S E D A R

Southeast Data, Assessment, and Review

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SEDAR 18

Stock Assessment Report

Atlantic Red Drum

October 16, 2009

SEDAR is a Cooperative Initiative of:

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

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Stock Assessment Report

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1 SEDAR Process Description

SEDAR (Southeast Data, Assessment and Review) was initially developed by the Southeast Fisheries Science Center and the South Atlantic Fishery Management Council to improve the quality and reliability of stock assessments and to ensure a robust and independent peer review of stock assessment products. SEDAR was expanded in 2003 to address the assessment needs of all three Fishery Management Council in the Southeast Region (South Atlantic, Gulf of Mexico, and Caribbean) and to provide a platform for assessments developed through the Atlantic and Gulf States Marine Fisheries Commissions and state agencies within the southeast.

SEDAR strives to improve the quality of assessment advice provided for managing fisheries resources in the Southeast US by increasing and expanding participation in the assessment process, ensuring the assessment process is transparent and open, and providing a robust and independent review of assessment products. SEDAR is overseen by a Steering Committee composed of NOAA Fisheries representatives: Southeast Fisheries Science Center Director and the Southeast Regional Administrator; Regional Council representatives: the Executive Directors and Chairs of the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; and Interstate Commissions: the Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is organized around three workshops. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. Second is the Assessment Workshop, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. Third and final is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products.

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

SEDAR Review Workshop Panels consist of a chair, a reviewer appointed by the lead SEDAR cooperator, and 3 reviewers appointed by the Center for Independent Experts (CIE), an independent organization that provides independent, expert reviews of stock assessments and related work. The Review Workshop Chair is appointed by the SEFSC director and is usually selected from a NOAA Fisheries regional science center. Participating councils may appoint representatives of their SSC, Advisory, and other panels as observers to the review workshop.

SEDAR 18 was charged with assessing red drum in the US Atlantic. This task was accomplished through workshops held between February and August 2009.

2 Management Overview

This overview is first presented as working paper **S18-DW03**. The outline is modified here to meet SEDAR standards. The working paper provides the current management unit and area definitions, a management and regulatory history, and the current management criteria for Atlantic coast red drum.

2.1 Management Unit and Area Definitions

The management unit is defined as the red drum (*Sciaenops ocellatus)* resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundaries of the Exclusive Economic Zone. The selection of this management unit is based on the biological distribution of the species along the Atlantic coast and historical patterns which have identified fisheries for red drum extending north through New Jersey.

The management area is the entire Atlantic coast distribution of the resource from Florida through New Jersey. (Fig. 2.1) The management area is divided into a southern region which includes the waters of the Atlantic coast of Florida north to the North Carolina/South Carolina border. The northern region extends from the North Carolina/South Carolina border north through New Jersey (ASMFC 2002).

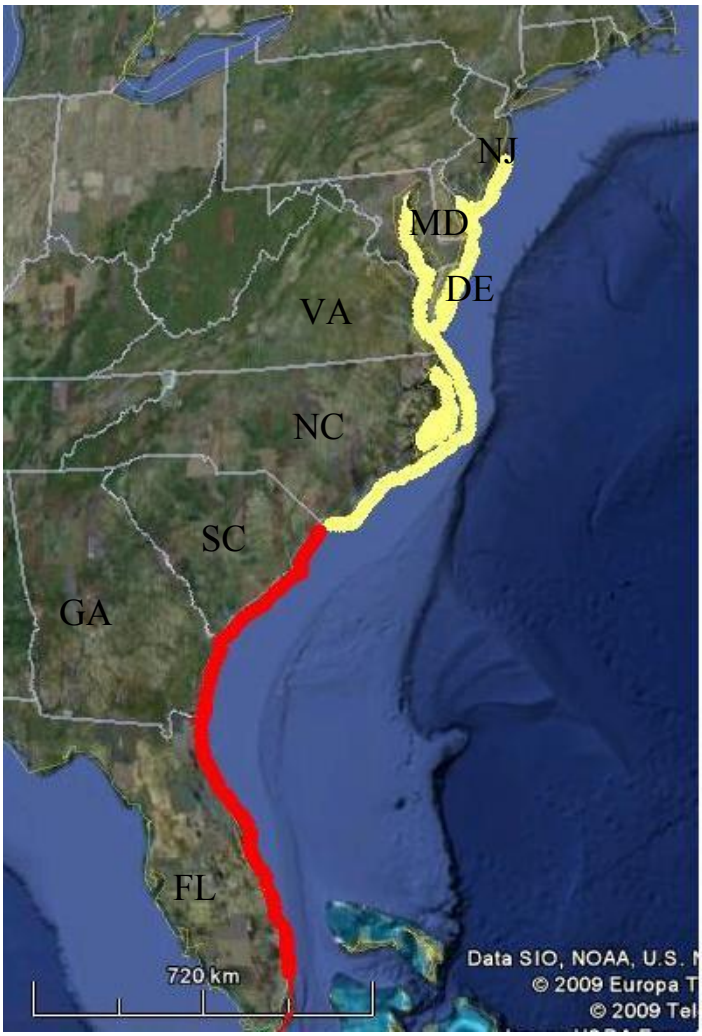

Figure 2.1. The management area is composed of two regions for assessment purposes. The southern region is waters of the Atlantic coast of Florida north to the NC/SC state line and the northern region extends from the NC/SC state line north through New Jersey.

2.2 Regulatory History

2.2.1 Atlantic States Marine Fisheries Commission

Interjurisdictional management of Atlantic coast red drum began in 1984 when the Atlantic States Marine Fisheries Commission (ASMFC) adopted the Fishery Management Plan (FMP) for Red Drum (ASMFC 1984). The interstate FMP provided recommended management measures to achieve its objectives for the states from Maryland through Florida. The ASMFC updated the interstate FMP in 1991 with Amendment 1 for consistency with measures recommended in the federal FMP for state waters. In 1994, the Atlantic Coastal Fisheries Cooperative Management Act provided the ASMFC with a means to enforce state adoption of required elements of fishery management plans. Subsequently, the ASFMC adopted Amendment 2 in June 2002 (ASMFC 2002), which required management measures to achieve its objectives in all states from New Jersey through Florida.

2.2.2 South Atlantic Fishery Management Council

In 1990, the South Atlantic Fishery Management Council (Council) adopted an FMP for red drum in federal waters (3-200 nautical miles offshore; SAFMC 1990). The Council adopted new definitions of the plan's management criteria in 1998. In 1999, the Council recommended that management authority for red drum be transferred to the states through the Commission's Interstate Fishery Management Program process. The final rule to fulfill this recommendation became effective November 5, 2008 (73 FR 58059).

2.2.3 Regulatory History per Jurisdiction

Table 1 provides a regulatory history for the ASMFC, the SAFMC, and each state in the management area. Actions are grouped by the responsible state or agency.

2.3 Current Management Criteria and Stock Benchmarks

2.3.1 Definition of Overfishing

Overfishing for red drum is defined as a fishing mortality rate (F) in excess of the fishing mortality rate at 30% Static Spawning Potential Ratio (SPR) or F30% SPR. The target fishing mortality rate is the fishing mortality rate at 40% Static Spawning Potential Ratio (SPR) or F40% SPR (ASMFC 2002).

2.4 References

Atlantic States Marine Fisheries Commission (ASMFC). 1984. Fishery Management Plan for Red Drum. Washington (DC): ASMFC. Fishery Management Report No. 5. 107 pp.

ASMFC. 1994. Fishery Management Plan for Red Drum - Amendment #1. Washington (DC): ASMFC. Fishery Management Report No. 19. 123 pp.

ASMFC. 2002. Amendment 2 to the Interstate Fishery Management Plan for Red Drum. Washington (DC): ASMFC. Fishery Management Report No. 38. 142 pp.

Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; Atlantic Coastal Fisheries Cooperative Management Act Provisions; Atlantic Coast Red Drum Fishery off the Atlantic States; Transfer of Management Authority, 73 Fed. Reg. 58059 (2008) (to be codified at 50 CFR Parts 622 and 697)

SAFMC (South Atlantic Fishery Management Council). 1990. The Atlantic Coast Red Drum Fishery Management Plan. Charleston (SC): SAFMC. 106pp.

Table 1. Regulatory history of red drum by jurisdiction

State/ Agency	Regulatory Description	Action	Effective Date
ASMFC	Recommends measures for Maryland-Florida to attain OY: 14" TL minimum size limit with comparable mesh size regulations in directed fisheries (defined as containing at least 60% red drum by weight), possession limit of 2 fish > 32" TL, prohibition of purse seining.	Original FMP	October 1984
ASMFC	Recommends that all Atlantic coast states implement measures to present the development of northern markets.	ISFMP Policy Board request	1988
ASMFC	Adopts the Federal FMP and recommends complimentary management measures for states (New Jersey - Florida) to achieve OY, starting with an interim 10% SSBR. Recommended measures are either, 1) 18-27" TL and 5 fish, including one >27", and 2) 14-27" TL and 5 fish.	Amendment 1	October 1991
ASMFC	Defined the goal of OY as the harvest associated with a 40% static SPR. Overfishing is defined as the fishing mortality rate that exceeds F30% SPR, and the target as F40% SPR. States are required to implement recreational regulations that achieve F30%SPR, and to maintain any existing (or more conservative) commercial regulations. Maximum size limit set at 27" TL.	Amendment 2	January 1, 2003
SAFMC	Defined optimum yield as the harvest amount that can be taken while maintaining SSBR at or above 30% and overfishing as the fishing mortality rate that will, if continued, reduce SSBR below 30%. Recommended that states implement measures necessary to achieve at least 30% escapement (estimated as necessary to achieve 30% SSBR). Prohibited the harvest of red drum in the EEZ.	Original FMP	November 9, 1990
SAFMC	Defined OY as the harvest associated with a 40% static, MSY as 30% static SPR, overfishing at less than 30% static SPR, and threshold overfishing at 10% static SPR.	Amendment 1	October 1998
New Jersey	18" minimum size limit, possession limit of 1 fish greater than 27" TL.		May 15, 1994
New Jersey	18" minimum size limit, 27" maximum size limit, 1 fish creel limit.	N. J. A. C. 7:25-18.1	November 1, 2002

Table 1. continued

Delaware	18" TL minimum size limit, 27" TL maximum size limit, 5 fish possession limit with 1 fish allowed > 27" TL.	Tidal Finfish Regulation 11	June 11, 1994
Delaware	20" TL minimum size limit, 27" TL maximum size limit, 5 fish possession limit.	Tidal Finfish Regulation 11	March 10, 2003
PRFC	14" TL minimum size limit.	Reg. III, Sec. 11(a)(13)	July 1, 1990
PRFC	18" TL minimum size limit, possession limit of 1 fish >27" TL.	Reg. III, Sec. 11(a)(13)	July 1, 1993
PRFC	18" TL minimum size limit, 27" TL maximum size limit, 5 fish possession limit with 1 fish allowed > 27" TL.	Order 96-2	January 1, 1996
PRFC	18" TL minimum size limit, 25" TL maximum size limit, 5 fish possession limit.	Order 2003-04	January 1, 2003
Maryland	14" TL minimum size limit, possession limit of 2 fish > 32" TL.	Md. Code Ann. Nat. Res. Section 4-734(12)	1991
Maryland	18" TL minimum size limit, 5 fish possession limit with 1 fish allowed > 27" TL (Chesapeake Bay Red Drum Fishery Management Plan incorporated into regulation)	COMAR 08.02.01.01, COMAR 08.02.05.16, 21:18 Md. R. 1257	September 12, 1994
Maryland	18" TL minimum size limit, 27" TL recreational maximum size limit, 25" TL commercial maximum size limit, 1 fish recreational possession limit, 5 fish commercial possession limit.	COMAR 08.02.05.16, emergency provision 30:13 Md. R. 850, amendment 30:16 Md. R. 1073	June 9, 2003 (emergency provision; permanent August 18, 2003)
Virginia	Possession limit of 2 fish > 32" TL.	Code of Virginia § 28.2-304	July 1, 1960
Virginia	14" TL minimum size limit, possession limit of 2 fish > 32" TL.	VR450-01-0037	June 1, 1986
Virginia	18" TL minimum size limit, 27" TL maximum size limit, 5 fish possession limit, with 1 fish allowed > 27" TL.	VR450-01-0037 as amended	March 1, 1992
Virginia	18" TL minimum size limit, 26" TL maximum size limit, 3 fish possession limit.	4 VAC 20-280-10 et seq. amended	January 1, 2003

Table 1. continued

North Carolina	14" TL minimum size limit, possession limit of 2 fish > 32" TL.	Rule NCAC 3B .0105	1-Feb-76
North Carolina	14" TL minimum size limit, 32" maximum size limit, 1 fish allowed >32" TL, 5 fish recreational possession limit, 300,000 pound commercial cap.	Rule NCAC 3B .0105 (Commercial Cap under Proclamation M-1-89/90)	January 1, 1990
North Carolina	18" TL minimum size limit, 32" maximum size limit, 1 fish allowed >32" TL, 5 fish recreational possession limit, 250,000 pound commercial cap.	Rule NCAC 3M .0501 (Commercial Cap under Proclamation FF-11-91)	August 26, 1991
North Carolina	18" TL minimum size limit, 27" maximum size limit, 1 fish allowed >27" TL (no sale >27" TL), 5 fish recreational possession limit, 250,000 pound commercial cap.	Rule NCAC 3M .0501 (Commercial Cap under Proclamation FF-8-92)	April 1, 1992
North Carolina	18" TL minimum size limit, 27" maximum size limit, 1 fish recreational possession limit, 100 pound daily commercial trip limit, 250,000 pound commercial cap.	Rule 3M .0501 & 3J .0103	October 22, 1998
North Carolina	18" TL minimum size limit, 27" maximum size limit, 1 fish recreational possession limit, 5 fish commercial trip limit (due to cap overages in 1999 and 2000), 250,000 pound commercial cap.	Proclamation FF-32-00	July 22, 2000
North Carolina	18" TL minimum size limit, 27" maximum size limit, 1 fish recreational possession limit, 5 fish commercial trip limit, the total weight of red drum can not exceed 50% total marketable catch (excluding menhaden), 250,000 pound commercial cap.	Proclamation FF-33-2001	March 31, 2001
North Carolina	Establishes authority for Director to adjust commercial trip limit as needed to avoid annual cap overages. Shifts commercial season to be monitored from September 1 through August 31.	Rule 3M .0501	May 1, 2001
North Carolina	18" TL minimum size limit, 27" maximum size limit, 1 fish recreational possession limit, 7 fish commercial trip limit, total weight of red drum can not exceed 50% total marketable catch (excluding menhaden), 250,000 pound commercial cap.	Proclamation FF-47-2001	September 6, 2001

