S E D A R

Southeast Data, Assessment, and Review

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SEDAR 18
Data Workshop Report

Atlantic Red Drum

April 24, 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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Section II. Data Workshop Report

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1. Introduction

1.1 Workshop Time and Place

The SEDAR 18 Data Workshop was held February 9-13, 2009, in Charleston, SC.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition. Provide a map of species and stock distribution(s).

2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics, discard mortality rates); provide appropriate models to describe natural mortality, growth, maturation, and fecundity by age, sex, or length as applicable; and provide appropriate relations between length and weight and between various length measures. Evaluate the adequacy of available life-history information for input into stock assessments and recommend life history information for use in population modeling.

3. Evaluate all available tag/recapture data for use in estimating mortality rates, both natural and fishing, within appropriate strata (e.g., age, size classes, areas); estimate tag/recapture-based selectivity vectors for fishery units, by length or age.

4. Consider relevant fishery dependent and independent data sources to develop measures of population abundance. Document all programs used to develop indices; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop relative abundance indices by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision. Evaluate the degree to which available indices represent fishery and population conditions. Evaluate stock enhancement effects on indices.

5. Characterize catch for each fishery unit (e.g., commercial hook and line, recreational, commercial gill net), including both landings and discard removals, in pounds and number. Discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery unit. For estimated catch provide measures of precision. Provide all available data on the length and age distributions of the catch, both harvest and discard. Provide figures of the amount of fishery effort and harvest. Also, provide a timeline of all fishery regulations relevant to the above fishery units, such as size limits, caps, and gear restrictions.

6. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Evaluate sampling intensity by sector (fleet), area, and season.

7. Develop a spreadsheet of potential assessment model input data that incorporates the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet within 6 weeks prior to the Assessment Workshop.

8. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report); prepare a list of tasks to be completed following the workshop, including deadlines and personnel assignments.

1.3 Participants

Scheduled to Attend

Appointee	Function	Affiliation
Coordination		
Dale Theiling	Chairman and Chief Editor	SEDAR
Rachael Lindsay	Administrative Support	SEDAR
Data Management		
Pat Campfield	Data Compiler	ASMFC
Consultant		
Doug Vaughan	Assessment History Consultation	SEFSC-Beaufort
Life History Workgroup		
Joe Grist	Leader and Editor	VMRC
Alicia Nelson	Rapporteur	VMRC
Stephanie McInerny	Data Provider	NC DMF
Mike Denson	Data Provider	SC DNR
Eric Robillard	Data Provider	GA DNR
Commercial Statistics Workgroup		
Lee Paramore	Leader and Editor	NC DMF
Stephanie McInerny	Rapporteur	NC DMF
Joe Grist	Data Provider	VMRC
Gabe Gaddis	Data Provider	GA DNR
Julie DeFilippi	Data Provider	ACCSP
Doug Vaughan	Data Provider	SEFSC/TIP & Logbook
Recreational Statistics Workgroup		
Mike Denson	Leader and Editor	SC DNR
Beverly Sauls	Rapporteur	FL FWCC
Joe Grist	Data Provider	VMRC
Stephanie McInerny	Data Provider	NC DMF
Gabe Gaddis	Data Provider	GA DNR
Tom Sminkey	Data Provider	MRFSS
Indices Workgroup		
Mike Murphy	Leader and Editor	FL FWCC
Carolyn Belcher	Rapporteur	GA DNR
Joe Grist	Data Provider	VMRC
Lee Paramore	Data Provider	NC DMF
Erin Levesque	Data Provider	SC DNR/SEAMAP

Julie DeFilippi	Data Provider	ACCSP

Analytical Team Representatives (all duplicates from workgroups)

Mike Murphy	Lead Analyst and Model Editor	ASMFC RD SAS
Joe Grist	Analyst	ASMFC RD SAS
Lee Paramore	Analyst	ASMFC RD SAS
Mike Denson	Analyst	ASMFC RD SAS
Carolyn Belcher	Analyst	ASMFC RD SAS

Commission Representatives

Robert Boyles	Commissioner	ASMFC
Spud Woodward	Commissioner	ASMFC
Nichola Meserve	Red Drum FMP Coordinator	ASMFC

Advisory Panel Representatives

Bill Windley	ASMFC AP Chair	Recreational, MD
Tom Powers	ASMFC AP Vice Chair	Recreational, VA

Official Observer

Kathy Knowlton		GA DNR

Acronyms used in SEDAR 18 Participants List

ACCSP	Atlantic Coastal Cooperative Statistics Program
ASMFC TC	Atlantic States Marine Fisheries Commission Technical Committee
CIE	Center for Independent Experts
FL FWCC	Florida Fish and Wildlife Conservation Commission
FMP	Fishery Management Plan
GA DNR	Georgia Department of Natural Resources
IT	Information Technology
ME DNR	Maine Department of Natural Resources
MRFSS	Marine Recreational Fisheries Statistics System
MRIP	Marine Recreational Information Program
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RD SAS	Red Drum Stock Assessment Subcommittee
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SC DNR	South Carolina Department of Natural Resources
SEDAR	Southeast Data, Assessment, and Review
TBN	To be named
TIP	Trip Interview Program, National Marine Fisheries Service
VMRC	Virginia Marine Resources Commission

1.4 Workshop Documents

SEDAR 18
Atlantic Red Drum
Workshops Document List

Document #	Title	Authors
	Documents Prepared for the Data Workshop	
SEDAR18-DW01	Red drum assessment history	Vaughan 2008
SEDAR18-DW02	Overview of Red Drum Tagging Data and Recapture Results by state from Virginia to Florida	S-18 DW Tagging Workgroup 2009
SEDAR18-DW03	Atlantic States Red Drum Management Overview	Meserve 2009
SEDAR18-DW04	Georgia's Marine Sportfish Carcass Recovery Project	Georgia DNR
SEDAR18-DW05	Georgia's Metadata for Fishery Independent RD Data 2002-07	Georgia DNR
SEDAR18-DW06	NC Biological Data-Surveys Descriptions and Background Info	Paramore 2009
SEDAR18-DW07	Life-History Based Estimates of Natural Mortality for U.S. South Atlantic Red Drum	Vaughan 2008
SEDAR18-DW08	Reported commercial landings of red drum in Florida and estimated annual length and age composition	Murphy 2009
SEDAR18-DW09	Recreational harvest estimates and estimated catch-at-age for the recreational fishery in Florida during 1982-2007	Murphy 2009
SEDAR18-DW10	Indices of relative abundance for young-of-the-year and subadult red drum in Florida	Murphy 2009
SEDAR18-DW11	SC Red drum electro-fishing survey	SC DNR undated
SEDAR18-DW12	SC Red Drum Tagging Data	S. Arnott 2009
SEDAR18-DW13	SC Tournament and Fish Wrack Recycle Program 2002-2007	McDonough undated
SEDAR18-DW14	Assessment of Adult Red Drum in South Carolina	SC DNR undated
SEDAR18-DW15	South Carolina Fishery Independent Survey Description and Protocol	SC DNR undated
SEDAR18-DW16	An Estimate of RD Removals from NC Estuarine Gill Net Fishery Occurring from both Rec Users of Gill Nets and from Regulatory and Unmarketable Discards.	Paramore 2009
SEDAR18-DW17	Estimating the size and age composition of the B–2 fish (caught and released alive) in the recreational fishery for red drum in South	SC DNR undated

	Carolina	
SEDAR18-DW18	South Carolina randomly stratified trammel net survey	Arnott 2009
Documents Prepared for the Assessment Workshop		
SEDAR18-AW01	None submitted	
Documents Prepared for the Review Workshop		
SEDAR18-RW01	SEDAR 18 Atlantic Red Drum Document for Peer Review	To be prepared following Assessment Workshop
Workshop Reports		
	SEDAR 18 Data Workshop Report	To be prepared following Data Workshop
	SEDAR 18 Assessment Workshop Report	To be prepared following Assessment Workshop
	SEDAR 18 Review Workshop Report	To be prepared following Review Workshop
Final Assessment Reports		
SEDAR18-SAR01	Assessment of the red drum stock in the US Atlantic	To be prepared following Review Workshop
Reference Documents		
SEDAR18-RD01	Tag-reporting levels for RD caught by anglers in SC and Georgia estuaries	Denson *et al* 2002
SEDAR18-RD02	Association of large juvenile RD with an estuarine creek on the Atlantic coast of Florida	Adams & Tremain 2000
SEDAR18-RD03	Use of passive acoustics to determine RD spawning in Georgia waters	Barbieri *et al* TAFS 2008
SEDAR18-RD04	Spatial and temporal patterns in modeled particle transport to estuarine habitat with comparisons to larval fish settlement patterns	Brown *et al* 2005
SEDAR18-RD05	Incidental catch and discard of RD, in a large mesh Paralichthyidae gillnet fishery: experimental evaluation of a fisher's experience at limiting bycatch	Buckel *et al* 2006
SEDAR18-RD06	Site fidelity and movement patterns of wild	Dresser & Kneib

	subadult RD, within a salt marsh-dominated estuarine landscape	2007
SEDAR18-RD07	Behavior and recruitment success in fish larvae: variation with growth rate and the batch effect	Fuiman *et al* 2005
SEDAR18-RD08	Estimating stock composition of anadromous fishes from mark–recovery data: possible application to American shad	Hoenic , Latour & Olney TAFS 2008
SEDAR18-RD09	Distribution of RD spawning sites Identified by a towed hydrophone array	Holt TAFS 2008
SEDAR18-RD10	Year-class component, growth, and movement of juvenile RD stocked seasonally in a SC estuary	Jenkins *et al* 2004
SEDAR18-RD11	Experimental investigation of spatial and temporal variation in estuarine growth of age-0 juvenile RD	Lanier & Scharf 2007
SEDAR18-RD12	Estimates of fishing and natural mortality for subadult RD in SC Waters	Latour *et al* 2001
SEDAR18-RD13	Properties of the residuals from two tag-recovery models	Latour *et al* 2002
SEDAR18-RD14	Habitat triage for exploited fishes: Can we identify essential ‘‘Essential Fish Habitat?’’	Levin & Stunz 2005
SEDAR18-RD15	Identifying Sciaenid critical spawning habitats by the use of passive acoustics	Luczkovich & Pullinger TAFS 2008
SEDAR18-RD16	Large scale patterns in fish trophodynamics of estuarine and shelf habitats of the SE US	Marancik & Hare 2007
SEDAR18-RD17	Ecophys.Fish: A simulation model of fish growth in time-varying environmental regimes	Neill *et al* 2004
SEDAR18-RD18	Population structure of RD as determined by otolith chemistry	Patterson *et al* 2004
SEDAR18-RD19	A new growth model for RD that accommodates seasonal and ontogenic changes in growth rates	Porch *et al* 2002
SEDAR18-RD20	Estimating abundance from gillnet samples with application to RD in Texas bays	Porch *et al* 2002b
SEDAR18-RD21	Icthyoplankton community structure in a shallow subtropical estuary of the Florida Atlantic coast	Reyier & Shenker 2007
SEDAR18-RD22	Role of an estuarine fisheries reserve in the production and export of ichthyoplankton	Reyier *et al* 2008
SEDAR18-RD23	Trophic plasticity and foraging performance in RD	Ruehl & DeWitt 2007
SEDAR18-RD24	Estuarine recruitment, growth, and first-year survival of juvenile RD in NC	Stewart & Scharf TAFS 2008
SEDAR 18-RD25	Habitat-related predation on juvenile wild-	Stunz & Minello

	caught and hatchery-reared RD	2001
SEDAR 18-RD26	Selection of estuarine nursery habitats by wild-caught and hatchery-reared juvenile red drum in laboratory mesocosms	Stunz *et al* 2001
SEDAR 18-RD27	Growth of newly settled red drum *Sciaenops ocellatus* in different estuarine habitat types	Stunz *et al* 2002
SEDAR 18-RD28	Multidirectional movements of sportfish species between an estuarine no-take zone and surrounding waters of the Indian River Lagoon, Florida	Tremain *et al* 2004
SEDAR 18-RD29	Marine stock enhancement in Florida: A multi-disciplinary, stakeholder-supported, accountability-based approach	Tringali *et al* 2008
SEDAR 18-RD30	Estimating improvement in spawning potential ratios for South Atlantic RD through bag and size limit regulations	Vaughan & Carmichael 2002
SEDAR 18-RD31	Catch-and-release mortality in subadult and adult red drum captured with popular fishing hook types	Vecchio & Wenner NAJFM 2008
SEDAR 18-RD32	Using estuarine landscape structure to model distribution patterns in nekton communities and in juveniles of fishery species	Whaley *et al* 2007
SEDAR 18-RD33	Reproductive biology of red drum, *Sciaenops ocellatus,* from the neritic waters of the northern Gulf of Mexico	Wilson and Neiland 1994
SEDAR 18-RD34	An age-dependent tag return model for estimating mortality and selectivity of an estuarine-dependent fish with high rates of catch and release	Bacheler *et al* 2008
SEDAR 18-RD35	Genetic effective size in populations of hatchery-raised red drum released for stock enhancement	Gold *et al* 2008
SEDAR 18-RD36	Contributions to the biology of red drum, *Sciaenops ocellatus*, in South Carolina	Wenner 2000
SEDAR 18-RD37	Recruitment of juvenile red drum in North Carolina: spatiotemporal patterns of year-class strength and validation of a seine survey	Bacheler, Paramore, Buckel, and Scharf 2008
SEDAR 18-RD38	Hooking Mortality of spotted seatrout (*Cynoscion nebulosus*), weakfish (*Cynoscion regalis*), red drum (*Sciaenops ocellatus*), and southern flounder (*Paralichthys lethostigma*) in North Carolina	Gearhart 2002
SEDAR 18-RD39	Evaluation of the estuarine hook and line recreational fishery in Neuse River, North	Brown 2007

	Carolina	
SEDAR 18-RD40	Large circle hooks and short leaders with fixed weights reduce incidence of deep hooking in angled adult red drum	Beckwith and Brown 2005
SEDAR 18-RD41	Abiotic and biotic factors influence the habitat use of an estuarine fish	Bacheler, Paramore, Buckel, and Hightower 2008
SEDAR 18-RD42	Stock Status of the northern red drum stock	Takade and Paramore 2005
SEDAR 18-RD43	Short-term hooking mortality and movement of adult red drum (*Sciaenops ocellatus*) in the Neuse River, North Carolina.	Aguilar 2003
SEDAR 18-RD44	Identification of critical spawning habitat and male courtship vocalization characteristics of red drum, *Sciaenops ocellatus*, in the lower Neuse River estuary of North Carolina	Beckwith 2006
SEDAR 18-RD45	Movement and selectivity of red drum and survival of adult red drum: an analysis of 20 years of tagging data	Burdick, Hightower, Buckel, Paramore, and Pollock 2007
SEDAR 18-RD46	Age, growth, mortality, and reproductive biology of red drums in North Carolina waters	Ross, Stephens, and Vaughan 1995
SEDAR 18-RD47	North Carolina red drum fishery management plan, amendment 1	Red drum fishery management plan advisory committee and NC DMF 2008
SEDAR 18-RD48	Status of the red drum stock of the Atlantic coast- stock assessment report for 1989	Vaughan and Helser 1990
SEDAR 18-RD49	Status of the red drum stock of the Atlantic coast- stock assessment report for 1991	Vaughan 1992
SEDAR 18-RD50	Status of the red drum stock of the Atlantic coast- stock assessment report for 1992	Vaughan 1993
SEDAR 18-RD51	Status of the red drum stock of the Atlantic coast- stock assessment report for 1995	Vaughan 1996
SEDAR 18-RD52	Assessment for Atlantic red drum for 1999- northern and southern regions	Vaughan and Carmichael 2000
SEDAR 18-RD53	Bag and size limit analysis for red drum in northern and southern regions of the U. S. Atlantic	Vaughan and Carmichael 2001
SEDAR 18-RD54	Seasonal variation in age-specific movement patterns of red drum *Sciaenops ocellatus* inferred from conventional tagging and telemetry	Bacheler, Paramore, Burdick, Buckel, Hightower in review

SEDAR 18-RD55	A combined telemetry – tag return approach to estimate fishing and natural mortality rates of an estuarine fish	Bacheler, Buckel, Hightower, Paramore and Pollock in review
SEDAR 18-RD56	Investigation into the Feasibility of Stocking Artificially Propagated Red Drum in Georgia	Pafford, Nicholson, and Woodward 1990
SEDAR 18-RD57	A Biological and Fisheries Profile of Red Drum, *Sciaenops ocellatus*	Mercer 1984
SEDAR 18-RD58	Ultrasonic Biotelemetry Study of Young-Adult Red Drum in Georgia, July 1993 – September 1995	Nicholson, Jordan, and Purser 1996
SEDAR 18-RD59	Habitat Use and Movement of Subadult Red Drum, *Sciaenops ocellatus*, within a Salt Marsh-Estuarine System	Dresser 1996
SEDAR 18-RD60	Mortality, Movement, and Growth of Red Drum in Georgia	Pafford, Woodward, and Nicholson 1990
SEDAR 18-RD61	Spatial Homogeneity & Temporal Heterogeneity of Red Drum Microsatellites-Effective Pop Size & Management Implications	Chapman, Ball, Mash 2002
SEDAR 18-RD62	A modified stepping-stone model of population structure in Red Drum from Northern GOM	Gold, Burridge, Turner 2001
SEDAR 18-RD63	Population structure of red drum in the Northern Gulf of Mexico, as inferred from variation in nuclear-coded microsatellites	Gold, Turner 2002
SEDAR 18-RD64	An analysis of genetic population structure of red drum based on mtDNA control region sequences	Seyoum, Tringali, Bert, McElroy, Stokes 2000
SEDAR18-RD65	The 1960 Salt-Water Angling Survey, USFWS Circular 153	J. R. Clark
SEDAR18-RD66	The 1965 Salt-Water Angling Survey, USFWS Resource Publication 67	D. G. Deuel and J. R. Clark. 1968
SEDAR18-RD67	1970 Salt-Water Angling Survey, NMFS Current Fisheries Statistics Number 6200	D. G. Deuel. 1973
SEDAR18-RD68	Overview of an experimental stock enhancement program for red drum in South Carolina	Smith, Jenkins, Denson 1997

2. Life History

2.1 Overview

The life history working group (LHG) reviewed information on stock structure and description, age, mortality, growth, reproduction, movement and migrations, and habitat, among others. Within the life history working group, there was a Tagging Subgroup made of members of the LHG along with members from some of the other working group.

2.1.1 Life History Group Membership

Joe Grist (Leader)	VMRC
Tonya Darden	SC DNR
Mike Denson	SC DNR
Stephanie McInerny	NC DMF
Chris Mcdonough	SC DNR
Alicia Nelson	VMRC
Eric Robillard	GA DNR
Doug Vaughan	SEFSC-Beaufort
Kirby Wolfe	GA DNR

2.1.2 Tagging Subgroup Membership

Joe Grist (Leader)	VMRC
Carolyn Belcher	GA DNR
Mike Denson	SC DNR
Jon Lucy	VIMS
Mike Murphy	FL FWC
Alicia Nelson	VMRC
Lee Paramore	NC DMF
Steve Arnott	SC DNR

2.1.3 Issues

Some of the key issues discussed by the Life History Group include the difference between total length and fork length including how each state had measured the fish, the possible split between a northern region (Virginia and North Carolina) and a southern region (South Carolina, Georgia, and Florida), and the different maximum ages for each region. It was decided that the maximum age for the northern region would be 62, and the southern region would be 38. For ageing data, there was also discussion on the age determination at the January 1 birthday being age 0 or age 1.

2.2 Review of Working Papers

S18-DW 02

Working paper S18-DW 02 provides overviews of the red drum tagging effort for each state from Virginia through Florida. It includes information on history and procedures of each state's tagging program(s), tag type usage, and recapture details. The paper provided the Life History Group important information regarding movements and migration of red drum populations through tagging and recapture information.

S18-DW 04

The Life History Workgroup reviewed the document S18-DW 04 and determined that it contained a useful narrative describing the GADNR carcass program and associated metadata, and the data provided by this program was useful age at length information. However, the workgroup feels this document is better served as a reference document and not a working paper.

S18-DW 07

The report S18-DW 07 described a variety of life history approaches for calculating natural mortality, both fixed and age-varying. This report, as amended and updated, was then used as the basis for Section 2.4 for Life History of the S18 DW Report. For these reasons, it was considered useful.

S18-DW08

This document provided in-depth detail into commercial data sources for Florida age and length samples as well as methods for calculating catch at age information. Florida age and length data for use in life history calculations were provided separately from this document and included commercial, recreational, and fishery-independent samples. Since, data from this document were provided subsequently to the life history workgroup, there was no need to pull data directly from S18-DW08.

S18-DW13

This analysis presents data from biological sampling of recreational fishing tournaments, and a carcass recovery program designed to supplement fishery independent collections, of recreationally important finfish. The utility of this type of program is the use of the angling public to provide fishery directed samples of fish species in the same habitats and environments where fishery independent sampling occurs. However, the carcass recovery programs, along with sampling at fishing tournaments are of limited utility for species such as red drum due to the size and bag limit restrictions which generally only give good information on fish that were harvested, not the general population. The best utility of this data set, for the red drum stock assessment, would be to use it as a check on the size frequency distributions of other fishery dependent sampling programs such as the

South Carolina creel census survey and the Marine Recreational Fishery Statistics Survey.

S18-DW16
This paper reviewed red drum removals and other harvest from estuarine gill net fisheries (commercial and recreational) in North Carolina. Both fisheries used the same gear types for large and small mesh gill nets, the main difference being the size of the net allowed for recreational users, which was significantly smaller than commercially used nets. These data represent the only commercial discard data presently available for both numbers and weights of red drum harvested, released alive, and direct net mortalities. The range of mortality rates (approximately 22% to 54%) represent a much higher reported rate than that for hook and line fisheries. The data presented for in this paper will be useful in the assessment for determining the level of discard mortalities in other fisheries or states (Virginia) where gill nets are used to harvest red drum.

2.3 Stock Definition and Description

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 (Lux & Mahoney 1969, in Mercer, 1984). The current distribution of red drum in the Atlantic Ocean, as indicated by commercial and recreational landings, extends from southern Florida to Chesapeake Bay (SAFMC 1990; Ross et al. 1995). Recent stock assessments (Vaughan 1993, 1996; Vaughan and Carmichael 2000) have divided this distribution into a northern region (Virginia and North Carolina) and a southern region (South Carolina, Georgia, and the eastern coast of Florida).

Seyoum *et al*.'s (2000) initial mitochondrial genetic work on red drum indicated a weak subdivision of red drum into GoM and Atlantic components with a genetic transition occurring around the southern Florida peninsula between Sarasota Bay and Mosquito Lagoon, supporting the separate management of these populations. Although little work has been conducted on the genetic structure of red drum along the southeast Atlantic coast, large-scale analyses have been conducted on red drum in the GoM (Gold et al. 2001, Gold & Turner 2002). Based on mitochondrial and microsatellite data, estuaries within the GoM showed temporal, but not spatial, stability in allele frequencies. Further analyses of spatial patterns indicated that the variability was not able to be partitioned into discrete geographic subpopulations, instead showing a pattern of isolation by distance. The proposed model of population structure fits well with gene flow predicted by life-history and due to their estuarine-dependent recruitment, a stepping stone model where gene flow primarily occurred among adjacent estuaries was described with geographic neighborhoods limited to 700-900 km. Additionally, the degree of genetic divergence detected was similar between the two markers, indicating the occurrence of sex-biased gene flow, due to female mediated dispersal and/or male philopatry.

Recommendation: Since gene flow could not be definitively defined geographically, a wider geographic context than the current state-based management would likely be appropriate.

Only two papers have addressed red drum population structure within the Atlantic (mitochondrial sequence data, Seyoum *et al*. 2000; microsatellite data, Chapman et al. 2002), both indicating little to no level of spatial structuring among estuaries. However, the Atlantic spatial scale of both projects were limited and likely confounded by low sample sizes. Additionally, an estuarine-collapsed analysis indicated temporal heterogeneity in the SC evaluation and was interpreted as a potential temporal instability of the reproductive pool (Chapman et al. 2002). SC DNR is currently in the process of re-evaluating the population structure based on subadults from Wassaw Sound, GA to Murrell's Inlet, SC with substantially higher samples sizes. Even if the lack of spatial structuring is verified with these analyses, these data would not preclude the possibility of coast-wide structure as the maximum distance among collection localities is 250 km which is substantially smaller than the geographic neighborhood limit found in GoM red drum. Therefore, the data currently available for Atlantic red drum is insufficient in respect to spatial distribution to determine the genetic population structure.

Recommendation: Therefore, based on life history differences noted during the 2000 Red Drum Assessment, the LHG recommends continuing the application of the division of the Atlantic red drum population into two regions, Northern defined as North Carolina and north and Southern defined as South Carolina and south.

Chapman et al. (2002) estimated a variance effective population size (*Ne*) of Atlantic red drum utilizing the temporal method of Waples (1989) which was an order of magnitude lower than estimates of female *Ne* in the GoM (Turner et al. 1999). However, due to red drum overlapping generations, an estimate of *Ne* requires a modification based on age-specific life history information (Jorde & Ryman 1995). At that time, the only correction factor available for red drum was based on GoM fish (Turner et al. 1999); however the appropriateness of those data for Atlantic red drum is unlikely based on suspected age-structure differences resulting from differential commercial fishery impacts during the 1980s. Therefore, determination of age-specific survival and birth rates are needed to determine accurate estimates of *Ne* for Atlantic red drum.

The ASMFC-approved multi-state sampling program of adult Atlantic red drum from Florida to Virginia represents a unique opportunity to obtain critical comprehensive data. Specifically relevant to the genetic population structure evaluation is the concurrent aging of the fish which will allow for the determination if any detected genetic structure is the result of differential age composition of the reproductive stock, particularly in light of the proposed temporal genetic heterogeneity (Chapman *et al*. 2002) and suspected age structure differences from the GoM. The combined age-specific life history and genetic knowledge will allow for greater interpretive capabilities of the genetic data as well as provide the needed life history information necessary for an accurate estimate of effective population sizes for Atlantic red drum.

2.4 Natural Mortality

2.4.1 Life-History Based Approaches

In stock assessments, natural mortality (*M*) is one of the most difficult parameters to determine. Methods that relate life history traits with natural mortality were reviewed in Vetter (1987). Many new methods have been developed since then. A variety of methods have been explored during past SEDAR data workshops, and the results of some of these methods are summarized in this section. Often *M* is related to the parameters from the von Bertalanffy growth equation (k, L_∞), or as an inverse function of size at age, so consideration of growth of red drum is relevant to this section (*Section 2.7*).

Because the US south Atlantic population has been split into two regions/stocks for recent assessments (Vaughan 1996, Vaughan and Carmichael 2000), separate estimates are provided for these two regions/stocks. The two stocks/regions along the Atlantic coast are split at the North Carolina-South Carolina state border. Subsequently, two forms of the von Bertalanffy growth equation have been considered for red drum (both for the South Atlantic and Gulf of Mexico). These forms include the standard 3-parameter von Bertalanffy growth curve, and the "linear" 4-parameter von Bertalanffy growth curve (developed by Geaghan at LSU and referenced in Hoese et al. 1991). The latter form is referred to as "linear" because the expression for L_∞ is modeled as a linear equation ($L_\infty = b_0 + b_1$*Age). If b_1 is not significantly different from 0, that is the confidence interval includes 0, then this model reduces to the standard von Bertalanffy growth curve.

During the course of the SEDAR 18 Data Workshop, length at age data were re-analyzed using these growth models (*Section 2.7*). The fits to the "linear" form failed to converge within 1000 iterations. Based on the final iteration, the confidence intervals about parameter, b_1 included 0, and therefore, b_1 was not significantly different from 0. It was concluded that the preferred growth model should be based on the standard 3-parameter von Bertalanffy growth equation.

A preliminary version of this section was developed prior to the SEDAR 18 Data Workshop as *S18-DW07*.

2.4.1.1 Age-Constant M Approaches

In this section, we describe several methods for determining an age-constant *M* based on life history characteristics, notably maximum age (t_{max}), von Bertalanffy growth parameters (k, L_∞), and average water temperature (T^oC). Results from the following approaches are summarized in table 2.16.2.

Source	Equation
Alverson and Carney (1975)	$M = 3k/(exp(0.38*t_{max}*k)-1)$
Hoenig (1983; F ~ 0)	$M = exp(1.46 - 1.01*ln(t_{max}))$
Jensen (1996)	$M = 1.5*k$
Pauly (1980)	$M = exp(-0.0152+0.6543*ln(k)-0.279*ln(L_\infty,cm)+0.4634*ln(T^oC))$
"Rule of thumb" (Hewitt & Hoenig 2005)	$M = 3/t_{max}$

Average water temperature (T^oC) used here was 19^oC, from Williams et al. (1973; as referenced in Ross et al. 1995). Quinn and Deriso (1999) have converted Pauly's equation from base 10 to natural logarithms as presented above. The "rule of thumb" method has a long history in fisheries science, but it is difficult to pin down its source. I have referenced Hewitt and Hoenig (2005), who recently compare this approach to that of Hoenig (1983). Note that the Hoenig (1983) method provides an estimate of *Z*. It is only when fishing mortality can be assumed small ($F \sim 0$) that this becomes an estimate of *M*, otherwise it is an upper bound on *M*. It is believed that with sufficient age sampling over a long period of time, finding a red drum closely approximate true maximum age is obtained, and thus useful for determining *M*.

During the course of the SEDAR 18 Data Workshop, the Life History Working Group discussed the following topics with recommendations:

1) **What is maximum age of red drum in the US south Atlantic? Should we consider different values for the North and South regions?**
The group recommended that separate estimates of natural mortality be developed for the two regions based on differences in growth and maximum age observed. The oldest fish aged in the north region was 62 years, with numerous fish aged in their 50s. Meanwhile the oldest fish aged in the south region was 38 years.

2) **What is average water temperature for use in Pauly approach?**
We used the value from Williams et al. (1973) as provided in Ross et al. (1995) for this exercise. Because the Pauly method tends to give unreasonably high M, this method was not favored, so time was not spent to update temperature information.

3) **Which of the age-constant *M* approaches makes the most sense?**
Because some of these approaches will yield unrealistic estimates (either too large or too small), the Hoenig method was favored in consideration of previous SEDARs (e.g., S10, S15, and S17). We provide estimates of constant M of 0.067 for the north region and 0.11 for the south region, with suggested ranges of (0.04, 0.10) and (0.06, 0.15), respectively.

2.4.1.2 Age-Varying M Approaches

Several approaches have been developed to provide age-varying estimates of *M* (Peterson and Wroblewski 1984, Boudreau and Dickie 1989, Lorenzen 1996). All use an inverse relationship between size and natural mortality (*M*). To apply these methods, weight at age is calculated for the middle of the calendar year (July 1). Because biological year begins on September 1, or 2 months later, the fraction, 1/6, is subtracted from each age in the von Bertalanffy growth (length) equation to calculate corresponding length on July 1, and converted to weight using region-specific weight-length relationships for ages 1 and older.

The method of Peterson and Wroblewski (1984) recently was used to describe natural mortality for young-of-year Atlantic menhaden (Heimbuch et al. 2007), but requires dry weight as its independent variable, which is not readily available for red drum, and was not pursued further. The method of Boudreau and Dickie (1989) has been applied in several assessments, notably for red drum in Vaughan and Carmichael (2000). However, the method of Lorenzen (1996) has gained favor in recent years, especially in the SEDAR arena (e.g., S10, S15, and S17). When applying the method of Lorenzen (1996), estimates of age-varying *M* are scaled such that cumulative survival from age 1 through the maximum age is equal to 1.5%. This cumulative survival value comes from the fixed *M* method of Hoenig (1983) as described in Hewitt and Hoenig (2005). When scaled, the resulting M from Boudreau and Dickie (1989) and Lorenzen (1996) provide very similar results (*S18DW07*).

Unscaled and scaled estimates of *M* based on the approaches of Lorenzen (1996) were developed from von Bertalanffy growth parameters using the standard form of the 3-parameter von Bertalanffy growth equation applied to ages 1 through maximum age separately for each region (Figures 2.17.4 and 2.17.5). Additionally, a range in Hoenig-based estimates of *M* was used to rescale the Lorenzen estimates of M so as to provide a range of age-varying *M* for use by the SEDAR 18 Assessment Workshop.

The Hoenig-based estimate of *M* for the north region is 0.067, which produces a scaling to 1.5% survival from age 1 through age 62, and the *M* for the south region is 0.11, also producing a scaling to 1.5% survival from age 1 through age 38. Corresponding percentages can be developed to scale *M* ranging from *M* = 0.04 to 0.10 (or 8.4% and 0.2% survival, respectively) for the north region and *M* = 0.06 to 0.15 (or 10.2% and 0.3% survival, respectively) for the south region. Age-varying estimates of M are presented for subadult ages 1-5 (separately and averaged) and averaged over all adult (6+) ages, with range in parentheses (Table 2.16.3).

During the course of the SEDAR 18 Data Workshop, the Life History Working Group discussed these additional topics with recommendations:

4) **Does it make more sense to use age-varying estimates of *M*, recognizing higher natural mortality for the youngest ages?**
The group concurred that it is important to characterize declining natural mortality with older fish, especially distinguishing between natural mortality for the subadults (ages 1-5) and adults (ages 6+).

5) **To scale or not to scale: should the cumulative natural mortality over ages (1 through maximum age) be scaled to the equivalent mortality from a constant age approach (e.g., to Hoenig estimates as in recent SEDARs)?**
The group favored using the method of Lorenzen (1996; based on the equation described as ocean data only in Table 1), and scaled to fixed M estimates from Hoenig (1983) as used in other recent SEDARs (S10, S15, and S17).

6) **Should we average age-specific natural mortality over subadult ages (1-5) and adult ages (6+) as was done in Vaughan and Carmichael (2000)? How should we deal with age 0 (Sept – Dec of year hatched), or do we need to?**
The group suggested presenting both separate estimates for ages 1-5 and an averaged value for use by Assessment Workshop Panel, but to simply average ages 6+, since estimates are relatively constant for ages 6 and older. As for age 0 fish (Sept – Dec of first year of life), this question is moot since they are not landed, and hence not modeled.

7) **Can we recommend a range of natural mortality for use in the stock assessment sensitivity runs?**
In SEDAR 17, alternate scaling based on a range of estimates around Hoenig's was used. Hence, we have developed a range in M based on the Hoenig-based approach to re-scale the Lorenzen age-varying M to reflect different cumulative survival from age 1 through the maximum age for each stock/region.

2.5 Discard Mortality

Red drum are harvested primarily by recreational fishing gear (hook-and-line) in the southeastern United States. There is very limited information on the discard size frequencies and mortality of red drum in either commercial or recreational fisheries. There is some data available from the Marine Recreational Fisheries Statistics Survey (MRFSS) for most east coast states, but the reported percent standard error (PSE) on fish released alive (B2's) is high (> 20%) and the number of fish actually measured for lengths is low, making it difficult to extrapolate size frequency distributions. The lack of size data on discarded or released red drum has precluded estimates of discard mortality using size. In the previous stock assessment, Vaughan and Carmichael (2000) used a 10% mortality rate for sub-adult discards and assumed a 0% rate on adults due to the maximum size limit.
The data on discard length frequency that was available included Florida (MRFSS derived length frequencies) (SEDAR18-DW09) and South Carolina (Cooperative Angler Research Guide Surveys). In Florida, post release mortality had previously been estimated at 5% (Murphy 2005). Length distributions of B2 fish were determined from a volunteer angler log book program from 2002 to 2007 on Florida's Atlantic coast, and from a Gulf coast scientific hook-and-line survey from 2004 to 2007 designed to approximate angler catch and release behavior. The utility of this data set is limited by spatial and temporal gaps making it difficult to adapt to larger length data sets from previous years. The South Carolina Guide Survey data included lengths and number of all red drum released by anglers and were collected by professional fishing guides in 2007 and 2008. This study was specifically designed to collect length frequency data every month of the year in order to establish the size distribution of B2 fish. Carcass

recovery programs (which occur in both South Carolina and Georgia), shore based creel surveys, and sampling at fishing tournaments are of limited utility due to the size and bag limit restrictions which generally only give good information on fish that were harvested. The information gained in the Guide Survey data provides monthly size frequency distributions of both sub-adult and adult B2 fish in South Carolina. Previous assessments assumed a 0% discard mortality for adult red drum because these large fish were above legal size and limited data existed on them. It's been demonstrated the hooking mortality does occur on adult red drum (Vecchio & Wenner 2007), so a better estimate of adult discard mortality is needed.

The North Carolina discard data were collected through both a large and small mesh gill net fishery that had commercial and recreational components. Discards from the estuarine gill net fishery represented 22% to 54% of the total annual commercial harvest (all gears combined) between 2004 and 2006. In 2004 and 2005, dead discards from the gill net fishery represented between 46% and 51% of the total commercial removals (harvest + dead discards) by number. For this same period, recreational release mortality accounted for 39% of the total recreational removals (harvest + release mortality) by number. Discard mortality represented a large portion of the overall annual removals from the red drum population in both recreational and commercial fisheries. The current North Carolina red drum stock assessment (Takade and Paramore 2007) failed to account for between 14% and 18% of all annual removals from the population in 2004 and 2005.

The greatest factor likely to influence discard mortality is hooking mortality. Available mortality rates on discards that are attributable to hooking mortality can range from 2% to 15% depending on hook type and hook placement (Anguilar et al. 2002; Gearhart SD18-RD38; Vecchio & Wenner 2007). Overall hook utilization patterns in South Carolina have shown the majority of anglers use either J-hooks (47.5%), non-offset circle hooks (34.4%), and offset circle hooks (4.7%) (Vecchio & Wenner 2007). J-hooks have been shown to have much higher incidences of deep hooking in the gut which generally results in extensive damage and mortalities (Aguilar et al. 2002; Gearhart SD18-RD38; Vecchio & Wenner 2007). Higher gut hooking rates with J-hooks in North Carolina resulted in hooking mortality estimates approaching 15% (Aguilar et al. 2002). Overall hooking mortality of sub-adult fish in South Carolina was 2% for non-offset circle hooks while adult mortality was 1.9% for non-offset circle hooks and 3.3% for J-hooks. Using the total catch estimate for red drum in South Carolina from the MRFSS in 2005 (498,537 fish), the sub-adult mortality rates (since most of the fish caught throughout the year are sub-adults), and the assumption of 7% mortality for fish caught on J-hooks (which constitute 47.5% of the hooks used to fish for red drum: Vecchio 2006), 16,576 fish died after J-hook capture and release. Under an assumption of 2% mortality for non-offset circle hooks (34.4% of hooks used: Vecchio 2006), 3,429 fish captured by this hook type died after release. If 10% mortality is assumed for all other hook types (18.1% of hooks used: Vecchio 2006), then the estimate of post release mortality is 9,023 fish. These estimates indicate, that during 2005, approximately 29,000 red drum were killed as a result of catch-and-release fishing in South Carolina. If all South Carolina anglers used non-offset circle hooks when fishing for red drum, only 9,971 fish would have died during catch-and-release events translating into a 66% reduction in mortality.

