SEDAR
Southeast Data, Assessment, and Review

SEDAR 51
Stock Assessment Report

Gulf of Mexico Gray Snapper

April 2018

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

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SEDAR

Southeast Data, Assessment, and Review

SEDAR 51

Gulf of Mexico Gray Snapper

SECTION I: Introduction

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4055 Faber Place Drive, Suite 201
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EXECUTIVE SUMMARY

SEDAR 51 addressed the stock assessment for Gulf of Mexico Gray Snapper. The assessment process consisted of two in-person workshops, as well as a series of webinars. The Data Workshop was held April 24-28, 2017 in Tampa, Florida the Assessment Process was conducted via webinars June 2017 - January 2018, and the Review Workshop took place February 13-15, 2018 in Tampa, FL.

The Stock Assessment Report is organized into 6 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. The Data Workshop Report can be found in Section II. It documents the discussions and data recommendations from the Data Workshop Panel. Section III is the Assessment Process report. This section details the assessment model, as well as documents any changes to the data recommendations that may have occurred after the data workshop. Consolidated Research Recommendations from all three stages of the process (data, assessment, and review) can be found in Section IV for easy reference. Section V documents the discussions and findings of the Review Workshop (RW). Finally, Section VI – Addenda and Post-Review Workshop Documentation consists of any analyses conducted during or after the RW to address reviewer concerns or requests. It may also contain documentation of the final RW-recommended base model, should it differ from the model put forward in the Assessment Report for review.

The final Stock Assessment Reports (SAR) for Gulf of Mexico gray snapper was disseminated to the public in April 2018. The Council's Scientific and Statistical Committee (SSC) will review the SAR. 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 May 2018 meeting, followed by the Council receiving that information at its June 2018. 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 is normally organized around two workshops and a series of webinars. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. The second stage is the Assessment Process, which is conducted via a workshop and/or a series of webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. The final step is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products. The completed assessment, including the reports of all 3 stages and all supporting documentation, is then forwarded to the Council SSC for certification as 'appropriate for management' and development of specific management recommendations.

SEDAR workshops are public meetings organized by SEDAR staff and the lead 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 Plan and Amendments

Original 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 undersized fish; and, (3) data reporting requirements.

List of Amendments, Dates, and Actions

Description of Action	FMP/Amendment	Year Implemented
Set a 12-inch total length minimum size limit on gray, mutton, and yellowtail snappers; gray snapper included in the 10 reef fish recreational aggregate bag limit	Amendment 1	1990
Commercial reef fish permit moratorium established for three years	Amendment 4	1992
Fish trap endorsement and three year moratorium established	Amendment 5	1994
Extended commercial reef fish permit moratorium until January 1996.	Amendment 9	1994
Commercial reef fish permit moratorium extended until December 30, 2000. Reef fish permit requirement established for headboats and charter vessels.	Amendment 11	1996
Gray snapper included in the 20 reef fish recreational aggregate bag limit	Amendment 12	1997
10-year phase-out of fish traps in EEZ established (February 7, 1997 – February 7, 2007).	Amendment 14	1997
Commercial reef fish permit moratorium extended until December 31, 2005.	Amendment 17	2000
(1) Prohibits vessels from retaining reef fish caught under recreational bag/possession limits when commercial quantities of Gulf reef fish are aboard, (2) adjusts the maximum crew size on charter vessels that also have a commercial reef fish permit and a USCG certificate of inspection (COI) to allow the minimum crew size specified by the COI when the vessel is fishing commercially for more than 12 hours, (3) prohibits the use of reef fish for bait except for sand perch or dwarf sand perch, and (4) requires electronic VMS aboard vessels with federal reef fish permits, including vessels with both commercial and charter vessel permits (implemented May 6, 2007).	Amendment 18A	2006
Also known as Generic Essential Fish Habitat (EFH) Amendment 2. Established two marine reserves off the Dry Tortugas where fishing for any species and anchoring by fishing vessels is prohibited.	Amendment 19	2002
3-year moratorium on reef fish charter/headboat permits established	Amendment 20	2003

Continued the Steamboat Lumps and Madison-Swanson reserves for an additional six years, until June 2010. In combination with the initial four-year period (June 2000-June 2004), this allowed a total of ten years in which to evaluate the effects of these reserves.	Amendment 21	2003
Permanent moratorium established for commercial reef fish permits.	Amendment 24	2005
Permanent moratorium established for charter and headboat reef fish permits, with periodic reviews at least every 10 years.	Amendment 25	2006
Addressed the use of non-stainless steel circle hooks when using natural baits to fish for Gulf reef fish effective June 1, 2008, and required the use of venting tools and dehooking devices when participating in the commercial or recreational reef fish fisheries effective June 1, 2008.	Amendment 27	2008
Established additional restrictions on the use of bottom longline gear in the eastern Gulf of Mexico in order to reduce bycatch of endangered sea turtles, particularly loggerhead sea turtles. (1) Prohibits the use of bottom longline gear shoreward of a line approximating the 35-fathom contour from June through August; (2) reduces the number of longline vessels operating in the fishery through an endorsement provided only to vessel permits with a demonstrated history of landings, on average, of at least 40,000 pounds of reef fish annually with fish traps or longline gear during 1999-2007; and (3) restricts the total number of hooks that may be possessed onboard each reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing. The boundary line was initially moved from 20 to 50 fathoms by emergency rule effective May 18, 2009. That rule was replaced on October 16, 2009 by a rule under the Endangered Species Act moving the boundary to 35 fathoms and implementing the maximum hook provisions.	Amendment 31	2010

2.2 Generic Amendments

Generic Sustainable Fisheries Act Amendment: partially approved and implemented in **November 1999**, set the Maximum Fishing Mortality Threshold (MFMT) for most reef fish stocks at $F_{30\%}$ SPR. Estimates of maximum sustainable yield, Minimum Stock Size Threshold (MSST), and optimum yield were disapproved because they were based on SPR proxies rather than biomass based estimates.

Generic ACL/AM Amendment: Established in-season and post-season accountability measures for all stocks that did not already have such measures defined. This includes the "other shallow-water grouper species" complex. The accountability measure states that if an ACL is exceeded, in subsequent years an in-season accountability measure will be implemented that would close fishing when the ACL is reached or projected to be reached.

2.3 Emergency and Interim Rules (if any)

Emergency Rule - Implemented May 3, 2010 through November 15, 2010: NMFS issued an emergency rule to temporarily close a portion of the Gulf of Mexico EEZ to all fishing [75 FR 24822] in response to an uncontrolled oil spill resulting from the explosion on April 20, 2010 and subsequent sinking of the Deepwater Horizon oil rig approximately 36 nautical miles (41 statute miles) off the Louisiana coast. The initial closed area extended from approximately the mouth of the Mississippi River to south of Pensacola, Florida and covered an area of 6,817 square statute miles. The coordinates of the closed area were subsequently modified periodically in response to changes in the size and location of the area affected by the spill. At its largest size on June 1, 2010, the closed area covered 88,522 square statute miles, or approximately 37 percent of the Gulf of Mexico EEZ. This closure was implemented for public safety.

2.4 Management Parameters and Projection Specifications

Table 2.4.1. General Management Information

Species	Gray Snapper
Management Unit	Reef Fish
Management Unit Definition	Gulf of Mexico
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	Steven Atran, Dr. Carrie Simmons, Ryan Rindone SERO Staff
Current stock exploitation status	Undefined
Current stock biomass status	Undefined

Table 2.4.2. Specific Management Criteria

(Provide details on the management criteria to be estimated in this assessment)

Criteria	Proposed	
	Definition	Value
MSST	Value from the most recent stock assessment based on MSST = [(1-M) or 0.5 whichever is greater]*BMSY	SEDAR 51
MFMT	FMSY or proxy from the most recent stock assessment (median from probabilistic analysis)	SEDAR 51
MSY	Yield at F_{MSY}, landings and discards, pounds and numbers (median from probabilistic analysis)	SEDAR 51
F_{MSY}		SEDAR 51
B_{MSY}	Total or spawning stock, to be defined (median from probabilistic analysis)	SEDAR 51
F Targets (i.e., F_{OY})	75% F_{MSY}	SEDAR 51
Yield at F_{Target} (Equilibrium)	landings and discards, pounds and numbers	SEDAR 51
M	Natural Mortality, average across ages	SEDAR 51
Terminal F	Exploitation	SEDAR 51
Terminal Biomass[1]	Biomass	SEDAR 51
Exploitation Status	F/MFMT	SEDAR 51
Biomass Status[1]	B/MSST B/B_{MSY}	SEDAR 51
Generation Time		SEDAR 51
$T_{Rebuild}$ (if appropriate)		SEDAR 51

Table 2.4.3. General 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, and guidance for the information managers required from the projection analyses.)

Requested Information	Value
First Year of Management	2019 Fishing Year
Interim basis	ACL, if ACL is met average exploitation, if ACL is not met
Projection Outputs - By migratory group and Fishing Year	
Landings	pounds whole weight and numbers
Discards	pounds whole weight and numbers
Exploitation	F & Probability F>MFMT
Biomass (total or SSB, as appropriate)	B & Probability B>MSST (and Prob. $B>B_{MSY}$ if under rebuilding plan)
Recruits	Number

Table 2.4.4. Base Run Projections Specifications.

Criteria	Definition	If overfished	If overfishing	Neither overfished nor overfishing
Projection Span	Years	$T_{Rebuild}$	10	10
Projection Values	$F_{Current}$	X	X	X
	F_{MSY} (proxy)	X	X	X
	75% F_{MSY}	X	X	X
	$F_{Rebuild}$	X		
	F=0	X		

NOTE: Exploitation rates for projections may be based upon point estimates from the base run (current process) or upon the median of such values from the MCBS evaluation of uncertainty. The critical point is that the projections be based on the same criteria as the management specifications.

Table 2.4.5. P-Star Projections. Short term specifications for OFL and ABC recommendations. Additional P-Star projections may be requested by the SSC once the ABC control rule is applied.

Criteria		Overfished	Not overfished
Projection Span	Years	10	10
Probability Values	50%	Probability of stock rebuild	Probability of overfishing

Table 2.4.6. Quota Calculation Details

If the stock is managed by an annual catch limit (ACL), please provide the following information (millions of pounds, whole weight):

Current ACL Value	2.42 mp ww
Next Scheduled Quota Change	-
Annual or averaged quota?	Annual
If averaged, number of years to average	-
Does the quota include bycatch/discard?	Yes

The ACL (2.42 mp ww) and ACT (2.08 mp ww) for gray snapper were determined in the 2011 Generic ACL AM Amendment, and include landings and discards.

2.5. Management and Regulatory Timeline

Tables 2.5.1. Pertinent Federal management information.

Harvest Restrictions: Trip Limits

First Yr In Effect	Effective Date	End Date	Fishery	Bag Limit Per Person/Day	Bag Limit Per Boat/Day	Region Affected	FR Reference	Amendment Number or Rule Type
1990	4/23/90	1/14/97	Rec	10 reef fish aggregate limit	NA	Gulf of Mexico EEZ	55 FR 2078	Reef Fish Amendment 1
1997	1/15/97	Ongoing	Rec	20 reef fish aggregate limit	NA	Gulf of Mexico EEZ	61 FR 65983	Reef Fish Amendment 12

Harvest Restrictions: Size Limits

First Yr In Effect	Effective Date	End Date	Fishery	Size Length	Length Type	Region Affected	FR Reference	Amendment Number or Rule Type
1990	4/23/90	12/31/08	Both	12”	Total Length	Gulf of Mexico EEZ	55 FR 2078	Reef Fish Amendment 1

Quota History:

First Yr In Effect	Effective Date	End Date	ACL	ACT	Region Affected	FR Reference	Amendment Number or Rule Type
2012	1/30/12	Ongoing	2.42 mp ww[1]	2.08 mp ww[1]	Gulf of Mexico EEZ	76 FR 82043	Generic ACL/AM Amendment

[1]Combined commercial and recreational ACL and ACT; no sector allocations

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
Gulf of Mexico	1984	11/8/84	Ongoing	Both	Year round		Prohibited powerheads for Reef FMP	49 FR 39548	Original Reef Fish FMP
Stressed Areas	1984	11/8/84	Ongoing	Both	Year round		Prohibited pots and traps for Reef FMP	49 FR 39548	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
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
EEZ, inside 20 fathoms east of Cape San Blas, FL	1990	2/21/90	4/17/09	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	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
EEZ, inside 35 fathoms east of Cape San Blas, FL	2009	10/16/09	4/25/10	Both	Year round		Prohibited bottom longline for Reef FMP	74 FR 53889	Sea Turtle ESA Rule
	2010	4/26/10	Ongoing	Rec	Year round		Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31
	2010	4/26/10	Ongoing	Com	1-Jun	31-Aug	Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31
Madison-Swanson	2000	4/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment
	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
	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
Steamboat Lumps	2000	4/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment
	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
	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
The Edges	2010	7/24/09	Ongoing	Both	1-Jan	30-Apr	Fishing prohibited	74 FR 30001	Reef Fish Amendment 30B Supplement
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
Flower Garden	1992	1/17/92	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	56 FR 63634	Sanctuary Designation
Riley's Hump	1994	2/7/94	8/18/02	Both	1-May	30-Jun	Fishing prohibited	59 FR 966	Reef Fish Amendment 5
Tortugas Reserves	2002	8/19/02	Ongoing	Both	Year round		Fishing prohibited	67 FR 47467	Tortugas Amendment
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

[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

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

Gear Type	First Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	Region Affected	FR Reference	Amendment Number or Rule Type
Poison	1984	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
Explosives	1984	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
Pots and Traps	1984	11/23/84	2/3/94	Established fish trap permit	Gulf of Mexico EEZ	50 FR 39548	Original Reef Fish FMP
	1984	11/23/84	2/20/90	Set max number of traps fish by a vessel at 200	Gulf of Mexico EEZ	50 FR 39548	Original Reef Fish FMP
	1990	2/21/90	2/3/94	Set max number of traps fish by a vessel at 100	Gulf of Mexico EEZ	55 FR 2078	Reef Fish Amendment 1
	1994	2/4/94	2/7/97	Moratorium on additional commercial trap permits	Gulf of Mexico EEZ	59 FR 966	Reef Fish Amendment 5
	1997	3/25/97	2/6/07	Phase out of fish traps begins	Gulf of Mexico EEZ	62 FR 13983	Reef Fish Amendment 14
	1997	12/30/97	2/6/07	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	Reef Fish Amendment 15
	2007	2/7/07	Ongoing	Traps prohibited	Gulf of Mexico EEZ	62 FR 13983	Reef Fish Amendment 14
All	1992	4/8/92	12/31/95	Moratorium on commercial permits for Reef FMP	Gulf of Mexico EEZ	68 FR 11914 59 FR 39301	Reef Fish Amendment 4 Reef Fish Amendment 9
	1994	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 39301	Reef Fish Amendment 9
	1996	6/1/96	12/31/05	Moratorium on commercial permits for Gulf reef fish.	Gulf of Mexico EEZ	61 FR 34930 65 FR 41016	Interim Rule Reef Fish Amendment 17
	2006	9/8/06	Ongoing	Use of Gulf reef fish as bait prohibited.[1]	Gulf of Mexico EEZ	71 FR 45428	Reef Fish Amendment 18A
Vertical Line	2008	6/1/08	Ongoing	Requires non-stainless steel circle hooks and dehooking devices	Gulf of Mexico EEZ	74 FR 5117	Reef Fish Amendment 27
	2008	6/1/08	9/3/13	Requires venting tools	Gulf of Mexico EEZ	74 FR 5117 78 FR 46820	Reef Fish Amendment 27 Framework Action

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

3 ASSESSMENT HISTORY AND REVIEW

No formal stock assessment has been conducted for Gulf of Mexico gray snapper.

4 REGIONAL MAPS

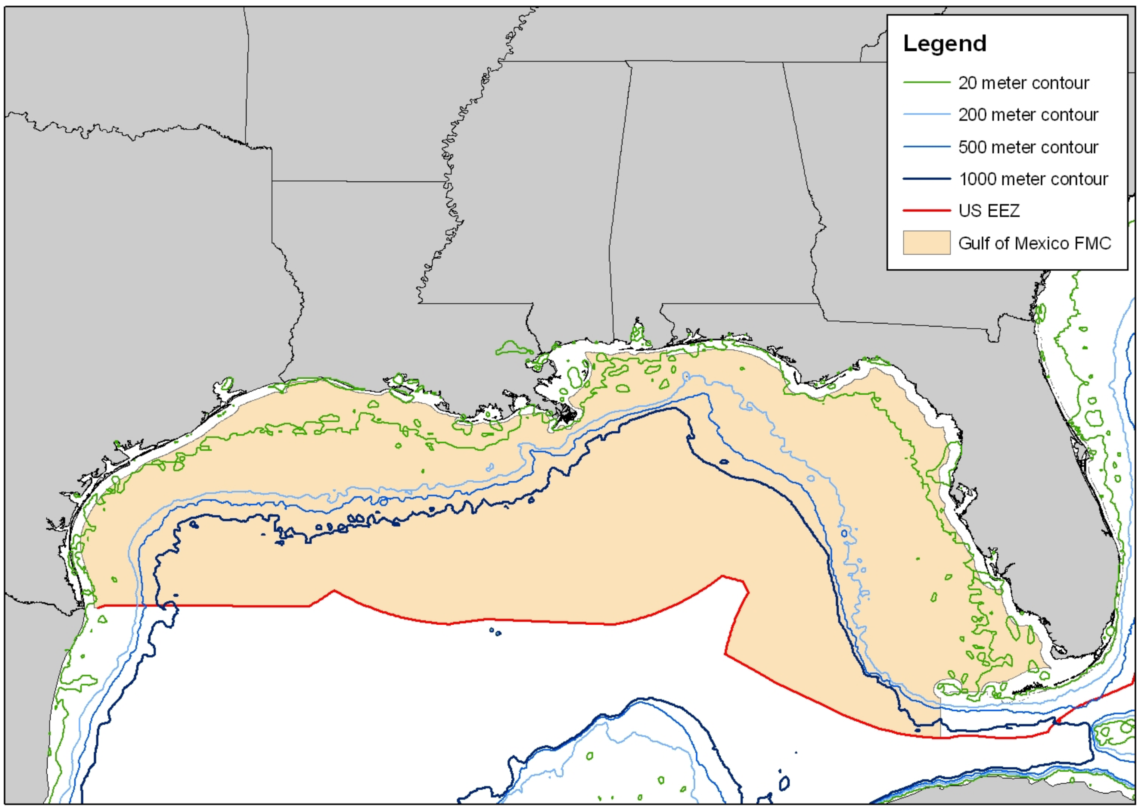

Figure 4.1 Southeast Region including Council and EEZ Boundaries.

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
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BAM	Beaufort Assessment Model
BMSY	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
EEZ	exclusive economic zone
F	fishing mortality (instantaneous)
FMSY	fishing mortality to produce MSY under equilibrium conditions
FOY	fishing mortality rate to produce Optimum Yield under equilibrium
FXX% SPR	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) 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)
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
MRIP	Marine Recreational Information Program
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
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS Corporation
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
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
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

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SEDAR 51

Gulf of Mexico Gray Snapper

SECTION II: Data Workshop Report

July 2017

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1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 51 Data Workshop was held April 24-28, 2017 in Tampa, Florida.

1.2 TERMS OF REFERNCE

1. Review stock structure and unit stock definitions and consider whether changes are required.

   NOTE: Information and recommendations to address this TOR will be developed prior to the Data Workshop by a Stock ID work group. The results of the workgroup will be reviewed by the data workshop panel. The work group is charged with addressing the following:

   a. *Review genetics studies, growth patterns, existing stock definitions, prior SEDAR stock ID recommendations and any other relevant information on gray snapper stock structure*
   b. *Make recommendations on biological stock structure and define the unit stock or stocks to be addressed through this assessment*
   c. *Document work group discussion and recommendations through a working paper for SEDAR 51*
   d. *Work Group recommendations will be used to address Data Workshop Term of Reference 1: Review stock structure and unit stock definitions and consider whether changes are required*

2. Review, discuss, and tabulate available life history information.
   - Evaluate age, growth, natural mortality, and reproductive characteristics
   - Provide appropriate models to describe population growth, maturation, and fecundity by age, sex, and/or length as applicable.
   - Evaluate the adequacy of available life history information for conducting stock assessments and recommend life history information for use in population modeling.
   - Evaluate and discuss the sources of uncertainty and error, and data limitations (such as temporal and spatial coverage) for each data source. Provide estimates or ranges of uncertainty for all life history information.
3. Recommend discard mortality rates.
   - Review available research and published literature
   - Consider research directed at gray snapper as well as similar species from the southeastern United States and other areas
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other strata as feasible or appropriate
   - Include thorough rationale for recommended discard mortality rates
   - Provide justification for any recommendations that deviate from the range of discard mortality provided in the last benchmark or other prior assessment

- Provide estimates of uncertainty around recommended discard mortality rates

4. Provide measures of population abundance that are appropriate for stock assessment.
    - Consider and discuss all available and relevant fishery-dependent and -independent data sources
        - Consider species identification issues between gray snapper and other lutjanids, and correct for these instances as appropriate
    - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics
    - Provide maps of fishery and survey coverage
    - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy
    - Discuss the degree to which available indices adequately represent fishery and population conditions
    - Recommend which data sources adequately and reliably represent population abundance for use in assessment modeling
    - Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models
    - Rank the available indices with regard to their reliability and suitability for use in assessment modeling
5. Provide commercial catch statistics, including both landings and discards in both pounds and number.
    - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by fishery sector or gear
    - Provide length and age distributions for both landings and discards if feasible
    - Provide maps of fishery effort and harvest and fishery sector or gear
    - Provide estimates of uncertainty around each set of landings and discard estimates
6. Provide recreational catch statistics, including both landings and discards in both pounds and number.
    - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear
    - Provide length and age distributions for both landings and discards if feasible
    - Provide maps of fishery effort and harvest and fishery sector or gear
    - Provide estimates of uncertainty around each set of landings and discard estimates
7. Identify and describe ecosystem, climate, species interactions, habitat considerations, and/or episodic events that would be reasonably expected to affect population dynamics.
8. Incorporate socioeconomic information into considerations of environmental events that affect stock status and related fishing effort and catch levels as practicable.

9. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
10. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Workshop Panel

Jeff Isely, Lead Analyst .... NMFS Miami
Robert Allman .... NMFS Panama City
Ryan Bradley .... MCFU
Erik Lang .... LDWF
Matt Campbell .... NMFS Pascagoula
Mary Christman .... SSC/MCC Consulting
Jason Delacruz .... RFSHA
Kelly Fitzpatrick .... NMFS Beaufort
Kerry Flaherty-Walia .... FWRI St. Pete
Chris Gardner .... NMFS Panama City
Jay Gardner .... Recreational Fisherman
David Hanisko .... NMFS Pascagoula
Jennifer Herbig .... FWC Marathon
Linda Lombardi .... NMFS Panama City
Vivian Matter .... NMFS Miami
Kevin McCarthy .... NMFS Miami
Adam Pollack .... NMFS Pascagoula
Adyan Rios .... NMFS Miami
Skyler Sagarese .... NMFS Miami
Beverly Sauls .... FWC St. Pete
Tom Sminkey .... NMFS Silver Spring
Matthew Smith .... NMFS Miami
Ted Switzer .... FWRI St. Pete
Kevin Thompson .... FWRI St. Pete
Laura Thornton .... NMFS Panama City
Jim Tolan .... SSC/TPWD
Ed Walker .... Commercial/Recreational Fisherman
Beth Wrege .... NMFS Miami

Attendees

Alisha Gray .... NMFS St. Pete
Amanda Tyler-Jedlund .... FWRI St. Pete
Dominque Lazare .... FWC St. Pete
Mandy Taylor-Sedlord .... FWRI St.Pete
Mike Larkin .... NOAA NMFA SERO

Staff
Julie Neer .... SEDAR
Jessica Matos ....GMFMC
Ryan Rindone...GMFMC
Charlotte Schiaffo ....GMFMC

Additional Participants via Webinar
Jason Adriance ....LDWF
Larry Beerkircher..NMFS Miami
Ken Brennan ....NMFS Beaufort
Shannon Cass-Calay ....NMFS Miami
Ching-ping Chih ....NMFS Miami
Nancie Cummings...NMFS Miami
Jim Eliason...
Paul Mickle ....GCRL
Refik Orhun ....NMFS Miami
Yuying Zhang ....FIU

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR51-DW-01	Brief Summary of FWRI-FDM Tag-Recapture Program and Brief Summary of FWRI-FIM Tag-Recapture Data	Rachel Germeroth, Kerry Flaherty-Walia, Beverly Sauls and Ted Switzer	4 Nov 2016
SEDAR51-DW-02	Summary of length and weight data for gray snapper (*Lutjanus griseus*) collected during NMFS and SEAMAP fishery-independent surveys in the Gulf of Mexico	David S. Hanisko and Adam Pollack	20 March 2017
SEDAR51-DW-03	Gray Snapper Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack, David S. Hanisko and G. Walter Ingram, Jr	7 April 2017 Updated: 12 June 2017
SEDAR51-DW-04	Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico	Ching-Ping Chih	9 April 2017
SEDAR51-DW-05	Gray snapper *Lutjanus griseus* Findings from the NMFS Panama	C.L. Gardner, D.A. DeVries, K.E.	7 April 2017

	City Laboratory Camera Fishery-Independent Survey 2005-2015	Overly, and A.G. Pollack	
SEDAR51-DW-06	Reproductive parameters for the Gulf of Mexico gray snapper, *Lutjanus griseus,* 1991-2015	G.R. Fitzhugh, V.C. Beech, H.M. Lyon, and P. Colson	13 April 2017
SEDAR51-DW-07	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Grey Snapper	Matthew D. Campbell, Kevin R. Rademacher, Michael Hendon, Paul Felts, Brandi Noble, Ryan Caillouet, Joseph Salisbury, and John Moser	10 April 2017
SEDAR51-DW-08	Description of age data and estimated growth of Gray Snapper from the northern Gulf of Mexico: 1982-1983 and 1990-2015	L.A. Thornton, L.A. Lombardi, and R.J. Allman	14 April 2017
SEDAR51-DW-09	SEDAR 51 Stock ID Working Paper	S51 Stock ID Working Group	February 2017
SEDAR51-DW-10	Indices of abundance for Gray Snapper (*Lutjanus griseus*) from the Florida Fish and Wildlife Research Institute (FWRI) video survey on the West Florida Shelf	Kevin A. Thompson, Theodore S. Switzer, and Sean F. Keenan	21 April 2017
SEDAR51-DW-11	Gray Snapper Abundance Indices from Inshore Surveys of Northeastern Gulf of Mexico estuaries	Kerry E. Flaherty-Walia, Theodore S. Switzer, and Amanda J. Tyler-Jedlund	24 April 2017 Updated: 27 April 2017
SEDAR51-DW-12	Standardized Catch-Per-Unit Effort Index for Gulf of Mexico Gray Snapper *Lutjanus griseus* Commercial Handline Fishery (1993 – 2015)	Matthew W. Smith	26 April 2017
SEDAR51-DW-13	Commercial Landings of Gray or Mangrove Snapper (*Lutjanus griseus*) from the Gulf of Mexico	Refik Orhun and Beth Wrege	Not Recieved
SEDAR51-DW-14	Standardized Reef Fish Visual Census index for Gray Snapper, *Lutjanus griseus*, for the Florida reef	Robert G. Muller	6 June 2017

	track from Biscayne Bay through the Florida Keys for 1997-2016		
SEDAR51-DW-15	Indices of abundance for Gray Snapper (*Lutjanus griseus*) using combined data from three independent video surveys	Kevin A. Thompson, Theodore S. Switzer, Mary C. Christman, Sean F. Keenan, Christopher Gardner, Matt Campbell, Adam Pollack	15 June 2017
Reference Documents			
SEDAR51-RD01	Short-Term Discard Mortality Estimates for Gray Snapper in a West-Central Florida Estuary and Adjacent Nearshore Gulf of Mexico Waters	Kerry E. Flaherty-Walia, Brent L. Winner, Amanda J. Tyler-Jedlund & John P. Davis	
SEDAR51-RD02	Regional Correspondence in Habitat Occupancy by Gray Snapper (*Lutjanus griseus*) in Estuaries of the Southeastern United States	Kerry E. Flaherty & Theodore S. Switzer & Brent L. Winner & Sean F. Keenan	
SEDAR51-RD03	Improved Ability to Characterize Recruitment of Gray Snapper in Three Florida Estuaries along the Gulf of Mexico through Targeted Sampling of Polyhaline Seagrass Beds	Kerry E. Flaherty-Walia, Theodore S. Switzer, Brent L. Winner, Amanda J. Tyler-Jedlund & Sean F. Keenan	
SEDAR51-RD04	Conservation Genetics of Gray Snapper (*Lutjanus griseus*) in U.S. Waters of the Northern Gulf of Mexico and Western Atlantic Ocean	John R. Gold, Eric Saillant, N. Danielle Ebelt, and Siya Lem	
SEDAR51-RD05	Developmental patterns within a multispecies reef fishery: management applications for essential fish habitats and protected areas	Kenyon C. Lindeman, Roger Pugliese, Gregg T. Waugh, and Jerald S. Ault	
SEDAR51-RD06	Age, growth, and mortality of gray snapper, *Lutjanus griseus*, from the east coast of Florida	Michael L. Burton	

SEDAR51-RD07	Ingress of transformation stage gray snapper, *Lutjanus griseus (*Pisces: Lutjanidae) through Beaufort Inlet, North Carolina	Mimi W. Tzeng, Jonathan A. Hare, and David G. Lindquist
SEDAR51-RD08	Biological response to changes in climate patterns: population increases of gray snapper (*Lutjanus griseus*) in Texas bays and estuaries	James M. Tolan and Mark Fisher
SEDAR51-RD09	Returns from the 1965 Schlitz tagging program including a cumulative analysis of previous results	Dale S. Beaumariage
SEDAR51-RD10	Recruitment dynamics and otolith chemical signatures of juvenile gray snapper, *Lutjanus griseus,* among West Florida estuarine and coastal marine ecosystems	Cecelia Lounder
SEDAR51-RD11	Reproductive biology of gray snapper (*Lutjanus griseus*), with notes on spawning for other Western Atlantic snappers (Lutjanidae)	M.L. Domeier, C. Koenig, and F. Colman
SEDAR51-RD12	Climate-related, decadal-scale assemblage changes of seagrass-associated fishes in the northern Gulf of Mexico	F. Joel Fodrie, Kenneth L. Heck, Jr., Sean P. Powers, William M. Graham, and Kelly L. Robinson
SEDAR51-RD13	Response of coastal fishes to the Gulf of Mexico oil disaster	F. Joel Fodrie and Kenneth L. Heck Jr.
SEDAR51-RD14	Variation in the isotopic signatures of juvenile gray snapper (*Lutjanus griseus*) from five southern Florida regions	Trika Gerard and Barbara Muhling
SEDAR51-RD15	Temporal and spatial dynamics of spawning, settlement, and growth of gray snapper (*Lutjanus griseus*) from the West Florida shelf as determined from otolith microstructures	Robert J. Allman and Churchill B. Grimes
SEDAR51-RD16	Regional variation in the population structure of gray snapper, *Lutjanus griseus,* along the West Florida shelf	R.J. Allman and L.A. Goetz
SEDAR51-RD17	Evaluating juvenile thermal	Mark J. Wuenschel, Jonathan A.

	tolerance as a constraint on adult range of gray snapper (Lutjanus griseus): A combined laboratory, field and modeling approach	Hare, Matthew E. Kimball, and Kenneth W. Able
SEDAR51-RD18	Growth variation, settlement, and spawning of gray snapper across a latitudinal gradient	Kelly Denit and Su Sponaugle
SEDAR51-RD19	Age, growth, mortality, and radiometric age validation of gray snapper (Lutjanus griseus) from Louisiana	Andrew J. Fischer, M. Scott Baker, Jr., Charles A. Wilson, and David L. Nieland
SEDAR51-RD20	Southeast Florida reef fish abundance and biology: Five year performance report	Luiz R. Barbieri and James A. Colvocoresses
SEDAR51-RD21	Larval ecology of a suite of snappers (family: Lutjanidae) in the Straits of Florida, western Atlantic Ocean	E. K. D'Alessandro, S. Sponaugle, and J. E. Serafy
SEDAR51-RD-22	Multidecadal otolith growth histories for red and gray snapper (Lutjanus spp.) in the northern Gulf of Mexico, USA	Bryan A. Black, Robert J. Allman, Isaac D. Schroeder, and Michael J. Schirripa
SEDAR51-RD-23	Investigations on the Gray Snapper, Lutjanus griseus	Walter A. Starck II and Robert E. Schroede
SEDAR51-RD-24	Age-size Structure of Gray Snapper from the Southeastern United States: A Comparison of Two Methods of Back-calculating Size at Age from Otolith Data	A.G. Johnson, L.A. Collins, and C.P. Keim

2 LIFE HISTORY

2.1 OVERVIEW

The life history workgroup (LHW) reviewed and discussed the available data for Gulf of Mexico gray snapper and offered recommendations. Information was examined on natural mortality, age, growth, reproduction, steepness, habitat, movements and migrations, size conversions and episodic events. A summary of the data presented, discussed and recommendations made is presented below.

2.1.1 Life History Workgroup members

Robert Allman-NMFS, Panama City, FL (leader)
Kerry Flaherty-Walia-FWRI, St. Petersburg, FL
Jennifer Herbig-FL FWC, Marathon, FL
Erik Lang-LDWF, Baton Rouge, LA
Linda Lombardi-NMFS, Panama City, FL
Skyler Sagarese-SEFSC, Miami, FL
Laura Thornton-NMFS, Panama City, FL (rapporteur)
Jim Tolan-TPWD, Corpus Christi, TX
Mandy Tyler-Jedlund-FWRI, St. Petersburg, FL

2.2 REVIEW OF WORKING PAPERS

The LHW group reviewed the following working papers:

1. Natural Mortality-SEDAR51-RD-6, SEDAR51-RD-16, SEDAR51-RD-19, SEDAR51-RD-21

2. Age and growth- SEDAR51-RD-6, SEDAR51-RD-7, SEDAR51-DW-8, SEDAR51-RD-10, SEDAR51-RD-15, SEDAR51-RD-16, SEDAR51-RD-18, SEDAR51-RD-19, SEDAR51-RD-21, SEDAR51-RD-24,

3. Reproduction- SEDAR51-DW-6, SEDAR51-RD-11, SEDAR51-RD-15, SEDAR51-RD-20, SEDAR51-RD-21

4. Habitat requirements- SEDAR51-RD-2, SEDAR51-DW-3, SEDAR51-RD-5, SEDAR51-RD-7, SEDAR51-RD-8, SEDAR51-RD-10, SEDAR51-RD-11, SEDAR51-RD-12, SEDAR51-RD-17, SEDAR51-RD-18, SEDAR51-RD-23

5. Movement and migrations- SEDAR51-RD-1, SEDAR51-RD-2, SEDAR51-RD-3, SEDAR51-RD-7, SEDAR51-RD-9, SEDAR51-RD-10, SEDAR51-RD-11, SEDAR51-RD-14, SEDAR51-RD-15, SEDAR51-RD-17, SEDAR51-RD-18, SEDAR51-RD-23, SEDAR51-DW-1

6. Episodic events- SEDAR51-RD-2, SEDAR51-RD-13.

Discussion of working papers and other literature reviewed is listed below by topic.

2.3 STOCK DEFINITION AND DESCRIPTION

A working group appointed by the Gulf and South Atlantic Councils, SERO, and the SEFSC reviewed information available for gray snapper stock structure within the Gulf of Mexico and South Atlantic Fishery Management Council jurisdictions prior to the start of the SEDAR51 assessment process. Discussions and the working group decisions are reported in SEDAR51-DW-09. One recommendation of the working group was to include all of Monroe county data in SEDAR51. The following criteria were used to identify fish selected in Monroe county waters: if waterbody codes were unavailable, county landed (Monroe) was used, waterbody codes from the Marine Fisheries Trip Ticket Fishing Area Map were used to assign water bodies if recorded. All of grid 748 was assigned to Monroe County and portions of grid 744 (i.e., 744.1 Florida Bay, 744.6 Card Sound and 744.7 Barnes sound). All Monroe county waters listed above and NMFS statistical zones 1-22 were considered Gulf of Mexico.

2.4 NATURAL MORTALITY

There are multiple methods to calculate estimates of natural mortality (M) and these methods use a variety of life history parameters (e.g., von Bertalanffy growth parameters, maximum age, age at 50% maturity, Table 2.17.1) and environmental parameters (water temperature). A constant natural mortality for the lifetime of species is unrealistic but an estimate of M is necessary for the calculation of an age-specific vector of natural mortality (Lorenzen 2005).

2.4.1 Young of the year

There are limited data and research available describing natural mortality at the larval stage (i.e., young of the year). Gray snapper larvae were caught in the Straits of Florida using multiple opening–closing nets at depths 0-75 m with most larvae caught in shallower depths (0-25 m, SEDAR51-RD-21). Total mortality was estimated using age-specific abundance data for gray snapper larvae ($Z = -0.508 \pm 0.075$, SEDAR51-RD-21). Age-specific natural mortality (M) was the highest for larvae (M = 0.51) and age 1 fish (Age 1 M = 0.35) estimated through a Lorenzen (2005) age-specific mortality vector (Figure 2.18.1).

2.4.2 Sub-adult/adult

Point estimates of Natural Mortality

Multiple life history parameters (asymptotic length, growth coefficient, maximum age, age at 50% mature) and water temperature were used to calculate various point estimates of M (Table 2.17.1).

The life history working group used these methods to calculate natural mortality, M ranged from 0.11 – 1.09 (Figure 2.18.2). These M values were similar to gray snapper published values (M range = 0.15 – 0.43; SEDAR51-RD-06, SEDAR51-RD-16, SEDAR51-RD-19), which also used a variety of methods and life history parameters (Pauly 1980, Hoenig 1983, Ralston 1987). The minimum M was calculated using the Hewitt and Hoenig (M = 0.11, 2005) method that divides the maximum age by a constant and the maximum M was calculated using Beverton and Holt (M = 1.09, 1956) that uses both the predicted von Bertalanffy growth coefficient and the age at 50% maturity (Table 2.17.2, Figure 2.18.2). The natural mortality methods that utilize the von Bertalanffy growth parameters (L_{inf} and/or k) estimated similar M values (0.23 – 0.40). Likewise, those natural mortality methods that took into consideration maximum age had similar M values (0.11 – 0.23).

Age-Specific vector of M

An age-specific vector of M was estimated (following Lorenzen 2005). This vector takes into consideration the first age at vulnerability into the fishery (age 4), the target M of 0.15 (Hoenig $_{teleost}$, maximum age of 28 years) and the von Bertalanffy growth parameters. In addition, the life history working group recommends sensitivities around M by using age 25 and age 32 as the lower and upper bounds, respectively (Figure 2.18.1, Table 2.17.3).

Assessment model sensitivities for M

In previous SEDARs, model sensitivities for natural mortality were based on the standard deviation around the average age of the older fish or average age of multiple readers of the oldest fish age structure or set arbitrarily (see SEDAR Best Practices). Based on the older gray snapper (those fish > age 24 yrs; n = 57 fish) average age was 26 ± 1.86 (std dev), yielding a range of M = 0.14-0.16. These values provided a narrow range compared to the base case of M = 0.15.

Instead of applying the calculated standard deviation around the older fish, an upper bound at age 32 (M = 0.13) and lower bound at age 25 (M = 0.17) are recommended to be used to estimate sensitivities around the base case for natural mortality (point estimate and age-specific M).

2.5 DISCARD MORTALITY

An ad-hoc panel discussed discard mortality during the Data Workshop. Participants included data providers, analysts, and professionals from the fishing industry representing both commercial and recreational fisheries. The panel reviewed available data and relevant research results to provide recommended estimates of discard mortality for each fishery by fishing mode/gear. Published studies that might have informed the working group's recommendations were very limited. Two studies, however, were informative and are summarized here.

2.5.1 Recreational fishery

Recreational discard mortality rates were recommended based on two complementary studies. The first study (Flaherty-Walia et al. 2016) characterized discard mortality for the Gray Snapper recreational fishery in a study area representative of the regions in which most of the recreational fishing for this species takes place (inshore and nearshore waters <20 nm offshore, Figure 2.18.3). During a two-year cooperative research project, recreational anglers and professional fishing guides were recruited for their expertise and to assist biologists during discard mortality experiments. Fishing tackle and field protocols were standardized to appropriately represent those of the recreational fishery while minimizing variability so that factors influencing mortality could be detected. Light to medium tackle and non-offset circle hooks were used exclusively, and fish were held in net pens or cages for 48-hrs to estimate short-term mortality. The overall mortality rate for Gray Snapper calculated from these studies was 6.9% (Table 2.17.4), with the rates being lower inshore (1.4%) than nearshore (14.4%). The water depth in which the fish were captured significantly influenced the probability of mortality; individuals caught in deeper water were less likely to survive catch-and-release. By using containment enclosures, fish potentially affected by barotrauma in deeper water were not only protected from predators but were effectively recompressed as the cage was submerged leading to conservative estimates of mortality. Anatomical location of the hook also significantly influenced the probability of mortality. Although the vast majority of fish were hooked in the lip, those that were hooked in the esophagus were the least likely to survive (Figure 2.18.4). The high proportion of lip-hooked fish was most likely due to the exclusive use of circle hooks, which are designed to hook fish in the lip area, improving discard survival.

A second study, Sauls and Ayala (2012), found that 88.8% of Gray Snapper caught with circle hooks were hooked in the lip and that use of circle hooks reduced potentially lethal injuries by 30% in this species. Overall discard mortality observed by Sauls and Ayala were similar to those reported by Flaherty-Walia et al. (2016).

2.5.2 Commercial fishery

Since 2006, the National Marine Fisheries Service has placed fishery observers on commercial vessels fishing with vertical line and bottom longline gears. A detailed description of methods are provided in Pulver et al. 2014. Size, capture depth, release condition, and final dispositions were recorded for discards. Few gray snapper discards were reported by commercial fishery observers. In the vertical line fishery only 151 discards were observed; of those, only 13 were reported as dead when discarded. Only 49 gray snapper discards were observed on bottom longline vessels; 16 of those reported as dead.

Due to the limited data available, discard mortality was not estimated by fishing depth. Percent dead discards was calculated for each gear across all observed fishing depths. The observed vertical line fishing depths ranged from five to 208 meters. Bottom longline fishing depths varied from 124 to 242 meters.

Immediate discard mortality across all depths was nine percent (vertical line) and 33% (bottom longline). Those mortality estimates were considered by the work group to be minimum discard mortality estimates because only instantaneous (at the boat) mortality was observed. Due to unknown delayed mortality, the work group agreed that an upper limit of 19% discard mortality be recommended. The upper discard mortality bound was informed by the cage study of Flaherty-Walia et al. (2016) and additional assumed predation induced mortality post-release.

The work group recommends a vertical line discard mortality of 14 percent of total discards (base run) with mortalities of nine percent and 19 percent used in sensitivity runs of the assessment model.

Observed immediate discard mortality was 33% across all depths fished in the bottom longline fishery. The working group recommended an upper bound of 100% discard mortality as per expert opinion of fishers in the working group. A discard mortality of 66% was recommended for base runs of the assessment model with sensitivity runs using discard mortalities of 33% and 100%.

Recommendations

Recreational discard mortality:

- 6.9% model base run with 1.4% and 14.4% recommended for sensitivity model runs

Commercial discard mortality:

- vertical line 14% with 9% and 19% recommended for sensitivity model runs
- bottom longline 66% with 33% and 100% recommended for sensitivity model runs

2.6 AGE AND GROWTH

2.6.1 Age

Larvae and juveniles

Larval and juvenile gray snapper have been aged by counting daily increments in otolith microstructure (SEDAR51-RD-7, SEDAR51-RD-10, SEDAR51-RD-15, SEDAR51-RD-18, SEDAR51-RD-21). Daily increment formation has been validated in juveniles (SEDAR51-RD-15). Planktonic larval duration is estimated to range from 22-42 days and juveniles collected from estuaries ranged in age from 25 to 229 days.

Adults

Gray snapper from off the southeastern U.S. have been aged using scales (Croker 1962, Starck and Schroeder 1970, Rutherford et al. 1983) and otoliths (Manooch and Matheson 1981, Johnson et al. 1994, Burton 2001, Fischer et al. 2005, Allman and Goetz 2009). Regional differences have been observed in the size and age structure of gray snapper. Burton (2001; SEDAR51-RD-06) aged fish from fishery dependent sources off the east coast of Florida and noted a lack of older, larger fish in south Florida compared to north Florida and concluded that this could be due to greater fishing pressure off south Florida. Allman and Goetz (2009; SEDAR51-RD16) also reported a decrease in mean size and age from north to south along the west Florida shelf for the recreational fishery and a decrease in mean size at age from north to south for the most common age classes and attributed these differences to greater exploitation in the south. The only ageing study from the central gulf was conducted by Fischer et al. (2005; SEDAR51-RD-19). Gray snapper from Louisiana recreational landings were aged and ages validated using bomb radiocarbon (C14). They noted an abundance of older, larger individuals in the population off Louisiana compared to off east Florida and stated that exploitation off Louisiana was low.

Gray snapper age data for SEDAR-51 were supplied by National Marine Fisheries Service, Panama City Laboratory (PCLAB), National Marine Fisheries Service Beaufort laboratory (Beaufort), the Florida Fish and Wildlife Research Institute (FWRI) and the Gulf States Marine Fisheries Commission (GSMFC). A total of 37,201 gray snapper otoliths were sampled during 1982-1983 and from 1990-2015 from the commercial and recreational fisheries and from fishery independent surveys by state and federal programs. Otolith sampling substantially increased in the late 2000's with samples fairly evenly split between the recreational and commercial fishery (Figure 2.18.5). Otoliths collected from Florida and Louisiana made up the majority of collections (80% and 17%, respectively), while AL, MS and TX collectively contributed approximately 3%.

To estimate reader precision a reference set of 100 gray snapper otolith sections was assembled by FWRI from previously aged sections. Otolith sections were selected based on time of year collected and across observed age classes. The reference set was read by 6 laboratories (PCLAB, Beaufort, FWRI, Mississippi Department of Marine Resources (MSDMR), Louisiana Division of Wildlife and Fisheries (LDWF) and Texas Department of Parks and Wildlife (TDPW)). Average percent error (APE), coefficient of variation (CV) and index of precision (D) were calculated (Beamish and Fournier 1981; Campana 2001) across all laboratories' final age and between each laboratories' final ages and the reference age (SEDAR51-DW-08). Average standard deviation for all laboratories by reference age indicated no clear pattern with peaks at age classes 3, 6 and 9 (Figure 2.18.6).

Gray snapper ranged in age from 1 to 32 years. Our maximum reported age of 32 is consistent with the maximum estimated age of 28 years reported by Fischer et al. (2005), validated with bomb C-14 to ~20 years and a minimum age of ~28 years reported from a bomb C-14 validation study currently being conducted by personnel from the PCLAB and the Pacific Islands Fisheries Science Center.

A comparison of age distributions indicated differences by fishing mode. The recreational hand-line fishery selected younger fish than the commercial fishery with over half of ages 3 to 6 years. Fish fully recruited to the fishery by age 4 with a mean age of 6.6 years and only 6% of fish aged 15 or older. Fish were recruited to the commercial hand-line fishery by age 4 with a mean age of 8.4 years and 12% of fish 15 years or older. The commercial long-line gear selected the oldest individuals with fish first fully recruited to the fishery by age 11, a mean age of 11.9 years and 26% of individuals 15 years or older (Figure 2.18.7). Gray snapper fully recruited to the fishery independent trawl gear by age 3 with a mean age of 3.6 and 78% of fish estimated less than age 5. Recruitment to the fishery-independent seine gear occurred at age 2 with a mean age of 1.7 years and 90% estimated as 1 or 2 years old. However, fishery-independent hand-line fish did not recruit to the gear until age 8 and had a mean age of 9.7 years. Most of these otoliths were collected offshore through the FWRI fishery-independent monitoring (FIM) program.

2.6.2 Growth

<u>Sexual Dimorphic Growth</u>

Sexual dimorphism in teleosts is determined when there are gender differences in age, length, and/or growth, typically one gender is older, larger and has faster growth. Previous research on gray snapper found minor evidence of differences between genders (SEDAR51-RD-16, SEDAR51-RD-19, SEDAR51-RD-24). Significant differences in length-weight relationships and von Bertalanffy growth parameters were determined from gray snapper caught in Louisiana from recreational intercepts; however, the authors state these differences 'may be of limited biological significance' (SEDAR51-RD-19).

Gray snapper mean size-at-age data were plotted by gender to visually investigate sexual dimorphic growth. The majority of the data reported with gender were intercepted from the recreational fishery (1991-2015; commercial, n = 2943; recreational, n = 12400; fishery independent, n = 2155). For each age class, average fork lengths (including standard deviations) at age by gender were very similar (Figure 2.18.8)

Growth Model

A growth curve, based on fractional ages and observed fork lengths at capture, was modeled using the von Bertalanffy growth model and was executed in ADMB (Auto Differentiate Model Builder). The size-modified growth model takes into account the non-random sampling due to minimum size restrictions (Diaz et al. 2004) and allows for alternative variance structures. Since not all species have the same variability in the variations of sizes-at-age, it is valuable to model growth with the variance structure most representative of the species. The model choices of the variance structures in the size-at-age data are: constant standard deviation (SD) with age, constant coefficient of variation (CV) with age, variance proportion to the mean, CV increases linearly with age, and CV increases linearly with size. Multiple model compilations were examined using four different variance structures (constant SD with age, constant CV with age, CV increases linearly with age, CV increases linearly with size-at-age). In addition, multiple size-limit scenarios were used to incorporate the various state and federal size limits (SEDAR51-DW-08). Model convergence was based on value of the model objective function (minimal log-likelihood), Akaike Information Criteria (AIC), and model residual diagnostic plots.

In each of the size-limit scenarios, the variances structure of CV increases linearly with age resulted in the small objective functions with similar patterns of residuals among variance types: normally distributed residuals, reasonable distribution of residuals by age, and probability plots showed divergence (for all models results see SEDAR51-DW-08). Therefore, the growth model with the variance structure of CV increase linearly with age and applying both state and federal size limits was chosen as the best predictor of growth for gray snapper (Figures 2.18.9 &

2.18.10). The recommended growth model parameters are L_∞= 54.69 cm FL, k = 0.1546, t_0 = -1.4554.

2.7 REPRODUCTION

Several studies indicate gray snapper have a protracted spawning season (May-Sept) with spawning peaking in the summer months (SEDAR51-RD-23, SEDAR51-RD-11, SEDAR51-RD-15, SEDAR51-RD-20, SEDAR51-RD-21, SEDAR51-DW-06). SEDAR51-RD-15 back-calculated some birth dates using otolith microstructure to February and March, and it was postulated that those fish may have been spawned outside of the Gulf of Mexico. Duration of the spawning period is estimated to be 137 days, and 37 spawns were estimated to occur within that period (SEDAR51-DW-06).

2.7.1 Fecundity

Batch fecundity was estimated for six fish, which did not allow for enough resolution to be length or age specific. Estimated range of batch fecundity fell between 222,642 and 1,405,892 ova with a mean (±SD) of 615,715 (±622,910) ova (SEDAR51-DW-06). These estimates were derived from females that ranged in size from 335mm-655mm FL. Relative fecundity ranged from 3,667 to 5,721 ova/g of body weight (BW) with a mean (±SD) of 4,546 (±664) ova/g of body weight (SEDAR51-DW-06). If annual fecundity were calculated as a product of average batch fecundity and spawning frequency, the result would be 22,781,455, but this annual fecundity estimate could not be size specific due to the lack of batch fecundity estimates. Additionally, batch fecundity estimates were obtained from females sampled near the peak of spawning season and during the 1990s, which denotes estimates that are not representative of the whole season and are not current or up to date.

2.7.2 Maturity

Sex ratio has been documented by several studies as 1:1 (SEDAR51-RD-23, SEDAR51-RD-11, SEDAR51-DW-06). The most recent sex ratio was 0.48 proportion females.

Maturity was determined from histological analysis of female gray snapper. Age and size at 50% maturity was calculated to be 2.3 years or 253mm FL respectively with 90% maturity occurring at 5.2 years or 362mm FL (Figure 2.18.11; SEDAR51-DW-06). SEDAR51-RD-11 estimated maturity to occur between 239-288mm FL, which brackets the most recent calculation of length at 50% maturity. Despite the 50% maturity metric, if female gonadosomatic index is observed within size it is evident that a significant contribution to the spawning stock is not achieved until 300mm FL (SEDAR51 DW-06). Consequently, the 300mm FL mark is a more accurate estimate of maturity for gray snapper. The LHW group noted there were few fish sampled below 300 mm FL and suggested that additional data points be added to the GSI using macroscopically sexed fish from the FWRI-FIM and PCLAB datasets (Figure 2.18.12). The addition of these fish did not change the conclusion that fish below 300 mm FL contribute little reproductively.

2.8 STEEPNESS

The steepness parameter intrinsically relates to the resilience of a species to exploitation and effectively determines the average productivity of fishery resources within a stationary environmental regime (Mangel et al. 2010). The Beverton-Holt spawner-recruit function is generally used except when there is strong evidence for mechanisms that lead to the Ricker function's dome shape (Shertzer and Conn 2012).

Two congeners of the gray snapper have been assessed in both the South Atlantic and Gulf of Mexico using data-rich methods: mutton snapper (*Lutjanus analis*) and red snapper (*Lutjanus campechanus*) (Table 2.17.5). The most recent assessment for mutton snapper estimated a steepness value of 0.81 and included an upper limit of 0.99 (O'Hop et al. 2015). In contrast, the most recent assessments for red snapper in both the Gulf of Mexico (SEDAR 2013, 2014) and South Atlantic (SEDAR 2017) fixed steepness at 0.99.

2.9 HABITAT REQUIREMENTS

Gray snapper larvae settle out of their planktonic stage into structurally complex estuarine habitats such as seagrass beds (SEDAR51-RD15, SEDAR51-RD07, SEDAR51-RD18), where they remain as juveniles (Nagelkerken et al. 2000, Cocheret de la Moriniere et al. 2002, Faunce and Serafy 2008). Juveniles have been documented in estuaries along the entire Gulf coast, with higher abundances in Florida estuaries at lower latitudes (SEDAR51-RD02, SEDAR51-RD10), such as Tampa Bay and Charlotte Harbor (SEDAR51-RD02). Juveniles (age 0) are most common from July - December when they are recruiting into the estuaries (SEDAR51-RD02). Studies in gulf estuarine systems have indicated that juvenile and subadult gray snapper use areas that have a high percentage of cover by seagrass and other submerged aquatic vegetation (Chester and Thayer 1990, SEDAR51-RD02). Juveniles (age 0) are most abundant in shallow, saline waters with a combination of seagrass and overhanging shorelines, while subadults (age 1) are most abundant in deep, saline water and are less habitat specific, although seagrass beds and mangrove shorelines continue to be important (SEDAR51-RD02, SEDAR51-RD10). Gray snapper tend to remain in mangrove habitats longer than other reef-associated fishes, and some mature individuals have been found in greater abundance in mangrove habitats than in nearby coral reefs (Nagelkerken et al. 2000, Cocheret de la Morinière et al. 2002, Faunce and Serafy 2007). Habitat suitability analyses within Florida estuaries indicated that gray snapper were most abundant in warmer temperatures (26-34 °C); no juveniles were collected at temperatures lower than 14°C, and no subadults were collected in temperatures lower than 10°C (SEDAR51-RD02). Laboratory studies reinforce this documented sensitivity to low temperature and indicated a lethal minimum temperature of 10.2°C and feeding cessation at 11.3°C (SEDAR51-RD17).

As gray snapper reach maturity at 175–198 mm SL, or at about 2–3 years of age, they move into channels and eventually migrate to offshore structured habitats (SEDAR51-RD11, SEDAR51-RD23). Adults occur mainly in the eastern Gulf of Mexico along the Florida coastline and abundance decreases with increases in latitude (SEDAR51-DW03). Adult gray snapper spawn during the summer (May–September) in offshore waters around reefs, wrecks, and other structured habitats (SEDAR51-RD23, SEDAR51-RD11). Documented spawning aggregations of gray snapper are rare and confined to south Florida (SEDAR51-RD05, SEDAR51-RD11, SEDAR51-RD23).

Observational studies documenting a recent range or distribution shift of Gulf of Mexico gray snapper include SEDAR51-RD08 (Western Gulf; entire length of the Texas coastline) and SEDAR51-RD12 (Northern Gulf; Mississippi, Alabama, and northwest Florida coastlines). In both cases, a general northward extension, coupled with a dramatic increase in overall abundance, is reported. Each study postulates that these changes are due to seasonal temperature changes, namely the warming of winter minimum water temperatures. This, in turn, has allowed for more successful over-wintering by recently recruited juveniles to estuarine habitats. SEDAR51-RD17 directly tested the thermal limits of juvenile gray snapper in the laboratory, and concluded that the lower lethal limit for this species (approximately 10ºC under both acute and chronic cooling scenarios) closely matched the latitudinal distribution of adults of this species along the US Atlantic coast. In recent decades, diminished severity of winter minimum water temperatures within Gulf of Mexico estuaries has likely lessened over-wintering juvenile mortality in gray snapper, as well as many other subtropical species in temperate systems, thereby facilitating poleward expansions in their range.

2.10 MOVEMENTS AND MIGRATIONS

2.10.1 Larvae

Little is known about the larval and transitional stage of gray snapper (SEDAR51-RD-18). Gray snapper larvae are planktonic with an average larval duration lasting between 22-42 days (SEDAR51-RD-7, SEDAR51-RD-15, SEDAR-RD-18). Due to cooler water temperatures, larval gray snapper north of Florida may undergo longer larval durations and may be larger in size at settlement (SEDAR51-RD-07, SEDAR51-RD-15, SEDAR51-RD-18). Larval gray snapper settle out of the plankton to structured estuarine habitat (SEDAR51-RD-3) and pulses in settlement may be correlated with moon phases (SEDAR51-RD-18).

2.10.2 Post-Settlement and Sub-adult

After settlement, juvenile gray snapper remain at shallow (<1 m) structured habitat, like sea grass beds, until outgrowing the protection of this habitat starting about eight months after settlement (Faunce and Serafy 2007, SEDAR51-RD-15, SEDAR51-RD-07, SEDAR51-RD-18). Gray snapper move to slightly deeper habitat and are found in areas with a combination of seagrass and overhanging shoreline vegetation, like mangrove habitat (SEDAR 51-RD-02, SEDAR51–RD-10). Juvenile gray snapper show high site fidelity (SEDAR51-RD-14) until approximately age two. Around age two, gray snapper typically shift to using inland mangroves (Faunce and Serafy 2007) or move to offshore structured habitats (SEDAR51-RD-23, SEDAR51-RD-11).

2.10.3 Adult

Tagging studies suggest that once gray snapper shift to reef habitat, adults make few long-distance migrations and show high site fidelity (SEDAR51-RD-1, SEDAR51-RD-9, Lindholm et al. 2005, Luo et al. 2009, Farmer and Ault 2011, Friedlander et al. 2013). Traditional mark recapture studies in the 1960's off Florida tagged 1,839 fish and 480 (15%) of these fish were recaptured after being at liberty between 7-385 days (SEDAR51-RD-9). Of the recaptured fish, few (14) showed movement from their original release locations with 1 fish recaptured (~30 nm) and the rest recaptured less than 20 nm from release sites. More recently, mark recapture studies off Florida tagged 1,602 gray snapper and 48 (3%) of these fish were recaptured after being at liberty between 1-712 days (SEDAR51-DW-1). Of the recaptured fish, few (6) showed movement (> 5 mi) from their original release locations with one fish recaptured ~30 mi from its release location. There is evidence that gray snapper aggregate at offshore spawning sites (SEDAR51-RD-15) and some of the larger movements by tagged gray snapper could be related to spawning migrations.

Advances in tagging technology led to studies collecting more detailed observations of gray snapper habitat use. While tagged gray snapper showed high site fidelity (Lindholm et al. 2005, Luo et al. 2009, Farmer and Ault 2011, Friedlander et al. 2013), tagged fish did show temporal movement patterns (Farmer and Ault 2011, Luo et al. 2009, Friedlander et al. 2013). Fish showed diel migrations (Farmer and Ault 2011, Luo et al. 2009, Friedlander et al. 2013), using structured habitat during the day and moving to seagrass at night (Luo et al. 2009). Gray snapper also showed movement from inshore to offshore during the spawning season (Luo et al. 2009).

2.11 MERISTICS AND CONVERSION FACTORS

Meristic data (various length and weight types) from multiple fishery independent and dependent data sources were combined to estimate conversion factors (Table 2.17.6). Meristic data corresponding to gray snapper with biological samples from the Gulf of Mexico were used in these regressions. Linear and non-linear regressions were calculated using R (lm and nls functions, respectively). Regressions were only employed for sample sizes ≥ 100 (Table 2.17.7).

2.12 EPISODIC EVENTS

2.12.1 Red Tide

In the Gulf of Mexico, blooms of *Karenia brevis,* or red tides, have resulted in large fish kills. There is some evidence that gray snapper may be affected by red tide events (Landsberg et al. 2009, SEDAR51-RD-02). However, other studies have shown red tide events may not impact gray snapper as much as other species because they can easily leave the affected area (Smith 1979, Dupont et al. 2010). Gray (2014) estimated a relatively low discard (0.000002 tonnes/km2) for a historical "HAB" fleet representing mortality due to red tide off the west coast of Florida.

2.12.2 Deepwater Horizon Oil Spill

In 2010, millions of barrels of oil were released into the northern Gulf of Mexico. There is little information about how this might have affected gray snapper in this area. Gray snapper larvae are abundant in the area of the spill, but after the spill the catch rate of juvenile gray snapper was up 82% when compared to the previous four years (SEDAR51-RD-13). However, this increase could be related to a decrease in fishing pressure during the time of the oil spill.

2.12.3 *Extreme Cold Events*

Gray snapper is primarily a tropical/sub-tropical species and could be affected by extreme cold events. Stark and Schroeder (1971) report several cold spells in Florida that resulted in fish kills, including gray snapper. However, in an extreme cold event in Florida during 1962, gray snapper were found alive in large motionless schools in canals (Stark and Schroeder, 1971). More recently, a cold spell in 2010 resulted in an increased CPUE for gray snapper in north Florida Bay (Santos et al. 2016). The cold event negatively affected many other species in the bay possibly resulting in a community shift leading to decreased predation and competition for gray snapper (Santos et al. 2016).

2.13 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

For stock assessments to provide meaningful results to inform management policies, the best available data must be used and the assessment scientists should be knowledgeable of data limitations. The data provided for SEDAR51 used the combined efforts of fishery dependent and fishery independent sources, although the majority were derived from fishery-dependent sources (Fig 3).

Fishery-dependent data can be advantageous in that it is more generally available for more species (all that have a management plan), inexpensive, and often routinely collected covering a broad geographic area (Begg 2005). There are several caveats to fishery-dependent data. One caveat of fishery dependent data is the size-selective nature of fisheries. A fishery can be size-selective due to a variety of fishery regulations of minimum size limit, an upper slot limit, gear restriction (e.g., hook size, bait type), area closures, or depth restrictions. Another caveat of fishery dependent data is how port agents collect biological samples from the landed catch. Most port agents' guidelines for biological sampling are to attempt to purposely sample landings of multiple species from one or many fishing vessels at one time, which has led to some species being under sampled while other more economically important species are oversampled. A third caveat of fishery-dependent data is the behavior of commercial fishers. A fisher's behavior can be affected by the current economics (i.e., cost per pound, fuel price, boat slip price), as well as technological advances (i.e., vessel electronics, changes in gear), which can alter the species being fished and the location of fishing.

Fishery-independent surveys provide an opportunity to collect data without the influences of the dynamics of a fishery (see caveats above). Gray snapper were collected by several fishery-independent surveys both at the state and federal level, as well as, special projects such as Cooperative Research Projects, Expanded Annual Stock Assessment Survey.

The LHW group agrees there were periods of low sampling effort from all data sources (pre-2007, fishery- dependent; pre-2009, fishery independent), but with the increase in sampling in all sectors, there is an increase in the resolution of the analysis.

2.14 RESEARCH RECOMMENDATIONS

2.14.1 Stock Definition and Description

- Expand upon the genetics work of Gold et al. (2009; SEDAR51-RD-04). Gray snapper fishery-dependent sampling can be sporadic and site-specific samples are needed. SEAMAP samples may be able to help fill this void.
- Identify natal origin of adult gray snapper by using otolith chemical signatures from juveniles. Since these signatures can vary annually, samples from an ongoing sampling program would be required. Florida fishery independent monitoring program may be able to provide this for the eastern gulf.

2.14.2 Natural Mortality

- LHW group recommends using the maximum age of 28 years to calculate natural mortality by applying Hoenig's regression for teleosts (M = 0.15) as the target M used to calculate an age-specific vector of M.
- The LHW group recommends applying the age-specific mortality vector using Lorenzen (2005).
- Therefore, the LHW group recommended using a wider range of sensitivity around M (lower bound = 0.13; upper bound = 0.17).
- Review of Then et al. 2015 data inputs, possibly restrict dataset to take into consideration fishes of similar maximum size, age, and latitude/longitude to improve the estimation of natural mortality.
- Expand fishery-independent sampling

2.14.3 Age and Growth

- Continue annual ageing workshops with GSMFC.
- Update the gray snapper reference set to include a greater range of ages, sampling locations and section quality.
- Expand sampling of otoliths from the central and western Gulf of Mexico.
- Increase resolution of jurisdictional waters within sampling programs, specifically for the head boat program.
- Expand fishery dependent sampling.

- The LHW group recommends all gray snapper data in the Gulf of Mexico, regardless of gender, to be combined and used in SEDAR51 assessment models.
- The LHW group recommends using the predicted growth parameters from the growth model using a CV that increases linearly with age variance structure from the size limit C scenario.
- The LHW group also recommends allowing the stock assessment analyst to decide whether to predict growth within the assessment model, using the recommended growth parameters as priors, or to use the growth parameters in the assessment model as fixed parameters.

2.14.4 Reproduction

- Due to the lack of fecundity information the female weight-length relationship should be used to calculate spawning stock biomass. Additionally, the 300mm FL mark should be used as the size at maturity parameter because of the marked contribution to the spawning stock beyond that point.
- More at sea sampling is necessary to obtain more freshly-fixed ovaries to be used for spawning frequency and fecundity analysis.
- More ovarian samples need to be obtained from the western Gulf of Mexico, as that region is poorly represented in life history information.
- Workshops are pivotal to establish consistency in reproductive histological determination throughout the Gulf of Mexico.
- Locate and characterize spawning habitat and spawning aggregations.

2.14.5 Steepness

- Based on the limited information available, the LHW group recommends a range of steepness from 0.81 to 0.99 based on the results and range considered in the mutton snapper assessment. The LHW group agreed that mutton snapper would be the more similar species to gray snapper as opposed to red snapper based on habitat (e.g., occurrence on reefs (Ault et al. 2006; Bryan et al. 2013)) and fishery characteristics.

2.14.6 Habitat Requirements

- Good information is available for juveniles in estuarine habitat, but data on ontogenetic shifts and habitat connectivity are needed between mangrove and seagrass habitats within estuaries to nearshore hard bottom and offshore spawning aggregations. Detailed classification of nearshore habitat is needed, possibly using video data (Low visibility for video work in nearshore habitats where gray snapper are located).
- Increase surveys in western Gulf of Mexico (Louisiana and Texas have ongoing sampling programs catching juvenile gray snapper, but information on adults lacking).
- Investigate more effective methods to capture adult gray snapper throughout the Gulf of Mexico. Develop alternative strategies for fishery-independent sampling (small hooks, night fishing, and video work).
- Expand seagrass mapping to track seagrass habitat changes over time. Along the coast of northern Gulf of Mexico observations of seagrass loss are being made in association with increasing water turbidity, whereas Tampa Bay has made significant progress in recovering seagrass habitat.
- Mangrove habitats are increasing all along the Gulf of Mexico coast, so tracking this expansion of mangrove habitat in Texas (black mangrove) and Florida (red mangrove) would be useful considering gray snapper's association with mangroves.

2.14.7 Movements and Migrations

- More tagging information including acoustic tagging, is needed to clarify temporal and spatial patterns of gray snapper movement, specifically movement to spawning aggregations. While there is some evidence gray snapper migrate to spawn, more information is needed to confirm these patterns.

2.14.8 Episodic Events

- More research should be done on the effects of episodic events on all life stages of gray snapper.
- Review available unpublished records on fish kills.
- Collections of fish during episodic events would allow for the size/age selectivity of mortality to be determined, and might also allow for some minimum estimates of total mortality.

2.15 DATA BEST PRACTICES COMMENTS AND SUGGESTIONS

The methods used in SEDAR51 to calculate point estimates and age-specific natural mortality follow the recommendations of Best Practices.

The methods used in SEDAR51 to predict growth follow the recommendations of SEDAR Best Practices.

The LHW group recommends a 2 to 3 year lead time to prepare life history information as was suggested by SEDAR Best Practices. This is especially important for species being assessed for the first time, since time is required to develop ageing protocols.

Data workshop reports have grown large and unwieldy. They are time consuming to produce and contain more text/information than is necessary. This is inefficient, and also makes it difficult for reviewers and other readers to glean relevant information. Furthermore, much of the information is duplicative with content that already exists elsewhere in the working papers (SEDAR Best Practices Report 2015). An effort needs to be made to streamline the report/outline process.

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2.17 TABLES

Table 2.17.1. Multiple methods to estimate natural mortality (M). Definitions of parameters: Linf = von Bertalanffy asymptotic length (FL, mm), k = von Bertalanffy growth coefficient, Amax = maximum age (yr), A50 = age at 50% mature, Lat = length at age (t), Temp = average water temperature (°C), S = survivorship. Water temperature based on annual mean estimate at bottom from the U.S. Gulf shelf (Johnson et al. 1995, DeVries 2006).

Method	Parameters	Citation	Equation
Alverson & Carney	k, Amax	Quinn & Deriso (1999)	M = 3k/(exp(0.38*Amax*k)-1)
Beverton & Holt	k, A50	Beverton and Holt (1956)	M = 3k/(exp(A50*k)-1)
$\text{Hoenig}_{\text{teleosts}}$	Amax	Hoenig (1983)	M=exp(1.46 - 1.01*ln(Amax))
$\text{Hoenig}_{\text{all taxa}}$	Amax	Hoenig(1983)	M=exp(1.44-0.982*ln(Amax))
Pauly	Linf, k, Temp	Quinn & Deriso (1999)	M = 10^(-0.0066-.279*(log(Linf))+0.6543*log(K)+0.4634*Log(Temp))
Pauly Method II (snappers and groupers)	Linf, k, Temp	Pauly and Binohlan (1996)	M=10^(-0.0636-0.279*(log(Linf)+0.6543*log(k)+0.4634*log(Temp))
Ralston	k	Ralston (1987)	M=0.0189 + 2.06*k
Ralston (geometric mean)	k	Ralston (1987)	M=-0.0666+2.52*k
Ralston Method II	k	Pauly and Binohlan (1996)	M=-0.1778+3.1687*k
Lorenzen Age-Specific	M, Linf, k	Lorenzen (2005)	Survival = Exp(-M*t1) = Exp(Ln((Lat/(Lat+Linf*(Exp(k* t1)-1)))*(M1/(Linf*K)))
Jensen	k	Jensen (1996)	M = 1.5*K
Alagaraja	Amax, Survivorship to Amax	Alagaraja (1984)	M=-ln[S(Amax)]/Amax; derived from S(Amax)=exp(-M*Amax)
Hewitt and Hoenig	Amax	Hewitt and Hoenig (2005)	M = 2.996/Amax
Then	Amax	Then et al. (2014)	M = 4.899* Amax^-0.916

Table 2.17.2. List of parameter values used to estimate natural mortality (M) for each method described in Table 1.

Parameter	Value
Data Source	1980-2015
Maximum age (Amax)	28
Number of fish aged	33,836
von Bertalanffy (Linf, FL mm)	546.85
von Bertalanffy (k)	0.1547
Age at 50% maturity (A50)	2.3

Table 2.17.3. Life history working group recommended model sensitivities for age-specific mortality. Base case used maximum aged of 28 yrs for Gray Snapper, this age was validated using radiocarbon (C14), the upper and lower bounds for mortality were based on ages 25 and 32 yrs.

Age	Base	Upper	Lower
0	0.5047	0.5659	0.4410
1	0.3552	0.3983	0.3104
2	0.2838	0.3183	0.2480
3	0.2423	0.2717	0.2117
4	0.2153	0.2415	0.1882
5	0.1966	0.2205	0.1718
6	0.1830	0.2052	0.1599
7	0.1728	0.1937	0.1510
8	0.1649	0.1849	0.1441
9	0.1587	0.1779	0.1386
10	0.1537	0.1723	0.1343
11	0.1497	0.1678	0.1308
12	0.1464	0.1642	0.1279
13	0.1437	0.1612	0.1256
14	0.1415	0.1587	0.1236
15	0.1396	0.1566	0.1220
16	0.1381	0.1548	0.1207
17	0.1368	0.1534	0.1195
18	0.1357	0.1522	0.1186
19	0.1348	0.1511	0.1178
20	0.1340	0.1502	0.1171
21	0.1333	0.1495	0.1165
22	0.1328	0.1489	0.1160
23	0.1323	0.1483	0.1156
24	0.1319	0.1479	0.1152
25	0.1315	0.1475	0.1149
26	0.1312	0.1472	0.1147
27	0.1310	0.1469	0.1145
28	0.1308	0.1466	0.1143

Table 2.17.4. Summary of discard mortality experiments on Gray Snapper conducted in two zones: the lower Tampa Bay estuary (inshore zone) and neighboring Gulf of Mexico waters (nearshore zone, 2009–2011.

Zone (number of experiments)	Standard length (mm) Mean ± SE	Min	Max	Total number	Number died	Percent mortality
Inshore (n = 4)	202.5 ± 2.9	150	312	143	2	1.4%
Nearshore (n = 5)	308.6 ± 3.6	208	410	104	15	14.4%
Combined	247.0 ± 4.0	150	410	247	17	6.9%

Table 2.17.5. Steepness values considered in the most recent stock assessments for species similar to Gray Snapper. BH = Beverton-Holt spawner-recruit relationship (SR Rel); Fix = Fixed steepness (h) value, Est = Estimated *h* value. Ranges were identified from either likelihood profiling or distributions of steepness considered in the assessment.

Species	Reference	Region	SR Rel	Type	h	Sensitivity runs	Notes
Mutton snapper (*Lutjanus analis*)	O'Hop et al. (2015)	SA/ GOM	BH	Est	0.81	0.4 - 0.99 in 0.05 intervals	Not enough information in the data to uniquely identify a steepness value.
Red snapper (*Lutjanus campechanus*)	SEDAR (2014)	GOM	BH	Fix	0.99	None	Steepness was estimated near the upper limit and was therefore fixed at 0.99
	SEDAR (2013)	GOM	BH	Fix	0.99	0.8	Estimate values for the steepness parameter near its maximum of 1.0
	SEDAR (2017)	SA	BH	Fix	0.99	0.84	Steepness not estimable
Yellowtail snapper (*Ocyurus chrysurus*)	O'Hop et al. (2012)	SA/ GOM	BH	Est	0.7	None	The fit is reasonable, but the trend is weak, so it is possible that the relationship will change as more data become available.
Vermilion snapper (*Rhomboplites aurorubens)*	SEDAR (2012)	SA	BH	Est	0.71	0.56	
	SEDAR (2016)	GOM	BH	Est	0.57	None	Estimate noted to be relatively low given its highly productive nature (i.e., it grows quickly, matures rapidly, and is relatively fecund).

Table 2.17.6. Data sources for Gulf of Mexico gray snapper metric conversions.

Data Source	
Fishery Independent	NMFS/SEFSC Pascagoula surveys (groundfish, bottom longline, reef fish)
	NMFS/SEFSC Panama City Reef Fish survey
	Florida Fish and Wildlife Conservation Commission, Fisheries Independent Monitoring (multiple surveys and gears)
Fishery Dependent	NMFS/SEFSC Trip Interview Program
	NMFS/SEFSC Southeast Headboat Survey
	NMFS/SEFSC Panama City recreational dockside sampling
	NMFS/SEFSC Galveston Reef Fish Observer Program
	NMFS/SEFSC Shark Bottom Longline Observer Program
	Gulf States Marine Fisheries Commission – Fisheries Information Network including Marine Recreational Fisheries Statistics Survey
	Florida Fish and Wildlife Conservation Commission, Fisheries Dependent Monitoring

Table 2.17.7. Meristic regressions for Gray Snapper (1991-2015) from the Gulf of Mexico. Data combined from all fishery independent and fishery dependent data sources. Length Type: Max TL – Maximum Total Length, FL – Fork Length, Nat TL – Natural Total Length, Type: SL – Standard Length; W Wt – Whole Weight, G Wt – Gutted Weight. Units: length (cm) and weight (kg). Linear and non-linear regressions calculated using R (lm and nls functions, respectively).

Regression	Equation	Parameters ± std. err.	statistic	N	Data Range
Max TL to FL	FL = a + max_TL *b	a = 0.36 ± 0.02 b = 0.93 ± 6.06e-04	r^2 =0.999	3050	Max TL: 10.1 – 63.5 FL: 9.6 – 60.5
Max TL to SL	SL = a + max_TL *b	a = -0.22 ± 0.03 b = 0.79 ± 9.75e-04	r^2 = 0.996	2661	Max TL: 10.1 – 63.2 SL: 7.9 – 51.7
Nat TL to FL	FL = a + nat_TL * b	a = -0.25 ± 0.03 b = 0.96 ± 8.89e-04	r^2 = 0.993	8722	Nat TL: 19.4 – 74.0 FL: 19.0 – 71.7
SL to FL	FL = a + SL * b	a = 0.77 ± 0.03 b = 1.17 ± 1.39e-03	r^2 = 0.997	2451	FL: 9.6 – 60.5 SL: 7.9 – 51.7
Max TL to W Wt	W WT =a* (max_TL^b)	a = 1.07e-05 ± 4.91e-07 b =3.08 ± 1.19e-02	RSE = 0.07	1302	Max TL: 10.1 – 66.0 W WT: 1.8 – 5.0
Nat TL to W Wt	W WT = a* (nat_TL^b)	a = 1.10e-05 ± 2.51e-07 b =3.05 ± 5.83e-03	RSE = 0.11	6937	Nat TL: 19.4 – 73.2 W WT: 1.0 – 6.6
FL to W Wt	W WT = a* (FL^b)	a = 1.43e-05 ± 2.69e-07 b =3.02 ± 4.76e-03	RSE = 0.13	10954	FL: 9.6 – 71.5 W WT: 1.8 – 6.6
SL to W Wt	W WT = a* (SL^b)	a = 6.55e-05 ± 2.16e-06 b = 2.74 ± 1.03e-02	RSE = 0.03	1224	SL: 7.9 – 43.6 W WT: 1.8 – 1.9
FL to G Wt	G WT = a* (FL^b)	a = 1.53e-05 ± 6.20e-07 b = 3.00 ± 1.04e-02	RSE = 0.17	4551	FL: 26.0 – 72.0 G WT: 2.3 – 6.1

2.18 FIGURES

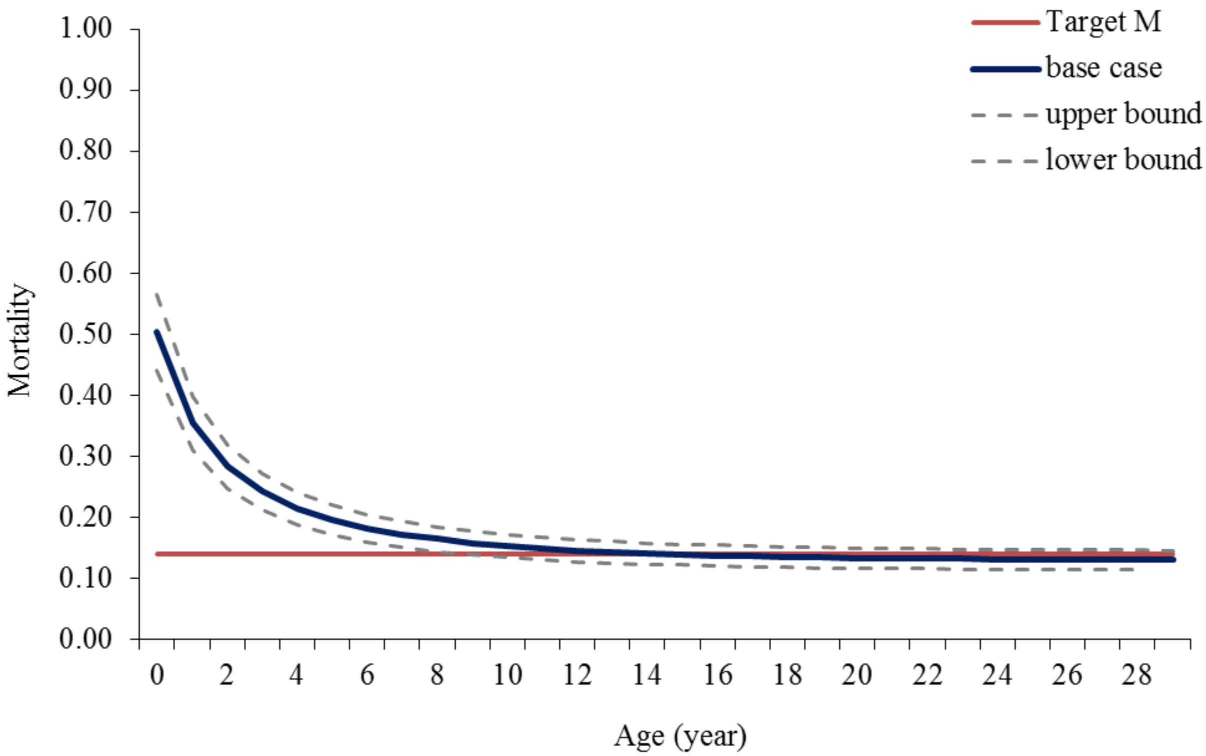


Figure 2.18.1. Life history working group recommended model sensitivities for age-specific mortality. Base case used maximum aged of 28 yrs for Gray Snapper, this age was validated using radiocarbon (C14), the upper and lower bounds for mortality were based on ages 25 and 32 yrs.

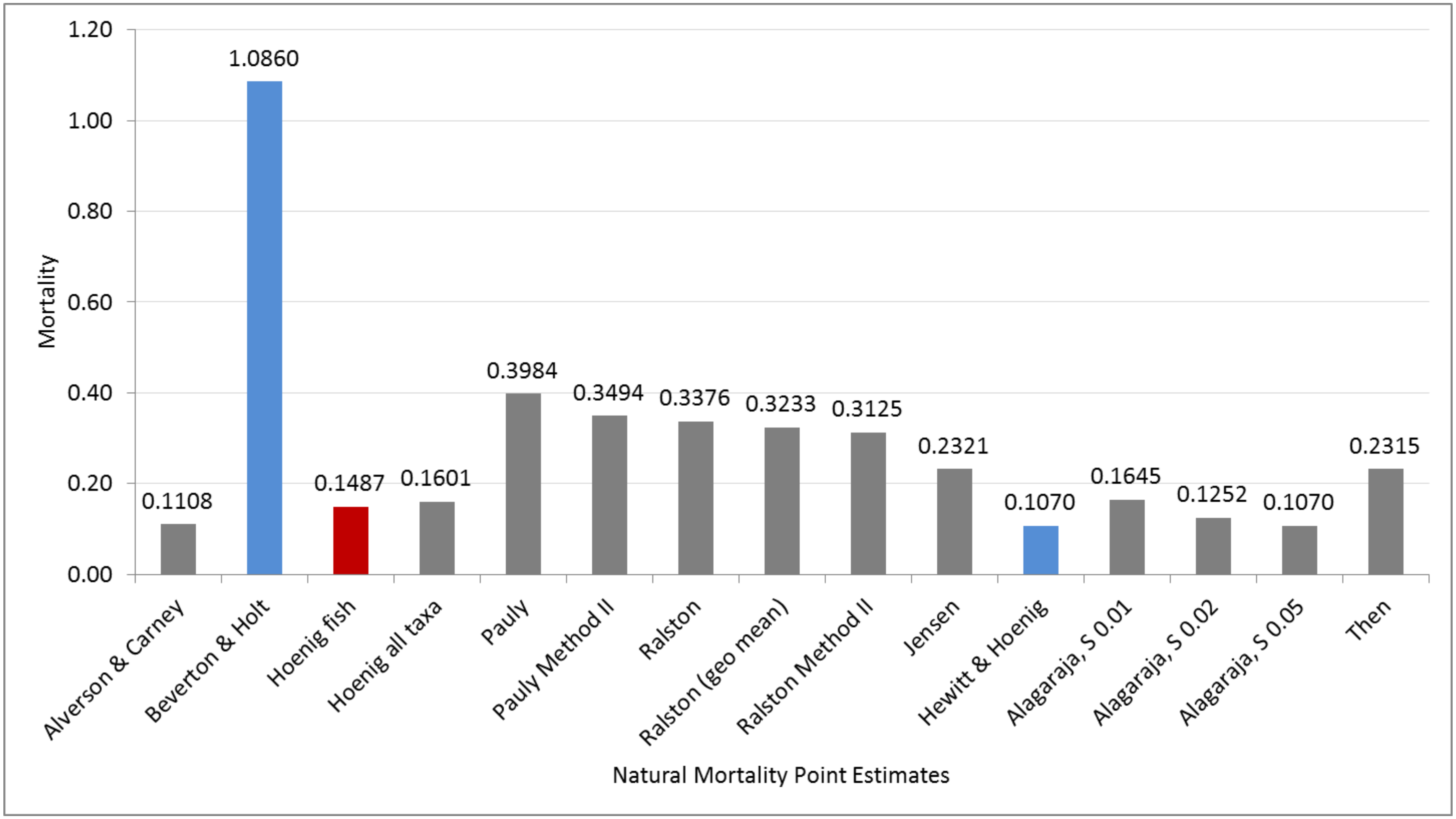


Figure 2.18.2. Natural mortalities (M) for each point estimate method described in Table 1, see Table 2 for parameter inputs. Blue bars identify the minimum and maximum values and red bar identifies the recommended point estimate.

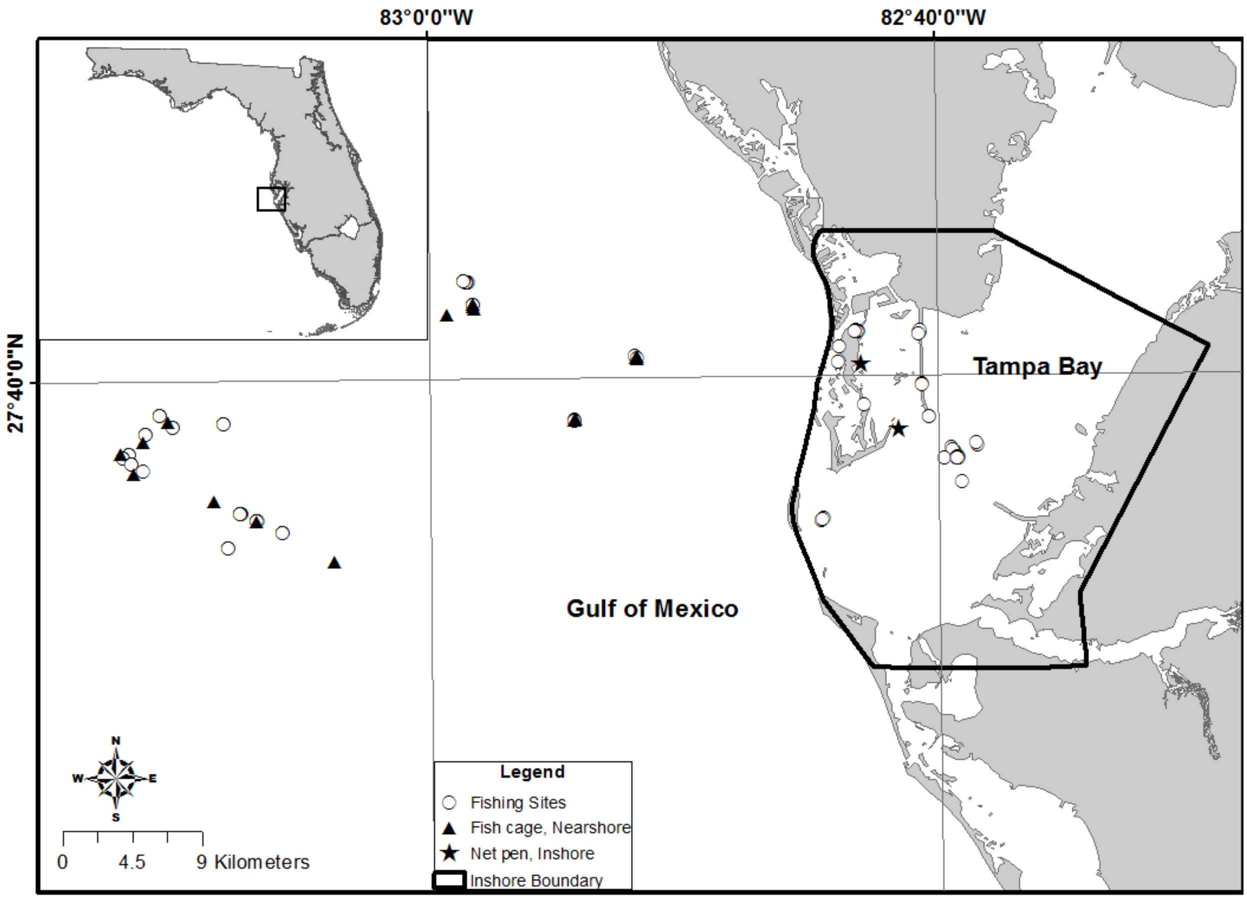


Figure 2.18.3. Map indicating the spatial extent of the inshore (lower Tampa Bay) and nearshore (Gulf of Mexico) sampling zones and locations of hook-and-line stations (white circles), net pens (black stars), and cage drops (black triangles) for Gray Snapper discard mortality experiments, 2009–2011.

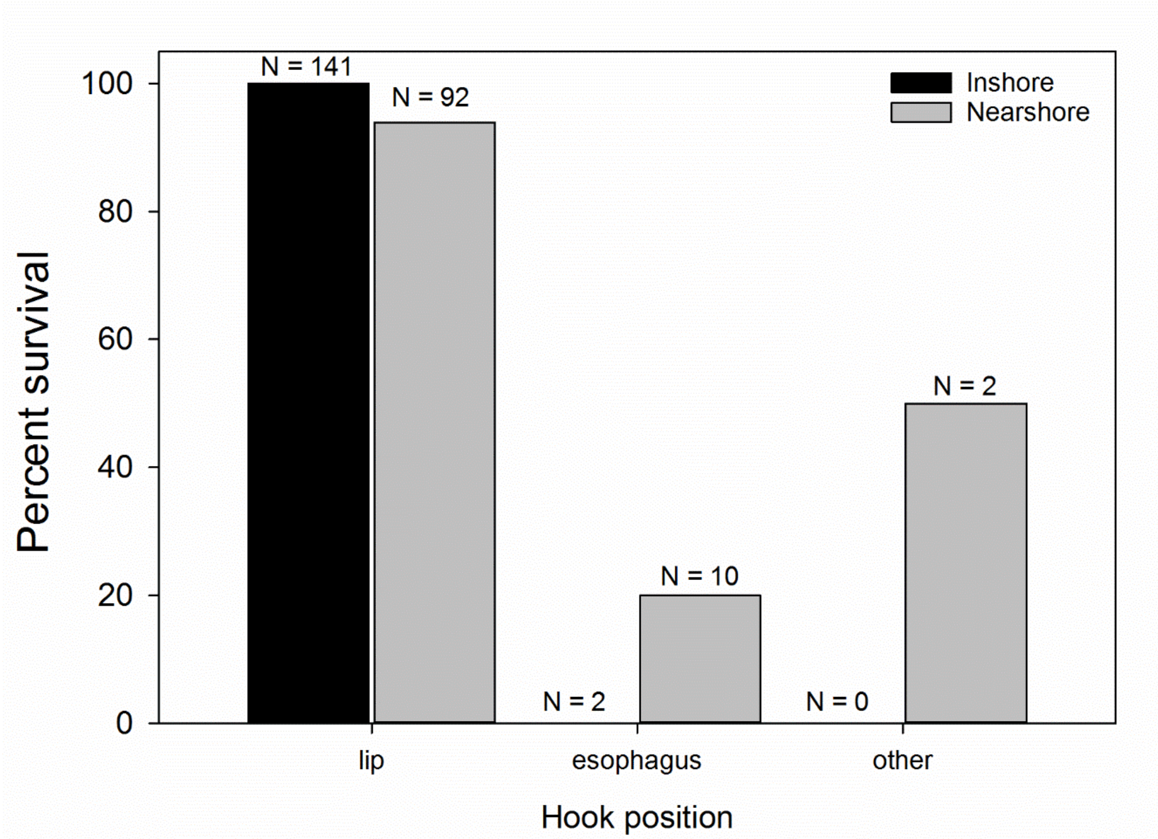


Figure 2.18.4. Percent survival of fish by observed hook position in discard mortality experiments conducted in inshore and nearshore zones, 2009–2011. The number of fish collected in each zone and hook position category are listed above each bar.

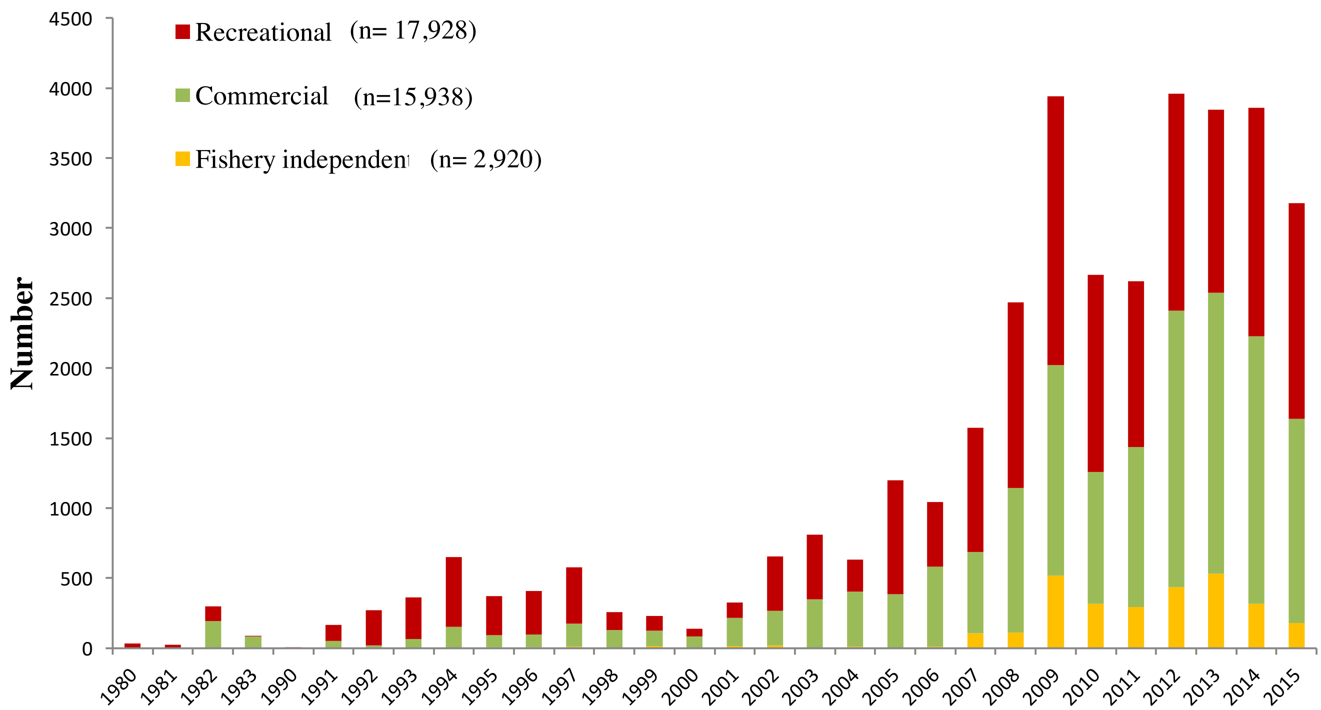


Figure 2.18.5. Number of Gulf of Mexico gray snapper otoliths sampled by fishing mode and year.

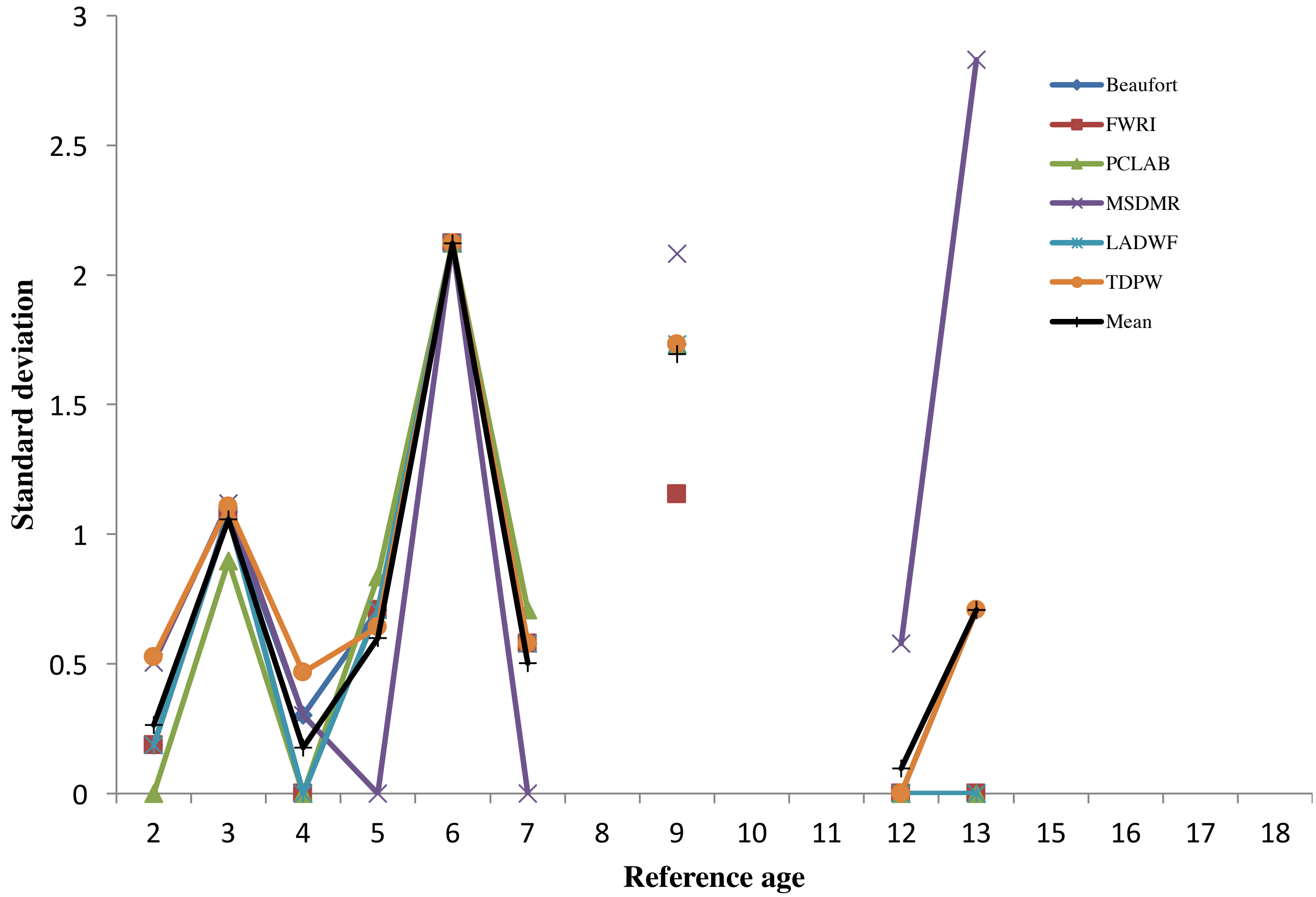


Figure 2.18.6. Standard deviation for reference ages by ageing laboratory

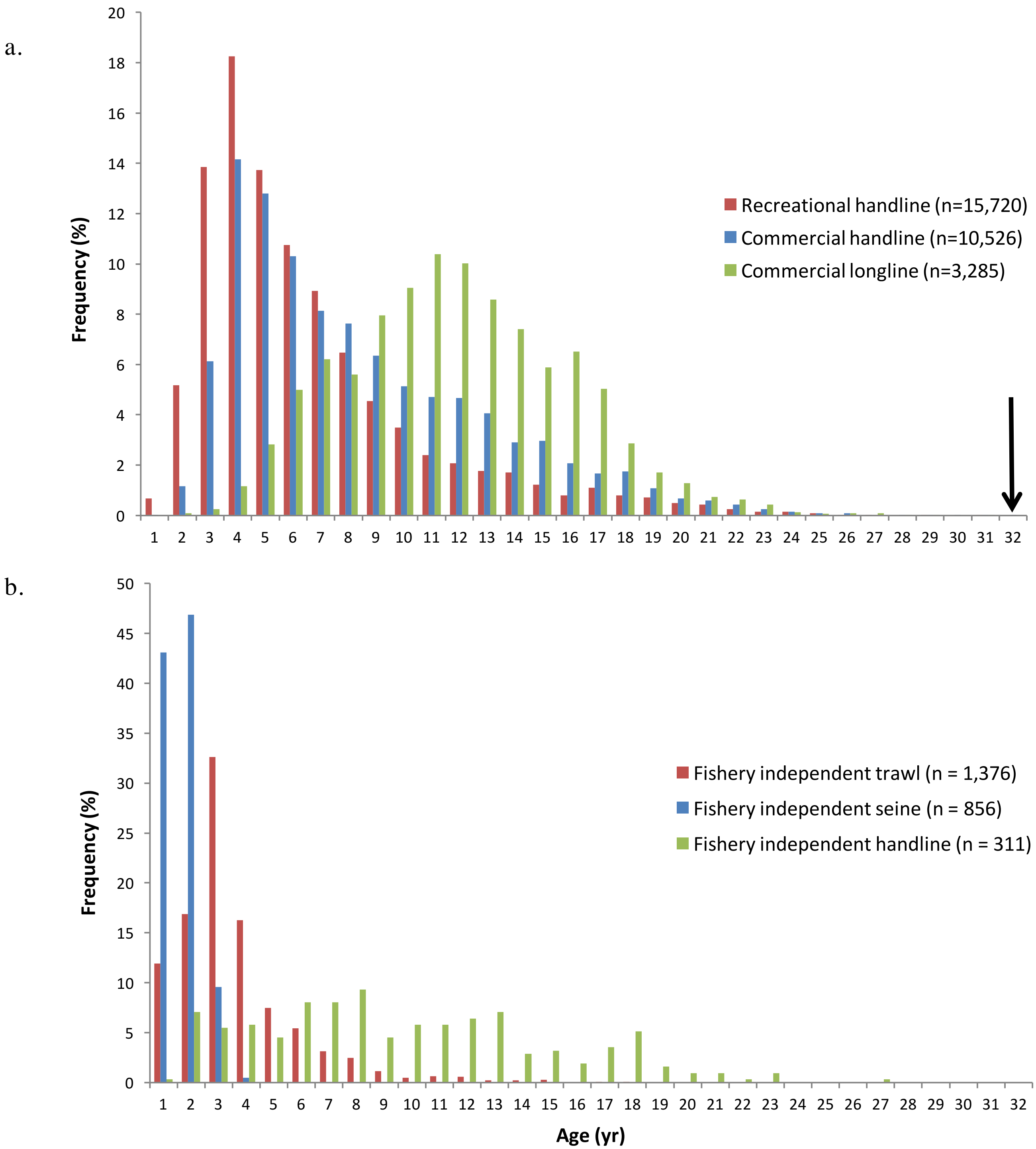


Figure 2.18.7. Gulf of Mexico gray snapper age frequency distributions for (a) fishery dependent and (b) fishery independent fish for all years combined (1980-2015). Not all ages are represented due to incomplete mode data. Arrow indicates maximum age.

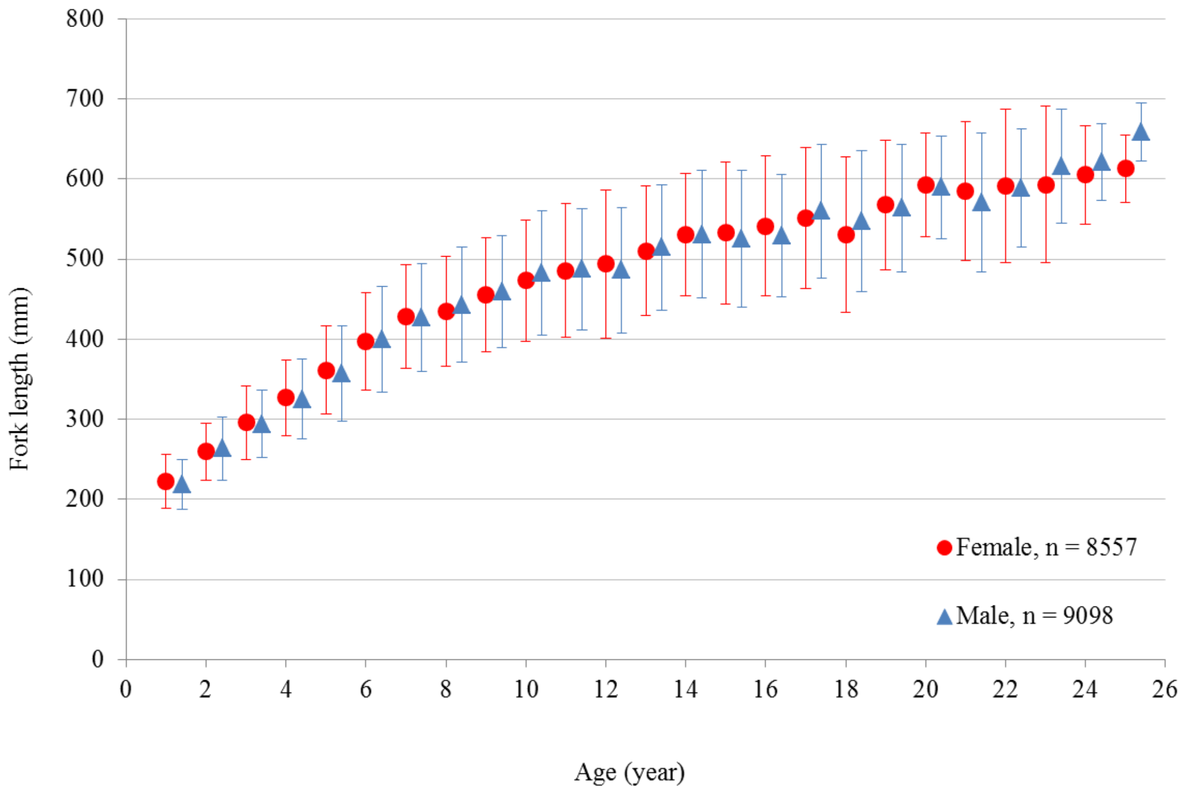


Figure 2.18.8. Gulf of Mexico Gray Snapper size-at-age data (average fork length ± standard deviation) by gender (female, red circle; male, blue triangle). All data combined (1991-2015; Commercial, n = 2943; Recreational, n = 12400; Fishery Independent, n = 2155).

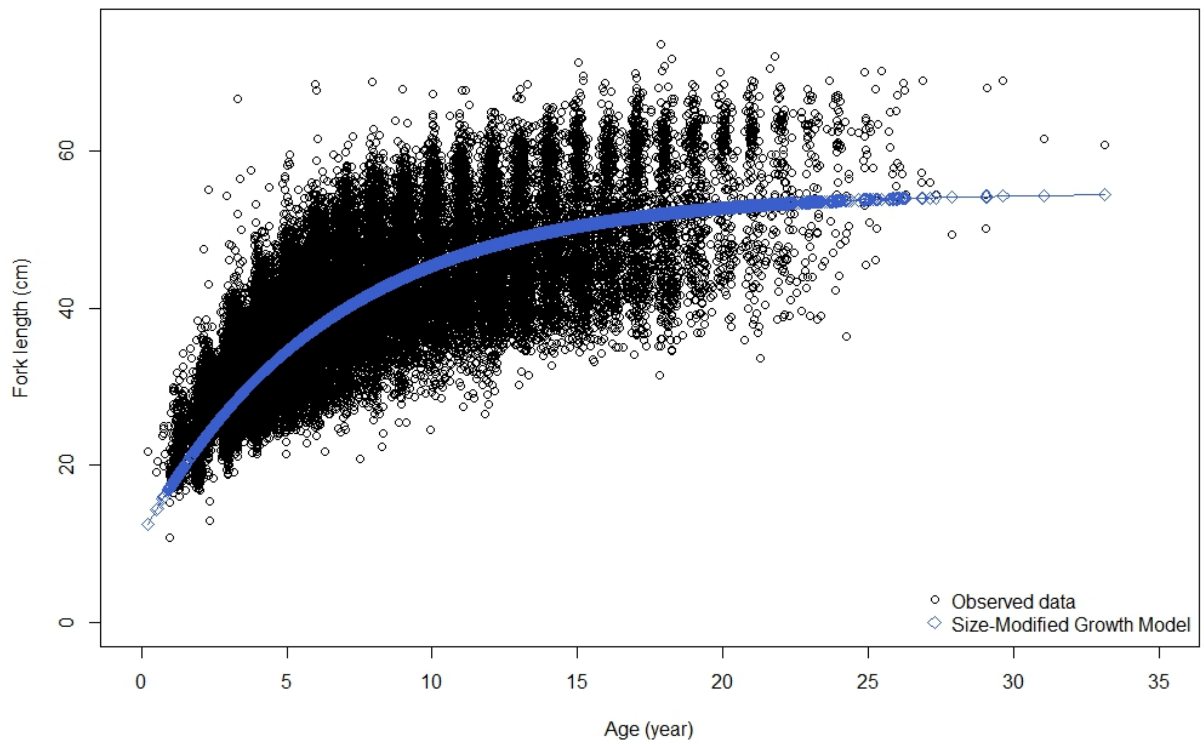
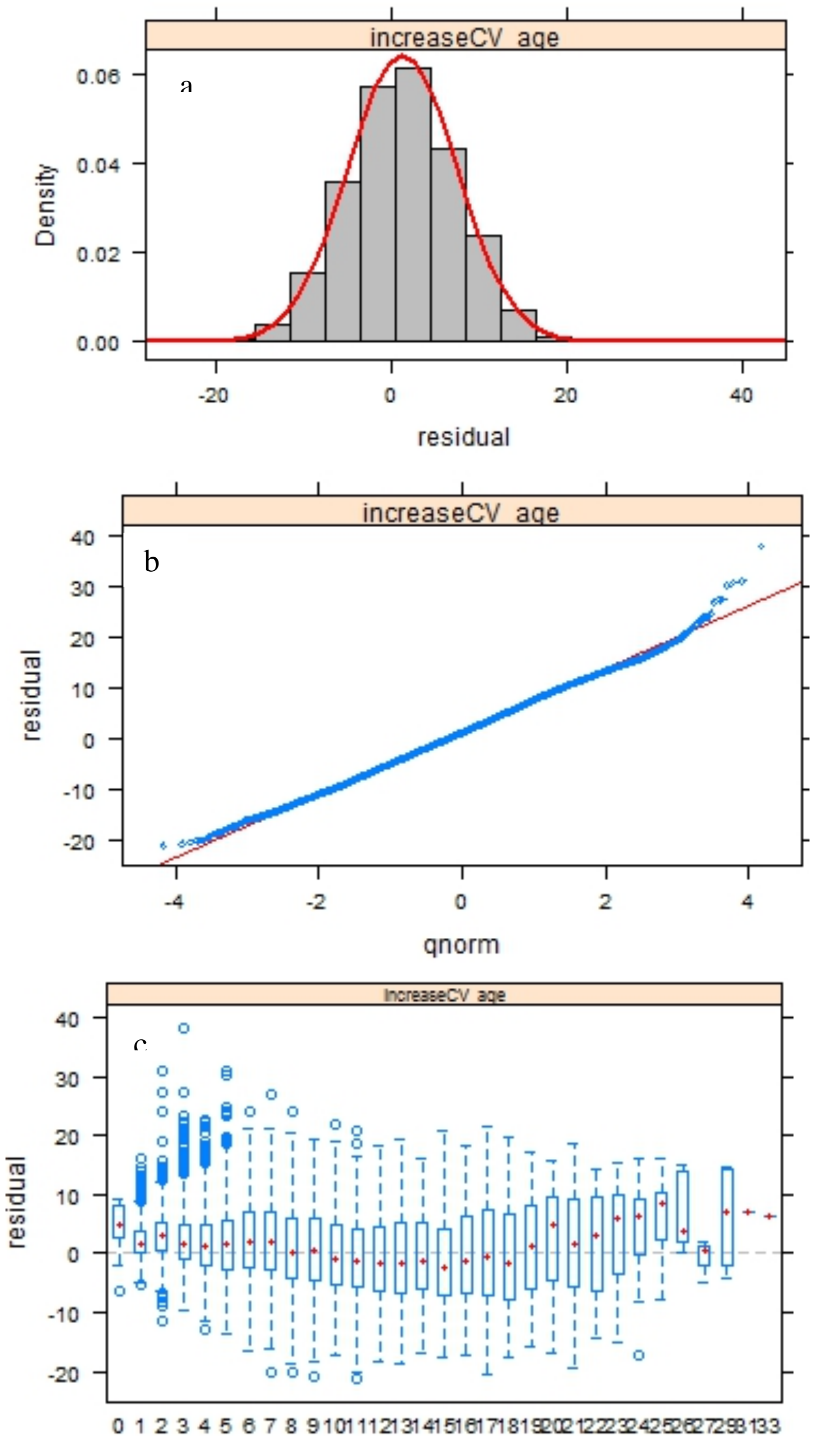


Figure 2.18.9. Gulf of Mexico Gray Snapper (1991-2015) observed ages and observed fork lengths with predicted growth curve using the size-modified von Bertalanffy growth model. Size-modified growth model with variance structure: CV increases linearly with age, using size limit scenario C: state of Florida recreational size limit for recreational fish landed in Florida, all other fishery dependent records federal size limit.

