Northeast Fisheries Science Center Reference Document 07-21

Monkfish Assessment Report for 2007

by Northeast Data Poor Stocks Working Group

December 2007

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Northeast Fisheries Science Center
Woods Hole, Massachusetts

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Monkfish Assessment Report 2007

Table of Contents

Foreword to the Monkfish Assessment Report

The Northeast Regional Stock Assessment Workshop (SAW) process has three parts: preparation of stock assessments by the SAW Working Groups and/or by ASMFC Technical Committees / Assessment Committees; peer review of the assessments by a panel of outside experts who judge the adequacy of the assessment as a basis for providing scientific advice to managers; and a presentation of the results and reports to the Region's fishery management bodies. Council and Commission teams (e.g., Plan Development Teams, Monitoring and Technical Committees) formulate management advice, after an assessment has been accepted by the peer review panel.

Reports that are produced following peer review meetings typically include: An *Assessment Summary Report* - a brief summary of the assessment results in a format useful to managers; this *Assessment Report* – a detailed account of the stock assessment; and the review panel report – a summary of the reviewer's opinions and recommendations. These reports are available online at http://www.nefsc.noaa.gov/nefsc/publications/series/crdlist.htm. The review panel report and assessment reports can be found at *http://www.nefsc.noaa.gov/nefsc/saw/*.

The Northeast "Data Poor Stocks" Working Group was formed in 2007, as part of the SAW process, to perform stock assessments of species that are difficult to assess due to lack of critical data. Monkfish was the first stock addressed by this Working Group. The team met in June and July, 2007, and had an integrated peer review meeting during July 9 – 13, 2007 in Woods Hole at the Northeast Fisheries Science Center.

This Foreword contains a brief summary of the integrated peer review meeting, lists of invited reviewers, the meeting agenda, and a list of Working Group members, contributors and attendees (Tables 1 – 3). Maps of the Atlantic coast of the USA and Canada are also provided (Figures 1 - 3).

Outcome of Stock Assessment Review Meeting (July 9-13, 2007):

The Review Panel concluded that the Assessment Team successfully completed six Terms of Reference (#1,2,5,6,8,9) and partially completed TORs #3, 4, and 7. All TORs are listed in Section 2.1. TOR#3 was partially completed because there was no clear recommendation in the report about whether additional cooperative surveys should be conducted. TOR#4 was partially completed because uncertainty was not fully characterized in estimates of some population parameters. TOR#7 was partially completed because a full projection model was not developed.

The Review Panel agreed with the following major conclusions from the stock assessment:

- The "SCALE" model (Statistical catch-at-length analysis) is the preferred model at this time for use in stock status determination, short-term projections, and management plan evaluation. The review panel concluded that the six other modeling approaches which were

undertaken had significant shortcomings.

- The age-based yield per recruit model is the preferred model to estimate fishing mortality based BRPs; and the "SCALE" model is the preferred model to estimate biomass-based BRPs.

- Biomass in both management units is expected to increase through 2009 at the TALs proposed for 2008 in Framework 4 of the Monkfish Plan (5000 mt in the northern management unit and 5100 mt in the southern management unit).

- Using the revised BRPs and latest estimates of stock status, monkfish in the two management units are not overfished and rebuilding is not required.

- The development of a new analytic model ("SCALE") for monkfish is a significant advance. However, the assessment results from the model are accompanied by substantial uncertainty, and therefore need to be viewed with caution.

Table 1. "Northeast Data Poor Stocks" Working Group: Monkfish Assessment. Listing of invited panelists for the Integrated Peer Review and Meeting Dates (See Table 3 for a comprehensive list of contributors).

Meeting 1. (June 12-15 and June 29, 2007)

Chairman:

Dr. Steve Cadrin, NOAA/ UMass CMER

Invited Panelists :

Dr. Michael Armstrong, Mass. DMF
Dr. JJ Maguire, Halieutikos Inc.
Mr. Galen Tromble, NOAA SF

Meeting 2. (July 9-13, 2007)

Chairman:

Dr. John Annala, GMRI, Maine

Invited Panelists :

Dr. Robert Mohn, BIO, Canada
Mr. Rafael Duarte, IPIMAR, Portugal

Table 2. Agenda, "Northeast Data Poor Stocks" Monkfish Assessment.

Data Poor Stocks Working Group: Monkfish

Stephen H. Clark Conference Room – Northeast Fisheries Science Center
Woods Hole, Massachusetts

July 9-13, 2007
Sessions are open to the public, except where indicated.

AGENDA (7-9-07)

TOPIC	PRESENTER	RAPPORTEUR
Monday, 9 July (1:00 – 5:00 PM)…….……		
Opening		
Welcome	**James Weinberg**, SAW Chairman	
Introduction	**John Annala**, Working Group Chairman	
Agenda		
Conduct of Meeting		
Assessment Presentation	**Steve Cadrin and others**	**Laurel Col**
Discussion	**John Annala**	
Tuesday, 10 July (9 AM – Noon PM)… (Lunch: Noon – 1:15 PM)**……..……**		
Assessment Presentation (cont.)	**Steve Cadrin and others**	**Laurel Col**
Discussion	**John Annala**	
Tuesday, 10 July (1:30 AM – 5 PM)……..…….		
Revisit Assessment with presenters, if needed.		
Discussion	**John Annala**	

Wednesday, 11 July (9 AM – 5:00 PM) ……..……
Revisit Assessment with presenters, if needed.
Discussion. Finalize results. **John Annala**

At some point near end of Wednesday, the meeting will be closed so the reviewers can discuss the assessment and write a Reviewer Summary Report. Depending on progress, the meeting will end on July 12 or 13.

Table 3. List of Working Group members, contributors and meeting attendees.

Name			Affiliation	Email
John	Annala	(independent panel chair)	GMRI	jannala@gmri.org
Mike	Armstrong	(independent panelist)	MA DMF	michael.armstrong@state.ma.us
Crista	Bank		SMAST	cbank@umassd.edu
Talia	Bigelow		NOAA/UMass CMER	tbigelow@umassd.edu
Liz	Brooks	(by correspondence)	NEFSC	Liz.Brooks@noaa.gov
Steve	Cadrin	(WG chair)	NOAA/UMass CMER	steven.cadrin@noaa.gov
Laurel	Col	(rapporteur)	NEFSC	laurel.col@noaa.gov
Rafael	Duarte	(independent panelist)	IPIMAR, Portugal	rduarte@ipimar.pt
Todd	Gedamke	(by correspondence)	VIMS	todd.gedamke@noaa.gov
Philip	Haring		NEFMC	pharing@nefmc.org
John	Hoenig	(by correspondence)	VIMS	hoenig@vims.edu
Chris	Legault	(by correspondence)	NEFSC	Chris.Legault@noaa.gov
J.J	Maguire	(independent panelist)	Halieutikos Inc	jjmaguire@syrupatico.ca
Dave	Martins		SMAST	dmartins@umassd.edu
Allison	McHale		NMFS NERO	allison.mchale@noaa.gov
Jess	Melgey		NOAA/UMass CMER	jmelgey@umassd.edu
Tim	Miller		NEFSC	timothy.j.miller@noaa.gov
Robert	Mohn	(independent panelist)	BIO, Canada	mohnr@mar.dfo-mpo.gc.ca
Paul	Nitschke		NEFSC	paul.nitschke@noaa.gov
Mike	Palmer		NEFSC	michael.palmer@noaa.gov
Paul	Rago		NMFS NEFSC	paul.rago@noaa.gov
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Gary	Shepherd		NEFSC	gary.shepherd@noaa.gov
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Mark	Terceiro		NEFSC	mark.terceiro@noaa.gov
Michele	Traver		NEFSC	michele.traver@noaa.gov
Galen	Tromble	(independent panelist)	NMFS HQ SF	galen.tromble@noaa.gov
Susan	Wigley		NEFSC	susan.wigley@noaa.gov
Trisha	Cheney		DMR, Maine	Trisha.Cheney@maine.gov
Nils	Stolpe		Monkfish Defense Fund	nilsstolpe@cfl.rr.com
Vidar	Wespestad		Research. Analysts Intl.	vidarw@verizon.net

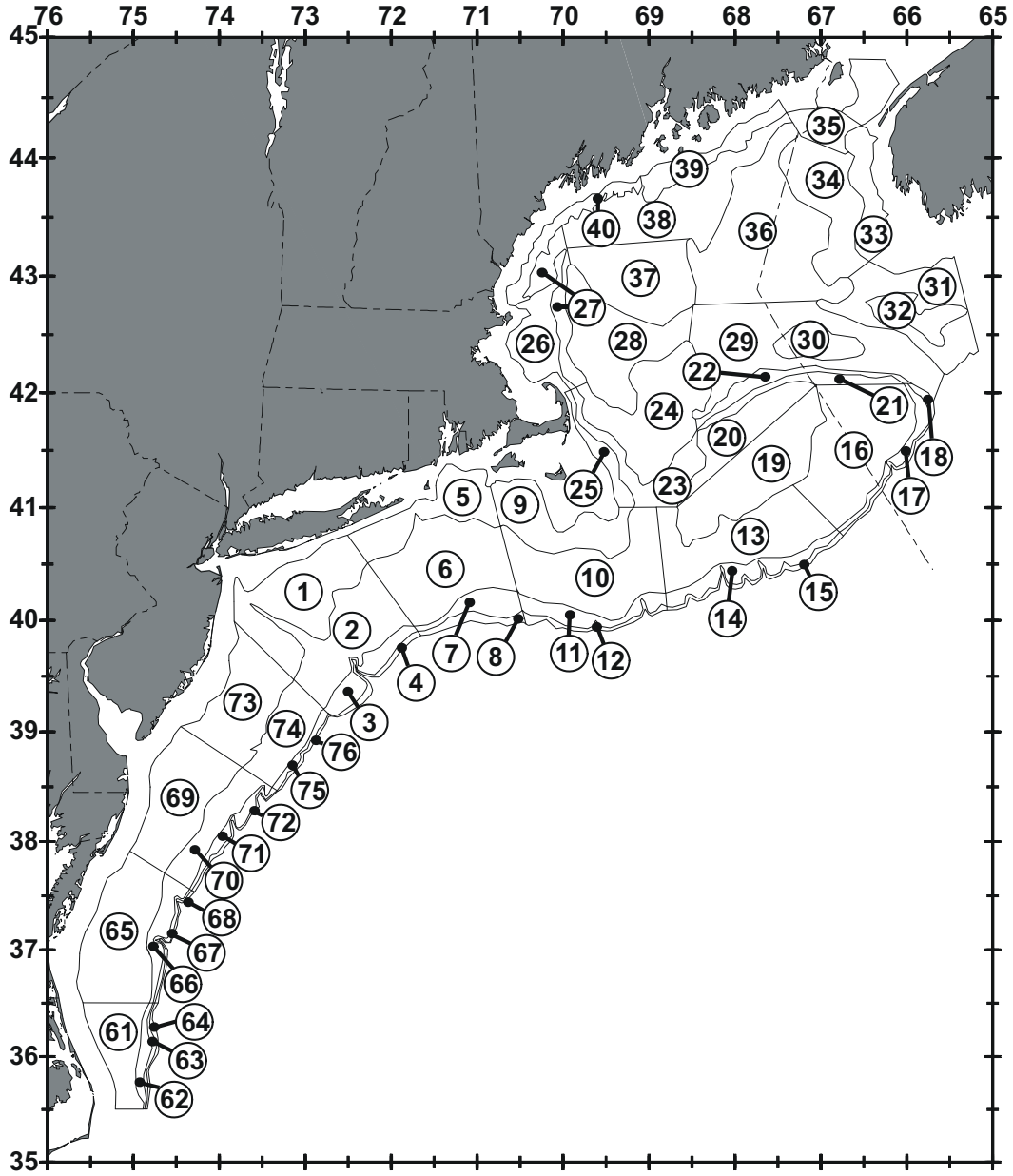

Figure 1. Offshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys.

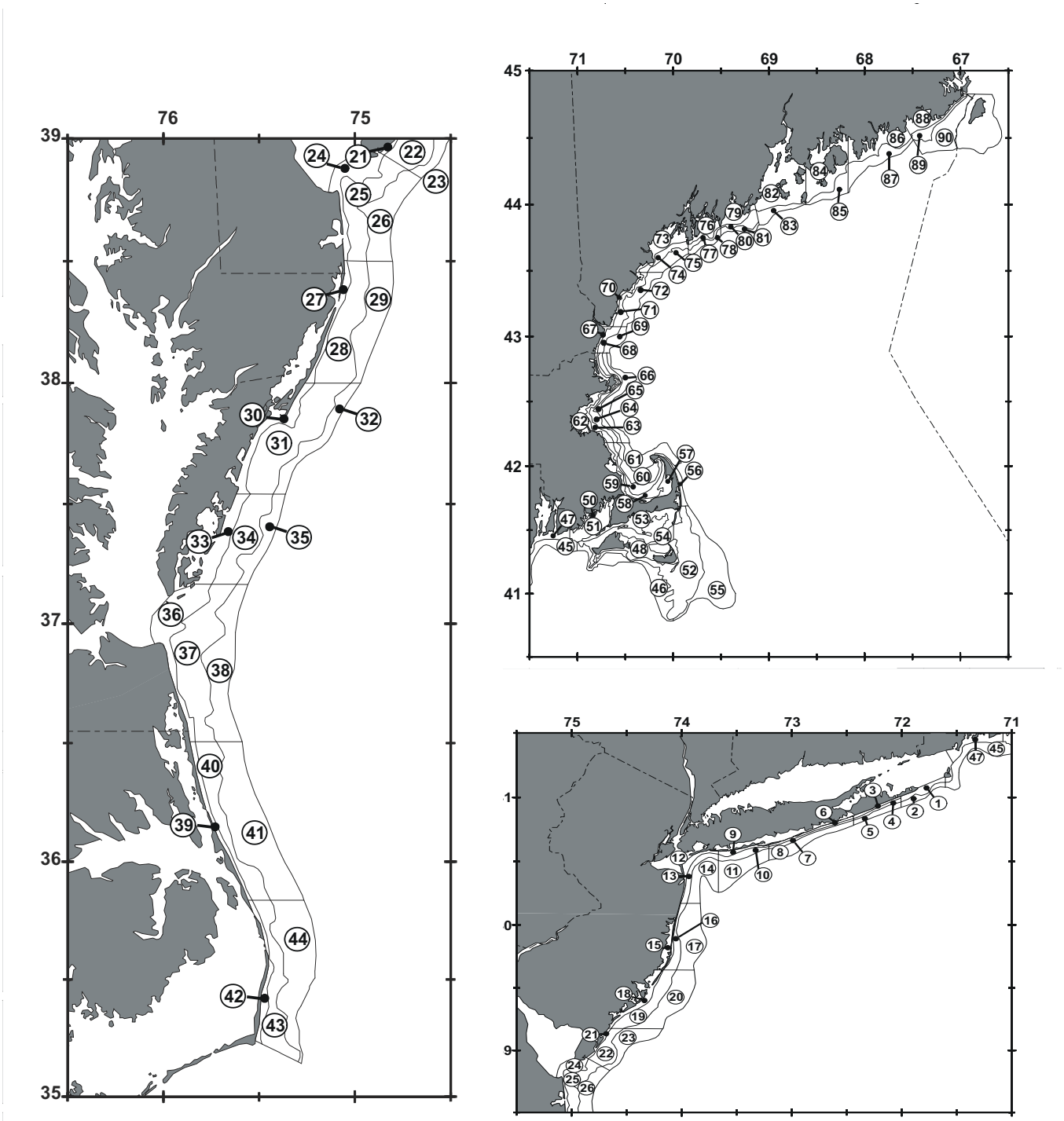

Figure 2. Inshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys.

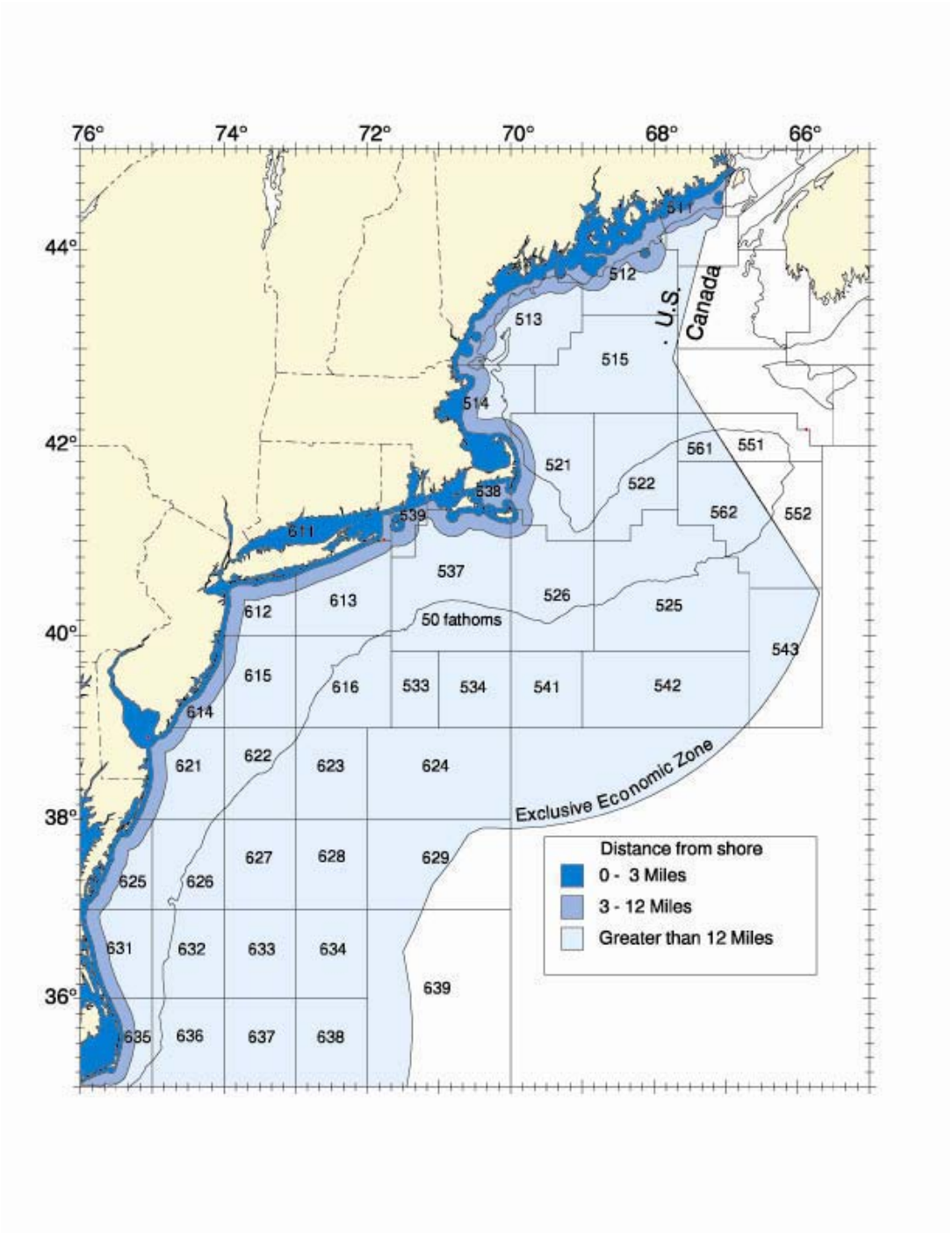

Figure 3. Statistical areas used for reporting commercial catches.

1.0 Executive Summary

The Northeast Data Poor Stocks Working Group is part of the SAW process. The Working Group (WG) met in June and July 2007 to develop a monkfish stock assessment for the northern and southern management areas of the U.S. fishery resource. The focus was on reviewing the quality of stock assessment data, and on developing potential new methods for stock status determination.

1.1 Fishery Data

Estimation of total catch has several sources of uncertainty. Before 1980, fishery removals were primarily incidental bycatch, but most were unreported. Therefore, evaluation of fishery development is difficult, leading to problems interpreting the state of the resource in the early years of the fishery. Since 1980, quality of the landings estimates has improved, but the series includes under-reporting and difficulties in converting landed products to live weight. Reported landings generally increased from approximately 100 mt per year in the mid 1960s to a peak of 28,000 mt in 1997. Landings remained above 20,000 mt per year until 2005, but decreased to 14,000 mt in 2006 as a result of fishery restrictions.

There is no information on the magnitude of discards prior to 1989. Discard rates may have been greater in earlier years when there was no market. Thus, it may not be correct to assume that historical discard rates were similar to those observed in later years. The quality of discard data generally improved during the 1989-2006 observer time series, as a result of greater observer coverage of fleets and improved protocols. But, some portions of the fishery often received no observer coverage (e.g., some half-year periods in which entire gear-types were not sampled). The overall annual discard ratio was estimated using several methods. It declined in the northern area, from an average of 16% of total monkfish catch in the 1980s to an annual average of 8% since 2002. However, the annual discard ratio in the southern area has generally increased since 1980, and has averaged 23% since 2002.

Size and age compositions of the catch also have considerable uncertainty. Port sampling of landings size composition began in 1996, and has generally been adequate in coverage and intensity to characterize the marketed catch. Total length measurements from at-sea observers are available since 1989, but sampling intensity in most years has been inadequate for sub-annual estimation (e.g. seasonal discards at length estimates). Age data from landed monkfish are available from port sampling since 2000, but coverage and intensity of the sampling is inadequate for estimation of landings at age. Age samples from at-sea observers have not been processed.

Evaluating trends in effort or catch rates in the monkfish fishery is difficult as much of the catch is taken in multi-species fisheries, making it difficult to define a targeted monkfish trips. Furthermore, programmatic changes from port interviews (1980-1993) to logbooks (1994-2006) make temporal comparison of effort data difficult. Recent observer data suggest that catch rates have increased in the southern management area, but have decreased in the northern area.

Fishery data available for the 2007 monkfish stock assessment.

Input Data	Time Series	Data Source	Comments
Total landings	before 1980		mostly unreported
	1980-1993	weighout	reliability increases
	1994-1999	weighout	some under-reporting
	2000-2003	weighout	reliable
	2004-2006	electronic reporting	under-reported, but improving
			conversion to live weight adds uncertainty
Landings by area	1980-1993	interviews	reliable proration
	1994-2006	logbooks	reliable proration
Discards by area	before 1980		most catch discarded
	1980-1989		historical average assumed
	1989-2006	observer samples	general improvement in coverage & protocols
			no sampling of southern dredge fishery before 1992
			expansion has same issues as landings
Landings at size	1996-2006	port sampling	stratified by market category
			conversion from tail lengths may be problematic
			generally adequate coverage & intensity
	1989-2006	observer samples	stratified by gear
			all measured as total length
			coverage inadequate for sub-annual stratification
Discards at size	1989-2006	observer samples	stratified by gear
			all measured as total length
			coverage inadequate for sub-annual stratification
Landings at age	2000-2006	port sampling	inadequate coverage and intensity
		observer samples	not processed
Effort	1980-1993	interviews	targeting difficult to define by trip
	1994-2006	logbooks	targeting difficult to define by trip
			comparison of interview & logbook effort problematic
	1992-2006	observer samples	incomplete coverage

1.2 Survey Data

Several fishery independent surveys sample monkfish and provide time series of relative abundance. However, no single survey catches large numbers of monkfish throughout either management area. The NEFSC spring and autumn bottom trawl surveys, which began in the 1960s, provide long-term series that cover the entire continental shelf to 300m depth. However, these seasonal surveys only capture approximately 100 monkfish in each management area each year. The NEFSC winter bottom trawl survey, the NEFSC sea scallop survey, and the ASMFC northern shrimp survey capture considerably more monkfish, but are shorter time series, and sample only a portion of either management area.

Within the northern management area, trends in stock size are generally consistent among the spring, autumn and shrimp surveys. These surveys indicate that biomass fluctuated without trend from 1963 to 1975, increased briefly in the late 1970s, but declined thereafter to near historic lows during the 1990s. Survey indices generally increased from 1999 to 2003, but have recently declined slightly.

General trends in stock size in the southern area are also consistent among surveys. Survey biomass indices were high during the mid-1960s, fluctuated around an intermediate level during the 1970s and mid 1980s, and then declined to low levels in the

1990s. Biomass indices increased slightly around 2000 and have been relatively stable since then.

Size-based indices of abundance indicate recent strong recruitment in the northern area and stable recruitment in the south. Length distributions became truncated between 1960 and 1990, and the median size of monkfish in survey catches has remained fairly constant since the early 1990s.

Survey data available for the 2007 monkfish stock assessment.

Survey	Time Series Series	Management Area	Maximum Depth	Average # monkfish	Comments
NEFSC Autumn	1963-2006	North, South	300m	98	southern strata not sampled 1963-1966 door & vessel changes, warp problems 2001-2002
NEFSC Spring	1968-2006	North, South	300m	100	net, door & vessel changes, warp problems 2001-2002
NEFSC Winter	1992-2007	~South	300m	438	deep strata not sampled before 1998 inconsistent coverage of Georges Bank warp problems 2001-2002
NEFSC Scallop	1984-2006	~South	300m	684	only scallop beds sampled no biomass index few large fish sampled
Shrimp	1991-2006	~North	deep	199	only western Gulf of Maine sampled
MADMF Spring	1978-2006	~North	<100m	?	only Mass. Territorial waters sampled
MADMF Autumn	1978-2006	~North	<100m	?	only Mass. Territorial waters sampled
Cooperative	2001, 2004	North, South	500m	thousands	multiple vessels & nets uneven spatial coverage random & nonrandom stations relatively low CVs for catch rates

1.3 Stock Status Determination

Underestimates of historic catches and the resulting lack of correspondence between research survey data and harvest trends precluded the use of long-term models (i.e., those using a long time series from the 1960s to the present). Therefore, status determination had to be based either entirely on fishery independent surveys (e.g., survey biomass indices and mortality based on survey size distributions), or on analysis of fishery independent survey data supplemented by fishery data from 1980 to the present. The latter approach was adopted.

Previous stock assessments assumed that natural mortality (M) =0.2. The current assessment assumed a higher value, M=0.3, based on the observed age structure of the population, with females living to at least age 12 (and likely older), but few males older than age 7exist in either area. The stock assessment results are sensitive to the assumed rate of natural mortality. Model estimates of absolute biomass were compared to an overfished reference point called B_{loss} (the lowest observed value in the total biomass time series [1980-2006] from which the stock has recovered). Current fishing mortality was compared to overfishing reference points (F_{max} and $F_{40\%}$) from a new age-based yield per recruit analysis.

Based on the biomass reference points in the monkfish Fishery Management Plan, the resource would be considered overfished in both the northern and southern stock management areas. In the northern area, the most recent biomass index, based on the 2004-2006 NEFSC autumn survey 3-yr average weight/tow value was 1.1 kg per tow. This is less than the value of $B_{threshold}$ (1.30 kg/tow) as well as B_{target} (2.60 kg/tow) for the northern area. In the southern area, the most recent biomass index, based on the 2004-

2006 NEFSC autumn survey 3-yr average, was 0.87 kg per tow. This is less than the value of $B_{threshold}$ (0.92 kg/tow) as well as B_{target} (1.84 kg/tow) for the southern area.

The 2007 assessment developed new reference points based on an updated yield-per-recruit analysis (using a revised value of M) and results of a length-tuned model (SCALE) that incorporates multiple survey indices and catch data. Based on the new assessment results, which have considerable uncertainty, monkfish in both management regions are not overfished and overfishing is not occurring. New estimates of $B_{threshold}$ are 65,200 mt of total biomass in the north and 96,400 mt of total biomass in the south. Estimates of B_{target} are 92,200 mt in the north and 122,500 mt in the south. Estimates of total biomass for 2006 are 118,700 mt in the north and 135,400 mt in the south, both of which are greater than their respective biomass targets. The existing overfishing threshold is still based on F_{max}, and this was retained in the new assessment, although new values were estimated. The new, updated estimates of F_{max} are 0.31 per year in the north and 0.40 per year in the south. Estimates of current annual F (2006) are 0.09 in the north and 0.12 in the south, both of which are less than their respective overfishing thresholds.

The development of an analytic model for monkfish represents significant progress; however, the assessment results have substantial uncertainty, and thus the results should be viewed with caution. Reservations stem from input uncertainties (under-reported landings and unknown discards during the 1980s and incomplete understanding of key biological parameters such as age and growth, longevity, natural mortality and stock structure), the shorter reference time frame (1980-2006) than in previous assessments (1963-2006), and the application of a new assessment model.

Recruitment patterns, as indicated by NEFSC survey abundance indices for approximate ages 1 and 2 (inferred from lengths), show increased frequency of recruitment events in the northern area since the late 1980s. Relatively strong year classes were produced in 1993, 1999 and 2001. In the south, recruitment varied without trend during 1963-2006; however, a relatively strong 2001 year class is apparent in the south.

Size composition of the monkfish population reflects its exploitation history. The median fish size in both regions decreased in the 1980s as landings increased. Maximum size has also declined, from around 110 cm during the 1960s to about 90 cm in the north, and in the south from around 100 cm in the 1960s to about 75 cm now.

2.0 Monkfish Working Group

The Monkfish Working Group was formed within the Northeast Data Poor Stocks Working Group. The Monkfish Working Group met during 12-15 June 2007 and 29 June 2007 and on July 9-12 2007 in Woods Hole, MA to develop a stock assessment and report. (See Table 3 in the "Foreward" for a list of contributors and attendees.)

2.1 Terms of Reference (TOR)

1. Characterize the commercial landings, effort, LPUE, and discards for monkfish in the northern and southern management areas.
2. Evaluate the fishery-independent and fishery-dependent measures of relative abundance with respect to their accuracy and precision.
3. Incorporate recommendations of the March 2006 External Peer Review of the 2001 and 2004 Cooperative Monkfish Surveys. Incorporate these industry based assessments as appropriate into the stock assessment. Recommend whether additional cooperative surveys should be conducted.
4. Estimate fishing mortality, spawning stock biomass, and total stock biomass or suitable proxies for as many years as possible for existing time series. Characterize the uncertainty of those estimates.
5. If appropriate, update or redefine biological reference points (BRPs) that could be used annually for stock status determination, taking into account that survey vessels will change in 2008, and that BRPs must be objective and measurable.
6. Evaluate the current status of the stock assessment units relative to both the existing BRPs and the updated or redefined BRPs (see TOR 5).
7. Compute TALs and measures of uncertainty for Fishing Years 2007 and 2008 (and if possible, future years) under various levels of fishing mortality. If fishing mortality can not be estimated, consider alternative or proxy methodologies for computing TALs.
8. Evaluate the efficacy of management measures and control rules that have been used to rebuild monkfish to target levels. Specifically address whether the stocks can be rebuilt by 2010 under the existing rebuilding program, and indicate what the fishing mortality rates or catch limits would have to be. Consider alternative approaches with respect to the probability of attaining target levels and the relevance of time lags in availability of information for formulation of management decisions.
9. Review research conducted to date that addresses research recommendations in the previous SARC-reviewed assessments. Incorporate any validated results into the current assessment. Update and prioritize Research Recommendations.

3.0 Introduction to Monkfish Assessment

3.1 Life History

Monkfish (*Lophius americanus*), also called goosefish, are distributed in the Northwest Atlantic from the Grand Banks and northern Gulf of St. Lawrence south to Cape Hatteras, North Carolina (Collette and Klein-Macphee 2002). Monkfish may be found from inshore areas to depths of at least 900 m (500 fathoms). Seasonal onshore-offshore migrations occur and appear to be related to spawning and possibly to food availability (Collette and Klein-MacPhee 2002).

Monkfish partially bury themselves in soft bottom substrates, and attract prey using a modified first dorsal fin ray that resembles a fishing pole and lure. Monkfish are piscivorous and commonly eat prey as large as themselves. Despite the behavior of monkfish as a demersal 'lie-in-wait' predator, recent information from electronic tagging suggests seasonal off-bottom movements (Rountree et al. 2006). Growth is rapid at about 10 cm per year, and is similar for both sexes up to age 6 and lengths of around 60 cm. Few males have been found older than age 7, but females 12-14 years old have been collected (NEFSC 2002, 2005). Monkfish as large as 138 cm have been captured in NEFSC bottom trawl surveys.

Female monkfish begin to mature at age 4 and 50% of females are mature by age 5 (about 43 cm). Males mature at slightly younger ages and smaller sizes (50% maturity at age 4.2 or 36 cm (NEFSC 2002). Spawning takes place from spring through early autumn, progressing from south to north, with most spawning occurring during the spring and early summer. Females lay a buoyant mucoid egg raft or veil which can be as large as 12 m long and 1.5 m wide and only a few mm thick. The eggs are arranged in a single layer in the veil, and the larvae hatch after about 1-3 weeks, depending on water temperature. The larvae and juveniles spend several months in a pelagic phase before settling to a benthic existence at a size of about 8 cm (Collette and Klein-MacPhee 2002).