Table 1. continued

South Carolina	14" TL minimum size limit from June 1 to September 1, possession limit of 1 fish > 32" TL	Amendment to Section 50-17-55, SC Code of Laws	June 9, 1986
South Carolina	14" TL minimum size limit from June 1 to September 1, possession limit of 1 fish > 32" TL, 20 fish possession limit, gamefish status (prohibiting the sale of native fish, except maricultured fish).	Amendment adding Section 50-17-56 to SC Code of Laws	June 30, 1987
South Carolina	14" TL minimum size limit from June 1-October 1, possession limit of 1 fish > 32" TL, 20 fish possession limit, gamefish status.	Amendment to Section 50-17-55, SC Code of Laws	April 5, 1988
South Carolina	14" TL minimum size limit, 32" TL maximum size limit, possession limit of 1 fish >32" TL, 20 fish possession limit, gamefish status.	Amendment to Section 50-17-510, SC Code of Laws	June 6, 1990
South Carolina	14" TL minimum size limit, 32" TL maximum size limit, possession limit of 1 fish >32" TL, 5 fish possession limit, gamefish status.	Amendment to Section 50-17-520, SC Code of Laws	April 29, 1991
South Carolina	14" TL minimum size limit, 27" TL maximum size limit, 5 fish possession limit, gamefish status.	Amendment to Section 50-17-510, SC Code of Laws	June 11, 1993
South Carolina	15" TL minimum size limit, 24" TL maximum size limit, 2 fish possession limit.	Amendment to Section 50-5-1705 and -1710, SC Code of Laws	August 31, 2001
South Carolina	15" TL minimum size limit, 23" TL maximum size limit, 3 fish possession limit.	Amendment to Section 50-5-1705 and -1710, SC Code of Laws	June 15, 2007
GA	14" TL minimum size limit, possession limit of 2 fish > 32" TL.	Game and Fish Law. 27-4-10 and -11	1986
GA	14" TL minimum size limit, possession limit of 2 fish > 32" TL, 10 fish daily possession limit.	"Saltwater Finfishing Rule" O.C.G.A. 27-4-130.1	September 13, 1989
GA	14" TL minimum size limit, possession limit of 1 fish > 27" TL, 5 fish daily possession limit.	Board of Natural Resources Action	August 19, 1991
GA	14" TL minimum size limit, 27" TL maximum size limit, 5 fish daily possession limit.	O.C.G.A 27-4-130.1	August 15, 1993
GA	14" TL minimum size limit, 23" TL maximum size limit, 5 fish daily possession limit.	O.C.G.A 27-4-130.1(b) and DNR Rule 391-2-4-.04	July 1, 2002

Table 1. continued

Florida	Prohibition on red drum harvest by out-of-state citizens or for industrial purposes		Before 1925
Florida	12" FL minimum size limit		1925
Florida	15" FL minimum size limit		1953
Florida	12" FL minimum size limit		1955
Florida	Length definition changed to TL		1971
Florida	Length definition changed back to FL		1973
Florida	18" TL minimum size limit, possession limit of 1 fish >32" TL, protected species designation.	CH 46-22, F.A.C.	September 12, 1985
Florida	Prohibition of harvest in state waters and any sale of native fish.	Emergency Rule, CH 46ER86-3, F.A.C.	November 7, 1986
Florida	Emergency rule lifted, 18" TL minimum size limit, possession limit of 1 fish >32" TL, March-April closure, must be landed whole, snatch hooking and use of treble hooks while fishing with natural bait prohibited.	CH 46-22, F.A.C.	February 12, 1987
Florida	Prohibition of harvest in state waters and any possession, transportation, buying, selling or exchanging of native fish	Emergency Rule, CH 46ER87-1, F.A.C, and CH 46-22, F.A.C	May 1, 1987
Florida	Temporary season opening, 18" TL minimum size limit, 27" TL maximum size limit, commercial possession limit of 5 fish, recreational possession limit of 1 fish, use of treble hooks while fishing with natural bait prohibited, "restricted species" designation, must be landed whole.	CH 46-22, F.A.C.	October 1, 1987
Florida	Statewide harvest closure resumes, sale of native redfish allowed until January 5, 1988.	CH 46-22, F.A.C.	January 1, 1988
Florida	Fishery reopens with prohibition on sale of native red drum, 18" minimum size limit, 27" maximum size limit, March-May closed season, 1 fish possession limit.	CH 46-22, F.A.C.	January 1, 1989
Florida	"Protected species" designation, gigging and spearing prohibited. Above rules continued indefinitely.	CH 46-22, F.A.C.	June 3, 1991
Florida	Prohibition on sale of native red drum, 18" minimum size limit, 27" maximum size limit, no closed season, 1 fish possession limit, must be landed whole.	CH 46-22, F.A.C.	1-Jan-96
Florida	Tournament exemptions to exceed bag limit defined	CH 68B-22, F.A.C.	March 17, 2004
Florida	Definition of total length clarified	CH 68B-22, F.A.C.	July 1, 2006

Table 2 provides a timeline of major regulatory changes (size limits, creel limits, commercial quotas, etc.) for red drum in the state waters of the management unit. Note that federal waters were closed to the harvest or possession of red drum on November 9, 1990. All lengths are total length (TL) unless reported as fork length (FL).

Table 2. Chronology of red drum size and creel restrictions and commercial quotas by state of jurisdiction

	1925	**~**	**1953**	**~**	**1955**	**~**	**1960**	**~**	**1976**	**~**	**1985**	**1986**	**1987**
New Jersey													
Delaware													
Maryland													
Potomac River													
Virginia							Only 2 fish > 32"					14" min., only 2 fish > 32"	
North Carolina									14" min., only 2 fish > 32"				
South Carolina												14" min. June -August, only 2 fish > 32"	No sale, 14" min. June-August, only 1 fish > 32", 20 fish limit
GA												14" min., only 2 fish > 32"	
Florida	12" FL min.		15" FL min.		12" FL min.						18" min., only 1 fish > 32"	Nov-Dec: Fishery Closed	Jan-Feb: 18" min., only 1 fish > 32". March-Sept: closed. Oct-Dec: 18" min., 27" max., 5 fish com., 1 fish rec.

Table 2. continued

	1988	1989	1990	1991	1992	1993	1994	~
New Jersey							18" min., only 1 > 27"	
Delaware							18" min., only 1 > 27", 5 fish	
Maryland				14" min., only 2 fish >32"			18" min., only 1 > 27", 5 fish	
Potomac River			14" min.			18" min., only 1 > 27"		
Virginia					18" min., only 1 fish > 27", 5 fish			
North Carolina			14" min., only 1 fish > 32", 5 fish rec., 300,000 lb com. cap	18" min., only 1 fish > 32", 5 fish rec., 250,000 lb com. cap	18" min., only 1 fish > 27", 5 fish rec., 250,000 lb com. cap			
South Carolina	No sale, 14" min. June-September, only 1 fish > 32", 20 fish limit		No sale, 14" min, only 1 fish > 32", 20 fish limit	No sale, 14" min, only 1 fish > 32", 5 fish limit		No sale, 14" min, 27" max., 5 fish limit		
GA		14" min., only 2 fish > 32", 10 fish limit		14" min., only 1 fish > 27", 5 fish limit		14" min., 27" max., 5 fish limit		
Florida	Fishery Closed	No sale, 18" min., 27" max., 1 fish, closed March-May						

Table 2. continued

	1996	~	1998	~	2000	2001	2002	2003	~	2007
New Jersey										
Delaware								20" min., 27" max., 5 fish		
Maryland										
Potomac River	18" min., only 1 > 27", 5 fish							18" min., 25" max., 5 fish		
Virginia								18" min., only 1 fish > 26", 3 fish		
North Carolina			18" min., 27" max., 1 fish rec., 250,000 lb com. cap, 100 lb daily limit com.		18" min., 27" max., 1 fish rec., 250,000 lb com. cap, 5 fish com.	18" min., 27" max., 1 fish rec., 250,000 lb com. cap, 5 fish com. (up to 7 in Sept), 50% bycatch rule				
South Carolina						No sale, 15" min, 24" max., 2 fish limit				No sale, 15" min, 23" max., 3 fish limit
GA							14" min., 23" max., 5 fish			
Florida	No sale, 18" min., 27" max., 1 fish									

3 Assessment History

This overview is first presented as working paper **S18-DW01**. The outline is modified to meet SEDAR standards.

3.1 Previous Assessments

The most recently completed assessment of the status of the Atlantic stock was documented in **Vaughan and Carmichael (2000)**. This assessment of red drum was conducted using recreational and commercial data from 1986 through 1998, and updates data and analyses from the 1989, 1991, 1992 and 1995 stock assessments on Atlantic coast red drum **(Vaughan and Helser, 1990; Vaughan 1992; 1993; 1996)**. Using available length-frequency distributions and age-length keys, recreational and commercial catches were converted to catch in numbers at age. Separable and tuned virtual population analyses were conducted on the catch in numbers at age to obtain estimates of fishing mortality rates and population size (including recruitment to age 1). In turn, these estimates of fishing mortality rates combined with estimates of growth (length and weight), sex ratios, sexual maturity and fecundity were used to estimate yield per recruit, escapement to age 4, and static (or equilibrium) spawning potential ratio (static SPR, based on both female biomass and egg production).

Three virtual analysis approaches (separable, spreadsheet, and FADAPT) were applied to catch matrices for two time periods (early: 1986-1991, and late: 1992-1998) and two regions (Northern: North Carolina and north, and Southern: South Carolina through east coast of Florida). Additional catch matrices were developed based on different treatments for the catch and-release recreationally-caught red drum (B2-type). These approaches included assuming 0% mortality (BASE0) versus 10% mortality for B2 fish. For the 10% mortality on B2 fish, sizes were assumed the same as caught fish (BASE1), or positive difference in size distribution between the early period and the later period (DELTA), or intermediate (PROP). Hence, a total of 8 catch matrices were developed (2 regions, and 4 B2 assumptions for 1986-1998) to which the three VPA approaches were applied. The question of when offshore emigration or reduced availability begins (during or after age 3) was to be a source of bias that tended to result in overestimates of fishing mortality. Additionally, the continued assumption **(Vaughan and Helser, 1990; Vaughan 1992; 1993; 1996)** of no fishing mortality on adults (ages 6 and older), causes a bias that results in underestimates of fishing mortality for adult ages (0 versus some positive value). Because of emigration and the effect of the slot limit for the later period, a range in relative exploitations of age 3 to age 2 red drum was considered. Tuning indices were developed from the MRFSS, and state indices for use in the spreadsheet and FADAPT VPAs.

The SAFMC Red Drum Assessment Group favored the FADAPT approach with catch matrix based on DELTA and a selectivity for age 3 relative to age 2 of 0.70 for the northern region and 0.87 for the southern region. In the northern region, estimates of static SPR increased from about 1.3% for the period 1987-1991 to approximately 18% (15% and 20%) for the period 1992-1998. For the southern region, estimates of static SPR increased from about 0.5% for the period 1988-1991 to approximately 15% for the period 1992-1998. Population models used in this assessment (specifically yield per recruit and static spawning potential ratio) are based on equilibrium assumptions: because no direct estimates are available as to the current status of the

adult stock, model results imply potential longer term, equilibrium effects. Because current status of the adult stock was unknown, a specific rebuilding schedule could not be determined. However, the duration of a rebuilding schedule should reflect, in part, a measure of the generation time of the fish species under consideration. For a long-lived, but relatively early spawning, species as red drum, mean generation time would be on the order of 15 to 20 years based on age-specific egg production. Maximum age is 50 to 60 years for the northern region, and about 40 years for the southern region. The ASMFC Red Drum Board's first phase recovery goal of increasing %SPR to at least 10% appeared to have been met.

Based on the joint Red Drum Technical Committee's (SAFMC/ASMFC) selection of the most appropriate catch matrix (incorporating an assumption on size of recreationally-released fish), selectivity of age 3 relative to age 2, and virtual population analysis (FADAPT), a bag and size limit analysis was conducted **(Vaughan and Carmichael 2001)**. Given gear- and age-specific estimates of fishing mortality (F) for the 1992-1998 period, analyses were made of potential gains in escapement through age 4 and static spawning potential ratio (SPR) from further reductions in fishing mortality due to changes in slot and bag limits. Savings from bag limits were calculated given a particular slot size for the recreational fishery, with no savings for the commercial fisheries in the northern region due to their being managed primarily through a quota. Relative changes in catch-at-age estimates were used to adjust age-specific F and hence calculated escapement through age 4 and static SPR. Adjustment was made with the recreational savings to account for release mortality (10%, as in the stock assessment). Alternate runs for the northern region commercial fishery considered 25% release mortality for lengths outside the slot (instead of 0% for the base run), and 0% vs. 10% gain or loss across legal sizes in F. These results were summarized for ranges of bag limits with increasing minimum size limit (for fixed maximum size), and with decreasing maximum size limit (for fixed minimum size limit). For the southern region, a bag limit of one-fish per angler trip would be required to attain the stated target of 40% static SPR if the current slot limit were not changed. However, for the northern region, a bag limit of one-fish per angler trip appears to be insufficient to attain the stated target of 40% static SPR while maintaining the current slot limit. A peer-reviewed version of these analyses as applied to the Southern Region was prepared **(Vaughan and Carmichael 2002)**.

3.2 References

Vaughan, D. S., and T. E. Helser. 1990. Status of the red drum stocks of the Atlantic coast: Stock assessment report for 1989. **NOAA Technical Memorandum NMFS-SEFC-263**, Beaufort Laboratory, Beaufort, North Carolina 28516, 117 p.

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Vaughan, D. S., and J. T. Carmichael. 2002. Estimating improvement in spawning potential ratios for South Atlantic red drum through bag and size limit regulations. **North Am. J. Fish. Manage.** 22:895-906.

4 Regional Map

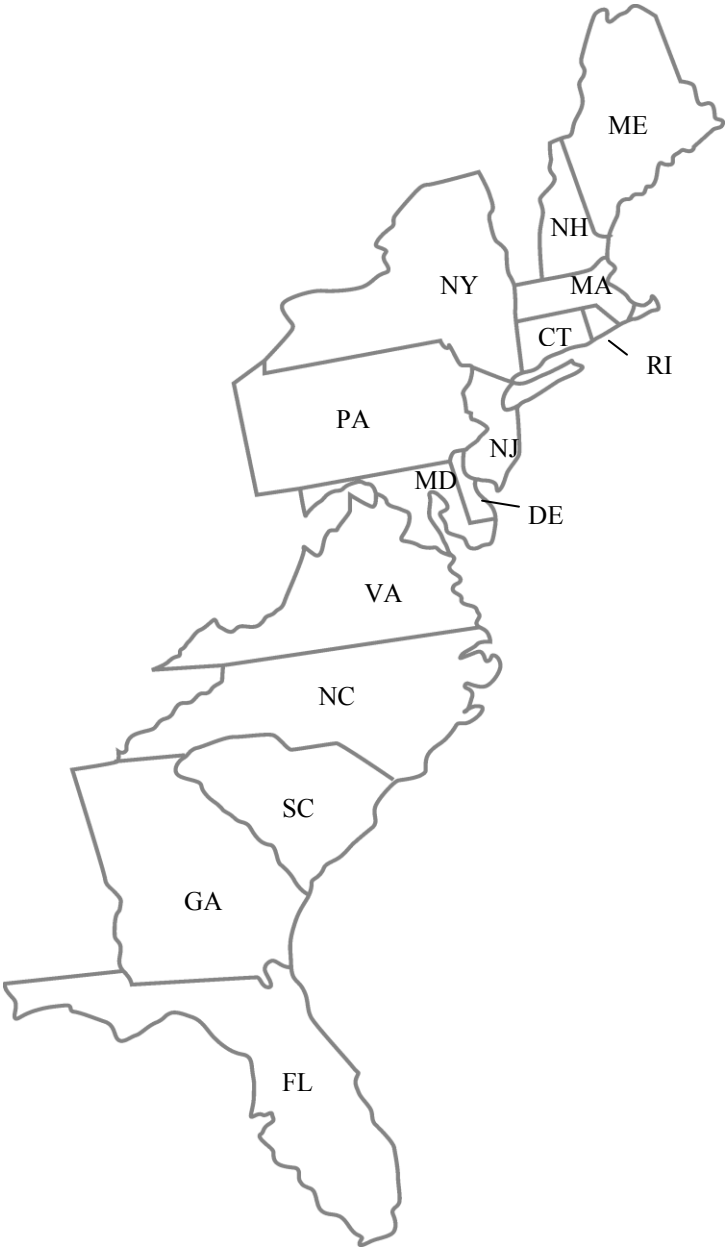


Figure 1. East coast states of the United States. ASMFC member states are Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, GA, and Florida. The Atlantic red drum management area is US waters of the northwest Atlantic Ocean from the estuaries to the seaward boundary of the exclusive economic zone from New Jersey through Florida.

