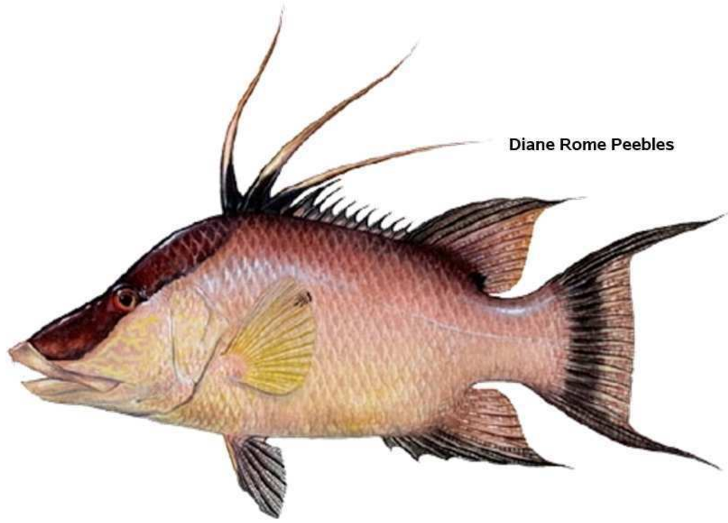

The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico

Wade Cooper, Angela Collins, Joe O'Hop, Dustin Addis

Florida Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
100 Eighth Ave Southeast
St. Petersburg, Florida 33701-5020

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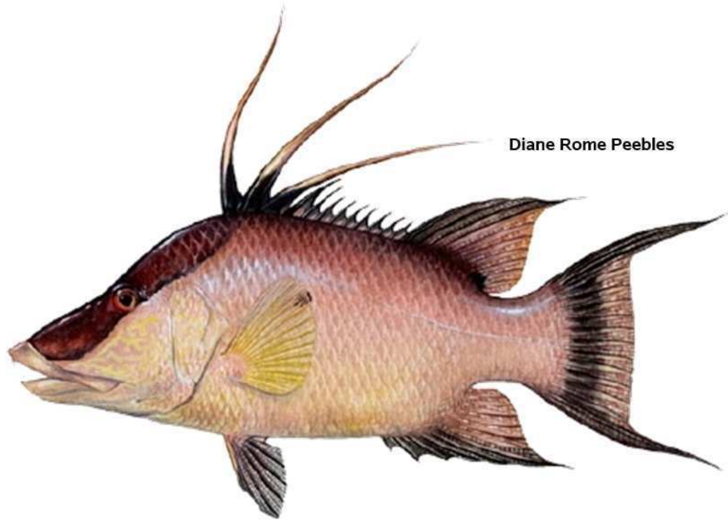

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Section I: Introduction

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1 Process Description

The Florida Fish and Wildlife Conservation Commission (FWC) is responsible for managing fish and wildlife resources for the people of the State of Florida. FWC works cooperatively with the regional fishery management councils (South Atlantic Fishery Management Council and Gulf of Mexico Fishery Management Council) and the National Marine Fisheries Service to effectively manage saltwater fisheries in Florida. The FWC Fish and Wildlife Institute is responsible for providing information and research on fish and wildlife resources in the state, including assessments of the status of fish populations whose centers of distribution fall primarily within Florida, such as Hogfish.

Information and data on Hogfish in state and federal waters within Florida and additional Southeastern US waters were assembled and analyzed for this assessment. The results of this assessment may serve as advice to managers of fisheries in the region regarding the current status of Hogfish populations within Southeastern US waters.

2 Management Overview

2.1 Fishery Management Plans and Amendments

The following summary describes only those management actions that likely affect Hogfish fisheries and harvest.

2.1.1 South Atlantic Fishery Management Council (SAFMC)

The Fishery Management Plan (FMP), Regulatory Impact Review, and Final Environmental Impact Statement for the Snapper-Grouper Fishery of the South Atlantic Region, approved in 1983 and implemented in August of 1983, establishes a management regime for the fishery for snappers, groupers and related demersal species of the Continental Shelf of the southeastern United States in the fishery conservation zone (FCZ) under the area of authority of the South Atlantic Fishery Management Council and the territorial seas of the states, extending from the North Carolina/Virginia border through the Atlantic side of the Florida Keys to 83° W longitude. In the case of the sea basses, the management regime applies only to south of Cape Hatteras, North Carolina. Regulations apply only to Federal waters.

SAFMC FMP Amendments affecting Hogfish

Description of Action	FMP/Amendment	Effective Date
4” trawl mesh; established minimum size limits for several species; limitations on harvest and gear	Snapper Grouper FMP	08/31/1983
Trawls prohibited	Snapper Grouper Amend 1	01/12/1989
Required permit to fish for, land or sell snapper grouper species	Snapper Grouper Amend 3	01/31/1991
Fish traps prohibited, entanglement nets & longlines within 50 fathoms prohibited, aggregate bag limit of 10 snappers	Snapper Grouper Amend 4	01/01/1992
Oculina Experimental Closed Area	Snapper Grouper Amend 6	06/27/1994
Established a minimum size limit of 12” (305 mm) FL for Hogfish; specified allowable gear; required dealer, charter, and headboat federal permits	Snapper Grouper Amend 7	01/23/1995
Implemented a Hogfish recreational bag limit of 5 per person within Florida EEZ	Snapper Grouper Regulatory Amend 6	05/1995
Limited entry program: transferable permits and 225-lb non-transferable permits	Snapper Grouper Amend 8	12/14/1998
MSY proxy for Hogfish is 30% static SPR; OY proxy is 40% static SPR	Snapper Grouper Amend 11B	12/02/1999
Extended for an indefinite period the regulation prohibiting fishing for and possessing snapper grouper species within the *Oculina* Experimental Closed Area	Snapper Grouper Amend 13A	04/26/2004
Established eight deepwater Type II marine protected areas to protect a portion of the population and habitat	Snapper Grouper Amend 14	02/12/2009

of long-lived deepwater snapper grouper species		
Required use by commercial and recreational fishermen of dehooking devices for releasing reef fish	Snapper Grouper Amend 16	07/29/2009
Use of non-stainless steel circle hooks in the snapper grouper fishery not required south of 28°N	Snapper Grouper Amend 17A	03/02/2011
Comprehensive ACL Amendment to meet MSA mandate to establish ACLs and AMs for species managed by the council that are not undergoing overfishing, including Hogfish. ACL for Hogfish in commercial sector: 48,772 lb (22,123 kg) round weight; ACL for Hogfish in recreational sector: 98,866 lb (44,845 kg) round weight	Snapper Grouper Amend 25	04/16/2012
Action to revise the acceptable biological catch estimates, annual catch limits (ACL), and recreational annual catch targets for Hogfish; ACL for Hogfish in commercial sector: 49,469 lb (22,439 kg) round weight; ACL for Hogfish in recreational sector: 85,355 lb (38,716 kg) round weight	Snapper Grouper Regulatory Amend 13	07/17/2013
Under review. Revising the Hogfish minimum size limit	Snapper Grouper Regulatory Amend 14	----------

2.1.2 Gulf of Mexico Fishery Management Council (GMFMC)

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

GMFMC FMP Amendments affecting Hogfish

Description of Action	FMP/Amendment	Effective Date
MSY and OY estimates for all groupers and snappers in aggregate, permits and gear specifications for fish traps and limits on the number of fish traps allowed per vessel, establishment of a stressed area within which	Reef Fish FMP	11/08/1984

the use of fish traps, roller trawls, and powerheads for reef fish harvest was prohibited, explosives and poisons for taking reef fish prohibited.		
The stressed area was expanded, and a longline/buoy gear boundary was established. The number of fish traps allowed per vessel was reduced from 200 to 100. Reef fish permits were required for commercial reef fish vessels. Commercial harvest of reef fish using trawls or entangling nets was prohibited. Reporting requirements established for commercial and for-hire recreational vessels, prohibited use of entangling gear for direct harvest, reef fish vessel permit established with an income qualification.	Reef Fish Amendment 1	02/21/1990
Moratorium on new reef fish permits which was extended at various times and was in effect through 2005.	Reef Fish Amendment 4	05/1992
Established restrictions on the use of fish traps in the Gulf of Mexico EEZ, implemented a three-year moratorium on the use of fish traps, created a SMZ off AL coast, created framework procedures for future SMZs.	Reef Fish Amendment 5	02/1994
Created an aggregate bag limit of 20 reef fish for all reef fish species not having a bag limit.	Reef Fish Amendment 12	01/1997
Provided a ten-year phase-out for the fish trap fishery; prohibited use of fish traps west of Cape San Blas, Florida.	Reef Fish Amendment 14	03/1997
Prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps.	Reef Fish Amendment 15	01/1998
Addresses new provisions implemented by the Sustainable Fisheries Act; proposed scientific definitions (MSY, OY, MFMT, MSST) for Hogfish	Generic SFA Amendment	02/24/1999
Hogfish moved to the list of species in the Reef Fish FMP management unit; established a minimum size limit of 12” (305 mm) FL and adopted a recreational bag limit of 5 Hogfish per person for entire Gulf EEZ to be compatible with FL regs.	Reef Fish Amendment 16B	11/1999
Prohibited retention of reef fish exhibiting “trap rash” on vessels with a reef fish permit that is fishing spiny lobster or stone crab traps except for vessels possessing a valid fish trap endorsement.	Reef Fish Amendment 16A	01/2000
Established a 3-year moratorium on the issuance of new charter and headboat vessel permits in the recreational for hire fisheries in the Gulf EEZ.	Reef Fish Amendment 20	07/2002
Generic amendment addressing the establishment of the Tortugas Marine Reserves – establishes two marine reserves and prohibits fishing for any species and anchoring by fishing vessels inside the two marine reserves.	Reef Fish Amendment 19	08/19/2002
Established a permanent limited access system for the	Reef Fish Amendment 24	08/2005

commercial fishery for Gulf reef fish.		
Established a limited access system on for-hire reef fish and CMP permits.	Reef Fish Amendment 25	06/2006
Commercial and recreational fishermen fishing for reef fish required to use non-stainless steel circle hooks when using natural baits, and to use dehooking and venting tools for releasing reef fish.	Reef Fish Amendment 27	02/2008
Generic Annual Catch Limits/Accountability Measures Amendment to the Red Drum, Reef Fish Resources, Shrimp, and Coral and Coral Reefs Fishery Management Plans for the Gulf of Mexico; set a stock ACL (208,000 lb, round weight) and implemented AMs for Gulf Hogfish	Generic ACL Amendment	12/29/2011
Currently under development. Addresses Sustainable Fisheries Act (SFA) requirements such as setting the minimum stock size threshold (MSST), maximum fishing mortality rate (MFMT), and other associated parameters for reef fish species for which these have not been defined.	Reef Fish Amendment 18B	----------

2.1.3 State of Florida

Florida's management of reef fish fisheries, prior to the establishment of the Marine Fisheries Commission (MFC) in 1983, began with the implementation of size limits in 1979 (Florida Statutes in chapter 370.11) for several groupers (red, Nassau, gag, black, and goliath). In July of 1985, the Florida MFC implemented rules in the Florida Administrative Code (F. A. C.) to establish minimum size limits for many species. Hogfish regulations were implemented in July 1, 1994, establishing a minimum size limit of 12" fork length and a 5-fish bag limit.

State of Florida F.A.C. Rules affecting Hogfish

Description of Action	F.A.C. Rules	Effective Date
Established 12" FL minimum size for Hogfish from state waters	F.A.C. Chap 68-14	07/1985
Established a 5 Hogfish per day bag limit in state waters	F.A.C. Chap 68-14	12/1986
Required the appropriate federal permit to exceed the recreational bag limit in state waters.	F.A.C. Chap 68-14	12/1992
Temporarily allowed fishermen to land reef fish in the Florida Keys if they possessed either South Atlantic snapper grouper permits or Gulf reef fish permits, with subsequent extensions of these provisions in July 1995 and January 1996.	F.A.C. Chap 68-14	10/1993
Designates Hogfish as a "restricted species", establishes a minimum size limit of 12 inches fork length, and establishes a daily recreational bag limit of	F.A.C. Chap 46-14	07/1994

5 Hogfish per person.		
Prohibited commercial fishermen from harvesting or possessing the recreational bag limit of reef fish species on commercial trips.	F.A.C. Chap 68-14	07/2007
Required commercial and recreational anglers fishing for any Gulf reef fish species to use circle hooks, de-hooking devices, and venting tools.	F.A.C. Chap 68-14	06/2008

2.2 Emergency and Interim Rules

December 2, 2013 – NOAA's National Marine Fisheries Service (NOAA Fisheries Service) issued a temporary final rule implementing accountability measures for the commercial and recreational sectors for Hogfish in the exclusive economic zone of the Gulf of Mexico for the 2013 fishing year. Based on the commercial and recreational landings, NMFS determined that the stock (commercial and recreational) annual catch limit (ACL) for Gulf Hogfish had been reached. Therefore, NMFS closed the commercial and recreational sectors for Hogfish in the Gulf EEZ at 12:01 a.m., local time, December 2, 2013, until January 1, 2014.

2.3 Management Program Specifications

Table 2.3.1. General Management Information

South Atlantic	Species	Hogfish (Lachnolaimus maximus)
	Management Unit	Southeastern U.S.
	Management Unit Definition	All waters within the South Atlantic Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
	Management Entity	South Atlantic Fishery Management Council
	Current stock exploitation status	Insufficient evidence to determine stock status (SEDAR 6, 2004)
Gulf of Mexico	Species	Hogfish (Lachnolaimus maximus)
	Management Unit	U. S. Gulf of Mexico
	Management Unit Definition	All waters within the Gulf of Mexico Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
	Management Entity	Gulf of Mexico Fishery Management Council
	Current stock exploitation status	Insufficient evidence to determine stock status (SEDAR 6, 2004)

Table 2.3.2. Specific Management Criteria

South Atlantic and Gulf of Mexico				
	Current *		Results from SEDAR 37	
Criteria	Definition	Value	Definition	Value
MSST (Minimum Stock Size Threshold)	[(1-M) or 0.5, whichever is greater] *BMSY (The estimated population biomass at MSY)	-	TBD	TBD
MFMT (Maximum Fishing Mortality Threshold)	F_{MSY}	-	TBD	TBD
MSY (Maximum Sustainable Yield)	Yield at 30% SPR (Spawning Potential Ratio)	-	TBD	TBD
F_{MSY} (Fishing Mortality Rate at MSY)	$F_{\text{at 30\% SPR}}$ (Spawning Potential Ratio)	-	TBD	TBD
OY (Optimum Yield)	40% SPR (Spawning Potential Ratio)	-	TBD	TBD
F_{OY} (Fishing Mortality Rate at OY)	$F_{\text{at 40\% SPR}}$ (Spawning Potential Ratio)	-	TBD	TBD
M (Natural Mortality Rate)	Constant	0.25 yr^{-1}	Time-varying	Target of 0.179 yr^{-1}

***** Generic Sustainable Fisheries Act Amendment (GCMFC 1999) set SFA criteria for reef fish which have not been assessed.

2.4 Stock Rebuilding Information

The SEDAR 6 assessment provided insufficient evidence of Hogfish stock status. Therefore, no stock rebuilding information is available.

2.5 Stock Projection Information

There was no requirement for SEDAR 6 to provide projections of the stock biomass or fishing mortality rate in future years.

2.6 Quota Calculation Details

Not applicable. Hogfish are not currently under quota management.

2.7 Management and Regulatory Timelines

The following table provides a timeline for federal and state management actions related to size and bag limits for the Hogfish fishery.

Table 2.7.1. Annual Hogfish Regulatory Summary (Size and Bag Limits)

	SAFMC		Florida		GMFMC	
Year	Minimum size (FL, inches)	Bag limit	Minimum size (FL, inches)	Bag limit	Minimum size (FL, inches)	Bag limit
1982	-----	-----	-----	-----	-----	-----
1983	-----	-----	-----	-----	-----	-----
1984	-----	-----	-----	-----	-----	-----
1985	-----	-----	-----	-----	-----	-----
1986	-----	-----	-----	-----	-----	-----
1987	-----	-----	-----	-----	-----	-----
1988	-----	-----	-----	-----	-----	-----
1989	-----	-----	-----	-----	-----	-----
1990	-----	-----	-----	-----	-----	-----
1991	-----	-----	-----	-----	-----	-----
1992	-----	-----	-----	-----	-----	-----
1993	-----	-----	-----	-----	-----	-----
1994	-----	-----	12	5	-----	-----
1995	12	5	12	5	-----	-----
1996	12	5	12	5	-----	-----
1997	12	5	12	5	-----	20 (aggregate)
1998	12	5	12	5	-----	20 (aggregate)
1999	12	5	12	5	12	5
2000	12	5	12	5	12	5
2001	12	5	12	5	12	5
2002	12	5	12	5	12	5
2003	12	5	12	5	12	5
2004	12	5	12	5	12	5
2005	12	5	12	5	12	5
2006	12	5	12	5	12	5
2007	12	5	12	5	12	5
2008	12	5	12	5	12	5
2009	12	5	12	5	12	5
2010	12	5	12	5	12	5
2011	12	5	12	5	12	5
2012	12	5	12	5	12	5
2013	12	5	12	5	12	5

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GMFMC (Gulf of Mexico Fishery Management Council). 1981. Fishery management plan for the reef fish fishery of the Gulf of Mexico and environmental impact statement. Gulf of Mexico Fishery Management Council, Tampa, Florida. 155 p.

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GMFMC (Gulf of Mexico Fishery Management Council). 1998. Amendment 16A to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 49 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1999. Amendment 16B to the fishery management plan for the reef fish resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 56 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1999. Generic Sustainable Fisheries Act Amendment. Gulf of Mexico Fishery Management Council, Tampa, Florida. 318 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2001. Generic Amendment Addressing the Establishment of the Tortugas Marine Reserves in the Following Fishery Management Plans of the Gulf of Mexico: Coastal Migratory Pelagics Fishery Management Plan

(Amendment 13), Coral and Coral Reefs Fishery Management Plan (Amendment 4), Red Drum Fishery Management Plan (Amendment 4), Reef Fish Fishery Management Plan (Amendment 19), Shrimp Fishery Management Plan (Amendment 12), Spiny Lobster Fishery Management Plan (Amendment 7), Stone Crab Fishery Management Plan (Amendment 8) (includes an IRFA, RIR and a FSEIS) (EFH Amendment 2). Gulf of Mexico Fishery Management Council, Tampa, Florida. 194 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2003. Corrected amendment for a charter vessel/headboat permit moratorium amending the FMPs for: Reef fish (Amendment 20) and coastal migratory pelagics (Amendment 14) (Including EA/RIR/IRFA). Gulf of Mexico Fishery Management Council, Tampa, Florida. 164 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Final Amendment 24 to the reef fish fishery management plan for reef fish resources in the Gulf of Mexico including environmental assessment, regulatory impact review, and initial regulatory flexibility analysis. Gulf of Mexico Fishery Management Council, Tampa, Florida. 143 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Final amendment to the FMPs for: Reef fish (Amendment 25) and coastal migratory pelagics (Amendment 17) for extending the charter vessel/headboat permit moratorium (including SEIS/RIR/IRFA). Gulf of Mexico Fishery Management Council, Tampa, Florida. 111 pp.

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

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GMFMC (Gulf of Mexico Fishery Management Council). Under development. Amendment 18B to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida.

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SAFMC (South Atlantic Fishery Management Council). 1993. Amendment Number 6, Regulatory Impact Review, Initial Regulatory Flexibility Analysis and Environmental Assessment for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 155 pp.

SAFMC (South Atlantic Fishery Management Council). 1994. Amendment Number 7, Regulatory Impact Review and Environmental Assessment for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 293 pp.

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SAFMC (South Atlantic Fishery Management Council). Under review. Regulatory Amendment 14 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405.

3 Assessment History and Review

SEDAR 6 and SAFMC 2004 conducted an analysis of both fishery-dependent commercial and recreational catch-and-effort and fishery independent design-based survey data which indicated that Hogfish was severely overfished (both growth and recruitment) and has been for the last two decades in Florida waters. The estimated total fishing mortality rate for 2001 was F = 0.57, which is four times greater than F_{MSY} = 0.13. The peer-review of this assessment found that there was qualitative evidence suggesting that Hogfish were growth overfished but provided insufficient evidence to determine the status of the stock (SEDAR 6 and SAFMC 2004). McBride and Murphy (2003) examined the status of the Hogfish fishery, particularly in reference to the effect of the 1994 minimum-size regulation on Hogfish landings in Florida, and explored some costs and benefits of increasing the minimum legal fish size to increase the yield-per-recruit of Hogfish. Results from this study indicated that, until 2000, the sizes of most Hogfish landed in Florida were very similar to the 12-inch (305mm) FL size limit. The observed maximum size is lower in south Florida, where mortality is greatest, suggesting that growth overfishing is occurring in this region. The yield-per-recruit analysis conducted by McBride and Murphy (2003) indicated that maximum yield-per-recruit for Hogfish would occur at a size larger than the current mean size of fish harvested. Evidence of significantly higher instantaneous mortality rates and smaller sizes/ages in regions of south Florida indicate size-selective fishing mortality of Hogfish in these areas (McBride and Richardson 2007).

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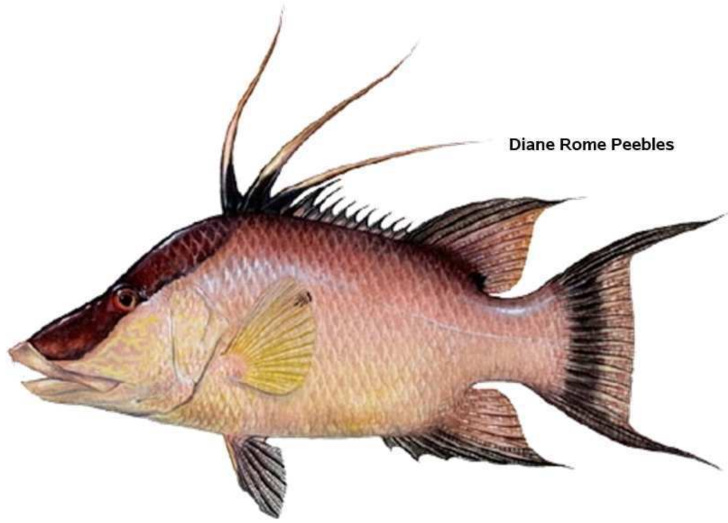

The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico

Section II: Data Inputs

Wade Cooper, Angela Collins, Joe O’Hop, Dustin Addis

Florida Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
100 Eighth Ave Southeast
St. Petersburg, Florida 33701-5020

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4 Introduction to Data Inputs

4.1 Terms 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 growth, maturation, and fecundity by age, sex, or length as applicable.
   - Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.

3. Recommend discard mortality rates.
   - Review available research and published literature
   - Consider research directed at these species as well as similar species from the SE and other areas.
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata.
   - 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.

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.
   - 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 are considered adequate and reliable for use in assessment modeling.
   - 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 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.

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.

7. 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.

4.2 List of Working Papers and Documents

SEDAR37-01	Seyoum S, Collins AB, Puchulutegue C, McBride RS, Tringali MD. 2014. Genetic population structure of Hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States.
SEDAR37-02	Cooper W. 2014. Commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2012.
SEDAR37-03	Cooper W. 2014. Recreational catch per unit effort of Hogfish (*Lachnolaimus maximus*) in the Southeast US using MRFSS-MRIP intercept data, 1991-2012.
SEDAR37-04	Cooper W. 2014. Relative index of abundance from visual order-of-magnitude REEF surveys applied to Hogfish (*Lachnolaimus maximus*) in the Southeast US, 1994-2012.
SEDAR37-05	Switzer TS, Keenan SF, McMichael RH Jr, DeVries DA, Gardner CL, Raley P. 2013. Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reef-fish video surveys on the West Florida Shelf, 2005-2012.
SEDAR37-06	Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual FWRI SEAMAP trawl survey, 2008-2012.
SEDAR37-07	Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual baitfish survey, 2002-2012.
SEDAR37-08	Switzer TS, Keenan SF, McMichael RH Jr, Fischer KM. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from polyhaline seagrasses of the Florida Big Bend, 2008-2012.
SEDAR37-09	Smith SG, Ault JS, Bohnsack JA, Blondeau J, Acosta A, Renchen J, Feeley MJ, Ziegler TA. 2013. Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reef-fish visual surveys in the Florida Keys and Dry Tortugas, 1994-2012.

SEDAR37-10	Bachelor and Reichert. 2014. Summary information for Hogfish *Lachnolaimus maximus* seen on videos collected by the SouthEast Reef Fish Survey in 2010 – 2012 between North Carolina and Florida.
SEDAR37-11	Hiltz et al. 2014. Standardization of commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from South Carolina Trip Ticket landings, 2012.
SEDAR37-12	McCarthy. 2014. Analysis of Hogfish data from Coastal Fisheries Logbook Program (CFLP).
SEDAR37-13	Collier. 2014. Standardization of commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from North Carolina Trip Ticket landings.

5 Life History

5.1 Overview

Nelson et al. (2006) assigned the following taxonomic classification to Hogfish:

Kingdom: Animalia
- Phylum: Chordata
  - Subphylum: Vertebrata
    - Class: Actinopterygii
      - Order: Perciformes
        - Family: Labridae (wrasses)
          - Genus: *Lachnolaimus*
            - Species: *maximus* (Walbaum 1792)

Common names include: Hogfish, Hog Snapper (English); Boquinete, Doncella de Pluma, Jaqueton Blanco, Pargo Gallo (Spanish); and Labre Capitaine (French).

The species is currently listed on the IUCN Red List as 'Vulnerable,' (http://www.iucnredlist.org/details/11130/0)

5.2 Review of Working Papers

5.2.1 Genetic Stock Definition (Seyoum et al. 2014 SEDAR37-01)

See section 5.3 for an overview of the stock definition and description based on genetic analyses by Seyoum et al. (2014).

5.3 Stock Definition and Description

Based upon recent genetic analyses that demonstrated a distinct spatial structure of the Hogfish population in the eastern U.S. (Seyoum et al., 2014), this assessment treated Western Florida (WFL), the Florida Keys including the Dry Tortugas and Eastern Florida (FLK/EFL), and the Georgia through North Carolina (GA-NC) areas as separate stocks in both the data inputs and assessment models. Hereafter, the preceding stock abbreviations will be used to denote the three stocks (WFL, FLK/EFL, GA-NC). Despite the history of using alternative labels to refer to stock areas in the literature (e.g., eastern Gulf of Mexico vs. South Florida; McBride and Richardson 2007), the labels used herein were chosen to explicitly denote the boundaries for which the stocks are delineated.

5.3.1 Stock Structure/Definition

Hogfish have been managed as a single stock within the United States since initial regulations were implemented in 1994 by the State of Florida. Landings within the US occur predominantly within state and federal waters adjacent to the state of Florida. Management regulations are consistent between state and federal waters throughout their US range. Genetic data were not available for this species prior to 2013, so previous stock assessments have treated Hogfish as a single stock (Ault et al., 2003). However, recent genetic analyses by Seyoum et al. (2014) have demonstrated distinct stocks between the eastern Gulf of Mexico (WFL), the Florida Keys and southeast Florida (FLK/EFL), and the Carolinas (GA-NC).

5.3.2 Population Genetics

Hogfish occur in warm temperate to tropical waters of the western Atlantic Ocean, and are observed from Brazil to Bermuda, as well as throughout the Caribbean and Gulf of Mexico. A suite of 24 microsatellite loci were used to examine the genetic structure of Hogfish collected from the eastern Gulf of Mexico (Florida Panhandle to the Florida Keys), the south east coast of Florida (Florida Keys to Jupiter), and off the coast of the Carolinas (North and South Carolina) (Seyoum et al., 2014). Although there was a discontinuity in sample coverage (notably a lack of samples between the central east coast of Florida (Jupiter) and South Carolina), three distinct clusters emerged. The WFL stock included samples collected from the Panhandle of Florida south along the west Florida shelf, and converged with the FLK/EFL stock south of Naples. The FLK/EFL stock included samples collected south of Naples, through the Florida Keys and up the southeastern coast of Florida. Hogfish collected off the coast of the Carolinas fell into the third cluster, and were genetically distinct from the two Florida groups. These analyses support the treatment of the Hogfish as three distinct stocks during this assessment. There is a noted lack of genetic information from other areas of the species' geographic range (namely, the western Gulf of Mexico, the wider Caribbean, Bermuda and South America), so further efforts are needed to collect samples that will better define population genetics throughout the South Atlantic and Gulf of Mexico.

5.3.3 Distribution

Hogfish occur in tropical, subtropical and warm temperate waters of the Atlantic Ocean (Brazil to Bermuda), and throughout the Gulf of Mexico and Caribbean Sea. After a planktonic larval phase (30 – 40 days), juvenile Hogfish settle nearshore in estuaries, seagrass beds or shallow reef habitats (Davis, 1976; Colin, 1982; Ault et al. 2003), and gradually move offshore with growth (Collins and McBride 2011). Adults are typically associated with hard bottom, reef habitats, and individuals have been observed as deep as 65 m (Collins and McBride 2011). Hogfish are visual predators that feed primarily during daylight hours on benthic invertebrates (Randall and Warmke, 1967), so their depth range is likely limited by light availability and food sources.

5.4 Mortality

5.4.1 Natural Mortality

For this assessment, natural mortality estimates were computed using a number of age-constant and age-specific methods from available fisheries independent and dependent data sources. For all analyses, the maximum age was assumed to be 25 yr as in McBride and Murphy (2003), which corresponds well to the maximum age observed from sampling the WFL stock (23yr, section 5.5.3); the growth parameters used were from section 5.5.4; the weight-length conversions used were from section 5.5.2; the age at 50% maturity was set to 0.9 (Collins and McBride 2008); and the average temperature was set to 24°C based on fisheries-independent monitoring data from Florida. Table 5.4.1.1 presents the age-constant estimates, and table 5.4.1.2 presents the age-specific estimates.

5.4.2 Release Mortality

Hogfish are primarily landed by spearfishing, so there are minimal data regarding catch and release mortality. Anecdotal reports indicate that hook and line gear are being increasingly used to target the species (Captains Pat Bennet and Ed Walker, personal communication); however, release mortality is still suspected to be minimal due to the fact that most Hogfish in deeper water (where barotrauma is more likely to occur) are of legal size (> 12" FL; Collins and McBride 2011), and are therefore unlikely to be released under the current management regime (12" FL minimum size limit and no closed seasons). The extent of mortality due to divers shooting sublegal fish is unknown. For the purpose of this assessment, a discard mortality rate of 10% was assumed for hook and line gear and 100% for spear gear.

5.5 Age and Growth

5.5.1 Available Length and Age Data

A total of 13,282 length and 2,592 age observations were obtained from multiple data sources, including: (1) fisheries dependent sampling programs in the southeastern US (Trip Interview Program (TIP), Head Boat Survey (HBS), and MRFSS/MRIP recreational programs); (2) fisheries independent surveys (FWRI sampling programs in the WFL stock: video surveys, SEAMAP, baitfish cruises, juvenile seagrass sampling, see Switzer et al. working documents; and UM-NMFS Reef Visual Census (RVC) surveys along the Florida Keys and Dry Tortugas, see Smith et al. 2013 working document), and (3) dedicated life-history studies on Hogfish conducted by FWRI in both the WFL and FLK/EFL stocks through grant-funded projects from 1995-2001 (McBride and Murphy 2003, McBride and Johnson 2007, McBride and Richardson 2007, McBride et al. 2008) and 2005-2007 (Collins and McBride 2008, Collins and McBride 2011). Raw data observations and ages from the FIM sampling and life-history studies were provided by T. Switzer and A. Collins (FWCC-FWRI). Otoliths for aging were obtained primarily from the NMFS Panama City and Beaufort Laboratories and from FWRI sampling programs. All otoliths obtained from the NMFS labs and from the fisheries independent sampling programs were aged by the FWRI laboratory. Otoliths from the life-history studies were aged following the methodology of McBride and Richardson 2007.

Length and age observations were relatively limited for Hogfish (Tables 5.5.1.1-5.5.1.4), particularly age observations from the commercial and recreational fisheries. The majority of age observations came from the life-history studies on Hogfish (69%) and secondarily from fisheries independent trawls (20%). Since the life-history studies were not included in the model as a survey (limited years in extent), the age and length observations were not used directly in the model. However, these data were used as the primary source for development of growth models used in each of the stock models. Age observations across stocks were limited for the fisheries, with a total sample across all years of n=26, 114, and 140, for the WFL, FLK/EFL, and GA-NC stock, respectively, with nearly all ages originating from recent years. The total number of length observations for the commercial fisheries was greater than the recreational fisheries (sometimes with >200 individuals per year), but commercial sampling was also more variable from year-to-year than the recreational sampling. Commercial fisheries for the WFL stock were the most poorly sampled, and the commercial fishery for the GA-NC stock had the highest number of length observations. While the number of observations for the recreational fisheries were less variable across years, length observations were fewer, often providing data from <50 individuals per year for the WFL and FLK/EFL stocks, and less from the GA-NC stock with 58 total observations from only 6 years, the majority of which were from 2011 and 2012.

5.5.2 Morphometric Models

Fork length (FL) is used as the preferred measurement for Hogfish (McBride and Johnson 2007, Collins and McBride 2011) because it is used in management for regulatory size (12” FL). Morphometric models were computed to convert observations with missing fork lengths from either standard lengths (SL; preferred) or total lengths (TL) using length-length regressions on the entire dataset of length observations discussed in 5.5.1. Additional weight-length regressions were performed on all available data that included both weight and length measurements. Due to lack of biological evidence for differences in growth across the genetic stock boundaries, and because of the limited amount of length and age observations for both the FLK/EFL and GA-NC stock, all models were done using all data combined.

Length-length regressions (cm) fit to all available data (n=2,232 FL-SL conversions; n=2,352 FL-TL conversions) resulted in the following models (Figure 5.5.2.1):

$$FL(cm) = 9.721758 + 1.180927*SL(cm) \qquad R^2=0.9966 \qquad \text{eq. 5.5.2.1}$$

$$FL(cm) = 12.4636084 + 0.8618861*TL(cm) \qquad R^2=0.9936 \qquad \text{eq. 5.5.2.2}$$

A weight-length regression fit to all available data (n=3,919) using total weight (grams) and FL (cm) resulted in the following model (Figure 5.5.2.2):

$$Weight(g) = 0.000095*FL^{2.74522} \qquad \text{eq. 5.5.2.3}$$

5.5.3 Maximum Age

Hogfish have been aged to 23 years (McBride and Richardson, 2008). As monandric, protogynous hermaphrodites, the oldest and largest fish are male. The oldest female aged to date was 10 years of age (685 mm FL; Collins and McBride 2011); all fish older than 10 are expected to be male.

The maximum age observed from the age observations discussed in section 5.5.1 was 23 years for two Hogfish sampled from the WFL stock during the life-history study (1995 – 2001; McBride and Richardson 2007). This study additionally sampled single Hogfish of ages 21 and 22 yrs old from the WFL stock (McBride and Richardson 2007). A second study within this region (2005 – 2007) sampled three 19-year old Hogfish as well as one Hogfish aged to 18 years from the GA-NC stock (Collins and McBride 2008). One individual of age 21 years was also sampled in the GA-NC stock in 2011 from the commercial TIP program. Hogfish in the eastern Gulf (WFL) and off of the Carolinas (GA-NC) reach larger sizes and greater ages than those in the FLK/EFL region (McBride and Richardson, 2008; Collins and McBride, 2011).

5.5.4 Growth

Growth was modeled with a von Bertalanffy model fit to a subset of the available age and length data using fork-length observations from the life-history studies of the WFL stock. Only the WFL stock observations were used due to the limited range of length and age observations in both the FLK/EFL and GA-NC stock, and only those WFL observations from the life history studies were used since all aging from these studies were done using the same methodology (McBride and Richardson 2007) with the same secondary reader. These data represent the largest proportion of the available aging data for a single data source (1,063 observations of the 2,592 total; Table 5.5.1.1). Data from the 1995-2001 life-history study from the FLK/EFL stock were not included in the growth analysis due to this stock having a truncated age distribution, currently assumed to be representative of higher exploitation (McBride and Richardson 2007, McBride et al. 2008), and not due to genetic differences, although this possibility exists (Seyoum et a. 2014).

The von Bertalanffy growth model fit to all data collected from the WFL stock life-history research studies (n=1,063), using FL (cm) and the expected age, resulted in the following model (Figure 5.5.4.1):

$$FL(cm) = 84.89885132*(1-e^{-0.1057678*(t+1.3290378)}) \quad \text{eq. 5.5.4.1}$$

Figure 5.5.4.1 shows the length at age samples from the different stocks, demonstrating the strong size/age truncation in the FLK/EFL stock (red circles) and the larger size/older age of individuals sampled in the GA-NC stock (blue triangles), relative to the WFL stock where lengths and ages existed across the entire range (black squares). The truncation in the FLK/EFL stock is likely a result of higher exploitation, which removes the larger and faster-growing individuals, thereby suppressing the estimated maximum length at age and leading to a perceived difference in growth rates. Despite the possibility of a unique growth curve for this stock based on genetic differences (Seyoum et al. 2014), the perceived differences in growth rates are currently assumed to be a result of differences in exploitation between the WFL and FLK/EFL stocks (McBride and Richardson 2007, McBride et al. 2008). The larger size and older age of individuals in the GA-NC stock are likely a result of fisheries selectivity, as the majority of length and age samples from this stock originated from the commercial hook-and-line fishery. Importantly, the distribution of length-at-age samples from the GA-NC stock occur in the same length and age range as those from the WFL stock (Figure 5.5.4.1), suggesting that the growth dynamics between stocks may be similar, despite lack of information for younger individuals from the GA-NC stock.

5.5.5 Length and Age Composition of Catches

Figures 5.5.5.1-5.5.5.15 present the length and age compositions by fishery, gear type, and year for the three separate Hogfish stocks. Figures 5.5.5.16-5.5.5.23 present the mean length with 95% confidence intervals by fishery, gear type, and year for the three separate stocks. Figures 5.5.5.24-5.5.5.26 present the density of length samples across all years by each fishery and gear, including the fisheries independent surveys. Finally, Figures 5.5.5.27-5.5.5.34 presents the length compositions standardized across year (z-score) to depict the changes in size composition from year to year for each fishery and gear combination.

5.6 Reproduction

5.6.1 Reproductive Characteristics

Hogfish are monandric, protogynous hermaphrodites that form harems. All fish mature as females first, and are expected to eventually become male if they live long enough. A single male maintains harems of 5 – 15 females (Colin, 1982; Munoz et al., 2010) during extended spawning seasons that last for months. Hogfish are pair spawners (Davis 1976; Colin 1982), and spawning occurs daily during spawning season (McBride and Johnson, 2007; Collins and McBride 2008; Munoz et al., 2010). The size (197 – 727 mm FL) and age (1 – 11 yr) range at which sexual transition occurs indicates that transition is socially mediated (Collins and McBride, 2011). Sex change can take several months (McBride and Johnson 2007), so removal of the dominant male has the potential to significantly affect harem stability and decrease reproductive potential (Munoz et al., 2010).

5.6.2 Spawning Season

Peak spawning activity for this species has been repeatedly demonstrated to occur during the winter and spring months (Davis 1976; Colin, 1982; Claro et al., 1989; McBride and Johnson, 2007; Collins and McBride, 2008; Munoz et al 2010). These studies have demonstrated that spawning activity occurs predominantly during the months of December through April, and begins (and ends) slightly earlier in the Florida Keys than on the West Florida shelf (Davis, 1976; McBride et al., 2008). Large Hogfish collected in deeper water (> 30 m) on the west Florida shelf have shown evidence of a more protracted spawning season, and approximately 50% of females were reproductively active during all months except September (Collins and McBride 2008).

5.6.3 Age/Size at Maturity

Life history studies have estimated female size and age at 50% maturity to occur between 151.6 – 192.7 mm FL and 0.9 – 1.6 years (McBride et al., 2008; Collins and McBride 2011). Size and age at female maturation was significantly larger in the FLK region (192.7 mm FL, 1.6 y; McBride et al., 2008) than in WFL (McBride et al., 2008; Collins and McBride 2011). Males may occur as small as 197 mm FL, but size at 50% male maturity has been estimated as 416 mm FL and 7 years for the FLK and 426 and 6.5 years in WFL (McBride et al., 2008). Additionally, subsequent work in WFL demonstrated that Hogfish in this region will transition to male earlier and younger in shallow water (343 mm FL and 4.9 years versus 638 mm FL and 9.8 years within deep water).

Reproductive data from the 2005-2007 life history study conducted by FWRI (see section 5.5.1) were analyzed for this assessment to conform to the parameterizations of the stock assessment model for multiple processes (fecundity relationship, female age at maturity, age at male transition). For the female maturity function, only those Hogfish classified as immature or mature females, excluding those transitioning, were analyzed (n=320). Female maturity was modeled using the Stock Synthesis parameterization:

$$Maturity = \frac{1}{1+e^{-0.09815*(FL(mm)-154.69570)}} \qquad \text{eq. 5.6.3.1}$$

For the male transition, code was obtained from J. Walter (NMFS-SEFSC) to fit the 3-parameter hermaphroditic transition approach used in Stock Synthesis. Stock Synthesis models male transition as the probability of transitioning to a male at each age class using a cumulative normal function. This parameterization takes an inflection age and sigma parameter to model the cumulative normal, and additionally an asymptotic rate parameter for situations where the max age (i.e., plus group) in the model may still have some females (i.e., not 100% transition by the maximum age). For this analysis, all individuals sampled from the reproductive study were used (n=465) with the asymptotic rate was set equal to 1.0 (max age of 20 in model), which resulted in the parameter estimates μ=7.497628 and σ=2.153877.

5.6.4 Fecundity

Fecundity estimates are available only for the WFL and FLK/EFL stocks. Batch fecundities calculated from WFL samples ranged from 1,700 to 64,600 (n= 42 females, ranging 266 to 626 mm FL and 1 to 9 years old; Collins and McBride, in review). Highest estimates occurred during the peak spawning season (February – April). The maximum batch fecundity estimated for this study was 64,600 eggs, a value almost three times larger than that estimated previously for the WFL region (McBride et al. 2008; estimate = 21,400, n = 23), which is likely a result of the larger, older females collected in the later study (626 mm FL and 10 years versus 442 mm FL and 7 years). Only a low number of batch fecundity estimates exist for the FLK region (n=10), but they ranged 138 – 10,800 (McBride et al., 2008). Batch fecundity is positively and significantly correlated with female weight and length for both regions. Annual and lifetime fecundity for Hogfish in the FLK region was notably lower than WFL for all age-classes (McBride et al., 2008).

Similar to the maturity analysis (section 5.6.3), the reproduction data from the 2005-2007 life history study conducted by FWRI was obtained in order to parameterize the batch fecundity and potential annual fecundity (PAF) to match Stock Synthesis input options. For this analysis, batch fecundity data were available on n=42 individuals, and spawning fraction data were available on n=653 individuals. Using these data two separate fecundity models were computed: (1) a simple batch fecundity relationship where batch fecundity was modeled as a function of weight, assuming no changes in spawning frequency with size or age; and (2) a composite analysis where total annual fecundity was computed as a function of both batch fecundity and spawning frequency with age following a similar approach used by Porch et al. (2013) in SEDAR 31.

For the batch fecundity relationship, the following model was estimated (Figure 5.6.4.1):

$$Batch\ Fecundity = 839.001 * Weight(g)^{0.478} \qquad \text{eq. 5.6.4.1}$$

For the PAF approach, Stock Synthesis provides the option to input fecundity as an age-specific vector. Therefore, both batch fecundity and spawning frequency were modeled as a function of age. Batch fecundity used a similar parameterization as eq. 5.6.4.1 above, but with age in place of weight. For spawning frequency, a generalized additive model (GAM) was used to model the probability of spawning from the presence of mature oocytes (following Collins and McBride, in review, which produces similar values when using post-ovulatory follicles for Hogfish) as a function of both age and calendar date. The predicted model was then integrated over the days of the year to determine the total number of spawns per year for each age class, following the general approach of Porch et al. (2013). The PAF was then computed as the product of the model-estimated age-specific batch fecundity and age-specific spawning days per year. The batch fecundity relationship as a function of age was estimated as:

$$Batch\ Fecundity = 7773.0278 * Age(g)^{0.7843} \qquad \text{eq. 5.6.4.2}$$

Figure 6.5.4.2 presents the predictions form the GAM model for the spawning frequency, and figure 6.5.4.3 presents the predicted spawning days per year (GAM model integrated over all days of year), the batch fecundity as a function of age, and the composite PAF. Hogfish demonstrated a peak in spawning frequency between 5-7yrs of age, after which the spawning frequency declines with age. This phenomenon may be due to the preparation of females transitioning to males at these older age classes, which could potentially bias the analyses if those females were not classified as transitioning females. Irrespective, this decline in egg production will occur as females transition to males, leading to a peaked pattern for hermaphroditic species as the male sex ratio increases at older ages.

5.6.5 Sperm Limitation

For Hogfish, no information currently exists on the importance of sperm limitation, but sex transition can take a moderate amount of time (a few months; McBride and Murphy 2003; McBride and Johnson 2007). This delay in transition could lead to sperm limitation under high fishing pressure if males are targeted for removal and a female takes a substantial amount of time to transition and fill the male role in the harem (McBride and Johnson 2007; Munoz et al., 2010). When uncertainty exists in the importance of sperm limitation, simulation studies suggest that including both male and female spawning stock biomass (SSB) in reference point calculations should be used for assessments of protogynous stocks (Brooks et al. 2008). Under this scenario, development of fecundity estimates, while informative, may not be appropriate as they do not account for the uncertainty in sperm limitation.

5.6.6 Sex Ratio

Existing literature based upon visual survey data have estimated mean sex ratios (males: females) of 0.14 in WFL (Collins and McBride 2011), 0.10 Puerto Rico (Colin, 1982); 0.20 in Cuba (Claro et al., 1989). Colin (1982) and Muñoz et al. (2010) reported high site fidelity and restricted home ranges for Hogfish, especially during spawning season, and Collins and McBride (2011) did not see a significant difference in sex ratio across seasons, suggesting that Hogfish maintain territories over extended periods and do not 'aggregate' during certain times of the year.

5.7 Habitats and Movements

5.7.1 EFH, Habitat Quality and Ontogenetic Shifts

Juvenile Hogfish typically settle in polyhaline estuarine seagrass beds or nearshore reef habitats after a pelagic larval phase (Davis, 1976; Colin, 1982). As fish increase in size, they are assumed to leave shallow inshore areas and move gradually into deeper water (Davis, 1976; Collins and McBride 2011). Adults are most common over reef and hard bottom habitats that provide structural cover, and have been observed at depths >60 m. Their distribution is likely limited by light penetration and habitat and prey availability. Healthy benthic invertebrate infauna and epifauna are critical diet items (e.g., bivalves, crustaceans, echinoderms; Randall and Warmke, 1967), and severe red tides that cause widespread invertebrate die-off can result in Hogfish departure or mortality (A Collins, personal observation).

5.7.2 Movements and Migrations

There are little data regarding the movement patterns of Hogfish. Hogfish tagged in the Florida Keys as part of a telemetry study were shown to have high site fidelity and restricted home ranges (Lindholm et al., 2006). Further, Colin (1982) and Muñoz et al. (2010) reported high site fidelity and restricted home ranges during the spawning season for Hogfish at specific sites in Puerto Rico and the FLK, respectively. Although further study is needed regarding home range size and site fidelity outside of spawning periods, consistent sex ratios observed throughout the year (Collins and McBride 2011) suggest that Hogfish maintain home ranges and territories for extended periods. Removal of the dominant male does not appear to necessitate harem relocation; rather it is more likely that one of the females will transition to male or that a nearby male will fill the void.

5.8 Adequacy of Data for Assessment Analyses

Due to the dedicated life-history analyses conducted by FWRI from 1995-2001 and 2005-2007, substantial life-history information exists for Hogfish for the WFL and FLK/EFL stock. While differences in life-history between the stocks may exist (e.g., growth, reproduction), it remains unclear whether these measured differences are genetically controlled or due to the differences in exploitation between the regions (McBride and Richardson 2007, McBride et al. 2008).

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5.10 Tables

Table 5.4.1.1. Age-constant natural mortality estimated from the following suite of parameters dependent on the method: *K*=0.106 (growth coefficient), *t_0*=-1.33 (growth coefficient), *L_inf*=849.0 (growth coefficient), *t_max*=25 (maximum age), *P*=0.01 (proportion of individuals surviving to maximum age), *a_50*=0.9 (50% maturity at age), and *Temp*=24°C.

Method	**Equation**	***M yr^{-1}***
Alverson and Carney (1975)	**M** = 3**K**/(exp[0.38***K*****t_max**) − 1]	0.183
Rikhter and Efanov (1977)	**M** = [1.521/(**a_50**^0.720)] − 0.155	1.486
Pauly (1980)	**M** = exp[−0.0152 + 0.6543*ln(**K**) − 0.279*ln(**L_inf**/10) + 0.4634*ln(**Temp**)]	0.286
Hoenig (1983; regression)	**M** = exp[1.44 − 0.982*ln(**t_max**)]	0.179
Hoenig (1983; rule-of-thumb)	**M** = −ln(**P**) ⁄ **t_max**	0.184
Ralston (1987; linear regression)	**M** = 0.0189 + 2.06***K**	0.237
Jensen (1996; theoretical)	**M** = 1.50***K**	0.159
Jensen (1996; derived from Pauly 1980)	**M** = 1.60***K**	0.169
Hewitt and Hoenig (2005)	**M** = 4.22 ⁄ **t_max**	0.169

Table 5.4.1.2. Age-specific natural mortality estimated from the following suite of parameters dependent on the method: *K*=0.106 (growth coefficient), *t_0*=-1.33 (growth coefficient), *L_inf*=849.0 (growth coefficient), *t_max*=25 (maximum age), *P*=0.01 (proportion of individuals surviving to maximum age), *alpha*=0.000095 (weight-length conversion), and *beta*=2.75 (weight-length conversion).

	Lorenzen (1996)		**Lorenzen (2005)**	**Gislason et al. (2010)**
Age	***M* yr^{-1} *(unscaled)***	***M* yr^{-1} *(scaled)***	***M* yr^{-1}**	***M* yr^{-1}**
0	1.041	0.640	0.597	2.27
1	0.696	0.428	0.400	1.00
2	0.546	0.336	0.309	0.61
3	0.461	0.284	0.257	0.43
4	0.406	0.250	0.223	0.33
5	0.368	0.227	0.200	0.27
6	0.340	0.209	0.182	0.23
7	0.319	0.196	0.169	0.20
8	0.302	0.186	0.159	0.18
9	0.289	0.177	0.150	0.17
10	0.277	0.171	0.144	0.15
11	0.268	0.165	0.138	0.14
12	0.261	0.160	0.134	0.14
13	0.254	0.156	0.130	0.13
14	0.249	0.153	0.126	0.12
15	0.244	0.150	0.123	0.12
16	0.240	0.147	0.121	0.11
17	0.236	0.145	0.119	0.11
18	0.233	0.143	0.117	0.11
19	0.230	0.142	0.115	0.11
20	0.228	0.140	0.114	0.10
21	0.226	0.139	0.113	0.10
22	0.224	0.138	0.112	0.10
23	0.222	0.137	0.111	0.10
24	0.221	0.136	0.110	0.10
25	0.220	0.135	0.109	0.10

Table 5.5.1.1. Length observations per year, stock, and data type (Comm=commercial; Rec=recreational intercepts; FIM=fisheries independent monitoring; MARFIN/CRP= FWCC-FWRI biological sampling from multiple-year grant-funded life history studies on Hogfish).

	WFL				FLK/EFL				GA-NC			
Year	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**
1981						91						
1982		2				20						
1983		3				10						
1984						23						
1985						4			72	7		
1986		36				28			15			
1987		33				62			57			
1988		17			7	33			71			
1989		16			2	29			88			
1990		6			114	25			135			
1991	7	27			74	24			94			
1992		22			252	74			85			
1993	31	20			201	65			141			
1994	14	31			104	82			91			
1995	1	43		10	17	39		11	181			
1996	23	10		203	53	57		121	83			
1997	38	28		372	154	34		211	136			
1998	53	49		196	199	31		300	217			
1999	140	43		187	93	45		544	376			
2000	80	23			146	21		7	376			
2001	67	28		27	50	26		28	234			
2002	127	23			118	25			201			
2003	32	60			95	39			152			
2004		44			46	32			122			
2005	1	30		79	47	20			105			
2006	1	21		388	56	21		1	75			
2007	14	27	30	179	6	53		4	56	4		
2008	18	65	25		163	31			85	1		
2009	2	51	168		43	38			224			
2010	34	73	102		174	16			167	6		
2011	112	72	68		118	30			268	12		
2012	249	140	165		56	137			151	28		
Total	1044	1043	558	1641	2388	1265	0	1227	4058	58		

Table 5.5.1.2. Age observations per year, stock, and data type (Comm=commercial; Rec=recreational intercepts; FIM=fisheries independent monitoring; MARFIN/CRP= FWCC-FWRI biological sampling from multiple-year grant-funded life history studies on Hogfish).

	WFL				FLK/EFL				GA-NC			
Year	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**	**Comm**	**Rec**	**FIM**	**MARFIN/ CRP**
1981												
1982						1						
1983												
1984												
1985						1						
1986												
1987												
1988												
1989												
1990												
1991												
1992												
1993												
1994												
1995												
1996				108				35				
1997				210				175				
1998				67				188				
1999				39				311				
2000								6				
2001				22				22				
2002					6							
2003		4				1						
2004					10							
2005				72	2	3						
2006				374		1		1				
2007			26	171				3		4		
2008		1	23						1	1		
2009		3	141		11							
2010	1	1	91		18					5		
2011			67		36	2			49	10		
2012	9	7	160		17	5			50	20		
Total	10	16	508	1063	100	14	0	741	100	40		

Table 5.5.1.3. Length observations per year, stock, and gear type.

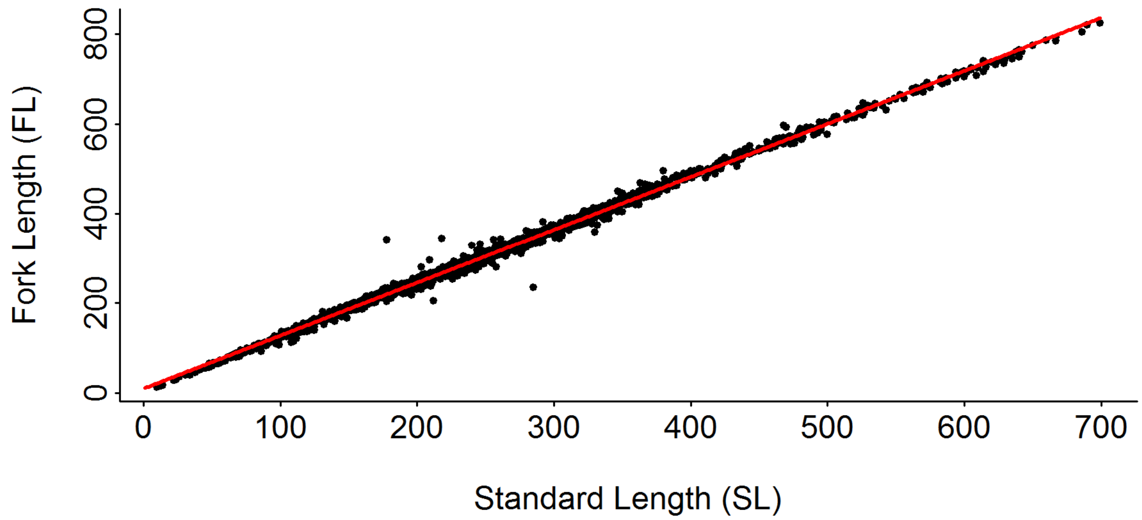
	WFL				FLK/EFL				GA-NC			
Year	**Hook & Line**	**Spear**	**Trap**	**Other/ Unkown**	**Hook & Line**	**Spear**	**Trap**	**Other/ Unkown**	**Hook & Line**	**Spear**	**Trap**	**Other/ Unkown**
1981					6	85						
1982		2			1	13		6				
1983				3				10				
1984								23				
1985					1			3	59			20
1986				36				28	15			
1987				33				62	32			25
1988				17		7		33	43			28
1989		16			20	11			87			1
1990				6	5	6	92	36	91			44
1991		7		27	33		38	27	72		3	19
1992				22	12	128	111	75	78	7		
1993	18	13	18	2	63	80	123		141			
1994	28	17			45	88	52	1	91			
1995	12	40		2	20	36	9	2	181			
1996	6	210	20		22	168	19	22	78	5		
1997	7	321		110	81	176	57	85	136			
1998	44	134	89	31	70	301	105	54	217			
1999	19	169	133	49	56	427	8	191	376			
2000	11	26	65	1	29	43	100	2	376			
2001	26	33	36	27	29	52	23		234			
2002	10	33	107		19	67	50	7	201			
2003	28	43	21		24	57	51	2	152			
2004	4	40			57	17	4		114	8		
2005	6	99		5	16	41	9	1	99	6		
2006	4	358		49	29	40	8	1	62	13		
2007	11	174	1	66	10	53			60	1		
2008	10	73		25	14	176	4		79	7		
2009	13	39	1	169	45	36			169	55		
2010	7	99	2	103	28	138	24		39	114		20
2011	33	151	1	68	22	116	10		142	106		48
2012	20	376	1	167	46	125	22		134	45		13
Total	317	2473	495	1018	803	2487	919	671	3558	367	3	218

Table 5.5.1.4. Age observations per year, stock, and gear type.

	WFL				FLK/EFL				GA-NC			
Year	Hook & Line	Spear	Trap	Other/ Unkown	Hook & Line	Spear	Trap	Other/ Unkown	Hook & Line	Spear	Trap	Other/ Unkown
1981												
1982					1							
1983												
1984												
1985					1							
1986												
1987												
1988												
1989												
1990												
1991												
1992												
1993												
1994												
1995												
1996		108				32	2	1				
1997		146		64		98		77				
1998	1	59		7		185		3				
1999		19		20		275		36				
2000						6						
2001				22		22						
2002							6					
2003	1	3			1							
2004					8	2						
2005		69		3	3	2						
2006	1	326		48	1	1						
2007		136	1	62		3			4	1		
2008	1			23					2			
2009	3		1	141	11							
2010	1	2	2	90	5	3	10		5			
2011			1	67	7	29	2		39	34		
2012		23	1	162	9	8	5		50	33		
Total	8	891	6	709	47	666	25	117	100	68		

5.11 Figures

Figure 5.5.2.1. Length-length regressions from all available fisheries-dependent and fisheries-independent data sources.



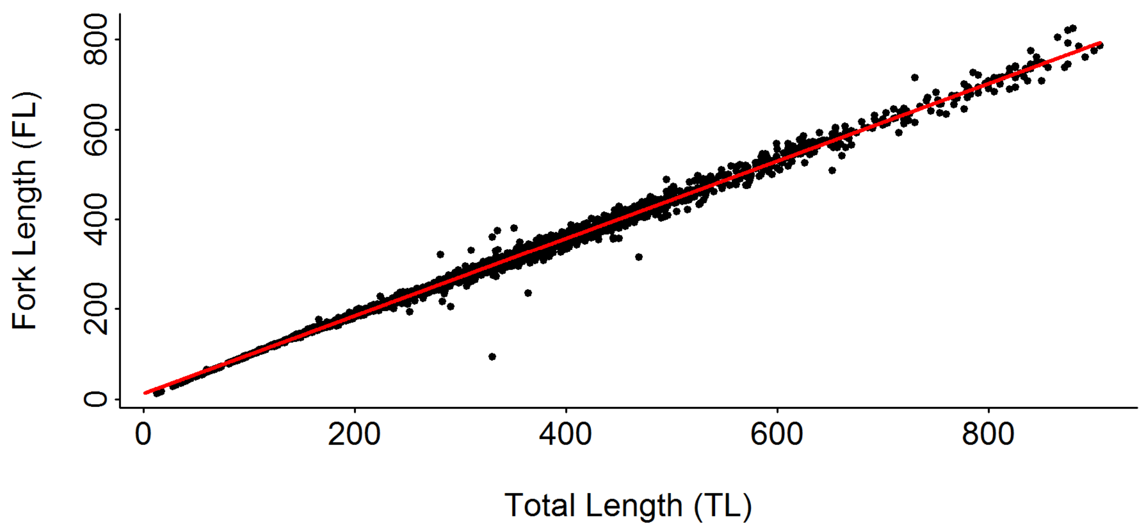


Figure 5.5.2.2. Weight-length regression from all available fisheries-dependent and fisheries-independent data sources.

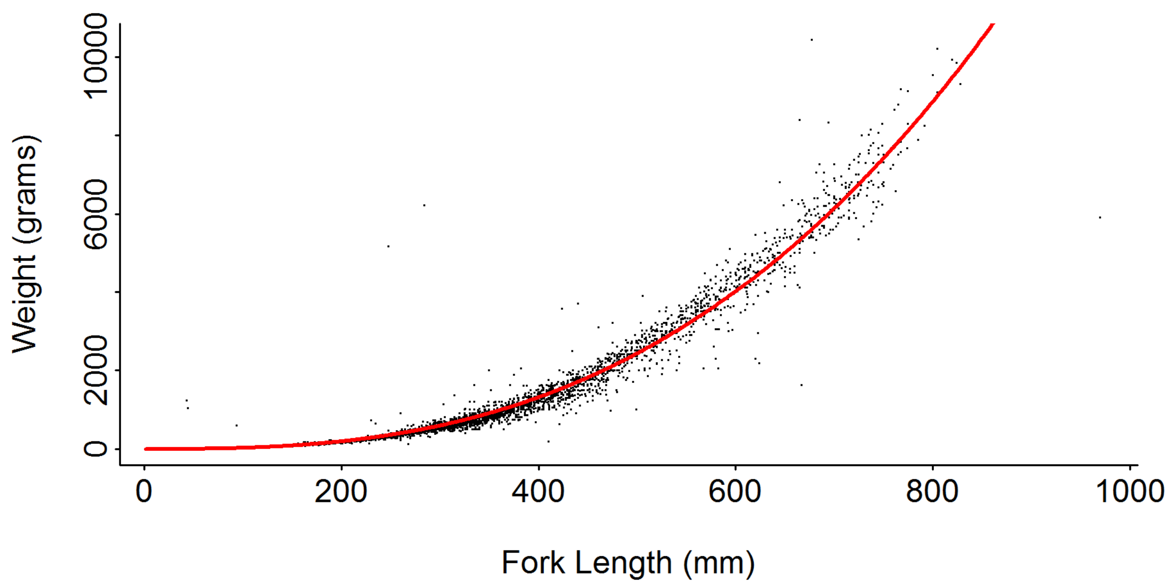


Figure 5.5.4.1. Size at age for each of the three stocks, where age class is adjusted to reflect the month of sampling (age+(month-1)/12). The solid black line is the von Bertalanffy growth function fit to just those data from the dedicated biological studies on Hogfish in the WFL.

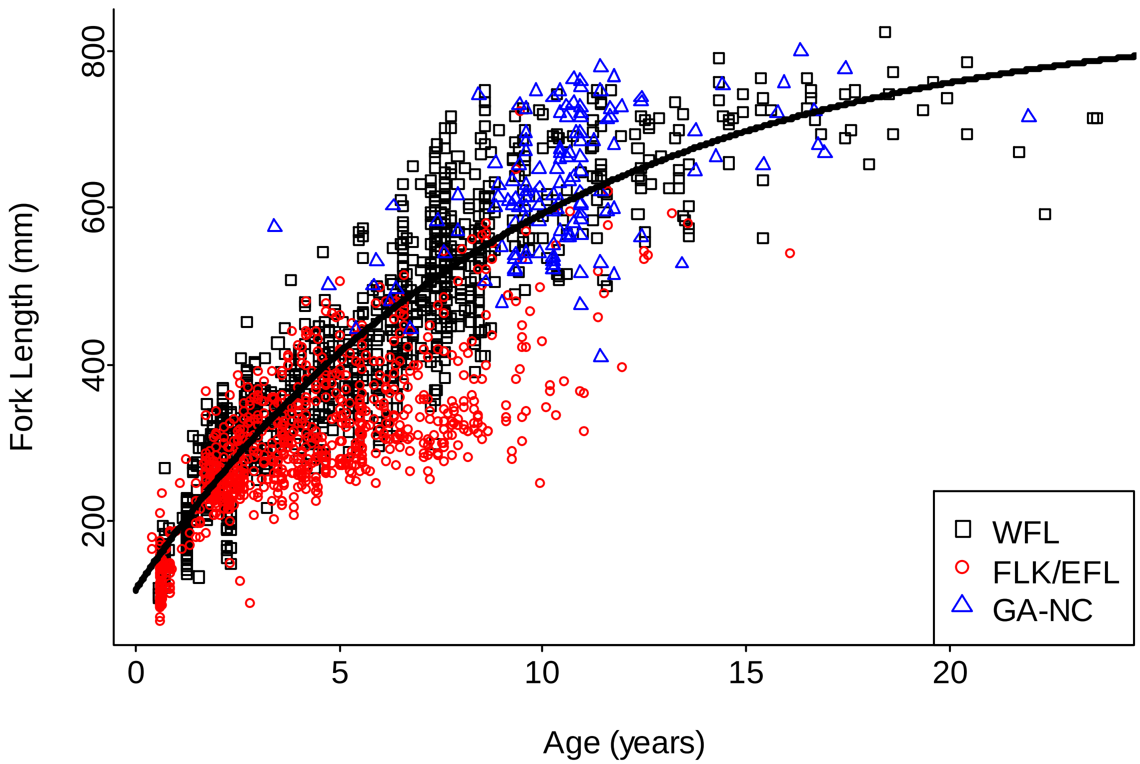


Figure 5.5.5.1. Length observations for the WFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

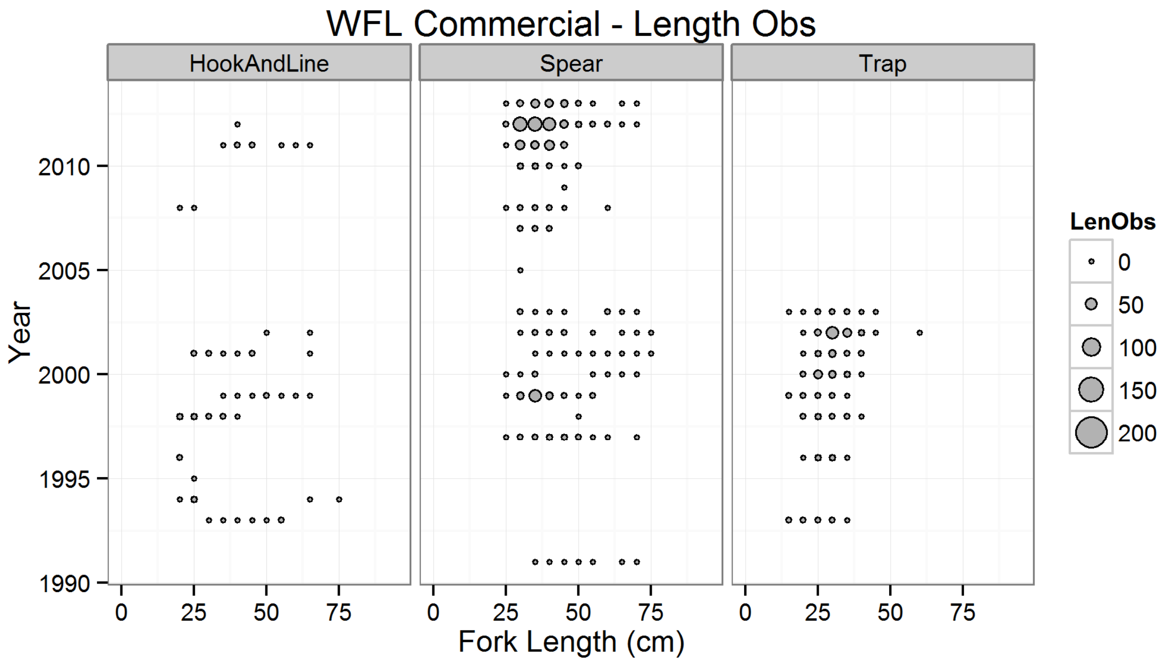


Figure 5.5.5.2. Age observations for the WFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

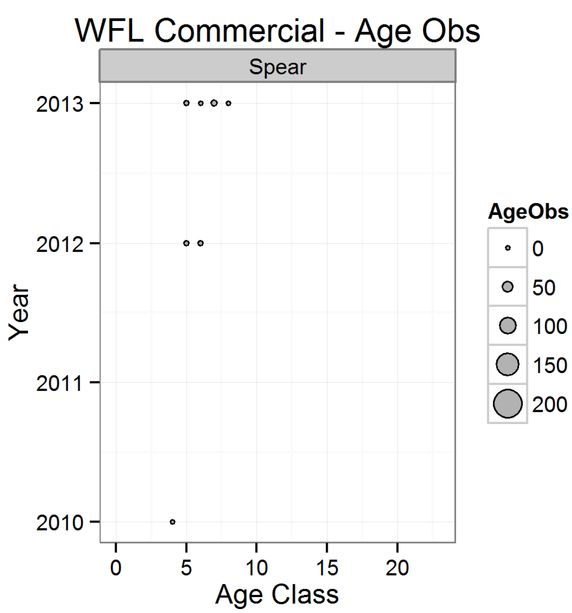


Figure 5.5.5.3. Length observations for the WFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

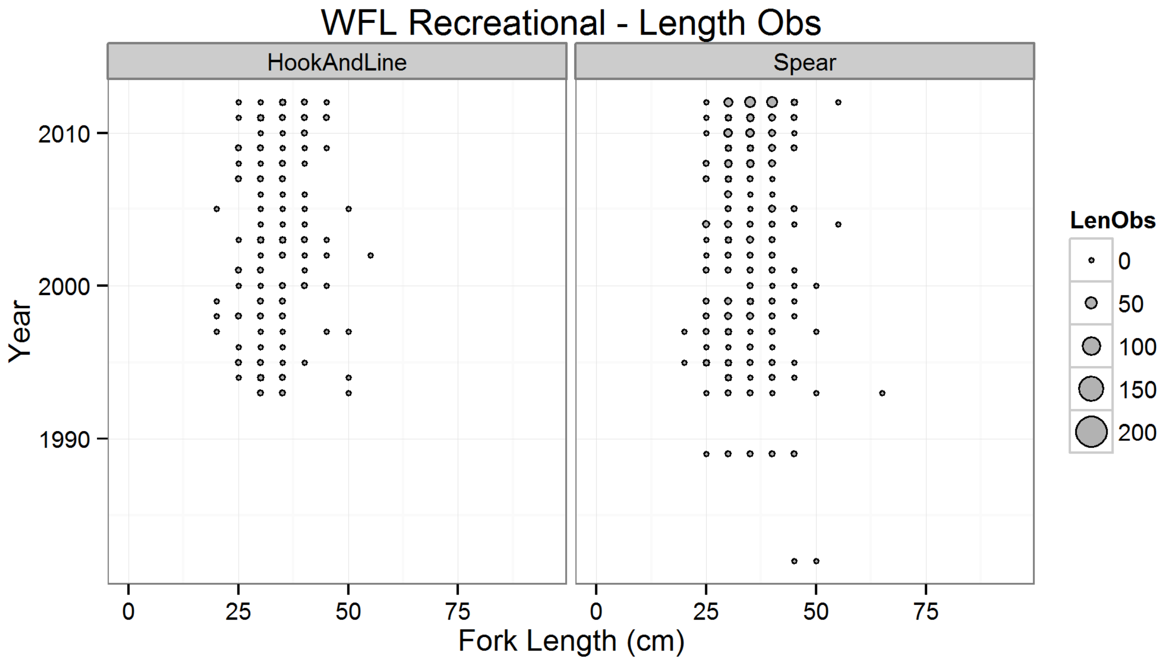


Figure 5.5.5.4. Length observations for the WFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

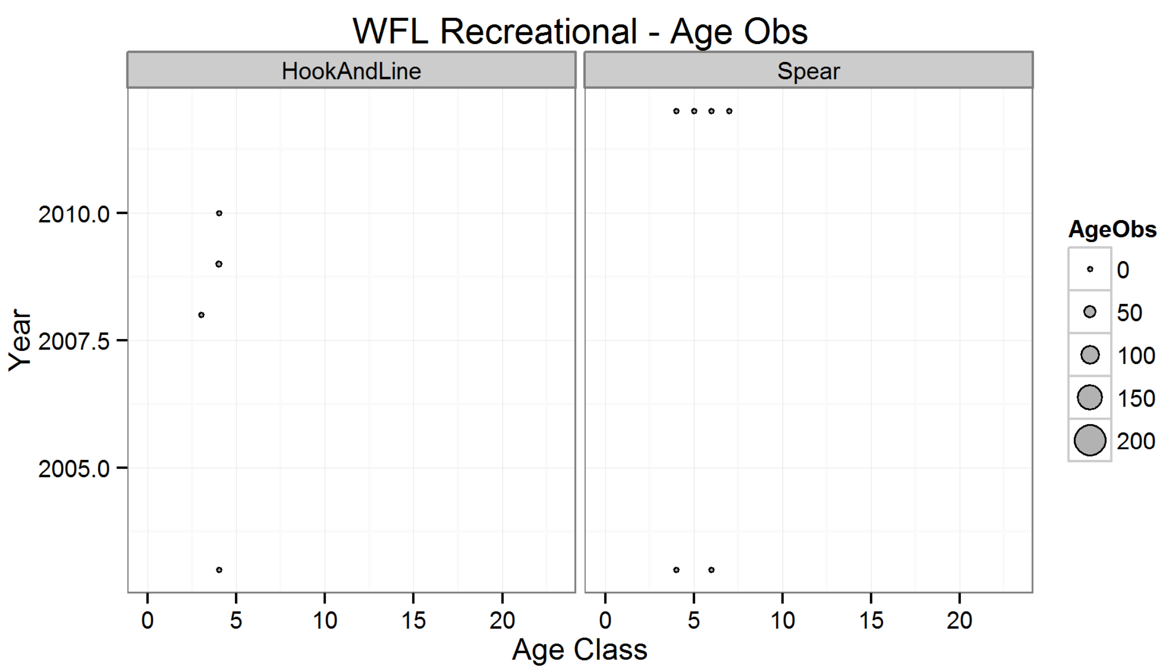


Figure 5.5.5.5. Length observations for the WFL stock fisheries independent surveys and life history studies (FWRI Research) by 5cm length bin and year for each gear type with available data.

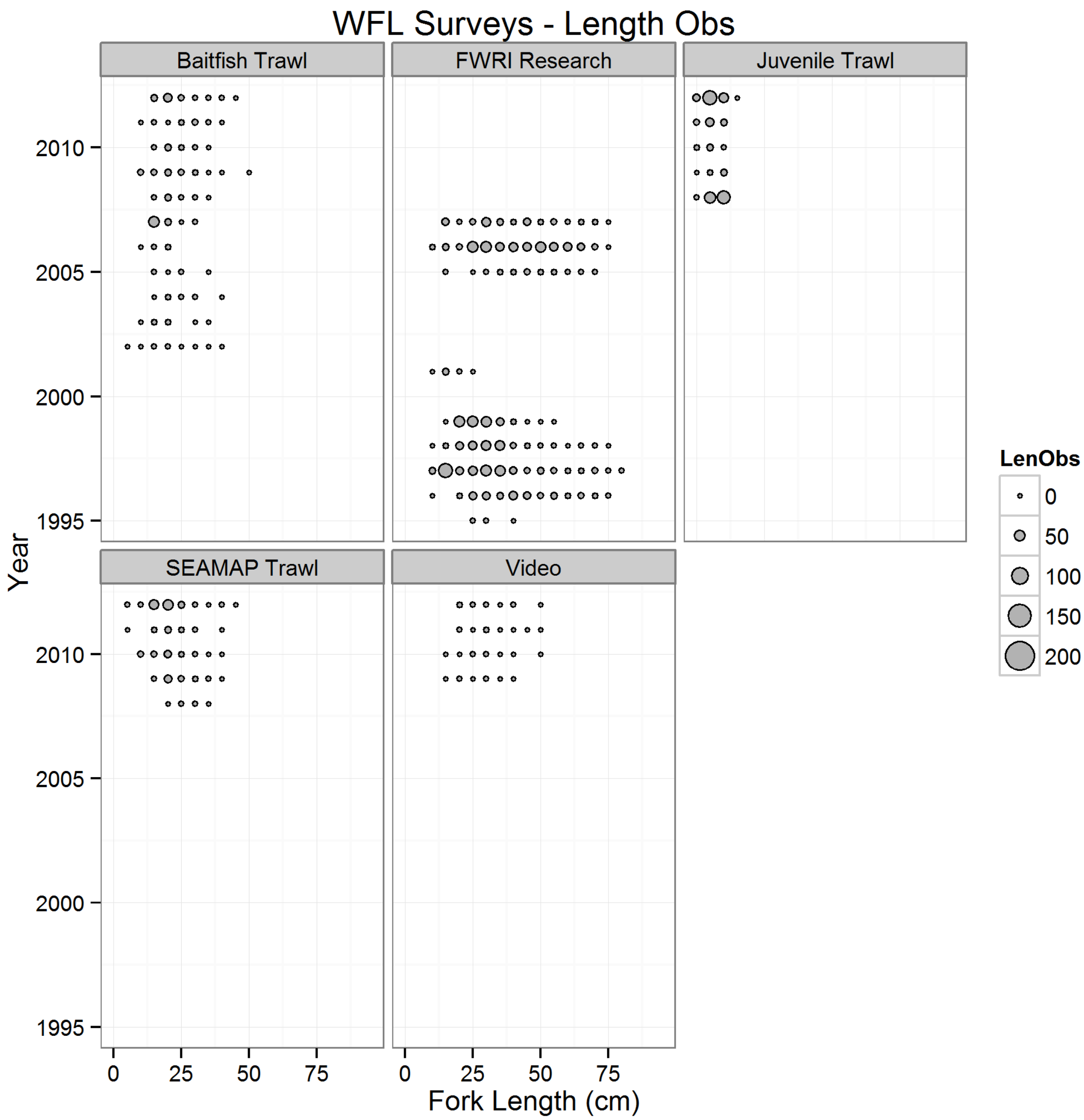


Figure 5.5.5.6. Age observations for the WFL stock fisheries independent surveys and life history studies (FWRI Research) by 5cm length bin and year for each gear type with available data.

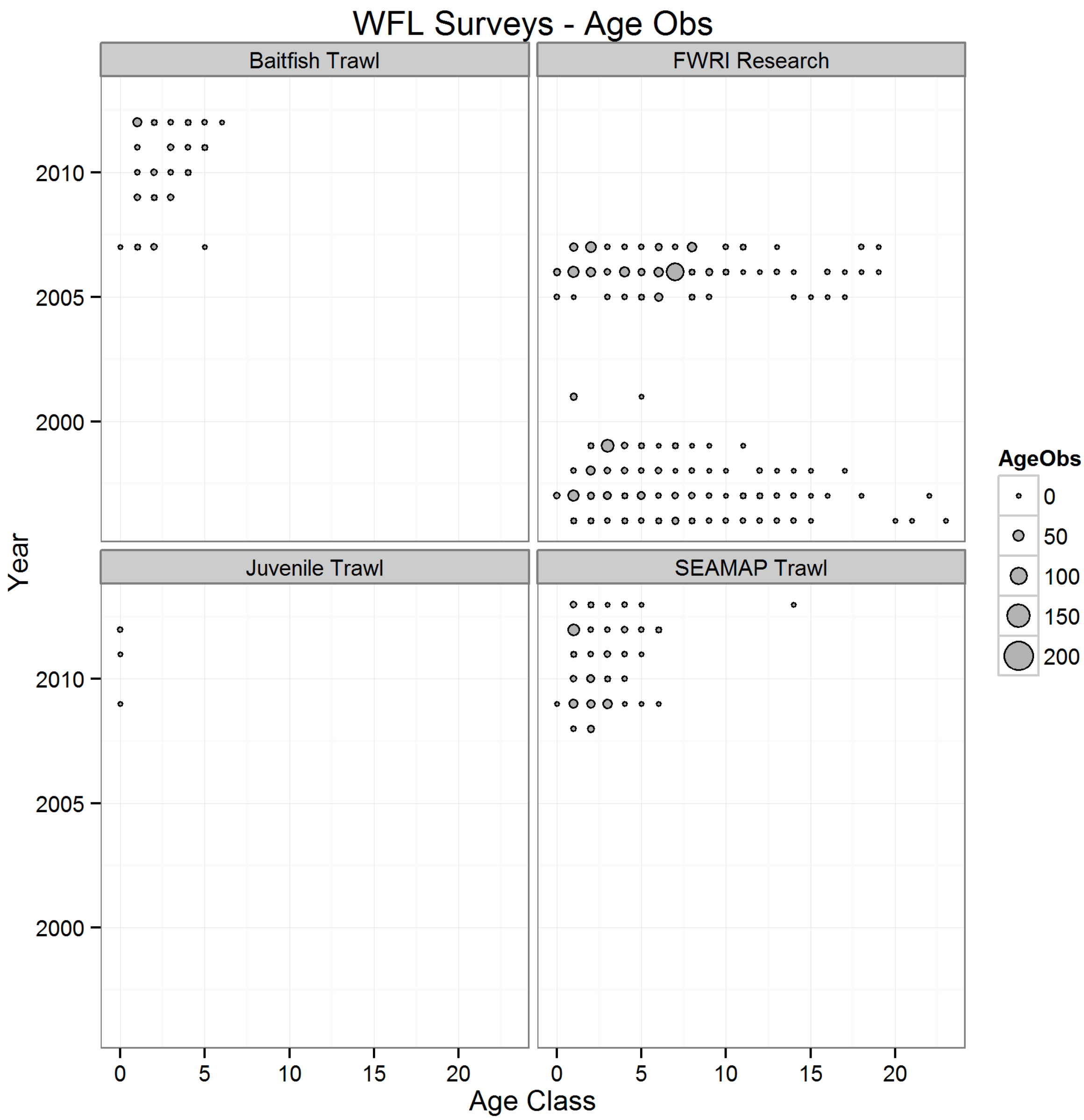


Figure 5.5.5.7. Length observations for the FLK/EFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

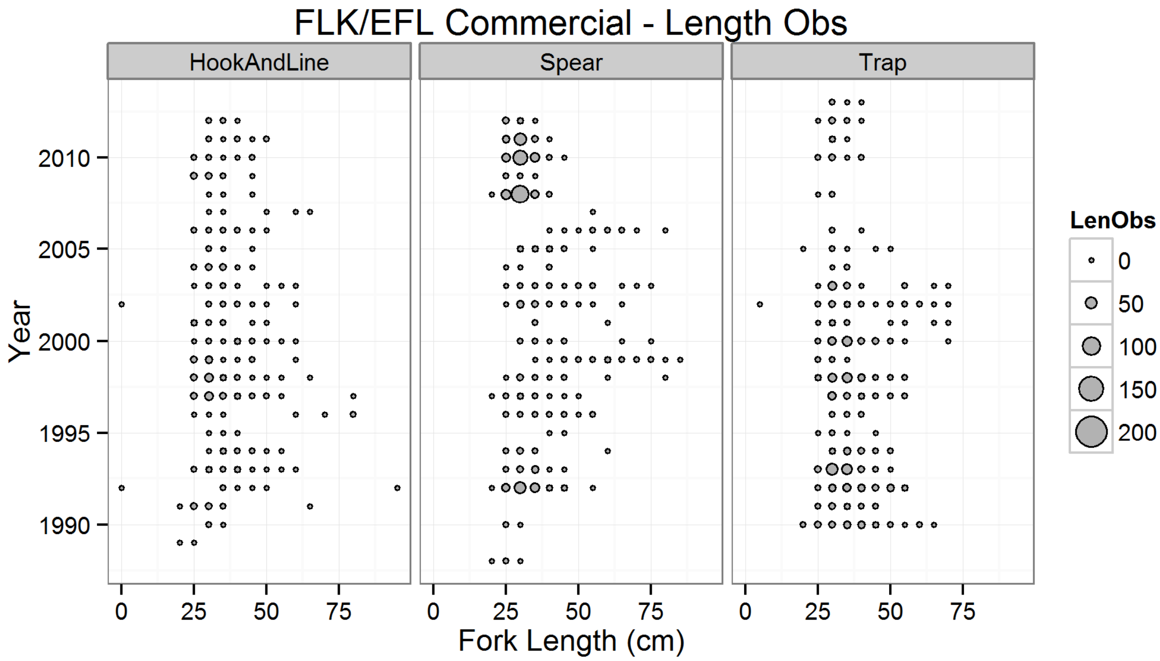


Figure 5.5.5.8. Age observations for the FLK/EFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

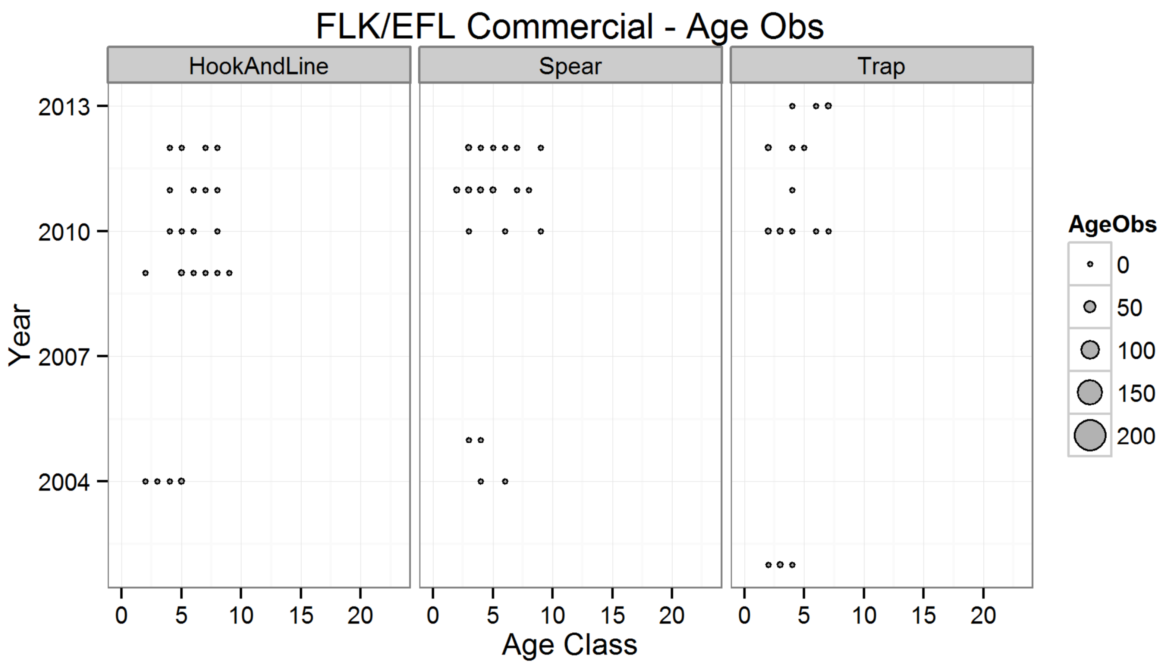


Figure 5.5.5.9. Length observations for the FLK/EFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

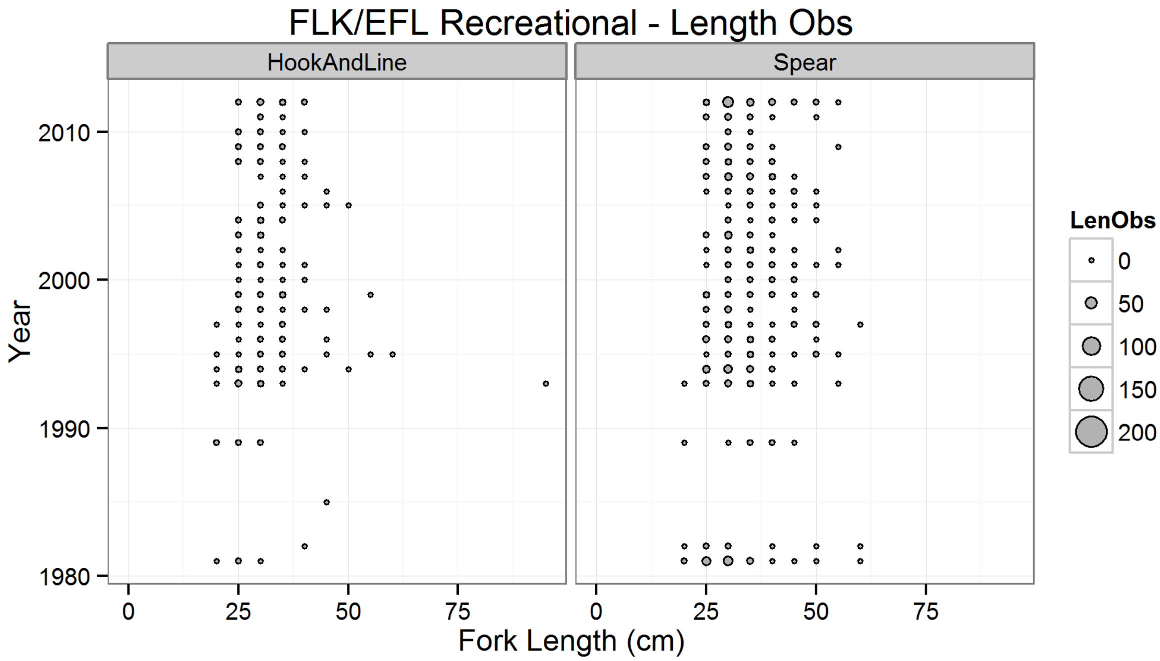


Figure 5.5.5.10. Age observations for the FLK/EFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

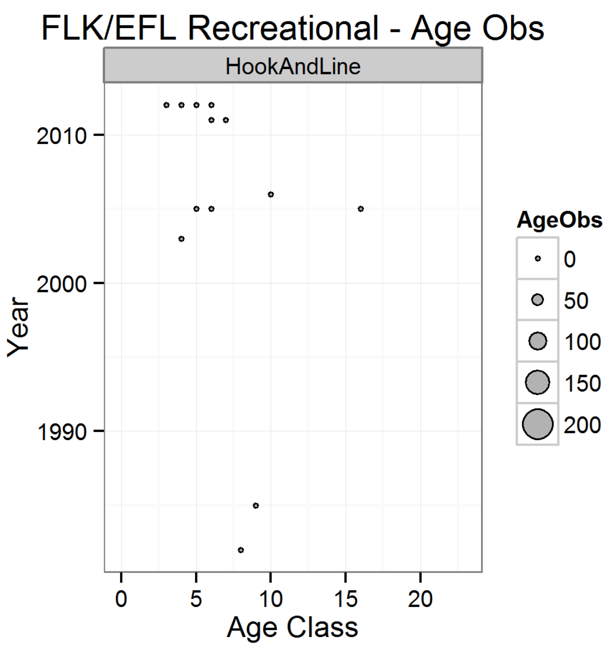


Figure 5.5.5.11. Length observations for the FLK/EFL stock fisheries independent survey (UM-NMFS RVC) by 5cm length bin and year for each gear type with available data.

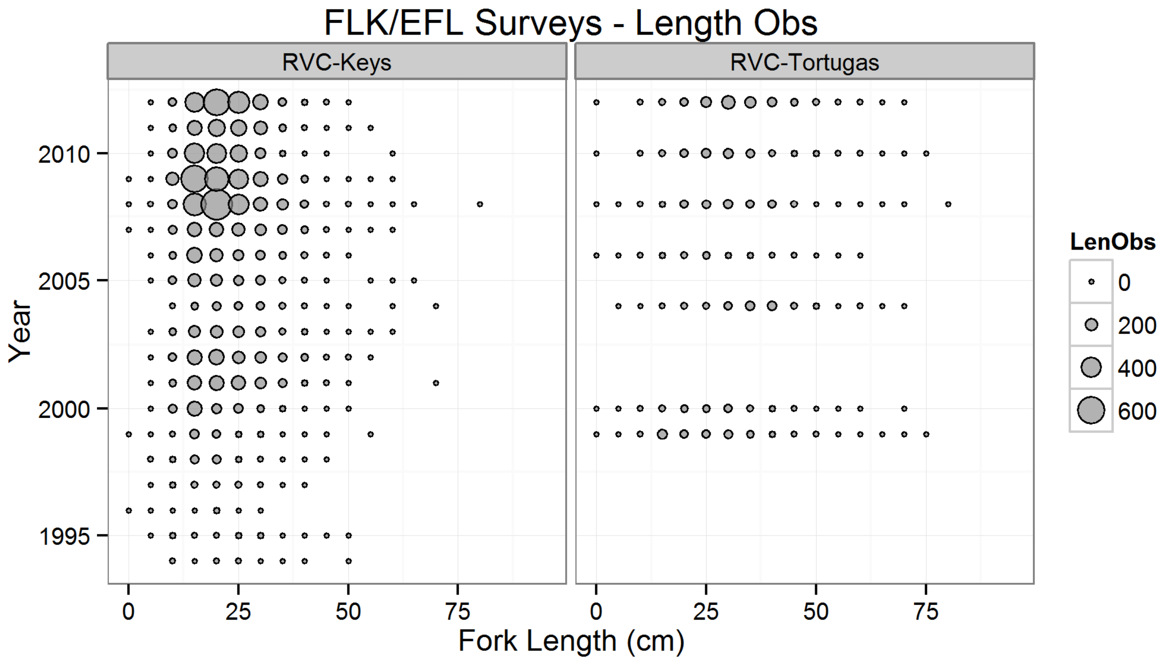


Figure 5.5.5.12. Length observations for the GA-NC stock commercial fisheries by 5cm length bin and year for each gear type with available data.

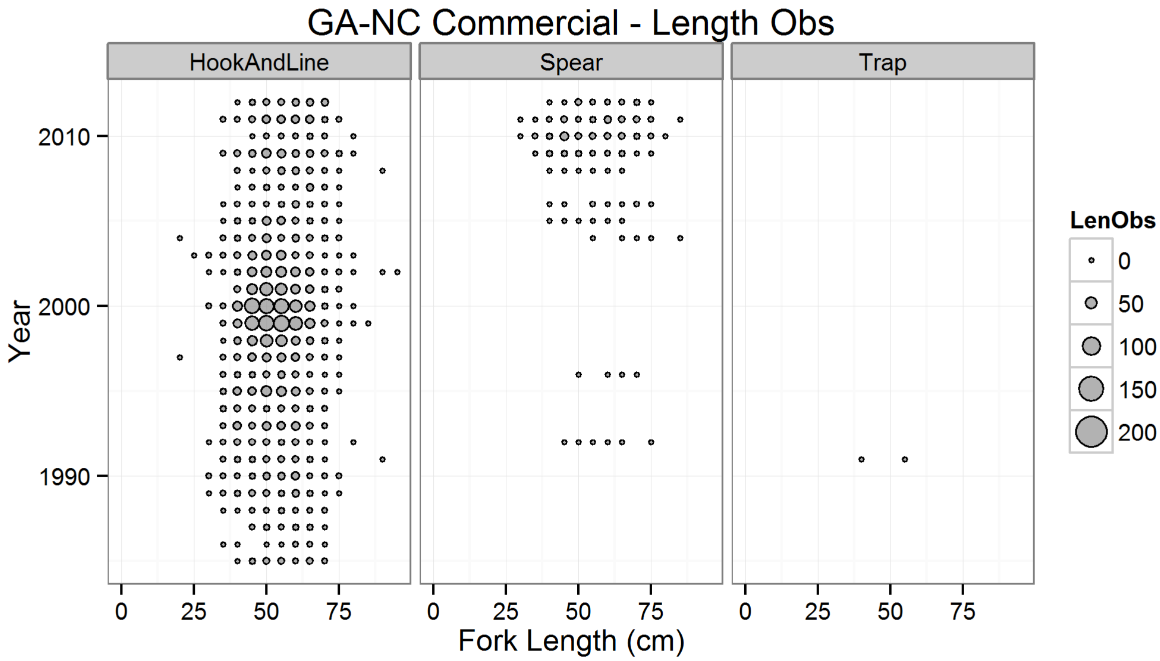


Figure 5.5.5.13. Age observations for the GA-NC stock commercial fisheries by 5cm length bin and year for each gear type with available data.

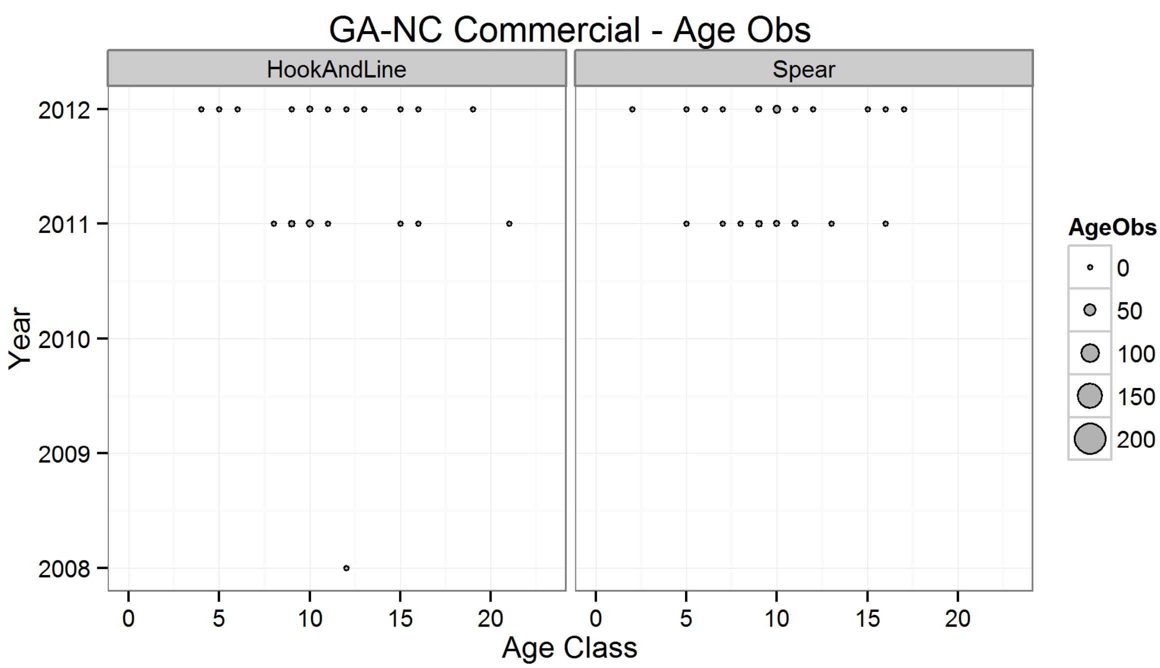


Figure 5.5.5.14. Length observations for the GA-NC stock recreational fisheries by 5cm length bin and year for each gear type with available data.

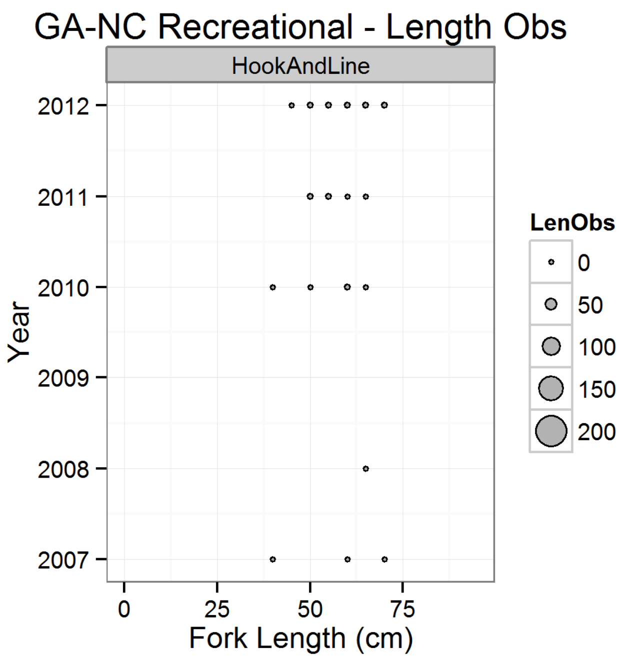


Figure 5.5.5.15. Age observations for the GA-NC stock recreational fisheries by 5cm length bin and year for each gear type with available data.

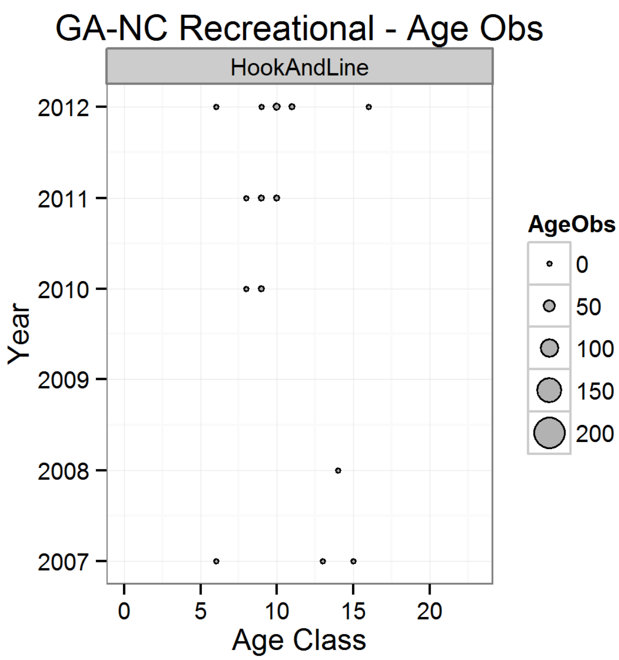


Figure 5.5.5.16. Mean length for the WFL stock commercial fisheries for each gear type and year with available data. Dashed line denotes the current 12" (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

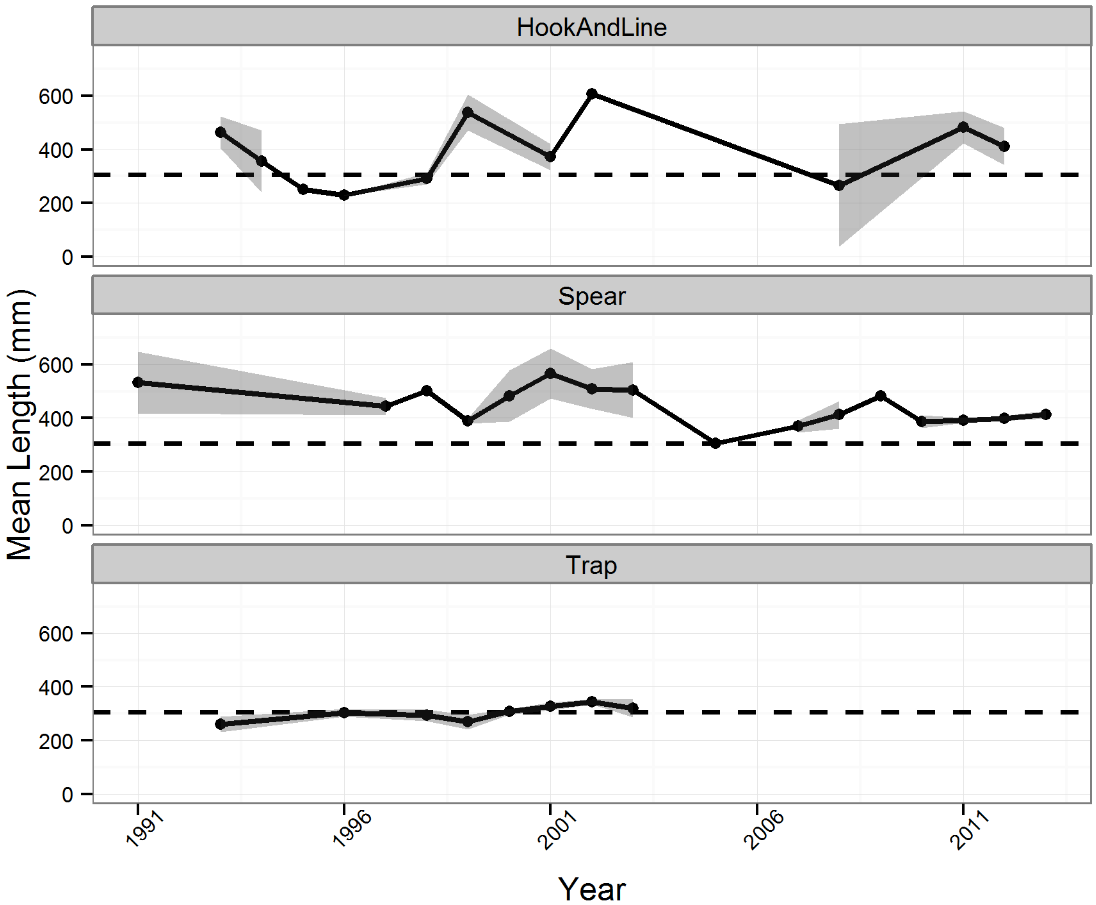


Figure 5.5.5.17. Mean length for the WFL stock recreational fisheries for each gear type and year with available data. Dashed line denotes the current 12” (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

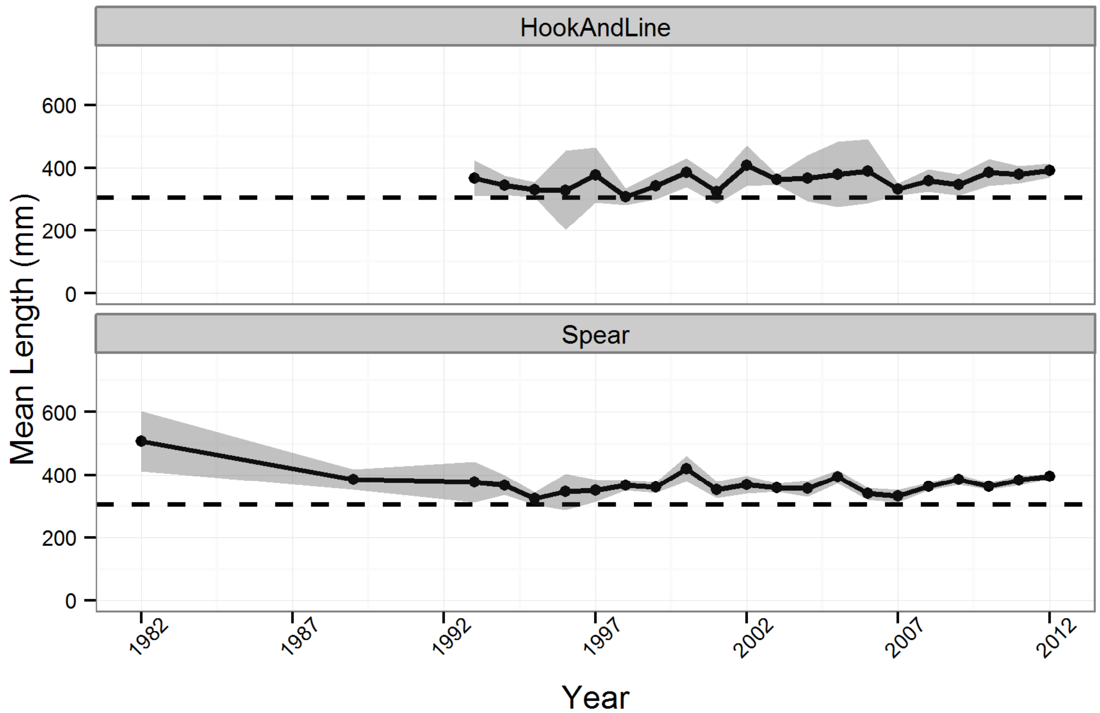


Figure 5.5.5.18. Mean length for the WFL stock fisheries independent surveys for each gear type and year with available data. Dashed line denotes the current 12" (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

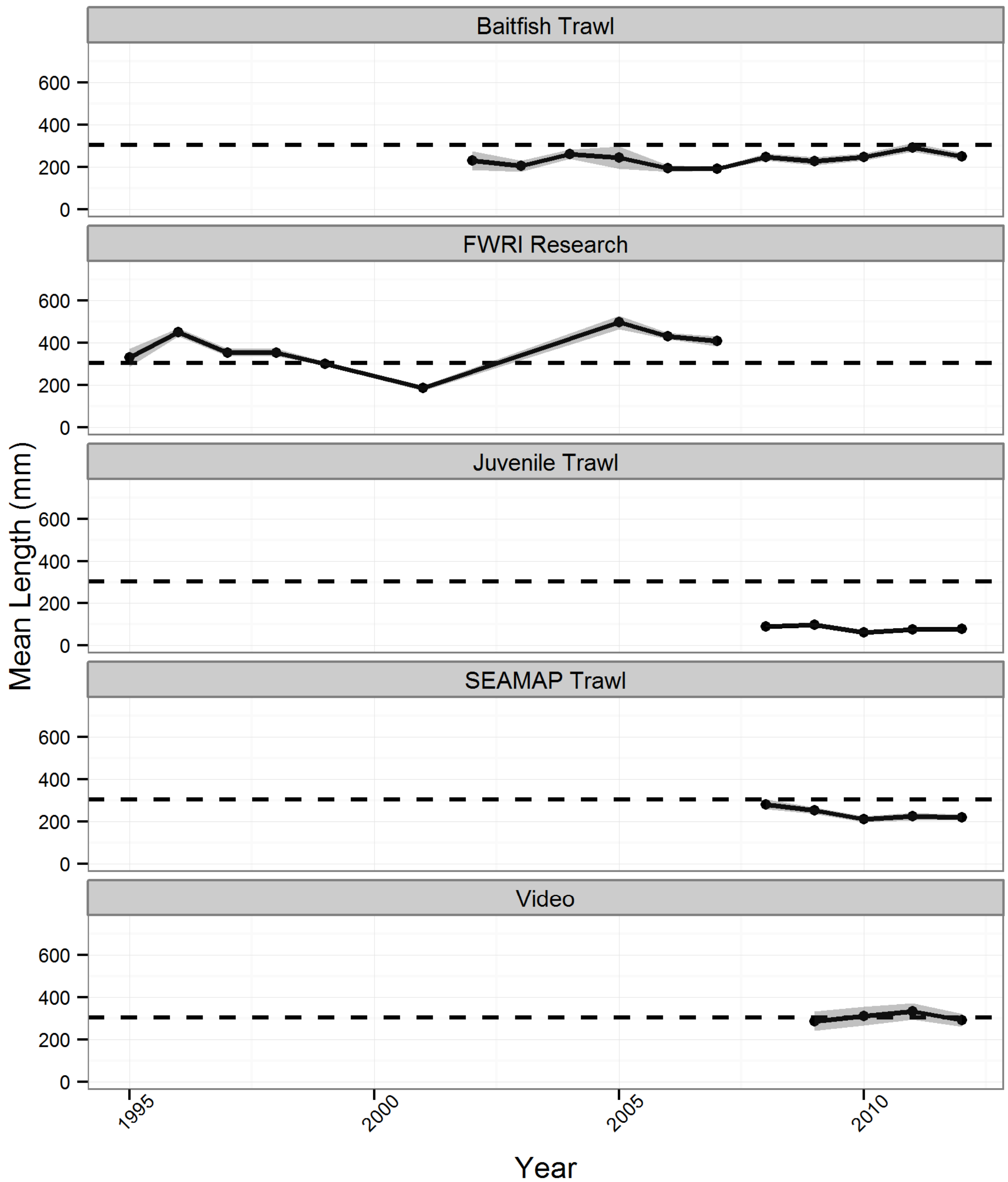


Figure 5.5.5.19. Mean length for the FLK/EFL stock commercial fisheries for each gear type and year with available data. Dashed line denotes the current 12” (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

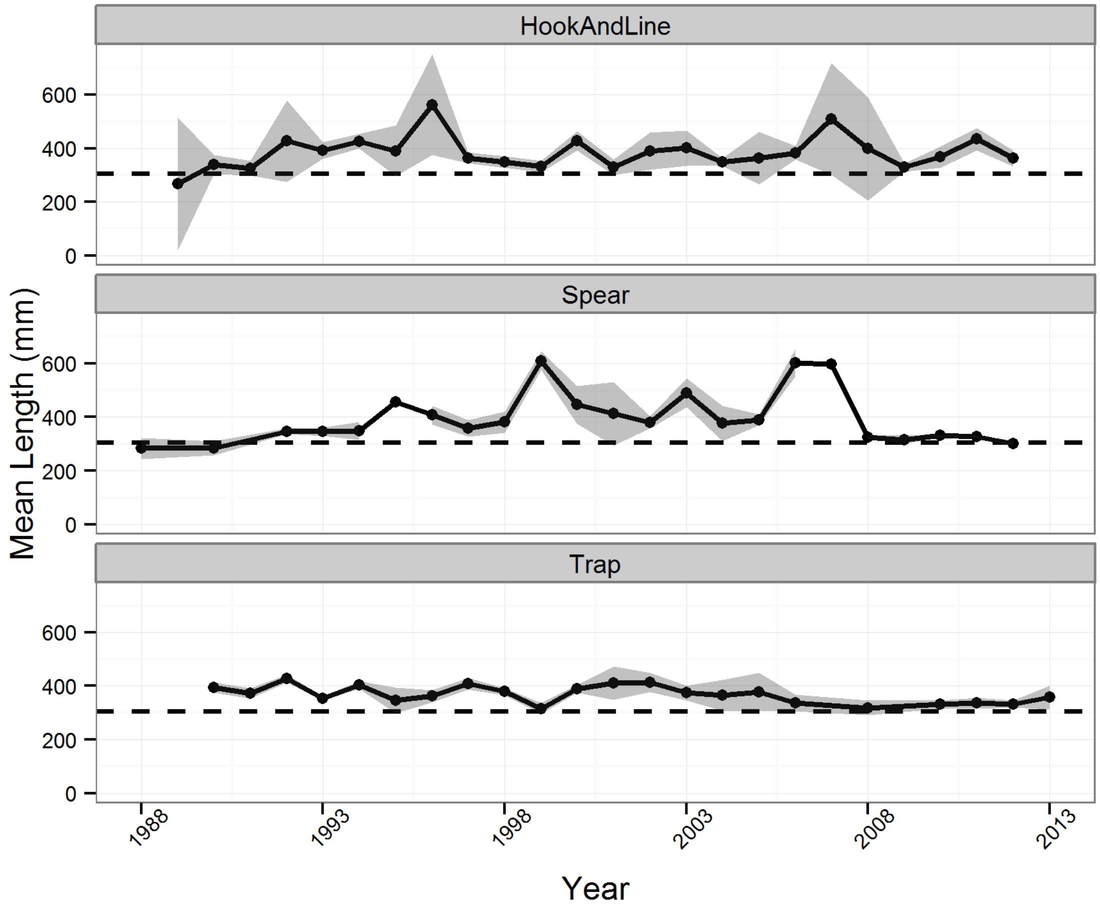


Figure 5.5.5.20. Mean length for the FLK/EFL stock recreational fisheries for each gear type and year with available data. Dashed line denotes the current 12” (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

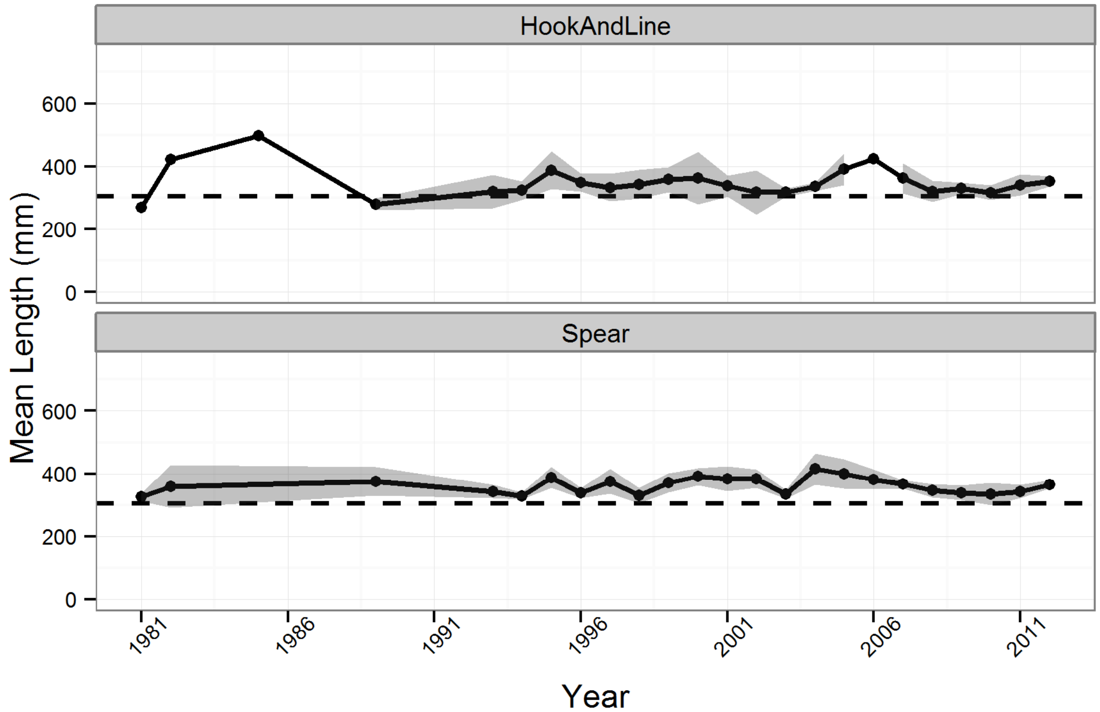


Figure 5.5.5.21. Mean length for the FLK/EFL stock fisheries independent surveys for each year with available data. Dashed line denotes the current 12” (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

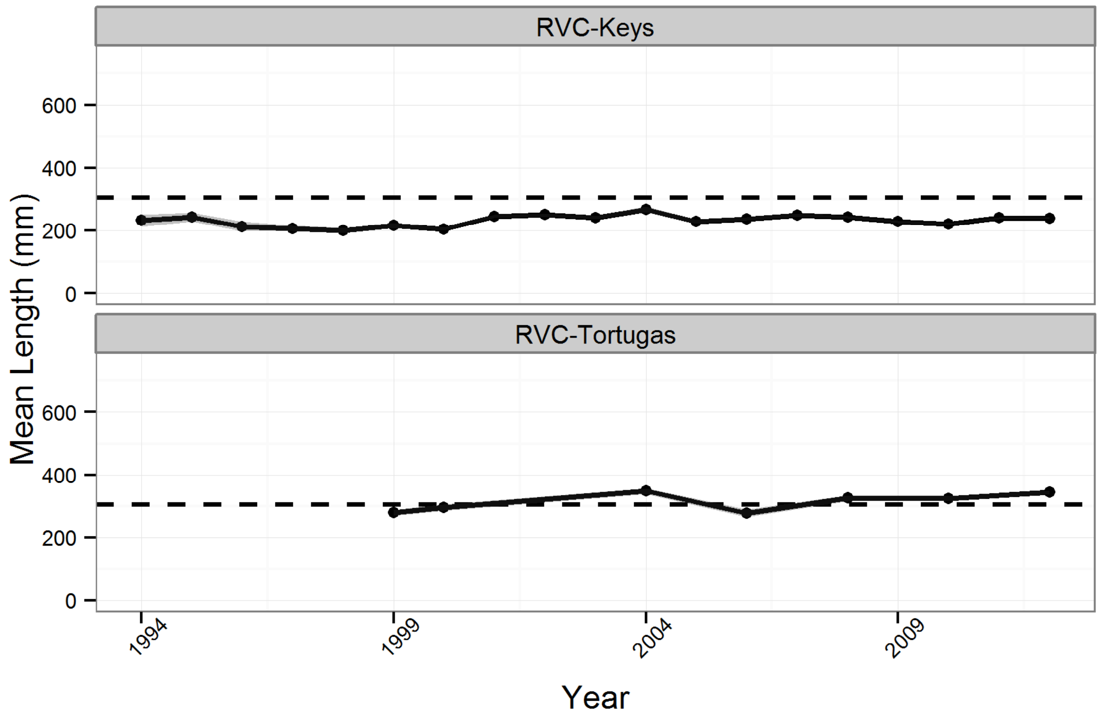


Figure 5.5.5.22. Mean length for the GA-NC stock commercial fisheries for each year with available data. Dashed line denotes the current 12" (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

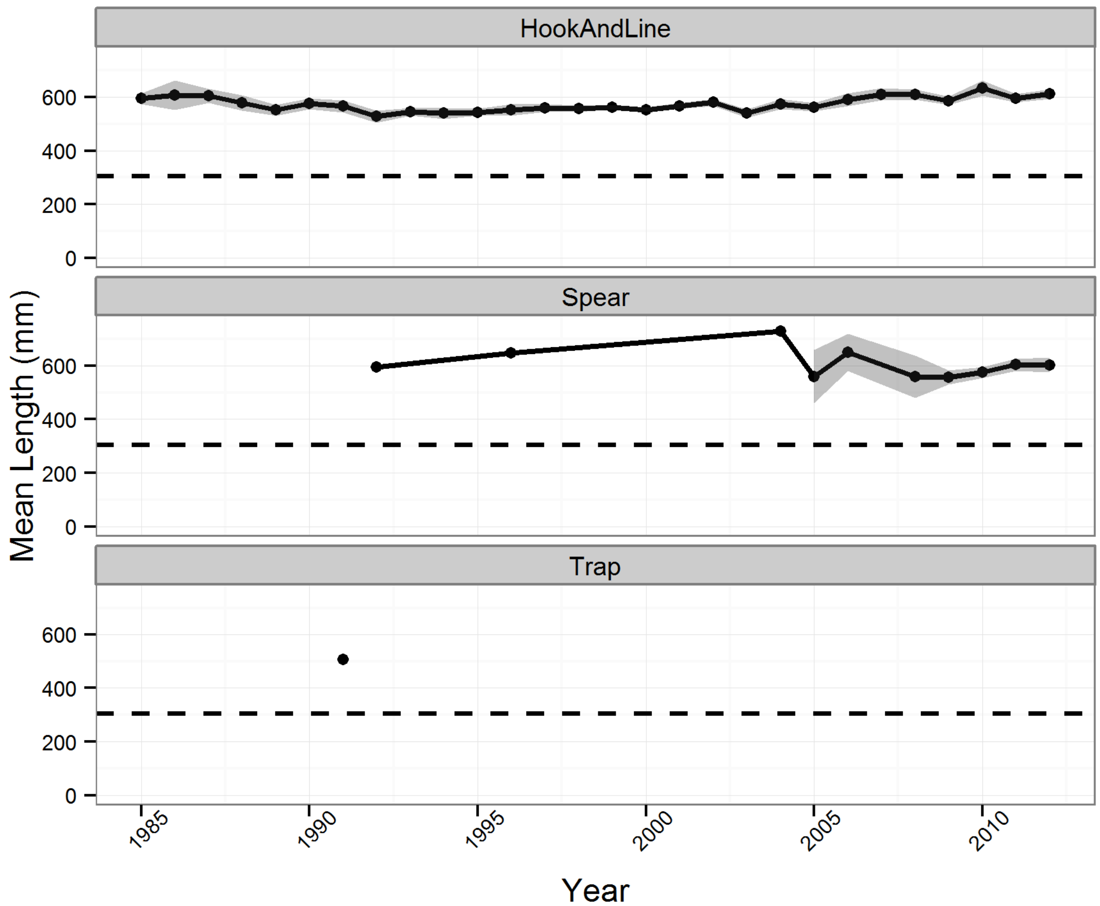


Figure 5.5.5.23. Mean length for the GA-NC stock recreational fisheries for each year with available data. Dashed line denotes the current 12” (1994-present) minimum FL, and shaded region denotes the 95% confidence interval.

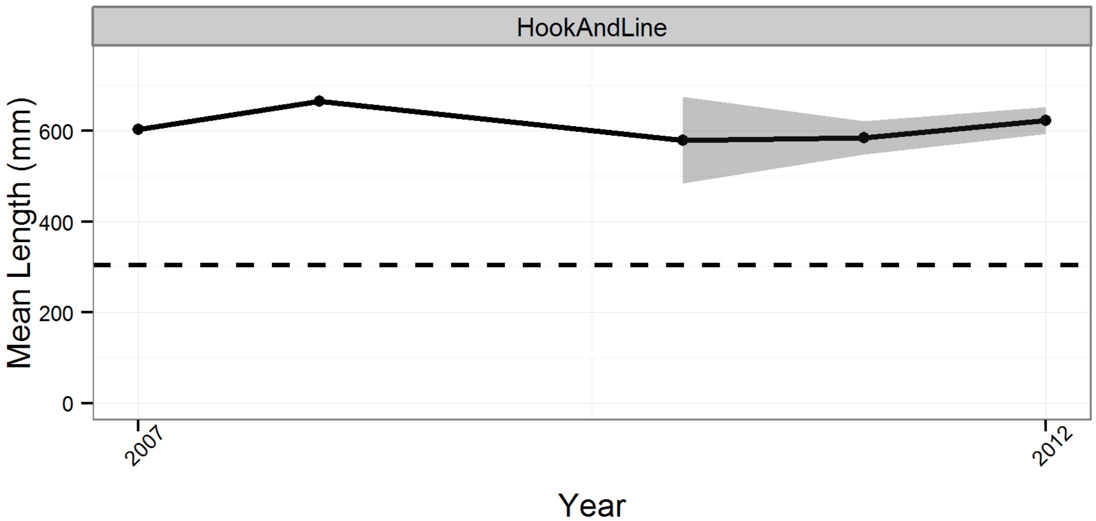


Figure 5.5.5.24. Length frequency distribution across all available years in the WFL stock for the different fisheries, life history studies, and fishery-independent surveys, demonstrating the different selectivities in each.

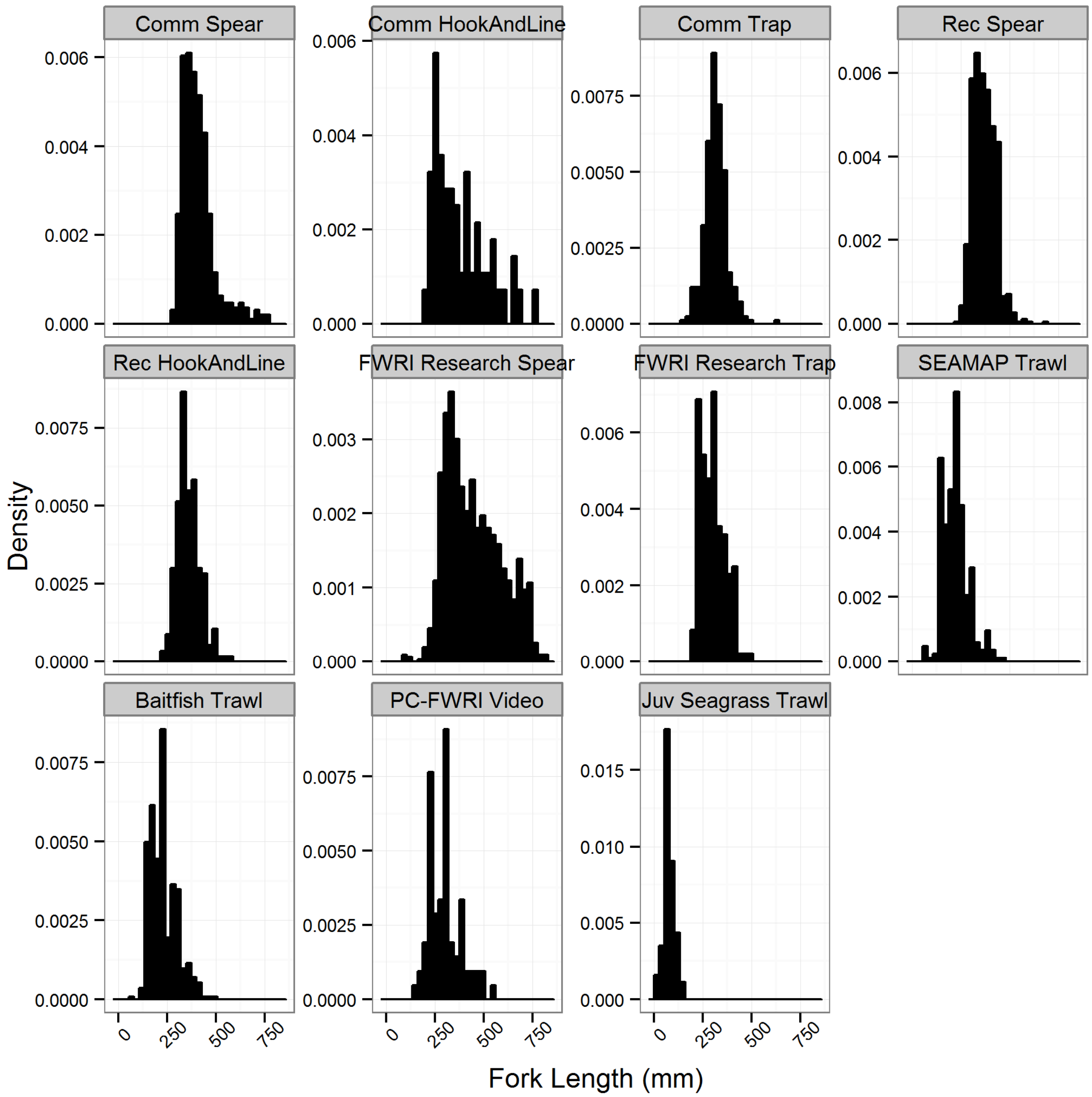


Figure 5.5.5.25. Length frequency distribution across all available years in the FLK/EFL stock for the different fisheries and fishery-independent surveys, demonstrating the different selectivities in each.

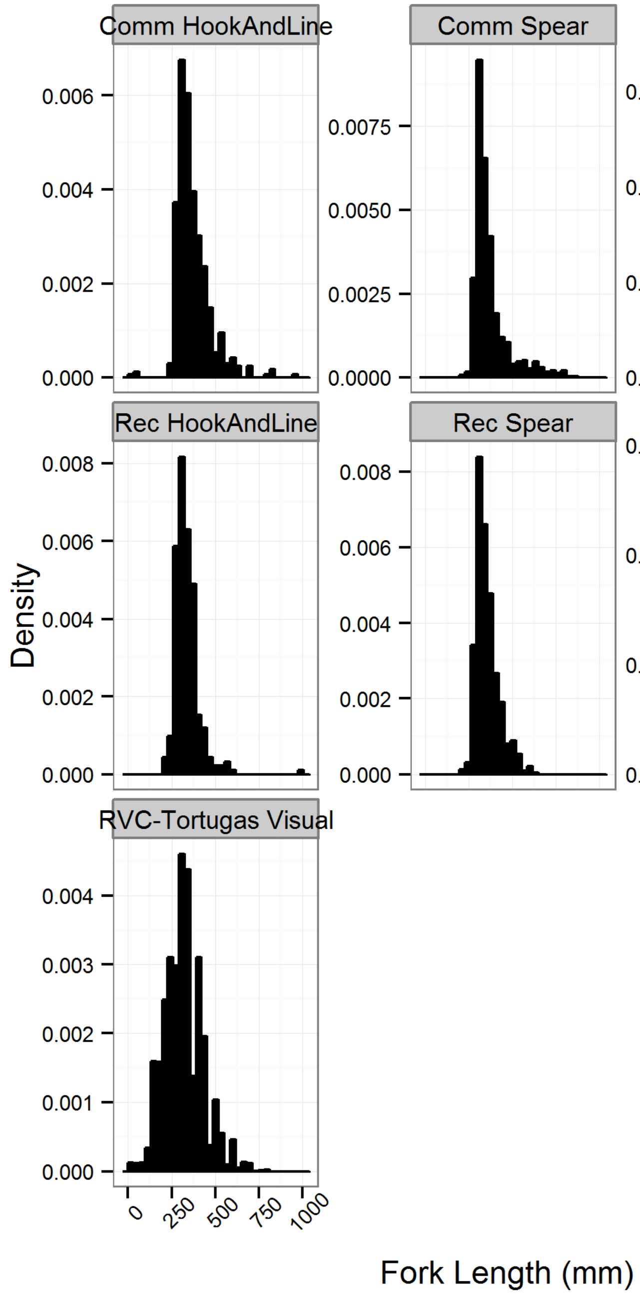


Figure 5.5.5.26. Length frequency distribution across all available years in the GA-NC stock for the different fisheries, demonstrating the different selectivities in each.

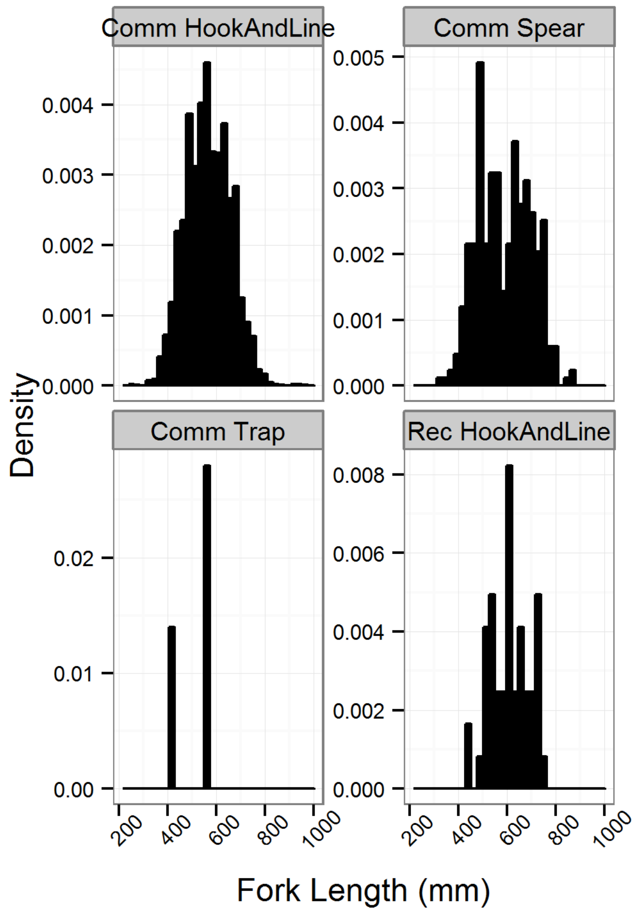


Figure 5.5.5.27. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the WFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

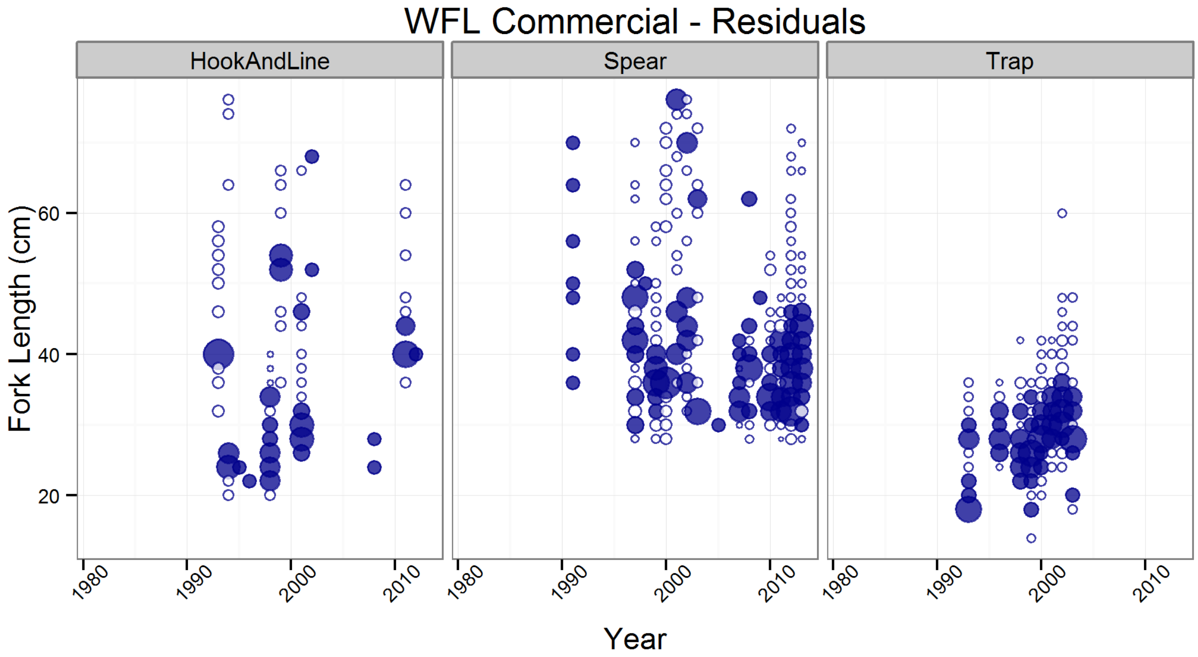


Figure 5.5.5.28. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the WFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

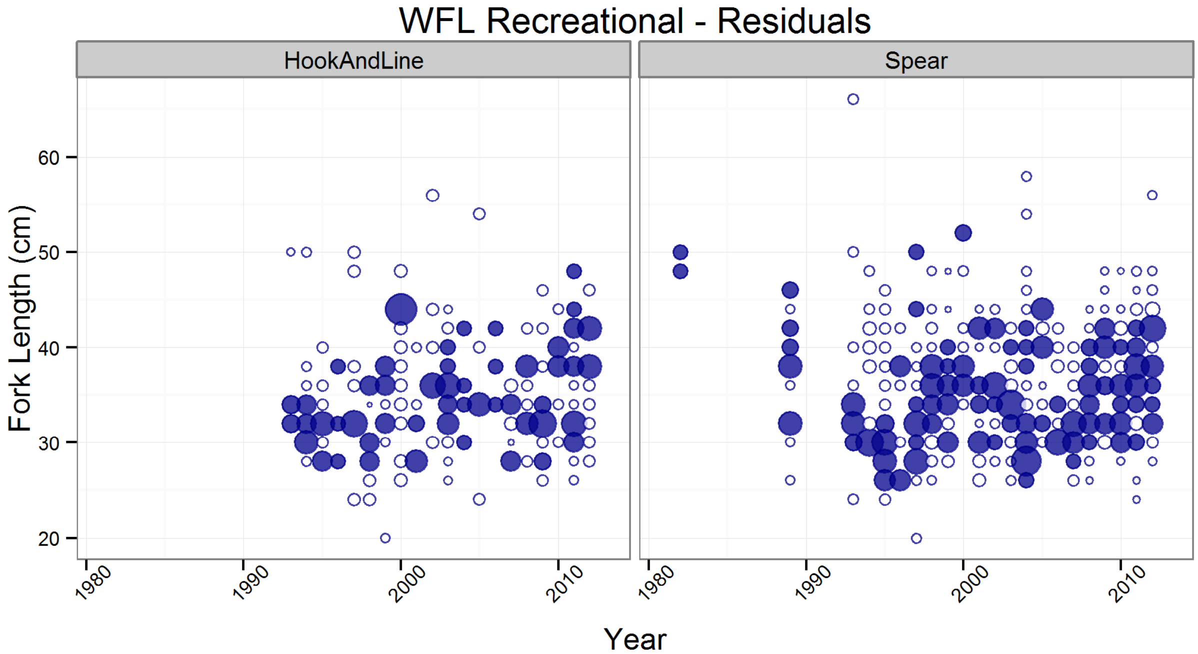


Figure 5.5.5.29. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the WFL stock fisheries independent surveys and life history studies (FWRI Research) by 5cm length bin and year for each gear type with available data.

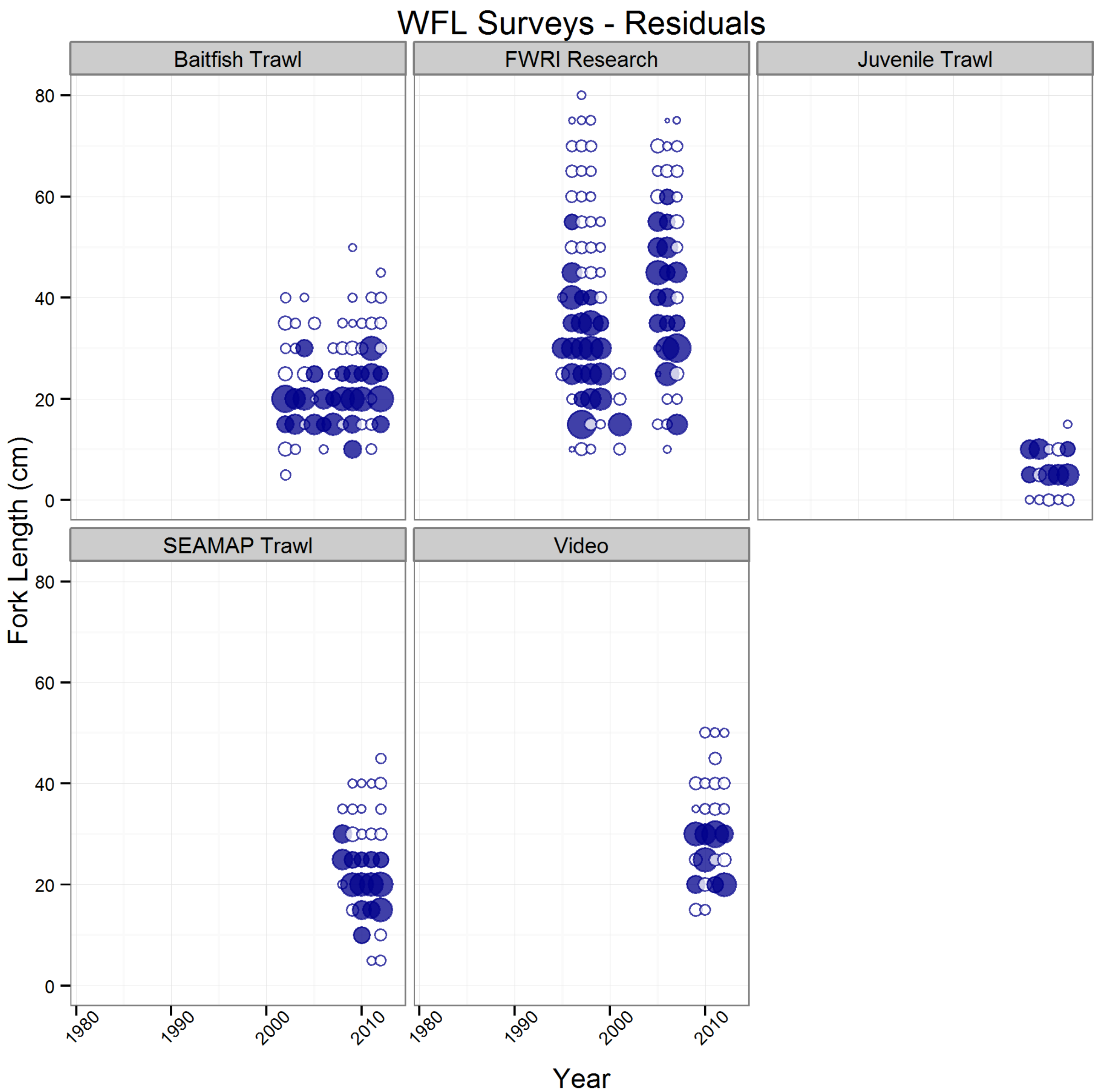


Figure 5.5.5.30. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the FLK/EFL stock commercial fisheries by 5cm length bin and year for each gear type with available data.

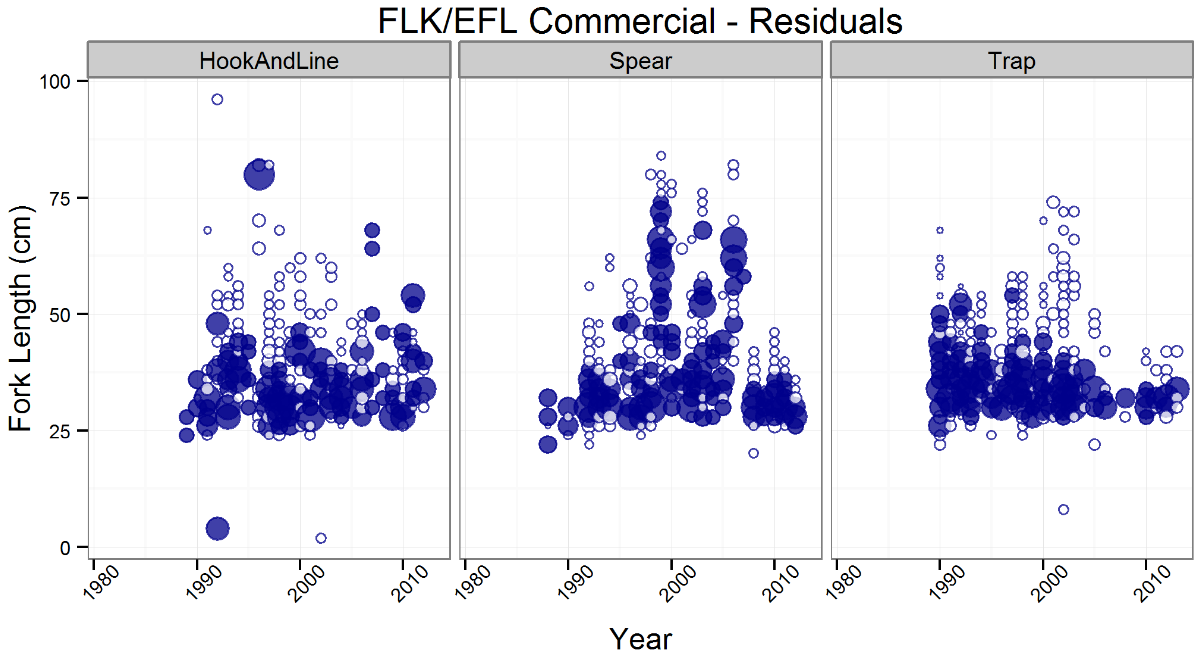


Figure 5.5.5.31. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the FLK/EFL stock recreational fisheries by 5cm length bin and year for each gear type with available data.

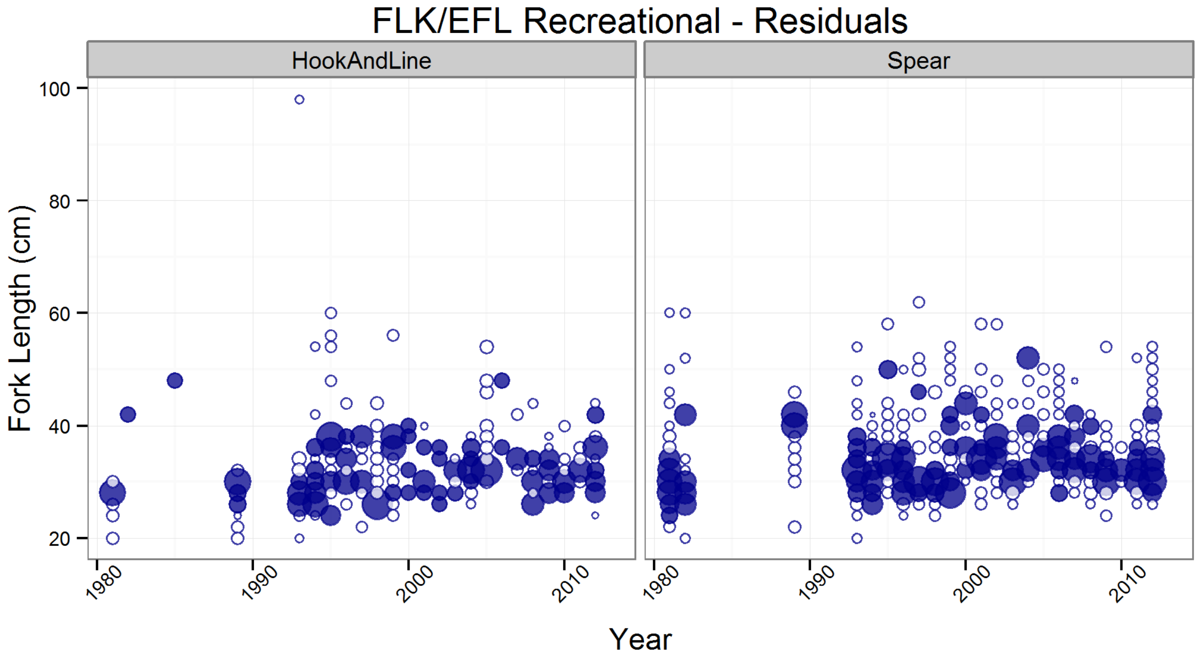


Figure 5.5.5.32. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the FLK/EFL stock fisheries independent survey (UM-NMFS RVC) by 5cm length bin and year for each gear type with available data.

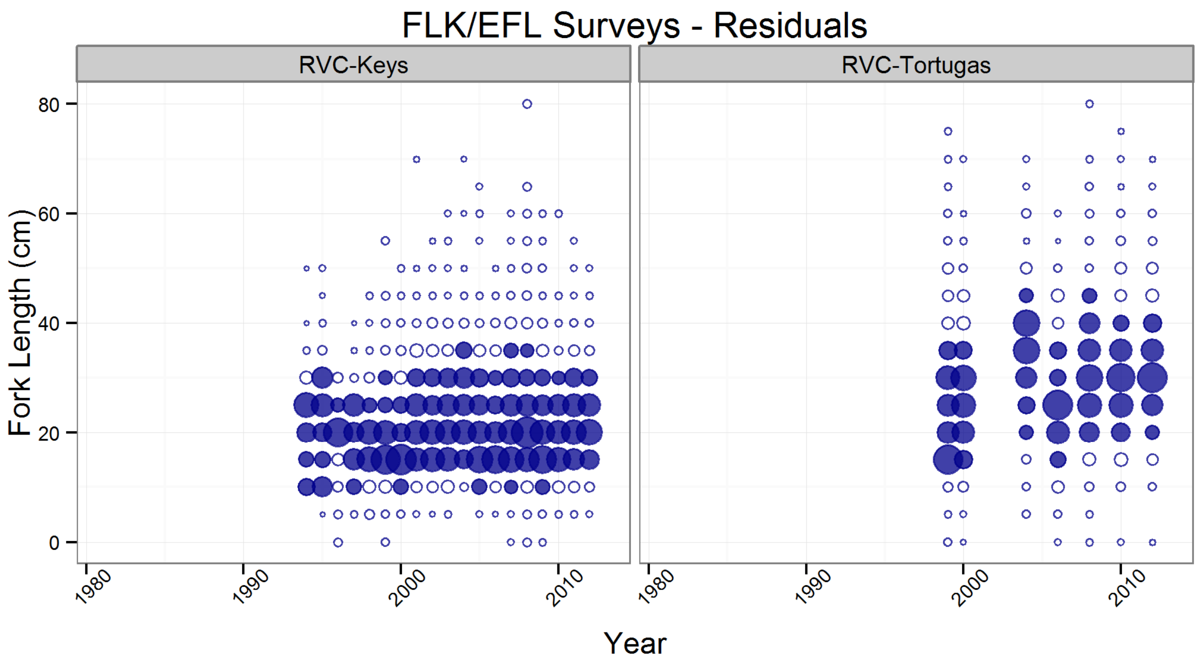


Figure 5.5.5.33. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the GA-NC stock commercial fisheries by 5cm length bin and year for each gear type with available data.

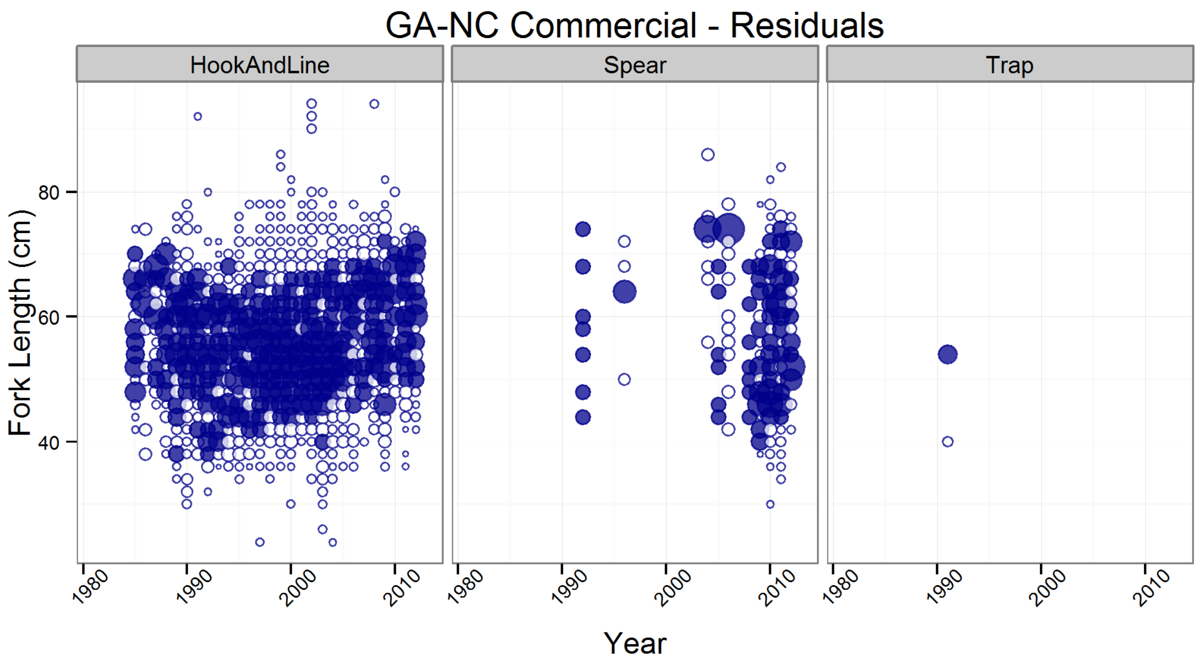


Figure 5.5.5.34. Length composition observations standardized by year (z-score; blue=positive, white=negative) for the GA-NC stock recreational fisheries by 5cm length bin and year for each gear type with available data.

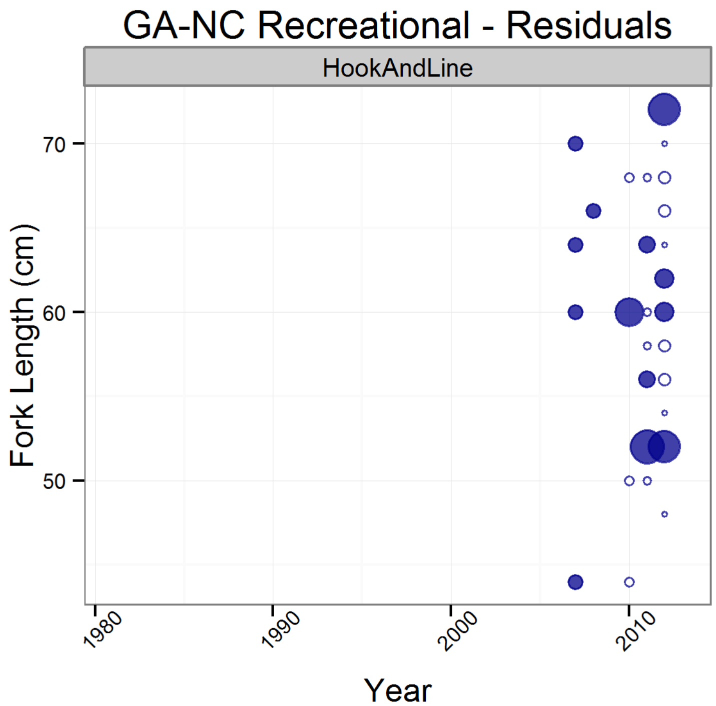


Figure 5.6.3.1. Female size at maturity using the Stock Synthesis maturity at length parameterization (see section 5.6.3 for description).

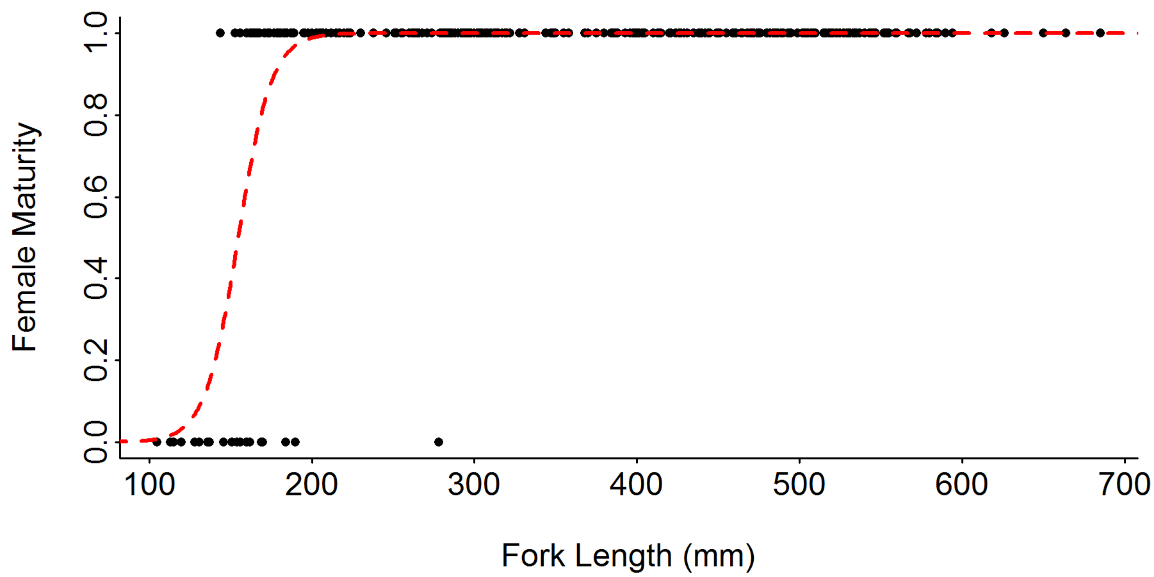


Figure 5.6.3.2. Probability of transitioning to a male at age using the Stock Synthesis parameterization (see section 5.6.3 for description).

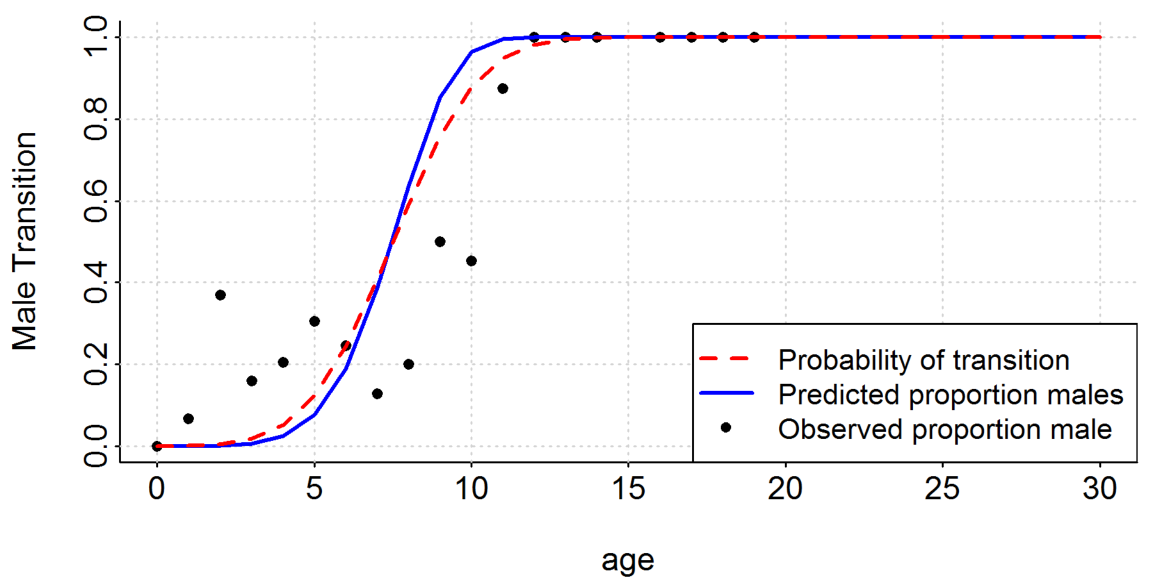


Figure 5.6.4.1. Batch fecundity of Hogfish as a function of weight.

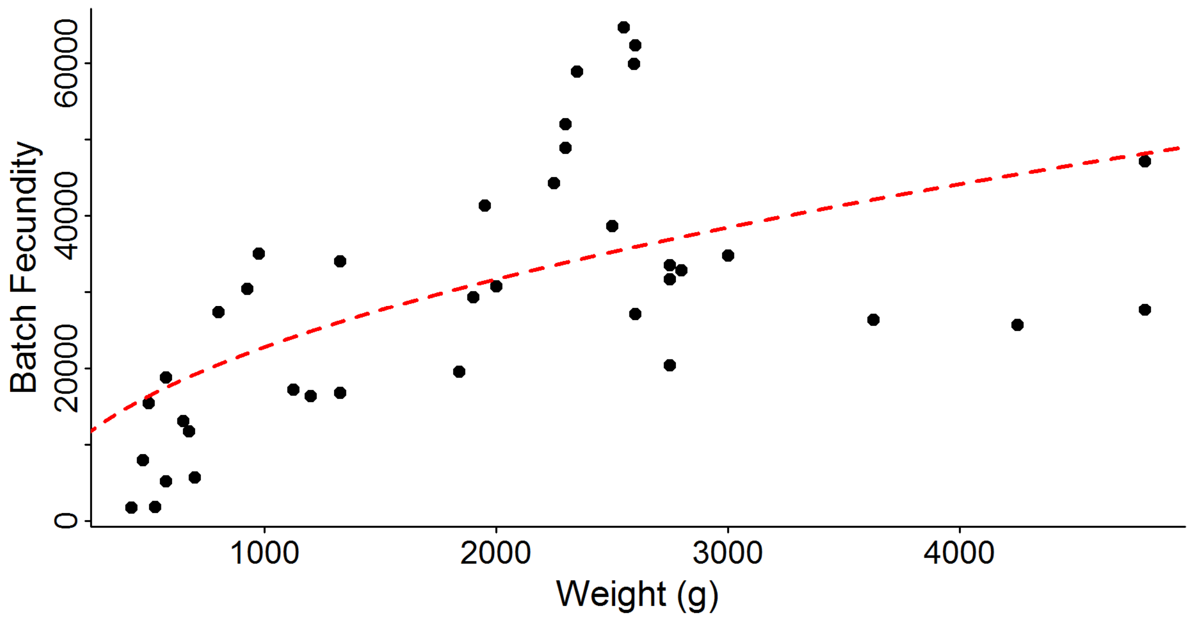


Figure 5.6.4.2. Partial effect plots from the generalized additive model (GAM) assessing the probability of spawning as a function of age and calendar date. Note the peak of spawning during April, but occurring through the majority of winter and spring.

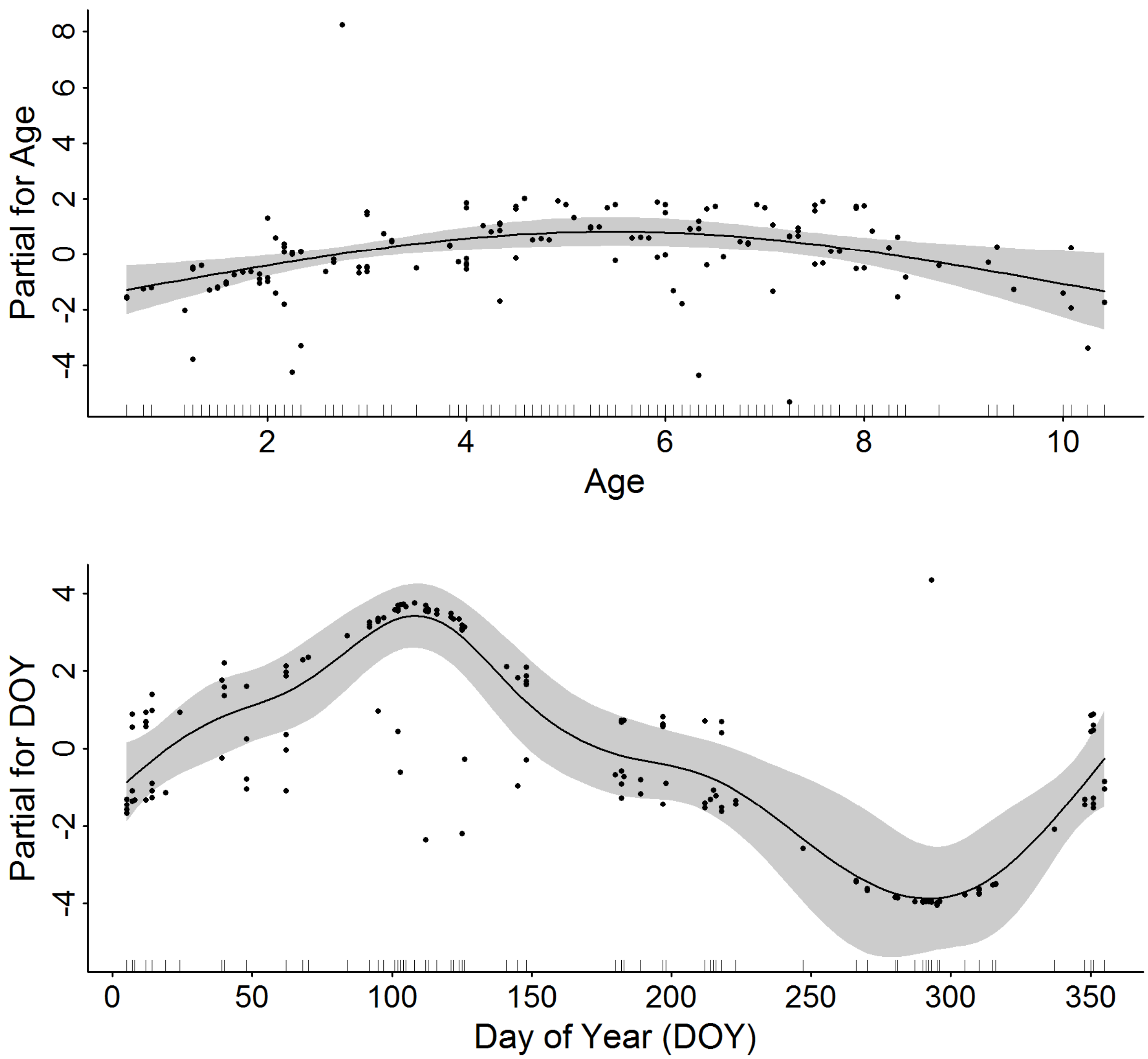
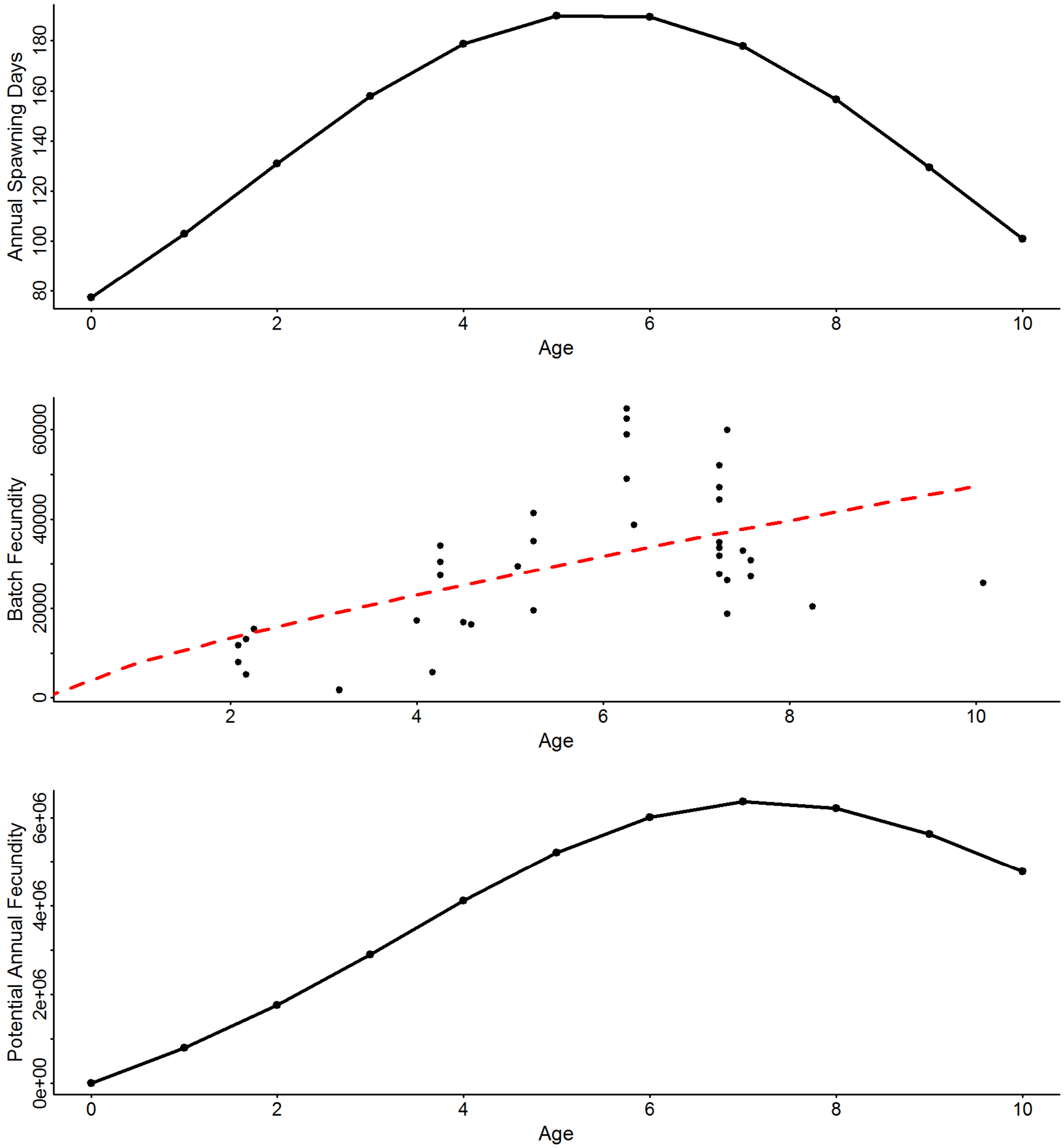


Figure 5.6.4.3. Analyses for estimating potential annual fecundity (PAF) of Hogfish. Top pane: the annual number of spawns as a function of age obtained from integrating the predicted relationship from the GAM model (Figure 5.6.4.2); middle pane: batch fecundity as a function of age (eq. 5.6.4.2); and bottom pane: the composite potential annual fecundity per age class.



6 Commercial Statistics

6.1 Review of Working Papers

There were no working papers for this section; all analyses are detailed herein.

6.2 Commercial Landings

6.2.1 Fishery Description

Hogfish have been caught commercially with a variety of gears including spear, vertical lines, and traps, with recorded landings dating as early as 1939 from Florida State Board of Conservation reports. The majority of landings originated from South Florida historically, with increasing landings in both Western Florida and the Carolinas during the last few decades. All recorded landings from the Gulf of Mexico are effectively from Florida, where the only year with recorded commercial landings from other Gulf States was from Louisiana in 1951 (http://www.st.nmfs.noaa.gov/commercial-fisheries/).

Management regulations impacting the size and allowable gears for harvesting reef fish (including Hogfish) were listed in Section 2.1. Briefly, a 12” FL minimum size limit and five fish bag limit were implemented for Hogfish in state waters by the State of Florida in 1994, by the South Atlantic Fishery Management Council (SAFMC) for South Atlantic federal waters in 1995, and in 1999 by the Gulf of Mexico Fishery Management Council (GMFMC) for Gulf of Mexico federal waters. Trawls for reef fish in the South Atlantic region were limited in 1983 to 4” minimum mesh and later eliminated in 1989 by the SAFMC and in 1990 by the GMFMC. Stab nets for reef fish harvest in state waters were prohibited by the State of Florida in 1986, by the GMFMC in 1990, and by the SAFMC in 1992. Fish traps were prohibited by the SAFMC in 1992, and a 10-year phase-out program was implemented by the GMFMC in 1997. Prohibition of retention of reef fish exhibiting “trap rash” was implemented in 2000 by the GMFMC. The SAFMC excluded bottom long lines for reef fish shoreward of the 50-fathom line in 1992, and the GMFMC excluded bottom long lines for reef fish shoreward of the 20-fathom line in 1990. There were also license and permit limitations that were implemented by the three management entities that restricted the commercial harvest and sale of reef fish by licensed commercial fishermen with federal permits to licensed seafood dealers with federal permits (see Section 2.1).

6.2.2 U.S. Commercial Landings

Due to the unique stock structure of Hogfish for Florida (section 5.3; Seyoum et al. 2014), which does not follow the typical East-West coast break where the Florida Keys are included in the Gulf of Mexico landings, the Florida landings were aggregated to the stock delineations based on area fished and the county of landing using the ALS data supplied by the NMFS-SEFSC for 1977-2012. For historic records (1950-1977), the state total landings were first acquired from the online interface of the NMFS ALS (http://www.st.nmfs.noaa.gov/st1/commercial/). To determine the proportion of the total landings within each stock unit for this historical time period (1950-1977), the proportion of landings within each stock were ascertained from Florida landings reports that included the county landed. These data were compiled by the Florida Fish and Wildlife Conservation Commission (FWCC) Fish and Wildlife Research Institute (FWRI), using the landings reported from a variety of sources, including federal port agents, the University of Miami under contract, or other reported landings to the state of Florida depending on the year. These data match the official NMFS ALS state totals well for the time period of 1958-1977 where the absolute difference between the FWRI data and official NMFS ALS data were within 200 lbs across years (<=1% difference; Table 6.2.2.1). Despite differences early on (1950-1957), the proportion of landings per stock from the reports is considered the best available data on the landings delineated by stock.

Because unique stock delineations were not required for the GA-NC stock, the total landings for this stock were summed among all three states using the ALS-SEFSC dataset for the period 1977-2012, and the ALS-online for 1950-1976. Only two years from 1950-1977 had recorded landings (1950, 1951). Note that the ALS-SEFSC and the ALS-online can differ as a result of the closing date for which data were compiled for the ALS-online data products. For the purpose of this analysis, the ALS-SEFSC is considered the official estimate, and is used for the final estimates for 1977-2012.

For the WFL stock, there were a small number of recorded landings in the ALS-SEFSC dataset from Louisiana (LA) from 1993-1995 (80 pounds total) that did not occur in the ALS-online dataset. Conversely in the ALS-online dataset, LA had a relatively substantial amount of recorded landings in 1951 (2.1 metric tons; 53% of WFL landings in that year). Although these data may be questionable given the relatively large amount relative to FL landings early in the time series and occurring in just a single year for the 63 year period, they were included in the 1951 landings of the WFL stock as unknown gear type.

Information on the gear type used was only available from 1977-2012 from the NMFS-SEFSC ALS dataset. Three main gear types emerged in the data: spear/diving fishery, vertical line/hook and line, and traps. All other gear types were aggregated into an “other” category, which mainly included unknown gear types that made up the bulk of the “other”. The proportion of the total landings per stock, including the other category, were reassigned to one of the three major gear types based on the relative proportions of these three gears on a yearly basis. Year specific proportions were used for the period 1977-2012 when yearly landings by gear were available, while a 5-year average proportion from 1977-1981 was used to estimate the gear proportions for 1950-1976 (for the WFL and FLK/EFL stocks only) when information on gear type was lacking.

The total landings by stock are presented in Tables 6.2.2.1 and 6.2.2.2 and Figure 6.2.2.1. The landings within the FLK/EFL stock have been steadily decreasing since a peak of 43 metric tons in 1993 and down to 6 metric tons in 2012. This decline has been relatively consistent across gear types over this period (Figure 6.2.2.2, Tables 6.2.2.3 and 6.2.2.4). In contrast to the FLK/SEFL stock, the landings in the WFL reached their highest levels in 2011 at 19 metric tons, which was similar in magnitude to 2012 of 18 metric tons (Figure 6.2.2.1). The increase in landings has been primarily due to an increase in spear fishing, which now makes up over 90%

of the 2012 landings, compared to 50-70% of the landings in the early to mid 1990's (Table 6.2.2.3 and 6.2.2.4, Figure 6.2.2.2). Similar to the WFL stock, the GA-NC stock has seen a growing commercial spear fishery since the early 2000s, where recent landings have been similar in magnitude to the hook and line landings in the early to mid 1990's (Table 6.2.2.3, Figure 6.2.2.2). The magnitude of these landings has been shifting from the North Carolina-dominated landings in the 1990s to being dominated by South Carolina since 2000 (Table 6.2.2.2).

6.3 Commercial Discards and Release Mortality

6.3.1 Logbook Discards

Discard totals were calculated for year, region, and gear type using fisher reported data to the discard logbook program and these data were used to calculate a discard rate. Total effort was calculated from reports to the coastal logbook program. Discards within each year/gear/region stratum were calculated as: discard rate*total effort. Reports of Hogfish discards were infrequent and because of those low sample sizes discard rates were the mean rate over the years 2002-2013 within each gear and region stratum. Discard rate data were available for the years 2002-2013, although 2013 data were likely incomplete. Effort data were available for the years 1993-2013 with 2013 incomplete. All analyses were done by K. McCarthy at the NMFS-SEFSC.

Divers reported 45% of discarded Hogfish as all the fish were dead or the majority of the fish were dead. An additional 49% of Hogfish were reported as kept by divers, while 4.4% of discarded Hogfish were reported as "majority alive" by divers. Vertical line fishers (both hand and electric) reported 79% of discarded Hogfish were alive with another 19.8% reported as kept. Table 6.3.1.1 presents the total discards estimated for each year, region, and gear type.

Discards in numbers were converted to discards in weight by applying the average weight from the fishery-dependent commercial sampling (primarily trip interview program, TIP; Table 6.3.1.2). The proportion of dead discards to total landings were then calculated for each stock, and applied to the historical years before logbooks (1950-1992 for WFL and FLK/EFL stocks; 1978-1992 for GA-NC stock) in order to estimate total discards for the entire time period (Table 6.3.1.3).

6.4 Commercial Effort

Commercial effort was calculated for each stock using multiple methods, including: (1) logbook records in diver hours or hook hours from the index standardization procedure, depending on the gear (provided by K. McCarthy at NMFS-SEFSC); (2) the Florida trip ticket database for the two Florida stocks in number of days fishing, as number of days per trip was generally found to be a significant factor in the CPUE standardization for the Florida stocks (see section 8.2.1 and 8.4.1); and (3) the Florida trip ticket database for the two Florida stocks in total number of saltwater product licenses (SPL) to gauge fishermen participation.

Effort from the commercial logbooks showed a declining trend in effort for hook and line fisheries in both the GA-NC stock and the FLK/EFL stock (Table 6.4.1; Figure 6.4.1). Effort from 1993-2012 for the spear fishery in the FLK/EFL stock has generally declined since a high in 2002, but has experienced a substantial increase from a low in 2010 through 2012. Comparatively, the effort in the WFL stock for the spear fishery has seen a steady increase since 1993.

Similar patterns were suggested from the number of days fished in the Florida trip ticket database for the Florida stocks (Table 6.4.2, Figure 6.4.2), where the effort in the FLK/EFL stock for hook and line has steadily decreased after peaking in the mid 1990s, and the effort for spear has decreased since 2002 with an increase in the last two years. However, a similar pattern was not evident for the WFL spear fishery, where relatively high numbers of days fished occurred in 1996 and 1997, similar in magnitude to more recent years (2009, 2010). The WFL effort for hook and line experienced a high in 2001, with a generally steady declining trend, except in 2009 when a high effort was recorded.

The generally declining trends from the FLK/EFL effort time series were supported by the total number of commercial licenses in Florida (SPLs), which has steadily declined from a peak in the mid 1990's for fishermen using both spear and hook and line. Similar declines in SPLs were evident for the WFL stock, where both diving and hook and line peaked in the mid 1990s, although the SPLs for diving has seen increases in recent years (Figure 6.4.3).

6.5 Biological Sampling

6.5.1 Adequacy for Characterizing Catch and for Assessment Analyses

Biological sampling of Hogfish from commercial trips is generally poor for age samples and poor to moderate for length samples (Tables 5.5.1.1, 5.5.1.2; Figures 5.5.5.1, 5.5.5.2, 5.5.5.7, 5.5.5.8, 5.5.5.12, 5.5.5.13). On average a total of 52, 103, and 165 fish lengths were sampled each year, for those years with data, from each of the WFL, FLK/EFL, and GA-NC stocks, respectively (Table 5.5.1.1). Aging of commercially-sampled Hogfish has been mostly missing until recent years, with a combined total across all years of 10, 100, and 100 fish aged from the WFL, FLK/EFL, and GA-NC stocks, respectively (Table 5.5.1.2).

Given the paucity of age information, use of stock-, gear-, and/or year-specific age-length information (e.g., age-length keys) would be introduce substantial uncertainty, particularly if one was to attempt to estimate growth parameters within a model. Since the life-history studies on Hogfish have characterized the growth dynamics with adequate sampling, one can use a combination of the existing growth models, length samples, and limited age samples to inform a model (i.e., Stock Synthesis, which can accommodate the various data inputs). This however will not detect potential changes in growth dynamics over time, which is a current limitation for modeling Hogfish.

6.6 Literature Cited

Seyoum S, Collins AB, Puchulutegue C, McBride RS, Tringali MD. 2014. Genetic population structure of Hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States. SEDAR37-DW01.

6.7 Tables

Table 6.2.2.1. Landings in pounds from the three primary data sources: ALS-online, ALS-SEFSC, and historical Florida landings reports.

	ALS-Online		ALS-SEFSC				Florida Reports		
Year	**FL Total**	**GA-NC**	**FL Total**	**GA-NC**	**FLK/EFL**	**WFL**	**FL Total**	**FLK/EFL**	**WFL**
1950	17400	4400					14364	14050	314
1951	34300	2000					29342	21897	7445
1952	42600						20427	20108	319
1953	34600						34504	29504	5000
1954	32000						29019	28704	315
1955	31600						31551	26880	4671
1956	33100						26093	23333	2760
1957	39700						38501	29433	9068
1958	24400						24539	18735	5804
1959	19200						19248	15375	3873
1960	21400						21207	19812	1395
1961	36900						36846	35727	1119
1962	16800						16654	15499	1155
1963	20900						20900	19900	1000
1964	24000						23990	22868	1122
1965	17200						17125	16350	775
1966	22600						22578	17297	5281
1967	18200						18222	14617	3605
1968	29700						29639	22883	6756
1969	19500						19671	14812	4859
1970	25700						25648	22598	3050
1971	22800						22778	19253	3525
1972	22700						22829	19358	3471
1973	17900						18090	16759	1331
1974	16400						16434	14692	1742
1975	21700						21788	17966	3822
1976	15700						15869	13237	2632
1977	44300		44300		11400	32900	44233	30145	14088

Table 6.2.2.1 (continued). Landings in pounds from the three primary data sources.

	ALS-Online		ALS-SEFSC				Florida Reports		
Year	**FL Total**	**GA-NC**	**FL Total**	**GA-NC**	**FLK/EFL**	**WFL**	**FL Total**	**FLK/EFL**	**WFL**
1977	44300		44300		11400	32900	44233	30145	14088
1978	39732	522	39600	522	2200	37400			
1979	50118	167	50200	167	2100	48100			
1980	66308		66293	966	19658	46635			
1981	62509		62509	11139	18050	44459			
1982	32188	16180	32188	16180	2267	29921			
1983	37027	9866	37027	9866	4624	32403			
1984	39160	2972	39160	2972	2317	36843			
1985	46990	6032	46990	6032	4437	42553			
1986	54315	8040	54315	8040	16462	37853			
1987	72828	9274	72977	9295	17120	55857			
1988	75616	10182	75412	10186	20194	55218			
1989	106223	15167	108885	15177	23507	85378			
1990	115395	27854	115210	27862	23366	91844			
1991	107580	23886	107311	23886	29433	77878			
1992	110012	32264	119284	32274	18423	100861			
1993	136528	31711	136715	31739	19769	116946			
1994	93632	23046	93636	23063	16611	77025			
1995	65013	36903	65011	36903	13707	51304			
1996	60786	17461	60781	17471	13660	47121			
1997	65682	25391	65974	25394	15176	50798			
1998	46959	21934	47153	21959	11108	36045			
1999	43845	29185	47266	29186	9006	38260			
2000	49011	24097	49123	24104	6226	42897			
2001	45020	20246	45514	14193	5765	39749			
2002	49313	26712	49912	20557	5816	44096			
2003	48231	21237	48659	9307	5913	42746			
2004	47924	19689	48603	19295	6399	42204			
2005	32398	19157	32490	19255	3765	28725			
2006	26657	23417	26967	23433	4466	22501			
2007	32255	20748	32427	20754	6195	26232			
2008	41606	30388	42032	30437	9552	32480			
2009	42903	34239	44330	34242	4372	39958			
2010	44612	41898	45480	41898	4076	41404			
2011	53235	35959	56379	35959	2166	54213			
2012	54892	20561	55134	20561	3955	51179			

Table 6.2.2.2. State specific landings for the GA-NC stock.

Year	Georgia	North Carolina	South Carolina
1950		4400	
1951		2000	
1978			522
1979		104	63
1982		1229	14951
1983		1743	8123
1984		2219	753
1985		4683	1349
1986		5052	2988
1987		5350	3924
1988		7243	2939
1989		9581	5586
1990		24216	3638
1991	56	19426	4404
1992		24186	8078
1993		21404	10307
1994		19156	3890
1995		33526	3377
1996		13855	3606
1997		14029	11362
1998		12053	9881
1999	49	12414	16722
2000		7736	16361
2001		8214	12032
2002		10688	16024
2003		9612	11625
2004		9384	10305
2005		7887	11270
2006		7301	16116
2007		7121	13627
2008		13045	17343
2009		10846	23393
2010		13055	28843
2011		10799	25160
2012		8264	12297

Table 6.2.2.3. Observed landings in pounds by gear type from the ALS-SEFSC dataset. Note, the "Other" category is mainly comprised of unknown gear types.

	WFL				FLK/SEFL				GA-NC			
Year	Spear	Hook & Line	Pots & Traps	Other	Spear	Hook & Line	Pots & Traps	Other	Spear	Hook & Line	Pots & Traps	Other
1977		7900			1000	35400						
1978		3000			600	31500	4500			522		
1979		5100			1800	38500	4800			167		
1980		3576			1688	58617	2412			966		
1981		1472			5356	51349	4332			709		10430
1982		1381			2087	25353	2793	574		4659		11521
1983		2448			1494	32089	498	498		2526		7340
1984	28	2302		37	3368	26495	5726	1204		2486		486
1985	2855	2191		95	2147	18166	15745	5791		5843	114	75
1986	3533	1676		86	22292	14361	7449	4918	1328	6668		44
1987	696	4201		116	13575	21418	27827	5144	2500	4312	21	2462
1988	476	6156		502	14749	16116	30323	7090	1654	6741	19	1772
1989	1056	27079			6676	24100	49967	151	1186	13272	143	576
1990	7166	30902			30839	11659	34641	3		14051	12828	983
1991	18575	10890	20	6385	31157	15094	24147	1043		12175	11108	603
1992	16384	4248	3800	1927	51552	18003	23227	143	2077	25872	4290	35
1993	15447	8903	16769	317	42173	18957	33426	781		28025	78	3636
1994	13186	11396	5281	164	34063	14875	14589	97	3848	19038	75	102
1995	5272	6538	3039	1629	23251	13880	11062	342	2382	32800	1633	88
1996	8157	4333	4526	218	25055	7577	10812	108	164	15569	1738	
1997	7490	3973	6780	68	16338	18837	12117	371	244	24075	1075	
1998	6299	3279	3312	193	14058	9847	8925	1240	80	21375	504	
1999	4411	4179	4294	103	9155	7241	17499	384	83	28987	116	
2000	7589	8889	1810	120	11648	7417	11520	130	67	23738	299	
2001	12146	5815	4070	8	11104	8203	3635	533	1684	10633	144	1732
2002	16599	4929	4025	675	11797	8364	2621	902	3094	15137	1522	804
2003	16094	5711	1331	80	7770	13499	3395	779	2805	6487	15	
2004	17696	2185	783	52	11436	13105	3129	167	9566	9729		
2005	12827	2553	24	532	8260	6220	1830	244	4581	14634	40	
2006	11537	1208	1	300	7839	3974	2032	76	7420	15887	126	
2007	13344	1607		387	9666	5237	1563	623	5453	15301		
2008	14988	2031		5412	11266	4249	1538	2548	8518	21919		
2009	23347	2178		4715	6864	5207	1702	317	20375	13399	5	463
2010	27324	5356	143	670	5380	5353	1136	118	29905	11814		179
2011	36321	5346	62	2054	6139	4711	1501	245	22048	13464		447
2012	36951	3884			8050	3845	2136	268	13176	7130		255

Table 6.2.2.4. Estimated landings in pounds by stock and gear type for the three primary gears (spear, hook and line, and pots and traps) with all other gear types, mostly unknown, reassigned based on proportions of the three primary types.