2.6 Age

2.6.1. Age Information by State

Virginia:

The Old Dominion University Center for Quantitative Fisheries Ecology Laboratory (CQFE) processes and ages hard parts collected by the Virginia Biological Sampling Program (BSP). CQFE also assists in the processing of fish, from both the recreational and commercial sectors. Currently, the BSP collects otoliths from multiple species including red drum, *Sciaenops ocellatus*. The goal of otolith collection is to correspond to the frequency distribution in lengths from past seasons, according to 1-inch length bins. The age sampling is designed to achieve a CV of 0.2 (Quinn & Deriso 1999) at each length interval. Fish are then randomly selected from each length interval (bin) to process. The sampling design does not provide targets for cobia, sheepshead, red drum, or black drum, as very few specimens have been collected on an annual basis. CQFE produces an annual report for all samples processed.

North Carolina:

Red drum (*Sciaenops ocellatus*) otoliths were collected from commercial, recreational, and North Carolina Division of Marine Fisheries (NCDMF) catches. Otoliths were removed from fish caught throughout state estuarine and coastal waters. The majority of fish sampled were from Pamlico Sound, its tributaries, and the coastal waters of the Outer Banks from Oregon Inlet to Cape Lookout. Fork length (FL) and total length (TL) in millimeters (mm) were recorded for most fish. When possible, whole weight to the nearest 0.1 kilogram (kg) or pound (later converted to kilograms), and sex were obtained.

Otoliths (sagittae) were excised from all fish and stored dry. Dorso-ventral sections of the left sagitta were made through the core to the nucleus perpendicular to the anterior-posterior plane with a Hilquist thin-sectioning machine as described by Cowan et al. (1995). Sections were mounted on slides with ultra-violet curing glue. All sections were read from a high resolution monitor coupled to a video camera mounted on a microscope. Age determination for red drum was based on the presence of annuli but had to be adjusted because the first annulus is not formed until 19-21 months after the hatching date. Additionally, a September 1 birthdate was used because this is the midpoint of the peak spawning season. Ages were incremented one year on this date. The system was calibrated with an ocular micrometer before each reading session. Validation of this technique is presented in Ross and Stevens (1991). Otolith sections were read independently by two readers.

South Carolina:

Red drum otoliths were collected from fishery independent gear surveys from 1990 to 2007. Since red drum otoliths are large and dense, they must be sectioned in order to count the rings. Prior to sectioning, the core was marked on the proximal surface with a

soft lead pencil and the bone was embedded in epoxide resin7 in a silicon mold. A low speed, Isomet saw7 equipped with two 10.2-cm (4-in) diameter diamond-coated blades separated by a ~0.5-mm thick spacer made the section of the sagittae. The resulting sections were mounted on glass sides and viewed under appropriate magnification.

Georgia:

Red drum (*Sciaenops ocellatus*) otoliths were collected from recreational and Georgia Department Natural Resources catches. Otoliths were removed from fish caught throughout state estuarine and coastal waters. The majority of fish sampled were from Wassaw and Altamaha Sound, its tributaries. Total length (TL) in millimeters (mm) were recorded for most fish. When possible, whole weight to the nearest 0.1 kilogram (kg) and sex were obtained. The right or left otolith was randomly selected for analysis. The otolith was mounted with hot glue to a piece of laminate with its distal surface upwards. The laminate was secured into a chuck to a Buehler Isomet saw equipped with two Norton diamond wafering blades separated with a 0.4 mm spacer that was positioned to straddle the focus of the otolith. Otoliths were examined using a Leica MZ-8 dissecting microscope with transmitted light and dark-field polarization at between 1.6 and 2 times magnification. All samples were aged in chronological order by collection date, without knowledge of previously estimated ages or the specimen lengths. Two readers independently read the sectioned otoliths. Age determination for red drum was based on the presence of annuli but had to be adjusted because the first annulus is not formed until 19-21 months after the hatching date. Ages were incremented one year for year class grouping.

Florida:

The age and length data from Florida contained samples taken from a variety of sources, including commercial or recreational landings, scientific surveys and research studies, and tagging study mortalities. These are delineated in the dataset as: scientific, commercial, or recreational. All ages were determined from thin-sections of sagitta, using typical methodology developed for red drum beginning in the early 1980's. In general, these techniques have a high degree of agreement (>95%) among otolith section readers. To avoid the confusion due to different age-anniversary use, all fish are assigned to a yearclass using the year of their fall hatch date.

2.6.2. Aging Workshop

A Croaker and Red Drum Aging Workshop was held at the South Carolina Department of Natural Resources, Marine Resources Center in Charleston, South Carolina on October 8, 2008. Participants were presented an overview of red drum otolith processing and reading conducted by SC DNR staff at the facility in Charleston. Participants from each state briefly described their otolith processing methods. Minor differences in cutting and polishing were noted but it was determined all produce easily readable otoliths. The group discussed reliability of scale aging. Scales appear to be accurate through Age 4 and are not reliable thereafter; otoliths should be used for Age 4 fish and older. The issue of determining 'birth date' and proper assignment of correct year-class was discussed at length. For assessment modeling purposes, the decision was made to use January 1 as the

birth date of all drum, regardless of differences between hatch dates among regions. For life history analyses (e.g., natural mortality estimation), a standard biological birth date of September 1 will be used.

2.6.3. Regional Age Analysis

The Data Workshop Panel decided that North Carolina and Virginia should be combined to represent the Northern region and that South Carolina, Georgia, and Florida should be combined to represent the Southern region based on differences in age structures present in data from each state and similarities in management of red drum between states. Fractional ages were calculated using a September 1 birth date. Fractional ages for the northern region ranged from 0.65 to 62.1 while integer ages ranged from 0 to 62 years (n=8,671). Fractional ages for the southern region ranged from 0.33 to 38.2 while integer ages ranged from 0 to 38 (n=26,042).

2.7 Growth

Three variations of the von Bertalanffy growth model were run for each state and by region (i.e. northern, southern) using nonlinear least squares regression, specifically, SAS's NLIN procedure (Marquardt method). Starting parameter values used for all models were t0 = 0.0, K = 0.3, and $L\infty = 990$. A single, or regular, von Bertalanffy model, a 4 parameter model, and a double von Bertalanffy model were calculated using fractional age and total length in millimeters. All growth models were inversely weighted by integer age. Previous aging studies and assessments for red drum found that the 4 parameter and double von Bertalanffy growth models fit better than the standard von Bertalanffy (S18-RD46). However, in most cases, the 4 parameter and double von Bertalanffy models calculated using data by state and region provided for this SEDAR did not converge. The 4 parameter model did converge for North Carolina data but the extra parameter (b1) was not significantly different from zero suggesting that the regular von Bertalanffy model should be used. Unweighted models were also run by state and region to determine whether this would help the 4 parameter model converge. Again, in most cases, the 4 parameter model did not converge. In those cases where the 4 parameter model did converge, b1 was not significantly different than zero. Regular von Bertalanffy growth models were presented to the Workshop Panel and it was decided that growth models by region were sufficient. Growth model parameters for the northern region were Linf = 1186.7, K = 0.19, and t0 = -1.30 (Figure 1) and parameters for the southern region were Linf = 1041.5, K = 0.23, and t0 = -1.14 (Figure 2). Models by region were plotted together and showed similar growth patterns but visually different Linfs (Figure 3). This is most likely the result of smaller observed lengths and lower maximum ages from the southern region.

Recommendation: Use weighted regular von Bertalanffy growth models by northern and southern regions.

2.8 Reproduction

Much of the reproductive data is based on histological data as well as observations using hydroacoustic receivers. Most of the hydroacoustic data seems to be supported by the histological data (Lowerre-Barbieri 2008). Due to a limited amount of data from the Atlantic coastal region it was necessary to use both Gulf of Mexico and Atlantic coast data.

2.8.1 Spawning Seasonality

Spawning season on the Gulf and Atlantic coasts of Florida peaks between September and October (Murphy & Taylor, 1990). The northern Gulf of Mexico appears to have a spawning season between mid-August to September. Along the coast of North Carolina spawning peaked between August and September based on GSI (Ross et. al., 1995). Along the Georgia coast based on hydroacoustic data red drum appear to congregate and spawn between August and mid-October (Lowerre-Barbieri et al. 2008)

2.8.2 Sexual Maturity

Interpolated lengths of 50% maturity for male red drum were 529 mm for Florida's Gulf coast and 511 mm for the Atlantic coast of Florida and were mature between ages 1 and 3 (Murphy and Taylor 1990). Fifty percent of females were mature between 825 mm and 900 mm and all females were mature at age 6 in Florida (Murphy and Taylor 1990). In North Carolina, females were mature at 4 years while males were mature at 3 years (Ross et. al. 1995). Fifty percent of males were mature between 1 and 2 years of age while females were didn't mature until 3 years old (Ross et. al. 1995). The size of 50% maturity for females in SC was 792 mm TL and 713 mm TL for males. The age of 50% maturity for females was 4.3 years (52 months), while for males it was determined to be 3.5 years (43 months) (Wenner 2000). In South Carolina, all males were mature at 4 years and all females were mature at 5 years (Wenner 2000).

2.8.3 Sex ratio

The sex ratio in North Carolina was 1:1 (349 males:373 females) (Ross et. al.. 1995). In the northern Gulf of Mexico, the sex ratio for spawning adults was also 1:1 (Wilson and Nieland 1994)

2.8.4 Spawning Frequencies

Wilson and Nieland (1994) estimated spawning frequencies for Northern Gulf of Mexico red drum from between 2 and 4 days.

2.8.5 Spawning Location

Spawning most likely occurs in the nearshore areas adjacent to channels and passes and may also occur over nearshore continental shelves (Lowerre-Barbieri et. al. 2008; Murphy and Taylor 1990). Spawning locations in South Carolina were also associated

with passes and channels (Wenner 2000).

2.8.6 Batch Fecundity

Batch fecundity estimates vs. fork length, gonad-free body weight, age in year, and BW were generated by Wilson and Nieland (1994) for red drum from the northern Gulf of Mexico from 1986 to 1992. The mean batch fecundity was 1.54 million ova. Fish ranged from 3-33 years of age, had a fork length range of 697-1005 mm, and a batch fecundity range of 0.16-3.27 (ova x 10^6).

2.9 Movements and Migrations

Tagging information provided the best insight into the movement and migration of red drum along the Atlantic coast. Each state, from Florida to Virginia, has participated in some form of tagging program. Volunteer angler programs are or have been active in each state in which trained volunteers participate by tagging fish and reporting tagged fish when recaptured. Other programs include agency staff tagging and cooperative projects with local commercial harvesters. Almost every program relies heavily on angler returns for recapture information.

Despite differences in state-to-state programs, there is evidence of adult drum movement between Virginia and North Carolina. Data suggest red drum movement into Virginia waters from North Carolina in late May. The fish appear to stay in the area during August through September when they ultimately move during fall months to North Carolina waters where the fish appear to overwinter.

Programs in the southern states (Florida, Georgia, and South Carolina) provided evidence of limited movement as well. For example, of 1,780 fish tagged in Georgia, 85.3 % were recaptured within state waters (11.0 % were recaptured in South Carolina, and 3.7 % were recaptured in Florida). In South Carolina, fish tagged in the SC Department of Natural Resources sub-adult tagging program were primarily recaptured within 30 miles (96.4 %) (S18-DW02).

An interesting pattern of movement, or lack of movement, was observed from fish over-wintering in the area of power plants. The most productive of these areas was the Elizabeth River Hot Ditch area, in Virginia. Rather than migrating out of the Chesapeake Bay during fall to North Carolina waters (considered the usual pattern for sub-adult red drum), fish in this area were observed over-wintering in bay tributaries in the area of power plants. The cycling of river water through the plants resulted in discharges of warmed water sufficient to maintain adjacent areas at temperatures generally suitable for the fish (as well as forage the fish could use-crabs, finger mullet, mummichogs, etc.). Similar patterns were also observed, to a lesser degree, at another nearby power plant (S18-DW02).

2.10 Meristics and Conversion Factors

Equations to make length-length and weight-length conversions were determined using the simple linear regression model and the power function, respectively (Table 2.16.1). All weights are shown in grams and all lengths in millimeters. No standard lengths were provided for the northern regions, so conversions between total or fork length and standard length for the southern region were used for the northern region. Coefficients of determination (r^2) ranged from 0.91 to 0.99 for these linear (length) and nonlinear (weight) regressions.

Recommendation: Use the conversion equations based on northern and southern regions.

2.11 Habitat

The following is quoted from the SAFMC "HABITAT PLAN FOR THE SOUTH ATLANTIC REGION: ESSENTIAL FISH HABITAT REQUIREMENTS FOR FISHERY MANAGEMENT PLANS OF THE SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL," (SAFMC 1998).

> **Essential Fish Habitat and Environmental Requirements**
> For red drum, essential fish habitat includes all the following habitats to a depth of 50 meters offshore: tidal freshwater; estuarine emergent vegetated wetlands (flooded saltmarshes, brackish marsh, and tidal creeks); estuarine scrub/shrub (mangrove fringe); submerged rooted vascular plants (sea grasses); oyster reefs and shell banks; unconsolidated bottom (soft sediments); ocean high salinity surf zones; and artificial reefs. The area covered includes Virginia through the Florida Keys.
> Red drum are distributed along the Atlantic coast, in the ocean and estuarine areas in relation to their stage of maturity. Juvenile red drum utilize the shallow backwaters of estuaries as nursery areas and remain there until they move to deeper water portions of the estuary associated with river mouths, oyster bars and front beaches. Estuarine wetlands are especially important to larval red drum. The types of estuarine systems vary along the Atlantic and subsequently, the preferred juvenile habitat also varies with distribution. Young red drum are found in quiet, shallow, protected waters with grassy or slightly muddy bottoms. Shallow bay bottoms or oyster reef substrates are preferred by subadult and adult red drum. Red drum utilize the oceanic system which is the area of the Atlantic ocean from the beachfront seaward. Large red drum are thought to migrate along the Atlantic coast and are subjected to man's alterations of the natural system. Nearshore and offshore bar and bank areas such as Gaskins and Joiner Banks in South Carolina have been identified as areas where concentrations of red drum could be located. Nearshore artificial reefs along the Atlantic are also known to attract red drum as they make their spring and fall migrations. In the fall and spring red drum concentrate around inlets, shoals, capes, and from the surfzone to several miles offshore, moving among these areas.

Description, Distribution and Use of Essential Fish Habitat
The distribution of red drum between estuarine habitat and oceanic waters is dependant mainly on stage of development and temporal and environmental factors. Red drum are euryhaline. Adult and subadult red drum are most often found in diluted/concentrated seawater of 20 to 40 ppt and rarely above 50 ppt, while juveniles range into the freshest parts of estuaries. Eggs and newly hatched larvae require salinities above 25 ppt. Spawning occurs in or near passes of inlets (e.g. "Grillage" at the mouth of Charleston Harbor) with larvae being transported into the upper estuarine areas of low salinity. As larvae develop into juveniles and sub-adults, they utilize progressively higher salinity estuarine and beachfront surf zones. Red drum move out of estuarine areas as adults and occupy the high salinity surf zone nearshore and offshore coastal waters. In North Carolina and Virginia, large adults move into estuaries during summer months.
Red drum are eurythermal, occuring over a temperature range of 2°-33°C, although they usually move into deeper water at extremes. Larger juveniles and adults are more susceptible to the effects of winter cold waves than small fish. High red drum mortality during freezes occurs and has the ability to decimate large portions of juvenile year classes. Thermal optimum is dependent on salinity, a characteristic of euryhaline fish.

2.12 Adequacy of Data for Assessment Analyses

Adequacy of the data presented in this report has been discussed in each individual section. Please refer to each section for information on the adequacy of data for assessment analysis.

2.13 Life History Research Recommendations

The ASMFC-approved multi-state sampling program of adult Atlantic red drum from Florida to Virginia represents a unique opportunity to obtain critical comprehensive data. Specifically relevant to the genetic population structure evaluation is the concurrent aging of the fish which will allow for the determination if any detected genetic structure is the result of differential age composition of the reproductive stock, particularly in light of the proposed temporal genetic heterogeneity (Chapman et al. 2002) and suspected age structure differences from the GoM. The combined age-specific life history and genetic knowledge will allow for greater interpretive capabilities of the genetic data as well as provide the needed life history information necessary for an accurate estimate of effective population sizes for Atlantic red drum.

Updated maturity schedules and fecundity information for adult Atlantic red drum from Florida to Virginia is lacking. Just as there are suspected age structure differences between the Atlantic and GoM stocks, maturity schedules and fecundity estimates are also suspected to be different in the Atlantic stock.

Further study is needed to determine discard mortality estimates for the Atlantic coast, both for recreational and commercial gears. Additionally, discard estimates should

examine the impact of slot-size limit management and explore regulatory discard impacts due to high-grading.

Dedicated northern and southern region larval and juvenile recruitment indices, as well as a Virginia adult recruitment index are recommended to provide more informative trends for future assessment processes.

Continued cooperation between state ageing labs, such as the October 2008 red drum ageing workshop, to provide consistent age verification between labs. Additionally, otolith microchemistry should be approached to look at state differences between regions for stock differentiation.

Identification of juvenile and adult habitat requirements and loss rates would provide more informative information for future management planning

2.14 Tasks for Completion following Data Workshop

All tasks given during the data workshop were completed prior to finalizing this report.

2.15 Literature Cited

Aguilar, R., P. S. Rand, and G. H. Beckwith. 2002. Quantifying the catch-and-release mortality rate of adult red drum in the Neuse River estuary. North Carolina Fisheries Resource Grant Program, 01-FEG-07. Raleigh, North Carolina.

Alverson, D.L., and M.J. Carney. 1975. A graphic review of the growth and decay of population cohorts. J. Cons. Int. Explor. Mer 36:133-143.

Boudreau, P.R., and L.M. Dickie. 1989. Biological model of fisheries production based on physiological and ecological scalings of body size. Can. J. Fish. Aquat. Sci. 46:614-623.

Chapman, R. W., A. O. Ball and L. R. Mash. 2002. Spatial homogeneity and temporal heterogeneity of red drum (*Sciaenops ocellatus*) microsatellites: Effective population sizes and management implications. Marine Biotechnology 4:589-603.

Gearhart , J. 2002. Hooking mortality of spotted seatrout (Cynoscion nebulosus), weakfish (Cynoscion regalis), red drum (Sciaenops ocellatus), and southern flounder (Paralichthys lethostigma) in North Carolina. North Carolina Division of Marine Fisheries, Morehead City, NC. Completion Rept. For Cooperative Grant NA 87FG0367 /2.

Gold, J. R., C. P. Burridge and T. F. Turner. 2001. A modified stepping-stone model of population structure in red drum, *Sciaenops ocellatus* (Sciaenidae), from the northern Gulf of Mexico. Genetica 111: 305-317.

Gold, J. R. and T. F. Turner. 2002. Population structure of red drum (*Sciaenops ocellatus*) in the northern Gulf of Mexico, as inferred from variation in nuclear-encoded microsatellites. Marine Biology 140: 249-265.

Heimbuch, D.G., E. Lorda, D. Vaughan, L.W. Barnthouse, J. Uphoff, W. Van Winkle, A. Kahnle, B. Young, J. Young, and L. Kline. 2007. Assessing coastwide effects of

power plant entrainment and impingement on fish populations: Atlantic menhaden example. No. Amer. J. Fish. Manage. 27:569-577.

Hewitt, D.A., and J.M. Hoenig. 2005. Comparison of two approaches for estimating natural mortality based on longevity. Fish. Bull. 103:433-437.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82:898-903.

Hoese, H.D., D.W. Beckman, R.H. Blanchet, D. Drullinger and D.L. Nieland. 1991. A biological and fisheries profile of Louisiana red drum *Sciaenops ocellatus*. Fishery Management Plan Series Number 4, Part 1. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, 93 p.

Jensen, A.L. 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Can. J. Fish. Aquat. Sci. 53:820-822.

Jorde, P. E. and N. Ryman. 1995. Temporal allele frequency change and estimation of effective population size in populations with overlapping generations. Genetics 139:1077-1090.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: A comparison of natural ecosystems and aquaculture. J. Fish. Biol. 49:627-647.

Lowerre-Barbieri, S.K., L.R. Barbieri, J.R. Flanders, A.G. Woodward, C.F. Cotton, and M.K. Knowlton. 2008. Use of passive acoustics to determine red drum spawning in Georgia waters. Trans. Am. Fish. Soc. 137:562-575.

Lux, F.E. & J.V. Mahoney. 1969. First records of the channel bass, *Sciaenops ocellatus*, in the Gulf of Maine. Copeia 1969: 632–633.

Mercer, L.P. 1984. A biological and fisheries profile of red drum, *Sciaenops ocellatus*. North Carolina Division of Marine Fisheries, Special Scientific Report 41, Morehead City. 89 pp.

Murphy, M. D. 2005. A stock assessment of red drum, *Sciaenops ocellatus* in Florida: status of the stocks through 2003. Report to the Florida Fish and Wildlife Conservation Commission from the Fish and Wildlife Research Institute, St. Petersburg. FWRI In-House Report 2005-006.

Murphy, M.D. and R.G. Taylor. 1990. Reproduction, growth, and mortality of red drum *Sciaenops ocellatus* in Florida waters. Fishery Bulletin. 88:531-542.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer 39:175-192.

Peterson, I., and J.S. Wroblewski. 1984. Mortality rate of fishes in the pelagic ecosystem. Can. J. Fish. Aquat. Sci. 41:1117-1120.

Quinn, T.J. II, and R.B. Deriso. 1999. Quantitative Fish Dynamics, Oxford University Press, New York, New York. 542 p.

Ross, J. L., T. M. Stevens, and D. S. Vaughan. 1995. Age, growth, mortality, and reproductive biology of red drum in North Carolina waters. Transactions of the American Fisheries Society 124:37–54.

SAFMC.1998a. Final Habitat Plan for the South Atlantic region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. South Atlantic Fishery Management Council, 1 Southpark Circle, Suite 306, Charleston, SC 29407-4699. 457 pp. plus appendices.

SAFMC (South Atlantic Fishery Management Council). 1990. The Atlantic coast red drum fishery management plan, including an environmental impact statement and regulatory impact review. South Atlantic Fishery Management Council, Charleston, South Carolina.

Seyoum, S., M. D. Tringali and T. M. Bert. 2000. An analysis of genetic population structure in red drum, Sciaenops ocellatus, based on mtDNA control region sequences. Fishery Bulletin 98: 127-138.

Takade, H. and L.M. Paramore. 2007. Draft stock status of the northern red drum stock. North Carolina Division of Marine Fisheries, Morehead City, NC. 47 pp. + appendices.

Turner, T. F., L. R. Richardson and J. R. Gold. 1999. Temporal genetic variation of mitochondrial DNA and the female effective population size of red drum (*Sciaenops ocellatus*) in the northern Gulf of Mexico. Molecular Ecology 8:1223-1229.

Vaughan, D. S. 1993. Status of the red drum stock of the Atlantic coast: stock assessment report for 1992. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFC-313.

Vaughan, D. S. 1996. Status of the red drum stock of the Atlantic coast: stock assessment report for 1995. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFC-380.

Vaughan, D. S., and J. T. Carmichael. 2000. Analysis of Atlantic red drum: northern and southern regions. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFC-447.

Vecchio, J. 2006. Catch and release in South Carolina's red drum recreational fishery. Master's thesis. College of Charleston, Charleston, South Carolina.

Vecchio, J.L. and C.A. Wenner, 2007. Catch-and-release mortality in sub-adult and adult Red Drum captured with popular fishing hook types. N. A. J. Fish. Manage. 27:891–899.

Vetter, E.F. 1987. Estimation of natural mortality in fish stocks: A review. Fish. Bull. 86:25-43.

Waples, R. S. 1989. A generalized approach for estimating effective population size from temporal changes in allele frequencies. Genetics 121:379-391.

Wenner, C.A. Contributions to the biology of red drum *Sciaenops ocellatus*, in South Carolina. Marine Resources Research Institutte South Carolina Department of Natural Resources Fort Johnson Road , Charleston, South Carolina. MARFIN:NA47FM0143

Williams, A.B., G.S. Posner, W.J. Woods, and E.E. Deubler. 1973. A hydrographic atlas of larger North Carolina sounds. University of North Carolina, Institute of Marine Science, Report UNC-SG-73-02, Morehead City.

Wilson, C.A. and D.L. Nieland. 1994. Reproductive biology of red drum, *Sciaenops ocellatus*, from the neritic waters of the northern Gulf of Mexico. Fishery Bulletin. 92:841-850.

2.16 Tables

Table 2.16.1. Conversion table for SEDAR 18 red drum age data.

Red Drum Conversions										
Length-Length										
Data Source	Dep. Variable	Ind. Variable	a	b	r^2	n	a SE	b SE	Ind Range	Units
Northern Region	TL	FL	1.085	-22.9	0.99	6887	0.0005	0.283	152-1300	mm
	FL	TL	0.919	22.1	0.99	6887	0.0006	0.319	149-1255	mm
	TL	SL	1.174	18.909	0.99	1684	0.0022	0.966	221-1243	mm
	FL	SL	1.048	49.347	0.91	1686	0.0081	3.517	215-1167	mm
Southern Region	TL	FL	1.057	-4.472	0.95	3227	0.0043	2.452	221-1243	mm
	FL	TL	0.899	31.636	0.95	3227	0.0036	2.192	215-1167	mm
	TL	SL	1.174	18.909	0.99	1684	0.0022	0.966	221-1243	mm
	FL	SL	1.048	49.347	0.91	1686	0.0081	3.517	215-1167	mm
Weight-Length										
Data Source	Dep. Variable	Ind. Variable	a	b	r^2	n	Len SE	Wt SE	Length Range	Units
Northern Region	Whole Wt	TL	0.00002	2.92	0.98	6316	1.03	1.01	152-1300	mm, g
Southern Region	Whole Wt	TL	0.00010	2.94	0.99	3549	1.04	1.01	221-1243	mm, g

Table 2.16.2. US South 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 2.16.3. US South 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)

2.17 Figures

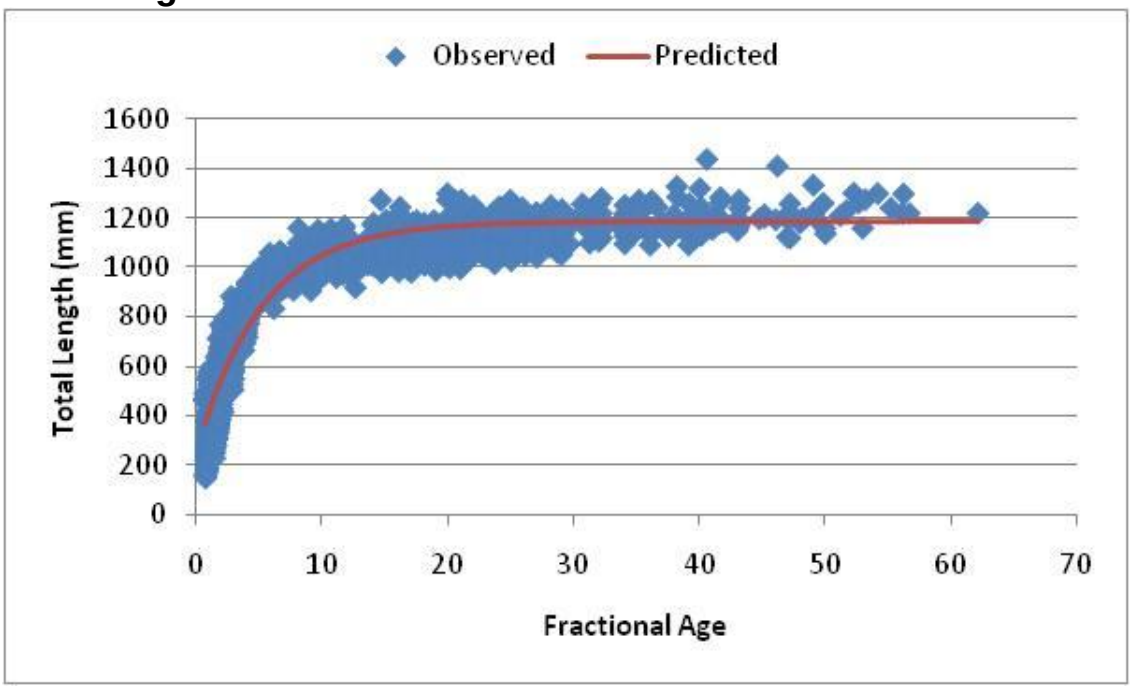


Figure 2.17.1. Observed and predicted total lengths from the regular von Bertalanffy growth model for the northern region (NC/VA).

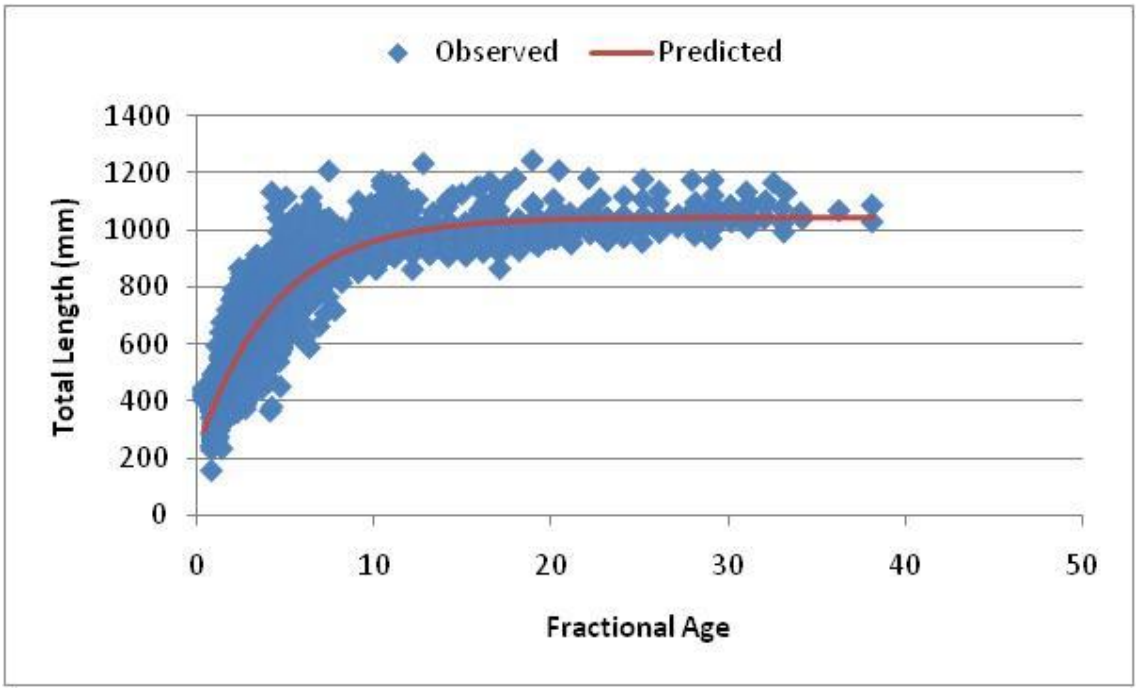


Figure 2.17.2. Observed and predicted total lengths from the regular von Bertalanffy growth model for the southern region (SC/GA/FL).

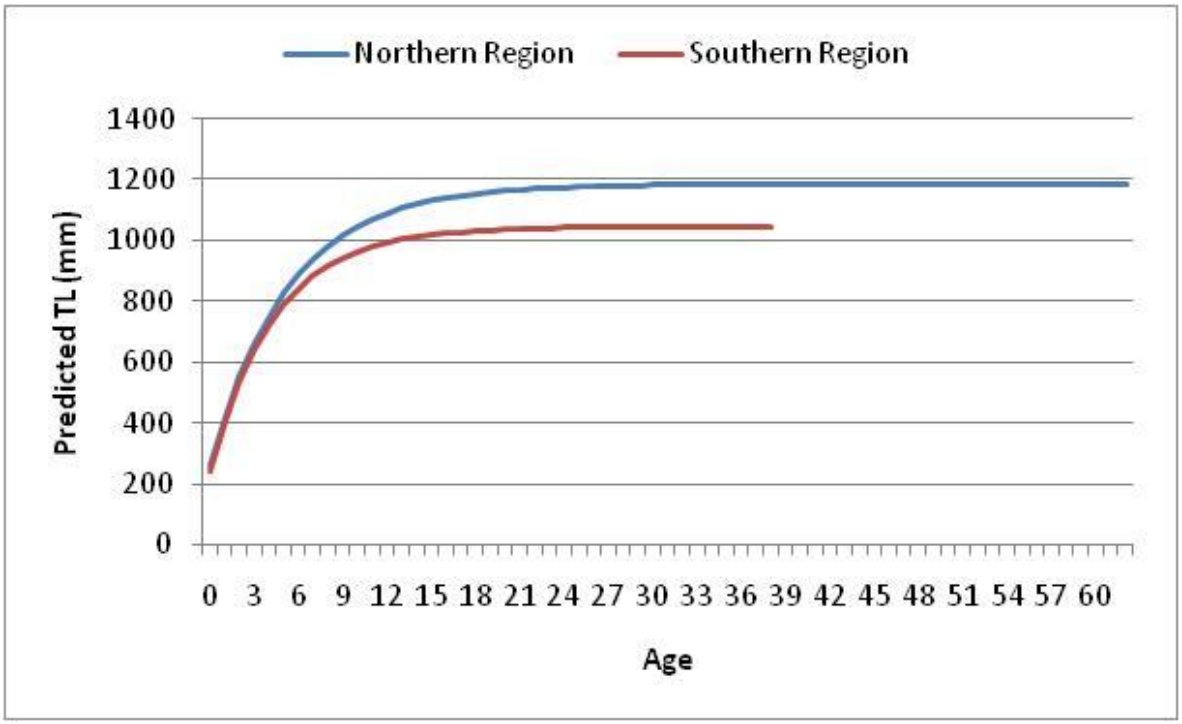


Figure 2.17.3. Comparison of predicted total lengths from von Bertalanffy models by region.

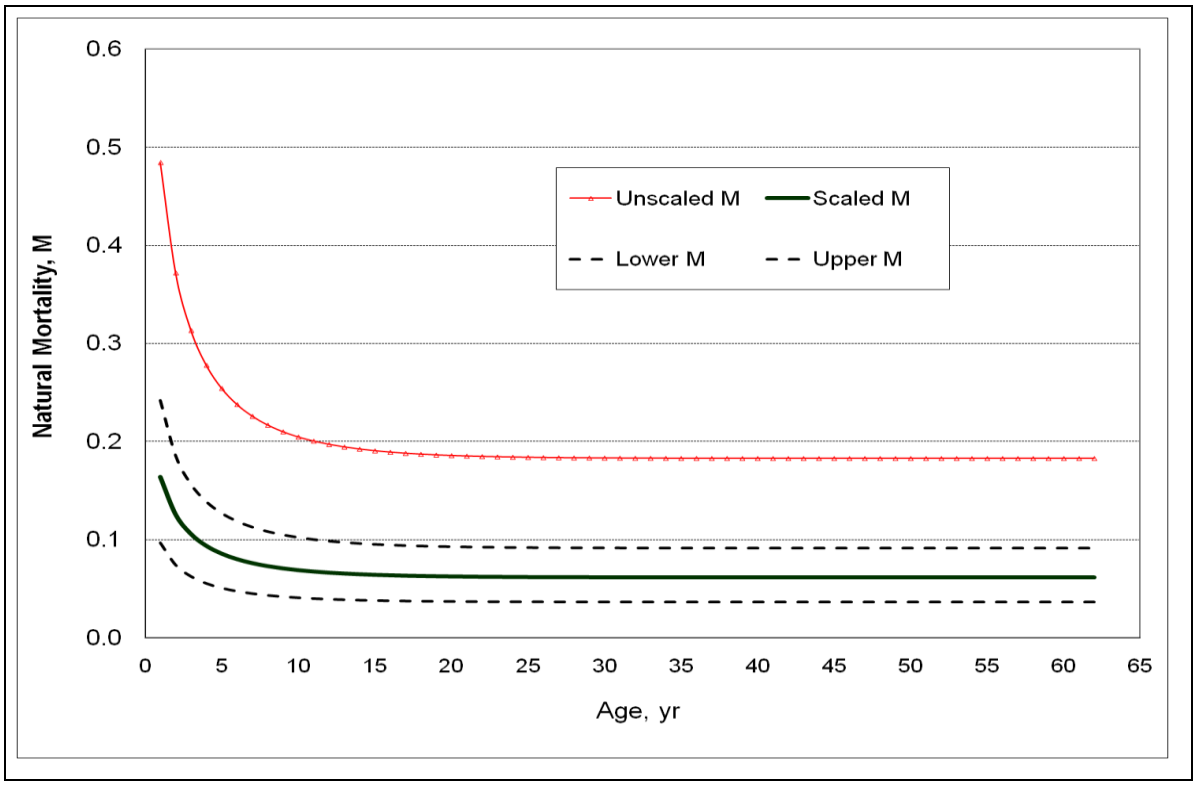


Figure 2.17.4 Comparison of unscaled and scaled estimates of age-varying *M* from the methods of Lorenzen (1996) based on growth predicted by the von Bertalanffy growth equation as applied to age and length data from the North Region. Scaled estimates assume a cumulative survival through maximum age equivalent to a constant Hoenig *M* (0.067). Also includes lower and upper range when scaled to range in Hoenig *M* (0.04, 0.10).

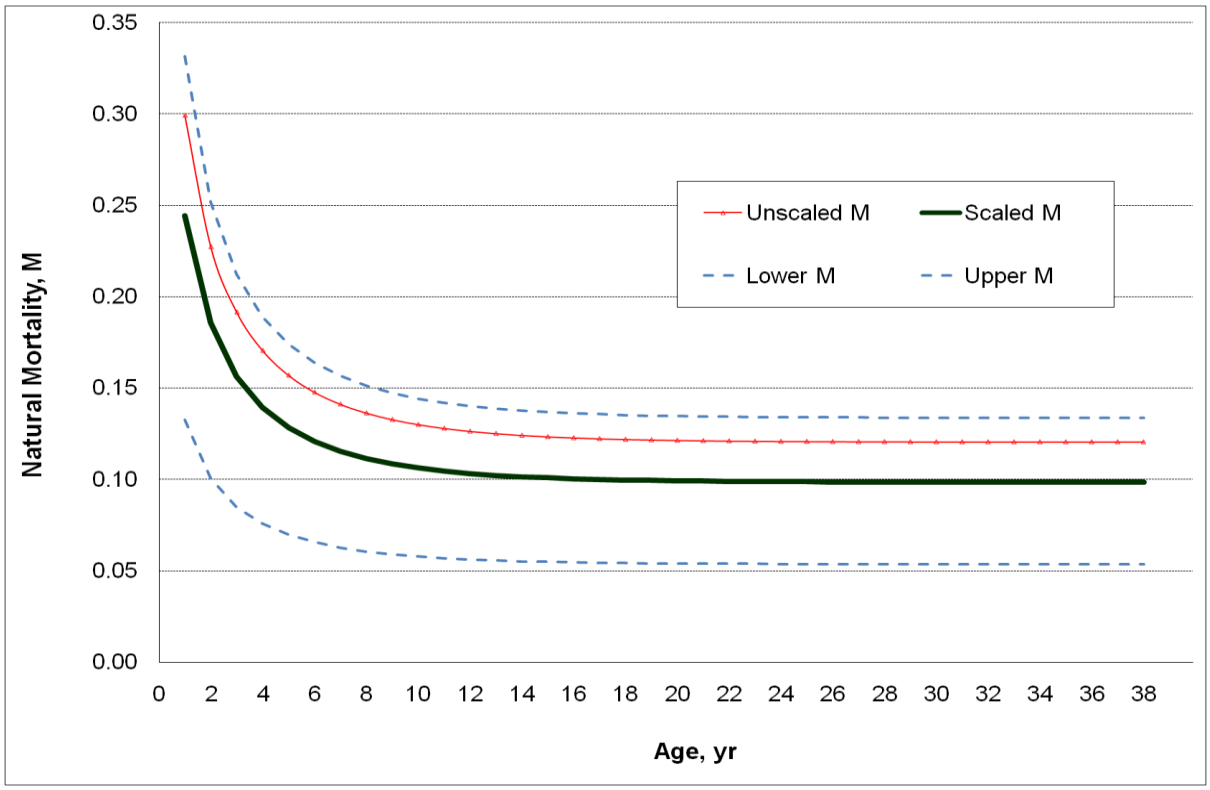


Figure 2.17.5 Comparison of unscaled and scaled estimates of age-varying *M* from the methods of Lorenzen (1996) based on growth predicted by the von Bertalanffy growth equation as applied to age and length data from the South Region. Scaled estimates assume a cumulative survival through maximum age equivalent to a constant Hoenig *M* (0.11). Also includes lower and upper range when scaled to range in Hoenig *M* (0.06, 0.15).