Atlantic Red Drum

Assessment Summary Report

SEDAR 18

Atlantic Red Drum Stock Assessment Report

Section I, Chapter 5

October 16, 2009

5 Assessment Summary Report

Sources of Information

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

All contents of the Assessment Summary Report are derived from the SEDAR 18 Atlantic Red Drum Stock Assessment Report (SAR). The source of information is identified in the paragraph title as being one or more SAR components:

- Introduction: SAR Section I - Introduction,
- DW: SAR Section II - Data Workshop Report,
- AW: SAR Section III - Assessment Workshop Report,
- (Section IV is Research Recommendations)
- RW: SAR Section V - Review Workshop Report, and
- RW Appendix A: SAR Section V Appendix A – Appendix A of the Review Workshop Report.

SAR copies are available on the SEDAR website (www.sefsc.gov/sedar) or through the SEDAR program office at the South Atlantic Fishery Management Council (4055 Faber Place Drive, Suite 201, North Charleston, SC 29405). Readers are advised that the Council or Commission receiving a SEDAR assessment may request additional sensitivity analyses or projection scenarios following receipt of this report and that the results of such further analyses are not included in the SEDAR report and not reflected in this summary.

Significant Assessment Modifications (AW, RW, RW Appendix A)

The reader's attention is directed to Appendix A of the RW Report. Appendix A presents responses by the Assessment Team (AT) to requests from the Review Panel (RP) formulated during the review process, both before and during the RW. Significant revisions were involved. These revisions affected data, data use, analytic approaches, assessment outputs, and interpretation of results. While there were essential differences between the analyses and accompanying discussion reported in the initial AW Report and those presented in the RW Report, Appendix A, the RP determined that the replacement model run and analyses did not constitute a new assessment. Furthermore, the reader should be aware that results summarized in this Assessment Summary Report relate to the revised analysis of the final assessment in the RW Report, Appendix A and not to that initially presented in the AW Report. To gain a full understanding of the assessment and its review through time, the reader should read the original AW Report (SAR Section III), the RW Report (SAR Section V), and the RW Report appendix (SAR Section V, Appendix A).

Stock Status and Determination Criteria (Introduction, RW, RW Appendix A)

Amendment 2 to the ASMFC Interstate Fishery Management Plan for Red Drum defines overfishing for red drum as a fishing mortality rate (F) in excess of the fishing mortality rate at 30% Static Spawning Potential Ratio (sSPR), or F30% sSPR. The target F is F40% sSPR. Based on these definitions and the recommended 3-year average annual sSPR as an indicator of stock status, overfishing was not occurring in either the southern or the northern stock component (Table 5.1, Figure 5.1). Northern stock 3-year average sSPR, ending 2007, is estimated at 45.3% with a range among sensitivities of 43-48%. Although only relative estimates of sSPR are considered informative for the south, all estimates derived from the models were above the overfishing benchmark. The southern 3-year average sSPR is estimated at 49.5%; discounting the sensitivity where selectivity was estimated for ages 1-5, the range is 37 to 65%.

Yield-per-recruit and spawning-stock-biomass-per-recruit analyses were evaluated against common biological benchmarks. Results suggest that recent (2005-2007) fishing mortality rates were at or below both Fmax and F0.1 benchmarks based on yield per recruit, and the F35% and F20% benchmarks based on SPR analyses (Table 5.2, Figure 5.2).

Table 5.1. (RW Appendix A Table A3.2.4.24 modified). The calculated annual and 3-year average (average of previous two and current years) static spawning potential ratios (sSPR) and year-specific escapement rate through age 5 (sEsc) for the northern and southern regions during 2005-2007 for the base data, using a release mortality of 0.16 (RM 0.16), using the low natural mortality-at-age vector (M low), the high vector (M high), and a model configured to estimate selectivities through age 5. Three-year average sSPR data are from RW Appendix A Table A3.2.4.23.

Northern region				**Southern region**			
sSPR	2005	2006	2007	**sSPR**	2005	2006	2007
Base	0.571	0.495	0.292	Base	0.438	0.539	0.507
3-yr avg	0.576	0.526	0.453	3-yr avg	0.458	0.481	0.495
Sel 1-5	0.529	0.481	0.277	Sel 1-5	<0.001	0.001	0.001
M low	0.571	0.499	0.298	M low	0.306	0.414	0.382
M high	0.578	0.495	0.289	M high	0.601	0.681	0.654
RM 0.16	0.506	0.547	0.391	RM 0.16	0.482	0.568	0.554
sEsc	2005	2006	2007	**sEsc**	2005	2006	2007
Base	0.602	0.540	0.327	Base	0.464	0.563	0.529
Sel 1-5	0.557	0.524	0.310	Sel 1-5	0.001	0.008	0.006
M low	0.598	0.541	0.329	M low	0.328	0.436	0.401
M high	0.611	0.544	0.328	M high	0.625	0.702	0.674
RM 0.16	0.643	0.677	0.539	RM 0.16	0.516	0.599	0.583

Table 5.2 (Appendix A Table A3.2.4.25.) Yield-per-recruit (lbs) and spawning stock biomass per recruit (defined as sSPR) benchmarks estimated using the recent selectivity vectors estimated by the SCA analysis. The apical fishing mortality, yield-per-recruit (Y/R) and static SPR (sSPR) are shown for the 2007 estimate of F (F_{2007}), maximum yield per recruit (F_{max}), yield per recruit where the slope is 10% of that at the origin ($F_{0.1}$), and sSPR equal to 20% ($F_{20\%}$) or 35% ($F_{35\%}$).

Northern region			
Benchmark	full F	Y/R	sSPR
F_{2007}	0.877	1.585	0.292
F_{max}	1.250	1.651	0.174
$F_{0.1}$	0.865	1.581	0.297
$F_{20\%}$	1.149	1.647	0.200
$F_{35\%}$	0.748	1.518	0.350
Southern region			
Benchmark	full F	Y/R	sSPR
F_{2007}	0.254	0.986	0.507
F_{max}	0.747	1.389	0.137
$F_{0.1}$	0.517	1.329	0.252
$F_{20\%}$	0.604	1.368	0.200
$F_{35\%}$	0.393	1.221	0.350

Northern region Southern region

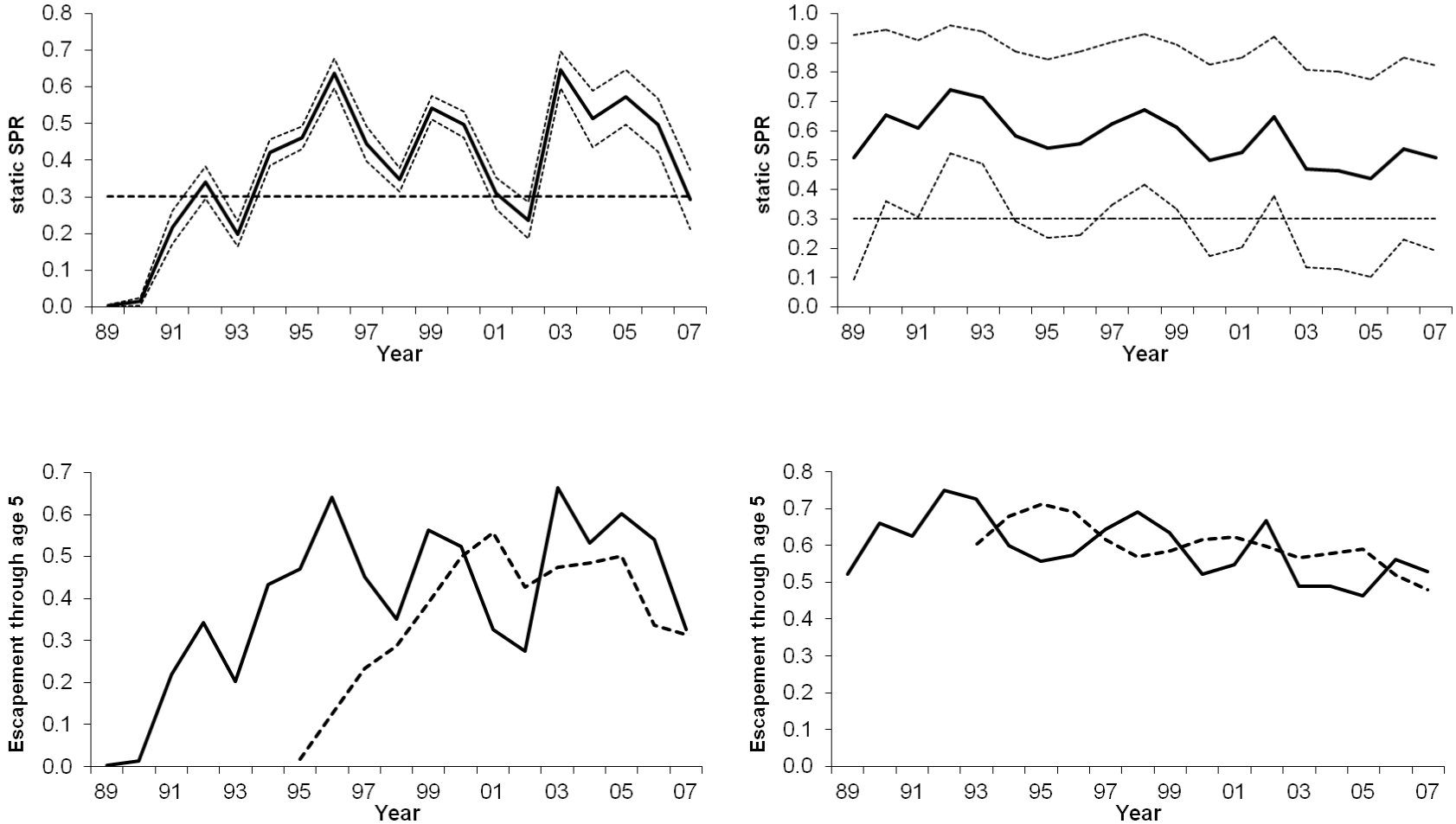
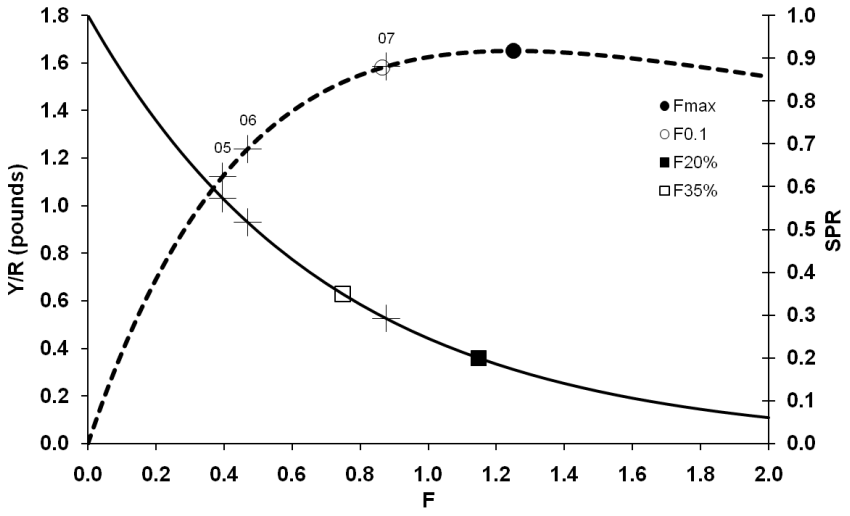


Figure 5.1. (RW Appendix A Figure A3.2.5.21.) **Northern** and **southern** region estimates of static spawning potential ratio with ± 1.96 standard errors (dashed lines) during 1989-2007 (top) and escapement rates (bottom) showing year-specific (heavy line) and year class-specific (dashed line) estimates.

Northern region



Southern Region

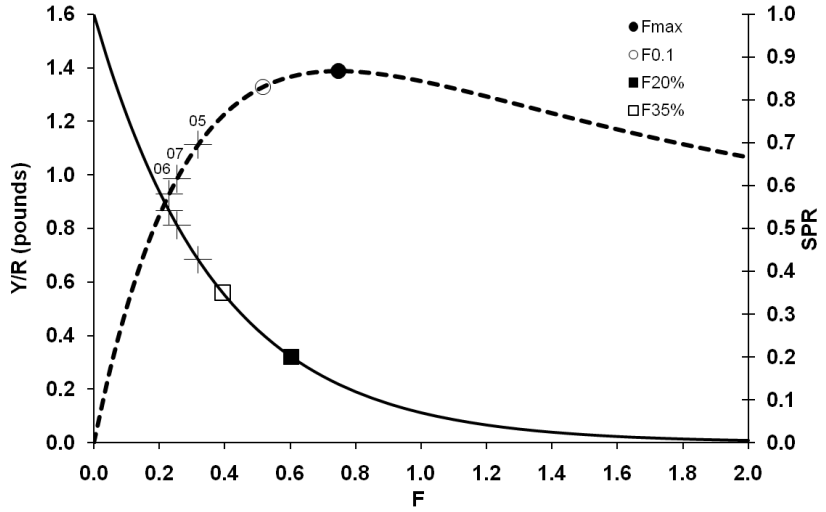


Figure 5.2. (RW appendix A3.2.5.24.) Equilibrium yield-per-recruit (dashed line) and spawning-stock-biomass-per-recruit (of spawning potential ratio, SPR, solid line) expected for red drum across a range of instantaneous fishing mortalities in the northern and southern. As indicated in legend, the YPR benchmarks F_{max} and $F_{0.1}$ are shown as are the SPR benchmarks for SPR=35% ($F_{35\%}$, hidden under pluses in southern region graph) and 20% ($F_{20\%}$). Also shown as '+'s' are the equilibrium values given fishing mortalities estimated for 2005, 2006, and 2007.

Species Distribution (DW)

The red drum, *Sciaenops ocellatus*, inhabits nearshore and estuarine waters of the U.S. Atlantic coast from Massachusetts to Florida and of the Gulf of Mexico (GoM) from Florida to northern Mexico.

Stock Identification and Management Unit (DW, AW, RW)

The stock under assessment is the red drum stock of the Atlantic Ocean. This assessment follows previous efforts in dividing the stock into two units - a northern region composed of Virginia and North Carolina, and a southern region composed of South Carolina, Georgia, and east Florida.

Stock Life History (DW, AW, RW Appendix A)

Separate growth models and estimates of natural mortality were provided for the two regions/stocks, based on observed differences in the life history characteristics over the two areas. The oldest fish aged in the north region was 62 years, with numerous fish aged in their 50s. The oldest fish aged in the south region was 38 years.

Several methods for determining an age-constant *M* based on life history characteristics were explored and results are summarized in Table 5.3. In addition, age-specific natural morality is estimated similar to several previous SEDARs, based on the Lorenzen (1996) approach scaled to fixed M estimates based on the Hoenig (1983) approach (Table 5.4). For assessment modeling purposes, January 1 was chosen as the birth date of all red drum across the management unit. For life history analyses, a standard biological birth date of September 1 was agreed to. Table 5.5 shows north and south fractional and integer ages.

