov	31-Dec	Gulf of Mexico EEZ	70 FR 42510	622.34	Temporary Rule	Groupers

Harvest Restrictions (Spatial Restrictions)

Area	First Yr In Effect	Effective Date	End Date	Fishery	First Day Closed	Last Day Closed	Restriction in Area	FR Reference	Amendment Number or Rule Type	FR Section	Amendment Number or Rule Type
Gulf of Mexico Stressed Areas	1984	11/8/84	Ongoing	Both	Year round		Prohibited powerheads for Reef FMP	49 FR 39548	Original Reef Fish FMP	641.7	Original Reef Fish FMP
	1984	11/8/84	Ongoing	Both	Year round		Prohibited pots and traps for Reef FMP	49 FR 39548	Original Reef Fish FMP	641.7	Original Reef Fish FMP
Alabama Special Management Zones	1994	2/7/94	Ongoing	Both	Year round		Allow only hook-and line gear with three or less hooks per line and spearfishing gear for fish in Reef FMP	59 FR 966	Reef Fish Amendment 5	641.23	Reef Fish Amendment 5
EEZ, inside 50 fathoms west of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1	641.7	Reef Fish Amendment 1
EEZ, inside 20 fathoms east of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1	NA	Reef Fish Amendment 1
EEZ, inside 50 fathoms east of Cape San Blas, FL	2009	5/18/09	10/15/09	Both	18-May	28-Oct	Prohibited bottom longline for Reef FMP	74 FR 20229	Emergency Rule	622.34	Emergency Rule
EEZ, inside 35 fathoms east of Cape San Blas, FL	2009	10/16/09	5/25/10	Both	Year round		Prohibited bottom longline for Reef FMP	74 FR 53889	Sea Turtle ESA Rule	223.206	Sea Turtle ESA Rule
	2010	5/26/10	Ongoing	Rec	Year round		Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31	622.34	Reef Fish Amendment 31
	2010	5/26/10	Ongoing	Com	1-Jun	31-Aug	Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31	622.34	Reef Fish Amendment 31
Madison-Swanson	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment	622.34	Reef Fish Regulatory Amendment
	2004	6/3/04	8/19/21	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	8/19/21	Both	1-Nov	30-Apr	Fishing prohibited	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2021	8/20/21	Ongoing	Both	Year round		Fishing prohibited	86 FR 38416	RF Framework Action	622.34	Reef Fish Regulatory Amendment
Steamboat Lumps	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34	Reef Fish Amendment 30B Supplement
	2021	8/20/21	Ongoing	Both	Year round		Fishing prohibited	86 FR 38416	RF Framework Action	622.34	Reef Fish Framework Action
The Edges	2010	7/24/09	Ongoing	Both	1-Jan	30-Apr	Fishing prohibited	74 FR 30001	Reef Fish Amendment 30B Supplement	934 622.34	Sanctuary Designation Essential Fish Habitat Amendment 3
20 Fathom Break	2014	7/5/13	Ongoing	Rec	1-Feb	31-Mar	Fishing for SWG prohibited[2]	78 FR 33259	Reef Fish Framework Action	641.23	Reef Fish Amendment 5
Flower Garden	1992	1/17/92	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	56 FR 63634	Sanctuary Designation	635.71 622.34	Tortugas Amendment Essential Fish Habitat Amendment 3
Riley's Hump	1994	2/7/94	8/18/02	Both	1-May	30-Jun	Fishing prohibited	59 FR 966	Reef Fish Amendment 5	622.34	Essential Fish Habitat Amendment 3
Tortugas Reserves	2002	8/19/02	Ongoing	Both	Year round		Fishing prohibited	67 FR 47467	Tortugas Amendment	622.34	Essential Fish Habitat Amendment 3
Pulley Ridge	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	622.34	Essential Fish Habitat Amendment 3
McGrail Bank	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	622.34	Essential Fish Habitat Amendment 3
Stetson Bank	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	622.34	Essential Fish Habitat Amendment 3

[1]HMS: highly migratory species (tuna species, marlin, oceanic sharks, sailfishes, and swordfish)

[2]SWG: shallow-water grouper (black, gag, red, red hind, rock hind, scamp, yellowfin, and yellowmouth)

[3]Bottom gears: Bottom longline, bottom trawl, buoy gear, pot, or trap

[3]Bottom gears: Bottom longline, bottom trawl, buoy gear, pot, or trap

Harvest Restrictions (Gear Restrictions*)
*Area specific gear regulations are documented under spatial restictions

Gear Type	First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type
Poison	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	641.24	Original Reef Fish FMP
Explosives	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	641.24	Original Reef Fish FMP
Pots and Traps	1984	1994	11/23/84	2/6/94	Established fish trap permit	Gulf of Mexico EEZ	49 FR 39548	641.4	Original Reef Fish FMP
	1984	1990	11/23/84	2/20/90	Set max number of traps fish by a vessel at 200	Gulf of Mexico EEZ	49 FR 39548	641.25	Original Reef Fish FMP
	1990	1994	2/21/90	2/6/94	Set max number of traps fish by a vessel at 100	Gulf of Mexico EEZ	55 FR 2078	641.22	Reef Fish Amendment 1
	1994	1997	2/7/94	2/7/97	Moratorium on additional commercial trap permits	Gulf of Mexico EEZ	59 FR 966	641.4	Reef Fish Amendment 5
	1997	2007	3/25/97	2/7/07	Phase out of fish traps begins	Gulf of Mexico EEZ	62 FR 13983	622.4	Reef Fish Amendment 14
	1997	2007	1/29/88	2/7/07	Prohibited harvest of reef fish from traps other than permited reef fish, stone crab, or spiny lobster traps.	Gulf of Mexico EEZ	62 FR 67714	622.39	Reef Fish Amendment 15
	2007	Ongoing	2/8/07	Ongoing	Traps prohibited	Gulf of Mexico EEZ	62 FR 13983	622.31	Reef Fish Amendment 14
All	1992	1995	5/8/92	12/31/95	Moratorium on commercial permits for Reef FMP	Gulf of Mexico EEZ	59 FR 11914 59 FR 39301	641.4 641.4	Reef Fish Amendment 4 Reef Fish Amendment 9
	1994	Ongoing	2/7/94	Ongoing	Finfish must have head and fins intact through landing, can be eviscerated, gilled, and scaled but must otherwise be whole (HMS and bait exceptions)	Gulf of Mexico EEZ	59 FR 966	641.21	Reef Fish Amendment 5
	1996	2005	7/1/96	12/31/05	Moratorium on commercial permits for Gulf reef fish	Gulf of Mexico EEZ	61 FR 34930 65 FR 41016	622.4 622.4	Interim Rule Reef Fish Amendment 17
	2006	Ongoing	9/8/06	Ongoing	Use of Gulf reef fish as bait prohibited[1]	Gulf of Mexico EEZ	71 FR 45428	622.31	Reef Fish Amendment 18A
Vertical Line	2008	Ongoing	6/1/08	Ongoing	Requires non-stainless steel circle hooks and dehooking devices	Gulf of Mexico EEZ	74 FR 5117	322.41	Reef Fish Amendment 27
	2008	2013	6/1/08	9/3/13	Requires venting tools	Gulf of Mexico EEZ	74 FR 5117 78 FR 46820	322.41 NA	Reef Fish Amendment 27 Framework Action
Bottom Longline	2010	Ongoing	5/26/10	Ongoing	Limited to 1,000 hooks of which no more than 750 hooks are rigged for fishing or fished	Gulf of Mexico EEZ	75 FR 21512	622.34	Reef Fish Amendment 31

[1]Except when, purchased from a fish processor, filleted carcasses may be used as bait crab and lobster traps.

Quota History:

First Yr In Effect	Last YR In Effect	Effective Date	End Date	Fishery	Species Affected	ACL	Comm Quota	Units	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type
1990	1992	02/21/1990	6/21/92	ALL	DWG	1.8	1.8	mp ww	Gulf of Mexico EEZ	55 FR 2078; 55 FR 51722; 56 FR 30513; 57 FR 21715	641.25	Reef Fish Amendment 1
1992	2004	06/22/1992	7/14/04	ALL	DWG	1.6	1.6	mp ww	Gulf of Mexico EEZ	57 FR 21751	641.25	
2004	2012	07/15/2004	1/29/12	ALL	DWG	1.02	1.02	mp gw	Gulf of Mexico EEZ	69 FR 33315	622.42	Secretarial Amendment 1
2012	2012	01/30/2012	12/31/12	ALL	DWG	1.216	1.127	mp gw	Gulf of Mexico EEZ	76 FR 82044	622.42	
2013	2013	01/30/2012	12/31/13	ALL	DWG	1.207	1.118	mp gw	Gulf of Mexico EEZ	76 FR 82044	622.42	
2014	2014	01/30/2012	12/31/14	ALL	DWG	1.198	1.11	mp gw	Gulf of Mexico EEZ	76 FR 82044	622.42	
2015	2015	01/30/2012	12/31/15	ALL	DWG	1.189	1.101	mp gw	Gulf of Mexico EEZ	76 FR 82044	622.42	
2016	Ongoing	01/30/2012	Ongoing	ALL	DWG	1.105	1.024	mp gw	Gulf of Mexico EEZ	76 FR 82044	622.42	

[1]DWG: deep-water grouper (misty grouper, snowy grouper, yellowedge grouper, warsaw grouper)

2.7 Closures in the Gulf of Mexico Due to Meeting Commercial Quota or Commercial/Recreational ACL

None

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 maximum sustainable yield (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 1990-2001 split into Eastern 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 years, 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.

The SEDAR 22 benchmark assessment (SEDAR 2011) considered three modeling platforms: Catch Curve Analysis, Stock Reduction Analysis (SRA), and Stock Synthesis. The first approach provided an estimate of natural mortality from the early time period (1977-1980) before the onset of the fishery for this deep-water species. Stock Synthesis was the primary model developed, with SRA used for comparison. The base model included a terminal year of 2009 and assumed two geographical areas (Eastern and Western Gulf) to capture differences in growth and natural mortality. Given the hermaphroditic nature of this species, spawning stock biomass included both male and female biomass estimates. Additional sources of information coupled with substantial efforts to extend the time series of landings back to the 1970s greatly improved the information content of the available data. Substantial increases were evident in the number of length and age composition samples from the fishery. A 10-year time series of CPUE and age composition was available from the NMFS bottom longline survey. 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 allowed an unparalleled view of the size and age structure of the population in the first years of the fishery. During the SEDAR 22 process, substantial discussion surrounded historical commercial landings (particularly early longline landings), natural mortality, steepness, time-varying selectivity for the commercial longline fleets, sex transition for this hermaphroditic species, and increased weighting on survey data. While juvenile abundance indices from the NMFS trawl survey were recommended for use in the assessment, they were ultimately not used because of the extremely low numbers of fish caught.

Eighteen sensitivity runs were presented during the SEDAR 22 Review Workshop, and six model runs were put forth for stochastic projections by the SEDAR 22 Review Panel: a base run (aka the central run), increased weight on indices, low M, high M, low landings, and low steepness. Three runs including the base run, a low M run, and a run that increased weighting of indices, were chosen to represent the estimates of uncertainty using MCMC stochastic simulations. Ultimately, the SS3 central run was chosen as the run to use for estimates of abundance, biomass and exploitation in order to visualize trends. This decision by the SSC was based on the fact that the "base" run model results fell in the middle of the projection runs. The SSC chose to use 30% SPR as the basis for the MSY proxy because that value was typically used by the Council and presented in the SEDAR 22 report. The base run with the SPR30% benchmark implied that Yellowedge Grouper was not overfished and overfishing was not occurring in 2009.

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. Available at: https://sedarweb.org/documents/s22rd02-status-of-the-yellowedge-grouper-fishery-in-the-gulf-of-mexico/

Gulf of Mexico Fishery Management Council (GMFMC). 2002. Report of the reef fish stock assessment panel. Reef Fish Stock Assessment Panel. September 17-19, 2002 Meeting NMFS, SEFSC, Miami, FL. 36 pp.

Porch, C.E. 2002. A preliminary assessment of Atlantic white marlin (*Tetrapturus albidus*) using a state-space implementation of an age-structured production model. SCRS/02/68 23 pp.

SEDAR (Southeast Data Assessment and Review). 2011. SEDAR 22 Stock Assessment Report for Gulf of Mexico Yellowedge Grouper. SEDAR, North Charleston, SC. 423 pp. Available at: https://sedarweb.org/documents/sedar-22-final-stock-assessment-report-gulf-of-mexico-yellowedge-grouper/

4 REGIONAL MAPS

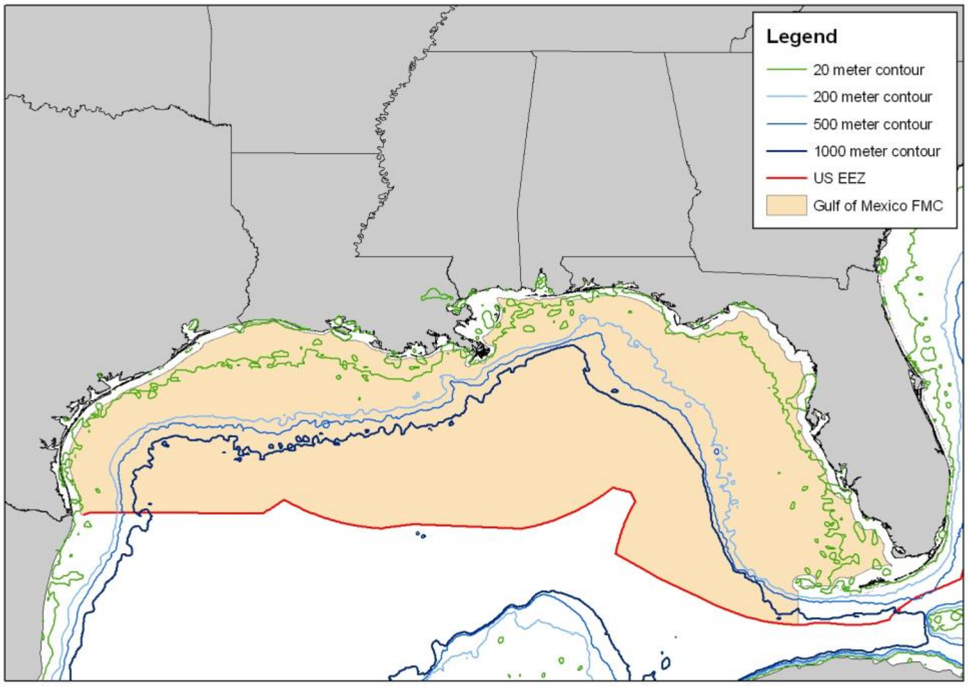

Figure 4.1 Gulf of Mexico Region including Council and EEZ Boundaries.

5 SEDAR ABBREVIATIONS

ABC	Acceptable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
AMRD	Alabama Marine Resources Division
APAIS	Access Point Angler Intercept Survey
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level

BAM	Beaufort Assessment Model
B_{msy}	value of B capable of producing MSY on a continuing basis
BSIA	Best Scientific Information Available
CHTS	Coastal Household Telephone Survey
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
EEZ	exclusive economic zone
F	fishing mortality (instantaneous)
FES	Fishing Effort Survey
FIN	Fisheries Information Network
F_{MSY}	fishing mortality to produce MSY under equilibrium conditions
F_{OY}	fishing mortality rate to produce Optimum Yield under equilibrium
$F_{XX\% SPR}$	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
F_{max}	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F_o	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	Florida Fish and Wildlife Research Institute
GA DNR	Georgia Department of Natural Resources
GLM	general linear model
GMFMC	Gulf of Mexico Fishery Management Council
GSMFC	Gulf States Marine Fisheries Commission
GULF FIN	GSMFC Fisheries Information Network

HMS	Highly Migratory Species
LDWF	Louisiana Department of Wildlife and Fisheries
M	natural mortality (instantaneous)
MARFIN	Marine Fisheries Initiative
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program
MSA	Magnuson Stevens Act
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OST NOAA	Fisheries Office of Science and Technology
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SC DNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey

SEFSC	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERFS	Southeast Reef Fish Survey
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
SRFS	State Reef Fish Survey (Florida)
SRHS	Southeast Region Headboat Survey
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SS	Stock Synthesis
SSC	Science and Statistics Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
TPWD	Texas Parks and Wildlife Department
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 85

Gulf of Mexico Yellowedge Grouper

SECTION II: Assessment Report

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

SEDAR 85 Gulf of Mexico Yellowedge Grouper Operational Assessment

Gulf Fisheries Branch
Sustainable Fisheries Division
NOAA Fisheries - Southeast Fisheries Science Center

November 2023

Table of Contents

1. Introduction

This document summarizes the SEDAR 85 (Southeast Data Assessment and Review) Gulf of Mexico Yellowedge Grouper Operational Assessment (OA) as implemented in the Stock Synthesis (version 3.30.21.00) modeling framework (Methot and Wetzel 2013). The last assessment for Gulf of Mexico Yellowedge Grouper was the SEDAR 22 Benchmark Assessment with data through 2009 (SEDAR 2011).

Where practicable, the SEDAR 85 OA Base Model used the same data sets as the SEDAR 22 Benchmark Base Model with time series updated through 2021. However, notable changes include:

- updating the time series of commercial landings by reviewing the SEDAR 22 methodology (assumptions and decisions) and making improvements where warranted
- updating the time series of commercial discards using the catch per unit of effort (CPUE)-expansion approach used since SEDAR 61 in Gulf of Mexico stock assessments
- updating the time series of recreational landings and discards from the Marine Recreational Fisheries Statistics Survey (MRFSS) estimates to the Marine Recreational Information Program Fishing Effort Survey (MRIP-FES)-based estimates
- incorporating more error in landings estimates to better reflect uncertainties in historical landings
- re-evaluating the representativeness and reliability of sex-specific composition data and switching to aggregated length and age compositions because of concerns over data quality and quantity
- using weighted length compositions for fisheries data where possible to better represent compositions of the landings
- inputting nominal age compositions instead of conditional age-at-length compositions because of concerns over violating assumptions
- reviewing composition data and excluding data which are not representative (e.g., fewer than 30 lengths for fisheries data, 2010-2012 fisheries age data, pre-2000 National Marine Fisheries Service (NMFS) Bottom Longline Survey compositions, and NMFS/SEAMAP (Southeast Area Monitoring and Assessment Program) Groundfish Trawl Survey age data)
- correcting the *a* parameter of the length-weight relationship input
- updating the first age mature, first age male, and fixing the hermaphroditism transition rate
- fixing steepness at a biologically plausible estimate of 0.827
- fixing recruitment variability (*SigmaR*) at a more realistic value of 0.5
- applying a Dirichlet-Multinomial internal re-weighting approach to age and length compositions

These changes reflect improvements in data inputs and parameterization compared with SEDAR 22. A more comprehensive description of these changes is detailed in subsequent sections of the assessment report. Assessment methods, results, model diagnostics, stock status determination criteria and projections are also provided through this report.

1.1. Workshop Time and Place

The SEDAR 85 Operational Assessment (OA) process for Gulf of Mexico Yellowedge Grouper was conducted by the Southeast Fisheries Science Center (SEFSC). One Topical Working Group (TWG) was convened by SEDAR to review and provide recommendations on data and modeling modifications from SEDAR 22. The group met by webinar in September 2023.

1.2. Terms of Reference

The terms of reference approved by the Gulf of Mexico Fishery Management Council (GMFMC) are listed below.

1. Update the approved SEDAR 22 Gulf of Mexico Yellowedge Grouper base model with data through 2021.

2. Document any changes or corrections made to model and input data sets and provide updated input data tables.

    a. Document changes in MRIP data, both pre- and post-recalibration, in terms of the magnitude of changes to catch and effort by mode if possible.
    b. Include available length frequency for the commercial fleet(s).
    c. Update life history data (e.g., growth, reproduction, mortality) if warranted.
    d. Consider the SEFSC's improved approach for estimating commercial discards and determine how the IFQ program affected discards.

3. To the extent possible, the following should be considered for inclusion in the model:

    a. Consider potential effects of red tide on Yellowedge Grouper, with consideration of past red tide events in 2005, 2014, 2018, and 2021.
    b. Consider whether steepness can be estimated, with or without a prior. If steepness is fixed, evaluate the sensitivity of that assumption.
    c. Consider the effects of the *Deepwater Horizon* MC252 oil spill from April 2010 on the Yellowedge Grouper stock.

4. Update model parameter estimates and their variances, model uncertainties, estimates of stock status and management benchmarks, and provide the probability of overfishing occurring at specified future harvest and exploitation levels. Provide commercial and recreational landings and discards in pounds and numbers.

    a. Use the following status determination criteria (SDC):
        i. MSY or MSY proxy ($F_{30\%SPR}$) = yield at F_{MSY}
        ii. MSST = 0.75*B_{MSY}
        iii. MFMT = F_{MSY} (or proxy) and $F_{Rebuild}$ (if overfished)
        iv. OY = 90% of MSY or MSY proxy ($F_{30\%SPR}$), per Reef Fish Amendment 48
        v. If different SDC are recommended, provide outputs for both the current and recommended SDC.

b. Describe changes in catch advice as they relate to the use of FES-adjusted MRIP recreational catch and effort data, versus changes related to stock abundance.
c. Unless otherwise recommended, use the geometric mean of the previous three years' fishing mortality to determine $F_{Current}$. If an alternative approach is recommended, provide justification and outputs for the current and alternative approach.
d. Provide yield and spawning stock biomass streams for the overfishing limit and acceptable biological catch in pounds:
    i. Annually for five years
    ii. Under a "constant catch" scenario for both three and five years
    iii. For the equilibrium yield at F_{MSY}, when estimable

5. Develop a stock assessment report to address these Terms of Reference and fully document the input data and results of the stock assessment model.

1.3. List of Participants

Topical Working Group Members

Skyler Sagarese (Lead analyst) .... NMFS SEFSC
David Chagaris .... SSC/UFL
Jim Nance .... SSC
Katie Siegfried .... NMFS SEFSC
Jim Tolan .... SSC/TPWD

Attendees

Manuel Coffill-Rivera ....
Maria Kappos .... FWC

Staff

Julie Neer .... SEDAR
Meisha Key .... SEDAR
Ryan Rindone .... GMFMC Staff

1.4. List of Working Papers and Reference Documents

Document #	Title	Authors	Date Submitted
Documents Prepared for the Operational Assessment			
SEDAR85-WP-01	SEDAR Metadata and QAQC	FWRI – Fisheries Independent Monitoring	17-Jan-23

Document #	Title	Authors	Date Submitted
SEDAR85-WP-02	Headboat Data for Yellowedge Grouper in the US Gulf of Mexico	Robin T. Cheshire, Kenneth Brennan, and Matthew E. Green	2-Jun-23
SEDAR85-WP-03	General Recreational Survey Data for Yellowedge Grouper in the Gulf of Mexico	Samantha M. Binion-Rock and Matthew A. Nuttall	9-Jun-23
SEDAR85-WP-04	Gulf of Mexico Yellowedge Grouper (*Hyporthodus flavolimbatus*) Commercial Landings Length and Age Compositions	Micki Pawluk	13-Jul-23
SEDAR85-WP-05	Shark Bottom Longline Observer Program Metadata	Gary Decossas and Alyssa Mathers	28-Jun-23
SEDAR85-WP-06	CPUE Expansion Estimation for Commercial Discards of Gulf of Mexico Yellowedge Grouper (*Hyporthodus flavolimbatus*)	Sarina Atkinson, Steven G. Smith, Gary Decossas	7-Jul-23
SEDAR85-WP-07	Commercial Landings of Gulf of Mexico Yellowedge Grouper (*Hyporthodus flavolimbatus*)	Micki Pawluk and Sarina Atkinson	7-Jul-23
SEDAR85-WP-08	A Review of the Gulf of Mexico yellowedge grouper (*Hyporthodus flavolimbatus*) Age-length Data, 1977-2021	Ashley Pacicco, Laura Thornton, Steve Garner, Beverly Barnett	14-Jul-23
SEDAR85-WP-09	Yellowedge Grouper Abundance Indices from NMFS Bottom Longline Surveys in the Northern Gulf of Mexico	Adam G. Pollack and David S. Hanisko	8-Aug-23
Final Stock Assessment Reports			
SEDAR85-SAR1	Gulf of Mexico Yellowedge Grouper	TBD	

2. Data Review and Update

A variety of data sources were used in the SEDAR 85 Operational Assessment (OA) following the SEDAR 22 Benchmark Assessment (terminal year of 2009). Where practicable, the SEDAR 85 OA Base Model used the same data sets as the SEDAR 22 Benchmark Base Model with an updated time series though 2021. However, there were a few new or revised data sets provided for consideration including:

1. An ageing error matrix accompanying the new age data since SEDAR 22 (2013-2021)
2. Commercial landings and discard estimates
3. Annual estimates of uncertainty accompanying landings estimates
4. National Marine Fisheries Service's (NMFS) Marine Recreational Information Program Fishing Effort Survey (MRIP-FES) catch and discard time series
5. Commercial length compositions weighted by landings where possible
6. Nominal age compositions of Yellowedge Grouper landed by each fleet or caught by each survey
7. Length and age compositions of Yellowedge Grouper aggregated across sex assignment (ie., unsexed + female + male) for each fleet and survey
8. Length composition of Yellowedge Grouper captured by the NMFS/SEAMAP (Southeast Area Monitoring and Assessment Program) Groundfish Trawl Survey since 1987 in the Eastern Gulf of Mexico and 1988 in the Western Gulf of Mexico
9. Mean length-at-age of Yellowedge Grouper landed by each fleet (for checking model predictions only, the model is not fitting to these data inputs)

These new data series were considered because they had not previously been available for the SEDAR 22 Benchmark Assessment or represented improved data inputs for use in the SEDAR 85 assessment. The data utilized in the SEDAR 85 OA Base Model are summarized below and illustrated in **Figure 1** along with their corresponding temporal scale. Comprehensive descriptions of individual data components are provided within each subsection below, with additional details provided in the SEDAR 22 Benchmark Assessment Report (SEDAR 2011).

1. Life history
    a. Meristics
    b. Age and growth
    c. Natural mortality
    d. Maturity
    e. Sex transition
    f. Fecundity
2. Discard mortality rates (based on numbers of fish)
    a. Commercial Vertical Line - East (recreational component)
    b. Commercial Vertical Line - West (recreational component)
    c. Commercial Longline - East
    d. Commercial Longline - West
3. Landings (and Dead Discards)

   a. Commercial Vertical Line - East: 1975-2021 (metric tons gutted weight)
   b. Commercial Vertical Line - West: 1975-2021 (metric tons gutted weight)
   c. Commercial Longline - East: 1980-2021 (metric tons gutted weight)
   d. Commercial Longline - West: 1979-2021 (metric tons gutted weight)
4. Length composition of landings (8:128 cm Total Length (cm TL), 2 cm TL bins)
   a. Commercial Vertical Line - East (weighted): 1978-2019
   b. Commercial Vertical Line - West (nominal): 1984-2021
   c. Commercial Longline - East (weighted): 1980-2021
   d. Commercial Longline - West (nominal): 1984-2021
5. Age composition of landings (1-year age bins, plus group ages 40 and older)
   a. Commercial Vertical Line - East (nominal): 1978-2021
   b. Commercial Vertical Line - West (nominal): 1991-2021
   c. Commercial Longline - East (nominal): 1980-2021
   d. Commercial Longline - West (nominal): 1991-2021
6. Mean length-at-age of landings
   a. Commercial Vertical Line - East: 1978-2021
   b. Commercial Vertical Line - West: 1979-2021
   c. Commercial Longline - East: 1980-2021
   d. Commercial Longline - West: 1991-2021
7. Abundance indices
   a. Fishery-independent:
      i. NMFS Bottom Longline Survey - East: 2000-2021
      ii. NMFS Bottom Longline Survey - West: 2000-2021
   b. Fishery-dependent:
      i. Longline CPUE - East: 1991-2009
      ii. Longline CPUE - West: 1991-2009
8. Length composition of surveys (8:128 cm TL, 2 cm TL bins)
   a. NMFS Bottom Longline Survey - East: 2000-2021
   b. NMFS Bottom Longline Survey - West: 2000-2021
   c. NMFS/SEAMAP Groundfish Trawl Survey - East: 1987-2021
   d. NMFS/SEAMAP Groundfish Trawl Survey - West: 1988-2019
9. Age composition of surveys (1-year age bins, plus group ages 40 and older)
   a. NMFS Bottom Longline Survey - East: 2000-2021
   b. NMFS Bottom Longline Survey - West: 2000-2021
   c. NMFS/SEAMAP Groundfish Trawl Survey - East: 2003-2010 (not included in model fitting)
   d. NMFS/SEAMAP Groundfish Trawl Survey - West: 2000-2009 (aggregated and treated as a super-period)

After review of data submitted for SEDAR 85, a Data Updates Topical Working Group (TWG) was requested by the SEFSC at the July 2023 Gulf of Mexico Fishery Management Council's Scientific and Statistical Committee meeting to review and evaluate data sets which exhibited large deviations from those used in SEDAR 22. For example, notable changes and improvements were made in methodologies for developing the commercial and recreational landings (see **Sections 2.3.1-2.3.2**) and composition data (see **Section 2.3.6**).

A summary listing of all data sets included in the assessment, along with any revisions to the contact information for who provided the analysis, has been compiled below. This will be the source of data information for the next assessment.

Primary Categories	Data Type	Contributing Organization	Data Providers	Contact Information
Life History	Raw age and length data	FWRI	Meagan Schrandt	meagan.schrandt@myfwc.com
	Raw age data	GulfFIN	Gregg Bray	gregg.bray@gsmfc.org
	Raw age and length data	SEFSC	Ashley Pacicco Laura Thornton	ashley.pacicco@noaa.gov laura.thornton@noaa.gov
	Raw age and length data combined	SEFSC	Ashley Pacicco Laura Thornton	ashley.pacicco@noaa.gov laura.thornton@noaa.gov
	Ageing error matrix	SEFSC	Steve Garner	steven.garner@noaa.gov
Fishery Dependent	Raw recreational headboat length data	SEFSC	Ken Brennan Rob Cheshire	kenneth.brennan@noaa.gov rob.cheshire@noaa.gov
	Raw length data	GulfFIN	Gregg Bray	gregg.bray@gsmfc.org
	Raw recreational length data	SEFSC	Matt Nuttall Samantha Binion-Rock Drew Cathey	matthew.nuttall@noaa.gov samantha.binion-rock@noaa.gov andrew.cathey@noaa.gov
	Raw coastal logbook catch and effort	SEFSC	Sydney Alhale	sydney.alhale@noaa.gov
	Raw discard logbook discards	SEFSC	Sydney Alhale	sydney.alhale@noaa.gov
	Raw commercial observer program data	SEFSC	Gary Decossas	gary.decossas@noaa.gov
	Raw commercial length data and sample sizes	SEFSC	Larry Beerkircher	lawrence.r.beerkircher@noaa.gov
	Commercial landings estimates	SEFSC	Sarina Atkinson Michaela Pawluk	sarina.atkinson@noaa.gov michaela.pawluk@noaa.gov

Primary Categories	Data Type	Contributing Organization	Data Providers	Contact Information
	Commercial discards estimates and length composition	SEFSC	Sarina Atkinson Gary Decossas	sarina.atkinson@noaa.gov gary.decossas@noaa.gov
	Southeast Regional Headboat Survey effort, catch, and CV	SEFSC	Ken Brennan Rob Cheshire	kenneth.brennan@noaa.gov rob.cheshire@noaa.gov
	Recreational catch (landings+discards) estimates, MRIP CVs, and recreational effort estimates	SEFSC	Matt Nuttall Samantha Binion-Rock Drew Cathey	matthew.nuttall@noaa.gov samantha.binion-rock@noaa.gov andrew.cathey@noaa.gov
	Commercial length compositions	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
	Commercial age compositions	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
	Commercial conditional age-at-length compositions	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
	Commercial mean length at age	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Fishery Independent	NMFS bottom longline index, length compositions, age compositions, and conditional age-at-length compositions	SEFSC	Adam Pollack	adam.pollack@noaa.gov
	SEAMAP groundfish trawl index, length compositions, age compositions, and conditional age-at-length compositions	SEFSC	Adam Pollack	adam.pollack@noaa.gov

2.1. Stock Structure and Management Unit

No new literature was identified during SEDAR 85, therefore the stock definition was left unchanged from the SEDAR 22 Benchmark Assessment. The Gulf of Mexico Yellowedge Grouper stock was assumed to be a single unit stock due to the lack of information on stock structure. The management unit for Gulf of Mexico Yellowedge Grouper extends from the

United States–Mexico border in the west through the northern Gulf waters and west of the Dry Tortugas and the Florida Keys (north of US Highway 1).

2.2. Life History Parameters

Life history data used in the assessment included length-length, weight-weight, and length-weight relationships, age and growth, natural mortality, maturity and hermaphroditic transition rates. Some of the life history data were input to the population model (Stock Synthesis) as fixed values, while other life history parameters were estimated. Regional differences were captured in the assessment model by estimating separate growth and natural mortality curves for the Eastern and Western Gulf of Mexico. The remaining life history parameters were the same between regions.

2.2.1. Morphometric and Conversion Factors

Morphometric and conversion factors developed during the SEDAR 22 Benchmark Assessment were not updated during the SEDAR 85 OA, however an error in the a parameter (when converting from millimeters to centimeters) was corrected within the SEDAR 85 OA Base Model (**Figure 2A**). The relationship between gutted weight (in kilograms) and total length (TL in centimeters; $gw = aTL^b$) for both sexes combined was used as a fixed model input and was identical between regions (**Table 1**, **Figure 2A**). Although not a direct input into the model, the whole weight to gutted weight conversion (**Table 1**) was used to convert the recreational landings from whole weight to gutted weight (**Section 2.3.2**).

2.2.2. Age and Growth

The SEDAR 22 Benchmark Base Model estimated growth rates separately for each region and for each sex, with the latter feasible given the inclusion of sex-specific composition data. For SEDAR 85, changes to the input composition data (discussed in **Section 2.3.6**) required modifying how growth was estimated. Given the removal of sex-specific composition data, growth was internally estimated for each region to capture regional differences (Cook 2007) using a von Bertalanffy growth function for both sexes combined (i.e., male and female curves are identical; **Figure 2B**). Input parameters were not updated during SEDAR 85 and therefore were based on starting values used for SEDAR 22 (**Table 2**).

Age data for SEDAR 85 were collected by federal and state sampling programs between 1977 and 2021 and submitted by the Panama City Laboratory of the SEFSC, the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC FWRI; SEDAR85-WP-01) and the Gulf States Marine Fisheries Commission Fisheries Information Network (GulfFIN) (detailed in SEDAR85-WP-08). Age data from the commercial sector and fishery independent monitoring programs were input into the assessment (see **Sections 2.3.7 and 2.4.1-2.4.2**).

To account for uncertainty in the ageing process and for differences between time periods (e.g., due to different readers; SEDAR85-WP-08), standard deviations (SD)-at-age were calculated and used as a measure of ageing error in the assessment model for ages associated with each time period: (1) 1977-2009 (SEDAR 22), (2) 2010-2012, and (3) 2013-2021 (SEDAR 85). For the SEDAR 85 time period, the ageing error model parameters estimated for primary vs reference set reads were used to inform ageing error. The best fit model based on Akaike's Information

Criterion values assumed curvilinear coefficient of variation (CV) for both the reference set and primary readers (SEDAR85-WP-08). Uncertainty in age estimates increased with age (**Table 3**), with wider distributions of observed ages evident for older Yellowedge Grouper (**Figure 3**).

2.2.3. Natural Mortality

As in SEDAR 22, natural mortality (*M*) was modeled using a Lorenzen function, i.e. a size-dependent mortality schedule (Lorenzen 2000) in which the instantaneous mortality rate-at-age is inversely proportional to length-at-age (**Table 4**, **Figure 2C**). Female and male natural mortality were assumed equivalent within a region. The *M* point estimate of 0.073 from SEDAR 22 was not updated for SEDAR 85. This estimate is the mean value of the most likely ranges of *M* based upon catch curves, maximum age-mortality regressions and other life-history-based proxies estimated during SEDAR 22 (SEDAR 2011). Importantly, estimates of *M* from catch curves constructed during SEDAR 22 from the 1977-1980 data (i.e., prior to the onset of the fishery) ranged from 0.068 to 0.078, and likely represent the best estimates for the true value of *M*.

2.2.4. Maturity

Maturity parameters developed during the SEDAR 22 Benchmark Assessment were not updated during the SEDAR 85 OA because no new data were provided. Yellowedge Grouper are protogynous hermaphrodites (i.e., transition from female to male), and all male or transitioning fish were considered mature in this assessment. A logistic relationship was recommended during SEDAR 22 to model maturity as a function of length (SEDAR22-DW-08). The slope was estimated at -0.33 and the length at 50% maturity predicted around 54.88 cm TL (**Figure 4A**). The first age mature based on available data was 6 years (SEDAR22-DW-08). Maturity curves were assumed identical between regions.

2.2.5. Sexual Transition

Sexual transition parameters developed during the SEDAR 22 Benchmark Assessment were not updated during the SEDAR 85 OA because no new data were provided. Hermaphroditism in Stock Synthesis is modeled as the proportion of individuals transitioning at a given age using a scaled cumulative normal distribution based on three parameters. The inflection age represents the age at which 50% of individuals transition to male, and differs from the traditional 50% probability of being male, which was predicted around 22 years (SEDAR22-DW-08; **Figure 5**). The SD controls how quickly the asymptote is reached. Lastly, the maximum value represents the asymptotic proportion of transition, and can be less than 1 if females still occur in the plus group (i.e., not 100% transition by the maximum age). Not all females are thought to undergo transition because large females occur in the population (Bullock et al. 1996; Keener 1984), with the SEDAR 22 Benchmark Base Model estimating a much larger fraction of females remaining in the population at ages 40+ (~20%; **Figure 4B**). The hermaphroditism transition function parameters recommended during SEDAR 22 for input in Stock Synthesis were: inflection age = 41, SD in age = 14.63 and asymptote = 0.47 (**Figure 5**). The sex ratio at birth (**Figure 4B**) was 100% females and females were assumed to first transition at age-5 (new option introduced in Stock Synthesis version 3.30.17). The probability of transition was assumed identical between regions.

2.2.6. Fecundity

Fecundity parameters used during the SEDAR 22 Benchmark Assessment (i.e., $eggs = aL^b$ where a and b were obtained from the length-weight relationship; **Table 1**) were not updated during the SEDAR 85 OA because no new data were provided (note the small difference due to the correction in the a parameter of the length-weight conversion discussed in **Section 2.2.1**; **Figure 4C**). The SEDAR 22 Benchmark Assessment recommended using combined male and female spawning stock biomass (SSB) as a measure of reproductive potential (i.e., SSB equivalent to body weight, **Figure 4C**). This implies that 1 kilogram of male biomass is equally important to the likelihood of spawning success as 1 kilogram of female biomass and is recommended in situations where the potential for decreased fertility is moderate or unknown (Brooks et al. 2008). Estimated sex ratios for Yellowedge Grouper from field collections have ranged from 36% in the late 1970s (Bullock et al. 1996) to 24% for data collected between 1999 and 2009 (SEDAR 2011).

2.2.7. Discard Mortality

Discard mortality estimates were unchanged from those recommended by the SEDAR 22 Benchmark Assessment. Given the continued lack of information available regarding Yellowedge Grouper discard mortality, it is assumed to be 100% given the depths fished and common information regarding the condition of captured fish (SEDAR 2011).

2.3. Fishery-Dependent Data

2.3.1. Commercial Landings

Commercial landings data (1975-2021) used in the assessment are presented in **Table 5** and **Figure 6**. Commercial landings for Yellowedge Grouper were constructed using data housed in NOAA's Southeast Fisheries Science Center's (SEFSC) Accumulated Landings System (ALS) and from state trip ticket programs when available: Texas 2014+, Louisiana 2000+, Mississippi 2014+, Alabama 2002+, and Florida 1985+. Landings from the Grouper-Tilefish Individual Fishing Quota (IFQ) program were used for 2010 to 2021 since Yellowedge Grouper fall within the Deepwater Grouper complex quota. Commercial landings begin in 1975 (**Table 5**), which corresponds to the beginning of the commercial fishery for this deepwater species using vertical line gears. For the assessment, commercial landings were partitioned into four fleets that represent the two main commercial harvesting gears in each region (Eastern Gulf of Mexico and Western Gulf of Mexico): (1) vertical line or handline and (2) longline (**Section 3.1.6**). For SEDAR 85, landings by other gears (<0.16% overall; SEDAR85-WP-07) were lumped into the vertical line fleets so no landings were excluded (as in SEDAR 22). Landings in both regions have been predominantly by longline gears since their use increased in the early 1980s (**Figure 7**).

During SEDAR 22, the reconstruction of Yellowedge Grouper landings required a number of decisions and assumptions related to: the mis-identification or mis-labeling of Yellowedge Grouper as Yellowfin Grouper between 1975 and 1990 Gulf-wide (documented in Prytherch 1983); the onset of the deepwater longline fishery; and the proportion of unclassified groupers attributed to Yellowedge Grouper, which was handled differently between time periods (pre-1986 and post-1986) and fisheries (longline vs vertical line). While most SEDAR 22 methodologies to estimate commercial landings of Yellowedge Grouper were followed as closely as possible, a few notable changes were made for SEDAR 85 (SEDAR85-WP-07).

Instead of interpolating the longline landings between 1982 and 1986 as done in SEDAR 22, SEDAR 85 interpolated the proportion used in 1982 to assign unclassified groupers to Yellowedge Grouper and the proportion of Yellowedge Grouper to all classified groupers in 1986. The calculated proportions from the linear interpolation were then used to assign unclassified grouper landings from 1983-1985 to Yellowedge Grouper. The reasoning for this deviation from SEDAR 22 was that the reported unclassified grouper landings from 1983-1985 are not linear and therefore a linear interpolation of the proportions seemed more appropriate for these years, as it assumes a smooth transition from the species composition in 1982 to that of 1986.

Another deviation affecting landings for the longline and vertical line fisheries was in relation to the methodology for calculating the proportion of Yellowedge Grouper to all classified groupers to apportion unclassified grouper landings from 1986 onward. For SEDAR 22, all grouper species were included in the calculation of the proportion of Yellowedge Grouper. For SEDAR 85, Warsaw and Goliath Grouper were excluded because those species had already been reported to species for several years prior to the beginning of the Yellowedge Grouper fishery. Therefore, the likelihood of Warsaw or Goliath Grouper being lumped in as unclassified groupers was considered very low.

Commercial landings were reported in pounds gutted weight and converted to metric tons for input into the assessment model. Uncertainty estimates for landings from the Gulf of Mexico were not provided during the SEDAR 22 Benchmark Assessment. Uncertainty estimates based on expert opinion were developed during the SEDAR 68 Gulf of Mexico Scamp Grouper Research Track Assessment by state (**Table 6**; SEDAR 2021b). Since Yellowedge Grouper were caught across the Gulf of Mexico, state-specific error estimates were multiplied by state landings to produce a weighted-error estimate for annual landings by fleet (**Table 7**). These error estimates were used in the SEDAR 85 OA Base Model for 1975-2009, whereas an error of 0.01 was implemented since 2010, corresponding to the implementation of the IFQ program in the Gulf of Mexico. More uncertainty is incorporated into the landings estimates in the earlier years of the time series (**Figure 6**).

Data Updates TWG Recommendations:

The Data Updates TWG reviewed the development and comparison of commercial landings estimates from SEDAR 85 and SEDAR 22. Below is a summary of the major issues discussed and decisions by the TWG.

1. *Commercial methodology*: Use the updated time series of commercial landings as provided given improvements to the methodology.
2. *Uncertainty in landings*: Consider increasing error estimates for landings estimates to better represent our uncertainty in landings, especially in the earlier years.
3. *Low landings scenario for Commercial Longline East 1979-1982*: Explore the influence of these early data in a sensitivity run (discussed in **Section 3.4.8**).

2.3.2. Recreational Landings

Recreational landings data (1981-2021) used in the assessment are presented in **Table 8**. Recreational landings of Yellowedge Grouper were estimated using fully calibrated estimates from the Marine Recreational Information Program (MRIP) using the Fishing Effort Survey (FES) and the redesigned Access Point Angler Intercept Survey (SEDAR85-WP-03), Texas Parks and Wildlife Department (SEDAR85-WP-03), Louisiana Creel survey (SEDAR85-WP-03), and the Southeast Regional Headboat survey (see SEDAR85-WP-02). While estimates by region were provided to the assessment analyst for each data source, only Gulf-wide estimates can be publically released due to confidentiality issues with the Southeast Regional Headboat survey data.

Even with the transition from the Marine Recreational Fisheries Statistics Survey (MRFSS) used during SEDAR 22 to using MRIP-FES data for SEDAR 85, recreational landings are still very minor (2% overall) when compared to commercial landings (**Figure 8**). Recreational landings remain sporadic and low, with annual landings estimates typically less than 5,000 pounds gutted weight in many years (**Table 8**; **Figure 8**). Even though recreational spikes are present in the data (e.g., 1982 in the East), the total commercial landings in these years dwarf the recreational landings estimates (**Figure 8**).

Following SEDAR 22, recreational landings by region were added to their respective Commercial Vertical Line fleets given similarities in gear types and fishing behavior.

Data Updates TWG Recommendations:

The Data Updates TWG reviewed the comparison of recreational landings estimates from SEDAR 85 and SEDAR 22. Below is a summary of the major issues discussed and decisions by the TWG.

1. *1982 recreational estimate in the East*: Replace the 1982 estimate (from private mode) with the mean of 1981-1985. The validity of this data point was questioned because: (1) it was much larger than any other value observed, even in more recent years where fishing effort and capability has increased; (2) it was driven by a single intercept survey of 1 angler trip where 15 Yellowedge Grouper were reportedly landed but not seen by the interviewer (SEDAR85-WP-03); and (3) it had a CV of 1. This logic and decision was consistent with recent decisions (e.g., Gulf Gag Grouper, SEDAR 2021a), although in this case the arithmetic mean of 1981-1985 was used because all neighboring years were 0. This resulted in an 80% decrease in the point estimate of landings for 1982 (from ~660,000 gutted pounds down to ~132,000 gutted pounds).
2. *Recreational data*: Consider excluding all recreational landings and dead discards (see **Section 2.3.4**) in a sensitivity run to demonstrate the influence of these data on the assessment. Given their low magnitude, little effect on the assessment is expected. All MRIP-FES landings estimates in the East with the exception of 2019 have a CV > 0.5. Uncertainty associated with landings estimates in the West vary, but are high (>0.5) in about half of the years (2005-2007, 2009, 2013, 2017, and 2020).

2.3.3. Commercial Discards

Commercial discards (1993-2021) for the longline fishery used in SEDAR 85 are presented in **Table 9**. The commercial discards for Gulf of Mexico Yellowedge Grouper were estimated using methods revised since SEDAR 22 and recently applied for Gulf of Mexico Red Grouper, Gray Triggerfish, Vermilion Snapper, Scamp Grouper, Greater Amberjack, Gag Grouper, and Red Snapper. The improved methodology uses catch per unit of effort (CPUE) from the coastal observer program and total fishing effort from the commercial reef logbook program to estimate total catch. A full description of the discards and CPUE-expansion estimation procedures is given in SEDAR85-WP-06. Overall, discards in weight by the longline fishery accounted for less than 1% of the total catch (kept + discards) between 1993 and 2021 (**Figure 8**). Discards from the vertical line fishery were considered negligible, as only 7 observer trips between 2007 and 2021 reported discarding of a Yellowedge Grouper.

Following SEDAR 22, dead discards by the commercial longline fleet were added into landings for each region, with an assumed discard mortality rate of 100% (SEDAR 2011).

2.3.4. Recreational Discards

Recreational discards in numbers of Yellowedge Grouper were estimated using fully calibrated estimates from MRIP using FES and the redesigned Access Point Angler Intercept Survey (SEDAR85-WP-03), Texas Parks and Wildlife Department, Louisiana Creel survey, and Southeast Regional Headboat survey (SEDAR85-WP-02). For the Charter and Private recreational fishing modes, most years exhibited low to no discarded Yellowedge Grouper, with the exception of a few years in the 1990s where discards ranged from 41 to 12,769 Yellowedge Grouper (SEDAR85-WP-03). For Headboat, only 16 Yellowedge Grouper were estimated to be discarded from 2004-2021 (SEDAR85-WP-02). While estimates by region were provided to the assessment analyst for each data source, only Gulf-wide estimates can be publically released due to confidentiality issues with the Southeast Regional Headboat survey data.

Following SEDAR 22, dead discards by the recreational fishing modes were added to landings for the Commercial Vertical Line fishery, with an assumed discard mortality rate of 100% (SEDAR 2011). Discards in numbers by mode (Charter-Private and Headboat) and region were multiplied by half the average weight of Yellowedge Grouper landed by each mode. Using data from 1981 through 2021, the average weight of Yellowedge Grouper landed by Charter-Private was 8.85 gutted pounds in the East and 8.84 gutted pounds in the West. Using data from 1986 through 2021, the average weight of Yellowedge Grouper landed by headboats was 7.53 gutted pounds in the East and 6.65 gutted pounds in the West. SEDAR 22 used an average weight of 5.6 pounds (from the headboat fishery) and added recreational dead discards in equal proportions to the East and West.

2.3.5. Total Catch (Commercial + Recreational)

Commercial Vertical Line landings were considerably higher throughout the 1970s and 1980s compared to more recent decades in both regions (**Figure 9**). Commercial Longline landings have remained relatively stable in both regions since the early 1990s, with much larger landings estimates in the early 1980s at the beginning of the fishery (**Figure 9**).

Overall, large differences (>10%) were evident in landings estimates provided for SEDAR 85 compared to SEDAR 22 (**Figure 9**; **Tables 10-11**). This result is not unexpected given the changes in landings inputs summarized in **Section 2.3.2** and further detailed in SEDAR85-WP-07. Differences in Vertical Line landings (**Figure 9**; **Table 10**) are attributed to the change in species considered when parsing out unclassified groupers and the proportions used (SEDAR85-WP-07) combined with differences in the recreational landings obtained from MRIP-FES (SEDAR85-WP-03). Differences in the Longline landings (**Figure 9**; **Table 11**) are attributed to changes in interpolations and proportioning of unclassified groupers (SEDAR85-WP-07).

2.3.6. Commercial Size Composition

The commercial data sources used to generate length compositions include length sample data collected by the Trip Interview Program (1983-2021) and three historical data sets 1) Bullock data set collected by Bullock (FWRI), Godcharles (NMFS) and Crabtree (FWRI) from 1977-1984, 2) Johnson data set collected by Lucious Johnson (1982-1983), and 3) Prytherch data set collected by Prytherch et al. (1983). Annual length compositions were combined into 2-cm Total Length interval bins (8:128 cm TL) following the SEDAR 22 Benchmark Assessment.

Overall, length compositions of Yellowedge Grouper landed by the Commercial Vertical Line fishery peaked between 40-50 cm TL in the East and 60 cm TL in the West (**Figure 10**). Annual Vertical Line length compositions of Yellowedge Grouper landed in the East (1978-2019) and West (1984-2021) are presented in **Figures 11-12**, respectively. Input sample sizes for the East averaged 152 length observations (range: 31-637) and for the West averaged 252 length observations (range: 32-738).

Overall, length compositions of Yellowedge Grouper landed by the Commercial Longline fishery peaked around 60 cm TL in the East and 70 cm TL in the West (**Figure 10**). Annual Longline length compositions of Yellowedge Grouper landed in the East (1980-2021) and West (1984-2021) are presented in **Figures 13-14**, respectively. Input sample sizes for the East averaged 1,609 length observations (range: 94-10,172) and for the West averaged 526 length observations (range: 31-1,995).

SEDAR 22 used nominal length compositions and also estimated length compositions by sex (female, male, and unknown), with sex based on histological assignment if available or macroscopic assignment (more frequently used) if reported. The vast majority of the available length data are for individuals with unknown sex. Length composition sample sizes in SEDAR 22 were input in numbers of length observations capped at a maximum effective sample size of 200 to prevent the length composition data from driving the model fitting process. For SEDAR 85, the new Dirichlet-Multinomial likelihood was used to adjust input sample sizes, as such capping the sample size was no longer necessary. The input sample size associated with each year/fleet was set as the number of length observations. Unfortunately the number of trips was not consistently available across data streams, and therefore the number of trips was not used as the input sample size for this assessment.

Data Update TWG Recommendations:

The Data Updates TWG reviewed the development and appropriateness of using sex-specific compositions during SEDAR 85. Below is a summary of the major issues discussed and decisions by the TWG.

1. *Sex-specific composition data*: Do not use due to data quality (sex assignment) and data quantity (low sample sizes); aggregate all female, male and unsexed samples into a single composition for each fleet and year. More recently, the life history experts at the SEFSC's Panama City Laboratory have suggested only using histology to assign sex given concerns over macroscopic identification issues for hermaphroditic species.
2. *Sample size cutoffs for inclusion in the assessment*: Use sample size cutoffs of 30 lengths for fishery length compositions based on recent best practices for developing compositions.
3. *Use weighted length compositions if possible*: Weight the fishery length compositions by regional landings as feasible. For each fleet in the East, length data of landed Yellowedge Grouper from the commercial trip intercept program and GulfFIN were aggregated into two major sub-regions (east, central) and weighted based on the distribution of landings estimates between sub-regions (SEDAR85-WP-04). No weighting scheme was undertaken in the West due to a lack of finer-scale landings. A detailed description of the revised methodology, data filtering, results and data limitations are discussed in SEDAR85-WP-04.

2.3.7. Commercial Age Composition

Conditional age-at-length compositions of Yellowedge Grouper landed by each fleet were initially used in the assessment following SEDAR 22 but resulted in poor fits, notably large residuals and undesirable residual patterns. Including conditional age-at-length compositions can contain more detailed information about the relationship between size and age, and can assist in the estimation of growth parameters, especially the variance of size-at-age (Methot et al. 2023). While the use of conditional age-at-length is considered best practices for integrated assessment models when data allow, the validity of this approach is contingent upon the assumption that each age observation is a random sample from the population for a given length bin. Recent assessments for Gulf of Mexico Gag Grouper (SEDAR 2021a) and Scamp Grouper (SEDAR 2021b) also attempted to input conditional age-at-length, but model fits were poor and results suggested that the conditional age-at-length data may not be appropriate, as observed here for Gulf of Mexico Yellowedge Grouper. If sampling has been opportunistic during some of the time period, the assumptions for using conditional age-at-length are likely violated. As a result, annual nominal age compositions were input into the model along with input sample sizes reflective of the number of ages (≥ 10).

Overall, age compositions of Yellowedge Grouper landed by the Commercial Vertical Line fishery peaked around 10 years in the East and around 13 years in the West (**Figure 15**). Annual Vertical Line age compositions of Yellowedge Grouper landed in the East and West are presented in **Figures 16-17**, respectively. Input sample sizes for the East averaged 52 ages (range: 12-183) and for the West averaged 139 ages (range: 10-412). Cohorts were not apparent in either region. Concerns over the representativeness of the 2010-2012 age data led to the exclusion of these years from modeling, given the lack of documentation on how ages were subsampled (SEDAR85-WP-08) and glaring residuals during model development.

Overall, age compositions of Yellowedge Grouper landed by the Commercial Longline fishery peaked around 12 years in the East and around 15 years in the West (**Figure 15**). Annual Longline age compositions of Yellowedge Grouper landed in the East and West are presented in

Figures 18-19, respectively. Input sample sizes for the East averaged 314 ages (range: 20-693) and for the West averaged 190 ages (range: 11-475). Cohorts were not apparent in either region. Concerns over the representativeness of the 2010-2012 age data led to the exclusion of these years from modeling, given the lack of documentation on how ages were subsampled (SEDAR85-WP-08) and glaring residuals during model development.

A mean length-at-age vector for each year and fleet was included in the model for comparison between the model expected length-at-age and the observed length-at-age.

2.3.8. Commercial Catch Per Unit of Effort (CPUE) Indices of Abundance

Two commercial CPUE indices of relative abundance were used in the SEDAR 22 assessment. The pre-IFQ index for the Commercial Longline - East and Commercial Longline - West fleets were recommended for use because of their long and fairly consistent time series before the frequent implementation of regulations (i.e., 2010+). The standard errors (SEs, converted from CV, see **Section 3.2**) as well as all index values by source are presented in **Table 12**, and the indices are shown in **Figure 20**. The East index had less uncertainty (mean SE = 0.19) compared to the West index (mean SE = 0.32). These indices remain unchanged from SEDAR 22 (**Figure 21**) and were not updated for SEDAR 85 because the implementation of the IFQ system is believed to have changed fishing behavior and catchability compared to the earlier years. Therefore, indices developed for IFQ years may not represent the relative abundance of the stock (see SEDAR 68 Gulf of Mexico Scamp Grouper Research Track Stock Assessment Report [SEDAR 2021b] for further discussion).

2.4. Fishery-Independent Surveys

2.4.1. NMFS Bottom Longline Survey

The NMFS Mississippi Laboratories have 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. These surveys are conducted annually and provide an important source of fisheries independent information on large coastal sharks, snappers and groupers from the Gulf of Mexico and Atlantic. In 2011, a Congressional Supplement Sampling Program was conducted where high levels of survey effort were maintained from April through October. For this analysis, only Congressional Supplement Sampling Program data collected during the same time period as the annual survey (August in the East and September in the West) were used to supplement missing data from the NMFS Bottom Longline Survey in 2011.

As in SEDAR 22, a standardized index was developed using NMFS Bottom Longline Survey data and standard delta-lognormal methods (SEDAR85-WP-09). Only data from stations within the depth range of capture for Yellowedge Grouper (i.e. 70 – 365 m) were used. Indices started in 2000 when circle hooks were employed because J hooks used in earlier years had led to low encounters with Yellowedge Grouper (Henwood et al. 2005). Survey year 2005 was dropped from the analysis in the West because of Hurricane Katrina. Survey year 2020 was dropped in both regions due to the COVID-19 pandemic. All SEDAR 85 index values fell within the confidence interval for the SEDAR 22 index, and the trends between indices were very similar (**Figure 21**). In the Western Gulf of Mexico, relative abundance peaked in 2010, remained above average until 2014, and has declined since, with the lowest level identified in 2021. In the Eastern Gulf of Mexico, relative abundance peaked in 2009, was lowest in 2001, and has generally remained below average since 2010 with the exception of 2011 and 2016. Both indices exhibited relatively high uncertainty estimates (East mean SE 0.48, West mean CV 0.44; **Table 12**).

Overall, length compositions of Yellowedge Grouper caught by the NMFS Bottom Longline Survey peaked around 60 cm TL in the East and 80 cm TL in the West (**Figure 22**). Survey length compositions of Yellowedge Grouper for East (2000-2021) and West (2000-2021) are presented in **Figures 23-24**. Input sample sizes for the East and West averaged 16 length observations (range: 5-49) and 13 length observations (range: 2-56), respectively. While length data prior to 2000 were used in SEDAR 22, these years were excluded in SEDAR 85 because of differences in hook size which could affect selectivity (SEDAR85-WP-09).

Overall, age compositions of Yellowedge Grouper caught by the NMFS Bottom Longline Survey peaked around 11 years in the East and 9 years in the West (**Figure 25**). Survey age compositions of Yellowedge Grouper for the East (2000-2021) and the West (2000-2021) are presented in **Figures 26-27**. Input sample sizes for the East and West averaged 15 ages (range: 5-43) and 13 ages (range: 2-47), respectively. Cohorts were not apparent in either region. While age data prior to 2000 were used in SEDAR 22, these years were excluded in SEDAR 85 because of differences in hook size which could affect selectivity (SEDAR85-WP-09).

Data Update TWG Recommendations:

The Data Updates TWG reviewed the development and use of sex-specific compositions during SEDAR 85. Below is a summary of the major issues discussed and decisions by the TWG.

1. *Sex-specific composition data*: Do not use due to data quality (sex assignment) and data quantity (low sample sizes); aggregate all female, male and unsexed samples into a single composition for each fleet. More recently, the life history experts at the SEFSC's Panama City Laboratory have suggested only using histology to assign sex given concerns over macroscopic identification issues for hermaphroditic species.
2. *Sample size cutoffs for inclusion in the assessment*: Use all available fishery-independent data for developing compositions as feasible.

2.4.2. NMFS/SEAMAP Groundfish Trawl Survey

Standardized trawl surveys have been conducted in the Gulf of Mexico since 1972 and continued under the Southeast Area Monitoring and Assessment Program (SEAMAP) in 1982 and 1987 for the summer and fall, respectively. The primary objective of this trawl survey conducted semi-annually is to collect data on the abundance and distribution of demersal organisms in the northern Gulf of Mexico. Prior to 2009, the summer survey did not sample from Mobile Bay, Alabama eastward to Florida. Full survey details can be found in Nichols (2004).

While juvenile Yellowedge Grouper indices were produced and reviewed during SEDAR 22, they were ultimately not used in the assessment model because of very low sample sizes. However, composition data were reviewed and incorporated into the SEDAR 22 Benchmark Base Model because of their potential utility in informing recruitment estimates. Survey length compositions of Yellowedge Grouper for East (1987-2021) and West (1988-2019) are presented in **Figures 28-29**. Input sample sizes for the East and West averaged 2 length observations (range: 1-8) and 5 length observations (range: 1-15), respectively. For both regions, length compositions of Yellowedge Grouper peaked around 15 cm TL, with very few Yellowedge Grouper observed larger than 30 cm TL (**Figure 22**).

Overall, the NMFS/SEAMAP Groundfish Trawl Survey tended to capture age-1 Yellowedge Grouper most frequently in the West, with only a few encounters occurring in the East, albeit at very different ages (**Figure 25**). Age compositions from the East were not fit to in the model due to very low sample sizes (N = 4; **Figures 25, 30**). While more annual data were available from the West, sample sizes averaged 7 fish (range: 1 to 14 fish). Therefore, the West age data were aggregated across years (2000-2009; **Figures 25, 31**), while still allowing the model to take into account relative differences in sample size across years. This was implemented in Stock Synthesis using the super-period approach (Methot et al. 2023).

Data Update TWG Recommendations:

The Data Updates TWG reviewed the development and use of sex-specific compositions during SEDAR 85. Below is a summary of the major issues discussed and decisions by the TWG.

1. *Sex-specific composition data*: Do not use due to data quality (sex assignment) and data quantity (low sample sizes); aggregate all female, male and unsexed samples into a single composition for each fleet. More recently, the life history experts at the SEFSC's Panama City Laboratory have suggested only using histology to assign sex given concerns over macroscopic identification issues for hermaphroditic species.
2. *Sample size cutoffs for inclusion in the assessment*: Use all available fishery-independent data for developing compositions as feasible.

2.5. Environmental Considerations and Contributions from Stakeholders

2.5.1. Red Tide

Red tide blooms caused by the dinoflagellate *Karenia brevis* have been hypothesized to cause severe mortality for shallow-water grouper species such as Red Grouper (SEDAR 2019) and Gag Grouper (SEDAR 2021a). Although fish kill observations often originate from beach sightings, blooms can impact offshore species as well, as blooms generally start offshore at depth (Steidinger and Vargo 1988). No evidence of red tide mortality was presented during the SEDAR 85 OA for Yellowedge Grouper. A review of the literature highlighted no mention of Yellowedge Grouper in red tide fish kills (Smith 1975, Driggers et al. 2015) or as potential species vulnerable to red tides according to local ecological knowledge interviews (Blake et al. 2023). Red tide mortality for Yellowedge Grouper was estimated by the West Florida Shelf Ecospace model (Vilas et al. 2023) but was very minor (via the Shiny app linked in Vilas et al. 2023), with the results requiring additional vetting of Yellowedge Grouper data inputs and Ecospace model predictions. Adult Yellowedge Grouper likely inhabit deeper areas less affected by red tides, however younger individuals may be more vulnerable to red tides depending upon their spatial distribution. Collectively, red tide mortality was not considered a major source of mortality for Gulf of Mexico Yellowedge Grouper at this time.

2.5.2. Deepwater Horizon Oil Spill

Negative effects of the Deepwater Horizon (DWH) oil spill have been hypothesized on marine resources due to the vast amount of oil spilled and the subsequent use of oil dispersant into the affected areas. Monitoring of reef fish communities in the region post-DWH did not identify Yellowedge Grouper in their results, suggesting they were not observed (Lewis et al. 2020). However, some negative impacts have been reported, such as elevated skin lesion prevalence for deep-dwelling shelf species such as Yellowedge Grouper (Murawski et al. 2014). Pulster et al. (2020) observed increased (800%) concentrations of polycyclic aromatic hydrocarbon in liver tissues of Yellowedge Grouper. Another study conducted by Granneman et al. (2017) did not detect significant multivariate structure within Yellowedge Grouper metal concentrations between lesioned and non-lesioned individuals. Unfortunately, a clear mechanism for incorporation into the stock assessment model is currently lacking. It is unclear whether the DWH event caused mass mortalities to deepwater species, and/or whether it led to reduced reproductive potential via poor body condition or reduced recruitment.

3. Stock Assessment Model Configuration and Methods

3.1. Stock Synthesis Model Configuration

The assessment model used was Stock Synthesis, version 3.30.21.00. Descriptions of algorithms and options are available in the User's Manual (Methot et al. 2023), the NOAA Fisheries Toolbox website (*http://nft.nefsc.noaa.gov/*), and Methot and Wetzel (2013). Stock Synthesis is a widely used integrated statistical catch-at-age model that has been tested for stock assessments in the United States (US), particularly on the West Coast and Southeast, and also throughout the world (see Dichmont et al. 2016 for review). Statistical catch-at-age models consist of three closely linked modules: the population dynamics module, an observation module, and a likelihood function. Input biological parameters (**Section 2.2**) are used to propagate abundance and biomass forward from initial conditions (population dynamics model) and Stock Synthesis develops expected data sets based on estimates of fishing mortality (F), selectivity, and catchability (the observation model). The observed and expected data are compared (the likelihood module) to determine best fit parameter estimates using a statistical maximum likelihood framework (detailed in Methot and Wetzel [2013]). Because many inputs are correlated, the concept behind Stock Synthesis is that processes should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment.

The Stock Synthesis modeling framework provides estimates for key derived quantities including: time series of recruitment (units: 1,000s of age-0 recruits), abundance (units: 1,000s of fish), biomass (units: metric tons), SSB (units for Yellowedge Grouper: male and female combined SSB in metric tons), and exploitation or harvest rate (units for Yellowedge Grouper: total biomass killed all ages / total biomass age 1+). The r4ss software (Taylor et al. 2021) was utilized extensively to develop various graphics for model outputs and was also used to summarize various output files and perform diagnostic runs. The ss3diags software (Carvalho et al. 2021) was also used to perform additional diagnostics.

3.1.1. Initial Conditions

The Gulf of Mexico Yellowedge Grouper assessment begins in 1975 and has a terminal year of 2021. Historical landings of Yellowedge Grouper prior to 1975 were assumed negligible because the deepwater fishery generally began in the mid to late 1970s (detailed in SEDAR 2011). The Gulf of Mexico Yellowedge Grouper stock was assumed to be at or close to virgin fishing conditions in 1974. While a later start year of 1986 was explored to remove the considerable uncertainty in pre-1986 landings, the model results were questionable given differences in model derived quantities between regions. This behavior was likely due to the limited contrast in landings when starting in 1986, because the model missed the large removals in the Eastern Gulf of Mexico. Starting the model in a fished state in 1986 would require a more thorough review of input data and model assumptions (e.g., how to specify initial equilibrium catches).

3.1.2. Temporal Structure

The Yellowedge Grouper population was modeled from age-0 (Stock Synthesis starts at age-0; Methot et al. 2023) through age-40, with data bins spanning age-0 through age-40+, with the last age representing a plus group (encompassing only ~2% of otoliths). The population was not modeled through the maximum age of 85 years because this would have substantially increased model run time. Data collection and fishing activities were assumed relatively continuous throughout the year; therefore, inclusion of a seasonal component to the removals was not deemed necessary. The fishing season was assumed to be continuous and homogeneously distributed throughout the year.

3.1.3. Spatial Structure

Two areas (East and West) were modeled assuming a single spawning population and associated stock-recruit function. The two areas were split roughly by the Mississippi River, with the East encompassing NMFS statistical grids 1-12 and the West encompassing NMFS statistical grids 13-21 (SEDAR85-WP-07). Total annual recruitment is estimated for the entire Gulf of Mexico, and then allocated to each area using region-specific apportionment factors (detailed in **Section 3.1.5**). Justification for separating the Eastern and Western Gulf of Mexico during SEDAR 22 included historical groupings of fishing areas (Prytherch 1983) and differing species compositions of bottom longline trips between regions (SEDAR 2011). Further, differences in growth and natural mortality estimates were identified between regions, with Yellowedge Grouper in the Western Gulf of Mexico observed to be larger and older (Cook 2007; SEDAR22DW-08; SEDAR 2011).

3.1.4. Life History

A fixed length-weight relationship was used to convert body length (cm TL) to body weight (kg gutted weight; **Table 1, Figure 2A**) and was consistent between regions. Stock Synthesis moves fish among age classes and length bins on January 1st of each modeled year starting from birth at age-0. Because the ‘true’ birth date often does not occur on January 1st, some slight alterations in growth (t_0, or the age at length 0) and *M* parameters may be required to account for the difference between true age and modeled age when parameters are input as fixed parameters instead of estimated within Stock Synthesis. Following SEDAR 22, these adjustments were not made for Yellowedge Grouper because of considerable uncertainty in peak spawning month (SEDAR85-WP-08; Cook 2007).

Growth within Stock Synthesis was modeled with a three parameter von Bertalanffy equation: (1) L_{Amin} (cm TL), the mean size at age-0 Yellowedge Grouper; (2) L_{Amax} (cm TL), the mean size at maximum aged Yellowedge Grouper; and (3) K (year^{-1}), the growth coefficient. In Stock Synthesis, when fish recruit at the real age of 0.0 they have a body size equal to the lower limit of the first population bin (fixed at 4 cm TL for Yellowedge Grouper). Fish then grow linearly until they reach a real age equal to the input value of A_{min} (growth age for L_{Amin}; age-0 for Yellowedge Grouper) and have a size equal to L_{Amin}. As they age further, they grow according to the von Bertalanffy growth equation (**Figure 2B**). L_{Amax} was specified as equivalent to $L\infty$. Two additional parameters are used to describe the variability in size-at-age and represent the CV in length-at-age at A_{min} (age-0) and A_{max} (age-40). For intermediate ages, a linear interpolation of the CV on mean size-at-age is used.

Diverging from SEDAR 22, growth rates were estimated for each region (and not by sex) in the SEDAR 85 OA Base Model because of data quality concerns regarding sex-specific composition data (discussed in **Section 2.3.6**). The von Bertalanffy parameters (L_{Amax} [i.e., $L\infty$], and K) were re-estimated internally to Stock Synthesis using updated length and age compositions, with starting values obtained from the SEDAR 22 Benchmark Assessment Data Workshop recommendations (**Table 2**). Following SEDAR 22, L_{Amin} was fixed at the mean value (5 cm TL) when externally estimating the growth curve during SEDAR 22 because sparse age-0 and age-1 Yellowedge Grouper data led to highly variable estimates of L_{Amin}. Variance parameters CV_{Amin} (0.163) and CV_{Amax} (0.116) were fixed at the values recommended at the SEDAR 22 Data Workshop (**Table 2**).

Age-specific M was specified in the SEDAR 85 OA Base Model using the Lorenzen option in Stock Synthesis and a reference age of 15 years (**Table 4, Figure 2C**). A reference age of 15 years was estimated externally during SEDAR 22 as the age where the input M of 0.073 was realized (see **Section 2.2.3**). The Lorenzen function scales M according to the growth curve, so the actual scaling of M varies according to the growth rates in the different regions.

The assessment model was set-up with two sexes to account for the reproductive biology of Yellowedge Grouper. As protogynous hermaphrodites, Yellowedge Grouper are born female (i.e., 100% female at birth), and starting at age-5, a portion of the population transitions to male. The two-sex model treated males and females identically, and data were input as combined due to the lack of reliable sex-specific data (discussed in **Section 2.3.6**). Immature females transitioned to mature females based on a fixed logistic function of length (**Section 2.2.4**; **Figure 4A**). The three required parameters to define the hermaphroditism transition rate (inflection age = 41, SD in age = 14.63, and asymptote = 0.47) were estimated externally to Stock Synthesis during SEDAR 22 (**Section 2.2.5**) and fixed in the SEDAR 85 OA Base Model (**Figure 5**). This change in the parameterization of hermaphroditism resulted in a smaller fraction of females in the plus group compared to SEDAR 22 (**Figure 4B**). Reproductive potential was defined in terms of male and female combined SSB (i.e., SSB equivalent to body weight, **Section 2.2.6**; **Figure 4C**).

3.1.5. Recruitment Dynamics

A Beverton-Holt stock-recruit function was used to parameterize the relationship between spawning output and resulting recruitment of age-0 fish. The stock-recruit function (representing the arithmetic mean stock-recruit levels) requires three parameters: (1) steepness characterizes the initial slope of the ascending limb (i.e., the fraction of virgin recruits produced at 20% of the equilibrium spawning biomass); (2) the virgin recruitment (R_0, estimated in log space; ln(R_0)) represents the asymptote or virgin recruitment levels; and (3) the variance or recruitment variability term (*SigmaR*) which is the SD of the log of recruitment (it both penalizes deviations from the stock-recruit curve and defines the offset between the arithmetic mean stock-recruit curve and the expected geometric mean from which the deviations are calculated).

The SEDAR 22 Benchmark Base Model estimated steepness using a prior and fixed *SigmaR* at 0.2, while freely estimating ln(R_0). The parameterizations of steepness and *SigmaR* were re-evaluated when building the SEDAR 85 OA Base Model. Steepness was fixed at a biologically plausible value of 0.827 because it was not estimable as evident by likelihood profiling analyses (discussed in **Section 3.4.3**). This value was obtained from the FishLife R package, which was used during the SEDAR 68 Gulf of Mexico Scamp Research Track Assessment to develop a biologically plausible value for steepness (SEDAR 2021b). FishLife synthesizes life history data and produces estimates of life history inputs (such as steepness) based on available studies of the target species and congeners (Thorson et al. 2017a). *SigmaR* was re-evaluated and fixed at 0.5 after reviewing diagnostics for an intermediate run, where the model was estimating unrealistically high values (>1) and *SigmaR* was poorly estimated as evident by likelihood profiling analyses (discussed in **Section 3.4.3**). More variability in recruitment estimates was expected given the additional years of NMFS/SEAMAP Groundfish Trawl length composition data included in the SEDAR 85 OA Base Model (20 years in the East [5 years for SEDAR 22] and 32 years in the West [9 years for SEDAR 22]).

Spawning stock was assumed to be the total spawners in both regions and a single parameter defining the fractional allocation of age-0 recruits was estimated. Total annual recruitment is estimated for the entire Gulf of Mexico, and then allocated to each area using region-specific apportionment factors. A logit transform is utilized to estimate the proportion of recruits apportioned to each region. Because the logit transform ensures automatic scaling and summation to 1.0 across the estimated parameters (i.e., ensuring that all recruits are apportioned to an area), only one of the apportionment factors needs to be estimated while the remaining parameter is fixed at 0 (Methot et al. 2023).

Annual deviations from the stock-recruit function were estimated in Stock Synthesis as a vector of deviations forced to sum to zero and assuming a lognormal error structure. A lognormal bias adjustment factor was applied to recruitment estimates as recommended by Methot et al. (2023).

For the SEDAR 85 OA Base Model, main period (i.e., data rich, when representative length or age composition data are available) recruitment deviations spanned 1975-2012. No recruitment deviations were estimated in the early period (i.e., pre-1975) because their estimation led to highly uncertain parameters (CV > 1), suggesting little information was available in the early composition data to inform the earlier age structure. Recruitment deviations were also not estimated in the most recent years (2013-2021) because recent composition data contain little information on recruitment (Yellowedge Grouper show up starting at age-1, but don't really recruit to the fishery until around 8 years old; SEDAR 2011). Full bias adjustment was used only from 2010 to 2012. Bias adjustment was phased in linearly, from no bias adjustment prior to 1986 (note that the model starts in 1975) to full bias adjustment in 2010. Bias adjustment was phased out in 2012, decreasing from full bias adjustment to no bias adjustment by 2027. The years selected for full bias adjustment were estimated following the methods of Methot and Taylor (2011).

3.1.6. Fleet Structure and Surveys

Four fishing fleets were modeled and had associated length and age compositions. The fleets were: Commercial Vertical Line - East (ComVL_E), Commercial Vertical Line - West (ComVL_W), Commercial Longline - East (ComLL_E), and Commercial Longline - West (ComLL_W). Fleet structure was unchanged from SEDAR 22, where it was characterized by the availability of length and age composition data, comparisons of length distributions between gears, and resulting sample sizes. Fishing was assumed to be continuous and homogeneous across the entire year.

Two fishery-dependent CPUE indices were included in the SEDAR 85 OA Base Model: pre-IFQ Longline CPUE - East (units: biomass kept per hook) and pre-IFQ Longline CPUE - West (units: biomass kept per hook). CPUE was treated as an index of biomass where the observed standardized CPUE time series was assumed to reflect annual variation in population trajectories. Both indices were of landings only, and the selectivity of each was assumed identical to the associated fleet.

Four fishery-independent surveys were modeled and had associated length and/or age compositions. The surveys were: NMFS Bottom Longline Survey - East (NMFSBLL_E), NMFS Bottom Longline Survey - West (NMFSBLL_W), NMFS/SEAMAP Groundfish Trawl Survey - East (NMFSTRW_E), and NMFS/SEAMAP Groundfish Trawl Survey - West (NMFSTRW_W).

Two fishery-independent indices were included in the SEDAR 85 OA Base Model: NMFS Bottom Longline Survey - East (units: number per 100 hook hour) and NMFS Bottom Longline Survey - West (units: number per 100 hook hour).

3.1.7. Selectivity

Selectivity represents the probability of capture by age or length for a given fleet and represents the net result of multiple interrelated factors (e.g., gear type, targeting, and availability of fish due to spatial and temporal constraints). Stock Synthesis allows users to specify length-based selectivity, age-based selectivity, or both. The final selectivity curve governing each fleet/survey reflects the additive effect of both age- and length- based processes.

For SEDAR 85, like SEDAR 22, only length-based selectivity was estimated and selectivities within a fleet or survey for both areas were mirrored (i.e., a single selectivity was estimated for the East and mirrored by the West). Most of the factors that affect selectivity (hook size, fishing location, fishing method) operate largely upon size or length rather than on fish age.

Selectivity patterns were assumed to be constant over time for each fleet and survey. Two time blocks were implemented for the Commercial Longline fishery in the SEDAR 22 Benchmark Base Model to account for changes in fishing behavior, with the earlier time period (1975-1985) being a mix of handline and longline gears and the later time period (1986-2009) characterized by a specialized deepwater fishery (detailed in SEDAR 2011). This decision was re-evaluated during SEDAR 85 model building because exploratory runs indicated that there was little difference in the selectivity estimates between time periods. Therefore, the SEDAR 85 OA Base Model did not incorporate time blocks of selectivity parameters. The Gulf of Mexico Yellowedge Grouper fishery has experienced some changes in management regulations over time such as commercial trip limits and recreational aggregate bag limits (**Figure 32**). Changes due to management regulations are usually accounted for in the assessment model using time-varying retention patterns (**Section 3.1.8**) and by modeling discards explicitly (**Section 3.1.10**).

3.1.7.1. Length-based Selectivity

Length-based selectivity patterns were specified for each fleet and survey and were characterized as one of two functional forms:

1. a two-parameter logistic function - a logistic curve implies that fish below a certain size range are not vulnerable, but then gradually increase in vulnerability with increasing size until all fish are fully vulnerable (asymptotic selectivity curve). Two parameters describe logistic selectivity: (1) the length at 50% selectivity, and (2) the difference between the length at 95% selectivity and the length at 50% selectivity.

2. the six-parameter double normal function - the double normal has the feature that it allows for domed or logistic selectivity and is a combination of two normal distributions; the first describes the ascending limb, while the second describes the descending limb. A line segment joins the maximum selectivity of the two functions. However, the double normal functional form can be more unstable than other selectivity functions due to the increased number of parameters. When robust length or age compositions are available with sufficient numbers of larger or older fish, it may be appropriate to freely estimate all parameters (especially the descending limb). If that is not the case, certain parameters can be fixed to improve model stability as long as fixing the parameter does not largely influence the point estimates of the remaining selectivity parameters. Unless strong evidence exists for domed selectivity, it is generally advisable to use the logistic function.

In the SEDAR 85 OA Base Model, length-based selectivity patterns were defined for each fleet/survey: 1) Commercial Vertical Line (double normal, West mirrored to East), 2) Commercial Longline (logistic, West mirrored to East), 3) NMFS Bottom Longline Survey (logistic, West mirrored to East), and 4) NMFS/SEAMAP Groundfish Trawl Survey (double normal, West mirrored to East). Double normal selectivity was implemented for the Commercial Vertical Line fishery because it could be limited by maximum depth fished. Logistic selectivity was modeled for the Commercial Longline fishery and the NMFS Bottom Longline Survey since both encountered Yellowedge Grouper throughout their size range. Dome-shaped selectivity was modeled for the NMFS/SEAMAP Groundfish Trawl Survey which fishes at the shallowest depths inhabited by Yellowedge Grouper and rarely captures large Yellowedge Grouper either due to gear avoidance, depth or movement of Yellowedge Grouper into untrawlable habitat. All selectivity parameters were freely estimated.

3.1.7.2. Age-based Selectivity

Age-based selectivity was not specified for any of the fleets (unchanged from SEDAR 22).

3.1.8. Retention

Time-varying retention functions are commonly used in Gulf stock assessments to allow for varying discards at size due to the impacts of management regulations. However, because discards of Yellowedge Grouper were minimal and no size limit exists for Yellowedge Grouper, retention was not modeled.

3.1.9. Landings and Age Compositions

Landings by fleet and associated length and age compositions were estimated using fleet-specific continuous fishing mortality rates and length-specific selectivity curves following Baranov's catch equation.

The commercial landings were assumed the most representative and reliable data source in the model, especially over the most recent time period, because this information was collected in the form of a census as opposed to being collected as part of a survey. The commercial landings were assumed to have a lognormal error structure, with annual log-scale SEs obtained from regionally weighted estimates for the pre-IFQ period (1975-2009) and a log-scale SE of 0.01 assumed for the 2010+ post-IFQ period (**Section 2.3.1**).

A new feature available for fitting composition data in Stock Synthesis is the Dirichlet-Multinomial which differs from the standard multinomial in that it includes an estimable parameter (theta) which scales the input sample size (Thorson et al. 2017b; Methot et al. 2023). The Dirichlet-Multinomial is self-weighting, which avoids the potential for subjectivity as when the Francis re-weighting procedure is applied (Francis 2011). This approach also allows for observed zeros in the data, and the effective sample sizes calculated are directly interpretable. The Dirichlet-Multinomial uses the input sample sizes directly, adjusted by an estimated variance inflation factor, which adjusts the overall weight of data for each fleet relative to one another based on model fit to reduce the potential for particular data sources to have a disproportionate effect on total model fit. The more positive the inflation factor, the more weight the data carry in the likelihood. The Dirichlet-Multinomial is considered an improved practice and recommended for use by the Stock Synthesis model developers, and was first used in a Gulf stock assessment in 2020 for SEDAR 70 Gulf of Mexico Greater Amberjack. A normal prior was used on the Dirichlet-Multinomial parameters of 0 (SD = 1.813), which is recommended to counteract the effect of the logistic transformation between the Dirichlet-Multinomial parameter and the data weighting (Methot et al. 2023).

Because Stock Synthesis models the growth internally and tracks individual fish from birth, it actually grows fish by length bins before eventually converting to age (based on the growth curve). As such, it is possible to fit both age and length compositions simultaneously. For SEDAR 85, the age and length composition data for each fleet/survey were assumed to follow a Dirichlet-Multinomial error structure where sample size represented the number of observations (i.e., length or age), adjusted by an estimated variance inflation factor. While the number of trips/sets is often preferred because using the number of lengths can overestimate sample sizes in fisheries data (samples are rarely truly random or independent; Hulson et al. 2012), the number of trips was not consistently available across data sources.

3.1.10. Discards

While no size limit exists for Yellowedge Grouper in the Gulf of Mexico, they are a deepwater grouper IFQ species which could lead to discarding if no quota is held. However, discard estimates for each fleet were very minor, and therefore discards were not directly fit to in the model using size-based retention functions. Where estimated, dead discards were included with landings for each fleet (**Sections 2.3.3-2.3.4**).

3.1.11. Indices

The indices are assumed to have a lognormal error structure. The CVs provided by the index standardization were converted to log-scale SEs required for input to Stock Synthesis for lognormal error structures (**Section 3.2**).

3.2. Goodness of Fit and Assumed Error Structure

A maximum likelihood approach was used to assess goodness of model fit to each of the data sources (e.g., catch, indices, compositions, etc.). For each separate data set, an assumed error distribution and an associated likelihood component was specified, the value of which was determined by the difference in observed and expected values along with the assumed variance of the error distribution. The total likelihood was the sum of each individual component. A nonlinear iterative search algorithm was used to minimize the total negative log-likelihood across the multidimensional parameter space to determine the parameter values that provide the best fit to the data. With this type of integrated modeling approach, data weighting (i.e., the variance associated with each data set) can affect model results, particularly if the various data sets indicate differing population trends.

Where lognormal error structures were used, annual CVs associated with each of the data sources were converted to log-scale SEs where necessary using the approximation: $log_e(SE) = \sqrt{(log_e(1 + CV^2))}$ provided in Methot et al. (2023).

Weak penalty functions were implemented to keep parameter estimates from hitting their bounds (Methot et al. 2023). Parameter bounds were set to be relatively wide and were unlikely to truncate the search algorithm.

Uncertainty in parameter estimates was quantified by computing asymptotic SEs for each parameter. Asymptotic SEs are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives) after the model fitting process (Methot and Wetzel, 2013). Asymptotic SEs provide a minimum estimate of uncertainty in parameter values.

3.3. Estimated Parameters

In total, 312 parameters were estimated for the SEDAR 85 OA Base Model, of which 247 were active parameters (**Tables 13 and A1**). These parameters include: the four von Bertalanffy growth parameters (L_{Amax} [i.e., $L\infty$] and K for each region), one stock-recruit relationship parameter (ln(R_0)), one recruitment distribution parameter, the stock-recruit deviations for the data-rich time period (1975-2012), year specific (1975-2021) F for each fleet, two parameters informing logistic selectivity for the Commercial Longline fleets (shared between regions) and the NMFS Bottom Longline Survey (shared between regions), six parameters informing selectivity for the Commercial Vertical Line fleets (shared between regions) and the NMFS/SEAMAP Groundfish Trawl Survey (shared between regions), catchability parameters for each index, and 8 parameters informing the Dirichlet-Multinomial length and age composition weightings.

3.4. Model Diagnostics

3.4.1. Residual Analysis

The main approach used to address model fit and performance was residual analysis of model fit to each of the data sets (e.g., catch, indices, length/age compositions). Any temporal trends in model residuals (or trends with age or length for composition data) can be indicative of model misspecification and poor performance. It is not expected that any model will perfectly fit any of the observed data sets, but ideally, residuals will be randomly distributed and conform to the assumed error structure for that data source. Any extreme patterns of positive or negative residuals are indicative of poor model performance and potential unaccounted for process or observation error.

3.4.2. Correlation Analysis

High correlation among parameters can lead to flat likelihood response surfaces and poor model stability. By performing a correlation analysis, modeling assumptions that lead to inadequate model parameterizations can be highlighted. Because of the highly parameterized nature of stock assessment models, it is expected that some parameters will always be correlated (e.g., stock-recruit parameters or growth parameters). However, a large number of extremely correlated parameters warrant reconsideration of modeling assumptions and parameterization. A correlation analysis was carried out and correlations with an absolute value greater than 0.7 were reported.

3.4.3. Likelihood Profiles

Likelihood profiles are used to examine the change in negative log-likelihood for each data source in order to address the stability of a given parameter estimate, and to see how each individual data source influences the estimate. The analysis is performed by holding the given parameter at a constant value and rerunning the model. This is repeated for a range of reasonable parameter values. Ideally, the graph of negative log-likelihood values against parameter values will give a well-defined minimum, indicating that data sources are in agreement. When a given parameter is not well estimated, the profile plot may show conflicting signals across the data sources. The resulting total likelihood surface will often be flat, indicating that multiple parameter values are equally likely given the data. In such instances, the model assumptions need to be reconsidered.

Typically, profiling is carried out for a few key parameters, particularly those defining the stock-recruit relationship. Profiles were carried out for $\ln(R_0)$, *SigmaR*, steepness, and the recruitment distribution parameter.

3.4.4. Jitter Analysis

Jitter analysis is a relatively simple method that can be used to assess model stability and to determine whether a global as opposed to a local minimum has been found by the search algorithm. The premise is that all of the starting values are randomly altered (or 'jittered') by an input constant value and the model is rerun from the new starting values. If the resulting population trajectories across a number of runs converge to the same final solution, it can be reasonably assumed that a global minimum has been obtained. This process is not fault-proof and no guarantee can ever be made that the 'true' solution has been found or that the model does not contain misspecification. However, if the jitter analysis results are consistent, it provides additional support that the model is performing well and has come to a stable solution.

For this assessment, a jitter value of 0.1 (10%) was applied to the starting values and 100 runs were completed.

3.4.5. Retrospective Analysis

Retrospective analysis evaluates the consistency of terminal year model estimates as it sequentially removes a year of data at a time and reruns the model. Mohn's Rho can be used to determine retrospective bias, with values between -0.15 to 0.2 considered acceptable for longer-lived species and values outside that range indicate of an undesirable retrospective pattern (Hurtado-Ferro et al. 2015; Carvalho et al. 2021). If the resulting estimates of derived quantities such as SSB or recruitment differ significantly, particularly if there is serial over- (+ Mohn's Rho) or underestimation (- Mohn's Rho) of any important quantities, it can indicate that the model has some unidentified process error, and requires reassessing model assumptions. It is expected that removing data will lead to slight differences between the new terminal year estimates and the updated estimates for that year in the model with the full data. Oftentimes additional data, especially compositional data, will improve estimates in years prior to the new terminal year, because the information on cohort strength becomes more reliable. Therefore, slight differences are expected between model runs as more years of data are peeled away. Ideally, the difference in estimates will be slight and more or less randomly distributed above and below the estimates from the model with the complete data sets.

A five-year retrospective analysis was carried out. Retrospective forecasts were also evaluated to determine consistency between forward projections and subsequent updates with newly available data added one year at a time (Carvalho et al. 2021).

3.4.6. Additional Diagnostics

Additional diagnostics using the R package 'SS3Diags' are presented following the recommendations of Carvalho et al. (2021). Joint residual plots were used to assess goodness of model fit by identifying conflicting time series and auto-correlation of residual patterns via a Loess smoother (Winker et al. 2018; Carvalho et al. 2021). Undesirably high root mean squared error (RMSE) were values which exceeded 30%. Model misspecification was evaluated by exploring patterns in residuals of indices and compositions using a runs test, which indicates the presence of nonrandom variation (Carvalho et al. 2021). In addition, outlier data points were identified via the 3-sigma limit, where any points beyond this limit would be unlikely given random process error in the observed residual distribution (Carvalho et al. 2021).

Prediction skill of the model was tested using the hindcasting cross-validation approach of Kell et al. (2021). The mean absolute scaled error (MASE; Hyndman and Koehler 2006) was calculated for a 5-year period for each data input where available. The mean absolute scaled error scales the mean absolute error of forecasts (i.e., prediction residuals) to the mean absolute error of a naïve in-sample prediction (Carvalho et al. 2021). A skilled model would improve the model forecast compared to the baseline (i.e., random walk), with a mean absolute scaled error value of 0.5 indicative of a forecast being twice as accurate as the baseline and values >1 indicative of average model forecasts worse than the baseline (Carvalho et al. 2021; Kell et al. 2021).

3.4.7. SEDAR 22 Benchmark Base Model Sensitivity Runs

Sensitivity runs were first conducted with the SEDAR 22 Benchmark Base Model to understand how changes in data inputs provided for SEDAR 85, either due to improvements in methodology or corrections, would have influenced model results. The following data inputs were included in this analysis:

1. *Use SEDAR 85 Landings*. This run used the landings submitted for SEDAR 85, which included new data sources (e.g., MRIP-FES) and improved methodologies for calculating historical commercial landings (reviewed in **Sections 2.3.1-2.3.4**).
2. *Fmethod 2 (F as parameters) and Increased Uncertainty in Landings*. This run incorporated more uncertainty when modeling the landings and allowed the SEDAR 22 Benchmark Base Model flexibility in fitting landings. The SEDAR 22 Benchmark Base Model was forced to fit landings very tightly, and this was of particular concern for the earlier years plagued by high uncertainty in assigning historical landings to Yellowedge Grouper. As a result of this uncertainty, during SEDAR 22 an alternative base model was explored (a Low Commercial Longline East Landings Scenario), and is discussed further in SEDAR (2011).
3. *Remove sex-specific composition data and fix hermaphroditism transition rate*. This run removed the sex-specific composition data and instead fit to aggregated (unsexed, female, and male) length and conditional age-at-length compositions. Because of the removal of the sex-specific data, the hermaphroditism transition rate was fixed at the parameters recommended during SEDAR 22 (**Section 2.2.5**).
4. *Use SEDAR 85 Compositions*. This run used the length and conditional age-at-length compositions submitted for SEDAR 85, which revealed noticeable differences (e.g., different years, variable sample sizes) compared to the data submitted for SEDAR 22 (discussed in **Section 2.3.6**).

3.4.8. SEDAR 85 OA Base Model Sensitivity Runs

Sensitivity runs were conducted with the SEDAR 85 OA Base Model to investigate critical uncertainty in data and reactivity to modeling assumptions. An exhaustive evaluation of model uncertainty was not carried out, but the aspects of model uncertainty judged to be the most important for model performance and accuracy were investigated.

Only the most important sensitivity runs are presented below, but many additional exploratory runs were also implemented. The order in which they are presented is not intended to reflect their importance; each run included here provided important information for developing or evaluating the base case model and alternate states of nature. Focus of the sensitivity runs was on population trajectories, improvements in fit and important parameter estimates (e.g., recruitment).

Landings - Uncertainty in landings remains a key concern for Yellowedge Grouper as discussed by the Data Updates TWG. Three sensitivity runs were conducted:

1. *Low Commercial Longline - East Landings Scenario (sensu SEDAR 22)*. This run used the lower landings estimates for the early years (1980-1985) of the Commercial Longline - East fishery. This scenario assumed that no Yellowedge Grouper were landed in area 7 (too shallow) and that area 6 landings were lower and more similar to the Southeast (23%) than the Northeast (96%; SEDAR85-WP-07).
2. *Exclude Recreational Landings and Dead Discards*. This run excluded the recreational landings and dead discards to demonstrate whether their removal had a noticeable effect on results.
3. *Increase Uncertainty in pre-1986 Landings*. This run allowed more uncertainty (log-scale SE = 0.3) in the historical landings estimates to see how the model would react.

Steepness - Steepness is generally one of the most uncertain parameters estimated in a stock assessment model and is a critical quantity to stock assessment. To determine whether steepness was estimable in the SEDAR 85 OA Base Model and to evaluate sensitivity of results to alternative fixed values, we conducted three sensitivity runs:

1. *Freely estimate steepness without a prior*. Steepness estimated at a bound in the absence of a prior can indicate that there is little information in the data about this quantity.
2. *Estimate steepness with a prior (sensu SEDAR 22)*. Steepness was estimated with a symmetric beta prior (min = 0.4, max = 0.99, central tendency = 0.7, SD = 2) in the SEDAR 22 Benchmark Base Model. This prior distribution for steepness is relatively non-constraining except at the boundaries of the distribution.
3. *Fix steepness at 0.7*. Alternative steepness value that was considered in a sensitivity run for both SEDAR 22 and the earlier 2002 Yellowedge Grouper assessment.

Recruitment variability (SigmaR) - *SigmaR* is rarely directly estimable from the given data and therefore is often input as a fixed parameter. To determine whether *SigmaR* was estimable in the SEDAR 85 OA Base Model, we conducted one sensitivity run:

1. *Estimate SigmaR*. *SigmaR* estimated at a bound can indicate that there is little information in the data about this quantity.

Jackknife of indices of abundance - The goal of these sensitivity runs was to determine if any single index of abundance was having undue influence on the model and causing tension with other data in terms of estimating parameters. The approach can be especially useful for identifying indices that may be giving conflicting abundance trend signals compared to the other indices. If removing a data set leads to dramatically different results, it suggests that the data set should be reexamined to determine if the sampling procedures are consistent and appropriate (e.g., an index may only be sampling a sub-unit of the stock and resulting abundance signals may only reflect a local sub-population and not the trend in the entire stock). Each index was removed and the model rerun. Additionally, all of the fishery-dependent indices were removed simultaneously. Other data sets (i.e., landings and compositional data) were deemed fundamentally necessary to stabilize the assessment and therefore their exclusion was not included in the jack-knife analysis (i.e., a full jackknife was not conducted).

4. Stock Assessment Model - Results

4.1. Estimated Parameters

Most parameter estimates and variances were reasonably well estimated (i.e., CV < 1) for the SEDAR 85 OA Base Model (**Tables 13 and A1**). Of the 247 active parameters, 23 exhibited CVs above 1 and were poorly estimated, including 20 recruitment deviations, the Dirichlet-Multinomial parameter for the Commercial Longline age data, and the parameters defining the top and ascending limb of the selectivity curve for the NMFS/SEAMAP Groundfish Trawl Survey. No parameters were estimated near bounds.

Figure 33 shows parameter distribution plots along with starting values and priors.

None of the Dirichlet-Multinomial parameters were estimated at the upper bound of 5 (i.e. a weight of >99% through inverse logit transformation), therefore input sample sizes were down-weighted for all fleets and surveys:

- Commercial Vertical Line (East and West) length (54%) and age (59%) compositions
- Commercial Longline (East and West) length (30%) and age (49%) compositions
- NMFS Bottom Longline Survey (East and West) length (92%) and age (88%) compositions
- NMFS/SEAMAP Groundfish Trawl Survey (East and West) length (98%) and age (13%) compositions.

4.2. Fishing Mortality

The exploitation rate (total biomass killed all ages / total biomass age 1+) for the entire stock (regions combined) is provided in **Table 14** and **Figure 34**. Since 1975, the exploitation rate for the stock has averaged around 0.048, and ranged between 0.01 in 1978 to 0.131 in 1982 (**Figure 34**). The exploitation rate remained above the time series mean throughout much of the 1980s and some of the 1990s. The exploitation rate dropped in 2010, and has increased to near average levels in recent years. The terminal year (2021) exploitation rate for the entire stock was 0.045, just below the time series mean. Similar trends in exploitation rates were observed for SEDAR 22, although slightly higher exploitation rates were estimated since 1981 (**Table 14**; **Figure 34**).

The exploitation rate for the stock was driven largely by the Commercial Longline fleet throughout the time series, particularly in the East (**Table 15**; **Figure 35**). The exploitation rate for the Commercial Longline - East fleet was largest on average (0.062) and ranged from 0 prior to 1980 to 0.161 in 1982. After 1982, the exploitation rate declined steeply, increased and oscillated around the time series mean until declining in 2010, and has since increased (**Figure 35**). The Commercial Longline - West fleet exhibited the next highest exploitation on average (0.024), particularly in the 1980s and 1990s. Exploitation increased considerably from 0 prior to 1979 to 0.083 in 1985 (**Figure 35**). Exploitation rates estimated for the Commercial Longline fleet in both regions were more similar in the SEDAR 22 Benchmark Base Model (**Figure 35**). Both the Commercial Vertical Line - East and Commercial Vertical Line - West fleets exhibited much lower exploitation rates (average of 0.01 and 0.007, respectively), with exploitation peaking in the late 1980s (**Figure 35**). The terminal year (2021) exploitation rates for the Commercial Vertical Line - East, Commercial Vertical Line - West, Commercial Longline - East, and Commercial Longline - West fleets were 0.002, 0.002, 0.103, and 0.013, respectively (**Table 15**).

4.3. Selectivity

Selectivity parameters for all fleets and surveys appeared well estimated (CV < 1; **Table 13**, Label prefix "Size_"), with the exception of the parameters defining the width of the peak and the ascending limb of the selectivity curve for the NMFS/SEAMAP Groundfish Trawl Survey. Length-based selectivity curves estimated in Stock Synthesis for the Commercial Longline fleets were similar between assessments, whereas the degree of doming differed for the Commercial Vertical Line fleets (**Figure 36**).

Yellowedge Grouper were fully selected (> 95%) for at larger sizes for the Commercial Longline fleets compared to the Commercial Vertical Line fleets (**Figure 36**). The Commercial Longline fleet (West mirroring East) reached 50% selection around 51 cm TL (**Table 13**), with full selection by 67 cm TL (**Figure 36**). The selectivity function estimated in SEDAR 85 shifted very slightly towards smaller Yellowedge Grouper with the addition of new data. The Commercial Vertical Line selectivity function was estimated as more dome-shaped in SEDAR 85 compared to SEDAR 22 and peaked at slightly larger Yellowedge Grouper. The Commercial Vertical Line fleet (West mirroring East) reached 50% selection around 41 cm TL, with full selection by 51 cm TL before declining for larger Yellowedge Grouper (**Figure 36**).

The derived age-based selectivity patterns illustrate that the Commercial Vertical Line fleets select younger fish (50% selection by 8+ years), with the Commercial Longline fleets generally selecting Yellowedge Grouper 11+ years (**Figure 37**). Derived age-based selectivity for the Commercial Longline fleets shifted slightly towards younger Yellowedge Grouper compared to SEDAR 22. The Commercial Longline fleets reached full selection (i.e., 95%) around age 22. Selectivity for the Commercial Vertical Line fleets peaked at 94.1% around age-13, and then declined slightly for older Yellowedge Grouper (**Figure 37**).

Selectivity for the NMFS Bottom Longline Survey (West mirroring East) reached 50% selection around 53 cm TL (**Table 13**), with full selection above 67 cm TL (**Figure 38**). This translated into 50% selection by 11 years, and full selection by 22 years (**Figure 39**). The selectivity function estimated in SEDAR 85 was shifted considerably towards smaller and younger Yellowedge Grouper with the addition of new data (and potentially the exclusion of composition data pre-2000).