3. Commercial Fisheries

3.1 Overview

Commercial landings of red drum are available from all states located on the east coast of the United States from Florida to Massachusetts. Historical commercial landings data for red drum were explored to address several issues. These issues included: (1) geographic stock boundaries, (2) historical perspective of landings data (duration of data for stock assessment), (3) grouping of commercial gears for pooling landings, (4) final presentation of landings by gear in pounds (whole weight) and in numbers based on state and federal data, (5) estimates of discards in numbers from commercial gill net fishery where available, (6) length and age compositions sampled from commercial fisheries, and (7) research needs.

3.1.1 Group Membership

Lee Paramore (Leader) .....NCDMF
Stephanie McInerny.....NCDMF
Julie Defilippi.....ACCSP
Doug Vaughan .....SEFSC
Joe Grist .....VMRC
Karl Brenkert .....SCDNR

3.2 Review of Working Papers

S18-DW08

Title: Reported commercial landings of red drum in Florida and estimated annual length and age composition.

Author: Murphy, M.D.

Abstract (written by group):

Commercial landings were obtained from the National Marine Fisheries Service and the Florida Fish and Wildlife Conservation Commission from 1950 to 1988. Annual commercial harvest of red drum in Florida was sporadically available between 1889 and the late 1920s and during the 1940s but only consistently since 1950. No commercial landings have been reported for Florida since 1988 when the sale of native-caught red drum was prohibited. From 1950 to 1988, the dominant commercial fishing gear used to capture red drum had consistently been gill nets. Biostatistics data were opportunistically collected during a red drum life history study conducted during the period 1981-1983 and during supplemental sampling of commercial gears in 1987 and 1988 while conducting tagging operations. An age length key comprised of all commercially-caught, aged, and measured red drum during 1981-1988 was applied to annual length frequencies to estimate the age composition of the commercial landings each year. The number of red drum landed from each age group during 1981-1988 was estimated by applying age-

length keys to estimated length frequencies to generate year-specific landings age frequencies.

Discussion:

This document provided in-depth detail of commercial data sources for Florida age and length samples as well as methods for calculating catch at age information. The commercial workgroup found this document very useful and have decided to use the catch at age data for Florida provided in S18-DW08 as input into the assessment model.

S18-DW16

Title: An Estimate of Red Drum Removals from the North Carolina Estuarine Gill Net Fishery Occurring from both Recreational Users of Gill Nets and from Regulatory and Unmarketable Discards.

Author: Lee Paramore

Abstract (written by group)

This paper reviewed red drum removals (other than harvest) from estuarine gill net fisheries (commercial and recreational) in North Carolina and also provides an estimate for red drum harvested through the use of 'recreational' gill nets. Both the commercial and recreational fisheries used the same gear types for large and small mesh gill nets, the main difference being that the amount of net allowed for recreational users is significantly less than that of commercial nets. Survey estimates of recreational harvest of red drum were available for the period of 2002 to 2006. Recreational landings of red drum with gill nets ranged from 4,245 lbs in 2003 to 9,893 lbs in 2002. Total red drum removals (commercial and recreational) associated with unmarketable or regulatory discards were estimated for all gill nets combined for the period of 2004 to 2006. These data represent the only commercial discard data presently available and were estimated for both numbers and weight. Estimated discard mortalities in the estuarine gill net fishery were between 20,142 lbs in 2005 and 68,997 lbs in 2006. This represents approximately 22% to 54% of the total annual commercial harvest in pounds for North Carolina.

Discussion:

The Workshop Panel accepted estimates of discards from the North Carolina estuarine gill net fishery and recommended that extrapolation may be possible within the management period using a ratio with commercial estuarine gill net landings. The Workshop Panel also accepted discard estimates of recreational landings from gill nets for the period of 2002 to 2007 and recommended that extrapolation may be possible within the management period using a ratio with commercial estuarine gill net landings.

3.3 Commercial Landings and Catch Trends

Decision 1. Because red drum landings rarely occur south of Martin County, the Dade/Monroe County line was recommended as the southern boundary for red drum landings along the US Atlantic coast. This avoids landings from the Gulf coast being counted towards the Atlantic stock.

Decision 2. Data were available for all states back to 1950. The Commercial Workgroup recommended that estimates of commercial landings be extended back to 1950 for potential use in assessments. Historical landings back to 1887 are available for some states and can be use to provide a historical perspective (i.e. North Carolina and Florida).

Decision 3. The Commercial Workgroup recommended that landings by fishing gear be reduced to six categories: gill nets, haul seines, pound nets, beach seines, trawls, and hook and line. The small percentage (typically less than 1%) from miscellaneous other gears can be pooled with gill nets.

3.3.1 Atlantic Coastal Cooperative Statistics Program (ACCSP) Warehouse

Historical commercial landings (1950 to present) for the Atlantic coast are maintained in the Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse. The Data Warehouse was queried on 09 February 2009 for all red drum landings (monthly summaries by state and gear category) from 1950 to 2007 for Florida (east coast), Georgia, South Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Rhode Island, and Massachusetts (ACCSP 2009). The gear categories were decided upon by the working group based on knowledge of the fisheries and reporting tendencies. The specific ACCSP gears included in each category can be found in Table 3.1. Commercial landings of red drum from the North Carolina Trip Ticket Program (NCTTP) and those in the ACCSP data warehouse for North Carolina did not match when broken down by gear; therefore commercial landings data provided by the NCTTP were preferred. Florida landings of red drum in numbers and pounds were also provided by the Florida Fish and Wildlife Conservation Commission (FWC) for 1950 to 1988 (SEDAR18-DW08). These data from Florida were preferred to those from the ACCSP data warehouse. A description of how landings data have been collected by the state of Virginia is provided below:

Virginia – The National Marine Fisheries Service (NMFS) collected landings data for Virginia from 1929 through the present. From 1973 to 1992, Virginia implemented a voluntary monthly inshore dealer reporting system. However, it was discovered that better inshore harvest data were required so the Virginia Marine Resources Commission (VMRC) implemented a Mandatory Reporting Program (MRP) that began January 1, 1993. The program currently is a complete census of all commercial inshore and offshore harvest in a daily format. Data collected are species type, date of harvest, species (unit and amount), gear type, gear (amount and length), area fished, dealer, vessel (name and number), hours fished (man and gear), crew amount, and county landed.

In 2001, several fields listed above (gear length, man hours, vessel information: name and number, and crew amounts) were added to come in compliance with the Atlantic Coastal Cooperative Statistical Program (ACCSP) identified critical data elements. Also data collection gaps in the NMFS offshore collection program were identified and all offshore harvest that was not a federally permitted species or sold to a federally permitted dealer was added to the MRP. The MRP reports are collected on daily trip tickets annually distributed to all commercially licensed harvesters and aquaculture product owners. All harvesters and product owners must report everything harvested and retained on the daily tickets. The daily tickets are put in monthly folders and submitted to VMRC. The monthly folders are provided by the VMRC and due by the 5th of the following month.

Decision 4. Due to discrepancies in landings data by gear reported from the North Carolina Trip Ticket Program and data queried from the ACCSP warehouse, it was decided to use landings data provided directly from North Carolina. Florida also directly provided landings through working paper S18-DW08. ACCSP provided all other commercial landings data and no discrepancies were found.

3.3.2 Commercial Landings Developed from State Databases

North Carolina – The National Marine Fisheries Service, prior to 1978, collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers. The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest. Annual landings of red drum were calculated for the SEDAR 18 Data Workshop for North Carolina and reported in pounds (whole weight) broken down by month and gear categories developed by the Commercial Workgroup. The annual landings are reported on an annual basis of January through December. Data used to calculate the annual landings for North Carolina from 1950 to 2007 included landings from the NCTTP (1994 to 2007), landings from NMFS (1978 to 1993), and landings from historical data (prior to 1978). Prior to 1972, monthly landings were not recorded for North Carolina.

Florida – Commercial harvest information was obtained from the FWC's Marine Fisheries Information System data and from the Fisheries Statistics Division of the National Marine Fisheries Service (NMFS) for the years 1950 to 1988. Earlier records came from various publications of Fisheries Statistics of the United States. No commercial landings have been reported for Florida since 1988 when the sale of native-caught red drum was prohibited. These data include annual landings tallied from monthly dealer reports collected by the NMFS during the period 1950 to 1985 and trip-

specific commercial landings reported within the FWC trip ticket program during the period 1986 to 1988. Florida trip tickets examined included edited batches 1 – 981.

Prior to 1986, landings of red drum were reported to the NMFS through monthly dealer reports made by major fish wholesalers in Florida. Since 1986, information on what is landed and by who in Florida's commercial fisheries comes from the FWC's Marine Resources Information System, commonly known as the trip-ticket program. Wholesale dealers are required to use trip tickets to report their purchase of saltwater products from commercial fishers. Conversely, commercial fishers must have Saltwater Products Licenses to sell saltwater products to licensed wholesale dealers. In addition, red drum became a "restricted species" in late 1987 so only fishers who had Restricted Species Endorsements on their Saltwater Products License qualified to sell red drum (though commercial fishing effectively ended beginning in 1988). Each trip ticket includes the Saltwater Products License number, the wholesale dealer license number, the date of the sale, the gear used, trip duration (time away from the dock), area fished, depth fished, number of traps or number of sets where applicable, species landed, quantity landed, and price paid per pound. During the early years of the program some data field were deleted from the records, e.g. Saltwater Products License number for much of 1986, or were not collected, e.g., gear used was not a data field until about 1991. Annual commercial harvest of red drum in Florida was sporadically available between 1889 and the late 1920's and during the 1940's but consistently since 1950. There was a clear increase in landings between the historic period and the early 1980's; landings averaged 0.07 million pounds during 1927 to 1940 and 0.13 million pounds during 1975 to 1984 (Table 1, Fig. 1). During the mid-1980's the commercial fisheries faced tightening restrictions resulting in declining landings prior to being prohibited after 1987.

3.3.3 Coastwide Landings in Pounds

Commercial landings in pounds (whole weight) were summarized by state (Figure 3.1), region (Table 3.1 and Figure 3.2), and gear (Table 3.2 and Figure 3.3). The Northern region, responsible for 62% of the total red drum landings from 1950 to 2007, included coastal Atlantic US States from North Carolina to Massachusetts. The Southern region, responsible for only 38% of the total landings, included South Carolina, Georgia, and east coast Florida. Landings of red drum were predominantly from North Carolina; however, Florida reported a large portion of the landings from 1950 to 1988 before the sale of native-caught red drum in Florida was prohibited (Figure 3.1). The dominant gear harvesting red drum was gill nets, however, beach seines appeared to dominate the landings from 1950 to 1962 (Figure 3.3). The decline in beach seine landings and the increase in gill net landings over the years from 1950 to 2007 may suggest a shift in gear preference by fishermen harvesting red drum. Pound nets, seines, and trawls were also on the decline during this time period. Overall, red drum commercial landings averaged 249,000 pounds (whole weight) between 1950 and 2007.

3.3.4 Coastwide Landings in Numbers

Conversion of commercial landings in weight to numbers is based on mean weights obtained from dependent commercial sampling by North Carolina and Virginia for the northern region and Florida for the southern region. All sampled lengths were converted to weights using the weight-length relationship given by the Life History Workgroup. When length samples were inadequate (n<20) by gear and year, a weighted average was

obtained by pooling across gears within a year. Further pooling across years was necessary in some cases. In these situations, pooling was limited to periods of constant size regulations. For hook and line gears, mean weights and length frequency distributions from the MRFSS were used when sampling was inadequate for a given year. During the early 1980's, pooling was required across both gear and year to obtain an adequate sample size in both North Carolina and Virginia (Table 3.4 and Table 3.6). Since the late 1980's, sampling was adequate for the majority of the landings (i.e. gill nets from North Carolina). Mean weights from Florida for the period of 1981 to 1988 are provided in Table 3.8 with details of the analysis provided in working paper S18-DW08. Landings in numbers were reported for North Carolina (Table 3.5), Virginia and all states north (Table 3.7), and Florida (Table 3.9).

Decision 5. It was agreed by the Workshop Panel that landings, mean weights, and conversions of lengths to ages for the commercial catch would be done annually with one inch size bins due to the limited length data by gear for many years.

Decision 6. The Workshop Panel recommended that length bins contain a minimum of 20 lengths per bin to describe commercial gears for any given year. When adequate lengths are not available, lengths will be substituted from other sampled gears within the same year. Collapsing lengths across years within a management period will occur if no appropriate gear is available for substitution.

Decision 7. Because no biological sampling data is available for SC or GA, mean weights and length distributions will be needed to describe limited commercial landings from these states. Hook and line gear will be described by state specific MRFSS sampling. For the period of 1981 to 1985, it was recommended to use available length and mean weight data from Florida during a period when these states had similar size regulations. Remaining years (1986-1988) will be described with commercial length data from North Carolina.

3.4 Commercial Discards and Discard Trends

The only available data on commercial discards for red drum were provided in the working paper S18-DW16. This working paper provided details from an observer program conducted in North Carolina from 2001 to 2006. Observer coverage was deemed adequate for the years of 2004 to 2006 because these years had expanded coverage by season and area making statewide estimates possible. Discard estimates were calculated by area and season for both large and small mesh gill nets. CPUE was defined as the number (or weight) of dead red drum observed per trip. In addition, a 10% release mortality was added for all red drum released alive. Extrapolation by area and season was then made by multiplying the CPUE by the number trips made for both large and small mesh gill nets from the NC Trip Ticket Program. Estimated discard mortalities from estuarine gill nets ranged from 20,142 lbs in 2004 to 68,997 lbs in 2006. This represented between 22% and 54% of the commercial harvest (all gears combined) for these years (Table 3.10). By number, dead red drum discards represented between 86% and 103% of the annual commercial harvest (Table 3.11). Length frequency distributions, weighted by area and season where samples were adequate, were calculated

for 2004 to 2006 (Figure 3.4). The length distribution for dead discards was bimodal with the majority of the fish being sub-legal (<18 inches TL). The second, smaller mode was for legal size fish (~24 inches TL). These two modes represented primarily age-1 and age-2 red drum.

Decision 8. The Workshop Panel accepted estimates of discards from the North Carolina estuarine gill net fishery from 2004 to 2006 and recommended that extrapolation may be possible within the management period using a ratio with commercial estuarine gill net landings.

Decision 9. The Workshop Panel accepted discard estimates of recreational landings from gill nets for the period of 2002 to 2007 and recommended that extrapolation may be possible within the management period using a ratio with commercial estuarine gill net landings.

3.5 Commercial Effort

Trip level commercial data were available from North Carolina (1994 to 2007) and Virginia (1993 to 2007), however, catch effort data from the red drum commercial fishery were confounded by trip limits put into place in 1992 for Virginia and in 1998 for North Carolina (S18-DW03). Trip level information was also available in Florida but only for the years 1986 to 1988. After 1988, the sale of native caught red drum in Florida became prohibited.

3.6 Biological Sampling

3.6.1 Sampling Methods

Virginia - In 1989 a biological sampling program (BSP) was initiated, with the intention of establishing a long-term database with biological data (lengths, weights, sex and age composition) from the commercial finfish fishery in Virginia. Sampled species were chosen if there was a current or upcoming management plan, either for Virginia, the Chesapeake Bay or interstate or federal, or if the species was managed by regulation. Species were ranked, by commercial landings in Virginia, and the ranking was used as a second criterion for sampling. Red drum have been sampled (for length and weight) since the program's inception. Since 1998 VMRC has been in a cooperative agreement with Old Dominion University Center for Quantitative Fisheries Ecology Laboratory (CQFE). All ageing of finfish collected by the BSP are processed by CQFE.

Field sampling at fish processing houses or dealers involved multi-stage random sampling. Targets were set per species based on mandatory reporting of harvest data by harvesters from the previous years. A three year moving average of landings by gear and by month (or other temporal segment) provided a preliminary goal for the amount of length and weight samples to be collected. Real time landings were used to adjust the preliminary targets. Targets for aging samples were tracked and collection updates were done weekly. The goal of otolith collection was to correspond to the frequency distribution in lengths from past seasons, according to 1-inch length bins. Methods for processing and aging of otoliths are provided in the Life History Section.

Subsamples of a catch or batch were processed for sex information (gender and gonadal maturity or spawning condition index). Such subsamples were indexed by visual inspection of the gonads. Females were indexed as gonadal stage I-V with males as I-IV. Stage I represents an immature or resting stage of gonadal development and stages IV (males) and V (females) represent spent fish. Fish that cannot be accurately categorized, in terms of spawning condition, were not assigned a gonadal maturity stage.

Ancillary data, for fish sampled at dealers, were also collected and included: species grade or market category, harvest area, gear type used, and total catch by species market category. This information allowed for the expansion of sample size to the total harvest reported for a species. Market category and species grade are not typical for red drum.

North Carolina - Commercial length frequency data were obtained by the NCDMF commercial fisheries dependent sampling program. Red drum lengths were collected at local fish houses by gear, market grade (not typical for red drum), and area fished. Individual fish were measured (mm, FL) and total weight (0.1 kg) of all fish measured in aggregate was obtained. Subsequent to sampling a portion of the catch, the total weight of the catch by species and market grade was obtained for each trip, either by using the trip ticket weights or some other reliable estimate. Length frequencies obtained from a sample were then expanded to the total catch using the total weights from the trip ticket. All expanded catches were then combined to describe a given commercial gear for a specified time period. Major commercial gears for North Carolina are gill net, long haul seine, and pound net. Commercial samples were taken throughout the year and from all areas where red drum were landed. Dependent length frequency data for red drum in North Carolina began in the early 1980's. Data adequate to describe the major fisheries is available beginning in the late 1980's.

South Carolina – No biological sampling data were provided for South Carolina commercial landings. South Carolina had landings for the period of 1981 to 1987, primarily from gill nets, hook and line, and trawls. Annual landings (all gears combined) ranged from 808 lbs in 1981 to 14,689 lbs in 1987. After 1987, commercial sale of red drum in South Carolina was prohibited.

Georgia - No biological sampling data were provided for Georgia commercial landings. During the 1980's, landings were primarily from hook and line, gill nets, and trawls. Since 1989, landings were almost exclusively from hook and line. Overall, landings have been low ranging from 19 lbs in 2008 to 4,565 lbs in 1987.

Florida – Commercial length frequency data from Florida were obtained from the Florida FWC and are summarized in the working paper S18-DW08. In summary, biostatistics data were opportunistically collected during a red drum life history study conducted during the period 1981to 1983 (Murphy and Taylor 1990) and during supplemental sampling of commercial gears in 1987 and 1988 while conducting tagging operations (Table 3.8). Generally, individual fish lengths, gear type, and date were recorded at the very least, with more in depth sample processing for sex, weight, and aging parts for life history research and for mortalities observed during tagging operations.

3.6.2 Sampling Intensity Length/Age/Weight

Sampling intensity to describe the commercial harvest was evaluated based on the number of lengths collected by gear and year for each of the states providing commercial length data. A minimum threshold of 20 lengths was set by the Data Workshop Panel to describe a gear by year.

Virginia – Landings in Virginia were small relative to North Carolina and since 1981 have typically accountted for less than less than 5% of the coastwide total (Figure 3.1). As a result of the low landings, commercial sampling for lengths from Virginia was relatively poor throughout the time series of 1981 to 2007 (Table 3.13).

North Carolina - Since the late 1980's North Carolina has been the major commercial harvester of red drum typically accounting for >90% of the coast wide annual landings (Figure 3.1). Length sampling in North Carolina was relatively poor for most gears from 1981 through 1988. Since 1989, greater than 70% of the harvest has been represented by adequate length sampling ($n \geq 20$). For most years, particularly since 1992, this total exceeded 95% (Table 3.12).

Available age and weight data were combined from both North Carolina and Virginia for the development of annual age length keys and length-weight conversions (see Life History Section 2.10 for details). A single length-weight conversion was calculated for the entire period (n=6,316 individuals). Annual age-length keys using 1-inch length bins were developed for each year where data were available. This included every year from 1988 to 2007. Annual age length keys had sample sizes ranging from 175 to 687 fish per year. A pooled key (across all years) was used for years 1981 to 1988. The pooled key was also used to fill any wholes by size bin in the annual keys.

Florida – The adequacy of length, age, and weight data for Florida are described in working paper S18-DW08. In summary, Florida was a major contributor to commercial landings from 1981to 1987 (Figure 3.1). Length, age, and weight data were sampled for major commercial gears (gill net, hook and line, seine, and trammel net) from 1981to 1983. Additional trammel net lengths were obtained in 1987 and 1988. Mean weight by gear and year was obtained from either fish that were directly weighed for whole weight or from all red drum measured (and then converted to weight). Sampling for length data only exceeded the minimum threshold ($n \geq 20$) from 1981 to 1983 for gill nets and trammel nets and in 1982 for hook and line and seines. Where sampling was deemed inadequate for either lengths or mean weights, extrapolations and interpolations by gear and year were required. Annual age length keys for Florida were not generated due to low sample sizes. Age data (n=593 individuals) for Florida were pooled across gears and years for the period of 1981to 1988. Missing data (age 10 and age 12 fish) were filled with age-length data from angler catches.

South Carolina and Georgia – No biological sampling of red drum occurred for either South Carolina or Georgia. Biological length data from Florida will be used to describe commercial landings from 1981 to 1985 during a time when size limits were similar between the states. All hook and line landings for the entire time series will be described from state specific recreationally sampled fish in the MRFSS survey. Additional commercial landings after 1985 will be described using available length data from North Carolina. While data are limited from South Carolina and Georgia, the overall contribution of these states is low for the southern region (South Carolina and south)

where Florida accounted for >90% of the landings from 1981 to 1985. Annual age-length keys for the south region are described in the Life History (Section 2.0) and will be used to derive the age composition for commercially captured red drum in these two states.

3.6.3 Length/Age Distributions

Length distributions for the northern region were derived from commercial length data provided from North Carolina and Virginia. All length distributions were described annually in one inch length bins with the length bin provided representing the floor (i.e. 15 inches = 15.0 to 15.99). As previously described, a minimum of 20 lengths by year and gear were required to represent a gear. Collapsing occurred first across gears within a year and secondly across years within a uniform management period (i.e. constant size limit). An annual age length key representing the northern region (North Carolina and north) was developed using all available age data from North Carolina and Virginia (see Life History Section for details). Any 'holes' in the age-length key were filled using a pooled (across all years) key.

Length and age distributions for the northern region are presented by major gear in Table 3.14 and Table 3.15 respectively. For the length distributions, all gears showed a notable shift towards larger fish, particularly after 1991 when both North Carolina and Virginia implemented a minimum size limit change from 14 to 18 inches total length. Likewise, the harvest of larger red drum has declined as harvest and sale of federally harvested adult red drum became illegal after 1992 in North Carolina. Similar to shifts in the length distributions, a notable shift in the age distribution from age-1 to age-2 fish was noted in 1992. Current commercial harvest of red drum within the existing slot limits is primarily on age-2 and to a lesser extent age-3 fish.

Length and age distributions for Florida are fully described in working paper SEDAR18-DW08.

The length and age distribution for South Carolina and Georgia will be derived as previously described in Section 3.6.2.

3.6.4 Adequacy for Characterizing Catch

Available length data by gear for the northern region are available in Table 3.12 for North Carolina and Table 3.13 for Virginia. Based on the minimum criteria of 20 lengths per year by gear, sampling was particularly poor prior to 1989. Previous assessments modeled the red drum population using virtual population analysis and utilized available length data from 1986 forward (Vaughan and Carmichael 2000). Since 1989, commercial sampling has been adequate to describe the vast majority of landings with length substitutions limited to minor gears.

Age data from all sources (commercial, recreational, and independent) for the northern region were combined to generate annual age length keys. Weighted length frequency distributions by gear and year were then applied to the annual age length keys. Since 1988, annual age length keys have typically had sample sizes exceeding 300 fish. A pooled key (across years) was used to fill holes where the sample size in a single length bin was less than 10 fish.

Available length, weight, and age data for Florida are fully described in working paper SEDAR18-DW08. Commercial landings occurred in Florida from 1981 to 1988,

however most length data for the major gears was only available for 1981 to 1983. Pooling using data from 1981 to 1983 was required to provide length and age distributions by gear for the entire period.
No data exists from either SC or GA to describe their commercial landings. Gear specific length and age distributions for these states will be developed using the assumptions described in Section 3.6.2.

3.6.5 Alternatives for Characterizing Discard Length/Age

Currently, the only available data to describe commercial discards are from the North Carolina estuarine gill net fishery for the period of 2004 to 2006. All available data and analysis are described in the working paper S18-DW16. The North Carolina estuarine gill net fishery is presumed to be the primary culprit of commercial red drum discards in North Carolina. The commercial working group has suggested that methods should be investigated to extrapolate discard estimates out for the entire regulatory period. For North Carolina, the current period of 1999 to 2007 has consistent regulations dealing with commercial size and trip limits, as well as regulations relative to the use of commercial gill nets. Prior to this period, extrapolation becomes more difficult due to decreased regulation in the gill net fishery and no trip limits in the commercial red drum fishery.

3.7 Commercial Workgroup Catch-at-Age/Length – directed and discard

3.8 Comments on Adequacy of Data for Assessment Analysis

3.9 Commercial Workgroup Research Recommendations

- Continued and expanded observer coverage for the NC and VA gill net fisheries (5-10% coverage).
- Expand observer coverage to include other gears of concern (i.e. haul seine, pound net, trawls).
- Expand biostatistical sampling (ages and lengths) to better cover all statistical strata (gears/states - principally NC and VA) – more ages proportional to lengths, preferably otoliths.

3.10 Tasks for Completion following Data Workshop

Complete workup of age and length distributions for South Carolina and Georgia (Lee Paramore; by May 1, 2009)

3.11 Literature Cited

Atlantic Coastal Cooperative Statistics Program. 2009. (1950-2007) Annual landings by state and custom gear category; generated by Julie Defilippi; using ACCSP Data Warehouse, Washington, D.C: accessed February 9-13, 2009.

Vaughan, D. S., and J. T. Carmichael. 2000. Assessment of the Atlantic red drum stock for 1999: Northern and southern regions. **NOAA Technical Memorandum NMFS-SEFC-447**, Beaufort Laboratory, Beaufort, North Carolina 28516.

3.12 Tables

Table 3.1. ACCSP gears included in each of the SEDAR 18 gear categories.

SEDAR18 CATEGORY	ACCSP		
	GEAR_CODE	GEAR_NAME	CATEGORY_NAME
Beach Seine	20	Other Seines	Other Seines
Beach Seine	76	Stop Net	Other Fixed Nets
Gill Nets	132	Pots and Traps, Blue Crab	Pots and Traps
Gill Nets	138	Pots and Traps, Eel	Pots and Traps
Gill Nets	139	Pots and Traps, Fish	Pots and Traps
Gill Nets	162	Pots and Traps, Lobster Offshore	Pots & Traps, Lobster
Gill Nets	180	Pots and Traps, Other	Pots & Traps, Other
Gill Nets	200	Gill Nets	Gill Nets
Gill Nets	201	Gill Nets, Floating Drift	Gill Nets
Gill Nets	204	Gill Nets, Sink Anchor	Gill Nets
Gill Nets	205	Gill Nets, Runaround	Gill Nets
Gill Nets	206	Gill Nets, Stake	Gill Nets
Gill Nets	207	Gill Nets, Other	Gill Nets
Gill Nets	210	Trammel Nets	Trammel Nets
Hook and Line	300	Hook and Line	Hook and Line
Hook and Line	301	Hook and Line, Manual	Hook and Line
Hook and Line	303	Electric/Hydraulic, Bandit Reels	Hook and Line
Hook and Line	320	Troll Lines	Troll Lines
Hook and Line	660	Spears	Spears
Hook and Line	700	Hand Line	Hand Line
Hook and Line	701	Troll and Hand Lines CMB	Hand Line
Other	0	Not Coded	Not Coded
Other	60	Fyke Nets	Fyke Nets
Other	73	Floating Traps (Shallow)	Other Fixed Nets
Other	74	Bag Nets	Other Fixed Nets
Other	400	Long Lines	Long Lines
Other	401	Long Lines, Vertical	Long Lines
Other	403	Long Lines, Bottom	Long Lines
Other	404	Long Lines, Surface, Midwater	Long Lines
Other	405	Long Lines, Trot	Long Lines
Other	500	Dredge	Dredge
Other	503	Dredge, Clam	Dredge
Other	511	Dredge, New Bedford	Dredge

Table 3.1. (cont.)

Other	551	Cast Nets	Dip Nets
Other	602	Patent Tongs	Tongs
Other	622	Rakes, Oyster	Rakes, Oyster
Other	800	Other Gears	Other Gears
Other	801	Unspecified Gear	Other Gears
Other	802	Combined Gears	Other Gears
Pound Net	50	Pound Nets	Pound Nets
Seine	10	Haul Seines	Haul Seines
Seine	22	Common Seine	Other Seines
Trawls	91	Otter Trawl Bottom, Crab	Otter Trawls
Trawls	92	Otter Trawl Bottom, Fish	Otter Trawls
Trawls	94	Otter Trawl Bottom, Scallop	Otter Trawls
Trawls	95	Otter Trawl Bottom, Shrimp	Otter Trawls
Trawls	96	Otter Trawl Bottom, Other	Otter Trawls
Trawls	97	Otter Trawl Midwater	Otter Trawls
Trawls	110	Other Trawls	Other Trawls

Table 3.2. Red drum commercial landings (pounds, whole weight) by region for the US Atlantic coast. Northern region includes states from Massachusetts to North Carolina. Southern region includes landings from South Carolina, Georgia, and east coast Florida.

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

Table 3.2 (cont.)

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

Table 3.3. Red drum commercial landings (pounds, whole weight) by gear for the US Atlantic coast (see text for gear descriptions). Landings included from Massachusetts to Florida.

Calendar	US Atlantic Coast							
Year	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
1987	9,130	168,041	17,705	2,026	60,832	35,567	21,203	314,504

Table 3.3. (cont.)

Calendar				US Atlantic Coast				
Year	Beach Seine	Gill Nets	Hook-n-Line	Other Gears	Pound Net	Seines	Trawls	Total
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 3.4. North Carolina mean weights (in pounds) by gear based on length data provided from state and weight-length relationship. Shaded numbers represent values that were obtained by pooling across gears within a year. Shaded with underline represent further pooling across years within a management period.

Year	Beach Seine	Gill net	Haul Seine	Poundnet	Trawl	Lines*	Other
1981	3.05	3.05	3.05	3.05	3.05	2.01	3.05
1982	3.05	3.05	3.05	3.05	3.05	2.16	3.05
1983	3.05	3.05	0.49	3.05	3.05	1.63	3.05
1984	3.4	3.4	3.4	2.16	3.4	14.7	3.4
1985	3.05	3.05	3.05	3.05	3.05	3.71	3.05
1986	3.05	3.05	3.05	3.05	3.05	11.32	3.05
1987	1.8	1.8	1.8	1.8	1.8	2.39	1.8
1988	2.95	2.95	2.92	2.95	2.95	3.68	2.95
1989	7.31	2.46	12.85	7.31	7.31	3.31	7.31
1990	3.39	2.34	3.62	6.39	3.39	2.76	3.39
1991	2.87	2.7	2.87	6.58	2.87	2.74	2.87
1992	4.87	3.39	5.8	6.71	4.87	4.57	.
1993	5.76	5.64	6.07	5.76	5.76	4.87	5.76
1994	6.19	5.62	7.43	6.19	6.19	6.95	6.19
1995	5.4	5.51	5.28	5.59	5.4	5.06	5.4
1996	5.84	4.98	5.01	5.84	6.44	5.09	5.84
1997	4.29	4.3	4.29	4.29	4.29	4.16	4.29
1998	3.1	3.25	2.87	3.1	3.1	5.43	3.1
1999	6.62	4.57	4.71	5.73	4.71	5.29	4.71
2000	5.87	5.19	4.05	5.26	5.26	5.72	5.26
2001	5.27	5.21	5.27	5.86	5.27	6.48	5.27
2002	4.38	4.28	4.71	4.9	4.38	3.72	4.38
2003	4.49	4.55	4.49	4.49	.	4.83	4.49
2004	4.56	5.58	5.38	5.38	5.38	4.47	5.38
2005	4.55	4.36	4.55	6.38	4.55	5.04	4.55
2006	5.1	4.86	4.89	6.45	4.96	4.69	4.96
2007	4.86	4.81	4.16	5.49	4.86	5.44	4.86

*Mean weights for underlined values acquired from MRFSS sampling.

Table 3.5. Estimated commercial landings (numbers) of red drum from North Carolina during 1981to 2007 by major gear category.

Year	Beach Seine	Gillnet	Haul Seine	Poundnet	Trawl	Lines*	Other	Total
1981	162	9,488	3,640	11,888	5,284	.	169	30,630
1982	349	7,956	2,278	1,109	5,534	12	-	17,236
1983	2,930	41,093	42,582	6,245	14,873	139	32	107,894
1984	5,246	50,613	6,006	3,157	19,140	53	4	84,218
1985	1,085	28,481	4,504	927	14,923	32	98	50,051
1986	1,918	36,697	23,296	2,407	17,259	23	-	81,601
1987	3,357	68,394	19,648	33,296	10,601	2,563	-	137,858
1988	3,845	45,159	8,210	8,230	8,373	751	-	74,566
1989	1,833	56,655	4,367	5,247	3,251	1,015	-	72,367
1990	8,044	41,871	5,037	3,928	4,117	245	-	63,242
1991	1,864	25,109	1,515	1,197	3,495	191	43	33,414
1992	409	31,073	1,093	1,838	474	42	-	34,928
1993	1,478	35,587	1,771	1,559	1,064	618	-	42,078
1994	343	20,369	2,185	851	256	333	20	24,356
1995	1,150	32,791	7,178	3,510	91	613	23	45,355
1996	794	18,307	1,897	853	141	410	8	22,411
1997	658	8,580	2,214	327	36	383	31	12,230
1998	1,913	76,021	12,432	438	24	783	1	91,612
1999	658	77,459	392	1,664	148	465	12	80,799
2000	3,354	46,437	430	891	177	497	9	51,796
2001	460	26,909	94	923	26	143	4	28,560
2002	175	17,166	236	1,128	12	90	24	18,831
2003	218	18,843	238	547	-	46	14	19,906
2004	134	9,024	187	346	13	41	-	9,745
2005	365	26,825	130	1,448	6	53	6	28,833
2006	361	32,556	394	1,033	17	81	18	34,460
2007	212	47,905	530	1,668	49	27	6	50,396

Table 3.6. Virginia mean weights (in pounds) by gear based on length data provided from state and weight-length relationship. Shaded numbers represent values that were obtained by pooling across gears within a year. Shaded with underline represent further pooling across years within a management period. Virginia mean weights were applied to all commercial landings from Virginia and north.

Year	Seines*	Gill net	Pound net	Trawls	Lines**	Other
1981	.	.	1.42	1.42	.	.
1982	.	.	1.42	1.42	.	.
1983	1.42	1.42	1.42	1.42	1.63	.
1984	.	.	1.42	1.42	14.7	1.42
1985	1.42	.	1.42	1.42	3.7	.
1986	1.42	1.42	1.42	1.42	.	.
1987	1.42	1.42	1.42	1.42	.	.
1988	1.42	1.42	1.42	1.42	3.68	.
1989	1.36	1.28	1.36	1.36	3.31	.
1990	.	.	1.42	1.42	2.76	1.42
1991	1.43	1.33	2.03	1.42	2.74	1.42
1992	2.86	2.86	2.86	2.86	4.57	.
1993	7.82	7.82	7.82	7.82	4.87	7.82
1994	9.5	11.1	11.1	11.1	6.95	.
1995	4	3.96	3.96	3.96	5.06	3.96
1996	7.81	7.81	7.81	7.81	5.09	7.81
1997	9.09	9.09	9.09	9.09	4.16	9.09
1998	3.96	3.96	3.4	3.96	5.44	3.96
1999	3.93	8.26	7.95	8.26	5.29	8.26
2000	4.45	9.81	9.81	9.81	5.72	.
2001	15.64	15.64	15.21	15.64	6.48	.
2002	5.01	10.08	11.06	10.08	3.72	10.08
2003	5.56	5.56	5.56	5.56	4.83	5.56
2004	5.24	5.24	5.24	5.24	4.47	5.24
2005	4.08	2.59	4.08	4.08	5.05	4.08
2006	4.31	4.31	4.31	4.31	4.69	4.31
2007	5.77	5.09	5.49	5.09	3.81	5.09

*Beach and Haul Seines were combined for Virginia.
** Mean weights for underlined values acquired from MRFSS sampling.

Table 3.7. Estimated commercial landings (numbers) of red drum for all states from Virginia and north during 1981-2007 by major gear category.

Year	Seines	Gillnet	Poundnet	Trawls	Lines	Other	Total
1981	.	.	70	70	.	.	140
1982	.	.	493	704	.	.	1,197
1983	5,141	10,915	12,113	1,197	61	.	29,428
1984	.	.	70	1,549	14	70	1,704
1985	70	.	282	282	54	.	688
1986	915	423	1,479	1,690	.	.	4,507
1987	775	211	634	211	.	.	1,831
1988	493	70	1,479	5,493	380	.	7,916
1989	1,838	2,500	1,471	441	272	.	6,522
1990	.	.	488	390	72	44	995
1991	6,041	8,129	5,842	573	55	21	20,661
1992	80	342	357	263	25	.	1,067
1993	246	485	337	35	20	4	1,128
1994	16	10	415	490	2	.	933
1995	183	142	420	169	6	2	922
1996	6	93	167	50	10	28	354
1997	21	62	323	0	87	7	500
1998	489	503	831	6	20	127	1,976
1999	551	559	514	163	196	13	1,997
2000	280	592	576	125	38	.	1,611
2001	31	99	212	18	87	.	448
2002	183	324	353	27	163	42	1,091
2003	54	333	239	831	30	5	1,492
2004	57	47	30	5	18	2	160
2005	11	307	74	5	17	124	539
2006	78	270	149	26	29	1,203	1,753
2007	156	621	404	80	99	1,317	2,677

Table 3.8. Florida estimated observed mean weights (pounds) from all red drum measured for length (and converted to weight) or directly weighed for whole weight. The 'Used' mean weights were those actually applied to the estimated gear-specific landings to calculate the numbers of landed red drum by gear. Differences between the observed and 'Used' were due to inadequate sampling or sampling that was known or judged to be biased relative to the commercial landings.