3.2 Stock Identification

The Fishery Management Plan defines two management areas for monkfish (northern and southern), divided roughly by a line bisecting Georges Bank (Figure 1). The two assessment and management areas for monkfish were defined based on differences in temporal patterns of recruitment (estimated from NEFSC surveys), the spatial and temporal distribution of all sizes of monkfish in NEFSC surveys, perceived differences in growth patterns, and differences in the contribution of fishing gear types (mainly trawl, gill net, and dredge) to the landings.

Genetic studies do not suggest that there are separate stocks of monkfish off the U.S. east coast (Chikarmane et al. 2000). Monkfish larvae are distributed over deep (< 300 m) offshore waters of the Mid-Atlantic Bight in March-April, and across the continental shelf (30 to 90 m) later in the year. Relatively few larvae have been sampled in the northern management area (Steimle et al. 1999). NEFSC surveys continue to indicate different recruitment patterns in the two units in the most recent years.

The perceived differences in growth were based on studies about 10 years apart and under different stock conditions (Armstrong 1987: Georges Bank to Mid-Atlantic Bight, 1982-1985; Hartley 1995: Gulf of Maine, 1992-1993). Age, growth, and maturity information from the NEFSC surveys and the 2001 cooperative monkfish survey indicated only minor differences in age, growth, and maturity between the areas. The recent biological evidence (growth, maturity, and genetic information) suggests that use of a single stock hypothesis in the assessment might be appropriate. However, substantial differences in the fisheries exist, and current management maintains separate regulatory areas to accommodate these differences.

The southern deepwater extent of the range of American monkfish (*L. americanus*) overlaps with the northern extent of the range of blackfin monkfish (*L. gastrophysus*; Caruso, 1983). These two species are morphologically similar, which may create a problem in identification of survey catches and landings from the southern extent of the range of monkfish. The potential for a problem however is believed to be small. The NEFSC closely examined winter and spring 2000 survey catches for the presence of blackfin monkfish and found none. The cooperative monkfish survey conducted in 2001 caught only eight blackfin monkfish of a total of 6,364 monkfish captured in the southern management region.

3.3 Fisheries Management

Commercial fisheries for monkfish occur year-round using gillnets, trawls and scallop dredges. No significant recreational fishery exists. The primary monkfish products are tails, livers and whole gutted fish. Peak fishing activity occurs during November through June, and value of the catch is highest in the fall due to the high quality of livers during this season.

U.S. fisheries for monkfish are managed in the Exclusive Economic Zone (EEZ) through a joint New England Fishery Management Council - Mid-Atlantic Fishery Management Council Monkfish Fishery Management Plan (FMP). The primary goals of the Monkfish FMP are to end and prevent overfishing and to optimize yield and economic benefits to various fishing sectors involved with the monkfish fisheries (NEFMC and MAFMC 1998). Current regulatory measures vary with type of permit but include limited access, limitations on days at sea, mesh size restrictions, trip limits, minimum size limits and other measures (Tables 1 and 2).

Biological reference points for monkfish were established in the original Fishery Management Plan (FMP), but were revised according to the conclusions of SAW 34 (NEFSC 2002). The overfishing definition is F_{max}. Framework 2 revised the biomass threshold reference points ($B_{threshold}$) to be consistent with National Standard 1 Guidelines ($B_{threshold} = ½*B_{target}$). For the both areas, $B_{threshold}$ is one-half of the median of the 1965-1981 3-year average NEFSC autumn trawl survey catch (kg) per tow). At the time of this assessment, the stocks were in a rebuilding plan, with a rebuilding date of 2010.

3.4 Previous Stock Assessment

The 40th SAW, in 2004, concluded that the resource was not overfished in either management area

(north or south) based on the existing reference points. However, fishing mortality rates estimated from NEFSC research and Cooperative survey data were not sufficiently reliable for evaluation of F with respect to the reference points.

- Biomass in the northern area had been above $B_{threshold}$ since 1999, and in 2003 was at about 81% of B_{target}. Given the variance in the survey biomass index, there was a 98% chance that the biomass index was above the northern area $B_{threshold}$ reference point.
- Biomass in the southern area increased to $B_{threshold}$ in 2003. Given the variance in the survey biomass index, there was a 56% chance that the biomass index is above the southern area $B_{threshold}$ reference point.
- Size distributions in research surveys became truncated during the 1970s and 1980s, and were stable during the 1990s. Indices of egg production had declined by around 80% since the 1970s and the proportion of spawners below the age of full maturity had increased. Egg production indices in both areas showed a recent increasing trend. Survey indices indicated recent improved recruitment in both the northern (1999 year class) and southern areas (2002 year class).

4.0 Fishery Information (TOR #1)

4.1 Landings

Early catch statistics are uncertain, because many of the monkfish caught were sold outside of the dealer system or used for personal consumption until the mid-1970's. For 1964 through 1989, there are two potential sources of landings information for monkfish; the NEFSC 'weigh-out' database, which consists of fish dealer reports of landings, and the 'general canvass' database, which contains landings data collected by NMFS port agents (for ports not included in the weigh-out system) or reported by states not included in the weigh-out system (Table 3). Landings statistics for monkfish are sensitive to conversion from landed weight to live weight, because a substantial fraction of the landings occur as tails only (or other parts). The conversion of landed weight of tails to live weight of monkfish in the NEFSC weigh-out database is made by multiplying landed tail weight by a factor of 3.32. All landings of monkfish are reported in the general canvass data as 'unclassified tails.' Consequently, some landed weight attributable to livers or whole fish in the canvass data may be inappropriately converted to live weight. This is not an issue for 1964-1981 when only tails were recorded in both databases. However, for 1982-1989, the weigh-out database contains market category information which allows for improved conversions from landed weight to live weight. The two data sources produce the same trends in landings, with general canvass landings slightly greater than the weigh-out system. It is not known which of the two measures more accurately reflects landings, but the additional data sources suggest that the general canvas is most reliable for 1964-1981 landings, whereas the availability of market category details suggests that the weigh-out database is most reliable for 1982-1989.

Beginning in 1990, most of the extra sources of landings in the general canvass database were incorporated into the NEFSC weigh-out database. However, North Carolina reported landings of monkfish to the Southeast Fisheries Science Center and until 1997 these landings were not added to the NEFSC general canvass database. Since these landings most likely come from the southern management area, they have been added to the weigh-out data for the southern management region for 1977-1997 for the landings statistics used for stock assessment.

Beginning in July 1994, the NEFSC commercial landings data collection system was redesigned to consist of vessel trip reports (VTR) and dealer weigh-out records. The VTRs include area fished for each trip which is used to apportion dealer-reported landings to statistical areas. The northern management area includes statistical areas 511-515, 521-523 and 561; and the southern management area includes areas 525-526, 562, 537-543 and 611-636 (Figure 1). Each VTR trip should have a direct match in the dealer data base, but this is not always true. VTR records with no matching dealer landings were excluded, but dealer landings with no matching VTR were included in landings statistics, apportioning the unmatched landings to area using proportions calculated from matched trips pooled over gear, state and quarter.

Total U.S. landings (live weight) remained at low levels until the middle 1970s, increasing less than 1,000 mt to around 6,000 mt in 1978 (Table 3, Figure 2). Annual landings remained stable at between 8,000 and 10,000 mt until the late 1980s. Landings increased steadily from the late 1980s to over 20,000 mt per year 1992-2004, peaking at 28,500 mt in 1997. Landings gradually decreased since 2001, to 14,461 mt in 2006. By region, landings began to increase in the north in the mid-1970s, and began to increase in the south in the late 1970s. Most of the increase in landings during the late 1980s through mid-1990s was from the southern region.

Trawls, scallop dredges and gill nets are the primary gear types that land monkfish (Table 4, Figure 3). Trawls have contributed approximately half of the landings. Prior to 1994, gillnets contributed less than 10% of total landings, but landings from gillnets generally increased to account for >35% of the recent fishery, with an associated decrease in monkfish landings from the scallop dredge fishery.

Until the late 1990s, total landings were dominated by landings of monkfish tails. From 1964 to 1980 landings of tails rose from 19 mt to 2,302 mt, and peaked at 7,191 mt in 1997 (Table 5). Landings of tails declined after 1997, but are still an important component of the landings. Landings of gutted whole fish have increased steadily since the early 1990s and are now the largest market category on a landed-weight basis. On a regional basis, more tails were landed from the northern area than the southern area prior to the late 1970s (Tables 6 and 7). From 1979 to 1989, landings of tails were about equal from both regions. In the 1990's, landings of tails from the south predominated, but since 2000, landings of tails have been greater in the north. Beginning in 1982, several market categories were added to the system (Table 5). Tails were broken down into large (> 2.0 lbs), small (0.5 to 2.0 lbs), and unclassified categories and the liver market category was added. In 1989, unclassified round fish were added, in 1991 peewee tails (<0.5 lbs) and cheeks, in 1992 belly flaps, and in 1993 whole gutted fish were added. Monkfish livers have become a very valuable product. Landings of livers increased from 10 mt in 1982 to an average of over 600 mt during 1998 - 2000. During 1982-1994, ex-vessel prices for livers rose from an average of $0.97/lb to over $5.00/lb, with seasonal variations as high

as $19.00/lb. Landings of unclassified round (whole) or gutted whole fish jumped in 1994 to 2,045 mt and 1,454 mt, respectively; landings of gutted fish continued to increase through 2000. The tonnage of peewee tails landed increased through 1995 to 364 mt and then declined to 153 mt in 1999 and 4 mt in 2000 when the category was essentially eliminated by regulations (Figure 4).

Reported monkfish landings (live wt) from foreign fisheries in NAFO areas 5 and 6 by countries other than the US (included in Table 3 and Figure 2) were high but variable in the 1960s and 1970s with a peak in 1973 of 6,818 mt. Landings were low but variable in the 1980s, declined in the early 1990s, and have generally been below 300 mt in recent years. Estimates of total landings generally increased from approximately 100mt per year in the mid 1960s to a peak of 28,000 mt in 1997. Landings remained greater than 20,000 mt per year until 2005, and decreased to 14,000 mt in 2006 as a result of fishery restrictions. Historical under-reporting of landings should be considered in the interpretation of this series.

4.2 Discard Estimates

Catch data from the fishery observer and VTR databases were used to investigate discarding frequencies and rates. The number of tows or trips with monkfish discards available for analysis varied widely among management areas and gear types (Table 8). Three methods were considered for the estimation of discards: 1) observed discard-per-kept-monkfish by gear, half-year and management area (Figure 5), expanded to total discards using total monkfish landings; 2) observed discard-per-all-kept-catch by gear, half-year and management area, expanded to total discards using total landings (Rago et al. 2005, Wigley et al. 2007); and 3) observed discard-per-days-absent by gear, half-year and management area, expanded to total discards using total days-absent (Rago et al. 2005, Wigley et al. 2007). The effort-based method (#3) was not appropriate, because much of the monkfish bycatch is taken incidentally or targeted on a tow-by-tow basis rather than a trip basis. Predicting discards using kept catch assumes a linear relationship between kept and discarded catch and that there is no discarding when there is no catch (i.e., the linear relationship passes through the origin). Inspection of the relationship between observed monkfish discards and monkfish kept (method #1) and total catch (method #2) by gear and year indicates weak correlation in general, but the relationships between kept and discarded monkfish (method #1) for trawls and gillnets conforms to the statistical assumptions best (Figure 6). Therefore, discards used in the assessment were based on discard-to-kept-monkfish for trawls and gillnets but discard-per-all-kept-catch for shrimp trawls and dredges, which do not currently target monkfish.

Discards for 1980-1988 were estimated by applying average discard ratios by management region and gear type (trawl, shrimp trawl, gillnet, dredge) from 1989-1991 to landings for 1980-1988. If insufficient samples were available, additional years of observer data were included until a sample size (number of trips) of at least 20 was reached. The resulting time periods entering the 1980-1988 discard ratio estimates were as follows:

Region	Shrimp Trawls	Trawls	Gillnets	Dredges
North				
Years included	1989-1991	1989-1991	1989-1991	1992-1997
Number of trips	124	180	852	20
South				
Years included	n/a	1989-1991	1991-1992	1991-1993
Number of trips		231	103	30

The overall annual discard ratio decreased in the northern area, from an average of 16% of total catch in the 1980s to an annual average of 8% since 2002 (Table 9, Figure 7). However, the proportion of discards in the southern area generally increased since 1980, with an annual average of 23% since 2002. Gill nets consistently have had the lowest discard ratios. Discarding has increased in the trawl fishery in recent years, particularly in the south. This may reflect imposition of size limits starting in 2000 and decreased trip limits in the south starting in 2002. In addition, the WG noted a potential bias in discard estimates due to increased observer sampling in the multispecies groundfish fishery. Monkfish discard rates may differ between the directed monkfish fisheries and bycatch fisheries. The most frequent discard reasons were that fish were too small for regulations or the market, and this may reflect the appearance of a relatively strong 1999 year class in the north.

4.3 Size and Age Composition of U.S. Catch

Length composition of the landings was estimated from port samples (1996-2006, no sampling before 1996) on a management region, market category, half-year basis (Table 10; Figure 8). Tail lengths were converted to total lengths using relations developed by Almeida et. al.(1995). Length composition of landings and discard was also estimated from fishery observer samples (1994-2006) by management region, year, gear-type (trawls, dredges and gillnets) and catch disposition (kept or discarded; Figures 8-10). Landings in other gear categories were allocated proportionately to the 3 major gear types before assigning lengths. Length composition based on observer sampling was used in subsequent analyses (e.g., SCALE, below). Discarded fish were generally 20-40 cm, while kept fish were greater than 40 cm. Age samples indicate that most of the catch is from ages 4 to 6, with few landed fish older than age-8 (Table 11, Figure 11).

4.4 Effort and CPUE

Evaluating trends in effort or catch rates in the monkfish fishery is difficult for several reasons. Much of the catch is taken in multi-species fisheries, and defining targeted monkfish trips is difficult. There have been programmatic changes from port interviews (1980-1993) and logbooks (1994-2006), and comparison of effort statistics among programs is difficult. Catch rates may not reflect patterns of abundance, because they have recently been affected by regulatory changes (e.g., 1994 closed areas, 2000 trip limits. Evaluation of catch rates from observed tows that caught monkfish indicated recent increases in catch rates by gear in the southern management area and recent decreases in catch rates in the northern area (Figures12a and 12b).

5.0 Research Survey Abundance and Biomass Indices (TOR #2)

The research survey strata used to define the northern and southern management regions are:

Survey	Northern Area	Southern Area
NEFSC Offshore bottom trawl	20-30, 34-40	1-19, 61-76
ASMFC Shrimp	1,3,5-8	
Shellfish		6,7,10,11,14,15,18,19,22-31,33-35,46,47,55,58-61,621,631

NEFSC spring and autumn bottom trawl survey indices were standardized to adjust for statistically significant effects of trawl type (Sissenwine and Bowman 1977) and vessel (NEFSC 1991) on catch rates . The trawl conversion coefficients apply only to the spring survey during 1973-1981. Geographic distributions of survey catches are shown in Figures 13 to 16.

5.1 Northern Region

Indices from NEFSC autumn research trawl surveys indicate that biomass fluctuated without trend between 1963 and 1975, appears to have increased briefly in the late 1970's, but declined thereafter to near historic lows during the 1990's (Table 12, Figures 17 and 18a). From 2000 to 2003, the index was greater than 2 kg/tow, but decreased to 1.04 kg/tow in 2006. Indices from the NEFSC spring research trawl surveys reflect similar trends of relatively high biomass levels in the mid 1970s (but with possible declines in the late 1970s), a declining trend from the early 1980s to the lowest values in the time series in 1998 an increase to relatively high biomass from 2001 to 2005, but a decrease in 2006 (Table 13, Figures 17 and 18b).

The NEFSC shrimp survey samples the western Gulf of Maine during summer and catches more monkfish than the spring or fall surveys (Table 14, Figures 17 and 18c). However, incomplete or inconsistent geographic coverage should be considered in the interpretation of survey indices. The Massachusetts surveys were not considered to reflect patterns of abundance for the entire management area. Patterns of abundance and biomass were relatively consistent among the spring, fall and shrimp surveys (Figure 19).

Abundance indices declined during the early 1960s, and then fluctuated without trend until the late 1980s. Abundance increased steadily from the late 1980s to a peak in 1994, declined during the late 1990s, and peaked in 2000, reflecting a relatively strong 1999 yearclass. Abundance has declined steadily since 2000, but remains high relative to the earlier part of the time series.

Length distributions have become increasingly truncated over time (Figure 20). By 1990, fish greater than 60 cm long were uncommon in length frequency distributions. The minimum, median and maximum lengths in the trawl surveys declined steadily from the early 1980s until around 2000, when they began to increase again (Figure 21). Several modes potentially representing strong year classes have appeared consistently in survey distributions in recent years.

Abundance indices were estimated for monkfish of lengths corresponding to ages 1 and 2 to help identify potential recruitment patterns. To the extent that these indices reflect recruitment, recruitment in the northern area has increased in the past decade. Relatively strong year-classes were produced in 1993 and 1999. Survey abundance at age data (available since the mid-1990s) corroborate the suggestion of relatively strong 1993 and 1999 year-classes in the northern area. Survey age data are available for 1993-2006 from the autumn trawl survey and for 1995-2006 for the spring trawl survey (Table 20). Within the range of ages observed in the surveys, growth is essentially linear and there are no obvious differences with gender or management area.

5.2 Southern Region

Biomass indices from the NEFSC autumn research survey were high during the mid-1960s, fluctuated around an intermediate level during the 1970s-mid 1980s, then declined to consistently low levels since the late 1980s (Table 15, Figures 22 and 23a). The biomass index increased slightly above the threshold in 2001 and has been relatively stable since then. NEFSC spring surveys reflect similar trends as the autumn series: biomass remained fairly high during the mid 1970s - early 1980s, but fluctuated around lower levels thereafter (Table 16, Figures 22 and 23b). A spike in biomass was observed in 2003, but 2004-2006 indices returned to low values. Biomass indices based on the NEFSC winter flatfish survey fluctuated without trend during the 1990s, but have remained relatively high since 2001, consistent with autumn survey indices (Table 17, Figures 22 and 23c). Abundance indices have fluctuated without trend. Although the winter survey series has a short duration, the gear used in the winter survey is more effective for capturing monkfish than the gear used in autumn or spring surveys. Abundance indices based on the NEFSC sea scallop survey show an increasing trend during 1984-1994 followed by a rapid decline from 1994-1998 and fluctuations at a somewhat higher level since then (Table 18, Figure 23d). Abundance indices were weakly correlated among surveys (Figures 24 and 25). Bootstrap analysis of survey data (Smith 1997) is presented in Table 19. The coefficient of variation (CV), design efficiency and estimates of precision for each survey is estimated by area for numbers and weight per tow.

Inconsistent geographic coverage should be considered in the interpretation of southern survey indices. For example the fall survey did not sample southern strata until 1967; therefore the current biomass reference points are based on an inconsistent strata set. The winter survey samples Georges Bank inconsistently and did not sample deep strata before 1998. The scallop survey does not currently sample the entire southern management area.

Abundance in numbers shows similar trends, with a spike in 1972, fluctuations around a relatively low level since the mid-1970s and a slight increase in 2002 and 2003. Age data are available for the fall survey (1993-2006) and the winter survey (1997-2004; Table 20). The mean catch at length for the winter survey samples is similar to mean catch at length from NEFSC spring surveys (Figure 26). Length distributions from the southern region showed increasing truncation over time, but the size distribution appears to have stabilized in recent years (Figure 27). Maximum lengths declined by approximately 20 cm or more over the time series. As in the northern region, fish greater than 60 cm have been rare since the 1980s, especially when compared to the 1960s. Any recent strong recruitment does not appear to survive long enough to contribute substantially to increased stock biomass. Survey age data are available for 1993-2006 from the autumn trawl survey, 1995-2006 for the spring trawl survey and 1997-2007 for the winter trawl survey (Table 20).

5.3 2001 Cooperative Monkfish Survey (TOR #3)

An industry-based survey for monkfish was conducted during Feb 27 - April 6, 2001 using two commercial trawlers fishing concurrently in the northern and southern management regions. The survey used a stratified random design with sampling effort proportional to reported fishing effort during 1995-1999. Additional station locations were assigned by fishermen. The stratum boundaries were those used in NEFSC bottom trawl surveys (defined by depth), with an additional set of strata from Georges Bank south in 100 to 500 fathoms. Standard protocols for tow speed, tow time, scope ratios and biological sampling were followed by each vessel.

Experimental tows were made with each of the 3 nets (2 flat nets, 1 rockhopper) to estimate net efficiency and wingspread at a range of depths. Video footage from cameras attached to the net provided no evidence of herding of monkfish by the gear, nor of strong escape responses. Area swept estimates of population size and biomass were derived using tow duration, vessel speed (as recorded by GPS) and wingspread under a range of assumptions regarding net efficiencies.

A total of 284 survey tows were used to estimate monkfish abundance. Swept area biomass and population size were estimated using nominal tow distances for the F/V Mary K and inclinometer distances for the F/V Drake, and assuming intermediate net efficiencies. The resulting estimates were 135 thousand metric tons (69,000 in the north, 66,000 in the south) and 91 million monkfish (53 million in the north, 38 million in the south). Minimum estimates (assuming 100% efficiency of nets and the same tow distance assumptions) were 72 thousand metric tons (33,000 north, 39,000 south) and 48 million monkfish (25 million north, 23 million south). Bootstrapped estimates of the coefficient of variation for these estimates ranged 4-7%.

Exploitation ratios were calculated from the 2001 cooperative survey using landings and exploitable biomass from the cooperative survey (> 40 cm north, > 52 cm south). Landings were added to the cooperative survey estimate of biomass to derive a proxy for biomass at the beginning of 2000, and the cooperative survey biomass was taken as biomass at the beginning of 2001. The exploitation ratio was calculated using the average between 2000 and 2001 biomass estimates. Assuming intermediate net efficiencies and nominal tow distances for the F/V Mary K, the overall exploitation ratio was 0.22 (0.20 in the north, 0.23 in the south).

Biological sampling and analysis indicated that growth rates are similar in the northern and southern areas, and between males and females. Sex ratios were length- and age-dependent. Most fish larger than 70 cm and age 7 were females. In the southern area, sex ratios were skewed towards males in the 40-60 cm size range. Female maturity (L_{50}) was 40 cm (4.7 years) in the north and 46 cm (5.1 years) in the south (43 cm or 4.8 years, regions combined). Male maturity (L_{50}) was 35 cm (4.1 years) in the north and 37 cm (4.3 years) in the south (36 cm or 4.2 years, regions combined).

5.4 2004 Cooperative Monkfish Survey (TOR #3)

The 2004 cooperative monkfish survey was conducted during March 1 - June 20, 2004 using one fishing vessel (F/V Mary K). All survey tows were completed by June 16, 2004. The Mary K was equipped with two nets (flat net and rockhopper). These were different nets than were used on the 2001 survey; however, they had the same codend mesh size (6 inch stretch mesh) as used in the 2001 survey. The survey stations were the same locations where successful tows were completed during the 2001 cooperative monkfish survey. However, not all stations could be occupied either because of problems with fixed gear or because of severe weather conditions, particularly during March and April. A total of 304 tows were made; 255 of these were successful survey tows (105 north, 150 south). A NetMind gear mensuration system was used to measure wingspread on all tows (only about 15% of tows successfully collected wingspread data). Bottom contact time was recorded using an inclinometer, GPS data were captured from the ship's GPS, and bottom temperature was recorded using a SeaBird SBE temperature and pressure recorder. Survey catches were processed using standard procedures for NEFSC surveys. Biological data were collected electronically using the NEFSC FSCS (Fisheries Scientific Computer System) package.

Gear experiments included depletion experiments and comparative (side-by-side) tows with the two nets. The depletion experiments were used to estimate efficiency of the nets. For each depletion experiment, standard 30 minute tows were repeated along a given tow path until catch rates dropped to near zero or until no further reduction in catches was observed. Four experiments were done with the flat net, one experiment was completed with the rock hopper. Approximately 10 comparison tows were completed.

A total of 255 survey tows were used to estimate monkfish abundance. Swept area biomass and population size were estimated using nominal tow distances and assuming intermediate net efficiencies. The resulting estimates were 229 thousand metric tons (87,000 in the north, 142,000 in the south) and 124 million monkfish (44 million in the north, 80 million in the south). Minimum estimates (assuming 100% efficiency of nets

and the same tow distance assumptions) were 96 thousand metric tons (28,000 north, 68,000 south) and 52 million monkfish (14 million north, 37 million south).

Exploitation ratios were calculated from the 2004 cooperative survey using landings and exploitable biomass from the cooperative survey (> 40 cm north, > 52 cm south). Landings were added to the cooperative survey estimate of biomass to derive a proxy for biomass at the beginning of 2003, and the cooperative survey biomass was taken as biomass at the beginning of 2004. The exploitation ratio was calculated using the average between 2003 and 2004 biomass estimates. Assuming intermediate net efficiencies and nominal tow distances, the overall exploitation ratio was 0.19 (0.26 in the north, 0.14 in the south).

In 2001, mature females in the south were heavier at length than males, probably because of the weight of developing egg veils. That pattern was not seen in 2004, possibly because the sampling occurred later in the year in 2004, and many females may have already spawned. Age-length relationships were similar to those observed in 2001, with growth nearly identical between males and females until age 7, when male growth slows and females continue a linear increase in length up to age 10, the oldest age observed in the surveys. No males older than age 8 were observed in 2001, and no males older than age 7 were observed in 2004. No differences were detectable in mean length at age between management areas. Monkfish weight at age increases exponentially up through the oldest ages observed in the survey, and does not differ between management areas. Sex ratio patterns were similar to those observed in 2001, with a roughly 50:50 male:female sex ratio in the north until approximately 60 cm, a rapid decline in the proportion of males greater than 60 cm, and no males greater than about 70 cm. In the south, male:female sex ratios are approximately 50:50 in the 20-40 cm size range, become skewed towards males in the 40-60 cm size range, then decline to zero (100% females) by around 70 cm.

Based on the peer review of the Cooperative Monkfish Surveys (March 2006), several aspects of the cooperative monkfish surveys were considered for the 2007 stock assessment. Biological information (e.g., size at age, Figure 28; maturity at size and age) was used for length-based modeling as well as yield- and spawning-biomass per recruit analyses. Estimates of stock size and efficiency were used to evaluate alternative modeling results. For example, comparison of the catch rates and efficiencies from the cooperative surveys were used to assess reasonable estimates of efficiency for research surveys.

6.0 Estimation of Stock Size and Fishing Mortality (TOR #4)

Several alternative methods were considered for estimating stock size and mortality rates, representing a series of models with increasing complexity.

(EDITOR'S NOTE: THE REVIEW PANEL CONCLUDED THAT OF ALL THE METHODS PRESENTED, THE SCALE MODEL IS THE PREFERRED MODEL AT THIS STAGE FOR USE IN STOCK ASSESSMENT. THE REVIEW PANEL CONCLUDED THAT THE OTHER APPROACHES HAD SIGNIFICANT SHORTCOMINGS.)

6.1 Index-based analysis

AIM, an index method (NEFSC 2002b; nft.nefsc.noaa.gov), fits a relationship between time series of relative stock abundance indices and catch data. Underlying the methodology is a linear model of population growth, which characterizes the population response to varying levels of fishing mortality. If the underlying model is valid, AIM can be used to estimate the level of relative fishing mortality (F) at which the population is likely to be stable. The index methodology can used to construct reference points based on relative abundance indices and catches and to perform deterministic or stochastic projections to achieve a target stock size.

Unfortunately the underlying model is not valid for any of the catch (1980-2006) and survey series (Figure 29). For most surveys, there is lack of coherence between the relative F (i.e., exploitation ratio) and rate of change in survey indices, as illustrated by a positive relationship between rate of change and relative F: fall and spring surveys in the northern area (Figures 29a and 29b), fall, spring and winter surveys in the southern area (Figures 29d-f). Unlike the other applications, rate of change in the shrimp survey index has the expected negative relationship with relative F (Figure 29c), but there is inadequate contrast in the data, because the index generally increases throughout the series (i.e., there is no estimate of the replacement ratio, when the stock is stable). Although AIM may not be a candidate for stock assessment of monkfish, because of lack of coherence or lack of contrast in survey and catch data, it suggests that the available data do not support models that analyze responses in survey indices from fishery removals (e.g., biomass dynamics models).

6.2 Biomass dynamics analysis

Similar to the previous assessment of monkfish, a Bayesian surplus production model (BSP; McAllister and Babcock 2007) was attempted. The BSP model was applied to the fall survey (1963-2006) and the total catch (discards+landings, 1980-2006). The cooperative research survey, with observations in 2001 and 2004, was believed to have closely approximated abundance in those years. This survey was also inputted to the model, and was weighted more heavily than the fall survey to reflect the assumed greater level of precision. The first model year was 1963, and a constant level of catch (Cat0) was estimated for years 1963-1979. A lognormal prior for this catch was specified, with a mean of 120 mt, and a log scale standard deviation of 0.7. Upper and lower bounds on this catch were set at 10 and 5000 mt. Additional priors were specified for carrying capacity, K, intrinsic rate of increase, r, and the ratio of starting biomass to carrying capacity, B_0/K (Table 21). To evaluate the sensitivity to the prior on r, three runs were made for both the northern and southern management areas, with means for the prior set at 0.4, 0.5, and 0.6.

Northern Management Area - While the precision of B_t/B_{MSY} and F_t/F_{MSY} is rather good, the precision of estimates on an absolute scale are very poor (CVs>200%). The expectation of K was rather large in all cases, ranging from about 652,000 to 664,000 mt, although the estimate of the posterior mode ranged from 87,000 to 119,000 mt (Table 22). The expectation of MSY ranged from 70,000 to 101,000 mt, The estimate for annual

catches prior to 1980 is about 112 mt per year. The estimate of historic removals did not appear sensitive to the prior on *r*, however the estimate of *K* appeared to be negatively correlated to the estimate of *r*. The expected values for the *r* posteriors did not vary much from the priors (Figure 30). Convergence was assessed by examining the ratio of the CV of the weights and the CV of the likelihood*priors, and the maximum weight of any draw. For both criteria, the diagnostics were satisfactory.

Southern Management Area –As with the northern area, precision on ratio estimates was good, while the absolute scale estimates were very poor. The expectation of *K* ranged from 180,000-219,000 mt, although the estimate of the posterior mode ranged from 77,000 to 127,000 mt (Table 23). The estimates of MSY ranged from about 22,000 to 25,000 mt. The priors and posteriors of *r* and *K* are shown in Figure 31. The estimate for catches prior to 1980 is about 118 to 119 mt per year. Convergence diagnostics were assessed as above, and were also satisfactory.

The sensitivity to the *r* prior, and the high imprecision of absolute magnitude estimates, indicate a solution surface that is not well defined. Further sensitivity runs would likely provide bounds for the additional axes of the solution surface at the levels explored (for example, initial depletion and the historic removals) but without increasing precision or certainty with regards to the true level of abundance.

The WG concluded that long-term production models were inappropriate for status determination of monkfish because of the general lack of correspondence between reported catch and survey trends.

6.3 Length-based mortality

The mean length of animals that are fully vulnerable to the fishery gear and growth estimates can be used to estimate total mortality, assuming constant recruitment (Beverton and Holt 1956). Gedamke and Hoenig (2006) developed a procedure that allows a series of mortality rates to be estimated from mean length data representing nonequilibrium conditions in multiple years and applied the method to monkfish survey data. Length-of-capture (L_c) was assumed to be 30cm, and growth was from NEFSC and cooperative monkfish survey age observations.

Total mortality of monkfish in the northern management area changed from 0.14 per year during 1963-1977, 0.31 during 1978-1987, 0.56 during 1988-1999, and 0.25 since 2000, with all changes improving the model significantly (Figure 32). Although the model allows for changes in total mortality rate, it still assumes constant recruitment, which may be violated in the northern management area.

Using data from the NEFSC fall survey, total mortality in the southern management area increased from 0.32 (1963-1976) to 0.55 per year since 1977 (Figure 33). Adding a second change in mortality was not significant but suggested that the early period was in transition from a period of lower mortality (0.27) before 1963. A third change was also insignificant but suggested a decrease in total mortality to 0.47 after 1999.

In addition to the possible violation of stationary recruitment in the northern area, the Beverton-Holt (1956) model and the method developed by Gedamke and Hoenig (2006) assume that growth conforms to a von Bertalanffy model. However, as illustrated in Figure 28, monkfish growth appears to be approximately linear for the observed range

of ages. If the growth parameters are in error, the resultant estimates will have bias but the trends in mortality over time will be accurate. The WG concluded that length-based mortality estimates were not appropriate for status determination of monkfish because of the apparent trend in recruitment in the northern area and the general lack of precision in estimates.