Selectivity for the NMFS/SEAMAP Groundfish Trawl Survey (West mirroring East) quickly reached 50% and full selection around 7 cm TL and dropped considerably for Yellowedge Grouper larger than 20 cm TL (**Figure 38**). This translated into 50% selection by age-1, with selection greatly reduced for older Yellowedge Grouper (**Figure 39**). The selectivity function estimated in SEDAR 85 was shifted slightly towards smaller Yellowedge Grouper with the addition of new data (including length data pre-2000 which were not included in SEDAR 22).

4.4. Recruitment

Steepness and *SigmaR* were fixed at 0.827 and 0.5, respectively, which differed from their specification in the SEDAR 22 Benchmark Base Model (discussed in **Section 3.1.5**). The corresponding Beverton-Holt stock-recruit relationship is shown in **Figure 40**. The SEDAR 85 OA Base Model estimated a ln(R_0) (CV) at 6.893 (0.004) (**Table 13**), which equates to 0.99 million age-0 Yellowedge Grouper.

Annual recruitment estimates (age-0, 1,000s of fish) from 1975 to 2021 are provided for the East (**Table 16**), West (**Table 17**), and Gulf-wide (**Table 18**). The highest recruitments estimated by the SEDAR 85 OA Base Model occurred during 1975 (3.97 million age-0s), 1994 (3.87 million age-0s), 1979 (3.31 million age-0s), 1999 (3.09 million age-0s), and 1985 (2.45 million age-0s; **Table 18**; **Figures 40-41**). Between 1975 and 2012 (when recruitment deviations were estimated), estimated recruitment averaged 1.2 million Yellowedge Grouper and remained low from 2005 to 2012, with a record low in 2012 at 0.24 million Yellowedge Grouper (**Figure 41**). Recruitment trajectories were very different than those estimated in SEDAR 22, likely due to the combination of changes to input data and model settings for recruitment (**Figure 41**).

Annual recruitment estimates were higher in the East compared to the West (**Tables 16-17**; **Figure 42**), according to the estimated recruitment distribution parameter (**Table 13**). However, larger differences were identified between regional recruitment during SEDAR 22.

Recruitment deviations were generally without pattern until 2005, where estimated deviations remained below average through 2012 (**Figure 43**). Unfortunately, recruitment deviations in 20 years where recruitment deviations were estimated (1975-2012) were highly uncertain (CV > 1) in the SEDAR 85 OA Base Model (**Table 13**). The SEDAR 22 Benchmark Base Model also exhibited similar behavior, with 22 recruitment deviations exhibiting CVs exceeding 1 where recruitment deviations were estimated (1975-2000). The asymptotic SEs for recruitment deviations estimated by the SEDAR 85 OA Base Model averaged 0.431 between 1975 and 2012, and ranged from 0.13 in 1975 up to 0.751 in 1980 (**Figure 44**). Much less variability in recruitment was estimated in the SEDAR 22 Benchmark Base Model, where *SigmaR* was fixed at 0.2. The estimated (and applied) recruitment bias adjustment ramp is shown in **Figure 45**. Two competing configurations were evident, with one resulting in a slightly lower negative log-likelihood (applied in the SEDAR 85 OA Base Model). Full bias adjustment was implemented for a very short time towards the end of the “data-rich” period (late 2000s), which is likely a function of the limited information in the model to estimate recruitment.

4.5. Biomass and Abundance Trajectories

Annual estimates of total biomass (metric tons), exploitable biomass (ages 1+, metric tons), SSB (metric tons), SSB ratio (SSB/virgin SSB [SSB_0]; also referred to as the fraction of virgin or unfished SSB) and exploitable abundance (ages 1+, 1,000s of fish) from 1975 to 2021 are provided for the East (**Table 16**), West (**Table 17**), and Gulf-wide (**Table 18**). The exploitation age of 1 year is based on Yellowedge Grouper landed by both the Commercial Vertical Line - West and Commercial Longline - East fleets. Below we summarize the Gulf-wide derived quantities.

Total biomass averaged 9,606 metric tons, and ranged from 7,094 metric tons in 2021 to 14,757 metric tons in 1975 (**Figure 46**). The SEDAR 85 OA Base Model estimated higher total biomass in the West compared to the SEDAR 22 Benchmark Base Model, with estimates in the East similar from the mid-1980s onward (**Figure 46**). Exploitable (ages 1+) biomass and numbers averaged 9,604 metric tons and 5,186,478 Yellowedge Grouper, respectively. Exploitable biomass and numbers were lowest in 2021 at 7,092 metric tons and in 2013 at 3,075,563 Yellowedge Grouper, respectively, and peaked in 1975 at 14,748 metric tons and in 1980 at 7,311,772 Yellowedge Grouper, respectively (**Table 18**). SSB averaged 7,888 metric tons and ranged from 6,017 metric tons in 2021 to 13,197 metric tons in 1975 (**Figure 47**). Starting from virgin conditions in 1975, both total biomass and SSB declined considerably in the early 1980s (**Figures 46-47**), with the SSB ratio dropping to about 50% by 1990 (as opposed to ~35% estimated by the SEDAR 22 Benchmark Base Model; **Figure 48**). The SEDAR 22 Benchmark Base Model estimates of total biomass and SSB remained relatively constant through its terminal year of 2009, whereas the SEDAR 85 OA Base Model estimated a slight uptick in total biomass and SSB starting in the mid-1990s until about 2010 (**Figures 46-47**). Both total biomass and SSB have since declined to record lows in 2021. The SSB ratio averaged 0.6, started at 1 in 1975 at virgin conditions, and declined to its lowest level at 46% of the corresponding virgin spawning stock biomass in 2021 for the SEDAR 85 OA Base Model (**Table 18**; **Figure 48**).

Estimated SSB (metric tons), exploitable biomass (ages 1+, metric tons), and exploitable abundance (1,000s of fish) by sex are provided for the East (**Table 19**), West (**Table 20**), and Gulf-wide (**Table 21**). Also included is the expected sex ratio of mature male to female Yellowedge Grouper, which averaged 14.6% and ranged from 6.2% in 1994 to 29.5% in 1978 (**Table 21**; **Figure 49**). The sex ratios expected by both the SEDAR 85 OA Base Model and SEDAR 22 Benchmark Base Model were lower than those observed in the field (**Section 2.2.6**), however the trends were similar, with higher sex ratios early on in the time series and lower sex ratios expected during the 1980s and 1990s after exploitation increased. The sex ratio increased throughout the 2000s until about 2015 and has declined in recent years. Sex ratios were consistently higher in the West compared to the East (**Figure 49**). The dramatic differences in sex ratios when comparing to the SEDAR 22 Benchmark Base Model results is likely due to model configuration. The SEDAR 22 Benchmark Base Model estimated the hermaphroditism transition rate using sex-specific composition data, where females had a very small chance (up to 7% at age 40+) of transitioning to male (yellow line in **Figure 5**).

The expected numbers-at-age and biomass-at-age of female and male Yellowedge Grouper at virgin conditions are shown in **Figure 50**. The sex ratio expected by the model at virgin conditions was 26.8%. At virgin conditions, age-0 and age-15 female Yellowedge Grouper dominated in numbers and biomass, respectively, whereas age 40+ male Yellowedge Grouper were most abundant and dominated biomass (**Figure 50**).

4.6. Model Fit and Residual Analysis

4.6.1. Landings

Similar to SEDAR 22, landings for all fleets were fit exactly in many years given their relatively small log-scale SEs (**Tables 22-25**, **Figure 51**). However, exceptions were noted for the SEDAR 85 OA Base Model in the late 1970s and early 1980s where higher uncertainty was incorporated and predicted landings had more freedom to deviate from input values. In the West, the SEDAR

85 OA Base Model predicted higher landings in a few early years for both the Commercial Vertical Line and Longline fleets, whereas the SEDAR 85 OA Base Model predicted lower landings during the early years for both fleets in the East (**Figure 51**). The majority of landings were attributed to the Commercial Longline fleets, particularly in the East (**Figure 52**).

The mean weight of Yellowedge Grouper landed by the Commercial Vertical Line - East fleet was the smallest of the fleets, averaging 7.1 gutted pounds and ranged from 5.8 in 2001 to 9.3 from 1975-1977 (**Table 22**). The Commercial Vertical Line - West fleet tended to land larger Yellowedge Grouper compared to the East, with the mean weight averaging 8.5 gutted pounds and ranging from 7.3 in 2001-2002 to 10.3 in 2018-2019 (**Table 23**). The mean weight of Yellowedge Grouper landed by the Commercial Longline - East fleet averaged 9.1 gutted pounds and ranged from 7.8 in 2003-2004 to 11.8 in 1980 (**Table 24**). The mean weight of Yellowedge Grouper landed by the Commercial Longline - West fleet was the largest of the fleets, averaging 11.2 gutted pounds, and ranged from 10.1 from 2002-2006 to 13 in 1979 and 2020-2021 (**Table 25**).

4.6.2. Indices

Observed and expected CPUE are provided in **Tables 26-27** and **Figure 53**. Fits to the indices were generally poor in both SEDAR 85 and SEDAR 22, as the expected relative abundance fits were relatively flat and did not capture the contrast exhibited by the input data (**Figure 53**). The Commercial Longline - West index exhibited the lowest RMSE value (0.326) and was most correlated (0.3) with the expected SSB. A slight improvement in fit was detected since SEDAR 22 (0.326 vs 0.349). The Commercial Longline - East index exhibited the next lowest RMSE value (0.364), and a lower correlation of 0.2 with the expected SSB. The fit was not improved compared to SEDAR 22, as both models failed to pick up on increased relative abundance in the early 1990s and through 2008.

Unfortunately, more than a decade of additional data for the NMFS Bottom Longline Survey did not lead to improved fits, as the SEDAR 85 OA Base Model did not fit the NMFS Bottom Longline indices well in either region (East RMSE = 0.483; West RMSE = 0.457). The SEDAR 85 OA Base Model predicted declines in indices for both regions in the most recent years, while the indices remained relatively flat in earlier years (**Figure 53**). Both indices were poorly correlated with the expected SSB (East = 0.19; West = 0.26). However, given the large uncertainty surrounding these indices as evident by the SE obtained from the standardization process (**Table 27**), these poor fits are not unexpected.

4.6.3. Length Compositions

Aggregate model fits to the retained length composition data for all fleets are presented in **Figure 54**. Annual fits along with residuals are presented in **Figures 55-62**.

Annual fits to retained length compositions for the Commercial Vertical Line - East fleet were variable, with expected and observed peaks corresponding in many years but some years showed clear mismatches (e.g., 1978-1980, 1991, and 2011; **Figure 55**). The Pearson residuals were relatively large (min = -2.85, max = 12.9), and unfortunately some patterns were evident such as large positive residuals (underpredicting Yellowedge Grouper) around 40 cm TL in the 1990s and at larger sizes in many of the years (**Figure 56**). The late 1970s also exhibited a clear pattern of overestimating smaller Yellowedge Grouper (large negative residuals) and underestimating larger Yellowedge Grouper (large positive residuals). Overall, the aggregated fit showed adequate correspondence to the input data (**Figure 54**).

Annual fits to retained length compositions for the Commercial Vertical Line - West fleet were generally good, with expected and observed peaks corresponding in many years (**Figure 57**). Exceptions were noted for years such as 1996 and 1998, where sample sizes were much smaller than most years. The Pearson residuals were relatively small (min = -2.53, max = 7.7), but clusters of large positive residuals (underpredicting Yellowedge Grouper) occurred between 30 and 50 cm TL prior to 1992 (**Figure 58**). Overall, the aggregated fit showed good correspondence to the input data (**Figure 54**).

Annual fits to retained length compositions for the Commercial Longline - East fleet were generally good, with expected and observed peaks corresponding in most years (**Figure 59**). Years such as 1986 and 1988 showed a strong mismatch, which in this case was not due to a sample size issue. The Pearson residuals were relatively small (min = -2.94, max = 8.68), and were much improved over those from SEDAR 22 (**Figure 60**). Some patterns were evident such as large positive residuals (underpredicting Yellowedge Grouper) around 40 cm TL during the mid 2000s and after 2016 (**Figure 60**). Overall, the aggregated fit showed very good correspondence to the input data (**Figure 54**).

Annual fits to retained length compositions for the Commercial Longline - West fleet were generally good, with expected and observed peaks corresponding in most years (**Figure 61**). The Pearson residuals were relatively small (min = -2.29, max = 6.33), and were much improved over those from SEDAR 22, however some patterns were evident such as large positive residuals (underpredicting Yellowedge Grouper) during the late 1980s and negative residuals (overpredicting Yellowedge Grouper) since 2014 while underpredicting Yellowedge Grouper above 70 cm TL (**Figure 62**). Overall, the aggregated fit showed adequate correspondence to the input data (**Figure 54**).

Aggregate model fits to the length composition data for all surveys are presented in **Figure 63**. Annual fits along with residuals are presented in **Figures 64-71**.

Annual fits to length compositions for the NMFS Bottom Longline Survey - East were poor due to the large inter-annual variability in the underlying length composition data, with most years suffering from low sample sizes (i.e., < 30 lengths; **Figure 64**). However, the overall aggregated fit was good (**Figure 63**). The Pearson residuals were relatively large (min = -1.7, max = 19.9), but were much improved over those from SEDAR 22 (**Figure 65**). No clear patterns in residuals were evident.

Annual fits to length compositions for the NMFS Bottom Longline Survey - West were also poor due to the large inter-annual variability in the underlying length composition data, again with most years suffering from low sample sizes (i.e., < 30 lengths; **Figure 66**). The overall aggregated fit was also poorly fit, as the expected peak did not correspond well with the input data (**Figure 63**). The Pearson residuals were relatively large (min = -1.72, max = 21.84), exhibited no strong patterns, and were improved over those from SEDAR 22 (**Figure 67**).

Annual fits to length compositions for the NMFS/SEAMAP Groundfish Trawl Survey - East were very poor due to consistently low sample sizes, with 11 of the 20 years having only a single length observation (**Figure 68**). However, the overall aggregated fit was adequate (**Figure 63**).

The Pearson residuals were very large (min = -1.19, max = 57.54) and comparable to those observed in the SEDAR 22 Benchmark Base Model, although many more years of data were included in SEDAR 85 (1987-2021) compared to SEDAR 22 (2001-2007). No strong patterns in residuals were evident (**Figure 69**).

Annual fits to length compositions for the NMFS/SEAMAP Groundfish Trawl Survey - West were also poor due to the large inter-annual variability in the underlying length composition data with all years suffering from low sample sizes (i.e., < 30 lengths; **Figure 70**). However, the overall aggregated fit was good (**Figure 63**). The Pearson residuals were relatively large (min = -1.3, max = 34.69) with many more years of data included in SEDAR 85 (1988-2019) compared to SEDAR 22 (2000-2009). No strong patterns in residuals were evident, although large Yellowedge Grouper were occasionally observed in the survey (**Figure 71**).

4.6.4. Age Compositions

Aggregate model fits to the retained age composition data for all fleets are presented in **Figure 72**.

Annual fits to nominal age compositions for the Commercial Vertical Line - East fleet showed considerable variability in the input data and varying levels of agreement between observed and expected compositions (**Figure 73**). The distributions were much more spread out in the late 1970s while other years had very spiky and patchy distributions, largely due to relatively low sample sizes. Overall, the aggregated fit showed good correspondence to the input data (**Figure 72**). The Pearson residuals did not reveal any concerning magnitudes (min = -1.7, max = 4.35), but clusters of positive residuals occurred in the late 1970s for ages 18-33 Yellowedge Grouper and in the plus group since 2013 (**Figure 74**). Mean age was highest in the 1970s, declined to the lowest values in the 2000s, and increased until about 2018 before declining thereafter (**Figure 75**). Expected mean age (range: 12 to 18 years) was much less variable compared to observed mean age (range: 7 to 23 years), and remained within the 95% confidence intervals of observed mean age for most of the years, with the exception of 1980, 2000, 2017, and 2018 (**Figure 75**). Agreement between observed and expected mean length-at-age was generally better for younger Yellowedge Grouper, as observed mean length-at-age in some years and for some age classes were often jagged due to lower sample sizes (**Figure 76**). The Pearson residuals for the mean length-at-age were relatively small (max = 2), but some patterns were evident such as large positive residuals (underpredicted Yellowedge Grouper) in many age classes in 2008 and in the plus group in recent years (**Figure 77**).

Annual fits to nominal age compositions for the Commercial Vertical Line - West fleet showed considerable variability in input data and sometimes poor agreement between observed and expected compositions, particularly in the early 2000s (**Figure 78**). Overall, the aggregated fit showed adequate correspondence to the input data (**Figure 72**). The Pearson residuals were relatively large (min = -1.95, max = 8.85) and revealed a cluster of large positive residuals (underpredicting Yellowedge Grouper) between 10-20 years since 2015 (**Figure 79**). Mean age was highest around 2018 and stayed relatively consistent between the early 1990s until 2008 (**Figure 80**). Differences in observed (range: 7 to 18 years) and expected (range: 14 to 18 years) mean age were evident, although the expected mean age remained within the 95% confidence intervals of the observed mean age for most of the years, with the exception of 1991, 1992, 2002, 2005, and 2009 (**Figure 80**). Agreement between observed and expected mean length-at-age was good starting in 2004, with earlier years suffering from low sample sizes (**Figure 81**). While the Pearson residuals for mean length-at-age did not reveal any concerning magnitudes (max = 2), large positive residuals (underpredicting Yellowedge Grouper) occurred in 2008-2009 and in more recent years for >20 year-old Yellowedge Grouper (**Figure 82**).

Annual fits to nominal age compositions for the Commercial Longline - East fleet also showed considerable variability in input data and variable agreement between observed and expected compositions, particularly with poorer fits in the early years and more recently (**Figure 83**). Overall, the aggregated fit showed good correspondence to the input data (**Figure 72**). The Pearson residuals did not reveal any concerning magnitudes (min = -5.16, max = 4.6), but did show large positive residuals (underpredicting Yellowedge Grouper) at younger ages in 1982 (**Figure 84**). Mean age was highest in the early 1980s, declined to the lowest values in the mid-2000s, and increased until about 2018 before declining thereafter (**Figure 85**). Differences in observed (range: 12 to 18 years) and expected (range: 14 to 23 years) mean age were evident, although the expected mean age remained within the 95% confidence intervals of the observed mean age for most of the years, with the exception of 1982-1983, 2002, 2005, 2009, 2013, and 2019-2020 (**Figure 85**). Agreement between observed and expected mean length-at-age was good since 1999 (**Figure 86**). The Pearson residuals for mean length-at-age did not reveal any concerning magnitudes (max = 4), but strong patterns were evident such as large positive residuals (underpredicting Yellowedge Grouper) across ages in the 1980s, large negative residuals (overpredicting Yellowedge Grouper) since 2003 for ages 10 and under, and large positive residuals (underpredicting Yellowedge Grouper) in the plus group across the time series (**Figure 87**).

Annual fits to nominal age compositions for the Commercial Longline - West fleet showed considerable variability in input data and sometimes poor agreement between observed and expected compositions, particularly in the early years (**Figure 88**). Overall, the aggregated fit showed adequate correspondence to the input data (**Figure 72**). The Pearson residuals did not reveal any concerning magnitudes (min = -2.2, max = 2.91), although there was a cluster of large positive residuals (underpredicting Yellowedge Grouper) between 10-20 years since 2017 (**Figure 89**). Mean age declined until about 2005 and then increased throughout the time series (**Figure 90**). Differences in observed (range: 13 to 23 years) and expected (range: 17 to 22 years) mean age were evident, although the expected mean age remained within the 95% confidence intervals of the observed mean age for most of the years, with the exception of 2006, 2008, 2015-2016, and 2019-2021 (**Figure 90**). Agreement between observed and expected mean length-at-age was generally better for younger Yellowedge Grouper, with expected values diverging from observed in many years for older Yellowedge Grouper (**Figure 91**). The Pearson residuals for mean length-at-age did not reveal any concerning magnitudes (max = 4), but strong patterns were evident such as large positive residuals (underpredicting Yellowedge Grouper) across ages in 2008-2009 and from 2013+ for ages 15+ (**Figure 92**).

Aggregate model fits to the age composition data for all surveys are presented in **Figure 93**.

Annual fits to nominal age compositions for the NMFS Bottom Longline Survey - East showed considerable variability in the underlying age data and sometimes poor agreement between observed and expected compositions (**Figure 94**). Overall, the aggregated fit showed a slight mismatch, with the expected composition peaking around 12 years while the observed composition peaked around 11 years (**Figure 93**). The Pearson residuals did not reveal any strong patterns or concerning magnitudes (min = -1.65, max = 7.83; **Figure 95**). Mean age increased throughout the time series, with more variability in observed mean age (range: 11 to 19 years) compared to expected (range: 15 to 18 years), although the expected mean age remained within the 95% confidence intervals of the observed mean age for most of the years, with the exception of 2007 and 2011 (**Figure 96**).

Annual fits to nominal age compositions for the NMFS Bottom Longline Survey - West also showed considerable variability in the underlying age data and sometimes poor agreement between observed and expected compositions, particularly in the most recent years where sample sizes were low (**Figure 97**). Overall, the aggregated fit showed a slight mismatch, with the expected composition peaking around 12 years while the observed composition peaked around 9 years (**Figure 93**). The Pearson residuals did not reveal any strong patterns or concerning magnitudes (min = -1.49, max = 5.23; **Figure 98**). Mean age increased slightly throughout the time series, and differences in observed (range: 12 to 26 years) and expected (range: 18 to 21 years) mean age were evident, although the expected mean age remained within the 95% confidence intervals of the observed mean age for most of the years, with the exception of 2004, 2006, and 2010-11 (**Figure 99**).

The aggregate fit to the nominal age compositions for the NMFS/SEAMAP Groundfish Trawl Survey - West showed good agreement between observed and expected compositions, both peaking for 1-year old Yellowedge Grouper (**Figure 100**). The Pearson residuals did not reveal any strong patterns or concerning magnitudes (min = -1.33, max = 2.68; **Figure 101**).

4.7. Model Diagnostics

4.7.1. Correlation Analysis

Given the highly parameterized nature of the SEDAR 85 OA Base Model, some parameters were mildly correlated (correlation coefficient > 70%) and one combination displayed a strong correlation (> 95%; **Table 28**). High correlation occurred between the parameters defining the peak and the width of the ascending limb of the double normal selectivity function for the NMFS/SEAMAP Groundfish Trawl Survey (West mirroring East). Moderate correlations occurred between the parameters defining the size at inflection and the width for 95% selection for the Commercial Longline - East fleet and NMFS Bottom Longline Survey - East, the parameters defining the peak and the width of the ascending limb of the double normal selectivity function for the Commercial Vertical Line - East fleet, the parameters defining the ending logit and the width of the descending limb of the double normal selectivity function for the Commercial Vertical Line - East fleet, and the von Bertalanffy growth parameters K and L_{Amax} in each region. Lastly, a few recruitment deviations demonstrated moderate correlations.

4.7.2. Likelihood Profiles

The total likelihood component from the ln(R_0) likelihood profile indicates that the global solution for this parameter is approximately 6.9 (**Figure 102**), with the SEDAR 85 OA Base Model estimating ln(R_0) at 6.893 (**Table 13**). Other ln(R_0) values which remained within 2 negative log-likelihood units included: 6.85 and 6.95. Conflicts were evident, particularly between the age data which favored lower values around 6.6 and the length data, index data, and catch data which supported higher values.

The total likelihood component from the *SigmaR* likelihood profile indicates that the global solution for this parameter is approximately 1.3 (**Figure 103**). However, values between 1 and 2 remained within 2 negative log-likelihood units, suggesting this parameter was not well estimated. *SigmaR* was fixed in the SEDAR 85 OA Base Model at 0.5 (see **Section 3.1.5**). Catch data supported lower values than the total minimum, whereas age data supported higher values.

The total likelihood component from the steepness likelihood profile (using a prior) supported a minimum around 0.7 (**Figure 104**), but values ranging from 0.7 to 0.88 remained within 2 negative log-likelihood units, suggesting this parameter was not well estimated. The fixed value of steepness in the SEDAR 85 OA Base Model at 0.827 falls within this range. Conflicts were evident, particularly between the index data and age data which favored higher values and the catch and length data which supported lower values. In the absence of a prior on steepness, the global solution for the steepness likelihood profile is 0.7, with values between 0.7 and 0.98 within 2 negative log-likelihood units (**Figure 105**).

The total likelihood component from the recruitment distribution parameter likelihood profile indicates that the global solution for this parameter is approximately -0.1 (**Figure 106**), with the SEDAR 85 OA Base Model estimating this parameter at -0.109 (**Table 13**). No other recruitment distribution values remained within 2 negative log-likelihood units. Conflicts were evident, particularly for the length data and index data which favored higher values.

4.7.3. Jitter Analysis

No jitter runs demonstrated a lower negative log-likelihood solution than the SEDAR 85 OA Base Model, and 29% and 76% of runs converged to the same likelihood solution or within 1 negative log-likelihood unit, respectively (**Figure 107**). This is much improved over the SEDAR 22 Benchmark Base Model, where only 17% and 26% of runs converged to the same likelihood solution or within 1 negative log-likelihood unit, respectively. For the remaining runs for the SEDAR 85 OA Base Model, given that the total negative log-likelihood values were much higher than that of the SEDAR 85 OA Base Model, it is probable that non-optimal solutions were found (i.e., the model search was stuck in local minima). Given these results, the jitter analysis indicates that the SEDAR 85 OA Base Model is relatively stable and reached the global solution.

4.7.4. Retrospective Analysis

Results from the retrospective analysis do not indicate any directional retrospective patterns. As the last few years of data are peeled off, the model estimates of SSB, recruitment and *F* in each successive terminal year do not change by a large margin (and confidence intervals overlap; **Figures 108-109**). Recruitment estimates in 2013 are more uncertain as more years of data are peeled off because the model is missing key composition data inputs that capture those cohorts (**Figure 109**).

Mohn's rho, which measures the severity of retrospective patterns, was equal to -0.11 and 0.12 for the SSB and *F* time series (**Table 29**), respectively, which is within the acceptable range (-0.15 to +0.20; see Hurtado-Ferro et al. (2015)). The largest difference was noted for a terminal year of 2019, where Mohn's Rho fell just outside of the acceptable range for SSB (**Table 29**). Mohn's rho for recruitment was also acceptable and equal to -0.02.

4.7.5. Additional Diagnostics

The SEDAR 85 OA Base Model displayed acceptable RMSE (<30%) for the joint residuals for mean age and mean length data sources but not for the indices (**Table 30**). Residuals revealed some conflict in indices of abundance and mean age (evident by colored vertical lines in opposite directions) and trends in the residuals (evident by Loess smoothed line; **Figure 110**). The lowest RMSE was exhibited for the length composition, which exhibited the smallest residuals but did reveal some conflicts (**Table 30**; **Figure 110**). The SEDAR 22 Benchmark Base Model revealed similarly poor diagnostics for the indices, where all indices exhibited a RMSE above 30%. Runs test results revealed evidence of non-randomly distributed residuals for the NMFS Bottom Longline Survey - West index of abundance, Commercial Longline - West age and length compositions, and NMFS Bottom Longline Survey - East length compositions (**Table 31**; **Figure 111**). Outliers (evident by red points) were identified in the residuals for the Commercial Longline - East and NMFS Bottom Longline Survey - West indices, residuals for mean age for all fleets, and in residuals for length compositions for the Commercial Vertical Line - West, Commercial Longline - East, Commercial Longline - West, the NMFS Bottom Longline Survey - West, and the NMFS/SEAMAP Groundfish Trawl Survey - West (**Figure 111**). Superior prediction skill (<1) was evident over the naive baseline forecast for the NMFS Bottom Longline Survey - East index (**Figure 112**), mean age for the Commercial Vertical Line - West fleet and NMFS Bottom Longline Survey - West (**Figure 113**), and mean length for the Commercial Vertical Line - East fleet, NMFS Bottom Longline Survey - West, NMFS/SEAMAP Groundfish Trawl Survey - East, and NMFS/SEAMAP Groundfish Trawl Survey - West (**Figure 114**; **Table 32**).

4.7.6. Bridging Analysis

The general flow of model building runs that led to the SEDAR 85 OA Base Model is shown in **Tables 33-34**. Changes in estimated quantities starting from the SEDAR 22 Benchmark Base Model are shown in **Figures 115-117**.

Model building occurred in phases, starting with converting the original SEDAR 22 Benchmark Base Model (Step 1) from Stock Synthesis version 3.24 to 3.30 (Step 2). Model results were nearly identical (**Tables 33-34**). Step 3 involved updating all data streams and maintaining the model structure of the SEDAR 22 Benchmark Base Model ("Continuity" model). Differences in key derived quantities were particularly evident since the 2000s for the Continuity Model, with additional years of data causing SSB to increase gradually until about 2013 and causing different recruitment trajectories, in particular higher estimates in the early 2000s (**Figure 115**). The Continuity model also estimated slightly higher steepness and a lower $\ln(R_0)$ (**Table 34**). Changes in data streams (e.g., landings, compositions) were likely a large reason for these differences (see **Section 4.7.7**). Step 4 implemented features in Stock Synthesis that were not available previously (e.g., defining the first age mature and the first age male) and corrected the *a* parameter for the length-weight conversion (also used in defining fecundity). This change led to a slightly higher $\ln(R_0)$ and consistently larger annual recruitment estimates, but did not appreciably change SSB or F estimates (**Table 34**; **Figure 115**). Step 5 corrected the input SE for the Commercial Longline - West index, which did not change model results. Step 6 turned off the recruitment deviations bias adjustment ramp, which increased the negative log-likelihood but had no noticeable impacts on model outputs (**Table 34**; **Figure 115**).

Step 7 removed the sex-specific composition data and fit to aggregated composition data (unsexed, female, and male) while fixing the hermaphroditism transition rate at the parameters recommended by SEDAR 22. This change had a major impact as SSB estimates shifted higher (including terminal year SSB ratio; **Table 34**), recruitment estimates were more pronounced (and ln(R_0) was higher), and *F* estimates were consistently lower (**Table 34**; **Figure 115**). Step 8 removed the estimation of male growth curves in each region following the removal of sex-specific composition data. Some minor changes in estimated steepness and annual recruitments were noted, as well as a slight upwards shift in SSB in the middle of the time series (**Figure 115**). Step 9 excluded years where fisheries length compositions had fewer than 30 lengths, which had no appreciable impact on model results.

The addition of Dirichlet-Multinomial parameters to the model for weighting age and length compositions in Step 10 shifted SSB lower (including terminal year SSB ratio; **Table 34**) and *F* higher throughout the time series (**Figure 116**). Step 11 input weighted length compositions for the commercial fleets in the East, which caused higher *F* and lower SSB since the early 1990s (**Figure 116**). Step 12 allowed recruitment deviations to be estimated through 2017 (assuming more recent NMFS/SEAMAP Groundfish Trawl Survey data would help inform more recent trends) and readjusted the recruitment bias ramp, which caused small reductions in SSB in the earliest and most recent years and a slightly lower steepness estimate (**Table 34**; **Figure 116**). Step 13 tuned the selectivity parameters to alleviate bounding parameters, estimated the starting logit parameter for the Commercial Vertical Line - East (previously fixed), and removed the time-varying selectivity for the Commercial Longline fleets given the lack of improvement in model fits. Step 14 floated the catchability parameters for each index. Neither Step 13 nor 14 led to noticeable differences in derived quantities (**Table 34**; **Figure 116**). Step 15 allowed the model to estimate annual *F* parameters for each fleet and incorporated more uncertainty in the landings estimates, which led to some slight shifts in *F* estimates in the early 1980s and 2000s but no detectable changes in SSB or recruitment (**Figure 116**). Step 16 reduced the 1982 Commercial Vertical Line - East landings estimate (driven by a highly uncertain recreational spike), which led to a lower *F* estimate in 1982 and slightly lower SSB in the earlier years (**Figure 116**).

Reviewing model results and diagnostics for Step 16 revealed a few concerning issues. First, poor model fits and residual patterns for the fishery age data between 2010 and 2012 were observed. Of particular concern was the presence of strong patterns of positive residuals for each fleet, where the model was severely underpredicting the number of Yellowedge Grouper at nearly every age class. A deeper dive into the age data (and SEDAR85-WP-08) revealed a lack of documentation regarding how otoliths were sub-sampled in these years. Given the apparent overrepresentation of data included for those years, all otoliths may have been processed in those years, potentially rendering the annual composition not representative of the landings. Therefore, these data were removed from model fitting in Step 17, and their exclusion led to improved residual patterns, reduced SSB estimates starting in 2009, and caused lower recruitment estimates in the early 2000s (**Figure 117**).

The other concerning issue surrounded the modeling of recruitment and model estimates. Recruitment deviations showed a steady increasing trend from 2013 to 2017 which was considered unrealistic. The Groundfish Trawl Survey captures younger Yellowedge Grouper, and in theory recruitment should be estimable in more recent years. However, very small sample sizes continue to limit the utility of these data as discussed in SEDAR 22. As a result, Step 18 estimated recruitment deviations through 2012, which led to a higher steepness value, higher SSB estimates in the earliest years and slightly lower *F* in the most recent years (**Table 34**; **Figure 117**). After confirming via diagnostics that steepness was not estimable in the model and was bounding if freely estimated, Step 19 fixed steepness at a biologically realistic value of 0.827. This change led to slight changes in trajectories since 2000, with SSB and recruitment slightly lower and *F* slightly higher (**Figure 117**). Step 20 fixed *SigmaR* at 0.5 because the model supported more variability in the estimated recruits, with this value recommended via tuning of *SigmaR* within Stock Synthesis (Taylor et al. 2021). This change had a substantial impact on estimated recruitment and SSB trajectories, with more strong recruitment events estimated and a higher SSB ratio throughout the time series (**Figure 117**).

Step 21 switched from modeling commercial age data conditional on length to fitting to nominal age compositions. This change was made due to concerns over the quality and representativeness of the conditional age-at-length data combined with very poor fits for most fleets and surveys. Better fits were achieved when fitting to the nominal age compositions, with this change in the input data leading to significantly larger SSB estimates (including terminal year SSB ratio; **Table 34**), lower *F* estimates, and changes in recruitment estimates (**Figure 117**). The composition data were further vetted for representativeness, and Step 22 removed the age and length data for the NMFS Bottom Longline Survey prior to 2000 as these years were not included during index development because of inconsistent sampling protocols (e.g., hook type; SEDAR85-WP-09). Step 23 removed the age data from the NMFS/SEAMAP Groundfish Trawl Survey - East and aggregated the age data from the NMFS/SEAMAP Groundfish Trawl Survey - West, fitting to it using the super-period approach in Stock Synthesis. No major changes in derived quantities were evident for Steps 22 or 23 (**Figure 117**). Step 24 was the final step where early recruitment deviations were removed (they were all poorly estimated, CV > 1) and the recruitment deviations bias adjustment ramp was applied (**Figure 117**).

4.7.7. SEDAR 22 Benchmark Base Model Sensitivity Runs

Results for the sensitivity runs summarized in **Section 3.4.7** for the SEDAR 22 Benchmark Base Model are presented in **Tables 35-36**. Even given the differences discussed below, the derived quantities for each sensitivity run generally remained within the confidence intervals of estimates from the SEDAR 22 Benchmark Base Model (**Figure 118**). Inputting the SEDAR 85 compositions led to the largest differences in model results, with consistently lower SSB (and SSB ratios) throughout the time series and at virgin conditions, with the confidence intervals barely overlapping (**Figure 118**). The SSB ratio differed most in recent years, with the terminal value dropping from 0.32 in the SEDAR 22 Benchmark Base Model to 0.28 (**Table 36**; **Figure 118**). Estimates of *F* were also consistently higher when using SEDAR 85 compositions, and although recruitment estimates changed considerably, their confidence intervals overlapped in all years (**Figure 118**). Inputting the SEDAR 85 landings into the SEDAR 22 Benchmark Base Model had a small impact on model results, with *F* estimates diverging in the early years and SSB slightly higher from 1985 to 1995 (**Table 36**; **Figure 118**). Estimating annual *F* parameters for each fleet led to many more estimated parameters (**Table 35**), slightly higher *F* estimates, lower recruitment estimates, and lower SSB estimates (and SSB ratios), although confidence intervals overlapped (**Figure 118**). Removing sex-specific composition data and allowing more uncertainty in landings (while estimating fleet-specific annual *F* parameters) each revealed no major changes in key trajectories when compared to the SEDAR 22 Benchmark Base Model (**Figure 118**).

4.7.8. SEDAR 85 OA Base Model Sensitivity Runs

Results for the sensitivity runs summarized in **Section 3.4.8** for the SEDAR 85 OA Base Model are presented in **Tables 37-38** and discussed below.

Landings

Because of their small magnitude, removal of recreational landings and dead discards did not appreciably alter model results for key model parameters (**Tables 37-38**) or for annual SSB, recruitment, or *F* estimates (**Figure 119**). The Commercial Longline - East fleet landed the majority of Yellowedge Grouper across most of the time series, so assuming lower Commercial Longline - East landings in the early 1980s resulted in lower estimates of virgin and early SSB (**Figure 119**). Because of the reduction in virgin SSB, the terminal SSB ratio was slightly higher at 0.5 compared to the SEDAR 85 OA Base Model estimate of 0.46 (**Table 38**). Allowing more uncertainty (log-scale SE = 0.3) in landings between 1975 and 1985 led to much higher virgin and early SSB (and ln(R_0)) and a steep drop in SSB in 1981 as a result of a very large *F* estimate (**Figure 119**). This change also resulted in a few more highly uncertain recruitment estimates (**Table 37**). The SSB ratio continued to drop until about 1990 (~40%), and increased until about 2012 before declining to 0.58 in 2021, which was much higher than the SEDAR 85 OA Base Model estimate of 0.46 (**Figure 119**).

Steepness

Changing the value of steepness had a significant impact on the results. Estimation of steepness led to much lower estimates, with steepness estimated at the lower bound of 0.4 without a prior and at 0.508 using a prior (**Table 38**). Large differences in trajectories were evident, with lower steepness values resulting in reduced SSB (falling outside the confidence interval of the SEDAR 85 OA Base Model), lower SSB ratios in the terminal year (0.33-0.37; **Table 38**), and higher *F* in more recent years (**Figure 120**). Fixing steepness at 0.7 led to more similar trajectories to the SEDAR 85 OA Base Model, as estimates fell within the confidence intervals. As discussed in **Section 4.7.2**, support for estimating steepness is lacking, and therefore steepness was fixed at a biologically plausible value in the SEDAR 85 OA Base Model.

SigmaR

Estimating *SigmaR* had a noticeable effect on recruitment estimates (**Figure 121**). The model estimated a much larger *SigmaR* of 1.4 (**Table 38**), with four fewer recruitment deviations exhibiting a CV > 1 (**Table 37**). When accounting for more variability in the recruitment estimates, most values fell within the confidence limits for the SEDAR 85 OA Base Model (**Figure 121**). Lower SSB estimates were evident early on in the time series and at virgin conditions, whereas slightly higher SSB was evident in more recent years (terminal SSB ratio of 0.48; **Table 38**). However, all values fell within the confidence limits of the SEDAR 85 OA Base Model (**Figure 121**). As discussed in **Section 4.7.2**, support for estimating *SigmaR* is lacking, and therefore *SigmaR* was fixed at a more realistic value. Even given the variability in *SigmaR* values, likelihood profiling across a range of *SigmaR* values (0.1-2) showed that SSB ratios did not diverge much from the SEDAR 85 OA Base Model value of 0.5.

Jack-knife Analysis on Indices of Abundance

The removal of one index at a time and all fishery-dependent indices at one time indicated that no one index or group of indices appeared to be having undue influence on estimates of key derived quantities (**Table 38**; **Figure 122**). Removal of the Commercial Longline - East index and both Commercial Longline indices led to slightly lower SSB estimates (and SSB ratios, with a lower terminal value of 0.43), but all values fell within the confidence intervals of the SEDAR 85 OA Base Model. Removal of the Commercial Longline - West and NMFS Bottom Longline Survey - East indices did not have a noticeable effect on model outputs. In contrast, removal of the NMFS Bottom Longline Survey - West resulted in a different recruitment trajectory in the late 1970s, but little change in SSB or *F* estimates.

5. Discussion

This Operational Assessment for Gulf of Mexico Yellowedge Grouper implemented a number of new or improved procedures and methodologies including: revised estimates of commercial landings and discards; revised estimates of recreational landings and discards (via MRIP-FES); incorporated more error in landings estimates to better reflect uncertainties in historical landings; re-evaluated the representativeness and reliability of sex-specific composition data; used weighted length compositions for fisheries data where possible; inputted nominal age compositions instead of conditional age-at-length compositions because of concerns over violating assumptions when using the latter; re-evaluated recruitment parameters (steepness and *SigmaR*) and whether they were estimable by the model; and utilized the Dirichlet-multinomial error distribution for composition data (Thorson et al. 2017). Further, switching to the newest Stock Synthesis version allowed more flexibility in handling a number of processes including data weighting and projections, which were not available during SEDAR 22 when Stock Synthesis was first applied to a Gulf of Mexico stock. Collectively, these changes to data inputs and model parameterization greatly affected the assessment results and improved many aspects of model performance.

More than a decade of new data was available since SEDAR 22 (terminal year of 2009), with time series more than doubling in length for fishery-independent surveys. Uniquely for Yellowedge Grouper, age data for all fleets and surveys were available and incorporated into the assessment model. Normally for Gulf of Mexico stocks, age data from fishery-independent surveys are not included in assessment models because of difficulties linking the length and age data (which come from different databases and can lack variables enabling linkage). In addition to more than a decade of new data, major revisions to data inputs were made across data streams. Given the large number of changes in data inputs compared to SEDAR 22, particularly concerning landings and compositions, the potential effects on model results were explored for the SEDAR 22 Benchmark Base Model. While some small differences in estimated trajectories of SSB and *F* were evident, no major differences in model outcome were noted for either terminal SSB ratios (**Section 4.7.7**) or catch advice (**Section 6.4**). While the switch to the MRIP-FES for estimating recreational landings and discards led to larger estimates compared to SEDAR 22 (detailed in SEDAR85-WP-03), the fact that the Yellowedge Grouper fishery is primarily commercial led to a negligible impact of this data change on the model results (**Section 4.7.8**).

Overall, the SEDAR 85 OA Base Model appears to perform well and exhibited some noticeable improvements in performance over the SEDAR 22 Benchmark Base Model, including fewer correlated parameters, more consistent jitter results, and less retrospective bias in SSB. Profile likelihood analyses provided support for the SEDAR 85 OA Base Model estimates of ln(R_0) and the recruitment distribution parameter. The SEDAR 85 OA Base Model fit most of the data sources well although some did exhibit residual patterns, but many of the fits were improved compared to the SEDAR 22 Benchmark Base Model. The dominant data inputs were the length and age compositions as these produced the greatest impact on the model fit (as measured in the total likelihood). Some of the data streams revealed very large residuals in terms of magnitude, with the largest observed in the NMFS/SEAMAP Groundfish Trawl Survey where larger individuals (> 40 cm TL) were occasionally caught. Patterns in residuals that were observed for the commercial fisheries data could be related to regulations for species other than Yellowedge Grouper. This assessment, as well as other Gulf of Mexico assessments, would greatly benefit from a better understanding of changes in management regulations for other species (e.g., groupers, Red snapper) that fall within the multi-species fisheries in the Gulf of Mexico, and how these regulations may affect the species under assessment (e.g., selectivity, catchability, etc.).

While some aspects of the model were greatly improved upon, some outstanding issues remain and would benefit from future investigation. No updates to life history parameters were made during SEDAR 85, but this is an area of future work that should be addressed. Growth curves, natural mortality, and reproduction inputs should all be revisited and explored for both temporal and spatial differences at some time in the future. The age data (in particular the sampling schemes) and development of compositions representative of the fishery being modeled require additional exploration, as some concerning patterns in residuals of mean length-at-age were observed in some years suggesting inconsistent sampling. For Yellowedge Grouper, there was a clear gap in documentation regarding how otoliths were sampled from between 2010 and 2012. Closer examination of the sample sizes suggested that all available otoliths might have been processed, because residuals showed strong positive trends where observed ages greatly exceeded expected ages (e.g., a similar issue may be occurring in 2008-2009 for Commercial Longline - West; **Figure 92**).

While a considerable amount of effort was expended during both SEDAR 22 and SEDAR 85 to recreate historical landings of Yellowedge Grouper, historical estimates remain very uncertain due to the assumptions and limited data used in their development. Starting the model in 1986 would alleviate many of these issues, and this was attempted in SEDAR 85, but this would require more thought on how to specify initial equilibrium catches. Preliminary analyses revealed much different model trajectories, as exclusion of the high 1980s landings in the East led to a much lower stock size in that region.

Unfortunately, data collection for the NMFS Bottom Longline Survey since SEDAR 22 did not improve index performance, as the regional indices remain plagued with high uncertainty (East mean SE 0.48, West mean SE 0.44). All index fits exhibited undesirable RMSE estimates exceeding 30%, both in the SEDAR 85 OA Base Model and in the SEDAR 22 Benchmark Base Model. While the NMFS Bottom Longline Survey index in the East displayed good prediction skill, both the age and length compositions performed poorly (MASE > 1). The NMFS Bottom Longline Survey in the West did not exhibit good prediction skill, and this index showed non-randomly distributed residuals. Given the two-area nature of this assessment, coupled with the overall poor fits to the fishery-independent indices, it is unclear how interim analyses will be conducted for this stock. While not feasible for this Operational Assessment, a single area model should be reconsidered to alleviate some of the poor sample size issues if warranted. For example, when calculated on the Gulf-wide scale for 2000-2019, the NMFS Bottom Longline Survey showed a much lower mean CV at 0.31.

A key modeling uncertainty for the Gulf of Mexico Yellowedge Grouper stock assessment and most assessment models in general, is the stock-recruit relationship. Both the SEDAR 22 Benchmark Base Model and the SEDAR 85 OA Base Model demonstrate highly uncertain recruitment estimates. While the NMFS/SEAMAP Groundfish Trawl Survey encounters younger Yellowedge Grouper throughout the Gulf of Mexico, small sample sizes continue to prevent these data from being informative. Ultimately, steepness was fixed at a biologically plausible value of 0.827 following the logic used during the SEDAR 68 Gulf of Mexico Scamp Grouper Research Track Assessment after obtaining poor diagnostics and the model being unable to estimate steepness. Similarly, *SigmaR* was fixed at 0.5 to allow more variability in estimated recruitments compared to the SEDAR 22 Benchmark Base Model. Sensitivity analyses focused on both steepness and *SigmaR* demonstrated clear differences in model results based on the input values. However, the likelihood profiling analysis for steepness provided support for a fixed value of 0.827, as this fell within the range of values within 2 negative log-likelihood units (**Section 4.7.2**). In contrast, the likelihood profiling analysis for *SigmaR* did not provide support for a fixed value of 0.5, and instead showed a minimum around 1.4 (with values between 1 and 2 remaining within 2 negative log-likelihood units). However, SSB ratio estimates across a range of *SigmaR* values did not show an appreciable difference in the terminal year value.

For this assessment report, benchmarks were determined through projections (see **Section 6**) using the stock-recruit curve. Given the inability to estimate steepness (e.g., wide range identified in the likelihood profile), MSY-based reference points are not supported by the results. Therefore, it may be more appropriate to use proxy reference points using spawning potential ratio (SPR). Simulations conducted by Harford et al. (2019) suggest that SPR ratios of 40% or 50% led to the highest probabilities of achieving long-term MSY for hermaphroditic stocks. They found that more conservative fishing mortality proxies were required to achieve MSY-based fishery objectives when steepness was "least certain" (i.e., uniform prior). While the current proxy for Yellowedge Grouper is 30% SPR, this decision should be re-evaluated in light of recent changes to proxies for Gulf of Mexico Scamp Grouper (from 30% SPR to 40% SPR) and Gag Grouper (from FMax to 40% SPR).

A number of research questions were raised during the SEDAR 85 assessment process. While attempts were made to address these questions through sensitivity runs and preliminary data exploration, the Operational nature of this assessment did not leave enough time to thoroughly evaluate each and every one of these questions. The SEFSC strongly recommends that these topics (listed in **Section 8**) be more thoroughly examined during a future assessment with targeted topical working groups.

Overall, the SEDAR 85 OA Base Model is improved since the SEDAR 22 Benchmark Assessment Review Workshop, and it incorporates the best available data and addressed some of the issues evident in the Benchmark Assessment. Spawning stock biomass started at virgin conditions in 1975, and has been fished down over time primarily by the Commercial Longline fishery since the early 1980s. According to the SEDAR 85 OA Base Model, the Gulf of Mexico

Yellowedge Grouper resource is not overfished nor undergoing overfishing in 2021, however the 2021 SSB estimate was the lowest on record. Further, some concerning trends in recent recruitment warrant careful consideration for management implementation. As shown in **Figure 41**, recruitment estimates in the late years of the assessment (2013-2021) are much higher than subsequent years (2005-2012) because they are derived from the stock-recruit curve. A similar result was observed for Gulf of Mexico Scamp Grouper, but is more pronounced for Yellowedge Grouper because of the larger gap in recent recruitment levels because Yellowedge Grouper do not appear in appreciable numbers in the fishery until about 8 years. The assumed recruitment values as placeholders in 2013-2021 and in the future will have important implications for determination of short-term catch advice. Additional projection scenarios exploring 40% SPR and recent mean recruitment estimates will be prepared and presented at the February 2024 Gulf of Mexico Fishery Management Council's Scientific and Statistical Committee meeting to demonstrate the effects of these projection specifications on forecasted yields and stock status.

6. Projections

6.1. Introduction

The SEDAR 85 projections were run for two key fishing mortality scenarios: $F_{MSYproxy}$ and 0.75 * Directed *F* at $F_{MSYproxy}$. Both an MSY proxy of 30% SPR ($SPR_{30\%}$) and the OY (0.9 * MSYproxy) were specified for the Deepwater Grouper complex (includes Yellowedge Grouper) in Amendment 48 (GMFMC 2021) and provided in the SEDAR 85 Terms of Reference.

6.2. Projection Methods

The simulated dynamics used for projections assumed nearly identical parameter values and population dynamics as the SEDAR 85 OA Base Model. **Table 39** provides a summary of projection settings. Projections were run assuming that relative *F* and selectivity associated with the last three years (2019-2021) would remain the same into the future. Forecast recruitment values (including late recruitment values for 2013-2021) were derived from the model-estimated Beverton-Holt stock-recruit relationship.

The terminal year of SEDAR 85 was 2021 and the first year of management advice will be 2025. Retained catch for the interim years (2022-2024) used landings estimates for 2022 and the average of the last three years of retained catches (2020-2022) for 2023 and 2024 (**Table 39**).

$F_{30\%SPR}$ was determined using a long-term 100-year projection assuming that equilibrium was obtained over the last 10 years (2112-2121). For the OFL projection, the $F_{30\%SPR}$ was applied to the stock starting in 2025. No fleet allocations exist for the Deepwater Grouper complex.

The status determination criteria for Gulf of Mexico Yellowedge Grouper were updated in Amendment 48 (GMFMC 2021). The minimum stock size threshold (MSST) was determined by multiplying the reference spawning stock biomass, $SSB_{30\%SPR}$, by 0.75 (per Amendment 48 and the SEDAR 85 Terms of Reference) and was used to determine stock status (**Table 40**). The maximum fishing mortality threshold (MFMT) was equivalent to the harvest rate ($F_{30\%SPR}$; total biomass killed all ages / total biomass age 1+) that achieved $SSB_{30\%SPR}$, and was used to assess whether overfishing was occurring in a given year (**Table 40**). A stock is considered overfished when $SSB_{Current}$ < MSST and undergoing overfishing if $F_{Current}$ > MFMT, where $F_{Current}$ is defined as the geometric mean of the fishing mortality over the most recent three years (2019-2021).

Once the proxy values were calculated, 2021 stock status was used to determine whether a rebuilding plan was required (i.e., if SSB < MSST then Gulf of Mexico Yellowedge Grouper would be considered overfished and a rebuilding plan would be required).

6.3. Projection Results

Benchmarks and reference points were calculated assuming an SSB defined in terms of male and female combined SSB.

6.3.1. Biological Reference Points

The status determination criteria for the Deepwater Grouper complex specified in Amendment 48 were adopted for Gulf of Mexico Yellowedge Grouper (**Table 40**; **Figure 123**).

- MSY proxy = yield at $F_{30\%SPR}$ = 623,630 pounds gutted weight
- MSST = 0.75*$SSB_{30\%SPR}$ = 2,589 metric tons
- MFMT = $F_{MSYproxy}$ ($F_{30\%SPR}$) = 0.061
- OY = 0.9*MSY proxy = 561,267 pounds gutted weight

6.3.2. Stock Status

Benchmarks and reference points are shown in **Table 40**. Detailed time series of derived quantities and benchmarks with SSB defined as male and female combined SSB are presented in **Table 41**. As of 2021, the Gulf of Mexico Yellowedge Grouper stock is not undergoing overfishing ($F_{Current}$ > MFMT) and is not overfished (SSB_{2021} > MSST) according to the SEDAR 85 OA Base Model (**Table 40**). The terminal year SSB (2021) is above $SSB_{30\%SPR}$ (**Figure 123**) at 174% of the biomass level needed to support MSY (**Table 41**). From 2019 to 2021 the estimated stock harvest rate, using the geometric mean, was 0.047, which was equivalent to 77% of $F_{30\%SPR}$ (**Table 40**).

The Kobe plot (**Figure 124**) indicates that over the time horizon of the assessment (i.e., 1975-2021), the stock has not been overfished in any year since 1975 but has experienced overfishing between 1981-1986, 1988, 1992, and 1994 (**Table 41**).

6.3.3. Overfishing Limit and Acceptable Biological Catch Projections

OFL and ABC projection results **assuming predicted recruitment follows the stock-recruit curve** are provided in **Tables 42-43** and **Figure 125**. Compared to 2019-2021, lower landings were realized in 2022 and assumed to occur in 2023 and 2024 based on the recent average (2020-2022). Forecasts indicate that yields can increase in the near-term for the OFL projection scenario presented whereas yields for the ABC projection would remain at slightly higher levels than recent (2020-2022) mean landings (**Figure 125**). However, these results are dependent upon the assumption of recruitment into the forecast period. Additional projection scenarios exploring 40% SPR and recent mean recruitment estimates will be prepared and presented at the February

2024 Gulf of Mexico Fishery Management Council's Scientific and Statistical Committee meeting to demonstrate the effects of these projection specifications on forecasted yields and stock status.

6.4. SEDAR 22 Catch Projections (FES + Commercial Landings)

The SEDAR 22 Benchmark Base Model was modified to include MRIP-FES-based estimates of recreational landings and discards in place of the MRFSS-based estimates and updated commercial landings estimates based on improved methodologies. Unfortunately, an MRIP-FES only projection was not feasible because the SEDAR 22 landings vector (i.e., showing the breakdown by data source) was not found and therefore could not be recreated. Projections were run to compare the catch recommendations which would have resulted had the SEDAR 85 data (including MRIP-FES and commercial landings) been used in SEDAR 22 (**Table 44**). Given the very low magnitude of recreational landings, differences in OFL between the two sets of projections were very small, and amounted to about a 2-3% difference in each year (**Table 44**).

7. Acknowledgements

The SEDAR 85 Operational Assessment for Gulf of Mexico Yellowedge Grouper would not have been possible without the efforts of the numerous SEFSC, SERO, and GMFMC staff along with the many state, academic, and research partners involved throughout the Gulf of Mexico listed in **Section 1.3** and **Section 2**. The following agencies contributed to the assessment and deserve notable attention and thanks for efforts extended to developing data inputs: NOAA SEFSC Fisheries Statistics Division (FSD), NOAA SEFSC Panama City Laboratory, NOAA SEFSC Mississippi Laboratories, NOAA Southeast Regional Office (SERO), Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, NOAA SEFSC Beaufort Laboratory, and the Gulf States Marine Fisheries Commission. Special thanks are also extended to the Data Updates TWG members for their rapid and helpful guidance with model development.

8. Research Recommendations

Recommendations for considerations of future research are provided below and do not indicate any particular order of priority.

Stock Structure

- Better understanding of the population genetics throughout the Gulf of Mexico and connectivity with the Atlantic

Age and Growth

- Investigate methods to better collect age structure samples randomly and systematically from all fishing sectors
- Continue collaboration with ageing facilities throughout the Gulf of Mexico and South Atlantic. These efforts will include the annual reading of references sets for Yellowedge Grouper and other reef fish, and annual meetings to review the interpretation of ageing structures and the timing of annual band deposition

Natural Mortality

- Explore more direct approaches to estimating natural mortality (e.g., Mark-recapture approaches (conventional, telemetry, or close-kin))
- Explore ways to better reflect uncertainty around the mortality at age vector

Reproduction

- Continue data collection for maturity, sex transition, and fecundity as detailed in the SEDAR 22 Benchmark Assessment DW Report Recommendations

Discard Mortality

- Continue data collection from observer programs or electronic monitoring programs (e.g., SEDAR68-DW-22)

Commercial Landings

- Explore approaches for assigning uncertainty estimates to commercial landings and revisit estimation of historic landings

Recreational Landings and Discards

- Further develop best practices for correcting for prominent peaks and troughs in the recreational landings and discards where uncertainty is high and estimates are driven by few but influential intercept records

CPUE Indices

- Consider developing indices of relative abundance from observer program data (e.g., SEDAR68-AW-04). Observer data would provide finer spatial resolution, a more accurate measure of CPUE, size frequency and discard information

Age and length composition

- Quantify and evaluate appropriate modeling and weighting procedures of length and age compositions to ensure age and length composition inputs are representative of the segment of the population being modeled

Selectivity and catchability

- Further investigate and quantify changes in selectivity/catchability through time to improve fit to the length and age compositions

Surveys

- Improve precision in survey abundance indices by increasing the number of samples, including expansion into deeper water - Increase collection of length and age information for compositions

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10. Tables

Table 1. Conversion factors from the SEDAR 22 Benchmark Assessment used to convert total length in centimeters (cm TL) to gutted weight (gw) in kilograms, whole weight (ww) in kilograms to gw in kilograms, and fork length (FL) in centimeters to total length for Gulf of Mexico Yellowedge Grouper males and females combined. Model fit criteria: linear regression models R2. Weight to weight conversion reported in Goodyear and Schirripa (1993).

Model	N	R2	Range
gw = 2.106 E-05 x (TL^2.91)	2,916	0.969	TL (cm): 25.0–117.8
gw = ww / 1.048	-	-	-
TL = 1.067*FL – 15.065	1,593	0.997	TL (cm): 9.9–117.4

Table 2. Growth parameters (and associated standard deviation, SD) recommended for Gulf of Mexico Yellowedge Grouper during the SEDAR 22 Benchmark Assessment. The von Bertalanffy parameters (L∞, K, and t0) and CV estimates were not updated during the SEDAR 85 Operational Assessment.

Parameter	Value	SD
L∞ (cm TL)	100.45	0.8
K (per year)	0.059	0.8
t0 (year)	-4.75	-
CV at age (young)	0.1626	0.05
CV at age (old)	0.1165	0.05

Table 3. Ageing error matrices (standard deviations associated with mean age) recommended for Gulf of Mexico Yellowedge Grouper during the Benchmark Assessment (1975-2009 age data) and for the Operational Assessment (2013-2021 age data) to incorporate uncertainty at age. Note that the Benchmark Assessment ageing error matrix was used for years 2010-2012 based on the agers.

Age	Benchmark	Operational (curvilinear CV)
0	1.1	0.4
1	1.0	0.4
2	1.2	0.7
3	1.3	1.0
4	1.8	1.3
5	1.9	1.5
6	2.6	1.7
7	2.2	1.9
8	2.5	2.1
9	2.6	2.2
10	2.6	2.4
11	2.7	2.5
12	2.3	2.6
13	3.1	2.7
14	3.2	2.8
15	2.8	2.9
16	2.5	3.0
17	3.2	3.1
18	3.0	3.2
19	3.3	3.3
20	3.5	3.4
21	3.7	3.5
22	3.9	3.5
23	4.1	3.6

Table 3 Continued. Ageing error matrices (standard deviations associated with mean age) recommended for Gulf of Mexico Yellowedge Grouper during the Benchmark Assessment (1975-2009 age data) and for the Operational Assessment (2013-2021 age data) to incorporate uncertainty at age. Note that the Benchmark Assessment ageing error matrix was used for years 2010-2012 based on the agers.

Age	Benchmark	Operational (curvilinear CV)
24	4.3	3.7
25	4.4	3.8
26	4.6	3.9
27	4.8	4.0
28	5.0	4.0
29	5.2	4.1
30	5.4	4.2
31	5.6	4.3
32	5.7	4.4
33	5.9	4.5
34	6.1	4.6
35	6.3	4.7
36	6.5	4.8
37	6.7	4.8
38	6.9	4.9
39	7.1	5.0
40	7.2	5.1

Table 4. Age-specific natural mortality (*M*, per year) for female and male Yellowedge Grouper in the Eastern and Western Gulf of Mexico estimated by Stock Synthesis. Female and male natural mortality were assumed equivalent within a region. For implementing Lorenzen scaling in Stock Synthesis, the reference age used was 15 years (in bold) and its corresponding *M* was obtained by externally estimating the Lorenzen curve during the SEDAR 22 Benchmark Assessment.

Age	Female East	Male East	Female West	Male West
0	0.435	0.435	0.445	0.445
1	0.280	0.280	0.287	0.287
2	0.211	0.211	0.216	0.216
3	0.172	0.172	0.176	0.176
4	0.147	0.147	0.150	0.150
5	0.130	0.130	0.132	0.132
6	0.117	0.117	0.119	0.119
7	0.107	0.107	0.109	0.109
8	0.100	0.100	0.101	0.101
9	0.094	0.094	0.095	0.095
10	0.089	0.089	0.089	0.089
11	0.084	0.084	0.085	0.085
12	0.081	0.081	0.081	0.081
13	0.078	0.078	0.078	0.078
14	0.075	0.075	0.075	0.075
15	**0.073**	**0.073**	**0.073**	**0.073**
16	0.071	0.071	0.071	0.071
17	0.069	0.069	0.069	0.069
18	0.068	0.068	0.068	0.068
19	0.066	0.066	0.066	0.066
20	0.065	0.065	0.065	0.065
21	0.064	0.064	0.064	0.064
22	0.063	0.063	0.063	0.063
23	0.062	0.062	0.062	0.062
24	0.062	0.062	0.061	0.061
25	0.061	0.061	0.060	0.060
26	0.060	0.060	0.060	0.060

Table 4 Continued. Age-specific natural mortality (*M*, per year) for female and male Yellowedge Grouper in the Eastern and Western Gulf of Mexico estimated by Stock Synthesis. Female and male natural mortality were assumed equivalent within a region. For implementing Lorenzen scaling in Stock Synthesis, the reference age used was 15 years (in bold) and its corresponding *M* was obtained by externally estimating the Lorenzen curve during the SEDAR 22 Benchmark Assessment.

Age	Female East	Male East	Female West	Male West
27	0.060	0.060	0.059	0.059
28	0.059	0.059	0.058	0.058
29	0.059	0.059	0.058	0.058
30	0.058	0.058	0.057	0.057
31	0.058	0.058	0.057	0.057
32	0.058	0.058	0.057	0.057
33	0.057	0.057	0.056	0.056
34	0.057	0.057	0.056	0.056
35	0.057	0.057	0.056	0.056
36	0.057	0.057	0.055	0.055
37	0.056	0.056	0.055	0.055
38	0.056	0.056	0.055	0.055
39	0.056	0.056	0.055	0.055
40	0.056	0.056	0.054	0.054

Table 5. Eastern and Western Gulf of Mexico Yellowedge Grouper commercial landings in pounds gutted weight. Landings by "Other" gears were lumped into vertical line for each region for input into the stock assessment model. In the absence of uncertainty estimates accompanying the submitted data, commercial landings for 1975-2009 were assigned a log-scale SE based on a weighted combination of expert opinion (**Table 7**) and regional landings (**Table 8**). A log-scale SE of 0.01 was used for 2010-2021 after implementation of the IFQ program.

Year	Vertical Line East	Vertical Line West	Longline East	Longline West
1975	318,132	152,638	0	0
1976	291,897	102,174	0	0
1977	264,837	87,583	0	0
1978	245,363	95,285	0	0
1979	337,186	110,448	0	35,954
1980	329,629	63,853	460,953	49,070
1981	293,565	322,614	1,515,398	686,805
1982	263,608	317,013	3,224,888	682,543
1983	244,206	161,160	1,745,382	339,358
1984	247,534	279,081	777,962	430,574
1985	309,150	344,821	606,996	915,565
1986	323,622	91,843	438,908	464,703
1987	337,739	70,924	333,361	476,484
1988	313,225	342,374	627,106	562,298
1989	75,226	219,691	316,360	290,219
1990	19,096	50,868	431,930	440,619
1991	16,389	59,335	305,330	439,567
1992	39,373	124,728	665,230	289,073
1993	36,420	89,684	390,572	282,364
1994	52,746	56,131	775,947	272,900
1995	24,694	54,504	455,862	362,486
1996	23,522	34,343	369,745	159,410
1997	17,745	39,651	636,162	110,155
1998	23,102	85,134	465,820	145,832
1999	31,971	37,496	725,602	278,291

Table 5 Continued. Eastern and Western Gulf of Mexico Yellowedge Grouper commercial landings in pounds gutted weight. Landings by "Other" gears were lumped into vertical line for each region for input into the stock assessment model. In the absence of uncertainty estimates accompanying the submitted data, commercial landings for 1975-2009 were assigned a log-scale SE based on a weighted combination of expert opinion (**Table 7**) and regional landings (**Table 8**). A log-scale SE of 0.01 was used for 2010-2021 after implementation of the IFQ program.

Year	Vertical Line East	Vertical Line West	Longline East	Longline West
2000	19,719	46,316	737,456	270,207
2001	13,165	31,365	530,977	157,775
2002	18,779	33,472	421,650	269,640
2003	23,153	37,877	674,615	338,524
2004	18,353	36,472	550,933	268,874
2005	14,596	26,882	443,479	252,102
2006	19,793	20,627	445,450	207,595
2007	10,310	27,572	672,808	136,396
2008	8,272	23,676	602,463	156,429
2009	18,669	30,053	548,634	214,392
2010	7,196	25,429	274,693	136,569
2011	9,694	29,979	303,688	215,546
2012	24,421	36,203	438,280	168,880
2013	11,517	13,656	384,104	264,072
2014	10,594	17,369	515,542	230,116
2015	22,151	7,882	406,134	299,052
2016	6,669	10,069	367,391	325,219
2017	5,162	14,286	400,003	258,476
2018	3,847	6,850	501,617	164,996
2019	8,564	9,148	506,824	280,022
2020	5,499	4,737	468,378	186,798
2021	7,941	6,541	534,069	133,116

Table 6. Uncertainty estimates for Gulf of Mexico commercial landings based on expert opinion derived from changes in reporting, following the approach taken in the South Atlantic and presented during the SEDAR 68 Gulf of Mexico Scamp Grouper Research Track Assessment (SEDAR 2021b). ALS = Accumulated Landings System.

Year Range	Texas	Louisiana	Mississippi	Alabama	Florida	Description
1962-1976	0.20	0.20	0.20	0.20	0.20	Annual state summaries
1977-1985	0.10	0.10	0.10	0.10	0.10	Monthly state summaries
1986-1999	0.10	0.10	0.10	0.10	0.05	Florida starts state trip ticket, used in ALS 1986
2000-2001	0.10	0.05	0.10	0.10	0.05	Louisiana starts state trip ticket 1997; used in ALS 2000
2002-2009	0.10	0.05	0.10	0.05	0.05	Alabama starts state trip ticket, used in ALS 2002
2010+	0.10	0.05	0.10	0.05	0.05	Shallow & Deep Water Grouper IFQ starts 2010
2014+	0.05	0.05	0.05	0.05	0.05	Texas (2008) and Mississippi (2012) state trip tickets begin; used in ALS 2014 [MS may change to 2015]

Table 7. Uncertainty estimates by fleet and region for Gulf of Mexico commercial landings. Estimates for 1975-2009 are based on expert opinion values weighted by regional landings and an assumed value of 0.01 after implementation of the IFQ program in 2010. These uncertainty estimates were used in the SEDAR 85 OA Base Model.

Year	Vertical Line East	Vertical Line West	Longline East	Longline West
1975-76	0.200	0.200		
1977-78	0.100	0.100		
1979	0.100	0.100		0.100
1980-85	0.100	0.100	0.100	0.100
1986	0.050	0.078	0.051	0.098
1987	0.050	0.099	0.051	0.098
1988	0.050	0.100	0.051	0.097
1989	0.050	0.099	0.050	0.092
1990	0.054	0.097	0.052	0.076
1991	0.051	0.092	0.051	0.075
1992	0.050	0.087	0.052	0.093
1993	0.051	0.092	0.053	0.088
1994	0.051	0.094	0.054	0.092
1995	0.051	0.096	0.053	0.093
1996	0.058	0.095	0.054	0.096
1997	0.053	0.094	0.051	0.093
1998	0.051	0.097	0.051	0.085
1999	0.052	0.093	0.050	0.094
2000	0.051	0.069	0.050	0.064
2001	0.050	0.074	0.051	0.073
2002	0.050	0.072	0.050	0.075
2003	0.053	0.070	0.050	0.084
2004	0.050	0.064	0.050	0.084
2005	0.050	0.064	0.050	0.083
2006	0.050	0.067	0.050	0.079
2007	0.050	0.057	0.050	0.076
2008	0.050	0.059	0.050	0.077
2009	0.050	0.074	0.050	0.071
2010-21	0.010	0.010	0.010	0.010

Table 8. Eastern and Western Gulf of Mexico Yellowedge Grouper recreational landings in pounds gutted weight (converted from pounds whole weight; **Table 1**) and dead discards in pounds gutted weight (converted from numbers using mean weight; **Section 2.3.4**). Given their small magnitude, recreational landings and dead discards were added to the Commercial Vertical Line fleet landings for each region following SEDAR 22. The 1982 peak in Private landings in the Eastern Gulf of Mexico (659,895 pounds gutted weight) was replaced with the average of 1981-1985 (131,979 pounds gutted weight).

Year	Landings_East	Landings_West	Dead_Discards_East	Dead_Discards_West
1981	0	0	0	0
1982	659,895	0	0	0
1983	0	0	0	0
1984	0	204	0	0
1985	0	0	0	0
1986	0	826	0	0
1987	4	1,089	0	0
1988	0	2,160	0	0
1989	29,648	723	0	0
1990	9	1,621	0	0
1991	16	1,304	56,508	0
1992	15	470	0	0
1993	12,923	251	0	0
1994	30	390	0	182
1995	0	600	0	0
1996	7	172	4,609	0
1997	2,734	353	6,710	0
1998	7,150	435	0	0
1999	3,584	53	0	4,489
2000	0	37	0	0
2001	1,333	49	0	0
2002	2,156	22	0	0
2003	168	82	0	0
2004	1,123	48	0	3
2005	96,784	6,241	0	0
2006	607	1,958	0	0

Table 8 Continued. Eastern and Western Gulf of Mexico Yellowedge Grouper recreational landings in pounds gutted weight (converted from pounds whole weight; **Table 1**) and dead discards in pounds gutted weight (converted from numbers using mean weight; **Section 2.3.4**). Given their small magnitude, recreational landings and dead discards were added to the Commercial Vertical Line fleet landings for each region following SEDAR 22.

Year	Landings_East	Landings_West	Dead_Discards_East	Dead_Discards_West
2007	89	412	0	0
2008	491	84	0	0
2009	591	2,021	0	0
2010	0	100	0	0
2011	9,282	256	8	0
2012	1,055	162	4	0
2013	4,206	2,023	4	0
2014	7,325	12,396	0	0
2015	5,631	7,690	0	0
2016	3,394	2,028	0	3
2017	3,241	948	19	0
2018	30,152	6,266	8	0
2019	55,957	6,457	0	0
2020	28,948	5,317	8	0
2021	2,341	14,401	0	0

Table 9. Eastern and Western Gulf of Mexico Yellowedge Grouper commercial discards in pounds gutted weight with associated log-scale standard errors (SE). Dead discards (100%) were added to the landings. Commercial Vertical Line discards were assumed negligible (see SEDAR85-WP-06 for further details).

Year	Longline East	Longline East SE	Longline West	Longline West SE
1993	618	0.424	641	0.429
1994	1,618	0.432	832	0.440
1995	1,100	0.424	1,076	0.431
1996	840	0.418	663	0.429
1997	2,081	0.428	658	0.435
1998	1,221	0.425	911	0.441
1999	1,206	0.419	1,365	0.440
2000	2,446	0.431	847	0.434
2001	1,698	0.424	394	0.417
2002	952	0.402	732	0.431
2003	1,883	0.421	1,280	0.440
2004	1,821	0.435	976	0.440
2005	1,333	0.428	816	0.434
2006	1,591	0.431	748	0.440
2007	1,943	0.448	473	0.448
2008	1,727	0.448	652	0.448
2009	1,726	0.448	969	0.448
2010	1,792	0.593	624	0.624
2011	2,220	0.593	667	0.624
2012	2,496	0.593	597	0.624
2013	2,279	0.593	1,171	0.624
2014	2,779	0.593	982	0.624
2015	2,680	0.448	528	0.515
2016	2,061	0.448	1,006	0.515
2017	2,451	0.448	924	0.515
2018	3,488	0.448	992	0.515
2019	3,621	0.448	1,247	0.515
2020	2,915	0.448	788	0.515
2021	3,310	0.448	422	0.515

Table 10. Percent difference (%Diff) in commercial landings (metric tons gutted weight) between SEDAR 85 and SEDAR 22 for the vertical line fleets in the Eastern and Western Gulf of Mexico. Vertical line fleet landings within the assessment included commercial landings from vertical line and other commercial gears, recreational landings, and recreational dead discards. Differences exceeding 10% are identified in red.

Year	East_85	East_22	%Diff_East	West_85	West_22	%Diff_West
1975	144.30	159.50	9.53	69.24	51.46	-34.54
1976	132.40	134.40	1.48	46.35	33.60	-37.92
1977	120.13	115.67	-3.85	39.73	27.66	-43.61
1978	111.30	105.21	-5.78	43.22	30.43	-42.04
1979	152.94	155.90	1.90	50.10	34.07	-47.04
1980	149.52	151.34	1.20	28.96	20.04	-44.54
1981	133.16	136.84	2.69	146.34	104.72	-39.75
1982	179.44	149.70	-19.86	143.79	131.85	-9.06
1983	110.77	106.63	-3.88	73.10	53.56	-36.48
1984	112.28	105.67	-6.26	126.68	90.27	-40.33
1985	140.23	133.71	-4.87	156.41	95.45	-63.86
1986	146.79	247.40	40.67	42.03	44.72	6.01
1987	153.20	160.57	4.59	32.66	32.49	-0.52
1988	142.08	122.25	-16.22	156.28	127.78	-22.31
1989	47.57	37.22	-27.82	99.98	29.30	-241.25
1990	8.67	53.61	83.84	23.81	17.87	-33.27
1991	33.07	36.99	10.58	27.51	19.38	-41.93
1992	17.87	30.77	41.94	56.79	36.00	-57.76
1993	22.38	14.96	-49.60	40.79	34.98	-16.62
1994	23.94	23.90	-0.17	25.72	20.01	-28.53
1995	11.20	11.86	5.59	24.99	15.32	-63.19
1996	12.76	11.86	-7.61	15.66	10.79	-45.11
1997	12.33	7.63	-61.63	18.15	9.13	-98.83
1998	13.72	10.36	-32.51	38.81	11.91	-225.76
1999	16.13	13.48	-19.63	19.07	17.55	-8.68
2000	8.94	10.87	17.74	21.03	20.64	-1.86

Table 10 Continued. Percent difference (%Diff) in commercial landings (metric tons gutted weight) between SEDAR 85 and SEDAR 22 for the vertical line fleets in the Eastern and Western Gulf of Mexico. Vertical line fleet landings within the assessment included commercial landings from vertical line and other commercial gears, recreational landings, and recreational dead discards. Differences exceeding 10% are identified in red.

Year	East_85	East_22	%Diff_East	West_85	West_22	%Diff_West
2001	6.58	7.28	9.68	14.25	10.85	-31.37
2002	9.50	10.30	7.84	15.19	12.26	-23.91
2003	10.58	24.03	55.98	17.22	27.79	38.04
2004	8.83	10.17	13.10	16.57	13.54	-22.39
2005	50.52	7.95	-535.25	15.02	11.23	-33.77
2006	9.25	10.22	9.46	10.24	7.99	-28.17
2007	4.72	8.71	45.82	12.69	16.42	22.72
2008	3.97	4.21	5.57	10.78	11.24	4.08
2009	8.74	10.39	15.90	14.55	20.84	30.21

Table 11. Percent difference (%Diff) in commercial landings (metric tons gutted weight) between SEDAR 85 and SEDAR 22 for the longline fleets in the Eastern and Western Gulf of Mexico. Longline fleet landings within the assessment included commercial longline landings and dead discards. Differences exceeding 10% are identified in red.

Year	East_85	East_22	%Diff_East	West_85	West_22	%Diff_West
1979	0.00	0.00		16.31	16.34	0.21
1980	209.08	202.63	-3.18	22.26	21.17	-5.12
1981	687.37	687.38	0.00	311.53	309.36	-0.70
1982	1,462.78	1,462.81	0.00	309.60	308.80	-0.26
1983	791.69	1,123.19	29.51	153.93	293.33	47.52
1984	352.88	783.57	54.97	195.30	277.85	29.71
1985	275.33	443.95	37.98	415.29	262.37	-58.28
1986	199.08	104.33	-90.83	210.79	246.89	14.62
1987	151.21	152.96	1.15	216.13	198.60	-8.83
1988	284.45	221.97	-28.15	255.05	275.03	7.26
1989	143.50	124.13	-15.60	131.64	159.32	17.37
1990	195.92	169.30	-15.72	199.86	156.92	-27.37

Table 11 Continued. Percent difference (%Diff) in commercial landings (metric tons gutted weight) between SEDAR 85 and SEDAR 22 for the longline fleets in the Eastern and Western Gulf of Mexico. Longline fleet landings within the assessment included commercial longline landings and dead discards. Differences exceeding 10% are identified in red.

Year	East_85	East_22	%Diff_East	West_85	West_22	%Diff_West
1991	138.50	151.86	8.80	199.38	143.81	-38.64
1992	301.74	231.85	-30.15	131.12	175.40	25.25
1993	177.44	157.85	-12.41	128.37	144.82	11.36
1994	352.70	316.82	-11.32	124.16	126.05	1.50
1995	207.27	188.37	-10.03	164.91	168.91	2.37
1996	168.09	150.84	-11.44	72.61	70.76	-2.61
1997	289.50	254.74	-13.65	50.26	56.46	10.98
1998	211.85	190.92	-10.96	66.56	97.54	31.76
1999	329.68	287.35	-14.73	126.85	124.39	-1.98
2000	335.61	332.14	-1.05	122.95	133.88	8.17
2001	241.62	245.76	1.69	71.74	89.48	19.82
2002	191.69	197.12	2.76	122.64	136.98	10.47
2003	306.85	309.70	0.92	154.13	164.68	6.40
2004	250.72	266.12	5.78	122.40	136.91	10.60
2005	201.76	217.38	7.19	114.72	121.86	5.86
2006	202.77	217.99	6.98	94.50	102.96	8.21
2007	306.06	314.20	2.59	62.08	62.48	0.63
2008	274.06	284.75	3.76	71.25	71.86	0.85
2009	249.64	251.21	0.62	97.69	95.65	-2.13

Table 12. Standardized indices of relative abundance (catch per unit of effort, CPUE) and associated log-scale standard errors (SE) for Yellowedge Grouper in the Eastern (E) and Western (W) Gulf of Mexico. ComLL = Commercial Longline, NMFSBLL = NMFS Bottom Longline Survey.

Year	ComLL_ E CPUE	ComLL_ E SE	ComLL_ W CPUE	ComLL_ W SE	NMFSBLL _E CPUE	NMFSBLL _E SE	NMFSBLL_ W CPUE	NMFSBLL _W SE
1991	1.749	0.276	1.706	0.327				
1992	1.450	0.286	1.086	0.332				
1993	0.375	0.231	1.238	0.328				
1994	0.760	0.173	1.192	0.313				
1995	0.735	0.183	1.006	0.307				
1996	0.742	0.197	0.462	0.321				
1997	0.927	0.161	0.573	0.320				
1998	0.636	0.173	0.961	0.316				
1999	0.775	0.176	0.868	0.307				
2000	0.963	0.165	0.627	0.309	1.029	0.404	0.917	0.290
2001	0.703	0.165	0.894	0.312	0.290	0.529	1.056	0.289
2002	0.828	0.170	0.593	0.314	0.924	0.501	0.878	0.283
2003	0.980	0.160	0.856	0.322	1.479	0.353	0.917	0.347
2004	0.846	0.172	0.878	0.329	0.932	0.418	1.158	0.379
2005	1.109	0.175	1.463	0.340	0.625	0.461		
2006	1.225	0.169	1.206	0.347	1.462	0.483	1.580	0.346
2007	1.413	0.162	0.815	0.359	1.495	0.435	0.731	0.450
2008	1.643	0.176	1.094	0.337	0.472	0.741	1.090	0.649
2009	1.141	0.174	1.482	0.355	1.931	0.375	1.088	0.381
2010					0.644	0.520	1.909	0.369
2011					1.068	0.300	1.415	0.261
2012					0.815	0.455	1.307	0.399
2013					1.004	0.453	1.475	0.358
2014					1.034	0.526	1.566	0.557
2015					0.893	0.525	0.791	0.438
2016					1.785	0.391	0.611	0.498
2017					0.737	0.570	0.442	0.501

Table 12 Continued. Standardized indices of relative abundance (catch per unit of effort, CPUE) and associated log-scale standard errors (SE) for Yellowedge Grouper in the Eastern (E) and Western (W) Gulf of Mexico. ComLL = Commercial Longline, NMFSBLL = NMFS Bottom Longline Survey.

Year	ComLL_ E CPUE	ComLL_ E SE	ComLL_ W CPUE	ComLL_ W SE	NMFSBLL _E CPUE	NMFSBLL _E SE	NMFSBLL_ W CPUE	NMFSBLL _W SE
2018					0.984	0.425	0.359	0.576
2019					0.366	0.744	0.412	0.677
2021					1.032	0.484	0.298	0.679

Table 13. List of Stock Synthesis parameters for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
NatM_Lorenzen_Fem_GP_1	0.073					Fixed
L_at_Amin_Fem_GP_1	5					Fixed
L_at_Amax_Fem_GP_1	91.6501	(70,120)	0.3772	0.004		3
VonBert_K_Fem_GP_1	0.0798	(0.02,0.15)	0.001	0.013		3
CV_young_Fem_GP_1	0.1626					Fixed
CV_old_Fem_GP_1	0.1165					Fixed
Wtlen_1_Fem_GP_1	1.71e-05					Fixed
Wtlen_2_Fem_GP_1	2.91					Fixed
Mat50%_Fem_GP_1	54.879					Fixed
Mat_slope_Fem_GP_1	-0.33					Fixed
Eggs_scalar_Fem_GP_1	1.71e-05					Fixed
Eggs_exp_len_Fem_GP_1	2.91					Fixed
NatM_Lorenzen_Fem_GP_2	0.073					Fixed
L_at_Amin_Fem_GP_2	5					Fixed
L_at_Amax_Fem_GP_2	96.2098	(70,120)	0.5067	0.005		3
VonBert_K_Fem_GP_2	0.0746	(0.02,0.15)	0.0012	0.016		3
CV_young_Fem_GP_2	0.1626					Fixed
CV_old_Fem_GP_2	0.1165					Fixed
Wtlen_1_Fem_GP_2	1.71e-05					Fixed
Wtlen_2_Fem_GP_2	2.91					Fixed
Mat50%_Fem_GP_2	54.879					Fixed
Mat_slope_Fem_GP_2	-0.33					Fixed
Eggs_scalar_Fem_GP_2	1.71e-05					Fixed
Eggs_exp_len_Fem_GP_2	2.91					Fixed
NatM_Lorenzen_Mal_GP_1	0					Fixed
L_at_Amin_Mal_GP_1	0					Fixed
L_at_Amax_Mal_GP_1	0					Fixed
VonBert_K_Mal_GP_1	0					Fixed

Table 13 Continued. List of Stock Synthesis parameters for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
CV_young_Mal_GP_1	0					Fixed
CV_old_Mal_GP_1	0					Fixed
Wtlen_1_Mal_GP_1	1.71e-05					Fixed
Wtlen_2_Mal_GP_1	2.91					Fixed
NatM_Lorenzen_Mal_GP_2	0					Fixed
L_at_Amin_Mal_GP_2	0					Fixed
L_at_Amax_Mal_GP_2	0					Fixed
VonBert_K_Mal_GP_2	0					Fixed
CV_young_Mal_GP_2	0					Fixed
CV_old_Mal_GP_2	0					Fixed
Wtlen_1_Mal_GP_2	1.71e-05					Fixed
Wtlen_2_Mal_GP_2	2.91					Fixed
Herm_Infl_age	41					Fixed
Herm_stdev	14.63					Fixed
Herm_asymptote	0.4702					Fixed
RecrDist_GP_1_area_1_month_1	0					Fixed
RecrDist_GP_2_area_2_month_1	-0.1089	(-5,5)	0.039	-0.360		2
CohortGrowDev	1					Fixed
FracFemale_GP_1	1					Fixed
FracFemale_GP_2	1					Fixed
SR_LN(R0)	6.893	(4.5,16.5)	0.026	0.004		1
SR_BH_steep	0.827					Fixed
SR_sigmaR	0.5					Fixed
SR_regime	0					Fixed
SR_autocorr	0					Fixed
Main_RecrDev_1975	1.3944	(-5,5)	0.138	0.099		4
Main_RecrDev_1976	-0.4159	(-5,5)	0.538	-1.294		4
Main_RecrDev_1977	-0.3098	(-5,5)	0.542	-1.751		4
Main_RecrDev_1978	-0.1801	(-5,5)	0.621	-3.451		4
Main_RecrDev_1979	1.2142	(-5,5)	0.280	0.231		4

Table 13 Continued. List of Stock Synthesis parameters for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_1980	0.0159	(-5,5)	0.749	47.086		4
Main_RecrDev_1981	0.1956	(-5,5)	0.6588	3.369		4
Main_RecrDev_1982	0.006	(-5,5)	0.5987	99.689		4
Main_RecrDev_1983	-0.2446	(-5,5)	0.5192	-2.122		4
Main_RecrDev_1984	-0.3105	(-5,5)	0.5589	-1.800		4
Main_RecrDev_1985	0.9389	(-5,5)	0.3822	0.407		4
Main_RecrDev_1986	0.3496	(-5,5)	0.6774	1.937		4
Main_RecrDev_1987	-0.2007	(-5,5)	0.5941	-2.961		4
Main_RecrDev_1988	0.375	(-5,5)	0.3236	0.863		4
Main_RecrDev_1989	-0.4371	(-5,5)	0.4764	-1.090		4
Main_RecrDev_1990	0.32	(-5,5)	0.2851	0.891		4
Main_RecrDev_1991	-0.1992	(-5,5)	0.4744	-2.382		4
Main_RecrDev_1992	0.6033	(-5,5)	0.4515	0.748		4
Main_RecrDev_1993	0.6681	(-5,5)	0.6474	0.969		4
Main_RecrDev_1994	1.4474	(-5,5)	0.2622	0.181		4
Main_RecrDev_1995	0.2079	(-5,5)	0.4446	2.139		4
Main_RecrDev_1996	-0.2413	(-5,5)	0.4585	-1.900		4
Main_RecrDev_1997	0.0645	(-5,5)	0.4327	6.710		4
Main_RecrDev_1998	-0.1691	(-5,5)	0.5914	-3.497		4
Main_RecrDev_1999	1.2409	(-5,5)	0.2021	0.163		4
Main_RecrDev_2000	-0.2756	(-5,5)	0.5539	-2.010		4
Main_RecrDev_2001	0.9554	(-5,5)	0.2483	0.260		4
Main_RecrDev_2002	-0.05	(-5,5)	0.5006	-10.017		4
Main_RecrDev_2003	0.2035	(-5,5)	0.3523	1.731		4
Main_RecrDev_2004	0.1166	(-5,5)	0.2817	2.416		4
Main_RecrDev_2005	-1.1602	(-5,5)	0.361	-0.311		4
Main_RecrDev_2006	-0.7366	(-5,5)	0.3044	-0.413		4
Main_RecrDev_2007	-0.6977	(-5,5)	0.2816	-0.404		4
Main_RecrDev_2008	-1.0241	(-5,5)	0.3182	-0.311		4
Main_RecrDev_2009	-0.6852	(-5,5)	0.3085	-0.450		4

Table 13 Continued. List of Stock Synthesis parameters for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_2010	-0.5465	(-5,5)	0.2945	-0.539		4
Main_RecrDev_2011	-1.1258	(-5,5)	0.3326	-0.295		4
Main_RecrDev_2012	-1.3071	(-5,5)	0.295	-0.226		4
Late_RecrDev_2013	0					Fixed
Late_RecrDev_2014	0					Fixed
Late_RecrDev_2015	0					Fixed
Late_RecrDev_2016	0					Fixed
Late_RecrDev_2017	0					Fixed
Late_RecrDev_2018	0					Fixed
Late_RecrDev_2019	0					Fixed
Late_RecrDev_2020	0					Fixed
Late_RecrDev_2021	0					Fixed
LnQ_base_ComLL_E(3)	-7.8734	(-25,25)				Float
LnQ_base_ComLL_W(4)	-8.3381	(-25,25)				Float
LnQ_base_NMFSBLL_E(5)	-6.3673	(-25,25)				Float
LnQ_base_NMFSBLL_W(6)	-6.7483	(-25,25)				Float
Size_DblN_peak_ComVL_E(1)	56.1554	(30.3,119.79)	0.7008	0.012		2
Size_DblN_top_logit_ComVL_E(1)	-3.8699	(-5,3)	2.4131	-0.624		2
Size_DblN_ascend_se_ComVL_E(1)	5.2016	(-4,12)	0.0685	0.013		2
Size_DblN_descend_se_ComVL_E(1)	7.2443	(-2,8)	0.3691	0.051		2
Size_DblN_start_logit_ComVL_E(1)	-8.8591	(-15,5)	0.6564	-0.074		2
Size_DblN_end_logit_ComVL_E(1)	-0.6155	(-6,5)	0.3845	-0.625		2
Size_inflection_ComLL_E(3)	54.4413	(30,100)	0.2533	0.005		2
Size_95%width_ComLL_E(3)	14.9185	(10,50)	0.2073	0.014		2
Size_inflection_NMFSBLL_E(5)	55.1881	(30,100)	1.1362	0.021		2
Size_95%width_NMFSBLL_E(5)	14.2513	(10,50)	1.4184	0.100		2
Size_DblN_peak_NMFSTRW_E(7)	11.0128	(8,50)	0.1052	0.010		2
Size_DblN_top_logit_NMFSTRW_E(7)	-9.5459	(-10,3)	11.965	-1.254		2
Size_DblN_ascend_se_NMFSTRW_E(7)	-7.3807	(-8,12)	17.382	-2.355		2
Size_DblN_descend_se_NMFSTRW_E(7)	5.0468	(-3,8)	0.1241	0.025		2

Table 13 Continued. List of Stock Synthesis parameters for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Size_DblN_start_logit_NMFSTRW_E(7)	-3.9973	(-15,5)	0.7276	-0.182		2
Size_DblN_end_logit_NMFSTRW_E(7)	-4.6059	(-10,1)	0.4119	-0.089		2
ln(DM_theta)_Len_P1	0.1435	(-5,5)	0.0721	0.503	Normal(0,1.81)	6
ln(DM_theta)_Len_P2	-0.8274	(-5,5)	0.0413	-0.050	Normal(0,1.81)	6
ln(DM_theta)_Len_P3	2.4591	(-5,5)	0.5078	0.207	Normal(0,1.81)	6
ln(DM_theta)_Len_P4	3.9464	(-5,5)	0.831	0.211	Normal(0,1.81)	6
ln(DM_theta)_Age_P5	0.3622	(-5,5)	0.1162	0.321	Normal(0,1.81)	6
ln(DM_theta)_Age_P6	-0.0486	(-5,5)	0.0841	-1.732	Normal(0,1.81)	6
ln(DM_theta)_Age_P7	1.993	(-5,5)	0.4297	0.216	Normal(0,1.81)	6
ln(DM_theta)_Age_P8	-1.8626	(-5,5)	0.5413	-0.291	Normal(0,1.81)	6

Table 14. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) combined across all fleets and regions for Gulf of Mexico Yellowedge Grouper, which was used as the proxy for annual fishing mortality rate. Estimates are provided for the SEDAR 85 Operational Assessment and the SEDAR 22 Benchmark Assessment.

Year	SEDAR 85	SEDAR 22	Year	SEDAR 85	SEDAR 22
1975	0.014	0.014	1999	0.058	0.074
1976	0.011	0.011	2000	0.059	0.083
1977	0.011	0.010	2001	0.04	0.06
1978	0.010	0.009	2002	0.039	0.06
1979	0.015	0.014	2003	0.055	0.088
1980	0.028	0.028	2004	0.045	0.073
1981	0.088	0.090	2005	0.043	0.061
1982	0.131	0.163	2006	0.036	0.058
1983	0.083	0.148	2007	0.044	0.068
1984	0.070	0.136	2008	0.041	0.063
1985	0.100	0.115	2009	0.042	0.064
1986	0.063	0.087	2010	0.023	
1987	0.060	0.078	2011	0.029	
1988	0.092	0.112	2012	0.035	
1989	0.049	0.056	2013	0.036	
1990	0.050	0.065	2014	0.042	
1991	0.047	0.058	2015	0.041	
1992	0.061	0.079	2016	0.04	
1993	0.045	0.060	2017	0.04	
1994	0.065	0.084	2018	0.042	
1995	0.050	0.067	2019	0.053	
1996	0.033	0.043	2020	0.044	
1997	0.045	0.056	2021	0.045	
1998	0.040	0.053			

Table 15. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total) in the Eastern and Western Gulf of Mexico for Yellowedge Grouper.

Year	Commercial Vertical Line - East	Commercial Vertical Line - West	Commercial Longline - East	Commercial Longline - West	Total - East	Total - West
1975	0.019	0.010	0.000	0.000	0.019	0.010
1976	0.014	0.007	0.000	0.000	0.014	0.007
1977	0.015	0.006	0.000	0.000	0.015	0.006
1978	0.014	0.006	0.000	0.000	0.014	0.006
1979	0.020	0.007	0.000	0.002	0.020	0.010
1980	0.020	0.004	0.029	0.003	0.048	0.007
1981	0.018	0.022	0.085	0.052	0.103	0.074
1982	0.026	0.023	0.161	0.055	0.188	0.077
1983	0.020	0.012	0.116	0.026	0.136	0.038
1984	0.023	0.021	0.066	0.035	0.088	0.056
1985	0.030	0.028	0.056	0.083	0.086	0.111
1986	0.034	0.008	0.046	0.042	0.079	0.050
1987	0.037	0.006	0.036	0.043	0.073	0.050
1988	0.035	0.031	0.070	0.052	0.105	0.083
1989	0.012	0.021	0.037	0.028	0.050	0.048
1990	0.002	0.005	0.051	0.042	0.054	0.047
1991	0.009	0.006	0.036	0.043	0.045	0.049
1992	0.005	0.012	0.080	0.028	0.085	0.041
1993	0.006	0.009	0.048	0.028	0.054	0.037
1994	0.006	0.006	0.097	0.027	0.103	0.033
1995	0.003	0.005	0.059	0.035	0.062	0.041
1996	0.004	0.003	0.047	0.016	0.051	0.019
1997	0.003	0.004	0.080	0.011	0.084	0.015
1998	0.004	0.008	0.059	0.014	0.063	0.022
1999	0.004	0.004	0.093	0.025	0.097	0.029
2000	0.003	0.004	0.098	0.025	0.100	0.029
2001	0.002	0.003	0.071	0.014	0.073	0.017
2002	0.003	0.003	0.055	0.024	0.058	0.027

Table 15 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total) in the Eastern and Western Gulf of Mexico for Yellowedge Grouper.