	Gill Net			Hook and Line			Seine			Trammel Net		
Year	N	Obs	Used	N	Obs	Used	N	Obs	Used	N	Obs	Used
1981	649	2.808	2.808	8	19.148	3.98	0		4.759	90	7.154	7.154
1982	1,149	3.731	3.731	80	11.898	6.55	51	4.277	4.277	377	9.416	9.416
1983	108	2.448	2.448	0		5.265	15	6.397	4.277	276	7.213	7.213
1984	0		2.996	0		5.265	0		4.277	0		5.483
1985	0		2.996	0		5.265	0		4.277	0		5.483
1986	0		2.996	0		5.265	0		4.277	0		5.483
1987	0		2.996	0		5.265	0		4.277	14	3.754	3.754
1988	0		2.996	0		5.265	0		4.277	10	4.645	4.645

Table 3.9. Estimated commercial landings (numbers) of red drum for the Atlantic coast of Florida during 1981-1988 by collapsed gear category.

Year	Gill Net	Hook&Line	Seine	Trammel Net	Totals
1981	76,614	10,323	109	229	87,276
1982	29,488	4,230	112	102	33,931
1983	32,310	4,714	121	104	37,248
1984	31,308	5,469	635	1,018	38,431
1985	21,248	4,029	144	629	26,050
1986	19,304	3,205	100	0	22,609
1987	10,547	1,782	464	0	12,793
1988	44	29	0	0	73

Table 3.10. Summary of all estimated mortalities in pounds associated with the estuarine gill net fishery in North Carolina.

	Estuarine Gill Net Dead Discards (lb)			Estuarine Gill Net Mortality from Releases (lb)			RCGL Mortalities (lb)*	Total Discard Mortality (lb)	Combined Commercial Harvest (lb)	% of Commercial Landings
Year	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Large Mesh	All		
2004	3,042	12,393	15,435	1,005	2,613	3,618	1,089	20,142	54,086	37%
2005	4,807	54,143	58,950	2,222	6,229	8,451	1,596	68,997	128,770	54%
2006	5,570	27,106	32,676	1,268	3,001	4,269	882	37,827	169,206	22%

*no estimates for RCGL releases or for RCGL small mesh gill nets

Table 3.11. Summary of all estimated mortalities in numbers associated with the estuarine gill net fishery in North Carolina during 2004 and 2005.

	Estuarine Gill Net Dead Discards (number)			Estuarine Gill Net Mortality from Releases (number)			RCGL Mortalities (number)*	Total Discard Mortality (number)	Combined Commercial Harvest** (number)	% of Commercial Landings
Year	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Large Mesh	All		
2004	1,112	7,138	8,250	729	1,630	2,359	626	11,235	10,900	103%
2005	3,066	17,925	20,991	1,503	2,844	4,347	528	25,866	30,000	86%

*no estimates for RCGL releases or for RCGL small mesh gill nets
**all gears combined (number generated from stock assessment catch at age analysis)

Table 3.12. Red drum lengths sampled from the commercial fishery in North Carolina and the percent of total harvest that a gear contributed to the overall annual commercial landings. Areas shaded in gray are where less than 20 lengths were acquired in a year. % adequate column represents the percentage of landings that had adequate sampling based on a minimum of 20 lengths by gear and year.

	Beach Seine		Gill Nets		Long Haul		Trawls		Pound Net		Rod-n-Reel*		Others		All
Year	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	% adequate
1983	1	4%	0	56%	40	10%	0	21%	15	9%	rec A+B1	0%	0	0%	19%
1984	0	6%	14	61%	4	7%	7	23%	26	2%	rec A+B1	0%	0	0%	3%
1985	0	2%	0	57%	2	9%	4	30%	1	2%	rec A+B1	0%	0	0%	0%
1986	0	2%	0	45%	12	29%	5	21%	0	3%	rec A+B1	0%	0	0%	0%
1987	0	2%	0	49%	20	14%	0	8%	2	24%	rec A+B1	2%	0	0%	17%
1988	0	5%	14	60%	29	11%	1	11%	1	11%	rec A+B1	1%	0	0%	12%
1989	0	5%	60	51%	44	20%	8	9%	11	14%	rec A+B1	1%	0	0%	72%
1990	0	15%	398	53%	47	10%	2	8%	69	14%	rec A+B1	0%	0	0%	77%
1991	18	6%	121	71%	10	5%	0	10%	34	8%	rec A+B1	1%	0	0%	79%
1992	6	2%	231	82%	94	5%	1	2%	55	10%	rec A+B1	0%	0	0%	97%
1993	3	4%	546	84%	41	5%	5	3%	8	4%	rec A+B1	1%	0	0%	90%
1994	9	1%	84	81%	42	11%	1	1%	6	4%	rec A+B1	2%	0	0%	94%
1995	0	3%	324	73%	96	15%	1	0%	75	8%	rec A+B1	1%	0	0%	97%
1996	0	4%	31	80%	58	8%	24	1%	7	4%	rec A+B1	2%	0	0%	91%
1997	7	5%	249	70%	7	18%	0	0%	9	3%	rec A+B1	3%	0	0%	73%
1998	0	2%	737	84%	340	12%	0	0%	5	0%	rec A+B1	1%	0	0%	97%
1999	35	1%	903	95%	16	0%	0	0%	54	3%	rec A+B1	1%	0	0%	99%
2000	69	7%	602	89%	23	1%	19	0%	12	2%	rec A+B1	1%	0	0%	98%
2001	1	2%	381	94%	2	0%	2	0%	33	4%	rec A+B1	1%	0	0%	98%
2002	1	1%	393	90%	35	1%	0	0%	38	7%	rec A+B1	0%	0	0%	99%
2003	8	1%	356	95%	18	1%	0	0%	2	3%	rec A+B1	0%	0	0%	95%
2004	57	1%	259	93%	6	2%	0	0%	6	3%	rec A+B1	0%	0	0%	95%
2005	7	1%	730	91%	2	0%	0	0%	72	7%	rec A+B1	0%	0	0%	98%
2006	40	1%	1164	94%	25	1%	0	0%	60	4%	rec A+B1	0%	0	0%	100%
2007	12	0%	1334	95%	22	1%	62	0%	126	4%	rec A+B1	0%	0	0%	100%

*MRFSS data used to represent rod-n-reel length distribution from commercial catch.

Table 3.13. Red drum lengths sampled from the commercial fishery in Virginia and the percent of total harvest that a gear contributed to the overall annual commercial landings. Areas shaded in gray are where less than 20 lengths were acquired in a year. % adequate column represents the percentage of landings that had adequate sampling based on a minimum of 20 lengths by gear and year.

	Seines		Gillnets		Rod-n-Reel		Pound		Trawl		Other		
Year	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	# meas	% Harv	% Adequate
1981	0	0%	0	0%	rec A+B1	0%	0	50%	0	50%	0	0%	0%
1982	0	0%	0	0%	rec A+B1	0%	0	41%	0	59%	0	0%	0%
1983	0	18%	0	37%	rec A+B1	0%	0	41%	0	4%	0	0%	0%
1984	0	0%	0	0%	rec A+B1	8%	0	4%	0	85%	0	4%	8%
1985	0	9%	0	0%	rec A+B1	18%	0	36%	0	36%	0	0%	18%
1986	0	24%	0	11%	rec A+B1	0%	0	39%	0	26%	0	0%	0%
1987	0	42%	0	12%	rec A+B1	0%	0	35%	0	12%	0	0%	0%
1988	0	18%	0	3%	rec A+B1	0%	0	53%	0	28%	0	0%	0%
1989	0	30%	31	39%	rec A+B1	2%	13	24%	0	4%	0	0%	2%
1990	0	0%	0	0%	rec A+B1	14%		45%	0	37%	0	4%	14%
1991	197	35%	412	43%	rec A+B1	0%	58	20%	0	2%	0	0%	98%
1992	5	10%	18	27%	rec A+B1	0%	3	33%	0	30%	0	0%	0%
1993	5	22%	13	44%	rec A+B1	1%	9	30%	0	2%	0	0%	1%
1994	49	4%	1	2%	rec A+B1	0%	5	93%	0	1%	0	0%	4%
1995	23	24%	0	19%	rec A+B1	1%	0	56%	0	0%	0	0%	26%
1996	1	2%	1	33%	rec A+B1	2%	6	63%	0	0%	0	0%	2%
1997		5%	3	14%	rec A+B1	9%	1	73%	0	0%	0	0%	9%
1998	5	30%	11	25%	rec A+B1	2%	36	43%	0	0%	0	0%	45%
1999	25	18%	11	34%	rec A+B1	8%	58	30%	0	9%	0	1%	56%
2000	19	11%	19	45%	rec A+B1	2%	35	42%	0	0%	0	0%	44%
2001	2	9%	0	29%	rec A+B2	8%	27	48%	0	5%	0	0%	57%
2002	27	12%	8	41%	rec A+B3	7%	59	34%	0	1%	0	5%	53%
2003	0	10%	2	54%	rec A+B4	3%	23	30%	0	2%	0	0%	33%
2004	1	38%	0	31%	rec A+B5	10%	5	20%	0	0%	0	0%	10%
2005	1	7%	26	35%	rec A+B6	13%	8	41%	0	3%	0	0%	48%
2006	15	16%	14	56%	rec A+B7	6%	4	22%	0	0%	0	0%	6%
2007	27	13%	7	44%	32	5%	57	31%	0	5%	0	2%	5%

*MRFSS data used to represent rod-n-reel length distribution from commercial catch with exception of 2007.

Table 3.14. Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007. **Beach Seines**

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	9	54	54	-	20	35	361	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	532
9	13	78	78	-	29	51	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	249
10	35	210	210	-	78	138	166	605	-	-	-	5	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1,448
11	32	190	190	-	70	125	993	18	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,643
12	35	206	206	448	76	135	414	1,068	-	274	5	-	-	-	-	-	1	1	-	-	-	0	-	-	-	-	-	2,867
13	17	98	98	50	36	64	-	748	16	192	109	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1,432
14	39	232	232	99	86	152	135	107	264	1,125	180	-	8	1	-	-	2	-	-	-	-	-	-	-	0	12	-	2,674
15	52	312	312	199	115	204	8	71	136	2,269	104	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3,783
16	41	245	245	671	91	160	-	516	320	993	38	5	-	3	-	3	7	1	-	-	-	-	-	-	0	-	0	3,341
17	56	333	333	149	123	218	324	-	328	1,317	278	81	2	-	1	-	13	47	-	-	-	2	4	6	11	24	2	3,652
18	55	325	325	2,064	120	213	-	18	152	881	578	25	45	4	9	17	98	576	-	133	42	25	30	21	63	24	15	5,856
19	27	161	161	-	60	105	15	-	24	314	349	9	58	14	6	13	148	668	-	66	20	33	26	14	37	-	16	2,345
20	6	38	38	-	14	25	8	36	112	41	65	11	52	25	26	10	148	409	-	100	23	17	19	8	25	18	17	1,292
21	29	175	175	448	65	115	926	-	-	30	82	23	170	68	78	60	51	143	-	-	35	18	20	4	33	24	23	2,795
22	1	9	9	-	3	6	8	36	16	-	16	73	99	25	237	43	4	39	49	232	47	17	28	16	37	18	34	1,103
23	11	66	66	-	24	43	-	374	40	-	-	55	244	20	298	146	1	24	99	432	75	15	30	16	34	114	39	2,266
24	4	24	24	99	9	16	-	53	88	41	-	52	333	25	287	179	10	3	164	1,162	83	20	30	27	52	36	30	2,852
25	4	22	22	174	8	14	-	-	-	101	16	30	161	31	131	142	48	2	132	664	69	14	16	10	41	48	18	1,921
26	3	20	20	373	7	13	-	-	-	30	-	12	229	29	69	103	74	1	99	399	42	9	11	8	20	24	11	1,605
27	3	21	21	472	8	14	-	-	-	-	-	9	49	68	3	79	41	0	16	166	20	2	-	2	8	6	5	1,014
28	2	12	12	-	4	8	-	-	48	20	16	2	9	7	3	-	8	-	-	-	2	1	2	-	1	-	1	160
29	1	4	4	-	2	3	-	-	8	30	-	2	3	15	0	-	-	-	99	-	1	-	1	-	1	-	0	175
30	0	1	1	-	0	1	-	-	-	10	-	1	-	1	-	-	-	-	-	-	-	0	-	-	-	12	0	28
31	0	1	1	-	0	1	-	-	8	-	-	1	-	-	0	-	1	-	-	-	-	0	-	-	-	-	-	14
32	0	1	1	-	0	1	-	-	8	-	-	9	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	21
33	0	2	2	-	1	1	-	-	-	-	11	0	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	22
34	0	2	2	-	1	1	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
37	0	1	1	-	0	1	-	18	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
38	1	5	5	-	2	4	-	18	-	41	-	0	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	80
39	0	2	2	-	1	1	-	-	16	-	-	-	1	1	-	-	-	0	-	-	-	-	-	-	-	-	-	25
40+	13	80	80	-	30	52	-	160	224	334	16	3	10	4	-	-	-	-	-	-	-	-	-	-	-	-	-	1,007
Total	**493**	**2,930**	**2,930**	**5,247**	**1,085**	**1,918**	**3,357**	**3,845**	**1,833**	**8,044**	**1,864**	**409**	**1,478**	**343**	**1,150**	**794**	**658**	**1,913**	**658**	**3,354**	**460**	**175**	**218**	**134**	**365**	**361**	**212**	**46,230**

Table 3.14 (cont.). Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007.

Gill Nets

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	530	767	767	-	521	672	7,361	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,619
9	767	1,151	1,151	-	755	975	1	0	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,820
10	2,075	3,069	3,069	-	2,042	2,636	3,376	7,109	-	-	99	13	-	-	-	0	0	-	-	-	-	3	-	-	-	-	-	23,492
11	1,880	3,361	3,361	-	1,850	2,411	20,255	214	-	-	493	-	-	-	-	1	0	-	-	-	-	13	-	0	-	8	-	33,847
12	2,031	4,005	4,005	4,318	1,999	2,620	8,456	12,551	323	-	697	-	-	-	-	1	1	37	-	-	-	17	-	0	-	16	-	41,078
13	973	2,962	2,962	480	957	1,295	31	8,791	323	883	1,810	26	-	-	-	1	31	-	150	-	-	10	-	0	-	16	-	21,700
14	2,291	5,986	5,986	960	2,255	3,011	2,813	1,272	17,181	8,923	3,634	39	48	51	12	2	16	27	87	-	-	3	-	1	36	-	-	54,633
15	3,079	6,845	6,845	1,919	3,031	4,001	201	852	12,759	14,022	2,692	66	-	0	6	4	3	108	5	15	-	3	13	0	-	-	-	56,469
16	2,420	4,849	4,849	6,476	2,382	3,124	27	6,072	10,629	7,943	1,296	869	-	254	6	594	77	45	5	30	-	3	13	35	76	27	39	52,140
17	3,285	5,141	5,141	1,439	3,233	4,184	6,603	3	6,610	5,785	5,011	14,911	48	-	45	3	167	1,009	1,177	628	3	251	430	276	904	480	546	67,314
18	3,209	4,695	4,695	19,909	3,159	4,075	3	210	7,554	1,961	8,796	4,531	1,287	305	286	2,368	1,276	14,782	6,038	4,569	2,625	2,603	2,662	970	5,290	2,923	3,610	114,391
19	1,588	2,302	2,302	-	1,563	2,016	307	0	-	883	5,822	1,561	1,663	1,115	222	1,776	1,948	27,240	5,846	3,864	1,242	3,159	1,775	765	3,051	3,001	3,773	78,783
20	378	552	552	-	372	480	154	418	944	-	969	1,494	1,454	1,976	550	594	1,970	21,534	7,117	1,794	1,449	1,572	1,461	314	2,066	2,268	3,993	56,427
21	1,729	2,455	2,455	4,318	1,702	2,193	18,862	-	-	-	1,371	2,168	2,425	5,016	2,761	1,186	676	7,543	9,923	2,391	2,139	1,958	1,735	174	2,672	3,157	5,296	86,305
22	87	123	123	-	85	110	153	418	-	-	317	1,454	2,753	1,216	3,415	4	40	2,204	16,457	3,986	2,691	1,983	2,583	347	2,850	4,134	7,664	55,197
23	648	920	920	-	638	822	-	4,390	944	-	-	567	6,513	963	10,330	3,548	11	1,569	13,290	6,891	4,485	1,549	2,870	933	2,529	5,300	8,857	79,490
24	238	338	338	960	234	302	-	627	944	294	-	497	7,097	1,064	7,936	2,958	123	159	10,938	9,574	4,761	1,970	2,882	1,072	3,598	5,202	6,709	70,815
25	216	307	307	1,679	213	274	-	-	-	196	-	319	4,595	1,420	4,126	3,551	649	186	4,471	6,938	4,009	1,350	1,565	1,520	2,565	3,237	4,099	47,791
26	194	276	276	3,598	191	247	-	-	-	-	-	1,029	6,585	1,825	2,950	1,778	976	50	1,920	4,155	2,215	768	1,017	1,588	997	1,735	2,647	37,019
27	205	291	291	4,558	202	260	-	-	-	-	-	1,313	1,293	4,561	131	4	541	12	294	1,341	1,111	180	-	657	428	996	1,048	19,716
28	119	169	169	-	117	151	-	-	-	-	-	-	203	558	144	2	114	-	10	513	145	3	157	311	36	195	205	3,319
29	43	61	61	-	42	55	-	-	-	196	-	390	42	0	13	2	1	-	5	92	69	10	-	104	36	88	34	1,344
30	11	15	15	-	11	14	-	-	-	98	-	26	-	1	-	2	2	-	5	92	3	3	13	1	-	43	-	354
31	11	15	15	-	11	14	-	-	-	-	-	-	-	2	-	3	9	-	222	7	10	7	-	-	-	-	-	325
32	11	15	15	-	11	14	-	-	-	-	-	-	-	1	-	3	2	-	-	30	10	7	-	-	-	-	-	117
33	22	31	31	-	21	28	-	-	-	-	211	-	24	1	-	3	2	-	5	37	3	13	-	-	-	-	-	432
34	22	46	46	-	21	28	0	0	-	-	-	-	-	0	-	1	1	-	-	7	13	-	-	-	-	-	-	187
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	7	-	-	-	-	-	-	-	8
36	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	2	1	-	-	15	13	7	-	-	-	-	-	38
37	11	15	15	-	11	14	-	209	-	-	-	-	-	-	-	0	0	-	-	-	-	7	-	-	-	-	-	282
38	54	77	77	-	53	69	-	209	-	-	-	-	-	-	-	1	0	-	-	7	3	-	-	-	-	-	-	550
39	22	31	31	-	21	28	-	-	-	-	-	-	-	-	-	1	0	9	-	7	-	-	-	-	-	-	-	150
40+	789	1,136	1,136	-	776	1,001	0	1,882	944	686	-	142	42	51	-	8	5	9	54	37	10	40	-	1	-	-	5	8,754
Total	**28,937**	**52,008**	**52,008**	**50,613**	**28,481**	**37,120**	**68,604**	**45,230**	**59,156**	**41,870**	**33,238**	**31,414**	**36,073**	**20,379**	**32,933**	**18,400**	**8,641**	**76,524**	**78,019**	**47,029**	**27,009**	**17,489**	**19,176**	**9,071**	**27,133**	**32,826**	**48,526**	**1,027,905**

Table 3.14 (cont.). Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007.

Haul Seine

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	203	786	178	-	83	428	2,116	1	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,824
9	294	1,158	12,122	-	120	623	4	3	-	-	61	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	14,387
10	796	3,111	23,222	-	324	1,681	978	1,394	-	-	61	28	-	-	-	0	6	-	-	-	-	7	-	-	-	-	-	31,608
11	721	3,092	6,798	-	297	1,571	5,864	31	279	-	613	-	-	-	-	0	0	-	-	-	-	14	-	0	-	2	-	19,283
12	779	3,517	1,039	512	323	1,729	2,503	2,501	209	535	1,135	-	-	-	-	0	2	-	-	-	-	-	-	0	-	5	-	14,790
13	373	2,176	745	57	162	916	112	1,746	353	159	1,449	6	-	-	-	0	8	-	23	-	-	-	-	0	-	5	-	8,288
14	879	4,658	1,457	114	374	2,073	987	164	1,133	198	1,685	9	68	-	16	0	6	26	44	-	-	-	-	1	0	-	-	13,895
15	1,181	5,696	1,164	228	495	2,686	220	112	645	1,349	1,457	15	-	0	8	0	3	105	22	7	-	-	2	1	-	-	-	15,395
16	929	4,227	665	769	386	2,067	100	1,167	292	59	698	12	-	0	8	0	23	53	22	14	-	-	2	2	1	-	-	11,496
17	1,260	5,058	224	171	514	2,684	1,928	21	135	1,031	245	6	-	-	27	0	44	609	72	29	1	-	2	7	4	-	-	14,075
18	1,231	4,787	65	2,363	500	2,595	10	47	93	1,031	61	9	-	1	48	0	331	5,731	72	121	10	5	22	30	27	12	74	19,276
19	609	2,359	22	-	248	1,283	91	2	186	178	-	2	9	-	22	0	499	4,215	93	89	4	39	97	26	17	60	121	10,270
20	145	564	7	-	59	306	45	82	186	79	-	28	9	-	208	30	499	1,449	32	38	5	85	54	12	9	14	163	4,108
21	663	2,544	-	512	269	1,392	5,419	-	-	59	29	65	873	182	378	301	171	521	47	21	7	95	34	6	12	70	27	13,700
22	33	127	-	-	13	70	44	82	186	-	-	321	52	425	2,341	392	14	118	123	75	10	37	15	13	13	102	72	4,678
23	249	954	-	-	101	522	-	858	372	-	-	248	44	303	1,472	603	5	29	89	28	15	34	8	24	12	113	101	6,184
24	91	350	-	114	37	191	-	82	-	-	-	223	616	516	1,898	573	33	15	169	50	17	24	19	29	19	21	37	5,124
25	83	318	-	199	34	174	-	-	-	59	-	111	63	305	776	1	165	35	93	81	16	21	8	33	15	16	27	2,633
26	75	286	-	427	30	157	-	-	-	40	-	18	64	215	152	0	249	-	34	20	11	18	4	33	7	14	37	1,890
27	79	302	-	541	32	165	-	-	-	-	-	-	36	63	6	0	137	-	3	27	6	20	-	15	3	16	21	1,472
28	46	175	-	-	19	96	-	-	557	20	-	-	44	1	-	0	29	-	2	14	3	5	-	7	0	16	-	1,032
29	17	63	-	-	7	35	-	-	93	-	-	1	35	0	-	0	0	-	2	11	0	-	22	3	0	2	-	291
30	4	16	-	-	2	9	-	-	-	-	-	10	-	2	-	0	1	-	-	11	1	5	2	1	-	5	-	67
31	4	16	-	-	2	9	-	-	93	-	-	6	-	3	-	0	2	-	1	4	3	5	-	-	-	-	-	146
32	4	16	-	-	2	9	-	-	93	-	-	44	-	1	-	0	1	-	-	14	3	-	-	-	-	-	-	187
33	8	32	-	-	3	17	-	-	-	-	-	1	-	2	-	0	1	-	-	18	1	-	-	-	-	-	-	83
34	8	39	7	-	3	19	1	1	-	-	-	2	-	0	-	0	0	-	-	4	4	-	-	-	-	-	-	89
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	4	-	-	-	-	-	-	-	4
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	7	4	7	-	-	-	-	-	18
37	4	16	-	-	2	9	-	41	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	71
38	21	80	-	-	8	44	-	41	-	20	-	1	-	-	-	0	2	-	-	4	1	-	-	-	-	-	-	221
39	8	32	-	-	3	17	-	-	186	-	-	-	9	30	-	0	0	9	-	4	-	-	-	-	-	-	-	298
40+	303	1,168	7	-	123	636	1	328	1,115	218	31	8	95	152	-	1	2	9	-	18	3	-	-	1	0	-	6	4,223
Total	**11,102**	**47,722**	**47,723**	**6,006**	**4,574**	**24,211**	**20,423**	**8,703**	**6,205**	**5,037**	**7,556**	**1,173**	**2,017**	**2,201**	**7,361**	**1,904**	**2,235**	**12,922**	**944**	**711**	**125**	**419**	**291**	**244**	**141**	**472**	**686**	**223,106**

Table 3.14 (cont.). Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007.

Trawl

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	664	274	274	2	273	318	1,141	8	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,956
9	962	401	401	9	397	467	1	31	-	2	3	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	2,675
10	2,601	1,080	1,080	17	1,073	1,256	525	1,380	-	4	7	10	-	-	-	0	0	-	-	-	-	0	-	-	-	-	-	9,035
11	2,362	1,042	1,042	98	987	1,228	3,151	386	43	25	39	-	-	-	-	0	0	-	-	-	-	1	-	0	-	1	-	10,405
12	2,556	1,167	1,167	159	1,076	1,385	1,329	2,890	50	40	58	-	-	-	-	0	0	0	-	-	-	2	-	0	-	2	-	11,881
13	1,233	673	673	680	542	825	31	2,424	68	131	85	20	-	-	-	1	0	-	1	-	-	1	-	0	-	2	-	7,391
14	2,895	1,477	1,477	1,299	1,252	1,789	481	1,608	629	469	139	30	6	0	15	1	0	0	4	-	-	0	-	0	-	-	-	13,573
15	3,881	1,854	1,854	2,174	1,652	2,219	72	1,399	352	571	335	51	-	9	7	2	0	1	1	3	-	0	-	0	-	-	-	16,436
16	3,045	1,399	1,399	5,669	1,285	1,662	27	1,835	638	570	73	54	-	11	7	2	0	1	1	6	-	0	-	0	1	-	1	17,687
17	4,120	1,741	1,741	295	1,706	2,033	1,031	239	592	722	334	32	1	-	24	2	1	2	9	4	1	-	-	1	0	-	-	14,629
18	4,022	1,665	1,665	10,273	1,658	1,935	3	108	270	561	1,241	20	33	30	58	6	5	8	13	19	1	3	-	2	2	4	5	23,612
19	1,991	821	821	7	820	954	48	23	43	484	517	-	43	11	2	5	8	9	17	13	1	5	-	2	2	6	13	6,667
20	474	196	196	2	195	228	24	85	199	1	206	30	37	19	2	4	8	6	9	7	-	2	-	1	-	-	15	1,946
21	2,166	889	889	-	892	1,031	2,924	-	-	-	103	30	123	51	1	13	3	2	10	21	2	3	-	0	0	1	11	9,164
22	108	44	44	-	45	52	24	78	28	-	-	-	74	18	8	10	0	1	23	25	3	2	-	1	0	3	16	608
23	812	333	333	-	334	387	-	814	71	-	-	35	179	15	17	28	0	1	49	37	3	0	-	2	0	3	19	3,472
24	298	122	122	-	123	142	-	116	156	37	-	100	241	28	21	35	1	0	75	49	6	2	-	2	2	7	17	1,701
25	271	111	111	-	111	129	-	-	-	185	308	135	123	67	66	30	3	0	47	34	5	2	-	2	2	6	16	1,766
26	244	100	100	-	100	116	-	-	-	37	-	74	174	84	27	21	4	0	20	20	5	4	-	2	1	4	9	1,147
27	257	105	105	-	106	122	-	-	-	-	-	43	39	104	2	16	2	0	4	11	4	2	-	1	1	1	5	931
28	149	61	61	-	61	71	-	-	85	37	308	43	9	23	1	1	0	-	6	8	1	1	-	0	0	1	0	931
29	54	22	22	-	22	26	-	-	14	37	-	-	4	20	1	1	0	-	1	5	-	1	-	0	0	1	0	232
30	13	6	6	-	6	6	-	-	-	-	-	20	-	45	-	1	0	-	1	5	1	0	-	0	-	2	1	113
31	13	6	6	-	6	6	-	-	14	-	-	-	-	71	1	1	0	-	1	2	2	1	-	-	-	-	-	130
32	13	6	6	-	6	6	-	-	14	-	-	4	-	45	1	1	0	-	-	7	2	1	-	-	-	-	0	111
33	27	11	11	-	11	13	-	-	-	-	-	-	1	46	-	2	0	-	1	8	1	1	-	-	-	-	-	133
34	27	13	13	2	12	15	0	8	-	1	1	-	-	9	-	1	0	-	-	2	2	-	-	-	-	-	-	105
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	2	-	-	-	-	-	-	-	2
36	-	-	-	-	-	-	-	-	-	-	-	-	1	9	-	1	0	-	-	3	2	1	-	-	-	-	-	17
37	13	6	6	-	6	6	-	39	-	-	-	-	-	-	-	0	0	-	-	-	-	1	-	-	-	-	-	76
38	68	28	28	-	28	32	-	39	-	111	-	-	2	-	-	0	0	-	-	2	1	-	-	-	-	-	-	339
39	27	11	11	-	11	13	-	-	28	-	-	-	1	0	-	0	0	0	-	2	-	-	-	-	-	-	-	105
40+	989	407	407	2	407	473	0	357	397	483	309	4	9	30	-	4	0	0	16	8	2	3	-	0	0	-	1	4,308
Total	**36,357**	**16,070**	**16,070**	**20,689**	**15,204**	**18,949**	**10,812**	**13,866**	**3,692**	**4,507**	**4,069**	**737**	**1,100**	**746**	**260**	**191**	**37**	**31**	**311**	**302**	**45**	**39**	**-**	**18**	**12**	**42**	**128**	**164,282**

Table 3.14 (cont.). Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007.

Pound Net

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	304	131	131	0	17	46	3,584	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,218
9	441	234	234	0	26	72	4	8	-	3	101	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	1,123
10	1,194	584	584	1	70	189	1,650	1,312	-	5	101	37	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	5,728
11	1,087	1,172	1,172	4	78	250	9,894	132	69	31	-	-	-	-	-	1	2	-	-	-	-	12	-	0	-	5	-	13,910
12	1,178	1,682	1,682	277	94	321	4,171	2,438	167	184	104	-	-	-	-	2	3	0	-	-	-	32	-	0	-	9	-	12,344
13	573	1,965	1,965	40	72	295	92	1,814	179	165	171	27	-	-	-	2	5	-	3	-	-	18	-	0	-	9	-	7,395
14	1,342	3,527	3,527	77	144	561	1,502	599	1,291	671	821	41	9	2	37	4	8	46	1	-	-	6	-	1	2	1	-	14,219
15	1,793	3,407	3,407	136	162	591	218	487	757	1,219	1,376	69	-	8	18	7	15	231	-	-	-	6	10	0	-	-	-	13,918
16	1,404	2,090	2,090	413	114	393	82	1,296	1,150	548	1,233	77	-	16	18	5	14	69	-	-	-	6	10	2	9	1	1	11,041
17	1,892	1,237	1,237	93	118	338	3,238	64	973	664	1,589	377	2	-	58	6	18	103	27	28	8	13	21	12	46	16	17	12,195
18	1,846	846	846	1,243	106	286	8	57	435	437	875	140	48	32	136	11	70	201	147	115	92	176	76	46	284	106	131	8,794
19	913	394	394	0	52	138	152	6	69	155	425	39	74	36	19	8	89	199	158	67	41	253	65	35	175	120	169	4,246
20	218	99	99	0	13	34	75	78	321	20	42	93	55	63	79	6	86	163	164	33	45	135	49	16	101	66	169	2,320
21	994	373	373	269	55	144	9,182	-	-	15	52	143	191	169	238	45	41	56	208	73	71	130	51	8	132	99	199	13,314
22	50	19	19	-	3	7	75	76	46	-	10	328	130	61	724	8	17	32	370	122	95	123	90	20	146	138	293	3,000
23	373	140	140	-	21	54	-	800	115	-	-	247	294	50	927	119	17	75	364	203	151	104	106	38	135	181	352	5,006
24	137	51	51	60	8	20	-	114	252	20	-	235	363	70	894	194	24	24	357	272	166	141	160	48	208	179	289	4,338
25	124	47	47	105	7	18	-	-	-	49	10	136	233	114	529	235	51	47	193	198	146	95	82	54	163	119	230	3,031
26	112	42	42	224	6	16	-	-	-	15	-	56	329	124	230	164	57	0	93	86	92	72	47	55	80	67	137	2,147
27	118	44	44	284	7	17	-	-	-	-	-	40	89	213	10	154	33	0	11	92	57	22	-	24	31	35	70	1,393
28	68	26	26	-	4	10	-	-	137	10	10	8	35	33	9	4	12	-	8	59	20	13	4	11	5	13	9	534
29	25	9	9	-	1	4	-	-	23	15	-	10	16	45	1	3	6	-	17	52	2	18	3	4	3	7	2	276
30	6	2	2	-	0	1	-	-	-	5	-	31	-	39	-	4	8	-	9	34	8	8	10	1	-	11	3	184
31	6	2	2	-	0	1	-	-	23	-	-	5	-	60	1	5	10	-	13	-	24	8	-	-	-	-	-	160
32	6	2	2	-	0	1	-	-	23	-	-	41	-	38	1	5	9	-	-	1	24	12	-	-	-	-	1	166
33	12	5	5	-	1	2	-	-	-	-	7	1	1	44	-	5	11	-	-	16	8	18	-	-	-	-	-	136
34	13	22	22	0	1	4	1	2	-	1	101	2	-	8	-	2	4	-	-	-	31	-	-	-	-	-	-	212
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	-	-	-	-	-	-	-	-	-	1
36	-	-	-	-	-	-	-	-	-	-	-	-	1	8	-	3	6	-	-	16	31	6	-	-	-	-	-	71
37	6	2	2	-	0	1	-	38	-	-	-	1	-	-	-	1	1	-	-	-	-	6	-	-	-	-	-	59
38	31	12	12	-	2	5	-	38	-	20	-	1	4	-	-	1	2	-	-	-	8	-	-	-	-	-	-	134
39	12	5	5	-	1	2	-	-	46	-	-	-	1	2	-	1	2	23	-	-	-	-	-	-	-	-	-	99
40+	454	187	187	0	26	68	1	345	642	164	10	12	23	32	-	14	26	-	35	-	16	48	-	0	2	-	-	2,292
Total	**16,731**	**18,358**	**18,358**	**3,227**	**1,209**	**3,885**	**33,929**	**9,709**	**6,717**	**4,417**	**7,039**	**2,195**	**1,896**	**1,266**	**3,930**	**1,021**	**650**	**1,268**	**2,179**	**1,467**	**1,135**	**1,481**	**786**	**377**	**1,522**	**1,182**	**2,072**	**148,005**

Table 3.14 (cont.). Length frequencies for commercial red drum landings for the northern region (North Carolina and North) during 1981 to 2007.

Lines (hook and lines)

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
6	-	-	-	-	-	-	-	20	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
7	-	-	-	-	-	1	145	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	154
8	-	-	-	1	-	3	9	-	-	-	-	-	-	-	7	-	62	0	-	-	-	-	-	-	-	-	-	83
9	-	-	-	-	-	-	7	-	4	-	-	-	-	-	7	-	62	0	-	-	-	-	-	-	-	-	-	80
10	-	-	-	0	-	-	-	-	4	9	4	-	0	-	-	-	31	0	-	-	-	-	-	-	-	-	-	49
11	-	-	25	-	-	2	26	-	13	-	0	-	-	0	2	-	-	-	-	-	-	-	-	-	-	-	-	68
12	-	-	14	3	-	1	19	-	13	16	6	1	-	9	-	-	-	-	-	-	-	-	-	-	-	-	0	83
13	-	67	58	1	6	1	75	-	57	55	8	2	1	2	-	8	-	-	-	-	-	1	-	-	-	-	-	343
14	-	67	55	-	-	1	266	131	157	69	6	-	16	1	9	18	5	0	13	-	-	0	-	1	-	1	-	818
15	-	33	42	-	-	0	559	39	100	53	19	2	3	-	0	33	12	0	5	-	-	4	-	-	-	5	-	909
16	-	-	-	20	9	2	736	277	142	47	25	2	35	13	5	8	-	-	9	14	9	5	-	1	-	4	3	1,366
17	-	-	-	1	19	3	264	-	286	30	18	5	42	20	5	35	34	0	10	0	2	2	-	-	-	-	0	775
18	-	-	-	-	9	2	118	131	88	13	91	8	61	8	43	43	22	10	34	27	23	74	7	7	1	3	4	828
19	-	7	-	-	19	1	89	131	42	-	29	4	2	18	33	42	36	25	55	37	1	81	14	9	4	13	32	723
20	-	-	1	-	-	1	75	131	14	0	17	4	28	10	27	18	-	27	44	19	2	40	5	9	5	21	34	532
21	-	-	-	-	-	-	-	-	14	-	6	2	19	27	59	12	22	84	54	38	9	2	6	7	7	8	15	391
22	-	-	-	-	-	-	9	-	9	1	3	5	95	12	47	-	5	165	47	38	19	5	9	5	17	12	6	509
23	-	-	-	-	-	-	30	-	83	-	4	10	150	19	120	23	-	175	79	36	28	4	7	1	4	12	6	789
24	-	-	-	-	-	-	-	-	131	1	4	4	77	30	126	38	31	187	102	77	19	11	8	8	22	8	10	893
25	-	-	-	-	9	-	42	-	43	-	-	9	25	50	71	18	35	72	72	85	27	6	9	3	3	4	4	590
26	-	-	3	-	-	-	-	131	23	0	0	6	24	22	12	54	-	25	71	93	17	8	8	4	1	10	9	520
27	-	26	-	-	9	-	2	131	34	10	1	2	42	33	11	22	-	15	25	49	19	0	1	3	5	2	2	445
28	-	-	-	-	5	-	-	-	8	1	0	2	16	9	8	23	93	3	34	17	44	1	1	1	-	2	0	268
29	-	-	-	-	-	-	-	-	4	7	-	-	-	6	0	9	6	-	0	5	9	-	1	-	-	3	-	49
30	-	-	-	10	-	-	-	-	-	-	-	-	-	6	1	-	-	-	7	0	-	0	-	-	-	-	-	24
31	-	-	-	-	-	-	-	-	-	-	0	-	-	6	7	8	-	2	-	-	1	-	-	0	-	1	-	25
32	-	-	-	-	-	-	-	-	-	0	4	-	-	7	2	2	-	-	-	-	-	2	0	-	-	-	-	17
33	-	-	-	-	-	-	-	-	-	-	-	-	-	15	0	-	12	2	-	-	-	1	-	-	-	-	-	29
34	-	-	-	10	-	-	87	-	-	-	-	-	-	-	8	1	-	2	-	-	-	-	-	-	-	-	-	108
35	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	1	-	-	-	-	-	-	1
36	-	-	-	-	-	-	-	-	-	-	-	0	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	3
37	-	-	-	10	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	21
38	-	-	-	-	-	-	-	-	18	1	-	-	0	1	-	-	-	1	-	-	-	-	-	-	-	-	-	21
39	-	-	-	-	-	1	-	-	-	2	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	6
40+	-	-	3	10	-	7	4	-	1	3	0	0	2	10	1	4	1	5	0	-	2	-	-	-	-	-	-	53
Total	**-**	**201**	**201**	**66**	**86**	**24**	**2,562**	**1,131**	**1,287**	**317**	**246**	**67**	**638**	**335**	**619**	**419**	**470**	**803**	**662**	**536**	**230**	**253**	**76**	**59**	**70**	**109**	**126**	**11,594**

Table 3.15. Estimated age frequencies of red drum harvested from all major commercial gear categories for the northern region combined (North Carolina and north) for the period of 1981 to 2007.