		WFL			FLK/SEFL			GA-NC	
Year	**Spear**	**Hook & Line**	**Pots & Traps**	**Spear**	**Hook & Line**	**Pots & Traps**	**Spear**	**Hook & Line**	**Pots & Traps**
1950	0.0	380.4	0.0	735.0	15155.6	1129.0	0.0	4400.0	0.0
1951	0.0	*13332.7*†	0.0	1105.4	22793.6	1698.0	0.0	2000.0	0.0
1952	0.0	665.3	0.0	1810.9	37342.0	2781.8	0.0	0.0	0.0
1953	0.0	5013.9	0.0	1277.6	26345.8	1962.7	0.0	0.0	0.0
1954	0.0	347.4	0.0	1366.9	28186.0	2099.8	0.0	0.0	0.0
1955	0.0	4678.3	0.0	1162.6	23973.3	1785.9	0.0	0.0	0.0
1956	0.0	3501.2	0.0	1278.2	26357.1	1963.5	0.0	0.0	0.0
1957	0.0	9350.4	0.0	1310.6	27025.7	2013.3	0.0	0.0	0.0
1958	0.0	5771.1	0.0	804.5	16588.6	1235.8	0.0	0.0	0.0
1959	0.0	3863.3	0.0	662.3	13657.0	1017.4	0.0	0.0	0.0
1960	0.0	1407.7	0.0	863.3	17802.7	1326.2	0.0	0.0	0.0
1961	0.0	1120.6	0.0	1545.1	31860.8	2373.5	0.0	0.0	0.0
1962	0.0	1165.1	0.0	675.2	13922.5	1037.2	0.0	0.0	0.0
1963	0.0	1000.0	0.0	859.3	17720.5	1320.1	0.0	0.0	0.0
1964	0.0	1122.5	0.0	987.9	20372.0	1517.6	0.0	0.0	0.0
1965	0.0	778.4	0.0	709.1	14623.1	1089.4	0.0	0.0	0.0
1966	0.0	5286.1	0.0	747.7	15417.6	1148.6	0.0	0.0	0.0
1967	0.0	3600.6	0.0	630.4	13000.4	968.5	0.0	0.0	0.0
1968	0.0	6769.9	0.0	990.2	20418.8	1521.1	0.0	0.0	0.0
1969	0.0	4816.8	0.0	634.1	13075.1	974.1	0.0	0.0	0.0
1970	0.0	3056.2	0.0	977.8	20163.9	1502.1	0.0	0.0	0.0
1971	0.0	3528.4	0.0	832.2	17161.0	1278.4	0.0	0.0	0.0
1972	0.0	3451.4	0.0	831.2	17140.5	1276.9	0.0	0.0	0.0
1973	0.0	1317.0	0.0	716.1	14766.8	1100.1	0.0	0.0	0.0
1974	0.0	1738.4	0.0	633.1	13055.9	972.6	0.0	0.0	0.0
1975	0.0	3806.6	0.0	772.7	15933.7	1187.0	0.0	0.0	0.0
1976	0.0	2604.0	0.0	565.5	11661.7	868.8	0.0	0.0	0.0

†The estimated total for the WFL stock in 1951 includes an additional 4,629.7 lbs recorded from Louisiana during that year.

Table 6.2.2.4 (cont). Estimated landings in pounds by stock and gear type for the three primary gears (spear, hook and line, and pots and traps) with all other gear types, mostly unknown, reassigned based on proportions of the three primary types.

		WFL			FLK/SEFL			GA-NC	
Year	Spear	Hook & Line	Pots & Traps	Spear	Hook & Line	Pots & Traps	Spear	Hook & Line	Pots & Traps
1977	0.0	7900.0	0.0	1000.0	35400.0	0.0	0.0	0.0	0.0
1978	0.0	3000.0	0.0	600.0	31500.0	4500.0	0.0	522.0	0.0
1979	0.0	5100.0	0.0	1800.0	38500.0	4800.0	0.0	167.0	0.0
1980	0.0	3576.0	0.0	1688.0	58617.0	2412.0	0.0	966.0	0.0
1981	0.0	1472.0	0.0	5356.0	51349.0	4332.0	0.0	11139.0	0.0
1982	0.0	1381.0	0.0	2126.6	25834.3	2846.0	0.0	16180.0	0.0
1983	0.0	2448.0	0.0	1515.8	32557.9	505.3	0.0	9866.0	0.0
1984	28.4	2338.6	0.0	3481.9	27391.3	5919.7	0.0	2972.0	0.0
1985	2908.8	2232.2	0.0	2491.8	21083.5	18273.7	0.0	5916.6	115.4
1986	3591.3	1703.7	0.0	24777.9	15962.5	8279.7	1335.3	6704.7	0.0
1987	712.5	4300.5	0.0	14686.6	23171.8	30105.6	3400.8	5865.7	28.6
1988	512.0	6622.0	0.0	16458.0	17983.4	33836.6	2002.3	8160.7	23.0
1989	1056.0	27079.0	0.0	6688.5	24145.1	50060.4	1232.8	13795.6	148.6
1990	7166.0	30902.0	0.0	30840.2	11659.5	34642.3	0.0	14564.9	13297.1
1991	22597.4	13248.2	24.3	31618.6	15317.6	24504.8	0.0	12490.3	11395.7
1992	17676.2	4583.0	4099.7	51631.5	18030.7	23262.8	2079.3	25900.1	4294.7
1993	15566.1	8971.6	16898.3	42521.3	19113.6	33702.1	0.0	31650.9	88.1
1994	13258.4	11458.6	5310.0	34115.0	14897.7	14611.3	3865.1	19122.6	75.3
1995	5850.4	7255.2	3372.4	23416.0	13978.5	11140.5	2387.7	32878.4	1636.9
1996	8261.5	4388.5	4584.0	25117.3	7595.8	10838.9	164.0	15569.0	1738.0
1997	7517.9	3987.8	6805.3	16466.2	18984.8	12212.1	244.0	24075.0	1075.0
1998	6393.3	3328.1	3361.6	14589.0	10218.9	9262.1	80.0	21375.0	504.0
1999	4446.3	4212.4	4328.3	9258.7	7323.0	17697.2	83.0	28987.0	116.0
2000	7638.8	8947.3	1821.9	11697.5	7448.5	11569.0	67.0	23738.0	299.0
2001	12150.4	5817.1	4071.5	11362.0	8393.6	3719.5	1918.1	12110.9	164.0
2002	17037.5	5059.2	4131.3	12264.1	8695.2	2724.8	3219.9	15753.1	1583.9
2003	16149.7	5730.7	1335.6	8015.4	13925.4	3502.2	2805.0	6487.0	15.0
2004	17740.5	2190.5	785.0	11505.0	13184.1	3147.9	9566.0	9729.0	0.0
2005	13270.0	2641.2	24.8	8383.6	6313.1	1857.4	4581.0	14634.0	40.0
2006	11808.5	1236.4	1.0	7882.0	3995.8	2043.2	7420.0	15887.0	126.0
2007	13689.4	1648.6	0.0	10031.7	5435.1	1622.1	5453.0	15301.0	0.0
2008	19754.1	2676.9	0.0	12949.3	4883.9	1767.8	8518.0	21919.0	0.0
2009	27659.7	2580.3	0.0	7022.0	5326.8	1741.2	20654.3	13582.7	5.1
2010	27881.8	5465.3	145.9	5433.5	5406.2	1147.3	30033.3	11864.7	0.0
2011	38108.8	5609.1	65.1	6260.8	4804.4	1530.8	22325.5	13633.5	0.0
2012	36951.0	3884.0	0.0	8203.8	3918.4	2176.8	13341.5	7219.5	0.0

Table 6.3.1.1. Calculated discards in number for Hogfish as discard rate * total effort. Diving gear includes spear fishing and powerhead gear. Vertical line includes handline and electric/hydraulic (bandit rig) gear.

Year	GA-NC		FLK/SEFL		WFL		Total
	Diving	Vertical line	Diving	Vertical line	Diving	Vertical line	
1993	0	12	181	154	40	0	388
1994	0	15	232	255	62	0	564
1995	0	14	232	197	39	0	483
1996	0	14	257	197	61	0	529
1997	0	14	289	226	69	0	598
1998	0	12	278	165	47	0	503
1999	0	9	235	200	45	0	489
2000	0	10	252	179	64	0	505
2001	0	12	239	132	59	0	441
2002	0	11	237	142	67	0	457
2003	0	9	185	112	88	0	393
2004	0	8	186	100	80	0	374
2005	0	8	172	85	87	0	352
2006	0	9	163	90	87	0	349
2007	0	9	212	93	82	0	396
2008	0	10	173	91	100	0	374
2009	0	9	133	109	103	0	355
2010	0	8	143	88	141	0	381
2011	0	7	166	97	128	0	397
2012	0	6	201	91	121	0	419
2013	0	5	144	74	79	0	302

Table 6.3.1.2. Mean weight of a Hogfish in pounds per stock and gear type from the commercial biostatistical sampling, used to convert discards in numbers (Table 6.3.1.1) to discards in weight. Note: mean weights were calculated across all years due to missing years for each stock and gear combinations.

Stock	Gear	Weight (lbs)	N
GA-NC	Hook & Line	9.15	91
FLK/SEFL	Hook & Line	3.28	83
WFL	Hook & Line	2.83	23
GA-NC	Long Line	13.89	1
FLK/SEFL	Long Line	16.80	4
WFL	Long Line	9.37	4
GA-NC	Spear	7.69	30
FLK/SEFL	Spear	3.93	249
WFL	Spear	3.20	382
FLK/SEFL	Trap	1.83	86
WFL	Trap	1.41	53

Table 6.3.1.3. Calculated weight of dead discards in pounds from the commercial logbook program. The total number of dead discards were determined from the proportion dead and alive, and assuming a 10% discard mortality rate for those released alive from vertical lines and a 100% mortality for diving gear. Means weights from Table 6.3.1.2 were used to convert total numbers from Table 6.3.1.1.

Year	GA-NC		FLK/SEFL		WFL	
	Diving	Vertical line	Diving	Vertical line	Diving	Vertical line
1993	0	30.41	700.59	139.81	126.07	0
1994	0	38.01	898.00	231.50	195.41	0
1995	0	35.47	898.00	178.84	122.92	0
1996	0	35.47	994.76	178.84	192.26	0
1997	0	35.47	1118.63	205.17	217.47	0
1998	0	30.41	1076.05	149.79	148.13	0
1999	0	22.81	909.61	181.57	141.83	0
2000	0	25.34	975.41	162.50	201.71	0
2001	0	30.41	925.09	119.83	185.95	0
2002	0	27.87	917.35	128.91	211.17	0
2003	0	22.81	716.08	101.68	277.35	0
2004	0	20.27	719.95	90.78	252.14	0
2005	0	20.27	665.76	77.17	274.20	0
2006	0	22.81	630.92	81.70	274.20	0
2007	0	22.81	820.58	84.43	258.44	0
2008	0	25.34	669.63	82.61	315.18	0
2009	0	22.81	514.80	98.95	324.63	0
2010	0	20.27	553.51	79.89	444.40	0
2011	0	17.74	642.53	88.06	403.42	0
2012	0	15.20	778.01	82.61	381.36	0
2013	0	12.67	557.38	67.18	248.99	0

Table 6.4.1. Total effort from the logbook analyses provided by the NMSF-SEFSC for the different stocks in either diver hours (for spear) or hook hours (for hook and line). Note: the GA-NC spear records and WFL hook and line records were too sparse to create a CPUE index and therefore not provided.

Year	WFL	FLK/EFL		GA-NC
	Spear	Hook & Line	Spear	Hook & Line
1993	896.7	96570	1727	85988
1994	514	138386.5	1877.5	147221
1995	452.5	132010	2589	182311
1996	938.5	124445.5	1573	156731
1997	877.5	178609.5	2952	201457
1998	656	169490.2	2847	145219
1999	1102.5	158844.5	2043	124280
2000	1257	187508	2620	142880
2001	1243.5	99830.5	3501.5	166585
2002	2087	139160	3824	141444
2003	2195	75932.5	1739	118898
2004	2734	65145.5	2640	136284
2005	3400	49246.5	2439	108615
2006	3473	46484	1498	147555
2007	3277	29403	2066	162800
2008	4267	29982	1902	148516
2009	4276	26405	1078	103782
2010	6126	20459	913	72418
2011	4532	20074	1918	62377
2012	4557	20015	2732	29654

Table 6.4.2. Total days fished from the Florida trip ticket database for both Florida stocks and two main gear types. The total days fished includes all trips catching Hogfish and associated species identified from a cluster analysis for the CPUE standardization procedure (see sections 8.2.1 and 8.4.1).

Year	WFL		FLK/EFL	
	Spear	Hook & Line	Spear	Hook & Line
1994	95	6375	604	3408
1995	160	7129	653	6149
1996	323	7631	862	6051
1997	292	8150	1029	6698
1998	237	8666	986	5616
1999	230	8730	595	3956
2000	246	9931	743	4243
2001	255	10322	762	4500
2002	267	9816	844	4292
2003	222	9832	581	4384
2004	192	9405	551	4565
2005	189	8145	527	3830
2006	163	7606	458	3121
2007	165	7355	470	2655
2008	264	7015	372	2456
2009	325	10285	453	2945
2010	320	5519	340	2777
2011	261	5016	397	2962
2012	241	5123	466	2801

Figure 6.4.3. Number of SPL licenses landing Hogfish from the Florida Trip Ticket database for the two Florida stocks.

Year	WFL	FLK/EFL
1987	129	1050
1988	154	897
1989	185	1014
1990	151	881
1991	135	749
1992	182	832
1993	216	763
1994	221	698
1995	123	580
1996	104	518
1997	107	461
1998	89	401
1999	103	323
2000	106	350
2001	115	388
2002	101	401
2003	90	376
2004	63	344
2005	61	251
2006	34	214
2007	33	218
2008	53	170
2009	59	216
2010	62	159
2011	66	163
2012	60	148

6.8 Figures

Figure 6.2.2.1. Total landings of Hogfish by stock from 1950-2012.

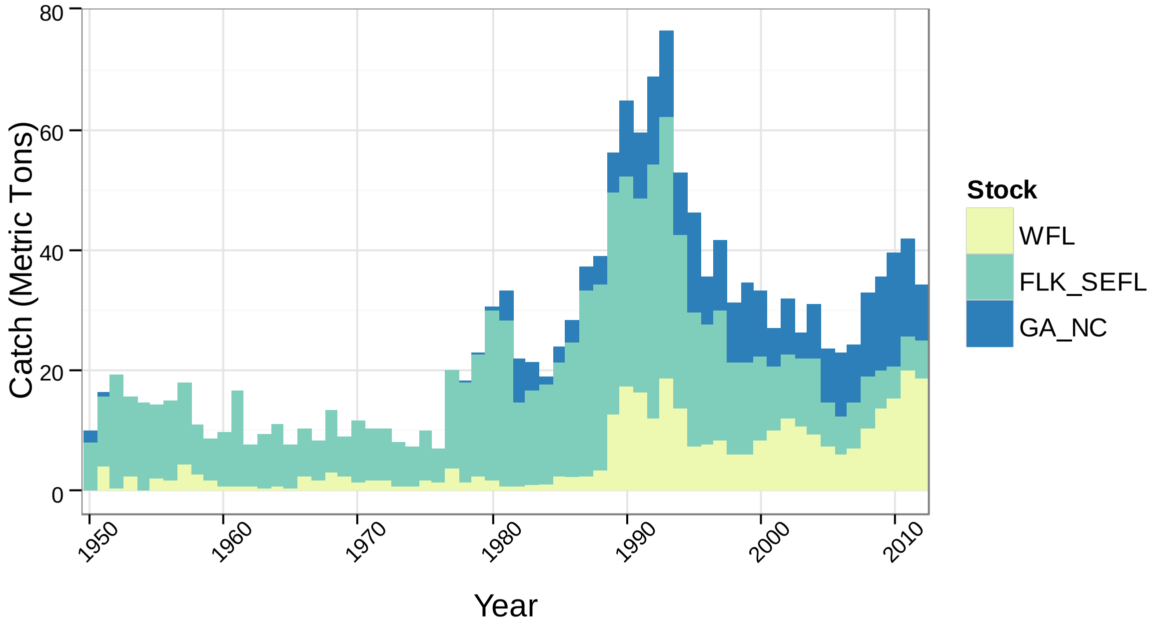


Figure 6.2.2.2. Total landings of Hogfish by stock and gear type from 1977-2012.

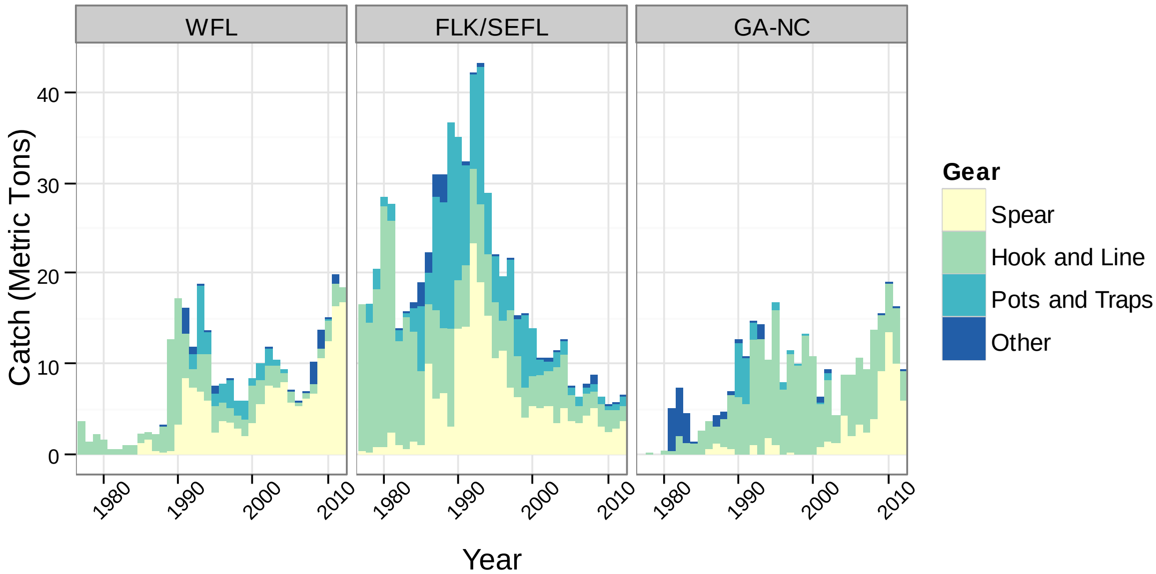


Figure 6.4.1. Total effort from the logbook analyses for the different stocks in either diver hours (for spear) or hook hours (for hook and line). Note: the GA-NC spear records and WFL hook and line records were too sparse to create a CPUE index and not provided.

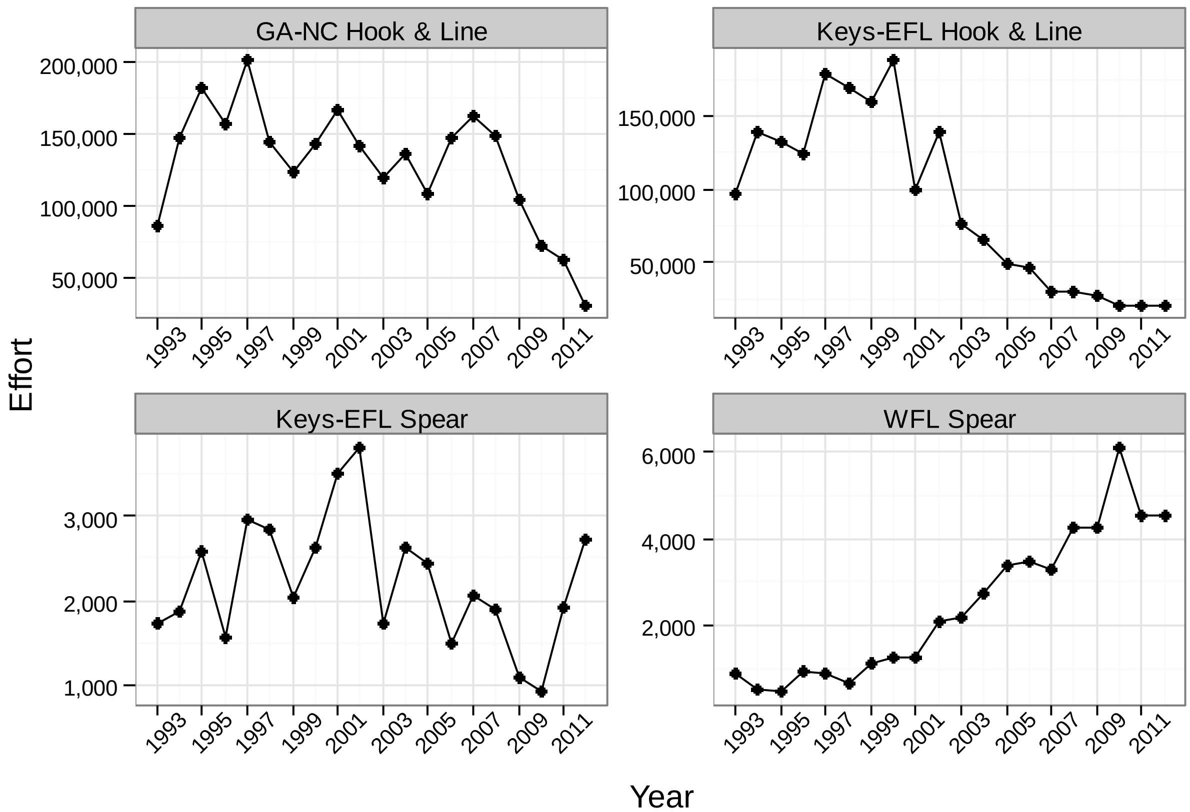


Figure 6.4.2. Total effort in total days fished from the Florida trip ticket database for both Florida stocks and two main gear types. The total days fished includes all trips catching Hogfish or the associated species from a cluster analysis in the CPUE standardization procedure (see sections 8.2.1 and 8.4.1).

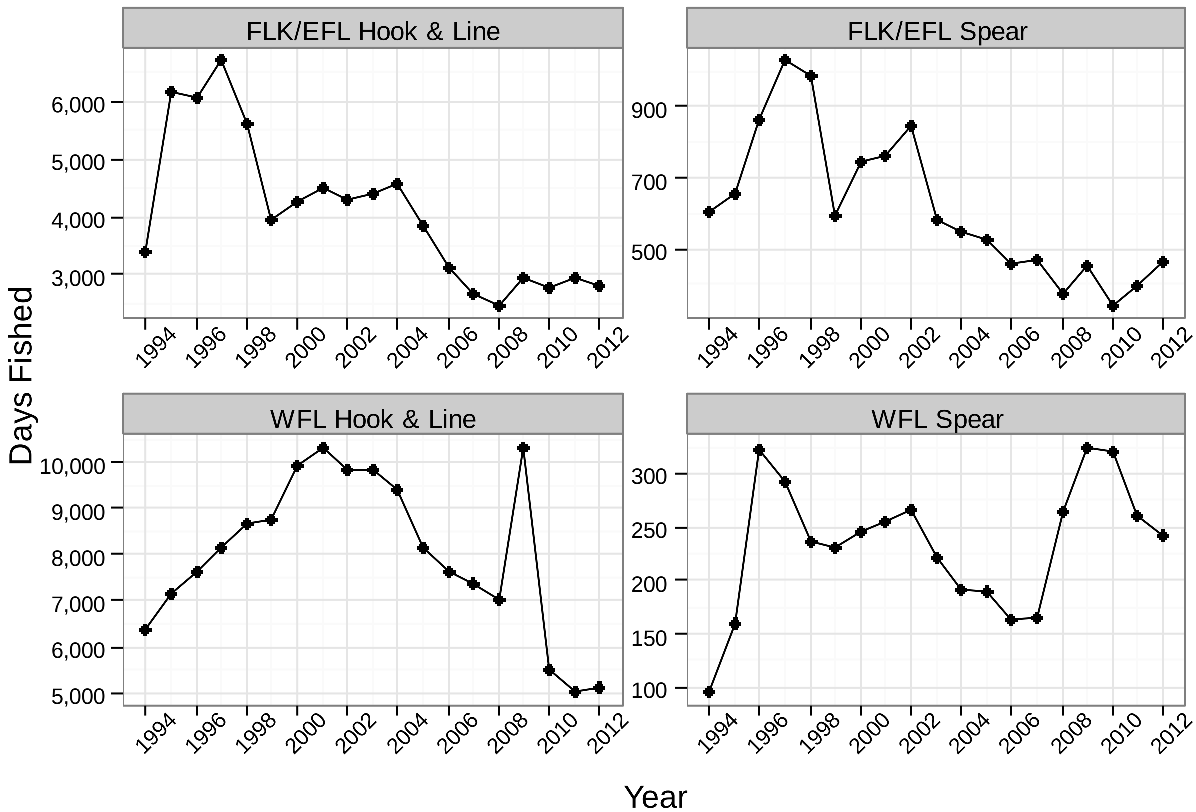
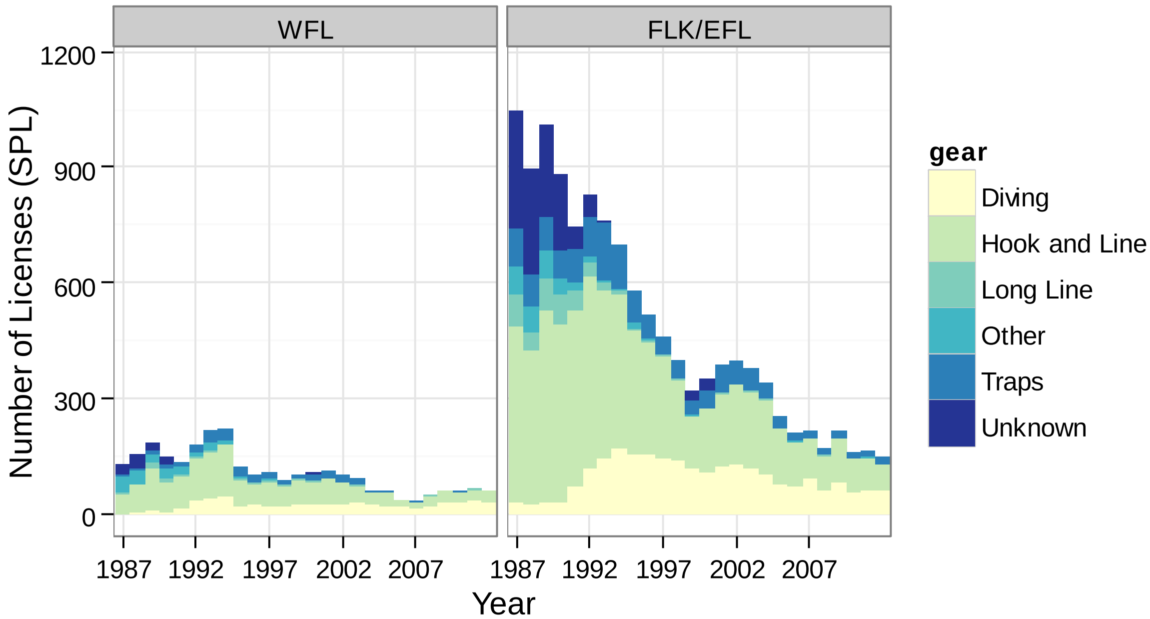


Figure 6.4.3. Number of SPL licenses landing Hogfish from the Florida Trip Ticket database for the two Florida stocks and different gear designations.



7 Recreational Statistics

7.1 Review of Working Papers

There were no working papers for this section; all analyses are detailed herein.

7.2 Recreational Landings

7.2.1 Recreational Fishing Overview

Hogfish are most frequently caught recreationally in Florida (Table 7.2.1.1), with the majority of the landings coming from South/Southeastern and Western Florida. From 1981-2012, only nine total intercepts had recorded catching Hogfish from Gulf states other than Florida, and only fourteen total intercepts had recorded Hogfish from either Georgia or South Carolina in the South Atlantic (Table 7.2.1.2). Hogfish are often associated primarily with spearfishing, being one of the most targeted and caught species using spear. Spearfishing has had a historic presence in Florida, and has been described as increasing greatly in recreational popularity after a Sports Illustrated article from September 5th, 1955 detailing record-holding spearfishermen from the Florida Keys (http://sportsillustrated.cnn.com/vault/article/magazine/MAG1130156/). Given the timing of the article, it can be concluded that recreational harvest by spear existed to some capacity prior to the 1950's. Despite Hogfish being caught infrequently on hook and line (Kingsley 2004), landings from hook and line make up a substantial fraction of the recorded landings, given that the majority of recreational trips are hook and line (see section 7.4.2). Recent media have additionally focused on targeting Hogfish on hook and line (e.g., http://www.bradenton.com/2014/02/09/4981478/outdoors-use-these-tips-to-hook.html), which is additionally supported from discussions with captains in the WFL region, and this could suggest an increasing trend towards directed targeting. For the Florida stocks, recent landings (2004-2012 from the Marine Recreational Information Program, MRIP) have estimated approximately 20% of the total recreational harvest coming from hook and line (Table 7.2.1.3, 7.2.1.4), while for the GA-NC stocks, approximately 90% is estimated as hook and line (Table 7.2.1.5). Recreational harvest of Hogfish is primarily from private boats, with only a small proportion from either charter boats, shore-based fishing (Tables 7.2.1.3-7.2.1.5), or headboats (see section 7.2.2).

7.2.2 Southeast Region Headboat Survey (SRHS)

Estimates of total recreational landings from headboats were obtained from the NMFS Southeast Region Headboat Survey (SRHS) provided to the Florida Fish and Wildlife Research Institute. Stock delineations were based on the headboat survey areas, where areas <10 were assigned as the GA-NC stock; areas 7, 8, 11, 12, 17, and 18 were the FLK/EFL stock; and areas 21-23 were the WFL stock. Catch data were then aggregated for years and stock areas to provide estimates of total landings in number of fish from the SRHS.

Total landings of Hogfish from headboats are low (Table 7.2.2.1), averaging a few hundred total Hogfish per year, depending on the stock. The WFL stock has experienced the highest total numbers of Hogfish caught recently, with a peak in the early to mid 1990's (654 in 1994), and a rapid increase in the number landed in the most recent years (2945 and 4137 in 2011 and 2012, respectively). Despite this increase, the total landings from headboats on hook and line represent only a small fraction of the total landings from other fishing modes (Tables 7.2.1.3-7.2.1.5).

7.2.3 Marine Recreational Fishery Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP)

Both MRFSS (1981-2012) and MRIP (2004-2012) data were used to derive a time series of recreational landings of Hogfish, where the early MRFSS data were calibrated to the MRIP data following the procedures of Salt et al. (2012). Due to the unique stock structure of Hogfish, the MRFSS post-stratification routine was used to estimate landings for the Florida stocks by post-stratifying the MRFSS dataset using the Collier-Monroe county border as the WFL-FLK/EFL boundary, respectively. For-hire adjustments were applied to the MRFSS data using the coast-specific (Gulf and Atlantic) calibration factors from SEDAR 28 (Matter 2012). Data were analyzed by year and gear type for each of the Florida stocks, for both kept (Types A+B1) and released (Type B2) fish.

One data adjustment was made to the raw MRFSS data after locating an unreasonable value in the dataset for the Florida recreational data. In 1984, two hook-and-line records from the FLK/EFL stock in the I2 files (B1 records, disposition=5) were recorded as having caught 100 fish each, while other records from the same year ranged from 0-4 fish total. Due to the improbable nature of these data and the strong influence it had on the yearly total estimate (>3 million fish harvested when including the raw data), these records were replaced with the average number of fish recorded in the same wave of the following year (the preceding year did not have any intercepts for that wave).

For the GA-NC stock, the MRFSS estimates were obtained directly from the Atlantic Coastal Cooperative Statistics Program (ACCSP) database for the period of 1981-2012 for each state separately. The catch estimates and variances were then summed across each state to develop the estimates for the entire GA-NC stock. These data were based on less than ten total intercepts per year across states for all years except 1995 (Table 7.2.3.1), of which no intercepted trips were targeting Hogfish (Table 7.2.3.2). Due to only two total intercepts from spear fishing gear in the GA-NC stock, all recreational landings from the GA-NC stock were assumed to be from hook and line.

The MRIP estimates for the Florida stocks were obtained in a similar fashion to the MRFSS data by setting the unique domain of each stock based on the county boundaries (Collier-Monroe line), while the MRIP estimates for GA-NC were similarly obtained from ACCSP database. The overlapping years of the MRFSS and MRIP data were used to calibrate the MRFSS time-series to the MRIP estimates, following the procedure outlined by the MRFSS/MRIP Calibration Ad

Hoc Working Group (Salt et al. 2012). Harvested fish (types A and B1) and released fish (type B2; see section 7.3.1) were analyzed and calibrated separately.

Recreational landings in numbers were converted to weight by applying the length-weight conversion (section 5.5.2) to the average lengths from the MRFSS/MRIP intercepts (Table 7.2.3.3). Due to relatively low numbers of intercepts on a yearly basis, particularly when disaggregating by stock and gear type, year-specific average lengths were used across gear types for the WFL and FLK/EFL stocks, and the year-combined average length was used for the GA-NC stock.

Tables 7.2.3.4-7.2.3.8 present the estimated recreational harvest for the different stocks and gears. The total recreational harvest of Hogfish from the WFL stock has shown an increasing trend since the initiation of the MRFSS surveys in 1981, both for hook and line and spear fishing, while the total number harvested by spear fishing is estimated as nearly five times greater than the hook and line fishery. The FLK/EFL stock has shown an opposite trend to the WFL stock, where recreational landings have generally decreased since initiation of the MRFSS surveys. The highest estimated landings for the FLK/EFL stock came from the spear fishery in the first year of the MRFSS survey, which was nearly three times greater than the next highest year. While this estimate may be a biased outlier, no issues were detected in the raw data files for this year. Similar to the FLK/EFL stock, the GA-NC stock showed highly variable estimates during the early years of the MRFSS survey, with generally decreasing estimates over time.

7.2.4 Historical Reconstruction for Florida Stocks

Historical recreational landings were extrapolated back to 1950 using all available harvest data (MRFSS/MRIP types A and B1, plus headboat landings), using a combination of data related to possible changes in recreational anglers since that time. This extrapolation was done in order to estimate the potential magnitude of recreational landings that would have occurred over a larger time period, particularly since license data suggests a peak in recreational effort prior to initiation of the MRFSS data (mid-1970's), thereby providing more contrast in information for the assessment model. The approach used here was borrowed directly from an analysis recently completed by D. Chagaris (FWCC-FWRI) as part of the Atlantic coast black drum assessment workshop through the Atlantic States Marine Fisheries Commission (ASMFC).

Previous estimates of historic recreational catch have been based on human population from the U.S. Census (Florida spotted seatrout, Murphy et al. 2011) or coastwide estimates of saltwater anglers and days spent saltwater fishing from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) (South Atlantic Spanish mackerel, Brennan and Fitzpatrick 2012). The human population method assumes that the number of anglers is proportional to the total coastal population and does not account for periods when recreational fishing expanded faster (or slower) than human population. The FHWAR method applied to Spanish mackerel uses coastwide estimates of saltwater fishing effort and assumes that the rate of expansion in saltwater angling was the same across the entire region. Here, information from the FHWAR survey was combined with historical fishing license data to estimate historical recreational catch in each year and state from 1950-1980.

Historic fishing license data were available in the USFWS National Fishing License Reports (http://wsfrprograms.fws.gov/Subpages/LicenseInfo/Fishing.htm) from 1958-2013 for each state. No data were available in 1960 and only Georgia was available in 1959. These reports provide values for the number of certified paid fishing license holders (participants) in each state, where a license holder is one individual regardless of the number of licenses purchased. The reports do not differentiate between saltwater and freshwater anglers. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) provides data about the state in which these activities occurred; number of trips taken; days of participation; and expenditures for food, lodging, transportation, and equipment. The survey was conducted 1991, 1996, 2001, 2006, and 2011 by the Census Bureau for the U.S. Fish and Wildlife Service. An estimate of the percentage of anglers in each state that fish in saltwater is provided in these reports (%saltwater). This percentage was extrapolated linearly between years when the survey was not conducted. Prior to 1991, the %saltwater was only available nationally and only every five years from 1955-1985. These national percentages were used to extrapolate back the statewide estimates. The total number of license holders from the USFWS Historic Fishing License data was then adjusted by the percent estimates from the FHWAR surveys to get the total number of saltwater participants by year and state. Lastly, CPUE was calculated for each year and state from 1981-2012 by dividing the total harvest estimates (MRFSS/MRIP and headboat) by the total number of saltwater participants. The number of saltwater participants was then multiplied by the average CPUE from 1981-1990 in each state to estimate historical harvest since 1950. For this analysis, the average PSE from 1981-1990 was used to estimate the early uncertainty in the data. Tables 7.2.4.1 presents the estimated number of saltwater participants from 1950-2012. Tables 7.2.4.2-7.2.4.6 and Figures 7.2.4.1-7.2.4.3 present the historical reconstruction for the three stocks and gear combinations.

7.3 Recreational Discards and Release Mortality

7.3.1 Discards

Recreational discards (released fish, type B2 records) were estimated using the same procedures outlined above (section 7.2.3) for the harvested fish (type A and B1). Tables 7.3.1.1-7.3.1.4 present the recreational discards from the different stocks and gears, including the separate estimates from MRFSS and MRIP and the calibrated time series with the two combined. Generally the discards were highly variable where many years did not have any estimated released fish. Note, no discards were recorded from spearfishing from the WFL stock, although a small proportion of discarded Hogfish were recorded as coming from spearfishing in the FLK/EFL stock (Table 7.3.1.3).

7.4 Recreational Effort

7.4.1 Southeast Region Headboat Survey (SRHS)

Total recreational effort from the SRHS was determined by totaling the angler days for the different stocks. Estimates of directed effort were not available from the SRHS data. Despite the steep increase in headboat landings for the WFL stock, the total effort of headboat angler days from the WFL region has not seen a similar increase (Table 7.4.1.1), although this would not detect potential efforts to target Hogfish since the effort trend is in total angler days.

7.4.2 Marine Recreational Fishery Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP)

Total and directed effort were estimated from the MRFSS intercept and estimates files. Directed effort consisted of all angler trips catching either Hogfish or one of the species associated with Hogfish as identified in the cluster analyses used for the generation of recreational catch per unit effort (see sections 8.2.1 and 8.4.1). The directed effort was only calculated for the Florida stocks where sufficient intercept data existed to develop the associated species list from the cluster analysis.

Total recreational effort for the GA-NC stock, including separate estimates per each state in the stock, were obtained from the NMFS recreational statistics website (http://www.st.nmfs.noaa.gov/st1/recreational/). Note that the GA-NC data utilized the MRIP weighted adjustments, while the effort for the Florida stocks used only the MRFSS data. Despite this potential bias for the Florida stocks, the differences between the MRFSS-MRIP effort estimates are typically minor (comparisons available on the website), and importantly these effort data were not used directly in the assessment model (effort was integrated into the CPUE standardization procedure for indices of abundance; see sections 8.2.2 and 8.4.2).

Tables 7.4.2.1-7.4.2.3 and Figures 7.4.2.1-7.4.2.5 present the effort data estimates by stock and gear type. For the Florida stocks, effort estimates in the early years of MRFSS (1981-1985) tended to be low, and then increased dramatically in 1986. While total angler trips for hook and line have increased in the WFL stock, directed trips have tended to remain stable, although the highest peak was in 2008-2009. Spear effort has tended to remain stable for both total and directed effort. For the FLK/EFL stock, total effort from hook and line has been relatively stable from 1986 until recent declines, while total effort from spear has tended to increase in recent years after a stable period. For both gear types, directed effort has remained stable. For the GA-NC stock, total effort has increased since data were recorded, with the majority of trips coming from North Carolina (67% over all years), followed by South Carolina (23%) and Georgia (10%).

7.5 Biological Sampling

7.5.1 Adequacy for Characterizing Catch and for Assessment Analyses

Overall sampling for recreationally-caught Hogfish is limited with moderate to high percent standard errors (PSEs >30%) for most years, particularly the early time series (1980s) with PSEs from the calibrated time series often approaching or greater than 100% (Tables 7.2.3.4-7). Note that the PSE estimates can vary between the MRFSS estimates and MRIP estimates, with the MRFSS estimates from the post-stratification routine typically being lower than the MRIP estimates in the same years. While the MRFSS PSE estimates were in the moderate range for the early years, the variance adjustments applied during the calibration routine (Salt et al. 2012) tended to increase the PSE estimates of the calibrated time series substantially. High error estimates as suggested by the calibrated time series indicate high variability around the estimate and therefore low precision, and warrant caution as suggested as by the MRFSS/MRIP program for any PSEs greater than 50%. Therefore, adequacy of these data for assessment analyses for all three of the stocks may be limited for the early years of the recreational surveys when errors were greatest, although the original MRFSS PSE estimates prior to the calibration procedure suggest the estimates are suitable. Given these data represent the best available science, these landings data are considered adequate for assessment analyses if uncertainty in the recreational landings is handled appropriately within the assessment. In particular, it is recommended that the recreational landings not be assumed known with no or limited error (e.g., fixing the standard error for the recreational landings to 1-5% as done in many assessments), but an appropriate error estimate be used in the model (e.g., year specific values or median of PSE values for a representative period).

Similar to commercial sampling, biological sampling of Hogfish from recreational trips is generally poor for age samples and poor to moderate for length samples (Tables 5.5.1.1, 5.5.1.2; Figures 5.5.5.3, 5.5.5.4, 5.5.5.9, 5.5.5.10, 5.5.5.14, 5.5.5.15). On average a total of 36, 40, and 10 fish lengths were sampled each year, for those years with data, from each of the WFL, FLK/EFL, and GA-NC stocks, respectively (Table 5.5.1.1). Aging of recreationally-sampled Hogfish has been mostly missing, with a combined total across all years of 16, 14, and 40 fish aged from the WFL, FLK/EFL, and GA-NC stocks, respectively (Table 5.5.1.2).

As with the commercial data, use of stock-, gear-, and/or year-specific age-length information (e.g., age-length keys) could be biased, particularly if one was to attempt to estimate growth parameters within a model. Since the life-history studies on Hogfish have characterized the growth dynamics with adequate sampling, one can use a combination of the existing growth models, length samples, and limited age samples to inform the assessment model (Stock Synthesis, which can accommodate the various data inputs). This however will not detect potential changes in growth dynamics over time, which is a current limitation for modeling Hogfish from lack of suitable age information.

7.6 Literature Cited

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7.7 Tables

Table 7.2.1.1. Estimated number of Hogfish caught recreationally per state, both harvested and released combined (types A+B1+B2), from the Southeastern US. Data obtained from the Marine Resources Information Program (MRIP) web interface (http://www.st.nmfs.noaa.gov/st1/recreational).

Year	ALABAMA	FLORIDA	GEORGIA	LOUISIANA	MISSISSIPPI	NORTH CAROLINA	SOUTH CAROLINA
1981		1020253					
1982		69416				196650	
1983		251567				32349	
1984		3073490					
1985		151046		12440		44184	
1986		141765		351		41395	
1987		252260				1890	
1988		185950				50	
1989		105211				262	289
1990	407	129223				871	
1991		174719					
1992		202335			479	531	
1993		217252				681	
1994		180857				34	
1995		145760				22100	2227
1996		101688			2909	270	
1997		95088			1257	1082	
1998		73328	228				
1999		101034	26				
2000		45616					25
2001		77423					
2002		65479				716	62
2003		151514	21		3990	76	
2004		152673				309	
2005		148547				1406	
2006		88749	34			1881	
2007		170434				2859	496
2008		265029				5875	
2009		159559				152	29
2010		172916				4201	773
2011		69395				2248	
2012		213555				1339	

Table 7.2.1.2. Total number of recreational intercepts of Hogfish from MRFSS/MRIP for each state.

Year	ALABAMA	FLORIDA	GEORGIA	LOUISIANA	MISSISSIPPI	NORTH CAROLINA	SOUTH CAROLINA
1981		37					
1982		27				5	
1983		15				1	
1984		25					
1985		10		3		2	
1986		17		1		5	
1987		57				2	
1988		39				1	
1989		31				2	1
1990	1	28				2	
1991		23					
1992		103			1	7	
1993		82				5	
1994		113				1	
1995		71				14	1
1996		53			1	1	
1997		54			1	2	
1998		71	1				
1999		100	1				
2000		33					1
2001		70					
2002		71				1	1
2003		100	1		1	1	
2004		100				1	
2005		77				3	1
2006		63	1			5	
2007		119				2	2
2008		137				5	
2009		99				1	1
2010		103				7	2
2011		124				4	
2012		129				4	

Table 7.2.1.3. Total recreational harvest (types A+B1) of Hogfish by mode and gear type from MRIP for the WFL stock.

Year	Charter Boat		Private Boat		Shore	
	Hook and Line	Spear	Hook and Line	Spear	Hook and Line	Spear
2004	190.5242	0	1039.082	41648.92	0	0
2005	53.56821	319.1992	4416.703	14019.67	0	0
2006	97.97859	0	7303.096	15122.07	0	0
2007	1211.626	0	6701.558	23052.02	0	0
2008	409.1455	0	5353.98	71908.94	3018.392	0
2009	650.1681	0	5554.325	37083.68	1270.041	0
2010	0	28010.19	13031.25	48879.85	0	0
2011	764.0761	1874.024	8007.015	19571.82	0	0
2012	1087.945	5397.463	9434.213	38837.58	0	0
Proportion:	**0.010751**	**0.085719**	**0.146492**	**0.746712**	**0.010326**	**0**

Table 7.2.1.4. Total recreational harvest (types A+B1) of Hogfish by mode and gear type from MRIP for the FLK/EFL stock.

Year	Charter Boat		Private Boat		Shore	
	Hook and Line	Spear	Hook and Line	Spear	Hook and Line	Spear
2004	2533.227	917.596	36463.5	46578.49	3103.22	0
2005	301.1889	285.5544	7100.632	77628.46	1859.124	0
2006	1465.006	0	14706.09	37338.57	1715.225	0
2007	486.5303	0	28213.73	93241.62	0	0
2008	6020.605	0	12422.26	148230.1	0	696.7199
2009	65.57439	0	34683.53	75521.14	596.5049	0
2010	475.0498	4.025337	15239.76	61512.07	0	0
2011	364.9008	0	11638.17	24487.57	722.8714	0
2012	1320.601	67.16481	15043.66	130569.9	521.3602	0
Proportion:	**0.014576**	**0.001425**	**0.19629**	**0.777403**	**0.009527**	**0.000779**

Table 7.2.1.5. Total recreational harvest (types A+B1) of Hogfish by mode and gear type from MRIP for the GA-NC stock.

Year	Charter Boat		Private Boat		Shore	
	Hook and Line	Spear	Hook and Line	Spear	Hook and Line	Spear
2004	0	0	309.2945	0	0	0
2005	0	0	688.6734	717.1153	0	0
2006	34.24846	0	1607.799	0	0	0
2007	25.87806	0	469.7617	0	0	0
2008	43.53771	0	760.3908	0	0	0
2009	28.64256	0	152.4297	0	0	0
2010	46.60104	0	1391.084	0	0	0
2011	0	0	174.4912	0	0	0
2012	22.99057	0	1196.299	0	0	0
Proportion:	**0.026326**	**0**	**0.880169**	**0.093505**	**0**	**0**

Table 7.2.2.1. Estimated number of Hogfish caught from the Southeast Region Headboat Survey (SRHS) for each of the three stocks. Note: the Western Gulf states other than FL (WGOM) are shown separately to highlight the focal distribution for Hogfish, but were included in the WFL stock.

Year	WGOM	WFL	EFL	GA-NC
1981	0	0	962	0
1982	0	0	105	59
1983	0	0	314	7
1984	0	0	567	60
1985	0	0	273	234
1986	0	117	589	197
1987	1	34	562	62
1988	14	187	512	71
1989	0	41	392	34
1990	1	147	226	119
1991	5	94	239	236
1992	0	213	383	212
1993	0	167	251	189
1994	0	654	188	151
1995	0	465	414	178
1996	0	13	230	79
1997	0	7	226	146
1998	0	25	236	194
1999	2	40	207	301
2000	0	66	166	214
2001	0	57	200	150
2002	0	61	152	114
2003	0	80	146	57
2004	0	53	467	66
2005	1	123	543	50
2006	0	41	608	36
2007	3	76	336	352
2008	0	61	203	69
2009	1	125	134	20
2010	0	430	71	28
2011	1	2945	95	12
2012	0	4137	106	110

Table 7.2.3.1. Total number of intercepted trips from the dockside surveys catching Hogfish by year, stock, and gear type.

	WFL			FLK/EFL			GA-NC		
Year	**Spear**	**Hook and Line**	**Other**	**Spear**	**Hook and Line**	**Other**	**Spear**	**Hook and Line**	**Other**
1981	4	1	0	27	5	0	0	0	0
1982	4	0	0	16	0	7	0	5	0
1983	2	0	0	11	2	0	0	1	0
1984	0	0	0	10	15	0	0	0	0
1985	0	0	0	1	9	0	0	2	0
1986	3	3	0	5	6	0	0	5	0
1987	17	2	0	28	10	0	0	2	0
1988	12	4	0	14	9	0	0	1	0
1989	11	3	0	2	15	0	0	3	0
1990	2	1	0	13	12	0	0	2	0
1991	10	1	1	6	5	0	0	0	0
1992	9	9	7	47	30	1	1	6	0
1993	14	9	0	27	32	0	0	5	0
1994	15	8	0	60	30	0	0	1	0
1995	10	16	1	16	28	0	0	15	0
1996	11	7	0	17	18	0	0	1	0
1997	16	9	0	11	17	1	0	2	0
1998	20	12	0	17	22	0	0	1	0
1999	32	11	0	34	23	0	0	1	0
2000	3	9	0	12	9	0	0	1	0
2001	17	8	0	24	21	0	0	0	0
2002	10	10	0	40	11	0	0	2	0
2003	18	19	0	37	26	0	0	2	0
2004	19	4	0	47	30	0	0	1	0
2005	8	14	0	33	22	0	1	3	0
2006	18	4	0	23	18	0	0	6	0
2007	11	10	0	62	36	0	0	4	0
2008	34	16	0	58	29	0	0	5	0
2009	19	22	0	38	20	0	0	2	0
2010	33	12	0	38	20	0	0	9	0
2011	55	20	0	32	17	0	0	4	0
2012	32	11	0	58	28	0	0	4	0
Total	**469**	**255**	**9**	**864**	**575**	**9**	**2**	**96**	**0**

Table 7.2.3.2. Total number of intercepted trips from the dockside surveys targeting Hogfish by year, stock, and gear type.

	WFL			FLK/EFL			GA-NC		
Year	**Spear**	**Hook and Line**	**Other**	**Spear**	**Hook and Line**	**Other**	**Spear**	**Hook and Line**	**Other**
1981	0	1	0	14	2	0	0	0	0
1982	2	0	0	2	0	5	0	0	0
1983	0	0	0	7	0	0	0	0	0
1984	0	0	0	4	2	0	0	0	0
1985	0	0	0	1	1	0	0	0	0
1986	2	0	0	3	0	0	0	0	0
1987	7	0	0	15	1	0	0	0	0
1988	5	0	0	10	4	0	0	0	0
1989	3	1	0	1	1	0	0	0	0
1990	1	0	0	1	1	0	0	0	0
1991	7	0	0	5	1	0	0	0	0
1992	6	1	6	34	3	0	0	0	0
1993	7	3	0	25	12	0	0	0	0
1994	9	0	0	49	8	0	0	0	0
1995	6	7	1	8	6	0	0	0	0
1996	3	1	0	7	3	0	0	0	0
1997	10	0	0	2	0	0	0	0	0
1998	14	0	0	4	0	0	0	0	0
1999	15	0	0	21	1	0	0	0	0
2000	1	0	0	9	2	0	0	0	0
2001	10	0	0	16	7	0	0	0	0
2002	7	0	0	33	2	0	0	0	0
2003	5	4	0	23	0	0	0	0	0
2004	9	0	0	29	2	0	0	0	0
2005	2	5	0	19	5	0	0	0	0
2006	12	0	0	15	2	0	0	0	0
2007	6	0	0	38	16	0	0	0	0
2008	27	4	0	43	3	0	0	0	0
2009	10	6	0	16	7	0	0	0	0
2010	23	4	0	27	11	0	0	0	0
2011	55	10	0	16	4	0	0	0	0
2012	28	10	0	29	7	0	0	1	0
Total	**292**	**57**	**7**	**526**	**114**	**5**	**0**	**1**	**0**

Table 7.2.3.3. Average weight of recreationally caught fish per stock and year, with the total number of fish measured for each year.

Year	WFL		Keys		GA-NC	
	Wt (g)	Sample	Wt (g)	Sample	Wt (g)	Sample
1981		0	795.7965	91		0
1982	2540.785	2	1055.72	19	178.2572	2
1983	424.2159	3	745.067	10		0
1984		0	725.1969	23		0
1985		0	856.3993	3		0
1986	1007.518	36	871.8273	28	48.47676	1
1987	1416.323	33	912.7698	62		0
1988	1386.77	17	1125.217	33	5511.212	1
1989	1263.89	16	772.0817	29	3554.822	2
1990	1202.87	6	953.2964	25	10732.93	2
1991	1019.537	27	782.1524	24		0
1992	1251.302	22	850.0403	74	4017.004	6
1993	1259.124	20	1029.124	65	3285.451	10
1994	1029.712	31	805.2909	82	3166.81	1
1995	880.9514	43	1379.827	39	1133.101	57
1996	899.3598	10	892.2144	57		0
1997	1082.187	28	1186.62	34	3088.403	1
1998	964.477	49	857.5313	31	1580.618	1
1999	1001.762	43	1149.736	45	5223.866	1
2000	1434.654	23	1243.45	21	7474.366	1
2001	939.3886	28	1161.398	26		0
2002	1237.984	23	1174.769	25	8307.186	2
2003	1027.774	56	795.3205	38	2175.416	2
2004	1074.484	44	1081.938	32		0
2005	1310.492	30	1223.096	16	4583.282	4
2006	923.2821	21	1286.728	20	4049.748	5
2007	810.4352	27	1068.179	53	243.3956	1
2008	1030.52	64	864.838	31	6163.759	1
2009	1153.917	48	859.097	38	5129.249	2
2010	1075.435	72	742.1016	16	3067.357	2
2011	1209.82	72	922.2293	28	3681.249	1
2012	1318.593	133	1078.092	132	5285.077	8

Table 7.2.3.4. Recreational harvest (types A+B1) of Hogfish from hook and line in the WFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981	6290.06	39564861.89			5293.46	6.65	1.28
1982							
1983							
1984							
1985							
1986	3123.09	2895669.45			2628.26	2.65	0.71
1987	1401.37	1963826.98			1179.33	1.67	1.28
1988	7037.59	7514108.67			5922.54	8.21	0.52
1989	4687.51	21972768.59			3944.82	4.99	1.28
1990	6040.46	36487119.03			5083.40	6.11	1.28
1991							
1992	5502.81	3394506.81			4630.94	5.79	0.45
1993	13687.44	19151770.17			11518.79	14.50	0.43
1994	12864.80	16552913.50			10826.48	11.15	0.43
1995	17982.88	30042702.89			15133.65	13.33	0.42
1996	7872.57	11576315.10			6625.23	5.96	0.57
1997	15523.23	93967185.75			13063.71	14.14	0.81
1998	5252.31	4302519.12			4420.13	4.26	0.52
1999	2934.31	1268860.68			2469.40	2.47	0.51
2000	12813.53	17072063.42			10783.34	15.47	0.44
2001	9825.28	12196325.74			8268.55	7.77	0.48
2002	7583.39	7209512.14			6381.87	7.90	0.47
2003	27280.90	34852441.64			22958.49	23.60	0.31
2004	1507.82	666136.73	1229.61	1092474.00	1229.61	1.32	0.85
2005	8196.52	4954126.63	4470.27	6388049.00	4470.27	5.86	0.57
2006	2715.27	3515449.13	7401.07	53335217.00	7401.07	6.83	0.99
2007	10624.22	7188493.87	7913.18	13892074.00	7913.18	6.41	0.47
2008	10118.62	27667289.65	8781.52	11751818.00	8781.52	9.05	0.39
2009	8002.43	7413842.07	7474.53	10434061.00	7474.53	8.62	0.43
2010	13889.95	20886574.12	13031.25	39841529.00	13031.25	14.01	0.48
2011	15139.34	21434204.07	8771.09	18254148.00	8771.09	10.61	0.49
2012			10522.16	50962454.00	10522.16	13.87	0.68

Table 7.2.3.5. Recreational harvest (types A+B1) of Hogfish from spear fishing in the WFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982	4756.30	6567585.21			5329.09	6.69	1.18
1983	18375.80	121295569.95			20588.76	25.85	1.31
1984							
1985							
1986	40628.02	427140054.53			45520.76	45.86	1.11
1987	41474.31	99451627.15			46468.96	65.82	0.54
1988	33805.76	90186034.08			37876.91	52.53	0.63
1989	33975.40	193801797.22			38066.98	48.11	0.90
1990	5458.80	8270118.62			6116.19	7.36	1.15
1991	101146.47	2045119771.65			113327.31	115.54	0.98
1992	46796.98	738418704.61			52432.64	65.61	1.27
1993	68366.08	827387649.92			76599.26	96.45	0.92
1994	33568.12	221481428.50			37610.65	38.73	0.97
1995	29193.59	109870020.31			32709.31	28.82	0.79
1996	13874.32	18897270.32			15545.18	13.98	0.70
1997	21671.07	38150489.02			24280.86	26.28	0.64
1998	26905.26	39994810.92			30145.40	29.07	0.53
1999	35765.08	69144351.61			40072.18	40.14	0.53
2000	10330.25	16086985.73			11574.30	16.61	0.85
2001	27120.01	46146663.39			30386.01	28.54	0.56
2002	12658.97	24871824.65			14183.46	17.56	0.87
2003	40019.39	70045685.63			44838.83	46.08	0.48
2004	37061.26	78057353.47	41648.92	464965294.00	41648.92	44.75	0.52
2005	12973.43	18584105.98	14338.87	66231248.00	14338.87	18.79	0.57
2006	17226.61	19386189.25	15122.07	41286586.00	15122.07	13.96	0.42
2007	27822.31	47411044.08	23052.02	112099658.00	23052.02	18.68	0.46
2008	64624.27	165484809.52	71908.94	561546413.00	71908.94	74.10	0.33
2009	42522.33	108790850.59	37083.68	172448872.00	37083.68	42.79	0.35
2010	42021.06	64910940.73	76890.05	1125329073.00	76890.05	82.69	0.44
2011	24833.84	37706285.56	21445.85	53579794.00	21445.85	25.95	0.34
2012			44235.04	221862666.00	44235.04	58.33	0.34

Table 7.2.3.6. Recreational harvest (types A+B1) of Hogfish from hook and line in the FLK/EFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981	10661.92	13055170.07			18487.19	14.71	1.12
1982							
1983	4709.62	8051121.55			8166.23	6.08	1.99
1984	141397.84	5114356749.31			245176.22	177.80	1.67
1985	136117.04	3665418142.16			236019.60	202.13	1.47
1986	18754.95	38450794.48			32520.07	28.35	1.10
1987	68613.78	344871942.66			118972.59	108.59	0.90
1988	21467.79	52357318.78			37223.99	41.89	1.12
1989	48776.77	215207886.46			84576.29	65.30	1.00
1990	34502.47	343511493.53			59825.42	57.03	1.77
1991	42939.35	193050940.51			74454.51	58.23	1.07
1992	34480.33	74807794.57			59787.04	50.82	0.84
1993	80352.35	713576324.05			139326.65	143.38	1.10
1994	36888.51	53235256.36			63962.69	51.51	0.67
1995	47440.61	260565676.75			82259.46	113.50	1.13
1996	26331.07	27918949.62			45656.65	40.74	0.68
1997	16085.96	10521797.06			27892.18	33.10	0.68
1998	10997.82	7295531.49			19069.63	16.35	0.82
1999	6239.19	1976300.12			10818.41	12.44	0.76
2000	4521.57	4406947.04			7840.15	9.75	1.53
2001	20239.70	36063364.28			35094.55	40.76	0.99
2002	7270.40	7837046.35			12606.48	14.81	1.28
2003	18081.70	42238950.79			31352.70	24.94	1.19
2004	17219.06	15599479.21	42099.95	646725049.75	42099.95	45.55	0.60
2005	10711.05	10986884.86	9260.94	10380903.00	9260.94	11.33	0.35
2006	10153.88	9256684.10	17886.32	41104421.00	17886.32	23.01	0.36
2007	23932.40	40400798.55	28700.26	96246419.00	28700.26	30.66	0.34
2008	8444.23	3671893.88	18442.87	76409612.47	18442.87	15.95	0.47
2009	14931.11	15700792.78	35345.60	362545112.00	35345.60	30.37	0.54
2010	10595.80	26112949.96	15714.81	141069539.00	15714.81	11.66	0.76
2011	7923.83	7789596.84	12725.94	58765895.00	12725.94	11.74	0.60
2012			16885.63	45192490.00	16885.63	18.20	0.40

Table 7.2.3.7. Recreational harvest (types A+B1) of Hogfish from spear fishing in the FLK/EFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981	1014392.63	199871397742.61			1699556.36	1352.50	1.83
1982	38966.19	195881632.98			65285.61	68.92	1.50
1983	229647.92	12867170690.36			384761.85	286.67	2.05
1984	211848.96	6909818698.69			354940.72	257.40	1.63
1985							
1986	78540.00	1721835376.00			131589.23	114.72	2.19
1987	125382.82	1549012604.81			210071.69	191.75	1.31
1988	88205.34	1071220351.24			147782.96	166.29	1.54
1989	12421.91	114612854.29			20812.19	16.07	3.58
1990	57742.51	230038604.31			96744.25	92.23	1.10
1991	29813.63	255283779.37			49951.01	39.07	2.23
1992	91698.57	525264436.98			153635.67	130.60	1.04
1993	48318.33	183426664.36			80954.58	83.31	1.17
1994	88878.43	252141817.60			148910.68	119.92	0.75
1995	26199.91	65487365.12			43896.44	60.57	1.29
1996	30453.09	52179371.35			51022.40	45.52	0.99
1997	28066.87	39592789.86			47024.42	55.80	0.94
1998	17762.65	13879965.98			29760.29	25.52	0.88
1999	35043.13	61494081.99			58712.74	67.50	0.94
2000	13165.03	16597733.85			22057.25	27.43	1.29
2001	18793.87	21841571.42			31488.05	36.57	1.04
2002	35479.83	62583026.78			59444.41	69.83	0.93
2003	54609.65	115635101.24			91495.32	72.77	0.83
2004	32600.80	33767606.59	47496.08	257317340.91	47496.08	51.39	0.34
2005	39252.07	69163310.02	77914.02	1918372336.89	77914.02	95.30	0.56
2006	19709.37	22586458.25	37338.57	246281908.00	37338.57	48.04	0.42
2007	74755.84	128873460.40	93241.62	480825839.00	93241.62	99.60	0.24
2008	66907.70	131321373.20	148926.78	4774939589.00	148926.78	128.80	0.46
2009	48806.48	65715207.95	75521.14	758607881.00	75521.14	64.88	0.36
2010	31004.64	39643644.41	61516.09	741097462.20	61516.09	45.65	0.44
2011	25048.07	37888119.41	24487.57	77772819.00	24487.57	22.58	0.36
2012			130637.05	3352092694.11	130637.05	140.84	0.44

Table 7.2.3.8. Recreational harvest (types A+B1) of Hogfish in the GA-NC stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series. Note: this includes all gears, primarily which is hook and line (see Table 7.2.3.1).

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982	36042.62	467326183.74			37142.77	99.33	0.65
1983							
1984							
1985	17941.99	90732521.45			18489.64	49.45	0.58
1986	8770.25	59368385.74			9037.94	24.17	0.95
1987	1889.58	701166.15			1947.25	5.21	0.49
1988	50.33	848.15			51.87	0.14	0.63
1989	303.86	30603.12			313.14	0.84	0.63
1990	870.92	253670.01			897.51	2.40	0.63
1991							
1992	531.43	42600.72			547.65	1.46	0.44
1993	681.44	39835.74			702.24	1.88	0.35
1994	34.23	250.64			35.27	0.09	0.51
1995	24326.72	65842440.77			25069.25	67.04	0.39
1996							
1997	81.16	6582.78			83.64	0.22	1.07
1998	228.35				235.32	0.63	0.15
1999	26.12	482.17			26.92	0.07	0.91
2000	25.17	554.82			25.94	0.07	1.01
2001							
2002	778.00	511949.28			801.75	2.14	0.99
2003	97.56	6150.21			100.54	0.27	0.87
2004	380.01	139267.03	309.29	97772.74	309.29	0.83	1.01
2005	855.37	327114.86	1431.01	985575.45	1431.01	3.83	0.69
2006	1650.84	690112.07	1642.05	1052760.49	1642.05	4.39	0.62
2007	971.86	631418.15	598.08	251088.03	598.08	1.60	0.84
2008	575.46	243493.72	803.93	604594.31	803.93	2.15	0.97
2009	275.56	42485.08	181.07	24366.40	181.07	0.48	0.86
2010	1822.09	1623416.98	1437.68	1028829.46	1437.68	3.84	0.71
2011	224.77	49697.50	174.49	30088.57	174.49	0.47	0.99
2012	1170.99	927135.27	1248.40	1267712.98	1248.40	3.34	0.90

Table 7.2.4.1. Estimated number of saltwater participants (license holders) for the historical reconstruction of the recreational harvest.

Year	FL	GA-NC		Year	FL	GA-NC
1950	265,900	199,115		**1982**	563,339	417,319
1951	274,187	205,321		**1983**	607,404	429,510
1952	282,475	211,526		**1984**	649,083	373,075
1953	290,762	217,732		**1985**	684,301	427,483
1954	299,049	223,938		**1986**	687,402	425,884
1955	307,337	230,144		**1987**	645,483	399,412
1956	315,624	236,350		**1988**	644,860	388,255
1957	323,911	242,556		**1989**	632,557	395,496
1958	332,199	248,762		**1990**	693,183	392,425
1959	365,676	220,202		**1991**	731,261	394,694
1960	374,577	224,808		**1992**	775,458	427,755
1961	414,720	264,729		**1993**	745,297	456,137
1962	391,199	271,871		**1994**	777,864	494,825
1963	399,699	289,341		**1995**	791,477	546,015
1964	418,956	313,992		**1996**	770,610	573,246
1965	442,416	347,563		**1997**	782,742	563,296
1966	453,819	360,110		**1998**	806,434	558,127
1967	493,510	384,527		**1999**	935,546	611,902
1968	496,090	387,876		**2000**	925,380	603,580
1969	521,289	408,459		**2001**	871,024	629,291
1970	562,752	383,258		**2002**	846,377	626,161
1971	705,592	397,970		**2003**	796,720	576,681
1972	731,204	413,836		**2004**	815,838	602,977
1973	772,865	441,995		**2005**	767,444	554,957
1974	834,392	479,549		**2006**	933,356	569,796
1975	870,670	492,358		**2007**	1,008,471	579,062
1976	821,995	480,897		**2008**	1,057,003	592,602
1977	739,438	445,532		**2009**	1,085,113	686,855
1978	667,847	428,453		**2010**	1,079,780	749,642
1979	716,261	432,471		**2011**	1,059,224	774,229
1980	588,882	420,618		**2012**	1,140,376	825,429
1981	581,532	444,984		**2013**	1,066,988	820,392

Table 7.2.4.2. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from hook and line in the WFL stock.

Year	Number	Metric Tons	PSE		Year	Number	Metric Tons	PSE
1950	1018.31	1.28	1.06		1982			
1951	1050.05	1.32	1.06		1983			
1952	1081.79	1.36	1.06		1984			
1953	1113.53	1.40	1.06		1985			
1954	1145.26	1.44	1.06		1986	2745.26	2.77	0.71
1955	1177.00	1.48	1.06		1987	1213.33	1.72	1.28
1956	1208.74	1.52	1.06		1988	6109.54	8.47	0.52
1957	1240.48	1.56	1.06		1989	3985.82	5.04	1.28
1958	1272.22	1.60	1.06		1990	5230.40	6.29	1.28
1959	1400.42	1.76	1.06		1991	94.00	0.10	
1960	1434.51	1.80	1.06		1992	4843.94	6.06	0.45
1961	1588.25	1.99	1.06		1993	11685.79	14.71	0.43
1962	1498.17	1.88	1.06		1994	11480.48	11.82	0.43
1963	1530.72	1.92	1.06		1995	15598.65	13.74	0.42
1964	1604.47	2.01	1.06		1996	6638.23	5.97	0.57
1965	1694.31	2.13	1.06		1997	13070.71	14.14	0.81
1966	1737.98	2.18	1.06		1998	4445.13	4.29	0.52
1967	1889.99	2.37	1.06		1999	2509.40	2.51	0.51
1968	1899.87	2.39	1.06		2000	10849.34	15.57	0.44
1969	1996.37	2.51	1.06		2001	8325.55	7.82	0.48
1970	2155.16	2.71	1.06		2002	6442.87	7.98	0.47
1971	2702.19	3.39	1.06		2003	23038.49	23.68	0.31
1972	2800.28	3.52	1.06		2004	1282.61	1.38	0.85
1973	2959.83	3.72	1.06		2005	4593.27	6.02	0.57
1974	3195.46	4.01	1.06		2006	7442.07	6.87	0.99
1975	3334.39	4.19	1.06		2007	7989.18	6.47	0.47
1976	3147.98	3.95	1.06		2008	8842.52	9.11	0.39
1977	2831.81	3.56	1.06		2009	7599.53	8.77	0.43
1978	2557.64	3.21	1.06		2010	13461.25	14.48	0.48
1979	2743.05	3.44	1.06		2011	11716.09	14.17	0.49
1980	2255.23	2.83	1.06		2012	14659.16	19.33	0.68
1981	5293.46	6.65	1.28					

Table 7.2.4.3. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from spear fishing in the WFL stock.

Year	Number	Metric Tons	PSE		Year	Number	Metric Tons	PSE
1950	8224.50	10.33	0.97		1982	5329.09	6.69	1.18
1951	8480.83	10.65	0.97		1983	20588.76	25.85	1.31
1952	8737.18	10.97	0.97		1984			
1953	8993.50	11.29	0.97		1985			
1954	9249.83	11.61	0.97		1986	45520.76	45.86	1.11
1955	9506.18	11.93	0.97		1987	46468.96	65.82	0.54
1956	9762.51	12.26	0.97		1988	37876.91	52.53	0.63
1957	10018.83	12.58	0.97		1989	38066.98	48.11	0.90
1958	10275.18	12.90	0.97		1990	6116.19	7.36	1.15
1959	11310.65	14.20	0.97		1991	113327.31	115.54	0.98
1960	11585.97	14.55	0.97		1992	52432.64	65.61	1.27
1961	12827.63	16.10	0.97		1993	76599.26	96.45	0.92
1962	12100.10	15.19	0.97		1994	37610.65	38.73	0.97
1963	12363.01	15.52	0.97		1995	32709.31	28.82	0.79
1964	12958.65	16.27	0.97		1996	15545.18	13.98	0.70
1965	13684.29	17.18	0.97		1997	24280.86	26.28	0.64
1966	14036.99	17.62	0.97		1998	30145.40	29.07	0.53
1967	15264.66	19.16	0.97		1999	40072.18	40.14	0.53
1968	15344.47	19.26	0.97		2000	11574.30	16.61	0.85
1969	16123.89	20.24	0.97		2001	30386.01	28.54	0.56
1970	17406.38	21.85	0.97		2002	14183.46	17.56	0.87
1971	21824.53	27.40	0.97		2003	44838.83	46.08	0.48
1972	22616.73	28.39	0.97		2004	41648.92	44.75	0.52
1973	23905.34	30.01	0.97		2005	14338.87	18.79	0.57
1974	25808.42	32.40	0.97		2006	15122.07	13.96	0.42
1975	26930.53	33.81	0.97		2007	23052.02	18.68	0.46
1976	25424.97	31.92	0.97		2008	71908.94	74.10	0.33
1977	22871.42	28.71	0.97		2009	37083.68	42.79	0.35
1978	20657.05	25.93	0.97		2010	76890.05	82.69	0.44
1979	22154.53	27.81	0.97		2011	21445.85	25.95	0.34
1980	18214.60	22.87	0.97		2012	44235.04	58.33	0.34
1981								

Table 7.2.4.4. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from hook and line in the FLK/EFL stock.

Year	Number	Metric Tons	PSE		Year	Number	Metric Tons	PSE
1950	34150.19	28.54	1.21		1982	105.00	0.11	
1951	35214.51	29.43	1.21		1983	8480.23	6.32	1.99
1952	36278.96	30.32	1.21		1984	245743.22	178.21	1.67
1953	37343.28	31.21	1.21		1985	236292.60	202.36	1.47
1954	38407.60	32.09	1.21		1986	33109.07	28.87	1.10
1955	39472.05	32.98	1.21		1987	119534.59	109.11	0.90
1956	40536.37	33.87	1.21		1988	37735.99	42.46	1.12
1957	41600.69	34.76	1.21		1989	84968.29	65.60	1.00
1958	42665.14	35.65	1.21		1990	60051.42	57.25	1.77
1959	46964.67	39.25	1.21		1991	74693.51	58.42	1.07
1960	48107.85	40.20	1.21		1992	60170.04	51.15	0.84
1961	53263.51	44.51	1.21		1993	139577.65	143.64	1.10
1962	50242.65	41.98	1.21		1994	64150.69	51.66	0.67
1963	51334.33	42.90	1.21		1995	82673.46	114.08	1.13
1964	53807.55	44.96	1.21		1996	45886.65	40.94	0.68
1965	56820.58	47.48	1.21		1997	28118.18	33.37	0.68
1966	58285.09	48.71	1.21		1998	19305.63	16.56	0.82
1967	63382.71	52.96	1.21		1999	11025.41	12.68	0.76
1968	63714.06	53.24	1.21		2000	8006.15	9.96	1.53
1969	66950.43	55.95	1.21		2001	35294.55	40.99	0.99
1970	72275.63	60.40	1.21		2002	12758.48	14.99	1.28
1971	90620.92	75.73	1.21		2003	31498.70	25.05	1.19
1972	93910.33	78.47	1.21		2004	42566.95	46.05	0.60
1973	99260.96	82.95	1.21		2005	9803.94	11.99	0.35
1974	107163.02	89.55	1.21		2006	18494.32	23.80	0.36
1975	111822.30	93.44	1.21		2007	29036.26	31.02	0.34
1976	105570.85	88.22	1.21		2008	18645.87	16.13	0.47
1977	94967.85	79.36	1.21		2009	35479.60	30.48	0.54
1978	85773.24	71.68	1.21		2010	15785.81	11.71	0.76
1979	91991.17	76.87	1.21		2011	12820.94	11.82	0.60
1980	75631.57	63.20	1.21		2012	16991.63	18.32	0.40
1981	19449.19	15.48	1.12					

Table 7.2.4.5. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from spearfishing in the FLK/EFL stock.

Year	Number	Metric Tons	PSE		Year	Number	Metric Tons	PSE
1950	136599.31	114.15	1.86		1982	65285.61	68.92	1.50
1951	140856.54	117.70	1.86		1983	384761.85	286.67	2.05
1952	145114.29	121.26	1.86		1984	354940.72	257.40	1.63
1953	149371.52	124.82	1.86		1985			
1954	153628.76	128.38	1.86		1986	131589.23	114.72	2.19
1955	157886.51	131.94	1.86		1987	210071.69	191.75	1.31
1956	162143.74	135.49	1.86		1988	147782.96	166.29	1.54
1957	166400.97	139.05	1.86		1989	20812.19	16.07	3.58
1958	170658.72	142.61	1.86		1990	96744.25	92.23	1.10
1959	187856.67	156.98	1.86		1991	49951.01	39.07	2.23
1960	192429.33	160.80	1.86		1992	153635.67	130.60	1.04
1961	213051.77	178.03	1.86		1993	80954.58	83.31	1.17
1962	200968.46	167.94	1.86		1994	148910.68	119.92	0.75
1963	205335.12	171.59	1.86		1995	43896.44	60.57	1.29
1964	215227.91	179.85	1.86		1996	51022.40	45.52	0.99
1965	227279.88	189.92	1.86		1997	47024.42	55.80	0.94
1966	233137.88	194.82	1.86		1998	29760.29	25.52	0.88
1967	253528.11	211.86	1.86		1999	58712.74	67.50	0.94
1968	254853.52	212.96	1.86		2000	22057.25	27.43	1.29
1969	267798.86	223.78	1.86		2001	31488.05	36.57	1.04
1970	289099.42	241.58	1.86		2002	59444.41	69.83	0.93
1971	362479.80	302.90	1.86		2003	91495.32	72.77	0.83
1972	375637.31	313.90	1.86		2004	47496.08	51.39	0.34
1973	397039.58	331.78	1.86		2005	77914.02	95.30	0.56
1974	428647.50	358.19	1.86		2006	37338.57	48.04	0.42
1975	447284.40	373.77	1.86		2007	93241.62	99.60	0.24
1976	422278.86	352.87	1.86		2008	148926.78	128.80	0.46
1977	379867.32	317.43	1.86		2009	75521.14	64.88	0.36
1978	343089.28	286.70	1.86		2010	61516.09	45.65	0.44
1979	367960.73	307.48	1.86		2011	24487.57	22.58	0.36
1980	302523.03	252.80	1.86		2012	130637.05	140.84	0.44
1981	1699556.36	1352.50	1.83					

Table 7.2.4.6. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish in the GA-NC stock.

Year	Number	Metric Tons	PSE		Year	Number	Metric Tons	PSE
1950	3257.93	8.71	0.65		1982	37201.77	99.49	0.65
1951	3359.47	8.98	0.65		1983	7.00	0.02	
1952	3461.01	9.26	0.65		1984	60.00	0.16	
1953	3562.55	9.53	0.65		1985	18723.64	50.07	0.57
1954	3664.10	9.80	0.65		1986	9234.94	24.70	0.92
1955	3765.64	10.07	0.65		1987	2009.25	5.37	0.49
1956	3867.18	10.34	0.65		1988	122.87	0.33	0.62
1957	3968.72	10.61	0.65		1989	347.14	0.93	0.62
1958	4070.26	10.89	0.65		1990	1016.51	2.72	0.62
1959	3602.96	9.64	0.65		1991	236.00	0.63	
1960	3678.32	9.84	0.65		1992	759.65	2.03	0.44
1961	4331.52	11.58	0.65		1993	891.24	2.38	0.35
1962	4448.37	11.90	0.65		1994	186.27	0.50	0.51
1963	4734.22	12.66	0.65		1995	25247.25	67.52	0.39
1964	5137.56	13.74	0.65		1996	79.00	0.21	0.00
1965	5686.86	15.21	0.65		1997	229.64	0.61	1.04
1966	5892.15	15.76	0.65		1998	429.32	1.15	0.18
1967	6291.66	16.83	0.65		1999	327.92	0.88	0.88
1968	6346.47	16.97	0.65		2000	239.94	0.64	0.98
1969	6683.25	17.87	0.65		2001	150.00	0.40	
1970	6270.89	16.77	0.65		2002	915.75	2.45	0.96
1971	6511.61	17.41	0.65		2003	157.54	0.42	0.84
1972	6771.23	18.11	0.65		2004	375.29	1.00	1.01
1973	7231.95	19.34	0.65		2005	1481.01	3.96	0.69
1974	7846.42	20.98	0.65		2006	1678.05	4.49	0.62
1975	8056.01	21.54	0.65		2007	950.08	2.54	0.84
1976	7868.48	21.04	0.65		2008	872.93	2.33	0.97
1977	7289.83	19.50	0.65		2009	201.07	0.54	0.86
1978	7010.39	18.75	0.65		2010	1465.68	3.92	0.71
1979	7076.13	18.92	0.65		2011	186.49	0.50	0.99
1980	6882.18	18.41	0.65		2012	1358.40	3.63	0.90
1981								

Table 7.3.1.1. Recreational discards (type B2) of Hogfish from hook and line in the WFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982							
1983							
1984							
1985							
1986							
1987	1786.32	3190945.56			1464.90	2.07	0.78
1988							
1989	1171.88	1373298.04			961.01	1.21	0.78
1990							
1991							
1992	2312.61	5348147.79			1896.48	2.37	0.78
1993							
1994							
1995	1915.39	1863467.10			1570.74	1.38	0.57
1996	3645.40	7764089.34			2989.46	2.69	0.60
1997	571.96	327142.61			469.05	0.51	0.78
1998	1395.77	433156.61			1144.62	1.10	0.39
1999	2380.61	3211930.11			1952.25	1.96	0.60
2000	787.48	620128.68			645.79	0.93	0.78
2001							
2002	579.90	336280.68			475.55	0.59	0.78
2003	743.84	553297.89			610.00	0.63	0.78
2004	705.07	497119.01	393.04	154477.00	393.04	0.42	1.00
2005	3781.43	4028538.20	2662.44	3740822.00	2662.44	3.49	0.73
2006	1728.87	1621414.16	2539.60	150075.00	2539.60	2.34	0.15
2007	1349.42	1820928.79	463.57	214896.00	463.57	0.38	1.00
2008	5351.58	5225477.64	5099.15	2596988.00	5099.15	5.25	0.32
2009	3156.68	3386787.53	2102.19	1248670.00	2102.19	2.43	0.53
2010	3635.22	3996660.34	3023.83	4208908.00	3023.83	3.25	0.68
2011	532.07	283099.33	314.54	98935.00	314.54	0.38	1.00
2012							

Table 7.3.1.2. Recreational discards (type B2) of Hogfish from hook and line in the FLK/EFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982							
1983							
1984							
1985							
1986							
1987	1994.70	3978821.89			3958.29	3.61	3.49
1988	34515.04	429936298.65			68491.87	77.07	2.10
1989	1757.76	3089734.62			3488.12	2.69	3.49
1990	8336.43	39973344.48			16542.86	15.77	2.65
1991							
1992	6398.76	7189618.09			12697.75	10.79	1.47
1993	798.94	638311.54			1585.43	1.63	3.49
1994	6710.04	7208666.64			13315.44	10.72	1.41
1995	13823.62	16388926.82			27431.68	37.85	1.04
1996	10130.91	19669912.78			20103.84	17.94	1.54
1997	3911.48	3117399.49			7761.96	9.21	1.59
1998	9913.23	8688247.50			19671.88	16.87	1.06
1999	8774.57	9211077.06			17412.30	20.02	1.22
2000	2356.41	2860379.39			4676.07	5.81	2.51
2001	2072.41	1334644.13			4112.50	4.78	1.95
2002							
2003	10114.45	17700441.19			20071.19	15.96	1.46
2004	6273.00	4239315.53	19622.92	197234779.00	19622.92	21.23	0.72
2005	18012.33	79239210.97	39900.71	###########	39900.71	48.80	0.79
2006	3298.13	2804677.60	7465.01	23547559.00	7465.01	9.61	0.65
2007	6000.65	4460565.21	14609.40	105909367.00	14609.40	15.61	0.70
2008	10271.95	11206946.62	11869.31	31543614.00	11869.31	10.27	0.47
2009	710.96	349191.46	2031.29	3798456.14	2031.29	1.75	0.96
2010	3756.74	4343400.81	2739.05	4921315.00	2739.05	2.03	0.81
2011	2012.44	1185970.72	1649.78	796574.72	1649.78	1.52	0.54
2012			11274.99	67871486.00	11274.99	12.16	0.73

Table 7.3.1.3. Recreational discards (type B2) of Hogfish from spear fishing in the FLK/EFL stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series.

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982							
1983							
1984							
1985							
1986							
1987							
1988	1360.66	1851391.55			1614.07	1.82	1.38
1989							
1990	1928.20	3717937.57			2287.31	2.18	1.38
1991							
1992	2853.95	5110543.19			3385.48	2.88	1.13
1993							
1994							
1995	2050.13	4203031.53			2431.95	3.36	1.38
1996	1121.27	1257242.37			1330.10	1.19	1.38
1997							
1998							
1999	504.65	254674.17			598.64	0.69	1.38
2000	446.64	199490.55			529.83	0.66	1.38
2001							
2002	974.68	509520.09			1156.21	1.36	1.05
2003							
2004	833.80	355038.54	182.14	33174.00	182.14	0.20	1.00
2005							
2006	612.51	375173.81	995.83	991680.00	995.83	1.28	1.00
2007	1616.81	2614089.72	2455.64	6030189.00	2455.64	2.62	1.00
2008							
2009							
2010							
2011							
2012							

Table 7.3.1.4. Recreational discards (type B2) of Hogfish in the GA-NC stock. Both the MRFSS and MRIP estimates are presented, along with the calibrated time series. Note: this includes all gears, primarily which is hook and line (see Table 7.2.3.1).

Year	MRFSS		MRIP		Calibrated Harvest		
	Number	Variance	Number	Variance	Number	Metric Tons	PSE
1981							
1982	160607.36	25222707144.53			106335.94	284.38	0.86
1983	32348.96	1046455339.89			21417.81	57.28	0.87
1984							
1985	26241.74	363435572.40			17374.30	46.47	0.65
1986	32624.31	534149798.13			21600.11	57.77	0.64
1987							
1988							
1989	247.94	61476.59			164.16	0.44	0.87
1990							
1991							
1992							
1993							
1994							
1995							
1996	270.12	72963.67			178.84	0.48	0.87
1997	1001.07	1002142.45			662.80	1.77	0.87
1998							
1999							
2000							
2001							
2002							
2003							
2004							
2005	1083.99	630004.49					
2006	519.08	269446.13	272.89	75299.11	272.89	0.73	1.01
2007	2769.67	7671080.08	2859.25	7861988.58	2859.25	7.65	0.98
2008	9731.04	43351652.01	5071.39	23491679.05	5071.39	13.56	0.96
2009							
2010	4082.55	3957029.99	3535.58	9391283.76	3535.58	9.46	0.87
2011	2690.36	2874966.36	2073.17	2430632.57	2073.17	5.54	0.75
2012	165.37	27346.07	119.37	13874.47	119.37	0.32	0.99

Table 7.4.1.1. Total angler days from the Southeast Region Headboat Survey (SRHB) for each of the three stocks and with the Western Gulf states other than FL (WGOM) separate.

Year	WGOM	WFL	FLK/EFL	GA-NC
1981			298883	78404
1982			293133	94478
1983			277863	89563
1984			288994	96179
1985			280845	97385
1986	62459	239303	317832	98414
1987	69725	217049	333041	114067
1988	78087	195948	301775	118889
1989	66256	207739	317450	101386
1990	65042	210373	326422	100394
1991	66342	172990	281344	108918
1992	86129	183410	265855	102966
1993	92160	204659	240212	107243
1994	113429	203616	243242	100407
1995	100962	181464	207798	105248
1996	102840	154913	197173	92755
1997	91215	149442	170367	100245
1998	85504	185331	153339	100743
1999	66261	176117	162195	88952
2000	63347	159331	180097	73794
2001	61583	156676	161619	83381
2002	73173	141831	149274	72340
2003	81068	144211	143585	60980
2004	64990	158430	173701	79415
2005	59857	130233	171078	67370
2006	75794	124049	173604	83728
2007	66286	133856	158208	91697
2008	44133	129480	123241	65843
2009	54005	141289	135478	62478
2010	47869	109707	123016	67979
2011	50941	155620	123881	64667
2012	55456	161135	139402	62830

Table 7.4.2.1. Directed recreational angler trips from MRFSS/MRIP for the two Florida Stocks. Trips include those catching either Hogfish or species associated with Hogfish as identified from a cluster analysis (see sections 8.2.2 and 8.4.2).

Year	FLK/EFL				WFL			
	Hook and Line		Spear		Hook and Line		Spear	
	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE
1981	23616.11	1.474376	236028.3	2.037456	39565.45	1.368144	14822.09	2.029688
1982	3906.728	2.961387	19197.55	1.43476	10919.11	1.564445	9876.643	1.891247
1983	12690.07	2.02686	39304.86	1.163369	35000.02	1.372561	31496.83	1.399849
1984	61031.93	1.049059	67900.51	0.977023	0		0	
1985	115197.9	1.16629	0		58611.29	1.013157	0	
1986	25603.2	1.242886	9196.945	1.807457	127115.2	0.458205	16197.7	1.409481
1987	60725.17	2.451737	40106.49	0.734807	105845.8	0.550193	24386.6	0.854284
1988	28832	1.059511	19656.58	0.927131	122308.2	0.385723	43238.71	0.592751
1989	61504.64	0.780549	7226.181	1.573783	105927.5	0.468877	17672.17	1.141473
1990	44221.16	0.644023	26298.4	0.669398	81316.82	0.36218	9283.546	1.063446
1991	23271.59	0.788565	9479.349	1.255335	137650.3	0.33762	20568.02	0.91004
1992	43382.68	0.50242	28958.94	0.470091	135244.6	0.22294	14027.34	0.683238
1993	48889.22	0.330493	14708.51	0.55286	147505.9	0.1741	14841.8	0.585403
1994	44899.94	0.331019	26835.88	0.445746	121911.6	0.181166	14975.46	0.532214
1995	34088.17	0.373593	12409.57	0.602557	131889	0.196365	11794.71	0.579621
1996	27138.73	0.50094	14674.96	0.639737	75695.49	0.234154	23914.69	0.428363
1997	27275.8	0.500154	11034.75	0.743853	97780.25	0.235675	17579.74	0.551546
1998	27270.39	0.524489	10051.2	0.833342	83495.62	0.237656	12117.06	0.698934
1999	23280.6	0.554882	12302.87	0.7831	94534.76	0.250674	17403.39	0.588824
2000	29502.07	0.623023	8136.156	1.24321	114764.4	0.280827	11261.13	0.899015
2001	23207.56	0.654313	9418.089	1.137979	122965.7	0.251501	12392.01	0.821859
2002	17274.48	0.763029	9102.975	1.067256	120176	0.245476	11964.14	0.812451
2003	26141.61	0.65115	15748.43	0.867595	104375.2	0.286966	19009.54	0.709405
2004	31448.7	0.62196	16815.8	0.908251	131397.4	0.243124	19647.76	0.710431
2005	28035.66	0.694151	14324.24	0.972725	115309.5	0.255633	13285.35	0.860251
2006	18947.68	0.762655	11324.61	1.039624	101926.3	0.319258	14080.09	0.983322
2007	38202.55	0.623859	31201.61	0.707263	122046.4	0.335372	10717.61	1.191153
2008	35707.6	0.582689	22270.89	0.79172	170263.7	0.316273	20593.5	0.825704
2009	22309.18	0.748563	18371.23	0.874478	170480.4	0.318519	14303.46	1.041854
2010	17119.53	0.843446	12554.99	1.064655	63401.73	0.434637	12549.25	1.077866
2011	20446.99	0.739455	14951.25	0.893102	96150.31	0.294607	12334.66	0.939177
2012	30924.97	0.6132	27228.9	0.660701	140103.5	0.301856	12186.05	0.960436

Table 7.4.2.2. Total recreational angler trips from MRFSS/MRIP for the two Florida Stocks.

Year	FLK/EFL				WFL			
	Hook and Line		Spear		Hook and Line		Spear	
	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE
1981	3621498	0.359707	487838	1.396458	2901884	0.271946	34291.49	1.339702
1982	2846222	0.118113	110162.7	0.593662	2095800	0.123474	42482.85	0.89457
1983	3807743	0.113658	161143.3	0.586286	3389251	0.124877	71440.49	0.895345
1984	5400460	0.091881	110223.1	0.754465	4223337	0.108652	58317.82	0.70135
1985	4859776	0.123387	41428.89	1.600142	4415871	0.142547	48837.69	0.977877
1986	10407497	0.063069	16512.2	1.313037	13224281	0.060629	49753.71	0.807867
1987	12360855	0.07792	110078	0.448233	10243372	0.052166	104407.9	0.418706
1988	12217308	0.043794	85824.69	0.445737	13437216	0.041998	160843.4	0.332545
1989	11751740	0.055408	60344.75	0.772717	10802452	0.05664	72595.89	0.596034
1990	9146668	0.041517	81155.42	0.38317	8633290	0.047379	38272.58	0.586645
1991	13412370	0.038122	74638.86	0.464085	11667601	0.045195	42762.48	0.620272
1992	12036611	0.025617	138834.4	0.214802	11659293	0.028669	69548.94	0.326217
1993	11696031	0.021908	65959.5	0.264072	10577026	0.024566	61629.49	0.294418
1994	13402804	0.019748	114215.3	0.208196	11293182	0.023289	57699.89	0.272525
1995	13247221	0.020577	49542.5	0.305621	10530411	0.02248	59784.06	0.267028
1996	12375746	0.024092	66061.84	0.297101	10139535	0.024106	82782.44	0.232353
1997	13040130	0.024419	52499.46	0.338982	11230021	0.024802	74374.55	0.27025
1998	11162135	0.028135	50434.79	0.363872	10923545	0.026487	52478.88	0.332815
1999	8943339	0.03121	48546.53	0.39181	10305778	0.027229	50610.39	0.349721
2000	12193499	0.032067	51059.55	0.493145	14152210	0.027443	34879.89	0.513971
2001	13283132	0.030702	60852.97	0.448267	15307859	0.025353	51303.36	0.400206
2002	10794255	0.032714	52105.97	0.443945	13716107	0.024227	45125.8	0.40611
2003	12140617	0.03275	89111.38	0.37071	15077134	0.026265	67158.43	0.376578
2004	11180185	0.03817	96469.69	0.37872	15630624	0.027007	74810.75	0.371137
2005	12348753	0.037362	56909.11	0.481071	14985748	0.026938	39818.91	0.489609
2006	13432678	0.031532	55618.21	0.463482	15719148	0.030993	33793.71	0.640798
2007	15640506	0.032834	136568.7	0.337564	15636549	0.033937	44307.47	0.603155
2008	11916560	0.033673	129405	0.332712	15929292	0.033562	56652.52	0.499475
2009	10387528	0.036	118183.9	0.335729	15018226	0.034952	35911.25	0.653161
2010	10447567	0.037096	111064.4	0.360733	13445283	0.035098	52330.38	0.530394
2011	10372645	0.037247	98335.96	0.35995	13206500	0.032464	58579.36	0.421237
2012	9737808	0.034833	148029	0.280752	14154599	0.033921	55769.97	0.466297

Table 7.4.2.3. Total recreational angler trips from MRFSS/MRIP for GA, SC, NC, and combined.

Year	GEORGIA		NORTH CAROLINA		SOUTH CAROLINA		GA-NC Combined	
	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE	Angler Trips	PSE
1981	326668	0.20	2074197	0.12	606451	0.15	3007316	0.09
1982	492758	0.17	3439298	0.07	1458758	0.15	5390814	0.06
1983	479809	0.16	4562782	0.10	1183337	0.12	6225928	0.08
1984	528532	0.14	3809178	0.09	1734418	0.26	6072128	0.09
1985	438863	0.12	3380362	0.07	1571874	0.19	5391099	0.07
1986	639429	0.09	2977064	0.09	1447731	0.09	5064224	0.06
1987	751345	0.10	3861937	0.06	1648123	0.08	6261405	0.04
1988	666724	0.09	4762892	0.05	1906129	0.07	7335745	0.04
1989	625890	0.14	3848897	0.06	1080628	0.09	5555415	0.05
1990	705443	0.12	3867934	0.05	931063	0.09	5504440	0.04
1991	740819	0.14	3762391	0.05	1796213	0.08	6299423	0.04
1992	572145	0.08	4372004	0.04	1457232	0.07	6401381	0.03
1993	673464	0.07	4716082	0.04	1776210	0.05	7165756	0.03
1994	955824	0.09	5170137	0.03	1987302	0.06	8113263	0.03
1995	781715	0.09	5106667	0.04	1530254	0.05	7418636	0.03
1996	617362	0.09	4741821	0.04	1434078	0.05	6793261	0.03
1997	575872	0.08	4891509	0.03	1606383	0.05	7073764	0.03
1998	571859	0.08	4461461	0.04	1714089	0.07	6747409	0.03
1999	472577	0.09	4555039	0.04	1213324	0.06	6240940	0.03
2000	795778	0.09	6460011	0.04	1339788	0.07	8595577	0.03
2001	806849	0.10	6649546	0.04	1675601	0.07	9131996	0.03
2002	619085	0.09	5586122	0.04	1254295	0.08	7459502	0.03
2003	971208	0.09	6733464	0.04	2097813	0.08	9802485	0.03
2004	969242	0.11	6912766	0.04	2447627	0.10	10329635	0.04
2005	932689	0.10	6542798	0.05	2193830	0.12	9669317	0.04
2006	798250	0.08	6863981	0.05	2238488	0.09	9900719	0.04
2007	1028696	0.10	6333377	0.04	2030174	0.08	9392247	0.04
2008	1204060	0.07	6898425	0.04	2451345	0.09	10553830	0.04
2009	842438	0.09	5308692	0.05	2413124	0.11	8564254	0.05
2010	872803	0.07	5677574	0.04	2298189	0.10	8848566	0.04
2011	970147	0.11	4739744	0.04	1806449	0.09	7516340	0.04
2012	892417	0.11	5303480	0.04	2206383	0.08	8402280	0.03
2013	680844	0.11	4996503	0.04	1944080	0.06	7621427	0.03

7.8 Figures

Figure 7.2.2.1. Estimated number of Hogfish caught from the Southeast Region Headboat Survey (SRHS) for each of the three stocks. Note: the Western Gulf states other than FL (WGOM) are shown separately to highlight the focal distribution for Hogfish, but were included in the WFL stock.

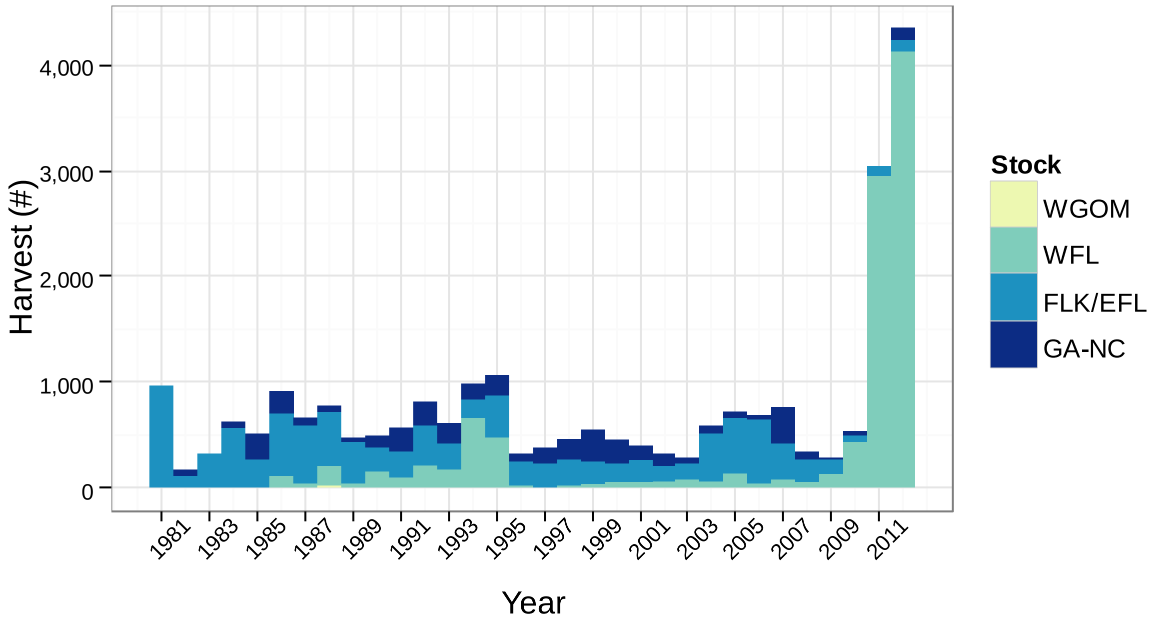


Figure 7.2.4.1. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from the two main gear types in the WFL stock.

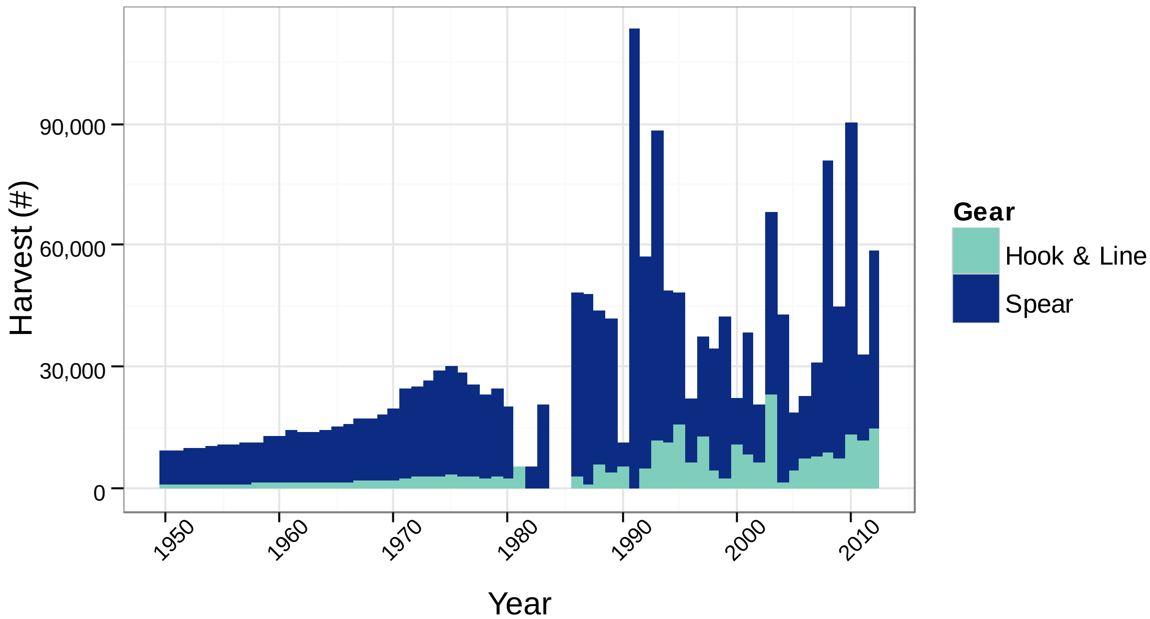


Figure 7.2.4.2. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish from the two main gear types in the FLK/EFL stock.

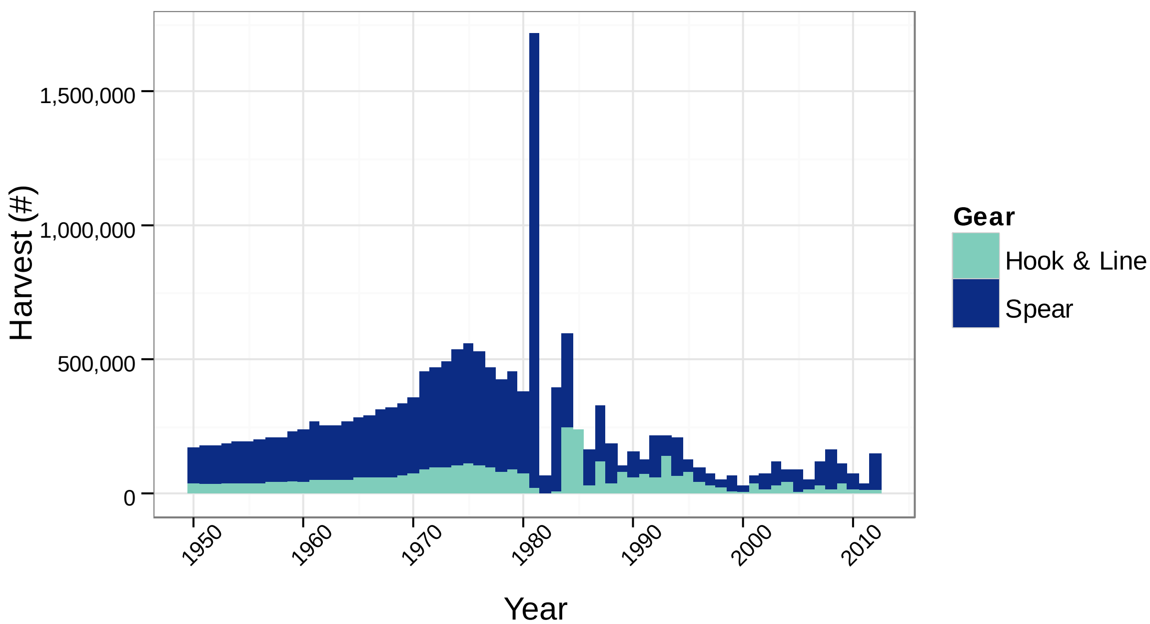


Figure 7.2.4.3. Historical reconstruction of recreational harvest (MRFSS/MRIP and headboat) of Hogfish in the GA-NC stock. Note: all but two total dock-side intercepts were from hook and line, therefore all landings are assumed as coming from hook and line.

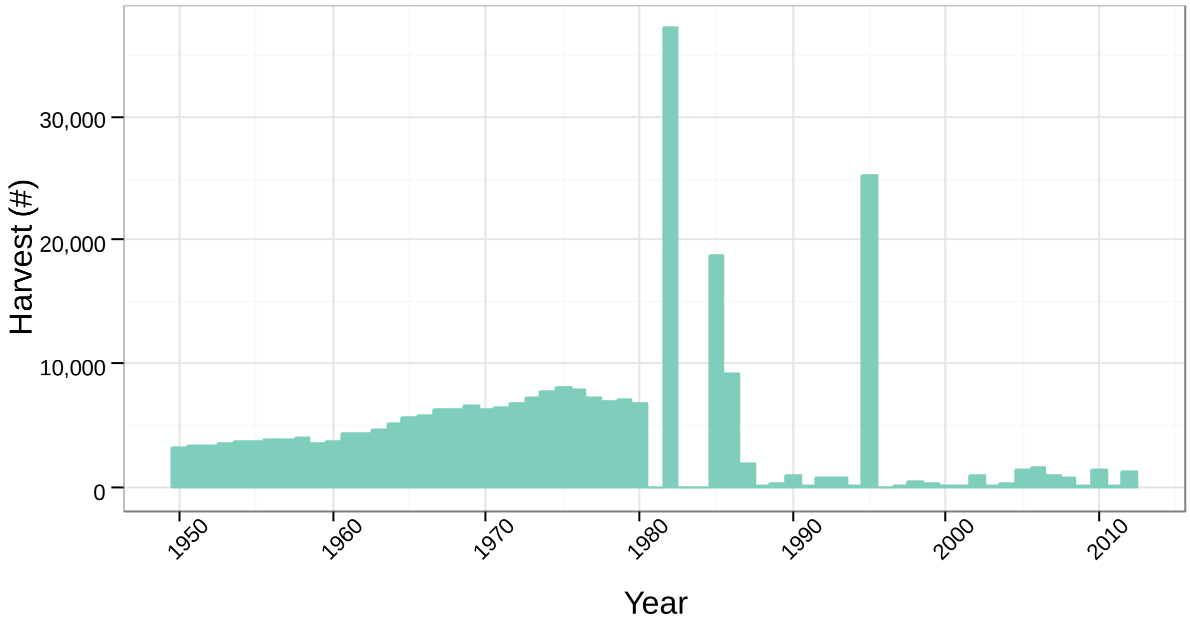


Figure 7.4.1.1. Total angler days from the Southeast Region Headboat Survey (SRHB) for each of the three stocks and with the Western Gulf states other than FL (WGOM) separate. Note: records for the Gulf (WGOM, WFL) began in 1986.

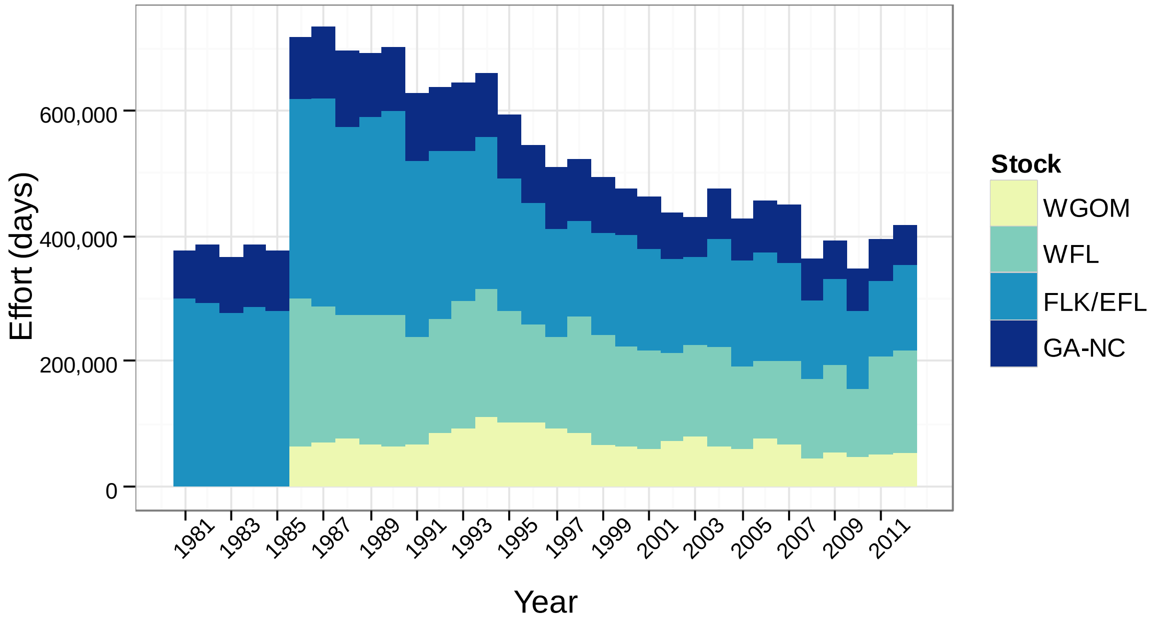


Figure 7.4.2.1. Directed effort in number of angler trips from the MRFSS data through 2012 for the WFL stock. Trips include those catching either Hogfish or species associated with Hogfish as identified from a cluster analysis (see sections 8.2.2 and 8.4.2).

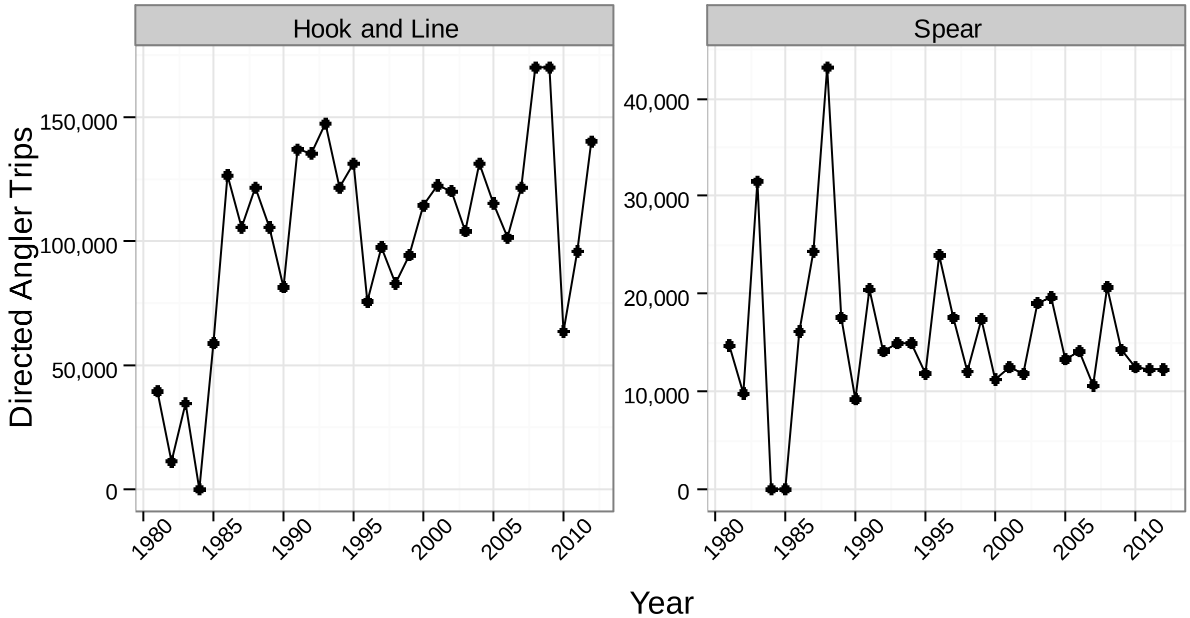


Figure 7.4.2.2. Total effort in number of angler trips from the MRFSS data through 2012 for the WFL stock.

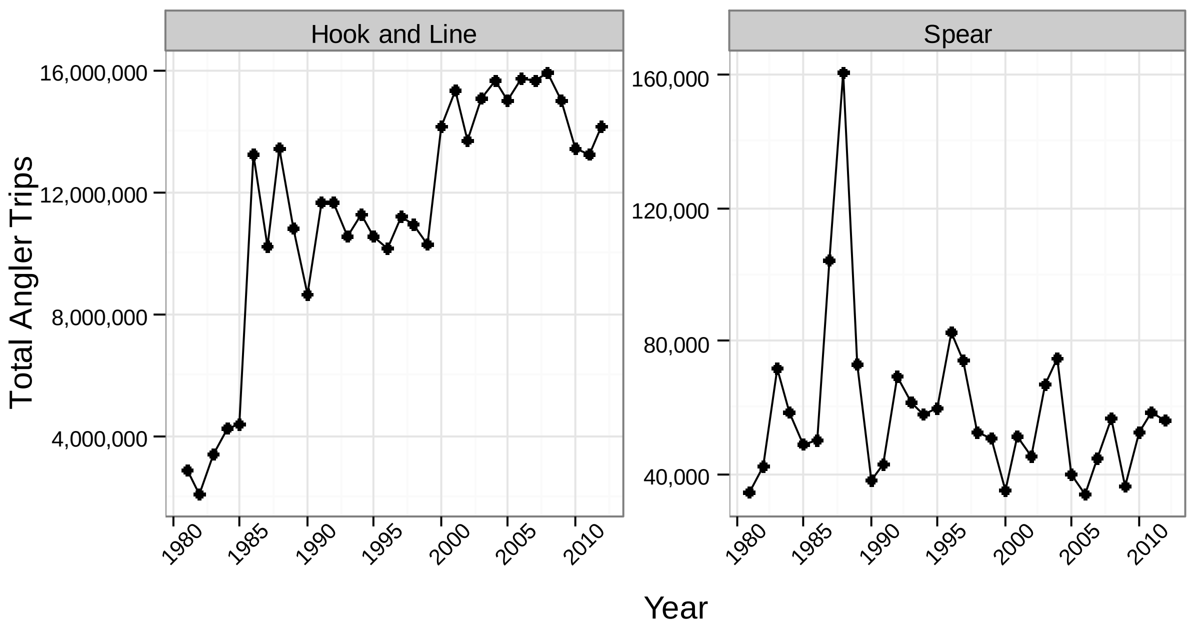


Figure 7.4.2.3. Directed effort in number of angler trips from the MRFSS data through 2012 for the FLK/SEFL stock. Trips include those catching either Hogfish or species associated with Hogfish as identified from a cluster analysis (see sections 8.2.2 and 8.4.2).

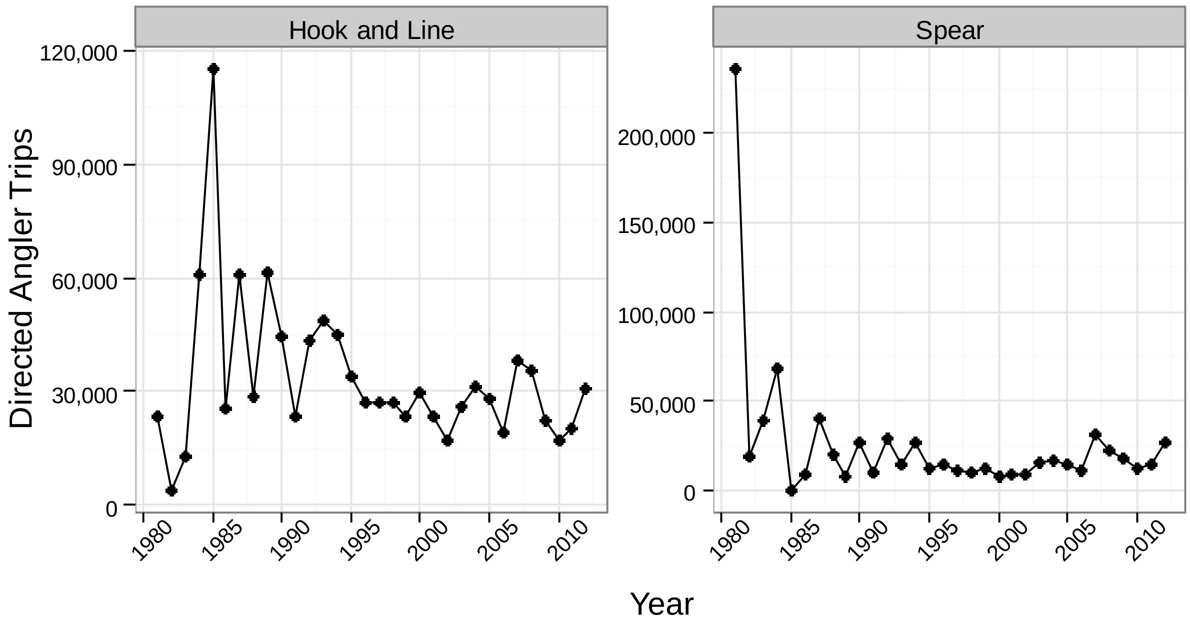


Figure 7.4.2.4. Total effort in number of angler trips from the MRFSS data through 2012 for the FLK/SEFL stock.

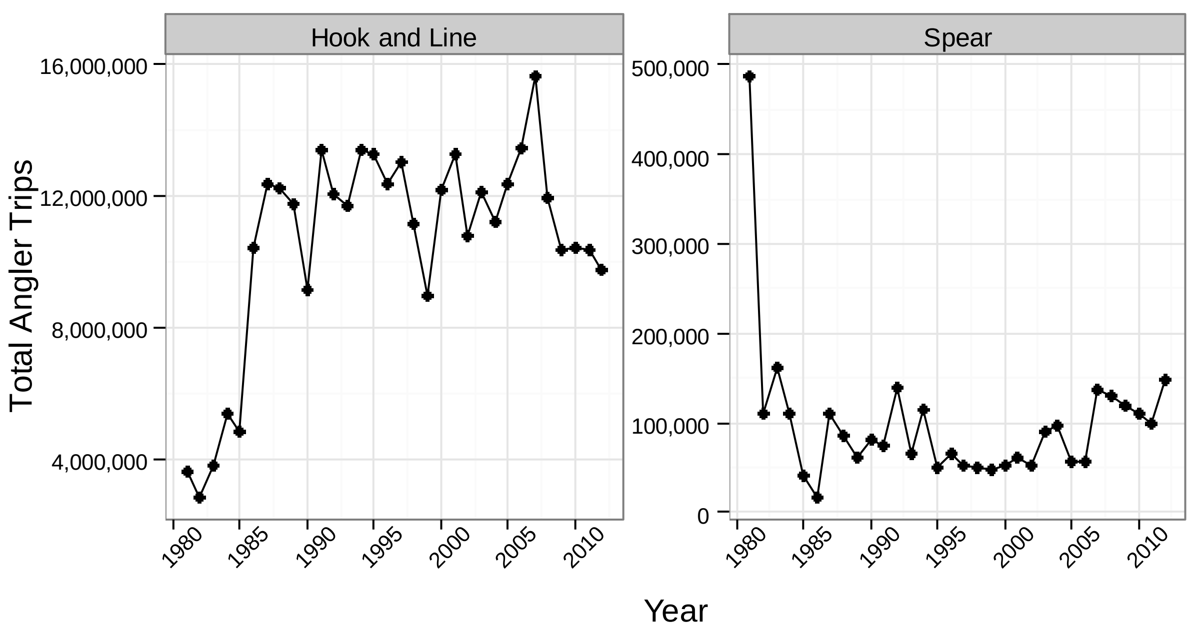
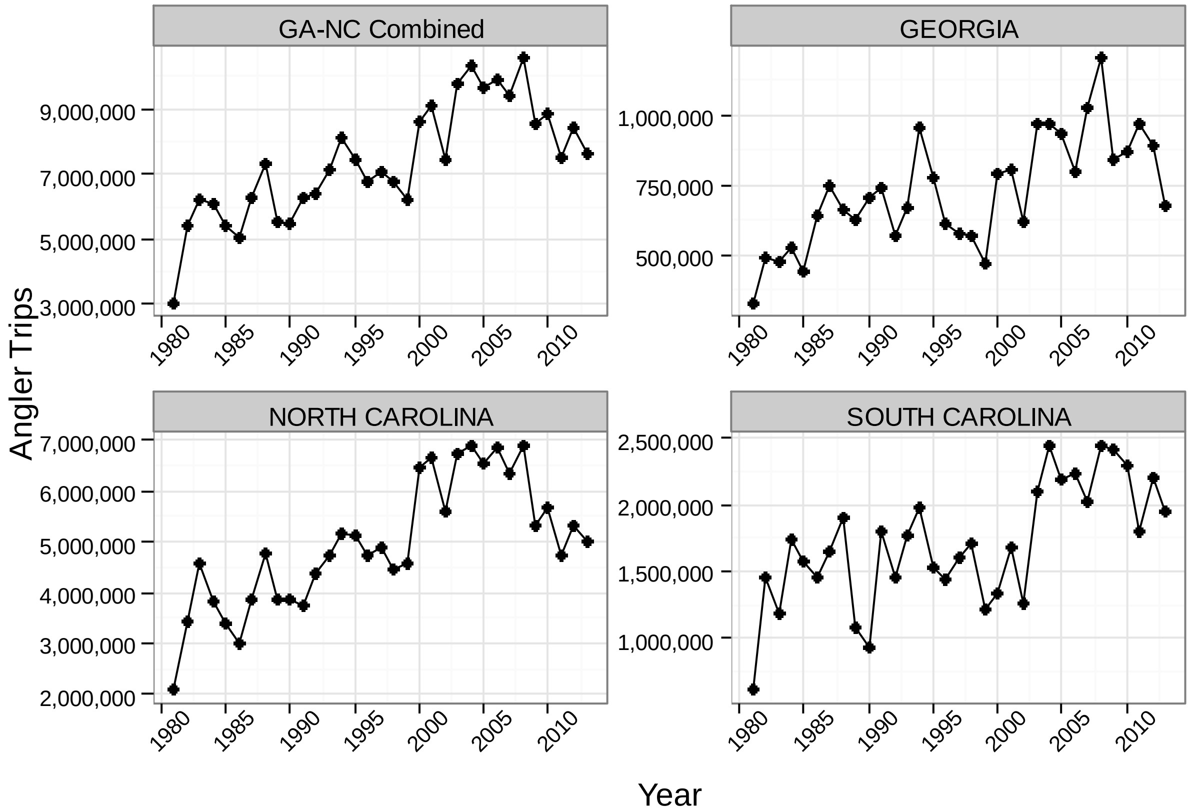


Figure 7.4.2.5. Total effort in number of angler trips from MRIP through 2012 for the GA-NC stock combined and with each state seperate.



8 Measures of Population Abundance

8.1 Overview

8.1.1 Issues

Indices of population abundances should have good spatial coverage (area, depth, habitat) throughout the distribution and range of ages of a species, the temporal coverage should be as long as possible, trends in the indices should track trends in population abundance without bias, and variability in the estimates because of sampling issues should be as small as possible. However, this is rarely achieved in practice for logistical reasons. For Hogfish, evidence of ontogenetic migration and escapement of fast-growing fish to offshore habitat (Collins and McBride 2011), combined with differences in habitat extent between stocks (e.g., extended continental shelf in the Eastern Gulf; limited continental shelf in the Florida Keys/SE Florida), lends added complexity to interpreting both indices of abundance and selectivity patterns.

Hogfish are a relatively small magnitude commercial fishery (<50 metric tons), and recreational harvest from spearfishing, which accounts for the majority of Hogfish harvest, is not well sampled due to its small proportion of the total recreational trips. Because of these factors, standardization of catch-per-unit effort series are often conducted on small data sets with subsequently large ranges of uncertainty. Appropriate statistically-designed fisheries-independent surveys do exist for Hogfish (e.g., NMFS/FWC-FWRI reef video surveys of WFL stock; UM/NMFS Reef Visual Census for FLK/EFL stock). However, the surveys for the WFL stock are relatively short in nature, particularly those that are designed for reef-obligate species (video surveys; juvenile seagrass surveys). The UM/NMFS RVC survey for the Florida Keys and Tortugas is an extensive yearly survey over a longer period of time that tracks Hogfish density well (e.g., 1994-present; with Tortugas portion every few years). However, because this survey is visual and non-extractive, no age information is available, and the length data is estimated by eye so tends to fluctuate between 1cm and 5cm bin size resolution. For the GA-NC stock, no fisheries-independent surveys exist that routinely sample Hogfish. The SouthEast Reef Fish Survey (SERFS) video surveys from the South Atlantic are only a few years mature and typically have less than 4% of surveys sighting a Hogfish (Bacheler and Reichert 2013), so it was not possible to generate an index using these data.

8.1.2 Review of Working Papers

Twelve total working papers were prepared for this section: (1) commercial CPUE analyses from Florida trip ticket records for both Florida stocks and gear types (Cooper 2014, SEDAR37-02); (2) recreational CPUE analyses from MRFSS/MRIP intercepts for both Florida stocks and gear types (Cooper 2014, SEDAR37-03); (3) fisheries-independent indices of abundance for both Florida stocks from REEF visual order-of-magnitude surveys (i.e., none, single, few, and abundant categories; Cooper 2014, SEDAR37-04); (4) a fisheries-independent index of abundance for the WFL stock from NMFS/FWC-FWRI video surveys (Switzer et al. 2013, SEDAR37-05); (5) a fisheries-independent index of abundance for the WFL stock from

SEAMAP trawl surveys (Switzer et al. 2013, SEDAR37-06); (6) a fisheries-independent index of abundance for the WFL stock from FWC-FWRI baitfish trawl surveys (Switzer et al. 2013, SEDAR37-07); (7) a fisheries-independent index of abundance for the WFL stock from FWC-FWRI juvenile Hogfish seagrass surveys (Switzer et al. 2013, SEDAR37-05); (8) fisheries-independent indices of abundance for the FLK/EFL stock, with the Florida Keys and Dry Tortugas presented separately, from the UM/NMFS Reef Visual Census (RVC) using a stratified random survey design (Smith et al. 2013, SEDAR37-09); (9) a summary of Hogfish surveyed from the SouthEast Reef Fish Survey (SERFS) video surveys between North Carolina and Florida, although low Hogfish densities precluded development of an index of abundance (Bacheler and Reichert 2013, SEDAR37-10); (10) commercial CPUE analyses from South Carolina ticket records (Hiltz et al. 2014, SEDAR37-11); (11) analysis of Hogfish data from the Coastal Fisheries Logbook Program (McCarthy 2014, SEDAR37-12); and (12) commercial CPUE analyses from North Carolina ticket records (Collier 2014, SEDAR37-13).

8.1.3 Review of Indices

Disaggregating the working papers by stock and gear type, a total of 21 indices of abundance (IOAs) were prepared for this assessment:

WFL Stock

- *Fisheries Dependent*
  - *Commercial*
    - *Florida Trip Ticket*
      - (1) Hook and line 1994-2012
      - (2) Spear 1994-2012
    - *Coastal Fisheries Logbook Program (CFLP)*
      - (3) Spear 1993-2012
  - *Recreational*
    - *MRFSS/MRIP*
      - (4) Hook and line 1991-2012
      - (5) Spear 1992-2012
- *Fisheries Independent*
  - *Visual*
    - (6) REEF 1996-2012
  - *Video*
    - (7) NMFS/FWC-FWRI video survey
  - *Trawl*
    - (8) FWC-FWRI juvenile seagrass survey
    - (9) SEAMAP trawl surveys
    - (10) FWC-FWRI baitfish trawl surveys

FLK/EFL Stock

Fisheries Dependent

Commercial

Florida Trip Ticket

(11) Hook and line 1994-2012

(12) Spear 1994-2012

Coastal Fisheries Logbook Program (CFLP)

(13) Spear 1993-2012

(14) Vertical hook and line 1993-2012

Recreational

MRFSS/MRIP

(15) Hook and line 1991-2012

(16) Spear 1991-2012

Fisheries Independent

Visual

(17) REEF 1994-2012

(18) UM/NMFS RVC – Florida Keys 1994-2012

(19) UM/NMFS RVC – Dry Tortugas 1999-2012

GA-NC Stock

Fisheries Dependent

Commercial

Coastal Fisheries Logbook Program (CFLP)

(20) Vertical hook and line 1993-2012

South Carolina Trip Ticket

(21) All gears combined 2004-2013

North Carolina Trip Ticket

(22) Diving gear 1994-2013

8.2 Review of Working Papers

8.2.1 Florida Trip Ticket CPUE (Cooper 2014 SEDAR37-02)

The commercial CPUE indices of abundance based on Florida trip ticket data (IOAs 1, 2, 11, and 12) all used the same methodological approach: first, an affinity propagation clustering (APC) analysis was performed on presence-absence data of the landings (commercial landings by weight) to identify those species caught in association with Hogfish to include as zero-catch trips; and second, a delta-lognormal (hurdle) generalized linear model (GLM) was fit to the data using a forward-selection procedure to produce an index of abundance time-series. Data were analyzed only from 1994-2012, due to gear becoming a required entry on the trip tickets in 1994. The APC procedure was used because it automatically selects an optimal number of clusters in the data, and a Bray measure of similarity was used due to it being presence-absence data. For these analyses, multiple explanatory variables were used to model the change in landings over time, and those variables selected in a forward selection procedure were included in the final models. Effort was modeled as number of trips, with total days fished per trip included as a potential explanatory variable.

Tables and Figures 8.2.1.1-8.2.1.4 present the IOAs for the Florida trip ticket CPUE analyses. Three of the indices (IOAs 1, 11, 12) were found to be variable but relatively stable over time, without any clear trends in the data over time, while index 2 (WFL-spear) was found to increase over time. The WFL hook and line index (IOA 1) showed a similar increase in recent years as in the spear index (IOA 2), but experienced a strong drop in 2012 to levels similar to those early in the series. Diagnostics of the model fits were generally favorable, with the positives-component of the hurdle model being modeled well with a lognormal distribution.

8.2.2 MRFSS/MRIP CPUE (Cooper 2014 SEDAR37-03)

The recreational CPUE indices of abundance based on MRFSS/MRIP data (IOAs 4, 5, 15, 16) used the same methodological approach as in the commercial CPUE analyses: first, an affinity propagation clustering (APC) analysis was performed on count data of the landings (recreational landings in numbers) to identify those species caught in association with Hogfish to include as zero-catch trips; and second, a delta-lognormal (hurdle) generalized linear model (GLM) was fit to the data using a forward-selection procedure to produce an index of abundance time-series. Although data existed from 1981-2012, data were only analyzed from 1991-2012 due to 1991 being the first year that the party code was recorded. Prior to 1991, interviews done on multiple individuals form the same trip could not be distinguished. The APC procedure for the recreational analysis was conducted on the MRFSS/MRIP count data, and therefore a Morisita measure of similarity was used as this is a preferred method for count data insensitive to sample sizes. Multiple explanatory variables were used to model the change in landings over time, and those variables selected in a forward selection procedure were included in the final models. Effort was modeled as number of trips, with hours fished and number of anglers per trip included as potential explanatory variables.

Tables and Figures 8.2.2.1-8.2.2.4 present the IOAs for the Florida trip ticket CPUE analyses. The WFL spear index showed an increasing trend over time, while the WFL hook and line index showed a variable but stable trend over time, with a peak in abundance in 2010 and 2011 similar to the commercial hook and line index for this stock from the Florida trip ticket database. Both of the FLK/EFL stocks showed declining trends over time. Diagnostics of the model fits were favorable for the spear indices of abundance, but poor for the hook and line indices of abundance, when assessing the residuals of the positives component of the hurdle models.

8.2.3 REEF Visual Survey (Cooper 2014c SEDAR37-04)

The REEF visual surveys are conducted by volunteer divers and gather order-of-magnitude abundance estimates for categories of abundance: none = 0, Single = 1, Few = 2-10, Many = 11-100, and Abundant > 100 (SFMA counts; Wolfe and Pattengill-Semmens 2013). Given the data structure, typical standardization approaches (e.g., delta-lognormal GLMs) are not possible, since statistical models need to be developed that can explore alternative explanatory variables while accounting for the SFMA data structure. Different approaches can be used on these data, reviewed in the working paper, where two were chosen for the analyses: (1) a multinomial model that predicts the order-of-magnitude categories, and then scales the abundance in each category based on the scaling models presented in Wolfe and Pattengill-Semmens (2013); and (2) a censored regression model (e.g., Porch and Eklund 2003). REEF data were provided b C. Pattengill-Semmens, including the zero-count data. In order to exclude those surveys that may have been conducted in areas not suitable for Hogfish (e.g., habitat types not typically encountering Hogfish), an APC procedure was conducted as in the recreational and commercial CPUE analyses (sections 8.2.1, 8.2.2) to identify those trips that caught species often found in association with Hogfish. Once those trips were identified, the two alternative models (multinomial model with abundance scaling and censored regression models) were applied to the data with a forward selection procedure to identify those variables important to Hogfish abundance.

The REEF data were analyzed for each of the three stocks separately. However, lack of sufficient samples with Hogfish present in the GA-NC stock (only 5% of surveys sighted a Hogfish) precluded development of an index of abundance for that stock. Due to the distribution of samples in the FLK/EFL stock, where a change in the prevalence of Hogfish per survey was evident around the Miami/Dade-Monroe county borders, the Florida Keys (FLK) and Southeast Florida (SEFL) surveys were analyzed both separately and combined.

Tables 8.2.3.1-8.2.3.7 and Figures 8.2.3.1 and 8.2.3.2 present the IOAs from the REEF surveys for these different regions. Due to low sample sizes from the WFL stock, the IOA was generally highly variable with large uncertainty bounds. The FLK and SEFL stock, which were analyzed separately, tended to diverge towards the later half of the time series: while both had a peak in the late 1990s and early 2000s, the FLK stock experienced a low from 2004-2007 and a peak from 2008 until 2012, while the SEFL stock had an opposite trend with a secondary peak from 2004-2007 and a low from 2008-2012. Given the lack of convergence with the censored Poisson model for the SEFL data, it remains unclear whether these divergent trends are a result of bias in the scaling model or representative of strong intra-stock spatial variability.

8.2.4 NMFS/FWC-FWRI Video Survey (Switzer et al. 2013 SEDAR37-05)

The NMFS/FWC-FWRI video survey IOA is a combination of the NMFS-Panama City video survey in the big bend region and westward, and the FWC-FWRI video survey southward of Anclote Key from the Tampa Bay region. The NMFS-PC surveys began in 2005, beginning as a systematic survey and shifting to a two-stage random survey by 2010, and collecting data using a stationary camera array. The FWRI surveys began in 2008 with stratified-random design and a stationary camera array, but have experienced changes in the sampling universe as more habitat information has become available since the initiation of the project. Surveys were combined for the analyses, and the relative abundance of Hogfish (MaxN) was modeled using a GLM with a negative binomial distribution to standardize an index of abundance.

Table and Figure 8.2.4.1 present the IOA from the combined NMFS/FWC-FWRI video survey. The IOA was generally increasing over time, with a decline from 2009 to 2011, and the highest abundance in 2012. Yearly CVs were moderate, averaging at 20% across years when ignoring the extreme low value with associated high CV in 2007 from the NMFS-PC survey. Diagnostics for the analyses were not presented, but the authors noted that testing of alternative distributions and techniques (e.g. delta-lognormal versus negative binomial) generally had little impact on the final standardized index.

8.2.5 FWC-FWRI Juvenile Seagrass Survey (Switzer et al. 2013 SEDAR37-08)

FWC-FWRI began a polyhaline seagrass survey in 2008 using a stratified-random design within five estuarine systems along the West Florida Shelf, with the intent of targeting reef fishes, particularly in preparation for the most recent Gulf of Mexico gag assessment. All sites were located between 1.0 and 7.6m in seagrass habitat and sampled with a 6.1-m otter trawl. Hogfish young-of-the-year were primarily found in only the big bend region within three locations (St Marks, Ecofina, and Steinhatchee). The number of Hogfish per set was modeled using a GLM with a negative binomial distribution to standardize an index of abundance.

Table and Figure 8.2.5.1 present the IOA from the seagrass sampling. The estimated abundance declined from the initial year in 2008 to a low in 2009, and then increased to a high in 2012. The peak in 2012 was consistent with the video surveys on older individuals from section 8.2.4. Yearly CVs were moderate, averaging at 20% across years. Diagnostics for the analyses were not presented, but the authors noted that testing of alternative distributions and techniques (e.g. delta-lognormal versus negative binomial) generally had little impact on the final standardized index.

8.2.6 SEAMAP Survey (Switzer et al. 2013 SEDAR37-06)

FWC-FWRI began a summer SEAMAP trawl survey of the WFS in 2008 using a stratified-random design, covering waters from 10-110m deep within NMFS statistical zones 2-10, and sampled with a 12.8-m shrimp trawl. The number of Hogfish per set was modeled using a GLM with a negative binomial distribution to standardize an index of abundance.

Table and Figure 8.2.6.1 present the IOA from the SEAMAP trawls. The estimated abundance declined from the initial year in 2008 to a low in 2011, and then increased to in 2012, which was generally consistent with the video (section 8.2.4) and juvenile seagrass (section 8.2.5) surveys. Yearly CVs were moderate to high, averaging at 45% across all years, and 34% if excluding the initially high CV in 2008. Diagnostics for the analyses were not presented, but the authors noted that testing of alternative distributions and techniques (e.g. delta-lognormal versus negative binomial) generally had little impact on the final standardized index.

8.2.7 FWC-FWRI Baitfish Survey (Switzer et al. 2013 SEDAR37-07)

FWC-FWRI began an annual spring baitfish trawl survey of the WFS in 1994 using a stratified-random design, covering waters from 6-28 m deep, and sampled with a 19.8-m balloon trawl. Due to inconsistencies in the early data, only those years from 2002-present were used for the analyses. The number of Hogfish per set was modeled using a GLM with a negative binomial distribution to standardize an index of abundance.

Table and Figure 8.2.7.1 present the IOA from the baitfish trawls. No underlying trend was evident from the beginning to the end of the survey period, although certain patterns emerged in the later years consistent with the other surveys of the WFS. In particularly, the abundances increased in 2012 from lows in both 2010 and 2011, similar to the patterns in sections 8.2.4-8.2.6. Yearly CVs were high, averaging at 68% across all years with large confidence intervals for yearly estimates. Diagnostics for the analyses were not presented, but the authors noted that testing of alternative distributions and techniques (e.g. delta-lognormal versus negative binomial) generally had little impact on the final standardized index.

8.2.8 UM-NMFS Reef Visual Census (RVC; Smith et al. 2013 SEDAR37-09)

Fishery-independent diver visual sampling of the reef-fish community in southern Florida began in 1979 in shallow fore-reef habitats (depth<10 m), and was conducted by scientists from NOAA's Southeast Fisheries Science Center (SEFSC). Scientists from the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) began collaborating with NOAA scientists on the visual surveys in 1993, and in 1994 the survey was expanded to cover the full range of reef habitats to depths of 33 m along the coral reef tract extending from Miami to Key West. In 1999, the visual survey was further expanded to the Dry Tortugas region, which has been conducted in 1999, 2000, 2004, 2006, 2008, 2010, and 2012. The survey utilizes a two-stage stratified-random sampling design, where the spatial domain of the survey encompasses the full extent of mapped Holocene live-coral reef habitats to 33 m. The potential does exist for unsampled mesophytic reef habitat below the 33m designation, particularly west of the Dry Tortugas (i.e., Pulley Ridge, Tortugas Bank, Sherwood Forest, Riley’s Hump, and Miller’s Ledge), although the amount of unsampled mesophytic habitat in the Florida Keys and SEFL is likely limited due to the steep drop in depths in the Florida Straits (Locker et al. 2010). RVC survey precision improved in the late 1990s—early 2000s due to refinements in the benthic habitat maps, statistical design, and efficiency of field sampling.

Table and Figure 8.2.8.1 present the IOAs for both the Florida Keys and Dry Torgugas surveys, disaggregated to pre-exploited life stage (<300 mm) and exploited life stage (>=300 mm). The abundances of both the exploited and pre-exploited stages in the Florida Keys region experienced a sharp increase from 1998-2001. The exploited stages have experienced a slight negative trend since 2001, while the pre-exploited stages have remained relatively constant. The sharp increase coincided with the period when the sampling design was updated, so may be partially due to improvements in the design in the late 1990’s to early 2000s. For the Dry Tortugas region, both stages have been relatively stable. The mean density of pre-exploited stages is similar for both the Florida Keys and Tortugas region, while the mean density of exploited stages is lower in the Keys than the Dry Tortugas. Yearly CVs for all sizes are low, often below 10% for both the Florida Keys and Dry Tortugas since the survey design was updated in the late 1990s-early 2000s. Diagnostics for the analyses were not presented.

8.2.9 SERFS Video Survey (Bacheler and Reichert 2013 SEDAR37-10)

The SouthEast Reef Fish Survey (SERFS) is a combination of three fishery independent sampling programs – the SouthEast Fishery-Independent Survey, the South East Area Monitoring and Assessment Program – South Atlantic, and the Marine Resources Monitoring, Assessment, and Prediction program – that sample reef fish between North Carolina and Florida using identical trap and video methodologies from 2010-2012. Sites were sampled using both a stratified-random design and opportunistically, with Georgia and Florida being sampled in 2010 and an expansion to Florida through North Carolina in 2011 and 2012.

Hogfish were not caught in the Chevron fish traps deployed, and were only infrequently monitored via the video recording (4.2% occurrence across years; Table 8.2.9.1). Due to the low occurrence of Hogfish over a short period of time (3 yr) an index of abundance was not attempted for this dataset.

8.2.10 Commercial logbook CPUE (McCarthy 2014 SEDAR37-12)

Commercial fishermen provide landings and effort data to NMFS through the Coastal Fisheries Log Book (CFLB) program. The CFLB began collecting data from vessels federally permitted to fish in a number of fisheries in waters of the Gulf of Mexico (from Texas to the southwest Florida and most of the Tortugas) in 1990, and in 1992 from the South Atlantic (from NC to Key West to southeast of the Tortugas). This program was intended to collect fishing effort and landings in a complete census of federally permitted vessels; however, through 1992 the program included only a subsample of 20% of Florida vessels. Beginning in 1993, all of the federally permitted vessels were required to report.

The commercial logbook analyses (indices 3, 13, 14, and 20) were conducted by K. McCarthy at the NMFS-SEFSC, utilizing a Stephens and MacCall (2004) approach to select zero-catch trips, and a delta-lognormal GLM to standardize indices of abundance for each stock and gear type. Due to limited data, only a spear index was possible in the WFL stock, and only a vertical line index was possible for the GA-NC stock. The Stephen and MacCall (2004) approach failed for the FLK/EFL vertical line index, so an ad hoc species association was utilized.

Tables 8.2.10.1-8.2.10.4 and Figure 8.2.10.1 present the CPUEs for each stock and gear combination. The FLK/EFL vertical line index showed a steady increase from initially very low numbers in the 1990s to a relatively stable abundance from 2002-2012. This pattern was not consistent with the commercial CPUE developed from the Florida Trip Tickets for the initial years, where the Florida Trip Tickets showed a declining trend from 1994-1999. However, the pattern was similar for the remainder of the time series, with a peak in 2003/2004, followed by a dip in abundance during 2005/2006. The FLK/EFL spear CPUE from the logbook analysis showed an initial decline, with peaks in 1998 and again in 2008-2010. This was generally consistent with the Trip Ticket CPUE, showing the same initial decline with smaller peaks corresponding in some years. The WFL spear index showed two peaks in abundance, one in 2001 and a second in 2009, with a relatively increasing trend from 2005 through 2012. This pattern was generally consistent with the commercial CPUE developed from the Florida Trip

Tickets (section 8.2.1), where a peak occurred in 2001 and then increased steadily from 2008-2012. The GA-NC vertical line CPUE showed a declining trend throughout the entire period, although a peak in abundance was found in 1999. The average yearly CVs for the spear indices were 21 and 25% for the WFL and FLK/EFL stocks, 48% for the FLK/EFL vertical line, and 31% for the GA-NC vertical line. Diagnostics for the analyses were not presented.

8.2.11 South Carolina Trip Ticket CPUE (Hiltz et al. 2014 SEDAR37-11)

The South Carolina Trip Ticket CPUE used the same methodological approach as in the commercial and recreational CPUE analyses (sections 8.2.1 and 8.2.2): first, an affinity propagation clustering (APC) analysis was performed on count data of the landings (recreational landings in numbers) to identify those species caught in association with Hogfish to include as zero-catch trips; and second, a delta-lognormal (hurdle) generalized linear model (GLM) was fit to the data using a forward-selection procedure to produce an index of abundance time-series. Data were analyzed from 2004-2012. The APC procedure for the commercial analysis was conducted on presence/absence data of landings in weight, and therefore a Bray measure of similarity was utilized. A few explanatory variables were used to model the change in landings over time (month and days fished), and those variables selected in a forward selection procedure were included in the final models. Effort was modeled as number of trips.

Table and Figure 8.2.11.1 present the IOAs for the SC trip ticket CPUE analyses. Overall the index had a moderately low coefficient of variation (CV) of 15 %. The abundance was relatively stable over the eight year period, with three separate peaks in 2006, 2008, and 2011.

8.2.12 North Carolina Trip Ticket CPUE (Collier SEDAR37-13)

The North Carolina Trip Ticket CPUE was conducted on landings by the diving fishery between 1994-2012. Included trips were those that caught Hogfish, gag grouper, red grouper, and scamp grouper, and these were analyzed using a negative binomial model with year and month as factors. Table and Figure 8.2.12.1 present the IOAs for the NC trip ticket CPUE analyses. Compared to both the logbook and SC CPUEs, the NC CPUE increased substantially from 2000-2011, similar to increases in landings by the dive fishery during this period, with declines in 2012 and 2013. As this was a brief exploratory analysis not recommended for use in the assessment, diagnostics were not conducted.

8.3 Fishery Independent Indices

8.3.1 REEF Visual Survey (Cooper 2014 SEDAR37-04)

See section 8.2.3 for a review of the analyses and results.

8.3.2 NMFS/FWC-FWRI Video Survey (Switzer et al. 2014 SEDAR37-05)

See section 8.2.4 for a review of the analyses and results.

8.3.3 FWC-FWRI Juvenile Seagrass Survey (Switzer et al. 2014 SEDAR37-08)

See section 8.2.5 for a review of the analyses and results.

8.3.4 SEAMAP Survey (Switzer et al. 2014 SEDAR37-06)

See section 8.2.6 for a review of the analyses and results.

8.3.5 FWC-FWRI Baitfish Survey (Switzer et al. 2014 SEDAR37-07)

See section 8.2.7 for a review of the analyses and results.

8.3.6 UM-NMFS Reef Visual Census (RVC; Smith et al. 2013 SEDAR37-09)

See section 8.2.8 for a review of the analyses and results.

8.4 Fishery Dependent Indices

8.4.1 Commercial logbook CPUE (McCarthy 2014 SEDAR37-12)

See section 8.2.10 for a review of the analyses and results.

8.4.2 Florida Trip Ticket CPUE (Cooper 2014 SEDAR37-02)

See section 8.2.1 for a review of the analyses and results.

8.4.3 MRFSS/MRIP CPUE (Cooper 2014 SEDAR37-03)

See section 8.2.2 for a review of the analyses and results.

8.4.4 South Carolina Trip Ticket CPUE (Hiltz et al. 2014 SEDAR37-11)

See section 8.2.11 for a review of the analyses and results.

8.4.5 North Carolina Trip Ticket CPUE (Collier 2014 SEDAR37-13)

See section 8.2.12 for a review of the analyses and results.

8.5 Recommendations on Indices

8.5.1 WFL Stock Indices

For the WFL stock, there are three indices for the commercial fishery, two for the recreational fishery, and five fisheries independent indices of abundance (Figure 8.5.1). For the commercial fishery, a trip ticket index was developed for hook and line, while both a trip ticket and commercial logbook index were developed for spear. A logbook index was not possible on vertical lines (including long lines) due to low numbers of observations (K. McCarthy, pers. comm.). All three indices are relatively consistent with each other , although the logbook spear analysis presents an increase in 2000-2002 that is on magnitude with the more recent increases from 2009-present. Due to the logbook index being one year longer and likely a more accurate representation of the effort (dive hours) versus the trip tickets (per trip, accounting for trip days), the logbook should be considered the preferred index for the base model. The recreational indices were relatively consistent, being stable until more recent years when increases in abundance were suggested. Both the commercial and recreational spear and hook and line indices should be linked to the respective fleets in the model.

Regarding the fisheries independent indices in the WFL stock, the REEF visual survey index spanned the longest time (1996-2012), but was the only survey without a statistical survey design. In addition, the REEF index was marked by high uncertainty without a clear pattern, so would likely provide little informative guidance for the model, and was the only index that did not show the consistent pattern of an increase in abundance in the last year (2012). Of the four additional indices (video, juvenile seagrass trawls, SEAMAP trawls, and baitfish trawls), each present information on different size classes/age ranges, and generally seemed to show similar trends in the few years on which they overlap, particularly in picking up an increase in abundance in 2012. As a result, the recommendation is to use all indices in the base model configuration, and address the influence of each index through sensitivity analyses. Of these, the baitfish spans the longest timeframe (2002-2012), but had the highest variability. The SEAMAP trawls were the most spatially extensive. Both the baitfish and SEAMAP were conducted in areas near reef habitat using trawls, so did not sample directly on the primary Hogfish habitat. The video surveys were the most reef-specific methods, being dropped directly on reef habitat that Hogfish are associated with, and as such picked up a slighter larger size range then either of the trawls. The seagrass trawls, while spatially and temporally limited, were the only surveys to focus solely on age-0 Hogfish. The juvenile seagrass surveys conducted in the big bend region were the only ones that located Hogfish, suggesting that either this location may served as a spatially distinct recruiting area, or other recruiting habitats are not sampled by the FWRI surveys.

8.5.2 FLK/EFL Stock Indices

For the FLK/EFL stock, indices exist for commercial by gear (spear and hook and line) and source (trip tickets and logbooks), recreational by gear, and fishery-independent surveys (Figure 8.5.2) Three of the commercial indices (both trip ticket indices and the logbook spear index) were consistent in showing a relatively stable trend throughout the entire period. However, the logbook hook and line showed a steadily increasing trend over the entire period. The recreational indices and the REEF indices showed slightly declining trends over the time period. This increasing trend was closely mirrored by the RVC Keys survey, where strong increases were noted from 1995-2000, but were then generally stable for the remainder of the time period. Two possible mechanisms could be at play to explain the steep rises in abundances measured in RVC and the logbook hook and line: (1) the increase could represent a lag response to the implementation of the no-take reserves throughout the Keys in 1997, thereby demonstrating a potential improvement in stock abundance due to no-take implementation; or (2) for the RVC, the increase could have resulted from changes to the statistical design that occurred in the late 1990's/early 2000's (Smith et al. 2013), which additionally incorporated inclusion of the no-take reserves into the survey design at that time. If the population abundance did actually increase, the logbook hook and line may be reflecting this increase. However, given the relatively stable or slightly declining trends in all other indices, and the fact that the CVs were highest for the logbook hook and line versus the logbook and spear and an ad-hoc species cluster was used for the logbook hook and line due to convergence issues with the Stephens and MacCall approach, the logbook hook and line increase may be an artifact. As such, the recommended index for the hook and line commercial fishery is that developed from the Florida Trip Tickets, which is more consistent with the other indices. For the FLK/EFL survey indices, the RVC indices should be preferred over the REEF visual surveys due to the statistical design of the RVC. As previously stated, changes to the RVC survey methodology should be accounted for in the assessment model as a change in catchability, as this may have led to the steep increases noted from the late 1990's to early 2000's. Both the RVC-Keys and RVC-Tortugas should be included as they sample areas of the population that experience different exploitation pressures.

8.5.3 GA-NC Stock Indices

For the GA-NC stock, only three fishery-dependent indices exist (Figure 8.5.3): the logbook hook and line index from 1993-2012, the South Carolina Trip Ticket index with both gears combined from 2004-2012, and the North Carolina index for the diving fishery from 1994-2012. The logbook index shows a relatively constant decline over the entire time period, with some of the low abundances in later years (2004, 2007, 2009) also detected with the South Carolina trip ticket index. The North Carolina index shows an inverse pattern to the logbook index, with an increase from 2000-2011. Since the logbook is over a longer period of time for the hook and line gears compared to the South Carolina index, this should be considered the preferred index for hook and line. The North Carolina index, which provides additional information on the diving fishery, was run as a brief exploratory analysis and obtained at a later date when the base models were finalized; as a result, this index was not included as an option in the assessment models but discussed here for reference. The North Carolina index follows the pattern of catch for the dive fishery, which began expanding in 2000 with a peak in 2010, and subsequent declines in 2011-2012, suggesting either an increased targeting of Hogfish by the fishery or an increase in the abundance from 2000-2011.

8.5.4 Index Selectivity

Choosing the proper selectivity patterns for each index is challenging, especially given the spatial patterns of ontogenetic movement and the operation of the fisheries, and how these processes differ among stocks. As such, no simple selectivity assumption should be made for Hogfish across stocks and fisheries. Given the paucity of age information for Hogfish, the size selectivity in the model should be informed from the length frequency composition, and attempted to be fit in the model when possible and appropriate. For the purpose of the assessment model, the recommendation is to base the selectivity assumptions largely on the length composition data from the various fisheries (section 5.5.5) and knowledge of the fisheries and habitat distribution in the various stocks.

For the WFL stock, length observations from the commercial spear fishery and commercial hook and line fisheries have included Hogfish ranging up to 75cm, which is near the largest sizes sampled during the FWRI life history research studies. Comparatively, length observations from the commercial trap and the recreational fisheries (spear and hook and line) have rarely included Hogfish greater than 50cm, suggesting that the commercial spear and hook and line fisheries are selecting larger sizes that may approach an asymptotic selectivity pattern. Comparatively, all of the fisheries independent surveys sample Hogfish of smaller sizes, typically <50cm as in the recreational fisheries. These length frequency observations tend to support knowledge based on the habitat distribution and gear selectivity. The juvenile seagrass trawl is an age-0 index, where the fish that have been aged have all been young of year. The width of the continental shelf in the WFL stock provides for substantial reef habitat, including large areas of mesophytic habitat (30-100m) in which Hogfish can be found (Locker et al. 2010), that is generally cost- and time-prohibitive for most day trips (e.g., recreational fishermen). From the FWRI life history studies, large Hogfish have been collected as deep as 220 feet on low-relief hardbottom, demonstrating the ability for individuals to utilize marginal habitat at deeper depths. The life-history studies also focused on collecting a range of sizes from the entire population (shallow and deep) and typically found a less truncated size frequency distribution than what the recreational and commercial fisheries samples demonstrate. Regarding the fisheries independent surveys, although the video surveys and SEAMAP trawls sample a large portion of the continental shelf, the maximum size of Hogfish sampled are all <50cm. Based on the length frequency observations and knowledge of the fisheries and Hogfish distribution, there is strong evidence in support of dome-shaped selectivity for the recreational fisheries and the surveys, but potential asymptotic selectivity for the commercial fisheries. The distribution of lengths from the commercial hook and line suggests an asympototic selectivity pattern, which is not surprising given that the commercial hook and line fishery is not targeting Hogfish, but other species that occur across the continental shelf. As such it is recommended to fix a dome-shaped selectivity pattern for the recreational fisheries, commercial trap fishery, and the surveys; fix an asymptotic selectivity to the commercial hook and line to provide for one fishery or survey with asymptotic selectivity (i.e., avoiding cryptic biomass issues with fully dome-shaped selectivity); and attempt to fit the selectivity shape for the commercial spear fishery based on the length compositions. Alternative selectivity patterns should be explored in sensitivity runs.

For the FLK/EFL stock, similar patterns emerge in the length observations, where the commercial fisheries (spear, hook and line, and trap) often include Hogfish up to 75cm, while the recreational fisheries (spear and hook and line) consist of a limited size range (typically <60cm for recreational spear, and <50 for recreational HL). The larger sizes collected in traps in the FLK/EFL stock compared to the WFL stock is likely a result of differences in trap configuration in the FLK/EFL stock providing for larger fish (B. Mueller FWCC-FWRI, pers. comm.). The RVC-Keys rarely encounters Hogfish near 75cm, although they do tend to sample individuals larger than the recreational hook and line fishery, but similar to the recreational spear fishery. Comparatively, the RVC-Tortugas samples individuals up to 75cm, similar to the commercial fisheries that additionally operate in the Tortugas areas not subject to spatial closures. Therefore, although the Keys-specific RVC likely operates as an asymptotic selectivity function within the primary reef habitat along the Keys reef tract, it does not sample a portion of the entire stock (Tortugas region) that may hold larger individuals. Based on the length composition data and knowledge of the fisheries, the recommendation is to fix a dome-shaped pattern for the recreational fisheries and RVC-Keys survey; fix an asymptotic pattern for the commercial hook and line and trap fisheries; and attempt to fit the selectivity shape for the commercial spear fishery. Alternative selectivity patterns should be explored in sensitivity runs.

For the GA-NC stock, the fishery samples older and larger fish than in either of the other two stocks. Given the distribution of the length observations, selectivity for the GA-NC stock should be modeled as asymptotic.

8.6 Literature Cited

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8.7 Tables

Table 8.2.1.1. Standardized index of abundance from commercial Florida trip tickets for the WFL spear model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	50	28	24.83549	7.144333	0.287666
1995	85	58	28.51978	5.799997	0.203367
1996	158	101	25.12175	3.890817	0.154878
1997	130	91	24.75848	4.044583	0.163362
1998	111	71	23.85446	4.432902	0.185831
1999	117	62	19.58608	4.105368	0.209606
2000	145	95	24.03803	3.833815	0.15949
2001	137	87	53.12662	8.79615	0.16557
2002	152	106	45.99106	6.993925	0.152071
2003	153	97	41.2072	6.548965	0.158928
2004	111	77	38.03491	6.571957	0.172788
2005	103	59	41.2495	8.404146	0.203739
2006	92	56	33.58897	7.045026	0.209742
2007	92	49	38.45632	8.918896	0.231923
2008	151	114	56.48918	8.077882	0.142999
2009	178	123	67.77923	9.611339	0.141804
2010	178	125	73.95688	10.18725	0.137746
2011	149	102	80.56392	12.44911	0.154525
2012	126	98	84.02584	12.52194	0.149025

Table 8.2.1.2. Standardized index of abundance from commercial Florida trip tickets for the WFL hook-and-line model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	2639	149	0.777395	0.106599	0.137124
1995	2795	86	0.735322	0.131493	0.178824
1996	3025	111	0.65381	0.104474	0.159792
1997	3115	92	0.530552	0.091877	0.173173
1998	3620	70	0.297956	0.059951	0.201209
1999	3628	78	0.366005	0.068313	0.186646
2000	4228	136	0.702338	0.102033	0.145277
2001	3773	141	0.680889	0.099156	0.145628
2002	3408	118	0.862523	0.135837	0.157488
2003	3271	64	0.515478	0.106161	0.205947
2004	3227	53	0.243458	0.055887	0.229554
2005	2658	47	0.424661	0.101453	0.238904
2006	2154	28	0.411451	0.129055	0.313659
2007	2083	21	0.273016	0.099745	0.365345
2008	2137	24	0.465299	0.153976	0.330919
2009	2737	36	0.517842	0.142109	0.274426
2010	1605	30	1.033917	0.305846	0.295813
2011	1525	58	1.629565	0.350885	0.215324
2012	1568	21	0.634684	0.230154	0.362627

Table 8.2.1.3. Standardized index of abundance from commercial Florida trip tickets for the FLK/SEFL spear model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	474	241	12.37902	0.6157	0.049737
1995	517	264	11.37773	0.547645	0.048133
1996	669	403	11.2784	0.467984	0.041494
1997	855	487	8.482529	0.3399	0.040071
1998	834	487	9.593651	0.387129	0.040353
1999	498	274	8.141443	0.406499	0.04993
2000	570	346	9.375735	0.415985	0.044368
2001	677	401	9.775725	0.428915	0.043875
2002	748	444	8.417263	0.351025	0.041703
2003	552	292	8.885067	0.433152	0.048751
2004	538	342	10.69344	0.495633	0.046349
2005	479	317	10.45703	0.492758	0.047122
2006	428	265	8.781702	0.444302	0.050594
2007	428	259	8.429941	0.431315	0.051165
2008	336	214	10.83168	0.602682	0.055641
2009	412	197	8.991021	0.495166	0.055073
2010	308	141	9.595727	0.621361	0.064754
2011	369	156	9.98716	0.626561	0.062737
2012	413	163	9.724014	0.590992	0.060777

Table 8.2.1.4. Standardized index of abundance from commercial Florida trip tickets for the FLK/SEFL hook-and-line model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	2399	231	1.133401	0.121854	0.107512
1995	3428	364	1.105646	0.097814	0.088468
1996	3799	326	1.011449	0.093184	0.092129
1997	3817	239	0.778278	0.082037	0.105408
1998	3605	241	0.689917	0.073333	0.106292
1999	2395	117	0.631448	0.092312	0.146192
2000	2398	218	1.096454	0.120615	0.110005
2001	3014	280	1.118615	0.112262	0.100358
2002	2754	286	1.287162	0.12568	0.097641
2003	2928	317	1.607304	0.152012	0.094576
2004	2968	253	1.232936	0.129378	0.104935
2005	2504	150	0.860383	0.113504	0.131922
2006	1883	133	1.086084	0.149848	0.137971
2007	1790	122	0.887981	0.127245	0.143297
2008	1795	129	1.173346	0.164415	0.140125
2009	2192	152	1.397413	0.180595	0.129235
2010	2099	119	1.577364	0.229983	0.145802
2011	2057	114	1.162097	0.172045	0.148047
2012	1722	124	1.285118	0.183549	0.142827

Table 8.2.2.1. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the WFL spear model. Note: year 1991 was removed due to convergence issues.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1992	13	5	1.443826	0.788723	0.546273
1993	14	11	4.000411	1.265951	0.316455
1994	21	10	1.874579	0.707339	0.377332
1995	16	8	2.079268	0.843176	0.405516
1996	28	9	0.798433	0.337858	0.423151
1997	23	10	1.38286	0.524321	0.379157
1998	21	14	2.616298	0.769566	0.294143
1999	34	26	1.846531	0.375926	0.203585
2000	10	3	1.278246	0.982112	0.768328
2001	20	13	1.638807	0.504285	0.307715
2002	19	7	1.317326	0.612578	0.465016
2003	26	17	2.171707	0.5654	0.260348
2004	18	10	2.093937	0.755937	0.361012
2005	17	8	1.109907	0.46188	0.416143
2006	14	11	1.692072	0.527033	0.311472
2007	10	8	2.745495	1.011081	0.368269
2008	24	17	2.808413	0.725105	0.25819
2009	22	16	2.755354	0.728718	0.264473
2010	20	16	3.543814	0.945166	0.266709
2011	17	15	3.098297	0.816493	0.26353
2012	22	20	5.577909	1.269787	0.227646

Table 8.2.2.2. Standardized ndex of abundance from recreational MRFSS/MRIP intercept data for the WFL hook-and-line model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1991	44	1	0.32336	0.55143	1.705316
1992	130	8	0.103127	0.045541	0.441597
1993	110	6	0.153604	0.078233	0.509313
1994	82	8	0.205855	0.08737	0.424427
1995	122	11	0.173212	0.064167	0.370452
1996	75	6	0.211736	0.108214	0.511079
1997	85	9	0.186695	0.075301	0.403337
1998	126	12	0.200083	0.07028	0.351252
1999	163	10	0.102653	0.040046	0.390111
2000	137	9	0.136437	0.055661	0.407963
2001	148	8	0.118422	0.052163	0.440482
2002	165	10	0.09643	0.037164	0.385404
2003	148	16	0.342653	0.10195	0.297532
2004	160	4	0.044853	0.028919	0.644763
2005	163	7	0.129531	0.060803	0.469412
2006	66	4	0.127265	0.079955	0.628251
2007	80	10	0.225016	0.085377	0.379427
2008	121	12	0.172345	0.060593	0.351579
2009	144	15	0.177461	0.055574	0.313163
2010	49	9	0.675596	0.255226	0.377778
2011	72	9	0.424696	0.167936	0.395428
2012	162	5	0.168238	0.098392	0.584842

Table 8.2.2.3. Standardized ndex of abundance from recreational MRFSS/MRIP intercept data for the FLK/SEFL spear model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1991	7	4	1.994887	0.995293	0.498922
1992	32	24	2.865121	0.537329	0.187541
1993	19	14	2.56872	0.625195	0.243388
1994	31	30	2.548989	0.381095	0.149508
1995	14	12	2.064031	0.522786	0.253284
1996	20	15	1.868412	0.461086	0.24678
1997	14	10	1.927575	0.580389	0.301098
1998	20	15	1.928215	0.456421	0.236707
1999	24	21	2.728113	0.499895	0.183238
2000	13	9	1.991561	0.599747	0.301144
2001	19	14	2.369064	0.556748	0.235008
2002	22	16	2.516233	0.561271	0.22306
2003	26	21	2.677963	0.509953	0.190426
2004	36	30	2.098498	0.334603	0.159449
2005	24	21	2.177644	0.410965	0.18872
2006	18	16	1.611543	0.345773	0.21456
2007	38	35	2.551408	0.359466	0.140889
2008	32	27	2.383003	0.398424	0.167194
2009	34	27	2.150687	0.365185	0.169799
2010	21	16	1.663643	0.380359	0.22863
2011	25	20	1.710873	0.335661	0.196193
2012	49	40	1.607146	0.222916	0.138703

Table 8.2.2.4. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the FLK/SEFL hook-and-line model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1991	17	5	1.00428	0.490139	0.48805
1992	49	28	0.965804	0.185406	0.191971
1993	60	26	1.066079	0.225792	0.211796
1994	56	25	0.852024	0.181044	0.212487
1995	39	25	1.204035	0.242562	0.201458
1996	34	17	1.303322	0.320114	0.245614
1997	38	16	0.598802	0.157751	0.263444
1998	47	21	0.649418	0.145902	0.224666
1999	63	23	0.637007	0.149179	0.234188
2000	43	8	0.261647	0.109044	0.41676
2001	62	16	0.605467	0.171665	0.283524
2002	64	10	0.338851	0.128719	0.379869
2003	75	26	0.719481	0.152771	0.212335
2004	70	25	0.630087	0.141239	0.224158
2005	59	18	0.502286	0.132921	0.264631
2006	46	15	0.54304	0.158956	0.292715
2007	64	21	0.632424	0.150061	0.237279
2008	77	22	0.524849	0.125146	0.238443
2009	49	14	0.468333	0.141143	0.301374
2010	58	12	0.411565	0.139703	0.339443
2011	48	12	0.476065	0.157186	0.330177
2012	77	22	0.559993	0.134359	0.239929

Table 8.2.3.1. Index of abundance from the REEF visual surveys for the WFL multinomial scaling model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1996	18	14	1.069073	0.411186	0.384619
1997	19	13	1.567447	0.437988	0.279428
1998	70	47	4.267835	2.188715	0.51284
1999	111	41	2.136562	1.150702	0.538577
2000	118	49	3.338532	1.071706	0.321011
2001	99	46	2.234285	0.536497	0.24012
2002	162	77	2.919133	0.830962	0.284661
2003	110	61	3.892962	1.138507	0.292453
2004	62	35	2.608749	1.063964	0.407844
2005	34	9	0.877655	0.312425	0.355977
2006	87	53	3.259059	0.990171	0.303821
2007	63	35	2.98904	0.804513	0.269155
2008	34	20	2.208799	0.360442	0.163185
2009	24	12	0.986612	0.305192	0.309333
2010	34	23	2.381907	1.245926	0.523079
2011	22	10	1.582299	1.289102	0.814702
2012	25	11	0.757233	0.195258	0.257858

Table 8.2.3.2. Index of abundance from the REEF visual surveys for the WFL censored Poisson model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1996	18	14	1.237635	0.377596	0.305095
1997	19	13	1.845836	0.567005	0.307181
1998	70	47	2.40488	0.476145	0.197991
1999	111	41	1.463846	0.33343	0.227777
2000	118	49	2.267839	0.427306	0.18842
2001	99	46	2.284234	0.425785	0.186402
2002	162	77	2.051782	0.317998	0.154986
2003	110	61	2.626852	0.439468	0.167298
2004	62	35	2.57911	0.572857	0.222114
2005	34	9	0.870169	0.322432	0.37054
2006	87	53	3.052478	0.50394	0.165092
2007	63	35	2.995624	0.591306	0.19739
2008	34	20	2.599109	0.582749	0.224211
2009	24	12	1.180342	0.374083	0.316928
2010	34	23	2.184495	0.583976	0.267327
2011	22	10	1.356832	0.528122	0.389232
2012	25	11	0.957944	0.264624	0.276242

Table 8.2.3.3. Index of abundance from the REEF visual surveys for the FLK multinomial scaling model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	1201	609	1.238812	0.062365	0.050343
1995	715	416	1.544508	0.095474	0.061815
1996	584	282	1.240506	0.109314	0.088121
1997	680	421	1.83552	0.119404	0.065052
1998	452	302	2.658775	0.231813	0.087188
1999	538	362	2.064409	0.140372	0.067996
2000	746	486	2.630238	0.163323	0.062094
2001	1588	1081	2.882901	0.117932	0.040907
2002	1643	1211	2.969873	0.111954	0.037697
2003	876	627	2.131483	0.101497	0.047618
2004	534	342	2.092777	0.148625	0.071018
2005	663	404	1.828669	0.119374	0.065279
2006	619	396	1.863916	0.121601	0.065239
2007	493	314	1.792065	0.12248	0.068346
2008	353	231	2.323282	0.193901	0.08346
2009	460	305	2.614551	0.224749	0.085961
2010	315	209	2.791731	0.25878	0.092695
2011	222	170	2.490712	0.19164	0.076942
2012	289	209	2.350956	0.164963	0.070168

Table 8.2.3.4. Index of abundance from the REEF visual surveys for the FLK censored Poisson model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	1201	609	1.257171	0.055342	0.044021
1995	715	416	1.56178	0.081476	0.052169
1996	584	282	1.220529	0.082677	0.067739
1997	680	421	1.78138	0.095208	0.053446
1998	452	302	2.311278	0.150758	0.065227
1999	538	362	2.047692	0.11243	0.054906
2000	746	486	2.40363	0.11823	0.049188
2001	1588	1081	2.684521	0.089996	0.033524
2002	1643	1211	2.804579	0.088877	0.03169
2003	876	627	2.11681	0.087596	0.041381
2004	534	342	2.016297	0.119556	0.059295
2005	663	404	1.793946	0.095463	0.053214
2006	619	396	1.814775	0.099768	0.054976
2007	493	314	1.748284	0.10609	0.060682
2008	353	231	2.233579	0.157039	0.070308
2009	460	305	2.351622	0.156063	0.066364
2010	315	209	2.604755	0.200549	0.076994
2011	222	170	2.623483	0.197624	0.075329
2012	289	209	2.443446	0.160246	0.065582

Table 8.2.3.5. Index of abundance from the REEF visual surveys for the SEFL multinomial scaling model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	21	3	0.194916	0.137864	0.707298
1995	26	7	0.384166	0.180423	0.46965
1996	11	1	0.23698	0.305291	1.288254
1997	59	20	1.703367	0.670571	0.393674
1998	104	33	0.624909	0.180401	0.288683
1999	317	97	0.811387	0.188146	0.231882
2000	336	122	0.819506	0.124579	0.152018
2001	696	247	0.713786	0.085831	0.120247
2002	948	198	0.405756	0.052283	0.128854
2003	1067	236	0.421486	0.048999	0.116253
2004	646	119	0.520101	0.098199	0.188808
2005	530	137	0.723469	0.111952	0.154744
2006	834	239	0.817155	0.097752	0.119624
2007	574	161	0.674286	0.080864	0.119926
2008	319	41	0.400028	0.089706	0.224248
2009	233	35	0.226398	0.044362	0.195947
2010	457	57	0.301003	0.048052	0.159638
2011	297	28	0.157036	0.037398	0.23815
2012	339	62	0.279318	0.043467	0.155618

Table 8.2.3.6. Index of abundance from the REEF visual surveys for the FLK+SEFL multinomial scaling model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	1222	612	1.173837	0.064063	0.054576
1995	741	423	1.156219	0.092241	0.079778
1996	595	283	0.920688	0.087175	0.094685
1997	739	441	1.472047	0.107548	0.07306
1998	556	335	2.138416	0.211448	0.098881
1999	855	459	1.473165	0.116879	0.079339
2000	1082	608	1.926278	0.135878	0.070539
2001	2284	1328	1.901209	0.099433	0.0523
2002	2591	1409	1.775033	0.088028	0.049592
2003	1943	863	1.119545	0.060436	0.053983
2004	1180	461	1.116703	0.088337	0.079105
2005	1193	541	1.162988	0.081675	0.070229
2006	1453	635	1.116863	0.077114	0.069045
2007	1067	475	1.044286	0.069668	0.066714
2008	672	272	1.111771	0.099529	0.089523
2009	693	340	1.466129	0.136187	0.092889
2010	772	266	1.09451	0.106965	0.097729
2011	519	198	0.990004	0.086124	0.086993
2012	628	271	1.076397	0.082686	0.076818

Table 8.2.3.7. Index of abundance from the REEF visual surveys for the FLK+SEFL censored Poisson model.

Year	Total trips	Positive Trips	Mean	std.dev	CV
1994	1222	612	1.258809	0.062089	0.049324
1995	741	423	1.216724	0.069124	0.056812
1996	595	283	0.991147	0.06784	0.068446
1997	739	441	1.37839	0.074571	0.0541
1998	556	335	1.70129	0.109084	0.064118
1999	855	459	1.399072	0.076585	0.05474
2000	1082	608	1.676359	0.079455	0.047397
2001	2284	1328	1.729199	0.062091	0.035908
2002	2591	1409	1.58059	0.055139	0.034885
2003	1943	863	1.030997	0.042152	0.040884
2004	1180	461	0.995913	0.057577	0.057813
2005	1193	541	1.095921	0.056128	0.051215
2006	1453	635	0.992834	0.050471	0.050835
2007	1067	475	0.974473	0.052766	0.054148
2008	672	272	1.026032	0.071323	0.069513
2009	693	340	1.297652	0.083893	0.06465
2010	772	266	0.938027	0.068652	0.073188
2011	519	198	0.918153	0.06608	0.071971
2012	628	271	1.067434	0.069194	0.064823

Table 8.2.4.1. Annual indices of relative abundance (MaxN) as well as coefficient of variation (CV) and lower (LCL) and upper (UCL) 95% confidence limits for Hogfish as determined via a generalized linear modeling analysis of data from the NMFS – PC and FWRI video surveys. Analyses were calculated using censored data sets (see Analytical Methods section).

Year	Standardized Index	CV	LCL	UCL
2005	0.2702	0.3023	0.1534	0.4760
2006	0.2187	0.2616	0.1325	0.3610
2007	0.0142	1.4799	0.0019	0.1060
2008	0.3453	0.2062	0.2328	0.5122
2009	0.3791	0.1707	0.2724	0.5275
2010	0.2838	0.1958	0.1948	0.4134
2011	0.2452	0.1610	0.1793	0.3353
2012	0.4761	0.1254	0.3724	0.6085

Table 8.2.5.1. Annual indices of relative abundance (Individuals Per Set) as well as coefficient of variation (CV) and lower (LCL) and upper (UCL) 95% confidence limits for Hogfish as determined via a generalized linear modeling analysis of data from the FWRI polyhaline seagrass trawl survey. Analyses were calculated using censored data sets (see Analytical Methods section).

Year	Standardized Index	CV	LCL	UCL
2008	0.6218	0.1553	0.4605	0.8397
2009	0.1235	0.2507	0.0767	0.1990
2010	0.2047	0.2260	0.1320	0.3174
2011	0.2960	0.1943	0.2029	0.4319
2012	1.0638	0.1617	0.7812	1.4487

Table 8.2.6.1. Annual indices of relative abundance (Individuals Per Set) as well as coefficient of variation (CV) and lower (LCL) and upper (UCL) 95% confidence limits for Hogfish as determined via a generalized linear modeling analysis of data from the summer FWRI SEAMAP trawl survey.

Year	Standardized Index	CV	LCL	UCL
2008	1.0888	0.8898	0.3047	3.8909
2009	0.4009	0.3689	0.2012	0.7985
2010	0.3861	0.3269	0.2071	0.7197
2011	0.2366	0.4044	0.1118	0.5006
2012	0.5875	0.2762	0.3448	1.0021

Table 8.2.7.1. Annual indices of relative abundance (Individuals Per Set) as well as coefficient of variation (CV) and lower (LCL) and upper (UCL) 95% confidence limits for Hogfish as determined via a generalized linear modeling analysis of data from the FWRI baitfish trawl survey.

Year	Standardized Index	CV	LCL	UCL
2002	0.1619	0.9496	0.0427	0.6131
2003	1.4667	0.7135	0.4546	4.7320
2004	1.5352	0.7343	0.4928	4.7829
2005	0.9542	1.0380	0.2649	3.4381
2006	0.2487	0.6244	0.0866	0.7142
2007	1.3454	0.5198	0.5498	3.2922
2008	0.9278	0.5769	0.3567	2.4135
2009	2.0751	0.5393	0.8159	5.2773
2010	0.6966	0.5861	0.2584	1.8783
2011	0.6302	0.5914	0.2300	1.7263
2012	1.1644	0.5762	0.4345	3.1204

Table 8.2.8.1. Reef Visual Census (RVC) survey estimates of Hogfish mean density and precision (CV) for pre-exploited and exploited life stages for the (A) Florida Keys and (B) Dry Tortugas regions. Density units are number of fish per 177 m^2 (second-stage unit SSU). Sample sizes: n = primary sample units, nm = second-stage units.

(A) Florida Keys

Year	n	nm	Pre-exploited Density (L<300 mm)		Exploited Density (L≥300 mm)		All Sizes	
			Mean	CV (%)	Mean	CV (%)	Mean	CV (%)
1994	24	117	0.2414	39.4	0.0629	41.9	0.3346	26.9
1995	61	278	0.2701	24.5	0.1093	33.2	0.3791	19.5
1996	27	143	0.1560	42.1	0.0132	44.5	0.1739	38.4
1997	66	388	0.3453	22.7	0.0340	35.7	0.3805	21.7
1998	75	428	0.3185	18.9	0.0314	36.3	0.3649	16.0
1999	160	408	0.4897	12.1	0.0965	23.3	0.5951	10.3
2000	228	499	0.8182	10.3	0.1565	17.1	0.9380	9.8
2001	304	701	1.0144	10.1	0.4130	12.8	1.3825	9.2
2002	356	665	0.8068	8.8	0.3774	15.6	1.1839	8.6
2003	237	433	0.8685	12.2	0.3239	17.6	1.1928	12.1
2004	136	259	0.7425	12.6	0.4736	19.6	1.2161	12.2
2005	256	498	0.9299	12.4	0.3070	14.3	1.2370	10.6
2006	328	593	0.7323	8.8	0.2767	14.4	1.0090	8.6
2007	317	614	0.7265	9.9	0.3578	17.3	1.0843	10.5
2008	376	735	1.2754	6.7	0.3806	10.4	1.6560	6.5
2009	516	1005	0.9641	6.2	0.2665	10.9	1.2307	6.3
2010	379	740	0.9527	8.0	0.1534	10.8	1.1060	7.4
2011	402	789	0.8121	8.3	0.2798	14.7	1.0919	7.7
2012	416	803	1.0522	6.8	0.2839	9.4	1.3361	6.3

(B) Dry Tortugas

Year	n	nm	Pre-exploited Density (L<300 mm)		Exploited Density (L≥300 mm)		All Sizes	
			Mean	CV (%)	Mean	CV (%)	Mean	CV (%)
1999	168	298	0.4286	19.6	0.3229	16.0	0.7514	12.9
2000	203	360	0.2661	13.9	0.2552	13.1	0.5267	9.7
2004	310	576	0.1189	19.7	0.3494	11.9	0.4683	10.6
2006	260	497	0.2737	14.2	0.1848	14.0	0.4585	9.2
2008	338	653	0.2177	21.8	0.3530	13.4	0.5707	13.9
2010	364	703	0.1677	13.3	0.2648	11.2	0.4325	9.0
2012	416	813	0.1907	11.4	0.4528	8.7	0.6435	7.7

Table 8.2.9.1. Summary information for Hogfish *Lachnolaimus maximus* in videos collected by the SouthEast Reef Fish Survey, 2010 – 2012. Video deployments target hardbottom habitats between North Carolina and Florida except in 2010, when sampling only occurred in Georgia and Florida.

Year	Latitude range sampled (°N)	Date range sampled	Depth range sampled (m)	# Videos examined	# Videos with Hogfish present	Frequency of occurrence (%)	Mean depth of readable videos	Mean depth when Hogfish were seen on video
2010	28.7-31.7	7/28-10/27	16-83	231	9	3.9	40.1	51.4
2011	27.2-34.3	5/12-10/25	14-94	717	42	5.9	40.4	46.6
2012	27.2-35.0	4/24-10/10	15-106	1102	35	3.2	40.7	49.6
Overall	27.2-35.0	4/24-10/27	14-106	2050	86	4.2	40.5	48.3

Table 8.2.10.1. Commercial logbook index of abundance for spear fisheries in the WFL stock.

Year	Std. CPUE	CV	Lower CI	Upper CI	Nom. CPUE	Prop. Positive	N Obs.
1993	0.899901	0.27	0.5286	1.5319	0.8498	0.8333	36
1994	0.751151	0.25	0.4602	1.2259	0.7703	0.8649	37
1995	0.924176	0.27	0.5438	1.5708	0.8378	0.6889	45
1996	0.495002	0.24	0.3092	0.7924	0.4894	0.7288	59
1997	0.743264	0.21	0.4914	1.1241	0.6620	0.7917	72
1998	0.776958	0.23	0.4887	1.2352	0.7454	0.7593	54
1999	0.596117	0.23	0.3808	0.9332	0.5620	0.6901	71
2000	1.154608	0.19	0.7899	1.6878	1.0885	0.8571	91
2001	1.816105	0.20	1.2298	2.6818	1.5130	0.8152	92
2002	1.527801	0.20	1.0302	2.2658	1.4753	0.7714	105
2003	1.352185	0.19	0.9261	1.9742	1.1633	0.8585	106
2004	0.767096	0.21	0.5061	1.1626	0.8289	0.7087	103
2005	0.897373	0.22	0.5801	1.3882	0.7791	0.7143	91
2006	0.450141	0.22	0.2942	0.6888	0.4368	0.6863	102
2007	0.662014	0.22	0.4296	1.0201	0.6531	0.7097	93
2008	0.932584	0.18	0.6491	1.3399	0.9295	0.8346	133
2009	1.76563	0.19	1.2116	2.5731	2.2468	0.7820	133
2010	0.988246	0.18	0.6888	1.4179	0.9297	0.8194	144
2011	1.20725	0.18	0.8389	1.7374	1.4783	0.8346	127
2012	1.292397	0.18	0.9109	1.8337	1.5611	0.8267	150

Table 8.2.10.2. Commercial logbook index of abundance for vertical line fisheries in the FLK/EFL stock.

Year	Std. CPUE	CV	Lower CI	Upper CI	Nom. CPUE	Prop. Positive	N Obs.
1993	0.110994	0.57	0.0385	0.3200	0.0913	0.0717	920
1994	0.213612	0.48	0.0860	0.5307	0.1614	0.1170	1274
1995	0.170792	0.49	0.0678	0.4304	0.0885	0.1124	1148
1996	0.255322	0.50	0.0985	0.6620	0.2700	0.1167	960
1997	0.392624	0.46	0.1641	0.9392	0.3762	0.1246	1461
1998	0.267377	0.50	0.1046	0.6836	0.1701	0.0943	1273
1999	0.406607	0.50	0.1582	1.0453	0.3133	0.1194	938
2000	0.735478	0.46	0.3037	1.7813	1.9342	0.1849	876
2001	0.580217	0.44	0.2500	1.3465	0.5053	0.2116	1068
2002	1.091293	0.42	0.4905	2.4280	1.8071	0.2644	1229
2003	1.791459	0.42	0.8012	4.0055	1.5072	0.2671	1217
2004	1.910038	0.42	0.8544	4.2698	1.1303	0.2874	1117
2005	1.117849	0.47	0.4574	2.7322	1.0289	0.2038	795
2006	0.965509	0.49	0.3814	2.4442	1.2085	0.1887	620
2007	1.761694	0.48	0.7145	4.3434	1.6780	0.2591	521
2008	1.438804	0.47	0.5888	3.5157	1.1135	0.2849	523
2009	1.557038	0.51	0.5978	4.0558	1.5329	0.2390	431
2010	1.418319	0.54	0.5143	3.9117	1.0984	0.2211	380
2011	1.73189	0.51	0.6569	4.5658	1.8619	0.2514	370
2012	2.083085	0.49	0.8196	5.2941	2.1229	0.3103	348

Table 8.2.10.3. Commercial logbook index of abundance for spear fisheries in the FLK/EFL stock.

Year	Std. CPUE	CV	Lower CI	Upper CI	Nom. CPUE	Prop. Positive	N Obs.
1993	1.560919	0.24	0.9718	2.5072	1.5947	0.6624	157
1994	1.226235	0.24	0.7691	1.9550	1.2667	0.7262	168
1995	1.158058	0.24	0.7219	1.8576	1.1620	0.7117	163
1996	0.88849	0.28	0.5107	1.5457	0.7942	0.6937	111
1997	0.70887	0.24	0.4401	1.1417	0.7534	0.6241	290
1998	1.317246	0.23	0.8311	2.0878	0.9826	0.6221	299
1999	1.045294	0.26	0.6304	1.7334	1.4807	0.6111	180
2000	0.986722	0.23	0.6232	1.5623	1.3754	0.7170	265
2001	0.736817	0.23	0.4689	1.1578	0.7907	0.6358	335
2002	0.750792	0.23	0.4787	1.1775	0.8027	0.6371	361
2003	0.790917	0.25	0.4802	1.3026	0.8577	0.5913	208
2004	0.949359	0.23	0.6055	1.4886	0.9489	0.7500	248
2005	0.903994	0.24	0.5669	1.4415	0.8667	0.6651	218
2006	0.847061	0.26	0.5067	1.4160	0.6629	0.6204	137
2007	0.943644	0.25	0.5798	1.5358	0.7458	0.7151	186
2008	1.176429	0.25	0.7205	1.9210	1.2172	0.7410	139
2009	1.135319	0.27	0.6661	1.9349	1.0821	0.7129	101
2010	1.252325	0.29	0.7145	2.1950	1.2744	0.6486	74
2011	0.94109	0.27	0.5577	1.5880	0.7824	0.5610	123
2012	0.680422	0.25	0.4139	1.1185	0.5589	0.5189	185

Table 8.2.10.4. Commercial logbook index of abundance for vertical line fisheries in the GA-NC stock.

Year	Std. CPUE	CV	Lower CI	Upper CI	Nom. CPUE	Prop. Positive	N Obs.
1993	1.190205	0.32	0.6316	2.2428	1.4862	0.4888	223
1994	1.027163	0.29	0.5764	1.8304	1.6359	0.5552	299
1995	1.644174	0.27	0.9660	2.7984	2.2093	0.6154	416
1996	0.892088	0.29	0.5089	1.5638	0.8205	0.5684	329
1997	1.031188	0.28	0.5990	1.7752	1.0437	0.5886	457
1998	1.392885	0.28	0.8091	2.3979	1.1480	0.6220	381
1999	2.28076	0.27	1.3411	3.8787	2.3177	0.6279	438
2000	1.243957	0.28	0.7133	2.1693	1.1171	0.5011	441
2001	1.137274	0.28	0.6576	1.9669	0.8805	0.5649	416
2002	1.281619	0.29	0.7229	2.2722	0.9920	0.5424	330
2003	1.058467	0.29	0.6011	1.8639	0.8351	0.6033	305
2004	0.5653	0.32	0.3044	1.0499	0.4981	0.4534	311
2005	0.930506	0.31	0.5101	1.6974	0.9089	0.4932	294
2006	0.819446	0.30	0.4533	1.4815	0.7175	0.4593	405
2007	0.580379	0.30	0.3208	1.0501	0.5016	0.3957	465
2008	0.739369	0.30	0.4073	1.3423	0.6917	0.4189	413
2009	0.337883	0.38	0.1627	0.7016	0.6536	0.2763	257
2010	0.482724	0.38	0.2315	1.0067	0.4992	0.4011	177
2011	0.707657	0.36	0.3507	1.4278	0.5774	0.4506	162
2012	0.656957	0.43	0.2863	1.5076	0.4659	0.4419	86

Table 8.2.11.1. Standardized index of abundance from the commercial South Carolina trip ticket analysis.

Year	Total trips	Number positive trips	Mean	CV
2004	870	165	1.845741	0.143177
2005	844	162	2.069867	0.143229
2006	915	200	2.792795	0.134924
2007	1047	199	1.925927	0.136313
2008	1019	248	3.067773	0.121826
2009	853	152	2.126086	0.149738
2010	743	129	2.595884	0.165177
2011	757	163	3.086009	0.148859
2012	765	125	1.669052	0.16555

Table 8.2.12.1. Standardized index of abundance from the commercial North Carolina trip ticket analysis.