Year	Commercial Vertical Line - East	Commercial Vertical Line - West	Commercial Longline - East	Commercial Longline - West	Total - East	Total - West
2003	0.003	0.003	0.086	0.029	0.089	0.032
2004	0.002	0.003	0.071	0.023	0.073	0.026
2005	0.014	0.003	0.057	0.021	0.072	0.024
2006	0.003	0.002	0.058	0.017	0.061	0.019
2007	0.001	0.002	0.088	0.011	0.090	0.014
2008	0.001	0.002	0.082	0.013	0.083	0.015
2009	0.003	0.003	0.076	0.017	0.078	0.020
2010	0.001	0.002	0.038	0.011	0.039	0.013
2011	0.003	0.002	0.042	0.018	0.044	0.020
2012	0.003	0.003	0.060	0.014	0.064	0.017
2013	0.002	0.001	0.054	0.022	0.056	0.023
2014	0.003	0.003	0.075	0.020	0.077	0.022
2015	0.004	0.001	0.062	0.026	0.066	0.027
2016	0.002	0.001	0.058	0.029	0.059	0.030
2017	0.001	0.001	0.064	0.023	0.066	0.025
2018	0.006	0.001	0.083	0.015	0.089	0.016
2019	0.011	0.001	0.089	0.026	0.100	0.028
2020	0.006	0.001	0.087	0.018	0.093	0.019
2021	0.002	0.002	0.103	0.013	0.105	0.015

Table 16. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB_0) where SSB_0 = 6,741 metric tons for Yellowedge Grouper in the Eastern Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1975	7,585	7,580	6,741	2,898.04	2,094.97	1.00
1976	7,460	7,459	6,606	3,885.57	342.45	0.98
1977	7,388	7,387	6,504	3,499.78	380.56	0.96
1978	7,319	7,318	6,397	3,268.85	432.98	0.95
1979	7,266	7,263	6,298	3,133.41	1,744.86	0.93
1980	7,191	7,190	6,166	3,865.37	525.97	0.92
1981	6,937	6,936	5,859	3,582.96	628.49	0.87
1982	6,350	6,348	5,241	3,385.56	517.04	0.78
1983	5,328	5,327	4,239	3,050.10	398.70	0.63
1984	4,779	4,778	3,703	2,769.95	371.26	0.55
1985	4,528	4,525	3,462	2,573.28	1,289.59	0.51
1986	4,317	4,315	3,265	3,003.85	710.35	0.48
1987	4,159	4,158	3,129	2,943.33	407.14	0.46
1988	4,044	4,042	3,043	2,715.76	719.97	0.45
1989	3,819	3,819	2,857	2,720.20	316.73	0.42
1990	3,819	3,817	2,861	2,508.87	672.35	0.42
1991	3,807	3,806	2,849	2,580.89	398.21	0.42
1992	3,823	3,821	2,862	2,455.64	884.63	0.42
1993	3,700	3,698	2,752	2,641.06	938.55	0.41
1994	3,700	3,696	2,755	2,832.92	2,038.82	0.41
1995	3,552	3,551	2,610	3,651.90	587.07	0.39
1996	3,575	3,574	2,598	3,373.30	373.17	0.38
1997	3,644	3,643	2,613	3,073.57	505.55	0.39
1998	3,602	3,601	2,519	2,915.08	398.73	0.37
1999	3,633	3,629	2,488	2,735.93	1,627.94	0.37
2000	3,554	3,553	2,369	3,357.09	355.48	0.35
2001	3,478	3,475	2,274	2,984.27	1,212.12	0.34

Table 16 Continued. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB_0) where SSB_0 = 6,741 metric tons for Yellowedge Grouper in the Eastern Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
2002	3,503	3,502	2,298	3,297.34	443.11	0.34
2003	3,578	3,577	2,389	3,044.94	570.75	0.35
2004	3,546	3,545	2,389	2,919.13	522.06	0.35
2005	3,560	3,560	2,423	2,800.72	145.40	0.36
2006	3,563	3,563	2,447	2,459.08	221.69	0.36
2007	3,587	3,586	2,500	2,256.03	230.21	0.37
2008	3,493	3,492	2,471	2,063.97	165.78	0.37
2009	3,407	3,407	2,471	1,864.16	232.26	0.37
2010	3,321	3,320	2,485	1,742.72	266.54	0.37
2011	3,343	3,343	2,599	1,691.09	149.75	0.38
2012	3,329	3,329	2,679	1,561.28	125.32	0.40
2013	3,237	3,236	2,677	1,422.63	500.32	0.40
2014	3,159	3,158	2,668	1,555.01	500.14	0.40
2015	3,017	3,016	2,574	1,628.53	499.35	0.38
2016	2,914	2,913	2,493	1,689.59	498.28	0.37
2017	2,837	2,836	2,414	1,742.27	496.98	0.36
2018	2,751	2,750	2,308	1,781.61	495.49	0.34
2019	2,615	2,614	2,139	1,800.61	493.68	0.32
2020	2,470	2,469	1,951	1,810.18	491.11	0.29
2021	2,364	2,363	1,797	1,822.43	488.99	0.27

Table 17. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB$_0$) where SSB$_0$ = 6,455 metric tons for Yellowedge Grouper in the Western Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1975	7,172	7,168	6,456	2,534.68	1,878.76	1.00
1976	7,117	7,117	6,388	3,425.01	307.11	0.99
1977	7,096	7,095	6,339	3,087.83	341.28	0.98
1978	7,093	7,092	6,300	2,894.32	388.30	0.98
1979	7,093	7,089	6,259	2,783.62	1,564.79	0.97
1980	7,082	7,081	6,195	3,446.40	471.69	0.96
1981	7,100	7,098	6,157	3,241.04	563.62	0.95
1982	6,666	6,665	5,696	3,083.89	463.68	0.88
1983	6,253	6,252	5,276	2,890.19	357.56	0.82
1984	6,117	6,116	5,136	2,713.89	332.95	0.80
1985	5,880	5,877	4,916	2,534.49	1,156.50	0.76
1986	5,356	5,355	4,427	2,851.89	637.04	0.69
1987	5,221	5,220	4,304	2,806.93	365.12	0.67
1988	5,099	5,097	4,202	2,608.35	645.67	0.65
1989	4,819	4,818	3,961	2,599.67	284.04	0.61
1990	4,723	4,722	3,883	2,386.76	602.96	0.60
1991	4,641	4,640	3,806	2,435.41	357.12	0.59
1992	4,557	4,555	3,724	2,303.93	793.33	0.58
1993	4,512	4,510	3,685	2,486.63	841.69	0.57
1994	4,493	4,489	3,671	2,652.50	1,828.41	0.57
1995	4,512	4,511	3,679	3,418.31	526.49	0.57
1996	4,513	4,512	3,653	3,161.17	334.65	0.57
1997	4,614	4,613	3,708	2,900.65	453.37	0.57
1998	4,737	4,736	3,776	2,797.12	357.58	0.58
1999	4,825	4,821	3,810	2,648.34	1,459.93	0.59
2000	4,883	4,882	3,823	3,232.38	318.79	0.59
2001	4,944	4,942	3,858	2,930.42	1,087.02	0.60

Table 17 Continued. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB_0) where SSB_0 = 6,455 metric tons for Yellowedge Grouper in the Western Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
2002	5,064	5,063	3,973	3,227.54	397.38	0.62
2003	5,138	5,137	4,067	2,998.21	511.85	0.63
2004	5,181	5,180	4,134	2,904.55	468.18	0.64
2005	5,247	5,247	4,217	2,808.84	130.39	0.65
2006	5,309	5,308	4,296	2,518.55	198.81	0.66
2007	5,378	5,378	4,394	2,344.48	206.45	0.68
2008	5,456	5,455	4,520	2,210.85	148.67	0.70
2009	5,507	5,506	4,642	2,058.90	208.29	0.72
2010	5,509	5,509	4,732	1,963.58	239.03	0.73
2011	5,527	5,526	4,842	1,904.16	134.30	0.75
2012	5,488	5,488	4,895	1,773.01	112.39	0.76
2013	5,448	5,448	4,937	1,652.93	448.68	0.76
2014	5,363	5,362	4,916	1,760.27	448.52	0.76
2015	5,278	5,277	4,874	1,828.73	447.81	0.76
2016	5,162	5,161	4,780	1,871.66	446.85	0.74
2017	5,035	5,034	4,656	1,900.19	445.69	0.72
2018	4,937	4,936	4,542	1,925.48	444.36	0.70
2019	4,885	4,885	4,460	1,952.02	442.74	0.69
2020	4,783	4,782	4,318	1,964.42	440.43	0.67
2021	4,730	4,729	4,220	1,980.43	438.52	0.65

Table 18. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB_0) where SSB_0 = 13,197 metric tons for Yellowedge Grouper in the Eastern and Western Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1975	14,757	14,748	13,197	5,432.72	3,973.73	1.00
1976	14,577	14,576	12,994	7,310.58	649.56	0.98
1977	14,483	14,482	12,843	6,587.61	721.84	0.97
1978	14,412	14,410	12,697	6,163.17	821.28	0.96
1979	14,359	14,352	12,557	5,917.03	3,309.65	0.95
1980	14,273	14,271	12,362	7,311.77	997.66	0.94
1981	14,037	14,034	12,016	6,824.00	1,192.11	0.91
1982	13,015	13,013	10,937	6,469.45	980.72	0.83
1983	11,581	11,579	9,515	5,940.29	756.26	0.72
1984	10,896	10,894	8,839	5,483.84	704.21	0.67
1985	10,408	10,402	8,378	5,107.77	2,446.09	0.63
1986	9,673	9,670	7,692	5,855.74	1,347.39	0.58
1987	9,380	9,379	7,433	5,750.26	772.26	0.56
1988	9,143	9,140	7,245	5,324.11	1,365.64	0.55
1989	8,638	8,637	6,818	5,319.87	600.77	0.52
1990	8,542	8,539	6,744	4,895.63	1,275.31	0.51
1991	8,448	8,446	6,654	5,016.30	755.33	0.50
1992	8,380	8,376	6,587	4,759.57	1,677.96	0.50
1993	8,212	8,208	6,437	5,127.69	1,780.24	0.49
1994	8,193	8,185	6,426	5,485.42	3,867.23	0.49
1995	8,064	8,062	6,289	7,070.21	1,113.56	0.48
1996	8,087	8,086	6,251	6,534.47	707.82	0.47
1997	8,258	8,256	6,321	5,974.22	958.92	0.48
1998	8,339	8,337	6,295	5,712.20	756.31	0.48
1999	8,457	8,450	6,299	5,384.27	3,087.87	0.48
2000	8,436	8,435	6,191	6,589.47	674.27	0.47
2001	8,422	8,416	6,131	5,914.69	2,299.14	0.46

Table 18 Continued. Expected biomass (metric tons) for all Yellowedge Grouper and exploited Yellowedge Grouper (1+ years), spawning stock biomass (male and female combined SSB, metric tons), exploited numbers (1+ years, 1,000s of fish), age-0 recruits (1,000s of fish), and SSB ratio (SSB/SSB_0) where SSB_0 = 13,197 metric tons for Yellowedge Grouper in the Eastern and Western Gulf of Mexico.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
2002	8,567	8,565	6,272	6,524.88	840.49	0.48
2003	8,717	8,714	6,455	6,043.15	1,082.60	0.49
2004	8,728	8,725	6,523	5,823.68	990.24	0.49
2005	8,807	8,806	6,640	5,609.56	275.79	0.50
2006	8,872	8,871	6,742	4,977.63	420.50	0.51
2007	8,965	8,964	6,894	4,600.51	436.66	0.52
2008	8,949	8,948	6,991	4,274.82	314.45	0.53
2009	8,914	8,913	7,113	3,923.06	440.55	0.54
2010	8,830	8,829	7,217	3,706.30	505.57	0.55
2011	8,870	8,869	7,440	3,595.25	284.05	0.56
2012	8,817	8,816	7,574	3,334.29	237.71	0.57
2013	8,685	8,683	7,614	3,075.56	949.00	0.58
2014	8,522	8,520	7,583	3,315.28	948.66	0.57
2015	8,295	8,293	7,448	3,457.26	947.16	0.56
2016	8,076	8,074	7,273	3,561.25	945.13	0.55
2017	7,872	7,870	7,070	3,642.46	942.67	0.54
2018	7,688	7,686	6,850	3,707.09	939.85	0.52
2019	7,500	7,498	6,598	3,752.63	936.42	0.50
2020	7,253	7,251	6,268	3,774.60	931.54	0.47
2021	7,094	7,092	6,017	3,802.86	927.51	0.46

Table 19. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Eastern Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
1975	2,351	4,390	3,191	4,390	2,258.19	639.85	27.8
1976	2,300	4,306	3,154	4,306	3,258.19	627.38	19.4
1977	2,262	4,241	3,145	4,241	2,881.89	617.89	21.4
1978	2,223	4,173	3,145	4,173	2,661.00	607.85	29.3
1979	2,189	4,109	3,153	4,109	2,534.90	598.51	23.3
1980	2,143	4,023	3,167	4,023	3,279.42	585.95	17.6
1981	2,050	3,809	3,127	3,809	3,026.23	556.73	20.6
1982	1,876	3,366	2,983	3,366	2,890.74	494.82	19.6
1983	1,594	2,645	2,682	2,645	2,657.19	392.91	14.6
1984	1,474	2,229	2,549	2,229	2,435.30	334.65	15.0
1985	1,454	2,008	2,517	2,008	2,267.62	305.66	11.2
1986	1,443	1,822	2,493	1,822	2,722.53	281.32	8.9
1987	1,454	1,675	2,483	1,675	2,680.87	262.46	9.4
1988	1,483	1,560	2,482	1,560	2,467.76	248.00	10.0
1989	1,461	1,395	2,423	1,395	2,494.70	225.50	8.8
1990	1,519	1,342	2,476	1,342	2,289.08	219.79	10.3
1991	1,562	1,286	2,520	1,286	2,366.40	214.49	9.3
1992	1,607	1,255	2,566	1,255	2,242.94	212.70	8.0
1993	1,585	1,167	2,531	1,167	2,439.86	201.20	7.3
1994	1,619	1,136	2,560	1,136	2,634.18	198.74	5.0
1995	1,569	1,041	2,510	1,041	3,466.97	184.93	5.4
1996	1,586	1,012	2,562	1,012	3,191.37	181.93	7.7
1997	1,611	1,002	2,640	1,002	2,891.97	181.60	6.4
1998	1,567	951	2,649	951	2,740.86	174.22	6.5
1999	1,557	931	2,698	931	2,563.70	172.23	4.9
2000	1,497	871	2,682	871	3,192.68	164.41	5.1
2001	1,461	813	2,662	813	2,827.66	156.62	4.6

Table 19 Continued. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Eastern Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
2002	1,506	793	2,709	793	3,142.27	155.07	6.3
2003	1,595	794	2,783	794	2,888.02	156.92	6.4
2004	1,625	764	2,781	764	2,766.61	152.52	5.7
2005	1,667	755	2,805	755	2,648.04	152.68	8.3
2006	1,693	754	2,809	754	2,305.79	153.29	8.0
2007	1,736	764	2,822	764	2,099.50	156.54	8.4
2008	1,725	746	2,746	746	1,909.98	153.99	10.5
2009	1,732	739	2,668	739	1,711.08	153.08	10.1
2010	1,746	739	2,581	739	1,589.47	153.25	9.9
2011	1,819	780	2,563	780	1,530.77	160.32	12.7
2012	1,861	818	2,511	818	1,395.12	166.16	12.8
2013	1,840	837	2,398	837	1,254.70	167.93	10.7
2014	1,804	864	2,294	864	1,384.54	170.47	15.0
2015	1,706	868	2,148	868	1,460.08	168.45	12.6
2016	1,612	881	2,032	881	1,521.56	168.02	13.4
2017	1,517	898	1,938	898	1,574.25	168.02	13.1
2018	1,405	903	1,847	903	1,615.76	165.85	12.1
2019	1,261	878	1,736	878	1,641.89	158.72	11.8
2020	1,114	837	1,632	837	1,660.88	149.30	11.2
2021	999	798	1,565	798	1,681.35	141.08	10.0

Table 20. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Western Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
1975	2,166	4,289	2,878	4,289	1,971.05	563.63	27.8
1976	2,141	4,247	2,870	4,247	2,867.08	557.93	19.4
1977	2,124	4,216	2,880	4,216	2,534.10	553.73	21.6
1978	2,110	4,190	2,902	4,190	2,343.95	550.37	29.6
1979	2,096	4,163	2,926	4,163	2,236.90	546.72	23.8
1980	2,075	4,120	2,961	4,120	2,905.27	541.13	18.1
1981	2,069	4,088	3,011	4,088	2,702.69	538.35	21.8
1982	1,938	3,758	2,907	3,758	2,587.19	496.70	21.3
1983	1,837	3,439	2,813	3,439	2,433.80	456.38	17.8
1984	1,840	3,296	2,820	3,296	2,274.83	439.06	19.8
1985	1,818	3,098	2,779	3,098	2,119.02	415.47	15.5
1986	1,704	2,723	2,632	2,723	2,483.38	368.51	12.3
1987	1,723	2,581	2,639	2,581	2,454.45	352.48	13.2
1988	1,752	2,450	2,647	2,450	2,270.58	337.77	14.0
1989	1,714	2,247	2,571	2,247	2,287.16	312.51	12.7
1990	1,732	2,151	2,571	2,151	2,085.31	301.45	14.6
1991	1,746	2,060	2,580	2,060	2,143.62	291.79	13.2
1992	1,749	1,975	2,580	1,975	2,021.01	282.92	11.4
1993	1,764	1,920	2,589	1,920	2,209.00	277.63	10.7
1994	1,791	1,880	2,609	1,880	2,378.21	274.29	7.4
1995	1,825	1,854	2,658	1,854	3,145.81	272.50	8.5
1996	1,839	1,814	2,697	1,814	2,892.47	268.70	11.9
1997	1,882	1,826	2,787	1,826	2,628.88	271.77	10.0
1998	1,924	1,852	2,884	1,852	2,520.25	276.87	10.7
1999	1,944	1,867	2,955	1,867	2,368.03	280.31	8.5
2000	1,956	1,867	3,015	1,867	2,949.66	282.72	9.1
2001	1,987	1,871	3,070	1,871	2,645.00	285.42	8.6

Table 20 Continued. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Western Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
2002	2,068	1,906	3,158	1,906	2,935.46	292.08	12.1
2003	2,145	1,921	3,216	1,921	2,702.60	295.61	12.0
2004	2,207	1,927	3,254	1,927	2,607.43	297.12	11.2
2005	2,269	1,949	3,298	1,949	2,507.10	301.74	15.7
2006	2,318	1,978	3,331	1,978	2,211.72	306.83	15.2
2007	2,374	2,020	3,357	2,020	2,030.32	314.16	15.9
2008	2,441	2,079	3,376	2,079	1,887.45	323.40	19.7
2009	2,504	2,137	3,369	2,137	1,726.63	332.27	19.4
2010	2,547	2,186	3,323	2,186	1,624.44	339.14	19.3
2011	2,590	2,252	3,275	2,252	1,556.20	347.96	23.6
2012	2,593	2,302	3,186	2,302	1,419.27	353.74	23.6
2013	2,576	2,361	3,087	2,361	1,292.75	360.18	20.8
2014	2,514	2,402	2,960	2,402	1,396.86	363.41	26.9
2015	2,428	2,446	2,831	2,446	1,462.33	366.40	24.2
2016	2,309	2,471	2,690	2,471	1,505.03	366.63	25.4
2017	2,170	2,485	2,549	2,485	1,535.35	364.84	25.0
2018	2,034	2,508	2,428	2,508	1,561.55	363.93	23.8
2019	1,911	2,548	2,336	2,548	1,586.54	365.48	24.1
2020	1,769	2,549	2,233	2,549	1,602.58	361.84	23.9
2021	1,652	2,568	2,162	2,568	1,619.51	360.92	22.7

Table 21. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Eastern and Western Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
1975	4,517	8,679	6,069	8,679	4,229.24	1,203.48	27.8
1976	4,441	8,553	6,023	8,553	6,125.27	1,185.31	19.4
1977	4,386	8,457	6,025	8,457	5,415.99	1,171.62	21.5
1978	4,334	8,363	6,047	8,363	5,004.95	1,158.22	29.5
1979	4,285	8,272	6,080	8,272	4,771.80	1,145.23	23.5
1980	4,218	8,144	6,128	8,144	6,184.69	1,127.08	17.8
1981	4,120	7,897	6,137	7,897	5,728.92	1,095.08	21.2
1982	3,814	7,124	5,889	7,124	5,477.93	991.52	20.4
1983	3,431	6,084	5,495	6,084	5,090.99	849.29	16.1
1984	3,314	5,525	5,369	5,525	4,710.13	773.71	17.4
1985	3,271	5,106	5,296	5,106	4,386.64	721.13	13.4
1986	3,147	4,545	5,125	4,545	5,205.91	649.83	10.5
1987	3,177	4,256	5,122	4,256	5,135.32	614.94	11.3
1988	3,235	4,010	5,129	4,010	4,738.34	585.77	12.0
1989	3,176	3,642	4,994	3,642	4,781.86	538.01	10.7
1990	3,251	3,493	5,046	3,493	4,374.39	521.24	12.4
1991	3,308	3,346	5,100	3,346	4,510.02	506.28	11.2
1992	3,356	3,231	5,146	3,231	4,263.95	495.62	9.7
1993	3,349	3,087	5,120	3,087	4,648.86	478.83	9.0
1994	3,410	3,016	5,169	3,016	5,012.39	473.03	6.2
1995	3,394	2,895	5,167	2,895	6,612.78	457.43	6.9
1996	3,425	2,827	5,259	2,827	6,083.84	450.63	9.8
1997	3,493	2,828	5,427	2,828	5,520.85	453.37	8.1
1998	3,491	2,803	5,534	2,803	5,261.11	451.09	8.5
1999	3,500	2,798	5,652	2,798	4,931.73	452.54	6.7
2000	3,453	2,738	5,697	2,738	6,142.34	447.13	7.0
2001	3,447	2,684	5,733	2,684	5,472.66	442.04	6.6

Table 21 Continued. Expected spawning stock biomass (SSB, metric tons), exploitable biomass (1+ years, metric tons), and exploitable abundance (1+ years, 1,000s of fish) by sex and associated sex ratio (mature male:female) for Yellowedge Grouper in the Eastern and Western Gulf of Mexico.

Year	SSB (female)	SSB (male)	Biomass (female)	Biomass (male)	Abundance (female)	Abundance (male)	Sex ratio
2002	3,573	2,698	5,867	2,698	6,077.73	447.15	9.2
2003	3,740	2,715	5,999	2,715	5,590.62	452.53	9.2
2004	3,832	2,690	6,035	2,690	5,374.04	449.64	8.5
2005	3,936	2,704	6,102	2,704	5,155.14	454.42	12.1
2006	4,011	2,731	6,140	2,731	4,517.51	460.12	11.7
2007	4,110	2,784	6,180	2,784	4,129.82	470.70	12.3
2008	4,166	2,825	6,123	2,825	3,797.43	477.39	15.4
2009	4,237	2,876	6,037	2,876	3,437.71	485.35	15.1
2010	4,292	2,925	5,904	2,925	3,213.91	492.39	14.9
2011	4,409	3,031	5,838	3,031	3,086.97	508.28	18.6
2012	4,455	3,119	5,697	3,119	2,814.39	519.90	18.6
2013	4,416	3,198	5,485	3,198	2,547.45	528.11	16.0
2014	4,318	3,265	5,254	3,265	2,781.40	533.88	21.4
2015	4,134	3,314	4,979	3,314	2,922.41	534.85	18.8
2016	3,921	3,352	4,721	3,352	3,026.59	534.65	19.8
2017	3,687	3,383	4,487	3,383	3,109.60	532.86	19.4
2018	3,439	3,411	4,275	3,411	3,177.31	529.78	18.2
2019	3,172	3,426	4,072	3,426	3,228.43	524.20	18.3
2020	2,883	3,386	3,865	3,386	3,263.46	511.14	18.0
2021	2,651	3,366	3,727	3,366	3,300.86	502.00	16.7

Table 22. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line - East fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Eastern Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Vertical line fleet landings included vertical line and other commercial gears, recreational landings, and recreational dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
1975	0.050	0.318	0.313	33.592	9.3
1976	0.200	0.292	0.237	25.441	9.3
1977	0.100	0.265	0.251	26.999	9.3
1978	0.100	0.245	0.233	25.292	9.2
1979	0.100	0.337	0.316	34.808	9.1
1980	0.100	0.330	0.311	35.108	8.9
1981	0.100	0.294	0.278	32.654	8.5
1982	0.100	0.396	0.368	45.531	8.1
1983	0.100	0.244	0.234	30.674	7.6
1984	0.100	0.248	0.239	32.695	7.3
1985	0.100	0.309	0.299	42.328	7.1
1986	0.050	0.324	0.322	46.583	6.9
1987	0.050	0.338	0.337	49.205	6.8
1988	0.050	0.313	0.313	45.915	6.8
1989	0.050	0.105	0.105	15.431	6.8
1990	0.054	0.019	0.019	2.821	6.8
1991	0.051	0.073	0.073	10.860	6.7
1992	0.050	0.039	0.039	5.912	6.7
1993	0.051	0.049	0.049	7.448	6.6
1994	0.051	0.053	0.053	7.974	6.6
1995	0.051	0.025	0.025	3.729	6.6
1996	0.058	0.028	0.028	4.245	6.6
1997	0.053	0.027	0.027	4.147	6.6
1998	0.051	0.030	0.030	4.748	6.4
1999	0.052	0.036	0.036	5.804	6.1
2000	0.051	0.020	0.020	3.341	5.9
2001	0.050	0.014	0.015	2.495	5.8

Table 22 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line - East fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Eastern Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Vertical line fleet landings included vertical line and other commercial gears, recreational landings, and recreational dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
2002	0.050	0.021	0.021	3.581	5.9
2003	0.053	0.023	0.023	3.946	5.9
2004	0.050	0.019	0.019	3.275	6.0
2005	0.050	0.111	0.112	18.755	6.0
2006	0.050	0.020	0.020	3.409	6.0
2007	0.050	0.010	0.010	1.728	6.0
2008	0.050	0.009	0.009	1.443	6.1
2009	0.050	0.019	0.019	3.112	6.2
2010	0.010	0.007	0.007	1.126	6.4
2011	0.010	0.019	0.019	2.853	6.7
2012	0.010	0.025	0.025	3.672	6.9
2013	0.010	0.016	0.016	2.177	7.2
2014	0.010	0.018	0.018	2.390	7.5
2015	0.010	0.028	0.028	3.592	7.7
2016	0.010	0.010	0.010	1.268	7.9
2017	0.010	0.008	0.008	1.044	8.1
2018	0.010	0.034	0.034	4.219	8.1
2019	0.010	0.065	0.065	8.187	7.9
2020	0.010	0.034	0.034	4.556	7.6
2021	0.010	0.010	0.010	1.433	7.2

Table 23. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line - West fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Western Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Vertical line fleet landings included vertical line and other commercial gears, recreational landings, and recreational dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
1975	0.050	0.153	0.154	15.532	9.9
1976	0.200	0.102	0.112	11.324	9.9
1977	0.100	0.088	0.089	9.025	9.9
1978	0.100	0.095	0.097	9.884	9.8
1979	0.100	0.110	0.113	11.646	9.7
1980	0.100	0.064	0.065	6.813	9.5
1981	0.100	0.323	0.344	37.267	9.2
1982	0.100	0.317	0.335	37.544	8.9
1983	0.100	0.161	0.165	18.970	8.7
1984	0.100	0.279	0.290	33.989	8.5
1985	0.100	0.345	0.357	43.047	8.3
1986	0.078	0.093	0.093	11.507	8.1
1987	0.099	0.072	0.072	9.020	8.0
1988	0.100	0.345	0.345	43.234	8.0
1989	0.099	0.220	0.219	27.494	8.0
1990	0.097	0.052	0.052	6.596	7.9
1991	0.092	0.061	0.060	7.674	7.9
1992	0.087	0.125	0.123	15.846	7.8
1993	0.092	0.090	0.089	11.425	7.8
1994	0.094	0.057	0.056	7.211	7.8
1995	0.096	0.055	0.055	6.971	7.8
1996	0.095	0.035	0.034	4.365	7.9
1997	0.094	0.040	0.040	5.066	7.8
1998	0.097	0.086	0.084	10.897	7.7
1999	0.093	0.042	0.042	5.539	7.5
2000	0.069	0.046	0.046	6.267	7.4
2001	0.074	0.031	0.031	4.288	7.3

Table 23 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line - West fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Western Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Vertical line fleet landings included vertical line and other commercial gears, recreational landings, and recreational dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
2002	0.072	0.033	0.033	4.547	7.3
2003	0.070	0.038	0.038	5.101	7.4
2004	0.064	0.037	0.036	4.872	7.5
2005	0.064	0.033	0.033	4.397	7.5
2006	0.067	0.023	0.023	2.986	7.5
2007	0.057	0.028	0.028	3.669	7.6
2008	0.059	0.024	0.024	3.071	7.7
2009	0.074	0.032	0.032	4.051	7.9
2010	0.010	0.026	0.026	3.146	8.1
2011	0.010	0.030	0.030	3.602	8.4
2012	0.010	0.036	0.036	4.175	8.7
2013	0.010	0.016	0.016	1.734	9.0
2014	0.010	0.030	0.030	3.177	9.4
2015	0.010	0.016	0.016	1.609	9.7
2016	0.010	0.012	0.012	1.216	10.0
2017	0.010	0.015	0.015	1.498	10.2
2018	0.010	0.013	0.013	1.274	10.3
2019	0.010	0.016	0.016	1.517	10.3
2020	0.010	0.010	0.010	0.989	10.2
2021	0.010	0.021	0.021	2.102	10.0

Table 24. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline - East fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Eastern Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Longline fleet landings include longline landings and dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
1980	0.050	0.461	0.455	38.433	11.8
1981	0.100	1.515	1.297	111.744	11.6
1982	0.100	3.225	2.258	201.322	11.2
1983	0.100	1.745	1.364	127.040	10.7
1984	0.100	0.778	0.692	66.981	10.3
1985	0.100	0.607	0.560	55.919	10.0
1986	0.051	0.439	0.434	44.559	9.7
1987	0.051	0.333	0.331	34.764	9.5
1988	0.051	0.627	0.620	66.339	9.3
1989	0.050	0.316	0.315	34.207	9.2
1990	0.052	0.432	0.431	47.153	9.1
1991	0.051	0.305	0.306	33.701	9.1
1992	0.052	0.665	0.674	74.879	9.0
1993	0.053	0.391	0.395	44.243	8.9
1994	0.054	0.778	0.789	89.153	8.8
1995	0.053	0.457	0.461	52.471	8.8
1996	0.054	0.371	0.373	42.586	8.8
1997	0.051	0.638	0.645	73.913	8.7
1998	0.051	0.467	0.472	54.665	8.6
1999	0.050	0.727	0.741	87.574	8.5
2000	0.050	0.740	0.766	93.231	8.2
2001	0.051	0.533	0.547	68.344	8.0
2002	0.050	0.423	0.427	54.205	7.9
2003	0.050	0.676	0.678	86.461	7.8
2004	0.050	0.553	0.553	70.580	7.8
2005	0.050	0.445	0.450	57.190	7.9
2006	0.050	0.447	0.456	57.711	7.9

Table 24 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline - East fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Eastern Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Longline fleet landings include longline landings and dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
2007	0.05	0.675	0.699	88.340	7.9
2008	0.05	0.604	0.629	79.237	7.9
2009	0.05	0.550	0.568	71.015	8.0
2010	0.01	0.276	0.277	33.995	8.1
2011	0.01	0.306	0.306	36.700	8.3
2012	0.01	0.441	0.441	51.436	8.6
2013	0.01	0.386	0.387	43.754	8.8
2014	0.01	0.518	0.519	56.946	9.1
2015	0.01	0.409	0.409	43.611	9.4
2016	0.01	0.369	0.370	38.351	9.6
2017	0.01	0.402	0.403	40.819	9.9
2018	0.01	0.505	0.505	50.410	10.0
2019	0.01	0.510	0.510	50.651	10.1
2020	0.01	0.471	0.471	47.113	10.0
2021	0.01	0.537	0.537	54.891	9.8

Table 25. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline - West fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Western Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Longline fleet landings include longline landings and dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
1979	0.050	0.036	0.036	2.768	13.0
1980	0.100	0.049	0.050	3.836	12.9
1981	0.100	0.687	0.810	63.476	12.8
1982	0.100	0.683	0.802	64.163	12.5
1983	0.100	0.339	0.365	29.815	12.2
1984	0.100	0.431	0.469	39.128	12.0
1985	0.100	0.916	1.080	92.093	11.7
1986	0.098	0.465	0.492	42.953	11.5
1987	0.098	0.476	0.499	44.366	11.2
1988	0.097	0.562	0.584	52.752	11.1
1989	0.092	0.290	0.293	26.743	11.0
1990	0.076	0.441	0.441	40.543	10.9
1991	0.075	0.440	0.436	40.382	10.8
1992	0.093	0.289	0.284	26.517	10.7
1993	0.088	0.283	0.277	25.991	10.7
1994	0.092	0.274	0.266	25.101	10.6
1995	0.093	0.364	0.349	33.016	10.6
1996	0.096	0.160	0.157	14.839	10.6
1997	0.093	0.111	0.109	10.329	10.6
1998	0.085	0.147	0.144	13.675	10.6
1999	0.094	0.280	0.269	25.709	10.5
2000	0.064	0.271	0.266	25.756	10.3
2001	0.073	0.158	0.156	15.285	10.2
2002	0.075	0.270	0.263	26.037	10.1
2003	0.084	0.340	0.325	32.298	10.1
2004	0.084	0.270	0.260	25.861	10.1
2005	0.083	0.253	0.245	24.202	10.1

Table 25 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline - West fleet in weight (W, million pounds gutted weight) and number (N, 1,000s of fish) for Yellowedge Grouper in the Western Gulf of Mexico. The expected mean weight (MW, gutted pounds per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. Longline fleet landings include longline landings and dead discards.

Year	Input W SE	Input W	Exp W	Exp N	Exp MW
2006	0.079	0.208	0.203	20.004	10.1
2007	0.076	0.137	0.135	13.199	10.2
2008	0.077	0.157	0.154	14.995	10.3
2009	0.071	0.215	0.211	20.311	10.4
2010	0.010	0.137	0.137	13.039	10.5
2011	0.010	0.216	0.216	20.175	10.7
2012	0.010	0.169	0.169	15.473	10.9
2013	0.010	0.265	0.265	23.623	11.2
2014	0.010	0.231	0.231	20.055	11.5
2015	0.010	0.300	0.299	25.318	11.8
2016	0.010	0.326	0.326	26.896	12.1
2017	0.010	0.259	0.259	20.906	12.4
2018	0.010	0.166	0.166	13.114	12.7
2019	0.010	0.281	0.281	21.879	12.9
2020	0.010	0.188	0.188	14.466	13.0
2021	0.010	0.134	0.134	10.272	13.0

Table 26. Observed (Obs) versus expected (Exp) standardized Commercial Longline (ComLL) catch-per-unit-effort (CPUE) indices for Yellowedge Grouper in the Eastern and Western Gulf of Mexico. Values are normalized to the mean. CVs estimated by the standardization process were converted to log-scale SEs. Indices end in 2009 due to the implementation of the IFQ program in 2010.

Year	ComLL_E (Obs)	ComLL_E (Exp)	ComLL_E (SE)	ComLL_W (Obs)	ComLL_W (Exp)	ComLL_W (SE)
1991	1.749	1.069	0.276	1.706	0.889	0.327
1992	1.450	1.052	0.286	1.086	0.875	0.332
1993	0.375	1.032	0.231	1.238	0.869	0.328
1994	0.760	1.005	0.173	1.192	0.868	0.313
1995	0.735	0.974	0.183	1.006	0.865	0.307
1996	0.742	0.974	0.197	0.462	0.868	0.321
1997	0.927	0.959	0.161	0.573	0.882	0.320
1998	0.636	0.938	0.173	0.961	0.895	0.316
1999	0.775	0.913	0.176	0.868	0.903	0.307
2000	0.963	0.877	0.165	0.627	0.910	0.309
2001	0.703	0.865	0.165	0.894	0.928	0.312
2002	0.828	0.883	0.170	0.593	0.951	0.314
2003	0.980	0.896	0.160	0.856	0.968	0.322
2004	0.846	0.899	0.172	0.878	0.983	0.329
2005	1.109	0.909	0.175	1.463	1.002	0.340
2006	1.225	0.924	0.169	1.206	1.023	0.347
2007	1.413	0.930	0.162	0.815	1.050	0.359
2008	1.643	0.924	0.176	1.094	1.079	0.337
2009	1.141	0.925	0.174	1.482	1.103	0.355

Table 27. Observed (Obs) versus expected (Exp) standardized NMFS Bottom Longline (NMFSBLL) survey indices for Yellowedge Grouper in the Eastern and Western Gulf of Mexico. Values are normalized to the mean. CVs estimated by the standardization process were converted to log-scale SEs. Data were not collected in 2020 due to the COVID-19 pandemic.

Year	NMFSBLL_E (Obs)	NMFSBLL_E (Exp)	NMFSBLL_E (SE)	NMFSBLL_W (Obs)	NMFSBLL_W (Exp)	NMFSBLL_W (SE)
2000	1.029	1.010	0.404	0.917	0.921	0.290
2001	0.290	1.023	0.529	1.056	0.951	0.289
2002	0.924	1.062	0.501	0.878	0.985	0.283
2003	1.479	1.086	0.353	0.917	1.007	0.347
2004	0.932	1.092	0.418	1.158	1.024	0.379
2005	0.625	1.101	0.461			
2006	1.462	1.115	0.483	1.580	1.059	0.346
2007	1.495	1.119	0.435	0.731	1.082	0.450
2008	0.472	1.110	0.741	1.090	1.105	0.649
2009	1.931	1.104	0.375	1.088	1.121	0.381
2010	0.644	1.115	0.520	1.909	1.130	0.369
2011	1.068	1.130	0.300	1.415	1.130	0.261
2012	0.815	1.116	0.455	1.307	1.118	0.399
2013	1.004	1.083	0.453	1.475	1.095	0.358
2014	1.034	1.033	0.526	1.566	1.062	0.557
2015	0.893	0.972	0.525	0.791	1.022	0.438
2016	1.785	0.919	0.391	0.611	0.977	0.498
2017	0.737	0.866	0.570	0.442	0.932	0.501
2018	0.984	0.803	0.425	0.359	0.895	0.576
2019	0.366	0.735	0.744	0.412	0.860	0.677
2021	1.032	0.635	0.484	0.298	0.811	0.679

Table 28. Summary of correlated parameters with correlation coefficients > 0.7 for the Gulf of Mexico Yellowedge Grouper SEDAR 85 OA Base Model.

Parameter 1	Parameter 2	Correlation
Main_RecrDev_1986	Main_RecrDev_1985	-0.870
Main_RecrDev_1993	Main_RecrDev_1992	-0.831
Main_RecrDev_1994	Main_RecrDev_1993	-0.867
Size_95%width_ComLL_E(3)	Size_inflection_ComLL_E(3)	0.765
Size_95%width_NMFSBLL_E(5)	Size_inflection_NMFSBLL_E(5)	0.755
Size_DblN_ascend_se_ComVL_E(1)	Size_DblN_peak_ComVL_E(1)	0.937
Size_DblN_ascend_se_NMFSTRW_E(7)	Size_DblN_peak_NMFSTRW_E(7)	0.995
Size_DblN_end_logit_ComVL_E(1)	Size_DblN_descend_se_ComVL_E(1)	-0.773
VonBert_K_Fem_GP_1	L_at_Amax_Fem_GP_1	-0.799
VonBert_K_Fem_GP_2	L_at_Amax_Fem_GP_2	-0.820

Table 29. Retrospective analysis and retrospective forecast spawning stock biomass (male and female combined SSB, metric tons) and fishing mortality (F, total biomass killed all ages / total biomass age 1+) for the last five terminal years and combined (grey rows) for the Gulf of Mexico Yellowedge Grouper SEDAR 85 OA Base Model. N = number of observations to compute each statistic. Values within -0.15 to 0.2 are highlighted in green and are considered acceptable levels of retrospective bias. Values outside the acceptable range of -0.15 to 0.2 for longer-lived species (Hurtado-Ferro et al. 2015) are highlighted in red and indicate an undesirable retrospective pattern. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
SSB (-2020)	Mohn's Rho	-0.100	1
SSB (-2019)	Mohn's Rho	-0.175	1
SSB (-2018)	Mohn's Rho	-0.127	1
SSB (-2017)	Mohn's Rho	-0.097	1
SSB (-2016)	Mohn's Rho	-0.050	1
SSB (-Combined)	Mohn's Rho	-0.110	5
SSB (-2020)	Forecast bias	-0.104	1
SSB (-2019)	Forecast bias	-0.185	1
SSB (-2018)	Forecast bias	-0.137	1
SSB (-2017)	Forecast bias	-0.108	1
SSB (-2016)	Forecast bias	-0.060	1
SSB (-Combined)	Forecast bias	-0.119	5
F (-2020)	Mohn's Rho	0.100	1
F (-2019)	Mohn's Rho	0.196	1
F (-2018)	Mohn's Rho	0.140	1
F (-2017)	Mohn's Rho	0.110	1
F (-2016)	Mohn's Rho	0.061	1
F (-Combined)	Mohn's Rho	0.121	5
F (-2020)	Forecast bias	0.102	1
F (-2019)	Forecast bias	0.203	1
F (-2018)	Forecast bias	0.145	1
F (-2017)	Forecast bias	0.114	1
F (-2016)	Forecast bias	0.065	1
F (-Combined)	Forecast bias	0.126	5

Table 30. Joint residual summary statistics for the Gulf of Mexico Yellowedge Grouper SEDAR 85 OA Base Model. N = number of observations to compute each statistic. RMSE = root mean squared error (as a percentage), with values above 30% for joint residuals (grey rows) highlighted in red if present and acceptable values below 30% highlighted in green. See Carvalho et al. (2021) for additional details.

Data Source	Statistic	Value	N
Index of Abundance			
Commercial Longline - East	RMSE(%)	36.4	19
Commercial Longline - West	RMSE(%)	36.4	19
NMFS Bottom Longline - East	RMSE(%)	34.6	21
NMFS Bottom Longline - West	RMSE(%)	35.5	20
Combined	RMSE(%)	41.5	79
Age			
Commercial Vertical Line - East	RMSE(%)	20.7	19
Commercial Vertical Line - West	RMSE(%)	20.2	20
Commercial Longline - East	RMSE(%)	18.8	23
Commercial Longline - West	RMSE(%)	21.3	18
NMFS Bottom Longline - East	RMSE(%)	20.2	20
NMFS Bottom Longline - West	RMSE(%)	20.7	19
NMFS/SEAMAP Groundfish Trawl - East	RMSE(%)		3
NMFS/SEAMAP Groundfish Trawl - West	RMSE(%)	90.4	1
Combined	RMSE(%)	19.7	123
Length			
Commercial Vertical Line - East	RMSE(%)	8.1	30
Commercial Vertical Line - West	RMSE(%)	7.8	32
Commercial Longline - East	RMSE(%)	6.9	41
Commercial Longline - West	RMSE(%)	7.7	33
NMFS Bottom Longline - East	RMSE(%)	9.7	21
NMFS Bottom Longline - West	RMSE(%)	9.9	20
NMFS/SEAMAP Groundfish Trawl - East	RMSE(%)	9.9	20
NMFS/SEAMAP Groundfish Trawl - West	RMSE(%)	7.8	32
Combined	RMSE(%)	19.4	229

Table 31. Runs tests summary statistics for the Gulf of Mexico Yellowedge Grouper SEDAR 85 OA Base Model. N = number of observations to compute each statistic. P-values greater than 0.05% (in green) provide support for randomly distributed residuals whereas p-values less than 0.05% (in red) indicate non-randomly distributed residuals. See Carvalho et al. (2021) for additional details.

Data Source	Statistic	Value	N
Index of Abundance			
Commercial Longline - East	p-value	0.05	19
Commercial Longline - West	p-value	0.05	19
NMFS Bottom Longline - East	p-value	0.955	21
NMFS Bottom Longline - West	p-value	0.042	20
Age			
Commercial Vertical Line - East	p-value	0.121	19
Commercial Vertical Line - West	p-value	0.676	20
Commercial Longline - East	p-value	0.145	23
Commercial Longline - West	p-value	0.024	18
NMFS Bottom Longline - East	p-value	0.058	20
NMFS Bottom Longline - West	p-value	0.334	19
NMFS/SEAMAP Groundfish Trawl - East	p-value		3
NMFS/SEAMAP Groundfish Trawl - West	p-value		1
Length			
Commercial Vertical Line - East	p-value	0.057	30
Commercial Vertical Line - West	p-value	0.145	32
Commercial Longline - East	p-value	0.24	41
Commercial Longline - West	p-value	0.026	33
NMFS Bottom Longline - East	p-value	0.025	21
NMFS Bottom Longline - West	p-value	0.716	20
NMFS/SEAMAP Groundfish Trawl - East	p-value	0.377	20
NMFS/SEAMAP Groundfish Trawl - West	p-value	0.085	32

Table 32. Hindcast cross-validation summary statistics for the Gulf of Mexico Yellowedge Grouper SEDAR 85 OA Base Model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with values < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill.

Data Source	Statistic	Value	N
Index of Abundance			
Commercial Longline - East	MASE		0
Commercial Longline - West	MASE		0
NMFS Bottom Longline - East	MASE	0.485	4
NMFS Bottom Longline - West	MASE	3.309	4
joint	MASE	1.154	8
Age			
Commercial Vertical Line - East	MASE	1.39	5
Commercial Vertical Line - West	MASE	0.804	5
Commercial Longline - East	MASE	1.483	5
Commercial Longline - West	MASE	1.862	5
NMFS Bottom Longline - East	MASE	1.263	3
NMFS Bottom Longline - West	MASE	0.479	3
NMFS/SEAMAP Groundfish Trawl - East	MASE		0
NMFS/SEAMAP Groundfish Trawl - West	MASE		0
joint	MASE	1.123	26
Length			
Commercial Vertical Line - East	MASE	0.601	2
Commercial Vertical Line - West	MASE	1.652	5
Commercial Longline - East	MASE	1.017	5
Commercial Longline - West	MASE	1.821	5
NMFS Bottom Longline - East	MASE	1.044	4
NMFS Bottom Longline - West	MASE	0.904	4
NMFS/SEAMAP Groundfish Trawl - East	MASE	0.977	4
NMFS/SEAMAP Groundfish Trawl - West	MASE	0.537	3
joint	MASE	0.727	32

Table 33. Summary of key model building steps towards the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
1_SEDAR22	SEDAR 22 Base Model	13,428.1	0.00006	69 (0)	31
2_SEDAR22 _3.3	SEDAR 22 Base Model converted to newest Stock Synthesis version	13,427.8	0.00006	69 (0)	27
3_Continuity	Step 2 + update all data	28,268.5	0.00010	81 (3)	26
4_3+LH Updates	Step 3 + update first age mature, first age male, minimum length bin of population, and correct a parameter for length-weight conversion	28,276.5	0.00103	81 (3)	26
5_4+Correct IndexSE	Step 4 + correct SE for commercial longline west index	28,277.2	0.00091	81 (3)	26
6_5+RecBias	Step 5 + adjust recruitment bias	28,330.4	0.00037	81 (3)	26
7_6+Remove SexData	Step 6 + fit to combined (male + female + unsexed) compositions and fix hermaphroditism parameters	28,662.9	0.00512	78 (1)	22
8_7+NoMale Growth Estimation	Step 7 + remove male growth estimation (removed male composition data)	28,783.9	0.00124	74 (3)	25
9_8+Comp Cutoffs	Step 8 + remove years of data with < 30 lengths for each fleet and region	28,158.8	0.00061	74 (3)	26
10_9+ Dirichlet	Step 9 + estimate Dirichlet parameters (share between fleets or surveys)	44,616.7	0.00015	82 (4)	23
11_10+ WeightedLC	Step 10 + use weighted length compositions for commercial east fleets	44,529.5	0.01142	82 (2)	27
12_11+ RecDevsBias	Step 11 + estimate recruitment deviations through 2017 and adjust recruitment bias	44,470.7	0.00074	87 (2)	25

Table 33 Continued. Summary of key model building steps towards the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
13_12+Selex	Step 12 + reduce lower bound for groundfish survey (peak and ascending), estimate starting logit parameter for ComVL_E, and remove time-varying selectivity for ComLL_E	44,465.6	0.00035	86 (1)	24
14_13+Catch ability	Step 13 + float Q parameters, reduce bounds for Q parameters, and use later phase for fishery-dependent indices	44,465.7	0.00217	82 (1)	24
15_14+Catch Uncertainty	Step 14 + change Fmethod to 2 and use regional CVs	44,448.4	0.00462	261 (1)	25
16_15+ Reduce1982 Rec	Step 15 + reduce 1982 recreational landings for East	44,443.5	0.01251	261 (1)	24
17_16+NoFD ages2010-12	Step 16 + remove fishery-dependent ages 2010-2012	38,343.0	0.04785	260 (1)	24
18_17+ RecDevs2012	Step 17 + estimate rec devs through 2012	38,381.3	0.01509	255 (1)	27
19_18+ FixSteepness	Step 18 + fix steepness at 0.827	38,398.7	0.00996	254 (1)	33
20_19+ FixSigmaR	Step 19 + fix SigmaR at 0.5	38,245.2	0.00173	255 (2)	25
21_20+ NominalAges	Step 20 + use nominal age comps	21,471.6	0.00404	255 (1)	29
22_21+BLL Comps2000+	Step 21 + remove BLL Comps pre-2000	21,086.1	0.00402	255 (0)	31
23_22+GF AgeChanges	Step 22 + remove GF East Ages and treat GF West Ages as a super-period	21,032.2	0.00122	255 (0)	30
24_23 + RecBias	Step 23 + start rec devs in 1975 and adjust recruitment bias	21,035.6	0.00095	247 (0)	23

Table 34. Summary of key model building steps towards the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper and associated key estimates and derived quantities. R0 = virgin recruitment (log-scale), SSB defined as male and female combined SSB in metric tons (mt), Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0. Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Steepness	SigmaR	ln(R0)	Virgin SSB (mt)	Virgin Recr (1,000s)	SSB ratio Start Yr	SSB ratio End Yr
1_SEDAR22	0.947	0.2	6.76	13,783	861.1	1	0.32
2_SEDAR22_3.3	0.947	0.2	6.76	13,782	859.3	1	0.32
3_Continuity	0.974	0.2	6.60	13,069	737.7	1	0.37
4_3+LH Updates	0.974	0.2	6.81	13,042	906.9	1	0.37
5_4+CorrectIndexSE	0.974	0.2	6.81	13,048	907.3	1	0.37
6_5+RecBias	0.974	0.2	6.80	12,985	902.2	1	0.38
7_6+RemoveSexData	0.948	0.2	6.91	13,140	1,000.2	1	0.46
8_7+NoMaleGrowthEsti	0.958	0.2	6.84	13,527	934.6	1	0.46
9_8+CompCutoffs	0.956	0.2	6.84	13,549	935.8	1	0.46
10_9+Dirichlet	0.968	0.2	6.81	13,173	910.2	1	0.40
11_10+WeightedLC	0.965	0.2	6.80	13,042	900.3	1	0.36
12_11+RecDevsBias	0.946	0.2	6.76	12,507	861.2	1	0.35
13_12+Selex	0.949	0.2	6.75	12,458	857.7	1	0.34
14_13+Catchability	0.949	0.2	6.75	12,458	857.7	1	0.34
15_14+CatchUncertainty	0.953	0.2	6.75	12,456	856.6	1	0.35
16_15+Reduce1982Rec	0.954	0.2	6.74	12,335	847.8	1	0.35
17_16+NoFDages2010-12	0.950	0.2	6.81	12,384	903.6	1	0.31
18_17+RecDevs2012	0.963	0.2	6.86	12,977	948.7	1	0.32
19_18+FixSteepness	0.827	0.2	6.86	13,095	957.8	1	0.29
20_19+FixSigmaR	0.827	0.5	6.68	10,906	792.4	1	0.35
21_20+NominalAges	0.827	0.5	6.85	12,711	947.3	1	0.47
22_21+BLLComps2000+	0.827	0.5	6.84	12,551	934.1	1	0.46
23_22+GFAgeChanges	0.827	0.5	6.84	12,541	933.9	1	0.46
24_23 + RecBias	0.827	0.5	6.89	13,197	985.4	1	0.46

Table 35. Summary of sensitivity runs conducted with the SEDAR 22 Benchmark Base Model using new data inputs provided during the SEDAR 85 OA for Gulf of Mexico Yellowedge Grouper and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation).

Model Name	Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
SEDAR 22	SEDAR 22 base model	13,427.8	0.00006	69 (0)	27
SEDAR 85 Landings	+ use SEDAR 85 landings	13,425.2	0.00011	69 (0)	27
Fmethod2 (F as parameters)	+ estimate F as parameters	13,433.9	0.00271	200 (0)	28
Fmethod2 + Landings SE	+ estimate F as parameters with increased uncertainty	13,419.7	0.00087	200 (0)	28
No sex data + fix herm	+ remove sex-specific compositions and fix hermaphroditism parameters at SEDAR 22 estimates	9,135.9	0.00004	66 (0)	28
SEDAR 85 Compositions	+ use SEDAR 85 compositions (QAQC, improved procedures)	14,142.6	0.00004	69 (2)	27

Table 36. Summary of sensitivity runs conducted with the SEDAR 22 Benchmark Base Model using new data inputs provided during the SEDAR 85 OA for Gulf of Mexico Yellowedge Grouper and associated key estimates and derived quantities (note that SigmaR was fixed at 0.2 across all runs). R0 = virgin recruitment (log-scale), SSB defined as male and female combined SSB in metric tons (mt) and Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0.

Model Name	Steepness	ln(R0)	Virgin SSB (mt)	Virgin Recr (1,000s)	SSB ratio Start Yr	SSB ratio End Yr
SEDAR 22	0.947	6.76	13,782	859.34	1	0.32
SEDAR 85 Landings	0.948	6.75	13,666	851.47	1	0.31
Fmethod2 (F as parameters)	0.953	6.72	13,519	829.09	1	0.30
Fmethod2 + Landings SE	0.946	6.75	13,733	856.42	1	0.31
No sex data + fix herm	0.941	6.83	13,799	920.68	1	0.32
SEDAR 85 Compositions	0.958	6.70	13,159	809.51	1	0.28

Table 37. Summary of sensitivity runs conducted for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation).

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
SEDAR 85 OA Base Model	21,035.6	0.00095	247 (0)	23
Landings				
Low Commercial Longline East scenario	21,004.2	0.00077	247 (0)	23
No recreational landings or dead discards	21,035.3	0.00446	247 (0)	23
CV = 0.3 for all landings pre-1986	20,965.8	0.00286	247 (0)	27
Steepness				
Estimate (No prior)	21,030.9	0.01149	248 (1)	21
Estimate (With prior)	21,033.7	0.00570	248 (0)	24
Fix at 0.7	21,034.5	0.00248	247 (0)	24
SigmaR				
Estimate	21,011.5	0.00227	248 (0)	19
Indices of Abundance				
No Commercial Longline East	21,035.8	0.00076	247 (0)	23
No Commercial Longline West	21,047.3	0.00347	247 (0)	23
No NMFS Bottom Longline East	21,041.8	0.00435	247 (0)	23
No NMFS Bottom Longline West	21,045.4	0.00175	247 (0)	24
No Fishery-dependent	21,047.5	0.00198	247 (0)	23

Table 38. Summary of sensitivity runs conducted for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper and associated key estimates and derived quantities. R0 = virgin recruitment (log-scale), SSB defined as male and female combined SSB in metric tons (mt), Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0.

Description	Steepness	SigmaR	ln(R0)	Virgin SSB (mt)	Virgin Recr (1,000s)	SSB ratio Start Yr	SSB ratio End Yr
SEDAR 85 OA Base Model	0.827	0.5	6.89	13,197	985.4	1	0.46
Landings							
Low Commercial Longline East scenario	0.827	0.5	6.82	12,323	918.5	1	0.50
No recreational landings or dead discards	0.827	0.5	6.88	13,081	976.3	1	0.46
CV = 0.3 for all landings pre-1986	0.827	0.5	7.27	19,547	1,434.0	1	0.58
Steepness							
Estimate (No prior)	0.400	0.5	6.89	13,126	983.9	1	0.33
Estimate (With prior)	0.508	0.5	6.89	13,131	982.9	1	0.37
Fix at 0.7	0.700	0.5	6.89	13,171	984.3	1	0.43
SigmaR							
Estimate	0.827	1.4	6.87	12,887	959.2	1	0.48
Indices of Abundance							
No Commercial Longline East	0.827	0.5	6.88	13,025	974.0	1	0.43
No Commercial Longline West	0.827	0.5	6.89	13,197	985.2	1	0.46
No NMFS Bottom Longline East	0.827	0.5	6.89	13,169	983.4	1	0.45
No NMFS Bottom Longline West	0.827	0.5	6.90	13,236	988.5	1	0.46
No Fishery-dependent	0.827	0.5	6.88	13,025	973.8	1	0.43

Table 39. Settings used for Gulf of Mexico Yellowedge Grouper projections.

Parameter	Value	Comment
Relative F	Average from 2019-2021	Average relative fishing mortality (apical *F*) over terminal three years of model
Selectivity	Average from 2019-2021	Fleet specific selectivity estimated over terminal three years of model
Recruitment	Beverton-Holt stock-recruit relationship	Derived from the model estimated Beverton-Holt stock-recruit relationship
Interim Landings (2022-2024)	9.04/9.78 metric tons (Commercial Vertical Line - East); 12.53/8.86 metric tons (Commercial Vertical Line - West); 161.73/206.42 metric tons (Commercial Longline - East); 34.38/60.01 metric tons (Commercial Longline - West)	Landings provided for 2022; For 2023 and 2024, used 3-year average of landings (2020-2022)
Allocation Ratio	None	

Table 40. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points for the SEDAR 85 Gulf of Mexico Yellowedge Grouper Operational Assessment **assuming predicted recruitment from the stock-recruit curve from 2013 throughout the projection period**. Spawning Stock Biomass (SSB) is in metric tons (male and female combined SSB), whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.

Criteria	Definition	Value
Base *M*	Target *M* for fully selected ages in the Lorenzen (2000) scaling	0.073
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (fixed)	0.827
R0	Virgin recruitment (1,000s)	985
Generation Time	Fecundity-weighted mean age	18.17
SSB_0	Virgin spawning stock biomass (mt)	13,197
	Mortality Rate Criteria	
$F_{MSYproxy}$	Equilibrium F that achieves SPR 30%	0.061
MFMT	$F_{MSYproxy}$	0.061
$F_{current}$	Geometric mean of the last 3 years of the assessment ($F_{2019-2021}$)	0.047
$F_{current}$/MFMT	Current stock status based on MFMT	0.775
	Biomass Criteria	
$SSB_{MSYproxy}$	Equilibrium SSB at $F_{30\%SPR}$	3,452
MSST	0.75 * $SSB_{SPR30\%}$	2,589
$SSB_{current}$	SSB in 2021	6,017
$SSB_{current}/SSB_{FMSYproxy}$	Current stock status based on $SSB_{SPR30\%}$ (Equilibrium)	1.74
$SSB_{current}$/MSST	Current stock status based on MSST	2.32
$SSB_{current}/SSB_0$	SSB ratio in 2021	0.46

Table 41. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points for Gulf of Mexico Yellowedge Grouper **assuming predicted recruitment from the stock-recruit curve from 2013 throughout the projection period**. SSB is in metric tons (male and female combined SSB), whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.061, $SSB_{F30\%SPR}$ = 3,452 metric tons, and $MSST_{F30\%SPR}$ = 2,589 metric tons which was calculated as (0.75) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 13,197 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
1975	0.014	0.237	13,197	3.823	5.097	1.000
1976	0.011	0.179	12,994	3.764	5.019	0.985
1977	0.011	0.175	12,843	3.720	4.960	0.973
1978	0.010	0.171	12,697	3.678	4.904	0.962
1979	0.015	0.242	12,557	3.637	4.850	0.952
1980	0.028	0.461	12,362	3.581	4.774	0.937
1981	0.088	1.453	12,016	3.481	4.641	0.911
1982	0.131	2.161	10,937	3.168	4.224	0.829
1983	0.083	1.373	9,515	2.756	3.675	0.721
1984	0.070	1.159	8,839	2.560	3.414	0.670
1985	0.100	1.649	8,378	2.427	3.236	0.635
1986	0.063	1.036	7,692	2.228	2.971	0.583
1987	0.060	0.987	7,433	2.153	2.871	0.563
1988	0.092	1.522	7,245	2.099	2.798	0.549
1989	0.049	0.807	6,818	1.975	2.633	0.517
1990	0.050	0.826	6,744	1.954	2.605	0.511
1991	0.047	0.775	6,654	1.927	2.570	0.504
1992	0.061	1.001	6,587	1.908	2.544	0.499
1993	0.045	0.737	6,437	1.865	2.486	0.488
1994	0.065	1.063	6,426	1.861	2.482	0.487
1995	0.050	0.824	6,289	1.822	2.429	0.477
1996	0.033	0.548	6,251	1.811	2.414	0.474
1997	0.045	0.743	6,321	1.831	2.441	0.479
1998	0.040	0.655	6,295	1.823	2.431	0.477

Table 41 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points for Gulf of Mexico Yellowedge Grouper **assuming predicted recruitment from the stock-recruit curve from 2013 throughout the projection period**. SSB is in metric tons (male and female combined SSB), whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.061, $SSB_{F30\%SPR}$ = 3,452 metric tons, and $MSST_{F30\%SPR}$ = 2,589 metric tons which was calculated as (0.75) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 13,197 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
1999	0.058	0.962	6,299	1.825	2.433	0.477
2000	0.059	0.973	6,191	1.793	2.391	0.469
2001	0.040	0.664	6,131	1.776	2.368	0.465
2002	0.039	0.650	6,272	1.817	2.422	0.475
2003	0.055	0.912	6,455	1.870	2.493	0.489
2004	0.045	0.745	6,523	1.889	2.519	0.494
2005	0.043	0.712	6,640	1.923	2.565	0.503
2006	0.036	0.591	6,742	1.953	2.604	0.511
2007	0.044	0.727	6,894	1.997	2.663	0.522
2008	0.041	0.681	6,991	2.025	2.700	0.530
2009	0.042	0.696	7,113	2.060	2.747	0.539
2010	0.023	0.378	7,217	2.091	2.787	0.547
2011	0.029	0.481	7,440	2.155	2.874	0.564
2012	0.035	0.570	7,574	2.194	2.925	0.574
2013	0.036	0.588	7,614	2.206	2.941	0.577
2014	0.042	0.699	7,583	2.197	2.929	0.575
2015	0.041	0.678	7,448	2.157	2.877	0.564
2016	0.040	0.664	7,273	2.107	2.809	0.551
2017	0.040	0.651	7,070	2.048	2.731	0.536
2018	0.042	0.698	6,850	1.984	2.646	0.519
2019	0.053	0.869	6,598	1.911	2.548	0.500
2020	0.044	0.725	6,268	1.816	2.421	0.475
2021	0.045	0.740	6,017	1.743	2.324	0.456

Table 42. Results of the OFL projection (fishing set at $F_{30\%SPR}$) for Gulf of Mexico Yellowedge Grouper **assuming predicted recruitment from the stock-recruit curve from 2013 throughout the projection period**. Recruitment (Recr) is in 1,000s of age-0 fish, *F* is a harvest rate (total biomass killed all ages / total biomass age 1+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{30\%SPR}$ = 0.061, $SSB_{F30\%SPR}$ = 3,452 metric tons, and $MSST_{F30\%SPR}$ = 2,589 metric tons which was calculated as (0.75) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 13,197 metric tons. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.

Year	Recr	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio	OFL
2025	917	0.061	1	5,443	1.577	2.102	0.412	0.904
2026	913	0.061	1	5,250	1.521	2.028	0.398	0.879
2027	909	0.061	1	5,083	1.472	1.963	0.385	0.857
2028	906	0.061	1	4,939	1.431	1.907	0.374	0.837
2029	903	0.061	1	4,810	1.393	1.858	0.365	0.820
2030	900	0.061	1	4,697	1.361	1.814	0.356	0.804

Table 43. Results of the ABC projection (directed *F* = 0.75 * Directed *F* at $F_{30\%SPR}$ (0.061)) for Gulf of Mexico Yellowedge Grouper **assuming predicted recruitment from the stock-recruit curve from 2013 throughout the projection period**. Recruitment (Recr) is in 1,000s of age-0 fish, *F* is a harvest rate (total biomass killed all ages / total biomass age 1+), SSB is in metric tons (male and female combined SSB), and yield in millions of pounds gutted weight. Reference points include $F_{30\%SPR}$ = 0.061, $SSB_{F30\%SPR}$ = 3,452 metric tons, and $MSST_{F30\%SPR}$ = 2,589 metric tons which was calculated as (0.75) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 13,197 metric tons. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.

Year	Recr	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio	Yield
2025	917	0.046	0.75	5,443	1.577	2.102	0.412	0.678
2026	914	0.046	0.75	5,338	1.546	2.062	0.405	0.669
2027	913	0.046	0.75	5,253	1.522	2.029	0.398	0.661
2028	911	0.046	0.75	5,185	1.502	2.002	0.393	0.655
2029	910	0.046	0.75	5,127	1.485	1.980	0.389	0.649
2030	909	0.046	0.75	5,080	1.472	1.962	0.385	0.644

Table 44. Catch equivalency table describing the OFL recommendations which would have resulted had SEDAR 85 landings (includes MRIP-FES and updated commercial landings) been used in SEDAR 22 (recreational estimates based on the Marine Recreational Fisheries Statistics Survey, MRFSS). The percent differences in annual OFL are shown. Note that an MRIP-FES only projection was not feasible because the SEDAR 22 landings vector (including a breakdown by data source) was not found.

Year	SEDAR 22 MRFSS OFL	SEDAR 22 FES/Comm OFL	%Difference OFL
2012	0.913	0.940	3
2013	0.903	0.926	3
2014	0.893	0.912	2
2015	0.883	0.899	2

11. Figures

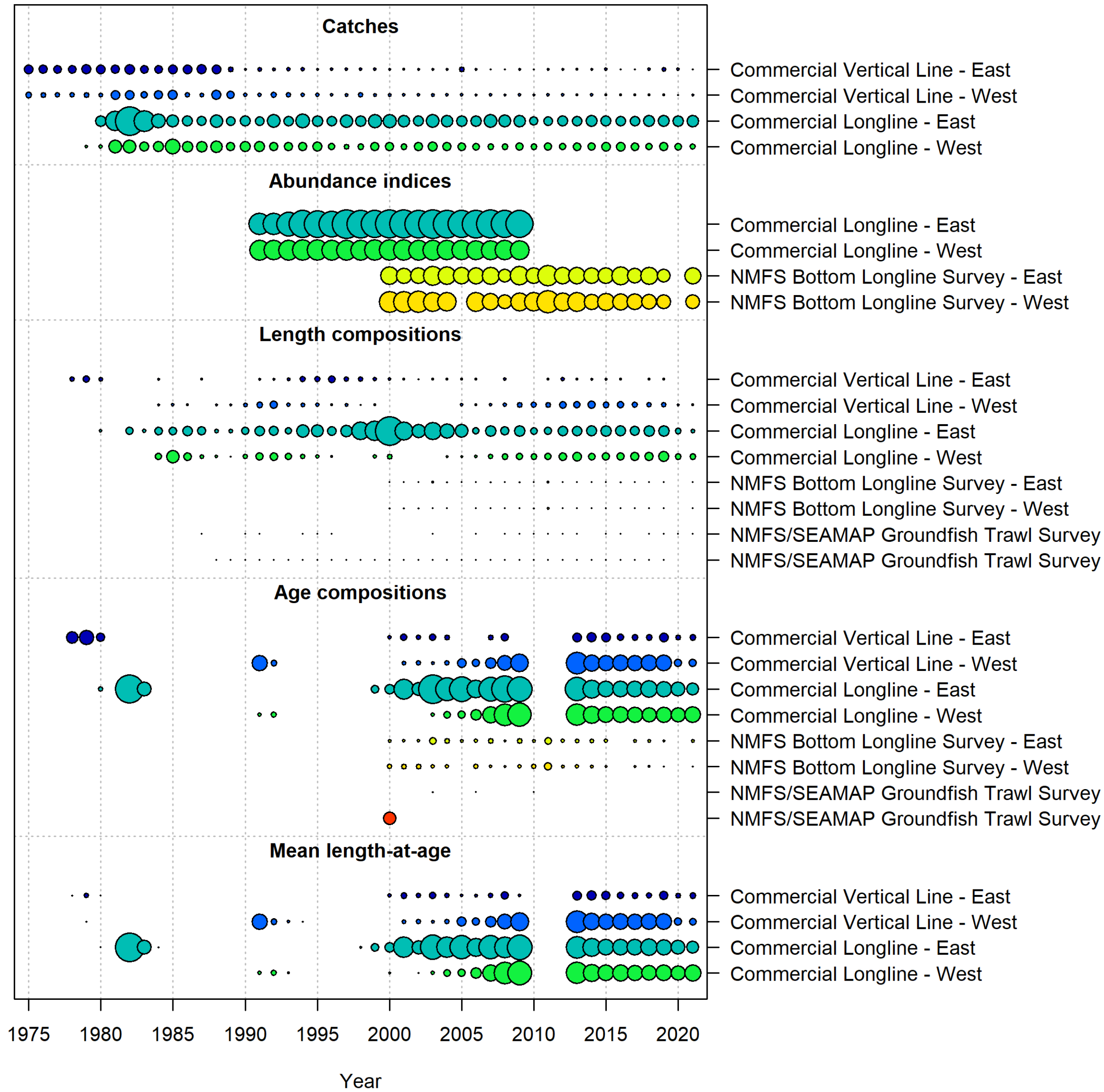


Figure 1. Data sources used in the Gulf of Mexico Yellowedge Grouper Stock Synthesis assessment model. Circle area is relative within a data type. Circles are proportional to total catch for catches; to precision for indices observations; and to total sample size for compositions or mean length-at-age observations. Note that since the circles are scaled relative to the maximum within each type, the scaling between separate data types should not be compared. Age data for the NMFS/SEAMAP Groundfish Trawl Survey - East are shown in the plot but not included in model fitting, whereas Age data for the NMFS/SEAMAP Groundfish Trawl Survey - West were aggregated (2000-2009) and input using the super-period approach.

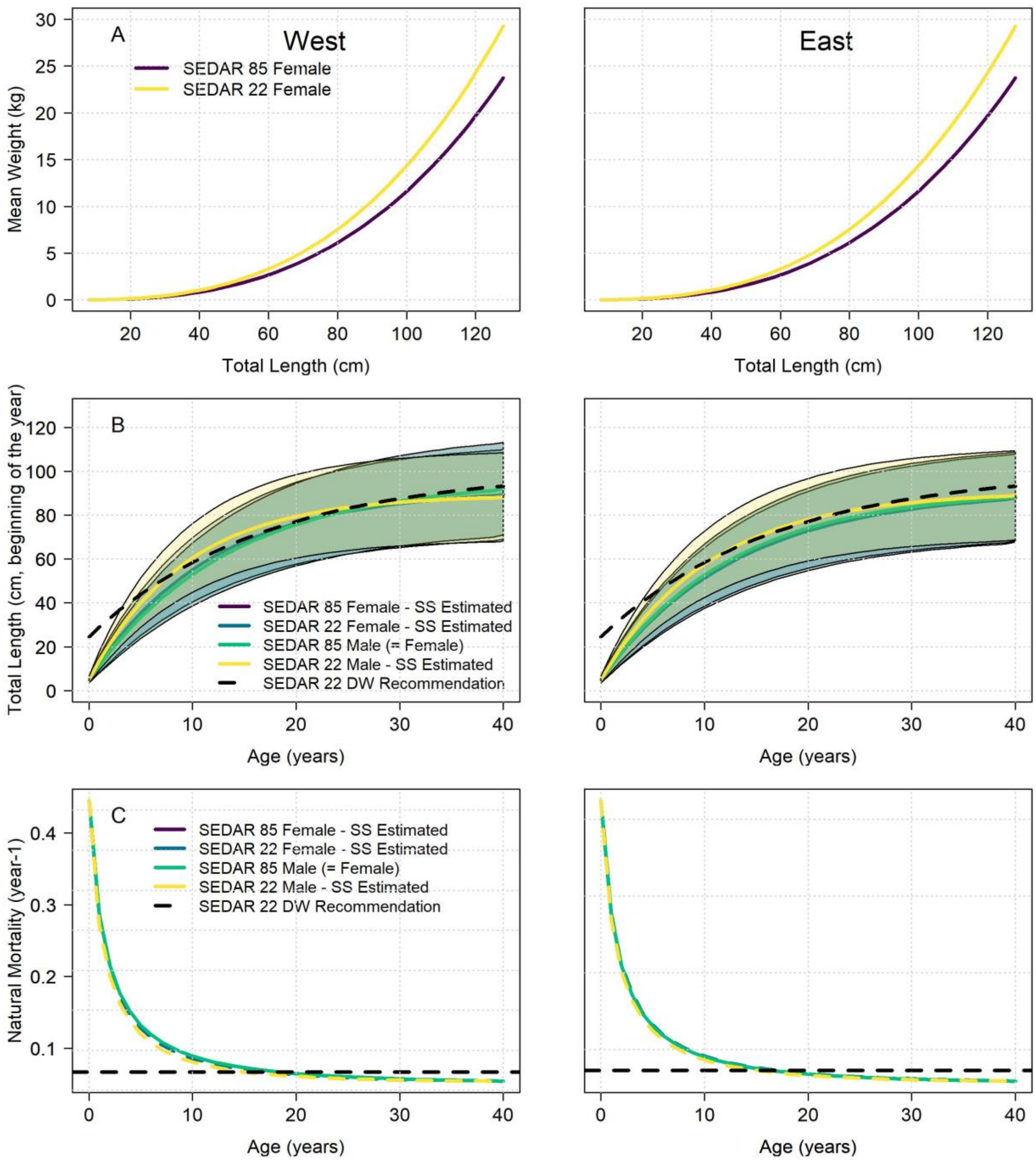


Figure 2. Comparison of life history relationships for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22. (A) mean weight-at-length, (B) recommended (SEDAR 22) and estimated growth curves (shaded area indicates the 95% distribution of length-at-age), and (C) recommended point estimate (SEDAR 22) and estimated natural mortality-at-age vectors.

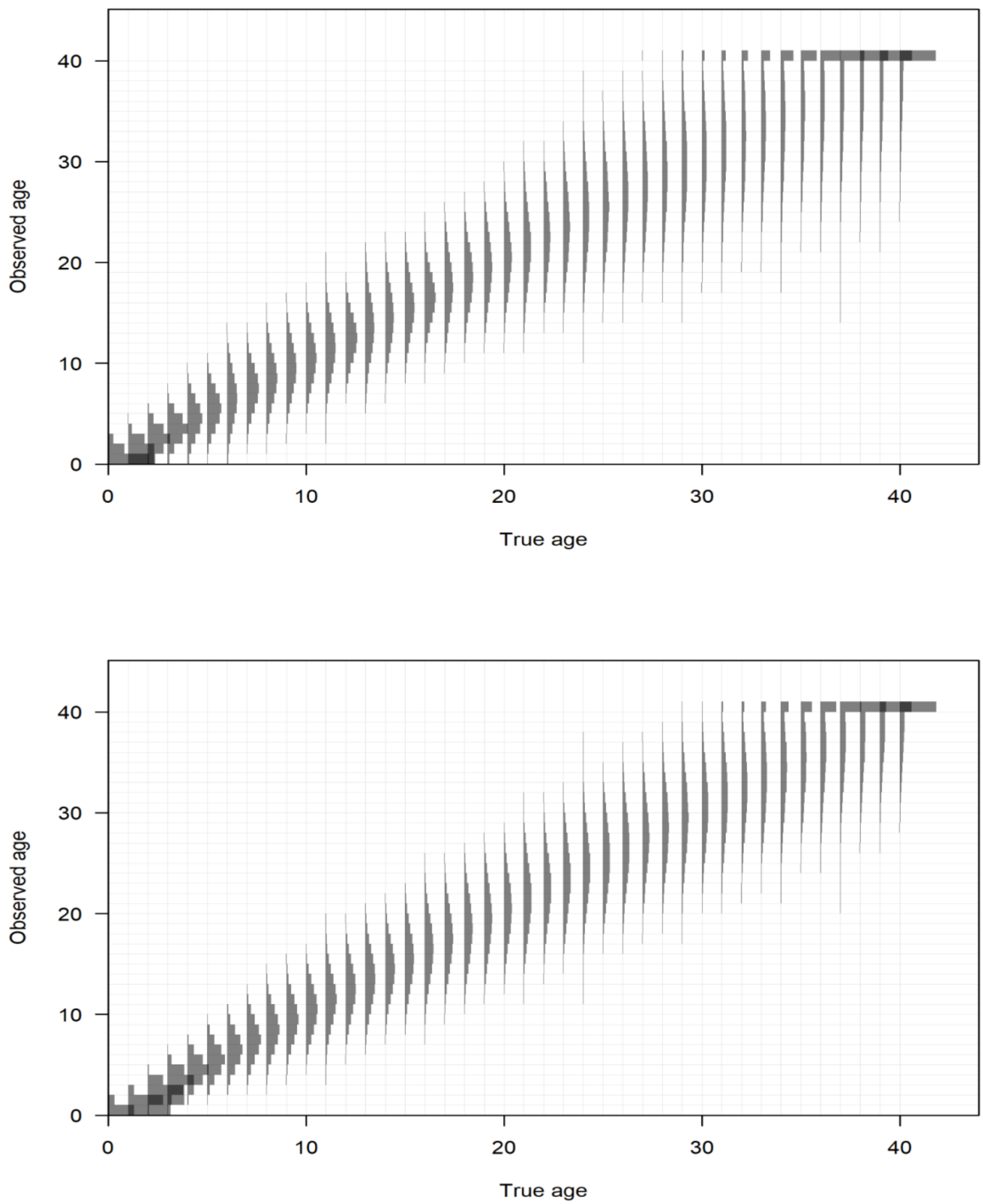


Figure 3. Distribution of observed age at true age based on ageing error matrices developed for the Benchmark Assessment (top; used for years 1975-2009, 2010-2012) and the Operational Assessment (bottom; used for years 2013-2021) for Gulf of Mexico Yellowedge Grouper.

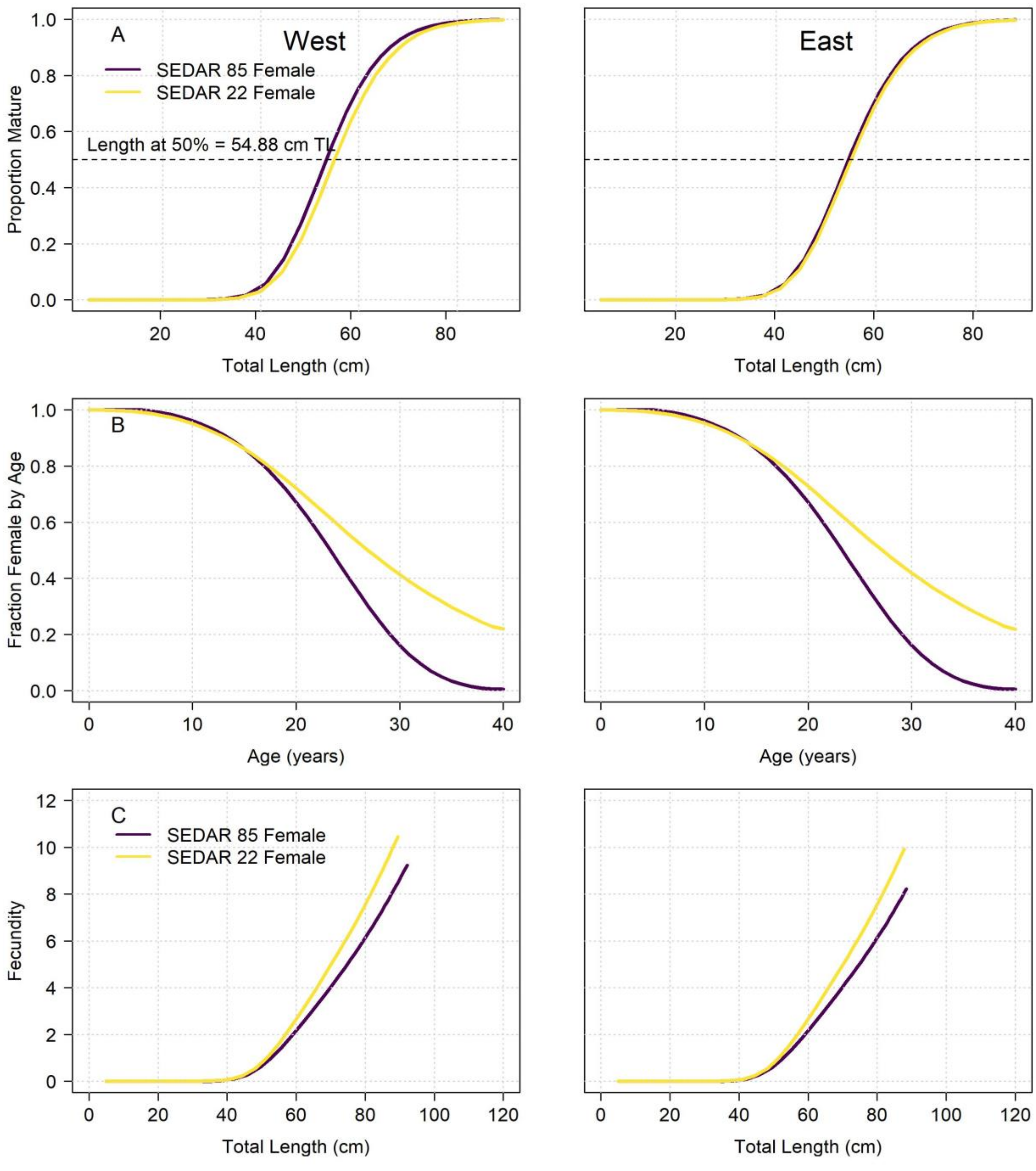


Figure 4. Comparison of life history relationships for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22. (A) maturity-at-length, (B) the fraction female by age estimated using the hermaphroditism transition rate, and (C) fecundity at length (note that the differences here are attributed to the correction to the a parameter for the length-weight conversion).

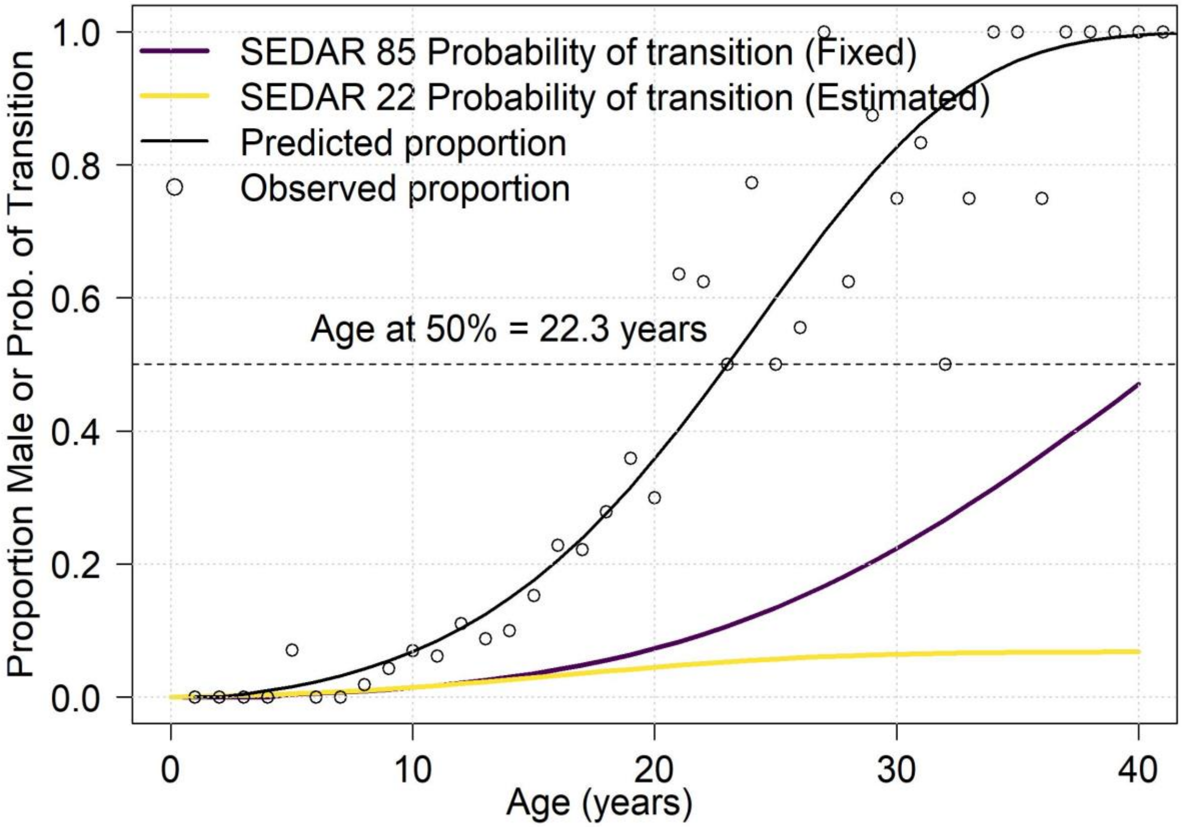


Figure 5. Comparison of the hermaphroditism transition rate (probability of transition) for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22. Also shown is the proportion male which is not required by Stock Synthesis as an input.

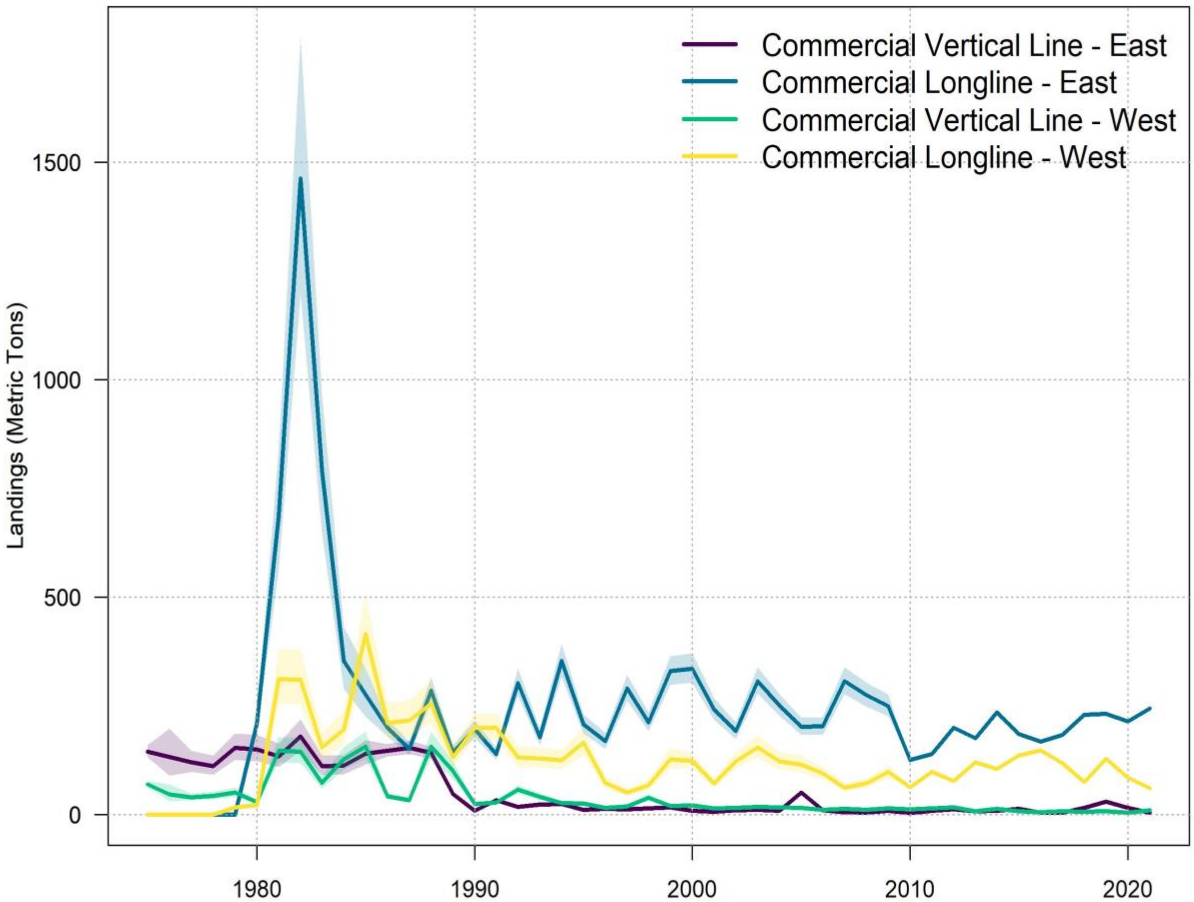


Figure 6. Gulf of Mexico Yellowedge Grouper observed landings (with associated error estimates; ***Table 7****) by fishery and region input into the stock assessment.*

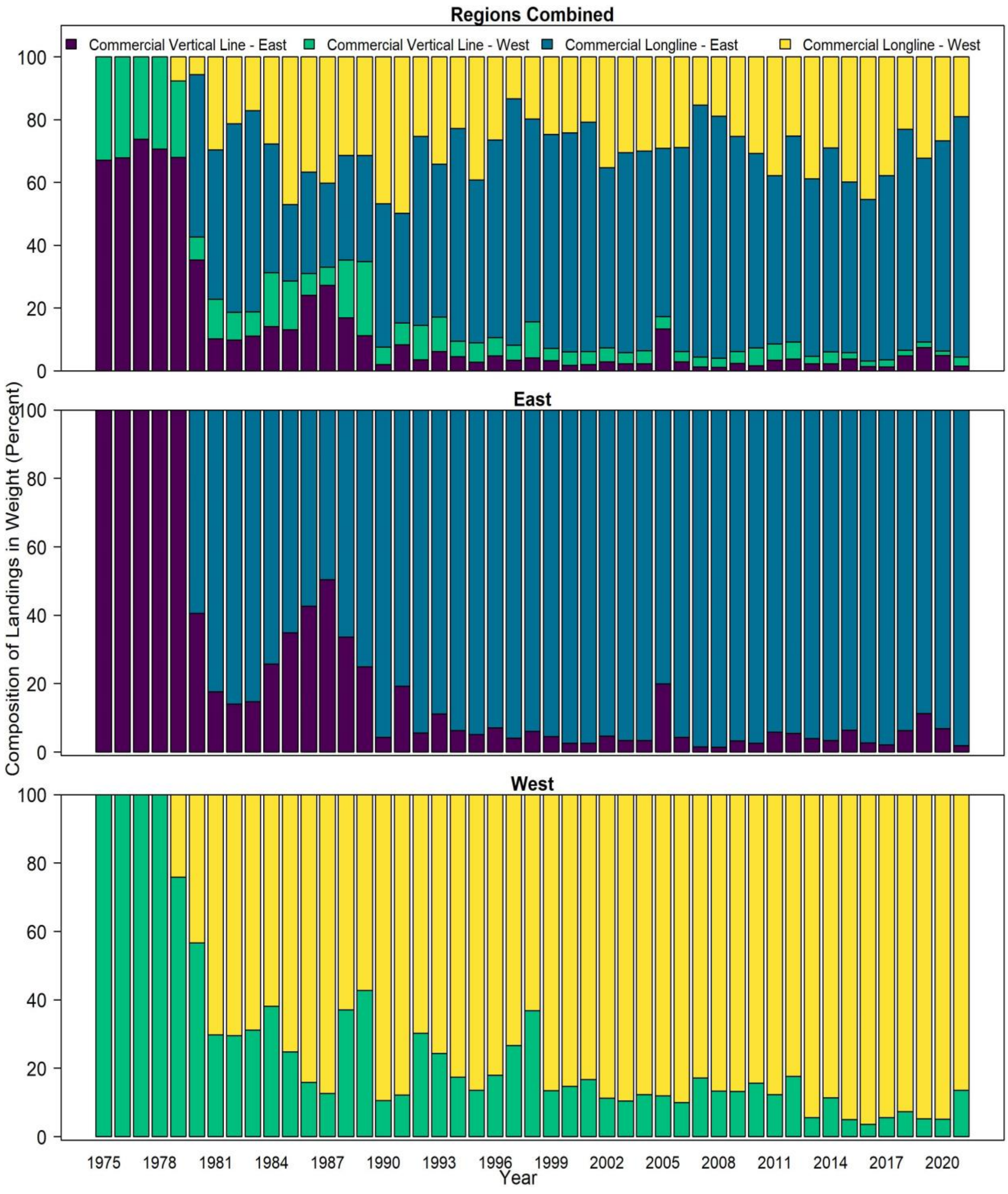


Figure 7. Percent composition of landings for Gulf of Mexico Yellowedge Grouper by fishery and region.

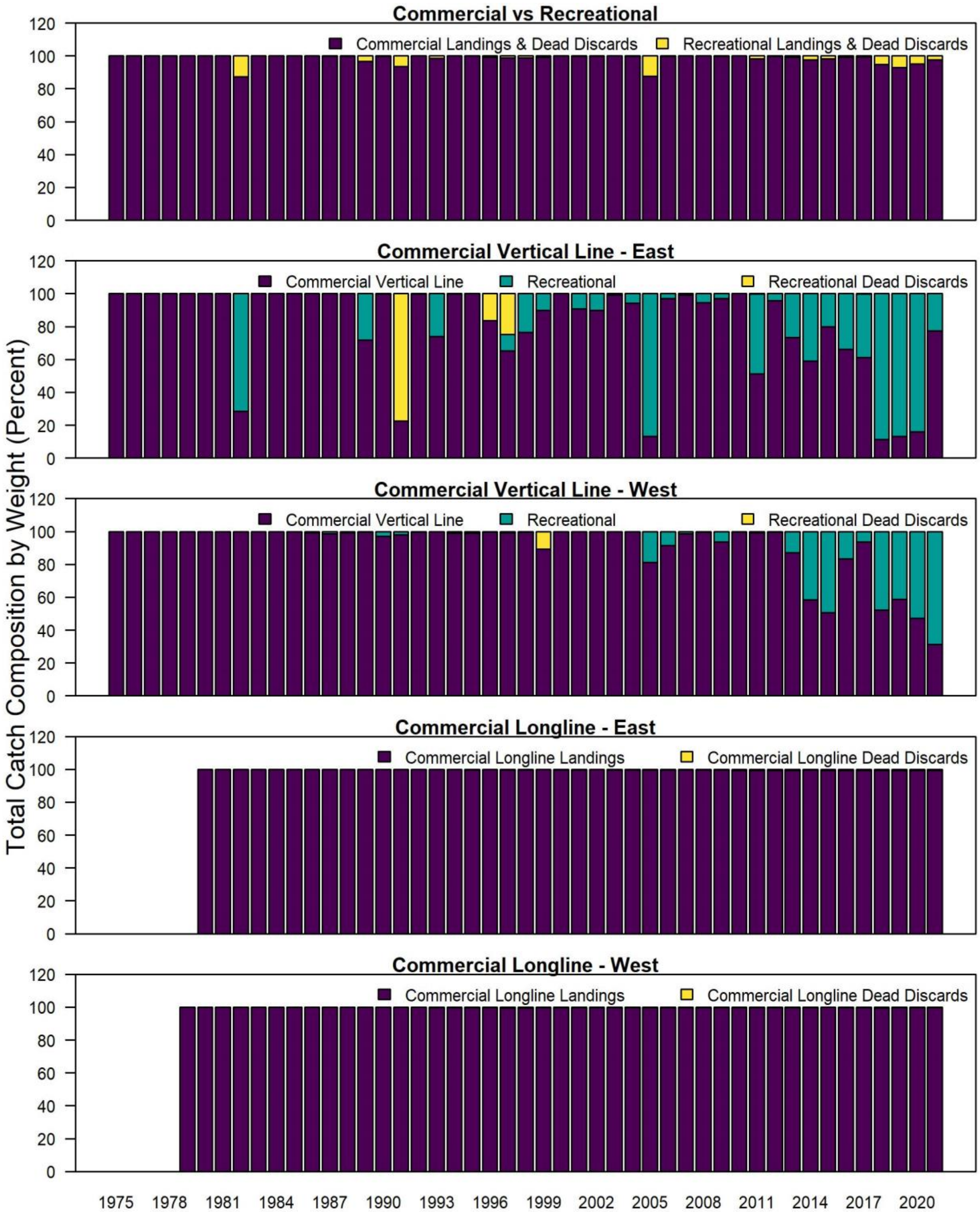


Figure 8. Percent composition and comparison of commercial and recreational landings and dead discards for Gulf of Mexico Yellowedge Grouper.

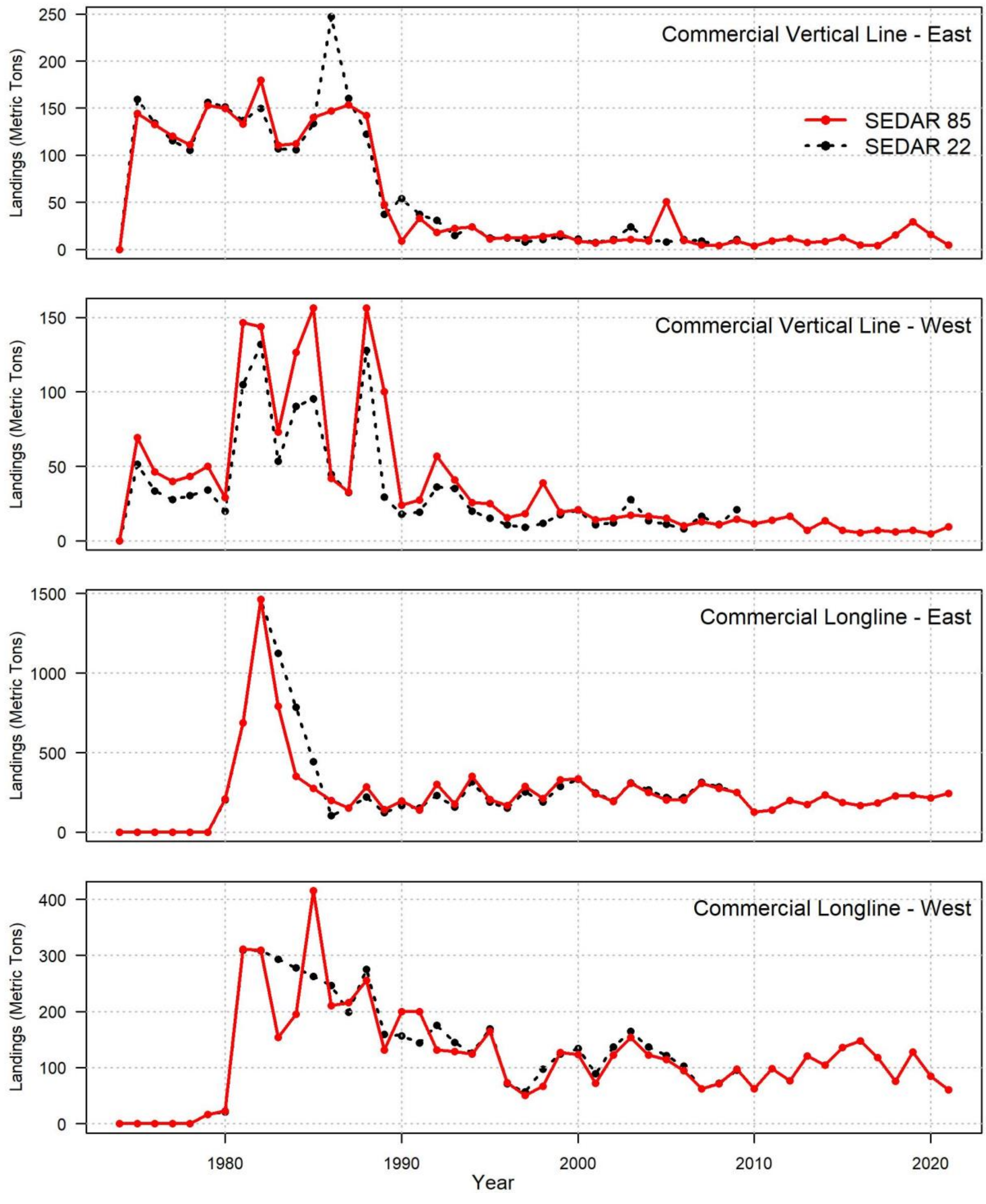


Figure 9. Gulf of Mexico Yellowedge Grouper observed landings (in metric tons) by fishery and region for SEDAR 85 and SEDAR 22.

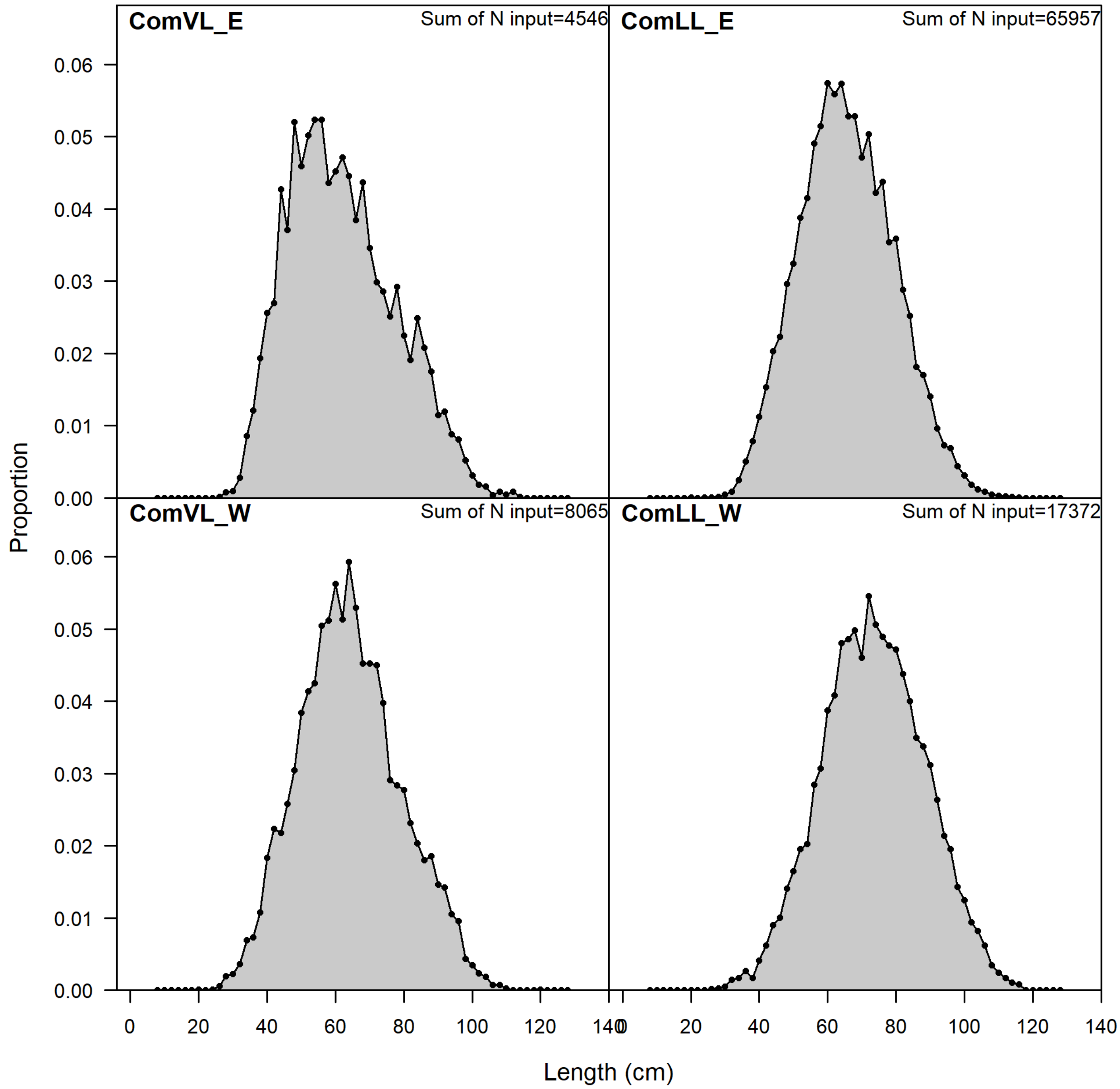


Figure 10. Length compositions of Yellowedge Grouper aggregated across years for the Commercial Vertical Line (ComVL) and Longline (ComLL) fisheries in the Eastern (E) and Western (W) Gulf of Mexico. 'N input' is the number of length observations.

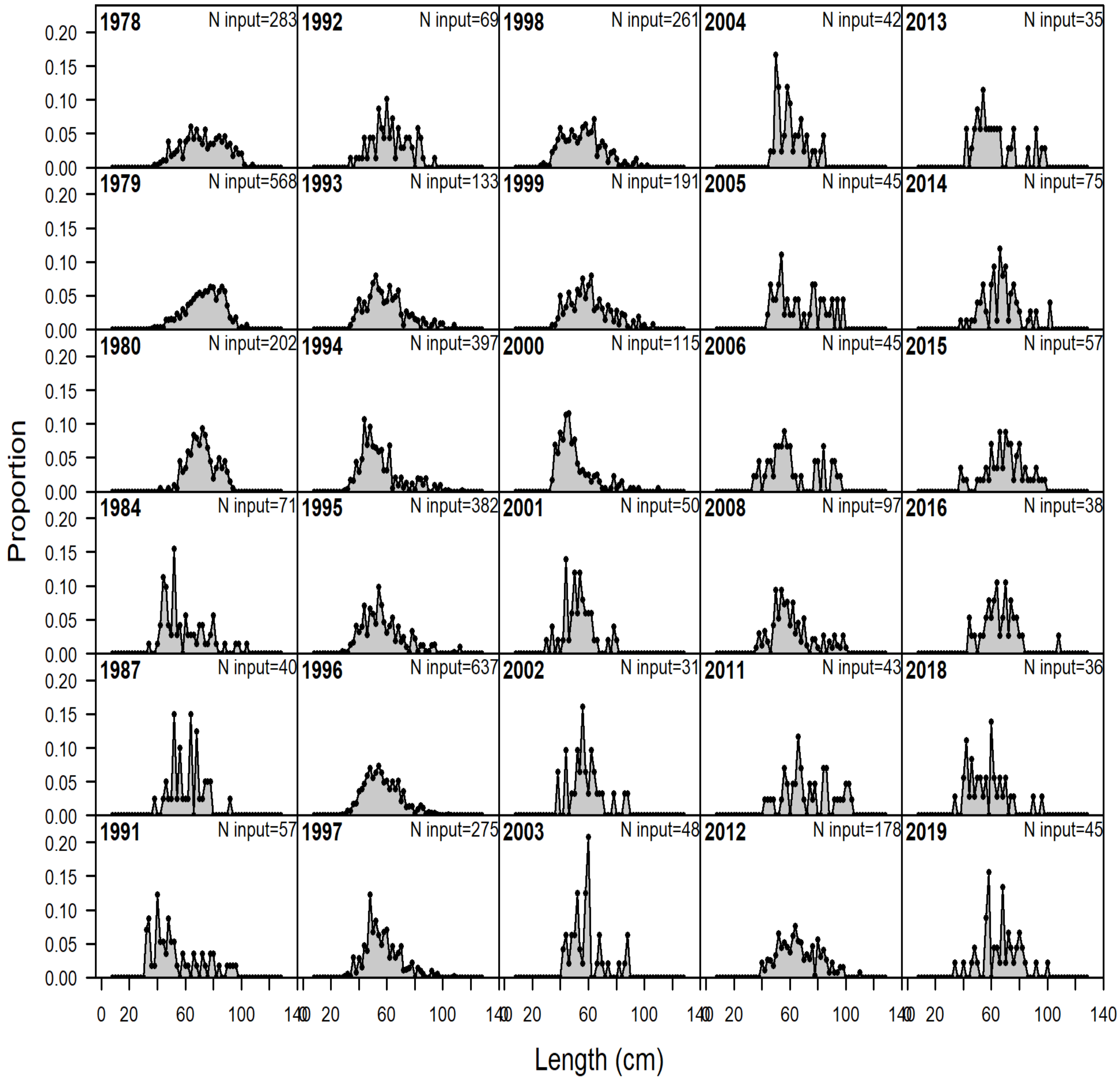


Figure 11. Observed length composition of Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - East fishery. 'N input' is the number of length observations.