Three variations of the von Bertalanffy growth model were explored, with the single von Bertalanffy growth models by region recommended as appropriate for the assessment. Models by region show similar growth patterns but have visually different L_{infs} (Figure 5.3).

Known reproductive features were compiled (Table 5.6). Depending on area, male red drum mature at age 1 to 4 and females at age 3 to 6. Male size at maturity is determined to be from 511mm to 713mm and female size at 792mm to 900mm. (Table 5.7).

There is little evidence of significant migration by red drum. Tag return data suggest movement into VA waters from NC waters in late May, followed by return to NC waters in the fall for overwintering. Also, some red drum have been observed over-wintering in Chesapeake Bay tributaries near power plants. Less movement is indicated for fish from the southern stock, with 85.3 % of GA-tagged fish recaptured within state waters, and 96.4% of tagged sub-adults in SC recaptured within 30 miles of the tagging site.

Equations for length-length and weight-length conversions for available data were determined using the simple linear regression model and the power function. Details were presented in tabular form in the DW report. Coefficients of determination (r^2) ranged from 0.91 to 0.99 for these length and weight regressions. The DW recommended use of the conversion equations based on northern and southern regions.

Assessment Methods (AW, RW Appendix A)

This assessment is based on a standard statistical Catch-at-Age (SCA) model developed through ADMB software. The configuration includes features for capturing some information from tagging programs and restricting the selectivity estimated for older fish. Analyses were defined for 1982-2007 and include age-specific data for red drum ages 1 through 7^+.

The initial SCA model was revised at the request of the RP to reduce the number of parameters used to describe recruitment and the initial population age structure, solve for parameters that relate age-4 and age-5 selectivities to that estimated for age 3, and include only those data available for 1989-2007. Also, errors found in the original model coding (intra-annual decrement of abundance) and input data (northern Juvenile Abundance Index data) were corrected.

Assessment Data (DW, AW, RW Appendix A)

Data incorporated in the initial (1982-2007) and final (1989-2007) analyses are summarized in Table 5.8 and Table 5.9. Northern assessment harvest data were commercial seine/gill net and other gear combined landings, and MRFSS recreational landings and live release mortality rates. Proportion-at-age information was derived from commercial beach seine/gillnet, commercial other gear, and recreational harvest data. Indices of abundance sources were NC gillnet surveys, NC juvenile age-1 abundance index, and angler total age 1-3 catch rate. Tagging data were used to estimate F for total age-1-4^+ harvest and fully recruited F for recreational live-release. Southern harvest data were FL, GA, and SC commercial and recreational harvest, and FL, GA, and SC recreational live-release mortality rates. Proportion-at-age information was derived from FL, GA, and SC commercial and recreational harvest, and SC and GA recreational live-release mortality data. Indices of abundance surveys considered were FL small seine young-of-the-year and haul seine; GA gillnet; and SC electro-shocking, trammel net, and longline.

Release (Discard) Mortality (DW, AW)

Release mortality for recreational fisheries is assumed to be 8%, based on the mean of a range of studies examined by the Data Workshop. A sensitivity run including 16% release mortality was recommended to reflect potential delayed mortality. Although survival of released fish is high, overall removals through discard mortality are significant due to high encounter and discard rates.

Release mortality for commercial gill net fisheries is assumed to be 5%, but overall is not a large component of mortality.

Catch Trends (DW, AW)

Commercial

For modeling, northern assessment harvest data were reduced to: (1) commercial seine/gill net and (2) other gear combined. Southern harvest data were FL, GA, and SC commercial harvest combined.

Commercial landings are highly variable and exhibit little trend over time (Table 5.10, Table 5.11, and Figure 5.4). Commercial landings are predominantly from NC through the time series, and exclusively from NC since 1987 when the sale of native-caught red drum had become prohibited in FL, SC and GA. Interestingly, sporadic records indicate commercial harvest in FL as early as 1889. The dominant gear across the Atlantic range is gill nets, although in the early period of 1950-1962 beach seines dominated.

Overall, red drum commercial landings averaged 249,000 pounds (whole weight) annually between 1950 and 2007.

Recreational - Headboat Landings

The DW Recreational Workgroup concluded headboat data were insufficient to characterize catch or the effect of the headboat fishery and would not be useful in the assessment. Red drum encounters in the headboat fishery are patchy and inconsistent, ranging from 1 to 451 fish per year resulting in annual total harvest estimates of 6 to 3,228 pounds. From 1981-2007, the Southeast Region Headboat Survey sampled landing by all headboats operating in the SE U.S. EEZ. Data available were catch and total weight.

Recreational – Marine Recreational Fishing Statistics Survey

Trends in estimated landings [MRFSS Type A+B1] are highly variable during the initial and final assessment periods with extreme swings apparent annually and across ages. Some variability may be explained by regulatory changes effected by states (Table 5.12).

Fishing Mortality Trends (RW Appendix A)

Northern region estimated exploitation rates of age 1-3 fish declined considerably from 0.8 to about 0.3 between 1989 and 1992. Mortality continued to slowly drop to a low of around 0.1 in 2004, but has since increased to a 2005-2007 average of 0.2. Since reaching a minimum in 1992, in the southern region there has been a slow but statistically significant increasing trend in age 1-3 exploitation, but it has remained below 0.2 during 1989-2007 (Table 5.13, Figure 5.5).

Stock Abundance and Biomass Trends (RW Appendix A)

Estimates of total abundance for red drum indicate a decline in the northern region and about a 50% increase through 1991 in the southern region followed by stable abundance through 2007. In the northern region, estimated total population abundance was over 5 million fish (mostly 7^+) through 1992 declining to just over 3 million fish by 2007 (Table 5.14, Figure 5.6). In the southern region, the total population was estimated at about 6-7 million fish after 1990.

Much of this rapid decrease in estimated abundance in the northern region comes from the decreases in the ‘less available’ adult portion (ages 7^+) of the population, and may be an artifact of the assessment model. The abundance of ages 1-3 are shown in Figure 5.7.

The total stock biomass was not estimated in these analyses.

Scientific Uncertainty (RW Appendix A)

Observed Data

Estimated coefficients of variation (or proportional standard errors) were used as measures of precision for observed data. For the proportion-at-age data, samples size and proportion indicated the precision of the observed data. For the model-estimated parameters, asymptotic standard errors were estimated during the model fitting process. The precision of important derived values, e.g., average static spawning potential, was explored by describing their likelihood profiles. The implied precision from likelihood profiles is probably too great (i.e., narrow) given that there were no errors associated with input parameters, e.g., M at age, and the standard deviations of the standardized residuals often departed significantly from 1.0. This would suggest that there was additional ‘process error’ that was not

included in the model. For these reasons, the precision of the estimated parameters and derived values is almost certainly too great, i.e., confidence bands are too narrow.

Parameter Estimates

The parameters estimated in the SCA include annual fully recruited estimates of F by fishery, period-specific age 1-3 selectivities, age-4 and -5 selectivity constraints, initial age-specific abundances, annual recruitment, and survey catchability coefficients.

Recruitment

Estimated recruitment each year during 1989-2007 was more precise in the northern region than in the southern region. In the northern region, the estimated ± 2-standard-error bounds for recruitment were relatively larger during the years where recruitment abruptly peaked (Table 5.15, Figure 5.8). In the southern region, the precision of the estimates was greater (smaller standard errors) during the mid 1990's than either earlier or later. Annual estimated southern region recruitment is much greater than northern region recruitment and the year-to-year trend has been relatively stable.

Fishing Mortality

The estimated asymptotic standard errors for the fully recruited F estimates were generally larger in the early years of the analyses in the northern region and in the later years in the southern region. In the northern region the coefficients of variation (asymptotic standard error/estimate) were higher during 1989-1990 for the commercial and similar across years for the recreational fisheries (Figure 5.9). In the southern region, the estimated fully recruited F's were generally less precise in the later years for the commercial and recreational landed fisheries (Figure 5.10).

Sensitivity Runs

Sensitivity runs were made to investigate the effects of changes to selectivity estimates, use of tag-based estimates of F (northern region), and changes to the input values for the instantaneous natural mortality and live-release fisheries' release mortality rate.

The revised models were configured such that the selectivities of age 4 and age 5 were estimated as a proportion (between 0.0 and 1.0) of the selectivity at age 3. To determine the sensitivity of these analyses to this configuration, the model was reconfigured so that selectivity was estimated for ages 1 through 5. This configuration for the north provided estimates of exploitation and abundance that were only slightly different from the base model runs; the south was highly sensitive. Without restrictions to selectivity, the estimates of abundance are much lower than base model estimates. Exploitation rates estimated for ages 1-3 were about four times higher when selectivity was estimated for ages 1-5.

The review panel requested additional sensitivity runs involving the use of various selectivity constraints. The requested diagnostics are given in RW Appendix A.

Where the northern tag-based data were dropped from the model, the analysis converged on unrealistically large population estimates, low fishing mortality rates, and high sSPRs.

The input information on natural mortality at age and hooking mortality were uncertain so the 'best' estimates were used in the base model runs and alternatives were relegated to sensitivity runs.

For the instantaneous natural mortality rate, an upper and lower age-specific vector was estimated from the available life history information. In the northern region, these alternative natural mortalities had only a minor effect on the estimates of abundance or exploitation for ages 1-3.

The southern region analysis was more sensitive. In general, at the higher levels of M, the population size was estimated to be larger for all age groups and therefore the exploitation rate was lower.

A hooking mortality value of 0.16 was compared to the base level of 0.08. In the northern region, the high-release-mortality model estimated greater age 1-3 abundances, which largely offset the increased number killed so that age 1-3 exploitation remained about the same. The trend in the age 4^+ abundance changed dramatically from a declining trend over high abundances to a slowly increasing trend over very low abundance. In the southern region, the sensitivity run (high release mortality) showed higher abundances for all age groups and lower age 1-3 exploitation rates.

Retrospective analyses were conducted using the base model configurations and sequentially eliminating data available for 2007, 2006, 2005, 2004, 2003 then 2002. The southern region short Georgia gillnet survey was dropped from the 2004, 2003, and 2002 runs because the survey began in 2003. For the northern region, there was no strong evidence of significant difference between the base and retrospective runs estimates of age 1-3 abundance or exploitation. In the southern region, the retrospective pattern was much more apparent. There was a consistent revision of past F's downward and past estimates of abundance upward as additional years of data were included. There was no indication of a convergence between the different retrospective runs. This pattern greatly eroded the capacity of this model to estimate absolute levels of abundance, F, or static spawning potential.

Special Comments

None were submitted.

Tables

See the **Stock Status and Determination Criteria** paragraph above for Table 5.1 and Table 5.2.

Table 5.3 (DW Table 2.16.2.) US Atlantic red drum age-constant natural mortality rates. *M*: Natural mortality, k: Von Bertalanffy growth parameter, T: average water temperature (°C), L_∞: Von Bertalanffy asymptotic length (mm), Maximum age: t_{max} = **62** in north region, t_{max} = **38** in south region; and average water temperature = **19**° C (Williams et al. 1973 as used in Ross et al. 1995).

Life History	Parameters	North Region	South Region
Approach		L_∞ = 118.67 cm, k =0.19	L_∞ = 104.15 cm, k= 0.23
Alverson & Carney	k, t_{max}	0.006	0.026
Hoenig	t_{max}	0.067	0.109
Jensen	K	0.287	0.343
Pauly	k, L_∞, T°C	0.345	0.401
Rule of thumb	t_{max}	0.048	0.079

Table 5.4 (DW Table 2.16.3.) US Atlantic red drum age-varying natural mortality rates for subadult (ages 1-5, including average across ages) and average over adult ages (6+) ages. Age-varying estimates are based on the Lorenzen (1996) approach for two regions (North and South. Age-specific estimates of natural mortality have been scaled to cumulative survival of 1.5% at maximum observed age. A range of age-varying M is also provided based on scaling to a range in Hoenig M's (giving alternate cumulative survival).

Age Grouping	Northern Region	Southern Region
Subadult Ages:		
1	0.16 (0.10, 0.24)	0.24 (0.13, 0.33)
2	0.13 (0.07, 0.19)	0.19 (0.10, 0.25)
3	0.11 (0.06, 0.16)	0.16 (0.08, 0.21)
4	0.09 (0.06, 0.14)	0.14 (0.08, 0.19)
5	0.09 (0.05, 0.13)	0.13 (0.07, 0.17)
Average 1-5	0.12 (0.07, 0.17)	0.17 (0.09, 0.23)
Ages 6+	0.06 (0.04, 0.09)	0.10 (0.06, 0.14)

Table 5.5. Fractional and integer ages determined for red drum by region

Region	Fractional Age (biological birth date Sept 1)	Integer Age (assessment model birth date Jan 1)	Sample Size
Northern	0.65 to 62.1	0 to 62	8,671
Southern	0.33 to 38.2	0 to 38	26,042

Table 5.6. Known red drum reproductive features

Reproductive Feature	Findings
Spawning season	NC: Aug/Sept. GA: Aug/mid – Oct. Atlantic FL/Sept - Oct
Spawning location	nearshore adjacent to channels and passes; nearshore continental shelves
Spawning frequency	N Gulf of Mexico: 2-4 days
Sex ratio	1:1
Mean fecundity	N Gulf of Mexico: 1.54 mil ova

Table 5.7. Sexual maturity at size and age by state

Maturity	NC		SC		Atlantic FL	
	male	female	male	female	male	female
50% size (mm)	-	-	713	792	511	825-900
50% age (years)	1-2	3	3.6	4.3	1-3	-
100% age (years)	3	4	4	5	-	6

Table 5.8 Data employed for the initial (1982-2007) and final (1989-2007) northern assessment, statistical catch-at-age model – ages 1-7$^+$.

Observed data:	Initial Base Run	Final Base Run
• Total annual harvest in numbers		
– Commercial beach seine/gillnet	1982-2007	1989-2007
– Commercial other gear	1982-2007	1989-2007
– Recreational harvest	1982-2007	1989-2007
– Recreational live-release deaths	1983-2007	1989-2007
• Proportion-at-age for ages 1-7$^+$		
– Commercial beach seine/gillnet	1982-2007	1989-2007
– Commercial other gear	1982-2007	1989-2007
– Recreational harvest	1982-2007	1989-2007
• Indices of abundance		
– NC gillnet survey-age 1	2001-2007	2001-2007
– NC gillnet survey-age 2	2001-2007	2001-2007
– NC juvenile abundance index-age 1	1992-2007	1992-2007 (corrected)
– Angler total catch rate, ages 1-3	1991-2007	1991-2007
• Tagging-estimated F estimates		
– F for total harvest, ages 1-4$^+$	1983-2004	1989-2004
– Fully recruited F for rec live-release	1986-2004	1989-2004

Table 5.9 Data employed for the initial (1982-2007) and final (1989-2007) southern assessment, statistical catch-at-age model – ages 1-7$^+$.