Figure 2.18.10. Residual diagnostic plots (a) density distribution, (b) normal probability plot (quantiles vs residuals), and (c) residuals by age for Gray Snapper size-modified von Bertalanffy growth model using the variance structure of CV increases linearly with age, using size limit scenario C. Boxplots include the median, upper and lower quartiles (boxes: drawn in proportion to the square root of the sample size by age, upper and lower range (dashed line), and outliers (open circles).



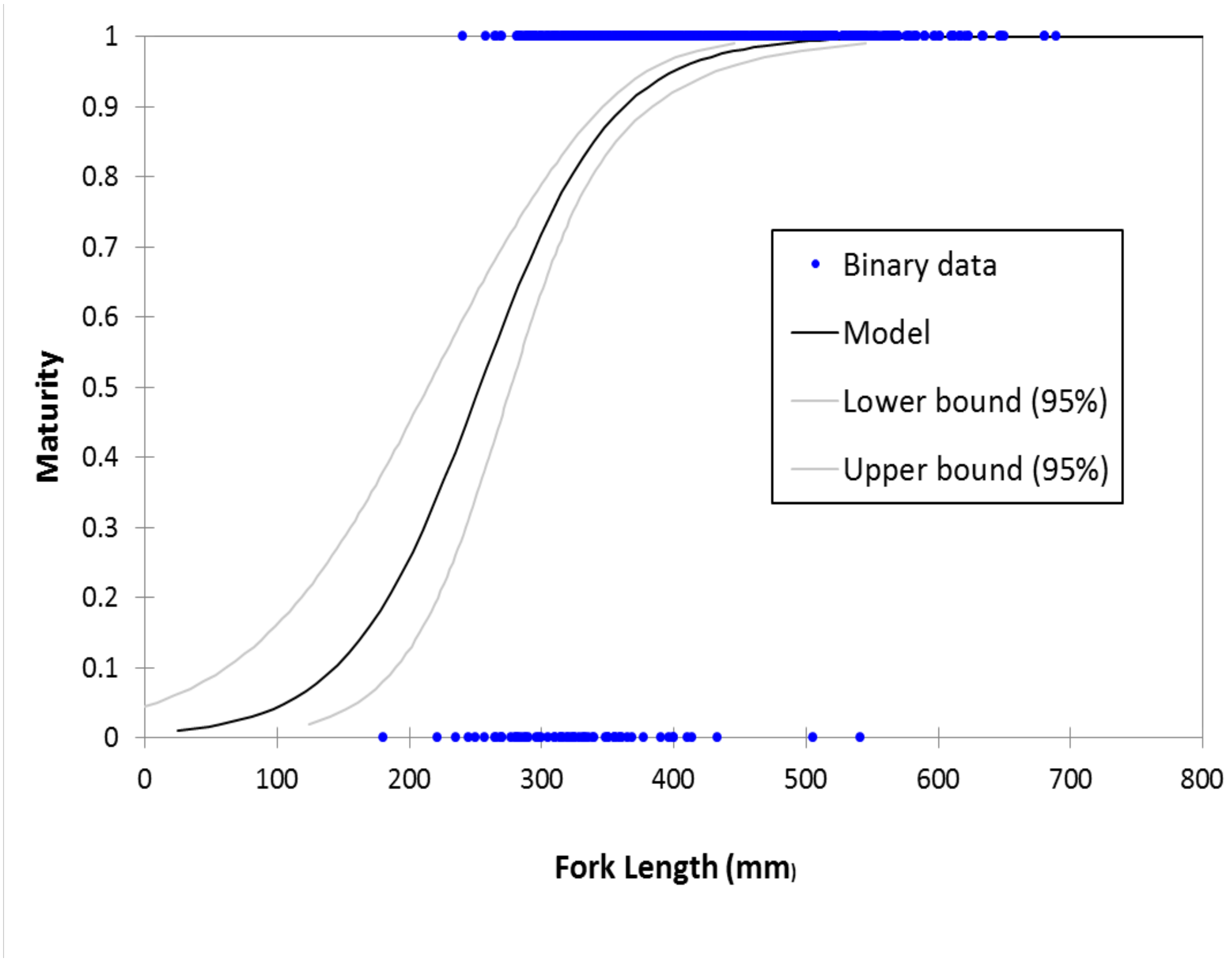


Figure 2.18.11. Logistic regression of female gray snapper maturity by fork length. The blue circles denote the binary data wherein an individual should be spawning (1) or not (0) during the reproductive season. The dark line is the predicted maturity, light lines are 95% confidence intervals. A total of 719 histology slides for female gray snapper captured during the months of April-October (spanning reproductive season) with length recorded, were assessed for a maturity ogive. Females with cortical alveolar or more advanced oocytes and/or postovulatory follicles were denoted as mature. Females with primary growth oocytes as leading stage but displaying potential atretic yolked oocytes observed outside the lamella (potential contaminants from storage) are of uncertain maturity and maturity was not assigned.

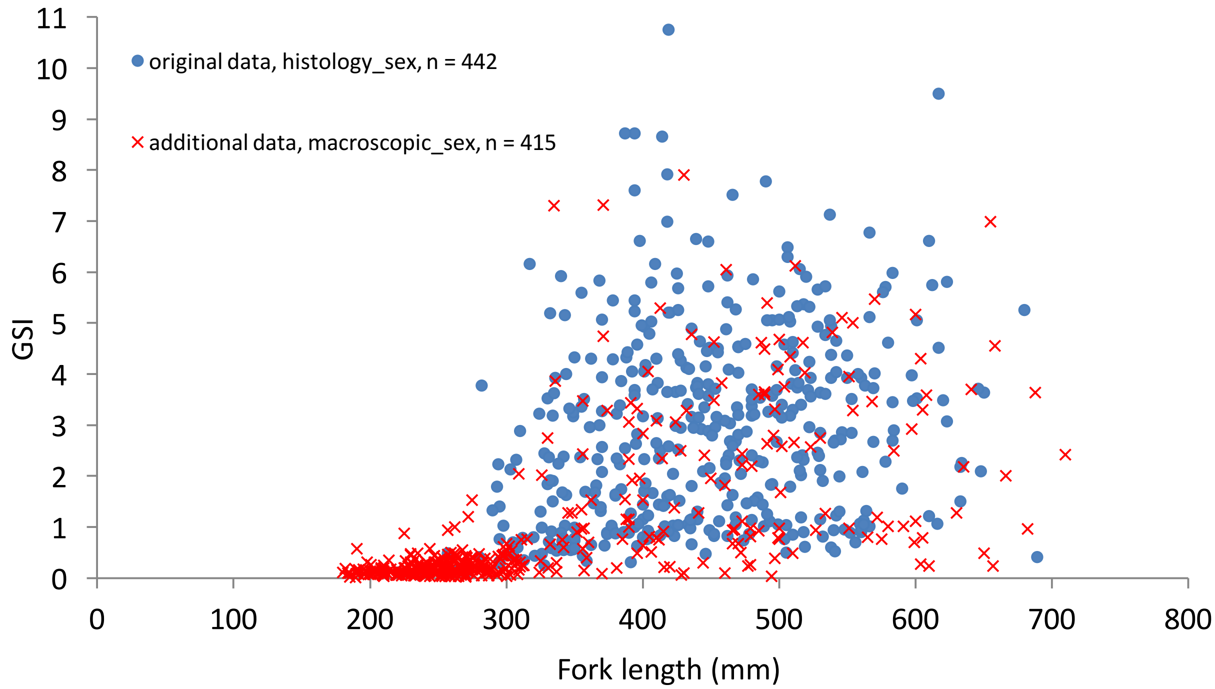


Figure 2.18.12. Female gonadosomatic index (GSI) by fork length with histologically determined females in the blue circles and macroscopically determined females in the red Xs. GSI is the percentage of gonad weight relative to body weight (total weight minus gonad weight). One outlier not shown (GSI=27%).

3 COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

Commercial landings of Gray Snapper were developed using data from multiple state and federal databases for the Gulf of Mexico and Monroe County, FL. These landings were provided in whole pounds from 1962 through 2015 and were also split into three primary gear groups: handline, nets and traps, and other.

Commercial discards were calculated from vessels fishing in the Gulf of Mexico and Monroe County, FL, using data from the Coastal Fisheries Logbook Program (CFLP) from 1990 through

June 2015 and observer reported discard and kept rates along with region specific commercial landings by gear (Gulf of Mexico).

Commercial length samples were obtained from the Trip Interview Program (TIP) databases. Sampling intensity for lengths by region, year, and gear were considered and appeared to be adequate for most strata from 1988 onward.

3.1.1. Commercial Workgroup Participants

Beth M. Wrege	Workgroup Leader	SEFSC Miami
Jason Delacruz	Workgroup Participant	
Kevin McCarthy	Data Provider	SEFSC Miami
Refik Orhun	Data Provider, Online	SEFSC Miami
Ryan Rindone	Liaison to participants	Gulf Council
Ryan Bradley	Workgroup Participant	Mississippi Commercial Fisheries United
Chris Bradshaw	Workgroup Participant	Florida Fish and Wildlife Conservation Com
Ed Walker	Workgroup Participant	

3.1.2 Issues Discussed at the Data Workshop

Issues discussed by the Commercial Workgroup (CWG) concerning Gray Snapper landings included region assignments, gear groupings, and historical landings. For discards, the workgroup discussed the discard estimation methodologies employed as well as the usefulness of the limited number of discards in the stock assessment.

3.2 REVIEW OF WORKING PAPERS

SEDAR 51 DW-04: Length frequency distributions for Gray Snapper length and age samples collected from the Gulf of Mexico. This report documents the differences in the frequency distributions for Gray Snapper length and age samples from the Gulf of Mexico collected from different regions, depths and gear groups. The report found distributions of lengths from within Monroe County were generally smaller than those from outside of Monroe County. The Commercial Workgroup chose not to divide commercial landings by sub-region due to relatively low commercial landings and length samples.

SEDAR 51 DW-08: Description of age data and estimated growth of Gray Snapper from the northern Gulf of Mexico: 1982-1983 and 1990-2015. Almost half (47%) of Gray Snapper otoliths (1991-2015; n = 37,482) were collected through the Trip Interview Program (TIP). The Commercial Workgroup determined that annual sample sizes were adequate to produce annual age-length keys. The report also mentions that a few samples reported as Gray Snapper were actually Cubera Snapper (*Lutjanus cyanopterus*). The Commercial Workgroup group concluded that misidentification of Gray Snapper as other species is unlikely in commercial landings.

SEDAR 51 DW-13 Commercial Landings of Gray or Mangrove Snapper (*Lutjanus griseus*), from the Gulf of Mexico. This document provided information on landings and informed discussions at the Data Workshop. The commercial landings of Gray Snapper for the Gulf of Mexico were derived from the Accumulated Landings System (ALS) a continuous Fisheries database that began in the 1960's.

3.3 COMMERCIAL LANDINGS

Commercial landings of Gray Snapper were compiled from 1962 through 2015 for the US Gulf of Mexico and all of Monroe County, FL. Gray Snapper landings were provided in whole pounds through 2016. The terminal year was defined as calendar year 2015. The 2016 data are provided for projections.

Gulf of Mexico landings for the non-Florida Gulf states of Alabama, Mississippi, Louisiana and Texas were compiled from the NOAA Fisheries Services' Accumulated Landings System (ALS) starting in 1962. The ALS data were aggregated monthly and are available by county code and name, state code and name, NMFS area code, water body, gear code, gear description and aggregated gear groups (handline, gillnet, and other). The data can also be aggregated by calendar year and fishing year. The Fisheries Information Network (FIN), a state/federal cooperative program among agencies to collect, manage, and disseminate statistical data and information on the commercial fisheries of the Southeast Region began in 1999. GulfFIN started receiving Louisiana, Mississippi and Alabama trip ticket data beginning in 2000 and provided Gray Snapper landings data for Louisiana in whole pounds from 2000 through 2013 by state, year, month, and gear. Landings prior to 2000 were extracted from ALS (1962-1999) or from historical databases of NOAA Fisheries' Office of Science and Technology (1950 to 1963).

Commercial landings of Gray Snapper were compiled from 1962 through 2016 for Monroe County, FL. Further discussion of how the commercial landings were compiled from these sources can be found in SEDAR51-DW-13

Historical landings of Gray Snapper for 1897 through 1961 were obtained from multiple sources. Further discussion of how the commercial landings were compiled from these sources can be found in SEDAR51-DW-13. Detailed descriptions of historical federal and state data collections can be found in Appendix A.

3.3.1 Commercial Landings Fleet

Statistics on commercial landings (1960 to present) for Gray Snapper of the Gulf of Mexico are maintained in the Accumulated Landings System (ALS) Data Warehouse. Data to the county level are only provided for Florida. Data are presented using the gear categories as determined at the Data Workshop. Allocation of specific National Marine Fisheries Service (NMFS) gears to each gear category for SEDAR 51 is displayed in Table 3.3.2-1. Commercial landings in pounds (whole weight) were developed based on methodologies for gear as defined by the Commercial Workgroup for each gear as available for 1962 through 2015 (Table 3.3.2-2).

The Workgroup consulted with the assessment scientist on the topic of data a requirement for the FFmodel. The model aggregates gears into fleets with similar size composition characteristics. The characteristics are a function of selectivity (fish that are available to the gear) either by hook size, mesh size or location. The group was charged with providing a recommending for a minimum number of fleets with pooled gears of similar size composition.

All gears used in the commercial harvest of Gray Snapper in the GoM and Monroe County were reviewed and are shown in figure 3.3.2-1. The initial grouping based on size selectivity by NMFS Gear Code is shown in Table 3.3.2-1 each gear type was discussed and sorted by the size that the majority of the fish were caught. It was decided to sort the fish into 3 size classes, 1) Smaller 2) Larger and 3) Mixed, based on size caught, not just size kept. The source for this information was primarily fishermen and dealers.

The Workgroup then requested the total commercial recorded catch of Gray Snapper be re-aggregated and reviewed. This is shown in figure 3.3.2-2 The Workgroup requested to see landings by gear as a proportion of the total this figure is shown in Figure 3.3.2-3. After the initial sorting it was determined that all gears needed addressed for size selectivity. Therefore, based on the commercial extraction an inclusive list of all gears represented in the commercial fishery was sorted by size of catch for size selectivity in the model. This initial sorting was further discussed and minor revisions made as additional data were investigated. Participation was garnered from non-attending participants who had agreed to make themselves available if needed. The initial result of the size selectivity determined by the Workgroup is shown in table 3.3.3-2.

Landings of Gray Snapper by Gillnet and Trap gears were combined as they had similar size frequencies and occurred over the same time period, these are shown in figure 3.3.3-5. Following regulatory changes banning or reducing some of these gears, landings dropped to trivial levels.

Commercial landings were grouped into three fleets based on gear size selectivity: Handline+, Nets+, and Other+. Handline includes all hook and line gear including electric/hydraulic bandit reels. Miscellaneous gear with small (<1% of total) landings (e.g. spear, hand net, bully net) were also aggregated with handline. In the 1960s and 1970s, gillnet landings accounted for more than half of landings.

Recommendation #1: The Commercial Workgroup recommends three gear groupings: Handline+, Nets+, and Other+. Handline+ includes hook and line, rod and reel, handline, electric/hydraulic bandit reels, diving and trolling. Nets+ includes gillnets, nets, pots & traps. Other+ includes longline and others.

3.3.2 Historic Commercial Landings

Historic landings from 1950 through 1961 were obtained from multiple sources including the Florida Fish and Wildlife Conservation Commission, referenced documents, and from NOAA Fisheries' Office of Science and Technology. While reported landings are available back to 1897, no appreciable landings are seen until 1918. In addition, reporting became more consistent beginning in 1927. Between 1938 and 1950, several years have no landings available, most noticeably the years during World War II, 1941-1944. Since it is possible these years had no landings, due to wartime port closures, attempts to interpolate landings were not made. Reported historical landings can be found in Table 3.3.3.1 and Figure 3.3.3-7. After the total landings Commercial landings of Gray Snapper by fleet were determined the historic landing available was plotted to see the data range.

Recommendation #2: Provide historic landings as available. No interpolation for missing years.

3.4 COMMERCIAL DISCARDS

Available data useful for calculating commercial discards included fisher reported discard rates and gear-specific effort from the commercial fishery (South Atlantic) and observer reported discard and kept rates along with region specific commercial landings by gear (Gulf of Mexico).

3.4.1 Florida Keys Oceanside

Discard data were available for the years 2002 through 2015 from the discard logbook program. The program data base contains discard reports from a 20% sample (by region and gear fished) of all commercial vessels with federal fishing permits. No bottom longline trips in the Florida Keys had reports of Gray Snapper discards; therefore, discards could be calculated for only vertical line gear (handline, electric and hydraulic reels). Very few Gray Snapper (~ 0.3% of all Gray Snapper discards) were reported as "kept for bait" from vertical line trips. The number of Gray Snapper kept for bait was not calculated for the vertical line fishery.

An increase in the number of reports of "no discards" (of any species) over the period 2002 through 2015 may have resulted in under reporting of commercial discards. To reduce the likelihood of erroneously low discard rates, data were filtering followed the recommendations of SEDAR 32. The filter excluded data from vessels that reported more than 17 trips without reporting discards of any species (two standard deviations above the mean number of trips prior to the first trip with reported discards). Effort data were also filtered to remove data from trips with landings of mackerel only. This filter was recommended in SEDAR 32 because mackerel only trips were unlikely to have had Gray Snapper discards; therefore, including effort from mackerel only trips would be inappropriate. Data were also filtered to remove trips that included clearly erroneous data (e.g., fishing more than 24 hours per day).

Discard rates were calculated as the nominal discard rate per year during the period 2002 through 2015. The discard rate was then multiplied by the yearly vertical line total fishing effort (total hook-hours fished) reported to the coastal logbook program. Effort data were available for the period 1993 through 2015. To calculate discards prior to 2002, the mean rate for the years 2002 through 2015 was multiplied by the yearly effort during the period 1993 through 2001. Conversion of calculated numbers of fish discarded to pounds of fish discarded was completed using the mean weight per discard reported in the Gulf of Mexico reef fish observer program.

Due to suspected underreporting of discards, CVs for South Atlantic discard estimates were assumed to be 0.3.

3.4.2 Gulf of Mexico

Data available for Gray Snapper discard calculation in the Gulf of Mexico included reef fish observer vertical line, reef fish observer bottom longline, and shark observer bottom longline data. Gear specific landings data were also available for use in discard calculations. The observer data were used to calculate Gray Snapper [discard rate: kept rate] ratios. Those ratios were applied to the Gulf of Mexico Gray Snapper landings to estimate Gray Snapper discards.

Calculated dead discards from the Gulf of Mexico and the South Atlantic side of the Florida Keys were summed and are provided by gear and assumed discard mortality in weight (Table 3.4.1) and in numbers (Table 3.4.2). Discard calculations using Gulf of Mexico observer data were hindered by small sample size. Due to uncertainty in the representativeness of the observer data, CVs of 0.3 were recommended for the discard estimates. A file containing size composition of discards was provided to the lead assessment biologist.

3.4.3 US Shrimp Fishery Bycatch

Gray Snapper bycatch estimates from the shrimp fishery were trivial. Therefore, shrimp fishery bycatch was excluded from the model.

3.5 COMMERCIAL EFFORT

The distribution of directed commercial effort in hook hours was compiled from the Coastal Fisheries Logbook Program (CFLP) for 1990 through 2015 and supplied here for informational purposes. These data are presented in Figure 3.5.1.

3.6 BIOLOGICAL SAMPLING

Commercial length samples were obtained from the Trip Interview Program (TIP) databases. Data from Texas through Monroe County in FL were included in the extraction. All lengths are fork lengths in centimeters. Details are captured in SEDAR51-DW-04. Weights are in whole weight, no conversions were made for the commercial catch.

3.7 COMMERCIAL CATCH-AT-AGE/LENGTH

Most length and age samples from commercial fisheries were obtained from the Trip Interview Program (TIP) database housed at the Southeast Fisheries Science Center (SEFSC). A small number of commercial samples were also obtained from the Gulf States Marine Fisheries Commission FIN database (GFIN). Length and age samples from recreational fisheries were obtained from the Marine Recreational Fisheries Statistics Survey, (i.e., the Marine Recreational Information Program, MRIP), the Head Boat Survey (HB), the Texas Parks and Wildlife Department database (TPWD), the Gulf State Marine Fisheries Commission FIN database (GFIN), and the TIP database, which is described in detail in SEDAR51-DW-04.

3.8 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

The Commercial Workgroup group considered the majority of landings data from the Gulf of Mexico and Monroe County, FL, to be adequate for assessment analyses. Data appeared to be most accurate and reliable in more recent years. This is likely due to the implementation of state trip ticket programs, beginning with Florida in 1986. Historic landings prior to 1962 were found to be the least reliable as there appears to be missing data for various years and states. Discards were found to be insignificant for all fleets. As discussed in Section 3.4, the variation in calculated commercial discards does not represent changes in recruitment. Gray Snapper bycatch from the shrimp fishery is also insignificant. Length samples appeared to be adequate for assessment analyses as there were a relatively high number of samples for most years and strata.

3.8.1 Estimates of Uncertainty

The Commercial Workgroup discussed uncertainty for landings by year and state, and reported that increased uncertainty should be noted as one goes back in time (Table 3.8.1). CVs were developed from expert opinion recognizing time breaks that reflect improvements in data collection methodologies leading to smaller CVs over time. Sources of uncertainty discussed included; 1962 through 1977 landings were aggregated for the year; 1978 through 1985 landings were reported monthly; 1986 – Present Florida Trip Ticket and prior to 1999 Louisiana Trip program was unfunded.

3.9 RESEARCH RECOMMENDATIONS

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and Monroe County, FL, to document discard length and mortality.
- Increase biological sampling efforts to better define stock boundaries.
- Automate volunteer and required fisher data reporting to reduce reporting complexity and time commitment for fishermen. Automation will improve both data quality and quantity.

3.10 LITERATURE CITED

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Manooch III, C.S. and R.H. Matheson III. 1981. Age, growth and mortality of Gray Snapper collected from Florida waters. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies. 35:331-344.

Starck, W. A. II, and R. E. Schroeder. 1970. Investigations on the Gray Snapper, *Lutjanus griseus*. Stud. Trop. Oceanogr. 10, Univ. Miami Press, Coral Gables, FL, 224 p. myfwc.com:website: myfwc.com/fishing/saltwater/

3.11 TABLES

Table 3.3.1 Size selectivity of various gears and NMFS Gear Codes which encountered Gray Snapper.

Smaller	Larger	Mixed
200 – Trawl Uncl.	32 – Spear	20 – H Seine
210 – Otter Trawl F	## – All Long-line	30 – L H Seine
215 – Otter Trawl S		25 – Gill Net Drift
300 – Trap		26 – Gill Net Strike
330 – Trap/Pot		28 – Trammel Net
330 – Crab Pot		31 – Cast Net
345 – Fish Traps		192 – Butterfly Trawl
355 – Spiny Lobster Traps		
379 – Traps – Other		
400 – Nets –Unknown		
705 – Dip Nets		

Table 3.3.2 Select National Marine Fisheries Service (NMFS) gears as assigned to gear groups for determining Gray Snapper commercial landings.

NMFS GEAR CODE	Gear Description	SEDAR 51 Group
0	NOT CODED 000	Other +
15	.	Other +
20	HAUL SEINES, BEACH	Net+
30	HAUL SEINES, LONG	Net+
100	ENCIRCLINLING NETS (PURSE)	Net+
145	SEINE, PURSE	Net+
187	TRAWL, SKIMMER	Net+
192	BEAM TRAWLS, SHRIMP	Net+
200	TRAWL, UNCLASSIFIED	Net+
210	TRAWL, OTTER FISH	Net+
215	OTTER TRAWL BOTTOM, SHRIMP	Net+
300	POTS AND TRAPS, CMB	Net+
330	POTS AND TRAPS, CRAB, BLUE	Net+
333	POTS, CRAB	Net+
345	TRAPS, FISH	Net+
355	TRAPS, SPINY LOBSTER	Net+
379	TRAPS, OTHER	Net+
400	ENTANGLING NETS (GILL) UNSPC	Net+
420	GILL NETS, SEA BASS	Net+
425	GILL NETS, OTHER	Net+
470	GILL NETS, DRIFT	Net+
475	GILL NETS, STRIKE	Net+
530	TRAMMEL NETS	Net+
600	TROLL & HAND LINES CMB	Hand+
610	HOOK AND LINE, HAND	Hand+
611	HOOK AND LINE, ROD AND REEL	Hand+
612	REEL, MANUAL	Hand+

613	HOOK AND LINE,LECTRIC/HYDRAULIC	Hand+
614	HOOK AND LINE, BUOY	Hand+
616	HOOK AND LINE, BANDIT	Hand+
660	TROLLING, OTHER	Hand+
661	LINES POWER TROLL OTHER	Hand+
675	LONGLINE, PELAGIC	Other +
676	LONGLINE. REEFFISH	Other +
677	LONGLINE. SHARK	Other +
678	LONGLINE, DRIFT	Other +
690	DEVICE	Hand+
705	DIP NET	Net+
735	CAST NET	Net+
760	SPEAR, NON-DIVING	Hand+
943	DIVING, POWER DEVICE	Hand+
955	DIVING, NON-POWER	Hand+
989	UNSPECIFIED	Hand+
999	COMBINED	Hand+

Table 3.3.3 Gray Snapper landings (1,000 pounds whole weight) for the Gulf of Mexico by gear type. Cells with a '*' indicate confidential data and therefore were suppressed.

Year	Handline+	Nets, Pots & Traps	Other +
1962	322	0	15
1963	302	0	9
1964	311	0	14
1965	360	0	47
1966	281	0	31
1967	319	0	54
1968	399	0	72
1969	373	0	107
1970	338	0	104
1971	360	0	109
1972	403	0	127
1973	388	0	169
1974	393	0	194
1975	257	0	228
1976	473	0	125
1977	269	0	357
1978	234	0	433
1979	275	0	399
1980	508	20	178
1981	508	20	162
1982	677	47	174
1983	671	86	176
1984	470	47	268
1985	373	35	218
1986	421	41	169
1987	517	44	137
1988	338	29	98
1989	388	45	119
1990	312	40	43
1991	383	43	42
1992	361	50	21
1993	434	78	13
1994	533	9	35
1995	433	7	20
1996	411	5	11
1997	408	5	12
1998	309	5	13
1999	274	11	8

2000	291	10	8
2001	313	10	6
2002	371	13	5
2003	321	9	6
2004	333	14	3
2005	301	13	2
2006	264	13	1
2007	199	12	1
2008	207	15	1
2009	261	17	1
2010	214	6	1
2011	237	12	0
2012	248	13	1
2013	223	12	2
2014	282	18	1
2015	239	25	2

Table 3.3.3.1 Historic Landings of Gray Snapper (pounds whole weight) for the Gulf of Mexico.

Year	Landings
1897	93,312
1902	153,636
1918	103,999
1927	186,918
1928	185,661
1929	158,278
1930	98,020
1931	92,210
1932	67,326
1934	156,200
1936	225,100
1937	198,300
1938	245,800
1950	271,400
1951	228,600
1952	165,900
1953	139,800
1954	172,000
1955	412,300
1956	169,500
1957	366,500
1958	446,000
1959	288,300
1960	333,000
1961	262,100

Table 3.4.1. Calculated dead Gray Snapper discards from the commercial fishery in pounds whole weight. Dead discards were calculated using 14% (vertical line) and 66% (bottom longline) discard mortalities. Max dead discards were calculated using 19% (vertical line) and 100% (bottom longline) discard mortalities. Min dead discards were calculated using nine percent (vertical line) and 33% (bottom longline) discard mortalities.

Year	Vertical line dead discards	Vertical line max dead discards	Vertical line min dead discards	Longline dead discards	Longline max dead discards	Longline min dead discards
1993	18,604	25,248	11,959	1,565	2,371	783
1994	23,015	31,235	14,796	791	1,199	396
1995	19,644	26,660	12,628	614	931	307
1996	15,062	20,442	9,683	477	723	239
1997	16,223	22,017	10,429	430	652	215
1998	11,861	16,097	7,625	457	692	228
1999	10,810	14,670	6,949	1,071	1,623	535
2000	11,778	15,984	7,571	826	1,252	413
2001	13,333	18,095	8,571	848	1,285	424
2002	14,575	19,781	9,370	1,029	1,559	514
2003	12,181	16,531	7,831	839	1,271	420
2004	12,139	16,475	7,804	1,316	1,994	658
2005	10,127	13,744	6,510	1,154	1,749	577
2006	10,734	14,568	6,900	868	1,314	434
2007	8,894	12,070	5,717	351	532	176
2008	7,327	9,944	4,710	0	0	0
2009	5,043	6,844	3,242	233	353	117
2010	3,129	4,247	2,012	8	13	4
2011	7,557	10,256	4,858	534	809	267
2012	899	1,220	578	487	738	244
2013	19,023	25,817	12,229	55	83	27
2014	12,793	17,362	8,224	1,205	1,826	603
2015	647	878	416	75	416	137

Table 3.4.2. Calculated dead Gray Snapper discards from the commercial fishery in number of fish. Dead discards were calculated using 14% (vertical line) and 66% (bottom longline) discard mortalities. Max dead discards were calculated using 19% (vertical line) and 100% (bottom longline) discard mortalities. Min dead discards were calculated using nine percent (vertical line) and 33% (bottom longline) discard mortalities.

Year	Vertical line dead discards	Vertical line max dead discards	Vertical line min dead discards	Longline dead discards	Longline max dead discards	Longline min dead discards
1993	23,676	32,131	15,220	826	1,252	413
1994	29,296	39,760	18,833	418	633	209
1995	25,005	33,935	16,074	324	491	162
1996	19,163	26,006	12,319	252	382	126
1997	20,643	28,015	13,270	227	344	114
1998	15,091	20,480	9,701	241	365	121
1999	13,751	18,662	8,840	565	857	283
2000	14,981	20,331	9,630	436	661	218
2001	16,965	23,024	10,906	448	678	224
2002	18,545	25,169	11,922	543	823	272
2003	15,496	21,030	9,962	443	671	221
2004	15,441	20,956	9,926	695	1,053	347
2005	12,879	17,479	8,280	609	923	305
2006	13,656	18,533	8,779	458	694	229
2007	11,302	15,338	7,265	186	281	93
2008	8,464	11,486	5,441	0	0	0
2009	6,420	8,713	4,127	123	187	62
2010	3,133	4,252	2,014	4	7	2
2011	9,621	13,057	6,185	282	427	141
2012	1,028	1,395	661	257	390	129
2013	24,165	32,795	15,534	29	44	14
2014	12,424	16,861	7,987	636	964	318
2015	739	1,002	475	145	220	73

Table 3.8.1 Uncertainty in Commercial Landings in the Gulf of Mexico and GOM - Monroe County, FL.

Year	FL - GOM	GOM
1962-1977	0.2	NA
1978-1985	0.1	0.1
1986-1998	0.05	0.1
1999-2005	0.05	0.08
2006-2010	0.05	0.07
2010-present	0.05	0.05

3.12 FIGURES

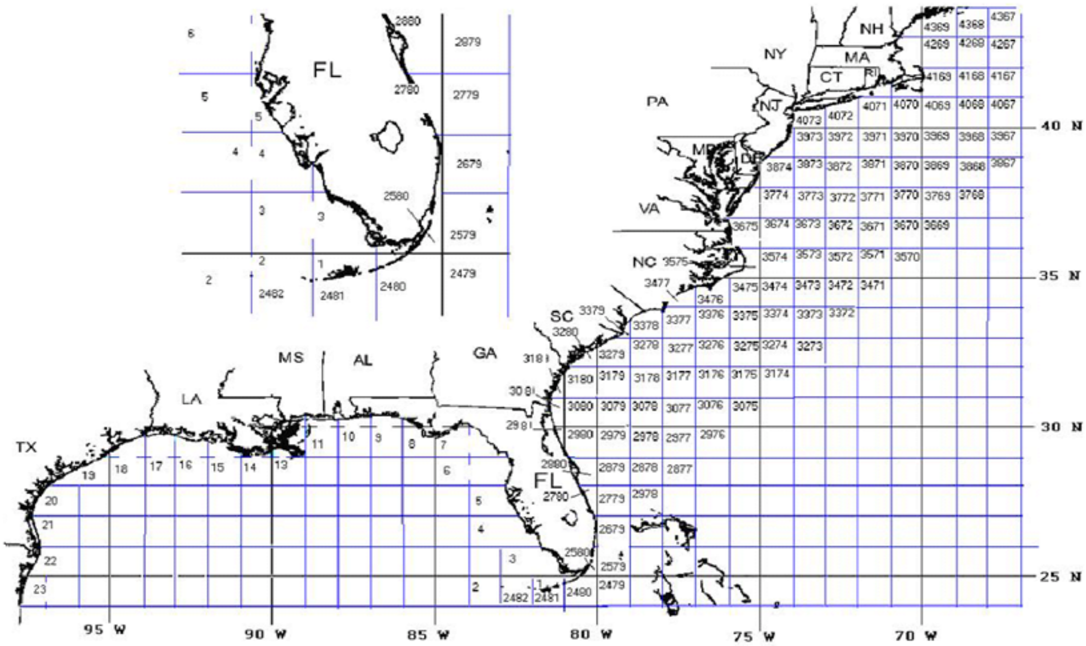

Figure 3.3.1. Map of Coastal Fisheries Logbook Program (CFLP) statistical grid denoting "Area_Fished" modified from latitude and longitude prior to 2013 for the Gulf of Mexico.

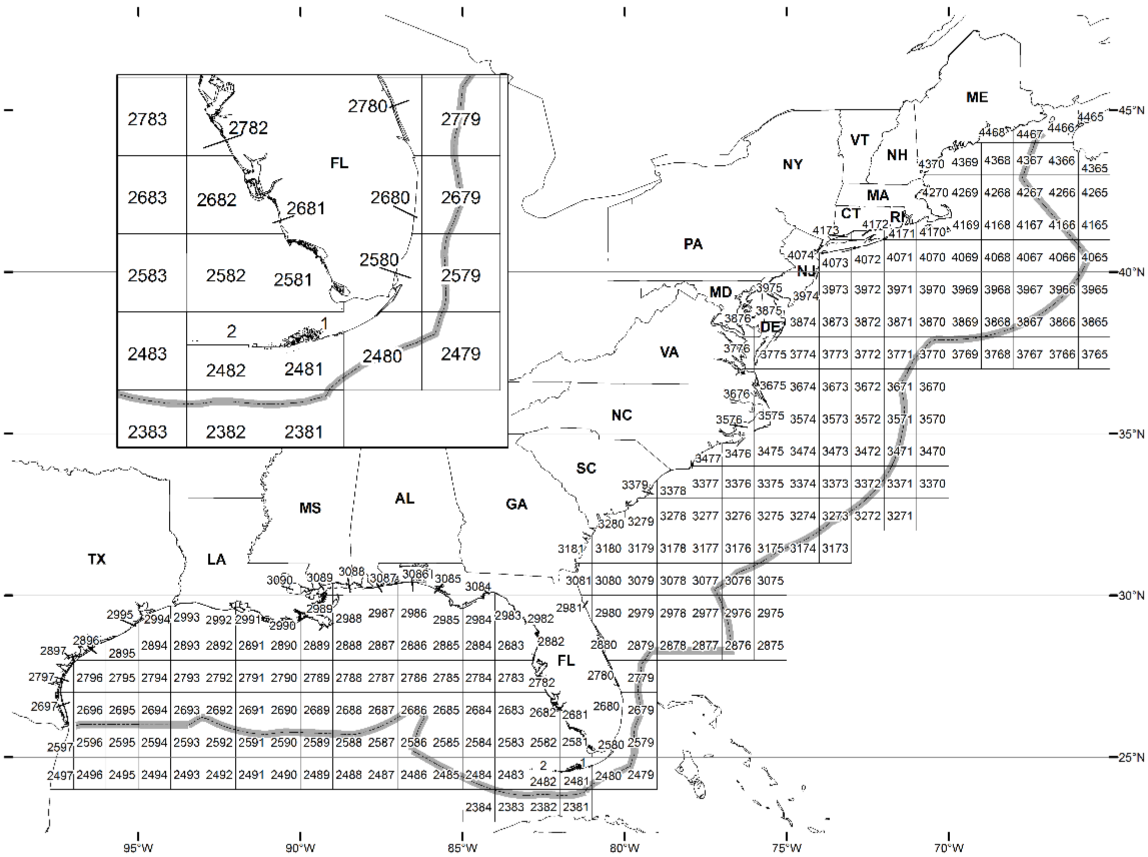

Figure 3.3.2. Map of Coastal Fisheries Logbook Program (CFLP) statistical grid denoting “Area_Fished” modified from latitude and longitude used beginning in 2013 for the Gulf of Mexico.

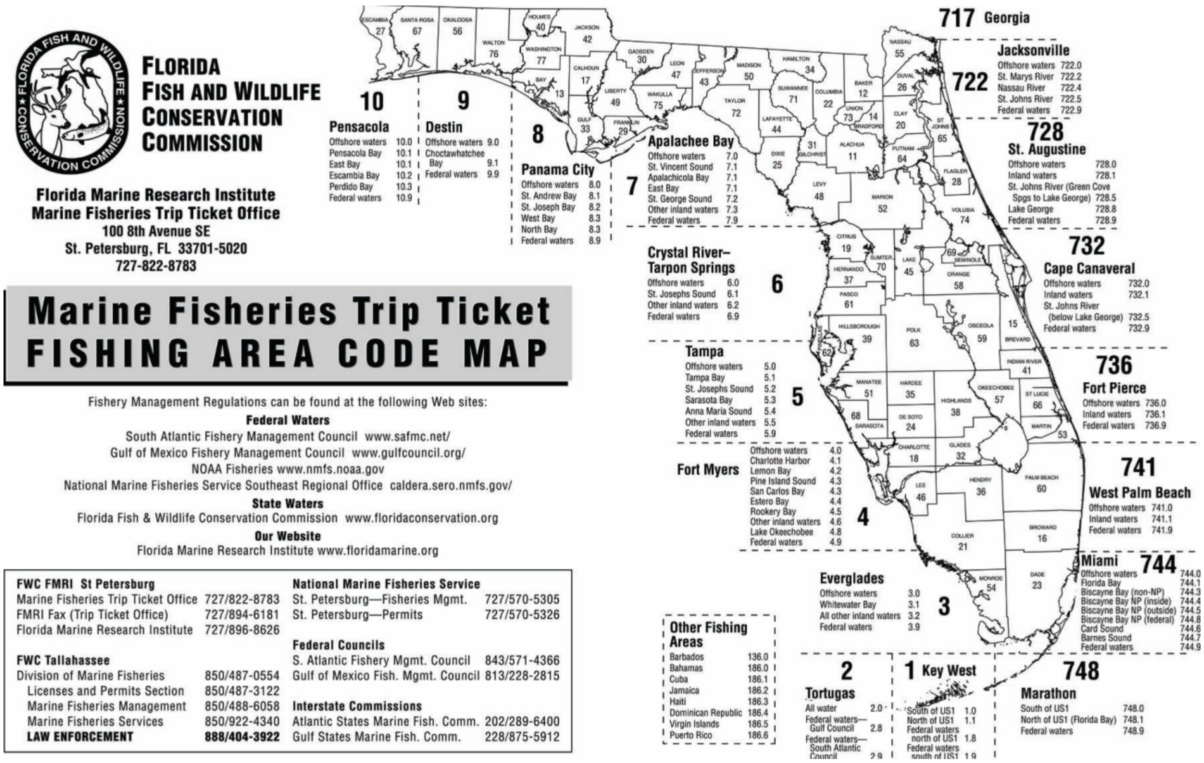

Figure 3.3.3. Marine fisheries trip ticket fishing area code map for Florida.

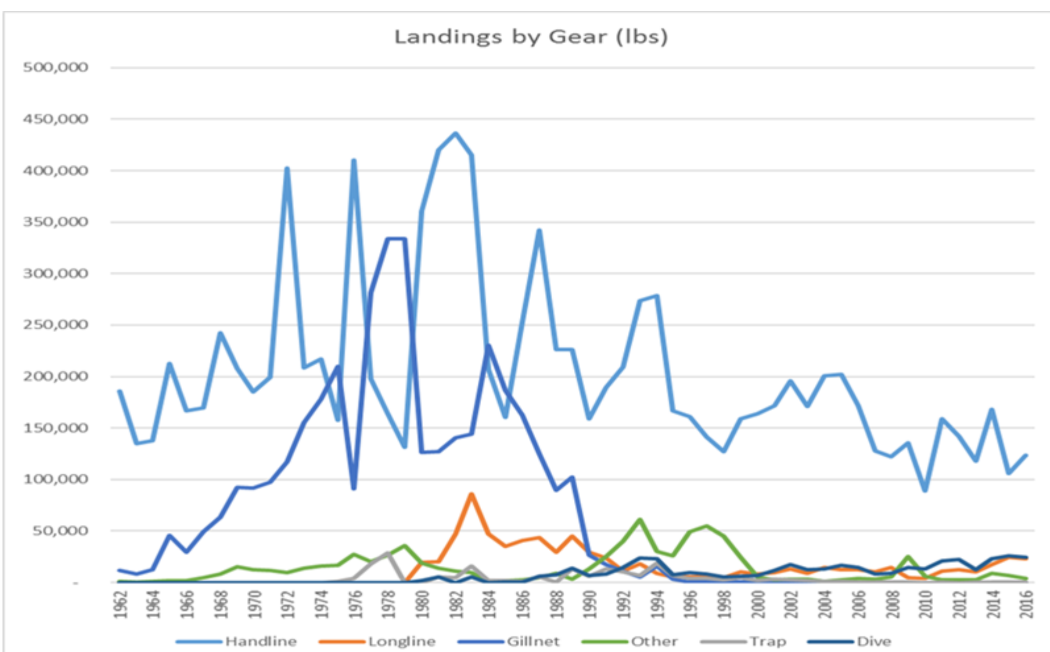

Figure 3.3.3-1 Commercial Landings of Gray Snapper by Gear from the Gulf of Mexico (1962 - 2015).

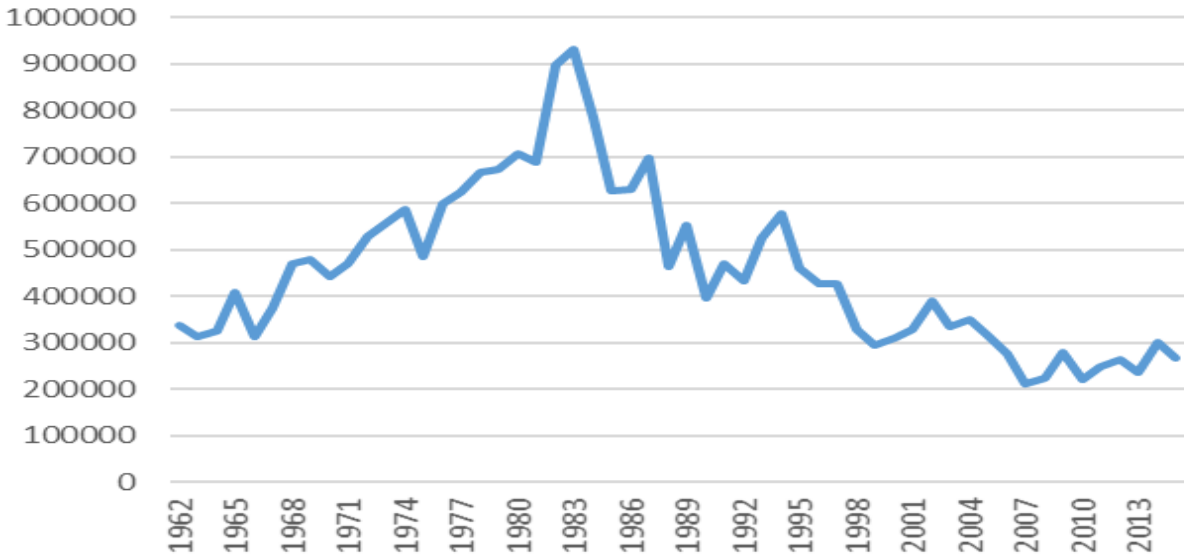

Figure 3.3.3-2 Total commercial recorded catch of Gray Snapper from the Gulf of Mexico (1962 - 2015).

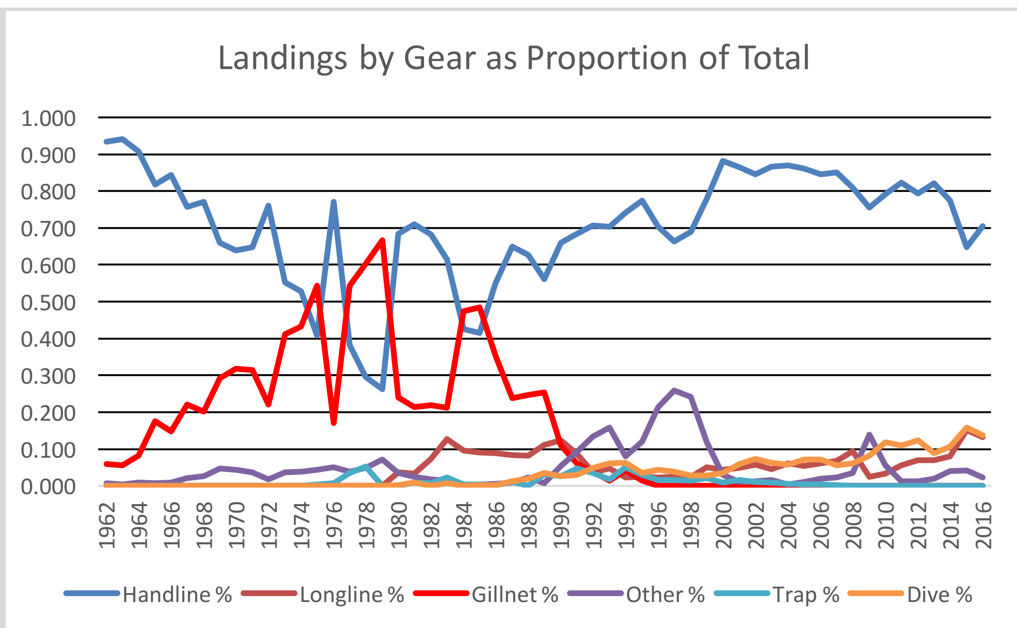

Figure 3.3.3-3 Gray Snapper Landings by Gear as a Proportion of Total Commercial Landings (1962 - 2015).

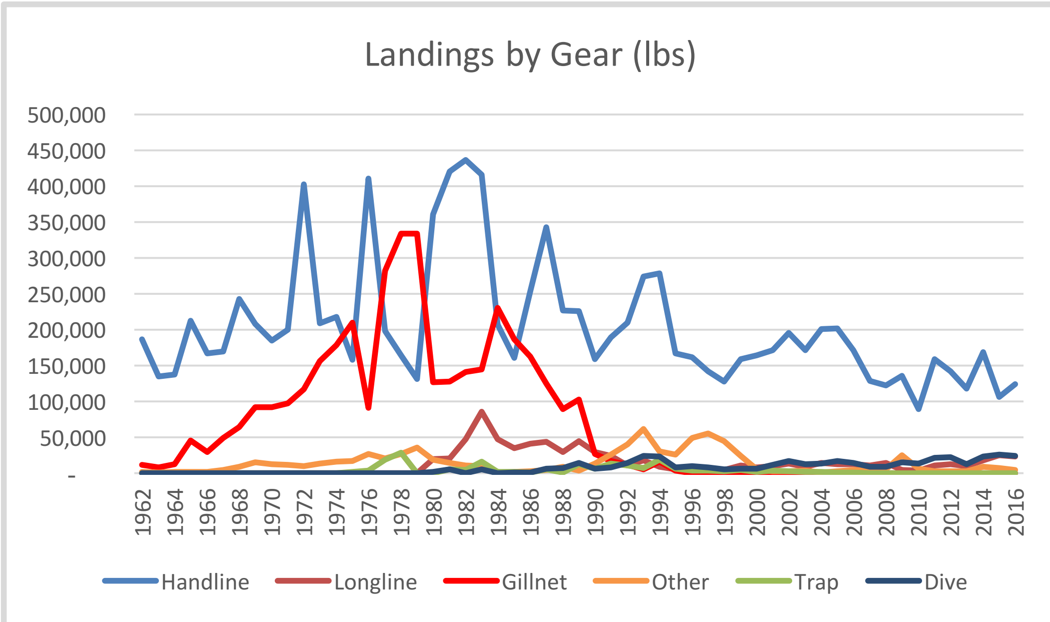

Figure 3.3.3-4 Commercial landings of Gray Snapper by grouped gear (1962 - 2015).

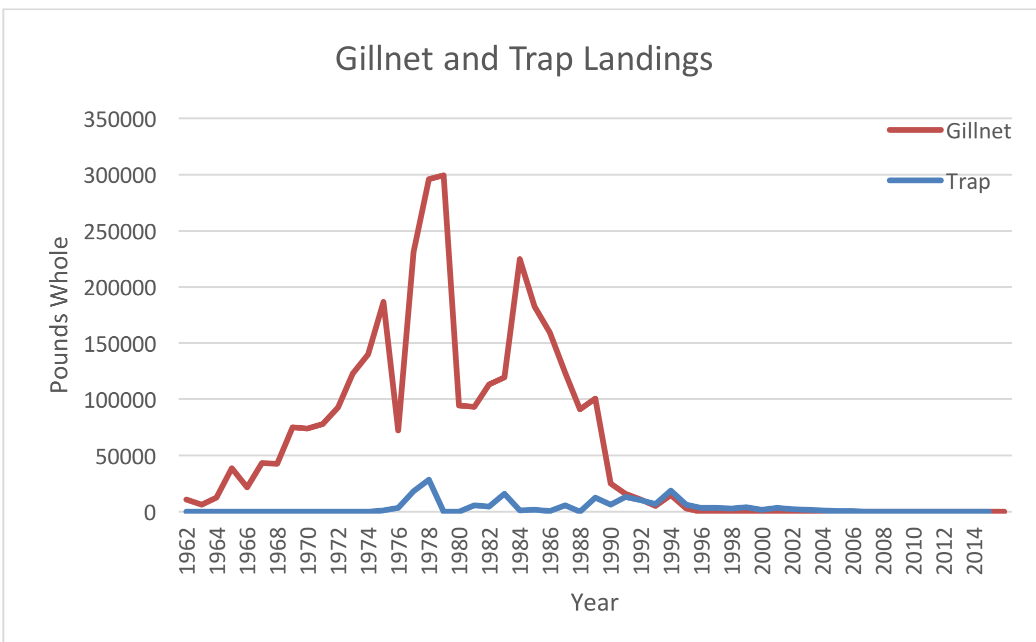

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Figure 3.3.3-5 Commercial landings of Gray Snapper by Gillnet and Trap (1962 - 2015).

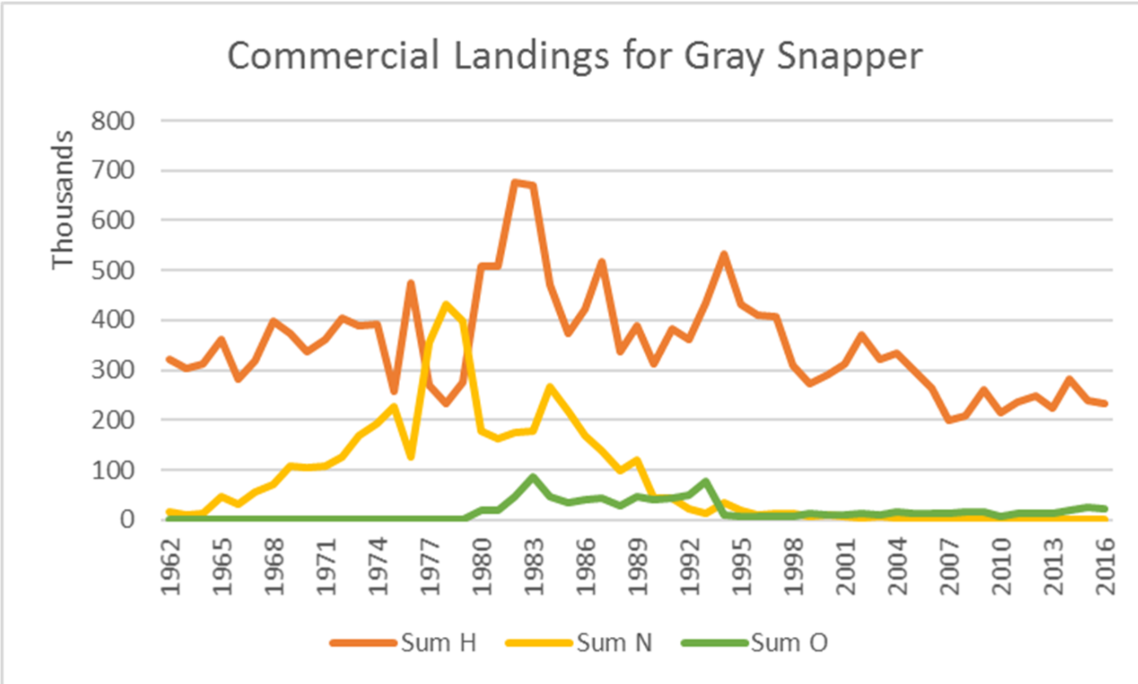


Figure 3.3.3-6 Commercial landings of Gray Snapper by gear and fleet, H = handline+, N = nets+, O = Other+, (1962 - 2015).

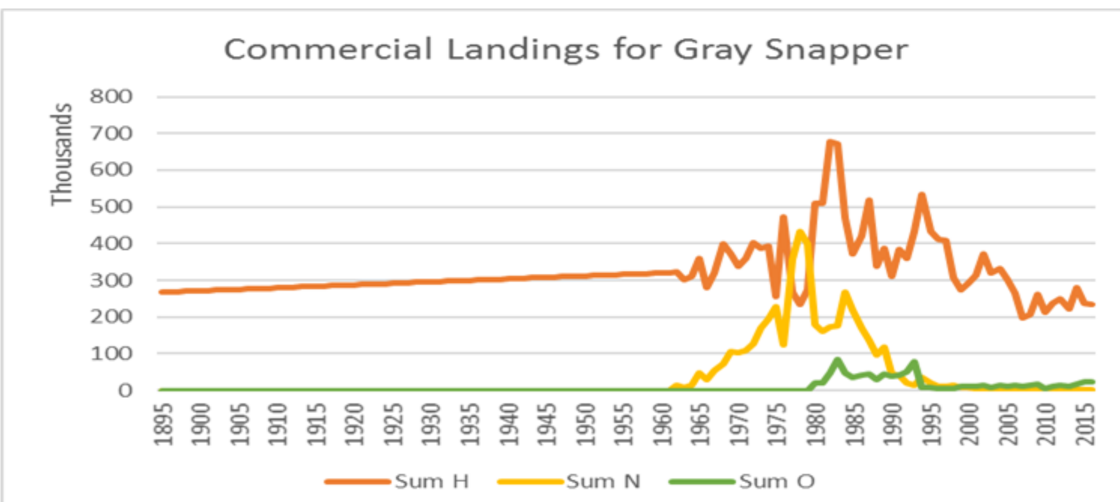


Figure 3.3.3-7 Commercial landings of Gray Snapper by fleet (H = handline+, N = nets+, O = Other+) with initial historic data point in 1897.

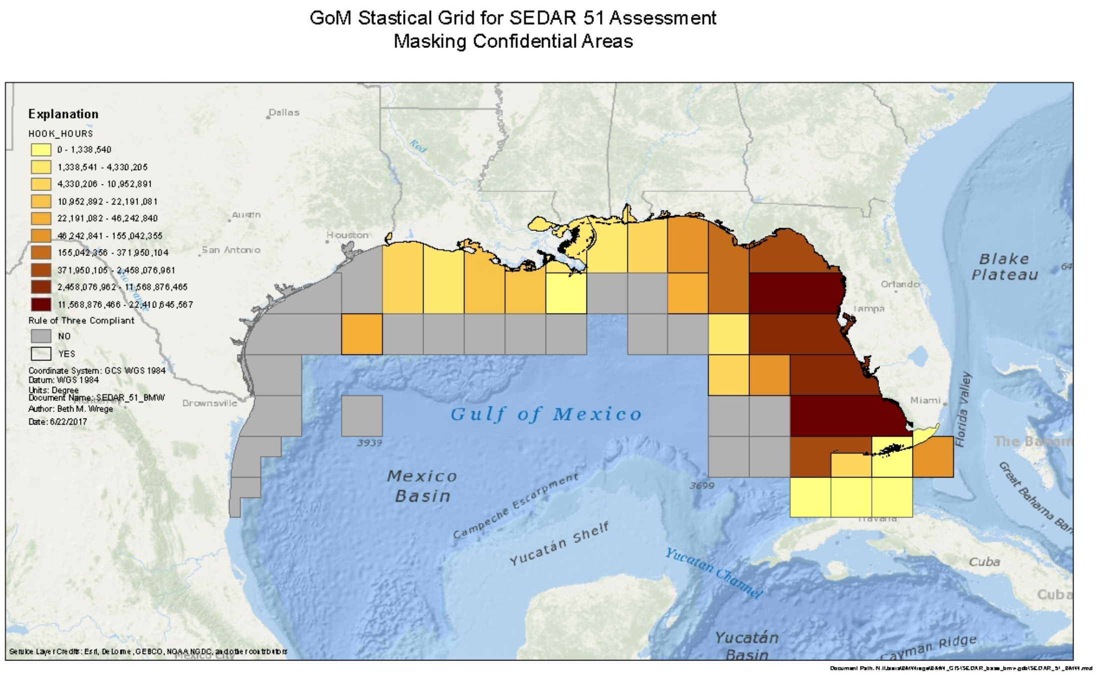


Figure 3.5-1 Gray Snapper commercial fishing effort in hook hours from the CFLP (1962 - 2015).

3.13 APPENDIX I

NMFS SEFIN Accumulated Landings (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected as early as the late 1890s. Fairly serious collection activity began in the 1920s.

The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SEFIN database management system is a continuous data set that begins in 1962.

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

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

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

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

1960 - Late 1980s

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

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

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

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

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

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

Cooperative Statistics Program

In the early 1980s, it became apparent that the collection of commercial fisheries statistics was an activity that was conducted by both the Federal government and individual state fishery agencies. Plans and negotiations were initiated to develop a program that would provide the fisheries statistics that are needed for management by both Federal and state agencies. By the mid-1980s, formal cooperative agreements had been signed between the NMFS/SEFSC and each of the eight coastal states in the southeast, Puerto Rico, and the US Virgin Islands.

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

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

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

Florida

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

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

NMFS SEFIN Annual Canvas Data for Florida

The Florida Annual Data files from 1976 – 1996 represent annual landings by county (from dealer reports) which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents, which were assigned responsibility for the particular county, from interviews and discussions from dealers and fishermen collected throughout the year.

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

4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

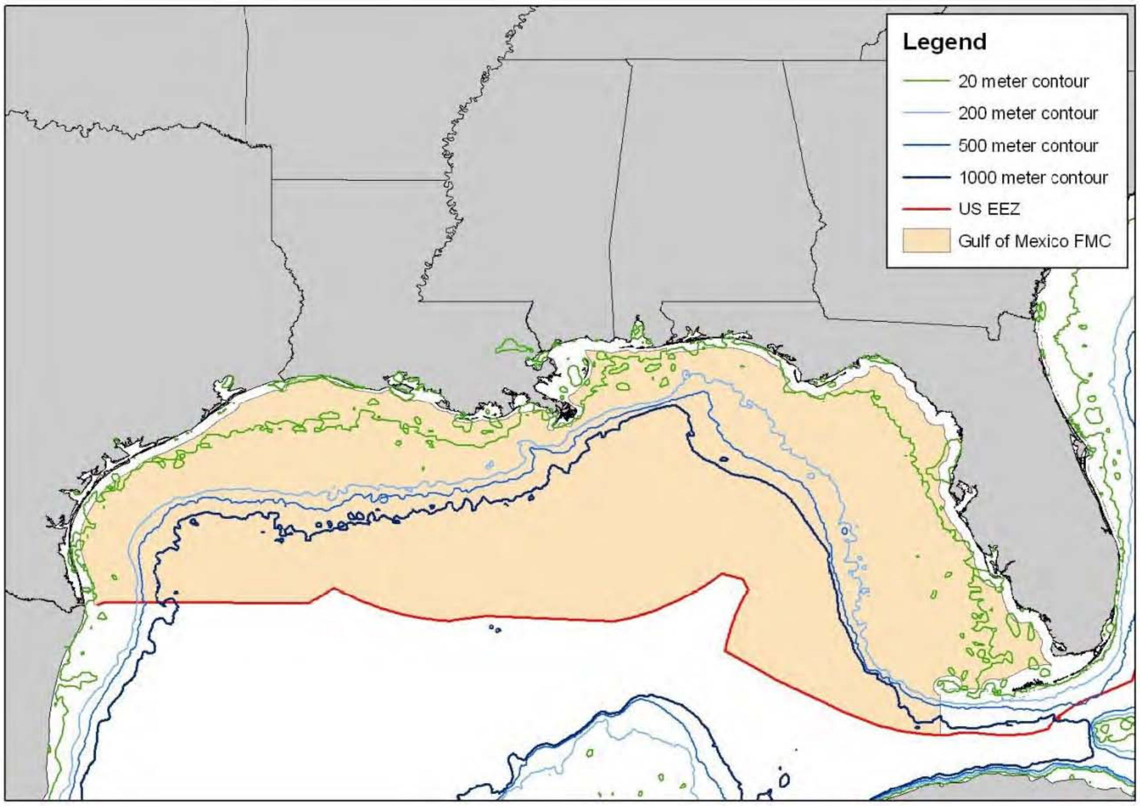
4.1.1 Recreational Workgroup (RWG) Members

Members- Kelly Fitzpatrick (NMFS Beaufort, NC), Jay Gardner (AP/Industry rep TX), Dominique Lazarre (FWL, FL), Vivian Matter (NMFS Miami, FL), Adyan Rios (Leader, NMFS Miami, FL), Beverly Sauls (FWL, FL), and Tom Sminkey (NMFS Silver Spring, MD).

4.1.2 Issues Discussed at the Data Workshop

1. Calibration of MRFSS charter boat landings 1981-1997
2. Adjustment of 1981-2003 MRFSS to MRIP APAIS estimates
3. Conversion of landings from numbers to weight using MRFSS sample weights
4. Adjustment of variances for MRFSS/MRIP recreational catch estimates
5. MRFSS hole-filling for missing strata in early years using best practices
6. Investigating high MRIP landings in 1984
7. No back calculation of headboat discards
8. Historical estimates of landings prior to 1981
9. Distributions of length and proportions of landings by strata
10. Distributions of length from length and age samples by strata

4.1.3 Gulf of Mexico Fishery Management Council Jurisdictional Boundaries



4.2 REVIEW OF WORKING PAPERS

SEDAR 51-DW-04, Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico

- This report documents the length frequency distributions (LFDs) of the lengths and ages of gray snapper collected from the Gulf of Mexico.

4.3 RECREATIONAL LANDINGS

The recreational landings for gray snapper were obtained from the following separate sampling programs:

1. Marine Recreational Fisheries Statistics Survey and the Marine Recreational Information Program

2. Southeast Region Headboat Survey

3. Texas Parks and Wildlife Department

4. Louisiana Creel Survey

Total recreational landings are summarized below by survey. A map and figures summarizing the total recreational gray snapper landings are included in Figure 4.10.1.

4.3.1 Marine Recreational Fisheries Statistics Survey (MRFSS) and Marine Recreational Information Program (MRIP)

Introduction

MRFSS/MRIP provides a long time series of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. MRFSS/MRIP provides estimates for three recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (CH). When the survey first began in Wave 2 (Mar/Apr), 1981, headboats were included in the for-hire mode, but were excluded after 1985 in the South Atlantic and Gulf of Mexico to avoid overlap with the Southeast Region Headboat Survey (SRHS) conducted by the NMFS Beaufort, NC lab.

The MRFSS/MRIP survey covers coastal Gulf of Mexico states from Florida to Louisiana. The state of Texas was included in the survey from 1981-1985, although not all modes and waves were covered. The state of Florida is sampled as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Miami-Dade County, and the west Florida sub-region includes Monroe County (Florida Keys) and counties adjacent to the Gulf of Mexico. Separate estimates are generated for each Florida sub-region, and those estimates may be post-stratified into smaller regions based on proportional sampling.

The MRFSS/MRIP design incorporates three complementary survey methods for estimating catch and effort. Catch data are collected through angler interviews during dockside intercept surveys of recreational fishing trips after they have been completed. Effort data are collected using two telephone surveys. The Coastal Household Telephone Survey (CHTS) uses random digit dialing of coastal households to obtain detailed information about the previous two months of recreational fishing trips from the anglers. The weekly For-Hire Survey interviews charter boat operators (captains or owners) to obtain the trip information with only one-week recall period. Effort estimates from the two telephone surveys are aggregated to produce total effort estimates by wave. Catch rates from dockside intercept surveys are combined with estimates of effort from telephone interviews to estimate total landings and discards by wave, mode, and area fished (inland, state, and federal waters).

Catch estimates from early years of the survey are highly variable with high proportional standard errors (PSE's), and sample sizes in the dockside intercept portion have been increased over time to improve precision of catch estimates. Several quality assurance and quality control improvements were implemented for the intercept surveys in 1990. Prior to 1990 the contractor did not have regional representatives hired to supervise the samplers in any given area. All samplers were hired as independent sub-contractors and communicated directly with the contractor's home office staff. It is much more likely that the samplers who worked in the 1980's would have varied more in their interpretation of sampling protocols and their ability to identify at least some of the more difficult-to-recognize species. There were a number of other changes made to enhance consistency in sampling protocols and improve error-checking in the Statement of Work for the 1990-1992 contracts. Improvements have continued over the years, but the biggest changes happened at that time (personal communication, NMFS). Full survey documentation and ongoing efforts to review and improve survey methods are available at: http://www.st.nmfs.gov/st1/recreational.

Survey methods for the for-hire fishing mode have seen the most improvement over time. Increased sample quotas and additional sampling (requested and funded by the states) to the intercept portion of the survey has improved catch rate data. It was also recognized that the random household telephone survey was intercepting relatively few anglers in the for-hire fishing mode and the For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. The FHS was officially adopted in the Gulf states in 2000, in East Florida in 2003, and in Georgia through Maine in 2005. The FHS was pilot tested in the Gulf of Mexico in 1998 and 1999 and in Georgia through Maine in 2004. The FHS does not consider the estimates during pilot years as official estimates; however, FHS data for these years have been used in past SEDARs (e.g. SEDAR 7 red snapper, SEDAR 16 king mackerel, SEDAR 25 black sea bass, etc). As a result of the Deepwater Horizon oil spill in April 2010, the MRFSS/MRIP For-Hire Survey increased sampling rates of charter boat vessel operators from 10% to 40% from May, 2010 through June 2011.

A further improvement in the FHS method was the pre-stratification of Florida into smaller sub-regions for estimating effort. Pre-stratification defines the sample unit on a sub-state level to produce separate effort estimates by these finer geographical regions. The FHS sub-regions include three distinct regions bordering the Atlantic coast: Monroe County (sub-region 3), SE Florida from Dade through Indian River counties (sub-region 4), and NE Florida from Martin through Nassau counties (sub-region 5). The coastal household telephone survey method for the for-hire fishing mode continues to run concurrently with the newer FHS method.

Calibration of traditional MRFSS charter boat estimates

Conversion factors have been estimated to calibrate the traditional MRFSS charter boat estimates with the FHS for 1986-1997 in the Gulf of Mexico (SEDAR7-AW-03). The relationship between the old charter boat method estimates of angler trips and the FHS estimates of angler trips was used to estimate the conversion factors. Since these factors are based on effort, they can be applied to all species' landings. In the Gulf of Mexico and the South Atlantic, the period of 1981-1985 could not be calibrated with the same ratios developed for 1986+ because in the earlier 1981-1985 time period, MRFSS considered charter boat and headboat as a single combined mode. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Headboat Survey (SRHS) were included in the analysis. To calibrate the MRFSS combined charter boat and headboat mode effort estimates in 1981-1985, conversion factors were estimated using 1986-1990 effort estimates from both modes, in equivalent effort units, an angler trip (SEDAR28-DW-12).

MRIP weighted estimates, APAIS changes, and the calibration of MRFSS estimates

The Marine Recreational Information Program (MRIP) was developed to generate more accurate recreational catch rates by re-designing the MRFSS sampling protocol to address potential biases including port activity and time of day. Revised catch and effort estimates, based on MRIP's improved estimation methodology, were released on January 25, 2012. These estimates are available for the Atlantic and Gulf Coasts starting in 2004.

Starting in 2013, wave 2, the MRIP Access Point Angler Intercept Survey (APAIS) implemented a "revised sampling design that includes an updated sampling frame; eliminates interviewer latitude in selecting interviewing sites; establishes discrete sampling periods of fixed duration, including nighttime sampling; and requires interviewers to collect detailed information about the number of completed boat and angler fishing trips during the sampling period" (MRIP Implementation Plan 2011). Revised catch estimates for gray snapper, based on this improved APAIS design, were calculated by the SEFSC using programs and guidance provided by the Office of Science and Technology (Carmichael 2015). These estimates are provided by state and mode, with all waves and areas combined.

As new MRIP APAIS estimates are available for a portion of the recreational time series that the MRFSS covers, conversion factors between the MRFSS estimates and the MRIP APAIS estimates were developed in order to maintain one consistent time series for the recreational catch estimates. Ratio estimators, based on the ratios of the means, were developed for Gulf of Mexico gray snapper to hind-cast catch and variance estimates by fishing mode. In order to apply the charter boat ratio estimator back in time to 1981, charter boat landings were isolated from the combined charter boat /headboat mode for 1981-1985. The MRFSS to MRIP APAIS calibration process is the same as the original MRFSS to MRIP adjustment that has been used since 2012, which is detailed in SEDAR31-DW25 and SEDAR32-DW02. Table 4.9.1 shows the ratio estimators used in the calibration. Figure 4.10.2 shows the MRFSS versus MRIP APAIS adjusted estimates for Gulf of Mexico gray snapper from 1981 to 2015.

Monroe County

Monroe County estimates are included in the official West Florida estimates. Since gray snapper estimates from Monroe County are included in the Gulf of Mexico stock, no stratification or domain estimation (to separate out Monroe County) is required.

Calculating landings estimates in weight

The MRFSS and the MRIP surveys use different methodologies to estimate landings in weight. To apply a consistent methodology over the entire recreational time series, the Southeast Fisheries Science Center (SEFSC) implemented a method for calculating average weights for the MRIP (and MRIP adjusted) landings. This method is detailed in SEDAR32-DW-02. The length-weight equation developed by the Life History Working Group for SEDAR 51 (W=1.356E-5*(L^3.024)) was used to convert gray snapper sample lengths into weights, when no weight was recorded. W is whole weight in grams and L is fork length in millimeters. This method was used to calculate landings estimates in weight from the MRIP, TPWD, and LA Creel programs.

1981, wave 1

MRFSS began in 1981, wave 2. In the Gulf of Mexico, catch for 1981 wave 1 was estimated by determining the proportion of catch in wave 1 to catch in all other waves for 1982-1984 by fishing mode and area. These proportions were then used to estimate wave 1 in 1981 from the estimated catches in other waves of that year. This methodology is consistent with past SEDARs (e.g., SEDAR 28 Spanish mackerel and cobia).

Variances

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

Texas

Texas data from the MRFSS are only available from 1981-1985 and is sporadic, not covering all modes and waves. For these reasons, Texas boat mode estimates from the MRFSS were not included. Instead, TPWD data, which covers charter and private modes, were used to fill in these modes prior to the start of the TPWD survey in May 1983. Shore mode estimates from Texas are retained.

Louisiana

MRIP did not operate in Louisiana in 2014. Landings from the LA Creel Survey are used in the absence of MRIP LA estimates in that year.

Results

MRIP landings estimates in numbers of fish and in whole weight in pounds are presented in Table 4.9.2, and by year and state in Figure 4.9.3. CVs associated with estimated landings in numbers are also shown in Table 4.9.2. High estimates of MRIP landings in weight were observed for 1984 (Figure 4.10.3). As described in Section 4.3.1, the landings in weight were calculated using MRIP landings in numbers and average weights by strata. Figure 4.10.4 shows the MRIP landings estimates in numbers of fish and in whole weight in pounds by year. The average weight of the landings estimates by year (landings in weight/landings in number) is also shown in Figure 4.10.4. Investigating these inputs revealed that the cause of the unusually high landings in 1984 was the estimates of landings in numbers. The majority of landings in 1984 were associated with west Florida (Figure 4.10.5) and with the private fishing mode (Figure 4.10.6) and more specifically, were associated with wave 6 (Figure 4.10.7). Further review of the MRFSS APAIS data revealed that there were high reported catch rates for private mode fishing in this wave and year particularly from anglers that fished in state waters (Table 4.9.3). Although the MRIP estimate for landings in 1984 was substantially high, the recreational workgroup recommended that no changes to this value were necessary. The high uncertainty reported for 1984 adequately reflects the methods used to expand to total landings, and no individual input to the calculation appeared to be associated with errors that would warrant correction.

4.3.2 Southeast Region Headboat Survey (SRHS)

Introduction

The Southeast Region Headboat Survey (SRHS) estimates landings and effort for headboats in the South Atlantic and Gulf of Mexico. The SRHS began in the South Atlantic in 1972 and Gulf of Mexico in 1986 and extends from the North Carolina\Virginia border to the Texas\Mexico border. Mississippi headboats were added to the survey in 2010. The South Atlantic and Gulf of Mexico Headboat Surveys generally include 70-80 vessels participating in each region annually.

The SRHS incorporates two components for estimating catch and effort. 1) Biological information: sizes of the fish landed are collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate length frequency distributions and mean weights for all species by area and month. Port samplers also collect otoliths and spines for ageing studies during dockside sampling events. 2) Information about total catch and effort are collected via a logbook form that is filled out by vessel personnel for individual trips. These logbooks are summarized by vessel to generate estimated landings by species, area, and time strata. Most recently, the SRHS implemented electronic logbook reporting in the South Atlantic and Gulf of Mexico as of Jan 1, 2013. Headboat personnel now have the ability to report trip information via a website or mobile application. Electronic reporting became mandatory in 2014.

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

Variances

Variance estimates are not currently available for the SRHS catch estimates. Further research is required to develop a suitable method to calculate variance. This task has been prioritized and is currently in the planning stage.

Texas headboat landings 1981-1985

Headboat landings estimates from 1981-1985 come from the MRFSS/MRIP survey for all states except Texas. As in previous SEDARs, headboat landings for Texas from 1981 to 1985 were estimated using a 3yr average (1986-1988) from SRHS Texas landings.

Catch Estimates

SRHS landings estimates are shown in Table 4.9.4, by year and state in Figure 4.10.8. SRHS areas 12, 17, 18, and 21-29 are included in the Gulf of Mexico gray snapper stock.

4.3.3 Texas Parks and Wildlife Department (TPWD)

Introduction

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

1981-1983 Texas estimates

The TPWD survey began with the high-use season in 1983 (May 15, 1983). Texas charter and private mode estimates do not exist from the start of 1981 to May of 1983. Averages from TPWD 1983-1985 by mode and wave were used to fill in the missing estimates.

Catch Estimates

TPWD landings estimates are shown in Table 4.9.5 and by year in Figure 4.10.9.

4.3.4 Louisiana Creel Survey (LA Creel)

Introduction

The Louisiana Department of Wildlife and Fisheries (LDWF) began conducting the Louisiana Creel (LA Creel) survey program for monitoring marine recreational fishery catch and effort on January 1, 2014. Private and charter modes of fishing are sampled. The program is comprised of three separate surveys: a shoreside intercept survey, a private telephone survey, and a for-hire telephone survey. The shoreside survey is used to collect data needed to estimate the mean numbers of fish landed by species for each of five different inshore basins and one offshore area. The private telephone survey samples from a list of people who possess either a LA fishing license or a LA offshore fishing permit and provided a valid telephone number. The for-hire telephone survey samples from a list of Louisiana's registered for-hire captains who provided a valid telephone number. Both telephone surveys are conducted weekly. No information is collected on released fish.

Catch Estimates

LA Creel landings estimates for 2014 are shown in Table 4.9.6.

4.3.5 Historical Recreational Landings

Historical (1945-1980) recreational charterboat and private angler landings were estimated using the FHWAR method following the SEDAR Best Practices recommendations (SEDAR Best Practices, 2016). Historical shore estimates were estimated by fitting a liner regression to the ratio of annual landings between the shore and sum of the private and charter modes from 1987 to 2012. During these years, shore landings made up an increasingly smaller proportion of total landings. The early years (1981-1996) of the time series for recreational landings were not used in this analysis due to their high variability. The slope and intercept of the regression (Figure 4.10.10) were used to obtain estimates of historical shore mode landings from the historical charter and private mode landings. Historical landings are provided in Table 4.9.7 and plotted in Figure 4.10.11.

4.4 RECREATIONAL DISCARDS

The recreational discards for gray snapper were obtained from the following separate sampling programs:

1. Marine Recreational Fisheries Statistics Survey and the Marine Recreational Information Program

2. Southeast Region Headboat Survey

Total recreational discards are summarized below by survey. A map and figures summarizing the total recreational gray snapper discards are included in Figure 4.10.12. There are no estimates from the Texas Parks and Wildlife Survey or from the Louisiana Creel Survey for this species.

4.4.1 Marine Recreational Fisheries Statistics Survey (MRFSS) and Marine Recreational Information Program (MRIP) Discards

Discarded live fish are reported by the anglers interviewed by the MRIP/MRFSS. Consequently, neither the identity nor the quantities reported are verified. Lengths and weights of discarded fish are not sampled or estimated by the MRFSS/MRIP. MRFSS/MRIP estimates of live released fish (B2 fish) were adjusted in the same manner as the landings (i.e., using charter boat calibration factors, MRIP adjustment, substitutions, etc. described above in section 4.3.1). MRIP discards in numbers of fish and associated CVs are presented in Table 4.9.8.

4.4.2 Southeast Region Headboat Survey (SRHS) Discards

The Southeast Region Headboat Survey logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered “released alive” if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered “released dead”. As of Jan 1, 2013 the SRHS began collecting logbook data electronically. Changes to the trip report were also made at this time, one of which removed the condition category for discards i.e., released alive vs. released dead. The new form now collects only the total number of fish released regardless of condition. These self-reported data are currently not validated within the Headboat Survey. SHRS discards in numbers of fish are presented in Table 4.9.9.

SRHS discards prior to 2004

Headboat discards prior to 2004 were not estimated. Figure 4.10.12 shows that the headboat fishery accounted for a low portion of total recreational discards (2%). Since the headboat fleet released so few gray snappers compared to the other recreational modes, the recreational workgroup determined that estimating the discards prior to 2004 was not necessary. Applying a back-calculation for headboat discards would not substantially affect the total recreational discards.

4.4.3 Texas and Louisiana Discards

There are no discard estimates from the TPWD Survey or the LA Creel Survey for gray snapper. TPWD landings of gray snapper are extremely low. Typically, the LA discard ratio is applied to the TPWD landings as proxy. However, because the TPWD landings are negligible and the LA discard estimates are negligible, discards from TX are assumed to be negligible.

4.5 BIOLOGICAL SAMPLING

4.5.1 Sampling Intensity Length/Weight

MRFSS/MRIP Biological Sampling

The MRFSS/MRIP angler intercept survey includes the sampling of fish lengths from the harvested (landed, whole condition) catch. Up to 15 of each species landed per angler interviewed are measured to the nearest mm along a center line (defined as tip of snout to center of tail along a straight line, not curved over body). In those fish with a forked tail, this measure would typically be referred to as a fork length, and in those fish that do not have a forked tail it would typically be referred to as a total length with the exception of some fishes that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured although weights are not preferred when time is constrained.

The number of angler trips with measured gray snapper in the Gulf of Mexico in the MRFSS/MRIP by year and mode are summarized in Table 4.9.10. Information on the weights collected (number, mean, minimum, and maximum weights) by year and state from the MRFSS/MRIP is tabulated in Table 4.9.11.

SRHS Biological Sampling

Lengths were collected by headboat dockside samples. Weights are typically collected for the same fish measured during dockside sampling. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely and processed for aging, diet studies, and maturity studies.

Annual numbers of gray snapper measured for length in the headboat fleet and the number of trips from which gray snapper were measured are summarized in Table 4.9.12. Dockside mean weights for the headboat fishery are tabulated in Table 4.9.13.

TPWD Biological Sampling

The TPWD Sport-boat Angling Survey samples fishing trips made by sport-boat anglers fishing in Texas marine waters. All sampling takes place at recreational boat access sites. Length composition of the catch for sampled boat-trips has been collected since the high-season of 1983 (mid-May). Total length is measured by compressing the caudal fin lobes dorsoventrally to obtain the maximum possible total length. Weights of sampled fish are not recorded. Lengths are converted to weights using a length weight equation.

The number of trips with measured gray snapper in the TPWD charter and private-rental modes are summarized by year in Table 4.9.14. Converted weights (number, mean, minimum, and maximum weights) for the TPWD charter and private-rental modes are summarized by year in Table 4.9.15.

4.5.2 Sampling Intensity Length/Age

Length and age samples from recreational fisheries landings of gray snapper were obtained from the MRFSS/MRIP, SRHS, TPWD, the Gulf States Marine Fisheries Commission FIN database (GFIN), and the TIP database. Otolith samples were processed and read by the Panama City

Laboratory, SEFSC.

The number of gray snapper measured and aged by year and mode are tabulated in Table 4.9.16.

Comparing the proportion of ages and lengths sampled by recreational fishing mode to the proportion of total landings by recreational fishing mode (Figure 4.10.13) shows that the headboat and charterboat were oversampled. This observation prompted further review of the length composition data by strata.

The recreational workgroup recommended that the data be reweighted by strata to more appropriately reflect the length composition of the landings. The workgroup evaluated the options of stratifying by region (Monroe County/Not Monroe County as suggested by Chih (2017)), by mode (Private/Charter/Headboat/Shore), or by area fished (Inshore/State/EEZ) and ultimately recommended that the length composition data be weighted only by mode. The recreational workgroup also recommended that, if a reduced number of fleets is desired, recreational landings and reweighted length composition data could be aggregated to reflect a shore fleet (shore mode) and an offshore fleet (private, headboat and charterboat modes).

4.5.3 Length Composition Data by Mode

For the charter and private modes, differences in the length composition by region (Figure 4.9.14) are explained by differences in the areas fished (Figures 4.10.15 and 4.10.16). Since the data do not suggest that the stocks are biologically different across regions, stratification by region (county) was not recommended. Furthermore, although differences in selectivity between the areas fished are evident, area fished was not recommended as a stratum since it is currently not possible to sort the annual landings data by area fished; area fished has not yet been included as a stratum in the MRFSS calibration.

Previously identified differences in the length composition by region for the headboat mode (Figure 4.10.14) could not be investigated beyond the SRHS area level. However, since the headboat fleet makes up only 3% of the total recreational landings, the recreational workgroup does not deem it necessary to stratify the landings and length composition by region. The group reasoned that the differences observed between regions are likely due to regional differences in targeting and not biological in nature.

The differences in the size composition across regions for the shore mode were not as pronounced as in the other modes (Figure 4.10.14 and reproduced in Figure 4.10.17). Although there are relatively few lengths associated with this mode (Table 4.9.16), the recreational workgroup recommended keeping the data stratified by mode. The shore data make up the second largest component (31%) of the recreational landings and this mode is associated with a noticeably smaller range of lengths compared to the other modes (Figure 4.10.18).

4.6 RECREATIONAL EFFORT

Total recreational effort is summarized below by survey. Effort is summarized for all marine fishing by mode, regardless of what was caught. A map and figures summarizing MRFSS/MRIP effort in angler trips are included in Figure 4.10.19. A map and figures summarizing SRHS effort in angler days are included in Figure 4.10.20.

4.6.1 MRFSS/MRIP Effort

Effort estimates for the recreational fishery survey are produced via telephone surveys of both anglers (private/rental boats and shore fishers) and for-hire boat operators (charter boat anglers, and in early years, party or charter anglers). The methods have changed during the full time series (see section 4.3 for descriptions of survey method changes and adjustments to survey estimates for uniform time-series of catch estimates). An angler-trip is defined as a single day of fishing by a single angler in the specified mode, not to exceed 24 hours. MRFSS effort estimates are presented from 1981 to 2003. MRIP effort estimates are presented starting in 2004. Angler trip estimates are tabulated in Table 4.8.17 by year and mode and include all Gulf of Mexico states from Louisiana to West Florida.

4.6.2 SRHS Effort

Catch and effort data are reported by all headboats in the survey. Trip reports are completed by the captain or designated crew member after each trip and represent the total of all the species kept, along with the total number of fish discarded for each species. Data on effort are provided as number of anglers on a given trip. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to “angler days” (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Each month, port agents review these trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for nonreporting, a correction factor is developed based on sampler observations, angler numbers from office books and all available information. This information is used to provide estimates of total catch (expanded or corrected for non-reporting) by month and area, along with estimates of effort.

Estimated headboat angler days are tabulated for the Gulf of Mexico in Table 4.9.18 and include SRHS areas 12, 17, 18, and 21-29.

4.6.3 TPWD Effort

The TPWD survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). Only private and charterboat fishing modes are surveyed. Most of the sampled trips are from private boats fishing in bay/pass because these represent most of the fishing effort, but all trips (private, charterboat, ocean, bay/pass) are sampled. Charterboat trips in ocean waters are the least encountered in the survey. Estimates of TPWD angler trips are shown in Table 4.9.19 by year and mode.

4.7 RESEARCH RECOMMENDATIONS

1. Future MRIP calibration consideration – provide cell-level adjusted time-series of catch estimates (state, wave, mode, area-fished by species).
2. Explore landings and length composition by area to investigate possible species stock expansion.
3. Determine adequacy of regional sampling design given changing species distributions and developing fisheries (ex: spearfishing, targeted hook & line methods). Continue to monitor regions and gears where gray snapper observations are increasing. Adequately sample inshore fishing in LA.

4.8 LITERATURE CITED

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4.9 TABLES

Table 4.9.1. Gulf of Mexico gray snapper ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP APAIS numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**
Charter boat	1.600439	1.272236	23.52918	10.60737	0.006903	0.003907
Private	1.607952	1.343479	23.81655	12.82602	0.030565	0.002077
Shore	2.011891	1.606027	26.89155	16.90104	0.020269	0.010889

Table 4.9.2. Gulf of Mexico (LA-FLW, including the Keys) gray snapper landings (numbers of fish and whole weight in pounds) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004+). MRFSS estimates adjusted to MRIP APAIS estimates prior to 2004 (except for HB mode). CH mode adjusted for FHS conversion prior to 2004. *CVs for CH and HB mode 1981-1985 are unavailable.

	Estimated CH Landings			Estimated HB Landings			Estimated PR Landings			Estimated SH Landings			ALL MODES Landings		
Year	Number	CV*	Pounds	Number	CV*	Pounds	Number	CV	Pounds	Number	CV	Pounds	Number	CV	Pounds
1981	30,283		37,035	11,834		14,495	815,636	1.28	1,622,524	301,543	1.38	89,336	1,159,295	0.97*	1,763,391
1982	359,824		293,970	140,616		234,578	565,323	1.25	620,509	714,266	0.98	372,674	1,780,029	0.56*	1,521,731
1983	136,354		261,137	49,382		143,204	320,038	1.76	616,582	2,736,225	2.48	1,597,683	3,242,000	2.10*	2,618,605
1984	63,519		108,638	24,823		64,054	4,321,924	1.49	7,391,857	1,582,077	1.26	1,070,206	5,992,342	1.13*	8,634,755
1985	41,938		85,863	16,389		33,555	933,464	1.27	1,911,157	281,093	1.37	223,334	1,272,884	0.98*	2,253,909
1986	75,865	1.10	261,581				567,922	1.39	618,782	1,240,619	1.43	986,064	1,884,405	1.03	1,866,427
1987	49,645	2.06	156,241				782,869	0.76	788,624	1,353,073	4.24	2,061,032	2,185,586	2.64	3,005,897
1988	53,845	1.49	45,079				828,272	0.71	741,508	707,871	0.96	353,431	1,589,988	0.57	1,140,018
1989	110,080	1.94	94,516				1,565,659	0.60	1,243,875	1,102,678	1.08	611,750	2,778,417	0.55	1,950,141
1990	26,538	1.36	35,258				939,920	0.90	1,267,024	525,191	1.16	688,421	1,491,649	0.70	1,990,703
1991	83,556	0.89	102,223				1,063,408	0.61	1,456,257	1,877,417	1.06	1,325,982	3,024,381	0.69	2,884,462
1992	92,570	1.06	200,660				882,219	0.36	1,026,938	651,367	0.71	443,089	1,626,157	0.35	1,670,687
1993	90,109	0.93	191,514				1,068,654	0.38	1,123,633	757,977	0.59	550,646	1,916,741	0.32	1,865,793
1994	146,146	1.01	273,228				947,867	0.38	1,192,810	516,177	1.03	452,987	1,610,190	0.41	1,919,025
1995	140,660	1.89	168,918				930,297	0.45	1,284,818	373,621	0.81	283,867	1,444,579	0.40	1,737,603
1996	70,198	1.22	91,300				788,409	0.51	1,064,825	483,516	0.75	428,170	1,342,123	0.41	1,584,294
1997	57,379	1.77	125,867				816,580	0.61	965,707	389,734	0.86	369,139	1,263,694	0.48	1,460,713
1998	116,297	0.46	301,563				898,991	0.43	981,004	376,061	0.69	372,575	1,391,348	0.33	1,655,142
1999	106,845	0.58	285,317				771,063	0.45	1,057,347	157,758	0.86	138,797	1,035,666	0.37	1,481,460
2000	142,398	0.86	298,356				891,655	0.44	1,190,010	282,444	1.07	270,913	1,316,498	0.39	1,759,279
2001	137,317	0.49	331,301				993,675	0.38	1,321,171	386,580	0.92	313,375	1,517,572	0.34	1,965,846
2002	139,996	0.53	448,782				891,773	0.41	1,198,167	228,561	1.08	261,883	1,260,330	0.36	1,908,832

2003	208,409	0.45	558,207		1,330,240	0.40	2,203,342	298,137	0.88	253,163	1,836,786	0.33	3,014,712
2004	200,832	0.23	547,814		1,766,407	0.28	4,411,949	404,819	0.55	323,452	2,372,058	0.23	5,283,216
2005	153,990	0.27	416,065		1,149,909	0.24	2,367,108	348,828	0.45	280,425	1,652,726	0.19	3,063,597
2006	166,830	0.25	521,882		647,478	0.20	1,134,504	263,089	0.43	281,378	1,077,396	0.16	1,937,764
2007	209,269	0.26	479,187		995,459	0.16	1,578,336	323,194	0.43	283,933	1,527,922	0.14	2,341,457
2008	272,664	0.30	795,399		1,390,746	0.18	1,769,926	484,343	0.44	384,073	2,147,753	0.16	2,949,398
2009	321,058	0.42	677,053		1,221,386	0.19	1,640,061	418,610	0.48	310,586	1,961,054	0.17	2,627,701
2010	138,198	0.28	284,674		436,100	0.19	630,733	149,712	0.58	93,589	724,010	0.17	1,008,995
2011	162,084	0.28	328,559		581,171	0.32	1,550,831	59,853	0.55	93,315	803,109	0.24	1,972,705
2012	142,773	0.24	307,184		1,224,314	0.37	3,027,212	376,127	0.46	381,161	1,743,214	0.28	3,715,557
2013	246,790	0.24	381,708		1,140,451	0.15	1,171,890	179,261	0.26	141,306	1,566,502	0.12	1,694,904
2014	242,570	0.17	373,745		1,366,687	0.14	1,403,208	331,414	0.18	202,746	1,940,671	0.10	1,979,699
2015	200,897	0.13	288,739		1,126,631	0.10	1,426,306	199,512	0.36	229,671	1,527,041	0.09	1,944,716

Table 4.9.3 MRIP APAIS data summary for gray snapper in 1984 for the private recreational fishing mode in west Florida.

		Type B1			Type A		
Wave	Area	N	Anglers	Per Trip	N	Anglers	Per Trip
1	State, Ocean	1	139	0.007	1	140	0.007
	EEZ, Ocean	15	14	1.071		14	
	Inland		55			55	
2	State, Ocean		105		5	116	0.043
	EEZ, Ocean		9			10	
	Inland		33		1	33	0.03
3	State, Ocean	1	268	0.004		283	
	EEZ, Ocean		17			22	
	Inland		29			30	
4	State, Ocean	70	162	0.432	6	168	0.036
	EEZ, Ocean		16			18	
	Inland		1			1	
5	State, Ocean	22	84	0.262	1	86	0.012
	EEZ, Ocean		2		2	2	1
	Inland		6			6	
6	State, Ocean	90	53	1.698	35	54	0.648
	EEZ, Ocean	2	5	0.4		5	
	Inland	5	13	0.385		13	

Table 4.9.4. Estimated headboat landings of gray snapper in the Gulf of Mexico 1981-2015. Due to headboat area definitions and confidentiality issues, FLW must be combined with AL and MS must be combined with LA and TX.

	HB Landings							
	Number				Pounds			
Year	FLW/AL	KEYS	LA/MS/TX	Gulf of Mexico	FLW/AL	KEYS	LA/MS/TX	Gulf of Mexico
1981		7,641	147	7,788		10,593	742	11,335
1982		9,322	147	9,469		12,641	742	13,383
1983		23,264	147	23,411		23,991	742	24,733
1984		16,656	147	16,803		22,901	742	23,643
1985		22,001	147	22,148		29,076	742	29,819
1986	55,093	24,086	129	79,308	151,051	31,479	680	183,209
1987	31,856	17,380	216	49,452	66,476	20,729	1,276	88,482
1988	25,354	21,709	303	47,366	59,930	43,384	1,098	104,412
1989	53,837	19,133	199	73,169	112,454	24,442	671	137,566
1990	37,535	22,660	986	61,181	82,862	27,384	4,472	114,718
1991	41,497	12,609	1,374	55,480	101,995	14,319	3,375	119,688
1992	34,226	18,218	1,785	54,229	65,954	21,358	6,602	93,913
1993	43,339	21,997	2,048	67,384	131,721	28,166	6,862	166,749
1994	44,198	26,879	3,931	75,008	96,055	32,048	13,871	141,974
1995	26,557	27,690	2,906	57,153	56,237	43,540	11,752	111,529
1996	13,079	26,890	4,302	44,271	30,892	36,139	17,422	84,454
1997	14,746	21,807	9,895	46,448	38,659	25,663	39,708	104,030
1998	35,291	19,364	6,920	61,575	79,924	23,301	30,304	133,529
1999	43,578	17,879	5,394	66,851	77,339	18,432	23,362	119,132
2000	16,895	20,706	2,577	40,178	41,472	22,728	9,429	73,629
2001	25,191	31,471	4,311	60,973	55,557	33,020	16,617	105,194
2002	24,397	31,055	4,657	60,109	46,333	31,866	14,151	92,350
2003	14,109	31,700	7,620	53,429	28,670	34,792	27,775	91,237
2004	19,563	29,545	1,115	50,223	50,558	34,208	3,410	88,177
2005	20,741	30,709	2,273	53,723	39,295	44,051	8,791	92,137
2006	14,170	38,619	1,376	54,165	31,516	37,723	7,110	76,349
2007	11,570	22,695	3,338	37,603	21,026	24,496	9,751	55,272
2008	17,813	17,446	1,797	37,056	38,366	19,740	8,361	66,466
2009	25,948	25,418	1,989	53,355	55,262	23,826	8,807	87,895
2010	12,087	24,914	568	37,569	24,947	24,369	1,608	50,925
2011	19,686	33,686	2,223	55,595	48,285	31,789	7,985	88,059
2012	28,109	38,236	1,635	67,980	72,103	41,344	8,069	121,515
2013	21,661	32,932	833	55,426	46,659	34,752	2,813	84,224
2014	26,121	50,650	1,871	78,642	53,062	54,469	7,082	114,614
2015	31,864	36,022	1,189	69,075	63,080	39,266	3,819	106,164

Table 4.9.5. Estimated TPWD landings of gray snapper in the Gulf of Mexico 1981-2015.

	Number			Pounds		
Year	CH Landings	PR Landings	All Modes	CH Landings	PR Landings	All Modes
1981		262	262		479	479
1982		262	262		479	479
1983		557	557		1,033	1,033
1984		177	177		303	303
1985	15	153	168	30	302	332
1986	40	484	524	78	948	1,027
1987	618	1617	2,235	1,040	2,720	3,760
1988		360	360		288	288
1989		360	360		322	322
1990		208	208		302	302
1991		44	44		59	59
1992		808	808		1,196	1,196
1993	281	7638	7,919	155	4,140	4,295
1994	2661	10929	13,590	2,309	9,849	12,158
1995	1451	8851	10,302	1,311	7,758	9,069
1996	3627	8319	11,946	3,625	10,344	13,968
1997	169	1492	1,661	262	1,970	2,232
1998	2380	2858	5,238	5,343	5,539	10,882
1999	778	16191	16,969	597	11,624	12,221
2000	2588	22853	25,441	2,204	18,063	20,267
2001	590	3746	4,336	931	6,127	7,058
2002	2225	8360	10,585	3,054	9,793	12,846
2003	2385	10390	12,775	2,924	7,893	10,817
2004	3462	29902	33,364	3,047	25,936	28,982
2005	9074	38784	47,858	9,003	30,719	39,722
2006	4018	36862	40,880	4,736	29,833	34,569
2007	2049	10907	12,956	2,469	13,003	15,472
2008	2639	14674	17,313	3,352	16,008	19,360
2009	10038	57024	67,062	12,029	51,994	64,023
2010	499	3377	3,876	1,245	6,775	8,020
2011	818	5498	6,316	1,484	9,103	10,587
2012	5312	25971	31,283	3,322	17,927	21,249
2013	4486	42225	46,711	3,763	33,409	37,173
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0

Table 4.9.6. Estimated LA Creel landings of gray snapper in the Gulf of Mexico 2014.

Year	Number			Pounds		
	CH Landings	PR Landings	All Modes	CH Landings	PR Landings	All Modes
2014	13,849	57,617	71,466	17,570	73,100	90,671

Table 4.9.7. Historic recreational landings (1945 – 1980) in numbers of gray snapper in the Gulf of Mexico. Historical landings without shore were from FHWAR effort estimates referenced to the average of 1981-1985 total Gulf of Mexico estimates. Historical shore landings were estimated by fitting a liner regression to the ratio of annual landings between the shore and sum of the private and charter modes from 1987 to 2012.

Year	Numbers	
	Historical Recreational Landings (without Shore)	Historical Landings Shore
1945	-	-
1946	10,397	9,250
1947	59,423	52,560
1948	97,413	85,655
1949	135,402	118,355
1950	189,947	165,045
1951	227,936	196,869
1952	265,926	228,297
1953	303,915	259,331
1954	341,904	289,969
1955	379,894	320,212
1956	403,991	338,424
1957	428,089	356,384
1958	452,187	374,094
1959	476,284	391,553
1960	500,382	408,762
1961	501,685	407,218
1962	502,989	405,661
1963	504,293	404,090
1964	505,596	402,505
1965	506,900	400,907
1966	519,105	407,861
1967	531,311	414,688
1968	543,516	421,388
1969	555,721	427,961
1970	567,927	434,407
1971	587,901	446,628
1972	607,875	458,641
1973	627,849	470,447
1974	647,823	482,045
1975	667,797	493,435
1976	705,785	517,834
1977	743,772	541,838
1978	781,760	565,447
1979	819,748	588,661
1980	857,736	611,480

Table 4.9.8. Gulf of Mexico (LA-FLW, including the Keys) gray snapper discards (numbers of fish) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004+). MRFSS estimates adjusted to MRIP APAIS estimates prior to 2004. CH mode adjusted for FHS conversion prior to 2004. *CVs for CH and HB modes 1981-1985 are unavailable.

	Estimated CH Discards		Estimated HB Discards		Estimated PR Discards		Estimated SH Discards		Estimated Discards All Modes	
Year	Number	CV*	Number	CV*	Number	CV	Number	CV	Number	CV
1981	896		440		183,727	1.94	115,252	1.47	300,316	1.32*
1982	132,079		64,930		150,845	1.30	211,986	0.96	559,840	0.51*
1983	10,906		5,361		54,552	1.82	3,039,425	2.31	3,110,244	2.25*
1984	6,980		3,432		264,019	2.18	345,508	1.21	619,940	1.15*
1985	5,623		2,764		675,265	1.60	171,154	1.45	854,806	1.30*
1986	18,041	1.11			525,223	1.70	159,148	1.66	702,413	1.32
1987	23,013	1.72			185,831	0.86	15,331	3.32	224,175	0.77
1988	7,464	1.65			432,201	0.74	231,179	1.11	670,844	0.61
1989	29,581	2.17			759,730	0.59	450,168	1.03	1,239,478	0.52
1990	19,235	2.47			845,517	0.57	540,347	1.10	1,405,099	0.54
1991	77,436	0.97			2,745,409	0.50	4,198,219	0.52	7,021,065	0.37
1992	108,990	1.12			2,600,810	0.23	1,976,641	0.81	4,686,441	0.37
1993	54,401	1.20			2,508,504	0.25	2,234,235	0.36	4,797,140	0.21
1994	73,205	0.61			2,172,172	0.26	1,475,816	0.39	3,721,193	0.22
1995	134,162	1.27			1,928,168	0.27	1,567,836	0.36	3,630,166	0.22
1996	68,686	1.16			1,940,619	0.33	1,965,807	0.44	3,975,112	0.27
1997	98,005	0.96			2,333,470	0.23	2,312,296	0.38	4,743,771	0.22
1998	129,208	0.45			2,659,835	0.20	1,950,563	0.40	4,739,605	0.20
1999	136,287	0.57			2,004,747	0.24	1,150,366	0.38	3,291,399	0.20
2000	156,996	0.94			2,729,066	0.22	1,971,256	0.59	4,857,318	0.27
2001	64,345	0.73			2,243,238	0.26	1,437,835	0.46	3,745,418	0.24
2002	114,427	0.52			2,798,729	0.20	1,396,707	0.44	4,309,863	0.19
2003	103,790	0.35			4,087,704	0.20	2,961,567	0.38	7,153,061	0.19
2004	115,136	0.31			2,877,497	0.17	1,844,944	0.22	4,837,577	0.13

2005	119,428	0.27			3,314,634	0.17	3,320,739	0.20	6,754,801	0.13
2006	98,291	0.31			2,385,398	0.15	2,281,431	0.31	4,765,120	0.16
2007	139,483	0.31			3,018,197	0.15	3,413,081	0.27	6,570,761	0.16
2008	198,993	0.27			4,378,885	0.15	3,315,055	0.21	7,892,933	0.12
2009	136,329	0.31			2,742,082	0.14	1,536,069	0.20	4,414,480	0.11
2010	159,684	0.30			1,534,306	0.19	682,109	0.23	2,376,099	0.14
2011	182,212	0.32			1,817,443	0.21	940,491	0.23	2,940,145	0.15
2012	180,187	0.26			2,470,684	0.15	2,686,592	0.36	5,337,463	0.19
2013	279,965	0.29			3,275,233	0.13	1,871,907	0.13	5,427,105	0.09
2014	244,240	0.11			5,232,043	0.11	2,093,893	0.16	7,570,175	0.09
2015	281,506	0.16			3,817,931	0.11	1,821,545	0.18	5,920,982	0.09

Table 4.9.9. Estimated headboat discards of gray snapper in the Gulf of Mexico 2004-2015. Due to headboat area definitions and confidentiality issues, FLW must be combined with AL and MS must be combined with LA and TX.

	HB Discards			
Year	FLW/AL	KEYS	LA/MS/TX	Gulf of Mexico
2004	503	4949	0	5,452
2005	818	2666	0	3,484
2006	848	4564	1	5,413
2007	561	4798	12	5,371
2008	1802	2840	68	4,710
2009	2093	3572	1	5,666
2010	958	4890	1	5,849
2011	2002	8625	7	10,634
2012	1622	7013	1	8,636
2013	1939	5952	2	7,893
2014	2969	10023	25	13,017
2015	2951	6695	28	9,674

Table 4.9.10. Number of angler trips with measured gray snapper in the Gulf of Mexico (including the Florida Keys) in the MRFSS/MRIP by year and mode.

	Number of Trips with Samples Measured or Weighed				
Year	CB	HB	PR	SH	Grand Total
1981	1	14	13	24	52
1982	5	15	22	36	78
1983	8	33	10	25	76
1984	4	28	7	18	57
1985		20	9	16	45
1986	18		26	9	53
1987	20		73	10	103
1988	15		61	38	114
1989	9		58	38	105
1990	11		45	20	76
1991	20		64	35	119
1992	51		150	45	246
1993	21		128	74	223
1994	29		121	71	221
1995	19		105	54	178
1996	10		90	46	146
1997	60		86	33	179
1998	112		157	47	316
1999	184		187	40	411
2000	220		131	25	376
2001	163		171	36	370
2002	194		159	18	371
2003	244		170	36	450
2004	232		180	20	432
2005	215		176	26	417
2006	142		124	17	283
2007	136		177	34	347
2008	148		254	49	451
2009	113		242	41	396
2010	126		131	12	269
2011	93		111	6	210
2012	117		109	29	255
2013	89		236	19	344
2014	220		452	19	691
2015	126		357	14	497

Table 4.9.11. Number, mean, minimum, and maximum weights in pounds of gray snapper in the Gulf of Mexico (including the Florida Keys) in the MRFSS/MRIP by year and mode.

Year	CH				HB				PR				SH			
	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)
1981	3	3.67	3.31	4.41	16	2.30	1.10	5.07	64	1.94	0.22	9.04	73	0.34	0.22	2.20
1982	8	0.83	0.22	2.20	13	3.14	0.22	6.39	64	1.10	0.22	7.05	130	0.47	0.22	3.75
1983	16	2.12	0.44	8.82	68	3.05	0.22	12.13	16	1.02	0.44	2.87	62	0.57	0.22	1.32
1984	15	1.32	0.44	4.19	63	2.72	0.66	7.72	18	0.86	0.22	2.20	33	0.65	0.22	1.54
1985					27	3.85	0.88	8.16	11	1.60	0.22	3.31	33	0.81	0.22	2.20
1986	72	3.11	0.22	9.92					43	1.42	0.22	9.92	38	0.79	0.22	3.31
1987	52	2.40	0.88	5.73					214	1.18	0.22	4.85	13	0.75	0.22	1.32
1988	23	1.75	0.44	4.41					142	0.85	0.22	3.97	101	0.50	0.22	1.54
1989	17	2.20	0.44	6.61					144	0.85	0.22	2.87	81	0.70	0.22	1.98
1990	26	2.37	0.66	11.02					82	1.41	0.22	7.72	26	0.72	0.22	1.10
1991	48	2.03	0.44	9.04					151	1.37	0.44	4.85	68	0.71	0.22	2.20
1992	94	3.12	0.66	13.89					339	1.18	0.22	9.92	100	0.69	0.22	3.97
1993	39	2.38	0.66	9.92					257	1.02	0.22	6.17	154	0.74	0.22	11.02
1994	61	2.18	0.66	10.14					257	1.27	0.22	8.82	138	0.80	0.22	4.41
1995	49	2.39	0.66	9.48					293	1.30	0.22	3.97	101	0.73	0.22	3.64
1996	15	3.70	0.66	11.02					192	1.42	0.22	6.61	75	0.83	0.33	3.97
1997	124	2.60	0.66	8.82					187	1.16	0.22	14.33	51	0.94	0.11	2.43
1998	352	2.42	0.44	11.13					361	1.09	0.11	7.72	88	0.90	0.22	5.29
1999	429	2.47	0.51	13.67					459	1.43	0.22	9.92	65	0.85	0.29	2.65
2000	467	2.45	0.55	12.13					319	1.44	0.11	12.81	49	0.85	0.22	1.74
2001	403	2.42	0.44	12.74					404	1.47	0.22	11.02	85	0.80	0.26	2.82
2002	579	3.23	0.46	13.45					342	1.52	0.22	11.68	30	1.09	0.44	3.17
2003	776	2.69	0.49	11.42					419	1.67	0.35	16.98	58	0.71	0.18	1.32
2004	697	2.80	0.44	12.06					416	1.61	0.22	8.82	34	0.76	0.22	1.59
2005	594	2.67	0.40	12.30					386	1.44	0.35	12.13	47	0.77	0.31	3.20
2006	586	3.46	0.35	11.57					298	1.93	0.18	9.92	33	0.77	0.20	1.28
2007	518	2.86	0.31	12.13					478	1.70	0.24	10.47	51	0.86	0.22	2.47
2008	445	2.83	0.51	13.78					671	1.22	0.33	9.37	96	0.82	0.44	1.72
2009	371	2.14	0.44	12.35					720	1.24	0.31	10.45	87	0.75	0.26	1.76
2010	390	2.12	0.49	12.76					325	1.51	0.44	10.58	26	0.60	0.26	1.37
2011	334	2.51	0.40	13.23					256	1.98	0.44	11.02	7	1.15	0.49	2.54
2012	362	2.04	0.44	19.80					236	1.51	0.33	10.05	66	0.94	0.49	3.84
2013	281	1.45	0.44	10.63					627	1.30	0.40	13.23	40	0.78	0.22	1.46
2014	786	1.46	0.31	11.33					1398	1.12	0.31	11.24	31	0.61	0.31	1.15
2015	411	1.54	0.35	9.92					954	1.13	0.33	11.99	16	0.77	0.33	1.81

Table 4.9.12. Number of gray snapper measured and number of trips with measured gray snapper in the Gulf of Mexico from the SRHS by year and state 1978-2015. Due to headboat area definitions and confidentiality issues, FLW must be combined with AL and MS must be combined with LA and TX.

	Fish (n)				Trips (n)			
Year	KEYS	FLW/AL	LA/MS/TX	Gulf of Mexico	KEYS	FLW/AL	LA/MS/TX	Gulf of Mexico
1978	12			12	4			4
1979	68			68	16			16
1980	53			53	17			17
1981	79			79	44			44
1982	198			198	75			75
1983	344			344	107			107
1984	479			479	147			147
1985	526			526	144			144
1986	707	487	31	1225	126	127	12	265
1987	496	427	23	946	122	144	14	280
1988	375	428	12	815	103	126	11	240
1989	312	511	23	846	98	109	12	219
1990	226	311	47	584	84	73	16	173
1991	181	175	43	399	64	69	20	153
1992	165	206	139	510	52	55	52	159
1993	173	126	151	450	94	37	67	198
1994	167	148	158	473	72	78	57	207
1995	127	161	164	452	48	63	71	182
1996	103	70	170	343	52	36	39	127
1997	350	112	442	904	78	53	93	224
1998	368	150	714	1232	112	65	113	290
1999	556	222	565	1343	148	79	100	327
2000	337	142	305	784	122	58	73	253
2001	520	179	602	1301	164	44	89	297
2002	440	316	491	1247	144	67	75	286
2003	261	262	625	1148	127	75	70	272
2004	267	122	2	391	120	40	2	162
2005	257	125	116	498	109	45	27	181
2006	240	181	76	497	90	45	20	155
2007	273	178	121	572	98	49	31	178
2008	250	217	74	541	90	54	22	166
2009	316	245	101	662	118	72	31	221
2010	354	292	4	650	118	38	3	159
2011	413	162	103	678	103	24	14	141
2012	1424	271	157	1852	187	39	37	263

2013	774	169	130	1073	149	48	25	222
2014	1295	172	29	1496	151	50	8	209
2015	985	338	41	1364	160	67	22	249

Table 4.9.13. Mean weight (kg) of gray snapper measured in the Gulf of Mexico from the SRHS by year and state, 1978-2015. Due to confidentiality issues, SRHS estimates in LA and MS are aggregated with TX. In the SRHS FLW and AL cannot be separated prior to 2013, therefore FLW and AL are combined and shown as FLW/AL.

	FLW/AL				Keys				LA/MS/TX				Gulf of Mexico			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1978					12	0.8	0.19	4.2					12	0.8	0.19	4.2
1979					68	0.8	0.21	2.98					68	0.8	0.21	2.98
1980					53	0.81	0.15	1.92					53	0.81	0.15	1.92
1981					79	0.66	0.2	2.5					79	0.66	0.2	2.5
1982					198	0.63	0.16	2.4					198	0.63	0.16	2.4
1983					344	0.47	0.15	2.1					344	0.47	0.15	2.1
1984					479	0.58	0.15	3.5					479	0.58	0.15	3.5
1985					526	0.56	0.17	2.2					526	0.56	0.17	2.2
1986	487	1.14	0.2	7.04	707	0.51	0.18	2.4	31	1.57	0.26	6	408	1.07	0.21	5.15
1987	427	0.84	0.23	4.49	496	0.52	0.17	3.3	23	2.74	0.24	5.53	315	1.37	0.21	4.44
1988	428	0.86	0.1	5	375	0.67	0.17	4	12	1.78	0.56	4.04	272	1.1	0.28	4.35
1989	511	1.06	0.22	4.5	312	0.63	0.2	2.8	23	1.74	0.15	4.15	282	1.14	0.19	3.82
1990	311	1.15	0.24	22.15	226	0.56	0.18	2.11	47	1.59	0.41	5.28	195	1.1	0.28	9.85
1991	175	1.02	0.28	4.29	181	0.51	0.18	2.08	43	1.15	0.41	4	133	0.89	0.29	3.46
1992	206	0.82	0.18	4.01	165	0.47	0.22	2.5	139	1.57	0.32	5.21	170	0.95	0.24	3.91
1993	126	1.33	0.24	4.97	173	0.6	0.05	2.65	151	1.46	0.38	5.17	150	1.13	0.22	4.26
1994	148	1.16	0.23	4.98	167	0.56	0.17	2.09	158	1.46	0.01	5.87	158	1.06	0.14	4.31
1995	161	0.99	0.21	4.8	127	0.7	0.22	2.87	164	1.79	0.43	5.28	151	1.16	0.29	4.32
1996	70	1.21	0.32	3.66	103	0.65	0.17	1.99	170	1.65	0.36	4.71	114	1.17	0.28	3.45
1997	112	0.98	0.25	3.47	350	0.55	0.2	2.13	442	1.82	0.41	5.7	301	1.12	0.29	3.77
1998	150	0.81	0.18	3.98	368	0.54	0.19	2.04	714	1.94	0.46	5.39	411	1.09	0.28	3.8
1999	222	0.76	0.22	2.99	556	0.48	0.14	1.86	565	2.02	0.48	6.52	448	1.09	0.28	3.79
2000	142	0.97	0.12	3.68	337	0.5	0.13	2.12	305	1.63	0.35	4.25	261	1.03	0.2	3.35
2001	179	0.99	0.24	4.4	520	0.47	0.2	2.71	602	1.75	0.09	5.98	434	1.07	0.18	4.36
2002	316	0.77	0.19	4.22	440	0.46	0.21	1.46	491	1.35	0.02	5.26	416	0.86	0.14	3.65
2003	262	0.88	0.19	3.11	261	0.48	0.2	2.2	625	1.64	0.39	10.66	383	1	0.26	5.32
2004	122	0.87	0.23	3.02	267	0.51	0.2	2.62	2	3.49	1.76	5.22	130	1.62	0.73	3.62
2005	125	0.78	0.21	2.81	257	0.57	0.22	2.36	116	1.63	0.23	4.78	166	1	0.22	3.32
2006	181	0.91	0.21	3.07	240	0.43	0.19	2.22	76	2.22	0.47	4.72	166	1.19	0.29	3.34
2007	178	0.78	0.24	2.75	273	0.45	0.16	1.58	121	1.6	0.31	5.04	191	0.94	0.24	3.12
2008	217	0.91	0.25	3.77	250	0.48	0.14	2.93	74	2.12	0.37	5.4	180	1.17	0.25	4.03
2009	245	1.03	0.23	3.67	316	0.44	0.16	2.09	101	1.61	0.38	4.18	221	1.03	0.26	3.31
2010	292	0.98	0.21	3.93	354	0.42	0.17	2.01	4	1.64	0.83	2.4	217	1.01	0.4	2.78
2011	162	1.1	0.24	3.52	413	0.48	0.15	2.89	103	1.71	0.47	4.41	226	1.1	0.29	3.61
2012	271	1.13	0.23	5.71	1424	0.49	0.2	2.64	157	1.79	0.29	4.85	617	1.14	0.24	4.4
2013	169	0.97	0.11	3.95	774	0.48	0.18	2.89	130	1.92	0.18	5.79	358	1.12	0.16	4.21
2014	172	0.68	0.19	3.26	1295	0.45	0.18	3.37	29	1.11	0.34	2.84	499	0.74	0.24	3.16
2015	338	0.94	0.2	4.74	985	0.46	0.21	3.49	41	1.53	0.42	4.64	455	0.98	0.28	4.29

Table 4.9.14. Number of angler trips with measured gray snapper in Texas from TPWD by year and mode.