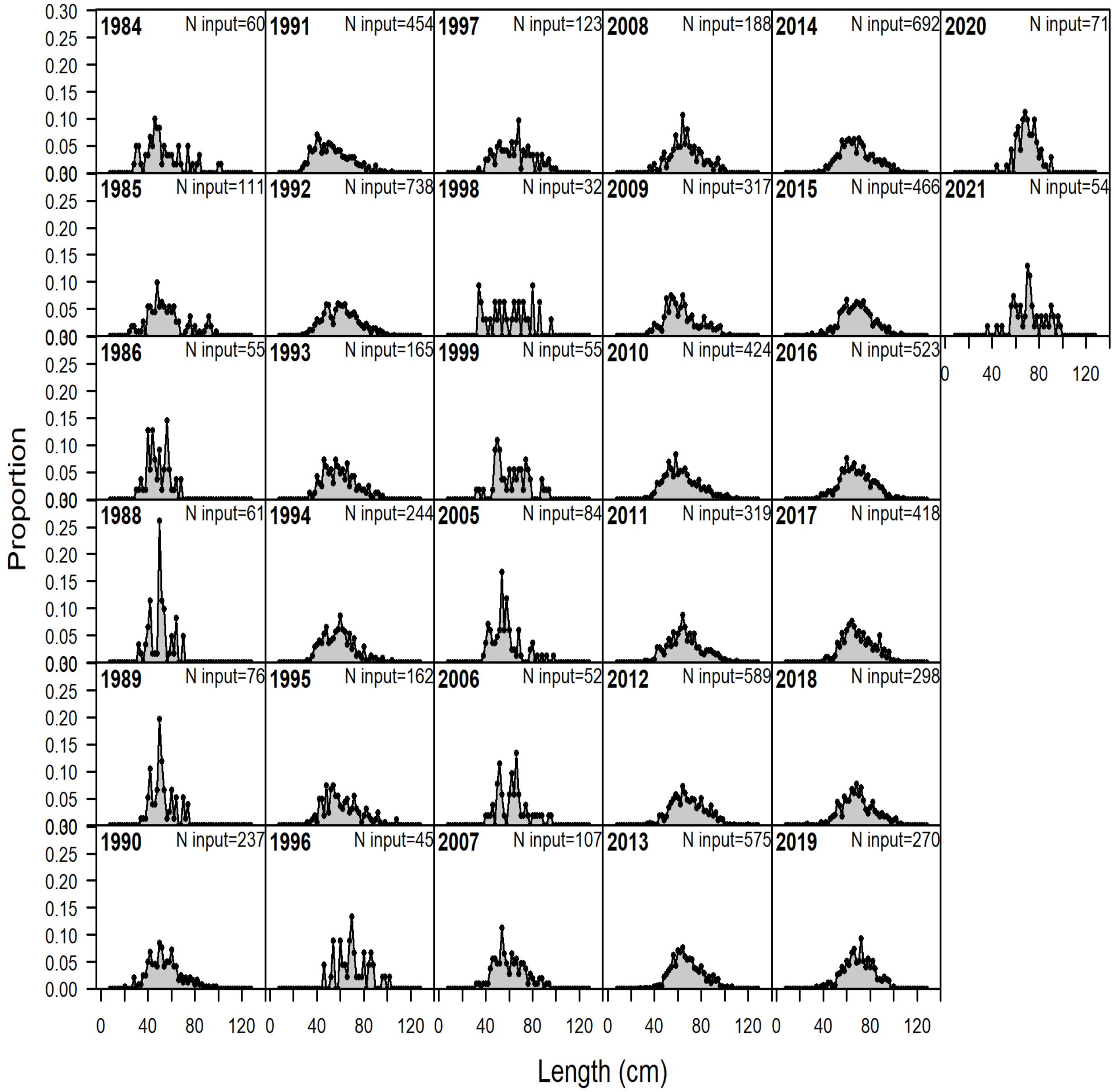


Figure 12. Observed length composition of Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - West fishery. 'N input' is the number of length observations.

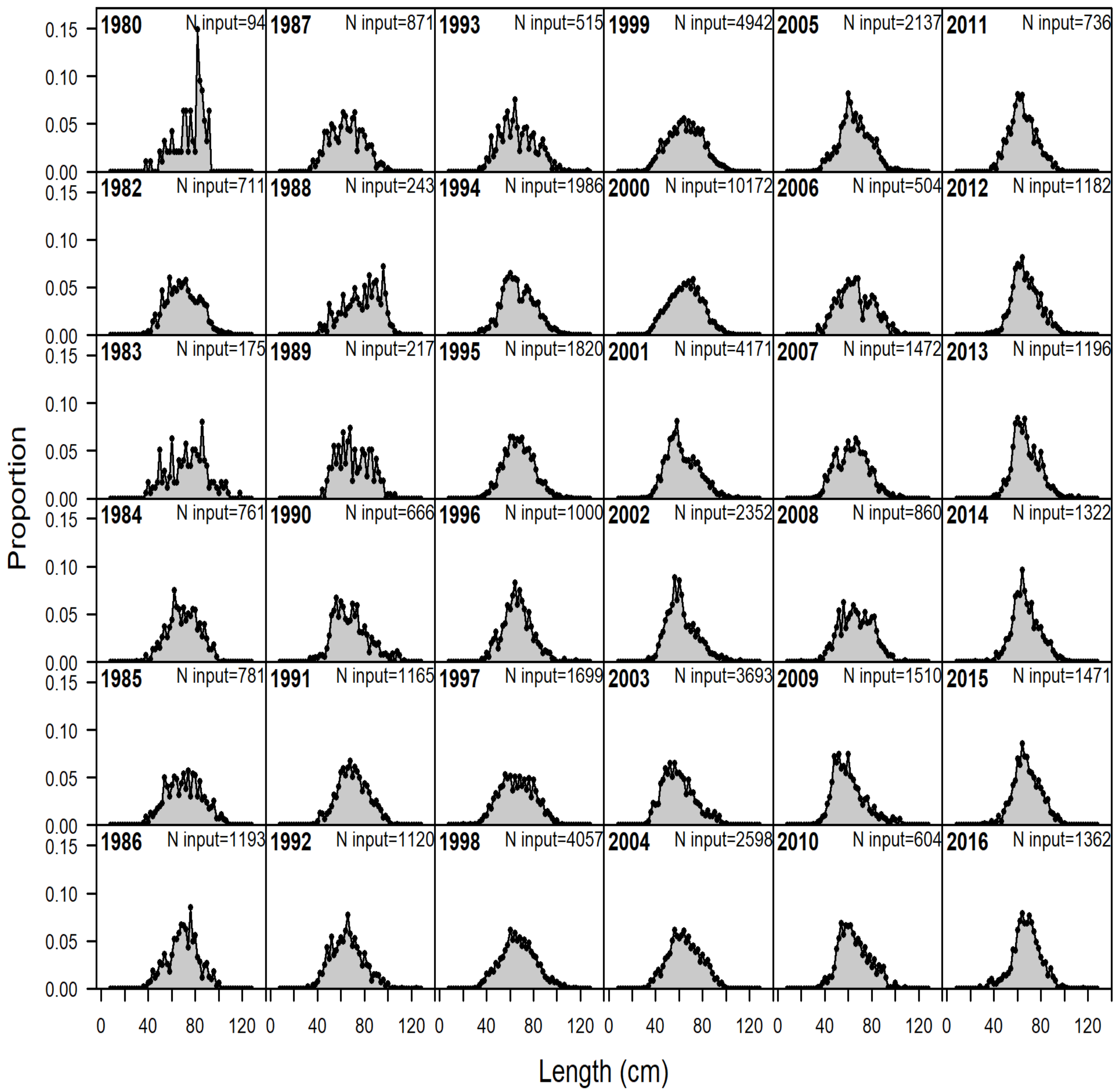


Figure 13. Observed length composition of Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery. 'N input' is the number of length observations.

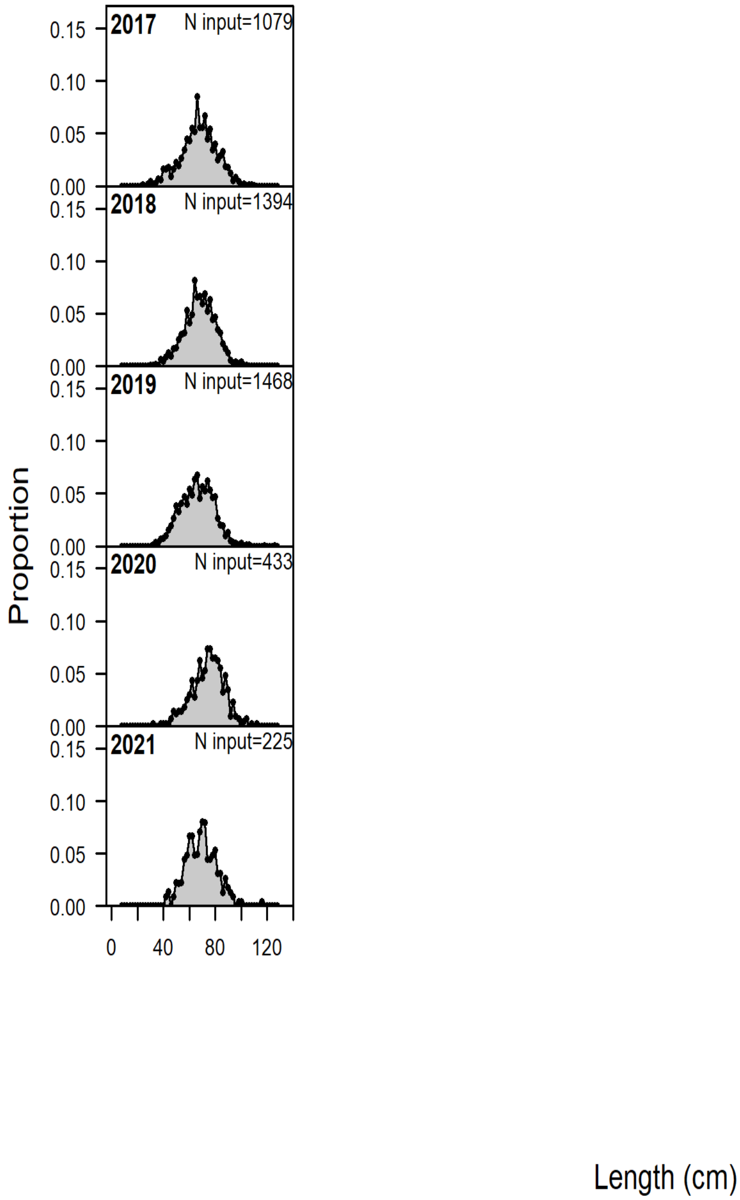


Figure 13 Continued. Observed length composition of Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery. 'N input' is the number of length observations.

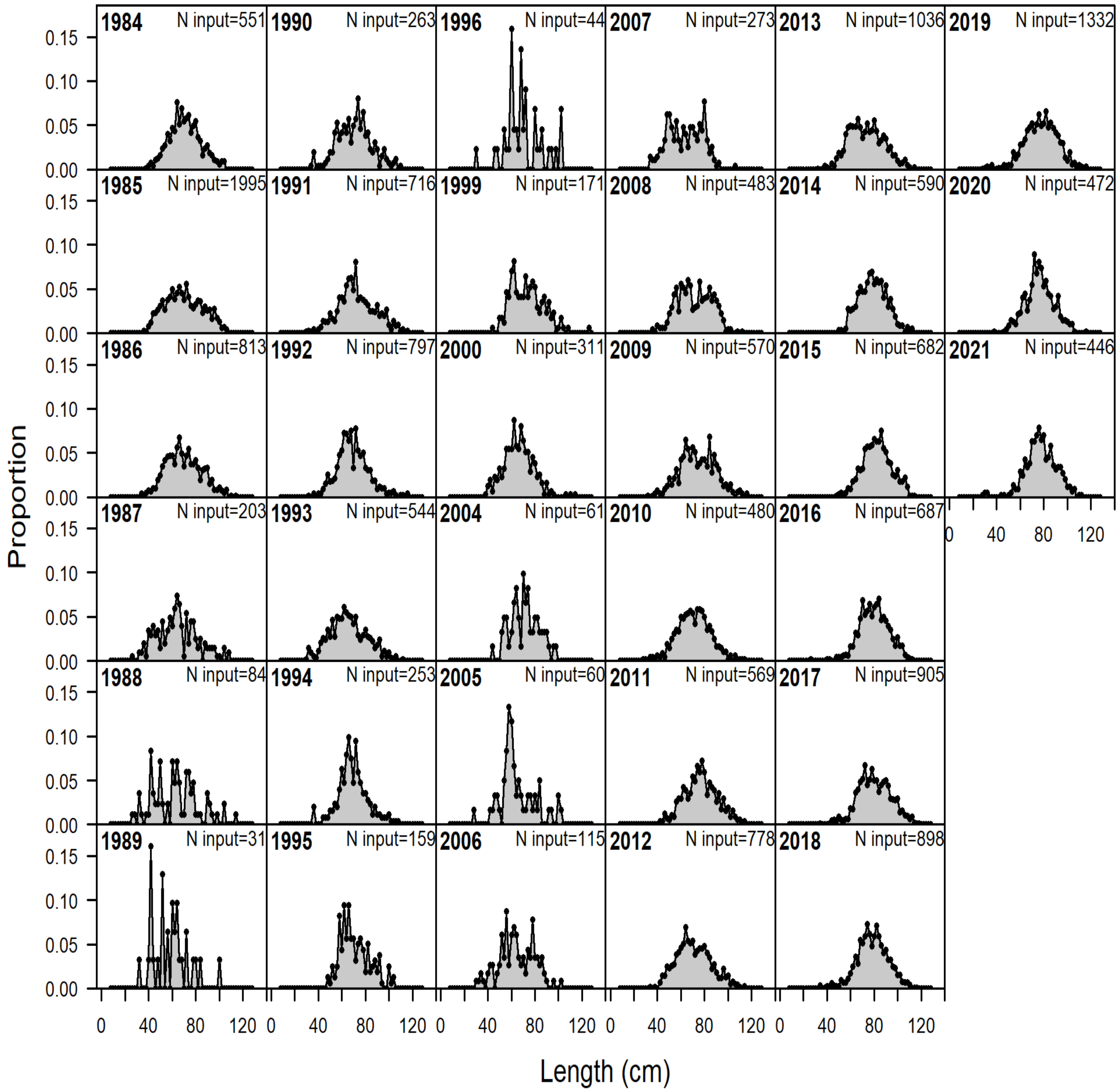


Figure 14. Observed length composition of Gulf of Mexico Yellowedge Grouper in the Commercial Longline - West fishery. 'N input' is the number of length observations.

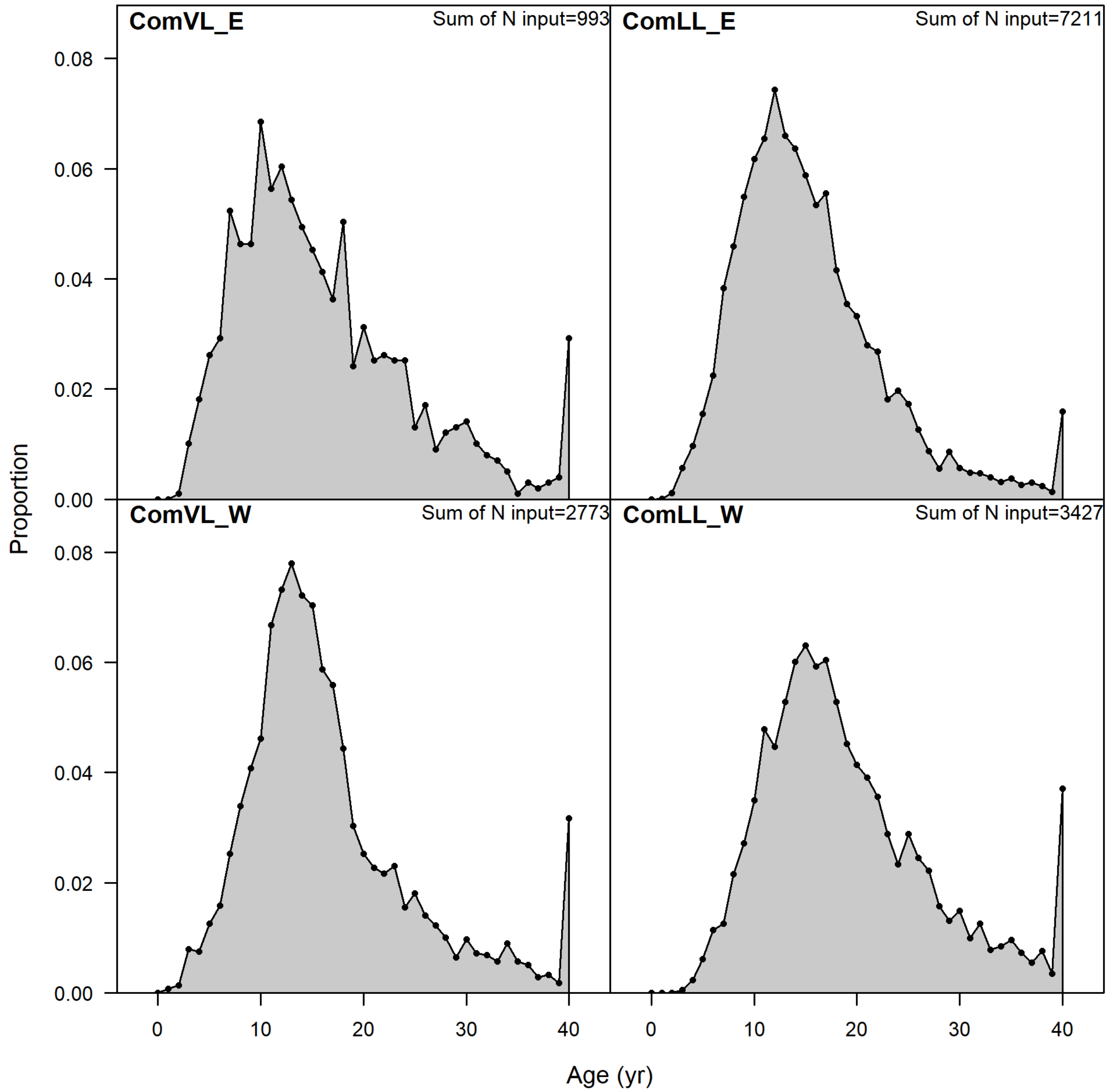


Figure 15. Age compositions of Yellowedge Grouper aggregated across years for the Commercial Vertical Line (ComVL) and Longline (ComLL) fisheries in the Eastern (E) and Western (W) Gulf of Mexico. 'N input' is the number of ages.

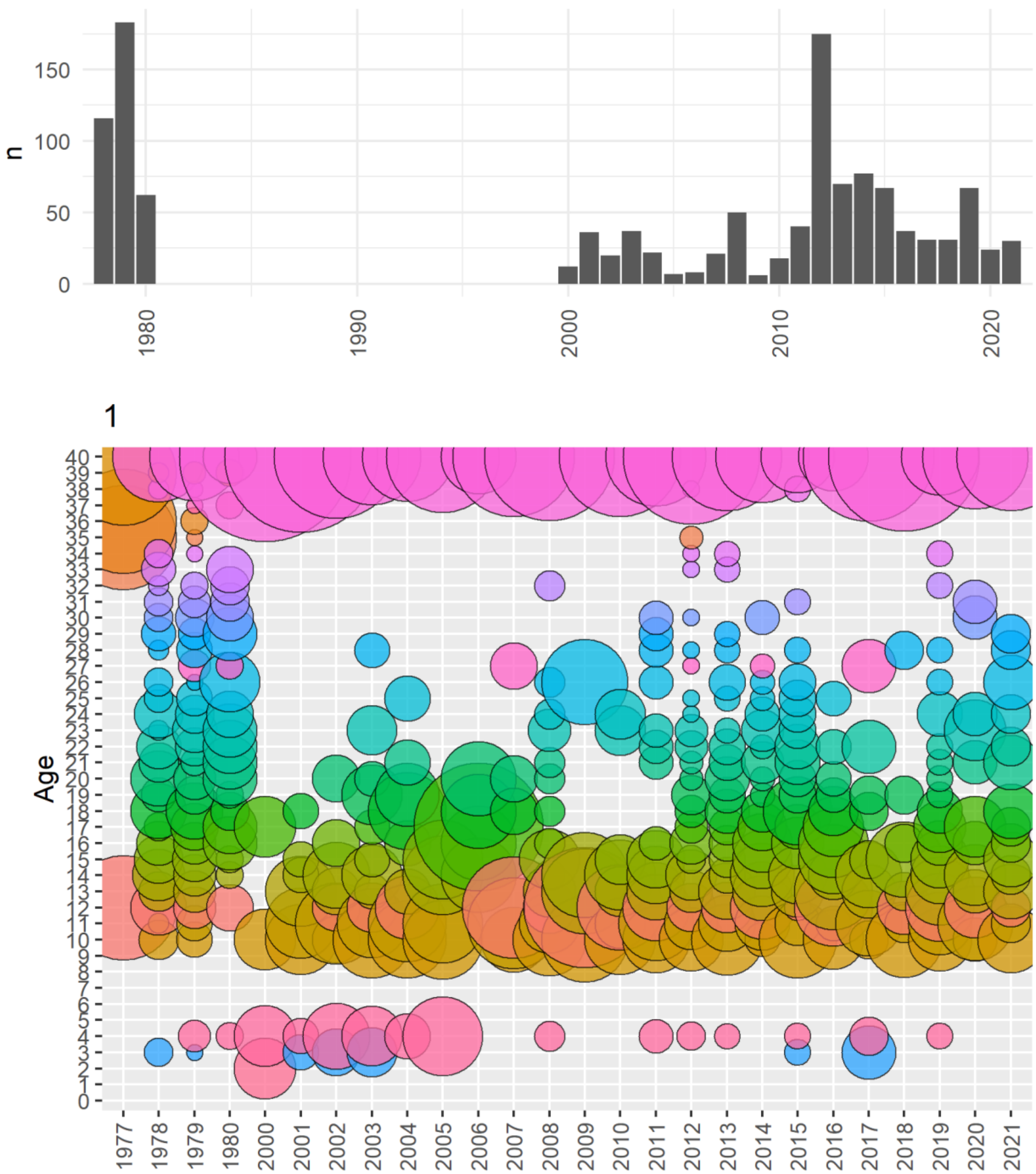


Figure 16. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - East fishery. The histogram shows annual sample sizes. All years of available data are shown before data exclusions.

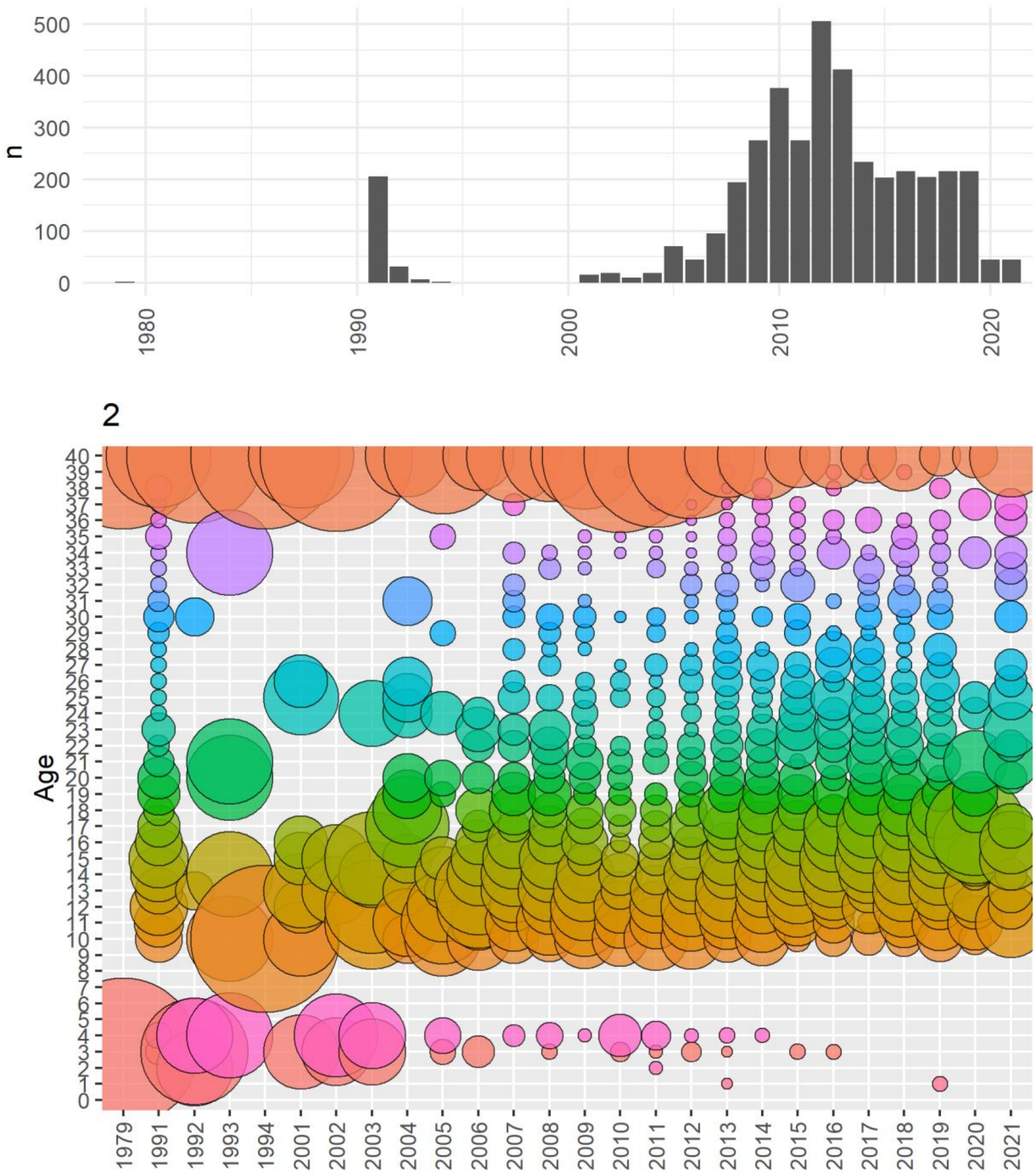


Figure 17. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - West fishery. The histogram shows annual sample sizes. All years of available data are shown before data exclusions.

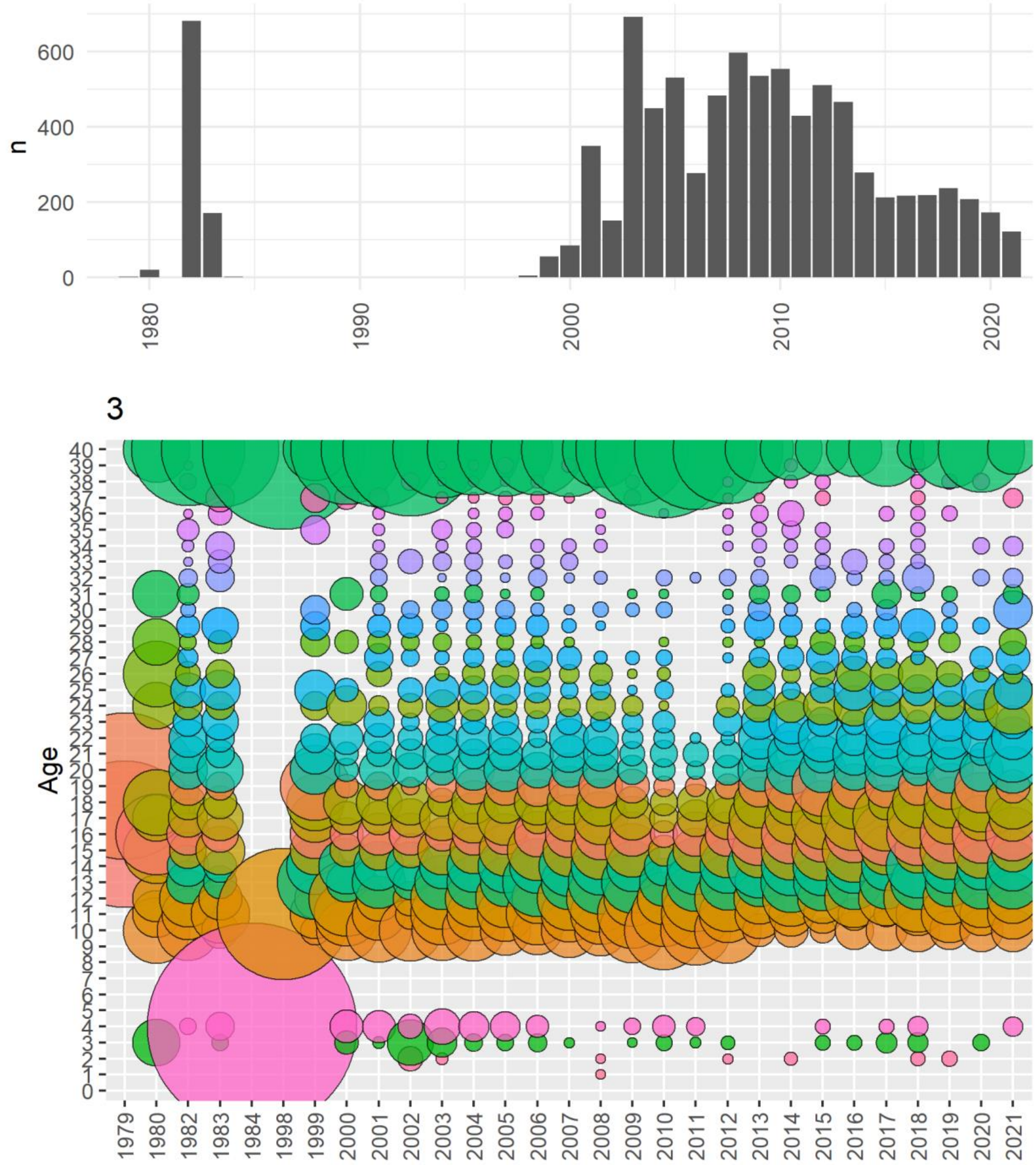


Figure 18. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery. The histogram shows annual sample sizes. All years of available data are shown before data exclusions.

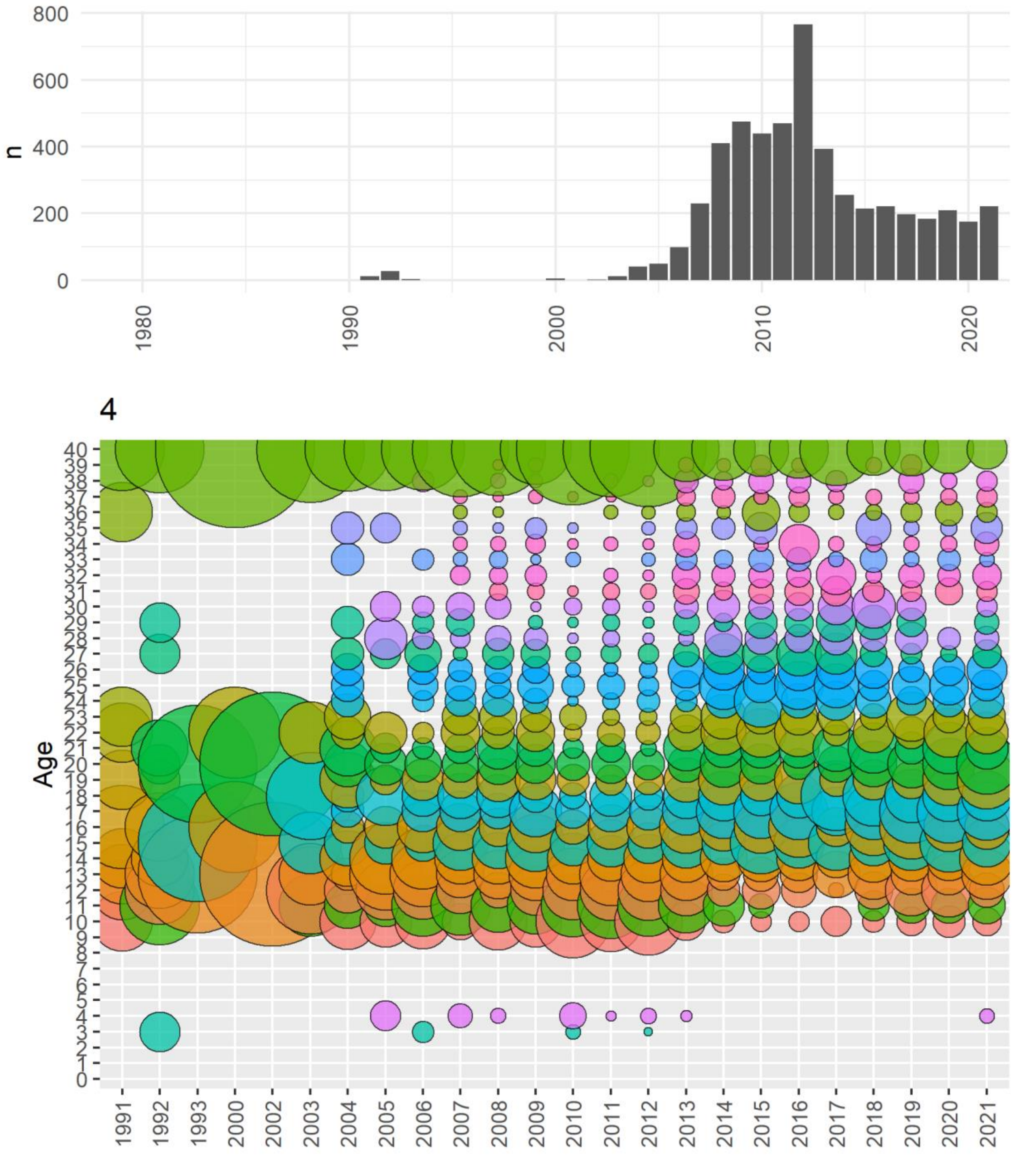


Figure 19. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - West fishery. The histogram shows annual sample sizes. All years of available data are shown before data exclusions.

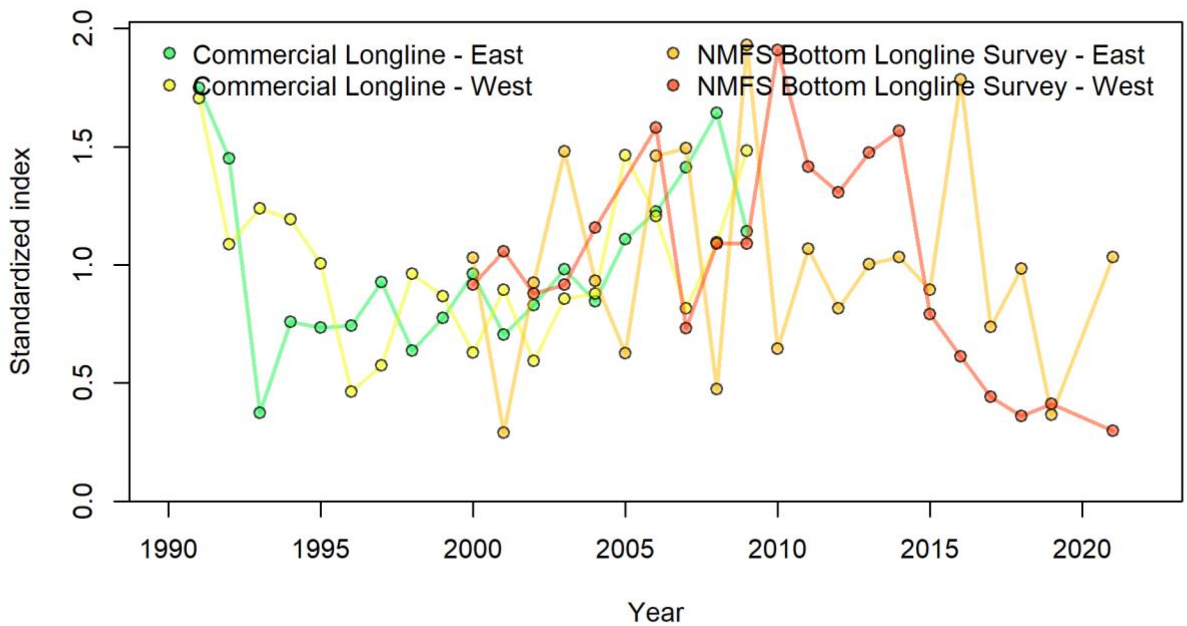


Figure 20. Standardized indices of relative abundance recommended for use during the SEDAR 22 Benchmark Assessment and extended for use (as feasible) in SEDAR 85 for Gulf of Mexico Yellowedge Grouper. Each index has been rescaled to have a mean observation = 1.0.

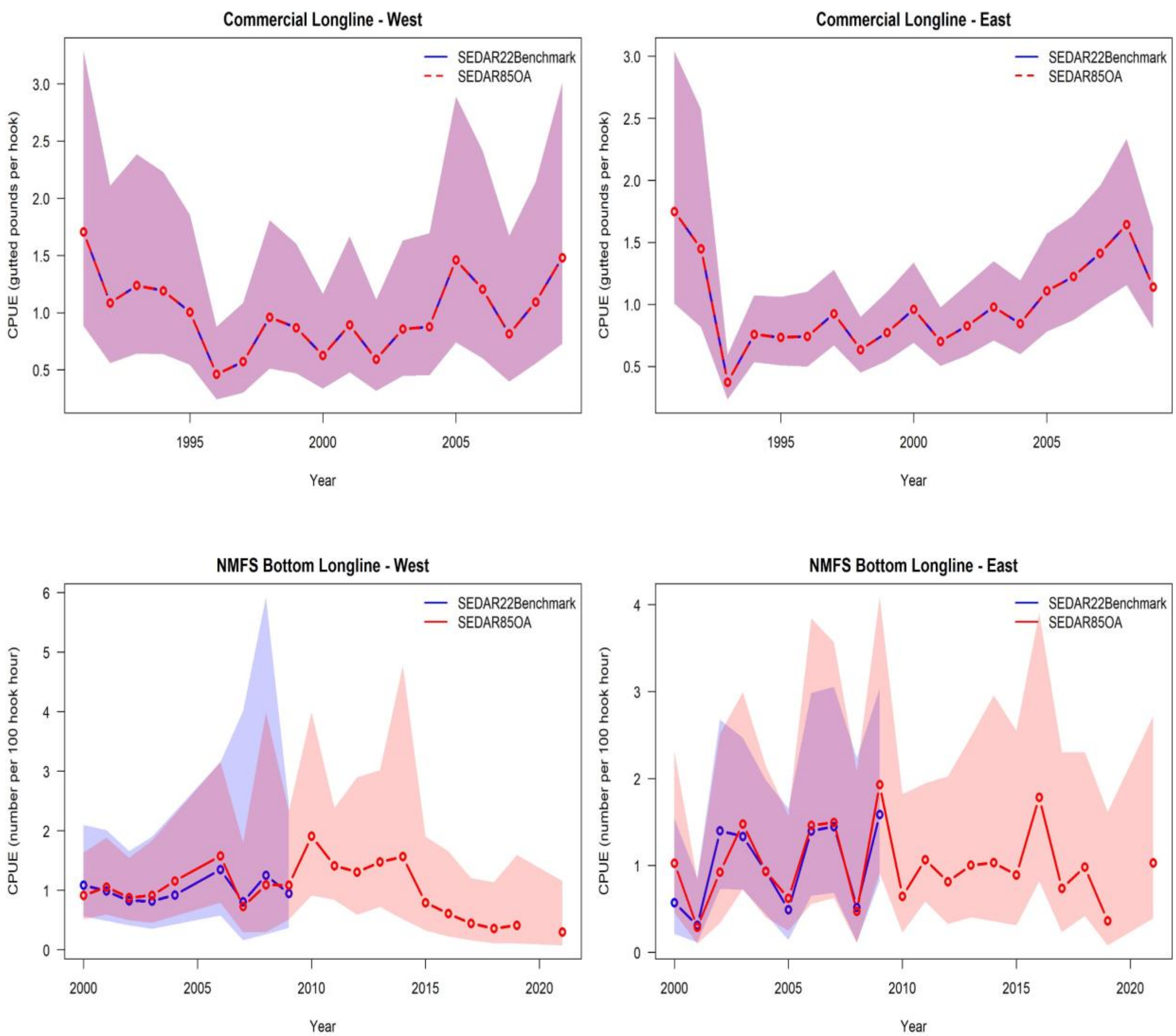


Figure 21. Comparison of indices of relative abundance for Gulf of Mexico Yellowedge Grouper developed for SEDAR 85 compared to the indices provided during the SEDAR 22 Benchmark Assessment with associated 95% confidence intervals.

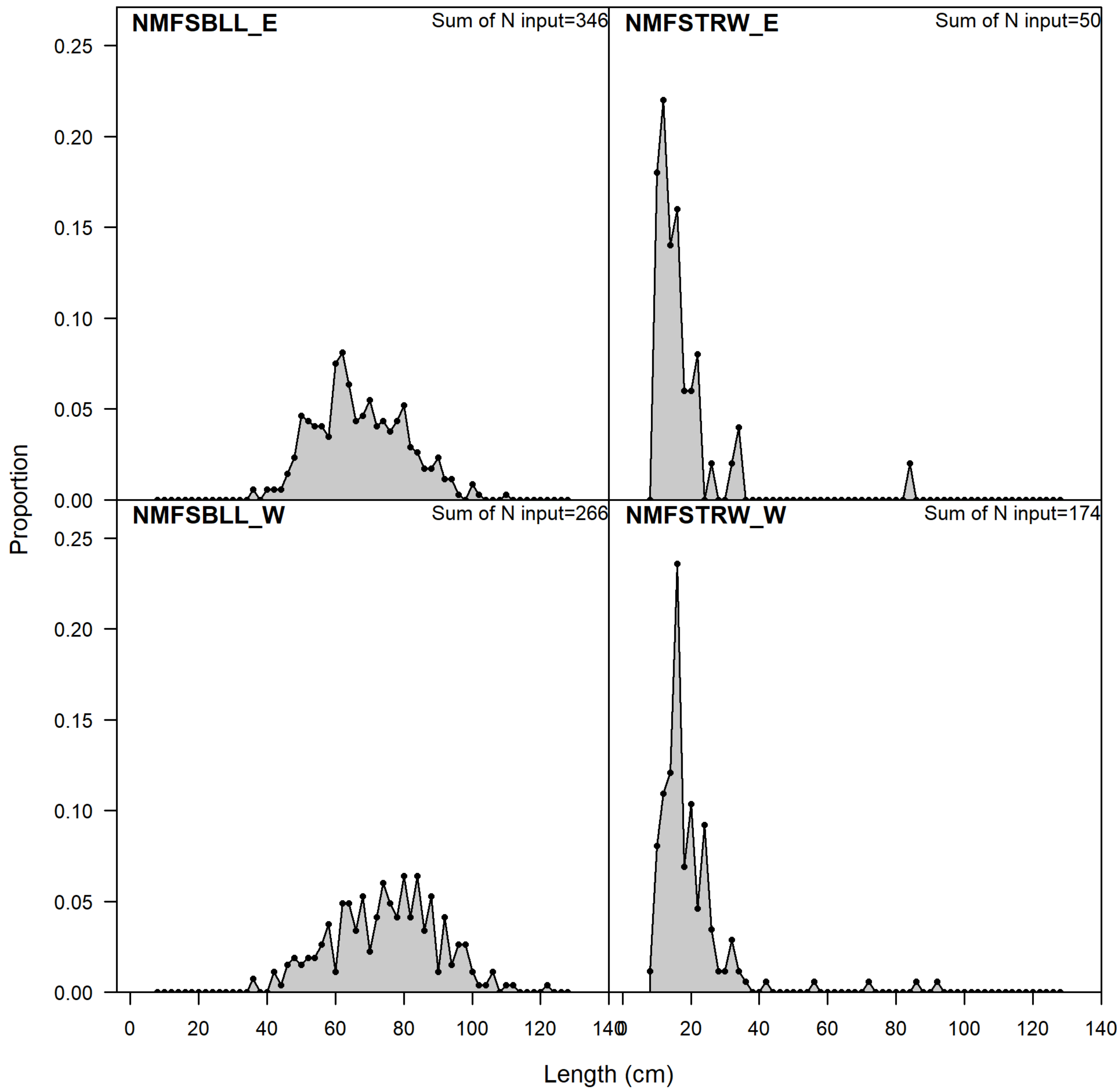


Figure 22. Length compositions of Yellowedge Grouper aggregated across years for the NMFS Bottom Longline (NMFSBLL) and NMFS/SEAMAP Groundfish Trawl (NMFSTRW) surveys in the Eastern (E) and Western (W) Gulf of Mexico. 'N input' is the number of length observations.

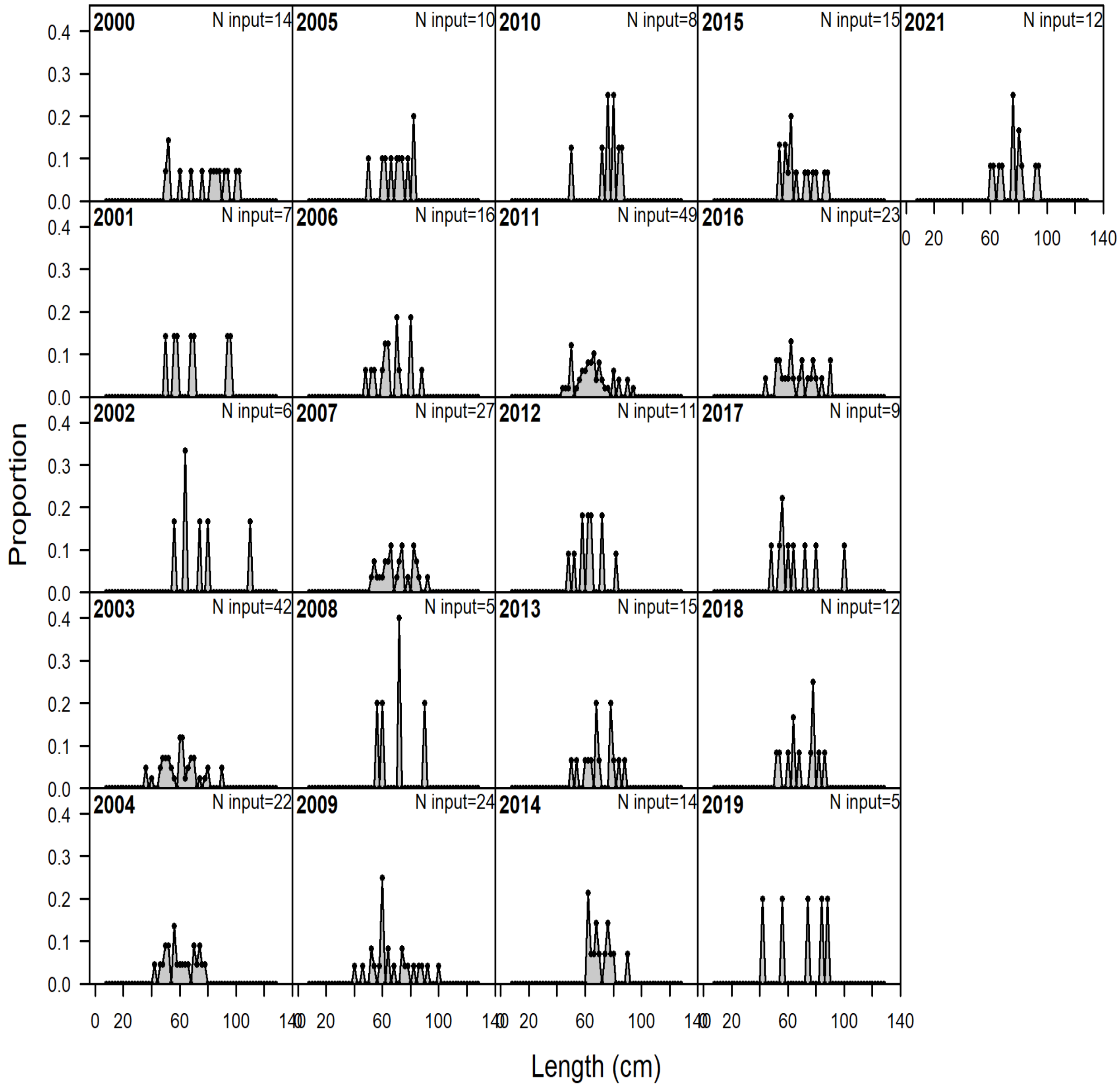


Figure 23. Observed length composition data of Gulf of Mexico Yellowedge Grouper from the NMFS Bottom Longline Survey - East. 'N input' is the number of length observations.

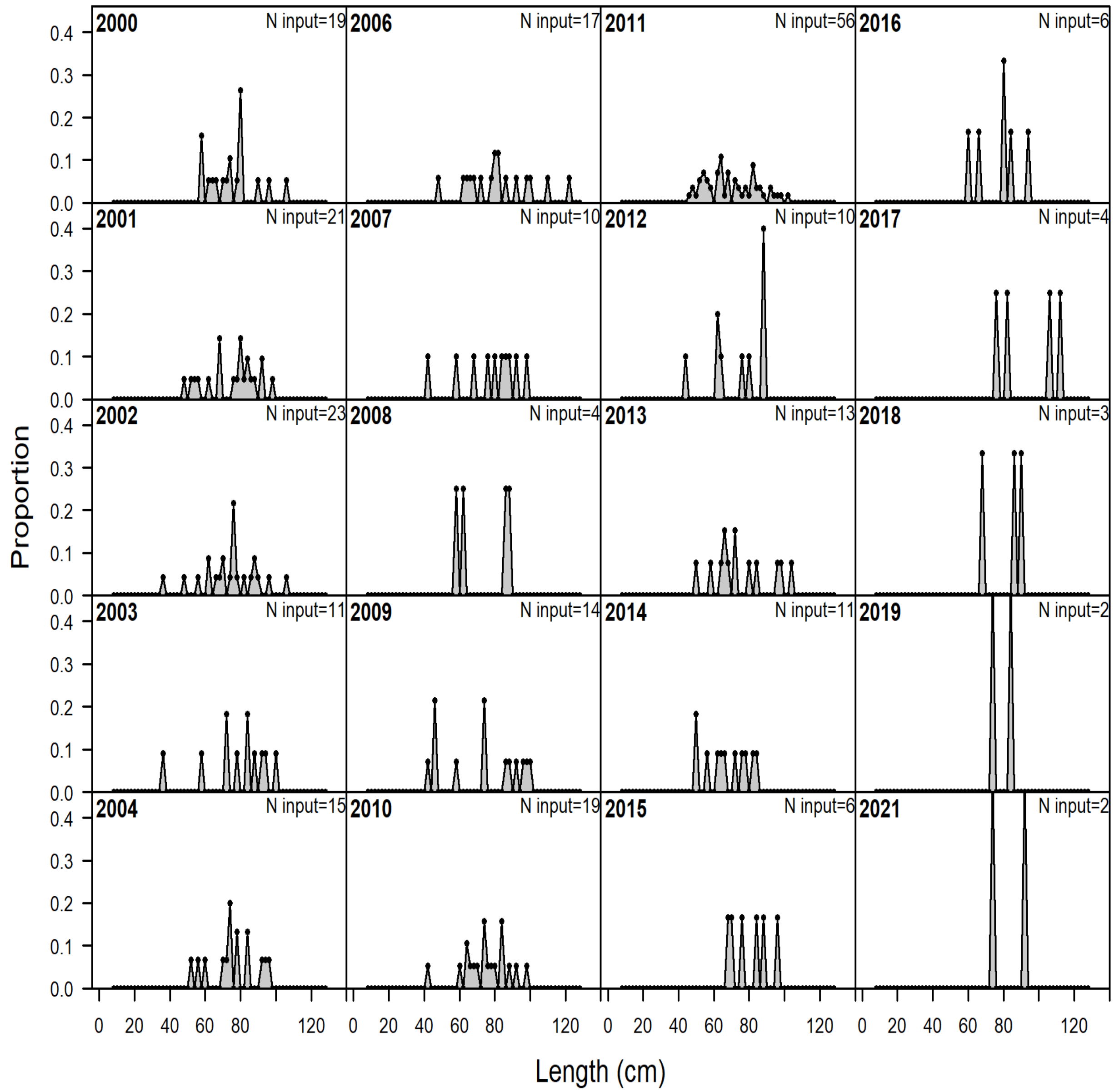


Figure 24. Observed length composition data of Gulf of Mexico Yellowedge Grouper from the NMFS Bottom Longline Survey - West. 'N input' is the number of length observations.

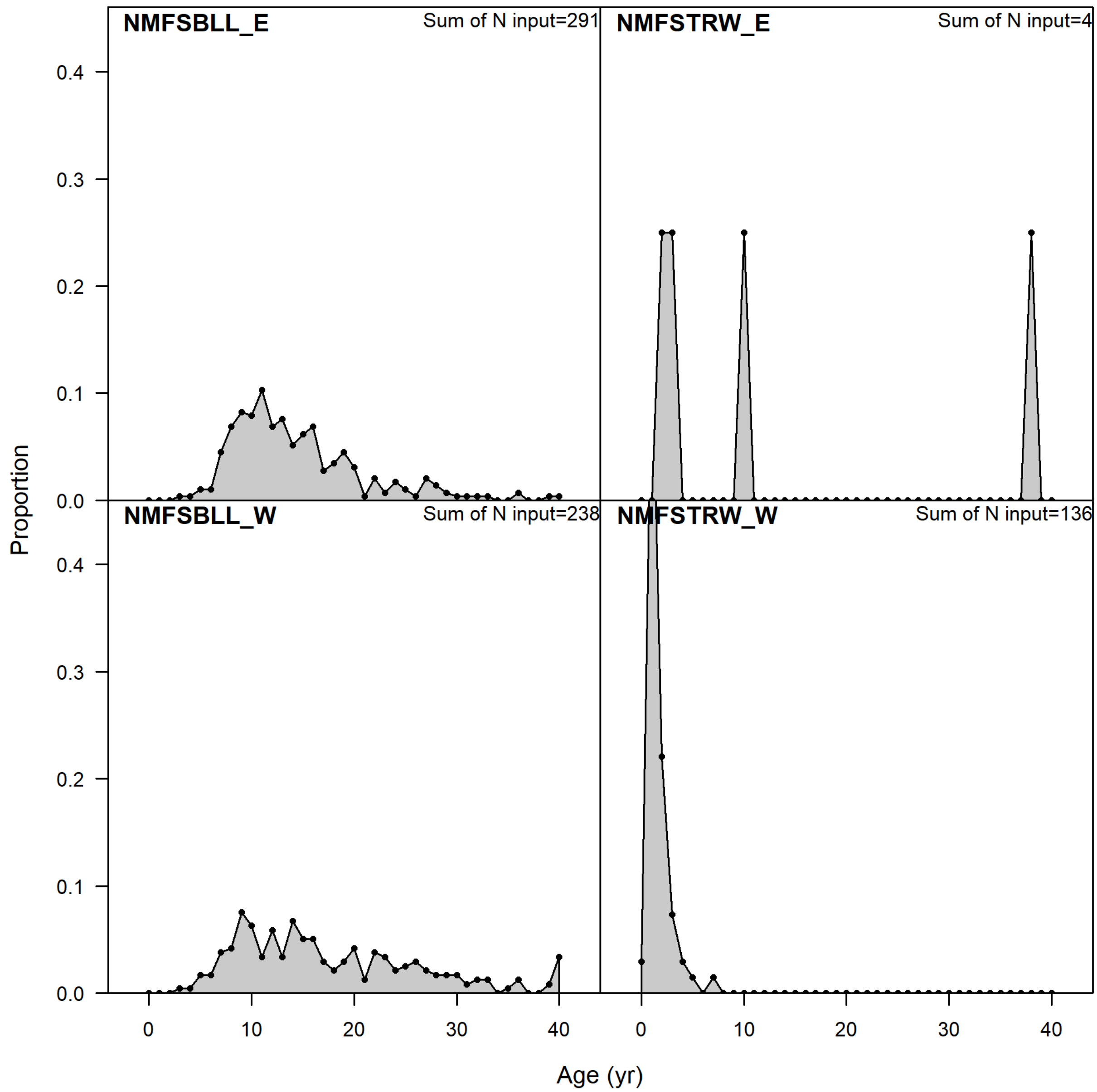


Figure 25. Age compositions of Yellowedge Grouper aggregated across years for the NMFS Bottom Longline (NMFSBLL) and NMFS/SEAMAP Groundfish Trawl (NMFSTRW) surveys in the Eastern (E) and Western (W) Gulf of Mexico. 'N input' is the number of ages.

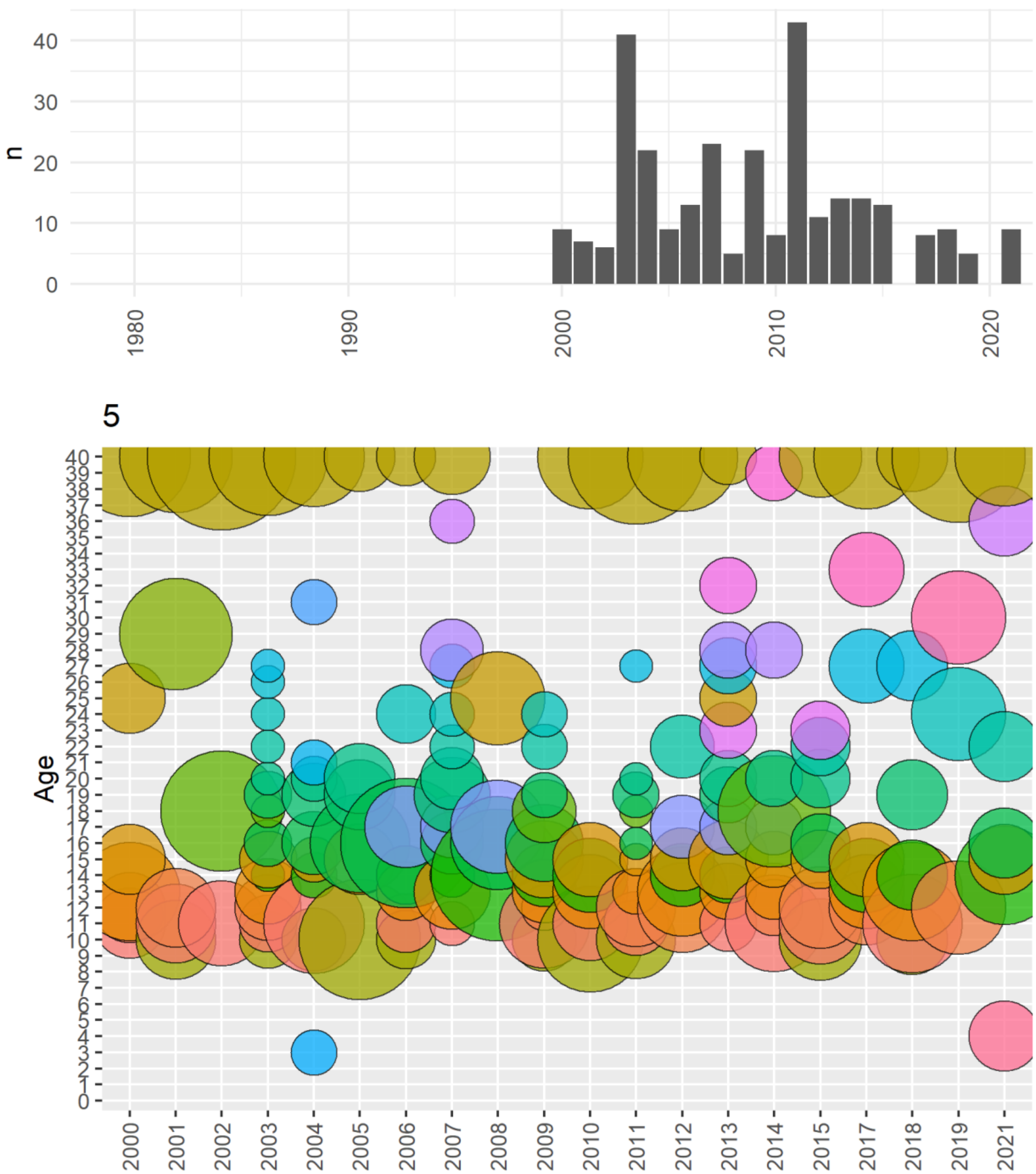


Figure 26. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper from the NMFS Bottom Longline Survey - East. The histogram shows annual sample sizes. All years of available data are shown.

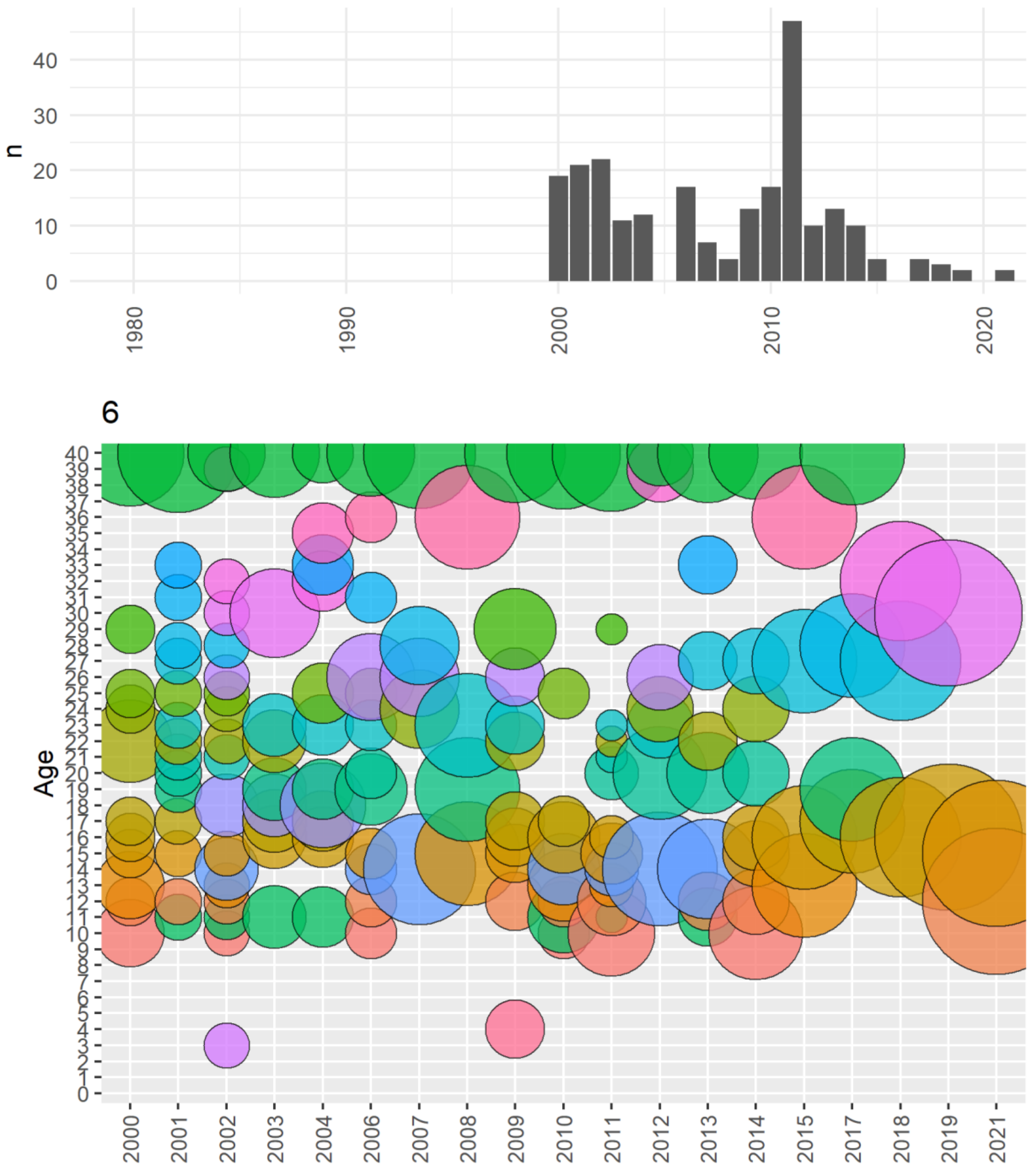


Figure 27. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper from the NMFS Bottom Longline Survey - West. The histogram shows annual sample sizes. All years of available data are shown.

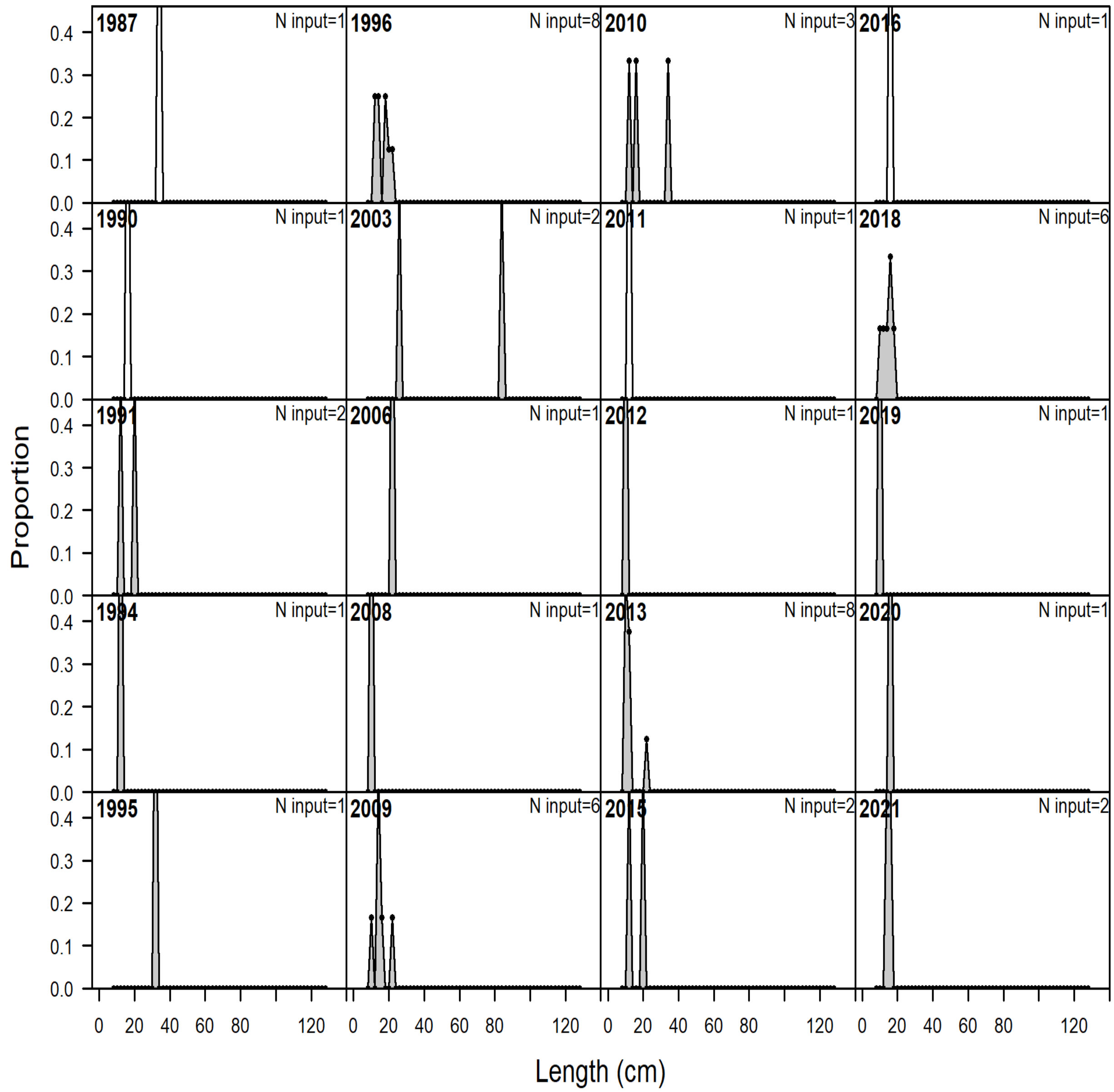


Figure 28. Observed length composition data of Gulf of Mexico Yellowedge Grouper from the NMFS/SEAMAP Groundfish Trawl Survey - East. 'N input' is the number of length observations.

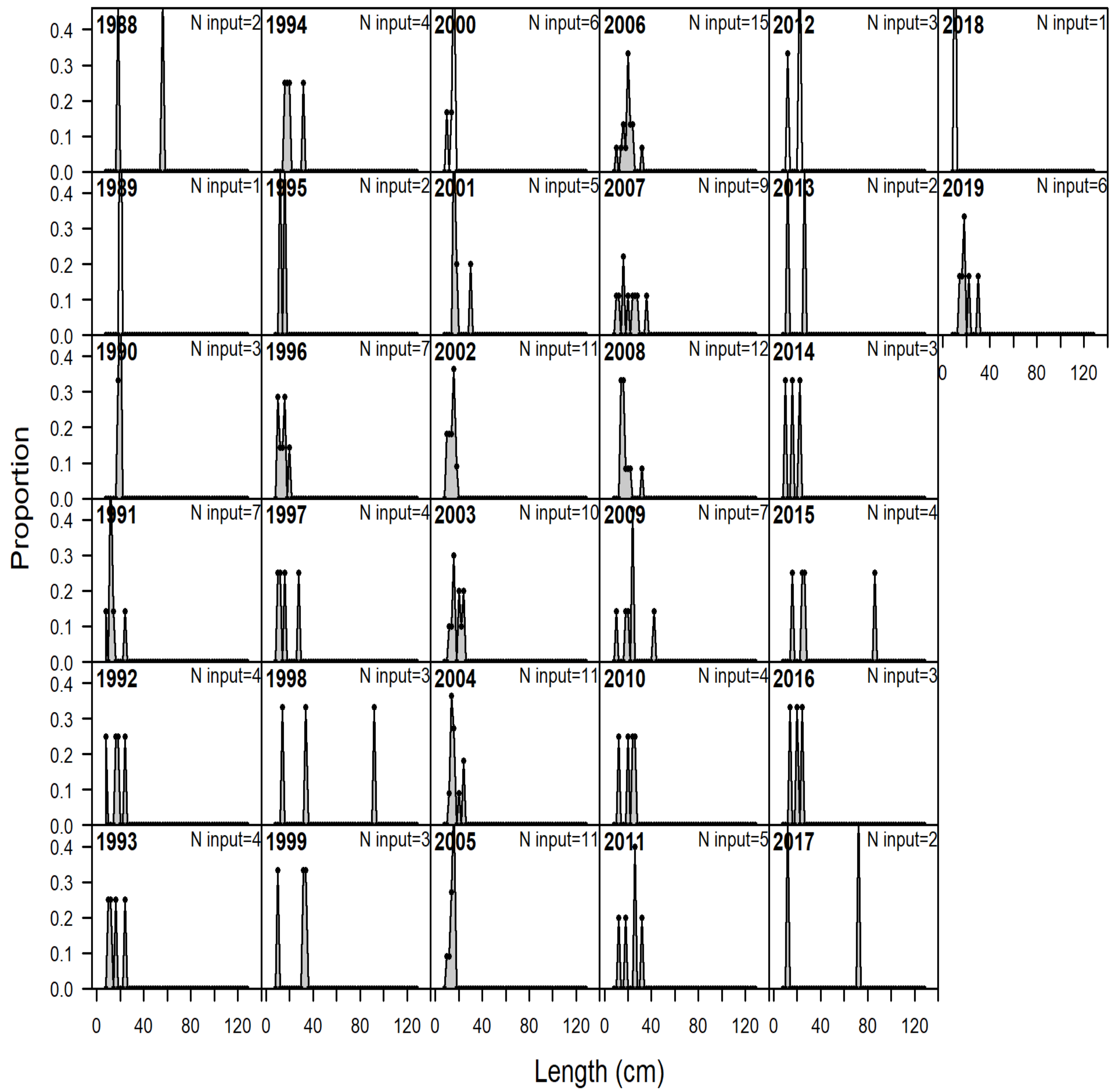


Figure 29. Observed length composition data of Gulf of Mexico Yellowedge Grouper from the NMFS/SEAMAP Groundfish Trawl Survey - West. 'N input' is the number of length observations.

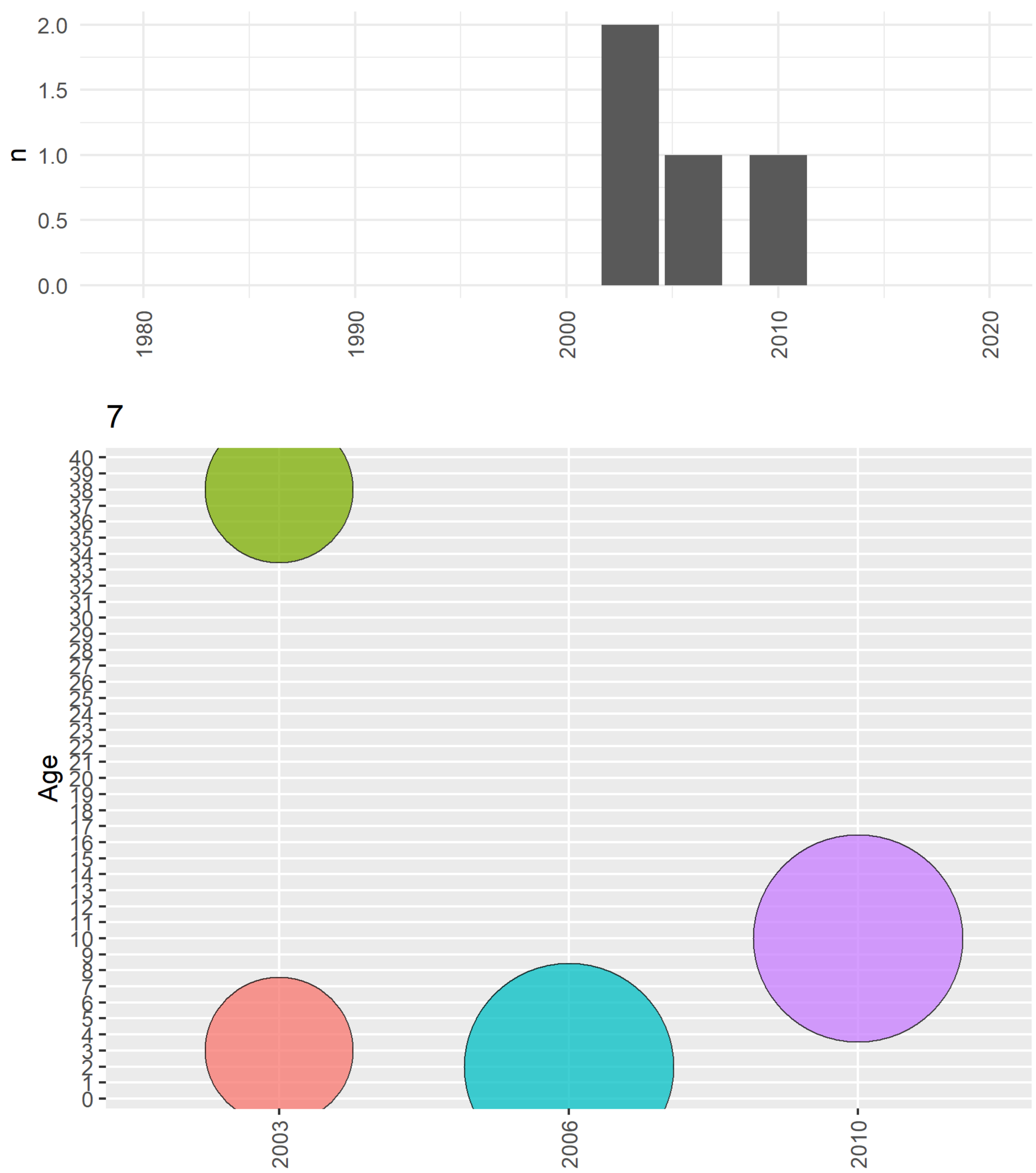


Figure 30. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper from the NMFS/SEAMAP Groundfish Trawl Survey - East. The histogram shows annual sample sizes. These age data were not fit to in the assessment.

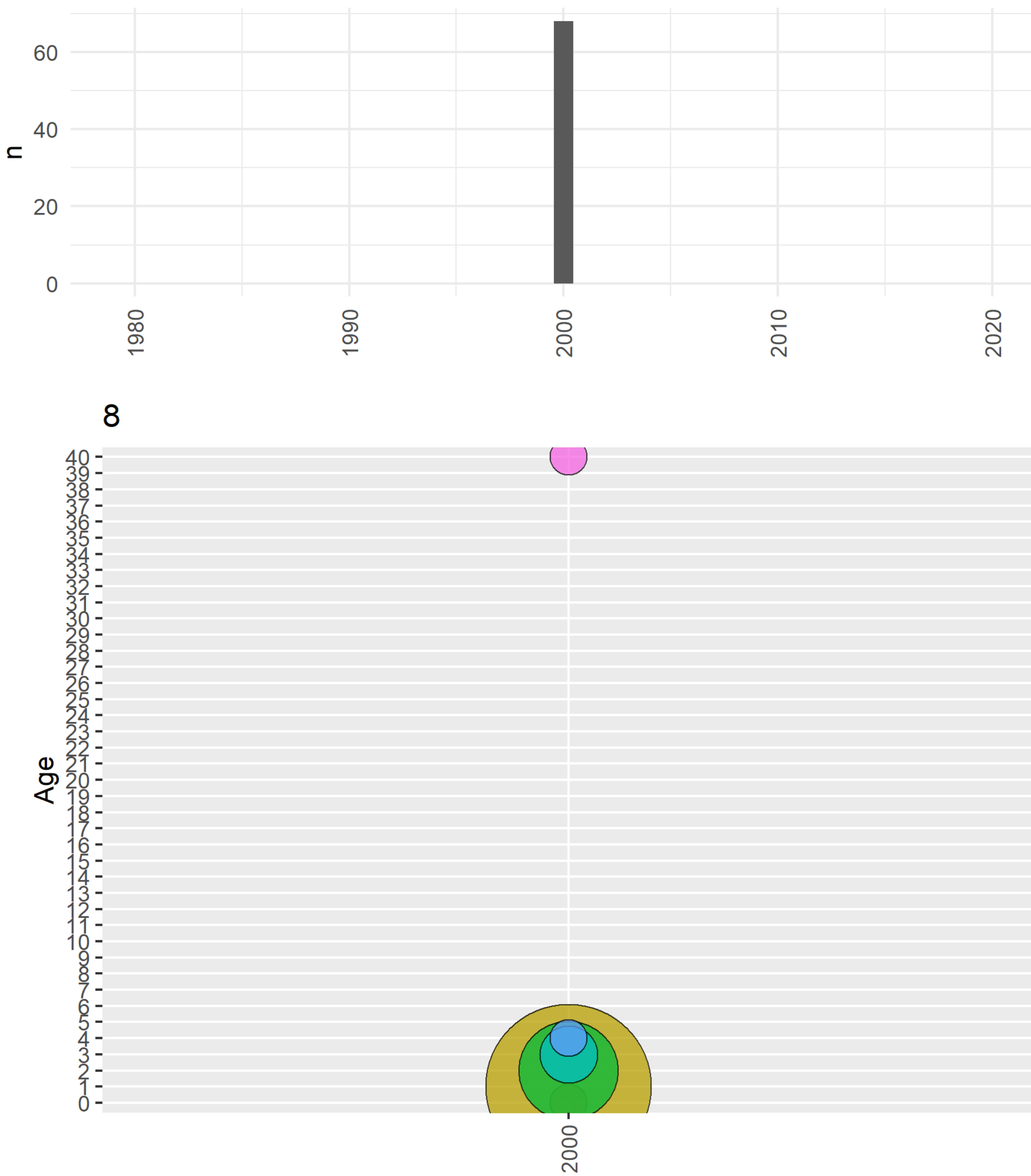


Figure 31. Observed relative age proportions (bubbles) in each year for Gulf of Mexico Yellowedge Grouper from the NMFS/SEAMAP Groundfish Trawl Survey - West. The histogram shows annual sample sizes. Age data from 2000-2009 were aggregated and fit to using the super year approach.

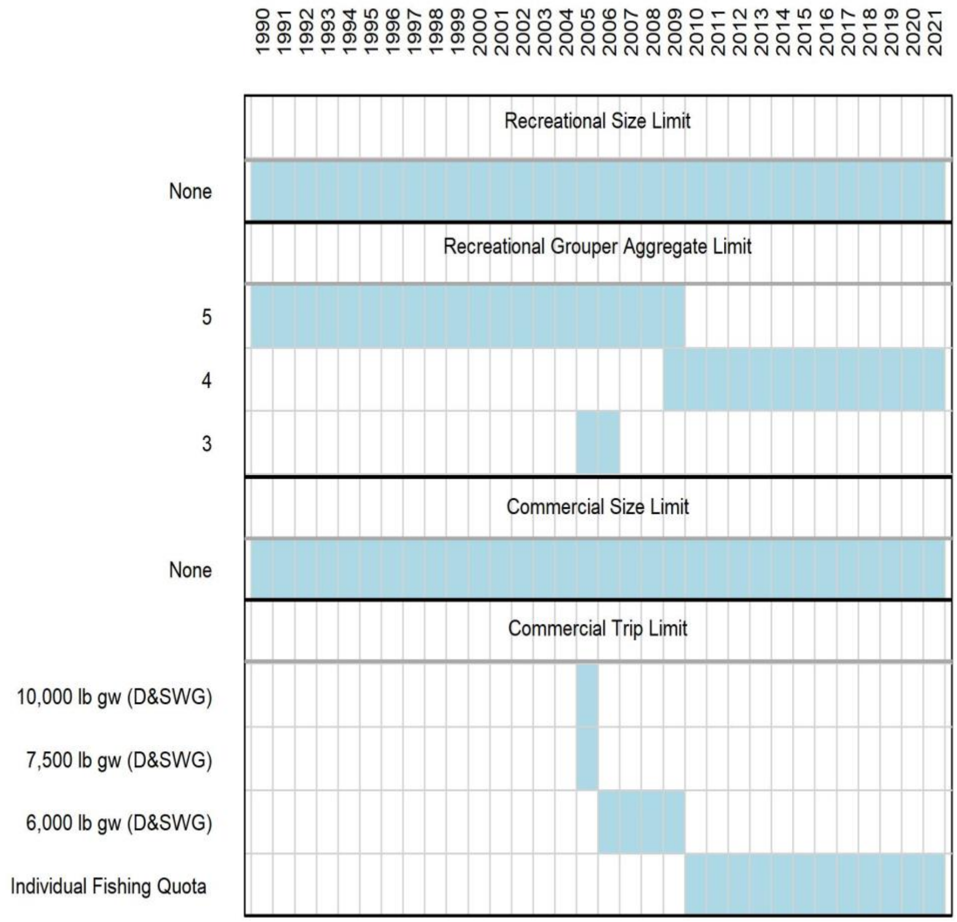


Figure 32. Summary of federal management regulations for Gulf of Mexico Yellowedge Grouper. Trip limits in pounds gutted weight (lb gw) are shown for deep and shallow-water grouper (D&SWG). IFQ refers to the implementation of the Grouper-Tilefish Individual Fishing Quota program. Not included are time or area closures.

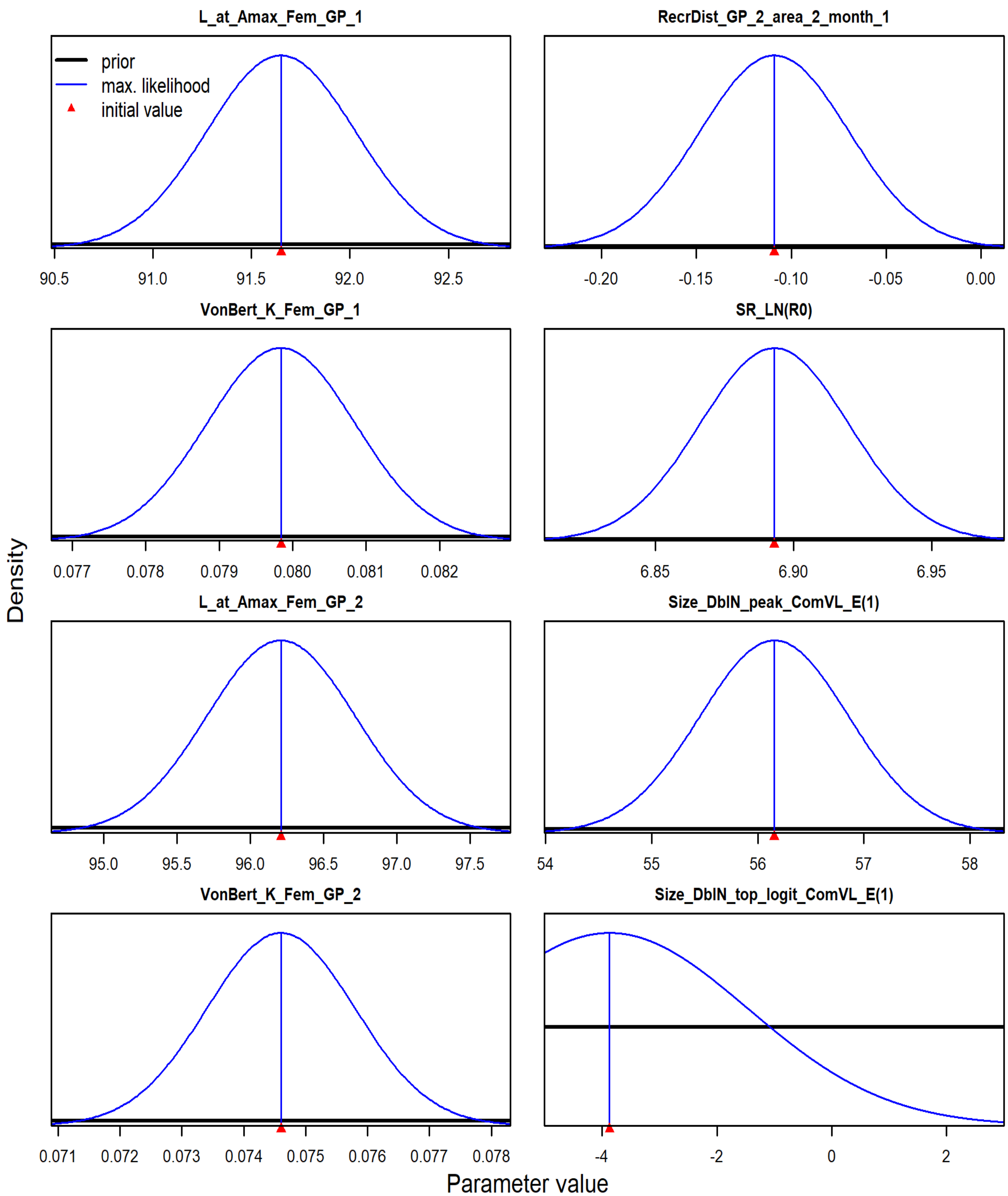


Figure 33. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

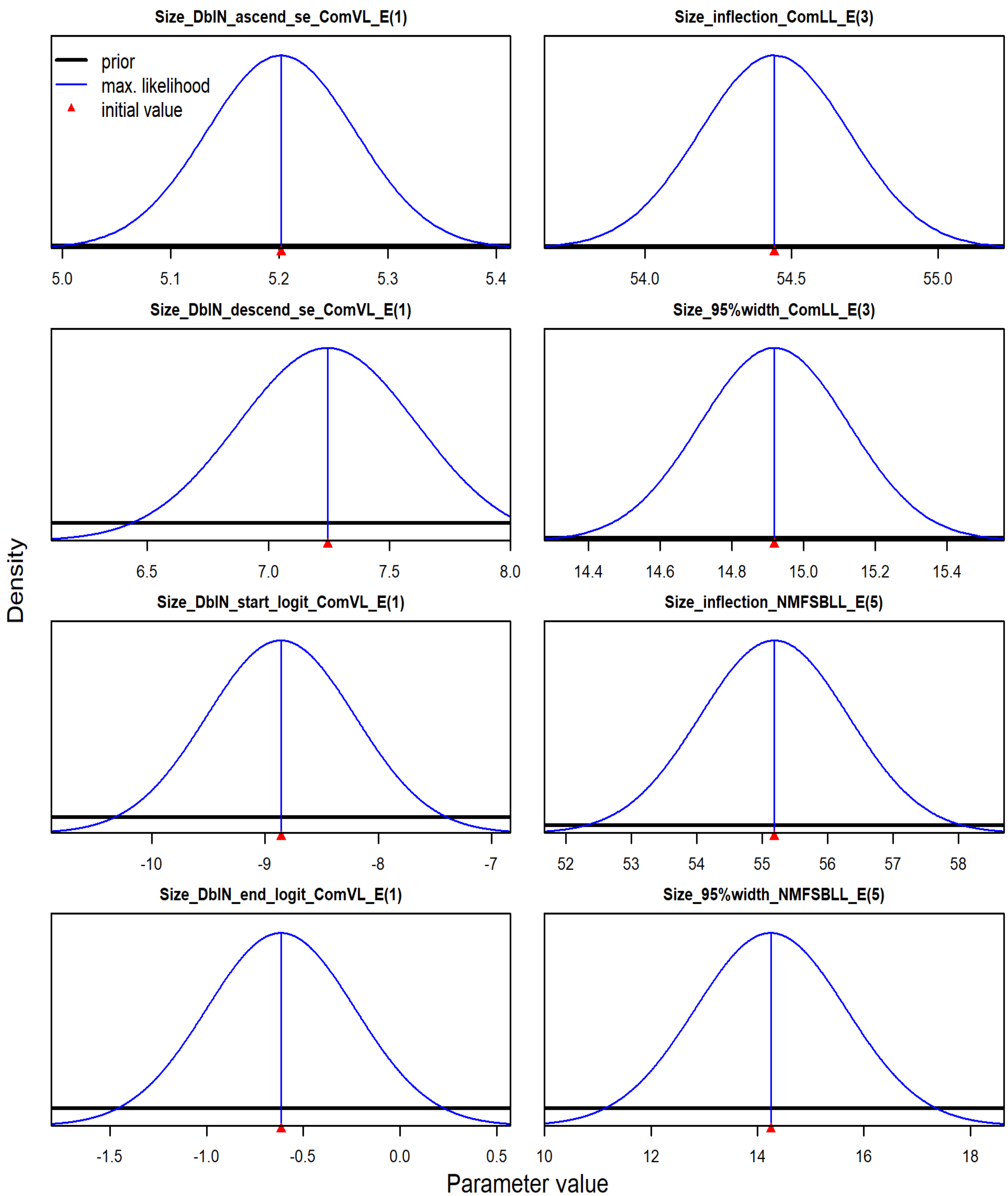


Figure 33 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

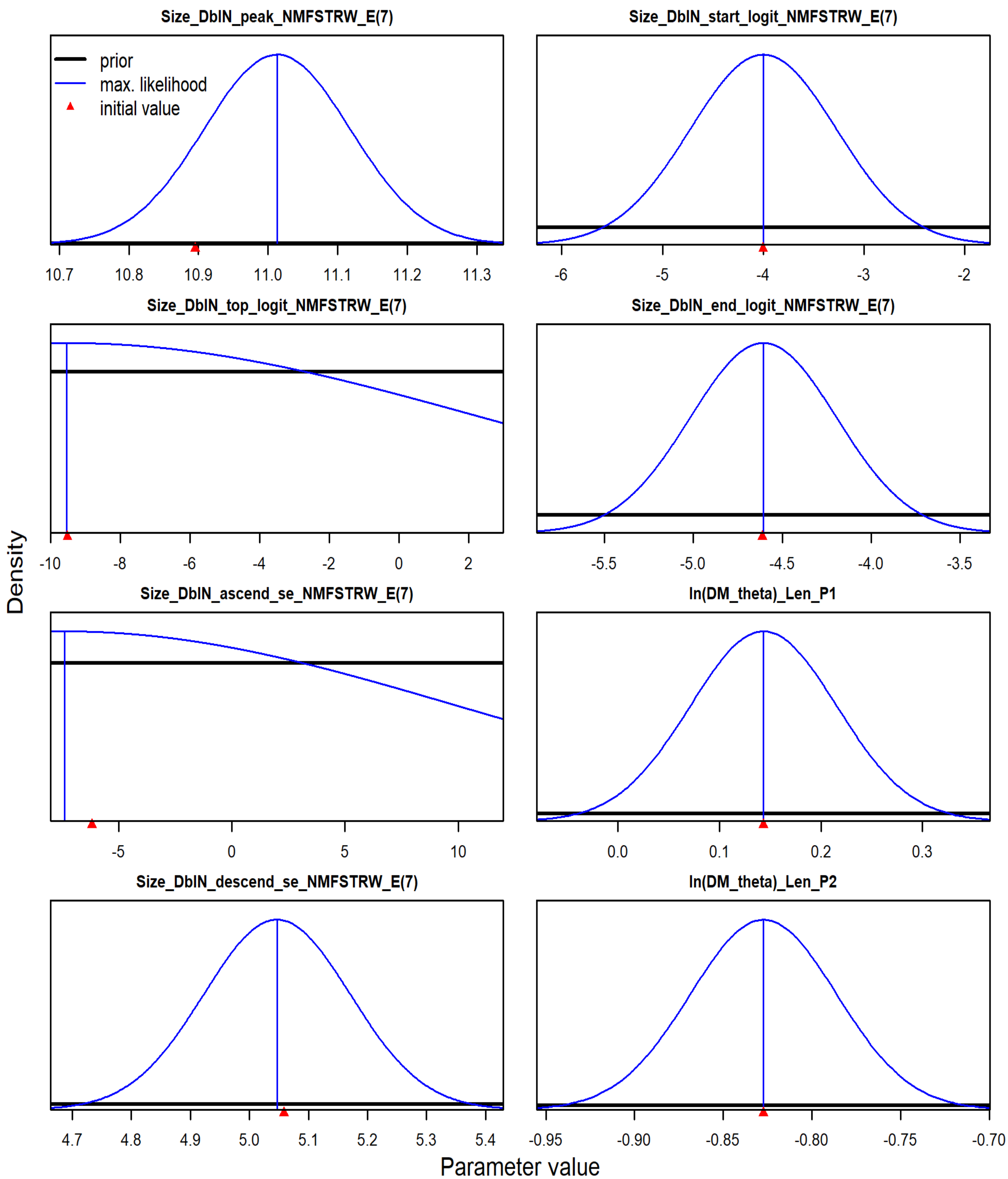


Figure 33 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

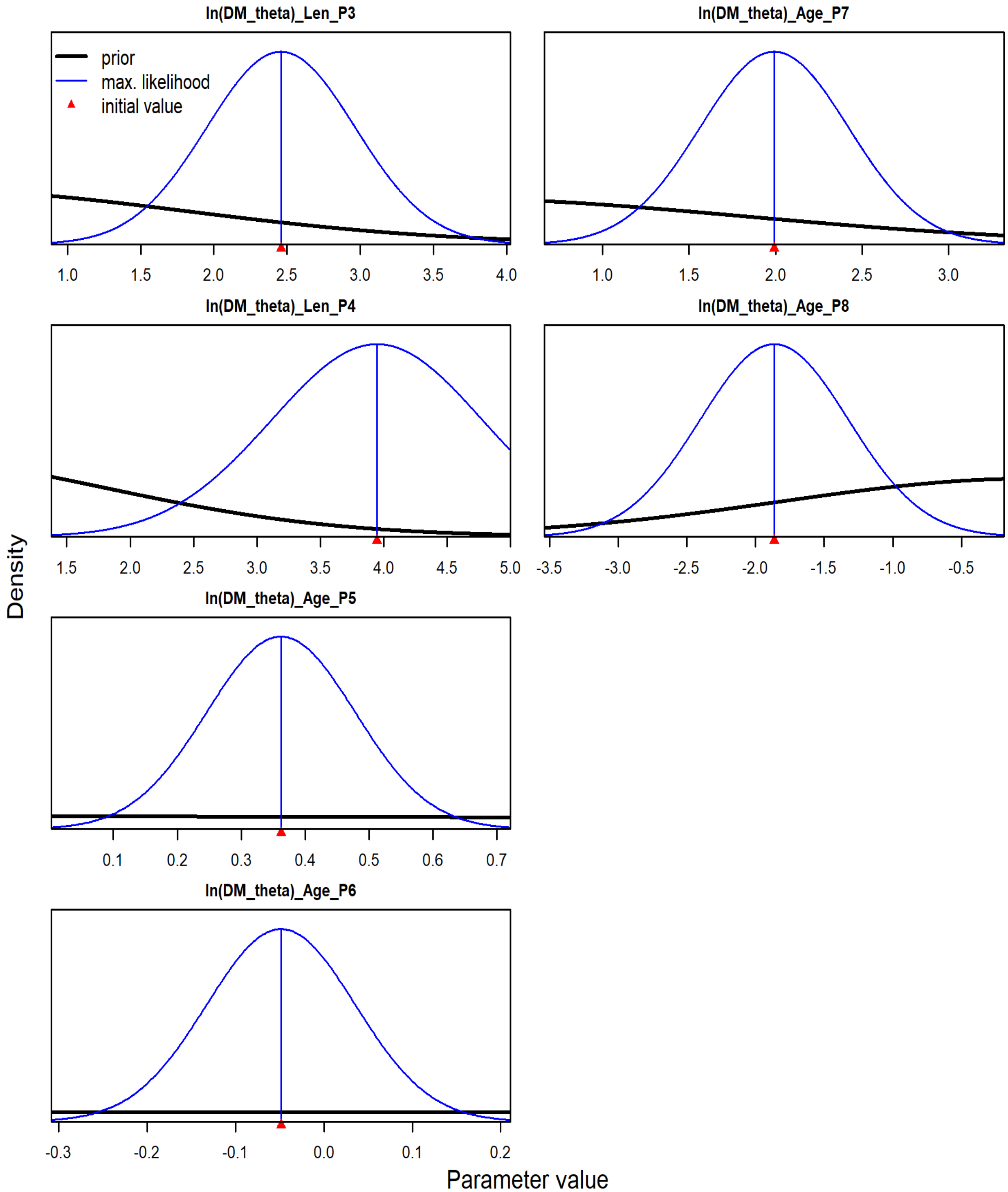
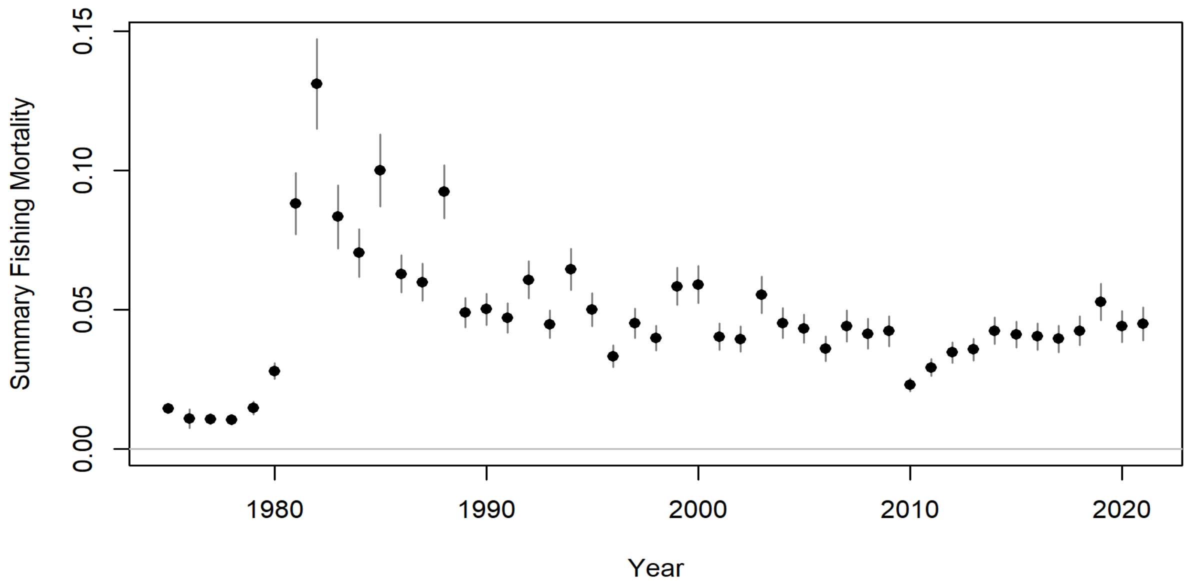


Figure 33 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

SEDAR 85



SEDAR 22

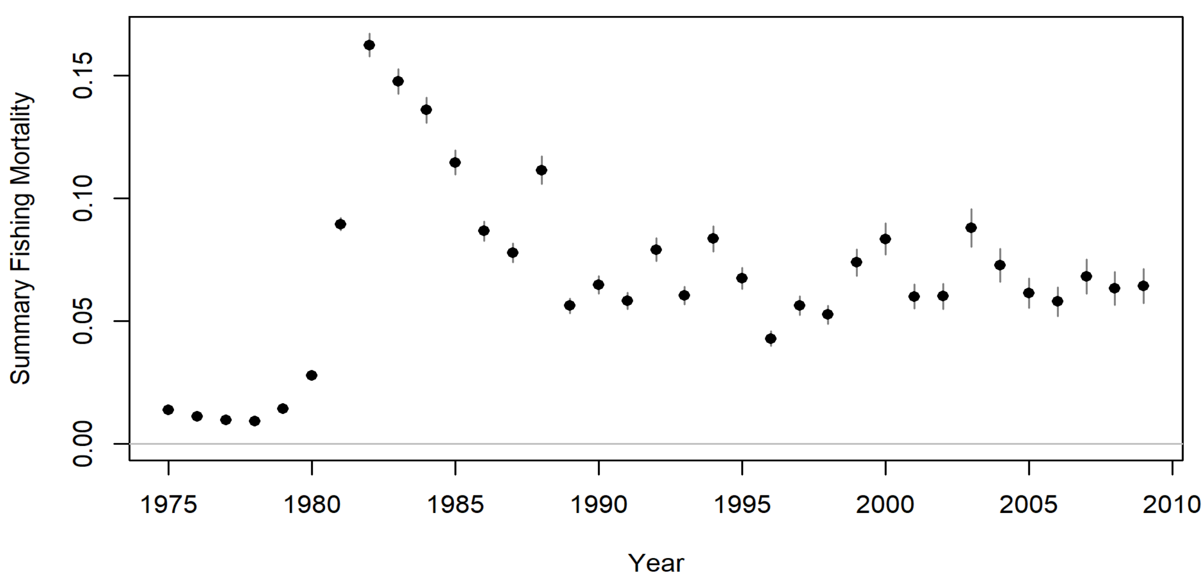
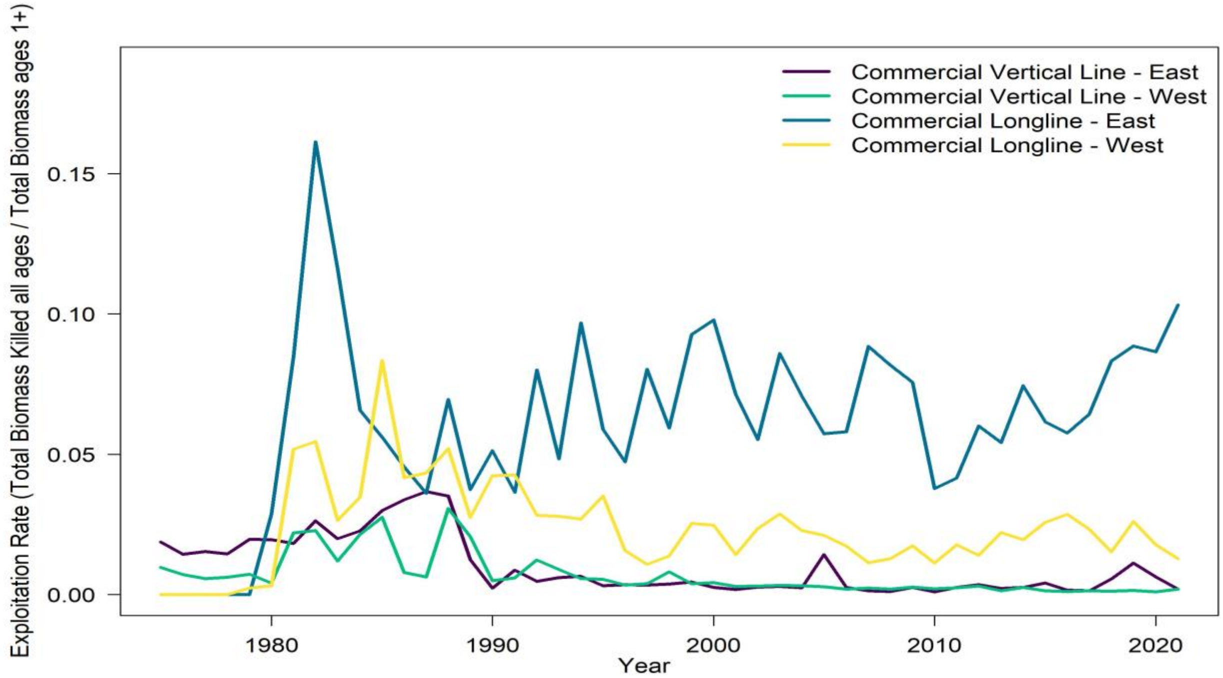


Figure 34. Annual exploitation rate estimates (total biomass killed all ages / total biomass age 1+) for Gulf of Mexico Yellowedge Grouper.