Gear	Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	Total
Beach Seine	1981	84	68	5	0	0	0	0	0	0	5	162
	1982	180	147	10	1	0	0	0	0	0	10	349
	1983	1,515	1,232	87	7	2	1	2	2	1	82	2,931
	1984	1,614	2,875	735	23	-	-	-	-	-	-	5,247
	1985	561	456	32	3	1	1	1	1	0	30	1,085
	1986	992	807	57	4	1	1	1	1	1	54	1,918
	1987	2,111	1,166	80	-	-	-	-	-	-	-	3,357
	1988	2,573	999	77	1	6	6	9	4	3	167	3,845
	1989	647	849	87	9	0	2	0	1	2	235	1,833
	1990	4,547	2,988	132	3	7	-	4	6	-	358	8,044
	1991	1,118	693	27	9	1	-	-	-	-	16	1,864
	1992	9	370	19	8	0	0	0	-	0	3	409
	1993	12	946	504	1	1	1	1	1	0	12	1,479
	1994	7	186	132	13	0	0	-	0	0	4	343
	1995	3	970	176	1	-	-	-	-	-	-	1,150
	1996	23	576	192	4	-	-	-	-	-	-	794
	1997	132	412	111	3	0	0	0	0	-	0	658
	1998	179	1,733	1	-	-	-	-	-	-	0	1,913
	1999	3	401	234	20	-	-	-	-	-	-	658
	2000	27	1,735	1,565	27	-	-	-	-	-	-	3,354
	2001	12	179	268	1	-	-	-	-	-	-	460
	2002	19	142	14	0	-	-	-	-	-	-	176
	2003	4	183	31	0	-	-	-	-	-	-	218
	2004	28	56	50	0	-	-	-	-	-	-	134
	2005	21	330	13	1	-	-	-	-	-	-	365
	2006	21	236	102	3	-	-	-	-	-	-	361
	2007	5	164	42	1	-	-	-	-	-	-	212
Gill Net	1981	4,905	3,990	281	22	6	4	6	6	3	265	9,487
	1982	4,113	3,346	236	18	5	4	5	5	3	223	7,956
	1983	28,755	20,655	1,218	103	30	19	25	26	13	1,165	52,008
	1984	15,570	27,731	7,086	226	-	-	-	-	-	-	50,613
	1985	14,723	11,978	844	66	18	13	17	18	9	797	28,481
	1986	19,261	15,564	1,087	85	23	17	22	23	12	1,027	37,120
	1987	43,148	23,829	1,626	0	0	-	-	-	-	0	68,604
	1988	30,271	11,750	908	10	69	69	111	45	31	1,967	45,230
	1989	30,541	27,424	247	-	-	-	-	-	-	944	59,156
	1990	26,600	14,135	428	22	-	-	-	-	-	686	41,870
	1991	21,437	11,408	233	145	14	-	-	-	-	-	33,238
	1992	812	28,715	1,611	135	-	-	-	-	10	132	31,414
	1993	197	22,771	13,044	16	2	1	0	2	0	39	36,073
	1994	565	11,958	7,223	582	0	1	0	2	1	48	20,379
	1995	122	27,088	5,677	45	-	-	-	-	-	-	32,933
	1996	2,637	13,127	2,619	7	2	1	1	0	0	8	18,400
	1997	1,665	5,439	1,485	45	1	0	0	0	0	5	8,641
	1998	6,600	69,800	105	1	0	1	0	1	1	15	76,524
	1999	6,124	59,623	12,100	113	4	-	-	0	0	54	78,019
	2000	1,228	28,688	16,644	393	18	5	4	2	2	46	47,029
	2001	751	10,735	15,401	93	12	3	3	1	0	12	27,009
	2002	1,949	14,318	1,136	34	6	3	3	1	1	40	17,489
	2003	326	15,961	2,868	21	-	-	-	-	-	-	19,176
	2004	1,405	2,788	4,809	68	-	-	-	-	-	1	9,071
	2005	1,788	24,600	718	28	-	-	-	-	-	-	27,133
	2006	825	23,997	7,921	82	-	-	-	-	-	-	32,826
	2007	1,210	37,880	9,366	65	-	-	-	-	-	5	48,526

Table 3.15 (cont.). Estimated age frequencies of red drum harvested from all major commercial gear categories for the northern region combined (North Carolina and north) for the period of 1981 to 2007.

Gear	Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	Total
Haul Seine	1981	1,882	1,531	108	8	2	2	2	2	1	102	3,640
	1982	1,177	958	68	5	1	1	1	1	1	64	2,278
	1983	45,100	2,608	1	4	3	0	-	0	-	7	47,723
	1984	1,848	3,291	841	27	-	-	-	-	-	-	6,006
	1985	2,377	1,916	133	11	3	2	3	3	1	126	4,575
	1986	12,673	10,080	690	54	15	11	14	15	7	653	24,211
	1987	12,887	7,066	467	1	0	-	-	-	-	1	20,423
	1988	5,887	2,238	167	2	14	13	22	9	6	344	8,703
	1989	2,180	1,866	745	109	4	20	5	15	20	1,240	6,205
	1990	2,706	2,018	75	0	4	-	2	5	-	228	5,037
	1991	7,269	253	3	-	-	-	-	-	-	31	7,556
	1992	58	1,035	34	34	1	1	0	0	0	9	1,173
	1993	55	1,389	470	-	0	1	2	1	1	98	2,017
	1994	9	1,270	722	18	1	5	2	8	5	162	2,201
	1995	59	6,371	929	2	-	-	-	-	-	-	7,361
	1996	28	1,725	150	1	0	-	-	-	-	1	1,904
	1997	448	1,392	379	12	1	0	1	0	0	3	2,235
	1998	1,444	11,446	14	-	0	1	0	1	1	15	12,922
	1999	128	695	119	1	-	-	-	-	-	-	944
	2000	46	418	177	34	8	2	2	1	1	22	711
	2001	3	39	66	8	4	1	1	0	0	4	125
	2002	38	324	46	5	4	1	1	-	-	0	419
	2003	6	248	32	5	-	-	-	-	-	-	291
	2004	47	83	113	2	-	-	-	-	-	1	244
	2005	9	127	5	0	-	-	-	-	-	0	141
	2006	19	359	91	3	-	-	-	-	-	-	472
	2007	20	568	91	1	-	-	-	-	-	6	686
Hook and Line	1981	-	-	-	-	-	-	-	-	-	-	-
	1982	7	3	1	0	-	-	-	-	-	-	12
	1983	146	50	2	-	-	-	-	-	-	3	201
	1984	16	11	8	8	6	2	3	1	1	11	66
	1985	23	47	16	1	-	-	-	-	-	-	86
	1986	10	6	-	-	-	0	0	0	0	7	24
	1987	1,332	1,114	31	49	30	2	-	2	-	4	2,562
	1988	338	594	186	7	2	2	2	1	1	1	1,131
	1989	466	693	109	1	2	2	4	2	1	8	1,287
	1990	201	91	18	0	0	-	0	0	0	6	317
	1991	160	79	4	3	-	0	-	-	-	0	246
	1992	5	56	5	0	-	-	-	-	-	-	67
	1993	39	442	155	0	0	0	0	0	-	2	638
	1994	32	150	115	24	2	1	0	1	0	11	335
	1995	51	468	86	10	3	0	-	0	-	1	619
	1996	130	186	90	9	0	0	-	-	-	4	419
	1997	225	122	105	16	2	0	0	-	-	1	470
	1998	9	726	55	4	1	0	0	0	0	6	803
	1999	52	438	166	5	-	-	-	-	-	0	662
	2000	13	270	243	9	-	-	-	-	-	-	536
	2001	10	69	143	6	0	-	-	-	-	2	230
	2002	53	185	9	2	1	1	1	0	0	0	253
	2003	1	59	16	1	-	-	-	-	-	-	76
	2004	12	28	19	0	-	-	-	-	-	-	59
	2005	0	65	5	0	-	-	-	-	-	-	70
	2006	6	78	24	1	-	-	-	-	-	-	109
	2007	4	105	17	0	-	-	-	-	-	-	126

Table 3.15 (cont.). Estimated age frequencies of red drum harvested from all major commercial gear categories for the northern region combined (North Carolina and north) for the period of 1981 to 2007.

Gear	Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	Total
Pound Net	1981	6,194	5,021	352	27	7	6	7	7	4	333	11,958
	1982	912	619	33	3	1	1	1	1	0	32	1,602
	1983	11,564	6,369	186	24	10	3	4	4	2	192	18,358
	1984	666	1,121	281	9	-	-	-	-	-	0	2,076
	1985	673	477	28	2	1	0	1	1	0	26	1,209
	1986	2,262	1,469	72	7	2	1	1	2	1	69	3,885
	1987	21,371	11,764	792	1	0	-	-	-	-	1	33,929
	1988	6,526	2,594	166	3	13	13	20	8	6	361	9,709
	1989	2,842	2,911	250	27	1	5	1	4	5	673	6,717
	1990	4,553	2,870	122	3	7	-	3	5	-	330	7,893
	1991	8,139	2,734	49	93	50	3	-	3	-	24	11,096
	1992	204	2,474	137	53	1	2	1	0	1	16	2,889
	1993	13	1,144	710	1	1	1	1	1	0	25	1,896
	1994	33	530	527	128	11	2	1	1	0	33	1,266
	1995	131	3,296	622	5	-	-	-	-	-	-	4,054
	1996	39	571	294	18	3	1	1	0	0	15	941
	1997	139	322	125	25	6	2	2	1	1	28	650
	1998	250	864	16	-	0	2	1	2	2	13	1,151
	1999	171	1,859	444	12	0	-	-	0	0	34	2,520
	2000	33	777	598	44	10	2	3	-	-	0	1,467
	2001	30	417	668	56	28	6	6	1	1	19	1,233
	2002	216	1,178	155	35	6	3	3	1	1	53	1,649
	2003	6	163	68	2	-	-	-	-	-	-	239
	2004	67	124	182	3	-	-	-	-	-	0	377
	2005	131	1,894	74	3	-	-	-	-	-	2	2,104
	2006	59	1,046	380	7	-	-	-	-	-	-	1,492
	2007	52	1,736	526	6	-	-	-	-	-	-	2,320
Trawl	1981	2,867	2,315	162	13	3	3	3	3	2	153	5,523
	1982	3,346	2,545	164	13	4	3	3	3	2	156	6,239
	1983	8,512	6,625	441	35	10	7	9	9	5	418	16,070
	1984	13,403	18,269	0	1	1	-	-	-	-	2	31,676
	1985	7,908	6,363	442	35	9	7	9	9	5	418	15,204
	1986	10,085	7,780	511	41	11	8	10	11	6	485	18,949
	1987	6,811	3,749	252	0	0	-	-	-	-	0	10,812
	1988	9,384	3,872	169	6	15	13	21	9	6	372	13,866
	1989	1,444	1,650	155	17	1	3	1	2	3	417	3,692
	1990	1,101	1,060	97	1	11	-	5	5	-	294	2,574
	1991	1,044	618	119	9	0	-	-	-	-	135	1,926
	1992	115	394	87	8	-	0	-	-	-	3	607
	1993	9	697	382	1	1	0	1	0	0	10	1,100
	1994	23	220	335	122	12	3	1	1	0	30	746
	1995	52	154	50	1	-	-	-	-	-	-	257
	1996	15	133	48	4	1	0	0	0	0	4	206
	1997	7	23	6	0	-	-	-	-	-	-	37
	1998	4	27	0	-	-	-	-	-	-	0	32
	1999	17	197	58	3	0	-	-	0	-	16	291
	2000	10	152	107	16	4	1	1	0	0	10	302
	2001	1	9	23	5	2	1	1	0	-	2	42
	2002	6	19	6	2	1	0	0	0	-	3	36
	2003	18	588	217	8	-	-	-	-	-	-	831
	2004	4	6	8	0	-	-	-	-	-	0	18
	2005	1	8	1	-	-	-	-	-	-	0	10
	2006	5	21	12	1	-	-	-	-	-	-	38
	2007	2	85	28	1	-	-	-	-	-	1	117

Table 3.15 (cont.). Estimated age frequencies of red drum harvested from all major commercial gear categories for the northern region combined (North Carolina and north) for the period of 1981 to 2007.

Gear	Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	Total
Other	1981	-	-	-	-	-	-	-	-	-	-	-
	1982	-	-	-	-	-	-	-	-	-	-	-
	1983	16	13	1	0	-	-	-	-	-	1	32
	1984	50	24	1	0	-	-	-	-	-	0	74
	1985	51	41	3	0	0	-	0	0	-	3	98
	1986	-	-	-	-	-	-	-	-	-	-	-
	1987	-	-	-	-	-	-	-	-	-	-	-
	1988	-	-	-	-	-	-	-	-	-	-	-
	1989	-	-	-	-	-	-	-	-	-	-	-
	1990	33	11	-	-	-	-	-	-	-	0	44
	1991	46	17	1	0	-	-	-	-	-	0	64
	1992	-	-	-	-	-	-	-	-	-	-	-
	1993	-	2	2	-	-	-	-	-	-	0	4
	1994	0	11	8	1	-	-	-	-	-	0	20
	1995	1	20	4	-	-	-	-	-	-	-	25
	1996	6	17	7	2	1	0	0	0	-	2	36
	1997	8	22	7	1	0	-	-	-	-	1	38
	1998	35	84	4	-	-	0	0	0	0	4	128
	1999	2	17	4	0	-	-	-	-	-	1	25
	2000	0	6	3	0	-	-	-	-	-	-	9
	2001	0	2	3	-	-	-	-	-	-	-	4
	2002	9	39	8	3	1	0	0	0	0	5	65
	2003	0	16	3	-	-	-	-	-	-	-	20
	2004	1	1	1	-	-	-	-	-	-	-	2
	2005	21	105	1	-	-	-	-	-	-	4	130
	2006	221	738	235	27	-	-	-	-	-	-	1,221
	2007	32	975	303	2	-	-	-	-	-	11	1,323

Table 3.16. Estimated age frequencies of red drum harvested for all major commercial gears combined for the northern region (North Carolina and north) during 1981-2007.

Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	Total
1981	15,930	12,925	907	71	19	14	18	19	10	857	30,770
1982	9,735	7,617	511	41	11	8	10	11	6	484	18,434
1983	95,609	37,552	1,935	173	54	31	39	41	21	1,867	137,322
1984	33,166	53,321	8,951	295	6	2	3	1	1	13	95,758
1985	26,315	21,279	1,497	116	31	23	30	31	16	1,400	50,738
1986	45,282	35,706	2,417	191	52	38	49	51	26	2,295	86,107
1987	87,659	48,688	3,247	50	30	2	-	2	-	7	139,686
1988	54,979	22,047	1,673	29	118	115	185	74	52	3,211	82,483
1989	38,120	35,392	1,592	163	8	32	11	24	31	3,517	78,890
1990	39,742	23,173	871	28	29	-	14	22	0	1,902	65,781
1991	39,213	15,803	436	259	65	3	-	3	-	207	55,989
1992	1,204	33,045	1,892	237	3	4	1	0	11	163	36,559
1993	325	27,392	15,266	19	4	4	5	4	3	186	43,206
1994	669	14,325	9,061	887	25	11	5	12	7	287	25,290
1995	419	38,367	7,544	64	3	0	-	0	-	1	46,398
1996	2,878	16,333	3,400	44	7	2	2	1	1	34	22,700
1997	2,625	7,731	2,218	101	10	3	3	1	1	38	12,730
1998	8,521	84,681	196	5	2	4	1	4	5	53	93,471
1999	6,497	63,230	13,125	155	4	-	0	0	0	106	83,117
2000	1,358	32,046	19,338	523	39	11	10	3	3	77	53,408
2001	807	11,449	16,571	168	47	10	11	2	1	38	29,103
2002	2,291	16,204	1,373	80	18	8	9	2	1	101	20,087
2003	362	17,218	3,235	36	-	-	-	-	-	-	20,851
2004	1,563	3,086	5,182	73	-	-	-	-	-	2	9,905
2005	1,971	27,127	816	32	-	-	-	-	-	7	29,954
2006	1,156	26,475	8,765	123	-	-	-	-	-	-	36,519
2007	1,326	41,513	10,373	75	-	-	-	-	-	22	53,310

Table 3.17. Estimated age frequencies of dead red drum discards resulting from the North Carolina estuarine gill net fishery from 2004 to 2006.

Year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10+	Total
2004	10,130	341	636	108	-	2	0	1	0	12	11,229
2005	13,160	11,719	922	65	-	-	-	-	-	-	25,866
2006	8,892	5,031	1,461	129	2	0	-	-	-	-	15,514

3.13 Figures

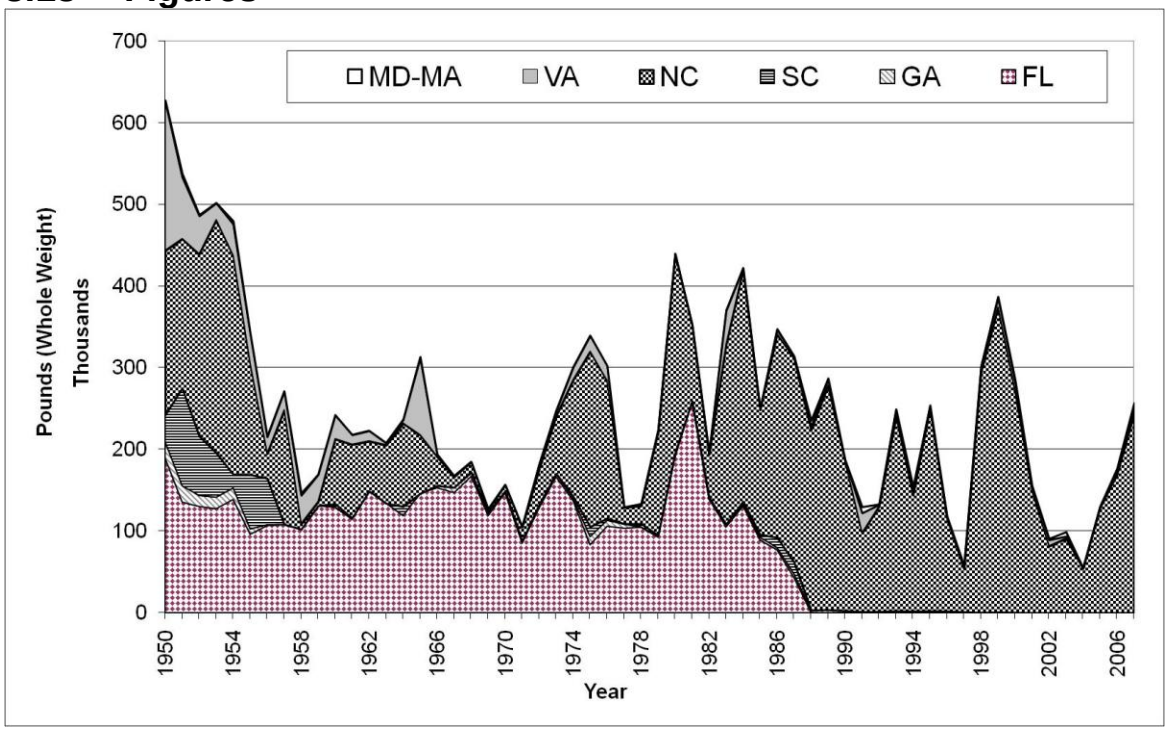


Figure 3.1. Red drum commercial landings in pounds (whole weight) by state from the US Atlantic coast, 1950-2007 (see text for data sources). MD-MA includes state landings from Maryland to Massachusetts excluding Virginia. Virginia landings were reported separately.

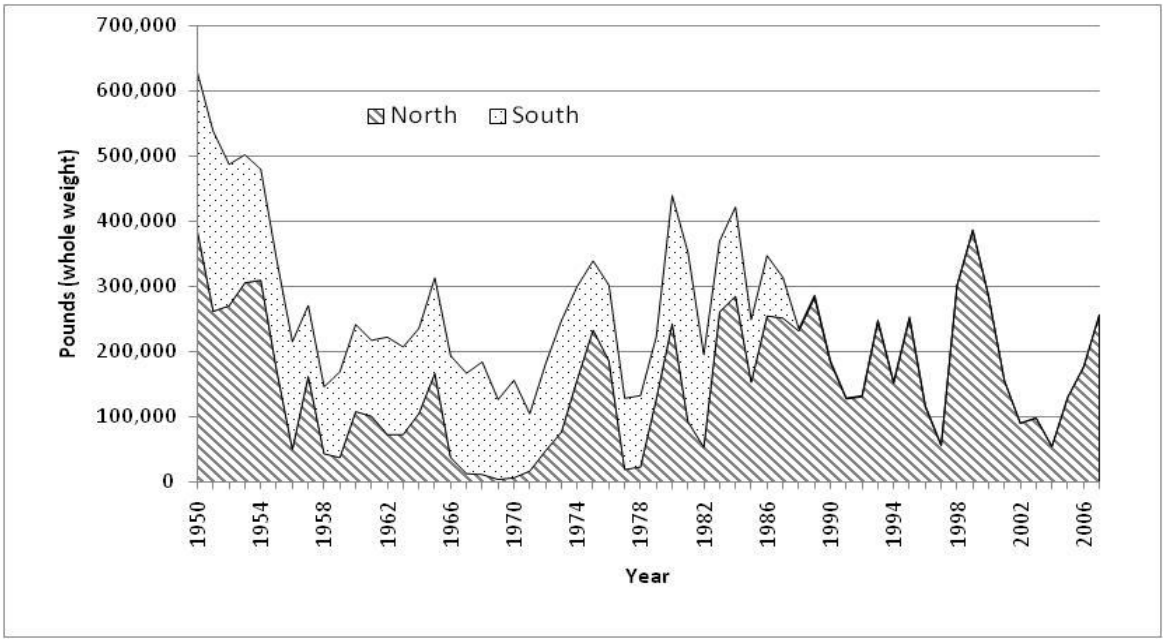


Figure 3.2. Red drum commercial landings in pounds (whole weight) by region from the US Atlantic coast, 1950-2007. Northern region includes states from Massachusetts to North Carolina. Southern region includes landings from South Carolina, Georgia, and Florida.

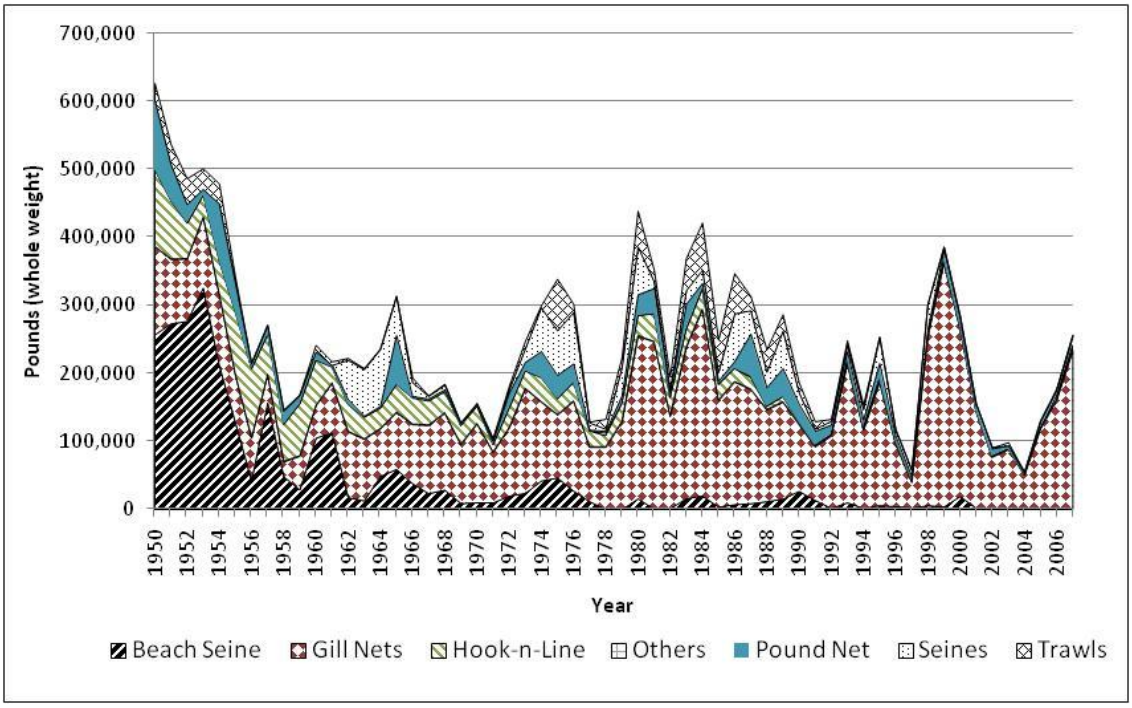


Figure 3.3. Red drum commercial landings in pounds (whole weight) by gear from the US Atlantic coast, 1950-2007 (see text for gear descriptions).

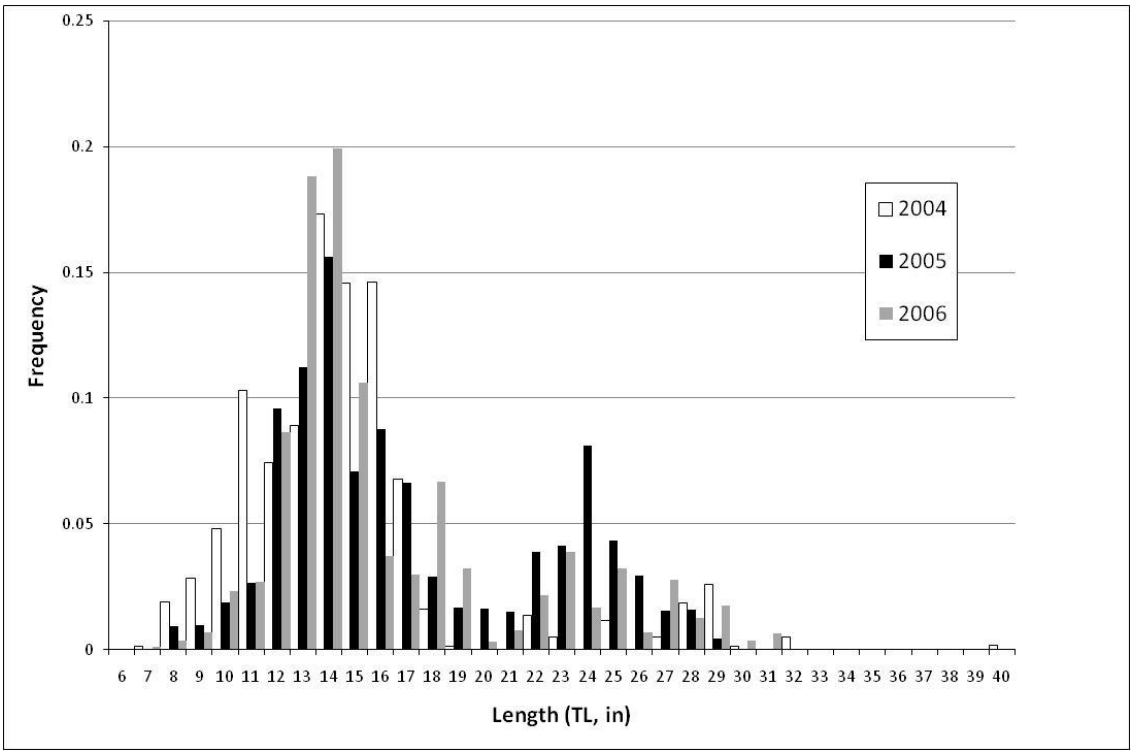


Figure 3.4. Red drum length frequency distribution that resulted from release mortality of the estuarine gill net fishery in North Carolina from 2004 to 2006.

4. Recreational Fishery Statistics

4.1 Overview

4.1.1 Group Membership

Chair	Mike Denson	SCDNR
Members	Tom Sminkey	NMFS Silver Spring
	Kathy Knowlton	GADNR
	Steve Arnott	SCDNR
	Chris McDonough	SCDNR
	Mike Murphy	FWC

4.1.2 Issues

None

4.2 Review of Working Papers

SEDAR18-DW09 "Recreational harvest estimates and estimated catch-at-age for the recreational fishery in Florida during 1982-2007."

The recreational fishery workgroup reviewed this document and determined that it provides background information on estimated red drum landings in Florida using MRFSS angler interview information. The survey covers the period Mar 1981 through 2007. It mentions significant changes in survey design that took place from 2004 onwards and references conversion factors to overcome this (also discussed during the work group sessions). It also makes assumptions used for back-dating total catch estimates to 1950. Estimated number of red drum killed by anglers in FL = 5% of live releases. In addition it gives extensive details of length-at-age keys (and assumptions), lengths of landed fish and ages of landed fish. Eleven tables of data and 1 figure are included.

SEDAR18-DW17 "Estimating the size and age composition of the B–2 fish (caught and released alive) in the recreational fishery for red drum in South Carolina."

The MRFSS (Marine Recreational Statistical Survey) conducted by the National Marine Fisheries Service) and the state's recreational survey provides data on the number, length and weight of harvested fish, but there are no weight data for the B-2 fish. There are methods available to assign fishes of a given length to a specific age group or cohort. The length composition can be used to estimate the age structure. If you have an estimate of the catch and release mortality by length (age) of the fish, then you can assign the losses from fishing into year classes by weight. As the year class progresses through time, its abundance decreases; the rate of loss is the mortality rate. Combined age length keys from South

Carolina's fishery independent surveys (trammel net, electroshock boat, long line surveys) covering the same time period will be applied the annual size frequency distributions during the SEDAR process to derive age distribution for this data set.

4. 3 Recreational Surveys

4.3.1 Headboat Fishery

4.3.1.1 Headboat Landings

Historical accounts of headboat fishing in the South Atlantic for offshore snapper-grouper species date back to the years immediately following World War II. The headboat fishery is a readily identifiable segment of the recreational fishery, and is responsible for a significant percent of the recreational catch for some species. Presently, the number of vessels in the headboat fleet fluctuates slightly from year to year as boats enter or leave the fishery, nonetheless, the relative size of the fleet is known, making it accessible to the Southeast Region Headboat Survey. From 1981-present the Survey included all headboats operating in the southeastern U.S. EEZ. The South Atlantic headboat sampling occurred from 1981-2007. The data available were catch and total weight. The number of samples was very patchy and ranges from 1-451 fish per year (Table 4.3.1.1). Red drum occur primarily inshore and therefore are less likely to be encountered on headboats, making these data of questionable use.

4.3.1.2 Headboat Discards

No data available

4.3.1.3 Headboat Catch-at-Age/Length - directed and discard

4.3.1.4 Headboat Effort

Not adequate

4.3.1.5 Headboat Sampling Intensity Length/Age/Weight

Total headboat weights ranged from 6-3228 lbs total harvest (See Table 4.3.1.1).

4.3.1.6 Headboat Length – Age Distributions

No length composition was generated from the headboat fishery.

4.3.1.7 Headboat Adequacy for Characterizing Catch

The workgroup concluded that the data are insufficient to draw conclusions about red drum and the effect of the headboat fishery and will not be useful in the assessment (Table 4.3.1.1).

4.3.1.8 Comments on Adequacy of Headboat Data for Assessment Analyses

The workgroup concluded that the data are insufficient to draw conclusions about red drum and the effect of the headboat fishery and will not be useful in the assessment

4.3.2 General Recreational Landings (MRFSS)

MRFSS description and data collection

4.3.2.1 MRFSS Intoduction

(Text taken from Diaz and Phares, 2004 and modified for Atlantic Coast.)

The Marine Recreational Fishery Statistics Survey (MRFSS) was established to create a reliable database for estimating catch and effort by the marine recreational fishery (http://www.st.nmfs.gov/st1/recreational/survey/overview.html). In the traditional MRFSS methodology, data are collected by a telephone survey of households in coastal counties and by interviewing anglers at fishing access sites. MRFSS acknowledged that the estimation of effort for the charterboat sector is difficult due to the low incidence of this type of fishing trips by households contacted in the telephone survey. To reduce the effect of small sample sizes on charterboat effort estimation, data from a 5-year period are combined for estimates using the traditional MRFSS method. Pooling data across years provides a larger data set to produce more reliable estimates of effort. However, this approach tends to mask trends in the fishery, annual weather patterns, etc. To improve the effort estimation procedure for the charterboat mode, MRFSS started testing a new survey protocol named For Hire Survey (FHS) in 1995 (http://www.st.nmfs.gov/st1/ recreational/pubs/charter_method.pdf). To implement the new FHS, charterboat directories were created by NMFS and participating state agencies and are maintained by the NMFS' Contractor. Approximately 10% of the charterboats in the directory are randomly contacted by phone and asked relevant information regarding their fishing activities (e.g., number of trips and anglers, area of fishing, etc.). MRFSS concluded that the FHS produced significantly 'more efficient, precise, and credible charter angler effort estimates than the traditional MRFSS method'. The FHS was officially adopted as the new charterboat method in the Gulf of Mexico in 2000 and expanded to the Atlantic Coast in 2004. This document provides conversion factors to adjust effort estimates obtained by MRFSS until 2004 along the Atlantic Coast to the FHS effort levels 2004-2007. The adjusted effort levels were applied to landings' CPUEs to produce adjusted historical Spanish mackerel landings from the Mid-Atlantic US.

4.3.2.2 MRFSS Methods

From 2004 to 2007, the NMFS estimated charterboat effort using both the MRFSS (old) and FHS (new) protocols. Thus, differences in effort estimates for each stratum between both methodologies can be directly compared only for that period of time. Each stratum is defined by a unique combination of state, year, wave, and fishing-area, where wave corresponds to bimonthly periods starting in January. The MRFSS defined fishing areas for most states as: a) Inshore waters, b) < 3 miles, and c) > 3 miles. For the period 1986-2003, charterboat effort was estimated using only the MRFSS protocol. To calibrate MRFSS charterboat effort estimates (1986-2003) to FHS levels, conversion factors (ratios) between FHS and MRFSS charterboat effort were estimated using 2004-2007 data and applied to the 1986-2003 MRFSS effort estimates. To estimate the conversion factors, a ratio of FHS/MRFSS effort estimates was calculated for each stratum using only the estimates from the period 2004-2007. A generalized linear model (GLM procedure, SAS Inst.) was used to identify significant factors and to estimate predicted ratios. The factors included in the model were year, wave, fishing area, state and the interaction terms. In the event that a factor was found non-significant ($P > 0.05$), it was removed and the regression re-run until all (highest order) model terms were significant (Hocking 1976, Draper and Smith 1981). In the Mid-Atlantic region the significant strata

were state and wave only, and Delaware and Maryland were not significantly different in the model so they were pooled for the purpose of conversion factor computation. In the South Atlantic region the significant factors were water body, wave and state and GA and SC clustered together. The predicted ratios are used as the conversion factors, which were then applied to the original cell-level effort estimates by stratum. The adjusted effort estimates were multiplied by the catch per trip by species to generate the adjusted Charter mode catch and landings estimates, then summed with the MRFSS private boat and shore catch statistics to produce the revised annual landings in numbers of fish. Weight landings were then produced using the average weight per fish landed by stratum then summing to produce annual state landings and annual coast or stock landings in pounds of fish.

From 1981 to 1985, the MRFSS considered charterboats and headboats as part of single fishing mode (party-charter). Thus, the conversion factors estimated with 2004-2007 charterboat data (used to calibrate 1986-2003 charterboat effort estimates) cannot be used to calibrate the 1981-1985 estimates. To calibrate the 1981-1985 combined charterboat and headboat catch estimates, conversion factors will be estimated using 1986-1990 catch estimates, by species, instead of 2004-2007 to minimize possible effects of changes in the fishery over time. To do so, headboat (NMFS Headboat Survey) and original (MRFSS) charterboat catch estimates were combined (summed) into one estimate for each year and wave. These estimates were then modeled against the MRFSS-only catch estimates to produce a time series factor for conversion of the PC estimates from the 1981-1985 period to a revised time series of annual Charter Boat only catch estimates for 1981-1985.

4.3.2.3 MRFSS Party-Charter Mode Red Drum Landings Estimation for 1981-1985

The annual landings of red drum in the mid-Atlantic region are extremely rare north of VA, particularly in the 1981-85 period. The SEHB survey does not include VA so we do not have any independent head boat landings for north of NC, which do use for adjustment of the 1981-85 Party-Charter (PC) MRFSS estimates, but based on landings during the same period from headboats in the South Atlantic region (very low annual totals with 3 of 5 years having recorded landings of 1 fish or less for the region from head boats), it is unlikely that a significant component of the PC landings (MRFSS) came from head boats in VA during 1981-85. Further, those annual PC landings are small enough relative to the total annual landings that any adjustment due to survey methodology compensation was considered insignificant. Therefore, the group decided that, due to the lack of detailed landings by mode for this time period, the MRFSS Party-Charter red drum landings estimates would be sufficient for this assessment without any additional adjustments.

4.3.2.4 MRFSS LSMEAN Ratios - Mid Atlantic Region

Significant factors are Wave and State, with DE and MD clustering together (Table 4.3.2.4).

4.3.2.5 MRFSS LSMEAN Ratios - South Atlantic Region

Significant factors are Water body, Wave, and State with SC and GA clustering together (Table 4.3.2.5).

4.3.2.6 MRFSS General Recreational Discards and Discard Trends

The access-point recreational fisheries surveys (angler intercept) ask anglers about any fish that was caught and then either landed with its body incomplete (gutted, filleted, etc), or not landed at all (released alive). Those that were released alive were designated as discards and the raw reported data were expanded to the estimated totals following the same procedures as the landed fish. No size data were available for this class of catch.

4.3.2.7 MRFSS Biological Sampling

4.3.2.7.1 Sampling Methods

The only biological data collected during the routine MRFSS/FHS surveys are length of fish and weight of landed fish. Both are collected opportunistically but field interviewers are instructed to measure and weigh up to fifteen fish of each available species from each angler interviewed. The individual fish are to be selected from the total landed catch at random to avoid any size-bias in the resultant sample. Fish are measured to the nearest mm fork length (center-line total length in non-forked fish) and weighed to the nearest 1/8 or ½ kg, depending on scale precision. Annual sample sizes of fish measured are included on the length-frequency worksheet.

4.3.2.7.2 Sampling Intensity Length/Age/Weight

See biological sampling section for length and weight sampling. No age samples are taken from MRFSS/FHS surveys.

4.3.2.7.3 Length – Age Distributions

None by surveys

4.3.2.7.4 Adequacy for Characterizing Catch

The samples of length and weight from the MRFSS/FHS surveys are stratified by year, wave, state, mode of fishing, and area fished (= cell) for purposes of estimating mean weight per fish and length frequency (weighted by catch). These cell samples are used to expand the cell catches in number to total kg and pounds landed, then are summed across cells to produce the annual statistics. Similarly, the length frequencies are expanded to counts per length group per cell, and then summed across cells to produce a single annual frequency distribution. If a cell is empty of sample, then a mode or state-level mean is substituted for mean weight. If the length frequency is absent from a cell but a catch number is estimated, then the cell is considered similar to the overall size-frequency distribution.

4.3.2.7.5 Alternatives for Characterizing Discards

None

4.3.2.8 MRFSS General Recreational Catch-at-Age/Length - Directed and Discard

None

4.3.2.9 MRFSS General Recreational Effort

Effort estimates by year, state, wave, fishing mode and area fished are available through the MRFSS for the entire time series. Recent years have an increased sample size for the Coastal Household Telephone Survey (2006 & 2007) in several states in which red drum

are caught, thereby improving the precision of the effort estimates. Improvements in effort estimates were also achieved in the charterboat mode based on the 2004 implementation of the For-Hire Survey (FHS). As previously stated in Section 4.3.1, the MRFSS concluded that the FHS produced significantly 'more efficient, precise, and credible charter angler effort estimates than the traditional MRFSS method'.