Year	CB Trips (n)	PR Trips (n)	All Mode Trips (n)
1983		8	8
1984		2	2
1985	1	2	3
1986	1	7	8
1987	2	14	16
1988		7	7
1989		6	6
1990		4	4
1991		1	1
1992		9	9
1993	2	44	46
1994	6	72	78
1995	9	80	89
1996	11	47	58
1997	3	24	27
1998	11	32	43
1999	8	78	86
2000	11	138	149
2001	8	37	45
2002	9	59	68
2003	12	85	97
2004	18	145	163
2005	36	202	238
2006	29	270	299
2007	17	127	144
2008	28	145	173
2009	39	286	325
2010	5	50	55
2011	9	54	63
2012	26	145	171
2013	32	274	306
2014	18	64	82
2015	3	34	37

Table 4.9.15. Number, mean, minimum, and maximum converted weights in pounds of gray snapper in Texas from TPWD by year and mode.

	CH				PR			
Year	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)
1983					12	0.53	0.31	1.08
1984					6	0.44	0.22	1.22
1985	1	0.42	0.42	0.42	3	0.55	0.27	0.84
1986	1	0.67	0.67	0.67	11	0.61	0.44	1.34
1987	4	0.48	0.40	0.59	25	0.50	0.27	1.04
1988					8	0.53	0.15	1.06
1989					7	0.54	0.29	0.65
1990					4	1.11	0.44	2.00
1991					1	6.36	6.36	6.36
1992					12	0.77	0.47	2.05
1993	4	0.40	0.06	0.94	92	0.56	0.25	1.79
1994	18	1.01	0.48	2.04	143	0.85	0.33	1.65
1995	19	0.81	0.31	2.05	163	0.91	0.19	3.16
1996	31	1.00	0.39	2.37	101	1.16	0.29	6.78
1997	5	3.14	1.41	4.10	35	1.32	0.25	3.74
1998	29	2.85	0.36	8.30	57	1.94	0.22	8.92
1999	16	1.29	0.54	4.96	192	0.72	0.12	3.03
2000	33	0.85	0.17	4.79	303	1.02	0.18	10.23
2001	13	1.56	0.85	3.47	75	1.58	0.27	4.96
2002	19	1.73	0.53	5.09	144	1.33	0.16	16.73
2003	25	1.14	0.32	6.27	176	1.24	0.06	6.94
2004	51	0.88	0.37	2.69	392	1.21	0.12	7.72
2005	93	1.12	0.38	6.15	569	0.91	0.17	5.76
2006	66	1.18	0.28	7.07	658	1.05	0.08	8.34
2007	37	1.21	0.31	4.76	236	1.30	0.23	6.60
2008	71	1.12	0.31	6.36	340	1.22	0.11	10.11
2009	101	1.39	0.25	6.30	919	1.20	0.22	10.03
2010	12	4.46	1.25	7.42	99	2.26	0.37	7.65
2011	15	1.24	0.22	7.13	100	1.90	0.32	7.16
2012	86	0.96	0.29	8.96	365	0.95	0.25	8.16
2013	92	0.83	0.25	2.94	711	0.86	0.05	8.23
2014	43	2.27	0.41	8.16	133	1.52	0.26	7.92
2015	3	2.08	1.01	3.08	80	2.46	0.22	9.41

Table 4.9.16. Sample sizes for length samples and for age samples collected between 1978 and 2015 from recreational fisheries in the Gulf of Mexico by year and mode.

	Length (n)					Age (n)				
Year	CP	HB	PR	SH	All Modes	CP	HB	PR	SH	All Modes
1978		12			12					
1979		68			68					
1980		53			53		33			33
1981	3	96	65	77	241		25			25
1982	9	223	63	134	429		103			103
1983	23	398	28	62	511		5			5
1984	15	539	28	41	623					
1985	1	538	13	32	584					
1986	72	1,222	57	38	1,389					
1987	75	938	242	22	1,277					
1988	20	812	105	89	1,026					
1989	22	840	167	86	1,115					
1990	21	581	86	25	713		3			3
1991	99	416	161	63	739	10	58	5		73
1992	172	517	377	105	1,171	46	149	22		217
1993	166	455	373	161	1,155	87	101	8		196
1994	378	500	423	143	1,444	203	149	8		360
1995	79	452	481	109	1,121	90	96	4		190
1996	76	356	295	77	804	104	79			183
1997	253	962	234	63	1,512	108	189	23		320
1998	476	1,233	453	88	2,250	81	12	22		115
1999	459	1,341	690	76	2,566	62	7	2		71
2000	508	781	644	50	1,983	9	15	11		35
2001	446	1,305	512	86	2,349	50	16	30		96
2002	827	1,255	548	30	2,660	189	53	28		270
2003	943	1,150	822	58	2,973	143	48	148		339
2004	836	456	842	39	2,173	74	97	52		223
2005	819	813	1,159	52	2,843	117	440	211		768
2006	797	524	1,097	34	2,452	105	219	96		420
2007	959	629	1,107	57	2,752	271	217	345		833
2008	1,133	668	1,649	107	3,557	429	278	541	8	1,256
2009	1,235	1,626	2,451	94	5,406	512	700	604		1,816
2010	785	1,992	693	30	3,500	306	784	238		1,328
2011	917	1,543	574	7	3,041	372	510	173		1,055
2012	1,070	2,792	849	74	4,785	490	811	233		1,534
2013	1,143	1,429	1,499	40	4,111	528	612	130		1,270
2014	1,695	1,524	1,963	36	5,218	413	710	125	4	1,252
2015	931	1,576	1,229	17	3,753	398	960	114		1,472

Table 4.9.17 Gulf of Mexico estimated number of angler trips by mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004+). CH mode adjusted for FHS conversion prior to 2004.

Year	Estimated CH Angler Trips	Estimated HB Angler Trips	Estimated PR Angler Trips	Estimated SH Angler Trips	All Modes
1981	212,803	63,838	6,801,904	7,119,118	14,197,662
1982	613,230	230,686	5,438,965	10,051,388	16,334,269
1983	487,725	184,587	6,608,030	16,623,065	23,903,407
1984	399,344	147,909	7,506,796	13,709,706	21,763,754
1985	491,051	200,067	6,927,563	10,268,895	17,887,577
1986	513,342		8,136,242	10,405,962	19,055,546
1987	546,764		8,517,788	6,923,388	15,987,940
1988	559,513		10,698,532	8,524,356	19,782,400
1989	524,157		8,712,307	6,419,667	15,656,131
1990	426,134		7,216,506	5,706,778	13,349,418
1991	449,908		9,086,738	8,642,251	18,178,897
1992	469,662		9,373,254	8,265,502	18,108,418
1993	788,055		9,041,306	7,642,451	17,471,813
1994	860,370		9,384,801	7,293,305	17,538,475
1995	1,020,387		9,570,896	6,925,453	17,516,736
1996	990,457		9,351,017	6,800,513	17,141,987
1997	1,091,871		10,195,083	7,423,022	18,709,976
1998	760,667		8,938,905	6,861,289	16,560,861
1999	683,768		9,097,803	5,918,885	15,700,455
2000	811,634		11,728,464	8,477,685	21,017,783
2001	742,386		12,371,138	9,776,174	22,889,697
2002	764,222		11,635,095	7,266,262	19,665,578
2003	691,362		14,110,007	8,155,304	22,956,673
2004	831,069		15,644,093	9,954,045	26,429,207
2005	690,735		13,585,144	9,013,928	23,289,807
2006	836,049		13,620,320	8,836,552	23,292,921
2007	851,757		14,980,146	8,457,361	24,289,264
2008	819,045		15,194,949	8,775,859	24,789,852
2009	822,266		13,442,881	8,332,102	22,597,249
2010	580,190		12,684,738	7,782,505	21,047,433
2011	734,606		12,911,353	8,929,820	22,575,779
2012	883,919		12,782,193	9,506,372	23,172,483
2013	906,928		13,509,599	10,816,844	25,233,371
2014	796,718		9,450,351	8,581,861	18,828,931
2015	926,105		11,228,825	9,023,136	21,178,066

Table 4.9.18 Estimated angler days from the SRHS in the Gulf of Mexico by year and state, 1981-2015. Due to headboat area definitions and confidentiality issues, FLW must be combined with AL and MS must be combined with LA.

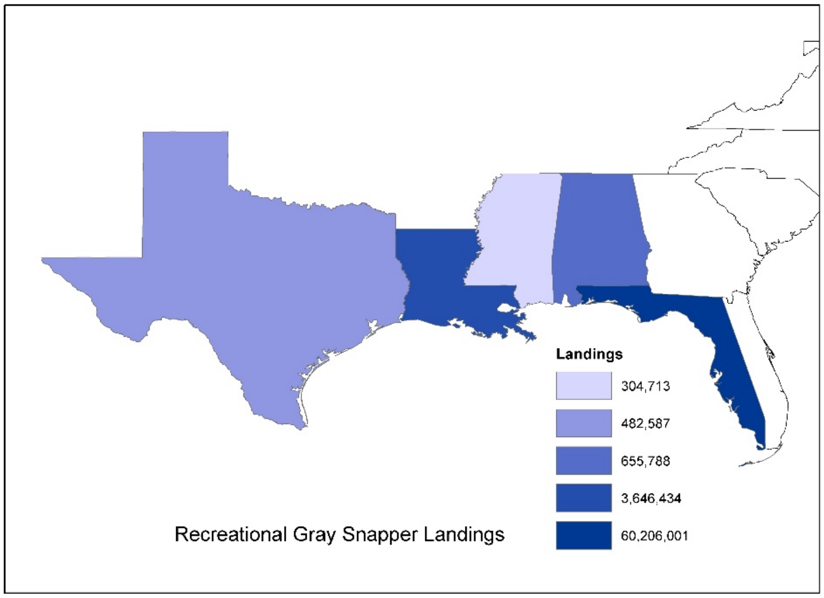
	Angler Days			
Year	FLW/AL	LA/MS	TX	Gulf of Mexico
1981	71,709			71,709
1982	71,614			71,614
1983	64,721			64,721
1984	71,314			71,314
1985	67,227			67,227
1986	315,521	5,891	56,568	377,980
1987	299,223	6,362	63,363	368,948
1988	272,589	7,691	70,396	350,676
1989	289,325	2,867	63,389	355,581
1990	291,561	6,898	58,144	356,603
1991	241,458	6,373	59,969	307,800
1992	251,472	9,911	76,218	337,601
1993	279,357	11,256	80,904	371,517
1994	268,272	12,651	100,778	381,701
1995	239,725	10,498	90,464	340,687
1996	213,734	10,988	91,852	316,574
1997	205,501	9,008	82,207	296,716
1998	234,936	7,854	77,650	320,440
1999	217,898	8,026	58,235	284,159
2000	205,559	4,952	58,395	268,906
2001	202,564	6,222	55,361	264,147
2002	189,735	6,222	66,951	262,908
2003	186,755	6,636	74,432	267,823
2004	206,749		64,990	271,739
2005	181,018		59,857	240,875
2006	176,727	5,005	70,789	252,521
2007	170,287	2,522	63,764	236,573
2008	160,825	2,945	41,188	204,958
2009	173,530	3,268	50,737	227,535
2010	138,542	715	47,154	186,411
2011	190,002	3,657	47,284	240,943
2012	199,745	3,680	51,776	255,201
2013	210,618	3,406	55,749	269,773
2014	237,661	3,257	51,231	292,149
2015	242,498	3,587	55,135	301,220

Table 4.9.19 TPWD estimated angler days by year and mode, 1983-2015.

Year	Estimated CH Angler Trips	Estimated PR Angler Trips	All Modes
1983	31,710	637,416	669,126
1984	22,580	712,741	735,321
1985	30,430	842,642	873,072
1986	29,908	900,634	930,542
1987	36,502	1,101,027	1,137,530
1988	28,452	1,042,690	1,071,143
1989	45,098	912,547	957,645
1990	34,617	836,507	871,125
1991	49,337	851,765	901,102
1992	46,987	983,387	1,030,374
1993	55,530	994,885	1,050,415
1994	91,731	1,094,067	1,185,798
1995	73,680	1,079,590	1,153,270
1996	78,566	1,098,874	1,177,440
1997	100,031	1,001,151	1,101,183
1998	113,400	972,189	1,085,590
1999	116,857	1,203,709	1,320,566
2000	163,253	1,160,245	1,323,498
2001	162,901	987,771	1,150,672
2002	141,888	964,901	1,106,789
2003	123,118	1,008,559	1,131,677
2004	120,675	1,005,883	1,126,558
2005	108,589	952,890	1,061,479
2006	162,959	993,831	1,156,790
2007	153,730	904,083	1,057,814
2008	149,921	905,679	1,055,600
2009	121,659	919,368	1,041,027
2010	123,095	868,390	991,485
2011	162,440	962,961	1,125,401
2012	226,767	932,422	1,159,189
2013	144,735	1,004,861	1,149,597
2014	137,474	931,653	1,069,128
2015	146,896	896,202	1,043,098

4.10 FIGURES

a) Gray Snapper Landings by State 1981-2015



b) Gray Snapper Landings by State and Year 1981-2015

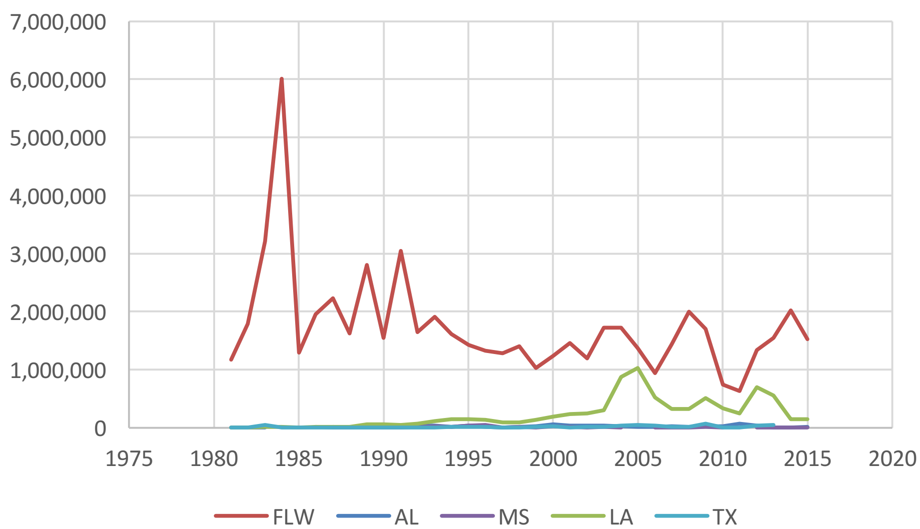
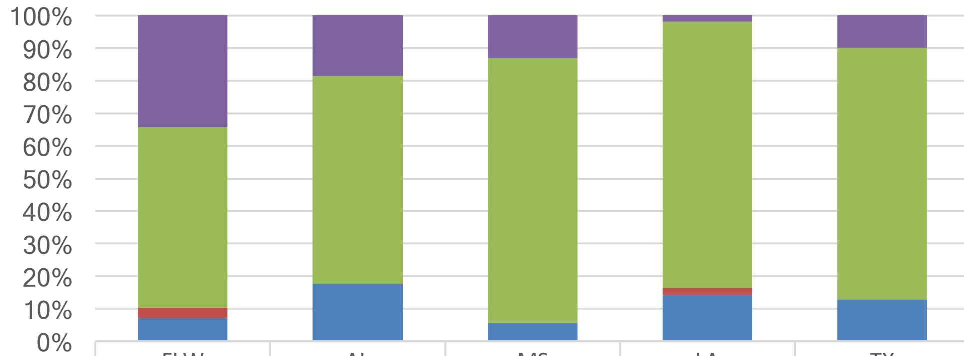


Figure 4.10.1. Estimated number of Gulf of Mexico gray snapper landings from MRIP (1981-2015), SRHS (1981-2015), TPWD (1981-2015) and LA Creel (2014) by state (a), by state and year (b), and by state and mode (c). Due to SRHS area definitions and confidentiality issues, SRHS FLW and AL estimates are combined and shown in FLW and SRHS MS, LA, and TX are combined and shown in LA.

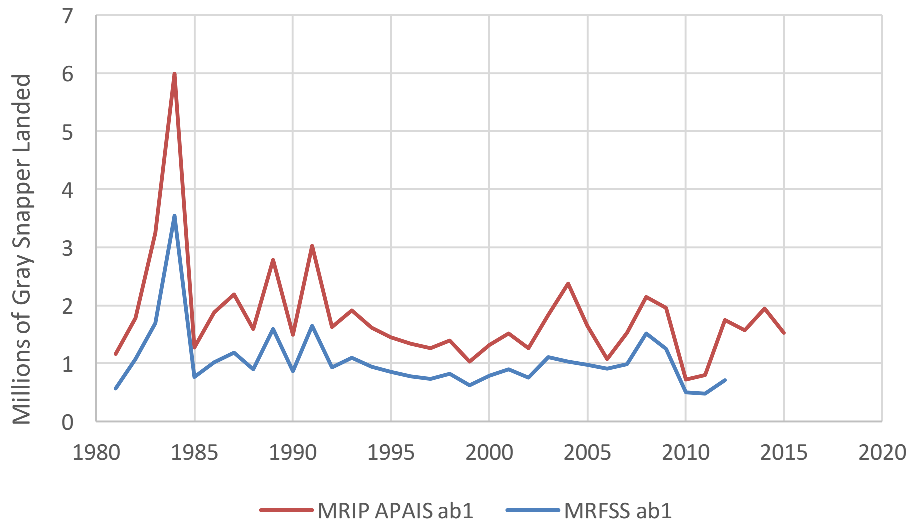
c) Gray Snapper Landings by State and Mode 1981-2015



	FLW	AL	MS	LA	TX
Shore	20,587,724	121,831	39,601	65,351	48,241
Priv	33,371,491	417,816	247,835	2,983,071	372,143
Hbt	1,945,396	114		81,127	
Cbt	4,301,390	116,027	17,278	516,885	62,203

Figure 4.10.1 Continued. Estimated number of Gulf of Mexico gray snapper landings from MRIP (1981-2015), SRHS (1981-2015), TPWD (1981-2015) and LA Creel (2014) by state (a), by state and year (b), and by state and mode (c). Due to SRHS area definitions and confidentiality issues, SRHS FLW and AL estimates are combined and shown in FLW and SRHS MS, LA, and TX are combined and shown in LA.

a) MRIP APAIS Adjustment for Landings (ab1) in Numbers by Year



b) MRIP APAIS Adjustment for Discards (b2) in Numbers by Year

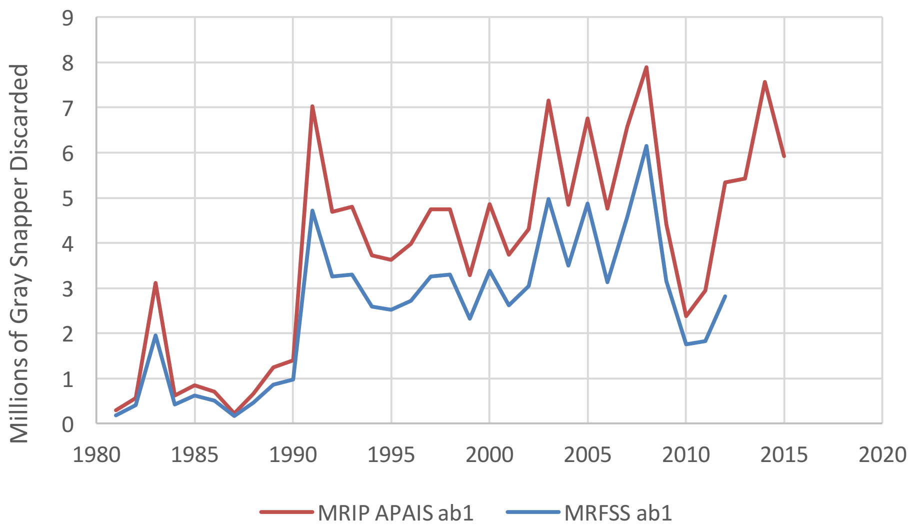
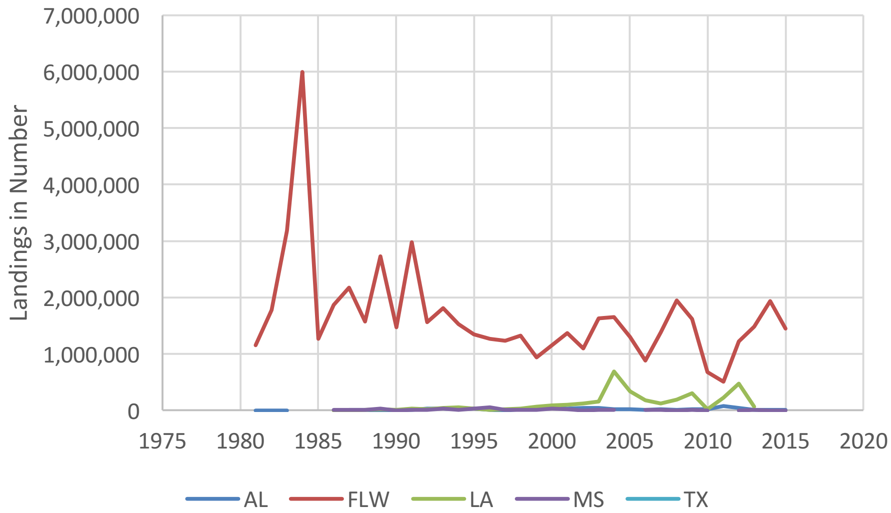


Figure 4.10.2. MRIP APAIS adjustment for Gulf of Mexico gray snapper for landings (a) and discards (b) by year.

a) MRIP Landings Estimates in Numbers of Fish by Year and State



b) MRIP Landings Estimates in Whole Weight in Pounds by Year and State

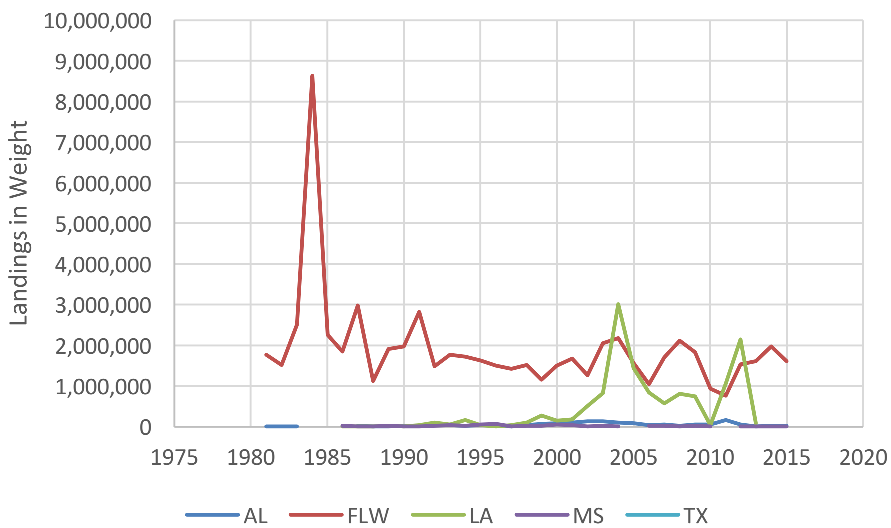


Figure 4.10.3. MRIP landings estimates in numbers of fish (a) and in whole weight in pounds (b) by year and state.

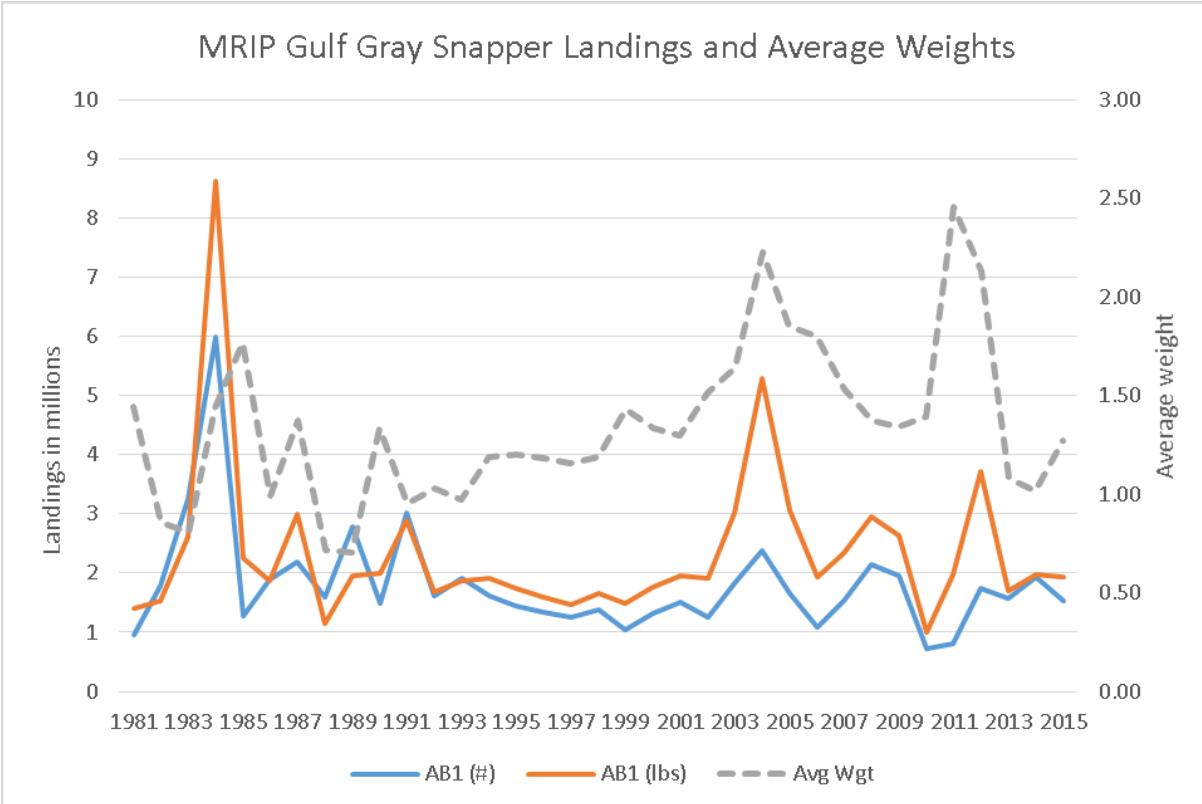


Figure 4.10.4. MRIP landings estimates in numbers of fish, whole weight in pounds, and average weight (landings in weight/landings in number) by year.

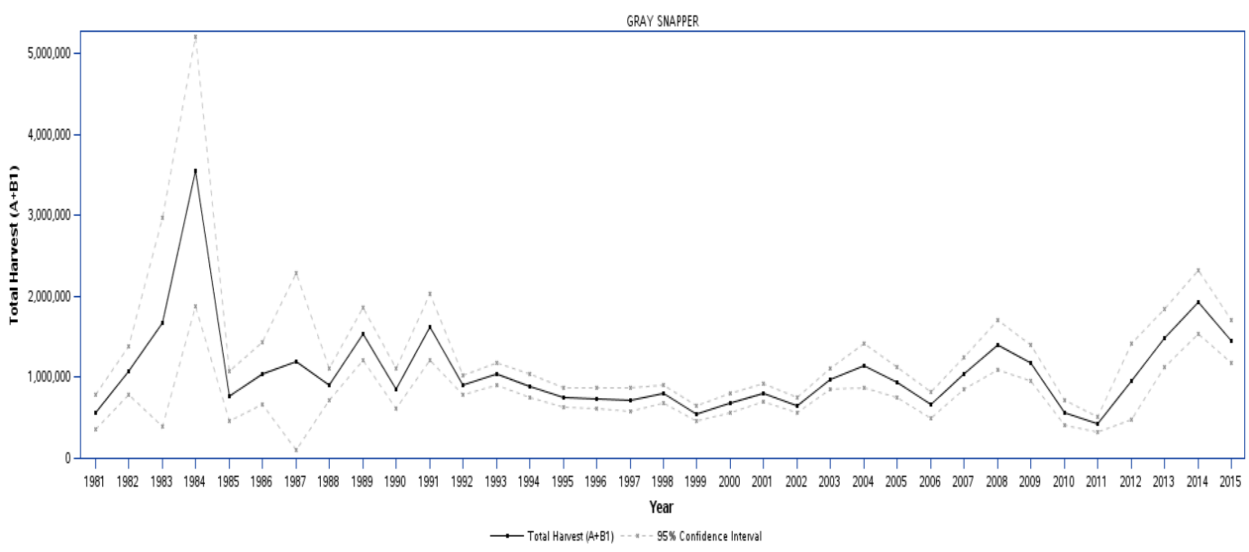


Figure 4.10.5. MRIP landings estimates in numbers of fish for gray snapper in west Florida for all fishing modes and all fishing areas by year (1981-2015). Plotted with 95% confidence interval.

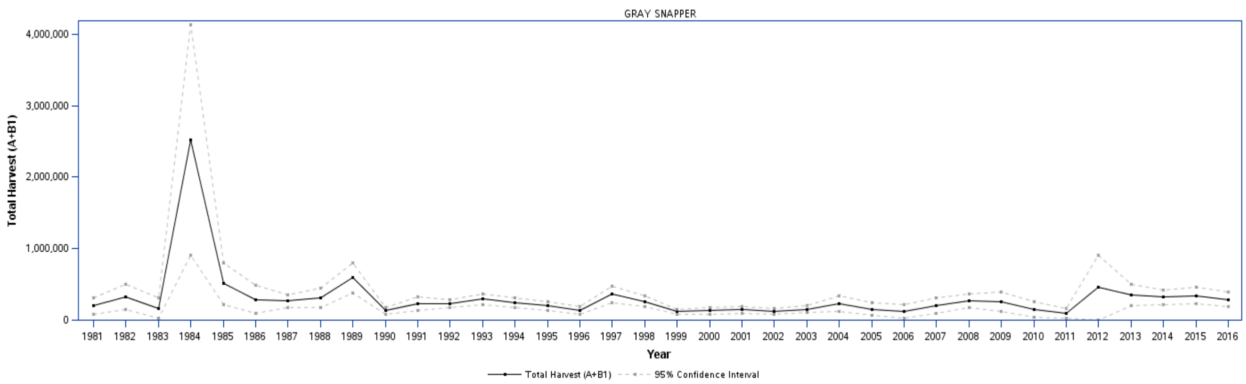


Figure 4.10.6. MRIP landings in numbers of fish estimated for gray snapper in west Florida for the private fishing mode in state waters by year (1981-2016). Plotted with 95% confidence interval.

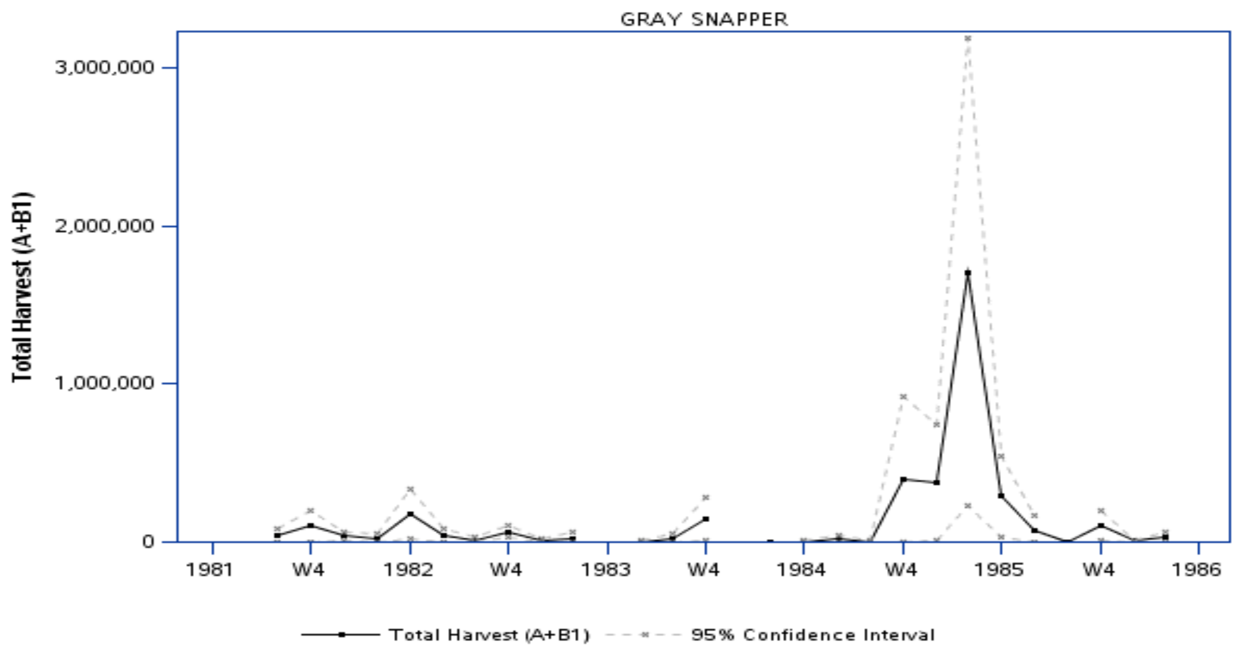
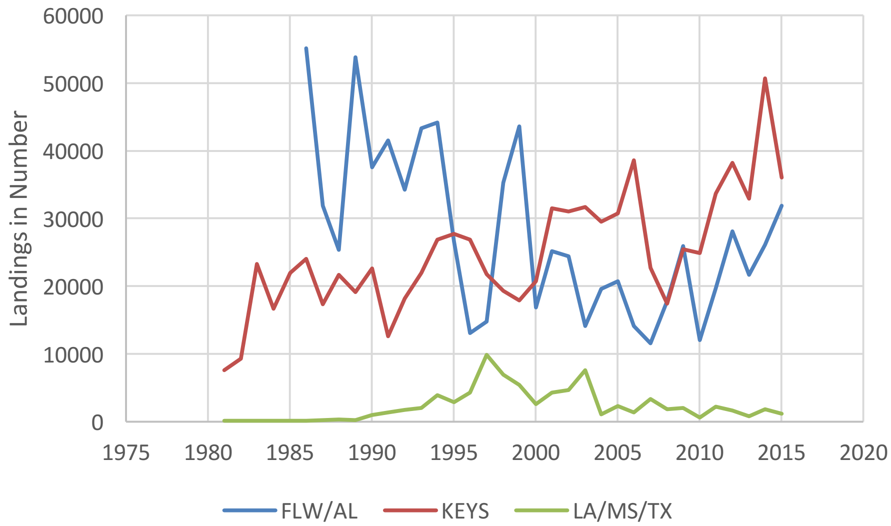


Figure 4.10.7. MRIP landings in numbers of fish estimated for gray snapper in west Florida for the private fishing mode in state waters by wave for years 1981 to 1985. Plotted with 95% confidence interval.

a) SRHS Landings Estimates in Numbers of Fish by Year and State



b) SRHS Landings Estimates in Whole Weight in Pounds by Year and State

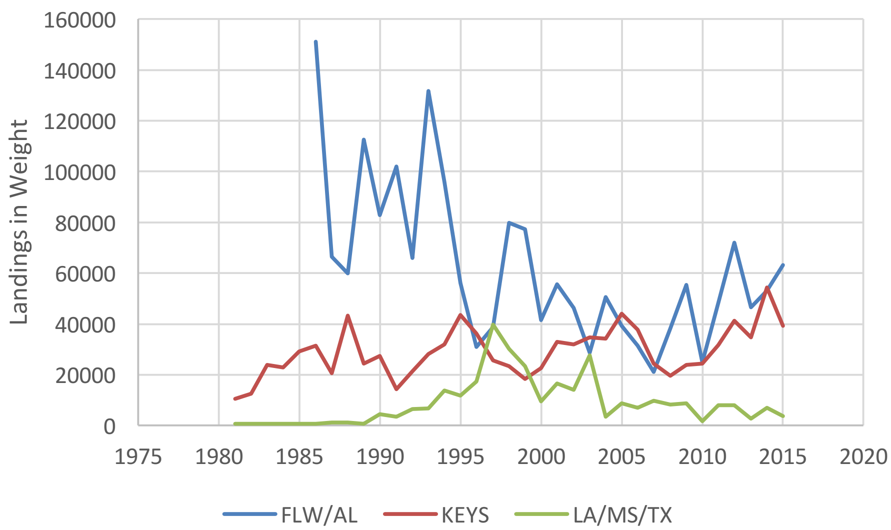


Figure 4.10.8. SRHS landings estimates in numbers (a) of fish and in whole weight in pounds (b) by year and state.

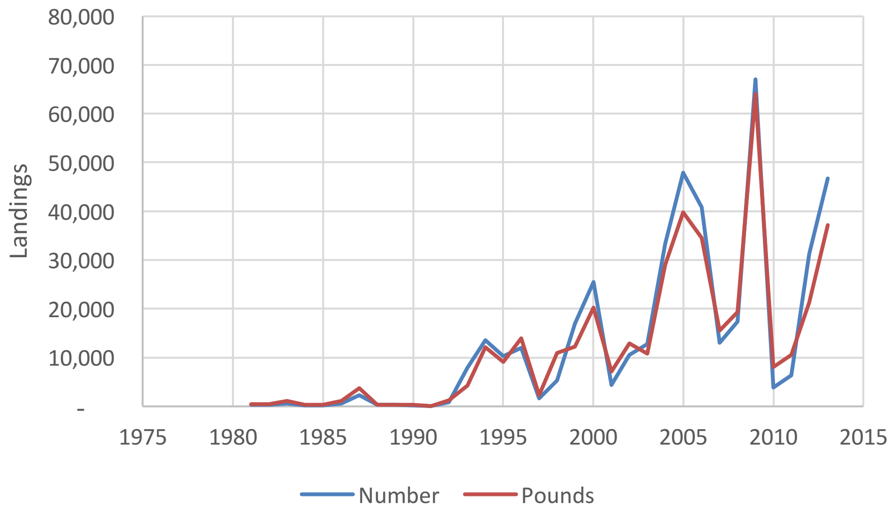


Figure 4.10.9. TPWD landings estimates in numbers of fish and in whole weight in pounds by year.

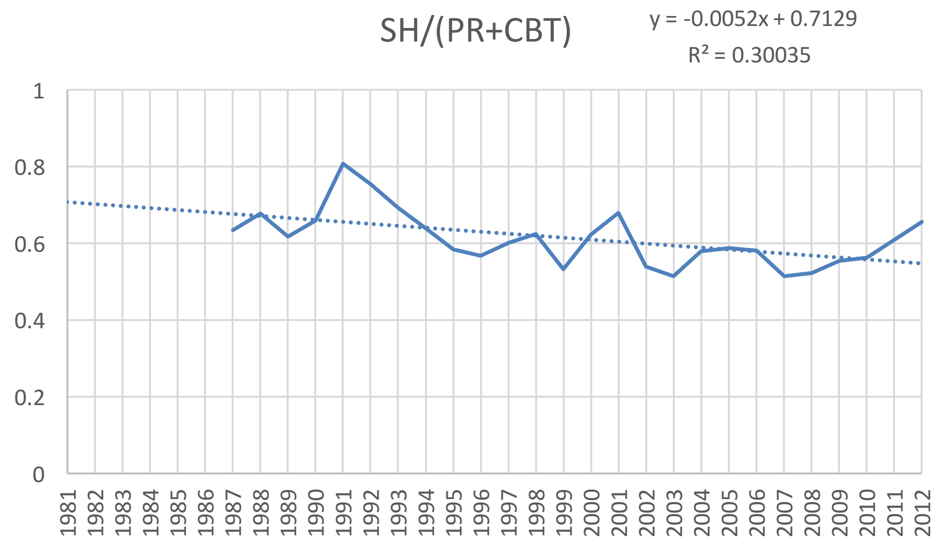


Figure 4.10.10. Linear regression fit to the ratio of annual landings between the shore and sum of the private and charter modes from 1987 to 2012.

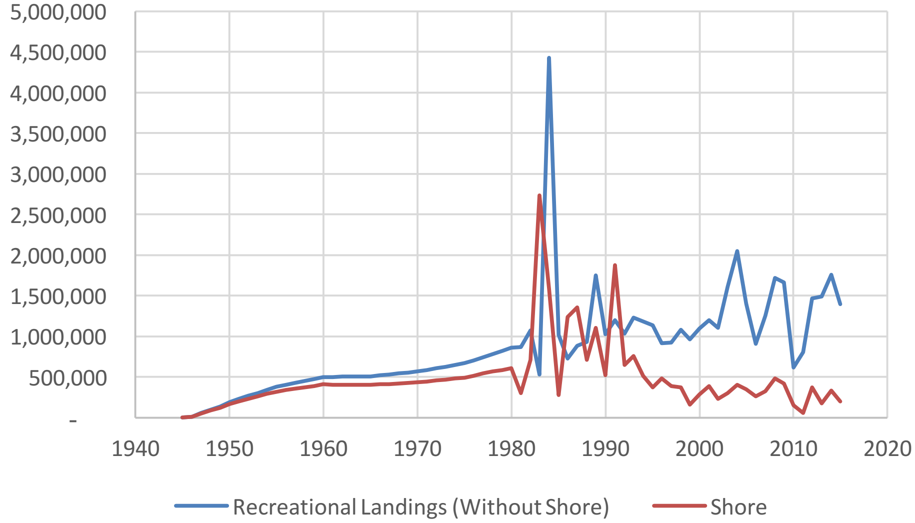
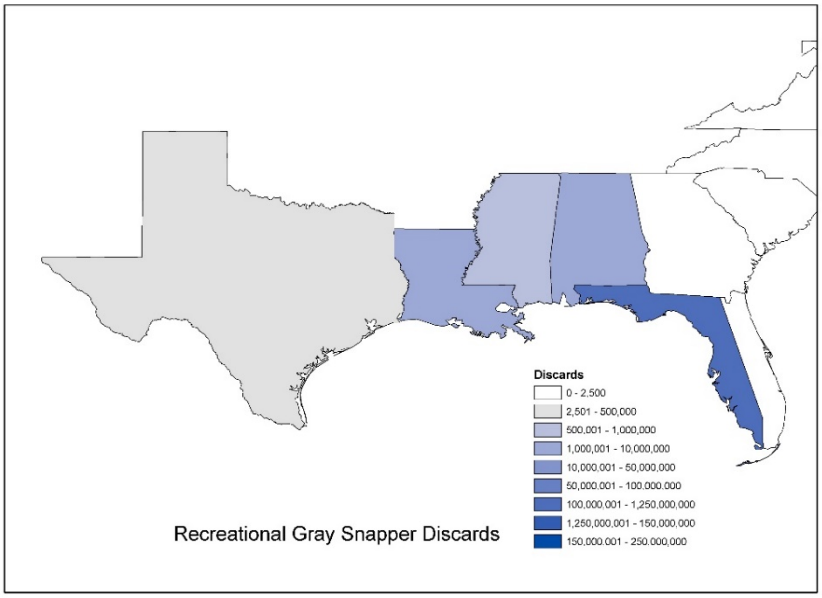


Figure 4.10.11. Recreational landings of gray snapper in the Gulf of Mexico by mode 1945-2015. Landings (without shore) were obtained using FHWAR effort estimates referenced to the 1981 estimate of total landings (without shore). Historical landing from the shore mode were obtained by back calculating the ratio of the shore mode landings to the rest of the recreational landings.

a) Gray Snapper Discards by State 1981-2015



b) Gray Snapper Discards by State and Year 1981-2015

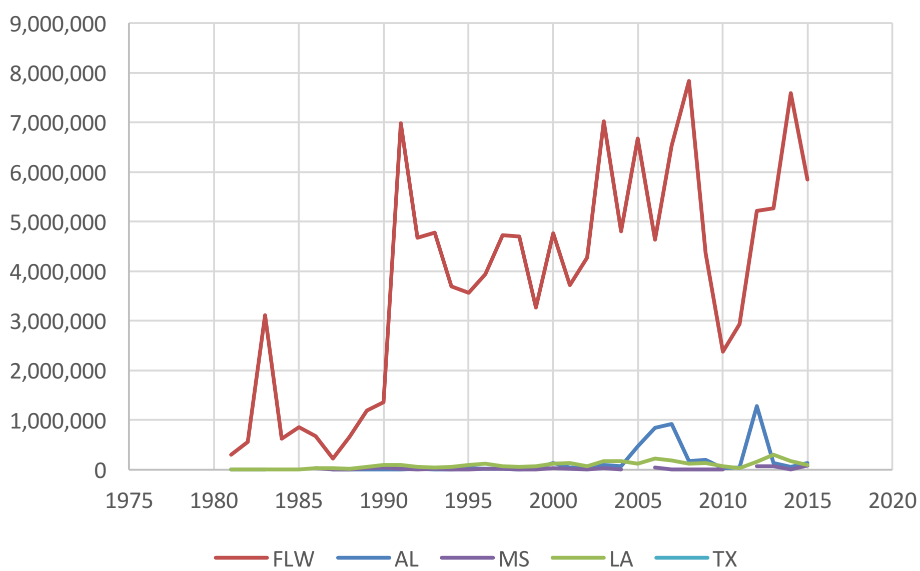
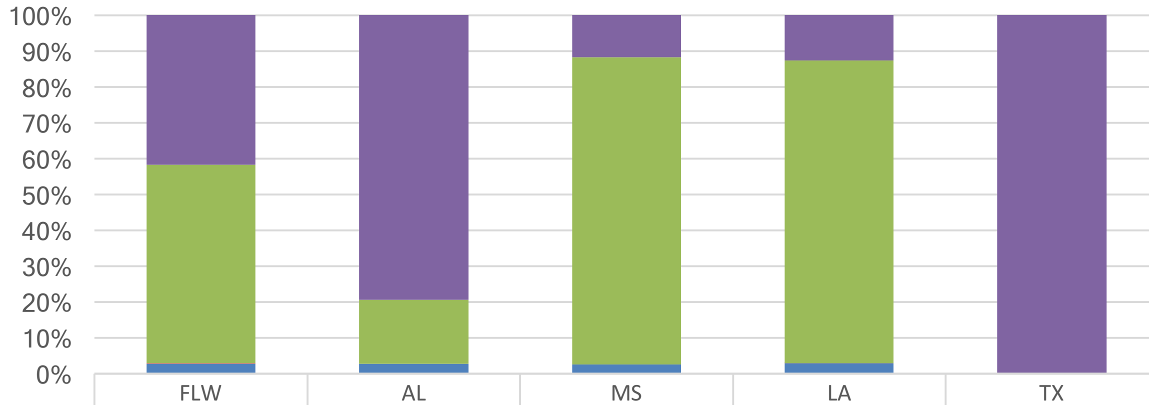


Figure 4.10.12. Estimated number of Gulf of Mexico gray snapper discards from MRIP (1981-2015) and SRHS (2004-2015) by state (a), by state and year (b), and by state and mode (c). Due to SRHS area definitions and confidentiality issues, SRHS FLW and AL estimates are combined and shown in FLW and SRHS MS, LA, and TX are combined and shown in LA.

c) Gray Snapper Landings by State and Mode 1981-2015



	FLW	AL	MS	LA	TX
Shore	53,732,168	3,756,737	60,954	133,420	3,217
Priv	71,507,942	843,479	446,049	896,243	
Hbt	162,581			146	
Cbt	3,541,049	124,926	12,820	30,415	

Figure 4.10.12. Continued. Estimated number of Gulf of Mexico gray snapper discards from MRIP (1981-2015) and SRHS (2004-2015) by state (a), by state and year (b), and by state and mode (c). Due to SRHS area definitions and confidentiality issues, SRHS FLW and AL estimates are combined and shown in FLW and SRHS MS, LA, and TX are combined and shown in LA.

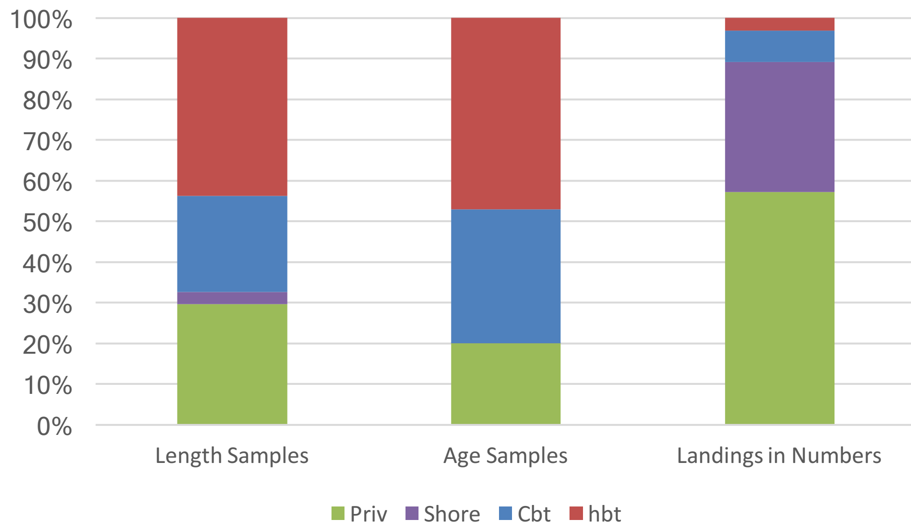


Figure 4.10.13. Percentage of age and length samples by mode compared to the proportion of total landings by mode

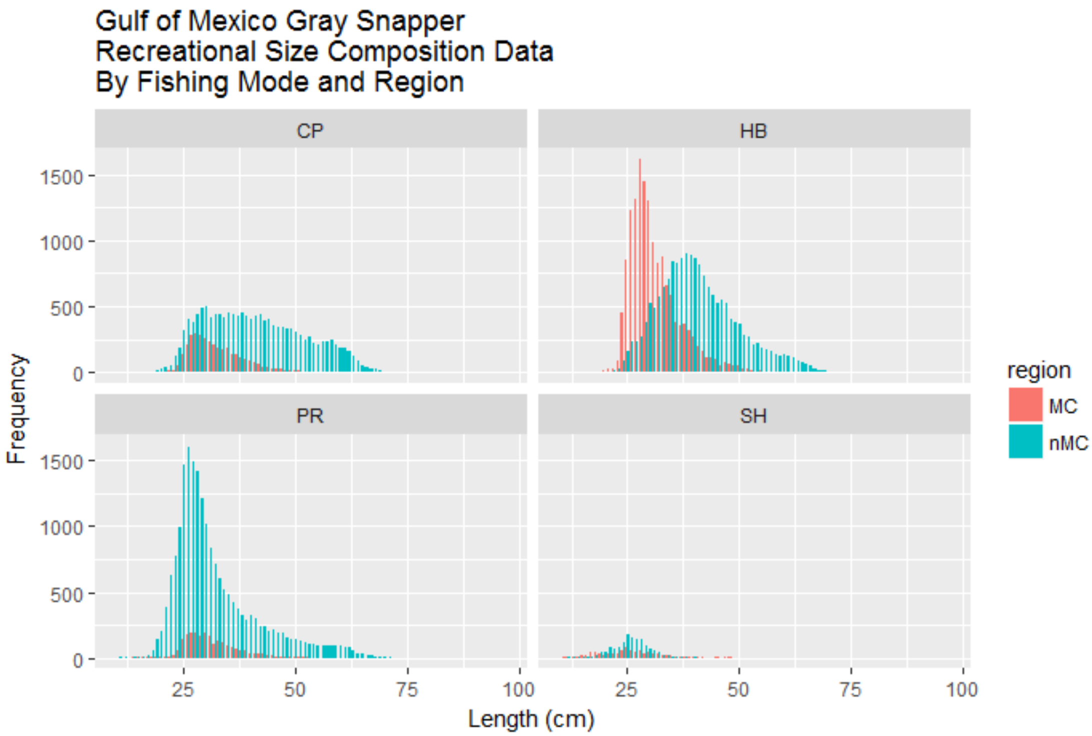


Figure 4.10.14. Histograms of the Gulf of Mexico Gray Snapper recreational length composition data by region and fishing mode. CP = Charterboat Mode, HB = Headboat Mode, PR = Private Mode, SH = Shore Mode, MC = Monroe County, nMC = Not Monroe County.

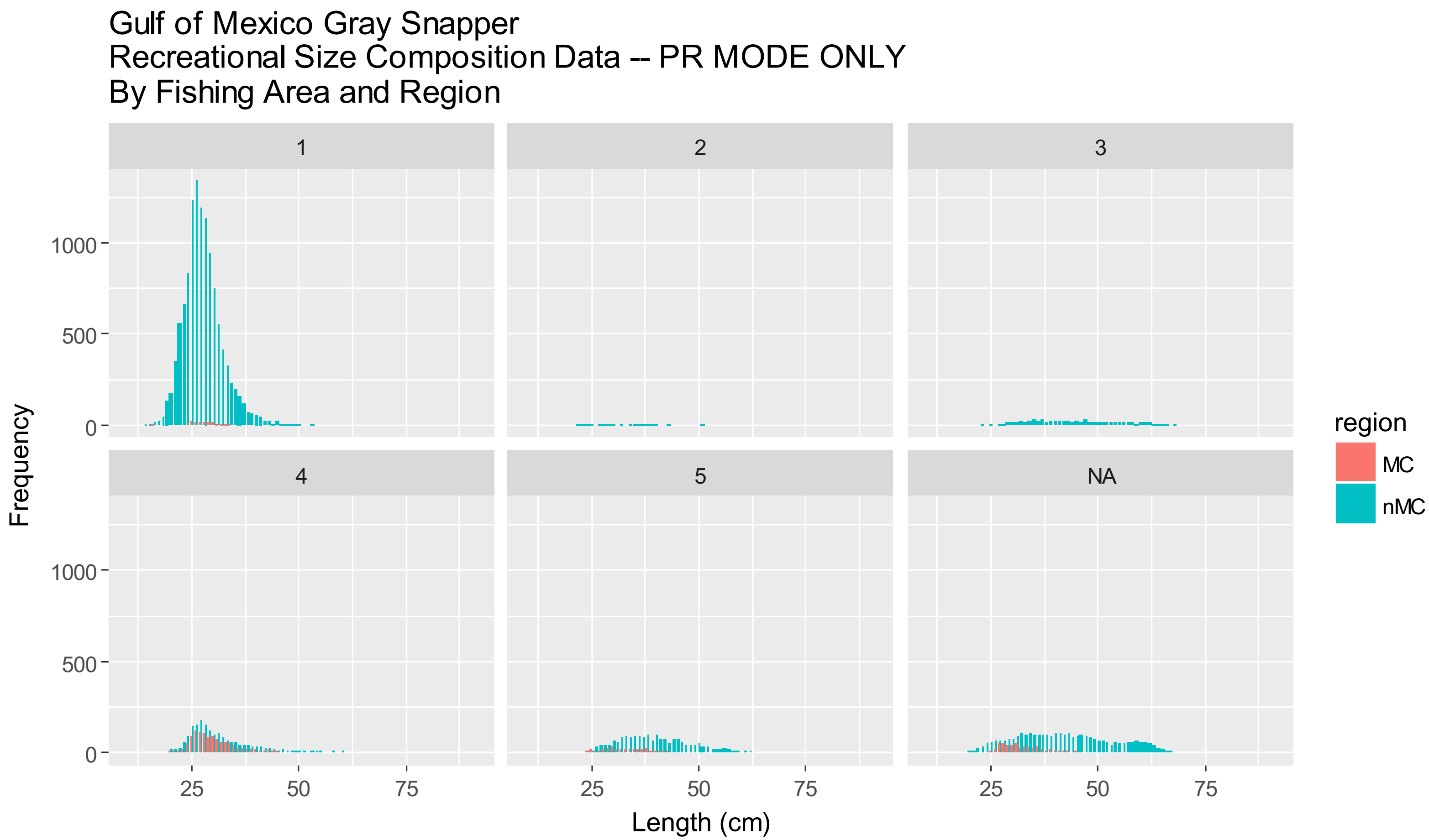


Figure 4.10.15. Histograms of the Gulf of Mexico Gray Snapper recreational length composition data by area fished and region for the private mode. NAs exist since only MRFSS and TPWD report area fished. PR = Private Mode, 1 = Inshore, 2 = Ocean (<3 miles), 3 = Ocean (>3 miles), 4 = Ocean (<10 miles), 5 = Ocean (>10 miles).

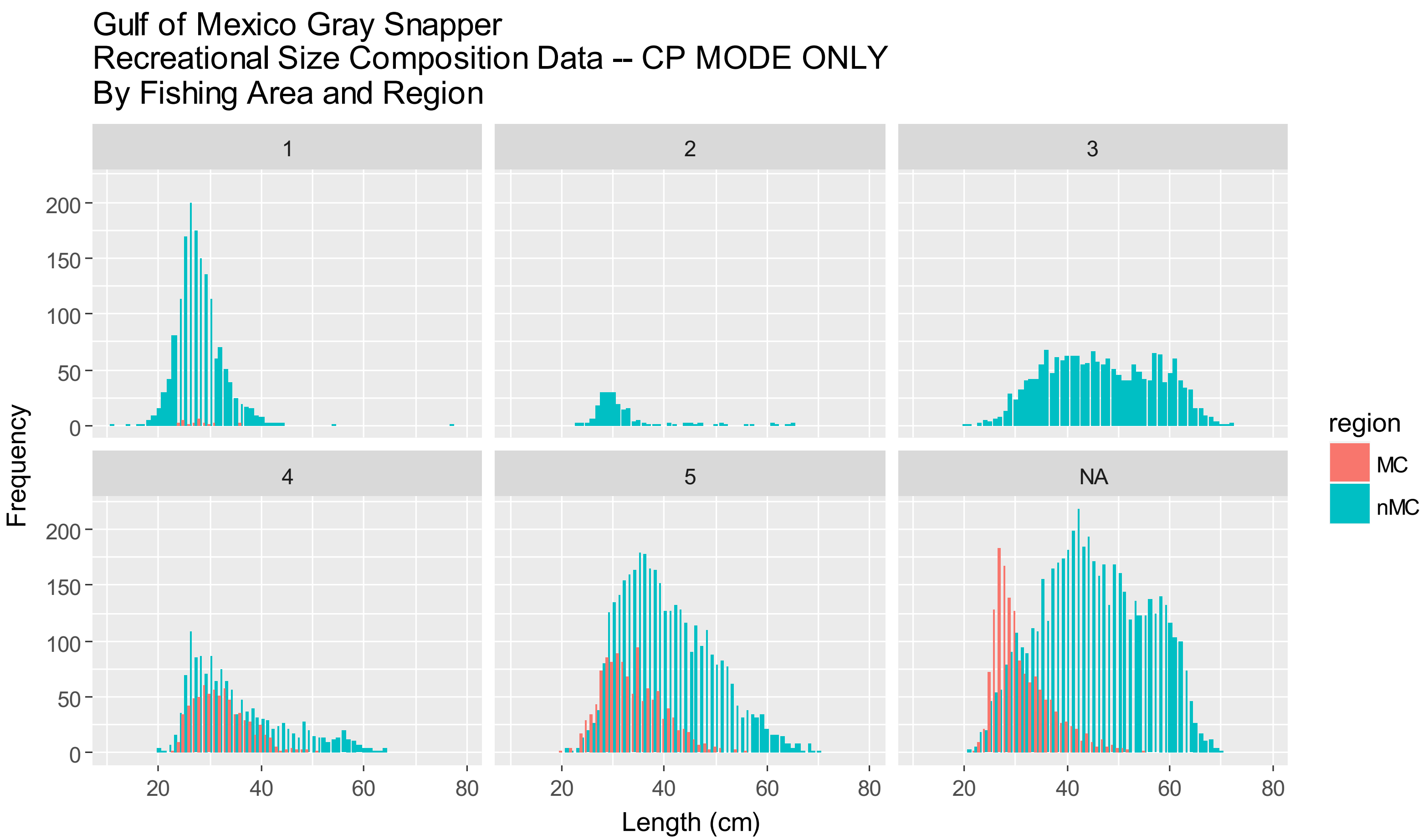


Figure 4.10.16. Histograms of the Gulf of Mexico Gray Snapper recreational length composition data by area fished and region for the charterboat mode. NAs exist since only MRFSS and TPWD report area fished. CP = Charterboat Mode, 1 = Inshore, 2 = Ocean (<3 miles), 3 = Ocean (>3 miles), 4 = Ocean (<10 miles), 5 = Ocean (>10 miles).

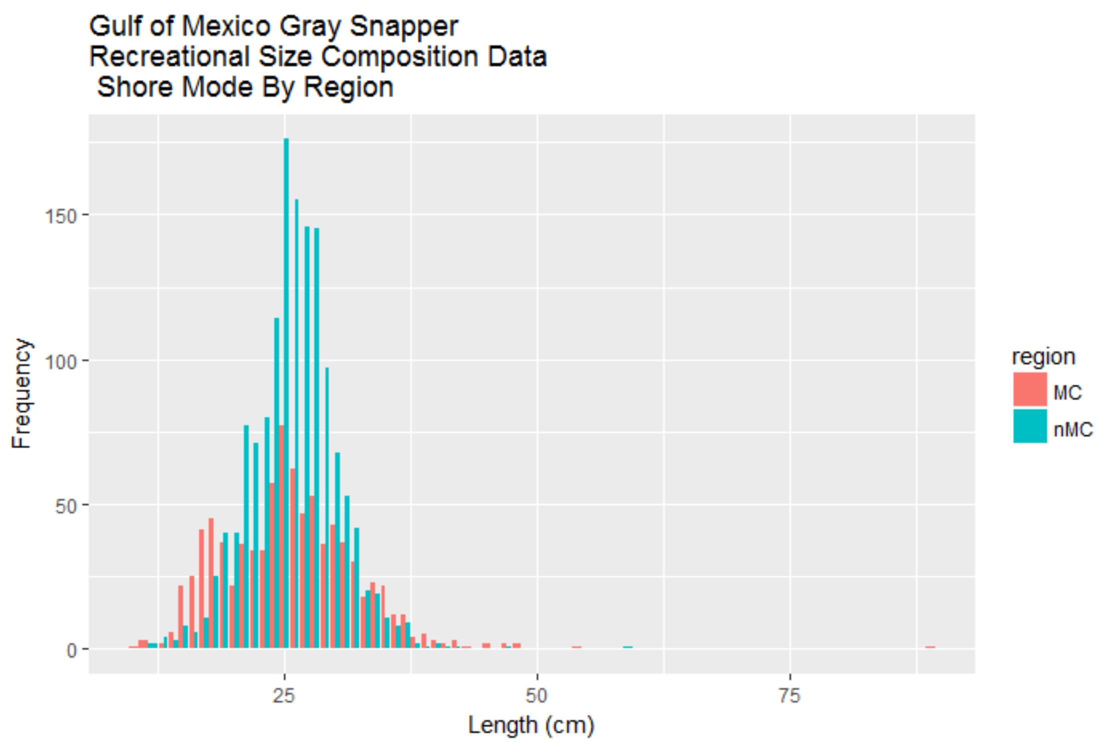


Figure 4.10.17. Histogram of the Gulf of Mexico Gray Snapper recreational length composition data by region for the shore fishing mode. MC = Monroe County (Headboat areas 12, 17, and 18), nMC = Not Monroe County (Headboat areas 21-29).

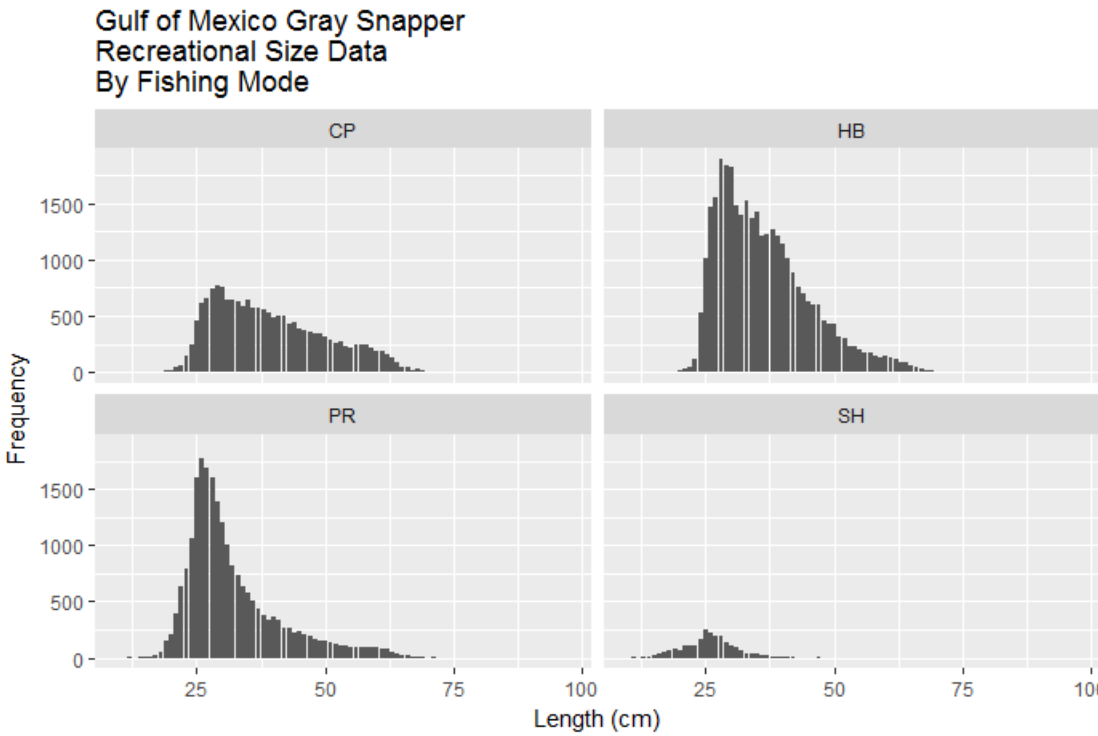
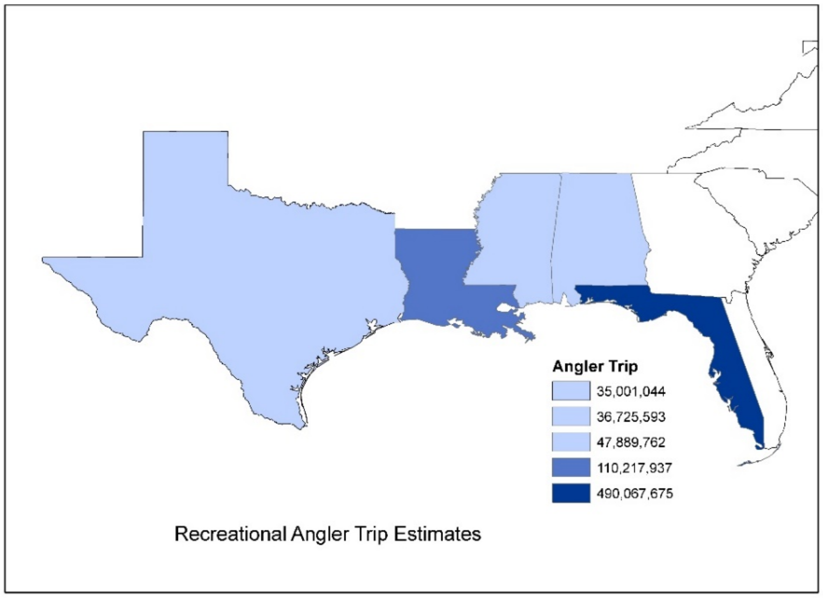


Figure 4.10.18. Histogram of the Gulf of Mexico Gray Snapper recreational length composition data by fishing mode. CP = Charterboat Mode, HB = Headboat Mode, PR = Private Mode, SH = Shore Mode.

a) Angler Trips by State



b) Angler Trips by State and Year

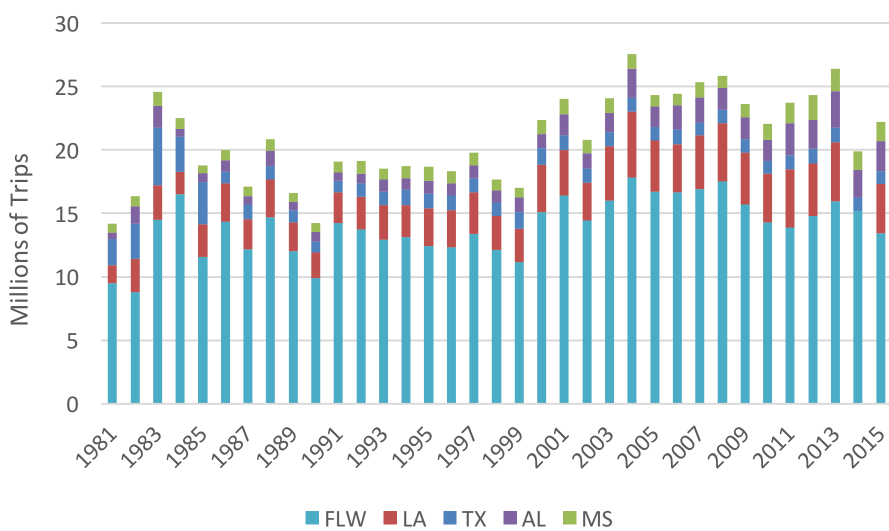
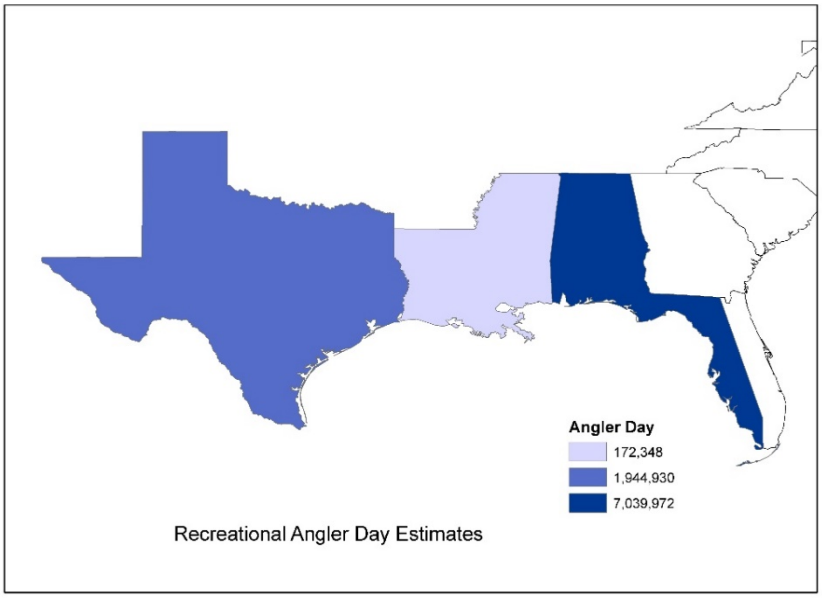


Figure 4.10.19. Gulf of Mexico estimated number of angler trips from MRFSS/MRIP and TPWD (1981-2015) by state (a), and by state and year (b).

a) Angler Days by State



b) Angler Days by State and Year

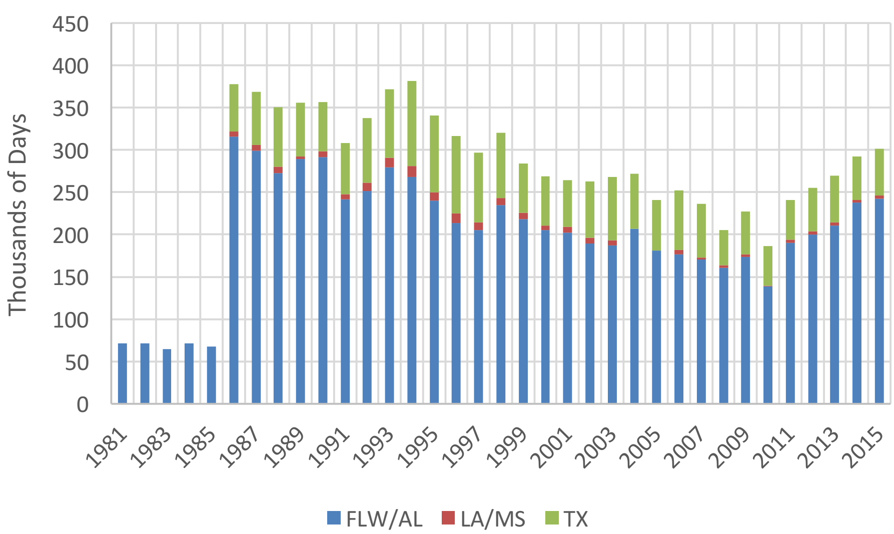


Figure 4.10.20. Gulf of Mexico estimated number of headboat angler days from SRHS (1986-2015) by state (a) and by state and year (b). Due to SRHS area definitions and confidentiality issues, SRHS FLW and AL estimates are combined and MS and LA are combined.

5 MEASURES OF POPULATION ABUNDANCE

The Indices Working Group (IWG) was tasked to review relative abundance indices for Gray Snapper from fishery-dependent and fishery-independent surveys for inclusion in the stock assessment model. Each index was evaluated on its own merit, while considering factors such as survey design, spatial coverage, temporal coverage, analytical methodology, data limitations, and size/age class sampled. Discussions for each index focused on whether they adequately represented fishery and population conditions, and whether modifications to analytical methods could be made to improve the quality of the index.

5.1.1 Group Membership

Adam Pollack (lead)	Riverside Technology, Inc. / NMFS / SEFSC, Pascagoula, MS
David Hanisko	NMFS / SEFSC, Pascagoula, MS
Matthew Smith	NMFS / SEFSC, Miami, FL
Adyan Rios	NMFS / SEFSC, Miami, FL
Chris Gardner	Riverside Technology, Inc. / NMFS / SEFSC, Panama City, FL
Theodore Switzer	FWRI, St. Petersburg, FL
Kevin Thompson	FWRI, St. Petersburg, FL
Kerry Flaherty-Walia	FWRI, St. Petersburg, FL
Mary Christman	MCC Statistical Consulting, Gainesville, FL

5.2 REVIEW OF WORKING PAPERS

There were seven working papers submitted for review to the IWG. One paper covered a fishery-dependent survey, while the other six covered fishery-independent surveys. Each working paper described the source data, information on quality control and subsetting methodology used to produce final datasets for the index. The reports also contain diagnostic plots and, where appropriate, more detailed information about the survey design.

In addition to the working papers listed below, indices of abundance and methodologies for Headboat, MFRSS Private Angler, MRFSS Shore Angler, and MRFSS Charterboat Angler were presented by Adyan Rios. No working papers were submitted for these analyses, but methods are detailed below in their respective sections.

SEDAR51-DW-03: Gray Snapper Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico

SEDAR51-DW-05: Gray snapper *Lutjanus griseus* Findings from the NMFS Panama City Laboratory Camera Fishery-Independent Survey 2005 – 2015

SEDAR51-DW-07: SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Grey Snapper

SEDAR51-DW-10: Indices of abundance for Gray Snapper (*Lutjanus griseus*) from the Florida Fish and Wildlife Research Institute (FWRI) video survey on the West Florida Shelf

SEDAR51-DW-11: Gray Snapper Abundance Indices from Inshore Surveys of Northeastern Gulf of Mexico estuaries

SEDAR51-DW-12: Standardized Catch-Per-Unit Effort Index for Gulf of Mexico Gray Snapper *Lutjanus griseus* Commercial Handline Fishery (1993 – 2015)

SEDAR51-DW-14: Standardized Reef Fish Visual Census Index for Gray Snapper, *Lutjanus griseus*, for the Florida reef track from Biscayne Bay through the Florida Keys for 1997-2016

SEDAR51-DW-15: Indices of abundance for Gray Snapper (*Lutjanus griseus*) using combined data from three independent video surveys

5.3 FISHERY INDEPENDENT SURVEYS

5.3.1 SEAMAP Summer Groundfish Survey

The Southeast Area Monitoring and Assessment Program (SEAMAP) is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute fishery-independent data throughout the region. This semi-annual groundfish trawl survey is conducted in the summer (June – July) and fall (October – November) and provides a valuable source of fisheries-independent information on many commercially and recreationally important species throughout the northern Gulf of Mexico (GOM). Currently, the SEAMAP survey samples the area between Brownsville, TX and the Florida Keys, FL from 9 – 110 m; however, prior to 2008, sampling only took place between Brownsville, TX and Mobile Bay, AL. A review and discussion about the survey design and specific data caveats can be found in Pollack et al. (2017).

A delta-lognormal model (Lo et al. 1992) was used to estimate a relative abundance index from the SEAMAP Summer Groundfish Survey for Gray Snapper. Because of the lack of positive occurrence in the trawl data in the western Gulf of Mexico, the index was limited to an area east of Cape San Blas, FL to the Florida Keys, FL from 2010 – 2015. The final index is relatively stable with a slight increase in 2014. A full review of the index and diagnostic plots for Gray Snapper can be found in Pollack et al. (2017).

5.3.2 SEAMAP Reef Fish Video Survey

The primary objective of the annual SEAMAP reef fish video survey is to provide an index of the relative abundances of fish species associated with topographic features (e.g. reefs, banks, and ledges) located on the continental shelf of the Gulf of Mexico (GOM) from Brownsville, TX to the Dry Tortugas, FL (Figures 1-20). The survey has been executed from 1992-1997, 2001-2002, and 2004-present and historically takes place from April - May, however in limited years the survey was conducted through the end of August. The 2001 survey was abbreviated due to ship scheduling, during which, the only sites that were completed were located in the western Gulf of Mexico. Types of data collected on the survey include diversity, abundance (min-count), fish length, habitat type, habitat coverage, bottom topography and water quality. A review and discussion about the survey design and specific data caveats can be found in Campbell et al. (2017).

Three different models, delta-lognormal, Poisson and negative-binomial, were evaluated for the video data. Delta-lognormal models were ultimately found to have the best fit for Gray Snapper and were used to estimate a relative abundance index from the SEAMAP Reef Fish Video Survey. Three indices were produced using the delta-lognormal model, east Gulf, west Gulf and

Gulf-wide. A full review of the index and diagnostic plots for Gray Snapper can be found in Campbell et al. (2017).

5.3.3 Panama City Reef Fish Video Survey

The NMFS Panama City Lab reef fish video survey collects fishery independent relative abundance and size data through the use of stationary stereo cameras in the NE Gulf of Mexico between Pensacola and Cedar Key, FL. The program began in 2005 and targets reef fish on hard bottom habitats between 6-57 m depth. Site selection is based on a 2-stage unequal probability sampling design accounting for a wide variety of habitats and range in depth and region. The estimator of abundance was the maximum number of a given species in the field of view at any time during the 20 min analyzed (= min count; Gledhill and Ingram 2004, or MaxN; Ellis and DeMartini 1995). Censored datasets were used in deriving the indices of relative abundance from video data. All video samples were screened, and those with no visible hard or live bottom and no visible species of fish strongly associated with hard bottom habitat, as well as samples where the view was obscured because of poor visibility, video out of focus, etc., were excluded from calculations of relative abundance.

A delta-lognormal model (Lo et al. 1992) was used to estimate a relative abundance index for Gray Snapper. Details on the temporal and spatial distribution of samples, sampling intensity and proportion positive, index of abundance and measures of uncertainty can be found in Gardner et al. (2017).

5.3.4 FWRI Inshore Survey

The Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (FWRI), has conducted estuarine surveys since 1989 (seasonally) and since 1996 (monthly) in estuarine systems along the northern Gulf of Mexico. In 2008, seagrass surveys in the polyhaline reaches of several estuarine systems were developed to improve abundance indices for estuarine-dependent reef fish.

These fisheries independent datasets were used to develop four separate abundance indices for Gray Snapper (*Lutjanus griseus*):

- age 0 (≤ 100 mm SL) from monthly collections with 21.3-m seines (1998-2015, recruitment window July-December)
- age 0 from seagrass surveys with 6.1-m otter trawls (2008-2015, July-November)
- age 1 (101-250 mm SL) from monthly collections with 183-m shoreline seines (1996-2015)
- age 1 from seagrass surveys with 6.1-m otter trawls and 183-m shoal seines (2008-2015)

Appropriate estuarine systems and gears, as determined by abundance of defined size classes, were combined for each index by using a weighting factor that takes into account differences between the proportion of available area and the proportion of sets completed within each sampling universe.

For all abundance indices for Gray Snapper, year, bay, month, SAV percentage, and depth were retained in the model. The interaction between year and bay was significant in all models except for age 1 Gray Snapper collected during FWRI seagrass surveys, while temperature and salinity were retained in all models except for age 0 Gray Snapper collected during FWRI seagrass surveys. Shore type was retained in both FWRI long-term FIM models. Full details pertaining to all the indices can be found in Flaherty-Walia et al. (2017).

5.3.5 FWRI Reef Fish Video Survey

The FWRI reef fish survey began in 2008 and includes a portion of the WFS bounded by 26° and 28° N latitude and depths from 10 – 110 m (NMFS statistical zones 4 and 5). From 2010 and after, the survey incorporated side-scan sonar imaging in identifying and subsequently sampling reef habitat. Gray Snapper were observed in a number of videos taken throughout the survey region and as such we developed an index of abundance from data from 2010-2015.

We used a zero-inflated negative binomial regression to model the MaxN (maximum number of fish at one time in a 20 minute video read time) as a function of year, depth, latitude, and presence/absence of relief, algae, and sponge. Coefficients of variation and confidence intervals were calculated by bootstrapping the model 1000 times. Model diagnostics indicated a good fit with no pattern in the residuals and agreement between predicted and observed values for MaxN.

Model CVs were low, except for the first year, 2010, in which there was a low proportion of sites where Gray Snapper were observed.

The standardized index shows a generally increasing trend for Gray Snapper CPUE in the WFS with peaks in abundance particularly in 2014 and 2015. This is in agreement to other fishery independent indices in the region for multiple life stages. Moving forward we recommend continued research into combining video indices for the GOM to allow for the greatest sample size across the longest potential time period. A full review of this index can be found in Thompson et al. (2017a).

5.3.6 Reef Fish Integrated Video Survey

Currently there are three different video surveys for reef fish in the Gulf of Mexico (GOM). The NMFS Pascagoula lab has the longest running survey with data from 1993-1997 and then 2004-2015. This survey uses bathymetry data to survey reef habitat along the shelf break and includes sites both west and east of the Mississippi river, however due to low occurrences of Gray Snapper in the western region, data were limited to the eastern portion of this survey for this species. The second longest running survey is carried out by the NMFS Panama City laboratory and has data from 2006-2015. This survey is smaller in spatial scope and uses a combination of side scan and known habitat to target reefs, with Cape San Blas as the dividing line between the western and eastern portions of the survey. Due to similar occurrences of Gray Snapper in both regions, all of the sites from this dataset were used. The most recent survey in the region is the FWC-FWRI reef fish survey with data from 2010-2015 contributing to this assessment. This survey uses side-scanned habitat geoforms in site selection throughout the West Florida Shelf (WFS) inclusive of NMFS statistical zones 2-9. However, data are only available for the regions offshore of Tampa Bay and Charlotte Harbor (stat zones 4 and 5) for the entire time series. For a full review of methods, see Thompson et al. (2017b).

While the surveys share many commonalities regarding the use of stationary cameras to assess fish abundances on reef or structured habitat, there are variations in survey design and habitat characteristics collected in addition to the time period and area sampled in each survey as previously outlined. However, it was noted in previous SEDAR Data Workshops and meetings among the researchers involved in the surveys that a combined index for the entire GOM would be advantageous for assessment purposes. As such, we developed a method for combining data into one survey using a habitat-based modelling approach in tandem with traditional, straightforward indexing methods.

We first used categorical regression trees (CART) to partition each surveys effort into sites that were Optimal, Suboptimal, or Poor (O,S,P) for Gray Snapper. This was achieved by determining the video survey site habitat characteristics that had high, average, or low to no catches of Gray Snapper for each survey individually since they varied in habitat characteristics. The variables included in our habitat models generally included: latitude, longitude, month, depth, relief, geoform (for two surveys – not available for NMFS Pascagoula), and presence/absence of a number of observed habitat types on video. We then created a Gray Snapper habitat code variable where each site was given a O,S, or P designation.

The CPUE of Gray Snapper was modeled using a zero-inflated negative binomial distribution, where numbers of observed Gray Snapper was a function of year, lab (survey), and habitat code described above. Coefficients of variation and confidence intervals were calculated by bootstrapping the model 1000 times. Model diagnostics indicated a good fit with no pattern in the residuals and agreement between predicted and observed values for MaxN. Model CVs were low indicating good model fit and furthermore, model CVs were in the same range or lower when compared to the individual indices.

The index shows a generally stable CPUE over time for Gray Snapper across the surveys. Peaks in abundance offshore occurred in 2008-2010 with a more recently increasing trend with peaks in abundance in 2014-15 (Table 5.9.1). These peaks are supported by the inshore, juvenile indices as well as the SEAMAP summer groundfish trawl index.

5.3.7 Reef Fish Visual Census

Personnel from the National Marine Fisheries Service began the Reef Fish Visual Census (RVC) in 1979 counting fish along the Florida reef track from Biscayne Bay to the Florida Keys. They employed a two-stage stratified random survey design with sampling frames by habitat that were created by dividing the Florida reef track into 200 m x 200 m blocks and listing the habitats in each block. The block size later was reduced to 100 m x 100 m in 2014 to improve the spatial resolution. The change in the block size does not affect the index because the index is a measure of the average number of Gray Snapper observed by the divers at a station.

Reef Fish Visual Census' observation rates for Gray Snapper, *Lutjanus griseus*, expressed as the average number of Gray Snapper observed per station, were standardized using a delta procedure. Point count data for the Gulf of Mexico from 1997 through 2016 were extracted for the Florida Keys and Dry Tortugas omitting stations north of the Miami-Dade/Monroe County line. The average number of Gray Snapper was calculated per station and potential explanatory variables included year (1997 to 2016), season (Apr-Jun, Jul-Sep, Oct-Dec), sub-regions of the reef track (Upper Keys, Middle Keys, Lower Keys, Tortugas), Sanctuary Protected Area (yes, no), strata (inshore patch reef, mid-channel patch reef, offshore patch reef, high relief reef, shallow forereef, mid-depth forereef, deep forereef), depth (2.5m categories with 25 m +), and underwater visibility (2.5m categories with 25 m +). The submodel for the proportion of stations that observed Gray Snapper reduced the mean deviance by 14.8% and the submodel for the mean number of Gray Snapper observed at positive stations reduced the deviance by 18.8%. The average number of Gray Snapper observed per station in 2014 and 2016 were among the highest in the time series. For information about subsetting and model diagnostics see Muller (2017).

5.4 FISHERY-DEPENDENT MEASURES

5.4.1 Commercial Vertical Line

The National Marine Fisheries Service Gulf of Mexico Reef Fish Logbook Program collects catch and effort data by trip for permitted vessels that participate in fisheries managed by the Gulf of Mexico and South Atlantic Fishery Management Councils. The program began in 1990 with a complete census of commercial reef fish trips by vessels permitted in TX, LA, MS and AL. A 20% sample of vessels permitted in FL was required until 1993, after which all permitted reef fish vessels were required to submit logs. Logbook records exist for all commercially used gears. Recently, commercially harvested Gray Snapper were primarily caught by the vertical line fishery with additional landings originating from the longline and spear fisheries. Historically, Gray Snapper were also harvested in trap and gill net fisheries; however, changes in the regulatory and fishery environments have eliminated landings from these sources.

An index of relative abundance was estimated from the commercial vertical line data. Annual sample sizes for longline and spear fishing gears were inadequate for index development. Prior to index construction, standard data filtering techniques were applied to remove erroneous logbook records and records that could not be incorporated in catch-per-unit effort index construction (Smith 2017). Stephens and MacCall (2004) trip selection was applied to the logbook data to limit records to those occurring in locations where Gray Snapper were likely to have been present (Smith 2017). Following trip selection, 66,841 vertical line records remained with approximately 50% of these reporting harvested Gray Snapper. Index standardization of the vertical line data was conducted using a delta-lognormal generalized mixed model (Lo et al. 1992). Factors explored and subsequently included in the standardization model were detailed in Smith (2017).

The standardized index of abundance derived from the commercial vertical line logbook data was relatively flat throughout the time series with some interannual variability. The index indicates that abundance, while generally stable over the last two decades, has recently been increasing after reaching a time series low in 2010. Annual CV's associated with the index are low ranging between 5% and 9%.

5.4.2 Headboat Survey

Rod and reel catch and effort from party (head) boats in the Gulf of Mexico have been monitored by the NMFS Southeast Region Headboat Survey (conducted by the NMFS Beaufort Laboratory) since 1986. The Headboat Survey collects data on the catch and effort for a vessel trip. Reported information includes landing date and location, vessel identification, the number of anglers, fishing location, trip duration and/or type (half/three-quarter/full/multi-day, day/night, morning/afternoon), and catch by species in number and weight. These data were reviewed at the SEDAR 51 Data Workshop, but were not used to develop an index of abundance. The main reason that a headboat index was not recommended is that the fleet has started using new gear configurations (smaller hooks to target Hogfish) since 2010. The headboat data reflect this change in targeting. Figure 5.10.1 shows the differences in species associated with Gray Snapper in the data before and after 2010. While the change in headboat targeting could be further investigated, doing so and developing a headboat index for SEDAR 51 was not deemed necessary, especially since the headboat fishery accounts for only 3% of total recreational landings.

5.4.3 Marine Recreational Fisheries Statistics Survey

NOAA Fisheries initiated the Marine Recreational Fisheries Statistics Survey (MRFSS) in 1979 in order to obtain standardized estimates of participation, effort and catch by recreational fishermen in U.S. marine waters. Data from the MRFSS dockside interviews associated with private anglers were used to construct an index of Gray Snapper catch rates in the Gulf of Mexico. The index was constructed using Generalized Linear Mixed Models, and a delta-lognormal approach.

Effort and catch were estimated by interview. Total numbers of Gray Snapper caught was equal to A + B1 + B2 fish, where A = fish observed, B1 = dead fish not observed, and B2 = fish released alive. Numbers of B1 and B2 fish were corrected for non-interviewed fishermen. CPUE for each interview was defined as the total Gray Snapper caught per angler hour, where the number of angler hours was calculated using the number of reported angler multiplied by the number of reported hours fished.

Private Anglers

Data were limited to interviews that reported the private fishing mode, fishing with hook and line gear, and fishing in west Florida from 1981-2015. Additionally, interviews that were flagged due to possible errors in group information or catch amount were excluded. The Stephens and MacCall (2004) approach was used to restrict the dataset to interviews that targeted Gray Snapper. This approach uses the species composition of each interview in a logistic regression of species presence/absence to infer if effort associated with a given interview occurred in similar habitat to Gray Snapper. The results of the trip selection procedure are provided in Table 5.9.2 and Figure 5.10.2.

A delta-lognormal approach (Lo et al. 1992) was used to develop standardized catch rate indices. This method combines separate generalized linear modeling (GLM) analyses of the proportion of trips that observed Gray Snapper and the catch rates on positive trips to construct a single standardized index of abundance. A forward stepwise approach was used during the construction of each GLM. The factors listed below were examined as possible influences on the proportion of positive trips, and the catch rates on positive trips.

Submodel Variables

Factor	DF	Details
Year	35	1981-2015
Wave	6	1-6
Time of Interview	10	10am (and earlier), 11am, 12pm, 1pm, 2pm, 3pm, 4pm, 5pm, 6pm, 7pm (and later)
Area	2	<10 miles offshore, > 10 miles offshore
Region	3	Florida Keys, West/Central Florida, Panhandle
Hours Fished*	6	1-2, 3, 4, 5, 6, 7+
Anglers*	2	1, 2+

*Number of hours fished and number of anglers were only explored as factors modeling success.

The final models for the binomial and lognormal components were:

Proportion Positive = YEAR + WAVE + AREA

LN(CPUE) = YEAR + AREA

This MRFSS private index (Figure 5.10.3) was developed using the total catch (A + B1 + B2 fish). Size and age data sampled only from landed fish that were observed (A fish) are available and are summarized in a separate section of this report.

Shore Anglers

Data were limited to interviews that reported the shore fishing mode, fishing with hook and line gear, and fishing in west Florida from 1981-2015. Additionally, interviews that were flagged due to possible errors in group information or catch amount were excluded. The Stephens and MacCall (2004) was attempted but not used to restrict the dataset. The model diagnostics revealed species associations were not informative enough to identify interviews that were likely to encounter Gray Snapper. Instead, the data were filtered using a guild-approach where trips that reported any reef species were retained. The results of the trip selection procedure are provided in Table 5.9.3 and Figure 5.10.4.

A delta-lognormal approach (Lo et al., 1992) was used to develop standardized catch rate indices. This method combines separate generalized linear modeling (GLM) analyses of the proportion of trips that observed Gray Snapper and the catch rates on positive trips to construct a single standardized index of abundance. A forward stepwise approach was used during the construction of each GLM. The factors listed below were examined as possible influences on the proportion of positive trips, and the catch rates on positive trips.

<u>Submodel Variables</u>

Factor	DF	Details
Year	35	1981-2015
Wave	6	1-6
Time of Interview	10	10am (and earlier), 11am, 12pm, 1pm, 2pm, 3pm, 4pm, 5pm, 6pm, 7pm (and later)
Size/Bag Limit	2	none (pre 04-23-1990), both (after 04-23-1990)
Area	2	<10 miles offshore, > 10 miles offshore
Hours Fished*	4	1-2, 3, 4, 5, 6, 7+
Anglers*	7	1, 2+

*Number of hours fished and number of anglers were only explored as factors modeling success.

The final models for the binomial and lognormal components were:

Proportion Positive = YEAR

LN(CPUE) = YEAR + WAVE + REGION

This MRFSS shore index (Figure 5.10.5) was developed using the total catch (A + B1 + B2). Size and age data sampled only from landed fish that were observed (A) are available and are summarized in a separate section of this report.

<u>Charterboat Anglers</u>

Data from the MRFSS dockside interviews associated with charterboat fishing were not used to construct an index of Gray Snapper catch rates in the Gulf of Mexico. These data were reviewed at the SEDAR 51 Data Workshop but an index was not recommended because there were few positive trips (Table 5.9.4). While an index could be developed for the charterboat data for part of the time series, doing so for SEDAR 51 was not deemed necessary, especially since there were adequate samples to develop indices for the private and shore sectors of the recreational fleet, which account for the majority (89%) of recreational landings.

5.5 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

During the course of the Data Workshop and webinars, the IWG evaluated numerous abundance indices and datasets for use in the Gray Snapper stock assessment model. Ultimately, the IWG recommended the following eight abundance indices for use: Commercial Handline, MRFSS – Private Angler, MRFSS – Shore Angler, FWRI – Age 0 Long-term, FWRI – Age 1 Long-term, Reef Fish Visual Census, SEAMAP Summer Groundfish Survey, and Reef Fish Integrated Video Survey. The values for each individual index and their respective CVs are presented in Table 5.9.5 and Figure 5.10.6. Below are the evaluations for each of the surveys and their respective indices.

5.5.1 SEAMAP Groundfish Survey

The SEAMAP Groundfish Survey index was recommended for use in the assessment. Though this survey is limited both temporally (6 years) and spatially (West Florida Shelf), it indexes size classes of fish not present in the FWRI Long term Surveys and Integrated Reef Fish Video Surveys.

5.5.2 SEAMAP Reef Fish Video Survey

The SEAMAP Reef Fish Video Survey index was not recommended for use in the assessment because the data have been combined with data from Panama City and FWRI surveys in the Reef Fish Integrated Video Survey index.

5.5.3 Panama City Reef Fish Video Survey

The Panama City Reef Fish Video Survey index was not recommended for use in the assessment because the data have been combined with data from SEAMAP and FWRI surveys in the Reef Fish Integrated Video Survey index.

5.5.4 FWRI Inshore Surveys

The FWRI Age 0 – Long-term and FWRI Age 1 – Long-term indices were recommended for use in the assessment. The FWRI Age 0 – Seagrass and FWRI Age 1 – Seagrass indices were not recommended for use in the assessment. Both surveys cover the same geographic area but do sample different habitats. However, the long-term indices for age 0 and age 1 were recommended due to the longer timeframe of sampling.

5.5.5 FWRI Reef Fish Video Survey

The FWRI Reef Fish Video Survey index was not recommended for use in the assessment because the data have been combined with data from SEAMAP and Panama City surveys in the Reef Fish Integrated Video Survey index.

5.5.6 Reef Fish Integrated Video Survey

The Reef Fish Integrated Video Survey was recommended for use in the assessment. This fishery-independent survey is a combination of data from SEAMAP, Panama City and FWRI. It has good spatial and temporal coverage.

5.5.7 Reef Fish Visual Census

The Reef Fish Visual Census index was recommended for use in the assessment. While the data are spatially limited, it covers an area that is not covered by any other fishery-independent index and has good temporal coverage.

5.5.8 Commercial Handline

The Commercial Handline index was recommended for use in the assessment. It is recommended that during the assessment process the CV's for the commercial index be scaled to a common value shared by the other fishery dependent and independent indices. This will ensure that other indices, which typically have higher annual estimated CV's, will contribute to the overall picture of Gray Snapper abundance in the stock assessment model.

5.5.9 Headboat Survey

The Headboat Survey index was not recommended for use in the assessment because of the change in targeting and gear configurations. In addition, the headboat fishery accounts for only 3% of total recreational landings.

5.5.10 MRFSS – Private Anglers

The MRFSS private index was deemed adequate for use in the assessment by the IWG. This decision was based on the long time series and large spatial coverage associated with the MRFSS angler intercept data.

5.5.11 MRFSS – Shore Anglers

The MRFSS shore index was deemed adequate for use in the assessment by the IWG. This decision was based on the long time series and large spatial coverage associated with the MRFSS angler intercept data.

5.5.12 MRFSS – Charterboat Anglers

No index was developed for the MRFSS – Charterboat Anglers because of the low number of positive trips.

5.6 RESEARCH RECOMMENDATIONS

During the review and evaluation of the various datasets and indices presented during the Data Workshop, the IWG identified the following research recommendations to further improve the abundance indices:

- Further exploration of various weighting alternatives for the combined video index from NMFS Mississippi Labs, NMFS Panama City, and FWC video datasets – especially in terms of ongoing and future survey expansion (new areas, overlapping areas, new habitats such as artificial reefs)

- Continued bottom mapping and identification of new reef to estimate Q
- Move to a unified, habitat-based sampling design, including the MS, PC, and FWC into a single sampling program
- Explore combining data from FWRI long-term and polyhaline seagrass surveys
- Explore temporal stability of Stevens-MacCall, and how to address when species relationships change through time

5.7 DATA BEST PRACTICES COMMENTS AND SUGGESTIONS

Several recommendations during the Data Best Practices Workshop (SEDAR 2015) were made concerning issues repeatedly faced by the IWG during Data Workshops. These recommendations were made to help smooth the process and insure each IWG followed similar protocols. One big time saver during the Data Workshop was not having to fill out report cards for every index. This allowed the IWG more time for discussion regarding the merits of the index rather than just making sure boxes were checked on the report card. Another improvement was made concerning the shortening and re-organization of the Data Workshop Report section. The changes should make it easier to find the final recommendations made by the IWG and reduce redundant information that is already documented in the working papers.

One issue that we did run into was timing of the presentation of new data. Going forward, new datasets should not be introduced on the last day of the Data Workshop. Ideally, at this point the indices have already been fully vetted and recommended for inclusion or rejected. This put us another couple weeks behind as we had to find the dataset and someone to analyze it. Then we needed to present everything to the panel for the final approval.

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5.9 TABLES

Table 5.9.1. Surveys included by year, number of stations sampled (N), proportion of positive sets, standardized index, and CV for the combined Gray Snapper video index of the West Florida Shelf, 1993-2015.

Year	Surveys	N	Proportion Positive	Std. Index	CV
1993	Pasc	123	0.1707	0.9960	0.27004
1994	Pasc	98	0.1735	1.2119	0.31257
1995	Pasc	69	0.2754	0.7804	0.26544
1996	Pasc	140	0.2000	1.3367	0.26765
1997	Pasc	161	0.2236	1.0878	0.21132
1998					
1999					
2000					
2001					
2002					
2003					
2004	Pasc	149	0.1409	0.6125	0.30286
2005	Pasc	274	0.0693	0.9747	0.27983
2006	Pasc,PC	359	0.1643	0.8913	0.17034
2007	Pasc,PC	381	0.1129	0.4397	0.19663
2008	Pasc,PC	293	0.2048	1.3786	0.16796
2009	Pasc,PC	364	0.2610	1.2904	0.14294
2010	Pasc, PC, FWRI	512	0.1895	1.2539	0.12659
2011	Pasc, PC, FWRI	726	0.1653	0.7204	0.11940
2012	Pasc, PC, FWRI	670	0.1836	0.9801	0.13120
2013	Pasc, PC, FWRI	444	0.2117	0.8685	0.13260
2014	Pasc, PC, FWRI	685	0.2686	1.1143	0.10295
2015	Pasc, PC, FWRI	533	0.2964	1.0628	0.10721

Table 5.9.2. Number of trips, number of positive trips, percent of positive trips (PPos) and abundance index statistics for the MRFSS Private Angler index.

MRFSS FLW HL Private Intercept Data											
	Before Trip Selection			After Trip Selection			MRFSS Private Index				
Year	Total Trips	Positive Trips	PPos	Total Trips	Positive Trips	PPos	Nominal	Index	LCI	UCI	CV
1981	870	44	5%	69	34	49%	0.7790	**0.8736**	0.4755	1.6051	0.3113
1982	1513	51	3%	58	16	28%	0.4045	**0.5193**	0.2121	1.2713	0.4710
1983	756	19	3%	50	10	20%	0.4327	**0.3409**	0.1101	1.0561	0.6136
1984	801	35	4%	66	15	23%	0.9974	**0.7320**	0.2858	1.8753	0.4976
1985	945	33	3%	58	21	36%	0.9045	**1.0336**	0.4778	2.2357	0.4006
1986	3035	105	3%	150	59	39%	0.7231	**0.6599**	0.4088	1.0652	0.2429
1987	4833	119	2%	166	67	40%	1.3938	**0.9579**	0.6206	1.4788	0.2197
1988	4980	141	3%	213	61	29%	1.0880	**0.8867**	0.5505	1.4283	0.2418
1989	3311	165	5%	183	75	41%	1.4365	**1.3758**	0.9076	2.0856	0.2103
1990	2978	123	4%	140	59	42%	2.8294	**1.4337**	0.9094	2.2603	0.2306
1991	2870	213	7%	221	72	33%	1.5234	**1.5496**	1.0127	2.3710	0.2151
1992	7308	591	8%	716	278	39%	1.0902	**1.2266**	0.9877	1.5232	0.1086
1993	6316	562	9%	679	290	43%	1.1360	**1.4734**	1.1969	1.8138	0.1042
1994	7134	575	8%	683	294	43%	0.9513	**1.1702**	0.9498	1.4417	0.1046
1995	6408	456	7%	681	225	33%	1.3131	**1.1971**	0.9364	1.5303	0.1232
1996	8254	527	6%	875	277	32%	0.8191	**0.8771**	0.7028	1.0945	0.1111
1997	8047	612	8%	866	307	35%	0.9427	**1.0625**	0.8585	1.3149	0.1069
1998	9194	805	9%	1175	417	35%	1.1699	**1.1351**	0.9457	1.3625	0.0915
1999	11821	842	7%	1552	466	30%	0.8237	**0.8957**	0.7534	1.0649	0.0867
2000	9431	720	8%	1059	336	32%	0.8511	**0.9286**	0.7586	1.1368	0.1014
2001	11002	704	6%	1184	363	31%	0.9056	**0.8822**	0.7242	1.0746	0.0989
2002	12091	957	8%	1384	482	35%	0.8030	**0.9067**	0.7654	1.0740	0.0848
2003	11518	1055	9%	1574	590	37%	0.8404	**0.9801**	0.8427	1.1399	0.0756
2004	12587	966	8%	1716	482	28%	0.5590	**0.7413**	0.6249	0.8794	0.0856
2005	11120	1011	9%	1622	534	33%	0.7400	**0.8385**	0.7127	0.9864	0.0814
2006	11298	800	7%	1319	441	33%	0.6785	**0.8829**	0.7398	1.0537	0.0886
2007	11865	976	8%	1315	498	38%	0.7221	**0.9940**	0.8420	1.1734	0.0831
2008	11764	1285	11%	1658	635	38%	1.1313	**1.1083**	0.9575	1.2827	0.0732
2009	12726	1210	10%	1644	584	36%	1.0500	**0.9511**	0.8132	1.1125	0.0785
2010	12238	681	6%	1140	268	24%	0.4729	**0.5703**	0.4511	0.7211	0.1177
2011	12584	677	5%	990	248	25%	0.5370	**0.6557**	0.5143	0.8359	0.1219
2012	11184	778	7%	927	269	29%	0.6924	**0.7599**	0.6042	0.9557	0.1150
2013	9025	1013	11%	1004	388	39%	0.9671	**1.1886**	0.9862	1.4325	0.0935
2014	12393	1807	15%	1516	770	51%	1.6961	**1.6818**	1.4768	1.9151	0.0650
2015	10718	1473	14%	1170	603	52%	1.5952	**1.5292**	1.3223	1.7684	0.0728

Table 5.9.3. Number of trips, number of positive trips, percent of positive trips (PPos) and abundance index statistics for the MRFSS Shore Angler index.

	MRFSS FLW Handline Shore Intercept Data										
	Before Trip Selection			**After Trip Selection**			**MRFSS Shore Index**				
Year	**Total Trips**	**Positive Trips**	**PPos**	**Total Trips**	**Positive Trips**	**PPos**	**Nominal**	**Index**	**LCI**	**UCI**	**CV**
1981	1393	50	4%	301	50	17%	0.9010	**0.6460**	0.3281	1.2721	0.3488
1982	1935	64	3%	410	64	16%	0.8414	**0.7100**	0.3868	1.3035	0.3109
1983	1245	42	3%	260	42	16%	0.5557	**0.5288**	0.2536	1.1025	0.3801
1984	1575	49	3%	205	49	24%	0.4944	**0.6252**	0.3239	1.2065	0.3378
1985	1990	43	2%	195	43	22%	0.5403	**0.6851**	0.3350	1.4010	0.3695
1986	981	21	2%	112	21	19%	1.2466	**0.7610**	0.2812	2.0594	0.5303
1987	1209	16	1%	176	16	9%	0.5164	**0.3468**	0.1074	1.1196	0.6401
1988	2335	62	3%	273	62	23%	0.9438	**0.9121**	0.4998	1.6645	0.3077
1989	1726	83	5%	266	83	31%	1.9621	**1.3312**	0.8072	2.1954	0.2541
1990	1367	62	5%	283	62	22%	0.5360	**0.6563**	0.3608	1.1938	0.3060
1991	1440	123	9%	349	123	35%	3.8752	**2.0445**	1.3705	3.0500	0.2020
1992	3404	219	6%	752	219	29%	1.1395	**0.9537**	0.6970	1.3051	0.1578
1993	5761	432	7%	1451	432	30%	1.0211	**1.0466**	0.8369	1.3089	0.1121
1994	6355	360	6%	1486	360	24%	0.9868	**0.9467**	0.7367	1.2165	0.1259
1995	6232	353	6%	1290	353	27%	0.8423	**0.9256**	0.7218	1.1871	0.1249
1996	4355	289	7%	810	289	36%	0.9171	**1.0731**	0.8244	1.3968	0.1324
1997	4286	300	7%	941	300	32%	0.7816	**1.0505**	0.8070	1.3674	0.1324
1998	4940	370	7%	1290	370	29%	0.7661	**0.9348**	0.7317	1.1942	0.1229
1999	6535	343	5%	1383	343	25%	0.6095	**0.7506**	0.5805	0.9707	0.1291
2000	5154	239	5%	994	239	24%	0.7030	**0.8052**	0.5919	1.0953	0.1548
2001	5358	215	4%	1161	215	19%	0.7025	**0.6605**	0.4740	0.9203	0.1670
2002	5463	270	5%	1113	270	24%	0.6303	**0.8676**	0.6501	1.1579	0.1450
2003	6085	446	7%	1105	446	40%	1.4436	**1.5655**	1.2736	1.9242	0.1034
2004	5559	343	6%	966	343	36%	1.1702	**1.3408**	1.0546	1.7046	0.1205
2005	5277	465	9%	1015	465	46%	1.6689	**1.8089**	1.4885	2.1982	0.0977
2006	4891	206	4%	752	206	27%	0.7743	**1.0064**	0.7310	1.3856	0.1609
2007	5056	434	9%	1066	434	41%	1.5572	**1.7849**	1.4490	2.1986	0.1045
2008	5085	420	8%	1153	420	36%	1.2473	**1.3905**	1.1180	1.7295	0.1094
2009	5502	353	6%	1118	353	32%	0.6887	**0.9627**	0.7553	1.2272	0.1218
2010	5919	243	4%	1086	243	22%	0.4521	**0.6413**	0.4719	0.8714	0.1542
2011	6035	237	4%	906	237	26%	0.7547	**0.8161**	0.6012	1.1077	0.1537
2012	5686	268	5%	1067	268	25%	0.8366	**0.9455**	0.7078	1.2630	0.1455
2013	4449	354	8%	1079	354	33%	0.8685	**1.0644**	0.8366	1.3541	0.1208
2014	3494	292	8%	849	292	34%	1.1545	**1.2670**	0.9754	1.6458	0.1313
2015	2632	227	9%	697	227	33%	0.8705	**1.1441**	0.8498	1.5404	0.1495

Table 5.9.4. Number of total trips, number of positive trips and percent of positive trips (PPos) for the MRFSS Charterboat Angler intercept data.

MRFSS FLW Handline Charterboat Intercept Data			
Before Trip Selection			
Year	**Total Trips**	**Positive Trips**	**PPos**
1981	139	6	4%
1982	63	11	17%
1983	109	3	3%
1984	160	11	7%
1985	145	13	9%
1986	796	56	7%
1987	607	28	5%
1988	616	31	5%
1989	335	16	5%
1990	240	8	3%
1991	282	20	7%
1992	538	53	10%
1993	568	44	8%
1994	546	29	5%
1995	422	20	5%
1996	515	24	5%
1997	995	80	8%
1998	1909	198	10%
1999	3924	310	8%
2000	4417	303	7%
2001	3383	207	6%
2002	3539	319	9%
2003	4251	437	10%
2004	4227	429	10%
2005	3557	438	12%
2006	2630	259	10%
2007	2731	270	10%
2008	2739	365	13%
2009	2226	240	11%
2010	2609	298	11%
2011	2665	259	10%
2012	2931	307	10%
2013	1211	194	16%
2014	2129	380	18%
2015	1826	311	17%

Table 5.9.5. Relative abundance index values and CVs recommended for use in the Gray Snapper assessment model.