SEDAR 85



SEDAR 22

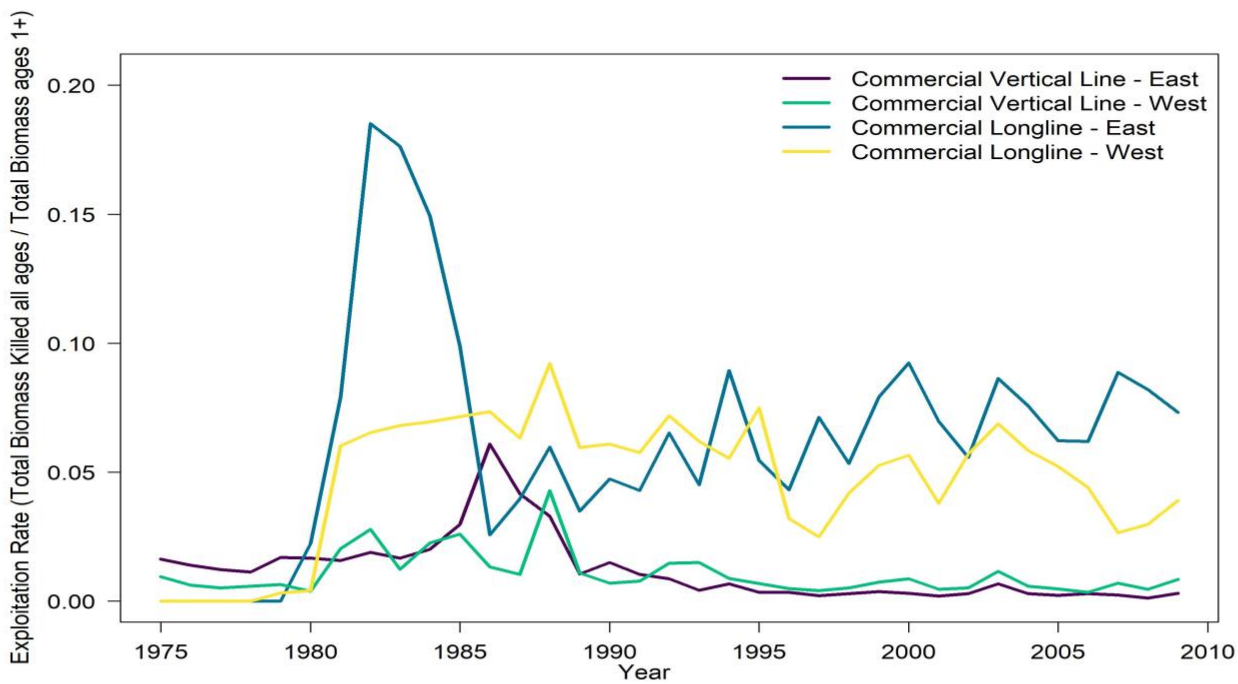


Figure 35. Annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet for Gulf of Mexico Yellowedge Grouper.

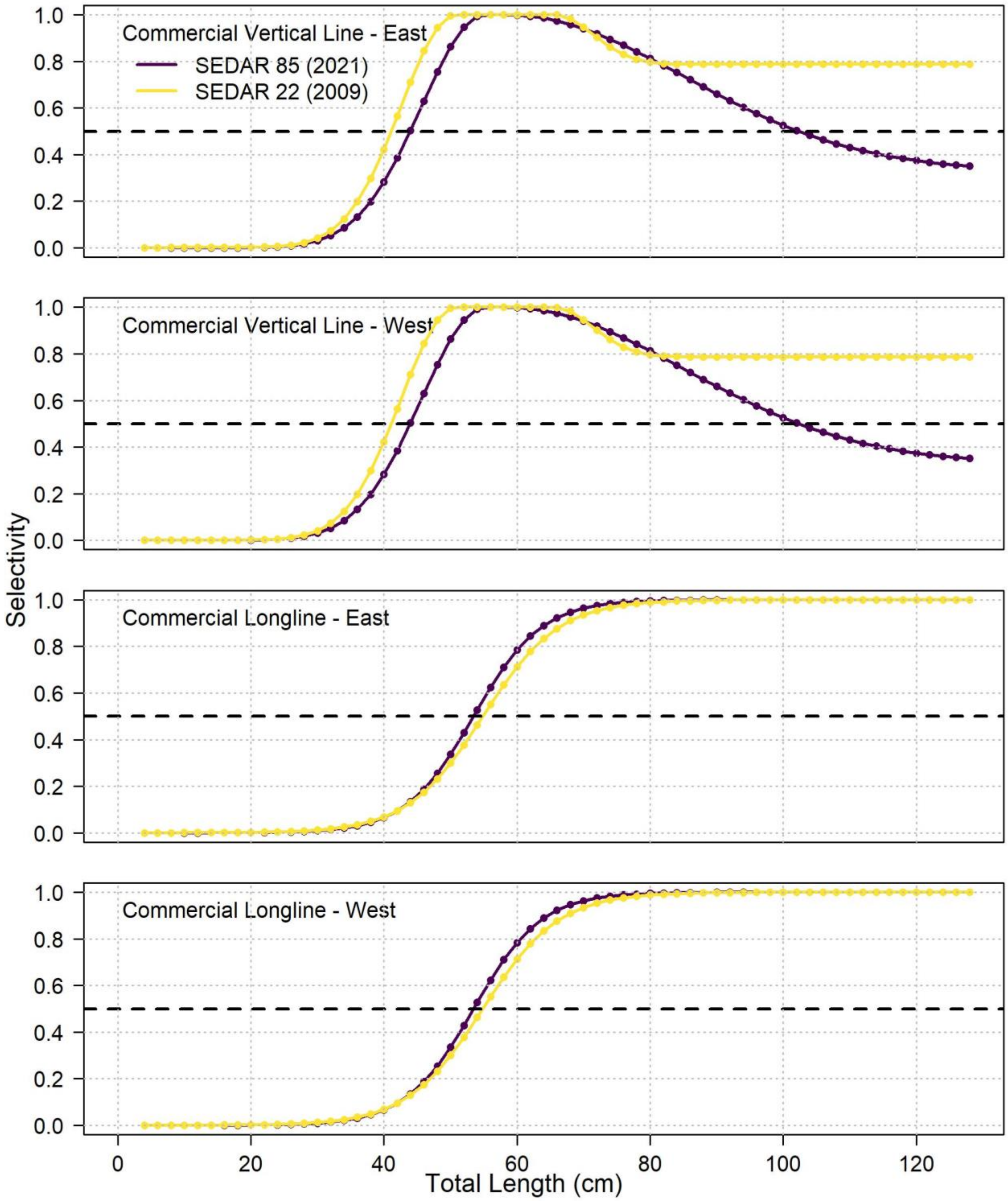


Figure 36. Length-based selectivity for each fleet for Gulf of Mexico Yellowedge Grouper in the terminal year of each assessment (given in parentheses). Dashed horizontal line indicates 50%.

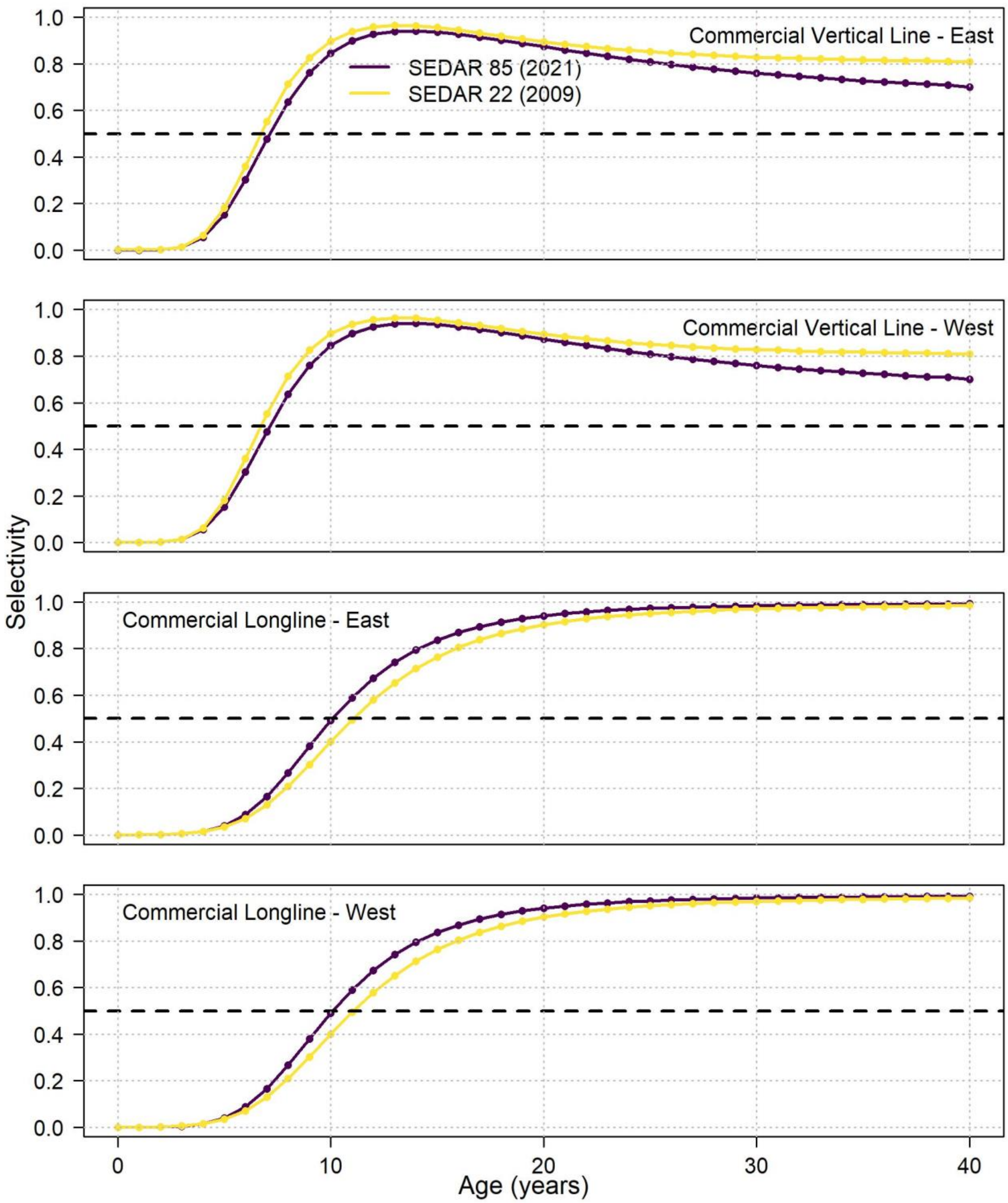


Figure 37. Derived age-based selectivity for each fleet for Gulf of Mexico Yellowedge Grouper in the terminal year of each assessment (given in parentheses). Dashed horizontal line indicates 50%.

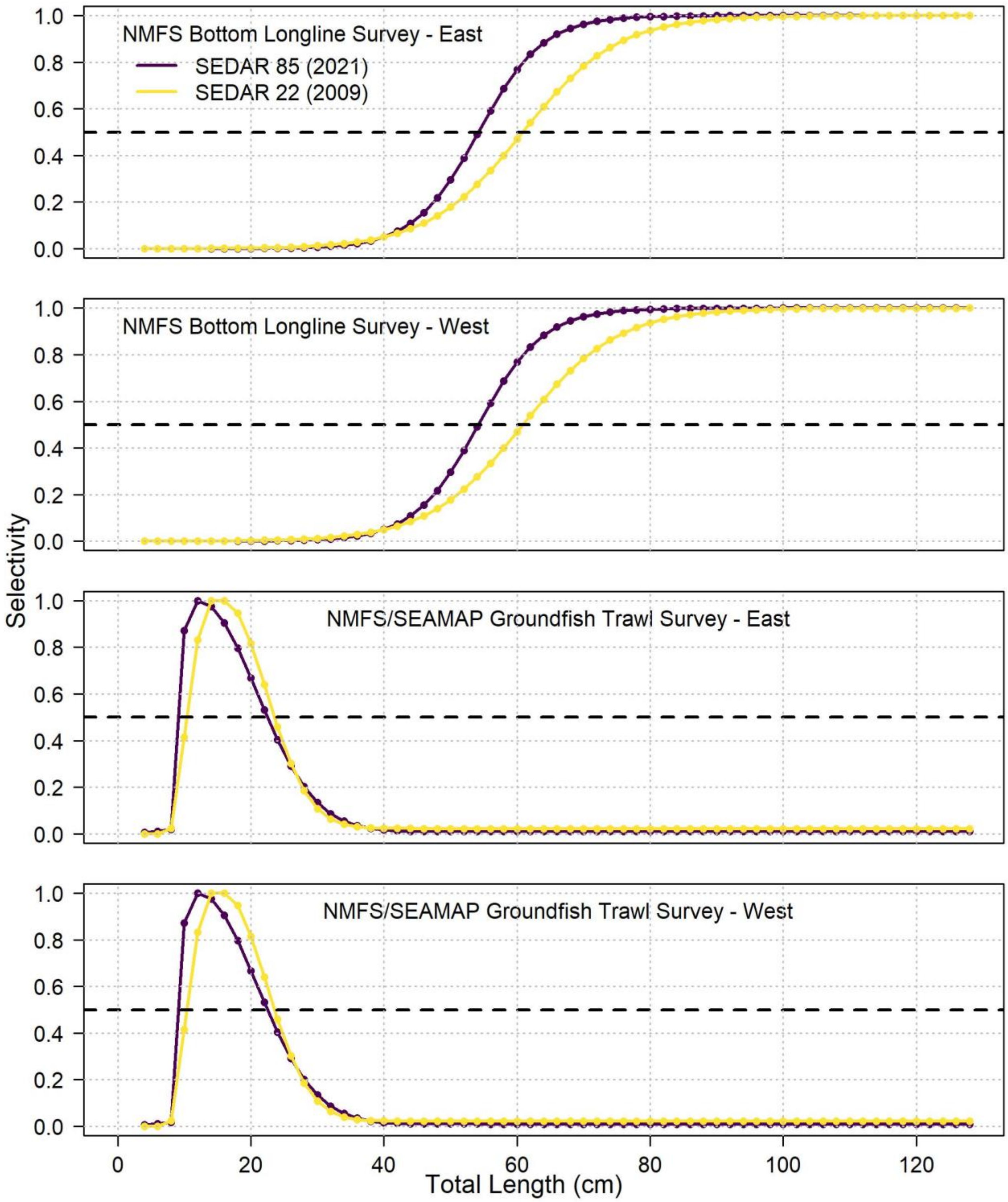


Figure 38. Length-based selectivity for each survey for Gulf of Mexico Yellowedge Grouper in the terminal year of each assessment (given in parentheses). Dashed horizontal line indicates 50%.

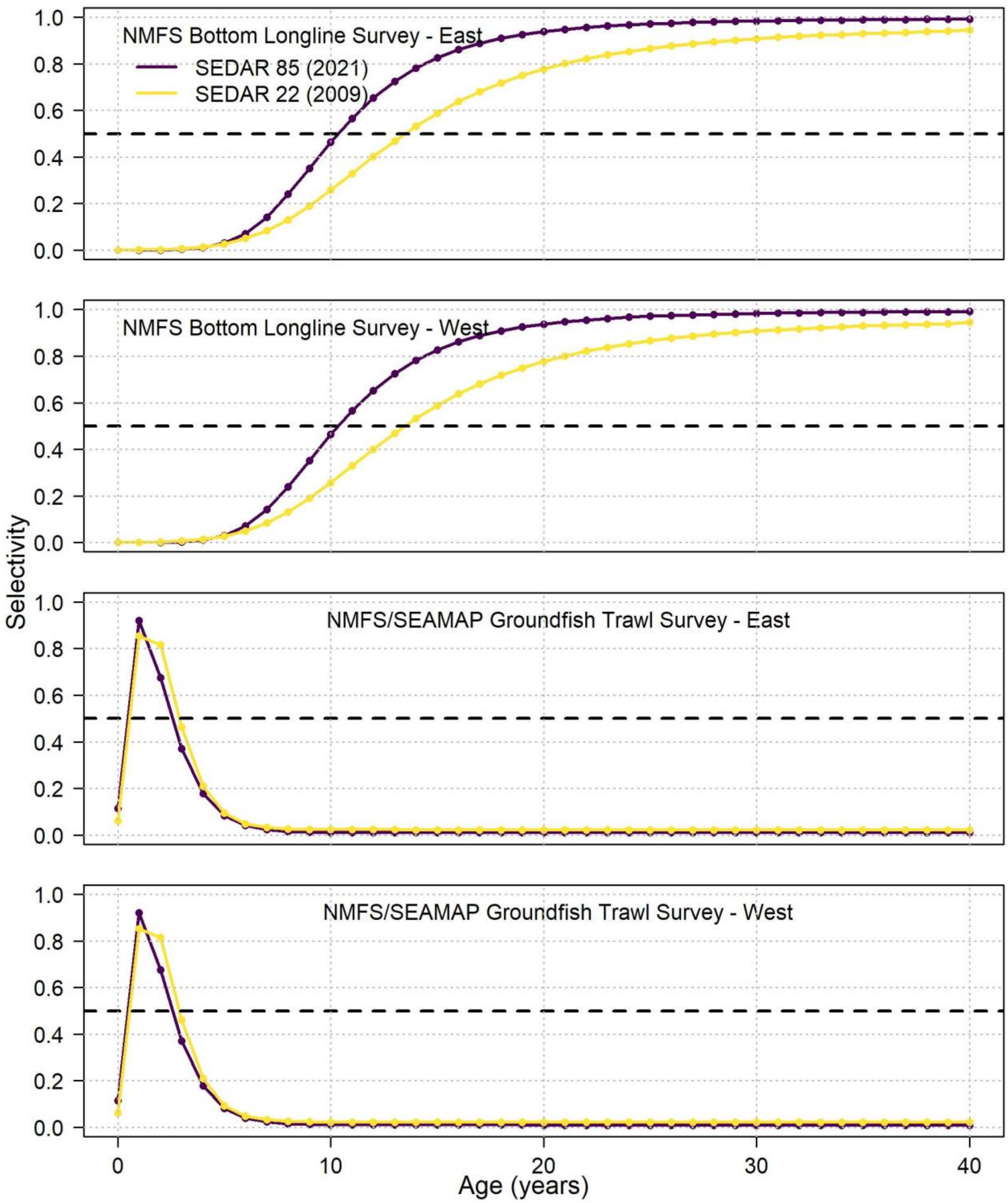
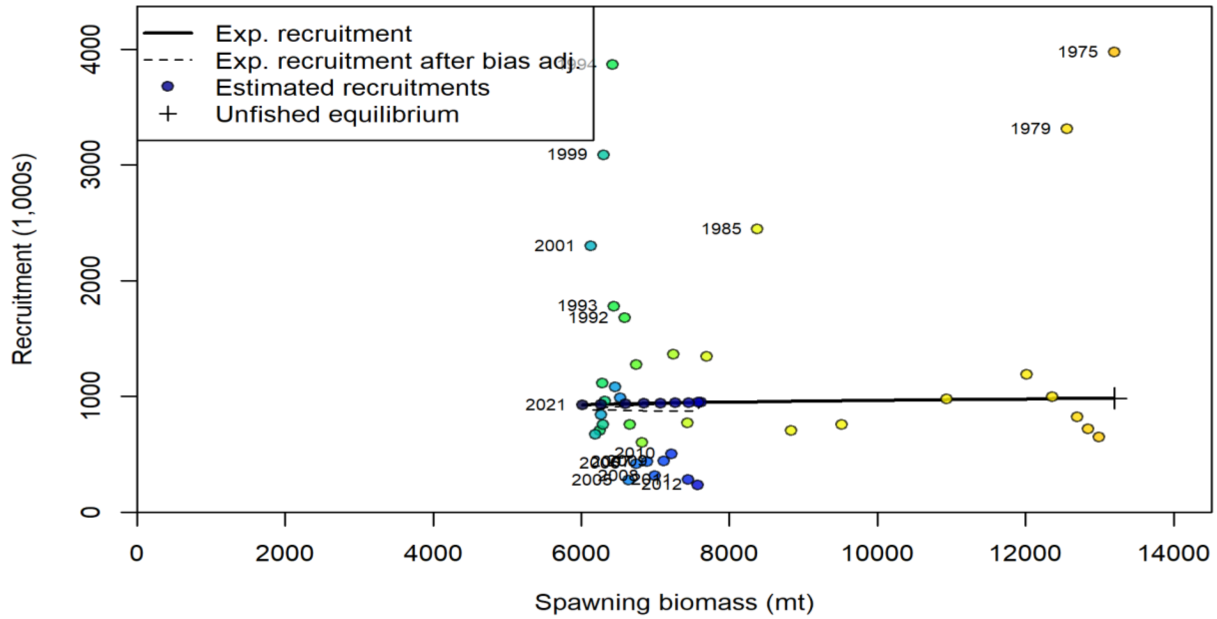


Figure 39. Derived age-based selectivity for each survey for Gulf of Mexico Yellowedge Grouper in the terminal year of each assessment (given in parentheses). Dashed horizontal line indicates 50%.

SEDAR 85



SEDAR 22

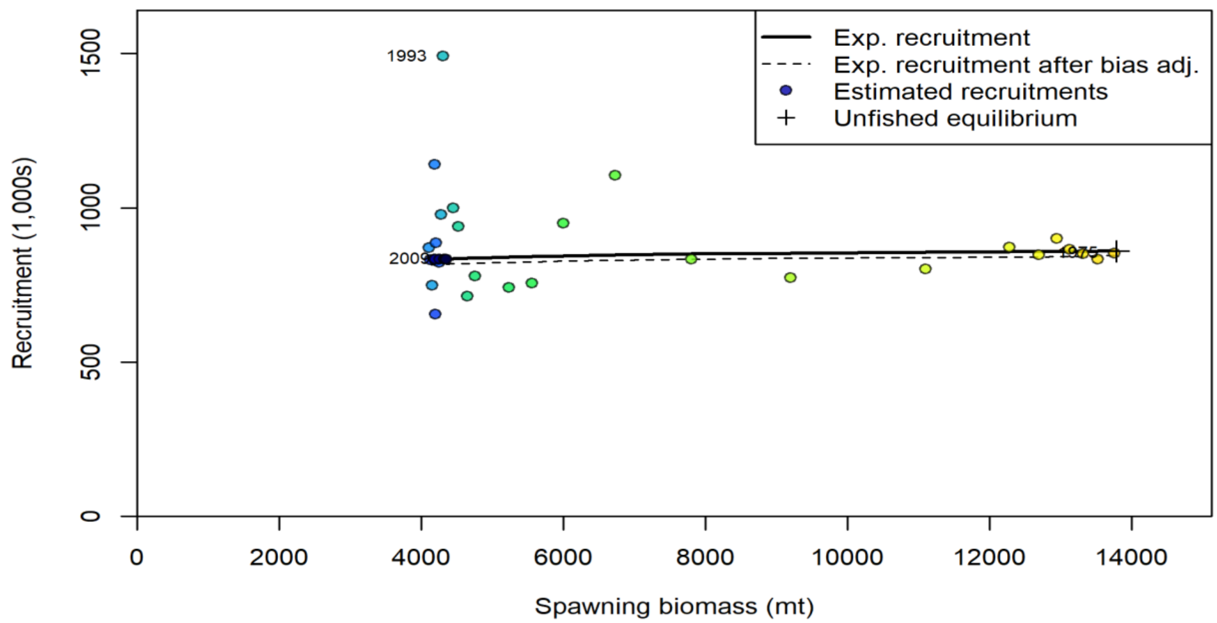
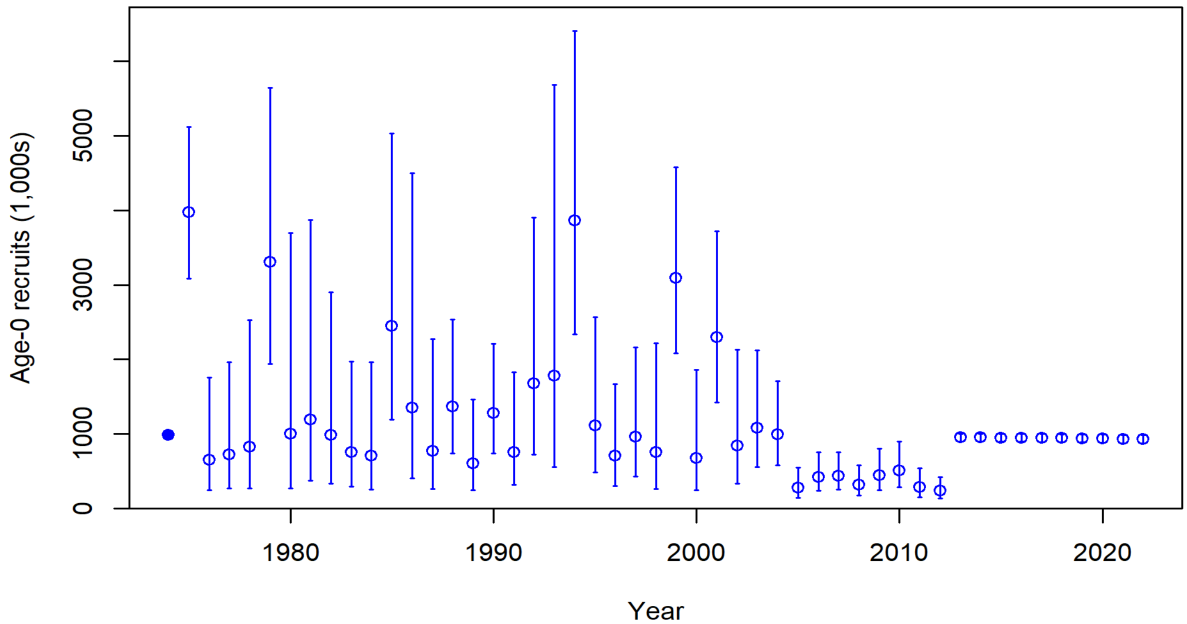


Figure 40. Predicted stock-recruitment relationship for Gulf of Mexico Yellowedge Grouper (steepness and SigmaR were fixed at 0.827 and 0.5, respectively). Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

SEDAR 85



SEDAR 22

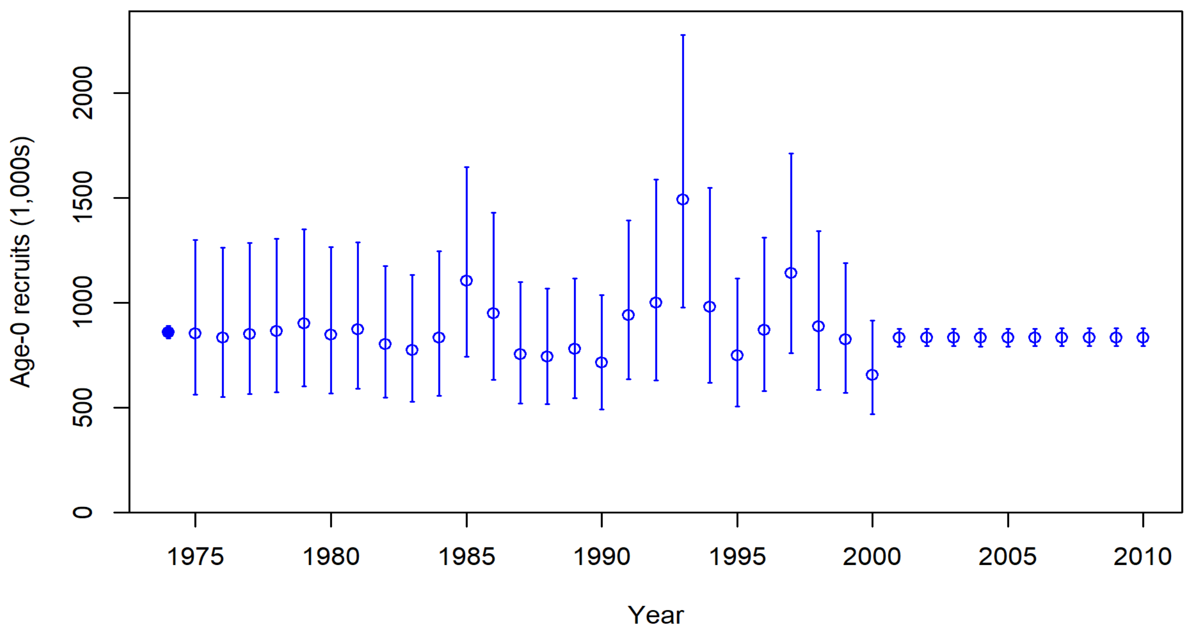
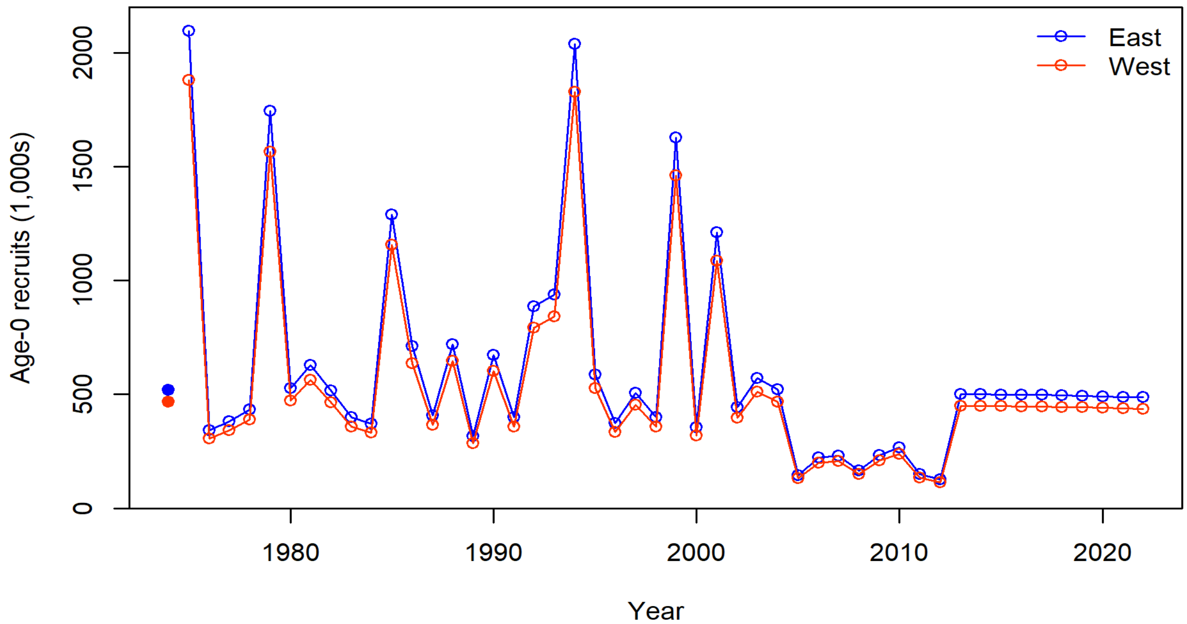


Figure 41. Estimated Age-0 recruitment with 95% confidence intervals for Gulf of Mexico Yellowedge Grouper (steepness and SigmaR were fixed at 0.827 and 0.5, respectively).

SEDAR 85



SEDAR 22

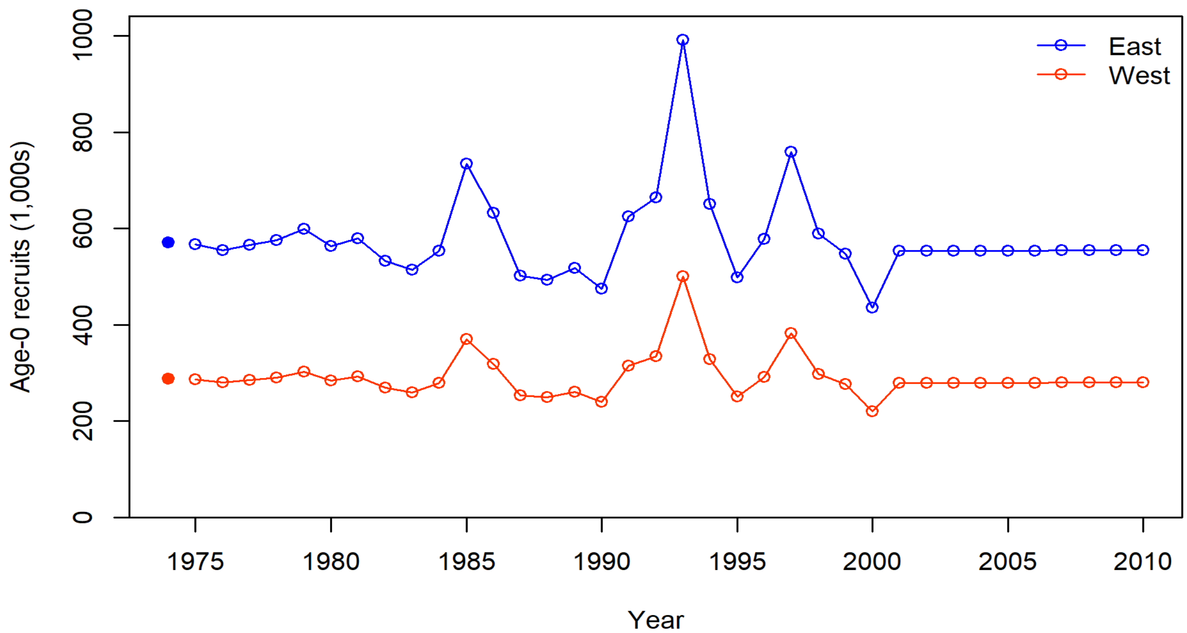
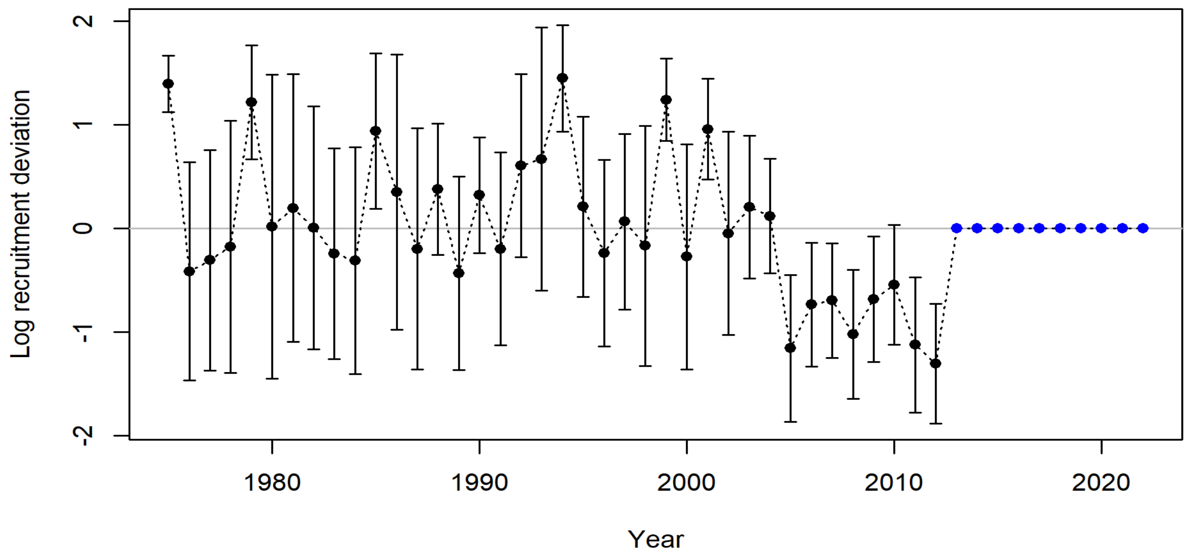


Figure 42. Estimated Age-0 recruitment by region for Gulf of Mexico Yellowedge Grouper (steepness and SigmaR were fixed at 0.827 and 0.5, respectively).

SEDAR 85



SEDAR 22

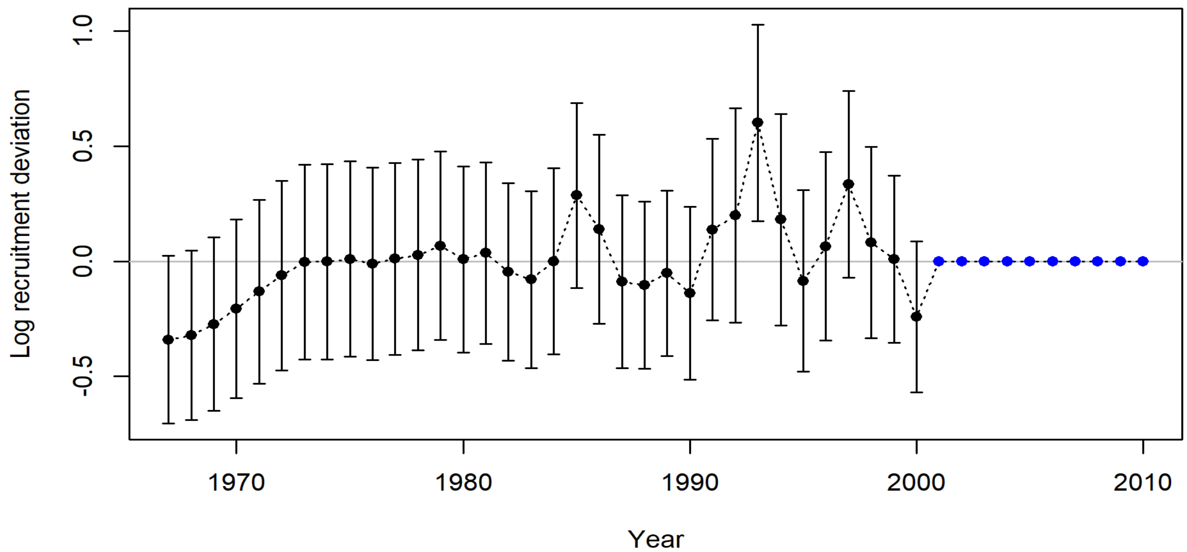
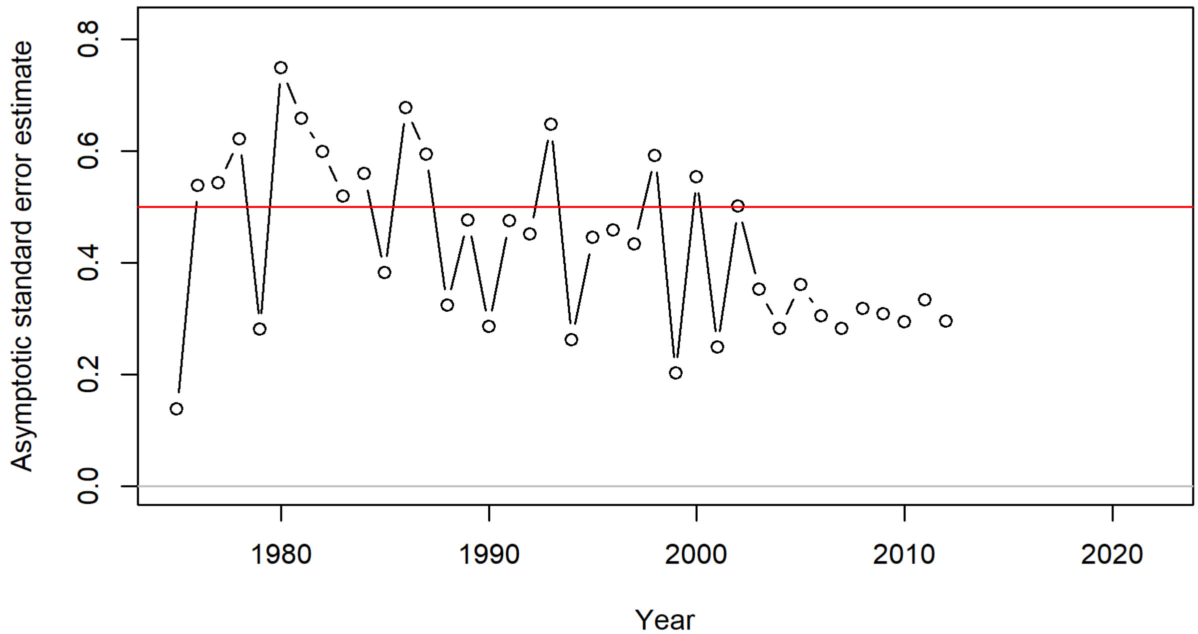


Figure 43. Estimated log recruitment deviations for Gulf of Mexico Yellowedge Grouper (steepness and SigmaR were fixed at 0.827 and 0.5, respectively). Blue dots identify years where recruitment deviations were not estimated.

SEDAR 85



SEDAR 22

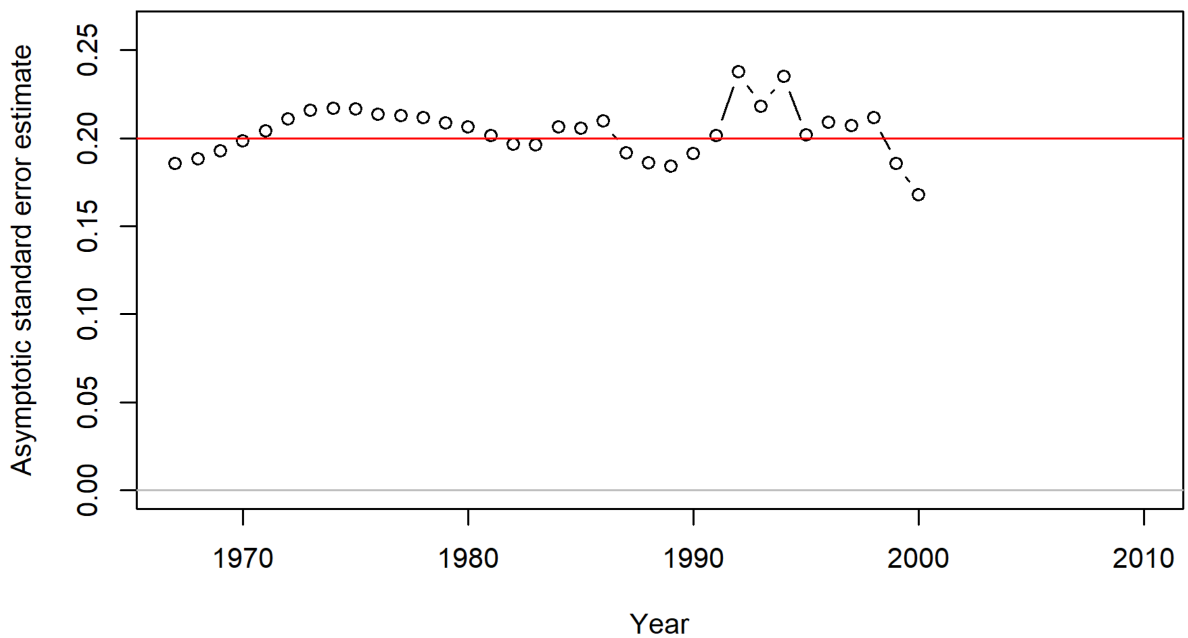


Figure 44. Asymptotic standard errors for recruitment deviations for Gulf of Mexico Yellowedge Grouper. The red line represents the fixed values of 0.5 and 0.2 used in the SEDAR 85 and SEDAR 22 models, respectively.

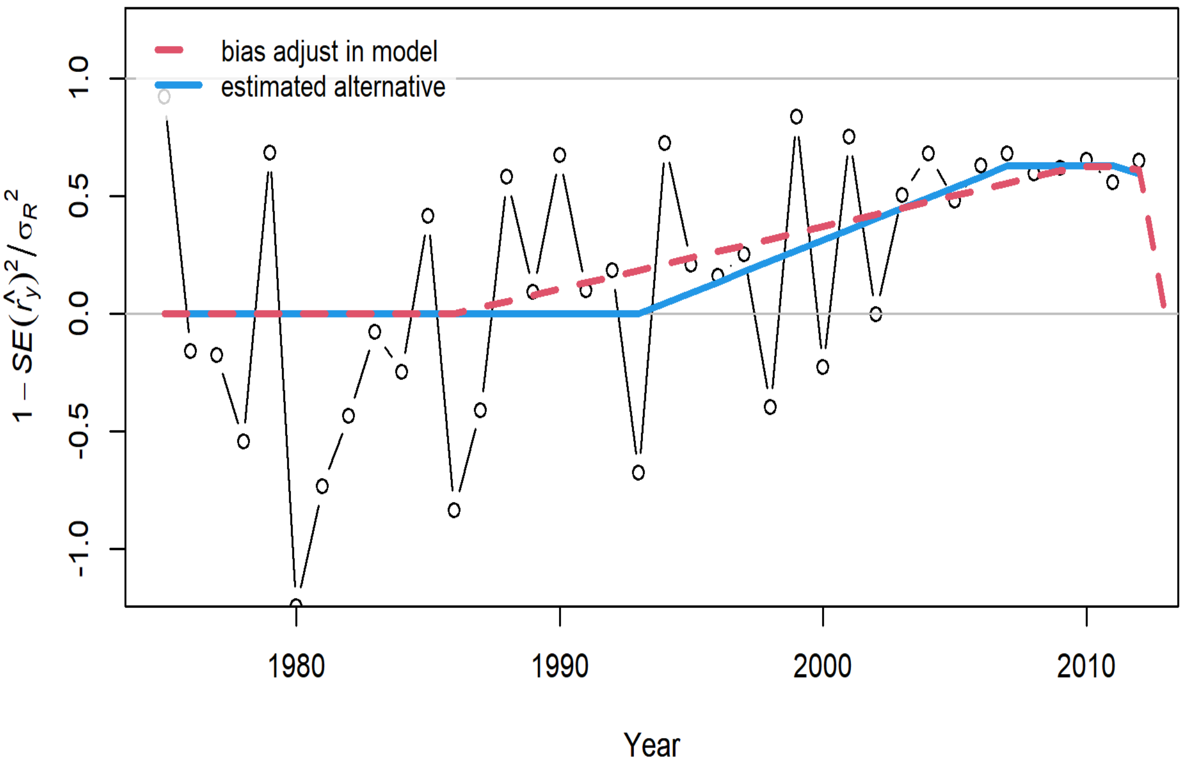


Figure 45. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 85 OA Base Model. The least squares estimate of alternative bias adjustment relationship for recruitment deviations (blue line) resulted in a slightly higher negative log-likelihood (21035.6 vs 21035.8). For more information, see Methot and Taylor 2011.

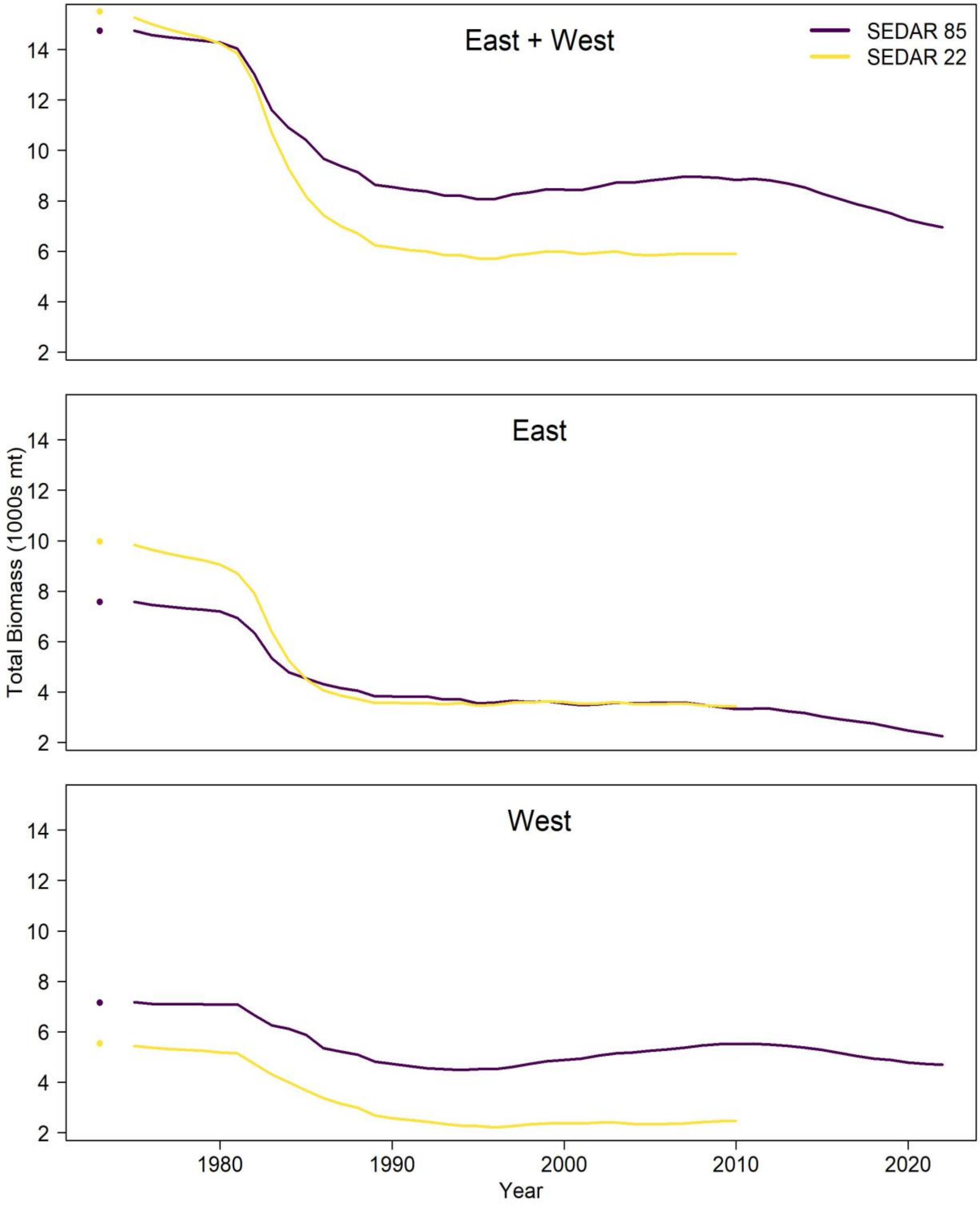


Figure 46. Estimates of virgin (dots) and annual total biomass (in 1000s of metric tons) for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22.

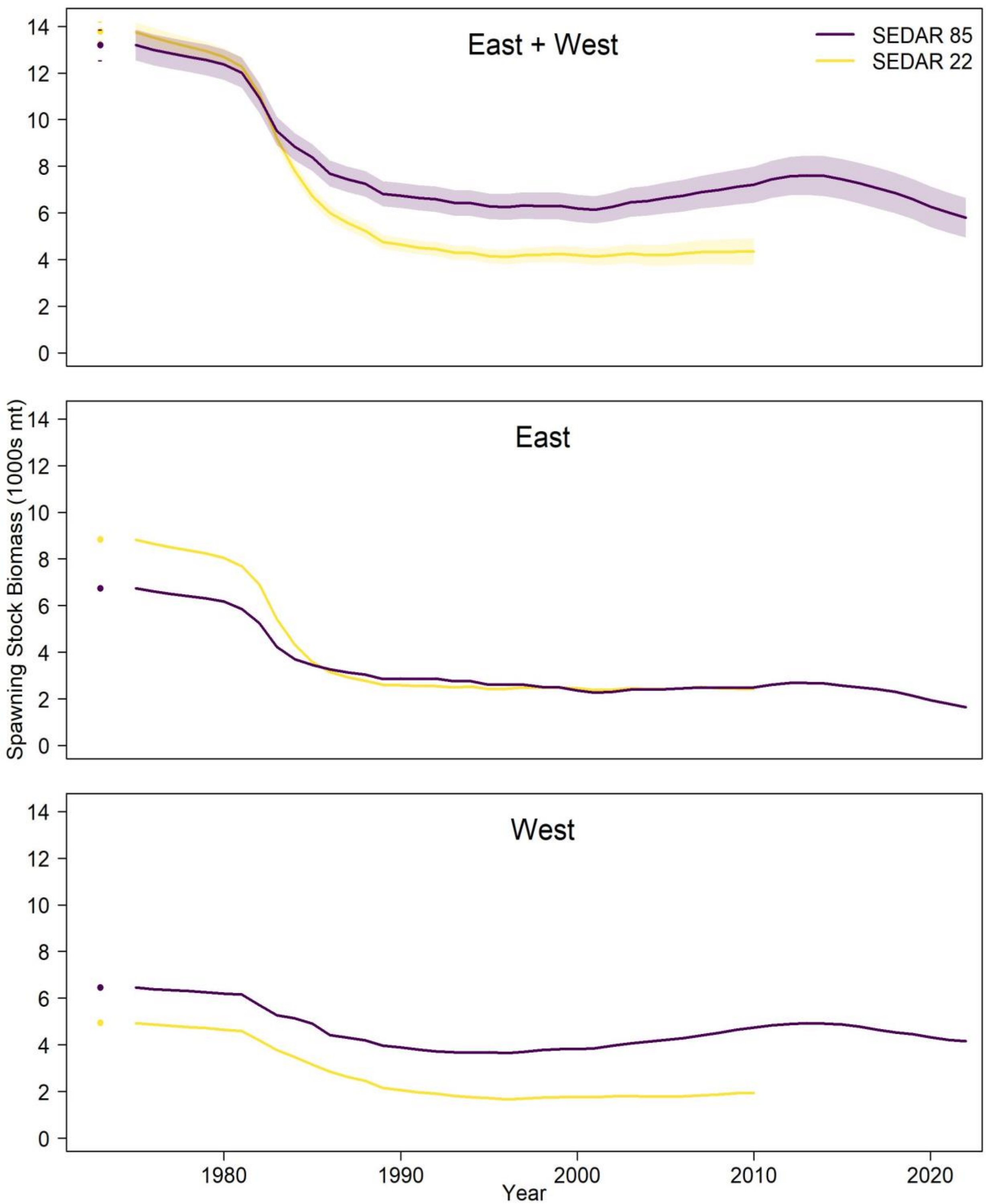


Figure 47. Estimates of virgin (dots) and annual spawning stock biomass (in 1000s of metric tons) for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22. Associated 95% confidence intervals are provided for the Gulf-wide estimates.

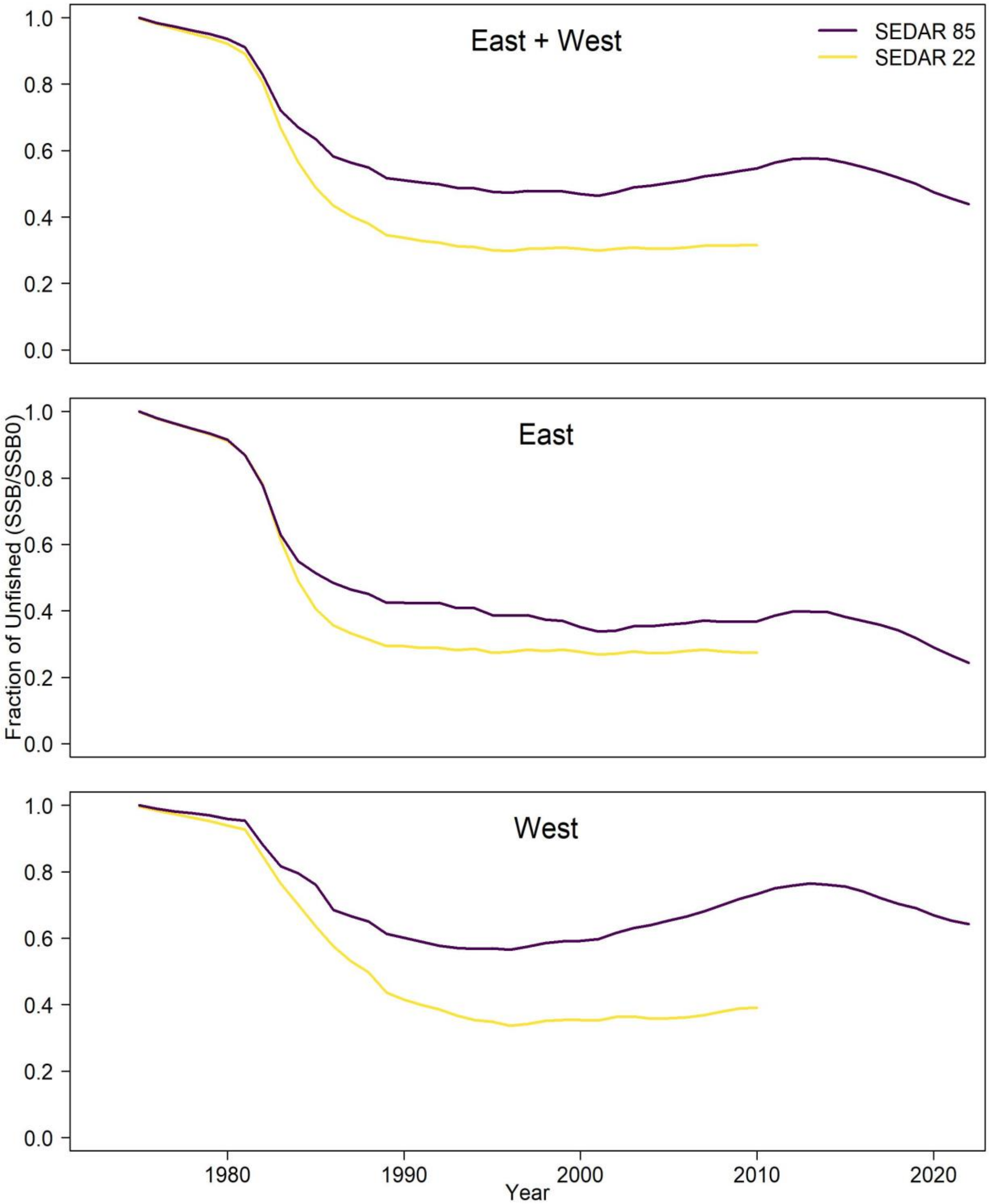
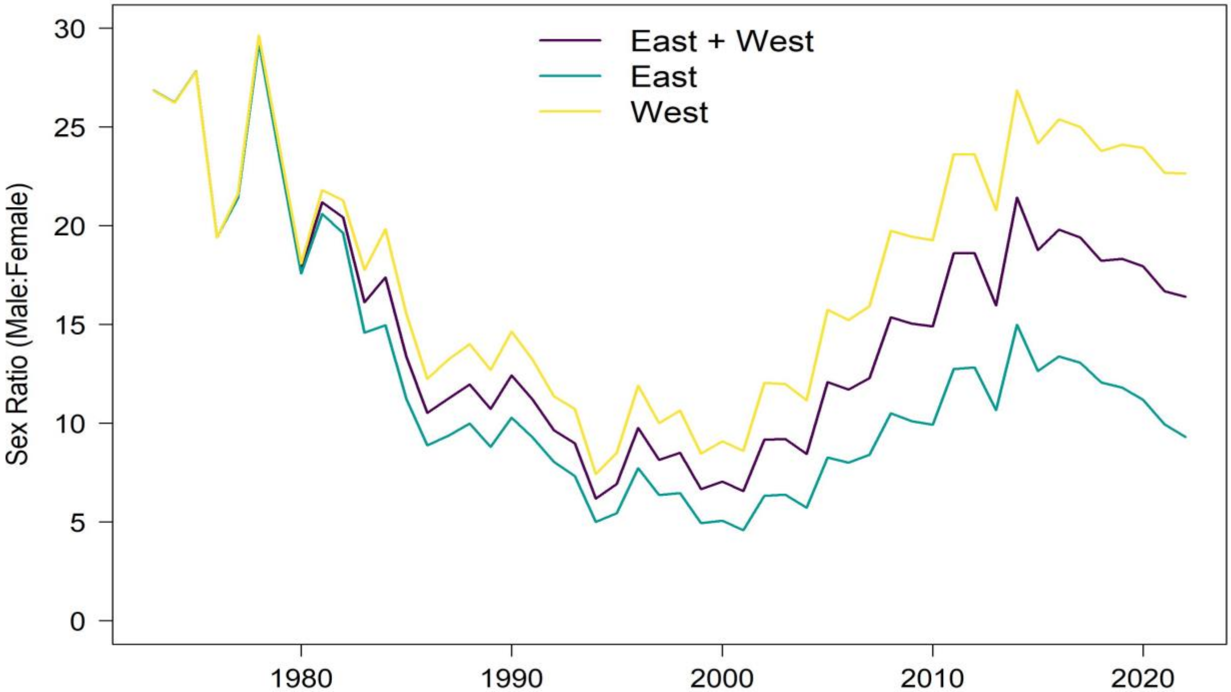


Figure 48. Differences in estimates of the fraction of virgin or unfished SSB (SSB/SSB$_0$) for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22.

SEDAR 85



SEDAR 22

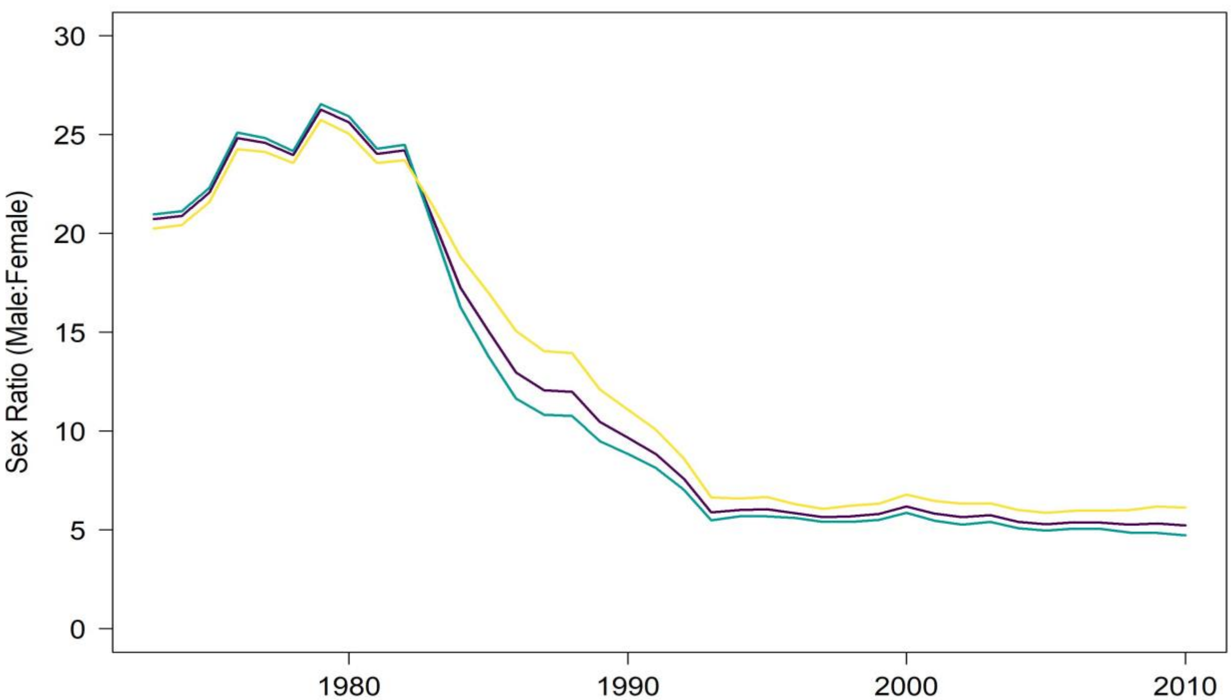


Figure 49. Estimated sex ratio (mature males:females) for Gulf of Mexico Yellowedge Grouper between SEDAR 85 and SEDAR 22.

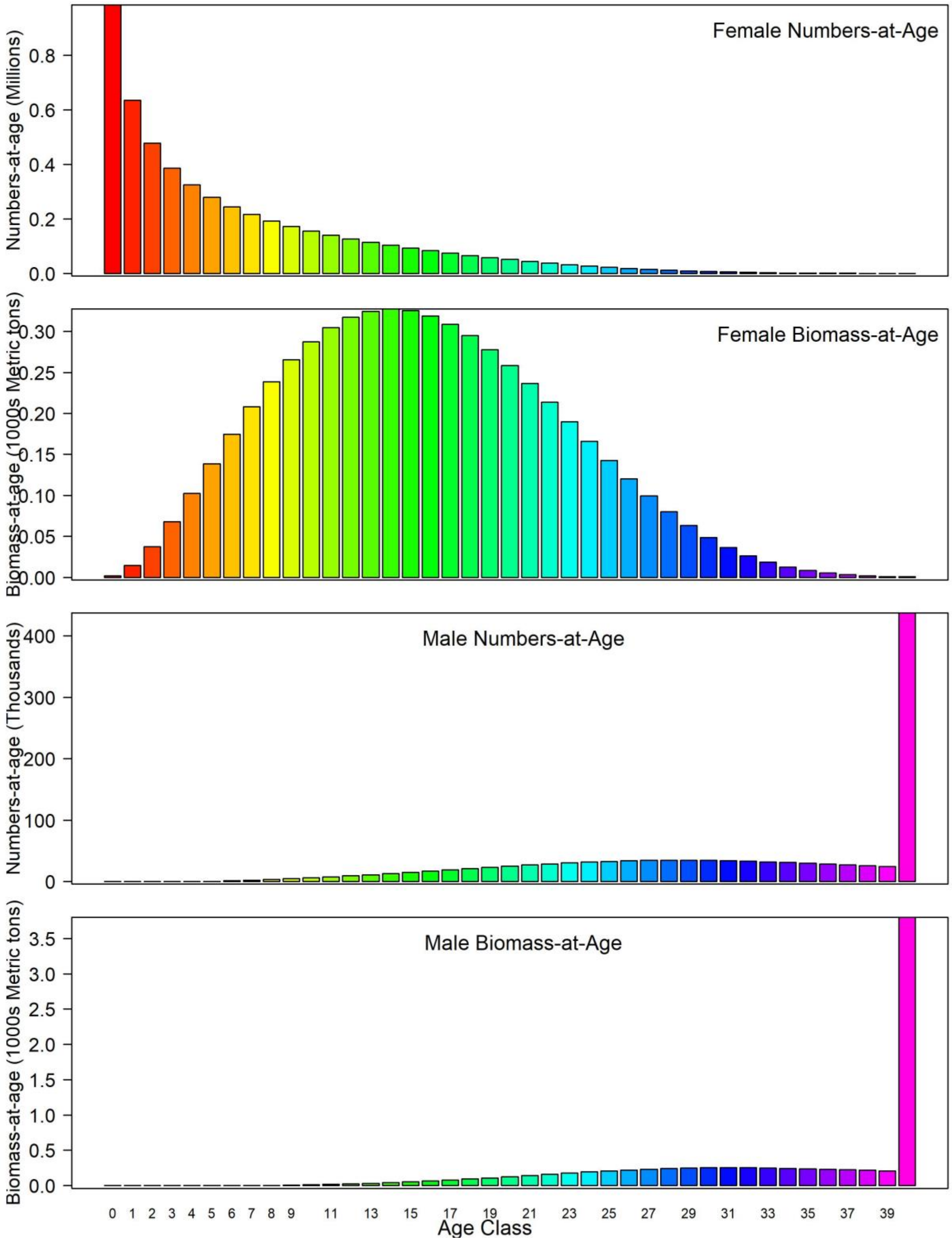


Figure 50. Expected numbers-at-age and biomass-at-age for female and male Yellowedge Grouper in the Gulf of Mexico at virgin stock conditions.

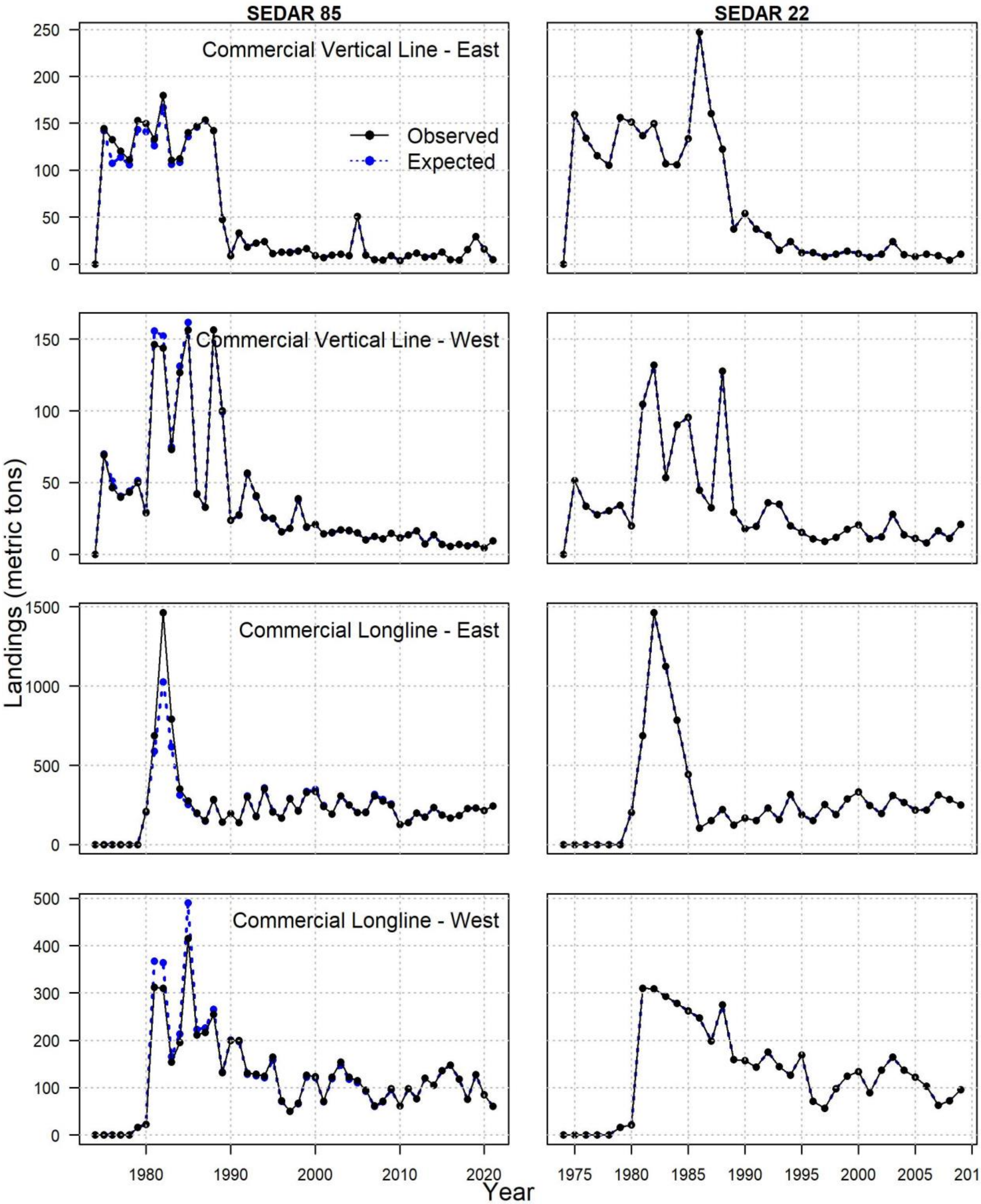
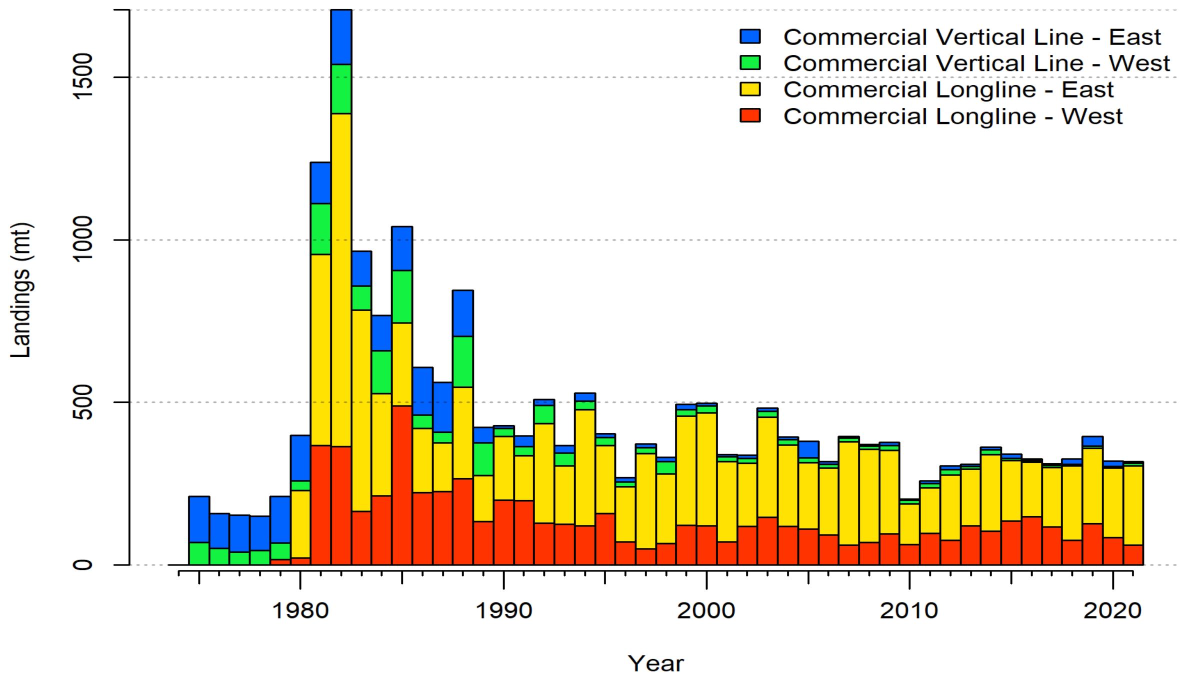


Figure 51. Gulf of Mexico Yellowedge Grouper observed and expected landings by fishery for SEDAR 85 (left panels) and SEDAR 22 (right panels).

SEDAR 85



SEDAR 22

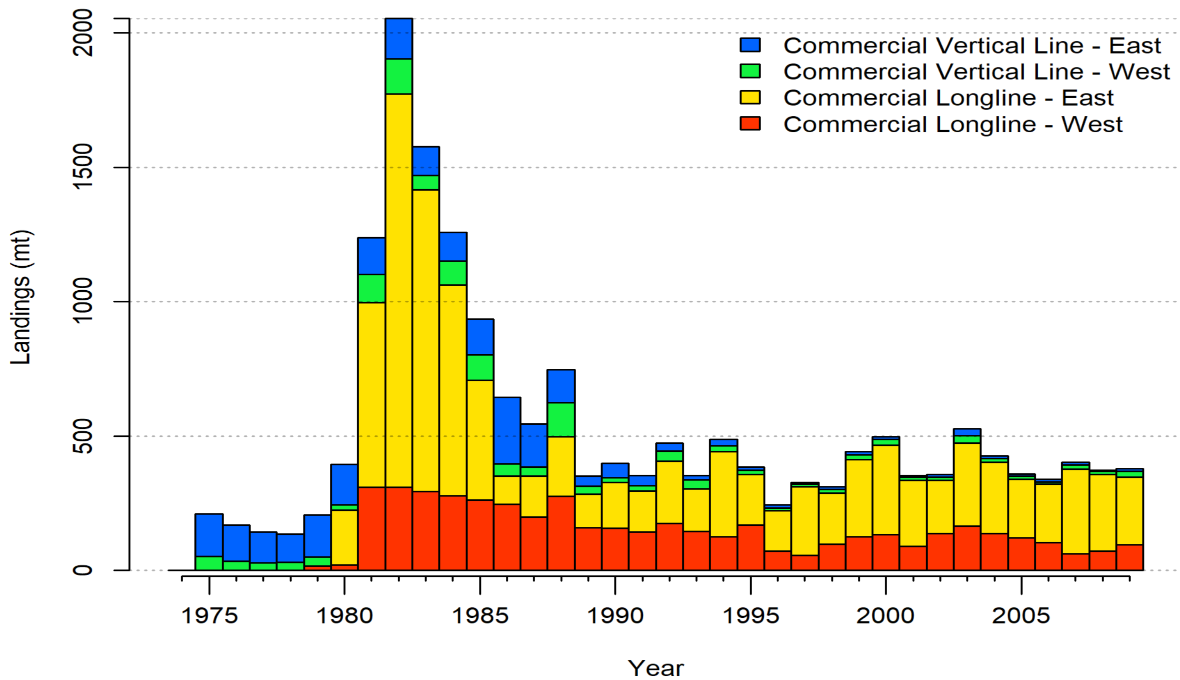


Figure 52. Expected landings by fleet for the SEDAR 85 OA Base Model and the SEDAR 22 Benchmark Base Model.

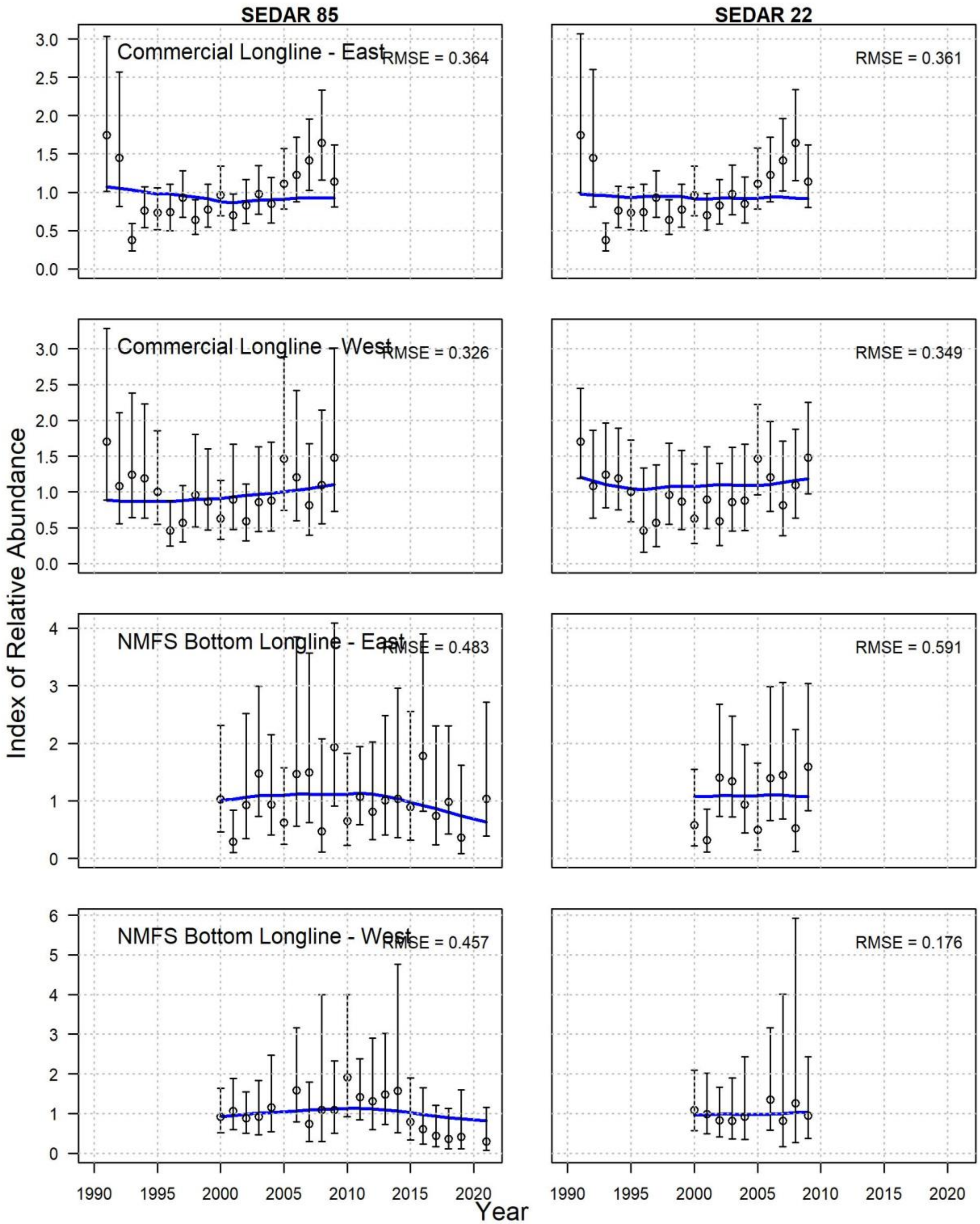


Figure 53. Gulf of Mexico Yellowedge Grouper observed and expected indices for SEDAR 85 (left panels) and SEDAR 22 (right panels). The root mean squared error (RMSE) is also provided.

SEDAR 85

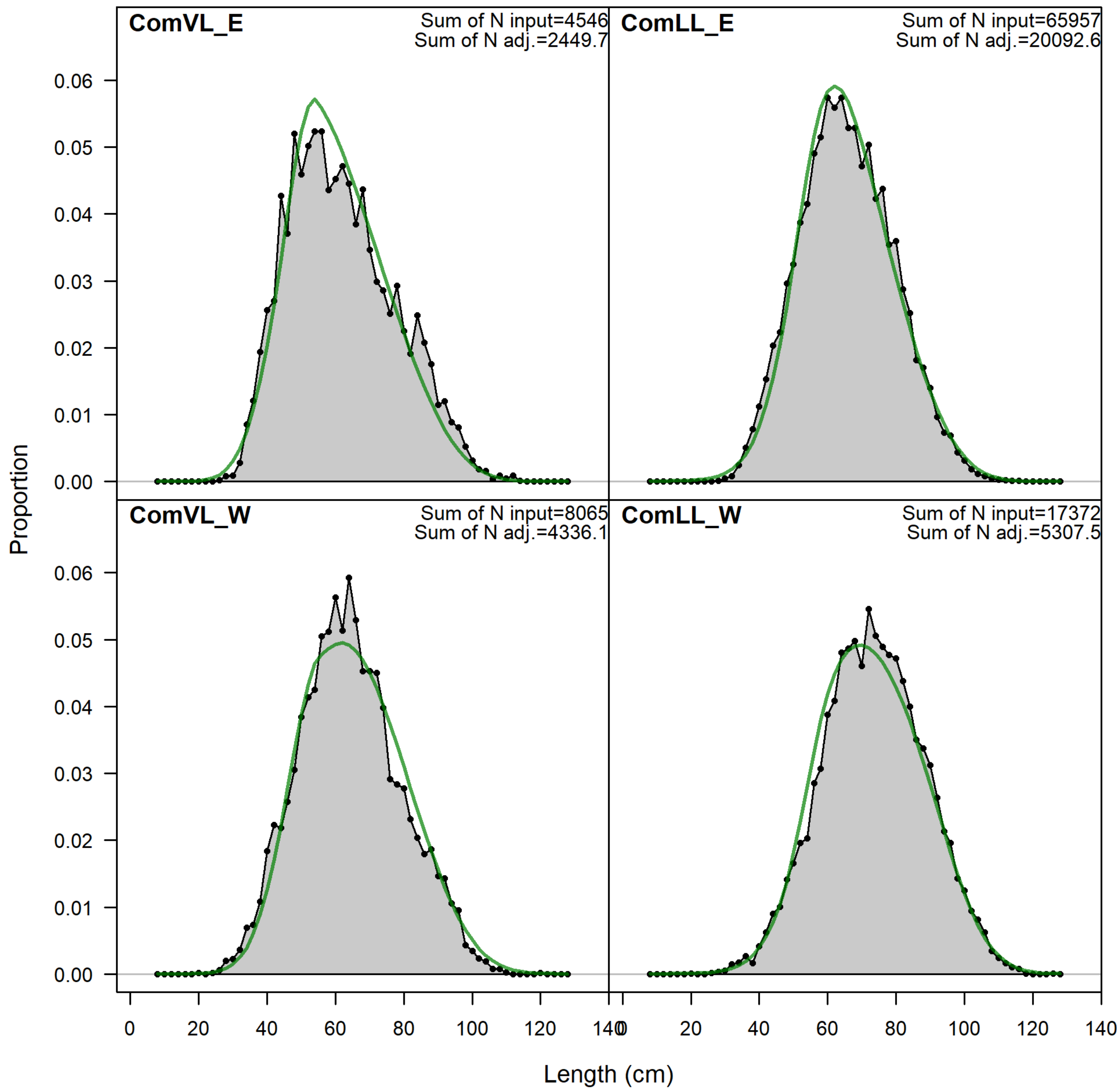


Figure 54. Model fits to the length composition of Yellowedge Grouper aggregated across years for the Commercial Vertical Line (ComVL) and Longline (ComLL) fisheries in the Eastern (E) and Western (W) Gulf of Mexico for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

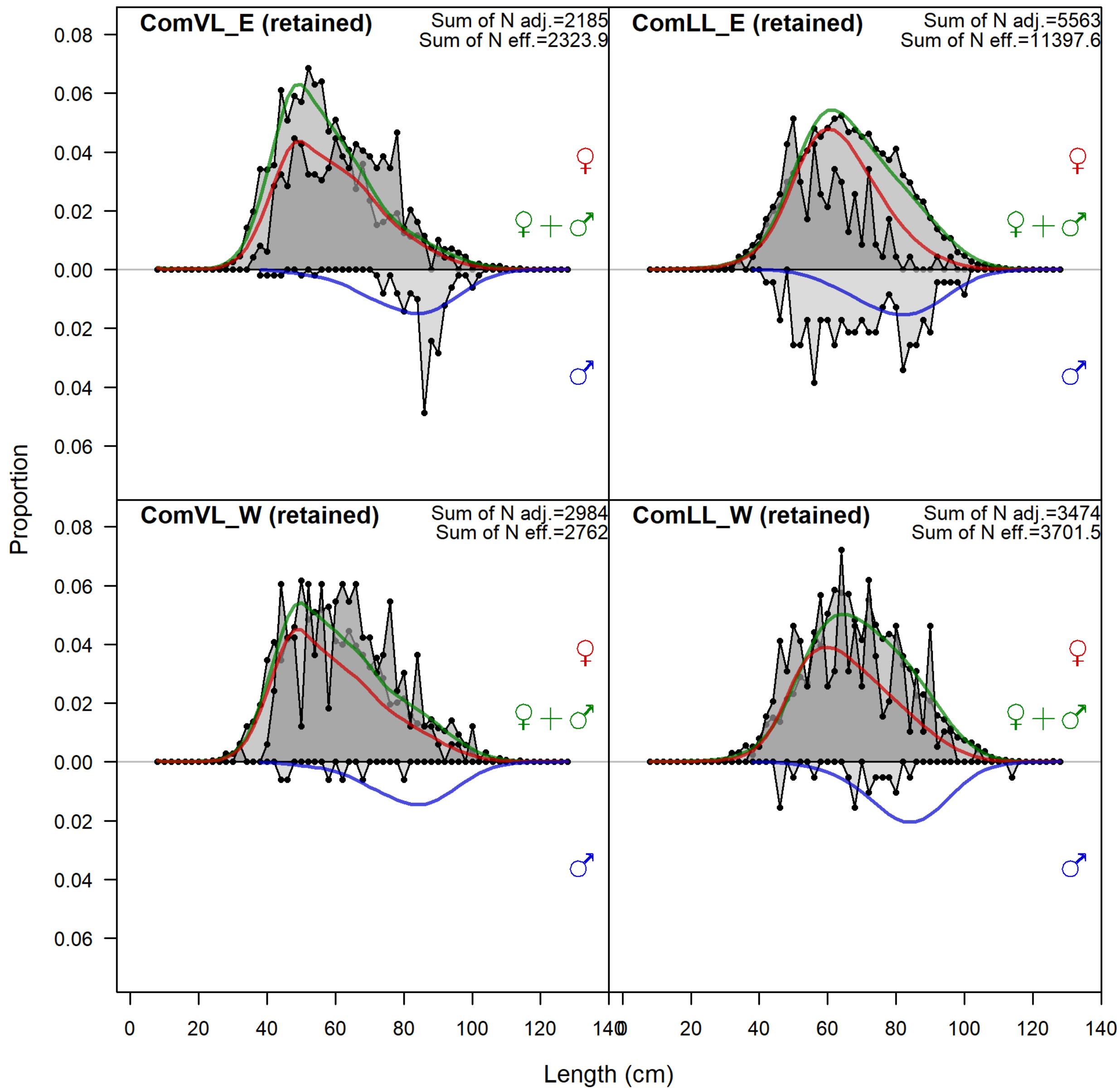


Figure 54 Continued. Model fits to the length composition of Yellowedge Grouper aggregated across years for the Commercial Vertical Line (ComVL) and Longline (ComLL) fisheries in the Eastern (E) and Western (W) Gulf of Mexico for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

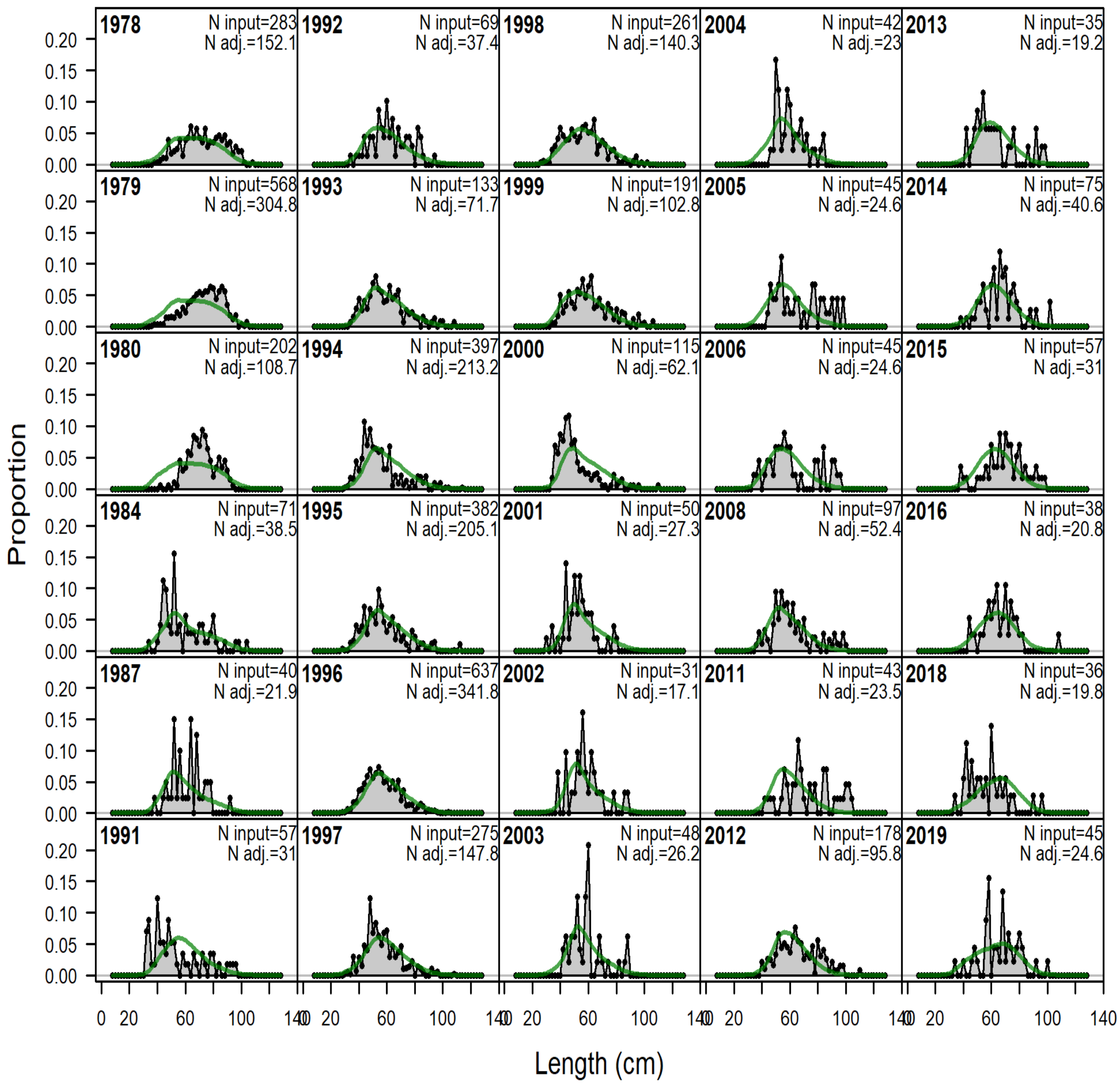


Figure 55. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - East fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

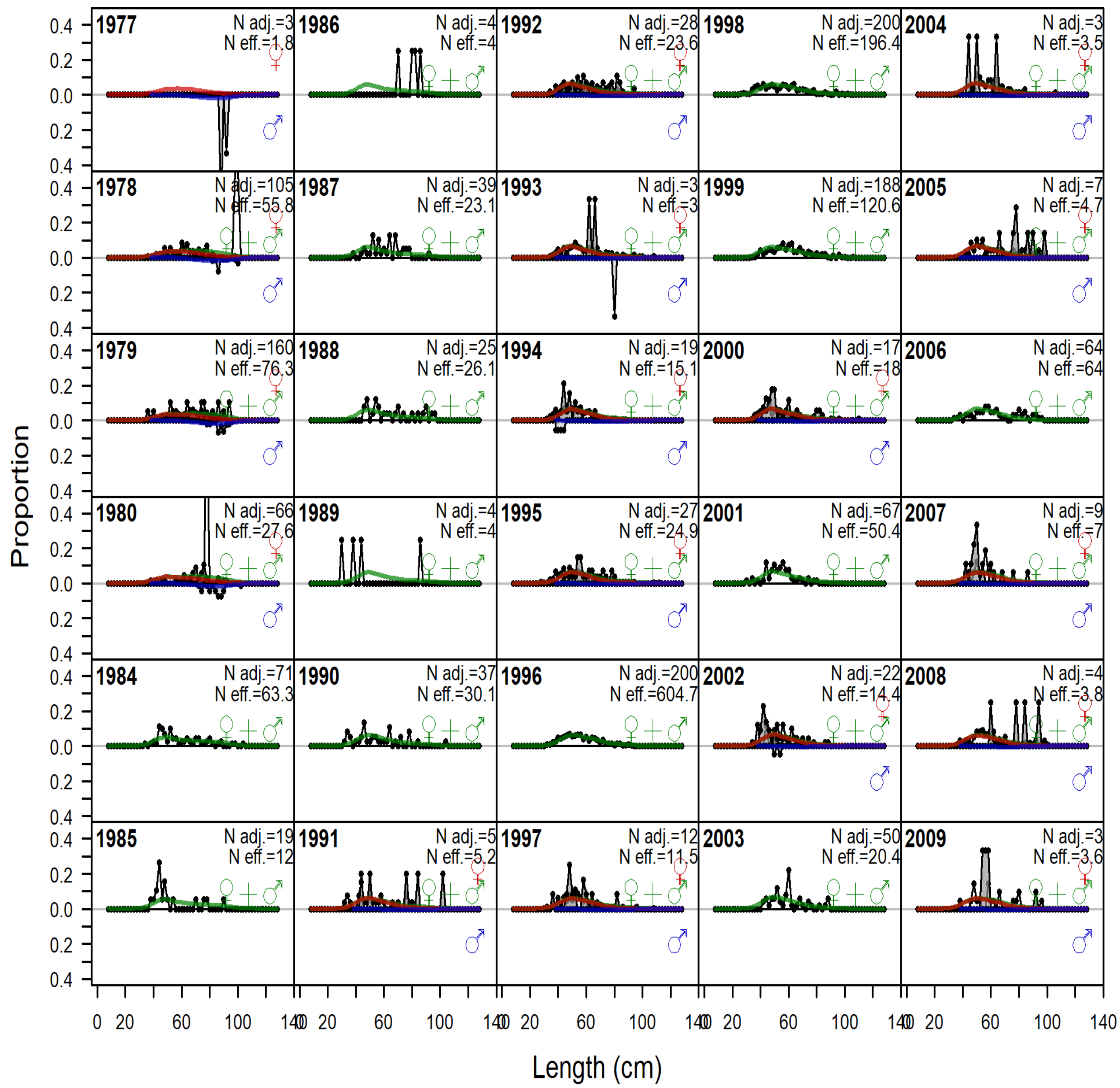
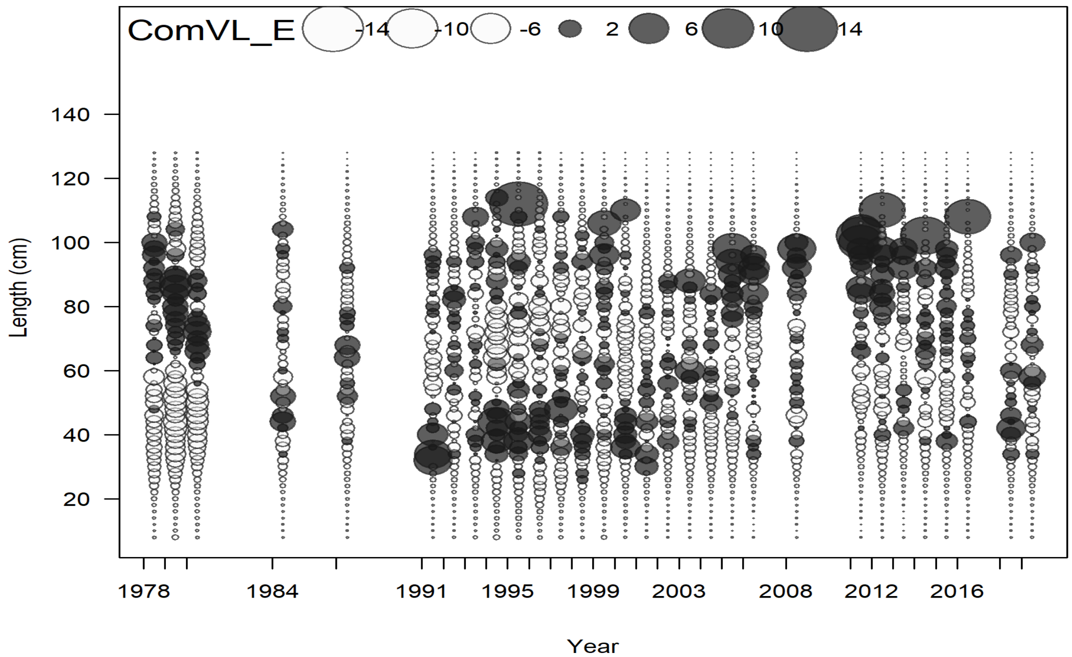


Figure 55 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - East fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

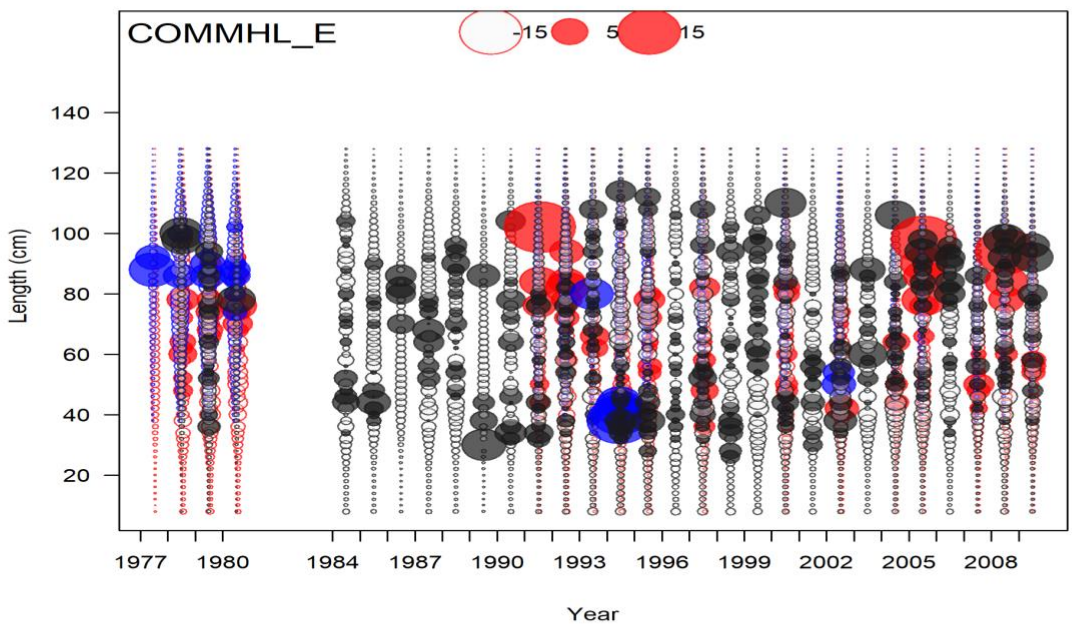


Figure 56. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper by the Commercial Vertical Line - East fishery for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not in SEDAR 85.