Year	Mean	Standard Error of Mean	Lower Mean	Upper Mean	Avg	Count of Trips	Positive Trips	Proportion positive
1994	73.1014	20.1882	42.5452	125.6	69.40574	61	37	0.606557
1995	83.9746	32.8425	39.016	180.74	87.79167	30	24	0.8
1996						8	0	
1997	1.7451	0.702	0.7932	3.8392	1.914063	32	3	0.09375
1998	4.2396	2.4537	1.3636	13.1814	5.333333	15	1	0.066667
1999	5.5392	3.0272	1.8979	16.1672	5.195625	16	2	0.125
2000	5.433	3.2889	1.6587	17.796	5.192308	13	2	0.153846
2001	50.2834	18.4704	24.4769	103.3	49.54647	34	19	0.558824
2002	68.2634	22.7279	35.5455	131.1	73.6531	42	27	0.642857
2003	60.7664	18.9915	32.9332	112.12	59.65447	47	26	0.553191
2004	75.6326	19.2386	45.9398	124.52	71.69611	72	40	0.555556
2005	55.5944	22.102	25.5052	121.18	57.06931	29	19	0.655172
2006	32.3648	10.7061	16.9238	61.8935	33.12548	42	27	0.642857
2007	24.2813	5.8284	15.1689	38.8679	24.83488	80	32	0.4
2008	75.3867	15.3162	50.6241	112.26	75.05369	111	83	0.747748
2009	67.8219	14.9258	44.0599	104.4	70.36	95	65	0.684211
2010	133.16	34.0215	80.7027	219.71	133.2663	70	53	0.757143
2011	168.68	55.8505	88.1535	322.78	178.2462	42	38	0.904762
2012	108.46	32.4696	60.3171	195.03	109.0792	51	34	0.666667
2013	99.4623	26.9282	58.5068	169.09	93.905	64	46	0.71875

8.8 Figures

Figure 8.2.1.1. Standardized index of abundance from commercial Florida trip tickets for the WFL spear model.

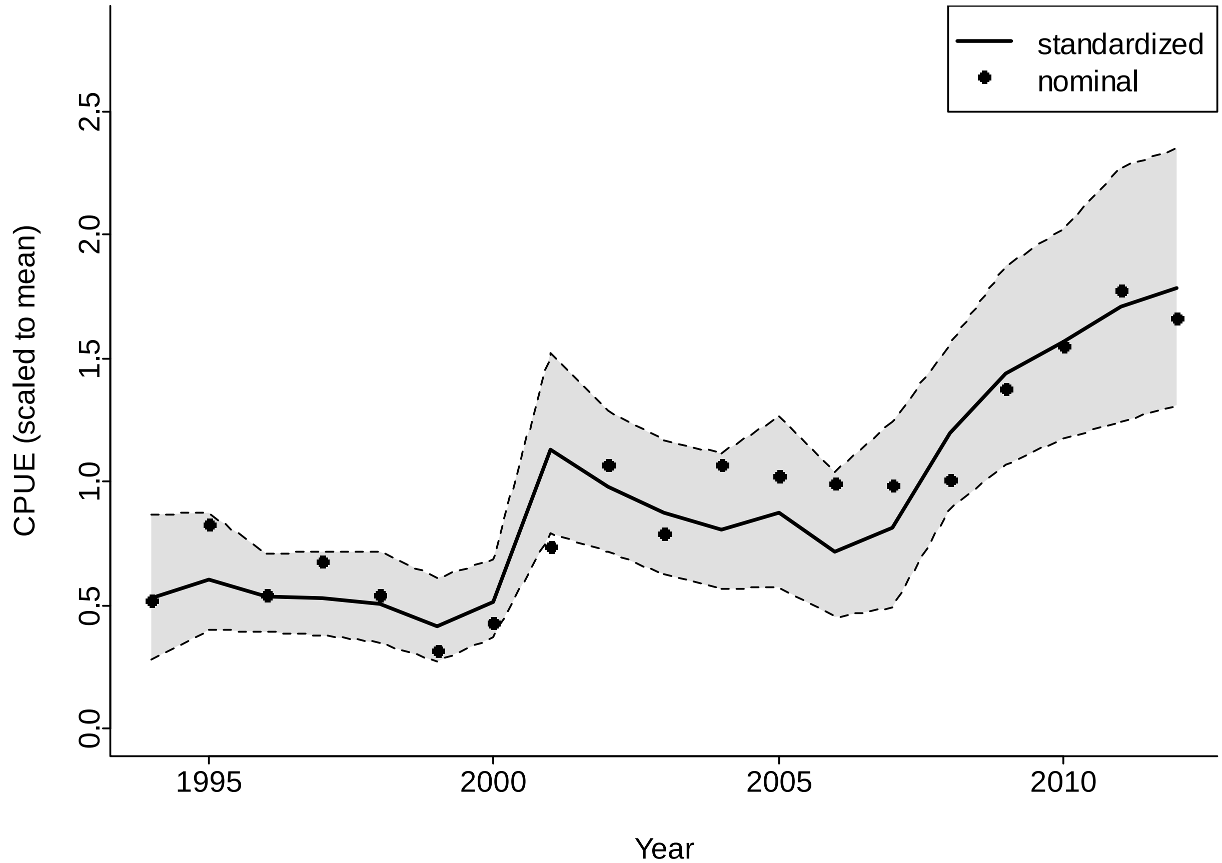


Figure 8.2.1.2. Standardized index of abundance from commercial Florida trip tickets for the WFL hook-and-line model.

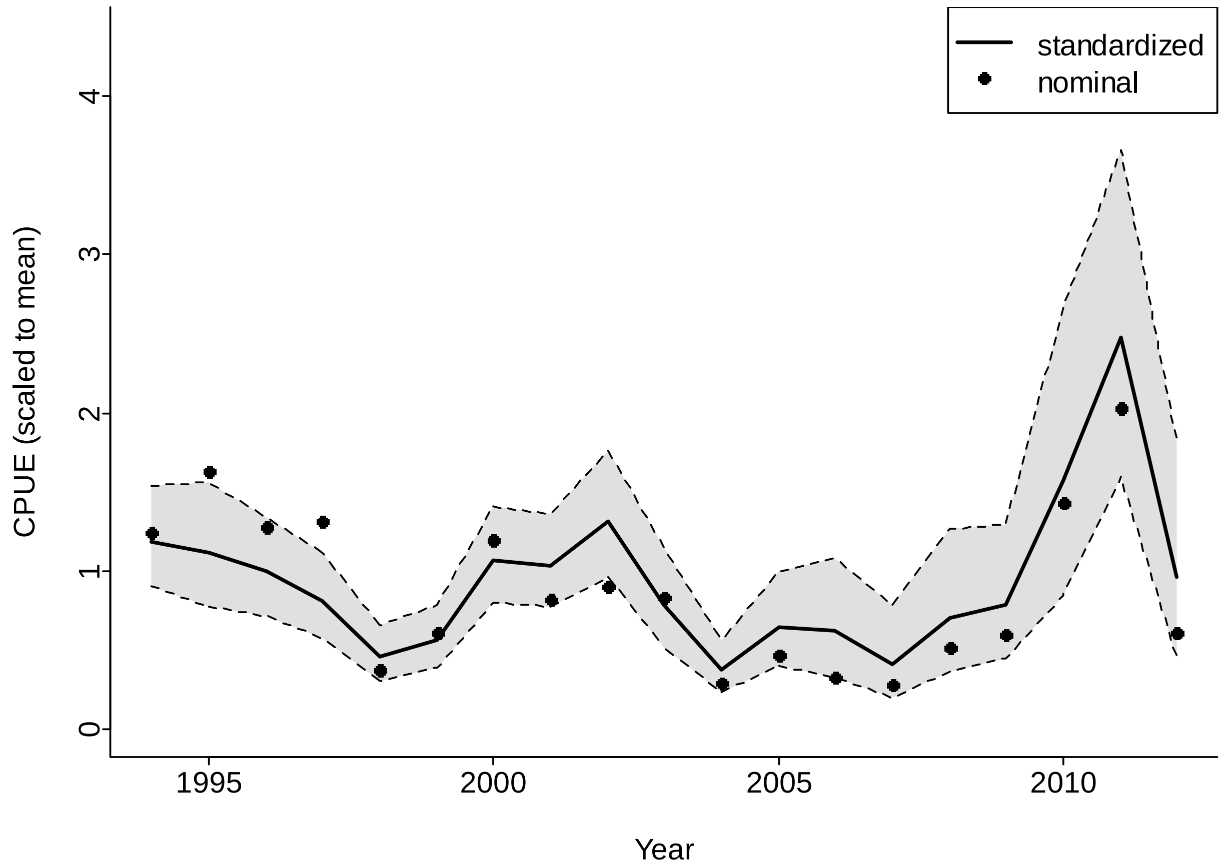


Figure 8.2.1.3. Standardized index of abundance from commercial Florida trip tickets for the FLK/SEFL spear model.

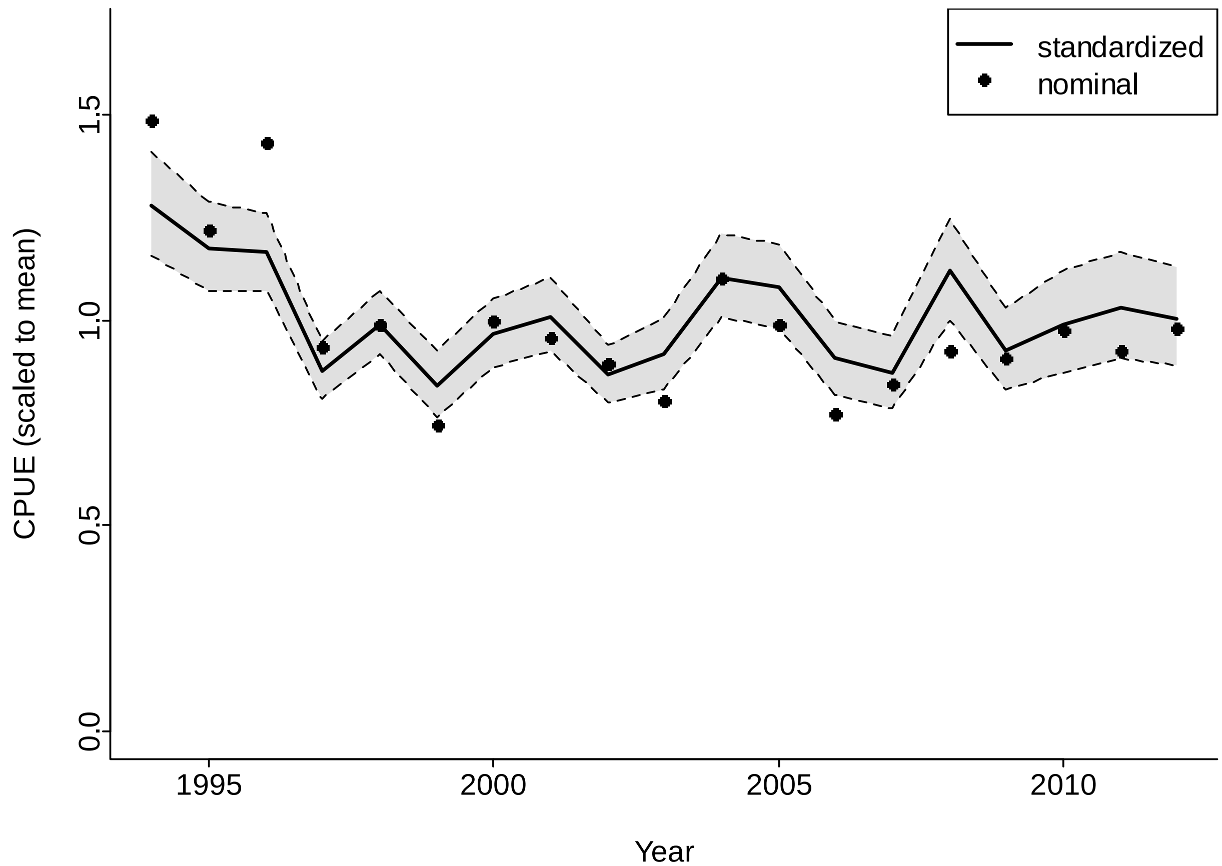


Figure 8.2.1.4. Standardized index of abundance from commercial Florida trip tickets for the FLK/SEFL hook-and-line model.

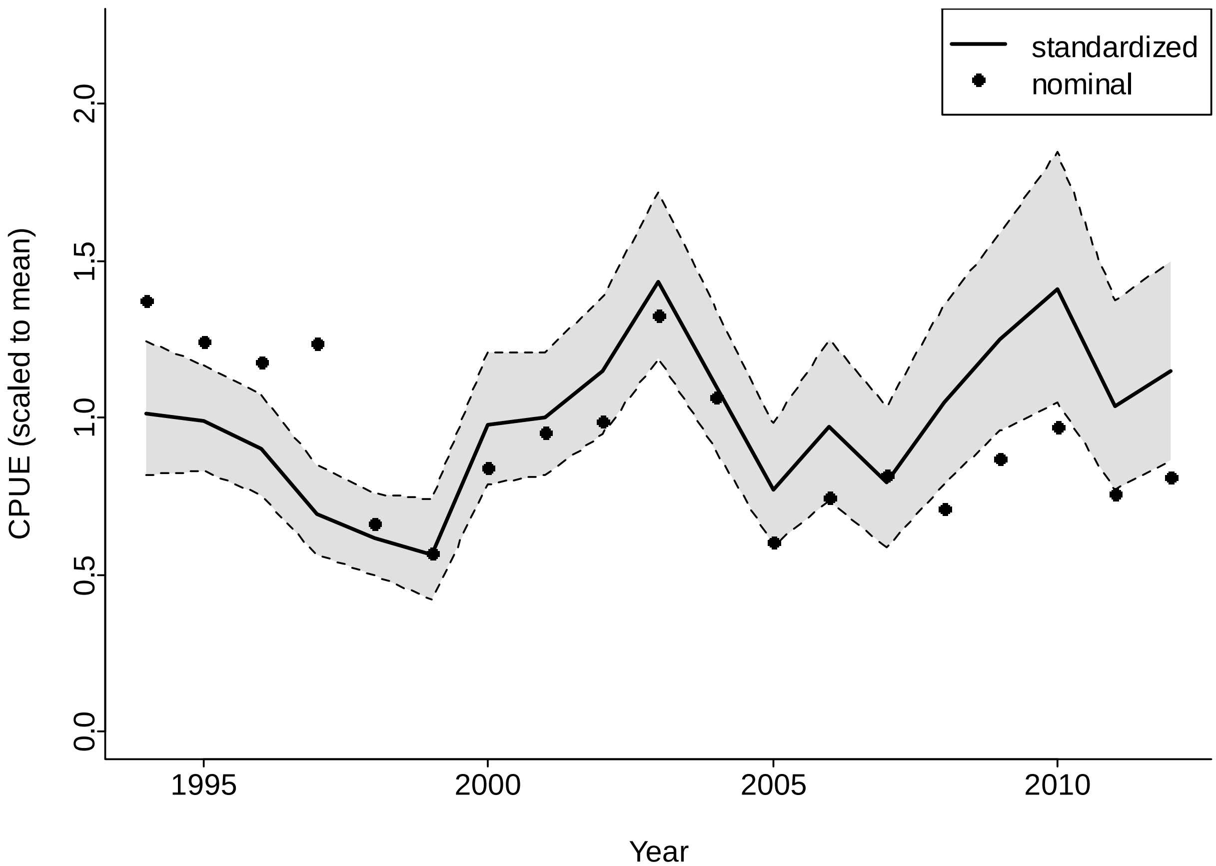


Figure 8.2.2.1. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the WFL spear model.

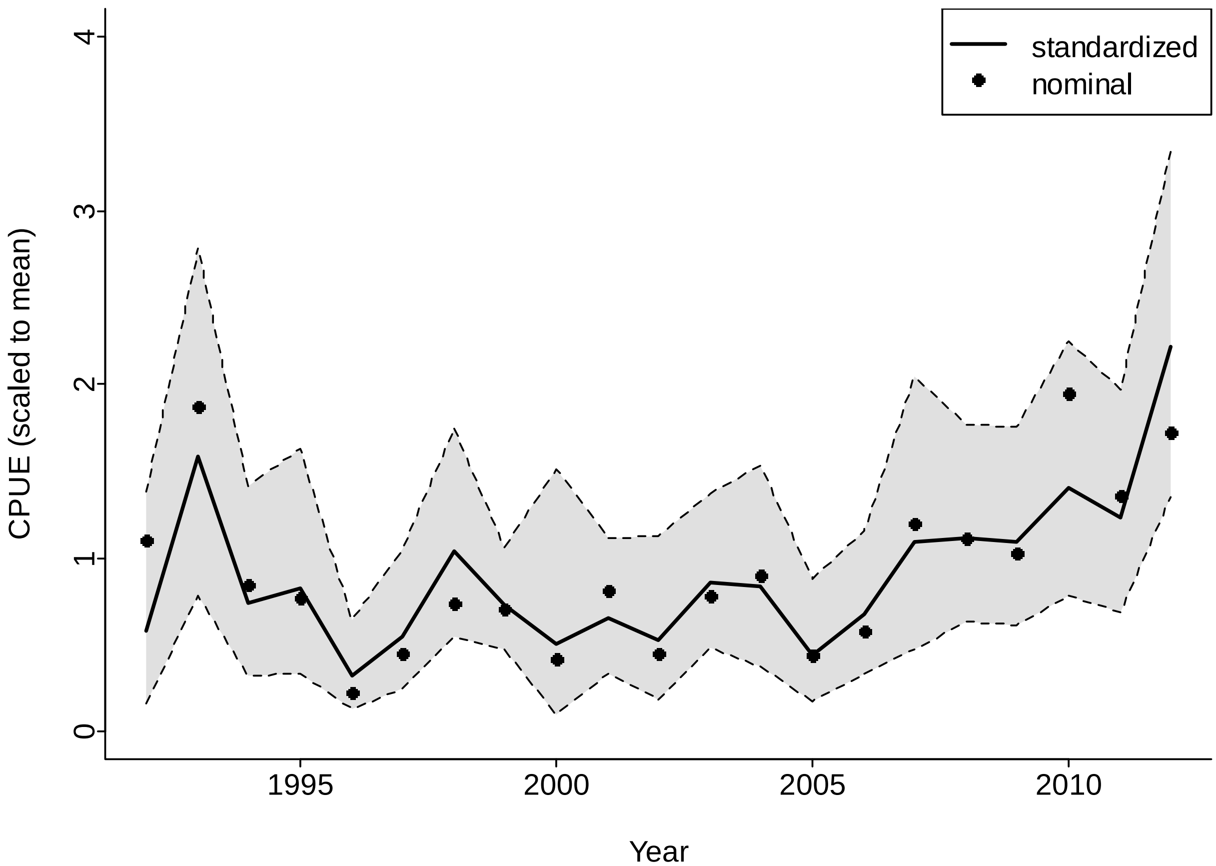


Figure 8.2.2.2. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the WFL hook-and-line model.

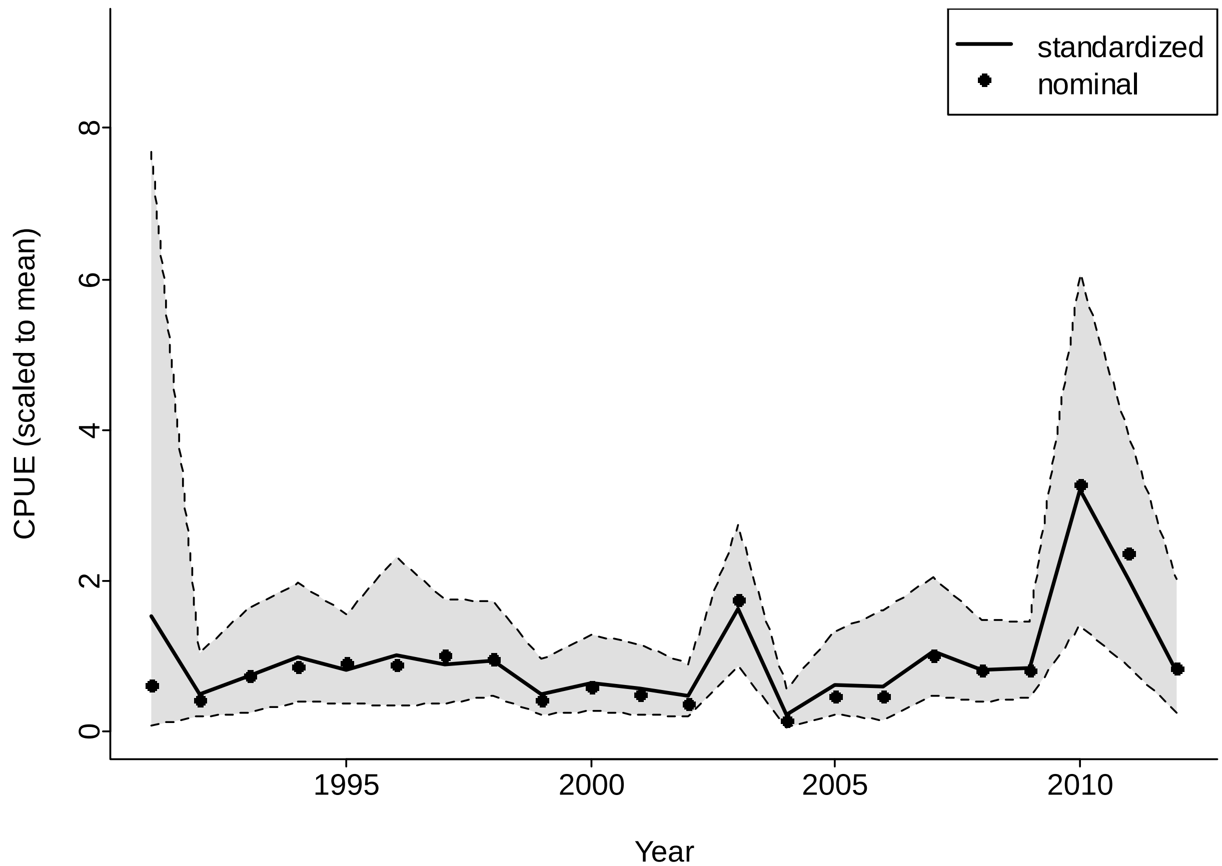


Figure 8.2.2.3. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the FLK/SEFL spear model.

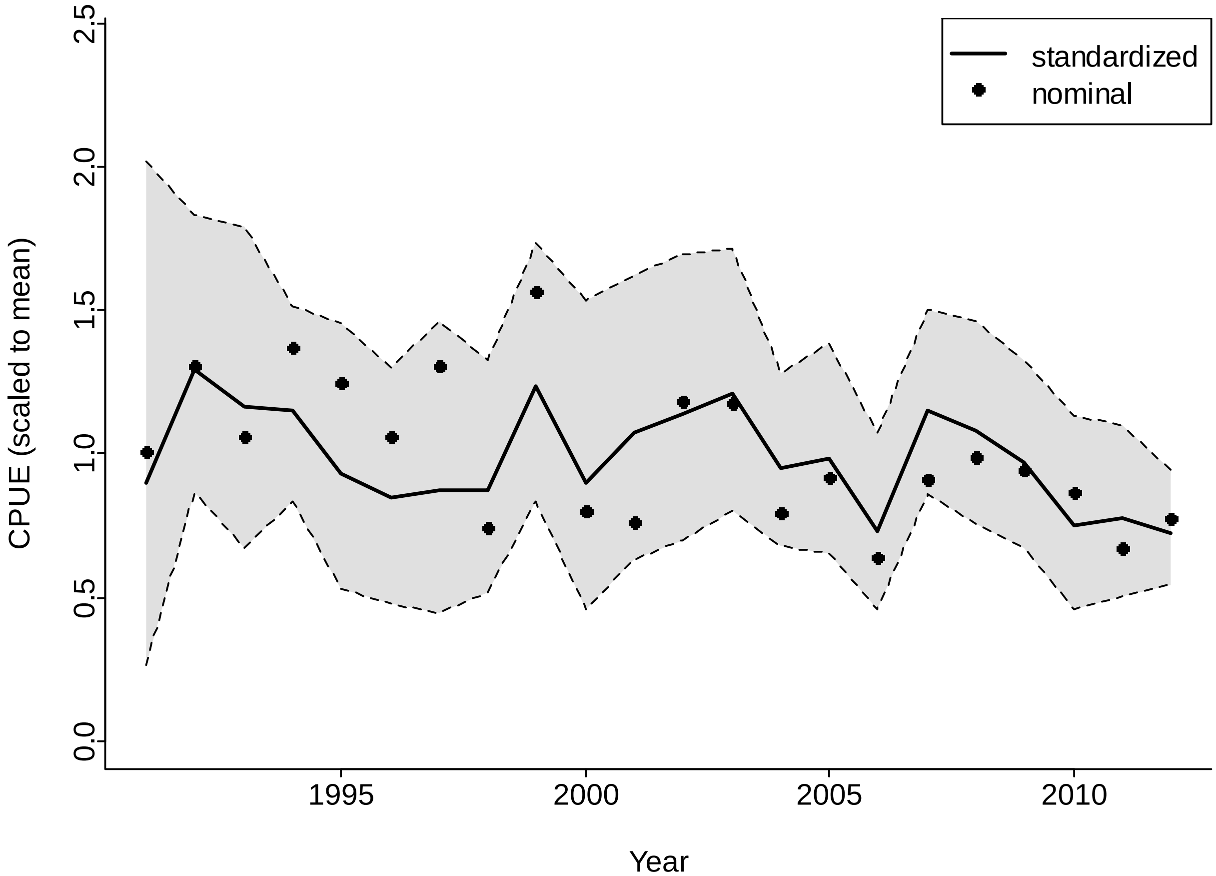


Figure 8.2.2.4. Standardized index of abundance from recreational MRFSS/MRIP intercept data for the FLK/SEFL hook-and-line model.

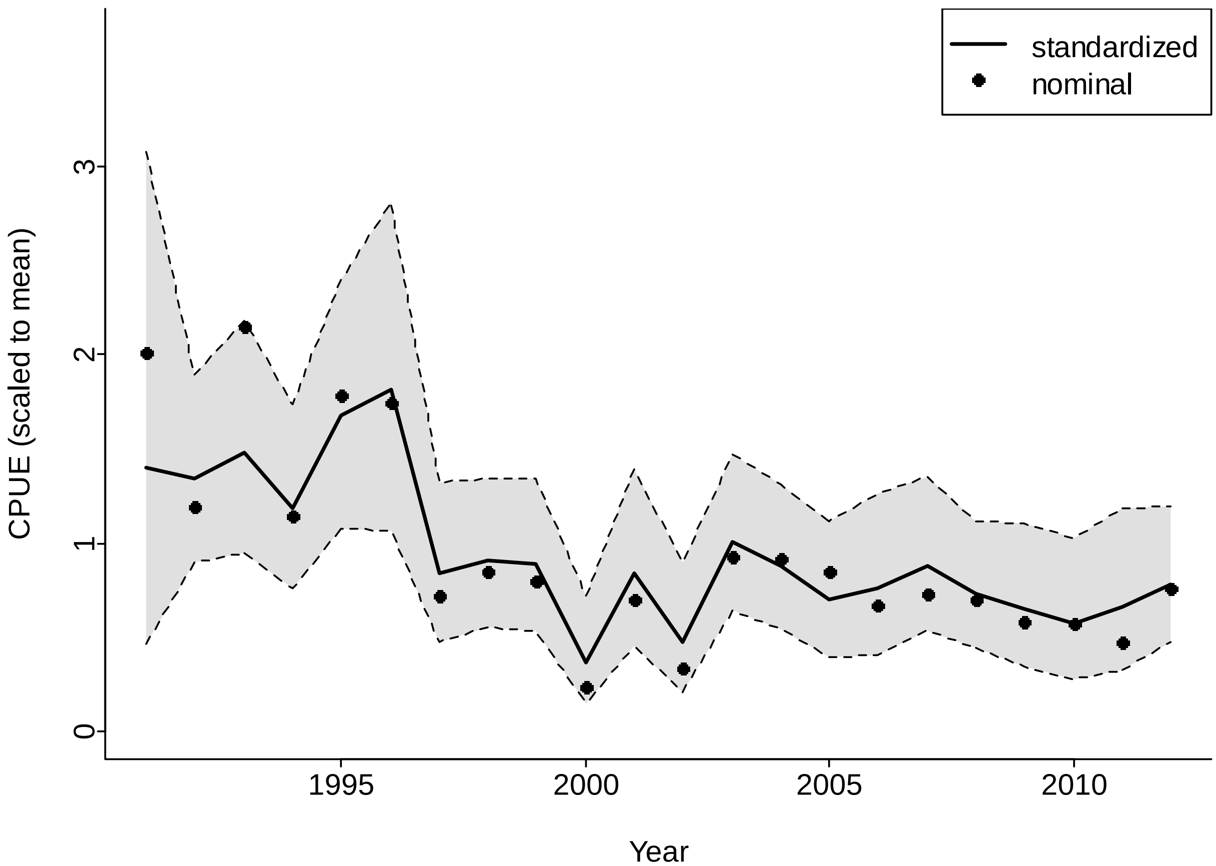


Figure 8.2.3.1. Indices of abundance from REEF visual surveys for the multinomial scaling model for the three survey regions (a-c) and for the FLK+SEFL combined stock (d).

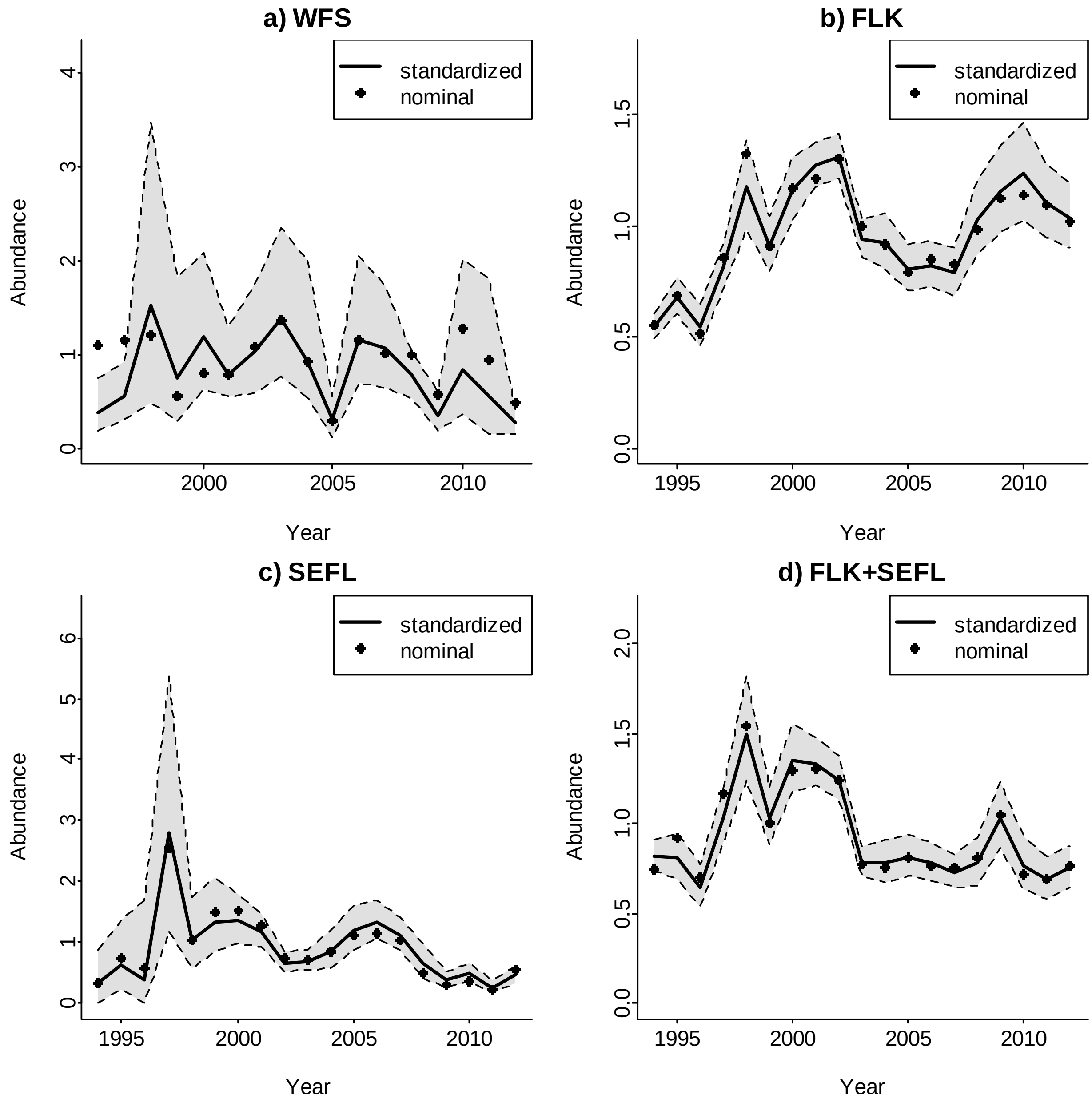


Figure 8.2.3.2. Indices of abundance from REEF visual surveys for the censored Poisson model for the three survey regions (a-c) and for the FLK+SEFL combined stock (d). Note: the null model for SEFL (with Year as the single predictor) did not converge; therefore, no results are shown.

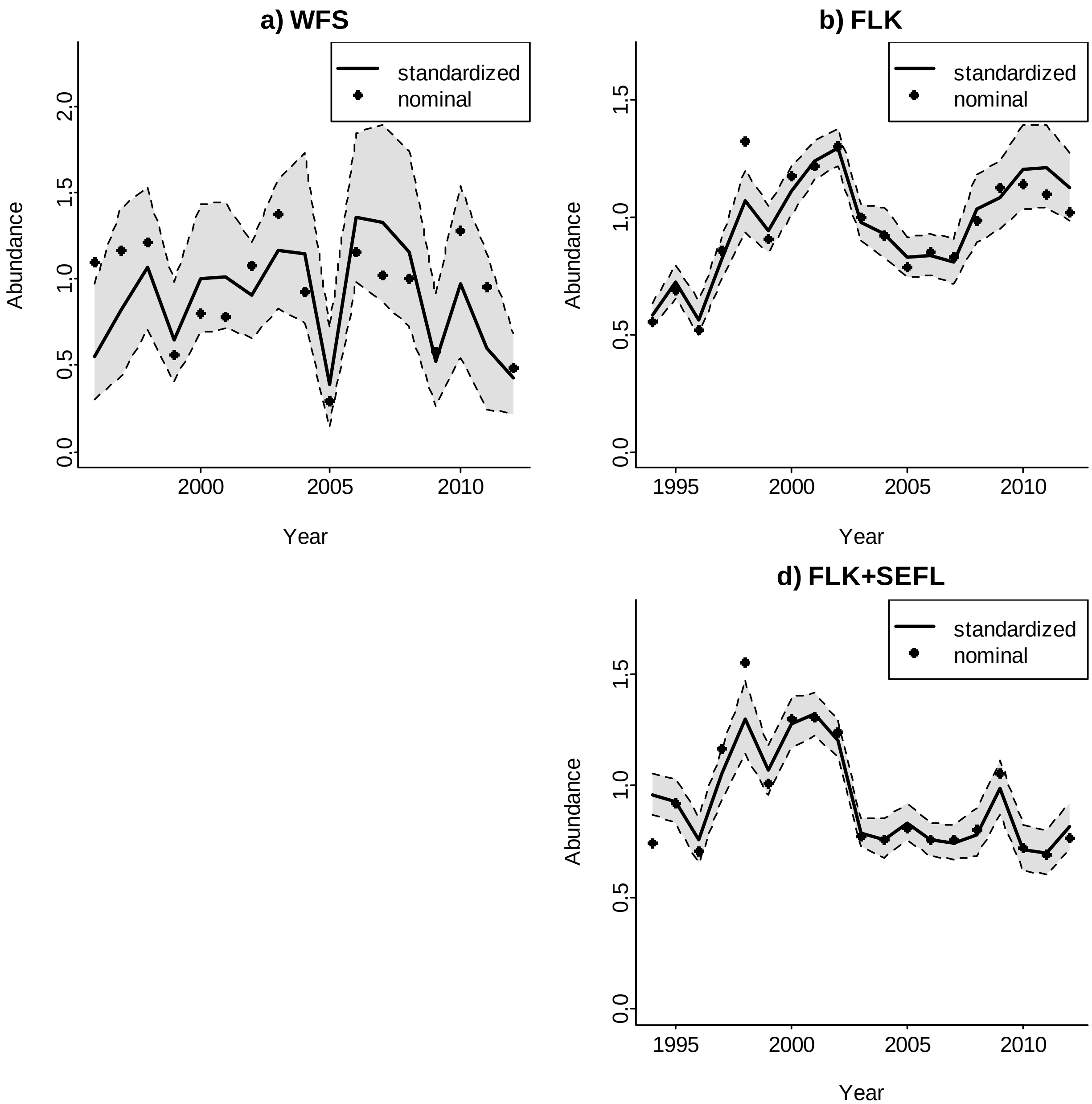


Figure 8.2.4.1. Annual estimates of relative abundance (MaxN) of Hogfish as determined via a generalized linear modeling analysis of data from the NMFS – PC and FWRI video surveys for the WFL stock.

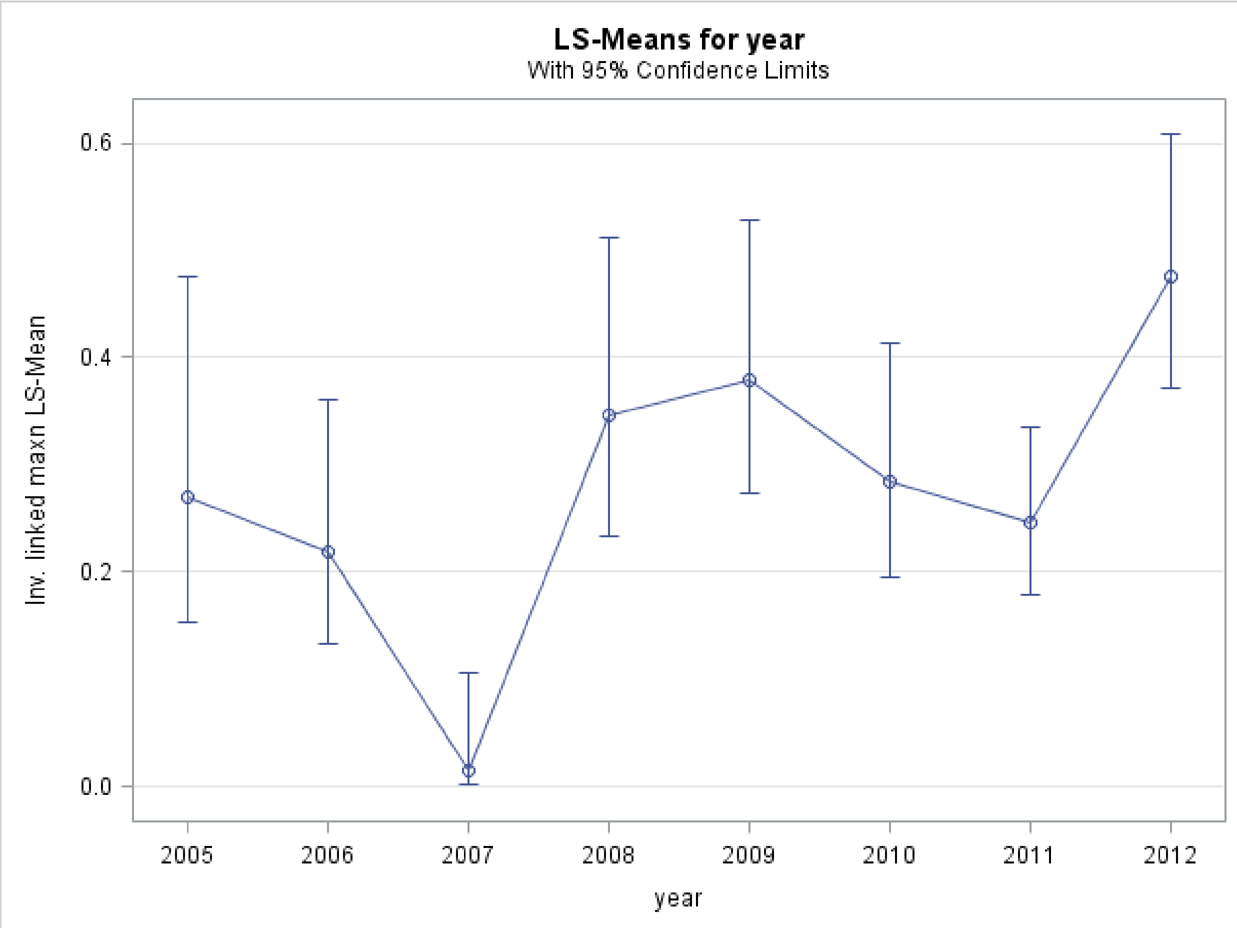


Figure 8.2.5.1. Annual estimates of relative abundance (Individuals Per Set) of Hogfish as determined via a generalized linear modeling analysis of data from the FWRI polyhaline seagrass trawl survey.

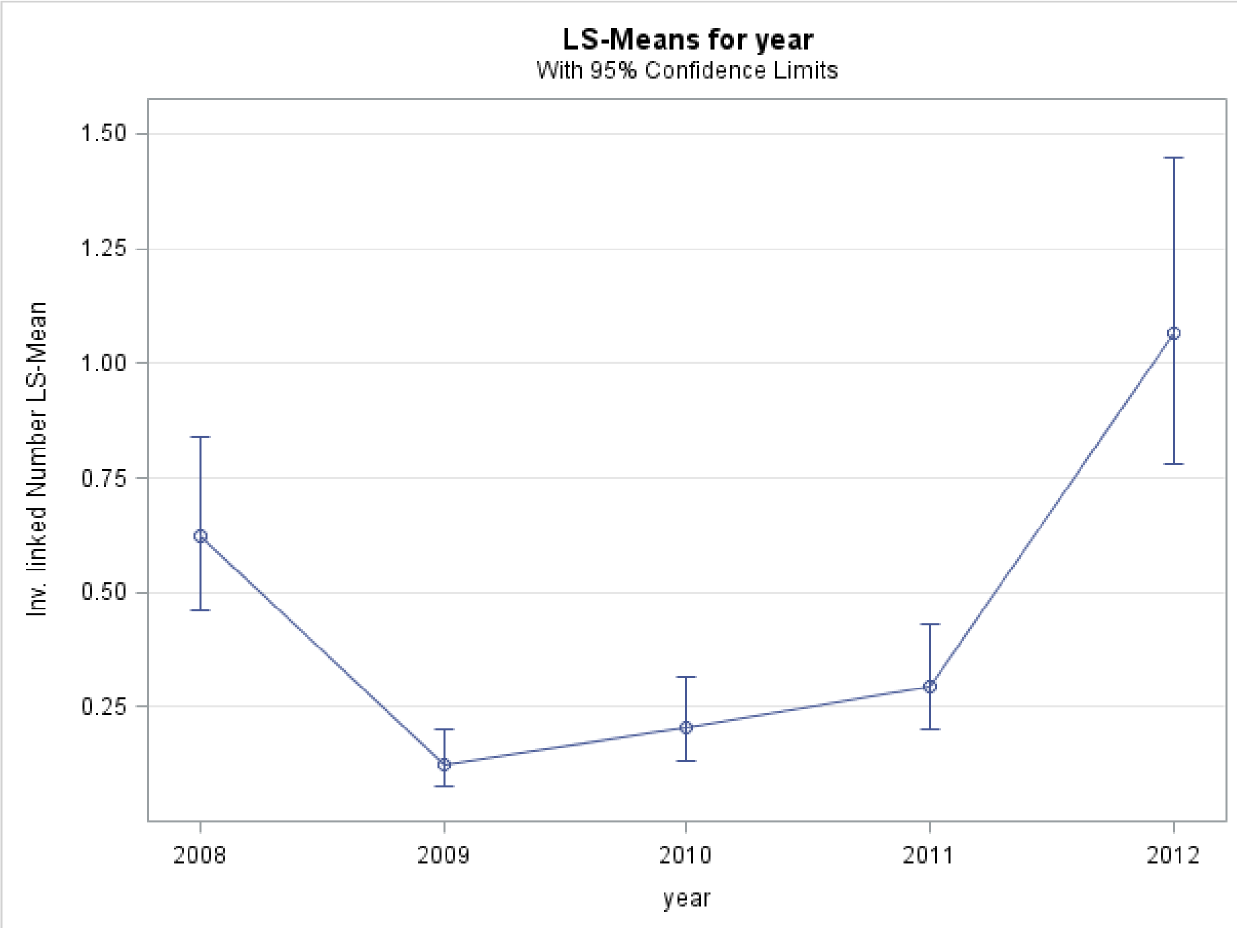


Figure 8.2.6.1. Annual estimates of relative abundance (Individuals Per Set) of Hogfish as determined via a generalized linear modeling analysis of data from the summer FWRI SEAMAP trawl survey.

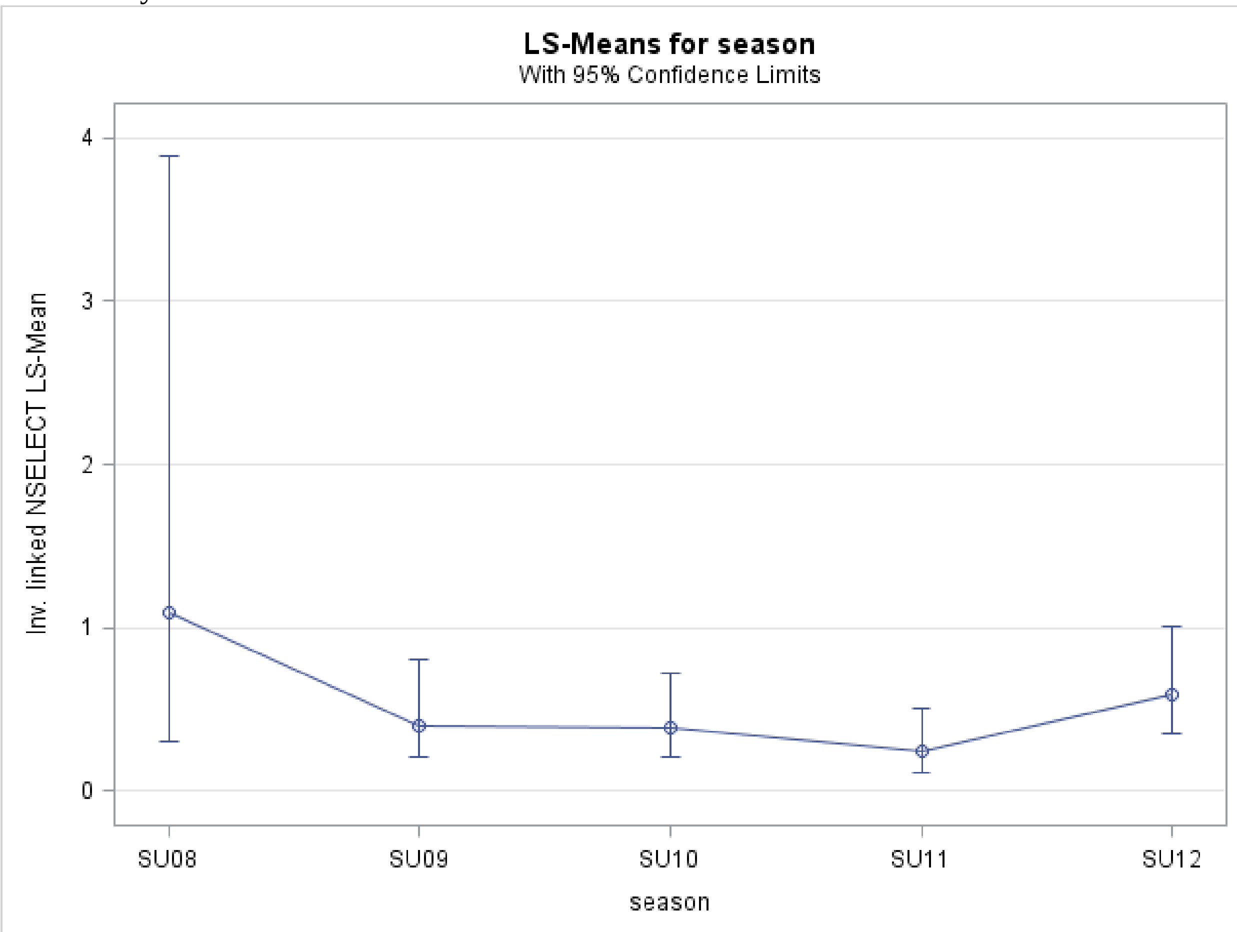


Figure 8.2.7.1. Annual estimates of relative abundance (Individuals Per Set) of Hogfish as determined via a generalized linear modeling analysis of data from the FWRI baitfish trawl survey.

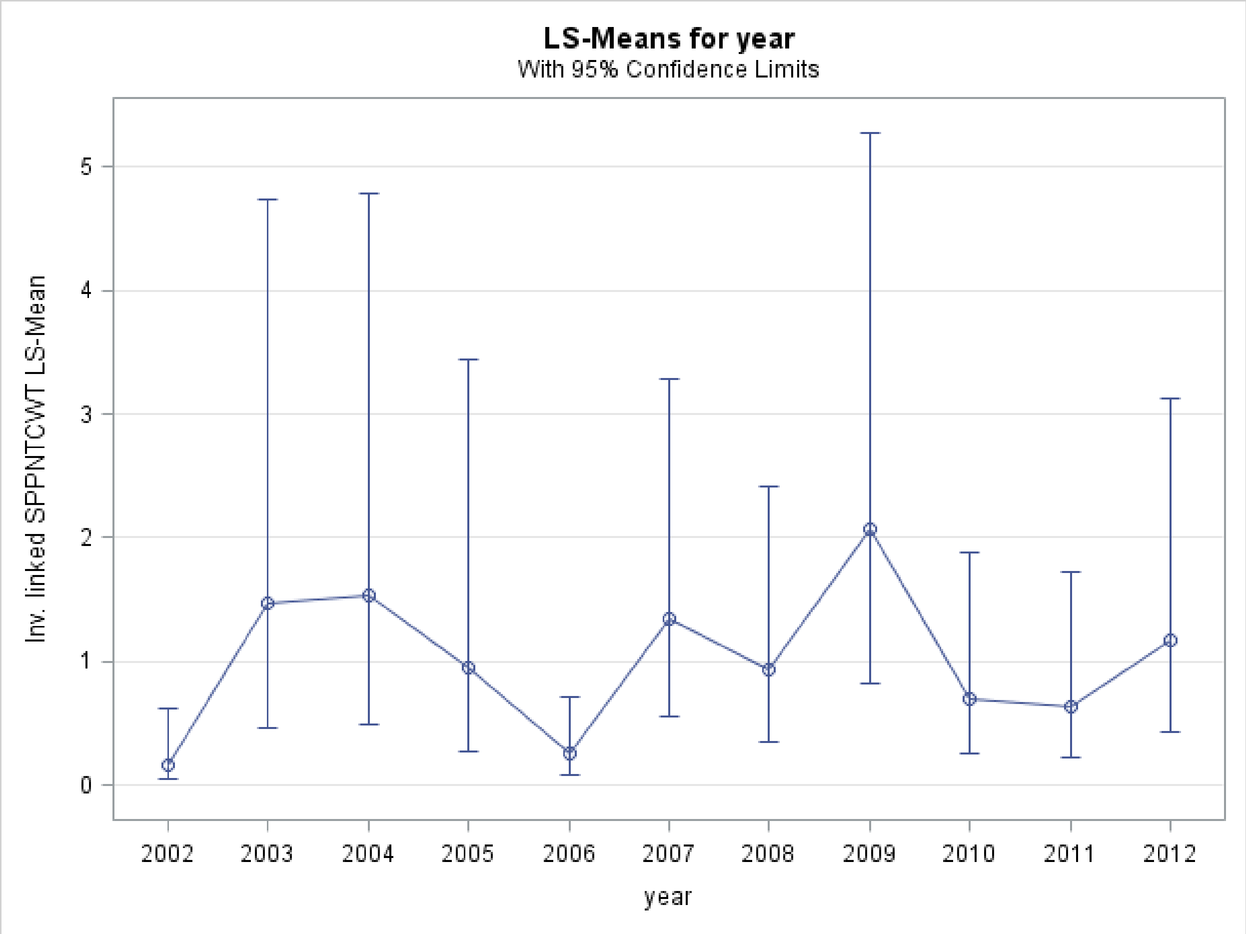
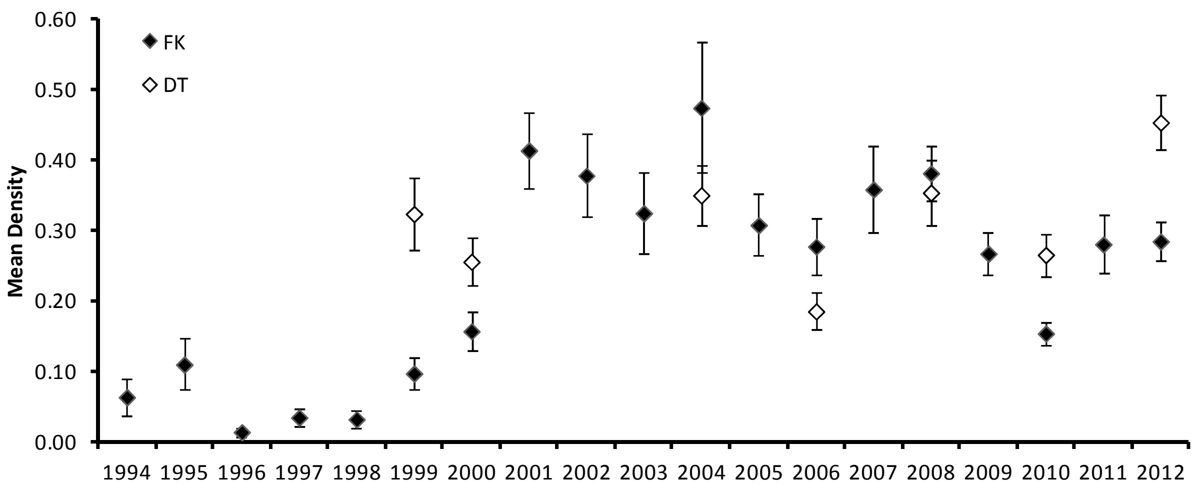


Figure 8.2.8.1. Visual survey estimates of Hogfish mean density (±SE) for (A) exploited and (B) pre-exploited life stages during 1994-2012 in the Florida Keys (solid diamonds) and Dry Tortugas (open diamonds). Density units are number of fish per SSU.

(A) Exploited Life Stage (L ≥ 300 mm)



(B) Pre-exploited Life Stage (L < 300 mm)

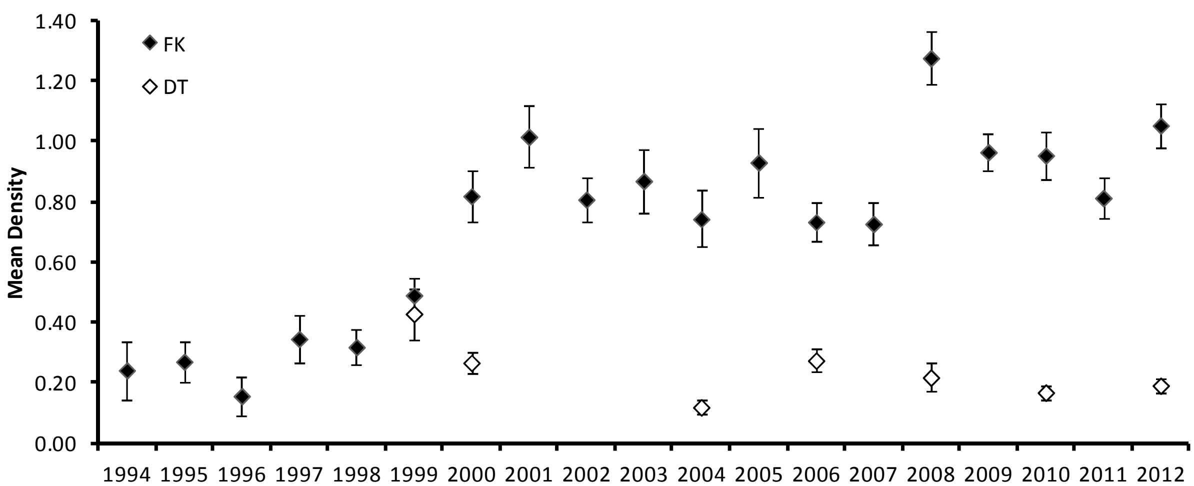


Figure 8.2.10.1. Indices of abundance from the commercial logbooks for each stock and gear combination. Points represent the observed nominal CPUE, lines are the standardized CPUE, and shaded areas are the confidence intervals.

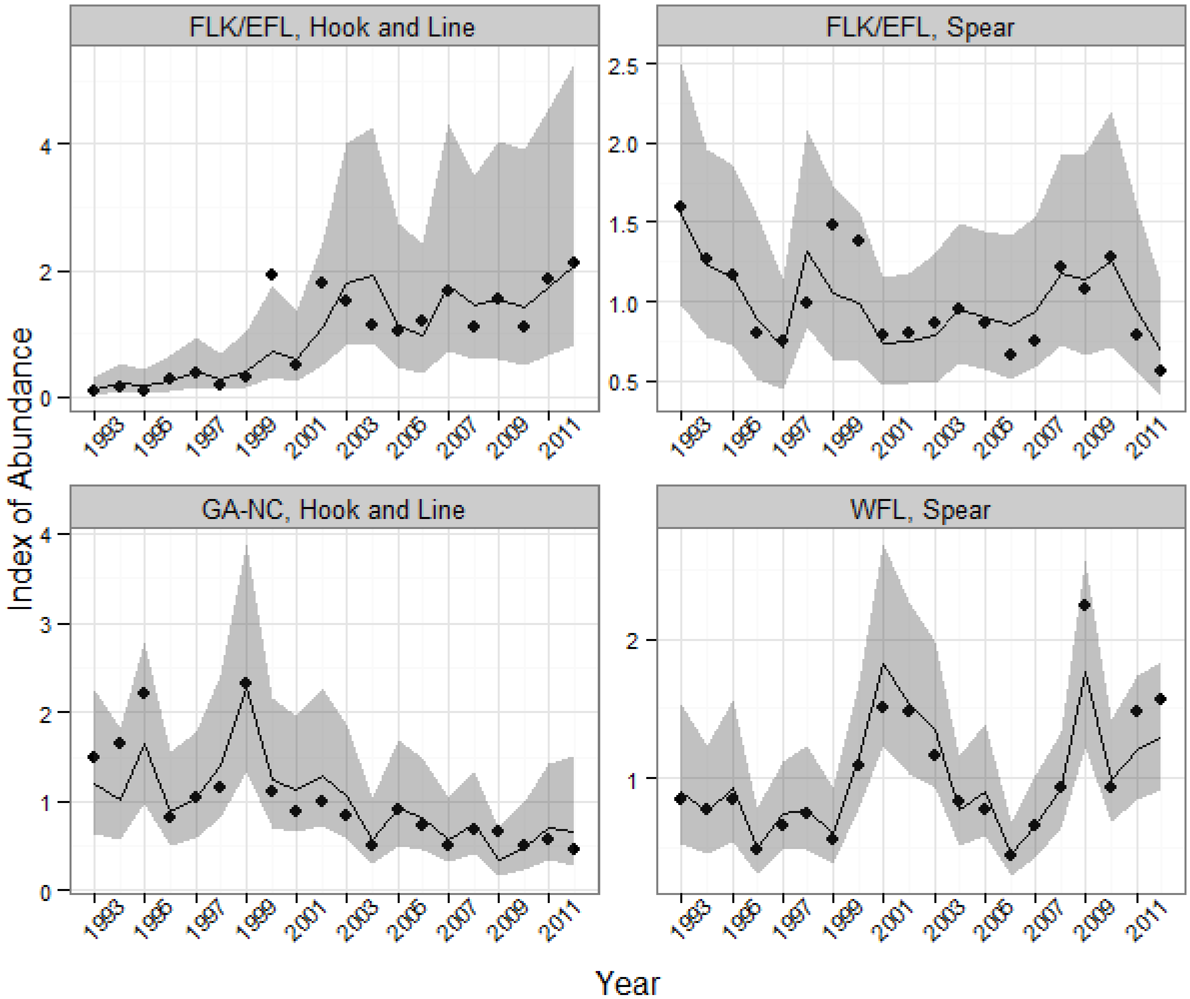


Figure 8.2.11.1. Standardized index of abundance from the commercial South Carolina trip ticket analysis.

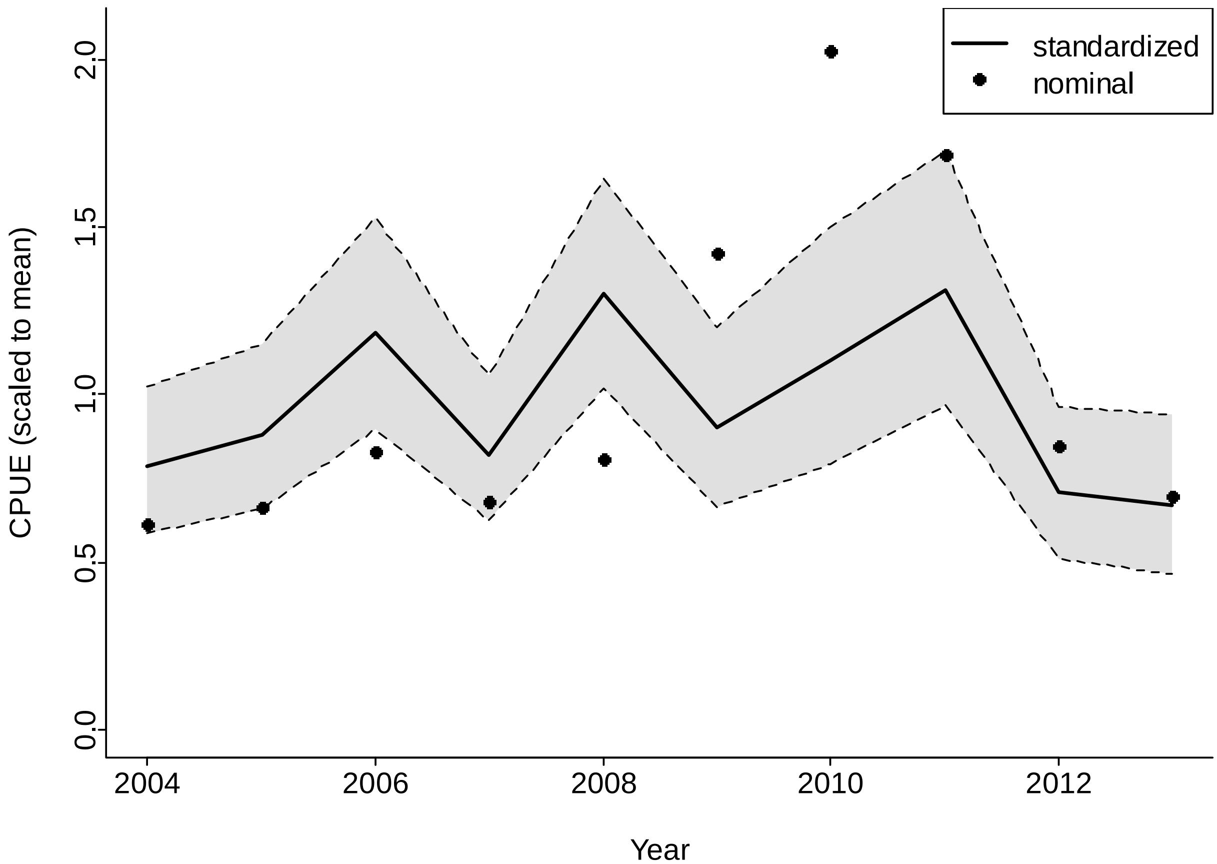
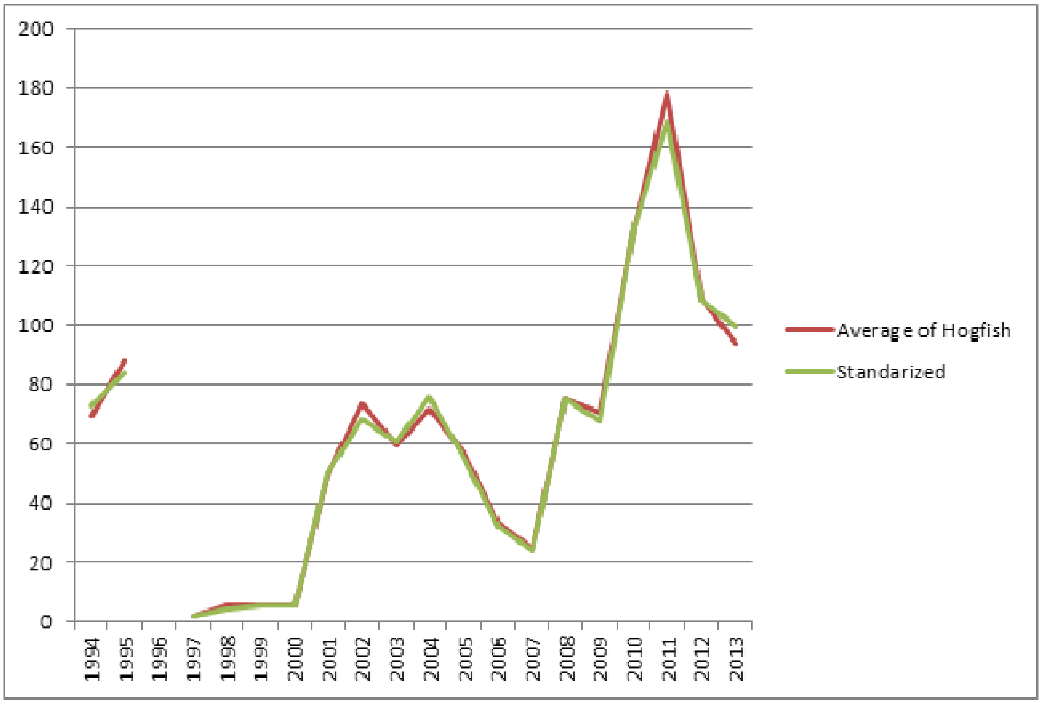


Figure 8.2.12.1. Standardized index of abundance from the commercial diving North Carolina trip ticket analysis.



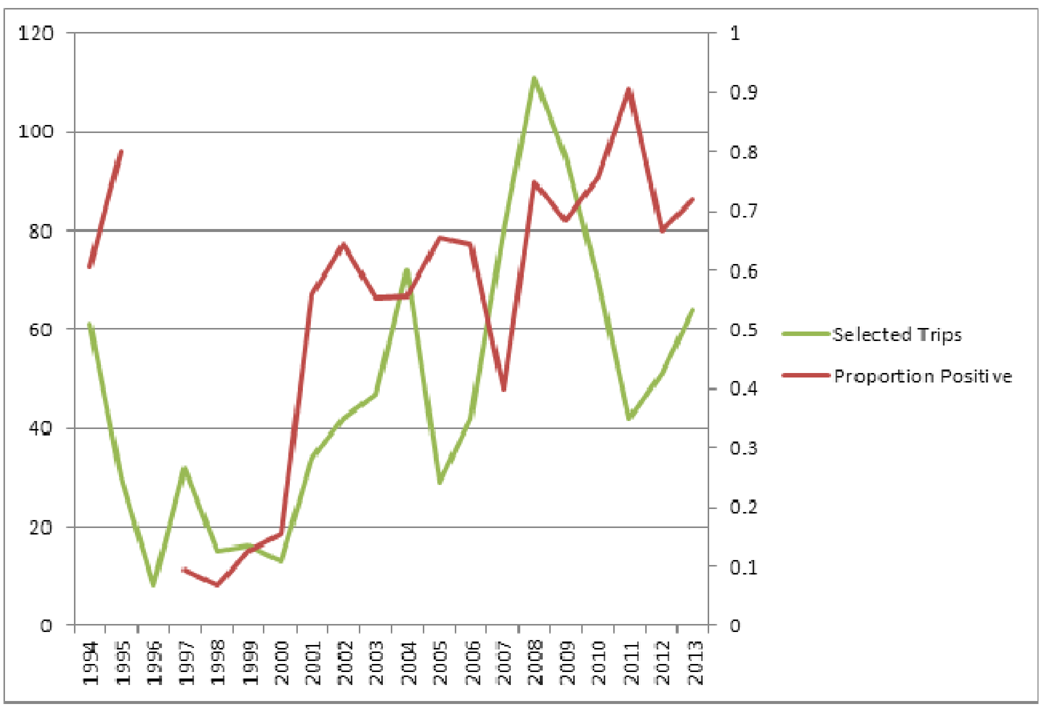


Figure 8.5.1.1. Indices of abundance for the WFL stock. Note: only the REEF indices using the multinomial approach are presented.

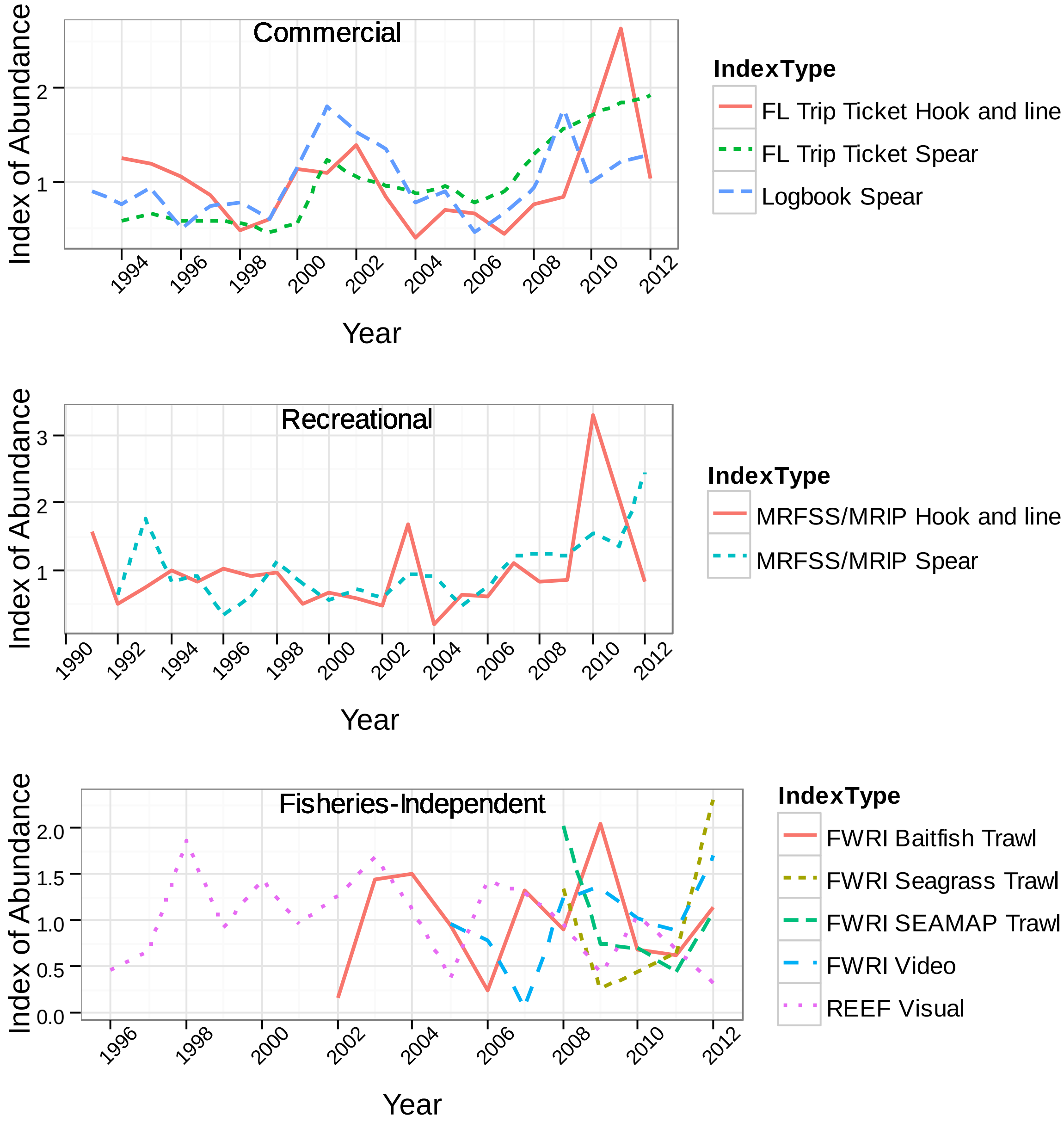
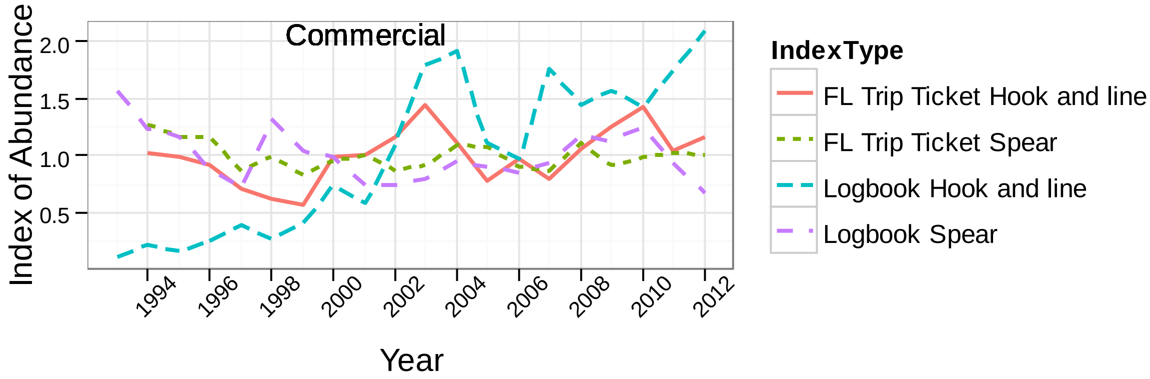
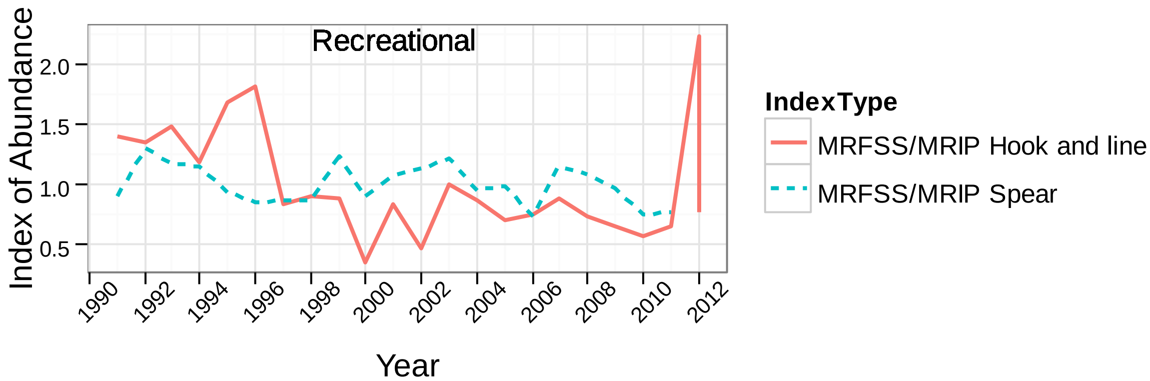


Figure 8.5.2.1. Indices of abundance for the FLK/EFL stock. Note: only the REEF indices using the multinomial approach and for the FLK and SEFL regions combined are presented.





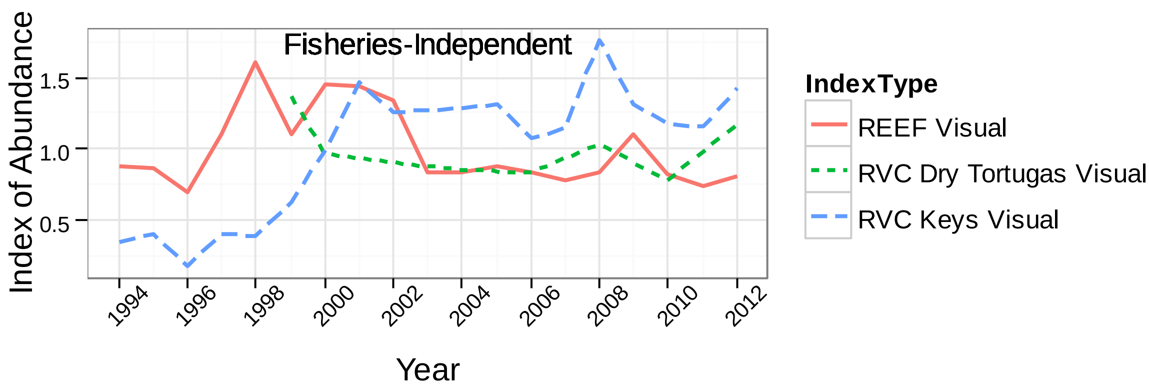
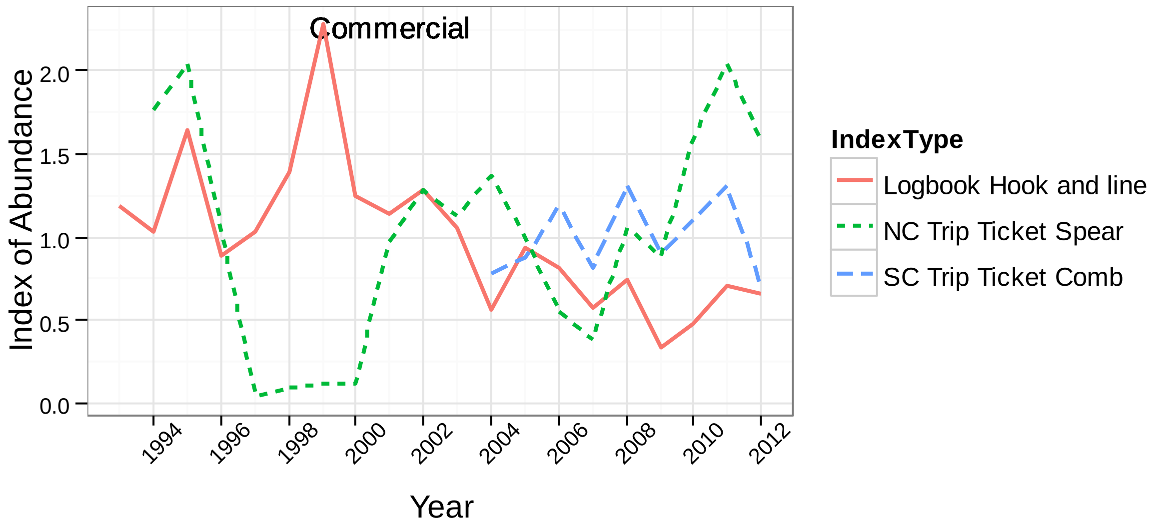
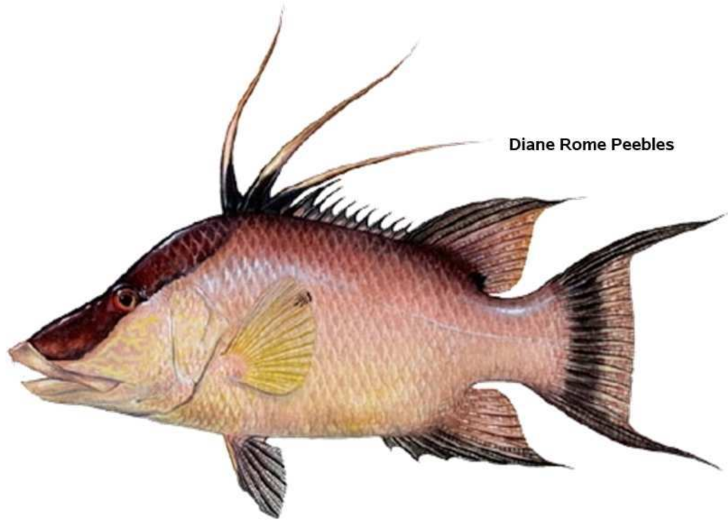


Figure 8.5.3.1. Indices of abundance for the GA/NC stock.





The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico

Section III: Assessment Report

Wade Cooper, Angela Collins, Joe O'Hop, Dustin Addis

Florida Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
100 Eighth Ave Southeast
St. Petersburg, Florida 33701-5020

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9 Introduction

9.1 Assessment Process

Assessment of Hogfish in the Southeastern U.S. was conducted by the State of Florida's Fish and Wildlife Research Institute (FWRI), with assistance from numerous state and federal collaborators. As this assessment was not formally conducted through the SEDAR process but was provided by the State of Florida, the typical Data, Assessment, and Review Workshops were not held by the State. Two Data Scoping Workshops were held to illicit stakeholder feedback in the process, the first in Marathon, FL in November 2013, and a second in St. Petersburg, FL in January 2014.

9.2 Terms of Reference

The following Terms of Reference (TOR) were used to guide the assessment of Hogfish in the Southeastern U.S. Comments are provided following each TOR regarding how these terms were addressed in this assessment.

Term of Reference 1

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

Comment: The previous Section II described the data used for inputs to the model, and reflects all revisions available and used in the model configurations. Chapter (Ch) 10 summarizes the data inputs.

Term of Reference 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.

Comment: A fully integrated length-based statistical-catch-at-age model configured using Stock Synthesis was used for the assessment. The model configuration and data inputs are described in Ch 11.1. Appendix A includes the data files to run the Stock Synthesis model.

Term of Reference 3

Provide estimates of stock population parameters, if feasible.

- *Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as necessary to describe the population.*
- *Include appropriate and representative measures of precision for parameter estimates.*

Comment: Estimates of all assessment model parameters and their associated standard errors are described in Ch 11.2.2. Estimates of spawning stock biomass, recruitment, fishing mortality, and their associated errors are discussed in Chapters 11.2.4-11.2.6. Estimates of uncertainty for select model parameters and derived quantities from the bootstrap analysis are discussed in Ch 11.2.7.1.

Term of Reference 4

Characterize uncertainty in the assessment and estimated values

- *Consider uncertainty in input data, modeling approach, and model configuration.*
- *Provide a continuity model consistent with the prior assessment configuration, if one exists, updated to include the most recent observations. Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered.*
- *Consider 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*

Comment: Measures of overall model fit are discussed in Ch 11.2.1. Model convergence was assessed by varying starting parameters and refitting the model (jitter analysis) and discussed in Ch 11.1.5. Uncertainty in the input data was explored through bootstrap analyses and discussed in Ch 11.2.7.1, while uncertainty in the model configuration was assessed through sensitivity analyses and discussed in Ch 11.2.7.2. As the prior assessment for Hogfish (SEDAR 6) was conducted in 2004 and found insufficient to determine status of the stock, a continuity model was not provided.

Term of Reference 5

Provide estimates of yield and productivity.

- *Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models.*

Comment: The evaluation of the estimated stock-recruitment parameters is presented in Ch 11.2.4. Equilibrium yield-per-recruit and spawner-per-recruit as determined by the assessment model are provided in Figures 11.2.8.1-11.2.8.3.

Term of Reference 6

Provide estimates of population benchmarks or management criteria consistent with the 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*

Comment: Both MSY-based reference points (F_{MSY}) and alternative SPR-based reference points ($F_{30\%}$, $F_{35\%}$, $F_{40\%}$), consistent with the Sustainable Fisheries Act (SFA) criteria for unassessed reef fish species (Ch 2.3), are provided as determined from both the base model configuration and bootstrap uncertainty results (Tables 11.2.7.1.1-11.2.7.1.3).

Term of Reference 7

Provide declarations of stock status relative to management benchmarks, or alternative data poor approaches if necessary.

Comment: Stock status was determined for each maximum fishing mortality threshold (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, $F_{40\%}$) and the corresponding minimum stock size thresholds (MSST). Resultant stock status is provided for each stock from the base model configuration with its associated uncertainty from the bootstrap analyses in Tables 11.2.7.1.1-11.2.7.1.3.

Term of Reference 8

Perform a probabilistic analysis of proposed reference points, stock status, and yield.

- *Provide the probability of overfishing at various harvest or exploitation levels.*
- *Provide a probability density function for biological reference point estimates.*
- *If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.*

Comment: Data quantiles of select parameters, reference points, and stock status from the bootstrap analyses are provided in Tables 11.2.7.1.1-11.2.7.1.3 and Figures 11.2.7.1.1-11.2.7.1.15. Probability distributions of overfishing limits (OFLs) and rebuilding schedules will be provided to the SSC directly.

Term of Reference 9

Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

A) If stock is overfished

F=0, F=current, F=Fmsy, Ftarget

F=Frebuild (max that rebuild in allowed time)

B) If stock is overfishing

F=Fcurrent, F=Fmsy, F= Ftarget

C) If stock is neither overfished nor overfishing

F=Fcurrent, F=Fmsy, F=Ftarget

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

Comment: Projections with accompanying OFLs were completed using the deterministic base model configurations for F=0, F=current, and each MFMT (F_{MSY}, $F_{30\%,}$ $F_{35\%,}$ $F_{40\%}$), and provided in Tables and Figures 11.2.9.1-11.2.9.3. Probability distributions of the projections from a bootstrap analysis and rebuilding schedules will be provided to the SSC directly.

Term of Reference 10

Provide recommendations for future research and data collection.

- *Be as specific as practicable in describing sampling design and sampling intensity.*
- *Emphasize items which will improve future assessment capabilities and reliability.*
- *Consider data, monitoring, and assessment needs.*

Comment: Research recommendations are provided in Ch 11.3.

10 Data Review and Updates

Section II: Data Inputs described the data used for inputs to the model, and reflects all revisions available and used in the model configurations. The following list summarizes the main data inputs used in each of the three assessment models for each genetically-distinct stock (Ch 5.3): (a) West Florida (WFL), (b) East Florida including the Florida Keys and Dry Tortugas (FLK/EFL), and (c) Georgia through North Carolina (GA-NC).

10.1 WFL Stock Data Summary

1. Life history
    - a. von Bertalanffy growth parameters
    - b. Morphometric parameters
    - c. Natural mortality estimates
2. Landings
    - a. Commercial spear: 1986-2012
    - b. Commercial hook and line: 1986-2012
    - c. Commercial traps: 1986-2012
    - d. Recreational spear: 1986-2012
    - d. Recreational hook and line: 1986-2012
3. Discards (included in landings with 10% release mortality for discarded alive)
    - a. Commercial spear: 1993-2012 (logbook program)
    - b. Recreational spear: 1986-2012
    - c. Recreational hook and line: 1986-2012
4. Length composition of landings
    - a. Commercial spear: 1991, 1997-2003, 2005, 207-2012
    - b. Commercial hook and line: 1993-1996, 1998-2002, 2008, 2011-2012
    - c. Commercial traps: 1993, 1996, 1998-2003
    - d. Recreational spear: 1992, 1989, 1993-2012
    - d. Recreational hook and line: 1993-2012
6. Age composition of landings
    - a. Commercial spear: 2010, 2012
    - d. Recreational spear: 2003, 2012
    - d. Recreational hook and line: 2003, 2008, 2009, 2010
7. Abundance indices
    - a. Fishery-dependent
        - i. Commercial spear (logbook): 1993-2012
        - ii. Commercial hook and line (FL trip tickets): 1994-2012
        - iii. Recreational spear: 1992-2012
        - iv. Recreational hook and line: 1991-2012
    - b. Fishery-independent
        - i. Baitfish trawl: 2002-2012
        - ii. SEAMAP trawl: 2008-2012
        - iii. PC/FWRI video survey: 2005-2012
        - iv. Age-0 seagrass trawl: 2008-2012
8. Length composition data from fishery-independent survey
    - a. Baitfish trawl: 2002-2012

b. SEAMAP trawl: 2008-2012
c. PC/FWRI video survey: 2010-2012
d. Age-0 seagrass trawl: 2008-2012
9.Age composition of fishery-independent surveys
i. Baitfish trawl: 2007, 2009-2012
ii. SEAMAP trawl: 2008-2012

10.2 FLK/EFL Stock Data Summary

1. Life history
    a. von Bertalanffy growth parameters
    b. Morphometric parameters
    c. Natural mortality estimates
2. Landings
    a. Commercial spear: 1986-2012
    b. Commercial hook and line: 1986-2012
    c. Commercial traps: 1986-2012
    d. Recreational spear: 1986-2012
    d. Recreational hook and line: 1986-2012
3. Discards (included in landings with 10% release mortality for discarded alive)
    a. Commercial spear: 1993-2012 (logbook program)
    a. Commercial hook and line: 1993-2012 (logbook program)
    b. Recreational spear: 1986-2012
    c. Recreational hook and line: 1986-2012
4. Length composition of landings
    a. Commercial spear: 1991, 1997-2003, 2005, 207-2012
    b. Commercial hook and line: 1993-1996, 1998-2002, 2008, 2011-2012
    c. Commercial traps: 1993, 1996, 1998-2003
    d. Recreational spear: 1992, 1989, 1993-2012
    d. Recreational hook and line: 1993-2012
6. Age composition of landings
    a. Commercial spear: 2010, 2012
    d. Recreational spear: 2003, 2012
    d. Recreational hook and line: 2003, 2008, 2009, 2010
7. Abundance indices
    a. Fishery-dependent
        i. Commercial spear (logbook): 1993-2012
        ii. Commercial hook and line (FL trip tickets): 1994-2012
        iii. Recreational spear: 1992-2012
        iv. Recreational hook and line: 1991-2012
    b. Fishery-independent
        i. Baitfish trawl: 2002-2012
        ii. SEAMAP trawl: 2008-2012
        iii. PC/FWRI video survey: 2005-2012
        iv. Age-0 seagrass trawl: 2008-2012
8. Length composition data from fishery-independent survey

   a. Baitfish trawl: 2002-2012
   b. SEAMAP trawl: 2008-2012
   c. PC/FWRI video survey: 2010-2012
   d. Age-0 seagrass trawl: 2008-2012

9.Age composition of fishery-independent surveys
   i. Baitfish trawl: 2007, 2009-2012
   ii. SEAMAP trawl: 2008-2012

10.3 GA-NC Stock Data Summary

1. Life history
   a. von Bertalanffy growth parameters
   b. Morphometric parameters
   c. Natural mortality estimates
2. Landings
   a. Commercial spear: 1986-2012
   b. Commercial hook and line: 1986-2012
   c. Commercial traps: 1986-2012
   d. Recreational hook and line: 1986-2012
3. Discards (included in landings with 10% release mortality for discarded alive)
   a. Commercial hook and line: 1993-2012 (logbook program)
   c. Recreational hook and line (interpolated; see Ch 7.2.3): 1986-2012
4. Length composition of landings
   a. Commercial spear: 1992, 1996, 2004-2006, 2008-2012
   b. Commercial hook and line: 1986-2012
   c. Commercial traps: 1991
   d. Recreational hook and line: 2007-2012
6. Age composition of landings
   a. Commercial spear: 2011, 2012
   d. Commercial hook and line: 2008, 2011, 2012
   d. Recreational hook and line: 2007, 2008, 2010-2012
7. Abundance indices
   a. Fishery-dependent
      ii. Commercial hook and line (FL trip tickets): 1994-2012

11 Stock Assessment Model and Results

11.1 Stock Synthesis Model Description

11.1.1 Overview

The assessment model selected for the assessment was Stock Synthesis (Methot 2013) version 3.24s. Stock Synthesis (SS) has been widely used and tested for assessment evaluations, particularly in the US west coast NMFS centers (Methot 2013). Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2013; http://nft.nefsc.noaa.gov/Stock_Synthesis_3.htm) and 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 of the important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. Because many of these inputs are correlated, the concept behind SS is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SS is comprised of three subcomponents: 1) a population subcomponent that recreates an estimate of the numbers/biomass at age using estimates of natural mortality, growth, fecundity, etc.; 2) an observational sub-component that consists of observed (measured) quantities such as CPUE or proportion at length/age; and 3) a statistical sub-component that uses likelihoods to quantify the fit of the observations to the recreated population.

11.1.2 Data Sources

All data sources are described in Chapters 5-8 and summarized in Chapter 10.

11.1.3 Model Configuration and Equations

A length-based, age-structured, forward-simulation population model was used to assess the status of Hogfish in the Southeastern U.S for each of the three genetically-distinct studies: West Florida (WFL), East Florida including the Florida Keys and Dry Tortugas (FLK/EFL), and Georgia through North Carolina (GA-NC). Nearly all landings of Hogfish from the Gulf of Mexico originate from within Florida, therefore the stock is described as a West Florida stock for the purpose of this assessment although the WFL stock included the limited catch data from other Gulf of Mexico states. Separate assessment models were developed for each of the three stocks using consistent model configurations. Since the model configurations are consistent, the models are presented and described together in each report section.

The models were implemented in Stock Synthesis (Methot 2011) version 3.24s. The separate models use data through 2012 and the time period of the assessments is 1986-2012. While historical reconstruction was applied for commercial and recreational data back to 1950, the early years of recreational data (1981-1985) were deemed unreliable due to low precision and high variability in catch estimates, in which zero catch was estimated for a number of these years in each stock and gear combination. Data collection was assumed to be relatively continuous throughout the year; therefore, a seasonal component to the removals and biological predictions was not modeled. The model was configured to include discards directly into the landings data, by assuming a 10% and 100% discard mortality rate for hook and line and spear fishing, respectively. This configuration was deemed appropriate given that Hogfish regulations (12" minimum FL; 5 fish per day recreational limit) have remained constant throughout the data rich period (1994-2012) without evidence for changes in the size or age composition, thereby precluding the need to model retention and discards explicitly.

11.1.3.1 Life history

Growth rates were fixed in the assessment model using a single growth curve for both sexes developed from the life history studies conducted on Hogfish in the WFL stock (Ch 5.5.4), thereby assuming Hogfish have similar growth dynamics among all stocks. Growth was modeled with a three parameter von Bertalanffy equation (L_{min}, L_{max}, 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 (L_{bin}; fixed at 2 cm FL). Fish then grow linearly until they reach a real age equal to the input value of A_{min} (growth age for L_{min}) and have a size equal to the L_{min}. As they age further, they grow according to the von Bertalanffy growth equation. L_{max} was specified as equivalent to L_{∞}. Two additional parameters are used to describe the variability in size-at-age; these parameters represent the CV in length-at-age at A_{min} (age 1) and A_{max} (age 21). For intermediate ages a linear interpolation of the CV on mean size-at-age is used. A single length-weight relationship was fixed for both sexes to convert body length (cm) to body weight (kg) using all available length-weight information (Ch 5.5.2). Alternative growth functions were assessed as sensitivity runs.

The natural mortality rate (M) was assumed constant over time but decreasing with age based on Lorenzen (2005), with a cumulative target M=0.179^{-1} across ages to scale the age-specific estimates. The M vector was computed assuming a maximum age of 25yrs (McBride and Murphy 2003), which supports the maximum age collected in the life history studies (23 years), and using the von Bertalanffy growth parameters from the life history studies (Ch 5.5.4). Alternative mortality-at-age functions were assessed as sensitivity runs by assuming alternative maximum ages (20 and 30).

The assessment model was set-up with two genders to account for the reproductive biology of Hogfish as protogynous hermaphrodites (female at birth, then a portion of the population transitions to male). Thus, it was assumed that the sex-ratio at birth was 100% females. Immature females transitioned to mature females based on a fixed logistic function of length, and mature females transitioned to mature males based on a fixed logistic function of length (Ch 5.6.3), based on reproductive data collected in the life history studies on Hogfish by FWRI researchers. Spawning stock biomass (SSB) was modeled using the mature biomass of both females and males in the base model, based on the general lack of information on the importance of sperm limitation for this species (Brooks et al. 2008). Therefore, use of a two gender model was not required, but was kept as is for sensitivity runs with alternative SSB approaches. More detailed fecundity ogives are available for Hogfish from reproductive studies (McBride and Johnson 2007, Collins and McBride in press; Ch 5.6.4); however, these tend to emphasize a decline in fecundity with age as females transition to males, and therefore would discount the influence of male contribution, which may be significant given their transition time of a few months and preference of males by the fishery due to size. Alternative scenarios with female fecundity were assessed as sensitivity runs.

11.1.3.2 Stock-recruitment model

A Beverton-Holt stock-recruitment model was used in this assessment. Three parameters of the stock recruitment relationship were estimated in the model: (1) the log of unexploited equilibrium recruitment (R_0), (2) an offset parameter for initial equilibrium recruitment relative to virgin recruitment log(R_1), and (3) the steepness (h) parameter. The steepness parameter describes the fraction of the unexploited recruits produced at 20% of the equilibrium spawning biomass level. A fourth parameter representing the standard deviation in recruitment (σ_R) was input as a fixed value of 0.6. Rarely is σ_R directly estimable from the given data and hence it is often necessary to input as a fixed parameter. For each of the three stocks, a steepness prior with a beta distribution was used from Shertzer and Conn (2012) for reef fish. For the SS parameterization, the alpha and beta estimates of the beta distribution from Shertzer and Conn (5.94 and 1.97, respectively) were converted to the mean and standard deviation (0.748 and 0.146, respectively) for input into SS.

Stock Synthesis provides an option for estimating the main recruitment deviations for a data-rich period, and early recruitment deviations for early years, including those prior to the start of the model in order to estimate the beginning age composition in the model. For this analysis, early recruitment deviations were used for the period of 1966-1992, thereby including years prior to the start of the model in order to estimate the initial age structure for all 21 ages. The main recruitment deviations were modeled from 1993-2012. Stock synthesis assumes a lognormal error structure for recruitment, so 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 and a few years into the data-rich period. This is done so SS will apply the full bias-correction only to those recruitment deviations that have enough data to inform the model about the full range of recruitment variability. The r4ss package provides a recommended function for the bias adjustment based on Methot and Taylor (2011), and these values were entered as the final parameters after an initial run of the base model to obtain the recommended function. There were no applicable environmental covariates to link to recruitment.

11.1.3.3 Starting conditions

The starting year of the assessment model is 1986. Removals of Hogfish are known to have occurred in the Southeastern US since the late 1930s, and thus the stock was not assumed to be at equilibrium at the start of the modeled period. Given the moderate to low precision for the recreational fishery data, which makes up the majority of the catch since recreational statistics have been collected, attempts at a historical reconstruction for Hogfish were considered unreliable. Because of the start of the model at 1986, initial F rates were estimated for those fisheries that had measured catches during 1986 for both the WFL and FLK/EFL stocks. One exception was made for the WFL stock, where attempts at estimating the initial F rates for each of the fleets failed to converge under multiple model configurations. Due to this, the commercial hook and line fishery was fixed at an initial F rate of 0.001 for 1986. This F rate was based loosely on the ratio of fleet-specific landings relative to 1998, where an independent F estimate of 0.06 was derived in McBride and Murphy (2003) using a catch curve analysis from the life history study conducted from 1995-2001. This low F rate is assumed to be of an appropriate magnitude, given the catch of Hogfish by the commercial hook and line fishery was 0.77 metric tons in 1986, likely representing fewer than 1000 total Hogfish caught of average weight.

11.1.3.4 Assumed error in landings data

For the base models, the commercial landings were assumed to have a constant standard error (log-space) of 0.1, while the recreational landings were assumed to have a constant error equal to the median of the MRIP error estimates from 2004-2012. The median MRIP estimates were used for the recreational data in order to avoid possible misspecification of the order-of-magnitude of error by using the estimated year-specific errors from the MRFSS/MRIP calibration procedure. Specifically, error estimates for the MRFSS time series (1981-2003) were exceptionally higher after calibration when compared to the original MRFSS estimates (Figures 11.1.3.4.1-11.1.3.4.3). Generally, the MRFSS error estimates from the post-stratification procedure were markedly less than the MRIP error estimates for the same period (2004-2011), and the calibration procedure magnified the early error estimates considerably. As a result, the year-specific error estimates for the early period, both the original MRFSS and calibrated series, were deemed questionable for the base model runs due to this "uncertainty in the uncertainty". Use of year-specific error estimates were assessed in sensitivity analyses using both the original and calibrated MRFSS error estimates.

11.1.3.5 Indices of abundance

The WFL assessment model includes five fishing fleets, four of which had associated indices of abundance, and four fishery-independent indices of abundance (see Ch 8.5.1). For the fisheries dependent indices, no CPUE analysis was available for the trap fishery, which was phased out in the 1990s. The logbook program provided for a standardized CPUE index of abundance for the commercial spear fishery, but data were insufficient for the commercial hook and line fishery (K. McCarthy SEFSC, pers. comm.). Therefore, a commercial hook and line index was developed from the Florida Trip Ticket program. Recreational indices of abundance for spear and hook and line were developed from the MRFSS/MRIP intercept data. Survey indices of abundance were developed from the baitfish trawl, SEAMAP trawl, FWRI and Panama City video surveys, and the FWRI seagrass trawl for young of year. Length and age composition data were available for some of the years in each fleet and survey, although the age composition data were sparse.

The FLK/EFL assessment model includes five fishing fleets, four of which had associated indices of abundance as in the WFL model, and two fishery-independent indices of abundance (see Ch 8.5.2). For the fisheries dependent indices, no CPUE analysis was available for the trap fishery, which was phased out in the 1990s. The logbook program provided for a standardized CPUE index of abundance for the commercial spear and hook and line fisheries, although the index for the hook and line developed from the logbooks (steadily increasing) did not correspond to other indices of abundance for this stock (generally stable or decreasing). This logbook index also had issues with the analysis for determining the associated species (Stephens and MacCall approach), and had the highest error compared to other logbook indices. Therefore, an alternate index was used in the base model for the commercial hook and line developed from the Florida Trip Ticket program. Recreational indices of abundance for the spear and hook and line were developed from the MRFSS/MRIP intercept data. Survey indices of abundance were developed from the Reef Visual Census (RVC) surveys conducted by the Univ. of Miami and partnering organizations (NOAA, NPS, FWRI, others). The RVC-Keys survey was conducted yearly in the Florida Keys from Miami to Key West, while the RVC-Tortugas survey was conducted every third year, in most years, in the Dry Tortugas region. Length and age composition data were available for some of the years in each fleet, although the age composition data were sparse. Only length information was conducted by the RVC program as this is a visual survey.

The GA-NC assessment model includes four fishing fleets, one of which had an associated index of abundance, and no fishery-independent survey data (see Ch 8.5.3). A commercial hook and line index was developed from the logbook program, but logbook data were insufficient to develop a commercial spear index. While an alternative combined-gear index was developed from the South Carolina Trip Ticket program, this index was of a shorter time frame and of similar variability. Additionally, an exploratory analysis of the North Carolina Trip Ticket program was conducted, but was provided at a late date so not included in the analyses. Therefore, the logbook index was used as the primary index for this stock. Adequate length information was available from the commercial hook and line fishery on a yearly basis, but was sparse for the commercial spear and recreational fisheries. Limited age samples were only available in recent years.

11.1.3.6 Selectivity distributions

Length-based selectivity functions were specified for each fishery and survey in all three assessment models, with the exception of the juvenile seagrass trawl surveys in the WFL stock where an age-based selectivity function was used since this survey catches only young-of-year. For most of the length-based selectivity functions, the length selectivity applied to ages 1 to 20 yr (i.e., selectivity by length did not include young-of-year). For the RVC surveys, the full set of ages were included (0-20 yr) since the RVC infrequently surveys individuals in the smallest size bins (2-6 cm), representing young-of-year. For most fisheries and surveys, unique selectivity functions were used for each, but a few exceptions did occur. In the WFL stock, the SEAMAP survey was set to mirror the Baitfish survey, since the length composition data was similar and they sample using trawls in similar habitat by the same organization (FWRI). In the GA-NC stock, the commercial trap fishery did not have any available length information (1 sample for the entire time frame), so this fishery was set to mirror the commercial hook and line fishery for lack of a clear alternative.

All length-based selectivities were parameterized with the SS double normal function option, but were parameterized to be either asymptotic or dome-shaped depending on the fishery and stock.

When using an asympototic function, four of the parameters were fixed to simulate a logistic function (start value=0, end value=1, and peak width and descending limb width fixed at any value as they are not relevant). Due to issues with freely fitting all parameters in the double normal function for dome-shaped functions (6 parameters total), each selectivity function had some of the parameters fixed. In most cases, the start and end values were fixed to 0.0, representing no selectivity on the smallest and largest size bins (2 and 90 cm), respectively. Decisions to fix other parameters were based on length composition data, knowledge of the fishery, and/or multiple runs to determine how the parameter would typically be estimated. Although a number of the selectivity parameters were estimated with high asymptotic standard errors, the decision was made to leave the parameters freely estimated albeit with low precision, in order to fully explore alternative model fits during the uncertainty analysis. Tables 11.1.4.1-11.1.4.3 present the parameters estimated by the model, including each selectivity function for the different fisheries and surveys in each stock.

For the WFL stock, it is generally assumed that dome-shaped selectivity is prevalent due to the wide continental shelf and potentially extensive mesophytic habitat available to Hogfish, and their known offshore ontogenetic movement with age (Collins and McBride 2011). Inspection of the length composition data (Ch 5.5.5 and associated figures) suggests that commercial spear and hook and line fisheries catch as large of individuals as found in the life history studies, with the commercial hook and line having a similar length frequency as the life history studies. Combined with the fact that the commercial hook and line fishery targets species other than Hogfish across the shelf, the commercial hook and line was fixed to an asymptotic selectivity function, while the commercial spear end value for the length selectivity was freely estimated (1=asymptotic, <1= dome-shaped to differing degrees). All other fisheries were fixed to fully dome-shaped selectivity (end value=0.0). The fisheries independent surveys were also assumed to be dome-shaped given the size frequency distributions of the catch (baitfish and SEAMAP trawls, video surveys), which suggested sampling of smaller-sized individuals than the fisheries.

For the FLK/EFL stock, different selectivity functions were assigned as in the WFL stock, dependent on the knowledge of the fisheries and surveys and available length composition data. The commercial hook and line fishery, commercial trap fishery, and RVC-Tortugas survey were all considered asymptotic. Note that the commercial trap fishery in the FLK/EFL stock catches larger individuals than the commercial trap fishery in the WFL stock, which is likely due to different trap configurations used in the two regions (B. Mueller FWRI, pers. comm.). The commercial spear fishery selectivity was modeled with the end value freely estimated as in WFL stock, in order to provide for a continuum of asymptotic to dome-shaped behavior. The recreational fisheries and the RVC-Keys survey were all considered dome-shaped due to the length frequency data (Figure 5.5.5.25). Although the RVC-Keys and RVC-Tortugas employ the same methods, the two surveys were modeled differently due to the areas of sampling. While extensive mesophytic habitat does exist in the Tortugas region (Locker et al. 2010), it is unknown whether unsampled mesophytic areas are different in size structure from the adjacent Dry Tortugas regions that are sampled by the RVC-Tortugas survey. As a result, no evidence exists to support a dome-shaped relationship for the RVC-Tortugas surveys. Comparison of the size frequency distributions between the RVC-Keys and the commercial fisheries suggest that the commercial fisheries may target individuals of larger sizes/ages not sampled by the RVC-Keys surveys in the 0-30 m depth limit. Use of a spatial sub-stock model that separates the Dry

Tortugas from the Keys reef tract would be more appropriate for this stock given the strong differences in fishing pressures and existence of large marine protected areas, but the data were deemed insufficient at this stage to attempt this more complex model configuration (i.e., requiring knowledge of adult movement patterns and larval dispersal pathways).

For the GA-NC stock, each of the four fisheries were assigned an asymptotic selectivity, given the large sizes of Hogfish caught in this region and lack of evidence for a dome-shaped selectivity (Figure 5.5.5.26). Because size data for the commercial trap fishery were not available (only a few measurements over all years), this fishery was assigned to mirror the commercial hook and line fishery for lack of a clear alternative.

11.1.4 Parameters Estimated

A total of 79, 78, and 58 parameters were estimated for the base model runs in the WFL, FLK/EFL, and GA-NC stocks, respectively (Tables 11.1.4.1-11.1.4.3). Since the recommended SS ‘hybrid’ F mode was used, year-specific continuous F rates were not estimated, which greatly reduced the total number of parameters necessary. Use of the continuous F option tended to produce similar model estimates during preliminary model runs. The estimated parameters in both models consisted of four major groups: (1) stock-recruitment parameters (h, R_0, and R_1 offset); (2) recruitment deviations, including early years prior to the start of the model to initialize the age structure (1966-1985), early years with lower precision data (1986-1992), and the main deviation years with higher precision data (1993-2012); (3) initial Fs for 1986; and (4) size selectivity parameters. The base model for the FLK/EFL stock additionally estimated Q for the initial year of the RVC-Keys survey (1994) and again in 2000 to model a change in catchability reflecting updates to the RVC methodology and increases in precision. 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). See the Appendices code for each model for bounds that were assigned for each estimated parameter.

11.1.5 Model Convergence

Model convergence was assessed using a jitter analysis, where the initial values used for minimization were randomly adjusted with the intention of causing the search to traverse a broader region of the likelihood surface. Starting values of all estimated parameters were randomly perturbed by 10% and 50 trials were run. For the WFL model, 41trials converged to a solution within two total log-likelihood units. One of the trials did not converge, and two trials were nearly 200 likelihood units larger. For the FLK/EFL stock, 42 trials converged to a solution within two total log-likelihood units. All trials converged, and those greater than 2 log-likelihood units from majority of trials were within 50 total log-likelihood units. For the GA-NC stock, 48 trials converged to a solution within two log-likelihood units, and the remaining two trials were within ten log-likelihood units. Tables and Figures 11.1.5.1-11.1.5.3 depict the changes in select quantities (parameters, biological reference points, total log-likelihood), which were relatively similar across the runs that successfully converged. While this test cannot prove convergence of three assessment models, it did not provide strong evidence to the contrary for the three stocks.

11.1.6 Uncertainty and Measures of Precision

Uncertainty in parameter estimates and derived quantities resulting from uncertainty in data inputs was investigated using a parametric bootstrap approach. Bootstrapping is a technique used to estimate confidence intervals for model parameters or other quantities of interest. To conduct the bootstrap analysis, a built-in option within SS was used to create bootstrapped data-sets. This feature performs a parametric bootstrap using the error assumptions and sample sizes from the input data to generate new observations about the fitted model expectations. The model was refit to 500 bootstrapped data-sets and the distribution of the parameter estimates was used to represent the uncertainty in the parameters and derived quantities of interest.

Asymptotic standard errors were also 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 (Tables 11.1.4.1-11.1.4.3). Asymptotic standard errors are based upon the model's analytical estimate of the variance near the converged solution.

Finally, likelihood profiles were completed for each stock for the steepness of the stock-recruit relationship (*h*). Likelihood profiles are 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.

11.1.7 Sensitivity Analyses

Uncertainty in model assumptions was assessed through sensitivity analyses. These scenarios are intended to provide more information about sensitivity to key model parameters and potential conflict in signal among data sources.

11.1.7.1 Initial conditions

As a test to the influence of the start date of the model, two options were utilized: the start date was decreased to 1981 in order to utilize the entire recreational landings from the initial 5 years for each stock. A second set of sensitivity runs were conducted with the historical landings taken back to 1950 for only the Florida stocks, which relied on the initial ten years of recreational landings (1981-1991) to develop the historical time series. For both sets of runs the initial equilibrium catch data input was adjusted to reflect the changes. The initial F parameters were additional fixed for those fleets where the starting year landings were zero.

SR-WFL-1.1: 1981 model start year
SR-FLK-1.1: 1981 model start year
SR-GANC-1.1: 1981 model start year

SR-WFL-1.2: 1950 model start year
SR-FLK-1.2: 1950 model start year

11.1.7.2 Indices of Abundance

Due to the variability in the fisheries independent indices for the WFL stock, different combinations of the indices were included in the model by conducting a jackknife leave-one-out analysis of the surveys. This analysis was conducting by setting the likelihood weights (lambdas) to zero for each component of the removed index (suvey, length comps, and age comps if available). In addition to setting the lambdas to zero, the size selectivity parameters were fixed.

SR-WFL-2.1: baitfish survey, length comps, and age comps removed (lambdas=0)
SR-WFL-2.2: SEAMAP survey, length comps, and age comps removed (lambdas=0)
SR-WFL-2.3: Video survey and length comps removed (lambdas=0)
SR-WFL-2.4: Juvenile survey and length comps removed (lambdas=0)

11.1.7.3 Assumed error in recreational catch time series

For the base models, the recreational catches were assumed to have a constant error equal to the median of the MRIP error estimates from 2004-2012 (see Ch 11.1.3.4). This was done in order to avoid possible misspecification in the magnitude of error by using the year-specific error estimates from the MRFSS/MRIP calibration procedure (Figures 11.1.3.4.1-11.1.3.4.3). To address the influence of this choice on the base model estimates, year-specific error estimates were run for each of the stocks under two separate scenarios: (1) error estimates from the calibrated time series (1981-2012); and use of the original MRFSS error estimates for the time period they exists (1981-2011 for the FL stocks; 1981-2012 for the GA-NC stock). For scenario (2) with the FL stocks, the final year error (2012) was set equal to the median of the 2004-2011 period.

SR-WFL-3.1: Calibrated year-specific PSEs
SR- FLK -3.1: Calibrated year-specific PSEs
SR-GANC-3.1: Calibrated year-specific PSEs

SR-WFL-3.2: MRFSS year-specific PSEs
SR- FLK -3.2: MRFSS year-specific PSEs
SR-GANC-3.2: MRFSS year-specific PSEs

11.1.7.4 Steepness prior

A steepness prior with a mode of h=0.84 (beta distribution) from Shertzer and Conn (2013) was used in the base model as a general estimate of steepness for reef fish in the Gulf of Mexico. To test the influence of this assumption, use of the prior in each of the base models was removed.

SR-WFL-4.1: The steepness prior from Shertzer and Conn (2013) was removed
SR- FLK-4.1: The steepness prior from Shertzer and Conn (2013) was removed
SR- GANC-4.1: The steepness prior from Shertzer and Conn (2013) was removed

11.1.7.5 Selectivity

Given the strong assumptions made in the selectivity parameters for each stock where asymptotic selectivity was assumed for at least one fishery/survey in each stock, and the strong influence that these decisions will make on stock abundance and status, the restriction of a fixed asymptotic selectivity was removed for each fishery/survey where it was fixed in the base models. For this set of sensitivities, a dome-shaped function was not fixed *a priori* as the alternative, but the shape was determined by freely estimating the end value, peak width, and the descending slope parameters of the double-normal selectivity function.

SR-WFL-5.1: Asymptotic selectivity not fixed (i.e., dome-shape possible) for relevant fleets/surveys
SR- FLK-5.1: Asymptotic selectivity not fixed (i.e., dome-shape possible) for relevant fleets/surveys
SR- GANC-5.1: Asymptotic selectivity not fixed (i.e., dome-shape possible) for relevant fleets/surveys

11.1.7.6 Reproduction

Spawning stock biomass was modeled as the sum of both females and males in the base models due to the unknown importance of sperm limitation in Hogfish. As a result of this assumption, the male transition parameters had no bearing on the outcome of the model, and fecundity relationships for females were not utilized since the female and male units of measure had to be on the same scale (i.e., biomass at size to sum both sexes). Since Hogfish are batch spawners, the potential exists for size- or age-based spawning frequency to alter the relationships between reproductive potential and spawning biomass (Cooper et al. 2012, Porch et al. 2013). In addition, Collins and McBride (2011) found that the male transition period can vary between inshore and offshore areas, presumably as a response to fishing pressures as males are removed from a harem.

To address the sensitivity of the three stocks to different assumptions on reproductive potential, alternate fecundity relationships and male transition parameterizations were used. For each stock, males were removed from the calculation of reproductive potential, and female fecundity was modeled using two alternative approaches: (1) a function of biomass as in the base model;

and (2) age-specific fecundity accounting for spawning frequency with age (Ch 5.6.4 and Figure 5.6.4.3; as in Porch et al. 2013 for SEDAR 31). In addition, three alternative male transition parameterizations were modeled with the female biomass option above: (1) average transition as in the base model; (2) nearshore transition from Collins and McBride (2011), which may be more appropriate for higher F scenarios; and (3) offshore transition from Collins and McBride (2011), which may be more appropriate for low F scenarios. Conditioning the transition parameters on F through estimation of a linkage parameter would be most appropriate, but such an option does not currently exist in Stock Synthesis (R. Methot, pers. comm.).

SR-WFL-6.1: Female SSB with average male transition parameters
SR- FLK-6.1: Female SSB with average male transition parameters
SR- GANC-6.1: Female SSB with average male transition parameters

SR-WFL-6.2: Female age-specific fecundity with average male transition parameters
SR- FLK-6.2: Female age-specific fecundity with average male transition parameters
SR- GANC-6.2: Female age-specific fecundity with average male transition parameters

SR-WFL-6.3: Female SSB with nearshore (higher F) male transition parameters
SR- FLK-6.3: Female SSB with nearshore (higher F) male transition parameters
SR- GANC-6.3: Female SSB with nearshore (higher F) male transition parameters

SR-WFL-6.4: Female SSB with offshore (lower F) male transition parameters
SR- FLK-6.4: Female SSB with offshore (lower F) male transition parameters
SR- GANC-6.4: Female SSB with offshore (lower F) male transition parameters

11.1.7.7 Age and Growth Data

Since the von Bertalanffy growth function was fixed using data from the life history studies for each of the base models, data inconsistencies were detected between the age and length observations when running the likelihood profiles (see Ch 11.2.4; Figures 11.2.4.4, 11.2.4.8, and 11.2.4.12). As a result, alternate approaches were used to both input the age data and represent growth in this set of sensitivities. These included (1) representing the data not as conditional age-at-length, but as age inputs across the entire length spectrum (i.e., the lbin_lo and lbin_hi inputs were set to -1); (2) removing the age data from the model analyses (i.e., assigning lambdas=0.0 for all phases); and (3) estimating the growth parameters in place of fixing them in the base model run.

SR-WFL-7.1: Age data input across all length bins (i.e., not conditional age-at-length)
SR- FLK-7.1: Age data input across all length bins (i.e., not conditional age-at-length)
SR- GANC-7.1: Age data input across all length bins (i.e., not conditional age-at-length)

SR-WFL-7.2: Age data removed (lambda=0.0 across all phases)
SR- FLK-7.2: Age data removed (lambda=0.0 across all phases)
SR- GANC-7.2: Age data removed (lambda=0.0 across all phases)

SR-WFL-7.3: Estimate growth parameters with the model
SR- FLK-7.3: Estimate growth parameters with the model
SR- GANC-7.3: Estimate growth parameters with the model

11.1.7.8 Life History

A few alternative life history parameterizations were used to address model assumptions for natural mortality, maturity, and growth. First, two alternative maximum assumed ages (20 and 30, versus 25 in the base model) were used to derive the mortality at age vector. Second, for the Florida stocks, the alternative maturity schedules presented in McBride et al. (2008) for each stock were used in place of the one derived using an extended dataset for the WFL shelf from both of the life history studies conducted (early studies from 1995-2001 and more recent studies from 2005-2007). Finally, for the Florida stocks, the growth functions derived in McBride and Richardson (2007) for each stock were used in place of the one derived using the extended life history dataset for the WFL stock.

SR-WFL-8.1: Maximum age of 20 used for age-specific M calculations
SR- FLK-8.1: Maximum age of 20 used for age-specific M calculations
SR- GANC-8.1: Maximum age of 20 used for age-specific M calculations

SR-WFL-8.2: Maximum age of 30 used for age-specific M calculations
SR- FLK-8.2: Maximum age of 30 used for age-specific M calculations
SR- GANC-8.2: Maximum age of 30 used for age-specific M calculations

SR-WFL-8.3: Stock-specific maturity schedule from McBride et al. 2008
SR- FLK-8.3: Stock-specific maturity schedule from McBride et al. 2008

SR-WFL-8.4: Stock-specific growth function from McBride and Richardson (2007)
SR- FLK-8.4: Stock-specific growth function from McBride and Richardson (2007)

11.1.8 Retrospective Analysis

Retrospective analysis was conducted to assess the consistency of stock assessment results by sequentially eliminating the last four years of data from the terminal year while using the same model configuration. The results of this analysis were useful in assessing potential biases, data inconsistencies, and uncertainty in terminal year estimates.

11.1.9 Benchmark/Reference Point Methods

Various stock status benchmarks and reference points are calculated in SS. The user can select reference points based on maximum sustainable yield (MSY), equilibrium spawning biomass per recruit (SPR), and spawning stock biomass (SSB). Stock Synthesis calculates SPR as the ratio of the equilibrium reproductive output per recruit that would occur with the current year's F intensities and biology, to the equilibrium reproductive output per recruit that would occur with the current year's biology and no fishing. For SPR-based reference points, SS searches for an F that will produce the specified level of spawning biomass per recruit relative to the unfished value. For spawning biomass-based reference points, SS searches for an F that produces the specified level of spawning biomass relative to the unfished value. Both MSY and spawning biomass-based reference points are dependent on the stock-recruit relationship. YPR and SPR fishing mortality reference points can be calculated independent of the stock-recruit relationship. However, biomass reference points based on YPR and SPR concepts do require knowledge of the stock-recruit relationship.

As no preferred reference point is currently set for Hogfish and an assessment workshop was not conducted in order to provide guidance on an appropriate metric, this assessment presents both SPR and MSY-based reference points. For all analyses, stock status was ascertained relative to maximum fishing mortality thresholds (MFMT, included: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) and their corresponding minimum stock size thresholds (MSST), calculated as $(1\text{-}M)*SSB_{REFERENCE}$ ($SSB_{REFERENCE}$ included: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). Here, M=0.179 y^{-1} for the base model configuration.

11.1.10 Projection Methods

Projections were run to evaluate stock status and associated yields for a range of fishing mortality rate scenarios. Projections were run from 2013 to 2032 for the base model using the following configurations for each of the three stocks:

- F_0: no fishing scenario
- $F_{Current}$: fishing mortality rates for all fleets were set to the geometric mean of the last three years (2010-2012)
- $F_{30\%}$: the fishing mortality rate that results in an equilibrium SPR of 30%
- $F_{35\%}$: the fishing mortality rate that results in an equilibrium SPR of 35%
- $F_{40\%}$: the fishing mortality rate that results in an equilibrium SPR of 40%
- F_{MSY}: the fishing mortality rate at MSY (note: this corresponds to fixing SPR_{MSY} in SS)

Determination of the $F_{rebuild}$ to rebuild the FLK/EFL stock within ten years, along with probability density functions of forecasted yields for the projection years (via bootstrapping of the projections above) will be provided directly to the SSC.

11.2 Model Results

11.2.1 Measures of overall model fit

11.2.1.1 Landings

Error in the landings data were assumed constant at a standard error of 0.1 (log-space) for the commercial landings, leading to precise fits to the commercial catch data. In contrast, the recreational landings error was assumed constant at a standard error equal to the MRIP PSE values from 2004-2012, which ranged from 0.4-0.46 for the Florida stock fisheries, and 0.77 for the GA-NC stock hook and line fishery. Due to these moderate to high error values, the fit to recreational landings were not as precise as in the commercial fisheries for the three stocks (Figures 11.2.1.1.1-11.2.1.1.3).

11.2.1.2 Indices of abundance

For the WFL stock, the model was fit to four fisheries-dependent indices (commercial spear from logbooks, commercial hook and line from Florida trip tickets, recreational spear, and recreational hook and line) and four fisheries-independent indices (baitfish trawl, SEAMAP trawl, video survey, and age-0 seagrass trawl). The observed and predicted indices are presented in Figures 11.2.1.2.1-11.2.1.2.8. The fits to the fisheries-dependent indices were similar, since the four fisheries tended to have similar trends in the observed CPUEs over time. The commercial indices had a stronger peak in observed abundance during 2000-2003, which was not evident in the recreational indices. As a result the predicted model was lower and higher for the commercial and recreational indices, respectively, during this period. Also during the last year, the hook and line fisheries (commercial and recreational) had an observed decline in 2012 while the spear fisheries had an observed increase, leading to differences between the predicted and observed fits. The predicted decline in 2011 and 2012 for the fisheries was primarily due to harvest of the strong (predicted) 2006 year class that led to the predicted increases in abundance through 2010. The predicted recruiting class was evident in the baitfish trawls, where an increase in abundance was measured between 2007-2009 (Figure 11.2.1.2.5), and similarly with the video survey in 2008 and 2009 (Figure 11.2.1.2.7). All of the fisheries independent surveys sampling smaller individuals (baitfish, SEAMAP, and age-0 seagrass surveys) had an observed increase in abundance during the terminal year that the model predicted as a result of the increase in the age-0 recruits from the seagrass trawls (Figure 11.2.1.2.8). The model fit the age-0 seagrass trawl data relatively well as the only index of recruits used.

For the FLK/EFL stock, the model was fit to four fisheries-dependent indices (commercial spear from logbooks, commercial hook and line from Florida trip tickets, recreational spear, and recreational hook and line) and two fisheries-independent indices (RVC-Keys and RVC-Tortugas). The observed and predicted indices are presented in Figures 11.2.1.2.9-11.2.1.2.15. The model performed relatively well at predicting the observed declines in abundance during the early to mid-1990's in the fisheries-dependent indices (Figures 11.2.1.2.9-11.2.1.2.11), but had variable fits to all indices after 2000, where some indices had downward trends (i.e. recreational fisheries) while the RVC surveys and commercial indices were relatively flat but variable from

2000-2012, without any clearly consistent patterns. The rapid increase in abundances from 1994-1998 to year 2000 as suggested by the RVC-Keys survey was modeled as a change in catchability (Figure 11.2.1.2.14), due to adjustments to the methodology with new benthic habitat maps that improved the precision of the surveys (Smith et al. 2013).

For the GA-NC stock, only one fisheries-dependent index was used (commercial hook and line from logbooks). The model fit to this index was poor, where the predicted was nearly reverse in trends compared to the observed data (Figure 11.2.1.2.16), suggesting an inconsistency in the logbook data compared to other data inputs (i.e., landings, length samples).

11.2.1.3 Length composition

For the WFL stock, the model was fit to length observations from all five fisheries-dependent indices (commercial spear, commercial hook and line, commercial traps, recreational spear, and recreational hook and line) and all four fisheries-independent indices (baitfish trawl, SEAMAP trawl, video survey, and age-0 seagrass trawl). The observed and predicted length composition data for each data source and year are presented in Figures 11.2.1.3.1-11.2.1.2.18, while Figures 11.2.1.3.19-11.2.1.3.20 present the observed and predicted data for all data sources averaged across all years. Given the sparsity and small sample sizes of observations on a yearly basis, the year-specific predictions relative to the observed data were often variable and poor. However, the model performed well at predicting the average length compositions when averaged across all years for each of the data sources (Figure 11.2.1.3.19), without any large residual patterns evident (11.2.1.3.20). The only exception with large residuals was with the smallest size classes predicted for the age-0 seagrass trawl (‘RecTrawlIOA’), where the model underestimated the fit for the smallest size (large positive residuals).

For the FLK/EFL stock, the model was fit to length observations from all five fisheries-dependent indices (commercial spear, commercial hook and line, commercial traps, recreational spear, and recreational hook and line) and the two fisheries-independent indices (RVC-Keys and RVC-Tortugas). The observed and predicted length composition data for each data source and year are presented in Figures 11.2.1.3.21-11.2.1.2.34, while Figures 11.2.1.3.35-11.2.1.3.36 present the observed and predicted data for all data sources averaged across all years. For the RVC surveys, the selectivity applied to all age classes including age-0, so a dual peak was evident in the model predictions, where the first peak signified the length composition of the age-0 year class (i.e., see numbers at length for the population for the length range of the age-0 class at the middle of the year; Figure 11.2.5.11). Given the sparsity and small sample sizes of observations from the fisheries on a yearly basis, the year-specific predictions relative to the observed data were often variable and poor. Year-specific predictions for the RVC data were more similar to the observations. Importantly the RVC data are from visual census by divers, and the lengths are estimated. The strong peaks in the observed data often correspond to the 5cm intervals, suggesting that divers will often estimate a fish length to the nearest 5cm bin versus 1cm bin. Despite this data imprecision, the model fit the year data relatively well for the RVC surveys. The model performed well at predicting the average length compositions when averaged across all years for each of the data sources (Figure 11.2.1.3.35), without any large residual patterns in general (11.2.1.3.36). Some large positive residuals were evident for the smallest size classes of the RVC surveys, as a result of the age-0 length compositions.

For the GA-NC stock, the model was fit to length observations from three of the four fisheries (commercial spear, commercial hook and line, and recreational hook and line). The observed and predicted length composition data for each data source and year are presented in Figures 11.2.1.3.37-11.2.1.2.42, while Figures 11.2.1.3.43-11.2.1.3.44 present the observed and predicted data for all data sources averaged across all years. Data were sparse for all but the commercial hook and line fishery, which was relatively well sampled across the entire time frame (Figures 11.2.1.3.39-11.2.1.3.40). Averaged cross all years, the model fit the data relatively well (Figure 11.2.1.3.43), although the observed data were more platykurtic than the model predicted.

11.2.1.4 Conditional Age-at-length

Age observations were included in the model as conditional age-at-length in order to avoid double-counting the observations, since all age observations had corresponding length measurements used in the length composition data. Model fits to the age-at-length data for the three stocks are presented in Figures 11.2.1.4.1-11.2.1.4.12. Given the sparsity of age observations, the model fits were highly variable. While conditional age-at-length is often used to improve estimates of the growth function, the growth function was fixed in this analysis due to the large number of age samples from the life history analysis relative to the fisheries and surveys. Estimates

11.2.2 Parameter estimates and associated measures of uncertainty

A list of all model parameters for each of the three stocks are provided in Tables 11.1.4.1-11.1.4.3. The tables include estimated parameter values and their associated asymptotic standard errors, initial parameter values, prior values, and whether the parameter was fixed or estimated.

The standard errors are low to moderate for the majority of parameters in each stock with a few exceptions. The initial age structure and early recruit deviations approached a standard error of 0.6, while the main recruitment deviations were generally between 0.1-0.3 for the WFL and GA-NC stocks, and 0.05-0.2 for the FLK/EFL stock. These analyses suggest that the data are not as informative for determining the stock recruitment relationship in the WFL and GA-NC stocks as in the FLK/EFL stock. This result is also supported by the likelihood profile of the steepness estimate (see Ch 11.2.4). For the majority of the selectivity parameterizations for the different fisheries and surveys, the 2nd parameter, which controls the peak width, was poorly estimated with high standard errors. This was mainly a result of most fisheries and surveys having a small peak width, allowing for a range of potential low values that would effectively produce the same peak width given the other parameters. Choosing to fix this parameter for most fisheries and surveys would have been suitable, but the choice was made to leave this freely estimated to explore more possible model fits in the bootstrap uncertainty analyses.

11.2.3 Fishery selectivity

The estimated selectivity patterns for the various fisheries and surveys of each stock are presented in Tables 11.1.4.1-11.1.4.3 and Figures 11.2.3.1-11.2.3.7, including the length-based selectivity functions, the age-based-selectivity function for the age-0 survey in the WFL stock (Figure 11.2.3.2), and the derived age-based selectivity functions (i.e., derived from the length-based selectivity functions used in the model). All length-based selectivity functions were modeled with the double-normal approach, where the asymptotic selectivity functions had a number of parameters fixed in order to simulate a logistic function.

For the WFL stock, all selectivity functions were modeled using length, except the age-0 seagrass trawl survey which used an age-based function for only age-0 individuals. All recreational fisheries and surveys were modeled using a dome-shaped function, while the commercial hook and line was modeled as asymptotic, and the commercial spear was given the option to choose asymptotic or dome-shaped. For the commercial spear, a selectivity function was chosen where individuals around 40cm in length were under full selectivity, and decreased sharply for all larger sizes that remained at approximately 20% selectivity. A similar parameter fit was additionally chosen for the FLK/EFL stock commercial spear fishery, and suggests directed targeting of the largest individuals, albeit to a lesser degree, across the entire stock. This pattern could emerge for commercial fishermen actively seeking the largest individuals during trips to locations furthest from port, which are not always targeted due to travel times and costs.

For the FLK/EFL stock, all selectivity functions were modeled using length, where the ages at which the length-based selectivity applied were age-1 to max age, except for the RVC surveys that sampled age-0 individuals also. Asymptotic selectivity was applied to the RVC Tortugas survey, where larger Hogfish are known to reside, and additionally to the commercial hook and line and trap fisheries that tend to catch the largest sized Hogfish. Similar to the WFL stock, the shape of the function was freely estimated for the commercial spear fishery, leading to a similar pattern where selectivity remained constant at about 0.5 for individuals from 40 cm to the maximum size. This suggests similar directed harvesting of the largest fish, presumably in spatial locations not often frequented by the recreational fisheries and outside the domain of the RVC-Keys survey (i.e., >30 m depth, where the RVC-Keys is restricted to 0-30 m depth). Given the length frequency distributions, the recreational fisheries and the RVC-Keys survey were modeled as dome-shaped functions, since they did not sample the largest individuals that were caught by the commercial fisheries or detected by the RVC-Tortugas surveys.

For the GA-NC stock, all selectivity functions were modeled with length-based functions using an asymptotic selectivity. This choice was made given the similarly large sizes of Hogfish caught by the commercial and recreational fisheries in this region. Similar functions were fit for each of the fisheries, suggesting they all sample a similar portion of the Hogfish stock.

11.2.4 Recruitment

For the WFL stock, the recruitment deviations had moderate asymptotic error estimates, likely resulting from the relatively stable SSB levels predicted throughout the model period (i.e., SSB ranging from 900-1300 MT; Figure 11.2.4.1). This lack of contrast in stock-recruit data additionally led to a relatively flat likelihood profile for steepness in this stock (Figure 11.2.4.4), and the sensitivity run where the steepness prior was removed (SR-WFL-4.1) led steepness to be estimated near the upper bounds of h=.9999. One of the strong features modeled with recruitment, which was consistently modeled through many alternative exploratory model configurations, was the exceptional recruitment year in 2006, leading to a strong year class in the population from 2006-2010. The various data sources tended to support this strong recruitment year (indices and length compositions), leading to consistency in the model fits. However, this strong recruitment class was one of the major factors leading the retrospective patterns as the end year of the model was decreased, causing a decrease in the strong year class and alternative model fits (see Ch 11.2.7.3). The numbers of recruits are presented in Table 11.2.4.1.

For the FLK/EFL stock, recruitment deviations were estimated with higher precision than the other stocks, leading to a more precise steepness estimate in the base model and a more well-defined likelihood profile for steepness (Figure 11.2.4.8). Use of the prior had little influence on the model results (sensitivity run SR- FLK-4.1). These results suggest that the stock-recruit relationship was relatively well-defined for Hogfish in the FLK/EFL stock. The numbers of recruits are presented in Table 11.2.4.2.

For the GA-NC stock, the recruitment deviations had moderate asymptotic errors, without a well-defined stock recruitment relationship. The pattern of recruits relative to the SSB was more similar to a Ricker function, with the largest SSB values (near 80 MT) corresponding to the smallest recruitment levels. As such, fitting a Beverton-Holt function through the cluster of points led to a high estimate of steepness when including the prior (h=0.91), which was not well defined from the likelihood profile (Figure 11.2.4.12), nor from the sensitivity run where the steepness prior was removed and steepness was estimated at the upper bounds (SR-GANC-4.1). Substantial patterns to the recruit residuals were evident from the base model fit where recruit deviations from 2003-2010 were below average, while those from 1993-2002 were above average. The numbers of recruits are presented in Table 11.2.4.3.

The likelihood profiles for steepness for the WFL and GA-NC stock generally demonstrate wide minima in the total likelihood with respect to steepness, while the FLK/EFL stock had a more defined minima. For both the GA-NC and WFL stocks, the prior estimate had a strong influence on the final steepness estimate, where the change in total log-likelihood units mirrored the change in the prior log-likelihood units, particularly at the upper range of the steepness values (i.e., .85-.99).

Alternative model fits in the likelihood surface, leading to strong ‘spikes’ in the change in log-likelihoods for the FLK/EFL and the WFL stocks (Figures 11.2.4.4 and 11.2.4.8), were a result of the model choosing alternative minima in the likelihood surface when different steepness values were fixed. This is particularly evidence for the FLK/EFL stock, where a steepness value of 0.82, which is close to the minima in the change in log-likelihoods, led to a particularly large change in the model fit. Inspection of the model fit for this value showed that the estimated size-selectivity parameters for the recreational fisheries, both spear and hook and line, were markedly different from surrounding values and from the base model fit. This suggests that poor contrast in the data led the model to choose alternative local minima of the likelihood surface during model estimation for this and other steepness values. However, this only happened for a small proportion of the likelihood profile, and the underlying minima were still evident for the stocks. Choosing to fix poorly-estimated selectivity values would potentially solve this problem and lead to a smoother likelihood profile; however, the choice was made to leave selectivity parameters freely estimated in order to explore a wider range of alternative model fits during the bootstrap uncertainty procedure, particularly since length and age data were sparse and the selectivity estimates have a strong influence on stock status.

Each of the models showed inconsistencies in the data inputs, particularly the age data which was inversely related to the length data, where the length data was the largest component of the total likelihood. This was likely due to the fact that the growth function was fixed, and the model had to reconcile fits to both the length and age observations when the relationship between the two was set *a priori*. To explore this inconsistency in more detail, multiple sensitivity runs were conducted where the age data input was modeled differently and the growth function was estimated (see Ch 11.2.7.2.7).

11.2.5 Stock biomass

For the WFL stock, the asymptotic errors for the time series of biomasses were relatively high, as can be seen in the 95% asymptotic intervals for SSB (Figure 11.2.5.2). Generally the model predicts the WFL stock remaining relatively constant from 1986-2005, with a more pronounced rise in abundance from 2006-2012 that corresponds to the indices of abundance, particularly the fisheries CPUEs. This rise in abundance was predicted as result of the large recruit class in 2006, as can be seen in the numbers of females at age (Figure 11.2.5.3). An additional large recruit class was predicted in 2012 as a result of the spike in recruitment recorded in 2012 with the age-0 survey for this stock. The SSB time series is presented in Table 11.2.4.1.

For the FLK/EFL stock, the biomass time series was relatively flat over the time period, with a slight downward trend from the mid-1980’s through to 2000. The biomass was low relative to the virgin abundance (Figure 11.2.5.7), with relatively high precision in the asymptotic errors (Figure 11.2.5.8). The recruiting classes were relatively constant throughout the time period of the model with the largest recruiting classes predicted in the beginning of the time series (Figure 11.2.5.9). The SSB time series is presented in Table 11.2.4.2.

For the GA-NC stock, two increases in biomasses were predicted, with the first beginning in the late 1980’s through 1995, and the second beginning in the early 2000’s through 2006. The large increase in abundance in the early period was likely driven by the exceptionally large recreational catch recorded in 1995, causing the model to compensate with a large recruit class in 1990 to provide the biomass for this observed catch. Given the low precision of the recreational data for this stock, it is unlikely that the fishery would experience such drastic year-to-year changes in landings, but the data were used as observed to represent the best available information on this stock. The second peak in biomass in 2010 was likely due to the low landings in the early 2000’s and subsequent increases in landings through 2010. This catch history led the model to estimate a large recruit class in 2002 to provide the biomass for the landings. An inconsistent pattern emerged with stock biomass over time relative to the index of abundance, leading to a negative relationship between the predicted and observed index estimates (Figure 11.2.1.2.16), suggesting strong conflicts in the landings and effort information. The SSB time series is presented in Table 11.2.4.3.

11.2.6 Fishing mortality

Fishing mortality rates were summarized using annual exploitation rates of biomass, represented as the total annual catch divided by the summary biomass at the start of the year. Here, summary biomass refers to the total biomass of ages 1-20, with 20 being the plus group. Exploitation rates were chosen to represent F due to difficulties in interpreting the sum of instantaneous F's from each fleet, especially under the selectivity functions modeled for the different fleets.

For the WFL stock, the exploitation rates averaged 0.05 across years, with a maximum in 1991 of 0.12 corresponding to the largest landings observed in 1991 (Table 11.2.4.1; Figure 11.2.6.1). The recreational spear fishery accounted for the majority of fishing pressure in all years, while recreational hook and line fishing rates were similar in magnitude to the commercial spear (Figure 11.2.6.2). The trap fishery represented only a small portion of the exploitation in the early 1990's prior to phasing out of the trap fishery, and the commercial hook and line fishery had limited fishing effort on Hogfish throughout the time period. Exploitation rates have been trending upwards in recent years since 2005, which is attributable to increases in harvest in both the commercial spear and recreational hook and line fisheries.

For the FLK/EFL stock, the exploitation rates averaged 0.33 across years, with a maximum in 1987 of 0.59 corresponding to the largest landings observed in 1987 (Table 11.2.4.2; Figure 11.2.6.3). The recreational spear fishery accounted for the majority of fishing pressure in nearly all of the years, although a few years in the late 1980's and early 1990's had larger predicted fishing pressure from the recreational hook and line fishery (Figure 11.2.6.4). The recreational hook and line fishery had a strong predicted drop in fishing pressure from the mid-1990's to 2000, corresponding to a drop in the observed landings. This drop coincided with implementation of the sanctuary preservation areas (SPAs) in the Florida Keys National Marine Scantuary (FKNMS) in 1997, which may have influenced the recreational hook and line fishing pressure due to protection of the most pristine and rugose reef habitat along the reef tract. A similar drop in spear fishing pressure was not detected during this time, suggesting that the spear fishery, which is not allowed in all areas of the FKNMS, was not impacted by the implementation of the SPAs as with the hook and line fishery. Similar to the WFL stock, the trap fishery represented only a small portion of the exploitation in the early 1990's prior to phasing out of the trap fishery, with limited fishing effort from the commercial hook and line fishery throughout the time period. Exploitation rates have been variable over the later part of the time series (2005-2012), without any clear trends overall or among fisheries. However, the recreational spear fishery has experienced two of the three largest peaks in fishing effort during the terminal five years of the model.

For the GA-NC stock, the exploitation rates averaged 0.24 across years, with a maximum in 1995 of 0.85 corresponding to the largest landings observed in 1995 (Table 11.2.4.3; Figure 11.2.6.5). The large spikes in the fishing effort were due to the large observed recreational landings in both 1986 and 1995, where the model predicted larger than expected landings on top of the already large observed landings (Figure 11.2.1.1.3). Such year-to-year variability in the recreational landings are unlikely in nature, and these estimated landings were likely biased due to the low precision of the recreational landings. In an exploratory model run, the recreational landings were filtered by removing these outlying years and interpolating in between, but the terminal year estimates remained similar, suggesting that the model results were not sensitive to these low precision estimates early in the time series. In effect they led to large recruit years early in the time series that did not persist into the later years. The commercial hook and line fishery had the most consistently large fishing effort for the majority of the time series, but decreased substantially from the mid 1990's to present. In more recent years, as the fishery has shifted from landings in North Carolina to South Carolina (Table 6.2.2.2), the composition of the landings has shifted from primarily the commercial hook and line to the commercial spear fishery. Similar to the other stocks, the commercial trap landings has declined from peaks in the early 1990's. While the primary fisheries have shifted in more recent years, the exploitation rates have been of similar magnitude to the early to mid-1990's, and have declined from a peak in 2010 through 2012.

11.2.7 Evaluation of uncertainty

11.2.7.1Parameter uncertainty

Tables 11.2.7.1.1-11.2.7.1.3 provide summary statistics (mean, SD, median, 95% confidence intervals, interquantile ranges) for key quantities (parameters, BRPs) from both the bootstrap runs and the base model run. The base model results are also provided in each table for comparison to the bootstrap results. Figures 11.2.7.1.1-11.2.7.1.15 present the probability distributions of key parameters, BRPs, and stock status (both single estimates and time-varying estimates). For the tables and figures, F/MFMT was calculated with F being the geometric mean of the terminal three years (2010-2012), while SSB/MMST was calculated as the terminal year SSB (2012) relative to the mortality-adjusted estimate of SSB (MSST=(1-M)*SSB_{TARGET}). MSY and SPR targets of 30%, 35%, and 40% were run separately to provide estimates of uncertainty in stock status at each target. In general, the asymptotic errors (Tables 11.1.4.1-11.1.4.3) tended to produce similar estimates to the bootstrap, as can be inferred from comparing to the bootstrap parameter estimates (Tables 11.2.7.1.1-11.2.7.1.3). However, given the highly skewed distributions for some quantities on restricted ranges (e.g., SPR, steepness), the percentile distributions from the bootstrap analysis provide a more informative metric of the error distribution. In general, the estimates from the WFL stock were the most variable, with the FLK/EFL estimates being the least variable of the three stocks.

11.2.7.2Sensitivity Analyses

Figures 11.2.7.2.1.1-11.2.7.2.8.3 present the results of the sensitivity runs for select time series (F, SSB, Depletion, SPR) and stock status (F/MFMT, SSB/MSST) for both MSY and an SPR target of 30%. Alternative SPR targets were not provided as part of the sensitivity analyses due to SS only providing for a single SPR target per run. Tables 11.2.7.2.1-11.2.7.2.3 provide key parameter estimates for each of the sensitivity runs, showing how the runs affected particular aspects of the model fits. Each sensitivity category of analysis is presented in detail below.

11.2.7.2.1 Initial conditions

For this sensitivity analysis, the start date of the model was adjusted to 1981 for all three stocks, and 1950 for the Florida stocks. However, the start of 1950 for the FLK/EFL stock did not converge so is not included in this discussion. Figures 11.2.7.2.1.1-11.2.7.2.1.3 provide a visual of how the various start dates affected each of the stocks. In general, the start date had a strong influence on the initial SSB, initial recruitment, and steepness estimate, but little influence on the size selectivity parameters (Tables 11.2.7.2.1-11.2.7.2.3). Changing the start date did not change the terminal year estimates of stock status for any of the three stocks, although the BRP ratios (F/MFMT, SSB/MSST) were impacted substantially for different ratios.

11.2.7.2.2 Indices of Abundance

For this sensitivity analysis, alternative indices of abundance were removed from the WFL base model to see if any had a strong influence on the model fits. Figure 11.2.7.2.2.1 provides a visual of how the indices affected the WFL stock fit. Eliminating each of the indices tended to have a minimal influence on the various parameters presented (Tables 11.2.7.2.1-11.2.7.2.3), and inspection of the Figure showed that while some of the time series estimates were influenced by the indices, none tended to have an overriding effect. Given the similarity of the baitfish an SEAMAP surveys, elimination of each of these data sets led to similar model predictions. Predictions of stock status did not change due to the indices, where the indices tended to impact estimates of biomass but not F.

11.2.7.2.3 Assumed error in recreational catch time series

For this sensitivity analysis, year-specific estimates of recreational error were input into the model to determine the influence of using a constant rate from recent years (2004-2012) for all years. Figures 11.2.7.2.3.1-11.2.7.2.3.3 provide a visual of how the year-specific PSE estimates affected each of the stock models. Including year-specific error estimates had relatively minor impacts on the key model parameters, although use of the MRFSS error estimates, which were lower (Figures 11.1.3.4.1-11.1.3.4.3) led to lower steepness estimates in each stock, particularly the Florida stocks (0.04 less). In each of the stocks, a few select years were modeled as having exceptionally high Fs relative to surrounding years (strong peaks in F) which also influenced the SSB time series and subsequent SSB/MSST estimates. Use of year-specific estimates were least pronounced for the FLK/EFL stock, which experienced the smallest peaks in F relative to the base model. The GA-NC model, which had the highest error estimates in more recent years, had a substantially altered biomass time series during the period from 1995-2002 as a result of strong F pulses in 1995 and 1999. For each of the stocks, the status of the stock relative to overfishing and overfished remained unchanged, although the terminal year ratios for SSB/MSST were substantially impacted in the WFL stock.

11.2.7.2.4 Steepness prior

For this sensitivity analysis, the steepness prior from Shertzer and Conn (2002), which is based on reef fish in the Southeastern US, was removed from the base model runs. Figures 11.2.7.2.4.1-11.2.7.2.4.3 provide a visual of how the steepness prior estimates affected each of the stock models. For both the WFL and the GA-NC stocks, removal of the steepness prior led to an inability to estimate steepness, where steepness was estimated near the upper bounds of 1.0, resulting in a change to the MSY estimate. As a result, only the MSY-based ratios (F/F_{MSY}, $SSB/MSST_{MSY}$) were impacted for these stocks (note: the time series for the $SSB/MSST_{MSY}$ is not included in Figure 11.2.7.2.4.1 for the WFL stock due to an extremely high ratio estimate). For the FLK/EFL stock, there was enough contrast in the data to freely estimate steepness, which was the same estimates as when including the steepness prior (h=0.83). As a result, this sensitivity had no perceivable impact on the FLK/EFL stock.

11.2.7.2.5 Selectivity

For this sensitivity analysis, those fisheries or surveys that had a fixed asymptotic size selectivity were provided the option to fit the shape of the selectivity as a continuum from dome-shaped to asymptotic. Figures 11.2.7.2.5.1-11.2.7.2.5.3 provide a visual of how the removed asymptotic restriction affected each of the stock models. In all cases, removal of the asymptotic restriction led to estimation of a fully dome-shaped function, leading to estimation of an unknown cryptic biomass in each of the stocks since no asympototic relationships were included as a result. The effect was substantial in each of the stocks, leading to higher estimates of population biomass and subsequently lower estimates of F. The effect was pronounced in the FLK/EFL stock, where the status of the stock changed from a highly overfished state to a non-overfished state when assuming all were dome-shaped selectivity. Given that evidence for dome-shaped selectivity for all fleets/surveys in each of the stocks does not exist, these sensitivities are presented for reference only to highly the importance of obtaining accurate estimates of the selectivity functions.

11.2.7.2.6 Reproduction

For this sensitivity analysis, alternative approaches to modeling reproductive potential were conducted, including using female SSB, female fecundity at age accounting for changes in spawning frequencies with age, and female SSB at different male transition probabilities. Figures 11.2.7.2.6.1-11.2.7.2.6.2 provide a visual of how the alternative reproductive potential approaches affected each of the stock models. Note, none of the alternative reproductive metrics in the GA-NC stock models successfully converged, although parameters estimates were still calculated for some parameters; this is most likely due to the available information from this stock being all fisheries-dependent, and the fishery mainly catches large males that have transitioned from females. As would be expected for the Florida stocks, removal of the male SSB from the reproductive potential had a strong impact on the model estimates of SSB and subsequent reference points and stock status, particularly with respect to the SPR targets that use

SSB as the primary metric. Use of female SSB led to markedly smaller steepness estimates in the FLK/EFL stock compared to the base model, but similar estimates in the WFL stock.

11.2.7.2.7 Age Data

For this sensitivity analysis, the age data was input in alternative forms, and the growth parameters were additionally estimated to ascertain the potential effect from the age data. This sensitivity was added to address issues with the data inconsistencies detected from the likelihood profiles of steepness across the stocks, where the age data was found to be inconsistent (negatively related) to the length data for each stock. For the first analysis, the age data was input as normally done for year-specific age compositions across all lengths (i.e., not conditional age-at-length) and the likelihood lambdas were decreased to account for double counting of observations with both length and age information (i.e., the age and length lambdas for a fleet summed to 1.0, where the proportion was determined based on the proportion of observations in each). Additionally, the age data was removed completely (all lambdas = 0.0) for the second sensitivity, and the growth function was estimated when using the conditional age-at-length as the third sensitivity. Figures 11.2.7.2.7.1-11.2.7.2.7.3 provide a visual of how these alternative inputs to the age and growth data affected each of the stock models. How the age data was input had a strong influence on the model results across stocks, with the FLK/EFL stock being the most robust to the age data, which is not surprising given this stock had the fewest age data available. Inputting the age as conditional age-at-length versus normal age data had some impact across stocks, but not a pronounced difference. When using the conditional age-at-length option, the total number of observations for the age data increases substantially in the model, leading to a large likelihood component due to the age data relative to other data sources. Conversely, when using the age composition input across all length bins, the likelihoods were adjusted to sum to 1.0 for both length and age data, leading to a smaller influence of the length and age data relative to other data inputs (indices, catch). Estimating the growth function directly had a large impact on the FLK/EFL and GA-NC stocks, but less of an effect for the WFL stock. This is not surprising given that the life history studies were conducted on the WFL shelf where the fixed growth function in the base models was estimated from, suggesting potential differences in age at length across stocks. The estimated growth function run for the FLK/EFL stock had a large impact, but may be questionable given the few age observations included in the model (n=114 across all years and data sources). The choice was made to retain the conditional age-at-length formulation in the base model due to more appropriate accounting of changes in observations across years (i.e., not having to adjust lambdas for all years combined).

11.2.7.2.8 Life History

For this final sensitivity analysis, alternative life history parameterizations were used for natural mortality for all three stocks, and stock-specific female maturity and growth from the literature for the Florida stocks. For the mortality sensitivities, two alternative maximum ages were modeled (20 and 30). The alternative stock-specific functions for maturity and growth were based on the early life history studies (1995-2001) conducted by FWRI that compared the WFL and FLK/EFL stocks directly. Differences in maturity and growth between stocks were substantial (McBride and Richardson 2007, McBride et al. 2008), although the effects of fishing on age truncation and subsequent estimates of these length-based functions are difficult to disentangle from potential inherent stock differences. As a result, the base model used updated data from just the WFL stock for all stocks, where a larger size distribution was available to estimate the relationships, assuming that inherent differences do not exist between the stocks in these life history parameters that could be either genetically or environmentally mediated. For the alternate mortality formulations, the lower natural mortality rates corresponding to a higher maximum age of 30 increased the estimates of virgin spawning biomass in all stocks, and steepness in the FLK/EFL and GA-NC stocks, but had little impact on the selectivity parameters. The higher M rates (max age of 20) tended to increase the status of the stock (higher depletion, higher SPR, higher SSB/MSST) across all stocks, although the effect was more pronounced for the WFL and GA-NC stocks. For the alternate maturity and growth functions in the Florida stocks, maturity had little impact on parameters, BRPs, and stock status for both Florida stocks (Figures 11.2.7.2.8.1-11.2.7.2.8.2). However, the alternate growth functions did have a large effect on the estimates, which was particularly pronounced in the FLK/EFL stock. This is not surprising given that the L_{∞} was half the size as used in the base model (42.6 cm versus 84.9 cm). As discussed in McBride and Richardson (2007), the low L_{∞} is likely a result of the heavy fishing pressures at the time and significant age truncation, so should not be viewed as a reasonable alternative, but useful for illustrative purposes. Use of the growth functions from just the Dry Tortugas region in McBride and Richardson (2007), where lower exploitation rates existed, would potentially be more informative when attempting to model stock-specific differences.

11.2.7.3 Retrospective Analysis

Strong retrospective patterns were evident for the base model of both the WFL and GA-NC stock, but not evident for the FLK/EFL stock (Figures 11.2.7.3.1-11.2.7.3.3). The strong pattern with the WFL stock is likely a result of the increasing CPUE from the commercial and recreational fisheries from 2007-2012, which is evident across all fisheries (Figure 8.5.1.1), and suggested by the fisheries independent surveys (Figure 8.5.1.1). Both the baitfish trawl and video surveys suggest an increase in the population after 2006 that could represent a strong year class, given the small size selectivity range for these surveys. To fit the CPUE and survey trends, the model predicts a strong recruit class in 2006. Exploration of the base model failed to find an alternative model fit that did not have a strong year class in 2006, suggesting a consistency in the data to support this. Removing the terminal years of data from the assessment model in the retrospective analysis leads to a systematic decrease in the strength of the 2006 recruiting class, and subsequently impacts the estimates of SSB and fishing mortality substantially. As suggested by Legault (2009), caution is warranted when attempting to use assessment models with strong retrospective patterns for stock status and subsequent management advice. However, the consistency in the CPUE trends from both spear and hook and line fisheries, which operate under substantially different catchability and targeting regimes, suggest that the base model estimates using all available years of data may represent the best available fit to the data, and not necessarily a model misspecification leading to the retrospective patterns. Attempts to fit temporal changes in catchability to all fisheries (commercial and recreational spear and hook and line), which is often considered a key process leading to potential retrospective patterns, generally failed to lead to a convergent model across different model configurations. For those attempts that did converge using a simple model configuration (e.g., just spear fisheries), changes in catchability were not consistent among fisheries (e.g., decrease in commercial spear catchability after 2010 with increase in recreational spear after 2010).

An additional strong retrospective pattern was evident in the GA-NC stock, suggesting inconsistencies in the data. This was markedly true when removing data for 2011 and 2012, which led to a strong change in the retrospective patterns for those years ending in 2008-2010 versus those years ending in 2011 and 2012. This is likely due to changes in the landings (peak in 2010), and due to the sample sizes of age and length observations being biased towards later years for some fisheries (e.g., commercial spear length samples; all commercial age samples from 2011 and 2012). As a result, removal of a few years of data in the retrospective analysis could lead to a substantial decline in the total amount of age or length observations being fit to particular fisheries in the model. As with the WFL model, caution is warranted given these retrospective patterns, but these patterns may be data-driven and not necessarily due to model misspecification, given a similar pattern was not evident for the FLK/EFL stock with a similar model specification.

11.2.8 Benchmarks/reference points

This assessment presents both SPR and MSY-based reference points for consideration. For all analyses, stock status was ascertained relative to maximum fishing mortality thresholds (MFMT, which included: F_{MSY}, $F_{30\%,}$ $F_{35\%}$, and $F_{40\%}$) and their corresponding minimum stock size thresholds (MSST), calculated as MSST=(1-M)*$SSB_{@MFMT}$. Here, M=0.179 y^{-1} for the base model configuration. All MFMTs are presented in terms of exploitation (harvest rate) of biomass. Resultant reference points, stock status, and their uncertainty are provided in Tables 11.2.7.1.1-11.2.7.1.3, which includes estimates from both the base model and the bootstrap runs. Graphical representations are included with the bootstrap output Figures 11.2.7.1.1-11.2.7.1.15. Additional equilibrium yield plots (SPR, YPR, and equilibrium catch) are provided in Figures 11.2.8.1-11.2.8.3.

For the WFL stock, steepness was estimable in the base model only when including the Shertzer and Conn (2012) prior, leading to a F_{MSY} of 0.15. The likelihood profiles of steepness suggest the upper bound of the steepness estimate is mediated by the prior input. The SPR references points ($F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) were incrementally lower than the F_{MSY}, ranging from 0.095-0.062, leading to lower estimates of stock status (Figures 11.2.7.1.3, 11.2.7.1.5). For all MFMTs, the base model predicted the population as being neither overfished nor experiencing overfishing, although the median estimate for F40% was experiencing overfishing but not overfished. Substantial uncertainty existed in the overfishing and overfished categories, as can be seen from the individual bootstrap plots in Figure 11.2.7.1.5, but these nearly always estimated a non-depleted stock (SSB/MSST>1.0) in the terminal years. Some deviance between the base model and the median from the bootstrap runs can be seen in Figure 11.2.7.1.5, where the base model predicted a lower F/FMFT and higher SSB/MSST than the median of the bootstraps. This result suggest some inconsistencies in the original input datasets leading to a difference in model parameter estimates in the base model relative to a wider exploration of the data uncertainty range from the bootstrap analysis.

For the FLK/EFL stock, steepness was estimable in the base model with and without including the Shertzer and Conn (2012) prior, leading to a F_{MSY} of 0.138. The SPR references points ($F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) were incrementally lower than the FMSY, ranging from 0.105-0.069, leading to lower estimates of stock status (Figures 11.2.7.1.8, 11.2.7.1.10). For all MFMTs, the base model predicted the population as being overfished and experiencing overfishing for nearly the entire time frame of the model runs. A few years low years in F (2000, 2006, 2011) approached the F/MFMT ratio of 1.0, but in all cases the stock was depleted (SSB/MSST>1.0). Unlike the WFL and GA-NC stocks, the base model was well approximated by the median of the bootstrap runs, suggesting a more robust model fit to the input datasets.

For the GA-NC stock, steepness was estimable in the base model only when including the Shertzer and Conn (2012) prior, leading to a F_{MSY} of 0.31. The likelihood profiles of steepness suggest the upper bound of the steepness estimate is mediated by the prior input. The SPR references points ($F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) were incrementally lower than the FMSY, ranging from 0.197-0.133, leading to lower estimates of stock status (Figures 11.2.7.1.13, 11.2.7.1.15). For all MFMTs, the base model predicted the population as experiencing overfishing in the terminal years, and being overfished in the SPR-based MSSTs but not the MSY-based MSST (Figure 11.2.7.1.15). Similar to the WFL model, the base model was not well predicted by the median of the bootstrap runs, where the base model tended to have higher F/MFMT and lower SSB/MSST in the most recent years. This result suggests that the large error ranges in the input data, particularly the recreational landings with an error rate of 0.75 (log-space), had a strong impact on the plausible model fits from the bootstrap analysis.

11.2.9 Projections

Time-series of projected F, SSB, and OFL from 2013-2032 are provided in Tables and Figures 11.2.9.1-11.2.9.3 for the base model configurations of each stock. Note that in SS, when the projection is done for a specific MFMT, the SPR associated with the MFMT is held constant and not the F (e.g., SPR at MSY is constant, not F_{MSY}), since SPR is a better gauge of fishing intensity in SS models (Methot 2013). Due to this, the projections show F changing over time although the projections were done for a specific F (F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$, F_0, and $F_{Current}$), which can be counterintuitive if one is expecting a constant F. Equilibrium is eventually reached with the projections when both the F and associated SPR are constant, but this can take a substantial timeframe to reach equilibrium.

For the WFL stock, the stock was neither overfished nor experiencing overfishing in the terminal year. Therefore, for those projections where the population was fished at a specific MFMT, the F increased over time to approach the given MFMT. For the projection years, the exploitation rates and OFLs increased for the first few projection years due to the projected increase in the Fs resulting from recruitment forecasts. Given that the population had low F/MFMT and high SSB/MSST ratios, the Fs steadily increased while the SSBs steadily decreased as the population moved closer to the target levels.

For the FLK/EFL stock, the population was both overfished and experiencing overfishing. As a result, the exploitation rate declined sharply in the first projection year, followed by a slowly declining period as it approached the given MFMT. Over this period the SSB steadily increased to attain the MSST within approximately 15-20 yrs for each MFMT. Removing exploitation completely (F_0) led to recovery of the population within 5-10yrs for all MFMTs. With a MFMT using $F_{40\%}$ as a proxy for F_{MSY}, the population reached the MSST for $F_{40\%}$ by 2021, which was the longest period to recover (9 yr).

For the GA-NC stock, the population was near the target levels in the terminal year. The base model F rates were higher than the associated MFMTs, leading to a decline for the first few years until approaching the equilibrium target. As a result, the SSB steadily increased for all scenarios, and typically reached non-depleted state within 5 yrs for those MFMTs where the population was overfished in the terminal year (i.e., SPR-based MFMTs).

11.3 Discussion and Recommendations

11.3.1 Discussion

This report provides three independent stock assessments for Hogfish across the Southeastern US, where the stock delineations were based on new genetic evidence suggesting strong genetic breaks between the Carolina region, Southeast Florida including the Keys and Dry Tortugas, and the West Florida shelf. These three regions additionally experience markedly different fishing pressures and fishery selectivities, providing utility in separating the stock boundaries by the genetic delineations. As a result of the differences in fishing pressures, different conclusions on the stock status were reached for each of the stocks.

Results from the WFL stock suggest the stock is neither overfished nor experiencing overfishing. While the uncertainty in the data input is high, the bootstrap results support this conclusion with respect to stock status. However, other sources of uncertainty remain in the model specification and model diagnostics, as assessed through the sensitivity and retrospective analyses. The abundance has remained relatively constant from the model start in 1986 through present, with a more recent increase in abundances from 2006-2010. The model estimates a large recruit class in 2006, leading to these recent increases, which was detected by the surveys and fisheries-dependent CPUEs. A second strong recruit class was predicted in 2012, suggesting the potential for increases in abundance in the upcoming years.

Results from the FLK/EFL stock suggest that Hogfish are currently overfished and experiencing overfishing, and have been for the majority of time since the model start in the mid-1980s. Nearly all uncertainty analyses, both for data and model specification uncertainty, support the current overfished and overfishing status with relatively high certainty. Abundances have declined slightly since the model start in 1986, but have been relatively constant since the early 2000s. Higher abundances early in the time series were partly attributable to the largest predicted recruit classes occurring between 1986-1991.

Results from the GA-NC stock suggest that Hogfish are experiencing overfishing in the most recent years, while the depletion of the stock is near the overfished limit. Although the MSY-based reference points may not be reliable given the poor estimation of steepness without use of a prior, the stock status relative to the MSY-based MSSTs suggests a non-depleted state, while the SPR-based MSSTs suggest a depleted state in the most recent years. Uncertainty in the data inputs provided inconsistent results relative to the base model run in the most recent years, where the base model tended to predict higher fishing pressures and lower abundances than the uncertainty analyses from the bootstrap procedure. Substantial uncertainty also exists with respect to model specification from the sensitivity runs and the retrospective analyses, although these generally did not influence the stock status in the terminal years.

11.3.2 Research Recommendations

Significant advancements in the understanding of life history for Hogfish were made since the last assessment in 2004 (SEDAR 6), mainly resulting from the effort of R. McBride and A. Collins (FWC-FWRI) and their collaborators from the fisheries, resulting in numerous publications and datasets. In particular, the age samples collected in both the WFL and FLK/EFL stock represent the vast majority of samples available for both stocks, providing for stronger estimates of growth and maturity than available from fisheries dependent sources or surveys. While the life history is particularly well categorized in the WFL, where more research has focused (i.e., 2005-2007 life history study), questions still remain regarding the perceived differences in growth, maturity, and fecundity between the FLK/EFL and WFL stocks, and how these may be regulated by fishing pressures. In addition, life history studies and fisheries independent surveys are sorely needed for the GA-NC stock, particularly with respect to juveniles and mature females, since all available data is from fishery-dependent sources that catch primarily large, older males. Specific recommendations are as follows:

(1) Conduct focused life history studies in the FLK/EFL and GA-NC stocks across a range of sizes/ages in order to test for differences in growth, maturity, and fecundity relative to the WFL stock where more information is available. While estimates from the FLK/EFL exist from the earlier life history study (1995-2001), additional sampling across a broader age spectrum by targeting more remote regions with lower fishing pressure (e.g., Dry Tortugas) may allow for better estimates of functional relationships.

(2) Develop/improve fisheries-independent surveys for the GA-NC stock to specifically track Hogfish abundance. Currently, the SERFS video program only detects Hogfish in less than 5% of surveys, leading to difficulties in estimating abundance.

(3) Improve biostatistical sampling of Hogfish in all regions from fisheries-dependent sources for both length and age observations.

(4) Develop a life history study to ascertain the contribution of males to spawning reproductive potential (SRP). Appropriate determination of male contribution will provide more certainty in modeling reproduction, which has a strong influence on stock status and could be instrumental in designing appropriate management regulations with respect to size limits to protect the spawning biomass.

11.4 Acknowledgements

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11.5 Literature Cited

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11.6 Tables

Table 11.1.4.1. List of SS parameters for the WFL stock Hogfish. The list includes fixed and estimated parameter values and their associated standard errors from the base model run, and any prior estimates that were used.

	Predicted		Prior				
Label	**Value**	**Parm_StDev**	**PR_type**	**Prior**	**Pr_SD**	**Status**	**Description**
L_at_Amin_Fem_GP_1	18.54	--	No_prior	--	--	Fixed	Female length at age 1
L_at_Amax_Fem_GP_1	84.89	--	No_prior	--	--	Fixed	Female length at age 21
VonBert_K_Fem_GP_1	0.1058	--	No_prior	--	--	Fixed	Female K
CV_young_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Young female growth CV
CV_old_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Old female growth CV
L_at_Amin_Mal_GP_1	18.54	--	No_prior	--	--	Fixed	Male length at age 1
L_at_Amax_Mal_GP_1	84.89	--	No_prior	--	--	Fixed	Male length at age 21
VonBert_K_Mal_GP_1	0.1058	--	No_prior	--	--	Fixed	Male K
CV_young_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Young male growth CV
CV_old_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Old male growth CV
Wtlen_1_Fem	5.28E-05	--	No_prior	--	--	Fixed	Female weight-length scalar
Wtlen_2_Fem	2.745	--	No_prior	--	--	Fixed	Female weight-lengt exponent
Mat50%_Fem	15.4696	--	No_prior	--	--	Fixed	Maturity inflection point
Mat_slope_Fem	-0.09815	--	No_prior	--	--	Fixed	Maturity slope
Eggs_scalar_Fem	1	--	No_prior	--	--	Fixed	Fecundity scalar
Eggs_exp_wt_Fem	1	--	No_prior	--	--	Fixed	Fecundity exponent
Wtlen_1_Mal	5.28E-05	--	No_prior	--	--	Fixed	Male weight-length scalar
Wtlen_2_Mal	2.745	--	No_prior	--	--	Fixed	Male weight-lengt exponent
Herm_Infl_age	7.5	--	No_prior	--	--	Fixed	Sex transition inflection point
Herm_stdev	2.15	--	No_prior	--	--	Fixed	Sextransition standard deviation
Herm_asymptote	0.999	--	No_prior	--	--	Fixed	Sex transition asymptote
SR_LN(R0)	6.11596	0.145442	No_prior	--	--	Estimated	Virgin recruit
SR_BH_steep	0.847309	0.151332	Full_Beta	0.748	0.146	Estimated	Steepness
SR_sigmaR	0.6	--	No_prior	--	--	Fixed	Stock-recruit standard deviation
SR_R1_offset	0.003224	0.088393	No_prior	--	--	Estimated	Stock-recruit offset
SR_autocorr	0	--	No_prior	--	--	Fixed	Stock-recruit autocorrelation
Early_InitAge_20	0.0568	0.612746	dev	--	--	Estimated	Age 20 Initial age structure
Early_InitAge_19	0.007239	0.602108	dev	--	--	Estimated	Age 19 Initial age structure
Early_InitAge_18	0.008259	0.602395	dev	--	--	Estimated	Age 18 Initial age structure
Early_InitAge_17	0.009438	0.602724	dev	--	--	Estimated	Age 17 Initial age structure
Early_InitAge_16	0.01084	0.603113	dev	--	--	Estimated	Age 16 Initial age structure
Early_InitAge_15	0.012442	0.603551	dev	--	--	Estimated	Age 15 Initial age structure
Early_InitAge_14	0.015659	0.604466	dev	--	--	Estimated	Age 14 Initial age structure
Early_InitAge_13	0.018629	0.605287	dev	--	--	Estimated	Age 13 Initial age structure
Early_InitAge_12	0.023667	0.606726	dev	--	--	Estimated	Age 12 Initial age structure
Early_InitAge_11	0.024124	0.606781	dev	--	--	Estimated	Age 11 Initial age structure
Early_InitAge_10	0.023976	0.606618	dev	--	--	Estimated	Age 10 Initial age structure
Early_InitAge_9	0.025856	0.607042	dev	--	--	Estimated	Age 9 Initial age structure
Early_InitAge_8	0.035882	0.609895	dev	--	--	Estimated	Age 8 Initial age structure
Early_InitAge_7	0.053856	0.615131	dev	--	--	Estimated	Age 7 Initial age structure
Early_InitAge_6	0.091955	0.626782	dev	--	--	Estimated	Age 6 Initial age structure
Early_InitAge_5	0.14391	0.643321	dev	--	--	Estimated	Age 5 Initial age structure
Early_InitAge_4	0.238812	0.676035	dev	--	--	Estimated	Age 4 Initial age structure
Early_InitAge_3	0.40958	0.740538	dev	--	--	Estimated	Age 3 Initial age structure
Early_InitAge_2	0.649259	0.765038	dev	--	--	Estimated	Age 2 Initial age structure
Early_InitAge_1	0.465576	0.715146	dev	--	--	Estimated	Age 1 Initial age structure
Early_RecrDev_1986	0.045635	0.59087	dev	--	--	Estimated	1986 recruit deviation
Early_RecrDev_1987	-0.17975	0.521984	dev	--	--	Estimated	1987 recruit deviation
Early_RecrDev_1988	-0.17697	0.512523	dev	--	--	Estimated	1988 recruit deviation
Early_RecrDev_1989	-0.25947	0.499183	dev	--	--	Estimated	1989 recruit deviation
Early_RecrDev_1990	-0.04415	0.458336	dev	--	--	Estimated	1990 recruit deviation
Early_RecrDev_1991	-0.19732	0.438706	dev	--	--	Estimated	1991 recruit deviation
Early_RecrDev_1992	0.070475	0.310032	dev	--	--	Estimated	1992 recruit deviation
Main_RecrDev_1993	0.280225	0.274601	dev	--	--	Estimated	1993 recruit deviation
Main_RecrDev_1994	-0.46027	0.410909	dev	--	--	Estimated	1994 recruit deviation
Main_RecrDev_1995	-0.37225	0.375641	dev	--	--	Estimated	1995 recruit deviation
Main_RecrDev_1996	0.619451	0.238573	dev	--	--	Estimated	1996 recruit deviation
Main_RecrDev_1997	-0.03515	0.319818	dev	--	--	Estimated	1997 recruit deviation
Main_RecrDev_1998	0.133938	0.299798	dev	--	--	Estimated	1998 recruit deviation
Main_RecrDev_1999	0.460743	0.214712	dev	--	--	Estimated	1999 recruit deviation
Main_RecrDev_2000	-1.03234	0.377722	dev	--	--	Estimated	2000 recruit deviation

Main_RecrDev_2001	-1.26435	0.318547	dev	--	--	Estimated	2001 recruit deviation
Main_RecrDev_2002	0.199475	0.191338	dev	--	--	Estimated	2002 recruit deviation
Main_RecrDev_2003	-0.92158	0.353938	dev	--	--	Estimated	2003 recruit deviation
Main_RecrDev_2004	-0.59145	0.312763	dev	--	--	Estimated	2004 recruit deviation
Main_RecrDev_2005	0.477706	0.162757	dev	--	--	Estimated	2005 recruit deviation
Main_RecrDev_2006	1.61322	0.089245	dev	--	--	Estimated	2006 recruit deviation
Main_RecrDev_2007	0.684423	0.112911	dev	--	--	Estimated	2007 recruit deviation
Main_RecrDev_2008	0.730045	0.09032	dev	--	--	Estimated	2008 recruit deviation
Main_RecrDev_2009	-0.79668	0.146272	dev	--	--	Estimated	2009 recruit deviation
Main_RecrDev_2010	-0.78269	0.146294	dev	--	--	Estimated	2010 recruit deviation
Main_RecrDev_2011	-0.02572	0.137546	dev	--	--	Estimated	2011 recruit deviation
Main_RecrDev_2012	1.08326	0.185207	dev	--	--	Estimated	2012 recruit deviation
InitF_1Comm_Spear	0.005878	0.000916	No_prior	--	--	Estimated	Comm. Spear initial F
InitF_2Comm_HL	0.001	--	No_prior	--	--	Fixed	Comm. HL initial F
InitF_3Comm_Trap	0	--	No_prior	--	--	Fixed	Comm. Trap initial F
InitF_4Rec_Spear	0.373029	0.072107	No_prior	--	--	Estimated	Rec. Spear initial F
InitF_5Rec_HL	0.014695	0.007678	No_prior	--	--	Estimated	Rec. HL initial F
SizeSel_1P_1_Comm_Spear	33.8666	0.526754	No_prior	--	--	Estimated	Comm spear size select peak
SizeSel_1P_2_Comm_Spear	-2.55632	0.466353	No_prior	--	--	Estimated	Comm spear size select top
SizeSel_1P_3_Comm_Spear	2.29765	0.25491	No_prior	--	--	Estimated	Comm spear size select ascending width
SizeSel_1P_4_Comm_Spear	3.89978	0.462456	No_prior	--	--	Estimated	Comm spear size select descending width
SizeSel_1P_5_Comm_Spear	-15	--	No_prior	--	--	Fixed	Comm spear size select initial
SizeSel_1P_6_Comm_Spear	-1.43495	0.22963	No_prior	--	--	Estimated	Comm spear size select final
SizeSel_2P_1_Comm_HL	21.8495	17.5659	No_prior	--	--	Estimated	Comm HL size select peak
SizeSel_2P_2_Comm_HL	-5	--	No_prior	--	--	Fixed	Comm HL size select top
SizeSel_2P_3_Comm_HL	-0.24792	41.3643	No_prior	--	--	Estimated	Comm HL size select ascending width
SizeSel_2P_4_Comm_HL	6	--	No_prior	--	--	Fixed	Comm HL size select descending width
SizeSel_2P_5_Comm_HL	-15	--	No_prior	--	--	Fixed	Comm HL size select initial
SizeSel_2P_6_Comm_HL	15	--	No_prior	--	--	Fixed	Comm HL size select final
SizeSel_3P_1_Comm_Trap	30.8979	0.720354	No_prior	--	--	Estimated	Comm trap size select peak
SizeSel_3P_2_Comm_Trap	-12.4605	44.1184	No_prior	--	--	Estimated	Comm trap size select top
SizeSel_3P_3_Comm_Trap	3.97924	0.196068	No_prior	--	--	Estimated	Comm trap size select ascending width
SizeSel_3P_4_Comm_Trap	4.10583	0.191578	No_prior	--	--	Estimated	Comm trap size select descending width
SizeSel_3P_5_Comm_Trap	-15	--	No_prior	--	--	Fixed	Comm trap size select initial
SizeSel_3P_6_Comm_Trap	-15	--	No_prior	--	--	Fixed	Comm trap size select final
SizeSel_4P_1_Rec_Spear	33.3925	0.645585	No_prior	--	--	Estimated	Rec spear size select peak
SizeSel_4P_2_Rec_Spear	-2.52215	0.363748	No_prior	--	--	Estimated	Rec spear size select top
SizeSel_4P_3_Rec_Spear	2.97334	0.2211	No_prior	--	--	Estimated	Rec spear size select ascending width
SizeSel_4P_4_Rec_Spear	4.18582	0.254701	No_prior	--	--	Estimated	Rec spear size select descending width
SizeSel_4P_5_Rec_Spear	-15	--	No_prior	--	--	Fixed	Rec spear size select initial
SizeSel_4P_6_Rec_Spear	-15	--	No_prior	--	--	Fixed	Rec spear size select final
SizeSel_5P_1_Rec_HL	33.8786	0.875042	No_prior	--	--	Estimated	Rec HL size select peak
SizeSel_5P_2_Rec_HL	-11.2063	58.0822	No_prior	--	--	Estimated	Rec HL size select top
SizeSel_5P_3_Rec_HL	3.36908	0.258	No_prior	--	--	Estimated	Rec HL size select ascending width
SizeSel_5P_4_Rec_HL	4.79587	0.221356	No_prior	--	--	Estimated	Rec HL size select descending width
SizeSel_5P_5_Rec_HL	-15	--	No_prior	--	--	Fixed	Rec HL size select initial
SizeSel_5P_6_Rec_HL	-15	--	No_prior	--	--	Fixed	Rec HL size select final
SizeSel_6P_1_Baitfish	7.00822	0.658318	No_prior	--	--	Estimated	Baitfish size select peak
SizeSel_6P_2_Baitfish	-9	--	No_prior	--	--	Fixed	Baitfish size select top
SizeSel_6P_3_Baitfish	-0.08586	40.4315	No_prior	--	--	Estimated	Baitfish size select ascending width
SizeSel_6P_4_Baitfish	5.8749	0.073103	No_prior	--	--	Estimated	Baitfish size select descending width
SizeSel_6P_5_Baitfish	-15	--	No_prior	--	--	Fixed	Baitfish size select initial
SizeSel_6P_6_Baitfish	-15	--	No_prior	--	--	Fixed	Baitfish size select final
SizeSel_7P_1_SEAMAP	0	--	No_prior	--	--	Fixed	SEAMAP size select mirror
SizeSel_7P_2_SEAMAP	0	--	No_prior	--	--	Fixed	SEAMAP size select mirror
SizeSel_8P_1_VideoIOA	24.0333	3.93039	No_prior	--	--	Estimated	Video size select peak
SizeSel_8P_2_VideoIOA	-9.6904	73.5258	No_prior	--	--	Estimated	Video size select top
SizeSel_8P_3_VideoIOA	3.59405	1.3786	No_prior	--	--	Estimated	Video size select ascending width
SizeSel_8P_4_VideoIOA	6.38983	0.517301	No_prior	--	--	Estimated	Video size select descending width
SizeSel_8P_5_VideoIOA	-15	--	No_prior	--	--	Fixed	Video size select initial
SizeSel_8P_6_VideoIOA	-15	--	No_prior	--	--	Fixed	Video size select final
AgeSel_9P_1_RecTrawlIOA	0.1	--	No_prior	--	--	Fixed	Rec Trawl age select initial
AgeSel_9P_2_RecTrawlIOA	0.9	--	No_prior	--	--	Fixed	Rec Trawl age select final

Table 11.1.4.2. List of SS parameters for the FLK/EFL stock Hogfish. The list includes fixed and estimated parameter values and their associated standard errors from the base model run, and any prior estimates that were used.

	Predicted		Prior				
Label	**Value**	**Parm_StDev**	**PR_type**	**Prior**	**Pr_SD**	**Status**	**Description**
L_at_Amin_Fem_GP_1	18.54	--	No_prior	--	--	Fixed	Female length at age 1
L_at_Amax_Fem_GP_1	84.89	--	No_prior	--	--	Fixed	Female length at age 21
VonBert_K_Fem_GP_1	0.1058	--	No_prior	--	--	Fixed	Female K
CV_young_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Young female growth CV
CV_old_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Old female growth CV
L_at_Amin_Mal_GP_1	18.54	--	No_prior	--	--	Fixed	Male length at age 1
L_at_Amax_Mal_GP_1	84.89	--	No_prior	--	--	Fixed	Male length at age 21
VonBert_K_Mal_GP_1	0.1058	--	No_prior	--	--	Fixed	Male K
CV_young_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Young male growth CV
CV_old_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Old male growth CV
Wtlen_1_Fem	5.28E-05	--	No_prior	--	--	Fixed	Female weight-length scalar
Wtlen_2_Fem	2.745	--	No_prior	--	--	Fixed	Female weight-lengt exponent
Mat50%_Fem	15.4696	--	No_prior	--	--	Fixed	Maturity inflection point
Mat_slope_Fem	-0.09815	--	No_prior	--	--	Fixed	Maturity slope
Eggs_scalar_Fem	1	--	No_prior	--	--	Fixed	Fecundity scalar
Eggs_exp_wt_Fem	1	--	No_prior	--	--	Fixed	Fecundity exponent
Wtlen_1_Mal	5.28E-05	--	No_prior	--	--	Fixed	Male weight-length scalar
Wtlen_2_Mal	2.745	--	No_prior	--	--	Fixed	Male weight-lengt exponent
Herm_Infl_age	7.5	--	No_prior	--	--	Fixed	Sex transition inflection point
Herm_stdev	2.15	--	No_prior	--	--	Fixed	Sextransition standard deviation
Herm_asymptote	0.999	--	No_prior	--	--	Fixed	Sex transition asymptote
SR_LN(R0)	6.78076	0.242539	No_prior	--	--	Estimated	Virgin recruit
SR_BH_steep	0.829849	0.0439119	Full_Beta	0.748	0.146	Estimated	Steepness
SR_sigmaR	0.6	--	No_prior	--	--	Fixed	Stock-recruit standard deviation
SR_R1_offset	-0.00084	0.0924229	No_prior	--	--	Estimated	Stock-recruit offset
SR_autocorr	0	--	No_prior	--	--	Fixed	Stock-recruit autocorrelation
Early_InitAge_20	-0.02331	0.592899	dev	--	--	Estimated	Age 20 Initial age structure
Early_InitAge_19	-0.00591	0.598216	dev	--	--	Estimated	Age 19 Initial age structure
Early_InitAge_18	-0.00728	0.597796	dev	--	--	Estimated	Age 18 Initial age structure
Early_InitAge_17	-0.009	0.597265	dev	--	--	Estimated	Age 17 Initial age structure
Early_InitAge_16	-0.01136	0.596537	dev	--	--	Estimated	Age 16 Initial age structure
Early_InitAge_15	-0.01274	0.596064	dev	--	--	Estimated	Age 15 Initial age structure
Early_InitAge_14	-0.01502	0.595294	dev	--	--	Estimated	Age 14 Initial age structure
Early_InitAge_13	-0.02306	0.593059	dev	--	--	Estimated	Age 13 Initial age structure
Early_InitAge_12	-0.02936	0.591225	dev	--	--	Estimated	Age 12 Initial age structure
Early_InitAge_11	-0.03639	0.589185	dev	--	--	Estimated	Age 11 Initial age structure
Early_InitAge_10	-0.04557	0.586559	dev	--	--	Estimated	Age 10 Initial age structure
Early_InitAge_9	-0.05706	0.583313	dev	--	--	Estimated	Age 9 Initial age structure
Early_InitAge_8	-0.06847	0.580037	dev	--	--	Estimated	Age 8 Initial age structure
Early_InitAge_7	-0.0799	0.576599	dev	--	--	Estimated	Age 7 Initial age structure
Early_InitAge_6	-0.08667	0.573774	dev	--	--	Estimated	Age 6 Initial age structure
Early_InitAge_5	-0.09378	0.569201	dev	--	--	Estimated	Age 5 Initial age structure
Early_InitAge_4	-0.10314	0.559724	dev	--	--	Estimated	Age 4 Initial age structure
Early_InitAge_3	-0.12219	0.54037	dev	--	--	Estimated	Age 3 Initial age structure
Early_InitAge_2	-0.11951	0.520678	dev	--	--	Estimated	Age 2 Initial age structure
Early_InitAge_1	0.078355	0.543403	dev	--	--	Estimated	Age 1 Initial age structure
Early_RecrDev_1986	0.645418	0.543407	dev	--	--	Estimated	1986 recruit deviation
Early_RecrDev_1987	0.293646	0.452404	dev	--	--	Estimated	1987 recruit deviation
Early_RecrDev_1988	0.272663	0.377963	dev	--	--	Estimated	1988 recruit deviation
Early_RecrDev_1989	0.992525	0.180364	dev	--	--	Estimated	1989 recruit deviation
Early_RecrDev_1990	-0.56705	0.427483	dev	--	--	Estimated	1990 recruit deviation
Early_RecrDev_1991	1.12471	0.134775	dev	--	--	Estimated	1991 recruit deviation
Early_RecrDev_1992	0.326706	0.254349	dev	--	--	Estimated	1992 recruit deviation
Main_RecrDev_1993	-0.10284	0.225547	dev	--	--	Estimated	1993 recruit deviation
Main_RecrDev_1994	-0.56309	0.185196	dev	--	--	Estimated	1994 recruit deviation
Main_RecrDev_1995	0.040557	0.110565	dev	--	--	Estimated	1995 recruit deviation
Main_RecrDev_1996	-0.27024	0.130595	dev	--	--	Estimated	1996 recruit deviation
Main_RecrDev_1997	0.131193	0.104774	dev	--	--	Estimated	1997 recruit deviation
Main_RecrDev_1998	0.430003	0.0952792	dev	--	--	Estimated	1998 recruit deviation
Main_RecrDev_1999	0.176953	0.101021	dev	--	--	Estimated	1999 recruit deviation
Main_RecrDev_2000	0.234456	0.105469	dev	--	--	Estimated	2000 recruit deviation
Main_RecrDev_2001	0.075237	0.111141	dev	--	--	Estimated	2001 recruit deviation
Main_RecrDev_2002	0.032392	0.107509	dev	--	--	Estimated	2002 recruit deviation

Main_RecrDev_2003	-0.44085	0.120394	dev	--	--	Estimated	2003 recruit deviation
Main_RecrDev_2004	-0.23889	0.106578	dev	--	--	Estimated	2004 recruit deviation
Main_RecrDev_2005	0.321056	0.0793414	dev	--	--	Estimated	2005 recruit deviation
Main_RecrDev_2006	0.26473	0.0900013	dev	--	--	Estimated	2006 recruit deviation
Main_RecrDev_2007	0.369897	0.0769063	dev	--	--	Estimated	2007 recruit deviation
Main_RecrDev_2008	-0.12949	0.101574	dev	--	--	Estimated	2008 recruit deviation
Main_RecrDev_2009	0.246259	0.0862898	dev	--	--	Estimated	2009 recruit deviation
Main_RecrDev_2010	0.017201	0.108402	dev	--	--	Estimated	2010 recruit deviation
Main_RecrDev_2011	0.221422	0.0957179	dev	--	--	Estimated	2011 recruit deviation
Main_RecrDev_2012	-0.81597	0.284532	dev	--	--	Estimated	2012 recruit deviation
InitF_1Comm_Spear	0.03791	0.00595355	No_prior	--	--	Estimated	Comm. Spear initial F
InitF_2Comm_HL	0.015732	0.00233462	No_prior	--	--	Estimated	Comm. HL initial F
InitF_3Comm_Trap	0.008488	--	No_prior	--	--	Fixed	Comm. Trap initial F
InitF_4Rec_Spear	0.494929	0.127684	No_prior	--	--	Estimated	Rec. Spear initial F
InitF_5Rec_HL	0.098184	0.04936	No_prior	--	--	Estimated	Rec. HL initial F
LnQ_base_6_RVCKeys	-6.60149	0.0766856	No_prior	--	--	Estimated	Initial Q for RVC-Keys
Q_walk_6y_2000	0.879222	0.0785857	No_prior	--	--	Estimated	Change in Q in 2000 for RVC-Keys
SizeSel_1P_1_Comm_Spear	31.4562	0.360077	No_prior	--	--	Estimated	Comm spear size select peak
SizeSel_1P_2_Comm_Spear	-2.84954	0.397185	No_prior	--	--	Estimated	Comm spear size select top
SizeSel_1P_3_Comm_Spear	2.35468	0.168611	No_prior	--	--	Estimated	Comm spear size select ascending width
SizeSel_1P_4_Comm_Spear	1.16609	0.994048	No_prior	--	--	Estimated	Comm spear size select descending width
SizeSel_1P_5_Comm_Spear	-15	--	No_prior	--	--	Fixed	Comm spear size select initial
SizeSel_1P_6_Comm_Spear	0.050017	0.197139	No_prior	--	--	Estimated	Comm spear size select final
SizeSel_2P_1_Comm_HL	30.8817	0.573135	No_prior	--	--	Estimated	Comm HL size select peak
SizeSel_2P_2_Comm_HL	-9	--	No_prior	--	--	Fixed	Comm HL size select top
SizeSel_2P_3_Comm_HL	2.47565	0.250554	No_prior	--	--	Estimated	Comm HL size select ascending width
SizeSel_2P_4_Comm_HL	6	--	No_prior	--	--	Fixed	Comm HL size select descending width
SizeSel_2P_5_Comm_HL	-15	--	No_prior	--	--	Fixed	Comm HL size select initial
SizeSel_2P_6_Comm_HL	15	--	No_prior	--	--	Fixed	Comm HL size select final
SizeSel_3P_1_Comm_Trap	34.4023	0.507749	No_prior	--	--	Estimated	Comm trap size select peak
SizeSel_3P_2_Comm_Trap	-9	--	No_prior	--	--	Fixed	Comm trap size select top
SizeSel_3P_3_Comm_Trap	3.11393	0.150386	No_prior	--	--	Estimated	Comm trap size select ascending width
SizeSel_3P_4_Comm_Trap	6	--	No_prior	--	--	Fixed	Comm trap size select descending width
SizeSel_3P_5_Comm_Trap	-15	--	No_prior	--	--	Fixed	Comm trap size select initial
SizeSel_3P_6_Comm_Trap	15	--	No_prior	--	--	Fixed	Comm trap size select final
SizeSel_4P_1_Rec_Spear	31.9448	0.516277	No_prior	--	--	Estimated	Rec spear size select peak
SizeSel_4P_2_Rec_Spear	-11.3131	56.9579	No_prior	--	--	Estimated	Rec spear size select top
SizeSel_4P_3_Rec_Spear	2.61649	0.219624	No_prior	--	--	Estimated	Rec spear size select ascending width
SizeSel_4P_4_Rec_Spear	6.39902	0.24207	No_prior	--	--	Estimated	Rec spear size select descending width
SizeSel_4P_5_Rec_Spear	-15	--	No_prior	--	--	Fixed	Rec spear size select initial
SizeSel_4P_6_Rec_Spear	-15	--	No_prior	--	--	Fixed	Rec spear size select final
SizeSel_5P_1_Rec_HL	31.4649	0.708774	No_prior	--	--	Estimated	Rec HL size select peak
SizeSel_5P_2_Rec_HL	-11.713	52.6491	No_prior	--	--	Estimated	Rec HL size select top
SizeSel_5P_3_Rec_HL	3.20985	0.225129	No_prior	--	--	Estimated	Rec HL size select ascending width
SizeSel_5P_4_Rec_HL	5.6477	0.297439	No_prior	--	--	Estimated	Rec HL size select descending width
SizeSel_5P_5_Rec_HL	-15	--	No_prior	--	--	Fixed	Rec HL size select initial
SizeSel_5P_6_Rec_HL	-15	--	No_prior	--	--	Fixed	Rec HL size select final
SizeSel_6P_1_RVCKeys	15.8085	0.146167	No_prior	--	--	Estimated	RVC-Keys size select peak
SizeSel_6P_2_RVCKeys	-9	--	No_prior	--	--	Fixed	RVC-Keys size select top
SizeSel_6P_3_RVCKeys	2.15865	0.0792009	No_prior	--	--	Estimated	RVC-Keys size select ascending width
SizeSel_6P_4_RVCKeys	6.21792	0.0657478	No_prior	--	--	Estimated	RVC-Keys size select descending width
SizeSel_6P_5_RVCKeys	-15	--	No_prior	--	--	Fixed	RVC-Keys size select initial
SizeSel_6P_6_RVCKeys	-15	--	No_prior	--	--	Fixed	RVC-Keys size select final
SizeSel_7P_1_RVCTortugas	41.8856	1.59832	No_prior	--	--	Estimated	RVC-Tortugas size select peak
SizeSel_7P_2_RVCTortugas	-9	--	No_prior	--	--	Fixed	RVC-Tortugas size select top
SizeSel_7P_3_RVCTortugas	5.90207	0.121244	No_prior	--	--	Estimated	RVC-Tortugas size select ascending width
SizeSel_7P_4_RVCTortugas	6	--	No_prior	--	--	Fixed	RVC-Tortugas size select descending width
SizeSel_7P_5_RVCTortugas	-15	--	No_prior	--	--	Fixed	RVC-Tortugas size select initial
SizeSel_7P_6_RVCTortugas	15	--	No_prior	--	--	Fixed	RVC-Tortugas size select final
AgeSel_6P_1_RVCKeys	0.1	--	No_prior	--	--	Fixed	RVC-Keys min age select
AgeSel_6P_2_RVCKeys	20	--	No_prior	--	--	Fixed	RVC-Keys max age select
AgeSel_7P_1_RVCTortugas	0.1	--	No_prior	--	--	Fixed	RVC-Tortugas min age select
AgeSel_7P_2_RVCTortugas	20	--	No_prior	--	--	Fixed	RVC-Tortugas max age select

Table 11.1.4.3. List of SS parameters for the GA-NC stock Hogfish. The list includes fixed and estimated parameter values and their associated standard errors from the base model run, and any prior estimates that were used.