Year	Commercial Handline		MRFSS – Private Angler		MRFSS – Shore Angler		FWRI – Age 0 Long-term		FWRI – Age 1 Long-term		Reef Fish Visual Census		SEAMAP Summer Groundfish Trawl		Reef Fish Integrated Video	
	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1981			0.873592	0.31133	0.646005	0.348771										
1982			0.519337	0.471026	0.710038	0.310881										
1983			0.340947	0.613622	0.528797	0.380136										
1984			0.732039	0.497593	0.625166	0.337827										
1985			1.03358	0.400567	0.685088	0.369455										
1986			0.659926	0.242865	0.760976	0.530273										
1987			0.957945	0.219665	0.346812	0.640078										
1988			0.886731	0.241781	0.912125	0.307677										
1989			1.375835	0.21028	1.331171	0.254117										
1990			1.433744	0.230592	0.656279	0.305984										
1991			1.549596	0.215095	2.044505	0.202007										
1992			1.226582	0.108603	0.953742	0.157798										
1993	0.88	0.08	1.473405	0.104217	1.046635	0.112136									0.996002	0.27004
1994	1.13	0.07	1.170199	0.10461	0.946687	0.12588									1.211921	0.312573
1995	0.92	0.07	1.197099	0.123244	0.925637	0.124872									0.780424	0.265444
1996	0.92	0.07	0.87705	0.111063	1.07308	0.132393			0.2443	0.3336					1.336661	0.267649
1997	1.1	0.07	1.062488	0.106887	1.050469	0.132412			0.441	0.2582	0.65	0.141			1.087784	0.211321
1998	1.03	0.07	1.135116	0.091494	0.934769	0.122932	0.174	0.3174	0.5001	0.2623	1.24	0.126				
1999	1.28	0.06	0.895737	0.086671	0.75064	0.129067	0.9568	0.2406	0.4648	0.2363	1.21	0.111				
2000	0.98	0.06	0.928648	0.10136	0.805161	0.154763	0.7112	0.2151	0.4377	0.2124	1.34	0.113				
2001	1.15	0.06	0.882169	0.09888	0.660457	0.167039	1.4862	0.1693	0.3391	0.2587	1.61	0.124				
2002	1.25	0.05	0.906674	0.084816	0.867635	0.14504	1.7114	0.166	1.145	0.1985	1.38	0.122				
2003	0.95	0.06	0.980108	0.075635	1.565499	0.103441	1.157	0.1651	0.9736	0.2292	0.88	0.154				
2004	0.99	0.06	0.741287	0.085588	1.340784	0.120478	1.7938	0.1621	1.0023	0.2236	0.67	0.13			0.612499	0.302856
2005	1.09	0.06	0.838456	0.081364	1.808909	0.097698	0.4623	0.2059	0.6948	0.2493	1.11	0.144			0.974709	0.27983
2006	1.14	0.06	0.882926	0.088588	1.006444	0.160896	1.3499	0.1581	0.4003	0.2434	0.73	0.126			0.89129	0.17034
2007	1	0.07	0.99399	0.08313	1.784857	0.104526	1.0352	0.172	2.6328	0.2077	0.91	0.146			0.439746	0.196625
2008	0.82	0.07	1.108268	0.073199	1.390504	0.109396	0.4745	0.1966	1.4781	0.2137	1	0.116			1.378596	0.167961
2009	0.9	0.07	0.951115	0.078479	0.962728	0.121791	1.3651	0.1558	0.9667	0.2113	1.3	0.115			1.290368	0.142941
2010	0.8	0.08	0.57033	0.117658	0.641256	0.154243	0.885	0.1675	0.3954	0.2401	1.08	0.102	1.18118	0.23777	1.253894	0.126587
2011	0.82	0.09	0.655693	0.121878	0.816103	0.153668	0.5319	0.1891	0.2727	0.2778	2.09	0.123	0.85757	0.28116	0.720415	0.119399
2012	0.96	0.08	0.759882	0.115026	0.945502	0.145545	1.4112	0.178	0.8087	0.193	1.19	0.103	0.8819	0.2407	0.980135	0.131198

2013	0.86	0.08	1.188553	0.093536	1.06439	0.120816	0.3827	0.3168	2.0825	0.2021			0.85459	0.2777	0.868507	0.132598
2014	0.98	0.07	1.681767	0.065042	1.267026	0.131328	1.4711	0.1663	1.3962	0.1987	2.61	0.112	1.21661	0.22033	1.114275	0.102945
2015	1.05	0.07	1.529188	0.072762	1.144122	0.149536	0.6407	0.194	3.3238	0.1928			1.00815	0.26248	1.062773	0.107213

5.10 FIGURES

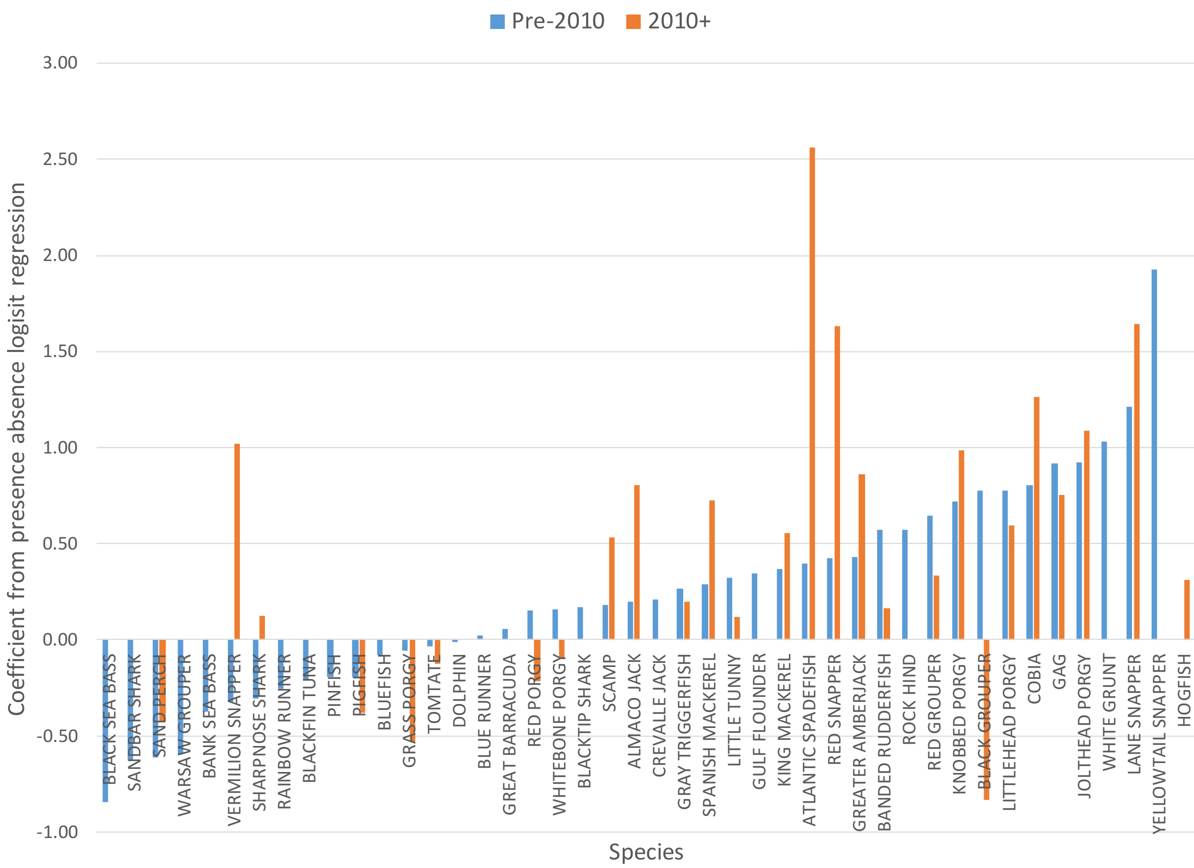


Figure 5.10.1. Species associated with Gray Snapper in the Southeast Region Headboat Survey logbook data before and after 2010. The coefficients reflect a positive or negative association with Gray Snapper and were derived from a logistic regression of species presence/absence. Species were only included in the analysis if they were encountered in at least 1% of trips during the respective time periods.

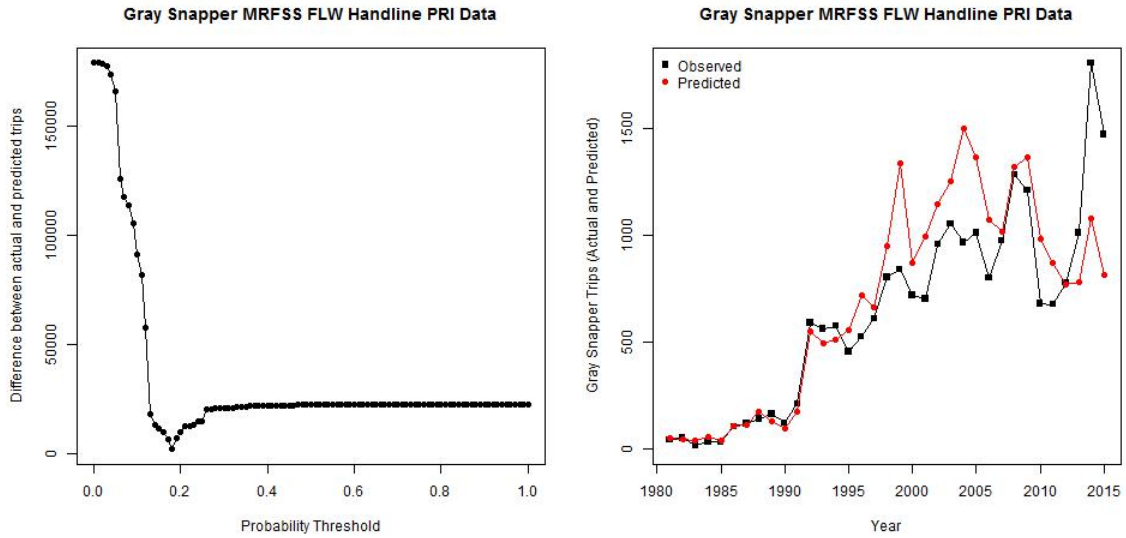


Figure 5.10.2. Stephens and MacCall diagnostic plots for predicting Gray Snapper catch among the private mode trips in the MRFSS intercept data.

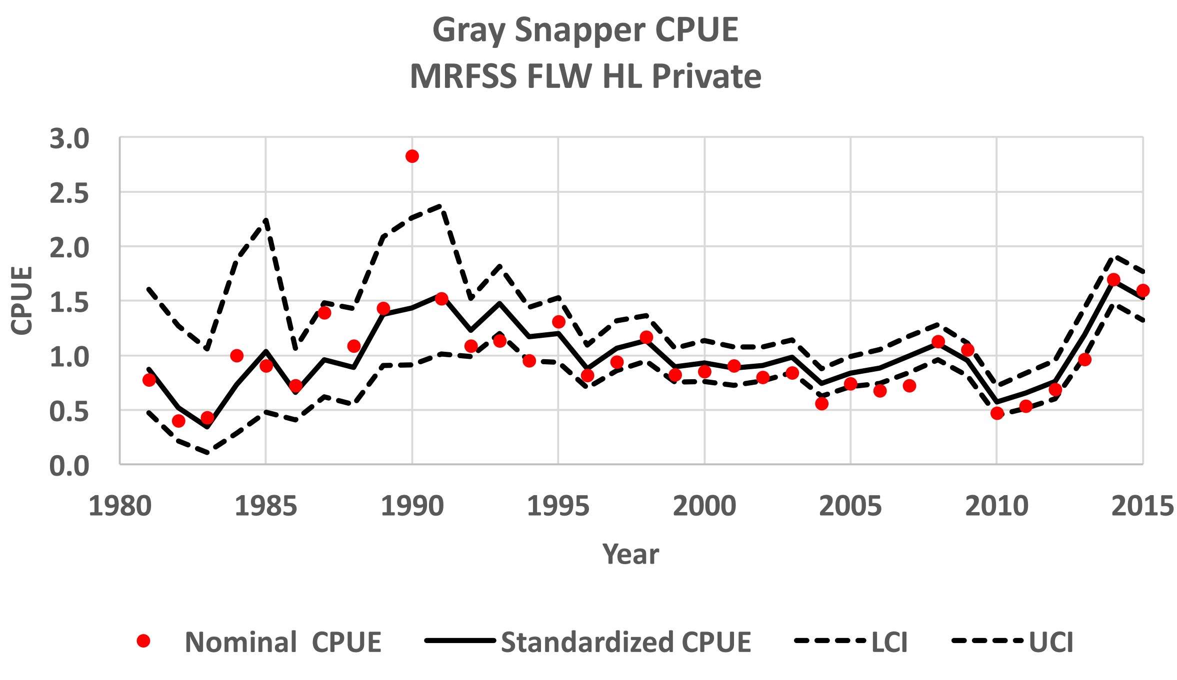


Figure 5.10.3. Standardized indices with 95% confidence intervals and nominal CPUE for the MRFSS Private Angler index.

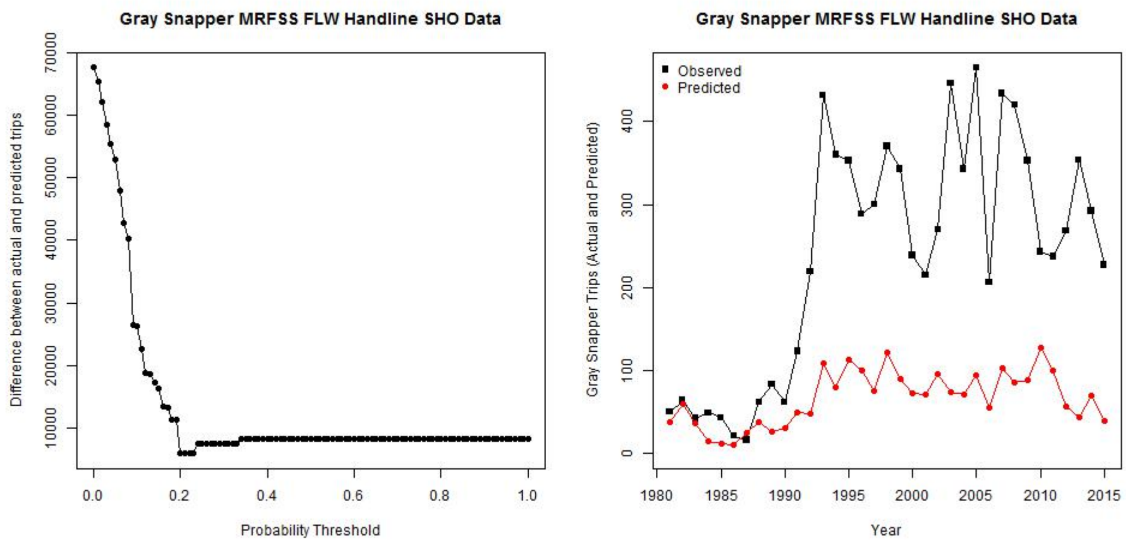


Figure 5.10.4. Stephens and MacCall diagnostic plots for predicting Gray Snapper catch among the shore mode trips in the MRFSS intercept data.

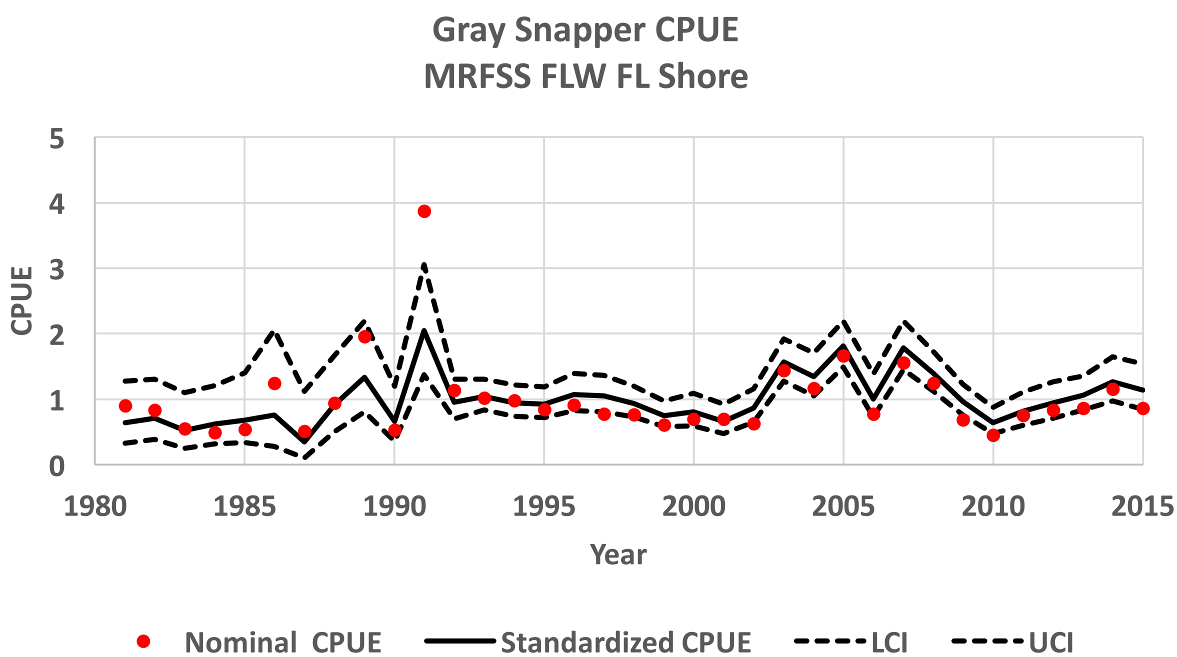
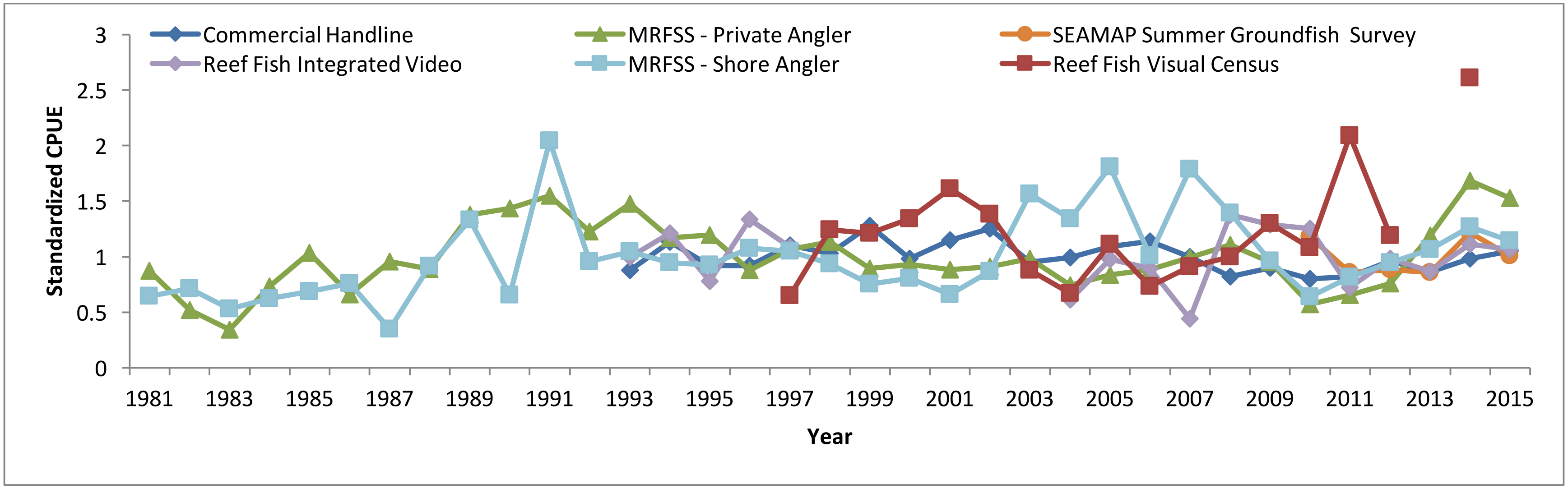


Figure 5.10.5. Standardized indices with 95% confidence intervals and nominal CPUE for the MRFSS Shore Angler index.



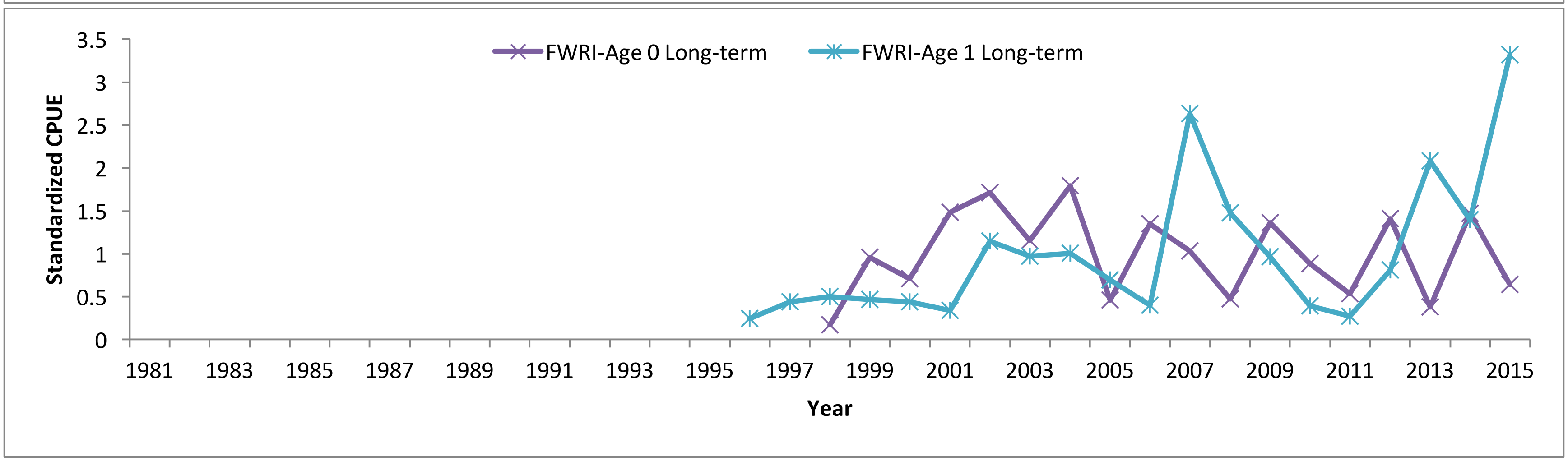


Figure 5.10.6. Indices of abundance recommended for use in the Gray Snapper assessment model. The FWRI long-term indices are presented separately for better visualization of how the age 0 and 1 indices line up with the rest of the indices and how they tend to track one another.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 51

Gulf of Mexico Gray Snapper

SECTION III: Assessment Process Report

March 2018

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

Table of Contents

1 Assessment Webinar Proceedings

1.1 Introduction

1.1.1. Workshop Time and Place

The SEDAR 51 Assessment Process for Gulf of Mexico Gray Snapper was conducted via a series of webinars held between July 2017 and January 2018.

1.1.2. Terms of Reference

Assessment Workshop Terms of Reference

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered.
3. Provide estimates of stock population parameters, if feasible:
    - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship (if applicable), and other parameters as necessary to describe the population.
    - Include appropriate measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values.
    - Consider uncertainty in input data, modeling approach, and model configuration
    - Consider and include other sources as appropriate for this assessment
    - Provide appropriate measures of model performance, reliability, and 'goodness of fit'
    - Provide measures of uncertainty for estimated parameters
5. Provide estimates of yield and productivity.
    - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models
    -
6. Provide estimates of population benchmarks or management criteria consistent with available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.

- Evaluate existing or proposed management criteria as specified in the management summary
- Recommend proxy values when necessary, and provide appropriate justification

7. Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment
   - Consider potential effects from the Deepwater Horizon oil spill, euryhaline movement patterns (by life stage, if available), and influence of tropical cyclones on movement and distribution
8. Provide declarations of stock status relative to management benchmarks or alternative data poor approaches if necessary.
9. Provide uncertainty distributions of proposed reference points and stock status metrics that provide the values indicated in the management specifications. Include probability density functions for biological reference point estimates and population metrics (e.g., biomass and exploitation) used to evaluate stock status.
10. Project future stock conditions (biomass, abundance, and exploitation; including probability density functions) and develop rebuilding schedules if warranted; include estimated generation time. Develop stock projections for the following circumstances, in accordance with the guidance on management needs provided in the management history:
    A) If stock is overfished:
       F=0, FCurrent, F=FMSY, F at 75% of FMSY
       F=FRebuild (max exploitation that rebuild in greatest allowed time)
    B) If overfishing is occurring:
       F=FCurrent, F=FMSY, F at 75% of FMSY
    C) If stock is neither overfished nor undergoing overfishing:
       F=FCurrent, F=FMSY, F at 75% of FMSY
    D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternative models to provide management advice

11. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity
    - Emphasize items that will improve future assessment capabilities and reliability
    - Consider data, monitoring, and assessment needs
12. Complete the Assessment Workshop Report in accordance with project schedule deadlines (Section III of the SEDAR Stock Assessment Report). List of Participants.

Panelists

Jeff Isley (Lead analyst)....................NMFS Miami
Shannon Cass-Calay....................NMFS Miami
Dave Chagaris....................UFL
Mary Christman....................MMC Consulting
Nancie Cummings....................NMFS Miami
Michael Drexler....................Ocean Conservancy/USF
Bob Gill....................SSC
Dan Goethel....................NMFS Miami
Erik Lang....................LDWF
Clay Porch....................NMFS Miami
Joe Powers....................SSC

Adyan Rios..NMFS Miami
Skyler Sagarese ....NMFS Miami
Matthew Smith ....NMFS Miami
Joe West..LDWF

Attendees
Mike Larkin..NMFS/SERO
Linda Lombardi .... NMFS Panama City
John Quinlan ....NMFS
Jim Tolan ....TPWD
Steve Turner ....NMFS Miami
Beth Wrege ....NMFS Miami
Yuying Zhang.. FIU

Staff
Julie Neer ....SEDAR
John Froeschke...GMFMC
Ryan Rindone...GMFMC
Carrie Simmons ....GMFMC

1.1.3. List of Assessment Workshop Working Papers

No Working Papers or reference Documents were provided for the Assessment portion of this assessment.

2 Panel Recommendations and Comments on Terms of Reference

***Term of Reference 1*:** The data workshop recommended separating commercial fleets by gear. However, the Fisheries Statistics Division recommended commercial data be divided longline, and geographically into Monroe County all remaining gear and all other counties combined across remaining gears. This recommendation was based on a significant difference in the size distribution between Monroe County and all other locations. All changes to the data following the Data and Assessment Workshop are reviewed in Section 3.

Term of Reference 2: The Panel recommended the use of a fully integrated age and length based statistical-catch-at-age model (Stock Synthesis) as the modeling platform. The model configuration and data inputs are described in Sections 3 and 4.1.

Term of Reference 3 and 4: Section 4.2 of this report contains estimates of stock parameters, assessment model parameters and their associated standard errors, sensitivity analyses. Sensitivity, biomass, spawning stock biomass, recruitment, and fishing mortality are also presented.

Term of Reference 5 and 6: Estimates of yield and population benchmarks are presented in Section 4.2.

Term of Reference 7: Environmental covariates were not available for this species.

Terms of reference 8 and 9: Stock status determination and associated uncertainty are presented in Section 4.2.9.

Term of Reference 10: -. Projections will be made available as an addendum to this report..

Term of Reference 11: Research recommendations are summarized in Section 4.2.11.

Term of Reference 12: This report satisfies this Term of Reference.

3 Data Review and Update

The following list summarizes the main data inputs used in the assessment model:

- Life history
    - Age and growth
    - Natural mortality
    - Maturity
    - Fecundity
- Landings
- Commercial
    - COM-MC: Commercial gear including vertical line, trap and other gear for Monroe County, Florida only from 1945-2015
    - COM-nMC: Commercial gear including vertical line, trap and other gear for all counties except Monroe County, Florida only from 1945-2015
    - COM-LL: Commercial Longline, all counties from 1980-2015.
- Recreational
    - REC_PRI: Recreational private from 1945-2015.
    - REC-CBHB: Recreational headboat and, charterboat, 1945-2015.
    - REC-SHORE: Recreational Shore, 1945-2015.
- Discards
    - Commercial Monroe County combined vertical line and trap 1981-2015.
    - Commercial not Monroe County combined vertical line and trap 1981-2015.
- Commercial longline – negligible and added to lanndings
    - Recreational headboat and charterboat, 1981-2015.
    - Recreational private, 1981-2015.
    - Recreational shore, 1981-2015.
- Length composition of landings
    - Commercial gear including vertical line, trap and other gear for Monroe County, Florida only from 1987-2015
    - Commercial gear including vertical line, trap and other gear for all counties except Monroe County, Florida only from 1985-2015

  - Commercial Longline, all counties from 1986-2015.
  - Recreational private from 1981-2015.
  - Recreational headboat and, charterboat, 1981-2015.
  - Recreational Shore, 1981-2015.
- Abundance indices
  - Fishery-independent
    - SEAMAP Groundfish Trawl: 2010-2015
    - FWRI Age-0 1998-2015
    - FWRI-Age1 1996-2015
    - Combined video: 1993-1997, 2004-2015
    - NMFS Visual Survey 1997-2014
  - Fishery-dependent
    - Commercial Handline 1993-2015
    - Recreational private (MRFSS) 1981-2015
    - Recreational Shore (MRFSS) 1981-2015
- Discard mortality
  - Commercial Monroe County
  - Commercial not Monroe County
  - Recreational fleets

- A brief summary of each input will be provided in the following sections.

3.1 Life history

3.1.1 Age and growth

Gray snapper age data for SEDAR-51 were supplied by National Marine Fisheries Service, Panama City Laboratory (PCLAB), National Marine Fisheries Service Beaufort laboratory (Beaufort), the Florida Fish and Wildlife Research Institute (FWRI) and the Gulf States Marine Fisheries Commission (GSMFC). A total of 37,201 gray snapper otoliths were sampled during 1982-1983 and from 1990-2015 from the commercial and recreational fisheries and from fishery independent surveys by state and federal programs. Otolith sampling substantially increased in the late 2000s with samples fairly evenly split between the recreational and commercial fishery. Otoliths collected from Florida and Louisiana made up the majority of collections (80% and 17%, respectively), while AL, MS and TX collectively contributed approximately 3%. Gray snapper ranged in age from 1 to 32 years.

A growth curve (**Figure 3.1.1.1**), based on fractional ages and observed fork lengths at capture, was modeled using the von Bertalanffy growth model and was executed in ADMB (Auto Differentiation Model Builder; SEDAR51-DW-08). The size-modified growth model takes into account the non-random sampling due to minimum size restrictions (Diaz et al. 2004) and allows for alternative variance structures. A growth model with a variance structure of CV increase linearly with age and applying both state and federal size limits was chosen as the best predictor of growth for gray snapper. The recommended growth model parameters are

L_{inf}= 54.69 cm FL,
k = 0.1546,
t_0 = -1.4554.

The CV as a function of length at age, the asymptotic length (*L_{inf}*), the von Bertalanffy growth coefficient *(k)* and the theoretical age at length zero *(t_0)*, were fixed within the SS model.

Meristic relationships were also provided to the Data and Assessment Workshop. The parameters describing these relationships are summarized in **Table 3.1.1.1**.

3.1.2 Natural mortality

The Data/Assessment Workshop developed an estimate of natural mortality-at-age using the Lorenzen (1996) estimator, and a target M estimated using Hoenig (1983) assuming a maximum age of 28 years. The resulting natural mortality vector (**Table 3.1.2.1** and **Figure 3.1.2.1**) was fixed within the assessment model. Instead of applying the calculated standard deviation around the older fish, an upper bound at age 32 (M = 0.13) and lower bound at age 25 (M = 0.17) were recommended to be used to estimate sensitivities around the base case for natural mortality (point estimate and age-specific M).

3.1.3 Maturity

The reproductive parameters of Gray Triggerfish, including the sex ratio, maturity and spawning fraction were described in SEDAR51-DW-06. Based upon histological preparations of ovary sections, females displaying vitellogenic or more advanced oocytes (yolked oocytes) were defined as “mature” (consistent with prior SEDARs). Females with cortical alveoli (CA) or primary growth oocytes (PG) as the leading stage, but displaying atretic-yolked oocytes, were classified as "uncertain maturity”. Females with primary growth oocytes and with no indications of prior spawning were classified as “immature”. Female records used to determine maturity were taken only from the reproductive period (June, July and August).

Maturity was determined from histological analysis of female gray snapper. Age and size at 50% maturity was calculated to be 2.3 years or 253mm FL respectively with 90% maturity occurring at 5.2 years or 362mm FL (**Figure 3.1.3.1**.; SEDAR51-DW-06). SEDAR51-RD-11 estimated maturity to occur between 239-288mm FL, which brackets the most recent calculation of length at 50% maturity. Despite the 50% maturity metric, if female gonadosomatic index is observed within size it is evident that a significant contribution to the spawning stock is not achieved until 300mm FL (SEDAR51 DW-06). Consequently, the 300mm FL mark is a more accurate estimate of maturity for gray snapper. The LHW group noted there were few fish sampled below 300 mm FL and suggested that additional data points be added to the GSI using macroscopically sexed fish from the FWRI-FIM and PCLAB datasets. The addition of these fish did not change the conclusion that fish below 300 mm FL contribute little reproductively. This maturity function was assumed fixed in the SS model.

3.1.4 Sex Ratio

Sex ratio has been documented by several studies (SEDAR51-RD-23, SEDAR51-RD-11, SEDAR51-DW-06). The most recent sex ratio was 0.48 proportion females; however, the model assumes a 50:50 sex ratio.

3.1.5 Fecundity

Batch fecundity estimates were available for only six fish, which did not allow estimation of length or age specific functions. Estimated range of batch fecundity fell between 222,642 and 1,405,892 ova with a mean (±SD) of 615,715 (±622,910) ova (SEDAR51-DW-06). These estimates were derived from females that ranged in size from 335mm-655mm FL. Relative fecundity ranged from 3,667 to 5,721 ova/g of body weight (BW) with a mean (±SD) of 4,546 (±664) ova/g of body weight (SEDAR51-DW-06). If annual fecundity were calculated as a product of average batch fecundity and spawning frequency, the result would be 22,781,455, but this annual fecundity estimate could not be size specific due to the lack of batch fecundity estimates. Additionally, batch fecundity estimates were obtained from females sampled near the peak of spawning season and during the 1990s, which denotes estimates that are not representative of the whole season and are not current or up to date. Because neither batch fecundity nor fecundity estimates were available, weight was used as a proxy for fecundity.

3.2 Landings

3.2.1 Commercial landings

Commercial landings statistics from 1963-2015 were obtained from the NMFS Accumulated Landings System (ALS). Several gears were combined under the designation “Handline” (aka vertical line) including electric reel, bandit rig, manual reel and manual handline. In addition, gear with <1% of landings such as spear, trawl, etc. were pooled in Handline.

Commercial effort was concentrated on the central west coast of Florida (**Figure 3.2.1.1).** Commercial landings were reviewed at the Data Workshop and are presented in **Table 3.2.1.1.** A significant change to commercial landing categories has taken place since the workshop. Commercial landings (excluding Longline) were split into Monroe County, Florida, and all other Gulf of Mexico Counties (not Monroe County). Further, trawl landings were combined with handline landings. This change was the result of pooling gear with similar selectivity patterns rather than gear type.

Commercial landings (mt whole weight) were reported by gear. All gears were pooled with the exception of longline. Landings were dominated by commercial handline (**Figure 3.2.1.2)**. A trap fishery existed for a period, but has since been eliminated by regulation. Although Gray Snapper are caught on bottom longline, Gray Snapper are not the targeted species. Landings reported under longline made up less than 1% of overall commercial landings, but were kept separate because the size composition indicated that large fish were retained, and due to the expectation that selectivity was near-asymptotic. The aggregated commercial landings were converted to metric tons whole weight for input into the SS model. Landings prior to 1963 were estimated. Commercial landings were assumed to have a standard error of 0.05.

3.2.2 Recreational landings

Recreational landings (in 1000s of fish) were reviewed by the Data/Assessment Workshop and are presented in **Table 3.2.2.1** and **Figure 3.2.2.1**. Recreational landings are available by mode and include headboat/charterboat, private boat, and shore. Prior to 1981, private and charterboat landings are only available as a single combined mode. Between 1945 and 1980, the recreational fleet landings are estimated from effort data using a constant catch per effort ratio.

The recreational fishery statistics for Gray Snapper were obtained from three separate sampling programs: Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD) and the Southeast Region Headboat Survey (SRHS). MRIP (formerly known as MRFSS) began in 1979 (data prior to 1981 are generally considered less reliable), and collects estimates of shore based, charter boat and private/rental boat fishing from Florida through Louisiana. MRIP also included information from headboat trips from 1981-1985. MRIP collects information on fish landed, discarded dead and released alive. However, it is important to note that estimates of discards and released fish are self-reported.

The SRHS focuses on monitoring and sampling the recreational headboat fisheries in the Atlantic and Gulf of Mexico, from Texas to Florida. SRHS data collection includes catch records from every trip and biological samples from dockside intercepts by port samplers.

Prior to 1986, TPWD was responsible for reporting landings from all recreational boat modes operating in Texas. However, since 1986 GOM headboat landings have been compiled by the SRHS. TPWD continued to sample charterboat and private boat fishing modes, but the emphasis was placed on sampling bay and inshore fishing effort. Therefore, it is likely that offshore fishing is under-represented in the TPWD estimates. TPWD also does not record information on discards.

3.3 Discards

3.3.1 Commercial discards

. For the SS model, the annual proportion discarded (discards/(total landings + discards)) was used rather than the absolute magnitude of discards. These proportions are illustrated in **Table 3.3.1.1**.

Discard observations from the commercial observer program could not be stratified according to the preferred model structure. Therefore, discard fractions were estimated for the commercial fleet (other than longline) operating inside and outside of Monroe County using area-specific landings, self-reported discards and gulf wide observer program reports as follows:

1) Typically, self-reported discard rates are biased low relative to those reported by observers. Therefore, a correction factor was calculated to scale the self-reported discards:

   Correction Factor = Total Gulfwide Discards from Observer Program / Total Gulfwide Self Reported Discards

2) Area-specific corrected discards were then estimated:

   Corrected Discards = Correction Factor * Self-Reported Discards

3) Finally, area-specific discard fractions were calculated:

   Discard Fraction = Corrected Discards/(Corrected Discards + Landings)

Longline discards were negligible, assumed to have 100% mortality, and were added to landings.

3.3.2 Recreational discards

Annual estimates of recreational discards were derived from MRIP for the years 1981-2015. Fleet-specific discards are based on dockside interviews (intercepts) of anglers and represent the self-reported number of fish discarded alive. The recreational discards were reviewed at the Data and Assessment Workshop and are presented in **Table 3.3.2.1**. Discards by headboat/charterboat, private and shore modes were used in the assessment model. For the SS model, the annual proportion discarded was used rather than the absolute magnitude of discards. These proportions are illustrated in **Figure 3.3.2.1**.

3.4 Length composition

3.4.1 Length composition of commercial landings

Estimated commercial length composition was derived using the observed length frequency (**Table 3.4.1.1**). The effective sample size was initially capped at 200 in order to reduce the effects of pseudoreplication. Later, the model components were re-weighted using the Francis (2014) procedure. The derived commercial length composition is summarized in **Figure 3.4.1.1**. Cohorts are not readily apparent in the commercial data.

3.4.2 Length composition of recreational landings

Estimated recreational Length composition was also derived using the observed length frequency. tThe effective sample size was capped at 100 (**Table 3.4.1.1).** Data for the charterboat and private modes were aggregated into a single combined mode. The derived recreational length composition is summarized in **Figure 3.4.1.1**. Like the commercial size composition, cohorts are also not readily apparent in the recreational size data.

3.5 Measures of population abundance

Indices of abundance were presented and considered during the Data/Assessment Workshop. The eight indices of abundance that were recommended for use in the assessment include:

- Fishery-independent
  - SEAMAP Groundfish Trawl: 2010-2015
  - FWRI Age-0 1998-2015
  - FWRI-Age1 1996-2015
  - Combined video: 1993-1997, 2004-2015
  - NMFS Visual Survey 1997-2014
- Fishery-dependent
  - Commercial Handline 1993-2015
  - Recreational private (MRFSS) 1981-2015
  - Recreational Shore (MRFSS) 1981-2015

The combined video survey index (SEAMAP VIDEO, Panama City Video, and FWRI Video) is a relatively new index that represents a longer time series than the SEAMAP Video alone. It was developed by standardizing three similar fishery-independent video surveys across common habitat types (SEDAR51-DW-14).

Five of the eight indices were derived from fishery-independent data sources (**Table 3.5.1**; **Figures 3.5.1 – 3.5.5**). The SEAMAP groundfish index was derived as the mean number of Gray Snapper caught per trawl hour. The combined video survey was derived as the minimum count of Gray Snapper (maximum number of individuals in the field of view at one instance) per 20 minute recording interval. The visual survey was derived as the mean number observed per 20 minute observation period. The FWRI Age-0 trawl survey and the FWRI Age-1 trawl survey were calculated as the mean number of Gray Snapper per trawl hour.

There were three fishery-dependent indices recommended by the Data Workshop: Marine Recreational Fishery Statistic Survey (MRFSS) private index, the MRFSS shore index, and the Commercial Vertical Line index, (**Tables 3.5.2; Figures 3.5.2 – 3.5.8**). The MRFSS indices, which represent the private mode and shore mode, were derived using the numbers of Gray Snapper landed or discarded per angler hour. The commercial vertical line index was derived as pounds of Gray Snapper landed per hook hour.

For input into the Stock Synthesis assessment model, the coefficients of variation (CV) associated with the standardized indices were converted to log-scale standard errors as follows:

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

As fishery dependent indices tend to have smaller errors than fishery independent indices due to very high sample sizes, and vagaries in the standardization procedure, there is a risk of overweighting them in stock assessment models. In this case, the assessment panel supported equal weighting. Therefore, index CVs input to the model were scaled to their own mean, and multiplied by 0.2 to put all indices on the same scale.

3.6 Discard Mortality

Discard mortality of gray Snapper has not been extensively studied. This topic was discussed at the Data/Assessment Workshop. Based on a review of best available information, the panel recommended a 14% discard mortality rate for recreational fleets and 6.9% for commercial fleets. T in the model. To reduce this effect, Index CVs were adjusted to the mean of their respective index (average 1) and multiplied by 0.2 to put all indices on the same scale.

3.7 Tables

Table 3.1.1.1--Meristic regressions for Gray Snapper (1991-2015) from the Gulf of Mexico. Data combined from all fishery independent and fishery dependent data sources. Length Type: Max TL – Maximum Total Length, FL – Fork Length, Nat TL – Natural Total Length, Type: SL – Standard Length; W Wt – Whole Weight, G Wt – Gutted Weight. Units: length (cm) and weight (kg). Linear and non-linear regressions calculated using R (lm and nls functions, respectively).

Regression	Equation	Parameters ± std. err.	Statistic	N	Data Range
Max TL to FL	FL = a + max_TL *b	a = 0.36 ± 0.02 b = 0.93 ± 6.06e-04	r^2 =0.999	3050	Max TL: 10.1 – 63.5 FL: 9.6 – 60.5
Max TL to SL	SL = a + max_TL *b	a = -0.22 ± 0.03 b = 0.79 ± 9.75e-04	r^2 = 0.996	2661	Max TL: 10.1 – 63.2 SL: 7.9 – 51.7
Nat TL to FL	FL = a + nat_TL * b	a = -0.25 ± 0.03 b = 0.96 ± 8.89e-04	r^2 = 0.993	8722	Nat TL: 19.4 – 74.0 FL: 19.0 – 71.7
SL to FL	FL = a + SL * b	a = 0.77 ± 0.03 b = 1.17 ± 1.39e-03	r^2 = 0.997	2451	FL: 9.6 – 60.5 SL: 7.9 – 51.7
Max TL to W Wt	W WT =a* (max_TL^b)	a = 1.07e-05 ± 4.91e-07 b =3.08 ± 1.19e-02	RSE = 0.07	1302	Max TL: 10.1 – 66.0 W WT: 1.8 – 5.0
Nat TL to W Wt	W WT = a* (nat_TL^b)	a = 1.10e-05 ± 2.51e-07 b =3.05 ± 5.83e-03	RSE = 0.11	6937	Nat TL: 19.4 – 73.2 W WT: 1.0 – 6.6
FL to W Wt	W WT = a* (FL^b)	a = 1.43e-05 ± 2.69e-07 b =3.02 ± 4.76e-03	RSE = 0.13	10954	FL: 9.6 – 71.5 W WT: 1.8 – 6.6
SL to W Wt	W WT = a* (SL^b)	a = 6.55e-05 ± 2.16e-06 b = 2.74 ± 1.03e-02	RSE = 0.03	1224	SL: 7.9 – 43.6 W WT: 1.8 – 1.9
FL to G Wt	G WT = a* (FL^b)	a = 1.53e-05 ± 6.20e-07 b = 3.00 ± 1.04e-02	RSE = 0.17	4551	FL: 26.0 – 72.0 G WT: 2.3 – 6.1

Table 3.1.2.1-- Life history working group recommended model sensitivities for age-specific mortality. Base case used maximum aged of 28 yrs for Gray Snapper, this age was validated using radiocarbon (C14), the upper and lower bounds for mortality were based on ages 25 and 32 yrs.

Age	Base	Upper	Lower
0	0.5047	0.5659	0.4410
1	0.3552	0.3983	0.3104
2	0.2838	0.3183	0.2480
3	0.2423	0.2717	0.2117
4	0.2153	0.2415	0.1882
5	0.1966	0.2205	0.1718
6	0.1830	0.2052	0.1599
7	0.1728	0.1937	0.1510
8	0.1649	0.1849	0.1441
9	0.1587	0.1779	0.1386
10	0.1537	0.1723	0.1343
11	0.1497	0.1678	0.1308
12	0.1464	0.1642	0.1279
13	0.1437	0.1612	0.1256
14	0.1415	0.1587	0.1236
15	0.1396	0.1566	0.1220
16	0.1381	0.1548	0.1207
17	0.1368	0.1534	0.1195
18	0.1357	0.1522	0.1186
19	0.1348	0.1511	0.1178
20	0.1340	0.1502	0.1171
21	0.1333	0.1495	0.1165
22	0.1328	0.1489	0.1160
23	0.1323	0.1483	0.1156
24	0.1319	0.1479	0.1152
25	0.1315	0.1475	0.1149
26	0.1312	0.1472	0.1147
27	0.1310	0.1469	0.1145
28	0.1308	0.1466	0.1143

Table 3.2.1.1-- Annual Gray Snapper commercial landings from the U.S. Gulf of Mexico in metric tons whole weight from 1945-2015. All commercial gears were pooled with the exception of longline. Landings from 1945-1962 are estimated.

Year	Monroe County	All Other Counties	Longline
1945	0	0	0
1946	0.5	0.5	0
1947	2.7	3.2	0
1948	4.5	5.4	0
1949	6.4	7.7	0
1950	8.6	10.9	0
1951	10.4	13.2	0
1952	12.3	15	0
1953	13.6	17.2	0
1954	15.4	19.5	0
1955	17.2	21.8	0
1956	18.1	23.1	0
1957	19.5	24.5	0
1958	20.4	25.9	0
1959	21.8	27.2	0
1960	22.7	28.6	0
1961	22.7	28.6	0
1962	22.7	28.6	0
1963	28.1	37.2	0
1964	32.2	36.8	0
1965	50.4	67.6	0
1966	39.9	49.9	0
1967	45.4	55.8	0
1968	56.7	86.2	0
1969	60.3	82.6	0
1970	55.4	76.2	0
1971	58.5	81.2	0
1972	153.4	86.7	0
1973	52.6	118.9	0
1974	54.9	132	0
1975	30.9	143.8	0
1976	50.4	190.1	0
1977	40.4	178.8	0
1978	41.3	190.1	0
1979	36.3	191	0
1980	45.4	184.7	9.1
1981	82.1	177.4	9.1

1982	96.2	169.2	21.3
1983	125.7	138.8	39
1984	122.5	60.8	21.3
1985	98.9	48.1	15.9
1986	139.3	47.2	18.6
1987	139.7	47.6	20
1988	113.9	33.1	13.2
1989	90.3	50.8	20.4
1990	42.2	45.4	13.6
1991	29.9	78.5	10.9
1992	46.7	52.2	5
1993	67.2	74	8.2
1994	51.3	100.3	4.1
1995	20	64.9	2.3
1996	29.5	50.8	2.3
1997	18.1	52.6	2.3
1998	17.7	45.4	1.8
1999	16.3	61.7	4.5
2000	15	65.3	3.6
2001	9.1	76.7	4.5
2002	13.6	85.3	5.9
2003	12.3	73	4.1
2004	16.8	81.2	6.4
2005	15.4	85.3	5.9
2006	14.1	72.1	5.4
2007	16.3	47.2	4.5
2008	6.4	55.8	6.4
2009	8.2	71.2	1.8
2010	11.8	37.7	1.8
2011	11.8	70.8	5
2012	12.7	63.1	5.4
2013	10	50.8	4.5
2014	3.6	79.4	7.7
2015	5	58.1	11.3

Table 3.2.2.1. Annual Gray Snapper recreational landings from the U.S. Gulf of Mexico in 1000s of fish from 1945-2015. Values prior to 1981 are estimated.

year	REC_PR	REC_Shore	REC_HB+CB
1945	0	0	0
1946	10	10	2
1947	55	55	10
1948	90	90	16
1949	124	125	22
1950	175	176	31
1951	210	211	37
1952	244	246	44
1953	279	281	50
1954	314	316	56
1955	349	351	62
1956	371	373	66
1957	393	396	70
1958	416	418	74
1959	438	440	78
1960	460	463	82
1961	461	464	82
1962	462	465	83
1963	464	466	83
1964	465	467	83
1965	466	469	83
1966	477	480	85
1967	488	491	87
1968	500	502	89
1969	511	514	91
1970	522	525	93
1971	540	543	97
1972	559	562	100
1973	577	580	103
1974	595	599	106
1975	614	617	110
1976	649	652	116
1977	684	688	122
1978	719	723	128
1979	753	758	135
1980	788	793	141
1981	816	302	38

1982	566	714	369
1983	321	1123	159
1984	1342	1582	81
1985	934	281	64
1986	568	1241	155
1987	784	1353	99
1988	829	708	101
1989	1566	1103	183
1990	940	525	88
1991	1063	1877	139
1992	883	651	147
1993	1076	758	157
1994	959	516	224
1995	939	374	199
1996	797	484	118
1997	818	390	104
1998	902	376	181
1999	787	158	175
2000	915	282	185
2001	997	387	199
2002	900	229	202
2003	1341	298	264
2004	1796	405	254
2005	1189	349	217
2006	684	263	225
2007	1006	323	249
2008	1405	484	312
2009	1278	419	384
2010	439	150	177
2011	587	60	219
2012	1250	376	216
2013	1183	179	306
2014	1424	331	335
2015	1127	200	270

Table 3.3.1.1-- Annual Gray Snapper commercial discards as a fraction of total catch (landings plus discards) from the U.S. Gulf of Mexico from 1993-2015.

Year	CHL_MC	CHL_nMC
1993	0.380015	0.156715
1994	0.492964	0.157534
1995	0.679761	0.176326
1996	0.507478	0.160561
1997	0.634813	0.171238
1998	0.55118	0.169
1999	0.541442	0.116203
2000	0.596406	0.116488
2001	0.723874	0.143788
2002	0.727693	0.09081
2003	0.154173	0.324029
2004	0.622986	0.102883
2005	0.658479	0.021984
2006	0.674428	0.121682
2007	0.437559	0.121682
2008	0.654623	0.143138
2009	0.53672	0.121682
2010	0.269618	0.014017
2011	0.5811	0.087832
2012	0.143129	0.000109
2013	0.822489	0.216059
2014	0.9074	0.047454
2015	0.046231	0.017478

Table 3.3.2.1--Annual Gray Snapper recreational discards as a fraction of total catch (landings plus discards) from the U.S. Gulf of Mexico from 1981-2015.

Year	REC_Private	REC_Shore	REC_CBHB
1981	0.183796	0.27652	0.026083
1982	0.210551	0.228864	0.278688
1983	0.145415	0.526248	0.072165
1984	0.057569	0.179244	0.090103
1985	0.419711	0.378452	0.094365
1986	0.480257	0.113696	0.10413
1987	0.191516	0.011204	0.187513
1988	0.34279	0.246184	0.068684
1989	0.32666	0.289899	0.138988
1990	0.473508	0.507112	0.179841
1991	0.720795	0.690993	0.357719
1992	0.746536	0.752144	0.426092
1993	0.699762	0.746683	0.256397
1994	0.69377	0.740874	0.246464
1995	0.672464	0.807556	0.402375
1996	0.708942	0.802592	0.367732
1997	0.740422	0.855763	0.485169
1998	0.746791	0.838366	0.417528
1999	0.718032	0.879401	0.438558
2000	0.749008	0.874675	0.458838
2001	0.692217	0.788107	0.24445
2002	0.756646	0.85937	0.361245
2003	0.753031	0.908539	0.282028
2004	0.615665	0.820061	0.321477
2005	0.736041	0.90494	0.361826
2006	0.777069	0.896606	0.315481
2007	0.749944	0.913498	0.367859
2008	0.757029	0.872521	0.394726
2009	0.682027	0.785842	0.269724
2010	0.777343	0.820019	0.484299
2011	0.755973	0.940167	0.46882
2012	0.663989	0.877192	0.466359
2013	0.734702	0.912605	0.484153
2014	0.786023	0.863352	0.434323
2015	0.772147	0.901283	0.518897

Table 3.4.1.1 Number of Gray Snapper lengths measured in the Gulf of Mexico by sector, gear and year.

Year	Commercial Monroe County	Commercial not Monroe County	Longline	Private	Charterboat/ Headboat	Shore
1981				59	54	
1982				63	108	
1983				16	58	90
1984				22	38	79
1985		74		10	32	52
1986		92	183	38	38	99
1987	602	527		216	20	512
1988	417	284		96	86	257
1989	1925	1007	27	160	77	351
1990	1107	200	203	76	23	169
1991	1631	354	310	152	62	362
1992	1230	395	92	343	105	776
1993	886	273	68	273	140	680
1994	2155	565	67	271	141	677
1995	1384	355	46	309	107	710
1996	935	956	27	194	77	463
1997	1259	681	29	196	63	444
1998	934	740	262	381	88	822
1999	879	1746	235	473	75	1019
2000	339	1178	128	329	50	689
2001	1303	950	152	424	84	931
2002	544	809	347	339	30	705
2003	669	423	230	426	58	910
2004	440	411	449	428	39	887
2005	377	301	232	390	52	829
2006	378	218	258	334	33	693
2007	316	239	225	489	57	1028
2008	573	382	348	765	105	1634
2009	627	884	127	780	94	1654
2010	432	397	218	341	30	712
2011	230	537	272	260	7	526
2012	740	963	218	241	74	555
2013	830	767	359	651	40	1342
2014	762	771	426	1437	36	2908
2015	391	532	306	988	17	1993

Table 3.5.1 Fishery-independent standardized indices of abundance and associated coefficients of variation for the Gulf of Mexico Gray Snapper. The indices are scaled to a mean of one over each respective time series.

	FWRI - Age 0		FWRI - Age 1		SEAMAP Trawl		NMFS/FWRI Video		NMFS Visual Survey	
Year	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1993							0.996	0.2700		
1994							1.212	0.3126		
1995							0.780	0.2654		
1996			0.244	0.3336			1.337	0.2676		
1997			0.441	0.2582			1.088	0.2113	0.650	0.141
1998	0.174	0.317	0.500	0.2623					1.240	0.126
1999	0.957	0.241	0.465	0.2363					1.210	0.111
2000	0.711	0.215	0.438	0.2124					1.340	0.113
2001	1.486	0.169	0.339	0.2587					1.610	0.124
2002	1.711	0.166	1.145	0.1985					1.380	0.122
2003	1.157	0.165	0.974	0.2292					0.880	0.154
2004	1.794	0.162	1.002	0.2236			0.612	0.3029	0.670	0.130
2005	0.462	0.206	0.695	0.2493			0.975	0.2798	1.110	0.144
2006	1.350	0.158	0.400	0.2434			0.891	0.1703	0.730	0.126
2007	1.035	0.172	2.633	0.2077			0.440	0.1966	0.910	0.146
2008	0.475	0.197	1.478	0.2137			1.379	0.1680	1.000	0.116
2009	1.365	0.156	0.967	0.2113			1.290	0.1429	1.300	0.115
2010	0.885	0.168	0.395	0.2401	1.043	0.2703	1.254	0.1266	1.080	0.102
2011	0.532	0.189	0.273	0.2778	0.881	0.2998	0.720	0.1194	2.090	0.123
2012	1.411	0.178	0.809	0.193	0.865	0.2650	0.980	0.1312	1.190	0.103
2013	0.383	0.317	2.083	0.2021	0.808	0.3066	0.869	0.1326		
2014	1.471	0.166	1.396	0.1987	1.395	0.2394	1.114	0.1029	2.610	0.112
2015	0.641	0.194	3.324	0.1928	1.008	0.2833	1.063	0.1072		

Table 3.5.2. Fishery-dependent standardized indices of abundance and associated CVs for Gulf of Mexico Gray Snapper. The indices are scaled to a mean of one over each respective time series.

	Commercial Handline		MRFSS- Private		MRFSS - Shore	
Year	Index	CV	Index	CV	Index	CV
1981			0.873592	0.31133	0.646005	0.348771
1982			0.519337	0.471026	0.710038	0.310881
1983			0.340947	0.613622	0.528797	0.380136
1984			0.732039	0.497593	0.625166	0.337827
1985			1.03358	0.400567	0.685088	0.369455
1986			0.659926	0.242865	0.760976	0.530273
1987			0.957945	0.219665	0.346812	0.640078
1988			0.886731	0.241781	0.912125	0.307677
1989			1.375835	0.21028	1.331171	0.254117
1990			1.433744	0.230592	0.656279	0.305984
1991			1.549596	0.215095	2.044505	0.202007
1992			1.226582	0.108603	0.953742	0.157798
1993	0.88	0.08	1.473405	0.104217	1.046635	0.112136
1994	1.13	0.07	1.170199	0.10461	0.946687	0.12588
1995	0.92	0.07	1.197099	0.123244	0.925637	0.124872
1996	0.92	0.07	0.87705	0.111063	1.07308	0.132393
1997	1.1	0.07	1.062488	0.106887	1.050469	0.132412
1998	1.03	0.07	1.135116	0.091494	0.934769	0.122932
1999	1.28	0.06	0.895737	0.086671	0.75064	0.129067
2000	0.98	0.06	0.928648	0.10136	0.805161	0.154763
2001	1.15	0.06	0.882169	0.09888	0.660457	0.167039
2002	1.25	0.05	0.906674	0.084816	0.867635	0.14504
2003	0.95	0.06	0.980108	0.075635	1.565499	0.103441
2004	0.99	0.06	0.741287	0.085588	1.340784	0.120478
2005	1.09	0.06	0.838456	0.081364	1.808909	0.097698
2006	1.14	0.06	0.882926	0.088588	1.006444	0.160896
2007	1	0.07	0.99399	0.08313	1.784857	0.104526
2008	0.82	0.07	1.108268	0.073199	1.390504	0.109396
2009	0.9	0.07	0.951115	0.078479	0.962728	0.121791
2010	0.8	0.08	0.57033	0.117658	0.641256	0.154243
2011	0.82	0.09	0.655693	0.121878	0.816103	0.153668
2012	0.96	0.08	0.759882	0.115026	0.945502	0.145545
2013	0.86	0.08	1.188553	0.093536	1.06439	0.120816
2014	0.98	0.07	1.681767	0.065042	1.267026	0.131328
2015	1.05	0.07	1.529188	0.072762	1.144122	0.149536

3.8 Figures

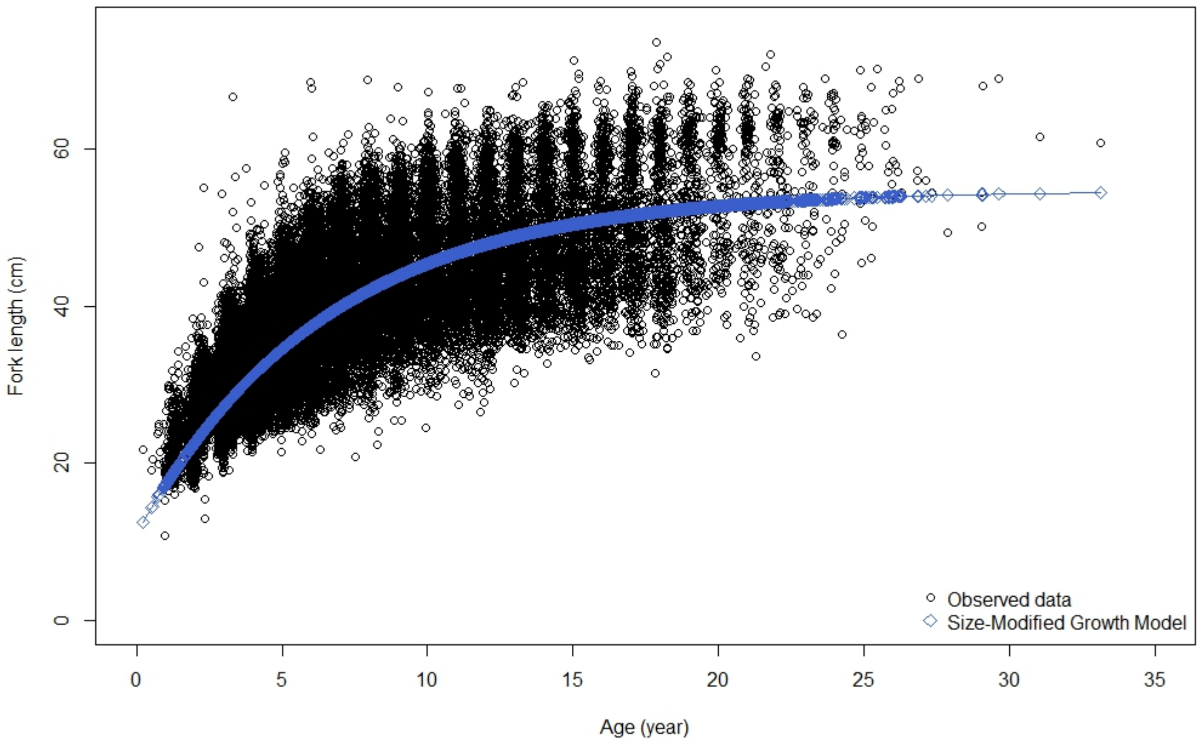


Figure 3.1.1.1 Von Bertalanffy growth relationship recommended by the Data Workshop (dark blue). The von Bertalanffy parameters assuming increasing CV with age were: L_{inf} = 54.69cm FL, K = 0.1546, and t_0 = -1.4554.

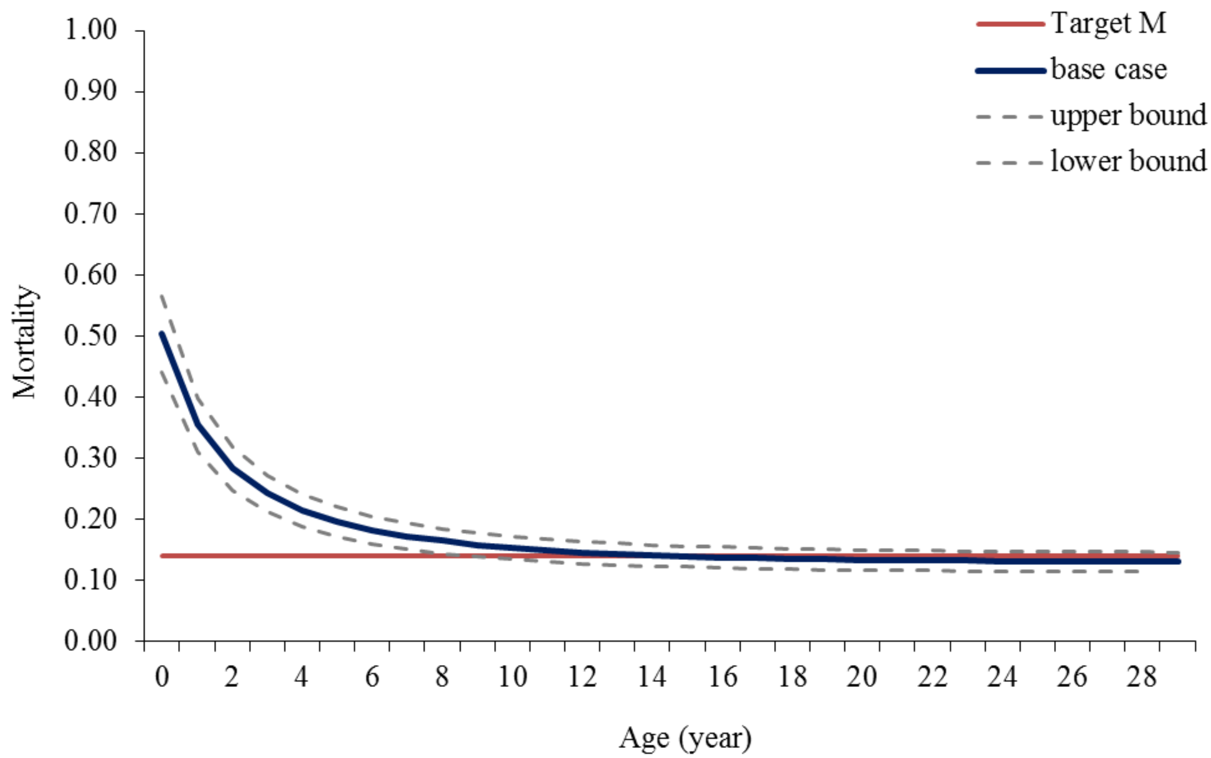


Figure 3.1.2.1 Recommended age-specific natural mortality vector recommended by the Data/Assessment Workshop (red line). The target mortality based on Hoenig et al. (1983) was 0.15 (red line).

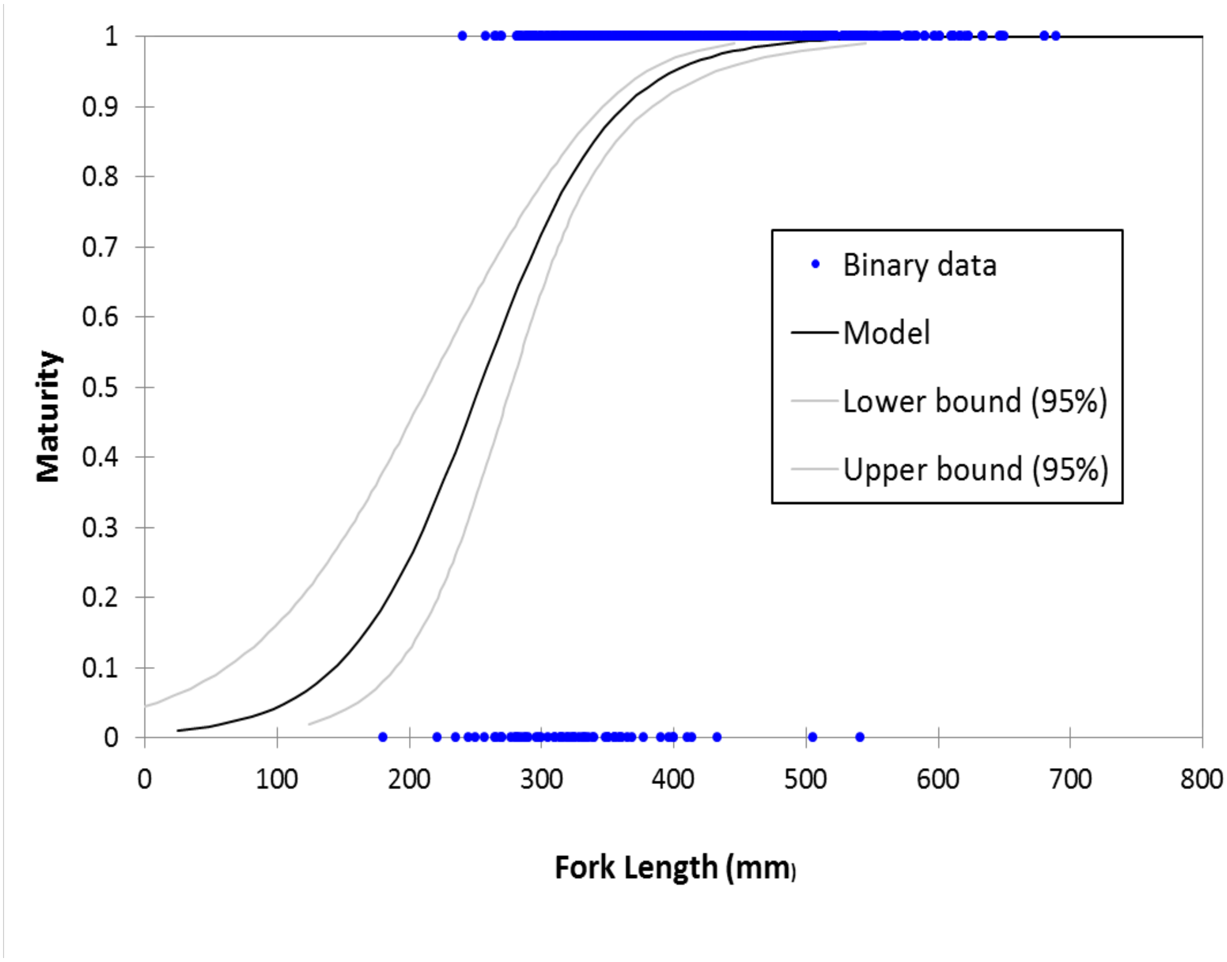


Figure 3.1.3.1 Proportion mature at size. Logistic regression of female gray snapper maturity by fork length. The blue circles denote the binary data wherein an individual should be spawning (1) or not (0) during the reproductive season. The dark line is the predicted maturity, light lines are 95% confidence intervals..

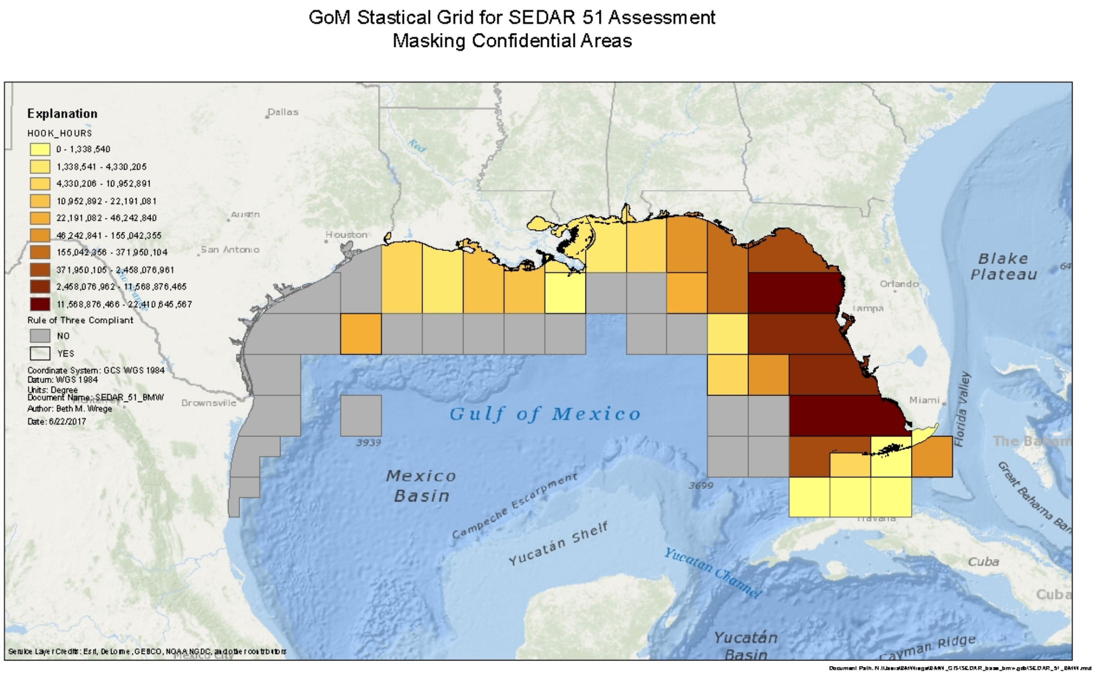


Figure 3.2.1.1 Gray Snapper commercial fishing effort in hook hours from the CFLP (1962 - 2015).

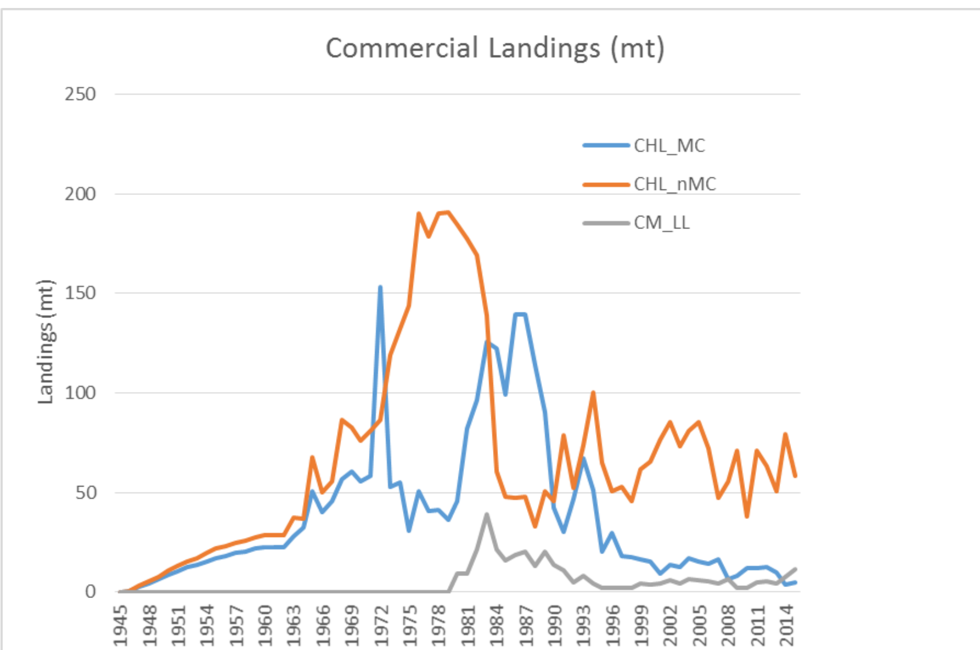


Figure 3.2.1.2 Gray Snapper Commercial landings (mt) from the U.S. Gulf of Mexico from 1945-2015. Values prior to 1962 are estimated.

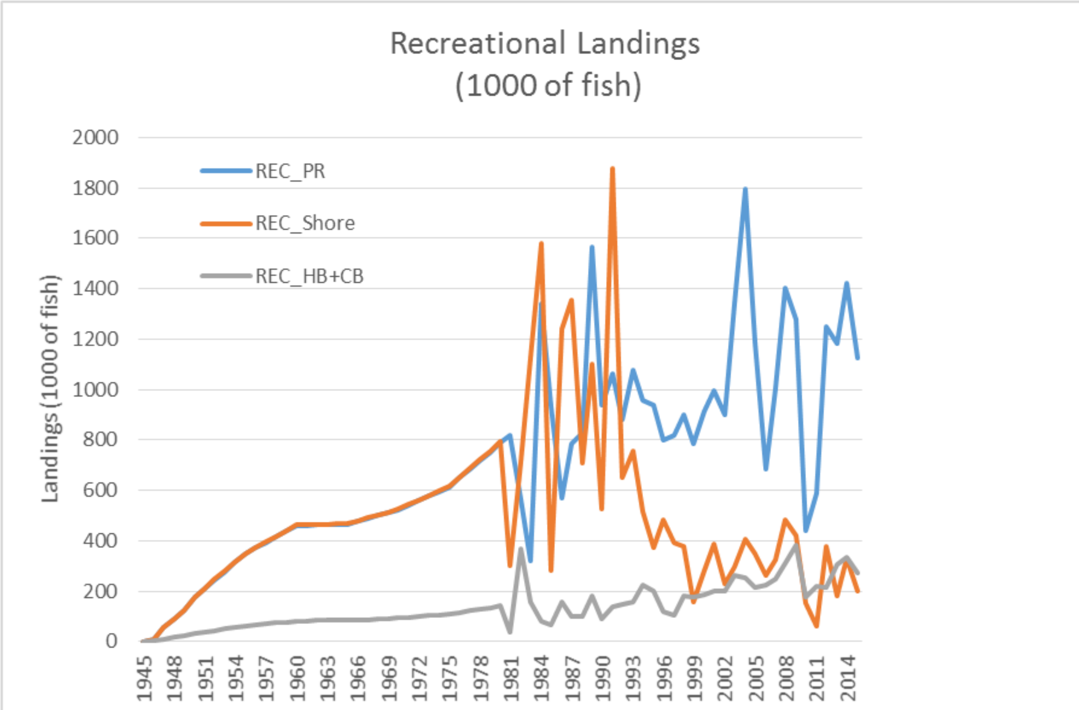


Figure 3.2.2.1 Gray Snapper recreational landings (thousands of fish) from the U.S. Gulf of Mexico from 1945-2015. Values prior to 1981 are estimated.

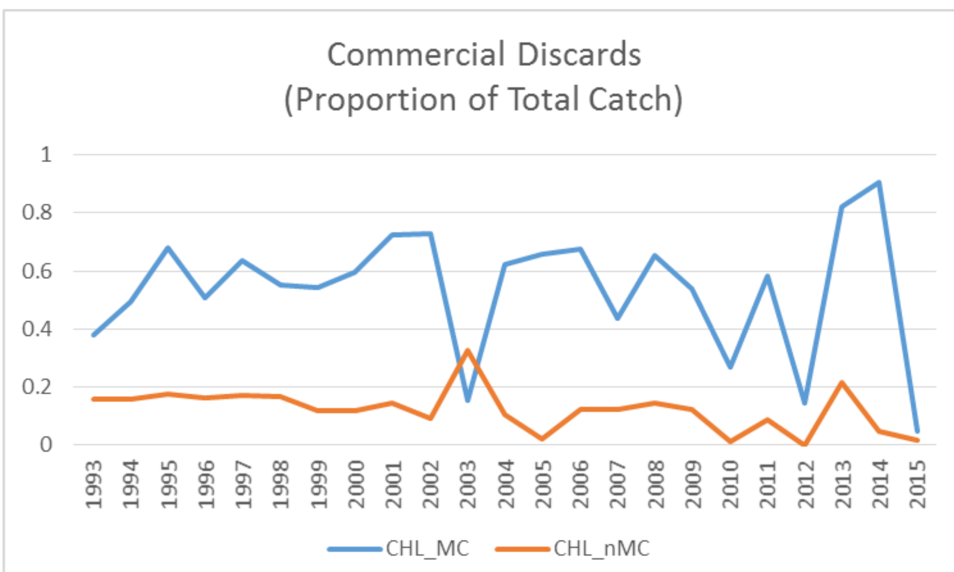


Figure 3.3.1.1 Gray Snapper commercial discards from the U.S. Gulf of Mexico as a proportion of total catch (landings + discards) from 2000-2015.

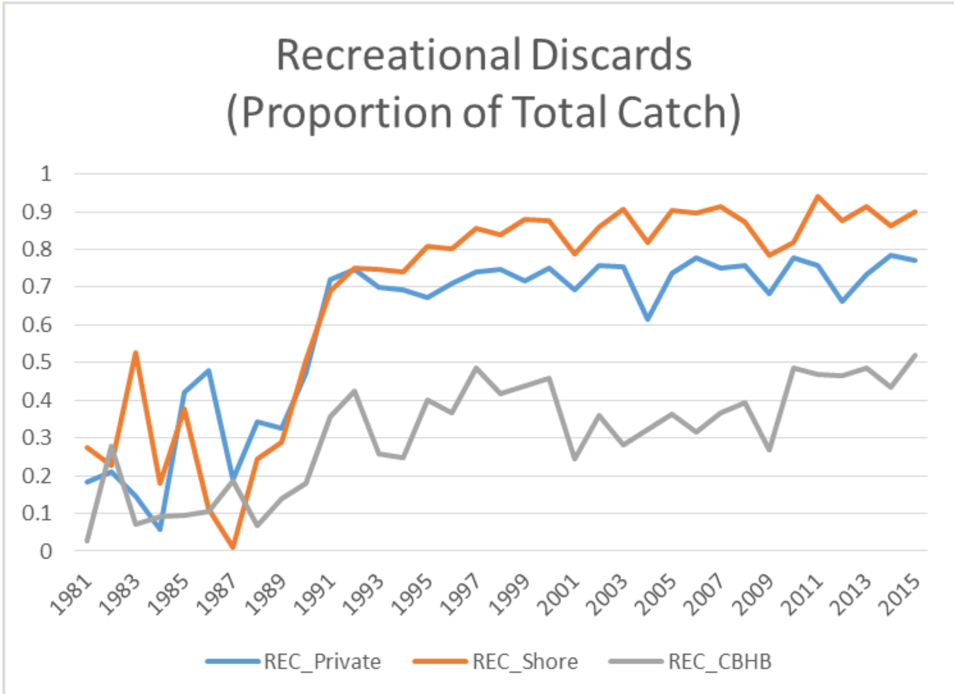


Figure 3.3.2.1 Gray Snapper recreational discards from the U.S. Gulf of Mexico as a proportion of total catch (ab1b2) from 1981-2015.

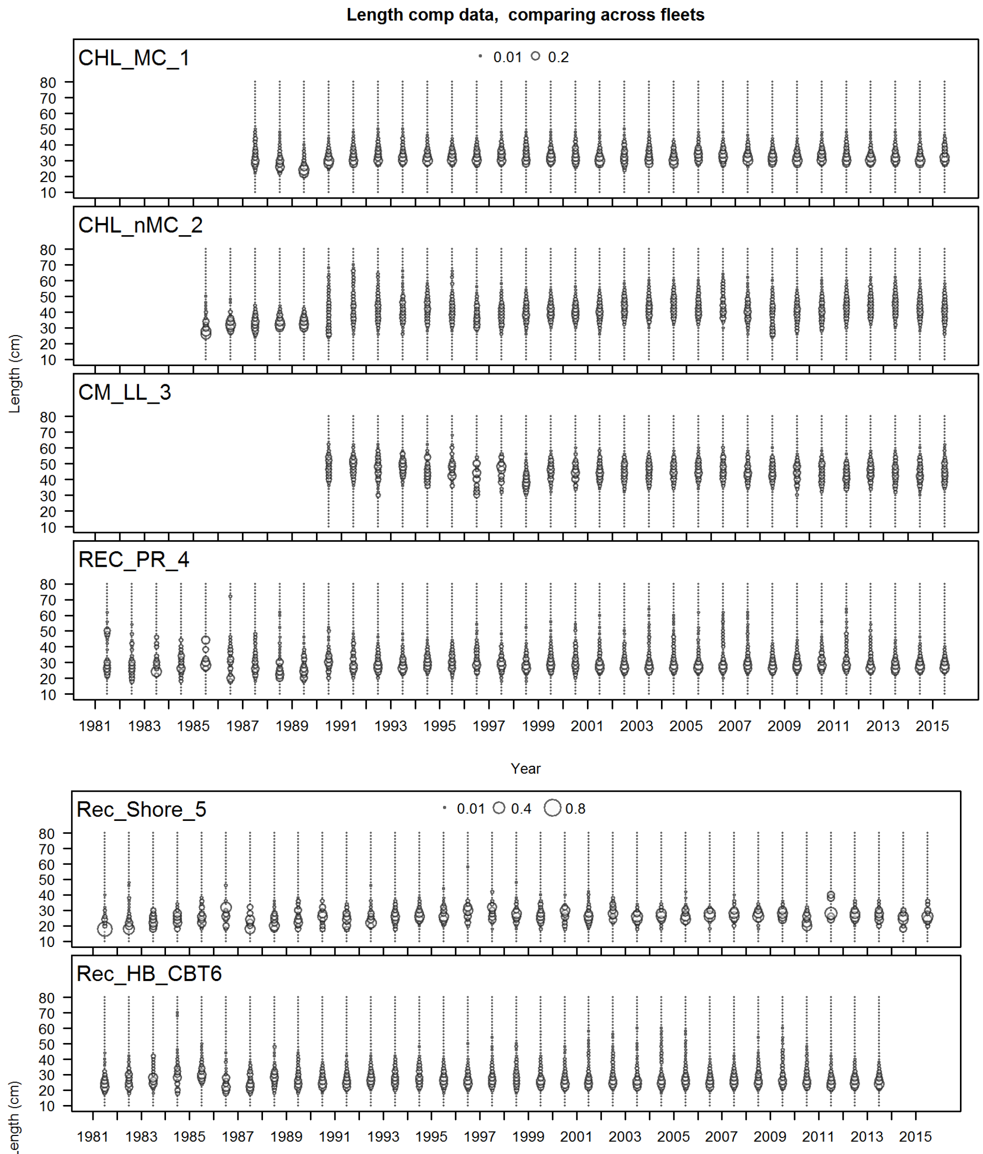


Figure 3.4.1.1 Length composition data of Gray Snapper, comparing across fleets in the Gulf of Mexico.

Year

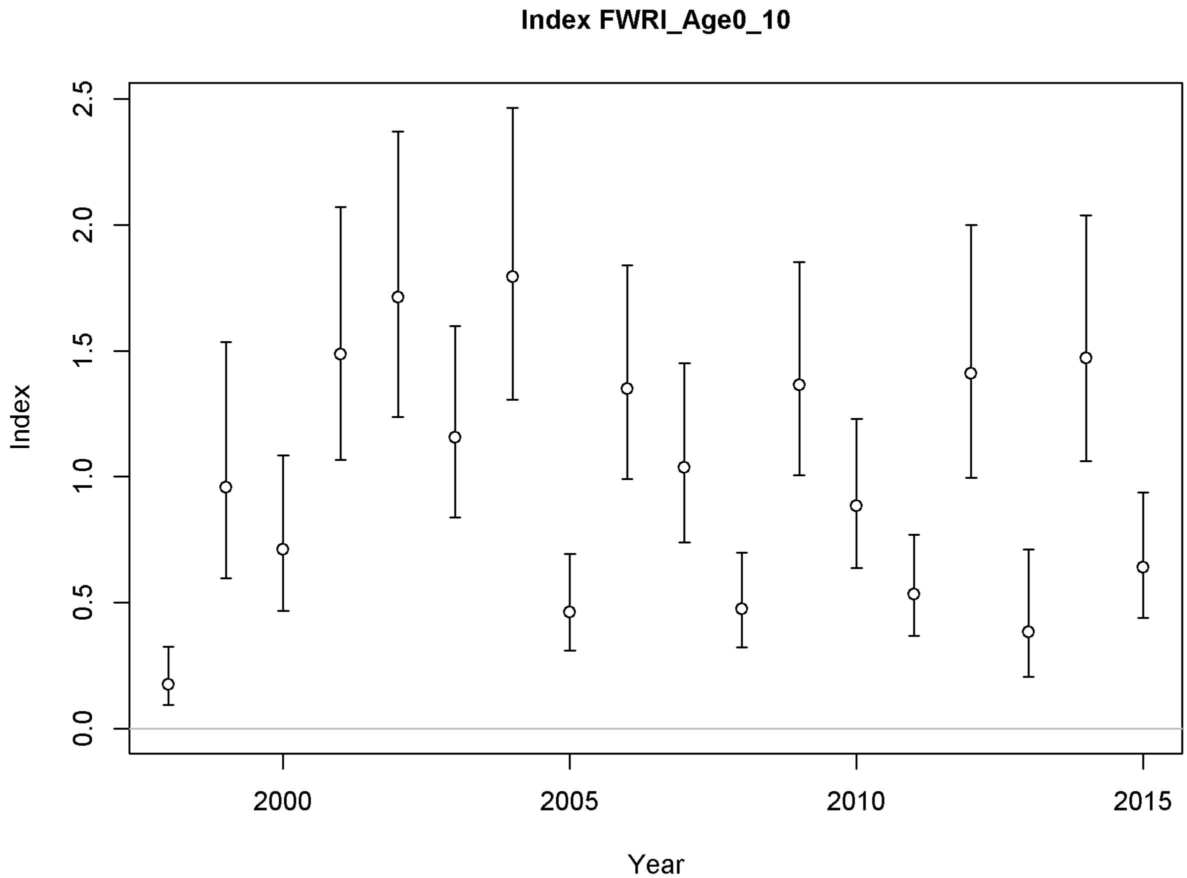


Figure 3.5.1. Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico FWRI Age-0 Survey in the U.S. Gulf of Mexico. The index is scaled to a mean of one over the time series and was derived using the number of Gray Snapper per trawl hour.

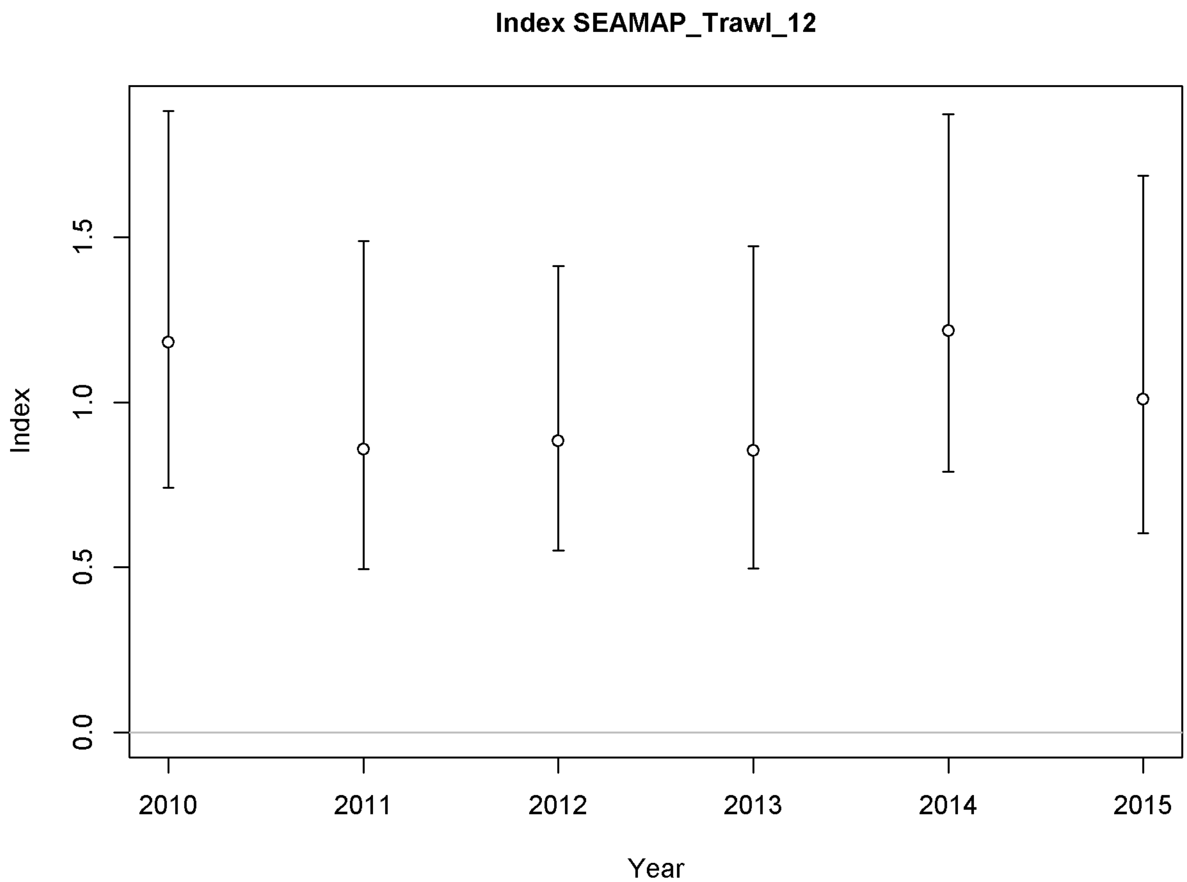


Figure 3.5.2 Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico fall SEAMAP groundfish trawl survey in the U.S. Gulf of Mexico. The index is scaled to a mean of one over the time series and was derived using the number of Gray Snapper per trawl hour.

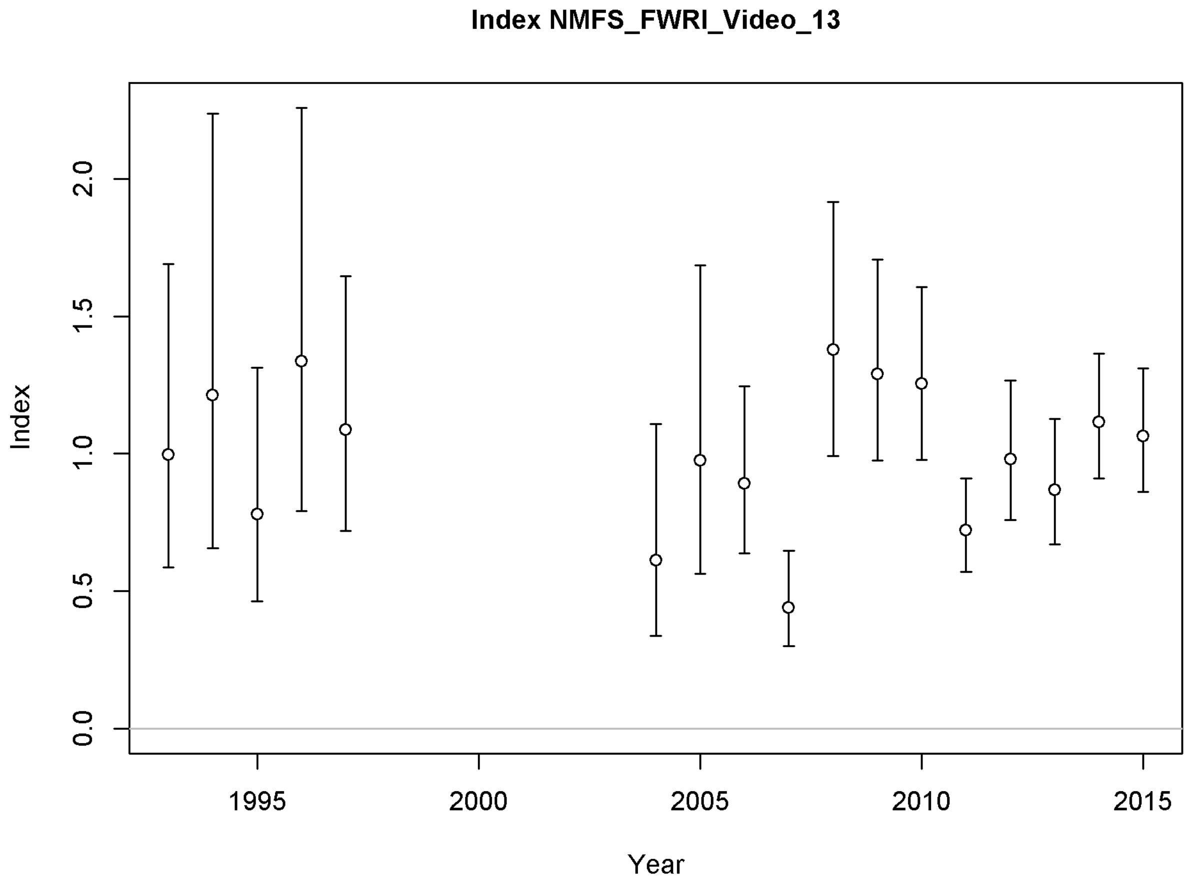


Figure 3.5.3 Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico combined SEAMAP, Panama City and FWRI video survey. The index is scaled to a mean of one over the time series and was derived using the minimum count (maximum number of individuals in the field of view at one instance) of Gray Snapper per 20 minute recording.

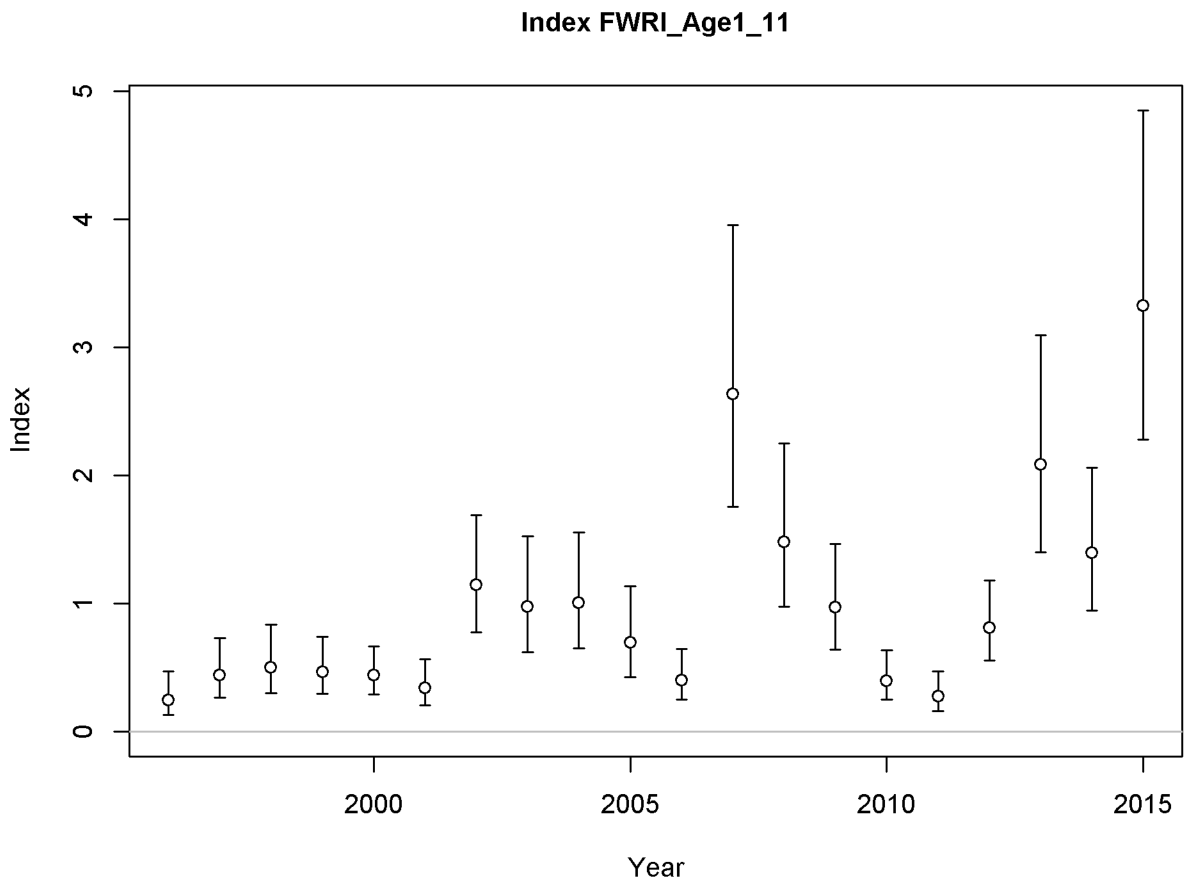


Figure 3.5.4 Standardized indices of abundance and the associated log-scale standard errors from the FWRI Gulf of Mexico Age-1 survey. The index is scaled to a mean of one over the time series and was derived using the number of Gray Snapper per angler hour.

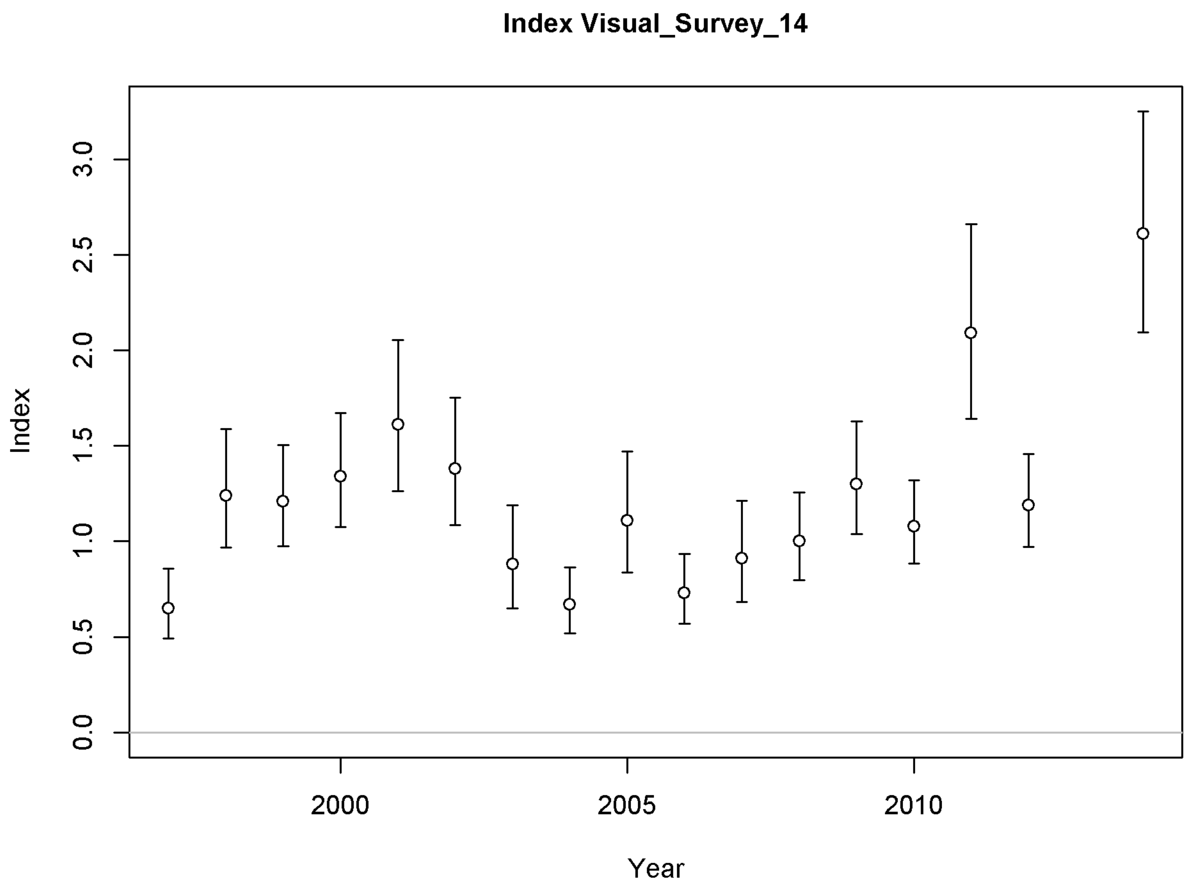


Figure 3.5.5 Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico visual survey. The index is scaled to a mean of one over the time series and was derived using the pounds of Gray Snapper per number of hook hours.

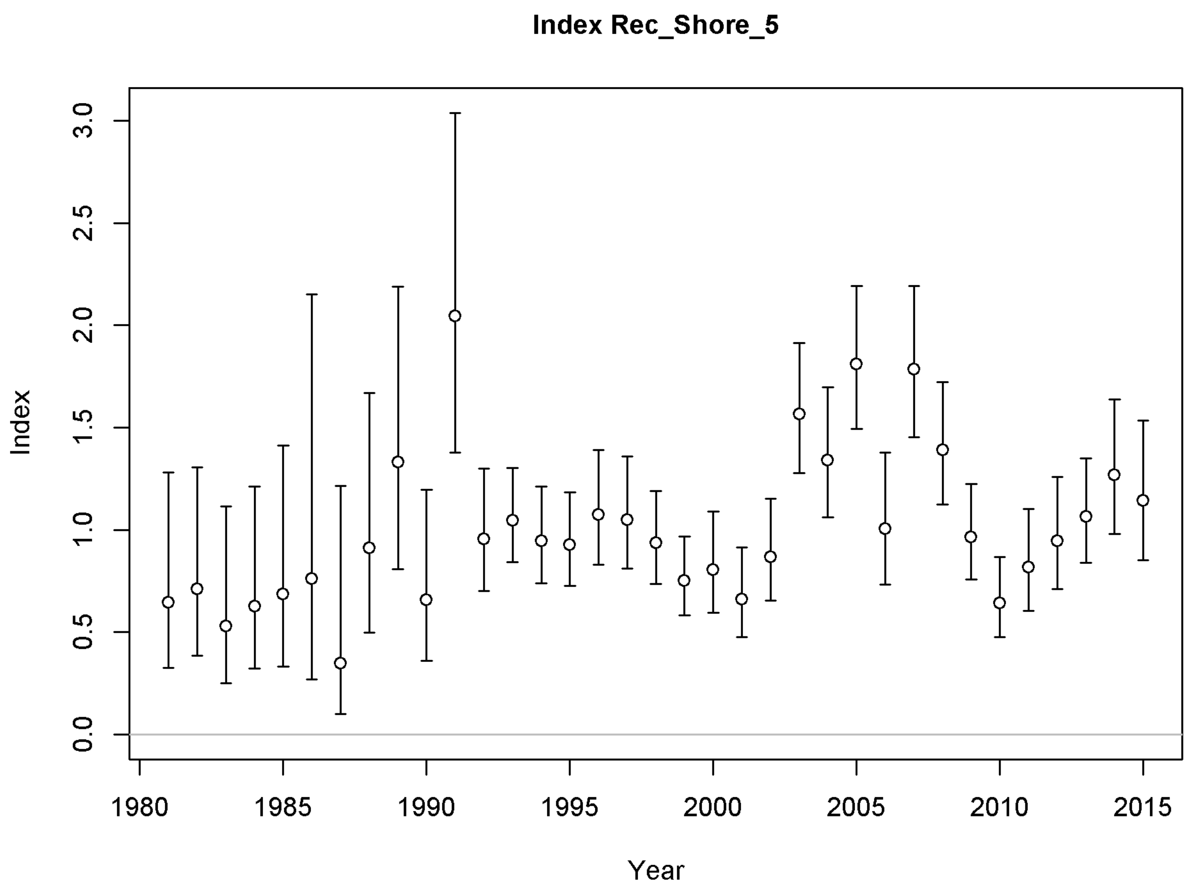


Figure 3.5.6 Standardized indices of abundance and the associated log-scale standard errors from the MRFSS Gulf of Mexico shore recreational fishery. The index is scaled to a mean of one over the time series and was derived using the number of Gray Snapper per angler hour.

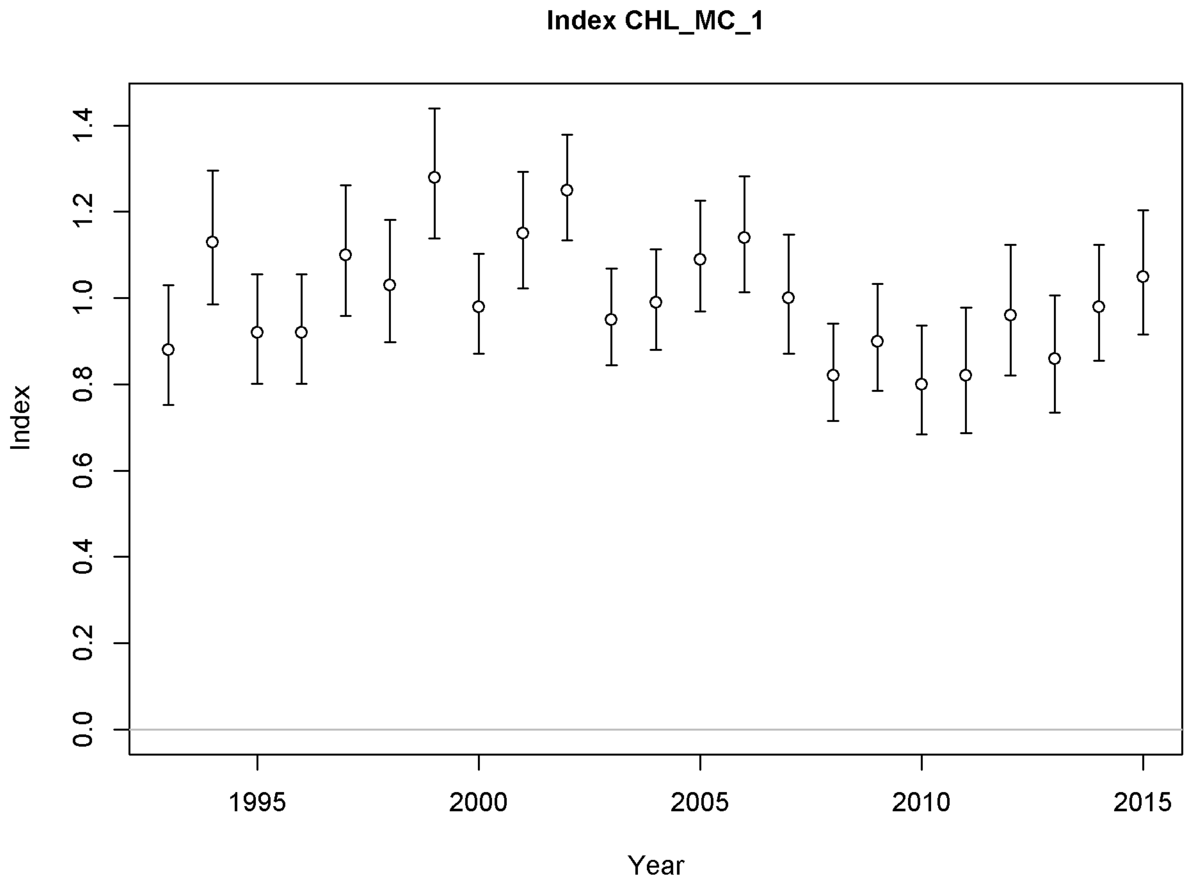


Figure 3.5.7 Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico vertical line commercial fishery. The index is scaled to a mean of one over the time series and was derived using the pounds of Gray Snapper per number of hook hours.

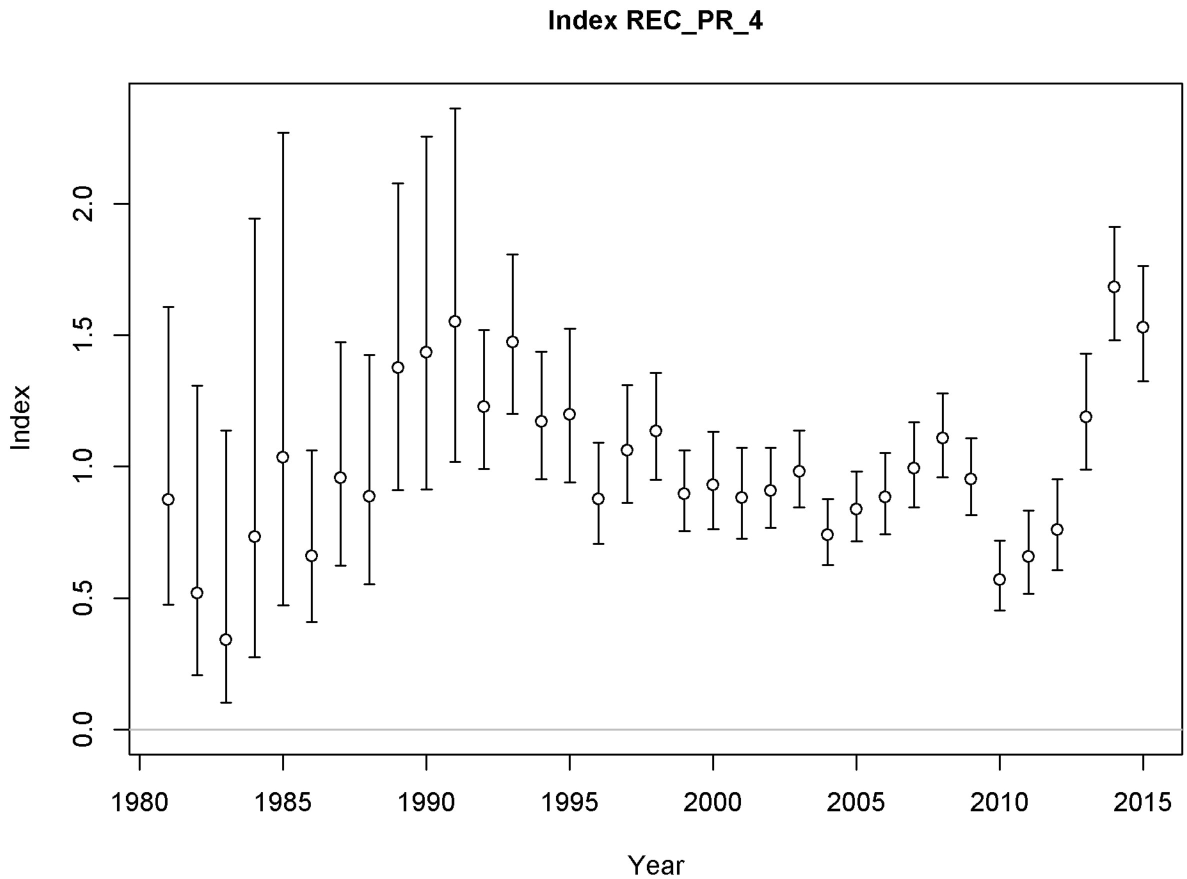


Figure 3.5.8 Standardized indices of abundance and the associated log-scale standard errors from the Gulf of Mexico MRFSS survey in the U.S. Gulf of Mexico. The index is scaled to a mean of one over the time series and was derived using the number of Gray Snapper per angler hour.

4 Stock assessment models and results

4.1 Stock Synthesis

4.1.1 Overview

The assessment model used for the SEDAR51 Gulf of Mexico Gray Snapper assessment was Stock Synthesis version 3.24S (Methot 2013). Stock Synthesis (SS) has been widely used and tested for assessment evaluations, particularly in the US west coast NMFS centers. Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2013) and in Methot and Wetzel (2013).

Stock Synthesis is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world (Methot and Wetzel 2013). SS takes relatively unprocessed input data and incorporates many important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce estimates of observed catch, size and age composition and CPUE indices. Because many inputs are correlated, the concept behind SS is that they should be modeled together. This helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SS is comprised of three sub-models: 1) a population sub-model that recreates an estimate of the numbers/biomass at age using estimates for various natural processes such as natural mortality, growth, fecundity, etc.; 2) an observational sub-model that consists of observed (measured) quantities from the population such as relative abundance (i.e., CPUE) or the proportion of individuals at length/age; and 3) a statistical sub-model that employs a likelihood framework to quantify the fit of the observations to the recreated population.

Data sources

The data sources used in the assessment model are described in Section 3. **Figure 4.1.1.1** summarizes the data sources and their corresponding temporal scale. The Stock Synthesis data file is included as **Appendix A**.

4.1.2 Model configuration

*The parameter settings and model specification are described in **Appendix B** (control file) and **Appendix C** (starter file).*

Life history

The growth parameters were estimated externally from the SS model assuming a single combined sex von Bertalanffy model (SEDAR51-WP-8). A growth model (**Figure 3.1.1.1**) with a variance structure of CV increase linearly with age and applying both state and federal size limits was chosen as the best predictor of growth for gray snapper. The recommended growth model parameters are

L_{inf}= 54.69 cm FL,
k = 0.1546,
t_0 = -1.4554.

The CV as a function of length at age, the asymptotic length (L_{inf}), the von Bertalanffy growth coefficient *(k)* and the theoretical age at length zero *(t_0)*, were fixed within the SS model.

The parameterization of the von Bertalanffy model in SS included two additional parameters used to describe the variability in size-at-age. These parameters represent the coefficient of variability (CV) in size-at-age at the minimum (age 1) and at the maximum observed ages. The CV for length at age(minimum) was 0.1514, and the CV for the $L_{infinity}$ =0.19922. Models testing the variance structure were compared; these assumed either constant standard deviation at age, constant CV at age, linear increase in CV with age, or linear increase in CV with length. AIC results indicated that assuming a linear increase in CV with age best described the data.

Within SS, growth is modeled with a three parameter von Bertalanffy equation (*Lmin, Lmax*, and *K*). In SS, 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 (*Lbin*). Fish then grow linearly until they reach a real age equal to the input value of *Amin* (1 year) and have a size equal to the *Lmin* (15.009 cm). As they age further, they grow according to the von Bertalanffy growth equation. *Lmax* was specified as equivalent to L_{inf} (54.7 cm). The three parameters of the von Bertalanffy equation (*Lmin*, *Lmax*, and *K*) were fixed in the SS model. A fixed length-weight relationship was used to convert body length (*cm*) to body weight (*kg*).