4.3.2.9.1 Historical Data

As with previous SEDARs, the workgroup was tasked with collecting recreational landings for years prior to the start of the MRFSS in 1981. The U.S. Fish and Wildlife Service conducted salt-water angling surveys in 1960, 1965, and 1970 (Clark 1962; Deuel and Clark 1968; Deuel 1973). These surveys resulted in estimates of the number of anglers, number and weight of fish caught by region for all recreational fishing, and number of days fished per year (1970 survey only). Catch data from the Middle and South Atlantic Regions are included in Table 4.3.2.9.1. In the 1960 survey, anglers reported only total number of fish caught and fishing method. Biologists and other knowledgeable professionals estimated the average weight per species post-angler interview. In addition to limited utility of weight data from the 1960 survey, the potential for recall bias is also possible in all three surveys. As noted in SEDAR 17, the long recall period of one year could likely lead to overestimates of landings and effort. SEDAR 17 assessment workshop authors reduced estimates to 75% of the reported values for the assessment model base run, and 50%, 100%, and125% for the sensitivity runs. As noted in SEDAR 17, should the historical catch estimates be utilized during the assessment, percent standard error (PSE) estimates will need to be derived from a linear interpolation of tabled values provided in the U.S. Fish and Wildlife Service salt-water angling survey reports.

4.3.2.10 MRFSS Comments on Adequacy of General Recreational Data for Assessment Analyses

The MRFSS provides the longest running, uninterrupted recreational and charter fishing catch data in the south and mid Atlantic. For those states catching significant numbers of red drum, most estimates of annual total catch (and often annual harvest estimates) have PSE's <20, indicating acceptable levels of precision.

4.3.3 South Carolina Finfish Survey (SFS)

4.3.3.1 SC-SFS Description and Sampling design

The collection of inshore finfish intercept data in South Carolina was conducted through a non-random intercept survey at public boat landings and piers in the following areas: 1) Georgetown/Murrells Inlet, 2) Metropolitan Charleston, and 3) Beaufort/Hilton Head. The survey focuses on known productive sample sites and was conducted during January-December using a questionnaire and interview procedures similar to those of the MRFSS.

4.3.3.2 SC-SFS Background

Implemented in 1989, the State Finfish Survey (SFS) was designed to address specific gaps within the MRFSS data, as identified by SCDNR staff. These gaps included the lack of length data from species of concern to the SCDNR and the lack of seasonal and area-specific catch frequencies. Another concern was the lack of catch and effort data

from private boat anglers, which make up a majority of the angling trips in South Carolina coastal waters. These data gaps were initially addressed by interviewing inshore anglers who were targeting the red drum at specific sample locations. Since 2002, more emphasis has been placed on acquiring length data from all finfish retained by anglers, canvassing at additional sampling locations, and interviewing all private fishing boats within each area of the coast. Broadening the scope of the survey may decrease some of the bias associated with the previous SFS protocol, which could potentially allow for better catch estimates and length frequency data.

4.3.3.3 SC-SFS Protocols

Sampling is conducted at public and selected private (with owner's permission) boat landings from January through December using a questionnaire and interview protocols similar to those of the MRFSS. However, the SFS questionnaire focuses on vessel surveys rather than individual angler surveys and primarily targets private boats. Interviews are obtained from cooperative anglers at each sampling site. If an angler is unwilling to participate, they can decline to be interviewed. Assigned Creel Clerks interview as many anglers as time allows at any given site.
The sampling schedule is determined by "needs assessments" of the SCDNR Marine Resources Division and creel clerks. Individual creel clerks are assigned to a sampling region and will determine their daily sampling schedules based on local conditions (i.e. weather, landing closures, or events), additional job duties, and research and management initiatives. Attempts are made to assess all sampling sites equally, and individual creel clerks randomly rotate between all sampling locations within their region. Creel clerks will remain at boat landings with fishing activity. If boat landings have little or no fishing activity, creel clerks move to alternative sampling locations in close proximity.

4.3.3.4 SC-SFS Landings

Red drum catch data by trip are available from 1991-2007 (~14,000 records). Strata include fishing mode (~95% private boat mode), area fished, number of anglers, number of hours fished, and total number of released and harvested fish by species. The dataset is available in the SEDAR 18 Data Workbook, file name: South Carolina State Creel Survey Data.

4.3.3.5 SC-SFS Biological Sampling

Over 8,000 red drum lengths (total length in mm) are available, with an average of ~470 per year. Length frequency per year can be generated.

4.3.3.6 SC-SFS Comments on Adequacy for Characterizing Catch

Length data from the SFS could be particularly helpful if there are gaps in the MRFSS length data for SC. However, since there are only biased estimates from directed sampling in non-random locations, estimates of total catch and harvest that are equivalent to MRFSS cannot be produced. A review of SC annual sample size obtained through the MRFSS indicates there is no year in which fewer than 20 red drum lengths were obtained. An additional comparison of catch estimates vs. presence/absence of length data for cell combinations of year, by wave, by fishing mode indicates that the length data are relatively complete (cell n=20). Since 1991 (when SC data start) there were only two waves in the MRFSS data (Wave 3 in 2003 and Wave 2 in 2005) in which there were

catch estimates but no length data. Neither of these waves occurs during peak red drum harvest season, and thus limited length data should have minimal effect (Data workbook files: *red_drum_length_smpl-sz.xls; and red_drum_length_smpl-sz_chking.xls)*

4.3.4 South Carolina Captains' Logbook - Description and sampling design

4.3.4.1 SC Logbook Landings

Trip level red drum catch data are available from 1994-2007 (~30,000 records) with an average of >2,000 records per year. Strata include area fished, number of anglers, pounds landed and number released. Dataset available in SEDAR 18 Data Workbook, file name: SC Captains' Log.

4.3.4.2 SC Logbook Biological Sampling

Length data are only available from 2007-2008, thereby not overlapping significantly with the date range for the current red drum assessment. Over 3,500 red drum lengths (total length in inches and converted to mm) are available by area fished. Length frequency per year can be generated. Dataset available in SEDAR 18 Data Workbook, file name: SC B2 RD lengths with locations.

4.3.4.3 SC Logbook Comments on Adequacy for Characterizing Catch

Since the logbook is a census, estimates of total catch and harvest could be produced in additional to SC data generated through the MRFSS.

4.4 Recreational Workgroup Research Recommendations

4.4.1 Review of Historical Data

Have experts in survey design and implementation review historical data.

4.4.2 Marine Recreational Information Program (MRIP)

The recreational statistics workgroup supports ongoing efforts to improve recreational and for-hire data collection through the Marine Recreational Information Program (MRIP).

4.4.3 Volunteer Logbook

We support inclusion of volunteer logbook data for length.

4.5 Tasks for Completion following Data Workshop

4.6 Literature Cited

Clark, J.R. 1962. The 1960 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Circular 153, 36 pp.

Deuel, D.G. 1973. The 1970 Salt-Water Angling Survey. U.S. Department of Commerce, National Marine Fisheries Service, Current Fishery Statistics No. 6200, 54 pp.

Deuel, D.G. and J.R. Clark. 1968. The 1965 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Resource Publication 67, 51 pp.

4.12 Tables

Table 4.3.1.1. South Atlantic estimated head boat landings of red drum from 1981-2007.

Year	Number	wt_kg	lbs
81	1	2.5	6
83	52	272	600
84	64	320	705
85	1	4.536	10
86	14	91.401	202
87	1	9.7	21
89	17	219.282	483
90	4	17.27	38
91	451	1464.14	3228
92	21	119.49	263
93	8	25.92	57
94	9	19.95	44
95	5	13.76	30
96	18	57.47	127
97	50	210.54	464
98	15	59.87	132
99	64	224.35	495
00	35	136.08	300
01	20	50.15	111
02	53	148.85	328
03	30	182.75	403
04	17	85.99	190
05	34	128.81	284
06	18	38.11	84
07	19	42.764	94

Table 4.3.2.4. Predicted ratios and standard errors (in parenthesis) of FHS/MRFSS charterboat effort estimates (to be applied to 1986-2003) for the Mid-Atlantic states. Significant factors included state and wave.

	Wave				
	2	3	4	5	6
DE / MD	1.294 (0.52)	1.599 (0.54)	1.930 (0.54)	0.861 (0.52)	1.171 (0.56)
NJ	1.289 (0.36)	1.179 (0.34)	1.644 (0.34)	0.809 (0.34)	1.115 (0.36)
NY	1.187 (0.48)	2.048 (0.54)	2.665 (0.48)	1.210 (0.51)	0.617 (0.48)
VA	0.770 (0.25)	0.680 (0.21)	0.761 (0.21)	0.324 (0.22)	0.313 (0.22)

Table 4.3.2.5. Predicted ratios and standard errors (in parenthesis) between FHS and MRFSS charterboat effort estimates (to be applied to 1986-2003) for the South Atlantic states (note header for specific state application).

EAST FLORIDA

	Wave					
Area	1	2	3	4	5	6
INSHORE	2.051 (0.73)	3.357 (0.73)	1.919 (0.73)	3.302 (0.73)	0.887 (0.73)	1.281 (0.82)
OCEAN	0.671 (0.12)	0.980 (0.12)	0.805 (0.12)	1.036 (0.12)	0.520 (0.12)	0.616 (0.14)

NORTH CAROLINA

	Wave				
Area	2	3	4	5	6
INSHORE	12.182 (3.68)	13.291(3.68)	7.966(4.25)	0.973 (4.25)	6.134 (5.20)
OCEAN	1.660 (0.45)	1.947 (0.45)	1.116 (0.48)	1.075 (0.48)	0.684 (0.52)

SOUTH CAROLINA, GEORGIA

	Wave				
Area	2	3	4	5	6
INSHORE	2.083 (1.56)	4.881 (1.56)	2.887 (1.56)	1.252 (1.56)	0.618 (1.80)
OCEAN	1.018 (0.54)	1.708 (0.52)	2.812 (0.52)	0.940 (0.54)	0.652 (0.74)

Table 4.3.2.9.1. Estimated red drum captured from saltwater anglers surveyed in 1960, 1965 and 1970 by species, region and principal fishing area. *See discussion of bias in SEDAR 17 Vermilion Snapper Stock Assessment Report under Section III. Assessment Workshop Report, 2.3.1[S17 VS SAR 2]

Number Red Drum Caught (x1,000)
(by species, region, principal area and method fishing)

Year	Region	Ocean	Sounds, Rivers, Bays	Boat - Still	Boat - Motion	Shore - Still	Shore - Motion	Annual Total
1960	Mid Atl	-	-	260	196	0	0	456
	South Atl	-	-	3968	199	181	179	4527

Year	Region	Ocean	Sounds, Rivers, Bays	Private/Rented	Party/ Charter	Bridge, Pier, Jetty	Beach, Bank	Annual Total
1965	Mid Atl	24	172	7	35	126	28	196
	South Atl	2436	1663	1497	235	1965	402	4099
1970	Mid Atl	51	46	46	0	0	51	97
	South Atl	1032	3851	3839	276	287	481	4883

Number US Saltwater Anglers (x1,000)				
	Mid Atl		South Atl	
Year	Annual Total	Target Red Drum	Annual Total	Target Red Drum
1960	1344	35	1024	157
1965	1375	68	1720	151
1970	1767	8	1808	164

Estimated TOTAL Weight (lbs) (x1,000)		
Year	Mid Atl	South Atl
1960	11400	27160
1965	1281	15171
1970	83	13358

Where: Mid Atl - Atlantic Coast from NJ to Cape Hatteras, NC
South Atl - Atlantic Coast from Cape Hatteras, NC to Southern FL including the Keys

4.13 Figures

None

5. Indicators of Population Abundance

5.1 Overview

Several red drum indices of abundance were considered for use in the assessment model. These indices are listed in Table 5.1.1, with pros and cons of each included. The possible indices come from fishery-dependent and –independent data. Nine fishery-independent sources and 4 fishery-dependent sources were considered by the workgroup.

The Indices workgroup representatives were Carolyn Belcher (GADNR), Mike Murphy (FFWCC) leader, Julie DeFelipi (ASMFC), Erin Levesque (SCDNR), Steve Arnott (SCDNR), Carl Brenkhert (SCDNR), Lee Paramore (NCDMF), and Joe Grist (VMRC). Several issues were discussed by the group, including how to reconcile different trends in the two southern region young-of-the-year indices.

5.2 Review of Working Papers

S 18-DW02 – History of red drum tagging in North Carolina

Abstract *(written by group)*

The various tagging programs conducted by the North Carolina Division of Marine Fisheries are described along with summaries of year-, gear-, and life-stage-specific sample sizes and recovery matrices for age groups 1-4^{+}. Tagging operations have been conducted in North Carolina since 1983. Eleven different tag types have been applied to fish captured during commercial fishing operations, volunteer angling trips, a variety of scientific sampling activities, by commercial fishers, and volunteer anglers.

Group discussion – The group did not discuss this paper at the data workshop but reviewed and approved the following text. The opportunistic feature to much of the sampling described make it unlikely an index of abundance could be developed from any catch rate data. The life history group at the workshop is investigation additional analysis of these tag/recapture data to estimate selectivity and possibly survival and exploitation rates. If the latter are estimable then they could be incorporated as an index to the trend in annual survival or exploitation estimates generated from the stock assessment model. The final decision on this awaits completion of the tagging data analysis prior to the assessment workshop.

S 18-DW05 -- Metadata for the Georgia Department of Natural Resources Division's Fishery Independent Red Drum Data 2002 – 2007 *(2007 Adult Red Drum Sacrifice also included)

Abstract
A description of three of Georgia's red drum surveys is given. The first entitled Fall 02 Adult Sacrifice targeted large adult red drum in 2002 for length and age estimates. Two hundred and thirty four fish were caught using hook and line and longline with lengths and ages recorded. The second survey entitled Fall 07 Adult Sacrifice also targeted adult red drum for age-length with hook and line and longline gear. Finally, the Summer Gillnet Survey targets young of the year red drum to produce indices of relative abundance.

Group discussion- The group reviewed the longline survey and summer gillnet survey for their use as index of red drum abundance. The longline survey was described as a stratified random survey where stations were selected at random from time and space strata within the universe of 120 possible grids. Given the short time series and small number of red drum encountered, the WG decided not to consider this survey for this assessment. The summer gillnet survey was described as a stratified random survey of 415 potential stations in the Wassaw region and 357 stations in the Altamaha region. These stations were assigned to area-specific strata that were further divided into one of two density strata based on the historically measured or perceived red drum density levels. Sampling was random within these strata. The group was concerned that the changes in the program over time, especially the reassignment of strata between the high and low density strata, could mask the changes in red drum abundance over time. This "hybrid random stratified and fixed station" design implied a very complex sampling probability scheme. The group suggested that a subset of stations consistently occupied over time be used to construct the indices, essentially a fixed station design.

S 18 DW06 -- SEDAR 18-Red Drum. NC Biological Data Survey Descriptions and Background Information: NC Red Drum Juvenile Seine Survey, NC Independent Gill Net Survey, NC Age and Growth Data, NC Commercial Dependent Sampling, NC Commercial Gillnet Observer Program.

Abstract *(written by group)*
This document briefly describes the design and results from several fisheries data collection programs being conducted in North Carolina. Two surveys for fish abundance are included: the North Carolina juvenile seine survey and the North Carolina independent gillnet survey.

Group discussion – The juvenile seine survey was a fixed station survey that appears to have been consistently sampled over time and could be used as a measure of young-of-the-year red drum abundance. The 1996 estimate of relative abundance is considered an anomaly that should be dropped from the data because of the high level of hurricane activity that year. The group suggested that the index be constructed using a geometric mean of the catch, average log(catch+1). The gillnet survey used a stratified random design to sample the Pamlico Sound and adjacent river areas. The group decided that only the Pamlico sound stations were consistently sampled over time and should be used in the index creation. Again, because of the skew in the distribution of the observed data, the group suggested that the geometric mean be estimated for the index. The index was disaggregated to age-specific estimates by applying an age-length key to the measured

lengths of sampled red drum to estimate the age composition of the sample catch each year. The group discussed the need to include some additional level of uncertainty (variance) to the final estimates that reflected this age-specific estimation process but needed to investigate this further.

S 18 DW 9 -- Recreational harvest estimates and estimated catch-at-age for the recreational fishery in Florida during 1982-2007.

Abstract *(written by group)*
The MRFSS-adjusted catch estimates for Florida's Atlantic red drum fishery are given for 1982-2007. Details are provided about the number of angler-interviews conducted each year and the available biostatistics information on landed or released red drum. The analysis provided estimated annual length frequencies for the landed and for the released-alive portions of the recreational catch, age-length keys, and resultant catch-at-age estimates for red drum.

Group discussion – The group did not discuss this paper at the data workshop but reviewed and approved the following text. There was no information presented in this paper that was directly pertinent to the development of indices of abundance for red drum.

S 18 DW-10 -- Indices of relative abundance for young-of-the-year and subadult red drum in Florida.

Abstract *(written by group)*
This document described the Florida fishery-independent monitoring program's small seine survey for young-of-the-year fishes and the large seine survey of larger-size fish. Sampling intensity, catch characteristics, and estimates of annual relative abundance are given. Diagnostic of the estimation procedures are attached as an Appendix.

Group discussion – The group accepted the survey design as adequate for measuring red drum abundance changes over time. The estimates presented were arithmetic means and delta lognormal standardized means for the full dataset and a species-association subset. The group agreed that the standardization procedure was appropriate but chose the use of the entire dataset over the subset because both surveys were conducted completely within areas of red drum habitat, i.e., there were no areas that could be considered outside the universe of where red drum could occur. The large seine survey disaggregated the standardized estimate into age-specific indices and needed to consider the increased variance associated with the age-assignment process.

S 18 DW-11 -- Electric Survey: Materials and Methods.

Abstract *(written by group)*
This document was a section out of a larger report. It described in detail an electro-fishing survey of fresh and brackish coastal South Carolina waters. It provides characteristics of the sampled fish, lengths and ages, over time. Geometric mean estimates of abundance are presented for the overall catch rates for red drum and the

early-age-one estimated catch rates. Cohort-specific estimates of instantaneous total mortality are also provided.

Group discussion – The group agreed that this stratified random transect survey design was appropriate. Some discussion questioned what age was best represented by the age-specific index provided. It appeared that the sizes of fish included in the age-specific index were late age-0 fish that could be used to back-cast the changes in age-0 relative abundance. As with the other age-disaggregated indices above, there was some discussion of inflating the variance of the age-specific index values.

S 18 DW-12 – Study on mortality using SC tagged red drum.

Abstract *(written by group)*
The data file names and necessary metadata needed to understand and use the data collected from various South Carolina tagging events are presented. Also included are summary tables of the numbers tagged and numbers recovered during inshore sampling programs by gear type, sample design, and tag type. A tag/recovery matrix is given for the adult red drum program.

Group discussion – The group did not discuss this paper at the data workshop but reviewed and approved the following text. There was no obvious information relating to trend in abundance in this report. Analysis of these data could possibly produce trends in exploitation or survival that could be useful (see above S 18 DW02).

S 18 DW 14 – Assessment of adult red drum in South Carolina waters

Abstract *(written by group)*
The sampling design is described for a bottom longline survey of adult red drum in South Carolina. The average catch rates per 1 mile of longline gear show an increasing trend during 1997-2005 before dropping substantially in 2006 and 2007. Yearclasses have been identified for a subsample of the fish captured.

Group discussion – The group discussed this program with South Carolina scientists, with a special thanks to Glenn Ulrich for his historic perspective on the survey. It appeared that the bottom longline catch rates would be a useful index of adult red drum abundance. The geographic scope of the sampling program was discussed and the group decided that the Charleston Harbor samples should be used in the index because of the consistency in sampling there over time and the relatively high success rate at encountering adult red drum. Questions were raised about what ages of adult red drum are best represented by the longline catch rates. Some size ‘cutoffs’ in the age sampling done from these fish may have affected the age composition of the samples. The group decided to use the annual geometric mean catch rates as indices of abundance for ages 8-10, the most encountered ages.

S 18 DW 15 – South Carolina independent survey description and protocol

Abstract *(written by group)*
The sampling design and protocol was given for stopnet sampling, trammel net sampling from 1991 through 2007, and an electrofishing survey during 2001-2007.

Group discussion – The group did not discuss this paper at the data workshop but reviewed and approved the following text. Two surveys described briefly in this document were more thoroughly covered in other data workshop working papers (electro-fishing S 18-DW11; trammel net S 18-DW 18). These were more pertinent to our discussion of the use of these surveys to generate indices of abundance.

S 18 DW 18 – South Carolina randomly stratified trammel net survey

Abstract *(written by group)*
The South Carolina trammel net survey has been conducted since 1991 in seven strata within the four major estuarine systems. The majority of fish caught are age-1 (11-16 months old, or beginning of model-age2). In general, the influence of the number of stocked fish caught on the catch rate was negligible. There was a general decline across the 1992-2000, followed by a sharp rise in 2001. CPUE then underwent a second period of decline, but catch rates in 2007 and 2008 (partial) show an increasing trend and are close to the long-term mean for the whole time series.

Group discussion –This paper was the basis for the group's decision to accept the South Carolina trammel net survey for use as an index of model-age-2 beginning-of-the-year relative abundance.

5.3 Fishery-Independent Surveys

5.3.1 Survey One – Florida young-of-the-year index (S18 DW 10)

5.3.1.1 Methods, Gears, and Coverage

The FWC's Fishery Independent Monitoring (FIM) program uses a stratified, random design to collect information on animal populations (Fisheries-Independent Monitoring Program Staff. 2008). Strata are primarily defined by depth, shore type (overhanging or not), and bottom vegetation (sea grass or not). This program also supplies length, weight, sex and material for the determination of age while monitoring abundance of young-of-the-year (biological-age-0; model-age 1) and larger fishes. Annual Atlantic coast young-of-the-year (red drum smaller than or equal to 40 mm standard length) indices were estimated from collections of red drum made using 21.3-m (3.1mm bar mesh) center-bag seines. Sets used to develop these indices were made from September through March during the periods 1997-2007 in the northern Indian River Lagoon and during 2001-2007 in the St. Johns River/Nassau Sound region (Fig. 5.3.1.1). Though data were available since 1990 few or no red drum were captured during these "start-up" years; the survey changed from seasonal sampling (spring and fall) to year round in 1996, and consistent sampling zones have been randomly surveyed since 1997.

5.3.1.2 Sampling Intensity

At least 100 sets were made each year after 1997. Up to 20 red drum-per-size-class captured during 21.3-m bag seine sampling were measured for standard length (SL) and all were counted within each size class. When more than 20 red drum were encountered then length frequencies of the 20 fish were expanded to the total number caught to estimate the sample catch length frequency. All red drum used in the analysis from the

young-of-the-year survey, 21.3-m bag seines, were less than or equal to 40 mm SL and were assumed to be age 1 (defined as beginning the first January 1st after fall hatching season).

5.3.1.3 Size/Age data

All red drum considered for this index were clearly age 0 based on the sizes of fish considered, less than or equal to 40 mm SL.

5.3.1.4 Catch Rates

The complete fishery-independent dataset was used to develop the relative abundance estimates. Standardized annual catch rates for red drum were estimated using a delta lognormal model (dual Generalized Linear Models, Lo et al. 1992). All factors used in the analyses were simplified categorical effects: bayzone (region within sampled estuary), bottom sediment type (sand, mud), month, shore type (overhanging vegetation, structure, other), bottom vegetation (seagrass, none), salinity (low,<8ppt; medium,8-33ppt; high,>33ppt), and temperature (low,<15degreesC; medium,16-25degreesC; high,>25 degrees C). Only main effects were used in the model.

The indices generated for young-of-the-year red drum indicate strong year-classes occurred periodically but the strongest of these occurred during the fall/winter of 2004 (January 1, 2005). A string of three consecutive, above-average year classes occurred during the period 2003-2005 (Table 5.3.1.1, Fig. 5.3.1.2). Weak year-classes have occurred recently; young-of-the-year were at low levels of abundance in 2000 and possibly again in 2006.

5.3.1.5 Uncertainty and Measures of Precision

The standardization process provided estimates of the asymptotic standard errors for the year-specific least squares mean for the binomial (presence/absence) component and the lognormal (positive catches) component. Model diagnostics for the positive-catch analysis showed a slight positive skew to the residuals and this will lead to slight under-estimation of the CV's of the annual index values. A final combined annual index value and its CV was estimated using a Monte Carlo simulation of the individual component distributions. The analysis contained comparisons between the trends in the empirical average catch rates (arithmetic), the standardized full dataset catch rates, and the species-association subset dataset (Stephens and McCall 2004). The group decided that because the survey included estuarine stations that were all potential habitat for juvenile red drum, the standardized full dataset index should be used. After the data workshop, during development of the index standardization diagnostics, the analysis (S 18 DW-10) was revised to include only those data collected since fall 1997. Estimates of coefficients of variation exceeded 100% for the original 1993-1996 index estimates and sampling design changes that occurred prior to 1997 justified dropping these early data from the analysis.

Another level of uncertainty not addressed results from the potential highly variable natural mortality rates experienced by such small red drum. The group was concerned that the year-class signals from fish this small could be modified by extreme levels of natural mortality early in the fish's first year of life, i.e., the 'critical period' could occur in older fish.

5.3.1.6 Comments on Adequacy for assessment

This index was deemed adequate for use in the assessment. The group decided that the delta lognormal standardization for the entire dataset was more useful than the species-association subset analysis. The survey area was conducted within the general habitat of young-of-the-year red drum. With multiple young-of-the-year indices in the southern red drum region, the group decided that, beside the year-specific estimates of precision, the survey weights should be made using the relative areal extent of each survey.

5.3.2 Survey Two – South Carolina electric survey (young-of-the-year index)

5.3.2.1 Methods, Gears, and Coverage

Prior to actual field sampling in May 2001, we erected six strata in estuarine systems along the South Carolina coast (Figure 5.3.2.1). These included the lower and upper Edisto Rivers, the Combahee River, The upper Ashley River, the upper Cooper River and the North Santee River. Winyah Bay replaced the North Santee stratum in November 2003. The Upper Edisto stratum was freshwater; the others had salinities that were generally less than 10 ppt.

5.3.2.2 Sampling Intensity – Time Series –

May 2001-present

5.3.2.3 Size/Age

Data generally age-1 though there is a high proportion of age-2 fish after the first year.

5.3.2.4 Catch Rates – Number and Biomass

Age 1 red drum generally accounted for the greatest percentage of the total fish caught during each year. To obtain an index of recruitment for a year class during a sampling year (the 2000 year class would be first fully recruited to the survey in 2001), the percent contribution of the newly recruited year class was multiplied by that year's annual mean catch per sample (Table 5.3.2.1 and Figure 5.3.2.2).

5.3.2.5 Uncertainty and Measures of Precision

The South Carolina electric survey sample size (number of sets) was fairly large and this is reflected in the low coefficients of variation, ranging 7-9 during 2001-2008. Proportional standard error (%) values for the annual arithmetic mean indices ranged between 8.5 and 13.5. Values for the $\log_e$ transformed data varied between 5.9 and 7.5. There was good agreement in annual trends between the juvenile indices of the SC electric survey and the SC trammel net survey (5.3.6).

5.3.2.6 Comments on Adequacy for assessment

The group agreed that catch rates for this survey would be useful as indices of abundance for young-of-the-year red drum, though there was work needed to look at the variance associated with the age composition split.

5.3.3 Survey Three – Georgia survey (model age-1)

5.3.3.1 Methods, Gears, and Coverage

From June through August, gill net surveys are conducted in Wassaw Sound and the Altamaha Sound Region (Figure 5.3.3.1). In Wassaw, stations are selected and sampled each month from a pool of 415 total stations using a hybrid random stratified and fixed station design. In the Altamaha Region, stations are selected and sampled each month from a pool of 357 total stations using a similar hybrid random stratified and fixed station design. In a given survey month, each selected station is sampled one time. All sampling occurs during the last three hours of ebb tide and only during daylight hours. Station pools in both survey areas were determined by initial surveys, which identified locations that could be effectively sampled with survey gear.

Survey gear is a single panel gillnet. The net is 300ft long by 9ft deep. The panel has 2.5in stretch mesh. The net has a 0.5in diameter float rope and a 75lb lead line. A 25lb anchor chain is attached to each end of the lead line, and a large orange bullet float is attached to each end of the float line.

A sampling event consists of a single net set. The net is deployed by boat starting at the bank following a semicircular path and ending back on the same bank. Net deployment is done against the tidal current. Immediately after deployment, the net is actively fished by making two to three passes with the boat in the area enclosed by the net. After the last pass is made, the net is retrieved starting with the end that was first set out. As the net is retrieved, catch is removed and put back into the water, inside a holding pen tied to the boat. After the net is fully retrieved, all catch is processed for information and released. All catch is identified to species and counted. All finfish specimens are measured, centerline in millimeters. In addition to catch information, temporal, spatial, weather, hydrographic and physio-chemical data are collected during each sampling event.

5.3.3.2 Sampling Intensity

A minimum of 36 stations are sampled in each sound system during each month of the sampling season (June – August). Time series covers from 2003-2007. Under the WG suggested approach (see Comments on Adequacy for Assessment) 13 fixed stations were sampled a minimum of two times within a sampling year and were represented in at least 4 of the 5 years. The number of sites visited by month and year are outlined in Table 5.3.3.1.

5.3.3.3 Size/Age

The majority of fish sampled are age-1 individuals.

5.3.3.4 Catch Rates – Number and Biomass

Two approaches were suggested for producing CPUE estimates for Georgia's age-1 red drum. First, a traditional CPUE was calculated based on the geometric means. Because of the high number of zeros in the raw data, it was also suggested that the trend in percent positive sets be examined. The use of this proportion as a measure of abundance was discussed in Bannerot and Austin (1983).

The catch rates calculated under both approaches suggested by the WG showed an oscillating trend between years, with a slight downward trend exhibited over the five years (Table 5.3.3.2). 2006 exhibited the lowest catch rate, with 2003 exhibiting the highest.

5.3.3.5 Uncertainty and Measures of Precision

Annual CPUEs and their associated 95% confidence limits / CVs were provided (Table 5.3.3.2) for the WG suggested approaches.

5.3.3.6 Comments on Adequacy for assessment

Issues were identified by the group associated with sampling units changing among strata (i.e., numbers of sampling units within strata varied across months and years). The WG recommended that GA look for sampling sites that could be considered index sites over the sampling period, and use those sites as a proxied fixed-station approach. The group agreed to the adequacy of the Georgia survey as a measure of the abundance of age-1 red drum.

5.3.4 Survey Four – North Carolina young-of-the-year index (S18 DW 6)

5.3.4.1 Methods, Gears, and Coverage

A red drum seine survey was conducted at 21 fixed sampling sites throughout coastal North Carolina (Figure 5.3.4.1) during September through November for each year from 1991 through 2007. Each of these sites was sampled in approximately two week intervals for a total of six samples with an 18.3 m (60 ft) x 1.8 m (6 ft) beach seine with 3.2 mm (1/8 in) mesh in the 1.8 m x 1.8 m bag. One “quarter sweep” pull was made at each location. This was done by stationing one end of the net onshore and stretching it perpendicularly as far out as water depth allowed. The deep end was brought ashore in the direction of the tide or current, resulting in the sweep of a quarter circle quadrant. All species were counted and identified; red drum were counted and measured to the nearest mm FL. Salinity (ppt), water temperature (^{o}C), tidal state or water level, and presence of aquatic vegetation were recorded. Locations of fixed stations were determined in 1990 based on previous catch rates and practicality for beach seining (Ross and Stevens 1992). The juvenile index, or CPUE, is the arithmetic mean catch/seine haul of young-of-the-year (YOY) individuals.

5.3.4.2 Sampling Intensity – time series-

Under the sampling design, complete survey coverage occurred at 120 seine sets per year. Only in 1994 and 1999 did the number of seine sets fall below 100.

5.3.4.3 Size/Age data

The size distribution of red drum caught during this survey indicated most fish were age-0. Size cutoff for age-0 was 100mm.

5.3.4.4 Catch Rates – Number and Biomass

Catch rates were variable early in the survey with apparent strong year classes in 1991, 1993, and 1997 (Table 5.3.4.1). During 1999-2001 there was a consistent series of low annual catch rates followed by an increase through 2005 before another drop in 2006.

5.3.4.5 Uncertainty and Measures of Precision

The estimated standard errors for the arithmetic mean catch rates were largest for the peak catch rates during the 1990's and lower since then especially for the years of lower catch rates. Hurricanes during this year caused extreme high and low water conditions and may have altered survey results. For this reason it was recommended that the 1996 data point be deleted from the index. The proportional standard errors (PSE is the same as CV of the mean) indicate that the estimated arithmetic mean catch rates were at least as precise as other indices for young-of-the-year red drum in the southern region, ranging from 13 to 31.

5.3.4.6 Comments on Adequacy for assessment

The group agreed that catch rates for this survey would be useful as an index of abundance for young-of-the-year red drum and agreed with the recommendation that 1996 data point not be used.

5.3.5 Survey Five – Florida subadult survey (S18 DW 10)

5.3.5.1 Methods, Gears, and Coverage.

This survey is a stratified random sampling, much like survey 5.3.1 above, except with 183-m seine sampling gear. This survey has operated in the southern and northern Indian River Lagoon since 1997 and in the St Johns/Nassau Sound area since 2001 (Fig. 5.3.1.1).

5.3.5.2 Sampling Intensity – time series

The calendar year sampling intensity ranged from 360 sets in 1997 to over 600 samples per year after 2002 (Table 5.3.5.1). Annual random samples of aging parts were taken from between about 60 and 150 fish each year.

5.3.5.3 Size/Age data

Estimated annual length frequencies for red drum caught in the 183-m haul seine showed a wide size range was captured by the gear. Most captured red drum were between 14 and 24 inches TL, also with a secondary mode at 5 or 6 inches. During 2004 there was an abundant group of red drum between 4 and 12 inches long. The ages of red drum captured in haul-seine sets was mostly model-age 2 and 3 years olds, with occasional high numbers of age-1 or age-4 fish.

5.3.5.4 Catch Rates – Number and Biomass

Indices generated for sub-adult red drum show relatively little change during the period 1997-2007 except for a slight increase after 2003 (Fig. 5.3.5.1). Age-specific indices seemed to show some correspondence year-to-year, with consistent abundant or rare year classes of red drum passing through model age 2 one year and model-age 3 the next. There was less correspondence seen between these relative abundance indices and that seen in the young-of-the-year (model-age 1) index.

5.3.5.5 Uncertainty and Measures of Precision

The estimated CV's for the pooled index ranged 12-17%. Age-specific partitioning uncertainty still needs to be incorporated into the final age-specific indices (variance

summation). Model diagnostics for the positive-catch analysis showed a slight positive skew to the residuals (Fig. 5.3.5.2) and this will lead to slight under-estimation of the true CV's of the annual index values.

5.3.5.6 Comments on Adequacy for assessment

The group agreed that catch rates for this survey would be useful for age-specific indices of abundance for model ages 2 and 3. The group also recommended using the delta lognormal standardization for the entire dataset.

5.3.6 Survey Six – South Carolina trammel net survey (age-1 index) (S18-DW18)

5.3.6.1 Methods, Gears, and Coverage

The SC trammel net survey has been conducted since 1991 (Wenner 2000) and is an ongoing program. It uses a stratified random sampling design and has long-term data sets for seven strata within four major SC estuary systems (Figure 5.3.2.1). Sites in each stratum are selected at random on a monthly basis (without replacement) and sampled primarily during early-, mid- and late-ebb tide. The trammel nets are 184 m long by 2.1 m deep with 177 mm outer mesh and 63 mm inner mesh. Nets are set close to shore (<2 m depth) by a fast moving boat and, before retrieval, the water surface is vigorously disturbed along the full length to chase fish into the mesh. The strata include Ace Basin (AB), Ashley River (AR), Charleston Harbor (CH), Lower Wando River (LW), McBanks (MB), Cape Romain Harbor (RH) and Winyah Bay (WB). AB is in the Ace Basin estuary system (AB); AR, LW and CH are in the Charleston Harbor system (CH); MB and RH are in the Cape Romain system (CR); WB is in the Winyah Bay system (WB).

The catch data presented are for age-1 red drum. For fish that settle in the estuaries in the fall of year Y, full recruitment to the trammel gear occurs in July of year Y+1. Indices of abundance for each year class were calculated using catch data from Jul-Dec of year Y+1 and Jan-Mar of year Y+2, when the Y year class is easily discernable due to non-overlapping size distributions. For the purposes of this report we refer to these fish as age-1, although the actual data straddle the calendar year (i.e. the age-1 to age-2 transition).

In some years of the survey, cultured red drum have been released into areas covered by the trammel net survey as part of an experimental stocking program. For the 1989-1993 year classes, stocked fish were identified in the trammel catches by external tags (Smith et al. 1997). The data extracted from the trammel database excluded these fish, so no correction factor has been applied for them. In other years when stocking occurred, the percentage contribution of stocked fish was determined by matching microsatellite genotypes of fin-clipped trammel-caught fish against the parental brood stock. This was performed on fish caught in the stratum that was stocked, as well as neighboring strata in the same estuarine system. To calculate catch rates of just the wild red drum component, the catch of each set was adjusted according to the percentage contribution of stocked fish (Table 5.3.6.1). Genotype data are not yet available for the 2007 year class, so no adjustment has been made for it.

5.3.6.2 Sampling Intensity – time series

The number of July-March trammel sets that were analyzed for the 1989-2007 year classes was 8,773 (Table 5.3.6.2). Only data from random sets made during daylight hours and during early-, mid- and late-ebb tide are included, since catches are affected by tide. The number of strata increased from 2 to 7 over the time series. Mean sampling intensity also increased from *ca* 15 sets per stratum initially to about *ca* 90-100 sets per stratum from the mid-1990s onwards. The 1989 year class was only sampled during Jan-Mar 1991 (no Jul-Dec 1990 data available). There was a reduced number of sets used assessing for the 2007 year class because data from some of the latter months are not yet available.

5.3.6.3 Size/Age data

Assuming a birth date of Sept 1, the red drum cohort considered in the analysis was 11-19 months old in the July-March trammel sets. Mean total length (TL) of each year class across all the months sampled varied between 350.9 mm and 391.5 mm and showed evidence of density-dependent growth. On average, mean cohort TL increased from 268 mm in July to 419 mm in March. Table 5.3.6.3 shows the total catch for each year class and stratum.

5.3.6.4 Catch Rates – Number and Biomass

The catch number in each trammel set was $\log_e$-transformed (Ln[Catch+1]. To examine whether different strata showed similar year class trends in catch per unit effort (CPUE), data were initially explored at the stratum level. CPUE was calculated as the least squares means catch ($\log_e$-transformed, wild fish only) per trammel set using a general linear model (GLM) with year class, month of capture and tide (early-, mid- or late-ebb) as fixed factors. The output from these models showed that although absolute catch rates differed between strata, the overall trends in relative year class strength were consistent.

To calculate a South Carolina-wide CPUE, least squares means were derived using a GLM that included the $\log_e$-transformed catch data from all strata, with stratum added as a model factor. Two runs were performed, first using catches of all fish (wild + stocked) (Table 5.3.6.4), and secondly using catches of just the wild fish (i.e. catches adjusted for stocked fish contributions) (Table 5.3.6.5).

In general, the influence of stocked fish on the SC-wide CPUE was negligible (Figure 5.3.6.1). There was a general decline in CPUE across the 1990-1999 year classes, followed by a sharp rise for the 2000 year class. CPUE then underwent a second period of decline, but the 2006 and 2007 year classes show an increasing trend and are close to the long-term mean for the whole time series.