6.4 Survey catch curves

Mortality rates were estimated from NEFSC survey abundance at age data using cohort-based catch curves (Figures 34-36). In the North (fall survey) estimates of Z from cohort-based catch curves ranged from 0.14 (1995 year class) to 0.88 (1991 year class). Trends in Z based on ages 3+ and 4+ were similar but highly variable over time. Average Z for 1990-1996 (year classes that would have been entered the fishery before 2000) for catch curves with $R^2 > 0.75$ was 0.58 (3+) and 0.73 (4+). For 1997 and later cohorts (entering the fishery after the FMP was implemented), average Z for catch curves with $R^2 > 0.75$ was 0.72 (3+) and 0.80 (4+). In the South, fall survey estimates of Z ranged from 0.10 (1993 year class) to 0.47 (1990 year class) for age 3+ and 0.07 (1996 year class) to 0.62 (1992 year class) for age 4+. Only one age 3+ catch curve for 1990-1996 year classes had an $R^2 > 0.75$ (1990 year class, Z=0.47); the mean Z for age 4+ curves with good fits (1990 and 1991 year classes) was 0.59. For year classes impacted by the FMP, only the 1998 year class age 4+ had a good fit (Z=0.76). There was no discernable trend evident over time in the estimates of Z from the fall survey, north or south.

Catch curves based on winter survey data generally had better fits than from the fall survey. For age 3+, Z ranged from 0.11 (2001 year class) to 0.70 (1998 year class), with a declining trend over time. For age 4+, Z ranged from 0.25 (2001 year class) to 0.90 (1995 and 1998 year class), and declined starting with the 1999 year class (the estimate for the 2002 year class is high, but based on only two years). For age 5+, Z ranged from 0.65 (2000 year class) to 1.22 (1995 year class) with no evident trend. All of the age 5+ Z catch curves had an $R^2 > 0.75$ and most of the age 4+ fits were good too. For year classes entering the fishery before the FMP was implemented, age 4+ Z averaged 0.73 and age 5+ averaged 0.94; for year classes entering the fishery after the FMP, age 4+ Z averaged 0.64 and age 5+ Z averaged 0.86.

Heincke's method of mortality estimation was applied to winter survey catch-at-age data for ages 3+/4+, 4+/5+ and 5+/6+ (Figure 37). This method resulted in many unreasonable estimates of Z and showed no trend over time. The WG concluded that catch curves and log-catch-ratios were inappropriate for status determination of monkfish because of the general lack of precision in estimates.

6.5 Survey stage-based mortality

Survival rates can be estimated from annual surveys by tracking the abundance of one or more cohorts. Several years can be analyzed simultaneously to obtain a single estimate of survival under the assumption that survival is constant over the period analyzed. The method requires that only a single cohort need be identified and separated

from the other ages. Estimates of monkfish survival from this method compare favorably with estimates obtained by analyzing changes in mean length over time.

Estimates were made for the two monkfish management areas. Monkfish were assumed to be fully vulnerable to the survey trawl when they reach 30 cm in total length (NEFSC 2002). The first fully vulnerable age class was determined using the von Bertalanffy growth models (L_∞=126.0 cm, k=0.1080; for the southern region the values are L_∞=129.2 cm, K=0.1198; NEFSC 2002). A t_0 value of 0.0 yr was assumed for both regions. Monkfish from age 2.5 to 3.5 have predicted lengths of 29.8 to 39.7 cm in the northern region. Consequently, fish in the size range 30 to 40 cm are defined as recruits, and all fish above the size 40 cm are considered to be previously recruited animals. For the southern region, the recruits were defined as those 33 to 44 cm.

The process equation:

1. $$\hat{S}_t = \frac{\hat{N}_{\geq a+1,t+1}}{\hat{N}_{\geq a,t}} = \frac{\hat{I}_{\geq a+1,t+1}}{\hat{I}_{\geq a,t}}$$

where S is survival rate in time t, N is population abundance at age a+, and I is the survey index of abundance, was applied to the catch rate data to obtain annual estimates of survival rate and then convert these to estimates of instantaneous rates of total mortality. The results are highly variable and often infeasible (i.e., estimates of mortality rate are negative).

The relationship between the number of previously recruited animals in year $t+1$, N_{t+1}, and the number of recruits, R_t, and previously recruited animals, N_t, in year t is

2. $$N_{t+1} = S\,N_t + \phi^*\,R_t\ , \qquad t = 1, \ldots, T\text{-}1$$

where ϕ^* and S are the survival rates of the recruits and previously recruited animals, respectively, and T is the number of years of survey data. In terms of the expected values of indices of abundance:

3. $$I_{t+1} = S\,I_t + \phi\,r_t\ , \qquad t = 1, \ldots, T\text{-}1$$

where r_t is the expected index of recruits in year t and ϕ subsumes the survival of recruits and the selectivity of the survey gear for recruits. If the indices I_t are independent then equation (2) is in the form of a multiple linear regression with no intercept. Parameter estimates can be found easily by minimizing the sum of squared deviations between observed indices, $\hat{I}_{t+1}$, and predictions obtained from the previous year's indices, $\hat{I}_t$ and $\hat{r}_t$.

The model in equation (2) is general because it allows for recruits to have a different catchability or survival rate than the previously recruited animals. However, estimates of S and ϕ may be highly negatively correlated and unstable unless appreciable contrast is observed in the recruitment over time. An alternative is based on the idea that the parameter ϕ likely is close to the value of S. Recruits may have a higher natural mortality than previously recruited animals but likely have a lower fishing mortality and a lower

catchability so that, on balance, it may be reasonable to set ϕ equal to S to obtain an estimate of survival. Thus, equation (2) would be replaced by

4. $$I_{t+1} = S\,(I_t + r_t)\,, \qquad t = 1, \ldots, T\text{-}1.$$

The resulting estimates of total mortality are similar to the results from length-based mortality estimation (Table 24). The WG concluded that estimates of mortality from stage-based analysis of survey data were inappropriate for status determination of monkfish because of the general lack of precision in estimates.

6.6 Catch-survey analysis

A Collie-Sissenwine catch-survey analysis (CSA; Collie and Sissenwine 1983) was performed for each management region using the shrimp survey in the North (1994-2006) and the winter survey in the South (1994-2007). Recruits were defined as 30-39 cm and post-recruits > 40 cm. M was assumed to be 0.3. The length-weight relation used to estimate mean weight in the landings (> 40 cm) was from 2004 cooperative survey data for females for regions combined (also used in SCALE, below). The model assumed lognormal observation error and precision was evaluated using 1000 non-parametric bootstrap trials with no bias correction.

Northern Management Area – Detailed results of the CSA using shrimp survey data are shown in Figure 38 and Appendix A. In general, confidence limits on estimated quantities were fairly wide; however, some significant (non-overlapping bootstrap interval) trends were detectable. Total abundance and biomass increased from 1994 to 2001 (2002), after which there has been no discernable trend. Fishing mortality estimates (assuming M=0.3) have tended to be lower during 1999-2005 than in earlier years; however, few of the comparisons have non-overlapping confidence intervals.

Southern Management Area – The CSA for the southern area using the winter survey did not result in useful estimates (Figure 39 and Appendix B). Confidence intervals were wide and overlapping among years. The downward trend in the bootstrapped F estimates is consistent with results from cohort-based catch curves of winter survey data and results of SCALE (below); however the absolute levels appear unreasonable (range F=0.02 to F=0.09). The catchability estimate was low (q=0.02). The WG concluded that CSA was inappropriate for status determination of monkfish because of the general lack of precision in estimates.

6.7 Statistical catch-at-length analysis (SCALE)

Incomplete or lack of age-specific catch and survey indices often limits the application of a full age-structured assessment (e.g. Virtual Population Analysis and many forward projecting age-structured models). Stock assessments will often rely on the simpler size/age aggregated models (e.g. surplus production models) when age-specific information is lacking. However the simpler size/age aggregated models may not utilize all of the available information for a stock assessment. Knowledge of a species growth and lifespan, along with total catch data, size composition of the removals, recruitment indices and indices on numbers and size composition of the large

fish in a survey can provide insights on population status using a simple model framework.

The Statistical Catch At Length (SCALE) model, previously known as the Length Tuned Model (LTM), is a forward projecting age-structured model tuned with total catch (mt), catch at length or proportional catch at length, recruitment at a specified age (usually estimated from first length mode in the survey), survey indices of abundance of the larger/older fish (usually adult fish) and the survey length frequency distributions. The SCALE model was developed in the AD model builder framework. The model parameter estimates are fishing mortality and recruitment in each year, fishing mortality to produce the initial population (Fstart), logistic selectivity parameters for each year or blocks of years and Qs for each survey index.

The SCALE model was developed as an age-structured model that does NOT rely on age-specific information on a yearly basis. The model is designed to fit length information, abundance indices, and recruitment at age which can be estimated by using survey length slicing. However the model does require an accurate representation of the average overall growth of the population which is input to the model as mean lengths at age. Growth can be modeled as sex-specific growth and natural mortality or growth and natural mortality can be model with the sexes combined. The SCALE model will allow for missing data.

Model Configuration - The SCALE model assumes growth follows the mean input length at age with predetermined input error in length at age. Therefore a growth model or estimates of mean lengths at age is essential for reliable results. The model assumes static growth and therefore population mean length/weight at age are assumed constant over time.

The SCALE model estimates logistic parameters for a flattop selectivity curve at length in each time block specified by the user for the calculation of population and catch age-length matrices or the user can input fixed logistic selectivity parameters. Presently the SCALE model can not account for the dome shaped selectivity pattern. If needed the SCALE model can approximate the influences of discarding with the estimation of a second logistic curve that will not get scaled to full selection in each time block. The model will use the higher estimated selectivity at length when the two selectivity curves are plotted together at length for the estimation of population and catch age-length matrices. User input bounds on the estimated discard logistic curve parameters will be needed for an appropriate combined partial recruitment pattern to be estimated.

The SCALE model computes an initial age-length population matrix in year one of the model as follows. First the estimated populations numbers at age starting with age-1 recruitment get normally distributed at one cm length intervals using the mean length at age with the assumed standard deviation. Next the initial population numbers at age are calculated from the previous age at length abundance using the survival equation. An estimated fishing mortality (Fstart) is also used to produce the initial population. This F can be thought of as the average fishing mortality that occurred before the first year in the model. Now the process repeats itself with the total of the estimated abundance at age getting redistributed according to the mean length at age and standard deviation in the next age (age+1).

This two step process is used to incorporate the effects of length specific selectivity and fishing mortality. The initial population length and age distribution is constructed by assuming population equilibrium with an initial value of F, called F_{start}. Length specific mortality is estimated as a two step process in which the population is first decremented for the length specific effects of mortality as follows:

$$N^{*}_{a,len,y_1} = N_{a-1,len,y_1} e^{-\left(PR_{len}F_{start}+M\right)}$$

In the second step, the total population of survivors is then redistributed over the lengths at age *a* by assuming that the proportions of numbers at length at age *a* follow a normal distribution with a mean length derived from the input growth curve (mean lengths at age).

$$N_{a,len,y_1} = \pi_{len,a} \sum_{len=0}^{L_\infty} N^{*}_{a,len,y_1}$$

where

$$\pi_{len,a} = \Phi\left(len+1 \mid \mu_a, \sigma_a^2\right) - \Phi\left(len \mid \mu_a, \sigma_a^2\right)$$

where

$$\mu_a = L_\infty \left(1 - e^{-K(a-t_0)}\right)$$

Mean lengths at age can be calculated from a von Bertalanffy model from a prior study as shown in the equation above or mean lengths at age can be calculated directly from an age-length key. Variation in length at age a (σ_a^2) can often be approximated empirically from the growth study used for the estimation of mean lengths at age. If large differences in growth exist between the sexes then growth can be input as sex-specific growth with sex-specific natural mortality. However catch and survey data are still fitted with sexes combined.

This SCALE model formulation does not explicitly track the dynamics of length groups across age because the consequences of differential survival at length at age a do not alter the mean length of fish at age a+1. However, it does more realistically account for the variations in age-specific partial recruitment patterns by incorporating the expected distribution of lengths at age.

In the next step the population numbers at age and length for years after the calculation of the initial population use the previous age and year for the estimate of abundance. Here the calculations are done on a cohort basis. Like in the previous initial population survival equation the partial recruitment is estimated on a length vector.

$$N^{*}_{a,len,y} = N_{a-1,len,y-1} e^{-\left(PR_{len}F_y+M\right)}$$

second stage

$$N_{a,len,y} = \pi_{len,a} \sum_{len=0}^{L_\infty} N^{*}_{a,len,y}$$

Constant M is assumed along with an estimated length-weight relationship to convert estimated catch in numbers to catch in weight. The standard Baranov=s catch equation is used to remove the catch from the population in estimating fishing mortality.

$$C_{y,a,len} = \frac{N_{y,a,len} F_y PR_{len} \left(1 - e^{-\left(F_y PR_{len}+M\right)}\right)}{\left(F_y \;\; PR_{len}\right) + M}$$

Catch is converted to yield by assuming a time invariant average weight at length.

$$Y_{y,a,len} = C_{y,a,len} W_{len}$$

The SCALE model results in the calculation of population and catch age-length matrices for the starting population and then for each year thereafter. The model is programmed to estimate recruitment in year 1 and estimate variation in recruitment relative to recruitment in year 1 for each year thereafter. Estimated recruitment in year one can be thought of as the estimated average long term recruitment in the population since it produces the initial population. The residual sum of squares of the variation in recruitment $\sum(\text{Vrec})^2$ is than used as a component of the total objective junction. The weight on the recruitment variation component of the objective junction (Vrec) can be used to penalize the model for estimating large changes in recruitment relative to estimated recruitment in year one.

The model requires an age-1 recruitment index for tuning or the user can assume relatively constant recruitment over time by using a high weight on Vrec. Usually there is little overlap in ages at length for fish that are one and/or two years of age in a survey of abundance. The first mode in a survey can generally index age-1 recruitment using length slicing. In addition numbers and the length frequency of the larger fish (adult fish) in a survey where overlap in ages at a particular length occurs can be used for tuning population abundance. The model tunes to the catch and survey length frequency data using a multinomial distribution. The user specifies the minimum size (cm) for the model to fit. Different minimum sizes can be fit for the catch and survey data length frequencies.

The number of parameters estimated is equal to the number of years in estimating F and recruitment plus one for the F to produce the initial population (Fstart), logistic selectivity parameters for each year or blocks of years, and for each survey Q. The total likelihood function to be minimized is made up of likelihood components comprised of fits to the catch, catch length frequencies, the recruitment variation penalty, each recruitment index, each adult index, and adult survey length frequencies:

$$\mathrm{L}_{\text{catch}} = \sum_{years}\left(l\,\mathrm{n}(Y_{\text{obs,y}}+1) - \ln\left(\sum_{a}\sum_{len}\mathrm{Y}_{\text{pred,len,a,y}}+1\right)\right)^2$$

$$L_{catch\_lf} = -N_{eff}\sum_{y}\left(\sum_{inlen}^{L_\infty}\left((C_{y,len}+1)\ln\left(1+\sum_{a}C_{pred,y,a,len}\right)-\ln(C_{y,len}+1)\right)\right)$$

$$\mathrm{L}_{\text{vrec}} = \sum_{y=2}^{Nyears}\left(Vrec_y\right)^2 = \sum_{y=2}^{Nyears}\left(R_1 - R_y\right)^2$$

$$\sum L_{rec} = \sum_{i=1}^{Nrec}\left[\sum_{y}^{Nyears}\left(\ln\left(I_{rec_i,inage_i,y}+1\right)-\ln\left(1+\sum_{len}^{L_\infty} N_{y,inage_i,len} * q_{rec\,i}\right)\right)^2\right]$$

$$\sum L_{adult} = \sum_{i=1}^{Nadult}\left[\sum_{y}^{Nyears}\left(\ln\left(I_{adult_i,inlen+_i,y}+1\right)-\left(\sum_{a}\sum_{inlen_i}^{L_\infty}\ln\left(1+N_{pred,y,a,len} * q_{adult\,i}\right)\right)\right)^2\right]$$

$$\sum L_{lf} = \sum_{i=1}^{Nlf}\left[-N_{eff}\sum_{y}\left(\sum_{inlen_i}^{L_\infty}\left(\left(I_{lf_i,y,len}+1\right)\ln\left(1+\sum_{a}N_{pred,y,a,len}\right)-\ln\left(I_{lf_i,y,len}+1\right)\right)\right)\right]$$

In equation L_{catch_lf} calculations of the sum of length is made from the user input specified catch length to the maximum length for fitting the catch. Input user specified fits are indicated with the prefix "in" in the equations. LF indicates fits to length frequencies. In equation L_{rec} the input specified recruitment age and in L_{adult} and L_{lf} the input survey specified lengths up to the maximum length is used in the calculation.

$$Obj\ fcn = \sum_{i=1}^{N} \lambda_i L_i$$

Lambdas represent the weights to be set by the user for each likelihood component in the total objective function.

Monkfish SCALE Model Configuration and results - Mean lengths at age and variation in mean length at age were estimated directly from ages in the cooperative surveys (2001, 2004), winter, spring, and fall surveys (Figure 40). A single growth estimate was used for both management units. No significant differences in growth were observed between the management units in the 2001 and 2004 cooperative surveys. Over 10,100 monkfish were aged from the combined surveys (Table 25). A standard deviation of 2.9 was estimated for age 1. For ages older than age one a standard deviation of 4.5 was used. No fish were older than age 10 in the surveys. An estimated von Bertalanffy model from Armstrong et al (1992) was used for ages older than age 11. Age 11 was estimated as the average between the two data sources using age 10 and 12.

Survey abundance trends of the adult (40+ cm) and recruitment indices (ages 1, 2, and/or 3) used for each management unit are summarized in Figures 41 to 44. The length interval used as a proxy for the recruitment ages are also shown on the plots. SCALE model runs were fit to 30+ cm fish for survey length frequencies and 40+ cm fish for the adult abundance indices. Both the northern and southern management units were fit to the spring and fall survey length frequencies, 40+ cm adult indices, recruitment indices and the cooperative survey length frequencies. In addition, length frequencies, 40+ cm adult abundance indices, and recruitment indices for the shrimp (1991-2006) survey were used for the northern management unit and the Scallop (1984-2006) and winter (1992-2006) surveys were used for the Southern management unit.

Indices were normalized to their mean and scaled-up by multiplying the index by one million for the initial 10 southern management unit sensitivity runs and the 11 northern management unit sensitivity runs. In the final 4 runs developed by the working group the adult indices (40+) were not normalized to their mean. The final runs were scaled using the approximate area of the management unit taken from the Fall survey coverage (North 26,829 square nautical miles, South 37,081 square nautical miles) divided by the average coverage of a survey tow (0.01 square nautical miles). This provided some insight on the survey efficiencies from the estimated model qs.

The catch was comprised of estimated discards, foreign and domestic landings. Estimated discards in the sensitivity runs used SBRM. In the four final runs total discards and catch length frequencies were estimated using discard to kept ratios for fisheries which target monkfish. Observer discarded and kept length data by gear was used to characterize the catch length frequency. Catch length frequencies were estimated from 1994 to 2006. There appears to be a shift in the catch to larger fish between 1995 and 1996. Many of sensitive runs use 1980-1995 as a separate block for estimating

selectivity. However, only two years of data exist for estimating selectivity for this first block. For the northern management unit the 1994 catch length frequency had a very large amount of small fish in the catch and was not used in the fitting for most of the sensitivity runs.

Age modes are seen for most ages in the model predicted length frequencies due to the linear nature of monkfish growth with a model structure possessing a single annual growth time step. The lack of slower growth with age in monkfish produces this additional process error in the SCALE model fits. This model error can be concealed by increasing the variance on mean lengths at age as seen in a sensitivity run (southern run 8) where the variance was doubled. However increasing the variance on the mean lengths at age beyond what is supported by the raw growth data was not done due to concerns on its effect the estimated selectivity.

A variety of conditions and assumptions were tested using the sensitivity runs which included different penalties on recruitment variation (Vrec), different assumptions on population starting condition (Fstart), modeling the population with sex specific natural mortality, different selectivity assumptions (blocks), two different natural mortality assumptions (0.3 and 0.2), a constant recruitment assumption, etc. The sensitivity analyses produced similar trends in F and biomass (Tables 26 and 27, Figures 45 and 46). There appears to be a weak relationship between the adult survey abundance and a truncation of the survey length frequencies with the total removals over the time series (1980-2006). The SCALE model results are consistent with the apparent lack of a relationship between abundance and catch.

The sensitivity analysis illustrates the tradeoff between shifts in the estimated selectivity and fishing mortality. Evidence of shifts in the overall selectivity to larger fish appear to have occurred over time especially with the increase in the gillnet catch in the south. However increasing the number of estimated selectivity blocks allows the model to estimate lower fishing morality by shifting the selectivity to larger fish.

Many of the monkfish sensitivity runs estimated a virgin biomass in year 1 of the model (1980). However at times a higher Fstart is estimated depending on the assumptions made in the model (Vrec penalty, assumption of m). The working group felt that the virgin biomass condition in 1980 was likely not true especially for the southern management unit.

Monkfish SCALE Model runs - Additional runs were made from suggestions of the working groups. The runs accepted as the final assessment runs by the Working Group in June and July, 2007 are shown in Tables 28-30 and Figures 47, 48, and 52.

Working Group Meeting (June 2007):

1. The effective sample sizes of the survey length frequencies were lowered to better reflect the number of fish caught in the surveys.
2. A maximum age of 12 was assumed with an M of 0.3 and a maximum age of 15 for a M of 0.2. Actual age data was used through age 12 using additional age information collected from the large monkfish study.
3. The discards and catch length frequency were updated using the discard to kept monkfish method suggested from the working group.
4. The time frame in the SCALE model was projected to 2009 to determine the

influence of an assumed catch of 5,623 mt (5,000 mt landed, 373 mt discards, 251 mt foreign) in the North and 6,561 mt (5,100 mt landed and 1461 mt discards) in the south. The average discard to kept ratios and foreign catch from 2004-2006 was used to project discards for 2007-2009.

5. A single selectivity block (1980-2006) was estimated for the northern management unit and three selectivity blocks (1980-1995, 1996-2003, 2004-2009) were estimated for the southern management unit to allow the model to estimate a closer fit to the catch length frequencies at the end of the time series.

Some exploratory runs were also made based on suggestions of working group II:

6. A series of runs was done with M ranging from 0.1 to 0.5 in increments of 0.1 to develop a likelihood profile for M.
7. The relative weights for survey and catch were adjusted to put more emphasis on survey data. These led to unreasonable selectivity patterns and were not carried forward.

Runs with either M of 0.3 or 0.2 for both management units indicate continued increases in biomass with lower fishing mortality using the assumed catch. A shift in selectivity to small sizes can be seen as the assumed natural mortality is decreased (Figures 49 and 50). The likelihood profile for M supported the use M=0.3 rather than M=0.2 (Figure 51).

Figure 52 compares the biomass estimates from the accepted SCALE runs to the biomass indices for each area from NEFSC autumn surveys.

7.0 Biological Reference Points (TOR #5)

Based on the conclusions of SAW 34 (NEFSC 2002), the existing overfishing definition is F_{max}, estimated as 0.2 for both management areas (assuming M=0.2). Framework 2 revised the biomass threshold reference points ($B_{threshold}$) to be consistent with National Standard 1 Guidelines ($B_{threshold} = ½*B_{target}$). For both areas, the existing $B_{threshold}$ is one-half of the median of the 1965-1981 3-year average NEFSC autumn trawl survey catch (kg) per tow).

7.1 Length-based yield per recruit

The length-based yield-per-recruit (LBYPR) calculations assume that growth conforms to a von Bertalanffy model. However, as illustrated in Figure 28, monkfish growth appears to be approximately linear for the observed range of ages. For this reason, LBYPR was not used to establish new reference points.

LBYPR was calculated under a range of assumptions regarding selectivity pattern, constant natural mortality and growth (Table 31). Maturation rates and length-weight relations were assumed the same in both regions. Selectivity patterns estimated by SCALE were used for the northern and southern management areas. Selectivity patterns were estimated from SCALE. Two estimates of von Bertalanffy growth parameters (from cooperative research data and Armstrong et al. 1992) and two levels of natural mortality (M=0.2, M=0.3) were used. Previous age-based YPR calculations assumed M=0.2 (NEFSC 2002). For the northern region, F_{max} ranged from 0.22 to 0.41 ($F_{0.1}$ =0.14

to 0.24; Figure 53a). For the southern region, F_{max} ranged from 0.27 to 0.51 ($F_{0.1}$ =0.17 to 0.28; Figure 53b).

7.2 Age-based yield-per-recruit

The existing overfishing threshold is based on F_{max} , and this was retained, although new values were estimated. Age-based YPR was calculated for each management region using constant natural mortality M=0.3 and applying selectivity at age approximated from SCALE output selectivity at length for each area. Mean weights at age for the catch and stock were from SCALE output and maturity ogives were from 2001 Cooperative Monkfish Survey data (NEFSC 2002) (Table 32, Figure 54). For the northern region, F_{max} = 0.31 and $F_{40\%}$=0.18. For the southern region, F_{max} =0.40 and $F_{40\%}$=0.31. The difference in the estimates for the two regions reflects differing selectivity of gillnets and trawls; more monkfish are landed using gillnets in the south than in the north.

7.3 Biomass reference points

New biomass reference points were developed based on results of the SCALE model, which assumed M=0.3. The recommended $B_{threshold}$ is the lowest estimated value in the total biomass time series available for the assessment (1980-2006) from which the stock then increased (termed "B_{Loss}"); B_{Loss} was estimated to be 65,200 mt in the north and 96,400 mt in the south. The recommended B_{target} is the average of the total biomass estimates for the time period used in the model (1980-2006); B_{target} was estimated to be 92,200 mt in the north and 122,500 mt in the south.

7.4 Fishing mortality reference points

F_{target} was not defined in the original monkfish FMP or in Framework Adjustment 2. The working group recommended that $F_{40\%}$ be used as a proxy for F_{target} .

8.0 Stock Status Determination (TOR #6)

8.1 Current fishery management plan definitions

Consistent with previous stock assessments, recent survey biomass indices and length-based mortality estimates were compared to current reference points. Currently, stock status determination is based on delta-transformed survey indices (Tables 33a and 33b).

Northern Management Area - The most recent three-year average of the autumn index (1.1 kg/tow) is less than the 'overfished' threshold (1.3 kg/tow; Figure 55a); according to this definition the resource is overfished.

Southern Management Area - The most recent three-year average of the autumn index (0.87 kg/tow) is less than Bthreshold (0.92 kg/tow; Figure 55b); according to this definition the resource is overfished.

8.2 Revised stock assessment method and reference points

New reference points (summarized in TOR # 5) were recommended based on a revised age-based yield per recruit and the results of the SCALE model. The existing overfishing threshold, based on F_{max}, was retained in the new assessment, although new values were estimated. The SCALE model is recommended for evaluating current status with respect to reference points. According to these revised criteria, the status in each area is as follows:

Northern Management Area -

- F for 2006 was estimated to be 0.09, which is less than F_{max} (0.31); therefore **overfishing is not occurring**.
- The estimate of total biomass in 2006 is 118,700 mt, which is greater than B_{Loss} (65,200 mt) and the Bmsy proxy (92,200 mt); according to this new definition the resource is **not overfished**

Southern Management Area -

- F for 2006 was estimated to be 0.12, which is less than F_{max} (0.40); therefore **overfishing is not occurring**.
- The estimate of total biomass in 2006 is 135,400 mt, which is greater than B_{Loss} (96,400 mt) and the Bmsy proxy (122,500 mt); according to this new definition the resource is **not overfished**.

9.0 Short-Term Projections (TOR #7)

The principal management problem for monkfish is the need to rebuild the stock by 2009. The monkfish Plan Development Team recommended setting the TAC's at about 5,000 tons for both stocks (Framework 4). These TAC's are similar to landings observed during the mid 1980's for both management areas, and the PDT concluded that these TAC's should reduce exploitation for the northern stock (Figure 56a), and maintain exploitation near recent values for the southern stock (Figure 56b). Based on the PDT recommendations the proposed TACs are 5,000 and 5,100 mt for the northern and southern areas, respectively.

The SCALE model was projected to 2009 to determine the influence of an assumed catch of 5,623 mt (5,000 mt landed, 373 mt discards, 251 mt foreign) in the North and 6,561 mt (5,100 mt landed and 1461 mt discards) in the south. The average discard to kept ratios and foreign catch from 2004-2006 was used to project discards for 2007-2009. As shown in Figure 47, projections of 5,000 mt in 2007 and 2008 in the northern area continue the increase in biomass above the biomass target. As shown in Figure 48, projections of 5,100 mt in 2007 and 2008 in the southern area produce approximately 20% growth in stock biomass from 2006 to 2009.

10.0 Management Plan Evaluation (TOR #8)

Optimum yield is calculated based on a method adopted in Framework 2 that compares the 3 year moving average of the NEFSC autumn survey biomass index to interim annual survey biomass index targets, and adjusts annual TACs and trip limits based on the difference between the observed and target biomass indices.

The monkfish rebuilding plan is based on changing catches to reflect changes in the survey index relative to a linear rebuilding plan. In equations,

1. $$C_{t+1} = C_{t-1}(\frac{\text{Index}_t}{\text{Rebuild}_t})$$

where Rebuild is determined by a linear function relating the index at the start of the rebuilding plan to a level for the index associated with B_{MSY}. The two year lag between catches is due to the time required to collect data and set management regulations. This rebuilding plan was examined using a deterministic surplus production model of the form

2. $$B_{t+1} = B_t + rB_t(1 - \frac{B_t}{K}) - C_t$$

which has the properties $B_{MSY} = K/2$, Fmsy = $r/2$, MSY = $rK/4$ for parameters r and K. To simplify matters further, K was set at 2000 units and an initial equilibrium state for the model was derived with C = 0.7*MSY which caused the initial biomass value to be 45% of Bmsy for any value of r. This initial biomass value was solved analytically as

3. $$B_{init} = \frac{K - \sqrt{K^2 - 4\frac{CK}{r}}}{2}$$

based on solving the quadratic equation that produced an overfished condition. Since catches in the two years prior to the starting year of the rebuilding plan could be either greater than or less than the catches that reduced the stock to 45% of Bmsy, two parameters were used that caused the catch in years zero and minus one of the simulation to be a multiple of the equilibrium catch. An index of abundance was created using a catchability coefficient applied to the biomass time series. The average of year t and the previous two years was calculated at the index 3 year moving average. The index three year moving average was used in equation 1 above. The rebuilding plan was set so that in ten years the stock increased linearly from 45% of B_{MSY} to B_{MSY}.

Given these conditions, the parameter r of the surplus production model and the catches in years zero and minus one of the simulations relative to the equilibrium catch (Crat) were varied. The values of Crat could be greater or less than one depending on whether catches in these years were above or below those that caused the population reduction. The resulting time streams of indices (three year moving average) were examined to determine if the rebuilding target of Bmsy was achieved in ten years or not.

When the initial catches were both fixed to be the equilibrium catch, values of $r<0.42$ did not rebuild within the ten year time period, while values of $r\geq0.42$ did rebuild (Table 34). Although the r=0.42 did achieve rebuilding in the ten year time period, it did not follow the linear rebuild trajectory (Figure 57a). In all cases, the catch was reduced initially from the equilibrium levels and then could increase if r was high enough. When r=0.42 the catch decreased from 147 to 68, a 54% decrease. Values of r greater than 0.7 produced catches that were greater than MSY in the final years of the simulations. These

catches are not sustainable deterministically and cause the index to decline, although the three year moving averages do not. These high values of r would not be expected for monkfish, but are reported here for completeness.

Next, the value of r was fixed at a level considered appropriate for monkfish, r=0.2, and the levels of initial catches relative to the equilibrium catch (Crat) was varied. When both years zero and minus one were set equal, values of Crat greater than 0.43 did not achieve the rebuilding target within the ten year time period, while values of Crat≤0.43 did (Table 35). In all cases examined, the catches were well below the equilibrium catch of 70 for r=0.2, with the exception of years 1 and 2 in the time series for high Crat values. In these cases, the high catches in years zero and minus one and the time lags in the calculations of both C(t+1) and the three year index average caused the catches to remain above MSY values even though the stock was overfished, followed by large declines in catch that were insufficient to rebuild the stock (Figure 57b).

The specific case of Crat=0.43 for both years zero and minus one and r of 0.2 produced a time series for the index that was close to, but still not equal to, the rebuild time series (Figure 57c). Combinations of r and Crat were not found that produced a linear trend in the index which matched the rebuild time series, although some combinations were close. This is because the dynamics of the surplus production model are not linear. More complex models which incorporate age structure and stochasticity would be expected to be more non-linear.

Differences in the year zero and minus one catches caused a noticeable up and down trend in the time series of catches even though the index three year moving average followed a smooth time trend (Figure 57d). This up and down trend is caused by the two year lag between projected catch and last observed catch. Low r values cause this cycling to be dampened over time, while high r values can cause the magnitude of annual changes to increase and even crash the population (Figure 57e).