	Predicted		Prior				
Label	Value	Parm_StDev	PR_type	Prior	Pr_SD	Status	Description
L_at_Amin_Fem_GP_1	18.54	--	No_prior	--	--	Fixed	Female length at age 1
L_at_Amax_Fem_GP_1	84.89	--	No_prior	--	--	Fixed	Female length at age 21
VonBert_K_Fem_GP_1	0.1058	--	No_prior	--	--	Fixed	Female K
CV_young_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Young female growth CV
CV_old_Fem_GP_1	0.2	--	No_prior	--	--	Fixed	Old female growth CV
L_at_Amin_Mal_GP_1	18.54	--	No_prior	--	--	Fixed	Male length at age 1
L_at_Amax_Mal_GP_1	84.89	--	No_prior	--	--	Fixed	Male length at age 21
VonBert_K_Mal_GP_1	0.1058	--	No_prior	--	--	Fixed	Male K
CV_young_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Young male growth CV
CV_old_Mal_GP_1	0.2	--	No_prior	--	--	Fixed	Old male growth CV
Wtlen_1_Fem	5.28E-05	--	No_prior	--	--	Fixed	Female weight-length scalar
Wtlen_2_Fem	2.745	--	No_prior	--	--	Fixed	Female weight-lengt exponent
Mat50%_Fem	15.4696	--	No_prior	--	--	Fixed	Maturity inflection point
Mat_slope_Fem	-0.09815	--	No_prior	--	--	Fixed	Maturity slope
Eggs_scalar_Fem	1	--	No_prior	--	--	Fixed	Fecundity scalar
Eggs_exp_wt_Fem	1	--	No_prior	--	--	Fixed	Fecundity exponent
Wtlen_1_Mal	5.28E-05	--	No_prior	--	--	Fixed	Male weight-length scalar
Wtlen_2_Mal	2.745	--	No_prior	--	--	Fixed	Male weight-lengt exponent
Herm_Infl_age	7.5	--	No_prior	--	--	Fixed	Sex transition inflection point
Herm_stdev	2.15	--	No_prior	--	--	Fixed	Sextransition standard deviation
Herm_asymptote	0.999	--	No_prior	--	--	Fixed	Sex transition asymptote
SR_LN(R0)	3.46857	0.095921	No_prior	--	--	Estimated	Virgin recruit
SR_BH_steep	0.90947	0.096252	Full_Beta	0.748	0.146	Estimated	Steepness
SR_sigmaR	0.6	--	No_prior	--	--	Fixed	Stock-recruit standard deviation
SR_R1_offset	0.000282	0.086451	No_prior	--	--	Estimated	Stock-recruit offset
SR_autocorr	0	--	No_prior	--	--	Fixed	Stock-recruit autocorrelation
Early_InitAge_20	-0.16407	0.563713	dev	--	--	Estimated	Age 20 Initial age structure
Early_InitAge_19	-0.05681	0.584133	dev	--	--	Estimated	Age 19 Initial age structure
Early_InitAge_18	-0.06965	0.580666	dev	--	--	Estimated	Age 18 Initial age structure
Early_InitAge_17	-0.08428	0.576718	dev	--	--	Estimated	Age 17 Initial age structure
Early_InitAge_16	-0.09935	0.572588	dev	--	--	Estimated	Age 16 Initial age structure
Early_InitAge_15	-0.11432	0.568345	dev	--	--	Estimated	Age 15 Initial age structure
Early_InitAge_14	-0.13134	0.563416	dev	--	--	Estimated	Age 14 Initial age structure
Early_InitAge_13	-0.1439	0.559158	dev	--	--	Estimated	Age 13 Initial age structure
Early_InitAge_12	-0.14987	0.555804	dev	--	--	Estimated	Age 12 Initial age structure
Early_InitAge_11	-0.14506	0.553895	dev	--	--	Estimated	Age 11 Initial age structure
Early_InitAge_10	-0.12406	0.553983	dev	--	--	Estimated	Age 10 Initial age structure
Early_InitAge_9	-0.08246	0.555968	dev	--	--	Estimated	Age 9 Initial age structure
Early_InitAge_8	-0.02255	0.557702	dev	--	--	Estimated	Age 8 Initial age structure
Early_InitAge_7	0.031741	0.553734	dev	--	--	Estimated	Age 7 Initial age structure
Early_InitAge_6	0.027098	0.541803	dev	--	--	Estimated	Age 6 Initial age structure
Early_InitAge_5	-0.05186	0.524127	dev	--	--	Estimated	Age 5 Initial age structure
Early_InitAge_4	-0.12014	0.50092	dev	--	--	Estimated	Age 4 Initial age structure
Early_InitAge_3	-0.13395	0.489229	dev	--	--	Estimated	Age 3 Initial age structure
Early_InitAge_2	-0.09914	0.497676	dev	--	--	Estimated	Age 2 Initial age structure
Early_InitAge_1	0.158346	0.490517	dev	--	--	Estimated	Age 1 Initial age structure
Early_RecrDev_1986	0.196996	0.510146	dev	--	--	Estimated	1986 recruit deviation
Early_RecrDev_1987	0.128497	0.590432	dev	--	--	Estimated	1987 recruit deviation
Early_RecrDev_1988	1.08969	0.412669	dev	--	--	Estimated	1988 recruit deviation
Early_RecrDev_1989	0.469534	0.737453	dev	--	--	Estimated	1989 recruit deviation
Early_RecrDev_1990	1.3666	0.341558	dev	--	--	Estimated	1990 recruit deviation
Early_RecrDev_1991	0.147329	0.590307	dev	--	--	Estimated	1991 recruit deviation
Early_RecrDev_1992	0.412827	0.423526	dev	--	--	Estimated	1992 recruit deviation
Main_RecrDev_1993	0.181785	0.440268	dev	--	--	Estimated	1993 recruit deviation
Main_RecrDev_1994	0.258152	0.363987	dev	--	--	Estimated	1994 recruit deviation
Main_RecrDev_1995	0.100015	0.384932	dev	--	--	Estimated	1995 recruit deviation
Main_RecrDev_1996	0.675815	0.305015	dev	--	--	Estimated	1996 recruit deviation
Main_RecrDev_1997	0.055315	0.45489	dev	--	--	Estimated	1997 recruit deviation
Main_RecrDev_1998	0.122667	0.38946	dev	--	--	Estimated	1998 recruit deviation
Main_RecrDev_1999	-0.30471	0.434848	dev	--	--	Estimated	1999 recruit deviation
Main_RecrDev_2000	0.300022	0.29832	dev	--	--	Estimated	2000 recruit deviation
Main_RecrDev_2001	1.11169	0.175134	dev	--	--	Estimated	2001 recruit deviation
Main_RecrDev_2002	1.36391	0.14235	dev	--	--	Estimated	2002 recruit deviation
Main_RecrDev_2003	-0.3191	0.298135	dev	--	--	Estimated	2003 recruit deviation
Main_RecrDev_2004	-0.71159	0.375765	dev	--	--	Estimated	2004 recruit deviation

Main_RecrDev_2005	-0.18605	0.357171	dev	--	--	Estimated	2005 recruit deviation
Main_RecrDev_2006	-0.19962	0.35326	dev	--	--	Estimated	2006 recruit deviation
Main_RecrDev_2007	-0.72347	0.371226	dev	--	--	Estimated	2007 recruit deviation
Main_RecrDev_2008	-0.74479	0.371925	dev	--	--	Estimated	2008 recruit deviation
Main_RecrDev_2009	-0.7739	0.415041	dev	--	--	Estimated	2009 recruit deviation
Main_RecrDev_2010	-0.43486	0.460174	dev	--	--	Estimated	2010 recruit deviation
Main_RecrDev_2011	0.043654	0.541151	dev	--	--	Estimated	2011 recruit deviation
Main_RecrDev_2012	0.185056	0.577614	dev	--	--	Estimated	2012 recruit deviation
InitF_1Comm_Spear	0.01	--	No_prior	--	--	Fixed	Comm. Spear initial F
InitF_2Comm_HL	0.053932	0.009142	No_prior	--	--	Estimated	Comm. HL initial F
InitF_3Comm_Trap	0	--	No_prior	--	--	Fixed	Comm. Trap initial F
InitF_4Rec_HL	0.113641	0.045573	No_prior	--	--	Estimated	Rec. Spear initial F
SizeSel_1P_1_Comm_Spear	65.9831	5.50144	No_prior	--	--	Estimated	Comm spear size select peak
SizeSel_1P_2_Comm_Spear	0	--	No_prior	--	--	Fixed	Comm spear size select top
SizeSel_1P_3_Comm_Spear	5.65297	0.361455	No_prior	--	--	Estimated	Comm spear size select ascending width
SizeSel_1P_4_Comm_Spear	6	--	No_prior	--	--	Fixed	Comm spear size select descending width
SizeSel_1P_5_Comm_Spear	-15	--	No_prior	--	--	Fixed	Comm spear size select initial
SizeSel_1P_6_Comm_Spear	15	--	No_prior	--	--	Fixed	Comm spear size select final
SizeSel_2P_1_Comm_HL	63.106	0.84902	No_prior	--	--	Estimated	Comm HL size select peak
SizeSel_2P_2_Comm_HL	0	--	No_prior	--	--	Fixed	Comm HL size select top
SizeSel_2P_3_Comm_HL	5.2208	0.05958	No_prior	--	--	Estimated	Comm HL size select ascending width
SizeSel_2P_4_Comm_HL	6	--	No_prior	--	--	Fixed	Comm HL size select descending width
SizeSel_2P_5_Comm_HL	-15	--	No_prior	--	--	Fixed	Comm HL size select initial
SizeSel_2P_6_Comm_HL	15	--	No_prior	--	--	Fixed	Comm HL size select final
SizeSel_3P_1_Comm_Trap	0	--	No_prior	--	--	Fixed	Comm trap size select mirror
SizeSel_3P_2_Comm_Trap	0	--	No_prior	--	--	Fixed	Comm trap size select mirror
SizeSel_4P_1_Rec_HL	61.6068	3.13353	No_prior	--	--	Estimated	Rec HL size select peak
SizeSel_4P_2_Rec_HL	0	--	No_prior	--	--	Fixed	Rec HL size select top
SizeSel_4P_3_Rec_HL	4.60271	0.468663	No_prior	--	--	Estimated	Rec HL size select ascending width
SizeSel_4P_4_Rec_HL	6	--	No_prior	--	--	Fixed	Rec HL size select descending width
SizeSel_4P_5_Rec_HL	-15	--	No_prior	--	--	Fixed	Rec HL size select initial
SizeSel_4P_6_Rec_HL	15	--	No_prior	--	--	Fixed	Rec HL size select final

Table 11.1.5.1. Model quantities from the jitter analysis for the WFL stock.

Rank	TOTAL	Steepness	SPB_Virgin	F_MSY	MSY	F/F_MSY	SSB/SSB_MSST	SPR	R0
1	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
2	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
3	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
4	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
5	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
6	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
7	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
8	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
9	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
10	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
11	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
12	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
13	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
14	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
15	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
16	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
17	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
18	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
19	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
20	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
21	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
22	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
23	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
24	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
25	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
26	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
27	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
28	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
29	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
30	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
31	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
32	1504.21	0.847309	2688.26	0.150043	76.5767	0.408822	3.501547	0.395545	453.0307
33	1504.3	0.847131	2697.8	0.149882	76.7978	0.40583	3.517526	0.397739	454.6373
34	1504.8	0.847449	2690.94	0.150126	76.657	0.406432	3.520293	0.396802	453.4795
35	1504.8	0.847449	2690.94	0.150126	76.657	0.406432	3.520293	0.396802	453.4795
36	1504.82	0.847453	2690.97	0.150128	76.6576	0.40635	3.521047	0.396835	453.484
37	1505.54	0.845615	2579.95	0.14892	73.4315	0.44558	3.339903	0.373998	434.7756
38	1505.54	0.845615	2579.95	0.14892	73.4315	0.44558	3.339903	0.373998	434.7756
39	1505.65	0.845923	2599.92	0.149126	74.0075	0.438582	3.368285	0.377733	438.1407
40	1505.69	0.845847	2588.97	0.149067	73.6974	0.441202	3.362675	0.376285	436.2956
41	1505.69	0.845847	2588.97	0.149067	73.6973	0.441203	3.362648	0.376285	436.2956
42	1507.9	0.844507	2504.32	0.148182	71.2855	0.474566	3.225971	0.360242	422.0315
43	1508.44	0.847361	2691.36	0.15007	76.658	0.406939	3.515336	0.396423	453.552
44	1512.51	0.847443	2696.44	0.150131	76.8221	0.406828	3.507276	0.397193	454.4055
45	1518.65	0.846861	2673.77	0.149825	76.1542	0.413468	3.480564	0.393109	450.5865
46	1518.65	0.84686	2673.88	0.149824	76.157	0.413431	3.480747	0.393134	450.6045
47	1518.65	0.84686	2673.88	0.149824	76.157	0.413431	3.480747	0.393134	450.6045
48	1533.43	0.860717	0	0	0	Inf	NA	0.727936	361.7488
49	1736.39	0.837981	2708.73	0.144126	76.032	0.406016	3.547562	0.410055	456.4778
50	1772.03	0.839115	2709.6	0.144919	76.2703	0.405184	3.546105	0.410239	456.6239

Table 11.1.5.2. Model quantities from the jitter analysis for the FLK/EFL stock.

Rank	TOTAL	Steepness	SPB_Virgin	F_MSY	MSY	F/F_MSY	SSB/SSB_MSST	SPR	R0
1	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
2	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
3	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
4	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
5	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
6	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
7	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
8	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
9	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
10	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
11	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
12	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
13	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
14	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
15	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
16	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
17	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
18	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
19	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
20	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
21	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
22	2848.73	0.829849	5226.28	0.138316	156.986	1.592735	0.466095	0.085839	880.7378
23	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
24	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
25	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
26	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
27	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
28	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
29	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
30	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
31	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
32	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
33	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
34	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
35	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
36	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
37	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
38	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
39	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
40	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
41	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
42	2848.75	0.829848	5226.64	0.138314	156.971	1.592942	0.465985	0.085822	880.7995
43	2849.14	0.83035	5223	0.138606	157.154	1.598596	0.463835	0.085485	880.1831
44	2849.14	0.83035	5223	0.138606	157.154	1.598596	0.463835	0.085485	880.1831
45	2858.83	0.832512	5164.79	0.141155	156.174	1.568161	0.483413	0.087806	870.3801
46	2858.86	0.832521	5165.03	0.141159	156.16	1.568453	0.483265	0.087785	870.4149
47	2859.31	0.833491	5141.93	0.141802	155.982	1.56279	0.486945	0.088117	866.5242
48	2859.31	0.833492	5141.9	0.141802	155.983	1.562775	0.486955	0.08812	866.5155
49	2859.31	0.833492	5141.9	0.141802	155.983	1.562775	0.486955	0.08812	866.5155
50	2893.63	0.836894	4992.62	0.140958	151.892	1.537836	0.495206	0.08638	841.3603

Table 11.1.5.3. Model quantities from the jitter analysis for the GA-NC stock.

Rank	TOTAL	Steepness	SPB_Virgin	F_MSY	MSY	F/F_MSY	SSB/SSB_MSST	SPR	R0
1	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
2	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
3	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
4	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
5	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
6	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
7	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
8	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
9	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
10	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
11	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
12	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
13	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
14	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
15	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
16	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
17	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
18	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
19	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
20	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
21	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
22	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
23	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
24	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
25	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
26	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
27	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
28	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
29	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
30	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
31	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
32	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
33	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
34	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
35	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
36	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
37	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
38	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
39	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
40	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
41	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
42	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
43	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
44	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
45	825.457	0.90947	190.425	0.312052	11.9897	1.174311	1.449468	0.238424	32.09082
46	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
47	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
48	825.457	0.90947	190.425	0.312053	11.9897	1.174307	1.449468	0.238424	32.09082
49	834.824	0.908179	191.448	0.323445	11.9748	1.119381	1.506814	0.235152	32.26297
50	835.077	0.905265	188.122	0.316763	11.1341	1.115391	1.569124	0.218697	31.70232

Table 11.2.4.1. Derived quantity estimates from the WFL stock based model configuration.

	SSB		Recruits		F		SPR	
Year	**Value**	**StdDev**	**Value**	**StdDev**	**Value**	**StdDev**	**Value**	**StdDev**
1986	920.396	147.440	430.399	257.221	0.051	0.008	0.576	0.092
1987	1004.260	153.572	342.268	181.176	0.048	0.007	0.614	0.078
1988	1074.830	164.163	340.991	177.134	0.046	0.007	0.619	0.072
1989	1128.140	175.977	311.208	157.409	0.052	0.008	0.540	0.069
1990	1152.210	186.502	381.453	176.041	0.025	0.004	0.719	0.041
1991	1203.280	195.399	324.126	143.970	0.119	0.018	0.175	0.049
1992	1086.270	195.511	413.565	135.819	0.068	0.011	0.306	0.066
1993	1051.360	197.999	501.298	148.274	0.106	0.019	0.151	0.044
1994	971.591	198.817	233.693	101.124	0.064	0.013	0.307	0.070
1995	946.245	202.087	250.896	101.600	0.058	0.012	0.368	0.071
1996	926.385	205.090	665.917	169.732	0.033	0.007	0.571	0.064
1997	953.130	211.076	347.215	122.765	0.048	0.010	0.428	0.068
1998	960.750	216.443	411.565	132.897	0.041	0.009	0.518	0.063
1999	983.525	222.316	572.193	131.540	0.050	0.011	0.478	0.064
2000	1007.800	228.755	128.914	51.781	0.030	0.007	0.644	0.053
2001	1036.650	233.394	102.540	35.285	0.048	0.011	0.512	0.058
2002	1028.140	235.086	442.826	98.454	0.034	0.008	0.605	0.053
2003	1037.510	237.580	144.476	55.563	0.085	0.019	0.224	0.053
2004	956.266	236.822	199.144	68.029	0.058	0.014	0.322	0.068
2005	908.893	234.625	576.575	117.640	0.031	0.008	0.546	0.068
2006	914.274	234.798	1796.050	260.846	0.032	0.008	0.516	0.067
2007	1008.740	245.257	717.673	117.283	0.032	0.007	0.558	0.059
2008	1124.570	257.918	759.914	114.206	0.069	0.015	0.454	0.058
2009	1225.820	273.026	166.482	32.340	0.044	0.010	0.645	0.048
2010	1316.980	286.430	169.930	33.445	0.082	0.017	0.454	0.058
2011	1315.270	295.924	362.216	70.344	0.043	0.010	0.614	0.053
2012	1340.350	304.109	1099.780	253.254	0.066	0.015	0.396	0.064

Table 11.2.4.2. Derived quantity estimates from the FLK/EFL stock based model configuration.

	SSB		Recruits		F		SPR	
Year	Value	StdDev	Value	StdDev	Value	StdDev	Value	StdDev
1986	483.272	63.794	1041.100	530.129	0.340	0.044	0.101	0.025
1987	500.793	59.481	731.938	332.325	0.586	0.040	0.049	0.008
1988	384.004	41.654	637.245	236.364	0.464	0.030	0.070	0.008
1989	359.979	30.717	1255.880	205.659	0.304	0.021	0.128	0.014
1990	429.268	28.927	280.353	119.147	0.360	0.017	0.093	0.008
1991	426.073	27.775	1497.100	180.831	0.299	0.016	0.143	0.011
1992	499.956	27.133	706.572	169.277	0.439	0.019	0.071	0.004
1993	463.898	23.900	441.279	98.720	0.432	0.016	0.079	0.005
1994	427.102	20.779	267.420	48.587	0.493	0.016	0.070	0.004
1995	336.233	17.382	441.576	46.285	0.410	0.016	0.084	0.004
1996	288.005	15.400	300.647	38.706	0.387	0.016	0.081	0.004
1997	248.224	14.535	416.156	38.303	0.356	0.017	0.093	0.005
1998	234.767	14.723	544.483	42.181	0.249	0.013	0.147	0.010
1999	262.259	16.114	448.404	41.466	0.292	0.015	0.118	0.007
2000	278.803	17.423	490.012	47.747	0.139	0.007	0.305	0.016
2001	342.692	19.662	461.125	49.365	0.197	0.010	0.224	0.013
2002	382.707	21.282	463.677	46.834	0.211	0.010	0.201	0.011
2003	410.120	22.319	297.295	34.724	0.324	0.014	0.107	0.006
2004	369.753	22.042	348.330	36.400	0.272	0.014	0.134	0.008
2005	350.799	22.159	595.843	44.103	0.298	0.016	0.113	0.007
2006	334.344	22.032	551.118	46.312	0.181	0.010	0.202	0.012
2007	371.592	22.375	641.672	46.294	0.329	0.016	0.094	0.005
2008	362.590	21.540	385.306	39.217	0.437	0.021	0.067	0.003
2009	308.331	20.366	520.920	43.992	0.325	0.018	0.106	0.007
2010	310.436	21.151	415.625	45.418	0.240	0.014	0.161	0.011
2011	332.726	22.821	526.588	50.296	0.117	0.007	0.374	0.018
2012	399.287	25.490	209.227	62.133	0.379	0.022	0.086	0.006

Table 11.2.4.3. Derived quantity estimates from the GA-NC stock based model configuration.

	SSB		Recruits		F		SPR	
Year	**Value**	**StdDev**	**Value**	**StdDev**	**Value**	**StdDev**	**Value**	**StdDev**
1986	83.303	5.013	35.717	18.078	0.662	0.032	0.183	0.009
1987	46.863	3.741	31.862	18.814	0.250	0.019	0.262	0.014
1988	46.131	3.918	82.867	32.794	0.101	0.008	0.397	0.024
1989	54.437	4.268	45.051	33.439	0.137	0.010	0.332	0.019
1990	61.073	4.811	111.042	36.162	0.246	0.019	0.243	0.013
1991	66.376	5.406	32.873	19.431	0.155	0.012	0.285	0.017
1992	74.604	6.172	43.026	17.453	0.210	0.017	0.246	0.014
1993	78.868	6.893	34.131	15.140	0.203	0.018	0.256	0.015
1994	81.858	7.525	36.775	13.084	0.125	0.011	0.348	0.022
1995	88.034	8.055	31.397	12.071	0.850	0.042	0.141	0.007
1996	47.795	2.903	53.286	15.181	0.156	0.009	0.297	0.013
1997	53.652	3.294	28.829	13.139	0.212	0.013	0.263	0.010
1998	55.765	3.634	30.815	11.732	0.190	0.012	0.286	0.012
1999	58.056	3.930	20.084	8.808	0.229	0.015	0.263	0.011
2000	57.076	4.152	36.578	10.604	0.193	0.013	0.296	0.014
2001	57.907	4.314	82.135	12.633	0.113	0.008	0.399	0.019
2002	64.880	4.469	106.170	12.500	0.184	0.011	0.310	0.014
2003	71.406	4.535	19.854	5.972	0.061	0.003	0.503	0.022
2004	82.731	4.688	13.527	5.189	0.114	0.006	0.374	0.016
2005	88.356	4.755	22.959	8.210	0.158	0.008	0.326	0.012
2006	89.035	4.678	22.659	8.150	0.187	0.009	0.313	0.011
2007	86.272	4.621	13.397	5.200	0.160	0.008	0.359	0.012
2008	83.683	4.705	13.093	5.160	0.226	0.012	0.316	0.010
2009	75.249	4.870	12.963	5.731	0.210	0.014	0.332	0.011
2010	67.398	5.153	18.581	9.103	0.393	0.030	0.242	0.010
2011	50.252	5.527	30.146	17.252	0.345	0.038	0.251	0.016
2012	40.767	6.135	34.997	21.342	0.363	0.055	0.238	0.021

Table 11.2.7.1.1. Estimates of parameters, derived quantities, BRPs, and stock status from both the base run and bootstrap analyses for the WFL stock base model configuration.

Parameter / Quantity	Base Run	Bootstrap Runs						
		2.5%	25%	50%	75%	97.5%	Mean	SD
SSB_Virgin	2688.260	2145.328	2430.160	2630.730	2852.380	3439.694	2671.403	331.389
SSB_2012	1340.350	742.643	955.948	1093.100	1272.410	1640.568	1125.053	236.120
MSY	76.577	57.568	66.865	73.750	79.805	92.658	73.564	9.266
SPR	0.396	0.158	0.286	0.355	0.427	0.551	0.357	0.106
R0	453.031	361.540	409.697	443.621	480.845	579.069	450.326	55.722
Steepness	0.847	0.649	0.789	0.840	0.870	0.912	0.822	0.068
FMSY	0.150	0.071	0.117	0.146	0.169	0.218	0.143	0.038
F/FMSY	0.409	0.280	0.408	0.501	0.631	1.141	0.556	0.225
MSSTMSY	382.788	260.896	331.801	387.244	456.537	710.428	411.399	115.885
SSB/MSSTMSY	3.502	1.484	2.392	2.940	3.338	4.058	2.860	0.685
F30%	0.095	0.094	0.095	0.096	0.097	0.099	0.096	0.001
F/F30%	0.643	0.453	0.613	0.719	0.833	1.093	0.732	0.164
MSST30%	589.233	452.899	525.109	563.313	616.215	711.408	571.482	68.021
SSB/MSST30%	2.275	1.540	1.859	2.013	2.185	2.541	2.037	0.277
F35%	0.077	0.075	0.076	0.077	0.078	0.079	0.077	0.001
F/F35%	0.801	0.553	0.801	0.926	1.086	1.410	0.943	0.221
MSST35%	704.792	543.045	625.103	669.482	727.340	853.710	680.141	78.847
SSB/MSST35%	1.902	1.289	1.526	1.642	1.781	2.126	1.665	0.209
F40%	0.062	0.061	0.062	0.063	0.063	0.065	0.063	0.001
F/F40%	0.985	0.702	0.965	1.144	1.338	1.761	1.167	0.266
MSST40%	820.352	632.849	722.358	775.545	846.640	1001.798	791.500	95.166
SSB/MSST40%	1.634	1.055	1.288	1.402	1.509	1.803	1.407	0.176

Table 11.2.7.1.2. Estimates of parameters, derived quantities, BRPs, and stock status from both the base run and bootstrap analyses for the FLK/EFL stock base model configuration.

Parameter / Quantity	Base Run	Bootstrap Runs						
		2.5%	25%	50%	75%	97.5%	Mean	SD
SSB_Virgin	5226.280	3899.018	4671.985	5219.785	5797.073	7478.715	5321.745	902.536
SSB_2012	399.287	337.624	383.302	416.169	449.684	533.745	420.070	49.895
MSY	156.986	129.383	145.136	156.973	170.060	207.377	159.329	19.914
SPR	0.086	0.045	0.072	0.092	0.124	0.254	0.110	0.085
R0	880.738	658.303	785.614	879.198	976.600	1256.648	896.245	151.846
Steepness	0.830	0.772	0.807	0.831	0.857	0.911	0.833	0.035
FMSY	0.138	0.111	0.127	0.140	0.155	0.204	0.143	0.022
F/FMSY	1.593	0.876	1.237	1.440	1.681	2.160	1.470	0.330
MSSTMSY	856.664	505.969	712.438	848.688	994.740	1359.576	867.481	220.267
SSB/MSSTMSY	0.466	0.287	0.406	0.494	0.598	0.904	0.518	0.157
F30%	0.105	0.101	0.103	0.104	0.106	0.109	0.104	0.002
F/F30%	2.103	1.345	1.707	1.915	2.207	2.730	1.959	0.368
MSST30%	1124.951	891.011	1044.521	1134.499	1235.634	1464.011	1149.940	150.029
SSB/MSST30%	0.355	0.253	0.324	0.366	0.420	0.523	0.371	0.068
F35%	0.085	0.081	0.083	0.084	0.086	0.088	0.084	0.002
F/F35%	2.601	1.694	2.182	2.450	2.760	3.315	2.478	0.429
MSST35%	1351.087	1035.708	1224.571	1348.406	1473.250	1769.142	1364.279	195.586
SSB/MSST35%	0.296	0.210	0.271	0.310	0.350	0.421	0.310	0.056
F40%	0.069	0.066	0.068	0.069	0.070	0.072	0.069	0.001
F/F40%	3.179	2.043	2.557	2.898	3.277	4.030	2.936	0.519
MSST40%	1577.215	1225.664	1435.929	1561.817	1729.566	2130.550	1596.832	231.292
SSB/MSST40%	0.253	0.182	0.237	0.270	0.301	0.368	0.270	0.049

Table 11.2.7.1.3. Estimates of parameters, derived quantities, BRPs, and stock status from both the base run and bootstrap analyses for the GA-NC stock base model configuration.

Parameter / Quantity	Base Run	Bootstrap Runs						
		2.5%	25%	50%	75%	97.5%	Mean	SD
SSB_Virgin	190.425	187.837	209.921	222.675	237.796	268.560	224.664	21.851
SSB_2012	40.767	40.773	50.027	56.420	63.772	84.460	58.127	12.656
MSY	11.9897	12.118	13.564	14.378	15.341	17.601	14.531	1.448
SPR	0.238424	0.202	0.258	0.288	0.317	0.404	0.295	0.069
R0	32.09082	31.703	35.360	37.480	40.049	45.253	37.836	3.668
Steepness	0.90947	0.887	0.922	0.930	0.938	0.950	0.928	0.016
FMSY	0.312053	0.277	0.325	0.343	0.361	0.400	0.342	0.030
F/FMSY	1.174307	0.558	0.728	0.823	0.913	1.116	0.824	0.149
MSSTMSY	28.12549	25.304	28.482	30.706	32.843	38.410	30.975	3.496
SSB/MSSTMSY	1.449468	1.431	1.688	1.844	2.001	2.466	1.871	0.283
F30%	0.196849	0.190	0.195	0.197	0.199	0.203	0.197	0.003
F/F30%	1.861559	1.023	1.272	1.431	1.576	1.877	1.434	0.222
MSST30%	44.10888	45.110	49.383	52.236	55.340	63.380	52.650	4.760
SSB/MSST30%	0.924236	0.872	0.993	1.074	1.164	1.349	1.081	0.118
F35%	0.16106	0.155	0.159	0.161	0.163	0.166	0.161	0.003
F/F35%	2.275215	1.176	1.505	1.701	1.923	2.310	1.716	0.299
MSST35%	52.12529	52.340	58.492	62.315	65.284	75.688	62.479	5.789
SSB/MSST35%	0.782096	0.729	0.863	0.931	1.001	1.166	0.937	0.110
F40%	0.133174	0.129	0.132	0.133	0.135	0.137	0.133	0.002
F/F40%	2.751634	1.503	1.876	2.118	2.326	2.746	2.112	0.329
MSST40%	60.14178	60.390	66.748	70.533	75.164	86.327	71.250	6.349
SSB/MSST40%	0.677848	0.649	0.732	0.788	0.847	0.989	0.795	0.090

Table 11.2.7.2.1. Select parameters for the sensitivity runs from the WFL stock. Note: only those parameters from fisheries where the asymptotic size selectivity restriction was removed in the "no_flattop" sensitivity are presented. For the size selectivity, the "Peak" parameter refers to the start of the full selectivity, while the "End" parameter refers to the shape, where -15 is fully dome-shaped (selectivity at maximum size is 0.0) and 15 is asymptotic (selectivity at maximum size is 1.0).

Sensitivity Run	SSB0	R0	Steepness	L_Amax	VB_K	Comm Spear Size Selectivity		Comm HL Size Selectivity	
						Peak	End	Peak	End
Base	2688.26	6.12	0.85	84.89	0.11	33.87	-1.43	21.85	15.00
Start_1981	1846.45	5.74	0.97	84.89	0.11	33.96	-1.21	21.93	15.00
Start_1950	1743.77	5.68	0.97	84.89	0.11	33.97	-1.17	21.95	15.00
No_baitfish	2613.63	6.09	0.86	84.89	0.11	33.99	-1.29	21.90	15.00
No_SEAMAP	2481.70	6.04	0.85	84.89	0.11	34.00	-1.26	21.91	15.00
No_video	2341.82	5.98	0.84	84.89	0.11	33.83	-1.41	21.86	15.00
No_age0	2539.02	6.06	0.85	84.89	0.11	33.85	-1.43	21.84	15.00
Calibrate_PSEs	2538.62	6.06	0.89	84.89	0.11	33.93	-1.14	24.01	15.00
MRFSS_PSEs	2381.78	5.99	0.85	84.89	0.11	33.92	-1.28	21.91	15.00
No_h_prior	2526.52	6.05	0.99	84.89	0.11	33.87	-1.44	21.85	15.00
No_flattop	3186.50	6.29	0.84	84.89	0.11	33.80	-1.71	21.86	-10.42
FemaleSSB	586.76	6.07	0.87	84.89	0.11	33.87	-1.43	21.85	15.00
FemaleEggs	335.32	6.07	0.87	84.89	0.11	33.87	-1.43	21.85	15.00
FemaleSSB_Inshore	353.18	6.07	0.87	84.89	0.11	33.87	-1.43	21.85	15.00
FemaleSSB_Offshore	797.49	6.08	0.87	84.89	0.11	33.87	-1.43	21.85	15.00
AgeCompIn	797.49	6.08	0.87	84.89	0.11	33.87	-1.43	21.85	15.00
NoAgeData	2244.65	5.94	0.87	84.89	0.11	34.45	-0.81	24.47	15.00
GrowthEst	1728.41	5.97	0.90	79.39	0.09	34.38	-9.82	22.62	15.00
MaxAge20	2449.48	6.45	0.85	84.89	0.11	33.89	-1.35	21.89	15.00
MaxAge30	2981.70	5.88	0.85	84.89	0.11	33.86	-1.49	21.83	15.00
AltMaturityFx	2624.84	6.12	0.84	84.89	0.11	33.87	-1.43	21.85	15.00
AltGrowthFx	1600.97	6.12	0.90	75.36	0.08	34.84	-7.36	22.64	15.00

Table 11.2.7.2.2. Select parameters for the sensitivity runs from the FLK/EFL stock. Note: only those parameters from fisheries where the asymptotic size selectivity restriction was removed in the "no_flattop" sensitivity are presented. For the size selectivity, the "Peak" parameter refers to the start of the full selectivity, while the "End" parameter refers to the shape, where -15 is fully dome-shaped (selectivity at maximum size is 0.0) and 15 is asymptotic (selectivity at maximum size is 1.0).

Sensitivity Run	SSB0	R0	Steepness	L_Amax	VB_K	Comm Spear Size Selectivity		Comm HL Size Selectivity		Comm Trap Size Selectivity		RVC Tortugas Size Selectivity	
						Peak	End	Peak	End	Peak	End	Peak	End
Base	5226.28	6.78	0.83	84.89	0.11	31.46	0.05	30.88	15.00	34.40	15.00	41.89	15.00
Start_1981	15007.90	7.84	0.73	84.89	0.11	31.45	0.07	30.84	15.00	34.46	15.00	42.10	15.00
Start_1950	0.00	7.82	0.73	84.89	0.11	31.46	0.05	30.89	15.00	34.40	15.00	41.89	15.00
Calibrate_PSEs	5113.60	6.76	0.87	84.89	0.11	31.47	0.20	31.11	15.00	34.66	15.00	43.01	15.00
MRFSS_PSEs	5245.36	6.78	0.83	84.89	0.11	31.45	0.10	30.96	15.00	34.51	15.00	42.46	15.00
No_h_prior	5232.54	6.78	0.83	84.89	0.11	31.46	0.05	30.88	15.00	34.40	15.00	41.89	15.00
No_flattop	5686.12	6.87	0.73	84.89	0.11	31.29	-1.39	30.57	-2.17	33.54	-3.45	36.02	-4.49
FemaleSSB	1057.60	6.66	0.58	84.89	0.11	31.46	0.05	30.88	15.00	34.40	15.00	41.86	15.00
FemaleEggs	580.87	6.62	0.52	84.89	0.11	31.44	0.06	30.88	15.00	34.40	15.00	41.85	15.00
FemaleSSB_Inshore	604.56	6.60	0.52	84.89	0.11	31.46	0.11	30.88	15.00	34.41	15.00	41.92	15.00
FemaleSSB_Offshore	1484.28	6.70	0.63	84.89	0.11	31.44	0.06	30.88	15.00	34.40	15.00	41.88	15.00
AgeCompIn	5361.97	6.81	0.83	84.89	0.11	31.51	0.27	31.10	15.00	34.64	15.00	44.35	15.00
NoAgeData	5356.00	6.81	0.84	84.89	0.11	31.51	0.28	31.08	15.00	34.65	15.00	44.45	15.00
GrowthEst	4410.18	7.16	0.75	74.08	0.09	31.46	0.35	30.93	15.00	34.59	15.00	43.54	15.00
MaxAge20	4074.67	6.96	0.79	84.89	0.11	31.48	0.06	30.93	15.00	34.44	15.00	41.81	15.00
MaxAge30	6435.22	6.65	0.86	84.89	0.11	31.44	0.04	30.84	15.00	34.38	15.00	41.95	15.00
AltMaturityFx	4929.57	6.78	0.85	84.89	0.11	31.46	0.05	30.88	15.00	34.40	15.00	41.89	15.00
AltGrowthFx	2016.64	6.94	0.78	42.61	0.26	30.61	0.01	30.41	15.00	34.45	15.00	50.00	15.00

Table 11.2.7.2.3. Select parameters for the sensitivity runs from the GA-NC stock. Note: only those parameters from fisheries where the asymptotic size selectivity restriction was removed in the "no_flattop" sensitivity are presented. For the size selectivity, the "Peak" parameter refers to the start of the full selectivity, while the "End" parameter refers to the shape, where -15 is fully dome-shaped (selectivity at maximum size is 0.0) and 15 is asymptotic (selectivity at maximum size is 1.0).

Sensitivity Run	SSB0	R0	Steepness	L_Amax	VB_K	Comm Spear Size Selectivity		Comm HL Size Selectivity		Rec HL Size Selectivity	
						Peak	End	Peak	End	Peak	End
Base	190.43	3.47	0.91	84.89	0.11	65.98	15.00	63.11	15.00	61.61	15.00
Start_1981	220.78	3.62	0.80	84.89	0.11	68.51	15.00	63.45	15.00	61.05	15.00
Calibrate_PSEs	251.50	3.75	0.91	84.89	0.11	68.88	15.00	64.62	15.00	62.86	15.00
MRFSS_PSEs	238.04	3.69	0.90	84.89	0.11	68.09	15.00	63.85	15.00	62.06	15.00
No_h_prior	183.60	3.43	1.00	84.89	0.11	65.96	15.00	63.13	15.00	61.62	15.00
No_flattop	284.42	3.87	0.88	84.89	0.11	50.11	-2.64	57.64	-3.41	54.81	-8.43
FemaleSSB	41.66	3.43	0.85	84.89	0.11	66.00	15.00	63.13	15.00	61.62	15.00
FemaleEggs	23.84	3.42	0.83	84.89	0.11	66.00	15.00	63.13	15.00	61.62	15.00
FemaleSSB_Inshore	25.11	3.42	0.83	84.89	0.11	66.00	15.00	63.12	15.00	61.62	15.00
FemaleSSB_Offshore	56.52	3.43	0.87	84.89	0.11	65.99	15.00	63.12	15.00	61.62	15.00
AgeCompIn	191.22	3.47	0.93	84.89	0.11	76.72	15.00	66.32	15.00	69.29	15.00
NoAgeData	177.99	3.40	0.93	84.89	0.11	80.00	15.00	69.14	15.00	66.58	15.00
GrowthEst	174.78	3.79	0.75	72.45	0.09	79.72	15.00	69.04	15.00	67.98	15.00
MaxAge20	172.67	3.80	0.90	84.89	0.11	65.90	15.00	63.12	15.00	61.81	15.00
MaxAge30	210.19	3.22	0.92	84.89	0.11	66.01	15.00	63.10	15.00	61.46	15.00

Table 11.2.9.1. Projections of F, SSB, and OFL from the WFL stock for alternative MFMTs (F_{MSY}, $F_{30\%,}$ $F_{35\%}$, and $F_{40\%}$), F_0, and $F_{Current}$, where $F_{Current}$ is the geometric mean of the terminal three years (2010-2012).

Year	F						SSB						OFL					
	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY
2010	0.082	0.082	0.082	0.082	0.082	0.082	1317.0	1317.0	1317.0	1317.0	1317.0	1317.0	115.1	115.1	115.1	115.1	115.1	115.1
2011	0.043	0.043	0.043	0.043	0.043	0.043	1315.3	1315.3	1315.3	1315.3	1315.3	1315.3	59.5	59.5	59.5	59.5	59.5	59.5
2012	0.066	0.066	0.066	0.066	0.066	0.066	1340.4	1340.4	1340.4	1340.4	1340.4	1340.4	92.1	92.1	92.1	92.1	92.1	92.1
2013	0.000	0.072	0.062	0.054	0.043	0.096	1344.3	1344.3	1344.3	1344.3	1344.3	1344.3	0.0	102.6	88.7	76.9	61.5	136.1
2014	0.000	0.080	0.069	0.060	0.048	0.106	1453.7	1322.1	1339.9	1355.0	1374.7	1279.1	0.0	112.2	98.5	86.5	70.4	143.4
2015	0.000	0.085	0.074	0.065	0.052	0.112	1564.2	1298.0	1332.1	1361.5	1400.5	1218.1	0.0	116.9	104.3	92.9	76.9	143.6
2016	0.000	0.082	0.071	0.062	0.050	0.106	1671.2	1260.4	1310.0	1353.5	1412.2	1147.5	0.0	107.9	97.8	88.3	74.4	127.9
2017	0.000	0.077	0.067	0.058	0.047	0.101	1769.5	1215.9	1278.9	1334.9	1412.0	1076.8	0.0	98.2	89.8	81.7	69.6	114.0
2018	0.000	0.075	0.065	0.056	0.045	0.099	1860.6	1173.4	1247.4	1314.2	1407.5	1014.2	0.0	91.7	84.3	77.0	66.0	105.5
2019	0.000	0.074	0.063	0.055	0.044	0.099	1944.5	1134.6	1217.8	1293.7	1401.2	959.5	0.0	87.8	80.9	74.1	63.7	100.4
2020	0.000	0.074	0.063	0.054	0.043	0.101	2019.5	1097.8	1188.7	1272.5	1392.6	909.9	0.0	85.4	78.8	72.4	62.4	97.1
2021	0.000	0.075	0.064	0.054	0.043	0.103	2087.5	1064.1	1161.6	1252.3	1383.4	865.7	0.0	83.7	77.5	71.2	61.6	94.7
2022	0.000	0.076	0.064	0.055	0.043	0.106	2150.5	1034.2	1137.3	1234.1	1375.1	827.0	0.0	82.5	76.5	70.5	61.1	92.9
2023	0.000	0.077	0.065	0.055	0.043	0.109	2205.7	1005.4	1113.5	1215.5	1365.2	791.1	0.0	81.5	75.8	69.9	60.7	91.4
2024	0.000	0.078	0.066	0.055	0.043	0.112	2256.0	979.3	1091.6	1198.2	1355.6	758.9	0.0	80.7	75.2	69.4	60.4	90.1
2025	0.000	0.079	0.066	0.056	0.043	0.114	2302.8	956.2	1072.2	1183.0	1347.3	730.6	0.0	80.1	74.6	69.1	60.2	89.0
2026	0.000	0.080	0.067	0.056	0.043	0.116	2349.9	937.5	1057.0	1171.7	1342.6	707.0	0.0	79.5	74.2	68.8	60.1	87.9
2027	0.000	0.081	0.068	0.056	0.043	0.119	2384.9	916.2	1038.4	1156.1	1332.4	682.4	0.0	79.0	73.8	68.5	59.9	87.0
2028	0.000	0.083	0.068	0.057	0.043	0.122	2416.6	896.6	1021.2	1141.6	1322.7	660.1	0.0	78.5	73.5	68.2	59.8	86.2
2029	0.000	0.084	0.069	0.057	0.044	0.124	2441.4	877.6	1003.9	1126.5	1311.6	639.1	0.0	78.0	73.2	68.0	59.7	85.4
2030	0.000	0.085	0.070	0.058	0.044	0.127	2464.8	860.7	988.7	1113.3	1301.9	620.6	0.0	77.6	72.9	67.8	59.5	84.6
2031	0.000	0.086	0.070	0.058	0.044	0.129	2488.2	846.1	975.6	1102.0	1294.0	604.4	0.0	77.2	72.6	67.6	59.4	83.9
2032	0.000	0.087	0.071	0.059	0.044	0.131	2514.9	834.1	965.2	1093.6	1289.1	590.5	0.0	76.9	72.3	67.4	59.4	83.3

Table 11.2.9.2. Projections of F, SSB, and OFL from the FLK/EFL stock for alternative MFMTs (F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$), F_0, and $F_{Current}$, where $F_{Current}$ is the geometric mean of the terminal three years (2010-2012).

Year	F						SSB						OFL					
	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY
2010	0.240	0.240	0.240	0.240	0.240	0.240	310.4	310.4	310.4	310.4	310.4	310.4	86.9	86.9	86.9	86.9	86.9	86.9
2011	0.117	0.117	0.117	0.117	0.117	0.117	332.7	332.7	332.7	332.7	332.7	332.7	45.2	45.2	45.2	45.2	45.2	45.2
2012	0.379	0.379	0.379	0.379	0.379	0.379	399.3	399.3	399.3	399.3	399.3	399.3	173.7	173.7	173.7	173.7	173.7	173.7
2013	0.000	0.149	0.128	0.110	0.257	0.180	336.6	336.6	336.6	336.6	336.6	336.6	0.0	56.5	48.5	41.8	97.6	68.6
2014	0.000	0.140	0.120	0.104	0.239	0.169	431.1	377.5	385.0	391.4	338.7	366.1	0.0	59.7	52.4	46.0	92.0	70.1
2015	0.000	0.136	0.117	0.101	0.236	0.165	543.9	423.5	439.3	452.9	348.1	400.4	0.0	65.4	58.2	51.6	93.9	75.2
2016	0.000	0.137	0.117	0.101	0.241	0.167	675.5	475.9	500.6	522.1	364.6	440.6	0.0	73.7	66.2	59.3	101.0	83.6
2017	0.000	0.137	0.117	0.101	0.245	0.168	824.9	531.5	566.1	596.6	382.4	483.0	0.0	82.3	74.6	67.3	107.6	92.1
2018	0.000	0.137	0.117	0.100	0.246	0.168	990.1	587.8	633.3	673.8	398.9	525.0	0.0	90.3	82.5	75.0	112.7	99.7
2019	0.000	0.135	0.115	0.098	0.246	0.167	1168.4	643.1	700.2	751.8	413.8	565.4	0.0	97.4	89.7	82.0	116.9	106.3
2020	0.000	0.134	0.113	0.097	0.246	0.165	1357.0	696.9	766.1	829.2	427.1	603.9	0.0	103.8	96.2	88.4	120.3	112.1
2021	0.000	0.132	0.111	0.095	0.245	0.164	1553.3	748.7	830.3	905.3	439.3	640.4	0.0	109.5	102.0	94.2	123.2	117.3
2022	0.000	0.130	0.109	0.093	0.244	0.162	1754.1	798.0	892.1	979.1	450.3	674.6	0.0	114.5	107.2	99.4	125.7	121.8
2023	0.000	0.128	0.107	0.091	0.244	0.160	1956.8	844.8	951.1	1050.2	460.2	706.7	0.0	119.0	111.8	104.0	127.8	125.8
2024	0.000	0.126	0.105	0.089	0.243	0.158	2159.0	888.8	1007.1	1118.2	469.1	736.5	0.0	122.9	116.0	108.2	129.7	129.3
2025	0.000	0.124	0.104	0.087	0.242	0.156	2358.9	930.2	1060.1	1182.8	477.3	764.2	0.0	126.4	119.6	111.8	131.4	132.4
2026	0.000	0.122	0.102	0.086	0.241	0.155	2554.4	968.8	1109.9	1243.9	484.7	789.8	0.0	129.5	122.8	115.0	132.8	135.1
2027	0.000	0.121	0.100	0.084	0.240	0.153	2744.4	1004.7	1156.5	1301.4	491.4	813.5	0.0	132.2	125.6	117.9	134.1	137.6
2028	0.000	0.119	0.099	0.083	0.239	0.152	2926.9	1037.8	1199.7	1354.8	497.3	835.1	0.0	134.7	128.2	120.4	135.2	139.7
2029	0.000	0.118	0.097	0.081	0.239	0.151	3102.2	1068.5	1239.9	1404.9	502.8	854.9	0.0	136.8	130.4	122.7	136.2	141.6
2030	0.000	0.116	0.096	0.080	0.238	0.149	3268.5	1096.6	1276.9	1451.1	507.6	873.0	0.0	138.7	132.4	124.7	137.1	143.3
2031	0.000	0.115	0.095	0.079	0.238	0.148	3427.0	1122.6	1311.3	1494.2	512.0	889.7	0.0	140.4	134.1	126.4	137.9	144.8
2032	0.000	0.114	0.094	0.078	0.237	0.147	3573.0	1145.9	1342.2	1533.1	515.9	904.5	0.0	141.9	135.7	128.0	138.6	146.1

Table 11.2.9.3. Projections of F, SSB, and OFL from the GA-NC stock for alternative MFMTs (F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$), F_0, and $F_{Current}$, where $F_{Current}$ is the geometric mean of the terminal three years (2010-2012).

Year	F						SSB						OFL					
	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY	F0	FCurr	F30	F35	F40	FMSY
2010	0.393	0.393	0.393	0.393	0.393	0.393	67.4	67.4	67.4	67.4	67.4	67.4	27.5	27.5	27.5	27.5	27.5	27.5
2011	0.345	0.345	0.345	0.345	0.345	0.345	50.3	50.3	50.3	50.3	50.3	50.3	18.2	18.2	18.2	18.2	18.2	18.2
2012	0.363	0.363	0.363	0.363	0.363	0.363	40.8	40.8	40.8	40.8	40.8	40.8	15.8	15.8	15.8	15.8	15.8	15.8
2013	0.000	0.286	0.197	0.148	0.114	0.400	34.4	34.4	34.4	34.4	34.4	34.4	0.0	10.9	7.5	5.6	4.3	15.2
2014	0.000	0.242	0.176	0.135	0.106	0.312	41.1	32.8	35.4	36.8	37.8	29.5	0.0	8.9	6.9	5.5	4.4	10.4
2015	0.000	0.218	0.164	0.129	0.103	0.272	48.5	33.6	37.5	40.0	41.8	29.4	0.0	8.2	6.8	5.7	4.7	9.1
2016	0.000	0.216	0.163	0.130	0.104	0.274	56.3	35.6	40.4	43.6	46.1	31.0	0.0	8.6	7.3	6.2	5.3	9.6
2017	0.000	0.226	0.170	0.135	0.108	0.292	64.4	37.8	43.4	47.3	50.4	32.7	0.0	9.5	8.1	7.0	5.9	10.8
2018	0.000	0.237	0.177	0.141	0.113	0.306	72.5	39.6	46.0	50.6	54.4	33.7	0.0	10.4	9.0	7.8	6.7	11.6
2019	0.000	0.245	0.184	0.146	0.118	0.312	80.6	40.8	48.1	53.5	57.9	34.1	0.0	11.0	9.7	8.5	7.4	11.9
2020	0.000	0.248	0.188	0.150	0.121	0.313	88.6	41.4	49.6	55.8	60.9	34.1	0.0	11.4	10.2	9.1	7.9	12.0
2021	0.000	0.250	0.191	0.153	0.124	0.312	96.3	41.8	50.7	57.6	63.4	34.1	0.0	11.5	10.5	9.5	8.4	11.9
2022	0.000	0.250	0.193	0.155	0.126	0.311	103.8	42.0	51.5	58.9	65.4	34.1	0.0	11.6	10.8	9.9	8.8	11.9
2023	0.000	0.251	0.194	0.157	0.128	0.311	110.8	42.2	52.1	60.0	67.0	34.1	0.0	11.7	11.0	10.1	9.2	11.9
2024	0.000	0.251	0.195	0.158	0.129	0.311	117.4	42.3	52.5	60.8	68.3	34.2	0.0	11.7	11.1	10.3	9.4	11.9
2025	0.000	0.251	0.195	0.158	0.130	0.312	123.7	42.4	52.8	61.4	69.4	34.2	0.0	11.8	11.2	10.5	9.6	12.0
2026	0.000	0.251	0.196	0.159	0.131	0.312	129.6	42.5	53.0	61.9	70.2	34.2	0.0	11.8	11.3	10.6	9.8	12.0
2027	0.000	0.252	0.196	0.160	0.131	0.312	135.1	42.6	53.2	62.3	70.8	34.2	0.0	11.8	11.3	10.7	9.9	12.0
2028	0.000	0.252	0.196	0.160	0.132	0.312	140.1	42.6	53.3	62.6	71.4	34.3	0.0	11.8	11.4	10.7	10.0	12.0
2029	0.000	0.252	0.196	0.160	0.132	0.312	144.8	42.7	53.4	62.8	71.8	34.3	0.0	11.8	11.4	10.8	10.1	12.0
2030	0.000	0.252	0.196	0.160	0.132	0.312	149.2	42.7	53.5	63.0	72.1	34.3	0.0	11.9	11.4	10.8	10.2	12.0
2031	0.000	0.252	0.197	0.161	0.132	0.312	153.3	42.7	53.6	63.1	72.4	34.3	0.0	11.9	11.4	10.9	10.2	12.0
2032	0.000	0.252	0.197	0.161	0.133	0.312	157.0	42.7	53.6	63.2	72.6	34.3	0.0	11.9	11.4	10.9	10.2	12.0

11.7 Figures

Figure 11.1.3.4.1. Year-specific error estimates from the WFL stock for the recreational landings comparing the original MRFSS estimates to those calibrated to the MRIP time-series. Note: the years 2004-2012 of the calibrated time series are the error estimates directly from the MRIP data.

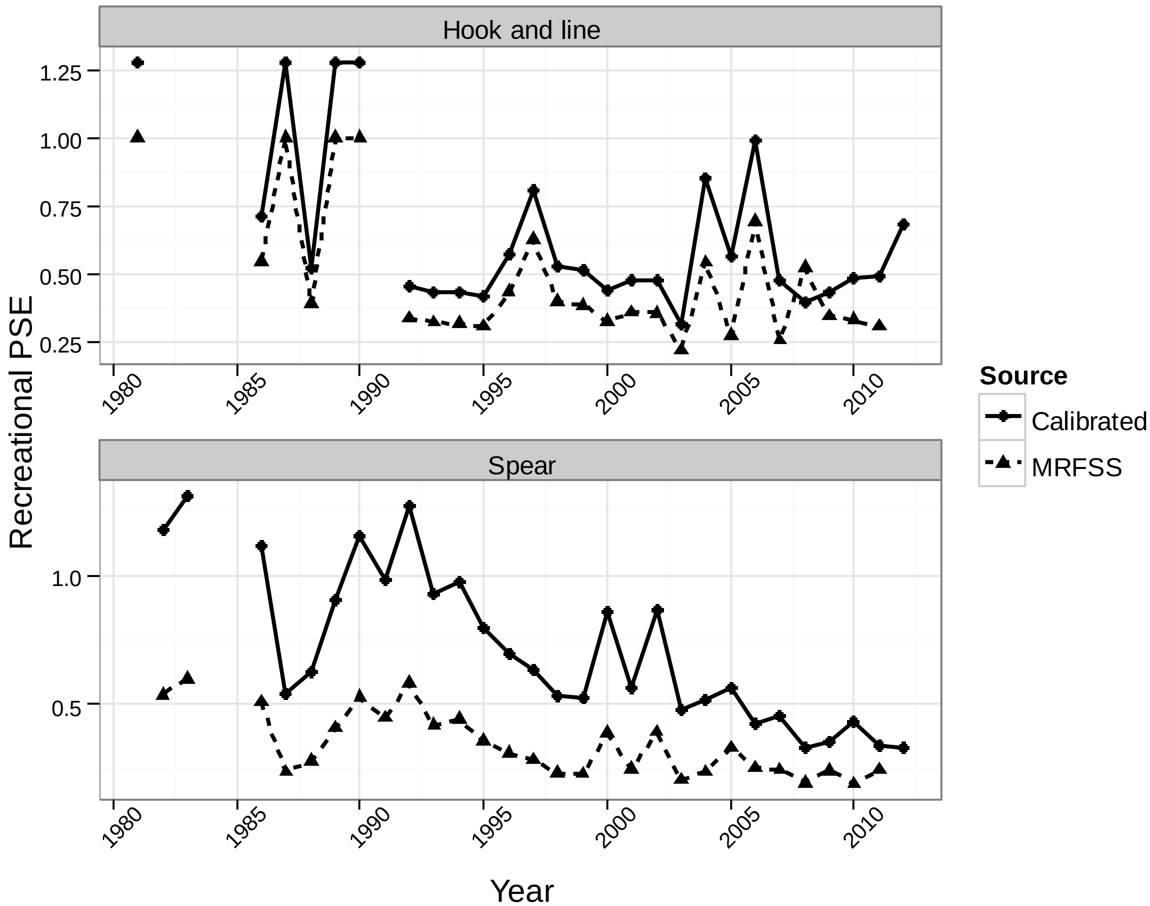


Figure 11.1.3.4.2. Year-specific error estimates from the FLK/EFL stock for the recreational landings comparing the original MRFSS estimates to those calibrated to the MRIP time-series. Note: the years 2004-2012 of the calibrated time series are the error estimates directly from the MRIP data.

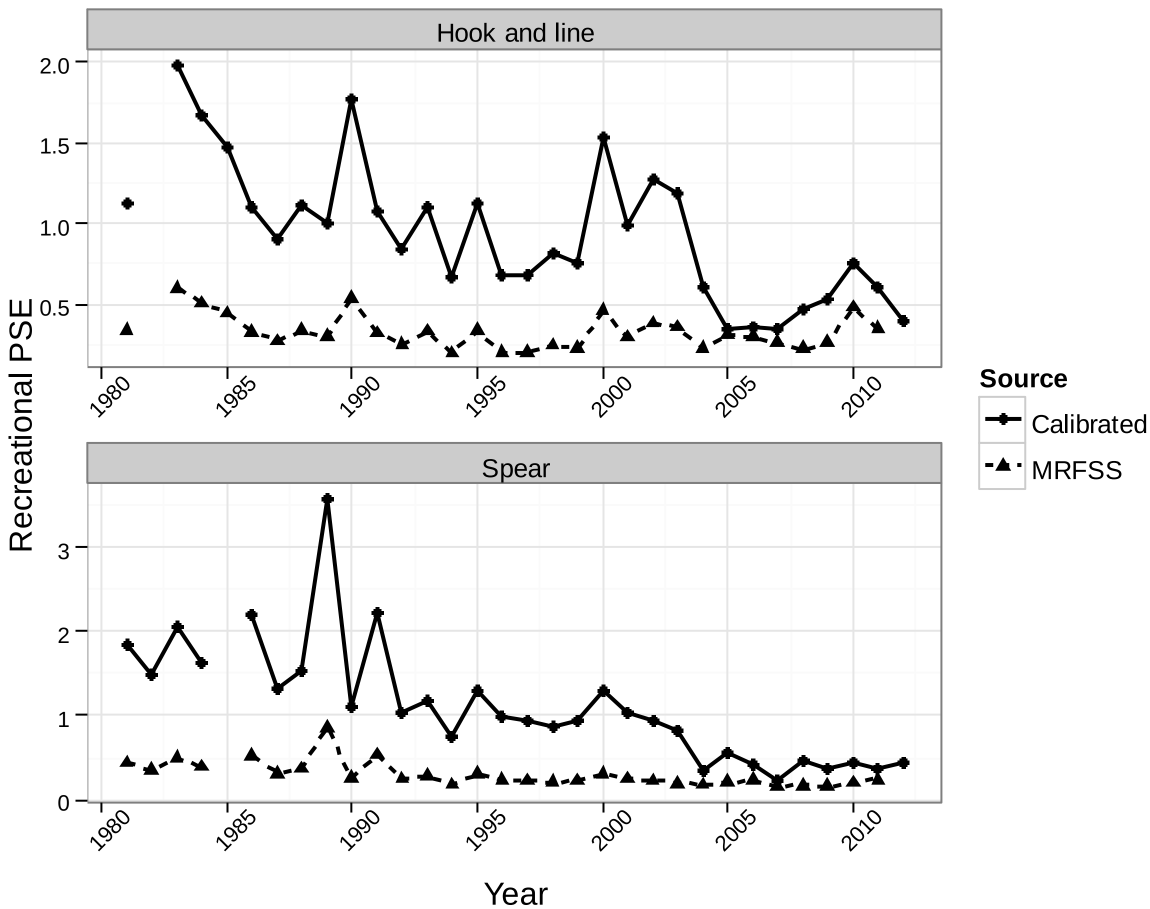


Figure 11.1.3.4.3. Year-specific error estimates from the GA-NC stock for the recreational landings comparing the original MRFSS estimates to those calibrated to the MRIP time-series. Note: the years 2004-2012 of the calibrated time series are the error estimates directly from the MRIP data.

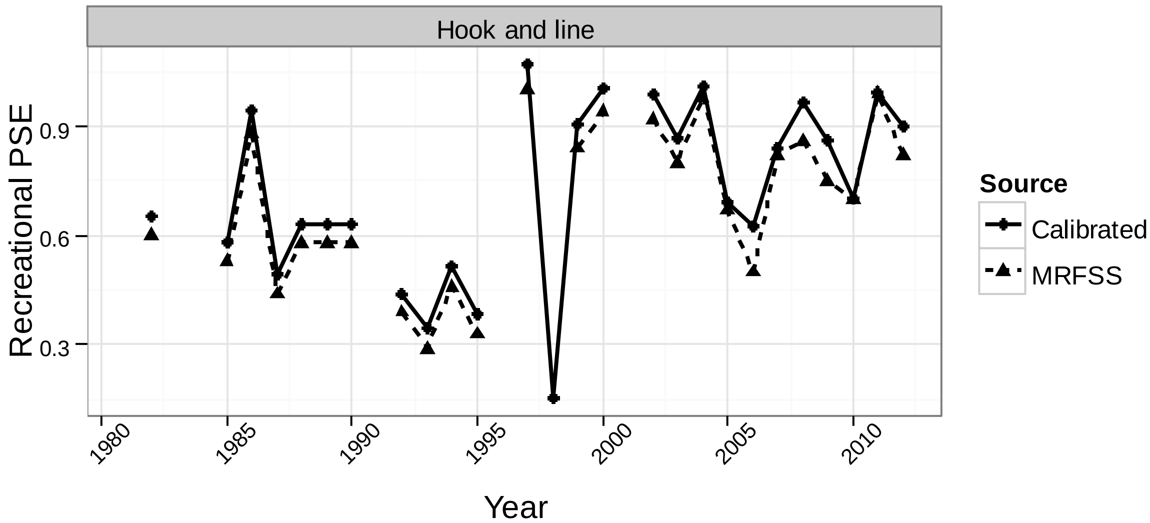


Figure 11.1.5.1. Total negative log-likelihood, stock-recruitment parameters, derived quantities, and stock-status reference points (current F/F_{MSY}, SSB/SSB_{MSST}, and SPR) from the jitter analysis to test for model convergence in the base model of the WFL stock.

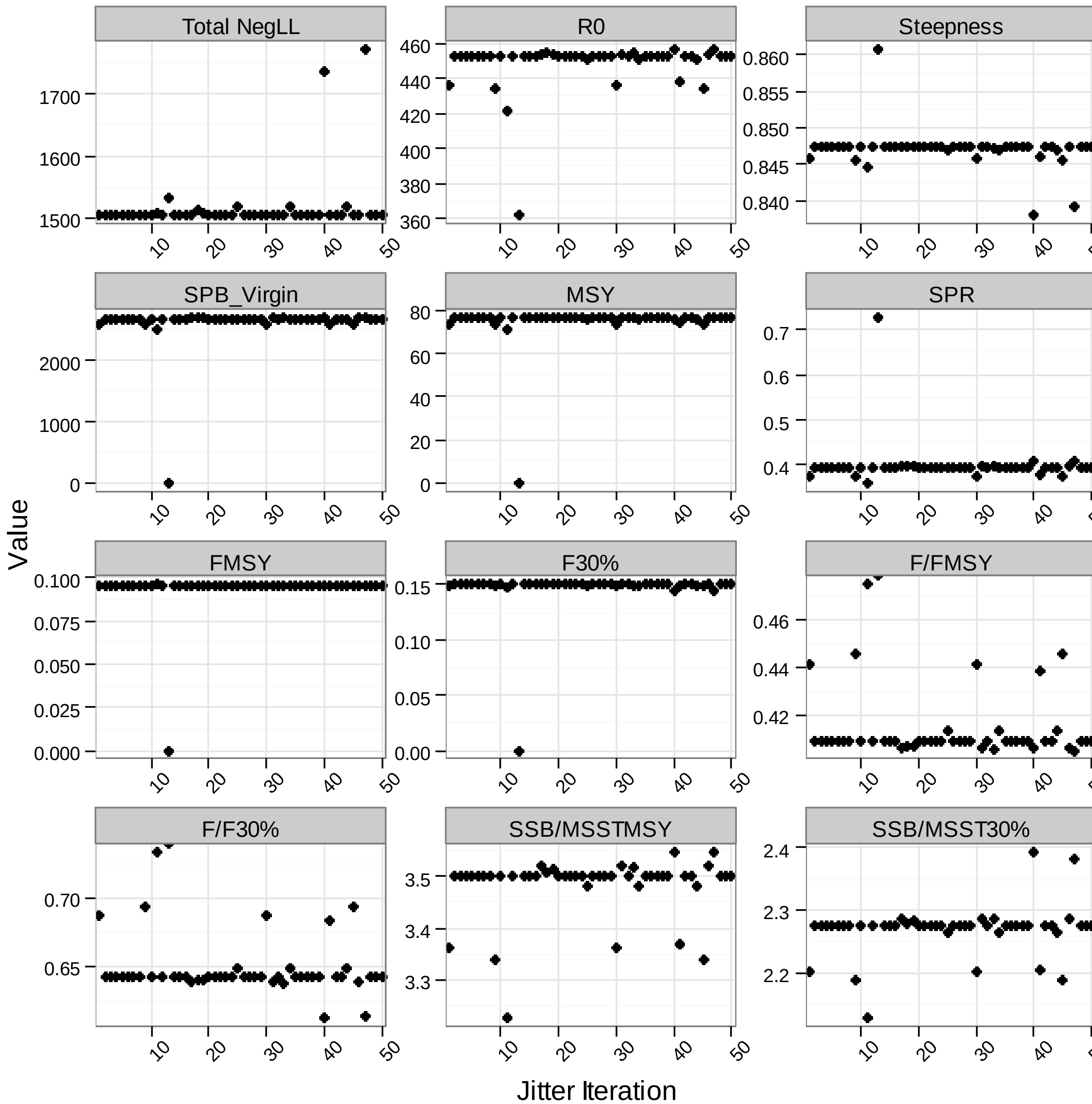


Figure 11.1.5.2. Total negative log-likelihood, stock-recruitment parameters, derived quantities, and stock-status reference points (current F/F_{MSY}, SSB/SSB_{MSST}, and SPR) from the jitter analysis to test for model convergence in the base model of the FLK/EFL stock.

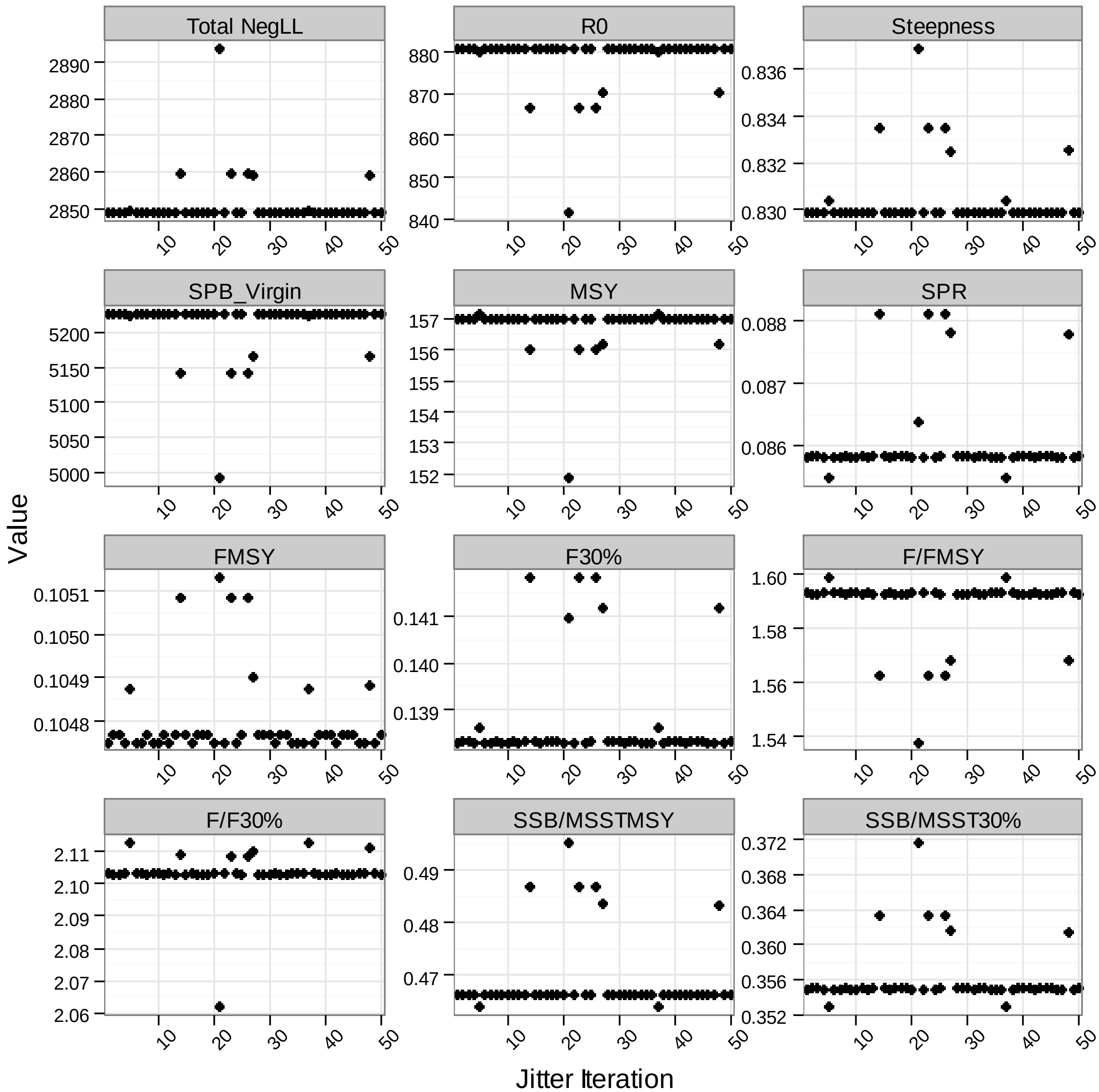


Figure 11.1.5.3. Total negative log-likelihood, stock-recruitment parameters, derived quantities, and stock-status reference points (current F/F_{MSY}, SSB/SSB_{MSST}, and SPR) from the jitter analysis to test for model convergence in the base model of the GA-NC stock.

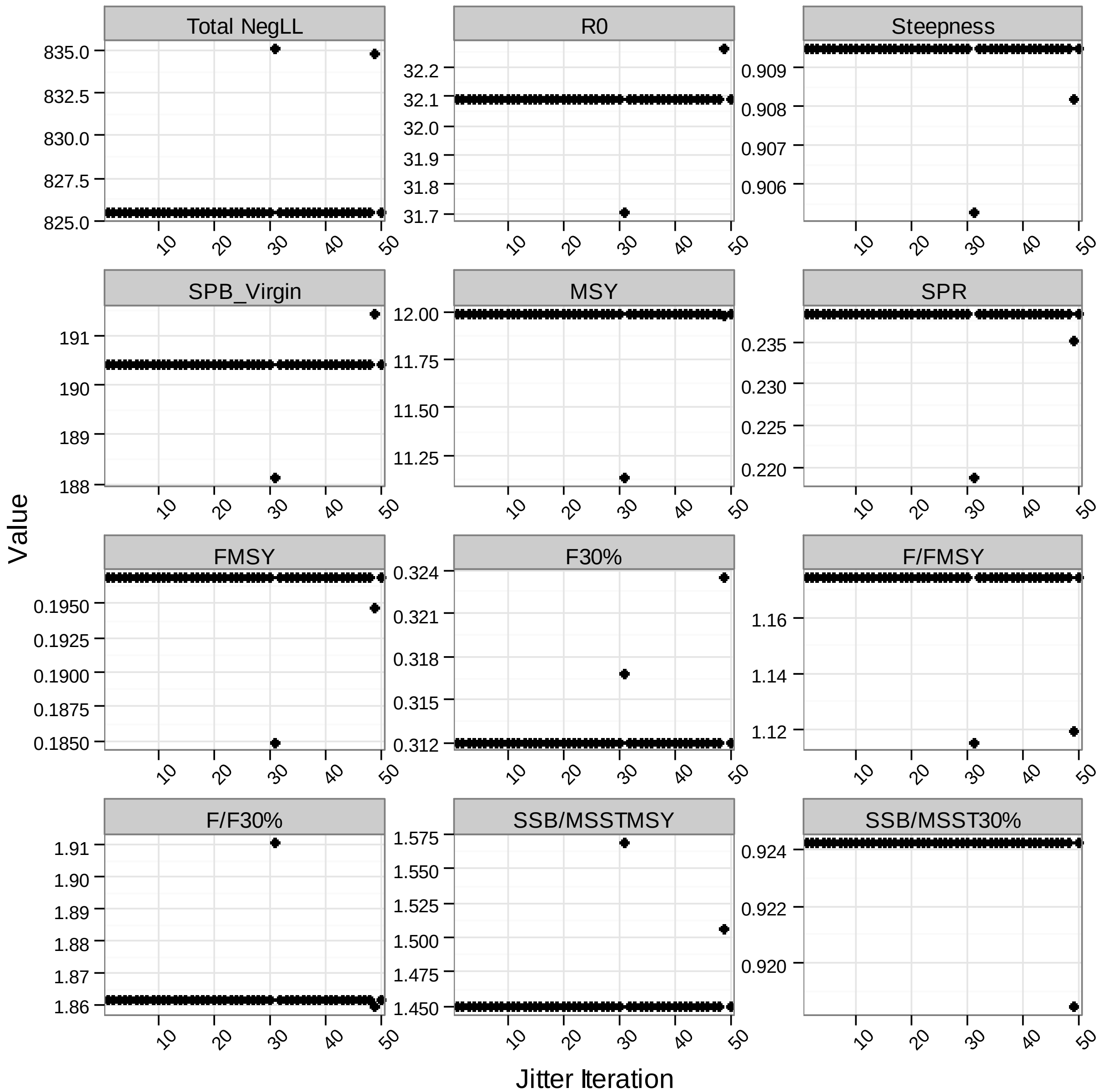


Figure 11.2.1.1.1. Estimated and observed landings for the WFL stock base model configuration.

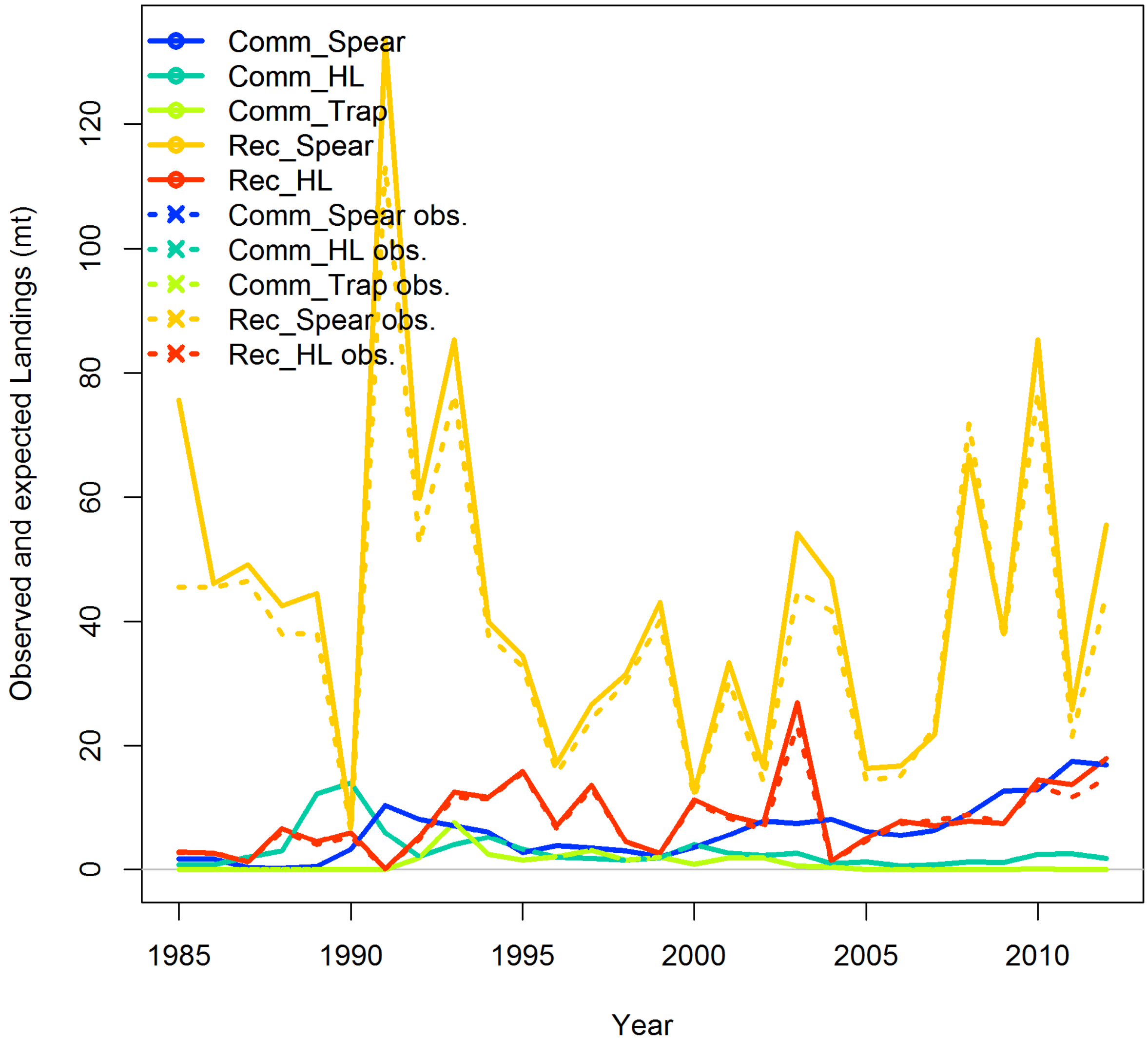


Figure 11.2.1.1.2. Estimated and observed landings for the FLK/EFL stock base model configuration.

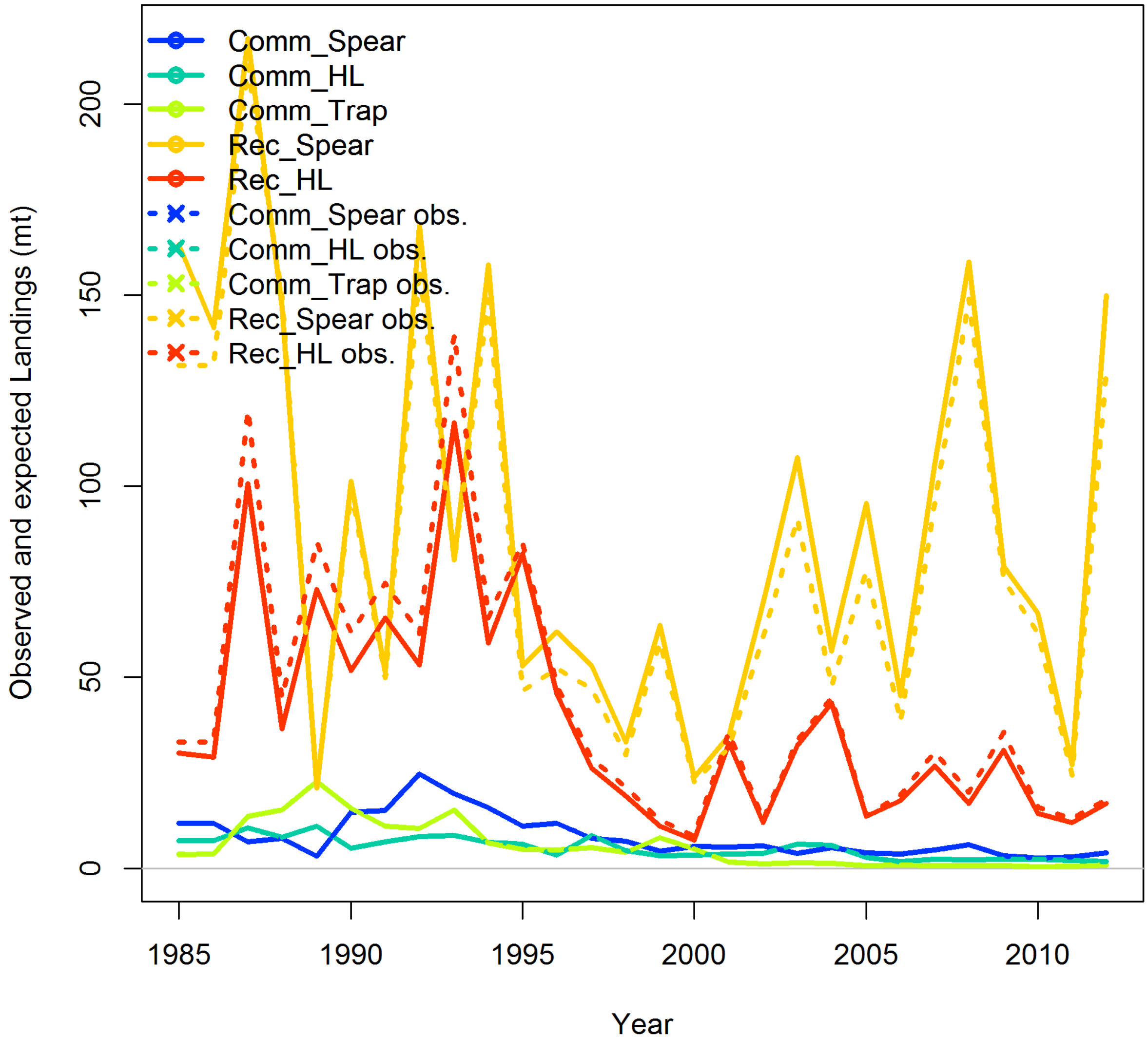


Figure 11.2.1.1.3. Estimated and observed landings for the GA-NC stock base model configuration.

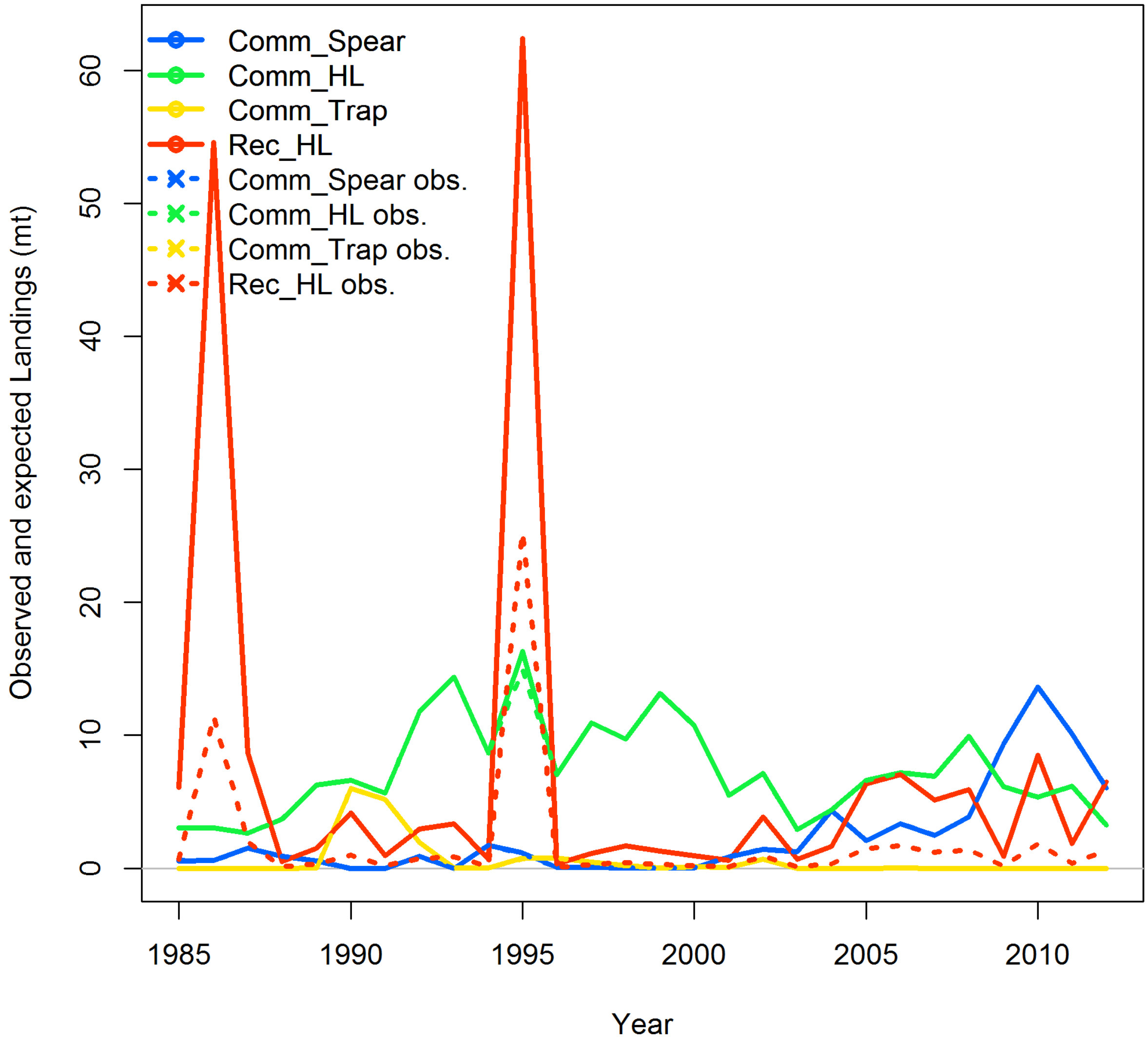


Figure 11.2.1.2.1. Model fit to the standardized commercial spear CPUE index for the WFL stock base model configuration.

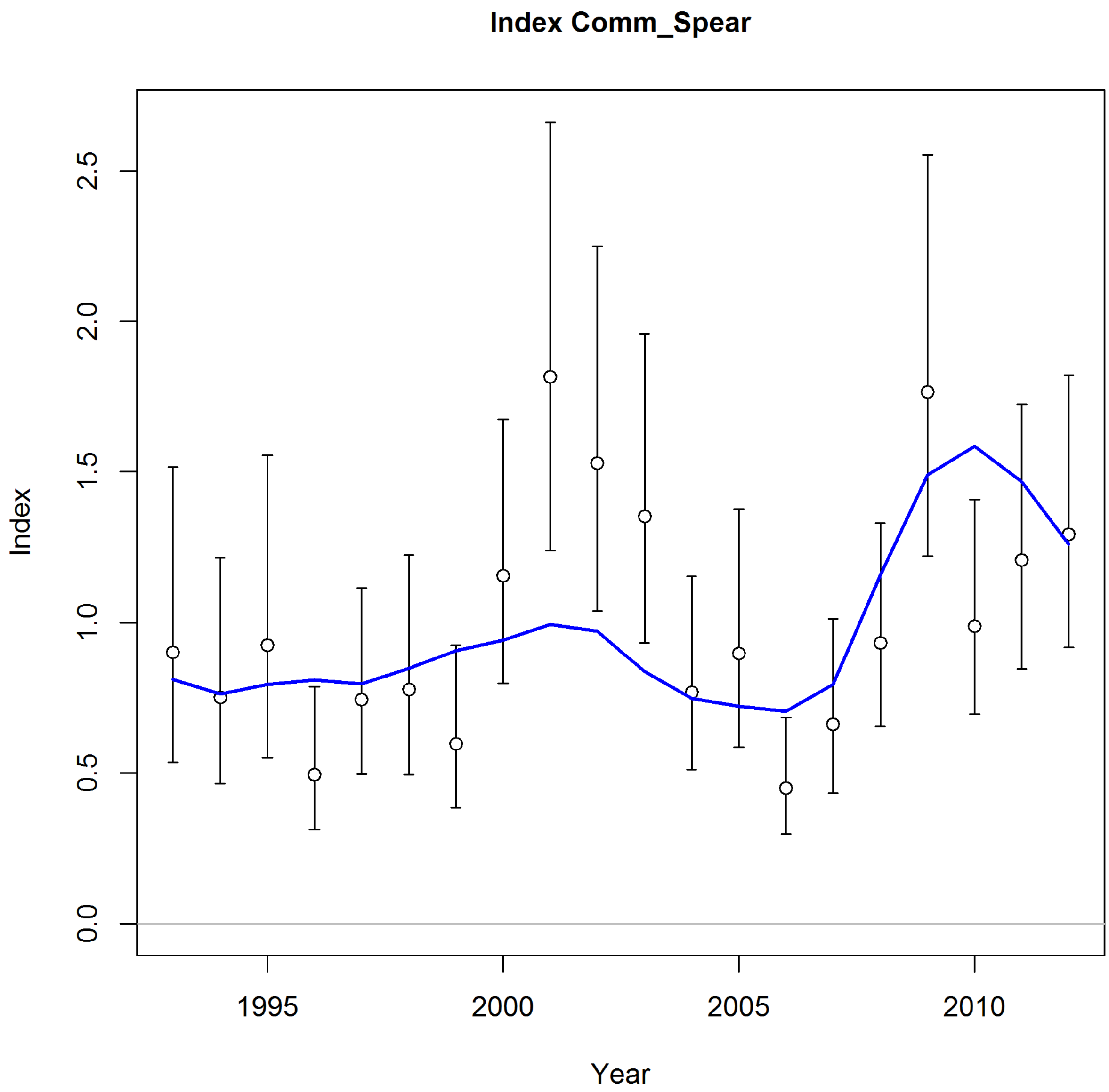


Figure 11.2.1.2.2. Model fit to the standardized commercial hook and line CPUE index for the WFL stock base model configuration.

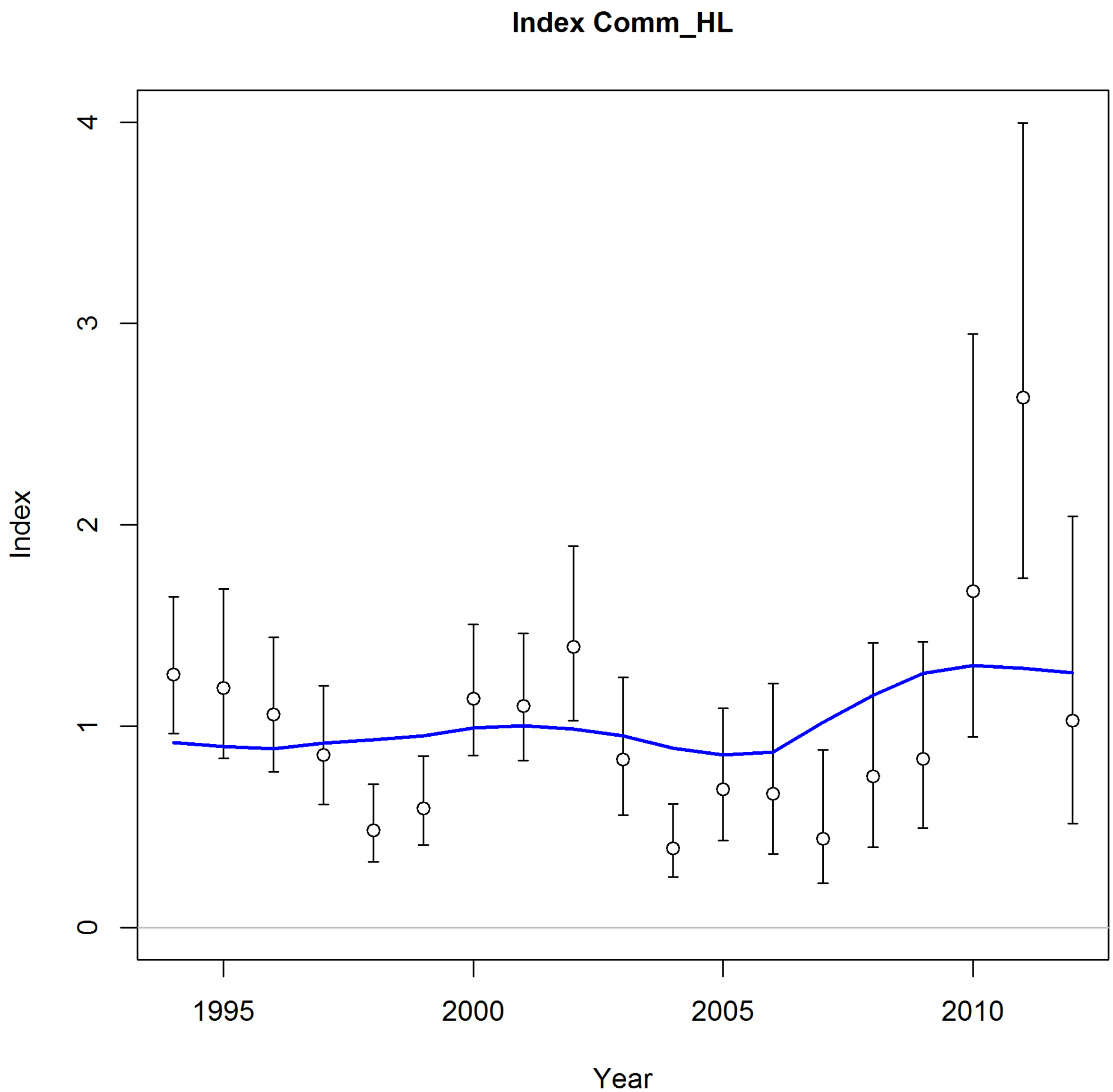


Figure 11.2.1.2.3. Model fit to the standardized recreational spear CPUE index for the WFL stock base model configuration.

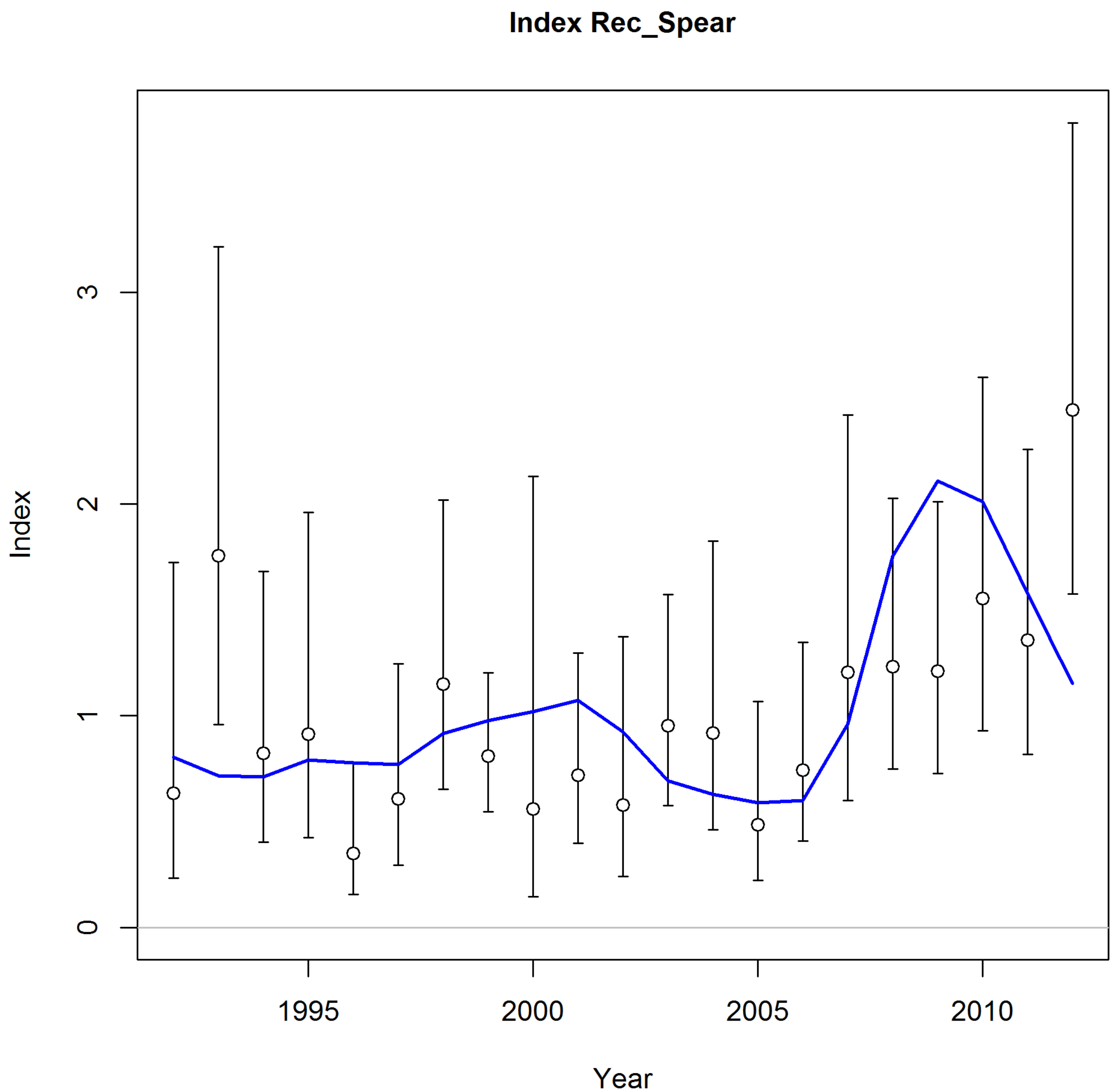


Figure 11.2.1.2.4. Model fit to the standardized recreational hook and line CPUE index for the WFL stock base model configuration.

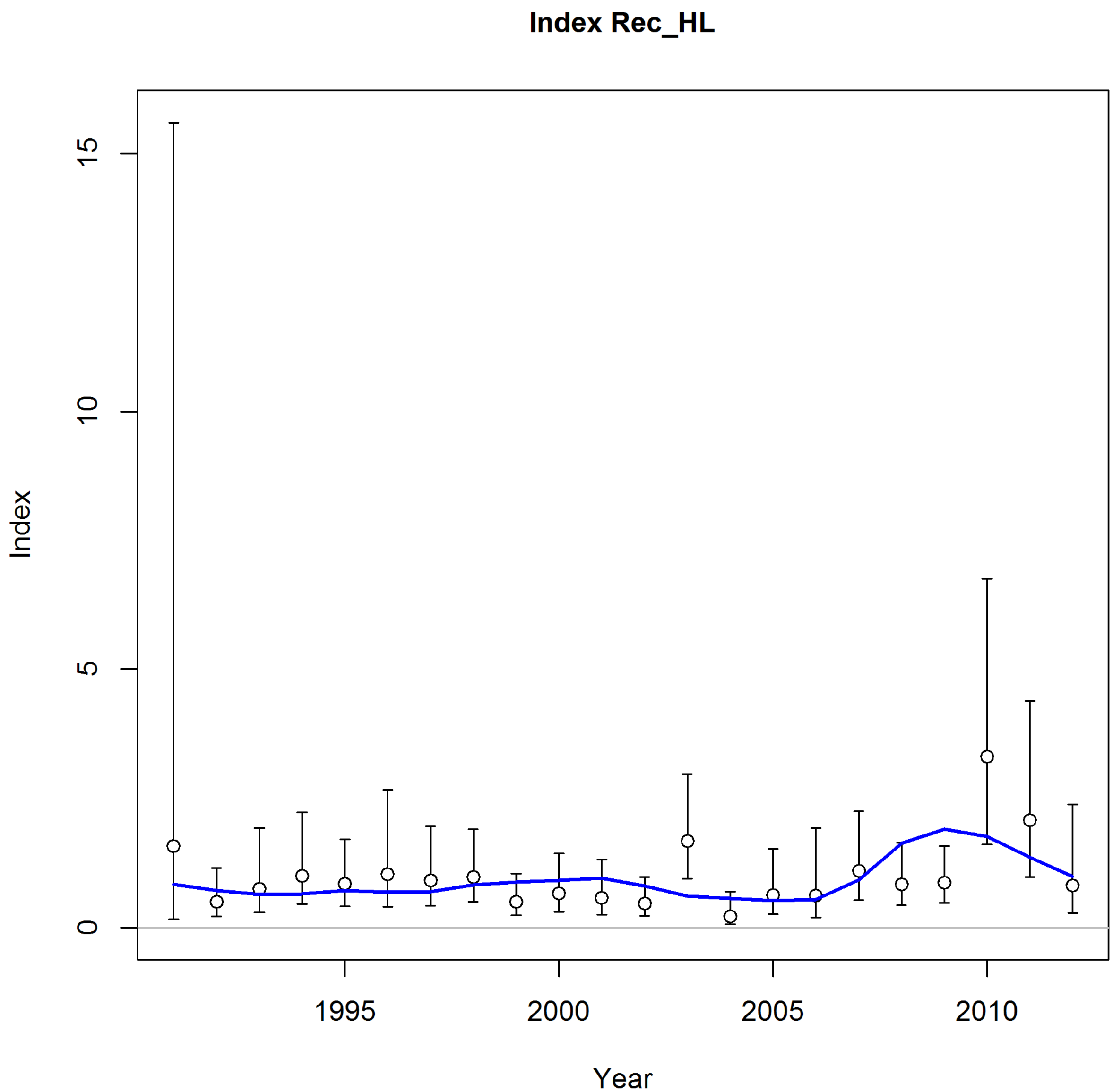


Figure 11.2.1.2.5. Model fit to the standardized baitfish trawl index for the WFL stock base model configuration.

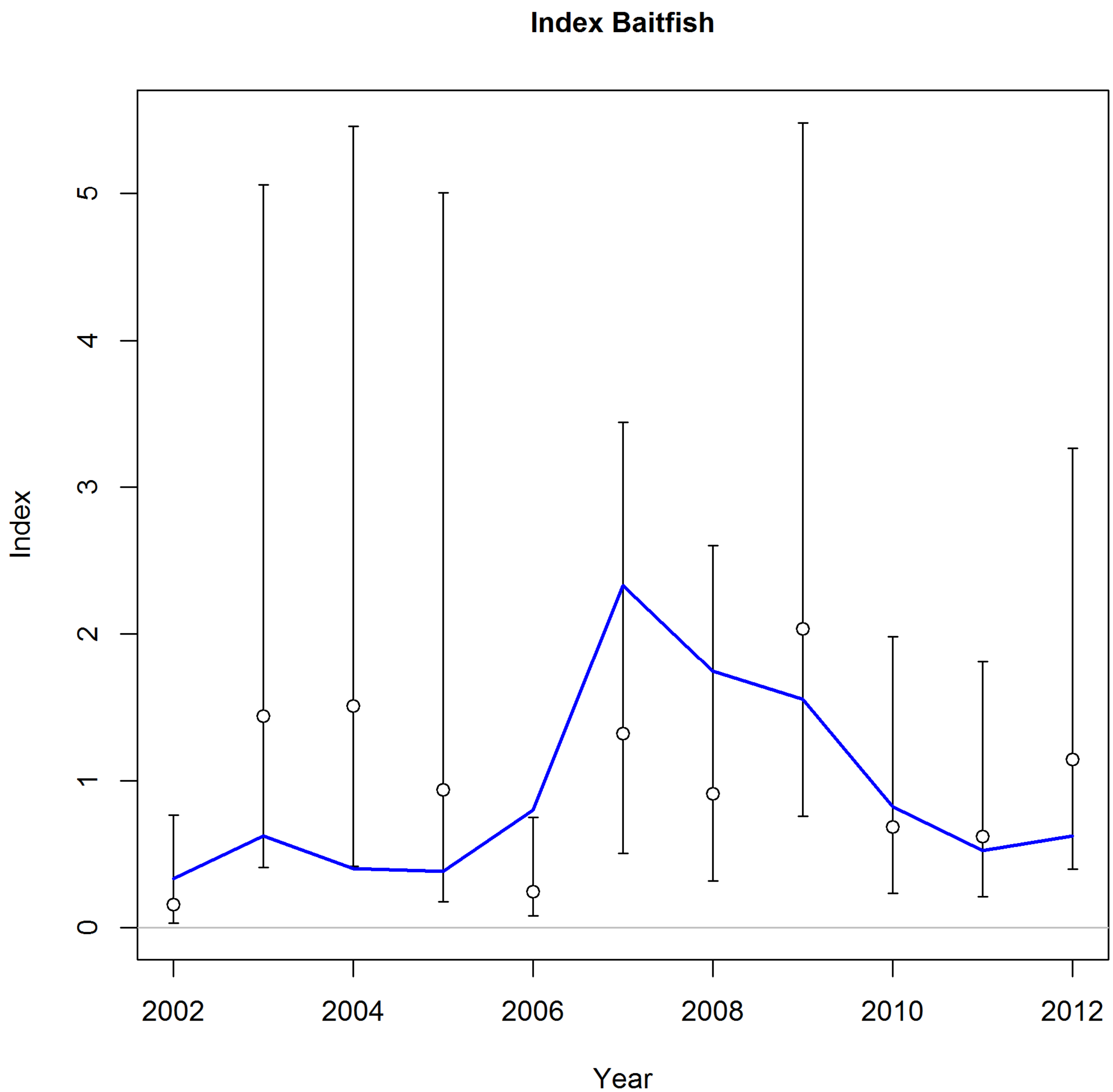


Figure 11.2.1.2.6. Model fit to the standardized SEAMAP trawl index for the WFL stock base model configuration.

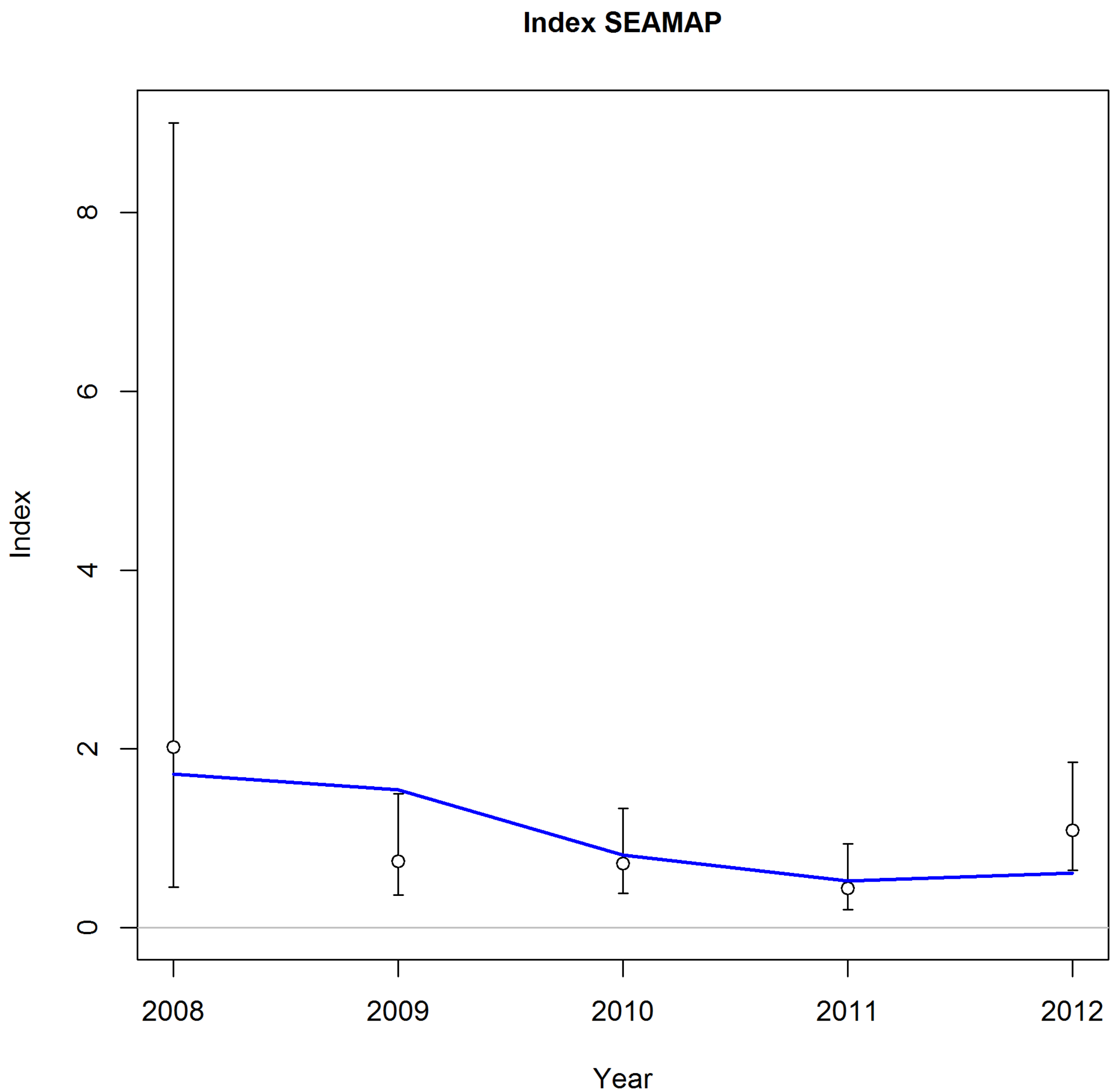


Figure 11.2.1.2.7. Model fit to the standardized video survey index for the WFL stock base model configuration.

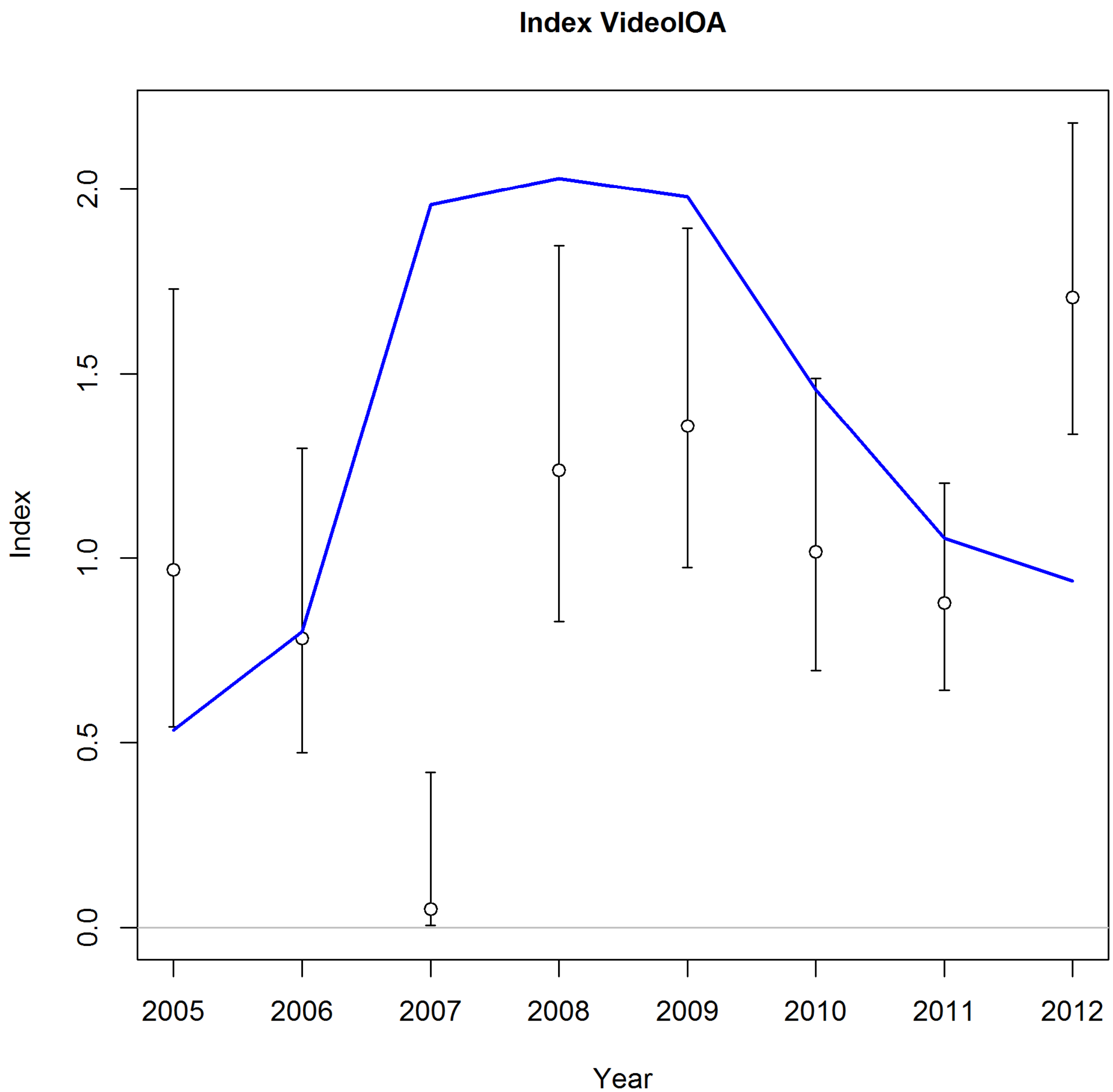


Figure 11.2.1.2.8. Model fit to the standardized age-0 seagrass trawl index for the WFL stock base model configuration.

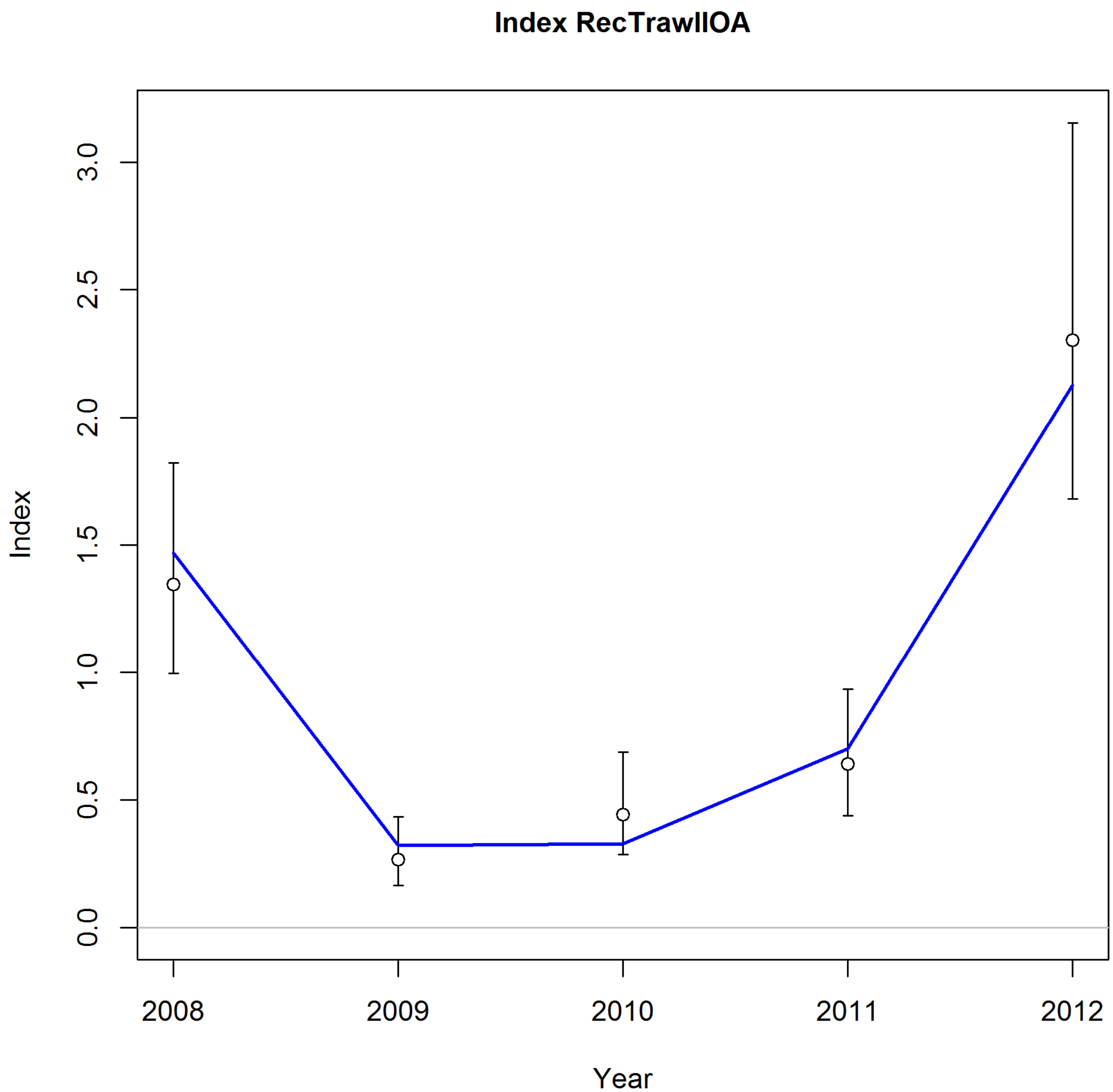


Figure 11.2.1.2.9. Model fit to the standardized commercial spear CPUE index for the FLK/EFL stock base model configuration.

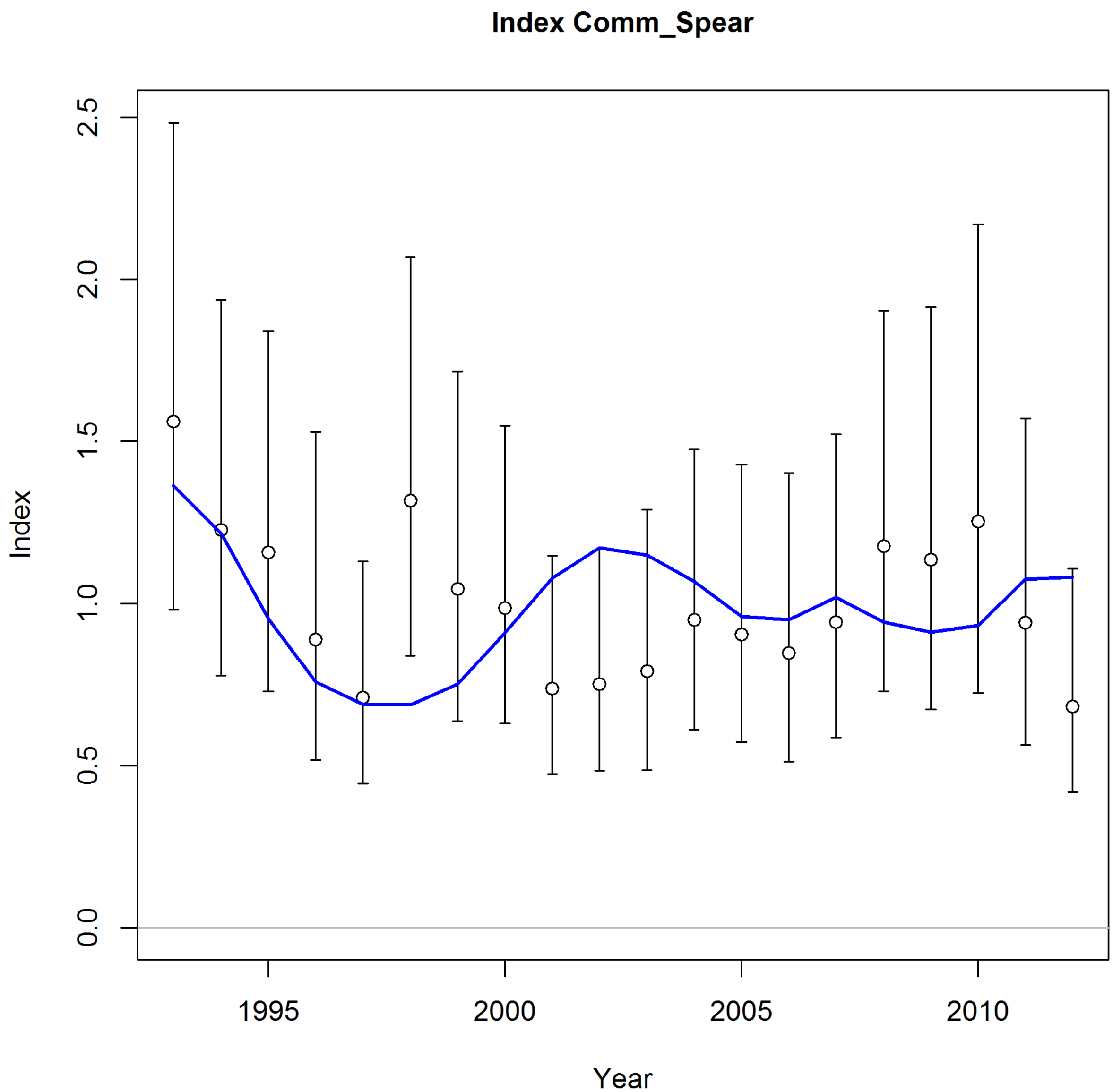


Figure 11.2.1.2.10. Model fit to the standardized commercial hook and line CPUE index for the FLK/EFL stock base model configuration.

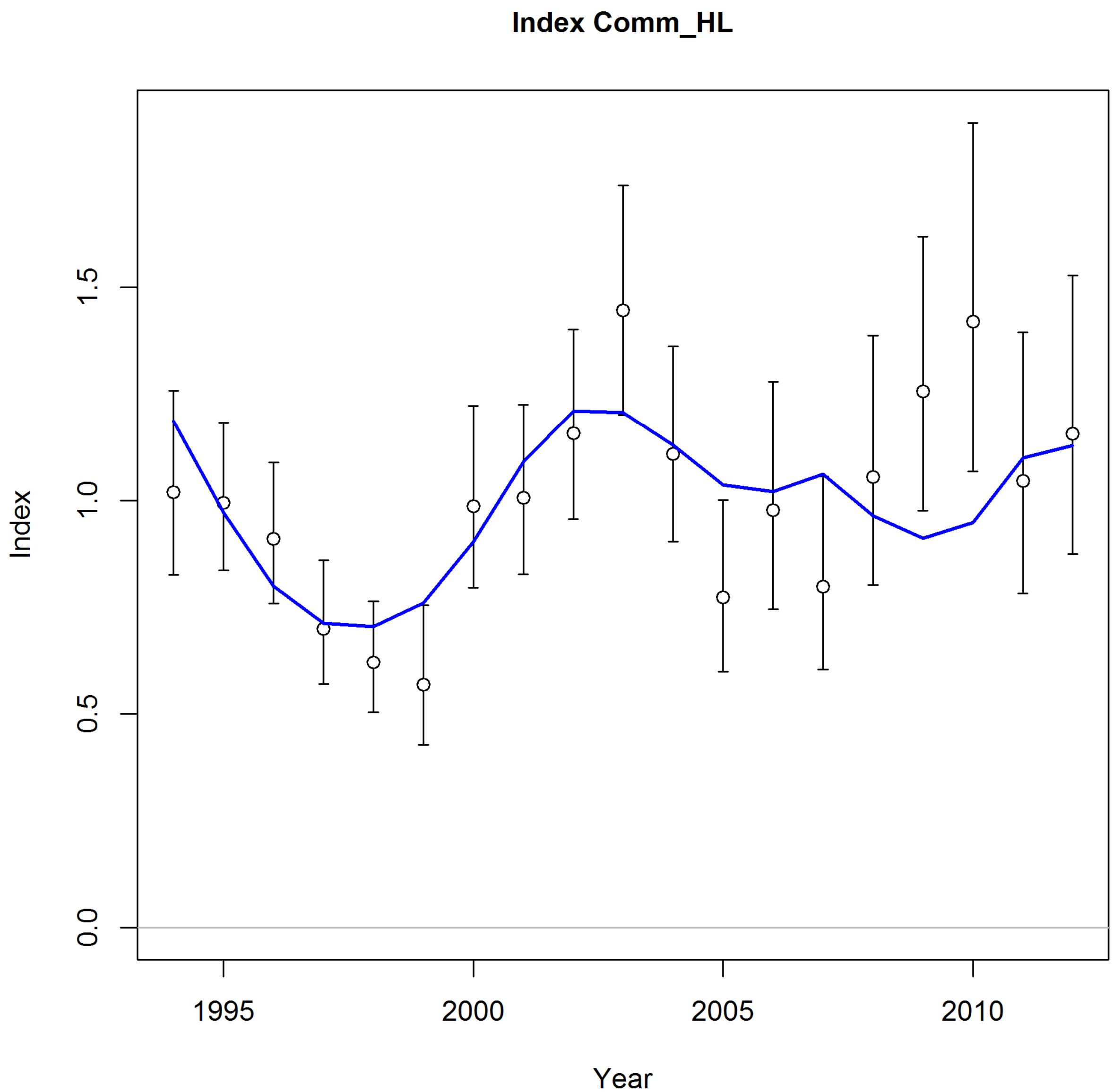


Figure 11.2.1.2.11. Model fit to the standardized recreational spear CPUE index for the FLK/EFL stock base model configuration.

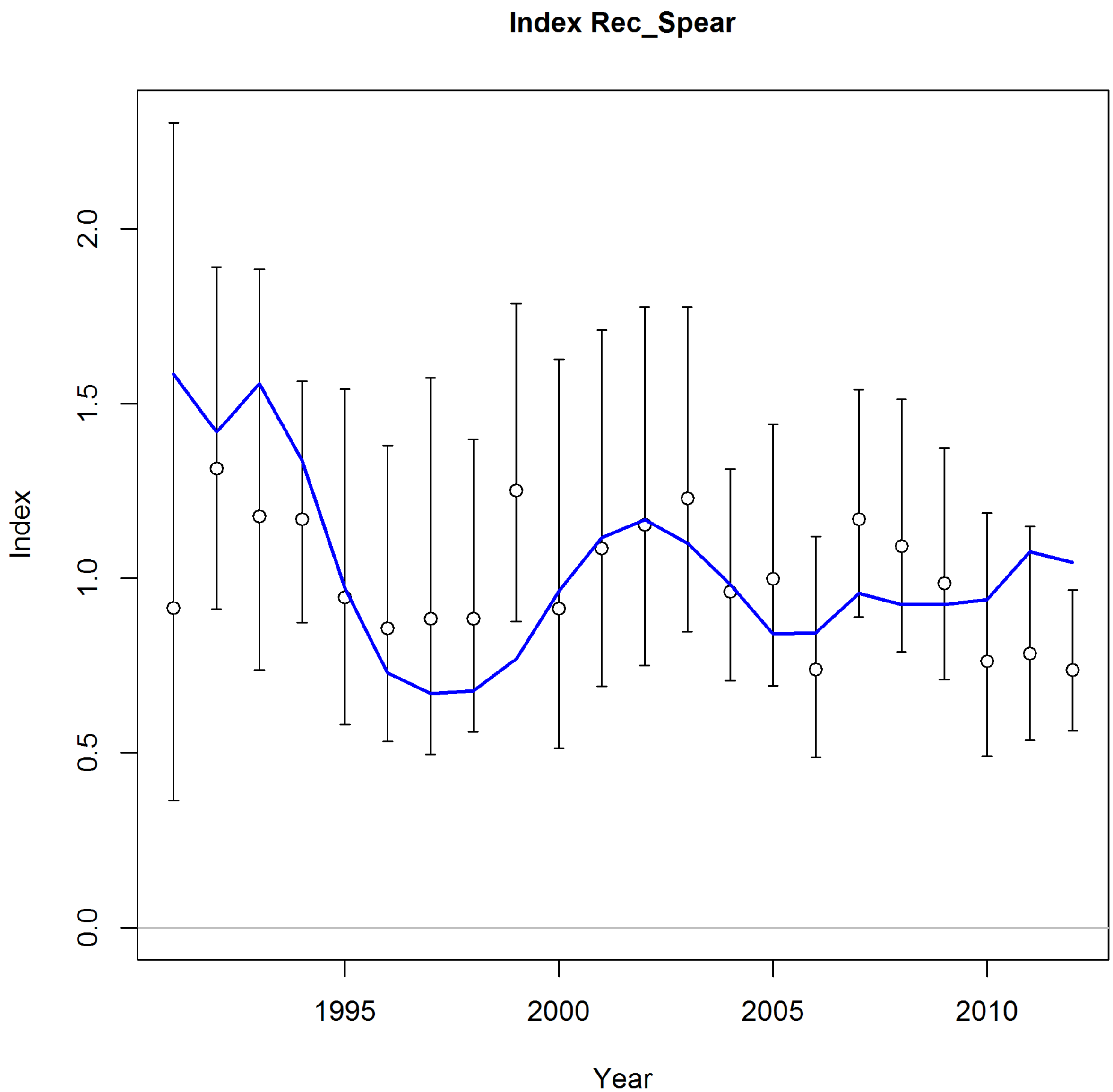


Figure 11.2.1.2.12. Model fit to the standardized recreational hook and line CPUE index for the FLK/EFL stock base model configuration.

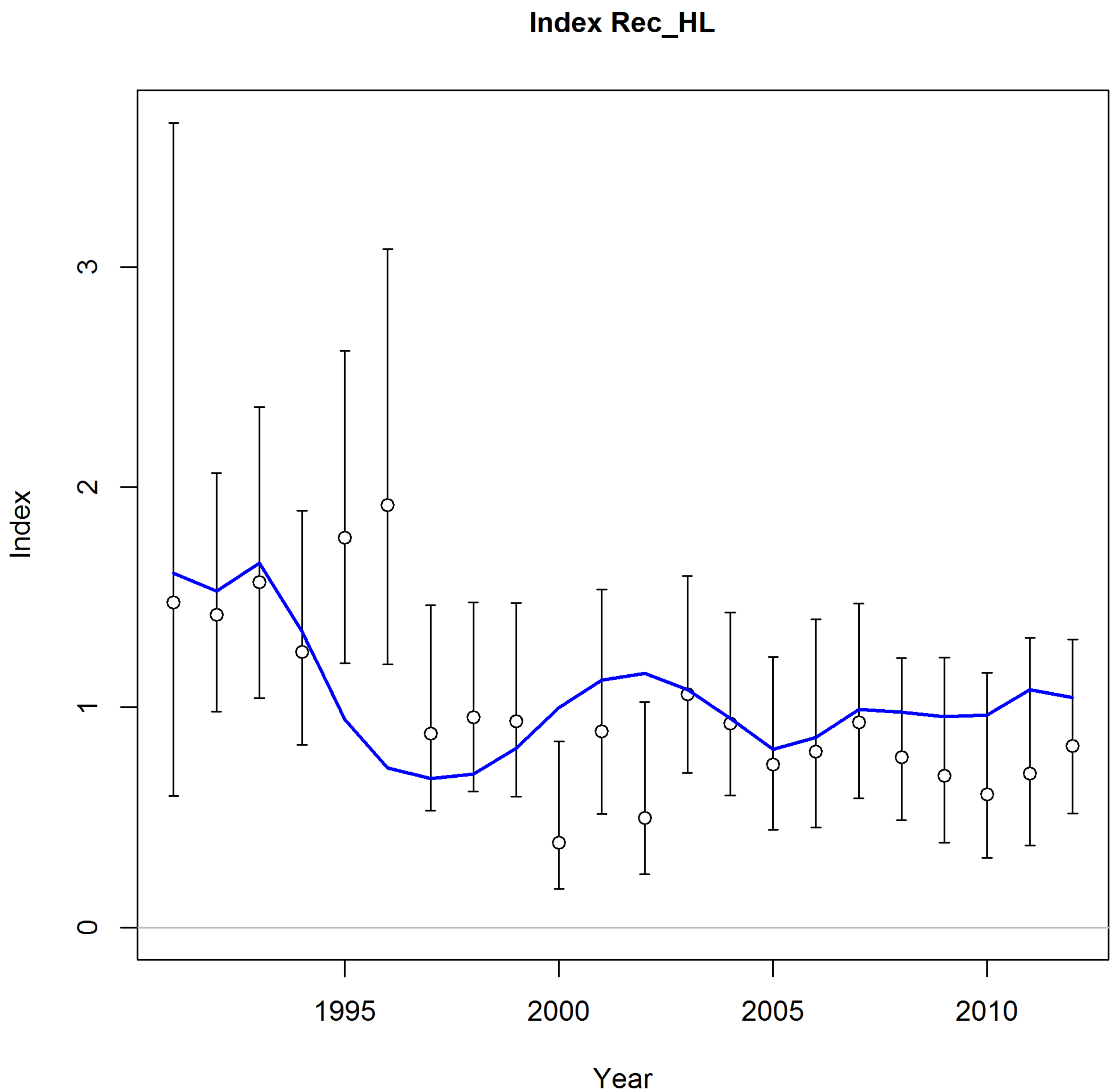


Figure 11.2.1.2.13. Model fit to the standardized RVC-Keys index for the FLK/EFL stock base model configuration.

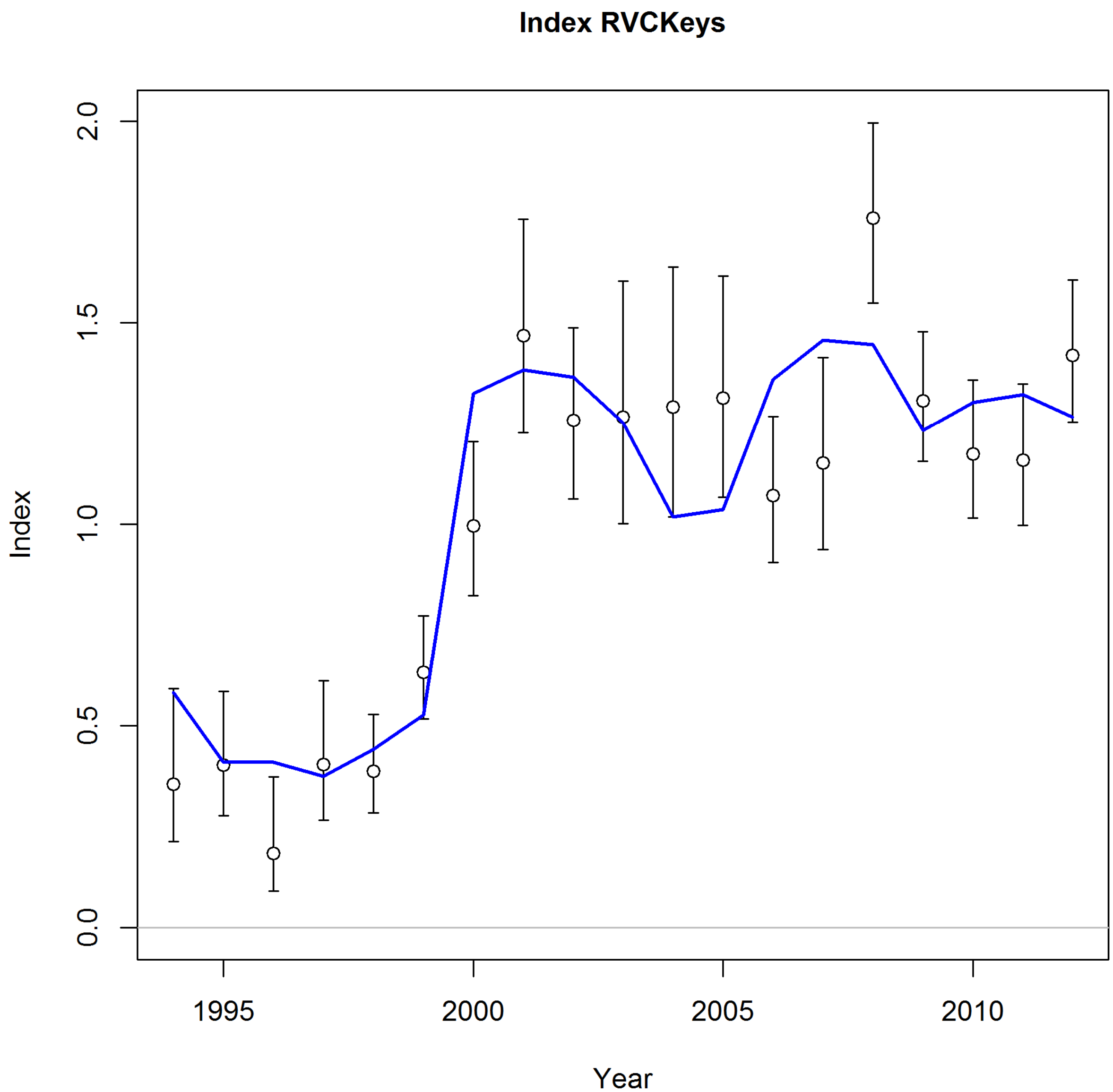


Figure 11.2.1.2.14. Time-varying catchability estimate for the RVC-Keys index in the FLK/EFL stock, used to represent changes to methodology in the late 1990's and early 2000's as a result of updated habitat maps (Smith et al. 2013).

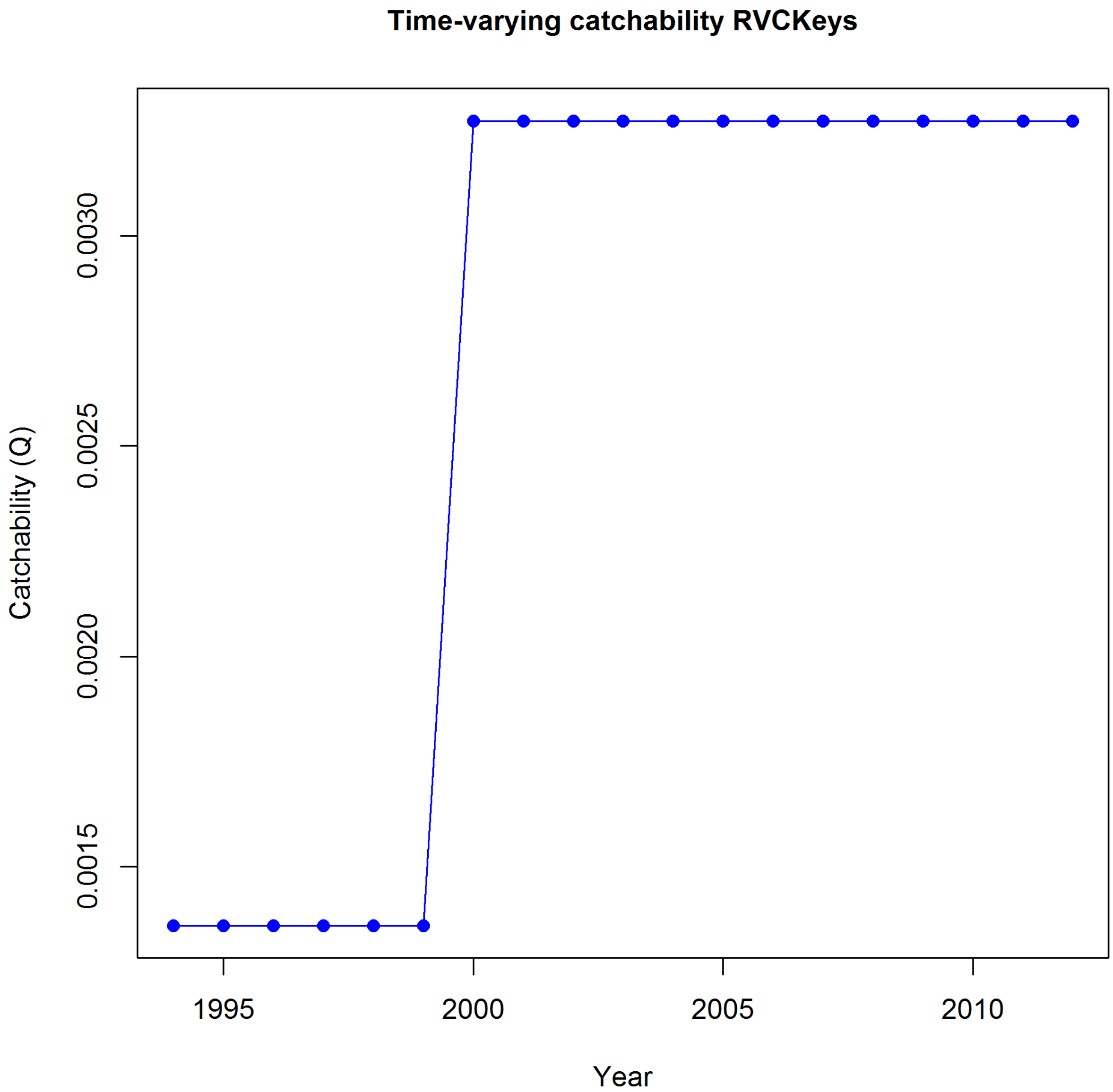


Figure 11.2.1.2.15. Model fit to the standardized RVC-Tortugas index for the FLK/EFL stock base model configuration.

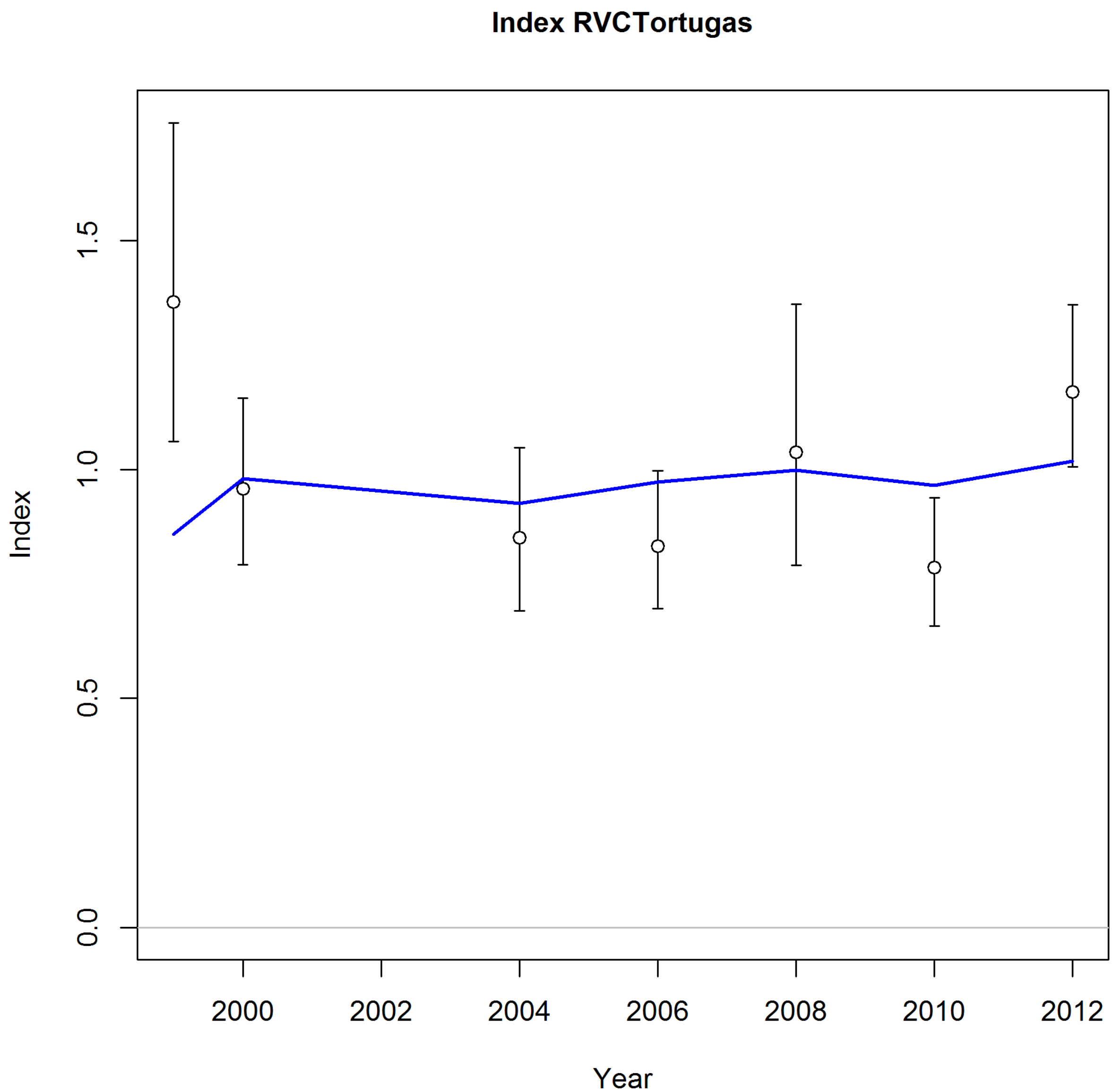


Figure 11.2.1.2.16. Model fit to the standardized commercial spear CPUE index for the GA-NC stock base model configuration.

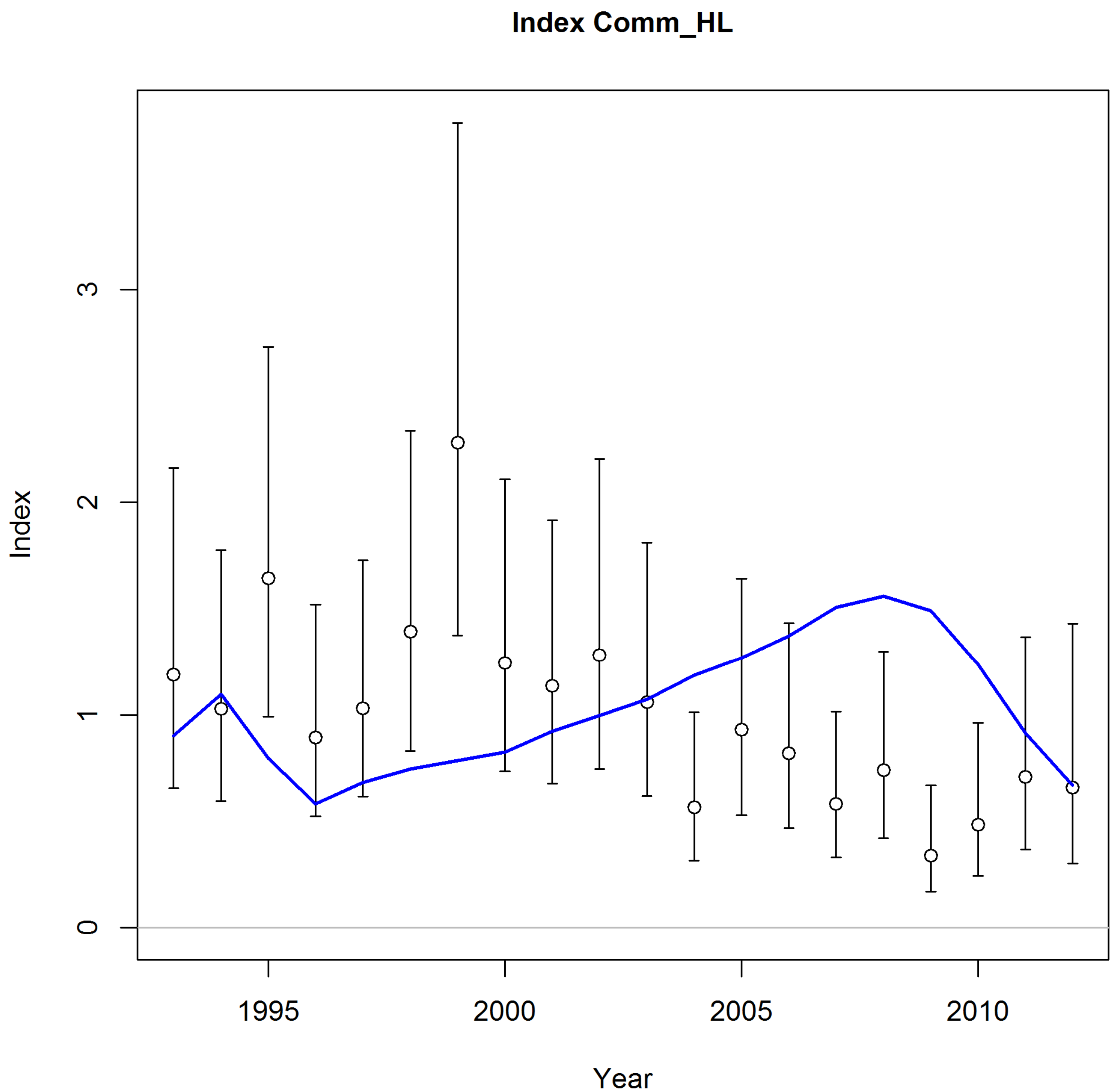


Figure 11.2.1.3.1. Observed and predicted length composition of landings from the commercial spear fishery of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

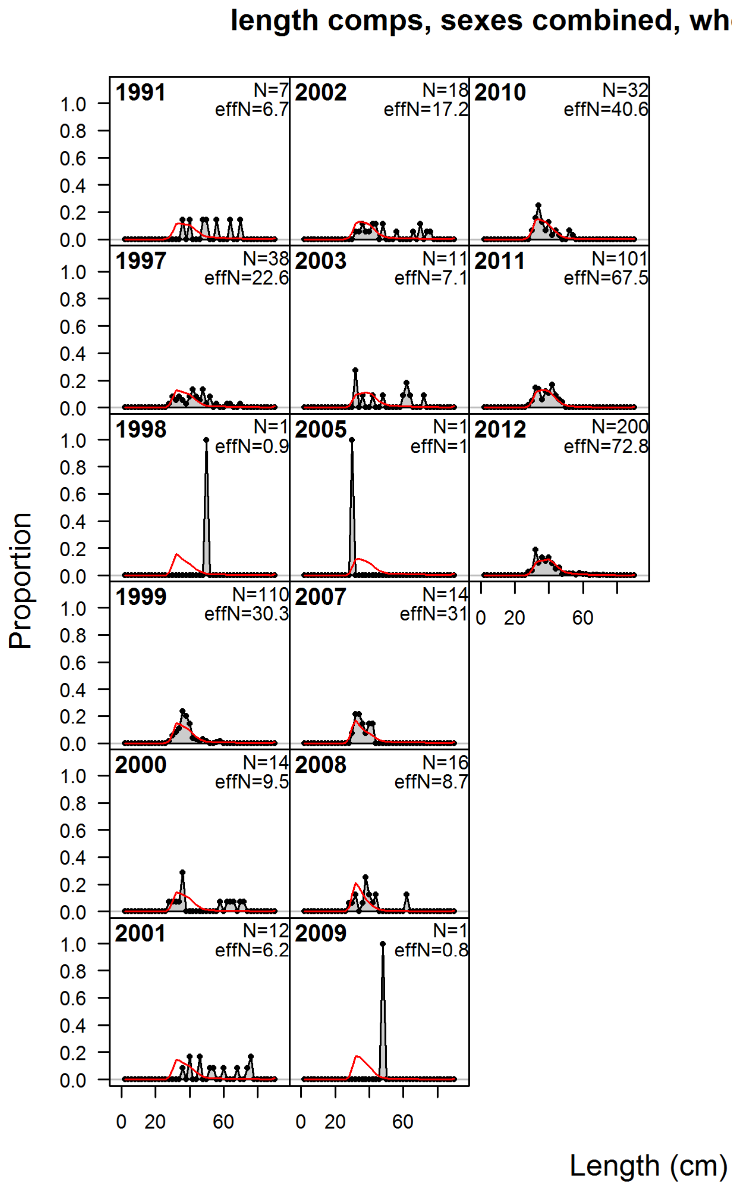


Figure 11.2.1.3.2. Pearson residuals for the length composition fit to the commercial spear fishery of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

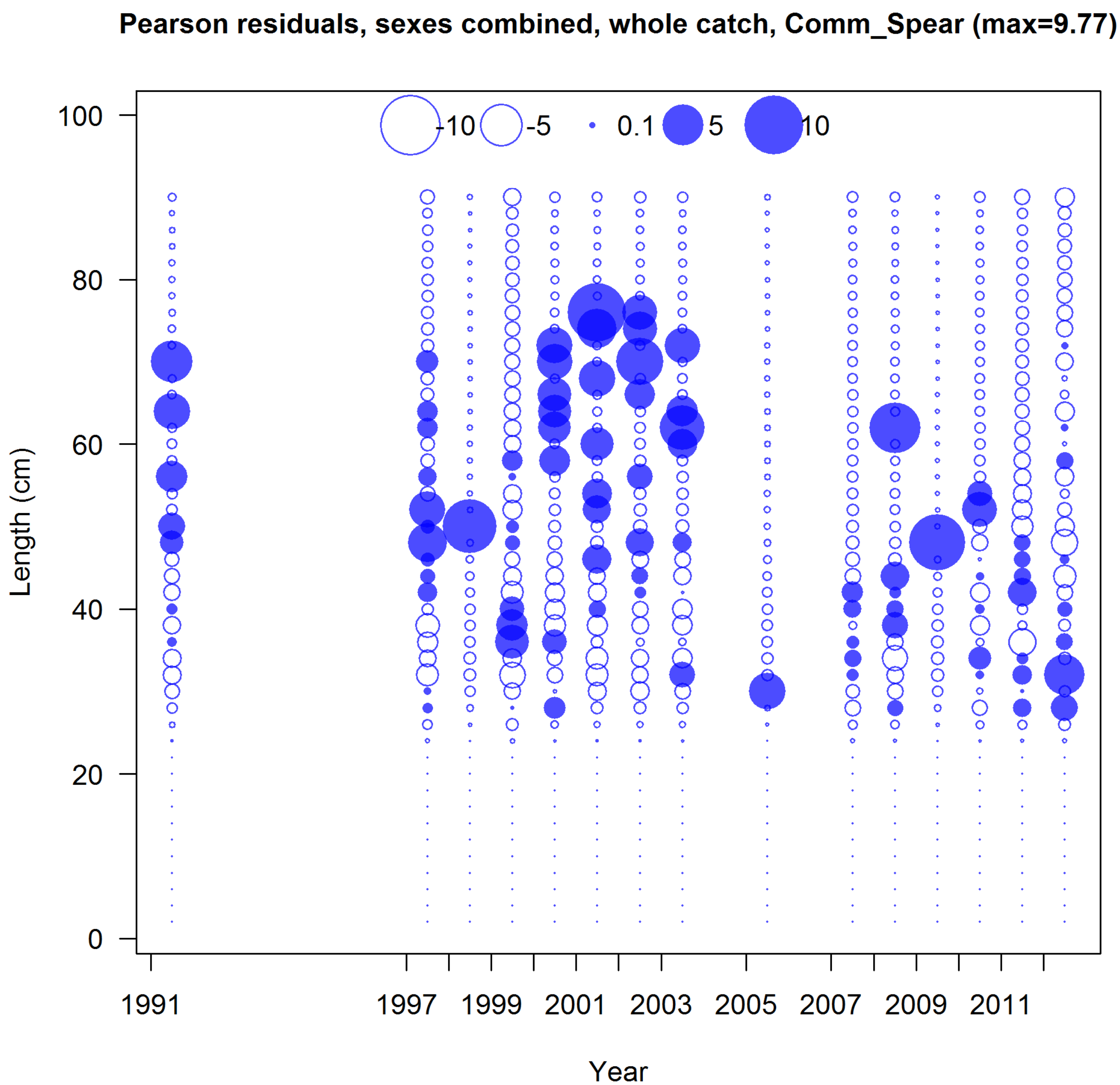


Figure 11.2.1.3.3. Observed and predicted length composition of landings from the commercial hook and line fishery of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

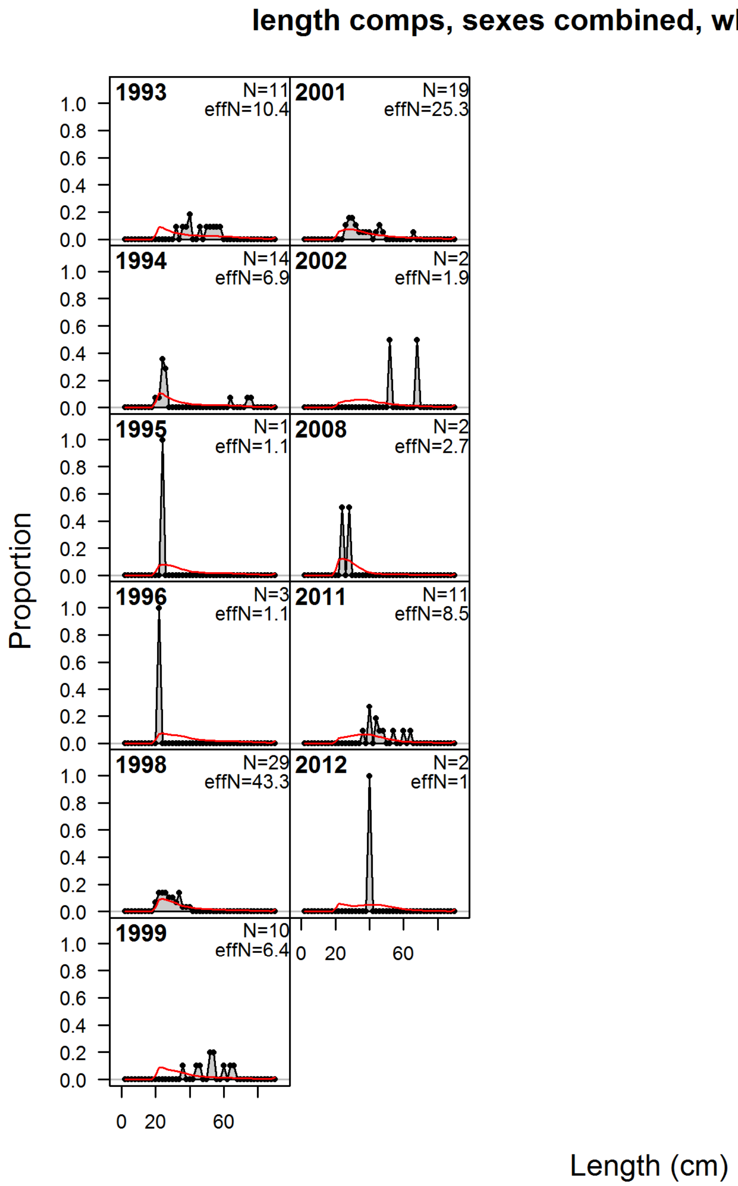


Figure 11.2.1.3.4. Pearson residuals for the length composition fit to the commercial hook and line fishery of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

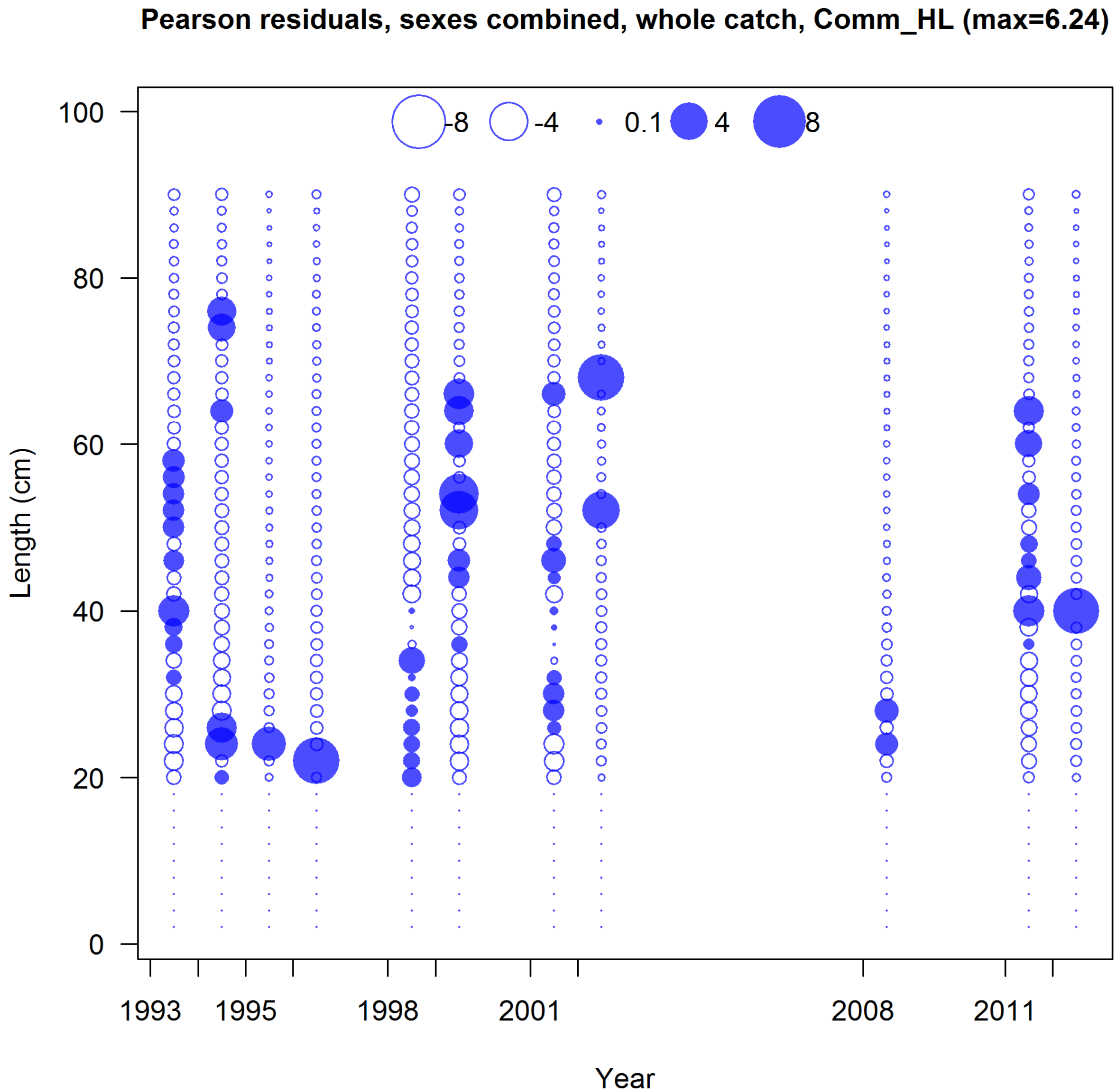


Figure 11.2.1.3.5. Observed and predicted length composition of landings from the commercial trap fishery of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

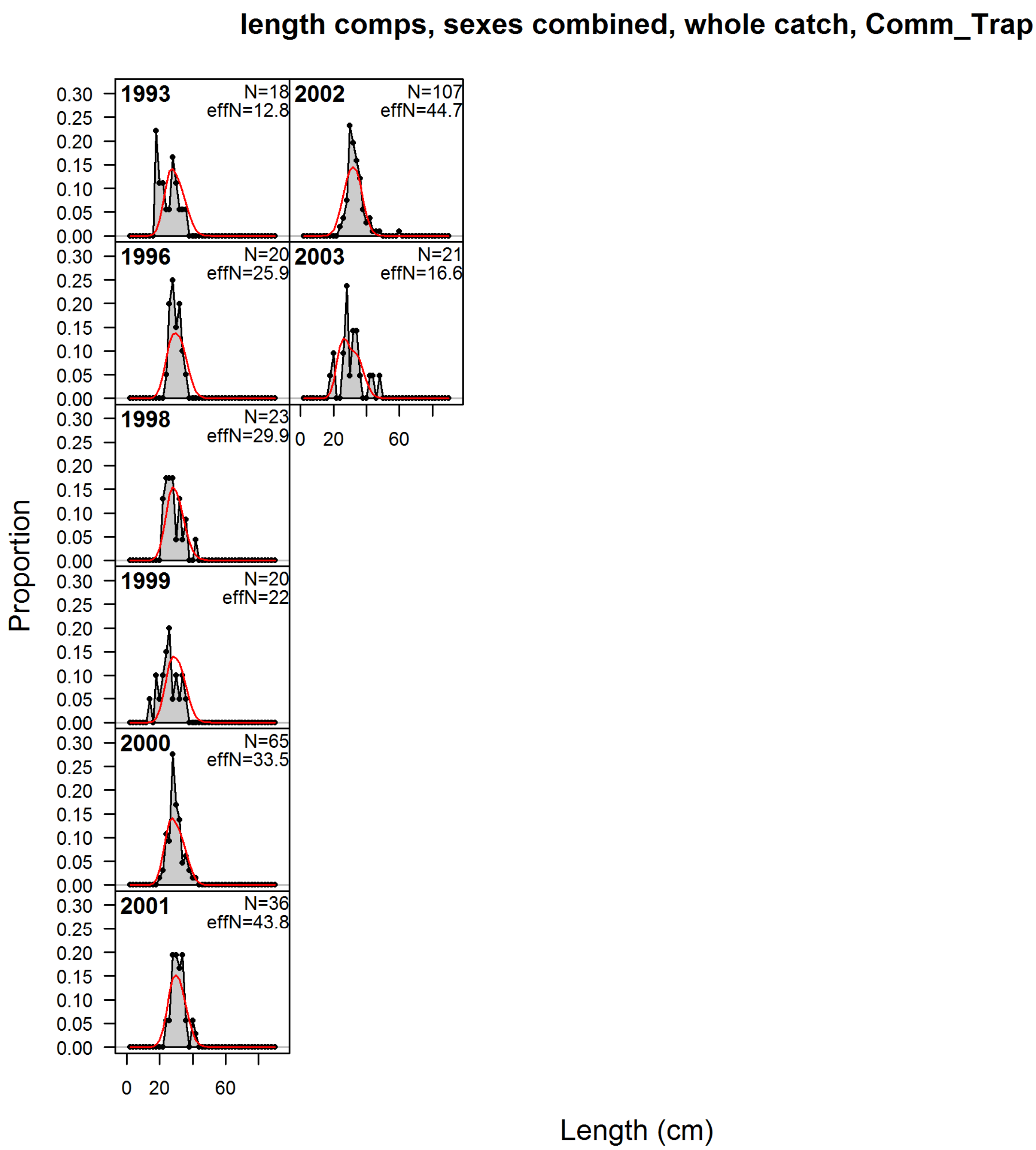


Figure 11.2.1.3.6. Pearson residuals for the length composition fit to the commercial trap fishery of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

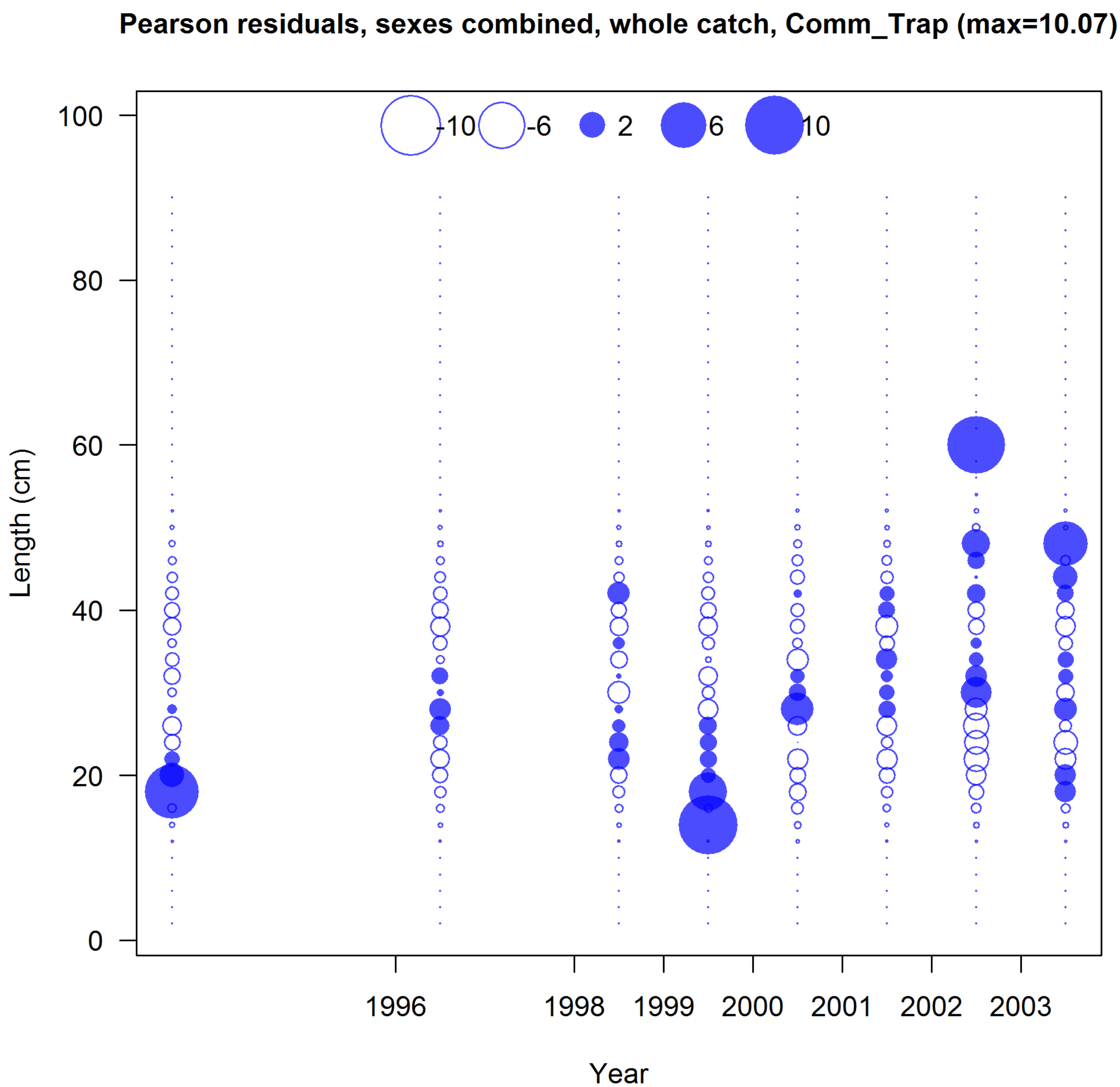


Figure 11.2.1.3.7. Observed and predicted length composition of landings from the recreational spear fishery of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

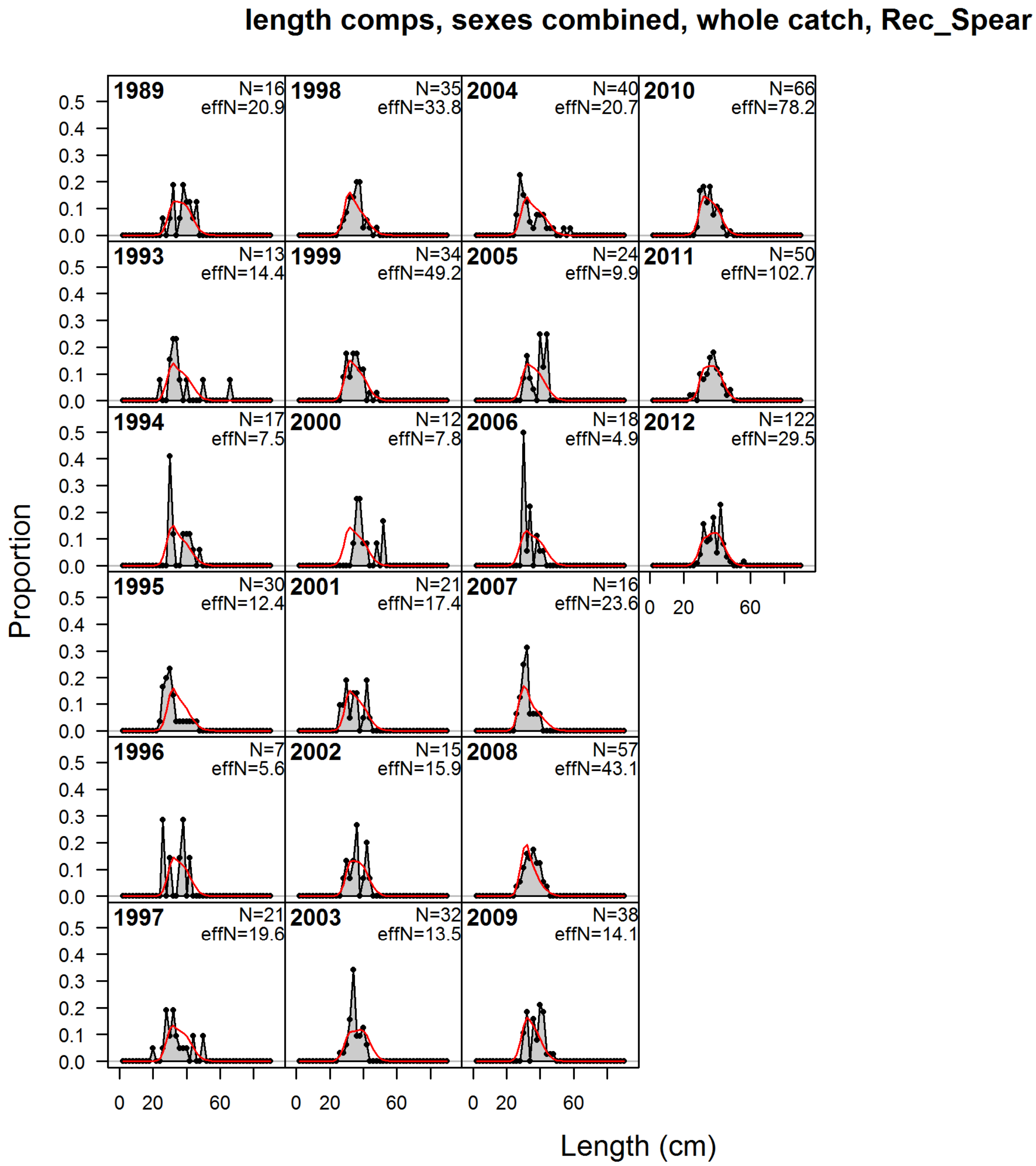


Figure 11.2.1.3.8. Pearson residuals for the length composition fit to the recreational spear fishery of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

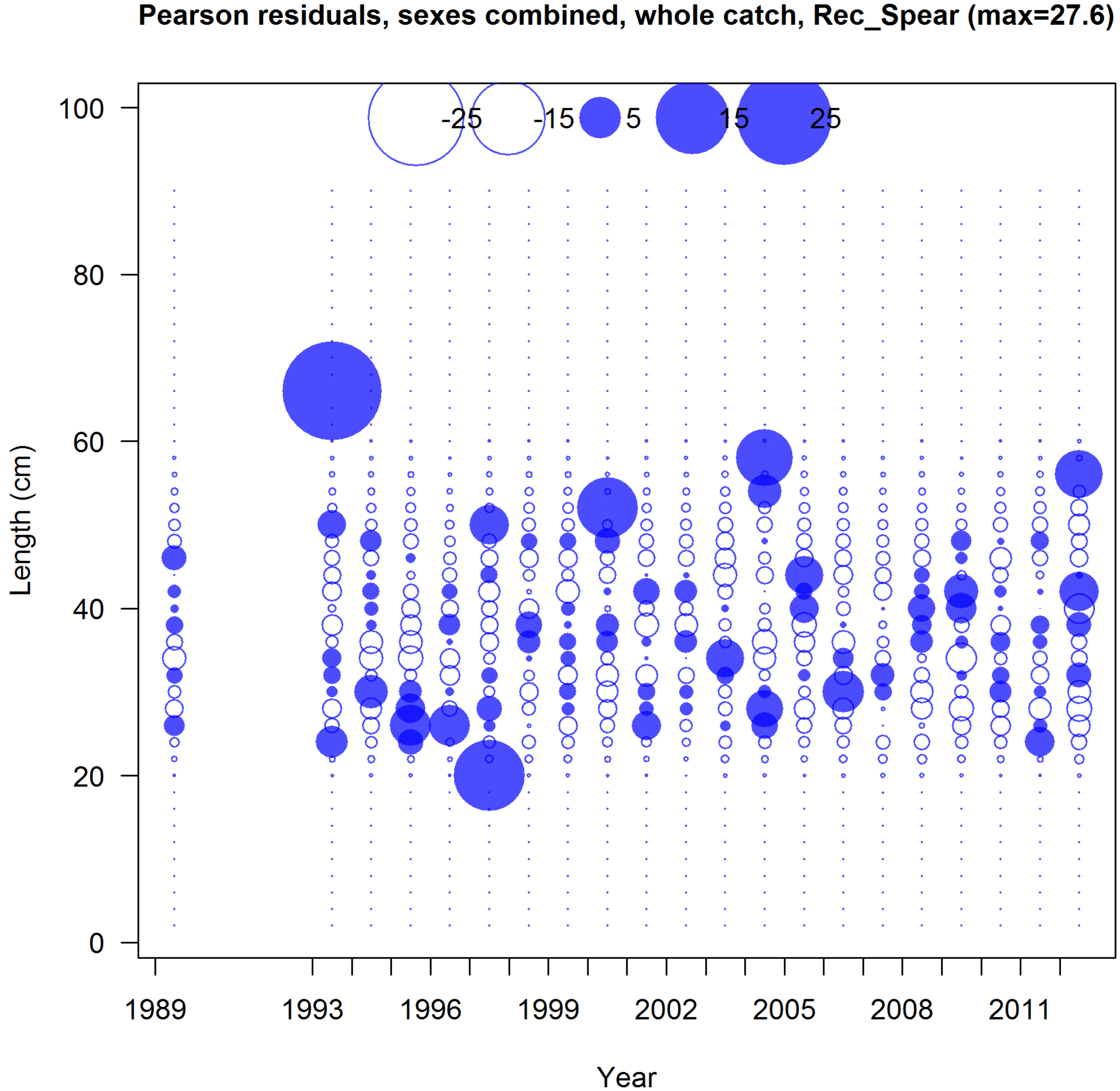


Figure 11.2.1.3.9. Observed and predicted length composition of landings from the recreational hook and line fishery of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

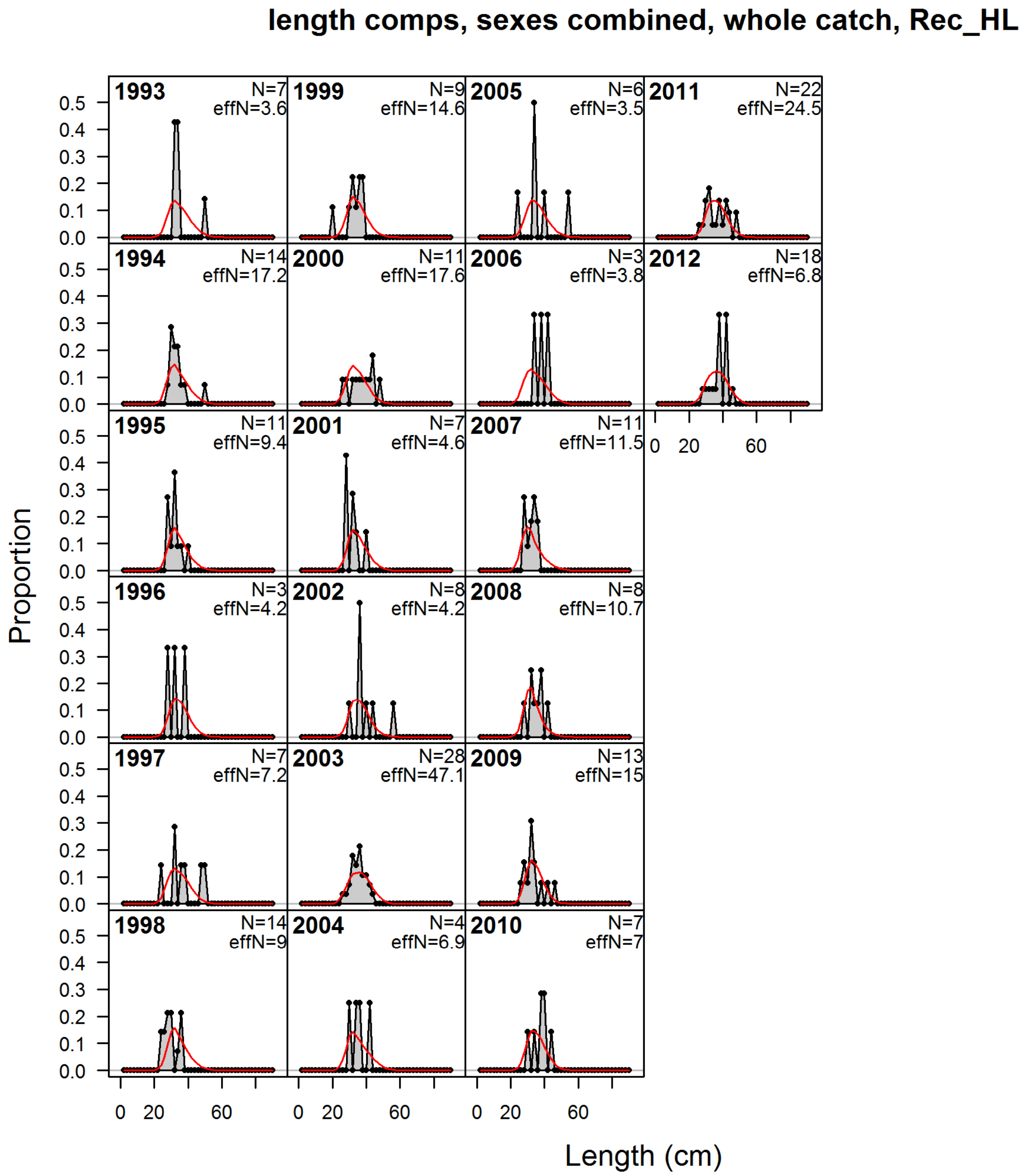


Figure 11.2.1.3.10. Pearson residuals for the length composition fit to the recreational hook and line fishery of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

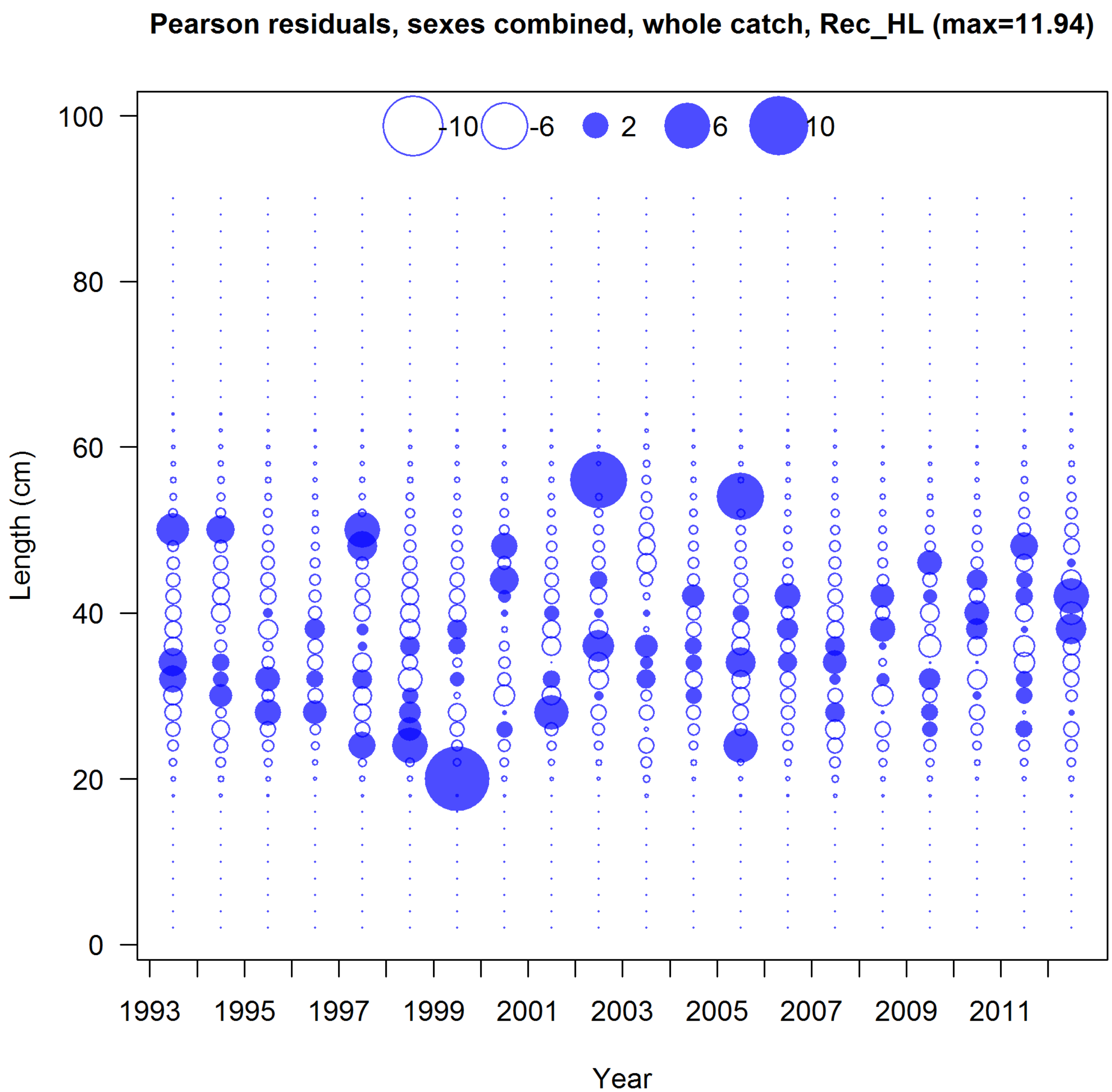


Figure 11.2.1.3.11. Observed and predicted length composition of landings from the baitfish trawl survey of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