Observed data:	Initial Base Run	Final Base Run
• Total annual harvest in numbers		
– Florida commercial	1982-1988	not used
– FL recreational harvest	1982-2007	1989-2007
– GA rec/com harvest	1982-2007	1989-2007
– South Carolina rec/com harvest	1982-2007	1989-2007
– FL recreational live-release deaths	1982-2007	1989-2007
– SC/GA rec live-release deaths	1982-2007	1989-2007
• Proportion-at-age for ages 1-7$^+$		
– Florida commercial	1982-1988	not used
– FL recreational harvest	1982-2007	1989-2007
– GA rec/com harvest	1982-2007	1989-2007
– South Carolina rec/com harvest	1982-2007	1989-2007
– SC/GA rec live-release deaths	1982-2007	1989-2007
• Indices of abundance		
– FL small seine yoy survey – age 1	1997-2006	1997-2006
– GA gillnet survey – age 1	2003-2007	2003-2007
– SC electro-shocking survey - age 1	2000-2007	2000-2007
– FL haul seine survey – age 2 & age 3	1997-2007	1997-2007
– SC trammel net survey – age 2	1991-2007	1991-2007
– Angler total catch rate, ages 1-3	1991-2007	1991-2007
– SC longline survey, ages 6+	1994-2007	1994-2007

Table 5.10 (DW Table 3.2.) Red drum commercial landings (pounds, whole weight) by region for the US Atlantic coast. Northern region includes states from Massachusetts to NC. Southern region includes landings from SC, GA, and east coast FL.

Calendar	US Atlantic Coast		
Year	North	South	Total
1950	385,100	242,700	627,800
1951	262,500	275,500	538,000
1952	271,100	216,600	487,700
1953	306,300	196,000	502,300
1954	310,200	169,800	480,000
1955	173,100	169,400	342,500
1956	51,100	164,900	216,000
1957	162,900	108,600	271,500
1958	44,400	102,500	146,900
1959	38,500	131,200	169,700
1960	108,900	133,600	242,500
1961	101,700	116,400	218,100
1962	73,800	149,300	223,100
1963	73,900	134,200	208,100
1964	106,100	130,500	236,600
1965	167,500	146,300	313,800
1966	38,500	155,900	194,400
1967	13,900	153,800	167,700
1968	12,600	172,500	185,100
1969	5,000	122,400	127,400
1970	7,600	149,400	157,000
1971	17,900	87,700	105,600
1972	48,819	133,000	181,819
1973	77,364	170,800	248,164
1974	158,137	142,700	300,837
1975	234,036	105,700	339,736
1976	186,859	115,900	302,759
1977	20,137	109,300	129,437
1978	24,174	109,353	133,527
1979	128,517	95,402	223,919
1980	243,623	196,300	439,923
1981	93,620	259,443	353,063
1982	54,261	141,649	195,910
1983	261,671	108,564	370,235
1984	285,620	136,796	422,416
1985	153,776	95,982	249,758
1986	255,476	92,438	347,914
1987	252,257	62,247	314,504
1988	232,371	3,565	235,936
1989	283,556	3,963	287,519
1990	184,726	2,763	187,489
1991	128,349	1,629	129,978
1992	131,591	1,759	133,350
1993	246,857	2,533	249,390
1994	152,445	2,129	154,574
1995	251,789	2,578	254,367
1996	116,077	2,271	118,348
1997	56,619	1,426	58,045
1998	301,754	672	302,426
1999	386,304	1,115	387,419
2000	285,098	707	285,805
2001	155,733	128	155,861
2002	90,751	379	91,130
2003	98,802	559	99,361
2004	54,913	357	55,270
2005	130,528	138	130,666
2006	176,771	444	177,215
2007	256,992	119	257,111

Year	North	South	Total

Table 5.11. (DW Table 3.3.) Red drum commercial landings (pounds, whole weight) by gear for the US Atlantic coast (see text for gear descriptions). Landings included MA to FL.

Calendar Year	US Atlantic Coast							
	Beach Seine	Gill Nets	Hook-n-Line	Other Gears	Pound Net	Seines	Trawls	Total
1950	257,600	129,500	112,800	0	103,300	0	24,600	627,800
1951	273,900	94,800	85,300	0	54,500	0	29,500	538,000
1952	277,300	91,700	52,500	0	28,000	0	38,200	487,700
1953	326,500	103,800	32,400	0	9,100	0	30,500	502,300
1954	212,100	103,600	49,600	0	85,200	0	29,500	480,000
1955	128,100	69,400	92,900	0	43,600	0	8,500	342,500
1956	43,100	62,300	102,100	0	7,300	0	1,200	216,000
1957	157,700	40,900	59,300	0	13,200	0	400	271,500
1958	48,900	21,600	55,100	0	19,700	0	1,600	146,900
1959	29,500	49,400	77,100	0	12,200	0	1,500	169,700
1960	105,700	47,500	67,200	0	12,300	0	9,800	242,500
1961	113,400	72,900	23,600	0	2,900	0	5,300	218,100
1962	18,200	96,600	40,100	0	6,400	58,900	2,900	223,100
1963	13,200	90,500	32,400	0	800	69,700	1,500	208,100
1964	49,200	69,900	30,300	0	2,000	84,400	800	236,600
1965	59,600	83,500	41,200	0	71,500	58,000	0	313,800
1966	38,600	86,800	39,100	100	1,300	21,700	6,800	194,400
1967	23,900	100,300	36,000	0	2,000	4,900	600	167,700
1968	29,100	112,800	31,800	0	2,300	7,500	1,600	185,100
1969	9,500	86,200	28,100	0	2,400	1,200	0	127,400
1970	10,400	115,900	26,100	0	600	2,400	1,600	157,000
1971	10,400	73,900	11,500	100	3,700	3,100	2,900	105,600
1972	20,151	100,119	29,000	200	21,193	5,551	5,605	181,819
1973	24,333	153,749	26,300	138	11,664	21,100	10,880	248,164
1974	42,526	115,893	35,800	0	37,946	65,321	3,351	300,837
1975	46,965	92,548	23,638	0	33,809	66,740	76,036	339,736
1976	27,548	132,043	27,700	100	26,630	76,700	12,038	302,759
1977	12,118	79,697	24,300	0	301	11,759	1,262	129,437
1978	800	91,299	17,278	3,875	1,346	4,200	14,729	133,527
1979	500	128,631	27,370	337	9,741	43,200	14,140	223,919
1980	16,409	239,196	29,880	145	29,984	71,382	52,927	439,923
1981	1,012	246,126	41,368	6	36,357	11,102	17,092	353,063
1982	1,542	135,687	28,445	557	4,081	6,947	18,651	195,910
1983	16,754	222,477	26,206	198	36,247	21,065	47,288	370,235
1984	20,555	274,062	29,950	1,082	6,919	20,421	69,427	422,416
1985	4,023	156,857	23,515	904	3,227	13,738	47,494	249,758
1986	7,590	180,521	19,681	214	9,440	71,085	59,383	347,914

Table 5.11 (continued).

Calendar Year	US Atlantic Coast							
	Beach Seine	Gill Nets	Hook-n-Line	Other Gears	Pound Net	Seines	Trawls	Total
1987	9,130	168,041	17,705	2,026	60,832	35,567	21,203	314,504
1988	12,042	134,747	5,215	431	26,378	23,972	33,151	235,936
1989	15,898	142,572	8,123	100	40,354	56,110	24,362	287,519
1990	27,269	97,977	3,549	153	25,796	18,234	14,511	187,489
1991	13,987	78,606	2,254	154	19,734	4,348	10,895	129,978
1992	2,220	106,313	2,065	0	13,351	6,341	3,060	133,350
1993	10,443	204,504	5,592	31	11,617	10,748	6,455	249,390
1994	2,125	114,588	4,429	122	9,874	16,385	7,051	154,574
1995	6,208	181,283	5,669	130	21,285	38,630	1,162	254,367
1996	4,639	91,896	4,268	400	6,290	9,555	1,300	118,348
1997	2,824	37,452	3,301	204	4,343	9,688	233	58,045
1998	5,931	249,059	5,005	505	4,181	37,618	127	302,426
1999	4,355	358,605	4,607	167	13,627	4,014	2,044	387,419
2000	19,690	246,812	3,770	49	10,338	2,990	2,156	285,805
2001	2,424	141,753	1,617	23	8,638	981	425	155,861
2002	769	76,731	1,321	524	9,427	2,029	329	91,130
2003	979	87,589	928	94	3,786	1,365	4,620	99,361
2004	610	50,600	622	12	2,023	1,306	97	55,270
2005	1,661	117,755	489	533	9,540	638	50	130,666
2006	1,843	159,384	956	5,273	7,304	2,263	192	177,215
2007	1,031	233,584	644	6,731	11,374	3,105	642	257,111

Table 5.12 (AW Table 2.3.1.) Estimated landings (MRFSS Type A+B1) –at-age for red drum in FL, GA, SC, and the north region (NC through Delaware) during 1982-2007. The unseen harvest (Type B1) is assumed to be distributed across ages the same as the inspected harvest (Type A).

Florida

	1	2	3	4	5	6	7	8	9	10+	Total
1982	145,344	54,714	1,544	900	1,115	340	43	14	14	373	204,400
1983	262,486	66,773	11,753	3,248	255	0	0	0	0	0	344,514
1984	417,109	90,176	22,810	5,497	1,344	673	0	5,887	0	5,887	549,382
1985	233,161	28,077	3,241	467	48	0	63	0	32	97	265,186
1986	37,551	49,127	21,682	2,005	456	0	524	0	524	1,571	113,439
1987	22,286	19,554	4,820	3,489	578	227	179	5	0	85	51,224
1988	3,531	4,829	757	311	33	22	11	12	0	36	9,544
1989	10,942	16,696	4,290	2,148	272	240	102	28	0	29	34,747
1990	10,671	20,993	7,084	3,744	615	626	272	0	23	251	44,279
1991	17,158	30,590	27,209	23,017	3,253	676	731	0	37	58	102,727
1992	32,245	32,962	20,530	15,094	1,422	795	607	366	10	95	104,125
1993	7,246	24,393	19,910	11,786	1,685	995	490	41	13	127	66,685
1994	21,713	38,202	36,320	21,696	1,519	611	753	106	6	13	120,938
1995	11,343	29,832	32,939	18,340	2,173	618	386	162	0	1,136	96,928
1996	32,317	49,634	38,378	22,754	2,626	549	560	4	0	0	146,822
1997	14,007	22,018	18,601	15,435	2,039	1,560	695	739	0	0	75,094
1998	11,695	39,378	37,988	16,190	1,980	846	360	4	0	0	108,440
1999	5,046	69,844	46,078	7,369	2,881	0	0	0	0	0	131,219
2000	4,676	99,458	70,136	13,967	6,440	0	0	0	0	0	194,677
2001	4,495	86,306	66,303	16,003	7,949	0	2	2	2	17	181,079
2002	1,215	57,527	45,217	11,457	5,223	0	0	0	0	0	120,640
2003	3,396	89,172	61,787	10,904	6,107	0	0	0	0	0	171,365
2004	2,554	72,736	57,369	30,121	1,391	0	0	0	0	0	164,171
2005	5,631	86,322	71,942	30,171	2,170	0	0	0	0	0	196,236
2006	2,537	56,600	67,088	21,135	2,380	5	0	0	5	7	149,756
2007	5,932	77,766	85,538	27,305	2,618	0	0	0	0	0	199,159

Table 5.12 (continued).

Goergia

	1	2	3	4	5	6	7	8	9	10+	Total
1982	25,866	3,239	638	128	10	50	46	10	19	751	30,757
1983	51,439	5,134	256	25	0	0	0	0	0	0	56,853
1984	237,256	15,739	4,665	293	0	78	78	0	0	78	258,188
1985	162,945	19,281	1,537	76	0	0	0	0	0	2	183,840
1986	72,441	28,612	2,566	370	13	0	0	0	0	13	104,015
1987	106,274	26,187	3,802	596	0	0	0	0	0	451	137,310
1988	84,998	45,773	4,800	883	24	0	0	0	0	806	137,284
1989	30,130	18,281	2,681	141	1	0	0	0	0	1	51,235
1990	45,492	20,020	6,755	1,123	27	286	286	27	27	2,571	76,612
1991	120,316	38,546	3,043	1,228	0	0	0	0	0	0	163,133
1992	60,963	21,097	2,680	342	87	95	178	166	166	99	85,875
1993	68,000	29,544	8,108	2,004	256	44	44	1	1	188	108,189
1994	96,309	38,070	4,606	275	0	0	0	0	0	0	139,260
1995	100,680	35,658	5,120	211	2	0	0	0	0	2	141,673
1996	43,516	17,897	1,511	220	4	1	1	0	0	1	63,151
1997	20,747	15,021	2,949	531	113	0	0	0	0	0	39,361
1998	14,037	11,732	1,528	303	0	0	0	0	0	0	27,600
1999	41,945	23,485	3,581	0	0	0	0	0	0	0	69,011
2000	53,312	29,444	10,218	1,455	0	0	0	0	0	0	94,429
2001	67,601	20,842	1,608	343	0	0	0	0	0	1	90,395
2002	58,445	32,518	2,073	269	0	0	0	0	0	0	93,305
2003	80,870	37,255	5,318	0	0	0	0	0	0	0	123,443
2004	40,047	81,912	11,035	409	0	0	0	0	0	0	133,402
2005	68,586	36,374	3,002	7	0	0	0	0	0	0	107,970
2006	37,033	43,681	1,341	210	0	0	0	0	0	4	82,269
2007	57,278	44,655	1,262	190	0	0	0	0	0	0	103,385

Table 5.12 (continued).

South Carolina

	1	2	3	4	5	6	7	8	9	10+	Total
1982	127,340	21,405	929	2,359	2,141	149	226	78	0	6,136	160,762
1983	77,182	22,444	4,186	979	12	0	0	0	0	0	104,803
1984	88,867	39,148	1,088	432	12	0	0	0	0	3	129,550
1985	369,762	124,774	30,846	4,726	0	0	0	0	0	0	530,108
1986	103,738	77,202	11,393	1,563	64	0	66	0	0	0	194,026
1987	391,860	114,970	13,552	1,610	45	0	0	0	0	6	522,044
1988	142,867	129,946	14,298	1,139	40	1	1	0	0	129	288,421
1989	59,660	51,798	13,650	2,591	94	2	0	0	0	31	127,826
1990	47,411	57,413	6,992	1,316	54	0	0	0	0	4	113,191
1991	88,404	36,305	2,420	120	49	12	4	1	1	105	127,421
1992	55,095	52,551	5,421	487	466	0	0	0	0	757	114,778
1993	48,425	61,023	10,226	2,248	171	0	0	1	0	46	122,141
1994	41,414	65,048	11,057	1,518	44	3	0	0	0	0	119,083
1995	110,033	55,633	8,460	2,569	368	0	0	0	0	8	177,072
1996	37,848	80,694	5,852	1,311	126	4	0	0	0	0	125,835
1997	112,215	12,150	4,198	3,058	152	53	9	0	0	0	131,834
1998	15,241	25,698	4,502	1,983	189	3	0	0	0	0	47,617
1999	22,236	19,441	3,585	530	34	0	0	0	0	0	45,826
2000	17,688	15,523	3,491	610	48	0	0	0	0	0	37,360
2001	38,822	16,805	4,430	953	35	0	0	0	0	1	61,046
2002	12,794	27,241	1,301	130	4	0	0	0	0	0	41,471
2003	40,913	99,119	14,406	7,500	750	7	0	0	0	0	162,695
2004	23,378	89,438	14,904	4,071	276	8	0	0	0	0	132,075
2005	49,074	71,256	18,561	2,072	59	0	0	0	0	0	141,023
2006	28,260	38,013	5,204	584	38	9	19	9	0	350	72,487
2007	42,724	45,001	490	5	0	0	0	0	0	0	88,220

Table 5.12 (continued).