The natural mortality rate (*M*) was assumed to decrease as a function of age based on a Lorenzen (2005) function. When using the Hoenig (1983) function to estimate *M* based on a maximum age of 28, the estimated base mortality rate was 0.15. This revised base *M* value was then used to develop the age-specific natural mortality vector input into SS as a fixed vector (**Table 3.1.2.1**).

Stock-recruitment model

The Beverton-Holt stock-recruitment function was used in this assessment to characterize the stock-recruitment (S-R) relationship. Two parameters of the S-R relationship were estimated in the model; the log of unexploited equilibrium recruitment *ln(R0)*, and an offset parameter for initial equilibrium recruitment relative to virgin recruitment *ln(R1)*. The steepness (*h*) parameter was fixed in the model at 0.99. The steepness parameter describes the fraction of the unexploited (virgin) recruits produced at 20% of the equilibrium spawning biomass level. A third parameter representing the standard deviation in recruitment (σ_R) was also estimated.

Annual deviations from the stock-recruit function were estimated for an early period (prior to 1981) and a later data-rich period (1981-2015). The data-rich period is associated with the beginning of collection of annual composition data (e.g, length). The SS model has the ability to track cohorts through time, so it was assumed that the length composition data provided some indication of trends in recruitment between 1970 and 1981. Prior to 1970, recruitment was estimated directly from the S-R relationship. Stock Synthesis assumes a lognormal error structure for recruitment. Therefore, expected recruitments were bias adjusted. Methot and Taylor (2011) recommend that the full bias adjustment only be applied to data-rich years in the assessment when there is sufficient data to inform the model about the full range of recruitment variability. Full bias adjustment was used from 1981 to 2015. Bias adjustment was phased in linearly from no bias adjustment to full bias adjustment from 1970-1981. Bias adjustment was phased out over the last year, decreasing from full bias adjustment to no bias adjustment.

Initial Model Starting conditions

The beginning year of the SS assessment model was 1945. Minor removals of Gray Snapper are assumed to have occurred in the Gulf of Mexico prior to 1945; however, for this evaluation the stock was assumed to be at near unfished condition at the start of the model. The assessment panel recommended the incorporation of data back only to 1945 for use in the base model.

Fleet structure and indices of abundance

The assessment model included six fishing fleets. Fleets include the aggregated recreational headboat and charterboat modes (REC_HB_CB), recreational private mode (REC_PR), recreational shore mode (REC_Shore), aggregated commercial handline and other gear in Monroe County, Florida (COM_MC), aggregated commercial handline and other gear in all other counties in the Gulf of Mexico (COM_notMC), and commercial longline (COM_LL). Gray Snapper as bycatch in the shrimp fishery was evaluated and considered to be negligible by the Data Workshop Panel.

The assessment model included eight indices of abundance as described in **Section 3**. The commercial index was modeled as retained landings. The MRFSS index of abundance included discards in the estimation, and thus treated as an index of total catch. Three of the five fishery-independent indices were also assumed to model total catch. The SEAMAP trawl survey and the FWRI age-0 trawl indices were used as indices of spawning stock biomass.

Selectivity and retention

Length-based selectivity functions were specified for all fleets. Selectivity of indices either mirrored the selectivity of their sister fleet, or were indices of age-0 recruits. Selectivity patterns characterize the probability of capture-at-length for a given gear and are used to model not only gear selectivity, but also fishery availability (due to spatial patterns of fish and fishers). Unless otherwise noted, length-based selectivity functions used in the Gray Snapper assessment were modeled using double normal functions. The double normal function is described by two adjacent normal distributions. Each has its own variance term and the two are joined by a horizontal line. This selectivity pattern is described by six parameters, 4 of which were estimated and 2 constrained in the SS model. Selectivity of the combined video index was modeled as a 2-parameter logistic function. The larval index was assumed to represent the adult spawning biomass; therefore, the selectivity pattern was fixed to the assumed biomass at length of mature fish.

With one exception, selectivity patterns were assumed to be constant over time for each fishery and survey. However, the Gray Snapper fishery has experienced changes in management regulations over time. These were assumed to influence retention patterns more so than selectivity. As such, these changes were accounted for in the model by the incorporation of time-varying retention patterns and modeling discards explicitly. For the aggregated commercial handline and other gear not Monroe County in the Gulf of Mexico fleet, time varying retention alone was not sufficient to model the changes in size composition observed. Fishers in this region historical caught and kept fish in excess of the size limit. For this fleet, changes in fishing behavior following the introduction of the size limit likely caused a change in selectivity. Consequently, time-varying selectivity was employed to improve model fit to the retained length composition.

Regulatory management changes include the implementation of a 12 inch (30.48 cm) fork-length size limit in federal waters and a 10 inch (25.4 cm) fork length size limit in Florida state waters in 1990. Retention patterns were assumed to change with the changes in the size limit. Retention is modeled as a logistic function with size in SS. Four parameters describe this function; the inflection point, the slope, the asymptote and the male offset inflection (not applicable to this model). The retention patterns associated with the 1990-2015 time blocks were assumed to be knife-edge at the size limit. The retention pattern for the pre-1990 time block for all fleets was a fixed, knife-edge relationship near the minimum size of retained fish in the landings. Estimated parameters

A total of 591 parameters were used for the base case model, and of these 503 were estimated. (**Table 4.1.4.1**). The estimated parameters included three parameters used to define the S-R Relationship (R1 offset, R_0, σR), 40 used to estimate selectivity and retention, and 45 used to estimate annual recruitment deviations.

Table 4.1.4.1 includes SS predicted parameter values and their associated standard errors, initial parameter values, and minimum and maximum values a parameter could take. Parameters designated as fixed were held at their initial values. Parameter bounds were selected to be sufficiently wide to avoid truncating the searching procedure during maximum likelihood estimation. The soft bounds option in SS was utilized when fitting the assessment model. This option creates a weak symmetric-beta penalty on selectivity parameters to move parameters away from the bounds (Methot 2013).

Model Convergence

4.1.3 Uncertainty and Measures of Precision

Uncertainty in parameter estimates and derived quantities were evaluated using multiple approaches. First, uncertainty in parameter estimates were quantified by computing asymptotic standard errors for each parameter. Asymptotic standard errors are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives of the likelihood with respect to the parameters) after the model fitting process. Asymptotic standard errors are based upon the analytical estimate of the variance near the converged solution.

Likelihood profiles were also completed for three key model parameters of the stock – recruitment function. Steepness of the stock-recruit relationship (h) likelihood profiles is commonly used to elucidate conflicting information among various data sources, to determine how asymmetric the likelihood surfaces surrounding point estimates may be, and to provide an additional evaluation of how precisely parameters are being estimated **.**

4.1.4 Sensitivity analysis

Uncertainty in data inputs and model configuration were also examined through sensitivity analyses. The sensitivity models reported in this section are not meant to be a comprehensive evaluation of all possible aspects of model uncertainty, nor do they reflect the full range of models considered in developing the base case. These scenarios are intended to provide information about sensitivity of model results (e.g., spawning stock biomass, recruitment, fishing mortality) to assumptions regarding key model parameters. The order in which they are presented is not intended to reflect their importance; each run included herein provided important information for developing or evaluating the base case model and alternate states of nature.

Discard Mortality

Discard mortality in the model was fixed at 6.9% for commercial fleets and 14% for recreational fleets based on recommendations by the SEDAR 51 Data workshop. The data workshop felt these values were conservative and recommended sensitivity runs at 11.9% and 19% (6.9% and 14% plus 5%) for commercial and recreational discards respectively.

Index Inclusion (Jack-knife analysis)

The final set of sensitivity runs was used to evaluate the model sensitivity to each of the indices of abundance. A jack-knife approach was used where each index of abundance was removed from the model and then the model was refit to the remaining data (**.**

4.1.5 Retrospective analysis

A retrospective analysis was conducted to evaluate the consistency of stock assessment results by sequentially eliminating a year of data from the terminal year while retaining the same model configuration. The results of this exercise are useful in assessing potential biases in the estimates of key SS derived quantities (e.g., stock biomass, fishing mortality, recruitment) and uncertainty in terminal year estimates.

4.2 Model Results

4.2.1 Measures of model fit

Landings

Landings were assumed to be known with error (CV=0.05 commercial, CV=0.1 recreational). As expected, model fit the observed data with little error.

Discards

The SS model was fit to the discard fractions estimated for five directed fleets: Commercial Monroe County, Commercial not Monroe County, Recreational Private, Recreational Shore and Recreational Charterboat/Headboat (**Figures 4.2.1.1 – 4.2.1.5**). The fractions of Gray Snapper discarded were modeled in with a time block to account for changes in fishing regulations. The observed and predicted discard fractions all fleets indicate an increasing shift roughly corresponding to regulatory changes. The model underestimated discard fractions in years both prior to regulations (before 1991) and following the regulation change of 1991. In general, the fit to the discard fractions is poor but this data component is highly uncertain. There is an inherent conflict between discard rates and length composition data. Length composition data suggest that to support the magnitude of estimated discard fraction, fish above the length limit would need to be discarded frequently. Anglers involved in the assessment workshop process did not report that this was likely.

Indices of abundance

The SS model was fit to three fishery-dependent indices and five fishery-independent indices. The fits to the indices are summarized in **Figures 4.2.1.6** - **4.2.1.13**. In general, models fit the indices relatively well. Most indices exhibited an increasing trend since 2010, which was captured by model fits. The standardized FWRI Age-0 and SEAMAP Fall Trawl Surveys were used as indices of recruitment, varied annually and without an overall trend.

The standardized SEAMAP Fall Groundfish (Trawl) Survey index is thought to reference abundance of young of the year Gray Snapper. Like the SEAMAP larval survey, it was highly variable with large CVs. In general, the index of abundance showed similar trends including an increasing trend after 2010.

Derived Size Composition

The model fits to the derived size composition associated with the landings series, and the corresponding Pearson residuals are presented in **Figures 4.2.1.14** – **4.2.1.23**. In general, the SS model fit the derived size compositions well across all fleets, as reflected by Pearson residual values generally less than four units.

The model fits to the recreational Private derived size composition were reasonable. In general, the predicted and observed distributions were nearly identical in most years. The slight degradation in the fits during the most recent years suggests that anglers may have responded to regulatory changes in length in a manner that differed somewhat from model predictions. Pearson residuals indicate that there is little systematic noise in the model fit to the data.

The fits to the recreational Shore derived size composition were also quite good. The predicted and observed distributions were nearly identical in most years. The model has overestimated the abundance of smaller size classes somewhat since 1991, the year following a change in regulations. Pearson residuals indicate a slight temporal bias as younger size classes were overestimated from 1994-2015 and underestimated thereafter.

The recreational charterboat+headboat derived size composition fit the observed values well. The predicted and observed distributions were nearly identical in most years. Small sample size in early years resulted in variability in fit prior to 1990. The model has overestimated the abundance of smaller size classes somewhat since 1991, the year following a change in regulations. Pearson residuals indicate a slight temporal bias as younger size classes were overestimated from 1994-2015 and underestimated thereafter.

The fits to the Commercial Monroe County Fleet derived size composition were strong. The predicted and observed distributions were similar in most years, except the earliest which were characterized by relatively low effective sample sizes. The model frequently overestimated or underestimated the numbers of individuals in the most dominant size class. However, the Pearson residuals suggest that there was little systematic noise in the model fit to the data for this fleet.

The fits to the Commercial Not Monroe County Fleet derived size composition were relatively good. The predicted and observed distributions were quite similar in all years except 2010 and 2011. The model overestimated the abundance of older size classes in these years. Because the model was constrained to discard sub-legal size fish, the lack of fit to these years could be a function of commercial landings that contained either sub-legal or faster growing fish. Regardless, Pearson residuals indicate that there as little systematic noise in the model fit to the data for this fleet.

The fits to the commercial long-line derived size composition were relatively good. The predicted and observed distributions were quite similar in all years.

4.2.2 Parameter estimates and associated uncertainty

Table 4.1.4.1 summarizes the parameter estimates and the asymptotic standard errors from SS. The majority of parameters have relatively low standard errors. The parameters with larger standard errors are mainly the size selectivity parameters and some years of the recruitment deviations

Model convergence was evaluated using a jitter analysis. The jitter analysis perturbs the initial values so that a broad range of parameter values along the likelihood surface are used as starting values. This exercise is typically used to confirm that the model converged to a global solution rather than a local minima. Starting values of all estimated parameters were randomly perturbed by 10% and the model was run for 100 trials. Seventy-one trials converged on a similar solution (**Figure 4.2.2.1**). While this test cannot prove convergence of the model, evidence suggests the base model configuration is sufficiently stable.

Likelihood profiles were generated for several key parameters in this assessment. They include three parameters in the Beverton-Holt stock-recruitment function: R_0, σR and Steepness. Likelihood profiles were used to evaluate how estimable these parameters were, and to identify possible conflicts in the signal derived from various data inputs.

The likelihood profile of the steepness parameter shows that there were possible conflicts between data sources (**Figure 4.2.2.2**). Specifically, the length and discard components exhibited similar likelihood patterns. The index component favored a lower steepness. Model runs with steepness less than 0.85 failed to converge. The general conclusion of the Assessment Workshop panel was that steepness was not estimable, and the profile supports this decision to fix steepness at o.99.

The total likelihood component from the *R0* likelihood profile indicates that the global solution for this parameter is greater than 9.0 (**Figure 4.2.2.3**). The recruitment likelihood component is the largest component of the total dictating this outcome. The data conflicts appear to be minimal.

The likelihood profile on the parameter accounting for the variation in recruitment (σ_R) suggests that the dominant influence on the likelihood is the catch component (**Figure 4.2.2.4**). Survey and discard components could not be estimated. It is clear that the model did not converge, or did not produce stable and consistent results are every value of σ_R examined.

4.2.3 Selectivity and retention

Fleet-specific length-based selectivity and retention patterns, and the assumed discard mortality rates are illustrated in **Figures 4.2.3.1– 4.2.3.6.** Size-based selectivity functions were estimated for all fleets and indices. Selectivity patterns represent the probability of capture-at-size for a given gear and are used to model not only gear selectivity but also fishery availability (due to spatial patterns of fish and fishers). With one exception (Commercial Handline not Monroe County), selectivity patterns were assumed to be constant over time for each fishery and survey. The Gray Snapper fisheries have experienced changes in management regulations over time. These were assumed to influence the retention patterns more so than selectivity. As such, these changes were accounted for in the model using time-varying retention patterns and by modeling discards explicitly.

Changes in the management regulations for all fleets include the implementation of a 10 and 12 inch total length (25.6 and 30.48 cm) size limit from 1990. Retention patterns were assumed to vary with the change in the size limit (**Figures 4.2.3.7 – 4.2.3.11)**.

The fishery-independent surveys size selectivity patterns were fixed based on either observed or assumed size composition, or set to mirror specific fleets for which they were derived. The SEAMAP fall groundfish survey was used as a proxy of spawning stock biomass in the previous year. Selectivity of other indices mirrored the selectivity of their associated fleets.

. The predicted numbers at size suggest recruitment has been relatively constant with the exception of a period of volatility from 1979 – 1986 (**Figure 4.2.3.12**). Mean age has varied between five in the early years and 2 in recent years. Mean age declined from 1945 - 1991, but has remained relatively constant since. Mean size showed little increase following the implementation of a length limit in 1990. Although mean age and mean size have not changed considerably over recent years, it is important to note that the relative proportion of larger and older fish has declined steadily.

4.2.4 Recruitment

The three key parameters for defining the stock-recruitment relationship were steepness (*h*), virgin recruitment (*R0*), and sigma(R). Steepness was fixed at 0.99 for the base model. The remaining parameters were estimated without priors (**Table 4.1.4.1**). The log of virgin recruitment is estimated at 9.276. The sigma (R) parameter was estimated at 0.897.

The plot of the stock-recruitment relationship suggests no relationship between spawning stock biomass and recruitment (**Figure 4.2.4.1**). Predicted age-0 recruits is presented in **Figure 4.2.4.2**, and in **Table 4.2.4.1**. Average recruitment was variable over time.

4.2.5 Stock biomass

Predicted total biomass and spawning output in eggs are summarized in **Table 4.2.4.1**. Total biomass generally decreased until 1980, then remained fairly constant (**Figure 4.2.5.1**) The decreasing trend seen in total biomass is also evident in the predicted spawning output time-series (**Figure 4.2.5.2**), and in the spawning depletion estimate (SSB/S0; **Figure 4.2.5.3**).

4.2.6 Fishing mortality

The predicted fishing mortalities (overall and by fleet) are presented in **Table 4.2.6.1** and **Figure 4.2.6.1**. Predicted total fishing mortality declined, on average, between 1981 and 2015, although the 2004 fishing mortality increased over 2010.

In recent years, the main source of directed fishing mortality is the recreational private fleet. The recreational shore fleet accounts for the next highest fishing mortality (**Figure 4.2.6.2**). Although the commercial fleets exhibited significant fishing pressure in the early 1990s, fishing mortality due to commercial fishing has remained low in recent years.

4.2.7 Sensitivity analyses

Discard mortality

The primary assessment results were relatively insensitive to an increase in discard mortality (**Figure 4.2.7.1**). Sensitivity runs were made using a previous base run that was modified following comments from the AW panelists in March 2018. Following the proposed revisions, the accepted base model (described throughout this report) had very similar results. It is expected that the sensitivity runs would behave similarly to what had been described previously, and these were not updated.

Size Lambda

Discard Lambda

High M

Low M

Jack-knife of indices

The results of the sensitivity exercise to evaluate index inclusion (i.e., jack-knife analysis) are summarized in **Figures 4.2.7.2**. Exclusion of individual indices had little effect on spawning stock biomass estimates.

4.2.8 Retrospective results

The results from the retrospective analysis are summarized in **Figure 4.2.8.1**. There was a slight pattern in spawning stock biomass. Retrospective trajectory shifted from a larger SSB in the earlier years, gradually shifting to the present level.

4.2.9 Benchmark and reference points

Annual estimates of SSB, F, SSB/SPR30, SSB/MSST and F/FSPR30 are summarized in **Table 4.2.9.1**. Reference points of interest are summarized in **Table 4.2.9.2**. For benchmarks and reference point calculations, SPR30% was selected as an MSY-proxy, and used to calculate stock status. The minimum stock size threshold (MSST) is defined as 50% of SSB_SPR 30. The maximum fishing mortality threshold (MFMT) is defined (the generic rule in the GMFMC FMP) as F30%SPR. A stock is declared overfished if SSBcurrent <- MSST, and overfishing is occurring if Fcurrent > MFMT. For purposes of calculating Fcurrent, "current time period" is defined as the geometric mean of Fs for 2013-2015. SSBcurrent is the model estimated SSB for calendar year 2015.

Based on these definitions, the stock biomass was below MSST from 1989-1995, but has remained above MSST since that time. The current stock status is not overfished (SSB2015/SSB_SPR30 = 0.703). Using the generic Fmsy proxy (FSPR30), the stock has been experiencing overfishing since 1976 (with few exceptions), and is current undergoing overfishing (Fcurrent/FSPR30 = .1.20). Discussion

The assessment model predicts that total biomass and the spawning potential (egg production) have decreased throughout the time series, and are currently estimated near (or at) the lowest annual value. Despite a decline in fishing mortality in all fleets since 2010, the stock has shown little sign of increase.

The Gray Snapper fishery is dominated by recreational fishing. Despite regulations, implemented in 1990, to increase size limits, the species has not exhibited a substantive increase in spawning stock biomass. This may be the result of unexpectedly high discards in excess of landings in both the commercial and recreational fleets following the implementation of a length limit.

4.2.10 Recommendations

1. Additional analyses are needed to determine biologically plausible Fmsy and MSY proxies.

2. Evaluate existing methods for deriving discard rates evaluate technical improvements to estimation methods as appropriate.

3. Develop/evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations.

4. Identify factors resulting in the release of fish in excess of size limits and improve estimates of asymptotic retention.

5. Conduct additional research on fleet-specific discard mortality rates.

4.3 Acknowledgements

Many people from state and federal agencies assisted with assembling the data included in this stock assessment. The Data and Assessment Workshop Panel was helpful with addressing issues and nuances of the data. The Panel provided important guidance to the stock assessment model configuration. The author would also like to acknowledge two internal reviews who made significant improvements to this report.

4.4 References

Methot Jr., R. D. 2013. User Manual for Stock Synthesis Model Version 3.24s NOAA Fisheries Seattle, WA. http://nft.nefsc.noaa.gov/Stock_Synthesis_3.htm

Methot Jr., R. D., and C. R. Wetzel. 2013. Stock Synthesis: A Biological and Statistical Framework for Fish Stock Assessment and Fishery Management. Fisheries Research 142 (2013) 86– 99

Tables

Table 4.1.4.1 List of SS parameters for Gulf of Mexico Gray Snapper. The list includes SS predicted parameter values and their associated standard errors, initial parameter values, and minimum and maximum values a parameter could take. Parameters designated as fixed were held at their initial values. Parameter bounds were selected to be sufficiently wide to avoid truncating the searching procedure during maximum likelihood estimation. The soft bounds option in SS was utilized when fitting the assessment model. This option creates a weak symmetric-beta penalty on selectivity parameters to move parameters away from the bounds (Methot 2011).

Num	Label	Value	Active_Cnt	Phase	Min	Max	Init	Status	Parm_StDev	PR_type
1	L_at_Amin_Fem_GP_1	15.0091	_	-3	0	40	15.0091	NA	_	No_prior
2	L_at_Amax_Fem_GP_1	54.7	_	-3	4	70	54.7	NA	_	No_prior
3	VonBert_K_Fem_GP_1	0.1546	_	-3	0.01	0.5	0.1546	NA	_	No_prior
4	CV_young_Fem_GP_1	0.1514	_	-6	0.05	0.3	0.1514	NA	_	No_prior
5	CV_old_Fem_GP_1	0.1922	_	-6	0.05	0.3	0.1922	NA	_	No_prior
6	Wtlen_1_Fem	1.43E-05	_	-2	1.00E-05	2	1.43E-05	NA	_	No_prior
7	Wtlen_2_Fem	3.02	_	-2	2	4	3.02	NA	_	No_prior
8	Mat50%_Fem	29	_	-3	20	60	29	NA	_	No_prior
9	Mat_slope_Fem	-5	_	-3	-1	0	-5	NA	_	No_prior
10	Eggs_scalar_Fem	1	_	-3	0	60	1	NA	_	No_prior
11	Eggs_exp_wt_Fem	1	_	-3	0	4	1	NA	_	No_prior
12	RecrDist_GP_1	0	_	-4	0	0	0	NA	_	No_prior
13	RecrDist_Area_1	0	_	-4	0	0	0	NA	_	No_prior
14	RecrDist_Seas_1	0	_	-4	0	0	0	NA	_	No_prior
15	CohortGrowDev	0	_	-4	0	0	0	NA	_	No_prior
16	SR_LN(R0)	9.27641	1	1	5	35	9.25896	OK	0.078723	No_prior
17	SR_BH_steep	0.99	_	-2	0.8	1	0.99	NA	_	No_prior
18	SR_sigmaR	0.897073	2	4	0.01	2	0.895405	OK	0.124115	No_prior
19	SR_envlink	0	_	-4	-5	5	0	NA	_	No_prior
20	SR_R1_offset	0	_	-4	-5	5	0	NA	_	No_prior
21	SR_autocorr	0	_	-4	0	0.5	0	NA	_	No_prior

22	Main_RecrDev_1970	-0.1708	3	_	_	_	_	act	0.803362	dev
23	Main_RecrDev_1971	-0.16145	4	_	_	_	_	act	0.800788	dev
24	Main_RecrDev_1972	-0.15628	5	_	_	_	_	act	0.797692	dev
25	Main_RecrDev_1973	-0.16997	6	_	_	_	_	act	0.791523	dev
26	Main_RecrDev_1974	-0.21515	7	_	_	_	_	act	0.778807	dev
27	Main_RecrDev_1975	-0.2899	8	_	_	_	_	act	0.758374	dev
28	Main_RecrDev_1976	-0.35121	9	_	_	_	_	act	0.740151	dev
29	Main_RecrDev_1977	-0.30037	10	_	_	_	_	act	0.740425	dev
30	Main_RecrDev_1978	0.187533	11	_	_	_	_	act	0.507224	dev
31	Main_RecrDev_1979	-0.53671	12	_	_	_	_	act	0.552515	dev
32	Main_RecrDev_1980	-0.55855	13	_	_	_	_	act	0.345766	dev
33	Main_RecrDev_1981	0.84061	14	_	_	_	_	act	0.189573	dev
34	Main_RecrDev_1982	0.102466	15	_	_	_	_	act	0.316512	dev
35	Main_RecrDev_1983	-1.29902	16	_	_	_	_	act	0.535597	dev
36	Main_RecrDev_1984	1.18651	17	_	_	_	_	act	0.100594	dev
37	Main_RecrDev_1985	-2.64074	18	_	_	_	_	act	0.506291	dev
38	Main_RecrDev_1986	-3.68143	19	_	_	_	_	act	0.478137	dev
39	Main_RecrDev_1987	0.896101	20	_	_	_	_	act	0.135262	dev
40	Main_RecrDev_1988	0.570359	21	_	_	_	_	act	0.265117	dev
41	Main_RecrDev_1989	0.226673	22	_	_	_	_	act	0.358675	dev
42	Main_RecrDev_1990	0.679958	23	_	_	_	_	act	0.25348	dev
43	Main_RecrDev_1991	0.442231	24	_	_	_	_	act	0.303212	dev
44	Main_RecrDev_1992	-0.1073	25	_	_	_	_	act	0.435548	dev
45	Main_RecrDev_1993	0.290953	26	_	_	_	_	act	0.285779	dev
46	Main_RecrDev_1994	0.401317	27	_	_	_	_	act	0.26443	dev
47	Main_RecrDev_1995	0.108012	28	_	_	_	_	act	0.34062	dev
48	Main_RecrDev_1996	-0.02089	29	_	_	_	_	act	0.339196	dev
49	Main_RecrDev_1997	0.228433	30	_	_	_	_	act	0.211366	dev
50	Main_RecrDev_1998	-0.87274	31	_	_	_	_	act	0.3283	dev
51	Main_RecrDev_1999	0.416711	32	_	_	_	_	act	0.137562	dev
52	Main_RecrDev_2000	-0.02245	33	_	_	_	_	act	0.167861	dev

53	Main_RecrDev_2001	0.546259	34	_	_	_	_	act	0.116182	dev
54	Main_RecrDev_2002	0.521534	35	_	_	_	_	act	0.113845	dev
55	Main_RecrDev_2003	0.222952	36	_	_	_	_	act	0.129803	dev
56	Main_RecrDev_2004	0.591636	37	_	_	_	_	act	0.111146	dev
57	Main_RecrDev_2005	-0.22467	38	_	_	_	_	act	0.188842	dev
58	Main_RecrDev_2006	0.458397	39	_	_	_	_	act	0.115112	dev
59	Main_RecrDev_2007	0.162327	40	_	_	_	_	act	0.12895	dev
60	Main_RecrDev_2008	-0.48666	41	_	_	_	_	act	0.167635	dev
61	Main_RecrDev_2009	0.517895	42	_	_	_	_	act	0.110773	dev
62	Main_RecrDev_2010	0.389938	43	_	_	_	_	act	0.115413	dev
63	Main_RecrDev_2011	0.299144	44	_	_	_	_	act	0.136746	dev
64	Main_RecrDev_2012	0.710175	45	_	_	_	_	act	0.111578	dev
65	Main_RecrDev_2013	0.013179	46	_	_	_	_	act	0.167021	dev
66	Main_RecrDev_2014	0.917119	47	_	_	_	_	act	0.116075	dev
67	Main_RecrDev_2015	0.337858	48	_	_	_	_	act	0.150764	dev
68	InitF_1CHL_MC_1	0	_	-1	0	0.5	0	NA	_	No_prior
69	InitF_2CHL_nMC_2	0	_	-1	0	0.5	0	NA	_	No_prior
70	InitF_3CM_LL_3	0	_	-1	0	0.5	0	NA	_	No_prior
71	InitF_4REC_PR_4	0	_	-1	0	0.5	0	NA	_	No_prior
72	InitF_5Rec_Shore_5	0	_	-1	0	0.5	0	NA	_	No_prior
73	InitF_6Rec_HB_CBT6	0	_	-1	0	0.5	0	NA	_	No_prior
74	F_fleet_1_YR_1945_s_1	1.99998	49	1	0	8	_	act	2828.43	F
75	F_fleet_1_YR_1946_s_1	4.99E-05	50	1	0	8	_	act	8.31E-06	F
76	F_fleet_1_YR_1947_s_1	0.00027	51	1	0	8	_	act	4.50E-05	F
77	F_fleet_1_YR_1948_s_1	0.000453	52	1	0	8	_	act	7.56E-05	F
78	F_fleet_1_YR_1949_s_1	0.000651	53	1	0	8	_	act	0.000109	F
79	F_fleet_1_YR_1950_s_1	0.000885	54	1	0	8	_	act	0.000148	F
80	F_fleet_1_YR_1951_s_1	0.001086	55	1	0	8	_	act	0.000183	F
81	F_fleet_1_YR_1952_s_1	0.001307	56	1	0	8	_	act	0.000221	F
82	F_fleet_1_YR_1953_s_1	0.001473	57	1	0	8	_	act	0.00025	F
83	F_fleet_1_YR_1954_s_1	0.001702	58	1	0	8	_	act	0.00029	F

84	F_fleet_1_YR_1955_s_1	0.001944	59	1	0	8	_	act	0.000333	F
85	F_fleet_1_YR_1956_s_1	0.002093	60	1	0	8	_	act	0.00036	F
86	F_fleet_1_YR_1957_s_1	0.002307	61	1	0	8	_	act	0.000398	F
87	F_fleet_1_YR_1958_s_1	0.002469	62	1	0	8	_	act	0.000427	F
88	F_fleet_1_YR_1959_s_1	0.0027	63	1	0	8	_	act	0.000468	F
89	F_fleet_1_YR_1960_s_1	0.002877	64	1	0	8	_	act	0.0005	F
90	F_fleet_1_YR_1961_s_1	0.002941	65	1	0	8	_	act	0.000512	F
91	F_fleet_1_YR_1962_s_1	0.003001	66	1	0	8	_	act	0.000524	F
92	F_fleet_1_YR_1963_s_1	0.003784	67	1	0	8	_	act	0.000661	F
93	F_fleet_1_YR_1964_s_1	0.00441	68	1	0	8	_	act	0.000771	F
94	F_fleet_1_YR_1965_s_1	0.007024	69	1	0	8	_	act	0.001231	F
95	F_fleet_1_YR_1966_s_1	0.005655	70	1	0	8	_	act	0.000992	F
96	F_fleet_1_YR_1967_s_1	0.006534	71	1	0	8	_	act	0.001148	F
97	F_fleet_1_YR_1968_s_1	0.008302	72	1	0	8	_	act	0.001463	F
98	F_fleet_1_YR_1969_s_1	0.008995	73	1	0	8	_	act	0.001591	F
99	F_fleet_1_YR_1970_s_1	0.008411	74	1	0	8	_	act	0.001493	F
100	F_fleet_1_YR_1971_s_1	0.009043	75	1	0	8	_	act	0.00161	F
101	F_fleet_1_YR_1972_s_1	0.024473	76	1	0	8	_	act	0.004457	F
102	F_fleet_1_YR_1973_s_1	0.008803	77	1	0	8	_	act	0.001773	F
103	F_fleet_1_YR_1974_s_1	0.009722	78	1	0	8	_	act	0.002193	F
104	F_fleet_1_YR_1975_s_1	0.005836	79	1	0	8	_	act	0.001398	F
105	F_fleet_1_YR_1976_s_1	0.010294	80	1	0	8	_	act	0.002487	F
106	F_fleet_1_YR_1977_s_1	0.009105	81	1	0	8	_	act	0.002154	F
107	F_fleet_1_YR_1978_s_1	0.0105	82	1	0	8	_	act	0.002411	F
108	F_fleet_1_YR_1979_s_1	0.010564	83	1	0	8	_	act	0.002358	F
109	F_fleet_1_YR_1980_s_1	0.0148	84	1	0	8	_	act	0.003049	F
110	F_fleet_1_YR_1981_s_1	0.029455	85	1	0	8	_	act	0.00555	F
111	F_fleet_1_YR_1982_s_1	0.03893	86	1	0	8	_	act	0.007259	F
112	F_fleet_1_YR_1983_s_1	0.05172	87	1	0	8	_	act	0.009147	F
113	F_fleet_1_YR_1984_s_1	0.049417	88	1	0	8	_	act	0.008228	F
114	F_fleet_1_YR_1985_s_1	0.043775	89	1	0	8	_	act	0.007378	F

115	F_fleet_1_YR_1986_s_1	0.056224	90	1	0	8	_	act	0.00871	F
116	F_fleet_1_YR_1987_s_1	0.053706	91	1	0	8	_	act	0.007849	F
117	F_fleet_1_YR_1988_s_1	0.053323	92	1	0	8	_	act	0.008304	F
118	F_fleet_1_YR_1989_s_1	0.04729	93	1	0	8	_	act	0.007631	F
119	F_fleet_1_YR_1990_s_1	0.024625	94	1	0	8	_	act	0.003946	F
120	F_fleet_1_YR_1991_s_1	0.015978	95	1	0	8	_	act	0.002519	F
121	F_fleet_1_YR_1992_s_1	0.024749	96	1	0	8	_	act	0.003986	F
122	F_fleet_1_YR_1993_s_1	0.03157	97	1	0	8	_	act	0.004955	F
123	F_fleet_1_YR_1994_s_1	0.022716	98	1	0	8	_	act	0.003567	F
124	F_fleet_1_YR_1995_s_1	0.008898	99	1	0	8	_	act	0.001425	F
125	F_fleet_1_YR_1996_s_1	0.012771	100	1	0	8	_	act	0.002044	F
126	F_fleet_1_YR_1997_s_1	0.0073	101	1	0	8	_	act	0.001147	F
127	F_fleet_1_YR_1998_s_1	0.006939	102	1	0	8	_	act	0.001078	F
128	F_fleet_1_YR_1999_s_1	0.006409	103	1	0	8	_	act	0.000989	F
129	F_fleet_1_YR_2000_s_1	0.005981	104	1	0	8	_	act	0.000914	F
130	F_fleet_1_YR_2001_s_1	0.003971	105	1	0	8	_	act	0.000617	F
131	F_fleet_1_YR_2002_s_1	0.006084	106	1	0	8	_	act	0.00094	F
132	F_fleet_1_YR_2003_s_1	0.0055	107	1	0	8	_	act	0.000847	F
133	F_fleet_1_YR_2004_s_1	0.007488	108	1	0	8	_	act	0.001163	F
134	F_fleet_1_YR_2005_s_1	0.006696	109	1	0	8	_	act	0.001058	F
135	F_fleet_1_YR_2006_s_1	0.00564	110	1	0	8	_	act	0.000884	F
136	F_fleet_1_YR_2007_s_1	0.005897	111	1	0	8	_	act	0.000905	F
137	F_fleet_1_YR_2008_s_1	0.002394	112	1	0	8	_	act	0.000375	F
138	F_fleet_1_YR_2009_s_1	0.003345	113	1	0	8	_	act	0.000546	F
139	F_fleet_1_YR_2010_s_1	0.004952	114	1	0	8	_	act	0.000827	F
140	F_fleet_1_YR_2011_s_1	0.00478	115	1	0	8	_	act	0.000781	F
141	F_fleet_1_YR_2012_s_1	0.004822	116	1	0	8	_	act	0.000768	F
142	F_fleet_1_YR_2013_s_1	0.003588	117	1	0	8	_	act	0.000563	F
143	F_fleet_1_YR_2014_s_1	0.001229	118	1	0	8	_	act	0.00019	F
144	F_fleet_1_YR_2015_s_1	0.001599	119	1	0	8	_	act	0.000244	F
145	F_fleet_2_YR_1945_s_1	1.99998	120	1	0	8	_	act	2828.43	F

146	F_fleet_2_YR_1946_s_1	5.40E-05	121	1	0	8	_	act	8.58E-06	F
147	F_fleet_2_YR_1947_s_1	0.000347	122	1	0	8	_	act	5.51E-05	F
148	F_fleet_2_YR_1948_s_1	0.000589	123	1	0	8	_	act	9.37E-05	F
149	F_fleet_2_YR_1949_s_1	0.000847	124	1	0	8	_	act	0.000135	F
150	F_fleet_2_YR_1950_s_1	0.001215	125	1	0	8	_	act	0.000195	F
151	F_fleet_2_YR_1951_s_1	0.001496	126	1	0	8	_	act	0.000241	F
152	F_fleet_2_YR_1952_s_1	0.001732	127	1	0	8	_	act	0.000281	F
153	F_fleet_2_YR_1953_s_1	0.002026	128	1	0	8	_	act	0.000331	F
154	F_fleet_2_YR_1954_s_1	0.002347	129	1	0	8	_	act	0.000385	F
155	F_fleet_2_YR_1955_s_1	0.002684	130	1	0	8	_	act	0.000444	F
156	F_fleet_2_YR_1956_s_1	0.002912	131	1	0	8	_	act	0.000484	F
157	F_fleet_2_YR_1957_s_1	0.00316	132	1	0	8	_	act	0.000529	F
158	F_fleet_2_YR_1958_s_1	0.003418	133	1	0	8	_	act	0.000575	F
159	F_fleet_2_YR_1959_s_1	0.003671	134	1	0	8	_	act	0.000621	F
160	F_fleet_2_YR_1960_s_1	0.003946	135	1	0	8	_	act	0.000672	F
161	F_fleet_2_YR_1961_s_1	0.00403	136	1	0	8	_	act	0.00069	F
162	F_fleet_2_YR_1962_s_1	0.004106	137	1	0	8	_	act	0.000706	F
163	F_fleet_2_YR_1963_s_1	0.005431	138	1	0	8	_	act	0.000937	F
164	F_fleet_2_YR_1964_s_1	0.005455	139	1	0	8	_	act	0.000944	F
165	F_fleet_2_YR_1965_s_1	0.010178	140	1	0	8	_	act	0.001769	F
166	F_fleet_2_YR_1966_s_1	0.007625	141	1	0	8	_	act	0.00133	F
167	F_fleet_2_YR_1967_s_1	0.008641	142	1	0	8	_	act	0.001512	F
168	F_fleet_2_YR_1968_s_1	0.013557	143	1	0	8	_	act	0.002384	F
169	F_fleet_2_YR_1969_s_1	0.013215	144	1	0	8	_	act	0.002337	F
170	F_fleet_2_YR_1970_s_1	0.012389	145	1	0	8	_	act	0.002202	F
171	F_fleet_2_YR_1971_s_1	0.013418	146	1	0	8	_	act	0.002397	F
172	F_fleet_2_YR_1972_s_1	0.014726	147	1	0	8	_	act	0.002661	F
173	F_fleet_2_YR_1973_s_1	0.021127	148	1	0	8	_	act	0.004163	F
174	F_fleet_2_YR_1974_s_1	0.024824	149	1	0	8	_	act	0.005624	F
175	F_fleet_2_YR_1975_s_1	0.028935	150	1	0	8	_	act	0.007247	F
176	F_fleet_2_YR_1976_s_1	0.041539	151	1	0	8	_	act	0.010785	F

177	F_fleet_2_YR_1977_s_1	0.043285	152	1	0	8	_	act	0.011118	F
178	F_fleet_2_YR_1978_s_1	0.052174	153	1	0	8	_	act	0.013022	F
179	F_fleet_2_YR_1979_s_1	0.060607	154	1	0	8	_	act	0.014765	F
180	F_fleet_2_YR_1980_s_1	0.067076	155	1	0	8	_	act	0.015594	F
181	F_fleet_2_YR_1981_s_1	0.070768	156	1	0	8	_	act	0.014963	F
182	F_fleet_2_YR_1982_s_1	0.075342	157	1	0	8	_	act	0.015479	F
183	F_fleet_2_YR_1983_s_1	0.065702	158	1	0	8	_	act	0.013333	F
184	F_fleet_2_YR_1984_s_1	0.027901	159	1	0	8	_	act	0.005445	F
185	F_fleet_2_YR_1985_s_1	0.023061	160	1	0	8	_	act	0.004429	F
186	F_fleet_2_YR_1986_s_1	0.021572	161	1	0	8	_	act	0.003983	F
187	F_fleet_2_YR_1987_s_1	0.019695	162	1	0	8	_	act	0.003342	F
188	F_fleet_2_YR_1988_s_1	0.015603	163	1	0	8	_	act	0.002649	F
189	F_fleet_2_YR_1989_s_1	0.028274	164	1	0	8	_	act	0.005049	F
190	F_fleet_2_YR_1990_s_1	0.025625	165	1	0	8	_	act	0.006426	F
191	F_fleet_2_YR_1991_s_1	0.047769	166	1	0	8	_	act	0.012257	F
192	F_fleet_2_YR_1992_s_1	0.033745	167	1	0	8	_	act	0.008955	F
193	F_fleet_2_YR_1993_s_1	0.0469	168	1	0	8	_	act	0.012594	F
194	F_fleet_2_YR_1994_s_1	0.061803	169	1	0	8	_	act	0.016847	F
195	F_fleet_2_YR_1995_s_1	0.038036	170	1	0	8	_	act	0.010429	F
196	F_fleet_2_YR_1996_s_1	0.027702	171	1	0	8	_	act	0.007516	F
197	F_fleet_2_YR_1997_s_1	0.026342	172	1	0	8	_	act	0.007007	F
198	F_fleet_2_YR_1998_s_1	0.021167	173	1	0	8	_	act	0.005537	F
199	F_fleet_2_YR_1999_s_1	0.027236	174	1	0	8	_	act	0.007026	F
200	F_fleet_2_YR_2000_s_1	0.02781	175	1	0	8	_	act	0.007078	F
201	F_fleet_2_YR_2001_s_1	0.033125	176	1	0	8	_	act	0.008426	F
202	F_fleet_2_YR_2002_s_1	0.037856	177	1	0	8	_	act	0.009651	F
203	F_fleet_2_YR_2003_s_1	0.033723	178	1	0	8	_	act	0.008685	F
204	F_fleet_2_YR_2004_s_1	0.040603	179	1	0	8	_	act	0.010784	F
205	F_fleet_2_YR_2005_s_1	0.045013	180	1	0	8	_	act	0.012355	F
206	F_fleet_2_YR_2006_s_1	0.036302	181	1	0	8	_	act	0.009962	F
207	F_fleet_2_YR_2007_s_1	0.021657	182	1	0	8	_	act	0.005815	F

208	F_fleet_2_YR_2008_s_1	0.024893	183	1	0	8	_	act	0.006685	F
209	F_fleet_2_YR_2009_s_1	0.03311	184	1	0	8	_	act	0.009159	F
210	F_fleet_2_YR_2010_s_1	0.01735	185	1	0	8	_	act	0.00485	F
211	F_fleet_2_YR_2011_s_1	0.030145	186	1	0	8	_	act	0.008223	F
212	F_fleet_2_YR_2012_s_1	0.025783	187	1	0	8	_	act	0.006919	F
213	F_fleet_2_YR_2013_s_1	0.020323	188	1	0	8	_	act	0.005407	F
214	F_fleet_2_YR_2014_s_1	0.030723	189	1	0	8	_	act	0.008081	F
215	F_fleet_2_YR_2015_s_1	0.02168	190	1	0	8	_	act	0.005644	F
216	F_fleet_3_YR_1945_s_1	1.99998	191	1	0	8	_	act	2828.43	F
217	F_fleet_3_YR_1946_s_1	1.99998	192	1	0	8	_	act	2828.43	F
218	F_fleet_3_YR_1947_s_1	1.99998	193	1	0	8	_	act	2828.43	F
219	F_fleet_3_YR_1948_s_1	1.99998	194	1	0	8	_	act	2828.43	F
220	F_fleet_3_YR_1949_s_1	1.99998	195	1	0	8	_	act	2828.43	F
221	F_fleet_3_YR_1950_s_1	1.99998	196	1	0	8	_	act	2828.43	F
222	F_fleet_3_YR_1951_s_1	1.99998	197	1	0	8	_	act	2828.43	F
223	F_fleet_3_YR_1952_s_1	1.99998	198	1	0	8	_	act	2828.43	F
224	F_fleet_3_YR_1953_s_1	1.99998	199	1	0	8	_	act	2828.43	F
225	F_fleet_3_YR_1954_s_1	1.99998	200	1	0	8	_	act	2828.43	F
226	F_fleet_3_YR_1955_s_1	1.99998	201	1	0	8	_	act	2828.43	F
227	F_fleet_3_YR_1956_s_1	1.99998	202	1	0	8	_	act	2828.43	F
228	F_fleet_3_YR_1957_s_1	1.99998	203	1	0	8	_	act	2828.43	F
229	F_fleet_3_YR_1958_s_1	1.99998	204	1	0	8	_	act	2828.43	F
230	F_fleet_3_YR_1959_s_1	1.99998	205	1	0	8	_	act	2828.43	F
231	F_fleet_3_YR_1960_s_1	1.99998	206	1	0	8	_	act	2828.43	F
232	F_fleet_3_YR_1961_s_1	1.99998	207	1	0	8	_	act	2828.43	F
233	F_fleet_3_YR_1962_s_1	1.99998	208	1	0	8	_	act	2828.43	F
234	F_fleet_3_YR_1963_s_1	1.99998	209	1	0	8	_	act	2828.43	F
235	F_fleet_3_YR_1964_s_1	1.99998	210	1	0	8	_	act	2828.43	F
236	F_fleet_3_YR_1965_s_1	1.99998	211	1	0	8	_	act	2828.43	F
237	F_fleet_3_YR_1966_s_1	1.99998	212	1	0	8	_	act	2828.43	F
238	F_fleet_3_YR_1967_s_1	1.99998	213	1	0	8	_	act	2828.43	F

239	F_fleet_3_YR_1968_s_1	1.99998	214	1	0	8	_	act	2828.43	F
240	F_fleet_3_YR_1969_s_1	1.99998	215	1	0	8	_	act	2828.43	F
241	F_fleet_3_YR_1970_s_1	1.99998	216	1	0	8	_	act	2828.43	F
242	F_fleet_3_YR_1971_s_1	1.99998	217	1	0	8	_	act	2828.43	F
243	F_fleet_3_YR_1972_s_1	1.99998	218	1	0	8	_	act	2828.43	F
244	F_fleet_3_YR_1973_s_1	1.99998	219	1	0	8	_	act	2828.43	F
245	F_fleet_3_YR_1974_s_1	1.99998	220	1	0	8	_	act	2828.43	F
246	F_fleet_3_YR_1975_s_1	1.99998	221	1	0	8	_	act	2828.43	F
247	F_fleet_3_YR_1976_s_1	1.99998	222	1	0	8	_	act	2828.43	F
248	F_fleet_3_YR_1977_s_1	1.99998	223	1	0	8	_	act	2828.43	F
249	F_fleet_3_YR_1978_s_1	1.99998	224	1	0	8	_	act	2828.43	F
250	F_fleet_3_YR_1979_s_1	1.99998	225	1	0	8	_	act	2828.43	F
251	F_fleet_3_YR_1980_s_1	0.001938	226	1	0	8	_	act	0.00046	F
252	F_fleet_3_YR_1981_s_1	0.00224	227	1	0	8	_	act	0.00054	F
253	F_fleet_3_YR_1982_s_1	0.006081	228	1	0	8	_	act	0.001492	F
254	F_fleet_3_YR_1983_s_1	0.012679	229	1	0	8	_	act	0.003142	F
255	F_fleet_3_YR_1984_s_1	0.008011	230	1	0	8	_	act	0.002001	F
256	F_fleet_3_YR_1985_s_1	0.006886	231	1	0	8	_	act	0.001731	F
257	F_fleet_3_YR_1986_s_1	0.008562	232	1	0	8	_	act	0.002112	F
258	F_fleet_3_YR_1987_s_1	0.009821	233	1	0	8	_	act	0.00238	F
259	F_fleet_3_YR_1988_s_1	0.007008	234	1	0	8	_	act	0.001684	F
260	F_fleet_3_YR_1989_s_1	0.011829	235	1	0	8	_	act	0.002844	F
261	F_fleet_3_YR_1990_s_1	0.00875	236	1	0	8	_	act	0.002135	F
262	F_fleet_3_YR_1991_s_1	0.007782	237	1	0	8	_	act	0.001951	F
263	F_fleet_3_YR_1992_s_1	0.003868	238	1	0	8	_	act	0.001	F
264	F_fleet_3_YR_1993_s_1	0.006364	239	1	0	8	_	act	0.001662	F
265	F_fleet_3_YR_1994_s_1	0.00313	240	1	0	8	_	act	0.000826	F
266	F_fleet_3_YR_1995_s_1	0.001665	241	1	0	8	_	act	0.00044	F
267	F_fleet_3_YR_1996_s_1	0.001535	242	1	0	8	_	act	0.0004	F
268	F_fleet_3_YR_1997_s_1	0.001403	243	1	0	8	_	act	0.000359	F
269	F_fleet_3_YR_1998_s_1	0.001018	244	1	0	8	_	act	0.000256	F

270	F_fleet_3_YR_1999_s_1	0.002385	245	1	0	8	_	act	0.000591	F
271	F_fleet_3_YR_2000_s_1	0.001826	246	1	0	8	_	act	0.000447	F
272	F_fleet_3_YR_2001_s_1	0.002288	247	1	0	8	_	act	0.000561	F
273	F_fleet_3_YR_2002_s_1	0.003067	248	1	0	8	_	act	0.000757	F
274	F_fleet_3_YR_2003_s_1	0.002224	249	1	0	8	_	act	0.000557	F
275	F_fleet_3_YR_2004_s_1	0.003802	250	1	0	8	_	act	0.000986	F
276	F_fleet_3_YR_2005_s_1	0.003757	251	1	0	8	_	act	0.001009	F
277	F_fleet_3_YR_2006_s_1	0.003313	252	1	0	8	_	act	0.000887	F
278	F_fleet_3_YR_2007_s_1	0.002531	253	1	0	8	_	act	0.00066	F
279	F_fleet_3_YR_2008_s_1	0.003467	254	1	0	8	_	act	0.0009	F
280	F_fleet_3_YR_2009_s_1	0.001003	255	1	0	8	_	act	0.000268	F
281	F_fleet_3_YR_2010_s_1	0.000987	256	1	0	8	_	act	0.000267	F
282	F_fleet_3_YR_2011_s_1	0.002521	257	1	0	8	_	act	0.000665	F
283	F_fleet_3_YR_2012_s_1	0.002617	258	1	0	8	_	act	0.000682	F
284	F_fleet_3_YR_2013_s_1	0.002151	259	1	0	8	_	act	0.000557	F
285	F_fleet_3_YR_2014_s_1	0.003593	260	1	0	8	_	act	0.00092	F
286	F_fleet_3_YR_2015_s_1	0.005089	261	1	0	8	_	act	0.001286	F
287	F_fleet_4_YR_1945_s_1	1.99998	262	1	0	8	_	act	2828.43	F
288	F_fleet_4_YR_1946_s_1	0.000527	263	1	0	8	_	act	7.18E-05	F
289	F_fleet_4_YR_1947_s_1	0.002906	264	1	0	8	_	act	0.000397	F
290	F_fleet_4_YR_1948_s_1	0.004782	265	1	0	8	_	act	0.000654	F
291	F_fleet_4_YR_1949_s_1	0.00664	266	1	0	8	_	act	0.000911	F
292	F_fleet_4_YR_1950_s_1	0.009467	267	1	0	8	_	act	0.001304	F
293	F_fleet_4_YR_1951_s_1	0.0115	268	1	0	8	_	act	0.00159	F
294	F_fleet_4_YR_1952_s_1	0.013539	269	1	0	8	_	act	0.00188	F
295	F_fleet_4_YR_1953_s_1	0.015702	270	1	0	8	_	act	0.002191	F
296	F_fleet_4_YR_1954_s_1	0.01794	271	1	0	8	_	act	0.002516	F
297	F_fleet_4_YR_1955_s_1	0.020261	272	1	0	8	_	act	0.002857	F
298	F_fleet_4_YR_1956_s_1	0.021889	273	1	0	8	_	act	0.003104	F
299	F_fleet_4_YR_1957_s_1	0.023557	274	1	0	8	_	act	0.003358	F
300	F_fleet_4_YR_1958_s_1	0.025328	275	1	0	8	_	act	0.003631	F

301	F_fleet_4_YR_1959_s_1	0.027085	276	1	0	8	_	act	0.003905	F
302	F_fleet_4_YR_1960_s_1	0.02889	277	1	0	8	_	act	0.004189	F
303	F_fleet_4_YR_1961_s_1	0.029371	278	1	0	8	_	act	0.004281	F
304	F_fleet_4_YR_1962_s_1	0.029801	279	1	0	8	_	act	0.004363	F
305	F_fleet_4_YR_1963_s_1	0.030265	280	1	0	8	_	act	0.004449	F
306	F_fleet_4_YR_1964_s_1	0.03064	281	1	0	8	_	act	0.004521	F
307	F_fleet_4_YR_1965_s_1	0.031033	282	1	0	8	_	act	0.004598	F
308	F_fleet_4_YR_1966_s_1	0.03209	283	1	0	8	_	act	0.004773	F
309	F_fleet_4_YR_1967_s_1	0.033144	284	1	0	8	_	act	0.004949	F
310	F_fleet_4_YR_1968_s_1	0.034339	285	1	0	8	_	act	0.005151	F
311	F_fleet_4_YR_1969_s_1	0.035514	286	1	0	8	_	act	0.005353	F
312	F_fleet_4_YR_1970_s_1	0.03668	287	1	0	8	_	act	0.005553	F
313	F_fleet_4_YR_1971_s_1	0.038978	288	1	0	8	_	act	0.006411	F
314	F_fleet_4_YR_1972_s_1	0.042583	289	1	0	8	_	act	0.009304	F
315	F_fleet_4_YR_1973_s_1	0.046556	290	1	0	8	_	act	0.011371	F
316	F_fleet_4_YR_1974_s_1	0.050804	291	1	0	8	_	act	0.01244	F
317	F_fleet_4_YR_1975_s_1	0.055886	292	1	0	8	_	act	0.013069	F
318	F_fleet_4_YR_1976_s_1	0.064183	293	1	0	8	_	act	0.014189	F
319	F_fleet_4_YR_1977_s_1	0.075152	294	1	0	8	_	act	0.015899	F
320	F_fleet_4_YR_1978_s_1	0.088455	295	1	0	8	_	act	0.018374	F
321	F_fleet_4_YR_1979_s_1	0.09662	296	1	0	8	_	act	0.017003	F
322	F_fleet_4_YR_1980_s_1	0.10657	297	1	0	8	_	act	0.016665	F
323	F_fleet_4_YR_1981_s_1	0.128418	298	1	0	8	_	act	0.020021	F
324	F_fleet_4_YR_1982_s_1	0.080113	299	1	0	8	_	act	0.01167	F
325	F_fleet_4_YR_1983_s_1	0.037716	300	1	0	8	_	act	0.005384	F
326	F_fleet_4_YR_1984_s_1	0.187138	301	1	0	8	_	act	0.026489	F
327	F_fleet_4_YR_1985_s_1	0.120718	302	1	0	8	_	act	0.015392	F
328	F_fleet_4_YR_1986_s_1	0.061731	303	1	0	8	_	act	0.007754	F
329	F_fleet_4_YR_1987_s_1	0.125107	304	1	0	8	_	act	0.01665	F
330	F_fleet_4_YR_1988_s_1	0.142076	305	1	0	8	_	act	0.019341	F
331	F_fleet_4_YR_1989_s_1	0.196155	306	1	0	8	_	act	0.025207	F

332	F_fleet_4_YR_1990_s_1	0.172785	307	1	0	8	_	act	0.023916	F
333	F_fleet_4_YR_1991_s_1	0.199136	308	1	0	8	_	act	0.027672	F
334	F_fleet_4_YR_1992_s_1	0.158646	309	1	0	8	_	act	0.022316	F
335	F_fleet_4_YR_1993_s_1	0.181774	310	1	0	8	_	act	0.025048	F
336	F_fleet_4_YR_1994_s_1	0.178003	311	1	0	8	_	act	0.025328	F
337	F_fleet_4_YR_1995_s_1	0.179098	312	1	0	8	_	act	0.025809	F
338	F_fleet_4_YR_1996_s_1	0.139499	313	1	0	8	_	act	0.01981	F
339	F_fleet_4_YR_1997_s_1	0.138478	314	1	0	8	_	act	0.019218	F
340	F_fleet_4_YR_1998_s_1	0.158833	315	1	0	8	_	act	0.021672	F
341	F_fleet_4_YR_1999_s_1	0.138045	316	1	0	8	_	act	0.018447	F
342	F_fleet_4_YR_2000_s_1	0.173576	317	1	0	8	_	act	0.022997	F
343	F_fleet_4_YR_2001_s_1	0.186636	318	1	0	8	_	act	0.024117	F
344	F_fleet_4_YR_2002_s_1	0.164825	319	1	0	8	_	act	0.021561	F
345	F_fleet_4_YR_2003_s_1	0.233026	320	1	0	8	_	act	0.030171	F
346	F_fleet_4_YR_2004_s_1	0.30866	321	1	0	8	_	act	0.040199	F
347	F_fleet_4_YR_2005_s_1	0.205845	322	1	0	8	_	act	0.028459	F
348	F_fleet_4_YR_2006_s_1	0.105782	323	1	0	8	_	act	0.014586	F
349	F_fleet_4_YR_2007_s_1	0.156027	324	1	0	8	_	act	0.021093	F
350	F_fleet_4_YR_2008_s_1	0.241123	325	1	0	8	_	act	0.033094	F
351	F_fleet_4_YR_2009_s_1	0.253831	326	1	0	8	_	act	0.038055	F
352	F_fleet_4_YR_2010_s_1	0.087605	327	1	0	8	_	act	0.013173	F
353	F_fleet_4_YR_2011_s_1	0.09968	328	1	0	8	_	act	0.014212	F
354	F_fleet_4_YR_2012_s_1	0.177257	329	1	0	8	_	act	0.023959	F
355	F_fleet_4_YR_2013_s_1	0.154585	330	1	0	8	_	act	0.020223	F
356	F_fleet_4_YR_2014_s_1	0.172238	331	1	0	8	_	act	0.02229	F
357	F_fleet_4_YR_2015_s_1	0.147384	332	1	0	8	_	act	0.020517	F
358	F_fleet_5_YR_1945_s_1	1.99998	333	1	0	8	_	act	2828.43	F
359	F_fleet_5_YR_1946_s_1	0.000911	334	1	0	8	_	act	0.000129	F
360	F_fleet_5_YR_1947_s_1	0.005029	335	1	0	8	_	act	0.00071	F
361	F_fleet_5_YR_1948_s_1	0.008279	336	1	0	8	_	act	0.001172	F
362	F_fleet_5_YR_1949_s_1	0.011585	337	1	0	8	_	act	0.001645	F

363	F_fleet_5_YR_1950_s_1	0.016463	338	1	0	8	_	act	0.002345	F
364	F_fleet_5_YR_1951_s_1	0.019942	339	1	0	8	_	act	0.002851	F
365	F_fleet_5_YR_1952_s_1	0.023492	340	1	0	8	_	act	0.003371	F
366	F_fleet_5_YR_1953_s_1	0.027118	341	1	0	8	_	act	0.003905	F
367	F_fleet_5_YR_1954_s_1	0.030824	342	1	0	8	_	act	0.004456	F
368	F_fleet_5_YR_1955_s_1	0.034616	343	1	0	8	_	act	0.005024	F
369	F_fleet_5_YR_1956_s_1	0.037175	344	1	0	8	_	act	0.005415	F
370	F_fleet_5_YR_1957_s_1	0.039852	345	1	0	8	_	act	0.005824	F
371	F_fleet_5_YR_1958_s_1	0.042455	346	1	0	8	_	act	0.006225	F
372	F_fleet_5_YR_1959_s_1	0.045093	347	1	0	8	_	act	0.006634	F
373	F_fleet_5_YR_1960_s_1	0.047875	348	1	0	8	_	act	0.007067	F
374	F_fleet_5_YR_1961_s_1	0.048345	349	1	0	8	_	act	0.007155	F
375	F_fleet_5_YR_1962_s_1	0.048718	350	1	0	8	_	act	0.007224	F
376	F_fleet_5_YR_1963_s_1	0.049049	351	1	0	8	_	act	0.007284	F
377	F_fleet_5_YR_1964_s_1	0.04935	352	1	0	8	_	act	0.007339	F
378	F_fleet_5_YR_1965_s_1	0.049793	353	1	0	8	_	act	0.007417	F
379	F_fleet_5_YR_1966_s_1	0.051186	354	1	0	8	_	act	0.007637	F
380	F_fleet_5_YR_1967_s_1	0.05259	355	1	0	8	_	act	0.007861	F
381	F_fleet_5_YR_1968_s_1	0.0541	356	1	0	8	_	act	0.008107	F
382	F_fleet_5_YR_1969_s_1	0.055764	357	1	0	8	_	act	0.008378	F
383	F_fleet_5_YR_1970_s_1	0.057291	358	1	0	8	_	act	0.008628	F
384	F_fleet_5_YR_1971_s_1	0.060889	359	1	0	8	_	act	0.010583	F
385	F_fleet_5_YR_1972_s_1	0.0674	360	1	0	8	_	act	0.019	F
386	F_fleet_5_YR_1973_s_1	0.0744	361	1	0	8	_	act	0.024079	F
387	F_fleet_5_YR_1974_s_1	0.081612	362	1	0	8	_	act	0.0262	F
388	F_fleet_5_YR_1975_s_1	0.089748	363	1	0	8	_	act	0.027509	F
389	F_fleet_5_YR_1976_s_1	0.103472	364	1	0	8	_	act	0.030553	F
390	F_fleet_5_YR_1977_s_1	0.122143	365	1	0	8	_	act	0.035426	F
391	F_fleet_5_YR_1978_s_1	0.144009	366	1	0	8	_	act	0.041679	F
392	F_fleet_5_YR_1979_s_1	0.151658	367	1	0	8	_	act	0.035802	F
393	F_fleet_5_YR_1980_s_1	0.157926	368	1	0	8	_	act	0.031031	F

394	F_fleet_5_YR_1981_s_1	0.071125	369	1	0	8	_	act	0.013025	F
395	F_fleet_5_YR_1982_s_1	0.143607	370	1	0	8	_	act	0.022419	F
396	F_fleet_5_YR_1983_s_1	0.165343	371	1	0	8	_	act	0.025075	F
397	F_fleet_5_YR_1984_s_1	0.283642	372	1	0	8	_	act	0.043739	F
398	F_fleet_5_YR_1985_s_1	0.048966	373	1	0	8	_	act	0.006751	F
399	F_fleet_5_YR_1986_s_1	0.159252	374	1	0	8	_	act	0.019981	F
400	F_fleet_5_YR_1987_s_1	0.280113	375	1	0	8	_	act	0.038754	F
401	F_fleet_5_YR_1988_s_1	0.173558	376	1	0	8	_	act	0.025013	F
402	F_fleet_5_YR_1989_s_1	0.172758	377	1	0	8	_	act	0.023262	F
403	F_fleet_5_YR_1990_s_1	0.124044	378	1	0	8	_	act	0.018276	F
404	F_fleet_5_YR_1991_s_1	0.456301	379	1	0	8	_	act	0.064878	F
405	F_fleet_5_YR_1992_s_1	0.147486	380	1	0	8	_	act	0.021521	F
406	F_fleet_5_YR_1993_s_1	0.161085	381	1	0	8	_	act	0.022904	F
407	F_fleet_5_YR_1994_s_1	0.124662	382	1	0	8	_	act	0.018388	F
408	F_fleet_5_YR_1995_s_1	0.093473	383	1	0	8	_	act	0.013828	F
409	F_fleet_5_YR_1996_s_1	0.111673	384	1	0	8	_	act	0.016229	F
410	F_fleet_5_YR_1997_s_1	0.089219	385	1	0	8	_	act	0.012772	F
411	F_fleet_5_YR_1998_s_1	0.092775	386	1	0	8	_	act	0.013188	F
412	F_fleet_5_YR_1999_s_1	0.039511	387	1	0	8	_	act	0.005518	F
413	F_fleet_5_YR_2000_s_1	0.081589	388	1	0	8	_	act	0.011633	F
414	F_fleet_5_YR_2001_s_1	0.10768	389	1	0	8	_	act	0.014847	F
415	F_fleet_5_YR_2002_s_1	0.060313	390	1	0	8	_	act	0.008379	F
416	F_fleet_5_YR_2003_s_1	0.069147	391	1	0	8	_	act	0.009413	F
417	F_fleet_5_YR_2004_s_1	0.087998	392	1	0	8	_	act	0.01211	F
418	F_fleet_5_YR_2005_s_1	0.077747	393	1	0	8	_	act	0.010938	F
419	F_fleet_5_YR_2006_s_1	0.053077	394	1	0	8	_	act	0.007367	F
420	F_fleet_5_YR_2007_s_1	0.068591	395	1	0	8	_	act	0.009533	F
421	F_fleet_5_YR_2008_s_1	0.110791	396	1	0	8	_	act	0.015348	F
422	F_fleet_5_YR_2009_s_1	0.107678	397	1	0	8	_	act	0.015644	F
423	F_fleet_5_YR_2010_s_1	0.042754	398	1	0	8	_	act	0.006344	F
424	F_fleet_5_YR_2011_s_1	0.014205	399	1	0	8	_	act	0.001998	F

425	F_fleet_5_YR_2012_s_1	0.076077	400	1	0	8	_	act	0.010485	F
426	F_fleet_5_YR_2013_s_1	0.035167	401	1	0	8	_	act	0.004847	F
427	F_fleet_5_YR_2014_s_1	0.058825	402	1	0	8	_	act	0.008009	F
428	F_fleet_5_YR_2015_s_1	0.037022	403	1	0	8	_	act	0.005253	F
429	F_fleet_6_YR_1945_s_1	1.99998	404	1	0	8	_	act	2828.43	F
430	F_fleet_6_YR_1946_s_1	0.000155	405	1	0	8	_	act	2.19E-05	F
431	F_fleet_6_YR_1947_s_1	0.000775	406	1	0	8	_	act	0.00011	F
432	F_fleet_6_YR_1948_s_1	0.001247	407	1	0	8	_	act	0.000177	F
433	F_fleet_6_YR_1949_s_1	0.001728	408	1	0	8	_	act	0.000246	F
434	F_fleet_6_YR_1950_s_1	0.00246	409	1	0	8	_	act	0.000351	F
435	F_fleet_6_YR_1951_s_1	0.002971	410	1	0	8	_	act	0.000425	F
436	F_fleet_6_YR_1952_s_1	0.003578	411	1	0	8	_	act	0.000513	F
437	F_fleet_6_YR_1953_s_1	0.004121	412	1	0	8	_	act	0.000593	F
438	F_fleet_6_YR_1954_s_1	0.004681	413	1	0	8	_	act	0.000676	F
439	F_fleet_6_YR_1955_s_1	0.00526	414	1	0	8	_	act	0.000762	F
440	F_fleet_6_YR_1956_s_1	0.005683	415	1	0	8	_	act	0.000827	F
441	F_fleet_6_YR_1957_s_1	0.006115	416	1	0	8	_	act	0.000893	F
442	F_fleet_6_YR_1958_s_1	0.006557	417	1	0	8	_	act	0.000962	F
443	F_fleet_6_YR_1959_s_1	0.007009	418	1	0	8	_	act	0.001032	F
444	F_fleet_6_YR_1960_s_1	0.007472	419	1	0	8	_	act	0.001105	F
445	F_fleet_6_YR_1961_s_1	0.007568	420	1	0	8	_	act	0.001124	F
446	F_fleet_6_YR_1962_s_1	0.007742	421	1	0	8	_	act	0.001154	F
447	F_fleet_6_YR_1963_s_1	0.007817	422	1	0	8	_	act	0.001169	F
448	F_fleet_6_YR_1964_s_1	0.007885	423	1	0	8	_	act	0.001182	F
449	F_fleet_6_YR_1965_s_1	0.007957	424	1	0	8	_	act	0.001197	F
450	F_fleet_6_YR_1966_s_1	0.008221	425	1	0	8	_	act	0.00124	F
451	F_fleet_6_YR_1967_s_1	0.008484	426	1	0	8	_	act	0.001284	F
452	F_fleet_6_YR_1968_s_1	0.008766	427	1	0	8	_	act	0.001331	F
453	F_fleet_6_YR_1969_s_1	0.009059	428	1	0	8	_	act	0.001381	F
454	F_fleet_6_YR_1970_s_1	0.009348	429	1	0	8	_	act	0.001431	F
455	F_fleet_6_YR_1971_s_1	0.009971	430	1	0	8	_	act	0.001607	F

456	F_fleet_6_YR_1972_s_1	0.010914	431	1	0	8	_	act	0.002642	F
457	F_fleet_6_YR_1973_s_1	0.011957	432	1	0	8	_	act	0.003307	F
458	F_fleet_6_YR_1974_s_1	0.013029	433	1	0	8	_	act	0.003604	F
459	F_fleet_6_YR_1975_s_1	0.014403	434	1	0	8	_	act	0.003807	F
460	F_fleet_6_YR_1976_s_1	0.016504	435	1	0	8	_	act	0.004142	F
461	F_fleet_6_YR_1977_s_1	0.019325	436	1	0	8	_	act	0.004664	F
462	F_fleet_6_YR_1978_s_1	0.0228	437	1	0	8	_	act	0.005412	F
463	F_fleet_6_YR_1979_s_1	0.025307	438	1	0	8	_	act	0.005371	F
464	F_fleet_6_YR_1980_s_1	0.026459	439	1	0	8	_	act	0.004674	F
465	F_fleet_6_YR_1981_s_1	0.008423	440	1	0	8	_	act	0.001405	F
466	F_fleet_6_YR_1982_s_1	0.078556	441	1	0	8	_	act	0.011939	F
467	F_fleet_6_YR_1983_s_1	0.024971	442	1	0	8	_	act	0.003816	F
468	F_fleet_6_YR_1984_s_1	0.015322	443	1	0	8	_	act	0.002358	F
469	F_fleet_6_YR_1985_s_1	0.012852	444	1	0	8	_	act	0.001846	F
470	F_fleet_6_YR_1986_s_1	0.021471	445	1	0	8	_	act	0.002811	F
471	F_fleet_6_YR_1987_s_1	0.021386	446	1	0	8	_	act	0.003072	F
472	F_fleet_6_YR_1988_s_1	0.027895	447	1	0	8	_	act	0.00413	F
473	F_fleet_6_YR_1989_s_1	0.032091	448	1	0	8	_	act	0.004528	F
474	F_fleet_6_YR_1990_s_1	0.020646	449	1	0	8	_	act	0.003014	F
475	F_fleet_6_YR_1991_s_1	0.033511	450	1	0	8	_	act	0.004938	F
476	F_fleet_6_YR_1992_s_1	0.032862	451	1	0	8	_	act	0.004808	F
477	F_fleet_6_YR_1993_s_1	0.032913	452	1	0	8	_	act	0.004702	F
478	F_fleet_6_YR_1994_s_1	0.052842	453	1	0	8	_	act	0.0078	F
479	F_fleet_6_YR_1995_s_1	0.047884	454	1	0	8	_	act	0.007069	F
480	F_fleet_6_YR_1996_s_1	0.026175	455	1	0	8	_	act	0.003815	F
481	F_fleet_6_YR_1997_s_1	0.0229	456	1	0	8	_	act	0.003308	F
482	F_fleet_6_YR_1998_s_1	0.042206	457	1	0	8	_	act	0.006034	F
483	F_fleet_6_YR_1999_s_1	0.040889	458	1	0	8	_	act	0.005706	F
484	F_fleet_6_YR_2000_s_1	0.049158	459	1	0	8	_	act	0.006977	F
485	F_fleet_6_YR_2001_s_1	0.050925	460	1	0	8	_	act	0.007015	F
486	F_fleet_6_YR_2002_s_1	0.049942	461	1	0	8	_	act	0.006901	F

487	F_fleet_6_YR_2003_s_1	0.058581	462	1	0	8	_	act	0.007987	F
488	F_fleet_6_YR_2004_s_1	0.053507	463	1	0	8	_	act	0.007399	F
489	F_fleet_6_YR_2005_s_1	0.047118	464	1	0	8	_	act	0.006682	F
490	F_fleet_6_YR_2006_s_1	0.044377	465	1	0	8	_	act	0.006223	F
491	F_fleet_6_YR_2007_s_1	0.051174	466	1	0	8	_	act	0.007204	F
492	F_fleet_6_YR_2008_s_1	0.067203	467	1	0	8	_	act	0.009423	F
493	F_fleet_6_YR_2009_s_1	0.092686	468	1	0	8	_	act	0.0136	F
494	F_fleet_6_YR_2010_s_1	0.047075	469	1	0	8	_	act	0.007074	F
495	F_fleet_6_YR_2011_s_1	0.048709	470	1	0	8	_	act	0.006945	F
496	F_fleet_6_YR_2012_s_1	0.04216	471	1	0	8	_	act	0.005902	F
497	F_fleet_6_YR_2013_s_1	0.057068	472	1	0	8	_	act	0.007917	F
498	F_fleet_6_YR_2014_s_1	0.057145	473	1	0	8	_	act	0.007843	F
499	F_fleet_6_YR_2015_s_1	0.047921	474	1	0	8	_	act	0.006832	F
500	SizeSel_1P_1_CHL_MC_1	31.6282	475	2	13	60	31.6912	OK	0.724262	No_prior
501	SizeSel_1P_2_CHL_MC_1	-11.5335	476	3	-15	0	-11.469	OK	58.4684	No_prior
502	SizeSel_1P_3_CHL_MC_1	3.53714	477	3	-25	10	3.54736	OK	0.246316	No_prior
503	SizeSel_1P_4_CHL_MC_1	4.76548	478	3	0	15	4.7605	OK	0.529854	No_prior
504	SizeSel_1P_5_CHL_MC_1	-11.8269	479	2	-15	10	-11.8346	OK	51.9341	No_prior
505	SizeSel_1P_6_CHL_MC_1	-1.58942	480	2	-15	5	-1.45108	OK	0.876087	No_prior
506	Retain_1P_1_CHL_MC_1	28.8	_	-3	13	79	28.8	NA	_	No_prior
507	Retain_1P_2_CHL_MC_1	1	_	-3	-1	30	1	NA	_	No_prior
508	Retain_1P_3_CHL_MC_1	1	_	-4	-1	2	1	NA	_	No_prior
509	Retain_1P_4_CHL_MC_1	0	_	-4	-1	2	0	NA	_	No_prior
510	DiscMort_1P_1_CHL_MC_1	-5	_	-2	-10	10	-5	NA	_	No_prior
511	DiscMort_1P_2_CHL_MC_1	1	_	-4	-1	2	1	NA	_	No_prior
512	DiscMort_1P_3_CHL_MC_1	0.14	_	-2	0	2	0.14	NA	_	No_prior
513	DiscMort_1P_4_CHL_MC_1	0	_	-4	-1	2	0	NA	_	No_prior
514	SizeSel_2P_1_CHL_nMC_2	49.6045	481	2	13	73	50.4161	OK	2.55626	No_prior
515	SizeSel_2P_2_CHL_nMC_2	1.85948	_	-3	-15	15	1.85948	NA	_	No_prior
516	SizeSel_2P_3_CHL_nMC_2	4.82478	482	3	-25	20	4.89067	OK	0.320949	No_prior
517	SizeSel_2P_4_CHL_nMC_2	-1.95604	_	-3	-20	15	-1.95604	NA	_	No_prior

518	SizeSel_2P_5_CHL_nMC_2	-3.62339	483	2	-15	15	-3.75866	OK	0.363289	No_prior
519	SizeSel_2P_6_CHL_nMC_2	-3.05871	484	2	-15	15	-5.82361	OK	14.8449	No_prior
520	Retain_2P_1_CHL_nMC_2	28.8	_	-3	13	79	28.8	NA	_	No_prior
521	Retain_2P_2_CHL_nMC_2	1	_	-3	-1	30	1	NA	_	No_prior
522	Retain_2P_3_CHL_nMC_2	1	_	-4	-1	2	1	NA	_	No_prior
523	Retain_2P_4_CHL_nMC_2	0	_	-4	-1	2	0	NA	_	No_prior
524	DiscMort_2P_1_CHL_nMC_2	-5	_	-2	-10	10	-5	NA	_	No_prior
525	DiscMort_2P_2_CHL_nMC_2	1	_	-4	-1	2	1	NA	_	No_prior
526	DiscMort_2P_3_CHL_nMC_2	0.14	_	-2	0	2	0.14	NA	_	No_prior
527	DiscMort_2P_4_CHL_nMC_2	0	_	-4	-1	2	0	NA	_	No_prior
528	SizeSel_3P_1_CM_LL_3	49.3072	485	2	13	73	49.6912	OK	1.07865	No_prior
529	SizeSel_3P_2_CM_LL_3	-5	_	-3	-10	50	-5	NA	_	No_prior
530	SizeSel_3P_3_CM_LL_3	4.26064	486	2	-15	20	4.28714	OK	0.135472	No_prior
531	SizeSel_3P_4_CM_LL_3	5	_	-3	-20	20	5	NA	_	No_prior
532	SizeSel_3P_5_CM_LL_3	-15	_	-2	-25	15	-15	NA	_	No_prior
533	SizeSel_3P_6_CM_LL_3	5	_	-3	-15	15	5	NA	_	No_prior
534	SizeSel_4P_1_REC_PR_4	18.9944	487	2	13	73	17.7934	OK	0.827724	No_prior
535	SizeSel_4P_2_REC_PR_4	-1.35615	488	3	-15	25	-1.47919	OK	0.074335	No_prior
536	SizeSel_4P_3_REC_PR_4	0.521139	489	3	-25	20	-1.46781	OK	1.04703	No_prior
537	SizeSel_4P_4_REC_PR_4	-2.92888	_	-3	-20	15	-2.92888	NA	_	No_prior
538	SizeSel_4P_5_REC_PR_4	-12.762	490	2	-15	15	-12.7841	OK	40.4295	No_prior
539	SizeSel_4P_6_REC_PR_4	0.712583	491	2	-15	15	0.955168	OK	0.294782	No_prior
540	Retain_4P_1_REC_PR_4	24.1	_	-3	13	79	24.1	NA	_	No_prior
541	Retain_4P_2_REC_PR_4	1	_	-3	-1	30	1	NA	_	No_prior
542	Retain_4P_3_REC_PR_4	1	_	-4	-1	2	1	NA	_	No_prior
543	Retain_4P_4_REC_PR_4	0	_	-4	-1	2	0	NA	_	No_prior
544	DiscMort_4P_1_REC_PR_4	-5	_	-2	-10	10	-5	NA	_	No_prior
545	DiscMort_4P_2_REC_PR_4	1	_	-4	-1	2	1	NA	_	No_prior
546	DiscMort_4P_3_REC_PR_4	0.069	_	-2	0	2	0.069	NA	_	No_prior
547	DiscMort_4P_4_REC_PR_4	0	_	-4	-1	2	0	NA	_	No_prior
548	SizeSel_5P_1_Rec_Shore_5	19.2332	492	2	13	73	19.2328	OK	0.031582	No_prior

549	SizeSel_5P_2_Rec_Shore_5	-1.99836	493	3	-15	15	-1.98723	OK	0.219322	No_prior
550	SizeSel_5P_3_Rec_Shore_5	-2.53854	_	-3	-15	20	-2.53854	NA	_	No_prior
551	SizeSel_5P_4_Rec_Shore_5	3.84109	494	3	-20	15	3.84143	OK	0.418024	No_prior
552	SizeSel_5P_5_Rec_Shore_5	-17.8605	495	2	-25	15	-17.8501	OK	87.6456	No_prior
553	SizeSel_5P_6_Rec_Shore_5	-3.45469	496	2	-15	15	-3.41191	OK	0.847403	No_prior
554	Retain_5P_1_Rec_Shore_5	24.1	_	-3	13	79	24.1	NA	_	No_prior
555	Retain_5P_2_Rec_Shore_5	1	_	-3	-1	30	1	NA	_	No_prior
556	Retain_5P_3_Rec_Shore_5	1	_	-4	-1	2	1	NA	_	No_prior
557	Retain_5P_4_Rec_Shore_5	0	_	-4	-1	2	0	NA	_	No_prior
558	DiscMort_5P_1_Rec_Shore_5	-5	_	-2	10	10	-5	NA	_	No_prior
559	DiscMort_5P_2_Rec_Shore_5	1	_	-4	-1	2	1	NA	_	No_prior
560	DiscMort_5P_3_Rec_Shore_5	0.069	_	-2	0	2	0.069	NA	_	No_prior
561	DiscMort_5P_4_Rec_Shore_5	0	_	-4	-1	2	0	NA	_	No_prior
562	SizeSel_6P_1_Rec_HB_CBT6	22.8836	497	2	13	73	22.9126	OK	0.522349	No_prior
563	SizeSel_6P_2_Rec_HB_CBT6	-11.6395	498	3	-15	15	-11.5949	OK	53.4501	No_prior
564	SizeSel_6P_3_Rec_HB_CBT6	1.86051	499	3	-15	30	1.8744	OK	0.32392	No_prior
565	SizeSel_6P_4_Rec_HB_CBT6	3.94197	500	3	-20	15	3.87555	OK	0.414924	No_prior
566	SizeSel_6P_5_Rec_HB_CBT6	-16.0956	501	2	-25	15	-16.0937	OK	103.256	No_prior
567	SizeSel_6P_6_Rec_HB_CBT6	-0.54751	502	2	-15	15	-0.45978	OK	0.263939	No_prior
568	Retain_6P_1_Rec_HB_CBT6	24.1	_	-3	13	79	24.1	NA	_	No_prior
569	Retain_6P_2_Rec_HB_CBT6	1	_	-3	-1	30	1	NA	_	No_prior
570	Retain_6P_3_Rec_HB_CBT6	1	_	-4	-1	2	1	NA	_	No_prior
571	Retain_6P_4_Rec_HB_CBT6	0	_	-4	-1	2	0	NA	_	No_prior
572	DiscMort_6P_1_Rec_HB_CBT6	-5	_	-2	-10	10	-5	NA	_	No_prior
573	DiscMort_6P_2_Rec_HB_CBT6	1	_	-4	-1	2	1	NA	_	No_prior
574	DiscMort_6P_3_Rec_HB_CBT6	0.069	_	-2	0	2	0.069	NA	_	No_prior
575	DiscMort_6P_4_Rec_HB_CBT6	0	_	-4	-1	2	0	NA	_	No_prior
576	Retain_1P_1_CHL_MC_1_BLK1repl_1945	22	_	-5	16	80	22	NA	_	No_prior
577	Retain_1P_2_CHL_MC_1_BLK1repl_1945	1	_	-5	0.0001	5	1	NA	_	No_prior
578	SizeSel_2P_1_CHL_nMC_2_BLK1repl_1945	32.2725	503	2	1	80	32.1228	OK	2.054	No_prior
579	SizeSel_2P_2_CHL_nMC_2_BLK1repl_1945	-1.17	504	3	-15	15	-0.93049	OK	0.328021	No_prior

580	SizeSel_2P_3_CHL_nMC_2_BLK1repl_1945	3.02208	505	3	-25	20	2.98312	OK	0.81822	No_prior
581	SizeSel_2P_4_CHL_nMC_2_BLK1repl_1945	0.426699	506	3	-20	15	0.181271	OK	2.61622	No_prior
582	SizeSel_2P_5_CHL_nMC_2_BLK1repl_1945	-9.72789	507	2	-15	15	-9.70855	OK	73.1205	No_prior
583	SizeSel_2P_6_CHL_nMC_2_BLK1repl_1945	-3.36116	508	2	-15	15	-3.64968	OK	1.73218	No_prior
584	Retain_2P_1_CHL_nMC_2_BLK1repl_1945	26	_	-5	16	80	26	NA	_	No_prior
585	Retain_2P_2_CHL_nMC_2_BLK1repl_1945	1	_	-5	0.0001	5	1	NA	_	No_prior
586	Retain_4P_1_REC_PR_4_BLK1repl_1945	20	_	-5	16	80	20	NA	_	No_prior
587	Retain_4P_2_REC_PR_4_BLK1repl_1945	1	_	-5	0.0001	5	1	NA	_	No_prior
588	Retain_5P_1_Rec_Shore_5_BLK1repl_1945	20	_	-5	16	80	20	NA	_	No_prior
589	Retain_5P_2_Rec_Shore_5_BLK1repl_1945	1	_	-6	0.0001	5	1	NA	_	No_prior
590	Retain_6P_1_Rec_HB_CBT6_BLK1repl_1945	20	_	-5	16	80	20	NA	_	No_prior
591	Retain_6P_2_Rec_HB_CBT6_BLK1repl_1945	1	_	-6	0.0001	5	1	NA	_	No_prior

Table 4.2.4.1 Predicted mature biomass (SSB, mt), and age-0 recruits (thousand fish for Gulf of Mexico Gray Snapper from the base model run.

Year	Total Biomass	Spawning Biomass	Recruitment
1945	24601.9	22200.1	10683
1946	24601.9	22200.1	10683
1947	24584.9	22184.7	10683
1948	24491.3	22099.7	10682.9
1949	24338.5	21957.4	10682.7
1950	24129.1	21759.3	10682.5
1951	23838.4	21483	10682.1
1952	23496.7	21154.8	10681.7
1953	23109.1	20780.4	10681.2
1954	22680.6	20364.8	10680.6
1955	22214.9	19912.2	10679.9
1956	21716.6	19427.2	10679.1
1957	21211.9	18933.7	10678.3
1958	20703.2	18435.4	10677.5
1959	20193.7	17935.9	10676.6
1960	19686	17438	10675.6
1961	19181.7	16943.6	10674.6
1962	18716.2	16484.1	10673.7
1963	18289.2	16061	10672.7
1964	17883.4	15658.9	10671.7
1965	17510.9	15289.4	10670.8
1966	17116.7	14900.1	10669.8
1967	16776.8	14563.9	10668.9
1968	16442.6	14235	10667.9
1969	16076.2	13876.2	10666.8
1970	15691.2	13533.6	8991.17
1971	15311.1	13219.1	8780.48
1972	14862.4	12889.9	8539
1973	14223.9	12385.5	8148.38
1974	13589.6	11854	7534.45
1975	12867.7	11238.9	6763.36
1976	12086.6	10580.5	6153.04
1977	11139.2	9764.65	6261.28
1978	10207.7	8870.84	9862.68
1979	9141.35	7871.63	4621.69

1980	8159.87	6902.54	4370.9
1981	7417.24	6061.18	17116.7
1982	6796.71	5372	8091.76
1983	6239.34	4627.05	1989.12
1984	6352.13	4429.58	23871.6
1985	5382.97	3895.58	518.78
1986	5407.57	3707.82	183.107
1987	5446.33	3848.64	17821.3
1988	4925.54	3635.02	12855.9
1989	4902.98	3158.75	9095.91
1990	4857.58	2824.16	14282.6
1991	5150.96	3032.22	11275.7
1992	4761.03	2790.2	6498.32
1993	5009.48	3013.19	9691.62
1994	5010.41	3208.12	10834.5
1995	4991.78	3263.71	8082.71
1996	5095.88	3333.81	7107.69
1997	5303.02	3578.83	9130.68
1998	5369.77	3847.32	3039.05
1999	5414.59	3906.94	11036.6
2000	5470.88	4050.84	7117.52
2001	5486.96	3903.5	12563
2002	5484.75	3699.66	12246.6
2003	5676.34	3702.53	9085.46
2004	5748.67	3613.65	13131.2
2005	5384.62	3441.49	5800.36
2006	5506.46	3538.46	11489.4
2007	5880.14	3988.33	8560.19
2008	5928.71	4191.15	4476.36
2009	5631.15	3948.96	12213.6
2010	5205.96	3647.31	10734.2
2011	5677.98	3877.42	9811.37
2012	6280.35	4143.68	14812.8
2013	6366.5	4265	7380.75
2014	6839.19	4485.23	18237
2015	6982.32	4660.34	10223.2

Table 4.2.6.1. Annual exploitation rate (a measure of fishing mortality), by fleet.

Year	COM-MC	COM-nMC	LL	Rec-PRI	REC-Shore	REC-CBHB
1945	0	0	0	0	0	0
1946	0.0000	0.0001	0	0.0005	0.0009	0.0002
1947	0.0003	0.0003	0	0.0029	0.0050	0.0008
1948	0.0005	0.0006	0	0.0048	0.0083	0.0012
1949	0.0007	0.0008	0	0.0066	0.0116	0.0017
1950	0.0009	0.0012	0	0.0095	0.0165	0.0025
1951	0.0011	0.0015	0	0.0115	0.0199	0.0030
1952	0.0013	0.0017	0	0.0135	0.0235	0.0036
1953	0.0015	0.0020	0	0.0157	0.0271	0.0041
1954	0.0017	0.0023	0	0.0179	0.0308	0.0047
1955	0.0019	0.0027	0	0.0203	0.0346	0.0053
1956	0.0021	0.0029	0	0.0219	0.0372	0.0057
1957	0.0023	0.0032	0	0.0236	0.0399	0.0061
1958	0.0025	0.0034	0	0.0253	0.0425	0.0066
1959	0.0027	0.0037	0	0.0271	0.0451	0.0070
1960	0.0029	0.0039	0	0.0289	0.0479	0.0075
1961	0.0029	0.0040	0	0.0294	0.0483	0.0076
1962	0.0030	0.0041	0	0.0298	0.0487	0.0077
1963	0.0038	0.0054	0	0.0303	0.0490	0.0078
1964	0.0044	0.0055	0	0.0306	0.0493	0.0079
1965	0.0070	0.0102	0	0.0310	0.0498	0.0080
1966	0.0057	0.0076	0	0.0321	0.0512	0.0082
1967	0.0065	0.0086	0	0.0331	0.0526	0.0085
1968	0.0083	0.0136	0	0.0343	0.0541	0.0088
1969	0.0090	0.0132	0	0.0355	0.0558	0.0091
1970	0.0084	0.0124	0	0.0367	0.0573	0.0093
1971	0.0090	0.0134	0	0.0390	0.0609	0.0100
1972	0.0245	0.0147	0	0.0426	0.0674	0.0109
1973	0.0088	0.0211	0	0.0466	0.0744	0.0120
1974	0.0097	0.0248	0	0.0508	0.0816	0.0130
1975	0.0058	0.0289	0	0.0559	0.0897	0.0144
1976	0.0103	0.0415	0	0.0642	0.1035	0.0165
1977	0.0091	0.0433	0	0.0752	0.1221	0.0193
1978	0.0105	0.0522	0	0.0885	0.1440	0.0228
1979	0.0106	0.0606	0	0.0966	0.1517	0.0253
1980	0.0148	0.0671	0.0019	0.1066	0.1579	0.0265
1981	0.0295	0.0708	0.0022	0.1284	0.0711	0.0084

1982	0.0389	0.0753	0.0061	0.0801	0.1436	0.0786
1983	0.0517	0.0657	0.0127	0.0377	0.1653	0.0250
1984	0.0494	0.0279	0.0080	0.1871	0.2836	0.0153
1985	0.0438	0.0231	0.0069	0.1207	0.0490	0.0129
1986	0.0562	0.0216	0.0086	0.0617	0.1593	0.0215
1987	0.0537	0.0197	0.0098	0.1251	0.2801	0.0214
1988	0.0533	0.0156	0.0070	0.1421	0.1736	0.0279
1989	0.0473	0.0283	0.0118	0.1962	0.1728	0.0321
1990	0.0246	0.0256	0.0087	0.1728	0.1240	0.0206
1991	0.0160	0.0478	0.0078	0.1991	0.4563	0.0335
1992	0.0247	0.0337	0.0039	0.1586	0.1475	0.0329
1993	0.0316	0.0469	0.0064	0.1818	0.1611	0.0329
1994	0.0227	0.0618	0.0031	0.1780	0.1247	0.0528
1995	0.0089	0.0380	0.0017	0.1791	0.0935	0.0479
1996	0.0128	0.0277	0.0015	0.1395	0.1117	0.0262
1997	0.0073	0.0263	0.0014	0.1385	0.0892	0.0229
1998	0.0069	0.0212	0.0010	0.1588	0.0928	0.0422
1999	0.0064	0.0272	0.0024	0.1380	0.0395	0.0409
2000	0.0060	0.0278	0.0018	0.1736	0.0816	0.0492
2001	0.0040	0.0331	0.0023	0.1866	0.1077	0.0509
2002	0.0061	0.0379	0.0031	0.1648	0.0603	0.0499
2003	0.0055	0.0337	0.0022	0.2330	0.0691	0.0586
2004	0.0075	0.0406	0.0038	0.3087	0.0880	0.0535
2005	0.0067	0.0450	0.0038	0.2058	0.0777	0.0471
2006	0.0056	0.0363	0.0033	0.1058	0.0531	0.0444
2007	0.0059	0.0217	0.0025	0.1560	0.0686	0.0512
2008	0.0024	0.0249	0.0035	0.2411	0.1108	0.0672
2009	0.0033	0.0331	0.0010	0.2538	0.1077	0.0927
2010	0.0050	0.0173	0.0010	0.0876	0.0428	0.0471
2011	0.0048	0.0301	0.0025	0.0997	0.0142	0.0487
2012	0.0048	0.0258	0.0026	0.1773	0.0761	0.0422
2013	0.0036	0.0203	0.0022	0.1546	0.0352	0.0571
2014	0.0012	0.0307	0.0036	0.1722	0.0588	0.0571
2015	0.0016	0.0217	0.0051	0.1474	0.0370	0.0479

Table 4.2.9.1. Annual estimates of SSB, SSB/SSBSPR30, SSB/MSST, F and F/SPR30. FSPR30 is also equal to MFMT.

Year	SSB	SSB/S0	SSB/SPR30	SSB/MSST		F	F/FSPR30
1945	22200	1.000	3.353	6.706		0.0000	0.000
1946	22200	1.000	3.353	6.706		0.0009	0.008
1947	22185	0.999	3.351	6.702		0.0051	0.044
1948	22100	0.995	3.338	6.676		0.0084	0.073
1949	21957	0.989	3.316	6.633		0.0117	0.102
1950	21759	0.980	3.287	6.573		0.0166	0.145
1951	21483	0.968	3.245	6.490		0.0202	0.175
1952	21155	0.953	3.195	6.391		0.0238	0.207
1953	20780	0.936	3.139	6.277		0.0275	0.240
1954	20365	0.917	3.076	6.152		0.0315	0.274
1955	19912	0.897	3.008	6.015		0.0355	0.309
1956	19427	0.875	2.934	5.869		0.0384	0.334
1957	18934	0.853	2.860	5.720		0.0414	0.360
1958	18435	0.830	2.785	5.569		0.0445	0.387
1959	17936	0.808	2.709	5.418		0.0476	0.414
1960	17438	0.785	2.634	5.268		0.0509	0.442
1961	16944	0.763	2.559	5.118		0.0518	0.450
1962	16484	0.743	2.490	4.980		0.0527	0.458
1963	16061	0.723	2.426	4.852		0.0544	0.473
1964	15659	0.705	2.365	4.730		0.0553	0.481
1965	15289	0.689	2.309	4.619		0.0592	0.515
1966	14900	0.671	2.251	4.501		0.0593	0.516
1967	14564	0.656	2.200	4.400		0.0619	0.539
1968	14235	0.641	2.150	4.300		0.0666	0.580
1969	13876	0.625	2.096	4.192		0.0689	0.599
1970	13534	0.610	2.044	4.088		0.0703	0.611
1971	13219	0.595	1.997	3.993		0.0737	0.641
1972	12890	0.581	1.947	3.894		0.0872	0.759
1973	12386	0.558	1.871	3.741		0.0892	0.775
1974	11854	0.534	1.790	3.581		0.0975	0.848
1975	11239	0.506	1.698	3.395		0.1050	0.913
1976	10581	0.477	1.598	3.196		0.1238	1.077
1977	9765	0.440	1.475	2.950		0.1403	1.221
1978	8871	0.400	1.340	2.680		0.1650	1.435
1979	7872	0.355	1.189	2.378		0.1906	1.658
1980	6903	0.311	1.043	2.085		0.1892	1.645
1981	6061	0.273	0.915	1.831		0.1716	1.492
1982	5372	0.242	0.811	1.623		0.2656	2.310

1983	4627	0.208	0.699	1.398		0.1714	1.491
1984	4430	0.200	0.669	1.338		0.2958	2.573
1985	3896	0.175	0.588	1.177		0.2288	1.990
1986	3708	0.167	0.560	1.120		0.1584	1.378
1987	3849	0.173	0.581	1.163		0.2657	2.311
1988	3635	0.164	0.549	1.098		0.3494	3.039
1989	3159	0.142	0.477	0.954		0.2969	2.582
1990	2824	0.127	0.427	0.853		0.1602	1.393
1991	3032	0.137	0.458	0.916		0.3165	2.753
1992	2790	0.126	0.421	0.843		0.1677	1.459
1993	3013	0.136	0.455	0.910		0.1912	1.663
1994	3208	0.145	0.485	0.969		0.1968	1.711
1995	3264	0.147	0.493	0.986		0.1673	1.455
1996	3334	0.150	0.504	1.007		0.1410	1.227
1997	3579	0.161	0.541	1.081		0.1336	1.162
1998	3847	0.173	0.581	1.162		0.1554	1.351
1999	3907	0.176	0.590	1.180		0.1158	1.007
2000	4051	0.182	0.612	1.224		0.1734	1.508
2001	3904	0.176	0.590	1.179		0.1651	1.436
2002	3700	0.167	0.559	1.118		0.1525	1.327
2003	3703	0.167	0.559	1.118		0.1823	1.585
2004	3614	0.163	0.546	1.092		0.2238	1.947
2005	3441	0.155	0.520	1.040		0.1801	1.566
2006	3538	0.159	0.534	1.069		0.1047	0.911
2007	3988	0.180	0.602	1.205		0.1540	1.339
2008	4191	0.189	0.633	1.266		0.2028	1.764
2009	3949	0.178	0.596	1.193		0.2190	1.904
2010	3647	0.164	0.551	1.102		0.1020	0.887
2011	3877	0.175	0.586	1.171		0.0882	0.767
2012	4144	0.187	0.626	1.252		0.1528	1.329
2013	4265	0.192	0.644	1.288		0.1356	1.180
2014	4485	0.202	0.677	1.355		0.1437	1.250
2015	4660	0.210	0.704	1.408		0.1347	1.172

Table 4.2.9.2. References and Benchmarks

Reference	Value	STD
SSB_Unfished	22200.1	1747.65
TotBio_Unfished	24601.9	1936.73
Recr_Unfished	10683	840.994
SSB_SPR30	6620.69	521.198
Fstd_SPR30	0.114978	0.001727
TotYield_SPR30	1099.95	82.5983
Fstd_MSY	0.208961	0.007121
SSB2015/MSST	0.703	
Fcurrent/MFMT	1.2	

4.5 Figures

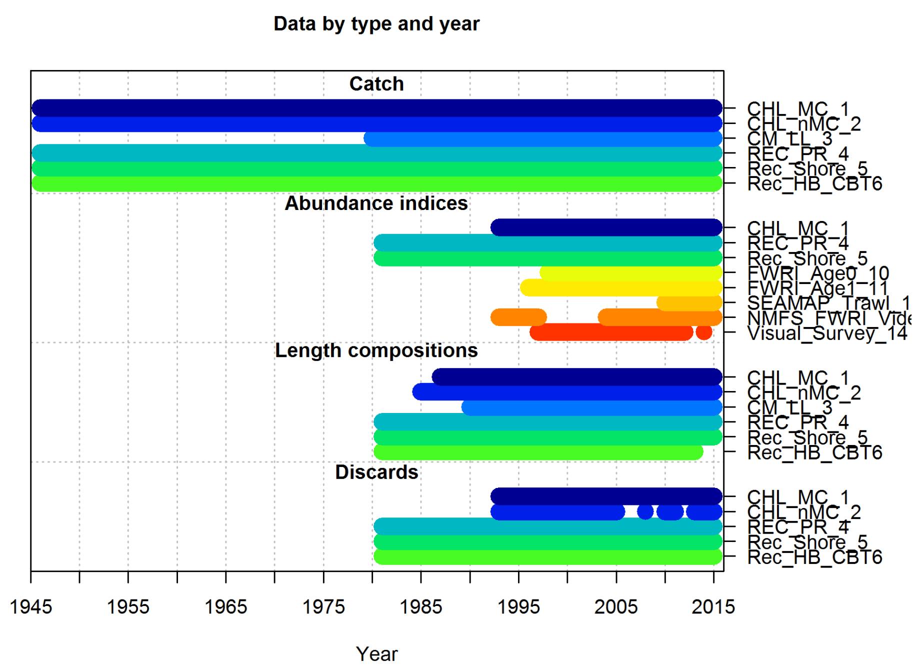


Figure 4.1.1.1 Data sources and time periods.

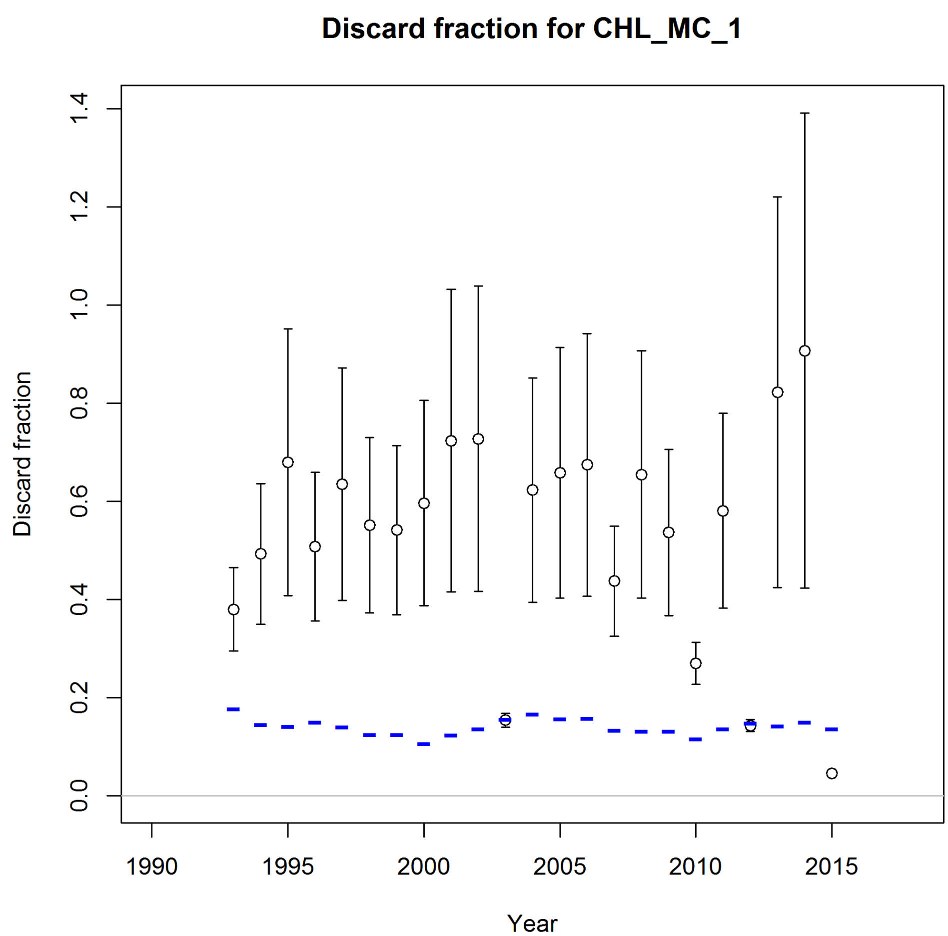


Figure 4.2.1.1 Observed (open circles) and SS predicted discard fractions (blue dashes) for Gulf of Mexico Gray Snapper from the Commercial Monroe County fishing fleet, 1993-2015.

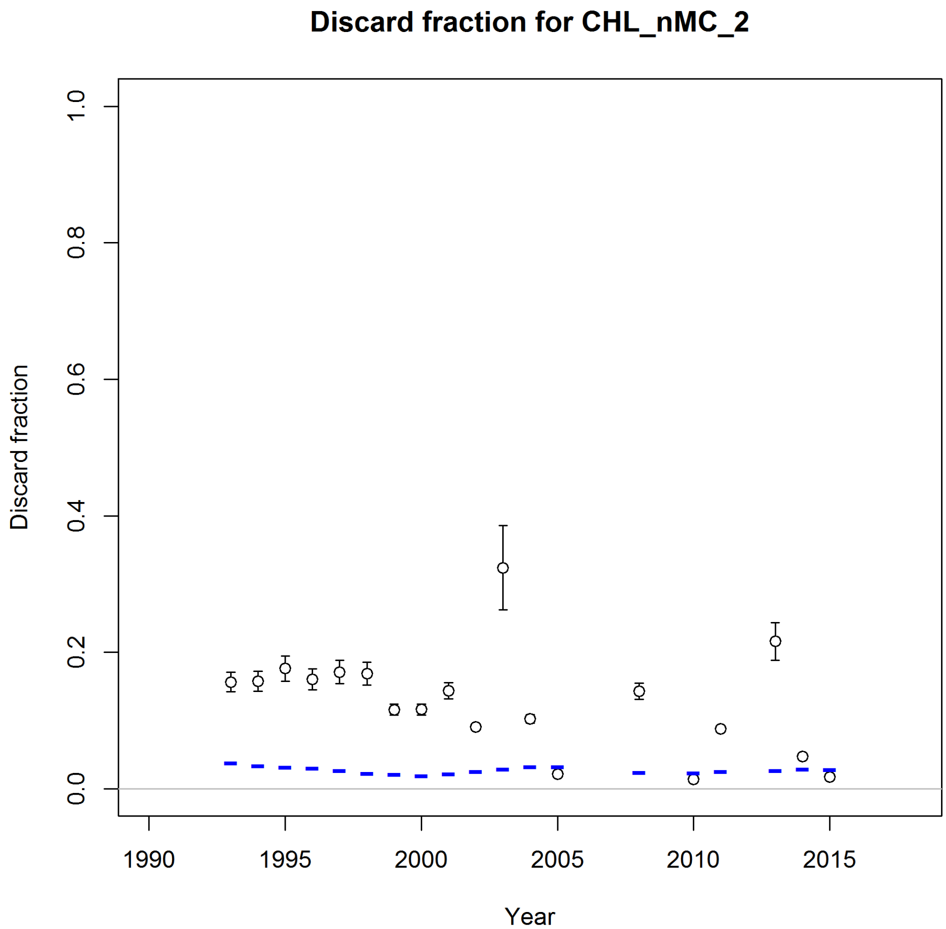


Figure 4.2.1.2. Observed (open circles) and SS predicted discard fractions (blue dashes) for Gulf of Mexico Gray Snapper from the Commercial Not Monroe County fishing fleet, 1993-2015.

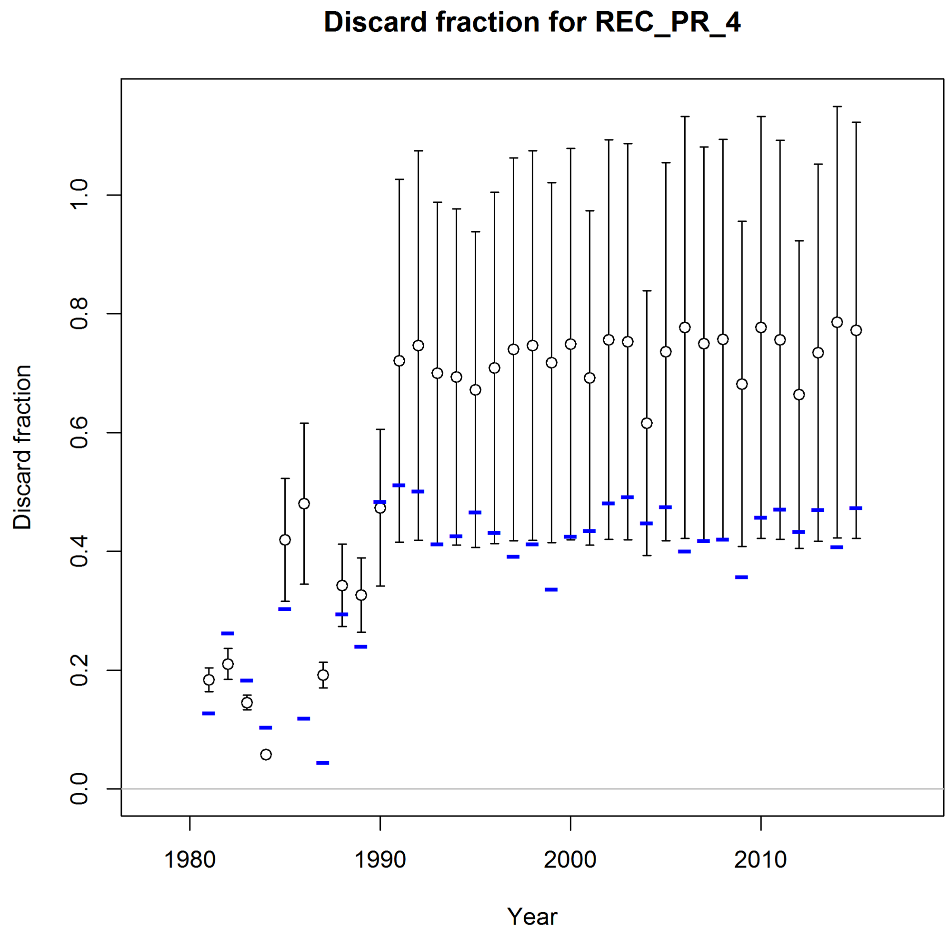


Figure 4.2.1.3. Observed (open circles) and SS predicted discard fractions (blue dashes) for Gulf of Mexico Gray Snapper from the Recreational Private fishing fleet, 1981-2015.

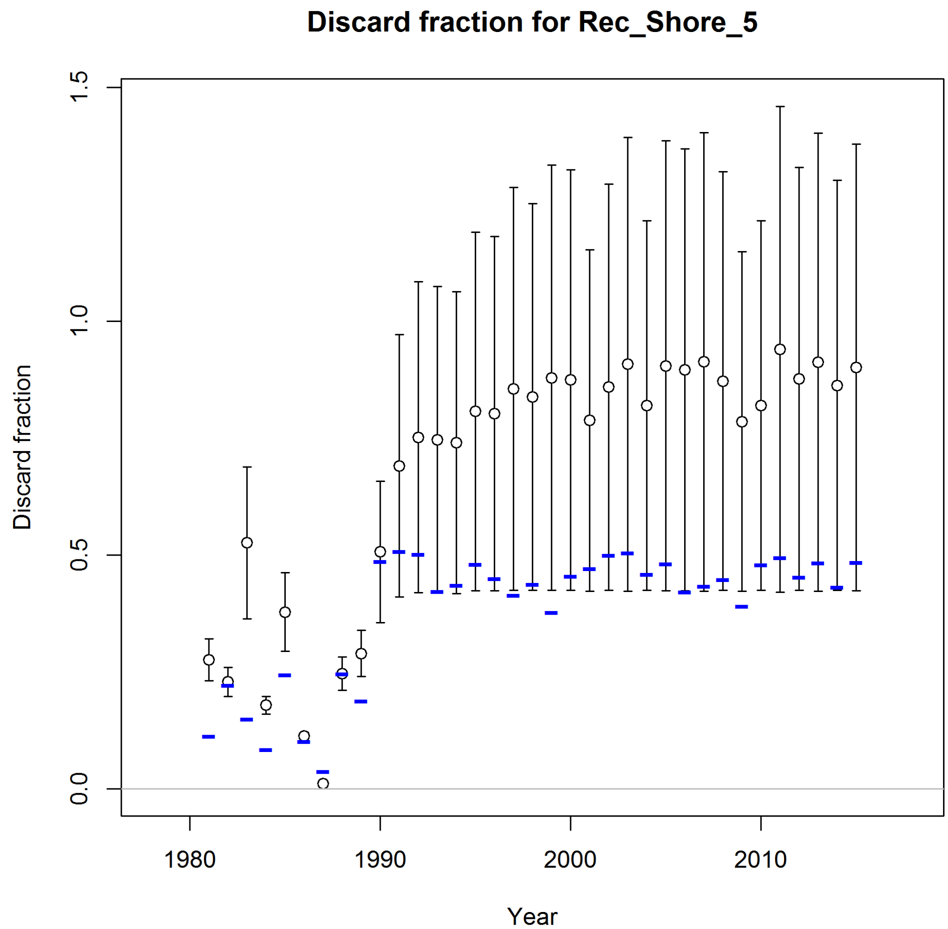


Figure 4.2.1.4. Observed (open circles) and SS predicted discard fractions (blue dashes) for Gulf of Mexico Gray Snapper from the Recreational Shore fishing fleet, 1981-2015.