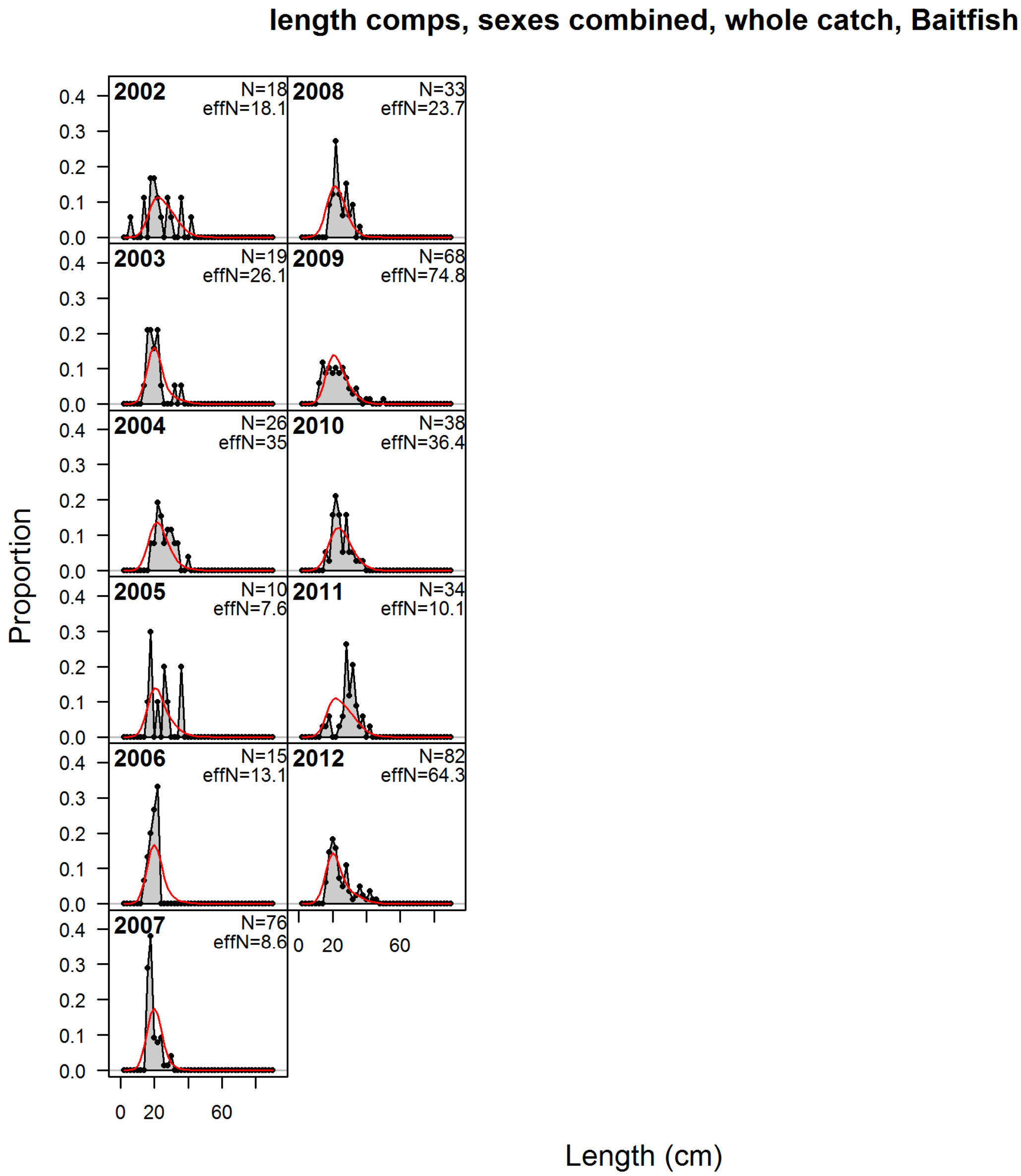


Figure 11.2.1.3.12. Pearson residuals for the length composition fit to the baitfish trawl survey of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

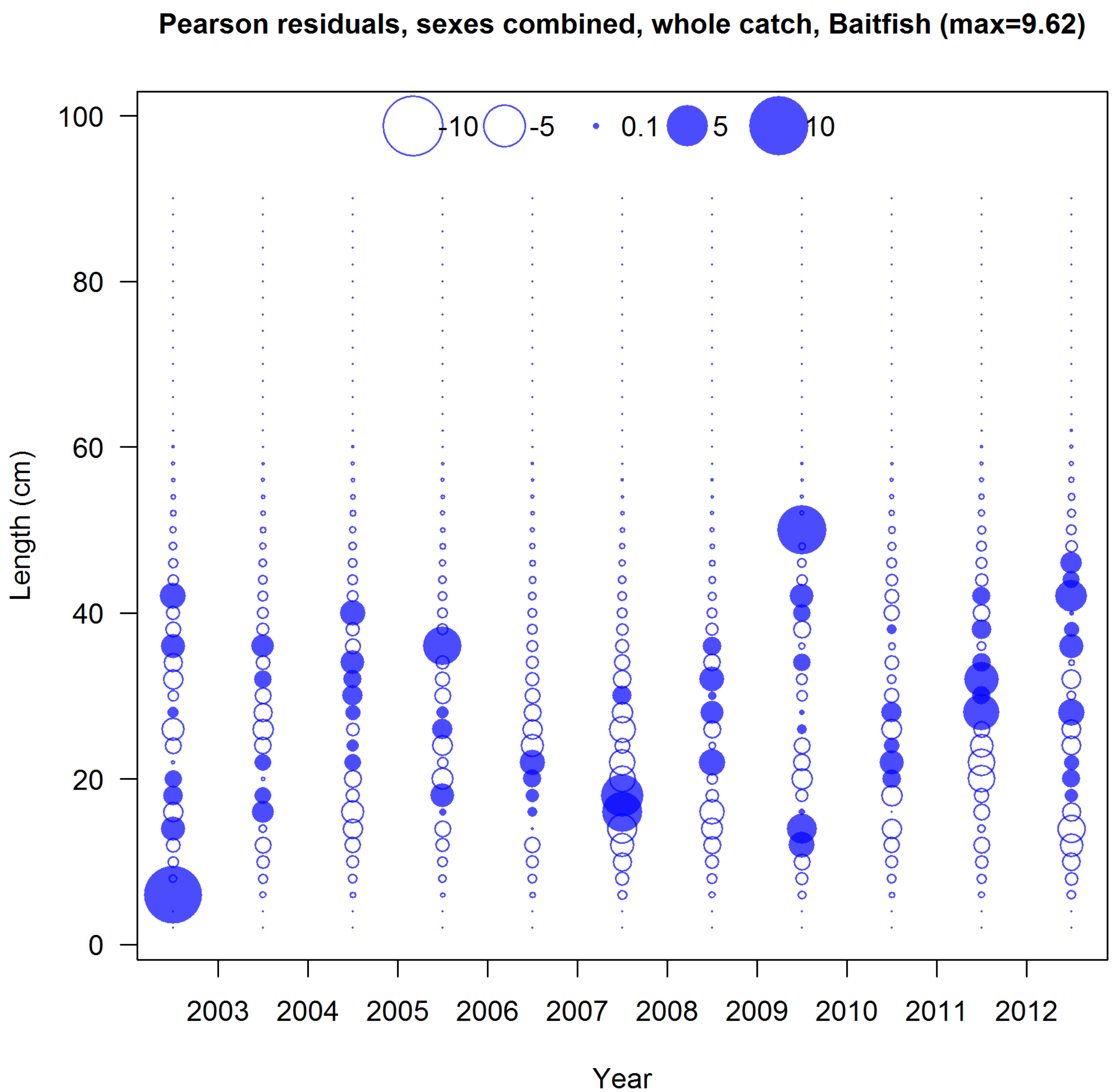


Figure 11.2.1.3.13. Observed and predicted length composition of landings from the SEAMAP trawl survey of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

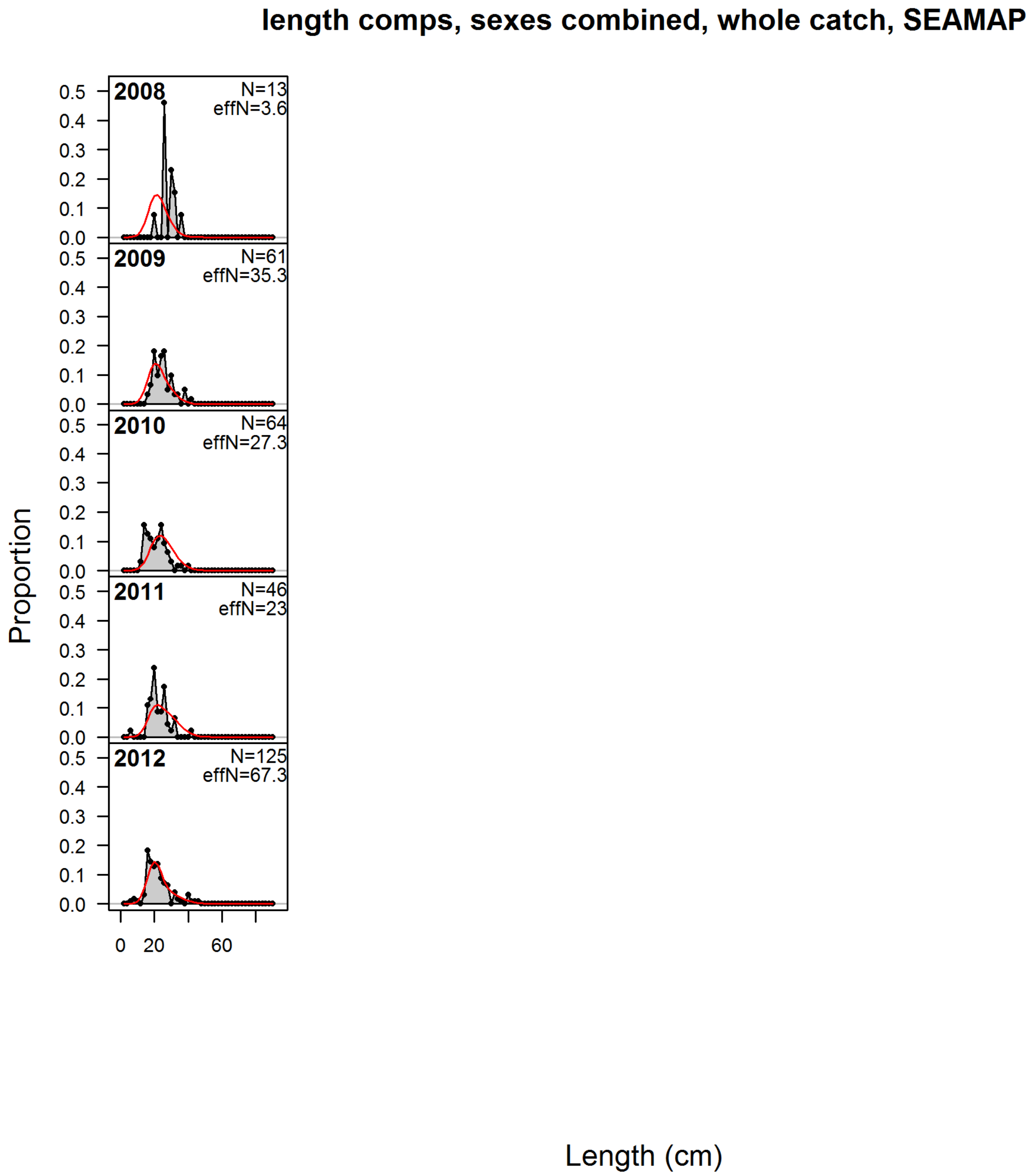


Figure 11.2.1.3.14. Pearson residuals for the length composition fit to the SEAMAP trawl survey of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

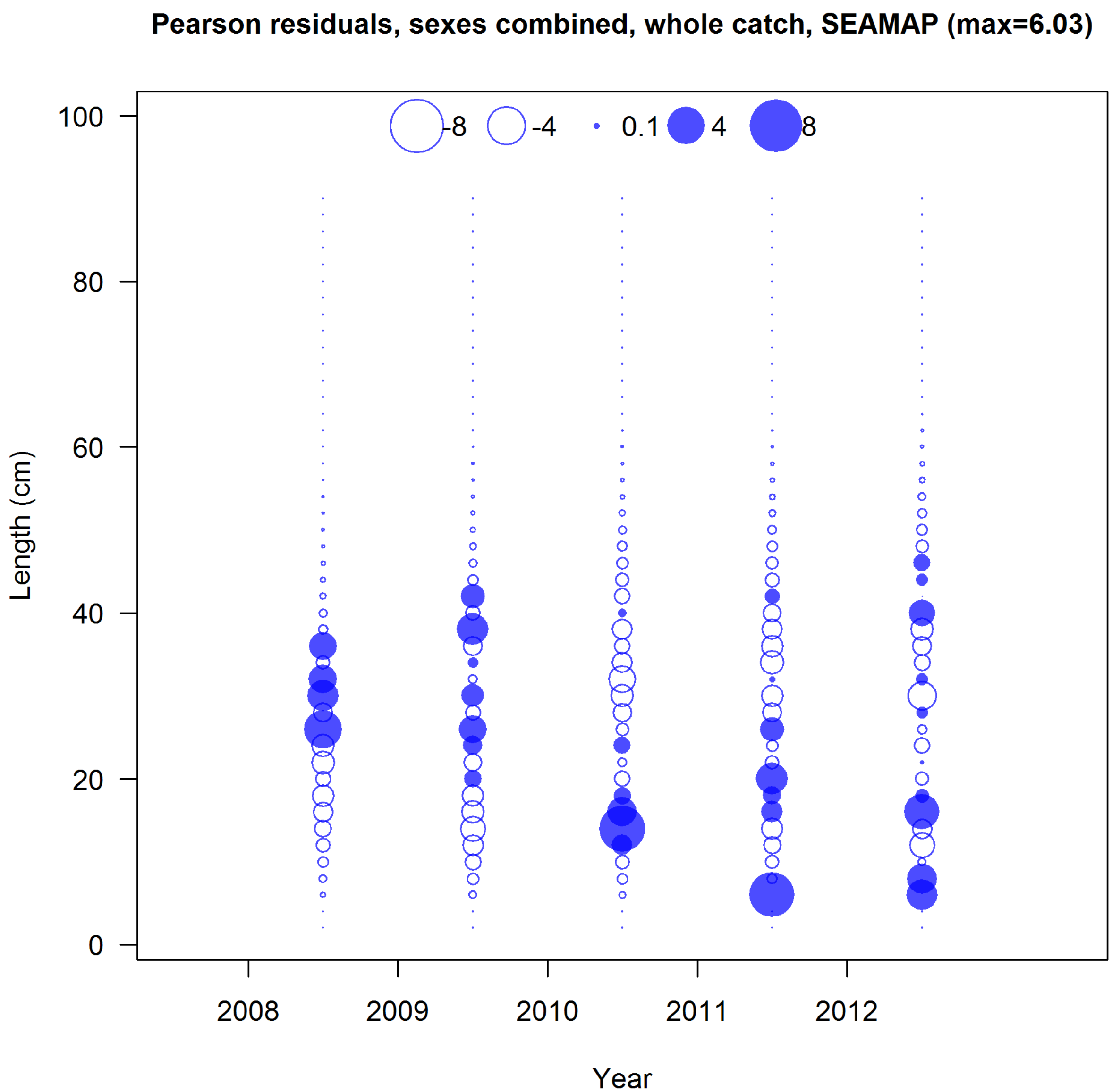


Figure 11.2.1.3.15. Observed and predicted length composition from the video survey of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

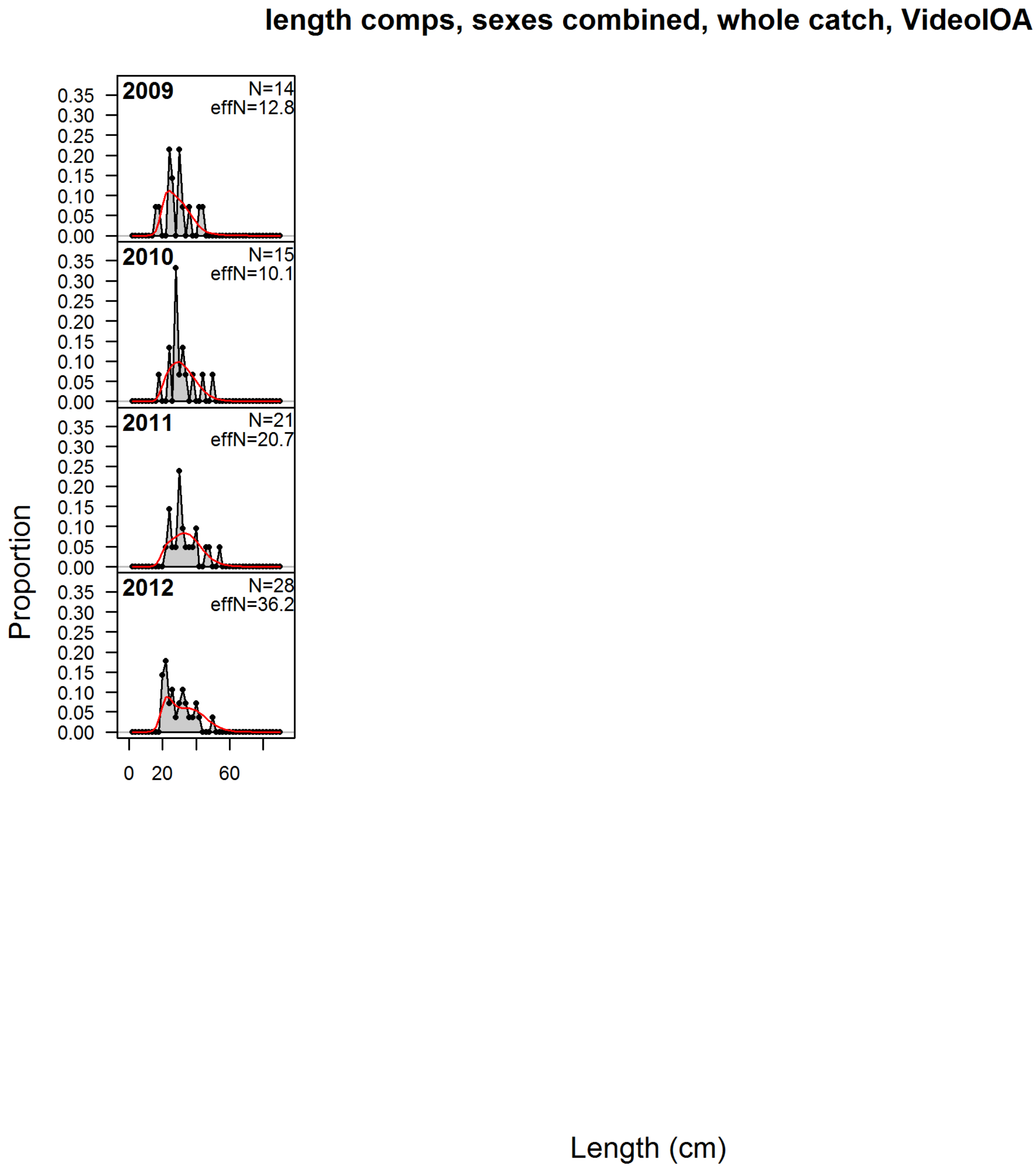


Figure 11.2.1.3.16. Pearson residuals for the length composition fit to the video survey of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

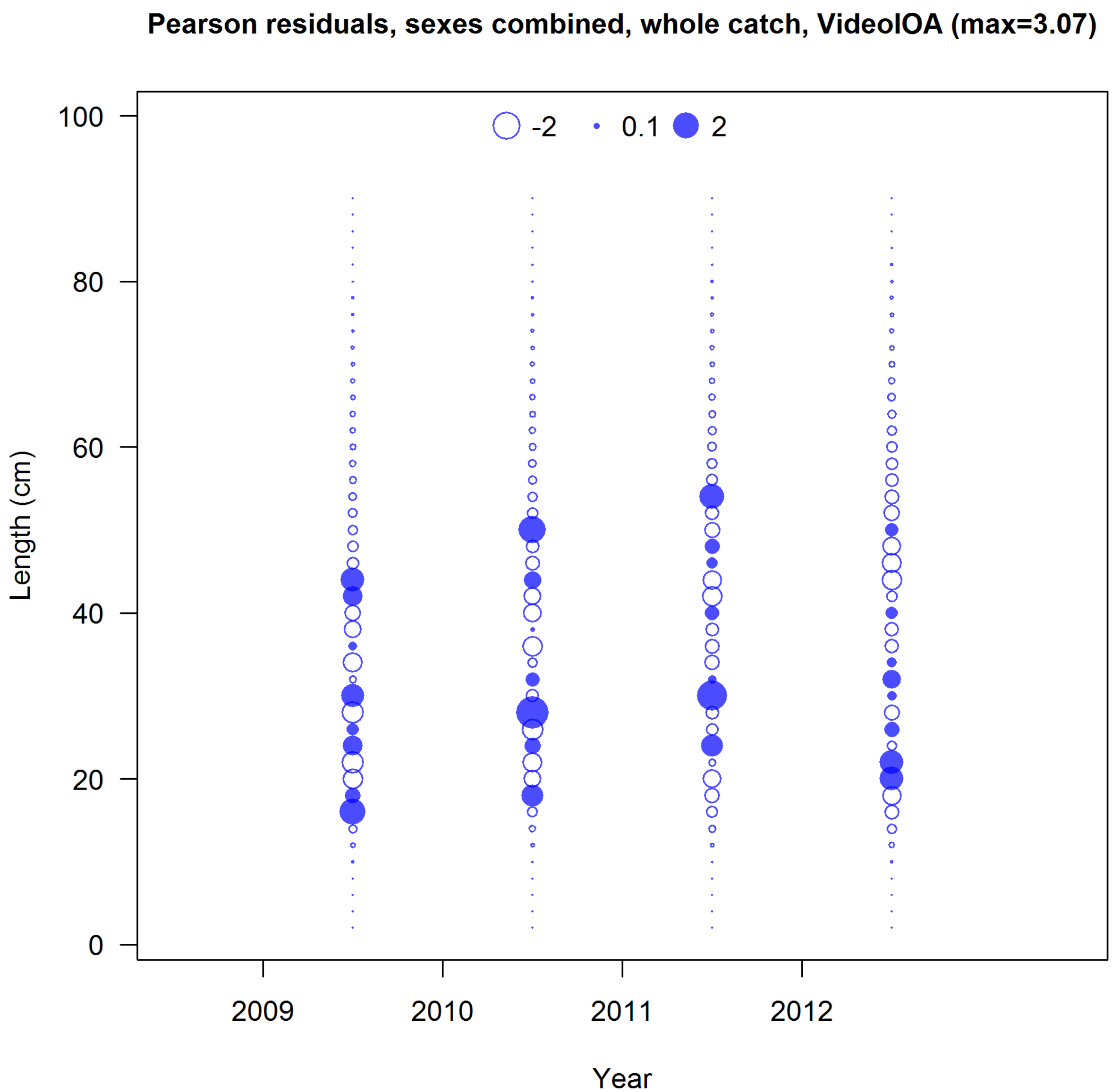


Figure 11.2.1.3.17. Observed and predicted length composition from the age-0 seagrass trawl survey of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

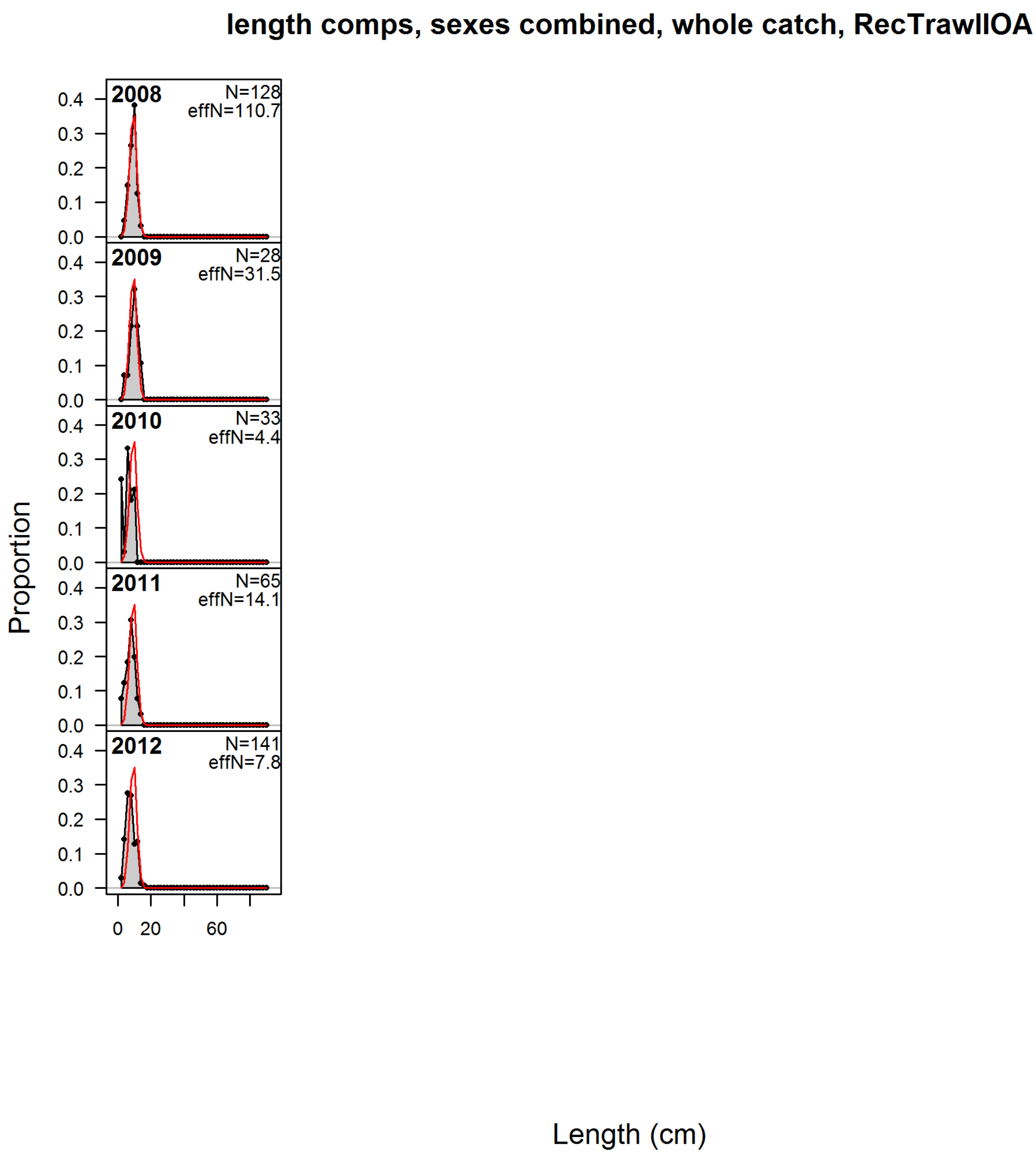


Figure 11.2.1.3.18. Pearson residuals for the length composition fit to the age-0 seagrass trawl survey of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

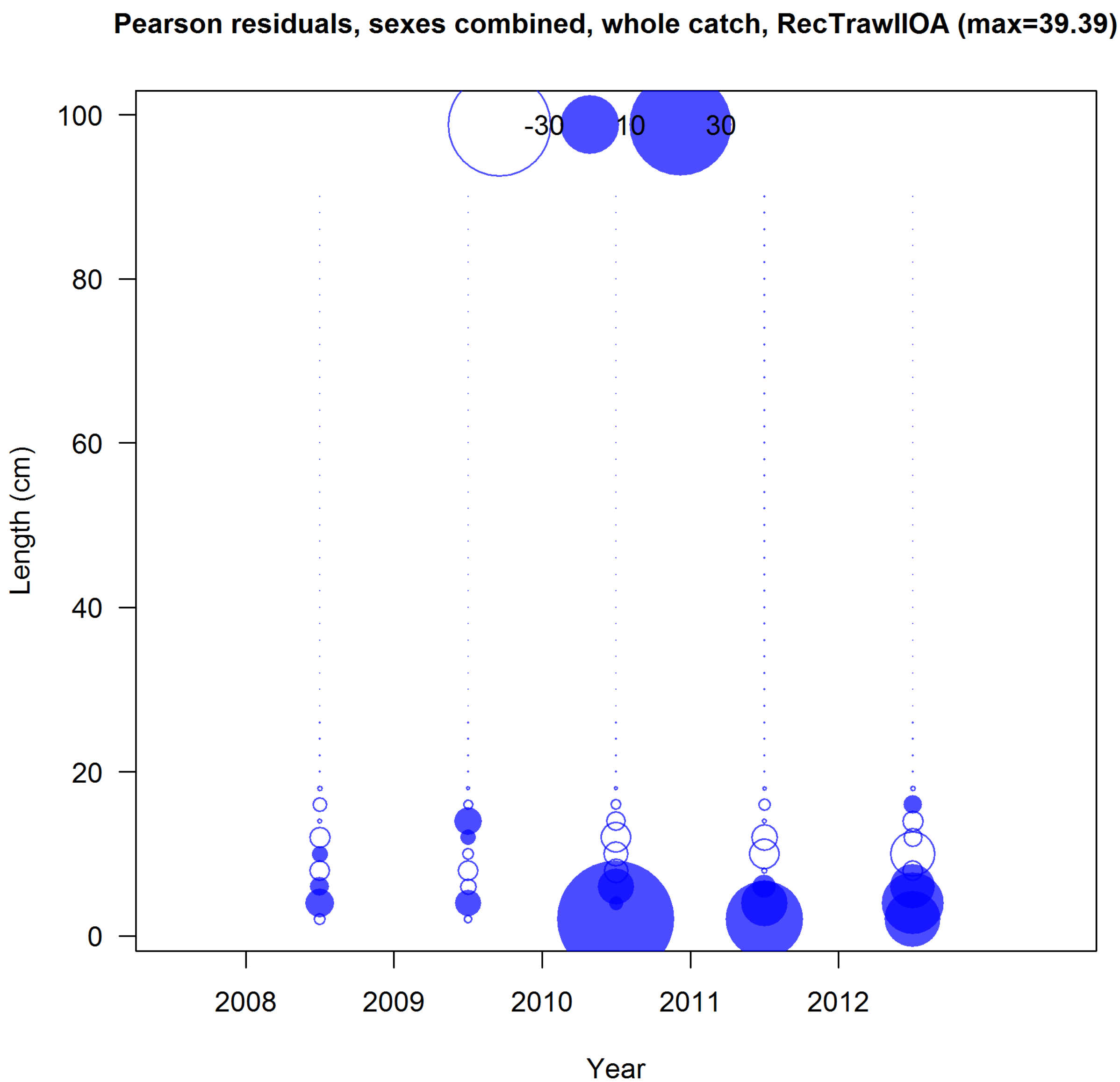


Figure 11.2.1.3.19. Observed and predicted length composition from all fisheries and surveys averaged across years of the WFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

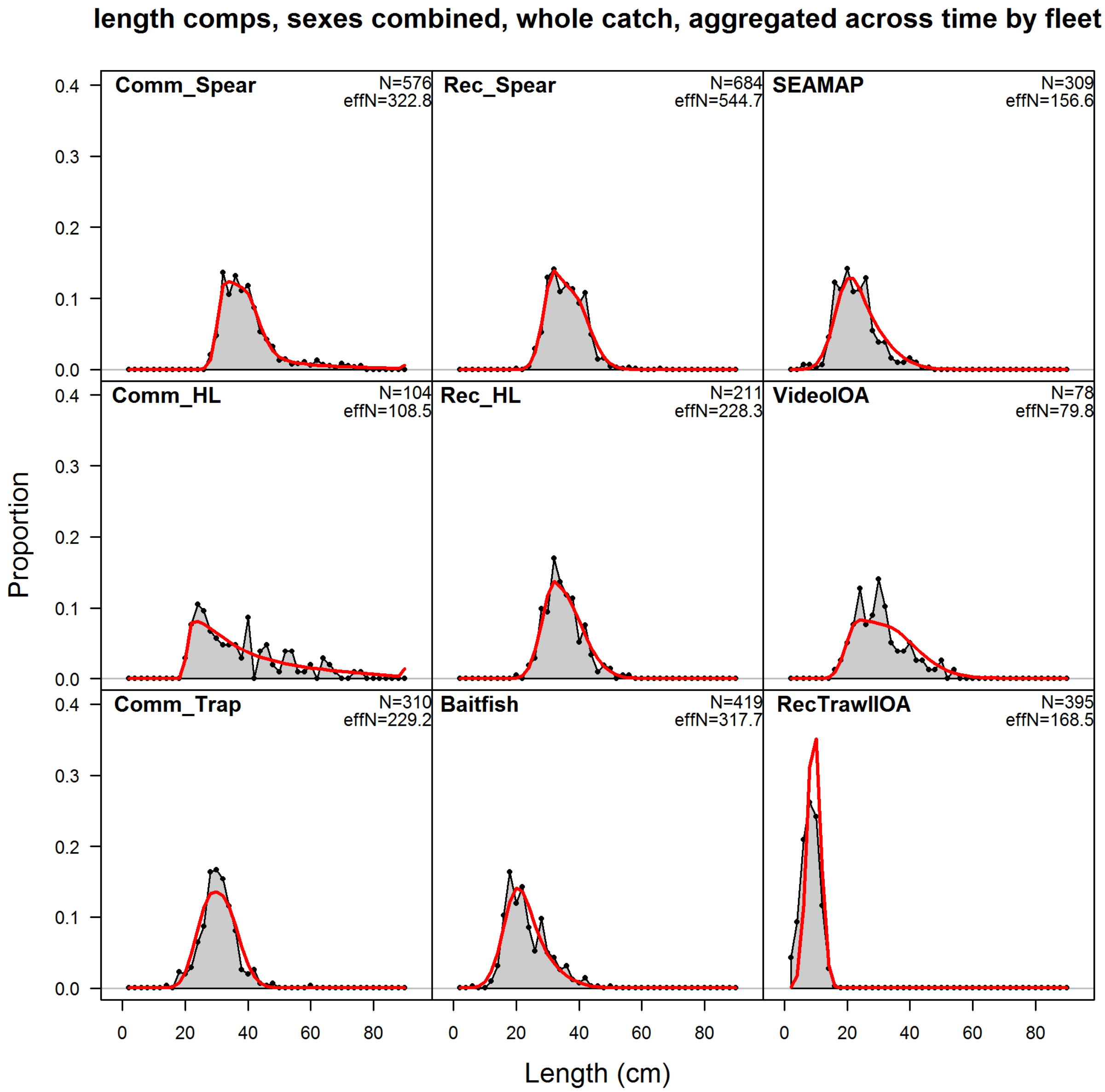


Figure 11.2.1.3.20. Pearson residuals for the length composition from all fisheries and surveys averaged across years of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

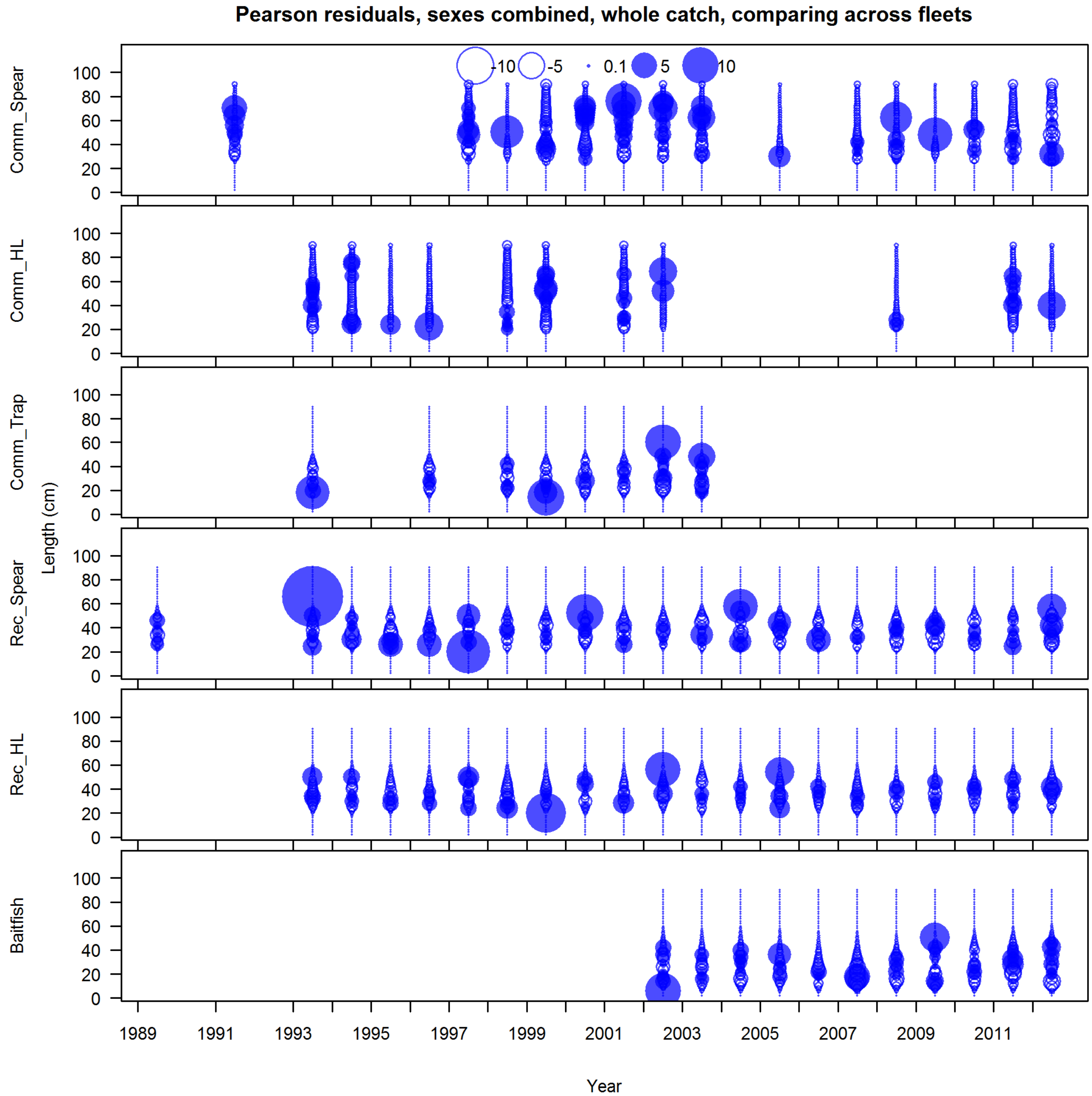


Figure 11.2.1.3.20 (continued). Pearson residuals for the length composition from all fisheries and surveys averaged across years of the WFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

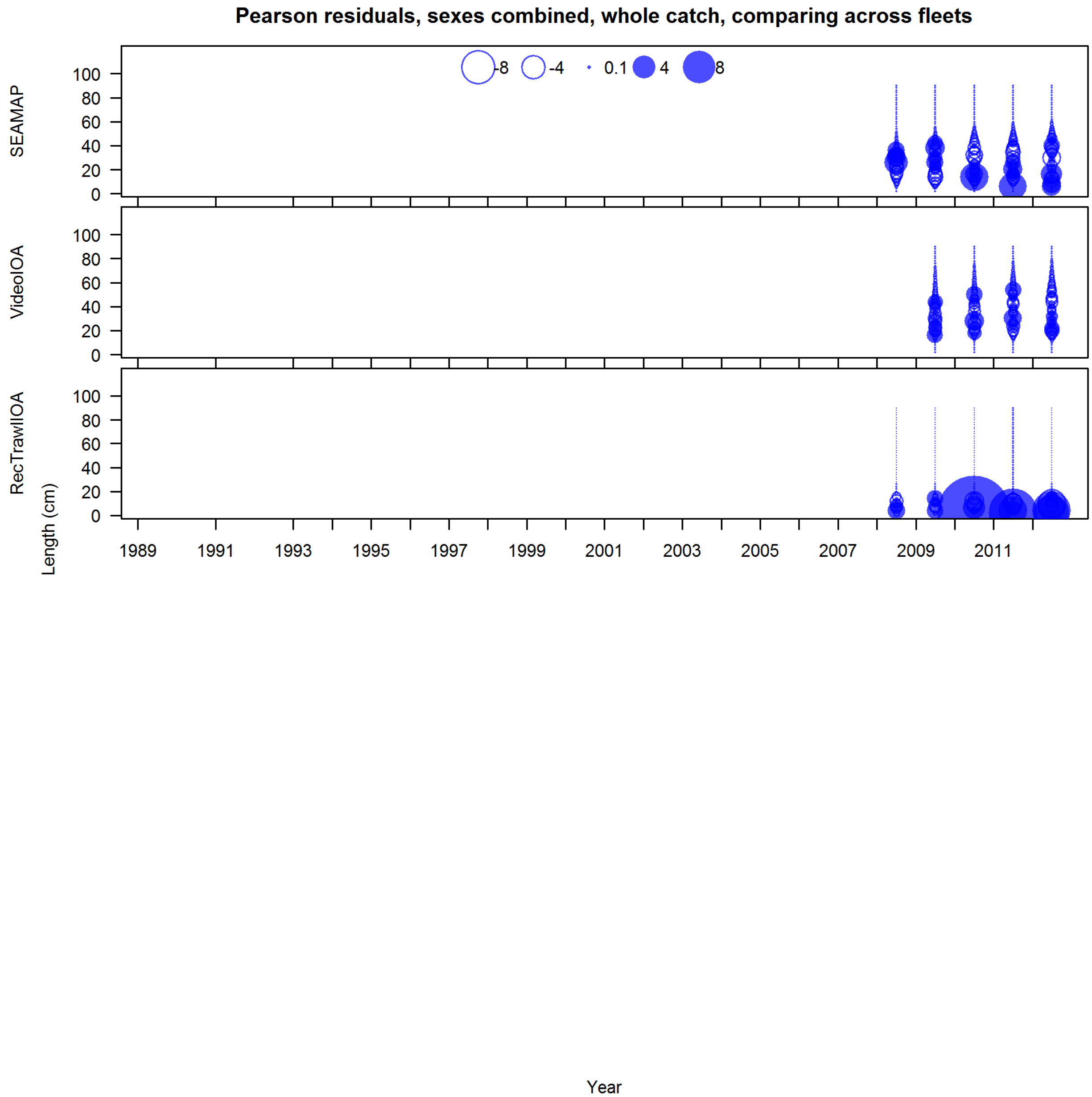


Figure 11.2.1.3.21. Observed and predicted length composition of landings from the commercial spear fishery of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

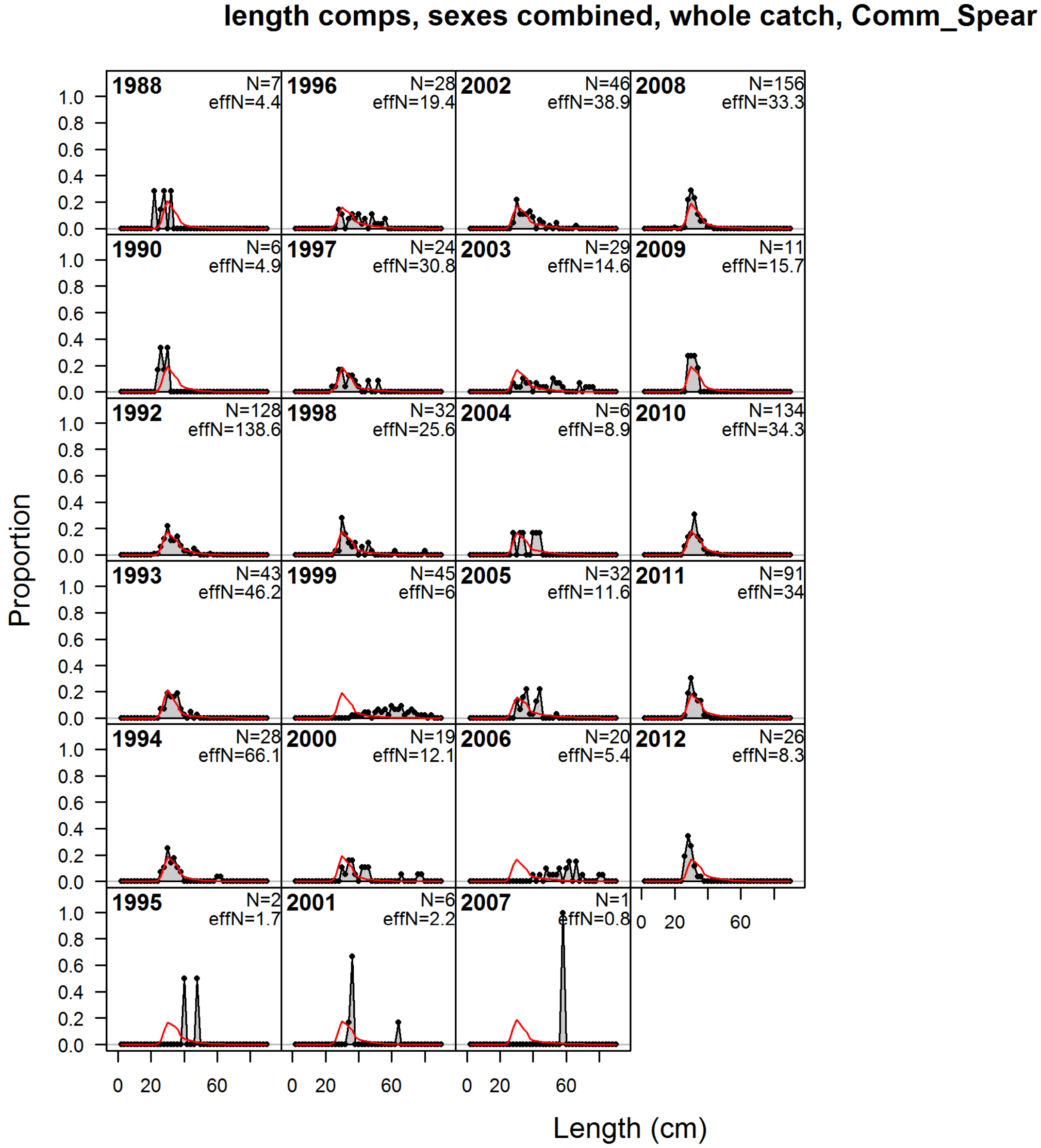


Figure 11.2.1.3.22. Pearson residuals for the length composition fit to the commercial spear fishery of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

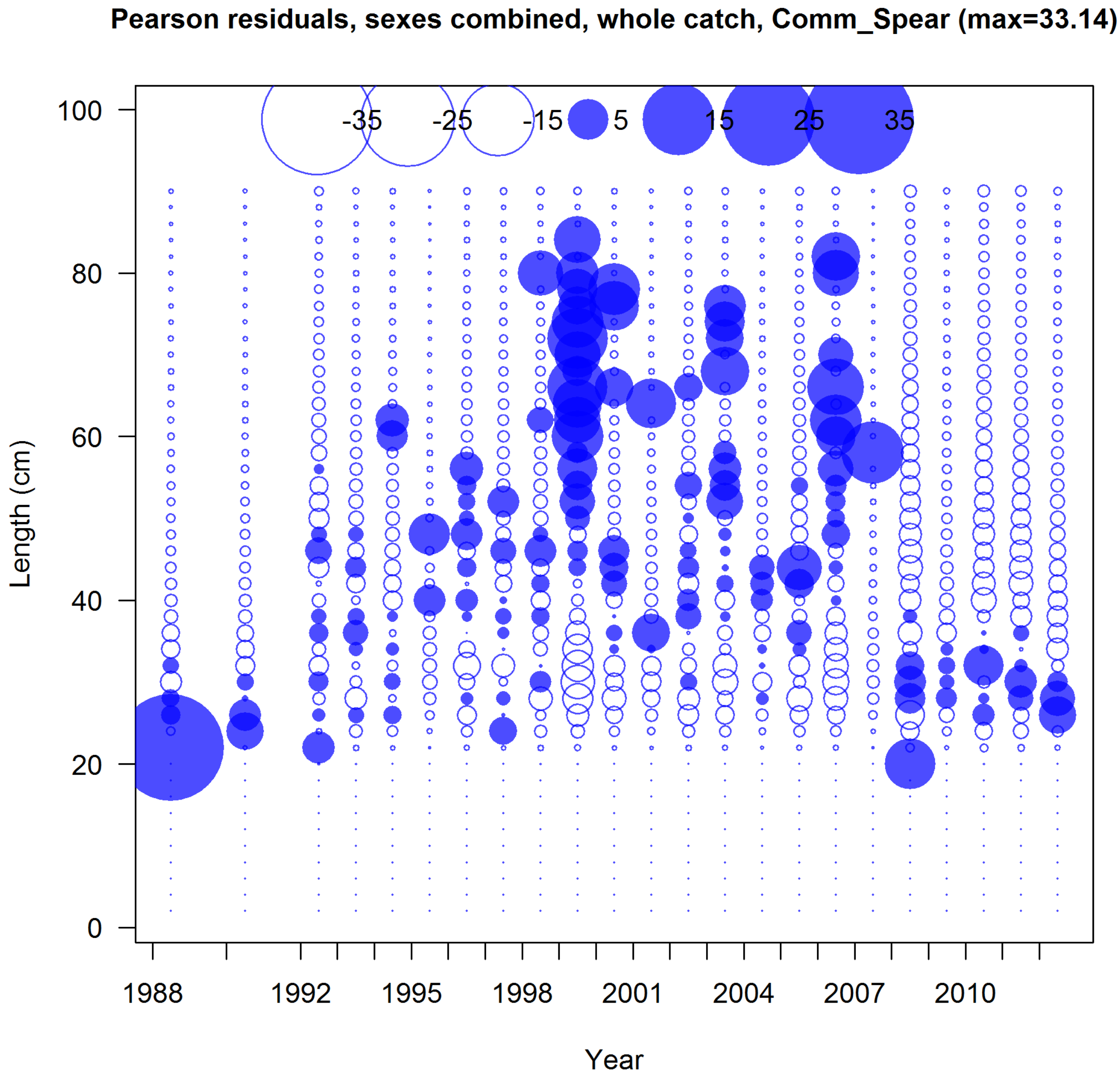


Figure 11.2.1.3.23. Observed and predicted length composition of landings from the commercial hook and line fishery of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

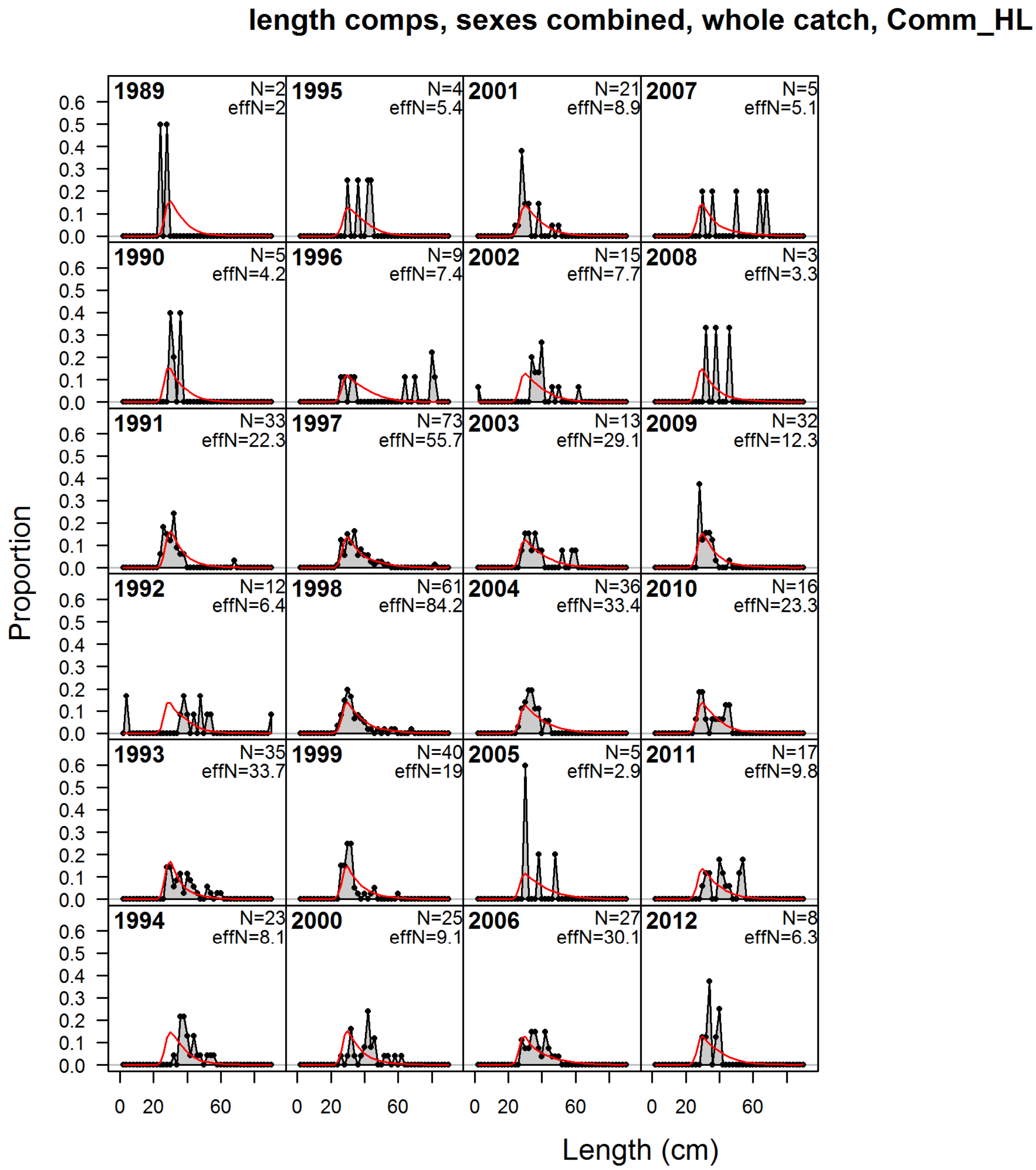


Figure 11.2.1.3.24. Pearson residuals for the length composition fit to the commercial hook and line fishery of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

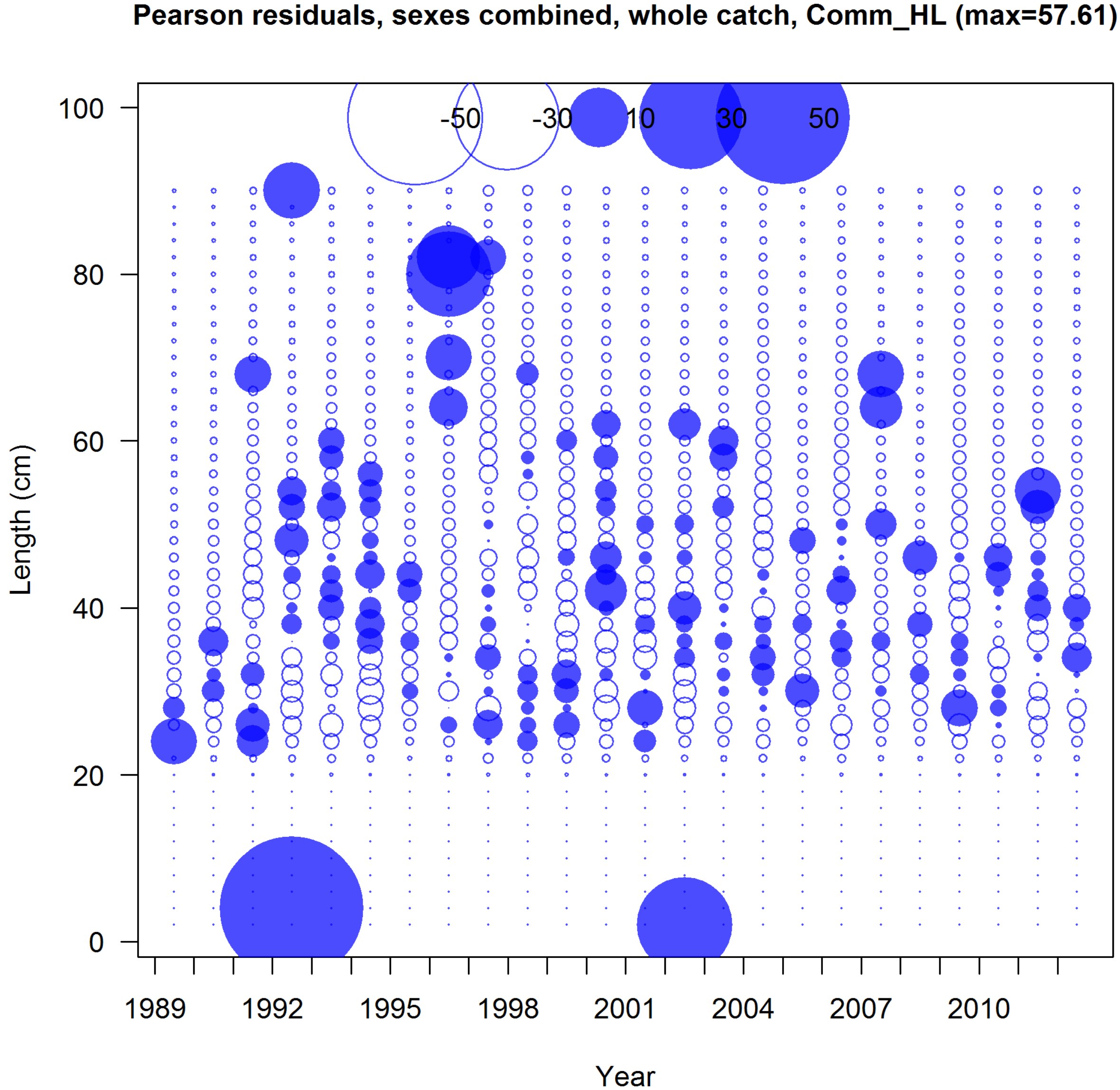


Figure 11.2.1.3.25. Observed and predicted length composition of landings from the commercial trap fishery of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

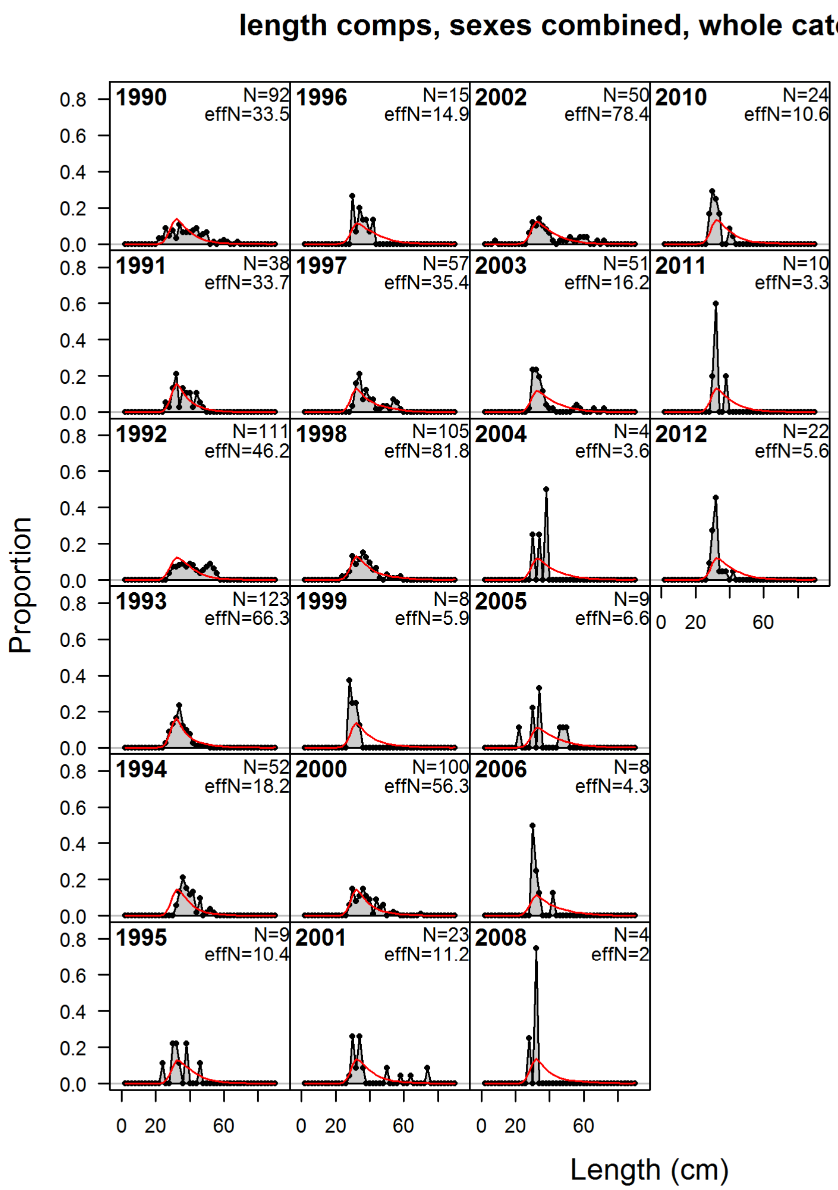


Figure 11.2.1.3.26. Pearson residuals for the length composition fit to the commercial trap fishery of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

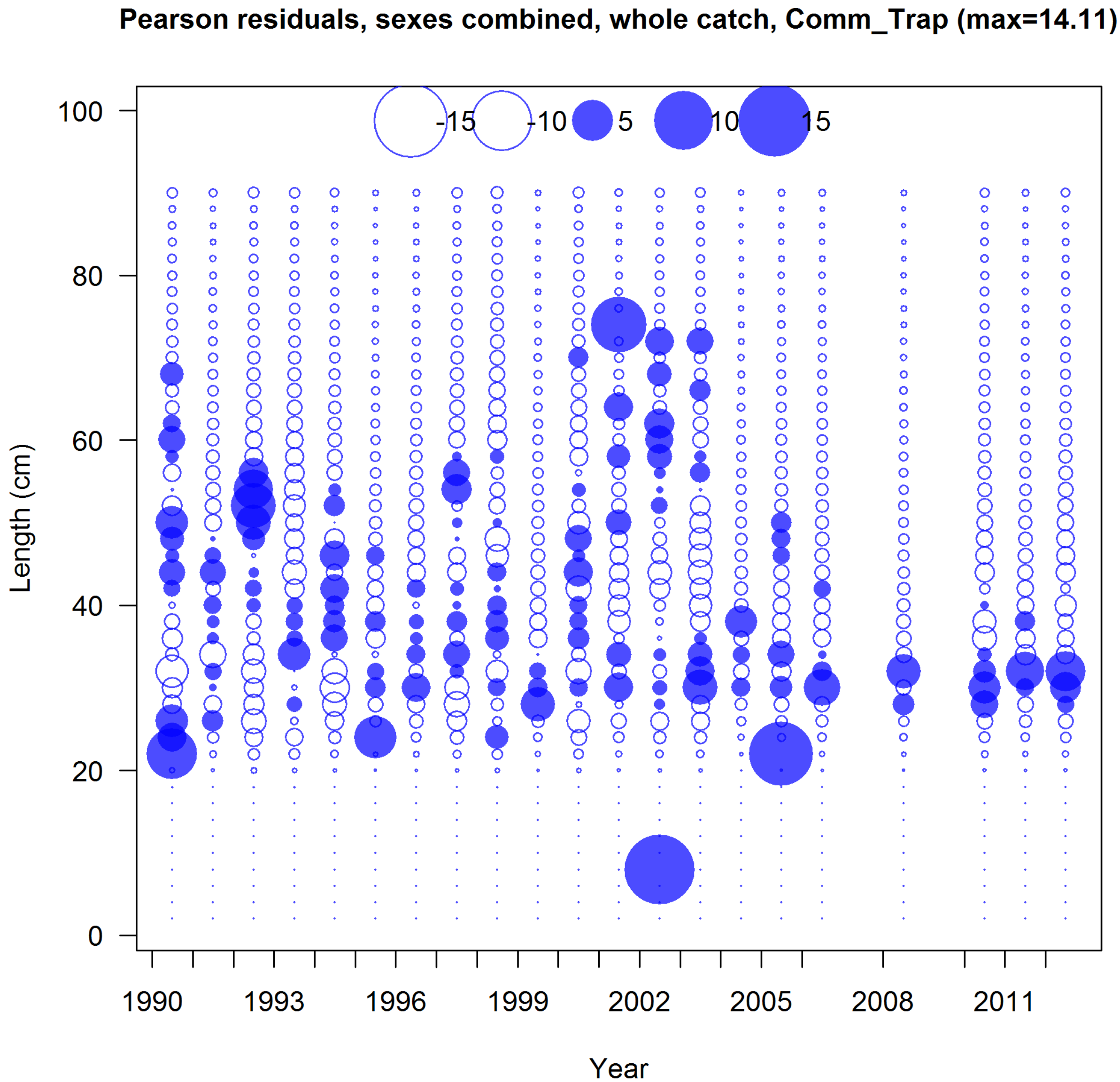


Figure 11.2.1.3.27. Observed and predicted length composition of landings from the recreational spear fishery of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

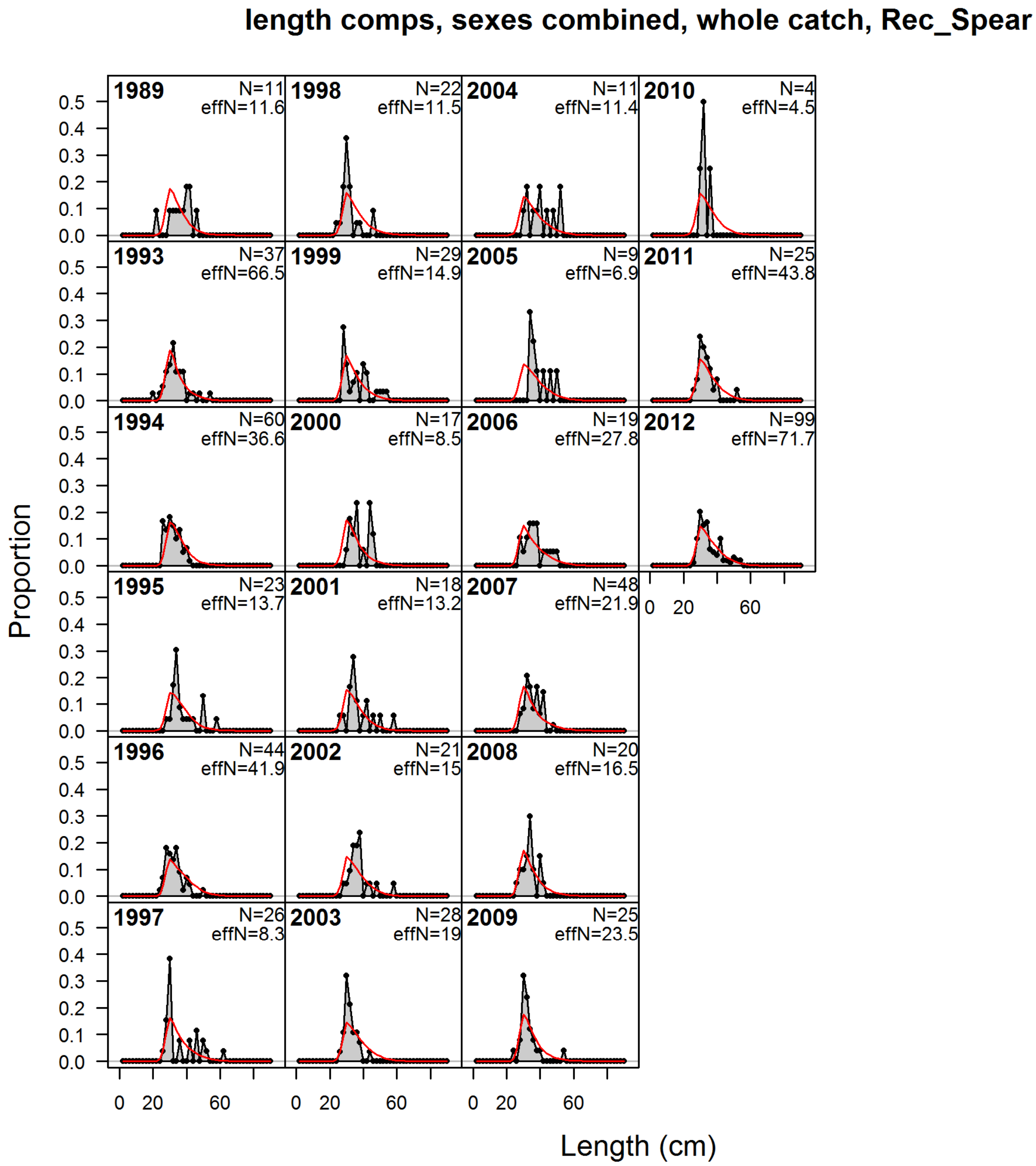


Figure 11.2.1.3.28. Pearson residuals for the length composition fit to the recreational spear fishery of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

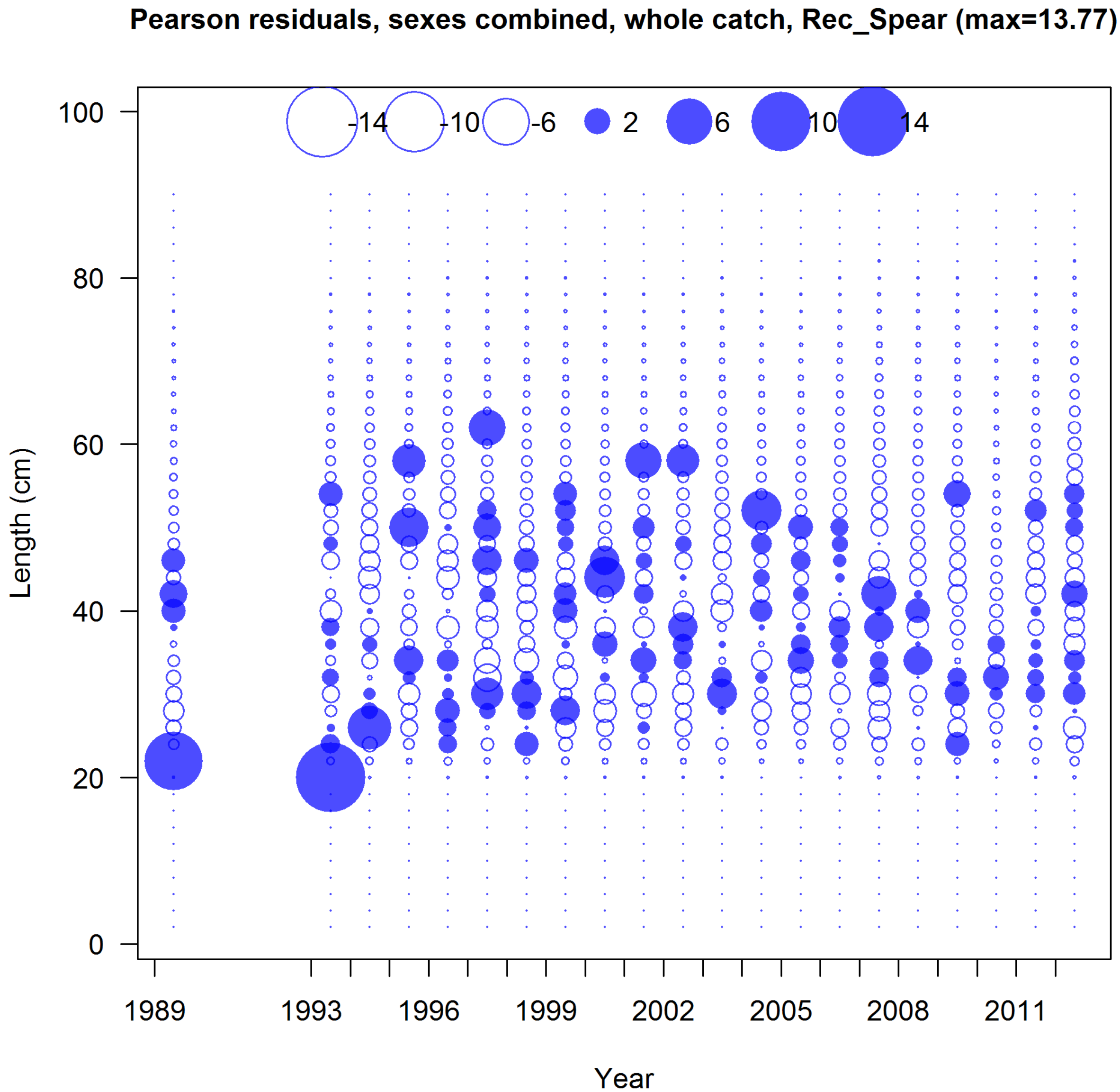


Figure 11.2.1.3.29. Observed and predicted length composition of landings from the recreational hook and line fishery of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

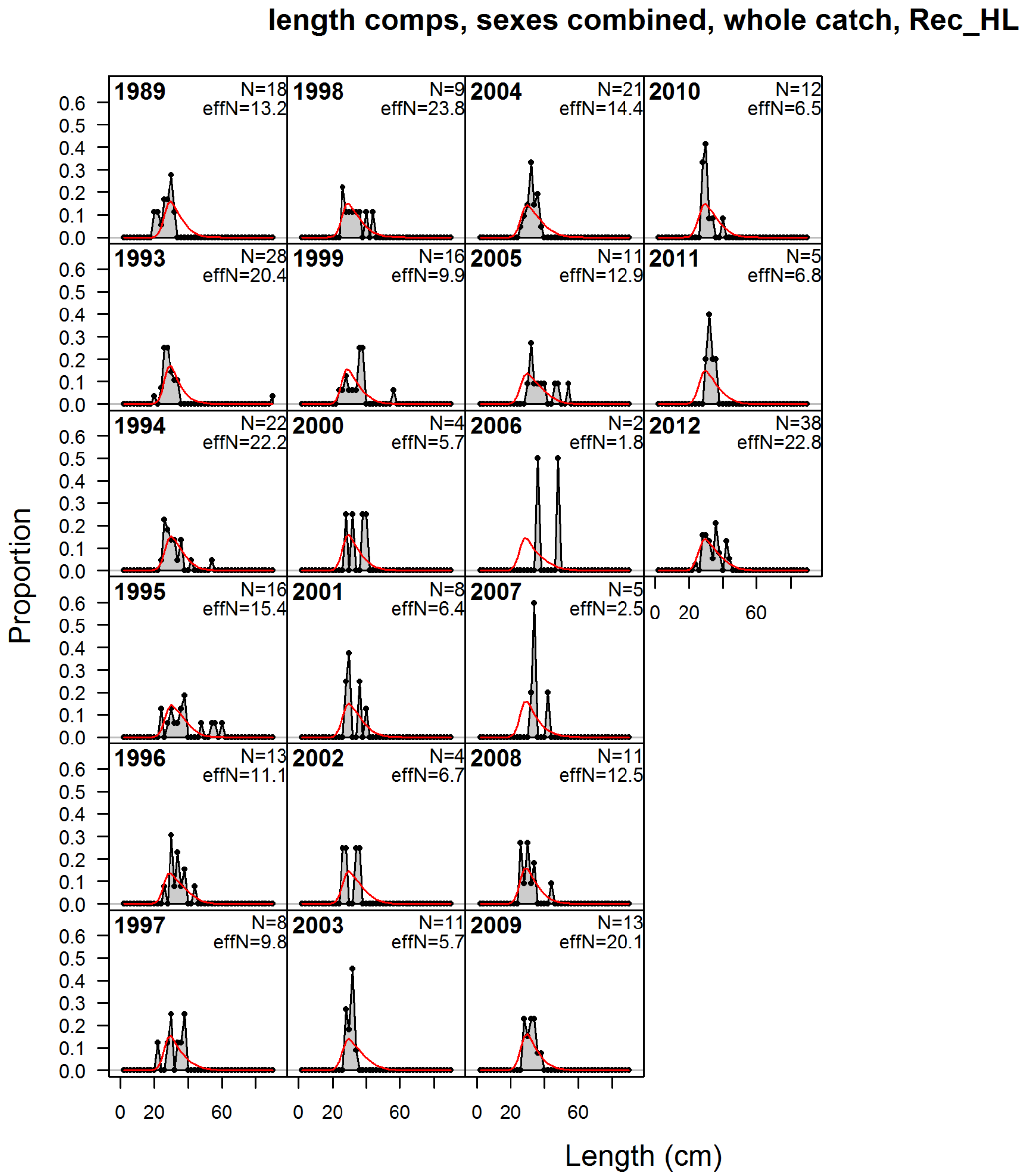


Figure 11.2.1.3.30. Pearson residuals for the length composition fit to the recreational hook and line fishery of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

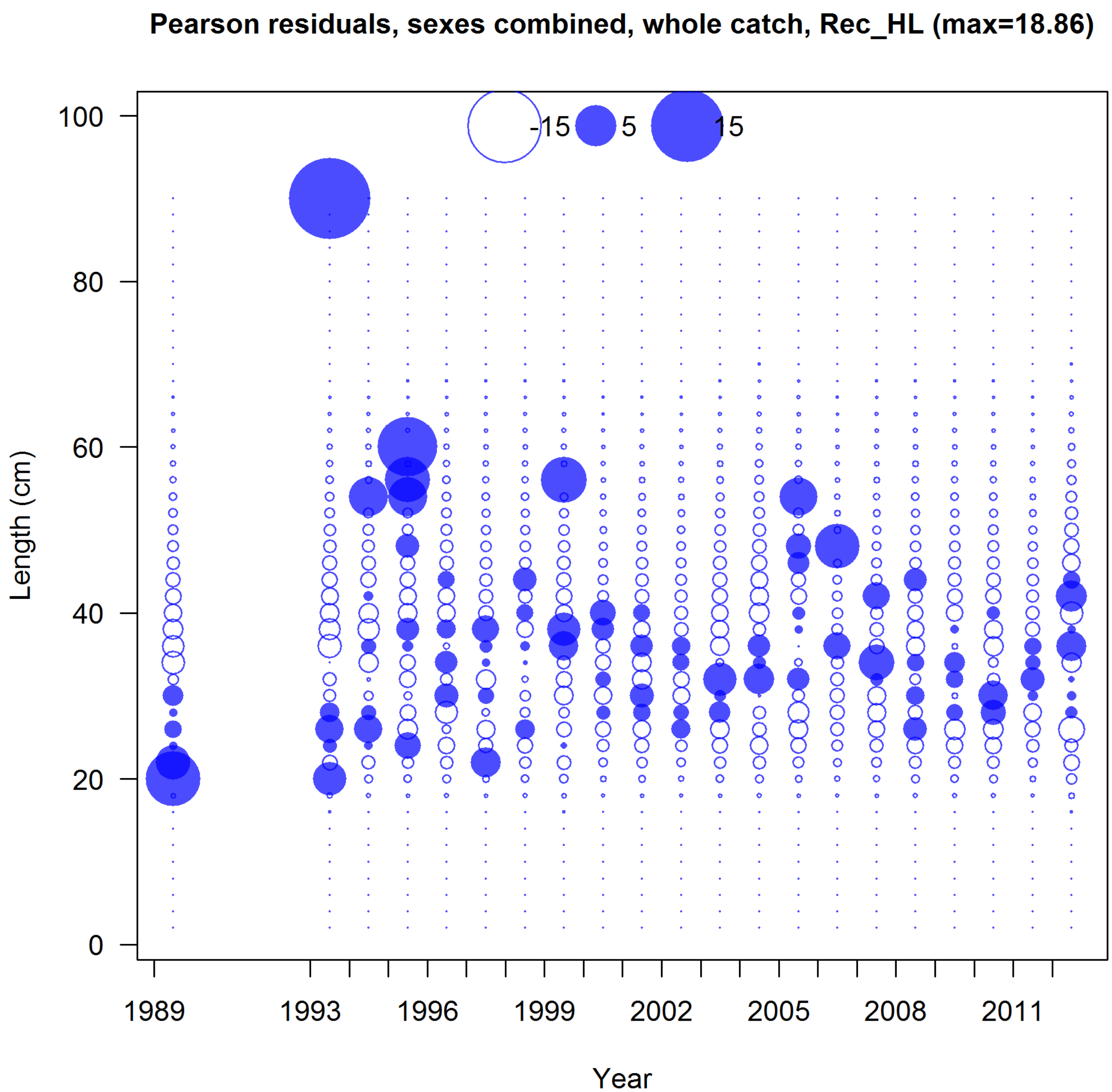


Figure 11.2.1.3.31. Observed and predicted length composition of landings from the RVC-Keys survey of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

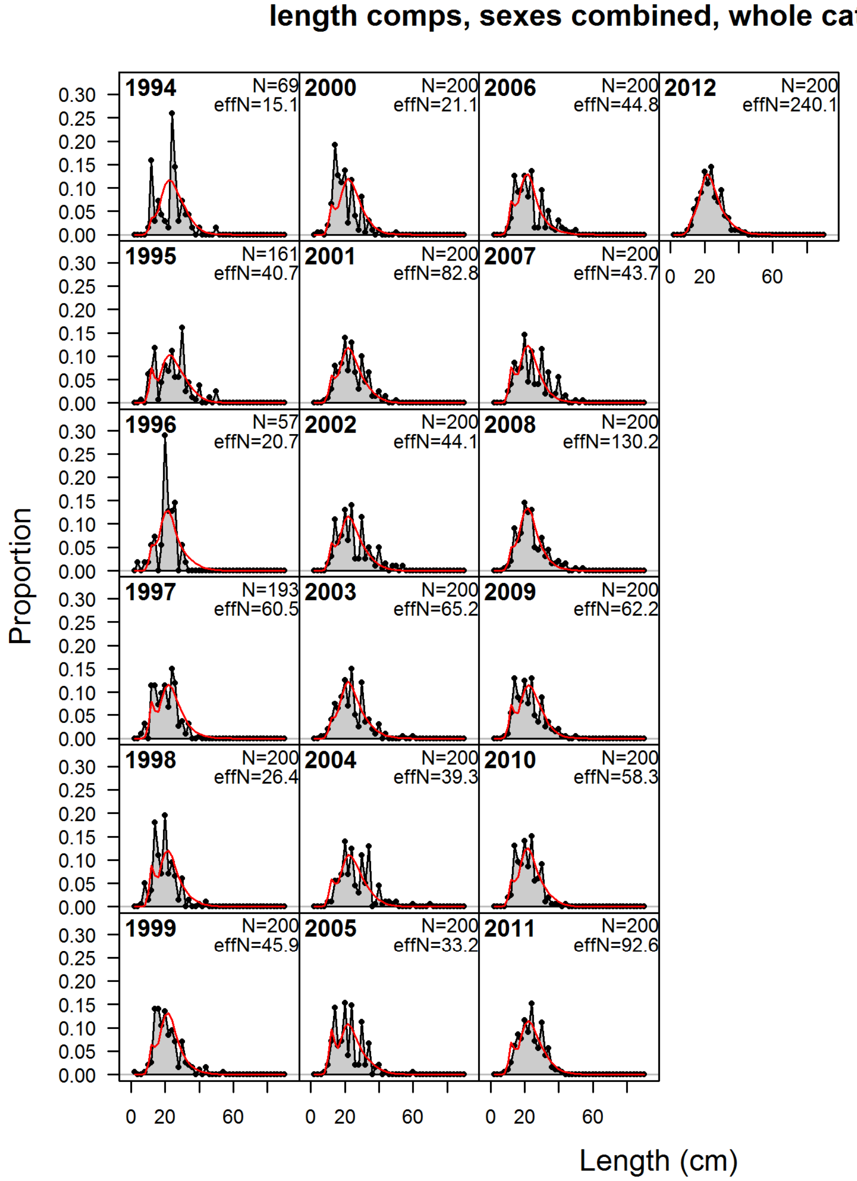


Figure 11.2.1.3.32. Pearson residuals for the length composition fit to the RVC-Keys survey of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

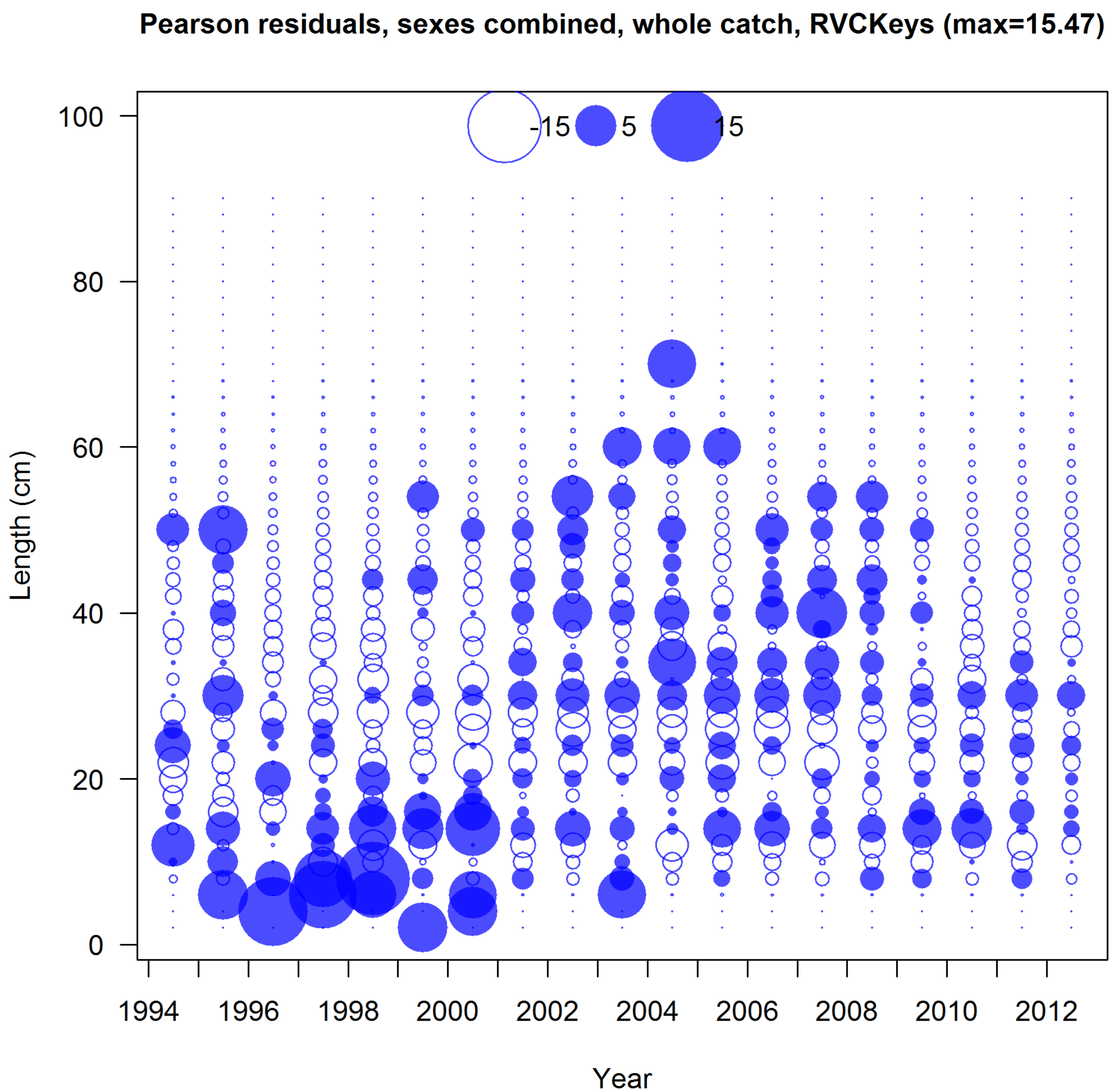


Figure 11.2.1.3.33. Observed and predicted length composition of landings from the RVC-Tortugas survey of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

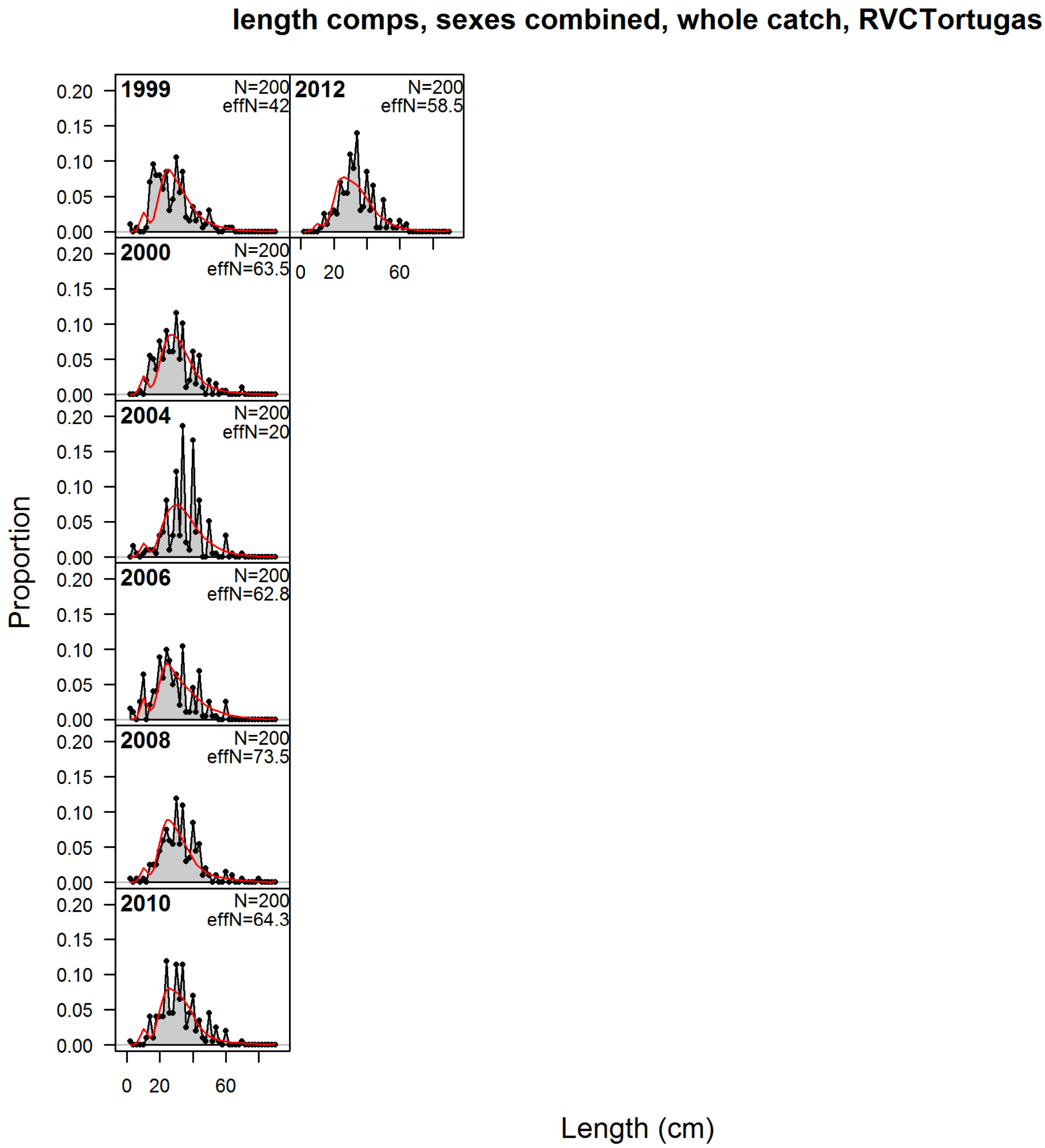


Figure 11.2.1.3.34. Pearson residuals for the length composition fit to the RVC-Tortugas survey of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

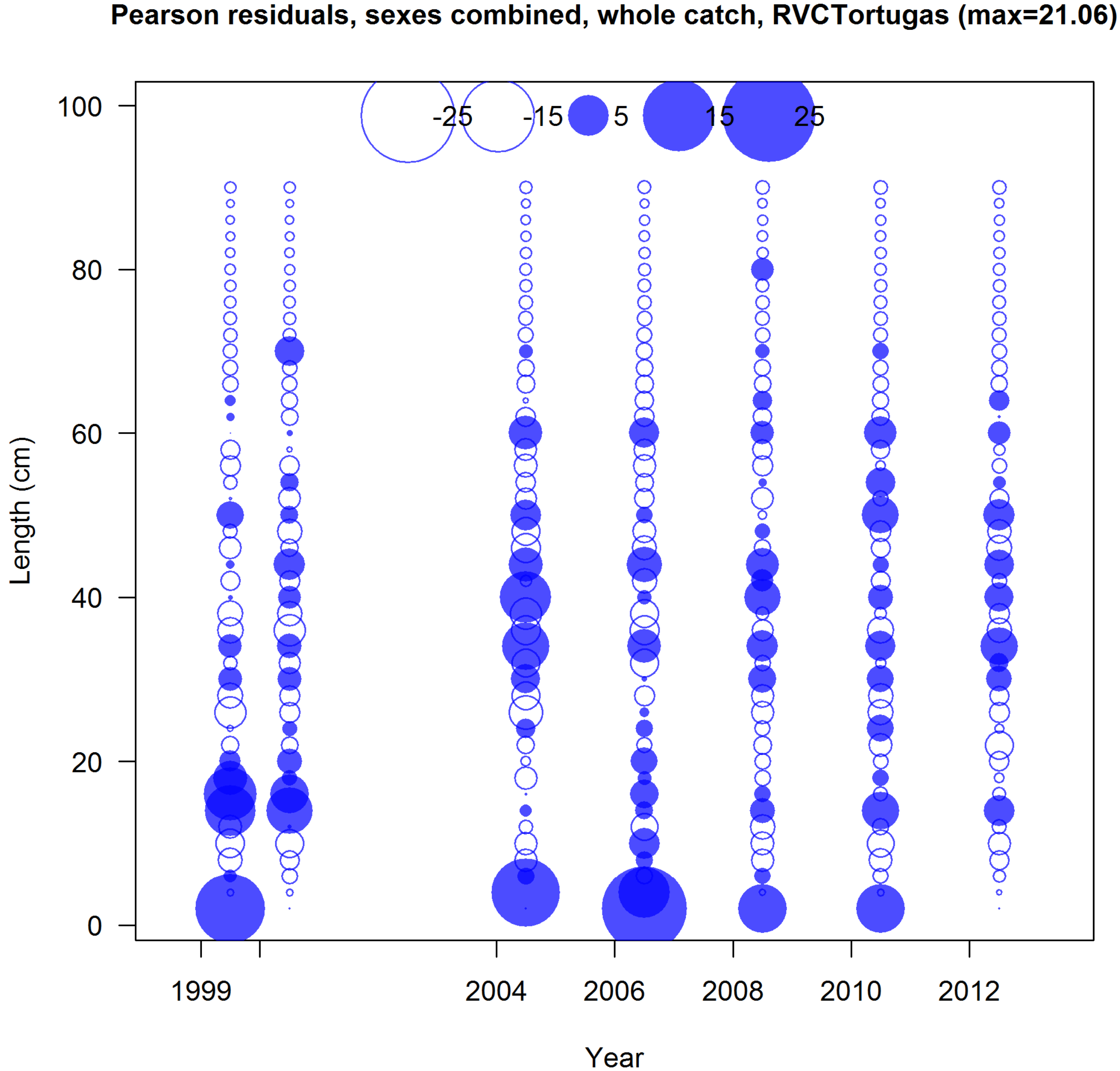


Figure 11.2.1.3.35. Observed and predicted length composition from all fisheries and surveys averaged across years of the FLK/EFL stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

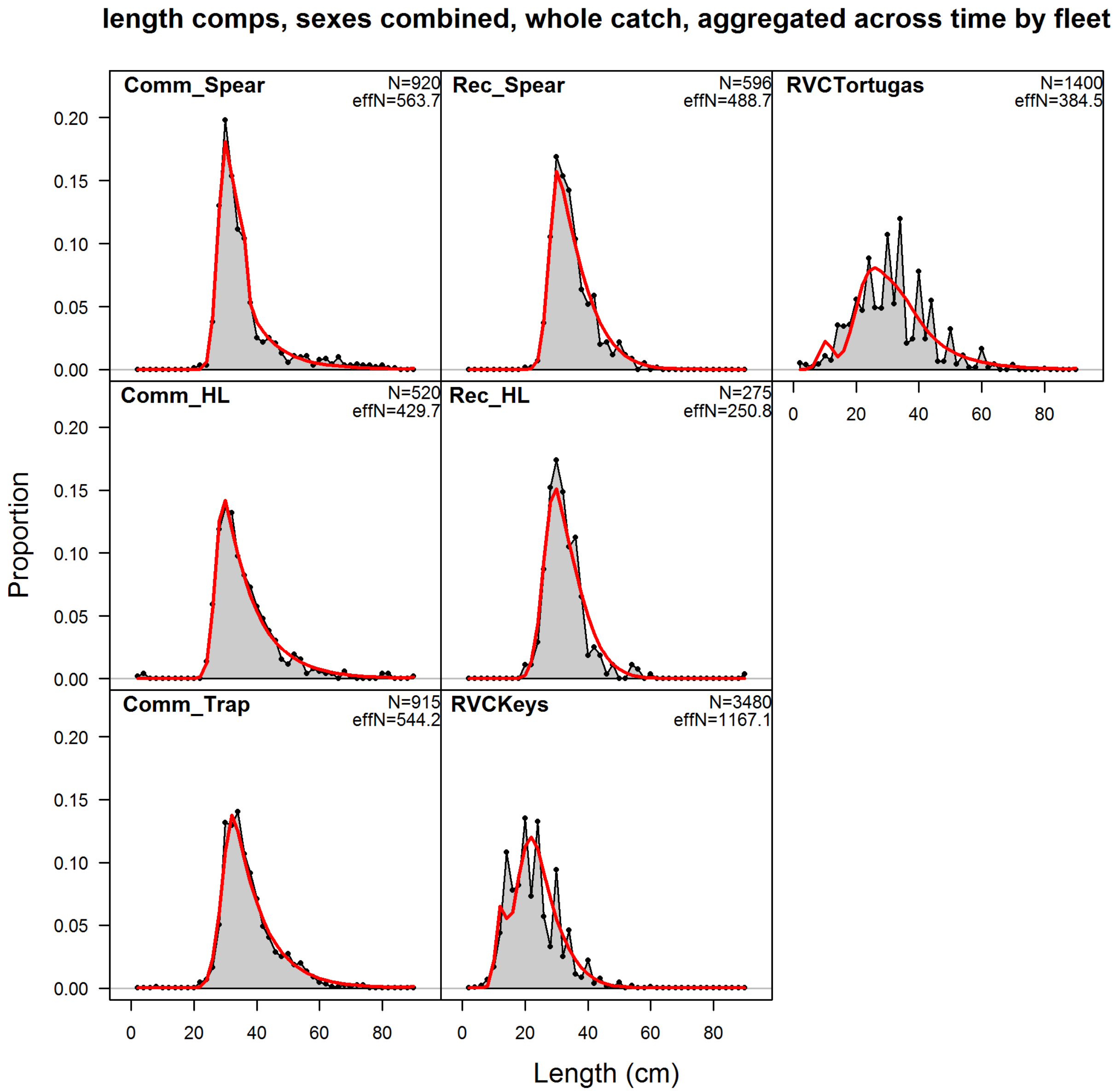


Figure 11.2.1.3.36. Pearson residuals for the length composition from all fisheries and surveys averaged across years of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

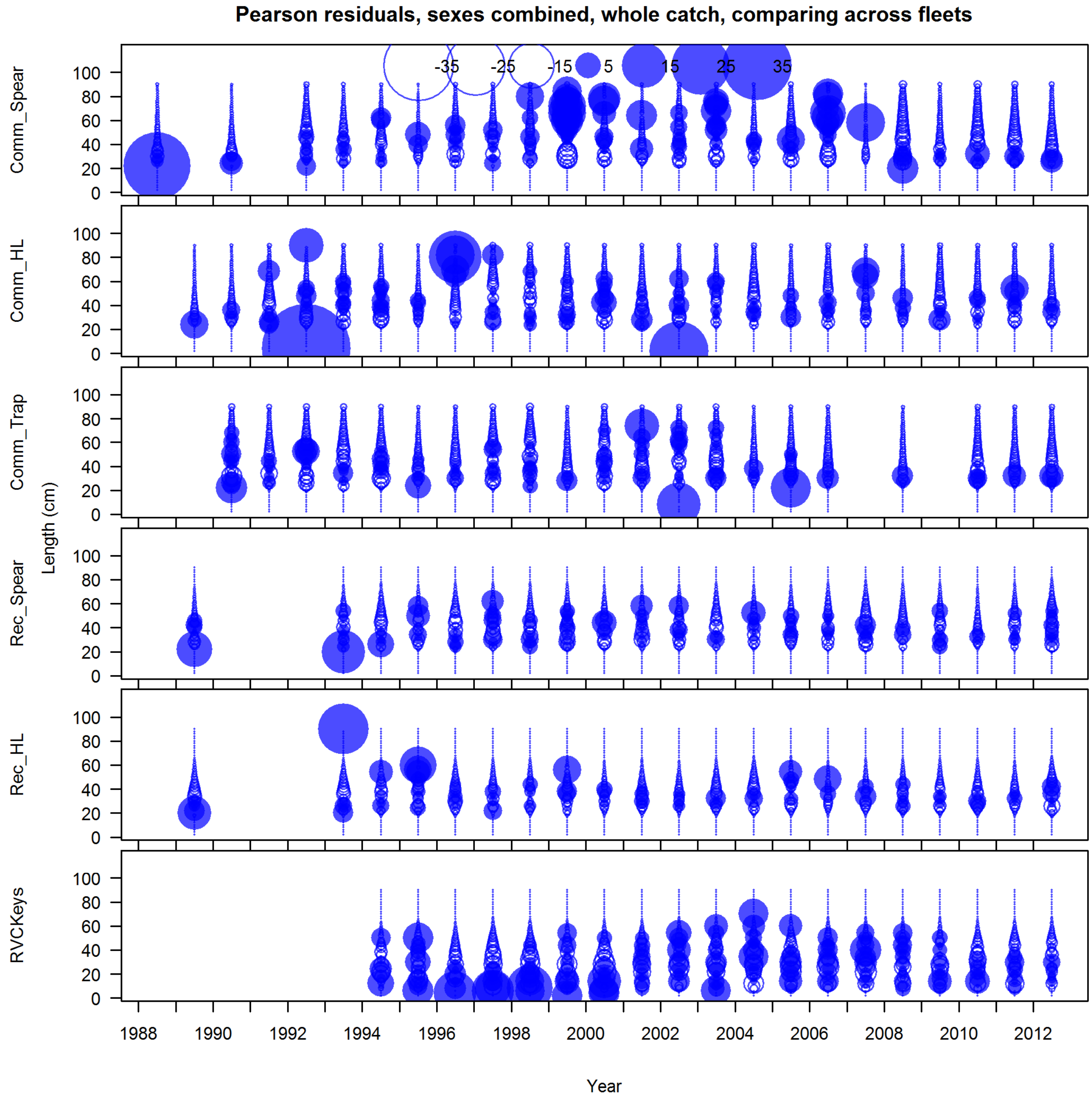


Figure 11.2.1.3.36 (continued). Pearson residuals for the length composition from all fisheries and surveys averaged across years of the FLK/EFL stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

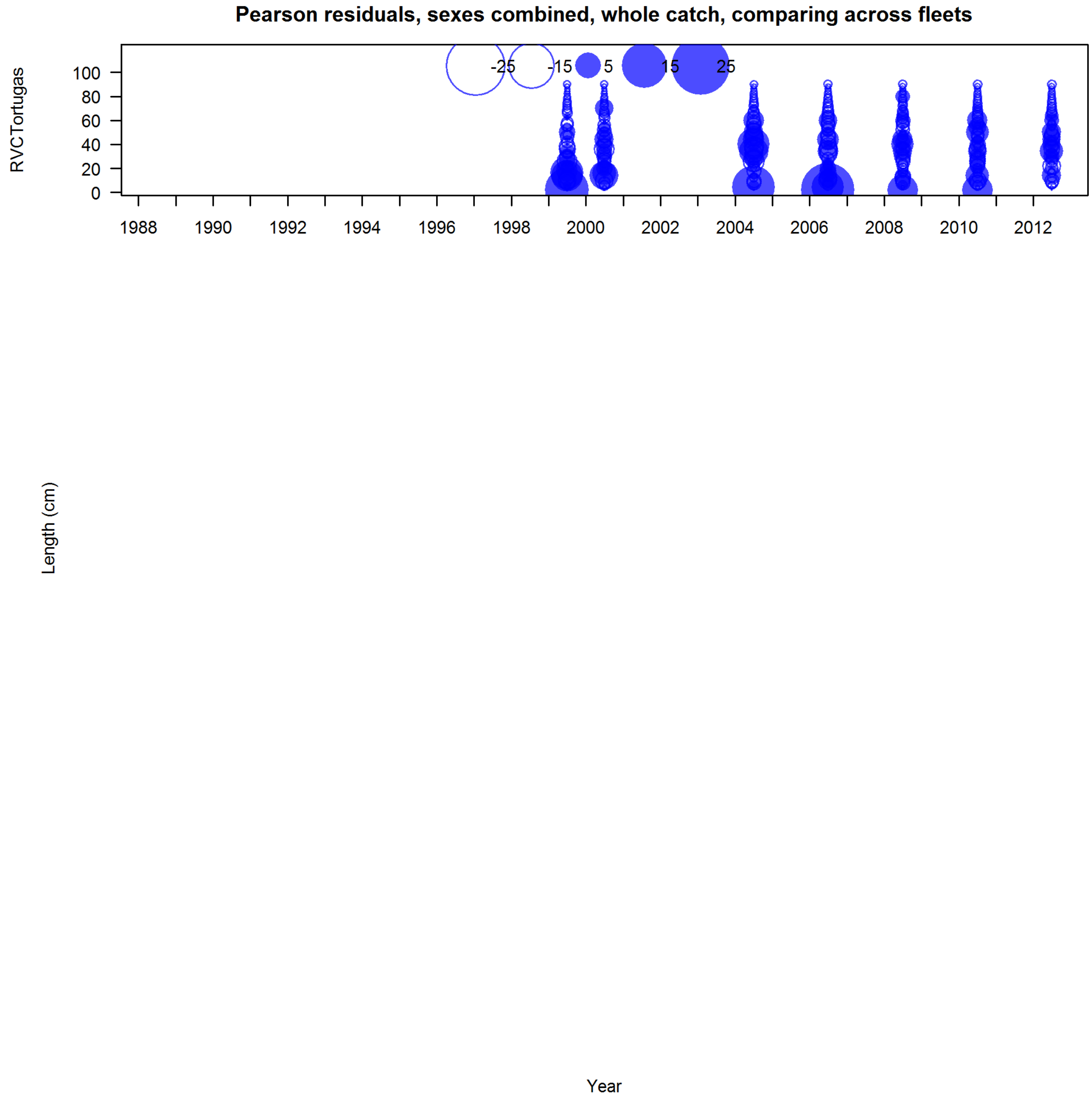


Figure 11.2.1.3.37. Observed and predicted length composition of landings from the commercial spear fishery of the GA-NC stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

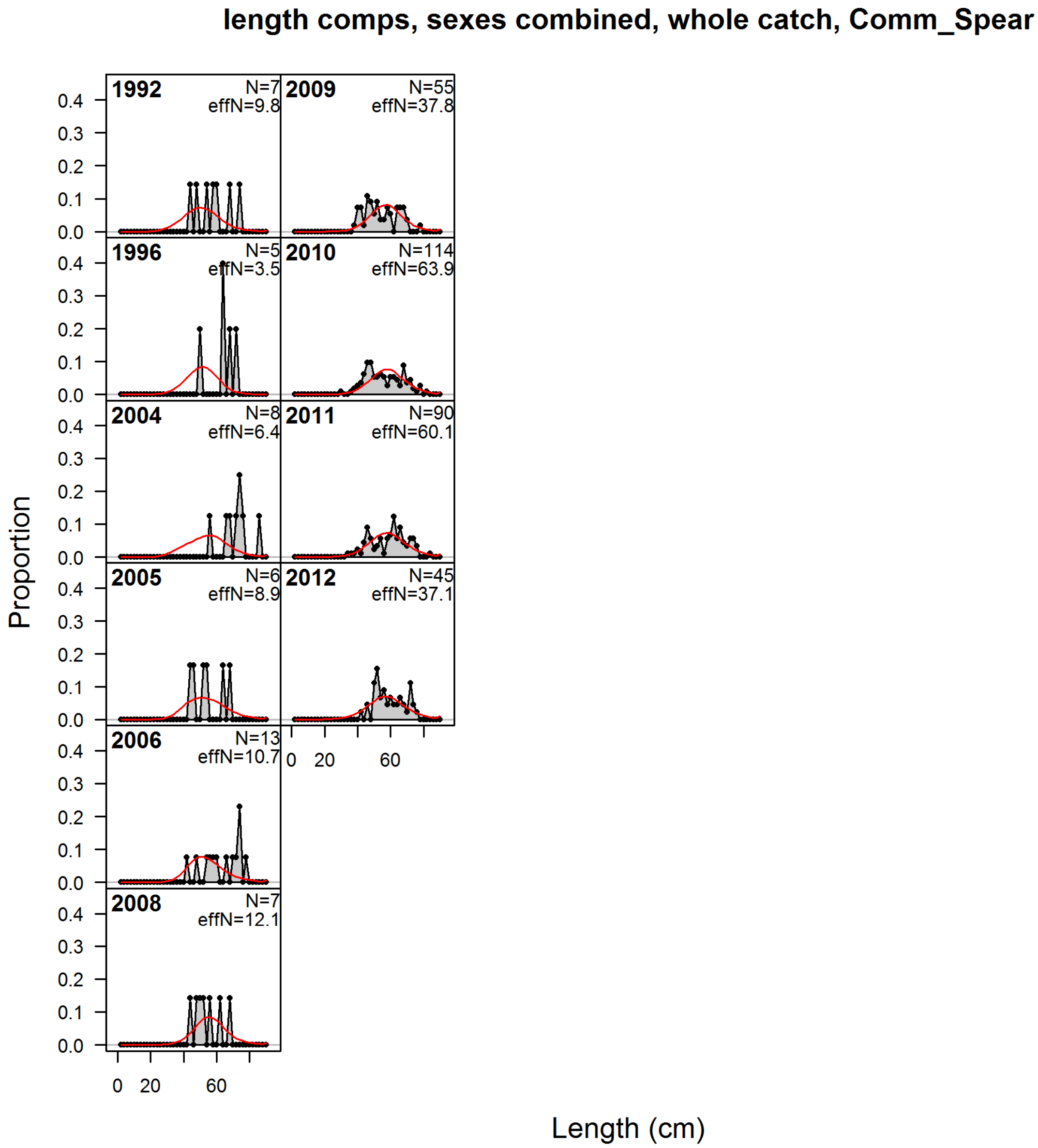


Figure 11.2.1.3.38. Pearson residuals for the length composition fit to the commercial spear fishery of the GA-NC stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

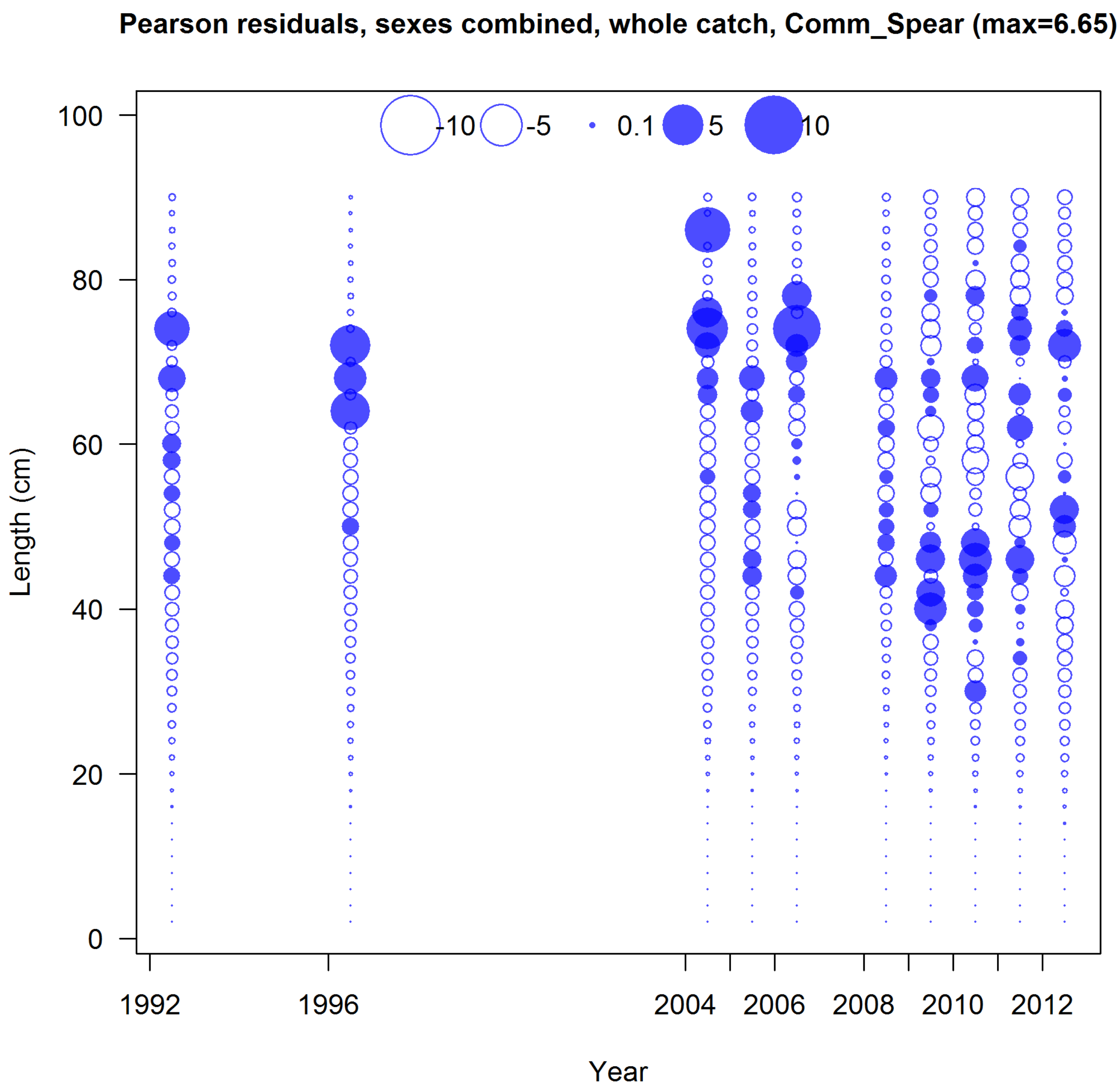


Figure 11.2.1.3.39. Observed and predicted length composition of landings from the commercial hook and line fishery of the GA-NC stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

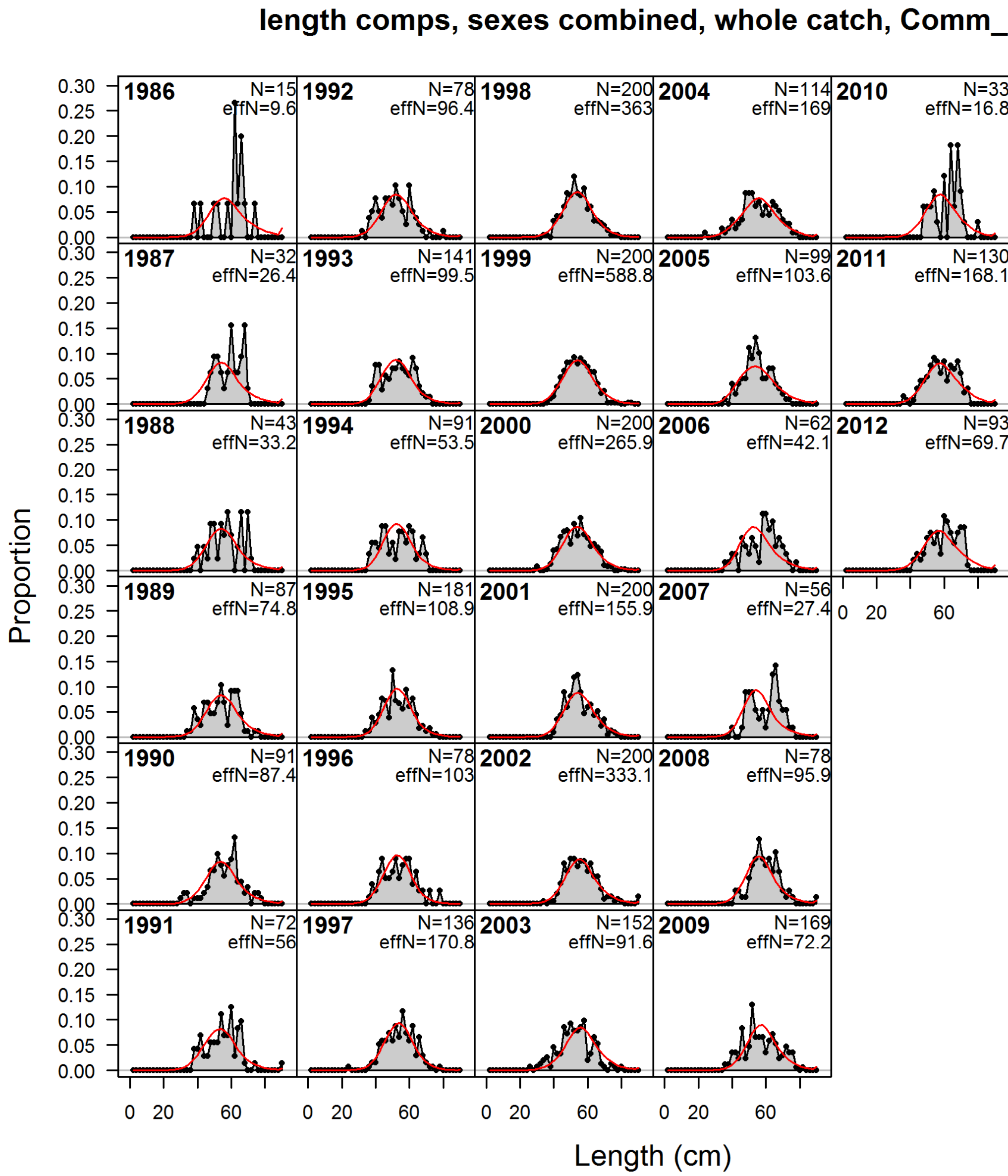


Figure 11.2.1.3.40. Pearson residuals for the length composition fit to the commercial hook and line fishery of the GA-NC stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

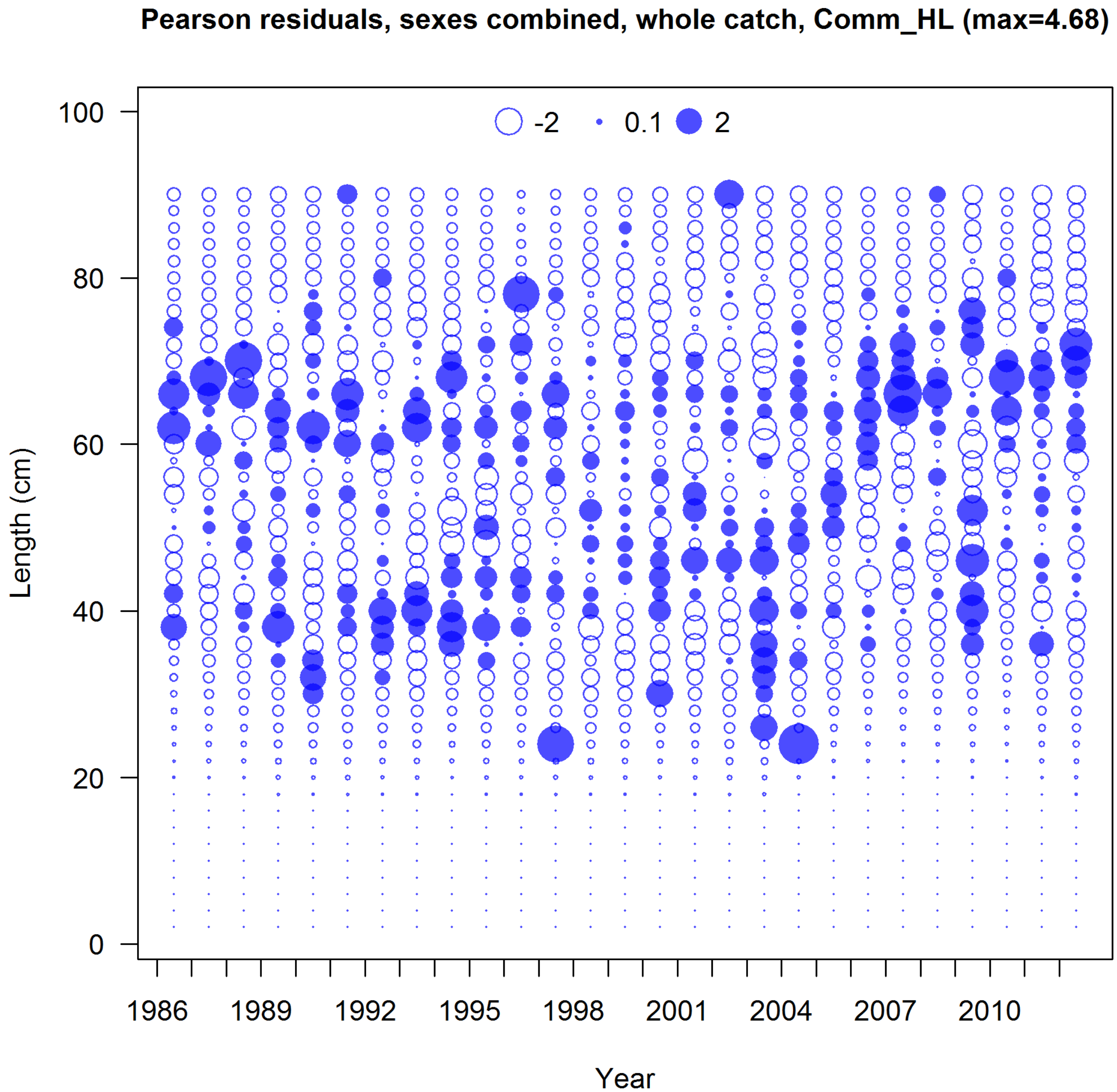


Figure 11.2.1.3.41. Observed and predicted length composition of landings from the recreational hook and line fishery of the GA-NC stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

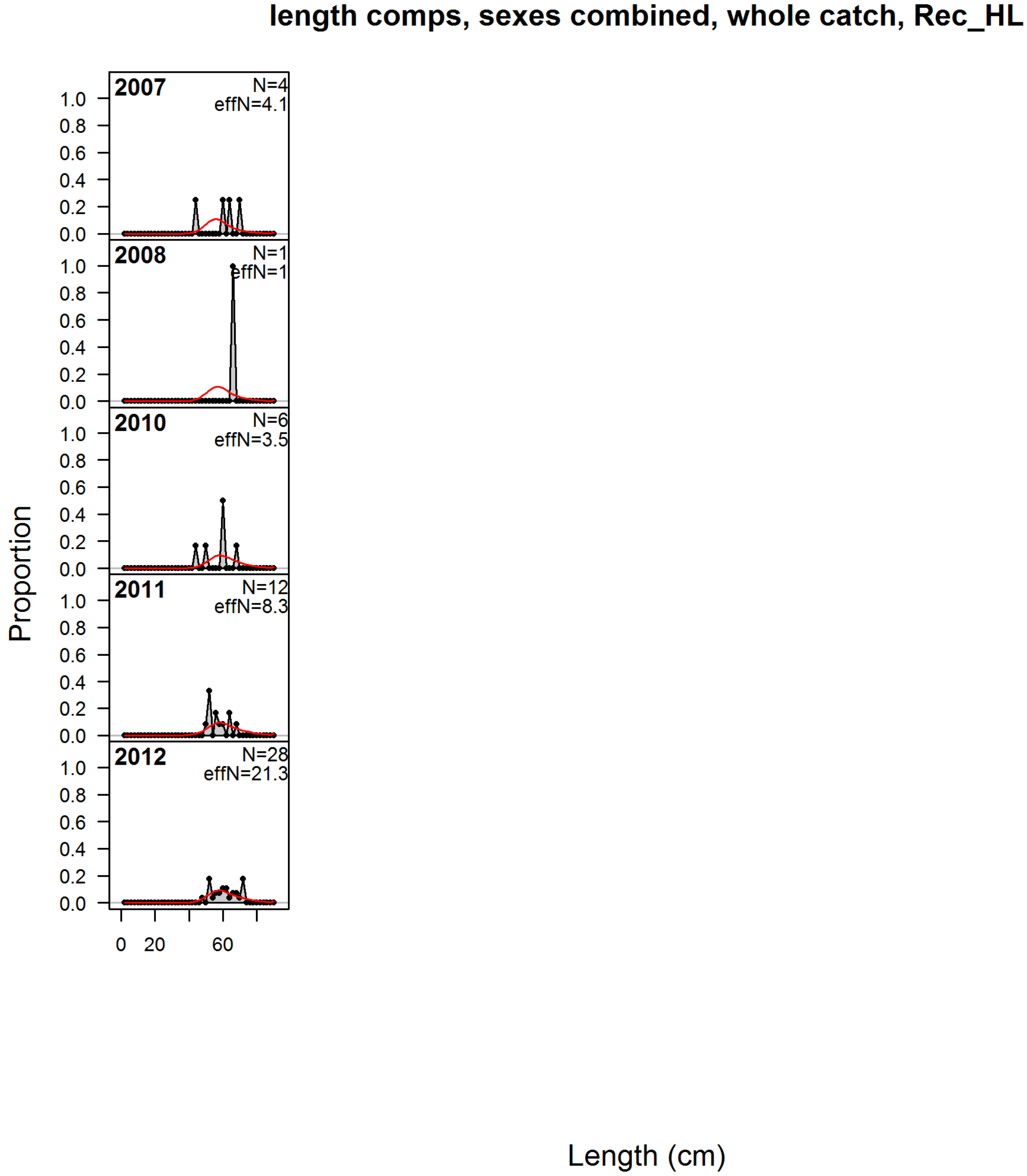


Figure 11.2.1.3.42. Pearson residuals for the length composition fit to the recreational hook and line fishery of the GA-NC stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

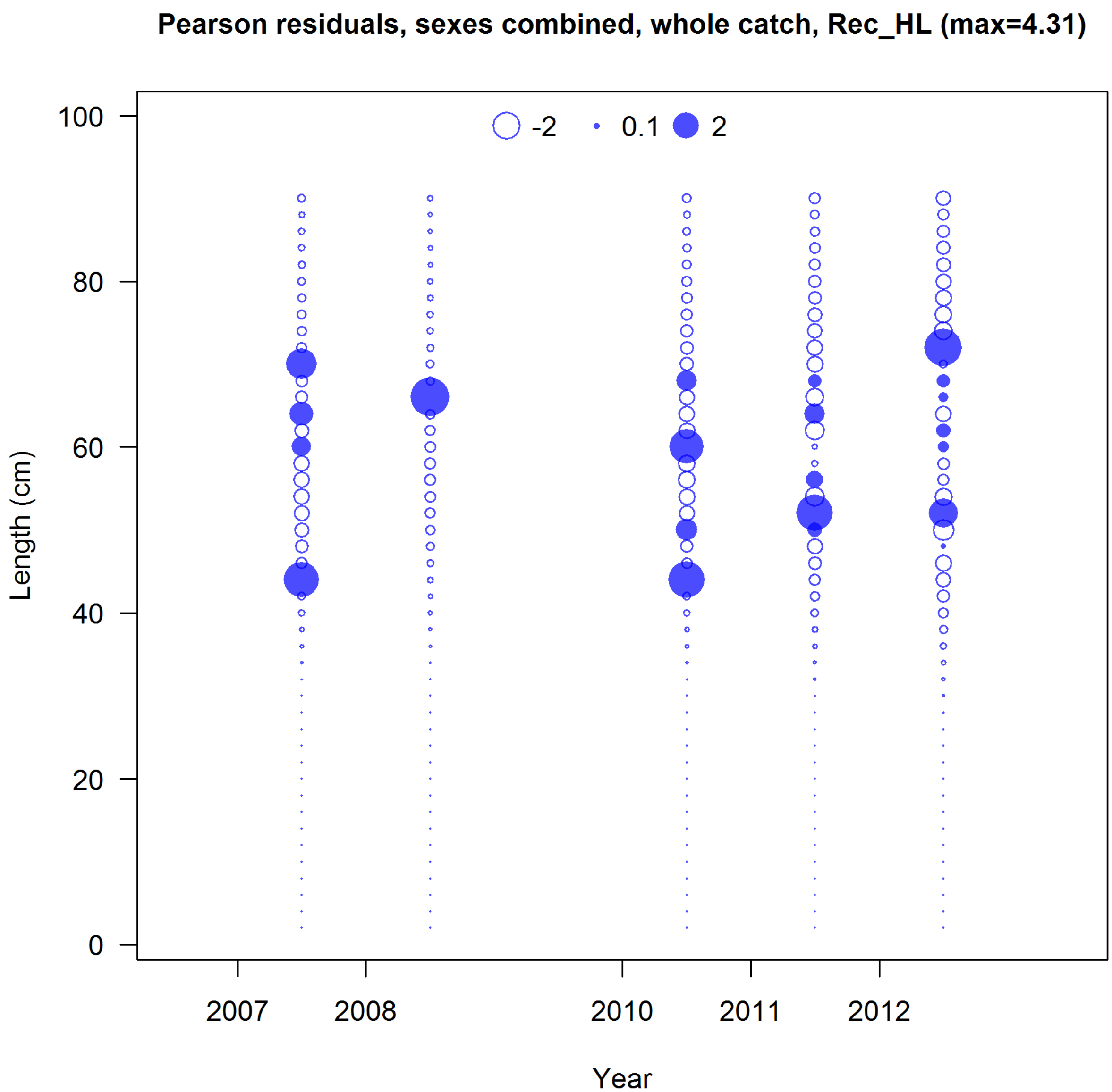


Figure 11.2.1.3.43. Observed and predicted length composition from all fisheries and surveys averaged across years of the GA-NC stock base model configuration. Observed sampled sizes were capped at a maximum of 200 fish.

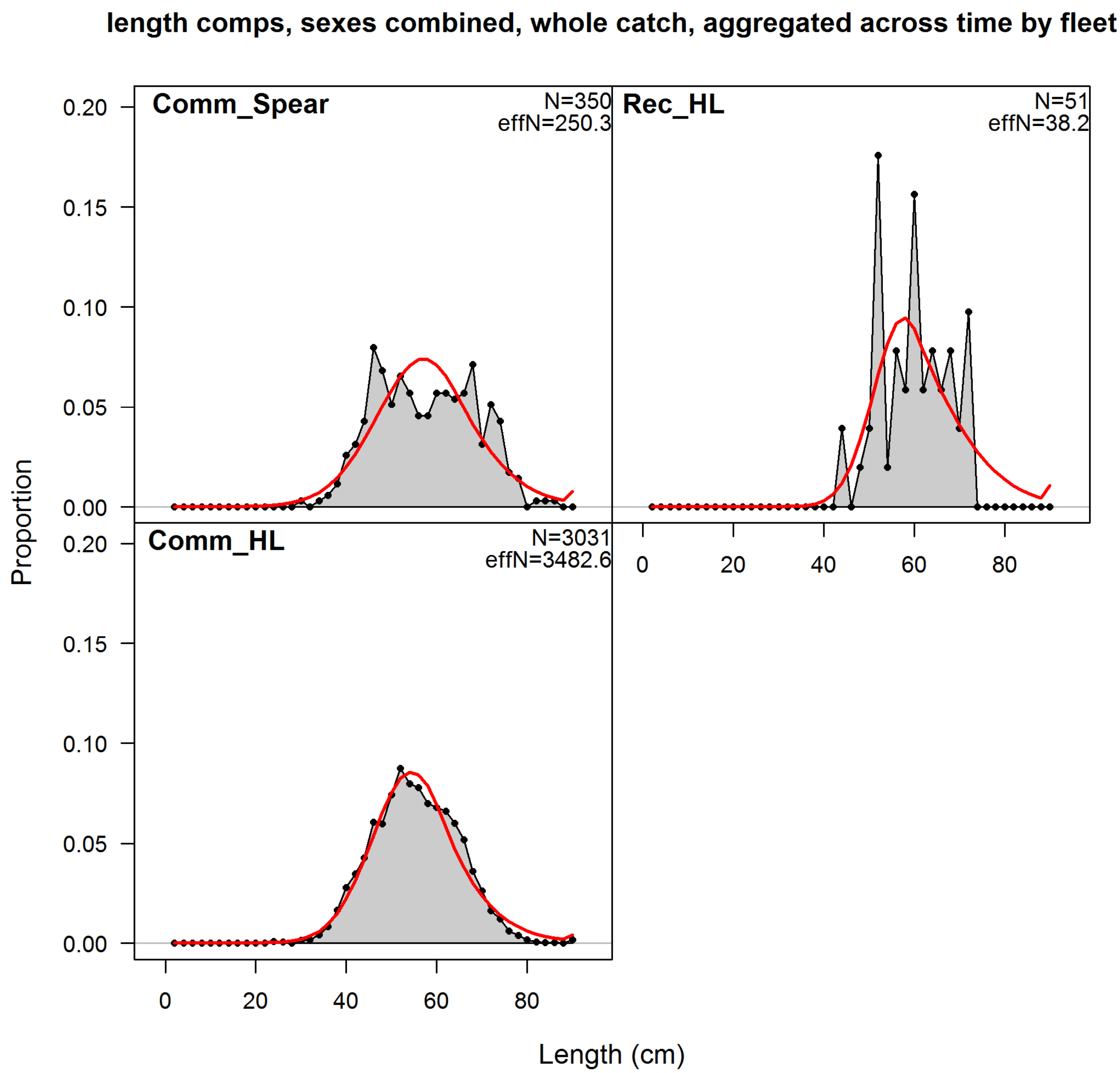


Figure 11.2.1.3.44. Pearson residuals for the length composition from all fisheries and surveys averaged across years of the GA-NC stock base model configuration. Solid blue circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

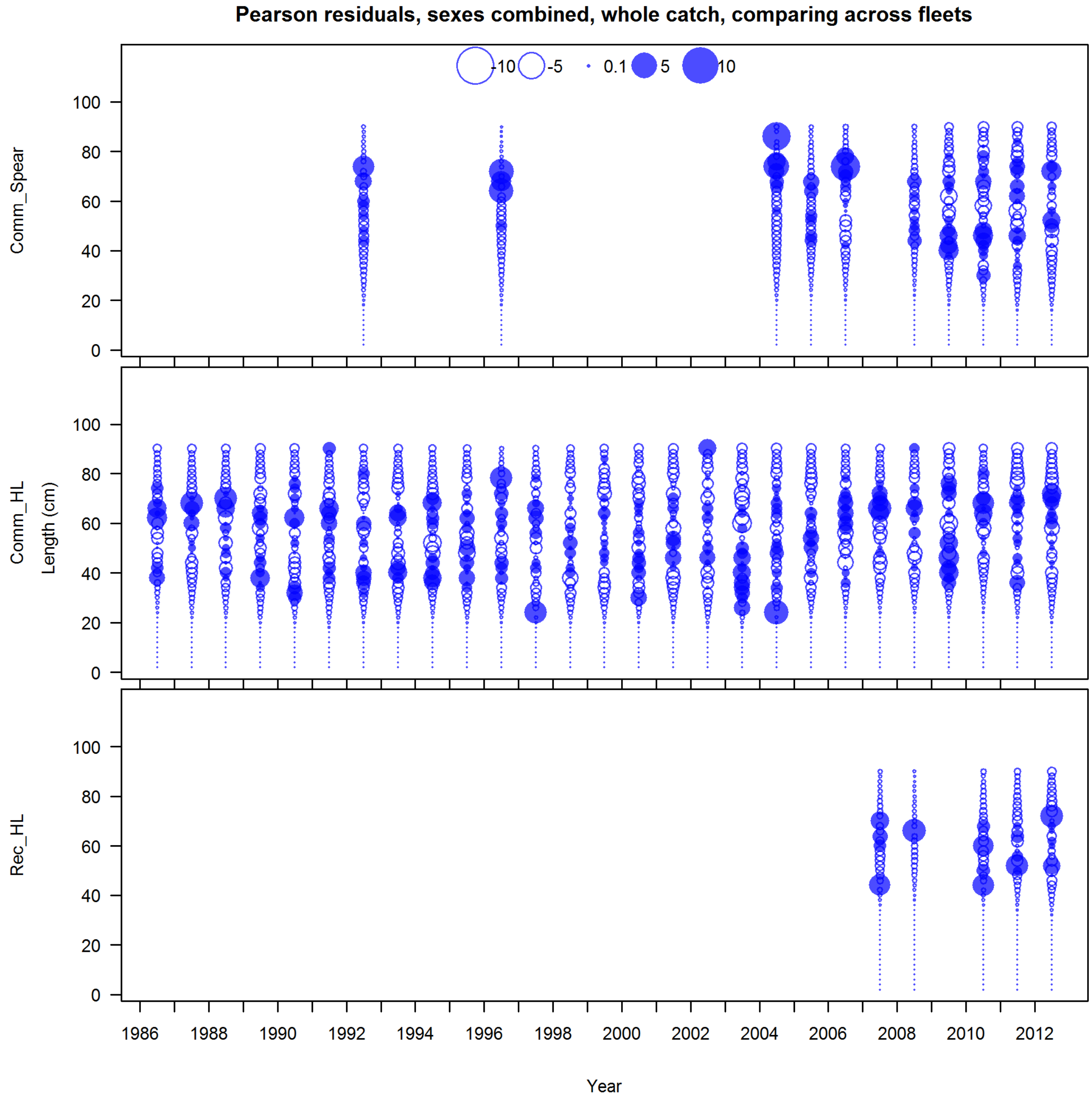


Figure 11.2.1.4.1. Observed and predicted age-at-length for the commercial spear fishery of the WFL stock base model configuration.

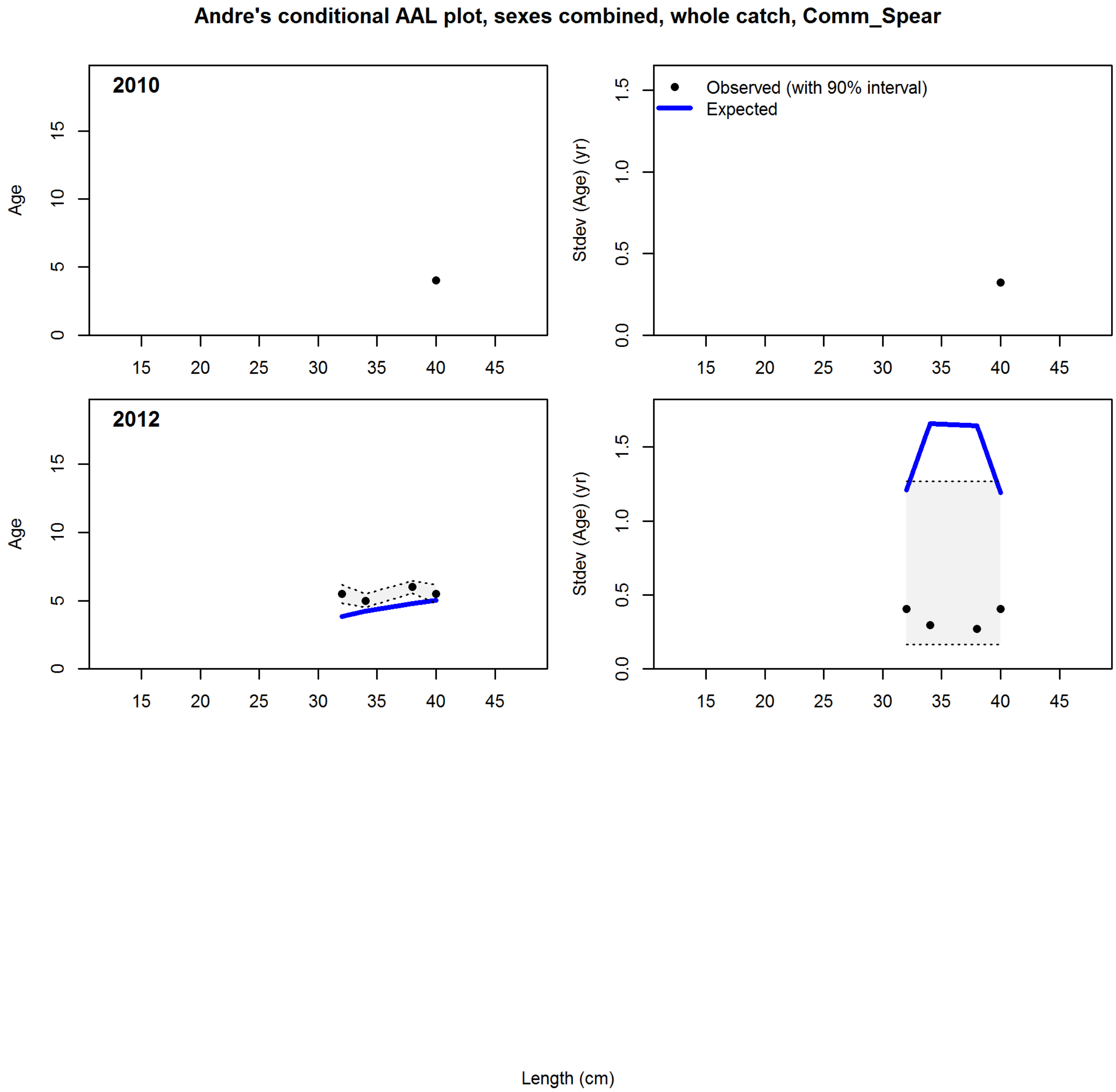


Figure 11.2.1.4.2. Observed and predicted age-at-length for the recreational spear fishery of the WFL stock base model configuration.

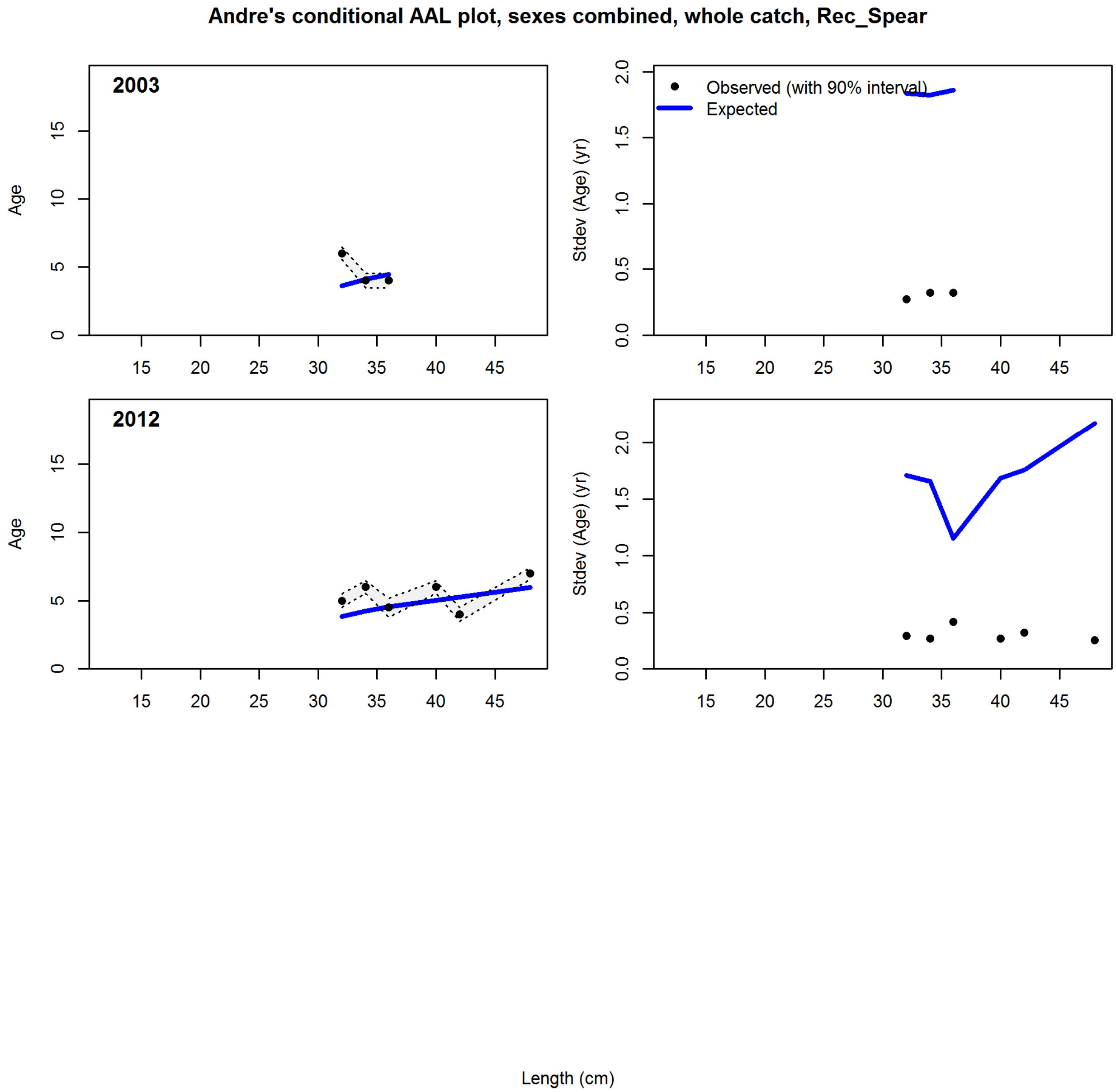


Figure 11.2.1.4.3. Observed and predicted age-at-length for the recreational hook and line fishery of the WFL stock base model configuration.

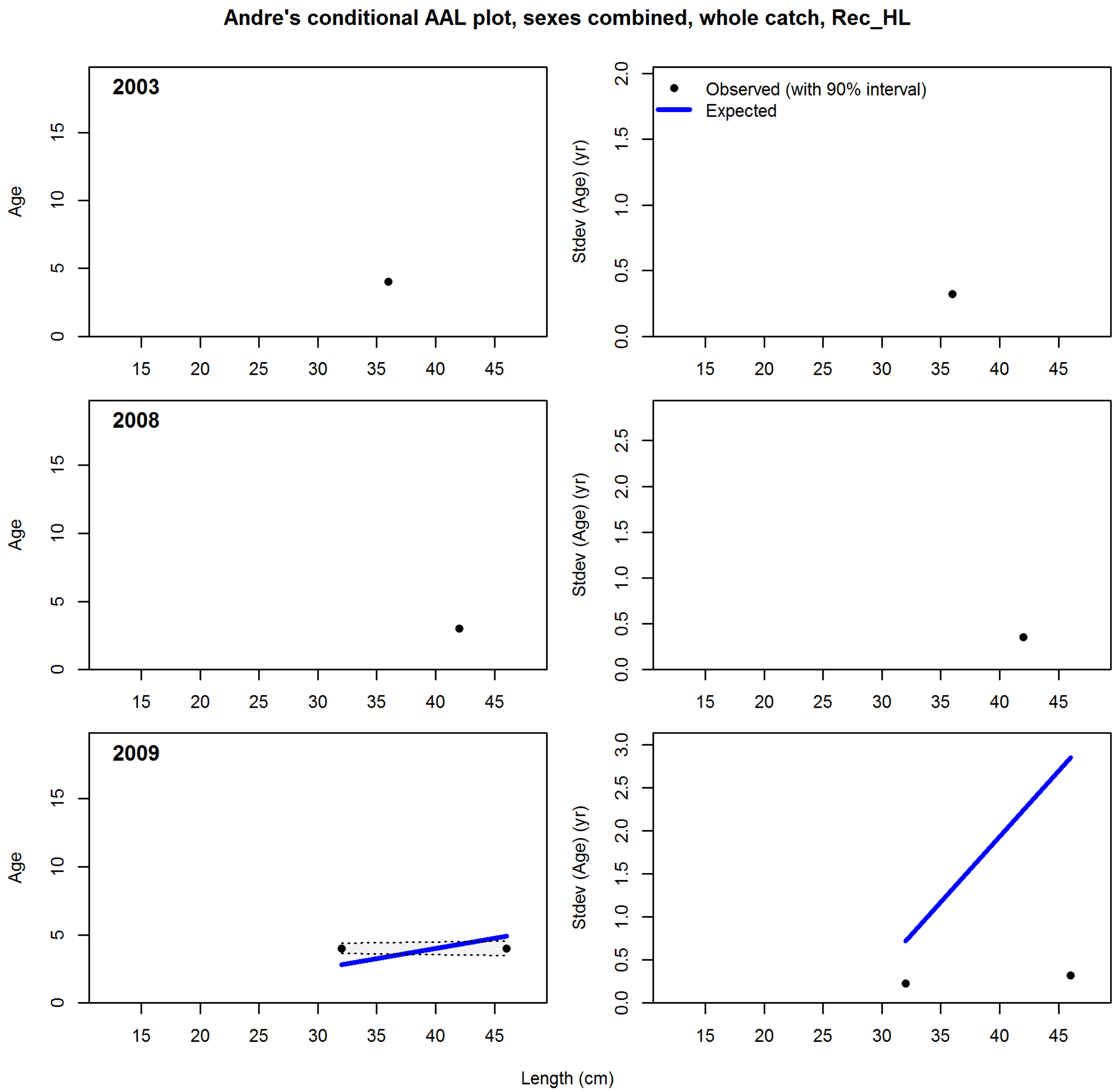


Figure 11.2.1.4.3 (continued). Observed and predicted age-at-length for the recreational hook and line fishery of the WFL stock base model configuration.

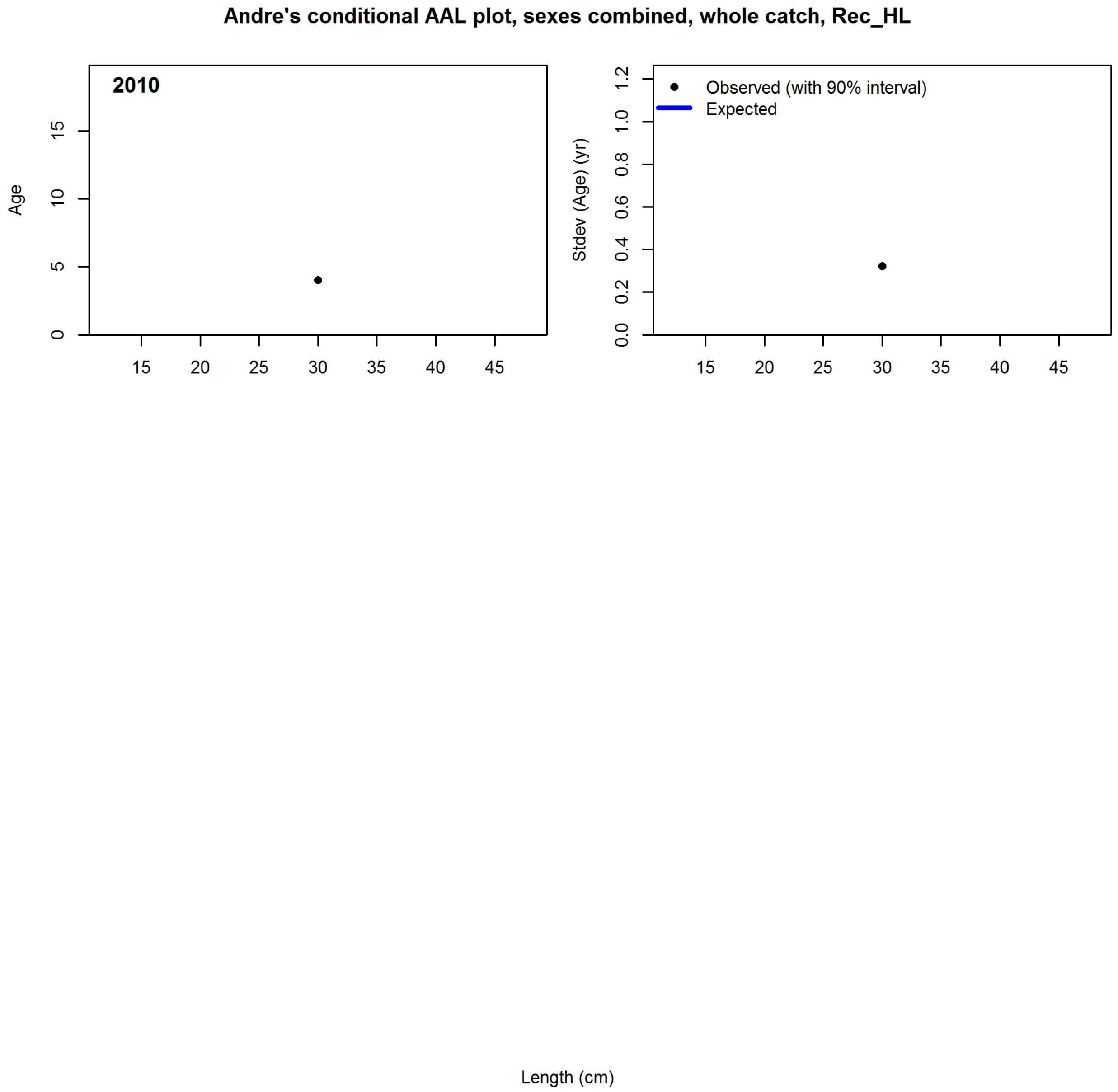


Figure 11.2.1.4.4. Observed and predicted age-at-length for the baitfish trawl survey of the WFL stock base model configuration.

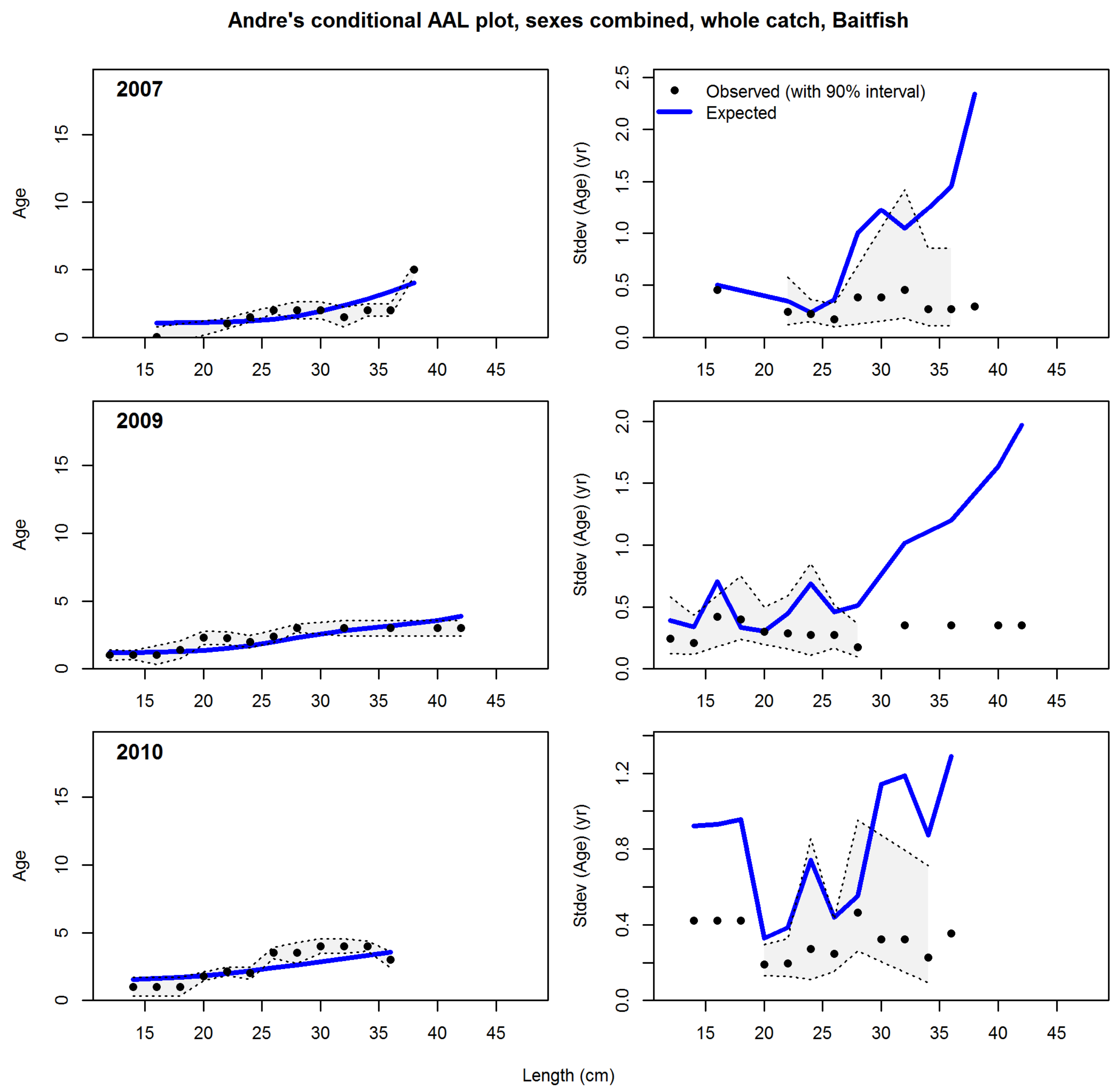


Figure 11.2.1.4.4 (continued). Observed and predicted age-at-length for the baitfish trawl survey of the WFL stock base model configuration.

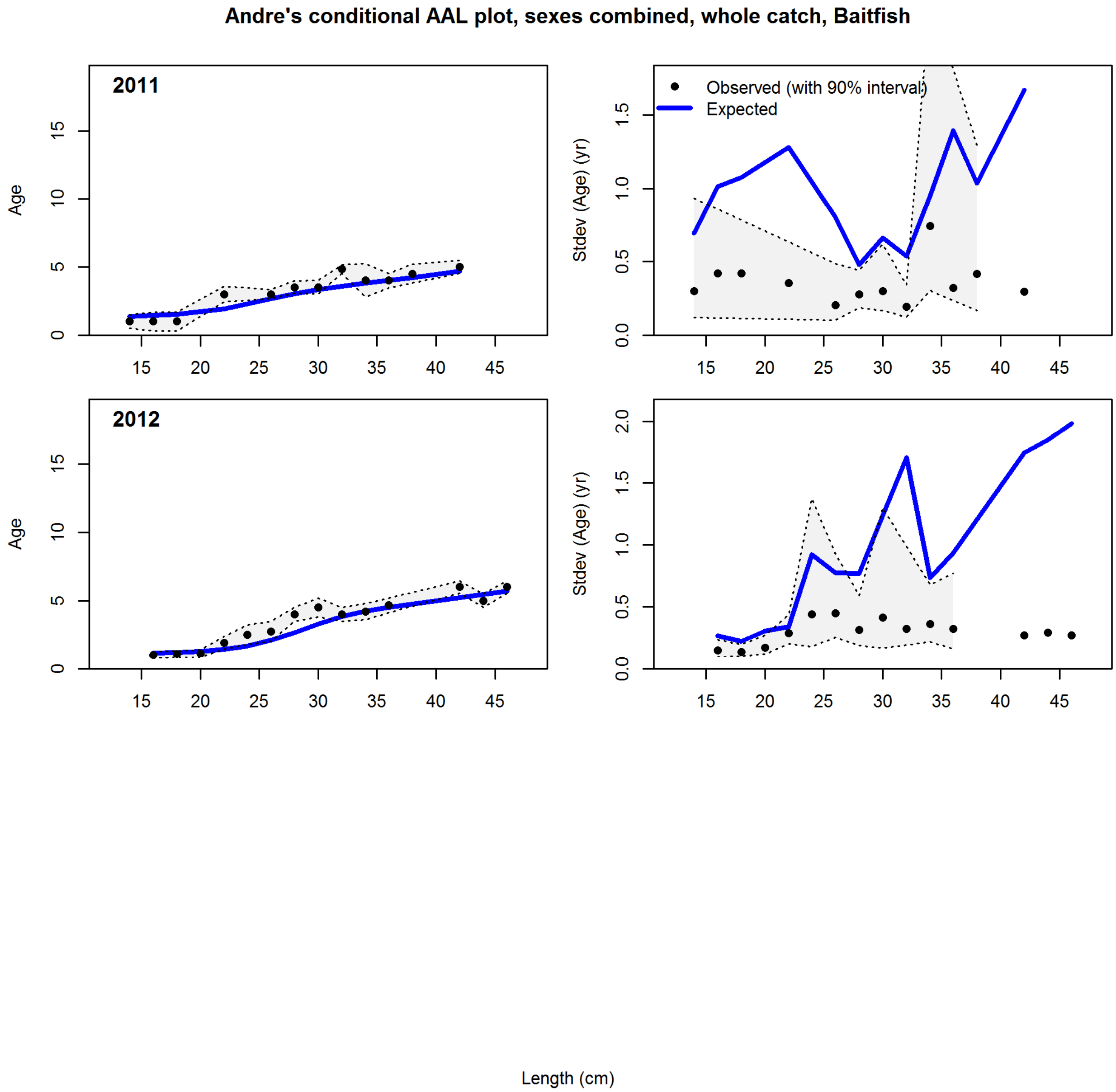


Figure 11.2.1.4.5. Observed and predicted age-at-length for the SEAMAP trawl survey of the WFL stock base model configuration.

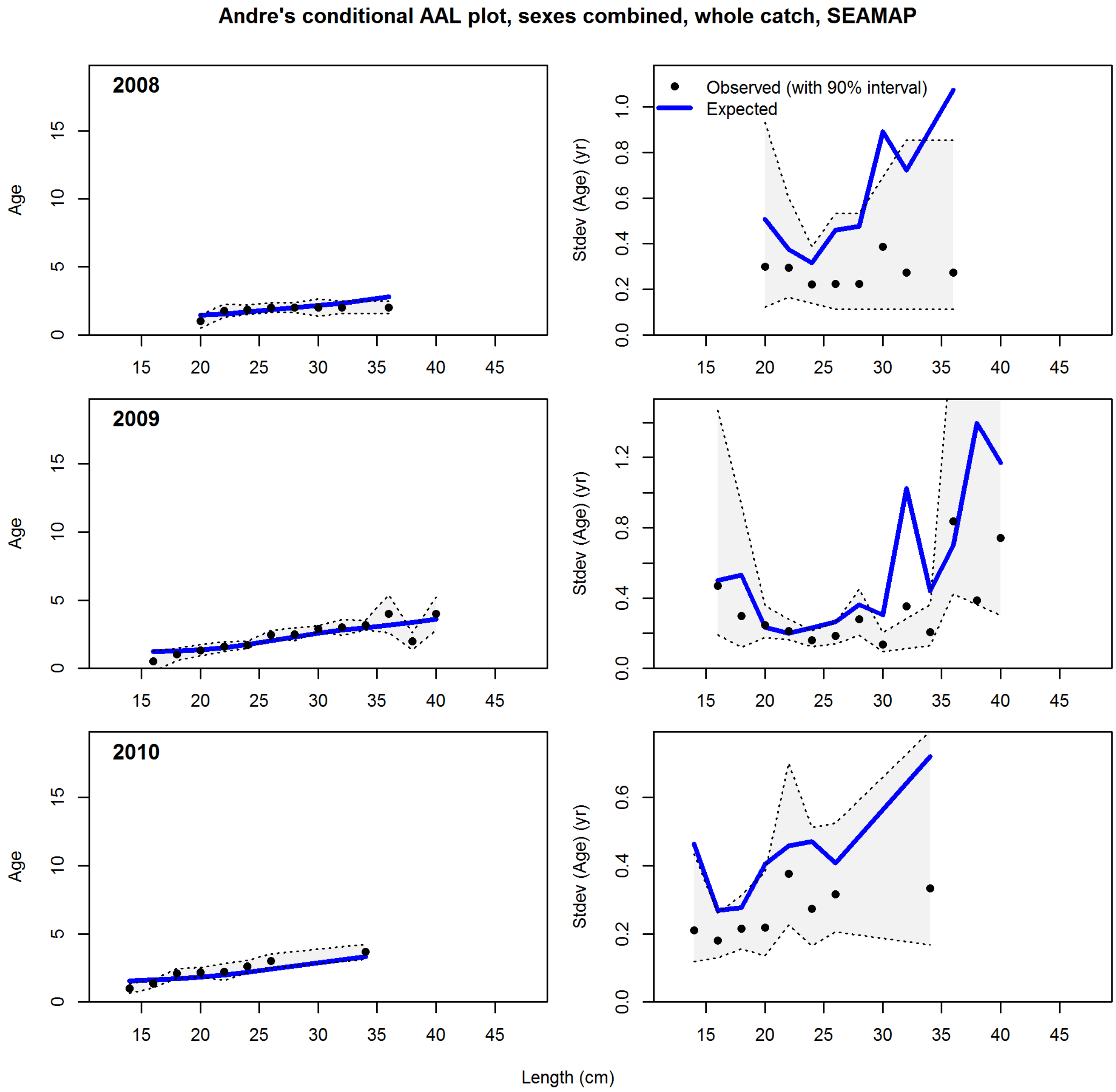


Figure 11.2.1.4.5 (continued). Observed and predicted age-at-length for the SEAMAP trawl survey of the WFL stock base model configuration.

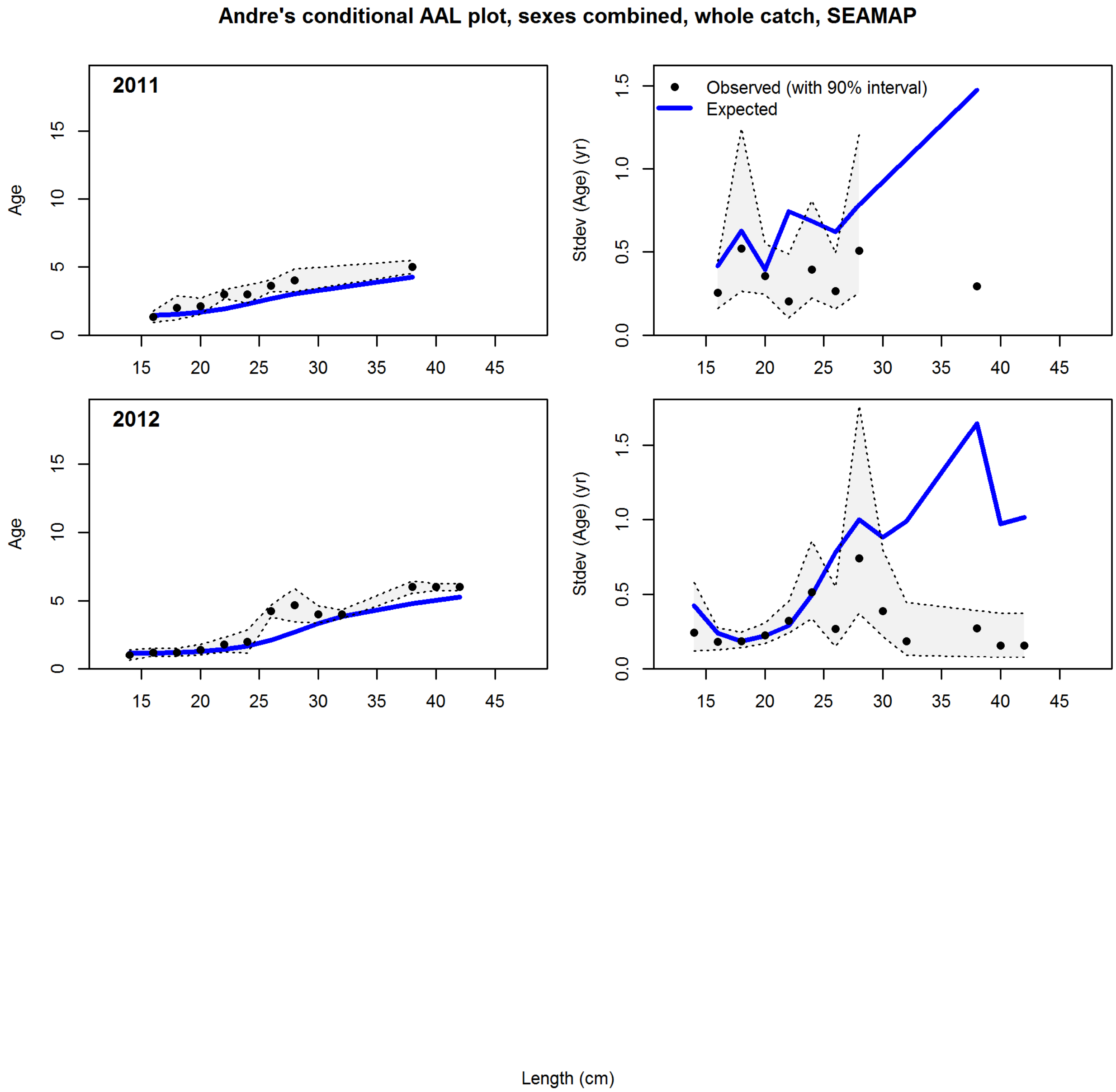


Figure 11.2.1.4.6. Observed and predicted age-at-length for the commercial spear fishery of the FLK/EFL stock base model configuration.

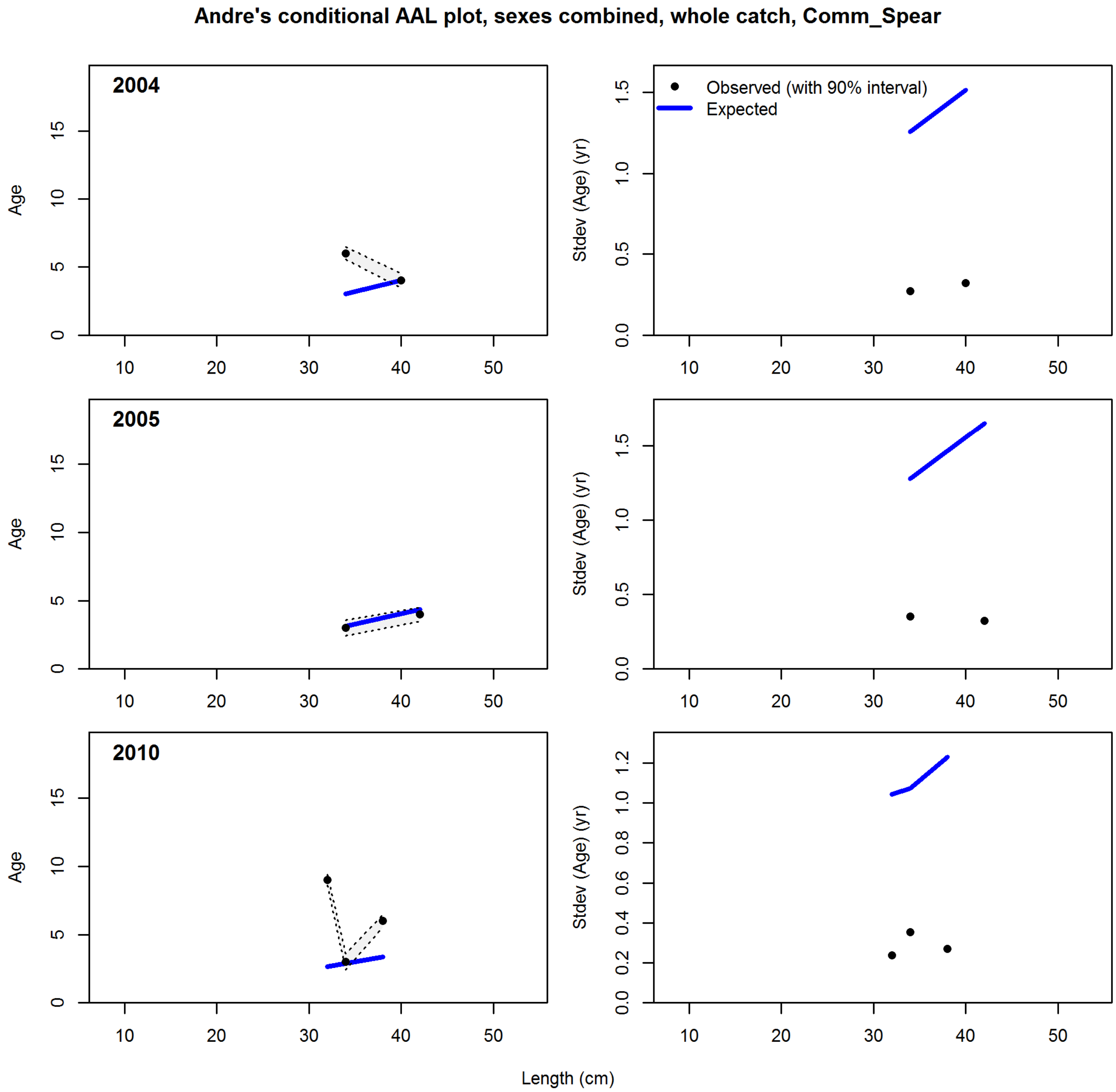


Figure 11.2.1.4.6 (continued). Observed and predicted age-at-length for the commercial spear fishery of the FLK/EFL stock base model configuration.

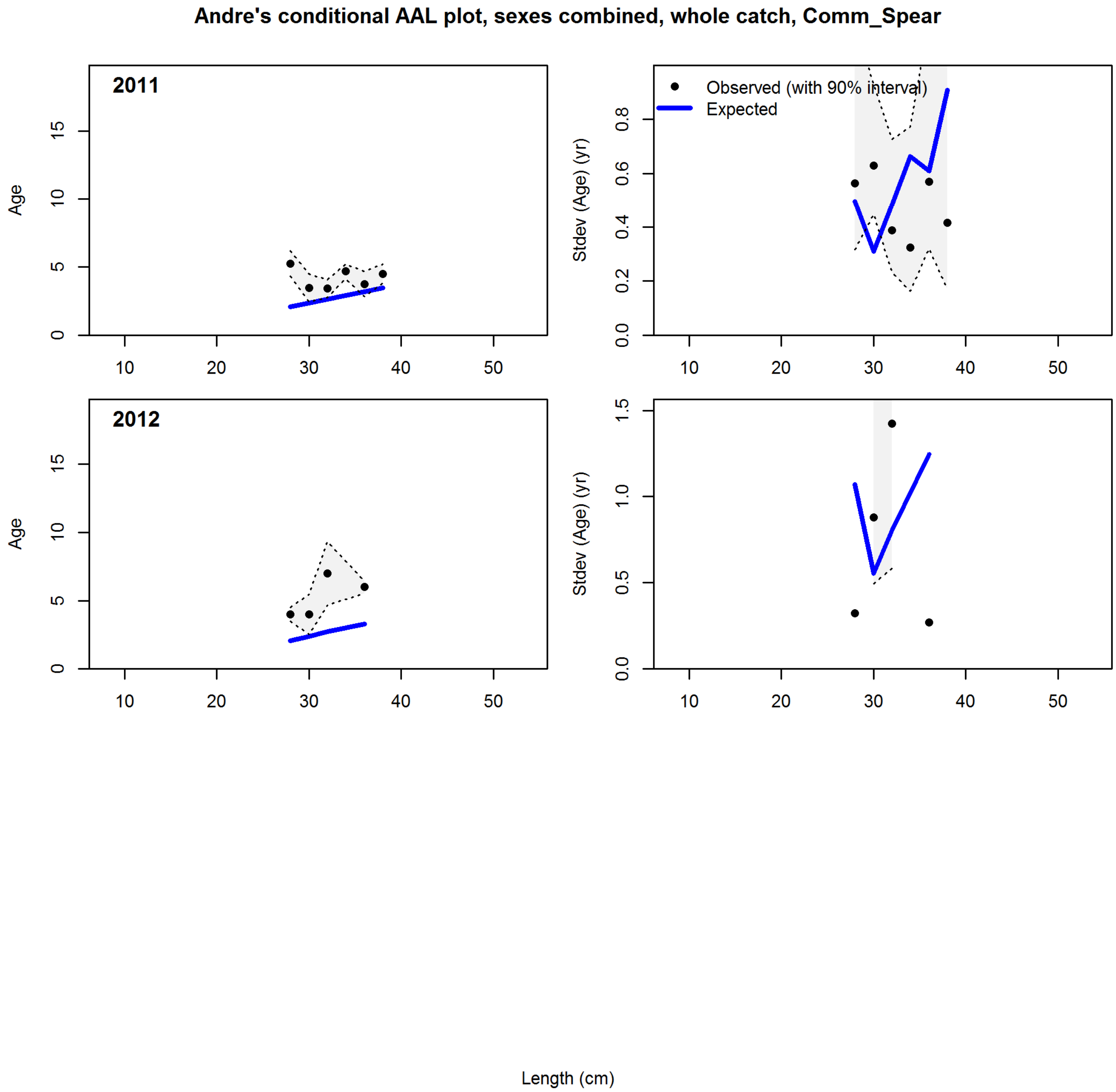


Figure 11.2.1.4.7. Observed and predicted age-at-length for the commercial hook and line fishery of the FLK/EFL stock base model configuration.

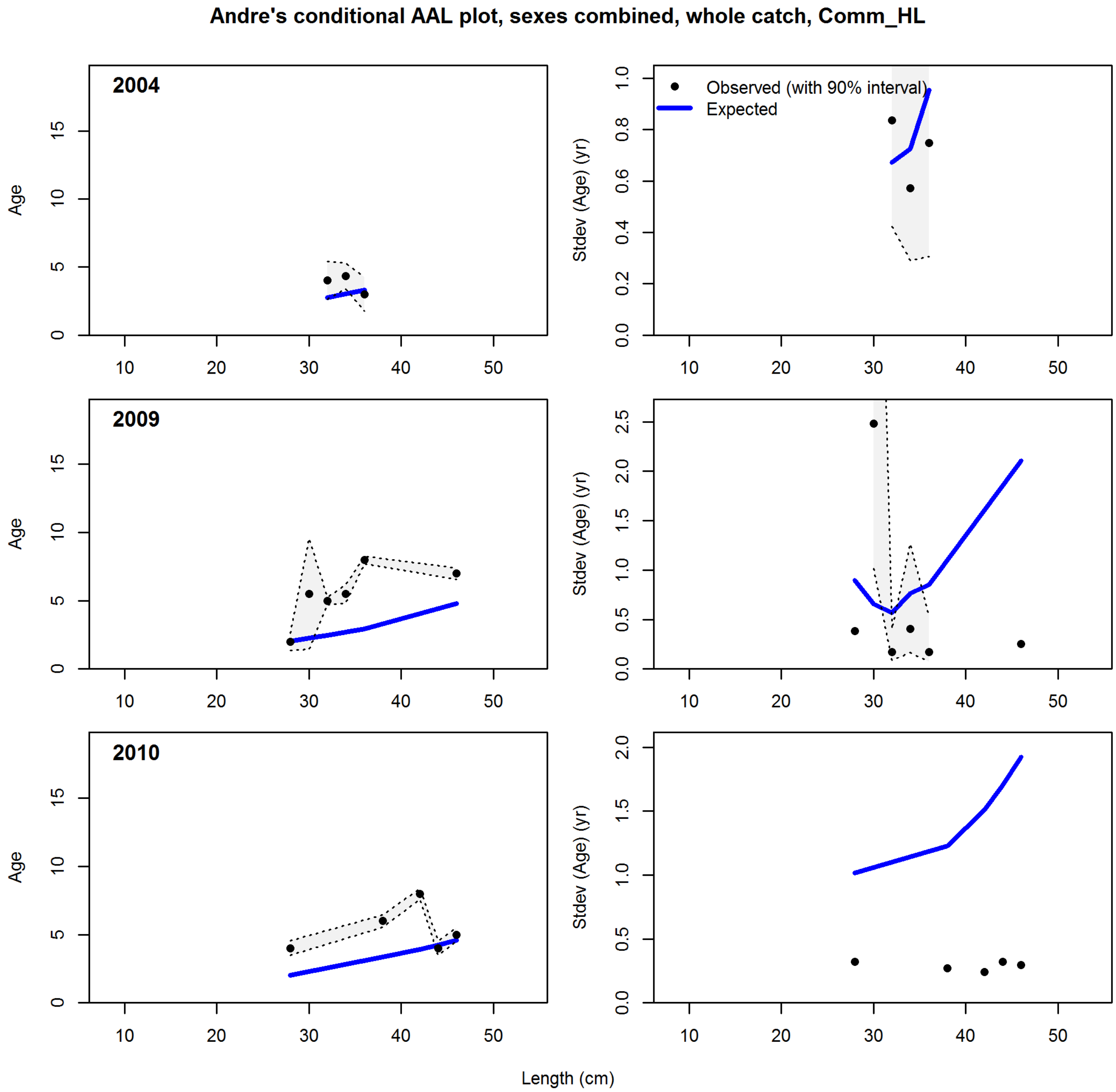


Figure 11.2.1.4.7 (continued). Observed and predicted age-at-length for the commercial hook and line fishery of the FLK/EFL stock base model configuration.

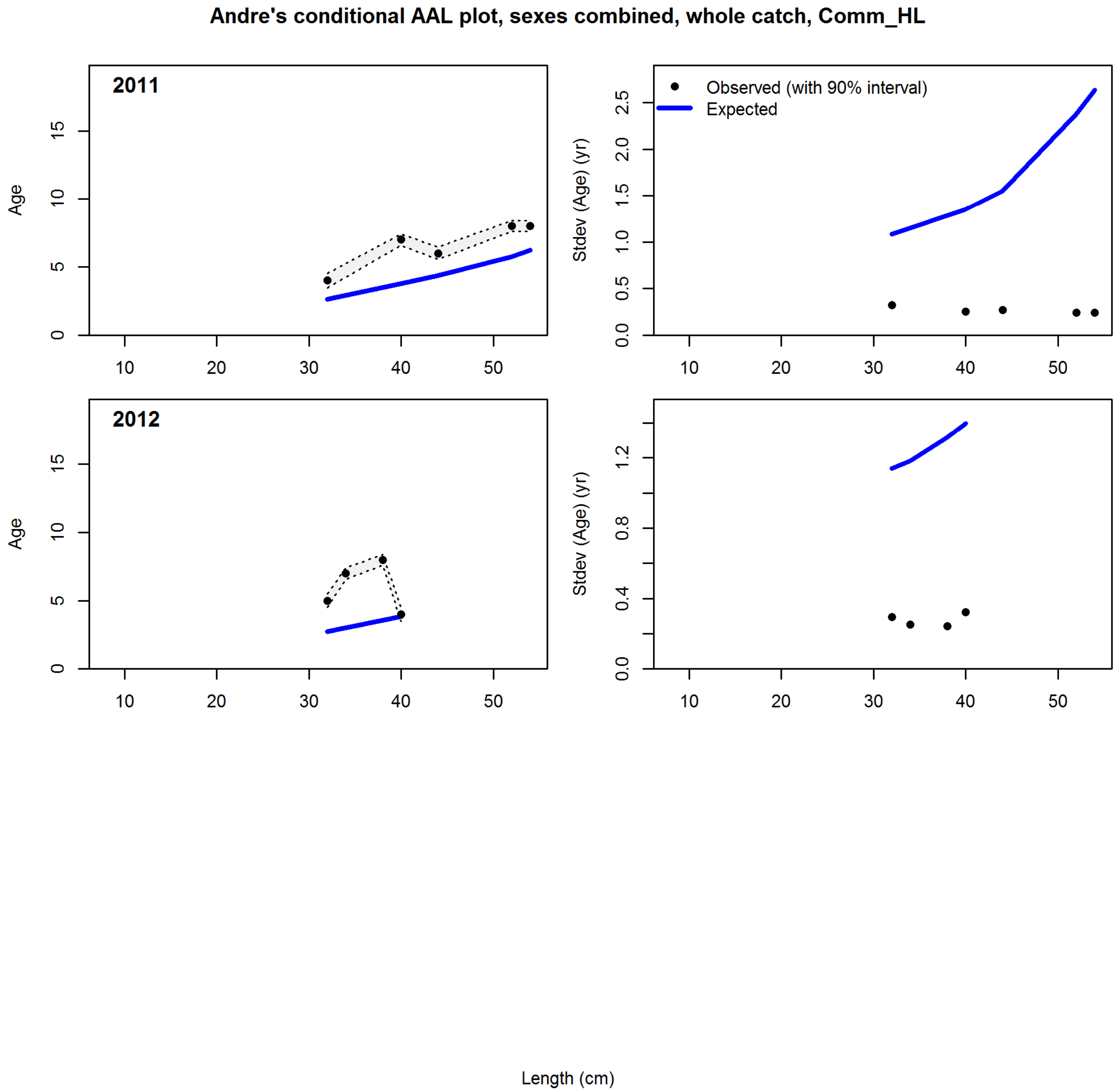


Figure 11.2.1.4.8. Observed and predicted age-at-length for the commercial trap fishery of the FLK/EFL stock base model configuration.

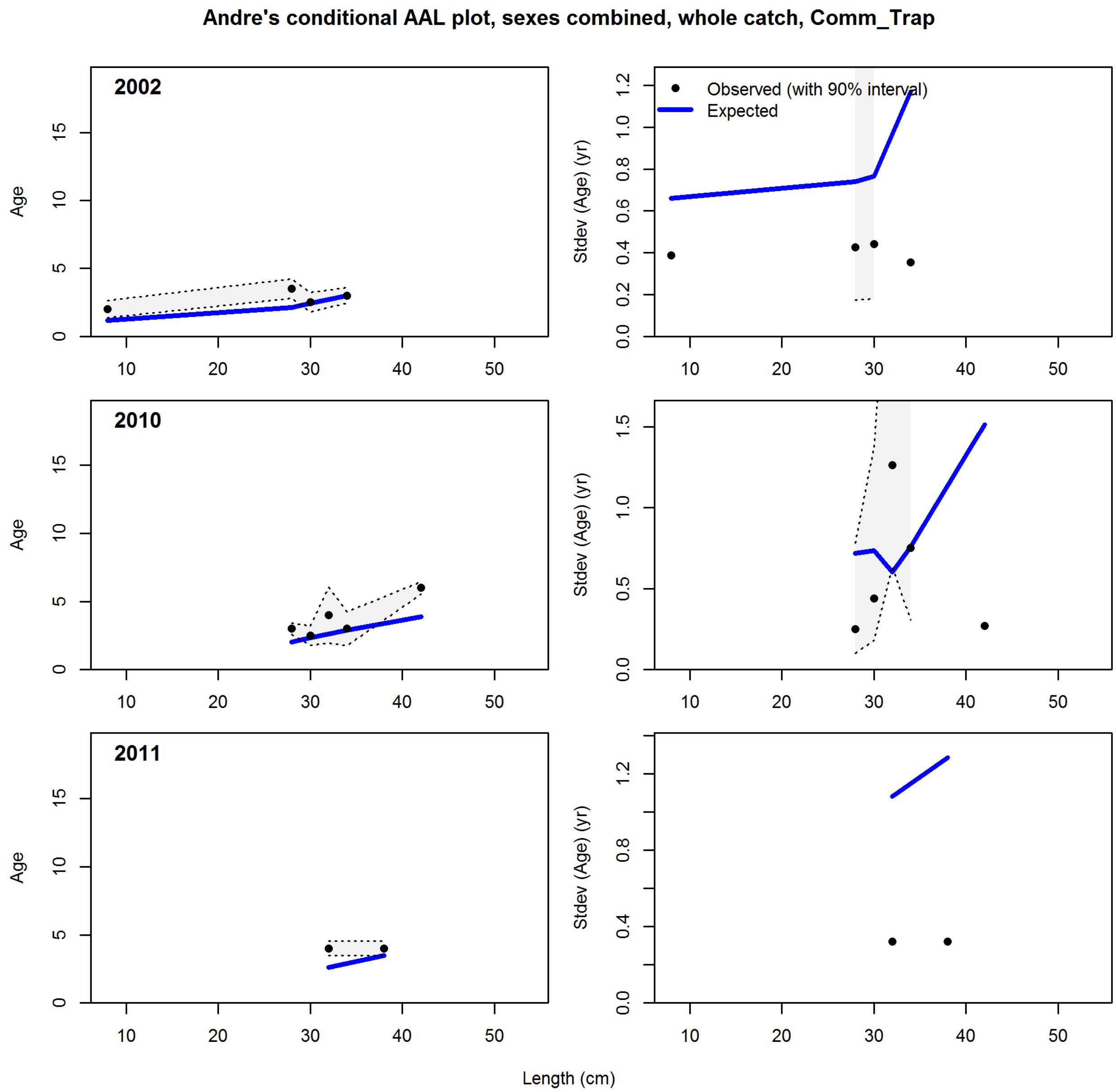


Figure 11.2.1.4.8 (continued). Observed and predicted age-at-length for the commercial trap fishery of the FLK/EFL stock base model configuration.