North region

	1	2	3	4	5	6	7	8	9	10+	Total
1982	11,462	3,205	915	263	0	0	116	36	18	432	16,446
1983	82,027	27,235	3,940	1,788	0	0	480	143	101	1,168	116,882
1984	79,686	20,560	5,192	1,930	0	0	672	202	131	1,873	110,247
1985	15,445	4,807	1,514	144	0	0	21	6	4	134	22,075
1986	47,299	7,905	0	0	0	0	0	0	0	3,239	58,443
1987	48,172	10,374	974	2,899	0	0	0	0	0	867	63,286
1988	110,318	27,974	4,900	503	0	0	85	38	0	3,159	146,977
1989	27,052	41,592	5,424	0	0	0	466	155	311	381	75,381
1990	31,338	866	1,755	69	0	0	0	6	4	459	34,497
1991	47,331	9,481	289	875	0	0	0	0	0	701	58,678
1992	1,639	32,778	2,250	13	63	0	19	0	0	108	36,869
1993	4,557	43,835	14,687	40	37	0	38	0	0	729	63,923
1994	1,762	11,614	11,728	1,959	85	0	475	85	526	2,368	30,603
1995	12,439	70,790	7,611	994	880	0	0	0	0	208	92,921
1996	12,997	14,830	7,548	1,104	453	0	0	0	0	538	37,470
1997	4,919	2,888	1,787	491	208	0	65	0	0	355	10,714
1998	2,450	122,742	5,285	712	544	132	27	133	0	739	132,765
1999	5,876	54,286	18,419	158	0	0	0	0	0	24	78,764
2000	1,134	37,909	44,151	1,067	0	0	0	0	0	0	84,262
2001	1,249	8,157	17,858	2,599	126	14	2	14	0	381	30,400
2002	19,085	76,491	2,678	1,410	154	189	334	70	0	70	100,481
2003	307	26,997	13,673	365	18	0	0	0	0	0	41,360
2004	7,108	12,398	15,148	686	0	0	0	0	0	0	35,340
2005	591	54,005	1,296	0	0	0	0	0	0	0	55,892
2006	5,533	49,441	17,889	1,735	0	0	0	0	0	0	74,598
2007	2,575	88,351	44,728	524	0	0	0	0	0	0	136,178

Table 5.13 (Appendix A Table A3.2.4.9.) Predicted catch (C_a), estimated abundance (N_a), and calculated exploitation rate ($\mu = C_a/N_a$) for ages 1 through 3 and 1 through 7^+ in the **northern** and **southern** regions during 1989-2007.

	Northern region							**Southern region**					
	C_a 1-3	**N_a 1-3**	**μ 1-3**	**C_a 1-7^+**	**N_a 1-7+**	μ 1-7^+		**C_a 1-3**	**N_a 1-3**	**μ 1-3**	**C_a 1-7^+**	**N_a 1-7+**	μ 1-7^+
1989	152,188	192,955	0.79	162,145	5,878,695	0.03		223,995	1,346,299	0.17	236,929	4,678,893	0.05
1990	98,087	152,645	0.64	104,790	5,446,735	0.02		254,403	2,504,318	0.10	260,360	5,522,593	0.05
1991	123,324	363,283	0.34	126,999	5,293,422	0.02		451,456	3,996,265	0.11	467,300	6,901,852	0.07
1992	115,146	454,953	0.25	118,030	5,049,643	0.02		336,192	4,346,331	0.08	345,541	7,202,501	0.05
1993	161,805	420,410	0.38	168,163	4,712,461	0.04		343,085	4,024,013	0.09	361,289	7,224,632	0.05
1994	89,672	462,657	0.19	97,846	4,508,490	0.02		428,161	3,261,934	0.13	472,352	7,100,650	0.07
1995	113,406	582,605	0.19	118,522	4,396,625	0.03		489,707	3,273,304	0.15	528,707	7,370,692	0.07
1996	68,928	512,844	0.13	70,684	4,101,914	0.02		362,707	2,467,701	0.15	395,641	6,586,327	0.06
1997	120,334	744,898	0.16	125,242	4,186,827	0.03		285,606	2,602,112	0.11	308,618	6,649,322	0.05
1998	276,446	1,205,205	0.23	281,502	4,527,275	0.06		202,798	2,154,196	0.09	231,650	6,320,568	0.04
1999	221,775	1,239,834	0.18	229,555	4,374,636	0.05		278,184	2,552,854	0.11	301,262	6,516,060	0.05
2000	178,150	834,369	0.21	188,376	3,891,527	0.05		353,454	2,251,526	0.16	397,378	6,252,330	0.06
2001	98,521	598,946	0.16	110,748	3,694,605	0.03		402,925	3,162,254	0.13	434,458	6,997,205	0.06
2002	188,188	717,621	0.26	218,617	3,760,256	0.06		318,562	3,002,987	0.11	341,910	6,806,124	0.05
2003	93,463	487,038	0.19	98,325	3,315,167	0.03		566,346	3,373,621	0.17	596,100	7,055,987	0.08
2004	58,974	744,964	0.08	65,294	3,433,057	0.02		526,360	3,037,321	0.17	578,953	6,978,165	0.08
2005	133,769	828,518	0.16	142,573	3,506,591	0.04		560,460	3,121,760	0.18	603,410	6,964,099	0.09
2006	162,605	1,053,965	0.15	176,164	3,568,477	0.05		392,009	2,748,202	0.14	426,992	6,561,053	0.07
2007	249,095	760,736	0.33	267,501	3,272,177	0.08		474,747	3,370,211	0.14	512,204	7,164,642	0.07

Table 5.14 (RW Appendix A Table A3.2.4.7.) Estimated beginning-of-the-year abundance of red drum ages 1 – 7^+ in the **northern** and **southern** regions during 1989-2007.

Northern	**1**	**2**	**3**	**4**	**5**	**6**	**7^+**	**Totals**
1989	126,360	47,100	19,495	14,457	35,614	64,623	5,571,045	5,878,695
1990	129,913	19,327	3,406	3,536	11,981	32,824	5,245,749	5,446,735
1991	325,426	35,287	2,570	912	3,001	11,045	4,915,181	5,293,422
1992	267,912	170,786	16,255	1,554	813	2,768	4,589,556	5,049,643
1993	153,194	181,333	85,882	10,837	1,394	750	4,279,071	4,712,461
1994	300,296	93,697	68,664	50,306	9,636	1,285	3,984,606	4,508,490
1995	325,276	203,747	53,581	50,624	45,334	8,878	3,709,184	4,396,625
1996	162,919	226,016	123,909	39,271	45,634	41,797	3,462,369	4,101,914
1997	463,875	122,274	158,749	98,730	35,604	42,107	3,265,487	4,186,827
1998	805,476	332,545	67,183	120,109	89,172	32,828	3,079,962	4,527,275
1999	526,829	544,080	168,925	45,534	107,788	82,237	2,899,243	4,374,636
2000	122,868	406,897	304,603	144,399	41,383	99,249	2,772,128	3,891,527
2001	290,489	94,244	214,213	259,015	131,105	38,074	2,667,465	3,694,605
2002	468,789	215,163	33,669	174,391	234,493	120,588	2,513,164	3,760,256
2003	83,915	334,437	68,687	27,042	156,876	214,290	2,429,922	3,315,167
2004	467,406	66,196	211,363	59,794	24,620	144,559	2,459,119	3,433,057
2005	431,431	362,228	34,859	180,483	54,347	22,673	2,420,571	3,506,591
2006	505,295	334,604	214,066	30,028	164,003	50,006	2,270,475	3,568,477
2007	192,825	384,172	183,739	182,547	27,215	150,553	2,151,126	3,272,177

Southern	**1**	**2**	**3**	**4**	**5**	**6**	**7^+**	**Total**
1989	801,345	437,369	107,584	120,696	1,086,033	1,245,351	880,516	4,678,893
1990	1,706,380	511,078	286,861	78,497	99,601	951,367	1,888,809	5,522,593
1991	2,452,544	1,175,498	368,222	219,629	65,778	87,355	2,532,825	6,901,852
1992	1,835,114	1,680,573	830,644	275,862	182,722	57,600	2,339,988	7,202,501
1993	1,454,805	1,308,101	1,261,106	661,772	234,038	160,241	2,144,569	7,224,632
1994	1,282,817	1,011,956	967,162	1,011,608	562,544	205,123	2,059,441	7,100,650
1995	1,730,071	848,509	694,724	738,386	846,455	492,347	2,020,199	7,370,692
1996	787,768	1,114,212	565,721	523,437	615,304	740,827	2,239,057	6,586,327
1997	1,324,526	525,420	752,166	419,777	434,139	538,629	2,654,665	6,649,322
1998	888,355	898,024	367,816	585,927	353,470	380,026	2,846,949	6,320,568
1999	1,267,246	632,429	653,179	282,994	491,511	309,494	2,879,207	6,516,060
2000	925,348	880,394	445,784	491,045	235,649	430,113	2,843,997	6,252,330
2001	1,961,418	620,056	580,781	313,008	400,163	205,974	2,915,805	6,997,205
2002	1,248,159	1,343,437	411,390	414,437	256,376	349,838	2,782,486	6,806,124
2003	1,538,121	879,837	955,663	315,897	347,430	224,453	2,794,586	7,055,987
2004	1,489,962	1,008,202	539,157	686,463	259,291	303,804	2,691,287	6,978,165
2005	1,525,795	974,481	621,484	386,669	563,000	226,476	2,666,194	6,964,099
2006	1,159,575	996,625	592,002	433,235	314,277	491,424	2,573,915	6,561,053
2007	1,920,497	788,187	661,527	432,940	357,559	274,713	2,729,219	7,164,642

Table 5.15. (Table A3.2.4.8.) Estimated recruitment (age-1 beginning-of-the-year abundance) and associated bounds using ± 1.96 asymptotic standard errors. All values were originally in log space so bounds are not symmetrical.

	Northern region				Southern region		
	-1.96SE	**Est**	**+1.96SE**		**-1.96SE**	**Est**	**+1.96SE**
1989	98,428	126,360	163,084		285,826	801,345	2,294,212
1990	102,712	129,913	165,234		761,413	1,706,380	3,888,523
1991	282,852	325,426	375,564		1,128,399	2,452,544	5,419,640
1992	227,821	267,912	315,838		822,679	1,835,114	4,164,305
1993	119,328	153,194	197,493		668,022	1,454,805	3,216,486
1994	256,884	300,296	352,504		626,728	1,282,817	2,666,721
1995	270,379	325,276	392,457		863,855	1,730,071	3,516,652
1996	131,357	162,919	202,951		377,318	787,768	1,669,743
1997	384,548	463,875	561,292		627,215	1,324,526	2,842,572
1998	723,879	805,476	897,884		412,784	888,355	1,941,478
1999	465,473	526,829	598,227		618,875	1,267,246	2,631,225
2000	101,491	122,868	149,369		453,556	925,348	1,915,865
2001	242,738	290,489	348,684		942,650	1,961,418	4,141,216
2002	399,548	468,789	551,929		614,689	1,248,159	2,570,420
2003	64,477	83,915	109,899		796,599	1,538,121	3,009,607
2004	393,406	467,406	557,334		781,541	1,489,962	2,876,659
2005	366,649	431,431	509,489		787,854	1,525,795	2,994,896
2006	429,717	505,295	596,256		583,308	1,159,575	2,339,763
2007	148,407	192,825	252,115		945,010	1,920,497	3,959,071

Figures

See the **Stock Status and Determination Criteria** paragraph for Figure 5.1 and Figure 5.2.

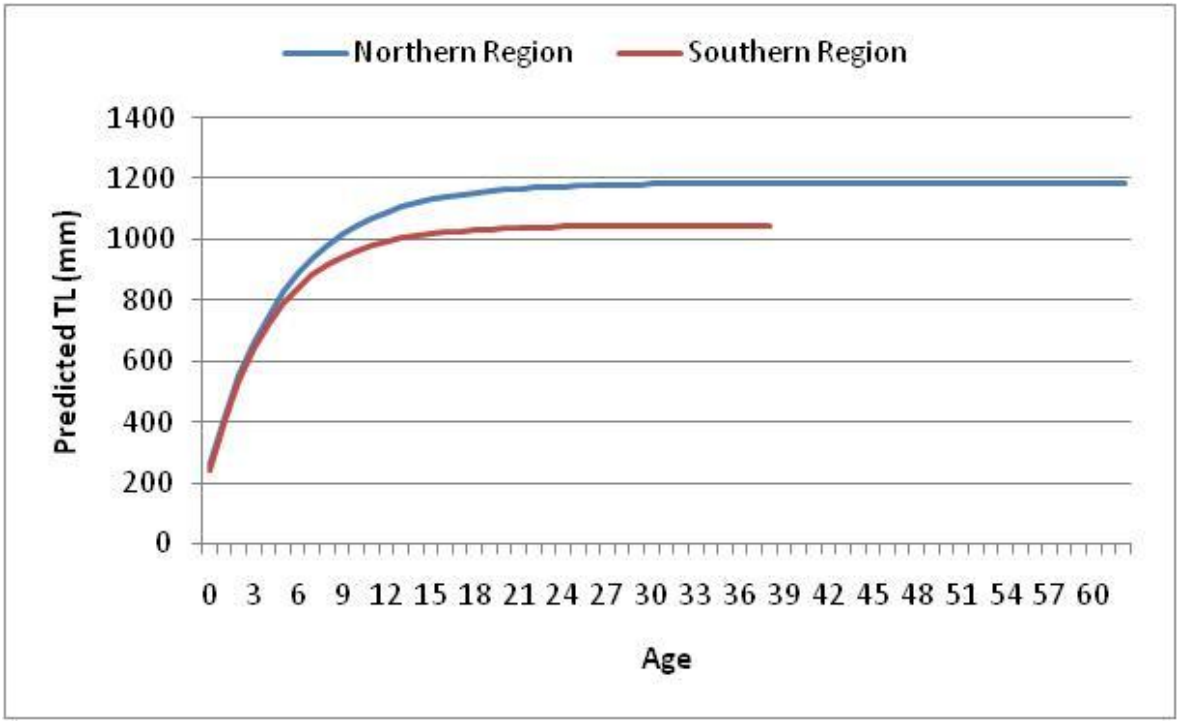


Figure 5.3 (DW Figure 2.17.3.). Comparison of predicted total lengths from von Bertalanffy models by region.