Based on these results, it is unlikely that the monkfish rebuilding plan will work. This is due to the non-linearities in fishery population dynamics combined with the relatively low productivity of monkfish, the level of depletion of the monkfish stocks, and the multiple time lags in the rebuilding plan equations. The simulations examined with low r required the initial catches to be well below the catches that reduced the population in order for the rebuilding target to be met. This initial condition does not appear to have been met for either monkfish stock. While additional simulations could be performed which incorporate age structure and stochasticity in recruitment, selectivity, growth, etc. it is likely those simulations would produce similar results.

11.0 Research Recommendations (TOR #9)

11.1 SAW 34 (2002) Research Recommendations

1. Research should be continued to define stock structure, including genetic studies, reproductive behavior analyses, morphometric studies, parasite studies, elemental analyses, and studies of egg and larvae transport. - *Otolith elemental composition study is underway using otoliths collected during 2004 cooperative monkfish survey. Otoliths have been processed; data analysis is underway, report expected*

before end of 2007 (Grabowski, Martin and Richards).- Web site established to gather information on location of egg veils – launched spring 2007.
http://www.nefsc.noaa.gov/read/popdy/monkfish/MonkfishEggveilReporting/

2. The SARC recommends changing the overfishing definitions for monkfish. Research on yield per recruit for monkfish should examine the effect and possible causes of differential natural mortality rates by sex, methods to estimate gear selectivity, and the incorporation of discards.
- Overfishing definition was changed in 2003 via Framework 2 based on SAW34 results.
- Current assessment includes new length-based YPR with revised estimates of gear selectivity in northern and southern regions (incorporating discards), and examines higher M to reflect shorter longevity of males.

3. Surplus production modeling should continue with special emphasis placed on uncertainty in under-reported catches and population size prior to 1980.
- Bayesian surplus production was updated in SAW 40 (2005) assessment and in current assessment.

4. Size selectivity studies should be conducted in the trawl fishery to investigate the potential effectiveness of minimum mesh size and shape regulations to reduce discards of undersize monkfish. Additionally, comparative studies of the size selectivity and catchability of trawls and gill nets should be undertaken in order to understand the differences in the numbers of large fish captured in the two gear types.
- A study using 12" diamond and square mesh was completed in 2006 (Raymond and Glass 2006). The study showed reduced catch rates of groundfish in the experimental nets compared to controls (6-6.5" mesh) and reduced discard of monkfish in the experimental nets. Monkfish was 35% of the catch (kg) in control nets and 73% in experimental nets. Discard of monkfish was reduced from 15% to 6%.

5. Another cooperative survey for monkfish should be conducted in 2004.
- A second cooperative survey was conducted during 2004. No cooperative survey was conducted in 2007.

6. Improved sampling rates (as observed in 2000-2001) for commercial landings should be maintained, which should eventually lead to an age-based assessment approach for this species.
- age sampling rates have been variable.

7. Tagging studies should be considered as a basis to evaluate adult movement and rates of growth.
- Tagging studies were initiated in 2006 (archival tagging, methods development) and 2007 (conventional tagging, releases scheduled for July and August; archival tags, releases planned for November 2007).

8. Spatial distribution of mature and immature fish and the potential effects of size limits on fishing behavior should be evaluated as a basis for advising on strategies to minimize catch and discard of immature fish.
- not done

9. Indices of abundance should be developed from industry "study fleets," including coverage from outside the depth and spatial range of the NEFSC research surveys.
- not addressed

11.2 SAW 40 (2004) Research Recommendations

1. An examination of the influence of fixed stations on the estimate of biomass from the cooperative research survey should be undertaken.
-As part of the 2006 cooperative monkfish survey review, catch rates, average monkfish size and density were compared between industry stations and random stations. Inclusion of the industry stations was judged to have had minimal impact on the population estimates.

2. An exploration of a geostatistical approach to estimate biomass from the cooperative survey would also be of value.
- not done

3. There are some concerns with the ageing results. An ageing validation study should be undertaken to confirm the accuracy of catch at age estimates.
-Direct validation studies (e.g. tetracycline marking) have not been done. Indirect criteria have been satisfied (Armstrong et al. 1992)

4. The changes in the distribution in the fishery over time may be influencing the results of the assessment. This should be examined more thoroughly.
-this has not been addressed.

5. The assessment lacks a reliable forecast. Since commercial catch-at-age data and survey catch-at-age data exist and assuming that ageing can be validated, alternative forward-projecting age structured models should be investigated.
-a forward projecting length-tuned model (SCALE) was used to provide forecasts in the 2007 assessment.

6. An examination of transect survey data for changes in the distribution of the depth would be informative.
-not done

7. Further consideration should be given to a more complete treatment of the Canadian portion of this stock, with possibly some interaction with the team doing the assessment of monkfish in NAFO Divisions 4VWX5Zc, possibly through the TRAC process.

-not done. At this time, there is not a Canadian assessment scientist assigned to monkfish.

8. Ways of estimating of fishing mortality at age should be investigated. This could take the form of a general linear modelling approach with survey age and year effects in an analysis of Z. Alternatively a more fully specified population model based on survey-at-age data such as the RCRV1A model of Cook (1997) and recent developments described under SURBA may be applicable.
-not done.

9. The co-operative survey should be continued as it is informative and can be used in the Bayesian surplus production model and may provide a means of calibrating the NEFSC survey data when the survey vessel is replaced.
- No cooperative survey was conducted in 2007 due to lack of appropriated funds.

11.3 2007 Northeast Data-Poor Stocks Working Group, Research Recommendations

June, 2007 Meeting

1. Observer samples should be aged.

2. Applications of the SCALE model for monkfish assessment should be developed further, including:
-Explore alternative growth functions (sigmoid etc.) since von Bertalanffy growth does not fit length-at-age data.
-Explore changing weighting on catch in relation to reliability of catch data (more uncertainty in early part of time series).
-Explore using the same M for males and females up to age 7, and then increasing M for males to account for the lack of males over age 7.
-Bin lengths into 2cm or 5 cm increments in order to eliminate zeros in survey length frequencies.
-Develop independent estimates of selectivity for application to SCALE.

3. Length-based mortality:
-Examine effects of vonBertalanffy growth assumption on Gedamke-Hoenig mortality estimates.

July, 2007 Meeting

1. Investigate foreign landings and reporting rates if possible.

2. Examine aging further and develop tagging studies to validate M, growth rates and Longevity.

3. Estimate biomass by sex since age 6+ fish that are predominantly female. appear to be decreasing in biomass at a greater rate.

4. SCALE model:
   -develop objective methods for weighting input series (e.g. inverse variance weighting).
   - do some runs with combined management areas.
   -develop a two-sex model.
   - incorporate cannibalism in SCALE model.

5. examine commercial sampling length modes in more detailed time steps (e.g. quarterly) to see if cohorts can be tracked (to indicate whether there are significant problems with aging.)

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Monkfish Tables

Table 1. Fishery management timeline for monkfish.

Month/Year	Regulatory Action
Nov. 1999	FMP implemented - Included a multi-level limited access program; two management areas; target TACs; effort limitations (DAS); Year 3 default measures (0 DAS); trip limits for limited access vessels; bycatch allowances; minimum fish sizes; minimum mesh sizes; gear restrictions; spawning season restrictions; a framework adjustment process; annual review requirements; permitting and reporting requirements; and other measures for administration and enforcement.
Nov. 1999	Amendment 1 effective – EFH Omnibus Amendment
May. 2000	DAS implemented
Jul. 2000	SAW 31
Spring 2001	Cooperative Survey
Fall 2001	Hall v. Evans decision - trip limit on gillnet vessels set equal to trawls, based on permit category.
Jan. 2002	SAW 34
Spring 2002	Councils submit Framework 1 – Proposes to fix landings at existing levels and postpone default measures for 1 year while Councils develop Amendment 2.
May. 2002	Emergency Rule – Framework 1 disapproved for non-compliance with Fthreshold in the original plan (which was invalidated by SAW 31 and SAW 34). Implemented a revision to the OFD based on SAW 34 recommendations, and management measures in FW 1.
May. 2003	Framework 2 - Modified the OFD reference points recommended by SAW 34; established an index- and landings-based method for setting TACs to achieve annual rebuilding goals; contained a method for calculating DAS and trip limits; and eliminated the default measures.
Spring 2004	Cooperative Survey
May. 2005	Amendment 2 - Made minimum fish size in SFMA equivalent to that in NFMA (11-inch tail/17-inch whole); established a 6-inch roller gear restriction in the SFMA, implemented two canyon closure areas; removed the 20-day spawning block requirement; established a research set-aside program; established an Offshore Fishery Program in the SFMA; modified some incidental catch limits; and modified the monkfish limited entry program to include vessels that had historically fished off of VA and NC.
Spring 2007	Councils submit Framework 4 - Would establish target TACs, trip limits, and DAS requirements for final 3 years of rebuilding plan; would require use of DAS in NFMA; contains backstop measures if target TACs exceeded; would revise incidental catch limits for NFMA and scallop access areas; and would adjust boundary line applicable to Category H vessels.
May. 2007	Interim Rule - Tempoarily implemented target TAC, DAS, and trip limits recommended in Framework 4 for the NFMA (except does not include the at-sea declaration provision); continues FY 2006 target TAC, DAS, and trip limits for the SFMA; and prohibits the use of carryover DAS. Also temporarily implements other measures contained in Framework 4: Revision to boarder applicable to Category H vessels and revisions to incidental catch limits in NFMA and scallop access areas.

Table 2. Management measures for monkfish, 2000-2006 (note that regulations pertain to 'fishing years,' and do not correspond to the calendar year landings in Table 3.)

FY MAY - APRIL	Trip Limits (lbs. tail wt./DAS) SFMA only	Management Area	DAS Allocations	TACs mt.	Landings mt.
2000	A&C: 1,500 trawls, 300 gillnets B&D: 1,000 trawls, 300 gillnets	SFMA	40	6,024	7,960
		NFMA	40	5,673	11,859
2001	Gillnet trip limits set equal to trawl/permit category	SFMA	40	6,024	11,069
		NFMA	40	5,673	14,853
2002	A&C: 550 B&D: 450	SFMA	40	7,921	7,478
		NFMA	40	11,674	14,491
2003	A&C: 1,250 B&D: 1,000	SFMA	40	10,211	12,198
		NFMA	40	17,708	14,155
2004	A&C: 550 B&D: 450	SFMA	28	6,772	6,193
		NFMA	40	16,968	11,750
2005	A&C: 700 B&D: 600	SFMA	39.3*	9,673	9,533
		NFMA	39.3*	13,160	9,656
2006	A&C: 550 B&D: 450	SFMA	12	3,667	TBD
		NFMA	39.3*	7,737	TBD

* Reduced by a fraction of a DAS (0.7) for DAS Research Set-Aside Program

FY MAY - APRIL	Management Area	Minimum Fish Size (inches)	Minimum Fish Size (cm)	Changes to Gear Requirements
2000	SFMA	14 tail/21 whole	36 tail/53 whole	Req. established in FMP*
	NFMA	11 tail/17 whole	28 tail/43 whole	
2001	SFMA	14 tail/21 whole	36 tail/53 whole	Req. established in FMP
	NFMA	11 tail/17 whole	28 tail/43 whole	
2002	SFMA	14 tail/21 whole	36 tail/53 whole	Req. established in FMP
	NFMA	11 tail/17 whole	28 tail/43 whole	
2003	SFMA	14 tail/21 whole	36 tail/53 whole	Req. established in FMP
	NFMA	11 tail/17 whole	28 tail/43 whole	
2004	SFMA	14 tail/21 whole	36 tail/53 whole	Req. established in FMP
	NFMA	11 tail/17 whole	28 tail/43 whole	
2005	SFMA	11 tail/17 whole	28 tail/43 whole	Added 6-inch roller gear restriction in
	NFMA	11 tail/17 whole	28 tail/43 whole	
2006	SFMA	11 tail/17 whole	28 tail/43 whole	6-inch roller gear restriction in SFMA
	NFMA	11 tail/17 whole	28 tail/43 whole	

Table 3. Landings (calculated live weight, mt) of monkfish as reported in NEFSC weigh-out data base (1964-1993) and vessel trip reports (1994-2006) (North = SA 511-523, 561; South = SA 524-639 excluding 551-561 plus landings from North Carolina for years 1977-1995); General Canvas database (1964-1989, North = ME, NH, northern weigh out proportion of MA; South = Southern weigh out proportion of MA, RI-VA); Foreign landings from NAFO database areas 5 and 6. Shaded cells denote the statistics used for stock assessment (see text for details).

	Weigh Out Plus NC			General Canvas				
Year	US North	US South	US Total	US North	US South	US Total	Foreign	Total
1964	45	19	64	45	61	106	0	106
1965	37	17	54	37	79	115	0	115
1966	299	13	312	299	69	368	2,397	2,765
1967	539	8	547	540	59	598	11	609
1968	451	2	453	449	36	485	2,231	2,716
1969	258	4	262	240	43	283	2,249	2,532
1970	199	12	211	199	53	251	477	728
1971	213	10	223	213	53	266	3,659	3,925
1972	437	24	461	437	65	502	4,102	4,604
1973	710	139	848	708	240	948	6,818	7,766
1974	1,197	101	1,297	1,200	183	1,383	727	2,110
1975	1,853	282	2,134	1,877	417	2,294	2,548	4,842
1976	2,236	428	2,663	2,256	608	2,865	341	3,206
1977	3,137	830	3,967	3,167	1,314	4,481	275	4,756
1978	3,889	1,384	5,273	3,976	2,073	6,049	38	6,087
1979	4,014	3,534	7,548	4,068	4,697	8,765	70	8,835
1980	3,695	4,232	7,927	3,623	6,035	9,658	132	9,790
1981	3,217	2,380	5,597	3,171	4,142	7,313	381	7,694
1982	3,860	3,722	7,582	3,757	4,492	8,249	310	7,892
1983	3,849	4,115	7,964	3,918	4,707	8,624	80	8,044
1984	4,202	3,699	7,901	4,220	4,171	8,391	395	8,296
1985	4,616	4,262	8,878	4,452	4,806	9,258	1,333	10,211
1986	4,327	4,037	8,364	4,322	4,264	8,586	341	8,705
1987	4,960	3,762	8,722	4,995	3,933	8,926	748	9,470
1988	5,066	4,595	9,661	5,033	4,775	9,809	909	10,570
1989	6,391	8,353	14,744	6,263	8,678	14,910	1,178	15,922
1990	5,802	7,204	13,006				1,557	14,563
1991	5,693	9,865	15,558				1,020	16,578
1992	6,923	13,942	20,865				473	21,338
1993	10,645	15,098	25,743				354	26,097
1994	10,950	12,126	23,076				543	23,619
1995	11,970	14,361	26,331				418	27,075
1996	10,791	15,715	26,507				184	26,978
1997	9,709	18,462	28,172				189	28,517
1998	7,281	19,337	26,618				190	26,866
1999	9,128	16,085	25,213				151	25,364
2000	10,729	10,147	20,876				176	21,052
2001	13,341	9,959	23,301				149	23,450
2002	14,011	8,884	22,896				294	23,189
2003	14,991	11,095	26,086				309	26,375
2004	13,209	7,978	21,186					21,186
2005	10,267	8,834	19,102					19,102
2006	6,706	7,755	14,461					14,461

Table 4. U.S. landings of monkfish (calculated live weight, mt) by gear type.

	North					South					Regions Combined				
Year	Trawl	Gill Net	Scallop Dredge	Other	Total	Trawl	Gill Net	Scallop Dredge	Other	Total	Trawl	Gill Net	Scallop Dredge	Other	Total
1964	45	0			45	19				19	64	0			64
1965	36	0			37	17				17	53	0			53
1966	299	0		0	299	13			0	13	311	0		0	312
1967	532		8		539	8				8	540		8		547
1968	447		4		451	2				2	449		4		453
1969	253	1	4		258	4				4	257	1	4		262
1970	198	0		0	199	12				12	210	0		0	211
1971	213		0		213	10				10	223		0		223
1972	426	8	1	2	437	24				24	451	8	1	2	461
1973	661	29	12	8	710	132		5	1	137	794	29	17	9	848
1974	1,060	105	7	25	1,197	98			0	98	1,160	105	7	25	1,297
1975	1,712	123	10	9	1,853	265	0	2	2	269	1,990	123	12	10	2,135
1976	2,031	143	47	15	2,236	333		7	0	340	2,459	143	54	15	2,670
1977	2,737	230	142	28	3,137	508		57	26	591	3,487	230	202	53	3,973
1978	3,255	368	212	54	3,889	605	0	507	26	1,138	4,016	368	774	80	5,238
1979	2,967	393	584	71	4,014	944	6	1,015	16	1,981	3,989	399	2,070	87	6,545
1980	2,526	518	596	56	3,696	1,139	10	1,274	7	2,429	3,723	528	2,276	62	6,589
1981	2,266	461	443	47	3,217	1,100	16	782	105	2,003	3,483	477	1,399	152	5,512
1982	3,040	421	367	32	3,860	1,806	12	1,507	27	3,352	4,998	433	2,061	60	7,551
1983	3,233	314	266	37	3,849	1,819	11	2,119	17	3,966	5,166	325	2,431	56	7,977
1984	3,648	315	196	43	4,202	1,714	15	1,704	18	3,452	5,513	330	1,968	61	7,871
1985	3,982	315	264	55	4,616	1,739	17	2,347	3	4,106	5,757	332	2,611	58	8,758
1986	3,412	326	553	36	4,327	1,841	32	2,068	12	3,954	5,318	358	2,621	48	8,345
1987	3,853	374	695	38	4,960	1,680	26	1,997	3	3,707	5,561	400	2,692	41	8,694
1988	3,554	304	1,172	36	5,066	1,828	58	2,594	3	4,483	5,399	363	3,765	39	9,567
1989	3,429	349	2,584	30	6,391	3,240	17	5,036	3	8,297	6,679	366	7,620	33	14,698
1990	3,298	338	2,141	25	5,802	2,361	32	4,744	5	7,142	5,697	372	6,885	30	12,984
1991	3,299	338	2,033	24	5,694	5,515	363	3,907	16	9,800	8,847	700	5,941	39	15,528
1992	4,330	359	2,211	24	6,923	6,528	977	6,409	11	13,925	10,860	1,336	8,619	35	20,850
1993	5,890	695	4,034	26	10,645	5,987	1,722	7,158	192	15,059	11,879	2,417	11,192	218	25,707
1994	7,574	1,571	1,808	86	11,039	5,233	2,342	3,995	556	12,126	12,707	3,884	5,759	638	22,988
1995	9,119	1,531	1,266	54	11,970	5,785	3,800	4,030	746	14,361	14,905	5,331	5,296	800	26,331
1996	8,445	1,389	913	45	10,791	7,141	4,211	4,330	33	15,715	15,586	5,599	5,243	78	26,507
1997	7,363	988	1,318	40	9,709	8,161	5,203	4,890	208	18,462	15,524	6,192	6,208	249	28,172
1998	5,421	885	948	27	7,281	7,815	6,198	5,190	134	19,337	13,236	7,083	6,138	161	26,618
1999	7,037	1,470	598	24	9,128	6,364	6,187	3,481	54	16,085	13,401	7,656	4,079	78	25,213
2000	8,234	2,102	316	76	10,729	4,018	4,005	1,975	150	10,147	12,252	6,107	2,291	226	20,876
2001	9,990	2,959	381	11	13,341	3,091	5,119	1,719	30	9,959	13,081	8,078	2,100	41	23,301
2002	10,839	2,978	181	13	14,011	1,584	5,410	1,847	43	8,884	12,423	8,389	2,028	56	22,896
2003	12,028	2,488	222	254	14,991	2,034	7,262	1,717	83	11,095	14,062	9,750	1,939	336	26,086
2004	9,918	2,866	14	411	13,209	1,228	4,605	671	1,474	7,978	11,145	7,471	685	1,885	21,186
2005	6,826	2,425	26	990	10,267	1,697	4,532	449	2,156	8,834	8,524	6,957	475	3,146	19,102
2006	4,961	1,483	33	229	6,706	1,435	3,658	336	2,326	7,755	6,396	5,141	369	2,555	14,461

Table 5. Landed weight (mt) of monkfish by market category for 1964-2006 for combined assessment areas (SA 511-636), NEFSC weighout database and vessel trip reports (1994-2006).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Dressed	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	0.0	0.0	0.0	0.0	0.0	0.0	19.3	0.0	0.0	0.0	19.3
1965	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	16.1
1966	0.0	0.0	0.0	0.0	0.0	0.0	93.9	0.0	0.0	0.0	93.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	164.8	0.0	0.0	0.0	164.8
1968	0.0	0.0	0.0	0.0	0.0	0.0	136.6	0.0	0.0	0.0	136.6
1969	0.0	0.0	0.0	0.0	0.0	0.0	79.1	0.0	0.0	0.0	79.1
1970	0.0	0.0	0.0	0.0	0.0	0.0	63.5	0.0	0.0	0.0	63.5
1971	0.0	0.0	0.0	0.0	0.0	0.0	67.1	0.0	0.0	0.0	67.1
1972	0.0	0.0	0.0	0.0	0.0	0.0	139.0	0.0	0.0	0.0	139.0
1973	0.0	0.0	0.0	0.0	0.0	0.0	255.5	0.0	0.0	0.0	255.5
1974	0.0	0.0	0.0	0.0	0.0	0.0	390.7	0.0	0.0	0.0	390.7
1975	0.0	0.0	0.0	0.0	0.0	0.0	642.8	0.0	0.0	0.0	642.8
1976	0.0	0.0	0.0	0.0	0.0	0.0	802.2	0.0	0.0	0.0	802.2
1977	0.0	0.0	0.0	0.0	0.0	0.0	1194.4	0.0	0.0	0.0	1194.4
1978	0.0	0.0	0.0	0.0	0.0	0.0	1574.5	0.0	0.0	0.0	1574.5
1979	0.0	0.0	0.0	0.0	0.0	0.0	2224.7	0.0	0.0	0.0	2224.7
1980	0.0	0.0	0.0	0.0	0.0	0.0	2302.4	0.0	0.0	0.0	2302.4
1981	0.0	0.0	0.0	0.0	0.0	0.0	1654.2	0.0	0.0	0.0	1654.2
1982	0.0	0.0	10.2	0.0	0.0	0.0	2059.8	153.1	53.3	0.0	2266.2
1983	0.0	0.0	11.6	0.0	0.0	0.0	2009.9	241.4	138.6	0.0	2390.0
1984	0.0	0.0	25.0	0.0	0.0	0.0	2121.6	186.8	44.5	0.0	2352.9
1985	0.0	0.0	28.0	0.0	0.0	0.0	2467.0	86.7	73.4	0.0	2627.1
1986	0.0	0.0	36.3	0.0	0.0	0.0	2365.4	76.4	52.2	0.0	2494.0
1987	0.0	0.0	54.2	0.0	0.0	0.0	2463.7	139.9	6.7	0.0	2610.3
1988	0.0	0.0	112.8	0.0	0.0	0.0	2646.3	195.1	34.8	0.0	2876.2
1989	0.0	0.0	146.3	0.0	15.6	0.0	3501.8	557.4	360.0	0.0	4419.2
1990	0.0	0.0	179.7	0.0	217.7	0.0	2601.8	854.1	377.4	0.0	3833.3
1991	0.0	8.6	270.3	0.0	415.4	0.0	2229.1	1661.9	614.1	36.6	4541.6
1992	0.2	3.7	321.5	0.0	386.0	0.0	2778.7	1908.1	1293.0	183.3	6163.1
1993	0.0	1.7	459.9	98.2	528.7	0.0	3503.2	1933.0	1851.1	262.4	7549.8
1994	0.0	5.3	458.1	1453.6	2044.8	0.0	1256.9	2230.7	2063.3	258.0	5808.9
1995	2.3	1.0	497.0	2752.4	2652.4	0.0	879.7	2521.4	2422.6	363.3	6187.1
1996	0.4	0.6	569.5	3467.8	1063.1	0.0	1086.0	2090.1	3027.2	269.6	6472.9
1997	0.1	0.1	628.0	3193.7	795.2	0.0	673.6	3050.1	3274.0	151.5	7149.3
1998	0.0	0.5	605.9	3586.9	581.8	0.0	858.3	3006.8	2649.8	95.5	6610.4
1999	0.1	0.2	597.4	5748.1	1131.4	0.0	537.2	2388.3	2200.8	153.4	5279.8
2000	0.0	3.7	624.0	6914.1	1091.0	0.0	293.6	1580.0	1707.3	4.3	3585.1
2001	0.5	0.0	559.4	7028.2	531.4	0.0	345.3	1958.9	2140.3	0.4	4444.9
2002	0.2	0.1	508.7	7801.7	575.4	0.0	246.6	1683.9	2113.3	0.2	4044.0
2003	0.0	1.0	486.3	7322.8	680.9	0.0	337.1	2362.6	2437.4	0.7	5137.8
2004	0.3	2.1	410.7	3404.6	2026.0	7.8	188.6	2553.4	1853.9	1.5	4597.4
2005	0.0	54.9	373.5	3361.0	2334.3	17.7	107.4	2209.9	1564.7	3.7	3885.6
2006	0.1	108.4	308.0	2850.0	2028.2	21.8	49.1	1563.5	1136.9	3.3	2752.8

Table 6. Landed weight (mt) of monkfish by market category for 1964-2006 for northern assessment area (SA 511-523 and 561), NEFSC weighout database and vessel trip reports (1994-2006).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Dressed	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	0.0	0.0	0.0	0.0	0.0	0.0	13.5	0.0	0.0	0.0	13.5
1965	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	11.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	90.1	0.0	0.0	0.0	90.1
1967	0.0	0.0	0.0	0.0	0.0	0.0	162.5	0.0	0.0	0.0	162.5
1968	0.0	0.0	0.0	0.0	0.0	0.0	135.9	0.0	0.0	0.0	135.9
1969	0.0	0.0	0.0	0.0	0.0	0.0	77.8	0.0	0.0	0.0	77.8
1970	0.0	0.0	0.0	0.0	0.0	0.0	59.8	0.0	0.0	0.0	59.8
1971	0.0	0.0	0.0	0.0	0.0	0.0	64.1	0.0	0.0	0.0	64.1
1972	0.0	0.0	0.0	0.0	0.0	0.0	131.6	0.0	0.0	0.0	131.6
1973	0.0	0.0	0.0	0.0	0.0	0.0	213.8	0.0	0.0	0.0	213.8
1974	0.0	0.0	0.0	0.0	0.0	0.0	360.4	0.0	0.0	0.0	360.4
1975	0.0	0.0	0.0	0.0	0.0	0.0	558.0	0.0	0.0	0.0	558.0
1976	0.0	0.0	0.0	0.0	0.0	0.0	673.4	0.0	0.0	0.0	673.4
1977	0.0	0.0	0.0	0.0	0.0	0.0	944.7	0.0	0.0	0.0	944.7
1978	0.0	0.0	0.0	0.0	0.0	0.0	1171.4	0.0	0.0	0.0	1171.4
1979	0.0	0.0	0.0	0.0	0.0	0.0	1209.1	0.0	0.0	0.0	1209.1
1980	0.0	0.0	0.0	0.0	0.0	0.0	1113.1	0.0	0.0	0.0	1113.1
1981	0.0	0.0	0.0	0.0	0.0	0.0	969.0	0.0	0.0	0.0	969.0
1982	0.0	0.0	10.0	0.0	0.0	0.0	1145.6	15.0	2.0	0.0	1162.6
1983	0.0	0.0	9.3	0.0	0.0	0.0	1152.3	4.8	2.4	0.0	1159.4
1984	0.0	0.0	14.7	0.0	0.0	0.0	1261.9	3.7	0.0	0.0	1265.6
1985	0.0	0.0	11.4	0.0	0.0	0.0	1385.9	1.6	2.6	0.0	1390.2
1986	0.0	0.0	13.7	0.0	0.0	0.0	1302.7	0.3	0.2	0.0	1303.2
1987	0.0	0.0	24.0	0.0	0.0	0.0	1491.5	1.7	0.7	0.0	1493.9
1988	0.0	0.0	47.4	0.0	0.0	0.0	1516.9	5.6	3.3	0.0	1525.8
1989	0.0	0.0	58.7	0.0	11.2	0.0	1464.5	327.0	130.2	0.0	1921.6
1990	0.0	0.0	77.9	0.0	30.3	0.0	1173.7	410.7	154.0	0.0	1738.4
1991	0.0	3.3	70.0	0.0	0.3	0.0	1013.9	538.6	153.2	9.1	1714.8
1992	0.0	0.7	83.0	0.0	0.1	0.0	910.5	589.9	505.4	79.4	2085.3
1993	0.0	0.6	208.3	98.2	350.6	0.0	1034.3	867.9	1061.8	102.9	3067.0
1994	0.0	1.4	207.6	532.7	981.3	0.0	403.0	1205.7	1074.8	136.2	2819.7
1995	0.0	0.7	45.7	1223.7	1113.3	0.0	361.7	1180.4	1003.3	304.4	2849.9
1996	0.3	0.2	65.1	1115.7	745.4	0.0	89.8	930.4	1398.6	223.9	2642.7
1997	0.0	0.1	50.9	634.3	244.3	0.0	26.4	1126.1	1361.5	119.1	2633.1
1998	0.0	0.0	24.0	550.9	143.9	0.0	16.3	1054.9	810.1	79.2	1960.5
1999	0.0	0.1	39.8	1700.8	510.6	0.0	28.3	995.5	848.4	139.4	2011.6
2000	0.0	0.0	93.9	3213.4	912.1	0.0	17.5	782.9	1050.4	2.7	1853.4
2001	0.0	0.0	93.5	3084.2	231.1	0.0	128.5	1114.6	1646.7	0.0	2889.8
2002	0.0	0.1	75.3	3788.7	24.1	0.0	79.6	1055.3	1777.2	0.0	2912.0
2003	0.0	0.0	60.6	2363.9	13.7	0.0	94.7	1572.5	2032.2	0.0	3699.5
2004	0.0	0.0	55.8	646.7	959.9	0.0	3.0	1882.5	1580.3	1.4	3467.3
2005	0.0	0.0	41.2	732.9	953.0	0.1	2.3	1498.5	1051.4	1.6	2553.8
2006	0.0	0.0	22.6	860.6	755.6	0.0	7.6	882.3	604.2	2.6	1496.7

Table 7. Landed weight (mt) of monkfish by market category for 1964-2006 for southern assessment area (SA 524-636 excluding 561), NEFSC weighout database and vessel trip reports (1994-2006).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Dressed	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
1965	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	3.8
1967	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.6
1969	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2
1970	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	3.7
1971	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0
1972	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	7.4
1973	0.0	0.0	0.0	0.0	0.0	0.0	41.7	0.0	0.0	0.0	41.7
1974	0.0	0.0	0.0	0.0	0.0	0.0	30.3	0.0	0.0	0.0	30.3
1975	0.0	0.0	0.0	0.0	0.0	0.0	84.8	0.0	0.0	0.0	84.8
1976	0.0	0.0	0.0	0.0	0.0	0.0	128.8	0.0	0.0	0.0	128.8
1977	0.0	0.0	0.0	0.0	0.0	0.0	249.6	0.0	0.0	0.0	249.6
1978	0.0	0.0	0.0	0.0	0.0	0.0	403.1	0.0	0.0	0.0	403.1
1979	0.0	0.0	0.0	0.0	0.0	0.0	1015.6	0.0	0.0	0.0	1015.6
1980	0.0	0.0	0.0	0.0	0.0	0.0	1189.3	0.0	0.0	0.0	1189.3
1981	0.0	0.0	0.0	0.0	0.0	0.0	685.0	0.0	0.0	0.0	685.0
1982	0.0	0.0	0.2	0.0	0.0	0.0	912.4	138.1	51.3	0.0	1101.8
1983	0.0	0.0	2.3	0.0	0.0	0.0	857.7	236.6	136.2	0.0	1230.5
1984	0.0	0.0	10.3	0.0	0.0	0.0	859.7	183.1	44.5	0.0	1087.3
1985	0.0	0.0	16.7	0.0	0.0	0.0	1081.1	85.1	70.8	0.0	1236.9
1986	0.0	0.0	22.6	0.0	0.0	0.0	1062.6	76.1	52.0	0.0	1190.8
1987	0.0	0.0	330.2	0.0	0.0	0.0	972.2	138.2	6.0	0.0	1116.4
1988	0.0	0.0	65.4	0.0	0.0	0.0	1129.3	189.5	31.5	0.0	1350.4
1989	0.0	0.0	87.6	0.0	4.5	0.0	2037.4	230.4	229.8	0.0	2497.5
1990	0.0	0.0	101.8	0.0	187.3	0.0	1428.1	443.4	223.4	0.0	2094.9
1991	0.0	5.2	200.2	0.0	415.1	0.0	1215.2	1123.3	460.9	27.5	2826.8
1992	0.2	3.0	238.5	0.0	385.9	0.0	1868.2	1318.3	787.6	103.9	4077.9
1993	0.0	1.1	251.5	0.0	178.1	0.0	2468.9	1065.1	789.3	159.4	4482.8
1994	0.0	3.8	250.5	921.0	1063.5	0.0	853.9	1025.0	988.5	121.8	2989.2
1995	2.3	0.3	451.3	1528.7	1539.1	0.0	518.0	1341.0	1419.3	58.9	3337.2
1996	0.4	0.5	504.4	2352.1	317.6	0.0	996.3	1159.7	1628.6	45.6	3830.2
1997	0.1	0.0	577.1	2559.4	550.9	0.0	647.2	1924.0	1912.6	32.4	4516.2
1998	0.0	0.5	581.9	3036.0	438.0	0.0	841.9	1952.0	1839.7	16.3	4649.9
1999	0.1	0.1	557.6	4047.4	620.9	0.0	508.9	1392.8	1352.4	14.1	3268.1
2000	0.0	3.7	530.1	3700.7	178.9	0.0	276.2	797.1	656.9	1.6	1731.8
2001	0.5	0.0	465.9	3944.0	300.3	0.0	216.8	844.3	493.6	0.4	1555.1
2002	0.2	0.0	433.3	4012.9	551.3	0.0	167.0	628.6	336.1	0.2	1132.0
2003	0.0	0.9	425.7	4958.8	667.2	0.0	242.4	790.1	405.1	0.7	1438.3
2004	0.3	2.1	354.9	2758.0	1066.1	7.8	185.6	670.8	273.6	0.1	1130.1
2005	0.0	54.9	332.3	2628.1	1381.3	17.7	105.0	711.3	513.3	2.1	1331.8
2006	0.1	108.4	285.4	1989.5	1272.6	21.8	41.5	681.2	532.7	0.7	1256.1

Table 8a. Discard estimates using (discard/multispecies kept) for dredges and shrimp trawls and (discarded/monks kept) for trawls and gillnets in the northern area.