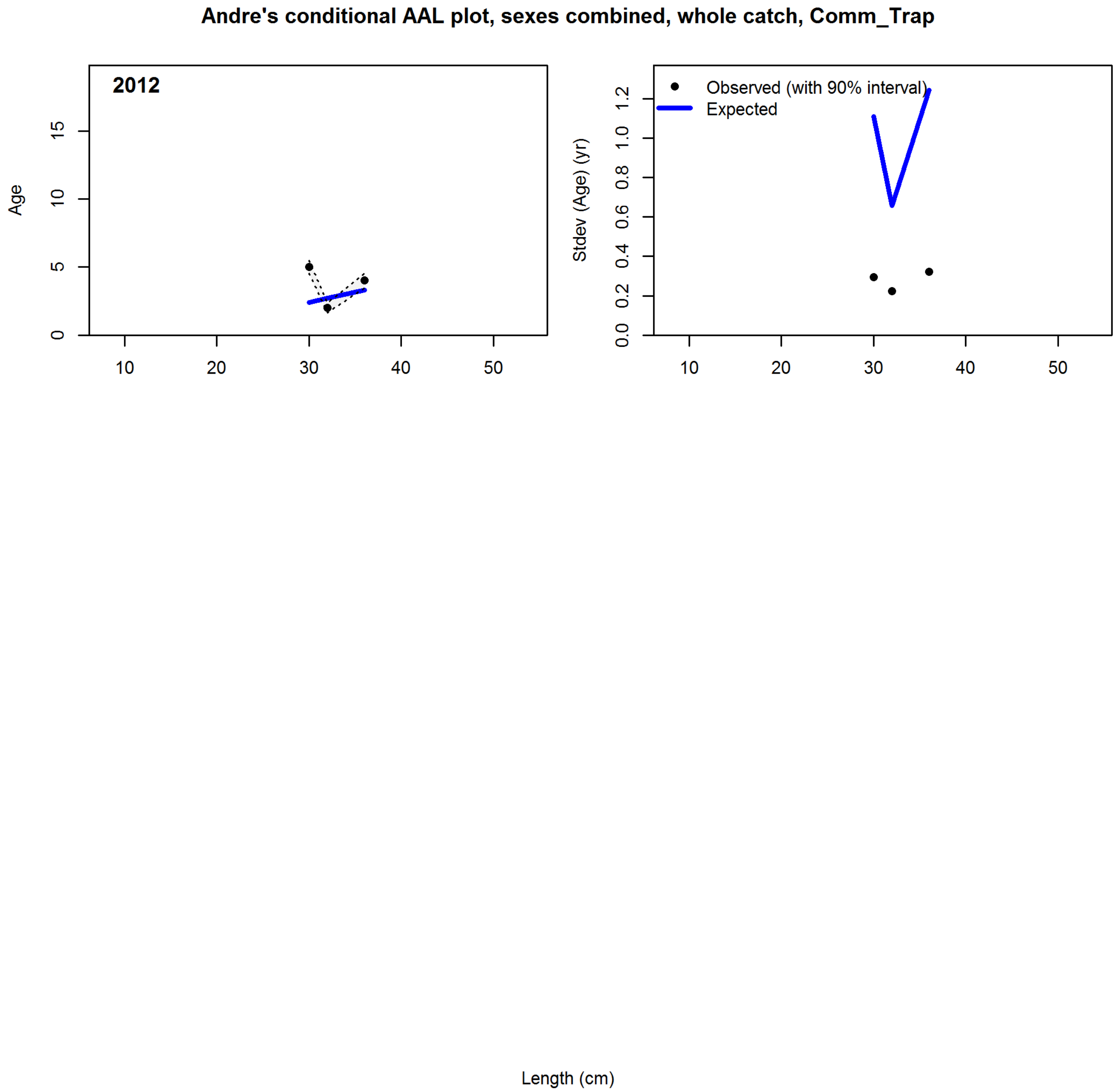


Figure 11.2.1.4.9. Observed and predicted age-at-length for the recreational hook and line fishery of the FLK/EFL stock base model configuration.

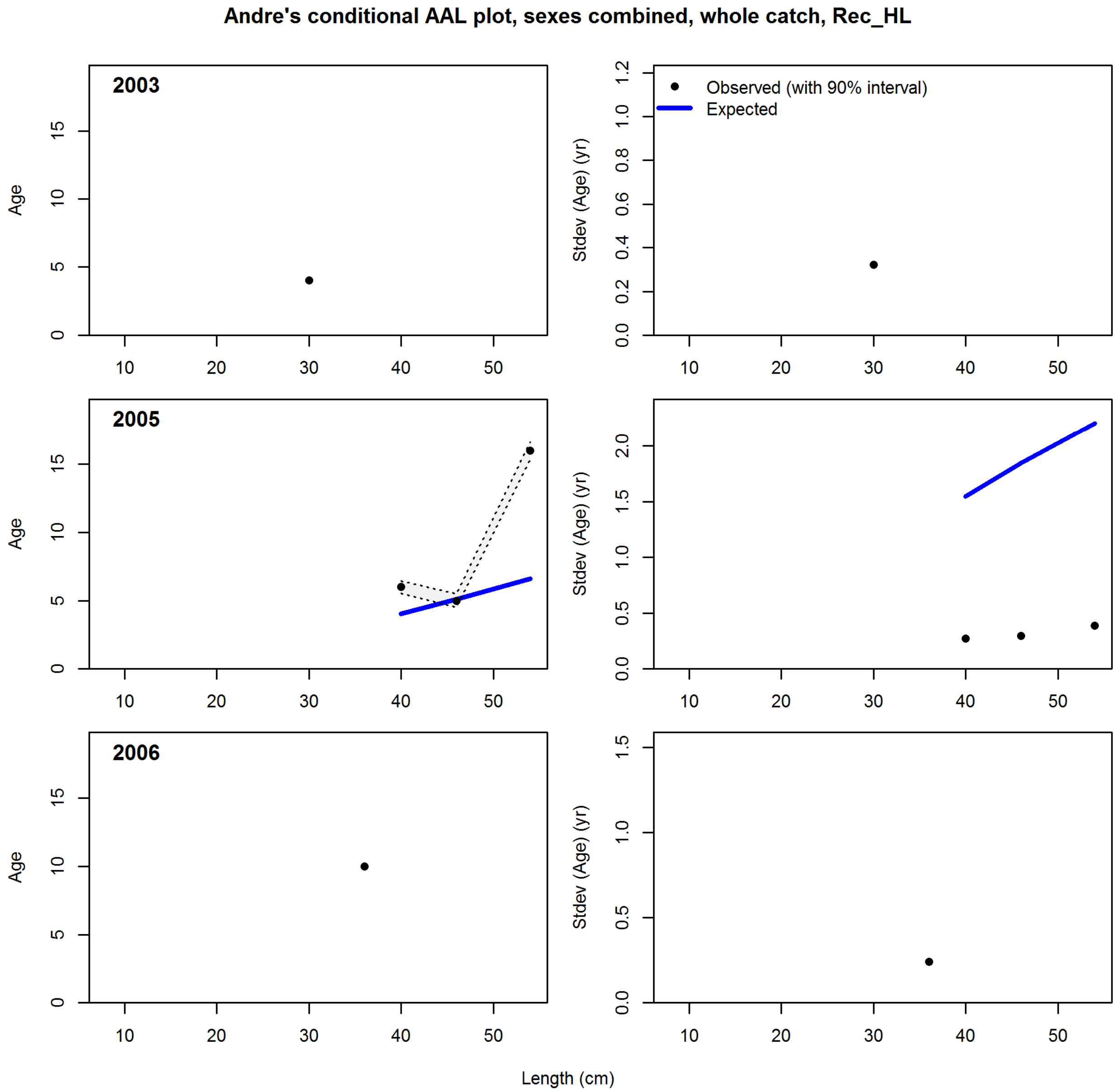


Figure 11.2.1.4.9 (continued). Observed and predicted age-at-length for the recreational hook and line fishery of the FLK/EFL stock base model configuration.

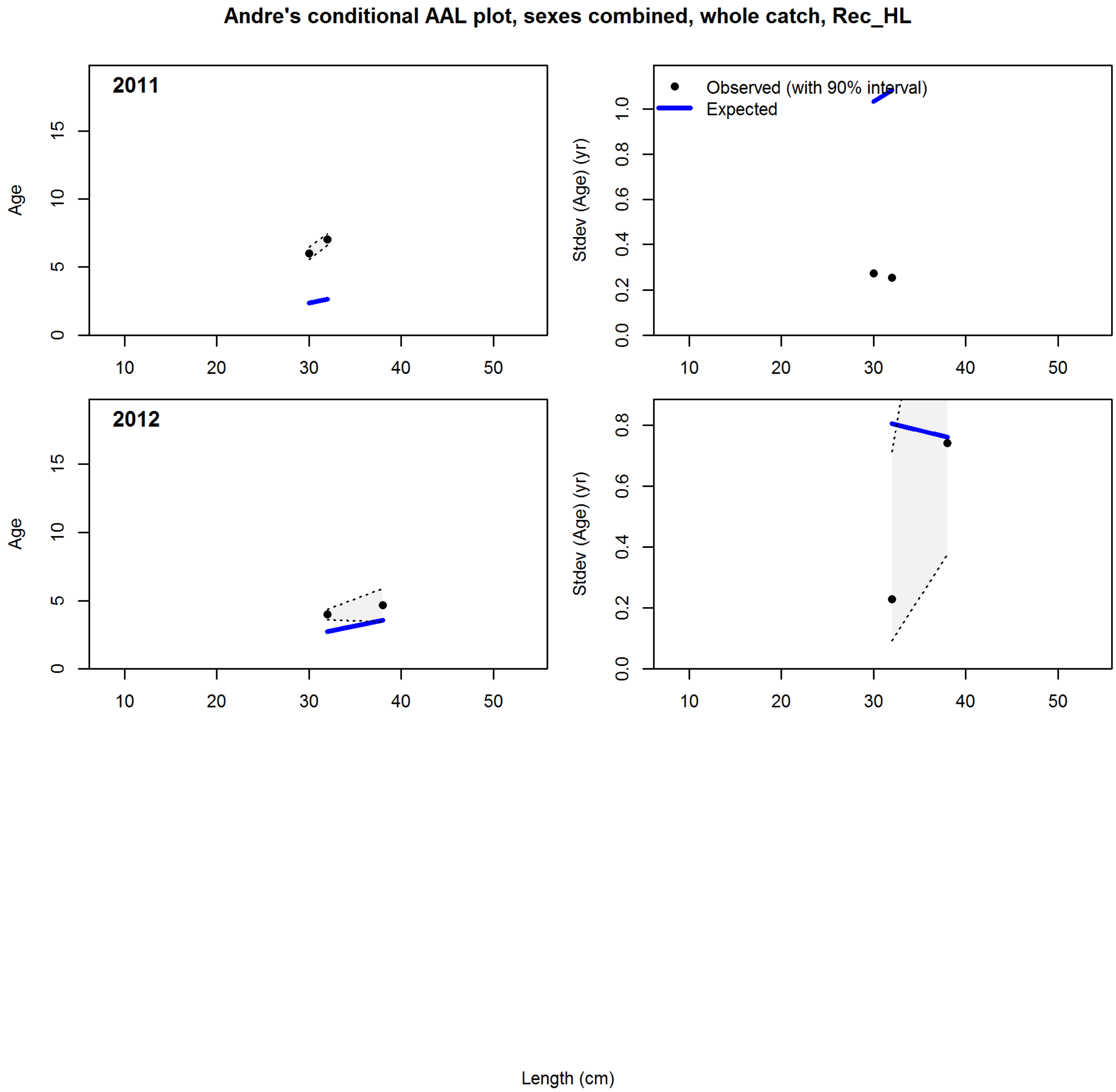


Figure 11.2.1.4.10. Observed and predicted age-at-length for the commercial spear fishery of the GA-NC stock base model configuration.

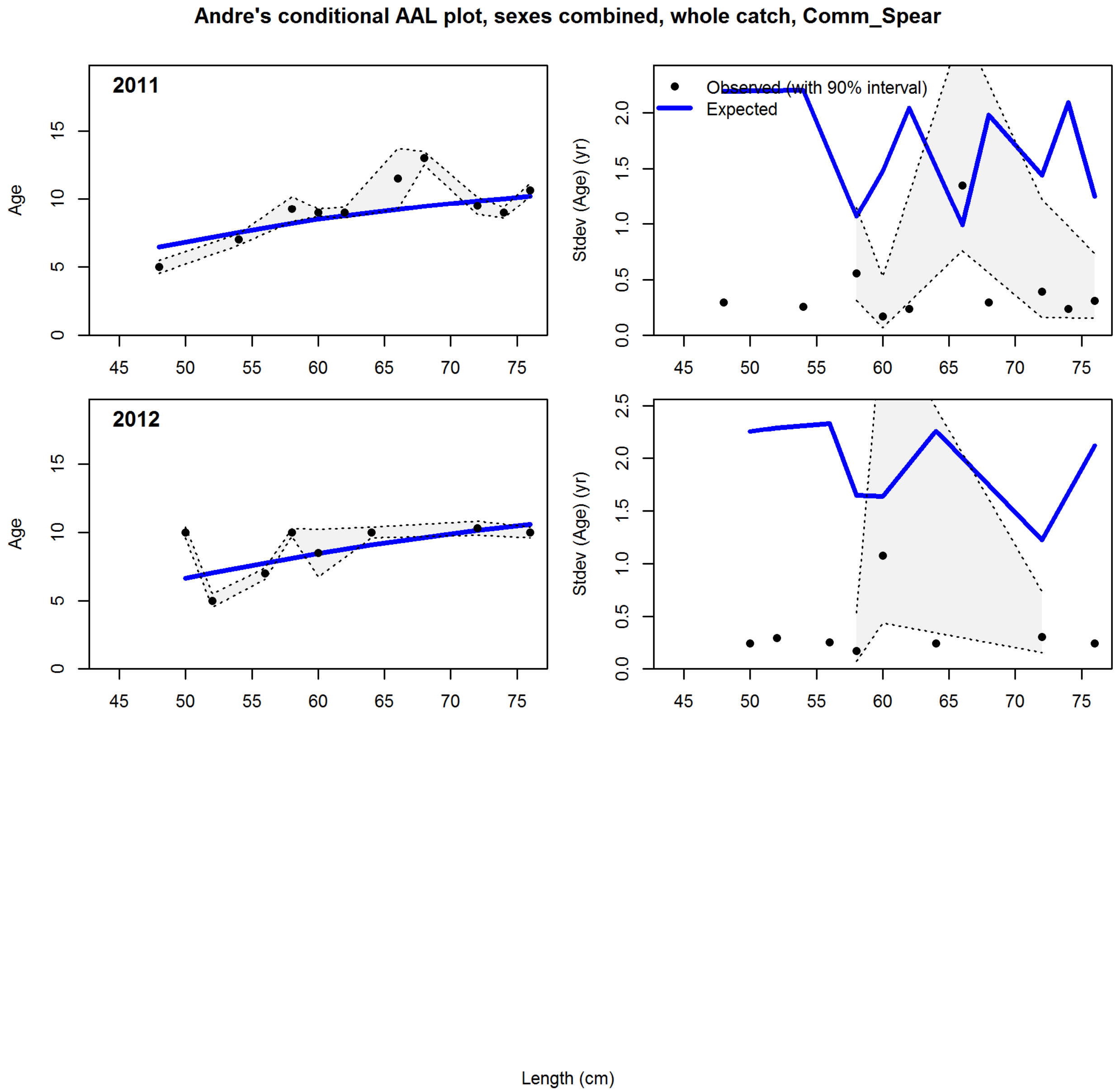


Figure 11.2.1.4.11. Observed and predicted age-at-length for the commercial hook and line fishery of the GA-NC stock base model configuration.

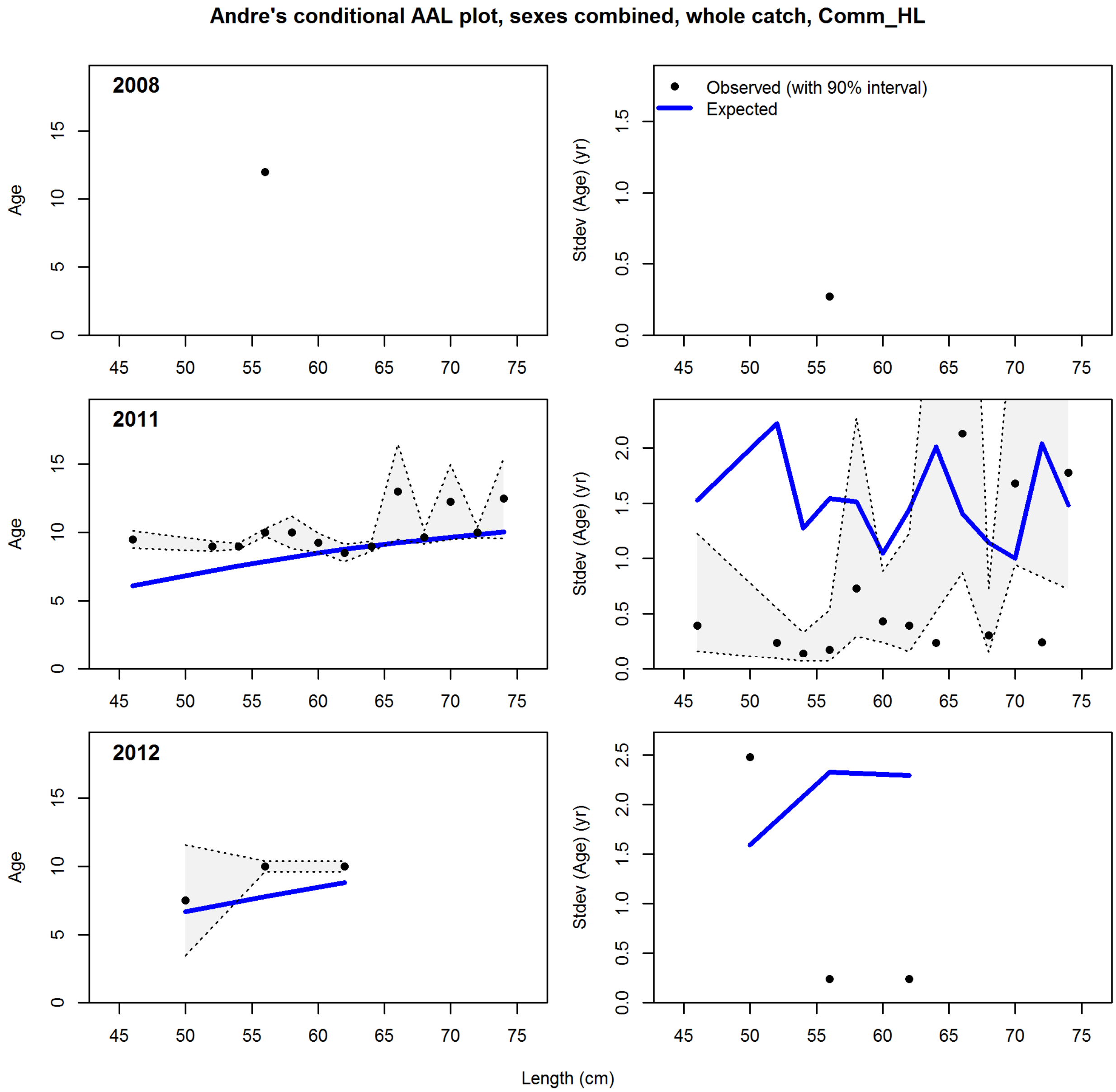


Figure 11.2.1.4.12. Observed and predicted age-at-length for the recreational hook and line fishery of the GA-NC stock base model configuration.

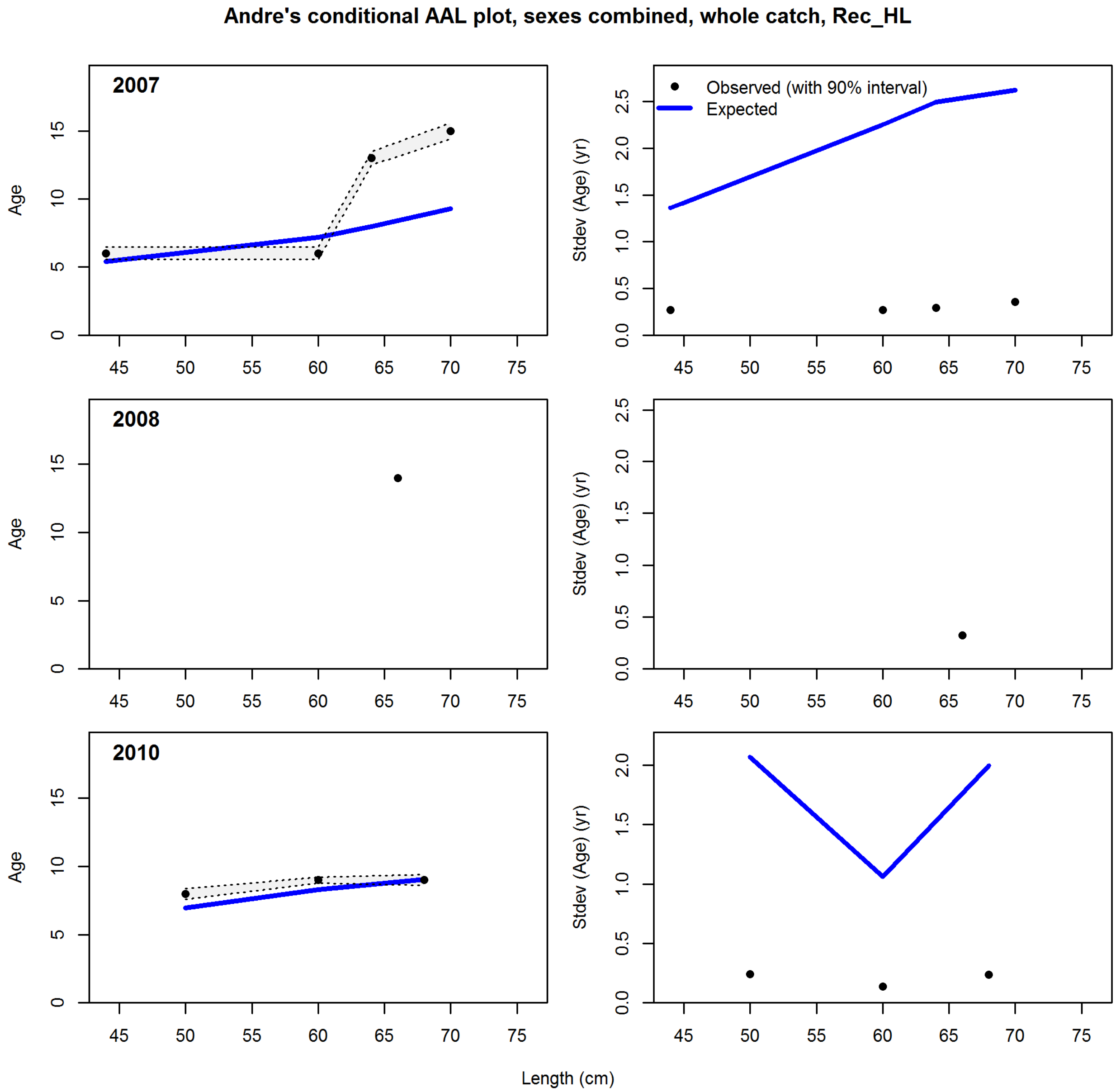


Figure 11.2.1.4.12 (continued). Observed and predicted age-at-length for the recreational hook and line fishery of the GA-NC stock base model configuration.

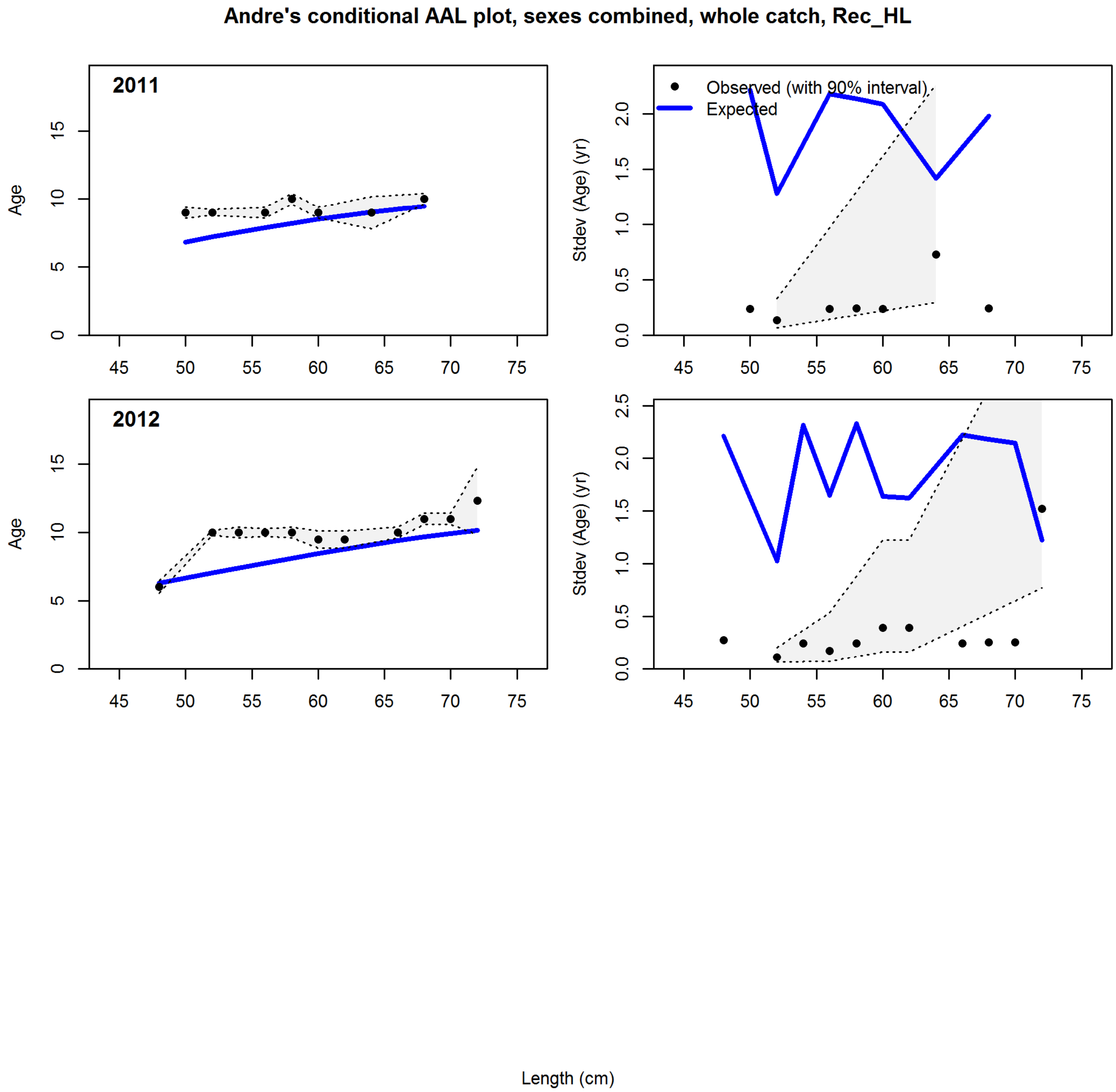


Figure 11.2.3.1. Estimated length-based selectivity functions for the fisheries and surveys in the WFL stock.

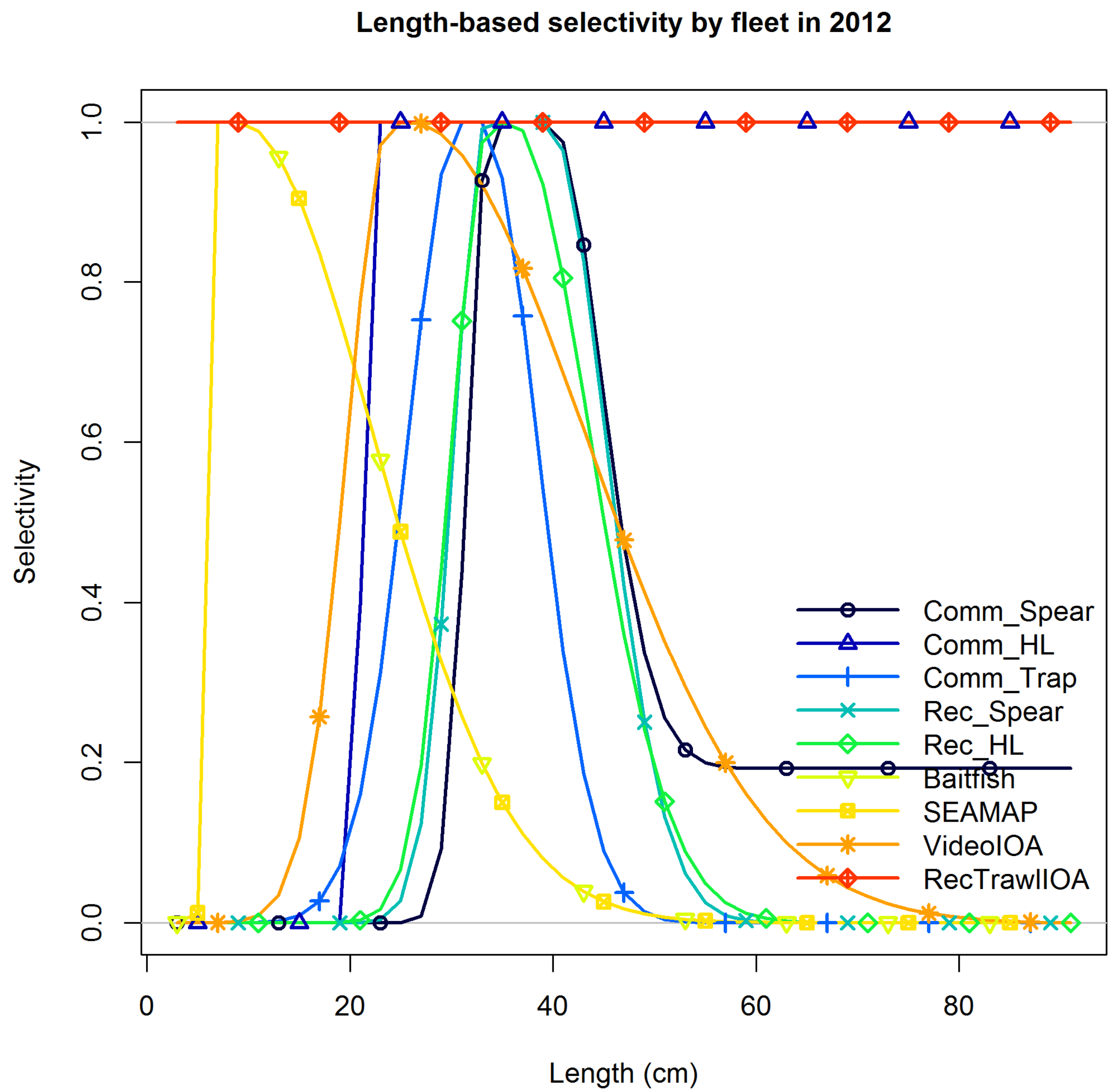


Figure 11.2.3.2. Age-based selectivity functions (i.e., ages across which the length-base selectivity functions apply for all fisheries/surveys except the age-0 seagrass trawl ('RecTrawlIOA'), which was modeled with age for only age-0 individuals.

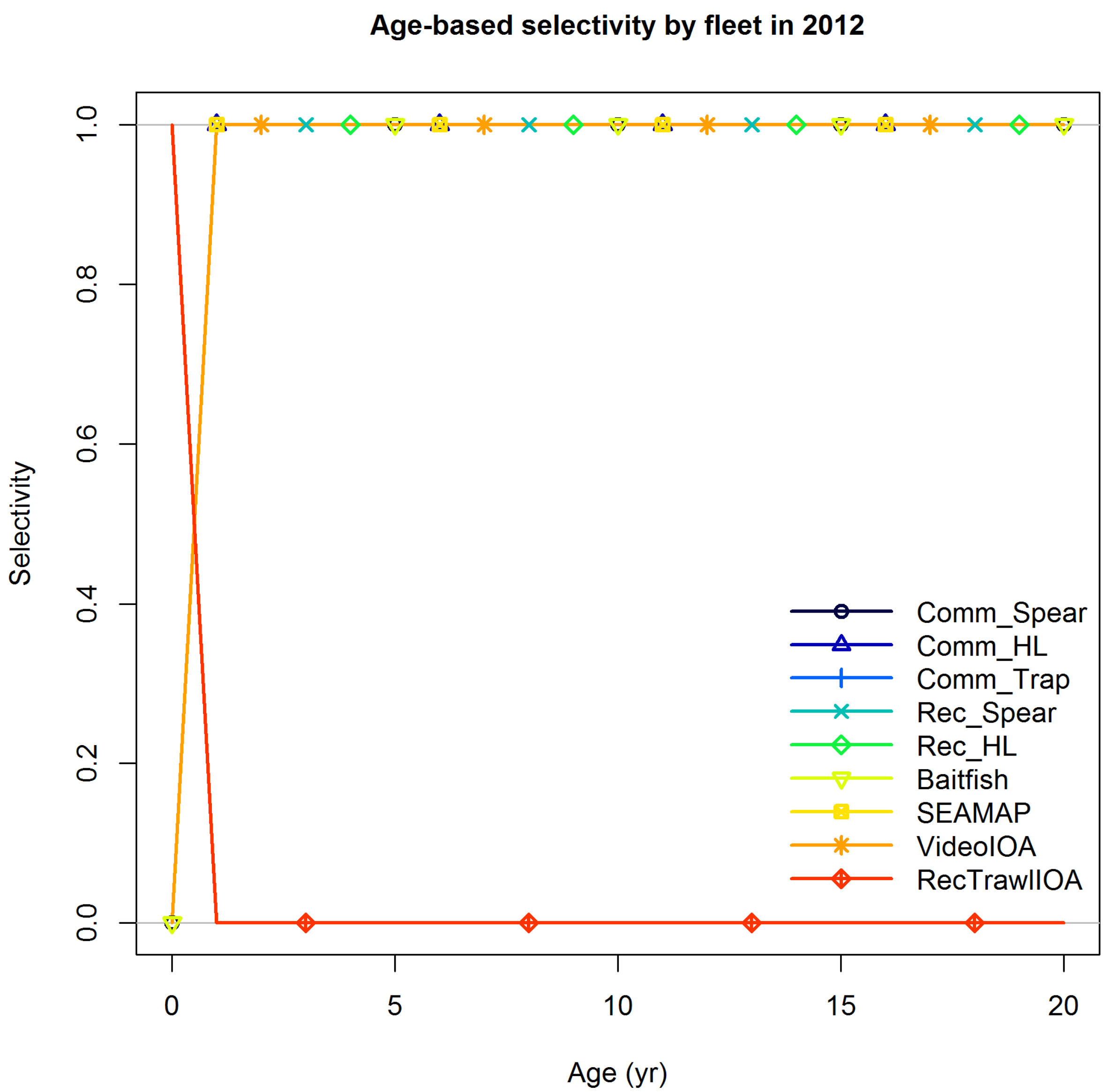


Figure 11.2.3.3. Derived age-based selectivity functions from the modeled length-base selectivity functions for the fisheries in the WFL stock.

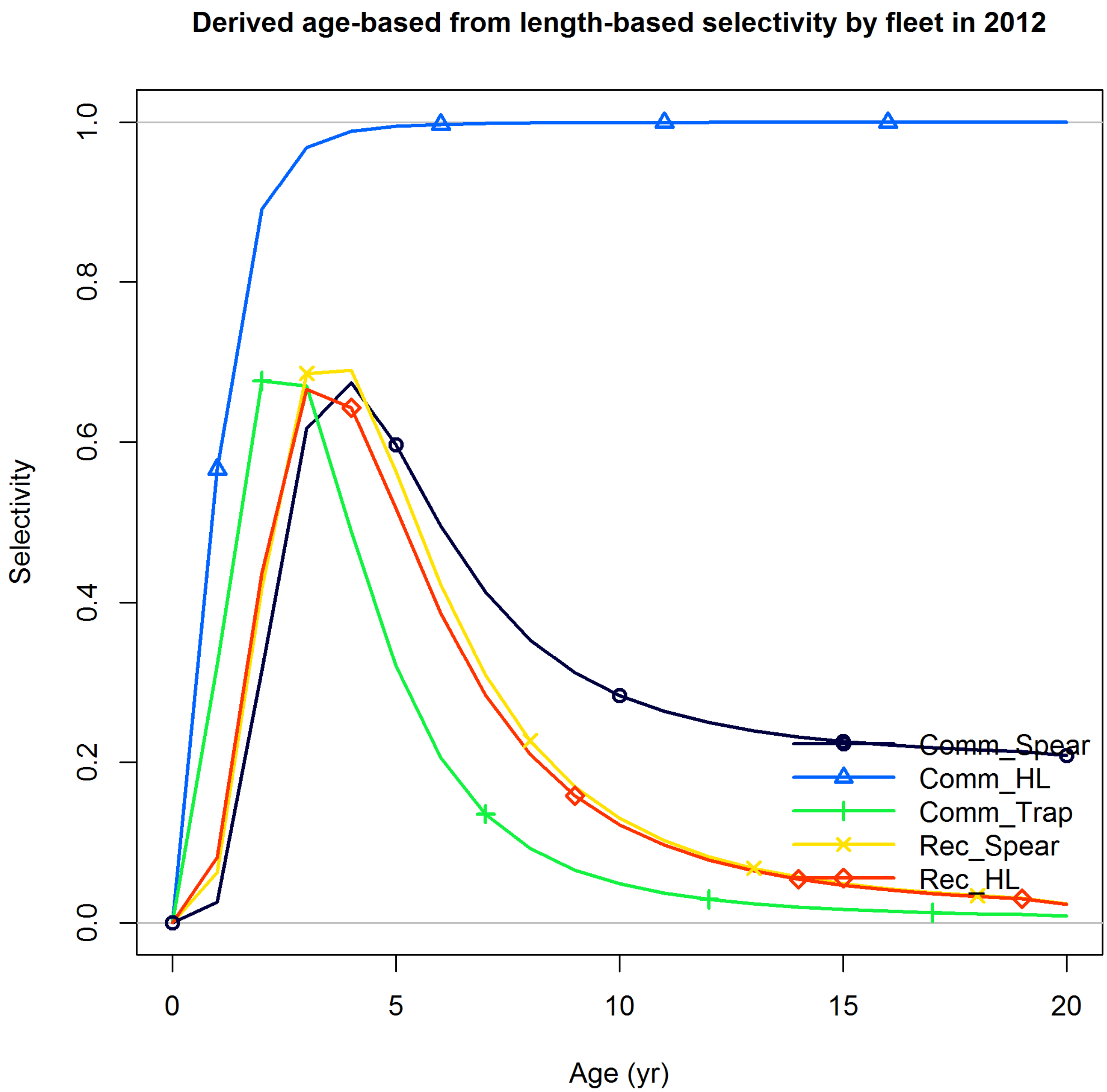


Figure 11.2.3.4. Estimated length-based selectivity functions for the fisheries and surveys in the FLK/EFL stock.

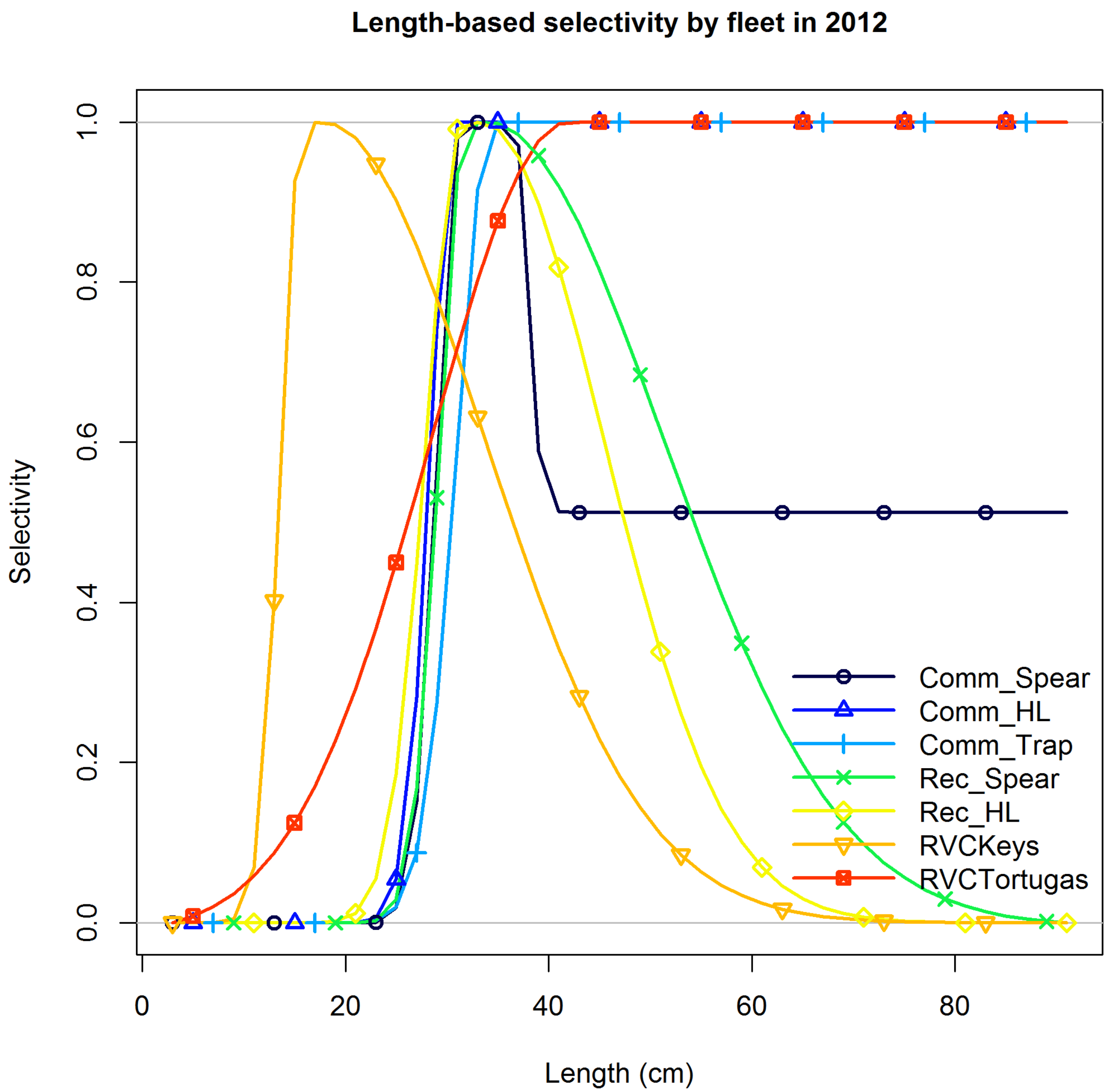


Figure 11.2.3.5. Derived age-based selectivity functions from the modeled length-base selectivity functions for the fisheries in the FLK/EFL stock.

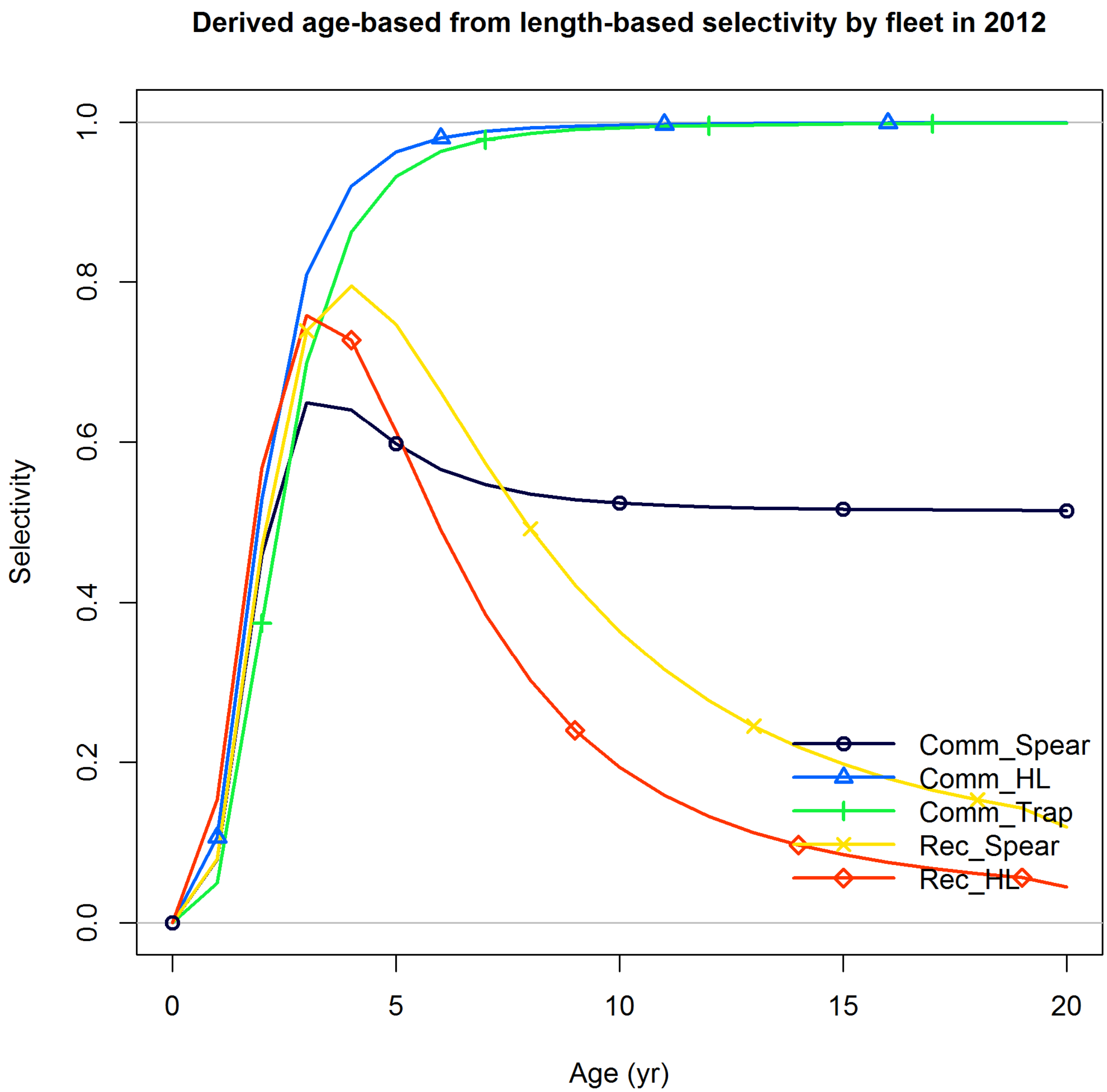


Figure 11.2.3.6. Estimated length-based selectivity functions for the fisheries in the GA-NC stock.

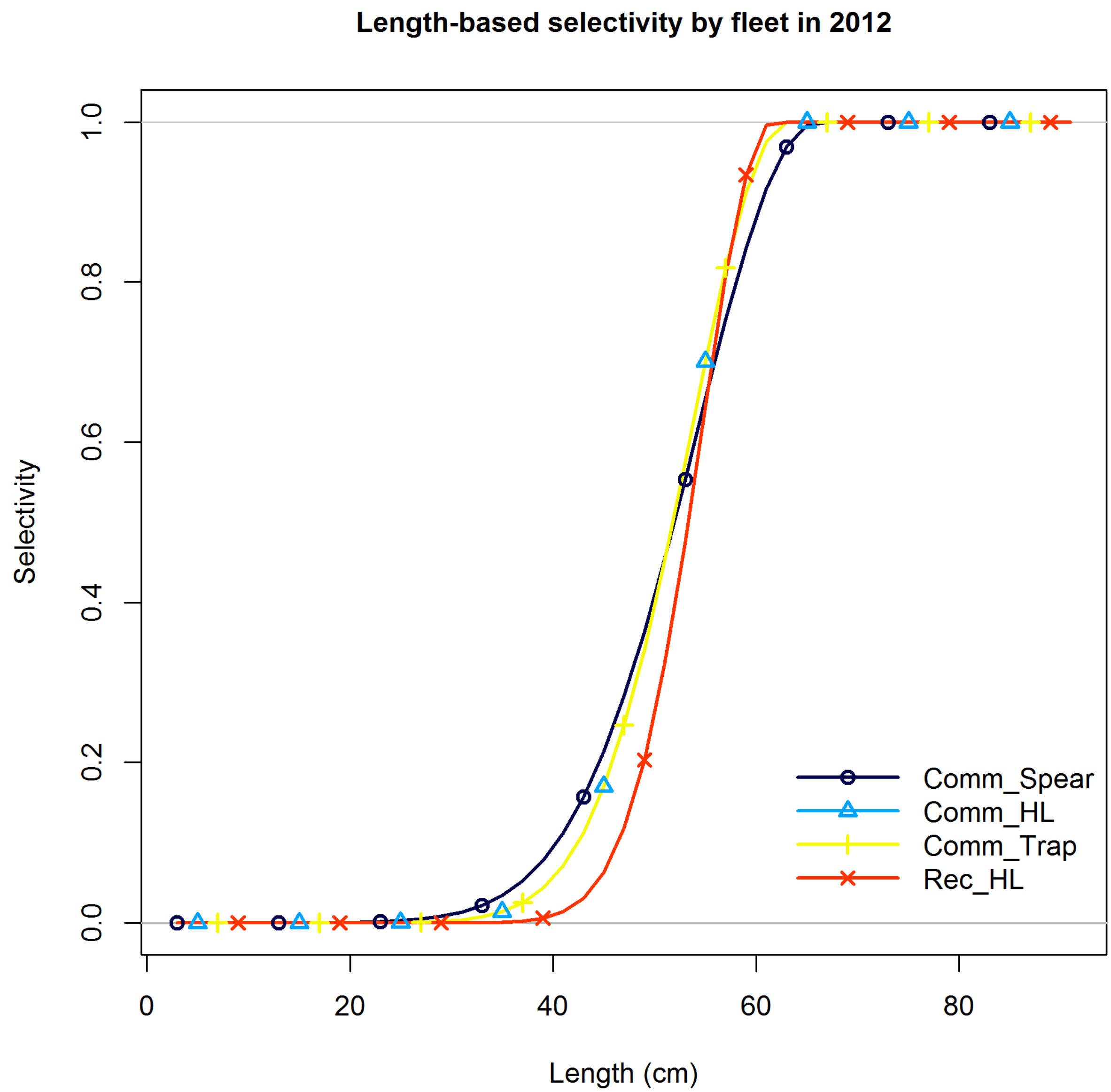


Figure 11.2.3.7. Derived age-based selectivity functions from the modeled length-base selectivity functions for the fisheries in the GA-NC stock.

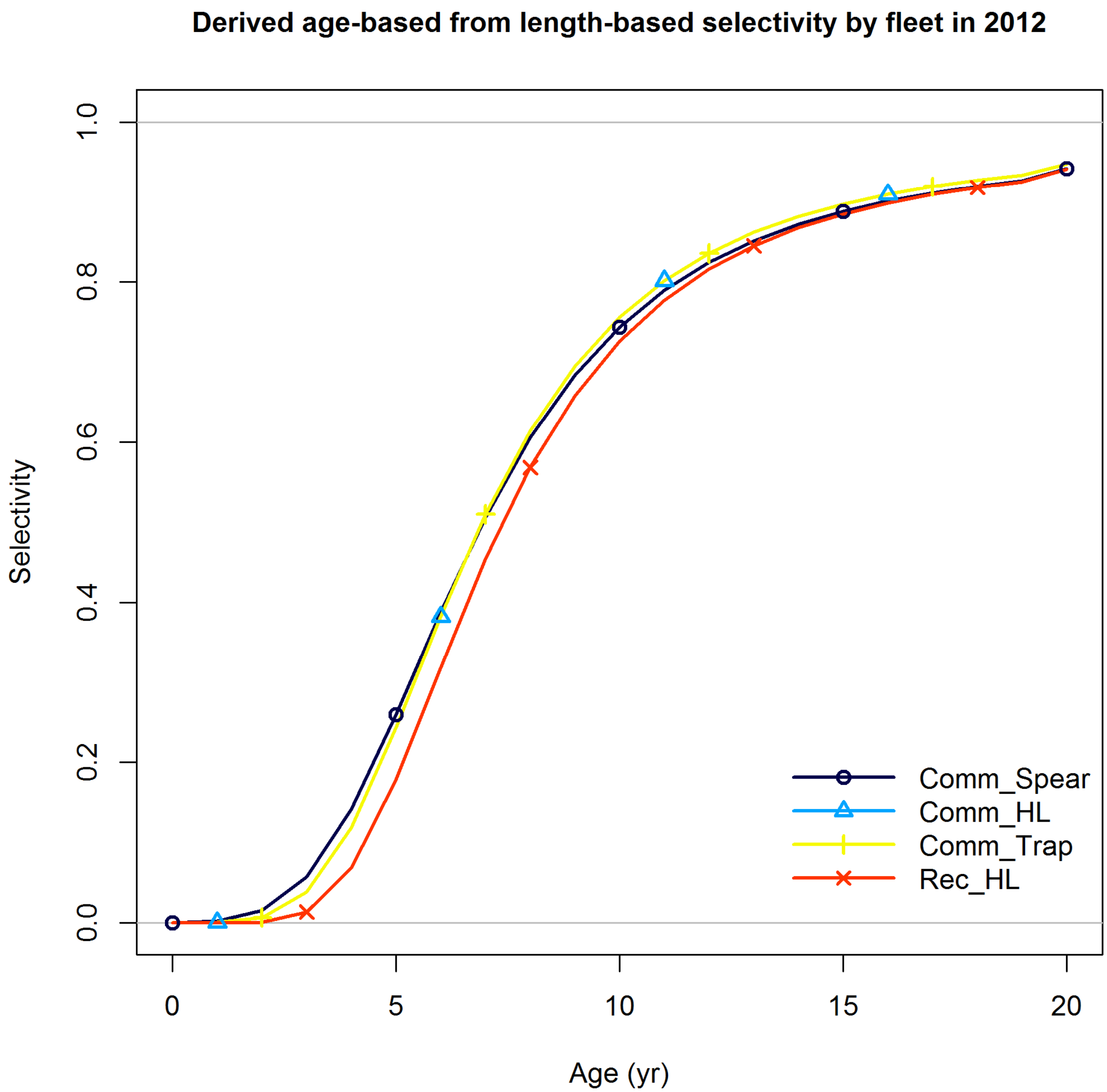


Figure 11.2.4.1. Predicted stock-recruitment relationship for the WFL stock base model configuration.

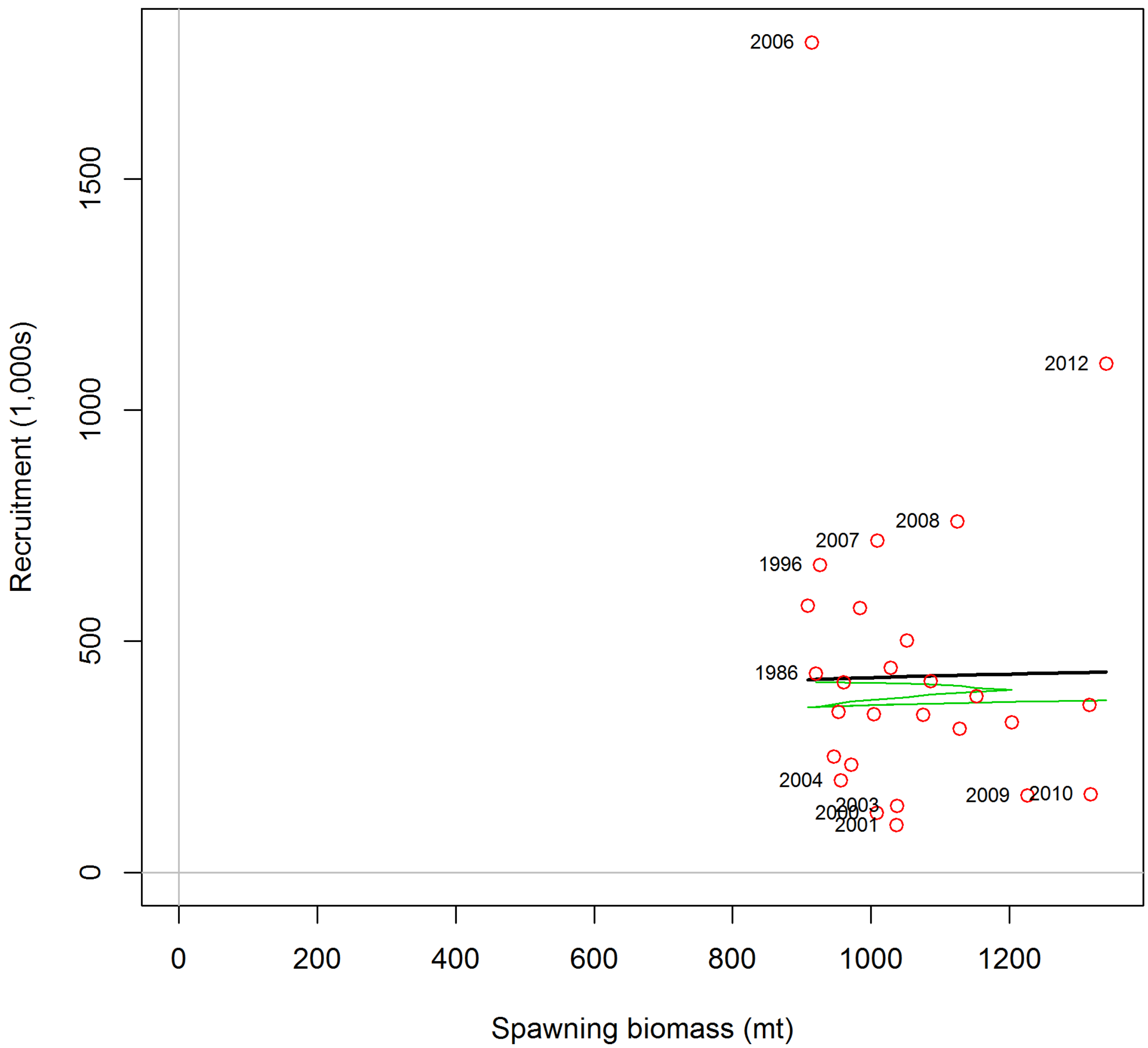


Figure 11.2.4.2. Recruitment deviations and measures of uncertainty for the WFL stock base model configuration.

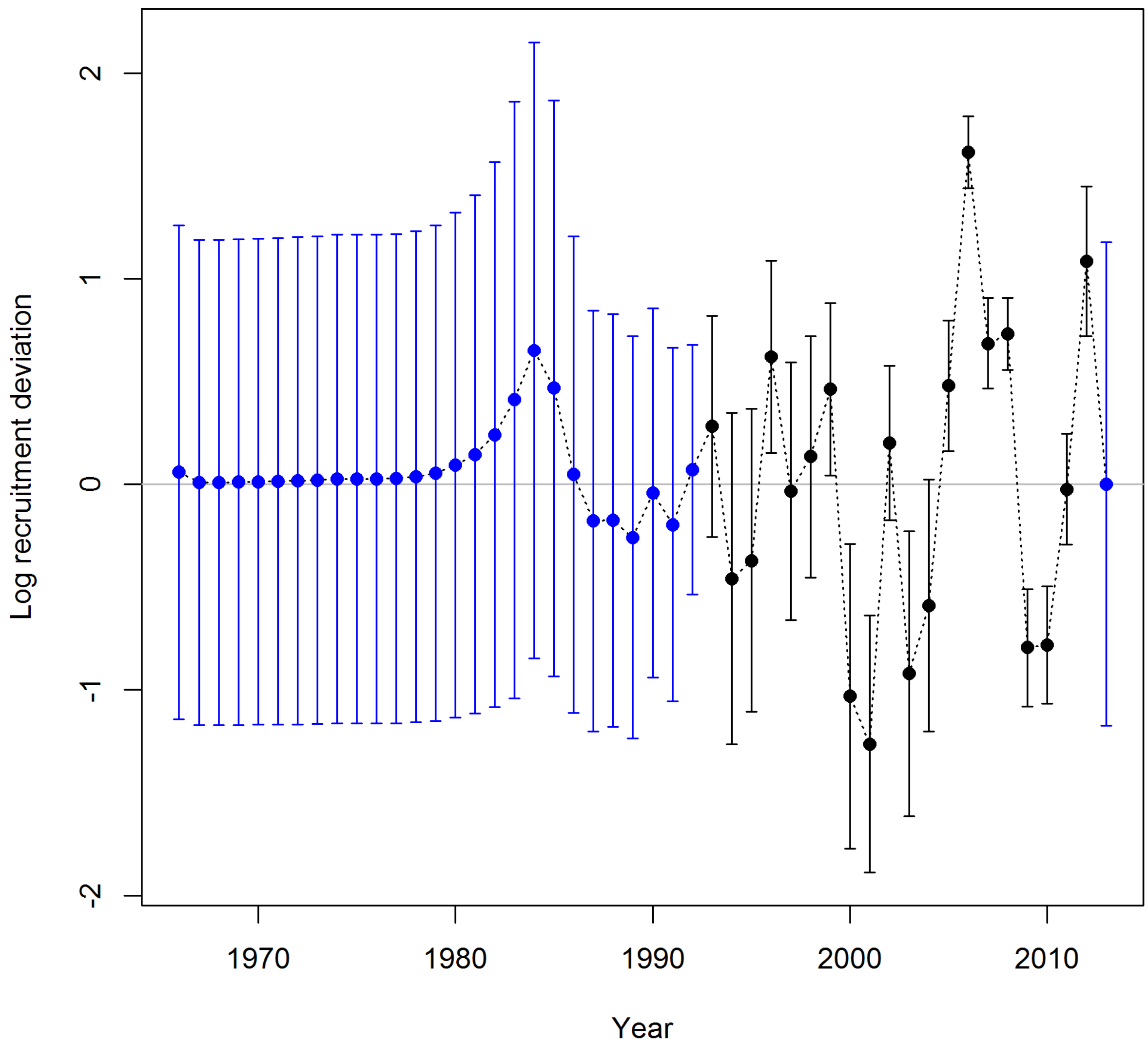
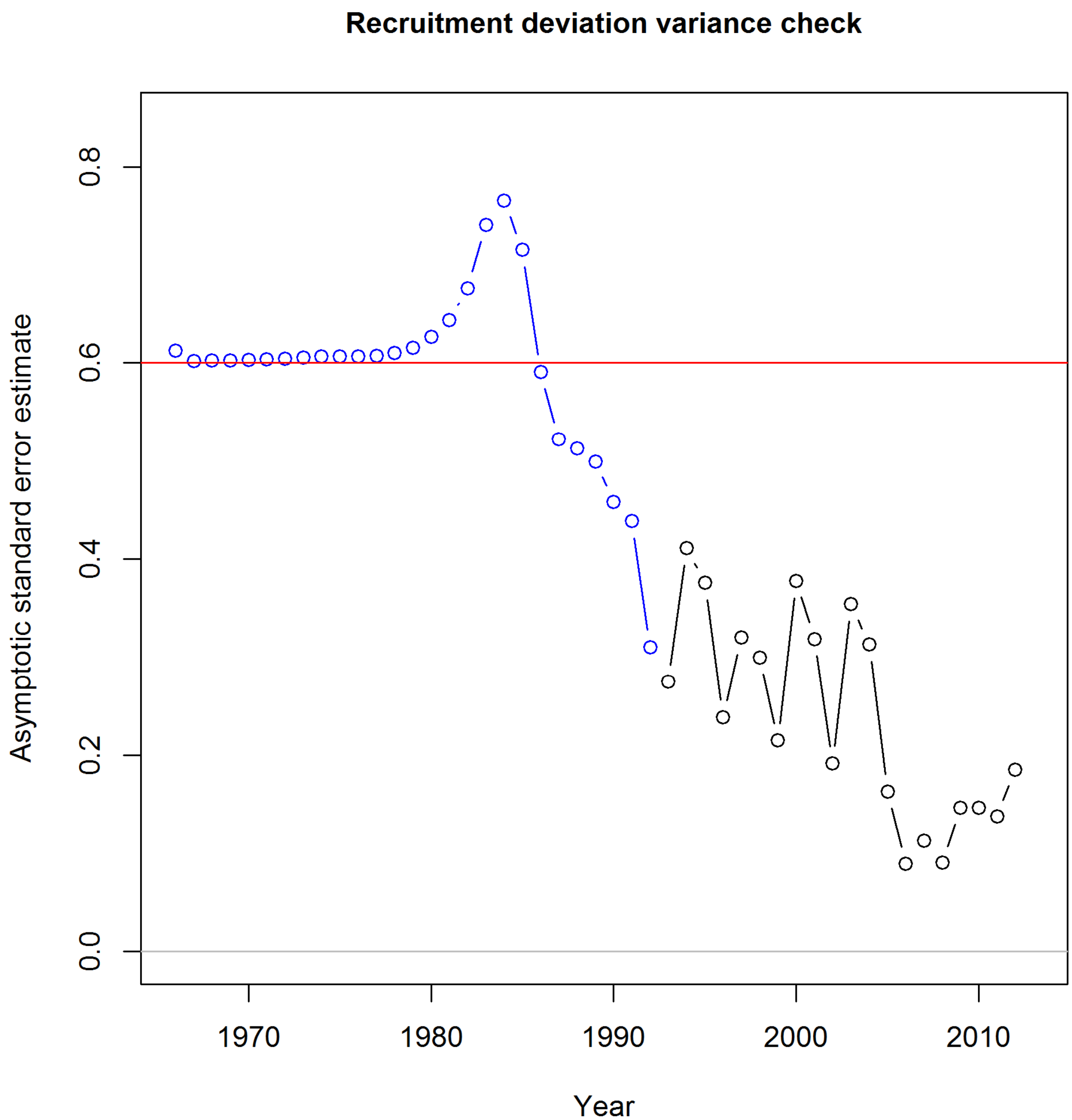


Figure 11.2.4.3. Recruitment deviation variance check for the WFL stock base model configuration.



11.2.4.4. Likelihood profile of steepness for the WFL stock base model.

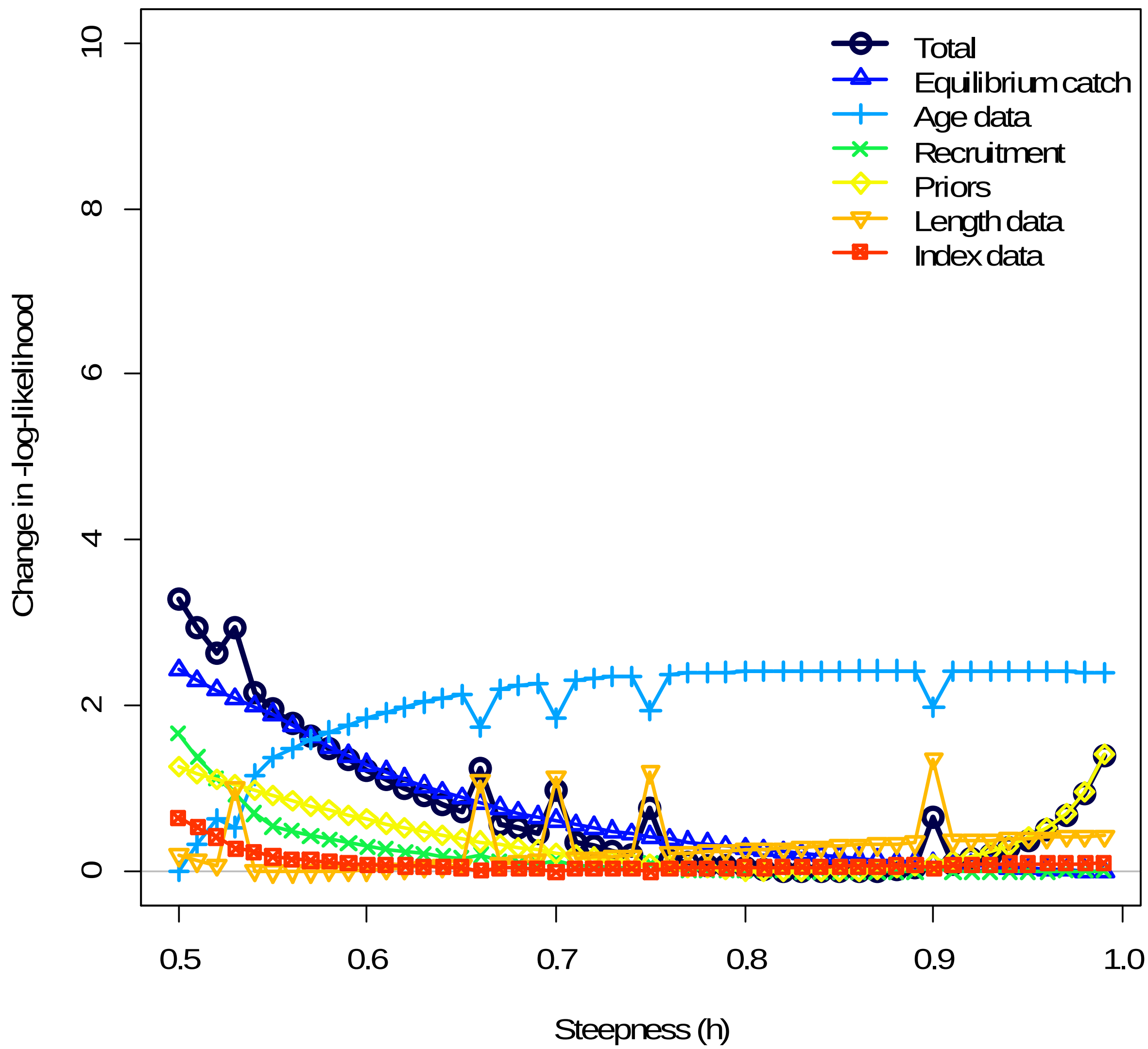


Figure 11.2.4.5. Predicted stock-recruitment relationship for the FLK/EFL stock base model configuration.

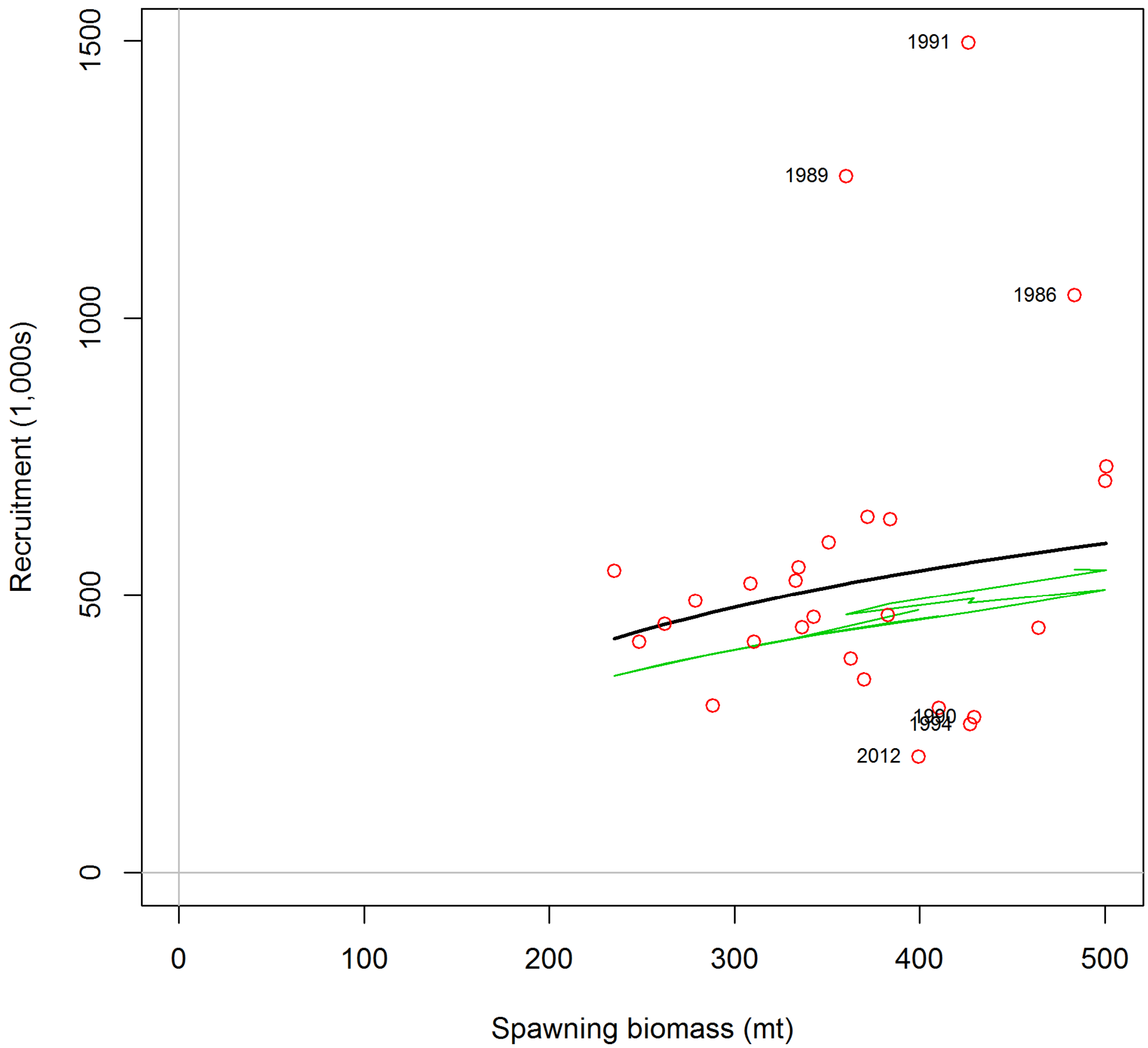


Figure 11.2.4.6. Recruitment deviations and measures of uncertainty for the FLK/EFL stock base model configuration.

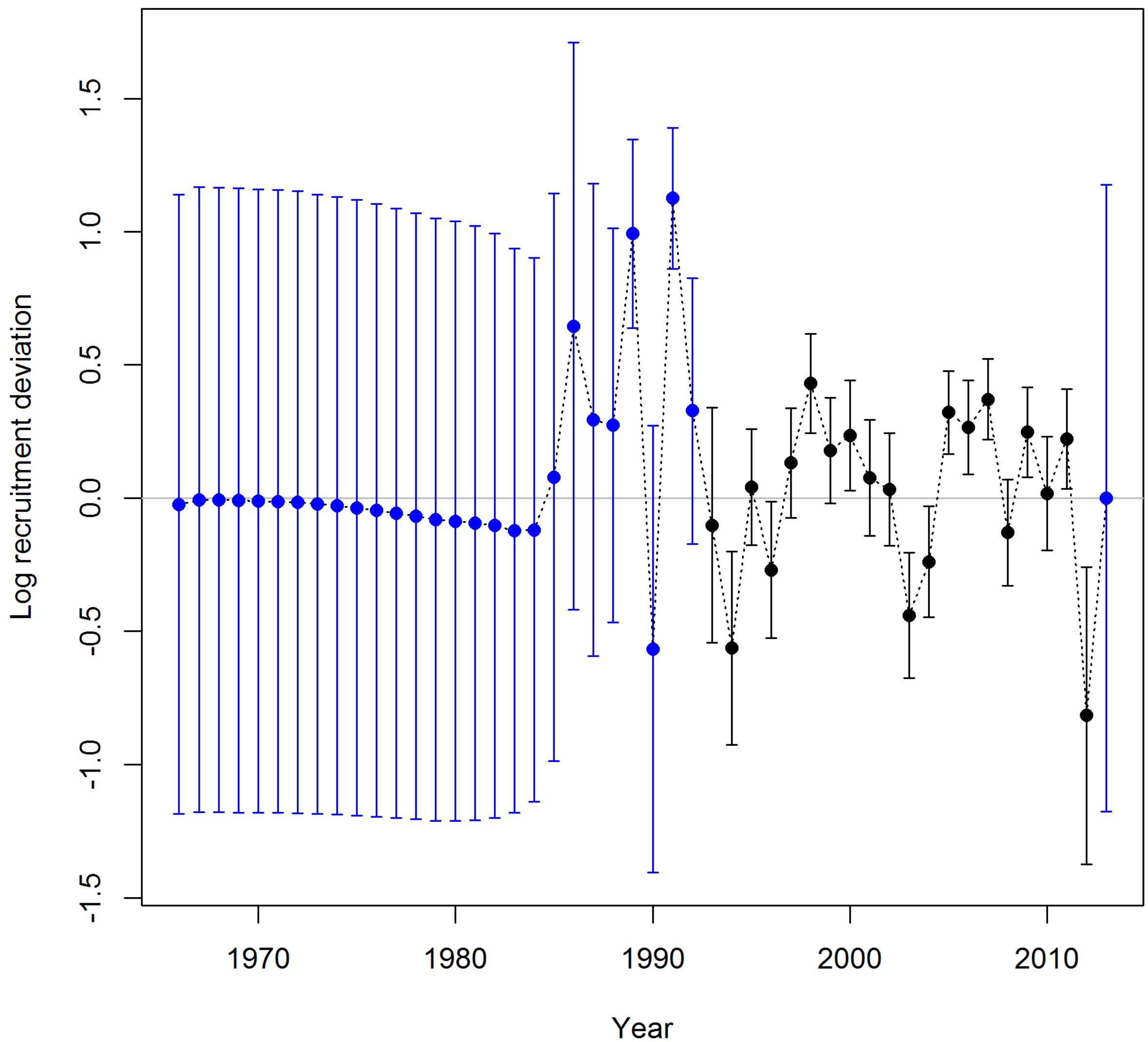


Figure 11.2.4.7. Recruitment deviation variance check for the FLK/EFL stock base model configuration.

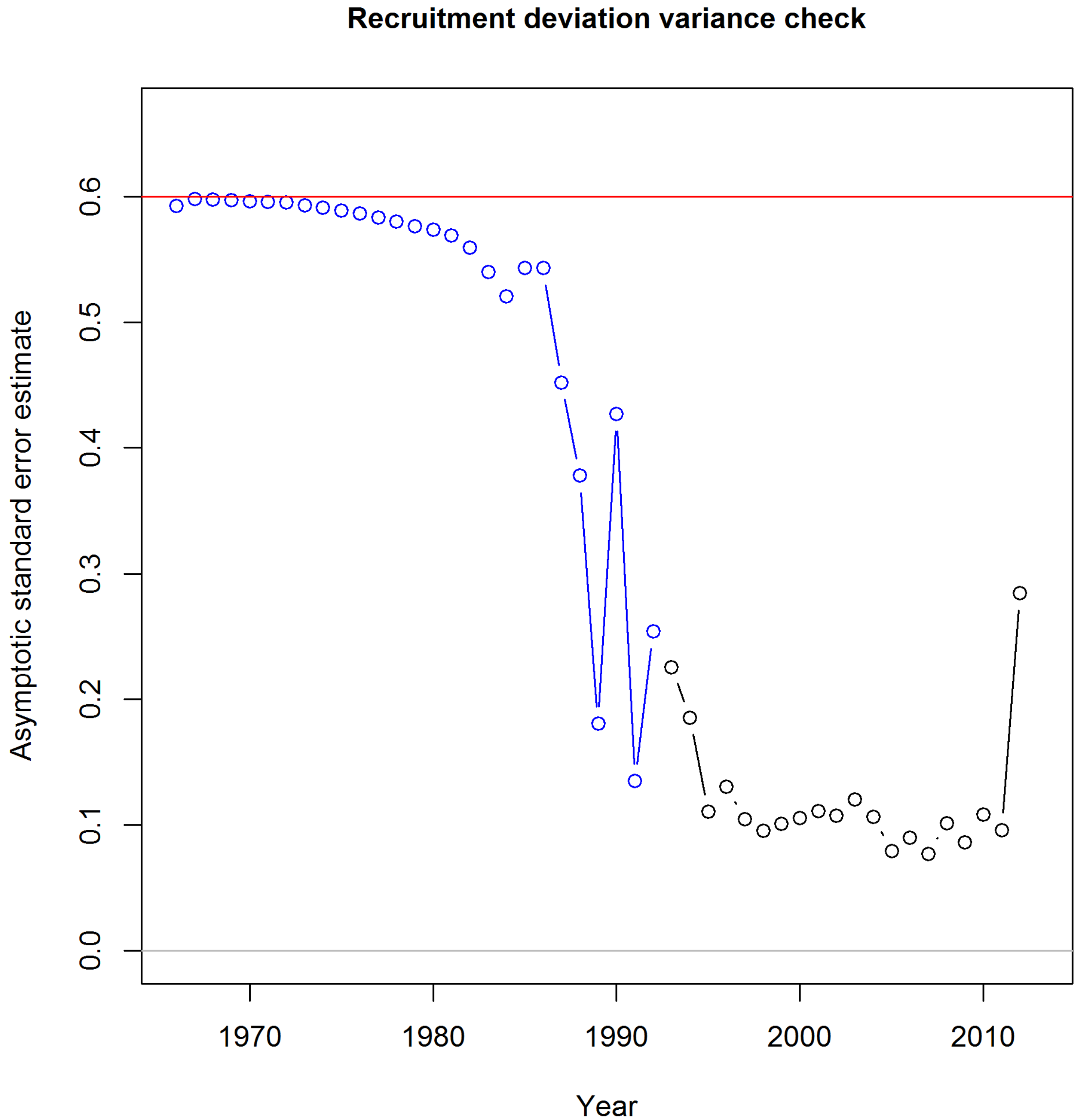


Figure 11.2.4.8. Likelihood profile of steepness for the FLK/EFL stock base model.

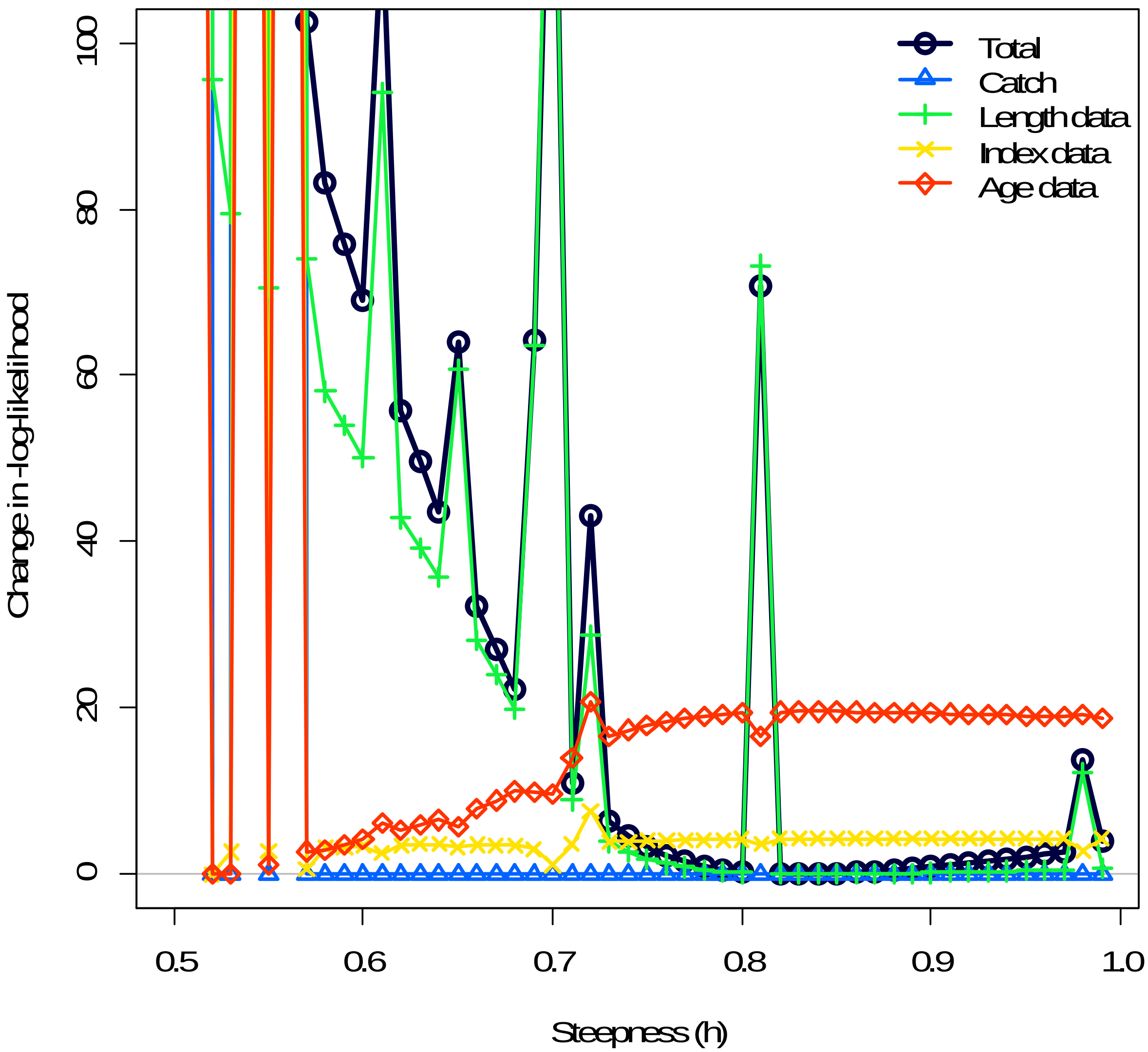


Figure 11.2.4.9. Predicted stock-recruitment relationship for the GA-NC stock base model configuration.

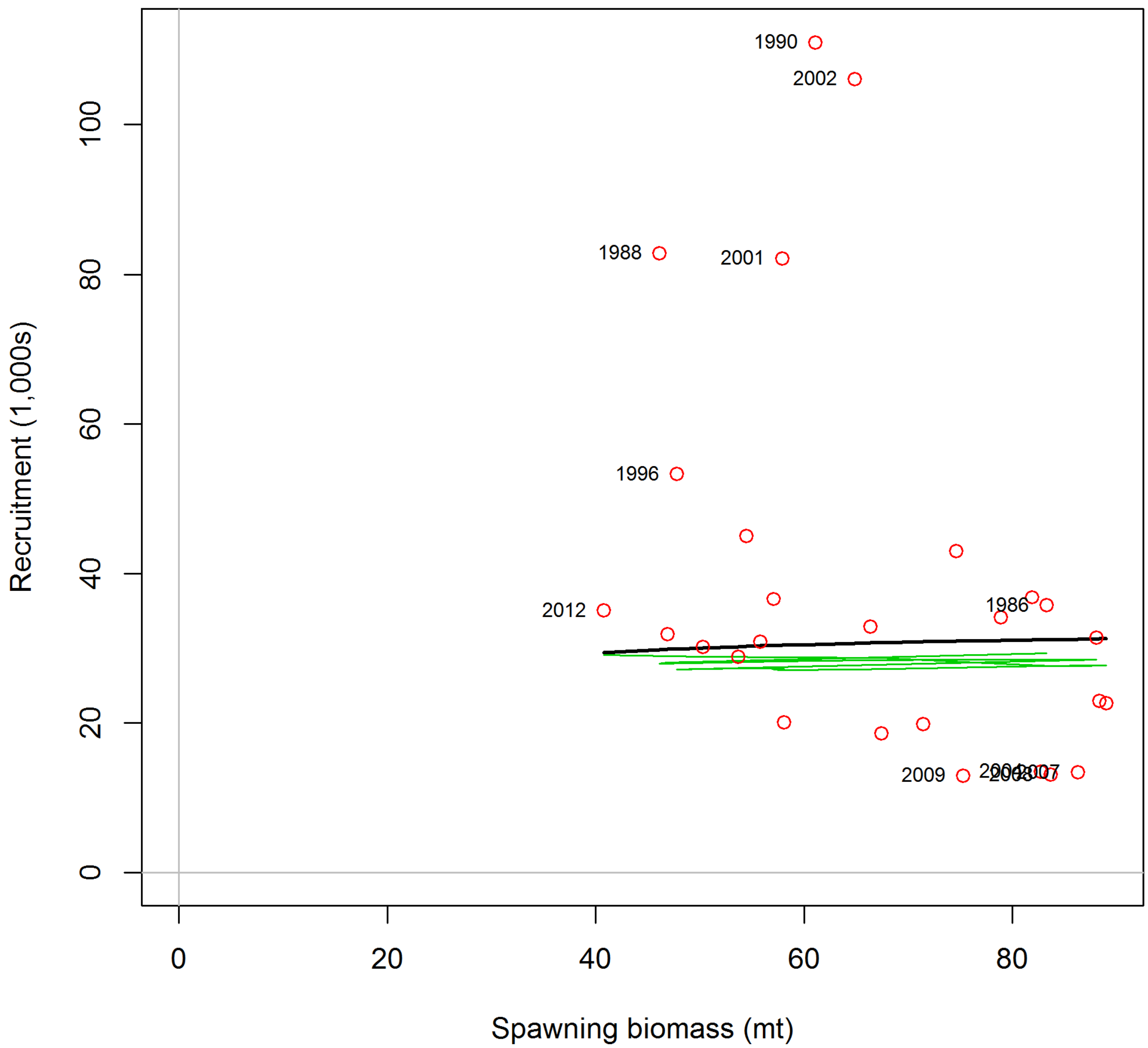


Figure 11.2.4.10. Recruitment deviations and measures of uncertainty for the GA-NC stock base model configuration.

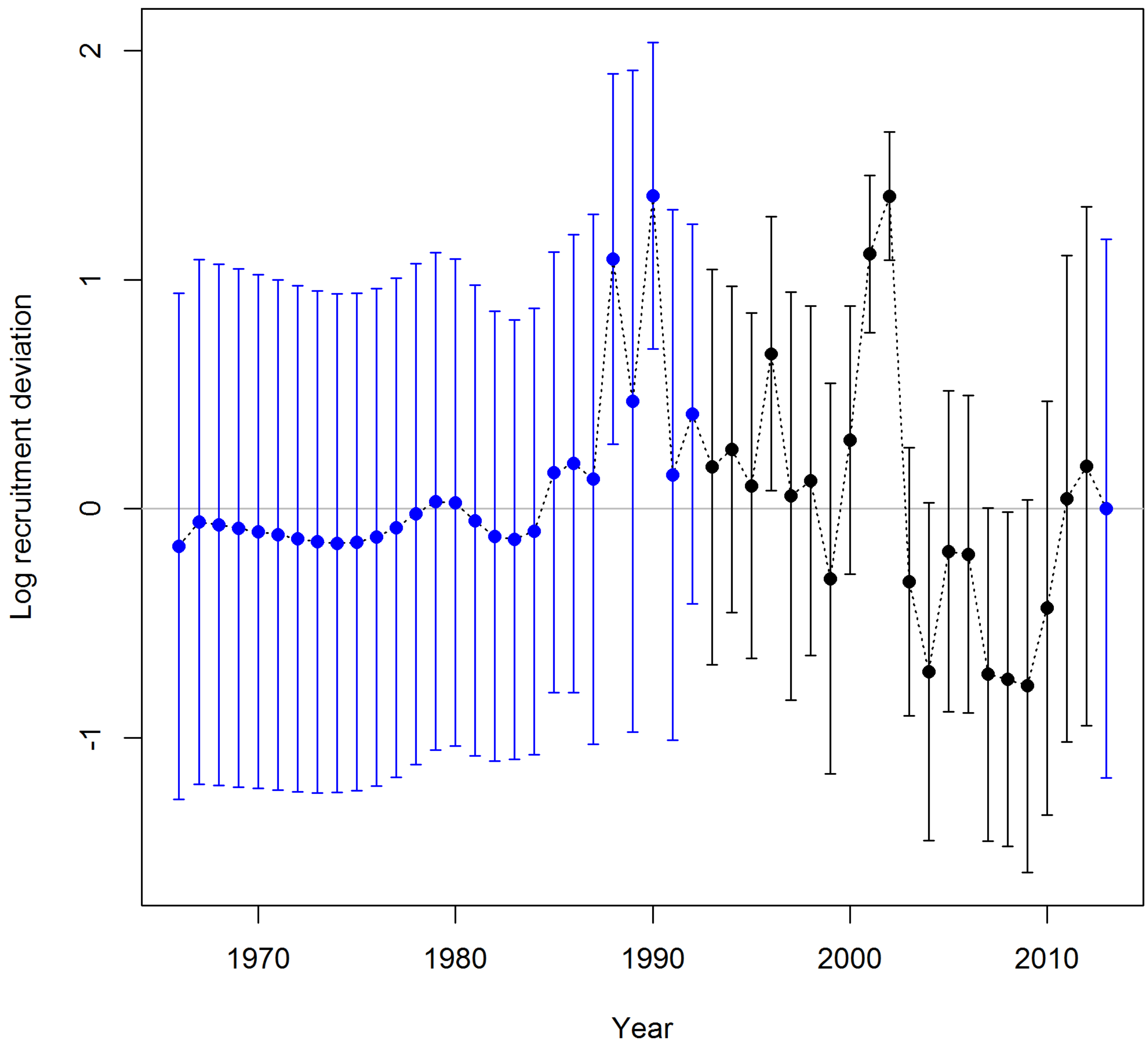


Figure 11.2.4.11. Recruitment deviation variance check for the GA-NC stock base model configuration.

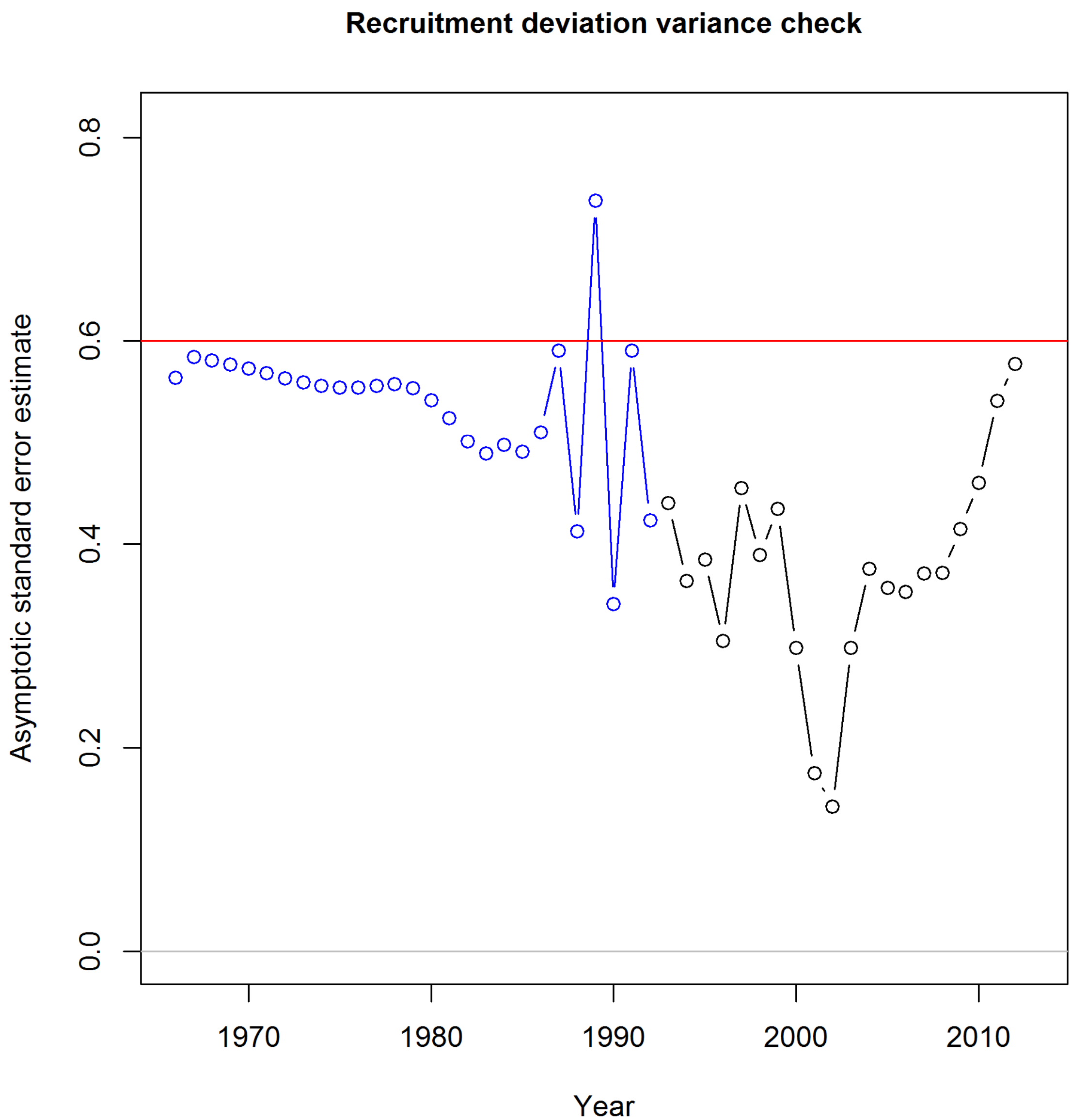


Figure 11.2.4.12. Likelihood profile of steepness for the GA-NC stock base model.

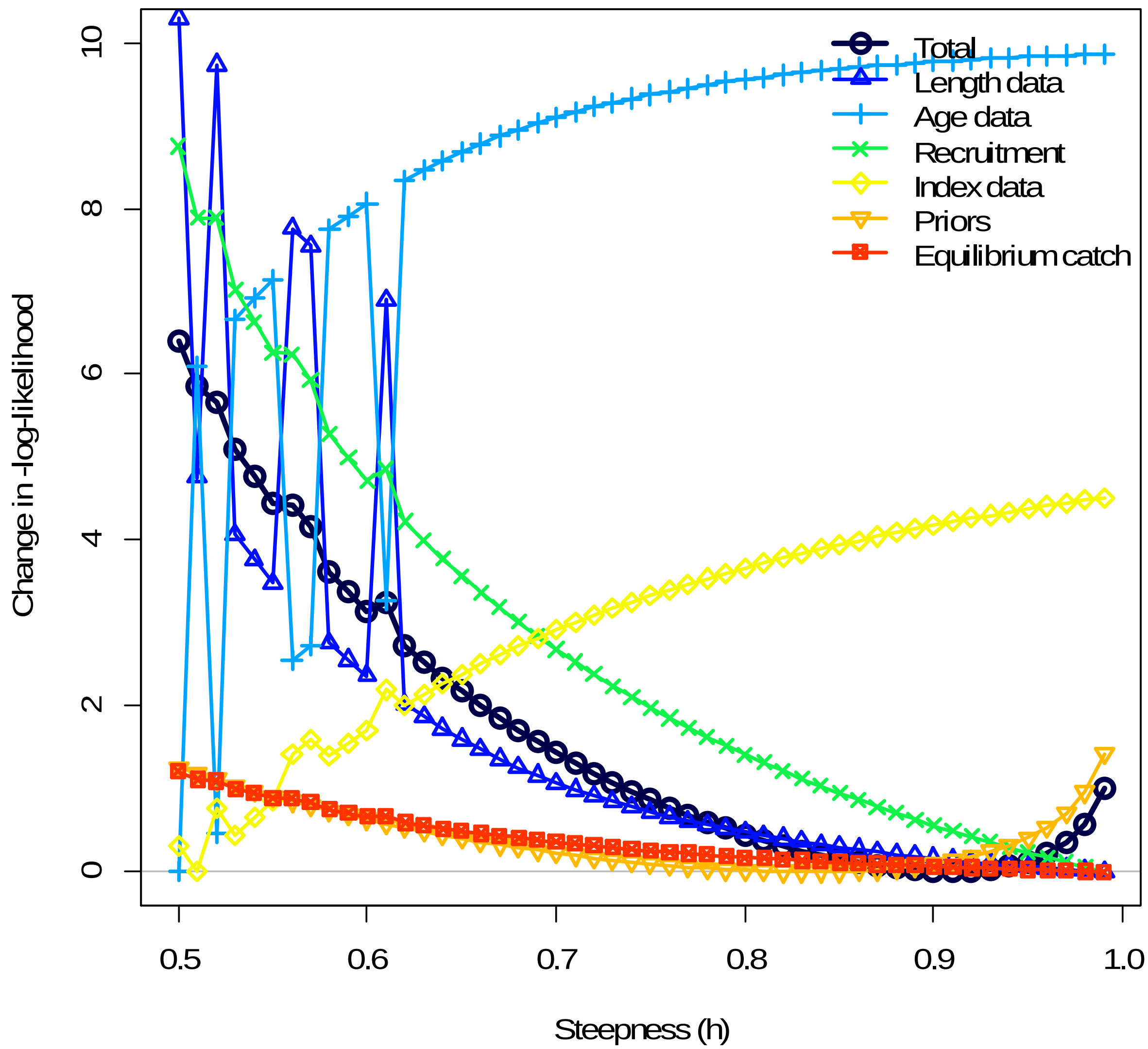


Figure 11.2.5.1. Predicted total biomass (mt) for the WFL stock base model configuration.

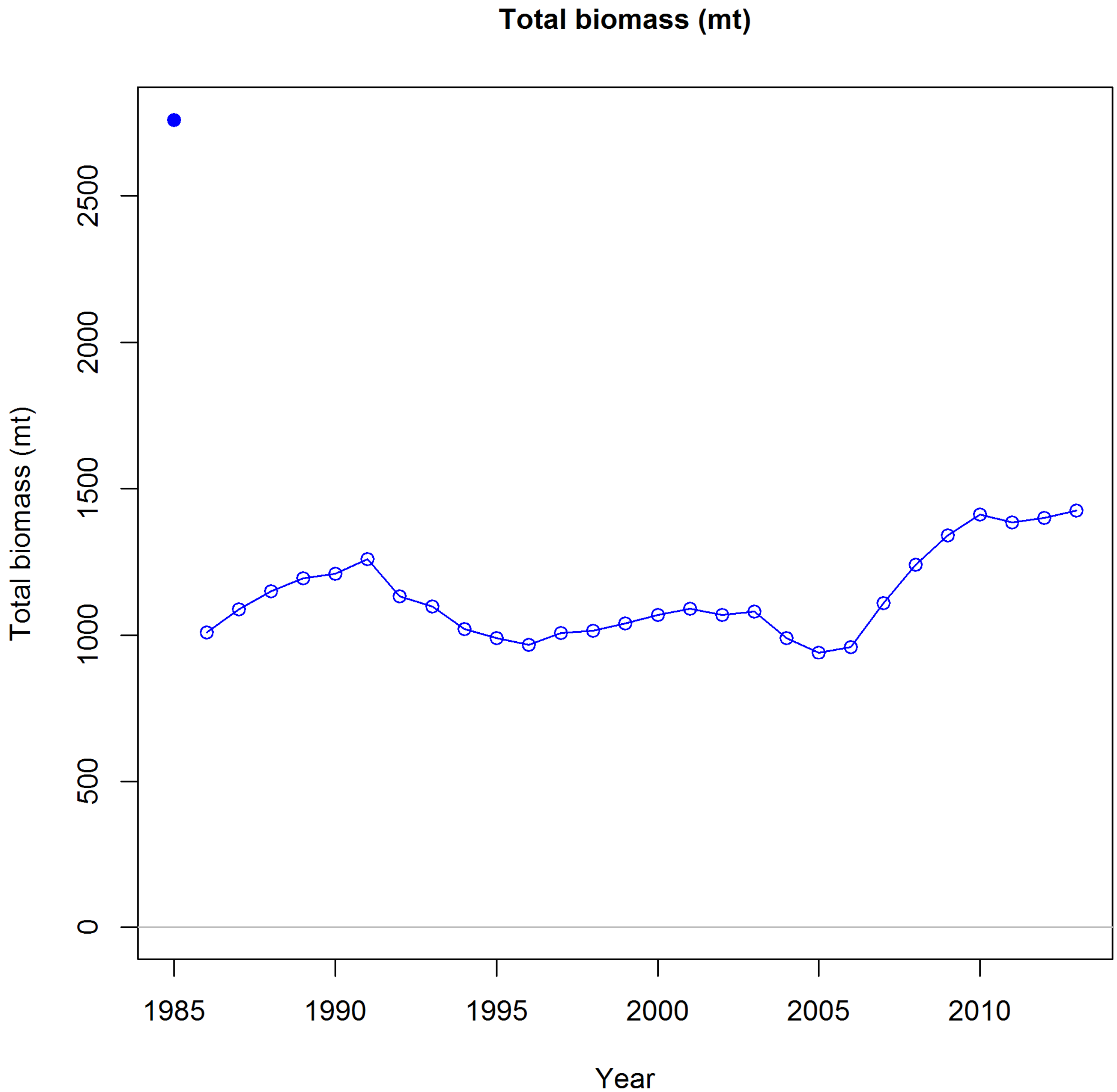


Figure 11.2.5.2. Predicted spawning biomass and associated 95% asymptotic error intervals for the WFL stock base model configuration.

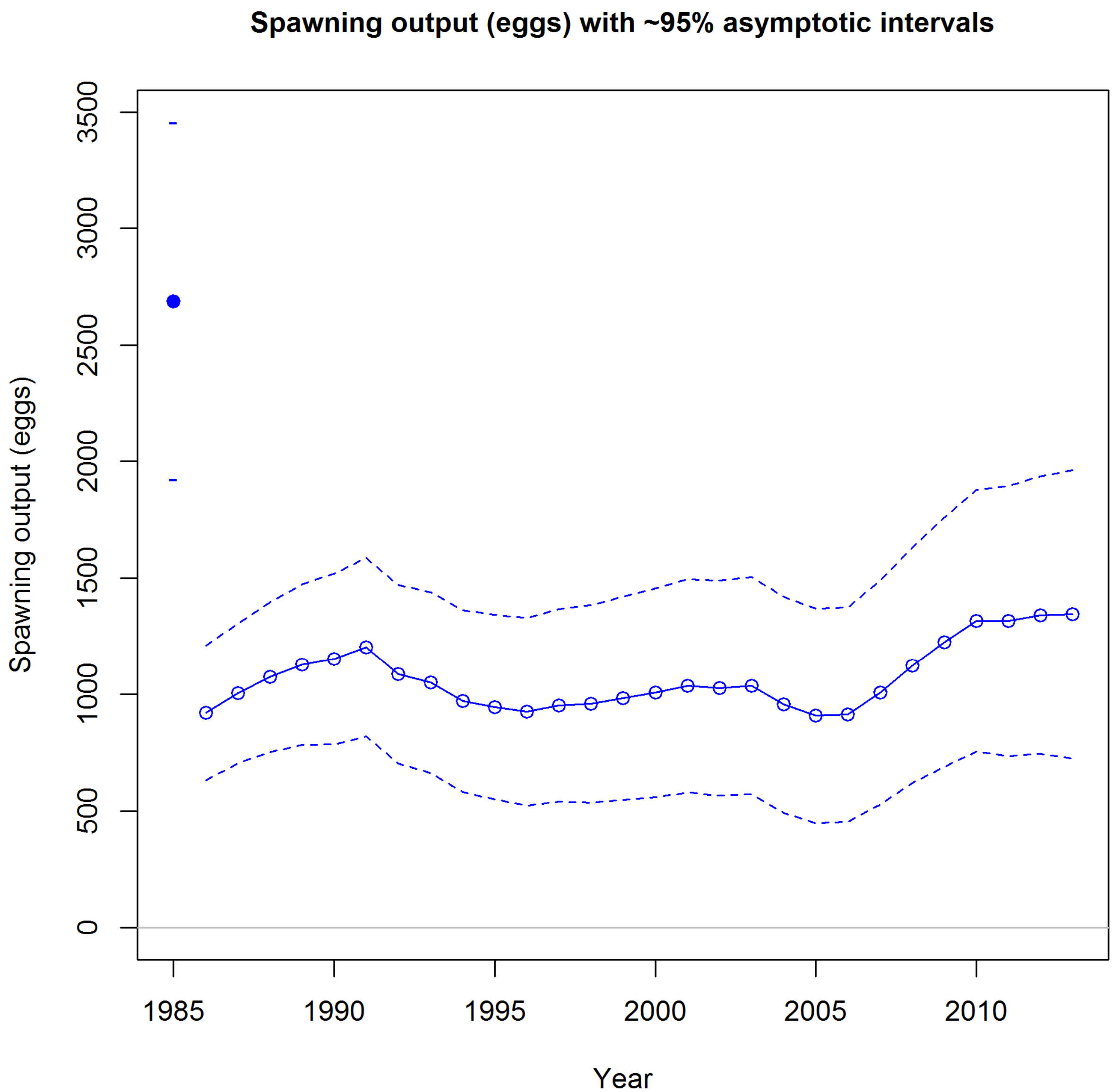


Figure 11.2.5.3. Predicted numbers-at-age (bubbles) and mean age (red line) of females for the WFL stock base model configuration.

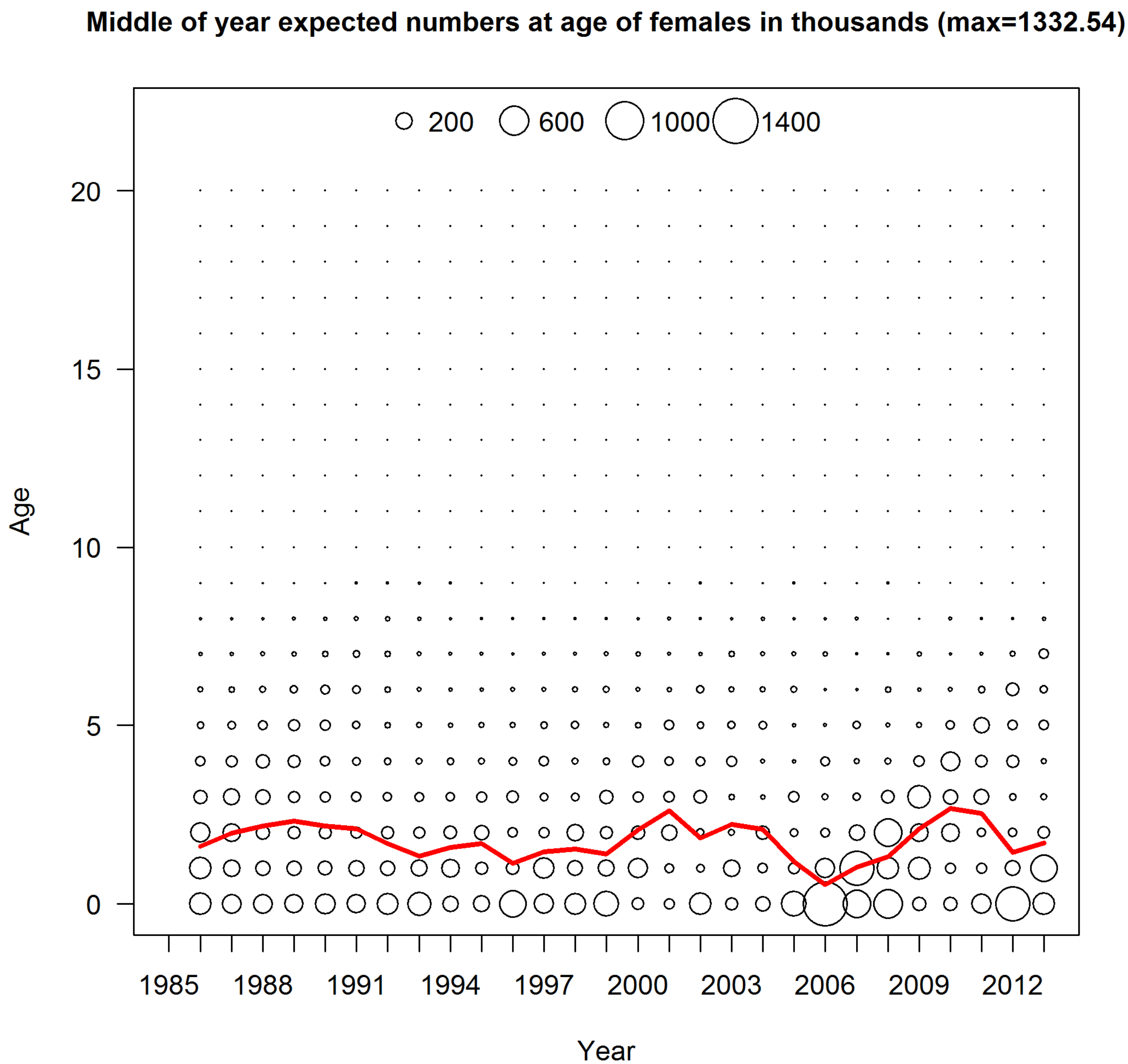


Figure 11.2.5.4. Predicted numbers-at-age (bubbles) and mean age (red line) of males for the WFL stock base model configuration.

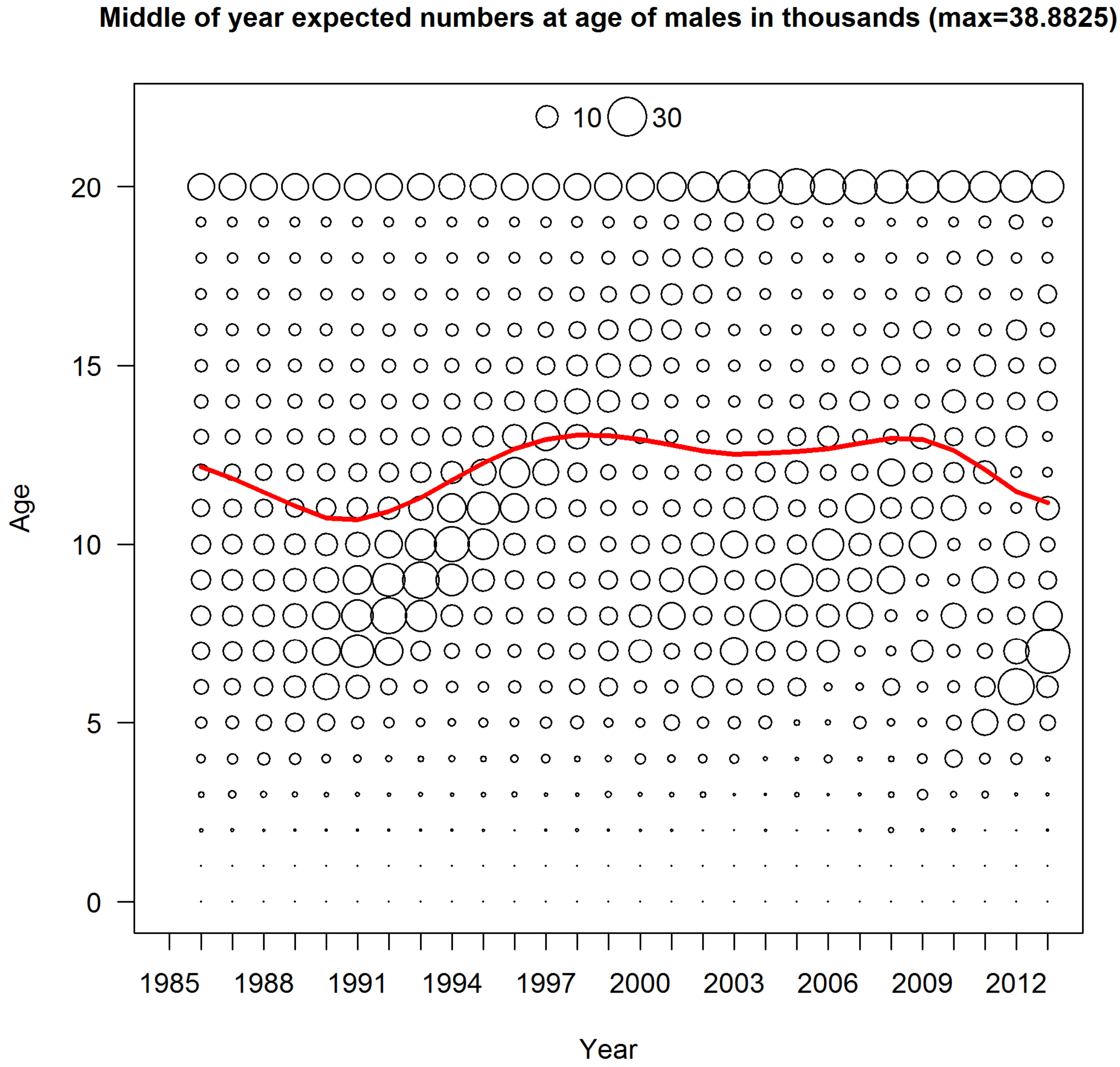


Figure 11.2.5.5. Predicted numbers-at-length (bubbles) and mean length (red line) of females for the WFL stock base model configuration.

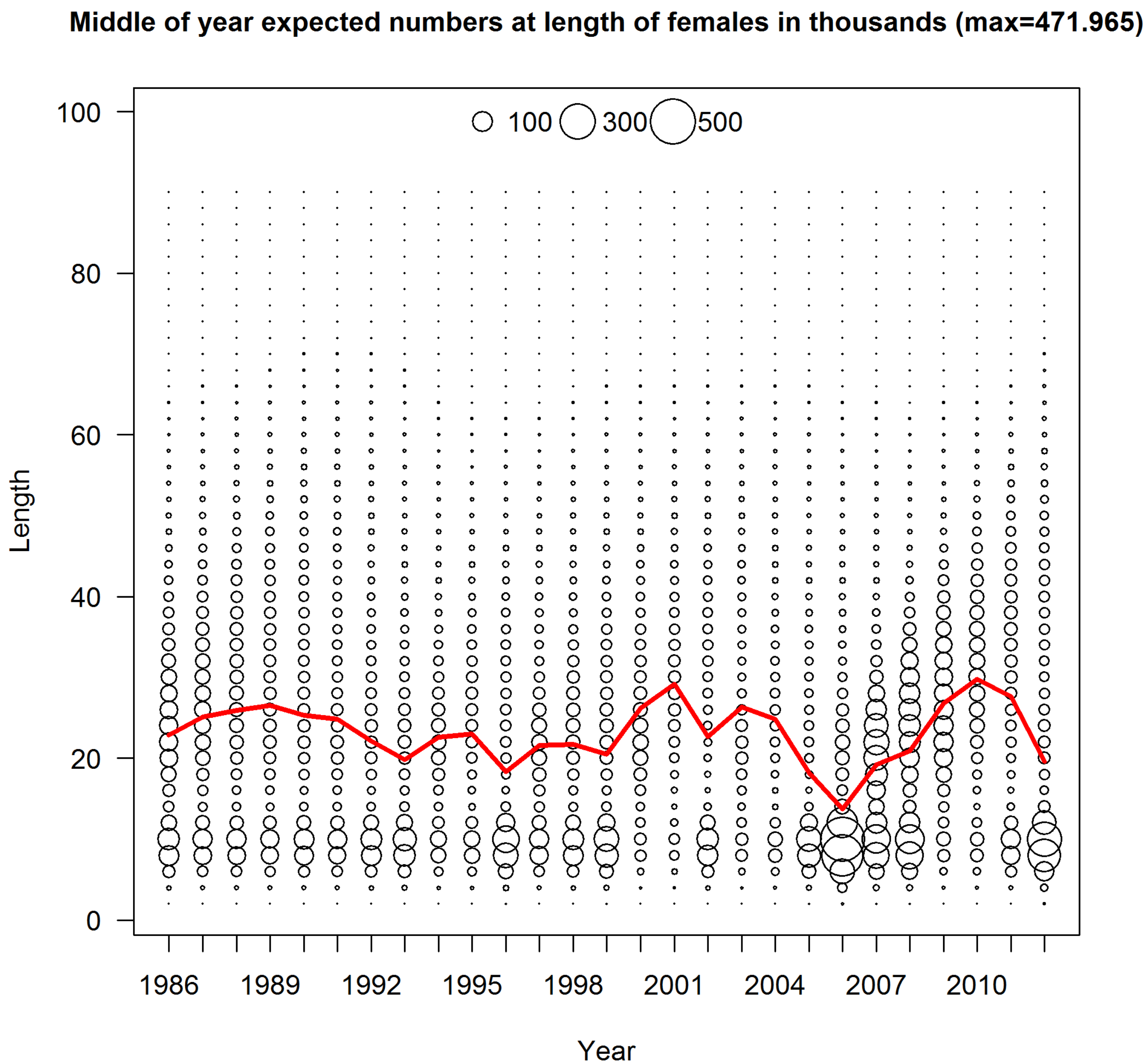


Figure 11.2.5.6. Predicted numbers-at-length (bubbles) and mean length (red line) of males for the WFL stock base model configuration.

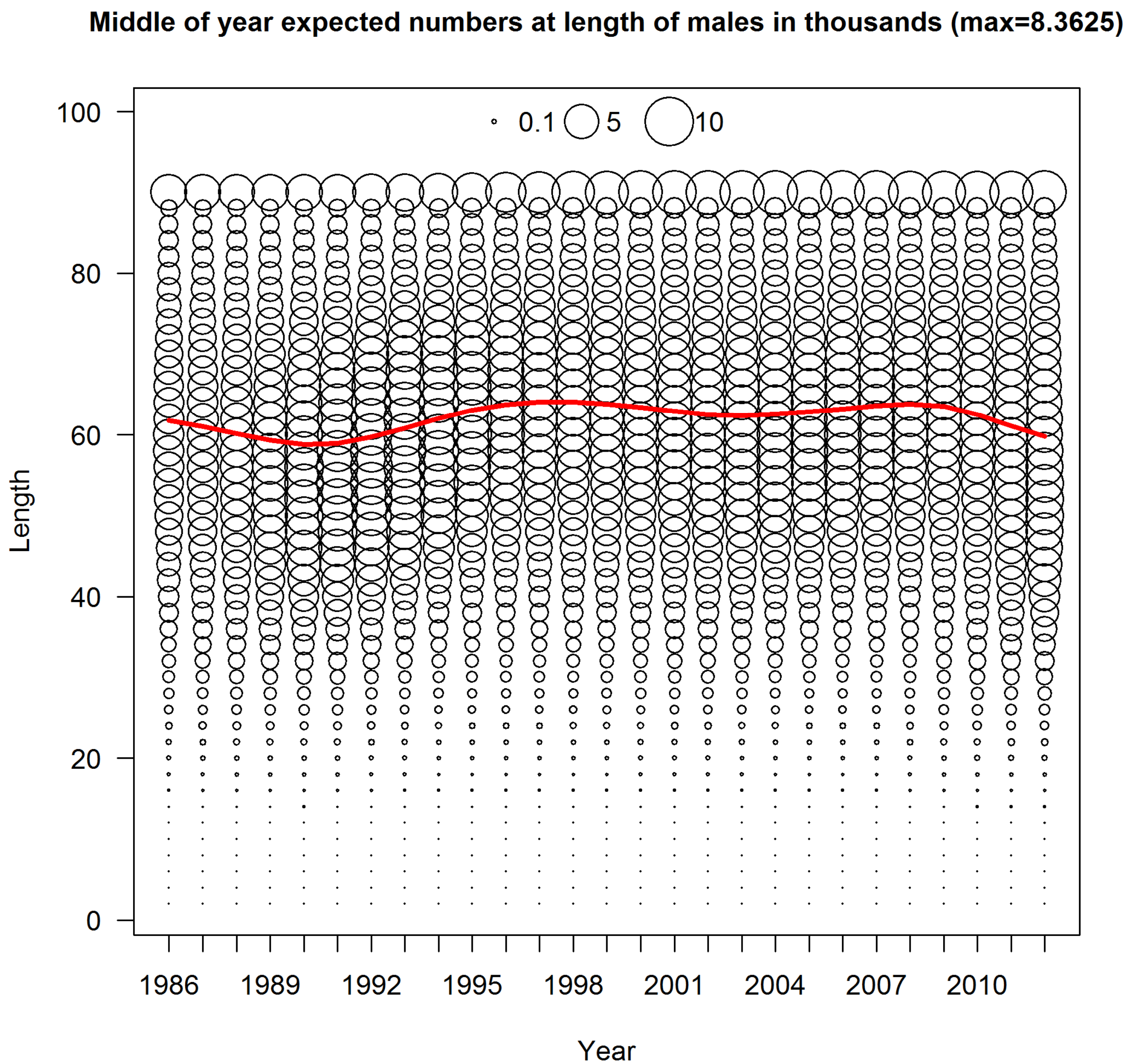


Figure 11.2.5.7. Predicted total biomass (mt) for the FLK/EFL stock base model configuration.

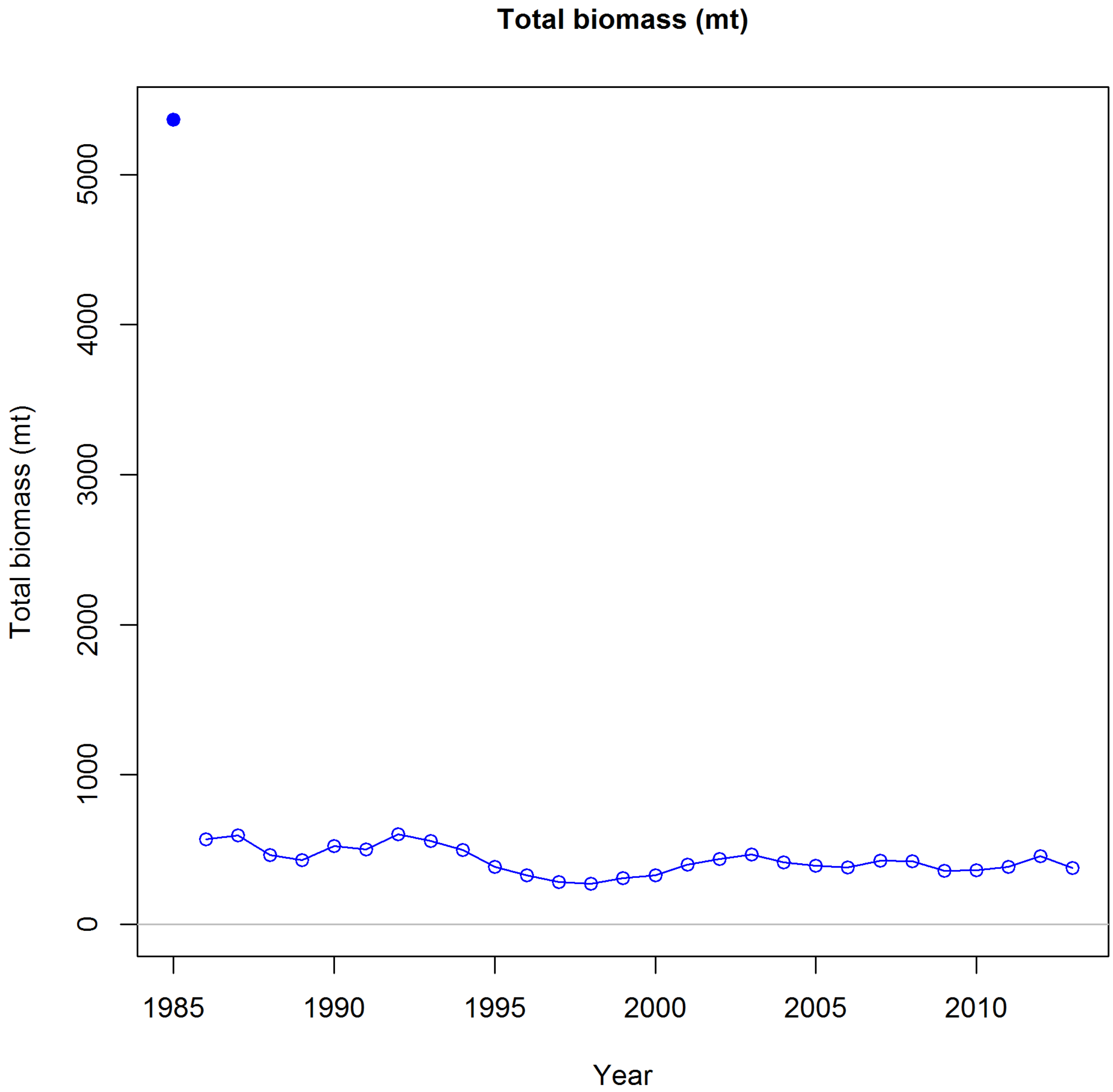


Figure 11.2.5.8. Predicted spawning biomass and associated 95% asymptotic error intervals for the FLK/EFL stock base model configuration.

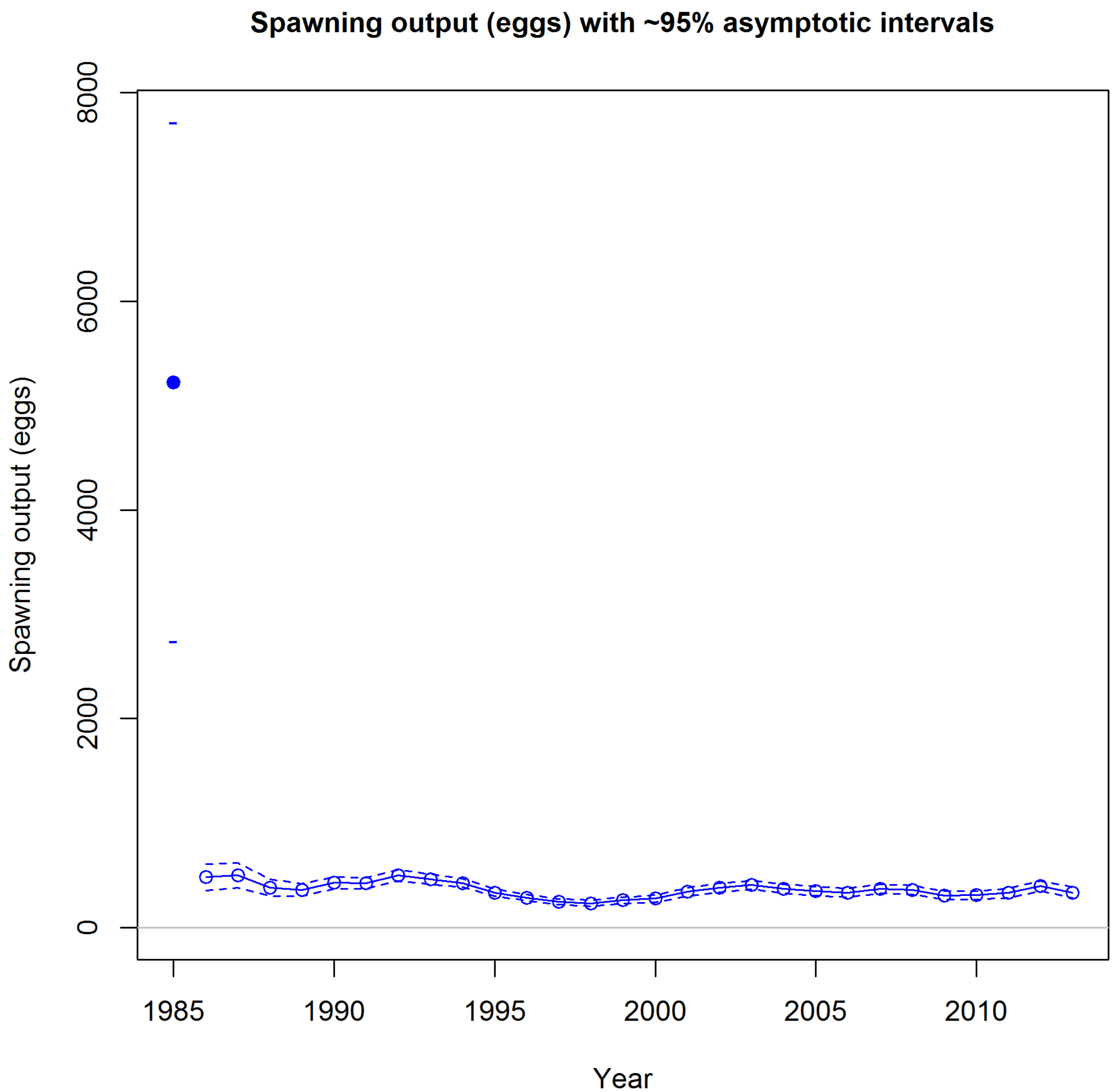


Figure 11.2.5.9. Predicted numbers-at-age (bubbles) and mean age (red line) of females for the FLK/EFL stock base model configuration.

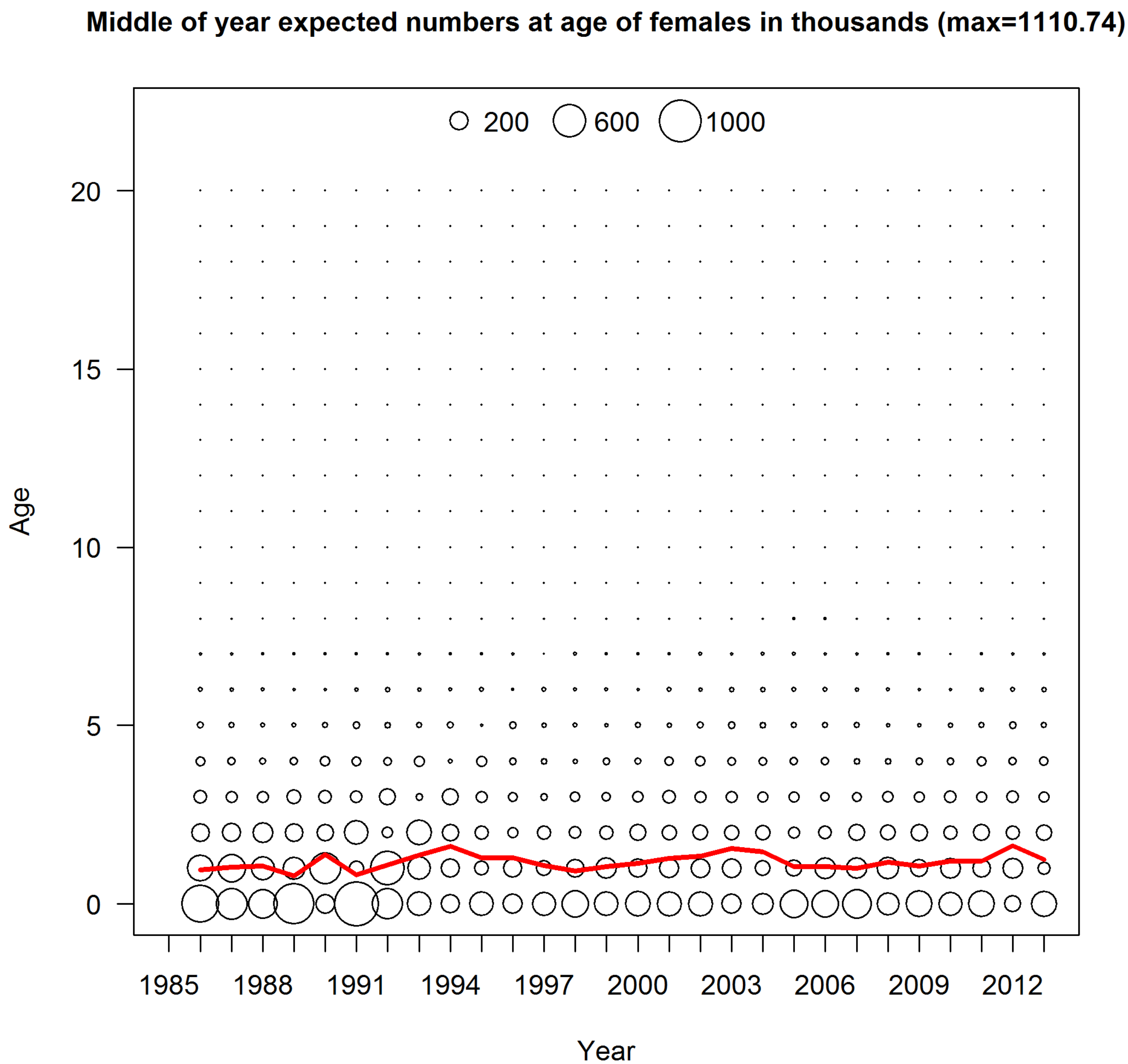


Figure 11.2.5.10. Predicted numbers-at-age (bubbles) and mean age (red line) of males for the FLK/EFL stock base model configuration.

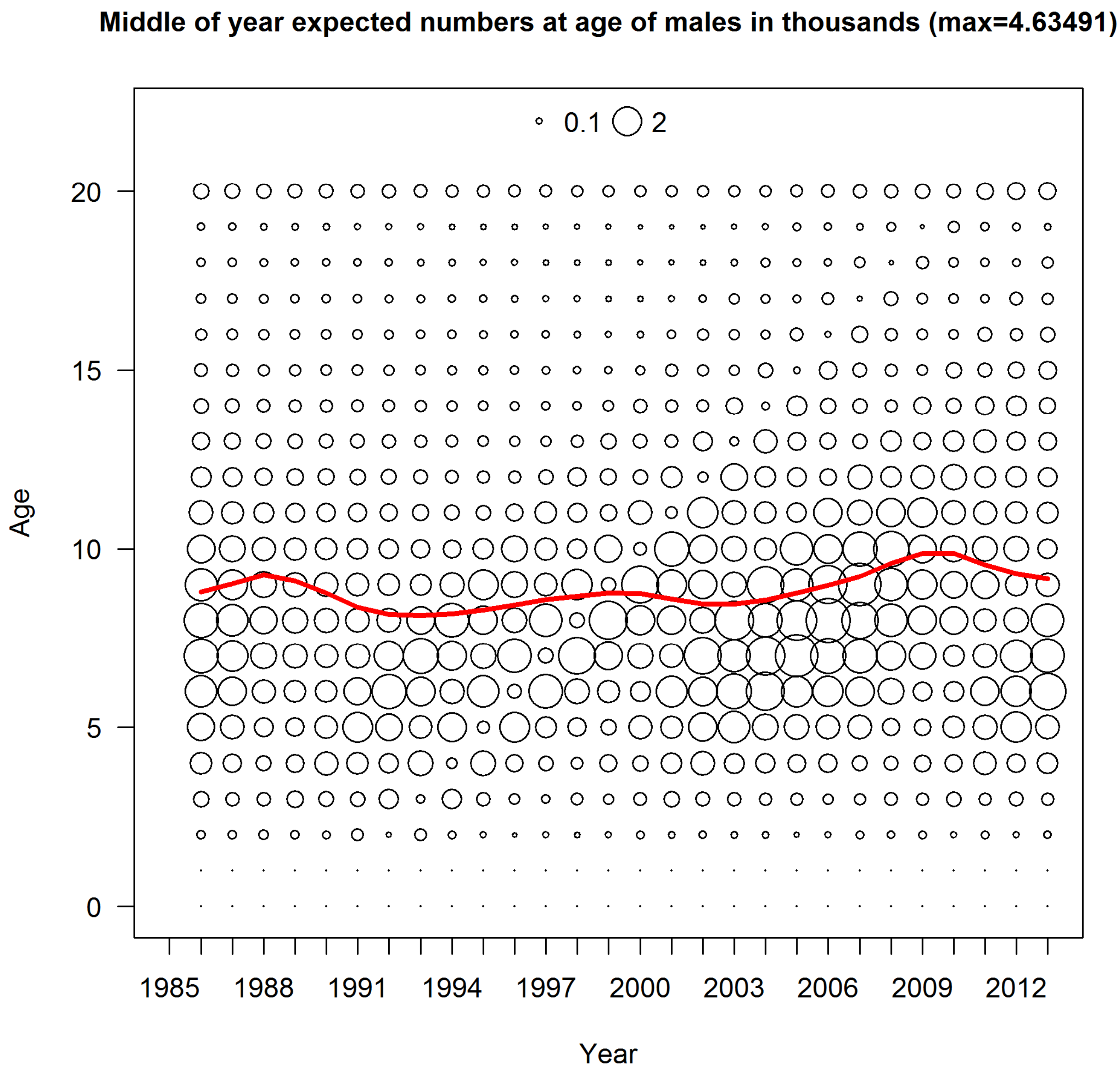


Figure 11.2.5.11. Predicted numbers-at-length (bubbles) and mean length (red line) of females for the FLK/EFL stock base model configuration.

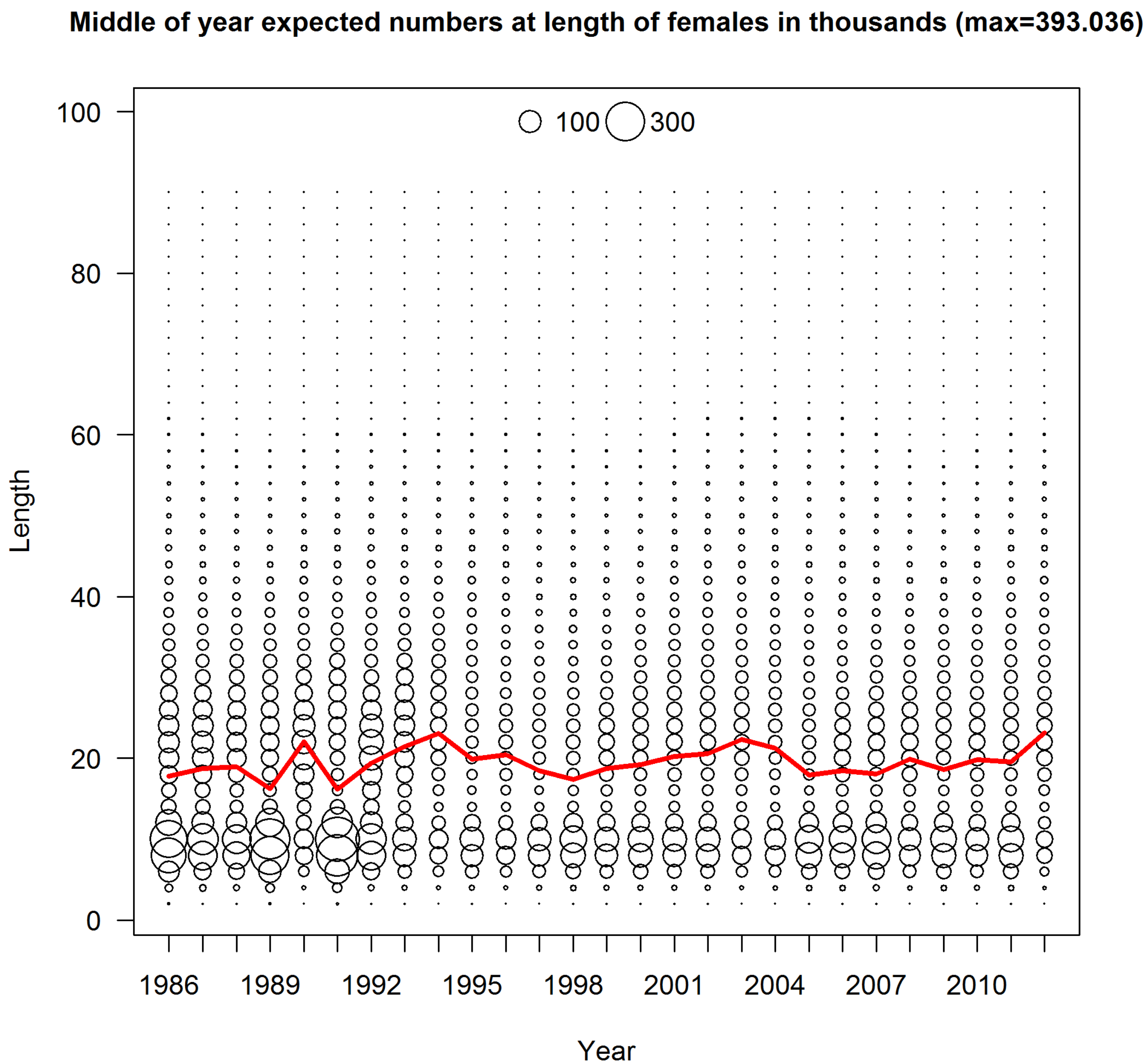


Figure 11.2.5.12. Predicted numbers-at-length (bubbles) and mean length (red line) of males for the FLK/EFL stock base model configuration.

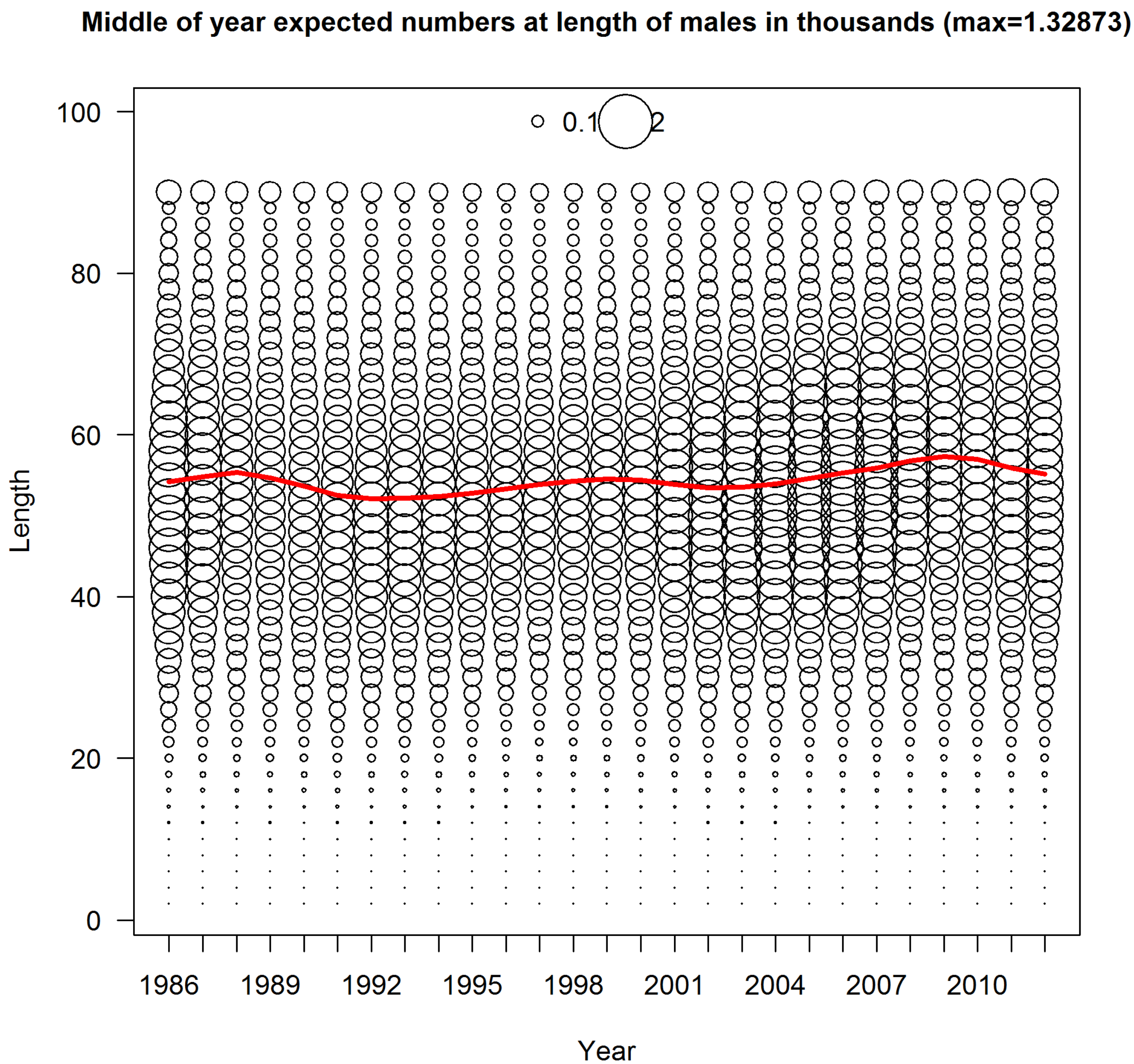


Figure 11.2.5.13. Predicted total biomass (mt) for the GA-NC stock base model configuration.

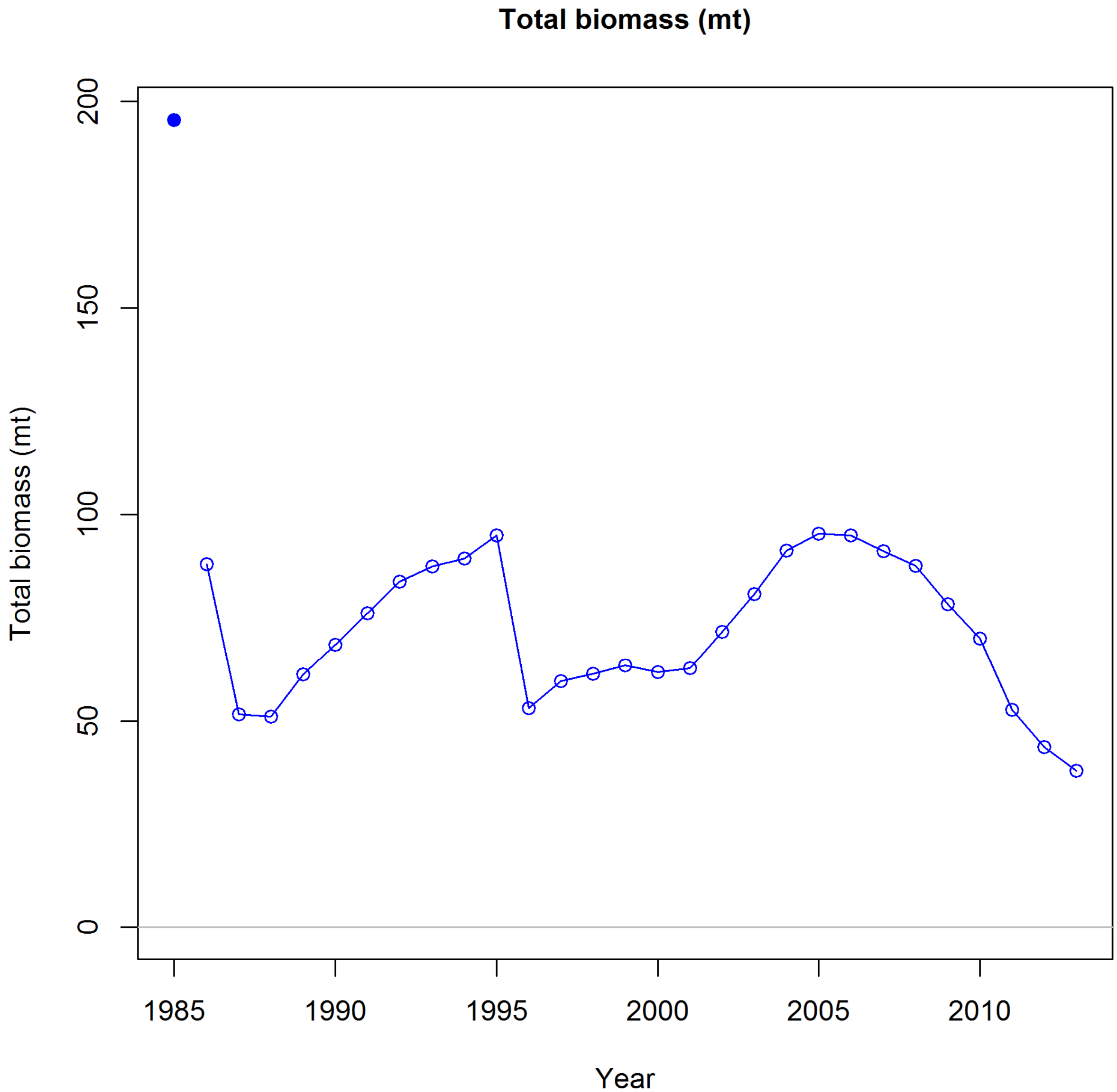


Figure 11.2.5.14. Predicted spawning biomass and associated 95% asymptotic error intervals the GA-NC stock base model configuration.

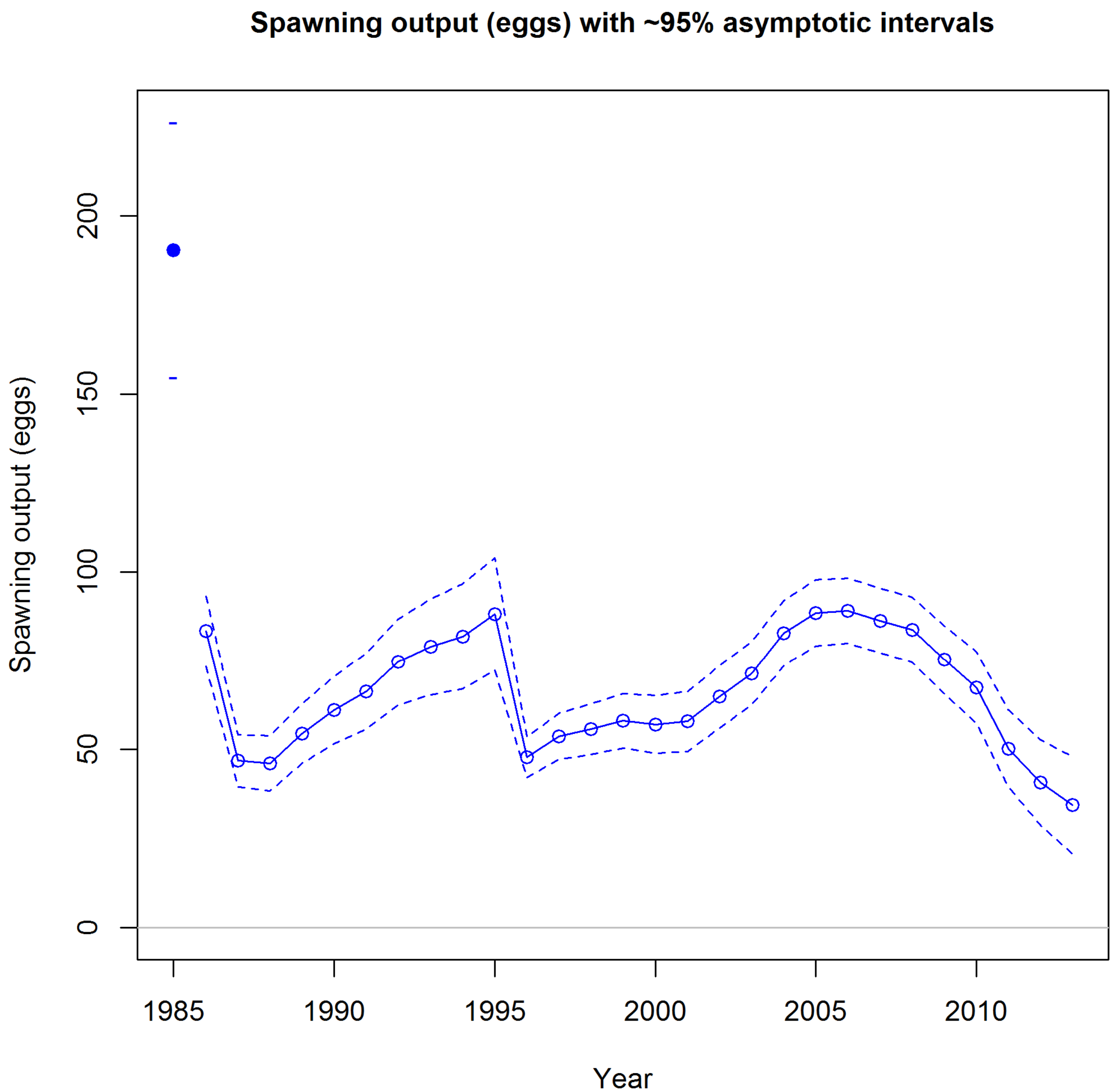


Figure 11.2.5.15. Predicted numbers-at-age (bubbles) and mean age (red line) of females for the GA-NC stock base model configuration.

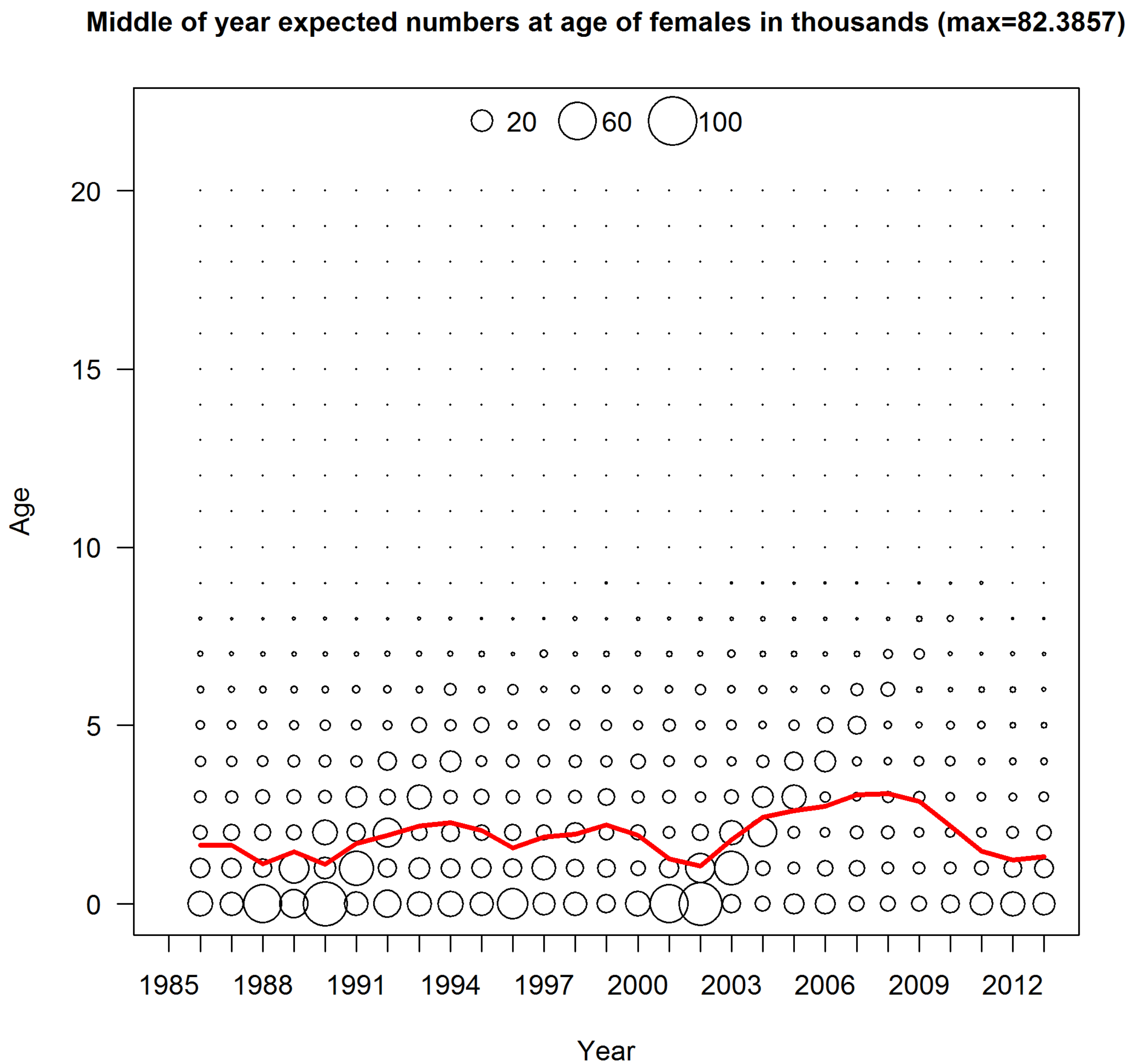


Figure 11.2.5.16. Predicted numbers-at-age (bubbles) and mean age (red line) of males for the GA-NC stock base model configuration.

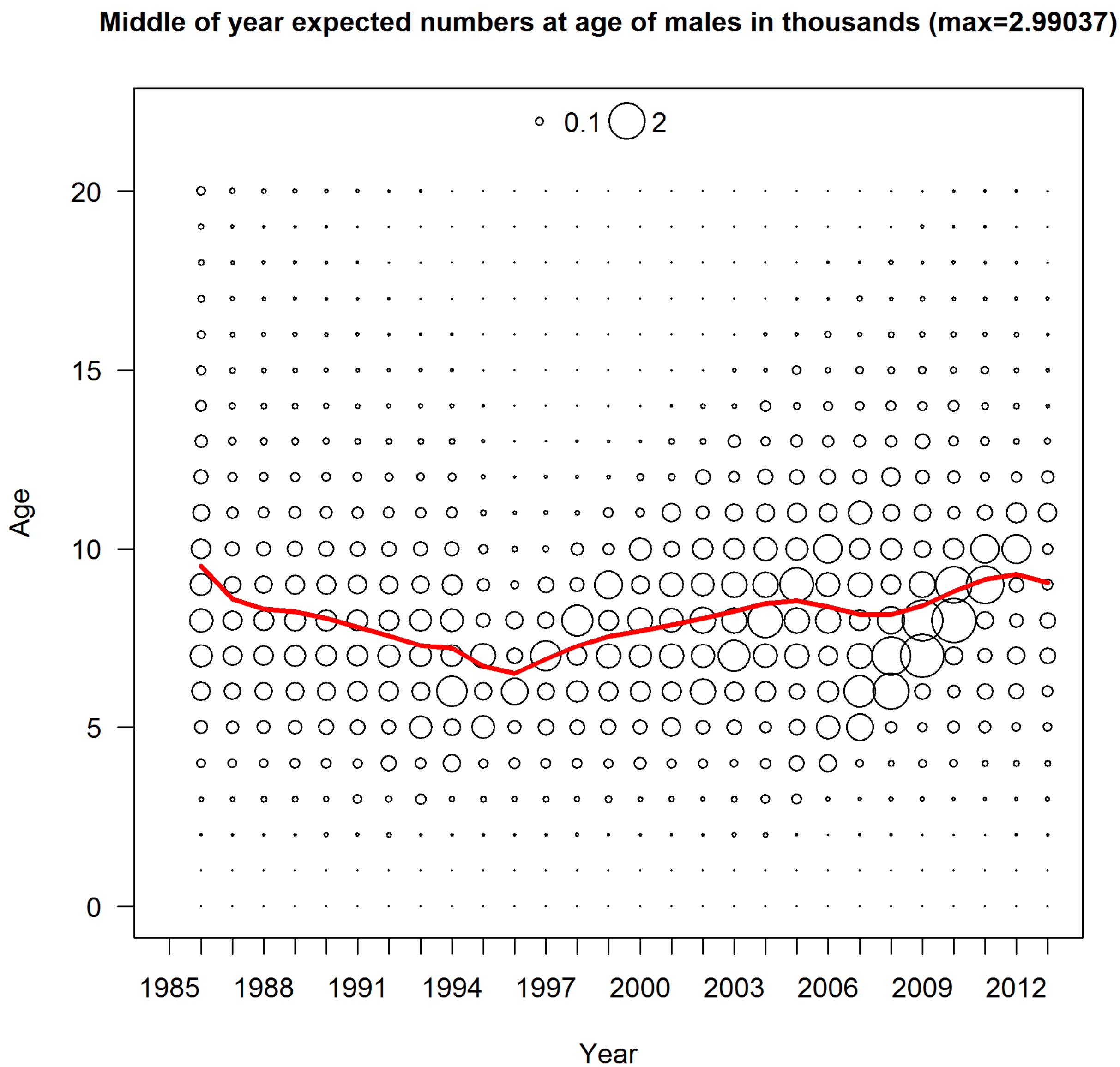


Figure 11.2.5.17. Predicted numbers-at-length (bubbles) and mean length (red line) of females for the GA-NC stock base model configuration.

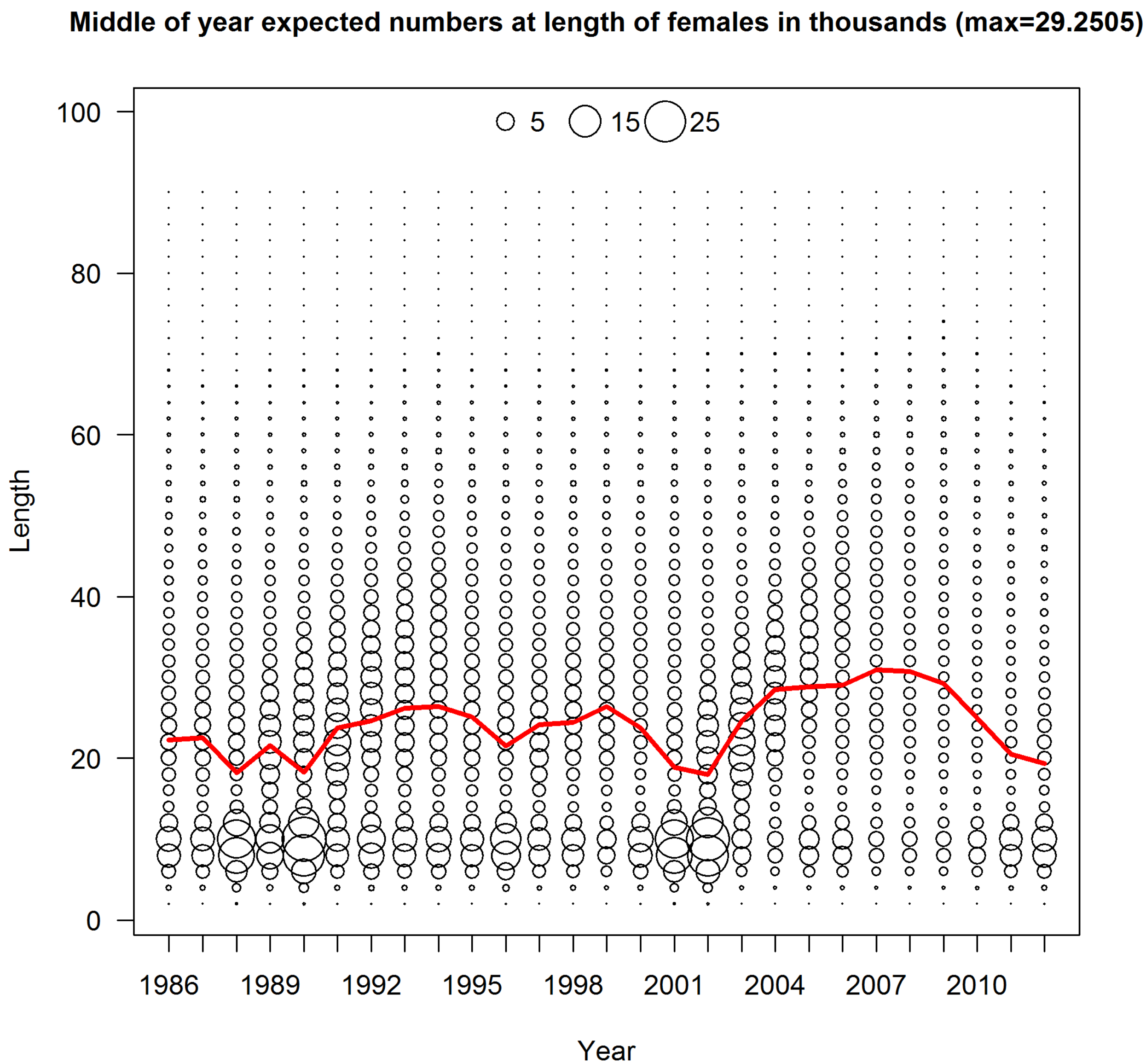


Figure 11.2.5.18. Predicted numbers-at-length (bubbles) and mean length (red line) of males for the GA-NC stock base model configuration.

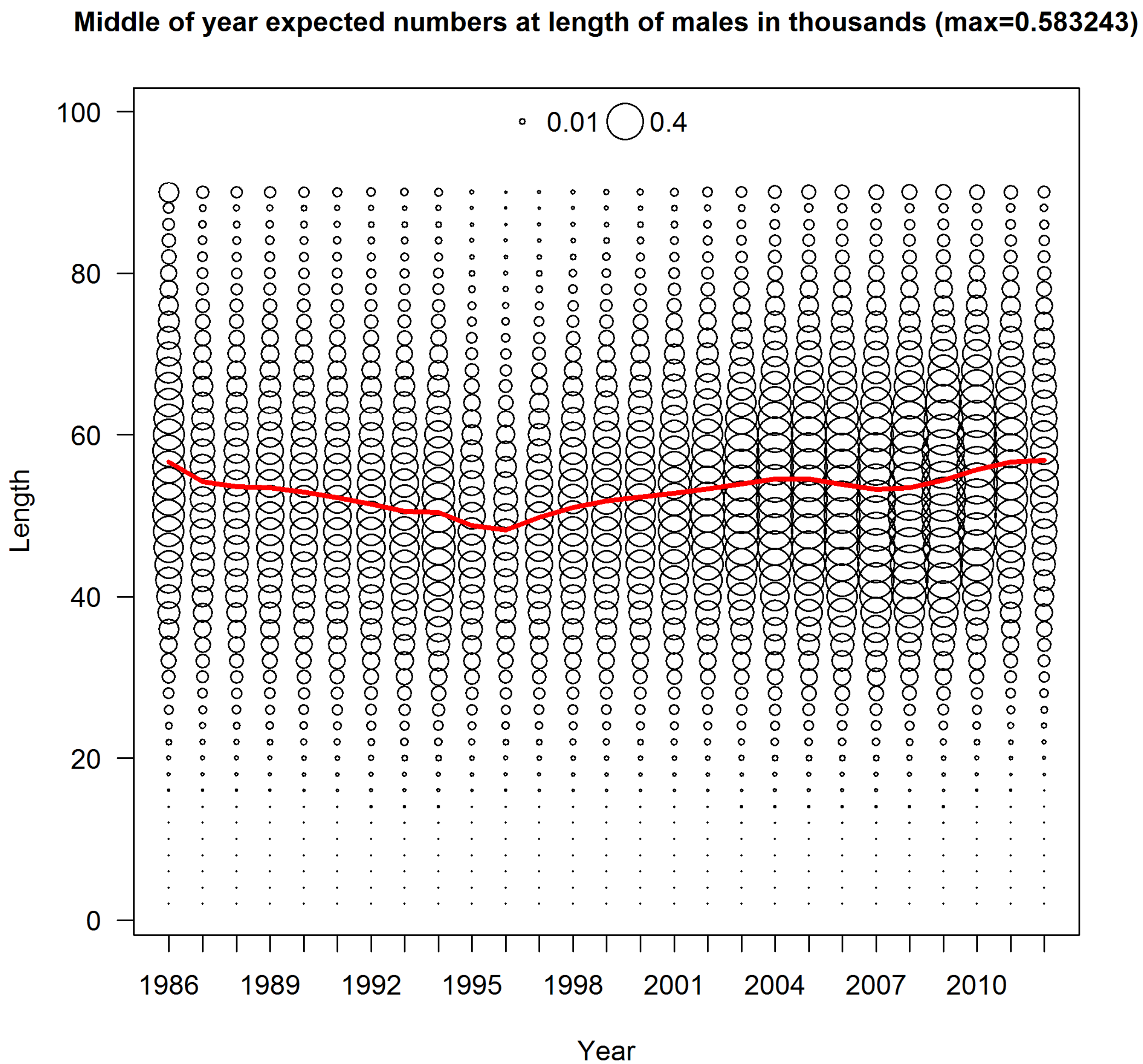


Figure 11.2.6.1. Predicted annual exploitation rate, calculated as the ratio of the total annual catch in biomass to the summary biomass at the beginning of the year, for the WFL model base configuration.

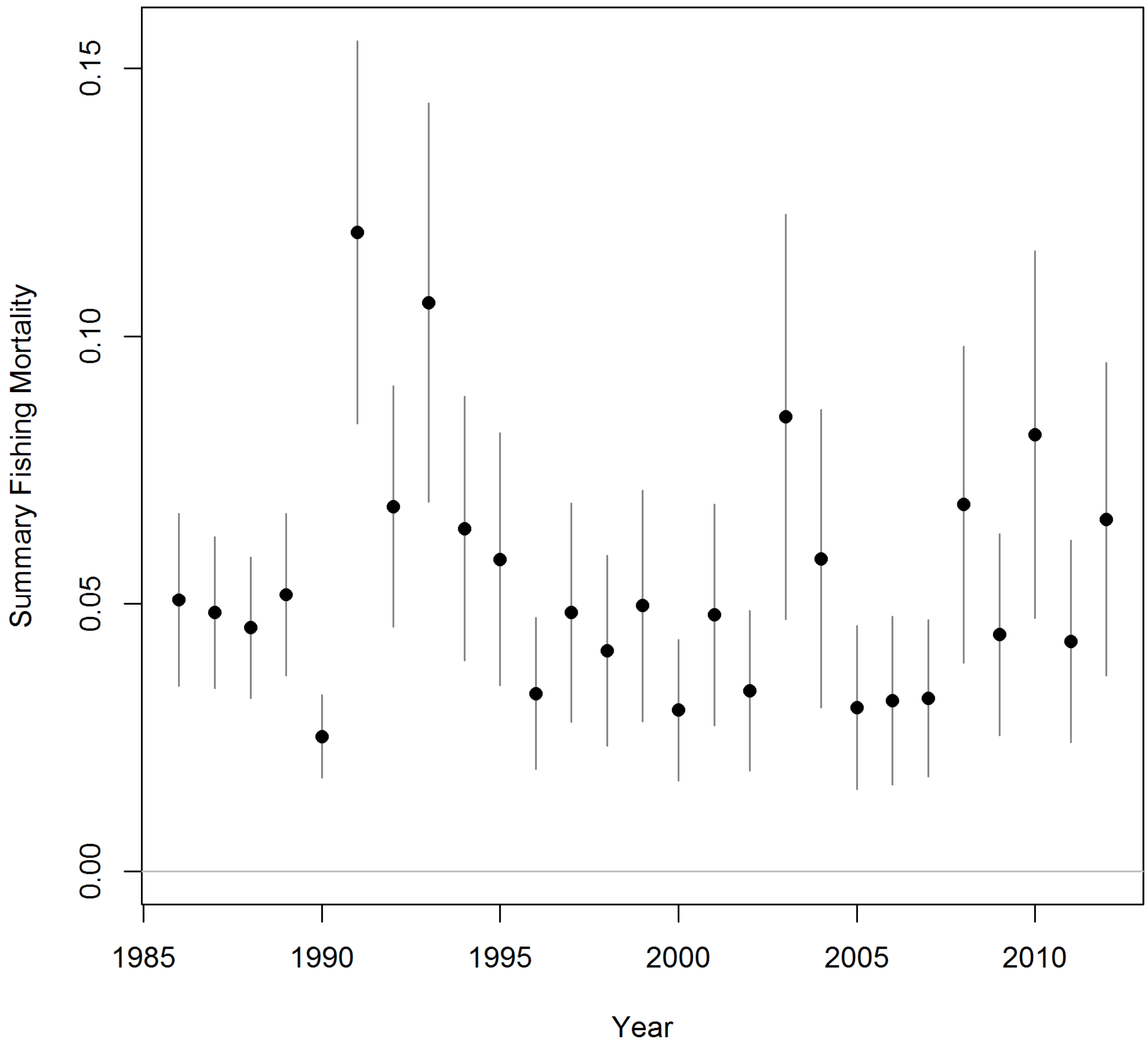


Figure 11.2.6.2. Predicted fleet specific continuous F rates for the WFL model base configuration.

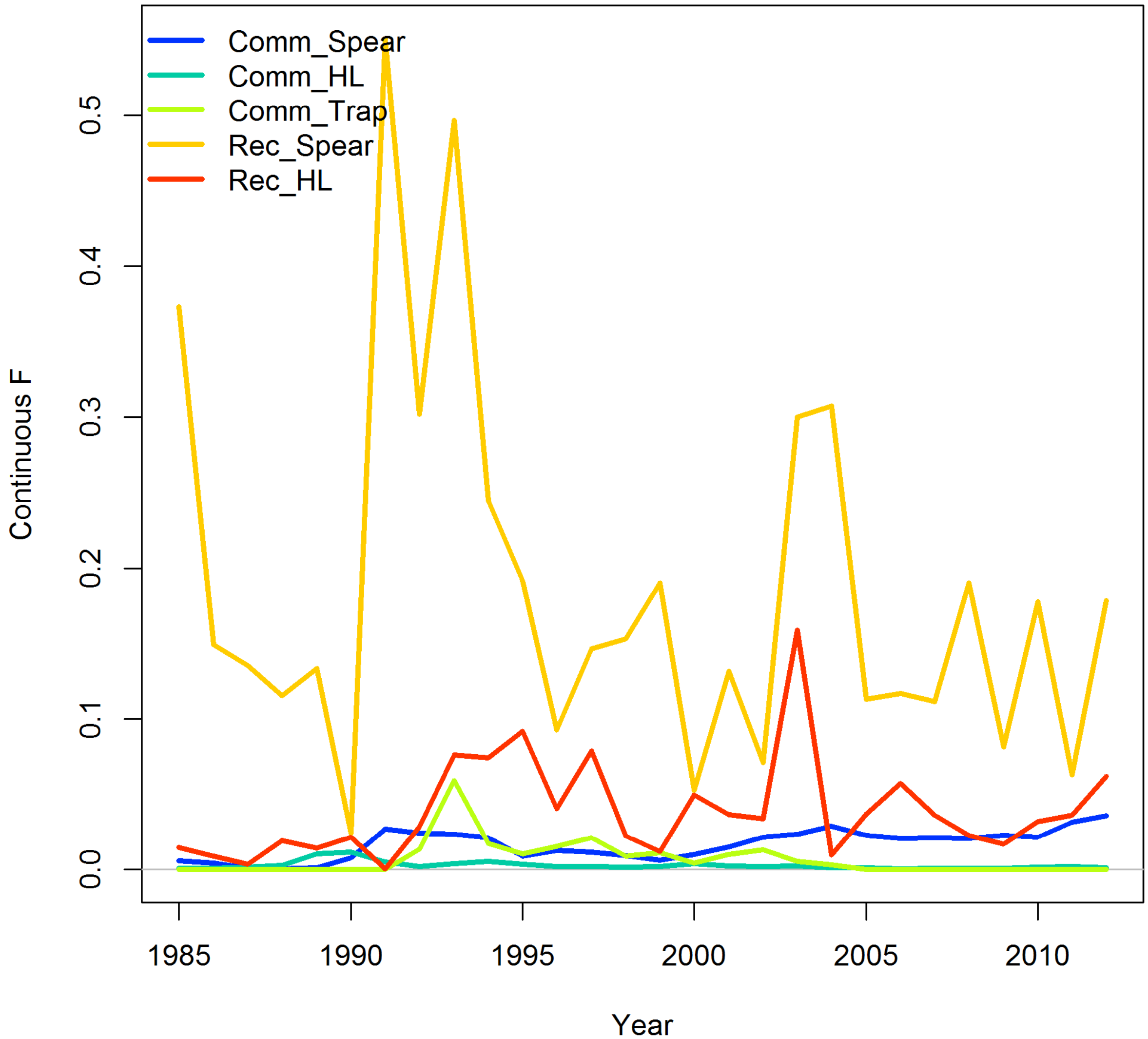


Figure 11.2.6.3. Predicted annual exploitation rate, calculated as the ratio of the total annual catch in biomass to the summary biomass at the beginning of the year, for the FLK/EFL model base configuration.

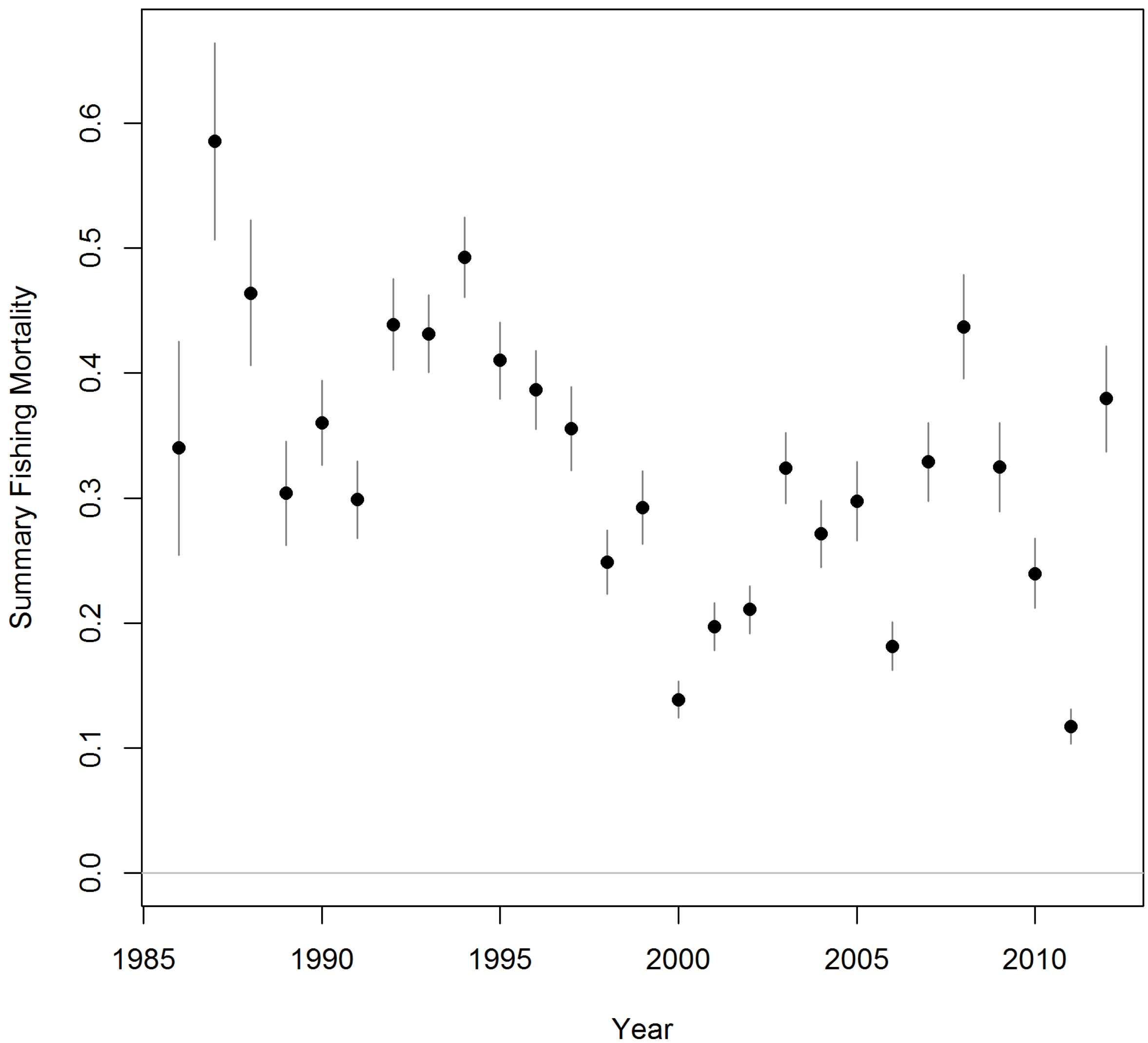


Figure 11.2.6.4. Predicted fleet specific continuous F rates for the FLK/EFL model base configuration.

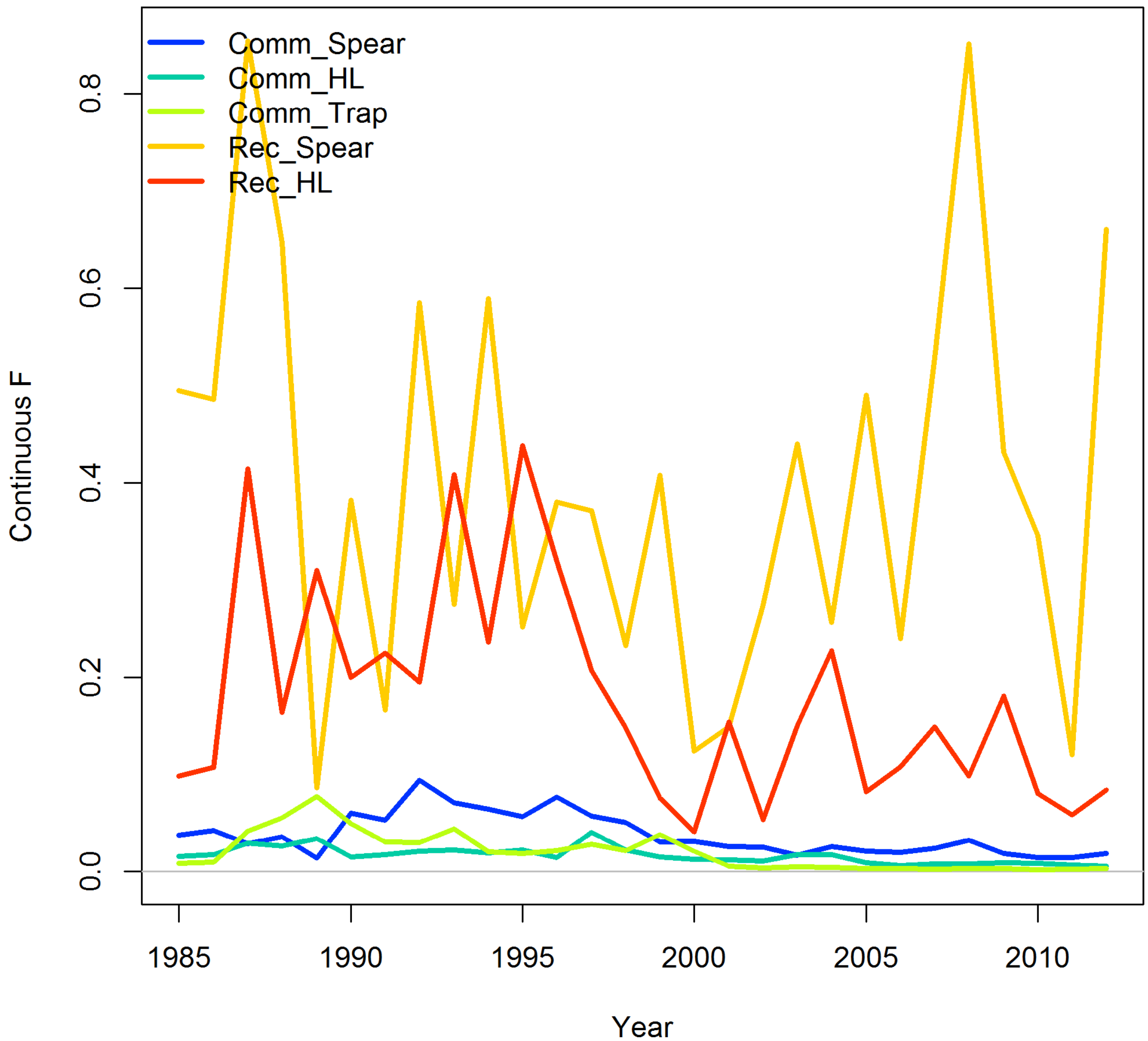


Figure 11.2.6.5. Predicted annual exploitation rate, calculated as the ratio of the total annual catch in biomass to the summary biomass at the beginning of the year, for the GA-NC model base configuration.

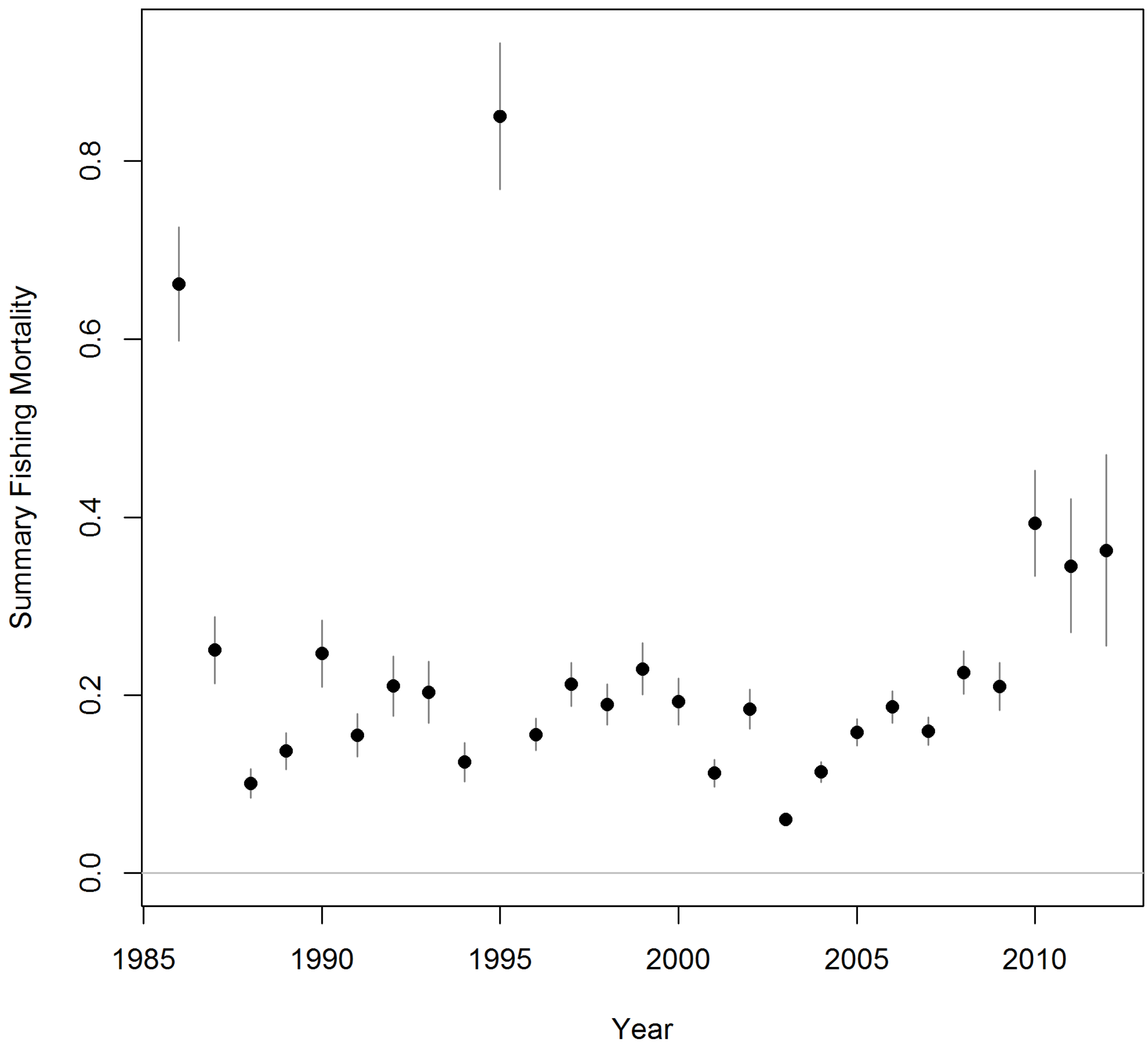


Figure 11.2.6.6. Predicted fleet specific continuous F rates for the GA-NC model base configuration.