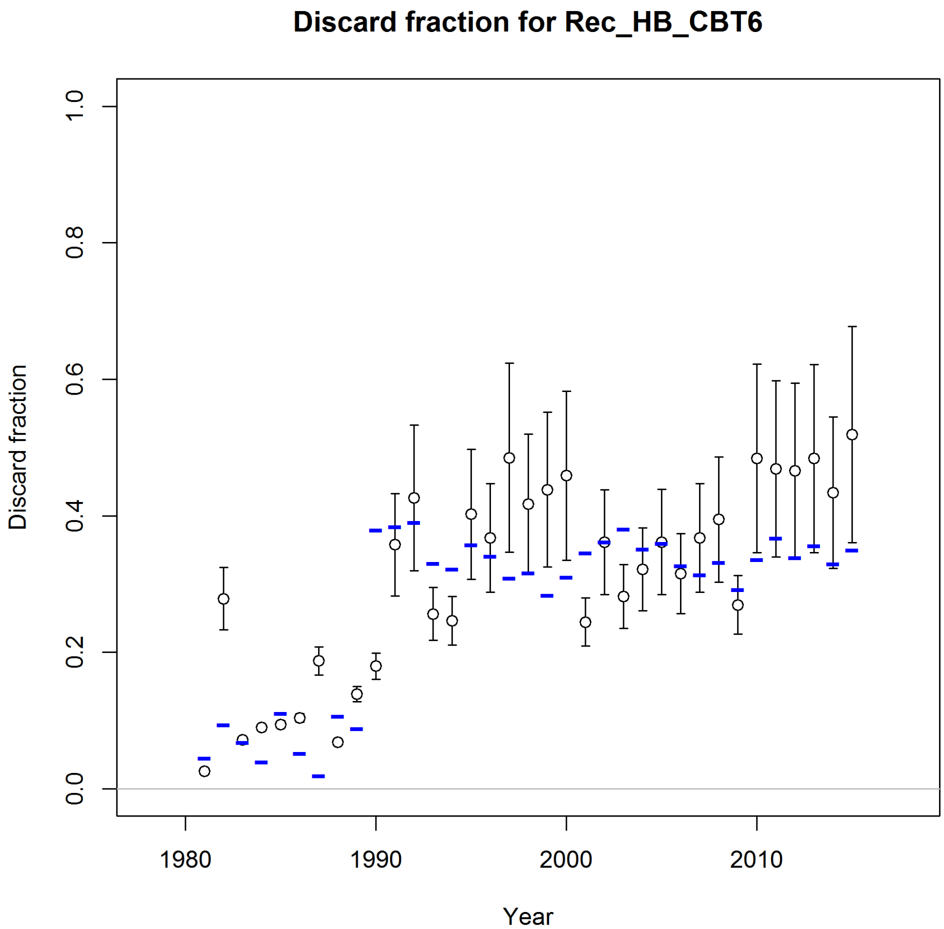
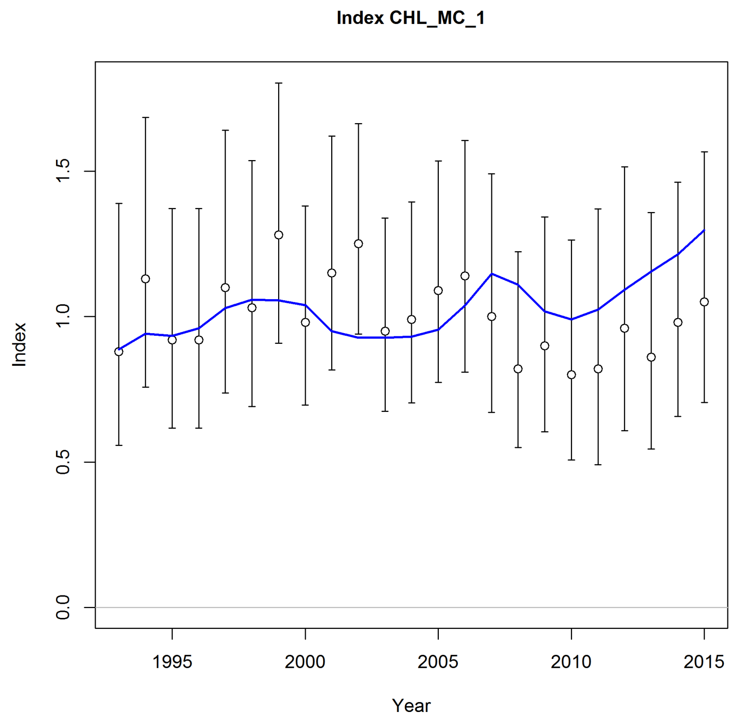


Figure 4.2.1.5. Observed (open circles) and SS predicted discard fraction (blue dashes) (thousands of fish) of Gulf of Mexico Gray Snapper from the Recreational Shore fishing fleet, 1981-2015.



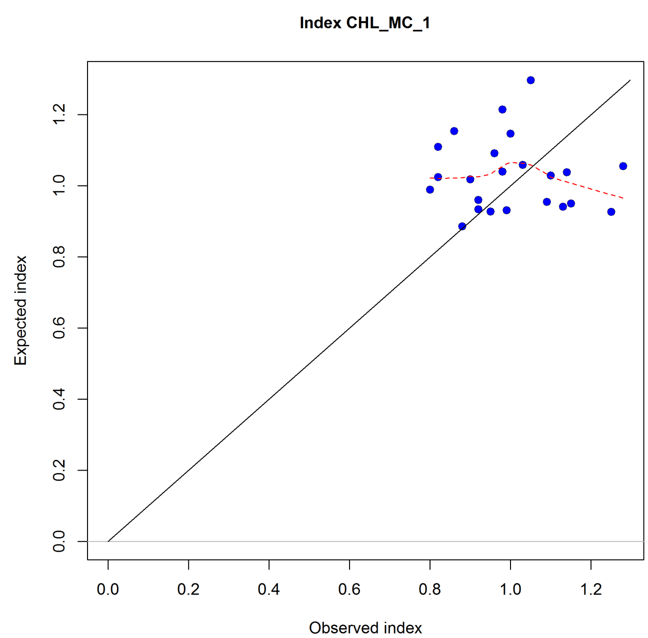
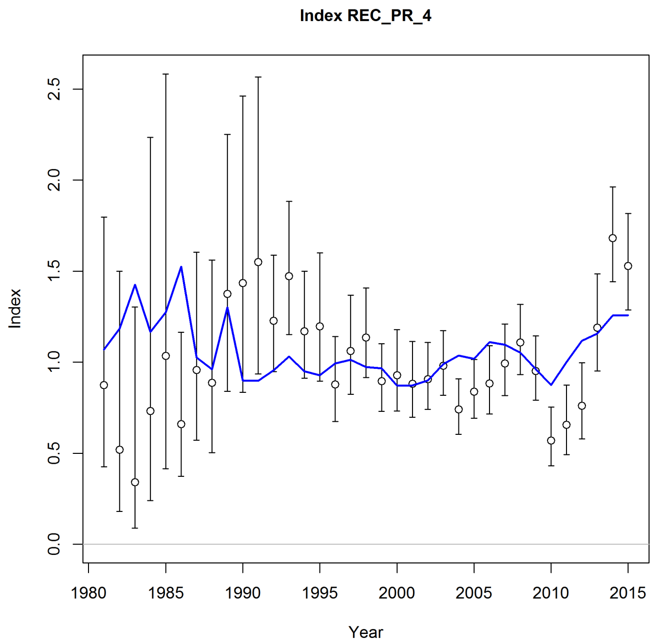


Figure 4.2.1.6. Model fit (blue line) to the standardized Commercial Monroe County index (open circles) (top panel). The bottom panel also shows a QQ-plot comparison of the observed and predicted indices, where the black line is the expected 1:1 line.

Headboat East



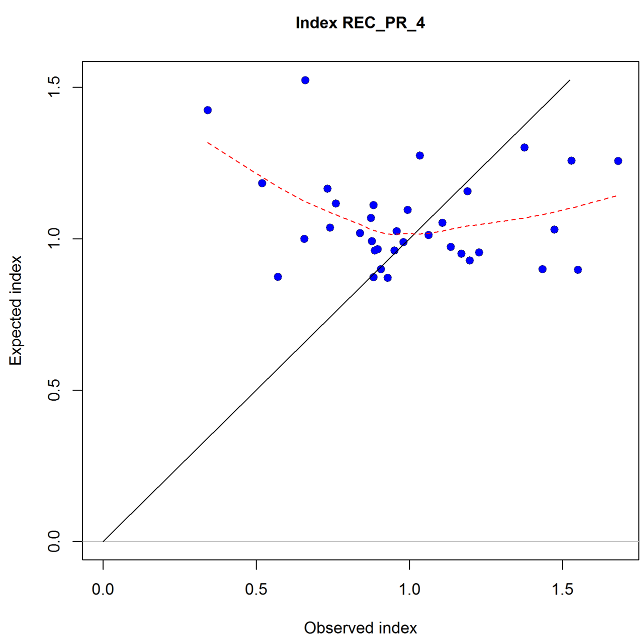
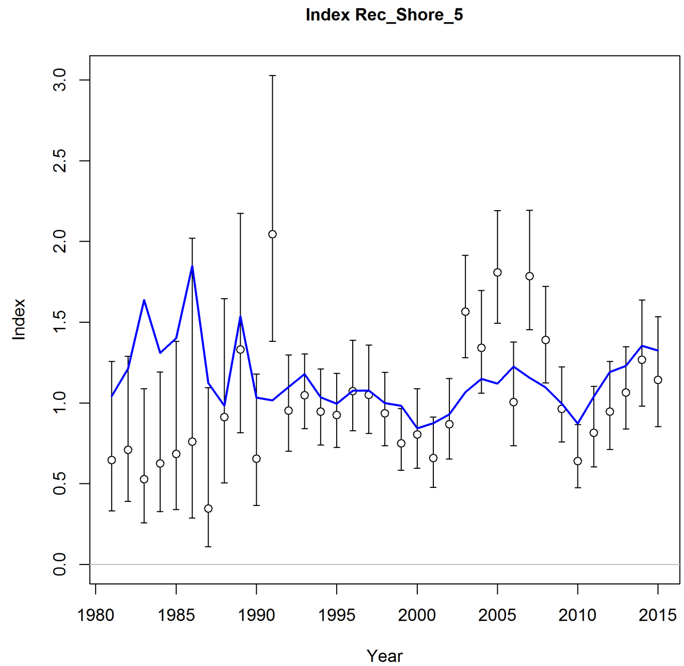


Figure 4.2.1.7. Model fit (blue line) to the standardized Recreational Private CPUE index (open circles) (top panel). The bottom panel also shows a QQ-plot comparison of the observed and predicted indices, where the black line is the expected 1:1 line.



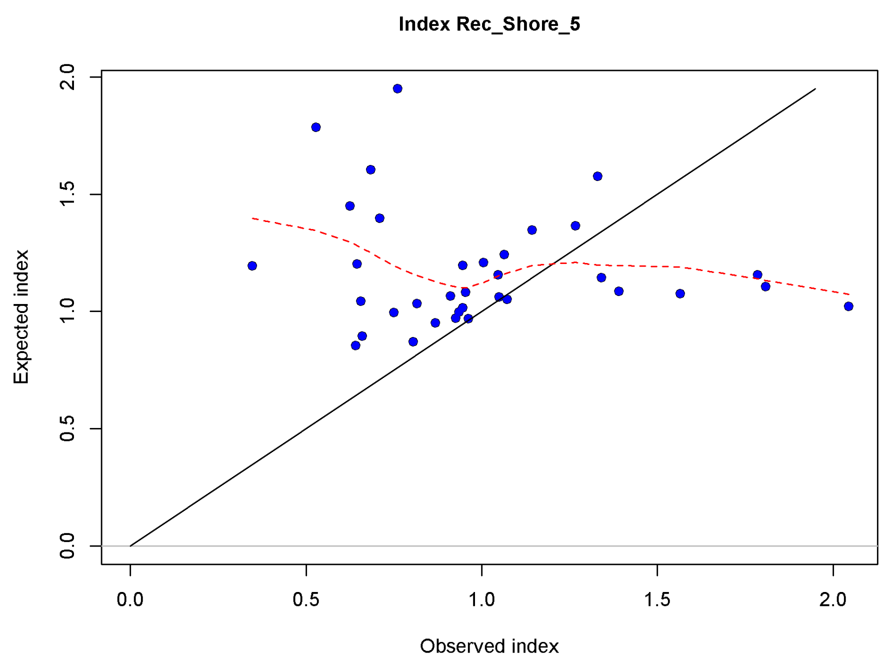
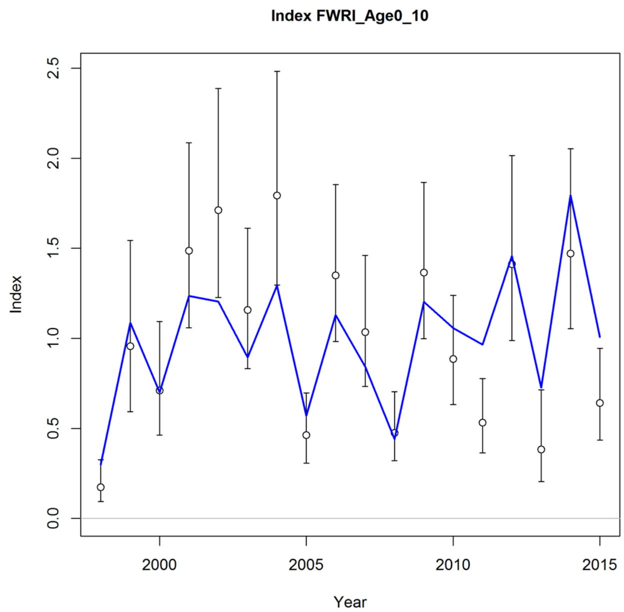


Figure 4.2.1.8. Model fit (blue line) to the standardized Recreational Shore CPUE index (open circles) (top panel). The bottom panel also shows a QQ-plot comparison of the observed and predicted indices, where the black line is the expected 1:1 line.



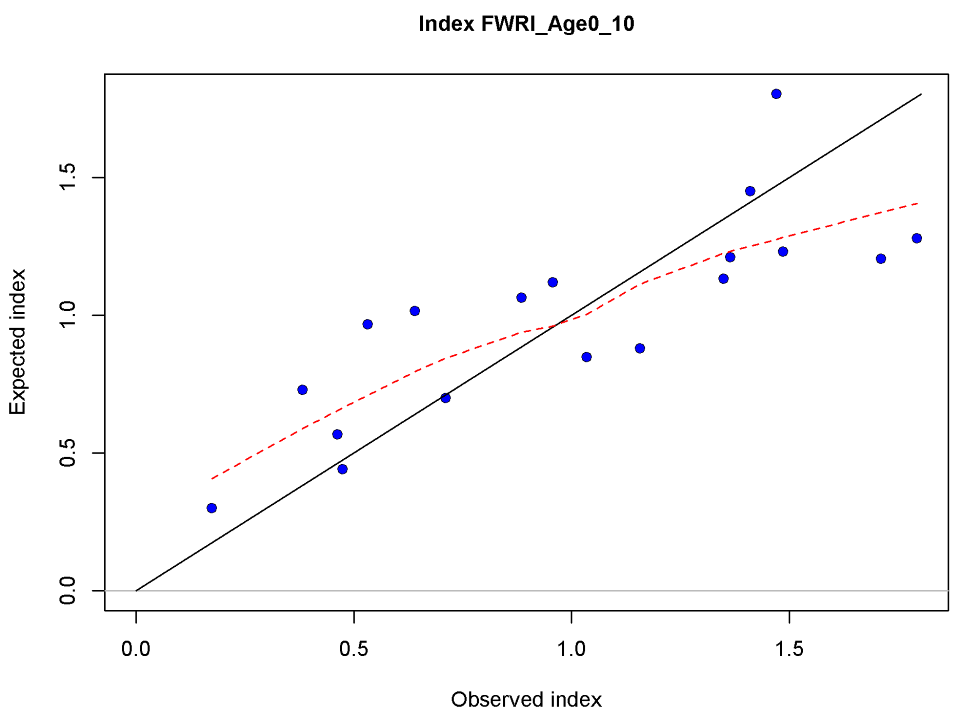


Figure 4.2.1.9. Model fit (blue line) to the FWRI Age-1 index (open circles) (top panel). The bottom panel also shows a comparison of the observed and predicted indices, where the black line is the 1:1 line.

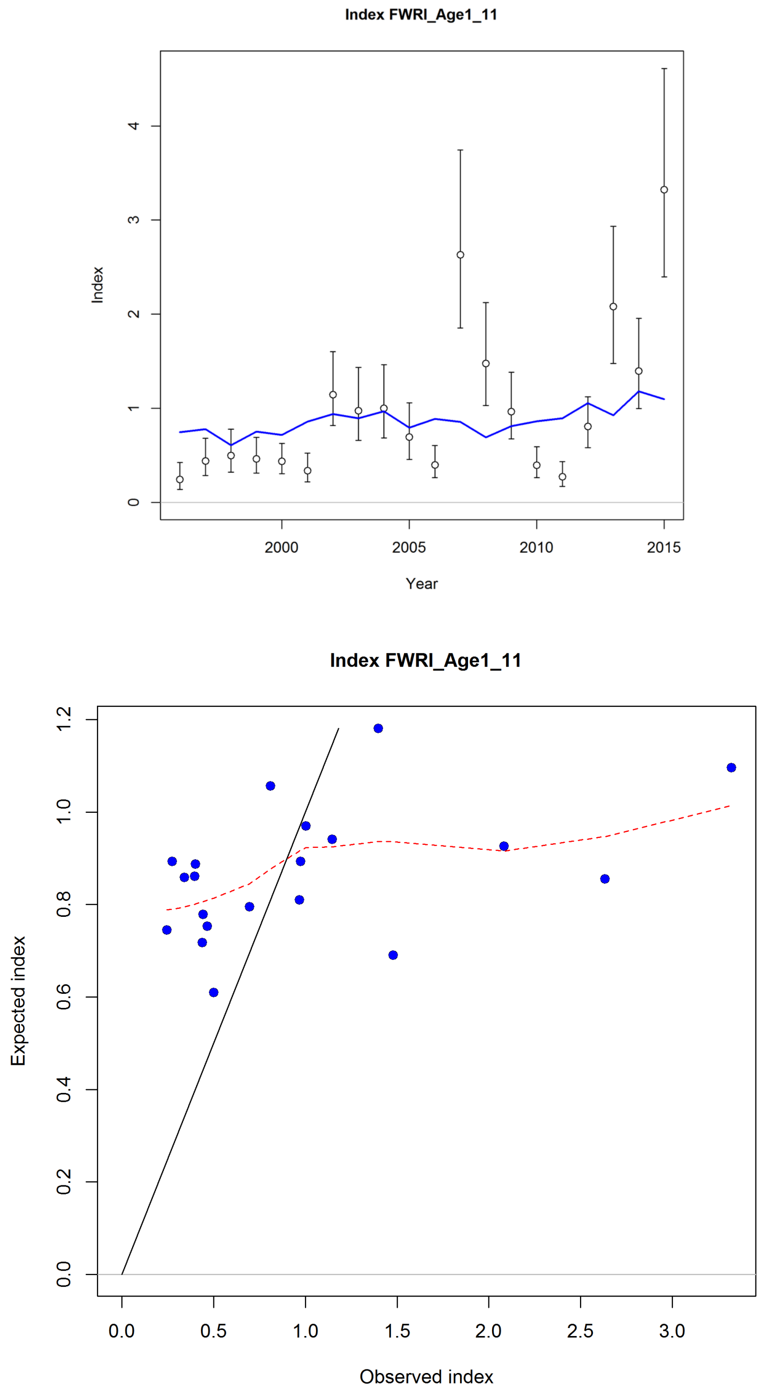
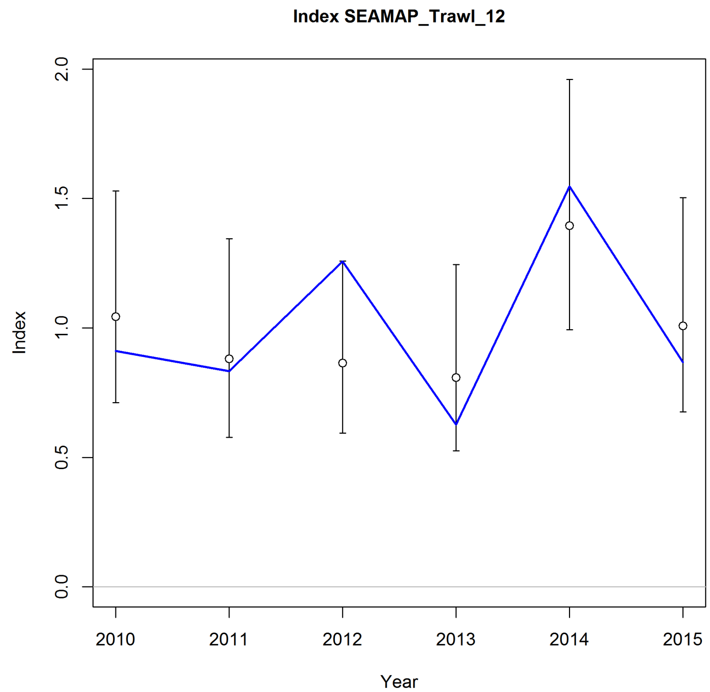


Figure 4.2.1.10. Model fit (blue line) to the FWRI Age-1 index (open circles) (top panel). The bottom panel also shows a comparison of the observed and predicted indices, where the black line is the 1:1 line.



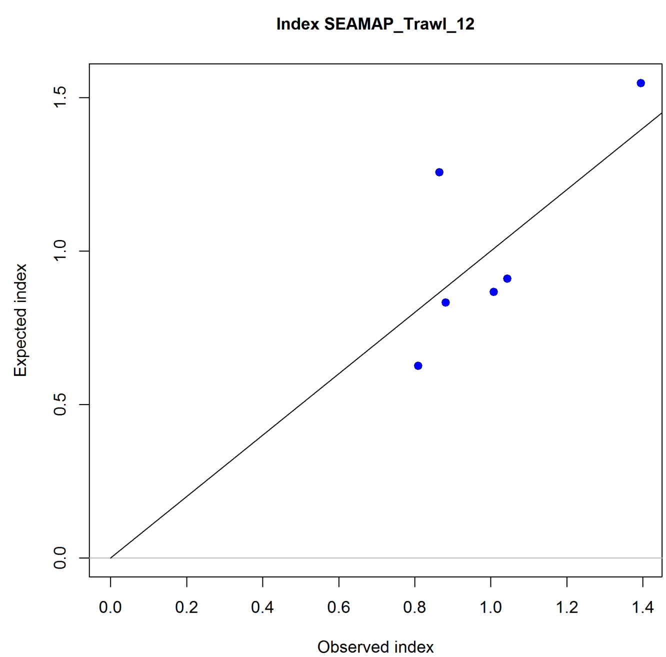
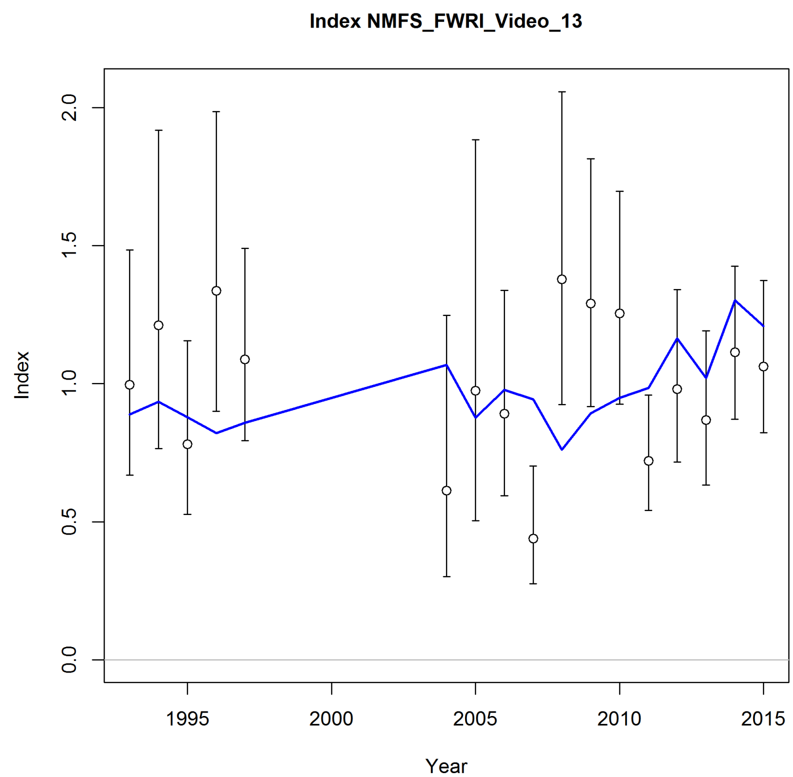


Figure 4.2.1.11. Model fit (blue line) to the SEAMAP Trawl CPUE index (open circles) (top panel). The bottom panel also shows a comparison of the observed and predicted indices, where the black line is the 1:1 line.



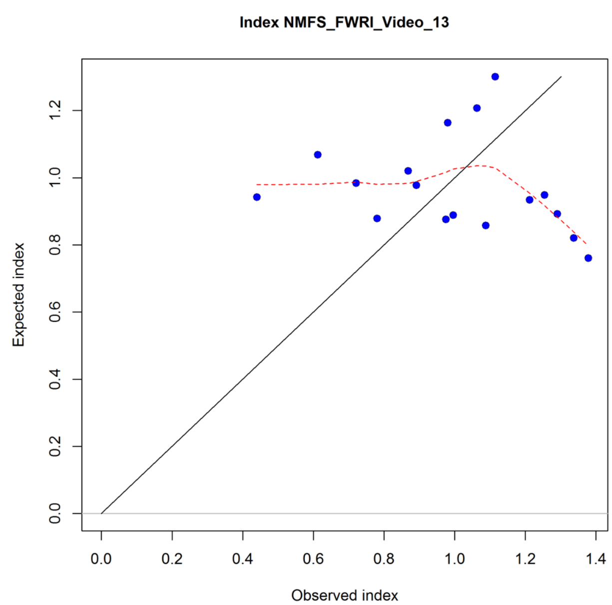


Figure 4.2.1.12. Model fit (blue line) to the standardized combined video survey index (open circles) (top panel). The bottom panel also shows a comparison of the observed and predicted indices, where the black line is the 1:1 line.

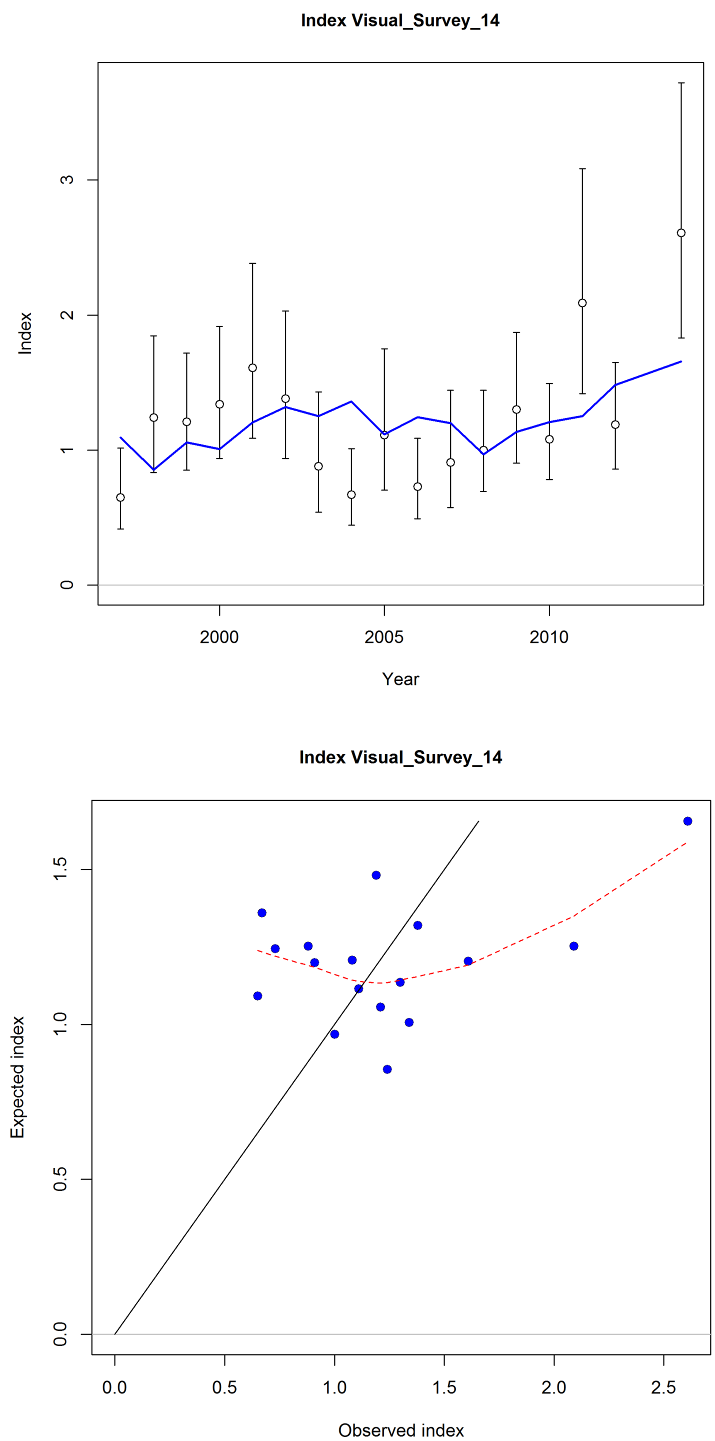


Figure 4.2.1.13. Model fit (blue line) to the standardized Visual Survey index (open circles) (top panel). The bottom panel also shows a comparison of the observed and predicted indices, where the black line is the 1:1 line.

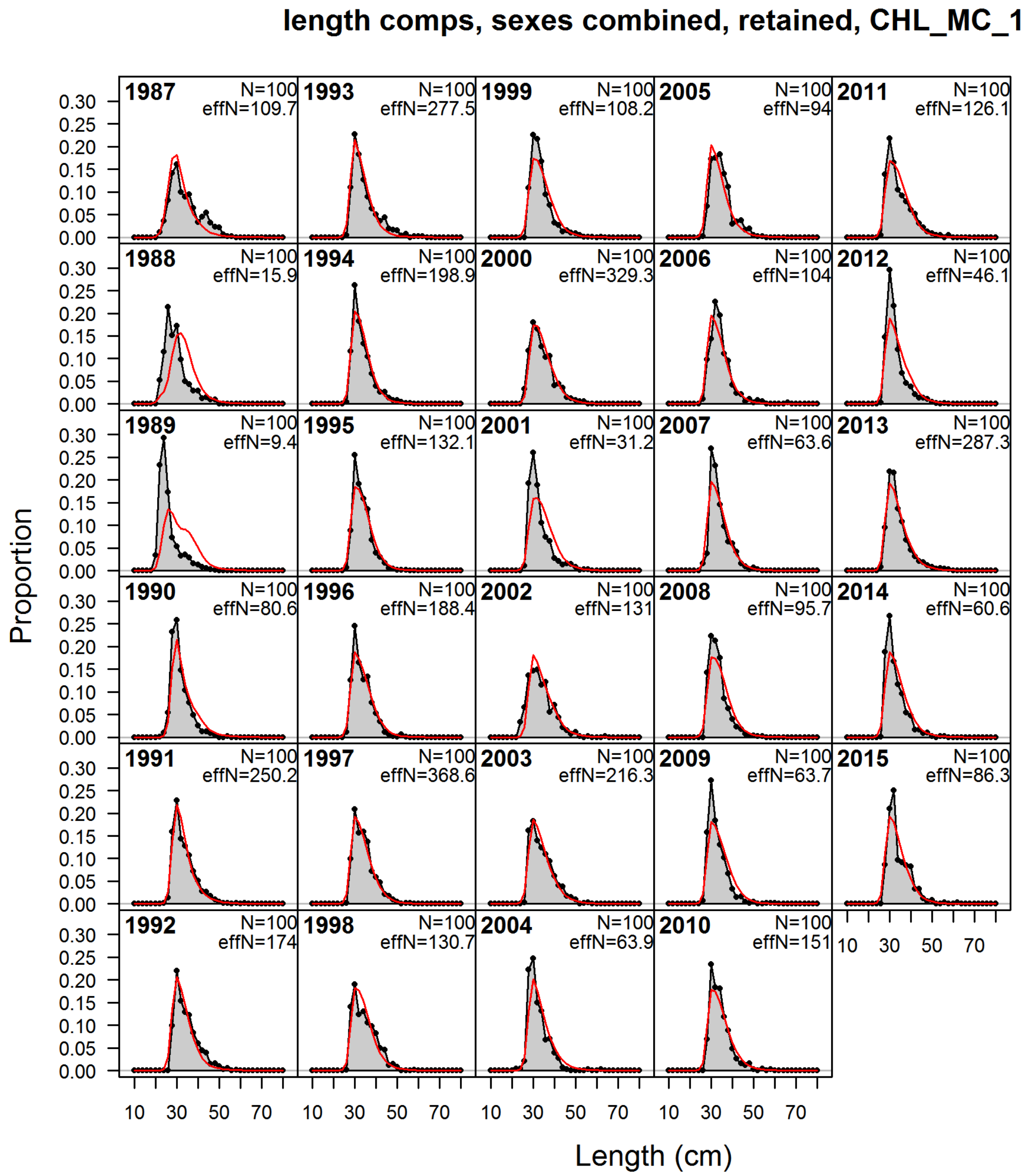


Figure 4.2.1.14. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Commercial Monroe County fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

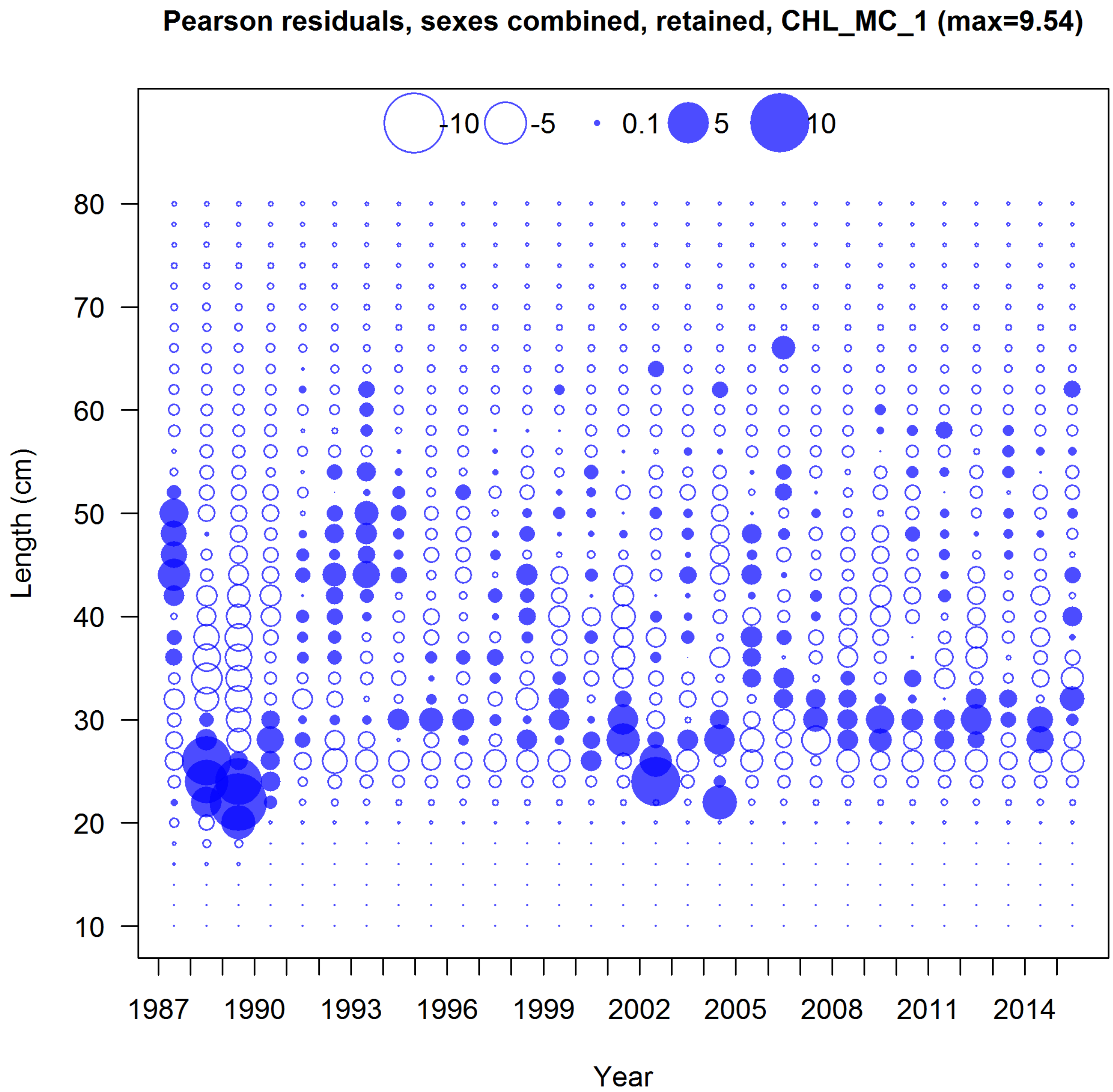


Figure 4.2.1.15. Pearson residuals for the size composition fit to Commercial Monroe County landings. Solid circles are positive residuals (i.e. observed greater than predicted) and open circles are negative residuals (i.e. predicted greater than observed).

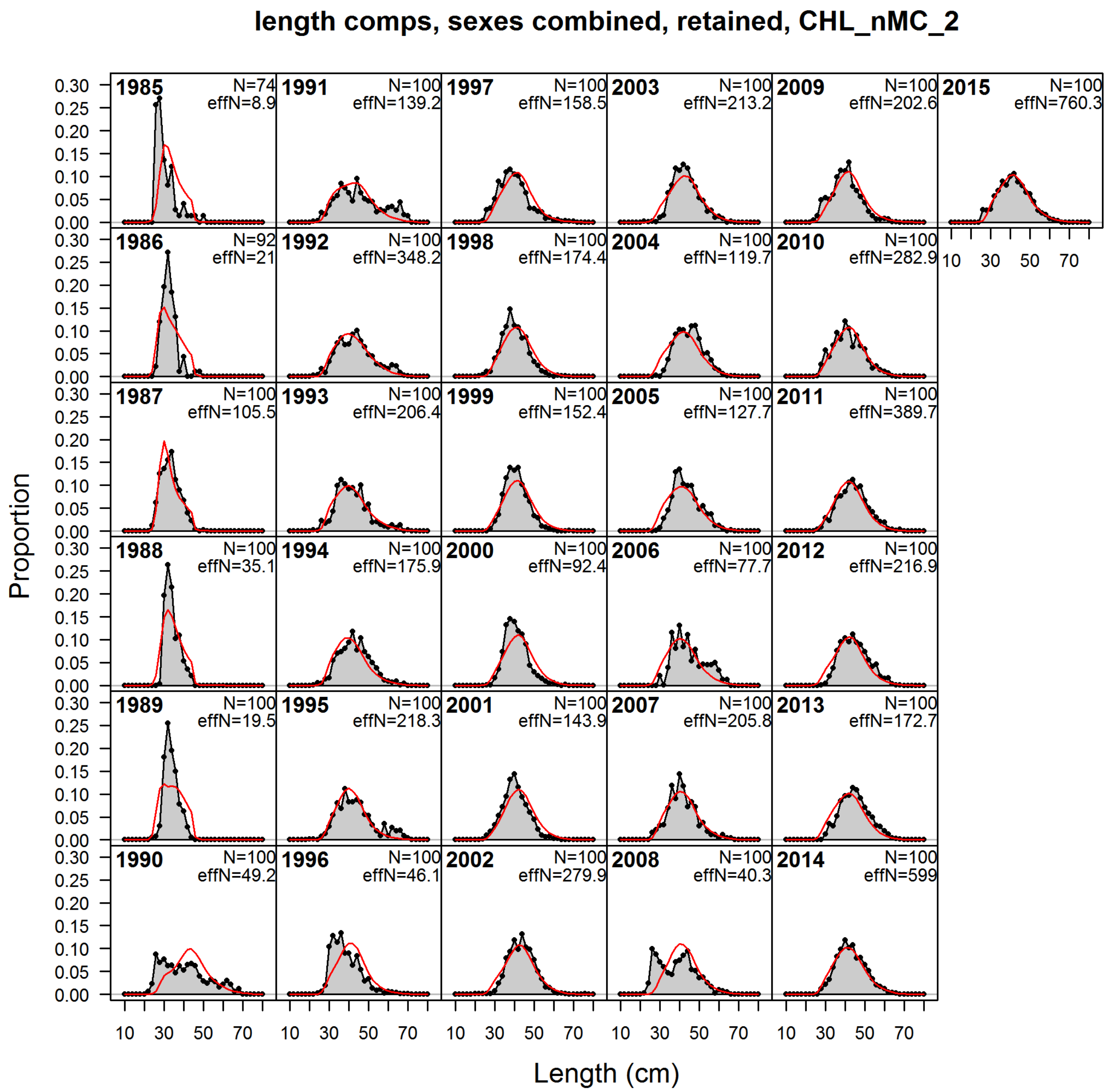


Figure 4.2.1.16. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Commercial Not Monroe County fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

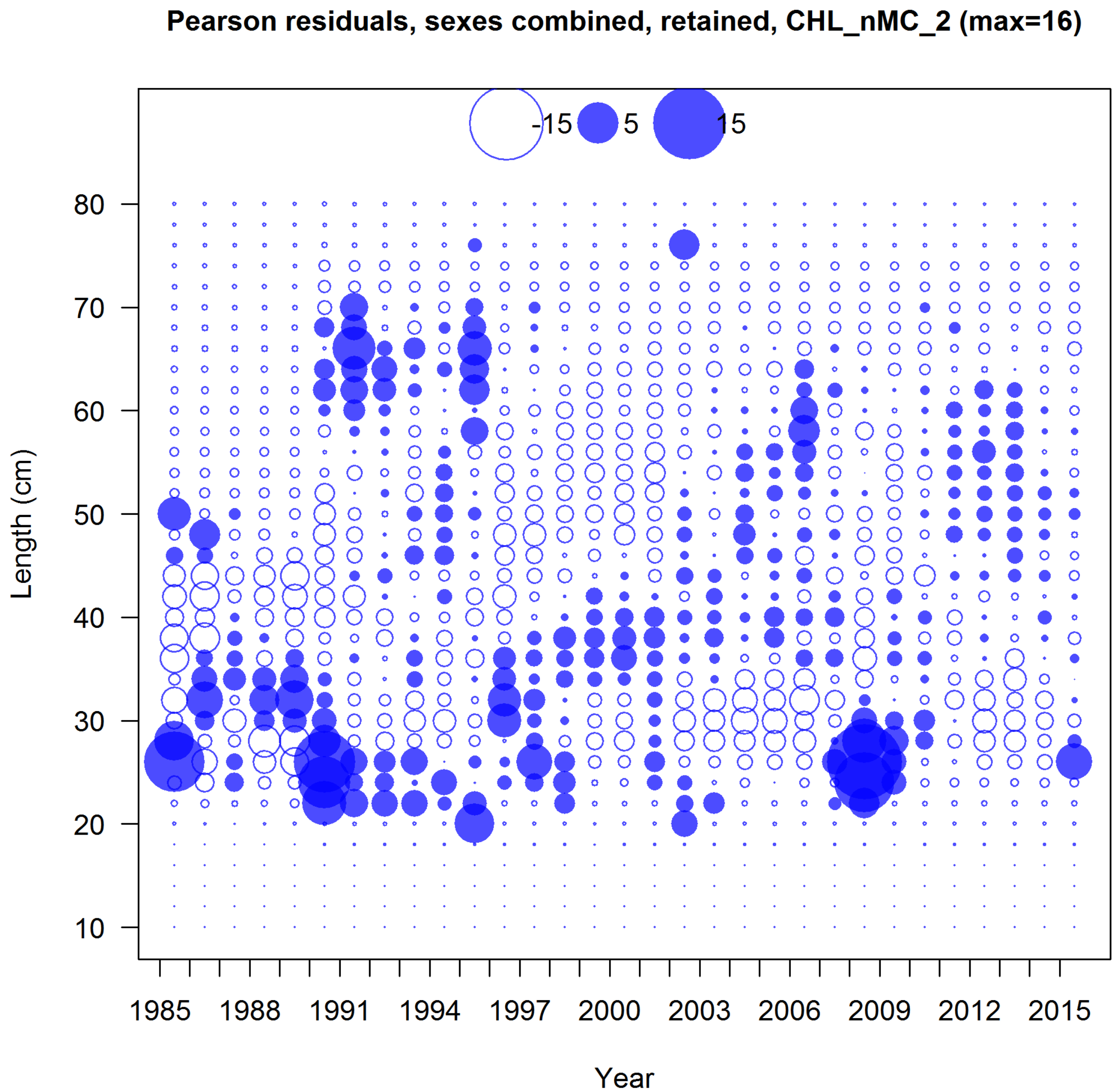


Figure 4.2.1.17. Pearson residuals for the length composition fit to Commercial Not Monroe County landings. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

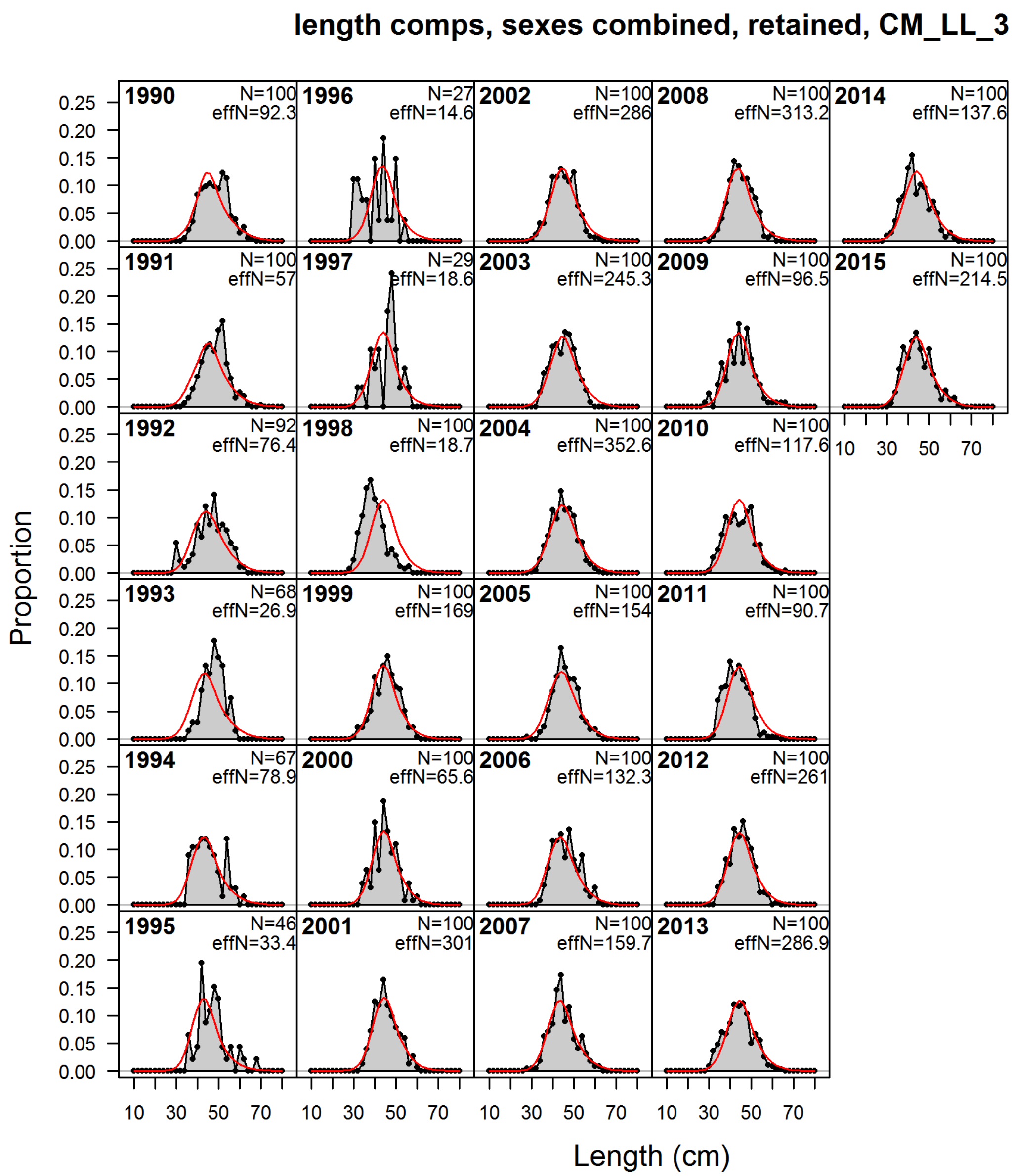


Figure 4.2.1.18. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Commercial Longline fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

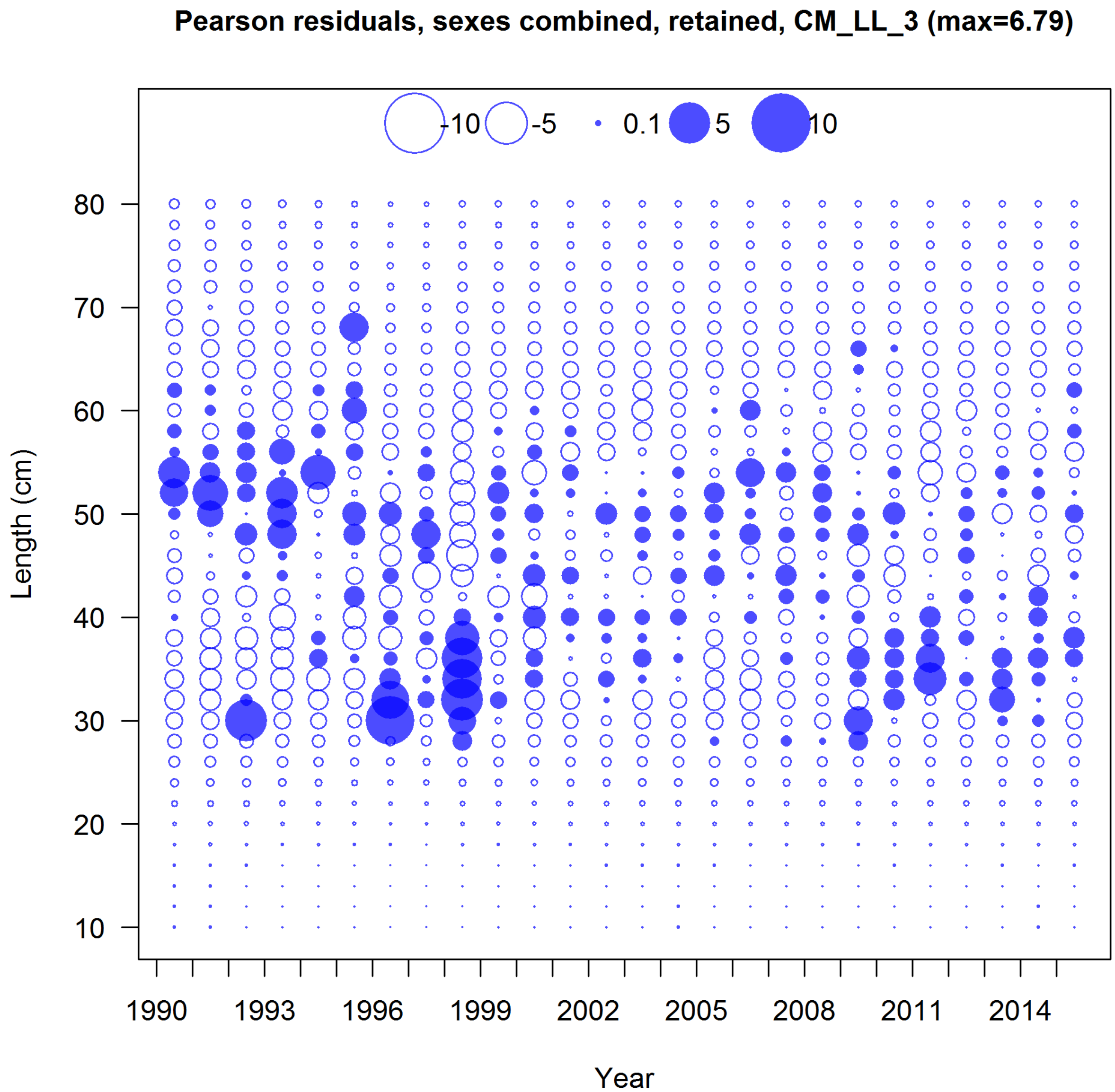


Figure 4.2.1.19. Pearson residuals for the size composition fit to Commercial Longline landings. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

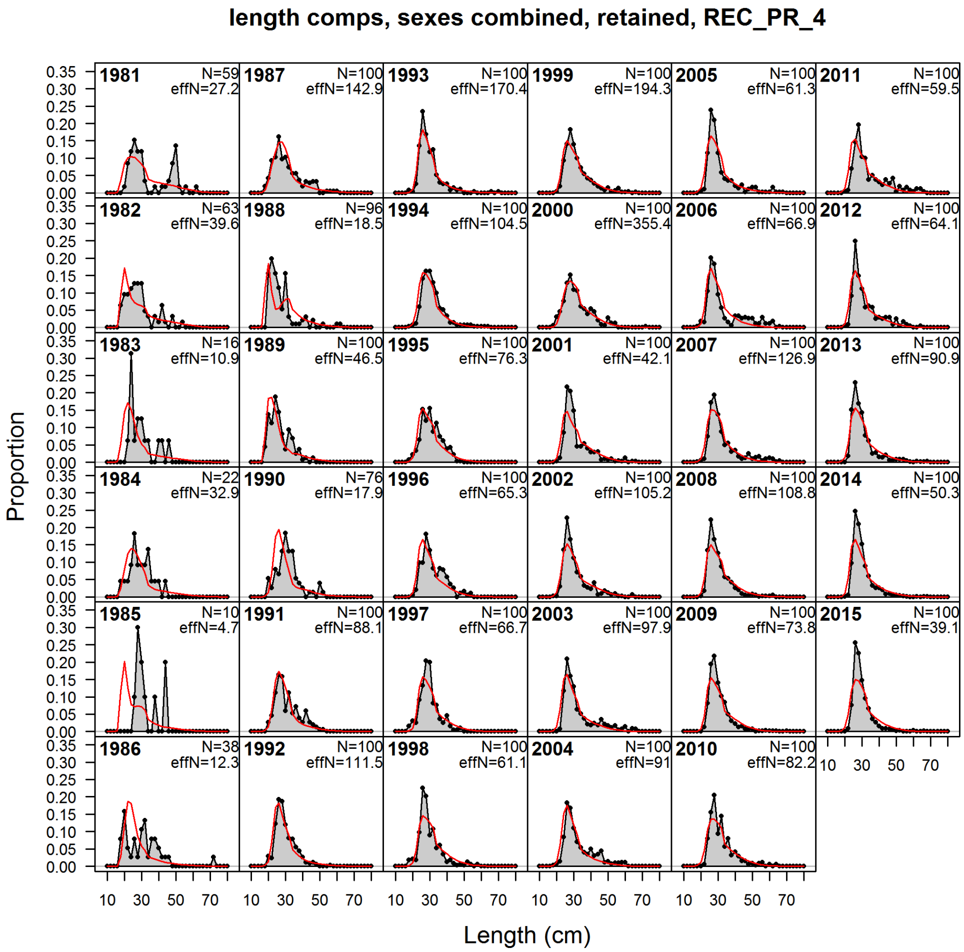


Figure 4.2.1.20. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Recreational Private fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

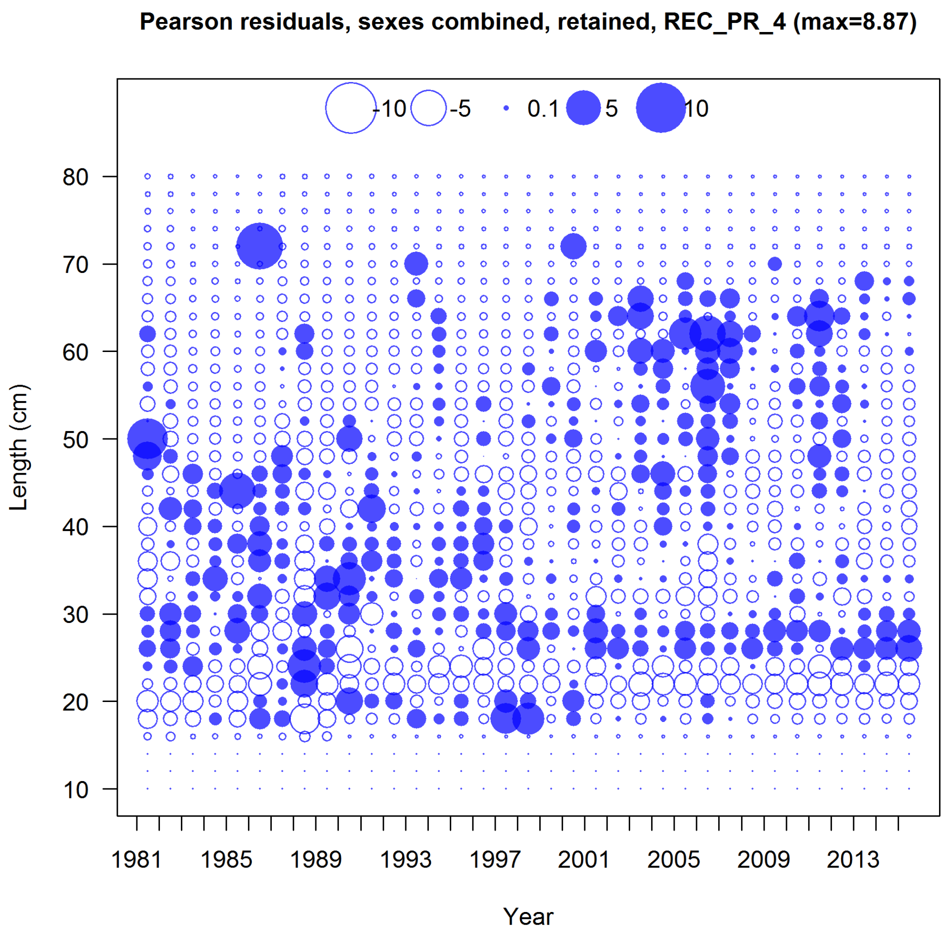


Figure 4.2.1.21. Pearson residuals for the **size** composition fit to the Recreational Private landings observations. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

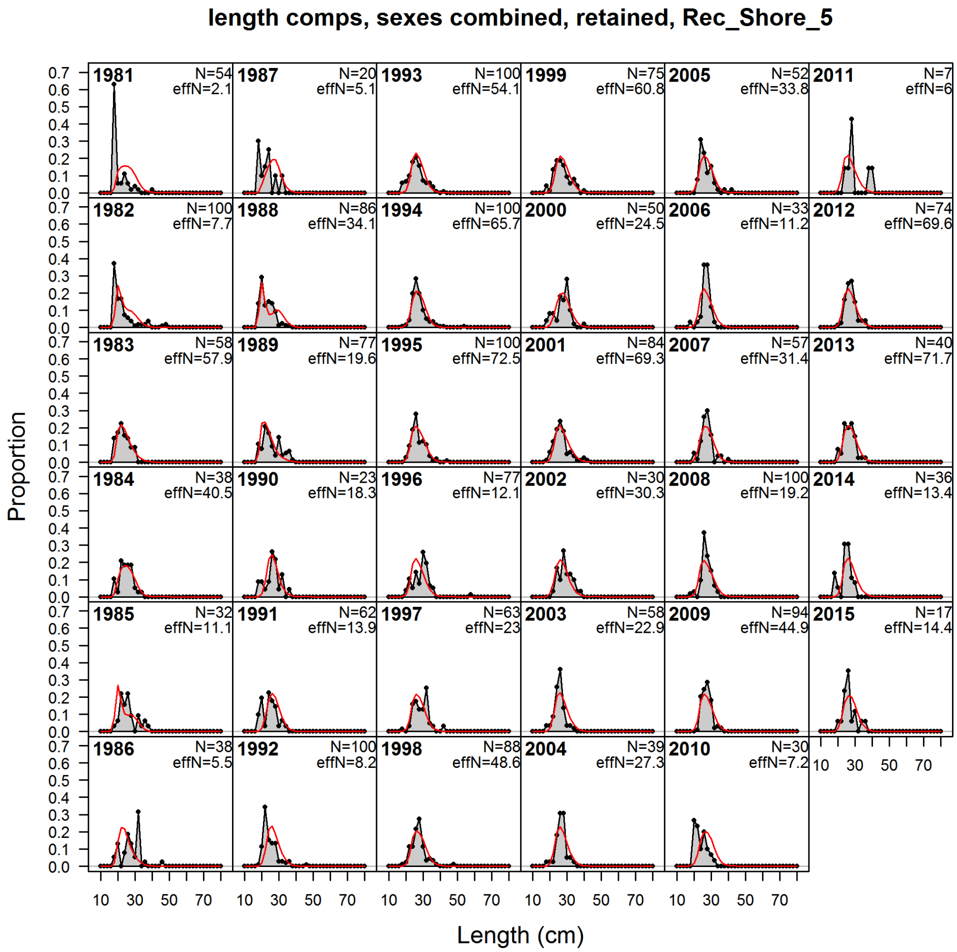


Figure 4.2.1.22. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Recreational Shore fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

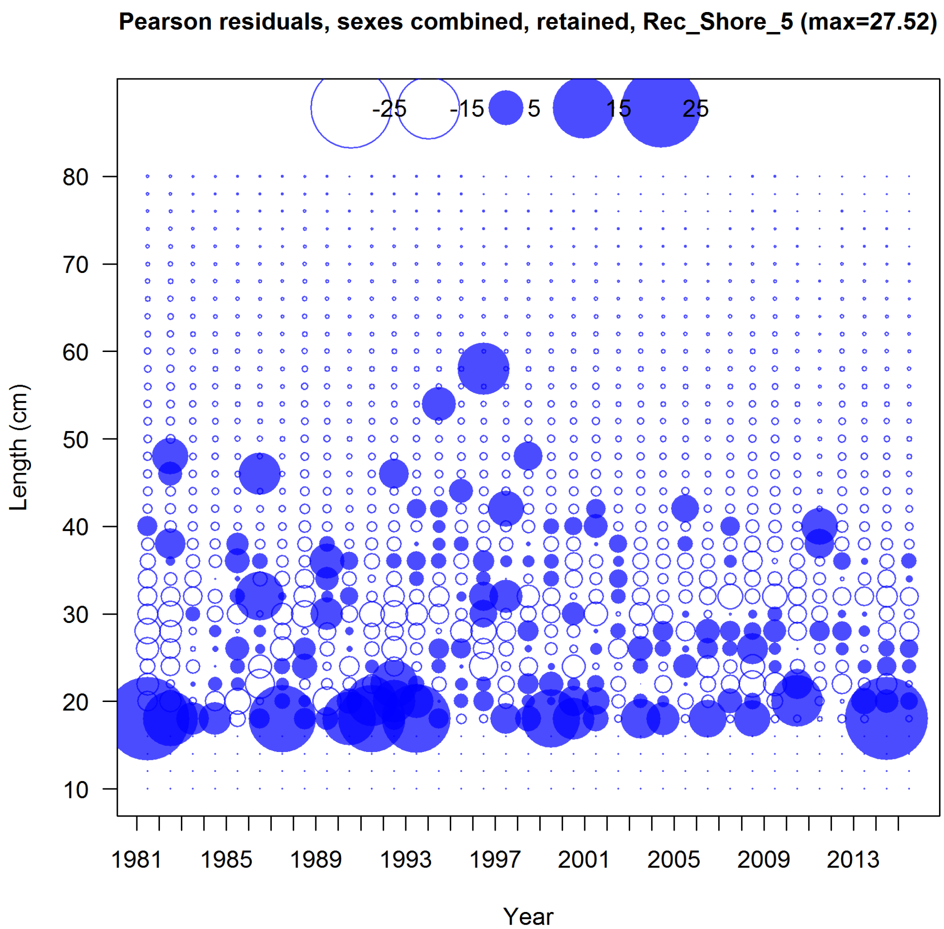


Figure 4.2.1.23. Pearson residuals for the size composition fit to the Recreational Shore landings observations. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

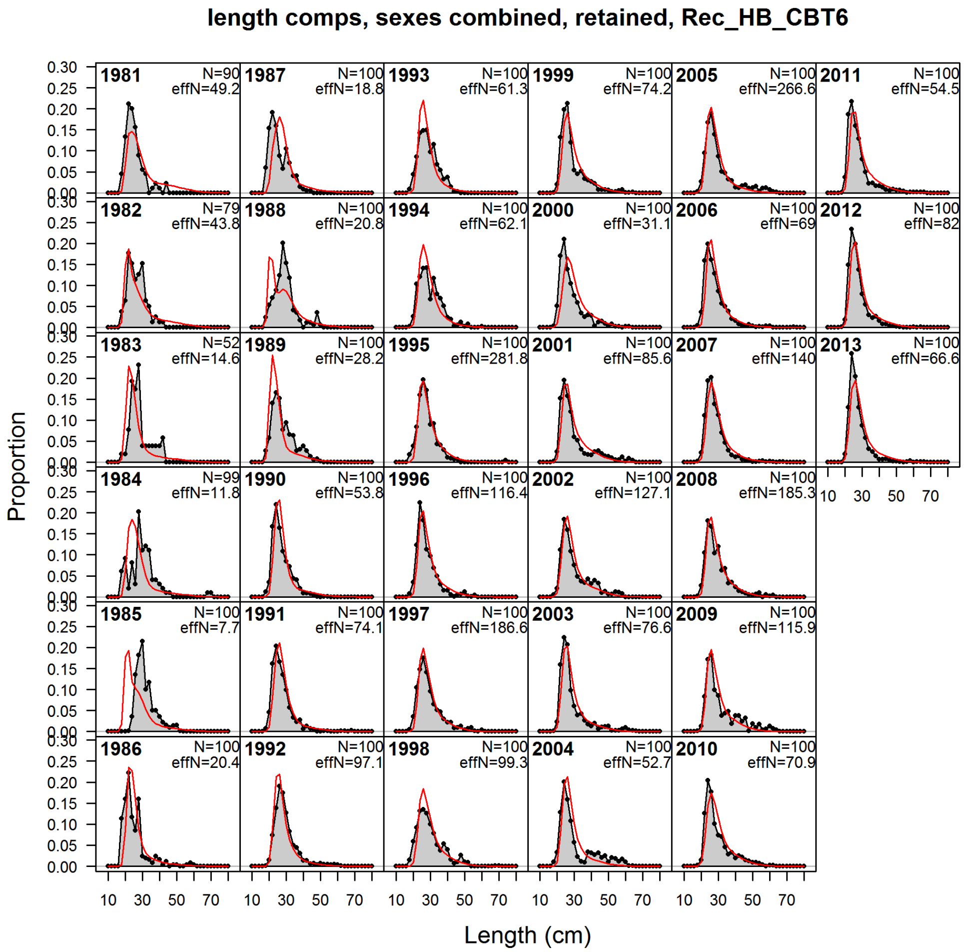


Figure 4.2.1.24. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from the Recreational Charterboat Headboat fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

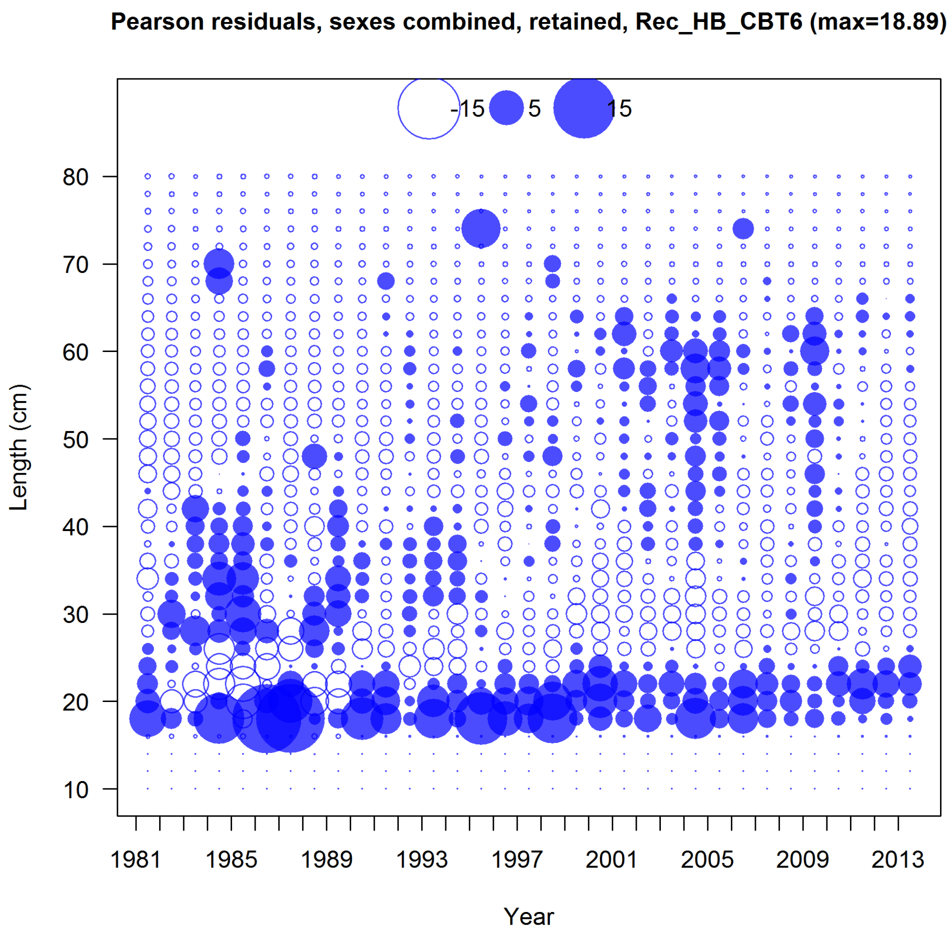


Figure 4.2.1.25. Pearson residuals for the **size** composition fit to the Recreational Charterboat Headboat landings observations. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

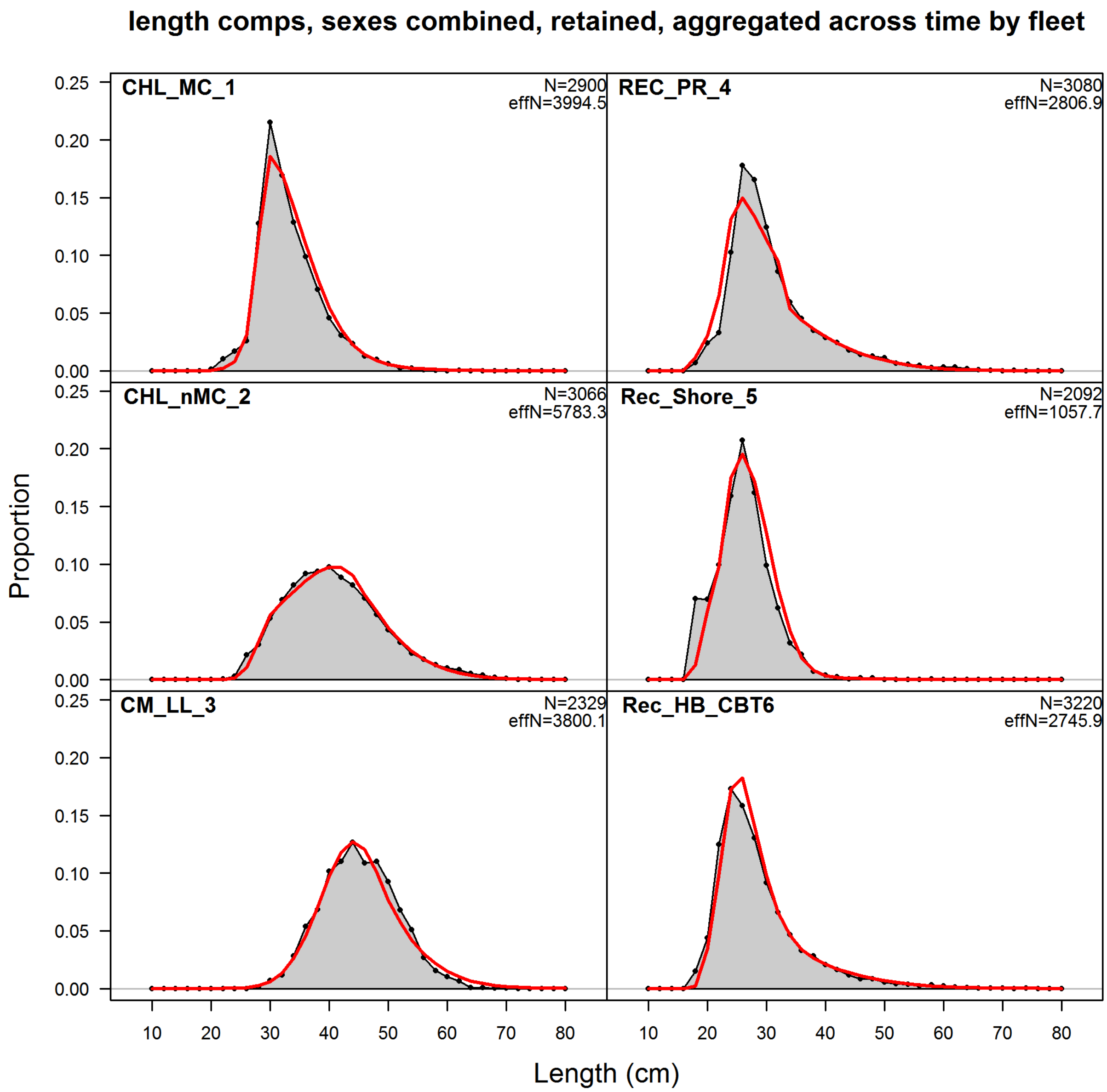


Figure 4.2.1.26. Observed (gray) and predicted (red) size (centimeters fork length) compositions of landings from each fleet aggregate over all years. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported.

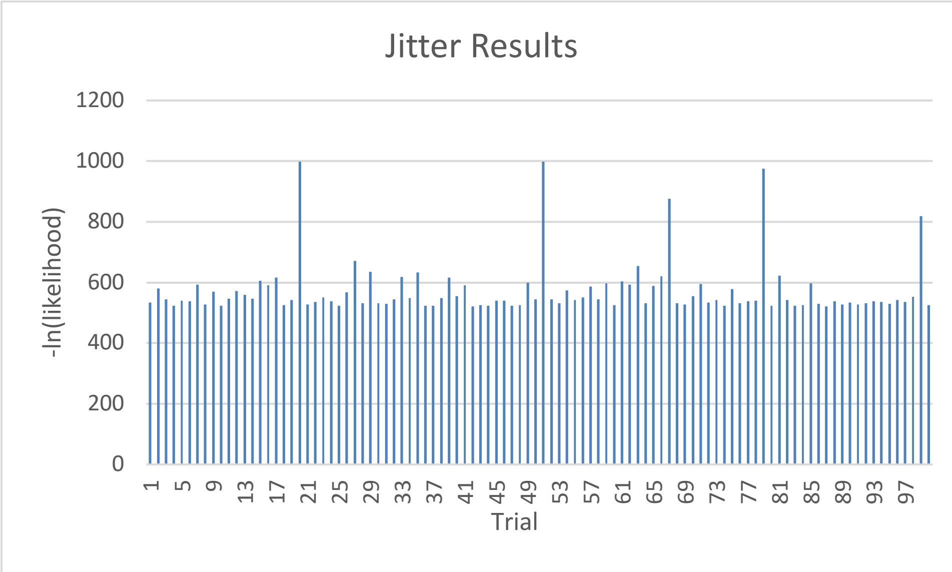


Figure 4.2.2.1. The results of randomly varying input parameters (Jitter) by up to 10% on –ln(likelihood) over 100 trials. All trials converged.

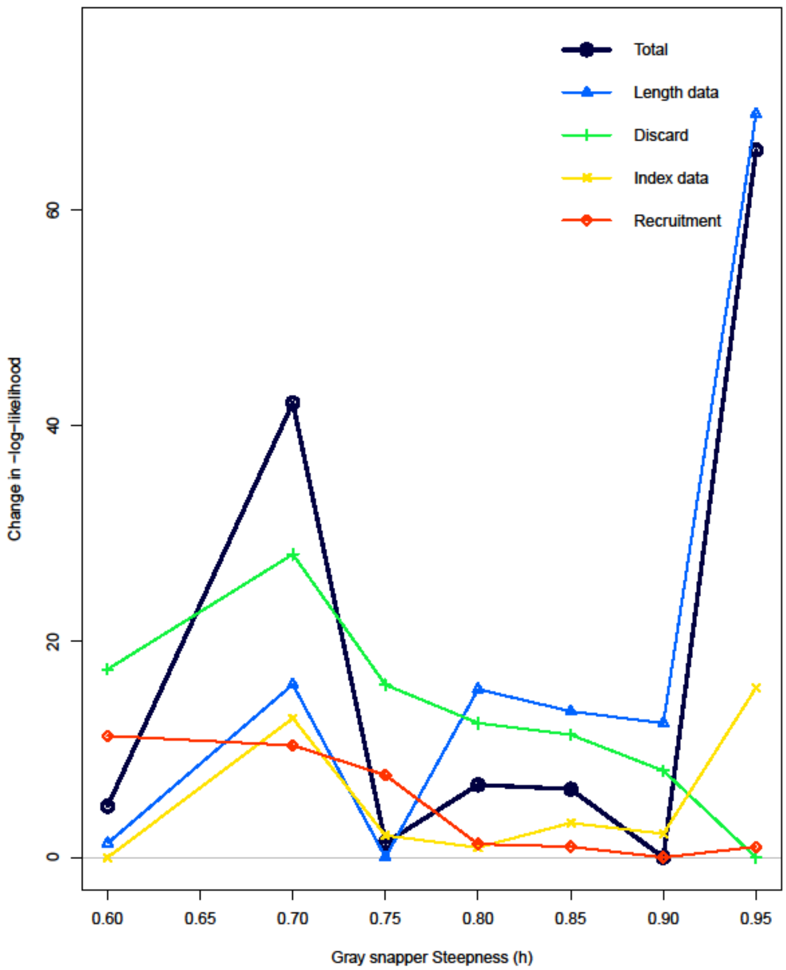


Figure 4.2.2.2 Likelihood profile on steepness at intervals of 0.05.

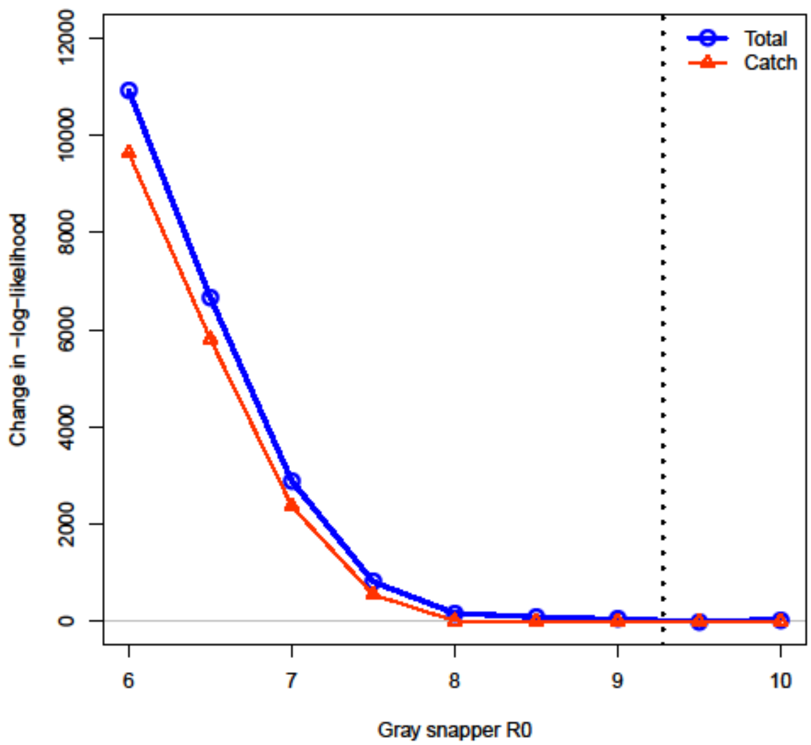


Figure 4.2.2.3 Likelihood profile on recruitment at an unexploited state, *ln(R0)*. Model runs with values of *R0* below 9.5 did not converge.

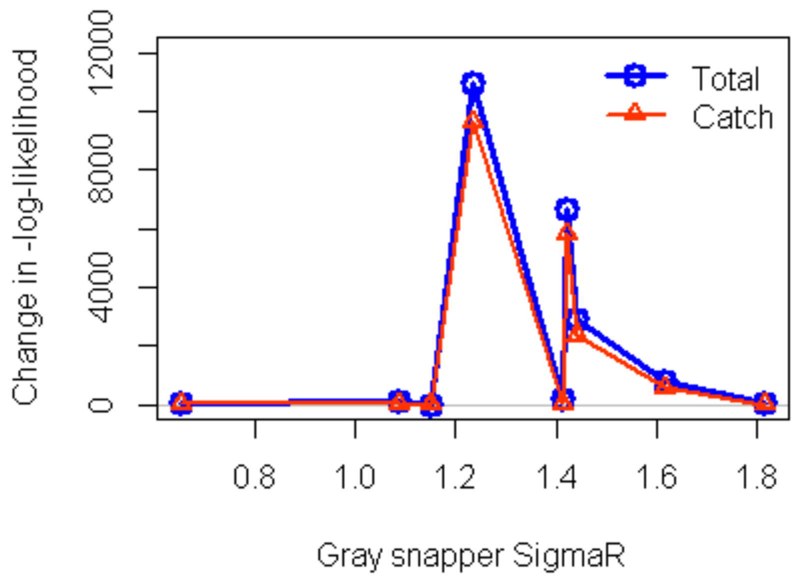


Figure 4.2.2.4 Likelihood profile on σ_R at intervals of 0.05

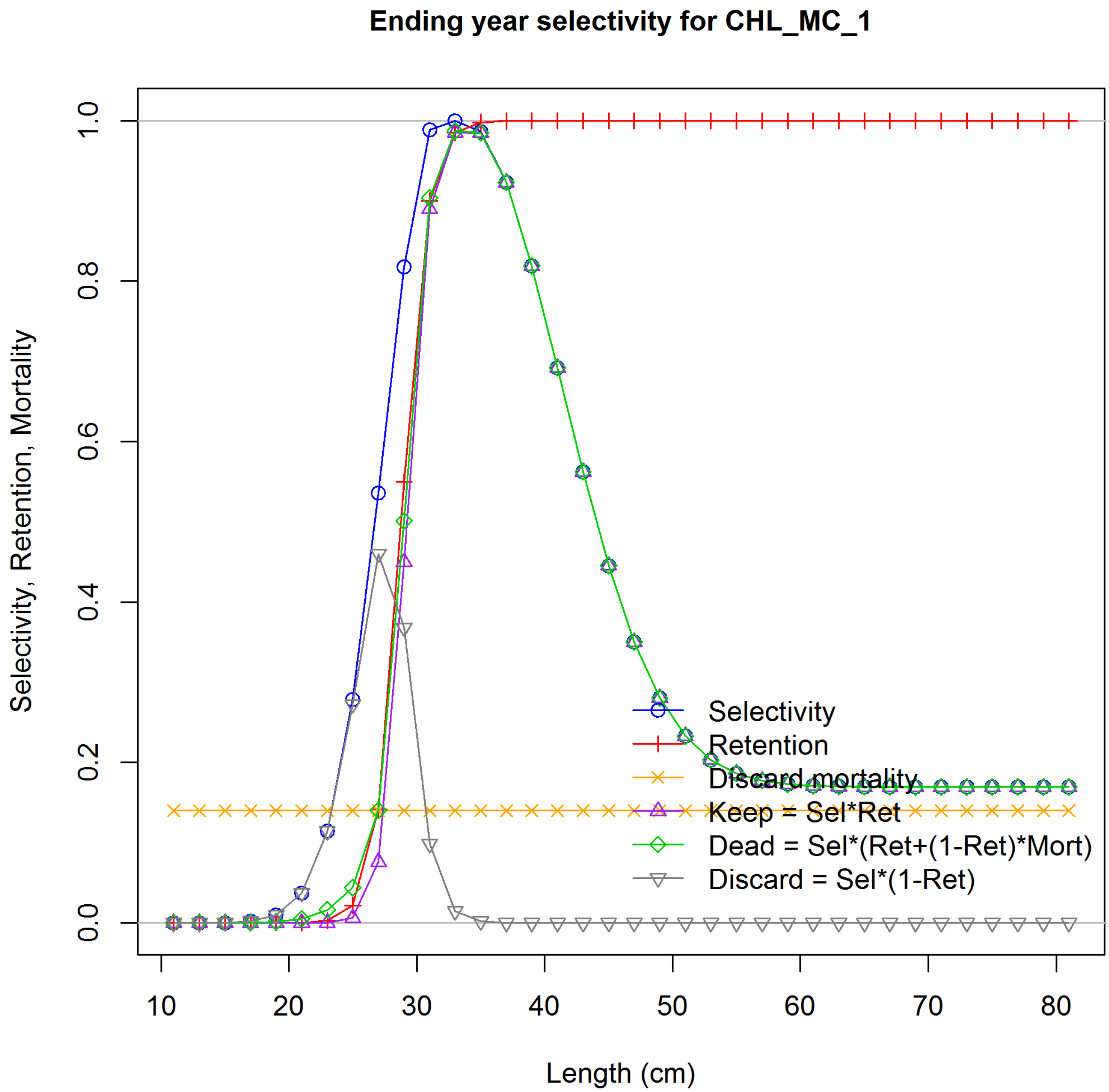


Figure 4.2.3.1 Terminal-year Commercial Monroe County fleet selectivity, retention and discard mortality pattern estimated from the SS model. Discard mortality was fixed at 5%. Selectivity was length-based, therefore all ages were vulnerable. Retention was estimated.

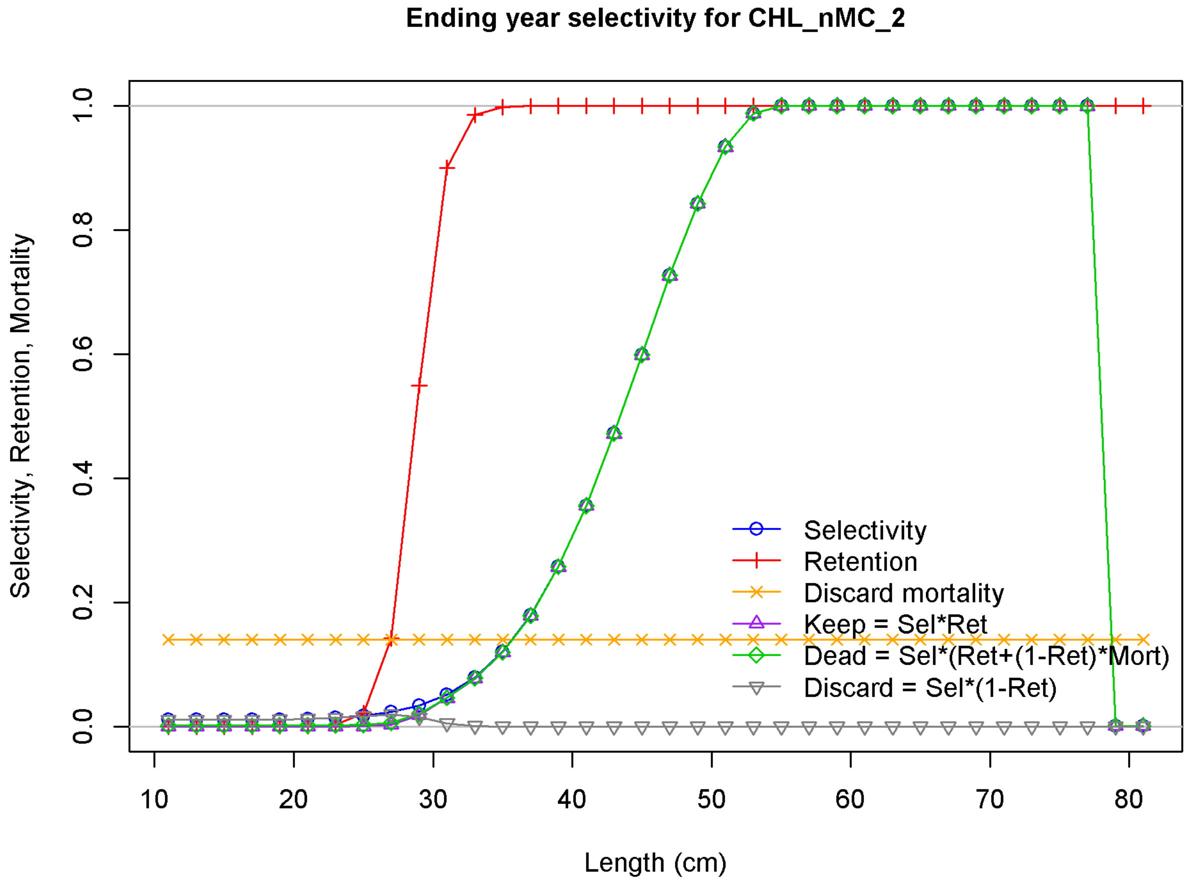


Figure 4.2.3.2. Terminal-year recreational Commercial Not Monroe County fleet selectivity, retention and discard mortality pattern from the SS model. Discard mortality was fixed at 5%. Selectivity was length-based, therefore all ages were vulnerable. Retention was estimated.

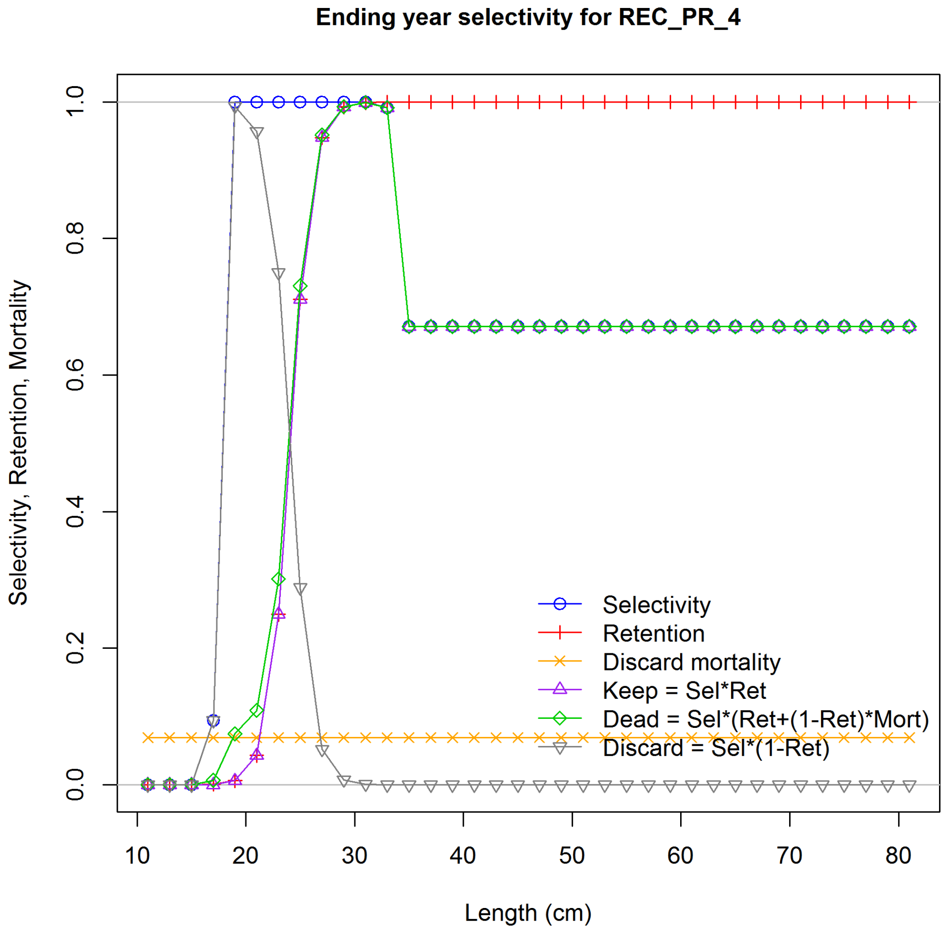


Figure 4.2.3.3. Terminal-year commercial Recreational Private fleet selectivity, retention and discard mortality pattern from the SS model. Discard mortality was fixed at 5%. Selectivity was length-based, therefore all ages were vulnerable. Retention was estimated.

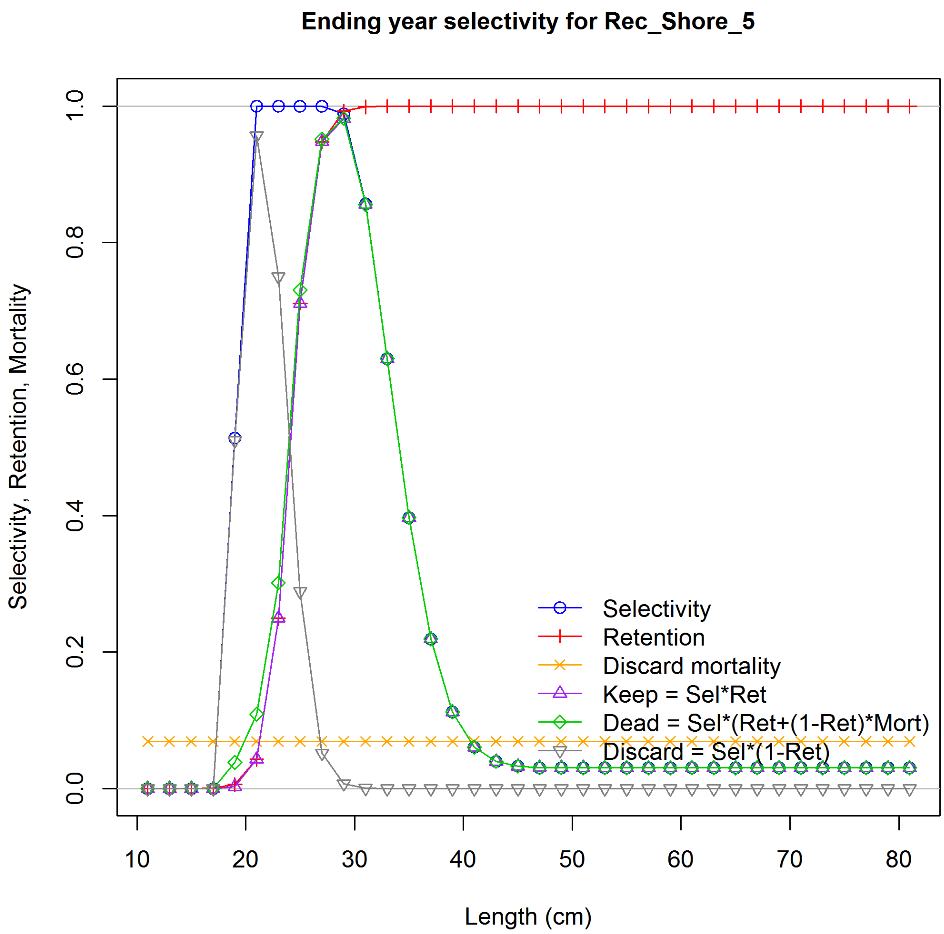


Figure 4.2.3.4. Terminal-year commercial Recreational Shore fleet selectivity, retention and discard mortality pattern from the SS model. Discard mortality was fixed at 5%. Selectivity was size-based, therefore all ages were vulnerable. Retention was estimated.

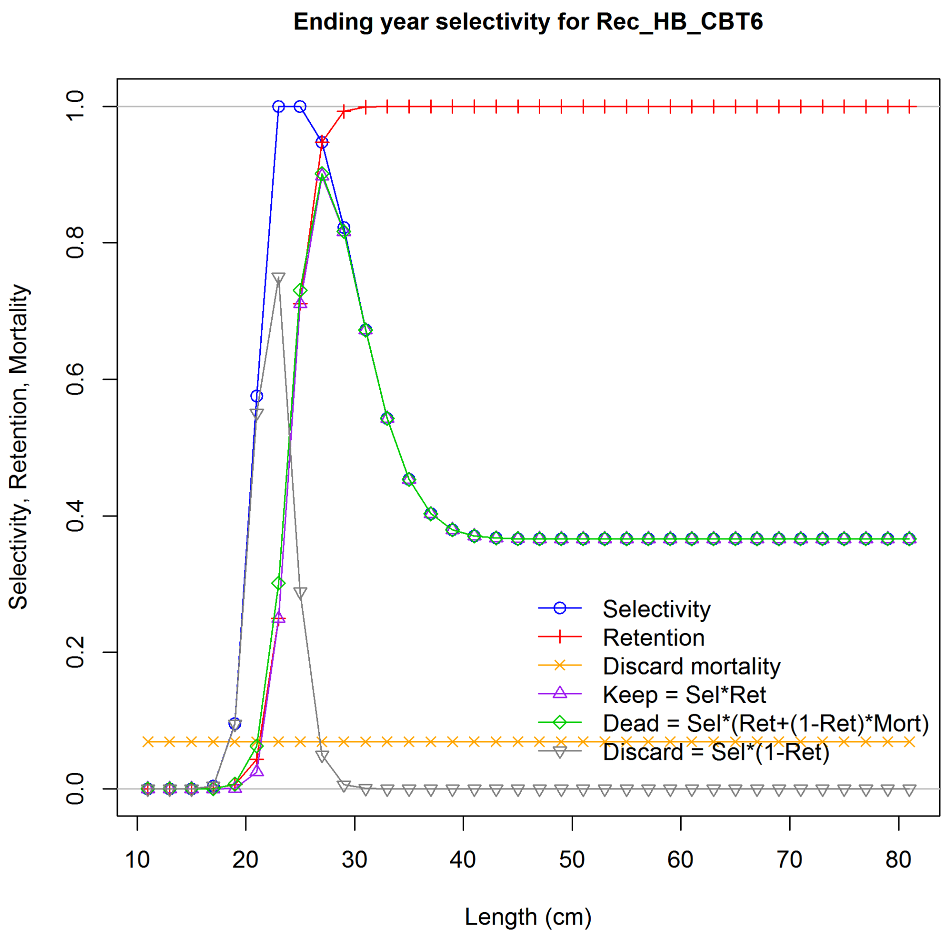


Figure 4.2.3.5. Terminal-year commercial Recreational Charterboat Headboat fleet selectivity, retention and discard mortality pattern from the SS model. Discard mortality was fixed at 5%. Selectivity was age-based, therefore all sizes were vulnerable. Retention was estimated.

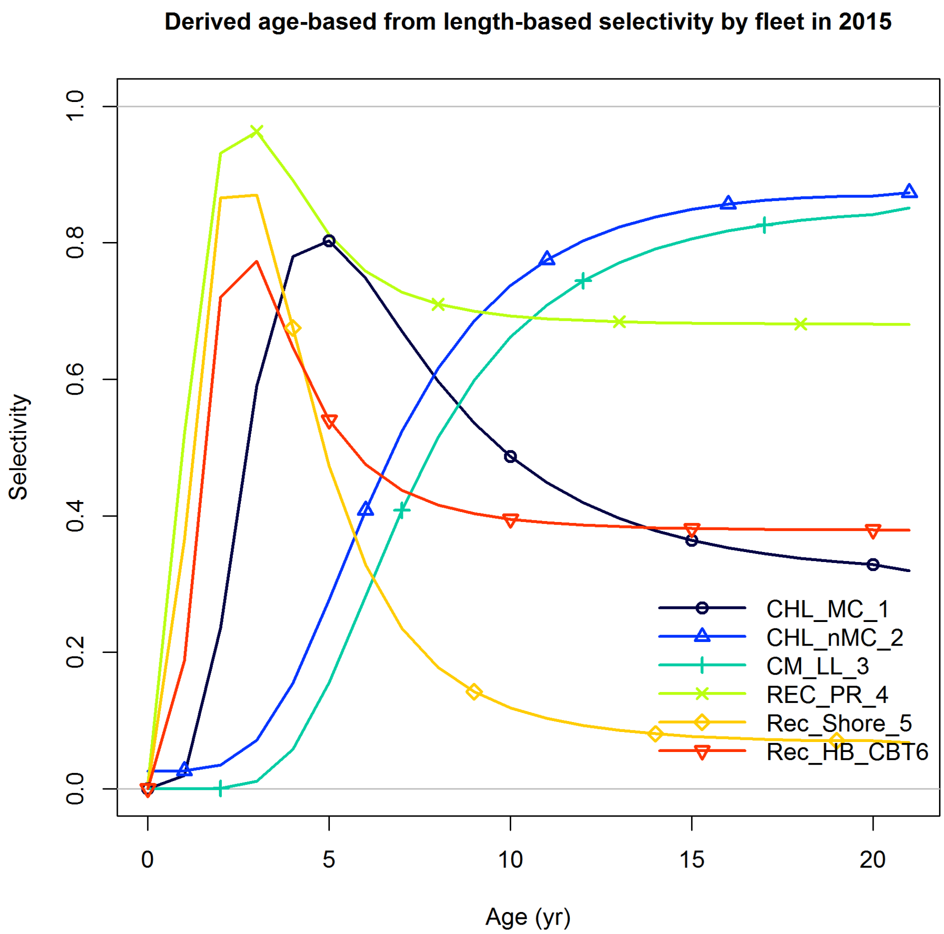


Figure 4.2.3.6 Estimated age-based selectivity patterns for the six fishing fleets.

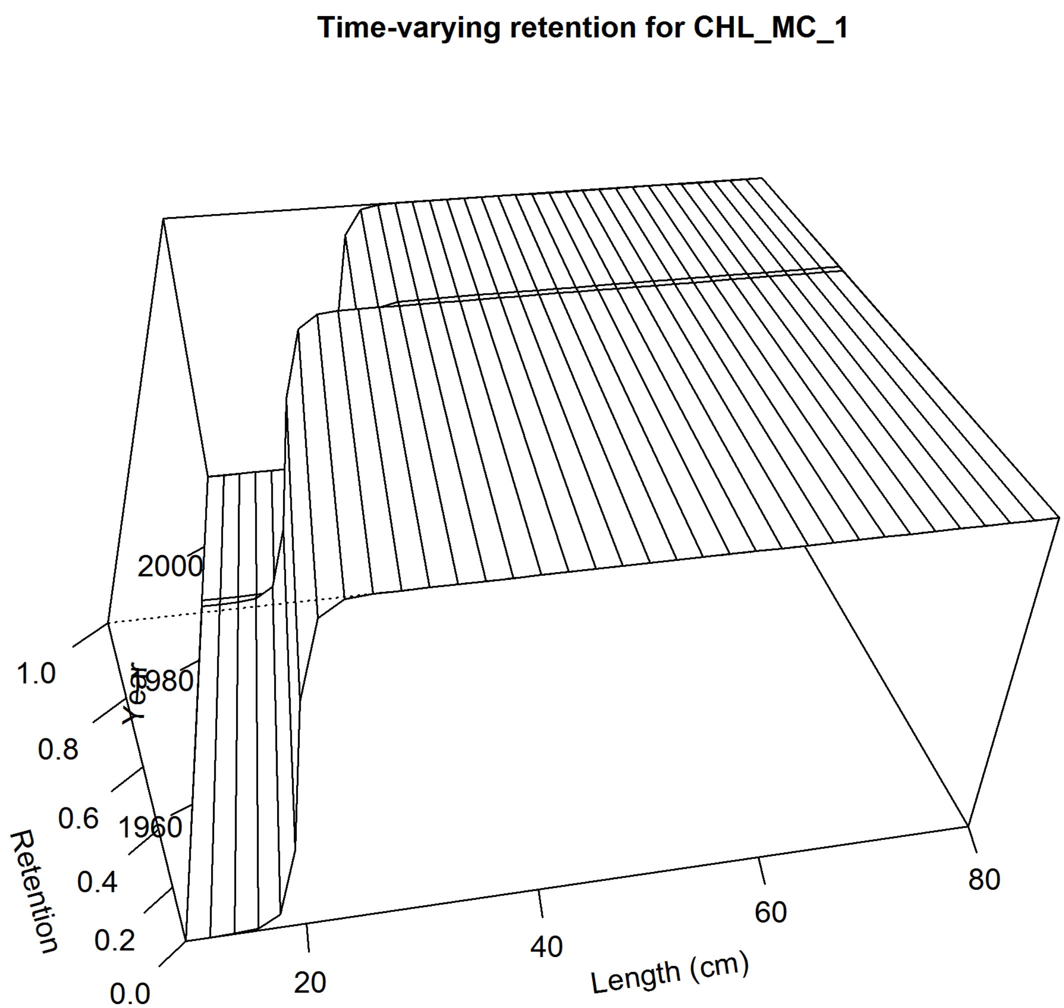


Figure 4.2.3.7. Time-varying retention for the Commercial Monroe County fleet. A near knife-edge retention function was modeled using a logistic fit. Initial minimum retained size was set at 6 inches fork length, the minimum size observed in the landings. Minimum retained size was advanced to 10 and 12 inches fork length corresponding to changes in regulations. Asymptotic retention was estimated by the model.

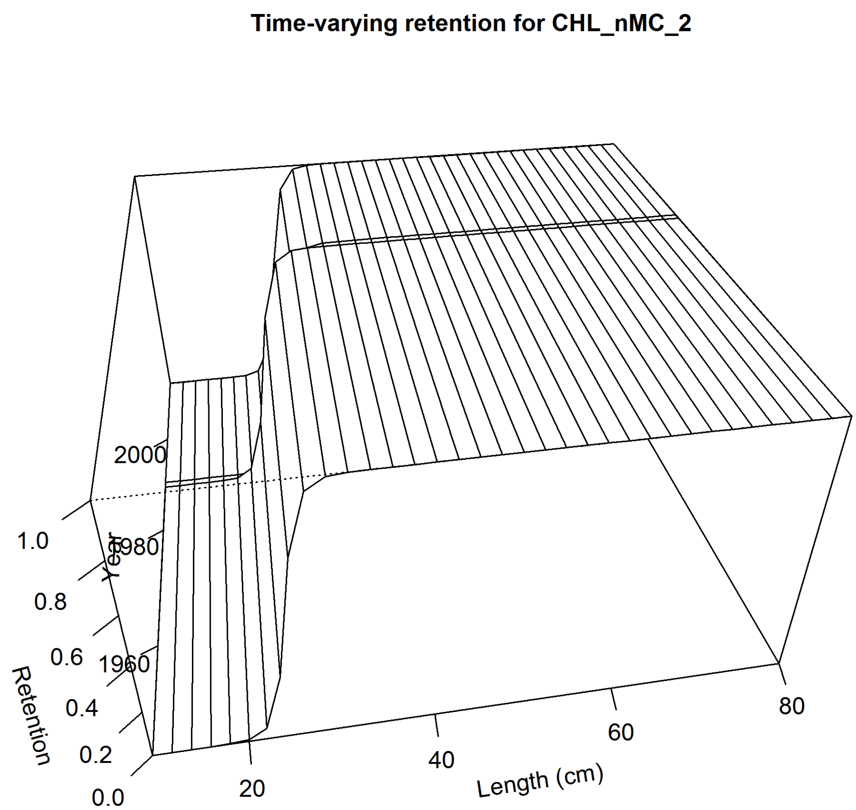


Figure 4.2.3.8. Time-varying retention for the Commercial Not Monroe County fleet. A near knife-edge retention function was modeled using a logistic fit. Initial minimum retained size was set at 6 inches fork length, the minimum size observed in the landings. Minimum retained size was advanced to 10 and 12 inches fork length corresponding to changes in regulations. Asymptotic retention was estimated by the model.

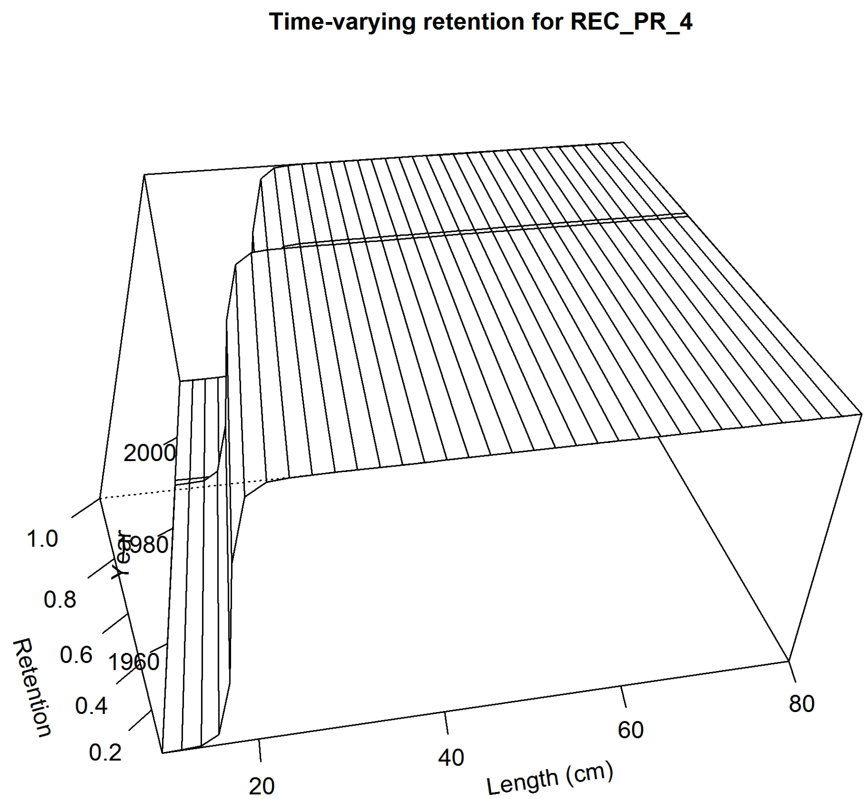


Figure 4.2.3.9. Time-varying retention for the Recreational Private fleet. A near knife-edge retention function was modeled using a logistic fit. Initial minimum retained size was set at 6 inches fork length, the minimum size observed in the landings. Minimum retained size was advanced to 10 and 12 inches fork length corresponding to changes in regulations. Asymptotic retention was estimated by the model.

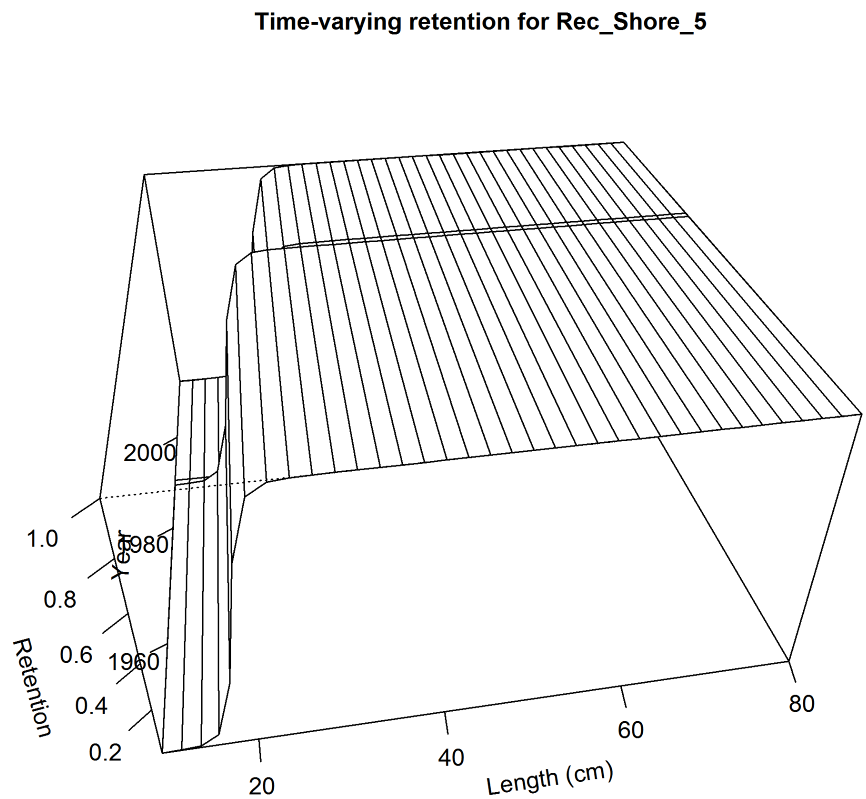


Figure 4.2.3.10. Time-varying retention for the Recreational Shore fleet. A near knife-edge retention function was modeled using a logistic fit. Initial minimum retained size was set at 6 inches fork length, the minimum size observed in the landings. Minimum retained size was advanced to 10 and 12 inches fork length corresponding to changes in regulations. Asymptotic retention was estimated by the model.

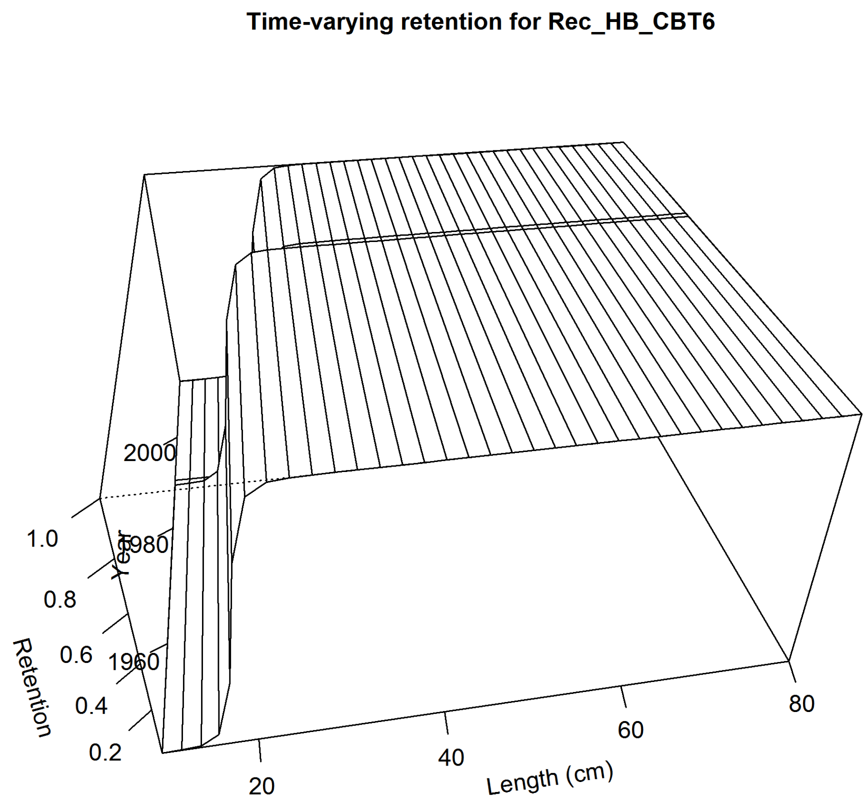


Figure 4.2.3.11. Time-varying retention for the Recreational Charterboat-Headboat fleet. A near knife-edge retention function was modeled using a logistic fit. Initial minimum retained size was set at 6 inches fork length, the minimum size observed in the landings. Minimum retained size was advanced to 10 and 12 inches fork length corresponding to changes in regulations. Asymptotic retention was estimated by the model.

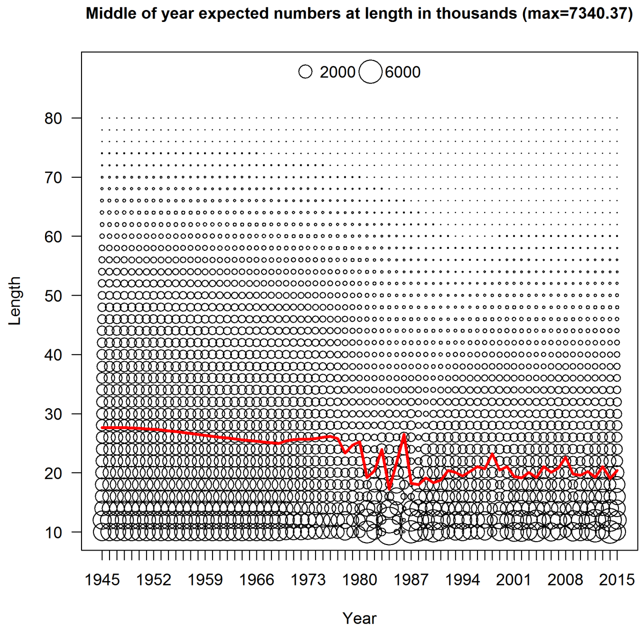


Figure 4.2.3.12. Predicted numbers-at-length (bubbles) and mean length (red line) of Gulf of Mexico Gray Snapper.