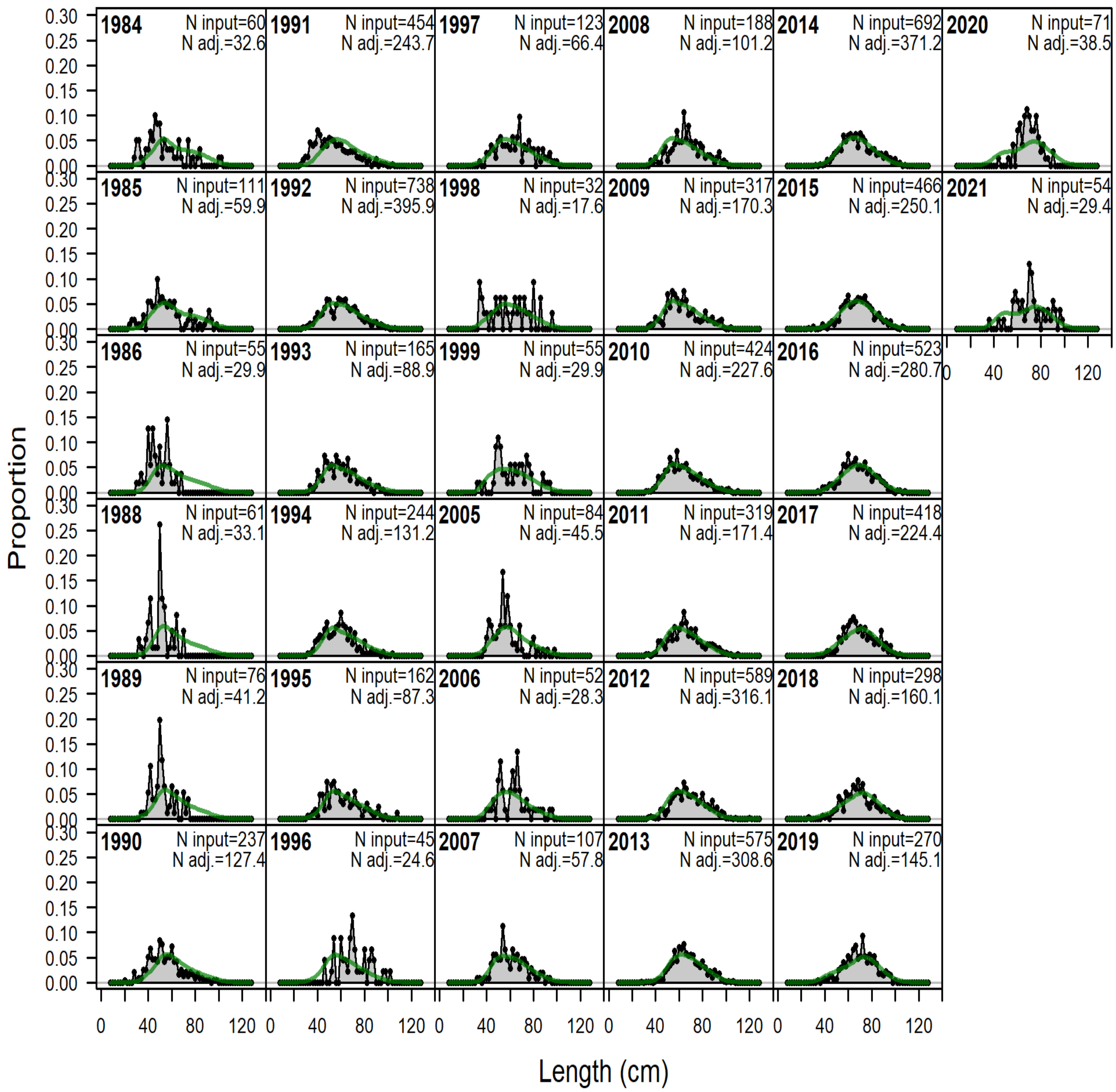


Figure 57. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - West fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

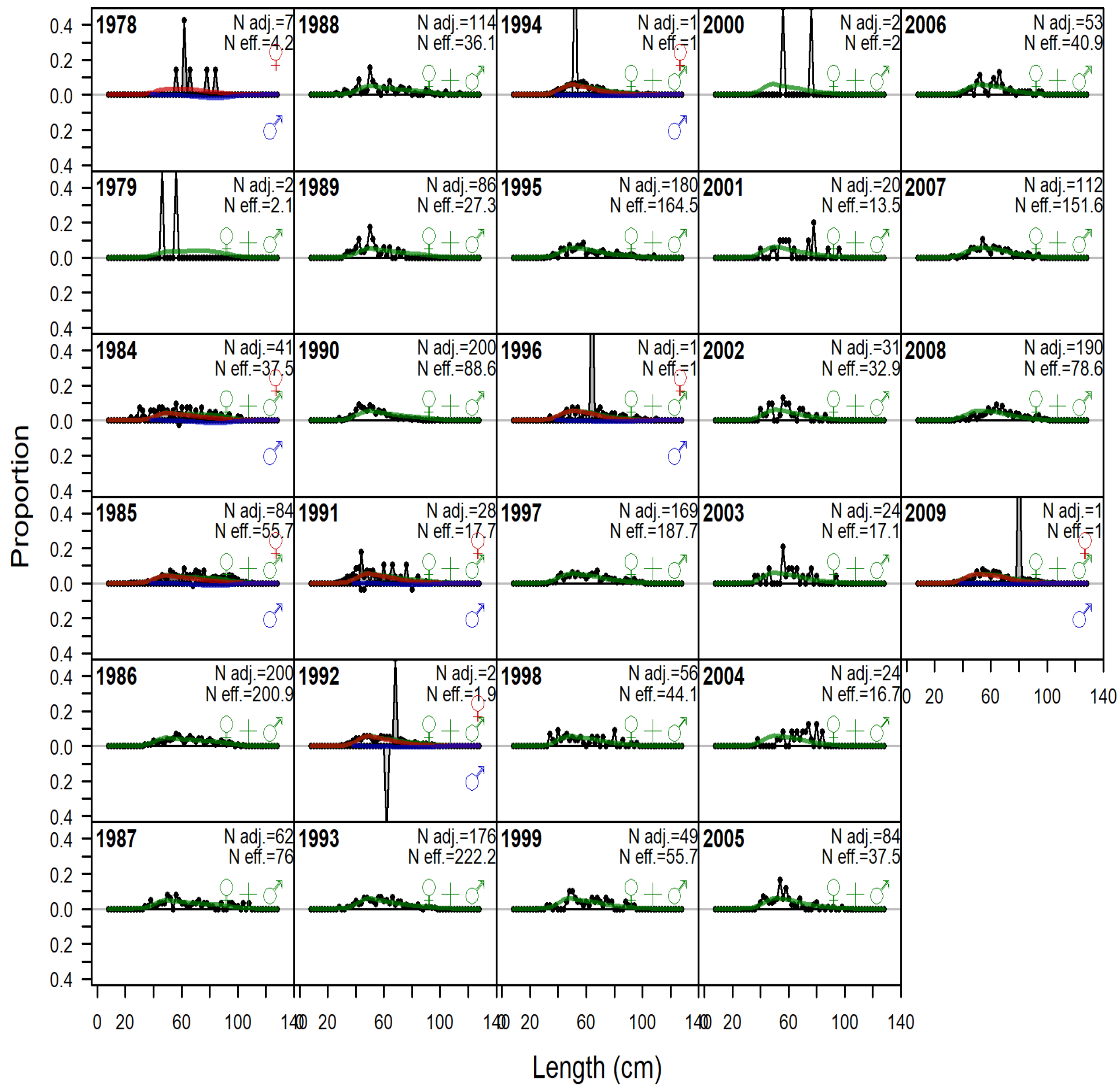
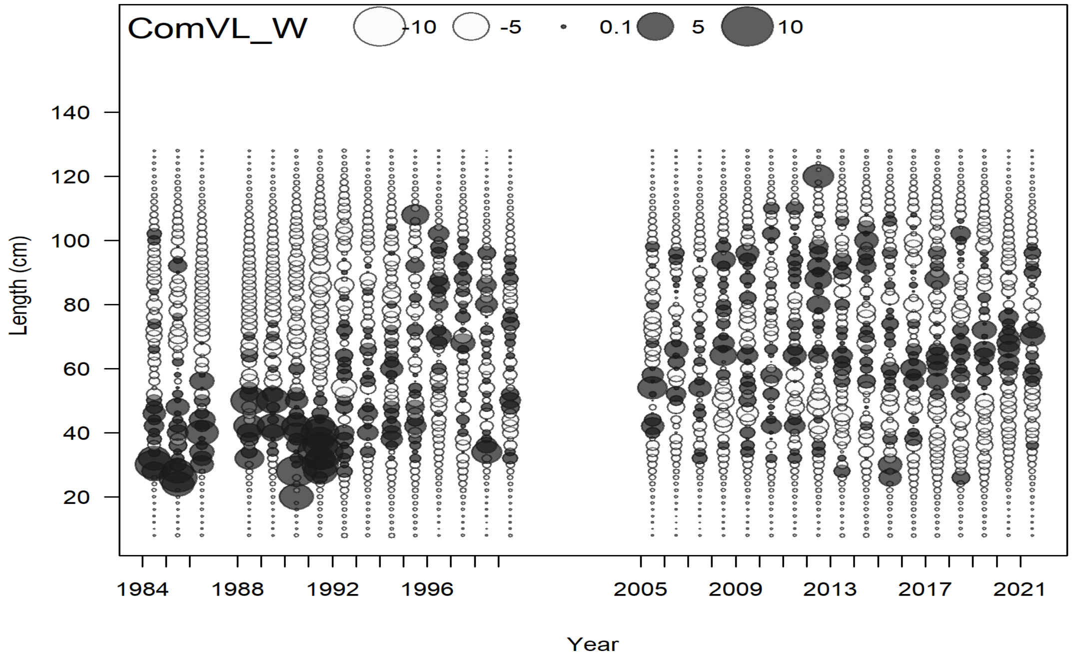


Figure 57 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Vertical Line - West fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

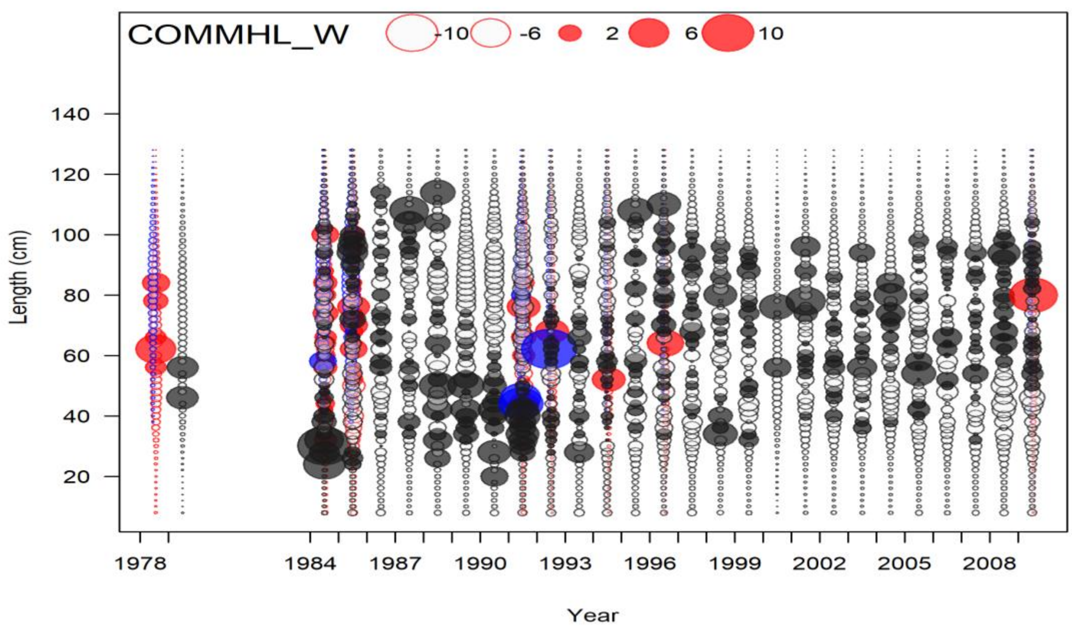


Figure 58. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper by the Commercial Vertical Line - West fishery for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not in SEDAR 85.

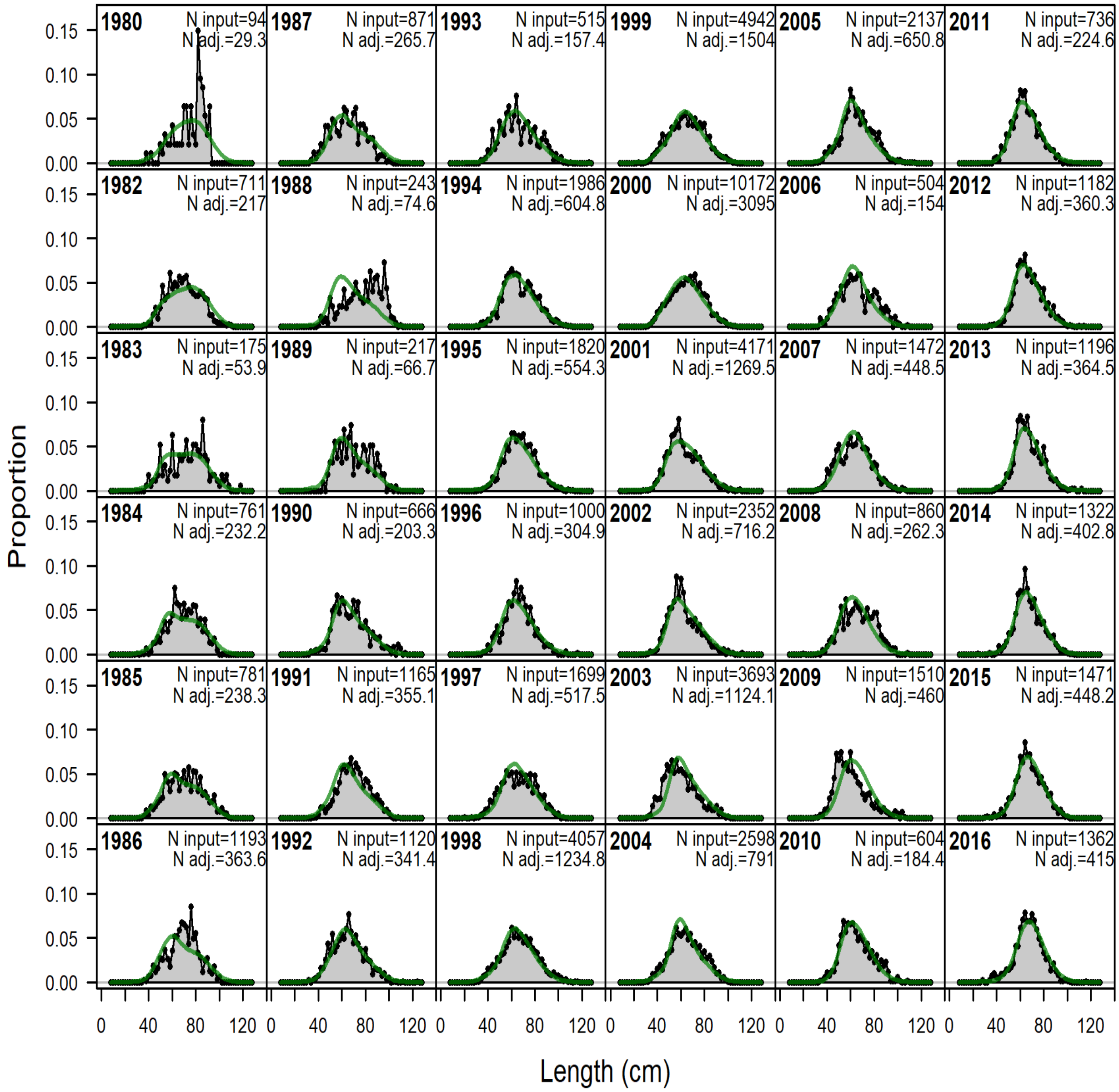


Figure 59. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

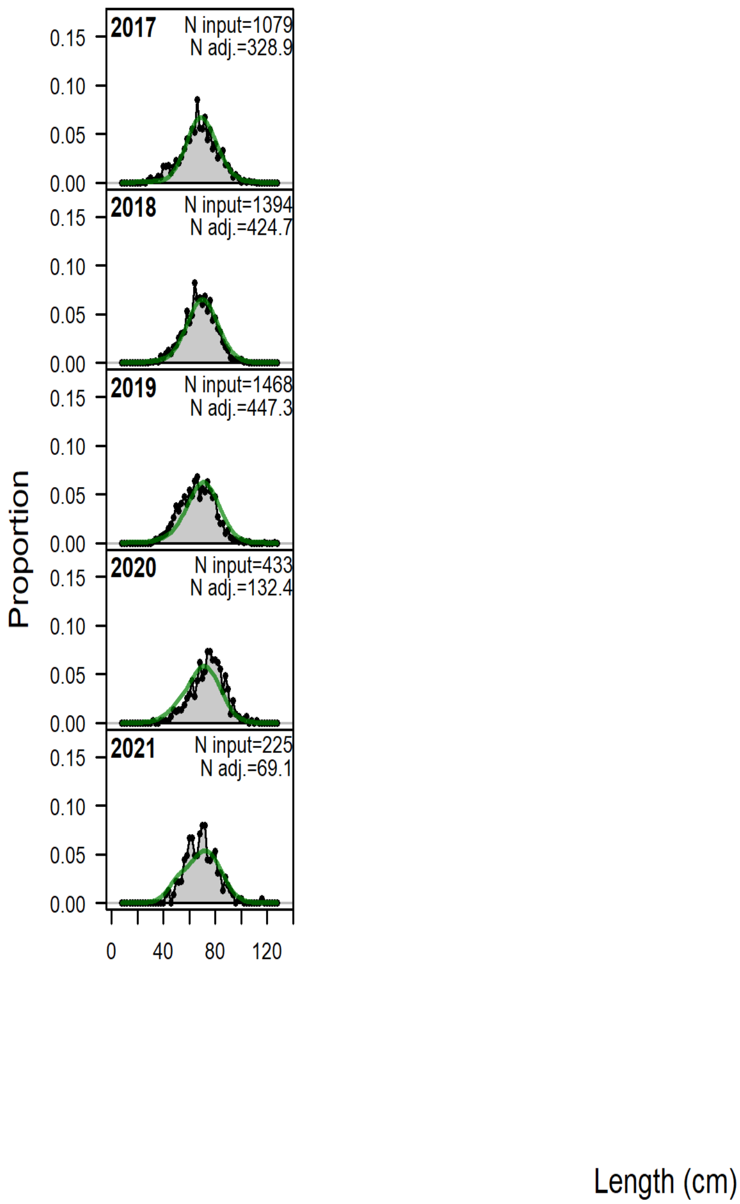


Figure 59 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

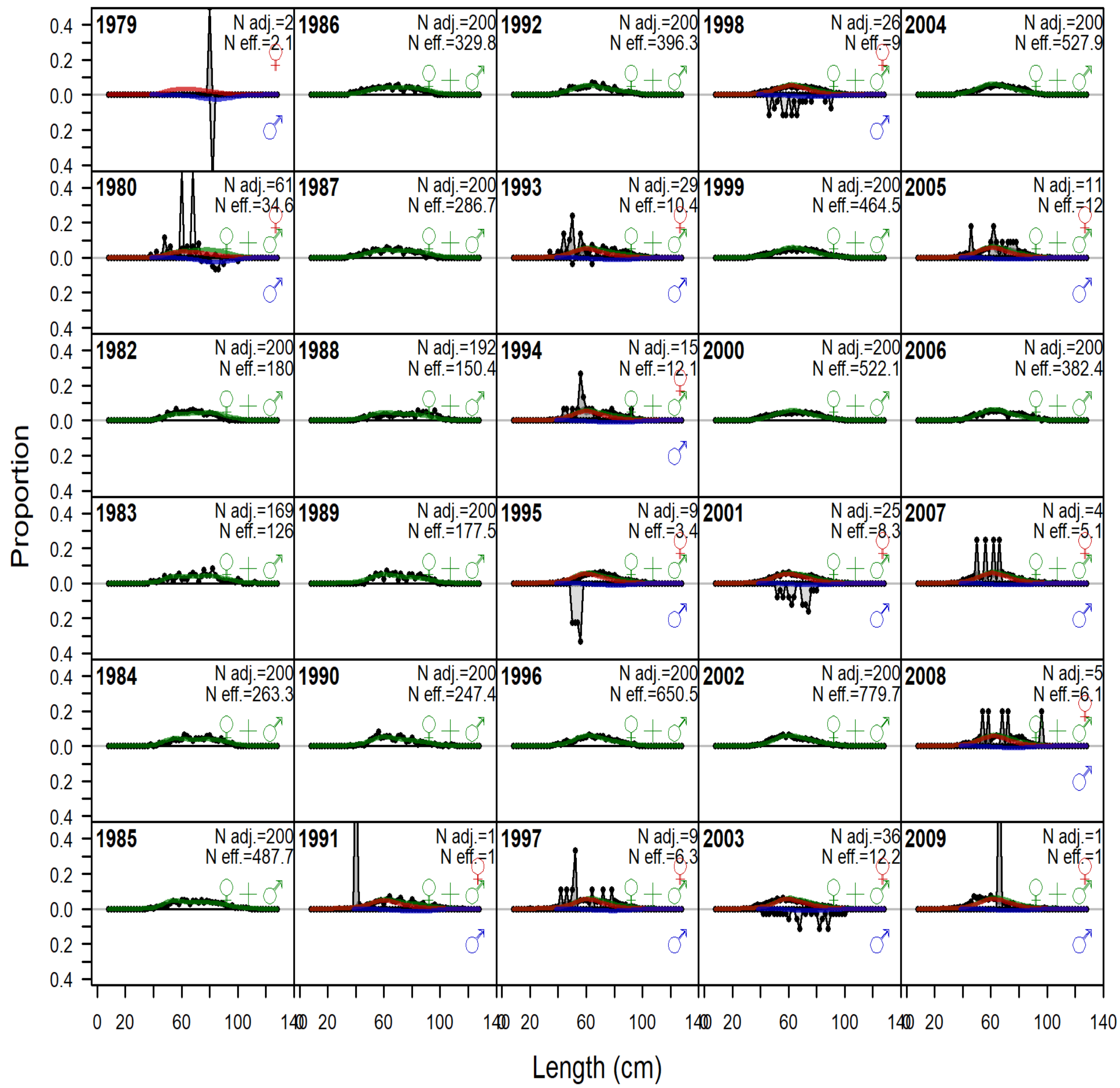
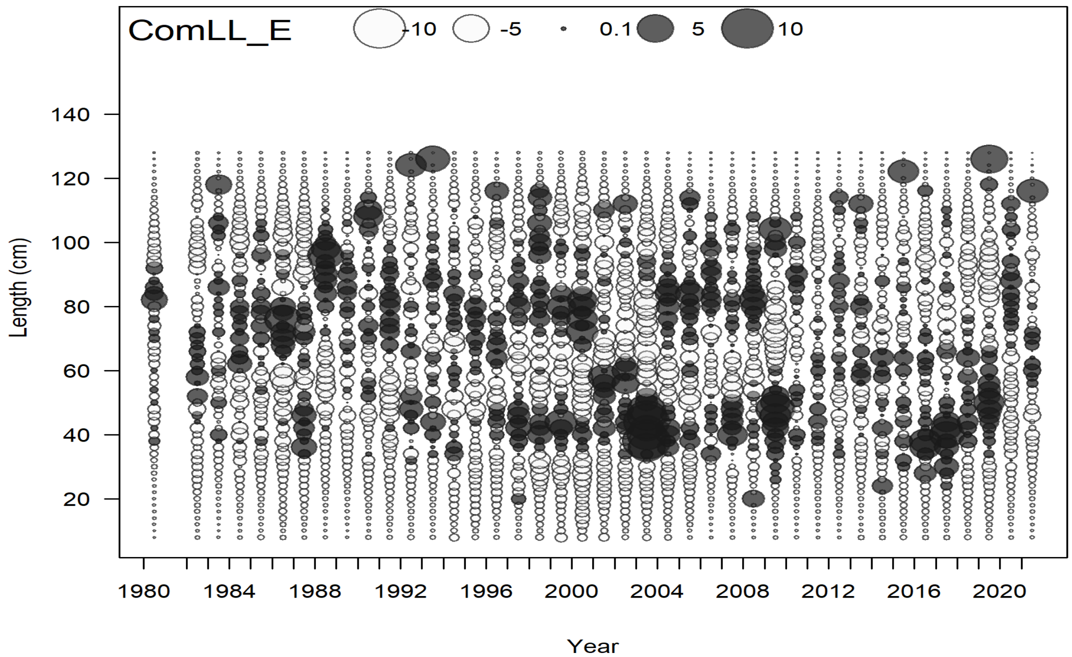


Figure 59 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - East fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

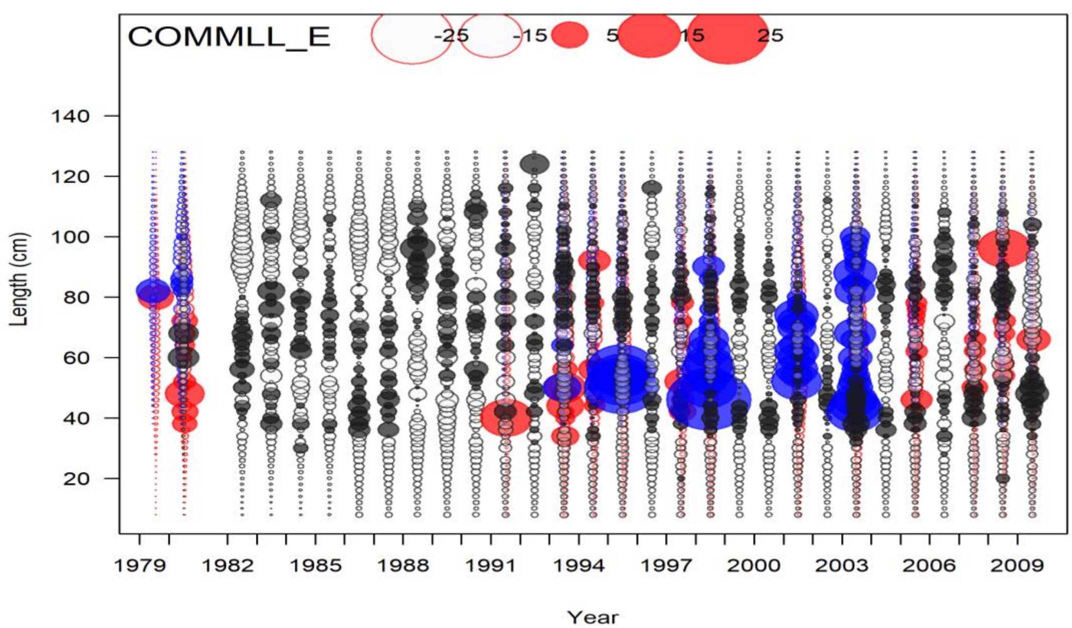


Figure 60. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper by the Commercial Longline - East fishery for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not in SEDAR 85.

SEDAR 85

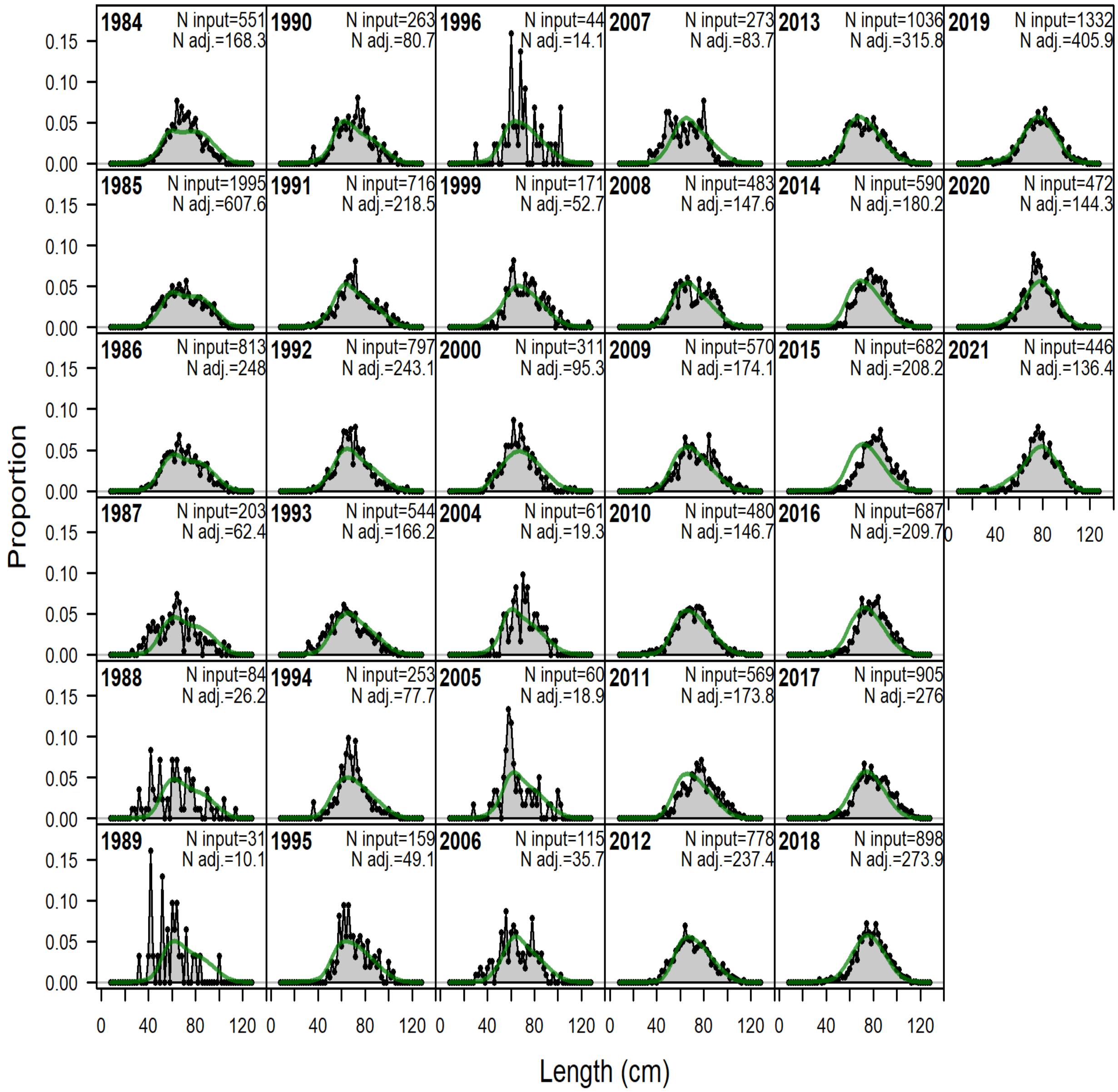


Figure 61. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - West fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

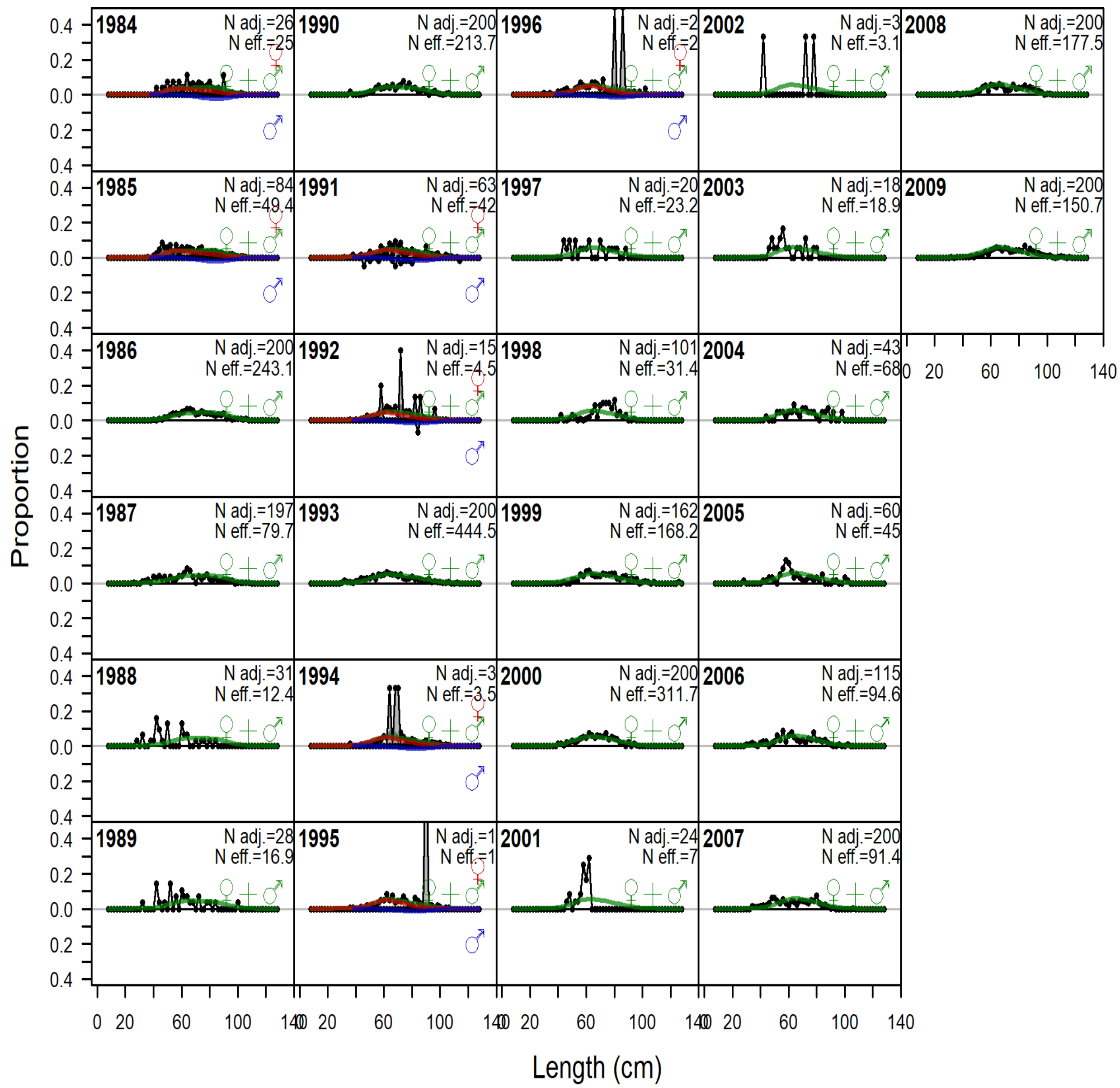
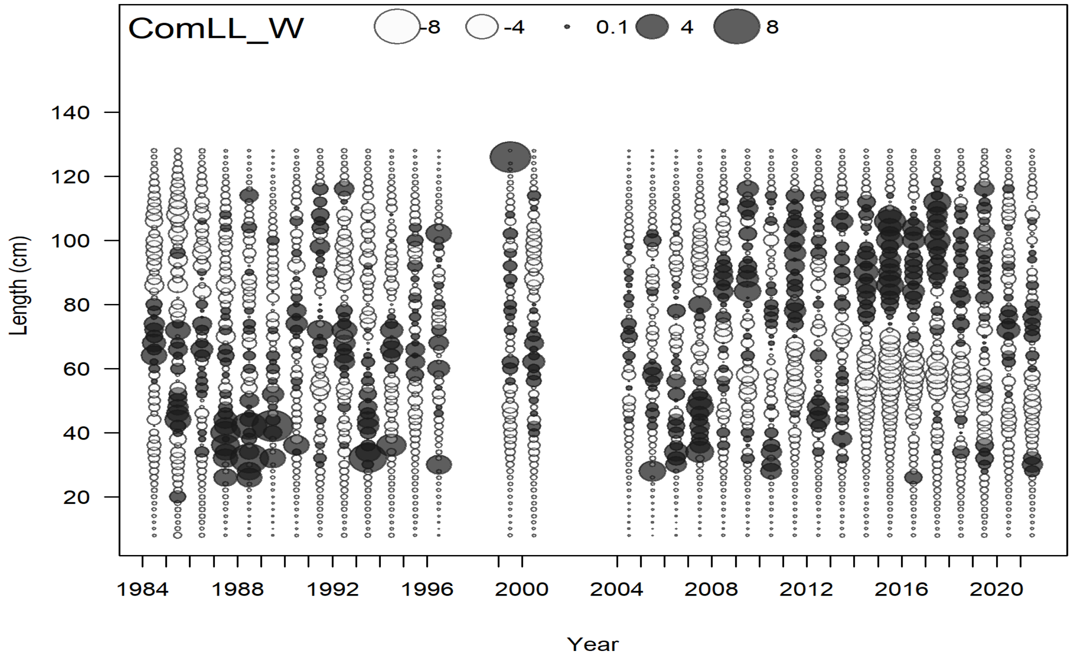


Figure 61 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper in the Commercial Longline - West fishery for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

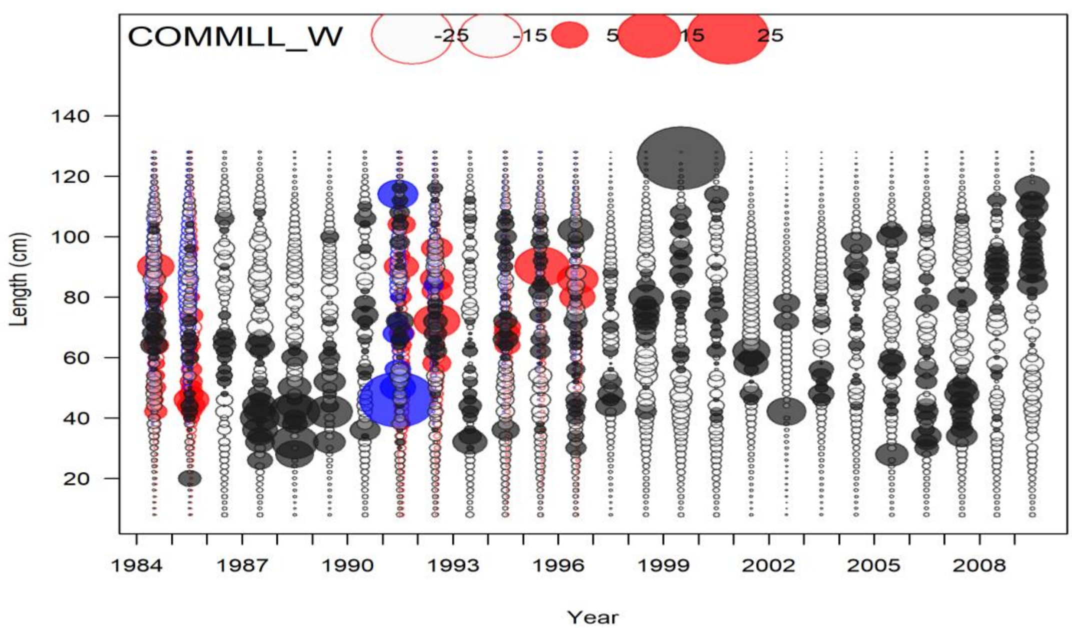


Figure 62. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper by the Commercial Longline - West fishery for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not in SEDAR 85.

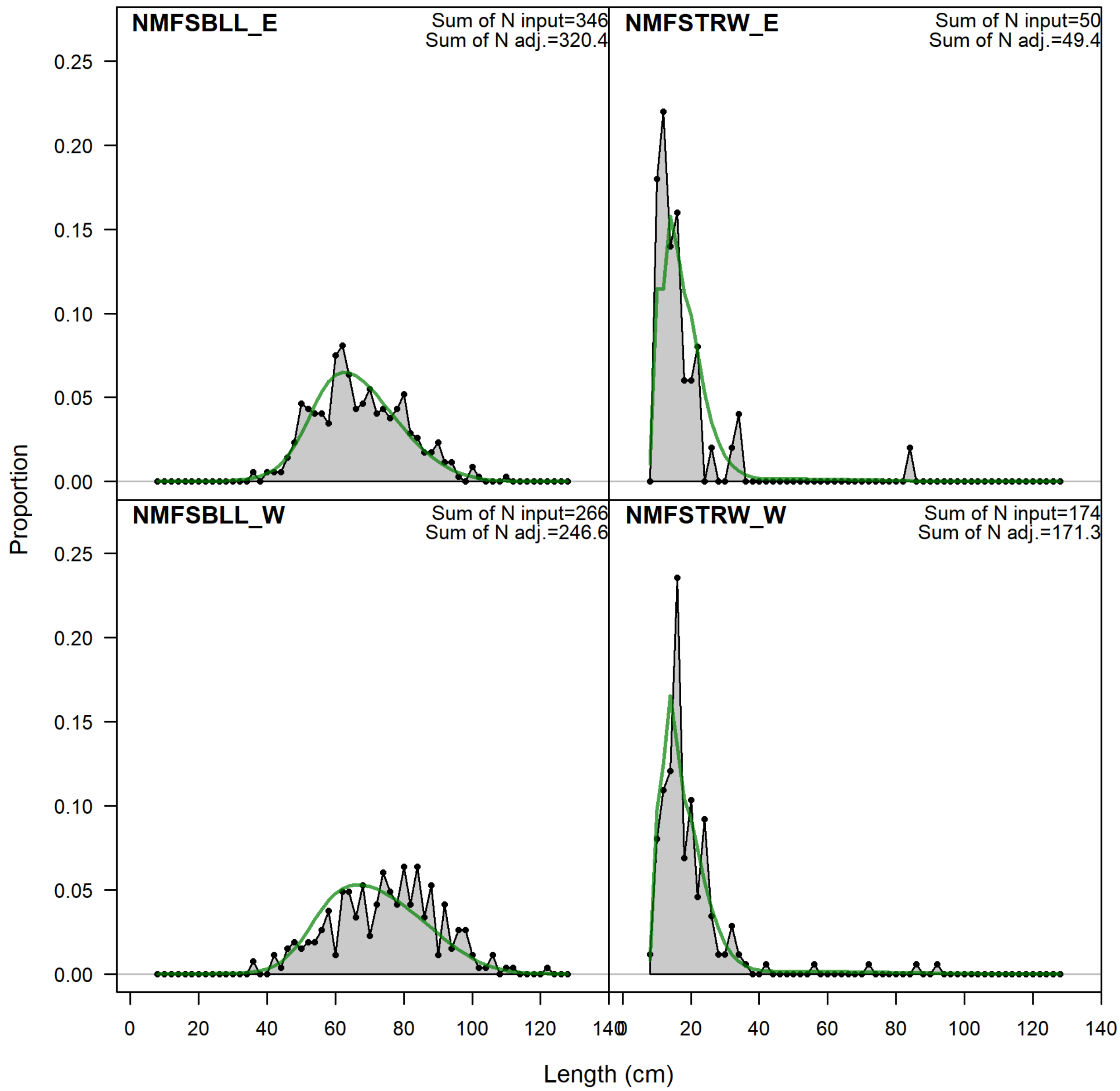


Figure 63. Model fits to the length composition of Yellowedge Grouper aggregated across years for the NMFS Bottom Longline (NMFSBLL) and NMFS/SEAMAP Groundfish Trawl (NMFSTRW) surveys in the Eastern (E) and Western (W) Gulf of Mexico for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

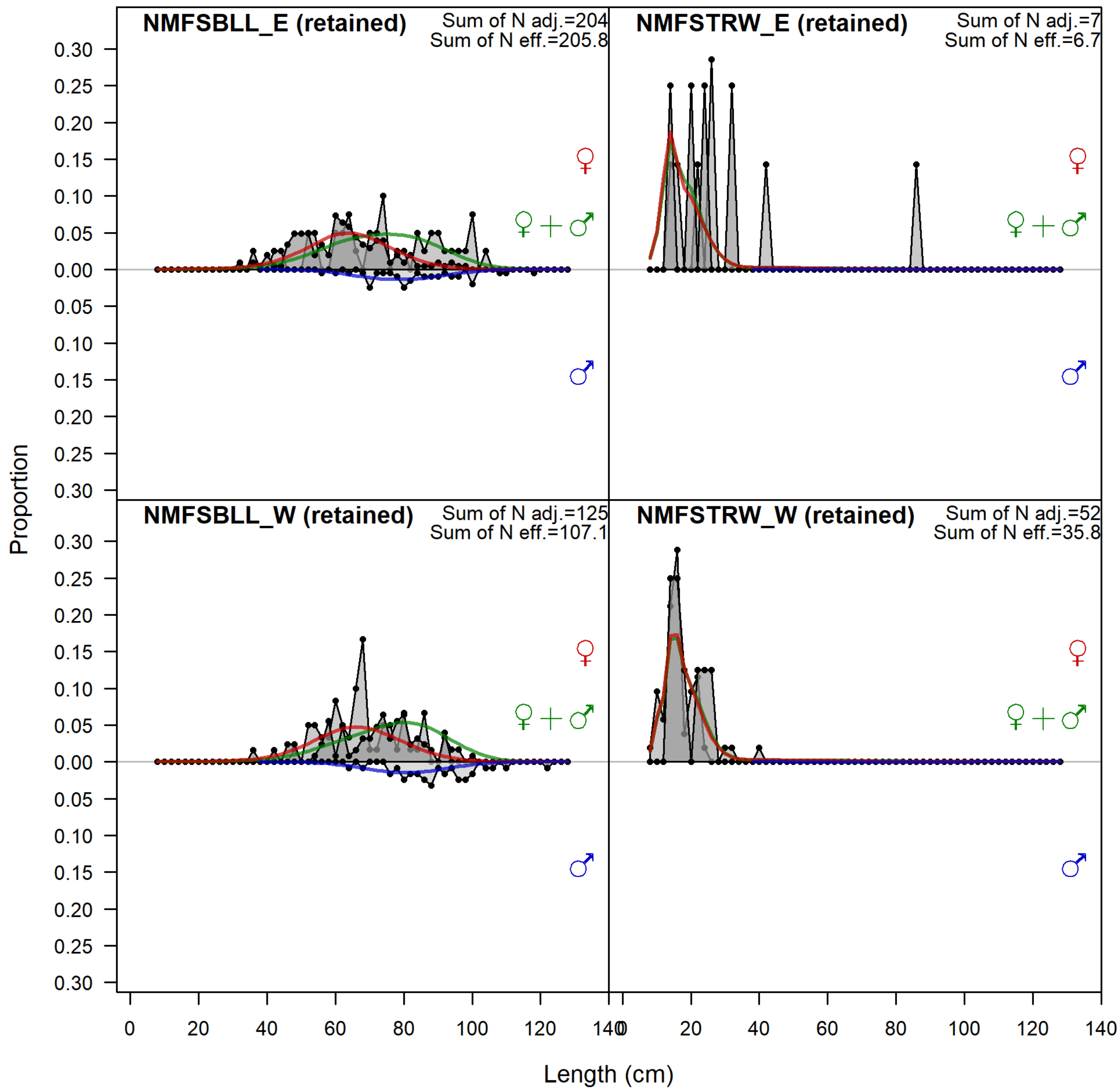


Figure 63 Continued. Model fits to the length composition of Yellowedge Grouper aggregated across years for the NMFS Bottom Longline (NMFSBLL) and NMFS/SEAMAP Groundfish Trawl (NMFSTRW) surveys in the Eastern (E) and Western (W) Gulf of Mexico for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

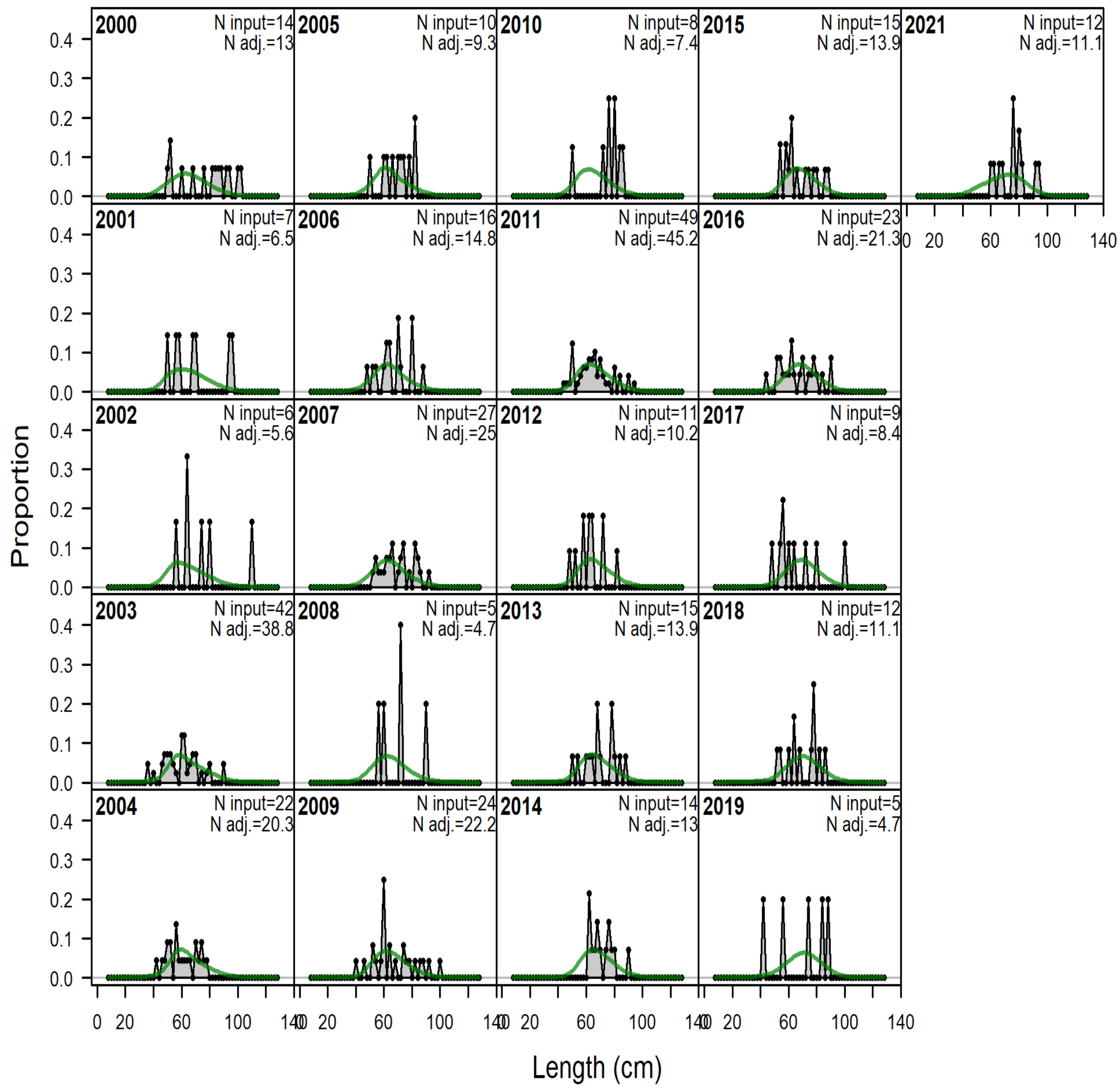


Figure 64. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS Bottom Longline Survey - East for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

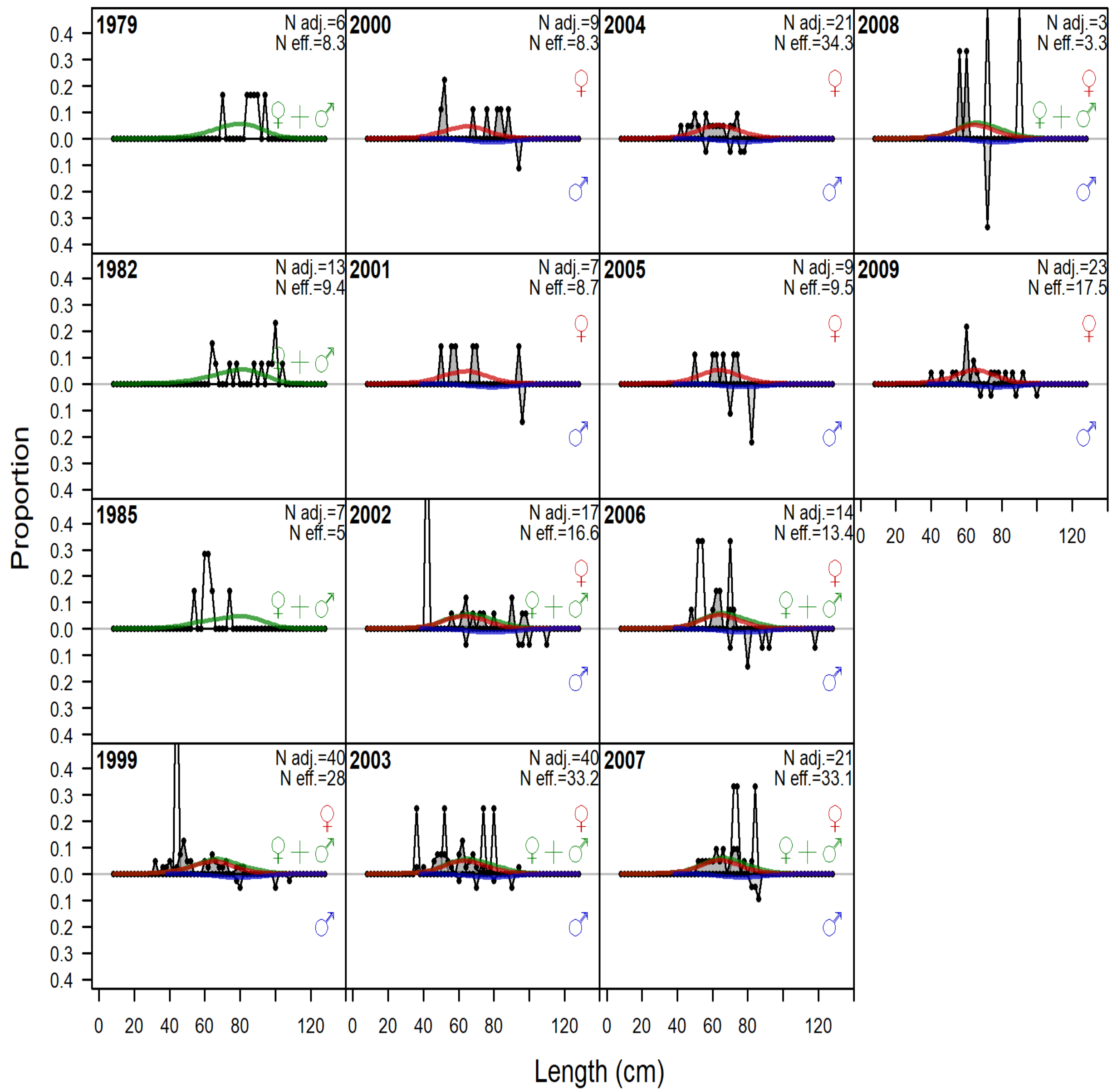
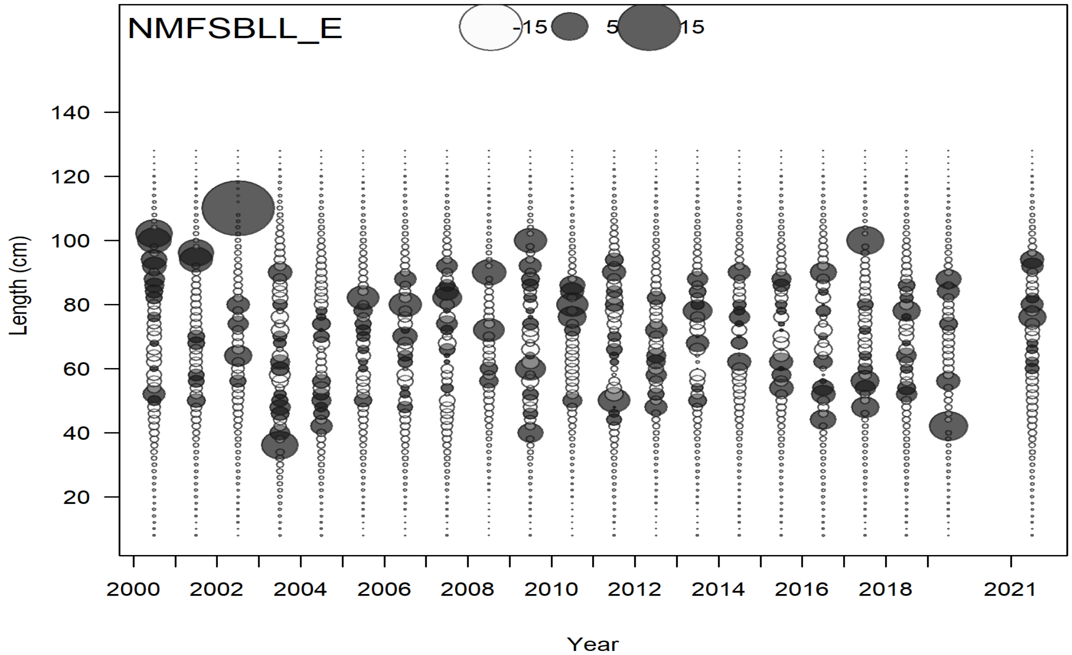


Figure 64 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS Bottom Longline Survey - East for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

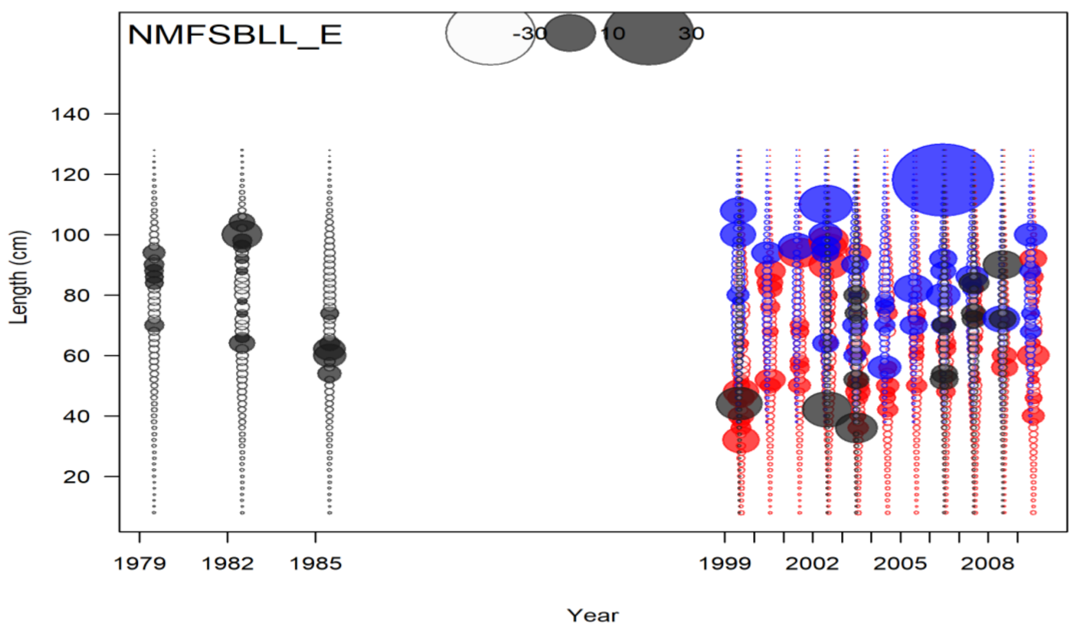


Figure 65. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - East for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not SEDAR 85.

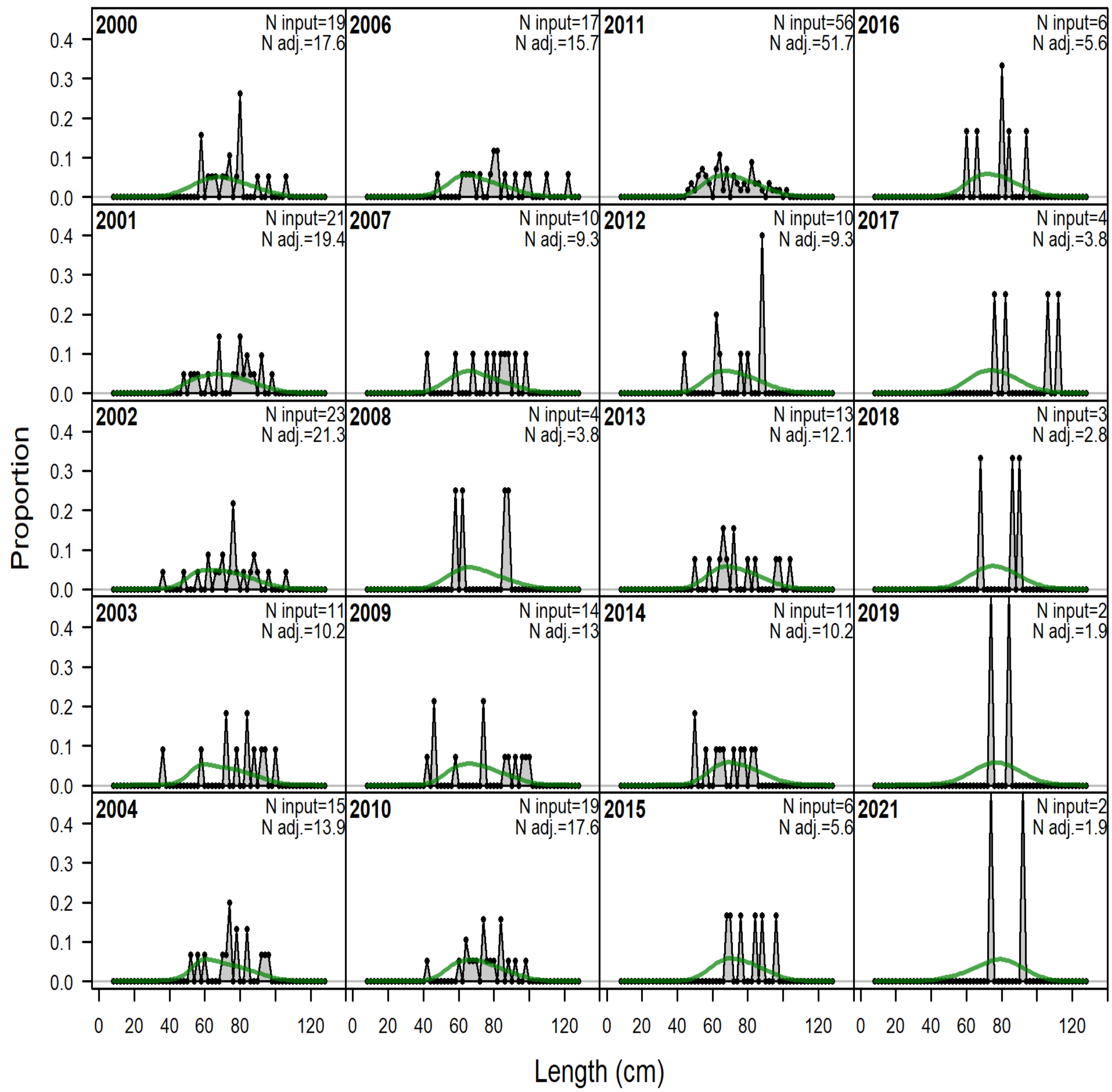


Figure 66. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS Bottom Longline Survey - West for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

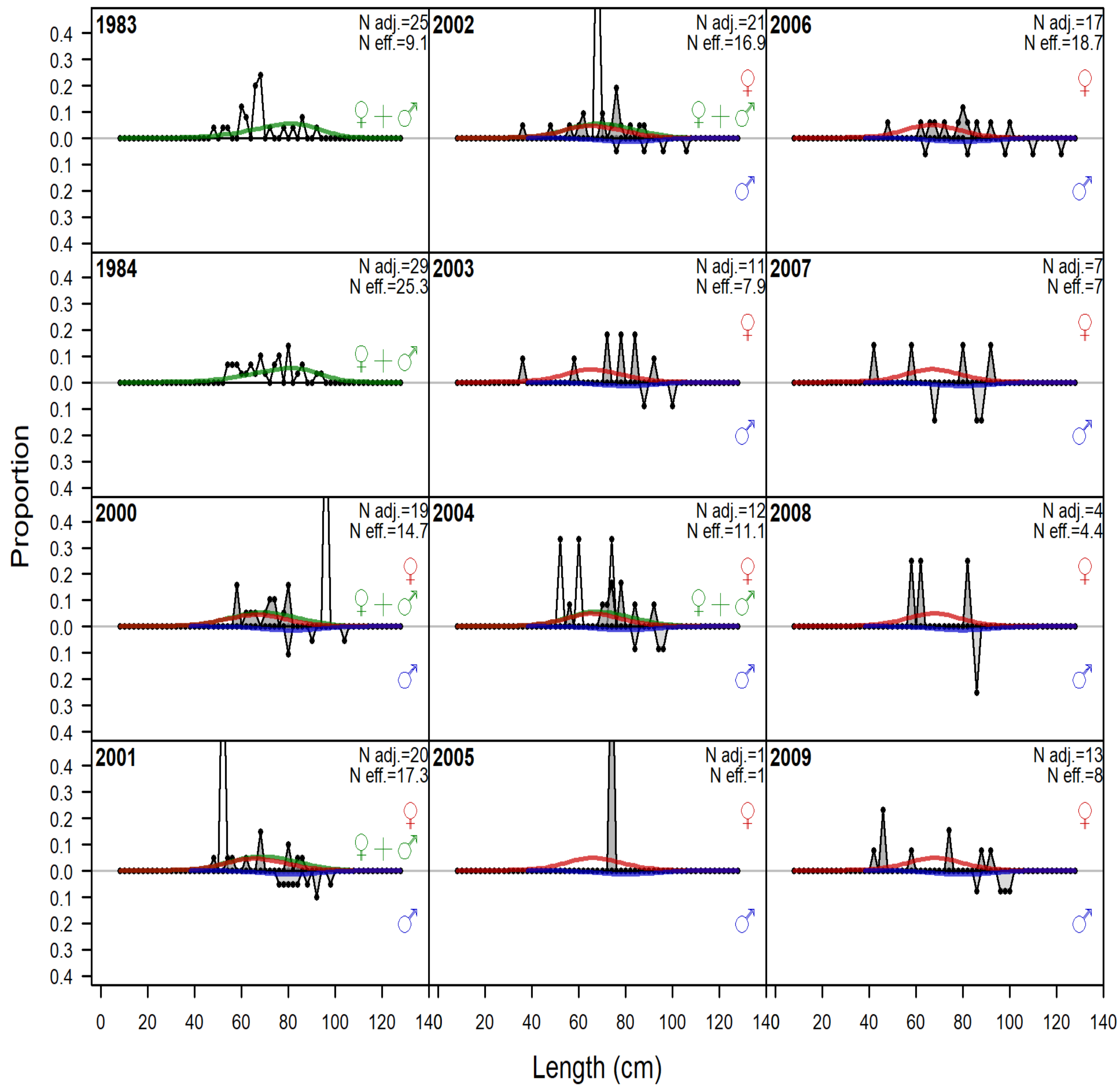
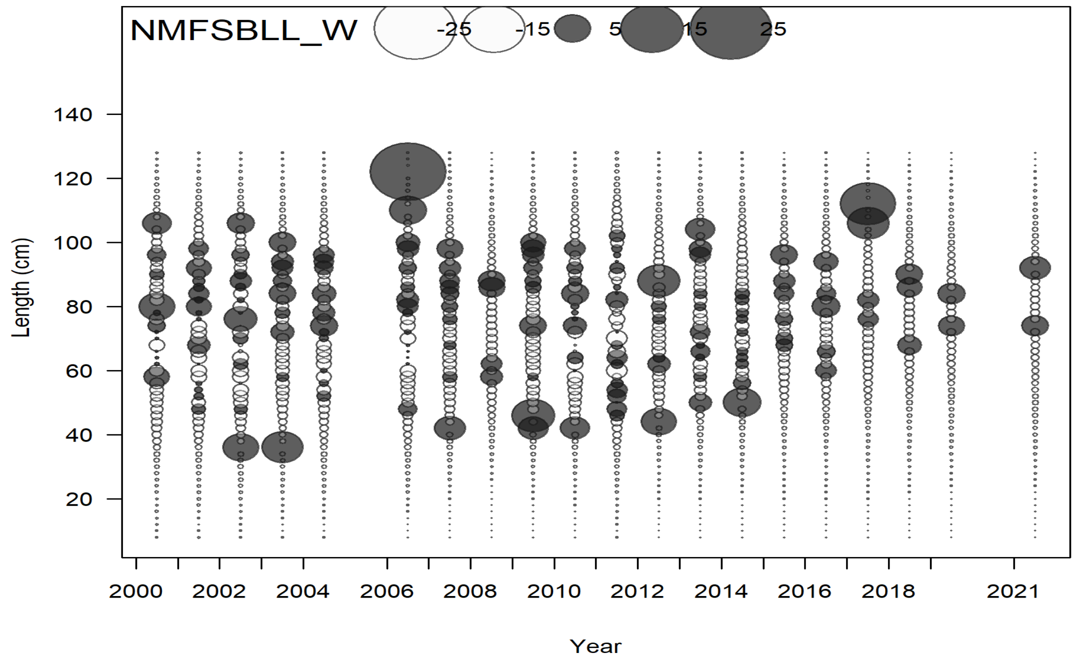


Figure 66 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS Bottom Longline Survey - West for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

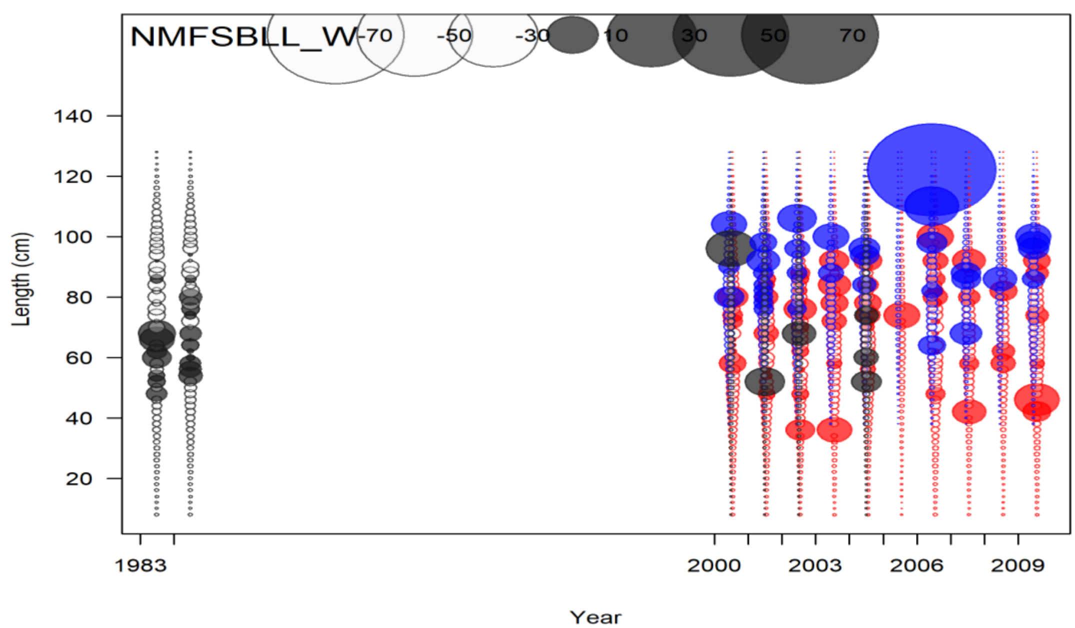


Figure 67. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - West for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not SEDAR 85.

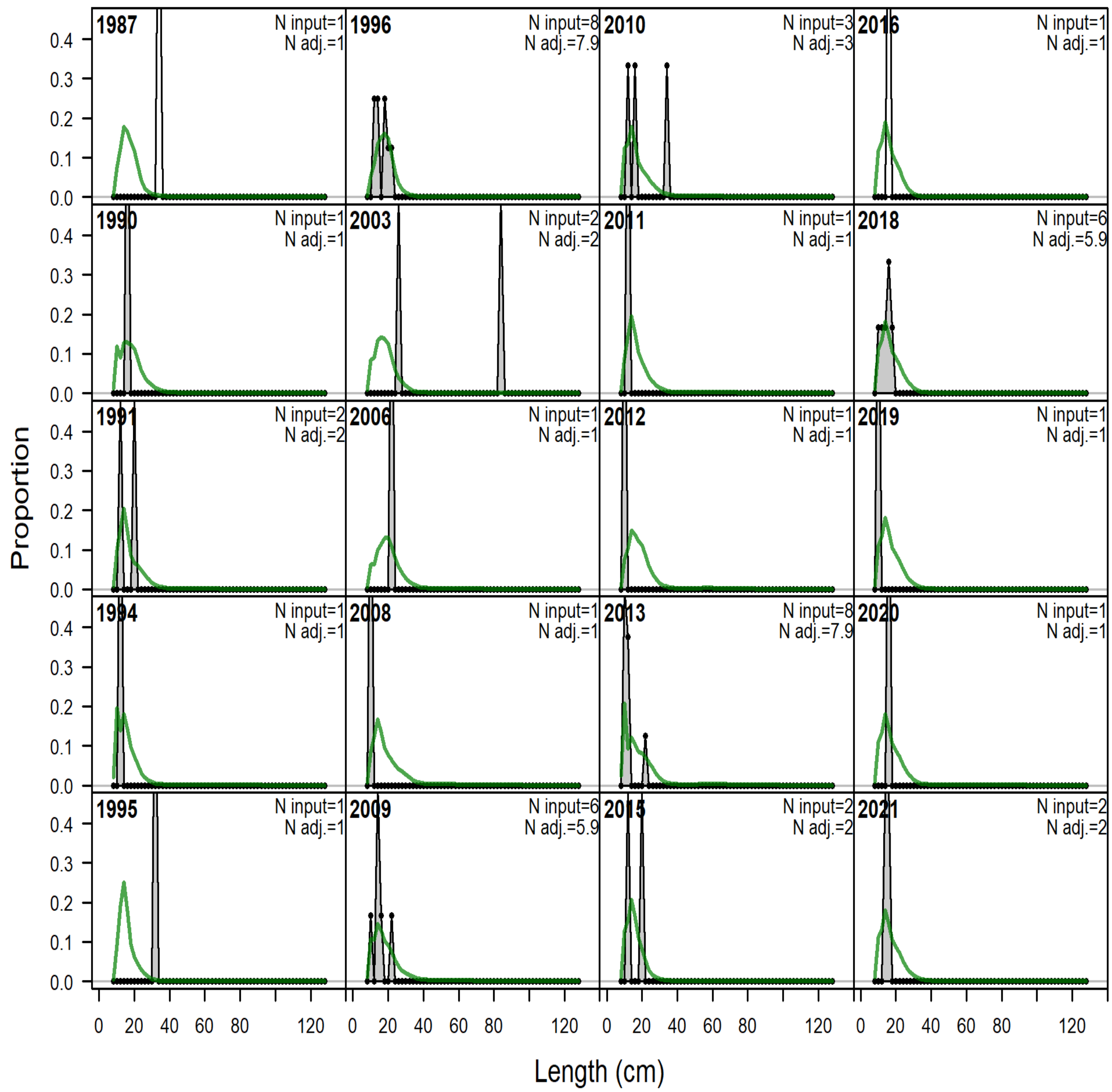


Figure 68. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS/SEAMAP Groundfish Trawl Survey - East for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 22

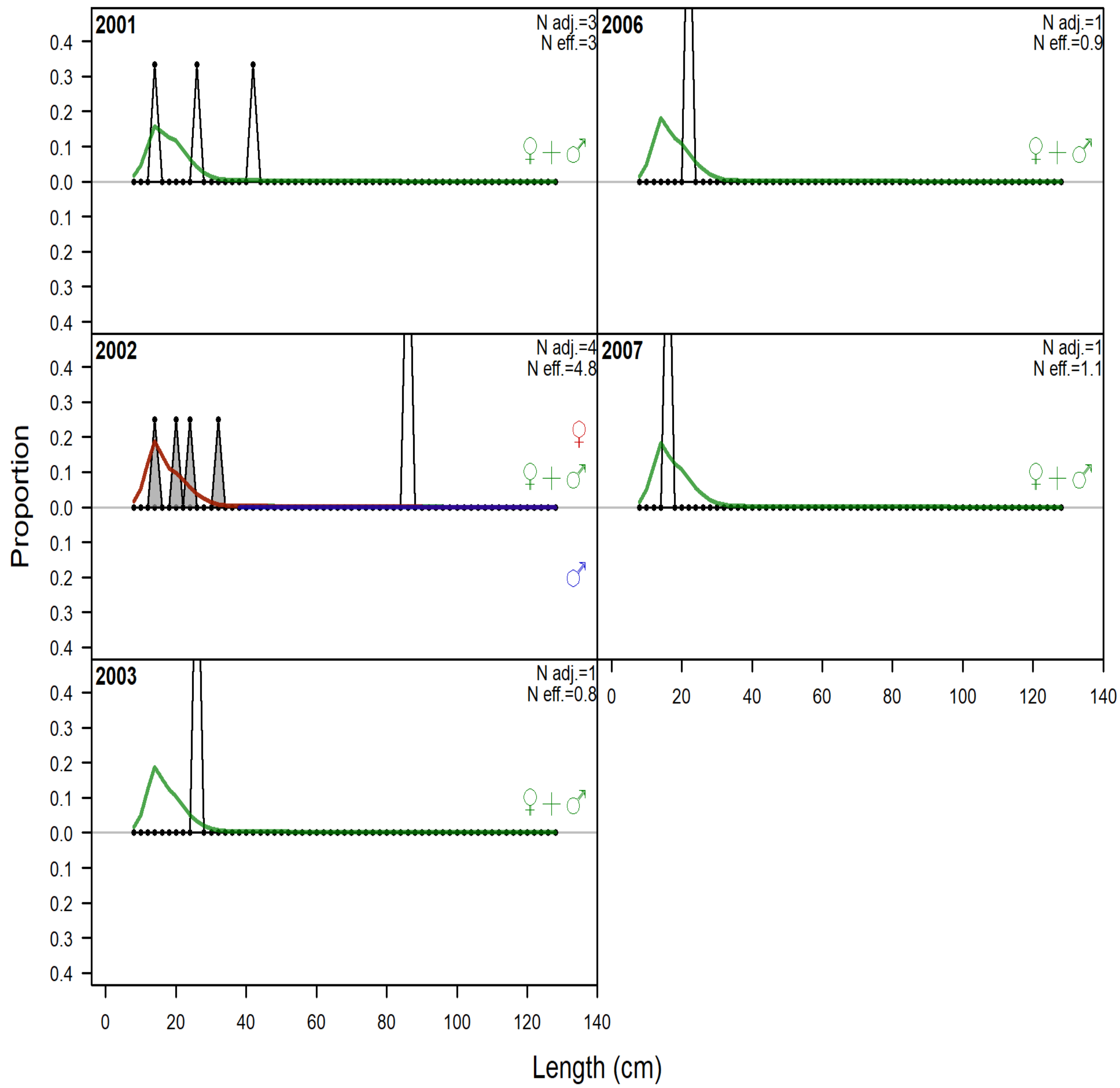
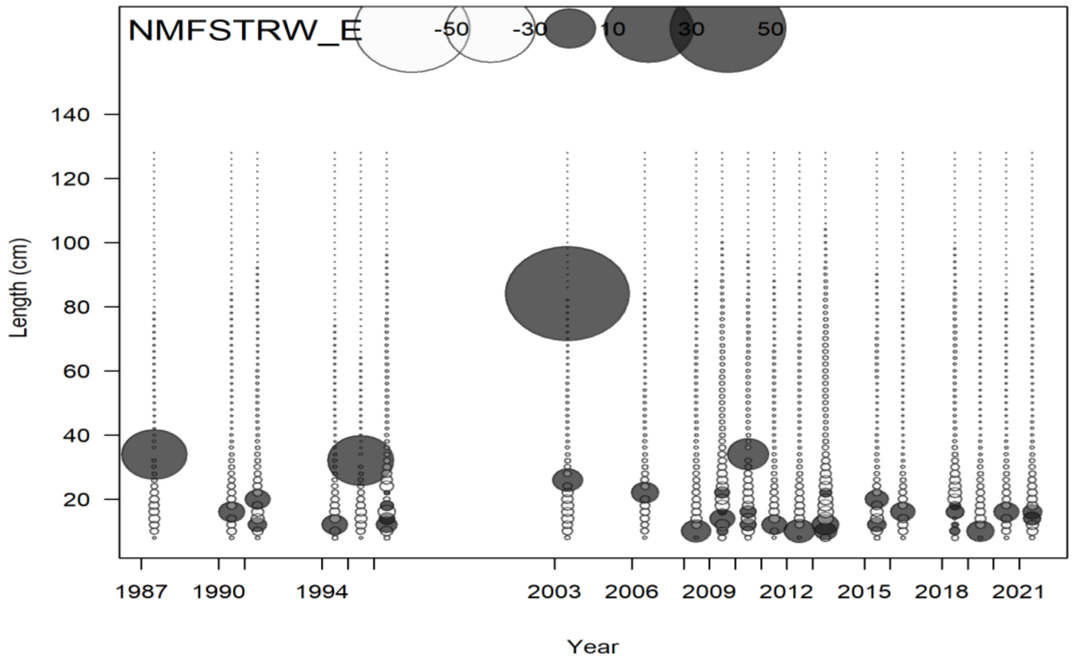


Figure 68 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS/SEAMAP Groundfish Trawl Survey - East for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

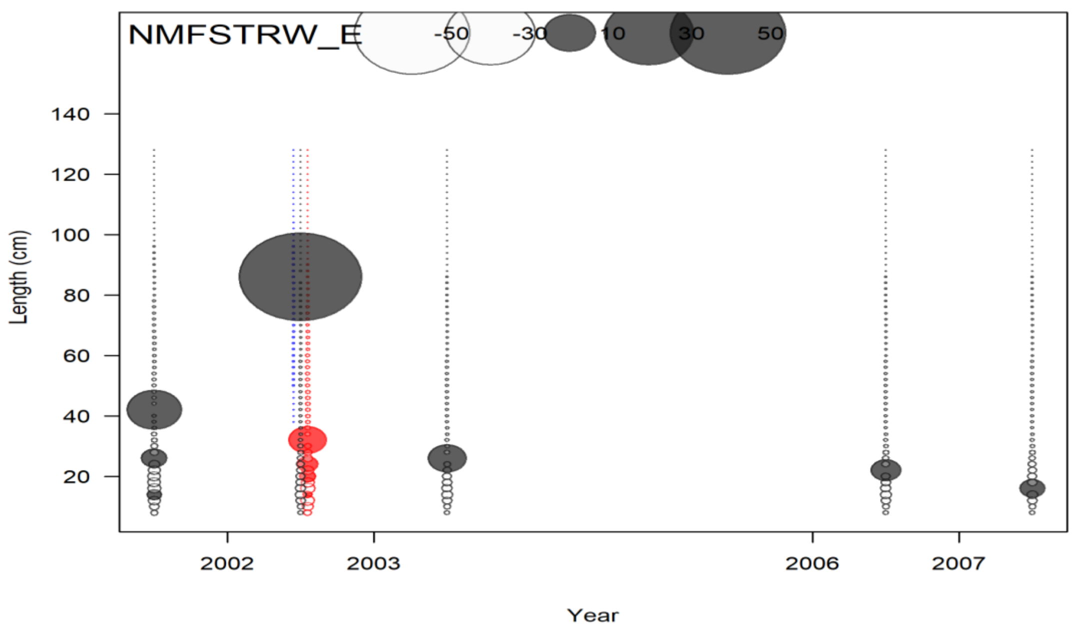


Figure 69. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS/SEAMAP Groundfish Trawl Survey - East for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not SEDAR 85.

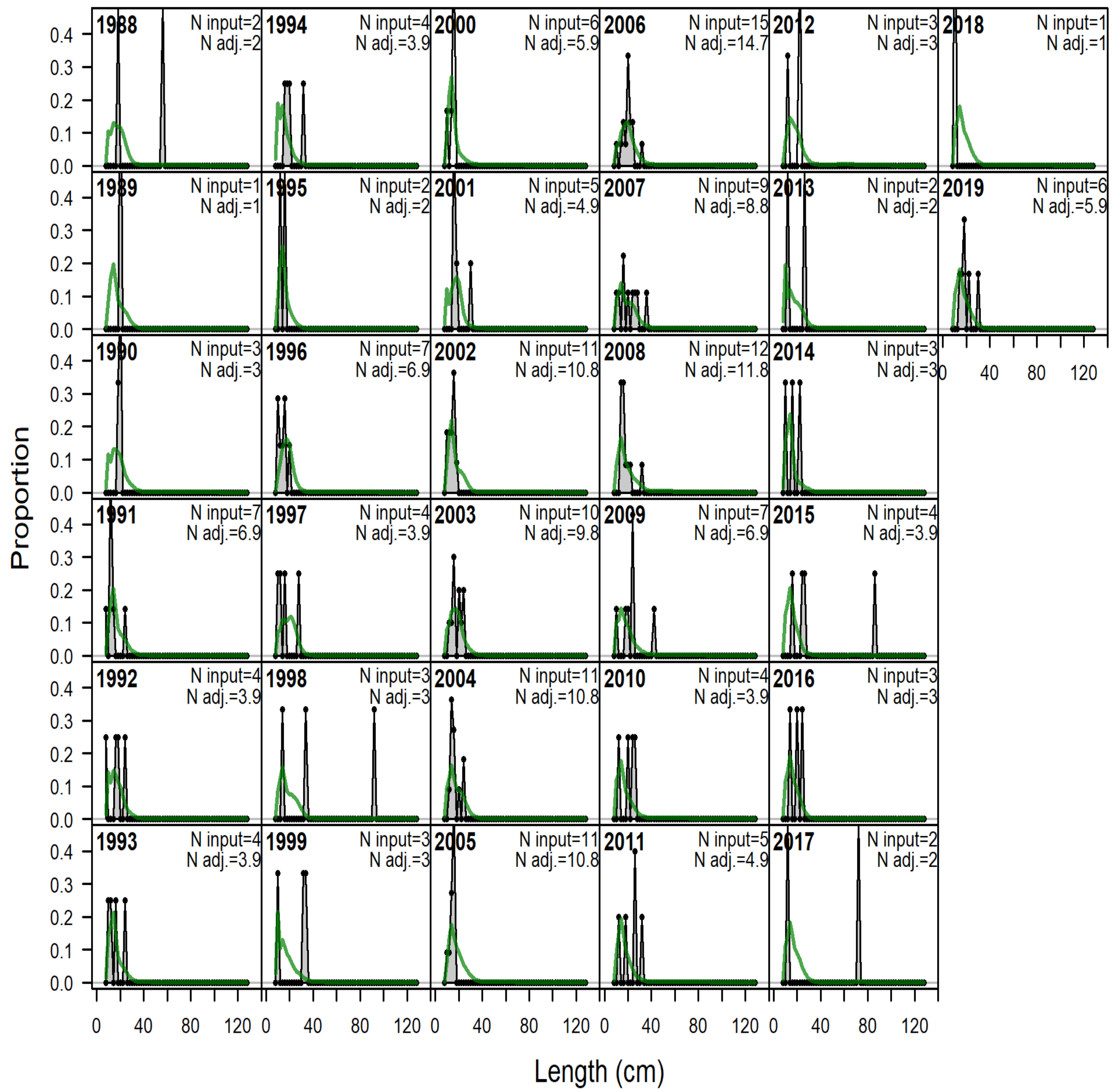


Figure 70. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS/SEAMAP Groundfish Trawl Survey - West for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

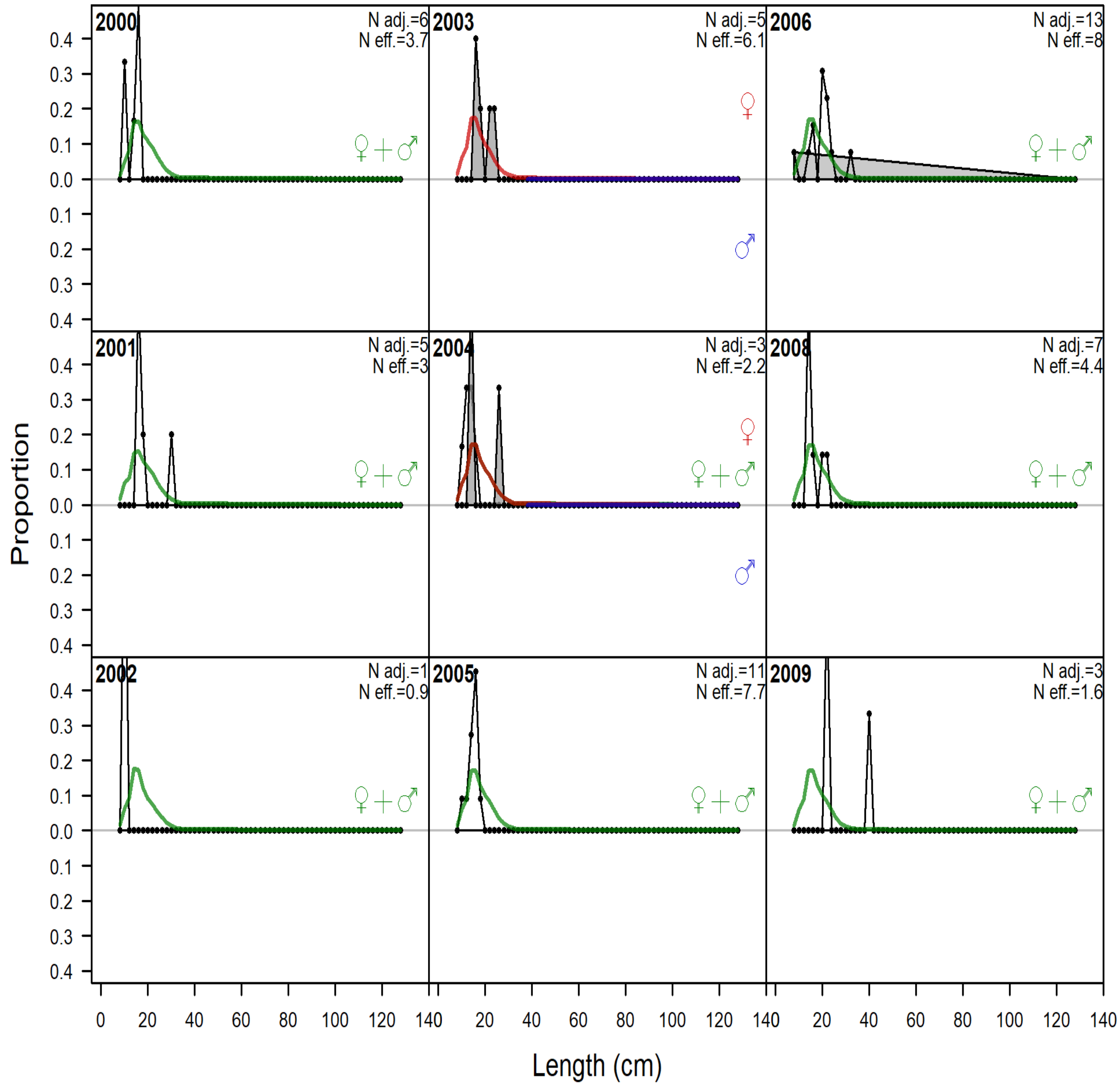
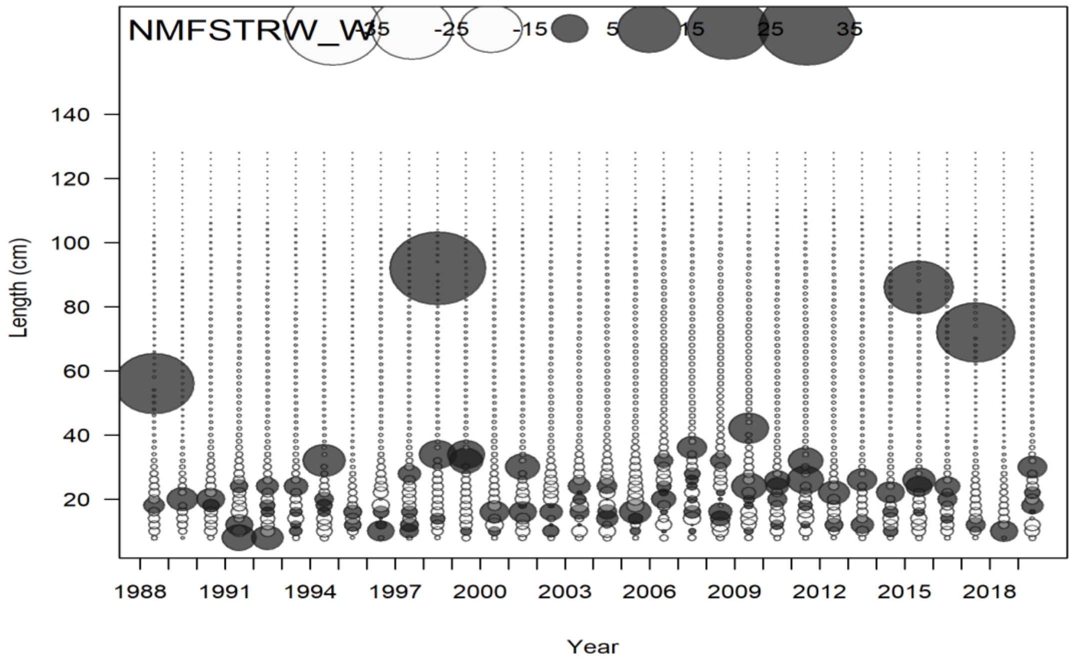


Figure 70 Continued. Observed and predicted length compositions for Gulf of Mexico Yellowedge Grouper caught in the NMFS/SEAMAP Groundfish Trawl Survey - West for SEDAR 85 and SEDAR 22. Green lines represent predicted length compositions (red = female, blue = male, not fit to in SEDAR 85), while grey shaded regions represent observed length compositions. For SEDAR 85, 'N input' is the input sample size (number of length observations) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter. For SEDAR 22, 'N adj.' is the input sample size ('N eff.' was not used).

SEDAR 85



SEDAR 22

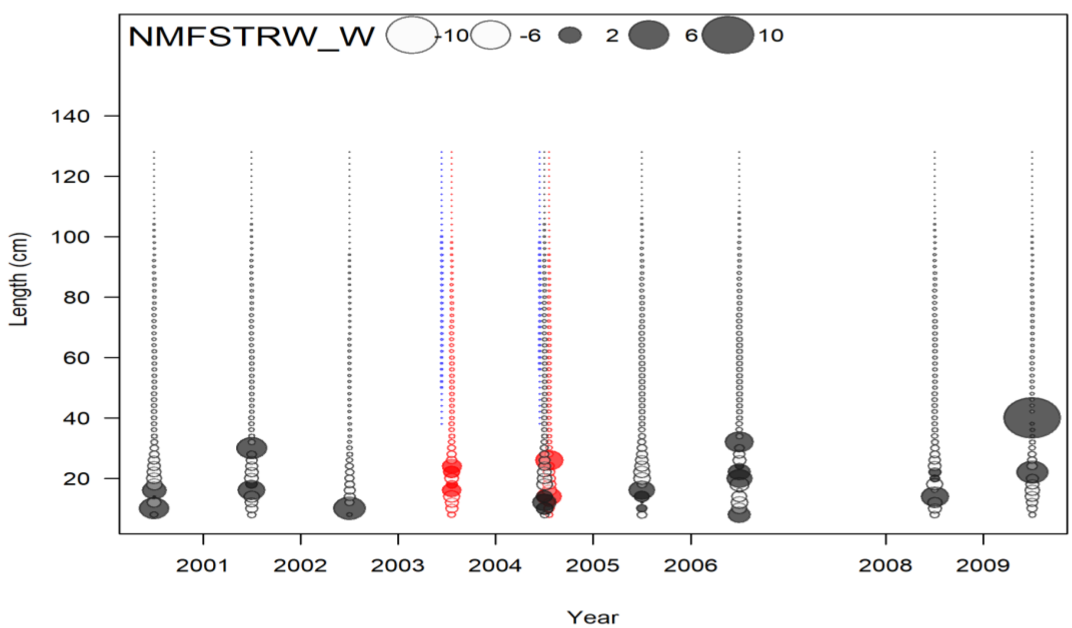


Figure 71. Pearson residuals for length compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS/SEAMAP Groundfish Trawl Survey - West for SEDAR 85 (upper panel) and SEDAR 22 (lower panel). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Red and blue bubbles represent female and male compositions which were fit to in SEDAR 22 but not SEDAR 85.

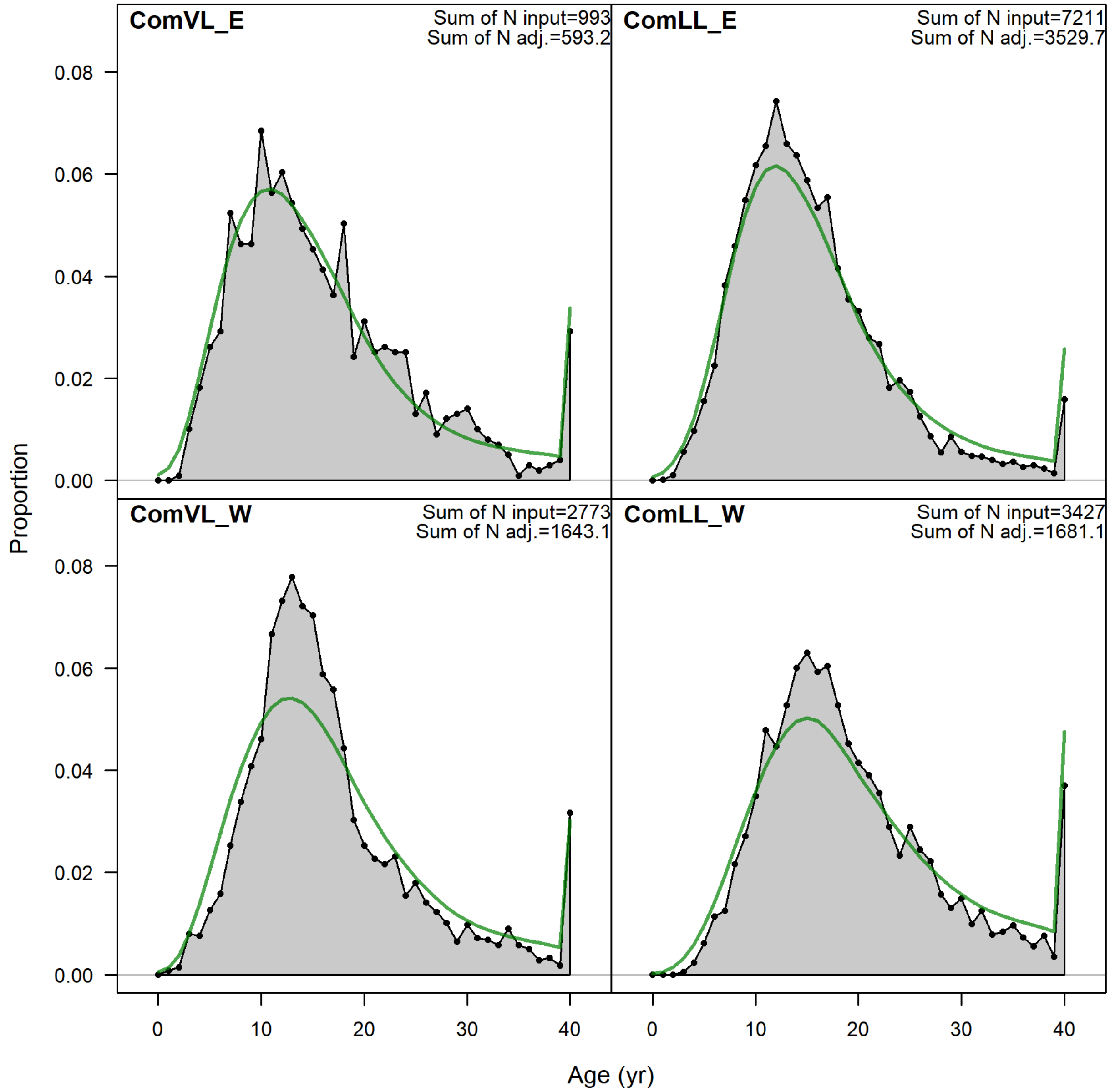


Figure 72. Model fits to the age composition of Yellowedge Grouper aggregated across years for the Commercial Vertical Line (ComVL) and Longline (ComLL) fisheries in the Eastern (E) and Western (W) Gulf of Mexico. Green lines represent predicted age compositions, while grey shaded regions represent observed age compositions. 'N input' is the input sample size (number of ages) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter.