North

GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Trawl	1989	1	17	0.041	0.63	1,550	63
		2	50	0.182	0.44	1,830	333
	1990	1	9	0.089	0.71	1,589	141
		2	30	0.040	0.46	1,694	68
	1991	1	21	0.043	0.47	1,239	53
		2	53	0.210	0.19	2,027	427
	1992	1	40	0.132	0.32	1,675	222
		2	18	0.266	0.38	2,625	698
	1993	1	8	0.076	0.36	2,821	216
		2	12	0.089	0.25	3,032	270
	1994	1	5	0.040	0.46	2,899	115
		2	4	0.037	0.44	4,353	161
	1995	1	22	0.154	0.32	4,224	652
		2	45	0.088	0.32	4,630	407
	1996	1	14	0.196	0.25	4,210	827
		2	41	0.134	0.57	4,188	559
	1997	1	10	0.099	0.49	3,364	332
		2	7	0.076	0.23	3,444	260
	1998	1	6	0.112	0.37	2,736	306
		2	3	0.088	0.09	2,376	210
	1999	1	2	0.098	0.04	3,742	368
		2	27	0.070	0.22	3,226	226
	2000	1	49	0.074	0.40	4,522	334
		2	53	0.081	0.21	4,200	341
	2001	1	40	0.099	0.22	5,564	553
		2	99	0.064	0.11	5,090	326
	2002	1	28	0.078	0.31	6,235	489
		2	198	0.102	0.12	5,037	514
	2003	1	123	0.099	0.16	7,256	717
		2	169	0.052	0.13	5,340	280
	2004	1	86	0.041	0.13	5,942	242
		2	225	0.045	0.14	4,120	184
	2005	1	55	0.091	0.36	3,825	348
		2	348	0.101	0.14	2,812	285
	2006	1	93	0.041	0.15	2,837	116
		2	58	0.083	0.13	2,259	189

North

GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Shrimp	1989	1	31	0.002	0.34	3,412	6
		2	9	0.001	0.62	931	1
	1990	1	27	0.020	0.34	4,548	92
		2	4	0.020	1.01	620	13
	1991	1	46	0.020	0.19	3,536	71
		2	7	0.020	0.40	340	7
	1992	1	76	0.003	0.23	3,285	10
		2	6	0.003	0.28	161	0
	1993	1	78	0.001	0.26	1,890	2
		2	4	0.001	0.70	316	0
	1994	1	69	0.002	0.39	2,431	6
		2	6	0.001	0.44	1,118	1
	1995	1	62	0.000	0.24	5,416	2
		2	9	0.001	0.43	1,509	1
	1996	1	31	0.000	0.34	7,687	1
		2	5	0.000	0.79	1,475	0
	1997	1	17	0.000	0.61	5,659	1
		2		0.001		655	0
	1998	1		0.000		3,423	1
		2		0.001		160	0
	1999	1		0.000		1,578	0
		2					
	2000	1		0.000		2,238	1
		2		0.001		98	0
	2001	1	3	0.000	0.14	1,094	0
		2					
	2002	1		0.000		417	0
		2					
	2003	1	13	0.000	1.00	1,017	0
		2					
	2004	1	12	0.000	0.25	1,518	0
		2		0.001		24	0
	2005	1	16	0.000	0.53	830	0
		2		0.001		56	0
	2006	1	10	0.000	0.72	618	0
		2	3	0.000	0.10	189	0

North

GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Gillnet	1989	1	1	0.000		84	0
		2	77	0.027	0.32	265	7
	1990	1	37	0.036	0.42	121	4
		2	51	0.029	0.37	219	6
	1991	1	131	0.030	0.48	120	4
		2	555	0.036	0.11	213	8
	1992	1	216	0.065	0.17	105	7
		2	430	0.040	0.25	248	10
	1993	1	106	0.084	0.22	119	10
		2	261	0.032	0.24	560	18
	1994	1	19	0.065	0.30	132	9
		2	38	0.054	0.20	959	52
	1995	1	26	0.141	0.31	334	47
		2	67	0.087	0.23	1,242	109
	1996	1	19	0.137	0.43	348	48
		2	31	0.131	0.19	1,063	140
	1997	1	15	0.036	0.32	244	9
		2	23	0.194	0.84	867	168
	1998	1	27	0.028	0.41	196	5
		2	63	0.043	0.28	746	32
	1999	1	27	0.067	0.66	344	23
		2	59	0.036	0.51	1,088	39
	2000	1	40	0.037	0.24	500	18
		2	59	0.077	0.24	1,879	145
	2001	1	25	0.061	0.70	919	56
		2	30	0.849	0.94	2,227	1,892
	2002	1	19	0.040	0.57	821	33
		2	38	0.048	0.30	2,127	103
	2003	1	83	0.037	0.24	567	21
		2	208	0.053	0.14	1,791	94
	2004	1	91	0.022	0.25	826	19
		2	504	0.054	0.12	2,067	112
	2005	1	37	0.106	0.29	545	58
		2	523	0.071	0.10	1,567	112
	2006	1	49	0.066	0.43	357	23
		2	48	0.082	0.18	1,172	96

North

GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Dredge	1989	1		0.002		18,213	37
		2		0.020		24,053	485
	1990	1		0.002		9,864	20
		2		0.020		19,293	389
	1991	1		0.002		16,608	34
		2		0.020		21,313	430
	1992	1		0.002		14,179	29
		2	1	0.003		20,033	56
	1993	1	2	0.002	0.05	13,702	27
		2	2	0.027	0.24	12,665	341
	1994	1	1	0.003		5,477	15
		2	2	0.006	0.64	4,500	27
	1995	1		0.002		2,915	6
		2	1	0.036		8,435	305
	1996	1	4	0.000	0.63	12,015	3
		2	1	0.034		12,182	420
	1997	1	3	0.004	0.79	19,009	69
		2	3	0.025	0.87	19,866	502
	1998	1	1	0.004		20,980	89
		2	2	0.017	0.07	16,979	281
	1999	1	1	0.002		27,495	65
		2		0.002		29,283	69
	2000	1		0.004		29,383	120
		2	84	0.004	0.15	13,809	56
	2001	1	13	0.003	0.52	16,174	44
		2		0.003		12,512	34
	2002	1		0.015		9,478	138
		2	5	0.015	0.95	11,713	170
	2003	1	3	0.000	1.50	17,082	2
		2	2	0.019	0.74	10,855	204
	2004	1	2	0.000		4,269	0
		2	7	0.276	0.61	1,080	298
	2005	1	15	0.001	0.60	2,427	3
		2	29	0.007	0.24	11,761	87
	2006	1	2	0.000	0.81	8,869	4
		2	10	0.010	0.36	5,445	54

Table 8b. Discard estimates using (discard/multispecies kept) for dredges and shrimp trawls and (discarded/monks kept) for trawls and gillnets in the southern area.

South							
GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Trawl	1989	1	37	0.791	0.37	2,195	1,736
		2	29	0.175	0.55	733	128
	1990	1	36	0.063	0.25	1,540	98
		2	19	0.114	0.33	755	86
	1991	1	51	0.255	0.30	1,251	319
		2	59	0.020	0.38	3,804	78
	1992	1	54	0.059	0.37	3,946	232
		2	25	0.028	0.84	2,134	60
	1993	1	36	0.089	0.59	2,598	232
		2	23	0.027	0.50	1,301	35
	1994	1	35	0.068	0.29	3,039	205
		2	18	0.228	0.63	2,089	477
	1995	1	43	0.150	0.41	3,252	488
		2	31	0.113	0.49	2,709	307
	1996	1	42	0.156	0.30	3,154	491
		2	29	0.094	0.19	3,818	359
	1997	1	43	0.025	0.47	4,355	107
		2	18	0.089	0.15	4,015	356
	1998	1	28	0.120	0.29	4,321	517
		2	15	0.027	0.52	3,648	100
	1999	1	29	0.050	0.36	4,180	209
		2	17	0.211	0.58	2,119	448
	2000	1	54	0.197	0.49	1,766	347
		2	37	0.102	0.52	1,645	167
	2001	1	42	1.551	0.46	1,460	2,265
		2	26	0.368	0.64	959	353
	2002	1	37	0.127	0.55	833	106
		2	30	0.128	0.25	314	40
	2003	1	94	0.156	0.24	712	111
		2	63	0.249	0.38	750	187
	2004	1	158	0.189	0.43	824	156
		2	176	0.981	0.36	755	740
	2005	1	149	0.592	0.34	730	432
		2	210	0.344	0.31	1,608	553
	2006	1	148	0.382	0.22	904	345
		2	102	0.130	0.35	925	121

South							
GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Gillnet	1989	1		0.031		12	0
		2		0.054		5	0
	1990	1		0.031		14	0
		2		0.054		18	1
	1991	1		0.031		209	7
		2	2	0.008	0.16	154	1
	1992	1	60	0.011	0.32	786	8
		2	41	0.020	0.20	176	4
	1993	1	50	0.034	0.71	1,306	44
		2	45	0.059	0.24	341	20
	1994	1	46	0.079	0.34	1,649	130
		2	61	0.058	0.19	830	48
	1995	1	156	0.038	0.19	2,810	108
		2	44	0.041	0.30	937	39
	1996	1	123	0.071	0.28	2,795	199
		2	14	0.052	0.30	1,363	70
	1997	1	150	0.070	0.35	3,688	257
		2	31	0.015	0.35	1,320	19
	1998	1	105	0.067	0.22	4,172	278
		2	13	0.063	0.46	1,948	122
	1999	1	22	0.052	0.35	4,338	227
		2	6	0.046	0.62	1,829	84
	2000	1	22	0.063	0.31	2,688	170
		2	10	0.056	0.93	1,034	58
	2001	1	16	0.030	0.44	2,175	65
		2	4	0.033	0.44	2,758	91
	2002	1	11	0.017	0.83	3,506	60
		2	7	0.063	0.47	1,933	122
	2003	1	31	0.016	0.35	4,671	73
		2	39	0.070	0.32	2,721	190
	2004	1	55	0.062	0.26	3,767	232
		2	43	0.096	0.26	1,221	118
	2005	1	66	0.127	0.23	3,586	456
		2	39	0.080	0.29	1,724	138
	2006	1	36	0.051	0.21	3,151	162
		2	7	0.087	0.37	1,034	89

South							
GEAR	YEAR	HALF	No. Trips	D/K Ratio	CV	mt	Monkfish Discard (mt)
Dredge	1989	1		0.012		59,697	706
		2		0.013		35,498	455
	1990	1		0.012		64,315	761
		2		0.013		53,041	679
	1991	1		0.012		67,830	802
		2	2	0.001	0.25	36,015	22
	1992	1	7	0.000	0.80	48,687	20
		2	7	0.006	0.62	39,127	253
	1993	1	11	0.008	0.29	23,971	184
		2	3	0.029	0.78	18,379	532
	1994	1	9	0.022	0.24	22,841	512
		2	8	0.015	0.29	27,175	420
	1995	1	14	0.029	0.17	34,832	1,016
		2	8	0.041	0.47	18,089	746
	1996	1	18	0.017	0.25	21,250	370
		2	14	0.024	0.28	18,878	448
	1997	1	16	0.026	0.21	10,175	261
		2	7	0.035	0.41	4,329	152
	1998	1	8	0.008	0.27	4,284	33
		2	15	0.011	0.55	4,700	53
	1999	1	2	0.016	0.18	11,695	192
		2	12	0.006	0.52	12,136	72
	2000	1	36	0.015	0.16	26,596	389
		2	132	0.008	0.17	42,541	360
	2001	1	44	0.014	0.12	62,987	907
		2	48	0.014	0.15	69,336	964
	2002	1	34	0.019	0.09	84,180	1,575
		2	55	0.018	0.10	81,242	1,479
	2003	1	46	0.014	0.16	82,123	1,138
		2	71	0.017	0.12	92,174	1,522
	2004	1	74	0.014	0.09	71,786	1,024
		2	164	0.014	0.10	30,188	430
	2005	1	98	0.012	0.14	41,192	500
		2	147	0.016	0.13	29,264	466
	2006	1	42	0.008	0.31	28,640	243
		2	135	0.024	0.14	35,961	846

Table 9. Annual catch, discards using (mt monks discarded / mt kept of all species) for dredges and shrimp trawls and (mt monks discarded / mt monks kept) for trawls and gillnets. The new estimates also reflect minor changes to allocation to stock based on live weight rather than landed weight. Foreign is NAFO areas 5 and 6.

	North			South			Foreign	Total
	Landings	Discard	Total (mt)	Landings	Discard	Total (mt)		
1980	3,623	767	4,390	6,035	395	6,430	132	10,953
1981	3,171	916	4,087	4,142	319	4,461	381	8,929
1982	3,860	841	4,701	3,722	417	4,139	310	9,150
1983	3,849	797	4,646	4,115	467	4,582	80	9,308
1984	4,202	733	4,935	3,699	483	4,182	395	9,512
1985	4,616	757	5,373	4,262	451	4,713	1,333	11,419
1986	4,327	652	4,979	4,037	439	4,476	341	9,796
1987	4,960	914	5,874	3,762	726	4,488	748	11,110
1988	5,066	942	6,008	4,595	721	5,316	909	12,234
1989	6,391	932	7,323	8,353	3,026	11,379	1,178	19,880
1990	5,802	733	6,535	7,204	1,626	8,830	1,557	16,922
1991	5,693	1,033	6,726	9,865	1,229	11,094	1,020	18,840
1992	6,923	1,031	7,954	13,942	577	14,519	473	22,946
1993	10,645	885	11,530	15,098	1,047	16,145	354	28,029
1994	10,950	385	11,335	12,126	1,793	13,919	543	25,797
1995	11,970	1,530	13,500	14,361	2,703	17,064	418	30,982
1996	10,791	1,998	12,789	15,715	1,937	17,652	184	30,625
1997	9,709	1,341	11,051	18,462	1,152	19,614	189	30,854
1998	7,281	924	8,205	19,337	1,102	20,438	190	28,833
1999	9,128	790	9,918	16,085	1,231	17,316	151	27,385
2000	10,729	1,015	11,743	10,147	1,491	11,638	176	23,558
2001	13,341	2,904	16,245	9,959	4,645	14,604	149	30,998
2002	14,011	1,446	15,457	8,884	3,382	12,266	294	28,018
2003	14,991	1,318	16,309	11,095	3,220	14,316	309	30,934
2004	13,209	854	14,062	7,978	2,699	10,677		24,739
2005	10,267	892	11,159	8,834	2,546	11,380		22,540
2006	6,706	481	7,187	7,755	1,806	9,561		16,748

Table10. Number of commercial port samples and length measurements of monkfish taken by year, market category, and stock area. Live metric tons are also shown.

	Market	NORTH				SOUTH				TOTAL			
Year	Category	Samples	Lengths	live mt	mt/sample	Samples	Lengths	live mt	mt/sample	Samples	Lengths	mt	mt/sample
1996	tails only	1	109	298	298	1	123	3,308	3,308	2	232	3,606	1,803
	tails large	13	1,383	3,089	238	6	618	3,850	642	19	2,001	6,939	365
	tails small	10	1,438	4,643	464	6	609	5,407	901	16	2,047	10,050	628
	tails peewee	9	1,258	743	83	4	415	152	38	13	1,673	895	69
	unclass round	2	252	745	373	-	-	318	-	-	-	1,063	-
	head on, gutted	3	478	1,272	424	7	1,287	2,681	383	10	1,765	3,953	395
	annual total	38	4,918	10,791	-	24	3,052	15,715	-	62	7,970	26,507	428
1997	tails only	-	-	88	-	-	-	2,149	-	-	-	2,236	-
	tails large	12	1,324	3,739	312	12	1,220	6,388	532	24	2,544	10,127	422
	tails small	12	1,262	4,520	377	14	1,451	6,350	454	26	2,713	10,870	418
	tails peewee	9	863	396	44	3	300	108	36	12	1,163	503	42
	unclass round	10	936	244	24	1	98	551	551	11	1,034	795	72
	head on, gutted	1	53	723	723	4	551	2,918	729	5	604	3,641	728
	annual total	44	4,438	9,709	-	34	3,620	18,462	-	78	8,058	28,172	361
1998	tails only	-	-	54	-	-	-	2,795	-	-	-	2,850	-
	tails large	6	713	3,502	584	5	487	6,481	1,296	11	1,200	9,983	908
	tails small	8	877	2,690	336	4	444	6,108	1,527	12	1,321	8,797	733
	tails peewee	1	136	263	263	-	-	54	-	-	-	317	-
	unclass round	-	-	144	-	-	-	438	-	-	-	582	-
	head on, gutted	-	-	628	-	-	-	3,461	-	-	-	4,089	-
	annual total	15	1,726	7,281	-	9	931	19,337	-	24	2,657	26,618	1,109
1999	tails only	-	-	94	-	-	-	1,690	-	-	-	1,784	-
	tails large	6	634	3,305	551	5	480	4,624	925	11	1,114	7,929	721
	tails small	19	1,997	2,817	148	8	814	4,490	561	27	2,811	7,307	271
	tails peewee	-	-	463	-	-	-	47	-	-	-	509	-
	unclass round	-	-	511	-	-	-	621	-	-	-	1,131	-
	head on, gutted	1	115	1,939	1,939	4	254	4,614	-	5	369	-	-
	annual total	26	2,746	9,128	-	17	1,548	16,085	-	43	4,294	25,213	586
2000	tails only	-	-	58	-	1	102	917	917	-	-	975	-
	tails large	6	567	2,599	433	7	667	2,646	378	13	1,234	5,246	404
	tails small	50	5,175	3,487	70	7	748	2,181	312	57	5,923	5,668	99
	tails peewee	-	-	9	-	-	-	5	-	-	-	14	-
	unclass round	16	1,839	912	57	-	-	179	-	-	-	1,091	-
	head on, gutted	21	2,095	3,663	174	14	1,175	4,219	301	35	3,270	7,882	225
	annual total	93	9,676	10,729	-	29	2,692	10,147	-	122	12,368	20,876	171
2001	tails only	-	-	427	-	-	-	720	-	-	-	1,146	-
	tails large	47	5,070	3,701	79	7	659	2,803	400	54	5,729	6,504	120
	tails small	54	5,684	5,467	101	8	741	1,639	205	62	6,425	7,106	115
	tails peewee	-	-	0	-	-	-	1	-	-	-	1	-
	unclass round	2	178	231	116	1	113	300	300	3	291	531	177
	head on, gutted	34	3,507	3,516	103	37	3,864	4,496	122	71	7,371	8,012	113
	annual total	137	14,439	13,341	-	53	5,377	9,959	-	190	19,816	23,301	123
2002	tails only	1	51	264	264	-	-	554	-	1	51	819	-
	tails large	55	6,081	3,504	64	16	1,121	2,087	130	71	7,202	5,591	79
	tails small	61	7,271	5,900	97	7	580	1,116	159	68	7,851	7,016	103
	tails peewee	-	-	0	-	-	-	1	-	-	-	1	-
	unclass round	1	91	24	24	1	126	551	551	2	217	575	288
	head on, gutted	26	2,588	4,319	166	29	3,055	4,575	158	55	5,643	8,894	162
	annual total	144	16,082	14,011	-	53	4,882	8,884	-	197	20,964	22,896	116
2003	tails only	-	-	314	-	-	-	805	-	-	-	1,119	-
	tails large	54	5,093	5,221	97	10	780	2,623	262	64	5,873	7,844	123
	tails small	63	5,431	6,747	107	7	566	1,345	192	70	5,997	8,092	116
	tails peewee	-	-	0	-	-	-	2	-	-	-	2	-
	unclass round	1	100	14	14	2	162	667	334	3	262	681	227
	head on, gutted	61	3,710	2,695	44	22	1,962	5,653	257	83	5,672	8,348	101
	annual total	179	14,334	14,991	-	41	3,470	11,095	-	220	17,804	26,086	119
2004	tails only	-	0	10	-	4	194	616	154	-	194	626	-
	tails large	51	4,501	6,250	123	10	778	2,227	223	61	5,279	8,477	139
	tails small	54	5,118	5,247	97	8	591	908	114	62	5,709	6,155	99
	tails peewee	-	-	5	-	-	-	0	-	-	-	5	-
	unclass round	-	-	960	-	-	-	1,066	-	-	-	2,026	-
	head on, gutted	15	975	737	49	1	119	3,144	3,144	16	1,094	3,881	243
	dressed	-	-	-		-	-	16	-	-	-	-	-
	annual total	120	10,594	13,209	-	23	1,682	7,978	-	143	12,276	21,186	148
2005	tails only	1	73	8	8	4	178	349	87	5	251	356	71
	tails large	42	4,133	4,975	118	10	888	2,362	236	52	5,021	7,337	141
	tails small	48	4,666	3,491	73	8	832	1,704	213	56	5,498	5,195	93
	tails peewee	-	-	5	-	-	-	7	-	-	-	12	-
	unclass round	-	0	953	-	1	100	1,381	1,381	-	100	2,334	-
	head on, gutted	51	3,244	836	16	23	1,794	2,996	130	74	5,038	3,832	52
	dressed	-	-	0		-	-	35	-	-	-	35	-
	annual total	142	12,116	10,267	-	46	3,792	8,834	-	188	15,908	19,102	102
2006	tails only	-	0	25	-	2	51	138	69	-	51	163	-
	tails large	38	3,655	2,929	77	12	848	2,262	188	50	4,503	5,191	104
	tails small	45	4,583	2,006	45	8	671	1,769	221	53	5,254	3,775	71
	tails peewee	-	-	9	-	-	-	2	-	-	-	11	-
	unclass round	-	-	756	-	-	-	1,273	-	-	-	2,028	-
	head on, gutted	57	3,943	981	17	20	2,143	2,268	113	77	6,086	3,249	42
	dressed	-	-	0	-	-	-	44	-	-	-	44	-
	annual total	140	12,181	6,706	-	42	3,713	7,755	-	182	15,894	14,461	79

Table 11a. Number of observer length frequency samples from trawls.

.

kept lengths							discard lengths						
stock	year	half	trips	hauls	landings	mt landings/# hauls	stock	year	half	trips	hauls	mt discards (SBRM d/k)	mt discards (SBRM d/k)/# hauls
North	1994	1	3	12			North	1994	1	34	48	49	1
North	1994	2	2	18			North	1994	2	6	10	188	19
North	1995	1	15	73	4850.0	66	North	1995	1	49	209	1003	5
North	1995	2	12	47	4269.4	91	North	1995	2	33	123	292	2
North	1996	1	8	19	4328.0	228	North	1996	1	19	47	1264	27
North	1996	2	8	17	4116.5	242	North	1996	2	23	47	135	3
North	1997	1	6	10	4024.9	402	North	1997	1	13	41	551	13
North	1997	2	6	12	3338.2	278	North	1997	2	6	13	179	14
North	1998	1	3	6	3179.7	530	North	1998	1	7	12	512	43
North	1998	2			2241.3		North	1998	2	1	2	98	49
North	1999	1	1	3	4013.0	1,338	North	1999	1	1	1	556	556
North	1999	2	13	28	3023.7	108	North	1999	2	30	61	218	4
North	2000	1	16	54	4060.5	75	North	2000	1	24	62	411	7
North	2000	2	19	56	4173.8	75	North	2000	2	17	41	354	9
North	2001	1	15	43	5195.8	121	North	2001	1	11	36	672	19
North	2001	2	26	73	4794.6	66	North	2001	2	28	45	521	12
North	2002	1	7	28	5992.8	214	North	2002	1	10	26	490	19
North	2002	2	77	275	4846.7	18	North	2002	2	153	384	579	2
North	2003	1	75	333	6952.2	21	North	2003	1	94	325	717	2
North	2003	2	71	306	5075.4	17	North	2003	2	81	338	373	1
North	2004	1	68	227	5755.5	25	North	2004	1	78	257	280	1
North	2004	2	141	506	4162.2	8	North	2004	2	175	642	264	0
North	2005	1	176	746	3761.6	5	North	2005	1	224	1361	197	0
North	2005	2	214	845	3064.7	4	North	2005	2	226	816	240	0
North	2006	1	101	404	2801.9	7	North	2006	1	118	607	157	0
North	2006	2	70	330	2159.3	7	North	2006	2	100	527	126	0
South	1994	1	10	72			South	1994	1	5	10	148	15
South	1994	2	4	6			South	1994	2	5	17	977	57
South	1995	1	24	93	2684.5	29	South	1995	1	21	106	1,394	13
South	1995	2	5	14	3101.0	221	South	1995	2	6	17	115	7
South	1996	1	23	53	3169.0	60	South	1996	1	10	15	190	13
South	1996	2	10	36	3972.4	110	South	1996	2	10	22	32	1
South	1997	1	27	94	3924.0	42	South	1997	1	21	61	173	3
South	1997	2	12	32	4237.0	132	South	1997	2	9	30	81	3
South	1998	1	16	29	3969.5	137	South	1998	1	9	16	138	9
South	1998	2	5	20	3845.0	192	South	1998	2	6	15	17	1
South	1999	1	13	37	4016.3	109	South	1999	1	8	15	26	2
South	1999	2	2	9	2347.9	261	South	1999	2	9	28	745	27
South	2000	1	14	27	2342.6	87	South	2000	1	12	25	168	7
South	2000	2	17	33	1675.1	51	South	2000	2	17	45	242	5
South	2001	1	10	20	1836.7	92	South	2001	1	13	56	317	6
South	2001	2	8	12	1254.3	105	South	2001	2	1	1	103	103
South	2002	1	16	37	1078.5	29	South	2002	1	5	10	145	14
South	2002	2	22	53	505.0	10	South	2002	2	12	36	370	10
South	2003	1	60	193	1019.7	5	South	2003	1	49	155	453	3
South	2003	2	39	143	1014.5	7	South	2003	2	31	68	83	1
South	2004	1	97	303	802.2	3	South	2004	1	79	309	581	2
South	2004	2	130	493	425.6	1	South	2004	2	124	450	383	1
South	2005	1	236	799	534.0	1	South	2005	1	200	825	340	0
South	2005	2	216	964	1163.2	1	South	2005	2	206	653	348	1
South	2006	1	153	573	698.0	1	South	2006	1	133	554	247	0
South	2006	2	93	340	736.9	2	South	2006	2	88	301	41	0

Table 11b. Number of observer length frequency samples from gillnets.

Kept Lengths

stock	year	half	trips	hauls	landings	mt landings/# hauls
North	1994	1	18	18		
North	1994	2	50	65		
North	1995	1	37	49	476.8	10
North	1995	2	156	208	1054.4	5
North	1996	1	47	49	379.0	8
North	1996	2	77	89	1009.7	11
North	1997	1	28	33	297.2	9
North	1997	2	42	53	691.1	13
North	1998	1	38	50	254.7	5
North	1998	2	62	95	630.1	7
North	1999	1	16	23	325.1	14
North	1999	2	62	89	1144.6	13
North	2000	1	37	49	384.8	8
North	2000	2	66	110	1717.3	16
North	2001	1	27	45	863.7	19
North	2001	2	50	76	2095.7	28
North	2002	1	29	50	755.1	15
North	2002	2	60	115	2223.3	19
North	2003	1	51	163	745.5	5
North	2003	2	131	341	1742.1	5
North	2004	1	70	220	893.8	4
North	2004	2	434	1314	1971.9	2
North	2005	1	29	54	641.5	12
North	2005	2	399	1251	1783.2	1
North	2006	1	43	102	353.2	3
North	2006	2	57	152	1129.8	7
South	1994	1	22	34		
South	1994	2	46	163		
South	1995	1	114	316	2669.1	8
South	1995	2	42	110	1125.3	10
South	1996	1	109	263	2766.7	11
South	1996	2	20	41	1444.1	35
South	1997	1	188	391	3704.7	9
South	1997	2	43	108	1498.6	14
South	1998	1	137	276	4127.1	15
South	1998	2	51	73	2071.4	28
South	1999	1	78	126	4399.4	35
South	1999	2	22	44	1787.1	41
South	2000	1	70	94	2809.3	30
South	2000	2	22	42	1196.0	28
South	2001	1	216	253	2230.0	9
South	2001	2	20	38	2888.9	76
South	2002	1	58	88	3573.1	41
South	2002	2	13	15	1837.2	122
South	2003	1	45	112	4492.2	40
South	2003	2	60	192	2769.8	14
South	2004	1	130	335	3538.8	11
South	2004	2	68	195	1066.3	5
South	2005	1	113	253	3217.5	13
South	2005	2	90	253	1314.9	5
South	2006	1	153	216	2829.0	13
South	2006	2	25	36	828.9	23

Discard Lengths

stock	year	half	trips	hauls	mt discards (SBRM d/k)	mt discards (SBRM d/k)/# hauls
North	1994	1	18	18	4	0
North	1994	2	50	65	112	2
North	1995	1	37	49	57	1
North	1995	2	156	208	91	0
North	1996	1	47	49	71	1
North	1996	2	77	89	85	1
North	1997	1	28	33	29	1
North	1997	2	42	53	123	2
North	1998	1	38	50	6	0
North	1998	2	62	95	23	0
North	1999	1	16	23	15	1
North	1999	2	62	89	19	0
North	2000	1	37	49	16	0
North	2000	2	66	110	198	2
North	2001	1	27	45	31	1
North	2001	2	50	76	1,640	22
North	2002	1	29	50	11	0
North	2002	2	60	115	105	1
North	2003	1	51	163	57	0
North	2003	2	131	341	94	0
North	2004	1	70	220	12	0
North	2004	2	434	1314	88	0
North	2005	1	29	54	71	1
North	2005	2	399	1251	124	0
North	2006	1	43	102	14	0
North	2006	2	57	152	60	0
South	1994	1	22	34	17	0
South	1994	2	46	163	22	0
South	1995	1	114	316	32	0
South	1995	2	42	110	12	0
South	1996	1	109	263	58	0
South	1996	2	20	41	15	0
South	1997	1	188	391	157	0
South	1997	2	43	108	14	0
South	1998	1	137	276	136	0
South	1998	2	51	73	48	1
South	1999	1	78	126	180	1
South	1999	2	22	44	41	1
South	2000	1	70	94	174	2
South	2000	2	22	42	40	1
South	2001	1	216	253	34	0
South	2001	2	20	38	47	1
South	2002	1	58	88	48	1
South	2002	2	13	15	124	8
South	2003	1	45	112	121	1
South	2003	2	60	192	209	1
South	2004	1	130	335	683	2
South	2004	2	68	195	296	2
South	2005	1	113	253	1191	5
South	2005	2	90	253	328	1
South	2006	1	153	216	389	2
South	2006	2	25	36	113	3

Table 11c. Number of observer length frequency samples from scallop dredges.