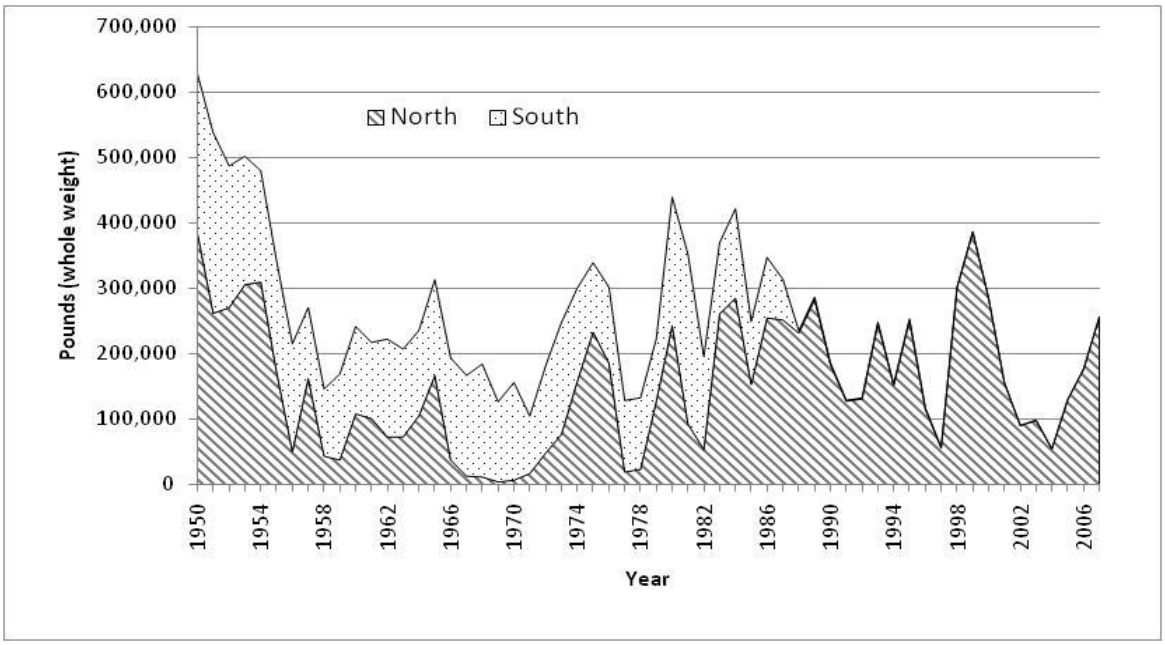
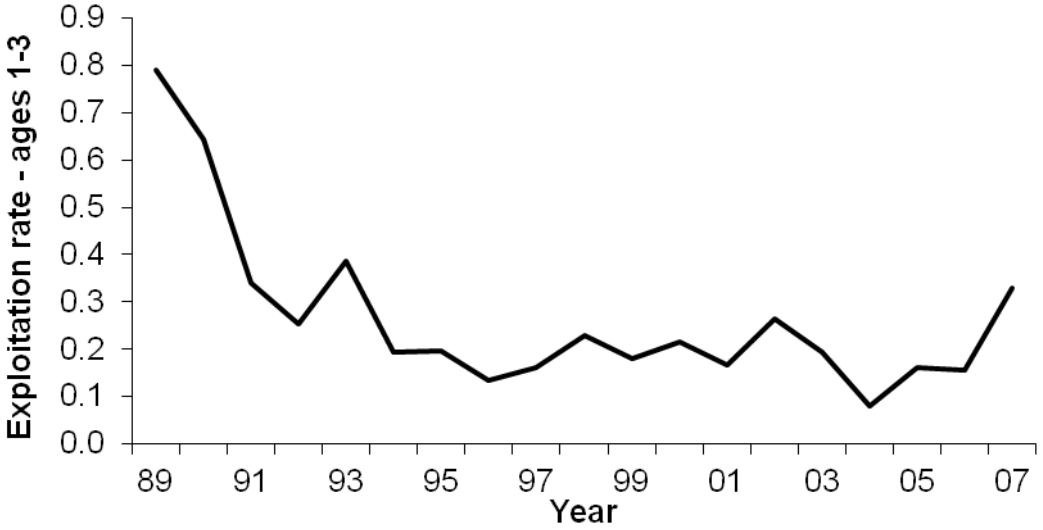


Figure 5.4 (DW Figure 3.2). Red drum commercial landings in pounds (whole weight) by region from the US Atlantic coast, 1950-2007.

Northern region



Southern region

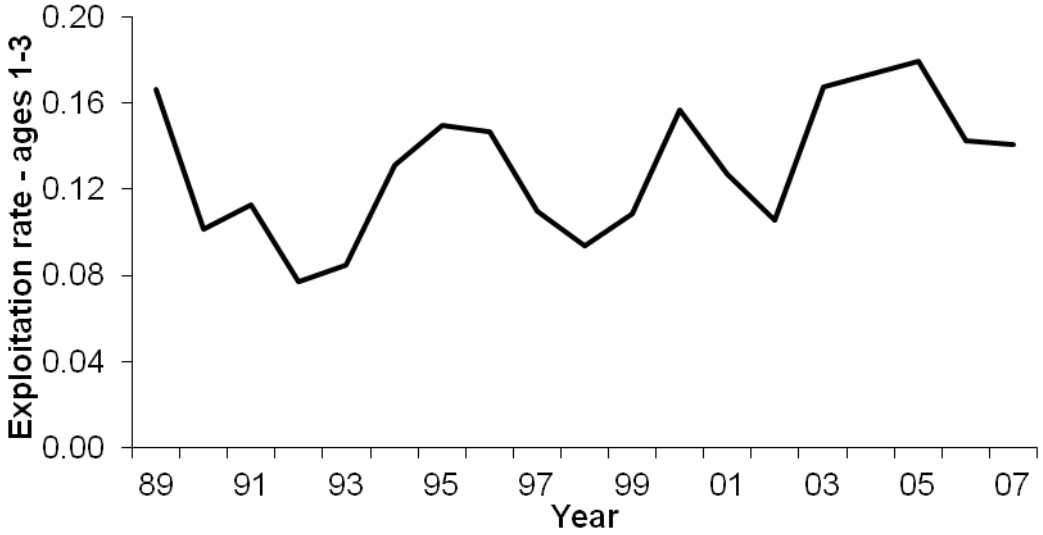
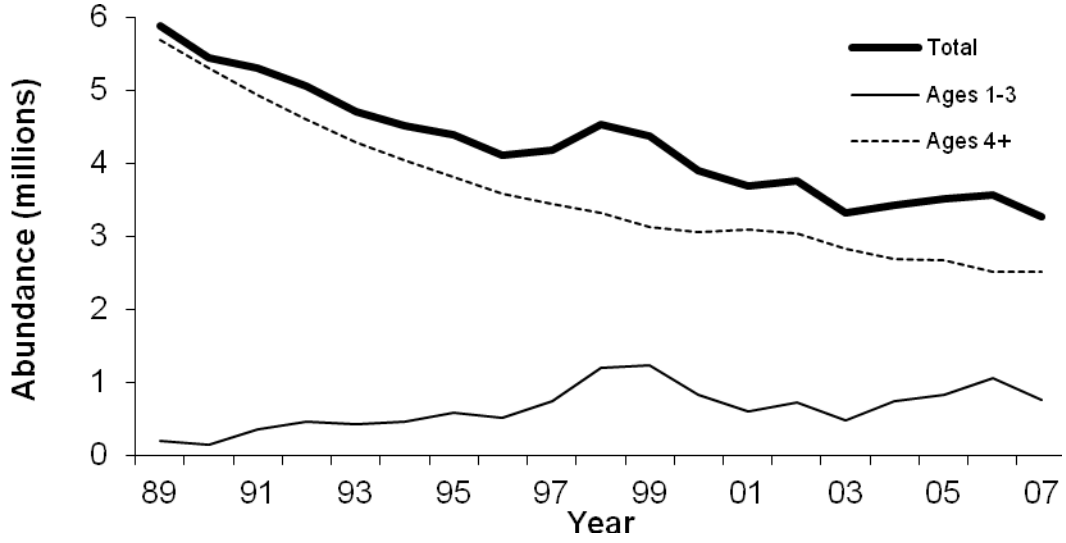


Figure 5.5 (RW Appendix Figure A3.2.5.12.). Estimated annual exploitation rate for red drum ages 1-3 in the northern and southern regions during 1989-2007.

Northern region



Southern region

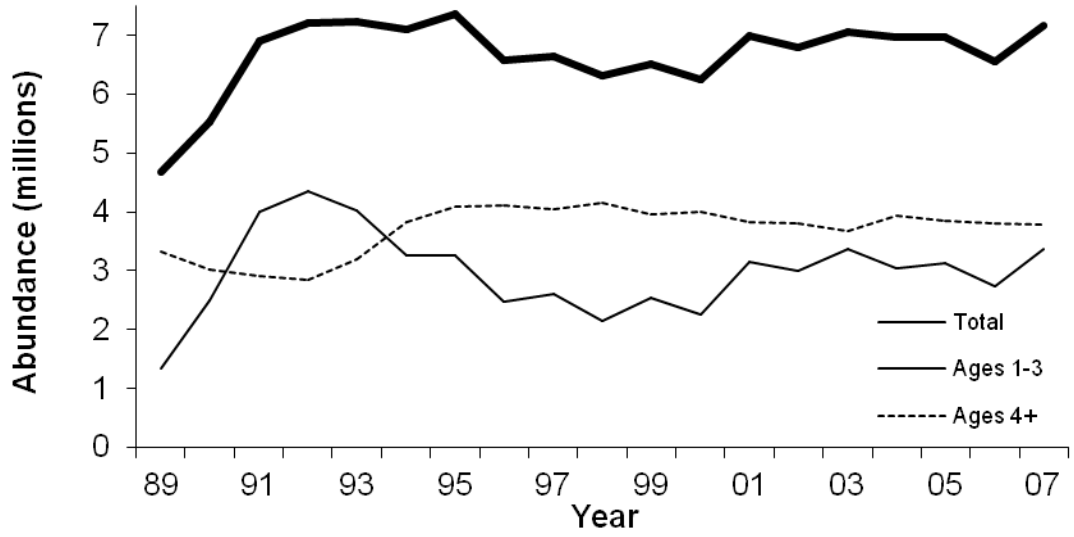
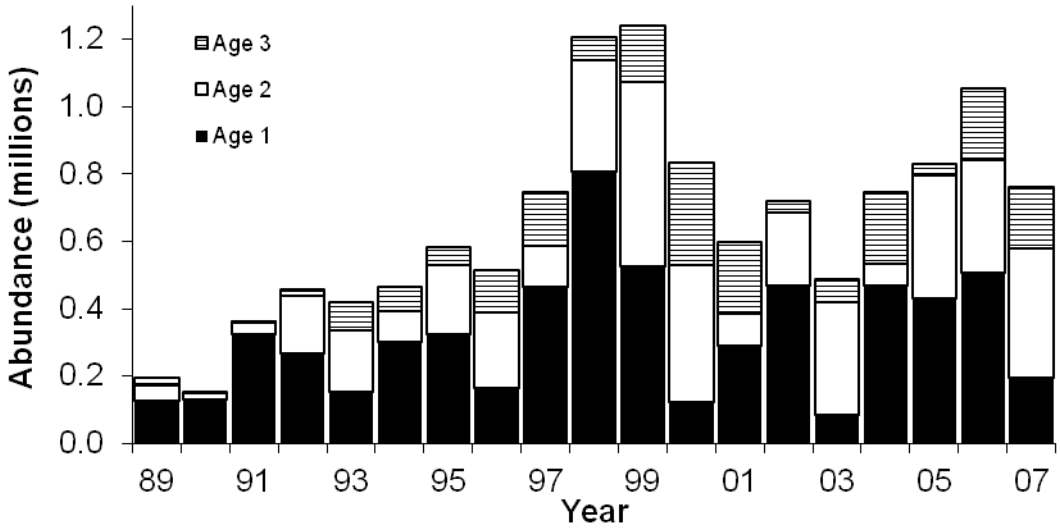


Figure 5.6 (Figure A3.2.5.7.). Estimated beginning-of-the-year abundance for red drum in the northern and southern stock areas during 1989-2007.

Northern region



Southern region

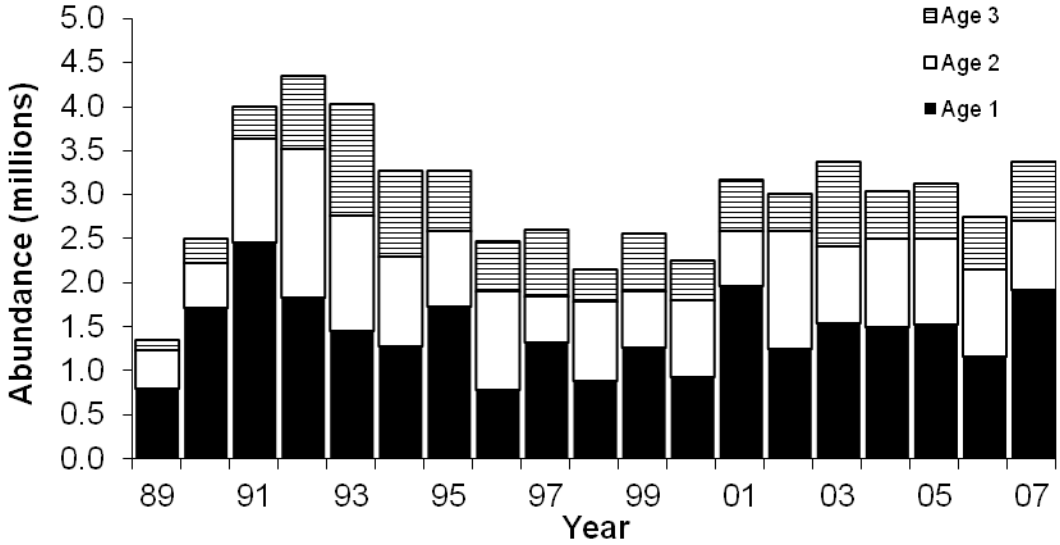
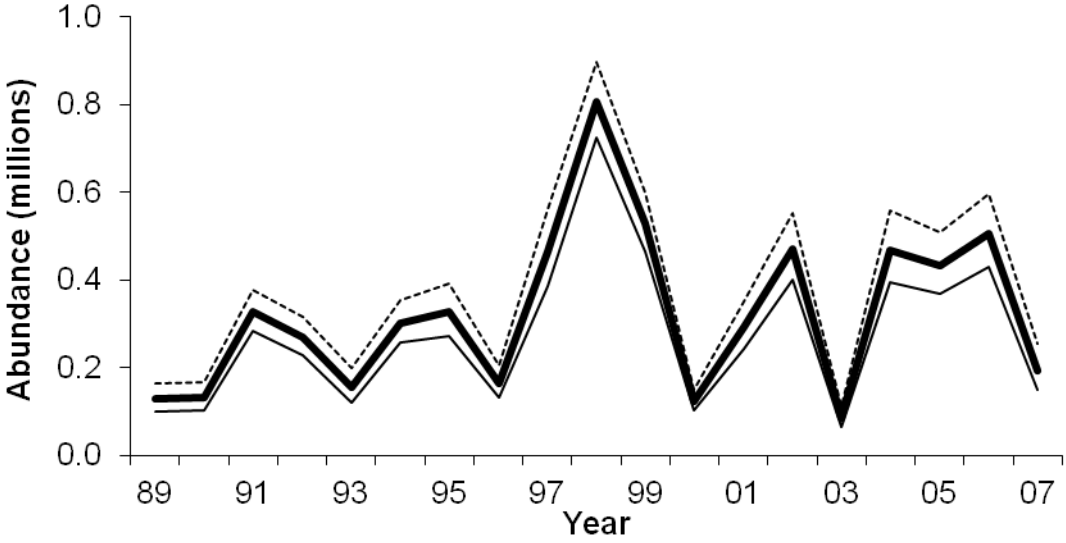


Figure 5.7 (Figure A3.2.5.8.). Estimates of abundance of red drum ages 1-3 in the northern and southern stock areas during 1989-2007