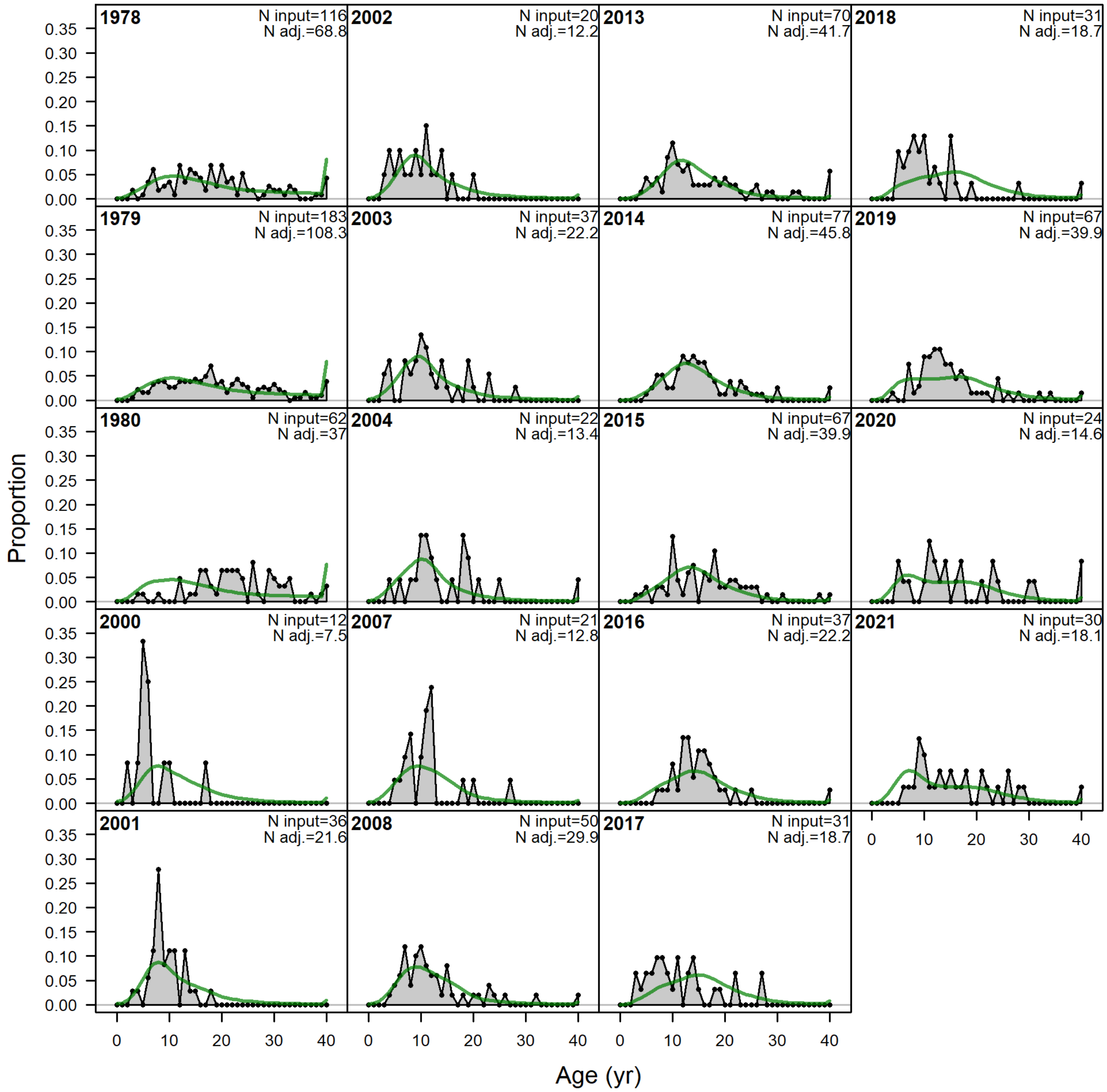


Figure 73. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - East fleet. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

Figure 74. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - East fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

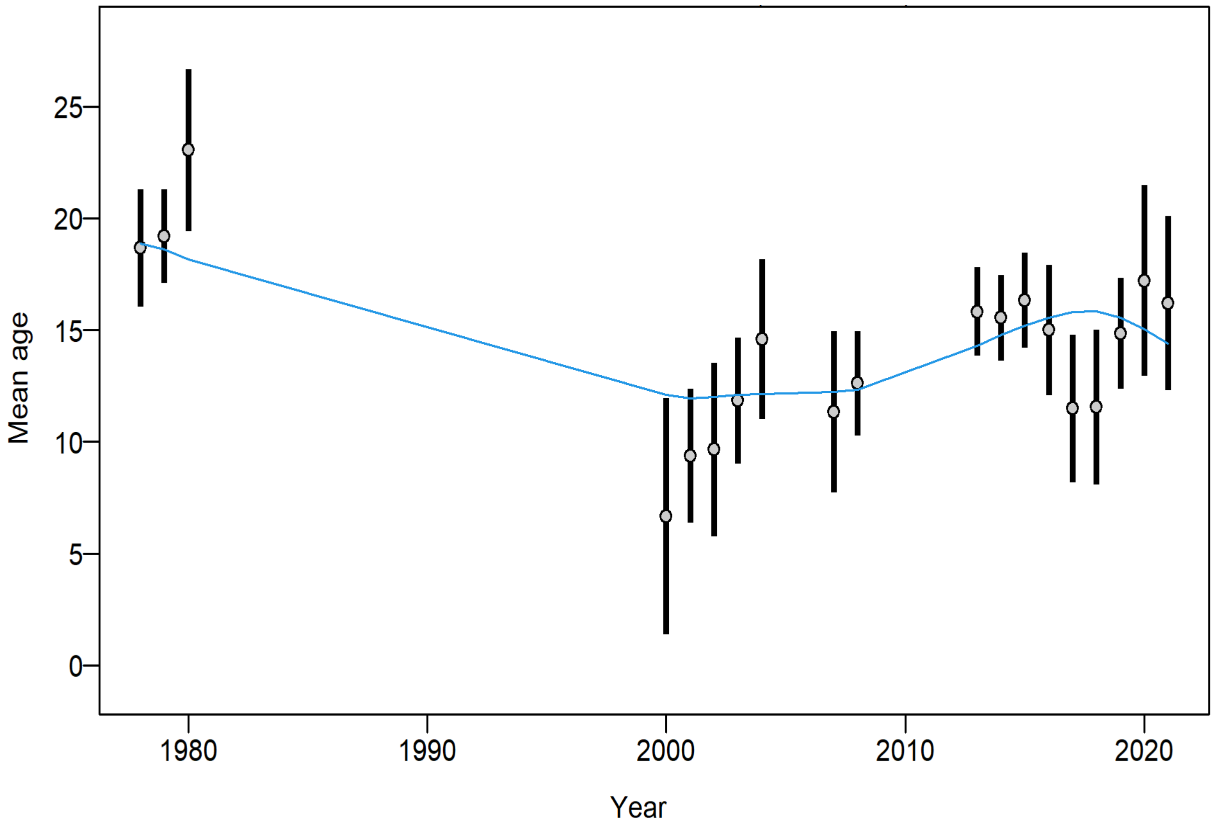


Figure 75. Mean age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - East fleet with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

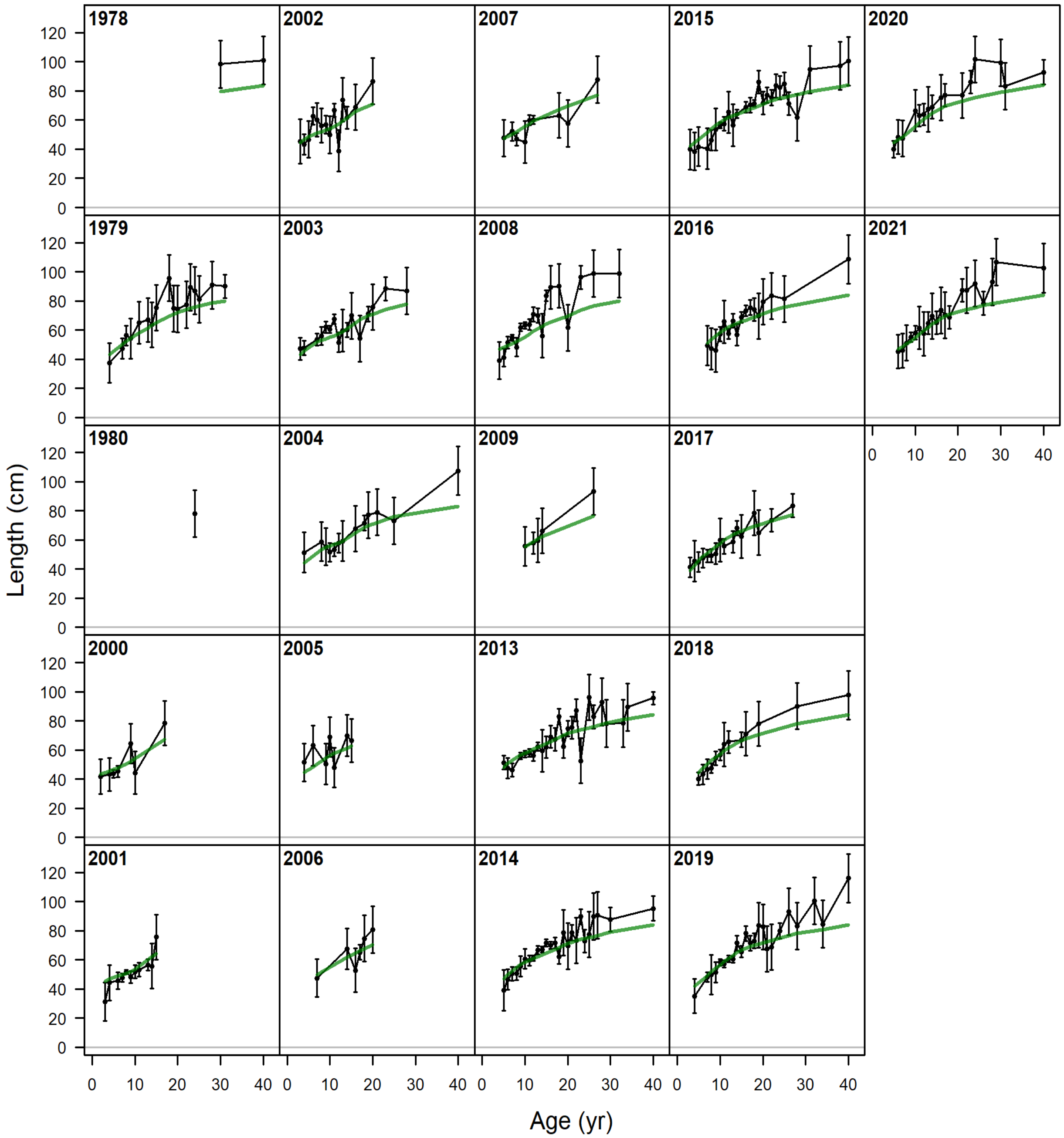


Figure 76. Observed and expected mean length-at-age for Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - East fleet. Green lines represent expected mean length-at-age, while solid lines with vertical bars represent observed mean length-at-age with error bars. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

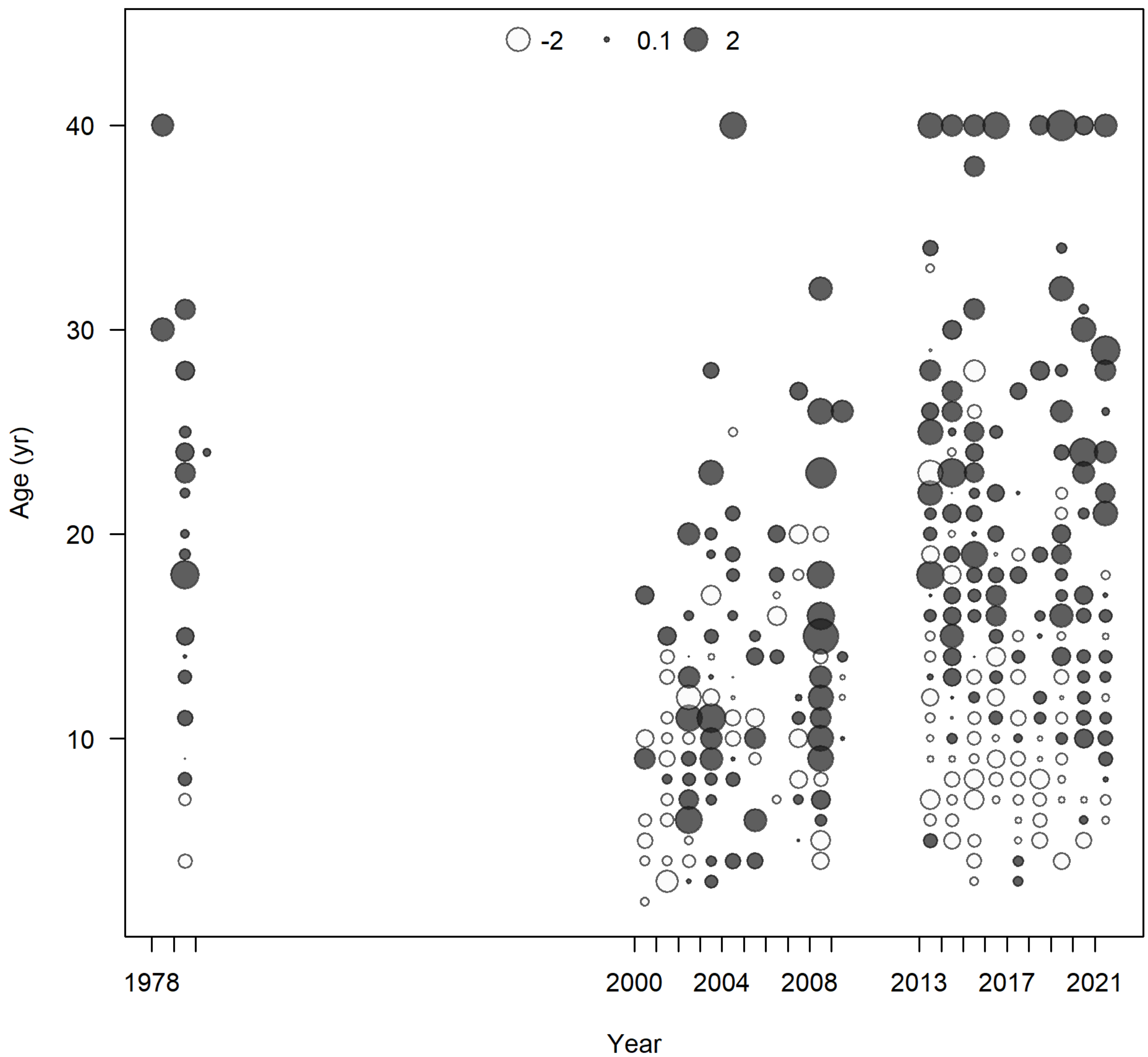


Figure 77. Pearson residuals for mean length-at-age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - East fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

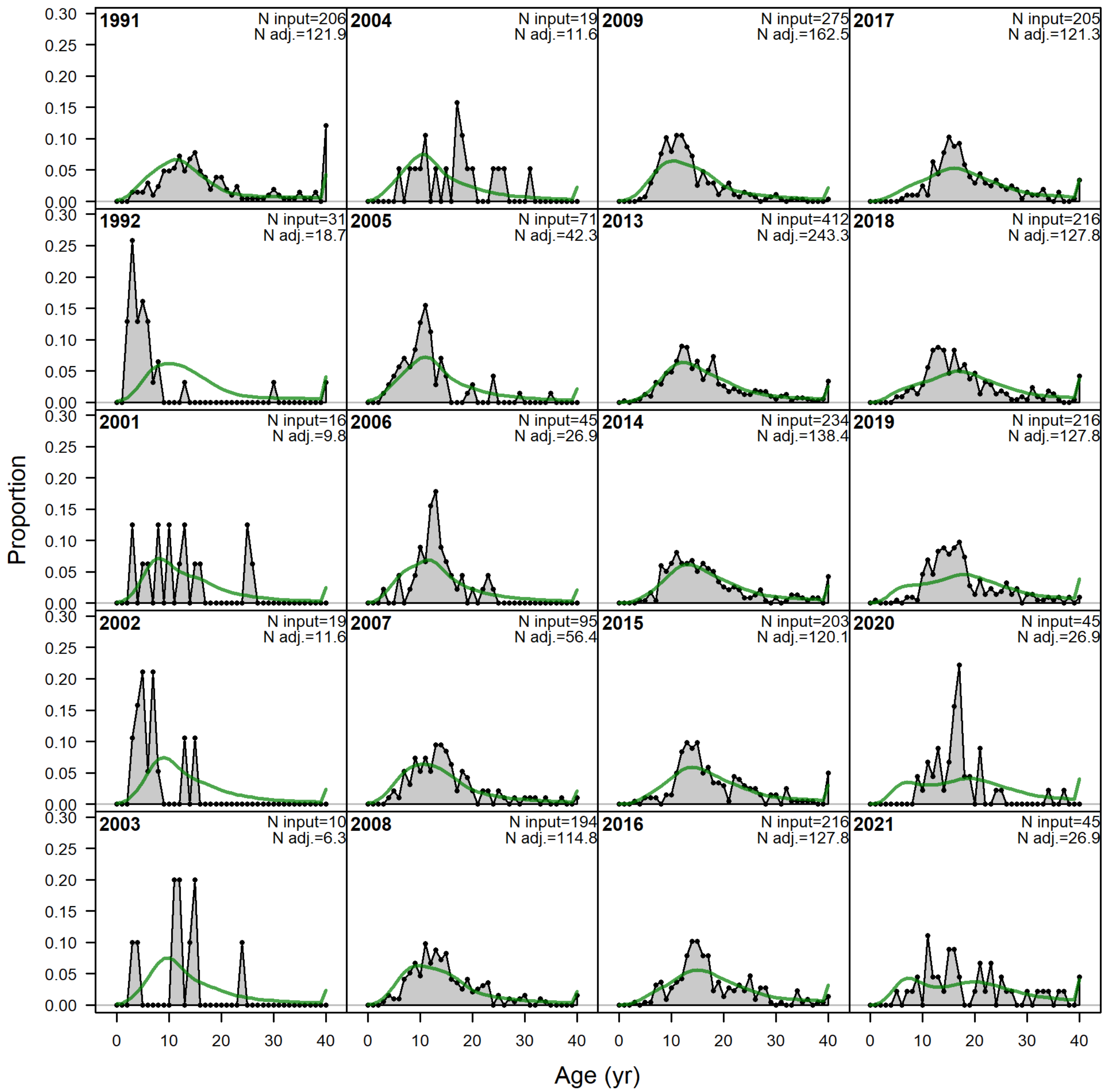


Figure 78. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - West fleet. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

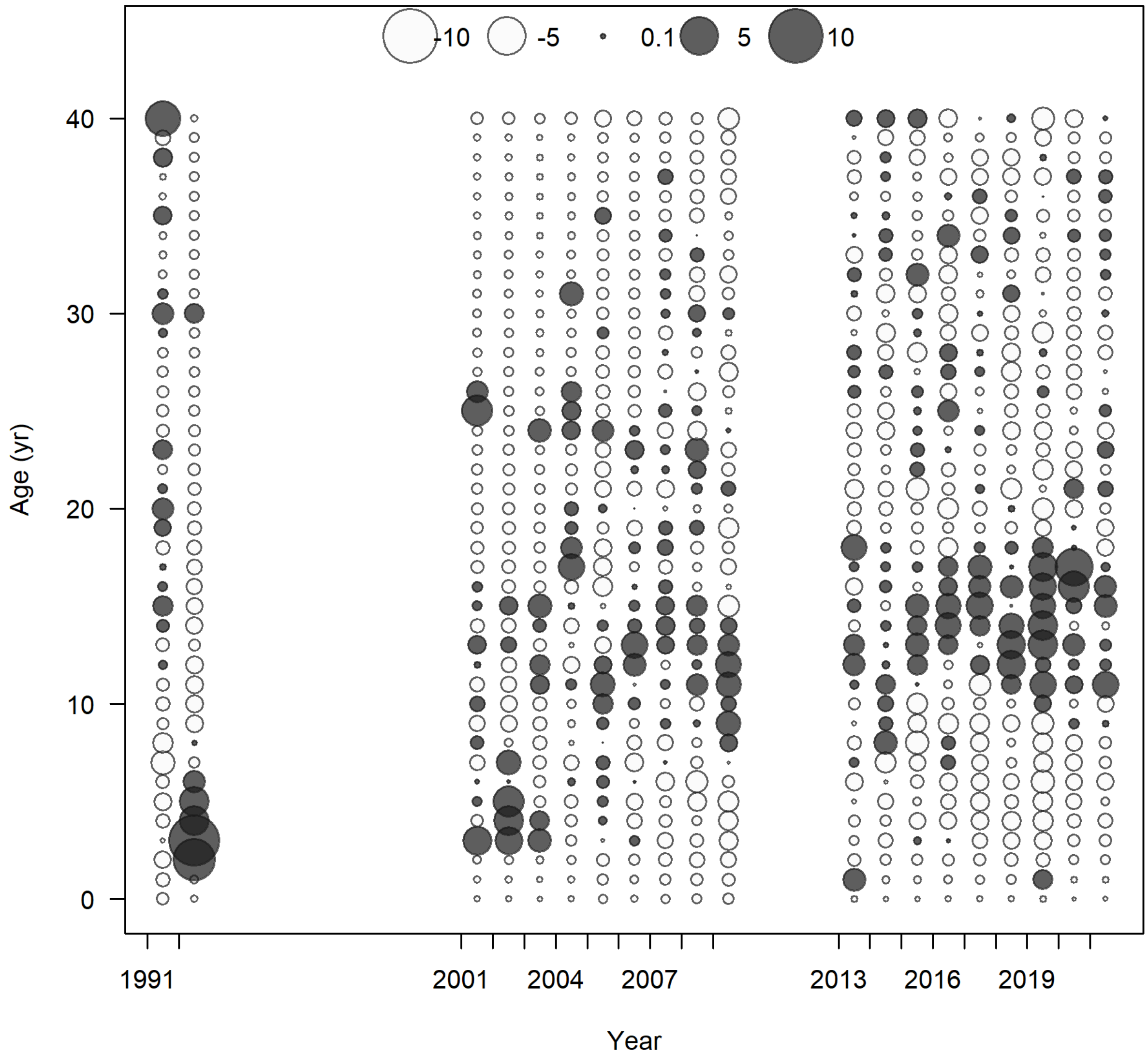


Figure 79. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - West fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

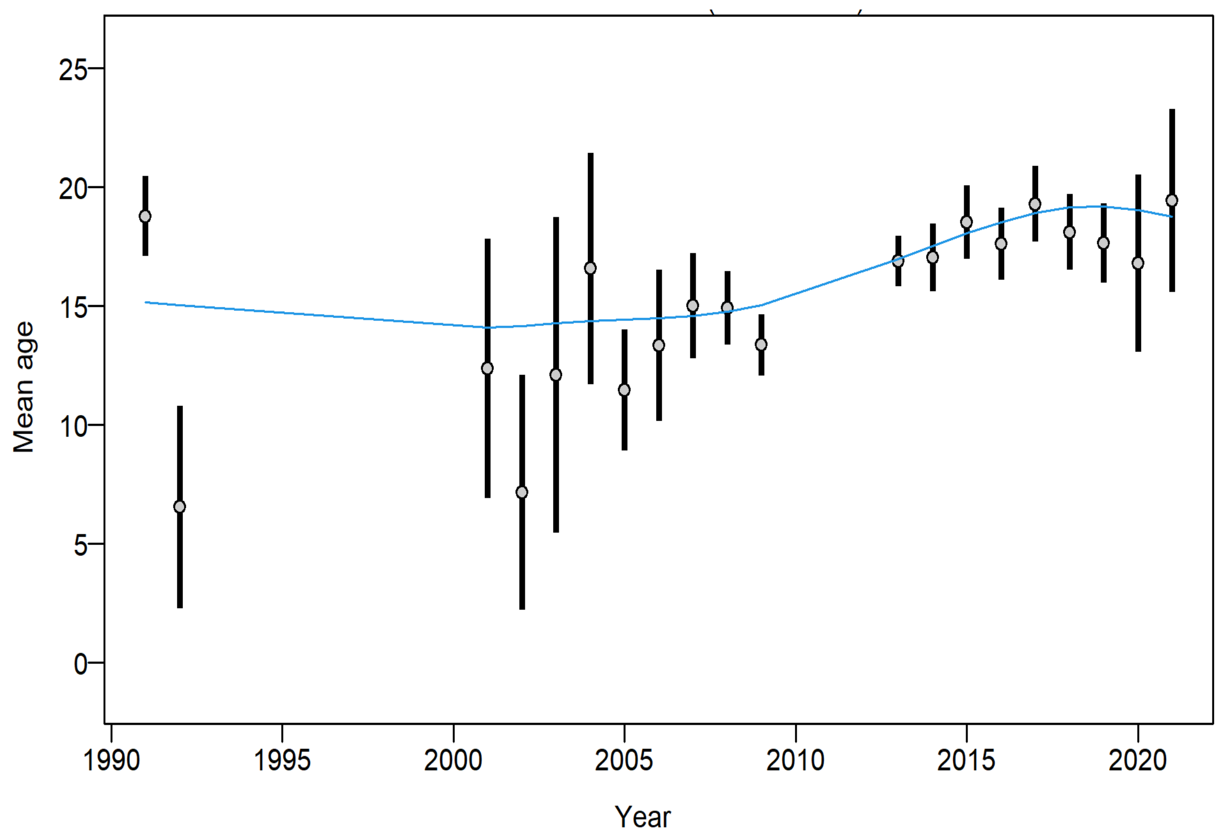


Figure 80. Mean age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - West fleet with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

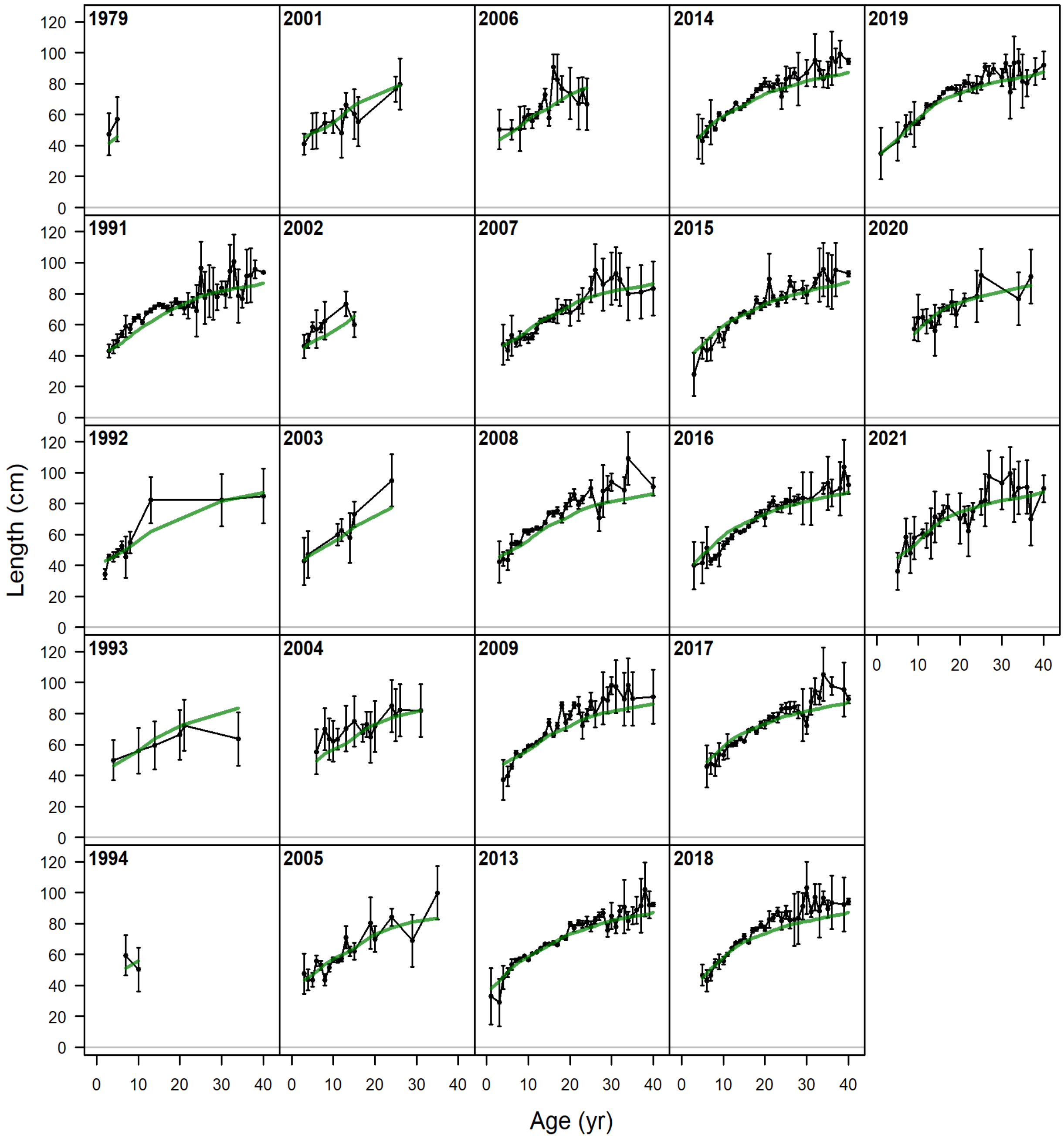


Figure 81. Observed and expected mean length-at-age for Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - West fleet. Green lines represent expected mean length-at-age, while solid lines with vertical bars represent observed mean length-at-age with error bars. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

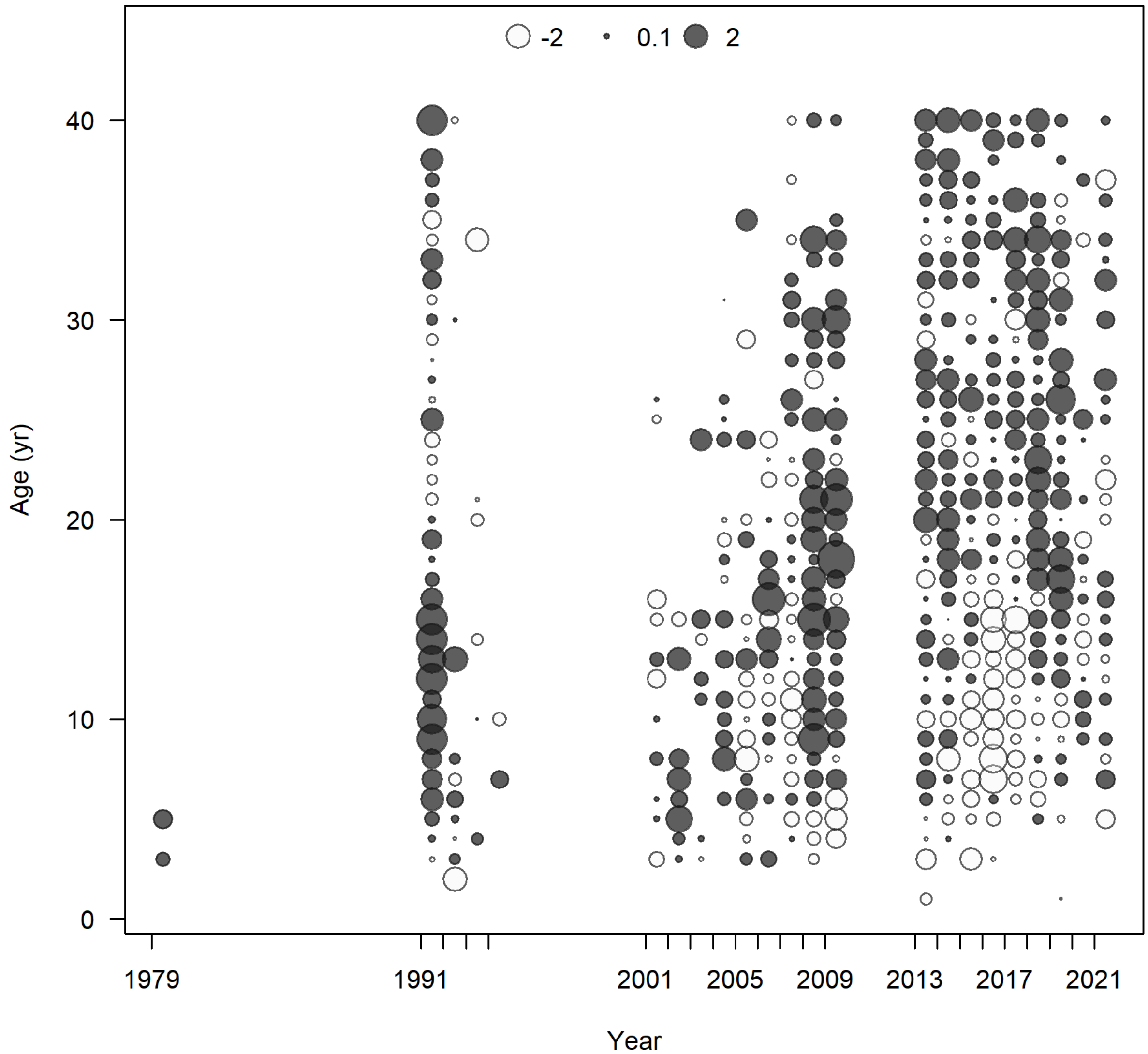


Figure 82. Pearson residuals for mean length-at-age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Vertical Line - West fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

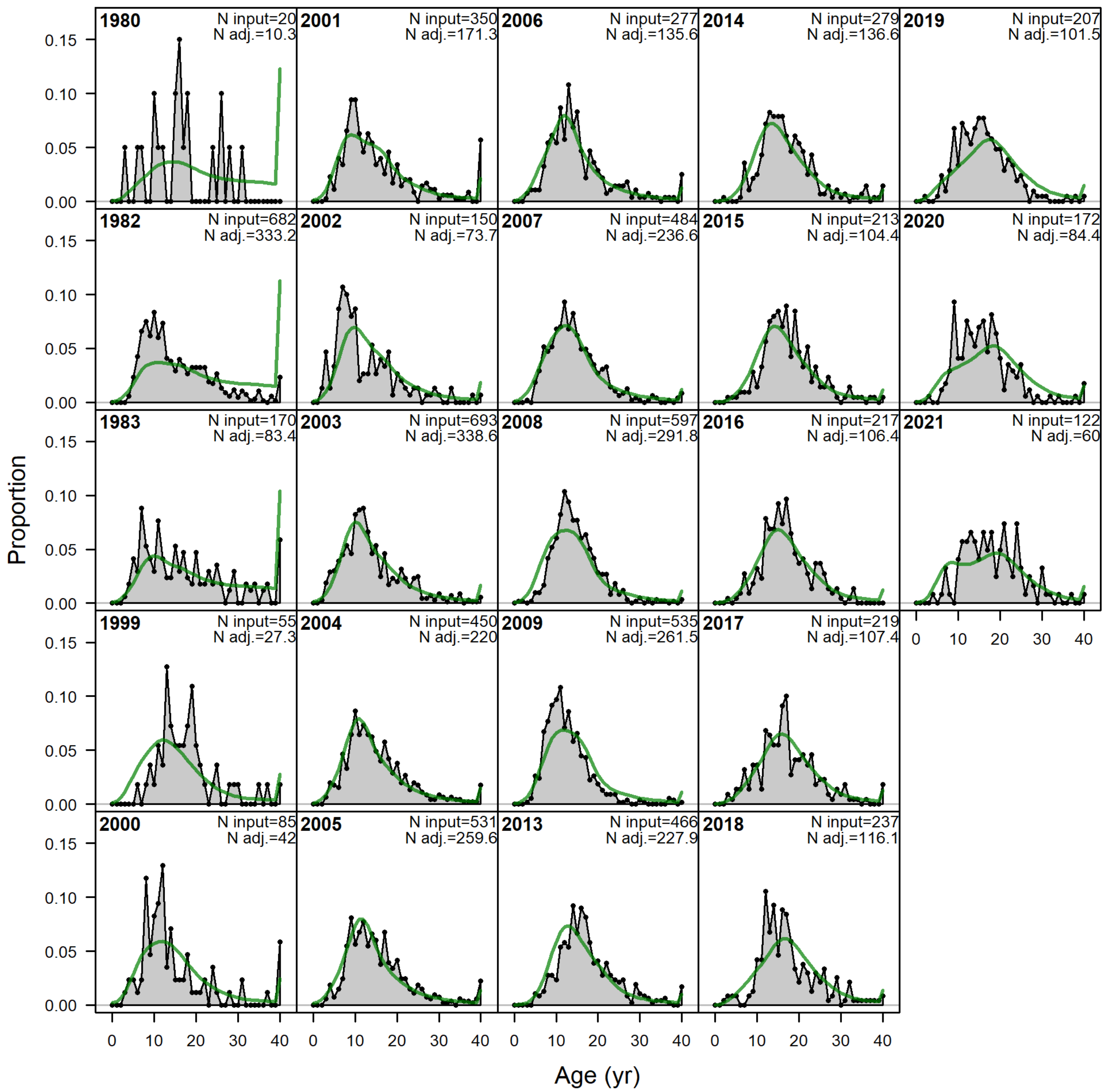


Figure 83. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - East fleet. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

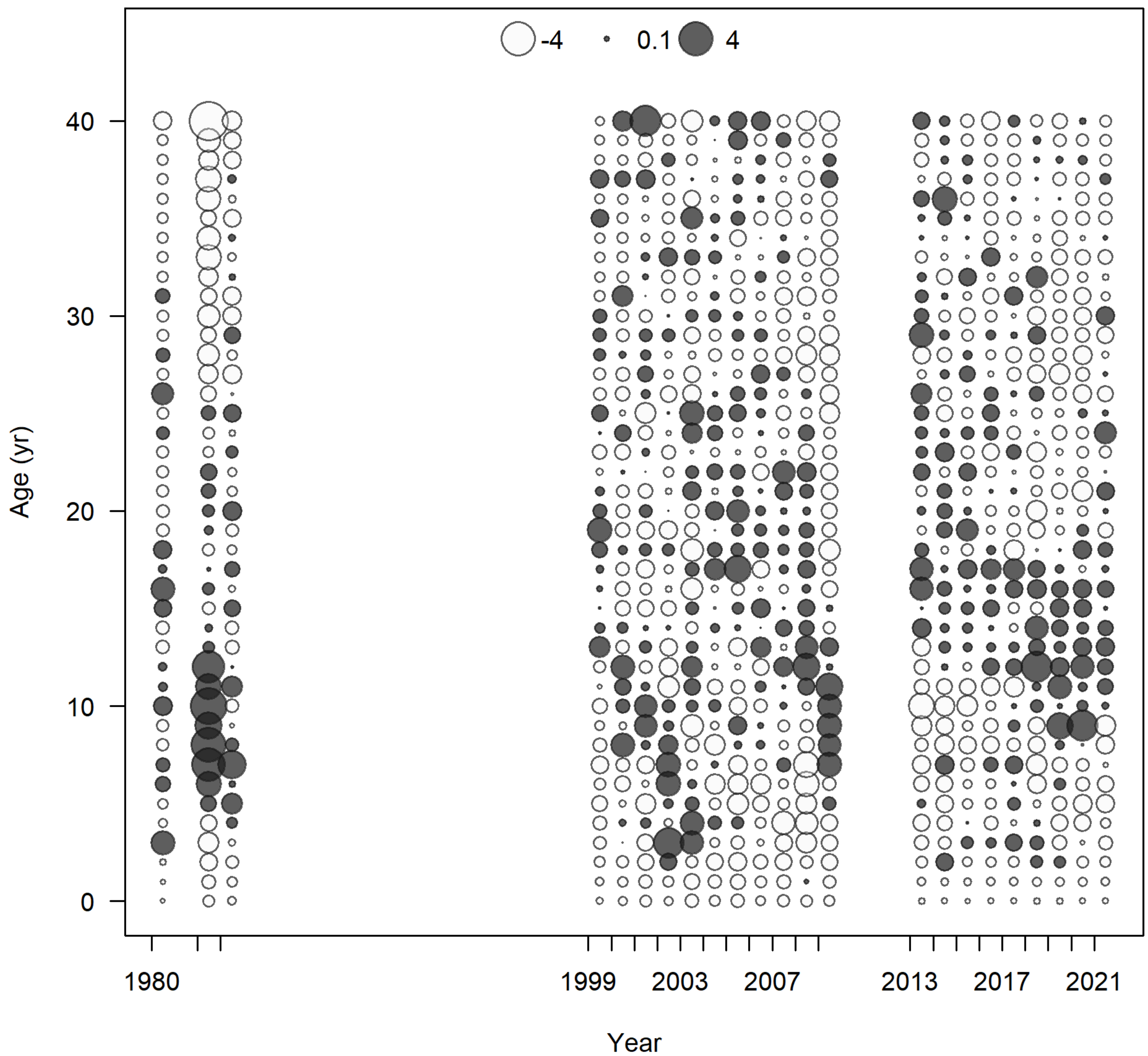


Figure 84. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - East fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

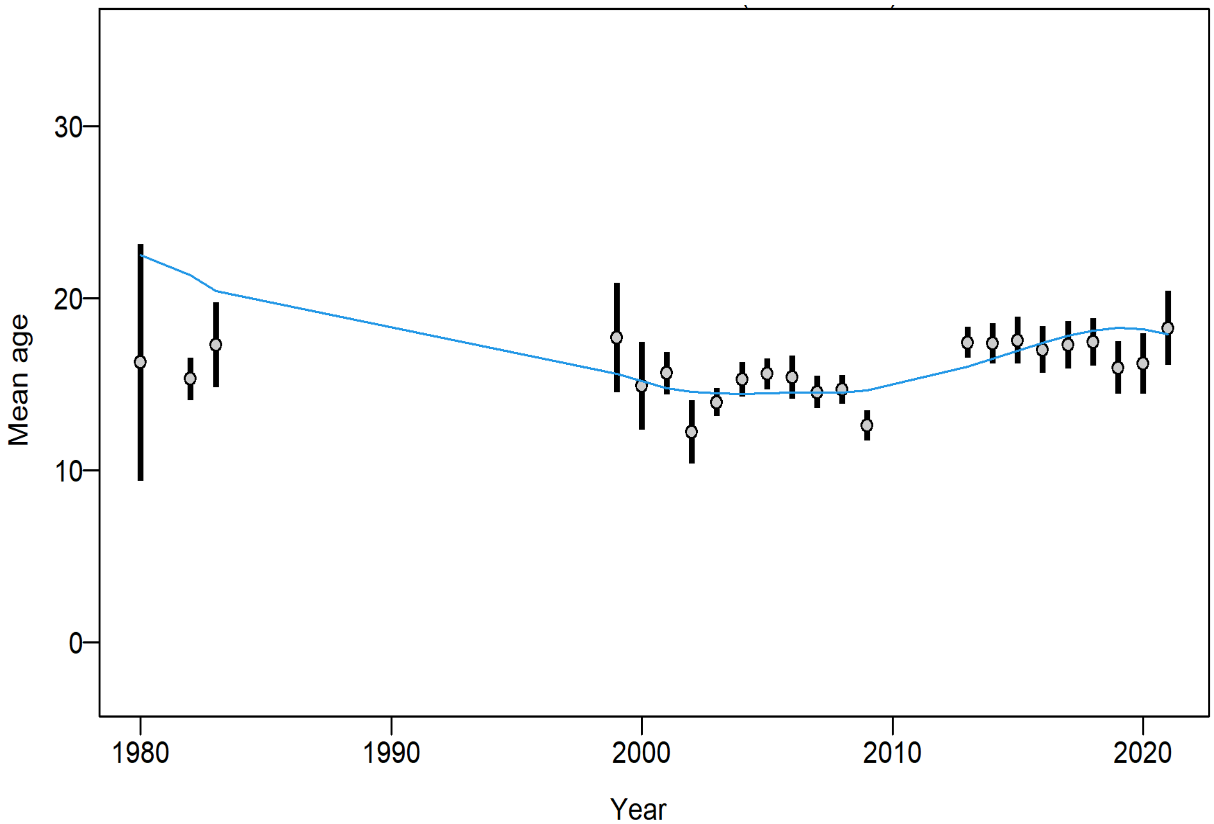


Figure 85. Mean age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - East fleet with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

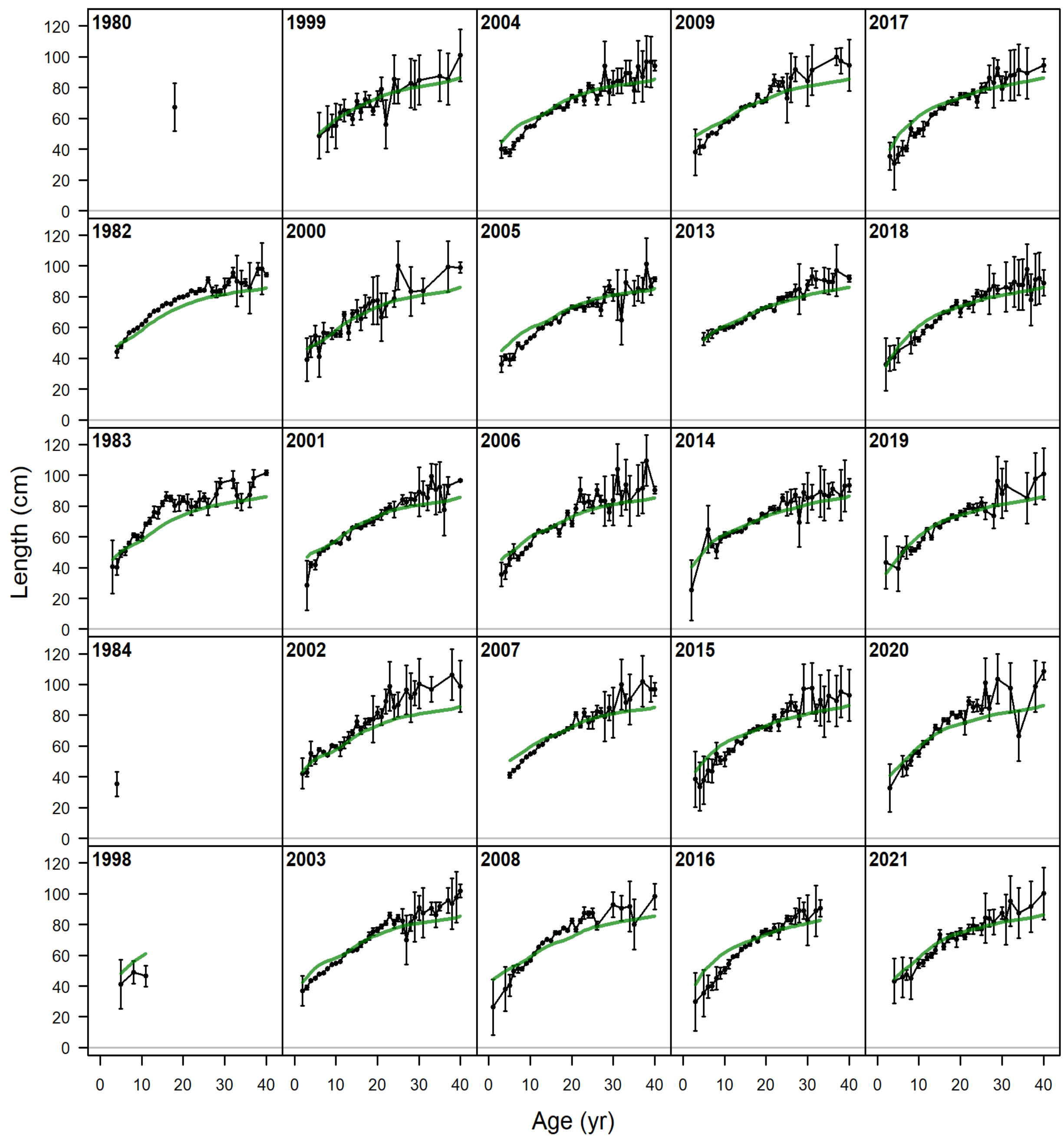


Figure 86. Observed and expected mean length-at-age for Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - East fleet. Green lines represent expected mean length-at-age, while solid lines with vertical bars represent observed mean length-at-age with error bars. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

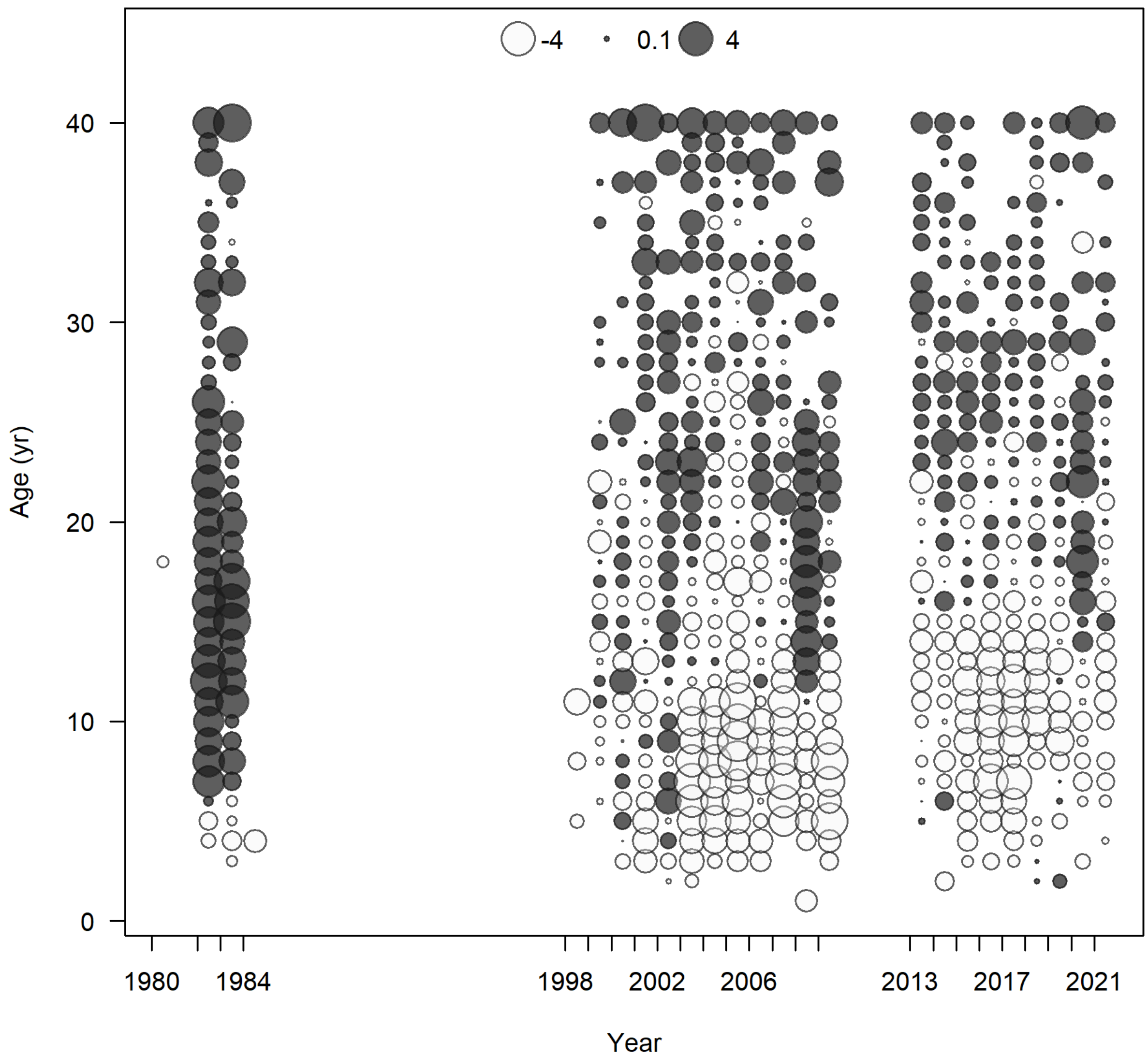


Figure 87. Pearson residuals for mean length-at-age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - East fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

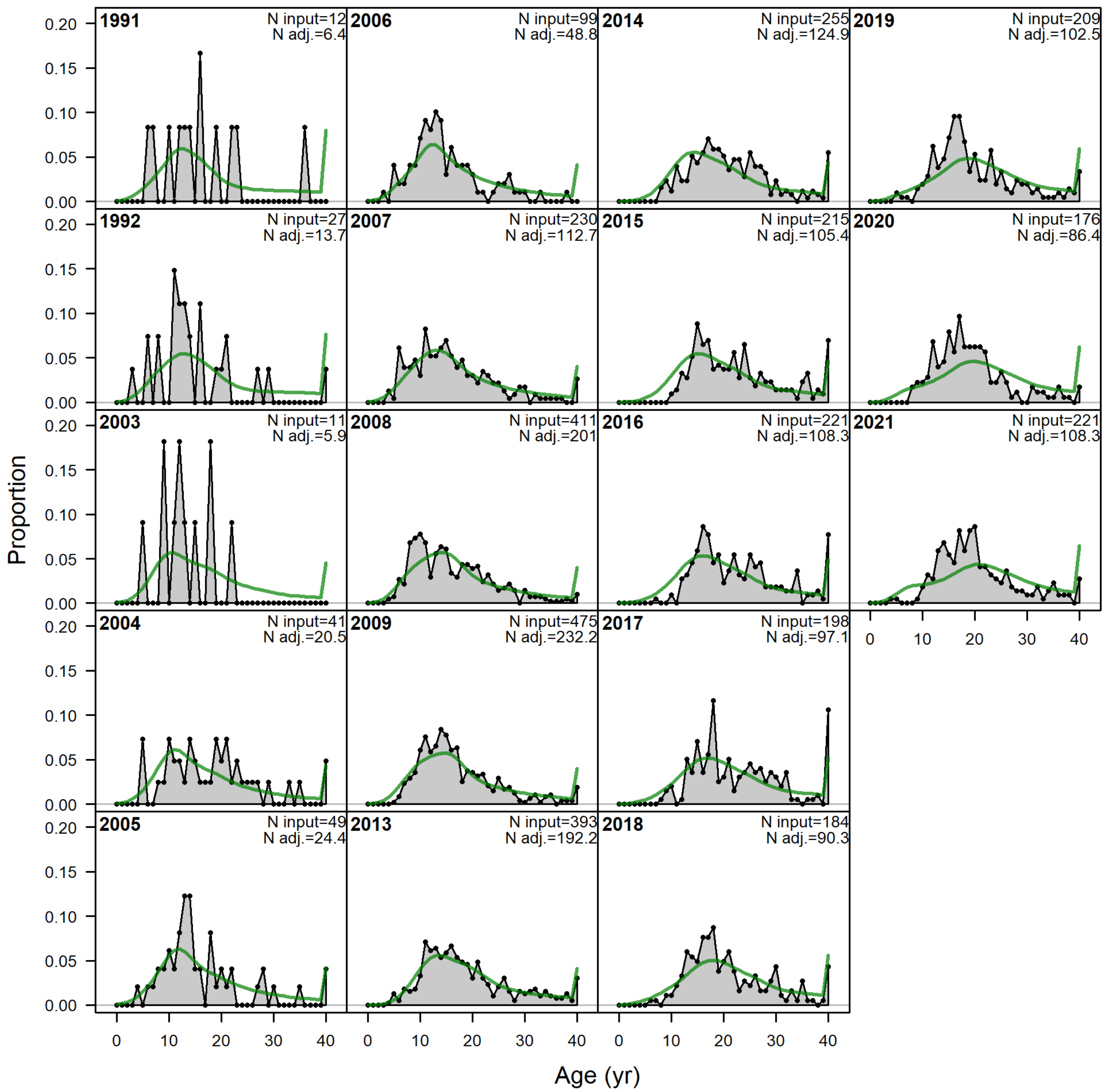


Figure 88. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - West fleet. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

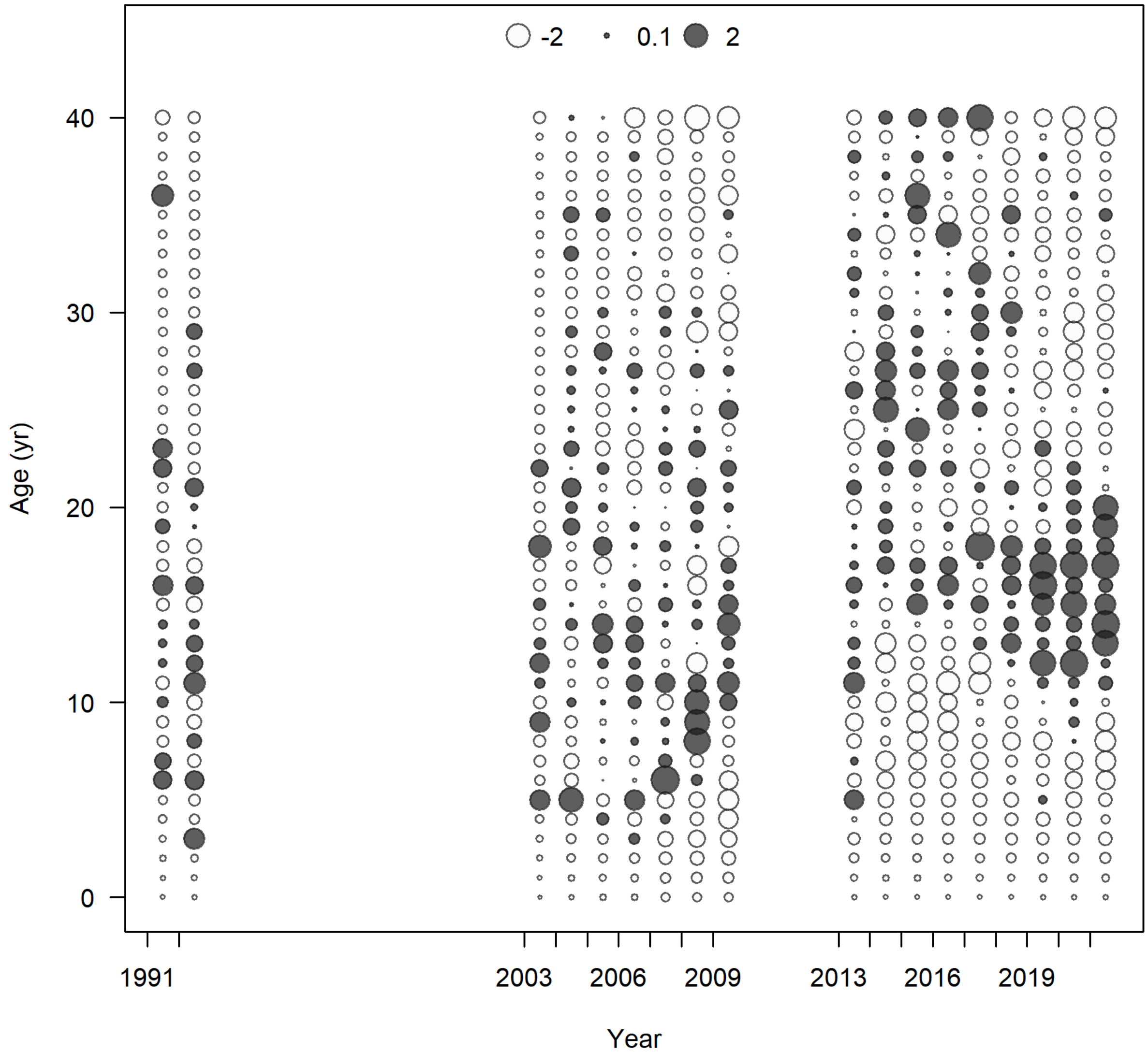


Figure 89. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - West fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

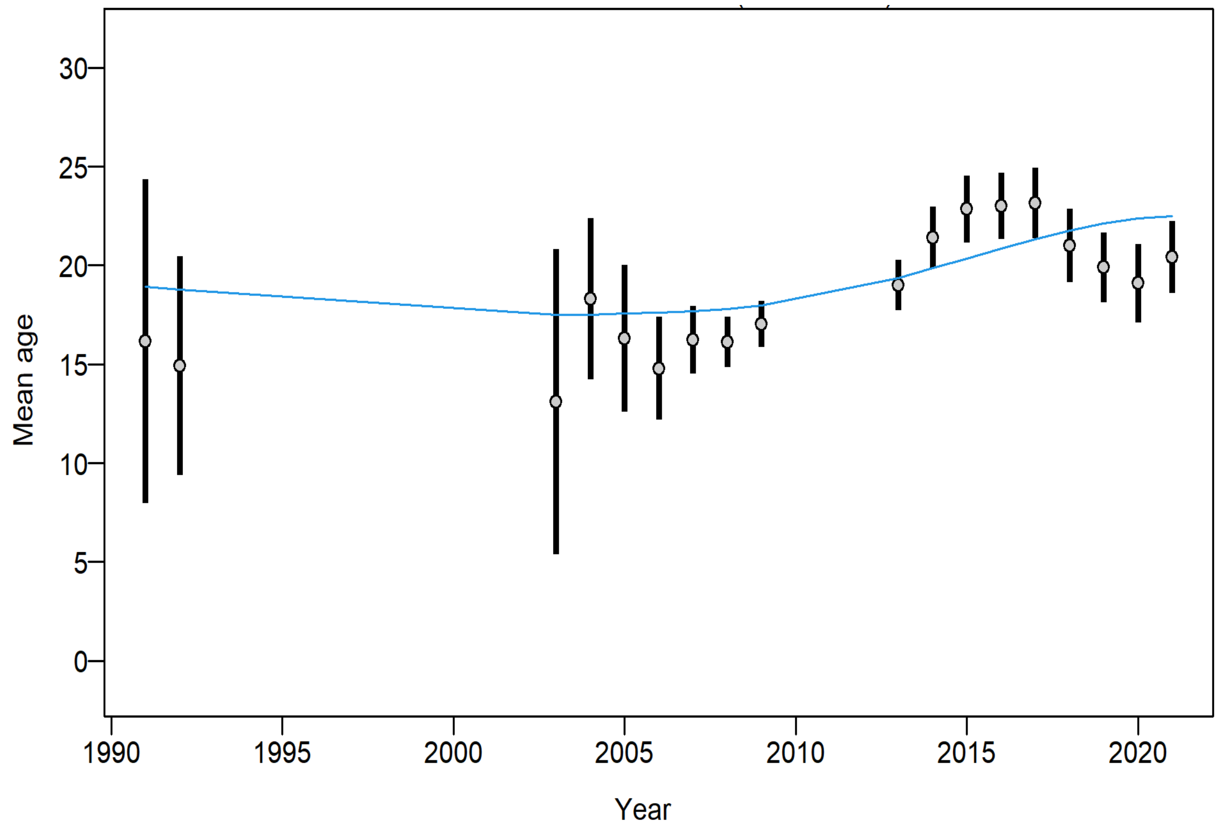


Figure 90. Mean age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - West fleet with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

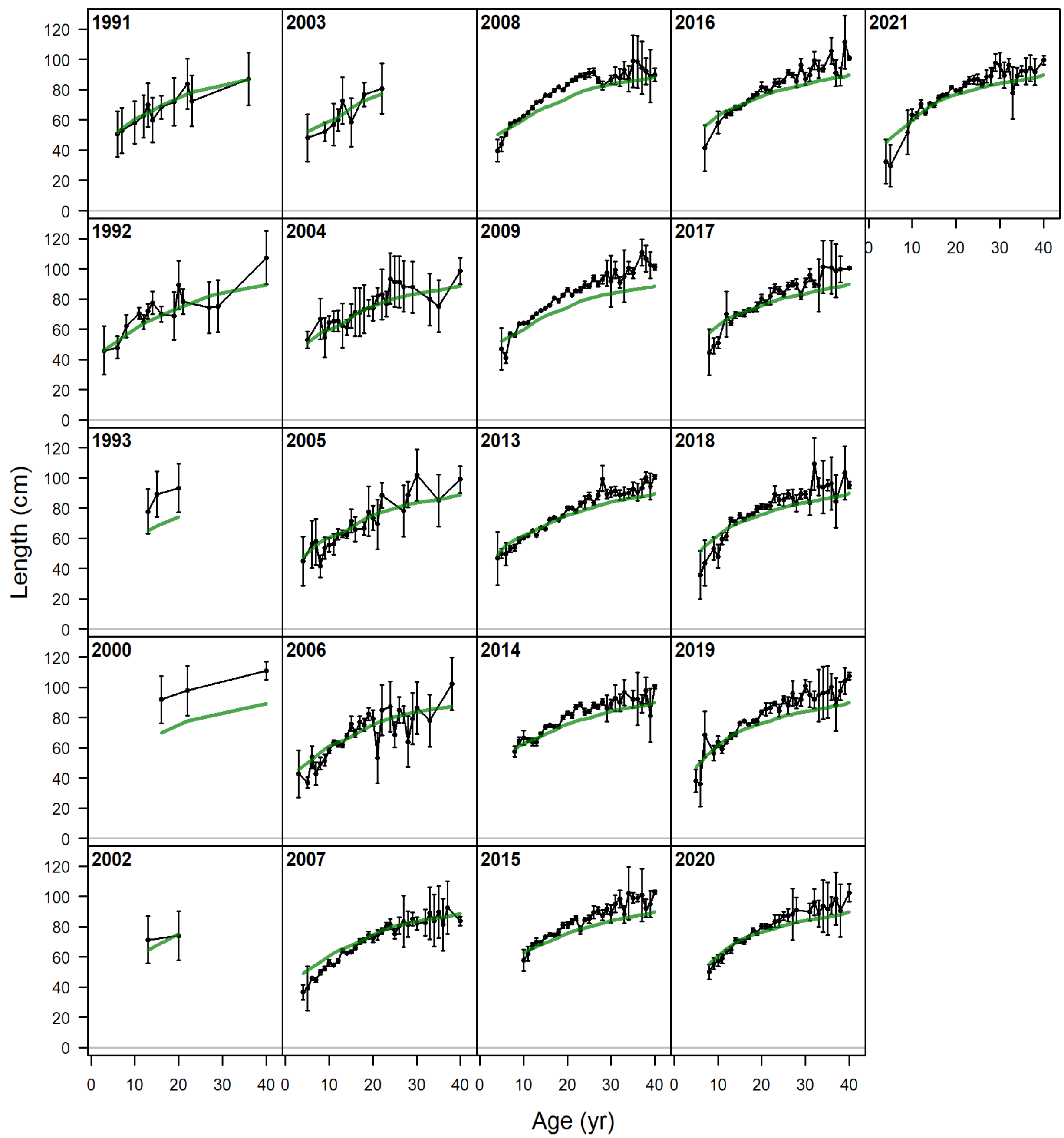


Figure 91. Observed and expected mean length-at-age for Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - West fleet. Green lines represent expected mean length-at-age, while solid lines with vertical bars represent observed mean length-at-age with error bars. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

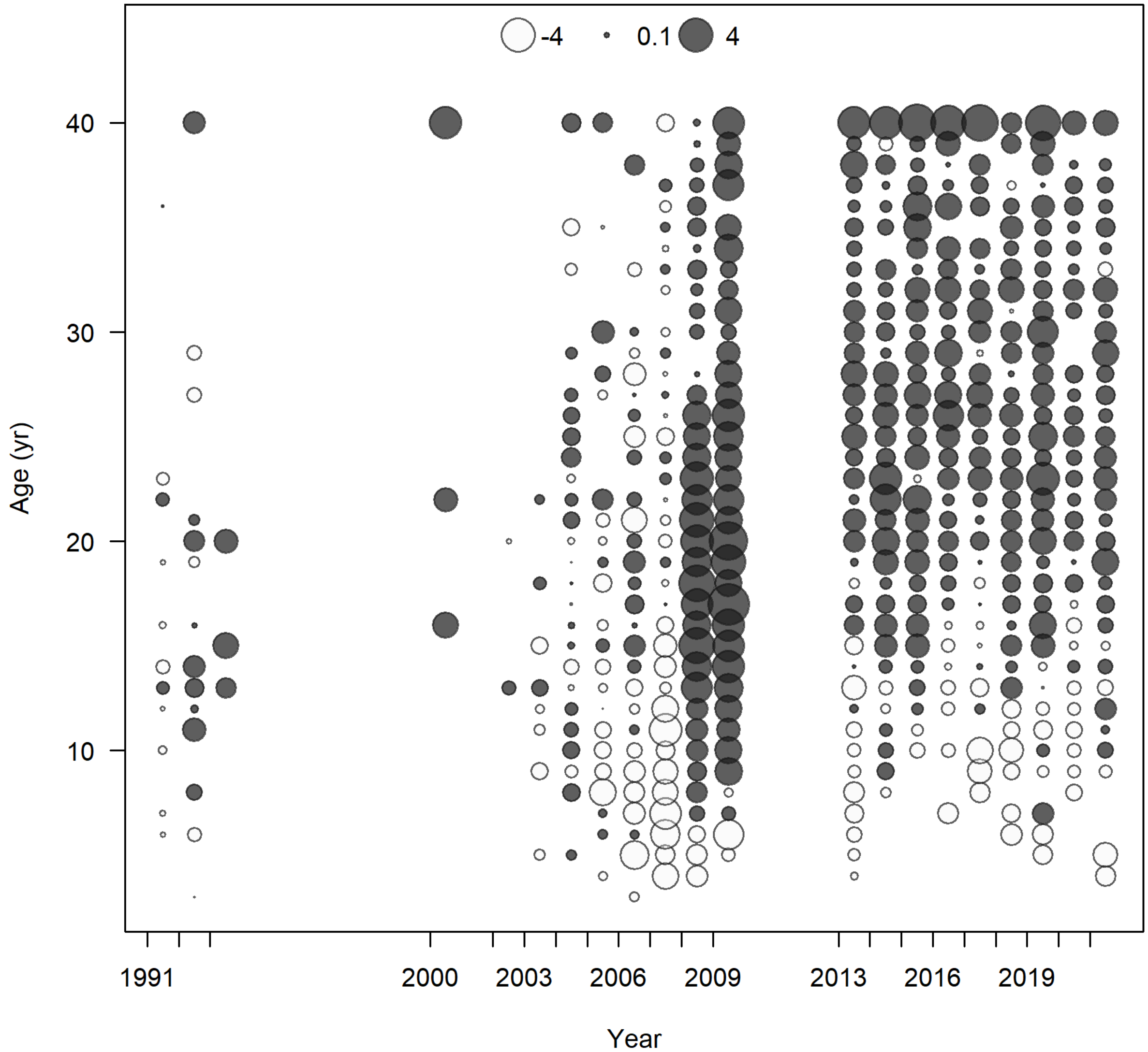


Figure 92. Pearson residuals for mean length-at-age of Gulf of Mexico Yellowedge Grouper landed by the Commercial Longline - West fleet. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

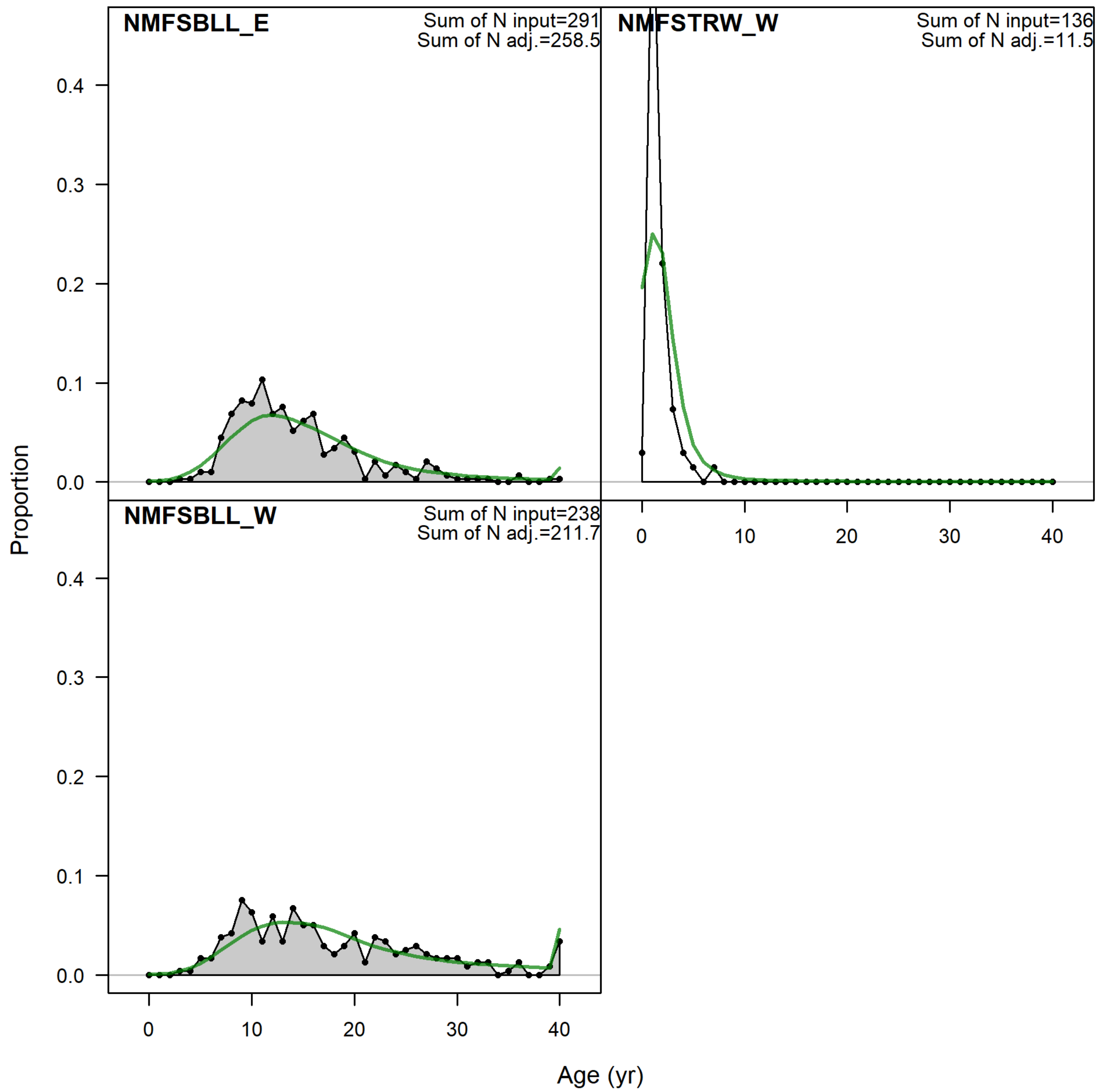


Figure 93. Model fits to the age composition of Yellowedge Grouper aggregated across years for the NMFS Bottom Longline Survey (NMFSBLL) and NMFS/SEAMAP Groundfish Trawl Survey (NMFSTRW) in the Eastern (E) and Western (W) Gulf of Mexico. Green lines represent predicted age compositions, while grey shaded regions represent observed age compositions. 'N input' is the input sample size (number of ages) and 'N adj.' is the sample size after adjustment by the Dirichlet-Multinomial parameter.

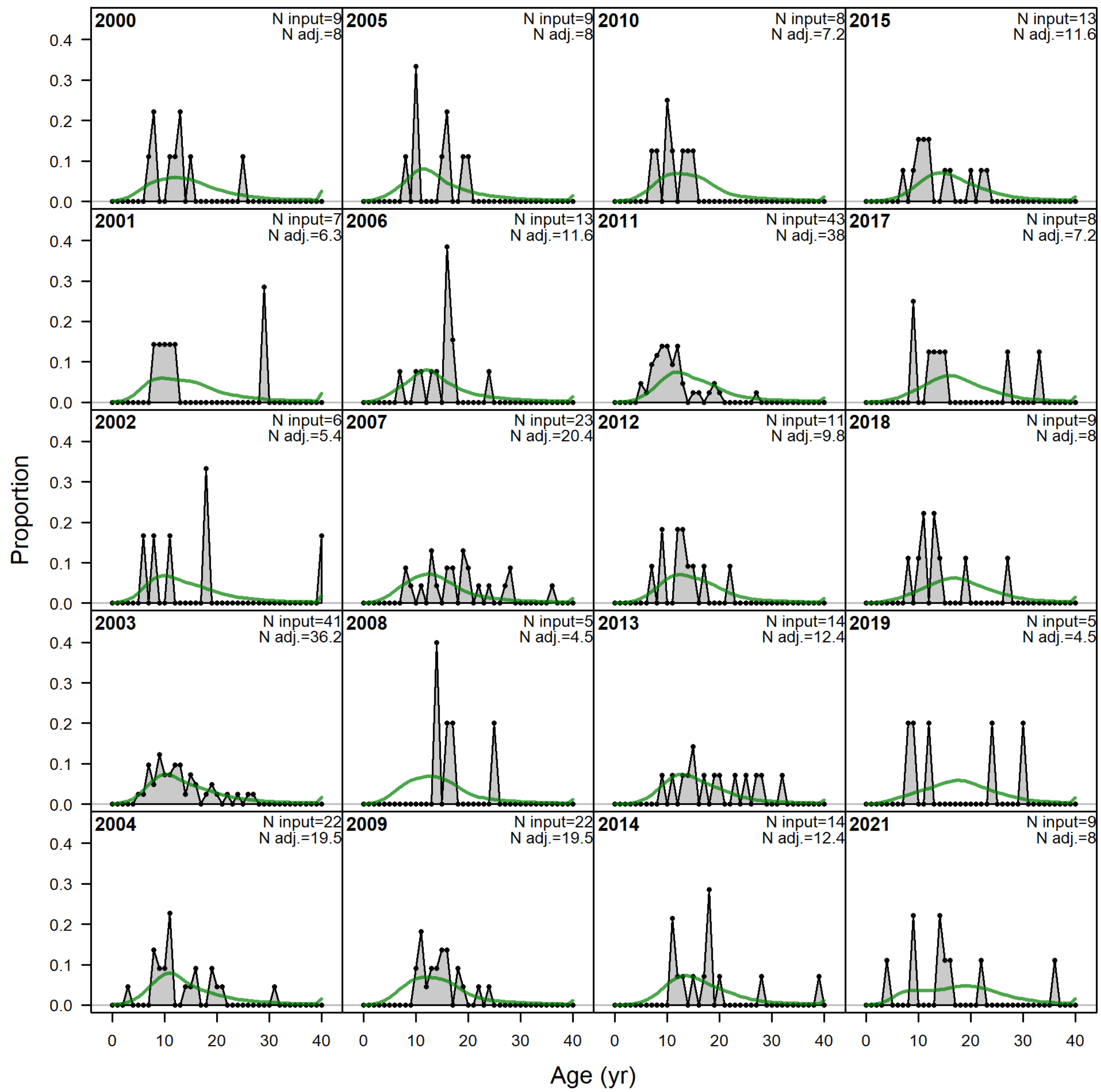


Figure 94. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - East. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

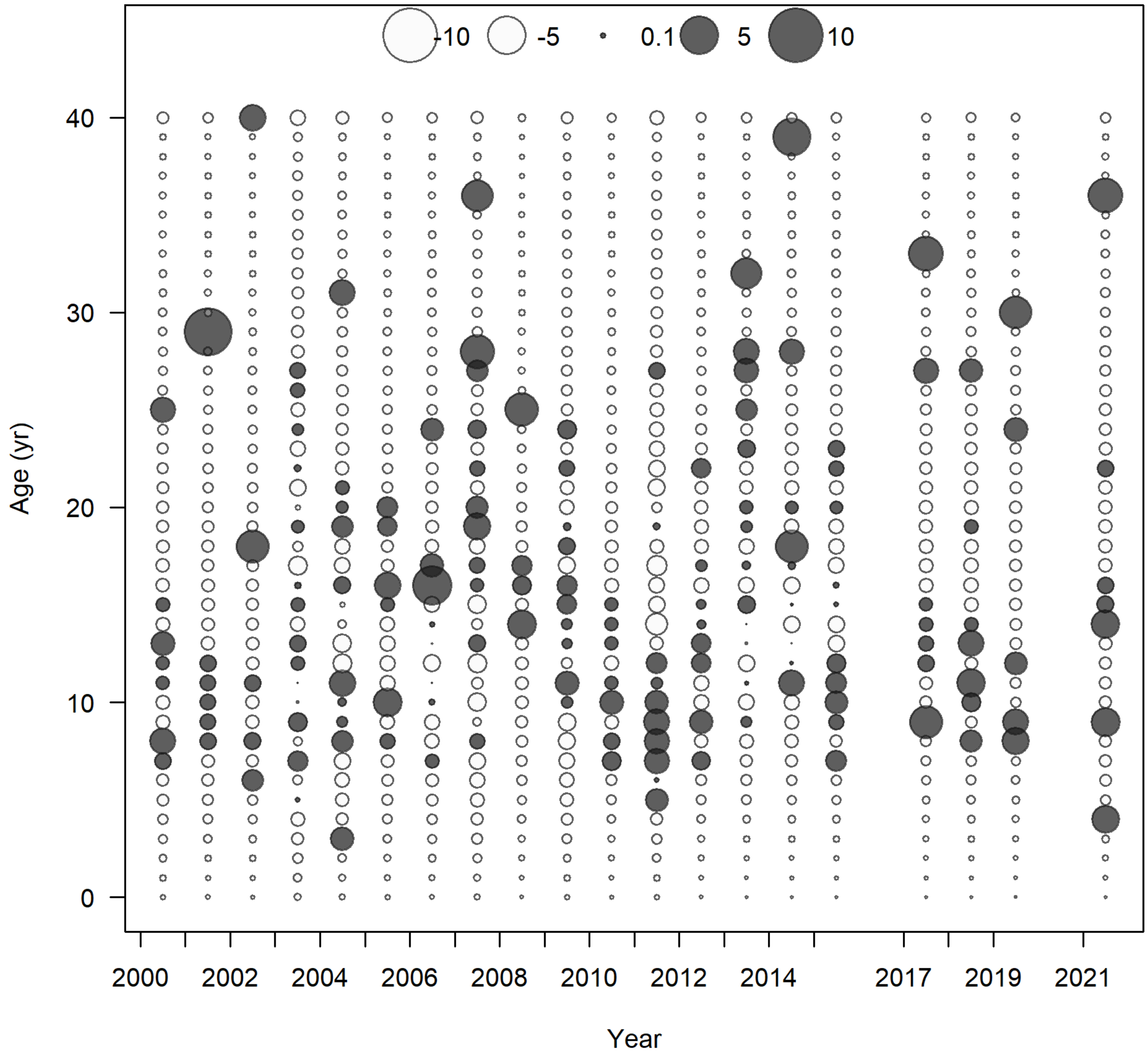


Figure 95. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - East. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

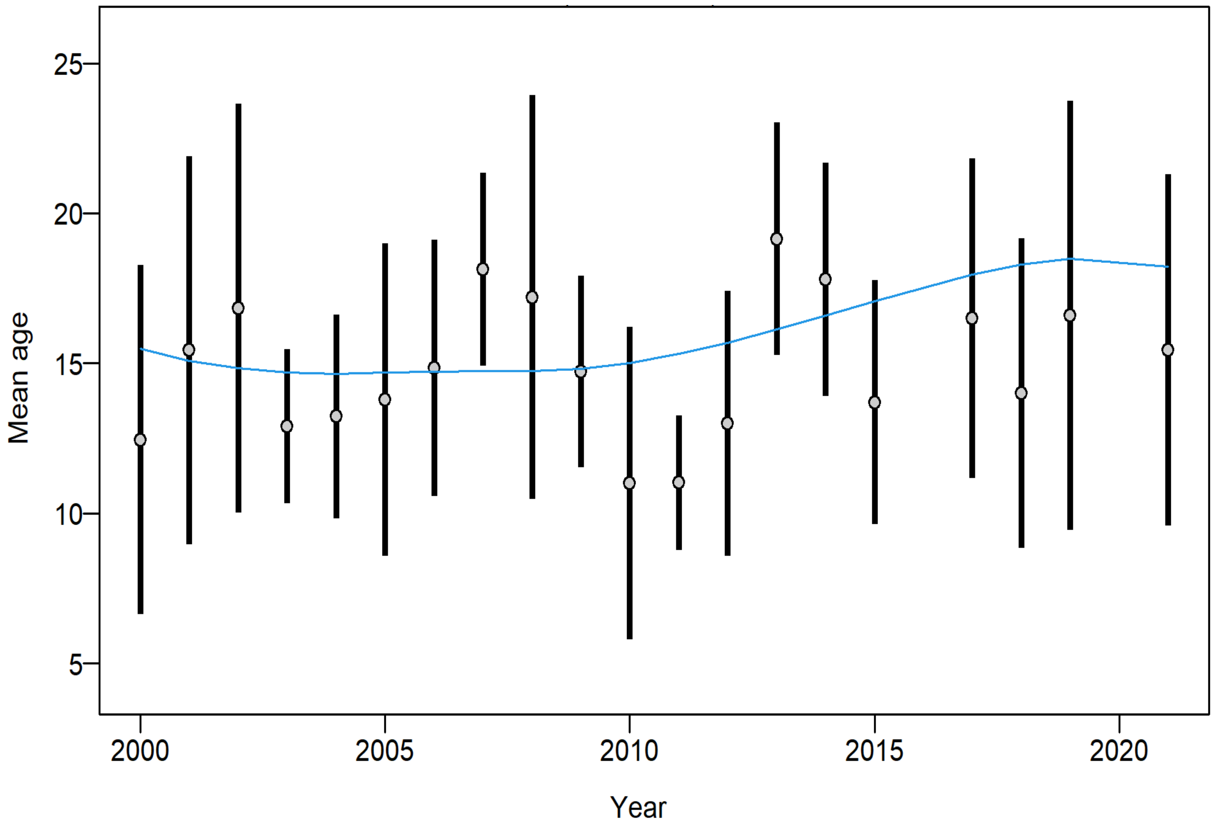


Figure 96. Mean age of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - East with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

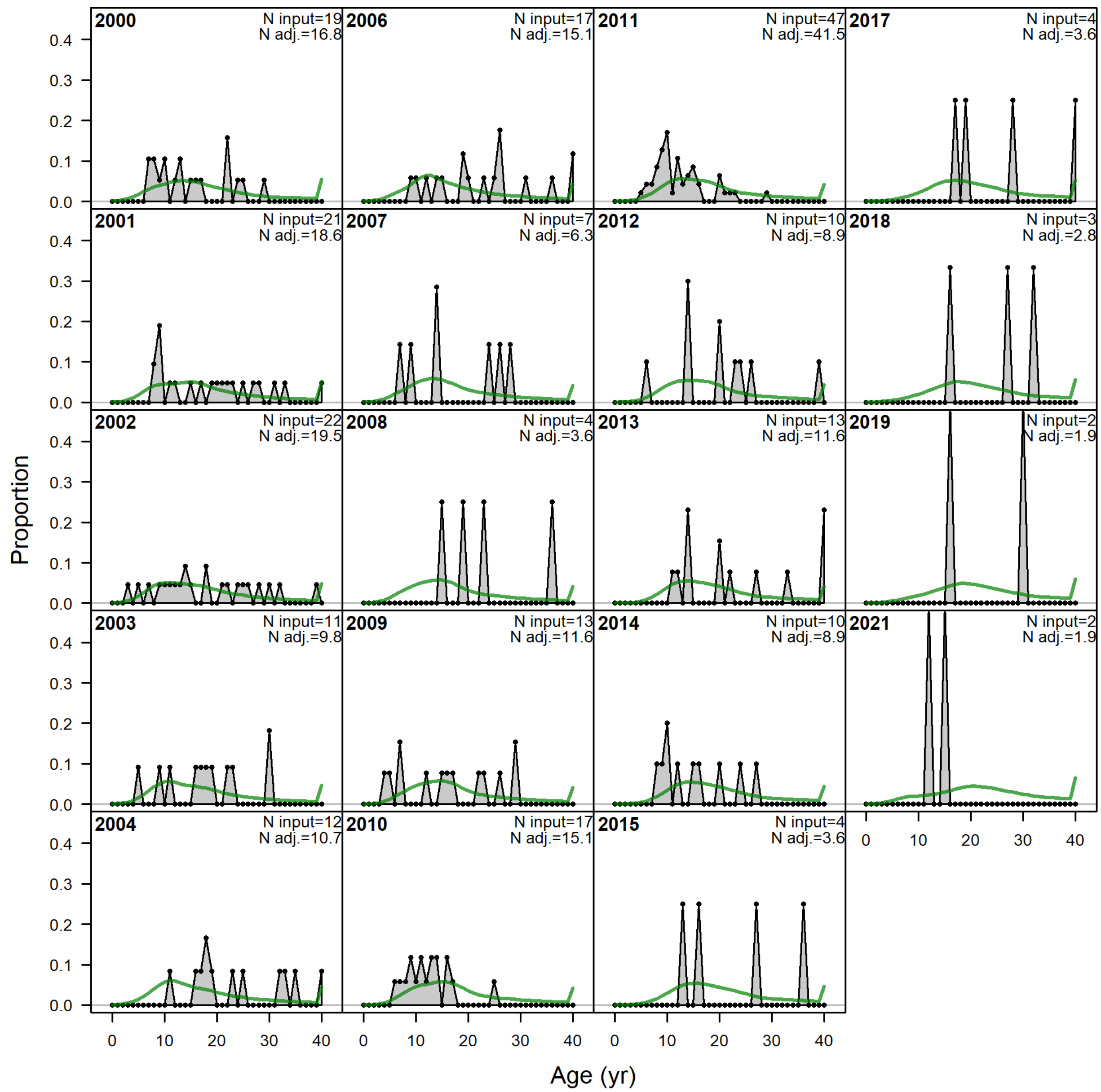


Figure 97. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - West. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

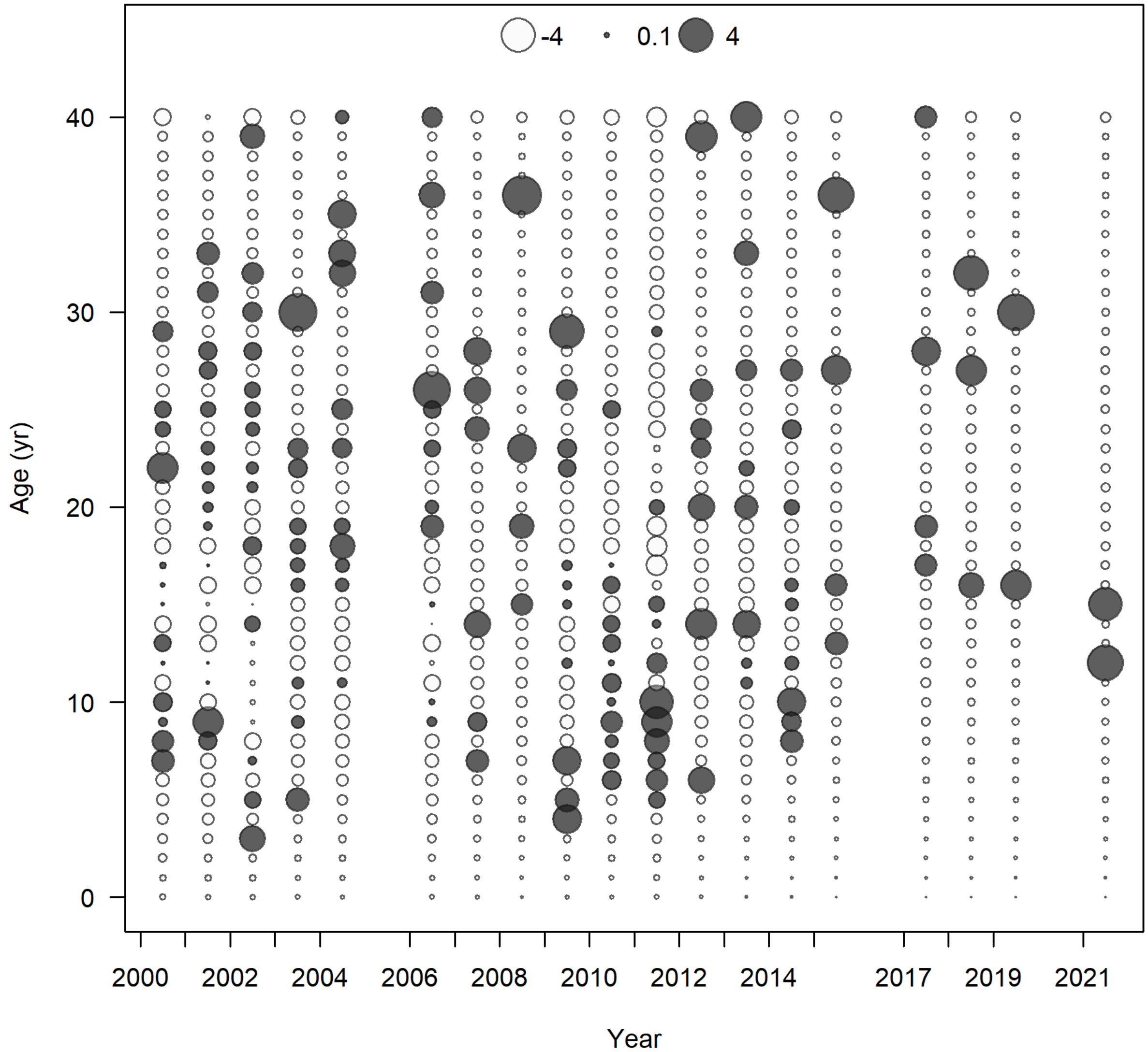


Figure 98. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - West. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

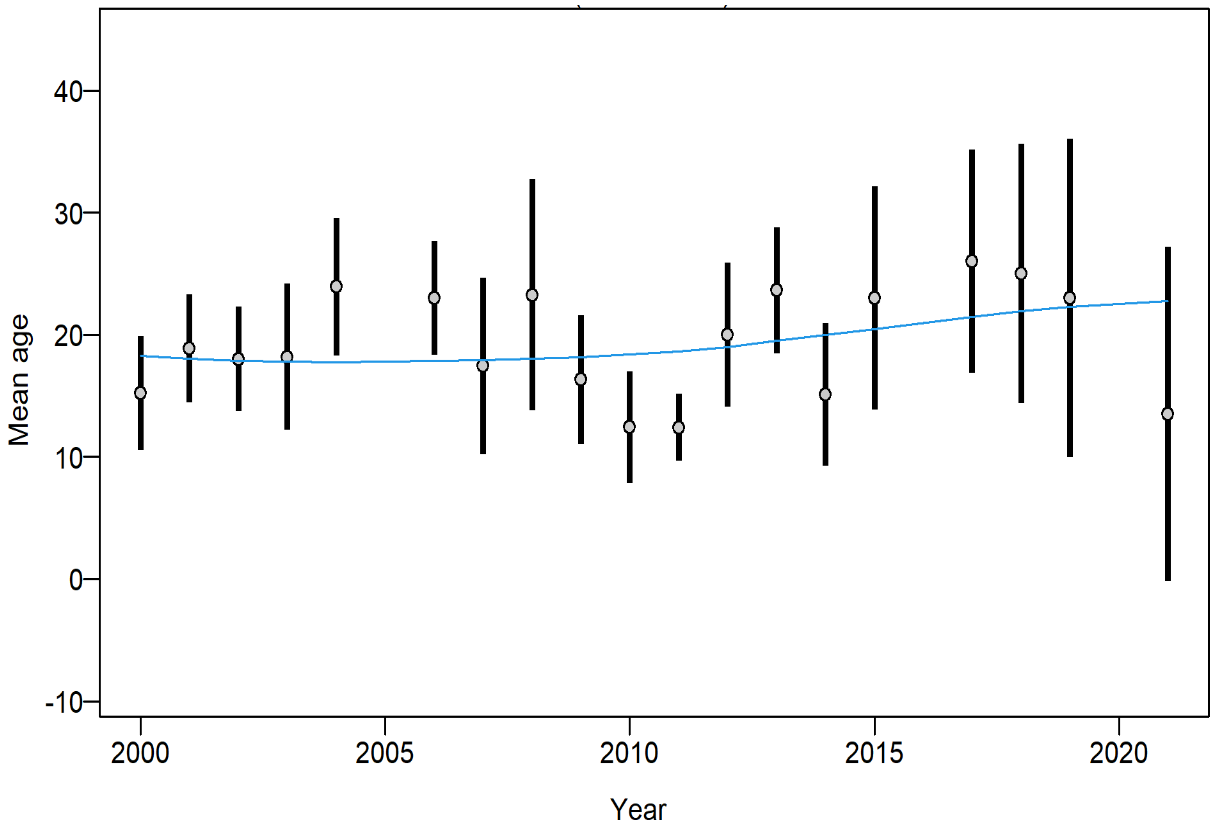


Figure 99. Mean age of Gulf of Mexico Yellowedge Grouper caught by the NMFS Bottom Longline Survey - West with 95% confidence intervals (thick bars) based on current sample sizes (including any Dirichlet Multinomial weighting).

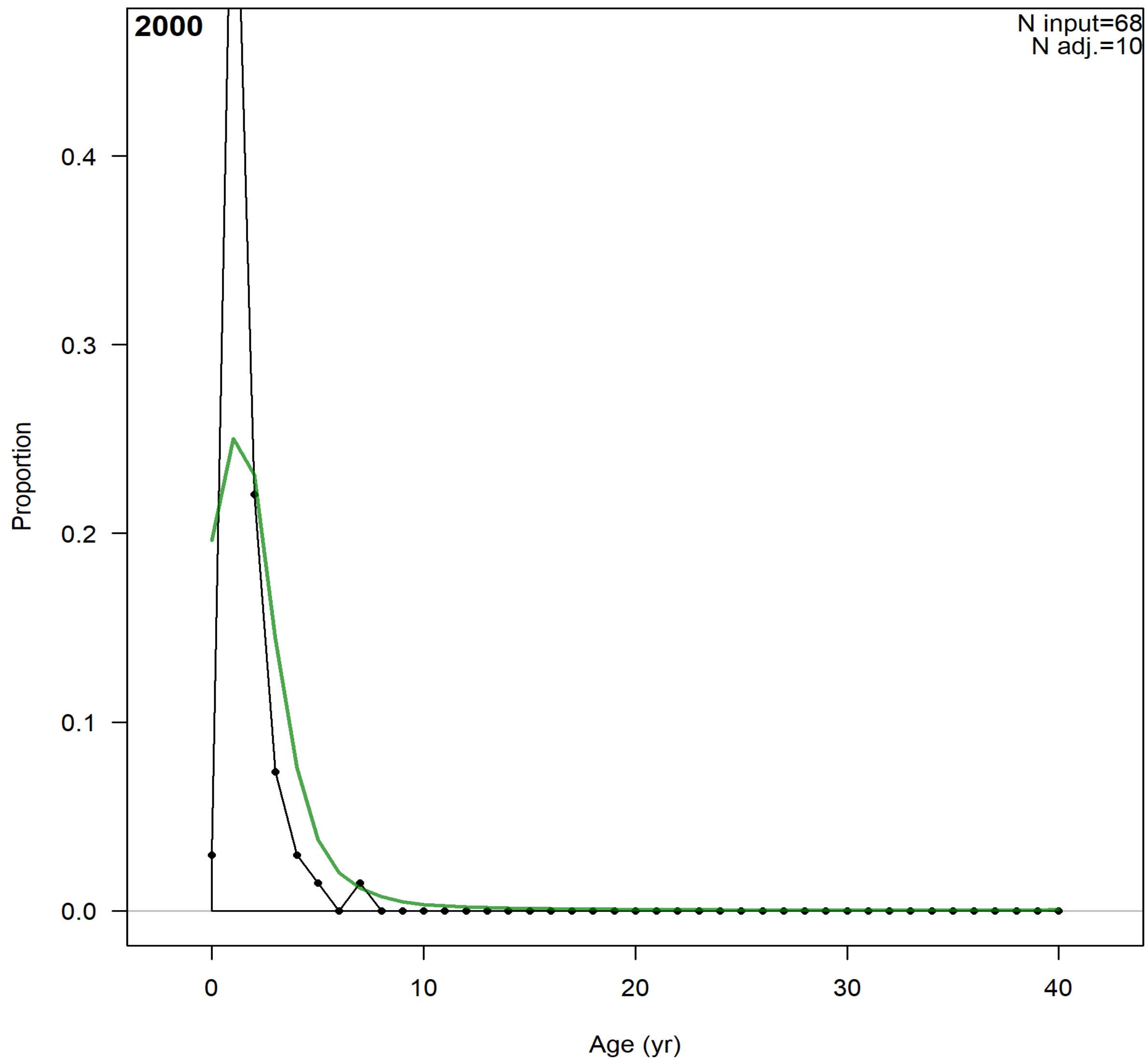


Figure 100. Observed and expected age compositions for Gulf of Mexico Yellowedge Grouper caught by the NMFS/SEAMAP Groundfish Trawl Survey - West. Green lines represent expected age compositions, while grey shaded regions represent observed age compositions. Input sample sizes (N input, number of ages) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported.