Kept Lengths

stock	year	half	trips	hauls	landings	mt landings/# hauls
North	1994	1	1	3		
North	1994	2	4	34		
North	1995	2	5	20		
North	1996	1	1	1	38.3	38
North	1996	2	3	10	874.7	87
North	1997	1	1	1	233.6	234
North	1997	2	2	8	1084.2	136
North	1998	1	2	3	242.8	81
North	1998	2	3	12	705.7	59
North	1999	1	1	13	221.6	17
North	1999	2	2	8	376.3	47
North	2000	2	1	1	244.9	245
North	2002	2	4	68	127.2	2
North	2003	2	6	50	199.8	4
North	2004	2	4	10	4.7	0
North	2005	2	1	9	22.2	2
North	2006	1	1	2	10.2	5
North	2006	2	13	76	23.0	0
South	1994	1	9	92		
South	1994	2	5	40		
South	1995	1	11	117	1855.0	16
South	1995	2	7	27	2174.7	81
South	1996	1	14	91	1790.3	20
South	1996	2	10	121	2540.1	21
South	1997	1	13	150	2187.1	15
South	1997	2	7	127	2702.7	21
South	1998	1	9	109	2512.8	23
South	1998	2	13	71	2676.9	38
South	1999	1	3	57	1872.0	33
South	1999	2	7	47	1608.7	34
South	2000	1	9	409	1101.3	3
South	2000	2	7	49	873.3	18
South	2001	1	3	18	728.5	40
South	2002	2	8	58	612.2	11
South	2003	1	16	171	1235.2	7
South	2003	2	15	72	962.8	13
South	2004	1	19	248	545.1	2
South	2004	2	30	430	125.6	0
South	2005	1	26	154	221.5	1
South	2005	2	63	151	227.6	2
South	2006	1	6	19	155.5	8
South	2006	2	49	382	180.0	0

Discard Lengths

stock	year	half	trips	hauls	discards (SBRM d/k)	mt discards (SBRM d/k)/# hauls
North	1994	1	1	2	16	8
North	1994	2	4	43	40	1
North	1995	2	2	8	269	34
North	1996	1	1	1	2	2
North	1996	2	3	3	382	127
North	1997	1	1	1	41	41
North	1997	2	1	2	261	130
North	1998	1	1	1	43	43
North	1998	2	3	10	125	12
North	1999	1	1	5	28	6
North	2002	2	4	13	177	14
North	2003	1	1	5	2	0
North	2003	2	4	45	213	5
North	2004	2	10	41	155	4
North	2005	1	2	3	2	1
North	2005	2	6	35	53	2
North	2006	1	1	11	2	0
North	2006	2	28	170	35	0
South	1994	1	9	92	464	5
South	1994	2	7	65	386	6
South	1995	1	11	102	1031	10
South	1995	2	5	41	787	19
South	1996	1	14	93	460	5
South	1996	2	8	92	475	5
South	1997	1	13	134	447	3
South	1997	2	4	101	472	5
South	1998	1	4	29	113	4
South	1998	2	3	12	155	13
South	1999	1	2	49	443	9
South	1999	2	4	10	180	18
South	2000	1	7	333	664	2
South	2000	2	9	89	359	4
South	2001	1	4	32	903	28
South	2002	2	15	136	1470	11
South	2003	1	24	250	1135	5
South	2003	2	32	252	1514	6
South	2004	1	28	386	866	2
South	2004	2	92	1157	262	0
South	2005	1	27	172	369	2
South	2005	2	69	368	295	1
South	2006	1	5	32	174	5
South	2006	2	49	385	559	1

Table 12. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC offshore autumn research vessel bottom trawl surveys in the northern management region (strata 20-30, 34-40); confidence limits for both the raw index and the indices smoothed using an integrated moving average (theta = 0.45); minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed in each year. Data prior to 1971 has been revised following an audit of historical data and the data reflects an increase in precision in the calculations of delta distributions (SAGA version 3.55).

	Biomass				Abundance				Length						Number	Number of	
	Raw Index				Raw Index										of	Nonzero	Number
	Mean	L95%	U95%	3ymean	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1963	3.821	2.339	5.304		0.801	0.512	1.090	4.661	11	14	59	58.3	103	111	86	39	90
1964	1.892	1.030	2.753	2.750	0.392	0.219	0.564	4.813	21	21	58	59.4	92	102	32	23	87
1965	2.537	1.407	3.667	2.604	0.347	0.230	0.463	7.279	28	36	70	71.6	96	110	40	30	88
1966	3.382	2.164	4.600	2.382	0.511	0.343	0.678	6.527	37	48	73	73.1	90	96	55	33	86
1967	1.226	0.404	2.049	2.220	0.189	0.090	0.288	6.504	48	48	69	70.3	91	92	18	14	86
1968	2.050	0.533	3.568	2.344	0.286	0.115	0.457	7.170	11	26	72	71.4	105	106	32	16	86
1969	3.757	1.823	5.690	2.696	0.418	0.278	0.559	8.839	13	41	78	78.8	101	110	39	30	88
1970	2.281	0.982	3.580	2.988	0.395	0.222	0.569	5.849	22	36	67	67.2	90	98	41	21	92
1971	2.928	1.450	4.405	2.210	0.491	0.312	0.671	5.864	15	22	69	67.0	97	101	44	27	94
1972	1.420	0.667	2.174	2.510	0.319	0.195	0.442	4.354	21	21	61	56.9	97	99	29	22	94
1973	3.183	1.773	4.594	2.222	0.514	0.320	0.709	5.992	16	16	58	65.2	109	112	63	29	92
1974	2.063	1.114	3.011	2.324	0.313	0.189	0.436	6.362	13	13	69	64.9	109	111	37	23	97
1975	1.726	1.020	2.432	2.392	0.298	0.178	0.418	5.721	11	11	60	62.9	97	102	40	27	106
1976	3.387	1.555	5.219	3.560	0.423	0.244	0.601	7.620	29	30	71	72.1	106	121	32	24	87
1977	5.568	3.489	7.646	4.688	0.626	0.458	0.794	7.167	21	35	73	71.1	107	119	112	56	126
1978	5.109	3.496	6.722	5.264	0.579	0.429	0.729	6.728	10	24	70	67.6	104	116	146	78	201
1979	5.116	3.566	6.665	4.894	0.474	0.364	0.584	8.887	15	19	77	73.5	103	115	125	78	211
1980	4.458	2.234	6.682	3.859	0.535	0.366	0.703	6.266	6	16	66	63.9	101	111	65	39	97
1981	2.004	0.345	1.529	2.466	0.406	0.068	0.216	4.399	9	13	55	57.5	93	101	46	30	93
1982	0.936	0.380	1.492	1.519	0.142	0.070	0.213	6.606	29	29	71	68.9	97	100	17	14	95
1983	1.617	0.927	2.308	1.855	0.470	0.284	0.656	3.415	13	17	54	53.0	88	96	38	27	82
1984	3.010	1.413	4.607	2.023	0.483	0.353	0.613	5.803	11	26	63	62.7	102	106	36	29	88
1985	1.441	0.419	2.463	2.268	0.369	0.191	0.548	3.965	12	15	55	53.1	101	102	32	23	88
1986	2.354	1.099	3.608	1.556	0.604	0.379	0.829	3.670	19	23	52	53.8	82	100	46	26	90
1987	0.873	0.256	1.491	1.584	0.264	0.116	0.411	3.324	15	15	53	52.2	92	96	22	15	87
1988	1.525	0.484	2.565	1.267	0.313	0.130	0.496	4.859	11	11	53	57.1	92	93	26	17	89
1989	1.403	0.496	2.310	1.329	0.428	0.266	0.590	2.569	9	9	39	40.8	93	96	39	25	87
1990	1.058	0.496	1.620	1.238	0.593	0.383	0.804	1.415	9	10	25	32.3	72	89	55	35	89
1991	1.253	0.599	1.908	1.142	0.576	0.383	0.769	1.715	9	10	31	38.3	83	95	62	33	88
1992	1.116	0.571	1.661	1.167	0.938	0.602	1.274	1.183	9	9	26	33.0	79	86	78	37	86
1993	1.133	0.513	1.754	1.098	0.989	0.691	1.287	0.894	6	9	20	27.1	71	94	103	45	86
1994	1.046	0.446	1.645	1.297	1.351	0.969	1.732	0.668	9	9	19	24.9	55	98	110	51	87
1995	1.711	0.663	2.759	1.282	0.922	0.688	1.155	1.724	10	12	34	39.6	84	91	87	40	93
1996	1.091	0.516	1.665	1.184	0.630	0.407	0.853	1.688	8	11	38	40.3	63	95	51	30	88
1997	0.751	0.400	1.102	0.954	0.498	0.304	0.693	1.335	8	9	35	35.4	70	86	39	27	90
1998	1.020	0.570	1.470	0.889	0.609	0.397	0.820	1.531	10	10	30	35.5	68	77	56	38	104
1999	0.895	0.370	1.420	1.481	1.084	0.737	1.431	0.716	8	8	22	25.7	58	81	111	44	106
2000	2.529	1.322	3.736	1.831	2.398	1.564	3.232	1.032	9	11	25	30.3	70	88	165	43	87
2001	2.071	1.136	3.005	2.307	1.620	1.212	2.027	1.144	8	12	31	34.7	65	93	145	50	90
2002	2.320	1.088	3.553	2.371	1.283	0.922	1.645	1.423	9	9	34	35.1	65	93	114	45	86
2003	2.723	1.054	4.393	1.890	1.067	0.778	1.357	1.695	8	8	40	37.8	73	88	90	39	88
2004	0.626	0.262	0.989	1.657	0.516	0.313	0.720	1.227	8	8	21	29.8	68	89	36	24	85
2005	1.623	0.152	3.094	1.097	0.595	0.359	0.830	1.686	8	8	24	34.3	79	88	46	29	87
2006	1.042	0.527	1.557		0.764	0.519	1.010	1.346	6	7	33	33.2	69	86	56	37	94

Table 13. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC offshore spring research vessel bottom trawl surveys in the northern management region (strata 20-30, 34-40); confidence limits for both the raw index and the indices smoothed using an integrated moving average (theta = 0.45); minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed in each year. Data prior to 1971 has been revised following an audit of historical data and the data reflects an increase in precision in the calculations of delta distributions (SAGA version 3.55).

	Biomass			Abundance											Number	Number of	
	Raw Index			Raw Index				Length							of	Nonzero	Number
	Mean	L95%CI	U95%CI	Mean	L95%CI	U95%CI	Ind wt	Min	5%	50%	Mean	95%	Max		Fish	Tows	of Tows
1968	1.008	0.298	1.718	0.168	0.065	0.272	5.980	50	51	68	70.4	89	90		13	11	86
1969	1.341	0.160	2.523	0.180	0.045	0.315	7.453	33	33	71	71.5	99	100		15	10	87
1970	2.021	0.798	3.245	0.344	0.216	0.472	5.867	30	30	62	65.4	98	99		32	22	90
1971	1.039	0.439	1.639	0.158	0.072	0.245	6.488	45	53	69	72.6	99	100		20	15	96
1972	4.678	3.048	6.307	0.643	0.453	0.832	7.105	13	39	74	72.7	100	105		59	38	96
1973	1.908	0.956	2.860	0.435	0.184	0.686	4.313	17	26	68	65.7	99	106		91	36	87
1974	1.477	0.863	2.090	0.438	0.315	0.561	3.391	20	23	58	58.3	97	111		86	41	83
1975	0.936	0.596	1.277	0.339	0.228	0.450	2.760	16	19	53	54.0	87	109		73	36	87
1976	2.826	1.691	3.962	0.673	0.469	0.877	3.759	14	20	60	61.5	95	106		158	52	99
1977	1.028	0.578	1.478	0.259	0.159	0.360	3.594	10	31	66	63.4	93	106		61	37	107
1978	0.626	0.340	0.913	0.141	0.095	0.186	4.014	15	19	73	65.5	89	92		37	30	113
1979	0.904	0.284	1.523	0.144	0.102	0.185	4.652	12	14	67	62.5	100	118		48	40	139
1980	1.622	0.787	2.458	0.379	0.270	0.488	3.748	17	22	43	53.3	98	107		84	38	85
1981	1.744	0.913	2.576	0.376	0.282	0.470	4.444	11	21	52	57.7	95	120		95	42	87
1982	3.015	1.273	4.758	0.346	0.155	0.536	8.594	25	36	61	68.8	105	108		33	22	92
1983	1.587	0.530	2.643	0.418	0.191	0.645	3.663	12	13	49	49.9	96	112		34	22	90
1984	1.696	0.596	2.796	0.328	0.181	0.475	4.732	17	19	62	60.8	93	100		26	19	86
1985	2.113	1.094	3.133	0.346	0.199	0.492	6.122	13	13	68	66.9	104	108		25	21	81
1986	2.165	0.960	3.370	0.340	0.200	0.481	6.244	11	14	63	65.4	109	121		30	22	90
1987	1.728	0.726	2.730	0.245	0.138	0.352	7.052	16	16	66	64.2	99	100		21	16	83
1988	2.111	0.906	3.315	0.610	0.398	0.822	3.343	10	20	49	49.8	89	110		43	26	90
1989	1.636	0.639	2.634	0.625	0.321	0.929	2.590	10	11	40	43.2	80	94		48	24	85
1990	1.005	0.366	1.643	0.282	0.157	0.407	3.587	15	18	47	49.1	106	107		25	17	90
1991	1.827	0.478	3.175	0.593	0.374	0.811	2.723	12	15	35	42.3	78	100		48	28	86
1992	0.910	-0.188	2.008	0.492	0.159	0.825	1.793	16	17	35	40.6	82	101		36	20	83
1993	1.202	0.736	1.668	0.684	0.475	0.893	1.695	10	11	44	41.0	71	90		59	27	87
1994	0.948	0.400	1.496	0.452	0.275	0.629	2.159	10	13	40	41.0	83	89		45	24	88
1995	1.752	0.806	2.698	0.984	0.662	1.305	1.817	15	16	33	39.9	73	97		83	39	88
1996	1.006	0.449	1.563	0.668	0.344	0.992	1.466	15	17	41	43.0	60	70		49	20	82
1997	0.560	0.174	0.946	0.339	0.158	0.520	1.595	9	9	36	39.4	75	89		34	19	89
1998	0.485	0.225	0.745	0.414	0.288	0.540	1.065	11	11	19	31.3	67	78		46	33	115
1999	1.225	0.646	1.804	0.824	0.547	1.102	1.389	9	14	31	35.5	71	97		62	33	87
2000	1.438	0.846	2.030	1.128	0.843	1.413	1.236	15	17	29	34.5	75	87		99	42	89
2001	1.970	0.690	3.251	1.686	1.221	2.151	1.109	9	11	24	31.4	75	86		151	50	89
2002	1.996	1.337	2.655	1.756	1.334	2.178	1.105	12	15	34	36.6	60	73		155	50	91
2003	2.383	0.817	3.949	0.811	0.479	1.144	2.304	10	13	42	44.2	69	95		79	30	86
2004	2.285	0.911	3.659	0.910	0.577	1.243	2.494	9	11	48	46.7	81	85		69	36	88
2005	2.057	0.505	3.609	0.708	0.487	0.929	2.050	11	13	48	45.1	68	75		52	31	87
2006	0.930	0.184	1.675	0.367	0.161	0.573	2.533	15	13	43	44.8	72	105		33	23	95
2007	1.647	(preliminary)		0.555	(preliminary)												

Table 14. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC shrimp summer surveys in the northern management region (strata 1, 3, 5-8); confidence limits for indices; minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed. (SURVAN version 8.13)

	Biomass			Abundance												
	Raw Index			Raw Index				Length						Number of	Number of Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1991	1.957	1.165	2.749	2.903	2.268	3.538	0.654	11	15	24	27.5	59	96	125	39	43
1992	2.915	1.399	4.431	2.907	2.27	3.544	0.928	11	13	28	31.5	56	78	135	40	45
1993	3.342	1.388	5.297	3.757	2.699	4.814	0.829	7	9	23	27.6	59	102	170	42	46
1994	1.644	0.837	2.452	3.475	2.430	4.520	0.484	5	10	19	24.1	48	95	166	37	43
1995	1.637	0.729	2.544	2.087	1.216	2.958	0.747	11	19	26	31.2	67	76	83	24	35
1996	3.431	1.331	5.530	2.967	2.105	3.830	1.123	13	14	34	34.4	63	90	107	30	32
1997	2.081	1.040	3.122	1.583	1.073	2.093	1.321	11	16	32	37.7	62	73	72	31	40
1998	2.301	0.714	3.888	2.118	1.500	2.735	1.070	12	16	23	31.3	61	77	84	31	35
1999	6.347	4.766	7.928	7.016	5.305	8.727	0.927	8	9	28	30.9	65	82	301	39	42
2000	4.121	2.090	6.152	5.756	4.101	7.412	0.671	11	15	28	30.2	51	82	215	30	35
2001	8.553	4.443	12.662	11.124	8.463	13.786	0.668	11	13	26	29.5	51	85	442	36	36
2002	12.857	9.180	16.535	11.789	9.379	14.198	1.067	11	17	32	35.3	59	94	493	38	38
2003	8.243	4.470	12.015	5.855	4.174	7.535	1.268	3	13	38	37.4	63	87	236	36	37
2004	4.604	3.464	5.744	3.388	2.662	4.113	1.315	11	11	34	35.7	66	75	142	33	35
2005	7.599	5.133	10.064	5.254	4.185	6.323	1.382	9	14	34	37.4	66	89	271	44	46
2006	7.360	3.812	10.908	4.344	3.089	5.598	1.519	7	11	30	37.2	70	89	143	29	29

Table 15. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC offshore autumn research vessel bottom trawl surveys in the southern management region (strata 1-19, 61-76); confidence limits for both the raw index and the indices smoothed using an integrated moving average (theta = 0.45); minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed in each year. Data prior to 1971 has been revised following an audit of historical data and the data reflects an increase in precision in the calculations of delta distributions (SAGA version 3.55).

	Biomass				Abundance				Length						Number	Number of	
	Raw Index				Raw Index										of	Nonzero	Number
	Mean	L95%	U95%	3-y Mean	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1963	3.642	1.818	5.466		1.197	0.737	1.656	2.969	7	17	53	50.4	91	97	102	36	73
1964	6.139	2.667	9.612		1.637	0.907	2.366	3.482	14	21	53	52.0	86	101	132	34	83
1965	5.093	2.907	7.279	4.958	1.148	0.778	1.519	4.247	10	15	59	56.3	91	104	83	39	85
1966	7.060	5.062	9.057	6.097	1.926	1.364	2.488	3.607	7	7	51	49.6	87	98	101	56	87
1967	1.151	0.623	1.679	4.434	0.519	0.324	0.715	2.195	14	19	31	40.6	83	100	98	42	163
1968	0.904	0.461	1.346	3.038	0.399	0.206	0.591	2.211	12	17	45	46.3	75	86	77	39	164
1969	1.360	0.506	2.214	1.138	0.537	0.308	0.766	2.466	10	14	41	45.4	88	96	101	43	163
1970	1.340	0.643	2.037	1.201	0.350	0.235	0.466	3.632	4	13	55	53.3	84	104	58	35	161
1971	0.711	0.282	1.139	1.137	0.282	0.150	0.414	2.788	5	8	39	42.3	95	98	55	28	168
1972	5.045	3.374	6.716	2.365	4.113	1.281	6.944	1.298	12	16	23	31.8	74	99	604	85	161
1973	2.030	1.036	3.025	2.595	1.176	0.857	1.495	1.568	13	14	32	37.7	77	93	280	70	154
1974	0.710	0.322	1.098	2.595	0.218	0.116	0.320	3.277	14	16	54	52.9	81	101	56	26	153
1975	2.050	1.333	2.767	1.597	0.653	0.434	0.871	2.653	8	17	45	46.3	87	105	127	51	158
1976	1.093	0.547	1.639	1.284	0.314	0.189	0.438	3.166	11	11	51	50.7	77	95	60	34	165
1977	1.883	1.203	2.563	1.675	0.372	0.265	0.479	4.170	5	16	55	53.1	95	106	94	50	172
1978	1.395	0.883	1.906	1.457	0.259	0.178	0.340	4.469	13	17	61	56.5	87	101	68	39	219
1979	2.275	1.278	3.272	1.851	0.694	0.483	0.905	2.307	7	16	34	40.5	84	109	182	70	205
1980	1.883	1.181	2.585	1.851	0.726	0.427	1.024	2.211	3	16	34	41.6	85	104	113	42	159
1981	2.864	0.889	4.840	2.341	0.965	0.579	1.351	1.961	6	17	38	40.7	71	99	176	59	146
1982	0.657	0.361	0.953	1.801	0.610	0.373	0.847	1.060	13	15	26	32.5	66	73	98	42	143
1983	2.156	0.700	3.611	1.892	0.776	0.470	1.082	2.304	7	16	45	44.4	72	100	109	49	146
1984	0.750	0.158	1.343	1.188	0.311	0.114	0.508	2.445	5	13	47	45.7	68	93	42	25	146
1985	1.327	0.761	1.893	1.411	0.524	0.356	0.692	2.055	17	17	40	42.0	72	96	100	46	145
1986	0.561	0.245	0.877	0.879	0.325	0.169	0.481	1.523	7	14	34	37.6	68	78	60	33	146
1987	0.276	0.118	0.433	0.721	0.482	0.308	0.657	0.575	12	13	20	25.0	56	61	67	27	132
1988	0.554	0.210	0.898	0.464	0.230	0.097	0.364	2.376	19	27	36	45.1	87	91	27	19	129
1989	0.642	0.300	0.985	0.491	0.382	0.182	0.582	1.366	7	7	42	38.0	57	77	57	23	129
1990	0.445	0.047	0.844	0.547	0.294	0.115	0.472	1.050	9	13	24	33.1	61	81	47	22	136
1991	0.797	0.244	1.349	0.628	0.690	0.248	1.133	0.901	14	15	23	30.8	57	81	106	27	131
1992	0.318	0.193	0.444	0.520	0.342	0.223	0.461	0.919	8	11	30	32.2	54	74	46	21	129
1993	0.295	0.058	0.532	0.470	0.290	0.136	0.444	0.784	10	13	32	30.4	52	68	46	24	130
1994	0.620	0.190	1.050	0.411	0.598	0.353	0.843	0.906	8	12	25	29.2	59	83	85	31	135
1995	0.413	0.186	0.640	0.443	0.493	0.259	0.727	0.777	11	13	25	29.4	54	66	72	29	129
1996	0.387	0.217	0.557	0.473	0.235	0.132	0.338	1.638	18	19	42	42.3	62	68	31	21	131
1997	0.592	0.354	0.829	0.464	0.308	0.198	0.418	1.914	9	9	49	44.6	70	71	43	24	131
1998	0.500	0.244	0.756	0.493	0.332	0.150	0.514	1.525	11	11	36	37.0	68	87	45	20	131
1999	0.304	0.196	0.412	0.465	0.450	0.319	0.582	0.672	12	14	27	29.2	52	55	109	44	106
2000	0.485	0.269	0.700	0.430	0.422	0.270	0.575	1.102	5	15	33	34.3	63	70	64	30	132
2001	0.712	0.373	1.050	0.500	0.378	0.239	0.518	1.724	4	11	39	41.69	70	80	51	30	130
2002	1.315	0.785	1.846	0.837	0.829	0.565	1.092	1.514	6	14	41	39.12	61	81	110	47	130
2003	0.827	0.542	1.112	0.951	0.951	0.627	1.276	0.858	6	7	18	28.25	59	70	128	41	130
2004	0.969	0.332	1.606	1.037	0.474	0.247	0.702	1.598	7	15	45	40.36	64	78	67	32	133
2005	0.804	0.409	1.198	0.867	0.575	0.339	0.811	1.309	7	13	42	38.47	57	67	76	34	123
2006	0.834	0.379	1.288	0.869	0.452	0.280	0.624	1.660	6	12	44	40.6	65	77	83	36	151

Table 16. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC offshore spring research vessel bottom trawl surveys in the southern management region (strata 1-19, 61-76); confidence limits for both the raw index and the indices smoothed using an integrated moving average (theta = 0.45); minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed in each year. Data prior to 1971 has been revised following an audit of historical data and the data reflects an increase in precision in the calculations of delta distributions (SAGA version 3.55).

	Biomass			Abundance											Number	Number of	
	Raw Index			Raw Index				Length							of	Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max		Fish	Tows	of Tows
1968	1.159	0.568	1.750	0.212	0.126	0.297	5.414	21	23	63	62.5	94	95		65	31	150
1969	0.955	0.444	1.466	0.221	0.138	0.305	4.097	7	25	47	54.3	91	111		41	31	155
1970	1.009	0.465	1.553	0.176	0.104	0.248	5.648	22	22	65	63.9	102	108		40	31	166
1971	0.769	0.322	1.216	0.204	0.105	0.304	3.675	13	16	50	53.3	101	115		42	24	160
1972	1.892	1.172	2.612	0.364	0.266	0.461	5.169	14	22	59	59.1	103	123		79	48	165
1973	1.897	1.539	2.255	1.051	0.854	1.249	2.172	11	19	32	41.1	80	110		589	128	187
1974	1.164	0.769	1.560	0.486	0.369	0.604	3.236	14	21	44	49.1	93	117		201	70	132
1975	0.947	0.574	1.320	0.447	0.326	0.568	2.795	10	22	44	47.6	87	107		169	61	134
1976	1.209	0.833	1.585	0.404	0.307	0.500	3.340	13	22	48	51.5	91	110		259	78	162
1977	1.205	0.771	1.640	0.299	0.231	0.367	4.607	16	21	51	56.8	95	116		173	75	160
1978	0.745	0.522	0.968	0.335	0.265	0.405	2.986	11	17	39	45.9	90	104		196	66	161
1979	0.757	0.464	1.051	0.281	0.164	0.397	2.944	10	14	37	44.4	98	124		125	50	194
1980	0.799	0.494	1.104	0.451	0.355	0.548	1.926	18	21	34	40.8	83	106		346	99	204
1981	1.816	1.157	2.475	0.784	0.542	1.027	2.563	12	22	40	44.6	89	113		345	74	141
1982	2.810	1.591	4.028	0.942	0.657	1.226	2.324	11	14	38	42.4	89	104		251	68	150
1983	0.955	0.421	1.489	0.270	0.176	0.365	3.514	24	24	47	51.8	97	112		55	36	147
1984	0.748	0.223	1.272	0.182	0.090	0.275	4.067	21	21	47	50.9	96	97		35	22	149
1985	0.327	0.089	0.565	0.159	0.072	0.247	2.052	22	22	39	42.3	85	90		31	21	147
1986	0.832	0.352	1.312	0.283	0.125	0.442	2.917	15	24	43	48.7	90	102		65	36	149
1987	0.496	-0.014	1.007	0.108	0.054	0.162	4.612	15	15	59	52.7	102	103		30	21	150
1988	0.427	0.302	0.552	0.440	0.286	0.595	0.971	17	18	30	34.0	61	82		67	33	132
1989	0.365	0.237	0.493	0.202	0.102	0.302	1.500	15	24	41	41.4	69	79		36	18	129
1990	1.005	0.565	1.445	0.205	0.152	0.258	4.034	16	21	53	56.5	86	93		39	23	128
1991	0.590	0.316	0.865	0.319	0.144	0.494	1.509	15	23	33	37.6	69	101		61	31	132
1992	0.210	0.070	0.350	0.177	0.089	0.266	1.235	14	19	28	35.0	69	85		28	17	128
1993	0.264	0.098	0.430	0.195	0.099	0.292	1.319	17	19	38	38.6	56	72		29	18	128
1994	0.321	0.138	0.504	0.114	0.058	0.170	2.379	13	13	41	43.8	91	93		24	18	131
1995	0.526	0.032	1.020	0.196	0.109	0.283	2.637	18	19	38	45.7	80	81		32	20	129
1996	0.286	0.146	0.426	0.135	0.075	0.196	2.083	9	9	44	43.7	80	81		27	20	143
1997	0.132	0.071	0.193	0.124	0.070	0.177	1.064	18	18	37	35.9	58	75		38	14	130
1998	0.282	0.190	0.374	0.254	0.175	0.333	1.110	12	16	35	35.9	64	77		40	30	131
1999	0.629	0.375	0.883	0.335	0.229	0.441	1.899	16	19	41	42.8	74	94		63	32	131
2000	0.294	0.179	0.408	0.242	0.155	0.329	1.222	14	14	38	37.9	61	78		32	25	131
2001	0.243	0.094	0.393	0.234	0.136	0.332	1.092	11	15	34	35.8	57	68		44	50	89
2002	0.375	0.134	0.616	0.318	0.096	0.540	1.181	22	23	37	39.3	53	62		50	50	91
2003	1.423	0.894	1.953	0.308	0.200	0.415	3.721	15	29	57	56.7	80	87		65	30	86
2004	0.193	0.061	0.324	0.116	0.055	0.178	1.565	22	21	37	39.7	61	62		24	36	88
2005	0.369	0.234	0.504	0.259	0.111	0.407	1.424	20	20	36	39.2	61	68		41	26	131
2006	0.540	0.216	0.863	0.172	0.097	0.247	3.136	24	15	37	53.5	80	80		28	20	132
2007	0.192	preliminary)		0.109	(preliminary)												

Table 17. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for monkfish from NEFSC winter flatfish surveys in the southern management region (strata 1-3, 5-7, 9-11, 13-14, 61-63, 65-67, 69-71, 73-75); confidence limits for indices; minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed. The data reflects changes due to the audit of historical data (prior to 1971) and an increase in precision in the calculations of delta distribution (SAGA version 3.55).

	Biomass			Abundance										Number	Number of	
	Raw Index			Raw Index				Length						of	Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1992	6.314	4.160	8.468	5.234	3.854	6.614	1.139	11	22	33	36.0	51	95	582	66	100
1993	6.357	4.563	8.150	4.952	3.898	6.005	1.193	9	21	36	37.7	53	98	555	77	108
1994	3.321	2.372	4.270	2.484	1.870	3.097	1.298	8	16	31	35.1	61	78	278	56	77
1995	3.774	2.472	5.076	3.137	2.104	4.170	1.209	19	21	35	37.4	57	101	365	76	106
1996	4.496	3.435	5.557	3.438	2.662	4.213	1.294	10	22	37	39.1	57	100	456	87	119
1997	4.460	3.190	5.731	2.976	2.323	3.629	1.456	10	18	39	39.8	59	82	359	89	107
1998	2.849	1.997	3.701	1.494	1.150	1.838	1.876	10	20	41	44.1	69	103	203	77	114
1999	4.090	3.066	5.114	3.068	2.370	3.767	1.319	10	17	34	37.8	61	87	362	83	115
2000	5.690	4.023	7.356	4.428	3.166	5.689	1.265	11	24	103	39.2	103	96	616	93	118
2001	7.182	4.501	9.863	4.380	2.997	5.762	1.383	8	24	103	39.3	103	84	729	115	142
2002	6.235	4.794	7.675	3.474	2.737	4.212	1.744	15	30	103	44.5	103	86	550	113	143
2003	5.482	3.491	7.473	2.258	1.580	2.937	2.418	12	25	103	45.5	103	85	316	72	86
2004	7.171	4.308	10.034	4.397	2.836	5.957	1.568	13	23	103	41.2	103	88	682	103	123
2005	4.531	2.657	6.405	2.972	2.043	3.902	1.497	13	23	103	40.0	103	90	313	59	91
2006	5.481	4.022	6.939	3.082	2.327	3.837	1.743	22	31	103	44.7	103	92	430	78	114
2007	3.395	2.586	4.205	1.472	1.212	1.732	2.251	14	23	42	48.3	103	91	217	83	118

Table 18. Stratified mean number and length (cm) per tow for monkfish from NEFSC summer scallop surveys in the southern management region (shellfish strata 6, 7, 10, 11, 14, 15, 18, 19, 22-31, 33-35, 46, 47, 55, 58-61, 621, 631); confidence limits for both the raw index and the indices smoothed using an integrated moving average (theta = 0.45); minimum and maximum lengths; number of fish caught, number of positive tows, and the total number of tows completed in each year (SURVAN version 8.13).