5.3.6.5 Uncertainty and Measures of Precision

There is less confidence in the earlier years of the survey because fewer estuarine systems and strata were covered, fewer trammels were set, and the 1989 year class was only sampled over three months (rather than 9). Values for the 2007 year class are preliminary because neither the most recent trammel data nor the percentage contribution of stocked fish to the AR, LW and CH strata are available yet. Evidence from previous years suggests that the effect of stocking is probably negligible to the SC-wide values.

Coefficients of variation were above 20 early in the time series and generally less than 15 after this.

5.3.6.6 Comments on Adequacy for assessment

The randomized stratified design of the trammel net survey is a statistically robust sampling protocol. There is good agreement in CPUE trends across strata, as well as with indices from the South Carolina red drum electroshock survey, which covers lower salinity areas of the trammel survey estuary systems (SC DNR 2009).

5.3.7 Survey Seven – South Carolina stopnet survey

The Indices Workgroup mistakenly assumed that this survey had been used during the last assessment. This survey was discontinued in the mid-1990's and was replaced by the trammel net survey discussed in a previous section. Given that this survey was not included in the previous assessment and that no new data has been added to the time series, the WG did not consider this survey for utility as an index of abundance.

5.3.8 Survey Eight – North Carolina Sub-Adult Survey

5.3.8.1 Methods, Gears, and Coverage

The Division's independent gill net study (Program 915) started as the presence and absence of disease sampling in 1998 on the Neuse, Pamlico and Pungo River systems (River Independent Gill Net Survey (RIGNS). Sampling in Pamlico Sound (The Pamlico Sound Independent Gill Net Survey (PSIGNS)) was initiated in May of 2001. Sampling in the RIGNS was dropped after 2000 and resumed in 2003 to present. The PSIGNS has sampled continuously since 2001. A primary objective of both the PSIGNS and the RIGNS is to provide independent relative abundance indices for key estuarine species including red drum. Sampling locations for the IGNS were selected using a stratified random sampling design based on area and water depth (Figure 5.3.8.1). The Sound was divided into eight areas: Hyde County 1 – 4 and Dare County 1 – 4. The Neuse River was divided into four areas (Upper, Upper-Middle, Middle-Lower, Lower) and the Pamlico River was divided into four areas (Upper, Middle, Lower and Pungo River). A one minute by one minute grid (i.e., one square nautical mile) was overlaid over all areas and each grid was classified as either shallow (< 6 ft), deep (≥ 6ft) or both based on bathymetric maps. Each area was sampled twice a month. For each random grid selected, both a shallow and deep sample were collected. Each sample (both shallow and deep) consisted of eight 30 yard segments of 3, 3½, 4, 4½, 5, 5½, 6, 6½ inch stretched mesh gill net, for a total of 240 yards per sample. Nets were typically deployed within an hour of sunset and retrieved the next morning, so all soak times were approximately 12 h. This sampling design results in a total of approximately 64 gill net samples (32 deep and 32 shallow samples) being collected per month across both the Rivers and Sound. Physical and environmental conditions, including surface and bottom water temperature (^{o}C), salinity (ppt), dissolved oxygen (mg/L), bottom composition, as well as, a qualitative assessment of sediment size, were recorded upon retrieval of the nets on each sampling trip. All attached submerged aquatic vegetation (SAV) in the immediate sample area was identified to species and density of coverage was estimated visually when possible. Additional habitat data recorded included distance from shore, presence or absence of sea grass or shell, and substrate type. Each collection of fish per mesh size (30-yard net) was

sorted into individual species groups. All species groups were enumerated and an aggregate weight (nearest 0.01 kilogram (kg)) was obtained for most species, including damaged (partially eaten or decayed) fish. The condition of each individual was recorded as live, dead, spoiled, or parts. Individuals were measured to the nearest millimeter for either fork or total length according to the morphology of the species.

5.3.8.2 Sampling Intensity –

Sets in the Pamlico Sound were made over a part of the year in 2001 (237 sets), and thereafter was sampled at 320 sets per year.

5.3.8.3 Size/Age data

A large range of sizes were caught (range 220-1260 mm TL), but most were sizes associated with young age-1 or age-2 fish (mean of 400 mm TL).

5.3.8.4 Catch Rates – Number and Biomass

The weighted mean CPUE showed an increase from 2003 through 2007 (Table 5.3.8.1 and Figure 5.3.8.2).

5.3.8.5 Uncertainty and Measures of Precision

Standard errors and proportional standard errors were presented for the annual estimates of CPUE (Table 5.3.8.1). The proportional standard errors indicate the precision of this index is slightly less than the southern region's Florida subadult survey and similar to the South Carolina trammel net survey.

5.3.8.6 Comments on Adequacy for assessment

The group agreed that catch rates for this survey would be useful as indices of abundance for young-of-the-year red drum, though there was work needed to look at the variance associated with the age composition split.

5.3.9 Survey Nine – South Carolina Adult Longline Survey

5.3.9.1 Methods, Gears, and Coverage (Include a map of the survey area.)

The data from the South Carolina Adult Red Drum Survey have been amended to include 1-mile long sets using a cable mainline. A cable mainline was used during the project exclusively in 1994, the first year of the study. Following discussion that sharks may be deterred by the cable (sharks were also a target species), in 1995 a monofilament mainline was also used. Both gear types were used until 1997. In 1998, the survey switched to monofilament mainline for all sets, since it was concluded that while the cable gear decreased the catch of sharks, red drum catches were unaffected by the gear. Both gear are now included in these updated data upon agreement by the Indices Sub-committee.

Since most catches of red drum occur in the fall, when they are most available to the gear, only sets made August through December have been included. Until 2007, most sampling occurred in the Charleston Harbor, using fixed stations, with occasional trips north and south, so these data only include samples from Charleston Harbor (Figure 5.3.2.1). In 2007, sampling was changed in order to cover more of the coast of South Carolina, geographically and temporally, and stations were chosen randomly from a

predetermined list of sites. The new sampling utilized gear with a mainline 1/3-mile long; these sets are not represented in the data since only one season would be available. Furthermore, due to the change in sampling, only a few (n=7) 1-mile long sets were made in 2007. These sets were utilized primarily to obtain red drum for broodstock. The sets were made in areas previously sampled with the fixed station design. Samples in 2005 and 2006 were also lower than previous years (n=29, n=51 respectively), because the vessel used for the survey broke down both years during the sampling season.

5.3.9.2 Sampling Intensity – time series

Sampling intensity ranged from 29 sets in 2005 to a maximum of 115 sets in 1998 (Table 5.3.9.1) . Approximately 95 – 100 sets were made per year provided there were no equipment issues. As mentioned in 2007, only 7 1-mile long sets were made due to change in sampling protocol.

5.3.9.3 Size/Age data

Most age samples were taken only for fish 950 mm TL or less. However, the age distribution for these, even though biased low for aveage size, indicated that it was likely that a majority of the fish captured in the longline sampled were biological-age 9 or older.

5.3.9.4 Catch Rates – Number and Biomass

Catch per unit effort by year for 1994 through 2007 are given (Table 5.3.9.1).

5.3.9.5 Uncertainty and Measures of Precision

Standard errors and variances were presented for the annual estimates of CPUE (Table 5.3.9.1). Apparent coefficients of variation was releatively low, <10, for most years.

5.3.9.6 Comments on Adequacy for assessment

The WG recommended using this survey but only for those index stations in the Charleston Harbor area.

5.4 Fishery-Dependent Indices

5.4.1 Survey One - MRFSS total catch rates

The access-point angler intercept survey (APAIS) is conducted at either public or private marine/brackish-water fishing access points (boat ramps, piers, beaches, jetties, bridges, marinas, etc.) to collect catch data from individual angler, including species identification, total number of each species, and length and weight measurements of individual fishes, as well as some angler-specific information about the fishing trip and the angler's fishing behavior. The sampling universe, called the master site register, is a dynamic list of identified access-point sites for marine recreational fishing in each state, including sites in tidal brackish waters where anglers who fished in saltwater can be intercepted. In general, the estimated fishing pressure for each site by mode, month and weekday/ weekend/holiday (KOD) is determined and used as a weight in the sampling site selection process. The targeted angler trips to sample are specified by year, wave, state, and mode within a subregion (mid-Atlantic, NY south through VA; south Atlantic, NC south through FL [Miami-Dade County]). Within the targeted population, sampling is

stratified by month-KOD (within the sampling wave) to assure a representative temporal distribution of samples.

This primary sampling unit is site-day with the ultimate sampling unit of individual angler-trip. Estimated catch rates for the entire 1981-2007 period were restricted to those interviews where there was no grouped catch, contributors equaled 1. Beginning in 1991, MRFSS created a 'Type-6' record that allows for all interviews within a fishing trip to be linked together. Using these linked data, catch rates for 1991-2007 were also estimated on a trip basis. The number of interviews by state across waves and collapsed fishing modes (Tables 1, 2) show the shift in interviews toward the private/rental boat mode and away from shore fishing in 1986 across all states and periodic increases in interviews (1992 and 1999) in Florida. Also, interviews during the Jan-Feb wave were periodic in North Carolina, infrequent in Georgia and South Carolina, and consistent in Florida.

5.4.1.1 Methods of Estimation

Total catches reported from MRFSS angler interview date were analyzed for different subsets of the data depending on what was assumed to retermine a directed red drum fishing trip and whether trip-specific or interview-specific catches were analyzed.

The effort definitions used to subset the MRFSS interview data were either all data where the angler reported targeting or catching red drum or all data predicted to be a red drum trip based on ana analysis of the species caught in association with red drum (Stephens and MacCall 2004). Two responses were modeled for each of these subsets: the total catch made by anglers fishing alone and total catch made by all anglers fishing on the same trip. The former was calculated for the period 1982-2007 while the latter was valid only for the period 1991-2007. A number of explanatory variables measured by the MRFSS were also grouped if specific levels occurred inconsistently in the data over time. For example, counties were grouped into logical watersheds to create a more consistent 'bay' variable; ocean waters (area_x in state and federal) were combined; and all boat trips (partyboat, charter boat, and private/rental) or shore fishing modes were combined. The final generalized linear models tested the significance of the explanatory variables wave, mode of fishing, bay, and area fished. The response variable used was total number of fish per angler-hour. Standardized annual catch rates for red drum were estimated using a delta lognormal model (dual Generalized Linear Models, Lo et al. 1992). The distribution of back-transformed least-square means estimates for each year was generated through Monte Carlo simulation using the annual least squares means and the estimated asymptotic standard errors.

5.4.1.2 Sampling Intensity

In the southern region, the number of interviews made and the number of interviews of targeted red drum anglers was greatest in Florida was increased significantly after 1991, especially in Florida.

5.4.1.3 Size/Age data

Most of the red drum caught by anglers during 1991-2007 were released. Though there is little historic information about the sizes of these released fish, recent information indicates that they are a mixture of legal sized fish, mostly model ages 2 and 3, and undersized fish, model age 1.

5.4.1.4 Catch Rates – number and biomass

Standardized catch rates for fishing-trip-aggregated data beginning in 1991show a variable but long tern increase in the northern region with particularly high levels during 1997-1999 and in 2002 (Table 5.4.1.4.1 and Fig. 5.4.1.4.1). In the southern region catch rates reached a peak in 1995 then declined through 2001. Since then there has beeen a general increase in catch rate.

5.4.1.5 Uncertainty and Measures of Precision

The distribution of the total catch rates were generated using a Monte Carlo simulation using of the estimated annual least square means and their assymtotic standard errors, backtransforming into the arithmetic scale. Generally less precision is seen in the higher catch rate estimates.

5.4.1.6 Comments on Adequacy for Assessment

The MRFSS index was calculated using aggregated total catch and effort or individual total catches pre interview of trip. The group decided that the individual trip aggregated data should be used to develop an index of abundance using the 1991-2007 data. These should be standardized using the delta lognormal approach. The species-association subsetting approach gave low numbers of valid observations, especially in the northern region, but this might be due to the changing fauna associated with red drum in the northern region. The group decided that the observations chosen for the index should be those angler intercepts that had caught a red drum or indicated they were targeting red drum.

5.4.2 Survey Two – North Carolina Trip Ticket

The North Carolina trip ticket program was considered for developing an index of abundance of red drum in the northern region. Many issues were brought forth supporting this decision: changes in regulations over time, including trip limits and bycatch restrictions; difficulty in determining a targeted trip within the diverse number of gears used in North Carolina, that trip tickets do not document trips where no fish were caught, and potential changes in catchability.

5.4.3 Survey Three – North Carolina Citation Program

An increasing trend in numbers of fish submitted for citation has been observed since the program began; however, the trend is confounded by a change in popularity of the program. The Indices subgroup does not recommend the use of this data for calculating an index of abundance.

5.4.4 Survey Four – Virginia Citation Program

Anglers only receive one Citation plaque per species regardless of how many Citation fish they register throughout the year. Virginia tracks an angler's heaviest entry for a species and the plaque acknowledges their heaviest catch of the year. Virginia also tracks the number of releases and this number will also be included on the Citation plaque. Due to space limitations, release lengths are not included. The Virginia program was not recommended for use as an index of abundance.

5.5 Consensus Recommendations and Survey Evaluations

The DW recommended that 1 fishery-dependent index derived from the general recreational survey (MRFSS) be used in the assessment. In addition, the DW recommended use of 8 fishery-independent datasets. YOY indices were calculated from data collected through Florida's seine survey, South Carolina's electroshock fishing survey, and North Carolina's seine survey. Sub-adult indices were calculated for multiple surveys and covered ages from late age 1 to age 3. These surveys include gillnet surveys from NC (ages 1 and 2) and GA (age 1), a trammel net survey from SC (ages 1 and 2), and a haul seine survey from FL (ages 1-3). An adult index was calculated from data collected by SC to be used for age 9 and older.

5.6 Indices Workgroup Research Recommendations

Adult sampling with the goal of small population estimates or density estimates through tag-recapture methods to evaluate trends in abundance over time. Secondarily, this would help with delineate the stock distribution and mixing rates.

Suggests a workshop on adaptive sampling techniques as applied to wildlife populations as well as other techniques that can be applied to aggregated species.

Encourage that states continue on with current surveys, and with current methodologies. If sampling methodologies change, the workgroup suggests some consistency exist between the original and new methodologies.

Age structure established for surveys internally rather through external age-length keys.

5.7 Tasks for Completion following Data Workshop

- State representatives review sections related to their surveys to ensure survey is accurately represented by 2/20/09.
- State representatives provide the necessary data diagnostics, figures, tables and literature cited needed to supplement their survey sections 2/20/09.
- Georgia representatives examine the feasibility of applying a positive catch analysis to their age-1 survey. Produce necessary estimates of catch and associated variance if applicable.
- Provide all necessary documents to C. Belcher for collation into the master document by 2/27/09.
- Proof final WG document for submittal to FTP site by 3/13/09
- Upload final datasets to FTP site by 3/27/09

5.8 Literature Cited

Bannerot, S. P. and C. B. Austin. 1983. Using frequency distributions of catch per unit effort to measure fish-stock abundance. Transactions of the American Fisheries Society. 112: 608–617.

Fisheries-Independent Monitoring Program Staff. 2008. Fisheries-independent monitoring program 2007 annual data summary report. Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute, In-House Report 2008-006.

Lo, N.C., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Ross, J.L. and T.M. Stevens. 1992. Life history and population dynamics of red drum (*Sciaenops ocellatus*) in North Carolina waters. North Carolina Division of Marine Fisheries, Marine Fisheries Completion Report Project F-29, Morehead City.

SC DNR (2009). SC red-drum electro-fishing survey. (Report prepared by Wenner, C.A.). SEDAR18-DW11.

Smith, T.I.J., Jenkins, W.E., Denson, M.R. (1997). Overview of an experimental stock enhancement program for the red drum in South Carolina. Bull. Natl. Res. Inst. Aquacult., Suppl. 3: 109-115. SEDAR18-RD68.

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

Wenner, C.A. (2000). Contributions to the biology of red drum, *Sciaenops ocellatus*, in South Carolina. Final Report, Federal number NA47FM0143. SEDAR 18-RD36.

5.9 Tables

Table 5.1.1. List of proposed indices of abundance for red drum indicating some of the pros and cons for their inclusion in the red drum assessment. Those highlighted were recommended for use in the assessment.

Florida young-of-the-year survey

pros – consistent stratified random sampling design since 1997 in Indian River Lagoon.
- at least 100 sets made each year.

cons – utilized only fish less than or equal to 40 mm standard length that may not reflect final year-class strength, i.e., susceptible to highly variable natural mortality rates.

- areal coverage is small part of entire southern stock distribution.

- St. Johns River/Nassau Sound sampling started in 2001.

South Carolina electric survey

pros – six strata sampled randomly

cons – limited to low salinity areas where electro-shocking is effective

Georgia survey

pros – consistent sampling methodology for 13 fixed stations

cons – thirteen fixed stations monitored during the summer between 2003 and 2007

- complex hybrid random stratified survey with underlying complex probability model

North Carolina young-of-the-year index

pros – consistently sampled methodology for 21 fixed stations chosen based on historic relative abundance work

- age composition all are young-of the-year based on survey time (September-November) and sizes of fish (<100 mm)

cons – possible changes in fixed station hasbitats during extreme climatic events

Table 5.1.1. continued.

Florida subadult survey

pros – stratified random survey with large numbers of sets made each year

- complete time series from 1997 through 2007

cons – postential for bias with addition of St Johns.Nassua Sound area survey in 2001

- potential underestimate of CV without accounting for aging error.
- limited correspondence with young-of-the-year indices in these areas

South Carolina trammel net survey

pros – stratified random sampling design ranging throughout most major South Carolina estuaries.

cons - later age 1 survey that corresponds only somewhat with electric survey for this age group

-complications in disentangling wild stock from hatchery fish in these areas.

South Carolina stop net survey

pros – prior to mid-1990's major indicator of relative abundance in South Carolina

cons – discontinued after mid 1990's

- not used as an index of abundance in the last assessment

North Carolina subadult survey

pros – stratified random survey design using gill nets of various mesh sizes

- continuous sampling in Pamlico Sound since 2001

cons – started as a disease sampling survey and dropped in river areas during 2001 and 2002

South Carolina Adult Longline Survey

pros – only available survey of adult relative abundance in southern region

- apparent CVs for mean catch rate is often low
- long time series, since 1994.

cons – potential sampling complications since this was modified from a shark survey

- some potential difficulty in determining adult contribution to the total catch rate since some selectivity in sampling for age.

Table 5.1.1. continued.

MRFSS total catch rate

pros - extensive areal and temporal coverage

cons – potentially total catch rates are affected by angler choices about where and when to fish, i.e., no strict survey design.

inability to consistently determine to total catch per trip prior to 1991

North Carolina trip ticket

pros – large number of observations

cons – changes in regulations bias this landings-only index, catchability changes

-difficulty in determining which trips are targeting red drum

North Carolina citation program

pros – potential coverage of little known adult relative abundance

cons – changes in popularity of red drum fishing and angler-defined trophy sizes

Virginia citation program

pros – potential coverage of little known adult relative abundance

cons – only one citation recorded regardless of the number of trophy fish registered

Table 5.3.1.1. Estimated catch rates for young-of-the-year red drum (less than or equal to 40-mm standard length) and captured during September-March; January year shown, by 21.3-m seines deployed during the Florida Fish and Wildlife Conservation Commission's fishery-independent monitoring on the Atlantic coast. The overall sample sizes (N all), number of sets catching young-of-the-year red drum (N pos), standardized median, mean and its coefficient of variation (CV) are given. Standardization used a delta lognormal approach with the median and CV's estimated using a Monte Carlo simulation.

	N (all)	N (pos)	Median	Mean	CV
1998	140	7	0.030	0.039	100.13
1999	204	32	0.092	0.099	38.67
2000	252	26	0.028	0.030	41.91
2001	238	36	0.050	0.053	36.91
2002	458	47	0.069	0.072	34.36
2003	464	69	0.133	0.136	29.19
2004	465	63	0.125	0.130	30.31
2005	518	103	0.228	0.237	28.27
2006	632	57	0.048	0.050	29.22
2007	588	71	0.109	0.112	27.61

Table 5.3.2.1. Annual arithmetic and transformed geometric (ln[x + 1]) CPUE (catch per transect station) for red drum in the electric survey. Mean = arithmetic mean; sd = standard deviation; Gmean = mean of ln([number + 1]; Gsd = their standard deviation; CV= coefficient of variation for the back transform of the geometric mean; present = number of stations with red drum; samples = total number of stations.

Year	Mean	SD	Gmean	Gsd	CV	Present	Samples
2001	1.99	3.00	0.72	0.82	8.53	117	233
2002	2.14	3.64	0.72	0.85	6.56	203	403
2003	2.34	4.51	0.70	0.91	7.08	165	372
2004	2.10	5.50	0.60	0.86	7.26	162	379
2005	1.97	4.44	0.62	0.83	7.26	171	363
2006	1.52	3.55	0.52	0.76	7.48	156	381
2007	1.31	2.25	0.54	0.70	7.50	157	361
2008	2.19	4.75	0.69	0.08	6.77	160	323

Table 5.3.3.1. Number of gillnet sites sampled in Georgia during 2003 – 2007 sampling seasons by year and month.

	Year				
Month	2003	2004	2005	2006	2007
June	6	10	12	9	7
July	9	12	11	10	9
August	9	12	10	8	5
Total Sites	24	34	33	27	21

Table 5.3.3.2. Annual arithmetic and geometric mean CPUEs and percent positive sets for age-1 red drum captured during Georgia's gillnet survey (2003-2007).

Geometric Mean

Year	Mean	95% LCL	95% UCL	CV
2003	1.59	1.06	2.11	24.55
2004	0.66	0.36	0.97	27.94
2005	1.03	0.64	1.42	25.15
2006	0.34	0.16	0.51	28.82
2007	0.95	0.43	1.47	34.79

Arithmetic Mean

Year	Mean	95% LCL	95% UCL	CV
2003	4.54	1.08	8.01	38.14
2004	1.91	-0.01	3.84	50.38
2005	2.85	0.87	4.83	34.71
2006	0.48	0.19	0.77	30.10
2007	3.14	0.07	6.22	48.91

Percent Positive Sets

Year	Mean	95% LCL	95% UCL
2003	58.33%	56.26%	60.40%
2004	41.18%	39.74%	42.62%
2005	42.42%	40.93%	43.92%
2006	33.33%	31.66%	35.01%
2007	38.10%	35.78%	40.41%

Table 5.3.4.1. Annual arithmetic mean or geometric mean CPUE for YOY red drum captured during the North Carolina seine survey 1991 - 2007. The coefficient of variation (CV) is for the observations and the proportional standard error (PSE) is equal to the other CV's reported in this report.

Arithmetic scale(mean)

Year	N	CPUE	lci	uci	SE	STDEV	CV	MIN	MAX	SUM	PSE
1991	105	14.85	10.58	19.12	2.18	22.33	150.4	0	122	1,559	15
1992	116	3.72	1.49	5.94	1.13	12.22	329.0	0	125	431	31
1993	117	12.65	8.30	17.00	2.22	23.98	189.6	0	130	1,480	18
1994	93	8.29	3.56	13.02	2.41	23.26	280.5	0	180	771	29
1995	119	4.61	3.19	6.03	0.72	7.90	171.2	0	44	549	16
1996	104	2.63	1.71	3.56	0.47	4.81	182.5	0	32	274	18
1997	126	13.13	7.10	19.15	3.07	34.50	262.9	0	236	1,654	23
1998	124	8.23	6.04	10.43	1.12	12.48	151.6	0	85	1,021	14
1999	98	1.88	1.06	2.69	0.42	4.11	219.0	0	29	184	22
2000	123	3.18	2.05	4.31	0.57	6.38	200.6	0	38	391	18
2001	122	0.98	0.61	1.34	0.19	2.07	212.3	0	11	119	19
2002	120	2.26	1.23	3.29	0.53	5.78	255.7	0	39	271	23
2003	120	5.01	2.60	7.42	1.23	13.49	269.3	0	113	601	25
2004	120	8.38	6.16	10.59	1.13	12.38	147.8	0	75	1,005	13
2005	120	9.02	6.26	11.77	1.40	15.39	170.6	0	80	1,082	16
2006	120	3.59	2.16	5.03	0.73	8.02	223.2	0	63	431	20
2007	119	5.46	2.48	8.44	1.52	16.59	303.7	0	149	650	28

Logarithmic scale (geometric mean)

North Carolina juvenile red drum seine index (age-0) with geometric mean

Year	E(YST)	SE OF E(YST)	PSE	Geo Mean	LCI of GEO MEAN	UCI of GEO MEAN	# Samples
1991	1.875	0.135	7	5.523	3.978	7.548	105
1992	0.851	0.091	11	1.342	0.953	1.809	116
1993	1.617	0.128	8	4.040	2.905	5.505	117
1994	1.312	0.122	9	2.714	1.911	3.737	93
1995	1.112	0.097	9	2.039	1.503	2.690	119
1996	0.765	0.092	12	1.149	0.790	1.581	104
1997	1.424	0.125	9	3.156	2.234	4.340	126
1998	1.525	0.109	7	3.595	2.698	4.710	124
1999	0.574	0.086	15	0.776	0.496	1.107	98
2000	0.853	0.087	10	1.346	0.970	1.794	123
2001	0.389	0.060	15	0.476	0.309	0.663	122
2002	0.602	0.082	14	0.826	0.551	1.150	120
2003	0.958	0.102	11	1.606	1.126	2.194	120
2004	1.533	0.109	7	3.631	2.724	4.760	120
2005	1.486	0.114	8	3.421	2.521	4.551	120
2006	0.859	0.092	11	1.361	0.964	1.838	120
2007	0.911	0.104	11	1.486	1.018	2.062	119

Table 5.3.5.1. Estimated catch rates for subadult red drum captured by 183-m seines deployed during the Florida Fish and Wildlife Conservation Commission's fishery-independent monitoring on the Atlantic coast. The overall sample sizes (N all), number of sets catching red drum (N pos), standardized median, mean and its coefficient of variation (CV)are given. Standardization used a delta lognormal approach with the median and CV's estimated using a Monte Carlo simulation. Age-specific rates, apportioned from overall catch rate using sampled age composition data each year, are given for model-age 2 and 3 fish.

	N (all)	N (pos)	Median	Mean	CV	mod-age 2	mod-age 3
1997	364	73	0.245	0.249	17.47	0.070	0.089
1998	434	91	0.276	0.281	16.12	0.169	0.044
1999	420	100	0.244	0.248	15.87	0.108	0.050
2000	420	106	0.292	0.294	15.64	0.198	0.038
2001	531	96	0.221	0.223	15.25	0.097	0.069
2002	589	129	0.274	0.275	13.35	0.169	0.051
2003	613	112	0.238	0.240	14.08	0.083	0.096
2004	614	137	0.276	0.280	12.84	0.146	0.050
2005	610	140	0.299	0.300	13.01	0.196	0.041
2006	611	114	0.270	0.274	13.23	0.136	0.075
2007	613	144	0.312	0.315	12.36	0.153	0.094

Table 5.3.6.1. Percent contribution of stocked red drum to the age-1 trammel net catches for each year classes and stratum. Blanks indicate no stocking. Stratum names are Ace Basin (AB), Ashley River (AR), Charleston Harbor (CH), Lower Wando River (LW), McBanks (MB), Cape Romain Harbor (RH) and Winyah Bay (WB).

	Ace Basin	Charleston Harbor			Cape Romain		Winyah Bay
Year Class	AB	AR	CH	LW	MB	RH	WB
1990		**	**	**			
1991		**	**	**			
1992		**	**	**			
1993		**	**	**			
1994							
1995							
1996							
1997							
1998							
1999		90.0%	31.0%	15.0%			
2000		35.6%	6.7%	13.5%			
2001		29.0%	1.6%	2.0%			
2002		0.0%	0.0%	0.0%			
2003							
2004							
2005	13.6%	3.1%	3.2%	0.0%			35.3%
2006		0.0%	0.0%	1.0%			
2007		*	*	*			*

* Contribution from stocked fish not yet determined from DNA samples.
** Stocking occurred, but stocked fish are not represented in catch data presented in Table 3.

Table 5.3.6.2. Number of trammel sets used for assessing the 1989-2007 year classes of age-1 red drum in South Carolina. Trammel sets cover the months July-March during daylight hours and mid- to late-ebb tide. (Strata names as in Table 1).

	Ace Basin	Charleston Harbor			Cape Romain		Winyah Bay		
Year Class	**AB**	**AR**	**CH**	**LW**	**MB**	**RH**	**WB**	**Total**	**Mean**
1989			10	21				31	15.5
1990			36	54				90	45.0
1991		49	36	71				156	52.0
1992	16	70	40	70				196	49.0
1993	84	82	60	78				304	76.0
1994	86	81	84	83				334	83.5
1995	89	98	88	84				359	89.8
1996	107	106	89	85	103	96		586	97.7
1997	102	107	91	90	95	102		587	97.8
1998	103	108	87	89	95	108		590	98.3
1999	91	106	88	90	82	98		555	92.5
2000	103	108	89	88	92	104		584	97.3
2001	102	108	87	87	91	87	45	607	86.7
2002	91	107	87	85	99	101	86	656	93.7
2003	104	106	88	90	101	99	87	675	96.4
2004	92	108	90	90	102	92	99	673	96.1
2005	86	107	86	90	91	102	83	645	92.1
2006	102	106	88	90	97	91	100	674	96.3
2007	74	79	60	65	75	70	48	471	67.3
Total	**1432**	**1636**	**1384**	**1500**	**1123**	**1150**	**548**	**8773**	

Table 5.3.6.3. Total catches of age-1 red drum (wild + stocked) in the July-March trammel sets (Stratum named as in Table 1).

	Ace Basin	Charleston Harbor			Cape Romain		Winyah Bay		
Year Class	**AB**	**AR**	**CH**	**LW**	**MB**	**RH**	**WB**	**Total**	**Mean**
1990			225	231				456	228.0
1991		45	183	285				513	171.0
1992	10	28	124	132				294	73.5
1993	126	66	201	115				508	127.0
1994	166	79	147	180				572	143.0
1995	145	18	69	91				323	80.8
1996	210	57	113	259	163	106		908	151.3
1997	109	43	85	72	113	131		553	92.2
1998	96	32	108	71	95	151		553	92.2
1999	59	118	30	42	60	42		351	58.5
2000	411	151	226	155	777	354		2074	345.7
2001	106	73	238	272	246	207	28	1170	167.1
2002	164	73	347	277	302	285	201	1649	235.6
2003	187	17	46	57	172	167	186	832	118.9
2004	111	47	85	134	157	86	67	687	98.1
2005	132	33	42	125	39	29	73	473	67.6
2006	179	35	129	103	197	223	95	961	137.3
2007	108	79	59	171	212	165	120	914	130.6
Total	**2319**	**994**	**2457**	**2772**	**2533**	**1946**	**770**	**13791**	**1970.1**

Table 5.3.6.4. CPUE of all age-1 red drum (i.e. wild + stocked fish) in the SC trammel net survey during July-March. (Stratum named as in Table 1).

	Ace Basin	Charleston Harbor			Cape Romain		Winyah Bay		
Year Class	**AB**	**AR**	**CH**	**LW**	**MB**	**RH**	**WB**	**Mean**	**SE**
1990			0.496	0.428				0.462	0.034
1991		0.152	0.563	0.255				0.323	0.124
1992	0.089	0.100	0.244	0.194				0.157	0.037
1993	0.186	0.151	0.329	0.175				0.210	0.040
1994	0.220	0.132	0.260	0.194				0.202	0.027
1995	0.191	0.044	0.161	0.170				0.141	0.033
1996	0.231	0.108	0.222	0.176	0.188	0.137		0.177	0.020
1997	0.101	0.083	0.151	0.098	0.178	0.166		0.130	0.016
1998	0.128	0.069	0.177	0.107	0.155	0.196		0.139	0.019
1999	0.100	0.138	0.086	0.072	0.139	0.099		0.105	0.011
2000	0.348	0.150	0.351	0.220	0.410	0.430		0.318	0.045
2001	0.166	0.128	0.322	0.271	0.314	0.307	0.114	0.232	0.035
2002	0.244	0.115	0.324	0.327	0.312	0.335	0.266	0.275	0.029
2003	0.184	0.039	0.104	0.076	0.262	0.244	0.250	0.165	0.035
2004	0.168	0.080	0.166	0.190	0.219	0.166	0.129	0.160	0.017
2005	0.193	0.065	0.089	0.209	0.102	0.074	0.174	0.129	0.023
2006	0.183	0.063	0.239	0.150	0.272	0.320	0.141	0.195	0.033
2007	0.219	0.135	0.175	0.251	0.310	0.309	0.260	0.237	0.025

Table 5.3.6.5. Catch per unit effort (CPUE) of wild age-1 red drum (i.e. excluding stocked fish) in the SC trammel net survey during July-March. (Stratum named as in Table 1)

	Ace Basin	Charleston Harbor			Cape Romain		Winyah Bay			
Year Class	AB	AR	CH	LW	MB	RH	WB	Mean	SE	CV
1990			0.496	0.428				0.462	0.034	7.36
1991		0.152	0.563	0.255				0.323	0.124	38.39
1992	0.089	0.1	0.244	0.194				0.157	0.037	23.57
1993	0.186	0.151	0.329	0.175				0.21	0.04	19.05
1994	0.22	0.132	0.26	0.194				0.202	0.027	13.37
1995	0.191	0.044	0.161	0.17				0.141	0.033	23.40
1996	0.231	0.108	0.222	0.176	0.188	0.137		0.177	0.02	11.30
1997	0.101	0.083	0.151	0.098	0.178	0.166		0.13	0.016	12.31
1998	0.128	0.069	0.177	0.107	0.155	0.196		0.139	0.019	13.67
1999	0.1	0.033	0.067	0.066	0.139	0.099		0.084	0.015	17.86
2000	0.348	0.12	0.339	0.204	0.41	0.43		0.308	0.05	16.23
2001	0.166	0.105	0.32	0.269	0.314	0.307	0.114	0.228	0.036	15.79
2002	0.244	0.115	0.324	0.327	0.312	0.335	0.266	0.275	0.029	10.55
2003	0.184	0.039	0.104	0.076	0.262	0.244	0.25	0.165	0.035	21.21
2004	0.168	0.08	0.166	0.19	0.219	0.166	0.129	0.16	0.017	10.63
2005	0.18	0.063	0.087	0.209	0.102	0.074	0.133	0.121	0.021	17.36
2006	0.183	0.063	0.239	0.15	0.272	0.32	0.141	0.195	0.033	16.92
2007	0.219	*	*	*	0.31	0.309		0.279	0.03	10.75

* Contribution from stocked fish not yet determined.

Table 5.3.8.1. North Carolina IGNS CPUE (arithmetic) for red drum during 2001-2007 (age aggregated). Note that the 2001 survey for for only part of the year.

Year	Number of Red Drum	# Sets	Weighted CPUE	SE	PSE	Mean Size (mm)	Min (mm)	Max (mm)
2001*	324	237	1.56	0.312	20	436	232	1,155
2002	907	320	3.22	0.419	13	406	228	1,194
2003	295	320	1.25	0.225	18	484	334	1,206
2004	525	320	1.99	0.299	15	388	250	1,200
2005	658	305	2.76	0.414	15	437	250	1,227
2006	730	320	2.91	0.349	12	422	240	1,257
2007	928	320	3.19	1.021	32	438	217	1,172

Table 5.3.9.1. Catch per unit effort (CPUE) of adult red drum in longline survey in Charleston Harbor, SC 1994 – 2007, August through December.

Year	# sets	Mean	Variance	CV
1994	71	2.58	28.9	15.78
1995	94	3.14	19.58	6.63
1996	112	2.88	36.89	11.44
1997	107	1.13	3.93	3.25
1998	115	1.91	13.24	6.03
1999	105	2.6	8.55	3.13
2000	96	1.88	13.46	7.46
2001	93	2.55	10.88	4.59
2002	91	4.05	30.14	8.18
2003	101	4.35	20.23	4.60
2004	87	2.93	12.86	5.04
2005	29	2.31	7.58	11.32
2006	51	1.94	4.94	4.99
2007	7	1.14	2.14	26.82

Table 5.4.1.4.1. Standardized total catch rates per angler-hour for anglers catching or targeting red drum during a fishing trip made in the northern or southern regions during 1991-2007. Estimated distribution of catch rates are shown given median, interquartiles, and extent of 95% confidence intervals. The number of observations made each year, N, and number with positive catches for red drum are given.

Northern region

	Mean	Median	2.5th	25th	75th	97.5th	N	Positives
1991	0.105	0.104	0.077	0.094	0.116	0.142	398	165
1992	0.058	0.057	0.041	0.051	0.064	0.078	333	98
1993	0.066	0.066	0.050	0.060	0.072	0.085	626	190
1994	0.064	0.064	0.050	0.058	0.070	0.083	728	191
1995	0.115	0.114	0.093	0.106	0.122	0.141	1,047	435
1996	0.068	0.067	0.051	0.062	0.074	0.088	637	171
1997	0.222	0.219	0.167	0.199	0.242	0.288	514	294
1998	0.147	0.146	0.117	0.136	0.158	0.180	897	461
1999	0.182	0.180	0.140	0.166	0.196	0.229	742	420
2000	0.096	0.095	0.075	0.088	0.103	0.121	772	295
2001	0.109	0.108	0.084	0.099	0.118	0.142	637	239
2002	0.294	0.292	0.230	0.269	0.316	0.371	990	671
2003	0.084	0.083	0.060	0.075	0.093	0.113	363	131
2004	0.131	0.130	0.098	0.117	0.144	0.171	443	252
2005	0.138	0.137	0.103	0.124	0.152	0.181	423	246
2006	0.159	0.156	0.124	0.145	0.172	0.198	642	373
2007	0.147	0.146	0.119	0.136	0.157	0.180	853	419

Southern Region

	Mean	Median	2.5th	25th	75th	97.5th	N	Positives
1991	0.140	0.138	0.105	0.126	0.153	0.184	354	212
1992	0.149	0.149	0.120	0.138	0.158	0.181	697	432
1993	0.148	0.148	0.120	0.137	0.158	0.181	643	363
1994	0.182	0.181	0.150	0.170	0.193	0.218	895	481
1995	0.208	0.207	0.171	0.193	0.222	0.252	941	567
1996	0.161	0.161	0.135	0.151	0.171	0.191	984	558
1997	0.165	0.165	0.138	0.154	0.175	0.197	898	528
1998	0.130	0.130	0.108	0.122	0.137	0.153	1,069	569
1999	0.125	0.125	0.108	0.119	0.131	0.144	1,614	779
2000	0.113	0.113	0.098	0.108	0.118	0.129	1,868	859
2001	0.141	0.141	0.123	0.134	0.148	0.161	2,001	940
2002	0.125	0.125	0.109	0.119	0.131	0.144	1,814	873
2003	0.153	0.153	0.132	0.146	0.160	0.176	1,598	817
2004	0.154	0.153	0.134	0.147	0.160	0.176	1,837	981
2005	0.164	0.164	0.142	0.157	0.172	0.188	1,952	1,061
2006	0.156	0.155	0.136	0.148	0.162	0.177	1,894	999
2007	0.144	0.144	0.123	0.137	0.150	0.163	1,714	846

5.10 Figures

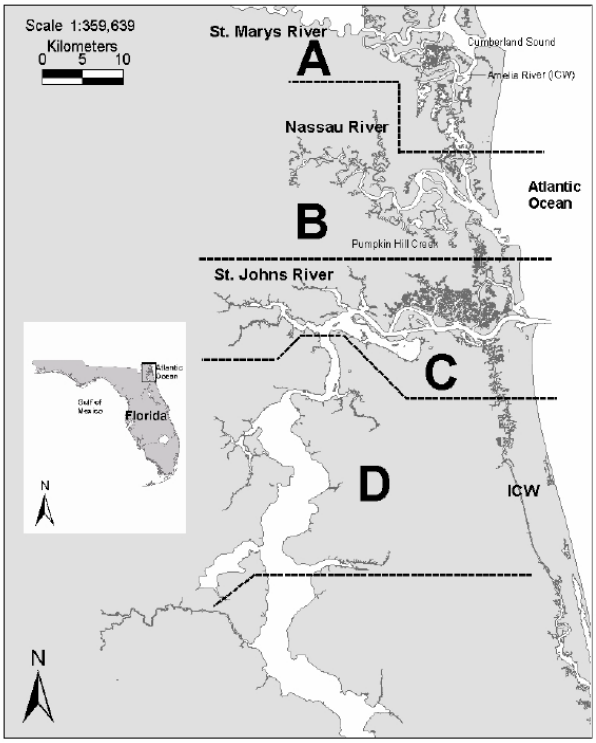


Figure JX05-01. Map of northeast Florida sampling area. Zones are labeled A-D.