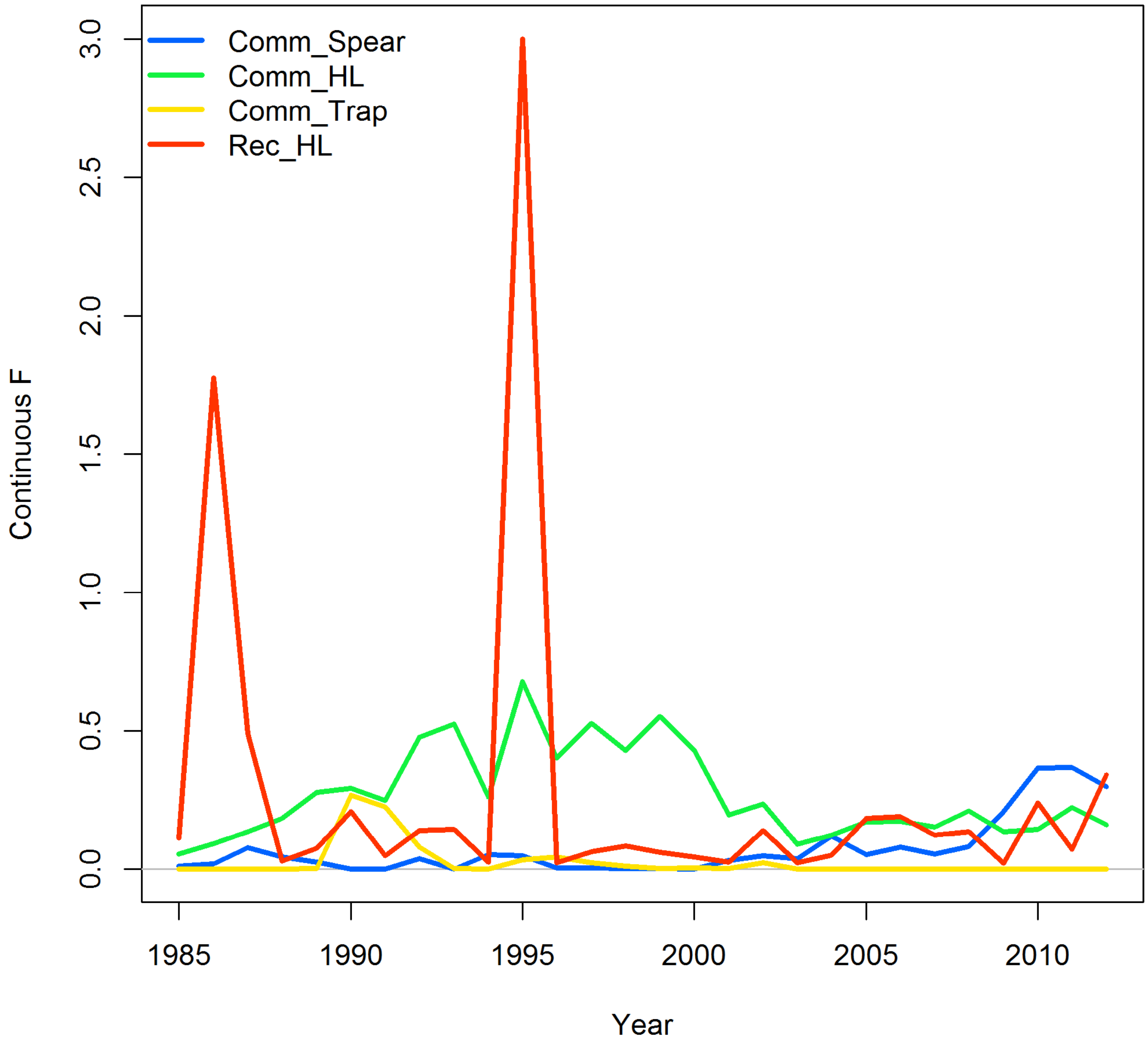


Figure 11.2.7.1.1. Density plots for derived quantities and stock-recruit parameters from the bootstrap analysis to test for model uncertainty in the base model of the WFL stock. SPR is the terminal year spawning potential ratio. Only F30% is presented here for reference to MSY, but terminal F35% and F40% were analyzed and presented in corresponding tables.

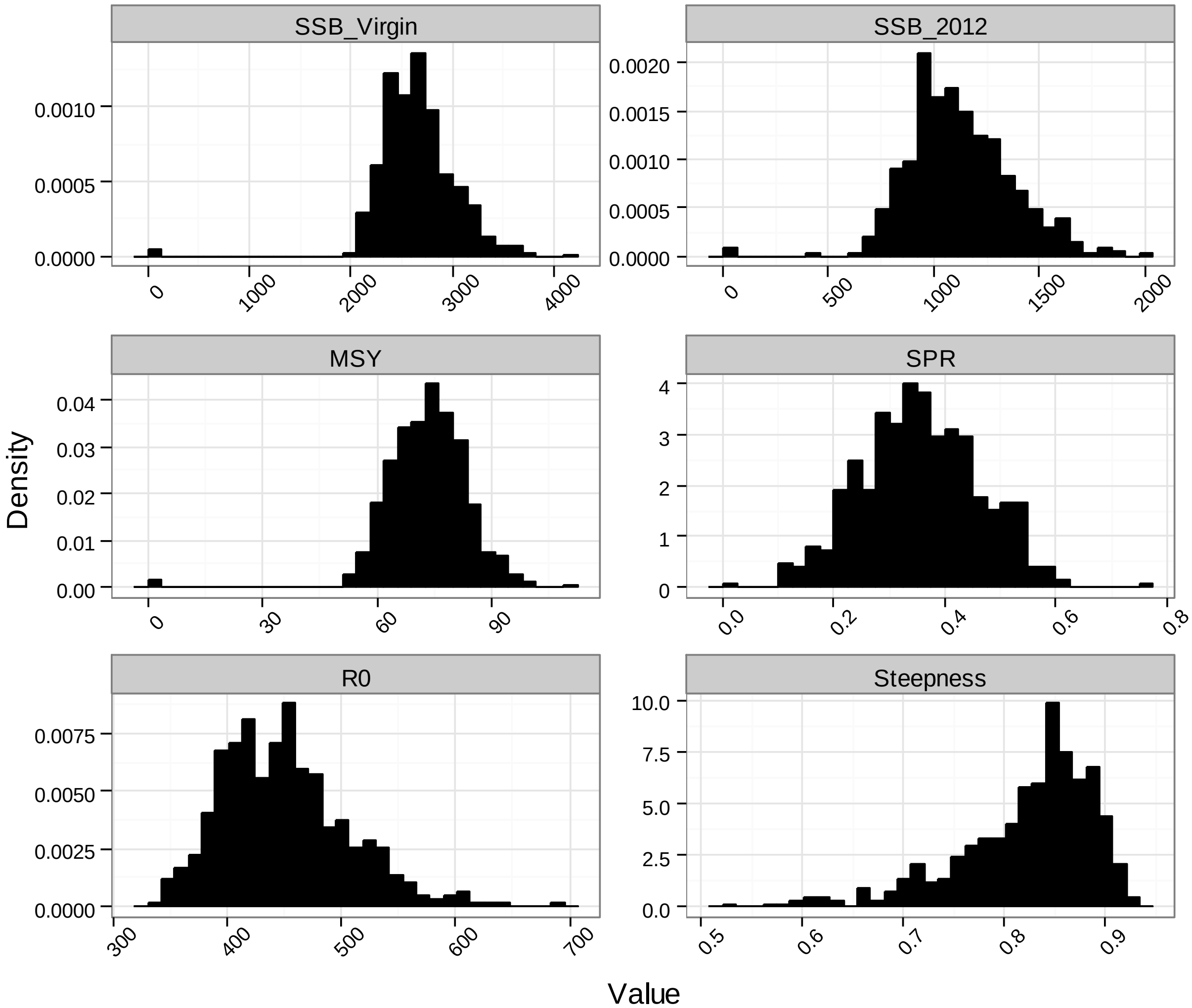


Figure 11.2.7.1.2. Density plots for biological reference points from the bootstrap analysis to test for model uncertainty in the base model of the WFL stock. Four alternatives are presented for maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

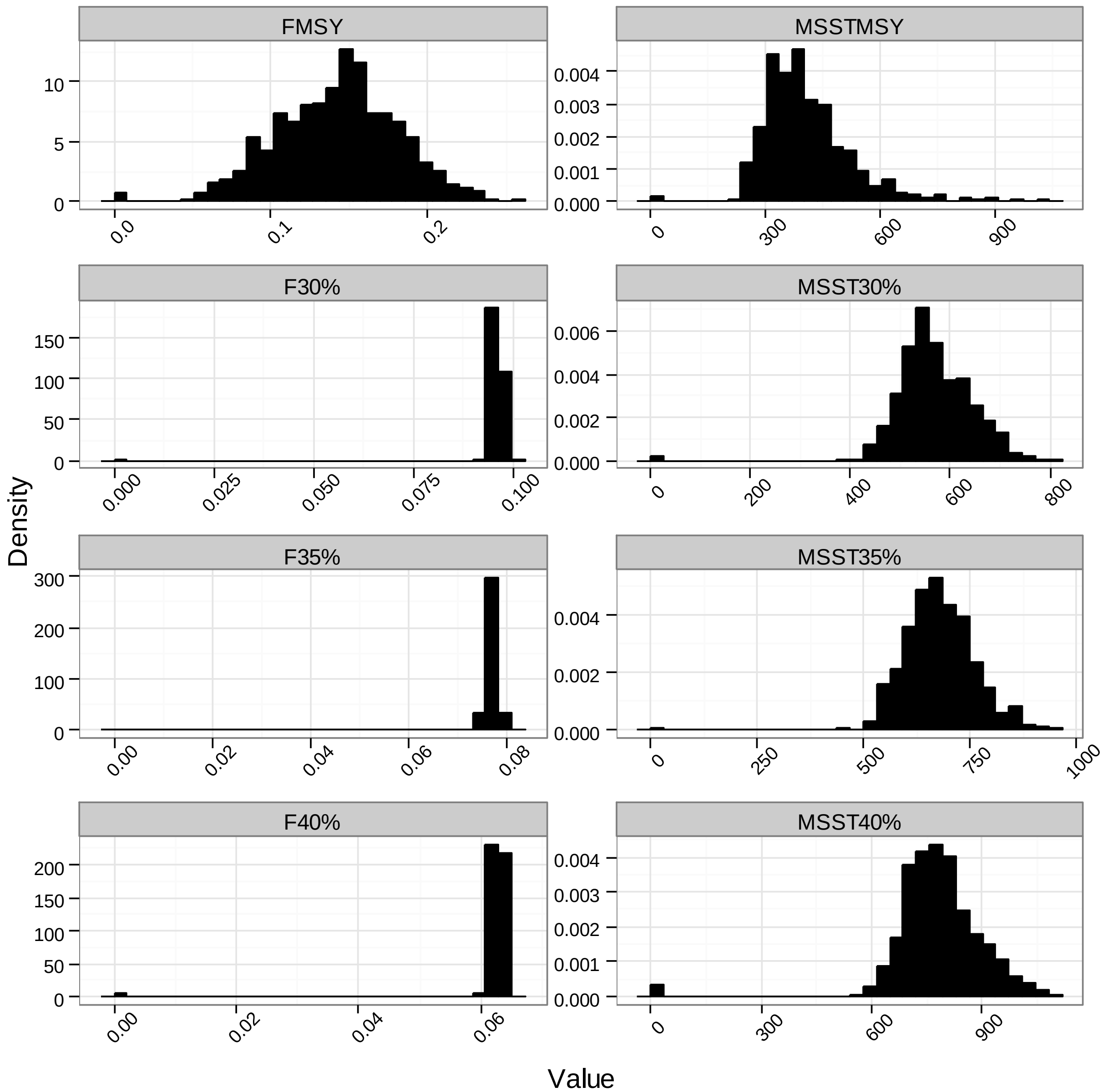


Figure 11.2.7.1.3. Density plots for stock status from the bootstrap analysis to test for model uncertainty in the base model of the WFL stock. Four alternatives are presented with maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) relative to the geometric mean of the most recent three years (2010-2012), and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

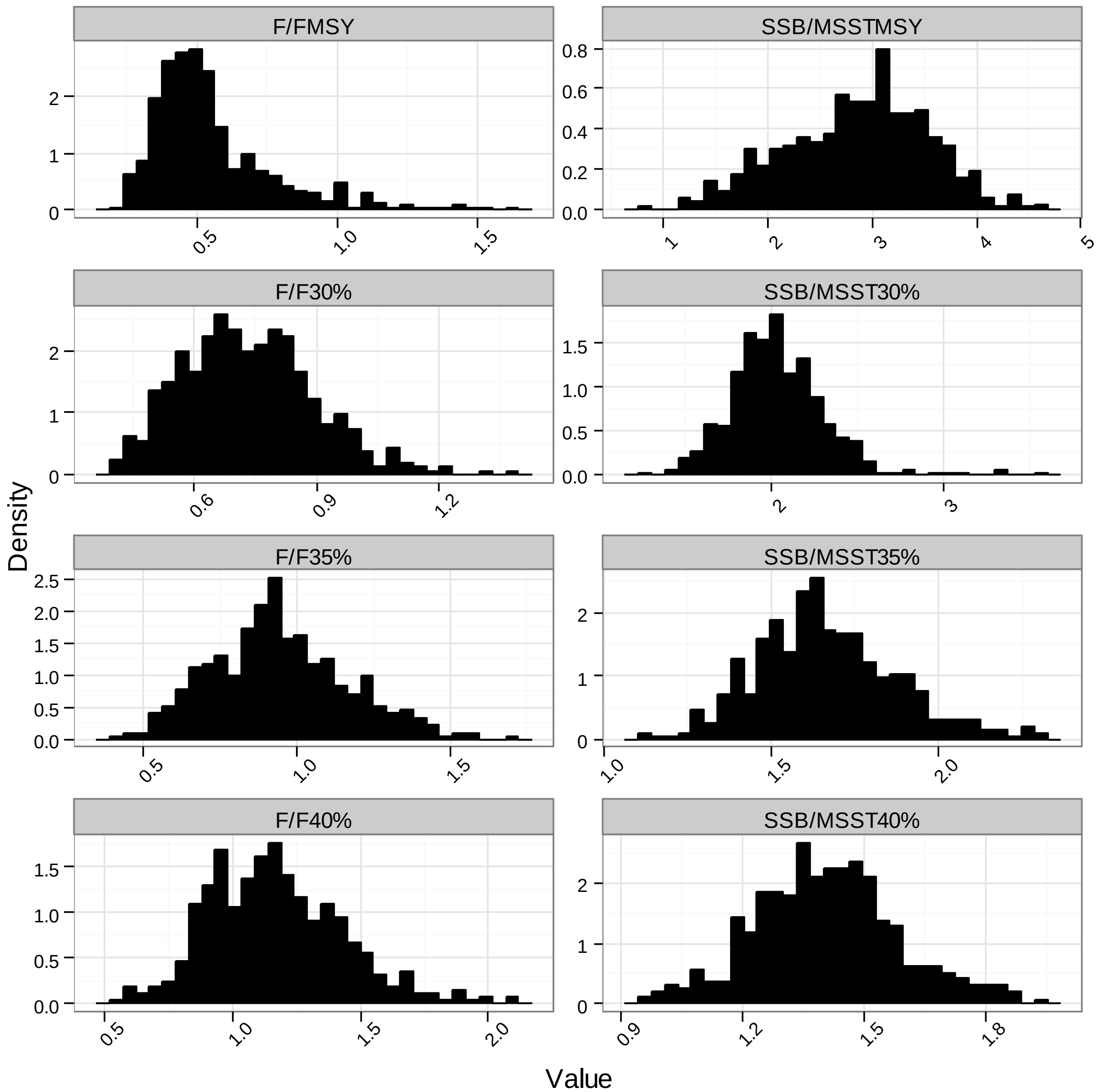


Figure 11.2.7.1.4. Time-series of derived quantities for the WFL stock for both the base model run (solid darker lines) and the 500 bootstrap iterations (lighter gray lines). SPR references levels of 30%, 35%, and 40% are presented on the SPR plot.

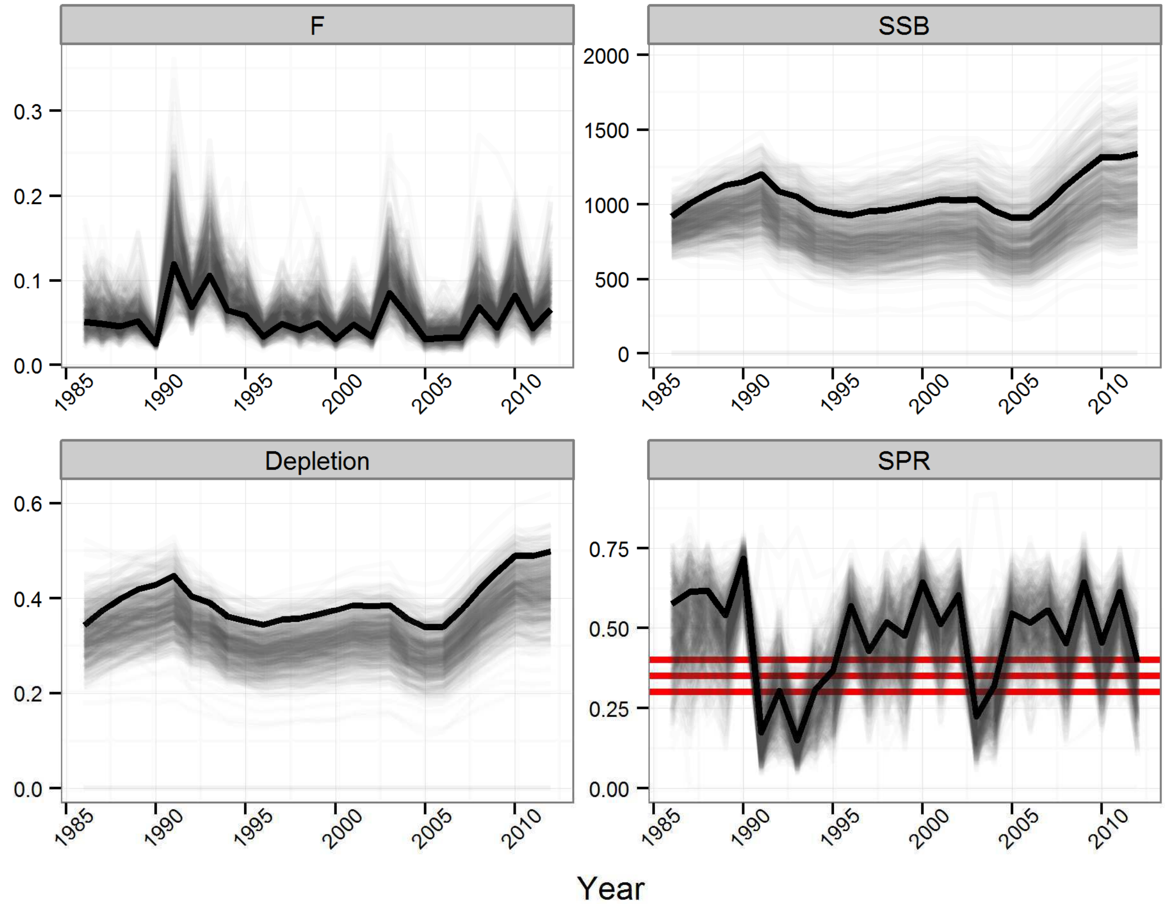


Figure 11.2.7.1.5. Time-series of stock status time series for the WFL stock for the 500 bootstrap iterations (lighter gray lines) and the base model configuration (solid darker lines).

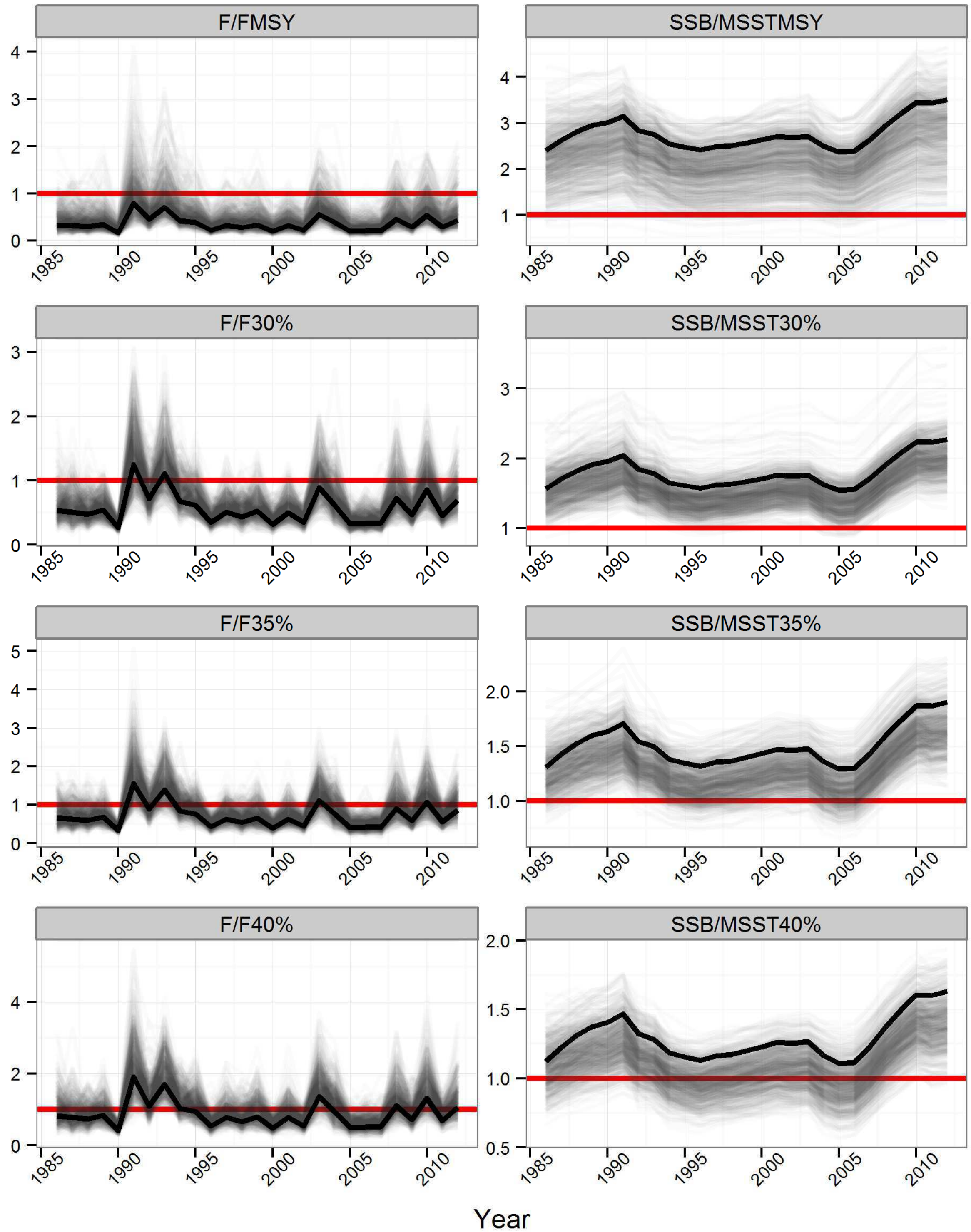


Figure 11.2.7.1.6. Density plots for derived quantities and stock-recruit parameters from the bootstrap analysis to test for model uncertainty in the base model of the FLK-EFL stock. SPB is the spawning biomass (SSB) and SPR is the terminal year spawning potential ratio. Only F30% is presented here for reference to MSY, but F35% and F40% were analyzed and presented in corresponding tables.

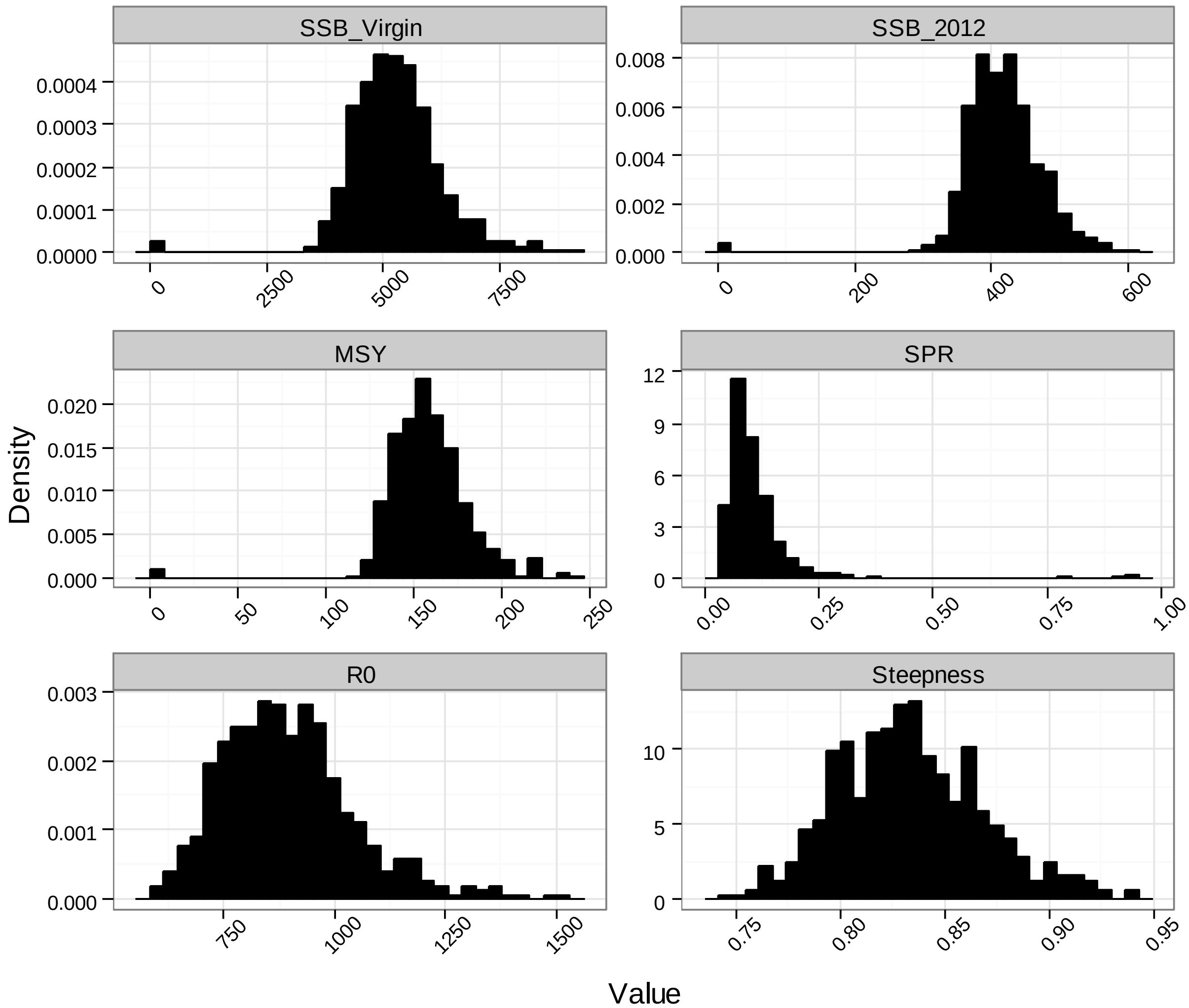


Figure 11.2.7.1.7. Density plots for biological reference points from the bootstrap analysis to test for model uncertainty in the base model of the FLK-EFL stock. Four alternatives are presented for maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

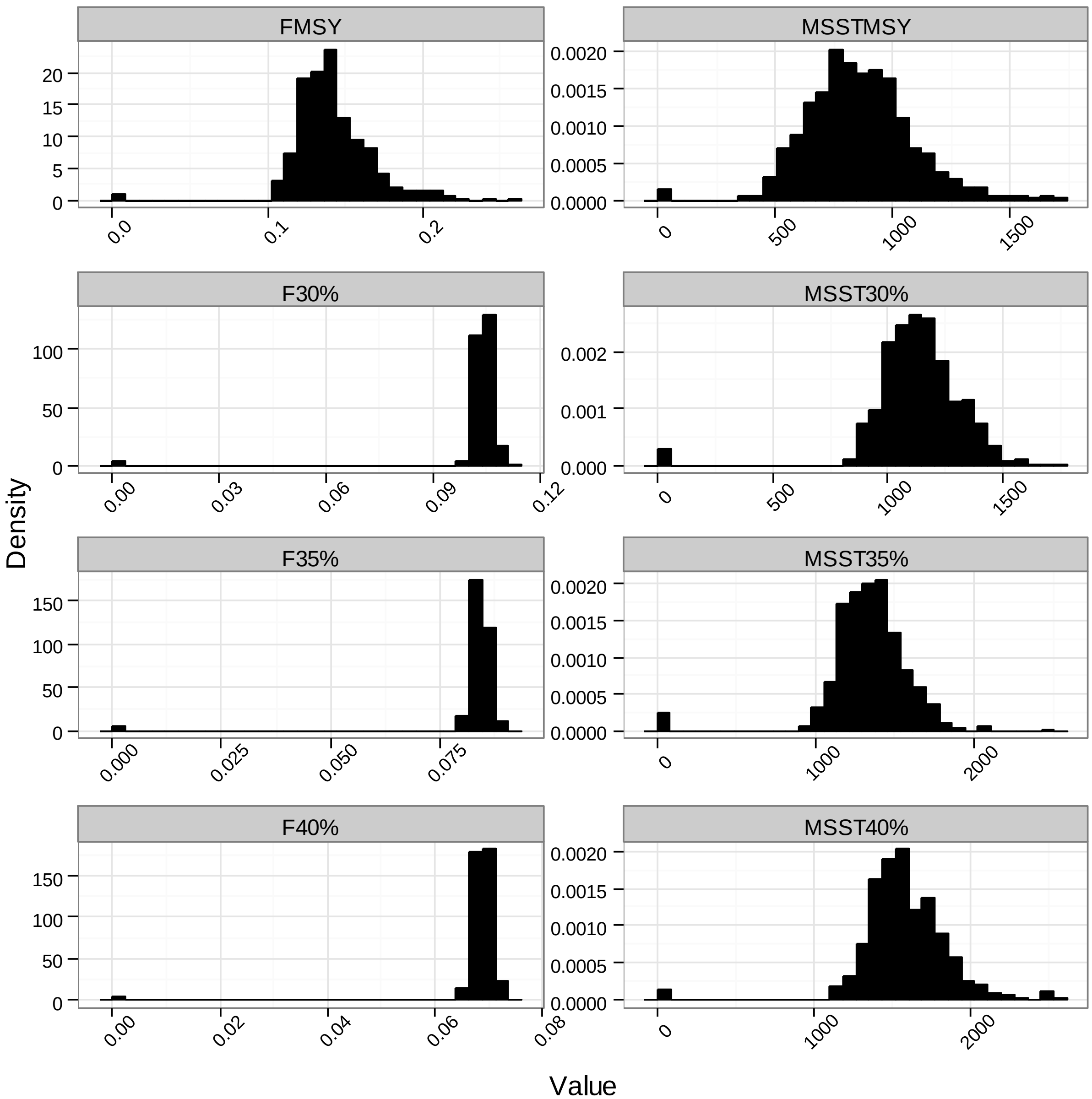


Figure 11.2.7.1.8. Density plots for stock status from the bootstrap analysis to test for model uncertainty in the base model of the FLK-EFL stock. Four alternatives are presented with maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) relative to the geometric mean of the most recent three years (2010-2012), and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

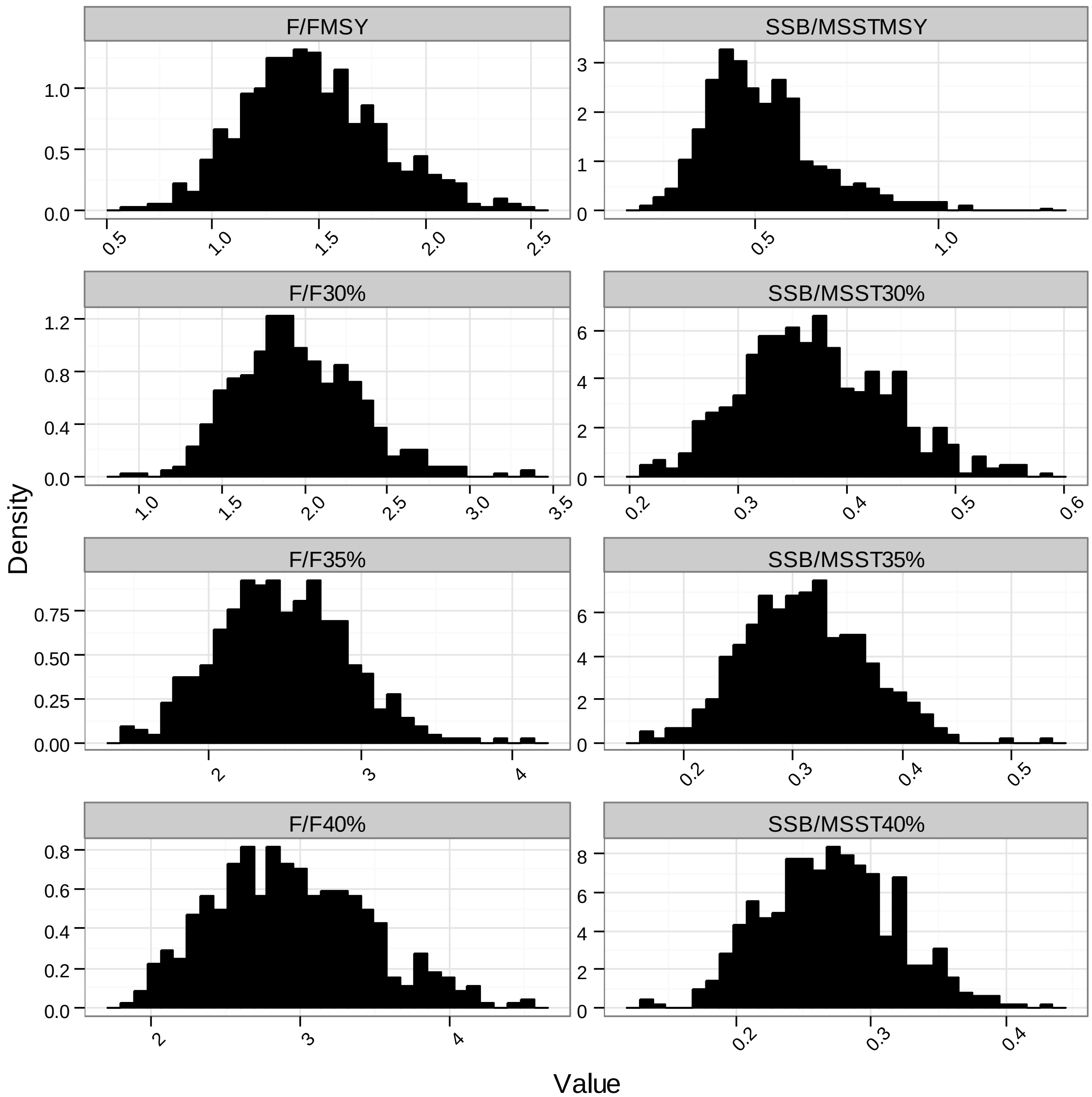


Figure 11.2.7.1.9. Time-series of derived quantities for the FLK-EFL stock for both the base model run (solid darker lines) and the 500 bootstrap iterations (lighter gray lines). SPR references levels of 30%, 35%, and 40% are presented on the SPR plot.

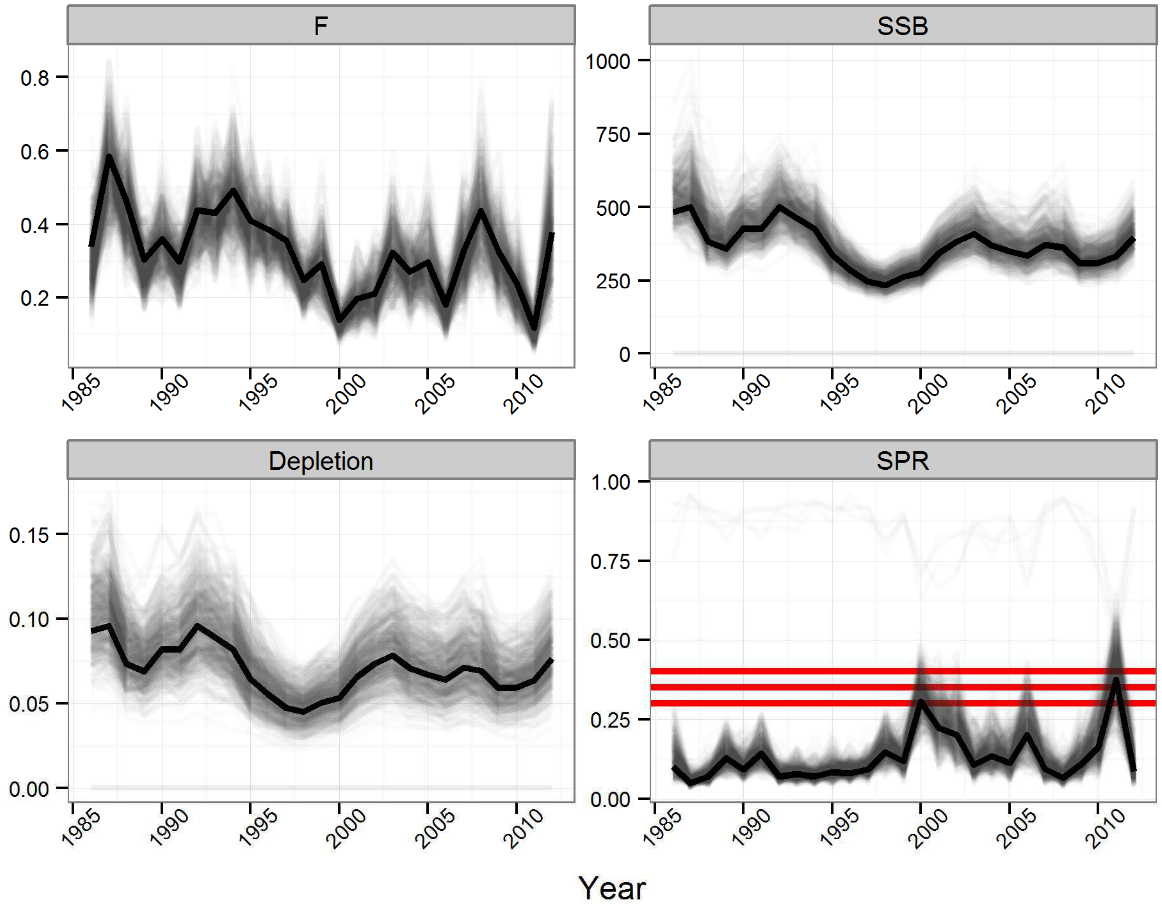


Figure 11.2.7.1.10. Time-series of stock status time series for the FLK-EFL stock for the 500 bootstrap iterations (lighter gray lines) and the base model configuration (solid darker lines).

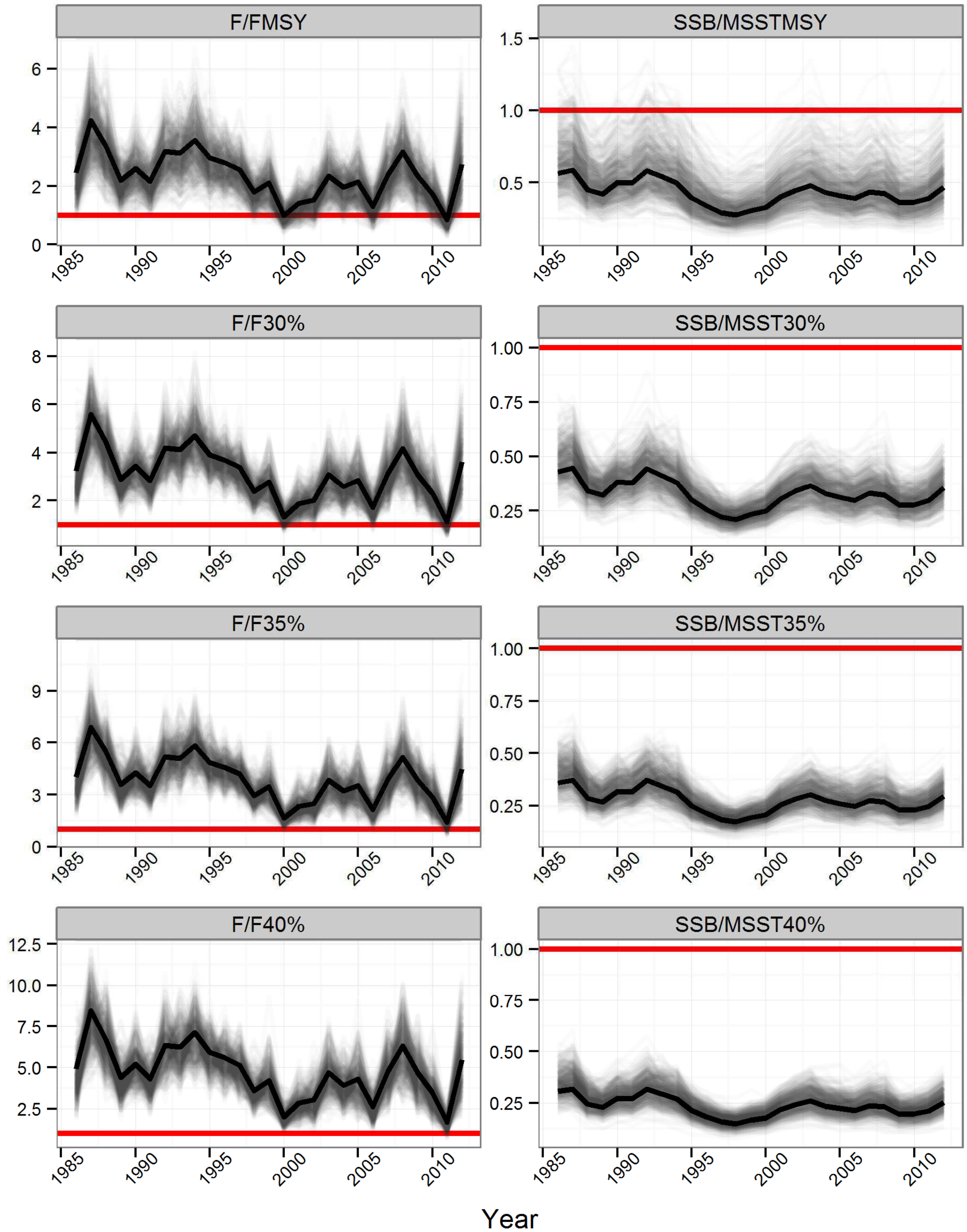


Figure 11.2.7.1.11. Density plots for derived quantities and stock-recruit parameters from the bootstrap analysis to test for model uncertainty in the base model of the GA-NC stock. SPB is the spawning biomass (SSB) and SPR is the terminal year spawning potential ratio. Only F30% is presented here for reference to MSY, but F35% and F40% were analyzed and presented in corresponding tables.

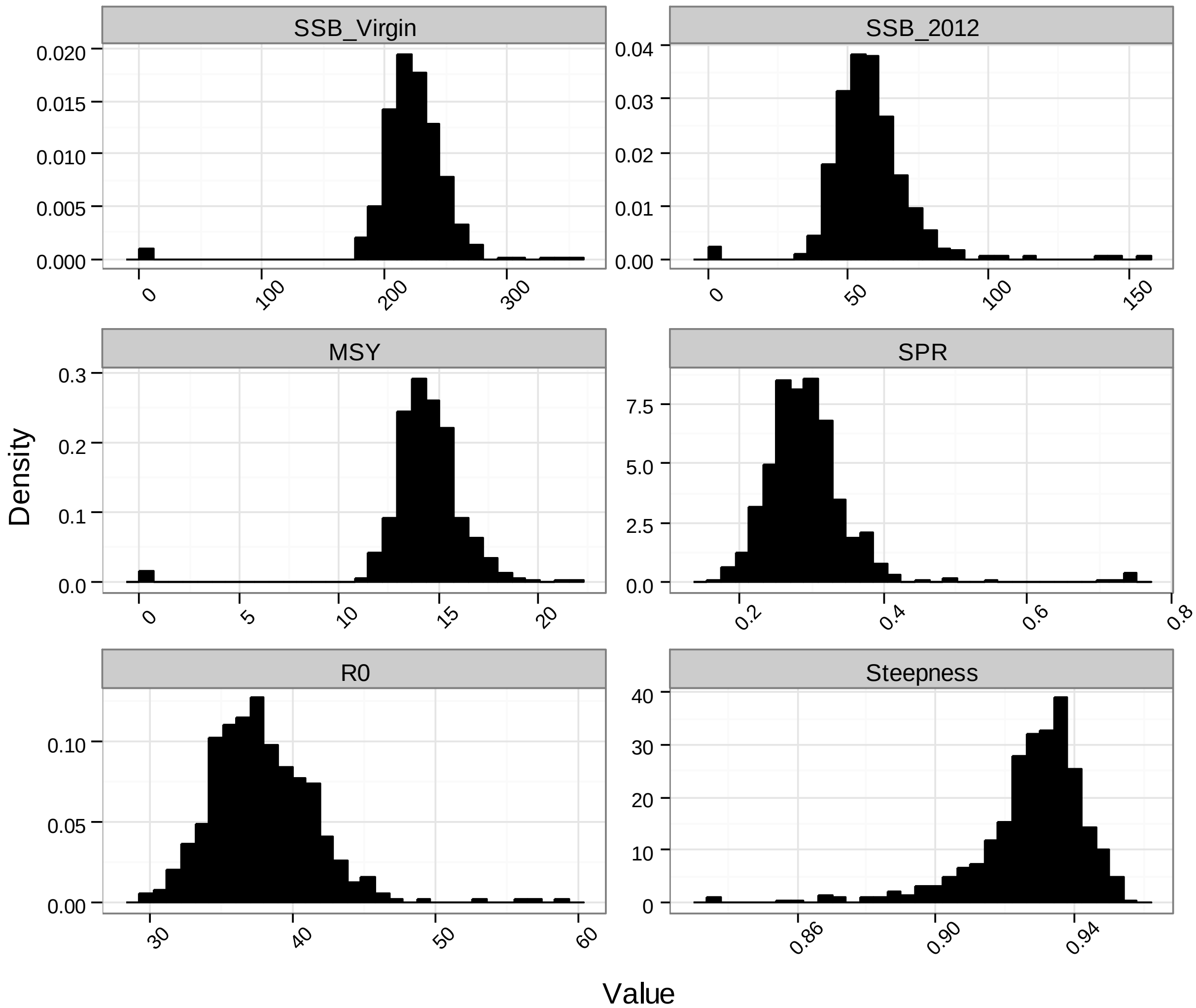


Figure 11.2.7.1.12. Density plots for biological reference points from the bootstrap analysis to test for model uncertainty in the base model of the GA-NC stock. Four alternatives are presented for maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

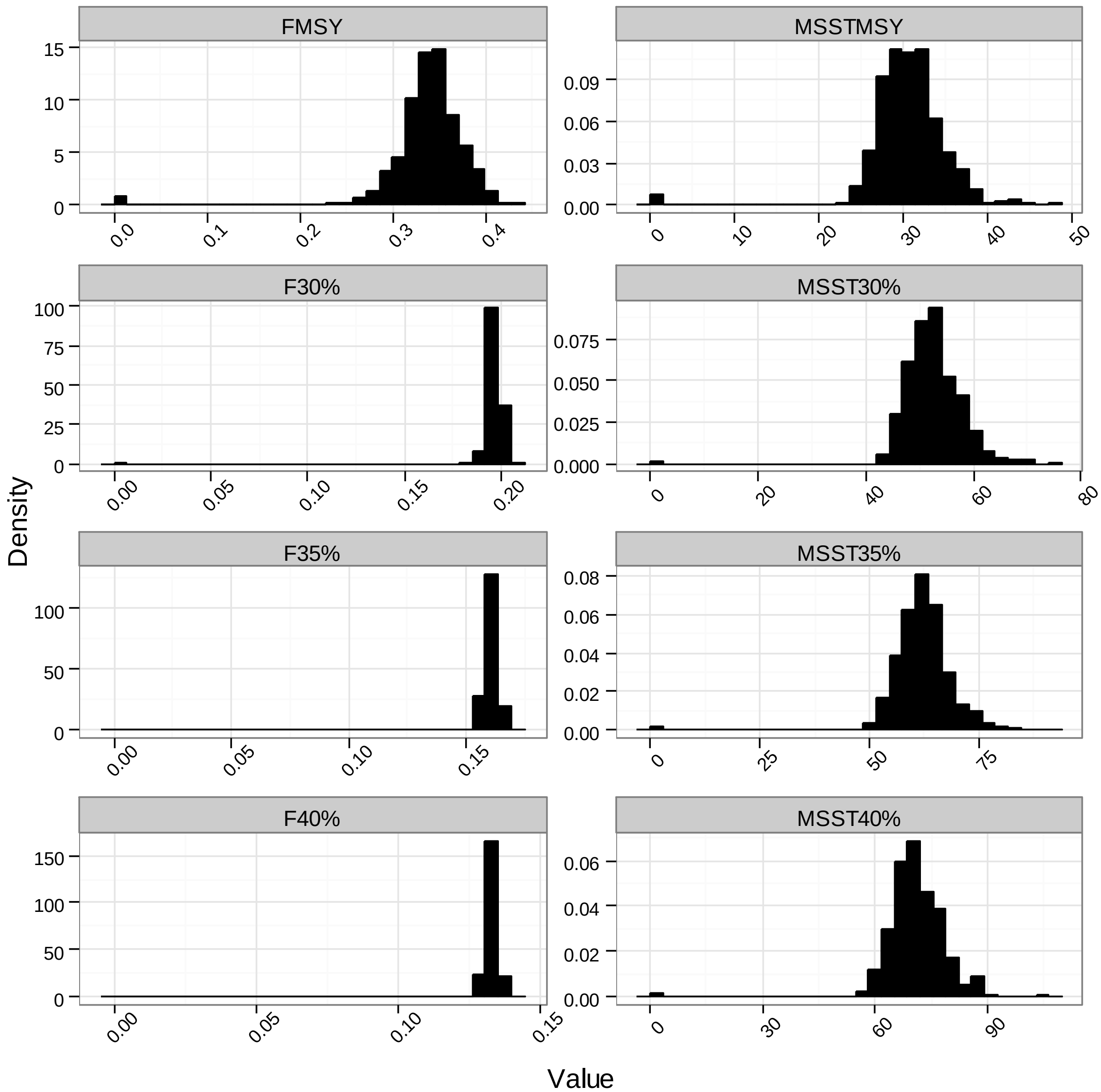


Figure 11.2.7.1.13. Density plots for stock status from the bootstrap analysis to test for model uncertainty in the base model of the GA-NC stock. Four alternatives are presented with maximum fishing mortality thresholds (MFMT: F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$) relative to the geometric mean of the most recent three years (2010-2012), and their corresponding minimum stock size thresholds (MSST), calculated as (1-M)*$SSB_{REFERENCE}$ ($SSB_{REFERENCE}$: SSB_{MSY}, $SSB_{30\%}$, $SSB_{35\%}$, and $SSB_{40\%}$). M=0.179 y^{-1} for the base model configuration.

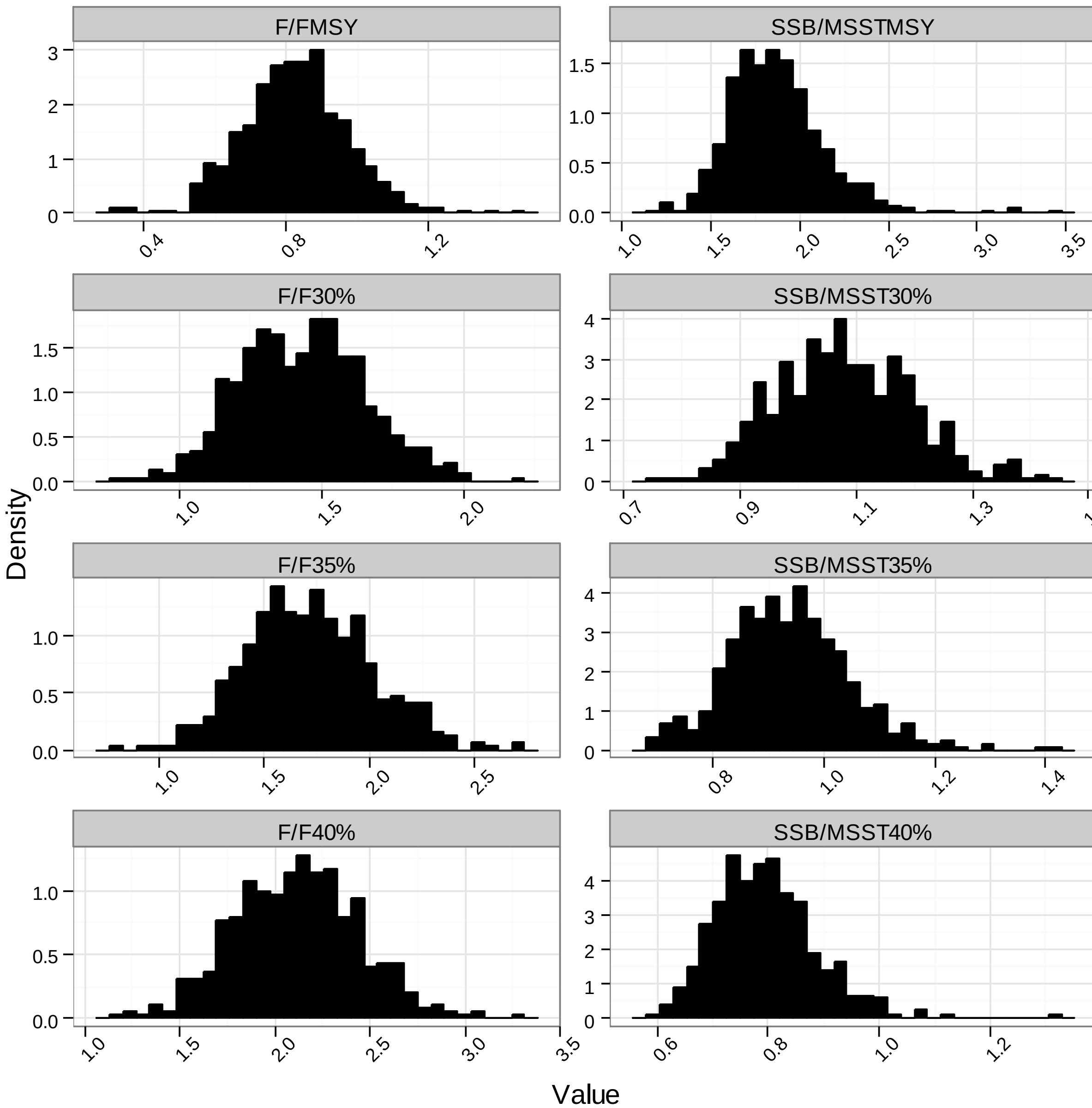


Figure 11.2.7.1.14. Time-series of derived quantities time series for the GA-NC stock for both the base model run (solid darker lines) and the 500 bootstrap iterations (lighter gray lines). SPR references levels of 30%, 35%, and 40% are presented on the SPR plot.

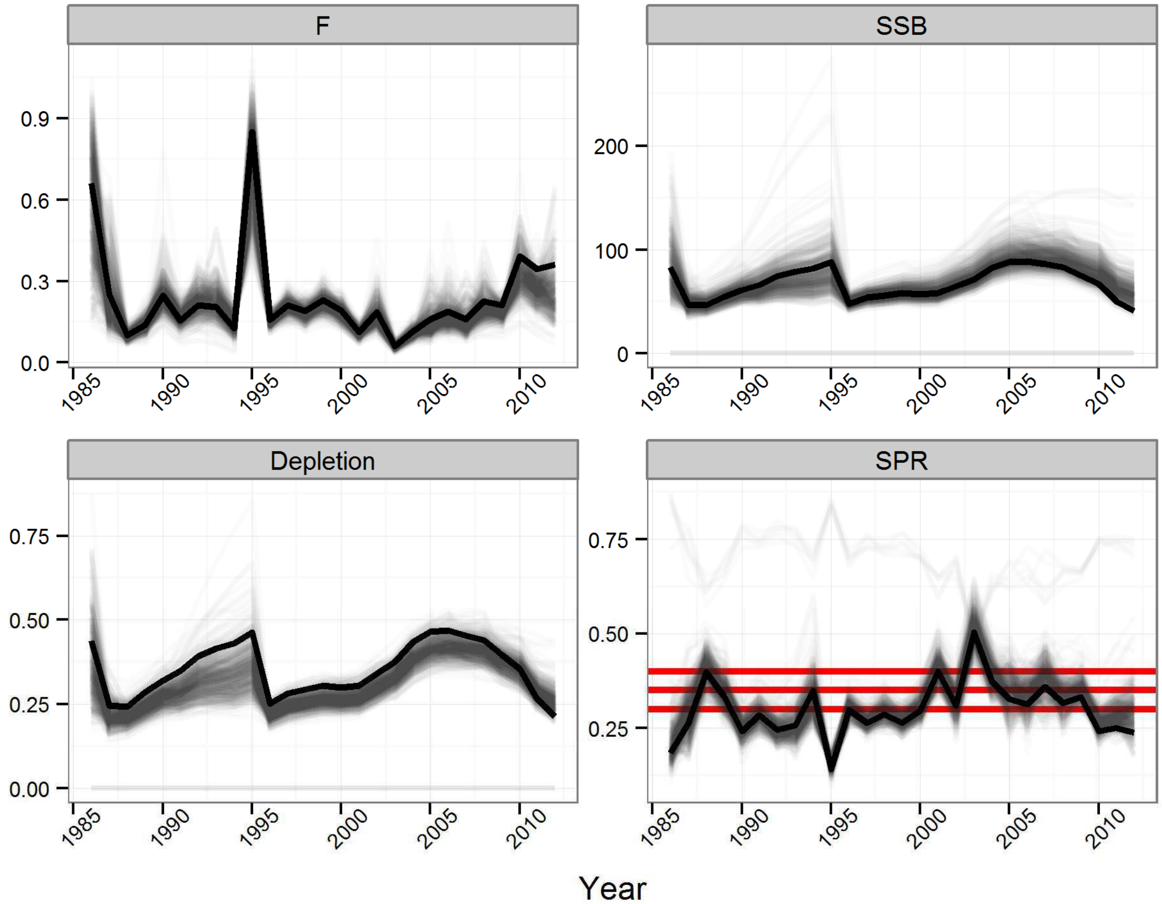


Figure 11.2.7.1.15. Time-series of stock status time series for the GA-NC stock for the 500 bootstrap iterations (lighter gray lines) and the base model configuration (solid darker lines).

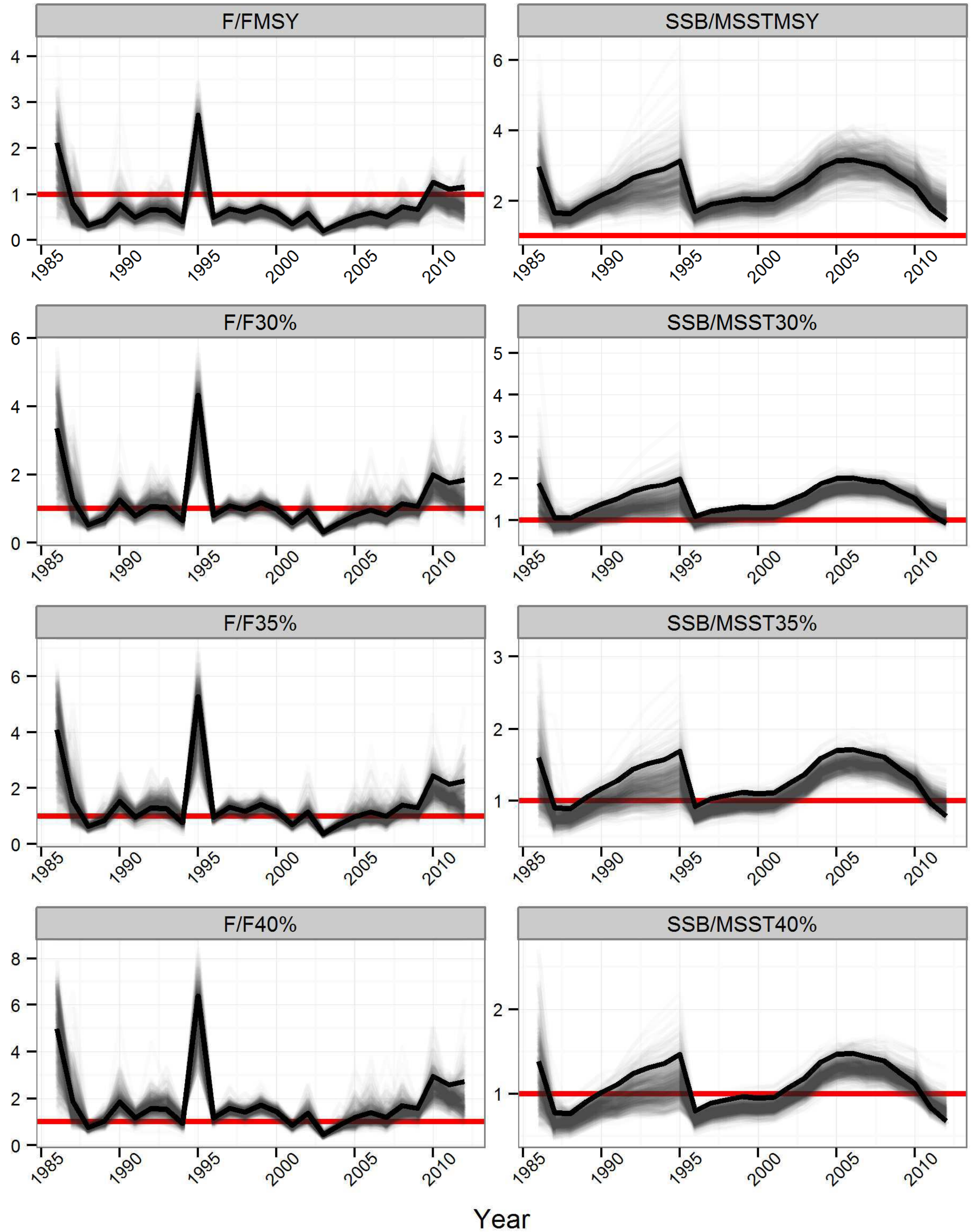


Figure 11.2.7.2.1.1. Sensitivity of the start date for the WFL stock, showing those sensitivity runs that successfully converged.

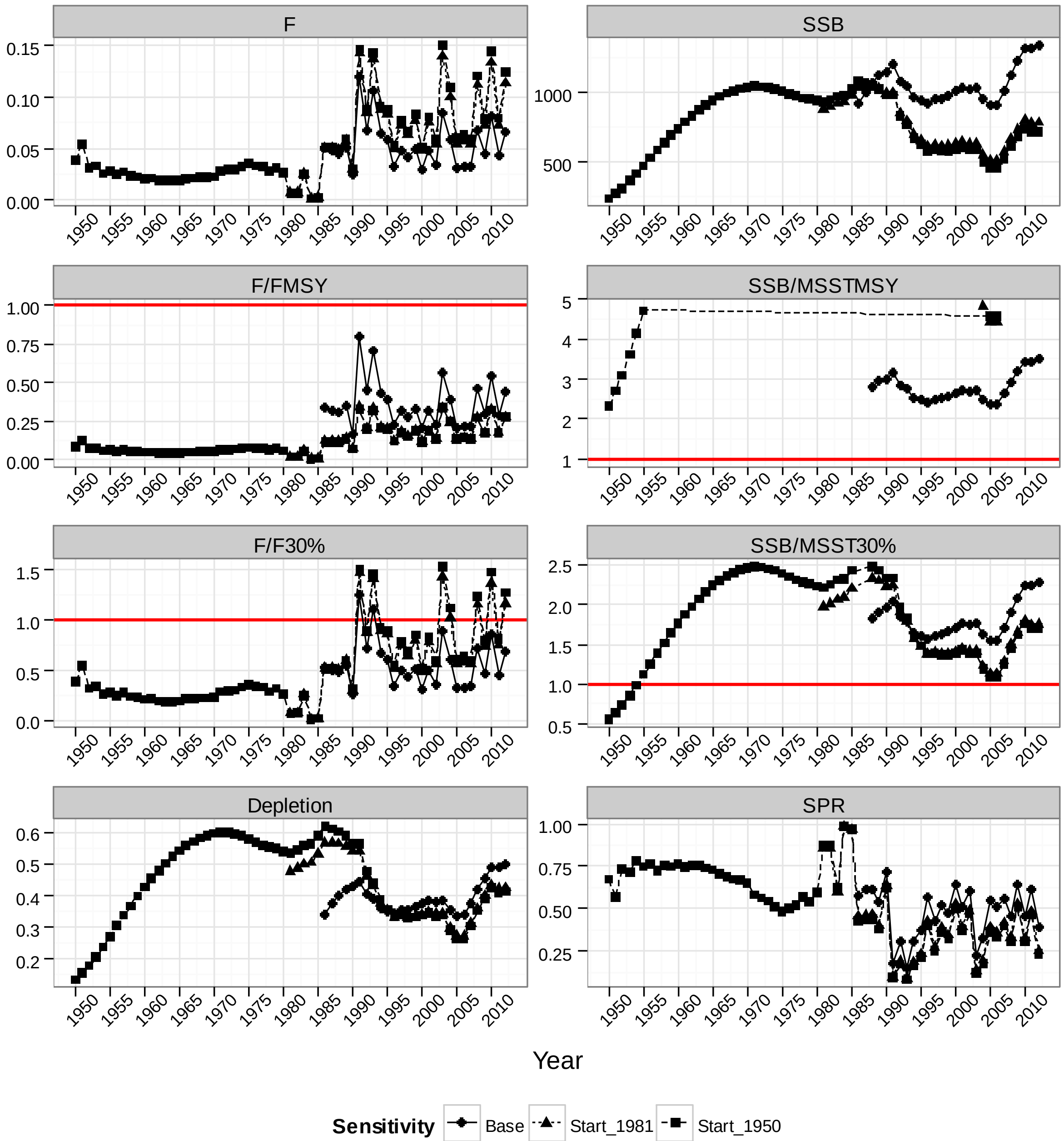


Figure 11.2.7.2.1.2. Sensitivity of the start date for the FLK/EFL stock, showing those sensitivity runs that successfully converged.

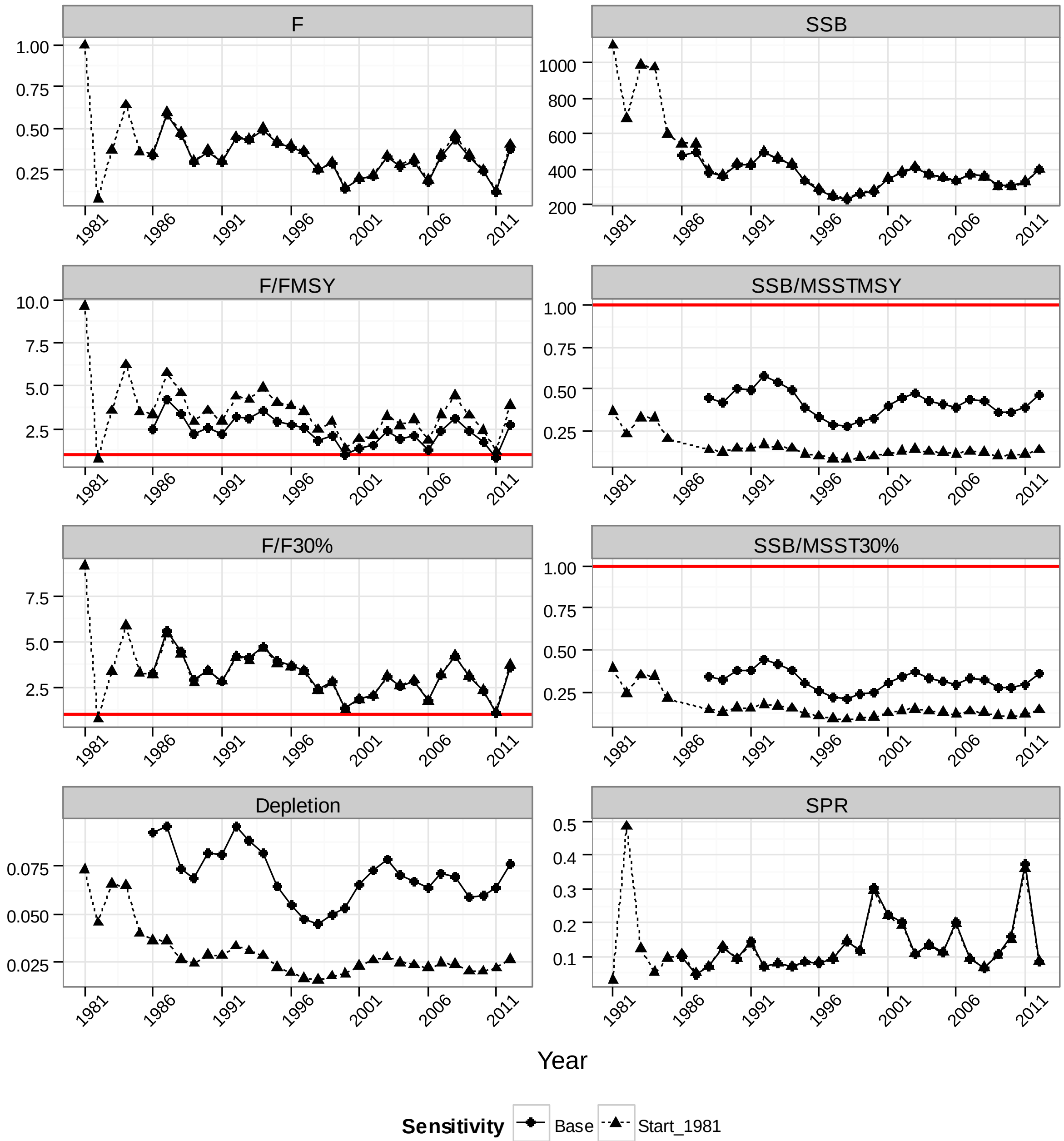


Figure 11.2.7.2.1.3. Sensitivity of the start date for the GA-NC stock, showing those sensitivity runs that successfully converged.

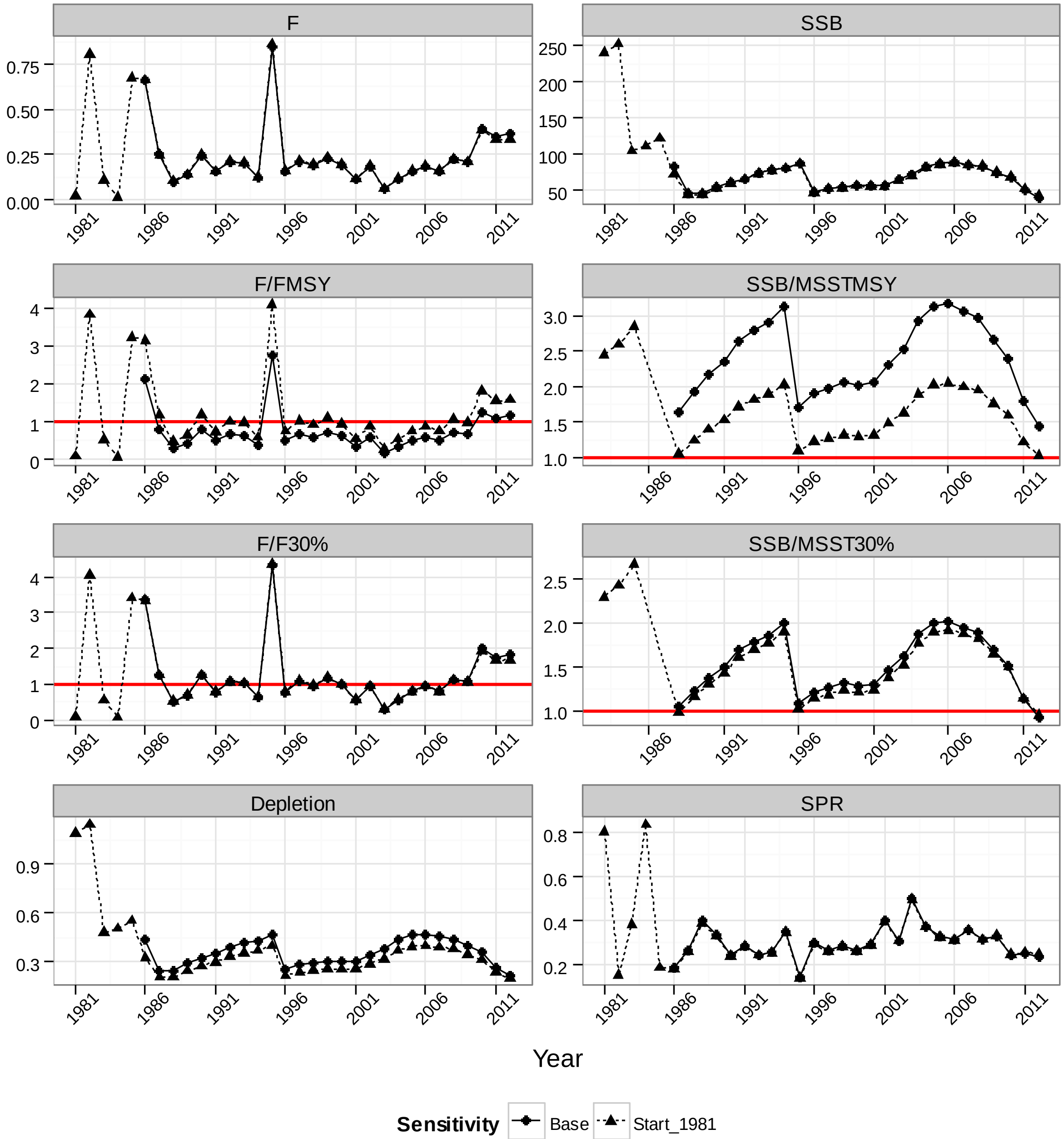


Figure 11.2.7.2.2.1. Sensitivity of removing indices of abundance for the WFL stock, showing those sensitivity runs that successfully converged.

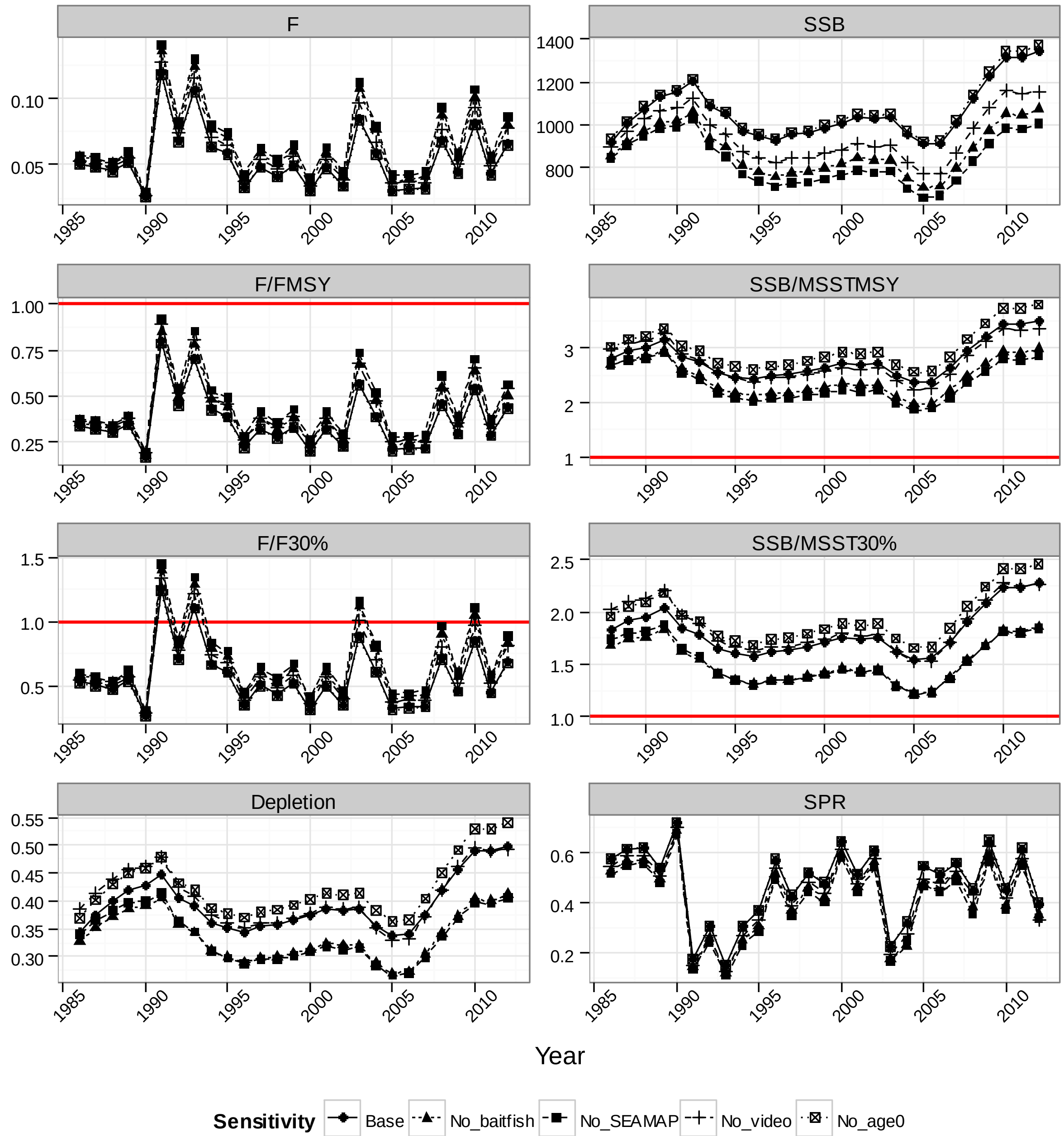


Figure 11.2.7.2.3.1. Sensitivity of including year-specific recreational errors for the WFL stock, showing those sensitivity runs that successfully converged.

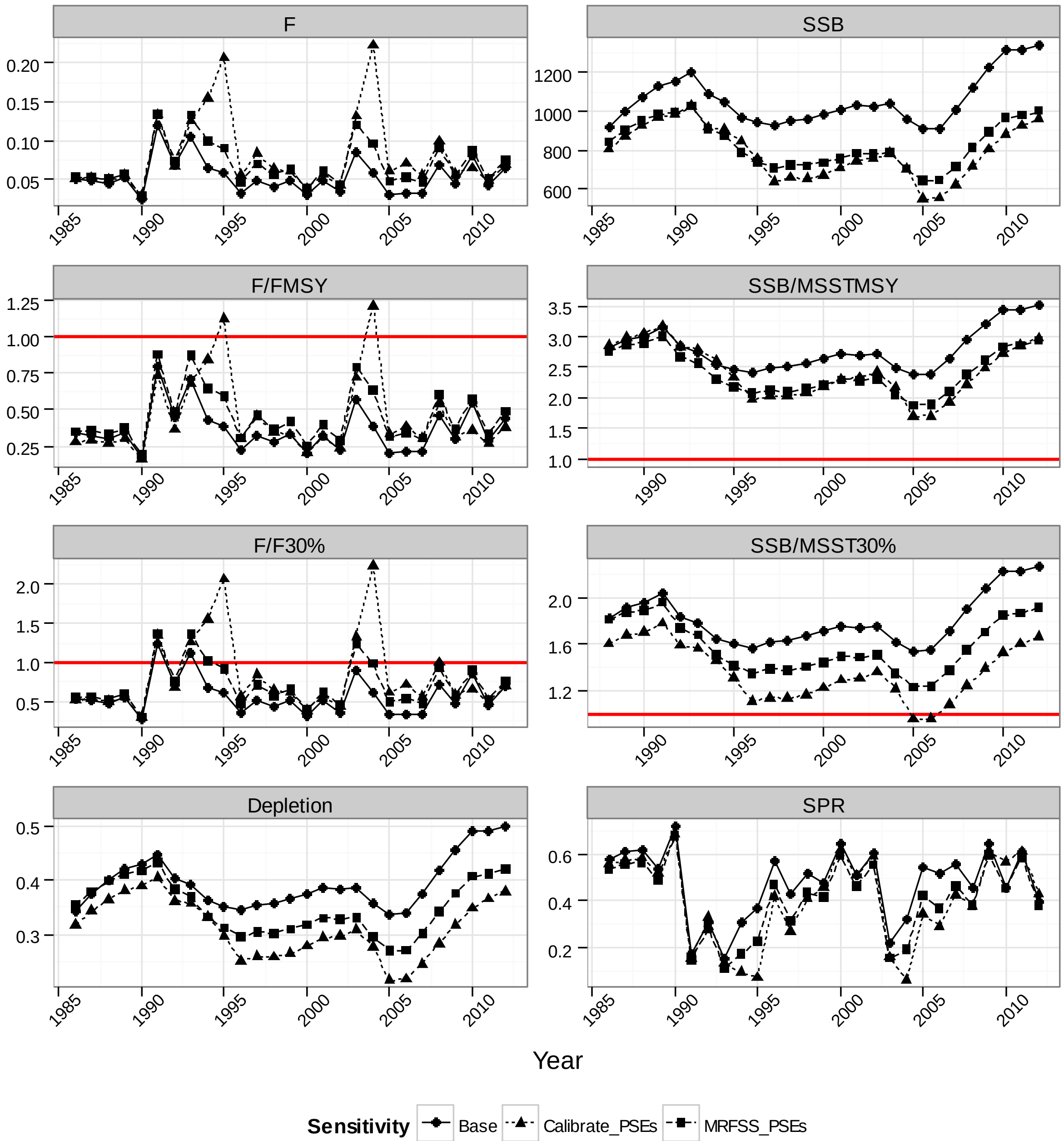


Figure 11.2.7.2.3.2. Sensitivity of including year-specific recreational errors for the FLK/EFL stock, showing those sensitivity runs that successfully converged.

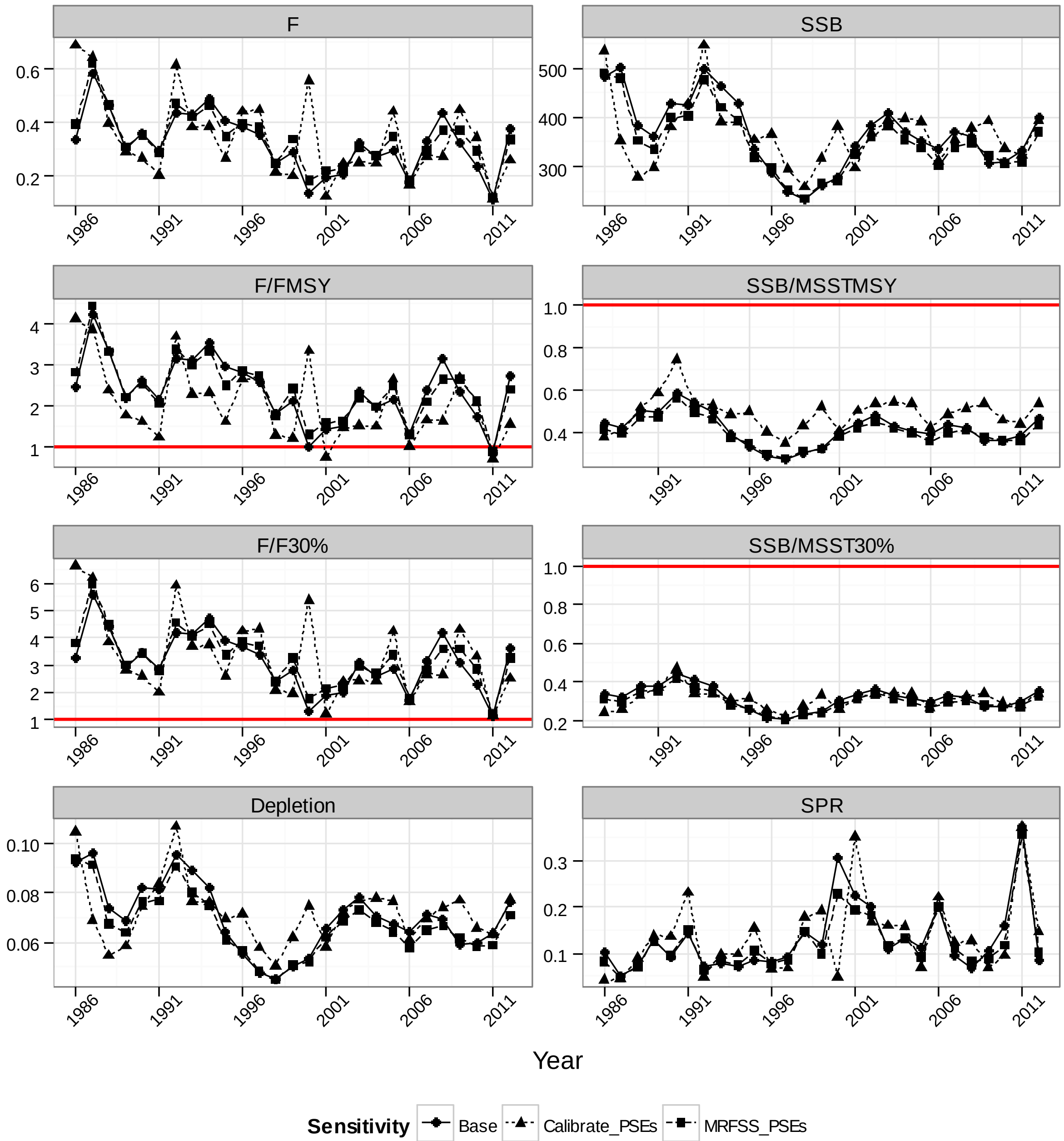


Figure 11.2.7.2.3.3. Sensitivity of including year-specific recreational errors for the GA-NC stock, showing those sensitivity runs that successfully converged.

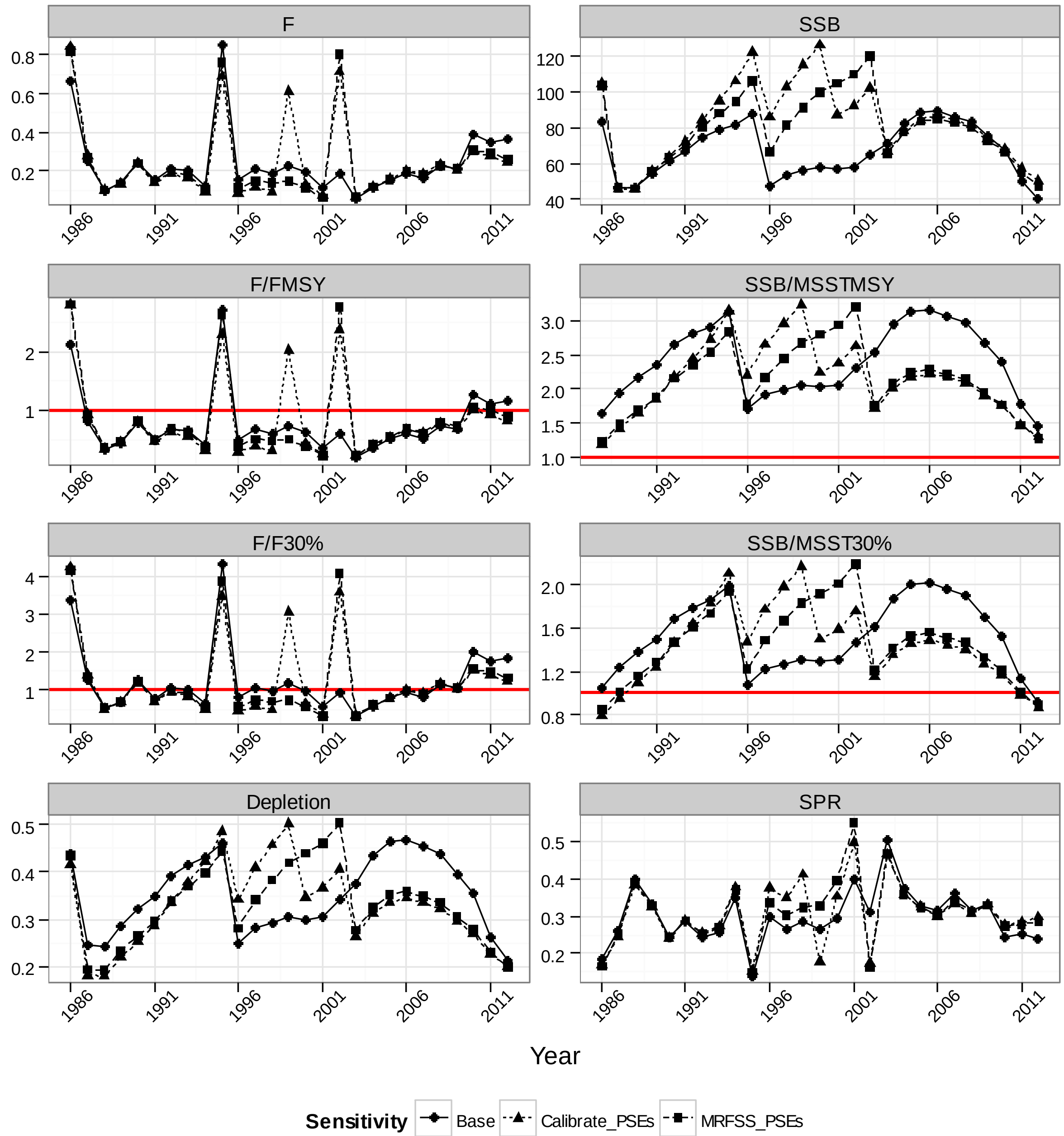


Figure 11.2.7.2.4.1. Sensitivity of removing the steepness prior for the WFL stock, showing those sensitivity runs that successfully converged.

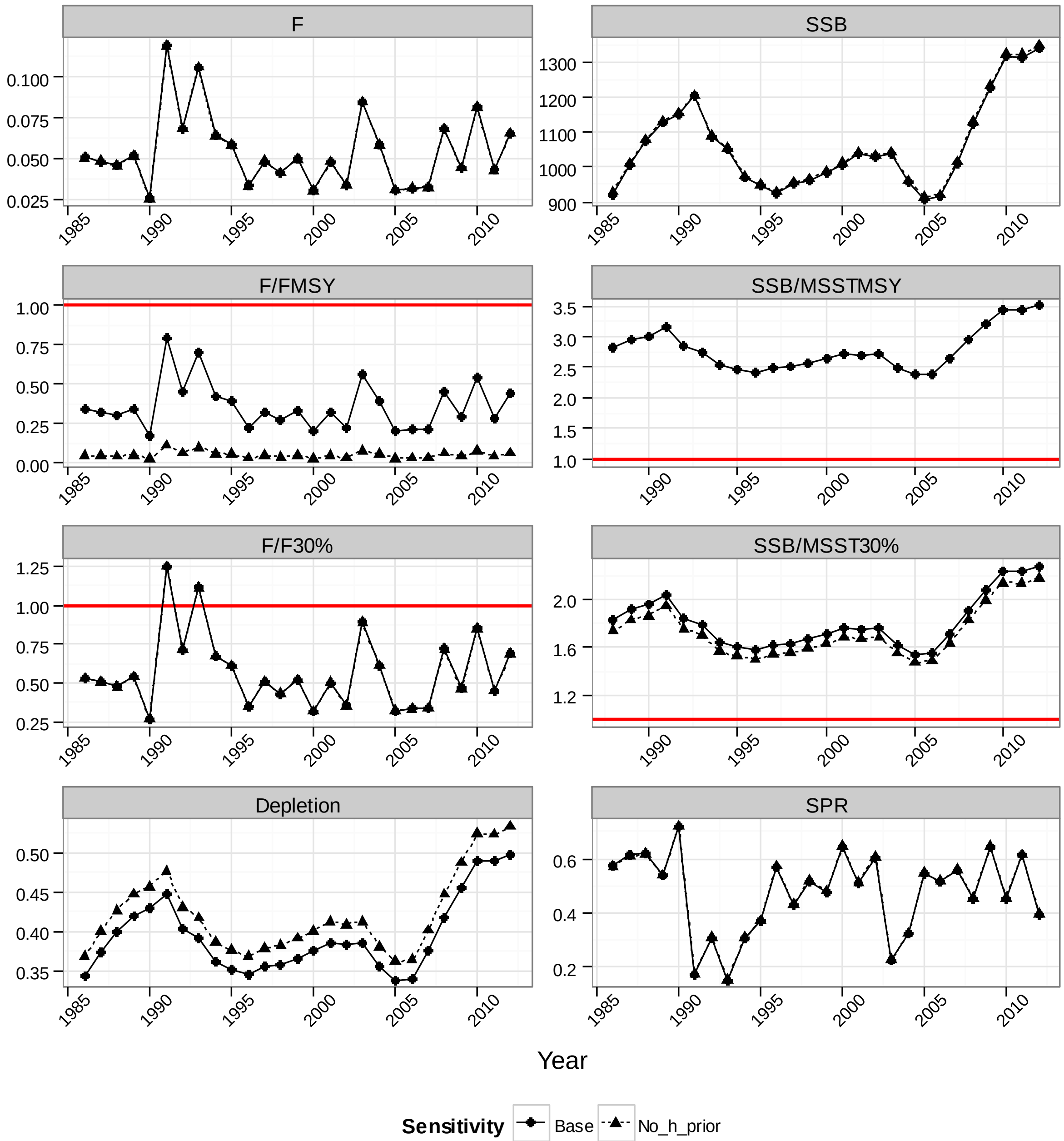


Figure 11.2.7.2.4.2. Sensitivity of removing the steepness prior for the FLK/EFL stock, showing those sensitivity runs that successfully converged.

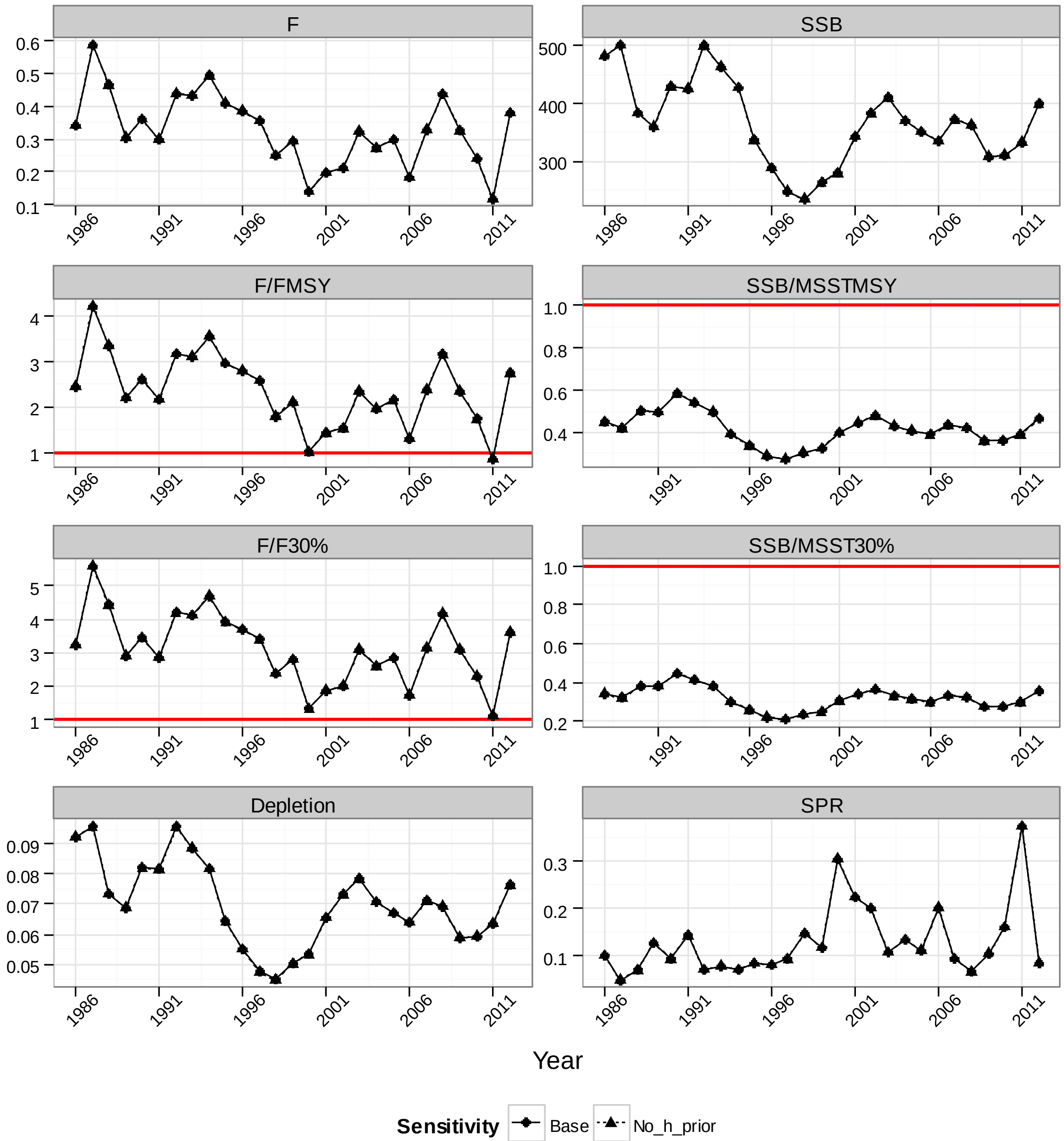


Figure 11.2.7.2.4.3. Sensitivity of removing the steepness prior for the GA-NC stock, showing those sensitivity runs that successfully converged.

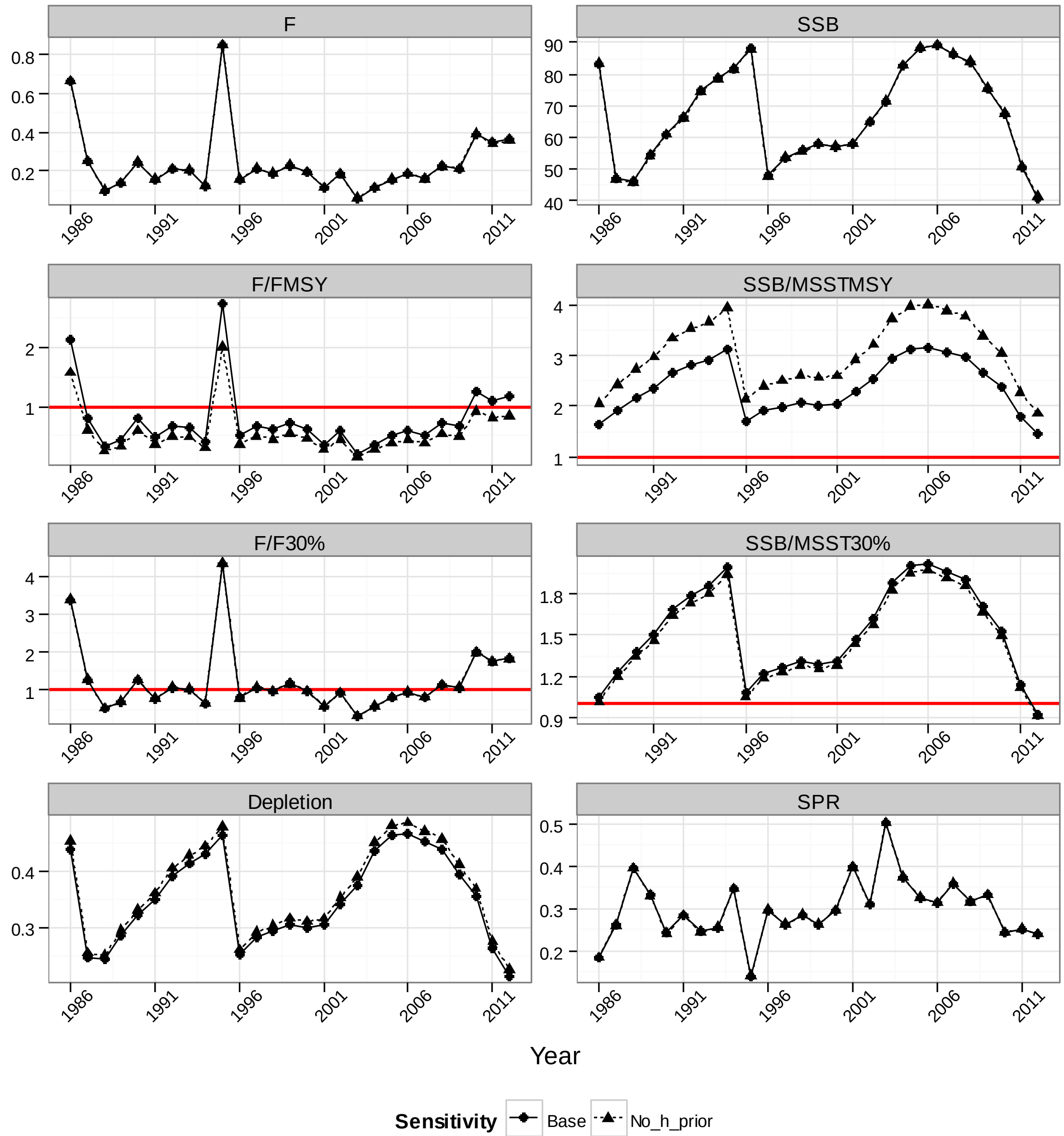


Figure 11.2.7.2.5.1. Sensitivity of removing forced asymptotic selectivity for the WFL stock, showing those sensitivity runs that successfully converged.

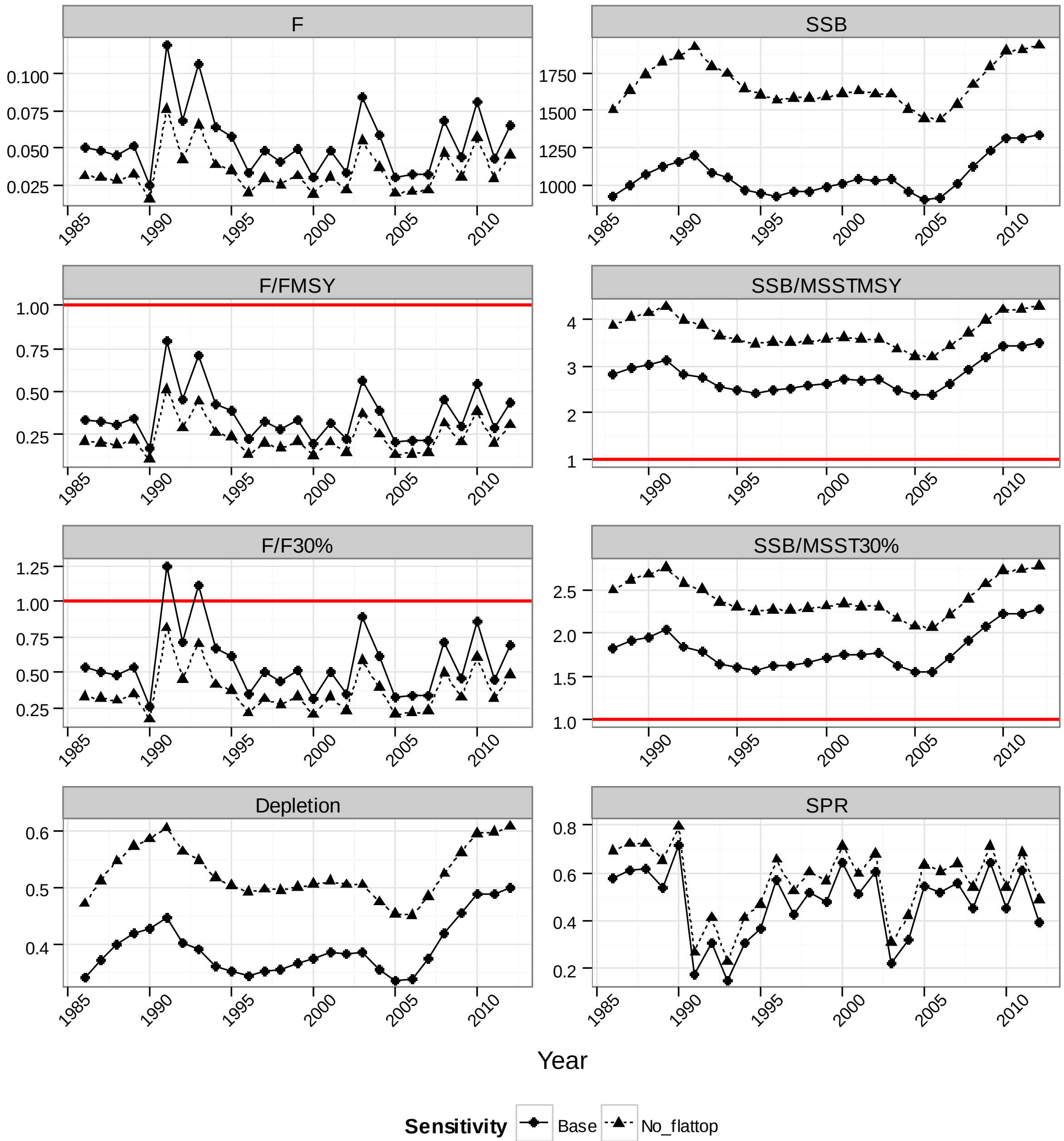


Figure 11.2.7.2.5.2. Sensitivity of removing forced asymptotic selectivity for the FLK/EFL stock, showing those sensitivity runs that successfully converged.

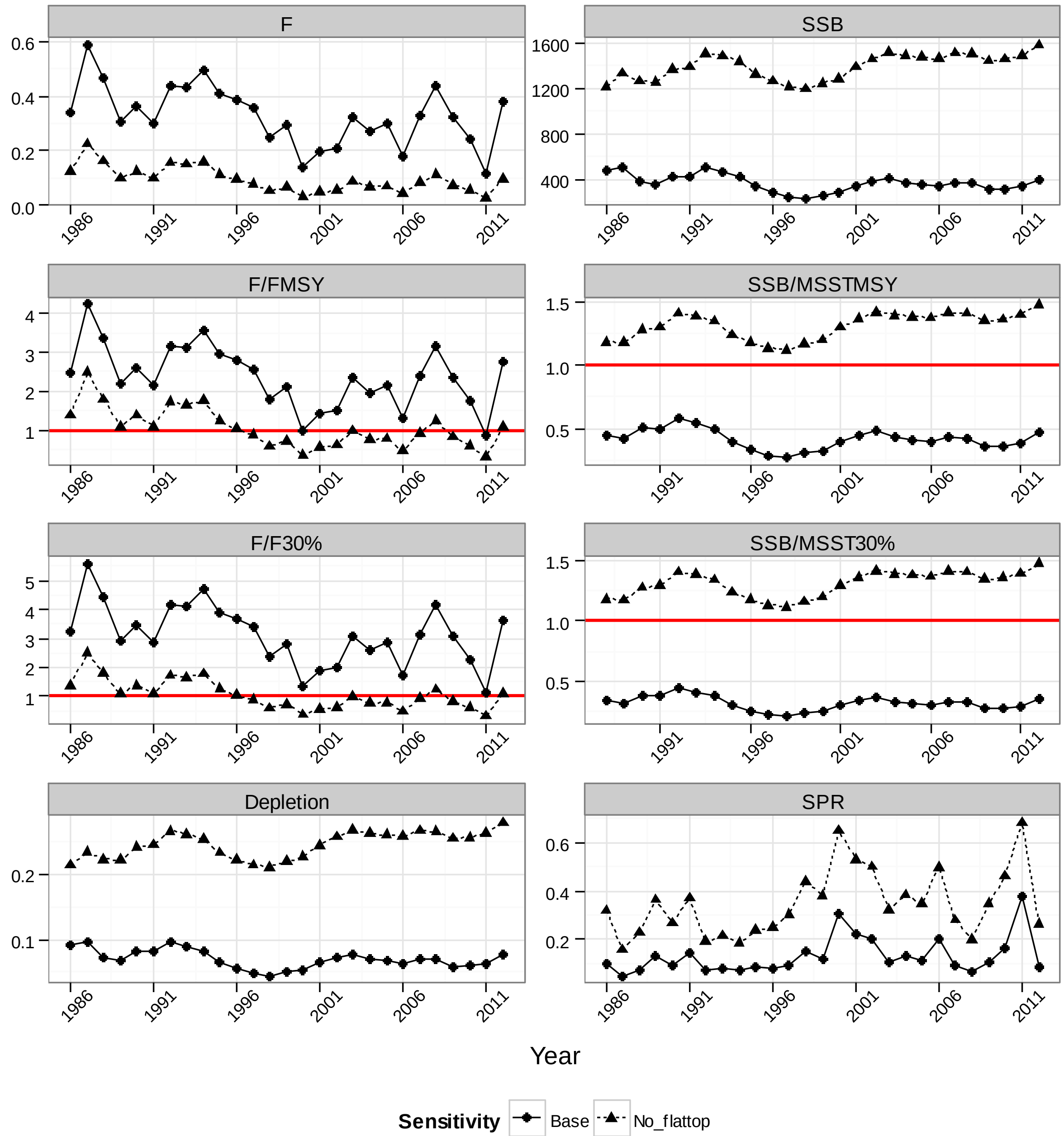


Figure 11.2.7.2.5.3. Sensitivity of removing forced asymptotic selectivity for the GA-NC stock, showing those sensitivity runs that successfully converged.

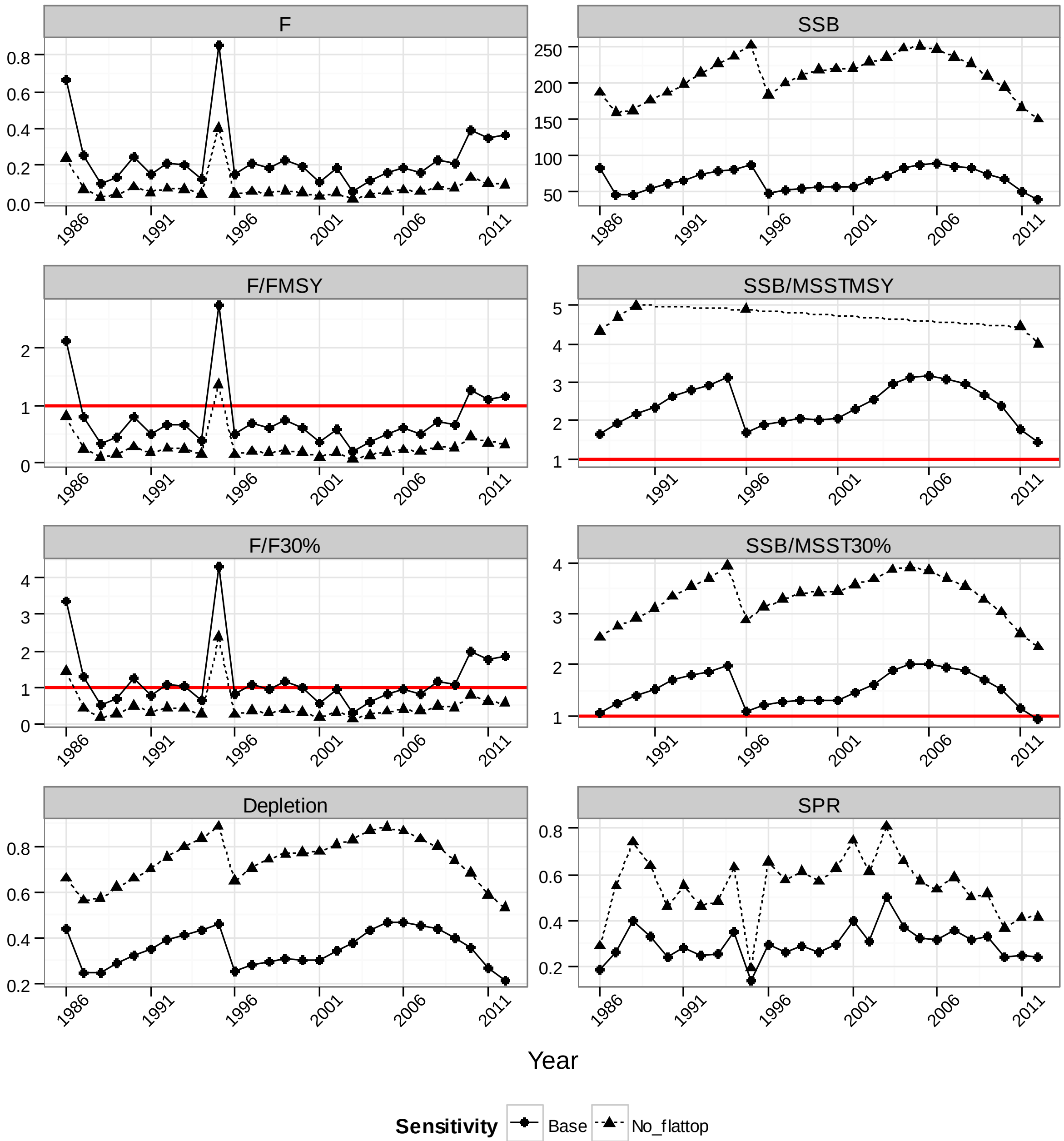


Figure 11.2.7.2.6.1. Sensitivity of alternative reproductive characterizations for the WFL stock, showing those sensitivity runs that successfully converged.

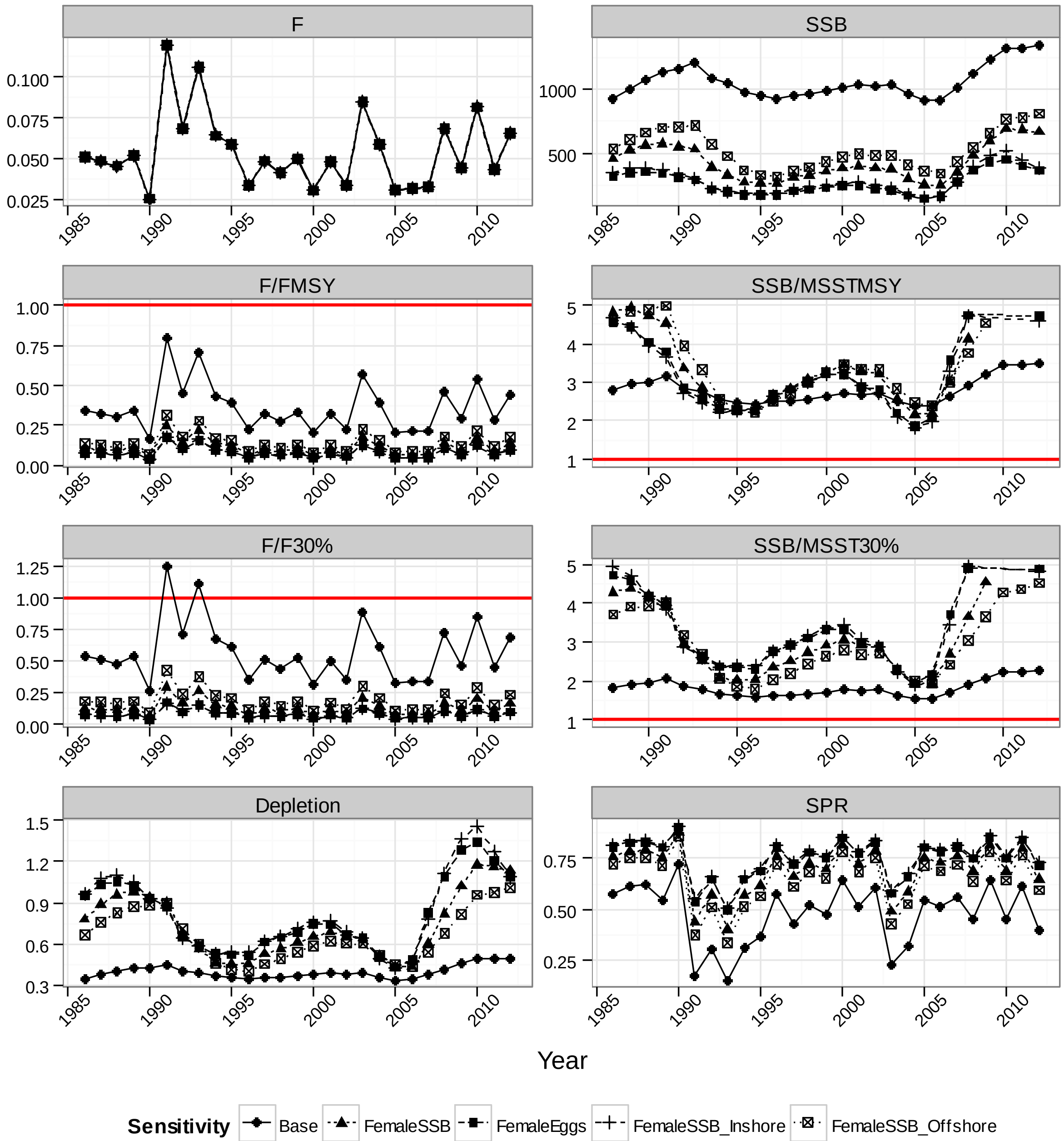


Figure 11.2.7.2.6.2. Sensitivity of alternative reproductive characterizations for the FLK/EFL stock, showing those sensitivity runs that successfully converged.

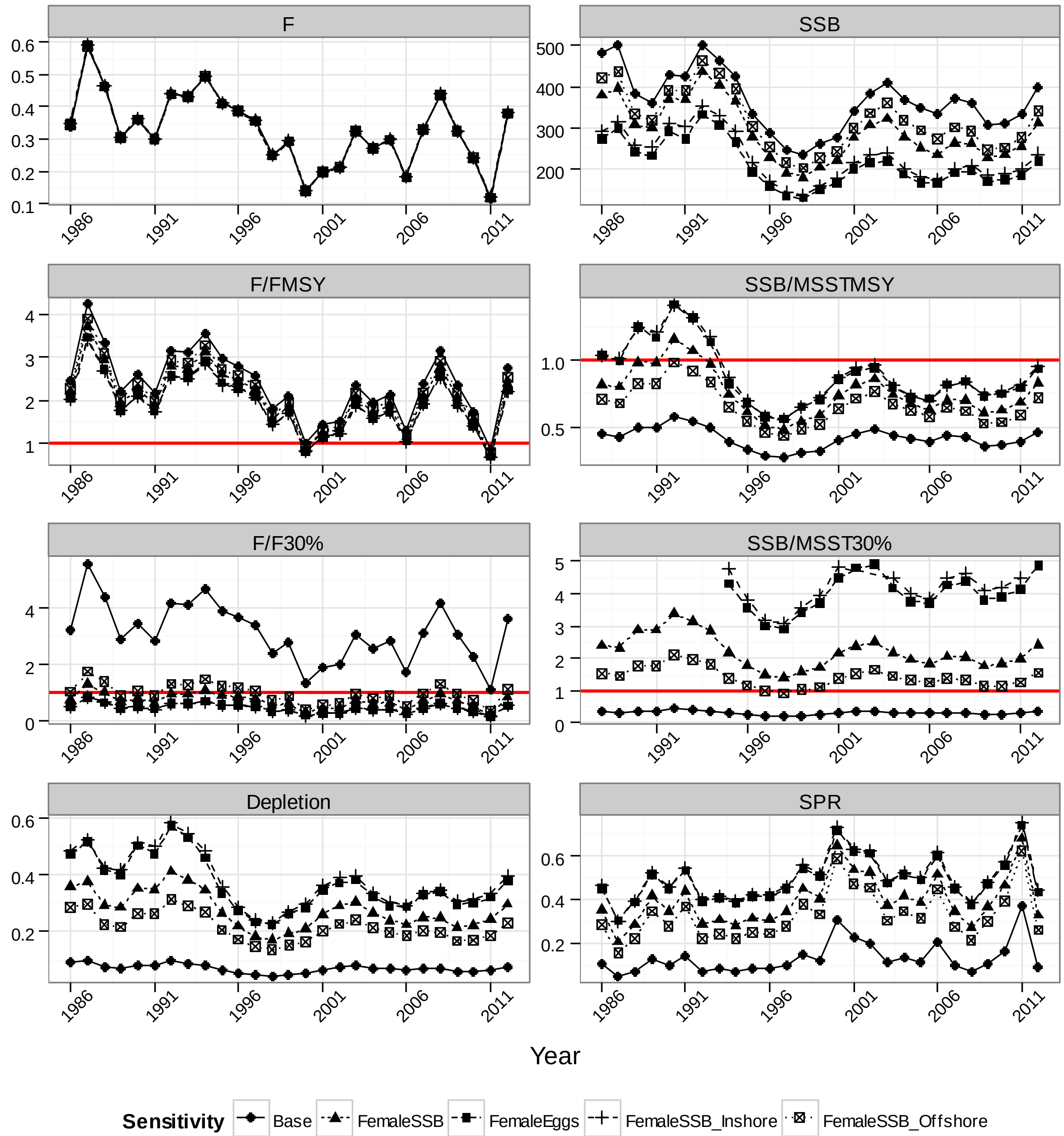


Figure 11.2.7.2.7.1. Sensitivity of alternative use of age data for the WFL stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

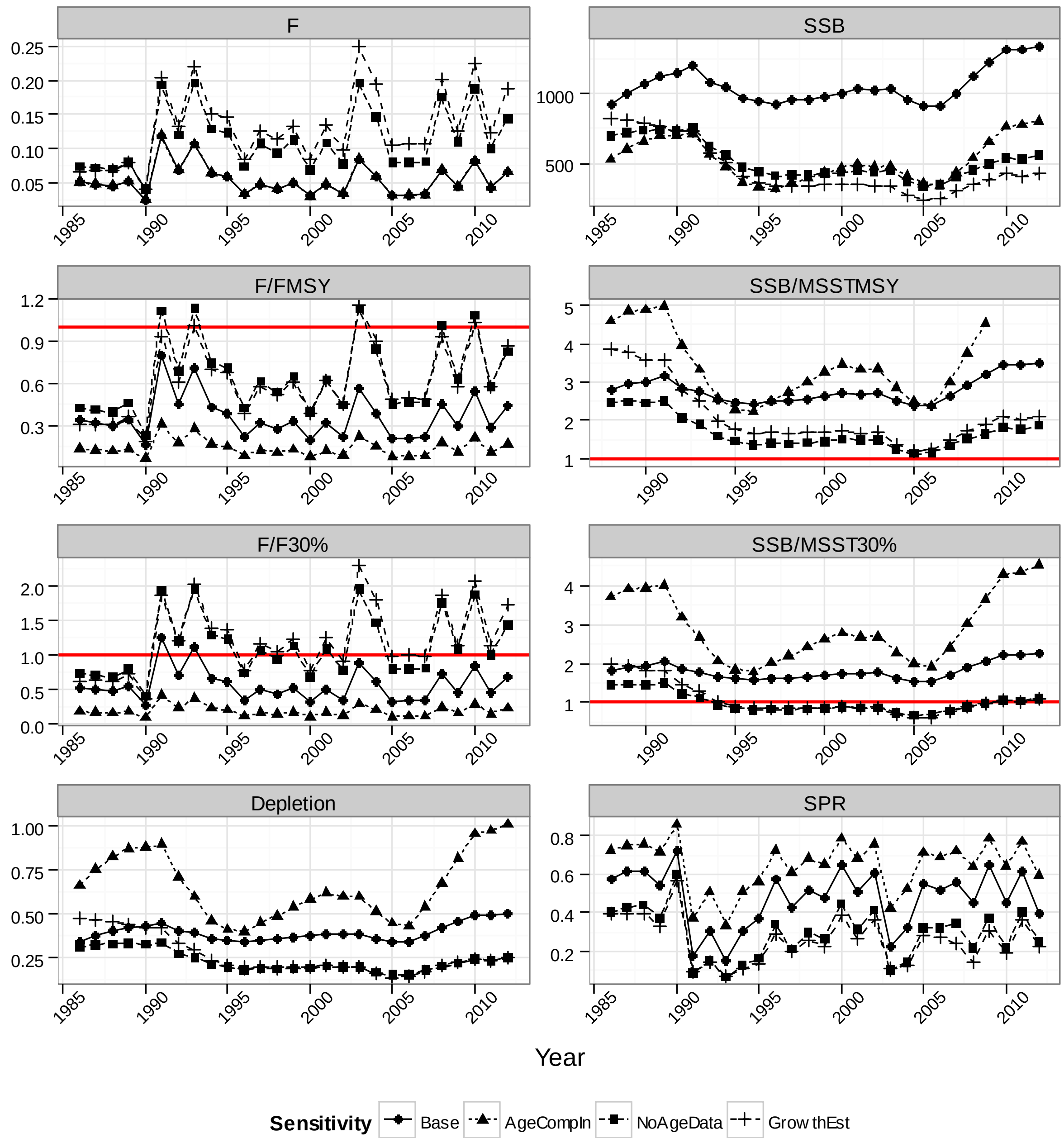


Figure 11.2.7.2.7.2. Sensitivity of alternative use of age data for the FLK/EFL stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

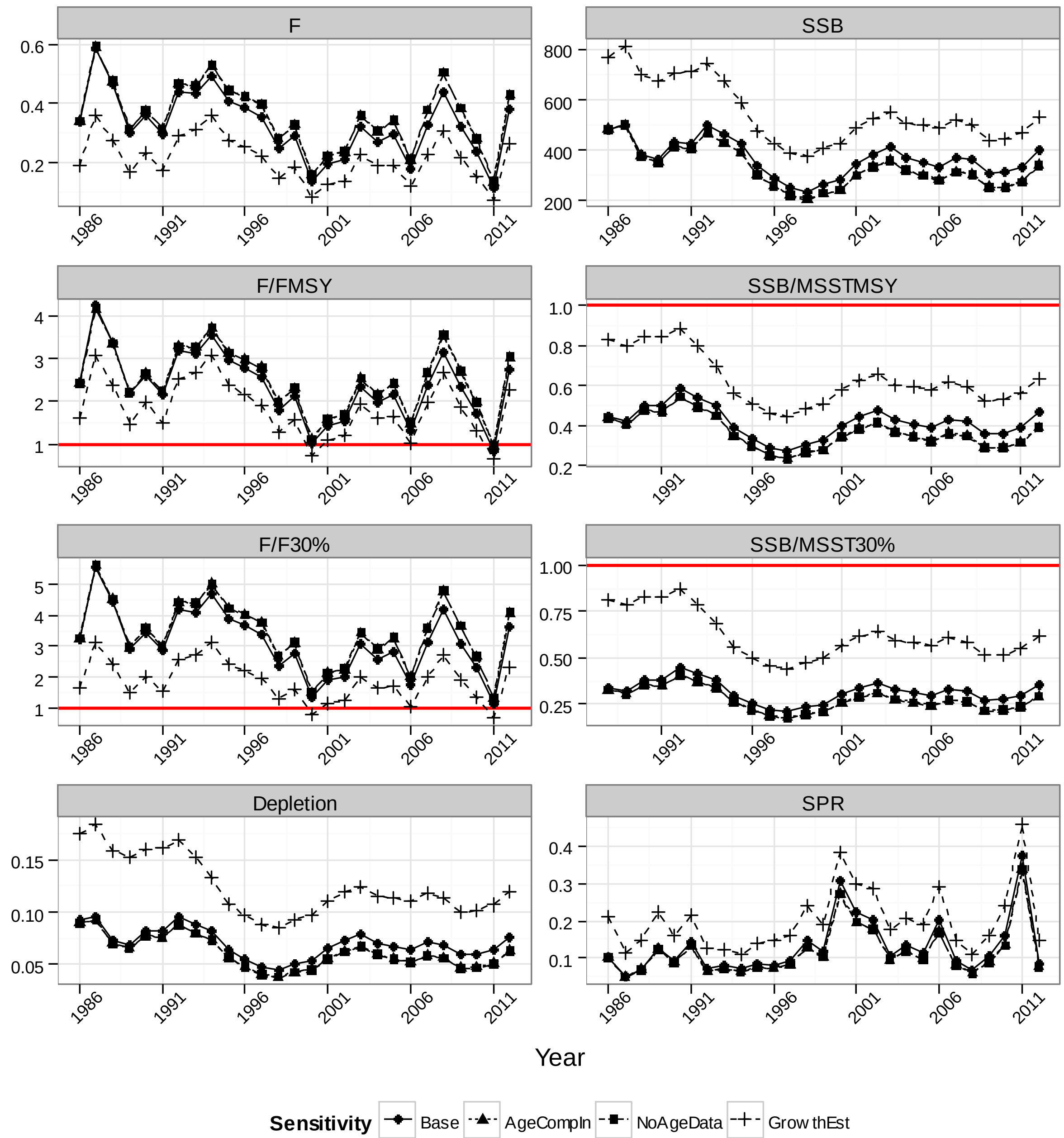


Figure 11.2.7.2.7.3. Sensitivity of alternative use of age data for the GA-NC stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

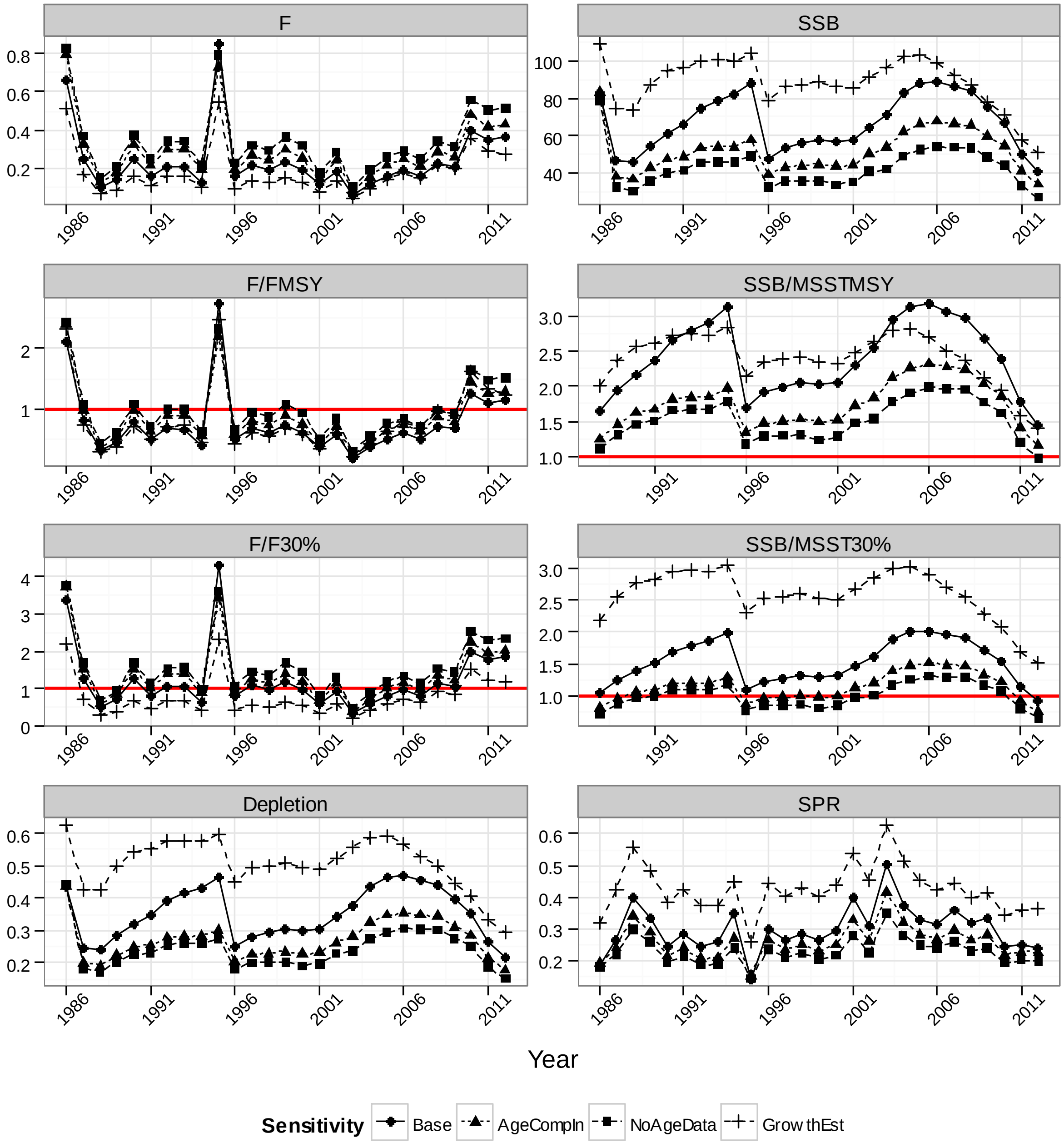


Figure 11.2.7.2.8.1. Sensitivity of alternative life history parameterizations for the WFL stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

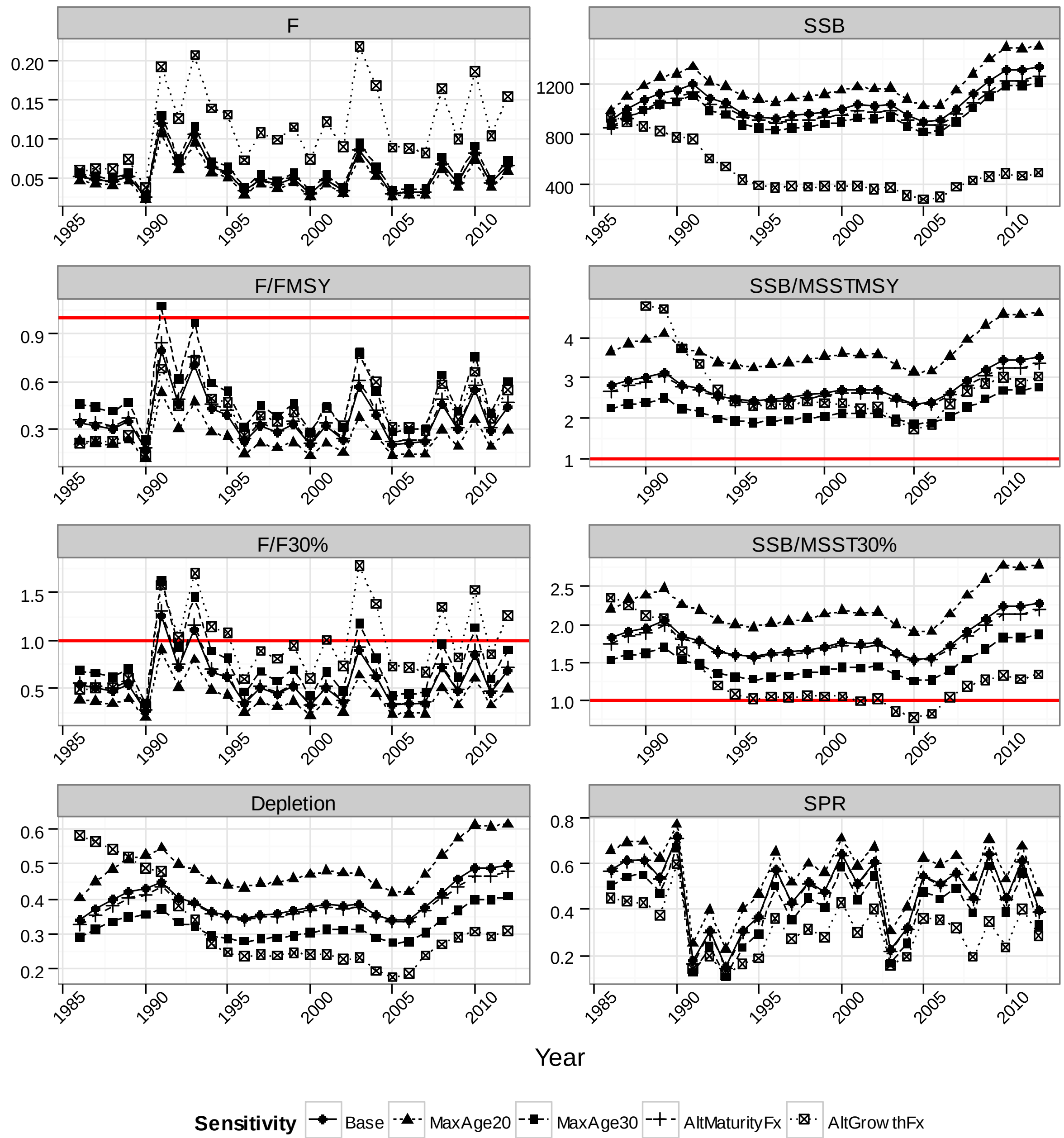


Figure 11.2.7.2.8.2. Sensitivity of alternative life history parameterizations for the FLK/EFL stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

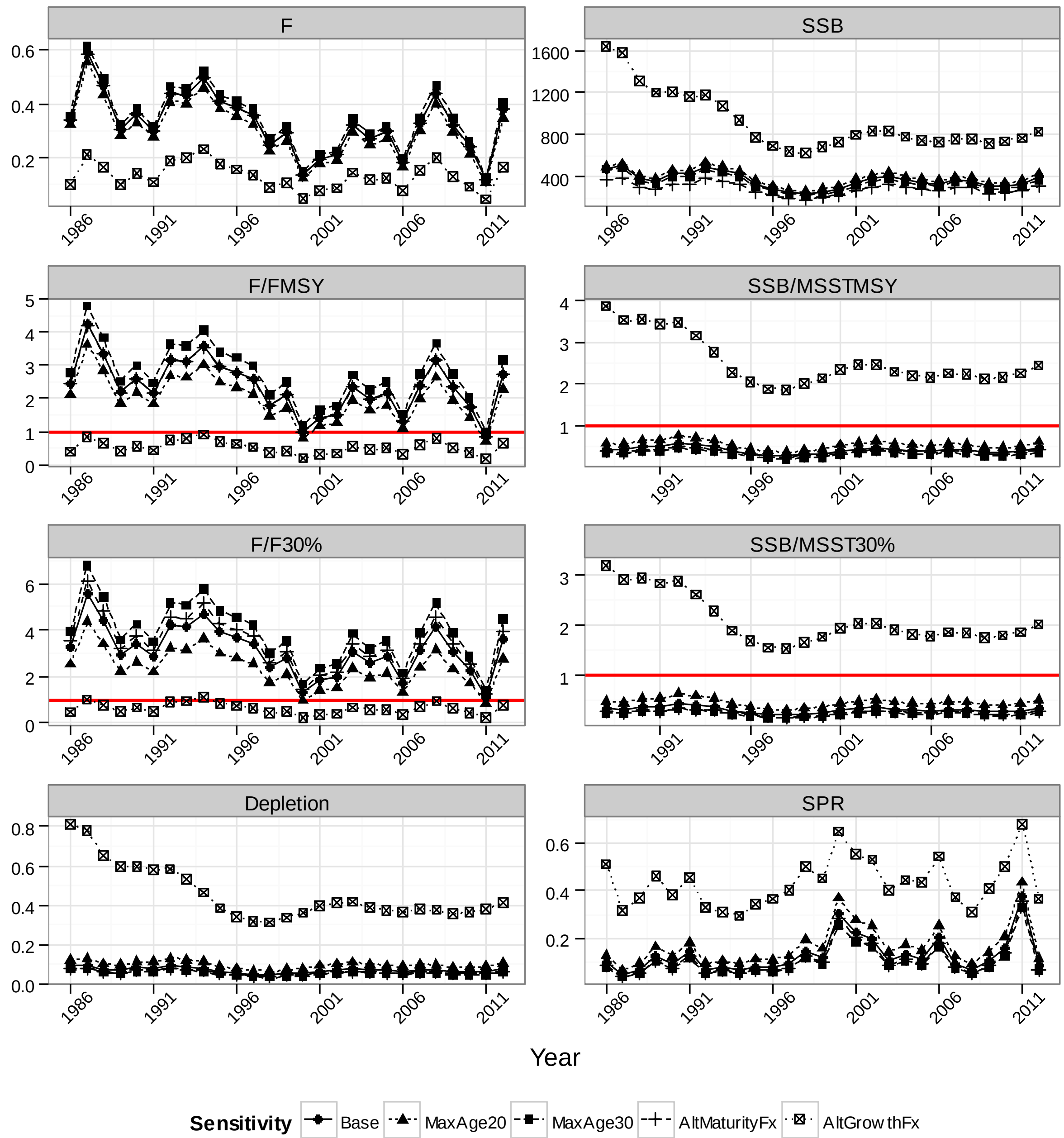


Figure 11.2.7.2.8.3. Sensitivity of alternative life history parameterizations for the GA-NC stock, showing those sensitivity runs that successfully converged. Here, 'AgeCompIn' refers to using the full length range for age data input in the age comps, versus using the conditional age-at-length approach from the base model.

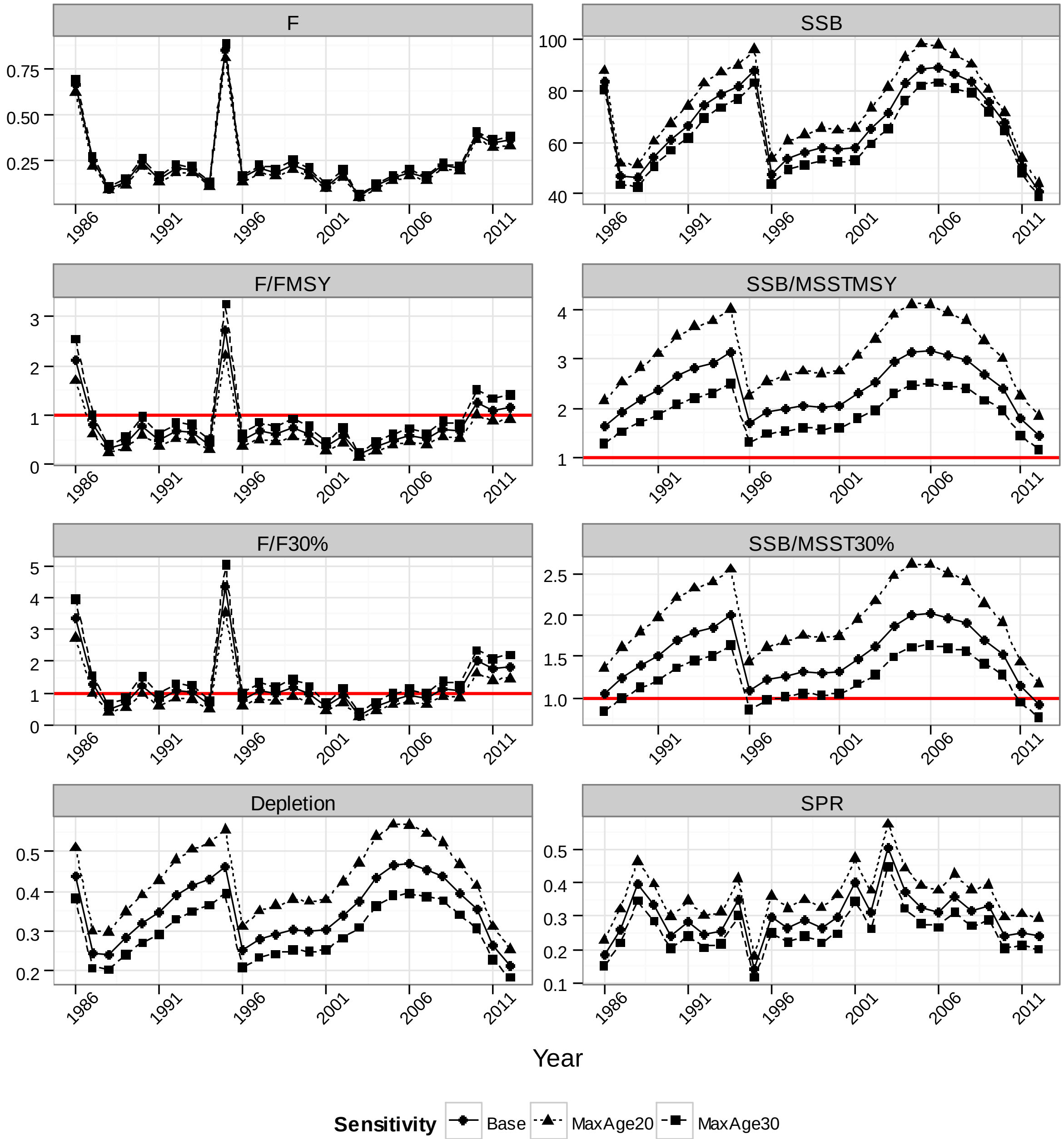


Figure 11.2.7.3.1. Retrospective analysis for the WFL stock base model run. The 2012 model run (solid red line) is the base model.

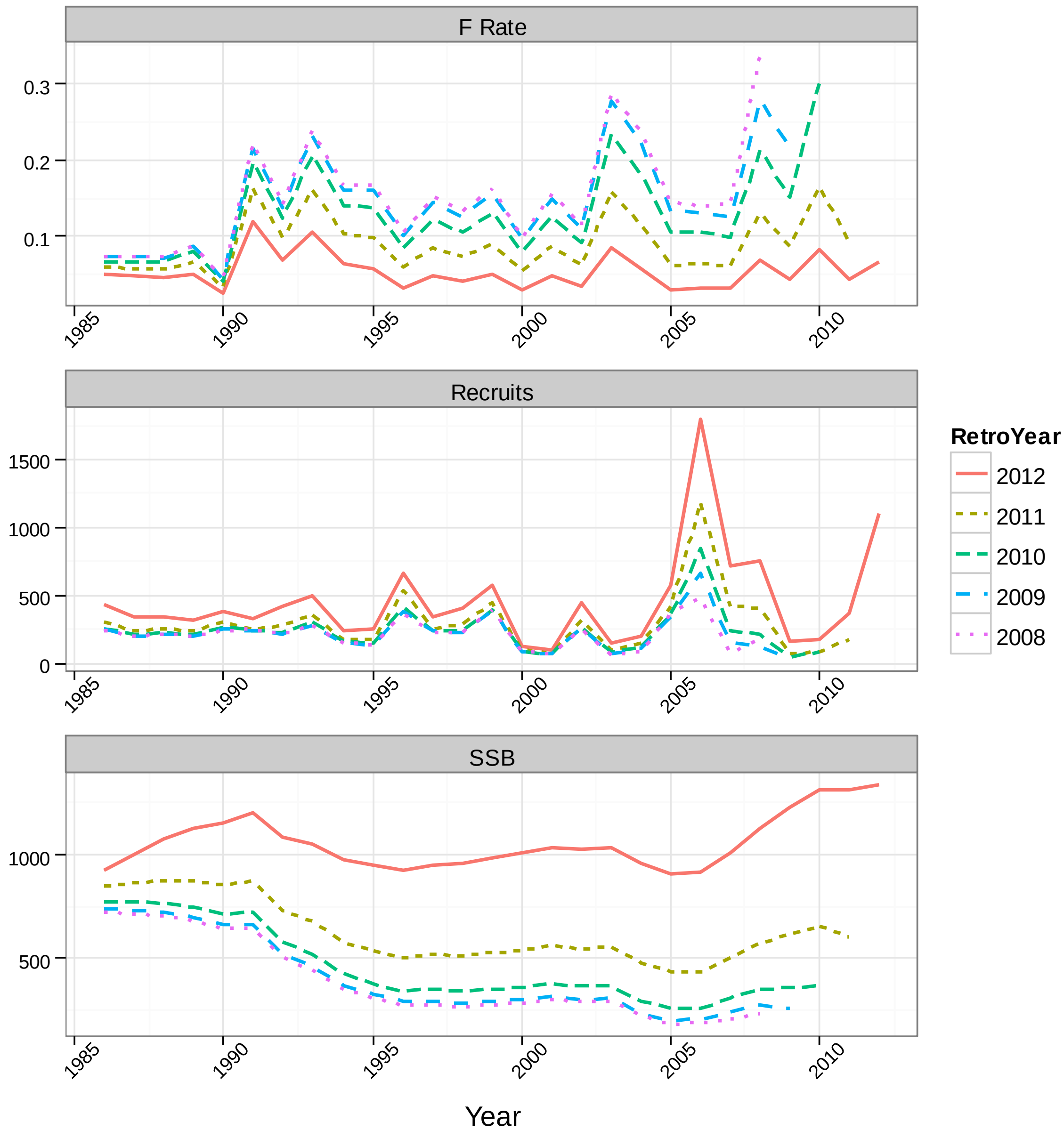


Figure 11.2.7.3.2. Retrospective analysis for the FLK/EFL stock base model run. The 2012 model run (solid red line) is the base model.

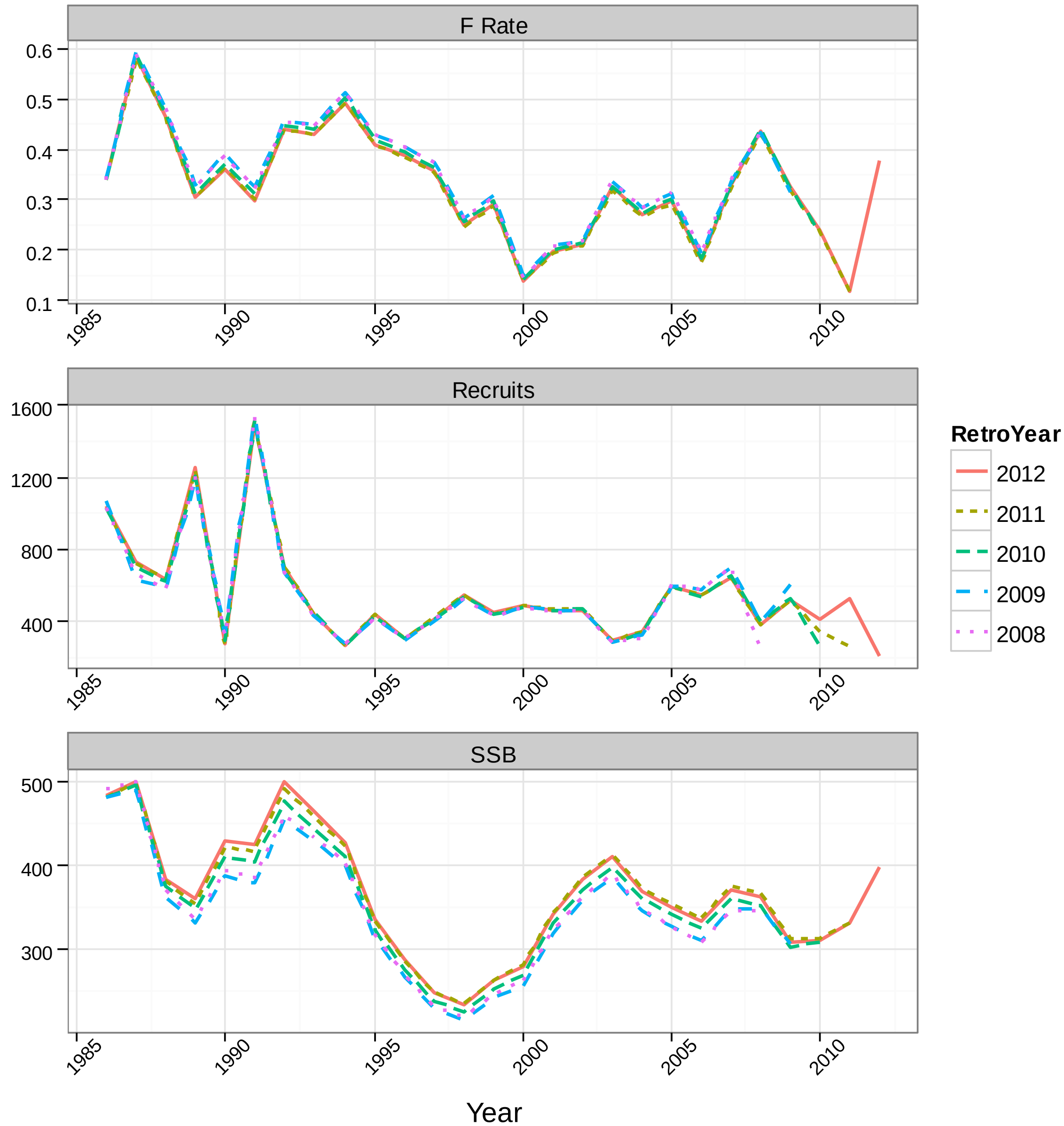


Figure 11.2.7.3.3. Retrospective analysis for the GA-NC stock base model run. The 2012 model run (solid red line) is the base model.

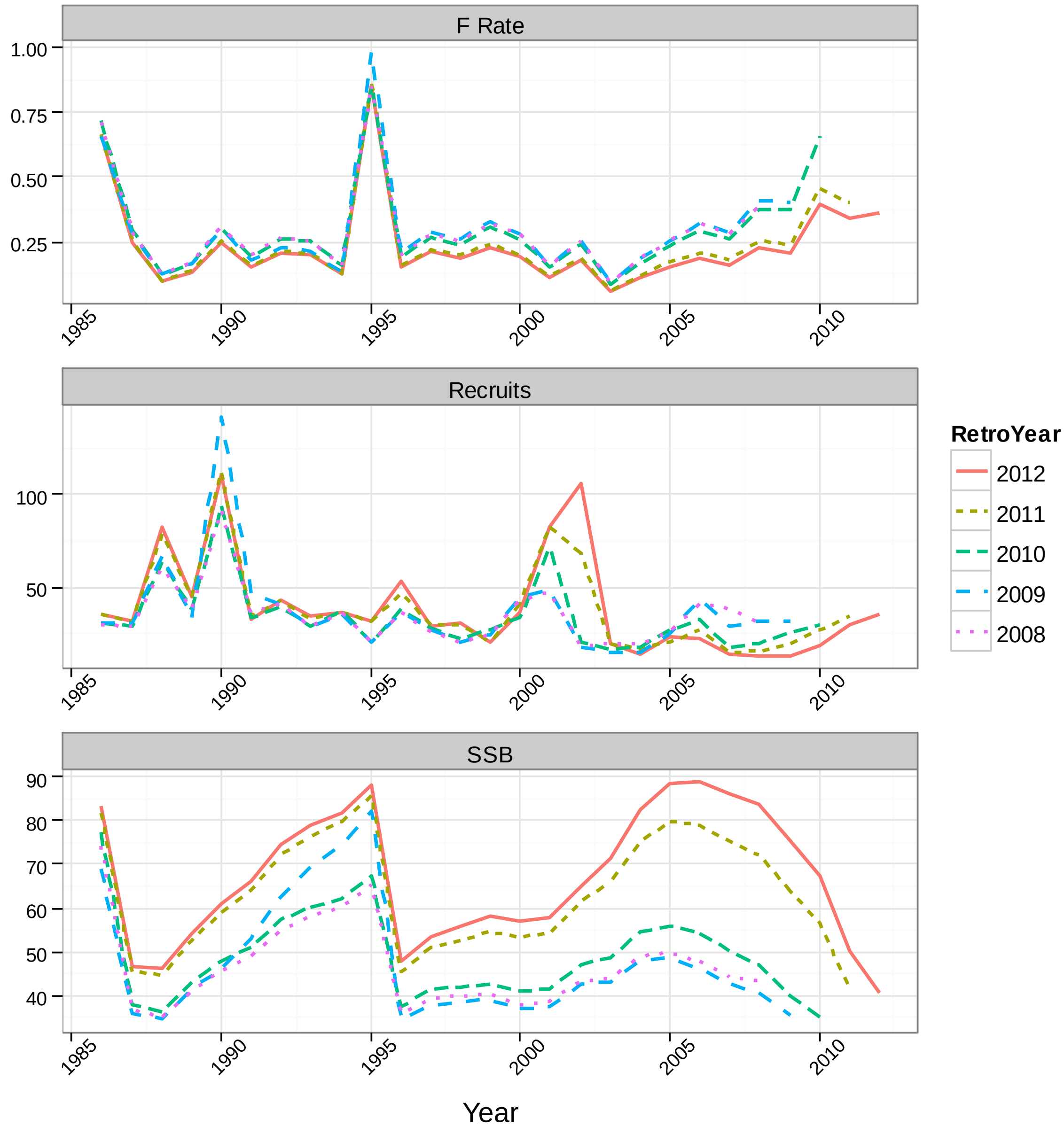


Figure 11.2.8.1. Equilibrium yield calculations from SS for Hogfish in the WFL stock base model configuration.

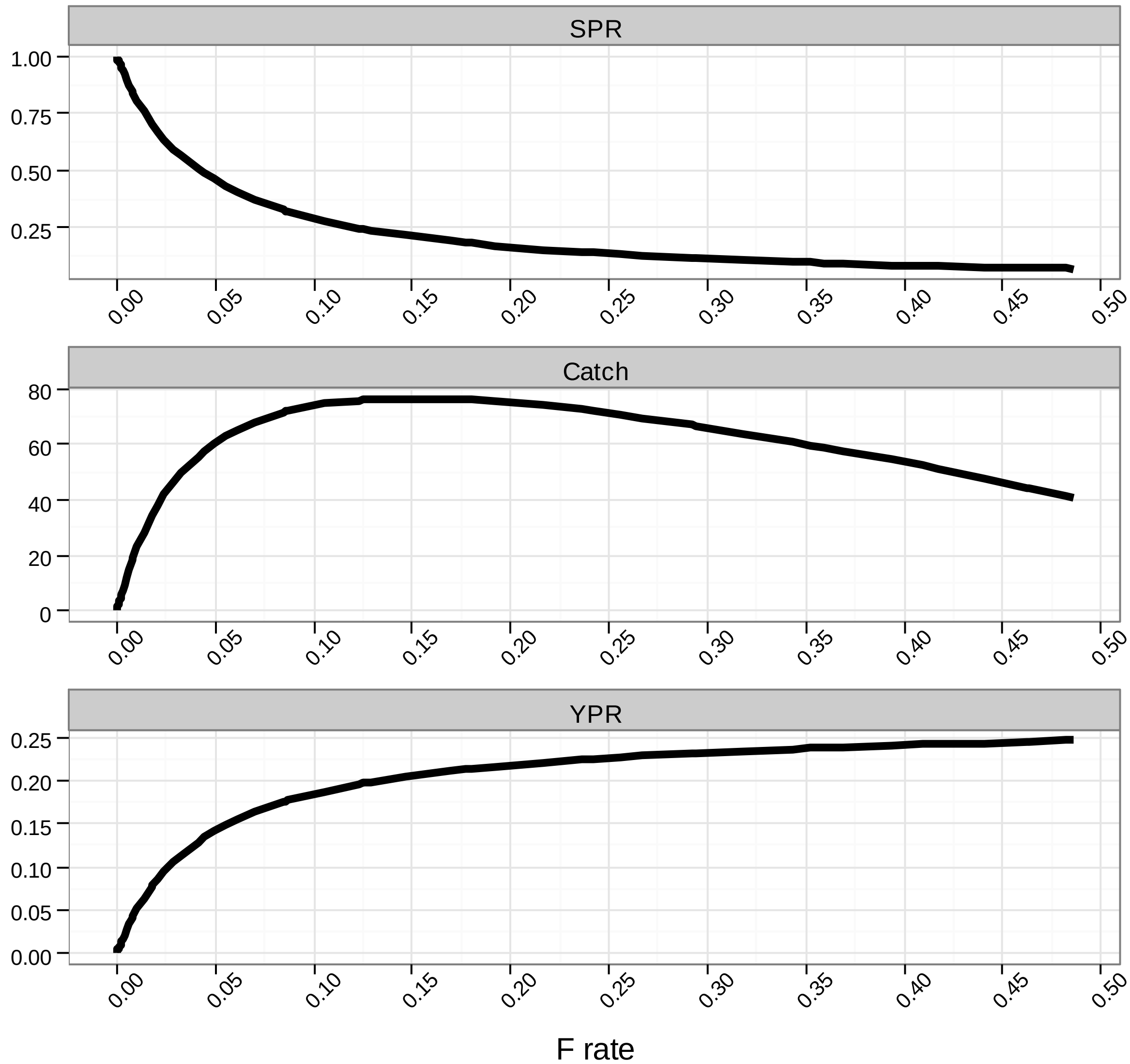


Figure 11.2.8.2. Equilibrium yield calculations from SS for Hogfish in the FLK/EFL stock base model configuration.

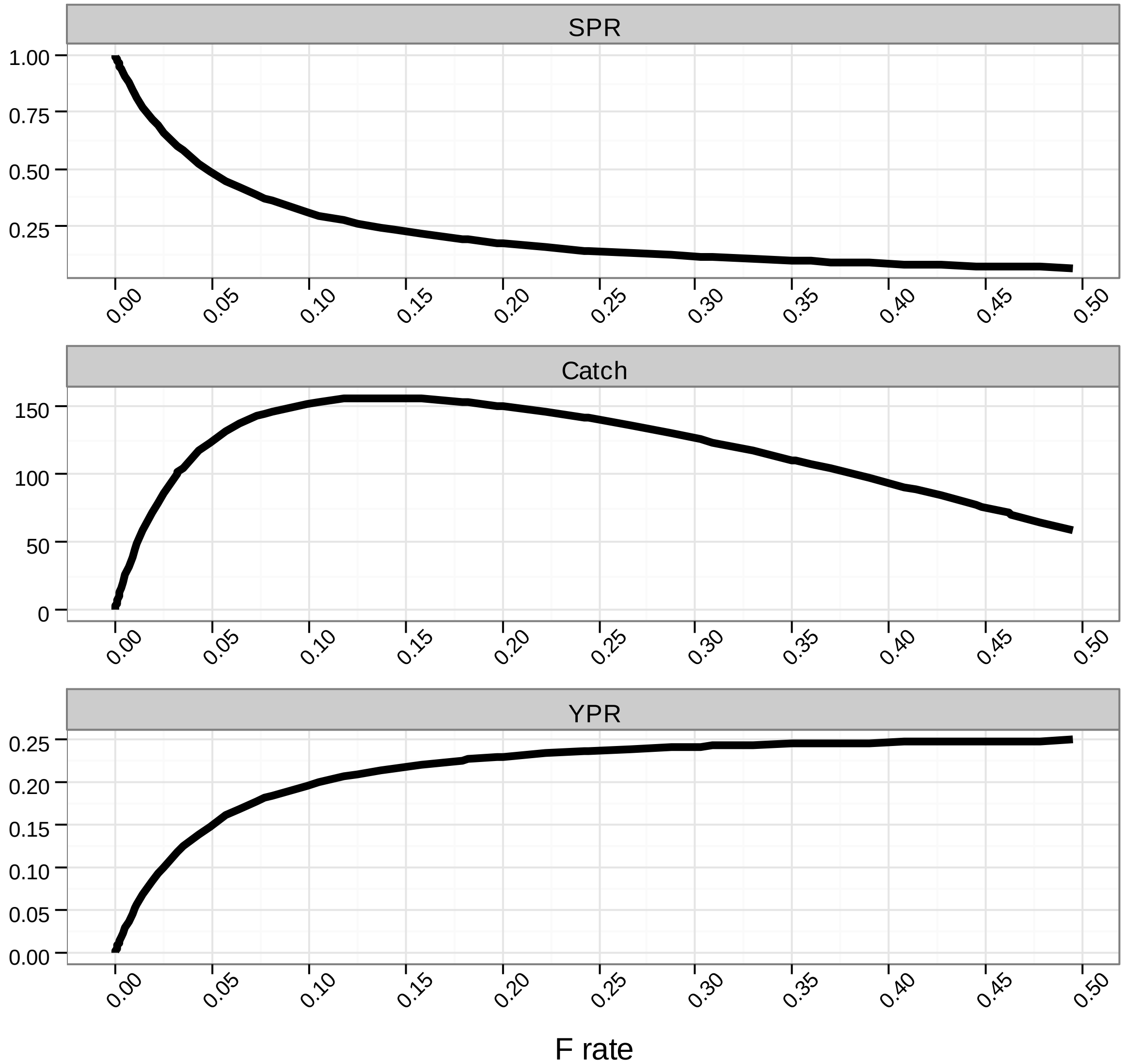


Figure 11.2.8.3. Equilibrium yield calculations from SS for Hogfish in the GA-NC stock base model configuration.

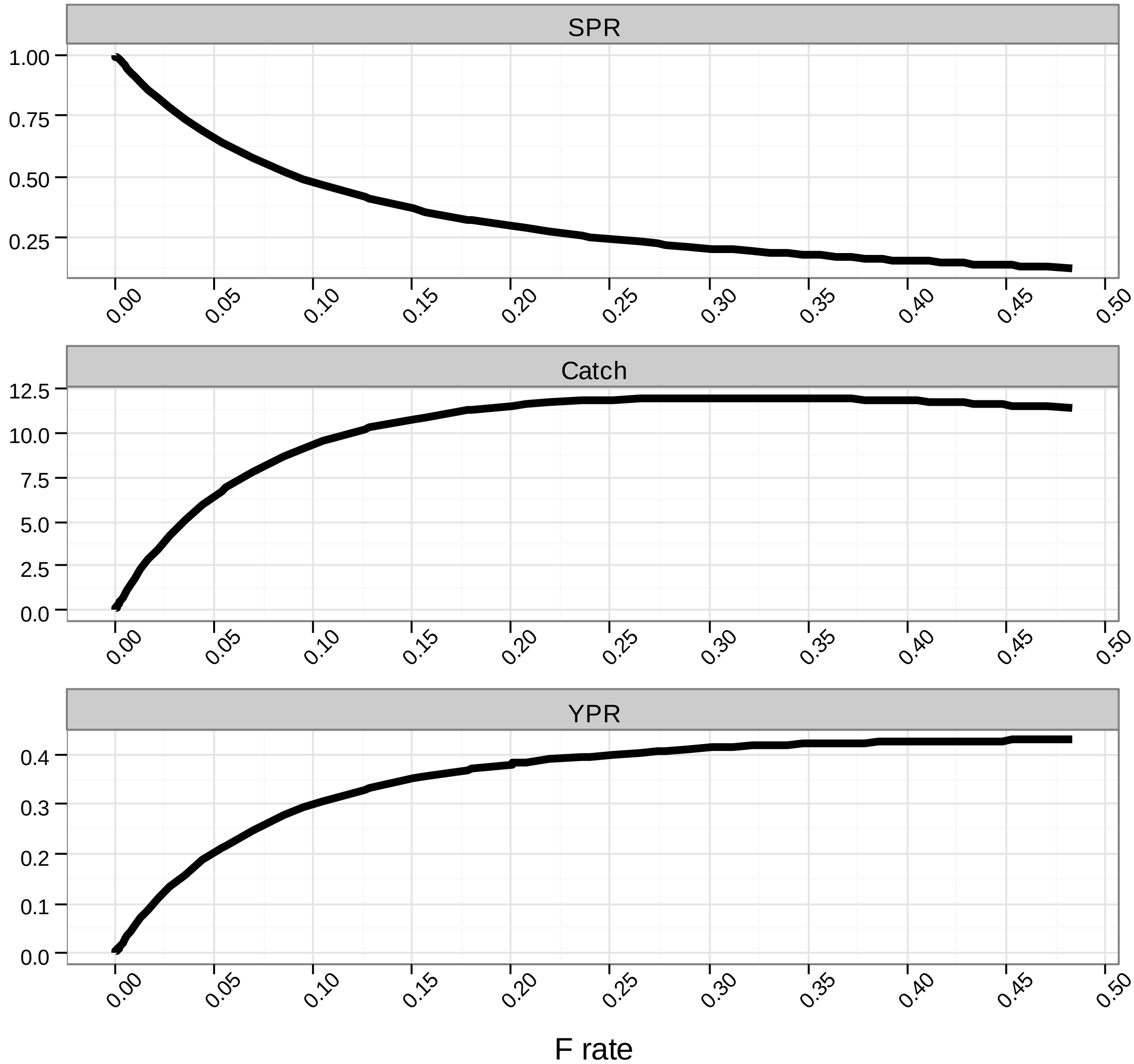


Figure 11.2.9.1. Projections from the WFL stock for alternative MFMTs (F_{MSY}, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$), F_0, and $F_{Current}$, where $F_{Current}$ is the geometric mean of the terminal three years (2010-2012).

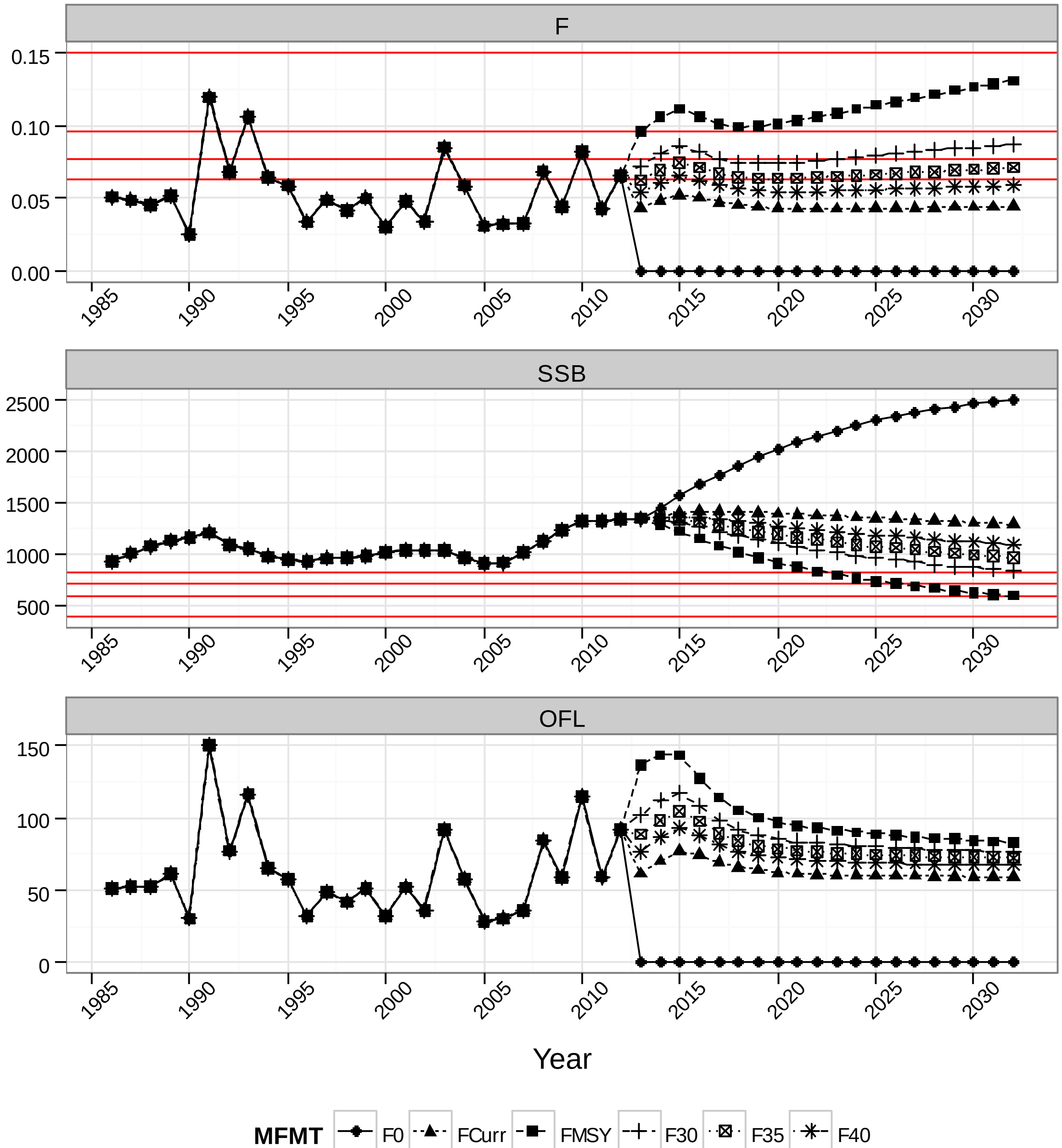


Figure 11.2.9.2. Projections from the FLK/EFL stock for alternative MFMTs (FMSY, F30%, F35%, and F40%), F0, and FCurrent, where FCurrent is the geometric mean of the terminal three years (2010-2012).

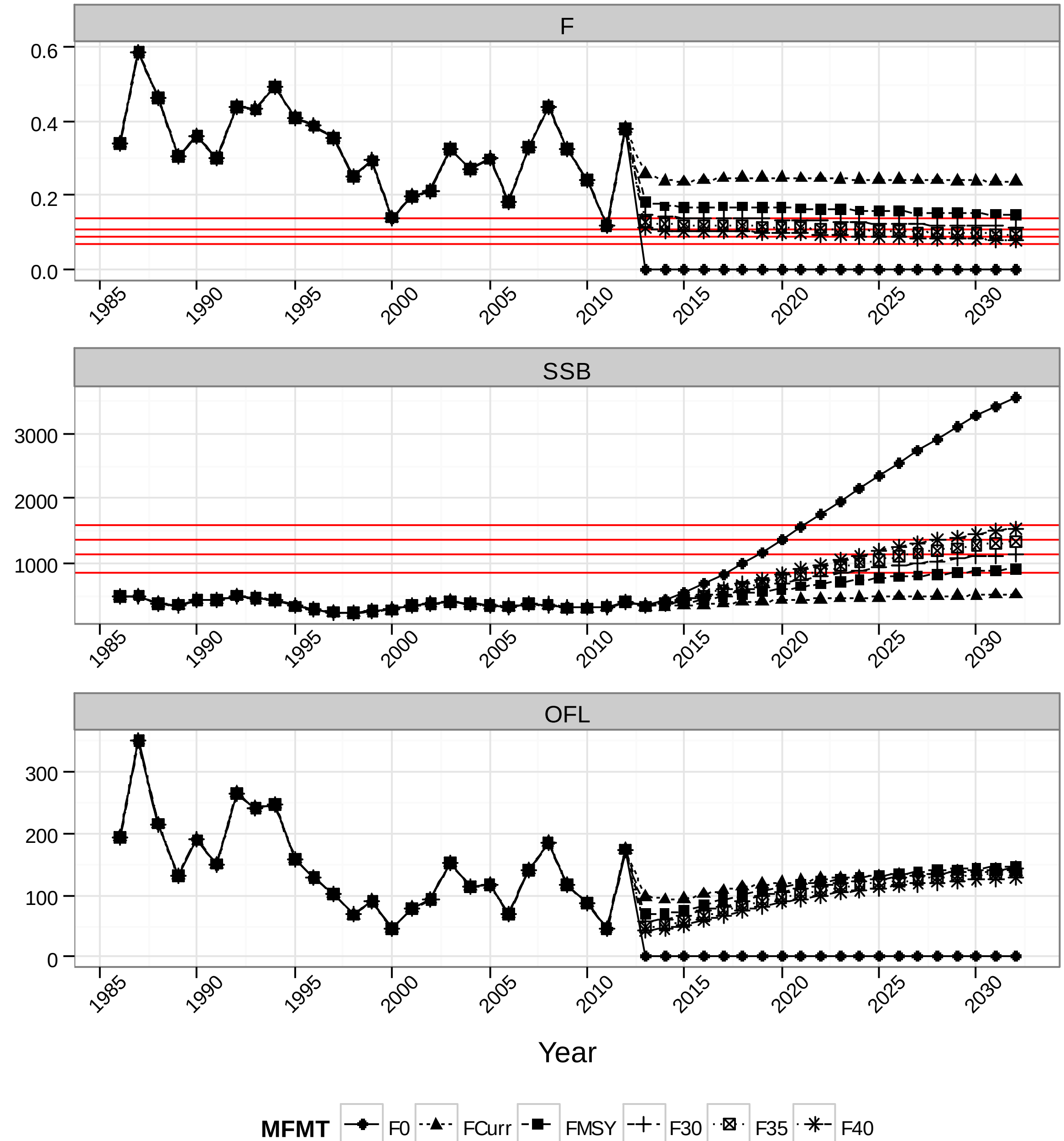
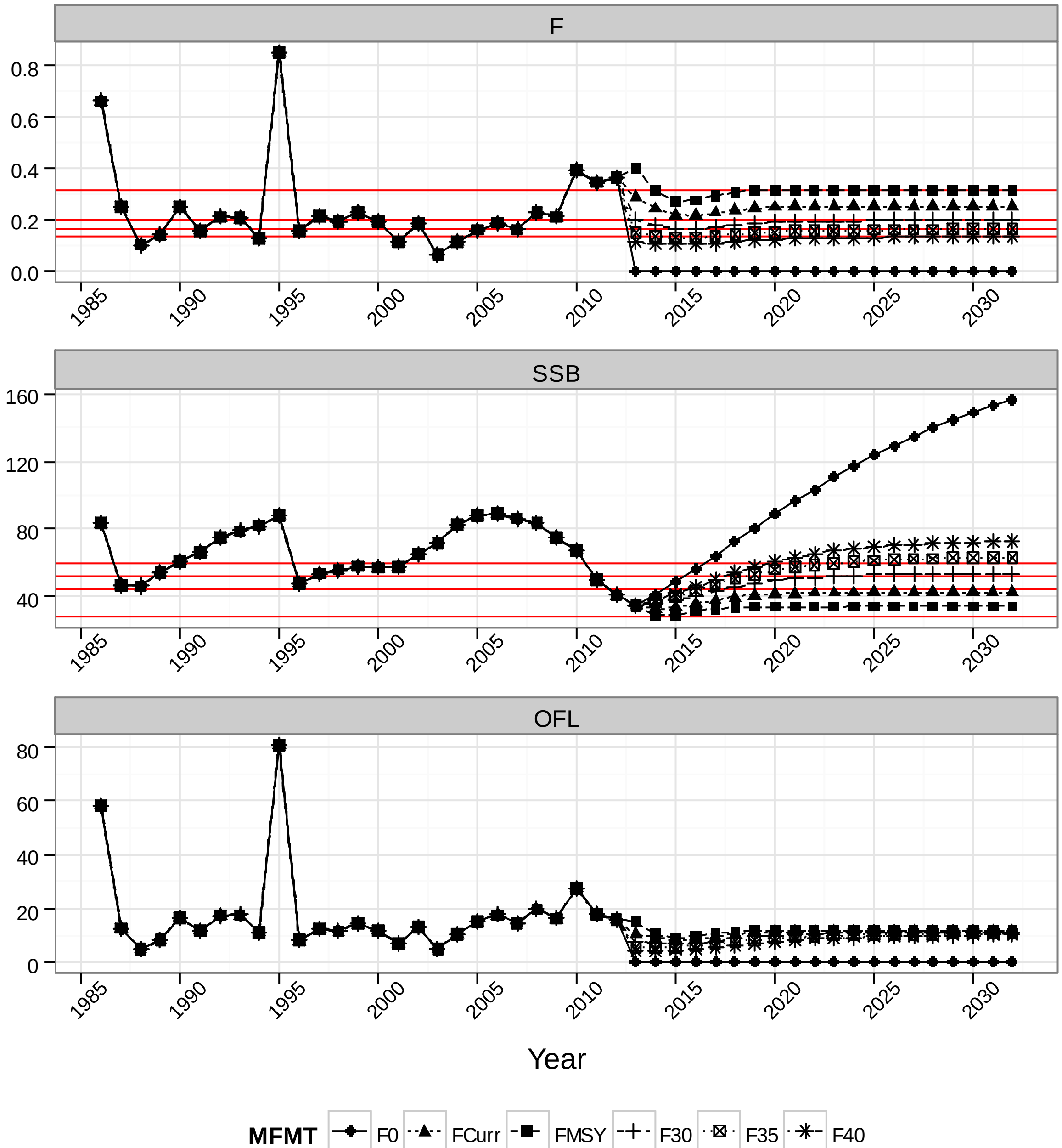


Figure 11.2.9.3. Projections from the GA-NC stock for alternative MFMTs (FMSY, F30%, F35%, and F40%), F0, and FCurrent, where FCurrent is the geometric mean of the terminal three years (2010-2012). Red lines are the corresponding targets (FMFMT, SSBMSST).