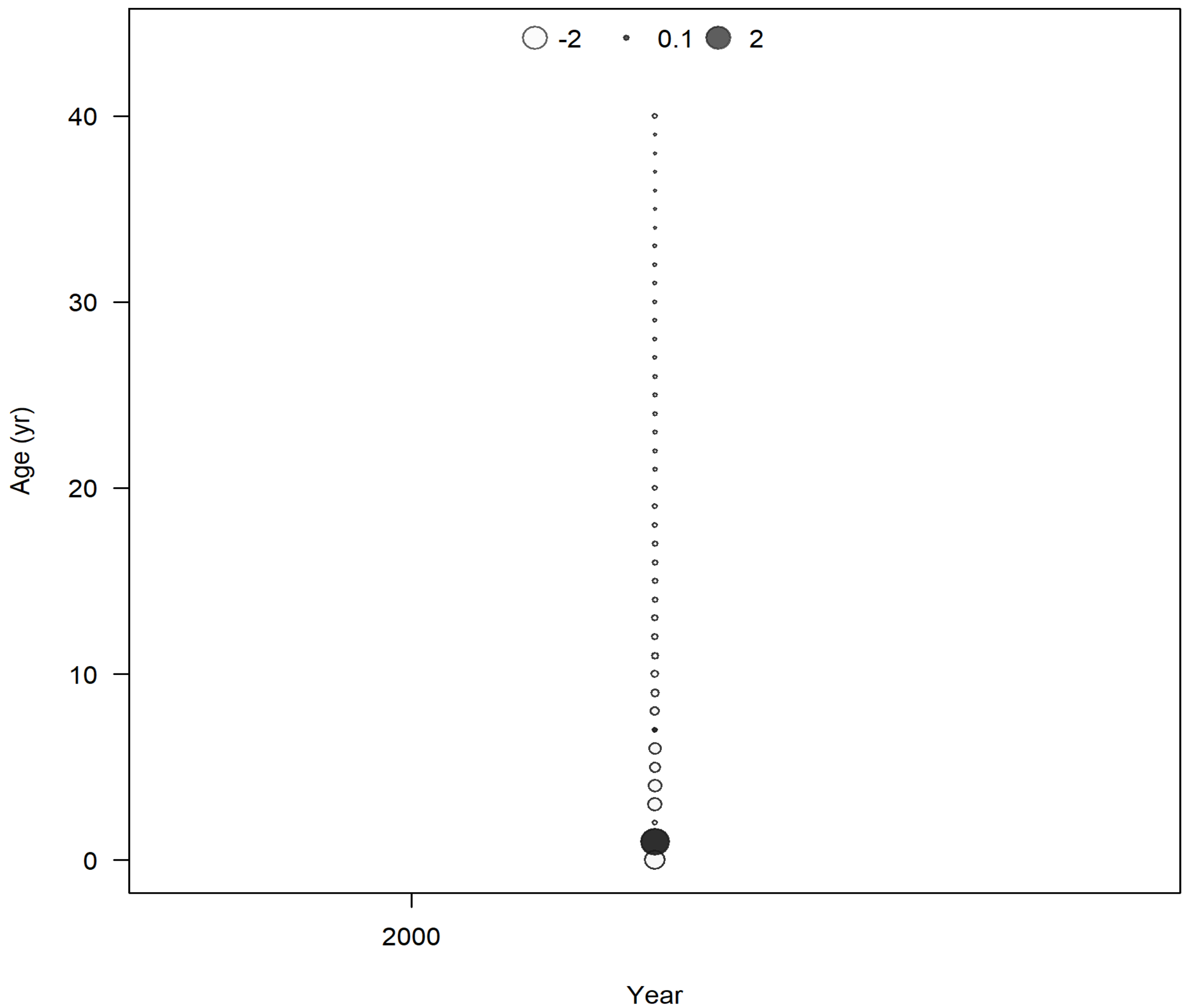


Figure 101. Pearson residuals for age compositions of Gulf of Mexico Yellowedge Grouper caught by the NMFS/SEAMAP Groundfish Trawl Survey - West. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

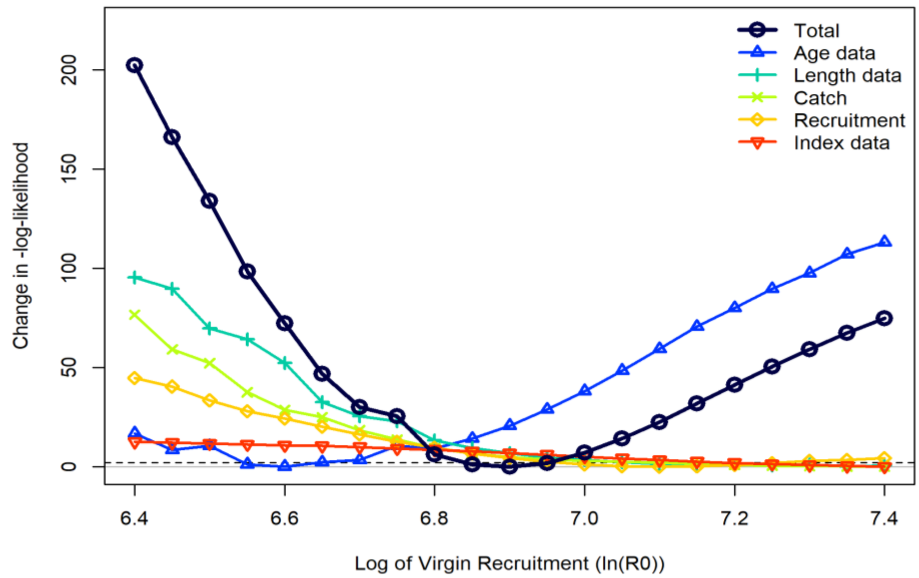


Figure 102. The likelihood profile for the natural log of the virgin recruitment parameter (ln(R_0)) of the Beverton – Holt stock-recruit function for Gulf of Mexico Yellowedge Grouper. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed ln(R_0) values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 85 OA Base Model was 6.893 (0.004). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

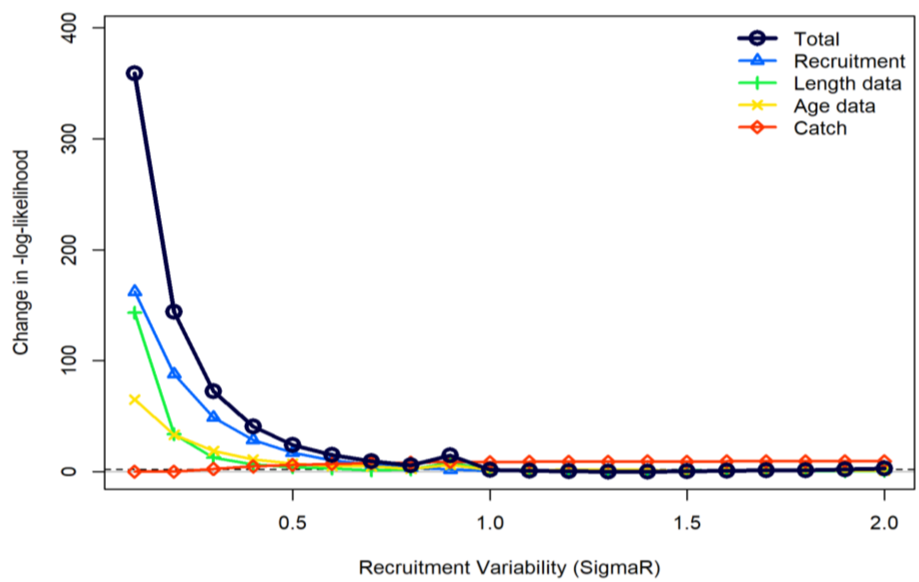


Figure 103. The likelihood profile for the recruitment variability (SigmaR) parameter of the Beverton – Holt stock-recruit function for Gulf of Mexico Yellowedge Grouper. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed SigmaR values tested in the profile diagnostic run. SigmaR was fixed at 0.5 in the SEDAR 85 OA Base Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

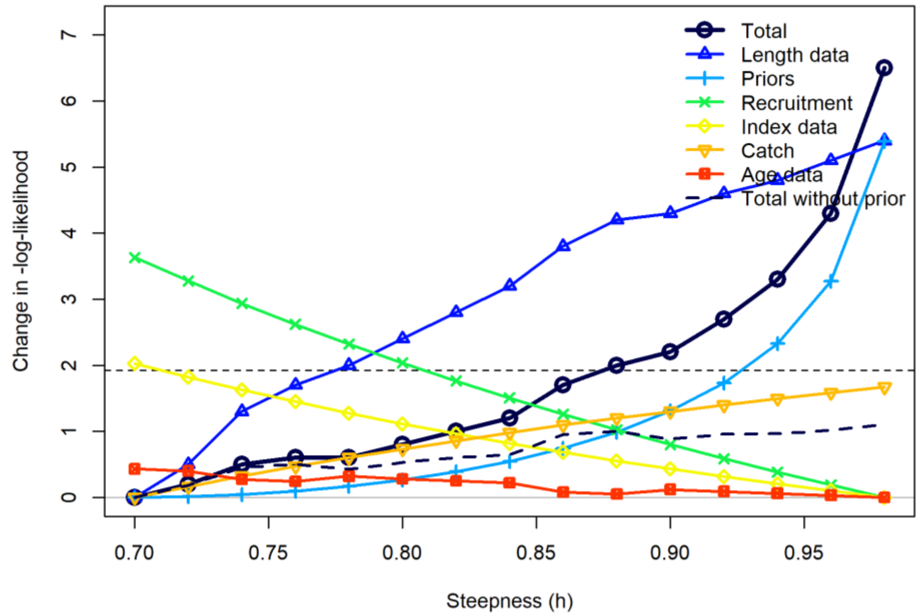


Figure 104. The likelihood profile for steepness using a prior. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed steepness values tested in the profile diagnostic run. Steepness was fixed at 0.827 in the SEDAR 85 OA Base Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

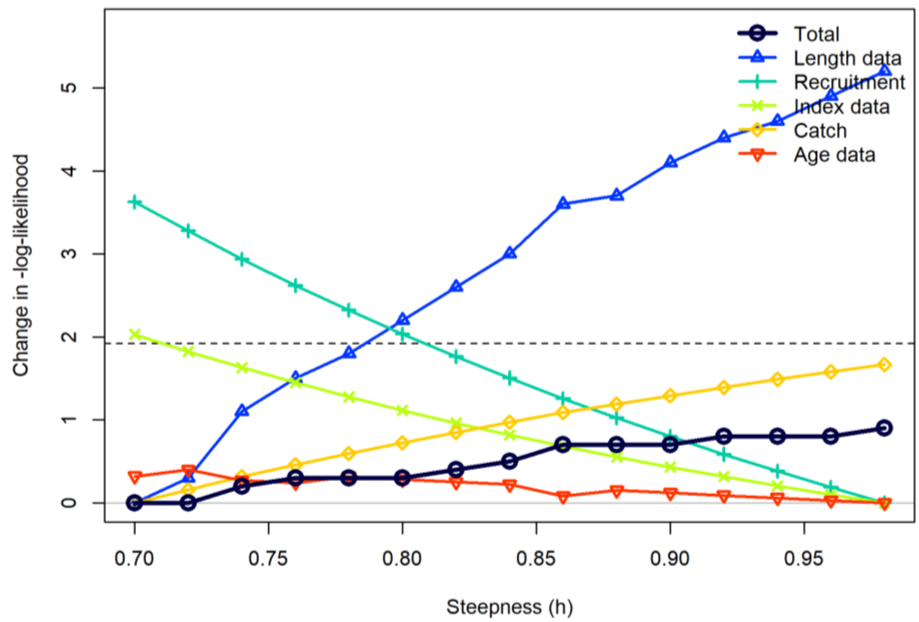


Figure 105. The likelihood profile for steepness without using a prior. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed steepness values tested in the profile diagnostic run. Steepness was fixed at 0.827 in the SEDAR 85 OA Base Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

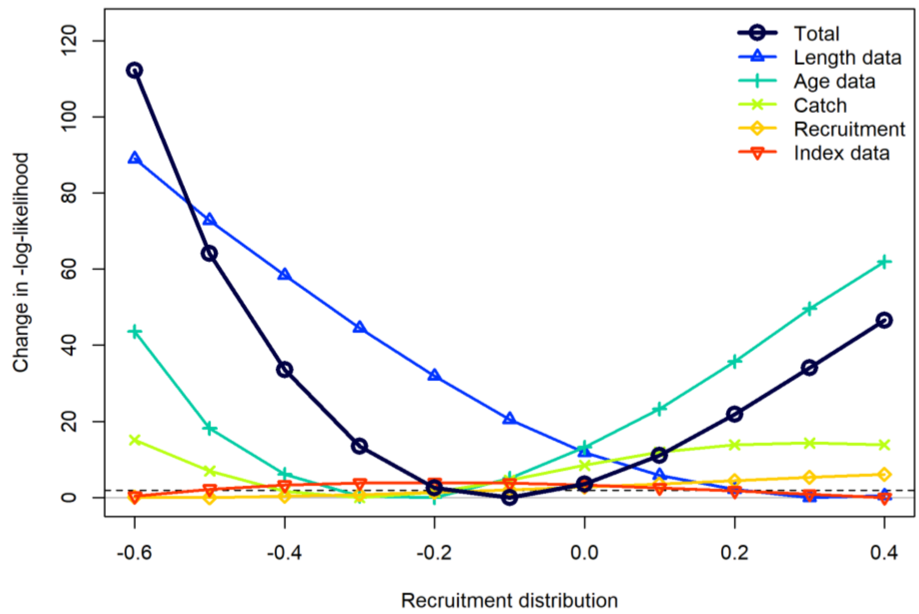


Figure 106. The likelihood profile for the recruitment distribution parameter. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed recruitment distribution values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 85 OA Base Model was -0.109 (0.36). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

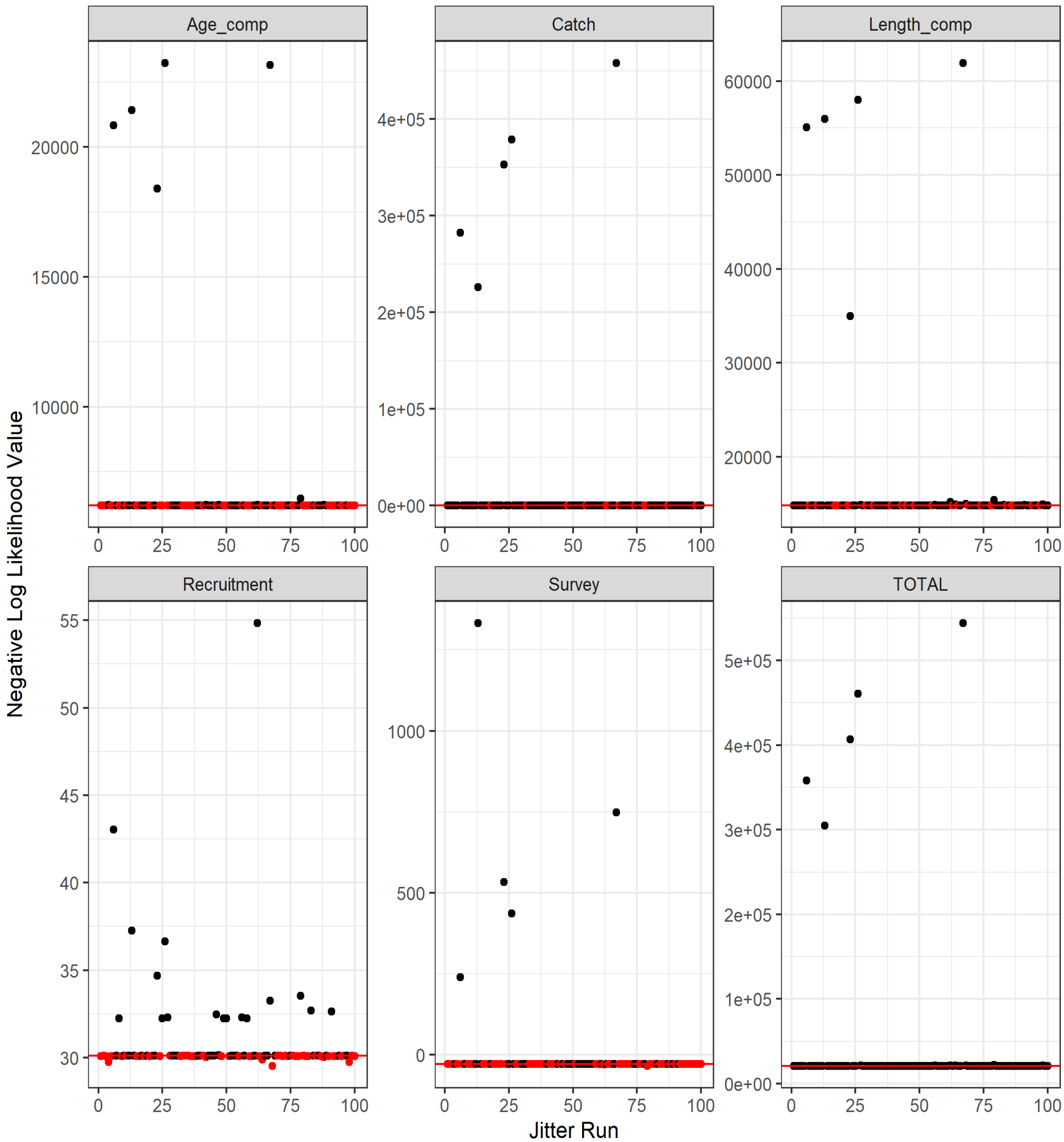


Figure 107. Results of the jitter analysis for various likelihood components for the SEDAR 85 OA Base Model. Each panel gives the results of 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the base model best fit values. The Base Run value for each panel is indicated by a red line.

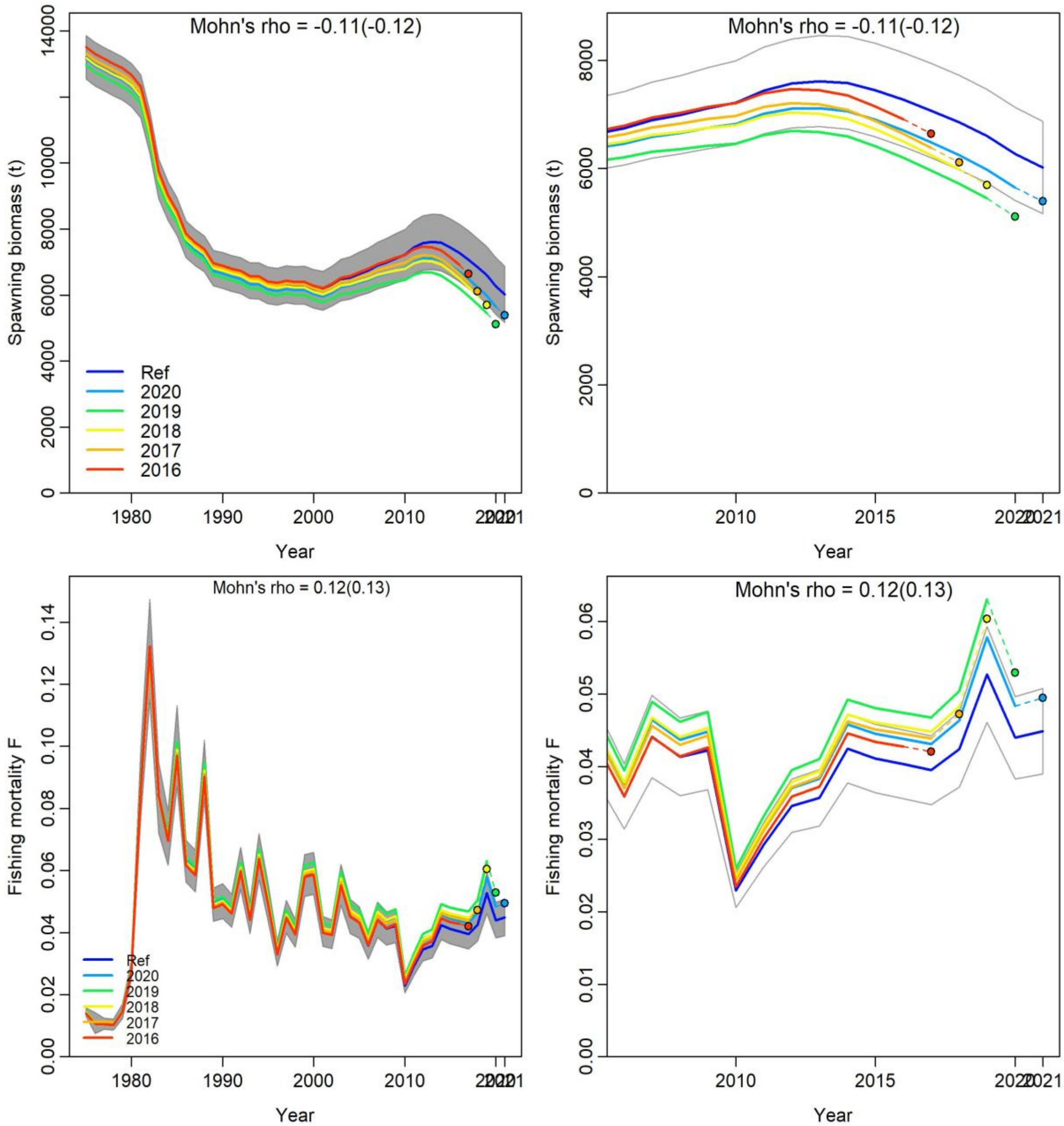


Figure 108. Retrospective analysis of spawning stock biomass (male and female combined SSB, top panels) and fishing mortality (F, bottom panels) estimates for Gulf of Mexico Yellowedge Grouper conducted by re-fitting each reference model (Ref) after removing five years of observations, one year at a time sequentially. The retrospective results are shown for the entire time series and for the most recent years only. Mohn's rho statistic and the corresponding 'hindcast rho' values (in brackets) are printed at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points shown for each model. Grey shaded areas are the 95% confidence intervals from the reference model. See Carvalho et al. (2021) for additional details.

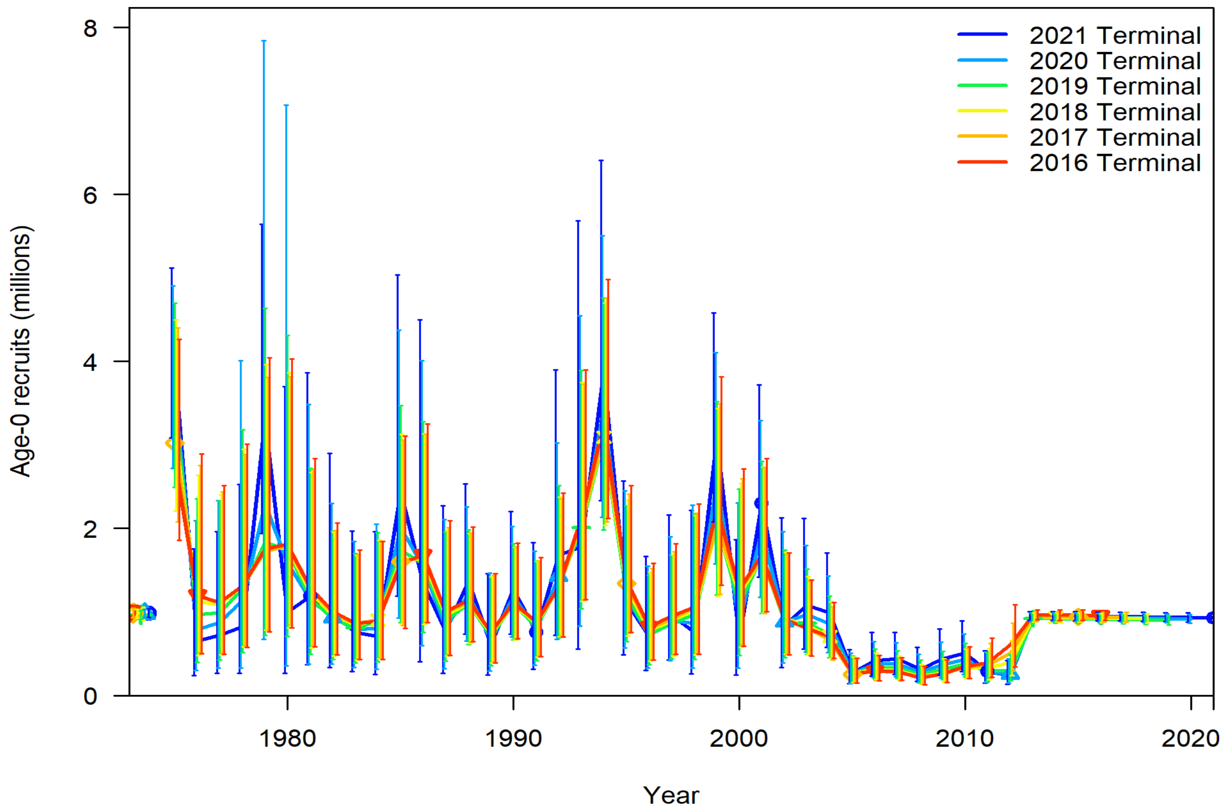


Figure 109. Results of a five year retrospective analysis for recruitment (millions of fish) for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper.

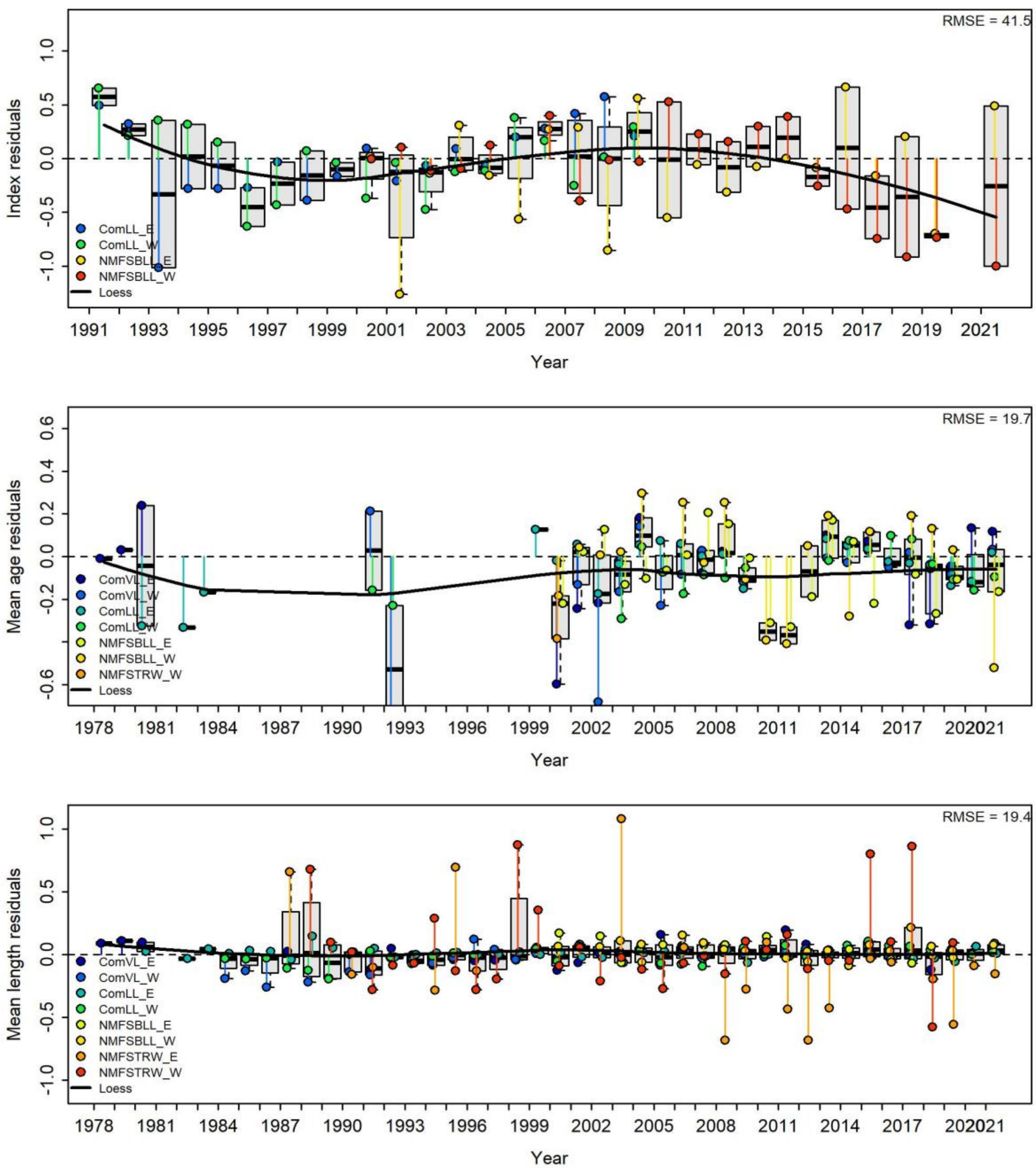


Figure 110. Joint residual plots for indices of abundance fits (top panel), annual mean age estimates (middle panel), and annual mean length estimates (bottom panel) for Gulf of Mexico Yellowedge Grouper. Vertical lines with points show the residuals (in colors by index), and solid black line reflects the loess smoother through all the residuals. Boxplots indicate the median and quantiles in cases where residuals from the multiple indices are available for any given year. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot. See Carvalho et al. (2021) for additional details.

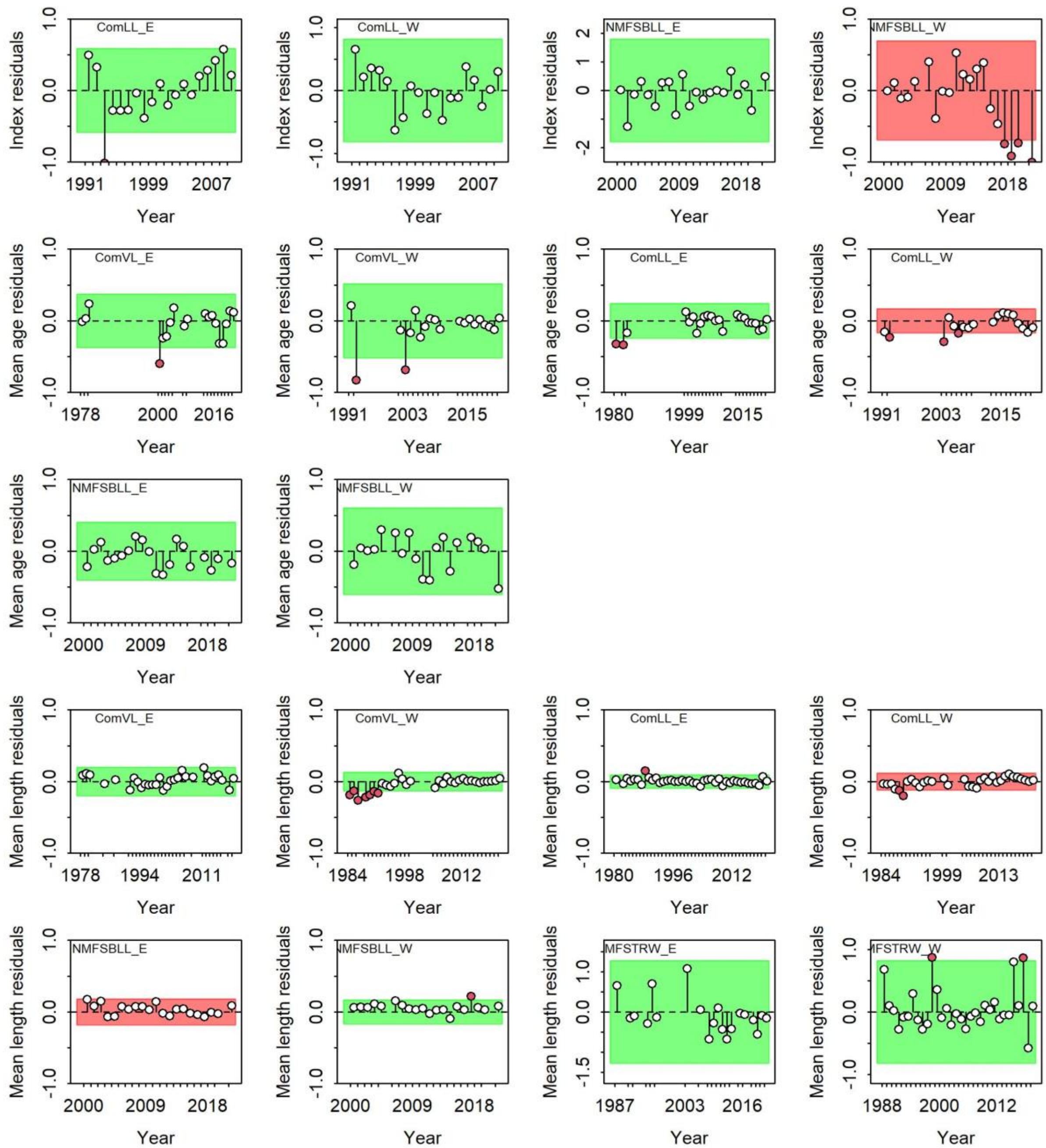


Figure 111. Runs tests results for indices of relative abundance (top row), mean age (second and third rows), and mean length (fourth and fifth rows) for Gulf of Mexico Yellowedge Grouper. Green shading indicates no evidence (p >= 0.05) and red shading evidence (p < 0.05) to reject the hypothesis of a randomly distributed time series of residuals, respectively. The shaded (green/red) area spans three residual standard deviations to either side from zero, and the red points outside of the shading violate the 'three-sigma limit' for that series. See Carvalho et al. (2021) for additional details.

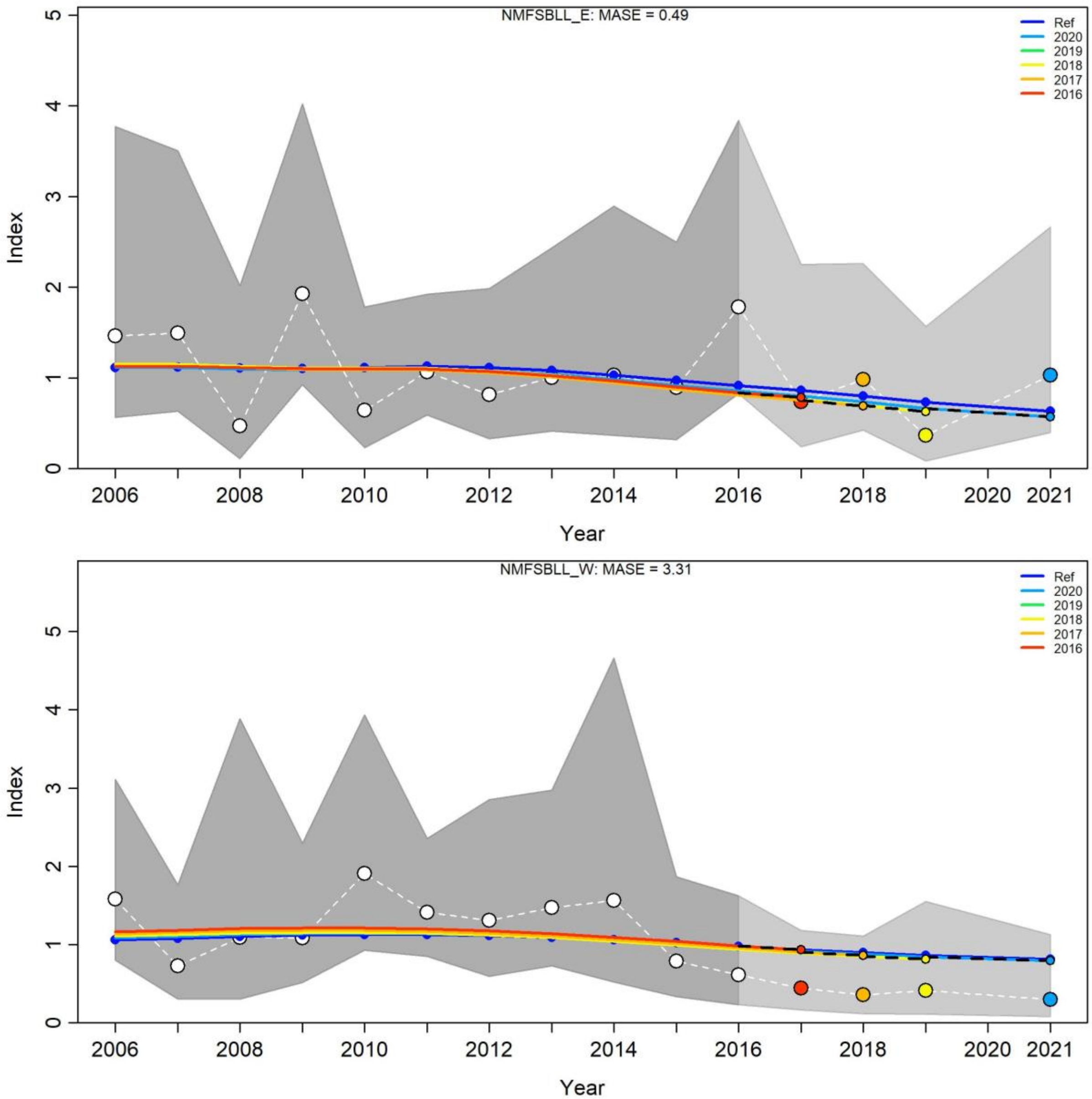


Figure 112. Hindcasting cross-validation (HCxval) results for the NMFS Bottom Longline Survey indices of abundance fits for Gulf of Mexico Yellowedge Grouper. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected index. The observations used for cross validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each index time series is denoted in each panel.

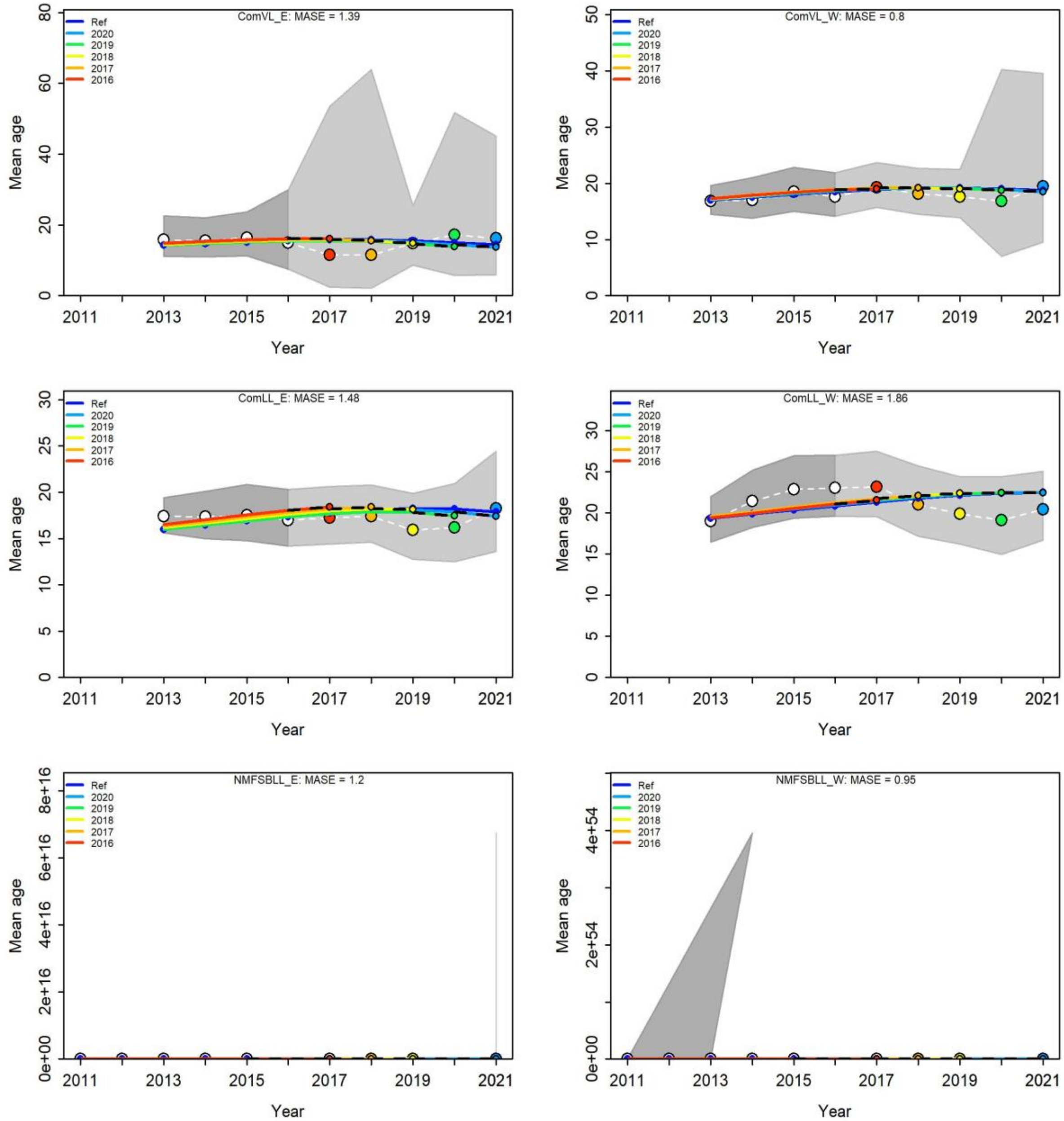


Figure 113. Hindcasting cross-validation (HCxval) results for age fits for Gulf of Mexico Yellowedge Grouper. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected index. The observations used for cross validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each index time series is denoted in each panel.

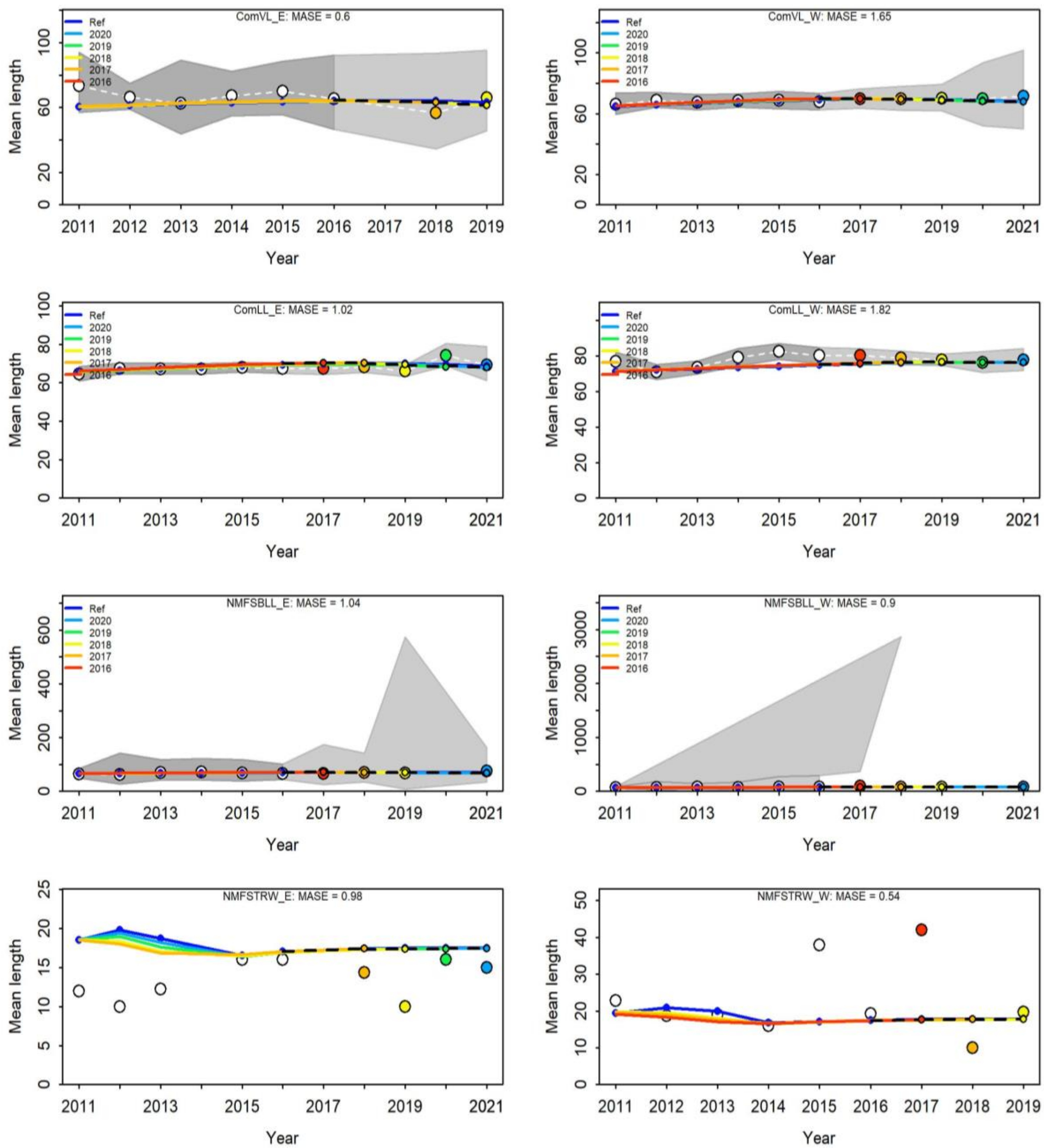


Figure 114. Hindcasting cross-validation (HCxval) results for fits to annual mean length estimates for Gulf of Mexico Yellowedge Grouper. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected mean length. The observations used for cross-validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each size composition time series is denoted in each panel.

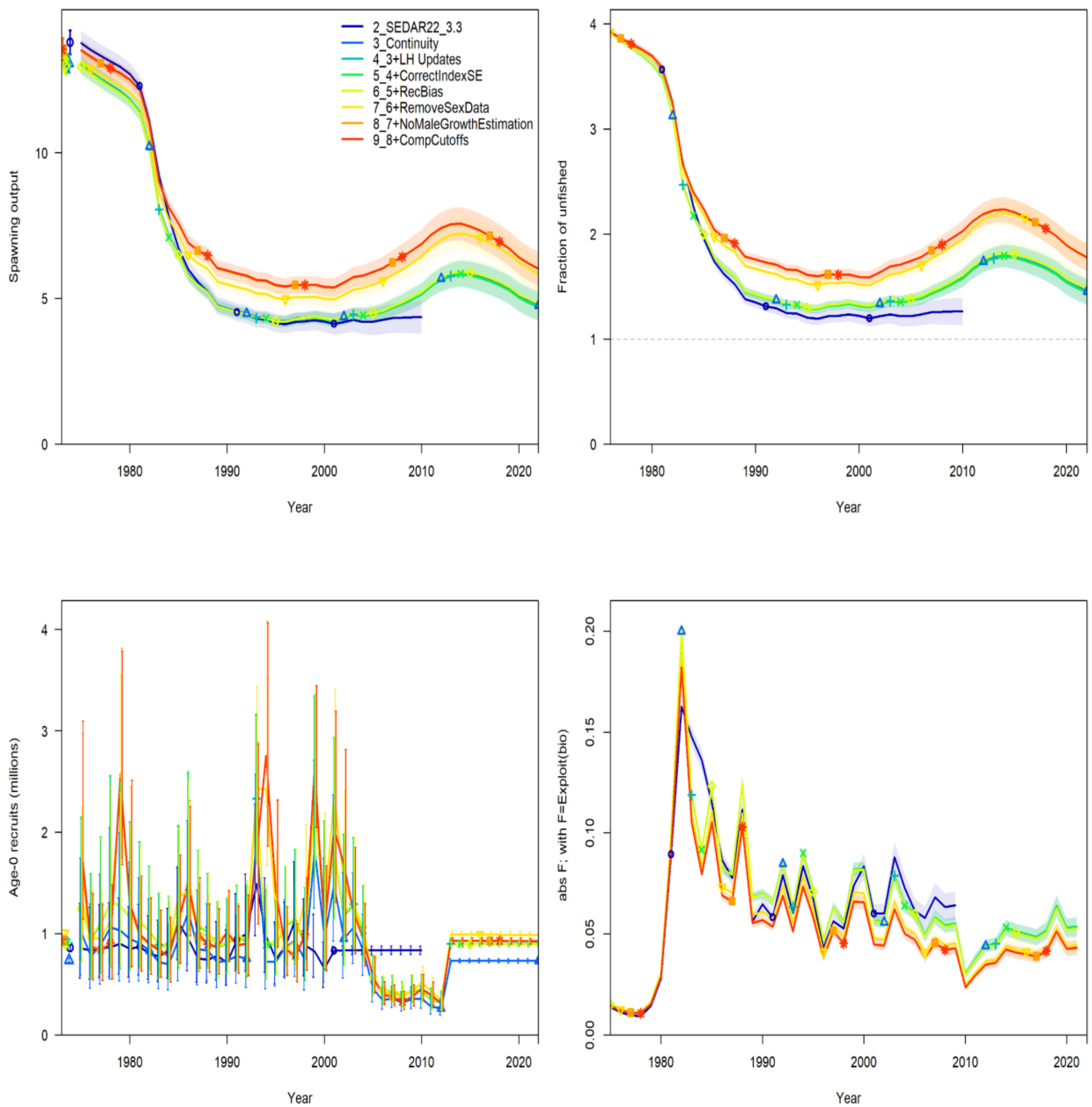


Figure 115. Bridging analysis showing phase 1 changes in estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 22 Benchmark Base Model (Step 1) and the SEDAR 85 OA Base Model (Step 24).

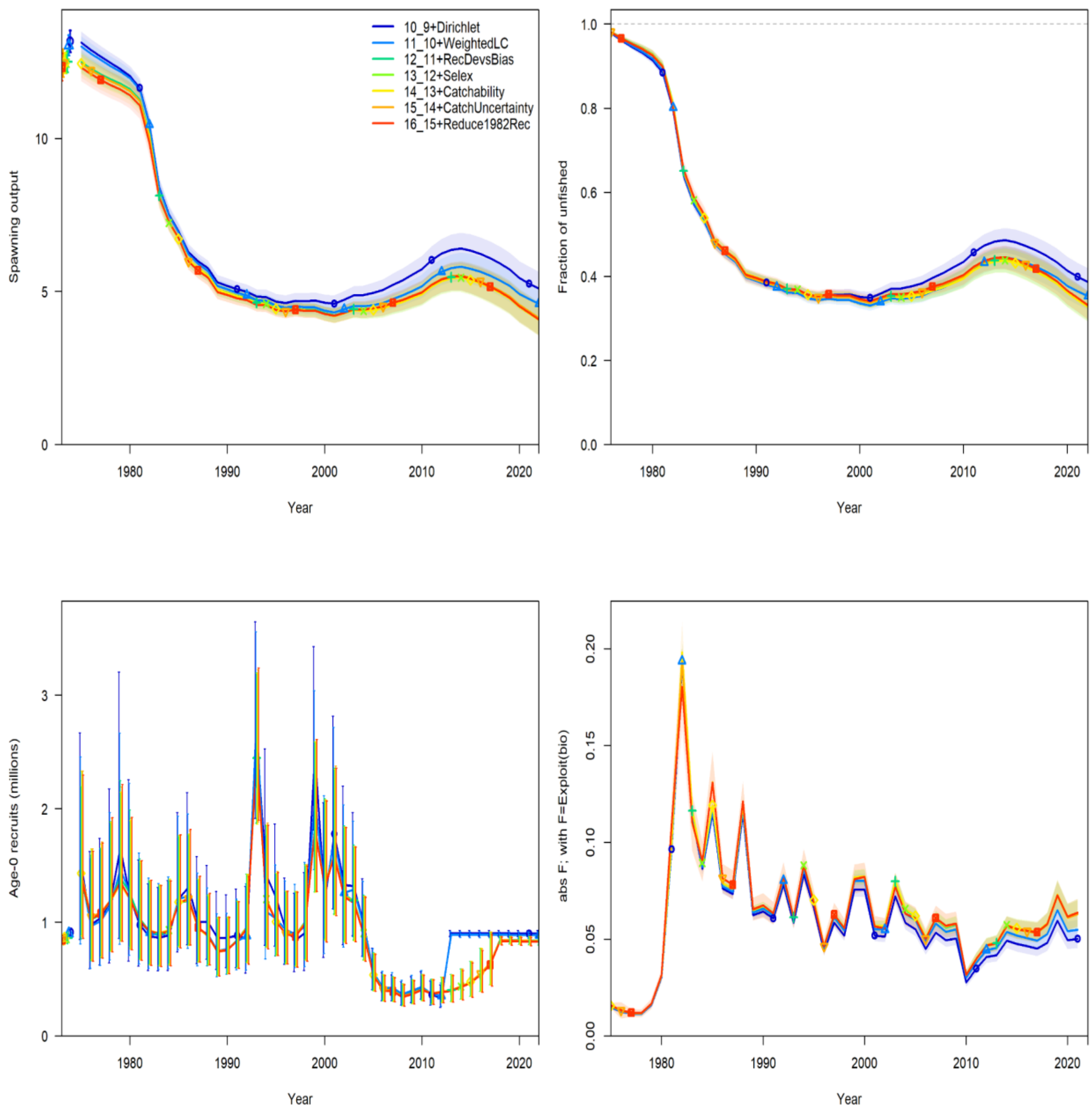


Figure 116. Bridging analysis showing phase 2 changes in estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 22 Benchmark Base Model (Step 1) and the SEDAR 85 OA Base Model (Step 24).

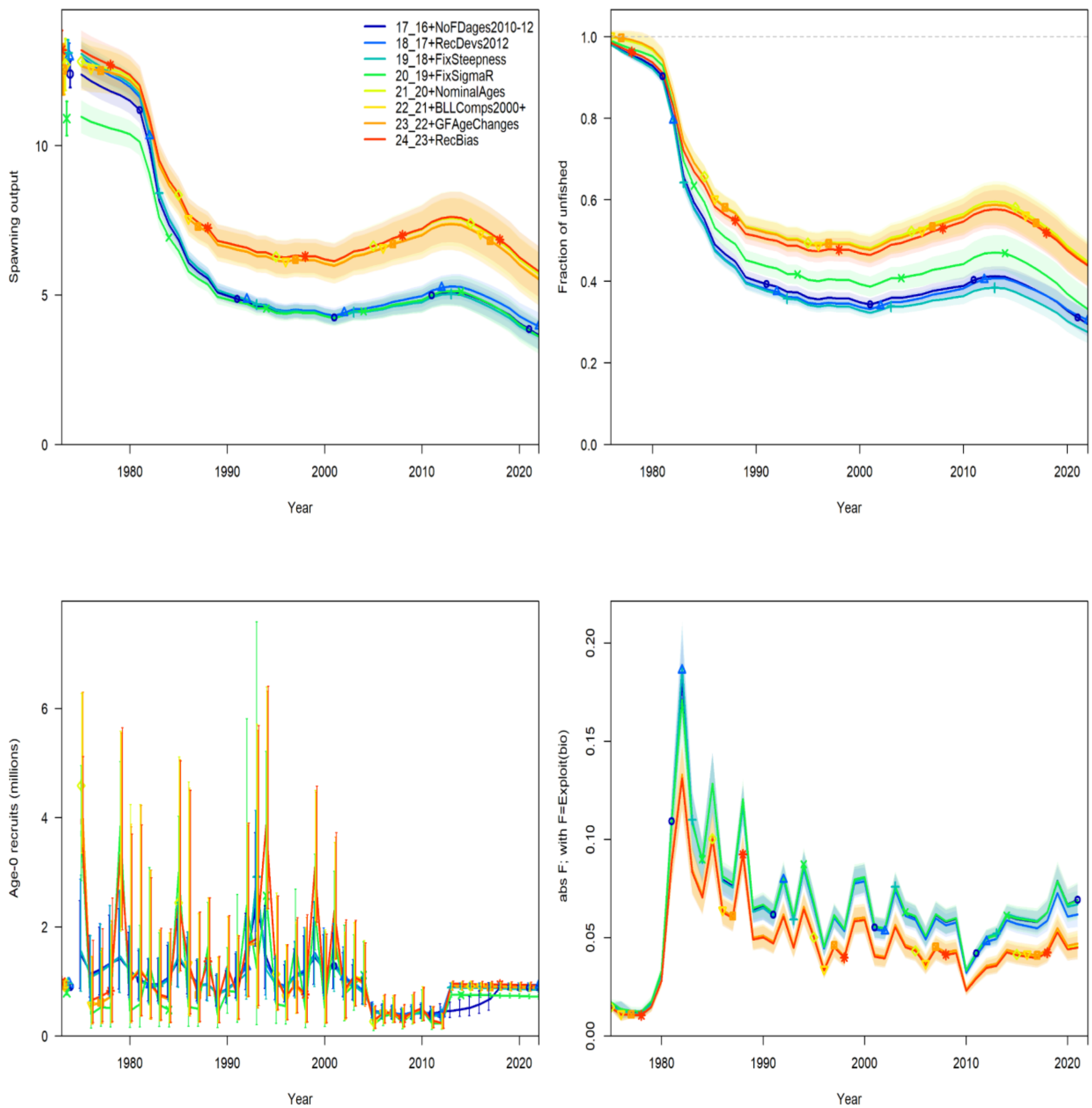


Figure 117. Bridging analysis showing phase 3 changes in estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 22 Benchmark Base Model (Step 1) and the SEDAR 85 OA Base Model (Step 24).

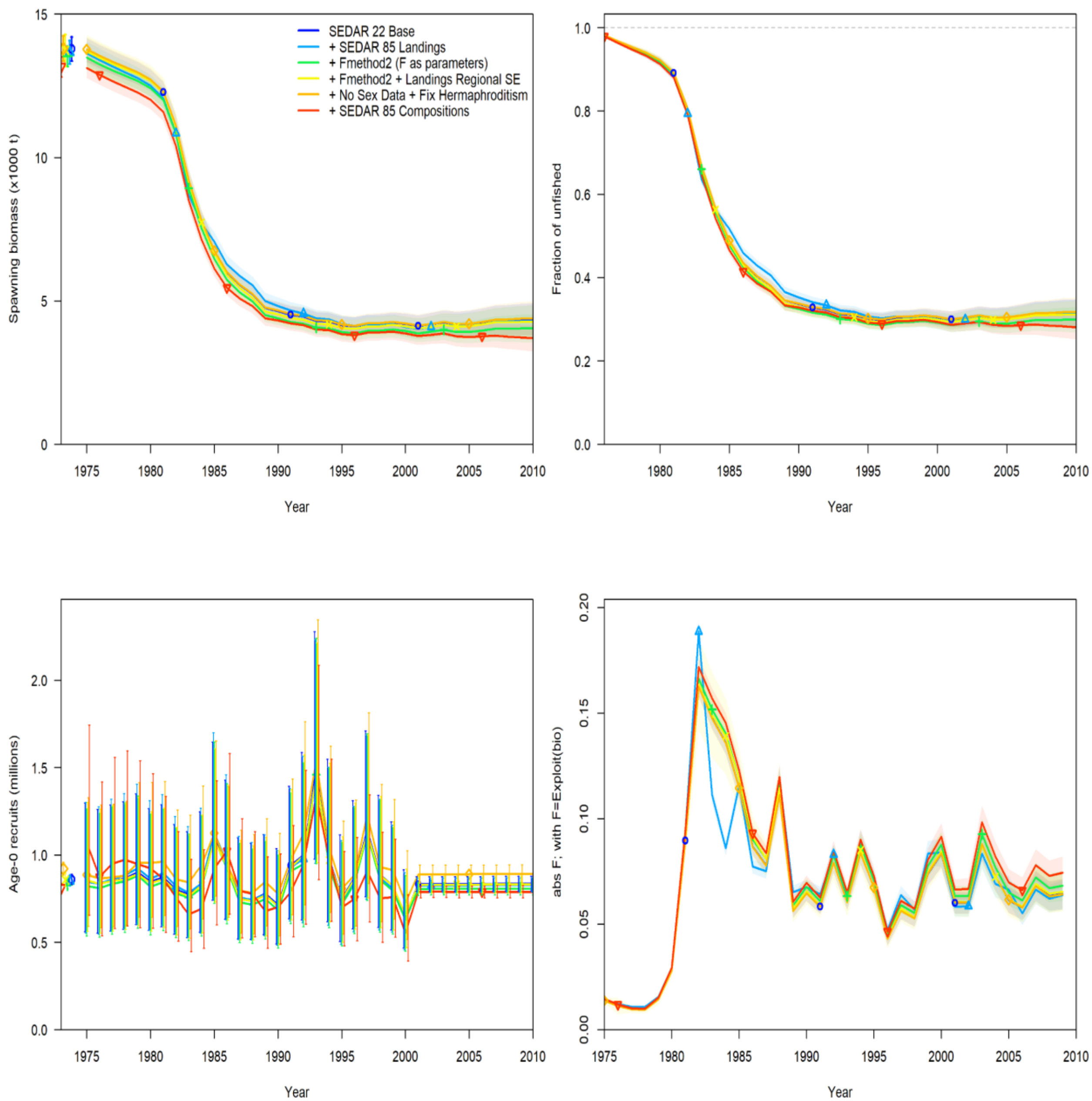


Figure 118. Comparison showing changes in estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel), and associated uncertainty with major data changes for the SEDAR 22 Benchmark Base Model for Gulf of Mexico Yellowedge Grouper using data inputs provided for SEDAR 85.

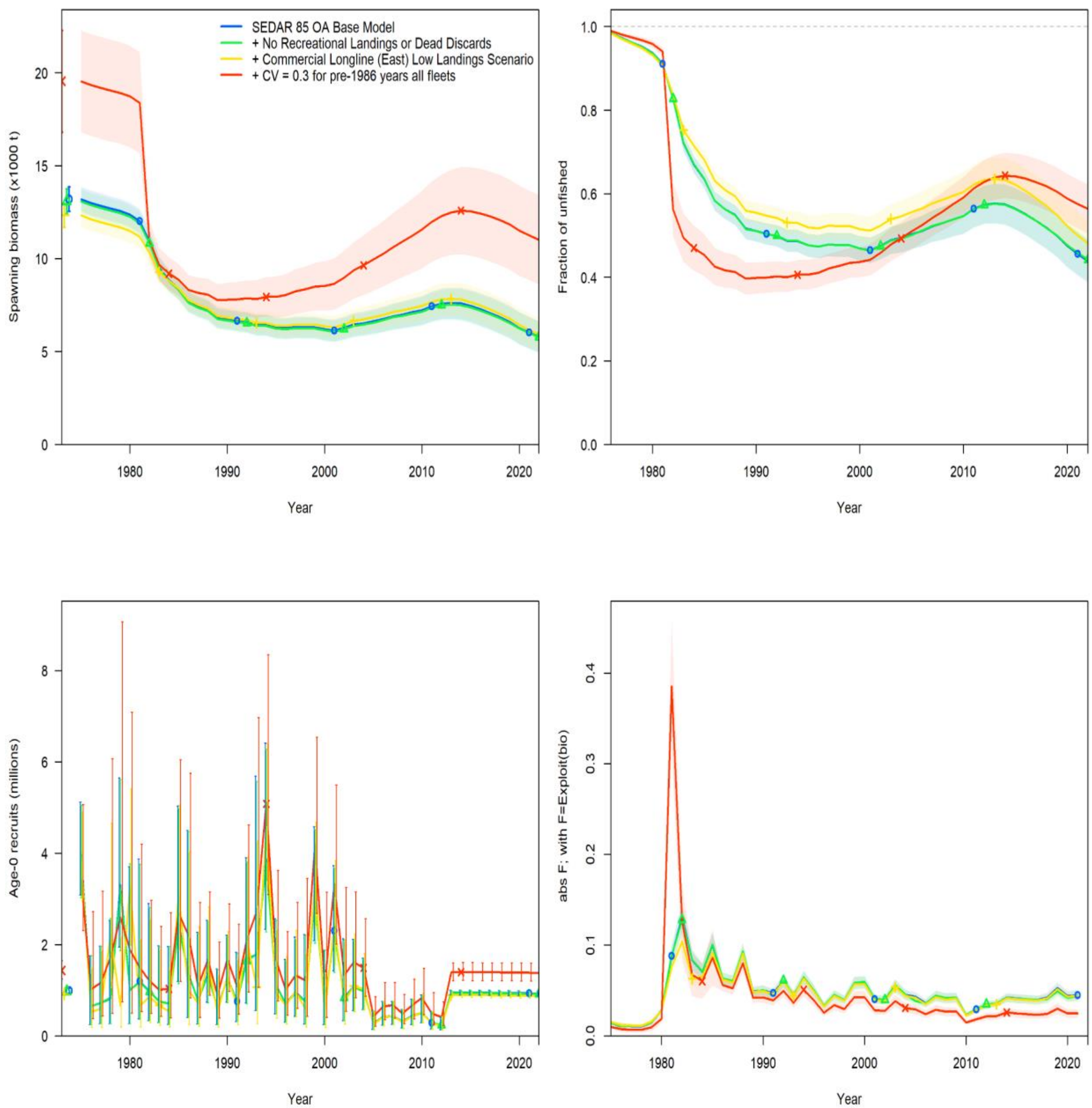


Figure 119. Estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring landings inputs for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper.

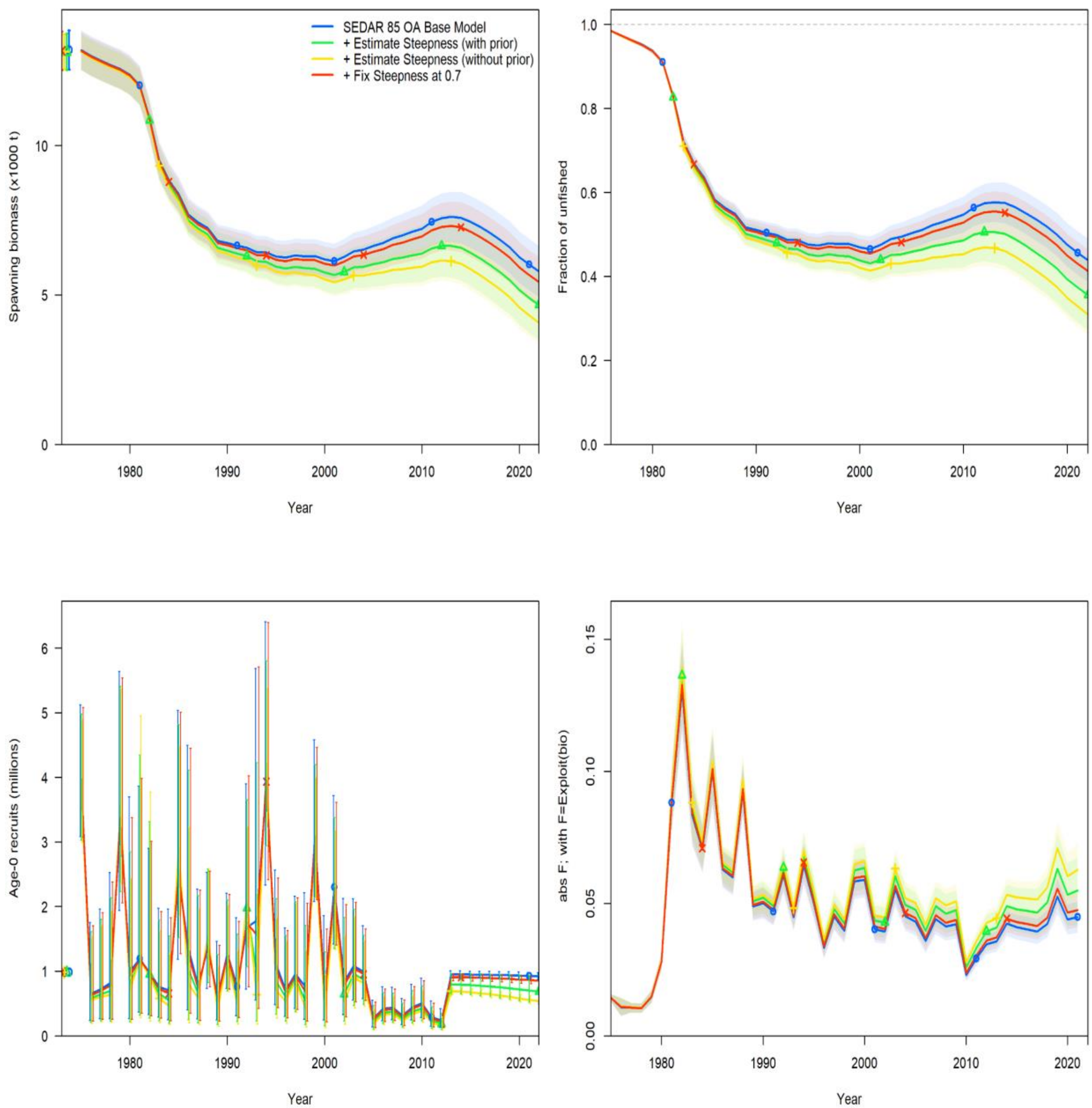


Figure 120. Estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring estimation or alternative values for steepness for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper.

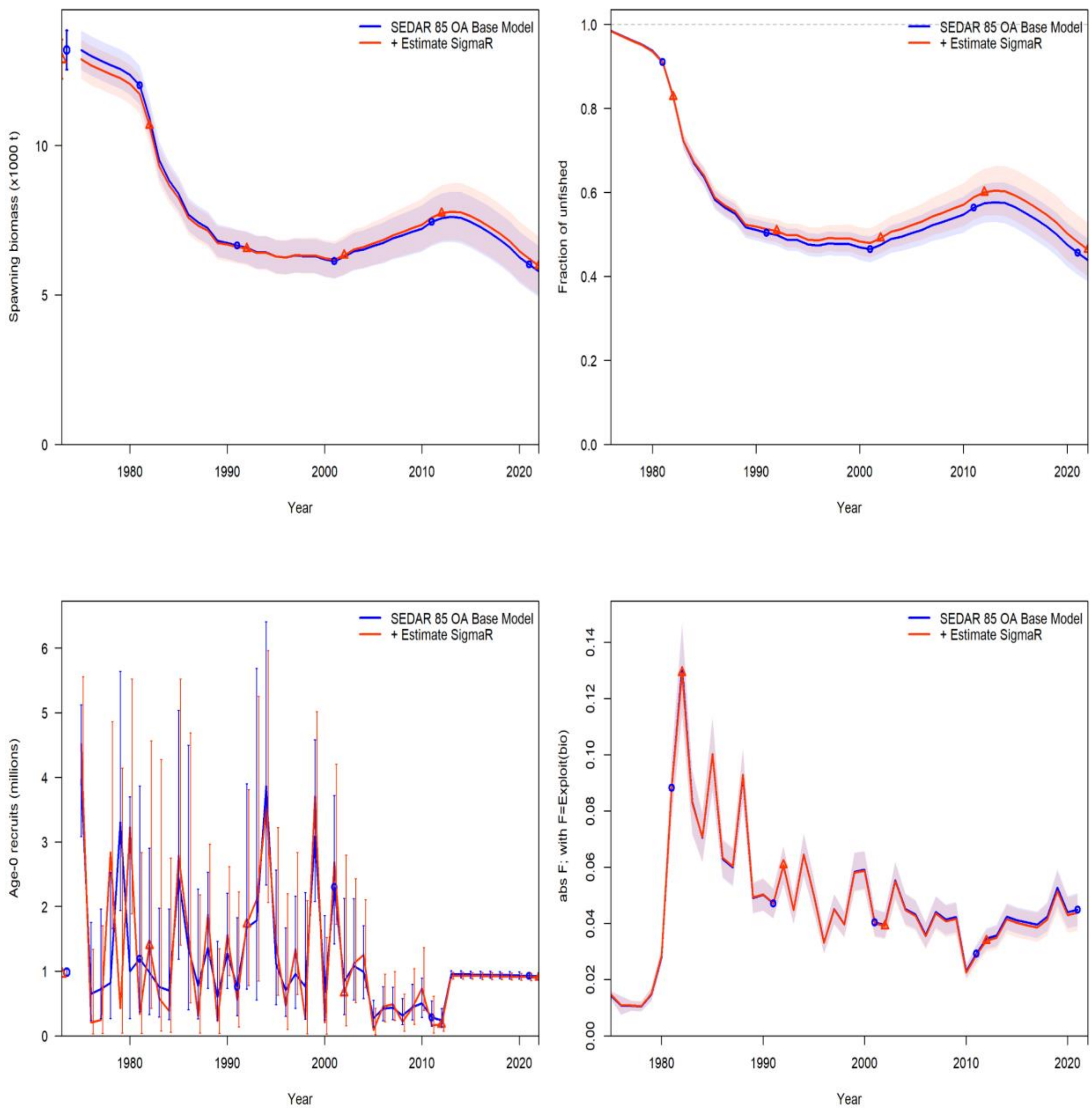


Figure 121. Estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring estimation of SigmaR for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper.

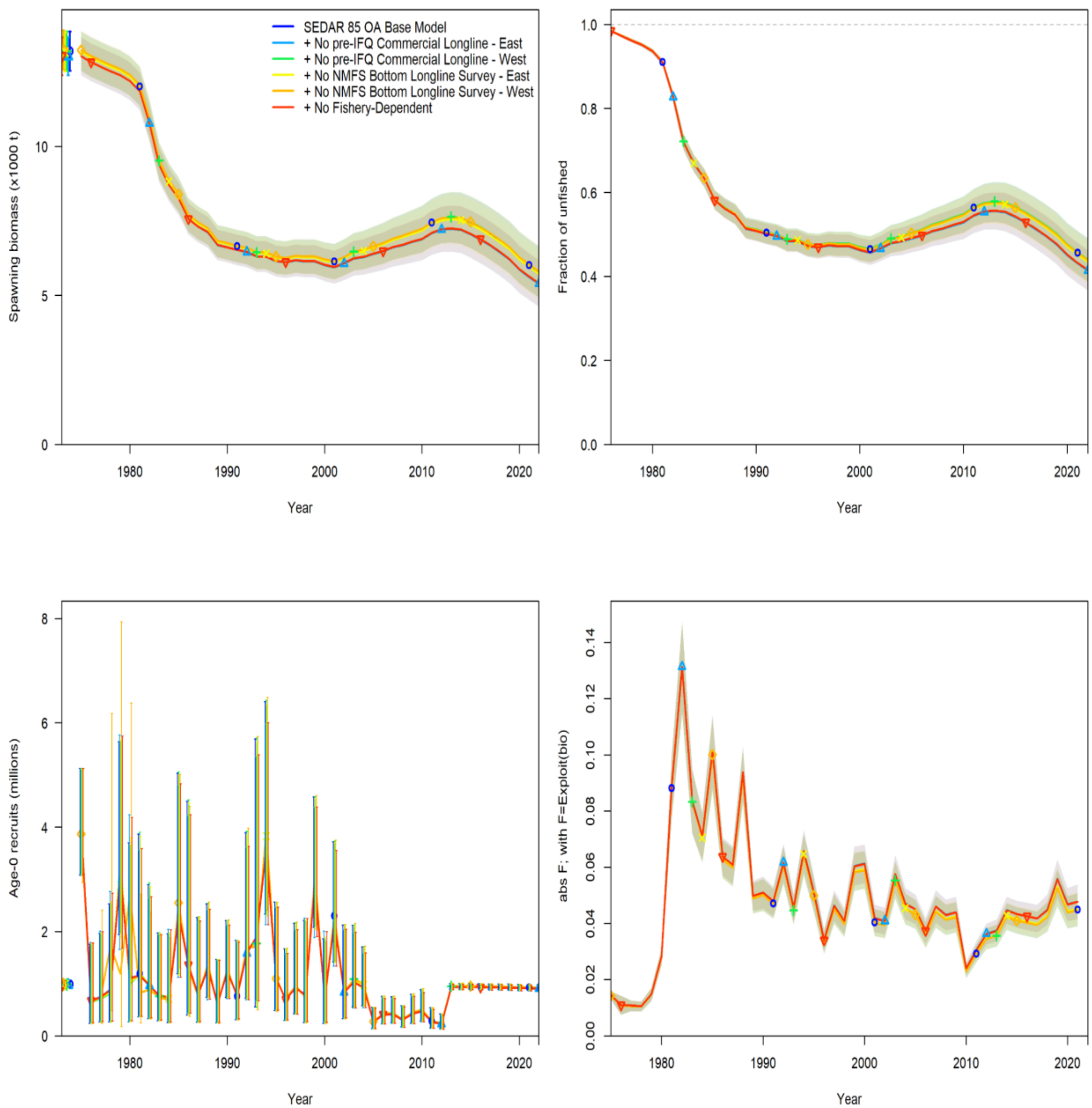


Figure 122. Estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs removing each index of abundance for the SEDAR 85 OA Base Model for Gulf of Mexico Yellowedge Grouper.

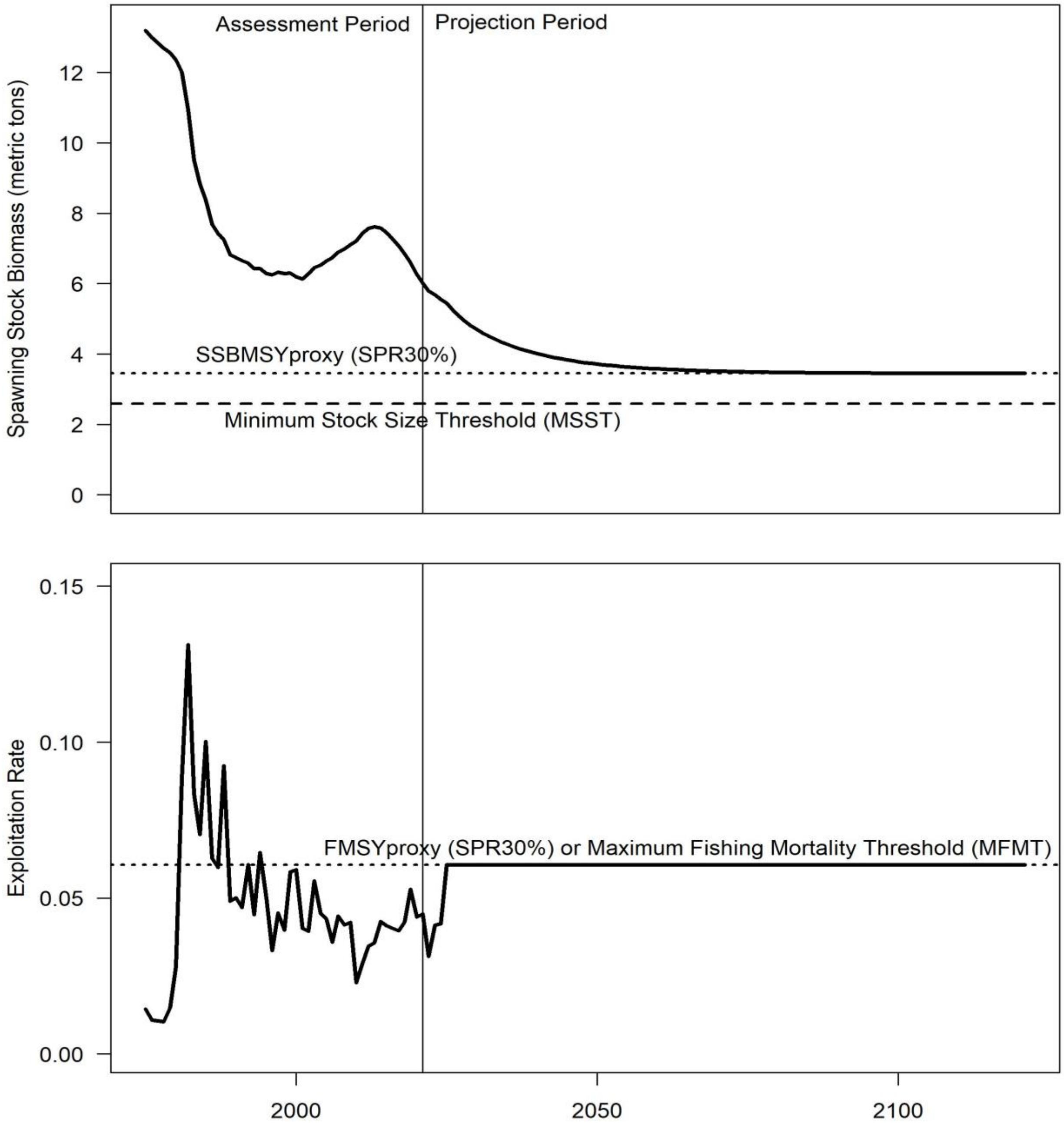


Figure 123. Time series of SSB (male and female combined SSB) and exploitation rate (total biomass killed all ages / total biomass age 1+) with respect to status determination criteria for the SEDAR 85 Gulf of Mexico Yellowedge Grouper Operational Assessment with ***recruitment predicted by the stock-recruit curve from 2013 throughout the projection period****. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.*

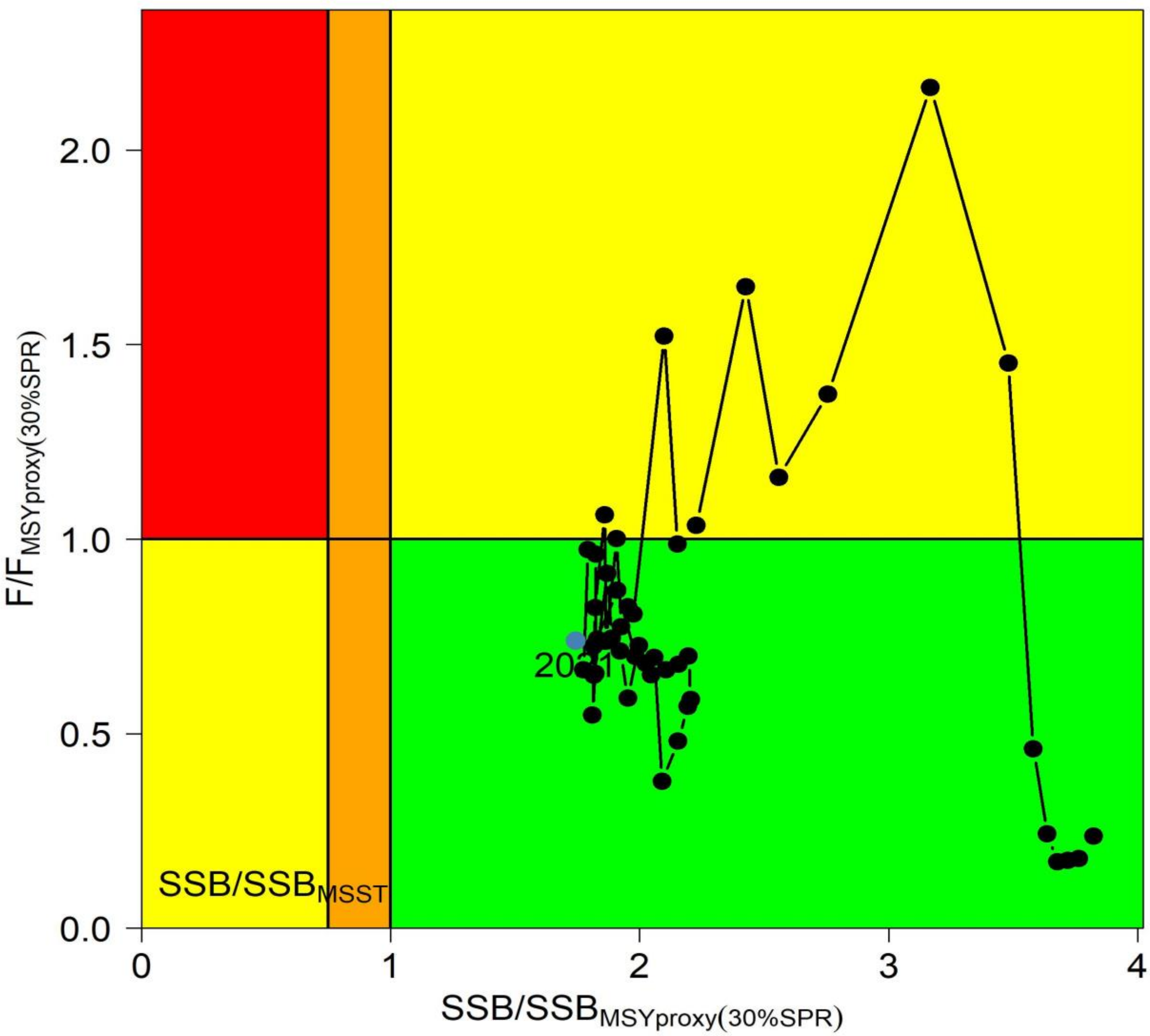


Figure 124. Kobe plot illustrating the trajectory of stock status for Gulf of Mexico Yellowedge Grouper with ***recruitment predicted by the stock-recruit curve from 2013 throughout the projection period****. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold (MSST = 0.75 x $SSB_{30\%SPR}$). The 2021 terminal year stock status is indicated by the gray dot. See* ***Table 41*** *for values. SSB defined as male and female combined SSB. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.*

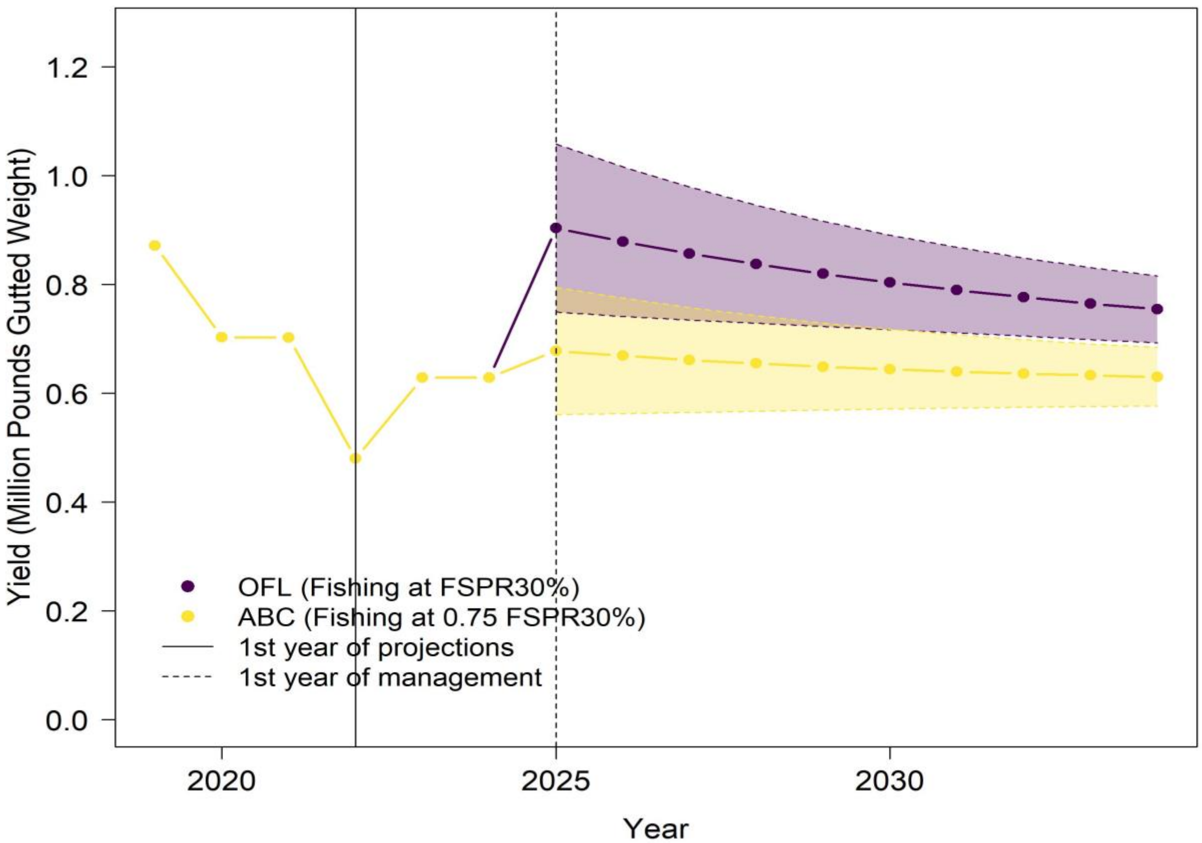


*Figure 125. Historic (2019-2021), interim (2022-2024) and forecasted yields (2025+) for the OFL (fishing set at $F_{30\%SPR}$) and ABC (directed F = 0.75 x Directed F at $F_{30\%SPR}$ (0.061)) projections for Gulf of Mexico Yellowedge Grouper with **recruitment predicted by the stock-recruit curve from 2013 throughout the projection period**. An SPR proxy of 30% was specified in the SEDAR 85 Terms of Reference.*

12. Appendix

Table A1. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_1975_s_1	0.0256	(0,3.9)	0.0016	0.064		1
F_fleet_1_YR_1976_s_1	0.0197	(0,3.9)	0.0041	0.207		1
F_fleet_1_YR_1977_s_1	0.0212	(0,3.9)	0.0024	0.112		1
F_fleet_1_YR_1978_s_1	0.02	(0,3.9)	0.0023	0.113		1
F_fleet_1_YR_1979_s_1	0.0276	(0,3.9)	0.0031	0.112		1
F_fleet_1_YR_1980_s_1	0.0278	(0,3.9)	0.0031	0.112		1
F_fleet_1_YR_1981_s_1	0.0266	(0,3.9)	0.003	0.112		1
F_fleet_1_YR_1982_s_1	0.0402	(0,3.9)	0.0045	0.111		1
F_fleet_1_YR_1983_s_1	0.0296	(0,3.9)	0.0033	0.112		1
F_fleet_1_YR_1984_s_1	0.0327	(0,3.9)	0.0037	0.112		1
F_fleet_1_YR_1985_s_1	0.0426	(0,3.9)	0.0047	0.111		1
F_fleet_1_YR_1986_s_1	0.0473	(0,3.9)	0.0029	0.062		1
F_fleet_1_YR_1987_s_1	0.0506	(0,3.9)	0.0031	0.062		1
F_fleet_1_YR_1988_s_1	0.0488	(0,3.9)	0.003	0.062		1
F_fleet_1_YR_1989_s_1	0.0168	(0,3.9)	0.0011	0.062		1
F_fleet_1_YR_1990_s_1	0.0031	(0,3.9)	2.04e-04	0.067		1
F_fleet_1_YR_1991_s_1	0.0116	(0,3.9)	7.39e-04	0.063		1
F_fleet_1_YR_1992_s_1	0.0063	(0,3.9)	3.97e-04	0.063		1
F_fleet_1_YR_1993_s_1	0.008	(0,3.9)	5.11e-04	0.064		1
F_fleet_1_YR_1994_s_1	0.0088	(0,3.9)	5.59e-04	0.064		1
F_fleet_1_YR_1995_s_1	0.0042	(0,3.9)	2.70e-04	0.064		1
F_fleet_1_YR_1996_s_1	0.0048	(0,3.9)	3.42e-04	0.071		1
F_fleet_1_YR_1997_s_1	0.0047	(0,3.9)	3.13e-04	0.066		1
F_fleet_1_YR_1998_s_1	0.0053	(0,3.9)	3.44e-04	0.065		1
F_fleet_1_YR_1999_s_1	0.0063	(0,3.9)	4.17e-04	0.066		1
F_fleet_1_YR_2000_s_1	0.0035	(0,3.9)	2.33e-04	0.066		1
F_fleet_1_YR_2001_s_1	0.0026	(0,3.9)	1.69e-04	0.066		1
F_fleet_1_YR_2002_s_1	0.0036	(0,3.9)	2.37e-04	0.066		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_2003_s_1	0.004	(0,3.9)	2.74e-04	0.069		1
F_fleet_1_YR_2004_s_1	0.0033	(0,3.9)	2.22e-04	0.067		1
F_fleet_1_YR_2005_s_1	0.0189	(0,3.9)	0.0013	0.068		1
F_fleet_1_YR_2006_s_1	0.0034	(0,3.9)	2.33e-04	0.069		1
F_fleet_1_YR_2007_s_1	0.0017	(0,3.9)	1.20e-04	0.070		1
F_fleet_1_YR_2008_s_1	0.0015	(0,3.9)	1.04e-04	0.071		1
F_fleet_1_YR_2009_s_1	0.0032	(0,3.9)	2.35e-04	0.073		1
F_fleet_1_YR_2010_s_1	0.0012	(0,3.9)	6.01e-05	0.050		1
F_fleet_1_YR_2011_s_1	0.0031	(0,3.9)	1.59e-04	0.051		1
F_fleet_1_YR_2012_s_1	0.0042	(0,3.9)	2.23e-04	0.053		1
F_fleet_1_YR_2013_s_1	0.0027	(0,3.9)	1.47e-04	0.055		1
F_fleet_1_YR_2014_s_1	0.0032	(0,3.9)	1.84e-04	0.058		1
F_fleet_1_YR_2015_s_1	0.0052	(0,3.9)	3.17e-04	0.061		1
F_fleet_1_YR_2016_s_1	0.002	(0,3.9)	1.26e-04	0.064		1
F_fleet_1_YR_2017_s_1	0.0017	(0,3.9)	1.16e-04	0.067		1
F_fleet_1_YR_2018_s_1	0.0075	(0,3.9)	5.33e-04	0.071		1
F_fleet_1_YR_2019_s_1	0.0155	(0,3.9)	0.0012	0.076		1
F_fleet_1_YR_2020_s_1	0.0089	(0,3.9)	7.18e-04	0.081		1
F_fleet_1_YR_2021_s_1	0.0028	(0,3.9)	2.40e-04	0.085		1
F_fleet_2_YR_1975_s_1	0.0138	(0,3.9)	9.56e-04	0.069		1
F_fleet_2_YR_1976_s_1	0.0102	(0,3.9)	0.0024	0.232		1
F_fleet_2_YR_1977_s_1	0.0081	(0,3.9)	9.65e-04	0.118		1
F_fleet_2_YR_1978_s_1	0.0089	(0,3.9)	0.0011	0.119		1
F_fleet_2_YR_1979_s_1	0.0104	(0,3.9)	0.0012	0.119		1
F_fleet_2_YR_1980_s_1	0.006	(0,3.9)	7.08e-04	0.118		1
F_fleet_2_YR_1981_s_1	0.0327	(0,3.9)	0.0039	0.120		1
F_fleet_2_YR_1982_s_1	0.034	(0,3.9)	0.0041	0.120		1
F_fleet_2_YR_1983_s_1	0.0174	(0,3.9)	0.0021	0.120		1
F_fleet_2_YR_1984_s_1	0.0313	(0,3.9)	0.0037	0.120		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_2_YR_1985_s_1	0.0409	(0,3.9)	0.0049	0.120		1
F_fleet_2_YR_1986_s_1	0.0112	(0,3.9)	0.0011	0.099		1
F_fleet_2_YR_1987_s_1	0.0088	(0,3.9)	0.0011	0.120		1
F_fleet_2_YR_1988_s_1	0.0438	(0,3.9)	0.0052	0.119		1
F_fleet_2_YR_1989_s_1	0.0288	(0,3.9)	0.0035	0.120		1
F_fleet_2_YR_1990_s_1	0.007	(0,3.9)	8.43e-04	0.120		1
F_fleet_2_YR_1991_s_1	0.0082	(0,3.9)	9.50e-04	0.116		1
F_fleet_2_YR_1992_s_1	0.0169	(0,3.9)	0.0019	0.111		1
F_fleet_2_YR_1993_s_1	0.0122	(0,3.9)	0.0014	0.116		1
F_fleet_2_YR_1994_s_1	0.0077	(0,3.9)	9.15e-04	0.119		1
F_fleet_2_YR_1995_s_1	0.0075	(0,3.9)	9.07e-04	0.121		1
F_fleet_2_YR_1996_s_1	0.0047	(0,3.9)	5.66e-04	0.120		1
F_fleet_2_YR_1997_s_1	0.0054	(0,3.9)	6.39e-04	0.119		1
F_fleet_2_YR_1998_s_1	0.0112	(0,3.9)	0.0014	0.121		1
F_fleet_2_YR_1999_s_1	0.0054	(0,3.9)	6.43e-04	0.118		1
F_fleet_2_YR_2000_s_1	0.0059	(0,3.9)	5.69e-04	0.097		1
F_fleet_2_YR_2001_s_1	0.0039	(0,3.9)	3.92e-04	0.101		1
F_fleet_2_YR_2002_s_1	0.004	(0,3.9)	3.98e-04	0.099		1
F_fleet_2_YR_2003_s_1	0.0045	(0,3.9)	4.37e-04	0.097		1
F_fleet_2_YR_2004_s_1	0.0043	(0,3.9)	3.95e-04	0.093		1
F_fleet_2_YR_2005_s_1	0.0038	(0,3.9)	3.54e-04	0.093		1
F_fleet_2_YR_2006_s_1	0.0025	(0,3.9)	2.44e-04	0.096		1
F_fleet_2_YR_2007_s_1	0.0031	(0,3.9)	2.71e-04	0.088		1
F_fleet_2_YR_2008_s_1	0.0026	(0,3.9)	2.29e-04	0.090		1
F_fleet_2_YR_2009_s_1	0.0034	(0,3.9)	3.47e-04	0.102		1
F_fleet_2_YR_2010_s_1	0.0027	(0,3.9)	1.70e-04	0.063		1
F_fleet_2_YR_2011_s_1	0.0032	(0,3.9)	2.03e-04	0.064		1
F_fleet_2_YR_2012_s_1	0.0038	(0,3.9)	2.48e-04	0.064		1
F_fleet_2_YR_2013_s_1	0.0017	(0,3.9)	1.10e-04	0.065		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_2_YR_2014_s_1	0.0033	(0,3.9)	2.16e-04	0.066		1
F_fleet_2_YR_2015_s_1	0.0018	(0,3.9)	1.19e-04	0.067		1
F_fleet_2_YR_2016_s_1	0.0014	(0,3.9)	9.78e-05	0.069		1
F_fleet_2_YR_2017_s_1	0.0019	(0,3.9)	1.31e-04	0.070		1
F_fleet_2_YR_2018_s_1	0.0017	(0,3.9)	1.18e-04	0.071		1
F_fleet_2_YR_2019_s_1	0.002	(0,3.9)	1.47e-04	0.072		1
F_fleet_2_YR_2020_s_1	0.0013	(0,3.9)	9.87e-05	0.073		1
F_fleet_2_YR_2021_s_1	0.0029	(0,3.9)	2.10e-04	0.074		1
F_fleet_3_YR_1980_s_1	0.0347	(0,3.9)	0.0021	0.060		1
F_fleet_3_YR_1981_s_1	0.1071	(0,3.9)	0.0112	0.105		1
F_fleet_3_YR_1982_s_1	0.2187	(0,3.9)	0.0206	0.094		1
F_fleet_3_YR_1983_s_1	0.1572	(0,3.9)	0.0156	0.100		1
F_fleet_3_YR_1984_s_1	0.0884	(0,3.9)	0.0094	0.106		1
F_fleet_3_YR_1985_s_1	0.0762	(0,3.9)	0.0082	0.108		1
F_fleet_3_YR_1986_s_1	0.0621	(0,3.9)	0.0039	0.062		1
F_fleet_3_YR_1987_s_1	0.0491	(0,3.9)	0.0031	0.062		1
F_fleet_3_YR_1988_s_1	0.0966	(0,3.9)	0.006	0.062		1
F_fleet_3_YR_1989_s_1	0.0508	(0,3.9)	0.0032	0.062		1
F_fleet_3_YR_1990_s_1	0.0697	(0,3.9)	0.0044	0.063		1
F_fleet_3_YR_1991_s_1	0.0495	(0,3.9)	0.0031	0.063		1
F_fleet_3_YR_1992_s_1	0.1107	(0,3.9)	0.007	0.063		1
F_fleet_3_YR_1993_s_1	0.066	(0,3.9)	0.0043	0.065		1
F_fleet_3_YR_1994_s_1	0.1356	(0,3.9)	0.0087	0.064		1
F_fleet_3_YR_1995_s_1	0.0817	(0,3.9)	0.0053	0.065		1
F_fleet_3_YR_1996_s_1	0.0662	(0,3.9)	0.0044	0.066		1
F_fleet_3_YR_1997_s_1	0.1161	(0,3.9)	0.0073	0.063		1
F_fleet_3_YR_1998_s_1	0.0868	(0,3.9)	0.0055	0.064		1
F_fleet_3_YR_1999_s_1	0.1402	(0,3.9)	0.0088	0.062		1
F_fleet_3_YR_2000_s_1	0.151	(0,3.9)	0.0096	0.064		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_3_YR_2001_s_1	0.1092	(0,3.9)	0.0072	0.066		1
F_fleet_3_YR_2002_s_1	0.0835	(0,3.9)	0.0055	0.066		1
F_fleet_3_YR_2003_s_1	0.1306	(0,3.9)	0.0085	0.065		1
F_fleet_3_YR_2004_s_1	0.1062	(0,3.9)	0.0071	0.067		1
F_fleet_3_YR_2005_s_1	0.0854	(0,3.9)	0.0059	0.069		1
F_fleet_3_YR_2006_s_1	0.0852	(0,3.9)	0.0059	0.070		1
F_fleet_3_YR_2007_s_1	0.1299	(0,3.9)	0.0092	0.071		1
F_fleet_3_YR_2008_s_1	0.1176	(0,3.9)	0.0086	0.073		1
F_fleet_3_YR_2009_s_1	0.1061	(0,3.9)	0.0079	0.075		1
F_fleet_3_YR_2010_s_1	0.0505	(0,3.9)	0.0027	0.054		1
F_fleet_3_YR_2011_s_1	0.054	(0,3.9)	0.0029	0.054		1
F_fleet_3_YR_2012_s_1	0.0769	(0,3.9)	0.0043	0.056		1
F_fleet_3_YR_2013_s_1	0.0676	(0,3.9)	0.0039	0.057		1
F_fleet_3_YR_2014_s_1	0.0925	(0,3.9)	0.0055	0.060		1
F_fleet_3_YR_2015_s_1	0.0754	(0,3.9)	0.0047	0.063		1
F_fleet_3_YR_2016_s_1	0.0702	(0,3.9)	0.0046	0.066		1
F_fleet_3_YR_2017_s_1	0.0793	(0,3.9)	0.0054	0.069		1
F_fleet_3_YR_2018_s_1	0.1054	(0,3.9)	0.0077	0.073		1
F_fleet_3_YR_2019_s_1	0.1154	(0,3.9)	0.0091	0.079		1
F_fleet_3_YR_2020_s_1	0.1158	(0,3.9)	0.01	0.086		1
F_fleet_3_YR_2021_s_1	0.1434	(0,3.9)	0.0134	0.093		1
F_fleet_4_YR_1979_s_1	0.0026	(0,3.9)	1.81e-04	0.068		1
F_fleet_4_YR_1980_s_1	0.0037	(0,3.9)	4.32e-04	0.118		1
F_fleet_4_YR_1981_s_1	0.0624	(0,3.9)	0.0077	0.124		1
F_fleet_4_YR_1982_s_1	0.0667	(0,3.9)	0.0083	0.124		1
F_fleet_4_YR_1983_s_1	0.032	(0,3.9)	0.0039	0.122		1
F_fleet_4_YR_1984_s_1	0.0427	(0,3.9)	0.0052	0.123		1
F_fleet_4_YR_1985_s_1	0.1059	(0,3.9)	0.0131	0.124		1
F_fleet_4_YR_1986_s_1	0.0516	(0,3.9)	0.0062	0.121		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_1987_s_1	0.0537	(0,3.9)	0.0065	0.121		1
F_fleet_4_YR_1988_s_1	0.0656	(0,3.9)	0.0078	0.119		1
F_fleet_4_YR_1989_s_1	0.0343	(0,3.9)	0.004	0.117		1
F_fleet_4_YR_1990_s_1	0.0528	(0,3.9)	0.0054	0.102		1
F_fleet_4_YR_1991_s_1	0.0533	(0,3.9)	0.0054	0.102		1
F_fleet_4_YR_1992_s_1	0.0353	(0,3.9)	0.0042	0.119		1
F_fleet_4_YR_1993_s_1	0.0346	(0,3.9)	0.004	0.114		1
F_fleet_4_YR_1994_s_1	0.0333	(0,3.9)	0.0039	0.118		1
F_fleet_4_YR_1995_s_1	0.0438	(0,3.9)	0.0052	0.118		1
F_fleet_4_YR_1996_s_1	0.0196	(0,3.9)	0.0024	0.123		1
F_fleet_4_YR_1997_s_1	0.0134	(0,3.9)	0.0016	0.121		1
F_fleet_4_YR_1998_s_1	0.0175	(0,3.9)	0.002	0.114		1
F_fleet_4_YR_1999_s_1	0.0324	(0,3.9)	0.0039	0.119		1
F_fleet_4_YR_2000_s_1	0.0317	(0,3.9)	0.003	0.096		1
F_fleet_4_YR_2001_s_1	0.0182	(0,3.9)	0.0019	0.104		1
F_fleet_4_YR_2002_s_1	0.03	(0,3.9)	0.0031	0.104		1
F_fleet_4_YR_2003_s_1	0.0365	(0,3.9)	0.004	0.111		1
F_fleet_4_YR_2004_s_1	0.0287	(0,3.9)	0.0032	0.112		1
F_fleet_4_YR_2005_s_1	0.0265	(0,3.9)	0.0029	0.111		1
F_fleet_4_YR_2006_s_1	0.0215	(0,3.9)	0.0023	0.109		1
F_fleet_4_YR_2007_s_1	0.0139	(0,3.9)	0.0015	0.107		1
F_fleet_4_YR_2008_s_1	0.0155	(0,3.9)	0.0017	0.107		1
F_fleet_4_YR_2009_s_1	0.0207	(0,3.9)	0.0021	0.102		1
F_fleet_4_YR_2010_s_1	0.0132	(0,3.9)	9.09e-04	0.069		1
F_fleet_4_YR_2011_s_1	0.0205	(0,3.9)	0.0014	0.069		1
F_fleet_4_YR_2012_s_1	0.0159	(0,3.9)	0.0011	0.069		1
F_fleet_4_YR_2013_s_1	0.0249	(0,3.9)	0.0017	0.069		1
F_fleet_4_YR_2014_s_1	0.0218	(0,3.9)	0.0015	0.070		1
F_fleet_4_YR_2015_s_1	0.0287	(0,3.9)	0.002	0.071		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis for Gulf of Mexico Yellowedge Grouper. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_2016_s_1	0.0319	(0,3.9)	0.0023	0.072		1
F_fleet_4_YR_2017_s_1	0.026	(0,3.9)	0.0019	0.074		1
F_fleet_4_YR_2018_s_1	0.017	(0,3.9)	0.0013	0.074		1
F_fleet_4_YR_2019_s_1	0.0294	(0,3.9)	0.0022	0.075		1
F_fleet_4_YR_2020_s_1	0.0201	(0,3.9)	0.0015	0.077		1
F_fleet_4_YR_2021_s_1	0.0146	(0,3.9)	0.0011	0.077		1