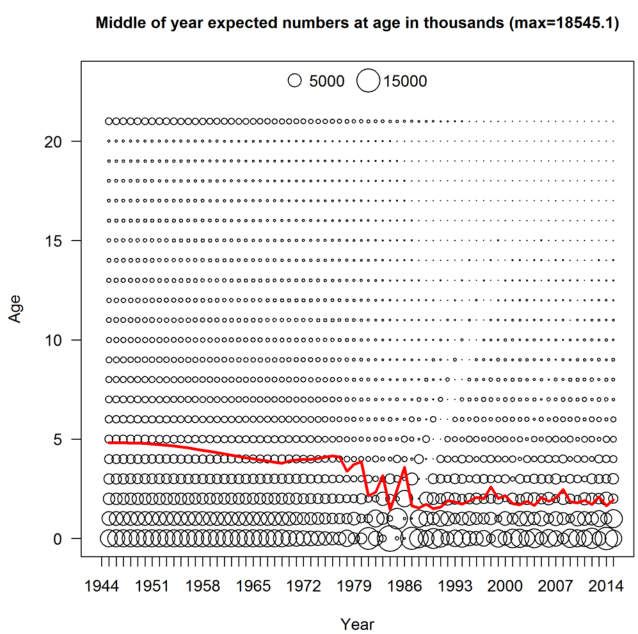


Figure 4.2.3.13. Predicted numbers-at-age (bubbles) and mean age (red line) of Gulf of Mexico Gray Snapper.

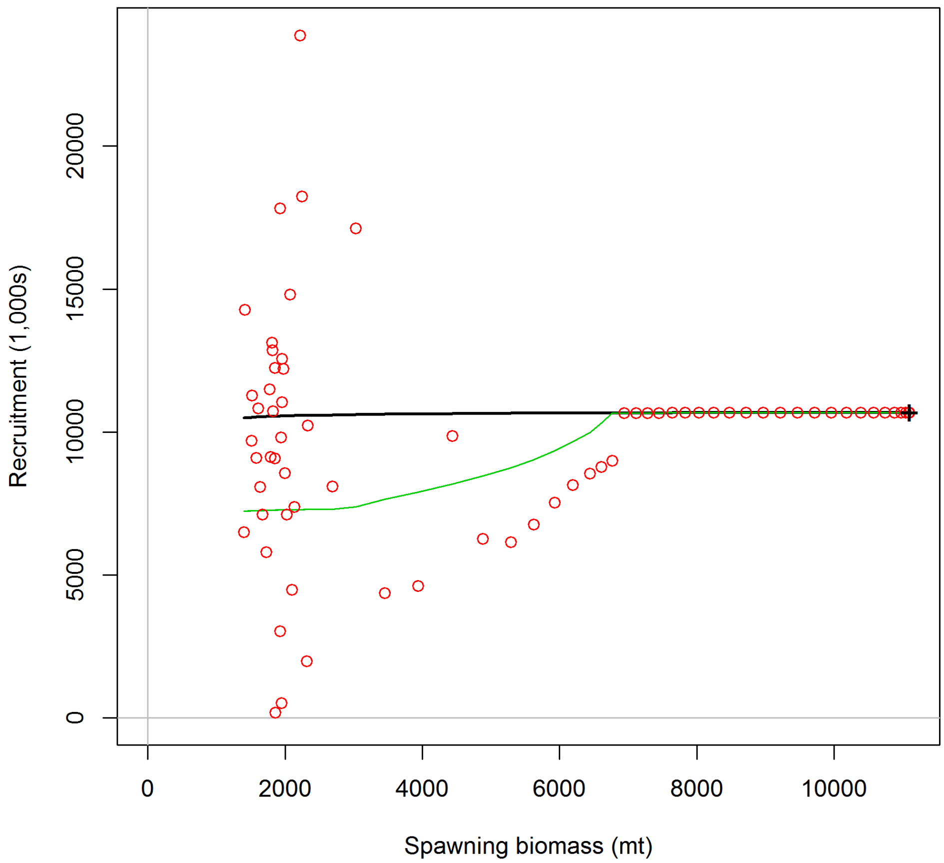


Figure 4.2.4.1. Predicted stock-recruitment relationship for Gulf of Mexico Gray Snapper. Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (green line).

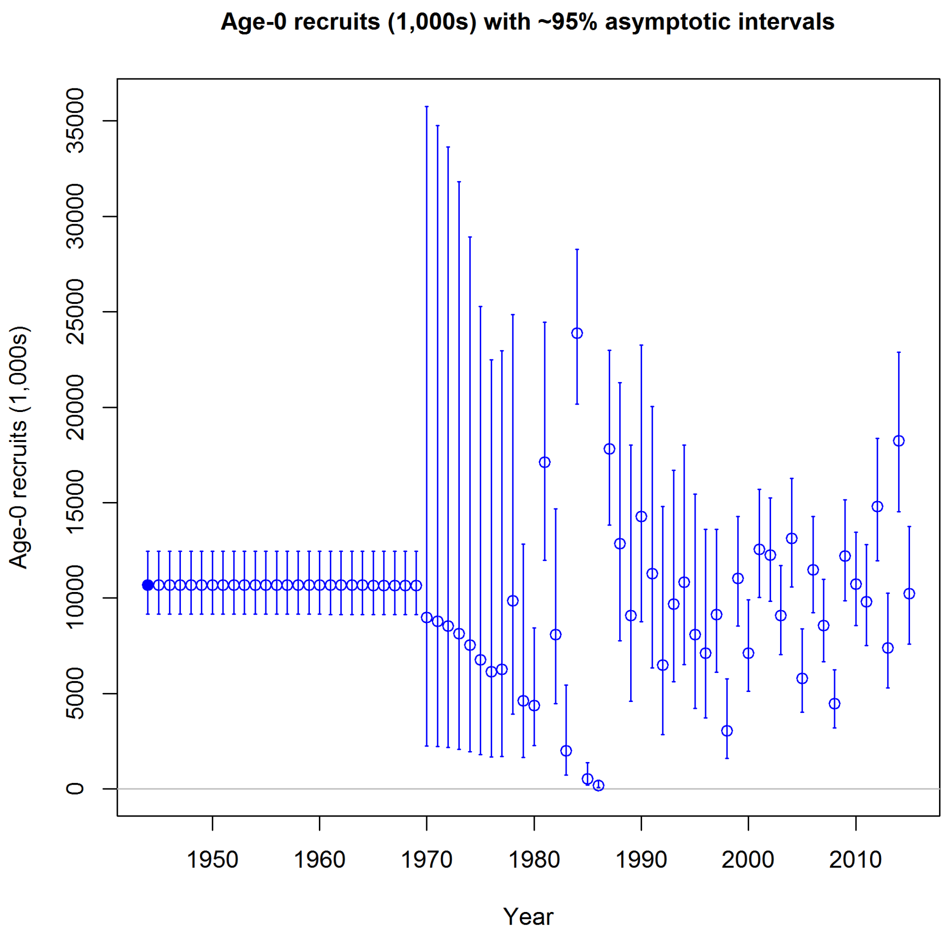


Figure 4.2.4.2 Predicted age-0 recruits with associated 95% asymptotic intervals.

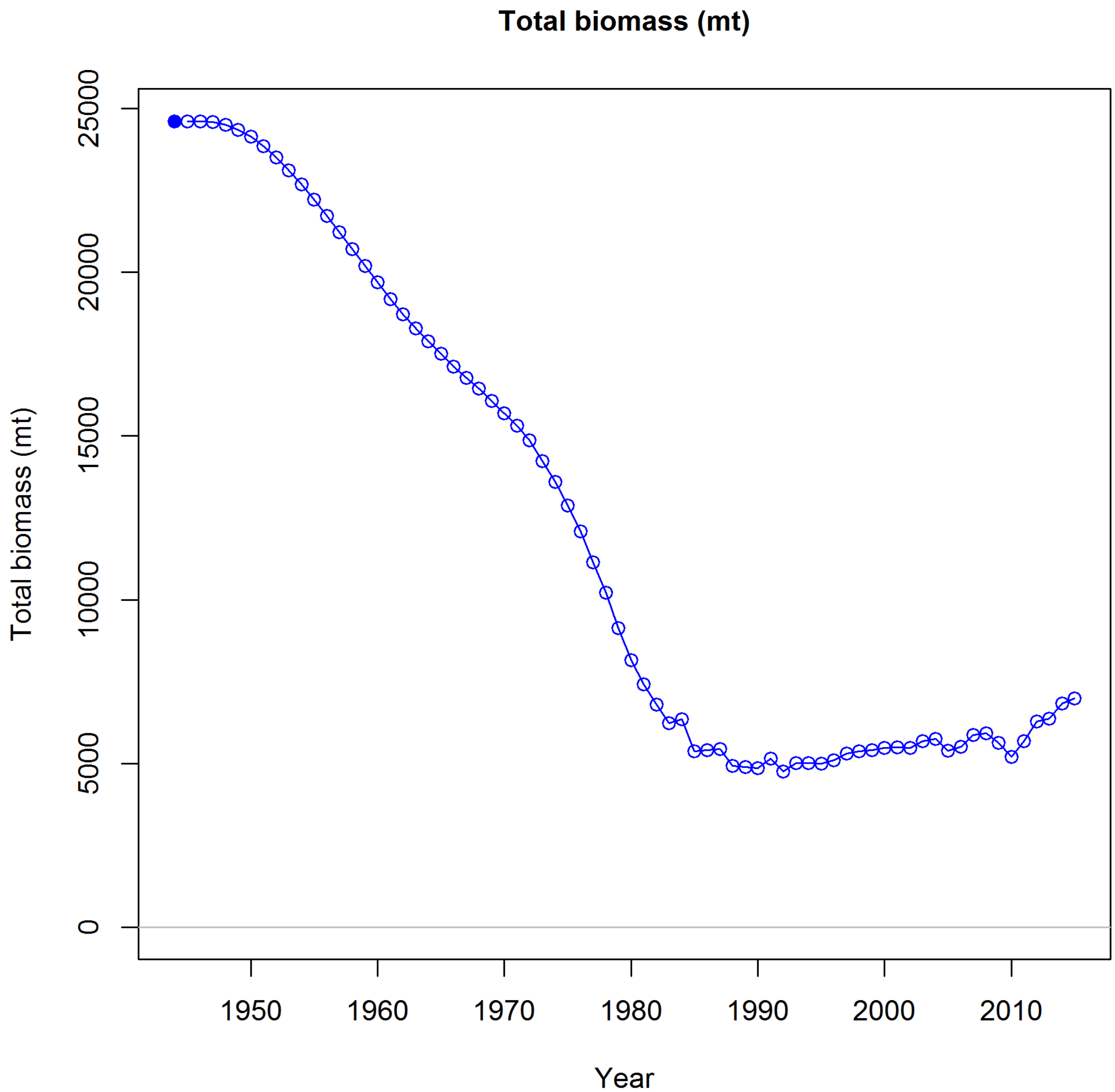


Figure 4.2.5.1. Predicted total biomass (mt) of Gulf of Mexico Gray Snapper from 1945-2015.

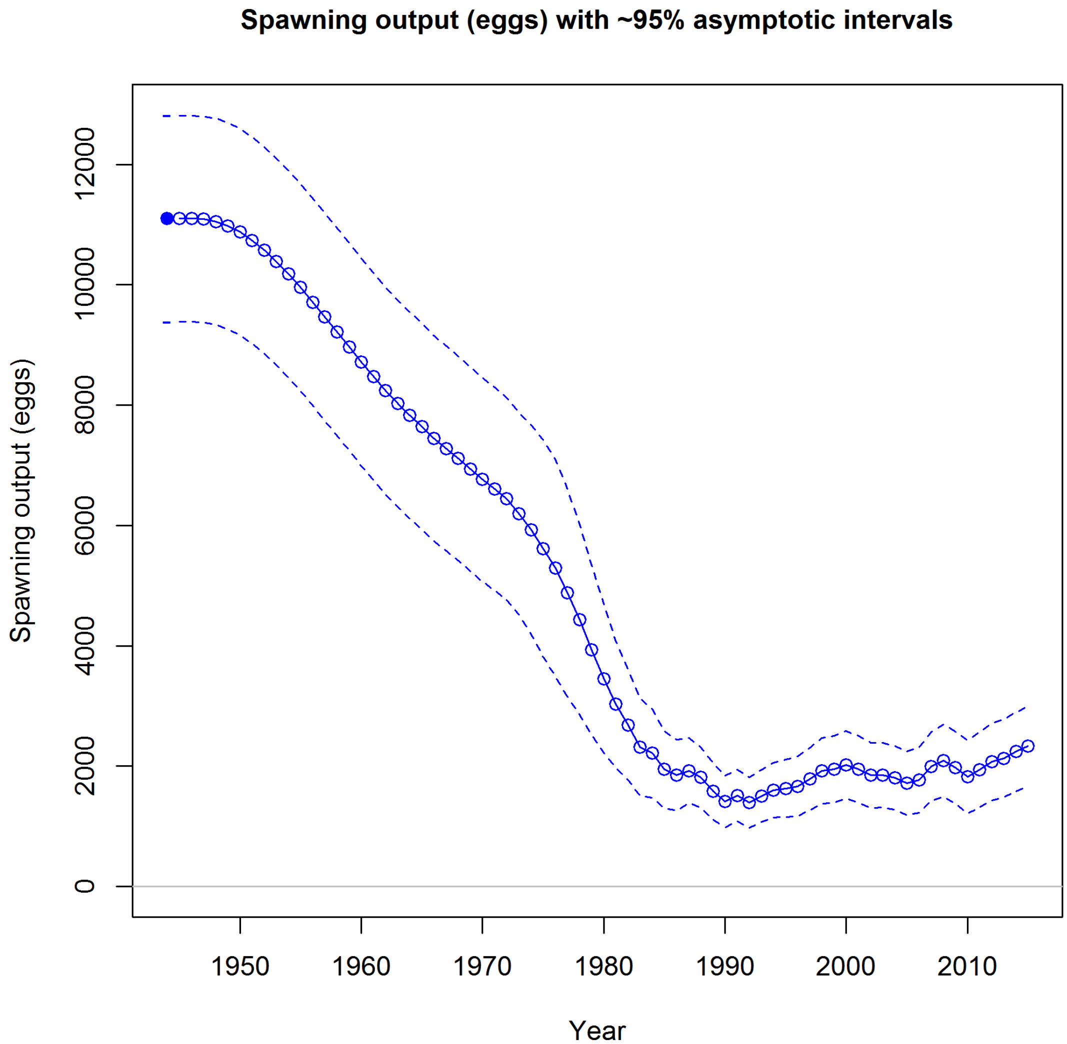


Figure 4.2.5.2. Predicted spawning output (eggs) with the associated 95% asymptotic intervals of Gulf of Mexico Gray Snapper from 1945-2015.

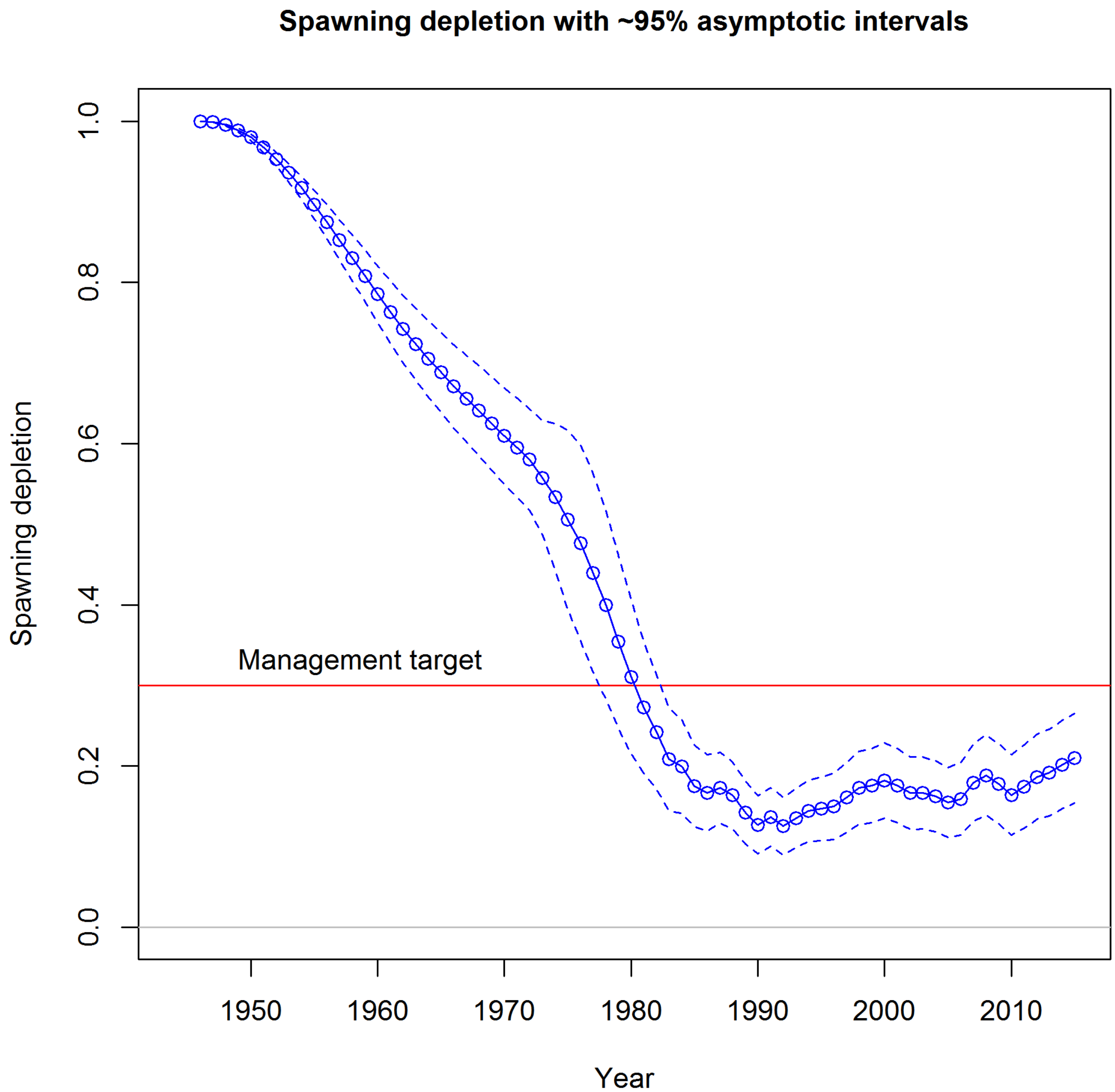


Figure 4.2.5.3. Predicted spawning depletion (SSB/S0) with the associated 95% asymptotic intervals of Gulf of Mexico Gray Snapper from 1945-2015.

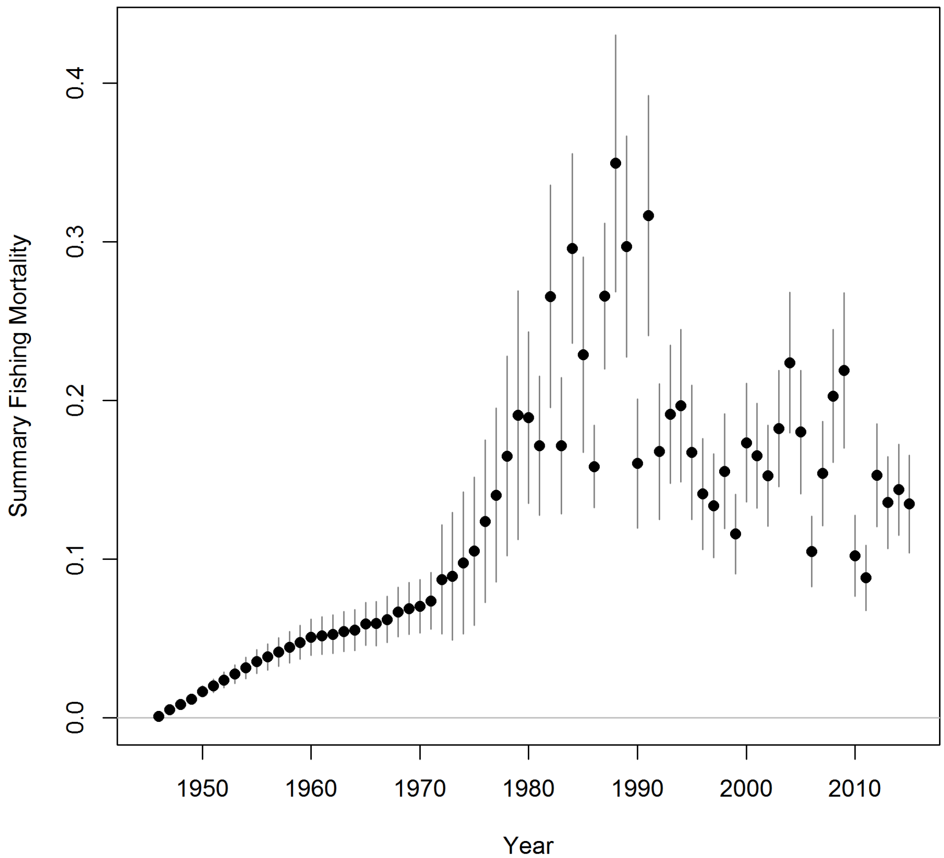


Figure 4.2.6.1.Predicted annual exploitation rate calculated as the ratio of total annual catch in numbers to total biomass in numbers.

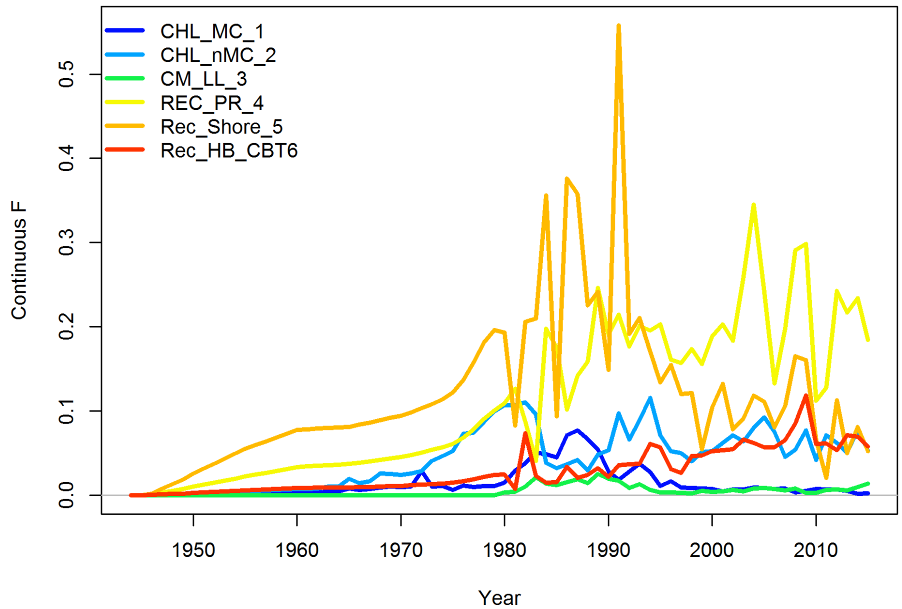


Figure 4.2.6.2. Predicted fleet specific fishing mortality.

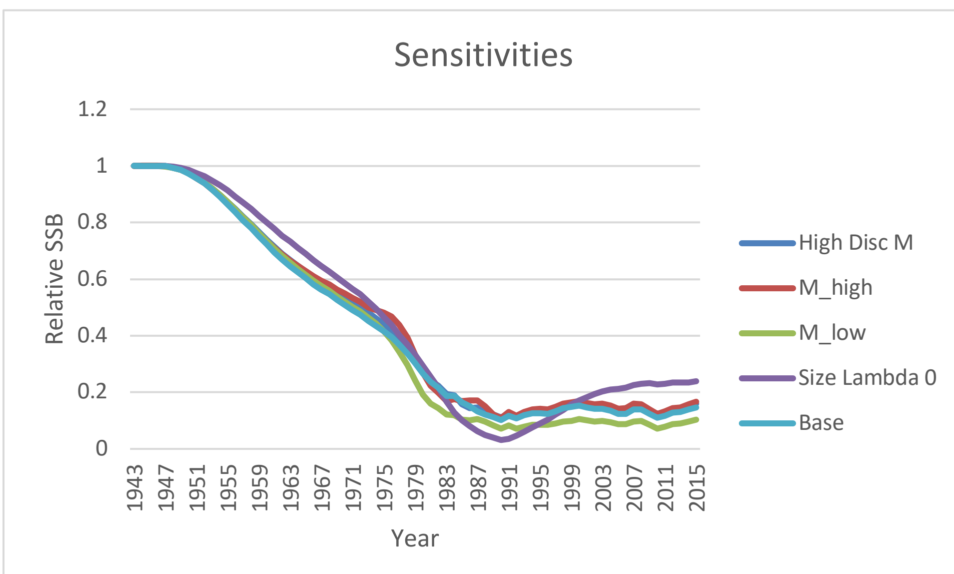


Figure 4.2.7.1. Estimates of spawning stock biomass (SSB) in eggs from all sensitivity runs.

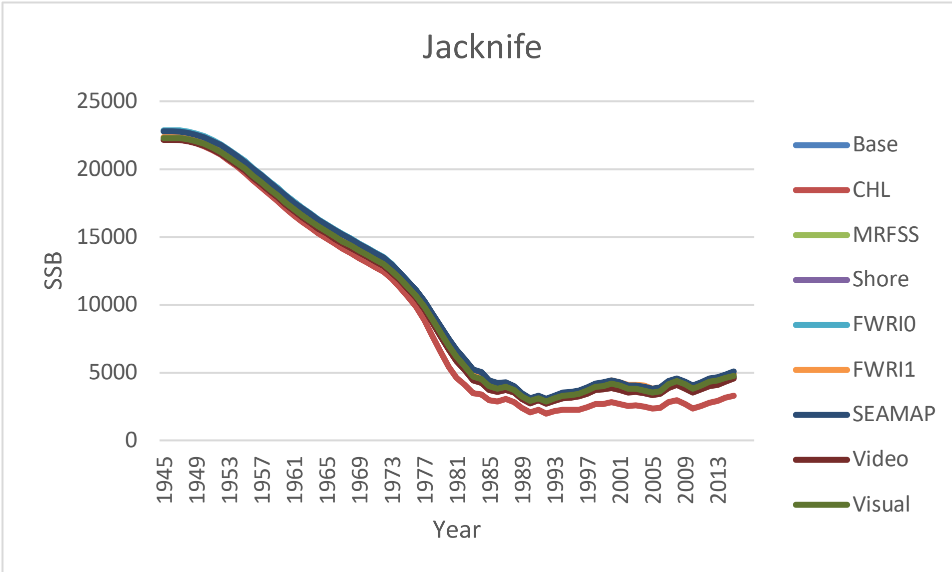


Figure 4.2.7.2. Estimates of spawning stock biomass (SSB, eggs) from the jack-knife analysis.

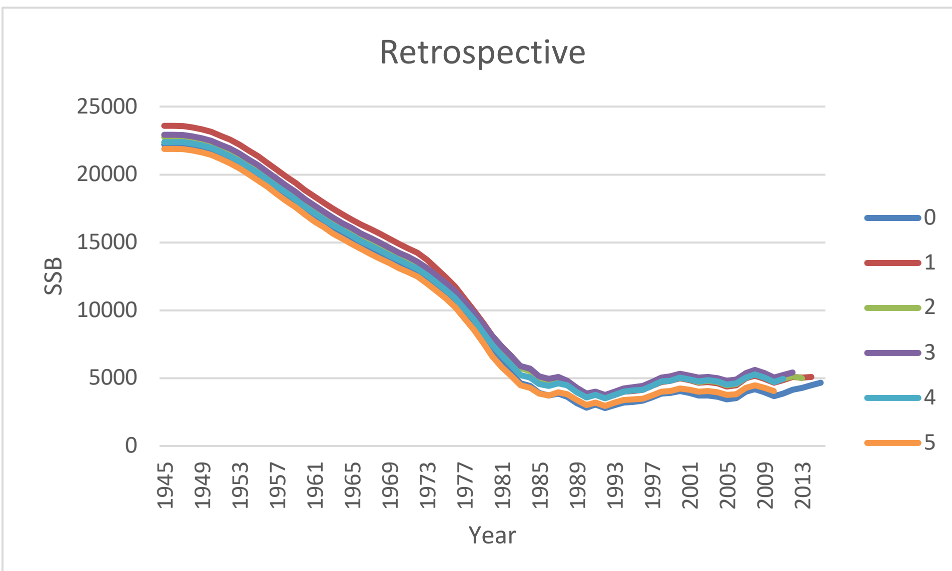


Figure 4.2.8.1. Estimates of spawning stock biomass (SSB, eggs) from the retrospective analysis.

#C   Data_file_written_using_a _previous_file_as_a_template

#C

#C   Final_file_completed_08/07/2017

#C

1945 #_styr

2015 #_endyr

1   #_nseas

12   #_months_per_seas

1   #_spawn_seas

6   #_Nfleets

8   #_Nsurveys

1   #_N_areas

CHL_MC_1%CHL_nMC_2%CM_LL_3%REC_PR_4%Rec_Shore_5%Rec_HB_CBT6%RCHL_7%MRFSS_Private_8%MRFSS_Shore_9%FWRI_Age0_10%FWRI_Age1_11%SEAMAP_Trawl_12%NMFS_FWRI_Video_13%Visual_Survey_14

```
#

-1    -1    -1    -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
      -1          #_survey_timing_in_season

1     1     1     1     1     1     1     1     1     1     1     1     1
      1           #_area_assignments_for_each_fishery_and_survey

1     1     1     2     2     2
            #_units_of_catch_1=Biomass,_2=numbers

0.05  0.05  0.05  0.10  0.10  0.10
      #_se_of_log(catch)_Only_used_for_init_eq_catch_and_for_Fmethods_2_a
nd_3

1           #_Ngenders

21          #_Nages     **** oldestage_=_25,_26_is_for_the_plus_group

0     0     0     0     0     0     #_init_equil_catch_for_each_fishery

71          #_N_lines_of_catch_to_read

#__________Updated_9/25/2017____________

#CHL_MC     CHL_nMC     CM_LL REC_PR      REC_Shore   REC_HB+CB   year  seas

0     0     0     0     0     0     1945  1
```

0.5	0.5	0	10	10	2	1946	1
2.7	3.2	0	55	55	10	1947	1
4.5	5.4	0	90	90	16	1948	1
6.4	7.7	0	124	125	22	1949	1
8.6	10.9	0	175	176	31	1950	1
10.4	13.2	0	210	211	37	1951	1
12.3	15	0	244	246	44	1952	1
13.6	17.2	0	279	281	50	1953	1
15.4	19.5	0	314	316	56	1954	1
17.2	21.8	0	349	351	62	1955	1
18.1	23.1	0	371	373	66	1956	1
19.5	24.5	0	393	396	70	1957	1
20.4	25.9	0	416	418	74	1958	1
21.8	27.2	0	438	440	78	1959	1

22.7	28.6	0	460	463	82	1960	1
22.7	28.6	0	461	464	82	1961	1
22.7	28.6	0	462	465	83	1962	1
28.1	37.2	0	464	466	83	1963	1
32.2	36.8	0	465	467	83	1964	1
50.4	67.6	0	466	469	83	1965	1
39.9	49.9	0	477	480	85	1966	1
45.4	55.8	0	488	491	87	1967	1
56.7	86.2	0	500	502	89	1968	1
60.3	82.6	0	511	514	91	1969	1
55.4	76.2	0	522	525	93	1970	1
58.5	81.2	0	540	543	97	1971	1
153.4	86.7	0	559	562	100	1972	1

52.6	118.9	0	577	580	103	1973	1
54.9	132	0	595	599	106	1974	1
30.9	143.8	0	614	617	110	1975	1
50.4	190.1	0	649	652	116	1976	1
40.4	178.8	0	684	688	122	1977	1
41.3	190.1	0	719	723	128	1978	1
36.3	191	0	753	758	135	1979	1
45.4	184.7	9.1	788	793	141	1980	1
82.1	177.4	9.1	816	302	38	1981	1
96.2	169.2	21.3	566	714	369	1982	1
125.7	138.8	39	321	1123	159	1983	1
122.5	60.8	21.3	1342	1582	81	1984	1
98.9	48.1	15.9	934	281	64	1985	1
139.3	47.2	18.6	568	1241	155	1986	1

139.7	47.6	20	784	1353	99	1987	1
113.9	33.1	13.2	829	708	101	1988	1
90.3	50.8	20.4	1566	1103	183	1989	1
42.2	45.4	13.6	940	525	88	1990	1
29.9	78.5	10.9	1063	1877	139	1991	1
46.7	52.2	5	883	651	147	1992	1
67.2	74	8.2	1076	758	157	1993	1
51.3	100.3	4.1	959	516	224	1994	1
20	64.9	2.3	939	374	199	1995	1
29.5	50.8	2.3	797	484	118	1996	1
18.1	52.6	2.3	818	390	104	1997	1
17.7	45.4	1.8	902	376	181	1998	1
16.3	61.7	4.5	787	158	175	1999	1

15	65.3	3.6	915	282	185	2000	1
9.1	76.7	4.5	997	387	199	2001	1
13.6	85.3	5.9	900	229	202	2002	1
12.3	73	4.1	1341	298	264	2003	1
16.8	81.2	6.4	1796	405	254	2004	1
15.4	85.3	5.9	1189	349	217	2005	1
14.1	72.1	5.4	684	263	225	2006	1
16.3	47.2	4.5	1006	323	249	2007	1
6.4	55.8	6.4	1405	484	312	2008	1
8.2	71.2	1.8	1278	419	384	2009	1
11.8	37.7	1.8	439	150	177	2010	1
11.8	70.8	5	587	60	219	2011	1
12.7	63.1	5.4	1250	376	216	2012	1
10	50.8	4.5	1183	179	306	2013	1

```
3.6   79.4  7.7   1424  331   335   2014  1

5     58.1  11.3  1127  200   270   2015  1

#

171         #_N_lines_cpue         Units_0_numbers,_1_lbs

#_Fleet     Units Errtype

      1     1     0             #_CHL_MC

      2     1     0             #_CHL_nMC

      3     1     0             #_CM_LL

      4     0     0             #_Rec_PR

      5     0     0             #_Rec_Shore

      6     0     0             #_Rec_HB_CBT

      7     0     0             #_CHL

      8     0     0             #_MRFSS_Private
```

```
      9     0     0             #_MRFSS _Shore

      10    0     0             #_FWRI_Age0

      11    0     0             #_FWRI_Age1

      12    0     0             #_SEAMAP_Trawl

      13    0     0             #_NMFS/FWRI_Video

      14    0     0             #_Visual_Survey

#Year Season      FLEET       INDEX  SE_LOG    Label

#_Commercial_Hand_Line #se   #     CV
1993  1     1     0.88  0.232828166
1994  1     1     1.13  0.203800699
1995  1     1     0.92  0.203800699
1996  1     1     0.92  0.203800699
1997  1     1     1.1   0.203800699
1998  1     1     1.03  0.203800699
1999  1     1     1.28  0.174742895
2000  1     1     0.98  0.174742895
2001  1     1     1.15  0.174742895
2002  1     1     1.25  0.145659027
2003  1     1     0.95  0.174742895
2004  1     1     0.99  0.174742895
2005  1     1     1.09  0.174742895
2006  1     1     1.14  0.174742895
2007  1     1     1     0.203800699
2008  1     1     0.82  0.203800699
2009  1     1     0.9   0.203800699
2010  1     1     0.8   0.232828166
2011  1     1     0.82  0.261821057
2012  1     1     0.96  0.232828166
2013  1     1     0.86  0.232828166
2014  1     1     0.98  0.203800699
2015  1     1     1.05  0.203800699
#_MRFSS_Private  #se   #     CV
1981  1     4     0.874 0.367528217
```

1982	1	4	0.519	0.541421627
1983	1	4	0.341	0.68413452
1984	1	4	0.732	0.569328465
1985	1	4	1.034	0.467073529
1986	1	4	0.66	0.289720306
1987	1	4	0.958	0.262967556
1988	1	4	0.887	0.288561399
1989	1	4	1.376	0.251274476
1990	1	4	1.434	0.275787562
1991	1	4	1.55	0.257125511
1992	1	4	1.227	0.131454159
1993	1	4	1.473	0.125457238
1994	1	4	1.17	0.126656998
1995	1	4	1.197	0.148219116
1996	1	4	0.877	0.133851584
1997	1	4	1.062	0.129055959
1998	1	4	1.135	0.109844126
1999	1	4	0.896	0.105034385
2000	1	4	0.929	0.12185685
2001	1	4	0.882	0.11945569
2002	1	4	0.907	0.102628573
2003	1	4	0.98	0.091795085
2004	1	4	0.741	0.103831556
2005	1	4	0.838	0.097815136
2006	1	4	0.883	0.107439574
2007	1	4	0.994	0.100222151
2008	1	4	1.108	0.088181403
2009	1	4	0.951	0.094203527
2010	1	4	0.57	0.142236279
2011	1	4	0.656	0.147022977
2012	1	4	0.76	0.138644058
2013	1	4	1.189	0.11344973
2014	1	4	1.682	0.078539276
2015	1	4	1.529	0.088181403
#_MRFSS		_Shore		#se #
1981	1	5	0.646	0.339342486
1982	1	5	0.71	0.304137875
1983	1	5	0.529	0.367608741
1984	1	5	0.625	0.329213042
1985	1	5	0.685	0.35762696
1986	1	5	0.761	0.498028396
1987	1	5	0.347	0.586478313
1988	1	5	0.912	0.301333653
1989	1	5	1.331	0.250277367
1990	1	5	0.656	0.299462205
1991	1	5	2.045	0.200173201
1992	1	5	0.954	0.15717581
1993	1	5	1.047	0.111756918
1994	1	5	0.947	0.125623069
1995	1	5	0.926	0.12463378
1996	1	5	1.073	0.131554895
1997	1	5	1.05	0.131554895
1998	1	5	0.935	0.122654655
1999	1	5	0.751	0.128589828

2000	1	5	0.805	0.154226937
2001	1	5	0.66	0.166010036
2002	1	5	0.868	0.144383068
2003	1	5	1.565	0.102825706
2004	1	5	1.341	0.119684624
2005	1	5	1.809	0.097858546
2006	1	5	1.006	0.160122642
2007	1	5	1.785	0.104811518
2008	1	5	1.391	0.108781277
2009	1	5	0.963	0.121664824
2010	1	5	0.641	0.153243531
2011	1	5	0.816	0.153243531
2012	1	5	0.946	0.14536842
2013	1	5	1.064	0.120674812
2014	1	5	1.267	0.13056673
2015	1	5	1.144	0.149307707
#_FWRI_Age0	#se	#	CV	
1998	1	10	0.174	0.31903052
1999	1	10	0.9568	0.244279562
2000	1	10	0.7112	0.218998574
2001	1	10	1.4862	0.173105804
2002	1	10	1.7114	0.169777506
2003	1	10	1.157	0.168869324
2004	1	10	1.7938	0.16584064
2005	1	10	0.4623	0.209827695
2006	1	10	1.3499	0.161799053
2007	1	10	1.0352	0.175826946
2008	1	10	0.4745	0.200531754
2009	1	10	1.3651	0.159473443
2010	1	10	0.885	0.171290701
2011	1	10	0.5319	0.193017116
2012	1	10	1.4112	0.181867311
2013	1	10	0.3827	0.318455404
2014	1	10	1.4711	0.170080189
2015	1	10	0.6407	0.197928459
#_FWRI_Age1	#se	#	CV	
1996	1	11	0.2443	0.283821778
1997	1	11	0.441	0.221967031
1998	1	11	0.5001	0.225377809
1999	1	11	0.4648	0.203664286
2000	1	11	0.4377	0.183536804
2001	1	11	0.3391	0.222383251
2002	1	11	1.145	0.171762457
2003	1	11	0.9736	0.197701135
2004	1	11	1.0023	0.192988048
2005	1	11	0.6948	0.214545807
2006	1	11	0.4003	0.209613285
2007	1	11	2.6328	0.179560969
2008	1	11	1.4781	0.184635504
2009	1	11	0.9667	0.182606794
2010	1	11	0.3954	0.206850039
2011	1	11	0.2727	0.238225393
2012	1	11	0.8087	0.167090443
2013	1	11	2.0825	0.17481654

```
2014  1     11    1.3962      0.171932211
2015  1     11    3.3238      0.166920415
#_SEAMAP_Trawl    #se   #     CV
2010  1     12    1.04289     0.195132146
2011  1     12    0.88101     0.215590707
2012  1     12    0.86483     0.191448259
2013  1     12    0.80844     0.220269082
2014  1     12    1.39514     0.173430489
2015  1     12    1.00769     0.204129317
#_NMFS/FWRI_Video#se   #     CV
1993  1     13    0.996 0.20350369
1994  1     13    1.2119      0.234250588
1995  1     13    0.7804      0.200152877
1996  1     13    1.3367      0.201756158
1997  1     13    1.0878      0.160336687
#_No_data_from_1998-2003     #     0     0
2004  1     13    0.6125      0.362619273
2005  1     13    0.9747      0.336019573
2006  1     13    0.8913      0.206945102
2007  1     13    0.4397      0.238344423
2008  1     13    1.3786      0.204188981
2009  1     13    1.2904      0.17401461
2010  1     13    1.2539      0.154332365
2011  1     13    0.7204      0.145618832
2012  1     13    0.9801      0.159893254
2013  1     13    0.8685      0.161584725
2014  1     13    1.1143      0.125609577
2015  1     13    1.0628      0.130829286
#_Visual_Survey   #se   #     CV
1997  1     14    0.65  0.227203152
1998  1     14    1.24  0.203233009
1999  1     14    1.21  0.179195946
2000  1     14    1.34  0.182404483
2001  1     14    1.61  0.200031769
2002  1     14    1.38  0.196829359
2003  1     14    0.88  0.247917394
2004  1     14    0.67  0.209631899
2005  1     14    1.11  0.231988493
2006  1     14    0.73  0.203233009
2007  1     14    0.91  0.235177038
2008  1     14    1     0.187215271
2009  1     14    1.3   0.185611947
2010  1     14    1.08  0.164744741
2011  1     14    2.09  0.198430709
2012  1     14    1.19  0.166351434
2014  1     14    2.61  0.180800349


#


5     #_N_discard_fleets
```

```
#_discard_units_(1=same_as_catchunits(bio/num);_2=fraction_of TOTAL
(AB1B2)_landings;_3=numbers_regardless of landings units)

#_discard_errtype:_>0_for_DF_of_T-
dist(read_CV_below_0_for_normal_with_CV;_-1_for_normal_with_se;_-
2_for_lognormal)

#_Fleet     units errtype                               #jeff set errtype to
-2 nc changed to 1-- review this

1     2     0

2     2     0

4     2     0

5     2     0

6     2     0

#151  # with fleets 1, 2, 4, 5 and 6

151   # fleets 4,5,6 only

#     Yr    Seas  FLEET Discard     Std_in

#COM_Mon
```

1993	1	1	0.380014966	0.3
1994	1	1	0.492963552	0.3
1995	1	1	0.679761189	0.3
1996	1	1	0.507477563	0.3
1997	1	1	0.634813321	0.3
1998	1	1	0.551180287	0.3
1999	1	1	0.541441543	0.3
2000	1	1	0.596406455	0.3
2001	1	1	0.723874266	0.3
2002	1	1	0.72769292	0.3
2003	1	1	0.154173335	0.3
2004	1	1	0.622985625	0.3
2005	1	1	0.658478725	0.3
2006	1	1	0.674427513	0.3
2007	1	1	0.437559066	0.3
2008	1	1	0.654623339	0.3
2009	1	1	0.536720056	0.3
2010	1	1	0.269618379	0.3
2011	1	1	0.581100417	0.3
2012	1	1	0.143129203	0.3
2013	1	1	0.822488617	0.3
2014	1	1	0.907399693	0.3
2015	1	1	0.046231248	0.3
#COM_nMC				
1993	1	2	0.156714833	0.3
1994	1	2	0.157534487	0.3
1995	1	2	0.176326487	0.3
1996	1	2	0.160560927	0.3
1997	1	2	0.171237826	0.3
1998	1	2	0.168999993	0.3
1999	1	2	0.116203071	0.3
2000	1	2	0.116488326	0.3
2001	1	2	0.143787971	0.3
2002	1	2	0.090809854	0.3
2003	1	2	0.324029082	0.3
2004	1	2	0.102882983	0.3
2005	1	2	0.021983987	0.3
-2006	1	2	0.121682387	0.3
-2007	1	2	0.121682387	0.3
2008	1	2	0.143137937	0.3
-2009	1	2	0.121682387	0.3
2010	1	2	0.014016802	0.3
2011	1	2	0.087832319	0.3
-2012	1	2	0.00010942	0.3
2013	1	2	0.216058635	0.3
2014	1	2	0.047454375	0.3
2015	1	2	0.017478428	0.3
#Rec PR				
1981	1	4	0.183796085	0.3
1982	1	4	0.210550973	0.3

1983	1	4	0.145414787	0.3	
1984	1	4	0.05756917	0.3	#
1985	1	4	0.419710642	0.3	
1986	1	4	0.480257316	0.3	
1987	1	4	0.191515535	0.3	
1988	1	4	0.342790073	0.3	
1989	1	4	0.326660261	0.3	
1990	1	4	0.473507901	0.3	
1991	1	4	0.720795342	0.3	
1992	1	4	0.746536051	0.3	
1993	1	4	0.699761917	0.3	
1994	1	4	0.693770125	0.3	
1995	1	4	0.672464296	0.3	

1996	1	4	0.708941656	0.3
1997	1	4	0.7404216	0.3
1998	1	4	0.746791452	0.3
1999	1	4	0.718032385	0.3
2000	1	4	0.749007895	0.3
2001	1	4	0.692216627	0.3
2002	1	4	0.756646054	0.3
2003	1	4	0.753031019	0.3
2004	1	4	0.615664662	0.3
2005	1	4	0.736041185	0.3
2006	1	4	0.777069044	0.3
2007	1	4	0.749944018	0.3
2008	1	4	0.757028715	0.3
2009	1	4	0.682026548	0.3

2010	1	4	0.777342958	0.3
2011	1	4	0.755972527	0.3
2012	1	4	0.663989373	0.3
2013	1	4	0.734701572	0.3
2014	1	4	0.786023185	0.3
2015	1	4	0.772147429	0.3

REC SHORE MODE

1981	1	5	0.27652008	0.3
1982	1	5	0.228864083	0.3
1983	1	5	0.526248144	0.3
1984	1	5	0.179244204	0.3
1985	1	5	0.378452124	0.3
1986	1	5	0.113696352	0.3

1987	1	5	0.011203848	0.3
1988	1	5	0.246183824	0.3
1989	1	5	0.289898603	0.3
1990	1	5	0.507111877	0.3
1991	1	5	0.690992509	0.3
1992	1	5	0.752144233	0.3
1993	1	5	0.746683392	0.3
1994	1	5	0.740874213	0.3
1995	1	5	0.807556286	0.3
1996	1	5	0.80259205	0.3
1997	1	5	0.855762555	0.3
1998	1	5	0.838366282	0.3
1999	1	5	0.879401038	0.3
2000	1	5	0.874675302	0.3

2001	1	5	0.788107362	0.3
2002	1	5	0.859370369	0.3
2003	1	5	0.908538758	0.3
2004	1	5	0.820061493	0.3
2005	1	5	0.904940366	0.3
2006	1	5	0.896605836	0.3
2007	1	5	0.913498366	0.3
2008	1	5	0.872521042	0.3
2009	1	5	0.78584189	0.3
2010	1	5	0.820018579	0.3
2011	1	5	0.940167143	0.3
2012	1	5	0.877191767	0.3
2013	1	5	0.912605309	0.3

```
2014  1     5     0.863351722 0.3

2015  1     5     0.901283118 0.3

# REC CB+HB

1981  1     6     0.026082953 0.3

1982  1     6     0.278687579 0.3

1983  1     6     0.072164658 0.3

1984  1     6     0.090102898 0.3

1985  1     6     0.094364733 0.3

1986  1     6     0.104130498 0.3

1987  1     6     0.187512669 0.3

1988  1     6     0.068683818 0.3

1989  1     6     0.13898821  0.3

1990  1     6     0.179841269 0.3

1991  1     6     0.357719278 0.3
```

1992	1	6	0.426092139	0.3
1993	1	6	0.256397315	0.3
1994	1	6	0.246463554	0.3
1995	1	6	0.402374924	0.3
1996	1	6	0.367731967	0.3
1997	1	6	0.485169193	0.3
1998	1	6	0.417528007	0.3
1999	1	6	0.438558057	0.3
2000	1	6	0.45883753	0.3
2001	1	6	0.244449674	0.3
2002	1	6	0.361244955	0.3
2003	1	6	0.282028232	0.3
2004	1	6	0.32147721	0.3

```
2005  1     6     0.361826201 0.3

2006  1     6     0.315480739 0.3

2007  1     6     0.367858872 0.3

2008  1     6     0.394725704 0.3

2009  1     6     0.26972441  0.3

2010  1     6     0.484298849 0.3

2011  1     6     0.468819866 0.3

2012  1     6     0.466359104 0.3

2013  1     6     0.484153347 0.3

2014  1     6     0.434322533 0.3

2015  1     6     0.518896717 0.3

0     #_N_meanodywt

30    #_DF_for_meanbodywt_T-distribution_like                    # Check
this number
```

1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector

-0.001 #_comp_tail_compression

1.00E-07 #_add_to_comp

0 #_combine males into females at or below this bin number

36 #_N_lbins

#_lbin_vector

10	12	14	16	18	20	22	24	26	28	30	32
34	36	38	40	42	44	46	48	50	52	54	56
58	60	62	64	66	68	70	72	74	76	78	80

191 #_N_Length_comp_observations 103 rec

Year__Season__Fleet/Suvey__Gender__Part__Nsamp

```
#CHL_MC Plus_Group_+51_and_over 1 total 10 12 14 16
     18   20   22   24   26   28   30   32   34   36   38   40
     42   44   46   48   50   52   54   56   58   60   62   64
     66   68   70   72   74   76   78   80
1987 1    1    0    2    100  0    0    0    0    0    0    7
     22   49   85   97   60   54   57   39   20   27   33   19
     14   13   4    1    1    0    0    0    0    0    0    0
     0    0    0    0    0
1988 1    1    0    2    100  0    0    0    0    0    0    22
     48   89   63   72   41   21   18   12   12   5    6    4
     4    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
1989 1    1    0    2    100  0    0    0    0    0    65   449
     563  333  141  102  63   67   55   31   24   14   10   6
     2    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
```

1990	1	1	0	2	100	0	0	0	0	0	0	1
	11	60	257	286	164	115	84	55	29	14	14	9
	6	0	0	2	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1991	1	1	0	2	100	0	0	0	0	0	0	0
	2	21	260	373	235	209	175	117	84	46	44	28
	16	8	3	4	1	2	0	2	1	0	0	0
	0	0	0	0	0							
1992	1	1	0	2	100	0	0	0	0	0	0	0
	0	0	121	270	189	158	151	103	74	54	48	18
	20	12	4	7	0	1	0	0	0	0	0	0
	0	0	0	0	0							
1993	1	1	0	2	100	0	0	0	0	0	0	0
	0	4	97	201	162	112	79	56	44	32	39	17
	15	13	3	6	0	2	2	2	0	0	0	0
	0	0	0	0	0							
1994	1	1	0	2	100	0	0	0	0	0	0	0
	0	8	250	563	393	286	225	145	86	58	58	28
	19	17	10	5	3	1	0	0	0	0	0	0
	0	0	0	0	0							
1995	1	1	0	2	100	0	0	0	0	0	0	0
	0	9	122	352	265	220	187	94	54	42	23	7
	5	1	2	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1996	1	1	0	2	100	0	0	0	0	0	0	0
	0	10	118	229	154	119	125	71	50	32	11	6
	2	1	6	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1997	1	1	0	2	100	0	0	0	0	0	0	0
	0	2	125	262	197	201	173	91	75	60	27	22
	12	5	1	3	2	1	0	0	0	0	0	0
	0	0	0	0	0							
1998	1	1	0	2	100	0	0	0	0	0	0	0
	0	1	131	178	115	122	99	91	76	46	42	11
	14	7	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	0							
1999	1	1	0	2	100	0	0	0	0	0	0	0
	0	0	96	198	191	147	83	63	28	24	11	13
	9	8	4	1	1	1	0	1	0	0	0	0
	0	0	0	0	0							
2000	1	1	0	2	100	0	0	0	0	0	0	0
	0	11	40	61	56	43	35	36	14	15	12	5
	4	3	2	2	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2001	1	1	0	2	100	0	0	0	0	0	0	0
	0	13	250	339	246	138	97	84	36	27	17	20
	18	10	1	4	3	0	0	0	0	0	0	0
	0	0	0	0	0							
2002	1	1	0	2	100	0	0	0	0	0	0	0
	18	36	74	80	81	63	66	30	39	24	12	8
	4	6	1	0	1	0	0	0	1	0	0	0
	0	0	0	0	0							
2003	1	1	0	2	100	0	0	0	0	0	0	0
	0	2	108	122	93	83	73	63	41	27	26	12

	10	6	0	1	2	0	0	0	0	0	0	0
	0	0	0	0	0							
2004	1	1	0	2	100	0	0	0	0	0	0	2
	2	9	98	109	66	58	30	31	17	12	3	1
	0	0	0	0	1	0	0	1	0	0	0	0
	0	0	0	0	0							
2005	1	1	0	2	100	0	0	0	0	0	0	0
	0	1	26	65	66	69	53	42	11	13	14	6
	7	2	1	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2006	1	1	0	2	100	0	0	0	0	0	0	0
	0	4	37	54	85	74	42	36	16	9	8	2
	4	1	3	2	0	0	0	0	0	1	0	0
	0	0	0	0	0							
2007	1	1	0	2	100	0	0	0	0	0	0	0
	0	5	12	85	73	46	31	20	19	13	5	3
	1	2	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2008	1	1	0	2	100	0	0	0	0	0	0	0
	0	0	82	128	122	100	49	36	23	13	10	4
	2	2	1	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2009	1	1	0	2	100	0	0	0	0	0	0	0
	0	4	99	171	115	82	64	42	21	9	10	3
	1	3	0	0	1	1	1	0	0	0	0	0
	0	0	0	0	0							
2010	1	1	0	2	100	0	0	0	0	0	0	0
	0	0	30	101	79	78	51	38	21	11	7	5
	7	1	0	2	0	1	0	0	0	0	0	0
	0	0	0	0	0							
2011	1	1	0	2	100	0	0	0	0	0	0	0
	0	1	32	50	38	24	21	18	14	12	7	5
	3	2	1	1	0	1	0	0	0	0	0	0
	0	0	0	0	0							
2012	1	1	0	2	100	0	0	0	0	0	0	0
	0	2	109	219	160	89	50	34	28	16	10	10
	8	3	1	0	1	0	0	0	0	0	0	0
	0	0	0	0	0							
2013	1	1	0	2	100	0	0	0	0	0	0	0
	0	7	79	181	179	113	90	56	38	26	17	15
	10	7	3	4	3	2	0	0	0	0	0	0
	0	0	0	0	0							
2014	1	1	0	2	100	0	0	0	0	0	0	0
	0	1	143	204	128	89	73	41	36	13	13	7
	8	2	0	2	2	0	0	0	0	0	0	0
	0	0	0	0	0							
2015	1	1	0	2	100	0	0	0	0	0	0	0
	0	0	34	82	98	38	36	33	32	13	13	5
	2	3	0	0	1	0	0	1	0	0	0	0
	0	0	0	0	0							

#_CHL_nMC

1985	1	2	0	2	74	0	0	0	0	0	0	0
	0	19	20	10	6	9	2	1	3	1	1	1
	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1986	1	2	0	2	92	0	0	0	0	0	0	0
	0	2	11	18	25	17	12	1	4	0	0	1
	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1987	1	2	0	2	100	0	0	0	0	0	0	0
	6	33	66	72	82	91	59	47	35	21	12	2
	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1988	1	2	0	2	100	0	0	0	0	0	0	0
	0	0	1	56	75	61	29	31	15	10	6	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1989	1	2	0	2	100	0	0	0	0	0	0	0
	5	8	31	182	257	196	151	79	63	28	5	1
	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1990	1	2	0	2	100	0	0	0	0	0	0	1.2
	4.6	17.4	13.8	15.2	12.3	12.6	9.2	12.4	10.5	13	13.4	12.4
	7.8	5.7	4.8	6.5	5.5	3.1	4.3	5.9	4.3	1.2	2.5	0
	0	0	0	0	0							
1991	1	2	0	2	100	0	0	0	0	0	0	0.9
	1.2	7.3	6	13	18	20.4	29.8	26.3	22.8	16.4	33.5	22.6
	18.1	16.4	15.9	8	9.5	8.5	11.4	12.1	9.2	15.6	5.7	5
	0	0	0	0	0							
1992	1	2	0	2	100	0	0	0	0	0	0	1
	1.7	6.8	3.7	13	20.5	29.1	33.1	27.4	27.8	36.7	40	30.7
	25.5	19.2	17.5	11.2	10.3	8.3	7	10.2	9.2	3.6	1	0.7
	0	0	0	0	0							
1993	1	2	0	2	100	0	0	0	0	0	0	0.6
	0.3	6.2	4.6	6	11.6	26.9	30.7	28.1	25	25.7	21.4	27.5
	12.9	16	5.1	5.4	3.8	2.8	2.4	3.5	2.1	3.5	0	0.7
	0	0	0	0	0							
1994	1	2	0	2	100	0	0	0	0	0	0	0.3
	3.1	2.5	7.7	9.3	31	39.3	41.5	45.6	53.2	66.4	43.7	58.4
	41.4	35.6	28.4	21.1	13.1	6.5	5.1	3.6	5.1	0.7	2.2	0
	0	0	0	0	0							
1995	1	2	0	2	100	0	0	0	0	0	0.6	0.6
	0.2	2.5	5	10.3	19.4	28.6	24.2	39.6	29.6	29.5	31.2	28.9
	19.8	19	11.5	7.1	3.2	12.6	3.2	9.5	7.1	7.3	3.2	1.6
	0	0	0.1	0	0							
1996	1	2	0	2	100	0	0	0	0	0	0	0
	2	6.2	18.2	99.3	121.8	108.5	128.2	85.8	85.5	60.3	79.8	51.7
	27.2	31.8	12.9	8.6	10.7	2.1	5.3	4.3	3.6	0.7	0.7	0.7
	0	0	0	0	0							
1997	1	2	0	2	100	0	0	0	0	0	0	0
	2	18.7	20.7	34.5	60.4	54	74.7	78.9	71	68.7	56.3	43.8
	21.2	20	15.8	15	5.7	7.2	2.9	3.6	1.4	2.1	1.4	1.4
	0	0	0	0	0							
1998	1	2	0	2	100	0	0	0	0	0	0	0.8
	2.7	8.2	8.2	29.4	39.9	69.3	81.1	109.2	82.8	79.4	62.5	63.5

	37.1	23.9	18.1	8.7	6.1	2.2	0.7	2.2	1.5	1.5	0.7	0
	0	0	0	0	0							
1999	1	2	0	2	100	0	0	0	0	0	0	0
	0.4	0.9	8.1	38.3	61.9	139.6	202.7	241.4	231	241.2	177.3	
	135.2	111.7	57.8	51	18	14.8	8.2	3.5	0	0.8	0.8	1.6
	0	0	0	0	0	0						
2000	1	2	0	2	100	0	0	0	0	0	0	0
	0	0.5	0.5	19.5	41.4	86.9	156.2	171.2	164.4	140.9	131.9	107
	51.2	34.8	24.6	18.3	11	5.5	7.3	2.7	0	1.8	0	0
	0.1	0	0	0	0							
2001	1	2	0	2	100	0	0	0	0	0	0	0
	1.8	9.8	17	30.9	50.2	68.1	89.9	125.6	136.1	109	88.4	72.7
	57.1	42.7	21.8	10	6.3	7.3	2.7	2.7	0	0	0	0
	0	0	0	0	0							
2002	1	2	0	2	100	0	0	0	0	0	0.6	0.6
	1.5	1	1	5.7	19.6	32.4	63.6	75.3	95.9	79.6	106.3	83.2
	79.4	60.8	41	26.8	12.5	11.7	5.4	1.8	1.8	0.9	0	0
	0	0	0.9	0	0							
2003	1	2	0	2	100	0	0	0	0	0	0	0.6
	0.2	0.7	0.2	4.5	6.4	27.1	34.3	49.6	47.8	53.2	49.6	38.8
	32.5	22.5	19.8	9.9	10.8	4.5	5.4	3.6	0	0.9	0	0
	0	0	0	0	0							
2004	1	2	0	2	100	0	0	0	0	0	0	0
	0	0.1	1	0	5.5	15.6	29.4	37.8	42.6	41.8	37.2	45.3
	46	34	20.3	21.2	14.7	7.5	5.5	2.8	0.9	0.9	0.9	0
	0	0	0	0	0							
2005	1	2	0	2	100	0	0	0	0	0	0	0
	0.2	0.1	0.5	2.1	8.4	13.8	22.6	38.9	40.7	30.8	29.8	29.8
	20.8	14.5	16.4	11	11	3.6	3.7	1.8	0	0.9	0	0
	0	0	0	0	0							
2006	1	2	0	2	100	0	0	0	0	0	0	0
	0	0	0	4.6	0.1	8.4	25.3	17.6	28.7	18.4	24.2	11.6
	17.2	9	10	9.9	9.9	10.9	7.1	2.7	2.7	0	0	0
	0	0	0	0	0							
2007	1	2	0	2	100	0	0	0	0	0	0	0.1
	0	3.7	5.1	7.6	7.9	16.6	28.2	21.6	34.2	27.9	17.1	19.8
	17.1	7.3	9	4.5	2.7	2.7	0.9	2.7	0.9	0.9	0	0
	0	0	0	0	0							
2008	1	2	0	2	100	0	0	0	0	0	0	0.9
	9	37.7	33.2	26.9	22.8	18	16.4	26.9	28.2	32.3	35.9	20.6
	19.8	13.5	14.3	9.8	6.3	1	3.6	2.7	1.8	0	0	0
	0	0	0	0	0							
2009	1	2	0	2	100	0	0	0	0	0	0	0
	4	12.8	43.1	47.5	43.7	53.5	87.2	100.4	98.6	116.2	68.9	60.9
	48.9	37.5	20.8	12.2	6.4	6.4	7.2	5.6	1	0.8	0	0
	0	0	0	0	0							
2010	1	2	0	2	100	0	0	0	0	0	0	0
	0	0.8	10.7	22.8	17.2	27.4	38.2	32.4	48.2	41.9	25.8	35.7
	26.8	23.8	14.3	7.5	9	5.8	4.2	3.2	0.8	0	0	0.8
	0	0	0	0	0							
2011	1	2	0	2	100	0	0	0	0	0	0	0
	0	1.7	4.3	15.6	12.2	26.9	40	40.9	46.1	57	60.2	49.9
	52.7	36	27	22.3	16.2	10.7	10.1	2.6	1.9	0.9	1.7	0
	0	0	0	0	0							

```
2012  1     2     0     2     100   0     0     0     0     0     0     0
      0     0     0.5   4.4   18.7  36.5  73.1  91.8  99.4  91.8  107.9 90.1
      85.8  71.4  53.5  39.9  45    18.7  14.4  15.3  3.4   0.8   0.8   0
      0     0     0     0     0
2013  1     2     0     2     100   0     0     0     0     0     0     0
      0.1   0.2   0     9.7   27.3  22.8  39.5  65    73.7  74.6  86.9  83.4
      70.2  54.4  43.9  37.8  24.6  21.9  14.9  9.7   3.5   1.8   0.9   0
      0     0     0     0     0
2014  1     2     0     2     100   0     0     0     0     0     0     0
      0     0     9.1   16.2  24.9  45.6  63.6  75.5  90.9  77.9  83.1  60.7
      61.4  49.9  39.8  25.4  16.1  12.7  9.3   4.2   2.5   1.7   0     0
      0     0     0     0     0
2015  1     2     0     2     100   0     0     0     0     0     0     0
      0     14.3  13.5  15.1  30.2  36.6  47.7  42.9  53.2  56.4  46.9  42.1
      35    32.6  23.8  13.5  10.3  8.7   4     3.2   1.6   0     0     0
      0     0     0     0     0
#Com_LL



-1986 1     3     0     2     100   0     0     0     0     0     0     0
      0     0     11    12    22    29    36    29    18    13    7     2
      0     4     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0
-1989 1     3     0     2     28    0     0     0     0     0     0     0
      0     0     0     0     0     2     0     2     1     2     1     8
      5     1     2     0     1     1     0     1     0     0     0     0
      0     0     0     0     0
1990  1     3     0     2     100   0     0     0     0     0     0     0
      0     0     0     0     0     1     4     7     17    19    20    21
      20    19    25    23    9     8     3     5     1     1     0     0
      0     0     0     0     0
1991  1     3     0     2     100   0     0     0     0     0     0     0
      0     0     0     0     0     2     5     10    17    25    33    35
      31    43    48    24    16    5     8     6     1     0     0     1
      0     0     0     0     0
1992  1     3     0     2     92    0     0     0     0     0     0     0
      0     0     0     5     2     1     2     3     8     6     11    8
      13    7     8     7     5     4     1     1     0     0     0     0
      0     0     0     0     0
1993  1     3     0     2     68    0     0     0     0     0     0     0
      0     0     0     0     0     0     1     2     2     6     9     8
      12    10    9     3     5     1     0     0     0     0     0     0
      0     0     0     0     0
1994  1     3     0     2     67    0     0     0     0     0     0     0
      0     0     0     0     0     0     6     7     7     8     8     7
      6     4     1     8     2     2     0     1     0     0     0     0
      0     0     0     0     0
1995  1     3     0     2     46    0     0     0     0     0     0     0
      0     0     0     0     0     0     3     1     2     9     4     5
      7     6     2     1     2     0     2     1     0     0     1     0
      0     0     0     0     0
1996  1     3     0     2     27    0     0     0     0     0     0     0
      0     0     0     3     3     2     2     0     4     1     5     1
```

	1	4	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1997	1	3	0	2	29	0	0	0	0	0	0	0
	0	0	0	0	1	1	0	3	2	3	0	5
	7	3	1	2	1	0	0	0	0	0	0	0
	0	0	0	0	0							
1998	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	2	6	19	27	40	44	35	31	22	9
	11	8	3	2	3	0	0	0	0	0	0	0
	0	0	0	0	0							
1999	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	1	5	5	8	12	26	19	31	35
	27	22	21	12	5	5	1	0	0	0	0	0
	0	0	0	0	0							
2000	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	0	5	8	4	19	8	24	17
	12	14	8	1	5	1	2	0	0	0	0	0
	0	0	0	0	0							
2001	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	0	2	6	11	19	18	25	18
	15	12	10	9	2	4	1	0	0	0	0	0
	0	0	0	0	0							
2002	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	1	4	11	11	24	40	40	45	40
	37	43	22	16	6	3	2	2	0	0	0	0
	0	0	0	0	0							
2003	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	0	6	14	16	25	26	22	31
	30	24	16	11	7	2	0	0	0	0	0	0
	0	0	0	0	0							
2004	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	1	2	11	22	30	51	44	66	51
	52	46	26	25	10	7	4	1	0	0	0	0
	0	0	0	0	0							
2005	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	1	0	0	3	5	12	20	26	38	30
	25	25	21	9	7	4	4	2	0	0	0	0
	0	0	0	0	0							
2006	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	0	2	9	17	30	30	33	22
	35	21	16	23	7	4	8	1	0	0	0	0
	0	0	0	0	0							
2007	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	1	1	1	4	14	16	19	33	39	20
	26	13	9	14	7	4	2	2	0	0	0	0
	0	0	0	0	0							
2008	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	1	0	3	7	14	24	38	50	47	39
	39	32	27	18	3	2	4	0	0	0	0	0
	0	0	0	0	0							
2009	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	1	3	0	5	10	6	15	10	19	10
	18	11	7	5	2	1	1	1	1	1	0	0
	0	0	0	0	0							

2010	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	1	6	9	15	22	20	23	19	20
	24	26	11	11	4	3	2	1	0	1	0	0
	0	0	0	0	0							
2011	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	2	19	25	26	38	32	36	29
	25	22	10	2	3	1	1	1	0	0	0	0
	0	0	0	0	0							
2012	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	0	7	9	18	16	30	27	33
	26	22	15	5	5	4	0	1	0	0	0	0
	0	0	0	0	0							
2013	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	3	13	17	25	24	31	43	42	44
	37	18	24	20	9	4	3	1	1	0	0	0
	0	0	0	0	0							
2014	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	4	6	15	31	34	56	66	36	43
	41	24	30	21	8	3	6	2	0	0	0	0
	0	0	0	0	0							
2015	1	3	0	2	100	0	0	0	0	0	0	0
	0	0	0	0	2	8	21	33	27	36	41	32
	22	32	18	11	4	9	4	5	1	0	0	0
	0	0	0	0	0							
#	Private											
1981	1	4	0	2	59	0	0	0	0	0	1	5
	7	9	7	7	2	0	0	1	0	1	1	2
	5	8	1	0	1	0	0	1	0	0	0	0
	0	0	0	0	0							
1982	1	4	0	2	63	0	0	0	0	4	6	6
	7	8	8	8	3	2	0	2	1	4	1	0
	2	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1983	1	4	0	2	16	0	0	0	0	0	0	1
	5	1	2	2	1	1	0	0	1	1	0	1
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1984	1	4	0	2	22	0	0	0	0	1	1	1
	2	4	2	2	2	3	1	1	1	0	1	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1985	1	4	0	2	10	0	0	0	0	0	0	0
	0	1	3	2	1	0	0	1	0	0	2	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1986	1	4	0	2	38	0	0	0	0	3	6	2
	1	3	1	4	5	1	3	3	2	1	1	1
	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0							
1987	1	4	0	2	100	0	0	0	0	4	9	20
	22	35	21	22	16	12	12	8	4	7	6	7

	7	0	0	1	1	1	1	0	0	0	0	0
	0	0	0	0	0							
1988	1	4	0	2	96	0	0	0	0	0	15	19
	15	11	5	15	3	1	1	1	2	3	0	2
	0	0	1	0	0	0	1	1	0	0	0	0
	0	0	0	0	0							
1989	1	4	0	2	100	0	0	0	0	7	22	18
	30	23	13	6	15	11	4	6	1	2	0	2
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1990	1	4	0	2	76	0	0	0	0	0	4	2
	6	5	10	14	10	10	4	3	2	0	1	1
	0	3	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1991	1	4	0	2	100	0	0	0	0	0	4	7
	17	25	24	9	17	8	11	6	4	9	4	3
	2	1	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1992	1	4	0	2	100	0	0	0	0	0	10	8
	42	66	64	41	28	27	19	15	9	4	3	4
	2	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0							
1993	1	4	0	2	100	0	0	0	0	2	1	7
	37	64	46	32	34	14	8	7	7	2	4	2
	3	0	0	0	1	0	0	0	0	1	0	1
	0	0	0	0	0							
1994	1	4	0	2	100	0	0	0	0	1	2	3
	16	38	44	44	35	27	15	14	9	4	4	2
	2	2	2	2	1	1	1	1	1	0	0	0
	0	0	0	0	0							
1995	1	4	0	2	100	0	0	0	0	2	7	10
	20	47	37	48	27	35	23	19	12	13	7	1
	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1996	1	4	0	2	100	0	0	0	0	0	1	4
	19	19	35	26	16	12	16	15	11	7	5	0
	2	3	1	2	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1997	1	4	0	2	100	0	0	0	0	3	6	5
	18	26	40	39	16	15	7	5	9	3	1	1
	2	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1998	1	4	0	2	100	0	0	0	0	7	8	7
	37	86	77	34	41	20	23	13	5	7	3	1
	2	1	5	2	0	2	0	0	0	0	0	0
	0	0	0	0	0							
1999	1	4	0	2	100	0	0	0	0	0	2	9
	44	67	86	66	47	34	26	20	17	13	9	6
	4	7	2	3	6	1	1	2	0	1	0	0
	0	0	0	0	0							
2000	1	4	0	2	100	0	0	0	0	2	10	15
	25	42	50	36	35	20	18	13	18	15	7	3
	2	9	4	4	0	0	0	0	0	0	0	0
	1	0	0	0	0							

2001	1	4	0	2	100	0	0	0	0	0	1	5
	36	92	87	63	19	19	23	17	12	12	13	3
	4	3	4	1	2	1	5	0	1	1	0	0
	0	0	0	0	0							
2002	1	4	0	2	100	0	0	0	0	1	1	10
	46	77	56	38	24	20	11	9	8	14	2	3
	6	4	2	3	1	1	0	0	2	0	0	0
	0	0	0	0	0							
2003	1	4	0	2	100	0	0	0	0	0	0	3
	50	89	68	55	27	22	16	9	8	10	8	15
	9	7	5	7	2	3	6	0	4	3	0	0
	0	0	0	0	0							
2004	1	4	0	2	100	0	0	0	0	1	3	6
	36	78	72	47	30	23	17	15	21	13	15	19
	5	6	3	4	4	5	5	0	0	0	0	0
	0	0	0	0	0							
2005	1	4	0	2	100	0	0	0	0	0	2	4
	45	93	82	45	23	16	14	14	8	5	9	1
	4	6	6	1	1	1	1	6	1	1	1	0
	0	0	0	0	0							
2006	1	4	0	2	100	0	0	0	0	1	6	5
	35	67	61	32	19	9	5	2	11	11	9	10
	9	9	4	4	10	4	4	6	0	1	0	0
	0	0	0	0	0							
2007	1	4	0	2	100	0	0	0	0	1	3	5
	36	84	95	67	43	24	27	15	17	8	5	6
	12	5	7	8	2	5	6	5	1	2	0	0
	0	0	0	0	0							
2008	1	4	0	2	100	0	0	0	0	0	2	13
	103	170	127	96	67	44	41	32	20	15	7	4
	3	6	4	1	2	2	2	4	0	0	0	0
	0	0	0	0	0							
2009	1	4	0	2	100	0	0	0	0	0	0	10
	64	151	170	110	80	66	39	24	18	10	12	6
	5	6	0	1	1	3	1	1	1	0	0	1
	0	0	0	0	0							
2010	1	4	0	2	100	0	0	0	0	0	0	2
	27	53	70	32	49	19	27	11	14	10	5	5
	2	3	1	3	4	0	2	0	2	0	0	0
	0	0	0	0	0							
2011	1	4	0	2	100	0	0	0	0	0	1	2
	18	38	51	27	26	10	13	10	8	6	10	7
	11	1	5	2	4	2	1	3	3	1	0	0
	0	0	0	0	0							
2012	1	4	0	2	100	0	0	0	0	0	1	2
	22	60	36	27	14	15	14	6	7	6	7	7
	2	6	1	4	2	1	0	0	1	0	0	0
	0	0	0	0	0							
2013	1	4	0	2	100	0	0	0	0	0	0	12
	98	149	110	93	50	40	16	18	10	9	13	4
	4	5	5	5	3	1	0	2	1	1	2	0
	0	0	0	0	0							
2014	1	4	0	2	100	0	0	0	0	0	1	8
	139	354	302	218	128	87	46	37	36	30	12	14

	5	7	5	3	1	0	0	2	0	1	1	0
	0	0	0	0	0							
2015	1	4	0	2	100	0	0	0	0	0	0	9
	75	253	223	146	94	66	36	26	15	9	8	7
	6	2	3	1	0	1	3	1	1	2	1	0
	0	0	0	0	0							
#	Shore											
1981	1	5	0	2	54	0	0	0	0	34	3	3
	6	3	1	2	1	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1982	1	5	0	2	100	0	0	0	0	40	18	18
	8	6	4	1	2	2	2	4	0	0	0	1
	2	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1983	1	5	0	2	58	0	0	0	0	8	10	13
	9	8	5	5	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1984	1	5	0	2	38	0	0	0	0	4	1	8
	7	7	7	2	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1985	1	5	0	2	32	0	0	0	0	1	2	7
	5	7	3	0	3	1	2	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1986	1	5	0	2	38	0	0	0	0	2	5	0
	3	7	5	2	12	0	1	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1987	1	5	0	2	20	0	0	0	0	6	2	3
	5	0	2	0	2	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1988	1	5	0	2	86	0	0	0	0	12	25	11
	13	12	8	1	2	1	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1989	1	5	0	2	77	0	0	0	0	8	6	16
	13	7	3	11	3	4	5	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1990	1	5	0	2	23	0	0	0	0	2	2	1
	2	6	5	1	3	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1991	1	5	0	2	62	0	0	0	0	6	12	2
	14	11	9	2	4	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							

1992	1	5	0	2	100	0	0	0	0	1	12	36
	16	14	14	3	3	2	3	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1993	1	5	0	2	100	0	0	0	0	8	9	14
	25	29	22	10	8	8	5	1	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1994	1	5	0	2	100	0	0	0	0	1	2	6
	28	40	28	14	7	5	5	2	1	1	0	0
	0	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1995	1	5	0	2	100	0	0	0	0	0	3	10
	20	30	12	13	11	4	1	2	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1996	1	5	0	2	77	0	0	0	0	0	3	8
	4	11	6	20	15	5	4	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	0							
1997	1	5	0	2	63	0	0	0	0	1	0	2
	10	11	8	8	16	3	2	0	0	2	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1998	1	5	0	2	88	0	0	0	0	1	2	10
	10	19	24	10	3	4	3	1	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1999	1	5	0	2	75	0	0	0	0	3	1	10
	14	14	12	7	4	6	3	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2000	1	5	0	2	50	0	0	0	0	2	4	4
	2	9	8	14	5	1	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2001	1	5	0	2	84	0	0	0	0	1	5	10
	16	20	15	4	5	3	1	1	2	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2002	1	5	0	2	30	0	0	0	0	0	0	1
	5	3	8	4	4	3	1	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2003	1	5	0	2	58	0	0	0	0	2	2	5
	15	21	8	2	2	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2004	1	5	0	2	39	0	0	0	0	1	1	1
	7	12	12	2	2	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2005	1	5	0	2	52	0	0	0	0	0	0	4
	16	12	6	8	3	1	0	1	0	1	0	0

```
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2006 1    5    0    2    33   0    0    0    0    1    0    1
     2    12   12   4    1    0    0    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2007 1    5    0    2    57   0    0    0    0    0    3    1
     7    15   17   9    0    2    2    0    1    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2008 1    5    0    2    100  0    0    0    0    2    3    0
     10   39   25   16   7    3    0    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2009 1    5    0    2    94   0    0    0    0    0    0    1
     19   23   27   17   2    3    2    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2010 1    5    0    2    30   0    0    0    0    0    8    7
     3    6    3    2    1    0    0    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2011 1    5    0    2    7    0    0    0    0    0    0    0
     1    1    3    0    0    0    0    1    1    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2012 1    5    0    2    74   0    0    0    0    0    1    2
     12   19   20   11   3    3    3    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2013 1    5    0    2    40   0    0    0    0    0    3    2
     9    8    9    6    1    1    1    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2014 1    5    0    2    36   0    0    0    0    5    2    0
     11   11   4    3    0    0    0    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
2015 1    5    0    2    17   0    0    0    0    0    1    1
     4    6    1    2    0    1    1    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
#Rec_CB_HB



1981 1    6    0    2    90   0    0    0    0    4    12   19
     18   14   8    5    4    0    1    2    1    0    2    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
1982 1    6    0    2    79   0    0    0    0    3    5    14
     12   9    10   12   5    4    1    2    1    1    0    0
     0    0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0
```

1983	1	6	0	2	52	0	0	0	0	1	1	4
	10	9	12	2	2	2	2	2	2	3	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1984	1	6	0	2	99	0	0	0	0	6	9	2
	8	3	20	11	12	11	4	4	3	2	1	1
	0	0	0	0	0	0	0	0	0	0	1	1
	0	0	0	0	0							
1985	1	6	0	2	100	0	0	0	0	0	0	1
	18	69	93	110	51	60	26	26	18	11	8	5
	7	8	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1986	1	6	0	2	100	0	0	0	0	29	41	57
	30	22	41	6	5	4	2	6	4	1	3	0
	1	1	0	0	1	2	1	0	0	0	0	0
	0	0	0	0	0							
1987	1	6	0	2	100	0	0	0	0	21	54	67
	56	31	20	37	25	14	14	5	3	2	2	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1988	1	6	0	2	100	0	0	0	0	4	9	12
	15	21	34	26	20	7	6	3	0	2	2	1
	6	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1989	1	6	0	2	100	0	0	0	0	10	21	51
	60	55	28	34	24	23	10	11	14	10	5	2
	3	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1990	1	6	0	2	100	0	0	0	0	9	27	130
	170	127	84	66	56	34	31	16	7	7	6	3
	1	0	1	1	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1991	1	6	0	2	100	0	0	0	0	5	31	110
	138	113	92	67	39	23	16	19	4	9	5	3
	0	0	1	1	0	0	0	1	1	0	2	0
	0	0	0	0	0							
1992	1	6	0	2	100	0	0	0	0	1	10	50
	94	129	118	86	56	34	30	21	9	9	4	5
	2	5	3	3	2	3	2	1	0	0	0	0
	0	0	0	0	0							
1993	1	6	0	2	100	0	0	0	0	6	31	61
	101	105	106	69	82	48	38	23	26	10	2	2
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
1994	1	6	0	2	100	0	0	0	0	1	12	48
	56	65	66	31	54	37	32	24	11	9	2	3
	6	1	4	0	0	0	1	0	0	0	0	0
	0	0	0	0	0							
1995	1	6	0	2	100	0	0	0	0	8	17	37
	71	87	76	40	41	19	18	13	5	4	3	3
	0	0	0	0	0	0	0	0	0	0	0	0
	0	2	0	0	0							
1996	1	6	0	2	100	0	0	0	0	6	29	101
	184	150	93	80	57	41	25	13	13	4	1	4

	5	10	2	1	3	0	0	0	0	0	0	0
	0	0	0	0	0							
1997	1	6	0	2	100	0	0	0	0	5	36	107
	151	178	144	97	66	52	48	30	22	22	8	10
	13	4	7	10	2	1	4	1	1	0	0	0
	0	0	0	0	0							
1998	1	6	0	2	100	0	0	0	0	10	41	63
	91	93	87	69	54	35	26	37	27	11	5	7
	18	7	6	0	0	0	0	0	0	0	1	1
	0	0	0	0	0							
1999	1	6	0	2	100	0	0	0	0	1	19	123
	184	198	112	50	42	48	31	28	25	21	7	7
	7	6	3	3	5	7	1	1	2	0	0	0
	0	0	0	0	0							
2000	1	6	0	2	100	0	0	0	0	3	36	120
	148	98	74	54	42	24	18	21	20	3	9	11
	7	3	6	2	2	0	2	2	0	0	0	0
	0	0	0	0	0							
2001	1	6	0	2	100	0	0	0	0	2	23	138
	177	143	109	55	47	28	19	17	16	23	25	19
	13	12	9	5	5	11	2	8	4	0	0	0
	0	0	0	0	0							
2002	1	6	0	2	100	0	0	0	0	5	18	99
	164	141	96	67	43	33	30	38	28	35	29	9
	12	6	6	11	10	7	0	0	0	0	0	0
	0	0	0	0	0							
2003	1	6	0	2	100	0	0	0	0	1	19	132
	185	171	81	50	32	35	22	14	11	16	5	9
	10	11	2	2	2	5	8	3	2	1	0	0
	0	0	0	0	0							
2004	1	6	0	2	100	0	0	0	0	7	23	89
	139	110	75	39	16	8	6	24	22	19	22	14
	17	7	14	13	8	12	7	1	1	0	0	0
	0	0	0	0	0							
2005	1	6	0	2	100	0	0	0	0	3	27	97
	172	193	143	89	52	48	33	30	14	12	17	19
	11	12	16	4	11	12	8	3	2	0	0	0
	0	0	0	0	0							
2006	1	6	0	2	100	0	0	0	0	8	60	260
	325	264	209	141	93	82	63	34	26	13	8	6
	12	7	2	5	2	6	6	0	0	0	0	0
	0	2	0	0	0							
2007	1	6	0	2	100	0	0	0	0	4	38	184
	320	333	229	185	117	76	47	29	20	25	11	8
	10	1	1	4	5	1	3	1	0	1	1	0
	0	0	0	0	0							
2008	1	6	0	2	100	0	0	0	0	1	19	75
	129	119	74	85	45	48	23	25	17	10	9	6
	4	3	5	7	0	4	1	3	0	0	0	0
	0	0	0	0	0							
2009	1	6	0	2	100	0	0	0	0	1	7	44
	90	96	52	45	20	23	25	10	20	20	13	17
	1	10	5	9	2	3	7	4	2	0	0	0
	0	0	0	0	0							

```
2010  1     6     0     2     100   0     0     0     0     1     8     70
      113   98    56    41    39    25    16    18    11    14    12    8
      7     5     5     4     2     0     1     1     0     0     0     0
      0     0     0     0     0
2011  1     6     0     2     100   0     0     0     0     1     50    250
      291   214   173   107   67    30    31    22    23    18    10    7
      12    9     8     6     1     2     3     2     3     2     0     0
      0     0     0     0     0
2012  1     6     0     2     100   0     0     0     0     3     53    432
      681   577   400   232   158   87    67    77    48    23    24    10
      12    9     5     2     0     1     3     0     3     1     0     0
      0     0     0     0     0
2013  1     6     0     2     100   0     0     0     0     1     38    259
      514   406   260   175   116   64    49    29    14    14    17    9
      4     4     2     1     2     6     1     3     3     2     0     0
      0     0     0     0     0
#     #Age Composition Here

21    #_Number_of_age_bins

0     1     2     3     4     5     6     7     8     9     10    11    12
      13    14    15    16    17    18    19    20

0 #_N_ageerror_definitions

0 #_Number_of_age_observations

2 #_Lbin_method: 1=poplenbins_index;    2=datalenbins_index;   3=lengths

0 #_combine males into  females     at    or    below this  bin   number

#_Year      season      Fleet Gender      Partition   Age_err_df  L_binLo
      L_Bin_Hi    Nsamp

0 #_N_MeanSize-at-Age_obs
```

```
0 #_N_environ_variables

0 #_N_environ_obs

0 # N sizefreq methods to read

#

0 # no tag data

#

0 # no morphcomp data

#

999
```

```
#V3.24S
#_data_and_control_files: gray_snapper_dat.ss // control_old.ss_new
#_SS-V3.24S-
safe;_07/24/2013;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_10.
1
1  #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond  1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)
#
#_Cond 0  #  N recruitment designs goes here if N_GP*nseas*area>1
#_Cond 0  #  placeholder for recruitment interaction request
#_Cond 1 1 1  # example recruitment design element for GP=1, seas=1,
area=1
#
#_Cond 0 # N_movement_definitions goes here if N_areas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not
integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1,
source=1 dest=2, age1=4, age2=10
#
1 #_Nblock_Patterns
 1 #_blocks_per_pattern
# begin and end years of blocks
 1945 1989
#
0.5 #_fracfemale
3 #_natM_type:_0=1Parm;
1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
 #_Age_natmort_by gender x growthpattern
 0.5047 0.3552 0.2838 0.2423 0.2153 0.1966 0.183 0.1728 0.1649 0.1587
0.1537 0.1497 0.1464 0.1437 0.1415 0.1396 0.1381 0.1368 0.1357 0.1348
0.134 0.134
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2;
3=age_speciific_K; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
1 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4
logSD=F(A)
1 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-
maturity by GP; 4=read age-fecundity by GP; 5=read fec and wt from
wtatage.ss; 6=read length-maturity by GP
#_placeholder for empirical age- or length- maturity by growth pattern
(female only)
2 #_First_Mature_Age
3 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b;
(4)eggs=a+b*L; (5)eggs=a+b*W
0 #_hermaphroditism option:  0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from
female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps
in base parm bounds; 3=standard w/ no bound check)
#
```

```
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr
dev_stddev Block Block_Fxn
 0 40 15.0091 15 -1 1 -3 0 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
 4 70 54.7 54.7 -1 3.6 -3 0 0 0 0 0.5 0 0 # L_at_Amax_Fem_GP_1
 0.01 0.5 0.1546 0.1546 -1 0.1514 -3 0 0 0 0 0.5 0 0 # VonBert_K_Fem_GP_1
 0.05 0.3 0.1514 0.1514 -1 0.2 -6 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1
 0.05 0.3 0.1922 0.1922 -1 0.2 -6 0 0 0 0 0.5 0 0 # CV_old_Fem_GP_1
 1e-005 2 1.43e-005 1.43e-005 -1 0.8 -2 0 0 0 0 0.5 0 0 # Wtlen_1_Fem
 2 4 3.02 3.02 -1 0.8 -2 0 0 0 0 0.5 0 0 # Wtlen_2_Fem
 20 60 29 29 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
 -1 0 -5 -5 -1 0.8 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
 0 60 1 1 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs_scalar_Fem
 0 4 1 1 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs_exp_wt_Fem
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Area_1
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # CohortGrowDev
#
#_Cond 0  #custom_MG-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters
#
#_Cond 0  #custom_MG-block_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters
#_Cond No MG parm trends
#
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0
#_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
#_Cond -4 #_MGparm_Dev_Phase
#
#_Spawner-Recruitment
3 #_SR_function: 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop;
7=survival_3Parm
#_LO HI INIT PRIOR PR_type SD PHASE
 5 35 9.25896 8 -1 99 1 # SR_LN(R0)
 0.8 1 0.99 0.95 -1 2.5 -2 # SR_BH_steep
 0.01 2 0.895405 0.6 -1 99 4 # SR_sigmaR
 -5 5 0 0 -1 50 -4 # SR_envlink
 -5 5 0 0 -1 50 -4 # SR_R1_offset
 0 0.5 0 0 -1 50 -4 # SR_autocorr
0 #_SR_env_link
0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
1 #do_recdev:  0=none; 1=devvector; 2=simple deviations
1970 # first year of main recr_devs; early devs can preceed this era
2015 # last year of main recr_devs; forecast devs start in following year
3 #_recdev phase
1 # (0/1) to read 13 advanced options
 0 #_recdev_early_start (0=none; neg value makes relative to
recdev_start)
 -4 #_recdev_early_phase
```

```
 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to
maxphase+1)
 1 #_lambda for Fcast_recr_like occurring before endyr+1
 1970 #_last_early_yr_nobias_adj_in_MPD
 1981.3 #_first_yr_fullbias_adj_in_MPD
 2015 #_last_yr_fullbias_adj_in_MPD
 2021 #_first_recent_yr_nobias_adj_in_MPD
 0.9255 #_max_bias_adj_in_MPD (-1 to override ramp and set biasadj=1.0
for all estimated recdevs)
 0 #_period of cycles in recruitment (N parms read below)
 -5 #min rec_dev
 5 #max rec_dev
 0 #_read_recdevs
#_end of advanced SR options
#
#_placeholder for full parameter lines for recruitment cycles
# read specified recr devs
#_Yr Input_value
#
# all recruitment deviations
#DisplayOnly -0.172431 # Main_RecrDev_1970
#DisplayOnly -0.168309 # Main_RecrDev_1971
#DisplayOnly -0.169945 # Main_RecrDev_1972
#DisplayOnly -0.191384 # Main_RecrDev_1973
#DisplayOnly -0.243071 # Main_RecrDev_1974
#DisplayOnly -0.319583 # Main_RecrDev_1975
#DisplayOnly -0.374571 # Main_RecrDev_1976
#DisplayOnly -0.304809 # Main_RecrDev_1977
#DisplayOnly 0.204805 # Main_RecrDev_1978
#DisplayOnly -0.547276 # Main_RecrDev_1979
#DisplayOnly -0.561099 # Main_RecrDev_1980
#DisplayOnly 0.838878 # Main_RecrDev_1981
#DisplayOnly 0.1268 # Main_RecrDev_1982
#DisplayOnly -1.27178 # Main_RecrDev_1983
#DisplayOnly 1.20379 # Main_RecrDev_1984
#DisplayOnly -2.62803 # Main_RecrDev_1985
#DisplayOnly -3.667 # Main_RecrDev_1986
#DisplayOnly 0.899675 # Main_RecrDev_1987
#DisplayOnly 0.574987 # Main_RecrDev_1988
#DisplayOnly 0.226732 # Main_RecrDev_1989
#DisplayOnly 0.674435 # Main_RecrDev_1990
#DisplayOnly 0.448836 # Main_RecrDev_1991
#DisplayOnly -0.109237 # Main_RecrDev_1992
#DisplayOnly 0.294059 # Main_RecrDev_1993
#DisplayOnly 0.395962 # Main_RecrDev_1994
#DisplayOnly 0.110393 # Main_RecrDev_1995
#DisplayOnly -0.0129758 # Main_RecrDev_1996
#DisplayOnly 0.227354 # Main_RecrDev_1997
#DisplayOnly -0.865532 # Main_RecrDev_1998
#DisplayOnly 0.417372 # Main_RecrDev_1999
#DisplayOnly -0.0221575 # Main_RecrDev_2000
#DisplayOnly 0.547186 # Main_RecrDev_2001
#DisplayOnly 0.52124 # Main_RecrDev_2002
#DisplayOnly 0.22201 # Main_RecrDev_2003
```

```
#DisplayOnly 0.588844 # Main_RecrDev_2004
#DisplayOnly -0.222777 # Main_RecrDev_2005
#DisplayOnly 0.461264 # Main_RecrDev_2006
#DisplayOnly 0.166289 # Main_RecrDev_2007
#DisplayOnly -0.485176 # Main_RecrDev_2008
#DisplayOnly 0.518288 # Main_RecrDev_2009
#DisplayOnly 0.388155 # Main_RecrDev_2010
#DisplayOnly 0.29678 # Main_RecrDev_2011
#DisplayOnly 0.711889 # Main_RecrDev_2012
#DisplayOnly 0.0141538 # Main_RecrDev_2013
#DisplayOnly 0.917624 # Main_RecrDev_2014
#DisplayOnly 0.339344 # Main_RecrDev_2015
#
#Fishing Mortality info
0.05 # F ballpark for annual F (=Z-M) for specified year
-1963 # F ballpark year (neg value to disable)
2 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
4 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
# if Fmethod=2; read overall start F value; overall phase; N detailed
inputs to read
# if Fmethod=3; read N iterations for tuning for Fmethod 3
 0.1 1 426 # overall start F value; overall phase; N detailed inputs to
read
#Fleet Year Seas F_value se phase (for detailed setup of F_Method=2)
1     1945  1     0.000E+00   0.1   1
1     1946  1     4.922E-05   0.1   1
1     1947  1     2.665E-04   0.1   1
1     1948  1     4.469E-04   0.1   1
1     1949  1     6.414E-04   0.1   1
1     1950  1     8.725E-04   0.1   1
1     1951  1     1.071E-03   0.1   1
1     1952  1     1.290E-03   0.1   1
1     1953  1     1.454E-03   0.1   1
1     1954  1     1.681E-03   0.1   1
1     1955  1     1.920E-03   0.1   1
1     1956  1     2.069E-03   0.1   1
1     1957  1     2.282E-03   0.1   1
1     1958  1     2.444E-03   0.1   1
1     1959  1     2.675E-03   0.1   1
1     1960  1     2.853E-03   0.1   1
1     1961  1     2.919E-03   0.1   1
1     1962  1     2.980E-03   0.1   1
1     1963  1     3.761E-03   0.1   1
1     1964  1     4.387E-03   0.1   1
1     1965  1     6.991E-03   0.1   1
1     1966  1     5.632E-03   0.1   1
1     1967  1     6.512E-03   0.1   1
1     1968  1     8.280E-03   0.1   1
1     1969  1     8.977E-03   0.1   1
1     1970  1     8.399E-03   0.1   1
1     1971  1     9.035E-03   0.1   1
1     1972  1     2.447E-02   0.1   1
1     1973  1     8.810E-03   0.1   1
```

1	1974	1	9.746E-03	0.1	1
1	1975	1	5.868E-03	0.1	1
1	1976	1	1.040E-02	0.1	1
1	1977	1	9.253E-03	0.1	1
1	1978	1	1.075E-02	0.1	1
1	1979	1	1.088E-02	0.1	1
1	1980	1	1.528E-02	0.1	1
1	1981	1	3.043E-02	0.1	1
1	1982	1	4.035E-02	0.1	1
1	1983	1	5.379E-02	0.1	1
1	1984	1	5.145E-02	0.1	1
1	1985	1	4.550E-02	0.1	1
1	1986	1	5.811E-02	0.1	1
1	1987	1	5.518E-02	0.1	1
1	1988	1	5.460E-02	0.1	1
1	1989	1	4.846E-02	0.1	1
1	1990	1	2.524E-02	0.1	1
1	1991	1	1.642E-02	0.1	1
1	1992	1	2.554E-02	0.1	1
1	1993	1	3.260E-02	0.1	1
1	1994	1	2.349E-02	0.1	1
1	1995	1	9.232E-03	0.1	1
1	1996	1	1.324E-02	0.1	1
1	1997	1	7.566E-03	0.1	1
1	1998	1	7.185E-03	0.1	1
1	1999	1	6.625E-03	0.1	1
1	2000	1	6.179E-03	0.1	1
1	2001	1	4.105E-03	0.1	1
1	2002	1	6.288E-03	0.1	1
1	2003	1	5.683E-03	0.1	1
1	2004	1	7.749E-03	0.1	1
1	2005	1	6.943E-03	0.1	1
1	2006	1	5.843E-03	0.1	1
1	2007	1	6.102E-03	0.1	1
1	2008	1	2.482E-03	0.1	1
1	2009	1	3.480E-03	0.1	1
1	2010	1	5.152E-03	0.1	1
1	2011	1	4.956E-03	0.1	1
1	2012	1	4.989E-03	0.1	1
1	2013	1	3.710E-03	0.1	1
1	2014	1	1.269E-03	0.1	1
1	2015	1	1.648E-03	0.1	1
2	1945	1	0.000E+00	0.1	1
2	1946	1	4.834E-05	0.1	1
2	1947	1	3.102E-04	0.1	1
2	1948	1	5.268E-04	0.1	1
2	1949	1	7.583E-04	0.1	1
2	1950	1	1.088E-03	0.1	1
2	1951	1	1.339E-03	0.1	1
2	1952	1	1.550E-03	0.1	1
2	1953	1	1.815E-03	0.1	1
2	1954	1	2.104E-03	0.1	1
2	1955	1	2.408E-03	0.1	1
2	1956	1	2.614E-03	0.1	1

2	1957	1	2.840E-03	0.1	1
2	1958	1	3.076E-03	0.1	1
2	1959	1	3.308E-03	0.1	1
2	1960	1	3.561E-03	0.1	1
2	1961	1	3.641E-03	0.1	1
2	1962	1	3.715E-03	0.1	1
2	1963	1	4.920E-03	0.1	1
2	1964	1	4.949E-03	0.1	1
2	1965	1	9.242E-03	0.1	1
2	1966	1	6.932E-03	0.1	1
2	1967	1	7.864E-03	0.1	1
2	1968	1	1.235E-02	0.1	1
2	1969	1	1.205E-02	0.1	1
2	1970	1	1.131E-02	0.1	1
2	1971	1	1.226E-02	0.1	1
2	1972	1	1.346E-02	0.1	1
2	1973	1	1.931E-02	0.1	1
2	1974	1	2.268E-02	0.1	1
2	1975	1	2.646E-02	0.1	1
2	1976	1	3.811E-02	0.1	1
2	1977	1	3.993E-02	0.1	1
2	1978	1	4.845E-02	0.1	1
2	1979	1	5.662E-02	0.1	1
2	1980	1	6.298E-02	0.1	1
2	1981	1	6.694E-02	0.1	1
2	1982	1	7.184E-02	0.1	1
2	1983	1	6.297E-02	0.1	1
2	1984	1	2.697E-02	0.1	1
2	1985	1	2.242E-02	0.1	1
2	1986	1	2.086E-02	0.1	1
2	1987	1	1.897E-02	0.1	1
2	1988	1	1.495E-02	0.1	1
2	1989	1	2.684E-02	0.1	1
2	1990	1	2.884E-02	0.1	1
2	1991	1	5.384E-02	0.1	1
2	1992	1	3.813E-02	0.1	1
2	1993	1	5.294E-02	0.1	1
2	1994	1	6.965E-02	0.1	1
2	1995	1	4.291E-02	0.1	1
2	1996	1	3.122E-02	0.1	1
2	1997	1	2.962E-02	0.1	1
2	1998	1	2.378E-02	0.1	1
2	1999	1	3.055E-02	0.1	1
2	2000	1	3.119E-02	0.1	1
2	2001	1	3.723E-02	0.1	1
2	2002	1	4.261E-02	0.1	1
2	2003	1	3.800E-02	0.1	1
2	2004	1	4.601E-02	0.1	1
2	2005	1	5.120E-02	0.1	1
2	2006	1	4.113E-02	0.1	1
2	2007	1	2.444E-02	0.1	1
2	2008	1	2.808E-02	0.1	1
2	2009	1	3.750E-02	0.1	1
2	2010	1	1.969E-02	0.1	1

2	2011	1	3.404E-02	0.1	1
2	2012	1	2.910E-02	0.1	1
2	2013	1	2.294E-02	0.1	1
2	2014	1	3.473E-02	0.1	1
2	2015	1	2.437E-02	0.1	1
3	1945	1	0.000E+00	0.1	1
3	1946	1	0.000E+00	0.1	1
3	1947	1	0.000E+00	0.1	1
3	1948	1	0.000E+00	0.1	1
3	1949	1	0.000E+00	0.1	1
3	1950	1	0.000E+00	0.1	1
3	1951	1	0.000E+00	0.1	1
3	1952	1	0.000E+00	0.1	1
3	1953	1	0.000E+00	0.1	1
3	1954	1	0.000E+00	0.1	1
3	1955	1	0.000E+00	0.1	1
3	1956	1	0.000E+00	0.1	1
3	1957	1	0.000E+00	0.1	1
3	1958	1	0.000E+00	0.1	1
3	1959	1	0.000E+00	0.1	1
3	1960	1	0.000E+00	0.1	1
3	1961	1	0.000E+00	0.1	1
3	1962	1	0.000E+00	0.1	1
3	1963	1	0.000E+00	0.1	1
3	1964	1	0.000E+00	0.1	1
3	1965	1	0.000E+00	0.1	1
3	1966	1	0.000E+00	0.1	1
3	1967	1	0.000E+00	0.1	1
3	1968	1	0.000E+00	0.1	1
3	1969	1	0.000E+00	0.1	1
3	1970	1	0.000E+00	0.1	1
3	1971	1	0.000E+00	0.1	1
3	1972	1	0.000E+00	0.1	1
3	1973	1	0.000E+00	0.1	1
3	1974	1	0.000E+00	0.1	1
3	1975	1	0.000E+00	0.1	1
3	1976	1	0.000E+00	0.1	1
3	1977	1	0.000E+00	0.1	1
3	1978	1	0.000E+00	0.1	1
3	1979	1	0.000E+00	0.1	1
3	1980	1	2.118E-03	0.1	1
3	1981	1	2.472E-03	0.1	1
3	1982	1	6.777E-03	0.1	1
3	1983	1	1.423E-02	0.1	1
3	1984	1	9.052E-03	0.1	1
3	1985	1	7.832E-03	0.1	1
3	1986	1	9.721E-03	0.1	1
3	1987	1	1.112E-02	0.1	1
3	1988	1	7.909E-03	0.1	1
3	1989	1	1.331E-02	0.1	1
3	1990	1	9.828E-03	0.1	1
3	1991	1	8.757E-03	0.1	1
3	1992	1	4.367E-03	0.1	1
3	1993	1	7.185E-03	0.1	1

3	1994	1	3.537E-03	0.1	1
3	1995	1	1.881E-03	0.1	1
3	1996	1	1.728E-03	0.1	1
3	1997	1	1.574E-03	0.1	1
3	1998	1	1.139E-03	0.1	1
3	1999	1	2.665E-03	0.1	1
3	2000	1	2.037E-03	0.1	1
3	2001	1	2.555E-03	0.1	1
3	2002	1	3.430E-03	0.1	1
3	2003	1	2.494E-03	0.1	1
3	2004	1	4.292E-03	0.1	1
3	2005	1	4.265E-03	0.1	1
3	2006	1	3.752E-03	0.1	1
3	2007	1	2.850E-03	0.1	1
3	2008	1	3.903E-03	0.1	1
3	2009	1	1.135E-03	0.1	1
3	2010	1	1.117E-03	0.1	1
3	2011	1	2.837E-03	0.1	1
3	2012	1	2.937E-03	0.1	1
3	2013	1	2.413E-03	0.1	1
3	2014	1	4.026E-03	0.1	1
3	2015	1	5.690E-03	0.1	1
4	1945	1	0.000E+00	0.1	1
4	1946	1	5.288E-04	0.1	1
4	1947	1	2.917E-03	0.1	1
4	1948	1	4.800E-03	0.1	1
4	1949	1	6.666E-03	0.1	1
4	1950	1	9.505E-03	0.1	1
4	1951	1	1.155E-02	0.1	1
4	1952	1	1.360E-02	0.1	1
4	1953	1	1.578E-02	0.1	1
4	1954	1	1.804E-02	0.1	1
4	1955	1	2.038E-02	0.1	1
4	1956	1	2.203E-02	0.1	1
4	1957	1	2.372E-02	0.1	1
4	1958	1	2.552E-02	0.1	1
4	1959	1	2.731E-02	0.1	1
4	1960	1	2.915E-02	0.1	1
4	1961	1	2.966E-02	0.1	1
4	1962	1	3.011E-02	0.1	1
4	1963	1	3.060E-02	0.1	1
4	1964	1	3.100E-02	0.1	1
4	1965	1	3.141E-02	0.1	1
4	1966	1	3.250E-02	0.1	1
4	1967	1	3.358E-02	0.1	1
4	1968	1	3.481E-02	0.1	1
4	1969	1	3.601E-02	0.1	1
4	1970	1	3.721E-02	0.1	1
4	1971	1	3.957E-02	0.1	1
4	1972	1	4.327E-02	0.1	1
4	1973	1	4.740E-02	0.1	1
4	1974	1	5.188E-02	0.1	1
4	1975	1	5.735E-02	0.1	1
4	1976	1	6.623E-02	0.1	1

4	1977	1	7.793E-02	0.1	1
4	1978	1	9.194E-02	0.1	1
4	1979	1	9.993E-02	0.1	1
4	1980	1	1.098E-01	0.1	1
4	1981	1	1.331E-01	0.1	1
4	1982	1	8.290E-02	0.1	1
4	1983	1	3.880E-02	0.1	1
4	1984	1	1.932E-01	0.1	1
4	1985	1	1.236E-01	0.1	1
4	1986	1	6.263E-02	0.1	1
4	1987	1	1.284E-01	0.1	1
4	1988	1	1.456E-01	0.1	1
4	1989	1	1.996E-01	0.1	1
4	1990	1	1.778E-01	0.1	1
4	1991	1	2.070E-01	0.1	1
4	1992	1	1.655E-01	0.1	1
4	1993	1	1.902E-01	0.1	1
4	1994	1	1.872E-01	0.1	1
4	1995	1	1.879E-01	0.1	1
4	1996	1	1.460E-01	0.1	1
4	1997	1	1.450E-01	0.1	1
4	1998	1	1.660E-01	0.1	1
4	1999	1	1.436E-01	0.1	1
4	2000	1	1.805E-01	0.1	1
4	2001	1	1.930E-01	0.1	1
4	2002	1	1.708E-01	0.1	1
4	2003	1	2.413E-01	0.1	1
4	2004	1	3.206E-01	0.1	1
4	2005	1	2.154E-01	0.1	1
4	2006	1	1.106E-01	0.1	1
4	2007	1	1.635E-01	0.1	1
4	2008	1	2.525E-01	0.1	1
4	2009	1	2.668E-01	0.1	1
4	2010	1	9.190E-02	0.1	1
4	2011	1	1.037E-01	0.1	1
4	2012	1	1.841E-01	0.1	1
4	2013	1	1.607E-01	0.1	1
4	2014	1	1.786E-01	0.1	1
4	2015	1	1.532E-01	0.1	1
5	1945	1	0.000E+00	0.1	1
5	1946	1	9.223E-04	0.1	1
5	1947	1	5.089E-03	0.1	1
5	1948	1	8.379E-03	0.1	1
5	1949	1	1.172E-02	0.1	1
5	1950	1	1.666E-02	0.1	1
5	1951	1	2.019E-02	0.1	1
5	1952	1	2.378E-02	0.1	1
5	1953	1	2.746E-02	0.1	1
5	1954	1	3.121E-02	0.1	1
5	1955	1	3.506E-02	0.1	1
5	1956	1	3.766E-02	0.1	1
5	1957	1	4.037E-02	0.1	1
5	1958	1	4.302E-02	0.1	1
5	1959	1	4.570E-02	0.1	1

5	1960	1	4.853E-02	0.1	1
5	1961	1	4.901E-02	0.1	1
5	1962	1	4.940E-02	0.1	1
5	1963	1	4.974E-02	0.1	1
5	1964	1	5.005E-02	0.1	1
5	1965	1	5.050E-02	0.1	1
5	1966	1	5.192E-02	0.1	1
5	1967	1	5.335E-02	0.1	1
5	1968	1	5.488E-02	0.1	1
5	1969	1	5.657E-02	0.1	1
5	1970	1	5.813E-02	0.1	1
5	1971	1	6.180E-02	0.1	1
5	1972	1	6.848E-02	0.1	1
5	1973	1	7.582E-02	0.1	1
5	1974	1	8.358E-02	0.1	1
5	1975	1	9.251E-02	0.1	1
5	1976	1	1.074E-01	0.1	1
5	1977	1	1.274E-01	0.1	1
5	1978	1	1.503E-01	0.1	1
5	1979	1	1.565E-01	0.1	1
5	1980	1	1.614E-01	0.1	1
5	1981	1	7.277E-02	0.1	1
5	1982	1	1.469E-01	0.1	1
5	1983	1	1.685E-01	0.1	1
5	1984	1	2.876E-01	0.1	1
5	1985	1	4.930E-02	0.1	1
5	1986	1	1.597E-01	0.1	1
5	1987	1	2.805E-01	0.1	1
5	1988	1	1.749E-01	0.1	1
5	1989	1	1.751E-01	0.1	1
5	1990	1	1.259E-01	0.1	1
5	1991	1	4.650E-01	0.1	1
5	1992	1	1.511E-01	0.1	1
5	1993	1	1.650E-01	0.1	1
5	1994	1	1.278E-01	0.1	1
5	1995	1	9.577E-02	0.1	1
5	1996	1	1.145E-01	0.1	1
5	1997	1	9.135E-02	0.1	1
5	1998	1	9.474E-02	0.1	1
5	1999	1	4.030E-02	0.1	1
5	2000	1	8.316E-02	0.1	1
5	2001	1	1.097E-01	0.1	1
5	2002	1	6.150E-02	0.1	1
5	2003	1	7.050E-02	0.1	1
5	2004	1	8.987E-02	0.1	1
5	2005	1	7.959E-02	0.1	1
5	2006	1	5.434E-02	0.1	1
5	2007	1	7.017E-02	0.1	1
5	2008	1	1.134E-01	0.1	1
5	2009	1	1.104E-01	0.1	1
5	2010	1	4.380E-02	0.1	1
5	2011	1	1.450E-02	0.1	1
5	2012	1	7.760E-02	0.1	1
5	2013	1	3.589E-02	0.1	1

5	2014	1	5.997E-02	0.1	1
5	2015	1	3.773E-02	0.1	1
6	1945	1	0.000E+00	0.1	1
6	1946	1	1.547E-04	0.1	1
6	1947	1	7.759E-04	0.1	1
6	1948	1	1.249E-03	0.1	1
6	1949	1	1.731E-03	0.1	1
6	1950	1	2.464E-03	0.1	1
6	1951	1	2.976E-03	0.1	1
6	1952	1	3.585E-03	0.1	1
6	1953	1	4.130E-03	0.1	1
6	1954	1	4.693E-03	0.1	1
6	1955	1	5.276E-03	0.1	1
6	1956	1	5.703E-03	0.1	1
6	1957	1	6.140E-03	0.1	1
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6	1959	1	7.044E-03	0.1	1
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6	1961	1	7.613E-03	0.1	1
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6	1964	1	7.942E-03	0.1	1
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6	1966	1	8.286E-03	0.1	1
6	1967	1	8.554E-03	0.1	1
6	1968	1	8.841E-03	0.1	1
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6	1970	1	9.433E-03	0.1	1
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6	1973	1	1.210E-02	0.1	1
6	1974	1	1.324E-02	0.1	1
6	1975	1	1.472E-02	0.1	1
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6	1979	1	2.610E-02	0.1	1
6	1980	1	2.709E-02	0.1	1
6	1981	1	8.646E-03	0.1	1
6	1982	1	8.075E-02	0.1	1
6	1983	1	2.558E-02	0.1	1
6	1984	1	1.563E-02	0.1	1
6	1985	1	1.304E-02	0.1	1
6	1986	1	2.162E-02	0.1	1
6	1987	1	2.155E-02	0.1	1
6	1988	1	2.823E-02	0.1	1
6	1989	1	3.260E-02	0.1	1
6	1990	1	2.101E-02	0.1	1
6	1991	1	3.423E-02	0.1	1
6	1992	1	3.372E-02	0.1	1
6	1993	1	3.375E-02	0.1	1
6	1994	1	5.426E-02	0.1	1
6	1995	1	4.915E-02	0.1	1
6	1996	1	2.687E-02	0.1	1