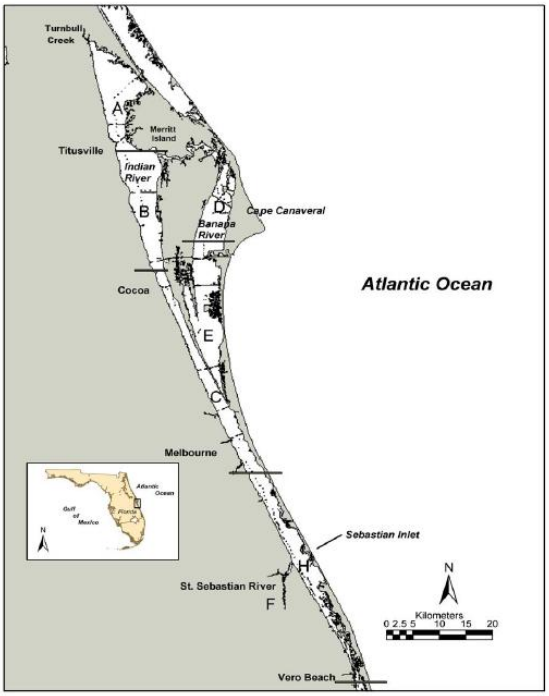


Figure IR05-01. Map of the Northern Indian River Lagoon sampling area. Zones are labeled A-F and H.

Figure 5.3.1.1 Caption is on following page.

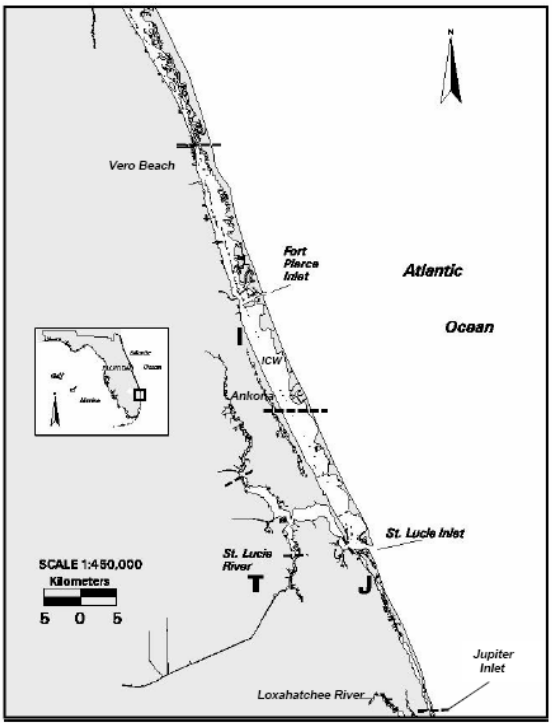


Figure TQ05-01. Map of southern Indian River Lagoon sampling area. Zones are I, J, and T.

Figure 5.3.1.1. Areas encompassing the Florida Fish and Wildlife Conservation Commission's Fishery Independent Monitoring Program's stratified random surveys for marine organisms along the Atlantic coast. Only the northeast (left) and northern Indian River Lagoon (center) areas are sampled using 21.3 m seines that effectively catch young-of-the-year red drum. In all three areas, including the southern Indian River Lagoon, 183 m seines that are used. This gear is effective in capturing subadult red drum.

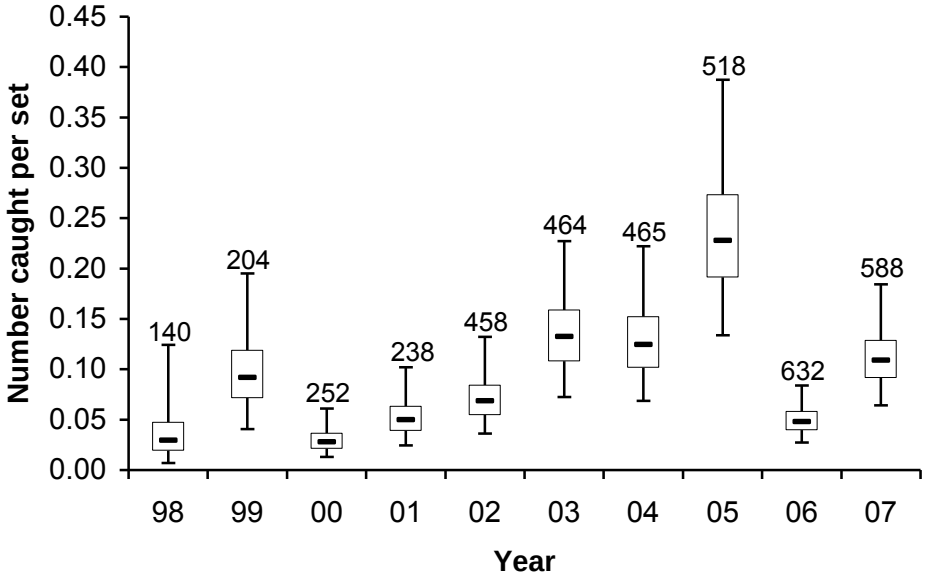


Figure 5.3.1.2. Distribution of a delta lognormal standardization for fall 1997 (fall 1997 through spring 1998 is labeled 1998) through spring 2007 data on the abundance for young-of-the-year red drum on the Atlantic coast of Florida. The dash shows the median, the box the inter-quartile range and the whiskers the 95% confidence interval. The number of sets made are given for each year.

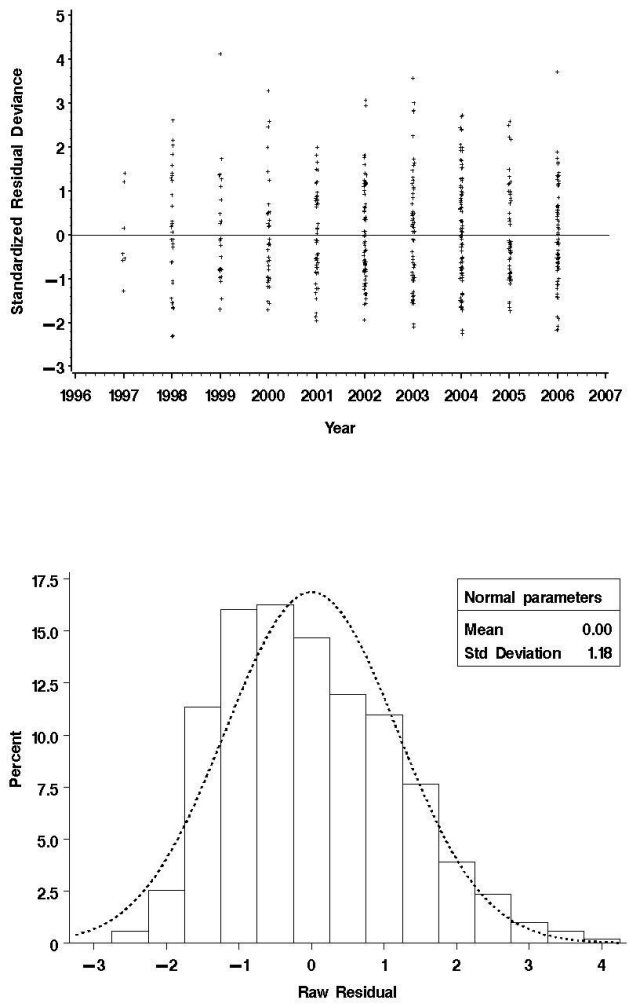


Figure 5.3.1.3. Diagnostics for fit to final lognormal standardization models for positive catch observations for young-of-the-year red drum from Florida's fisheries-independent monitoring dataset. Residual-plot year represent the fall spawning year and should range 1998-2007 to be consistent with the assumed January 1 year at beginning of age 1. By agreement, age 1 is assumed to begin on the first January 1st of the fish's life, at about 2-4 months of true age.

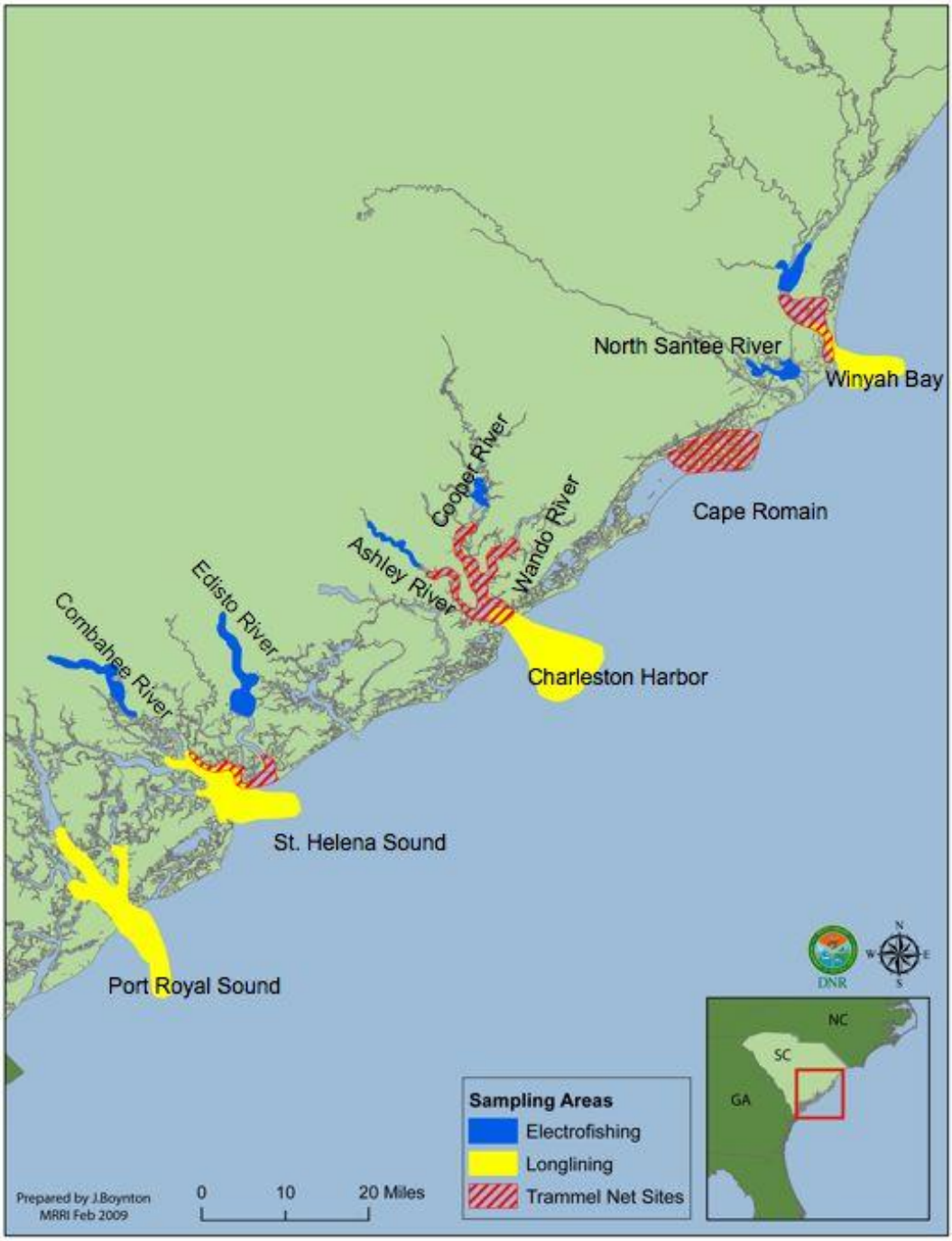


Figure 5.3.2.1. South Carolina fishery-independent sampling areas.

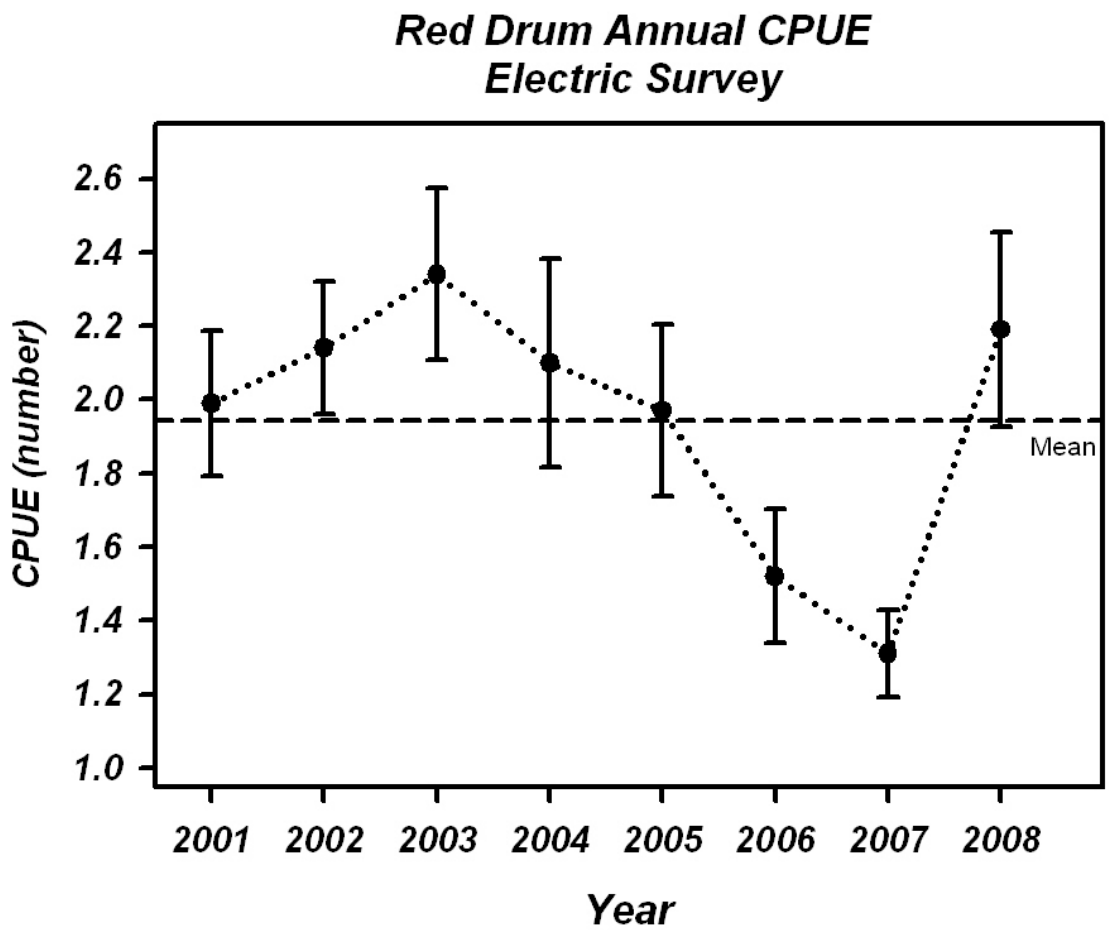


Figure 5.3.2.2. Annual mean catch per transect in numbers for red drum; filled circle = mean; vertical bars = +/- one standard error of the mean; dashed line = mean for period as a reference.

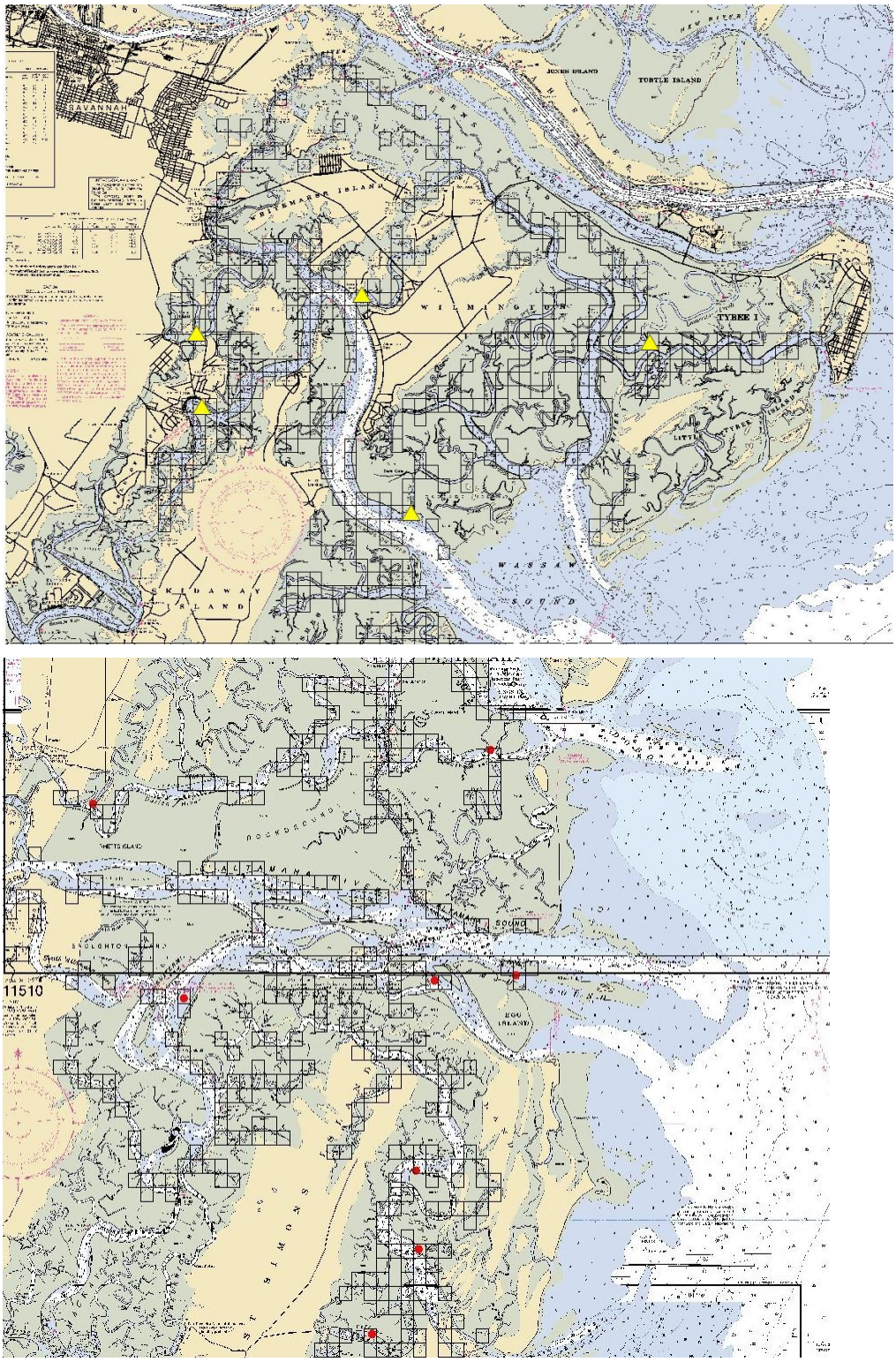


Figure 5.3.3.1. Fixed stations used in the WG suggested analysis for calculating an index of abundance for age-1 red drum in Georgia's sampled estuaries. Wassaw (top) and Altamaha (bottom) sounds are the only areas sampled.

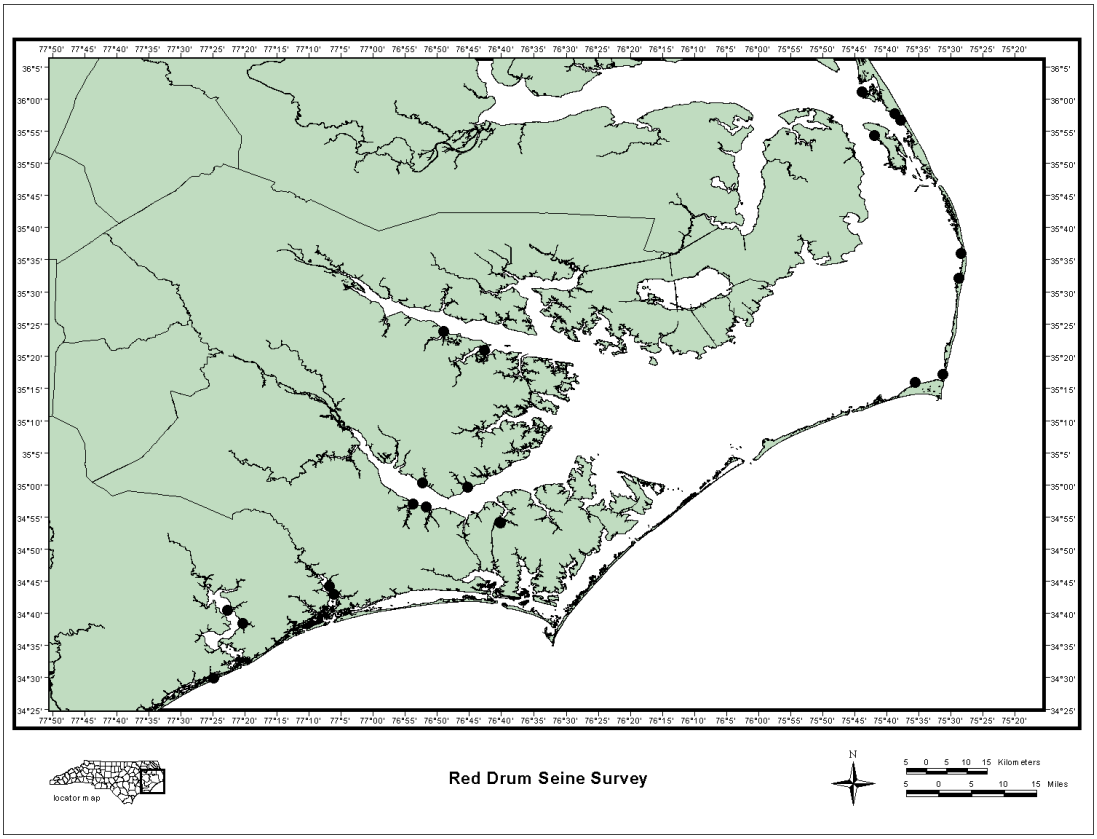


Figure 5.3.4.1. Sampling sites of the juvenile red drum survey in North Carolina.

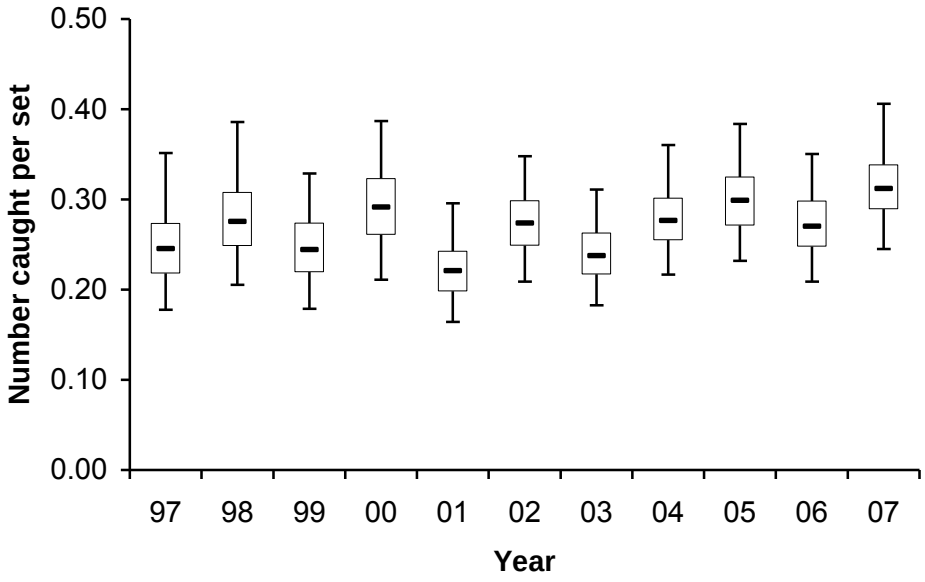


Figure 5.3.5.1. Distribution of a delta lognormal standardization for fall 1997 through spring 2007 data on the abundance for young-of-the-year red drum on the Atlantic coast of Florida. The dash shows the median, the box the inter-quartile range and the whiskers the 95% confidence interval. The number of sets made are given for each year.

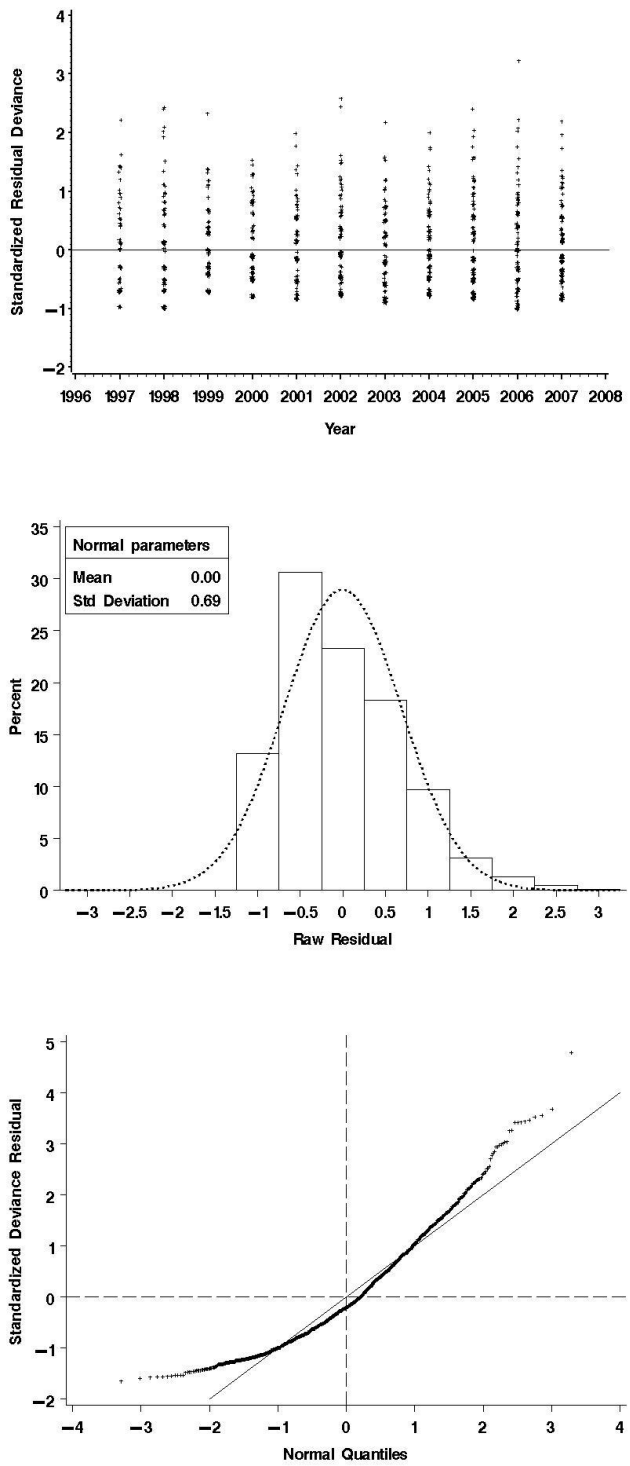


Figure 5.3.5.2. Diagnostics for fit to final lognormal standardization models for positive catch observations for subadult red drum from Florida's fisheries-independent monitoring dataset.

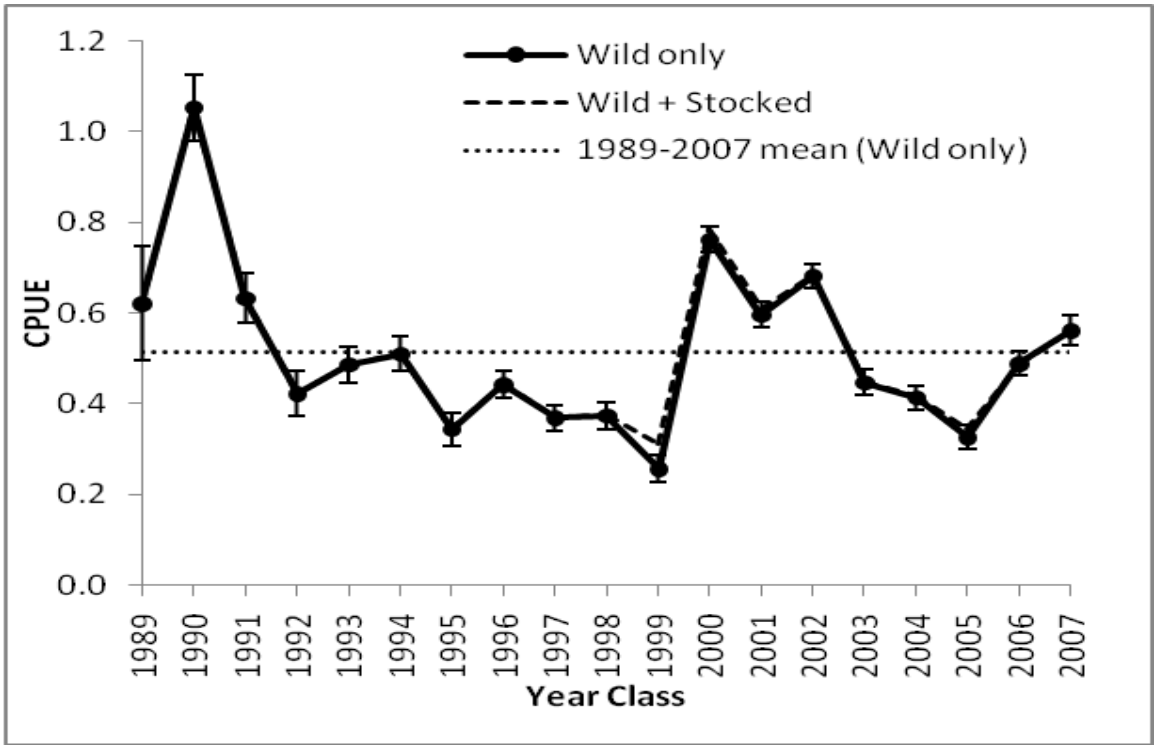


Figure 5.3.6.1. Least squares means SC-wide CPUE (ln[Catch+1] per trammel set) calculated for age-1 red drum across all strata, both before and after adjusting for stocked fish contributions. Error bars represent 1 SE.

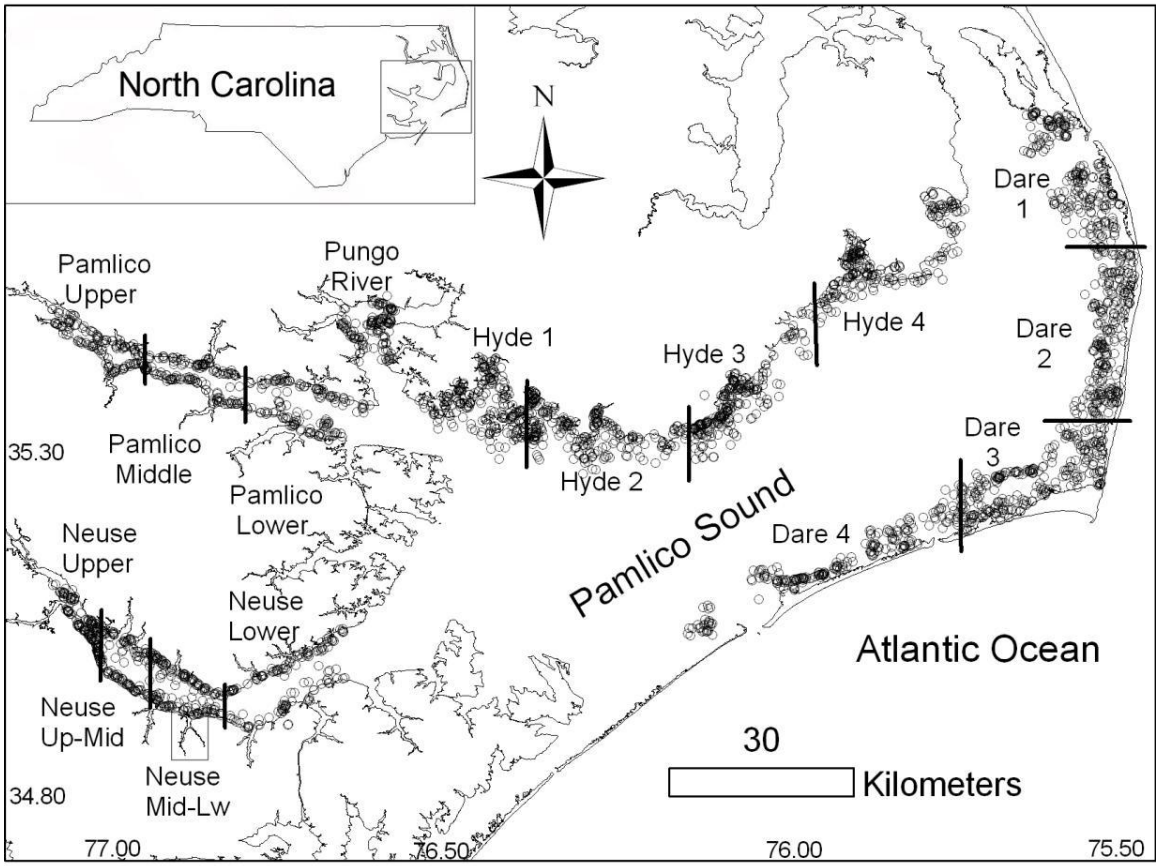


Figure 5.3.8.1. Map of Pamlico Sound and associated rivers showing the sample strata and locations of individual samples taken in the NCDMF independent gill net survey from 2001 to 2006.

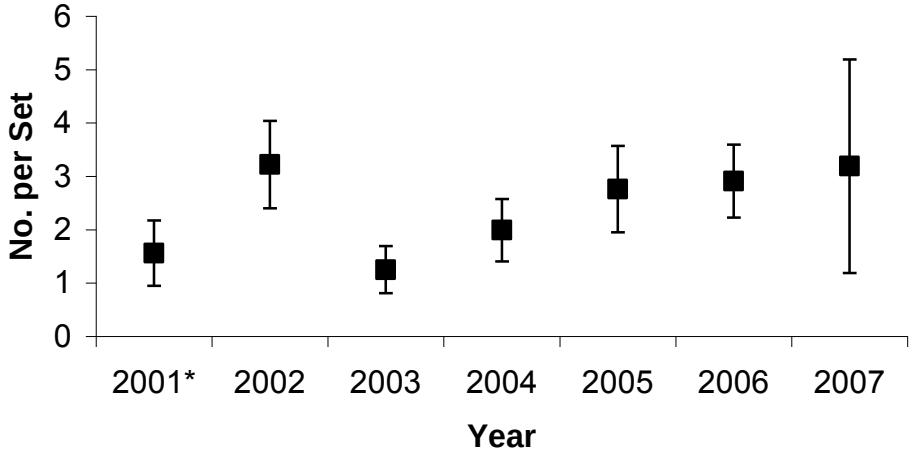
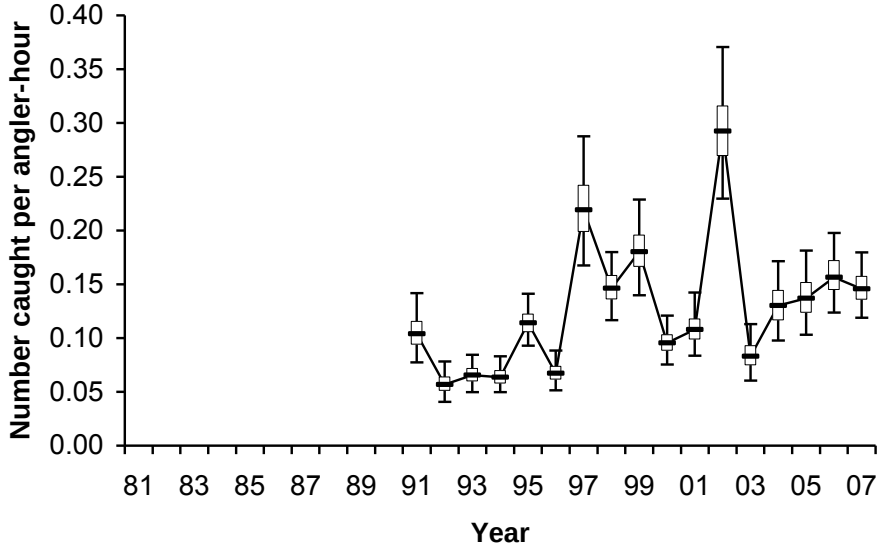


Figure 5.3.8.2. Annual average number of red drum caught per set during the North Carolina independent gill net survey. Error bars are +/- 1.96 the standard error; samples made during 2001 are for only part of the year

North Region



South Region

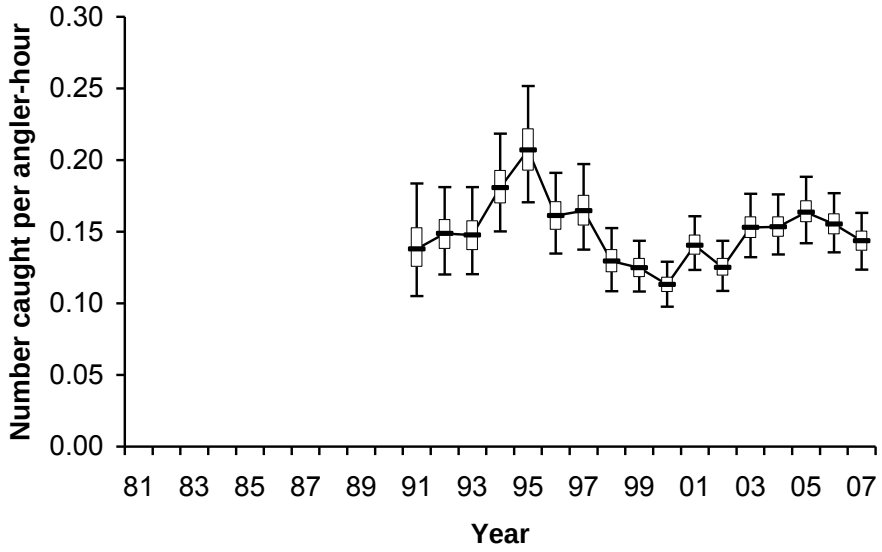


Figure 5.4.1.4.1. Standardized total catch rates per angler-hour for anglers catching or targeting red drum during a fishing trip made in the northern or southern regions. The dash shows the median, the box the inter-quartile range and the whiskers the 95% confidence interval. The number of sets made is given for each year.

6. Submitted Comment

No comments were submitted.