12 Appendices

12.1 SS ADMB Code

12.1.1 WFL Stock Model

12.1.1.1 Starter File

hog37WFS.dat
hog37WFS.ctl
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
1 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of datafiles to produce: 1st is input, 2nd is estimates, 3rd and higher are bootstrap
10 # Turn off estimation for parameters entering after this phase
0 # MCeval burn interval
1 # MCeval 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
#vector of year values

0.0001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
1 # 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 (e.g. 0.4)
4 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
1 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates); 4=true F for range of ages
20 23 #_min and max age over which average F will be calculated
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

12.1.1.2 Data File

#hogfish SEDAR 37 - WFL stock data file
#C data file for simple example
#_observed data:
1986 #_styr
2012 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
5 #_Nfleet
4 #_Nsurveys
1 #_N_areas

```
Comm_Spear%Comm_HL%Comm_Trap%Rec_Spear%Rec_HL%Baitfish%SEAMAP%VideoIOA%RecTrawlIOA
-1 -1 -1 -1 -1 0.3 0.5 0.5 0.5 #_surveytiming_in_season; Video/SEAMAP/RecTrawl=summer, baitfish=spring
1 1 1 1 1 1 1 1 1#_area_assignments_for_each_fishery_and_survey
1 1 1 2 2 #_units of catch:  1=bio; 2=num
0.1 0.1 0.1 0.41 0.46 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3; use -1 for discard only fleets
2 #_Ngenders
20 #_Nages
1.654100353	0.772771972	0	45.52075804	2.745264696 #init_equil_catch
63 #_N_lines_of_catch_to_read
#_catch_biomass(mtons):_columns_are_fisheries,year,season
#Comm_Spear	Comm_HL	Comm_Traps	Rec_Spear	Rec_HL	Year	Season
0	0.172531835	0	8.22450245	1.018312766	1950	1
0	6.047610991	0	8.480826074	1.05004935	1951	1
0	0.301759835	0	8.73718063	1.081789765	1952	1
0	2.274271969	0	8.993504255	1.11352635	1953	1
0	0.157559223	0	9.249827879	1.145262934	1954	1
0	2.122020435	0	9.506182435	1.177003349	1955	1
0	1.588103497	0	9.762506059	1.208739934	1956	1
0	4.241268325	0	10.01882968	1.240476518	1957	1
0	2.617737594	0	10.27518424	1.272216933	1958	1
0	1.752382293	0	11.31065497	1.400423238	1959	1
0	0.638519971	0	11.58597012	1.434511248	1960	1
0	0.508313736	0	12.82762563	1.588246221	1961	1
0	0.528492035	0	12.10010205	1.498168242	1962	1
0	0.45359237	0	12.36301393	1.53072055	1963	1
0	0.509142782	0	12.95864855	1.604468759	1964	1
0	0.353073652	0	13.68428535	1.694313127	1965	1
0	2.397755404	0	14.03698938	1.737983005	1966	1
0	1.633226264	0	15.26466417	1.889986961	1967	1
0	3.070777035	0	15.34446566	1.899867544	1968	1
0	2.184845908	0	16.12389115	1.996371731	1969	1
0	1.386261616	0	17.40637534	2.155161886	1970	1
0	1.600457405	0	21.82453228	2.702193836	1971	1
0	1.565522534	0	22.61673219	2.800279682	1972	1
0	0.597390429	0	23.90534068	2.959828115	1973	1
0	0.788523165	0	25.80842064	3.195457034	1974	1
0	1.726628044	0	26.93052857	3.334390281	1975	1
0	1.181140926	0	25.42497138	3.147980451	1976	1
0	3.583379723	0	22.87141648	2.831813294	1977	1
0	1.36077711	0	20.65704884	2.557642443	1978	1
0	2.313321087	0	22.15453309	2.743052726	1979	1
0	1.622046315	0	18.21459741	2.255231508	1980	1
0	0.667687969	0	0	5.29345646	1981	1
0	0.626411063	0	5.329090596	0	1982	1
0	1.110394122	0	20.58876015	0	1983	1
0.013101076	1.06075087	0	0	0	1984	1
1.339717036	1.012531343	0	0	0	1985	1
1.654100353	0.772771972	0	45.52075804	2.745264696	1986	1
0.328158343	1.950679962	0	46.4689627	1.213332125	1987	1
0.235831683	3.003674995	0	37.87690656	6.109542335	1988	1
0.486374198	12.28282779	0	38.0669843	3.985817436	1989	1
3.300527941	14.01691142	0	6.116190398	5.230400238	1990	1
10.40796149	6.009299712	0.011036363	113.3273081	0.094	1991	1
8.141350634	2.078835665	1.859598758	52.43263666	4.843938353	1992	1
7.11784228	4.069465717	7.664929867	76.5992564	11.68579079	1993	1
```

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6.102551352   5.197526243   2.40857635    37.61065428   11.48048467   1994   1
2.709434089   3.290924721   1.529691072   32.70931061   15.59865469   1995   1
3.834561045   1.990595607   2.079260493   15.54517642   6.638228968   1996   1
3.508713664   1.80883982    3.086819527   24.28086346   13.07070996   1997   1
2.967150127   1.509598937   1.524791607   30.14540494   4.445129606   1998   1
2.081123603   1.910716421   1.963296557   40.0721825    2.509396156   1999   1
3.55639492    4.058439156   0.826389343   11.57430194   10.84934319   2000   1
5.595680521   2.638597424   1.846791318   30.38600582   8.325553708   2001   1
7.823852094   2.294815839   1.873936651   14.18346362   6.442868508   2002   1
7.451163774   2.599423376   0.605819036   44.83882949   23.03848743   2003   1
8.161338417   0.993593384   0.356056577   41.64891792   1.282606638   2004   1
6.143546628   1.198015305   0.011262189   14.33886875   4.593271379   2005   1
5.480641579   0.560836325   0.000464268   15.12207256   7.442074993   2006   1
6.326637047   0.747790785   0   23.05202356   7.989183909   2007   1
9.103291411   1.214200091   0   71.90893607   8.842517893   2008   1
12.69346876   1.170414388   0   37.08368436   7.599534191   2009   1
12.84852486   2.479031731   0.06618774    76.89004881   13.46125293   2010   1
17.46885353   2.544264356   0.029506994   21.44584868   11.71609103   2011   1
16.93367453   1.761752765   0   44.23504369   14.65915885   2012   1
#
111 #with baitfish 105 #_N_cpue_and_surveyabundance_observations
#_Units:  0=numbers; 1=biomass; 2=F
#_Errtype:  -1=normal; 0=lognormal; >0=T
#_Fleet   Units   Errtype
1   1   0   #Comm_Spear
2   1   0   #Comm_HL
3   1   0   #Comm_Trap
4   0   0   #Rec_Spear
5   0   0   #Rec_HL
6   0   0   #BaitfishIOA
7   0   0   #SEAMAPIOA
8   0   0   #VideoIOA
9   0   0   #RecTrawlIOA
#year   Seas   Index   ObsScaled     LOG(SE)
1993   1   1   0.899900939   0.26598648    #Comm_Spear_Logbook
1994   1   1   0.75115147    0.244923625   #Comm_Spear_Logbook
1995   1   1   0.924176045   0.265204585   #Comm_Spear_Logbook
1996   1   1   0.495002101   0.235256925   #Comm_Spear_Logbook
1997   1   1   0.743263586   0.206864415   #Comm_Spear_Logbook
1998   1   1   0.776957835   0.231810447   #Comm_Spear_Logbook
1999   1   1   0.596117323   0.224099927   #Comm_Spear_Logbook
2000   1   1   1.154608488   0.189827785   #Comm_Spear_Logbook
2001   1   1   1.816105376   0.194906088   #Comm_Spear_Logbook
2002   1   1   1.527801002   0.197047714   #Comm_Spear_Logbook
2003   1   1   1.352185328   0.189230666   #Comm_Spear_Logbook
2004   1   1   0.767095964   0.207921739   #Comm_Spear_Logbook
2005   1   1   0.897373126   0.218137577   #Comm_Spear_Logbook
2006   1   1   0.450140957   0.212673403   #Comm_Spear_Logbook
2007   1   1   0.662014283   0.216160225   #Comm_Spear_Logbook
2008   1   1   0.932583648   0.181191844   #Comm_Spear_Logbook
2009   1   1   1.765629971   0.188301419   #Comm_Spear_Logbook
2010   1   1   0.988245674   0.180510303   #Comm_Spear_Logbook
2011   1   1   1.207250226   0.182017438   #Comm_Spear_Logbook
2012   1   1   1.292396656   0.174917361   #Comm_Spear_Logbook
1994   1   2   1.256405471   0.136485898   #Comm_HL
1995   1   2   1.188408189   0.177418633   #Comm_HL
```

1996	1	2	1.056670626	0.158785858	#Comm_HL
1997	1	2	0.857464269	0.171895357	#Comm_HL
1998	1	2	0.481548696	0.199215988	#Comm_HL
1999	1	2	0.59152771	0.185050439	#Comm_HL
2000	1	2	1.13510031	0.144519108	#Comm_HL
2001	1	2	1.100434997	0.144864643	#Comm_HL
2002	1	2	1.393987119	0.156524381	#Comm_HL
2003	1	2	0.833102065	0.203812015	#Comm_HL
2004	1	2	0.393470453	0.226613282	#Comm_HL
2005	1	2	0.686326004	0.235596635	#Comm_HL
2006	1	2	0.664976347	0.306330147	#Comm_HL
2007	1	2	0.44124132	0.353963095	#Comm_HL
2008	1	2	0.752004077	0.322360232	#Comm_HL
2009	1	2	0.8369227	0.269459918	#Comm_HL
2010	1	2	1.67098962	0.289631466	#Comm_HL
2011	1	2	2.633660342	0.212888947	#Comm_HL
2012	1	2	1.025759685	0.351486444	#Comm_HL
1992	1	4	0.63334313	0.511022178	#Rec_Spear
1993	1	4	1.75480482	0.308935056	#Rec_Spear
1994	1	4	0.822295575	0.364846973	#Rec_Spear
1995	1	4	0.91208366	0.390183361	#Rec_Spear
1996	1	4	0.350237532	0.405850675	#Rec_Spear
1997	1	4	0.60660002	0.366498441	#Rec_Spear
1998	1	4	1.147655164	0.288062536	#Rec_Spear
1999	1	4	0.809992148	0.201521588	#Rec_Spear
2000	1	4	0.560710447	0.681131581	#Rec_Spear
2001	1	4	0.718872741	0.300782093	#Rec_Spear
2002	1	4	0.577853129	0.442452296	#Rec_Spear
2003	1	4	0.952632595	0.256091271	#Rec_Spear
2004	1	4	0.918518307	0.350013326	#Rec_Spear
2005	1	4	0.486867513	0.399642022	#Rec_Spear
2006	1	4	0.74223776	0.304290451	#Rec_Spear
2007	1	4	1.20432822	0.356623847	#Rec_Spear
2008	1	4	1.231927587	0.254035859	#Rec_Spear
2009	1	4	1.208652931	0.260015672	#Rec_Spear
2010	1	4	1.554515746	0.262140442	#Rec_Spear
2011	1	4	1.359086981	0.259119055	#Rec_Spear
2012	1	4	2.446783993	0.224776701	#Rec_Spear
1991	1	5	1.581128308	1.167498181	#Rec_HL
1992	1	5	0.50425847	0.422081515	#Rec_HL
1993	1	5	0.751075064	0.480244942	#Rec_HL
1994	1	5	1.006565957	0.406978644	#Rec_HL
1995	1	5	0.846951993	0.358607864	#Rec_HL
1996	1	5	1.03532219	0.481731286	#Rec_HL
1997	1	5	0.912879606	0.38823745	#Rec_HL
1998	1	5	0.978342699	0.341086776	#Rec_HL
1999	1	5	0.50194076	0.376379492	#Rec_HL
2000	1	5	0.667133854	0.392365987	#Rec_HL
2001	1	5	0.579046192	0.421105027	#Rec_HL
2002	1	5	0.471512255	0.372140161	#Rec_HL
2003	1	5	1.675464987	0.29124532	#Rec_HL
2004	1	5	0.219317009	0.589608141	#Rec_HL
2005	1	5	0.633365694	0.446246297	#Rec_HL
2006	1	5	0.62228567	0.576783192	#Rec_HL
2007	1	5	1.100257197	0.366742642	#Rec_HL
2008	1	5	0.842712637	0.341386514	#Rec_HL

2009	1	5	0.867728262	0.305867721	#Rec_HL
2010	1	5	3.303451139	0.365250702	#Rec_HL
2011	1	5	2.076629354	0.381156132	#Rec_HL
2012	1	5	0.822630703	0.542393738	#Rec_HL
2002	1	6	0.158920954	0.80172897	#Baitfish
2003	1	6	1.439711945	0.641483971	#Baitfish
2004	1	6	1.506951509	0.656704287	#Baitfish
2005	1	6	0.936642216	0.85506625	#Baitfish
2006	1	6	0.244123789	0.573771796	#Baitfish
2007	1	6	1.320643929	0.489048159	#Baitfish
2008	1	6	0.91072799	0.535996459	#Baitfish
2009	1	6	2.036917064	0.505268886	#Baitfish
2010	1	6	0.683782192	0.543404068	#Baitfish
2011	1	6	0.618603987	0.547651645	#Baitfish
2012	1	6	1.142974425	0.535431048	#Baitfish
2008	1	7	2.016370977	0.763668429	#SEAMAP
2009	1	7	0.742434905	0.357197546	#SEAMAP
2010	1	7	0.715026482	0.318638415	#SEAMAP
2011	1	7	0.438164376	0.389187014	#SEAMAP
2012	1	7	1.088003259	0.271139511	#SEAMAP
2005	1	8	0.968198513	0.295715738	#VideoIOA
2006	1	8	0.783660306	0.257283014	#VideoIOA
2007	1	8	0.050882379	1.077057808	#VideoIOA
2008	1	8	1.237301801	0.204057254	#VideoIOA
2009	1	8	1.358416196	0.169475765	#VideoIOA
2010	1	8	1.016930933	0.193961365	#VideoIOA
2011	1	8	0.878616859	0.159971078	#VideoIOA
2012	1	8	1.705993013	0.124911171	#VideoIOA
2008	1	9	1.346003983	0.154375653	#RecTrawlIOA
2009	1	9	0.267339164	0.246889531	#RecTrawlIOA
2010	1	9	0.443111958	0.223191401	#RecTrawlIOA
2011	1	9	0.640748117	0.192502746	#RecTrawlIOA
2012	1	9	2.302796779	0.160657724	#RecTrawlIOA

0 #_N_fleets_with_discard
0 #N discard obs
#
0 #_N_meanbodywt_obs
30 #_DF_for_meanbodywt_T-distribution_like

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
2 # minimum size in the population (lower edge of first bin and size at age 0.00)
90 # maximum size in the population (lower edge of last bin)

-0.0001 #_comp_tail_compression

0.0001 #_add_to_comp
0 #_combine males into females at or below this bin number
45 #_N_LengthBins
2 4 6 8 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 82 84 86 88 90
101 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)

#Year Seas Fleet Gender Part NsampRaw 2 4 6 8 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 82 84 86 88 90 2 4 6 8 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 82 84 86 88 90
1991 1 1 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 1 1 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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19 #_N_age_bins
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1 #_N_ageerror_definitions; these define how SS will convert true age into a distribution of expected ages to represent the effect of ageing bias and imprecision
#true_age=0 1 2 etc.,
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
0.001 0.001
#
130 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
1 #_combine males into females at or below this bin number
#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
#Year Seas Fleet Gender Part AgeErr Lbin_lo Lbin_hi NsampRaw 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
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2011 1 6 0 0 1 21 21 1 0 0 0 0 0 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 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 8 8 8 0 8 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 9 9 13 0 12 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 10 10 9 0 8 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 11 11 10 0 4 3 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 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 12 12 2 0 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 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 13 13 4 0 0 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 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 14 14 5 0 0 0 1 3 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 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 15 15 2 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 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 16 16 1 0 0 0 0 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 0 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 17 17 5 0 0 0 1 2 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 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 18 18 3 0 0 0 0 1 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 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 21 21 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0
2012 1 6 0 0 1 22 22 1 0 0 0 0 0 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 0 0 0 0 0 0 0 0
2012 1 6 0 0 1 23 23 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0
2008 1 7 0 0 1 10 10 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 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 11 11 4 0 1 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 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 12 12 6 0 1 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 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 13 13 3 0 0 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 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 14 14 3 0 0 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 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 15 15 1 0 0 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 0 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 16 16 2 0 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 0 0 0 0 0 0 0 0 0 0 0
2008 1 7 0 0 1 18 18 2 0 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 0 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 8 8 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 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 9 9 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 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 10 10 12 0 10 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 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 11 11 20 0 12 5 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 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 12 12 18 0 6 11 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 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 13 13 15 0 1 6 8 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 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 14 14 8 0 1 2 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 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 15 15 11 0 0 1 10 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 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 16 16 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 17 17 6 0 0 0 5 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 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 18 18 3 0 0 0 2 0 0 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 0 0 0 0 0 0 0
2009 1 7 0 0 1 19 19 1 0 0 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 0 0 0 0 0 0 0 0 0 0 0
2009 1 7 0 0 1 20 20 2 0 0 0 1 0 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 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 7 7 4 0 4 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 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 8 8 12 0 8 4 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 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 9 9 12 0 1 10 0 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 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 10 10 6 0 0 5 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 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 11 11 5 0 1 2 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 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 12 12 5 0 0 2 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 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 13 13 7 0 0 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 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 1 17 17 3 0 0 0 1 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 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 8 8 6 0 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 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 9 9 3 0 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 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 10 10 9 0 4 0 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 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 11 11 3 0 0 0 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 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 12 12 4 0 0 1 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 0 0 0 0 0 0 0 0 0

2011 1 7 0 0 1 13 13 5 0 0 0 2 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 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 14 14 3 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 1 19 19 1 0 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 7 7 3 0 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 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 8 8 10 0 8 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 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 9 9 19 0 17 1 0 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 10 10 17 0 13 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 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 11 11 14 0 9 1 2 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 12 12 7 0 4 1 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 13 13 4 0 0 0 0 3 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 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 14 14 3 0 0 0 1 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 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 15 15 4 0 0 0 1 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 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 16 16 3 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 19 19 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 20 20 3 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0
2012 1 7 0 0 1 21 21 3 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0

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

12.1.1.3 Control File

#hogfish SEDAR 37 - WFL stock control file
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
1 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
2
begin and end years of blocks
1994 1998 1999 2012
#
1 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_Age_natmort_by gender x growthpattern
#Lorenz05:
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
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)
0 #_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 matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
1 #_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
1 #_hermaphroditism option: 0=none; 1=age-specific fxn
-1 #_season of transition (-1 at end of each season)
1 #_include males in spawning biomass (0=no, 1=yes)
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
0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Fem_GP_1
0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Mal_GP_1
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem
7.735 23.2 15.469570 15.469570 -1 0.2 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-0.1472 -0.04907 -0.09815 -0.09815 -1 0.2 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
-1 1 1 1 -1 0.2 -2 0 0 0 0 0 0 0 # Eg/kg_inter_Female
0 4 1 1 -1 0.2 -3 0 0 0 0 0 0 0 # Eg/kg_slope_wt_Female
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Mal
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Mal
1 15 7.5 7.5 -1 0 -4 0 0 0 0 0 0 0 # herm_inflection_age
1 5 2.15 2.15 -1 0 -4 0 0 0 0 0 0 0 # herm_stdev(in_age)
0 1 .999 .999 -1 0 -4 0 0 0 0 0 0 0 # herm_asymptotic_rate
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1
-4 4 0 0 -1 1 -4 0 0 0 0 0 0 0 # RecrDist_Area1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1
0 0 1 1 -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
1 40 10 10 -1 0.4 1 # SR_log(R0)
0.2 1 0.748 0.748 2 .146 1 # SR_steep #beta prior from Shertzer and Conn (2012)
0 2 0.6 0.6 -1 50 -4 # SR_sigmaR
-5 5 0 0 -1 50 -3 # SR_envlink
-5 5 0 0 -1 50 1 # SR_R1_offset
0 0.5 0 0 -1 50 -2 # 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
1993 # first year of main recr_devs; early devs can preceed this era
2012 # last year of main recr_devs; forecast devs start in following year
2 #_recdev phase
1 # (0/1) to read 13 advanced options
1950 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
3 #_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

#from preliminary SS run based on Methot and Taylor 2011
1985.0000 #_last_early_yr_nobias_adj_in_MPD
1995.9387 #_first_yr_fullbias_adj_in_MPD
2012.5754 #_last_yr_fullbias_adj_in_MPD
2012.7038 #_first_recent_yr_nobias_adj_in_MPD
0.8447 #_max_bias_adj_in_MPD (1.0 to mimic pre-2009 models)
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
#
#Fishing Mortality info
0.06 # F ballpark for tuning early phases #WTC - this from McBride MARFIN project catch curve; same as McBride and Murphy 2003
1998 # F ballpark year (neg value to disable)
3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
3 # max F or harvest rate, depends on F_Method

if Fmethod=3, then read number of tuning iterations in hybrid method
4

#_initial_F_parms - 1986 start
#_LO HI INIT PRIOR PR_type SD PHASE

0.00001	.1	0.004	0.002	-3	.1	1	#_InitF_1CommSpear
0.00001	.1	0.001	0.001	-3	.1	-1	#_InitF_1CommHL
0	.1	0	0.01	-1	.1	-1	#_InitF_1CommTrap
0.00001	.5	0.067	0.067	-3	.1	1	#_InitF_2RecSpear
0.00001	.1	0.004	0.004	-3	.1	1	#_InitF_2RecHL

#
#_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_CommSpear
0	0	0	0	#_2_CommHL
0	0	0	0	#_3_CommTraps - no CPUE
0	0	0	0	#_4_RecSpear
0	0	0	0	#_5_RecHL
0	0	0	0	#_6_Baitfish
0	0	0	0	#_7_SEAMAP
0	0	0	0	#_8_VideoIOA
0	0	0	0	#_9_RecTrawlIOA
#
#1 #_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)

#
#_size_selex_types
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead
#_Pattern Discard Male Special
24	0	0	0	#_1_CommSpear
24	0	0	0	#_2_CommHL
24	0	0	0	#_3_CommTrap
24	0	0	0	#_1_RecSpear
24	0	0	0	#_2_RecHL
24	0	0	0	#_6_BaitfishIOA
5	0	0	6	#_7_SEAMAP
24	0	0	0	#_8_VideoIOA
0	0	0	0	#_9_RecTrawlIOA

#
#_age_selex_types
#_Pattern ___ Male Special
10	0	0	0	#_1_CommSpear
10	0	0	0	#_2_CommHL
10	0	0	0	#_3_CommTrap
10	0	0	0	#_4_RecSpear
10	0	0	0	#_5_RecHL
10	0	0	0	#_6_BaitfishIOA
10	0	0	0	#_7_SEAMAP
10	0	0	0	#_8_VideoIOA
11	0	0	0	#_9_RecTrawlIOA

#Selectivity_parameters_to_be_estimated
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#Double Norm params: 1=peak start; 2=peak width; 3=asc limb width; 4=desc limb width; 5=start value (0-1); 6=end value (0-1)

15	40	32	32	-1	99	3	0	0	0	0	0	0
	0	#_CommSpear_SizeSel_p1
-15	15	-5	-3	-1	99	4	0	0	0	0	0	0
	0	#_CommSpear_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0
	0	#_CommSpear_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0
	0	#_CommSpear_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0
	0	#_CommSpear_SizeSel_p5
```

-15	15	0	0	-1	99	4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p6
15	80	32	32	-1	99	3	0	0	0	0	0	0	0	#_CommHL_SizeSel_p1
-15	15	-5	-3	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p2
-15	15	0	0	-1	99	4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p3
-15	15	6	6	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p5
-15	15	15	15	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p1
-15	15	-5	-3	-1	99	4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p5
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p1
-15	15	-5	-3	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p5
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_RecHL_SizeSel_p1
-15	15	-5	-3	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p5
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p6

6 50 10 10 -1 99 3 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p1
-15 15 -9 -3 -1 99 -4 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p2
-15 15 0 0 -1 99 4 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p3
-15 15 6 6 -1 99 4 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p4
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p5
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_Baitfish_SizeSel_p6

-5 5 0 0 -1 99 -3 0 0 0 0 0 0
0 #_SEAMAP_SizeSel_p1
-5 5 0 0 -1 99 -3 0 0 0 0 0 0
0 #_SEAMAP_SizeSel_p2

6 50 21 21 -1 99 3 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p1
-15 15 -5 -3 -1 99 4 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p2
-15 15 5 5 -1 99 4 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p3
-15 15 6 6 -1 99 4 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p4
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p5
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_VideoIOA_SizeSel_p6

#Age -- set min-max age to just use size selectivity
0.1 0.9 0.1 0.1 -1 99 -1 0 0 0 0 0 0
0 # _RecTrawlIOA_AgeSel_p1

0.1 0.9 0.9 0.9 -1 99 -1 0 0 0 0 0 0
0 # _RecTrawlIOA_AgeSel_p2

#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns
#_Cond

#_Cond No selex parm trends
#_Cond -4 # placeholder for selparm_Dev_Phase

#Turn next line on for change in selectivity 1994 regulations
#2 #_Cond 0 #_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
#
1 #_Variance_adjustments_to_input_values

#_fleet: 1 2 3
0 0 0 0 0 0 0 0 0#_add_to_survey_CV
0 0 0 0 0 0 0 0 0 #_add_to_discard_stddev
0 0 0 0 0 0 0 0 0 #_add_to_bodywt_CV
1 1 1 1 1 1 1 1 1 #_mult_by_lencomp_N
1 1 1 1 1 1 1 1 1 #_mult_by_agecomp_N
1 1 1 1 1 1 1 1 1 #_mult_by_size-at-age_N
#
1 #_maxlambdaphase
1 #_sd_offset
#
0 # 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
#like_comp fleet/survey phase value sizefreq_method
##
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

12.1.1.4 Forecast File

for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
2010 2012 2010 2012 2010 2012
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
2 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
20 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
2010 2012 2010 2012
2 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.01 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.001 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
1.0 # Control rule target as fraction of Flimit (e.g. 0.75)
3 #_N forecast loops (1-3) (fixed at 3 for now)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)

0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2012 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
this will just give you retained biomass and won't have to back out the discards
3 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum;6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
1
max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1 -1
max totalcatch by area (-1 to have no max); must enter value for each fleet
-1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0 0 0 0 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
-1 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)

#
999 # verify end of input

12.1.2 FLK/EFL Stock Model

12.1.2.1 Starter File

hog37SEF.dat
hog37SEF.ctl
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
1 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of datafiles to produce: 1st is input, 2nd is estimates, 3rd and higher are bootstrap
10 # Turn off estimation for parameters entering after this phase
0 # MCeval burn interval
1 # MCeval 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
#vector of year values

0.0001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
1 # 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 (e.g. 0.4)
4 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
1 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates); 4=true F for range of ages
20 23 #_min and max age over which average F will be calculated
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

12.1.2.2 Data File

#hogfish SEDAR 37 - FLK/EFL stock data file
#C data file for simple example
#_observed data:
1986 #_styr
2012 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
5 #_Nfleet
2 #_Nsurveys
1 #_N_areas
Comm_Spear%Comm_HL%Comm_Trap%Rec_Spear%Rec_HL%RVCKeys%RVCTortugas
-1 -1 -1 -1 -1 0.5 0.5 #_surveytiming_in_season
1 1 1 1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 1 2 2 #_units of catch: 1=bio; 2=num

0.1 0.1 0.1 0.40 0.45 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3; use -1 for discard only fleets
2 #_Ngenders #WTC -- biostat data not sufficient to split out sexes, very minimal age/length freq data
20 #_Nages
11.87164212 7.340666453 3.755594867 131.5892327 33.10906911 #init_equil_catch
63 #_N_lines_of_catch_to_read
#_catch_biomass(mtons):_columns_are_fisheries,year,season

#Comm_Spear	Comm_HL	Comm_Traps	Rec_Spear	Rec_HL	Year	Season
0.352136063	6.969631719	0.512124196	136.7536033	34.52703605	1950	1
0.529601679	10.4821092	0.770218853	141.0156458	35.60310054	1951	1
0.86762931	17.17250063	1.261824647	145.2782027	36.67929488	1952	1
0.612135943	12.11566362	0.890251414	149.5402452	37.75535937	1953	1
0.654892905	12.9619282	0.952434408	153.8022877	38.83142386	1954	1
0.557010711	11.0246008	0.810080798	158.0648446	39.9076182	1955	1
0.612399586	12.12088176	0.89063484	162.3268871	40.98368269	1956	1
0.62793307	12.42832729	0.913225746	166.5889297	42.05974718	1957	1
0.38543131	7.628625887	0.560546677	170.8514865	43.13594152	1958	1
0.317315343	6.28044472	0.461483165	188.0688629	47.48292003	1959	1
0.413640624	8.18695702	0.601572501	192.6466884	48.63871224	1960	1
0.740274682	14.65184186	1.076608211	213.2924195	53.85126887	1961	1
0.323485432	6.40256585	0.47045655	201.1954601	50.797074	1962	1
0.411730846	8.149157857	0.598795042	205.5670496	51.90079648	1963	1
0.473335966	9.368473474	0.688389594	215.471014	54.40131221	1964	1
0.339762898	6.724736595	0.494129455	227.5366008	57.44758624	1965	1
0.358223509	7.090117133	0.520977389	233.4012166	58.92826241	1966	1
0.302060489	5.978513948	0.43929748	253.814482	64.08212697	1967	1
0.474423498	9.38999838	0.689971231	255.1413879	64.41713921	1968	1
0.303796107	6.01286607	0.441821653	268.1013505	67.68922188	1969	1
0.468500383	9.272765496	0.681357031	289.4259637	73.07318012	1970	1
0.398729159	7.891822767	0.57988622	362.8892382	91.62091171	1971	1
0.398253666	7.882411598	0.579194693	376.0616086	94.9466223	1972	1
0.343101718	6.790820003	0.498985223	397.4880542	100.3562908	1973	1
0.303348473	6.0040063	0.441170642	429.1316756	108.3455535	1974	1
0.370215068	7.327459332	0.538417146	447.7896193	113.056241	1975	1
0.270956759	5.362895263	0.394062203	422.755841	106.7358067	1976	1
0.479122691	16.27942453	0	380.296393	96.01580476	1977	1
0.287473615	14.48592861	2.041165665	343.4768097	86.71973466	1978	1
0.862420844	17.70502386	2.177243376	368.3763544	93.00627819	1979	1
0.808759103	26.95624372	1.094064796	302.8647439	76.46615286	1980	1
2.566181134	23.61390312	1.964962147	1699.556359	19.44918703	1981	1
1.018913586	11.8804614	1.290936383	65.28561201	0.105	1982	1
0.726268883	14.97242238	0.229189746	384.7618465	8.48023372	1983	1
1.668277289	12.59647781	2.685137313	354.9407204	245.7432228	1984	1
1.193884281	9.695686108	8.288803726	0	236.2926015	1985	1
11.87164212	7.340666453	3.755594867	131.5892327	33.10906911	1986	1
7.03667636	10.65603652	13.6556736	210.0716883	119.9304217	1987	1
7.885402175	8.270039402	15.34802294	149.3970304	44.58517746	1988	1
3.204604931	11.10361151	22.70703582	20.81218842	85.31710063	1989	1
14.77623931	5.361841587	15.71350438	99.03156096	61.7057028	1990	1
15.14919576	7.044129579	11.11517044	49.95101281	74.69351136	1991	1
24.73780137	8.291813171	10.55182793	157.0211468	61.43981281	1992	1
19.60513636	8.733188285	15.28700963	80.95457884	139.7361899	1993	1
15.88163344	6.862494221	6.627563349	148.9106827	65.48223705	1994	1
11.0286436	6.421662266	5.053246302	46.32839646	85.41662783	1995	1
11.84422658	3.526535101	4.916432445	52.3524997	47.89703567	1996	1
7.976329056	8.704412207	5.539295602	47.02441703	28.89437609	1997	1

7.105535236	4.703170817	4.201217987	29.7602921	21.27282276	1998	1
4.612275637	3.404029523	8.027336663	59.31138489	12.76664242	1999	1
5.748339823	3.452304026	5.247594334	22.58707545	8.473761723	2000	1
5.573319223	3.86161784	1.687114202	31.48805012	35.7057994	2001	1
5.97899391	4.002528643	1.235935954	60.60062057	12.75847659	2002	1
3.960535837	6.362556647	1.588584517	91.49532137	33.50581541	2003	1
5.545151792	6.021383087	1.427856536	47.67822009	44.52924454	2004	1
4.104705852	2.898554061	0.842492067	77.91401662	13.79401547	2005	1
3.861409823	1.849531762	0.926759225	38.33439991	19.24081976	2006	1
4.922521383	2.503636253	0.735788943	95.69726619	30.49720262	2007	1
6.177453535	2.252759043	0.801861778	148.9267825	19.8328006	2008	1
3.418626932	2.461100694	0.789782928	75.52113689	35.68273377	2009	1
2.715654863	2.488456748	0.520403786	61.51609157	16.05971472	2010	1
3.131288047	2.219204863	0.694347639	24.48757327	12.98591525	2011	1
4.074060412	1.814847747	0.987379328	130.6370548	18.11912517	2012	1

#
109 #_N_cpue_and_surveyabundance_observations
#_Units: 0=numbers; 1=biomass; 2=F
#_Errtype: -1=normal; 0=lognormal; >0=T

#_Fleet	Units	Errtype	
1	1	0	#Comm_Spear
2	1	0	#Comm_HL
3	1	0	#Comm_Trap
4	0	0	#Rec_Spear
5	0	0	#Rec_HL
6	0	0	#RVCKeys
7	0	0	#RVCTortugas

#year	Seas	Index#	ObsScaled	LOG(SE)	
1993	1	1	1.560918518	0.236944667	#Comm_Spear_Logbook
1994	1	1	1.226234749	0.233210635	#Comm_Spear_Logbook
1995	1	1	1.158057574	0.236281893	#Comm_Spear_Logbook
1996	1	1	0.888489959	0.276867868	#Comm_Spear_Logbook
1997	1	1	0.708869569	0.238285003	#Comm_Spear_Logbook
1998	1	1	1.317245962	0.230290382	#Comm_Spear_Logbook
1999	1	1	1.045294405	0.252888339	#Comm_Spear_Logbook
2000	1	1	0.986721952	0.229754151	#Comm_Spear_Logbook
2001	1	1	0.736817075	0.225983497	#Comm_Spear_Logbook
2002	1	1	0.750791591	0.225027671	#Comm_Spear_Logbook
2003	1	1	0.79091657	0.249476039	#Comm_Spear_Logbook
2004	1	1	0.949358678	0.224907264	#Comm_Spear_Logbook
2005	1	1	0.903994307	0.233302623	#Comm_Spear_Logbook
2006	1	1	0.847060809	0.256904621	#Comm_Spear_Logbook
2007	1	1	0.94364369	0.243533417	#Comm_Spear_Logbook
2008	1	1	1.176428816	0.245174055	#Comm_Spear_Logbook
2009	1	1	1.135318659	0.26658385	#Comm_Spear_Logbook
2010	1	1	1.252324805	0.280582623	#Comm_Spear_Logbook
2011	1	1	0.941090048	0.261596067	#Comm_Spear_Logbook
2012	1	1	0.680422263	0.248503866	#Comm_Spear_Logbook
1994	1	2	1.01951592	0.107203252	#Comm_HL_TripTicket
1995	1	2	0.994549766	0.088295629	#Comm_HL_TripTicket
1996	1	2	0.909817759	0.091934402	#Comm_HL_TripTicket
1997	1	2	0.700075976	0.105116956	#Comm_HL_TripTicket
1998	1	2	0.620593563	0.105993602	#Comm_HL_TripTicket
1999	1	2	0.567999577	0.145419807	#Comm_HL_TripTicket
2000	1	2	0.986281386	0.109674368	#Comm_HL_TripTicket
2001	1	2	1.00621563	0.100106675	#Comm_HL_TripTicket

2002	1	2	1.157826887	0.097409473	#Comm_HL_TripTicket
2003	1	2	1.445800751	0.094365532	#Comm_HL_TripTicket
2004	1	2	1.10904956	0.104647841	#Comm_HL_TripTicket
2005	1	2	0.773930997	0.131353375	#Comm_HL_TripTicket
2006	1	2	0.976953372	0.137321081	#Comm_HL_TripTicket
2007	1	2	0.798755927	0.142569454	#Comm_HL_TripTicket
2008	1	2	1.055447213	0.139444381	#Comm_HL_TripTicket
2009	1	2	1.256999774	0.128700217	#Comm_HL_TripTicket
2010	1	2	1.418869147	0.145035924	#Comm_HL_TripTicket
2011	1	2	1.045328522	0.147245271	#Comm_HL_TripTicket
2012	1	2	1.15598827	0.142106538	#Comm_HL_TripTicket
1991	1	4	0.914259801	0.471467613	#Rec_Spear
1992	1	4	1.31308939	0.185922661	#Rec_Spear
1993	1	4	1.177248353	0.239894802	#Rec_Spear
1994	1	4	1.168205605	0.148682491	#Rec_Spear
1995	1	4	0.945948603	0.249357124	#Rec_Spear
1996	1	4	0.856296112	0.243141835	#Rec_Spear
1997	1	4	0.883410607	0.294589584	#Rec_Spear
1998	1	4	0.88370392	0.233488302	#Rec_Spear
1999	1	4	1.250298412	0.18172725	#Rec_Spear
2000	1	4	0.91273549	0.294632691	#Rec_Spear
2001	1	4	1.085745699	0.231856804	#Rec_Spear
2002	1	4	1.15319348	0.220357734	#Rec_Spear
2003	1	4	1.227314589	0.188732792	#Rec_Spear
2004	1	4	0.961744882	0.158449265	#Rec_Spear
2005	1	4	0.998017617	0.187071332	#Rec_Spear
2006	1	4	0.738572652	0.212150361	#Rec_Spear
2007	1	4	1.169314237	0.140197267	#Rec_Spear
2008	1	4	1.092133964	0.166042938	#Rec_Spear
2009	1	4	0.985663182	0.168593852	#Rec_Spear
2010	1	4	0.762450163	0.225724011	#Rec_Spear
2011	1	4	0.784095745	0.194343422	#Rec_Spear
2012	1	4	0.7365575	0.138042753	#Rec_Spear
1991	1	5	1.477390058	0.462226026	#Rec_HL
1992	1	5	1.420788254	0.190236783	#Rec_HL
1993	1	5	1.568302182	0.209476863	#Rec_HL
1994	1	5	1.253407204	0.210145449	#Rec_HL
1995	1	5	1.771248395	0.199457685	#Rec_HL
1996	1	5	1.917308883	0.242026097	#Rec_HL
1997	1	5	0.880893895	0.259037269	#Rec_HL
1998	1	5	0.955354778	0.221905979	#Rec_HL
1999	1	5	0.937097033	0.231069053	#Rec_HL
2000	1	5	0.384907273	0.400189571	#Rec_HL
2001	1	5	0.890698735	0.278061601	#Rec_HL
2002	1	5	0.498481597	0.367142337	#Rec_HL
2003	1	5	1.058424021	0.209998391	#Rec_HL
2004	1	5	0.926917064	0.221416333	#Rec_HL
2005	1	5	0.738909809	0.26016587	#Rec_HL
2006	1	5	0.798862764	0.286720119	#Rec_HL
2007	1	5	0.93035501	0.234037367	#Rec_HL
2008	1	5	0.772102097	0.23515437	#Rec_HL
2009	1	5	0.688961762	0.294848217	#Rec_HL
2010	1	5	0.60545071	0.330231865	#Rec_HL
2011	1	5	0.700336259	0.321673597	#Rec_HL
2012	1	5	0.823802217	0.236579734	#Rec_HL
1994	1	6	0.355279059	0.260224745	#RVCKeys

1995	1	6	0.402592611	0.191108689	#RVCKeys
1996	1	6	0.184629575	0.359282329	#RVCKeys
1997	1	6	0.404041061	0.211786303	#RVCKeys
1998	1	6	0.387453974	0.158201353	#RVCKeys
1999	1	6	0.631991393	0.102573288	#RVCKeys
2000	1	6	0.996049291	0.097250096	#RVCKeys
2001	1	6	1.468059182	0.091566598	#RVCKeys
2002	1	6	1.257171674	0.08602481	#RVCKeys
2003	1	6	1.266672613	0.119951724	#RVCKeys
2004	1	6	1.291347233	0.121261956	#RVCKeys
2005	1	6	1.313562462	0.105790105	#RVCKeys
2006	1	6	1.071471691	0.085836936	#RVCKeys
2007	1	6	1.151415718	0.104850797	#RVCKeys
2008	1	6	1.758520109	0.064627098	#RVCKeys
2009	1	6	1.306863912	0.062583702	#RVCKeys
2010	1	6	1.174524015	0.074133478	#RVCKeys
2011	1	6	1.159517055	0.076869822	#RVCKeys
2012	1	6	1.418837371	0.06295639	#RVCKeys
1999	1	7	1.365669261	0.128649769	#RVCTortugas
2000	1	7	0.957177769	0.096299993	#RVCTortugas
2004	1	7	0.851160698	0.106065122	#RVCTortugas
2006	1	7	0.833257652	0.091564868	#RVCTortugas
2008	1	7	1.037229882	0.138489158	#RVCTortugas
2010	1	7	0.786022036	0.090298436	#RVCTortugas
2012	1	7	1.169482703	0.077058974	#RVCTortugas

0 #_N_fleets_with_discard
0 #N discard obs
#
0 #_N_meanbodywt_obs
30 #_DF_for_meanbodywt_T-distribution_like

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
2 # minimum size in the population (lower edge of first bin and size at age 0.00)
90 # maximum size in the population (lower edge of last bin)

-0.0001 #_comp_tail_compression

0.0001 #_add_to_comp

0 #_combine males into females at or below this bin number
45 #_N_LengthBins
2 4 6 8 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 82 84 86 88 90
141 #_N_Length_obs

#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
#Year Seas Fleet Gender Part NsampRaw 2 4 6 8 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 82 84 86 88 90 2 4 6 8 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 82 84 86 88 90
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19 #_N_age_bins
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1 #_N_ageerror_definitions; these define how SS will convert true age into a distribution of expected ages to represent the effect of ageing bias and imprecision
#true_age=0 1 2 etc.,
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001
#
65 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
1 #_combine males into females at or below this bin number
#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
#Year Seas Fleet Gender Part AgeErr Lbin_lo Lbin_hi NsampRaw 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

2004	1	1	0	0	1	17	17	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2004	1	1	0	0	1	20	20	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2005	1	1	0	0	1	17	17	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	0	0	0	0
	0	0	0	0	0	0	0	0	0	0		
2005	1	1	0	0	1	21	21	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2010	1	1	0	0	1	16	16	1	0	0	0	0
	0	0	0	0	0	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	0	0	0	0		
2010	1	1	0	0	1	17	17	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	0	0	0	0
	0	0	0	0	0	0	0	0	0	0		
2010	1	1	0	0	1	19	19	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2011	1	1	0	0	1	14	14	4	0	0	0	0
	1	2	0	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	0	0	0	0	0	0		
2011	1	1	0	0	1	15	15	11	0	0	6	1
	2	0	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	0	0	0	0	0	0	0		
2011	1	1	0	0	1	16	16	5	0	0	0	4
	0	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	0	0	0	0	0	0	0	0		
2011	1	1	0	0	1	17	17	3	0	0	0	0
	1	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	0	0	0	0	0	0	0	0		
2011	1	1	0	0	1	18	18	4	0	0	1	0
	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	0	0	0	0	0	0	0	0		
2011	1	1	0	0	1	19	19	2	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	0	0
	0	0	0	0	0	0	0	0	0	0		
2012	1	1	0	0	1	14	14	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2012	1	1	0	0	1	15	15	4	0	0	0	3
	0	0	0	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	0	0	0	0	0	0		
2012	1	1	0	0	1	16	16	2	0	0	0	0
	0	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	0	0	0	0	0	0	0	0		
2012	1	1	0	0	1	18	18	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2004	1	2	0	0	1	16	16	3	0	0	1	0
	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	0	0	0	0	0	0	0	0		
2004	1	2	0	0	1	17	17	3	0	0	0	1
	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	0	0	0	0	0	0	0	0		
2004	1	2	0	0	1	18	18	2	0	0	1	0
	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	0	0	0	0	0	0	0	0	0		
2009	1	2	0	0	1	14	14	1	0	0	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	0
	0	0	0	0	0	0	0	0	0	0		
2009	1	2	0	0	1	15	15	2	0	0	1	0
	0	0	0	0	0	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	0	0	0	0		
2009	1	2	0	0	1	16	16	3	0	0	0	0
	0	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	0	0	0	0	0	0	0		
2009	1	2	0	0	1	17	17	2	0	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	0
	0	0	0	0	0	0	0	0	0	0		
2009	1	2	0	0	1	18	18	2	0	0	0	0
	0	0	0	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	0	0	0	0	0		
2009	1	2	0	0	1	23	23	1	0	0	0	0
	0	0	0	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	0	0	0	0	0	0		
2010	1	2	0	0	1	14	14	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2010	1	2	0	0	1	19	19	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2010	1	2	0	0	1	21	21	1	0	0	0	0
	0	0	0	0	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	0	0	0	0	0		
2010	1	2	0	0	1	22	22	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2010	1	2	0	0	1	23	23	1	0	0	0	0
	0	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	0	0	0	0	0	0	0	0		
2011	1	2	0	0	1	16	16	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2011	1	2	0	0	1	20	20	1	0	0	0	0
	0	0	0	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	0	0	0	0	0	0		
2011	1	2	0	0	1	22	22	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2011	1	2	0	0	1	26	26	1	0	0	0	0
	0	0	0	0	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	0	0	0	0	0		
2011	1	2	0	0	1	27	27	1	0	0	0	0
	0	0	0	0	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	0	0	0	0	0		
2012	1	2	0	0	1	16	16	1	0	0	0	0
	0	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	0	0	0	0	0	0	0	0		
2012	1	2	0	0	1	17	17	1	0	0	0	0
	0	0	0	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	0	0	0	0	0	0		
2012	1	2	0	0	1	19	19	1	0	0	0	0
	0	0	0	0	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	0	0	0	0	0		
2012	1	2	0	0	1	20	20	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2002	1	3	0	0	1	4	4	1	0	0	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	0
	0	0	0	0	0	0	0	0	0	0		
2002	1	3	0	0	1	14	14	2	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	0	0	0
	0	0	0	0	0	0	0	0	0	0		
2002	1	3	0	0	1	15	15	2	0	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	0	0
	0	0	0	0	0	0	0	0	0	0		
2002	1	3	0	0	1	17	17	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	0	0	0	0
	0	0	0	0	0	0	0	0	0	0		
2010	1	3	0	0	1	14	14	2	0	0	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
	0	0	0	0	0	0	0	0	0	0		
2010	1	3	0	0	1	15	15	2	0	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	0	0
	0	0	0	0	0	0	0	0	0	0		
2010	1	3	0	0	1	16	16	3	0	0	1	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
	0	0	0	0	0	0	0	0	0	0		
2010	1	3	0	0	1	17	17	2	0	0	1	0
	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	0	0	0	0	0	0	0	0	0		
2010	1	3	0	0	1	21	21	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2011	1	3	0	0	1	16	16	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2011	1	3	0	0	1	19	19	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2012	1	3	0	0	1	15	15	1	0	0	0	0
	0	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	0	0	0	0	0	0	0	0		
2012	1	3	0	0	1	16	16	3	0	0	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
	0	0	0	0	0	0	0	0	0	0		
2012	1	3	0	0	1	18	18	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
1982	1	5	0	0	1	21	21	1	0	0	0	0
	0	0	0	0	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	0	0	0	0	0		
1985	1	5	0	0	1	24	24	1	0	0	0	0
	0	0	0	0	0	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	0	0	0	0		
2003	1	5	0	0	1	15	15	1	0	0	0	0
	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	0	0	0	0	0	0	0	0	0		
2005	1	5	0	0	1	20	20	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2005	1	5	0	0	1	23	23	1	0	0	0	0
	0	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	0	0	0	0	0	0	0	0		
2005	1	5	0	0	1	27	27	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0		
2006	1	5	0	0	1	18	18	1	0	0	0	0
	0	0	0	0	0	0	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	0	0	0		
2011	1	5	0	0	1	15	15	1	0	0	0	0
	0	0	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	0	0	0	0	0	0	0		
2011	1	5	0	0	1	16	16	1	0	0	0	0
	0	0	0	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	0	0	0	0	0	0		
2012	1	5	0	0	1	16	16	2	0	0	0	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	0	0	0	0	0	0	0	0	0		
2012	1	5	0	0	1	19	19	3	0	0	0	1
	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	0	0	0	0	0	0	0	0	0		

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

12.1.2.3 Control File

#hogfish SEDAR 37 - FLK/EFL stock control file
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
2 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
1 1
begin and end years of blocks
1994 2012
1997 2012
#
1 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_Age_natmort_by gender x growthpattern
#Lorenz05:
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
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)
0 #_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 matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
1 #_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
1 #_hermaphroditism option: 0=none; 1=age-specific fxn
-1 #_season of transition (-1 at end of each season)
1 #_include males in spawning biomass (0=no, 1=yes)
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
# 0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Fem_GP_1
# 0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Mal_GP_1
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem
7.735 23.2 15.469570 15.469570 -1 0.2 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-0.1472 -0.04907 -0.09815 -0.09815 -1 0.2 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
-1 1 1 1 -1 0.2 -2 0 0 0 0 0 0 0 # Eg/kg_inter_Female
0 4 1 1 -1 0.2 -3 0 0 0 0 0 0 0 # Eg/kg_slope_wt_Female
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Mal
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Mal
1 15 7.5 7.5 -1 0 -4 0 0 0 0 0 0 0 # herm_inflection_age
1 5 2.15 2.15 -1 0 -4 0 0 0 0 0 0 0 # herm_stdev(in_age)
0 1 .999 .999 -1 0 -4 0 0 0 0 0 0 0 # herm_asymptotic_rate
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1
-4 4 0 0 -1 1 -4 0 0 0 0 0 0 0 # RecrDist_Area1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1
0 0 1 1 -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
1 40 10 10 -1 0.4 1 # SR_log(R0)
0.2 1 0.748 0.748 2 .146 1 # SR_steep  #beta prior from Shertzer and Conn (2012)
0 2 0.6 0.6 -1 50 -4 # SR_sigmaR
-5 5 0 0 -1 50 -3 # SR_envlink
-5 5 0 0 -1 50 1 # SR_R1_offset
0 0.5 0 0 -1 50 -2 # 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
1993 # first year of main recr_devs; early devs can preceed this era
```

2012 # last year of main recr_devs; forecast devs start in following year
2 #_recdev phase
1 # (0/1) to read 13 advanced options
1950 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
3 #_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

#from preliminary SS run based on Methot and Taylor 2011
1980.780 #_last_early_yr_nobias_adj_in_MPD
1993.630 #_first_yr_fullbias_adj_in_MPD
2011.800 #_last_yr_fullbias_adj_in_MPD
2012.800 #_first_recent_yr_nobias_adj_in_MPD
0.967 #_max_bias_adj_in_MPD (1.0 to mimic pre-2009 models)
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
#
#Fishing Mortality info
0.16 # F ballpark for tuning early phases #WTC - this from McBride MARFIN project catch curve; nearly same as McBride and Murphy 2003 (0.17)
1998 # F ballpark year (neg value to disable)
3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
3 # max F or harvest rate, depends on F_Method
no additional F input needed for Fmethod 1

if Fmethod=3, then read number of tuning iterations in hybrid method
4

#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
##version starting at 1986

0.000001	1	0.10	0.1	-1	.1	1	#_InitF_1CommSpear
0.000001	1	0.10	0.1	-1	.1	1	#_InitF_1CommHL
0.000001	1	0.008488	0.1	-1	.1	-1	#_InitF_1CommTrap
0.000001	1	0.10	0.1	-1	.1	1	#_InitF_2RecSpear
0.000001	1	0.10	0.1	-1	.1	1	#_InitF_2RecHL

#
#_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_CommSpear
0	0	0	0	#_2_CommHL
0	0	0	0	#_3_CommTraps - no CPUE
0	0	0	0	#_4_RecSpear
0	0	0	0	#_5_RecHL
0	0	0	4	#_6_RVCKeys
0	0	0	0	#_6_RVCTortugas

#
1 #_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)
model change in catchability for comm/rec fisheries as a result of changing reef fish regulations
LO HI INIT PRIOR PR_type SD PHASE
-10 4 0 0 -1 99 1 #_1_RVCKeys_1994
-10 4 0 0 -1 99 -10 #_1_RVCKeys_1995
-10 4 0 0 -1 99 -10 #_1_RVCKeys_1996
-10 4 0 0 -1 99 -10 #_1_RVCKeys_1997
-10 4 0 0 -1 99 -10 #_1_RVCKeys_1998
-10 4 0 0 -1 99 -10 #_1_RVCKeys_1999
-10 4 0 0 -1 99 1 #_1_RVCKeys_2000 #change in their estimation procedures
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2001
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2002
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2003
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2004
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2005
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2006
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2007
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2008
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2009
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2010
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2011
-10 4 0 0 -1 99 -10 #_1_RVCKeys_2012

#_size_selex_types
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead
#_Pattern Discard Male Special

24	0	0	0	#_1_CommSpear
24	0	0	0	#_2_CommHL
24	0	0	0	#_3_CommTrap
24	0	0	0	#_1_RecSpear
24	0	0	0	#_2_RecHL
#5	0	0	1	#_4_RecSpear
#5	0	0	2	#_5_RecHL
24	0	0	0	#_6_RVCKeys
24	0	0	0	#_6_RVCTortugas

#
#_age_selex_types
#_Pattern ___ Male Special

10	0	0	0	#_1_CommSpear
10	0	0	0	#_2_CommHL
10	0	0	0	#_3_CommTrap
10	0	0	0	#_4_RecSpear
10	0	0	0	#_5_RecHL
11	0	0	0	#_6_RVCKeys
11	0	0	0	#_6_RVCTortugas

#Selectivity_parameters_to_be_estimated
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#Double Norm params: 1=peak start; 2=peak width; 3=asc limb width; 4=desc limb width; 5=start value (0-1); 6=end value (0-1)

15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p1
-15	15	-9	-3	-1	99	4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p2

-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p5
-15	15	15	15	-1	99	4	0	0	0	0	0	0	0	#_CommSpear_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_CommHL_SizeSel_p1
-15	15	-9	-3	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p3
-15	15	6	6	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p5
-15	15	15	15	-1	99	-4	0	0	0	0	0	0	0	#_CommHL_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p1
-15	15	-9	-3	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p3
-15	15	6	6	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p5
-15	15	15	15	-1	99	-4	0	0	0	0	0	0	0	#_CommTrap_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p1
-15	15	-9	-3	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p5
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0	0	#_RecSpear_SizeSel_p6
15	40	32	32	-1	99	3	0	0	0	0	0	0	0	#_RecHL_SizeSel_p1
-15	15	-9	-3	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p2
-15	15	5	5	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p3
-15	15	6	6	-1	99	4	0	0	0	0	0	0	0	#_RecHL_SizeSel_p4

-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_RecHL_SizeSel_p5
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_RecHL_SizeSel_p6

6 50 16 16 -1 99 3 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p1
-15 15 -9 -3 -1 99 -4 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p2
-15 15 5 5 -1 99 4 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p3 - set due to high SD
-15 15 6 6 -1 99 4 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p4
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p5
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_RVCKeys_SizeSel_p6

6 50 42 42 -1 99 3 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p1
-15 15 -9 -3 -1 99 -4 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p2
-15 15 6 6 -1 99 4 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p3
-15 15 6 6 -1 99 -4 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p4
-15 15 -15 -15 -1 99 -4 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p5
-15 15 15 15 -1 99 -4 0 0 0 0 0 0
0 #_RVCTortugas_SizeSel_p6

0.1 20 0.1 0.1 -1 99 -1 0 0 0 0 0 0
0 # _RVCKeys_AgeSel_p1

20 20 20 20 -1 99 -1 0 0 0 0 0 0
0 # _RVCKeys_AgeSel_p2

0.1 20 0.1 0.1 -1 99 -1 0 0 0 0 0 0
0 # _RVCTortugas_AgeSel_p1

20 20 20 20 -1 99 -1 0 0 0 0 0 0
0 # _RVCTortugas_AgeSel_p2

#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns
#_Cond

#turn this block on for change in selectivity 1994 regulations
#1 #_custom_sel-blk_setup (0/1)

#_Cond No selex parm trends
#_Cond -4 # placeholder for selparm_Dev_Phase

#Turn next line on for change in selectivity 1994 regulations

#2 #_Cond 0 #_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
#
1 #_Variance_adjustments_to_input_values
#_fleet: 1 2 3
0 0 0 0 0 0 0 #_add_to_survey_CV
0 0 0 0 0 0 0 #_add_to_discard_stddev
0 0 0 0 0 0 0 #_add_to_bodywt_CV
1 1 1 1 1 1 1 #_mult_by_lencomp_N
1 1 1 1 1 1 1 #_mult_by_agecomp_N
1 1 1 1 1 1 1 #_mult_by_size-at-age_N
#
1 #_maxlambdaphase -- if >1, need row for each lambdaphase below
1 #_sd_offset
#
0 # 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
#like_comp fleet/survey phase value sizefreq_method
#
lambdas (for info only; columns are phases)
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

12.1.2.4 Forecast File

for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
2010 2012 2010 2012 2010 2012
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
2 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
20 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 2010 2012 2010 2012
2 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))

```
0.01 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.001 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
1.0 # Control rule target as fraction of Flimit (e.g. 0.75)
3 #_N forecast loops (1-3) (fixed at 3 for now)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2012 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
# Note that fleet allocation is used directly as average F if Do_Forecast=4
# this will just give you retained biomass and won't have to back out the discards
3 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio;
5=deadnum;6=retainnum)
# Conditional input if relative F choice = 2
# Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
# 1
# max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
-1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0 0 0 0 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch:  2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note
new codes in SSV3.20)
# Input fixed catch values
#Year Seas Fleet Catch(or_F)

#
999 # verify end of input
```

12.1.3 GA-NC Stock Model

12.1.3.1 Starter File

hog37GANC.dat
hog37GANC.ctl
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
1 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of datafiles to produce: 1st is input, 2nd is estimates, 3rd and higher are bootstrap
10 # Turn off estimation for parameters entering after this phase
0 # MCeval burn interval
1 # MCeval 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
#vector of year values

0.0001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
1 # 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 (e.g. 0.4)
4 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
1 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates); 4=true F for range of ages
20 23 #_min and max age over which average F will be calculated
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

12.1.3.2 Data File

#Hogfish SEDAR 37 - GA-NC Stock
#_observed data:
1986 #_styr
2012 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
4 #_Nfleet
0 #_Nsurveys
1 #_N_areas
Comm_Spear%Comm_HL%Comm_Trap%Rec_HL
-1 -1 -1 -1 #_surveytiming_in_season
1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 1 2 #_units of catch: 1=bio; 2=num

```
0.1 0.1 0.1 0.75  #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3; use -1 for discard only fleets
2 #_Ngenders
20 #_Nages
0.605685363	3.041771609	0	0.696780246 #init_equil_catch
63 #_N_lines_of_catch_to_read
#_catch_biomass(mtons):_columns_are_fisheries,year,season
#Comm_Spear	Comm_HL	Comm_Traps	Rec_HL	Year	Season
0	1.995806428	0	4.047321526	1950	1
0	0.90718474	0	4.173465724	1951	1
0	0	0	4.299609922	1952	1
0	0	0	4.425754121	1953	1
0	0	0	4.551898319	1954	1
0	0	0	4.678042519	1955	1
0	0	0	4.804186718	1956	1
0	0	0	4.930330916	1957	1
0	0	0	5.056475115	1958	1
0	0	0	4.475953258	1959	1
0	0	0	4.569570526	1960	1
0	0	0	5.381041291	1961	1
0	0	0	5.52620044	1962	1
0	0	0	5.881305595	1963	1
0	0	0	6.382378169	1964	1
0	0	0	7.064775959	1965	1
0	0	0	7.319810585	1966	1
0	0	0	7.816111654	1967	1
0	0	0	7.884201628	1968	1
0	0	0	8.302584551	1969	1
0	0	0	7.790317772	1970	1
0	0	0	8.089365081	1971	1
0	0	0	8.411881334	1972	1
0	0	0	8.984238256	1973	1
0	0	0	9.747585281	1974	1
0	0	0	10.00796349	1975	1
0	0	0	9.775000374	1976	1
0	0	0	9.056141769	1977	1
0	0.236775217	0	8.708995213	1978	1
0	0.075749926	0	8.790659861	1979	1
0	0.438170229	0	8.549724086	1980	1
0	5.052565409	0	0	1981	1
0	7.339124547	0	47.83536408	1982	1
0	4.475142322	0	2.148780642	1983	1
0	1.348076524	0	0.06	1984	1
0	2.683708611	0.052360565	20.46107321	1985	1
0.605685363	3.041197291	0	11.39495536	1986	1
1.542565886	2.66061764	0.012957553	2.009251603	1987	1
0.908243733	3.701614876	0.010433271	0.122869383	1988	1
0.559182746	6.257566113	0.06742254	0.363551379	1989	1
0	6.606510886	6.031479727	1.016506401	1990	1
0	5.665512476	5.168994874	0.236	1991	1
0.943134148	11.74808217	1.94802383	0.759646464	1992	1
0	14.35661049	0.039957738	0.891240035	1993	1
1.753177161	8.673853116	0.034170553	0.186269777	1994	1
1.083039674	14.91339266	0.742486897	25.24725485	1995	1
0.074389149	7.061979609	0.788343539	0.096884137	1996	1
0.110676538	10.92023631	0.487611798	0.295914636	1997	1
```

0.03628739	9.695536909	0.228610554	0.429318875	1998	1
0.037648167	13.14828203	0.052616715	0.32791868	1999	1
0.030390689	10.76737568	0.135624119	0.239936907	2000	1
0.870019796	5.493420719	0.074395992	0.15	2001	1
1.460537533	7.14549342	0.718467397	0.915748485	2002	1
1.272326598	2.942453704	0.006803886	0.157535919	2003	1
4.339064611	4.413000168	0	0.375294513	2004	1
2.077906647	6.637870743	0.018143695	1.481007825	2005	1
3.365655385	7.206221982	0.057152639	1.705336502	2006	1
2.473439194	6.940416853	0	1.23600981	2007	1
3.863699808	9.942291158	0	1.380067273	2008	1
9.368621478	6.160989408	0.002299048	0.201072291	2009	1
13.62288059	5.381732529	0	1.819242639	2010	1
10.12668765	6.184040387	0	0.393808329	2011	1
6.051585561	3.274727159	0	1.370338905	2012	1

20 #_N_cpue_and_surveyabundance_observations
#_Units: 0=numbers; 1=biomass; 2=F
#_Errtype: -1=normal; 0=lognormal; >0=T

#_Fleet	Units	Errtype	
1	1	0	#Comm_Spear
2	1	0	#Comm_HL
3	1	0	#Comm_Trap
4	0	0	#Rec_HL

#year Seas Index# ObsScaled LOG(SE)
1993 1 2 1.19020496 0.304602093 #Comm_HL_Logbook
1994 1 2 1.027162882 0.278951573 #Comm_HL_Logbook
1995 1 2 1.644173577 0.258990274 #Comm_HL_Logbook
1996 1 2 0.892087704 0.271736656 #Comm_HL_Logbook
1997 1 2 1.031187791 0.263604187 #Comm_HL_Logbook
1998 1 2 1.392884957 0.263802533 #Comm_HL_Logbook
1999 1 2 2.280760483 0.258574781 #Comm_HL_Logbook
2000 1 2 1.243956874 0.269266792 #Comm_HL_Logbook
2001 1 2 1.137274292 0.265754256 #Comm_HL_Logbook
2002 1 2 1.281618762 0.276610214 #Comm_HL_Logbook
2003 1 2 1.058466807 0.273640658 #Comm_HL_Logbook
2004 1 2 0.565300456 0.297246036 #Comm_HL_Logbook
2005 1 2 0.930505732 0.289194242 #Comm_HL_Logbook
2006 1 2 0.819445727 0.285013122 #Comm_HL_Logbook
2007 1 2 0.580378696 0.285322514 #Comm_HL_Logbook
2008 1 2 0.739368644 0.28693195 #Comm_HL_Logbook
2009 1 2 0.337883452 0.348696192 #Comm_HL_Logbook
2010 1 2 0.482724365 0.351146052 #Comm_HL_Logbook
2011 1 2 0.707657245 0.335806101 #Comm_HL_Logbook
2012 1 2 0.656956595 0.396402741 #Comm_HL_Logbook

0 #_N_fleets_with_discard
0 #N discard obs
#
0 #_N_meanbodywt_obs
30 #_DF_for_meanbodywt_T-distribution_like

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
2 # minimum size in the population (lower edge of first bin and size at age 0.00)

90 # maximum size in the population (lower edge of last bin)

-0.0001 #_comp_tail_compression
0.0001 #_add_to_comp

0 #_combine males into females at or below this bin number
45 #_N_LengthBins
2 4 6 8 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 82 84 86 88 90
44 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
#Year Seas Fleet Gender Part NsampRaw 2 4 6 8 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 82 84 86 88 90 2 4 6 8 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 82 84 86 88 90
1992 1 1 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 1 0 1 1 0 0 0 1 0 0 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 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 0 0 0 0 0
1996 1 1 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 2 0 1 0 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 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 0 0 0 0 0 0 0
2004 1 1 0 0 8 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 0 1 0 0 0 0 1 1 0 1 2 1 0 0 0 0 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 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
2005 1 1 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 1 0 0 0 0 1 0 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 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 0 0 0 0 0 0 0 0 0
2006 1 1 0 0 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 1 1 1 0 0 1 0 1 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 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 0 0 0 0 0 0
2008 1 1 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 1 0 0 1 0 0 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 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 0 0 0 0 0 0 0 0 0
2009 1 1 0 0 55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 4 4 1 6 5 3 5 2 2 4 3 0 4 4 4 2 0 0 0 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 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 0 0 0 0
2010 1 1 0 0 114 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 2 3 4 7 11 11 6 6 7 6 3 6 6 5 3 10 4 5 2 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 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 0 0 0
2011 1 1 0 0 90 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 1 4 8 5 2 3 5 1 5 6 11 5 8 4 3 5 5 3 0 0 0 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 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
2012 1 1 0 0 45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 2 0 5 7 3 4 2 3 2 2 3 2 1 5 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 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 0 0 0 0 0
1985 1 2 0 0 59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 6 2 6 5 5 6 3 2 5 7 3 4 0 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 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 0 0 0 0 0 0
1986 1 2 0 0 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 1 1 0 0 1 0 4 1 3 1 0 0 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 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 0 0 0 0 0 0
1987 1 2 0 0 32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 3 3 2 1 2 5 2 2 3 5 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 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 0 0 0 0 0 0 0 0
1988 1 2 0 0 43 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 0 2 1 4 4 1 4 3 5 3 0 2 5 0 5 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 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 0 0 0 0 0 0 0
1989 1 2 0 0 87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 5 3 2 6 6 4 4 6 9 6 2 8 8 8 4 1 1 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 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 0 0 0 0 0 0 0
1990 1 2 0 0 91 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 2 0 1 1 1 2 3 6 6 9 7 5 7 8 12 4 4 2 3 0 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 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 0 0 0 0 0
1991 1 2 0 0 72 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 5 2 2 4 4 4 8 5 5 9 2 6 7 1 0 0 1 0 0 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1992 1 2 0 0 78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 3 4 6 4 3 6 6 5 8 6 4 2 8 4 3 2 1 0 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 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 0 0 0 0 0 0
1993 1 2 0 0 141 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 11 11 4 8 7 10 10 12 10 9 8 13 10 5 3 2 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 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 0 0 0 0 0 0 0
1994 1 2 0 0 91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 5 5 4 8 8 3 5 2 7 7 5 8 7 2 3 6 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 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 0 0 0 0 0 0
1995 1 2 0 0 181 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 7 5 8 14 13 7 24 13 12 10 17 11 14 8 3 4 2 3 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 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 0 0 0 0 0 0

1996 1 2 0 0 78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 2 5 7 4 4 5 7 4 6 7 7 3 5 2 2 0 2 0 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 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 0
1997 1 2 0 0 136 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 2 2 7 8 8 10 8 12 9 16 10 8 12 4 9 4 2 1 1 0 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 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 0 0
1998 1 2 0 0 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 7 9 9 13 19 18 26 19 18 21 12 13 7 7 6 5 3 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 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 0 0 0 0
1999 1 2 0 0 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 4 6 13 20 25 31 31 35 30 34 31 28 24 24 15 8 10 1 1 1 1 0 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 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
2000 1 2 0 0 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 1 5 15 16 25 29 30 20 35 26 39 27 24 18 20 17 14 4 3 3 0 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 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 0 0
2001 1 2 0 0 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 8 10 21 14 19 28 29 21 11 14 15 10 12 5 8 1 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 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 0 0
2002 1 2 0 0 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 4 8 16 13 18 18 15 17 17 13 16 11 11 6 2 3 3 1 2 1 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2003 1 2 0 0 152 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 2 3 4 1 7 5 5 13 11 14 12 12 13 15 3 5 10 8 2 1 0 2 1 0 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 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 0
2004 1 2 0 0 114 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 2 1 2 4 2 3 4 10 10 10 7 8 5 7 5 8 7 6 4 3 3 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 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 0 0 0
2005 1 2 0 0 99 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 4 2 4 5 5 11 9 13 10 5 5 7 7 4 3 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 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 0 0 0 0 0
2006 1 2 0 0 62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 2 0 4 3 2 4 3 1 7 7 5 6 3 4 3 2 1 0 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 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 0 0
2007 1 2 0 0 56 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 5 5 5 3 2 3 1 3 7 8 4 3 3 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 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 0 0 0 0
2008 1 2 0 0 78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 1 1 4 6 7 10 7 6 7 5 8 5 2 1 2 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 2 0 0 169 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 6 6 4 14 4 8 22 11 11 11 6 10 12 9 4 5 8 6 6 1 0 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 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
2010 1 2 0 0 33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 3 1 0 4 0 6 2 6 3 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 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 0 0 0 0 0
2011 1 2 0 0 130 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 0 1 4 6 6 7 10 12 11 8 11 6 10 9 11 8 3 4 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 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 0 0 0
2012 1 2 0 0 93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 2 3 6 7 5 7 3 10 9 7 5 7 8 8 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 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 0 0 0 0
-1991 1 3 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 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 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2007 1 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 1 0 0 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 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 0 0 0 0 0 0
2008 1 4 0 0 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 0 0 0 0 0 0 0 0 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 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 0 0 0 0 0 0 0 0
2010 1 4 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 3 0 0 0 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 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 0 0 0 0 0 0 0
2011 1 4 0 0 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 4 0 2 1 1 0 2 0 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 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 0 0 0 0 0 0 0
2012 1 4 0 0 28 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 5 1 2 2 3 3 1 2 2 1 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 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 0 0 0 0

19 #_N_age_bins
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1 #_N_ageerror_definitions; these define how SS will convert true age into a distribution of expected ages to represent the effect of ageing bias and imprecision
#true_age=0 1 2 etc.,
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001
#

61 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
1 #_combine males into females at or below this bin number
#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
#Year Seas Fleet Gender Part AgeErr Lbin_lo Lbin_hi NsampRaw 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
2011 1 1 0 0 1 24 24 1 0 0 0 0 0 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 0 0 0 0 0 0 0 0
2011 1 1 0 0 1 27 27 1 0 0 0 0 0 0 0 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 0 0 0 0 0 0
2011 1 1 0 0 1 29 29 4 0 0 0 0 0 0 0 0 1 2 0 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 0 0
2011 1 1 0 0 1 30 30 2 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 1 0 0 1 31 31 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 1 0 0 1 33 33 4 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 1 0 0 1 34 34 1 0 0 0 0 0 0 0 0 0 0 0 0 0 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 1 0 0 1 36 36 2 0 0 0 0 0 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 0 0 0 0 0 0 0
2011 1 1 0 0 1 37 37 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 1 0 0 1 38 38 3 0 0 0 0 0 0 0 0 0 0 1 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 0 0
2012 1 1 0 0 1 25 25 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 1 0 0 1 26 26 1 0 0 0 0 0 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 0 0 0 0 0 0 0 0
2012 1 1 0 0 1 28 28 1 0 0 0 0 0 0 0 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 0 0 0 0 0 0
2012 1 1 0 0 1 29 29 2 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 1 0 0 1 30 30 2 0 0 0 0 0 0 0 1 0 0 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 0 0 0
2012 1 1 0 0 1 32 32 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 1 0 0 1 36 36 3 0 0 0 0 0 0 0 0 0 0 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 0 0
2012 1 1 0 0 1 38 38 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2008 1 2 0 0 1 28 28 1 0 0 0 0 0 0 0 0 0 0 0 0 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 0
2011 1 2 0 0 1 23 23 2 0 0 0 0 0 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 0 0 0 0 0 0 0
2011 1 2 0 0 1 26 26 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 2 0 0 1 27 27 3 0 0 0 0 0 0 0 0 0 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 0 0 0
2011 1 2 0 0 1 28 28 2 0 0 0 0 0 0 0 0 0 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 0 0 0
2011 1 2 0 0 1 29 29 2 0 0 0 0 0 0 0 0 0 1 0 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 0 0
2011 1 2 0 0 1 30 30 4 0 0 0 0 0 0 0 0 1 1 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 0 0 0
2011 1 2 0 0 1 31 31 2 0 0 0 0 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 0 0 0 0 0 0 0 0
2011 1 2 0 0 1 32 32 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 2 0 0 1 33 33 2 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 2 0 0 1 34 34 3 0 0 0 0 0 0 0 0 0 1 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 0 0 0
2011 1 2 0 0 1 35 35 4 0 0 0 0 0 0 0 0 0 0 2 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 2 0 0 1 36 36 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2011 1 2 0 0 1 37 37 2 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 2 0 0 1 25 25 2 0 0 0 0 1 0 0 0 0 0 0 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 0 0
2012 1 2 0 0 1 28 28 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 2 0 0 1 31 31 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2007 1 4 0 0 1 22 22 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0
2007 1 4 0 0 1 30 30 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0
2007 1 4 0 0 1 32 32 1 0 0 0 0 0 0 0 0 0 0 0 0 0 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 4 0 0 1 35 35 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 4 0 0 1 33 33 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 4 0 0 1 25 25 1 0 0 0 0 0 0 0 0 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 0 0 0 0 0
2010 1 4 0 0 1 30 30 3 0 0 0 0 0 0 0 0 0 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 0 0 0
2010 1 4 0 0 1 34 34 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 4 0 0 1 25 25 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 4 0 0 1 26 26 3 0 0 0 0 0 0 0 0 0 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 0 0 0
2011 1 4 0 0 1 28 28 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 4 0 0 1 29 29 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2011 1 4 0 0 1 30 30 1 0 0 0 0 0 0 0 0 0 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 0 0 0 0
2011 1 4 0 0 1 32 32 2 0 0 0 0 0 0 0 0 1 0 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 0 0 0
2011 1 4 0 0 1 34 34 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0

2012 1 4 0 0 1 24 24 1 0 0 0 0 0 0 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 0 0 0 0 0 0 0
2012 1 4 0 0 1 26 26 5 0 0 0 0 0 0 0 0 0 0 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 0 0
2012 1 4 0 0 1 27 27 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 4 0 0 1 28 28 2 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 4 0 0 1 29 29 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 4 0 0 1 30 30 2 0 0 0 0 0 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 0 0 0 0 0 0 0
2012 1 4 0 0 1 31 31 2 0 0 0 0 0 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 0 0 0 0 0 0 0
2012 1 4 0 0 1 33 33 1 0 0 0 0 0 0 0 0 0 0 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 0 0 0
2012 1 4 0 0 1 34 34 1 0 0 0 0 0 0 0 0 0 0 0 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 0 0
2012 1 4 0 0 1 35 35 1 0 0 0 0 0 0 0 0 0 0 0 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 0 0
2012 1 4 0 0 1 36 36 3 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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

12.1.3.3 Control File

#Hogfish SEDAR 37 - GA-NC Stock
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
1 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
1
begin and end years of blocks
1994 2012
#
1 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_Age_natmort_by gender x growthpattern
#Lorenz05:
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
0.597 0.400 0.309 0.257 0.223 0.200 0.182 0.169 0.159 0.150 0.144 0.138 0.134 0.130 0.126 0.123 0.121 0.119 0.117 0.115 0.114
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)
0 #_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 matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
1 #_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

```
1 #_hermaphroditism option:  0=none; 1=age-specific fxn
-1 #_season of transition (-1 at end of each season)
1 #_include males in spawning biomass (0=no, 1=yes)
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
# 0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Fem_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Fem_GP_1
# 0.2 0.5 0.38 0.4 0 1 -3 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
7 21 18.54 18.54 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
70 100 84.89 84.89 -1 1 -3 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.8 0.1058 0.1058 -1 1 -3 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_young_Mal_GP_1
0.05 0.25 0.2 0.2 -1 0.05 -3 0 0 0 0 0 0 0 #_CV_old_Mal_GP_1
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem
7.735 23.2 15.469570 15.469570 -1 0.2 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-0.1472 -0.04907 -0.09815 -0.09815 -1 0.2 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
-1 1 1 1 -1 0.2 -2 0 0 0 0 0 0 0 # Eg/kg_inter_Female
0 4 1 1 -1 0.2 -3 0 0 0 0 0 0 0 # Eg/kg_slope_wt_Female
0.00002642 0.0001057 .00005284 .00005284 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_1_Mal
1.373 4.118 2.745 2.745 -1 0.2 -3 0 0 0 0 0 0 0 # Wtlen_2_Mal
1 15 7.5 7.5 -1 0 -4 0 0 0 0 0 0 0 # herm_inflection_age
1 5 2.15 2.15 -1 0 -4 0 0 0 0 0 0 0 # herm_stdev(in_age)
0 1 .999 .999 -1 0 -4 0 0 0 0 0 0 0 # herm_asymptotic_rate
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1
-4 4 0 0 -1 1 -4 0 0 0 0 0 0 0 # RecrDist_Area1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1
0 0 1 1 -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
1 40 10 10 -1 0.4 1 # SR_log(R0)
0.2 1 0.748 0.748 2 .146 1 # SR_steep  #beta prior from Shertzer and Conn (2012)
0 2 0.6 0.6 -1 50 -4 # SR_sigmaR
```

```
-5 5 0 0 -1 50 -3 # SR_envlink
-5 5 0 0 -1 50 1 # SR_R1_offset
0 0.5 0 0 -1 50 -2 # 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
1993 # first year of main recr_devs; early devs can preceed this era
2012 # last year of main recr_devs; forecast devs start in following year
2 #_recdev phase
1 # (0/1) to read 13 advanced options
1950 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
3 #_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
#from preliminary SS run based on Methot and Taylor 2011
1970.9   #_last_early_yr_nobias_adj_in_MPD
2002.0   #_first_yr_fullbias_adj_in_MPD
2008.1   #_last_yr_fullbias_adj_in_MPD
2012.4   #_first_recent_yr_nobias_adj_in_MPD
0.6695   #_max_bias_adj_in_MPD (1.0 to mimic pre-2009 models)
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
#
#Fishing Mortality info
0.0 #
-1998 # F ballpark year (neg value to disable)
3 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
3 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
## if Fmethod=3, then read number of tuning iterations in hybrid method
4

#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
##version starting at 1986
0.000001    1    0.01    0.1    -1    .1    -1    #_InitF_1CommSpear  #fix to converge
0.000001    1    0.1     0.1    -1    .1    1     #_InitF_1CommHL
0.0 1    0.0    0.0    -1    .1    -1    #_InitF_1CommTrap
0.000001    1    0.1     0.1    -1    .1    1     #_InitF_2RecHL

#
#_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_CommSpear - no CPUE
0    0    0    0    #_2_CommHL
0    0    0    0    #_3_CommTraps - no CPUE
0    0    0    0    #_5_RecHL - no CPUE

#_size_selex_types
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead
```

```
#_Pattern Discard Male Special
24   0   0   0   #_1_CommSpear
24   0   0   0   #_2_CommHL
5    0   0   2   #_3_CommTrap -- no length or age data, so mirror Comm HL
24   0   0   0   #_2_RecHL

#
#_age_selex_types
#_Pattern ___ Male Special
10   0   0   0   #_1_CommSpear
10   0   0   0   #_2_CommHL
10   0   0   0   #_3_CommTrap
10   0   0   0   #_5_RecHL

#Selectivity_parameters_to_be_estimated
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#Double Norm params: 1=peak start; 2=peak width; 3=asc limb width; 4=desc limb width; 5=start value (0-1);
6=end value (0-1)

15   80   32   32   -1   99   3    0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p1
-15  15   0    0    -1   99   -4   0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p2
-15  15   5    5    -1   99   4    0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p3
-15  15   6    6    -1   99   -4   0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p4
-15  15   -15  -15  -1   99   -4   0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p5
-15  15   15   15   -1   99   -4   0   0   0   0   0   0
     0    #_CommSpear_SizeSel_p6

15   80   32   32   -1   99   3    0   0   0   0   0   0
     0    #_CommHL_SizeSel_p1
-15  15   0    0    -1   99   -4   0   0   0   0   0   0
     0    #_CommHL_SizeSel_p2
-15  15   5    5    -1   99   4    0   0   0   0   0   0
     0    #_CommHL_SizeSel_p3
-15  15   6    6    -1   99   -4   0   0   0   0   0   0
     0    #_CommHL_SizeSel_p4
-15  15   -15  -15  -1   99   -4   0   0   0   0   0   0
     0    #_CommHL_SizeSel_p5
-15  15   15   15   -1   99   -4   0   0   0   0   0   0
     0    #_CommHL_SizeSel_p6

##Size selectivity for mirror pattern (rec of comm) - use 0 and 0 for first and last bin, respective (pg 71 Pattern 5)
-5   5    0    0    -1   99   -3   0   0   0   0   0   0
     0    #_CommTrap_SizeSel_p1
-5   5    0    0    -1   99   -3   0   0   0   0   0   0
     0    #_CommTrap_SizeSel_p2

15   88   88   88   -1   99   3    0   0   0   0   0   0
     0    #_RecHL_SizeSel_p1
-15  15   0    0    -1   99   -4   0   0   0   0   0   0
     0    #_RecHL_SizeSel_p2
```

```
-15	15	5	5	-1	99	4	0	0	0	0	0	0
	0	#_RecHL_SizeSel_p3
-15	15	6	6	-1	99	-4	0	0	0	0	0	0
	0	#_RecHL_SizeSel_p4
-15	15	-15	-15	-1	99	-4	0	0	0	0	0	0
	0	#_RecHL_SizeSel_p5
-15	15	15	15	-1	99	-4	0	0	0	0	0	0
	0	#_RecHL_SizeSel_p6
```

```
# 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
#
1 #_Variance_adjustments_to_input_values
#_fleet: 1 2 3
0 0 0 0  #_add_to_survey_CV
0 0 0 0  #_add_to_discard_stddev
0 0 0 0  #_add_to_bodywt_CV
1 1 1 1  #_mult_by_lencomp_N
1 1 1 1  #_mult_by_agecomp_N
1 1 1 1  #_mult_by_size-at-age_N
#
1 #_maxlambdaphase
1 #_sd_offset
#
0 # 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
#like_comp fleet/survey phase value sizefreq_method
#
# lambdas (for info only; columns are phases)
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
```

12.1.3.4 Forecast File

```
# for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -
integer to be rel. endyr)
2010 2012 2010 2012 2010 2012
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
2 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
```

```
20 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years:  beg_selex, end_selex, beg_relF, end_relF  (enter actual year, or values of 0 or -integer to be rel. endyr)
 2010 2012 2010 2012
2 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.01 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.001 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
1.0 # Control rule target as fraction of Flimit (e.g. 0.75)
3 #_N forecast loops (1-3) (fixed at 3 for now)   # leave alone
3 #_First forecast loop with stochastic recruitment        # leave alone
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2012 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
# Note that fleet allocation is used directly as average F if Do_Forecast=4
# this will just give you retained biomass and won't have to back out the discards
3 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum;6=retainnum)
# Conditional input if relative F choice = 2
# Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
# 1
# max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
-1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0 0 0 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch:  2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
# Input fixed catch values
#Year Seas Fleet Catch(or_F)

#
999 # verify end of input
```

SEDAR

Southeast Data, Assessment, and Review

SEDAR 37

Southeastern U.S. Hogfish

SECTION IV: Review Report

September 2014

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

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1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 37 Peer Review Process was conducted via a CIE (Center for Independent Experts) Desk Review in lieu of a Panel Review Workshop. Three reviewers were selected by provided the CIE and provided with the assessment report and background materials. Each reviewer conducted a review of the material and produced an independent review report. Those reports are included below.

1.2 TERMS OF REFERENCE

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the assessment panel 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 the methods used to assess the stock, taking into account the available data.
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and used consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to 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, rebuilding timeframes, and generation times, addressing 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 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. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.

1.3 LIST OF PARTICIPANTS

CIE Reviewers

R.I.C. Chris Francis .... CIE Reviewer
Paul A. Medley .... CIE Reviewer
Geoff Tingley.. CIE Reviewer

2. CIE REVIEWER REPORTS

Report on the 2013 Assessments of Hogfish in the South Atlantic and Gulf of Mexico

by R.I.C. Chris Francis
123 Overtoun Terrace
Wellington 6021
New Zealand

September 2014

Prepared for

The Center for Independent Experts

Executive Summary

This is a desk review of the 2013 stock assessment report for hogfish in the south Atlantic and Gulf of Mexico. The computer program Stock Synthesis was used to assess three stocks: West Florida (WFL), East Florida including the Florida Keys and Dry Tortugas (FLK/EFL), and Georgia through North Carolina (GA-NC).

The hogfish assessment team had a daunting task. The available data are weak, which made the assessment particularly sensitive to the many assumptions used in compiling the data and structuring the model. Moreover, a big proportion of the changes in stock abundance may have occurred in the years preceding the period with data. Also, Stock Synthesis is rather complex, with many options and structures, some of which are easily misunderstood because they are not well documented. Although the assessment team generally did a good job in setting up this first hogfish assessment in Stock Synthesis I found sufficiently many causes for concern that I could not be confident that the assessment results were robust, and thus that the assessments constitute the best scientific information available.

Issues of concern for all three stocks include the construction and weighting of length compositions; the choice of initial equilibrium catches and growth CVs (coefficients of variation); and the treatment of uncertainty in recreational catches. It is not yet determined how serious these issues are for the hogfish assessments, but collectively they certainly have the potential to be serious. For the FLK/ELF stock, I was concerned about the assumption, which has profound implications for the assessment, that growth was the same as in WFL. The basis and support for a default selectivity assumption also have important consequences.

In considering future research I recommend that

- Priority be given to
    - improving age and length sampling of hogfish fisheries (with an emphasis on ages), and
    - fishery-independent surveys for GA-NC
- Consideration also be given to
    - rationalizing the calculation of biomass indices, and
    - better identifying the location of the stock boundary between east Florida and North Carolina

For the next hogfish assessment I recommend

- That particular attention be paid to three data sets:
    - length compositions (their construction, selection, and weighting),
    - initial equilibrium catches, and
    - (the treatment of uncertainty in) recreational catches;
- That two hypotheses be reconsidered:
    - default selectivities, and
    - the choice of growth parameters by stock;
- The use of
    - a likelihood profile on R0,
    - a sensitivity analysis for steepness, and
    - the incorporation of uncertainty in the projection results.

1. Background

This report reviews, at the request of Northern Taiga Ventures, Inc. (see Appendix 2), the 2013 assessment for hogfish (*Lachnolaimus maximus*) in the south Atlantic and Gulf of Mexico using the Assessment Report and other supporting documents (Appendix 1). This review, part of the SEDAR 37 process (http://www.sefsc.noaa.gov/sedar/Index.jsp), is "responsible for ensuring that the best possible assessment is provided", and is intended to "provide guidance" to the Southeast Fisheries Science Center (see Appendix 2).

2. Reviewer's Role

The role of the present reviewer was to read the documents provided (listed in Appendix 1), as well as some associated documents (e.g., Stock Synthesis documentation and some papers referred to in the provided documents), and write an independent peer review report in accordance with his Terms of Reference (given in Annex 2 of Appendix 2).

3. Findings

I will first discuss four matters that seemed to me to be of particular importance in these assessments, and then present my findings in relationship to each of the eight Terms of References (TORs) for the review, as given in Annex 2 of Appendix 2. In some cases I found it difficult to decide to which part of the TORs I should attach a comment, because several parts seemed equally appropriate. Rather than repeat comments in several places I have usually arbitrarily assigned each comment to one place. In what follows, the initials "AR" will be used to identify references to parts (e.g., sections, tables, figures) of the Assessment Report.

In reading these findings it is important to understand that the Assessment Report treated hogfish in the south Atlantic and Gulf of Mexico as consisting of three stocks: West Florida (WFL), East Florida including the Florida Keys and Dry Tortugas (FLK/EFL), and Georgia through North Carolina (GA-NC). These stocks were assessed separately, using very similar model configurations, but different data, for each stock.

3.0 Four matters of importance

3.0.1 Initial depletion

For all three stocks, the SSB (spawning stock biomass) is estimated to have changed more before the assessment period (1986–2012) than during it (Table 1). Thus it is important to understand how the assessment models estimate initial depletion (SSB_{1986} as a percentage of SSB_{Virgin}), and how robust these estimates are. If these estimates are badly wrong then the whole assessment is undermined.

Table 1: Base model estimates of depletion at the beginning (1986) and end (2012) of the period covered by the assessment models (tabulated figures were calculated from AR Tables 11.2.4.1-3 and 11.2.7.1-3).

	Depletion (SSB as % of virgin SSB)	
Stock	1986	2012
WFL	34	50
FLK/EFL	9	8
GA-NC	43	21

The assessment models' calculation of initial depletion is rather complex, but five main groups of estimated parameters are involved. The first three – (log)R0, the InitF parameters (one for each fishery), and the selectivity parameters – are used to set up an equilibrium age structure for 1986, and this structure is then perturbed using the other parameters – SR_R1_offset and the Early_InitAge parameters (for ages 1-20). In these assessments these last two groups had little influence (because they were almost all close to zero – see AR Tables 11.1.4.1-3). Further, given R0 and the selectivities, the InitF parameters are pretty much determined by the user-provided initial equilibrium catches. Thus it seems that, roughly speaking, amongst the estimated parameters, it is R0 and the selectivity parameters that determine the estimated initial depletion. As to the data sets that will most influence estimates of these parameters, clearly the initial equilibrium catches will be important and so, I assume, will be the length compositions (these will obviously affect the selectivities, and for fisheries with asymptotic selectivity the smaller the proportion of large fish in early catches, the greater the initial depletion). A likelihood profile on R0 would help to identify the relative influences of each data set on this parameter, and thus on initial depletion.

3.0.2 Default selectivity assumptions

In all three assessments some fishery or survey selectivities were either forced to be domed (by setting parameter 6 of the double normal selectivity to -15), and some were forced to be asymptotic (by setting the same parameter to +15). In deciding what selectivity shape to use, the authors of the Assessment Report seem to have taken the view that the default assumption is that it be asymptotic. That is, we should assume a selectivity is asymptotic unless we have information to the contrary. This assumption is not explicitly stated, but I infer it from text like "no evidence exists to support a dome-shaped relationship" (AR Section 11.1.3.6) and the suggestion that the sensitivity analyses in which no selectivities were forced to be asymptotic are presented "for reference only" (AR Section 11.2.7.2.5) (I take this last comment to mean that these sensitivities should be excluded from those defining the range of uncertainty in the assessments).

I think it is important to be absolutely clear in the Assessment Report about whether the basis for this default selectivity assumption is meant to be scientific or precautionary. My view (explained in the next two paragraphs) is that it has little scientific support but could plausibly be adopted as precautionary.

From a scientific point of view, it is clear that a fishery which does not catch the largest fish in a population (either because of the characteristics of the gear or the spatio-temporal location of the fishery) must have a domed selectivity. However, it does not follow that a fishery that *does* catch these largest fish *must* have an asymptotic selectivity. All we can say is that this selectivity must be non-zero for these fish, and the selectivity *may* be asymptotic. In the information presented in the Assessment Report I could see no scientific justification for forcing any selectivity to be asymptotic (and I note the relevance of a recent paper by Waterhouse et (2014)). Further, this forcing was unsupported by the data. This can be seen in two ways: (a) an examination of the residuals for length compositions associated with forced-asymptotic selectivities shows that those for the largest length bins are mostly negative (e.g., consider plots for the commercial hook and line fisheries – AR Figures 11.2.1.3.4, 24, & 40); and (b) removal of the asymptotic restriction in some sensitivity analyses "In all cases ... led to estimation of a fully dome-shaped function" (AR Section 11.2.7.2.5).

It is often the case in stock assessments that allowing the model to determine whether or not selectivities are asymptotic will produce a less conservative (i.e., more optimistic) estimate of depletion than if at least one selectivity is forced-asymptotic. This was certainly true for the present assessments (Table 2). Some people argue that these less conservative assessments are unsound because some of the stock biomass is "cryptic" (i.e., theoretically present, but unselected by the fisheries and surveys). The view is taken that the appropriate, precautionary, approach is to avoid this so-called cryptic biomass by forcing at least one selectivity to be asymptotic. If this view is the basis of the authors' decision to force some selectivities to be asymptotic then this should be explicitly stated, both when the assumption is made (AR Section 11.1.3.6) and also when results are presented (to alert readers to the possibility that actual stock status may be more optimistic than is estimated).

Table 2: The effect on estimates of initial depletion of removing (in sensitivity analyses No_flattop) the base model restriction that some selectivities were forced to be asymptotic (base values from Table 1; No_flattop values from AR Figures 11.2.7.5.1-3).

	Initial depletion (SSB_{1986} as % of virgin SSB)	
Stock	Base	No_flattop
WFL	34	47
FLK/EFL	9	21
GA-NC	43	66

3.0.3 The role of the growth parameters

The same growth parameters (describing mean growth [i.e., mean length at age] and its variability) were used for all three stocks. To understand the implications of this decision we need to consider (a) the extent to which it is consistent with the available data, and (b) the roles played by the growth parameters in the stock assessment models.

The mean growth function was calculated using only WFL data. This function also seems reasonable for GA-NC, for which the limited data available are not obviously inconsistent with the WFL function, but it looks obviously wrong for FLK/EFL, where observed mean lengths at age are substantially less than those for WFL (AR Figure 5.5.4.1). The decision to use the WFL growth function for FLK/EFL was based on the assumption that the substantially lower lengths at age in FLK/EFL are simply a result of a higher exploitation rate, rather than any real ("genetic") differences in growth (AR Section 5.5.4). Here it seems that a distinction is being made between what one might call the "real" (or perhaps "intrinsic") growth function for FLK/EFL (that which would occur without fishing) and the "current" growth function (which is different because of fishing), and the argument is that we should use the "real" function (assumed equal to the WFL function) in the assessment model. As to variability in growth, it was assumed that the CV (coefficient of variation) of length at age was equal to 0.2 for all ages and stocks. Where this value came from is not explained. It appears only in the assessment Control Files (AR Section 12) and is clearly inconsistent with the data plotted for WFL and GA-NC in AR Figure 5.5.4.1 (for example, it implies that 95% of 15 year old fish would lie between about 42 cm and 98 cm, whereas the plotted data appear more consistent with a CV of 0.1 or less). Note that these CVs can, and should, be estimated by the software used to estimate the mean growth curve.

The growth parameters have two distinct roles in the assessment models. One obvious role is to convert from numbers at age (the models' accounting system) to biomass (the weight-length relationship is also used in this conversion). In this role they have an effect on the estimated productivity of the stock, as measured by various biological reference points (BRPs) such as $F_{30\%}$. I can appreciate that an argument may be made that BRPs should be based on "real", rather than "current" growth. However, compared to natural mortality and steepness, the influence of growth parameters on BRPs is typically small. A second, and much less obvious, role for growth parameters is in the fitting of length compositions. The likelihood of observed length compositions is calculated by comparing them to expected length compositions, which are obtained by converting the model's expected numbers at age using the growth parameters. For the FLK/EFL assessment this conversion will have been badly wrong, because the WFL growth function is inconsistent with the relationship between age and length at the time that the length composition data were collected. This inconsistency will also badly affect the likelihoods for the conditional age-at-length data. I note that the FLK/EFL assessment results changed substantially – initial depletion changed from 9% to 80% – in the sensitivity run that used mean growth based on data from this stock (see run AltGrowthFx in AR Figure 11.2.7.2.8.2). [As an aside, I note that the estimate of 80% initial depletion is inconsistent with the view that this stock has long been "severely overfished" (AR Section 3) but suggest that, rather than being a reason to avoid using stock-specific growth, it is evidence of the difficulty of obtaining a robust estimate of initial depletion from this model.] I'm guessing that when the assessment team decided to use WFL growth parameters in the FLK/EFL model they were focussing on the first of the above two roles for these parameters and overlooked the negative consequences associated with the second role.

The fact that the growth CV parameters were too high will adversely affect the fitting of both the length composition and conditional age-at-length data for WFL and GA-NC, though I am not sure by how much. It will make the expected length compositions (and the expected conditional distributions of age at length) markedly wider than they should be.

3.0.4 Data weighting

The weight given to each data point in a stock assessment model is determined by a measure of the assumed size of the error associated with that point: typically a CV for biomass indices, and a sample size for composition data. These weightings are important because they can substantially affect both model outputs and all statistical inference from the model (Francis 2011). Likelihood profiles illustrate how different data sets favour higher or lower estimates of the parameter being profiled (e.g., AR Figure 11.2.4.8 shows that the length data favour a higher estimate of steepness than did the age data; Francis 2011 gives another example of this phenomenon in his figure 1). If we change the data weighting, we change the balance between the different data sets, and thus change the parameter estimate. Statistical inferences from assessment models (e.g., estimation of standard errors [SEs], whether from the inverse Hessian, a bootstrap, or a likelihood profile) are valid only if the assumed CVs and sample sizes are consistent with the actual error in the data.

I was concerned by the lack of discussion of data weighting in the Assessment Report. My concern is primarily that the length composition data are probably over-weighted. The sample sizes used for these data appear to be actual sample sizes (with a maximum of 200). But *effective* sample sizes for length compositions (i.e., those consistent with the error in the data) are known to be smaller, often much smaller, than *actual* sample sizes because of what Pennington & Vølstad (1994) called intra-haul correlation (i.e., fish caught in the same haul are typically more alike in length than those caught in different hauls). Stock Synthesis provides a method for calculating effective sample sizes (using the 'effN' values in plots like AR Figure 11.2.1.3.1), though this seems not to have been used in the present assessments (e.g., I note that effN < N in all 7 composition data sets for FLK/EFL [see AR Figure 11.2.1.3.35]). However, this method ignores the correlations in composition data and consequently overestimates effective sample sizes (this is illustrated in table 4 of Francis (2011), in which sample sizes based on 'effN' values [method TA1.1] are 5-24 times higher than those calculated following Pennington & Vølstad (1994) [method TA1.8]).

3.1 TOR 1: The Data

Evaluate the data used in the assessment.

The information provided to me was insufficient for a thorough evaluation of the data used in the assessment.

With regard to the fishery data, I imagine the Assessment Report was written with a local audience in mind, and so no need was felt to describe the various data collection systems. I am now aware that there are two parallel systems for collecting recreational data (MRFSS and MRIP) but I have no idea as to how they differ in terms of the data they collect, and their collection methods, and so find it impossible to assess their absolute or relative reliability. Similar comments apply to two systems for collecting commercial fisheries data: by trip ticket and logbook. Having said this I should note that fishery data collection systems are usually, in my experience, rather complex, often containing many spatial, temporal, and data-type anomalies, so it is difficult for an outsider to fully understand their strengths and weaknesses.

All the abundance index data series were documented to some degree in the Background Documents, though the level of detail provided was very variable. Only the Reef Visual Census surveys were thoroughly documented (via Smith et al., 2011). One thing lacking from the documentation of the model-based estimates was an exploration of the factors/variables deemed to be significant (see, e.g., Bentley et al. 2012). If, for example, area is found to be significant, it is useful background information to know which areas have higher or lower catch rates, and how strong the effect is (do mean catch rates in different areas differ by 10% or 100%?). The plausibility of these effects is sometimes a useful diagnostic. I would have liked more information about the treatment of year x factor interactions in Background Document 37-12. Often such interactions are avoided because of the difficulty of devising an overall year effect. How that difficulty was avoided is of great interest, but was unclear to me.

a) Are data decisions made by the assessment panel sound and robust?

I agreed with many of the data decisions made by the assessment panel. However, there are some decisions that I think were unsound. Moreover, I do not agree with the common point of view, apparently shared by the panel, that (almost) all available data should be presented to the model, regardless of how sound they are. I realise that it can be politically difficult to omit inadequate data, because this may offend those who collected the data, and the institutions that funded them. However, it is my fear that unrepresentative data can easily mislead stock assessment models, whose ability to distinguish signal from noise is not great, particularly in assessments like these where the signals are so weak. (When it is impossible to resist the pressure to include inadequate/suspect data I have found that a good strategy is to include them only in sensitivity analyses, or model runs that provide an alternative to the base assessment.)

For reasons given in Section 3.0.3 I think it was a serious mistake to use the WFL mean growth parameters in the FLK/EFL assessment, and also to use growth CVs that were inconsistent with the available data for at least two of the stocks (WFL and GA-NC).

A much more minor growth-related matter that caught my attention was the decision to include only data from the life history studies in the estimation of growth parameters, apparently because the otolith readings for all other available data were not made using the validated methodology of McBride & Richardson (2007) [Supplementary Document S37_RD04]. This decision would be standard, and sound, in an age and growth study, but it seemed odd in the context of this stock assessment because the excluded data apparently included all the conditional ages at length that were used in the assessment. Surely if the ages in these data were not sound enough to estimate a growth curve for use in the assessment then they should not have been included as observations in the assessment model. A simple qualitative check of the quality of these data is to plot residuals (observed length minus the growth curve mean length at age) against age using different plotting symbols for the two data sets (the life history data used to estimate the growth curve, and the assessment observations).

I was concerned about all of the length compositions used in the assessments, except for those from the Reef Visual Census (RVC) surveys. It was only for these surveys that I could find any description of how the length compositions were constructed. Without this information I am left with the strong suspicion that these compositions were simply raw data. This is inappropriate for fishery compositions because fishery catches are typically very heterogeneous. In particular, the length compositions of individual catches often vary in systematic ways, depending on factors such as the area fished, time of year, or vessel type. Thus a common way to obtain a length composition that might be representative of the catch for a given year is to (a) find out which factors most affect catch length compositions, (b) make sure to sample across these factors (i.e., stratify the catch), and (c) use these factors to scale up the length samples (e.g., if samples are collected for each quarter of the year, they should be weighted by the proportion of the total catch that comes from each quarter). Such a scheme highlights the necessity of discarding as unrepresentative data from years in which there was not adequate sampling in all strata. The sample sizes for many of the individual length compositions in these assessments were clearly too small to be considered representative. With stratified surveys it is conventional to use stratum area in weighting the compositions, but I saw no reference to such weighting in the documents provided (except for the RVC surveys).

Too little attention appears to have been paid to the initial equilibrium catches provided for each fishery. These are important because they affect the calculation of the initial (1986) age structure, and thus the estimation of initial depletion (see Section 3.0.1). In essence, the model assumes that the effect on the stock of all pre-1986 fishing is the same as if these initial equilibrium catches had been taken every year before 1986 for as long as it would take for the population to reach an equilibrium. Thus I was surprised to find that, with no discussion in the text, all but one of the initial equilibrium catches were set equal to the 1986 catch, rather than being based on the pre-1986 catches (the exception was Rec_HL in the GA-NC assessment). The 1986 catches were sometimes markedly less than most preceding ones (e.g., both recreational fisheries for FLK/EFL), and sometimes markedly more (e.g., Rec_Spear for WFL).

I am doubtful about the inclusion of three of the abundance indices – Video and SEAMAP for WFL, and RVCKeys for FLK/EFL – though I acknowledge that excluding them may not have much effect on the assessments. For the Video surveys my concerns are (a) the many changes over time in the equipment deployed and (b) doubt about whether the quantity measured (maximum number of hogfish in a single video frame) is proportional to abundance. For SEAMAP I was concerned that of the 5 zones used in the analysis, all were occupied in only three of the five years. For RVCKeys, I was unconvinced about the assumption that there was a step change in catchability in 2000. This is explained in AR Section 11.1.4 as being "to model a change in catchability reflecting updates to the RVC methodology and increases in precision". In Smith et al. (2011) I noted that the survey design/methodology was altered several times in different years, but I found no suggestion that the changes in 2000 could have more than doubled the survey catchability. The postulated change in catchability in 2000 might have been more convincing if evidence were presented of other species whose abundance index had jumped up in 2000. As to the reference to "increases in precision", (a) the undoubted improvement in precision over time seems to me to have been caused by a gradual increase in sampling intensity (I found that a plot of log(CV) vs *n* from table 1 of SEDAR37-09 is fairly linear), and (b) why should there be a connection between changes in catchability and precision?

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

The Assessment Report acknowledged major data uncertainties associated with recreational catches, stock structure, and, for FLK/EFL, growth rates and conflicting abundance index trends. These sorts of uncertainties are common in stock assessments, and their levels in the present assessments are not out of the ordinary.

One source of uncertainty that did not seem to be explored or acknowledged concerns the distinction between hogfish and non-hogfish habitat, which was used in the construction of the commercial and recreational CPUE (catch per unit effort) indices. Records from non-hogfish habitat were excluded from the index calculations. It is sensible and reasonable to make this distinction, but it seems to me that the boundary between the two habitats is essentially arbitrary. What remains uncertain is the degree to which the CPUE indices might change if the arbitrary definition of the boundary were changed. It could well be that the CPUE indices are relatively insensitive to this boundary definition, but we won't know that until the sensitivity has been explored.

c) Are data applied properly within the assessment model?

The data were generally well applied within the assessment model, with two exceptions.

First, I was concerned about the weighting of the length composition data: this was not discussed in the Assessment Report, and I am concerned that these data appear to have been over-weighted, which could have substantial effects on the assessment results (see Section 3.0.4).

My second concern relates to the treatment of the undoubtedly high uncertainty about the recreational catches. I think it is almost always a mistake to assign high SEs to any catches in assessment models. To do so is to say to the model "we don't really know what the catches from this fishery were, please estimate them for us". This is a mistake because I can't see what information the model has to make these estimates. I was particularly concerned to see that the model's estimates of recreational hook and line catches for the GA-NC assessment were substantially higher than the "observed" catches (AR Figure 11.2.1.1.3). Thus this model assesses the stock using catches that were much higher than the data indicate. On what basis? I suggest that a better way to deal with uncertainty in catch histories is to use best-estimate catches in the base model and then run sensitivity analyses with alternative high and low catch histories. This approach provides an explicit measure (lacking in the current assessments) of the effect of catch uncertainty on all assessment outputs. Note that by assigning low SEs to the catches we are not intending to assert that these catches are well known; we are simply trying to find out what the stock status would likely be *if* these catches were correct. [Technical note. The "hybrid F" option used in these assessments is recommended in Stock Synthesis, as stated in the Assessment report (see AR Section 11.1.4), but *not* for the case when catch SEs are high (see section 9.3.14 in Methot 2012).]

The best way to construct alternative high and low recreational catch histories depends on the nature of the errors in the catches. If this is purely sampling error (arising because a small number of trips has been sampled) then we can assume the errors are independent between years and calculate a variance, and thus 95% confidence interval, for the total catch (for a given stock and fishing method) by summing the catch variances across years. Then the low and high catch histories could be constructed by scaling the base catch history so that its total spanned the 95% confidence interval. If the catch errors involve bias (e.g., biased low because some sectors of the fishery are never sampled) then we must try to put bounds on the likely size of that bias, and use these (as well as the sampling error) in constructing low and high catch histories.

The two extreme spikes in the recreational hook and line catch history for GA-NC (AR Figure 11.2.1.1.3) are also of concern. I am surprised that these were included despite the authors' acknowledgments (in paragraph three of AR Section 11.2.5) that (a) "such drastic year-to-year changes in landings" are "unlikely", and (b) the first spike caused the model to estimate an implausible biomass trajectory (AR Section 11.2.5). An important point about the effect of catches in assessment models is that, in most assessments, all that matters is that the total historical catch from each fishery, and any broad trends in that catch, are approximately correct. An error in the catch for a specific year is usually unimportant, as long as the total catch from all nearby years is about right. This is a good reason, when catches are highly uncertain, to present catch histories that are reasonably smooth.

d) Are input data series reliable and sufficient to support the assessment approach and findings?

For reasons given above (see beginning of Section 3.1) it is difficult for me to fully evaluate the reliability of the input data series in these assessments. However, my general impression is that, with one exception, these data series are, on balance, no less reliable than those used in many acceptable stock assessments for small stocks in other parts of the world. The exception is the length composition data sets with very low sample sizes. It's not possible to specify a minimum acceptable sample size because the sample structure is important too (e.g., a sample of 200 fish would not be acceptable if they all came from one trip, which contributed only a small percentage of the catch for that fishery). However, it is hard to believe that the many compositions with sample sizes less than 20 could be representative of the catch for a year.

3.2 TOR 2: Assessment methods

Evaluate the methods used to assess the stock, taking into account the available data.

Evaluation of the methods used in the base assessments was greatly facilitated by the use of Stock Synthesis. I commend the authors for providing (a) the Stock Synthesis input files (AR Section 12), (b) tables of parameter estimates (AR Tables 11.1.4.1-3), and (c) many standard plots of outputs generated by the r4ss software. These allowed me to understand, in considerable detail, aspects of the data and model assumptions that were not clear from the text.

a) Are methods scientifically sound and robust?

The stock assessment program Stock Synthesis used in these assessments is widely used, well tested, and has a strong reputation, as evidenced by the recent special issue of the journal *Fisheries Research* (volume 142, 2013) that was dedicated to it. To use such a program is wise because it protects against coding errors and ensures that state of the art approaches to stock assessment are available. However, it does not imply that an assessment will be scientifically sound and robust, because this depends on the quality of the available data and many decisions made by the assessment team. Some decisions that have, or may have, undermined the present assessments are discussed under TOR 1 and the rest of TOR 2.

b) Are assessment models configured properly and used consistent with standard practices?

The assessment models are generally well configured, though it's difficult to comment in relation to "standard practices" because, in my experience, what is "standard" in stock assessments varies widely amongst institutions. There was one aspect of model configuration that I thought had a particularly strong bearing on these assessments.

The decision to force some selectivities in each assessment to be asymptotic was of key importance. In my view, this decision was "proper" if and only if (a) its basis was precautionary, rather than scientific, and (b) it is appropriate within the SEDAR system for a stock assessment team to make precautionary decisions (see Section 3.0.2). I make this latter point because in New Zealand (where I have worked) the invocation of precautionary arguments is explicitly outside the domain of assessment scientists.

c) Are the methods appropriate for the available data?

In general the methods used were appropriate for the available data. The only comment I would make is that more parameters were estimated than could be justified by the available data. In particular, I am sure that there was no point in estimating SR_R1_offset, and am dubious about most of the Early_InitAge parameters (as noted above, in Section 3.0.1, almost all these parameters differed only insignificantly from zero). Although estimating these parameters violates the principle of Occam's Razor, it does little other harm. However, I think it was definitely a mistake to try to estimate steepness (parameter SR_BH_steep), which is notoriously difficult, even in assessments with much better quality data than the present ones (Lee et al. 2012). In Section 3.5 I suggest a better way to deal with steepness.

3.3 TOR 3: Assessment findings

Evaluate the assessment findings with respect to 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?

For all stocks I am not confident of the reliability of estimates of abundance, exploitation, and biomass, or of estimates of the status with regard to overfished and overfishing thresholds.

Much of my lack of confidence is associated with the length compositions. Abundance indices are not very informative in stock assessments unless they show a strong trend, which was not the case for any of the indices used in these assessments. Therefore much of the inference in these assessments must depend on the length compositions (I discount the third type of observation – conditional ages at length – because of small sample sizes for almost all years). However, I am dubious about both the construction and weighting of the compositions (see Section 3.1a,c). Further, inferences based on length compositions require sound growth parameters (see Section 3.0.3), which I think were arguably lacking for all three stocks, but particularly for FLK/EFL (see Section 3.1a). I note also the link between the compositions and initial depletion, which is important in all three stocks (see Section 3.0.1). Another concern is the initial equilibrium catches, some of which were clearly inappropriate (see Section 3.1.a). I don't know how much effect a different treatment of the composition data and more appropriate initial equilibrium catches would have on the estimates from these assessments, but I think it quite possible that they could cause a substantial change.

The GA-NC assessment is particularly problematic because there was only one abundance index and this was not well fitted by the model (AR Figure 11.2.1.2.16). I suggest that either the abundance index is reliable, in which case the stock assessment (with which it is inconsistent) is not; or it is not reliable, in which case an assessment of this stock is not possible. I note however, that better weighting of the composition data (see Section 3.1c) might allow a good fit to the abundance index.

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

The stock recruit relationship was not well determined for any of the three stocks because the assessment period covered a relatively limited range of spawning biomass (AR Figures 11.2.4.1, 5, 9). This markedly limits the precision of estimates of steepness, and thus productivity and future stock conditions. However, I note that it is possible, via sensitivity analyses, to explore how uncertainty in the steepness of the stock-recruit relationship affects these estimates (see Section 3.5).

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?

I presume that "status determination criteria" refers to the F- and biomass-ratios in AR Tables 11.2.7.1-3 associated with the reference points of AR Section 11.2.8. I am not confident of the reliability of estimates of these ratios (for reasons given at the beginning of Section 3.3), and I am not aware of other indicators that are likely to be more useful.

3.4 TOR 4: Stock projections, rebuilding timeframes, and generation times

Evaluate the stock projections, rebuilding timeframes, and generation times, addressing the following:

For these assessments, projections were carried out and rebuilding timeframes were discussed, but generation times were not mentioned.

a) Are the methods consistent with accepted practices and available data?

In the realm of stock projections, what constitutes "accepted practice" varies greatly from place to place. The methods used here were those provided by Stock Synthesis, which I am sure reflect accepted practice on the west coast of the U.S.A. (though not in New Zealand), and are certainly not inconsistent with the available data. I don't know whether they are considered to be accepted practice within SEDAR.

b) Are the methods appropriate for the assessment model and outputs?

I am not aware of any aspect of the assessment model or its outputs that would make the Stock Synthesis projection methods inappropriate.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

I found the projection results hard to interpret. This is no fault of the assessment team (although it didn't help that the columns in some of the tabular output seem to have been mislabelled [e.g., I think the columns labelled F40 in AR Tables 11.2.9.1-2 should have been FCurr] – I assumed that the labelling in the associated plots [AR Figures 11.2.9.1-3] was correct). It is simply a consequence of the rather complex multiple-pass projection methodology (see appendix B of Methot 2012), which differs substantially from what I am accustomed to and produces some counter-intuitive results (e.g., see the first paragraph of AR Section 11.2.9, and note that for GA-NC, projected SSBs were higher with FCurr than with FMSY [AR Figure 11.2.9.3] despite FCurr being higher than FMSY [according to AR Table 11.2.7.1.3]). It may be that the projections also confused the assessment team because the text discussing them seemed sometimes to be inconsistent with the associated plots (e.g., I think "within 5 yrs" in the last paragraph of AR Section 11.2.9 should read something like "in 6-8 yrs"; also, in the preceding paragraph, "9 yr" in last sentence seemed inconsistent with "15-20 yrs" in the third sentence). However, if the Stock Synthesis projection methodology is accepted practice within SEDAR then I must assume that those who need to be able to interpret outputs such as those presented here have developed sufficient familiarity with them to find them informative.

As to robustness and utility in inferring probable future conditions, no projection results can be more robust than the associated assessment, and, as explained in Section 3.3, I am not convinced that the assessment results are robust.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

The projection results (as presented in AR Section 11.2.9 and associated tables and figures) included no presentation or discussion of uncertainty. For me, one of the weaknesses of the Stock Synthesis projection outputs (at least those presented in the Assessment Report) is that, although the calculations include some uncertainty (in the form of stochastic recruitment and catch implementation error), this is not reflected in the outputs. However, I would acknowledge that for many assessments (and certainly for the present ones) the uncertainty included in the projection calculations for a base model run is small compared to that between the base and plausible alternative models.

3.5 TOR 5: Uncertainties

Consider how uncertainties in the assessment, and their potential consequences, are addressed.

Five methods of addressing (various types of) uncertainty were considered in the Assessment Report: bootstrap simulation results (AR Figures 11.2.7.1.1-15); asymptotic (i.e., inverse Hessian) estimates of parameter SEs (AR Tables 11.1.4.1-3); likelihood profiles on steepness (AR Figures 11.2.4.4, 8, 12); sensitivity analyses (AR Figures 11.2.7.2.1.1-8.3); and retrospective analyses (AR Figures 11.2.7.3.1-3).

a) 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

For me, the least informative of the five methods were the likelihood profiles on steepness and retrospective analyses. The former were uninformative because (a) the data contain very little information about steepness (see Section 3.3d), and (b) the profiles are meaningless unless the data weightings are correct, which I don't think was true (see Section 3.0.4). For reasons given in Section 3.0.1 I think a much better choice for a parameter to profile would have been R0, with the aim being to understand which data sets were influencing the estimation of this parameter, and thus how robust the estimates of both R0 and initial depletion are. As to retrospective analyses, the problem with these is that when retrospective trends are found (as they were for WFL and GA-NC), it is very difficult to determine whether they are of concern (i.e., indicating some sort of model miss-specification) or simply arising from random patterns in observation error. Further, very similar trends can be caused by completely different types of model miss-specification (Mohn 1999).

I am dubious about asymptotic errors because I don't think the stock assessment situation is anything like asymptotic (what is meant by large sample size in an assessment with many sets of observations, some from complex sampling schemes?), and was surprised by the conclusion that "the asymptotic errors ... tended to produce similar estimates to the bootstrap parameter estimates" (AR Section 11.2.7.1) because my very limited comparison showed that these often differed by a factor of more than 2 (and not always in the same direction).

I think that a well-chosen set of sensitivity analyses usually provides the best description of uncertainty for stock assessments. A bootstrap approach is theoretically appealing but (a) as with a likelihood profile, the present results are probably misleading because composition data weightings (i.e., assumed observation errors) are wrong, and (b) my experience is that alternative model assumptions often cause a bigger change in model outputs than could be attributed to observation error (consider, e.g., the effect in the present sensitivity analyses of dropping the assumption that some selectivities must be asymptotic).

I offer some brief comments on the choice of sensitivity analyses and their interpretation:

– just removing 1 of the 8 biomass indices for WFL is unlikely to make much difference (AR Section 11.1.7.2);

– it would have been more informative to use alternative recreational catch histories (as suggested above, see Section 3.1c) rather than fiddling with SEs (AR Section 11.1.7.3);

– it would have been more informative to treat steepness in the same way as natural mortality – i.e., fix it in the base model and use bracketing values in the sensitivity analyses (the fixed and bracketing values could be taken as the 50th, 5th, and 95th percentiles of the prior) (AR Section 11.1.7.4);

– dropping the forcing of asymptotic selectivity (AR Section 11.1.7.5) is a key sensitivity;

– simply changing the conditional length at age data to unconditional makes sense only in the unlikely case that the fish can be considered a simple random sample from the catch; and are otolith sample sizes really big enough to estimate growth in FLK/EFL and GA-NC? (AR Section 11.1.7.7);

– the sensitivity analysis using stock-specific growth for FLK/EFL is a key result; for reasons given in Section 3.0.3 I don't agree with the suggestion that it "should not be viewed as a reasonable alternative, but useful for illustrative purposes" (AR Section 11.2.7.2.8).

A useful way to incorporate the uncertainty that was lacking from the projection outputs (see Section 3.4d) would have been to repeat the projections for a selected few of the sensitivity analyses.

b) Ensure that the implications of uncertainty in technical conclusions are clearly stated.

I am not sure that readers will appreciate the true range of uncertainty in the results from these assessments because (a) discussions of uncertainty seemed to focus mostly on the bootstraps results, with comparatively little attention paid to key sensitivity analyses, (b) there was no quantitative summary of the likely overall uncertainty (from bootstraps and sensitivity analyses) in key outputs and (c) no uncertainty was presented in the projection results.

3.6 TOR 6: Research recommendations

Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

The Assessment Report presented four research recommendations, which can be summarised as follows.

1. More growth, maturity, and fecundity information for FLK/EFL and GA-NC
2. Fishery-independent surveys for GA-NC
3. Improve age and length sampling of hogfish fisheries
4. Contribution of males to spawning reproductive potential

Of these, I think 3 and 2 are most likely to improve future assessments. With regard to 3, I would strongly emphasize the age data (age compositions are *much* more informative in a stock assessment model than length compositions) and comment that doubling the number of trips sampled has a much greater effect on precision than doubling the number of fish sampled per trip. There is a need to check that the ageing of the sampled fish is consistent with the validated method (see Section 3.1a) and to develop reliable methods to construct length compositions from these data (see Section 3.1a). With regard to 2, I note that GA-NC was the weakest of the three assessments because there was only one biomass index, and this was not well fitted by the model (see AR Figure 11.2.1.2.16).

I think that 4 is important, but perhaps more to inform fishery management (e.g., are special measures needed to protect males?) than to improve the stock assessment.

A comparative study of alternative methods of biomass index calculation would be useful. I was startled by the array of different methods used for indices in these assessments (markedly different methods are described in Background Documents 37-02, 37-05, 37-09, and 37-12) and wondered whether it was either necessary or desirable to use so many different methods. Perhaps some rationalization of methods would be possible. The study should include an investigation of sensitivity to habitat classification (see Section 3.1b) and the desirability of including year interactions (see beginning of Section 3.1) and, for the survey data, design-based methods (because they require fewer assumptions I think these methods are preferable unless demonstrated to be markedly less precise than the model-based methods).

Background Document 37-01 showed that fish from east Florida waters were genetically distinct from those from North Carolina waters, but was unable to be specific about the location of the boundary between these stocks. Samples from Georgia and South Carolina would be useful to check the stock assessment assumption that this boundary lies at the Florida-Georgia border.

b) Provide recommendations on possible ways to improve the SEDAR process.

I have no recommendations to make but would like to comment that I think the present review would have been much better informed, and thus more useful, had it involved participation in an assessment review meeting, during which both discussions with the assessment team and some additional model runs could have resolved some important uncertainties for me.

3.7 TOR 7: Improvements for next assessment

Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

Three sets of data merit particular attention in the next assessment. For length compositions, improve their construction (Section 3.1a), and selections (i.e., dropping years with small [unrepresentative] sample sizes – see Section 3.1d), and improve their weighting (Section 3.1c). Initial equilibrium catches need to be better related to pre-1986 catches (Section 3.1.a). For recreational catches, use small SEs, smooth spikes, and construct alternative low and high catch histories (Section 3.1c) to use in sensitivity analyses.

Two other model assumptions are worth reconsidering: the default selectivity (Section 3.0.2), and the growth parameters (including CVs) used for each stock (Section 3.0.3).

Some other suggestions that might improve the next assessment are as follows.

- Use a likelihood profile on R0 to help understand the data sets affecting the estimation of this parameter, and thus the robustness of the assessments' estimates of initial depletion (Section 3.0.1).
- Use sensitivity analyses to investigate the effect of uncertainty in steepness, just as was done for natural mortality (Section 3.5a).
- Characterize uncertainty in the projections by repeating them for selected sensitivity analyses (Section 3.5a).

3.8 TOR 8: Review report

Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.

You are reading the peer review report.

4. Conclusions and recommendations

The hogfish assessment team had a daunting task. The available data are weak: the abundance indices failed to show any strong trend; age data (often the second most informative data set) were very slight; and even the length data (typically a poor third in order of information content) were quite patchy. Moreover, a big proportion of the changes in stock abundance may have occurred in the years preceding the period with data (see Section 3.0.1). When the data are weak, assessments are more sensitive to the many assumptions that are made in compiling the data and structuring the model. The possibility of making an unfortunate assumption was particularly high in these assessments because they were the first for hogfish using Stock Synthesis, so the assessment team often could not rely on assumptions made, and ratified, in previous assessments. Furthermore, Stock Synthesis is rather complex, with many options, some of which are easily misunderstood (e.g., the assessment team's choice of initial equilibrium catches (see Section 3.1a) suggests that they may not have fully appreciated the role these played; this role is not well described in the Stock Synthesis User Manual).

Another complexity easily overlooked is the important role played by growth parameters in the fitting of length composition data (see Section 3.0.3).

Although the assessment team generally did a good job in setting up this first hogfish assessment in Stock Synthesis, I found sufficiently many causes for concern that I could not be confident that the assessment results were robust. This is particularly true for the FLK/ELF stock because of the profound implications of assuming the same growth as in WFL (see Section 3.0.3). For all stocks, I found reason for concern in issues such as the construction and weighting of length compositions (see Section 3.1a,c), the choice of initial equilibrium catches (see Section 3.1a) and growth CVs (Section 3.0.3), and the treatment of uncertainty in recreational catches (Section 3.1c). It could be that some or all of these issues turn out not to be important for the present assessments (e.g., I have found that changing the weighting of composition data makes a big difference to some assessments, but very little to others). It is their *potential* to cause substantial changes that makes me lack confidence in the robustness of these assessments.

Another issue that has the potential to undermine these assessments is the assessment team's default selectivity assumption (Section 3.0.2). Should this assumption not be deemed "proper" (see discussion in Section 3.2b) then all three assessments will be too pessimistic.

4.1 Recommendations

Amongst the Assessment Report's four suggestions for future research I recommend giving priority to the two concerning improve age and length sampling of hogfish fisheries (the focus should be on ages) and fishery-independent surveys for GA-NC. In addition, I recommend (a) research to rationalize the calculation of biomass indices, and (b) genetic sampling to better identify the location of the stock boundary between east Florida and North Carolina. (See Section 3.6a for more details).

For the next hogfish assessment I recommend that particular attention be paid to three data sets: length compositions (construction, selection, and weighting), initial equilibrium catches; and the treatment of uncertainty in recreational catches. Two hypotheses that should be reconsidered are those concerning default selectivities and growth. Other recommendations include a likelihood profile on R0, a sensitivity analysis for steepness, and a way of characterizing uncertainty in the projection results. (See Section 3.7 for more details).

5. References

Bentley, N.; Kendrick, T.H.; Starr, P.J.; Breen, P.A. 2012. Influence plots and metrics: tools for better understanding fisheries catch-per-unit-effort standardizations. *ICES J. Mar. Sci.* 69 (1): 84-88.

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Lee, H-H.; Maunder, M.N.; Piner, K.R.; Methot, R.D. 2012. Can steepness of the stock–recruitment relationship be estimated in fishery stock assessment models? *Fish. Res.* 125– 126: 254– 261.

Methot, R. D. 2012. User Manual for Stock Synthesis Model Version 3.24f. Updated October 3, 2012. NOAA Fisheries, Seattle, Washington.

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Waterhouse, L.; Sampson, D.B.; Maunder, M.; Semmens, B.X. 2014. Using areas-as-fleets selectivity to model spatial fishing: Asymptotic curves are unlikely under equilibrium conditions. *Fish. Res.* 158: 15-25.

Appendix 1 Materials Provided

The materials provided for the review fell into three categories: the assessment report; background documents; and supplementary documents.

Assessment Report

Cooper, W.; Collins, A.; O'Hop, J.; Addis, D. 2014. The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. Florida Fish and Wildlife Commission. 500 p.

Background Documents

SEDAR37-01 Seyoum S, Collins AB, Puchulutegue C, McBride RS, Tringali MD. 2014. Genetic population structure of Hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States.

SEDAR37-02 Cooper W. 2014. Commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2012.

SEDAR37-03 Cooper W. 2014. Recreational catch per unit effort of Hogfish (*Lachnolaimus maximus*) in the Southeast US using MRFSS-MRIP intercept data, 1991-2012.

SEDAR37-04 Cooper W. 2014. Relative index of abundance from visual order-of-magnitude REEF surveys applied to Hogfish (*Lachnolaimus maximus*) in the Southeast US, 1994-2012.

SEDAR37-05 Switzer TS, Keenan SF, McMichael RH Jr, DeVries DA, Gardner CL, Raley P. 2013. Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reeffish video surveys on the West Florida Shelf, 2005-2012.

SEDAR37-06 Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual FWRI SEAMAP trawl survey, 2008-2012.

SEDAR37-07 Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual baitfish survey, 2002-2012.

SEDAR37-08 Switzer TS, Keenan SF, McMichael RH Jr, Fischer KM. 2013. Fisheries independent data for juvenile Hogfish (*Lachnolaimus maximus*) from polyhaline seagrasses of the Florida Big Bend, 2008-2012.

SEDAR37-09 Smith SG, Ault JS, Bohnsack JA, Blondeau J, Acosta A, Renchen J, Feeley MJ, Ziegler TA. 2013. Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reef-fish visual surveys in the Florida Keys and Dry Tortugas, 1994-2012.

SEDAR37-10 Bachelor and Reichert. 2014. Summary information for Hogfish *Lachnolaimus maximus* seen on videos collected by the SouthEast Reef Fish Survey in 2010 – 2012 between North Carolina and Florida.

SEDAR37-11 Hiltz et al. 2014. Standardization of commercial catch per unit effort of Hogfish (Lachnolaimus maximus) from South Carolina Trip Ticket landings, 2012.

SEDAR37-12 McCarthy. 2014. Analysis of Hogfish data from Coastal Fisheries Logbook Program (CFLP).

SEDAR37-13 Collier. 2014. Standardization of commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from North Carolina Trip Ticket landings.

Supplementary Documents

SEDAR37-RD-01 Collins, A.; McBride, R. 2008. Integrating life history, mating system, fishing effects, and habitat of hogfish, *Lachnolaimus maximus*, a harem spawning fish in the southeast U.S.

SEDAR37-RD-02 Collins, A.B.; McBride, R.S. 2011. Demographics by depth: spatially explicit life-history dynamics of a protogynous reef fish. Fish. Bull. 109:232–242

SEDAR37-RD-03 McBride, R.S.; Johnson, M.R. 2007. Sexual development and reproductive seasonality of hogfish (Labridae: *Lachnolaimus maximus*), an hermaphroditic reef fish. Journal of Fish Biology 71, 1270–1292

SEDAR37-RD-04 McBride, R.S.; Richardson, A.K. 2007. Evidence of size-selective fishing mortality from an age an d growth study of hogfish (Labridae : *Lachnolaimus maximus*), a hermaphroditic reef fish. Bulletin of Marine Science, 80(2): 401–417.

SEDAR37-RD-05 McBride, R.S.; Thurman, P.E.; Bullock, L.H. 2008. Regional variations of hogfish (*Lachnolaimus maximus*) life history: consequences for spawning biomass and egg production models. J. Northw. Atl. Fish. Sci., Vol. 41: 1–12

SEDAR37-RD-06 Munoz, R.C.; Burton, M.L.; Brennan, K.J.; Parker, R.O. Jr. 2010. Reproduction, habitat utilization, and movements of hogfish (*Lachnolaimus maximus*) in the Florida Keys, U.S.A.: comparisons from fished versus unfished habitats. Bulletin of Marine Science, 86(1): 93–116.

Appendix 2: Statement of Work

This appendix contains the Statement of Work, including two annexes, that formed part of the consulting agreement between Northern Taiga Ventures Inc. and the author. Note that the dates in the Tentative Schedule of Milestones and Deliverables therein were not revised when the timing of the review was changed.

External Independent Peer Review by the Center for Independent Experts

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 37 will be a compilation of data, a benchmark assessment of the stock, and CIE assessment review conducted for South Atlantic and Gulf of Mexico hogfish. The desk review provides an independent peer review of SEDAR stock assessments. The review is responsible for ensuring that the best possible assessment is provided through the SEDAR process and will provide guidance to the SEFSC to aid in their review and determination of best available science, and when determining if the assessment is useful for management. The stocks assessed through SEDAR 37 are within the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils, and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review; therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than June 30, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Tentative Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

15 May 2014	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
1 June 2014	NMFS Project Contact sends the stock assessment report and background documents to the CIE reviewers.
9-20 June 2014	Each reviewer shall conduct an independent desk peer review
30 June 2014	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
13 July 2014	CIE submits CIE independent peer review reports to the COR

20 July 2014	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Allen Shimada
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Allen.Shimada@noaa.gov Phone: 301-427-8174

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

NMFS Project Contact:

Julie Neer, SEDAR Coordinator
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
Julie.Neer@safmc.net Phone: 843-571-4366

Appendix 2, Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Appendix 2, Annex 2 – Terms of Reference

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the assessment panel 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 the methods used to assess the stock, taking into account the available data.
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and used consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to 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, rebuilding timeframes, and generation times, addressing 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 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. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.

SEDAR 37 South Atlantic and Gulf of Mexico Hogfish Assessment Center for Independent Experts (CIE) Independent Peer Review Report

Paul A Medley

paulahmedley@yahoo.co.uk

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Executive Summary

This is one of three independent reports that describes the findings and conclusions of a desk peer review for the SEDAR 37 South Atlantic and Gulf of Mexico Hogfish (*Lachnolaimus maximus*) 2013 Stock Assessment.

The data inputs were well founded and represent the best science available. The stock assessment is based on reliable and well-tested software, and the assessment methodology is fundamentally sound.

For the Eastern Gulf of Mexico (WFL) stock, the stock is not overfished and overfishing is not occurring. The stock assessment model fits the available data reasonably well, but diagnostics suggest results remain uncertain.

For the Florida Keys and southeast Florida (FLK/EFL) stock, the stock is overfished and overfishing is occurring. Of the three stock assessments, this one fits the data best and its results are probably most reliable.

For the Carolinas (GA-NC) stock, the stock status is not reliably determined and conflicts in the available information have not yet been adequately resolved. Specifically, the model does not fit the abundance index.

Uncertainty in the assessment has been generally underestimated, and as currently reported, will not be easily incorporated in scientific advice. Errors in the estimates of recreational catches are a particular problem. The assessment and treatment of this uncertainty could be better in the stock assessment and projections.

Background

This is one of three independent reports that describes the findings and conclusions of this review for the SEDAR 37 South Atlantic and Gulf of Mexico Hogfish (*Lachnolaimus maximus*) 2013 Stock Assessment in accordance with the Center for Independent Experts (CIE) statement of work (Appendix 2). The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise to conduct independent peer reviews of NMFS scientific projects without conflicts of interest. Each reviewer contracted by the CIE q1provides an independent peer review report to be approved by the CIE Steering Committee (www.ciereviews.org).

SEDAR 37 will be a compilation of the data, a benchmark assessment, and the CIE review. The CIE review in this case is a desk review with the objective of ensuring that the best possible assessment is provided through the SEDAR process. The outputs from the SEDAR 37 will provide guidance to the SEFSC to aid in their review and determination of best available science, and when determining if the assessment is useful for management. The hogfish stock is within the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils, and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina.

Description of the Individual Reviewer's Role in the Review Activities

The Center for Independent Experts (CIE) provided the SoW and ToRs. The NMFS Project Contact provided the link to the assessment and background documents on 30th June 2014, which were downloaded for the desk review. All available documents were read. The review primarily covers the main assessment document, but the background material was used to check assessment decisions as well as provide the scientific context.

The review addressed each ToR as described in Appendix 2 Annex 2. The report is designed to be read independently, and therefore references to specific parts of the assessment report have been minimized.

This report fulfils the final term of reference for the SEDAR 37 review (8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.), and therefore this ToR has no further reference in this report.

1 Evaluate the data used in the assessment, addressing the following:

a) Are data decisions made by the assessment panel sound and robust?

Hogfish has a short planktonic larval phase, nearshore settlement, and is predominantly found as adults on reef coral to a maximum depth of 65m. They tend to occupy home ranges and movements of adults are not thought to be very great.

Based on what is known of the life history and recent genetic research, the division of data into the three stock areas appears sound. Seyoum et al. (SEDAR37-WP-01) demonstrated three distinct stocks through analysis of population genetics: the eastern Gulf of Mexico (WFL), the Florida Keys and southeast Florida (FLK/EFL), and the Carolinas (GA-NC). These therefore make appropriate stock divisions, bearing in mind that this leaves some areas with limited data, and given the species occupies home-ranges, it may still be possible to cause local population depletions of adults even if the overall SSB remains high.

Qualitative information and some quantitative information on life history and biology of the species is good, and raises confidence that main structural assumptions for the model are sound. Assumptions regarding the low discard mortality seem reasonable, and the morphometric conversion models clearly fit the data well. Natural mortality was estimated through a range of methods and has been well-described. Decisions made on sex, growth, maturity and calculation of SSB are well-founded and well-explored.

The small number of age observations justify the decision to estimate growth separate to the assessment model (although age data were included for sensitivity runs). It is necessary to assume a constant growth model and this is most easily enforced by fitting this model to the available age and length data separately. The decision to use the WFL data, which covers the greatest range over ages and lengths, seems reasonable, although there is clearly a risk of bias, since separate stocks need not show the same growth rates. Nevertheless, for this assessment, this is not the most critical source of error.

Abundance indices are developed and reported on. Full reports on the indices are not provided, but information is sufficient to make appropriate choices in the validity of indices. Some are excluded and good reasons are provided for this. Most are retained, and are explored as part of the assessment, which is good practice.

For the WFL stock, the available abundances indices are fairly flat from the 1990s, but most show an increasing trend for 2005-2012. However, this final trend is not strongly supported by the fishery independent indices. The decisions to include these all indices except the REEF visual survey is well justified.

For the FLK/EFL stock, the hook and line commercial indices show a slight upward trend for 2000-2012, while the commercial spear and both recreational indices and fishery independent indices are flat over the same period. Decisions on which indices to include seem well reasoned overall.

For the GA/NC stock, the hook and line logbook index shows a downward trend for 2000-2012. The two trip ticket indices are highly variable and show no overall trend. The hook and line logbook data create the most reliable and consistent index and was used for this stock.

Where they are available, the fishery independent abundance indices provide valuable information on stock size. These indices include fish size information, which improves their accuracy. They are shorter time series than the fishery dependent data, but as they build in length, they should improve the assessments significantly.

In some cases, the reasoning on indices included reference to trends (e.g. "REEF visual index… was the only index that did not show the consistent pattern of an increase in abundance in the last year."). This should be avoided as it presupposes that other indices, which are possibly related, are correct. These are reasons to exclude or include indices in sensitivity runs, but criteria to use or not use an index should depend on other information (coverage, consistency etc.).

Catches form an important part of any assessment as they measure the relative impact of fishing on the stock. Catches have been estimated independently of the assessment model and are provided as estimates with a standard error. This is standard practice and done appropriately. However, where catches are poorly estimated, as is arguably the case for the recreational catch, errors may not be fully taken into account. An alternative approach to this is outlined as a recommendation and further comment is made in discussing the modeling.

The assessment report states that "Given the paucity of age information, use of stock-, gear-, and/or year-specific age-length information (e.g. age-length keys) would introduce substantial uncertainty, particularly if one was to attempt to estimate growth parameters within a model." However, the point of stock assessment is to obtain not only the best estimates of parameters of interest, but also to correctly assess the uncertainty. The tendency in this assessment has been to avoid uncertainty by making more assumptions than are probably warranted. There is some justification for this to ensure the model is aligned within reasonable bounds based on knowledge of the species and history of the fishery, but in this case some decisions over development of data sets and their analysis may have led to an underestimate of the uncertainty. Some recommendations have been made to deal with this.

Overall decisions that had to be made are justified and appear sound and robust, although some decisions may have led to underestimates of uncertainty. Perhaps the most significant problem for all these stock assessments is the poor estimates of catch data and the lack of length data.

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

Data uncertainties are acknowledged and reported. The report and supporting documents provide information on uncertainties and how they have been dealt with. Estimates of error, such as PSE or SE, are provided.

Commercial catch data (discards and landings) appear relatively well estimated. These estimates come from standard monitoring in commercial fisheries, and errors are within acceptable levels.

Recreational catch uncertainties are outside normal levels, albeit high errors are expected for recreational fisheries. The problem does not arise from discarding, which does not appear to increase uncertainty significantly in this fishery and has been well accounted for, but from the estimates of the landings. These total landings estimates rely on MFRSS/MRIP intercept data since the majority of landings are from private vessels. There is nothing fundamentally wrong with these data as far as I can see, apart from the very limited size of the sampling in each year. This leads to some very large changes in catch estimates from year to year. Given that recreational fishing effort exhibits much lower year to year variation, this suggests catchability changes dramatically for some of these gears, which seems unlikely. This problem is recognized in the text, but no adjustment has been made to the data, except in one extreme case, because no justification has been found for any change.

Considerable work has been put into developing abundance indices for these stocks. The standardization process was objective and should have improved the indices, reducing error. The standardization process and associated errors were reported and are within expected levels.

Although there are limited amounts of length data for many gears, this is not an unusual problem. Length and age data are often over-weighted in stock assessments because they are usually not random samples, but are selected based on availability and often samples are correlated. Information on potential bias in sampling was not provided. Length sampling errors are dealt with in the assessment by using effective sample size rather than nominal ones.

Age data are even more limited. These have been combined to produce a growth model which is incorporated into the assessment. While this does introduce limitations in modelling changes in growth dynamics over time, it is probably not the most significant source of error.

c) Are data applied properly within the assessment model?

The model structure and assumptions are appropriate for these data, except errors have not necessarily been well accounted for in the catch data. Most of the “data” are derived estimates. The model is not fitted, with the exception of the length compositions, to raw observations. This builds greater complexity into the model which may not be immediately apparent, and can make it harder to trace and correct structural errors.

The use of derived abundance indices is standard practice, and the assessment model should be able to account for index errors. The significant errors associated with catches are more difficult to account for as catches determine the exploitation level which the assessment is trying to detect in other information.

For the FLK/EFL and WFL stocks, catches may be sufficiently well estimated for the assessment approach. It is less clear that estimated catches are adequately estimated for the GA-NC stock, which contains some outliers. The Stock Synthesis software (SS3), using the hybrid-F fitting method, will be forced to fit catch estimates well. However, trying to estimate catches within an assessment generally leads to excessive smoothing, so it is unclear whether much improvement can be achieved within SS3. Alternatives are suggested as recommendations for the next assessment (ToR 7).

d) Are input data series reliable and sufficient to support the assessment approach and findings?

In general, the assessment makes good use of the limited data available. Considerable work has been put into developing data series suitable for assessment. Where weaknesses have been identified, these indicate that this process is perhaps unfinished rather the methods are incorrect.

All commercial landings appear reasonably accurate, with consistent data collection throughout the time series. The assumptions made, including the allocation of landings among stocks, were justified. While discards are reported and therefore may be uncertain, there is a good attempt to account for discard mortality and no reason to suspect discards are a significant problem for this assessment. Spearing has become the dominant gear.

Recreational harvest of hogfish forms a significant proportion of catches in all stocks and all have significant errors. These data are dependent on intercepts within the Marine Recreational Fishery Statistical Survey (MRFSS) and the Marine Recreational Information Program (MRIP) data collection systems. For the GA-NC stock for example, data were based on less than ten total intercepts per year across states for 1981-2012 except 1995. The small samples have resulted in high standard errors in catches. Within the assessment model, catches are not treated as a time series, and there is no conditioning between sequential catches. This can change the catch estimate observation errors to process errors within the assessment. Whether this is a problem depends on the relative size of the various errors.

The historical reconstruction of landings before 1981 could be important in helping to determine B_0 and hence appropriate reference points. The methodology applied and resulting time series of catches seem reasonable, albeit very different to the time series based on MRFFS/MRIP data. The catches are much smoother than the later series. The historical catches were not used except in sensitivity runs.

While the method to estimate discarding is reasonable, it probably exacerbates errors in the landings time series as it is based on broadly the same information. Discard rates and mortality are low, so the effect of this error is small.

Estimates of total effort were not used directly in the assessment model. Effort information was used in CPUE calculations and in raising the total catch from the recreational sampling data.

Use of affinity propagation clustering (APC) to identify species clusters and subsequently fitting a delta-lognormal GLM to standardize the CPUE seems a reasonable and relatively simple approach. The number and type of independent variables used in the standardization were limited, and are unlikely to account for all changes to catchability. The approach is, importantly, objective and should allow corrections for independent effects on catch rates. Nevertheless, any procedure selecting zero catch trips increases errors, and the diagnostics for the binomial part of the model are less secure than log-normal for the positive trips. There was some, but limited adjustment to the nominal indices.

Overall, the abundance indices were well developed using consistent methods. The standardization methodologies to deal with zero catch trips for the CPUE indices were objective and justified. Fishery independent surveys are useful, but for many of them the time series are too short to have much impact on this assessment. Nominal indices and indices based only on non-zero trips were not explored.

2 Evaluate the methods used to assess the stock, taking into account the available data.

a) Are methods scientifically sound and robust?

Stock Synthesis (SS3) is a well-known, robust platform for catch-at-age modelling. It is well tested, accurate and flexible. The methods applied by the model are scientifically sound and robust. The main problem with Stock Synthesis is the lack of flexibility in modelling data, where such models may benefit from non-standard approaches.

Information on life history, including growth and natural mortality, is adequate for stock assessment. Hogfish are monandric, protogynous hermaphrodites that form harems. This is not modelled explicitly, except in considering how to calculate SSB. I agree with the decision that SSB should be calculated as the sum of males and females together. Separate modelling of each sex's contribution to reproduction would require explicit modelling of the effect of fishing mortality on each sex and the effect of transition. The impact of disrupting harems through higher mortalities is a concern for this fishery as it is not taken explicitly into account.

Without explicit modelling of harems and resultant effects on reproductive success as a function of mortality rates with explicit sex-linked growth and reproductive success, it seems unlikely that separate sexes in the model would make any difference. In this context, the best approach is to consider the stock as effectively a single sex and calculate the SSB as the sum of all mature fish above a particular age/size. Information on the sex ratio in the catches would seem to be a pre-requisite for any improvement on this approach.

Given the model and data limitations, the method applied is robust. The assessment should produce good scientific advice where configured properly, subject to the limited data available. Improvements in the modelling are possible, but would probably need to be implemented outside Stock Synthesis.

b) Are assessment models configured properly and used consistent with standard practices?

In general, the assessment models have been configured properly and are used consistent with standard practice. However, the assessment is data-limited, and therefore the models are more susceptible to structural error, and these errors are more difficult to detect.

Given the lack of data, where possible simpler model configurations were chosen. Combining discards with catches and avoiding seasonality simplify the model with little likely loss in assessment accuracy. The numbers of parameters fitted were not excessive, although the "hybrid-F" fitting configuration for the model hides the fishing mortality parameter fits.

The variation in natural mortality with age used in this assessment is an approach consistent with similar assessments in the region. This should have only a small effect, but probably describes natural mortality more accurately.

The two sex model was not used except for sensitivity runs. Without more extensive biological sampling covering sex as well as length, weight and age, it will be difficult to fit a 2-sex model.

The Beverton and Holt stock-recruitment function is appropriate for this species. The Ricker function may fit the data better, but more evidence to support this function would be required from the life history research.

The historical catch reconstruction for hogfish was considered unreliable and not used in the base run. Because of the start of the model at 1986, initial fishing mortality rates were estimated for those fisheries that had measured catches during 1986 for both the WFL and FLK/EFL stocks. Although it is better to estimate the starting state for the model where historical catches are unreliable, this degrades the likely model accuracy and can lead to dramatic revisions in stock status should more accurate historical data become available.

The choices made in indices of abundance were justified and reasonable. The only potential issue is the exclusion of the index from the commercial logbook hook and line data for the FLK/EFL stock, which showed an increasing trend in contrast to the other indices. While a justification is given, there is always the chance that this is following abundance trends more accurately than the other indices, so this should be considered for a sensitivity run.

The basis for the choices made for the abundance indices selectivity functions and catches appear sound. I agree with the selectivity configurations based on length and decisions made with respect to whether they are domed or logistic shape. The basic decision is whether to use a domed-shaped selectivity or a logistic function. Domed selectivity is difficult to estimate well, is likely to change from year to year and generally leads to less precautionary results (e.g. higher F_{MSY}). Given the data limitations, length compositions appear reasonably well fitted in this model.

The model uses fixed errors for the landings data. This is appropriate where catches are well estimated, but may lead to underestimates of uncertainty in the assessment in this case.

The "hybrid F" fitting method in SS3 binds the fishing mortality estimates closely to the catch. This is reasonable where the catches are well estimated or exact. However, in this case the catches are themselves estimates with high error. The greater flexibility offered by estimating fishing mortality as separate parameters ("continuous F") may be a better theoretical option, although it was noted that when this alternative approach was used, similar results were obtained.

Methods to test the model and map out the uncertainty apply good practice, including random starts for parameters to show that the maximum likelihood results are effectively global, a parametric bootstrap to estimate observation error, a wide number of sensitivity analyses to estimate structure error, and retrospective analyses. Implementation of these methods has not accounted for all errors.

c) Are the methods appropriate for the available data?

The methods applied are not wholly suitable for data limited assessments. While SS3 has been adapted to cope with a wide range of types of data, like all modelling approaches, it is dependent on quality of data and appropriate interpretation. In this case, the way data are treated could be improved, although this might require moving the assessment out of the SS3 framework. There are significant advantages with continuing SS3, as once an acceptable configuration is developed, updates become straightforward. To achieve this, more robust catches need to be estimated, perhaps linked to methods used to develop the CPUE index.

For the parametric bootstrap procedure, SS3 creates a new data set with the same variance properties that were estimated when analyzing the original data. This suggests that in this case the catch uncertainty will be underestimated. The model fits the catches almost exactly and therefore the estimated error will be lower than the input errors. No account is taken of the true sampling errors in estimating catches. A better bootstrap could be based on simulating the MRFSS/MRIP data used for these estimates (Manly 2006).

The model fits the commercial and recreational catch estimates well. The exception to the fitted landings are the 1986 and 1995 recreational hook and line landings for the GA-NC stock, which appear to be estimated to be even higher than the observed values, which I suspect are already over-estimated.

The fits to the abundance indices are generally poor, and the assessments should seek to improve these fits if possible. For the WFL stock, although the assessment report points out that all indices increased in 2012, the model predicts a decrease. The fits to the FLK/EFL abundance indices, judged by eye, seem a little better than the WFL indices. The model does not fit the commercial hook and line GA-NC abundance index at all, showing almost completely opposite trends.

The length compositions show reasonable fits for WFL gears and surveys, suggesting that the selectivity functions are broadly consistent with the available information. Time varying selectivity could improve the WFL and FLK/EFL commercial spear, although sampling is too limited to justify this. For the GA-NC commercial hook and line, the length compositions are fitted relatively well, in contrast to the abundance index fit. There is a strong argument for a change in RVC Keys selectivity before and after 2000, coinciding with the catchability change. This essentially means the index should be split into two separate series. Given this, it may be sensible to drop the index to the start in 2000 or 2001, because splitting the series probably makes the early period uninformative.

3 Evaluate the assessment findings with respect to the following:

a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

For the Eastern Gulf of Mexico (WFL) and Florida Keys and Southeast Florida (FLK/EFL), the estimates of abundance are probably good enough to support status inferences. The model results are broadly consistent with all data sources. Improvements are possible that could improve accuracy. More and better data could lead to revisions of stock status, but in my opinion these would not be large unless historical catch data became available.

The WFL exhibits strong retrospective patterns, which suggest changes over time, which are not being accounted for. These problems stem from unrecorded changes in mortality (e.g. unrecorded catches or changing natural mortality) or changing catchability in the abundance indices. Retrospective patterns can also result from changes in the selectivity pattern. Some effort has been made in exploring the causes of these patterns, but this has so far been unsuccessful.

For the Carolinas (GA-NC), estimates are not reliable and the status of this stock remains uncertain. The reported results are not wholly consistent with input data. The results reported for this stock are not, at this stage, useful for scientific advice.

b) Is the stock overfished? What information helps you reach this conclusion?

Eastern Gulf of Mexico (WFL)

The WFL stock is not overfished. The available evidence suggests that the spawning stock biomass is greater than that which would achieve maximum sustainable yield (SSB >

MSSTMSY). Trends in the abundance indices, catches and sizes suggest the stock is stable and are compatible with this conclusion. This result should be treated with caution, but the retrospective bias suggests SSB may be underestimated.

Florida Keys and southeast Florida (FLK/EFL)

The stock is overfished. The estimate of stock size relative to reference points suggests that the current estimated SSB is lower than key benchmarks (SSB < MSSTMSY). The bootstraps which account for observation error, support this. In addition, some estimates of steepness and of the mean recruitment for the unexploited stock from the sensitivity runs suggest a lower productivity and therefore the stock may be even more depleted than the base run.

This interpretation of stock status is dependent on the estimates for the stock status at the start of the time series, since the decline in stock size has not been large over the assessment period. With the lack of historical catch time series, this is uncertain, although it is worth noting that the sensitivity extending the time series back to 1981 did not improve the perceived status of the stock. Nevertheless, the current level of depletion implies relatively large catches prior to 1986.

Carolinas (GA-NC)

In my opinion, the GA-NC stock status is not reliably estimated in this assessment. It is not possible to determine from the available information whether the stock is overfished or not. However, with a significant declining trend in the abundance index, there is a significant risk that the stock is below the maximum sustainable yield level.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

Eastern Gulf of Mexico (WFL)

The WFL stock is not undergoing overfishing. While the model results remain uncertain, the available evidence suggests that fishing mortality is less than that which would achieve maximum sustainable yield ($F < F_{MSY}$). Trends in the abundance indices, catches and sizes suggest the stock is stable and are compatible with this conclusion. Although this result should be treated with caution, the retrospective bias suggests fishing mortality may be overestimated. The F estimate is well below its benchmarks and below the lower 95% limit generated from the bootstrap.

Florida Keys and southeast Florida (FLK/EFL)

The stock is undergoing overfishing. The estimate of fishing mortality relative to reference points suggests the current estimated catch is too high. The bootstraps, which account for observation error, confirm this. In addition, some estimates of steepness and of the mean recruitment for the unexploited stock from the sensitivity runs, suggest lower productivity and a higher risk of overfishing.

Carolinas (GA-NC)

Fishing mortality is not reliably estimated in this assessment. The abundance index suggests that the stock may have been increasing or has been stable 2009-1012, although the lowest index value was in 2009. There has been a slightly increasing trend in the mean length of the commercial hook and line landings since 1990. Landings have fluctuated with apparent peaks in the mid-1990s and in recent years 2005-2012. These conflicting patterns could be consistent with shifting selectivity and changes in recruitment as well as the effects of depletion.

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

Where the data are uninformative on steepness in the models, the prior is suitable for use not only in setting the value but also in projections. More precautionary steepness levels should also be considered in sensitivities, and could be chosen for more precautionary scientific advice. While the assessment considered the effect of sensitivities in estimates, this was not taken forward in the management advice.

For the Eastern Gulf of Mexico (WFL), the stock-recruitment relationship is flat and estimates of steepness are poorly determined from the data, but the values obtained remain reasonable and appropriate for the determination of reference points (benchmarks) and for the projections.

For the Florida Keys and southeast Florida (FLK/EFL), there is an apparent negative relationship between estimated spawning stock size and subsequent recruitment which makes the model informative on steepness. While there is considerable uncertainty in projecting individual recruitments, it is reasonable to use the steepness estimate from the model in this case. The final estimate (h=0.83) is not very different from the prior mode (h=0.84).

In the case of the Carolinas (GA-NC) stock, for the reasons given above, the stock recruitment is not 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?

Eastern Gulf of Mexico (WFL)

The diagnostics for the fitted model suggest some inconsistencies between the model and data. There is a retrospective pattern, which suggests structural bias in the model and significant increases in uncertainty. However, the estimates are likely negatively biased and taking into account observation error within the model, the parameter estimates are still within key benchmarks (MSSTMSY, FMSY, F30%) with high probability. Therefore, the accuracy of estimates is acceptable for precautionary decision-making.

Florida Keys and southeast Florida (FLK/EFL)

The diagnostics suggest the fitted model is consistent with the data and therefore the reported results are reliable.

Carolinas (GA-NC)

The quantitative estimates of status are not reliable and evidence is conflicting. The abundance index suggests that the stock may have been increasing or has been stable during 2009-2012, while there has been a slightly increasing trend in the mean length of the commercial hook and line landings since 1990. Landings have fluctuated with apparent peaks in the mid-1990s and in recent years 2005-2012. The task of stock assessment is to balance or explain conflicting information to draw out a conclusion. This has not yet been achieved for this stock.

4 Evaluate the stock projections, rebuilding timeframes, and generation times, addressing the following:

a) Are the methods consistent with accepted practices and available data?

The methods used for projections are integral to SS3, and consistent with accepted practices and the available data.

b) Are the methods appropriate for the assessment model and outputs?

The SS3 assessment model incorporates the ability to make projections that are consistent with the fitted model. The performance of the different fishing mortality controls have been reported for the best fit and bootstrapped data sets. This approach is appropriate for the model and outputs.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

For the Eastern Gulf of Mexico (WFL) stock, the retrospective pattern suggests that the performance of the projections in predicting outcomes may be poor. Although, they represent the best science available, the results should be treated with caution.

For the Florida Keys and southeast Florida (FLK/EFL), the projections are most likely reliable over a 5-10 year time frame. However, the lack of contrast in past stock conditions make the projections based on much lower or higher catches extrapolations rather than interpolations, and would therefore be much more sensitive to model errors.

For the Carolinas (GA-NC) stock, the projections are not useful and highly unlikely to accurately describe the response of the stock to changing catch levels.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

All key uncertainties are acknowledged, and discussed. These stem from uncertainties in the model and data, and are primarily due to uncertain catch and possible changes in selectivity or catchability over time. Although the uncertainties on management decisions can be inferred from the information presented, it is not explicit. Specifically, uncertainties associated with the sensitivity analyses and bootstrap simulation are not reflected in projections.

The retrospective bias is also not accounted for in the projections. This is difficult to do, however, without carrying out a full management strategy evaluation. A better approach would be to identify possible causes of the retrospective bias, account for them in the sensitivity analyses and see how that might affect the determination of current and projected status.

The result is that the projections do not account for uncertainty and overestimate the accuracy of the predicted results.

5 Consider how uncertainties in the assessment, and their potential consequences, are addressed.

a) 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

Parametric bootstraps can provide a good basis for assessing uncertainty, but the bootstrap simulations need to genuinely reflect the sampling process. In this case, this would be alternate catch time series, length compositions and abundance indices that could have been obtained from the sampling program. A parametric rather than non-parametric bootstrap is probably the best approach with small data sets, as in this case, but it is not clear that SS3's bootstrap implementation is entirely appropriate in this case. The SS3 bootstrap is based on the internal variance estimates, which are likely to have underestimated the true error.

Bootstrap simulated data could be generated for each data source, although this would require more work. Of the data used, it is likely the recreational catch data might benefit most from simulating the sampling program to generate alternate series. The delta-normal GLMs used to standardise the abundance indices could be used as the basis to provide alternative simulated abundance indices, whereas length compositions might be obtained from fitted densities (smoothed non-parametric bootstrap).

Sensitivity analysis is a good way to explore assumptions and structural uncertainty. A large number of sensitivity analyses were conducted, and some more are suggested for future assessments (ToR 7). However, while the effect of the sensitivity changes is reported, the results are not developed or taken forward in the management advice. A process is required to select one or two representative sensitivities as states of nature to include with the base case for further evaluation.

b) Ensure that the implications of uncertainty in technical conclusions are clearly stated.

Uncertainty is addressed in reporting data inputs, and for key outputs for the assessment, such as stock status, reference points. These are clearly stated in the technical conclusions.

The parametric bootstrap provides a robust way to assess observation error, but in this case it is not clear that all sampling errors are accounted for. Importantly, sampling errors associated with the recreational catch have not been fully addressed.

A large number of sensitivity analyses were conducted and described. Although extensive, these are not necessarily complete. Apart from indicating the range of results, no further decisions are made on which sensitivities might be used to represent structural uncertainty in the model.

Uncertainty in results were not carried forward into the management advice. As a result, it is difficult to see how the assessment of the uncertainty can be properly carried forward in scientific advice. Management guidance on acceptable risk and level of precaution would be useful in improving evaluations of possible management actions. This might be developed by reporting probabilities of falling above or below the different benchmarks in the projections under different levels of fishing mortality.

6 Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

The assessment document provides useful recommendations for further research, covering research on hogfish biology and improved monitoring data. Research on life history and growth has provided a good basis for the stock assessment modelling. While on-going research on hogfish biology will be useful, it is not a critical area for reducing uncertainty in the assessment at this stage. Improvements in monitoring data are more important.

Good stock assessments will not be possible without good estimates of catches and abundance indices. The assessment recommendations consist of improvements in biological sampling for lengths and age across all fisheries, and development of a fishery independent abundance index for the GA-NC stock.

While the assessment report recommendations are important, other areas of the assessment will also require improvement. The most valuable improvement would likely be better recreational catch data reporting. The proportional standard errors are very high for all estimated landings and it seems unlikely that catches will vary so significantly year by year as currently estimated. Some of these problems are historical, and recent years' catches appear more accurate. Dealing with past errors is an issue of improved robust estimation only, whereas ongoing improved sampling and estimation procedures could reduce errors in future. With recreational catches being so high in many Florida fisheries, improvement in monitoring recreational catches should provide benefits to a wide number of fishery assessments.

b) Provide recommendations on possible ways to improve the SEDAR process.

The SEDAR process would benefit from greater guidance on assessment output and greater focus on assessing uncertainty. It is recommended that the SEDAR process include:

- The stock assessment should identify a pair of sensitivities to bracket the uncertainty and bootstrap or MCMC simulations should be applied to these as well as the base case. These uncertainties should be included in the projections.
- Sensitivities should report changes in stock and fishing status, not only changes in parameter estimates. Parameter estimates may be correlated, so important indicators (e.g. F_{2012}/F_{MSY}, SSB_{2012}/SSB_{MSY}) may change very little.
- The assessment should report the breakdown of negative likelihood contributions for each of the main data components.
- It is useful to provide the input data and results in spreadsheet or text form if possible, so that additional graphs and tables can be made if necessary as part of the review. Although in most, but not all cases, tables are provided in the report and data can be extracted from these with some effort, it would be easier if original information was provided. Further diagnostic plots, such as observed vs expected values, residual plots and so on would have been useful and some of the presented graphs were unclear. Information provided in text or spreadsheets allows reviewers

to examine what they want while avoiding unnecessary work for the assessment team.

Terms of reference for the stock assessment and this review might be improved and better aligned. Specifically, the stock assessment ToRs should require that uncertainty is included in the projections, which is implied in the Review ToR 4.

The assessment should be given more guidance on practical management interventions so that the projection can be based on real options. In this case, it is also unclear how the fishing mortality targets used in the projections might be implemented where catches are so poorly monitored.

7 Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

It may be better to fit the model to the total recreational fishing effort (angler days) rather than the catch directly (e.g. Porch *et al.* 2006). The year-to-year variation in effort is much lower than the estimated catches and probably provides a better estimate of the variation in fishing mortality. An explicit likelihood linking the intercept samples and the total catch can be included in the stock assessment. This would account for the sampling error explicitly, and allow the model to smooth through the catches providing more accurate estimates. Currently, with no other information, the catch in the model is likely to follow the input estimate, while the implied catchability is not consistent with the abundance indices. If estimated within the model, the catches would be smoothed, but probably more accurate.

Including the catch estimation within the stock assessment is desirable, but may be too onerous as it would probably require developing a bespoke model. An alternative might be to link catch estimation to the development of abundance indices, which would limit the year to year variation in catch rates. Linear models could be used to build catch estimates conditional on observations across years consistent with the abundance indices implied catch rates rather than as independent samples.

Whereas parametric bootstraps provide an excellent tool for estimating uncertainty, the method used here does not account for much of the known uncertainty in input values. It would probably be better to simulate bootstrap datasets externally to SS3 where uncertainty in the dataset could be more accurately modelled. For example, the MRIP/MRFSS derived catch estimates could themselves be bootstrapped to generate alternative catch time series.

Identifying ways to remove the retrospective bias for the GA-NC and WFL stock assessments should help identify primary sources of structural error. Estimating time varying catchability is difficult within the model, but external adjustments to input data based on likely changes in catchability as well as adjusting catches (e.g. applying a smoothed catch time series) could at least identify possible causes for the bias as well as provide alternative sensitivities.

The purpose of sensitivity runs should not be so much to determine possible ranges for parameter estimates, but to try to incorporate uncertainty in key assumptions into management advice. The aim should be to identify a reasonable range from the sensitivities to capture this uncertainty and include the additional model configurations in projections.

Future additional sensitivities should be considered and include:

- Apply more changes on data component weights (lambdas) to explore how they affect the assessment outcome. Specifically for the GA-NC stock, weights to force fits alternately to the abundance index, landings and length frequency data (use the "continuous Fs" option) should help elucidate problems in this model.

- Time varying selectivity could improve abundance indices, including the WFL and FLK/EFL commercial spear, and the GA-NC commercial hook and line. The RVC Keys index selectivity should be split into two separate series before and after 2000, or possibly drop the earlier period from the assessment.
- Nominal indices and indices based only on non-zero trips were not tried. It is not clear from the information presented how much influence the APC / binomial model has on the final index. It may be useful to consider the positives trips model alone (hogfish caught >= 1) as this could avoid bias in the trip selection procedure which is always very uncertain. If these alternative abundance indices give different indications of stock trends, they could form the basis for additional sensitivities.

Conclusions

The data preparation and stock assessment shows considerable work and progress in developing assessments for hogfish stocks in the US South Atlantic and Gulf of Mexico. For the WFL and FLK/EFL stocks, the assessment provides a good basis for determining stock status and developing management advice. The assessment of the GA-NC stock assessment requires more work.

The assessments suggest that the WFL stock is not overfished, whereas the FLK/EFL stock is overfished. The status of the GA-NC stock cannot yet be determined.

The stock assessments are data limited, and have significant problems, particularly with estimated catches. Catches are effectively assumed to be well estimated without bias in the stock assessment model used. An alternative model which estimates catches internally may provide a better solution in this case.

Uncertainty has been underestimated in the stock assessments and not fully taken into account in the management advice. Improvements in the assessment of uncertainty could not only improve the management advice, but also lead to better stock assessments.

As well as the assessment being data limited, there is a lack of contrast in data over the available period (1986-2012). Abundance indices, sizes and, most likely, catches have not changed much. This will limit the ability of the assessment to predict outcomes for management actions accurately.

References

Manly, B.F.J. (2006) Randomization, Bootstrap and Monte Carlo Methods in Biology, Third Edition. Texts in Statistical Science, Chapman & Hall/CRC.

Porch, C. E., Eklund, A., Scott, G. P. (2006) A catch-free stock assessment model with application to goliath grouper (*Epinephelus itajara*) off southern Florida. Fishery Bulletin 104:1

Appendix 1: Bibliography of materials provided for review

SEDAR 37 Southeastern U.S. Hogfish Assessment Report

Cooper, W., Collins, A., O'Hop, J., Addis, D. 2014. The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 Eighth Ave Southeast, St. Petersburg, Florida 33701-5020

Working Papers

SEDAR37-WP-01: Genetic population structure of hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States

SEDAR37-WP-02: Commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2012

SEDAR37-WP-03: Recreational catch per unit effort of hogfish (*Lachnolaimus maximus*) in the Southeast US using MRFSS-MRIP intercept data, 1991-2012

SEDAR37-WP-04: Relative index of abundance from visual order-of-magnitude REEF surveys applied to Hogfish (*Lachnolaimus maximus*) in the Southeast US, 1994-2012

SEDAR37-WP-05: Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reef-fish video surveys on the West Florida Shelf, 2005-2012

SEDAR37-WP-06: Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual FWRI SEAMAP trawl survey, 2008-2012

SEDAR37-WP-07: Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual baitfish survey, 2002-2012

SEDAR37-WP-08: Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from polyhaline seagrasses of the Florida Big Bend, 2008-2012

SEDAR37-WP-09: Fisheries-independent data for hogfish (*Lachnolaimus maximus*) from reef-fish visual surveys in the Florida Keys and Dry Tortugas, 1994-2012

SEDAR37-WP-10: Summary information for hogfish *Lachnolaimus maximus* seen on videos collected by the SouthEast Reef Fish Survey in 2010 ¿ 2012 between North Carolina and Florida

SEDAR37-WP-11: Standardization of commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from South Carolina Trip Ticket landings, 2004-2012

SEDAR37-WP-12: Analysis of Hogfish data from Coastal Fisheries Logbook Program (CFLP)

SEDAR37-WP-13: Standardization of commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from North Carolina Trip Ticket landings.

Research Papers

SEDAR37-RD01: Integrating life history, mating system, fishing effects, and habitat of hogfish, *Lachnolaimus maximus*, a harem spawning fish in the southeast U.S.

SEDAR37-RD02: Demographics by depth: spatially explicit life-history dynamics of a protogynous reef fish

SEDAR37-RD03: Sexual development and reproductive seasonality of hogfish (Labridae: *Lachnolaimus maximus*), an hermaphroditic reef fish

SEDAR37-RD04: Evidence of size-selective fishing mortality from an age an d growth study of hogfish (Labridae : *Lachnolaimus maximus*), a hermaphroditic reef fish

SEDAR37-RD05: Regional Variations of Hogfish (*Lachnolaimus maximus*) Life History: Consequences for Spawning Biomass and Egg Production Models

SEDAR37-RD06: Reproduction, habitat utilization, and movements of hogfish (*Lachnolaimus maximus*) in the Florida Keys, U.S.A.: comparisons from fished versus unfished habitats.

Appendix 2: Statement of Work for Dr. Paul Medley

External Independent Peer Review by the Center for Independent Experts

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 37 will be a compilation of data, a benchmark assessment of the stock, and CIE assessment review conducted for South Atlantic and Gulf of Mexico hogfish. The desk review provides an independent peer review of SEDAR stock assessments. The review is responsible for ensuring that the best possible assessment is provided through the SEDAR process and will provide guidance to the SEFSC to aid in their review and determination of best available science, and when determining if the assessment is useful for management. The stocks assessed through SEDAR 37 are within the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils, and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review; therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the

Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (Annex 2).
3) No later than June 30, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2.

Tentative Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

15 May 2014	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact

1 June 2014	NMFS Project Contact sends the stock assessment report and background documents to the CIE reviewers.
9-20 June 2014	Each reviewer shall conduct an independent desk peer review
30 June 2014	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
13 July 2014	CIE submits CIE independent peer review reports to the COR
20 July 2014	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910

William.Michaels@noaa.gov Phone: 301-427-8155

Allen Shimada
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Allen.Shimada@noaa.gov Phone: 301-427-8174

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Roger W. Peretti, Executive Vice President
Northern Taiga Ventures, Inc. (NTVI)
22375 Broderick Drive, Suite 215, Sterling, VA 20166
RPerretti@ntvifederal.com Phone: 571-223-7717

Key Personnel:

NMFS Project Contact:

Julie Neer, SEDAR Coordinator
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
Julie.Neer@safmc.net Phone: 843-571-4366

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2 – Terms of Reference

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

1. Evaluate the data used in the assessment, addressing the following:
    a) Are data decisions made by the assessment panel 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 the methods used to assess the stock, taking into account the available data.
    a) Are methods scientifically sound and robust?
    b) Are assessment models configured properly and used consistent with standard practices?
    c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to 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, rebuilding timeframes, and generation times, addressing 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 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. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.

Independent Peer Review of the SEDAR 37 South Atlantic & Gulf of Mexico Hogfish

Prepared for the Center for Independent Experts

By

Dr. Geoff Tingley

Email: geoff.tingley@mpi.govt.nz

September 2014

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Executive Summary

- This document is the individual CIE Reviewer Report of the SEDAR 37 South Atlantic and Gulf of Mexico hogfish (*Lachnolaimus maximus*) desk-based CIE review. The review was conducted during July 2014 and solely represents the views of the independent reviewer (Geoff Tingley).

- Assessments for each of three hogfish stocks (WFL, EFL/FLK and GA-NC)[1] were clearly presented and documented, including detailed descriptions of the input data and an appropriate level of coverage of the uncertainties.

- The assessments presented all include time-series of data described as indices of abundance; however, some of these are extremely unlikely to index abundance. This issue is sufficiently important that this reviewer does not believe that these assessments should be accepted as 'best science' until this issue is rectified.

- Recent advances in stock discrimination incorporating genetic analyses greatly improved the understanding of the stock structure for this species and materially assisted in developing these stock assessments.

- The 2013 assessment for South Atlantic and Gulf of Mexico hogfish stocks shows considerable improvement over the previous assessment conducted in 2004. This appears to be principally due to some focused research and additional data collection, both identified as required in the earlier assessment process.

- All three of the hogfish stocks have significant data limitations that impact on the provision of good quality stock assessments but continuing improvements to address this should be possible and should be attempted.

- Re-examining aspects of the data inputs, especially the approach to developing and retaining abundance indices in the assessment, are likely to yield improved model fits.

- The assessment team recognized shortcomings in the analyses for these stocks and made some appropriate recommendations aimed at improving the current approach to the hogfish stock assessments through additional research.

- Specific recommendations aimed at improving the stock assessment approach for these stocks are made by the reviewer under Term of Reference 7 (page 12).

[1] WFL= Western Florida; EFL/FLK = Eastern Florida/Florida Keys; and GA-NC = Georgia to North Carolina.

Background

This desk-based review of the 2013 Stock Assessment Report for Hogfish (*Lachnolaimus maximus*) in the South Atlantic and Gulf of Mexico was conducted as part of an independent review of the overall assessment process under the Center for Independent Experts (CIE).

Documents were clearly presented and contained few omissions or typographical errors. The support provided by the SEDAR staff was excellent.

All views expressed in this report are solely those of the independent reviewer.

The fisheries for hogfish in the South Atlantic and Gulf of Mexico are complex, encompassing a number of different fishing methods, most of which are difficult to monitor consistently or effectively. These difficulties are exacerbated by a complex spatial distribution of habitat and thus fish abundance and also by the majority of the fishery being recreational.

It is of note that considerable improvements in input data have been achieved since the previous assessment for hogfish was conducted in the early 2000s (see SEDAR 6, 2004). It will be important to build upon these improvements in future.

Description of Review Activities

This review was undertaken by Geoff Tingley between the 7th and 28th July 2014 as part of the SEDAR 37 review of the 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. This review was delayed by approximately one month, as instructed by email, from the originally scheduled dates. The final submission date for this review report was changed to reflect the overall change in the review dates from 30th June to 28th July 2014.

The supporting documents (see Bibliography, Appendix 1) for the assessment were provided to the reviewer in electronic format adequately in advance of the review date. The assessment and supporting documentation were reviewed against the specific Terms of Reference (ToR) provided by the CIE (see Appendix 2). In order to understand more of the background and some details of the input data, the reviewer also accessed publicly available reports from the previous hogfish assessment (SEDAR 6).

Background information relevant to this review is presented in appendices to this review report, as required by the ToR for this review. These are Appendix 1: Bibliography of documents; and Appendix 2: CIE Statement of Work (which includes background information and Annexes describing (i) the Format and Contents of the CIE Peer Review Report, and (ii) Terms of Reference for the Peer Review, for SEDAR 37 South Atlantic and Gulf of Mexico hogfish review.

Comments are provided against the specific ToR given in Annex 2 of Appendix 2 and are solely those of the reviewer.

Summary of Findings

The South Atlantic and Gulf of Mexico hogfish assessment team should be commended for their thorough and professional approach to processing the basic data and developing and applying the models for a complex of stocks and fisheries to provide advice to managers, with the exception of how time-series of data were included as indices of abundance. A summary of findings and recommendations from this reviewer is presented below.

The findings of this reviewer are reported within relevant sections, addressing each of the ToR as set out in Annex 2 of Appendix 2.

Overall findings

The approaches to stock definition and modeling were thorough and sound, with the modeling appropriately addressing uncertainty through a wide range of sensitivities to the principle assumptions. The input data were clearly described and prepared for use. However, the lack of critical quality selection criteria in the selection of some of the input data, especially for time-series presented as indices of abundance, is considered a significant weakness of these assessments.

These fisheries have a general paucity of data that increases uncertainty in any stock assessment. While many of these uncertainties have been fully addressed, others remain unaddressed and intractable, and raise doubts about the robustness of the assessment outputs.

Summary

- The use of recent genetic studies to better define hogfish stock structure enabled all data to be appropriately spatially defined for use as inputs to the assessments for the different hogfish stocks.
- The majority of uncertainties in the input data, parameter assumptions and model structure were appropriately explored in the treatment of the input data and in sensitivity runs to the base case models.
- Two areas where uncertainty was not deemed to have been adequately addressed are (i) with respect to developing and selecting indices of abundance, and (ii) in the implicit assumptions made about the representativeness of the biostatistical data sampled from the various fisheries (e.g. length frequency and age data).
- The assessments presented all include time-series of data that are described as indices of abundance but are unlikely to be so. This issue is sufficiently important that this reviewer does not believe that these assessments should be accepted as 'best science', raising doubts about the validity of the assessment outputs.
- Development of an approach and subsequent application to quality-test the various time-series of data as possible indices of abundance prior to their inclusion in these assessments is required. This may yield improved model fits to key indices of abundance as well as improvements in the robustness of and confidence in the assessment results.
- The assessment team did a thorough job of preparing the various data sets and in developing and applying the models.

Comments on Individual Terms of Reference

1. *Evaluate the data used in the assessment, addressing the following:*
   a) *Are data decisions made by the assessment panel 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?*

It is clear from the types and amount of data available to assess hogfish, that it would be appropriate to describe these fisheries as data poor or data limited. The quantities and quality of the data available, much of it coming from recreational fisheries, are borderline in terms of being able to adequately support stock assessments. The best quality data have been collected for specific purposes (genetic discrimination) or through specific programs (life history data) to address previously defined data gaps relevant to assessments. Such limitations in the basic data available would be expected to create some difficult issues for an assessment team to address. These issues have generally been addressed in a sound, appropriate and robust manner by the hogfish assessment team.

The uncertainties in the data are reported and mostly acknowledged. This included clear descriptions of the uncertainties in the catch history, the patchiness in the spatial and temporal distribution of length frequency and age data from the three stock areas, and uncertainties in the estimated selectivity and natural mortality parameters. The uncertainties in the data used to derive the catch-per-unit-effort (CPUE) and fishery-independent survey time-series are also appropriately addressed. However, this was not followed through to an evaluation of the likelihood of the various time-series actually indexing stock abundance, which is an important omission.

A number of unusual variations in data presented are neither commented on nor explained. For example, effort levels in some of the fisheries were highly variable to a level that warrants further investigation, especially as there was no discussion of why this should occur and whether the data were usable (see FLK/EFL hook-and-line effort in Table 6.4.1. and WFL hook-and-line effort for 2009 in Table).

Appropriate biological data for hogfish were considered, analysed, reported on and used in the assessment. The genetic information was used to good effect in defining stock boundaries that were then consistently applied to all other datasets throughout the assessments. The other data considered included catch distribution (temporal, spatial and depth), length frequency, age, maturity (age, sex and size), sexual transition (age, size, depth, location), growth and natural mortality (*M*).

Information on catches (i.e. landings and discards) is fairly uncertain but this has been appropriately highlighted and dealt with, especially for the earlier years of the fishery. Length frequency and age data are very patchily available in time and space and in low numbers from most of the fisheries. Given the known difficulties of collecting appropriate data from small scale, mostly recreational fisheries, the uncertainties are within expected levels.

In the absence of detailed discard mortality data, the assumed discard mortalities appear reasonable but would bear further explanation of why particular values were selected, and the scale of potential impacts of error in the assumptions could be further explored.

To improve future assessments, the collection of the spatially and temporally patchy biological data from the fisheries, especially length frequency and age data, needs to be made more consistent in future.

The majority of the input data series are adequately reliable, and, with uncertainty taken into account, have been properly used within the assessments. There are two areas of concern where this does not appear to be the case and that merit further consideration. In particular, all three stocks have multiple time-series of what are described as indices of abundance, including both fishery-dependent and fishery-independent indices.

Having options to develop multiple time-series that could be used as indices of abundance is really useful in assessments of otherwise data poor fisheries. However, unquestioning acceptance that a time-series of CPUE or a fisheries independent survey does index abundance can introduce substantive problems in an assessment if it is not an index. This can downgrade the model fit to some or all of the other data sets, including other, genuine indices of abundance. In these assessments, all of the time-series presented were included, with no reported review about whether the time-series were likely to index stock abundance or not, or whether they were in opposition to other putative indices for the same stock.

For example, there is no consideration of the spatial coverage of data in SEDAR37-01 beyond the accepted stock boundaries and some habitat differences in the FLK/SEFL area. The model implicitly assumes that each group of trips are (i) representative of the fishery and (ii) covering the same spatial area in each time period (month, year). It may be that this is the case but there is no consideration or analysis of this and it is not possible for the reviewer to judge based on evidence, whether this assumption is likely to be correct or not. Given the length of some of the time-series of CPUE, it is difficult to believe, *a priori*, that the spatial distribution of the fishery is the same in each year. It is even more unlikely that the spatial coverage of the different fisheries by the often limited sampling effort will be either representative or adequately similar between years to enable a derived CPUE series to be considered a good index of abundance.

Reasons for doubting the validity of some of the time-series, requiring specific sensitivities to justify inclusion of an index in the assessment, or for fully rejecting some of the time-series used in these assessments, can be made based on one or more criteria.

The following examples explore this.

(i) It is implausible that the two-fold change in abundance in the WFL stock indicated by hook-and-line index between 2011 and 2012 is valid (Figure 8.2.1.2); similarly, the near four-fold increase between 2009 and 2010 for the WFL hook-and-line index is even harder to accept as real (Figure 8.2.2.2).

(ii) The very low value for the WFL video surveys in 2007 compared to the years either side (a 15-fold drop from 2006 followed by a 24-fold increase to 2008) makes this extremely unlikely to be a valid index as it stands. At least possible reasons for the low value of 2007 data point should have been explored and, if justified, the point could have been removed from the standardization (Figure 8.2.4.1).

(iii) There is a clear issue with the quality of the standardization of the FLK/SEFL[2] commercial Florida trip tickets hook-and-line index, where 13 of the 19 data points are below the standardized index. There is also a clear trend in the residuals (early years above, later years below) (Figure 8.2.1.4).

(iv) Some of the time-series used as indices of abundance in the assessment are clearly in opposition, which is recognized in the report by the assessment team. For example, for the FLK/EFL[3] fisheries the CPUE time-series from the commercial logbooks from the hook-and-line fishery has an increasing trend, while that from the spear fishery has a decreasing trend and are in such stark opposition that is difficult to justify the inclusion of both within the assessment (Figure 8.2.10.1). These measures cannot both be indexing the whole stock (or even the same component); therefore, one or other should be excluded from the assessment. If no justifiable case for exclusion can be made for either time-series, then this should be addressed through sensitivities that exclude first one and then the other, testing the overall goodness of fit of the model to all datasets to help define the most appropriate course of action.

(v) The coefficients of variation (CVs) on the baitfish index for the WFL stock are so large that this index is unlikely to add much to the assessment and it could be omitted from the base case of future assessments, possibly functioning as a sensitivity only.

Sensitivities to test the impact of different indices on the stock assessments (Sections 11.1.7.2 and 11.2.7.2.2) only removed time-series one at a time. While this should have identified issues due to particularly influential time-series, it is unlikely to have adequately addressed issues in the assessments caused by pairs of indices in opposition, as described in (iv) above (Figure 8.2.10.1).

The modelling package Stock Synthesis (SS) is designed to permit use of multiple input data sets such as abundance indices. However, getting an acceptable outcome relies on the ability of SS to 'balance' its fits to the input data. Where there are good data (quality and quantity) this may work, as those datasets that match will work together to override those that may be erroneous. However, where the other data (e.g. length frequency data or age data) are of poor quality due to lack of temporal or spatial coverage or low and variable sample sizes, it becomes considerably less likely that the model will be able to find the 'correct', i.e. real world, outcome.

It is recommended that there should be a specific requirement for assessment teams to consider the quality of the time-series being considered as abundance indices. This consideration should take account of evidence, or if evidence is lacking, logical argument, that supports or opposes the likelihood of the time-series indexing the stock in question. Where time-series are found to be unlikely or highly unlikely to index abundance they should be omitted from the assessment. Where the evidence or logical argument is inconclusive, the value of the time-series can be addressed through running sensitivities. One specific objective of this approach should be to eliminate the inclusion of multiple times series that show opposing trends in abundance within the same model run. Where

[2] FLK/SEFL = Florida Keys/Southeast Florida.
[3] FLK/EFL = Florida Keys/Eastern Florida.

opposing indices exist, their impacts upon the fits and outcomes of the assessments should be explored using sensitivity runs.

The only other area where it is arguable that uncertainties were not adequately addressed in the assessment relates to those input data sampled from the various fisheries. The assessment team notes that spatial and temporal coverage are important (in terms of abundance indices) and go on to note that this is rarely achieved in practice (Section 8.1.1). The issue of spatial and temporal coverage of the abundance indices has been dealt with above; however, it is also true that the sampling of the length frequency and age data from fisheries should also be adequately representative, to be of most use in assessments. In relatively small and complex fisheries, such as these for hogfish (multiple fleets; mostly recreational effort; spatially structured habitat; sexual transition based on size, age and location; etc.), obtaining sufficient length and age data is an achievement in itself. However, it should be recognised that the spatial and temporal coverage of these data sampled from the fisheries are more likely to be unrepresentative of the fisheries from which they sampled than will be the case is less structured, often larger scale and less complex fisheries, unless specific efforts have been made to ensure that representativeness is achieved.

The assessment report is silent on whether the length and age data from the different fisheries are representative or not. Given the structure of the fisheries, and the low level of and temporal variability in sampling, it is the reviewer's opinion that these datasets are unlikely to be representative of the fisheries from which they were sampled. The assessments under review did not address this possible lack of representativeness in the fisheries sampled data.

Ideally, future stock assessments should define whether or not any of these datasets are representative of the fisheries that they come from. If found to be unrepresentative, the relative scale of divergence from representativeness should be explored and the impacts of this evaluated as an uncertainty in the assessment. In the absence of such definition, assessments should still seek to explore the impacts of lack of representativeness on the fit of the model to the data and the robustness of the model outcomes (e.g. stock status).

With the exceptions of the lack of understanding about the representativeness of the fisheries sampling and the lack of critical evaluation of the value of the various putative indices of abundance, given a fairly difficult set of data to work with, the assessment team have done a thorough job of preparing the data for assessment. The data are adequately reliable and sufficient to support the modelling approach and are applied properly within the assessment. The apparent lack of critical review of the validity of the abundance indices could be serious issue in terms of potential error in the estimation of stock status for these stocks and does not meet the thresholds of proper application and reliability.

2. *Evaluate the methods used to assess the stock, taking into account the available data.*
   a) *Are methods scientifically sound and robust?*
   b) *Are assessment models configured properly and used consistent with standard practices?*
   c) *Are the methods appropriate for the available data?*

The methods used to develop the stock assessments for the three stocks are scientifically sound and robust. As far as is possible to ascertain in a desk-based review, the assessment models have been configured properly and used in a manner consistent with standard practices. The methods applied are appropriate for the available data.

For example, Stock Synthesis assumes that landings are precisely known and there is uncertainty about landings for most of the fisheries harvesting hogfish from the three stocks. These uncertainties have, however, been appropriately addressed, especially through the use of sensitivity model runs.

3. *Evaluate the assessment findings with respect to 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?*

The use of the model to produce population benchmarks and management information for the three stocks are appropriate. However, the reliability of the abundance, exploitation, and biomass estimates are compromised by the appropriateness of aspects of the data input decisions, specifically the inclusion of time-series expected to index stock abundance where there is evidence that they are probably not reliable indices.

The extent to which the assessment results been compromised, in terms of stock status and performance against management quantities such as the overfished and overfishing thresholds, is not possible to determine without additional assessment work. It is, therefore, not possible to be explicit about the stock status or performance of the stocks against management thresholds until the issue of the inclusion of inappropriate '*indices of abundance*' is appropriately addressed.

4. *Evaluate the stock projections, rebuilding timeframes, and generation times, addressing 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?*

The approaches used to develop projections, rebuild timeframes and generation times are appropriate. The use of projections that extend to two decades exceeds what would normally be accepted as robust even for a high quality assessment. In this case, given the quality of the input data, running projections over such long timeframes is likely to be unreliable and is also unnecessary. A table of three or five year projections would be useful for a range of realistic fishing mortalities (F), including current F. In terms of defining rebuild time-scales, a maximum projection period of about 10 years would be sufficient.

All projections were developed from the base case model (Section 11.1.10) and so did not address uncertainty in either data inputs, assumed values or model structure. Running projections from a base model only is not that unusual, although where assessments have high uncertainty, using selected sensitivity runs to explore the impact of projected stock status against management targets and a range of catch scenarios, is common. Given the overall quality of the input data (patchy length frequencies and age data in time and space; difficulties in defining the fisheries selectivities and issues with the inclusion of dubious abundance indices), these assessments could reasonably be described as having higher than normal uncertainty. It would, therefore, have been expected that key uncertainties would have been explored through to the projections.

Evaluating the information content and robustness of the results suffers from the same issue of needing to remove unreliable '*index*' data series before such an evaluation can reliably be conducted. As such, the results cannot really be described as robust, although they probably do retain an ability to inform on broad aspects of future performance, but with a higher level of associated uncertainty than would be desirable.

5. *Consider how uncertainties in the assessment, and their potential consequences, are addressed.*
   a) *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*
   b) *Ensure that the implications of uncertainty in technical conclusions are clearly stated.*

A key uncertainty in many stock assessments where there are multiple stocks is the quality and robustness of the knowledge about stock structure. Through some targeted genetic research, prioritised through the assessment process, this uncertainty has been substantially reduced for hogfish in the South Atlantic and Gulf of Mexico.

The majority of other uncertainties have been clearly expressed and addressed through the wide range of sensitivities to variability and uncertainty in the different input data, model structure, and parameter assumptions.

More effort to address uncertainties could and perhaps should have been directed to the quality and representativeness of, for example, the length frequency and age sampling from the various fisheries.

6. *Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.*
   a) *Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.*
   b) *Provide recommendations on possible ways to improve the SEDAR process.*

a) Research and monitoring recommendations:

- In a fishery with multiple data deficiencies, one of the potential objects of modeling is to identify those datasets that, by their inadequacy, associated uncertainties or absence, have a disproportionate impact on the outcomes of the assessment that managers have a particular interest in. This can then provide a coherent input to the prioritization of future research effort aimed at improving the assessment most effectively. More effective progress may be made by using the model outputs to review the immediate future research focus and prioritization.

Four recommendations are made in the assessment document but are not prioritized. The prioritization recommended by the reviewer of these, is as follows:

1) Improve the biostatistical sampling of hogfish.
2) Develop/ improve the fishery-independent surveys for the GA-NC stock and fisheries.
3) Conduct focused life history studies for the FLK/EFL and GA-NC stocks.
4) Develop a life-history study to address male contribution to spawning reproductive potential.

The first two of these recommendations are by far the more important, as these sit right at the heart of delivering acceptable stock assessments for these stocks.

b) SEDAR process improvement recommendations:

The organizational approach, provision of clear ToR and provision of documents for the SEDAR process is of a very high standard. The recommendation that follows addresses minor issues that particularly address the needs of external reviewers and general readers alike in understanding these fisheries and the complex assessments in a relatively short space of time. It is recommended that the following issues be considered for inclusion in future SEDAR assessment reports.

- A report structure with fully consecutive page numbering would have made the reading and reviewing the report easier.
- A list of acronyms should be included in the report. There was no list of acronyms in the assessment report which, given the number of acronyms used, would have been

very useful and would have expedited the work of the review (see for example http://sero.nmfs.noaa.gov/sustainable_fisheries/more_info/documents/pdfs/glossary_of_fishery_terms.pdf).

- Tables in assessment reports need to be appropriately formatted to enable effective interpretation of their information content: in a number of key tables in the assessment report, the columns of figures were neither right-justified nor aligned at the decimal point and the numbers had variable decimal places. The numbers in some of the tables were overly precise (i.e. there are too many places of decimals). While minor in themselves, these make reading the tables for scale, errors, outliers and areas of transition, both slower and harder.
- A map describing the key stock areas, locations and boundaries referred to, would have aided the reader's understanding of the spatial context of the fisheries, the stock structure, and sampling locations referred to.

7. *Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.*

- It is recommended that there should be a specific requirement for assessment teams to consider and report on the quality of all time-series being considered as abundance indices. This consideration should take account of evidence, or if evidence is lacking, logical arguments that support or oppose the likelihood of each time-series indexing the stock in question. Where time-series are found to be unlikely or highly unlikely to index abundance they should be omitted from the assessment. Where evidence and/or logical arguments are inconclusive, the value of the time-series may be addressed through running sensitivities. Specific objectives of this approach should be to (i) raise the quality standard of the input data to help improve the fit of the model to the data and increase the robustness of the assessment; and (ii) to eliminate the inclusion of times-series that show opposing trends in abundance within the same model run where the time-series relate to the whole stock or the same stock components.
- Length frequency and age samples from these fisheries are of borderline quality for enabling adequate stock assessments for the three hogfish stocks to be developed. Sampling in more recent years has been better than that from earlier years but ideally should be improved further. It is recommended that a more consistent approach to obtaining sufficient samples that are representative of each fishery in each year be developed. An approach that aims to obtain a balance of samples from the different fisheries and stocks should be developed and implemented. This will help enable stock assessments of adequate quality to be developed in future. This is essentially the same as the recommendation to 'improve the biostatistical sampling of hogfish' made by the assessment team (see section 6 above).

Appendix 1: Bibliography

SEDAR 37 Florida Hogfish Working Document List

SEDAR37-01	Seyoum S, Collins AB, Puchulutegue C, McBride RS, Tringali MD. 2014. Genetic population structure of hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States.
SEDAR37-02	Cooper W. 2014. Commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2012.
SEDAR37-03	Cooper W. 2014. Recreational catch per unit effort of hogfish (*Lachnolaimus maximus*) in the Southeast US using MRFSS-MRIP intercept data, 1991-2012.
SEDAR37-04	Cooper W. 2014. Relative index of abundance from visual order-of-magnitude REEF surveys applied to Hogfish (*Lachnolaimus maximus*) in the Southeast US, 1994-2012.
SEDAR37-05	Switzer TS, Keenan SF, McMichael RH Jr, DeVries DA, Gardner CL, Raley P. 2013. Fisheries-independent data for Hogfish (*Lachnolaimus maximus*) from reef-fish video surveys on the West Florida Shelf, 2005-2012.
SEDAR37-06	Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual FWRI SEAMAP trawl survey, 2008-2012.
SEDAR37-07	Switzer TS, Fischer KM, McMichael RH Jr. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from the annual baitfish survey, 2002-2012.
SEDAR37-08	Switzer TS, Keenan SF, McMichael RH Jr, Fischer KM. 2013. Fisheries-independent data for juvenile Hogfish (*Lachnolaimus maximus*) from polyhaline seagrasses of the Florida Big Bend, 2008-2012.
SEDAR37-09	Smith SG, Ault JS, Bohnsack JA, Blondeau J, Acosta A, Renchen J, Feeley MJ, Ziegler TA. 2013. Fisheries-independent data for hogfish (*Lachnolaimus maximus*) from reef-fish visual surveys in the Florida Keys and Dry Tortugas, 1994-2012.
SEDAR37-10	Bachelor and Reichert. 2014. Summary information for hogfish *Lachnolaimus maximus* seen on videos collected by the SouthEast Reef Fish Survey in 2010 – 2012 between North Carolina and Florida.
SEDAR37-11	Hiltz et al. 2014. Standardization of commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from South Carolina Trip Ticket landings, 2004-2012.
SEDAR37-12	McCarthy. 2014. Analysis of Hogfish data from Coastal Fisheries Logbook Program (CFLP).
SEDAR37-13	Collier. 2014. Standardization of commercial catch per unit effort of hogfish (*Lachnolaimus maximus*) from North Carolina Trip Ticket landings.

Appendix 2: Statement of Work

Attachment A: Statement of Work for Dr. Geoff Tingley

External Independent Peer Review by the Center for Independent Experts

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 37 will be a compilation of data, a benchmark assessment of the stock, and CIE assessment review conducted for South Atlantic and Gulf of Mexico hogfish. The desk review provides an independent peer review of SEDAR stock assessments. The review is responsible for ensuring that the best possible assessment is provided through the SEDAR process and will provide guidance to the SEFSC to aid in their review and determination of best available science, and when determining if the assessment is useful for management. The stocks assessed through SEDAR 37 are within the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils, and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review; therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than June 30, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Tentative Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

15 May 2014	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
1 June 2014	NMFS Project Contact sends the stock assessment report and background documents to the CIE reviewers.
9-20 June 2014	Each reviewer shall conduct an independent desk peer review
30 June 2014	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
13 July 2014	CIE submits CIE independent peer review reports to the COR
20 July 2014	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery

Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Allen Shimada
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Allen.Shimada@noaa.gov Phone: 301-427-8174

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Roger W. Peretti, Executive Vice President
Northern Taiga Ventures, Inc. (NTVI)
22375 Broderick Drive, Suite 215, Sterling, VA 20166
RPerretti@ntvifederal.com Phone: 571-223-7717

Key Personnel:

NMFS Project Contact:

Julie Neer, SEDAR Coordinator
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
Julie.Neer@safmc.net Phone: 843-571-4366

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2 – Terms of Reference

SEDAR 37: South Atlantic and Gulf of Mexico Hogfish Assessment Desk Review

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the assessment panel 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 the methods used to assess the stock, taking into account the available data. Are methods scientifically sound and robust?
   a) Are assessment models configured properly and used consistent with standard practices?
   b) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to 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, rebuilding timeframes, and generation times, addressing 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 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. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.