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6     1998  1     4.319E-02   0.1   1
6     1999  1     4.179E-02   0.1   1
6     2000  1     5.022E-02   0.1   1
6     2001  1     5.200E-02   0.1   1
6     2002  1     5.103E-02   0.1   1
6     2003  1     5.986E-02   0.1   1
6     2004  1     5.479E-02   0.1   1
6     2005  1     4.837E-02   0.1   1
6     2006  1     4.554E-02   0.1   1
6     2007  1     5.247E-02   0.1   1
6     2008  1     6.889E-02   0.1   1
6     2009  1     9.528E-02   0.1   1
6     2010  1     4.839E-02   0.1   1
6     2011  1     4.985E-02   0.1   1
6     2012  1     4.312E-02   0.1   1
6     2013  1     5.837E-02   0.1   1
6     2014  1     5.836E-02   0.1   1
6     2015  1     4.893E-02   0.1   1
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#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
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 0 0.5 0 0 -1 99 -1 # InitF_2CHL_nMC_2
 0 0.5 0 0 -1 99 -1 # InitF_3CM_LL_3
 0 0.5 0 0 -1 99 -1 # InitF_4REC_PR_4
 0 0.5 0 0 -1 99 -1 # InitF_5Rec_Shore_5
 0 0.5 0 0 -1 99 -1 # InitF_6Rec_HB_CBT6

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# 0.000446903 F_fleet_1_YR_1948_s_1
# 0.000641359 F_fleet_1_YR_1949_s_1
# 0.000872484 F_fleet_1_YR_1950_s_1
# 0.00107149 F_fleet_1_YR_1951_s_1
# 0.00128964 F_fleet_1_YR_1952_s_1
# 0.00145378 F_fleet_1_YR_1953_s_1
# 0.00168109 F_fleet_1_YR_1954_s_1
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# 0.0918952 F_fleet_4_YR_2010_s_1
# 0.10366 F_fleet_4_YR_2011_s_1
# 0.184117 F_fleet_4_YR_2012_s_1
# 0.160698 F_fleet_4_YR_2013_s_1
# 0.178566 F_fleet_4_YR_2014_s_1
# 0.15323 F_fleet_4_YR_2015_s_1
# 0 F_fleet_5_YR_1945_s_1
# 0.000922341 F_fleet_5_YR_1946_s_1
# 0.00508905 F_fleet_5_YR_1947_s_1
# 0.00837861 F_fleet_5_YR_1948_s_1
# 0.0117248 F_fleet_5_YR_1949_s_1
# 0.0166624 F_fleet_5_YR_1950_s_1
# 0.0201858 F_fleet_5_YR_1951_s_1
# 0.0237829 F_fleet_5_YR_1952_s_1
# 0.0274569 F_fleet_5_YR_1953_s_1
# 0.0312135 F_fleet_5_YR_1954_s_1
```

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# 0.0350591 F_fleet_5_YR_1955_s_1
# 0.0376571 F_fleet_5_YR_1956_s_1
# 0.0403746 F_fleet_5_YR_1957_s_1
# 0.0430194 F_fleet_5_YR_1958_s_1
# 0.0457 F_fleet_5_YR_1959_s_1
# 0.0485279 F_fleet_5_YR_1960_s_1
# 0.049012 F_fleet_5_YR_1961_s_1
# 0.0493982 F_fleet_5_YR_1962_s_1
# 0.0497387 F_fleet_5_YR_1963_s_1
# 0.0500488 F_fleet_5_YR_1964_s_1
# 0.050501 F_fleet_5_YR_1965_s_1
# 0.0519168 F_fleet_5_YR_1966_s_1
# 0.0533469 F_fleet_5_YR_1967_s_1
# 0.0548815 F_fleet_5_YR_1968_s_1
# 0.056573 F_fleet_5_YR_1969_s_1
# 0.0581287 F_fleet_5_YR_1970_s_1
# 0.0617956 F_fleet_5_YR_1971_s_1
# 0.0684792 F_fleet_5_YR_1972_s_1
# 0.0758157 F_fleet_5_YR_1973_s_1
# 0.0835818 F_fleet_5_YR_1974_s_1
# 0.0925143 F_fleet_5_YR_1975_s_1
# 0.107383 F_fleet_5_YR_1976_s_1
# 0.12742 F_fleet_5_YR_1977_s_1
# 0.150269 F_fleet_5_YR_1978_s_1
# 0.156492 F_fleet_5_YR_1979_s_1
# 0.161426 F_fleet_5_YR_1980_s_1
# 0.0727717 F_fleet_5_YR_1981_s_1
# 0.146926 F_fleet_5_YR_1982_s_1
# 0.168538 F_fleet_5_YR_1983_s_1
# 0.287584 F_fleet_5_YR_1984_s_1
# 0.0492988 F_fleet_5_YR_1985_s_1
# 0.15965 F_fleet_5_YR_1986_s_1
# 0.28051 F_fleet_5_YR_1987_s_1
# 0.174876 F_fleet_5_YR_1988_s_1
# 0.175062 F_fleet_5_YR_1989_s_1
# 0.125916 F_fleet_5_YR_1990_s_1
# 0.464963 F_fleet_5_YR_1991_s_1
# 0.151124 F_fleet_5_YR_1992_s_1
# 0.164965 F_fleet_5_YR_1993_s_1
# 0.127777 F_fleet_5_YR_1994_s_1
# 0.0957666 F_fleet_5_YR_1995_s_1
# 0.114477 F_fleet_5_YR_1996_s_1
# 0.0913468 F_fleet_5_YR_1997_s_1
# 0.0947386 F_fleet_5_YR_1998_s_1
# 0.0402969 F_fleet_5_YR_1999_s_1
# 0.0831625 F_fleet_5_YR_2000_s_1
# 0.109741 F_fleet_5_YR_2001_s_1
# 0.0614953 F_fleet_5_YR_2002_s_1
# 0.0704981 F_fleet_5_YR_2003_s_1
# 0.0898716 F_fleet_5_YR_2004_s_1
# 0.0795943 F_fleet_5_YR_2005_s_1
# 0.0543398 F_fleet_5_YR_2006_s_1
# 0.0701691 F_fleet_5_YR_2007_s_1
# 0.113366 F_fleet_5_YR_2008_s_1
```

0.1104 F_fleet_5_YR_2009_s_1
0.0438043 F_fleet_5_YR_2010_s_1
0.0145014 F_fleet_5_YR_2011_s_1
0.0776025 F_fleet_5_YR_2012_s_1
0.0358948 F_fleet_5_YR_2013_s_1
0.0599703 F_fleet_5_YR_2014_s_1
0.0377305 F_fleet_5_YR_2015_s_1
0 F_fleet_6_YR_1945_s_1
0.00015471 F_fleet_6_YR_1946_s_1
0.000775852 F_fleet_6_YR_1947_s_1
0.00124886 F_fleet_6_YR_1948_s_1
0.00173077 F_fleet_6_YR_1949_s_1
0.00246373 F_fleet_6_YR_1950_s_1
0.00297623 F_fleet_6_YR_1951_s_1
0.00358521 F_fleet_6_YR_1952_s_1
0.00413023 F_fleet_6_YR_1953_s_1
0.00469335 F_fleet_6_YR_1954_s_1
0.00527622 F_fleet_6_YR_1955_s_1
0.00570344 F_fleet_6_YR_1956_s_1
0.00613971 F_fleet_6_YR_1957_s_1
0.00658621 F_fleet_6_YR_1958_s_1
0.00704369 F_fleet_6_YR_1959_s_1
0.00751293 F_fleet_6_YR_1960_s_1
0.00761326 F_fleet_6_YR_1961_s_1
0.00779254 F_fleet_6_YR_1962_s_1
0.00787059 F_fleet_6_YR_1963_s_1
0.00794213 F_fleet_6_YR_1964_s_1
0.00801774 F_fleet_6_YR_1965_s_1
0.00828567 F_fleet_6_YR_1966_s_1
0.00855402 F_fleet_6_YR_1967_s_1
0.00884063 F_fleet_6_YR_1968_s_1
0.00913845 F_fleet_6_YR_1969_s_1
0.00943318 F_fleet_6_YR_1970_s_1
0.0100649 F_fleet_6_YR_1971_s_1
0.0110248 F_fleet_6_YR_1972_s_1
0.0121047 F_fleet_6_YR_1973_s_1
0.0132423 F_fleet_6_YR_1974_s_1
0.014718 F_fleet_6_YR_1975_s_1
0.0169671 F_fleet_6_YR_1976_s_1
0.0199745 F_fleet_6_YR_1977_s_1
0.0236284 F_fleet_6_YR_1978_s_1
0.0260999 F_fleet_6_YR_1979_s_1
0.0270902 F_fleet_6_YR_1980_s_1
0.00864634 F_fleet_6_YR_1981_s_1
0.080754 F_fleet_6_YR_1982_s_1
0.0255802 F_fleet_6_YR_1983_s_1
0.0156348 F_fleet_6_YR_1984_s_1
0.013041 F_fleet_6_YR_1985_s_1
0.0216214 F_fleet_6_YR_1986_s_1
0.0215488 F_fleet_6_YR_1987_s_1
0.0282279 F_fleet_6_YR_1988_s_1
0.0326031 F_fleet_6_YR_1989_s_1
0.0210063 F_fleet_6_YR_1990_s_1
0.0342327 F_fleet_6_YR_1991_s_1

```
# 0.0337224 F_fleet_6_YR_1992_s_1
# 0.0337526 F_fleet_6_YR_1993_s_1
# 0.0542631 F_fleet_6_YR_1994_s_1
# 0.0491473 F_fleet_6_YR_1995_s_1
# 0.0268749 F_fleet_6_YR_1996_s_1
# 0.0234894 F_fleet_6_YR_1997_s_1
# 0.0431872 F_fleet_6_YR_1998_s_1
# 0.0417871 F_fleet_6_YR_1999_s_1
# 0.050215 F_fleet_6_YR_2000_s_1
# 0.052002 F_fleet_6_YR_2001_s_1
# 0.0510337 F_fleet_6_YR_2002_s_1
# 0.0598616 F_fleet_6_YR_2003_s_1
# 0.0547897 F_fleet_6_YR_2004_s_1
# 0.0483659 F_fleet_6_YR_2005_s_1
# 0.0455378 F_fleet_6_YR_2006_s_1
# 0.0524671 F_fleet_6_YR_2007_s_1
# 0.0688864 F_fleet_6_YR_2008_s_1
# 0.095283 F_fleet_6_YR_2009_s_1
# 0.0483884 F_fleet_6_YR_2010_s_1
# 0.0498548 F_fleet_6_YR_2011_s_1
# 0.0431191 F_fleet_6_YR_2012_s_1
# 0.0583655 F_fleet_6_YR_2013_s_1
# 0.0583624 F_fleet_6_YR_2014_s_1
# 0.048933 F_fleet_6_YR_2015_s_1
#
#_Q_setup
 # Q_type options:  <0=mirror, 0=float_nobiasadj, 1=float_biasadj,
2=parm_nobiasadj, 3=parm_w_random_dev, 4=parm_w_randwalk,
5=mean_unbiased_float_assign_to_parm
#_for_env-var:_enter_index_of_the_env-var_to_be_linked
#_Den-dep  env-var  extra_se  Q_type
 0 0 0 0 # 1 CHL_MC_1
 0 0 0 0 # 2 CHL_nMC_2
 0 0 0 0 # 3 CM_LL_3
 0 0 0 0 # 4 REC_PR_4
 0 0 0 0 # 5 Rec_Shore_5
 0 0 0 0 # 6 Rec_HB_CBT6
 0 0 0 0 # 7 RCHL_7
 0 0 0 0 # 8 MRFSS_Private_8
 0 0 0 0 # 9 MRFSS_Shore_9
 0 0 0 0 # 10 FWRI_Age0_10
 0 0 0 0 # 11 FWRI_Age1_11
 0 0 0 0 # 12 SEAMAP_Trawl_12
 0 0 0 0 # 13 NMFS_FWRI_Video_13
 0 0 0 0 # 14 Visual_Survey_14
#
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet
with random q; 1=read a parm for each year of index
#_Q_parms(if_any);Qunits_are_ln(q)
#
#_size_selex_types
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=al
l_discarded_dead
#_Pattern Discard Male Special
```

```
 24 2 0 0 # 1 CHL_MC_1
 24 2 0 0 # 2 CHL_nMC_2
 24 0 0 0 # 3 CM_LL_3
 24 2 0 0 # 4 REC_PR_4
 24 2 0 0 # 5 Rec_Shore_5
 24 2 0 0 # 6 Rec_HB_CBT6
 0 0 0 2 # 7 RCHL_7
 0 0 0 4 # 8 MRFSS_Private_8
 0 0 0 5 # 9 MRFSS_Shore_9
 33 0 0 0 # 10 FWRI_Age0_10
 0 0 0 5 # 11 FWRI_Age1_11
 33 0 0 0 # 12 SEAMAP_Trawl_12
 0 0 0 4 # 13 NMFS_FWRI_Video_13
 0 0 0 4 # 14 Visual_Survey_14
#
#_age_selex_types
#_Pattern ___ Male Special
 0 0 0 0 # 1 CHL_MC_1
 0 0 0 0 # 2 CHL_nMC_2
 0 0 0 0 # 3 CM_LL_3
 0 0 0 0 # 4 REC_PR_4
 0 0 0 0 # 5 Rec_Shore_5
 0 0 0 0 # 6 Rec_HB_CBT6
 0 0 0 0 # 7 RCHL_7
 0 0 0 0 # 8 MRFSS_Private_8
 0 0 0 0 # 9 MRFSS_Shore_9
 0 0 0 0 # 10 FWRI_Age0_10
 0 0 0 0 # 11 FWRI_Age1_11
 0 0 0 0 # 12 SEAMAP_Trawl_12
 0 0 0 0 # 13 NMFS_FWRI_Video_13
 0 0 0 0 # 14 Visual_Survey_14
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr
dev_stddev Block Block_Fxn
 13 60 31.6912 30 -1 99 2 0 0 0 0 0 0 0 # SizeSel_1P_1_CHL_MC_1
 -15 0 -11.469 -5 -1 99 3 0 0 0 0 0 0 0 # SizeSel_1P_2_CHL_MC_1
 -25 10 3.54736 3.33 -1 99 3 0 0 0 0 0 0 0 # SizeSel_1P_3_CHL_MC_1
 0 15 4.7605 4.7 -1 99 3 0 0 0 0 0 0 0 # SizeSel_1P_4_CHL_MC_1
 -15 10 -11.8346 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_1P_5_CHL_MC_1
 -15 5 -1.45108 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_1P_6_CHL_MC_1
 13 79 28.8 28.8 -1 1 -3 0 0 0 0 0 1 2 # Retain_1P_1_CHL_MC_1
 -1 30 1 1 -1 1 -3 0 0 0 0 0 1 2 # Retain_1P_2_CHL_MC_1
 -1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # Retain_1P_3_CHL_MC_1
 -1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # Retain_1P_4_CHL_MC_1
 -10 10 -5 -5 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_1P_1_CHL_MC_1
 -1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_1P_2_CHL_MC_1
 0 2 0.14 0.14 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_1P_3_CHL_MC_1
 -1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_1P_4_CHL_MC_1
 13 73 50.4161 40 -1 99 2 0 0 0 0 0 1 2 # SizeSel_2P_1_CHL_nMC_2
 -15 15 1.85948 -0.8 -1 99 -3 0 0 0 0 0 1 2 # SizeSel_2P_2_CHL_nMC_2
 -25 20 4.89067 3.33 -1 99 3 0 0 0 0 0 1 2 # SizeSel_2P_3_CHL_nMC_2
 -20 15 -1.95604 5.2 -1 99 -3 0 0 0 0 0 1 2 # SizeSel_2P_4_CHL_nMC_2
 -15 15 -3.75866 -999 -1 99 2 0 0 0 0 0 1 2 # SizeSel_2P_5_CHL_nMC_2
 -15 15 -5.82361 -999 -1 99 2 0 0 0 0 0 1 2 # SizeSel_2P_6_CHL_nMC_2
 13 79 28.8 28.8 -1 1 -3 0 0 0 0 0 1 2 # Retain_2P_1_CHL_nMC_2
```

```
-1 30 1 1 -1 1 -3 0 0 0 0 0 1 2 # Retain_2P_2_CHL_nMC_2
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # Retain_2P_3_CHL_nMC_2
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # Retain_2P_4_CHL_nMC_2
-10 10 -5 -5 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_2P_1_CHL_nMC_2
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_2P_2_CHL_nMC_2
0 2 0.14 0.14 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_2P_3_CHL_nMC_2
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_2P_4_CHL_nMC_2
13 73 49.6912 40 -1 99 2 0 0 0 0 0 0 0 # SizeSel_3P_1_CM_LL_3
-10 50 -5 -5 -1 99 -3 0 0 0 0 0 0 0 # SizeSel_3P_2_CM_LL_3
-15 20 4.28714 3 -1 99 2 0 0 0 0 0 0 0 # SizeSel_3P_3_CM_LL_3
-20 20 5 5 -1 99 -3 0 0 0 0 0 0 0 # SizeSel_3P_4_CM_LL_3
-25 15 -15 -15 -1 99 -2 0 0 0 0 0 0 0 # SizeSel_3P_5_CM_LL_3
-15 15 5 5 -1 99 -3 0 0 0 0 0 0 0 # SizeSel_3P_6_CM_LL_3
13 73 17.7934 30 -1 99 2 0 0 0 0 0 0 0 # SizeSel_4P_1_REC_PR_4
-15 25 -1.47919 -0.8 -1 99 3 0 0 0 0 0 0 0 # SizeSel_4P_2_REC_PR_4
-25 20 -1.46781 3.33 -1 99 3 0 0 0 0 0 0 0 # SizeSel_4P_3_REC_PR_4
-20 15 -2.92888 5.2 -1 99 -3 0 0 0 0 0 0 0 # SizeSel_4P_4_REC_PR_4
-15 15 -12.7841 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_4P_5_REC_PR_4
-15 15 0.955168 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_4P_6_REC_PR_4
13 79 24.1 24.1 -1 1 -3 0 0 0 0 0 1 2 # Retain_4P_1_REC_PR_4
-1 30 1 1 -1 1 -3 0 0 0 0 0 1 2 # Retain_4P_2_REC_PR_4
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # Retain_4P_3_REC_PR_4
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # Retain_4P_4_REC_PR_4
-10 10 -5 -5 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_4P_1_REC_PR_4
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_4P_2_REC_PR_4
0 2 0.069 0.069 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_4P_3_REC_PR_4
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_4P_4_REC_PR_4
13 73 19.2328 30 -1 99 2 0 0 0 0 0 0 0 # SizeSel_5P_1_Rec_Shore_5
-15 15 -1.98723 -0.8 -1 99 3 0 0 0 0 0 0 0 # SizeSel_5P_2_Rec_Shore_5
-15 20 -2.53854 3.33 -1 99 -3 0 0 0 0 0 0 0 # SizeSel_5P_3_Rec_Shore_5
-20 15 3.84143 3.9 -1 99 3 0 0 0 0 0 0 0 # SizeSel_5P_4_Rec_Shore_5
-25 15 -17.8501 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_5P_5_Rec_Shore_5
-15 15 -3.41191 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_5P_6_Rec_Shore_5
13 79 24.1 24.1 -1 1 -3 0 0 0 0 0 1 2 # Retain_5P_1_Rec_Shore_5
-1 30 1 1 -1 1 -3 0 0 0 0 0 1 2 # Retain_5P_2_Rec_Shore_5
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # Retain_5P_3_Rec_Shore_5
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # Retain_5P_4_Rec_Shore_5
10 10 -5 -5 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_5P_1_Rec_Shore_5
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_5P_2_Rec_Shore_5
0 2 0.069 0.069 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_5P_3_Rec_Shore_5
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_5P_4_Rec_Shore_5
13 73 22.9126 30 -1 99 2 0 0 0 0 0 0 0 # SizeSel_6P_1_Rec_HB_CBT6
-15 15 -11.5949 -0.8 -1 99 3 0 0 0 0 0 0 0 # SizeSel_6P_2_Rec_HB_CBT6
-15 30 1.8744 3.3 -1 99 3 0 0 0 0 0 0 0 # SizeSel_6P_3_Rec_HB_CBT6
-20 15 3.87555 5.2 -1 99 3 0 0 0 0 0 0 0 # SizeSel_6P_4_Rec_HB_CBT6
-25 15 -16.0937 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_6P_5_Rec_HB_CBT6
-15 15 -0.459781 -999 -1 99 2 0 0 0 0 0 0 0 # SizeSel_6P_6_Rec_HB_CBT6
13 79 24.1 24.1 -1 1 -3 0 0 0 0 0 1 2 # Retain_6P_1_Rec_HB_CBT6
-1 30 1 1 -1 1 -3 0 0 0 0 0 1 2 # Retain_6P_2_Rec_HB_CBT6
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # Retain_6P_3_Rec_HB_CBT6
-1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # Retain_6P_4_Rec_HB_CBT6
-10 10 -5 -5 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_6P_1_Rec_HB_CBT6
-1 2 1 1 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_6P_2_Rec_HB_CBT6
0 2 0.069 0.069 -1 1 -2 0 0 0 0 0 0 0 # DiscMort_6P_3_Rec_HB_CBT6
```

```
 -1 2 0 0 -1 1 -4 0 0 0 0 0 0 0 # DiscMort_6P_4_Rec_HB_CBT6
#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns
1 #_custom_sel-blk_setup (0/1)
 16 80 22 22 -1 1 -5 # Retain_1P_1_CHL_MC_1_BLK1repl_1945
 0.0001 5 1 1 -1 1 -5 # Retain_1P_2_CHL_MC_1_BLK1repl_1945
 1 80 32.1228 40 -1 99 2 # SizeSel_2P_1_CHL_nMC_2_BLK1repl_1945
 -15 15 -0.930492 -0.8 -1 99 3 # SizeSel_2P_2_CHL_nMC_2_BLK1repl_1945
 -25 20 2.98312 3.33 -1 99 3 # SizeSel_2P_3_CHL_nMC_2_BLK1repl_1945
 -20 15 0.181271 5.2 -1 99 3 # SizeSel_2P_4_CHL_nMC_2_BLK1repl_1945
 -15 15 -9.70855 -999 -1 99 2 # SizeSel_2P_5_CHL_nMC_2_BLK1repl_1945
 -15 15 -3.64968 -999 -1 99 2 # SizeSel_2P_6_CHL_nMC_2_BLK1repl_1945
 16 80 26 26 -1 1 -5 # Retain_2P_1_CHL_nMC_2_BLK1repl_1945
 0.0001 5 1 1 -1 1 -5 # Retain_2P_2_CHL_nMC_2_BLK1repl_1945
 16 80 20 20 -1 1 -5 # Retain_4P_1_REC_PR_4_BLK1repl_1945
 0.0001 5 1 1 -1 1 -5 # Retain_4P_2_REC_PR_4_BLK1repl_1945
 16 80 20 20 -1 1 -5 # Retain_5P_1_Rec_Shore_5_BLK1repl_1945
 0.0001 5 1 1 -1 1 -6 # Retain_5P_2_Rec_Shore_5_BLK1repl_1945
 16 80 20 20 -1 1 -5 # Retain_6P_1_Rec_HB_CBT6_BLK1repl_1945
 0.0001 5 1 1 -1 1 -6 # Retain_6P_2_Rec_HB_CBT6_BLK1repl_1945
#_Cond No selex parm trends
#_Cond -4 # placeholder for selparm_Dev_Phase
3 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in
base parm bounds; 3=standard w/ no bound check)
#
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters
#
0 #_Variance_adjustments_to_input_values
#_fleet: 1 2 3 4 5 6 7 8 9 10 11 12 13 14
#_Cond  0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_survey_CV
#_Cond  0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_discard_stddev
#_Cond  0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_bodywt_CV
#_Cond  1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_lencomp_N
#_Cond  1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_agecomp_N
#_Cond  1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_size-at-age_N
#
1 #_maxlambdaphase
1 #_sd_offset
#
6 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq;
7=sizeage; 8=catch; 9=init_equ_catch;
# 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp;
15=Tag-comp; 16=Tag-negbin; 17=F_ballpark
#like_comp fleet/survey  phase  value  sizefreq_method
 4 1 1 0.1738 4
 4 2 1 0.1584 4
 4 3 1 0.2058 4
 4 4 1 0.3012 4
 4 5 1 0.1439 4
 4 6 1 0.1763 4
#
```

```
# lambdas (for info only; columns are phases)
#  1 #_CPUE/survey:_1
#  0 #_CPUE/survey:_2
#  0 #_CPUE/survey:_3
#  1 #_CPUE/survey:_4
#  1 #_CPUE/survey:_5
#  0 #_CPUE/survey:_6
#  0 #_CPUE/survey:_7
#  0 #_CPUE/survey:_8
#  0 #_CPUE/survey:_9
#  1 #_CPUE/survey:_10
#  1 #_CPUE/survey:_11
#  1 #_CPUE/survey:_12
#  1 #_CPUE/survey:_13
#  1 #_CPUE/survey:_14
#  1 #_discard:_1
#  1 #_discard:_2
#  0 #_discard:_3
#  1 #_discard:_4
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#  0 #_discard:_13
#  0 #_discard:_14
#  0.1738 #_lencomp:_1
#  0.1584 #_lencomp:_2
#  0.2058 #_lencomp:_3
#  0.3012 #_lencomp:_4
#  0.1439 #_lencomp:_5
#  0.1763 #_lencomp:_6
#  0 #_lencomp:_7
#  0 #_lencomp:_8
#  0 #_lencomp:_9
#  0 #_lencomp:_10
#  0 #_lencomp:_11
#  0 #_lencomp:_12
#  0 #_lencomp:_13
#  0 #_lencomp:_14
#  1 #_init_equ_catch
#  1 #_recruitments
#  1 #_parameter-priors
#  1 #_parameter-dev-vectors
#  1 #_crashPenLambda
#  0 # F_ballpark_lambda
0 # (0/1) read specs for more stddev reporting
 # 0 1 -1 5 1 5 1 -1 5 # placeholder for selex type, len/age, year, N
selex bins, Growth pattern, N growth ages, NatAge_area(-1 for all),
NatAge_yr, N Natages
 # placeholder for vector of selex bins to be reported
```

```
 # placeholder for vector of growth ages to be reported
 # placeholder for vector of NatAges ages to be reported
999
```

#Control file for S51 gray snapper

#Stock Synthesis Version 3.24j

gray_snapper_dat.ss

gray_snapper_ctl.ss

0 # 0=use init values in control file; 1=use ss3.par

1 # run display detail (0,1,2)

1 # detailed age-structured reports in REPORT.SSO (0,1)

1 # write detailed checkup.sso file (0,1)

1 # write pam values to ParmTrace.sso

2 # report level in CUMREPORT.SSO (0,1,2)

1 # Include prior_like for non-estimated parameters (0,1)

1 # Use Soft Boundaries to aid convergence

1 # Number of bootstrap datafiles to produce

7 # Turn off estimation for parameters entering after this phase

1000 # MCMC burn interval

100 # MCMC thin interval

0 # jitter initial parm value by this fraction

-1 # min yr for sdreport outputs (-1 for styr)

-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs

0 # N individual STD years

0.0001 # final convergence criteria

0 # retrospective year relative to end year

2 # min age for calc of summary biomass

1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr

1 # Fraction (X) for Depletion denominator

1 # (1-SPR)_reporting: 0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-SPR_Btarget); 4=notrel

2 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)

```
0     #     F_report_basis:  0=raw;      1=rel Fspr; 2=rel Fmsy  ;
      3=rel Fbtgt
999
```

SEDAR

Southeast Data, Assessment, and Review

SEDAR 51

Gulf of Mexico Gray Snapper

SECTION IV: Research Recommendations

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

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1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS

Stock Definition and Description

- Expand upon the genetics work of Gold et al. (2009; SEDAR51-RD-04). Gray snapper fishery-dependent sampling can be sporadic and site-specific samples are needed. SEAMAP samples may be able to help fill this void.
- Identify natal origin of adult gray snapper by using otolith chemical signatures from juveniles. Since these signatures can vary annually, samples from an ongoing sampling program would be required. Florida fishery independent monitoring program may be able to provide this for the eastern gulf.

Natural Mortality

- LHW group recommends using the maximum age of 28 years to calculate natural mortality by applying Hoenig's regression for teleosts (M = 0.15) as the target M used to calculate an age-specific vector of M.

- The LHW group recommends applying the age-specific mortality vector using Lorenzen (2005).
- Therefore, the LHW group recommended using a wider range of sensitivity around M (lower bound = 0.13; upper bound = 0.17).
- Review of Then et al. 2015 data inputs, possibly restrict dataset to take into consideration fishes of similar maximum size, age, and latitude/longitude to improve the estimation of natural mortality.
- Expand fishery-independent sampling

Age and Growth

- Continue annual ageing workshops with GSMFC.
- Update the gray snapper reference set to include a greater range of ages, sampling locations and section quality.
- Expand sampling of otoliths from the central and western Gulf of Mexico.
- Increase resolution of jurisdictional waters within sampling programs, specifically for the head boat program.
- Expand fishery dependent sampling.
- The LHW group recommends all gray snapper data in the Gulf of Mexico, regardless of gender, to be combined and used in SEDAR51 assessment models.
- The LHW group recommends using the predicted growth parameters from the growth model using a CV that increases linearly with age variance structure from the size limit C scenario.
- The LHW group also recommends allowing the stock assessment analyst to decide whether to predict growth within the assessment model, using the recommended growth parameters as priors, or to use the growth parameters in the assessment model as fixed parameters.

Reproduction

- Due to the lack of fecundity information the female weight-length relationship should be used to calculate spawning stock biomass. Additionally, the 300mm FL mark should be used as the size at maturity parameter because of the marked contribution to the spawning stock beyond that point.

- More at sea sampling is necessary to obtain more freshly-fixed ovaries to be used for spawning frequency and fecundity analysis.
- More ovarian samples need to be obtained from the western Gulf of Mexico, as that region is poorly represented in life history information.
- Workshops are pivotal to establish consistency in reproductive histological determination throughout the Gulf of Mexico.
- Locate and characterize spawning habitat and spawning aggregations.

Steepness

- Based on the limited information available, the LHW group recommends a range of steepness from 0.81 to 0.99 based on the results and range considered in the mutton snapper assessment. The LHW group agreed that mutton snapper would be the more similar species to gray snapper as opposed to red snapper based on habitat (e.g., occurrence on reefs (Ault et al. 2006; Bryan et al. 2013)) and fishery characteristics.

Habitat Requirements

- Good information is available for juveniles in estuarine habitat, but data on ontogenetic shifts and habitat connectivity are needed between mangrove and seagrass habitats within estuaries to nearshore hard bottom and offshore spawning aggregations. Detailed classification of nearshore habitat is needed, possibly using video data (Low visibility for video work in nearshore habitats where gray snapper are located).
- Increase surveys in western Gulf of Mexico (Louisiana and Texas have ongoing sampling programs catching juvenile gray snapper, but information on adults lacking).
- Investigate more effective methods to capture adult gray snapper throughout the Gulf of Mexico. Develop alternative strategies for fishery-independent sampling (small hooks, night fishing, and video work).
- Expand seagrass mapping to track seagrass habitat changes over time. Along the coast of northern Gulf of Mexico observations of seagrass loss are being made in association with

increasing water turbidity, whereas Tampa Bay has made significant progress in recovering seagrass habitat.

- Mangrove habitats are increasing all along the Gulf of Mexico coast, so tracking this expansion of mangrove habitat in Texas (black mangrove) and Florida (red mangrove) would be useful considering gray snapper's association with mangroves.

Movements and Migrations

- More tagging information including acoustic tagging, is needed to clarify temporal and spatial patterns of gray snapper movement, specifically movement to spawning aggregations. While there is some evidence gray snapper migrate to spawn, more information is needed to confirm these patterns.

Episodic Events

- More research should be done on the effects of episodic events on all life stages of gray snapper.
- Review available unpublished records on fish kills.
- Collections of fish during episodic events would allow for the size/age selectivity of mortality to be determined, and might also allow for some minimum estimates of total mortality.

1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and Monroe County, FL, to document discard length and mortality.
- Increase biological sampling efforts to better define stock boundaries.
- Automate volunteer and required fisher data reporting to reduce reporting complexity and time commitment for fishermen. Automation will improve both data quality and quantity.

1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

1. Future MRIP calibration consideration – provide cell-level adjusted time-series of catch estimates (state, wave, mode, area-fished by species).

2. Explore landings and length composition by area to investigate possible species stock expansion.
3. Determine adequacy of regional sampling design given changing species distributions and developing fisheries (ex: spearfishing, targeted hook & line methods). Continue to monitor regions and gears where gray snapper observations are increasing. Adequately sample inshore fishing in LA.

1.4 MEASURES OF POPULATION ABUNDANCE RESEARCH RECOMMENDATIONS

During the review and evaluation of the various datasets and indices presented during the Data Workshop, the Indices Working Group identified the following research recommendations to further improve the abundance indices:

- Further exploration of various weighting alternatives for the combined video index from NMFS Mississippi Labs, NMFS Panama City, and FWC video datasets – especially in terms of ongoing and future survey expansion (new areas, overlapping areas, new habitats such as artificial reefs)
- Continued bottom mapping and identification of new reef to estimate Q
- Move to a unified, habitat-based sampling design, including the MS, PC, and FWC into a single sampling program
- Explore combining data from FWRI long-term and polyhaline seagrass surveys
- Explore temporal stability of Stevens-MacCall, and how to address when species relationships change through time

2. ASSESSMENT WORKSHOP RESEARCH RECOMMENDATIONS

1. Additional analyses are needed to determine biologically plausible Fmsy and MSY proxies.

2. Evaluate existing methods for deriving discard rates evaluate technical improvements to estimation methods as appropriate.

3. Develop/evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations.

4. Identify factors resulting in the release of fish in excess of size limits and improve estimates of asymptotic retention.

5. Conduct additional research on fleet-specific discard mortality rates.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

The Review Workshop Panelists considered the research recommendations provided by both the Data and Assessment workshops and provide additional recommendations.

<u>Data and Modeling Recommendations</u>

- Continue to investigate the age and length discrepancies identified during the assessment process. This could be due to a problem in the data itself or model-misspecification (e.g. stock ID issues or regional variation in population dynamics).
- Information on release morality rates over a broader range of depth

<u>Longer-term Recommendations</u>

- Improve biological sampling of catch, particularly discard information (length composition, discard rates)
- Need for data, particularly the recreational data, to be provided at a finer spatial scale
- Simulation modeling to determine direct economic value to the fishery for improvements in data sources or modeling efforts
- Habitat suitability and distribution modeling
- Improve communications and research collaborations between various groups within the SEFSC to improve data and assessment products

<u>Recommendations on possible ways to improve the SEDAR process</u>

- Provide the Review Panel with a description of the SEDAR Process (assessment) and the Council Process (management after the assessment is complete).
  - A short presentation/synthesis on the basic biology of the species being assessed and a description of the fishery should be provided to the Review Panel. Standard infographics could be developed for this purpose and over time, provide for all stocks/fisheries.

- It might be helpful to have one member of the SSC participate in all three stages of the assessment process (Data, Assessment and Review workshops); this would help in resolving questions about decisions that were made prior to the review workshop.
- Several members of the panel felt that embedding figures into the text of the assessment report (rather than appending them) would make it easier to follow the report.
- Agree in advance a suite of tools for model validation
- Implement parallel processing so that more scenarios can be run

SEDAR
Southeast Data, Assessment, and Review

SEDAR 51

Gulf of Mexico Gray Snapper

SECTION IV: Review Workshop Report

April 2018

SEDAR
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1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 51 Review Workshop was held March 20-22, 2018 in Tampa, Florida.

1.2 TERMS OF REFERENCE

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:
   a) Are data decisions made by the DW and AW sound and robust?
   b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c) Are data applied properly within the assessment model?
   d) Are input data series reliable and sufficient to support the assessment approach and findings?
2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings and consider the following:
   a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

b) Is the stock overfished? What information helps you reach this conclusion?

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:

   a) Are the methods consistent with accepted practices and available data?

   b) Are the methods appropriate for the assessment model and outputs?

   c) Are the results informative and robust, and useful to support inferences of probable future conditions?

   d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

   - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments
   - Provide recommendations on possible ways to improve the SEDAR process

7. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.

8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.

9. Prepare a Peer Review Summary summarizing the Panel’s evaluation of the stock assessment and addressing each Term of Reference.

1.3 LIST OF PARTICIPANTS

Workshop Panel

Dr. Kai Lorenzen, Chair .... Chair, GMFMC SSC (Univ. of FL)
Dr. Luiz Barbieri .... GMFMC SSC (FWRI)
Dr. Yong Chen .... CIE Reviewer (Univ. of Maine)
Bob Gill .... GMFMC SSC
Dr. Laurence Kell.. CIE Reviewer (Henstead, UK)
Peter Stephenson .... CIE Reviewer (Perth, AUS)

Analytic Representation
Dr. Jeff Isely (Lead)..SEFSC, Miami
Dr. Shannon Cass-Calay ....SEFSC, Miami

Appointed Observers
Ed Walker..Industry Representative

Observers
Beth Wrege...SEFSC, Miami

Staff
Dr. Julie Neer ....SEDAR
Steven Atran ....GMFMC
Doug Gregory..GMFMC
Karen Hoak ....GMFMC
Ryan Rindone..GMFMC
Charlotte Schiaffo ....GMFMC

1.4 LIST OF REVIEW WORKSHOP WORKING PAPERS AND DOCUMENTS

Documents Prepared for the Review Workshop			
SEDAR51-RW-01	Commercial Landings of Gray or Mangrove Snapper (*Lutjanus griseus*) from the Gulf of Mexico	Refik Orhun and Beth Wrege	5 March 2018

2 REVIEW PANEL REPORT

2.1 Executive Summary

Following sound analyses and recommendations from the Data Workshop, the assessment used commercial and recreational landings and discard data, multiple fisheries-dependent and independent indices of abundance, and size composition data, with most data series starting in 1981. The only indices that covered the early period (1980-1995), i.e. two recreational indices, showed a strong residual pattern in the 1980s. Age composition data were not used in the assessment due to problems with the construction of age-length keys that could not be resolved in time for the assessment.

An integrated statistical catch-at-age model implemented in Stock Synthesis 3 (v. 3.24S) was used in the assessment and performed well overall with reasonable fits to the fishery dependent and fishery independent indices of abundance, and to catch size composition data. Indices showed little systematic variation over the assessment period, except for an increasing trend in the most recent years, which was captured by the model fits. Given such relatively uninformative indices of abundance, the assessment was strongly informed by size composition data.

The model consistently underestimated discard fractions in most fleets. Furthermore there was an inherent conflict between discard rates and size composition data such that to support the magnitude of reported discards would require fish above the size limit to be discarded frequently. This was considered unlikely by stakeholders involved in the assessment process. This, together with sensitivity runs that showed limited sensitivity of assessment results to alternative data weighting, satisfied the panel that the assessment was consistent across the scenarios evaluated despite issues with fits to discard data.

Despite these concerns, the Review Panel concluded that the data used in the assessment were generally sound and robust. Likewise, data generally were applied properly and uncertainty in data inputs was appropriately acknowledged. Numerous sensitivity analyses and exploration of alternative scenarios were presented and discussed during the Review Workshop all of which broadly agreed with the base model run conclusions of stock status.

For benchmarks and reference point calculations, SPR30% was selected as an MSY-proxy, and used to calculate stock status. The minimum stock size threshold (MSST) is defined as 50% of SSB_SPR 30. The maximum fishing mortality threshold (MFMT) is defined (the generic rule in the GMFMC FMP) as F30%SPR. Based on these definitions, stock is currently not overfished (SSB2015/SSB_SPR30 = 0.703), but is undergoing overfishing (Fcurrent/FSPR30 = 1.20) and has been undergoing overfishing for several decades. While a history of overfishing (fishing above F30%SPR) has reduced stock biomass to 70.3% of SSB_SPR30, that level is above the 50% SSB_SPR30 defined as the MSST.

In conclusion, the review workshop panelists found the assessment to be a rigorous analysis of current stock condition and concluded that projections for future yields were based on acceptable practices. The Review Panel commends the assessment team for their performance throughout the assessment and review process.

2.2 Terms of Reference Addressed

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions

A. Are data decisions made by the Data and Assessment Workshops sound and robust?

Overall, the Review Panel concludes that the decisions made by the Data and Assessment Workshops are sound and robust. The Data and Assessment Workshops made a number of important decisions around key parameters such as the natural mortality and discard mortality rates, length at maturity, for extrapolating catch data series back in time, and selection and construction of indices of abundance. Methods of analysis were appropriate and the decisions made by the Data and Assessment Workshops are well documented and justified.

B. Are data uncertainties acknowledged, reported, and within normal or expected levels?

The Panel considers that data uncertainties have been explored and reported adequately. Confidence limits were provided for all datasets and appear to be appropriate. The uncertainties associated with the data quality and quantity have been acknowledged. Uncertainties in most data series were within normal levels, but some data were problematic.

Discard data were limited to small observer samples in some of the commercial fleets and self-reported data for the recreational fleets. Self-reported discards were 'corrected' for estimated underreporting based on comparison of observer and self-reported data where both are available, but the validity of this correction is difficult to ascertain. Discard data also lacked size composition information (which ~~is~~ are available for s~~c~~ome other species). Overall, the discard data were judged by the panel to be highly uncertain and possibly biased.

Age composition data were not used due to poor fits when the ALK was included in the assessment and more time was required to conduct further analysis to identify if this was due to a problem in the data itself or model-misspecification on these data. It was not possible for the analytical team to resolve these issues in time for the assessment and therefore, only length composition data were used in the assessment (in conjunction with a growth model estimated from age-length data.

C. Are data applied properly within the assessment model?

The Panel concluded that the data have been properly applied within the assessment model, based on the workshop reports and presentations at the Review Meeting. The Panel explored additional data implementation options with the analytical team during the Workshop. Some panel members further explored the model's behavior independently and were able to reproduce the results, examine sensitivities, and conduct analyses both before and after the meeting.

Only one historical catch scenario was constructed for the period before actual catch data were available. Possible sensitivity runs with high and low historical catch scenarios were discussed but not constructed since, based on results from other assessments, such alternatives were expected to have little impact on model results. This was discussed by the Review Panel and found to be satisfactory.

D. Are input data series reliable and sufficient to support the assessment approach and findings?

The Panel concludes that, despite some issues discussed below, the input data series are generally reliable and are sufficient to support the assessment approach and findings. Both fishery-dependent and -independent data were available. The Data and Assessment teams are commended for their work in compiling and evaluating the wide range of data and parameters used in the assessment. The data are reliable in the sense that deficiencies and uncertainties in the data have been explored in detail and that assumptions and decisions made in compiling input parameters and data have been clearly presented and their effect on the assessment shown through sensitivity analyses.

Overall the least reliable component of the data concerned the magnitude and size composition of discards. Since discarding is believed to occur at a substantial magnitude in this fishery and to be associated with non-negligible mortality, it is important to represent these processes in the assessment model. Unfortunately, discard data were considered to be very uncertain, being based on self-reporting or observer programs of very limited coverage. Moreover, no length composition data were available for discards. Discard mortality information was also very limited. In the assessment, the model consistently underestimated discard fractions in most fleets. Furthermore there was an inherent conflict between discard rates and size composition data such that to support the magnitude of reported discards would require fish above the size limit to be discarded frequently. This was considered unlikely by stakeholders involved in the assessment process. This, together with sensitivity runs that showed limited sensitivity of assessment results to alternative data weighting, satisfied the panel that the assessment was consistent across the sensitivity runs despite issues with fits to discard data.

Use of age-length data to construct the age-length keys produced some spurious results that could not be fully explored or resolved in time for the assessment. The analytical team and Assessment Panel therefore decided not to construct or use catch age composition series but to rely on length composition data. Age-length data were used to estimate a von Bertalanffy growth model that was then used to predict length distributions from the age-structured model. The Panel discussed the issues with age-length data that precluded construction of age-length keys but was satisfied that the same issues would not substantially affect the growth model estimation.

Reasonable fits to the data and the ability of Stock Synthesis to find a stable solution indicate that the data are sufficient to support the assessment approach.

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data

A. Are methods scientifically sound and robust?

An integrated statistical catch-at-age model implemented in Stock Synthesis 3 (v. 3.24S) was used in the assessment. Stock Synthesis is an integrated assessment model that can accommodate a variety of model configurations and data inputs (Method and Wetzel 2013). The system and the specific assessment model set up used for the gray snapper assessment are scientifically sound and robust. The assessment team is experienced in the use of Stock Synthesis and was able to consult with its developer (Dr. Rick Methot) when needed. Stock

Synthesis is a sound and robust choice, which can be configured to be appropriate for the available data.

B. Are assessment models configured properly and consistent with standard practices?

The Panel concluded that the assessment model was configured properly and consistent with standard practices. It was configured in a manner so it was easy to explore the data, test hypotheses and apply appropriate diagnostics. The model was able to be run by others and reproduce the results, examine sensitivities, and conduct analysis.

C. Are the methods appropriate for the available data?

Overall the Panel felt that the assessment methods were appropriate to the available data. Given the high uncertainty in discard data and lack of discard size compositions, the panel discussed whether a model of lower complexity should have been explored as an alternative. However, due to discards likely being an important driving force in this fishery, a model incorporating a detailed representation of discarding and discard mortality was deemed necessary (even given the data limitations). Stock Synthesis could have been configure to explore alternative hypotheses, e.g. as an Age Specific Production Model (ASPM) to explore alternative assumptions about the stock dynamics and the information in the data (see Carvalho et al. 2017).

3. Evaluate the assessment findings

A. Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

The assessment model performed well overall with reasonable fits to the fishery dependent and fishery independent indices of abundance, and to catch size composition data. Indices showed little systematic variation over the assessment period, except for an increasing trend in the most recent years, which was captured by the model fits. Given such relatively uninformative indices of abundance, the assessment was strongly informed by size composition data. As discussed previously, the model consistently underestimated discard fractions in most fleets and demonstrated inherent conflict between discard rates and size composition data. Nonetheless, stakeholder input and sensitivity analyses satisfied the panel that the assessment was robust despite issues with fits to discard data.

Numerous sensitivity analyses and exploration of alternative scenarios were presented and discussed during the Review Workshop all of which broadly agreed with the base model run conclusions of stock status. Trends in abundance, exploitation, and stock biomass were robust to the various configurations the Panel examined. Absolute abundance varied slightly among the plausible scenarios but the status conclusions of the base case were robust to those changes.

B. Is the stock overfished?

For benchmarks and reference point calculations, SPR30% was selected as an MSY-proxy, and used to determine stock status. The minimum stock size threshold (MSST) is defined as 50% of

SSB_SPR 30. Based on this definitions, the stock is currently not overfished (SSB2015/SSB_SPR30 = 0.703).

C. Is the stock undergoing overfishing?

The maximum fishing mortality threshold (MFMT) is defined (the generic rule in the GMFMC FMP) as F30%SPR. Based on these definitions, the stock is currently undergoing overfishing (Fcurrent/FSPR30 = 1.20) and has been undergoing overfishing for most years since 1976. This history of overfishing (fishing above F30%SPR) has reduced stock biomass to 70.3% of SSB_SPR30 (see B above). However, since the MSST is set at 50% SSB_SPR30, the stock remains above the MSST and its status therefore determined as not overfished.

D. Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

Neither SSB nor recruitment showed major, systematic variation over the period for which most data series were available (since 1981). Moreover, no cohorts were consistently identifiable from size composition data. Estimated recruitment deviations closely followed the FWRI age 0 index since 1998 (start of index) and likely reflect variation in fishery catches of small fish prior to the introduction of a minimum length limit in 1990. Since no cohorts were evident in length composition data for larger/older fish, it is unclear whether the estimated recruitment deviations are biologically meaningful. Recruitment deviations showed an increasing trend in the most recent years and this may be related to climatic warming and range expansion of gray snapper and their preferred juvenile habitat (mangroves).

No relationship was evident between the estimates of SSB and recruitment. Consequently, SPR 30% was recommended for use as an MSY proxy and projections were obtained under the assumption of constant recruitment at the level of the most recent years.

E. Are the quantitative estimates of the status determination criteria for this stock reliable?

The quantitative estimates of biomass are reliable; they were robust to various sensitivity scenarios. The panel noted that, since the overfished and overfishing status determination criteria do not correspond to equivalent SSB and F reference points, it is possible for the stock to undergo overfishing for an extended period of time (or in perpetuity) without being declared overfished.

4. Evaluate the stock projections, including discussing strengths and weaknesses

A. Are the methods consistent with accepted practices and available data?

Projections were run to provide catch advice consistent with the aim of avoiding overfishing. Since the Spawner-Recruit relationship could not be determined, the panel supported the use of an FMSY-proxy set at FSPR30, the value specified in the GMFMC generic amendment. Projections assumed that recruitment would continue at the recent (1990-2015) average, at least in the short term, therefore steepness was fixed at 1.0. The selectivity and retention parameters were retained at the average of the three most recent years (2013-2015). Since the stock is not currently overfished, and no recovery plan is required, the panel agreed it would be rational to develop a projection of FSPR30 for the consideration of managers.

B. Are the methods appropriate for the assessment model and outputs?

The panel felt the methods for projections were appropriate. Projections were obtained by using the Stock Synthesis forecast module, which provides the capability to conduct a projection for multiple years that is directly linked to the model's ending conditions, associated uncertainty, and to a specified level of fishing intensity. The forecast module was used to calculate the OFL based on catching the OFL each year, and represents the absolute maximum upper limit to catches. These approaches are widely adopted in other assessments.

C. Are the results informative and robust, and useful to support inferences of probable future conditions?

The panel found the projections to be informative, and robust. Projections assumed constant recruitment at levels consistent with the average in recent years and no change in fishing patterns (i.e. selectivity and retention). These assumptions were considered reasonable by the panel given that no major changes had been observed in the recent past.

D. Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Key uncertainties based on the assessment are reflected in the projection results, since SS3 as an integrated assessment model propagates these forward.

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

The panel considered that the methods used to evaluate uncertainty reflected and captured the significant sources of uncertainty in the population, data sources, and assessment methods. Uncertainty about all model parameters are summarized by the estimated (Hessian based) standard deviations. Likelihood profiles were plotted for certain parameters of the stock-recruitment relationship. Sensitivity runs, retrospective analyses and various diagnostics were reviewed. . However, there was no time to run sufficient bootstrap or to conduct Monte Carlo

Markov Chain simulations to identify potential bias. Furthermore it is important to agree an objective way to validate assessment scenarios, this is an active research area and so it is not reasonable yet to expect this.

Certain parameters were fixed in the model (e.g. natural mortality, discard mortality). This is often necessary in highly parameterized models, and is within standard practices. Sensitivity runs were carried out for most of the fixed parameters. A consequence of fixing parameters is that the true uncertainties in estimated model parameters, reference points and projections may be underestimated.

The growth curve was estimated externally to the integrated assessment model, using an appropriate method to account for minimum size restrictions and exploring alternative assumptions about the relationship between CV and age.

Spatial or temporal variation in growth and other life history parameters was not explored. This is in line with current SEDAR practices. However, the panel noted that such analyses are increasingly carried out elsewhere and should be considered for future assessments.

All abundance indices were scaled to an overall average CV of 0.2, but inter-annual variability for each index was retained within the model. This was considered appropriate.

Data conflicts involving abundance indices and length composition data were explored with sensitivities containing fishery independent and dependent indices.

As already described in more detail above, certain data inputs were identified as particularly uncertain, in particular: discard rates, discard length composition (unknown), and discard mortality rate. Furthermore, age-length keys contained unusual features (such as bi-modal distributions for some years) and produced spurious results in initial model configurations, therefore age composition data series were not constructed or used in the assessment. It may be possible to include such data in future assessments.

A wide array of sensitivity runs were presented in the assessment report and additional runs were requested by the reviewers. However, no fundamentally different model configurations were explored, despite problems with fits to the age-length key and discard data and therefore, structural model uncertainty has not been extensively explored. This includes possible spatial model configurations. This is a slight weakness but not inconsistent with common practice.

The implications of uncertainty are clearly shown in all relevant graphs and tables. Stock status determination was robust.

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

The Review Workshop Panelists considered the research recommendations provided by both the Data and Assessment workshops and provide additional recommendations.

<u>Data and Modeling Recommendations</u>

- Continue to investigate the age and length discrepancies identified during the assessment process. This could be due to a problem in the data itself or model-misspecification (e.g. stock ID issues or regional variation in population dynamics).
- Information on release morality rates over a broader range of depth

Longer-term Recommendations

- Improve biological sampling of catch, particularly discard information (length composition, discard rates)
- Need for data, particularly the recreational data, to be provided at a finer spatial scale
- Simulation modeling to determine direct economic value to the fishery for improvements in data sources or modeling efforts
- Habitat suitability and distribution modeling
- Improve communications and research collaborations between various groups within the SEFSC to improve data and assessment products

Recommendations on possible ways to improve the SEDAR process

- Provide the Review Panel with a description of the SEDAR Process (assessment) and the Council Process (management after the assessment is complete).
  - A short presentation/synthesis on the basic biology of the species being assessed and a description of the fishery should be provided to the Review Panel. Standard infographics could be developed for this purpose and over time, provide for all stocks/fisheries.
- It might be helpful to have one member of the SSC participate in all three stages of the assessment process (Data, Assessment and Review workshops); this would help in resolving questions about decisions that were made prior to the review workshop.
- Several members of the panel felt that embedding figures into the text of the assessment report (rather than appending them) would make it easier to follow the report.
- Agree in advance a suite of tools for model validation
- Implement parallel processing so that more scenarios can be run

7. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity,

transparency, timeliness, verification, validation, and peer review of fishery management information.

The Review Panel concludes that the SEDAR 51 Gulf of Mexico gray snapper assessment constituted the best scientific information available on the status of this stock. The assessment is relevant to management, having determined reference points and stock status and provided catch projections. The assessment is inclusive, objective and transparent, having followed a rigorous approach of data sourcing, screening and analysis that has been well documented in the Data and Assessment workshop reports. The assessment is timely, given that no rigorous quantitative assessment has previously been conducted of this stock and that the assessment indicates that the stock has been undergoing sustainable overfishing. The assessment results have been verified and peer reviewed through the Data, Assessment and Review Workshops.

8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.

Three key suggestions are provided:

- Improvements to discard data (length composition and magnitude)
- Information on release morality rates over a broader range of depth
- Issues with age-length keys need to be resolved

9. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

This report satisfies this Term of Reference.

2.3 References

Carvalho, F., Punt, A.E., Chang, Y.-J., Maunder, M.N. and Piner, K.R.. 2017. Can diagnostic tests help identify model misspecification in integrated stock assessments? Fisheries Research 192, 28–44.

Methot, R.D. and Wetzel C.R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management, Fisheries Research 142: 86-99.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 51

Gulf of Mexico Gray Snapper

SECTION VI: Post-Review Workshop Addendum Report

April 2018

SEDAR
4055 Faber Place Drive, Suite 201
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1. Introduction

The SEDAR51 Gray Snapper Assessment Review Workshop (RW) took place March 20-22, 2018, in Tampa, Florida at the Gulf of Mexico Fishery Management Council offices. During the RW, the SEDAR51 Review Panel requested additional analyses from the analytical team and alternative graphical representations of model output, sensitivities and performance metrics.

2. Summary of Analyses Requested by the Review Panel (Homework)

2.1. Evaluate the model with the effects of length and indices of abundance weighted at 0 to attempt a better fit to the discards.

Rationale: Model negative log likelihoods are dominated by the lack of fit to the discards. The Review Panel was interested in determining if discards could be fit if other model factors were removed from the likelihood estimation.

2.2. Add a retrospective analysis of F and Recruitment.

Rationale: Results of the analysis on Recruitment and F may show retrospective patterns that are different than on SSB.

2.3. Produce a Kobe plot of SSB and F.

2.4. Rationale: A Kobe Plot illustrated stock status both in terms of stock size (overfished) and exploitation (overfishing) simultaneously. The confidence intervals on the estimated terminal year stock status are an important model diagnostic (i.e. stock status is more certain if the confidence intervals are contained in a single quadrant of the Kobe plot). Add a plot of the "jitter" analysis.

Rationale: A jitter analysis illustrates model stability.

2.5. Add a plot of Spawning Stock Biomass (SSB) with confidence intervals.

Rationale: Confidence intervals will provide a visual representation of model fits.

2.6. Compare model recruitment estimates to the predicted values of the FWRI_Age-0 recruitment index.

Rationale: This plot was examined to explore the importance on the index on model estimates of recruitment.

2.7. Provide Projections

Rationale: Short term projections (3-5 years) are required to inform managers.

The panel determined projections should be specified as follows:

Since the Spawner-Recruit relationship could not be determined, the panel supported the use of an FMSY-proxy set at FSPR30, the value specified in the GMFMC generic amendment. Projections assumed that recruitment would continue at the recent (1990-2015) average, at least in the short term, therefore steepness was fixed at 1.0. The selectivity and retention parameters were retained at the average of the three most recent years (2013-2015). Since the stock is not currently overfished, and no recovery plan is required, the panel agreed it would be rational to develop a projection of FSPR30 for the consideration of managers.

2.8. Provide a retrospective analysis relative to SSB_{virgin} for the Gulf of Mexico Gray Snapper stock assessment.
Rationale: Relative analysis may provide additional insights into the relationship.

2.9. Provide a sensitivity analyses of the base model without recreational indices or length effects relative to virgin Spawning Stock Biomass compared to the base model for the Gulf of Mexico Gray Snapper stock assessment.
Rationale: By eliminating the effects of recreational data, the model may provide a better fit to discards.

2.10. Provide sensitivities for the Gulf of Mexico Gray Snapper stock assessment comparing alternative data weighting (McAlister and Ionelli 1997) to the base model model.
Rationale: Alternative data weighting may provide a better fit to discards.

3. Results

3.1. Evaluate the model with the effects of length and indices weighted at 0 to attempt a better fit to the discards.

Down-weighting of the length and index data did not substantially improve the fits to discards (**Figure 1**). It also had the effect of reducing the stock size substantially (**Figure 2**). The Review Panel agreed that given data limitations, little can be done to improve fits to discards. The analytical team also noted that the magnitude of discards was very poorly known, and their size composition was not observed and therefore, required estimation using assumed retention patterns. Although the discards could have been fit more closely by freeing additional retention parameters, upweighting the importance of discards in the model and downweighting other better known model components, the panel generally agreed that this was not a desirable approach given the lack of available data.

3.2. Add a retrospective analysis of F and Recruitment.

Retrospective figures were added and discussed (**Figures 3-4**). The retrospective pattern in F suggests an increasing trend as one goes back in time. This is not unexpected as a recent increase in many cpue indices suggests a recent decrease in F, which is diminished as one moves back in time. The retrospective pattern in recruitment shows very little effect of retrospective year. However, it does illustrate the volatility in recruitment through time.

3.3. Produce a Kobe plot of SSB and F.

The terminal year of a Kobe Plot illustrates the Spawning Potential Ratio and exploitation ratio with 95% confidence limits for the Gulf of Mexico Gray Snapper stock assessment (**Figure 5**). Based on SPR30, the stock appears to be overfished and undergoing overfishing. However, current management measures are based on MSST, which is 50% of SPR30, so when the plot is redrawn using MSST (**Figure 6**), the stock is undergoing overfishing but is not overfished.

3.4. Add a plot of the "jitter" analysis.

A figure depicting the results of a Jitter analysis (**Figure 7**) was left out of the final report. The Jitter analysis indicated the model had bound parameters in a few cases, but generally converged to similar values.

3.5. Add a plot of Spawning Stock Biomass with confidence intervals.

Confidence intervals on Spawning Stock Biomass illustrated the model had a relatively low error around the mean, particularly in recent years (**Figure 8**)

3.6. Compare recruitment estimates to FWRI Age-0 index.

The model fit to the FWRI Age-0 index is shown in **Figure 9a**. The predicted FWRI-Age 0 index values are compared to model estimates of recruitment in **9b**. The model estimates of recruitment are very similar to the predicted values of the FWRI Age-0 index.

3.7. Projections

Projections were made through 2023 using two values of constant F, F_{SPR30} and F_{OY} (75% of F_{SPR30}). The projection specifications were further described in section 2.7. Currently, catch estimates for 2016 and 2017 are not available. To improve the management advice derived from projections, the panel strongly recommended that 2016-17 catch estimates be applied to the projections prior to their use for management, if feasible.

Projection of F_{SPR30}:

Projected values of SSB, depletion (SSB/SSB_0) and SSB/MSST are summarized in **Table 1** and **Figure 13**. During the terminal year (2015), the stock biomass was at 21% of unfished spawning potential, and about 141% of MSST, where MSST = 50% of SSB_{SPR30}. When projected at constant F_{SPR30}, the stock slowly recovered toward SSB_{SPR30}. Note that since the stock is not considered overfished, no recovery plan is required.

Projected values of F and F/MFMT are summarized in **Table 2** and **Figure 14**. During the terminal year (2015), the exploitation rate (F) was about 17% above MFMT (F_{SPR30}), suggesting that the stock was undergoing overfishing. When projected at constant F_{SPR30}, overfishing was eliminated throughout the projection interval.

Projected values of R and R/R0 are summarized in **Table 3** and **Figure 15**. During the short-term projection, it was assumed recent (1990-2015) values of recruitment would continue. Therefore, during the projection interval the average recruitment was nearly constant, with large confidence intervals due to the large estimated value of sigma-R. The panel expressed some concern that the value of sigma-R (0.897) could be unrealistically high, as suggested by the confidence intervals which include negative values.

The projected retained yield in metric tons and Overfishing Limit (OFL; yield at F_{SPR30}) in millions of pounds are summarized in **Table 4** and **Figure 16**. During the projection interval, the estimated OFL slowly increases from 2.2 to 2.4 million pounds, which is similar to recent landings.

Acceptable Biological Catch (ABC) was not calculated because the Gulf SSC has not determined the appropriate buffer. Once the buffer is determined, the values can be easily computed using the inverse hessian matrix.

Projection of F_{OY}:

The panel also recommended the development of an alternative projection, F_{OY}. In the past, the SSC has sometimes elected to use the F_{OY} projection to develop estimates of acceptable biological catch (ABC), particularly when projections are thought to underestimate the true scientific uncertainty. For this projection, a constant F equal to 75%F_{SPR30} was applied.

The results of this projection are summarized in **Tables 5-8** and **Figures 17-20**. The results are similar to the F_{SPR30} projection, but in this case a lower F was applied, so the stock recovers more rapidly, and to a higher biomass level (**Table 5, Figure 17**), and a lower yield is produced (**Table 8, Figure 20**).

3.8. Provide a retrospective analysis relative to SSB_{virgin} for the Gulf of Mexico Gray Snapper stock assessment.
A retrospective analysis relative to SSB_{virgin} illustrated the model was relatively stable. No significant retrospective pattern was observed (**Figure 10**).

3.9. Provide a sensitivity analyses of the base model without recreational indices or length effects relative to virgin Spawning Stock Biomass compared to the base model for the Gulf of Mexico Gray Snapper stock assessment.
Although recreational data dominate the assessment, little difference in model results was observed when recreational data were down-weighted in the model (**Figure 11**)

3.10. Provide a sensitivity for the Gulf of Mexico Gray Snapper stock assessment comparing alternative data weighting (McAlister and Ianelli 1997) to the base model.
Alternative data weighting did not appreciably change the model results (**Figure 12**)

References

McAllister, MK, and JN Ionelli. 1997. Bayesian stock assessment using catch-age data and the sampling-importance resampling algorithm. Canadian Journal of Fisheries and Aquatic Sciences, 1997, 54(2): 284-300.

Table 1. Project $F_{SPR\ 30}$: Projected spawning stock biomass (mt), lower and upper 80% confidence intervals, depletion (SSB/S0) and SSB/MSST ratio.

YEAR	LCI	SSB	UCI	SSB/S0	SSB/MSST
2018	4989	5837	6685	0.26	1.76
2019	5205	6125	7044	0.28	1.85
2020	4963	6297	7631	0.28	1.90
2021	4564	6409	8254	0.29	1.94
2022	4170	6484	8798	0.29	1.96
2023	3813	6534	9256	0.29	1.97

Table 2. Project $F_{SPR\ 30}$: Projected fishing mortality (exploitation), lower and upper 80% confidence intervals and F/MFMT, where MFMT = FSPR30.

YEAR	LCI	F	UCI	F/MFMT
2018	0.09	0.12	0.14	1.01
2019	0.09	0.12	0.15	1.01
2020	0.08	0.12	0.15	1.00
2021	0.08	0.12	0.15	1.00
2022	0.07	0.11	0.16	1.00
2023	0.07	0.11	0.16	1.00

Table 3. Project $F_{SPR\ 30}$: Projected recruitment (Age 0), lower and upper 80% confidence intervals and R/R0.

YEAR	LCI	Recruits	UCI	R/R0
2018	-1634	10608	22850	0.99
2019	-1635	10613	22860	0.99
2020	-1635	10615	22866	0.99
2021	-1635	10617	22869	0.99
2022	-1636	10618	22872	0.99
2023	-1636	10619	22873	0.99

Table 4. Project $F_{SPR\ 30}$: Projected retained yield (mt), lower and upper 80% confidence intervals (mt), and OFL millions of lbs.

YEAR	LCI	Retained Yield (mt)	UCI	OFL
2018	930	1033	1135	2.277
2019	951	1046	1142	2.307
2020	967	1059	1150	2.334
2021	978	1068	1159	2.355
2022	985	1076	1167	2.372
2023	988	1081	1174	2.383

Table 5. Project F_{OY}: Projected spawning stock biomass (mt), lower and upper 80% confidence intervals, depletion (SSB/S0) and SSB/MSST ratio.

YEAR	LCI	SSB	UCI	SSB/S0	SSB/MSST
2018	5348	6243	7137	0.28	1.89
2019	5774	6748	7723	0.30	2.04
2020	5740	7120	8499	0.32	2.15
2021	5508	7406	9304	0.33	2.24
2022	5248	7632	10016	0.34	2.31
2023	4999	7811	10622	0.35	2.36

Table 6. Project F_{OY}: Projected fishing mortality (exploitation), lower and upper 80% confidence intervals and F/MFMT, where MFMT = FSPR30.

YEAR	LCI	F	UCI	F/MFMT
2018	0.07	0.09	0.11	0.77
2019	0.07	0.09	0.11	0.77
2020	0.06	0.09	0.11	0.77
2021	0.06	0.09	0.12	0.76
2022	0.06	0.09	0.12	0.76
2023	0.06	0.09	0.12	0.76

Table 7. Project F_{OY}: Projected recruitment (Age 0), lower and upper 80% confidence intervals and R/R0.

YEAR	LCI	Recruits	UCI	R/R0
2018	-1635	10615	22864	0.99
2019	-1636	10622	22879	0.99
2020	-1637	10626	22889	0.99
2021	-1637	10629	22896	0.99
2022	-1638	10632	22901	1.00
2023	-1638	10634	22905	1.00

Table 8. Project F_{OY}: Projected retained yield (mt), lower and upper 80% confidence intervals (mt), and yield at F_{OY} in millions of lbs.

YEAR	LCI	Retained Yield (mt)	UCI	Yield @ F_{OY}
2018	751	834	916	1.838
2019	786	864	943	1.905
2020	815	891	968	1.965
2021	838	914	990	2.016
2022	856	933	1010	2.057
2023	870	948	1027	2.091

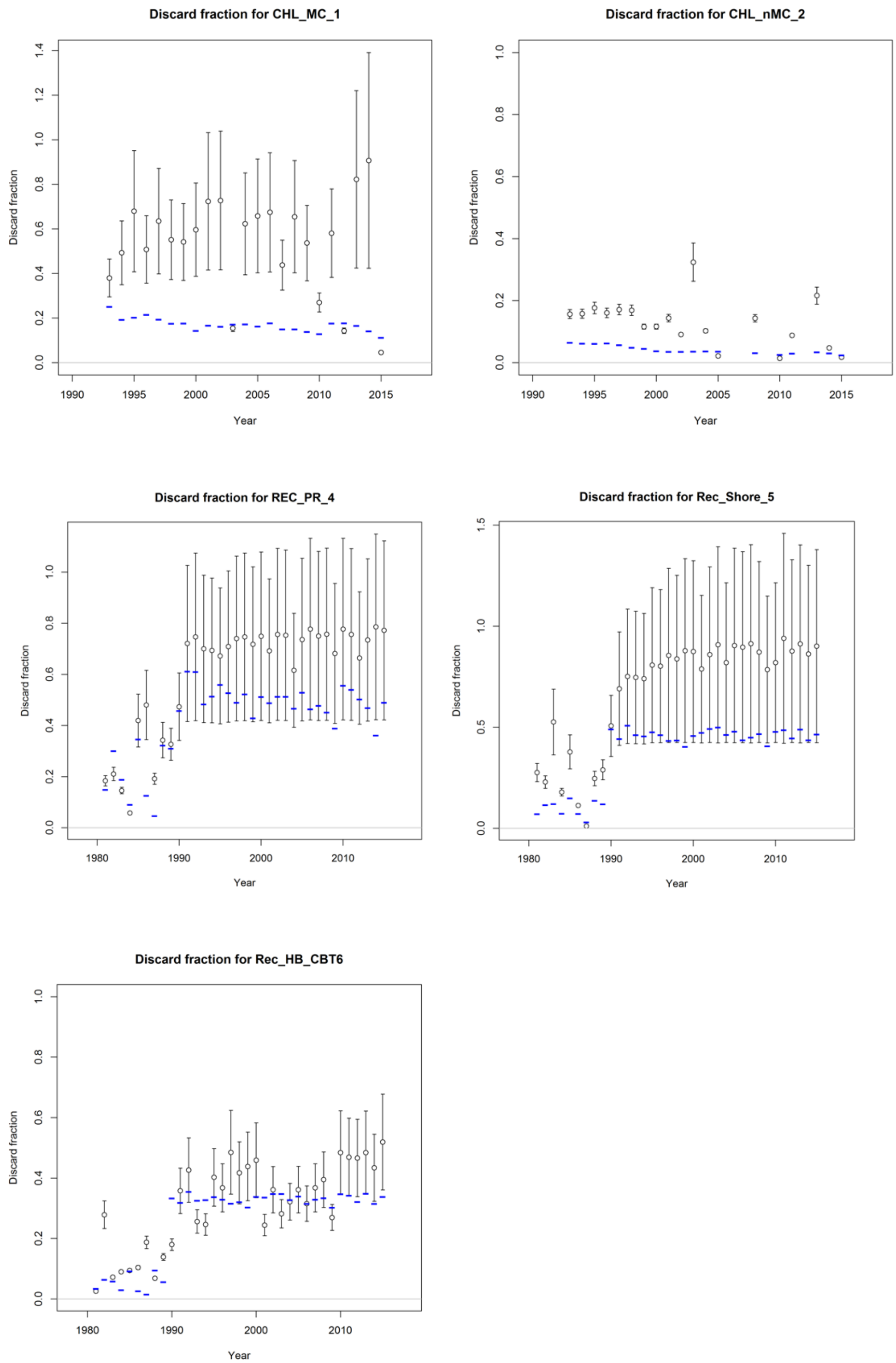


Figure 1.-Model fit to discards from 5 fleets when length and index weightings were set to 0 for the Gulf of Mexico Gray Snapper stock assessment.

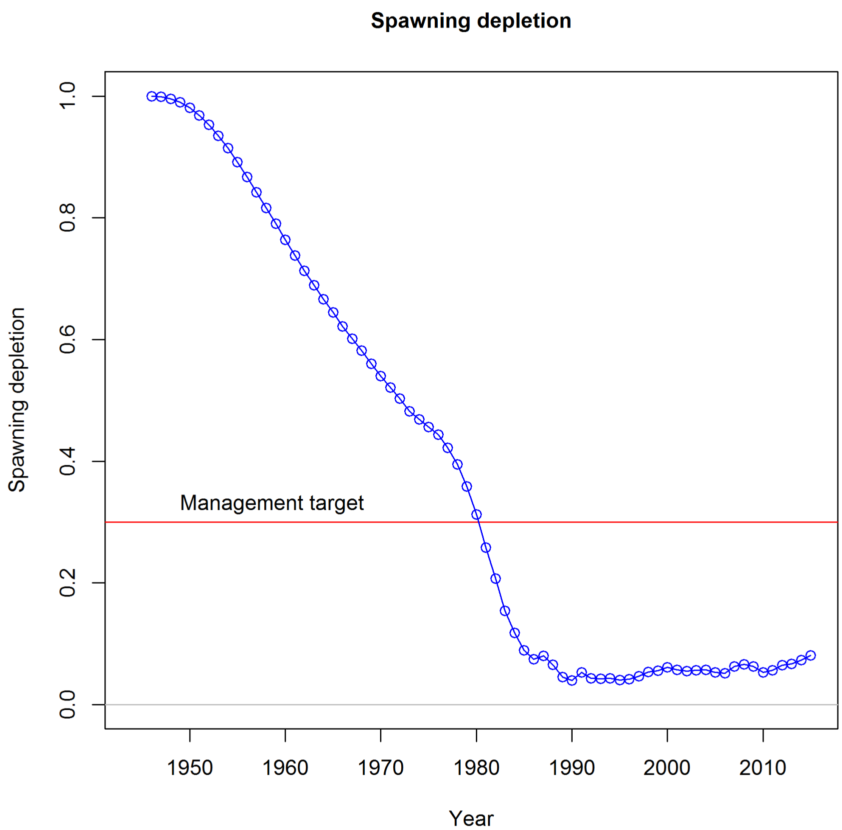


Figure 2.-Results of a sensitivity analysis for the Gulf of Mexico Gray Snapper stock assessment where length and index data were down-weighted so that only the effects of discards and indices of abundance contributed to the model results.

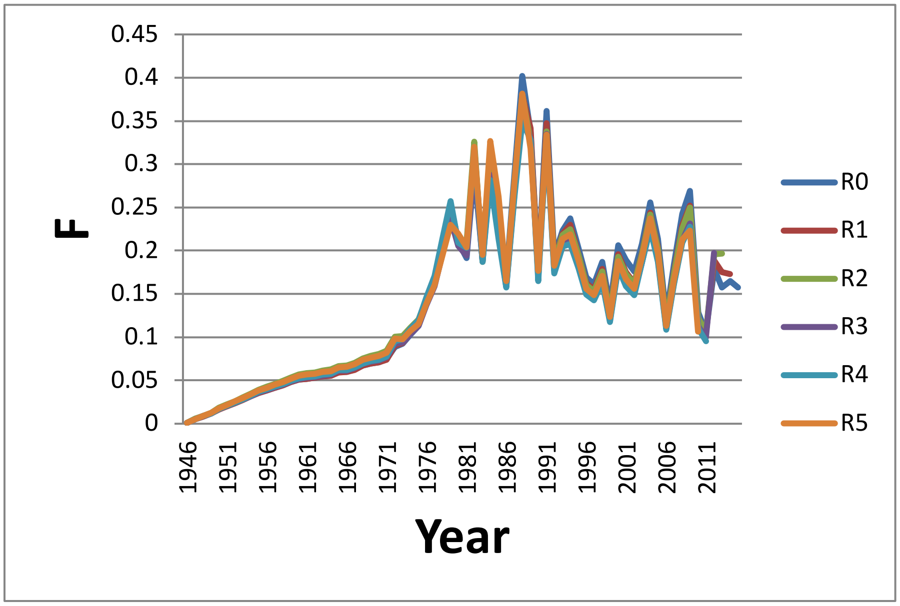


Figure 3.-Results of a retrospective analysis on exploitation (F) illustrating model stability when up to 5 years (R0-R5) of data are removed from the model for the Gulf of Mexico Gray Snapper stock assessment.

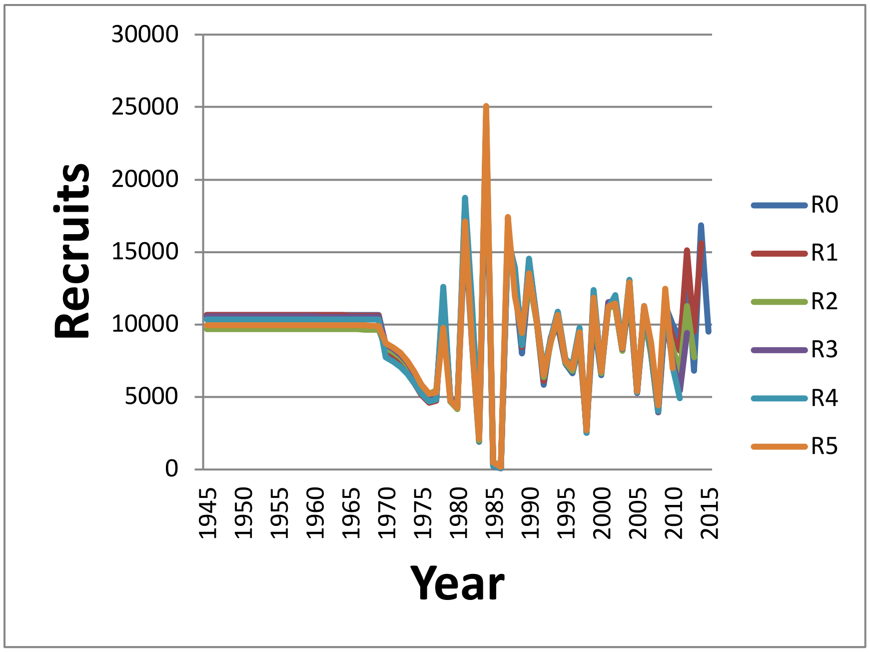


Figure 4.-Results of a retrospective analysis on recruitment illustrating model stability when up to 5 years (R0-R5) of data are removed from the model for the Gulf of Mexico Gray Snapper stock assessment.

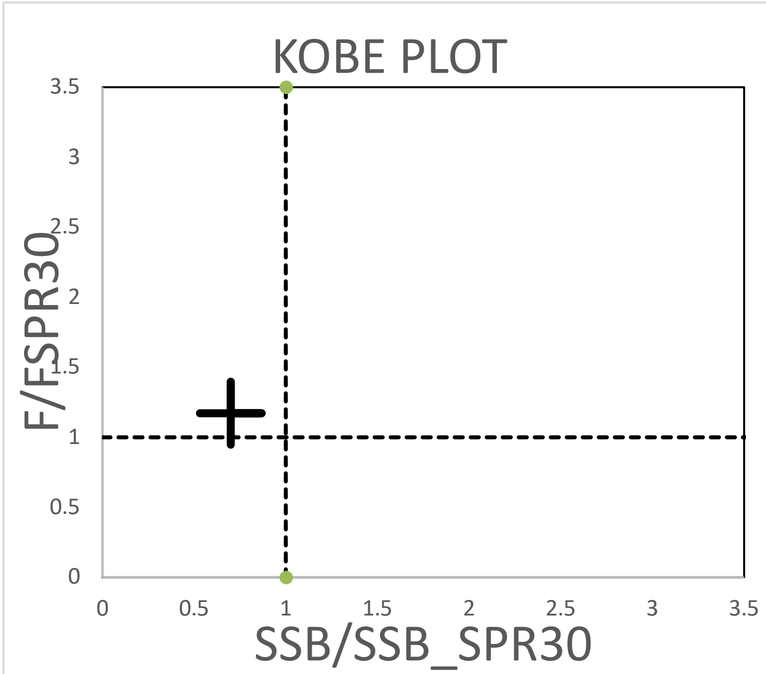


Figure 5.-Terminal year of a Kobe Plot illustrating Spawning Potential Ratio and exploitation ratio (95% confidence limits) for the Gulf of Mexico Gray Snapper stock assessment.

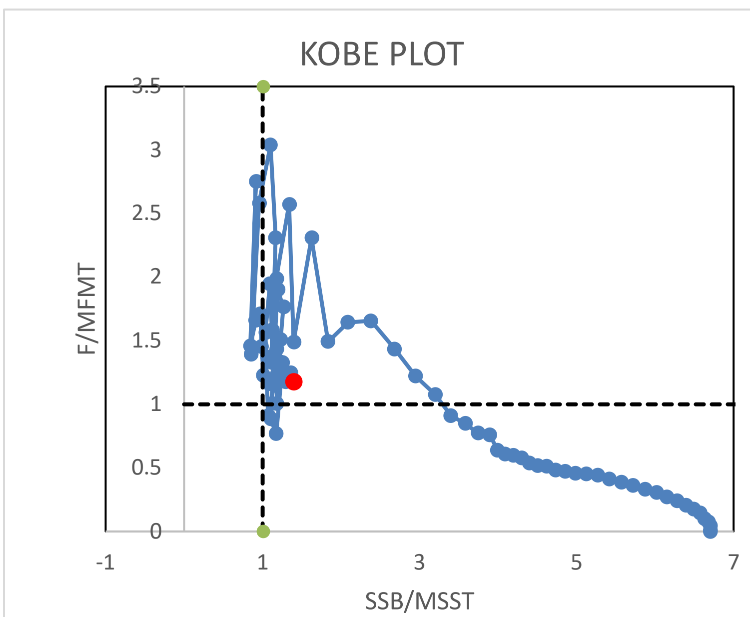


Figure 6.-Kobe Plot illustrating Spawning Potential Ratio and exploitation ratio history for the Gulf of Mexico Gray Snapper stock assessment. Solid red circle indicated present level. Reference lines indicate management targets of MSST (vertical line) and FSPR30 (horizontal line). Currently, the stock is undergoing overfishing but is not overfished.

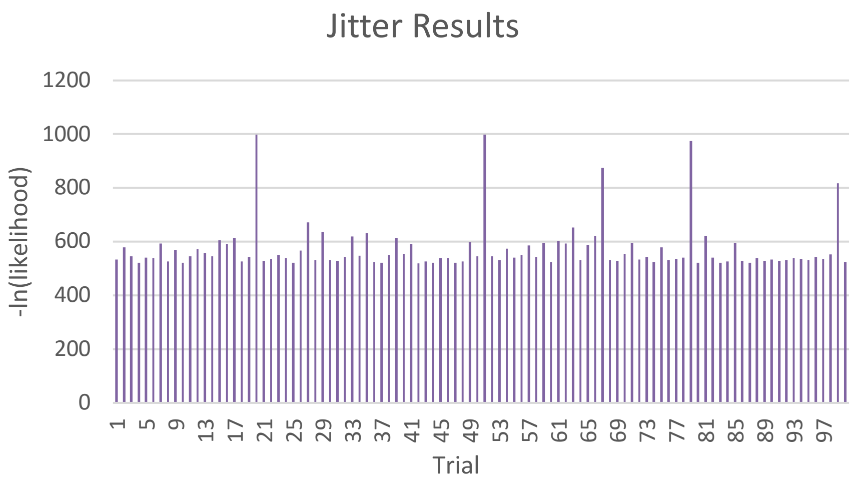


Figure 7.-Results of a jitter analysis for the Gulf of Mexico Gray Snapper stock assessment where the starting value of each estimated parameter was varied randomly by up to 10% on each of 100 model runs.

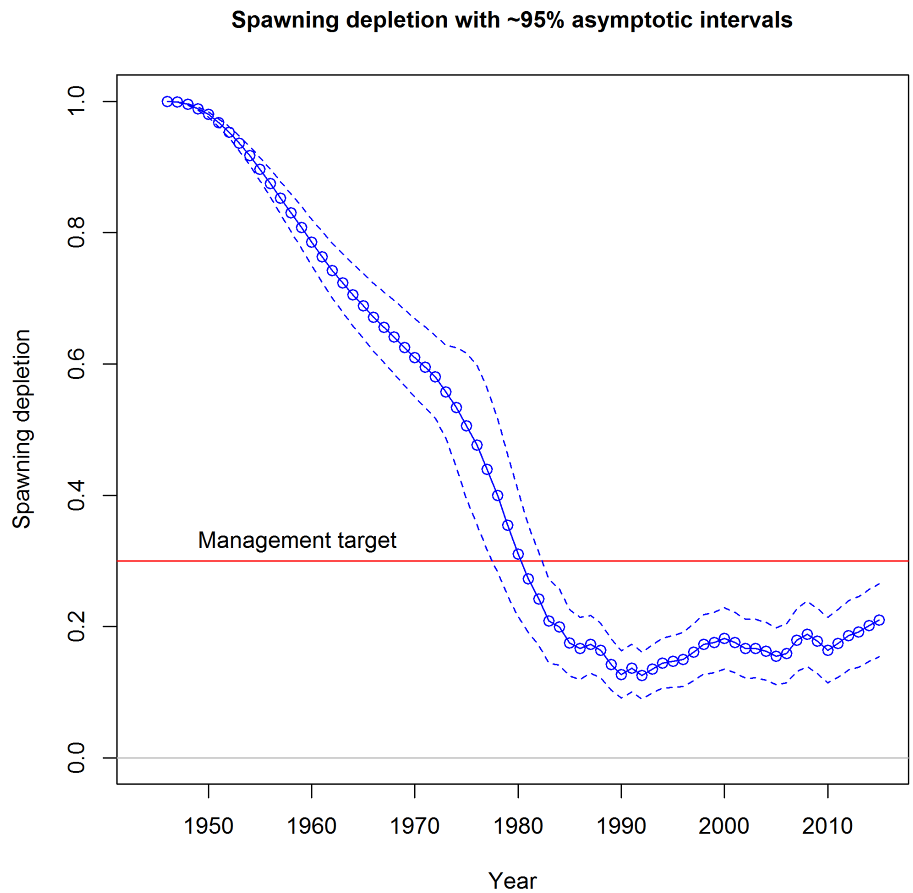
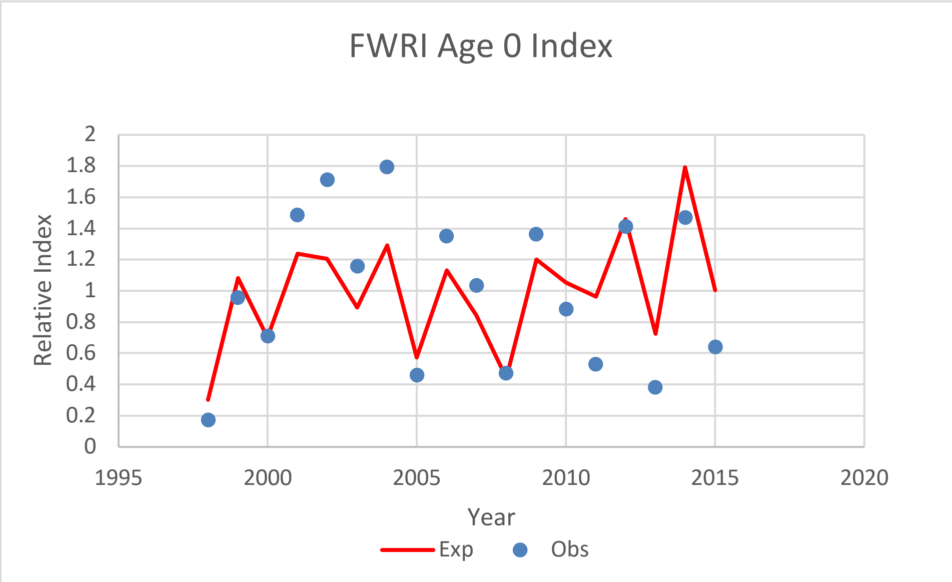


Figure 8.-Final predicted spawning Stock Biomass along with 95% confidence intervals for the Gulf of Mexico Gray Snapper stock assessment.

(**a**)



(**b**)

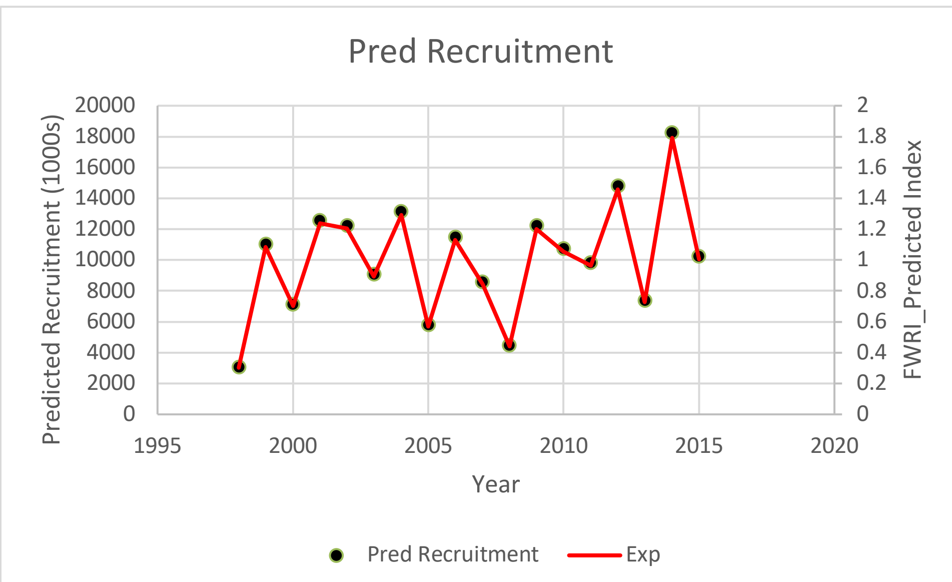


Figure 9: (**a**) Fit to the FWRI Age 0 Index and (**b**) the model predicted recruits (age-0) compared to the predicted value of the FWRI Age-0 index (secondary axis).

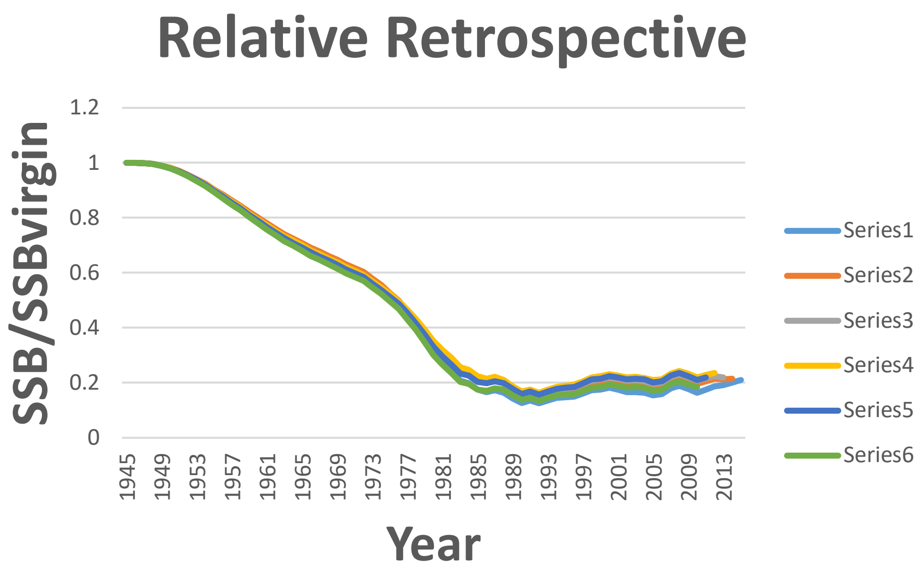


Figure 10.-Retrospective analyses relative to SSB_{virgin} for the Gulf of Mexico Gray Snapper stock assessment. Series 1 = Base model; series 2-6 = retrospective years 1-5 respectively.

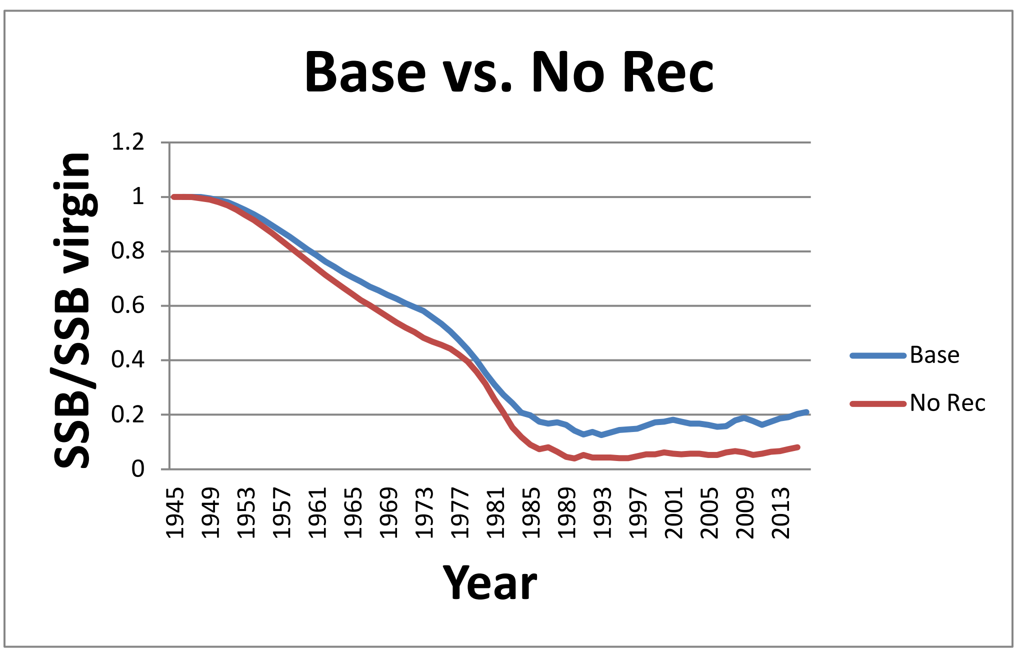


Figure 11.-Sensitivity analyses of the base model without recreational indices or length effects relative to virgin Spawning Stock Biomass compared to the base model for the Gulf of Mexico Gray Snapper stock assessment.

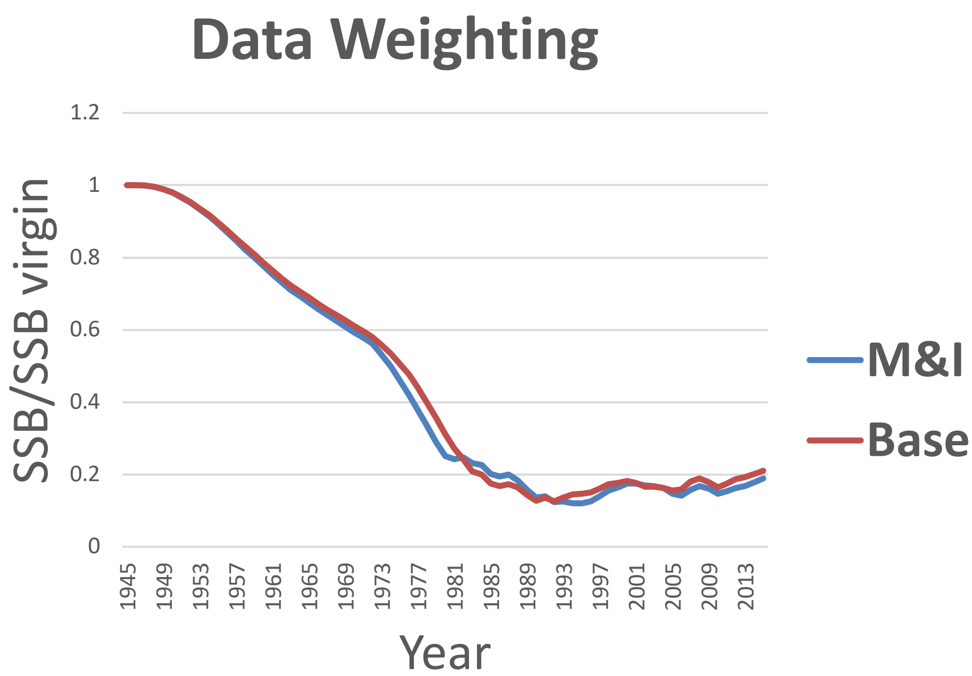


Figure 12.-Sensitivities for the Gulf of Mexico Gray Snapper stock assessment comparing alternative data weighting (McAlister and Ionelli 1997) to the base model model.

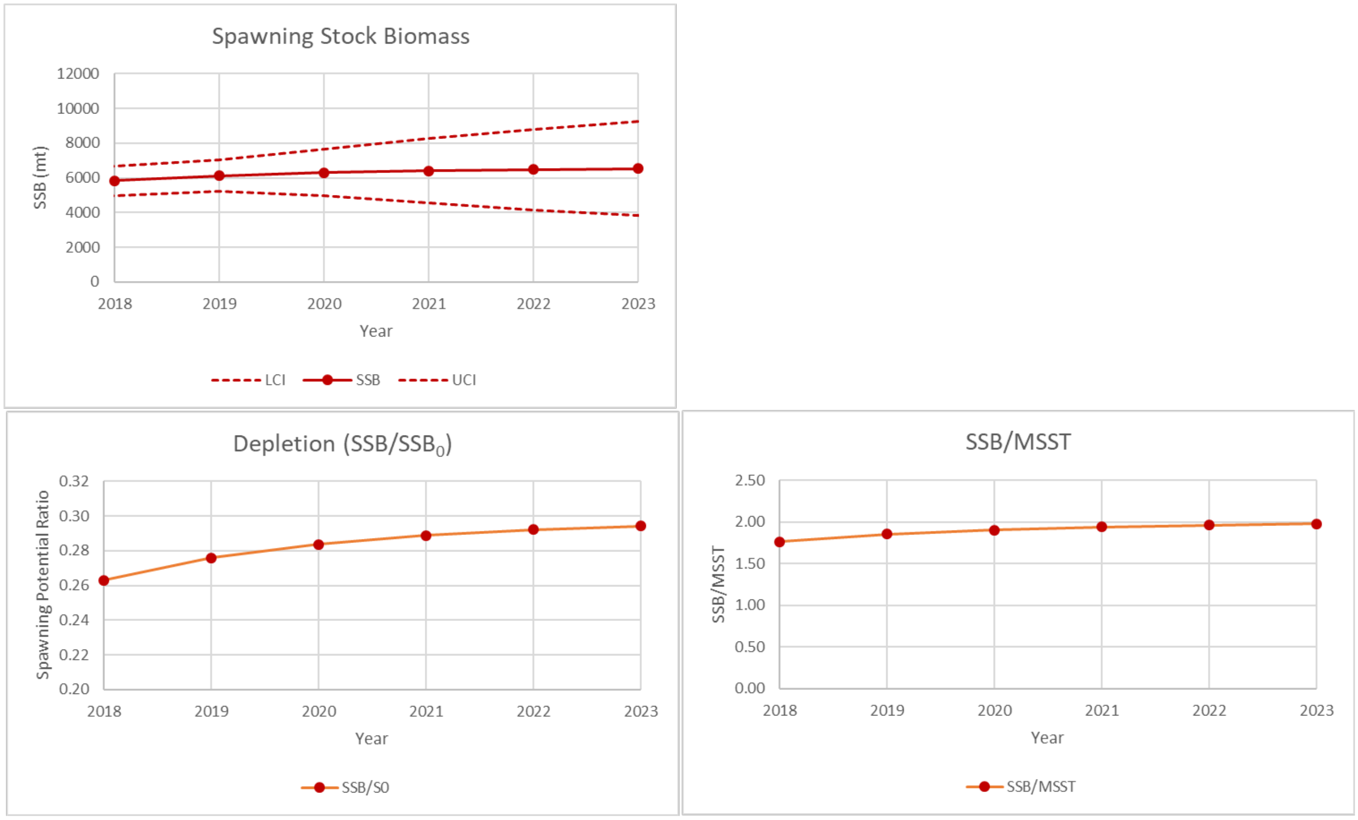


Figure 13: Project $F_{SPR\ 30}$: Projected spawning stock biomass (mt) with lower and upper 80% confidence intervals (upper panel), depletion (lower left) and SSB/MSST (lower right).

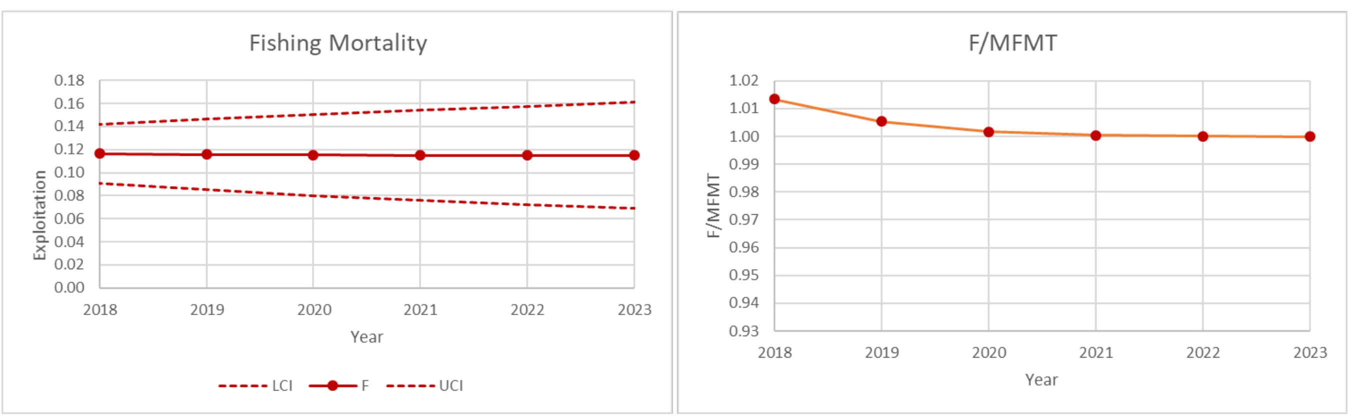


Figure 14: Project $F_{SPR\ 30}$: Projected exploitation (F) with lower and upper 80% confidence intervals (left panel), and F/MFMT (right panel).

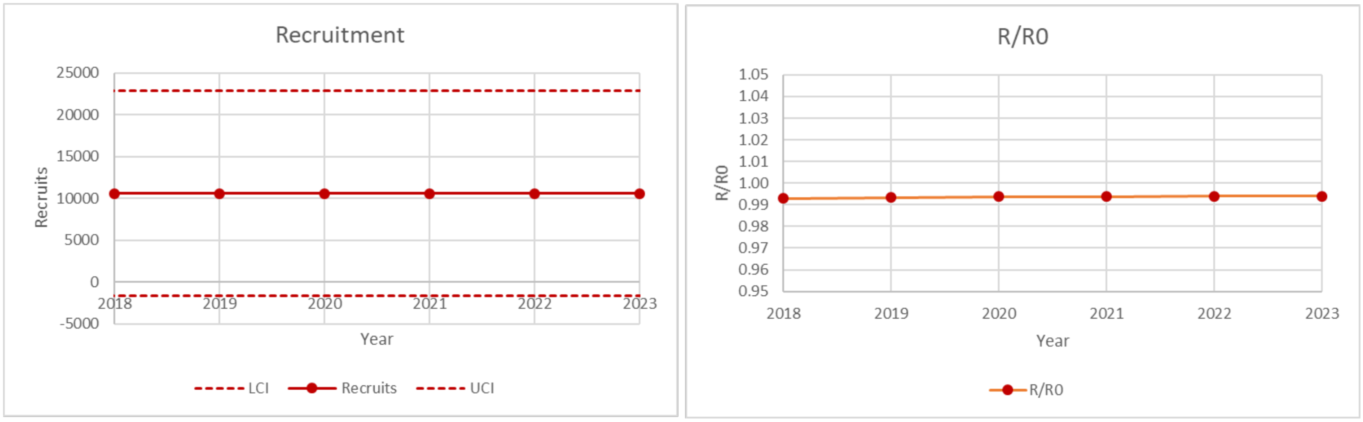


Figure 15: Project $F_{SPR\ 30}$: Projected age-0 recruitment with lower and upper 80% confidence intervals (left panel), and R/R0 (right panel).

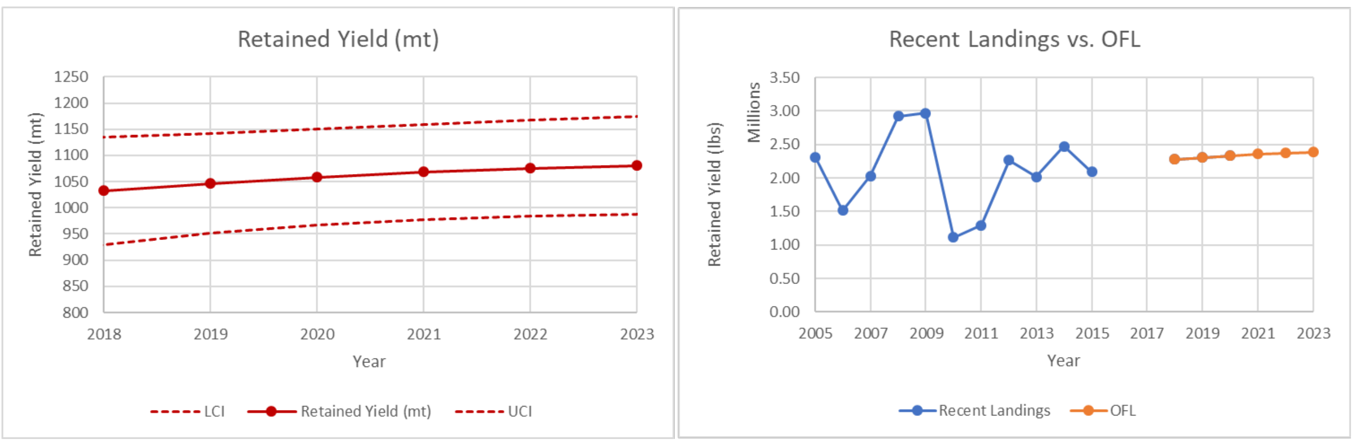


Figure 16: Project $F_{SPR\ 30}$: Projected retained yield (mt) with lower and upper 80% confidence intervals (left panel) and a comparison of recent landings and OFL in millions of pounds (right panel).

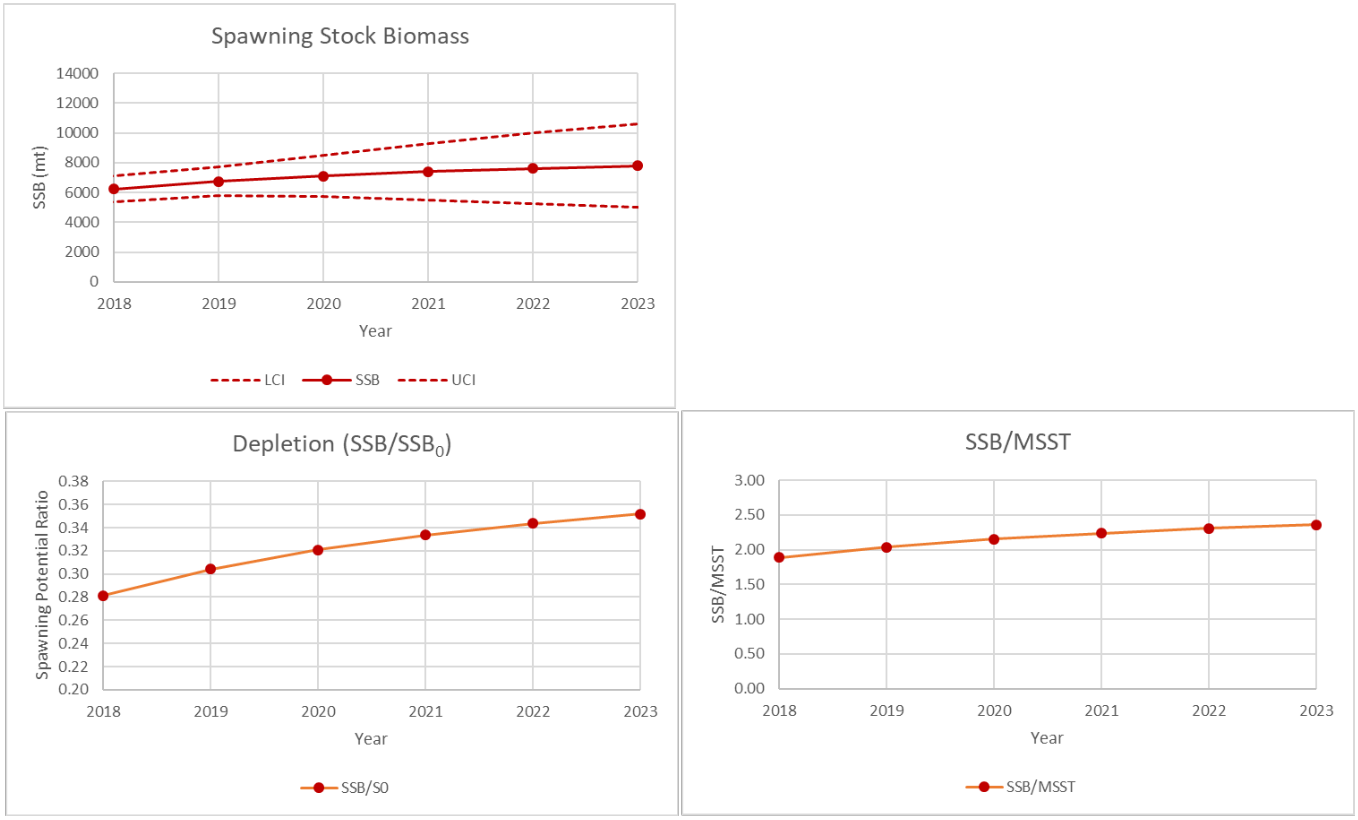


Figure 17: Project F_{OY}: Projected spawning stock biomass (mt) with lower and upper 80% confidence intervals (upper panel), depletion (lower left) and SSB/MSST (lower right).

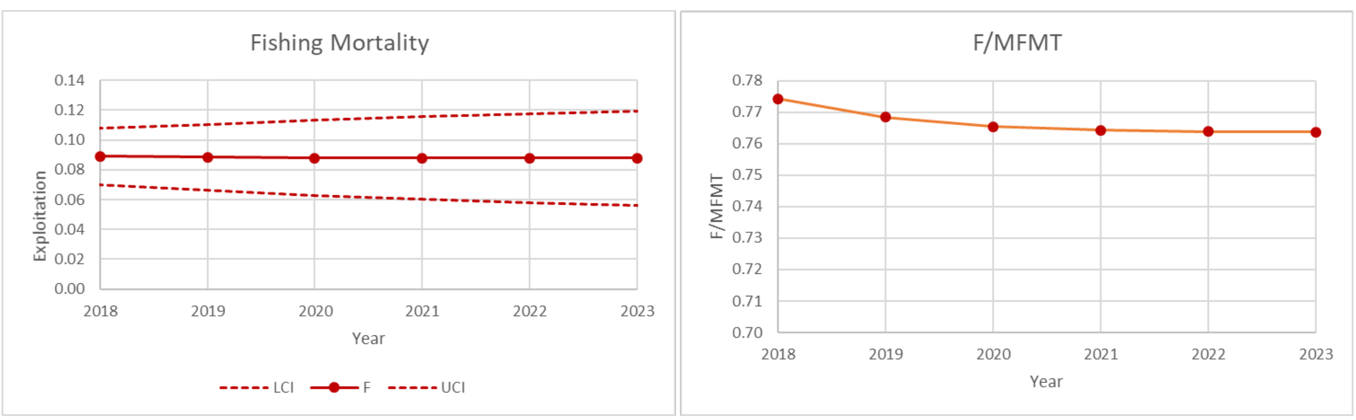


Figure 18: Project F_{OY}: Projected exploitation (F) with lower and upper 80% confidence intervals (left panel), and F/MFMT (right panel).

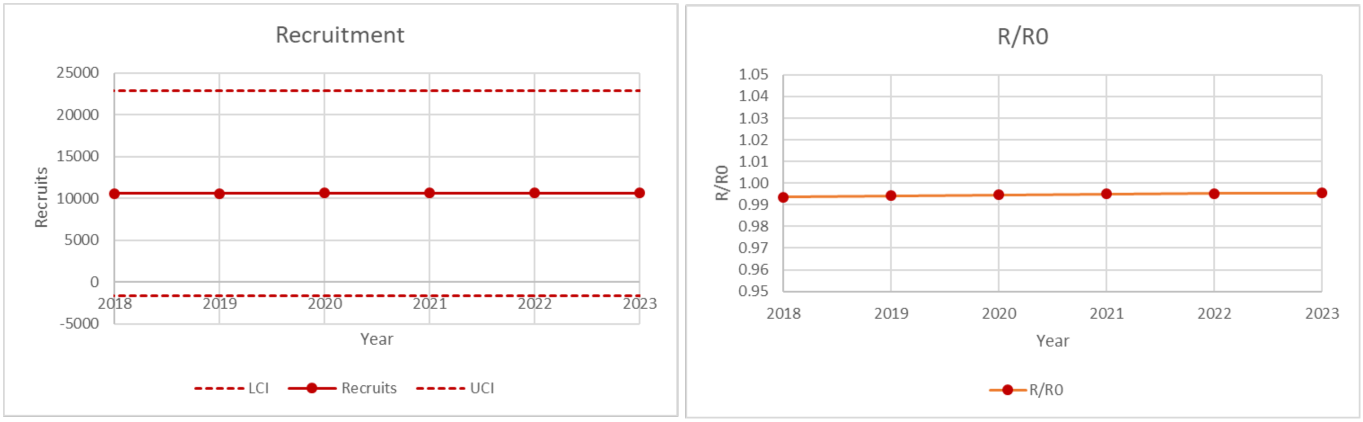


Figure 19: Project F_{OY}: Projected age-0 recruitment with lower and upper 80% confidence intervals (left panel), and R/R0 (right panel).

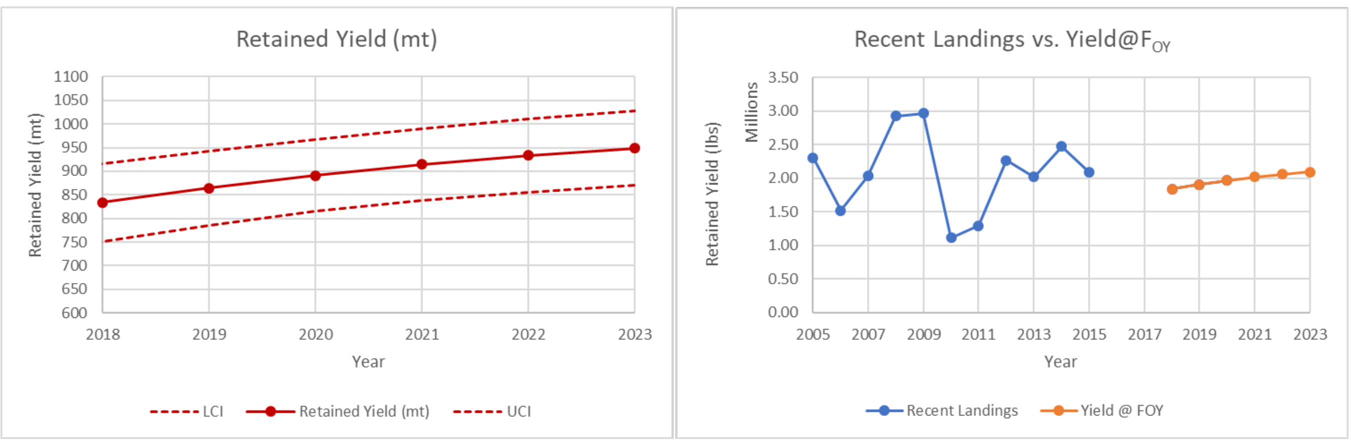


Figure 20: Project F_{OY}: Projected retained yield (mt) with lower and upper 80% confidence intervals (left panel) and a comparison of recent landings and yield at F_{OY} in millions of pounds (right panel).