Northern region



Southern region

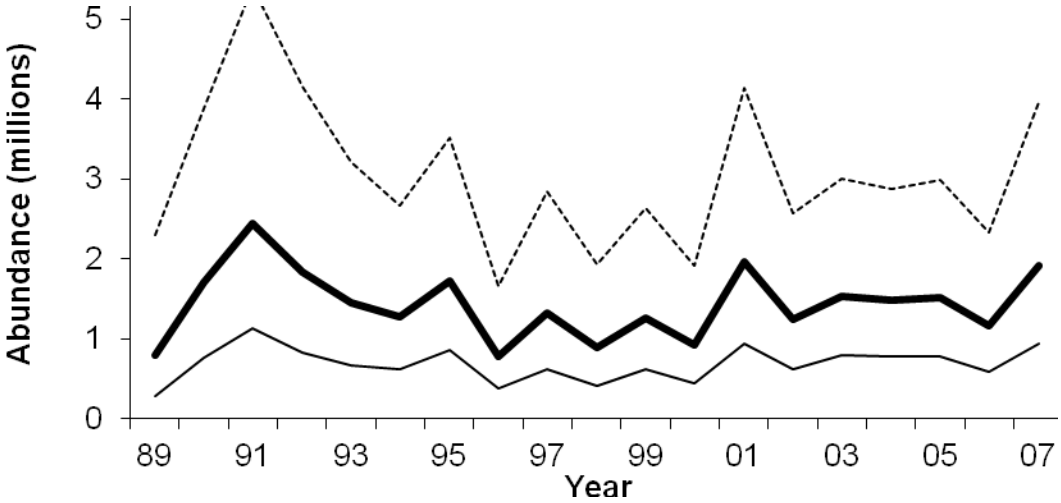


Figure 5.8 (Figure A3.2.5.9.). Estimated recruitment (age-1 abundance, heavy solid line) and ± 1.96 standard errors for the northern and southern regions during 1989-2007

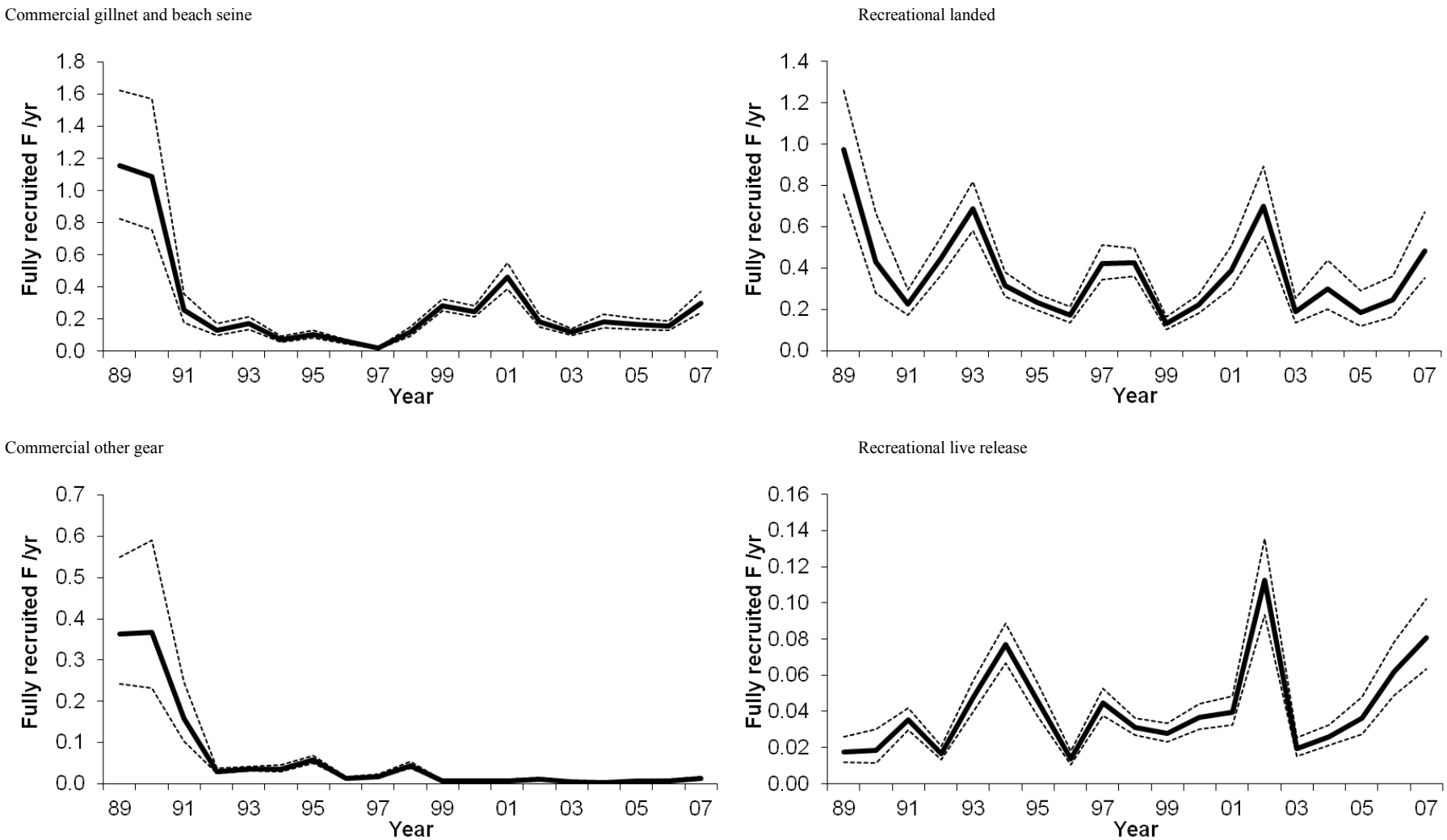
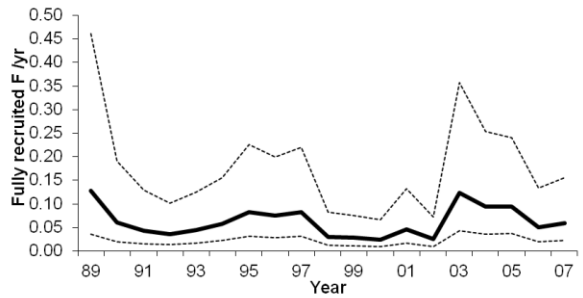
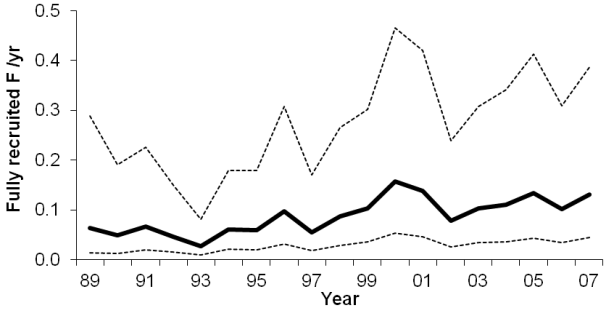


Figure 5.9 (Figure A3.2.5.13). Estimated fully recruited instantaneous fishing mortality (solid line) and ± 1.96 standard errors (dashed lines) for the four **northern** region fisheries during 1989-2007.

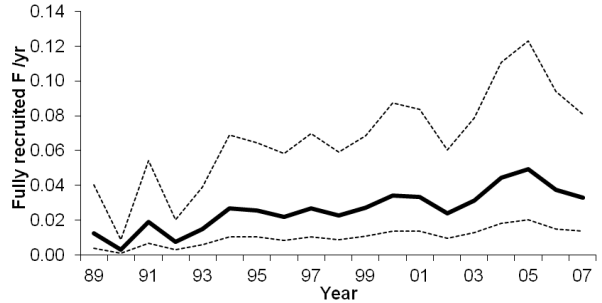
South Carolina recreational landed/commercial



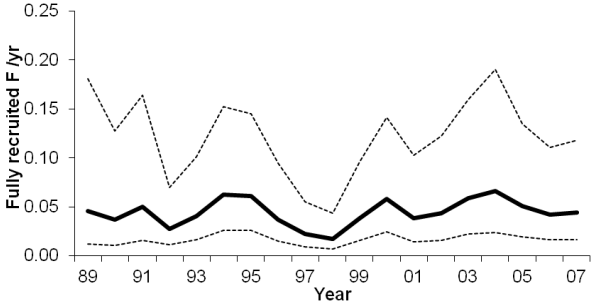
Florida recreational landed



Florida live-release



Georgia recreational landed/commercial



Georgia/South Carolina live-release

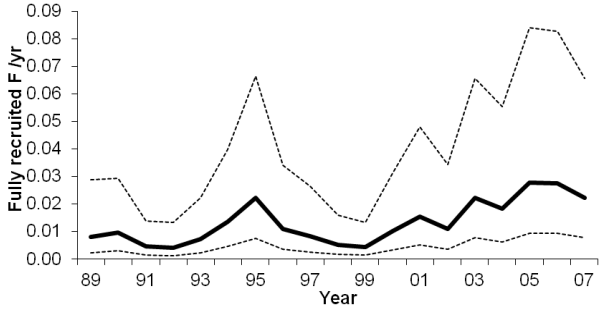


Figure 5.10. (Figure A3.2.5.14.) Estimated fully recruited instantaneous fishing mortality (solid line) and ± 1.96 standard errors (dashed lines) for the six **southern** region fisheries during 1989-2007.

6 Data for NMFS Species Information System

6.1 Atlantic Red Drum: Southern Stock - SEDAR 18

Data Elements:	Workshop Data:
Assessment Year	2009
Assessment Month	September
Last Data Year	2007
Assessment Model	Simple statistical catch-at-age model in AD Model Builder code
Model Version	Revised at SEDAR 18 Review Workshop, Atlanta, GA, 24-28 August 2009
Lead Lab	ASMFC Red drum Technical committee
Point of Contact	Michael D. Murphy
Update Type	Benchmark: Assessments that are substantially different from the previous assessment (new/updated model, inclusion of new data source)
Review Type	Accept: (with revisions and caveats) Assessment was accepted by the scientific review committee and is available for use as advice to management
Life History	2: Basic demographic parameters such as age, growth, and maturity rates provide information on productivity and natural mortality.
Frequency	1: Infrequent-the most recent assessment was conducted more than three years ago.
Level	4: Size, stage, or age structured models such as cohort analysis and untuned and tuned VPA analyses, age-structured production models, CAGEAN, stock synthesis, size or age-structured Bayesian models, modified DeLury methods, and size or age-based mark-recapture models;
Catch	2: Catch size composition provides a measure of the sizes of fish being impacted by the fishery, and when tracked over time can provide an index of recruitment to the fishery and total mortality rates.
Abundance	2: Precise, frequent surveys with age composition will provide more accurate tracking of changes in stock abundance and the associated age composition data will enable better estimation of historical and current levels of recruitment
Citation	Atlantic Red Drum Stock Assessment Report, SEDAR 18, 2009 http://www.sefsc.noaa.gov/sedar/
Minimum F Estimate	<1%
Maximum F Estimate	64.5%

Data Elements:	Workshop Data:
Best F Estimate	49.5%
F Unit	Dimensionless, calculated as a spawning stock biomass ratio so biomass/biomass units
F Year	2005-2007 average
F Basis	3-year average static spawning potential ratio (sSPR)
Flimit	sSPR threshold is defined as 30% and **this is a lower limit**.
Flimit Basis	$F_{30\%}$
Fmsy	Not available, though YPR-based F_{max} gave sSPR's of 13.7%.
Fmsy Basis	Not available
Ftarget	sSPR of 40%
Ftarget Basis	$F_{40\%}$
F/Flimit	Not applicable
F/Fmsy	Not applicable
F/Ftarget	Not applicable
Minimum B Estimate	Not Available
Maximum B Estimate	Not Available
Best B Estimate	Not Available
B Unit	Not Available
B Year	Not Available
B Basis	Not Available
Blimit	Not Available
Blimit Basis	Not Available
Bmsy	Not Available
Bmsy Basis	Not Available
MSY	Not Available
Stock Level to Bmsy	Not Available
B/Blimit	Not Available
B/Bmsy	Not Available
Comments	In general, the assessment analysis was not considered adequate to estimate biomass.

6.2 Atlantic Red Drum: Northern Stock - SEDAR 18

Data Elements:	Workshop Data:
Assessment Year	2009
Assessment Month	September
Last Data Year	2007
Assessment Model	Simple statistical catch-at-age model in AD Model Builder code
Model Version	Revised at SEDAR 18 Review Workshop, Atlanta, GA, 24-28 August 2009
Lead Lab	ASMFC Red drum Technical committee
Point of Contact	Michael D. Murphy
Update Type	Benchmark: Assessments that are substantially different from the previous assessment (new/updated model, inclusion of new data source)
Review Type	Accept: (with revisions and caveats) Assessment was accepted by the scientific review committee and is available for use as advice to management
Life History	2: Basic demographic parameters such as age, growth, and maturity rates provide information on productivity and natural mortality.
Frequency	1: Infrequent-the most recent assessment was conducted more than three years ago.
Level	4: Size, stage, or age structured models such as cohort analysis and untuned and tuned VPA analyses, age-structured production models, CAGEAN, stock synthesis, size or age-structured Bayesian models, modified DeLury methods, and size or age-based mark-recapture models;
Catch	2: Catch size composition provides a measure of the sizes of fish being impacted by the fishery, and when tracked over time can provide an index of recruitment to the fishery and total mortality rates.
Abundance	2: Precise, frequent surveys with age composition will provide more accurate tracking of changes in stock abundance and the associated age composition data will enable better estimation of historical and current levels of recruitment
Citation	Atlantic Red Drum Stock Assessment Report, SEDAR 18, 2009 http://www.sefsc.noaa.gov/sedar/
Minimum F Estimate	42.9%
Maximum F Estimate	48.1%
Best F Estimate	45.3%

Data Elements:	Workshop Data:
F Unit	Dimensionless, calculated as a spawning stock biomass ratio so biomass/biomass units
F Year	2005-2007 average
F Basis	3-year average static spawning potential ratio (sSPR)
Flimit	sSPR threshold is defined as 30% and **this is a lower limit**.
Flimit Basis	$F_{30\%}$
Fmsy	Not available, though YPR-based F_{max} gave sSPR's of 17.4%
Fmsy Basis	Not available
Ftarget	sSPR of 40%
Ftarget Basis	$F_{40\%}$
F/Flimit	Not applicable
F/Fmsy	Not applicable
F/Ftarget	Not applicable
Minimum B Estimate	Not Available
Maximum B Estimate	Not Available
Best B Estimate	Not Available
B Unit	Not Available
B Year	Not Available
B Basis	Not Available
Blimit	Not Available
Blimit Basis	Not Available
Bmsy	Not Available
Bmsy Basis	Not Available
MSY	Not Available
Stock Level to Bmsy	Not Available
B/Blimit	Not Available
B/Bmsy	Not Available
Comments	In general, the assessment analysis was not considered adequate to estimate biomass, especially in the Southern region.

7 SEDAR Abbreviations

ABC	Allowable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
ASMFC	Atlantic States Marine Fisheries Commission
AT	Assessment Team
B	stock biomass level
BAC	SAFMC SSC Bioassessment sub-Committee
B_{MSY}	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
GMFMC	Gulf of Mexico Fishery Management Council
F	fishing mortality (instantaneous)
FSAP	GMFMC Finfish Assessment Panel
F_{MSY}	fishing mortality to produce MSY under equilibrium conditions
F_{OY}	fishing mortality rate to produce Optimum Yield under equilibrium
F_{XX}% SPR	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
F_{MAX}	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F_0,	a fishing mortality close to, but slightly less than, Fmax
FWRI	(State of) Florida Fisheries and Wildlife Research Institute
GLM	general linear model
M	natural mortality (instantaneous)
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
RP	Review Panel
RVC	Reef Visual Census—a diver-operated survey of reef-fish numbers
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS corporation.
SEDAR	Southeast Data, Assessment and Review
SEFSC	NOAA Fisheries Southeast Fisheries Science Center
SERO	NOAA Fisheries Southeast Regional Office
SFA	Sustainable Fisheries Act of 1996
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SSC	Science and Statistics Committee
Z	total mortality, the sum of M and F