	Abundance												
	Raw Index			Length						Number of	Number of Nonzero	Number
	Mean	L95%	U95%	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1984	1.285	1.109	1.461	6	11	28	29.5	54	82	410	165	254
1985	1.521	1.256	1.786	7	9	25	28.7	53	84	493	183	282
1986	1.246	1.045	1.446	8	10	15	22.9	54	95	431	183	296
1987	3.152	2.767	3.537	8	9	13	18.6	51	90	1253	255	315
1988	1.666	1.385	1.947	7	12	28	29.8	49	97	572	187	316
1989	0.995	0.833	1.156	6	10	31	31.9	53	101	303	147	304
1990	1.534	1.339	1.729	6	10	18	24.4	54	94	563	205	303
1991	2.284	1.994	2.574	7	9	14	21.0	45	94	808	241	315
1992	1.939	1.661	2.217	5	9	25	27.3	52	97	644	235	316
1993	2.845	2.568	3.123	8	10	15	21.8	48	73	995	258	301
1994	3.401	3.006	3.796	8	10	15	22.2	51	87	1145	265	314
1995	2.263	1.968	2.558	7	9	27	29.6	57	92	764	243	314
1996	2.005	1.746	2.265	7	9	23	29.9	59	81	638	226	298
1997	1.110	0.954	1.265	7	13	33	36.7	65	76	388	196	313
1998	1.014	0.876	1.152	6	11	20	30.2	61	79	371	183	319
1999	2.592	2.161	3.022	6	10	16	23.5	55	84	856	248	306
2000	2.242	1.973	2.510	8	9	18	27.3	54	87	832	240	315
2001	1.710	1.484	1.936	7	8	35	36.0	64	77	549	233	334
2002	1.711	1.488	1.933	7	11	35	34.2	60	86	598	203	310
2003	2.784	2.394	3.174	6	9	15	24.4	58	87	819	211	294
2004	2.875	2.506	3.244	9	11	26	29.8	61	83	860	290	348
2005	2.013	1.753	2.274	8	11	28	31.3	56	83	859	265	344
2006	1.445	1.272	1.618	7	8	30	31.1	61	83	571	230	327

Table 19a. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the fall survey in the northern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1963	0.786	0.1478	0.188	5.79575	5.9542	11.74995	0.883	2109.3	0.497	0.780	1.080
1964	0.397	0.0890	0.224	-29.8882	-0.7793	-30.6675	1.307	1064.2	0.239	0.397	0.577
1965	0.355	0.0605	0.170	0.88684	22.9872	23.87404	0.761	953.4	0.240	0.352	0.479
1966	0.510	0.0820	0.161	5.64731	20.331	25.97831	0.740	1369.2	0.349	0.509	0.669
1967	0.200	0.0567	0.284	3.5537	3.866	7.4197	0.926	536.8	0.097	0.197	0.320
1968	0.295	0.0878	0.298	19.8695	0.3724	20.2419	0.798	790.9	0.130	0.290	0.467
1969	0.422	0.0730	0.173	-11.0082	6.457	-4.55118	1.046	1132.9	0.287	0.421	0.572
1970	0.415	0.0963	0.232	4.27999	7.9003	12.18029	0.878	1112.6	0.245	0.411	0.607
1971	0.481	0.0849	0.176	-10.156	27.4788	17.32277	0.827	1291.0	0.331	0.477	0.654
1972	0.312	0.0624	0.200	-13.8617	8.2478	-5.61385	1.056	837.4	0.189	0.310	0.436
1973	0.530	0.1177	0.222	42.12319	9.8196	51.94279	0.481	1421.0	0.324	0.520	0.771
1974	0.320	0.0681	0.213	8.92518	16.6218	25.54698	0.745	859.3	0.188	0.318	0.450
1975	0.294	0.0605	0.206	-0.21364	5.0465	4.83286	0.952	789.2	0.178	0.292	0.420
1976	0.420	0.0920	0.219	-37.7677	-8.5426	-46.3103	1.463	1127.6	0.257	0.419	0.620
1977	0.748	0.1027	0.137	-12.2217	12.4414	0.21972	0.998	2007.8	0.551	0.749	0.953
1978	0.705	0.0953	0.135	-28.4868	6.4129	-22.0739	1.221	1891.3	0.522	0.705	0.898
1979	0.524	0.0655	0.125	-22.8122	6.3428	-16.4694	1.165	1404.4	0.397	0.521	0.658
1980	0.656	0.1045	0.159	-16.818	20.5801	3.76214	0.962	1760.9	0.453	0.650	0.859
1981	0.457	0.0726	0.159	-13.5974	33.5654	19.968	0.800	1226.8	0.316	0.455	0.603
1982	0.144	0.0366	0.254	19.32959	2.9281	22.25769	0.778	386.6	0.077	0.143	0.219
1983	0.446	0.0884	0.198	-17.2795	10.9862	-6.29333	1.063	1197.4	0.289	0.443	0.626
1984	0.488	0.0708	0.145	-11.3163	18.9248	7.60852	0.924	1309.3	0.355	0.485	0.641
1985	0.373	0.0925	0.248	-21.5318	0.445	-21.0868	1.211	1000.2	0.209	0.369	0.565
1986	0.604	0.1104	0.183	-23.8124	10.6366	-13.1758	1.132	1619.8	0.396	0.598	0.822
1987	0.255	0.0722	0.283	-21.7459	11.27	-10.4759	1.105	698.3	0.128	0.252	0.405
1988	0.295	0.0883	0.300	-21.3508	0.9934	-20.3574	1.203	806.8	0.136	0.289	0.482
1989	0.501	0.0945	0.189	-21.0545	7.3854	-13.6691	1.137	1371.8	0.327	0.499	0.687
1990	0.675	0.1162	0.172	-25.7532	10.8797	-14.8735	1.149	1845.8	0.444	0.673	0.910
1991	0.685	0.1236	0.180	-15.5031	15.1226	-0.38046	1.004	1874.5	0.462	0.684	0.922
1992	0.895	0.1645	0.184	-18.727	0.9473	-17.7797	1.178	2447.9	0.595	0.886	1.214
1993	1.206	0.1964	0.163	-1.48622	12.3869	10.90068	0.891	3299.2	0.857	1.198	1.615
1994	1.327	0.1843	0.139	-12.0906	13.8745	1.78392	0.982	3630.0	0.985	1.331	1.707
1995	0.890	0.1195	0.134	0.42157	31.2162	31.63777	0.684	2434.2	0.669	0.893	1.128
1996	0.643	0.1252	0.195	-23.259	7.0327	-16.2263	1.162	1758.7	0.414	0.633	0.895
1997	0.487	0.0944	0.194	-22.6473	10.673	-11.9743	1.120	1332.1	0.308	0.481	0.670
1998	0.609	0.1191	0.196	-23.0085	6.3011	-16.7074	1.167	1666.5	0.406	0.606	0.866
1999	1.096	0.2022	0.185	-45.9519	7.9325	-38.0194	1.380	2997.4	0.733	1.089	1.528
2000	2.260	0.3346	0.148	-18.7435	31.3688	12.6253	0.874	6182.5	1.669	2.246	2.995
2001	1.568	0.1867	0.119	-16.7068	35.9159	19.20907	0.808	4290.0	1.224	1.569	1.965
2002	1.299	0.1977	0.152	-2.14465	14.8962	12.75155	0.873	3553.5	0.925	1.295	1.701
2003	1.034	0.1502	0.145	-5.09959	5.3913	0.29171	0.997	2829.0	0.763	1.024	1.346
2004	0.497	0.1031	0.208	-27.425	9.5638	-17.8612	1.179	1359.3	0.301	0.494	0.715
2005	0.581	0.1185	0.204	-13.4525	2.224	-11.2285	1.112	1590.1	0.369	0.581	0.833
2006	0.730	0.1210	0.166	-31.3933	13.8929	-17.5004	1.175	1998.0	0.518	0.724	0.985

Table 19b. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the fall survey in the northern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1963	3.589	0.7613	0.212	15.4234	-3.2622	12.1612	0.878	9629.5	2.065	3.618	5.106
1964	1.907	0.4314	0.226	-6.644	2.4257	-4.2183	1.042	5115.4	1.102	1.888	2.796
1965	2.608	0.5732	0.220	-2.789	21.1283	18.3393	0.817	6997.9	1.598	2.581	3.817
1966	3.295	0.5485	0.166	6.6964	14.7895	21.4859	0.785	8839.6	2.244	3.264	4.327
1967	1.283	0.4395	0.343	-33.2732	0.8497	-32.4235	1.324	3442.0	0.500	1.252	2.216
1968	2.081	0.7738	0.372	-4.1783	-2.793	-6.9713	1.070	5582.4	0.839	2.011	3.685
1969	3.722	0.9241	0.248	-43.0158	5.6375	-37.3783	1.374	9985.8	2.130	3.688	5.645
1970	2.507	0.7868	0.314	4.8614	1.1623	6.0237	0.940	6725.9	1.098	2.467	4.184
1971	2.806	0.6675	0.238	-24.9613	17.451	-7.5103	1.075	7527.7	1.635	2.760	4.137
1972	1.346	0.3713	0.276	3.0997	7.0393	10.139	0.899	3611.6	0.674	1.325	2.090
1973	3.182	0.7348	0.231	15.7981	7.0066	22.8047	0.772	8537.8	1.851	3.156	4.648
1974	2.049	0.4593	0.224	-5.4745	10.3506	4.8761	0.951	5496.7	1.222	2.024	2.995
1975	1.684	0.3516	0.209	21.3432	9.2985	30.6417	0.694	4518.0	1.002	1.671	2.371
1976	3.194	0.7642	0.239	-21.1812	-9.6532	-30.8344	1.308	8569.0	1.747	3.132	4.801
1977	5.359	1.0239	0.191	-38.4971	7.5002	-30.9969	1.310	14378.3	3.548	5.248	7.517
1978	4.753	0.6939	0.146	-36.2117	2.6698	-33.5419	1.335	12751.7	3.478	4.722	6.188
1979	4.689	0.7053	0.150	-45.3201	4.4605	-40.8596	1.409	12580.8	3.338	4.627	6.122
1980	4.105	0.8785	0.214	-39.8861	-4.2465	-44.1326	1.441	11012.4	2.507	4.108	5.966
1981	1.982	0.4047	0.204	10.2978	14.3138	24.6116	0.754	5316.8	1.222	1.948	2.779
1982	0.936	0.2758	0.295	30.9893	0.4348	31.4241	0.686	2511.6	0.417	0.923	1.507
1983	1.545	0.3353	0.217	0.9481	22.4625	23.4106	0.766	4144.6	0.921	1.544	2.210
1984	2.853	0.6347	0.222	-24.2259	7.8242	-16.4017	1.164	7653.3	1.671	2.854	4.132
1985	1.484	0.5595	0.377	-39.5291	-5.1408	-44.6699	1.447	3981.9	0.512	1.434	2.722
1986	2.204	0.5036	0.228	-20.5934	5.0694	-15.524	1.155	5913.2	1.248	2.151	3.215
1987	0.860	0.3105	0.361	0.3066	12.0285	12.3351	0.877	2352.9	0.296	0.830	1.502
1988	1.410	0.4925	0.349	-18.2166	-4.3564	-22.573	1.226	3858.6	0.518	1.358	2.422
1989	1.343	0.4142	0.308	-30.9002	1.7361	-29.1641	1.292	3674.5	0.590	1.307	2.194
1990	0.982	0.2843	0.290	-25.2858	-2.1546	-27.4404	1.274	2685.9	0.509	0.972	1.554
1991	1.191	0.3105	0.261	-10.6099	2.4857	-8.1242	1.081	3259.9	0.629	1.177	1.860
1992	1.081	0.2611	0.242	10.8021	-0.9864	9.8157	0.902	2957.0	0.616	1.064	1.621
1993	1.100	0.3492	0.317	-8.516	22.2034	13.6874	0.863	3009.6	0.535	1.073	1.904
1994	0.994	0.3173	0.319	-43.9335	-1.8774	-45.8109	1.458	2720.7	0.505	0.970	1.703
1995	1.536	0.3895	0.254	-26.8466	11.7523	-15.0943	1.151	4202.2	0.858	1.518	2.420
1996	1.150	0.3621	0.315	-37.1867	0.1982	-36.9885	1.370	3145.5	0.575	1.132	1.966
1997	0.641	0.1615	0.252	-12.7581	16.3467	3.5886	0.964	1753.4	0.337	0.634	0.970
1998	0.913	0.1949	0.213	-14.175	10.2509	-3.9241	1.039	2498.1	0.562	0.899	1.292
1999	0.746	0.1831	0.245	-15.4645	22.9383	7.4738	0.925	2042.0	0.391	0.745	1.137
2000	2.323	0.5132	0.221	-27.6064	11.919	-15.6874	1.157	6356.8	1.429	2.280	3.405
2001	1.785	0.3050	0.171	-10.3076	13.8314	3.5238	0.965	4885.0	1.224	1.770	2.410
2002	1.865	0.3797	0.204	-13.3723	2.6518	-10.7205	1.107	5102.8	1.143	1.850	2.651
2003	1.748	0.3411	0.195	-23.2627	-4.8835	-28.1462	1.281	4783.6	1.106	1.743	2.421
2004	0.603	0.1815	0.301	-5.2098	-8.8385	-14.0483	1.141	1649.8	0.277	0.589	0.994
2005	1.034	0.2586	0.250	-13.2643	0.4825	-12.7818	1.128	2828.4	0.551	1.023	1.563
2006	0.981	0.2490	0.254	-37.0595	10.5154	-26.5441	1.265	2684.4	0.526	0.986	1.518

Table 19c. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the fall survey in the southern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1963	1.236	0.2490	0.201	-12.5334	4.1139	-8.41945	1.084	3014.8	0.768	1.204	1.772
1964	1.580	0.2786	0.176	-6.12252	38.9102	32.78768	0.672	3853.4	1.026	1.576	2.130
1965	1.153	0.1891	0.164	-39.1282	7.7878	-31.3404	1.313	2811.0	0.803	1.145	1.547
1966	1.948	0.3061	0.157	-43.7017	24.4368	-19.2649	1.193	4752.0	1.398	1.921	2.590
1967	0.538	0.1010	0.188	-10.7919	11.2535	0.46158	0.995	1994.5	0.362	0.536	0.745
1968	0.401	0.0978	0.244	-17.5586	-3.5238	-21.0824	1.211	1488.2	0.231	0.393	0.609
1969	0.541	0.1178	0.218	-17.7595	9.5766	-8.18285	1.082	2006.5	0.340	0.536	0.797
1970	0.346	0.0613	0.177	-9.39103	17.8664	8.47537	0.915	1282.1	0.235	0.343	0.469
1971	0.279	0.0636	0.228	9.24657	15.3167	24.56327	0.754	1034.3	0.162	0.274	0.407
1972	3.748	0.9764	0.261	-6.63343	22.9249	16.29147	0.837	13898.0	2.173	3.709	5.721
1973	1.151	0.1485	0.129	18.58877	31.1858	49.77457	0.502	4268.4	0.870	1.143	1.464
1974	0.214	0.0505	0.236	22.89899	13.4918	36.39079	0.636	793.4	0.129	0.213	0.321
1975	0.748	0.1351	0.181	-4.34743	14.7041	10.35667	0.896	2771.6	0.506	0.744	1.014
1976	0.315	0.0663	0.211	-15.166	10.1234	-5.04258	1.050	1167.2	0.199	0.314	0.454
1977	0.452	0.0676	0.150	5.82878	16.9281	22.75688	0.772	1676.1	0.321	0.455	0.594
1978	0.314	0.0515	0.164	-4.44575	15.5131	11.06735	0.889	1165.4	0.218	0.311	0.419
1979	0.836	0.1227	0.147	-5.34512	20.6776	15.33248	0.847	3100.6	0.612	0.833	1.080
1980	0.839	0.1397	0.167	-18.1613	38.3817	20.22037	0.798	3109.3	0.551	0.834	1.113
1981	1.150	0.1992	0.173	-9.29499	33.5944	24.29941	0.757	4266.0	0.761	1.137	1.557
1982	0.615	0.1210	0.197	-13.5069	9.2824	-4.22454	1.042	2281.6	0.406	0.612	0.866
1983	0.758	0.1334	0.176	-15.6946	29.3186	13.62398	0.864	2809.5	0.512	0.751	1.033
1984	0.316	0.1095	0.346	-52.8026	6.9553	-45.8473	1.458	1170.4	0.144	0.302	0.535
1985	0.617	0.1072	0.174	0.07046	14.3039	14.37436	0.856	2289.4	0.429	0.608	0.843
1986	0.355	0.0830	0.234	-3.52055	8.026	4.50545	0.955	1317.8	0.216	0.350	0.527
1987	0.487	0.0971	0.200	-3.33573	44.0362	40.70047	0.593	1804.3	0.308	0.478	0.693
1988	0.232	0.0684	0.294	-22.5693	10.4172	-12.1521	1.121	860.5	0.115	0.226	0.386
1989	0.456	0.1129	0.248	-9.03837	13.6761	4.63773	0.954	1691.4	0.250	0.450	0.697
1990	0.350	0.1053	0.301	-10.1463	14.8783	4.73197	0.953	1298.5	0.160	0.345	0.566
1991	0.843	0.2679	0.318	-13.1374	14.2312	1.09376	0.989	3124.1	0.353	0.830	1.383
1992	0.348	0.0640	0.184	4.13317	37.75	41.88317	0.581	1291.6	0.230	0.346	0.472
1993	0.347	0.0938	0.271	-9.74639	1.9348	-7.81159	1.078	1285.2	0.174	0.347	0.548
1994	0.604	0.1361	0.225	-3.1647	3.7175	0.5528	0.995	2238.3	0.361	0.601	0.899
1995	0.506	0.1290	0.255	7.45053	8.8285	16.27903	0.837	1875.3	0.270	0.499	0.776
1996	0.237	0.0555	0.234	-3.94066	14.987	11.04634	0.890	880.4	0.134	0.236	0.352
1997	0.309	0.0610	0.198	0.259	27.6007	27.8597	0.721	1145.1	0.200	0.305	0.437
1998	0.326	0.0862	0.264	-1.74891	13.3173	11.56839	0.884	1209.5	0.172	0.326	0.511
1999	0.451	0.0741	0.164	19.54384	38.5581	58.10194	0.419	1672.2	0.313	0.442	0.594
2000	0.428	0.0805	0.188	3.28585	19.462	22.74785	0.773	1588.5	0.271	0.427	0.587
2001	0.378	0.0718	0.190	-2.29293	11.1846	8.89167	0.911	1400.5	0.244	0.377	0.525
2002	0.824	0.1338	0.162	-3.91809	15.908	11.98991	0.880	3055.4	0.570	0.820	1.104
2003	0.959	0.1722	0.180	-5.00419	25.6091	20.60491	0.794	3555.8	0.634	0.949	1.310
2004	0.465	0.1031	0.222	-5.09838	20.8983	15.79992	0.842	1723.6	0.276	0.462	0.672
2005	0.583	0.1314	0.225	-4.3986	0.7193	-3.6793	1.037	2161.4	0.352	0.579	0.864
2006	0.454	0.0953	0.210	14.56437	6.8446	21.40897	0.786	1685.1	0.274	0.448	0.660

Table 19d. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the fall survey in the southern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1963	3.653	0.9311	0.255	-26.9773	-4.5278	-31.5051	1.315	8908.8	2.043	3.610	5.566
1964	5.495	1.0552	0.192	-29.5142	24.4261	-5.0881	1.051	13402.6	3.497	5.512	7.645
1965	4.899	0.9592	0.196	-36.9943	-8.0235	-45.0178	1.450	11948.8	3.132	4.872	6.851
1966	7.024	1.0141	0.144	-32.6047	6.8011	-25.8036	1.258	17129.7	5.134	6.993	9.051
1967	1.131	0.2686	0.238	-10.7298	0.7662	-9.9636	1.099	4191.9	0.628	1.102	1.688
1968	1.046	0.2526	0.242	-22.0532	-1.6818	-23.735	1.237	3877.8	0.578	1.025	1.583
1969	1.436	0.4394	0.306	-35.7321	-0.7651	-36.4972	1.365	5325.4	0.722	1.401	2.428
1970	1.263	0.3097	0.245	-19.7108	21.5078	1.797	0.982	4682.3	0.700	1.265	1.889
1971	0.776	0.3008	0.388	12.0126	-0.1423	11.8703	0.881	2876.6	0.289	0.745	1.440
1972	4.856	0.7418	0.153	-3.9109	30.3142	26.4033	0.736	18008.2	3.525	4.859	6.317
1973	1.806	0.3196	0.177	-8.4252	21.3302	12.905	0.871	6697.9	1.230	1.798	2.453
1974	0.705	0.2047	0.290	-0.7165	16.215	15.4985	0.845	2614.0	0.339	0.704	1.133
1975	1.974	0.3408	0.173	-16.0744	6.9396	-9.1348	1.091	7318.8	1.351	1.958	2.665
1976	0.993	0.1993	0.201	5.4234	15.5634	20.9868	0.790	3682.7	0.615	0.988	1.386
1977	1.874	0.3481	0.186	-22.1498	10.0982	-12.0516	1.120	6950.2	1.229	1.875	2.581
1978	1.404	0.2674	0.190	-3.6012	12.615	9.0138	0.910	5206.1	0.916	1.404	1.966
1979	1.928	0.3136	0.163	9.9416	23.523	33.4646	0.666	7149.6	1.344	1.919	2.563
1980	1.860	0.3455	0.186	-21.2463	34.0734	12.8271	0.872	6896.2	1.248	1.869	2.574
1981	2.260	0.4197	0.186	-11.7051	37.1517	25.4466	0.746	8381.2	1.462	2.244	3.125
1982	0.653	0.1517	0.232	-12.085	7.4844	-4.6006	1.046	2422.2	0.388	0.652	0.976
1983	1.734	0.3791	0.219	-17.3031	26.9042	9.6011	0.904	6430.7	1.072	1.718	2.556
1984	0.774	0.3443	0.445	-49.6062	2.013	-47.5932	1.476	2861.7	0.236	0.732	1.562
1985	1.265	0.2661	0.210	-6.9654	10.914	3.9486	0.960	4689.3	0.787	1.260	1.823
1986	0.544	0.1568	0.288	-8.6764	3.971	-4.7054	1.047	2016.2	0.279	0.534	0.877
1987	0.280	0.0868	0.310	-6.9554	17.004	10.0486	0.900	1039.0	0.129	0.278	0.483
1988	0.551	0.1737	0.315	-7.9736	-2.684	-10.6576	1.107	2044.1	0.252	0.537	0.925
1989	0.624	0.1725	0.276	-4.3867	10.317	5.9303	0.941	2314.7	0.318	0.607	0.984
1990	0.364	0.1358	0.373	-6.2372	5.01	-1.2272	1.012	1348.4	0.118	0.359	0.660
1991	0.741	0.2472	0.334	-1.4823	10.021	8.5387	0.915	2748.0	0.318	0.732	1.281
1992	0.309	0.0741	0.240	-3.1573	55.827	52.6697	0.473	1145.6	0.190	0.300	0.474
1993	0.270	0.0978	0.362	-12.8617	5.355	-7.5067	1.075	1001.8	0.099	0.265	0.478
1994	0.554	0.1469	0.265	-3.201	21.566	18.365	0.816	2053.3	0.284	0.552	0.855
1995	0.392	0.1252	0.320	-8.1767	15.113	6.9363	0.931	1451.8	0.171	0.382	0.657
1996	0.389	0.0897	0.230	-4.0509	14.87	10.8191	0.892	1443.9	0.223	0.383	0.577
1997	0.592	0.1325	0.224	1.2372	19.882	21.1192	0.789	2194.0	0.353	0.578	0.867
1998	0.499	0.1355	0.271	0.4531	5.432	5.8851	0.941	1851.9	0.254	0.488	0.790
1999	0.296	0.0636	0.215	7.3167	21.184	28.5007	0.715	1096.4	0.181	0.299	0.431
2000	0.470	0.1006	0.214	-1.7064	18.208	16.5016	0.835	1743.0	0.283	0.467	0.677
2001	0.651	0.1320	0.203	2.9805	10.259	13.2395	0.868	2412.0	0.405	0.646	0.914
2002	1.250	0.2541	0.203	-3.2811	9.922	6.6409	0.934	4636.6	0.798	1.242	1.772
2003	0.828	0.1459	0.176	10.4164	26.22	36.6364	0.634	3070.0	0.554	0.829	1.132
2004	0.742	0.1567	0.211	4.5499	21.102	25.6519	0.744	2752.4	0.451	0.737	1.053
2005	0.761	0.1938	0.255	-5.0335	5.248	0.2145	0.998	2820.2	0.427	0.749	1.158
2006	0.749	0.1967	0.262	26.4822	3.727	30.2092	0.698	2778.8	0.410	0.728	1.162

Table 19e. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the spring survey in the northern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1968	0.169	0.0528	0.313	-28.3875	6.4719	-21.9156	1.219	452.5	0.074	0.163	0.278
1969	0.176	0.0643	0.365	-9.5356	-4.3178	-13.8534	1.138	472.8	0.066	0.175	0.323
1970	0.366	0.0764	0.209	-9.6644	10.2237	0.5593	0.994	982.1	0.223	0.366	0.526
1971	0.169	0.0518	0.306	-0.5737	17.3121	16.7384	0.833	454.3	0.083	0.166	0.281
1972	0.654	0.1079	0.165	-24.6136	19.3195	-5.2941	1.053	1754.6	0.460	0.647	0.870
1973	1.122	0.3208	0.286	-19.4545	-3.9171	-23.3716	1.234	3010.3	0.600	1.140	1.677
1974	1.056	0.1602	0.152	-20.0354	11.8281	-8.2073	1.082	2833.4	0.756	1.038	1.389
1975	0.811	0.1346	0.166	-20.6777	8.8113	-11.8664	1.119	2175.7	0.555	0.807	1.080
1976	1.645	0.2302	0.140	-18.1318	6.5296	-11.6022	1.116	4413.3	1.211	1.624	2.112
1977	0.632	0.1194	0.189	-33.0104	3.169	-29.8414	1.298	1694.9	0.424	0.636	0.881
1978	0.341	0.0552	0.162	-8.7905	7.7351	-1.0554	1.011	915.0	0.232	0.339	0.450
1979	0.359	0.0532	0.148	-25.525	1.8091	-23.7159	1.237	964.0	0.258	0.359	0.466
1980	1.120	0.1686	0.151	-16.4262	16.2868	-0.1394	1.001	3005.3	0.803	1.111	1.472
1981	1.111	0.1387	0.125	-9.1005	28.472	19.3715	0.806	2980.1	0.848	1.111	1.373
1982	0.436	0.1203	0.276	-49.7633	-2.309	-52.0723	1.521	1168.6	0.224	0.422	0.685
1983	0.422	0.1159	0.275	-37.397	1.4826	-35.9144	1.359	1131.3	0.227	0.414	0.675
1984	0.329	0.0796	0.242	-10.8892	6.2198	-4.6694	1.047	883.1	0.182	0.327	0.498
1985	0.353	0.0748	0.212	-32.7962	9.5292	-23.267	1.233	947.1	0.219	0.351	0.505
1986	0.336	0.0682	0.203	-13.2132	12.1623	-1.0509	1.011	902.0	0.202	0.336	0.476
1987	0.309	0.0772	0.250	-17.7201	0.6995	-17.0206	1.170	844.1	0.167	0.302	0.466
1988	0.576	0.0963	0.167	-16.3068	20.4947	4.1879	0.958	1575.4	0.401	0.574	0.761
1989	0.730	0.1649	0.226	-33.8048	20.7825	-13.0223	1.130	1995.9	0.434	0.737	1.081
1990	0.332	0.0748	0.226	-22.1327	12.8548	-9.2779	1.093	907.0	0.192	0.331	0.484
1991	0.697	0.1285	0.184	-33.4644	13.7525	-19.7119	1.197	1906.4	0.454	0.690	0.946
1992	0.472	0.1635	0.346	-36.9677	4.431	-32.5367	1.325	1267.4	0.209	0.453	0.819
1993	0.670	0.0989	0.148	-2.0989	44.0407	41.9418	0.581	1833.5	0.480	0.670	0.870
1994	0.547	0.1169	0.214	-24.7385	6.3166	-18.4219	1.184	1496.7	0.331	0.541	0.801
1995	0.984	0.1784	0.181	-20.5241	8.519	-12.0051	1.120	2692.3	0.680	0.979	1.353
1996	0.637	0.1517	0.238	-13.7633	15.1576	1.3943	0.986	1743.6	0.350	0.635	0.957
1997	0.335	0.0942	0.281	3.352	8.4481	11.8001	0.882	917.9	0.172	0.323	0.544
1998	0.415	0.0693	0.167	-19.8195	12.7036	-7.1159	1.071	1135.8	0.283	0.411	0.556
1999	0.806	0.1378	0.171	-14.7005	22.0635	7.363	0.926	2163.6	0.550	0.807	1.097
2000	1.128	0.1581	0.140	-16.3442	23.8596	7.5154	0.925	3086.8	0.834	1.122	1.462
2001	1.635	0.2116	0.129	-15.5426	27.4335	11.8909	0.881	4473.0	1.224	1.626	2.054
2002	1.716	0.1999	0.117	6.649	27.1449	33.7939	0.662	4694.1	1.324	1.712	2.123
2003	1.012	0.2180	0.215	-20.8254	14.8805	-5.9449	1.059	2769.2	0.626	1.001	1.467
2004	0.903	0.1577	0.175	-22.26	17.5358	-4.7242	1.047	2472.0	0.610	0.902	1.217
2005	0.687	0.1140	0.166	-16.779	25.3074	8.5284	0.915	1878.9	0.480	0.679	0.913
2006	0.359	0.1011	0.282	-47.8176	-5.9796	-53.7972	1.538	982.7	0.178	0.351	0.575
2007	0.648	0.1910	0.295	-27.24	19.04	-8.2	1.082	1252.7	0.303	0.636	1.046

Table 19f. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the spring survey in the northern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1968	1.008	0.3616	0.359	-28.324	1.7745	-26.5495	1.265	2705.1	0.366	0.992	1.795
1969	1.280	0.5511	0.431	-17.6426	-3.3558	-20.9984	1.210	3432.9	0.349	1.214	2.522
1970	2.392	0.9309	0.389	-11.3428	2.9854	-8.3574	1.084	6417.6	0.986	2.317	4.440
1971	1.166	0.3761	0.323	-7.8001	10.4738	2.6737	0.973	3127.0	0.506	1.151	1.936
1972	4.657	0.7868	0.169	-25.0049	19.0622	-5.9427	1.059	12495.1	3.204	4.603	6.345
1973	6.812	1.7083	0.251	-27.2439	-4.818	-32.0619	1.321	18274.5	3.706	6.776	10.002
1974	4.888	1.0757	0.220	-25.0727	2.8484	-22.2243	1.222	13112.9	2.989	4.867	7.134
1975	3.037	0.5761	0.190	-28.9984	14.7902	-14.2082	1.142	8147.6	1.938	3.041	4.176
1976	8.773	1.2913	0.147	-26.2259	7.971	-18.2549	1.183	23538.0	6.243	8.748	11.453
1977	3.122	0.5644	0.181	-14.7591	5.6197	-9.1394	1.091	8374.8	2.064	3.104	4.289
1978	1.872	0.3757	0.201	-14.0449	5.2835	-8.7614	1.088	5021.9	1.180	1.867	2.659
1979	2.173	0.4872	0.224	-60.6697	-6.2209	-66.8906	1.669	5830.6	1.232	2.166	3.187
1980	4.859	0.9448	0.194	-14.6372	19.4924	4.8552	0.951	13034.7	3.046	4.802	6.861
1981	5.649	1.2642	0.224	-40.8652	6.2755	-34.5897	1.346	15155.9	3.290	5.560	8.184
1982	3.328	1.0082	0.303	-27.218	-5.1944	-32.4124	1.324	8928.0	1.433	3.262	5.495
1983	1.558	0.5254	0.337	-45.4014	-3.1497	-48.5511	1.486	4180.3	0.713	1.527	2.739
1984	1.555	0.4514	0.290	-1.705	-2.1244	-3.8294	1.038	4170.5	0.764	1.531	2.520
1985	2.195	0.5258	0.240	-18.0355	6.2664	-11.7691	1.118	5887.8	1.231	2.185	3.300
1986	2.026	0.5533	0.273	-12.4692	0.9523	-11.5169	1.115	5434.8	1.039	2.008	3.225
1987	1.886	0.5967	0.316	-26.1634	3.3155	-22.8479	1.228	5159.8	0.792	1.861	3.065
1988	1.935	0.4763	0.246	-21.0082	8.7221	-12.2861	1.123	5293.3	1.059	1.901	2.927
1989	1.554	0.4788	0.308	-24.7997	1.3249	-23.4748	1.235	4251.0	0.722	1.516	2.560
1990	1.003	0.3309	0.330	-32.0433	8.3164	-23.7269	1.237	2745.1	0.425	0.970	1.722
1991	1.643	0.4121	0.251	-37.8002	12.8554	-24.9448	1.249	4495.4	0.872	1.625	2.511
1992	0.843	0.5406	0.641	-55.7858	-1.3781	-57.1639	1.572	2261.5	0.180	0.910	2.263
1993	1.123	0.2279	0.203	-5.5877	46.834	41.2463	0.588	3073.7	0.672	1.115	1.562
1994	0.969	0.3127	0.323	-23.2427	3.2265	-20.0162	1.200	2651.9	0.437	0.951	1.668
1995	1.867	0.5866	0.314	-20.1972	9.0094	-11.1878	1.112	5108.9	0.852	1.815	3.152
1996	0.960	0.2516	0.262	-23.3967	10.1017	-13.295	1.133	2626.5	0.508	0.948	1.499
1997	0.530	0.2116	0.399	-4.306	0.4554	-3.8506	1.039	1451.2	0.182	0.510	0.999
1998	0.425	0.1212	0.285	-21.8839	4.2513	-17.6326	1.176	1163.2	0.209	0.423	0.688
1999	1.170	0.2635	0.225	0.2479	9.944	10.1919	0.898	3137.9	0.681	1.160	1.756
2000	1.369	0.2690	0.197	-13.7636	10.7562	-3.0074	1.030	3745.1	0.883	1.360	1.950
2001	1.796	0.5260	0.293	-49.5103	3.5388	-45.9715	1.460	4915.0	0.922	1.765	2.912
2002	1.931	0.2772	0.144	-21.9453	20.8381	-1.1072	1.011	5283.9	1.391	1.926	2.487
2003	2.017	0.4919	0.244	-15.2452	13.7063	-1.5389	1.015	5517.6	1.105	1.980	3.087
2004	2.262	0.6130	0.271	-26.6815	15.8279	-10.8536	1.109	6187.8	1.171	2.240	3.555
2005	1.451	0.3245	0.224	-20.4692	16.8876	-3.5816	1.036	3971.4	0.860	1.436	2.094
2006	0.866	0.3221	0.372	-22.3645	4.174	-18.1905	1.182	2368.4	0.349	0.836	1.558
2007	1.416	0.6607	0.467	-29.53	11.04	-18.49	1.185	2736.6	0.328	1.382	2.871

Table 19g. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the spring survey in the southern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1968	0.215	0.0459	0.213	43.1199	8.3053	51.4252	0.486	797.5	0.130	0.215	0.311
1969	0.226	0.0488	0.216	-15.3234	22.4364	7.113	0.929	838.5	0.139	0.224	0.326
1970	0.175	0.0367	0.209	-9.0686	2.6869	-6.3817	1.064	649.3	0.107	0.172	0.252
1971	0.208	0.0540	0.259	1.4135	8.9975	10.411	0.896	772.9	0.110	0.204	0.323
1972	0.363	0.0496	0.136	5.1956	15.831	21.0266	0.790	1346.5	0.268	0.364	0.458
1973	2.814	0.2415	0.086	-11.0587	31.4047	20.346	0.797	10435.2	2.345	2.802	3.290
1974	1.199	0.1479	0.123	-5.712	24.9317	19.2197	0.808	4447.5	0.925	1.191	1.489
1975	1.095	0.1444	0.132	-7.3381	27.9573	20.6192	0.794	3879.5	0.820	1.083	1.370
1976	1.141	0.1438	0.126	15.2874	20.3964	35.6838	0.643	4229.2	0.869	1.147	1.455
1977	0.826	0.0955	0.116	1.4886	24.6639	26.1525	0.738	3062.1	0.646	0.822	1.019
1978	0.833	0.0917	0.110	21.4789	28.3752	49.8541	0.501	3087.5	0.650	0.829	1.012
1979	0.797	0.1331	0.167	-31.0372	37.5576	6.5204	0.935	2953.6	0.545	0.795	1.050
1980	1.286	0.1396	0.109	17.314	25.4925	42.8065	0.572	4766.7	1.013	1.282	1.585
1981	2.244	0.3019	0.135	-5.1251	33.7625	28.6374	0.714	8322.1	1.659	2.233	2.838
1982	1.105	0.1501	0.136	19.9234	26.6785	46.6019	0.534	4095.9	0.834	1.106	1.404
1983	0.273	0.0484	0.177	-2.1439	3.4036	1.2597	0.988	1013.1	0.182	0.270	0.374
1984	0.184	0.0473	0.257	-18.726	3.5266	-15.1994	1.152	683.1	0.096	0.181	0.284
1985	0.161	0.0452	0.281	-6.9543	2.7263	-4.228	1.042	595.0	0.077	0.158	0.260
1986	0.284	0.0809	0.284	-11.4245	5.0419	-6.3826	1.064	1054.2	0.159	0.273	0.465
1987	0.109	0.0270	0.249	13.4601	3.162	16.6221	0.834	402.8	0.060	0.107	0.166
1988	0.449	0.0821	0.183	3.5029	9.1048	12.6077	0.874	1664.7	0.303	0.445	0.611
1989	0.237	0.0619	0.261	4.7123	15.1171	19.8294	0.802	880.4	0.125	0.232	0.366
1990	0.261	0.0513	0.197	4.2124	48.5546	52.767	0.472	967.1	0.156	0.262	0.361
1991	0.380	0.1090	0.287	4.8873	-1.6676	3.2197	0.968	1410.2	0.197	0.367	0.619
1992	0.180	0.0472	0.263	4.042	19.8344	23.8764	0.761	666.3	0.094	0.178	0.281
1993	0.196	0.0507	0.259	2.273	8.4731	10.7461	0.893	726.6	0.110	0.193	0.305
1994	0.138	0.0348	0.253	-0.263	10.7172	10.4542	0.896	510.7	0.075	0.136	0.211
1995	0.191	0.0467	0.244	13.5038	6.0781	19.5819	0.804	708.4	0.104	0.189	0.284
1996	0.136	0.0329	0.242	-4.3254	27.2145	22.8891	0.771	505.4	0.074	0.135	0.202
1997	0.142	0.0514	0.362	56.9067	2.8781	59.7848	0.402	526.3	0.057	0.142	0.253
1998	0.256	0.0438	0.171	7.3983	18.1821	25.5804	0.744	948.1	0.175	0.254	0.340
1999	0.332	0.0566	0.170	12.471	22.5558	35.0268	0.650	1232.7	0.225	0.330	0.449
2000	0.241	0.0450	0.187	-4.7771	21.283	16.5059	0.835	892.2	0.156	0.240	0.328
2001	0.238	0.0537	0.226	4.2611	8.0403	12.3014	0.877	881.4	0.141	0.235	0.351
2002	0.316	0.1134	0.359	5.6532	1.7737	7.4269	0.926	1170.5	0.148	0.303	0.556
2003	0.371	0.0753	0.203	19.0539	14.2188	33.2727	0.667	1374.0	0.235	0.372	0.520
2004	0.121	0.0336	0.278	12.326	23.5098	35.8358	0.642	448.2	0.060	0.119	0.192
2005	0.259	0.0763	0.294	-6.189	8.3208	2.1318	0.979	961.2	0.135	0.250	0.416
2006	0.171	0.0396	0.231	9.8218	0.8343	10.6561	0.894	634.1	0.097	0.169	0.251
2007	0.164	0.0432	0.264	-11.65	32.41	20.76	0.792	585.4	0.085	0.162	0.252

Table 19h. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the spring survey in the southern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1968	1.162	0.3054	0.263	24.7872	6.0465	30.8337	0.692	4308.8	0.612	1.140	1.767
1969	0.930	0.2370	0.255	-6.4753	17.3719	10.8966	0.891	3446.9	0.507	0.922	1.436
1970	0.989	0.2722	0.275	-22.0119	2.2182	-19.7937	1.198	3667.4	0.505	0.982	1.573
1971	0.774	0.2308	0.298	10.5729	-0.5859	9.987	0.900	2868.2	0.371	0.762	1.252
1972	1.868	0.3675	0.197	9.2007	6.1	15.3007	0.847	6926.4	1.190	1.845	2.641
1973	6.140	0.5451	0.089	6.6924	24.3177	31.0101	0.690	22769.4	5.085	6.147	7.224
1974	3.895	0.7206	0.185	-12.6163	7.1062	-5.5101	1.055	14441.7	2.556	3.864	5.370
1975	3.072	0.5016	0.163	9.1955	26.4756	35.6711	0.643	10884.4	2.147	3.059	4.056
1976	3.821	0.4928	0.129	28.4422	13.2582	41.7004	0.583	14169.8	2.882	3.807	4.866
1977	3.778	0.6363	0.168	8.2236	17.301	25.5246	0.745	14009.5	2.637	3.738	5.087
1978	2.518	0.4017	0.160	49.2572	17.4566	66.7138	0.333	9335.2	1.771	2.522	3.338
1979	2.341	0.4401	0.188	-29.7345	13.7867	-15.9478	1.159	8679.6	1.516	2.351	3.242
1980	2.439	0.4168	0.171	37.9868	11.0407	49.0275	0.510	9042.5	1.691	2.412	3.353
1981	5.721	0.9898	0.173	-20.8032	5.8991	-14.9041	1.149	21215.3	3.882	5.647	7.798
1982	2.563	0.4974	0.194	18.8071	18.711	37.5181	0.625	9504.7	1.699	2.562	3.607
1983	0.943	0.2677	0.284	-10.7884	-1.7112	-12.4996	1.125	3498.2	0.476	0.928	1.539
1984	0.742	0.2611	0.352	-55.3543	4.5392	-50.8151	1.508	2753.0	0.271	0.733	1.290
1985	0.341	0.1274	0.374	39.6886	2.7061	42.3947	0.576	1262.8	0.124	0.332	0.610
1986	0.840	0.2480	0.295	10.6564	2.4214	13.0778	0.869	3113.3	0.404	0.822	1.354
1987	0.506	0.2604	0.514	-63.8053	0.8629	-62.9424	1.629	1877.8	0.144	0.502	1.098
1988	0.441	0.0856	0.194	36.6426	11.3289	47.9715	0.520	1634.3	0.277	0.443	0.611
1989	0.333	0.0966	0.290	56.9024	5.0196	61.922	0.381	1234.7	0.165	0.328	0.549
1990	1.042	0.2521	0.242	-0.9507	31.5918	30.6411	0.694	3864.3	0.543	1.034	1.568
1991	0.561	0.1707	0.304	5.8535	-1.5666	4.2869	0.957	2081.0	0.250	0.549	0.893
1992	0.231	0.0820	0.355	4.8314	11.6503	16.4817	0.835	857.2	0.091	0.233	0.415
1993	0.258	0.0810	0.314	-5.0639	7.2689	2.205	0.978	955.2	0.120	0.250	0.424
1994	0.333	0.1123	0.338	37.2451	4.6182	41.8633	0.581	1233.7	0.128	0.325	0.570
1995	0.519	0.2470	0.476	-39.3141	-1.1164	-40.4305	1.404	1924.1	0.153	0.520	1.014
1996	0.291	0.0867	0.298	4.4237	18.4343	22.858	0.771	1077.7	0.129	0.286	0.458
1997	0.159	0.0706	0.445	61.7818	-0.3181	61.4637	0.385	587.6	0.046	0.157	0.312
1998	0.292	0.0602	0.206	22.6723	22.9001	45.5724	0.544	1081.5	0.177	0.291	0.410
1999	0.654	0.1523	0.233	21.9064	18.483	40.3894	0.596	2426.0	0.371	0.645	0.982
2000	0.290	0.0657	0.226	6.1668	18.1562	24.323	0.757	1075.0	0.159	0.286	0.422
2001	0.263	0.0897	0.341	2.3552	17.0227	19.3779	0.806	975.6	0.110	0.252	0.455
2002	0.373	0.1238	0.332	7.5838	3.317	10.9008	0.891	1381.9	0.173	0.360	0.655
2003	1.355	0.3265	0.241	18.8261	7.6488	26.4749	0.735	5023.2	0.765	1.347	2.044
2004	0.190	0.0609	0.320	26.9746	16.7965	43.7711	0.562	706.0	0.075	0.187	0.320
2005	0.366	0.0801	0.219	12.9292	34.8628	47.792	0.522	1356.2	0.219	0.363	0.536
2006	0.540	0.1656	0.307	-12.5113	-6.1848	-18.6961	1.187	2002.7	0.248	0.533	0.880
2007	0.363	0.1257	0.346	-20.99	13.98	-7.01	1.070	1299.7	0.143	0.359	0.626

Table 19i. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the scallop survey in the southern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1983	1.835	0.1219	0.066	2.0073	23.096	25.1033	0.749	20710.8	1.595	1.830	2.090
1984	1.276	0.0984	0.077	7.9277	15.587	23.5147	0.765	14401.6	1.097	1.274	1.471
1985	1.541	0.1388	0.090	-71.4045	17.444	-53.9605	1.540	18355.4	1.291	1.533	1.845
1986	1.288	0.1088	0.085	-39.6341	17.7	-21.9341	1.219	13783.6	1.080	1.290	1.513
1987	3.068	0.1750	0.057	0.4638	37.995	38.4588	0.615	36544.7	2.717	3.056	3.408
1988	1.629	0.1192	0.073	-9.7046	33.188	23.4834	0.765	19396.9	1.401	1.628	1.851
1989	1.001	0.0818	0.082	-16.6123	25.365	8.7527	0.912	10189.4	0.844	0.998	1.166
1990	1.482	0.0931	0.063	-9.8028	25.157	15.3542	0.846	17646.7	1.303	1.475	1.664
1991	2.181	0.1316	0.060	-25.1886	24.555	-0.6336	1.006	25975.0	1.931	2.176	2.449
1992	1.951	0.1420	0.073	-42.3849	15.835	-26.5499	1.266	22357.0	1.684	1.948	2.235
1993	2.730	0.1307	0.048	-12.2045	35.553	23.3485	0.766	32519.4	2.485	2.735	2.995
1994	3.225	0.1677	0.052	-23.0817	27.289	4.2073	0.958	38412.2	2.888	3.226	3.550
1995	2.192	0.1409	0.064	-33.1248	16.651	-16.4738	1.165	26102.4	1.922	2.187	2.469
1996	1.966	0.1302	0.066	-38.9708	11.945	-27.0258	1.270	23412.8	1.715	1.961	2.223
1997	1.093	0.0805	0.074	-36.4763	12.13	-24.3463	1.244	13011.9	0.944	1.089	1.257
1998	1.037	0.0731	0.071	-5.8623	19.79	13.9277	0.861	11361.9	0.897	1.034	1.185
1999	2.548	0.1981	0.078	-35.4168	23.011	-12.4058	1.124	29530.4	2.183	2.545	2.965
2000	2.297	0.1716	0.075	-28.3667	21.904	-6.4627	1.065	26320.4	1.992	2.286	2.661
2002	1.706	0.0993	0.058	-0.1624	29.043	28.8806	0.711	19779.2	1.516	1.708	1.906
2003	2.728	0.1719	0.063	-13.6627	33.741	20.0783	0.799	31616.5	2.401	2.729	3.066
2004	2.865	0.2138	0.075	-147.774	21.556	-126.218	2.262	33209.1	2.487	2.868	3.312
2005	2.016	0.1312	0.065	-13.1154	16.788	3.6726	0.963	23371.2	1.766	2.017	2.281
2006	1.439	0.0869	0.060	-13.5053	26.07	12.5647	0.874	16679.1	1.273	1.439	1.615

Table 19j. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the scallop survey in the southern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1983	1.610	0.1809	0.112	-19.1865	15.832	-3.3545	1.033	18171.4	1.274	1.606	1.985
1984	1.236	0.1424	0.115	-25.7694	7.846	-17.9234	1.179	13951.8	0.967	1.232	1.520
1985	1.388	0.1536	0.111	-28.7444	14.071	-14.6734	1.147	16532.2	1.089	1.389	1.712
2000	0.462	0.1065	0.230	-35.5343	19.884	-15.6503	1.156	5299.6	0.270	0.461	0.697
2002	2.209	0.1939	0.088	-8.3612	26.718	18.3568	0.816	25609.8	1.851	2.207	2.603
2003	2.059	0.1992	0.097	-30.0133	6.41	-23.6033	1.236	23861.4	1.679	2.060	2.443
2004	2.882	0.3336	0.116	-110.029	18.273	-91.7561	1.918	33404.5	2.279	2.858	3.578
2005	2.235	0.2251	0.101	-29.2065	16.883	-12.3235	1.123	25909.9	1.820	2.223	2.673
2006	1.905	0.2642	0.139	-118.353	4.982	-113.371	2.134	22081.7	1.425	1.882	2.454

Table 19k. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the shrimp survey in the northern stock area. Response variable is numbers per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1991	2.879	0.3014	0.105	-5.5889	7.7569	2.168	0.978	5880.1	2.317	2.891	3.494
1992	2.905	0.3203	0.110	-0.9485	8.5022	7.5537	0.925	5932.5	2.300	2.904	3.581
1993	3.699	0.5067	0.137	-24.4381	-4.6498	-29.0879	1.291	7554.8	2.784	3.697	4.799
1994	3.423	0.4795	0.140	-2.9539	23.0984	20.1445	0.798	6990.0	2.509	3.423	4.398
1995	2.079	0.4319	0.208	-27.1078	-7.6133	-34.7211	1.347	4245.0	1.297	2.072	2.940
1996	2.988	0.4584	0.153	4.1799	-7.9242	-3.7443	1.037	6102.3	2.147	2.985	3.934
1997	1.573	0.2498	0.159	-12.4057	4.8592	-7.5465	1.076	3212.8	1.085	1.583	2.046
1998	2.124	0.3120	0.147	2.1492	-3.7975	-1.6483	1.016	4337.6	1.548	2.121	2.747
1999	6.780	0.6542	0.096	2.8968	15.9171	18.8139	0.812	13847.0	5.542	6.774	8.073
2000	5.721	0.8007	0.140	7.7116	5.9841	13.6957	0.863	11683.9	4.229	5.736	7.407
2001	10.887	1.0985	0.101	6.219	33.4566	39.6756	0.603	22232.3	8.950	10.901	13.111
2002	11.655	1.0634	0.091	16.5927	22.9897	39.5824	0.604	23800.9	9.724	11.626	13.851
2003	5.802	0.8510	0.147	-49.0718	-4.5574	-53.6292	1.536	11848.6	4.302	5.743	7.570
2004	3.380	0.3662	0.108	3.6581	34.6086	38.2667	0.617	6901.8	2.663	3.371	4.134
2005	5.251	0.5431	0.103	-1.1185	15.5209	14.4024	0.856	10722.6	4.221	5.229	6.328
2006	4.306	0.3229	0.075	15.4189	28.5908	44.0097	0.560	8794.6	3.478	4.149	4.847

Table 19l. Survey estimates of mean catch rates, CV, design efficiency and bootstrap estimates of precision for the shrimp survey in the northern stock area. Response variable is weight (kg) per tow.

				Design Efficiency: Reduction in							
Year	mean	SE mean	CV	Allocation	Stratification	Total	Ratio of Variance of current design to Random Sample	Swept Area Estimate of Total (000s)	2.5%-ile	Median 50%-ile	97.5%-ile
1991	1.883	0.3322	0.176	15.5551	7.4253	22.9804	0.770	3845.9	1.285	1.848	2.568
1992	2.695	0.4835	0.179	-30.6691	4.8954	-25.7737	1.258	5503.2	1.796	2.664	3.654
1993	3.068	0.8507	0.277	-39.9532	-9.078	-49.0312	1.490	6264.8	1.626	2.998	4.871
1994	1.655	0.3828	0.231	-10.5425	-5.3671	-15.9096	1.159	3380.7	0.964	1.627	2.493
1995	1.552	0.4113	0.265	-31.909	7.4185	-24.4905	1.245	3169.8	0.763	1.545	2.340
1996	3.355	1.2701	0.379	-76.6811	-5.8405	-82.5216	1.825	6851.9	1.605	3.528	5.998
1997	2.078	0.5337	0.257	-63.8241	0.7695	-63.0546	1.631	4244.1	1.055	2.070	3.148
1998	2.273	0.8086	0.356	-89.2132	-11.4796	-100.693	2.007	4641.8	1.045	2.243	4.021
1999	6.261	0.7207	0.115	-16.5314	-8.6971	-25.2285	1.252	12786.4	4.791	6.283	7.625
2000	3.838	0.6544	0.171	-6.6287	3.4438	-3.1849	1.032	7838.7	2.520	3.825	5.059
2001	7.271	0.8857	0.122	-19.8093	17.2188	-2.5905	1.026	14848.4	5.591	7.281	9.072
2002	12.435	1.4638	0.118	-15.4569	-2.3766	-17.8335	1.178	25395.6	9.614	12.450	15.337
2003	7.789	1.3794	0.177	-45.0619	-8.6112	-53.6731	1.537	15905.8	5.265	7.673	10.631
2004	4.446	0.4956	0.111	5.6525	39.9704	45.6229	0.544	9079.2	3.491	4.419	5.407
2005	7.255	1.0631	0.147	9.2601	-2.2974	6.9627	0.930	14815.5	5.245	7.160	9.407
2006	6.542	0.9070	0.139	-17.2875	-0.3704	-17.6579	1.177	13360.1	4.533	6.250	8.075

Table 20. NEFSC survey catch per tow at age.

Fall Survey - Northern Area											
	age-0	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	
1993	0.149	0.308	0.176	0.104	0.094	0.102	0.000	0.031	0.013	0.012	
1994	0.065	0.560	0.287	0.208	0.086	0.089	0.019	0.024	0.011	0.000	
1995	0.000	0.059	0.163	0.285	0.234	0.092	0.021	0.014	0.054	0.000	
1996	0.012	0.048	0.062	0.152	0.206	0.093	0.034	0.011	0.012	0.000	
1997	0.039	0.094	0.016	0.122	0.136	0.052	0.031	0.000	0.007	0.000	
1998	0.000	0.116	0.150	0.090	0.048	0.052	0.135	0.018	0.000	0.000	
1999	0.192	0.310	0.292	0.179	0.015	0.033	0.020	0.040	0.003	0.000	
2000	0.080	0.703	0.626	0.448	0.271	0.105	0.059	0.062	0.044	0.000	
2001	0.000	0.166	0.482	0.365	0.369	0.149	0.049	0.023	0.000	0.016	
2002	0.027	0.322	0.118	0.300	0.230	0.175	0.050	0.027	0.029	0.004	
2003	0.100	0.159	0.147	0.074	0.244	0.206	0.074	0.036	0.027	0.000	
2004	0.091	0.096	0.091	0.096	0.024	0.047	0.059	0.004	0.007	0.000	
2005	0.106	0.098	0.113	0.060	0.049	0.046	0.077	0.017	0.028	0.000	
2006	0.123	0.161	0.036	0.125	0.110	0.143	0.036	0.012	0.019	0.000	
Fall Survey - Southern Area											
	age-0	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	
1993	0.007	0.060	0.064	0.076	0.062	0.014	0.000	0.007	0.000	0.000	
1994	0.015	0.095	0.295	0.056	0.066	0.036	0.021	0.007	0.008	0.000	
1995	0.000	0.102	0.151	0.120	0.053	0.049	0.017	0.000	0.000	0.000	
1996	0.000	0.007	0.030	0.054	0.059	0.060	0.026	0.000	0.000	0.000	
1997	0.017	0.008	0.041	0.055	0.035	0.105	0.031	0.016	0.000	0.000	
1998	0.000	0.070	0.072	0.037	0.059	0.044	0.034	0.008	0.008	0.000	
1999	0.005	0.101	0.172	0.118	0.040	0.014	0.000	0.000	0.000	0.000	
2000	0.007	0.061	0.118	0.106	0.067	0.023	0.041	0.000	0.000	0.000	
2001	0.018	0.018	0.036	0.119	0.079	0.048	0.045	0.015	0.000	0.000	
2002	0.016	0.099	0.163	0.069	0.233	0.184	0.058	0.000	0.007	0.000	
2003	0.060	0.354	0.178	0.105	0.058	0.156	0.041	0.000	0.000	0.000	
2004	0.000	0.061	0.101	0.034	0.091	0.118	0.051	0.017	0.000	0.000	
2005	0.018	0.022	0.103	0.131	0.167	0.121	0.014	0.000	0.000	0.000	
2006	0.014	0.085	0.030	0.035	0.110	0.125	0.037	0.017	0.000	0.000	
Winter Survey											
	age-0	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	age-10
1997	0.000	0.060	0.127	0.758	0.479	0.711	0.681	0.111	0.050	0.000	0.000
1998	0.000	0.017	0.056	0.072	0.376	0.525	0.277	0.100	0.057	0.001	0.011
1999	0.000	0.031	0.168	0.760	0.772	0.618	0.532	0.123	0.054	0.010	0.000
2000	0.000	0.000	0.046	0.830	1.444	1.453	0.452	0.131	0.050	0.000	0.021
2001	0.000	0.029	0.210	0.767	1.442	1.000	0.746	0.114	0.059	0.013	0.000
2002	0.000	0.000	0.015	0.099	1.061	1.140	0.785	0.284	0.071	0.019	0.000
2003	0.000	0.000	0.087	0.334	0.260	0.666	0.673	0.129	0.084	0.025	0.000
2004	0.000	0.000	0.059	0.882	1.127	0.987	0.913	0.302	0.116	0.010	0.000
2005	0.000	0.000	0.060	0.612	0.917	0.693	0.392	0.160	0.101	0.023	0.013
2006	0.000	0.000	0.000	0.110	0.847	1.198	0.677	0.165	0.077	0.008	0.000
2007	0.000	0.000	0.037	0.127	0.151	0.360	0.553	0.190	0.043	0.010	0.000

Table 21. Prior BSP specifications for both the North and South stocks of monkfish.

Parameter	**Distribution**	**Lower bound**	**Upper bound**
r	lognormal (mean=0.4 or 0.5 or 0.6, lnσ=0.5)	0.001	2.0
K	uniform on ln(K)	10 mt	10,000,000 mt
B0/K	lognormal (mean=0.75, lnσ=0.35)	0.2	1.1
Cat0	lognormal (mean=120, lnσ=0.7)	10 mt	5000 mt

Table 22. Expected values, standard deviations, and CVs for the North stock of monkfish. Units for biomass are in thousands of metric tons.

r prior mean=0.4

E(K)	664.1694	SD(K)	1470.111	CV(K)	2.213458
E(r)	0.42632	SD(r)	0.212187	CV(r)	0.497718
E(MSY)	69.95063	SD(MSY)	186.1467	CV(MSY)	2.661115
E(Bcur)	615.2094	SD(Bcur)	1475.261	CV(Bcur)	2.397982
E(Bcur/K)	0.715833	SD(Bcur/K)	0.203521	CV(Bcur/K)	0.284313
E(binit1)	578.5006	SD(binit1)	1301.343	CV(binit1)	2.24951
E(Bcur/binit1)	0.851588	SD(Bcur/binit1)	0.272294	CV(Bcur/binit1)	0.319748
E(Ccur/MSY)	0.429238	SD(Ccur/MSY)	0.243237	CV(Ccur/MSY)	0.566671
E(fcur/fmsy)	0.394941	SD	0.36483	CV	0.923759
E(bcur/bmsy)	1.431652	SD	0.407037	CV	0.284313
E(ccur/repy)	0.607384	SD	0.129277	CV	0.212842
E(bmsy)	332.0854	SD	735.0555	CV	2.213453
E(repy)	12.04077	SD	1.813333	CV	0.150599
E(cat0)	0.119053	SD	0.093262	CV	0.783367

r prior mean=0.5

E(K)	654.3652	SD(K)	1488.646	CV(K)	2.274947
E(r)	0.522094	SD(r)	0.256375	CV(r)	0.491051
E(MSY)	85.36257	SD(MSY)	231.2166	CV(MSY)	2.708642
E(Bcur)	614.7197	SD(Bcur)	1493.313	CV(Bcur)	2.429259
E(Bcur/K)	0.736054	SD(Bcur/K)	0.200287	CV(Bcur/K)	0.272109
E(binit1)	571.6417	SD(binit1)	1320.223	CV(binit1)	2.30953
E(Bcur/binit1)	0.870323	SD(Bcur/binit1)	0.26647	CV(Bcur/binit1)	0.306174
E(Ccur/MSY)	0.399389	SD(Ccur/MSY)	0.230006	CV(Ccur/MSY)	0.575896
E(fcur/fmsy)	0.354328	SD	0.328248	CV	0.926394
E(bcur/bmsy)	1.472097	SD	0.400569	CV	0.272108
E(ccur/repy)	0.589855	SD	0.109286	CV	0.185276
E(bmsy)	327.183	SD	744.323	CV	2.274944
E(repy)	12.29839	SD	1.985691	CV	0.16146
E(cat0)	0.118855	SD	9.34E-02	CV	0.786177

r prior mean=0.6

E(K)	652.7311	SD(K)	1510.247	CV(K)	2.313735
E(r)	0.612581	SD(r)	0.292555	CV(r)	0.477578
E(MSY)	101.1055	SD(MSY)	275.4323	CV(MSY)	2.724208
E(Bcur)	619.6885	SD(Bcur)	1514.465	CV(Bcur)	2.443913
E(Bcur/K)	0.753644	SD(Bcur/K)	0.197108	CV(Bcur/K)	0.26154
E(binit1)	574.043	SD(binit1)	1347.981	CV(binit1)	2.348222
E(Bcur/binit1)	0.883398	SD(Bcur/binit1)	0.259728	CV(Bcur/binit1)	0.29401
E(Ccur/MSY)	0.377668	SD(Ccur/MSY)	0.222201	CV(Ccur/MSY)	0.58835
E(fcur/fmsy)	0.32472	SD	0.302195	CV	0.930633
E(bcur/bmsy)	1.507252	SD	0.39424	CV	0.261562
E(ccur/repy)	0.581858	SD	0.115845	CV	0.199096
E(bmsy)	326.3668	SD	755.1231	CV	2.313725
E(repy)	12.40495	SD	2.424426	CV	0.19544
E(cat0)	0.119686	SD	9.42E-02	CV	0.787097

Table 23. Expected values, standard deviations, and CVs for the South stock of monkfish. Units for biomass are in thousands of metric tons.

r prior mean=0.4

E(K)	214.7027	SD(K)	529.8886	CV(K)	2.468011
E(r)	0.502872	SD(r)	0.258288	CV(r)	0.513626
E(MSY)	22.61559	SD(MSY)	67.52135	CV(MSY)	2.985611
E(Bcur)	163.7066	SD(Bcur)	529.9812	CV(Bcur)	3.237384
E(Bcur/K)	0.67028	SD(Bcur/K)	0.150606	CV(Bcur/K)	0.22469
E(binit1)	203.4141	SD(binit1)	507.094	CV(binit1)	2.492915
E(Bcur/binit1)	0.720366	SD(Bcur/binit1)	0.179046	CV(Bcur/binit1)	0.248549
E(Ccur/MSY)	0.605445	SD(Ccur/MSY)	0.165214	CV(Ccur/MSY)	0.27288
E(fcur/fmsy)	0.510968	SD	0.287889	CV	0.563419
E(bcur/bmsy)	1.340544	SD	0.301182	CV	0.224671
E(ccur/repy)	0.729479	SD	9.61E-02	CV	0.13169
E(bmsy)	107.3512	SD	264.9443	CV	2.468015
E(repy)	12.87371	SD	1.248568	CV	9.70E-02
E(cat0)	0.117986	SD	9.22E-02	CV	0.781528

r prior mean=0.5

E(K)	218.1345	SD(K)	509.4943	CV(K)	2.335689
E(r)	0.515465	SD(r)	0.273441	CV(r)	0.530476
E(MSY)	22.96521	SD(MSY)	66.63349	CV(MSY)	2.901497
E(Bcur)	168.3818	SD(Bcur)	509.0676	CV(Bcur)	3.023293
E(Bcur/K)	0.680331	SD(Bcur/K)	0.148673	CV(Bcur/K)	0.218531
E(binit1)	235.1048	SD(binit1)	550.9469	CV(binit1)	2.34341
E(Bcur/binit1)	0.668812	SD(Bcur/binit1)	0.185395	CV(Bcur/binit1)	0.277201
E(Ccur/MSY)	0.596815	SD(Ccur/MSY)	0.16565	CV(Ccur/MSY)	0.277557
E(fcur/fmsy)	0.49401	SD	0.273033	CV	0.552687
E(bcur/bmsy)	1.360658	SD	0.297327	CV	0.218517
E(ccur/repy)	0.727554	SD	8.90E-02	CV	0.122291
E(bmsy)	109.0668	SD	254.747	CV	2.335698
E(repy)	12.89183	SD	1.257139	CV	9.75E-02
E(cat0)	0.118386	SD	9.28E-02	CV	0.783799

r prior mean=0.6

E(K)	179.9087	SD(K)	486.3036	CV(K)	2.703058
E(r)	0.658825	SD(r)	0.322145	CV(r)	0.488969
E(MSY)	24.7211	SD(MSY)	82.80024	CV(MSY)	3.349375
E(Bcur)	142.9702	SD(Bcur)	485.9473	CV(Bcur)	3.398941
E(Bcur/K)	0.712678	SD(Bcur/K)	0.139526	CV(Bcur/K)	0.195776
E(binit1)	182.5388	SD(binit1)	494.4646	CV(binit1)	2.70882
E(Bcur/binit1)	0.733074	SD(Bcur/binit1)	0.176167	CV(Bcur/binit1)	0.240312
E(Ccur/MSY)	0.568127	SD(Ccur/MSY)	0.142957	CV(Ccur/MSY)	0.251629
E(fcur/fmsy)	0.439782	SD	0.223586	CV	0.508401
E(bcur/bmsy)	1.425424	SD	0.279033	CV	0.195754
E(ccur/repy)	0.718225	SD	0.084288	CV	0.117355
E(bmsy)	89.95285	SD	243.1522	CV	2.703107
E(repy)	13.00761	SD	1.15281	CV	8.86E-02
E(cat0)	0.11964	SD	0.093875	CV	0.784647

Table 24. Estimates of total mortality rate for monkfish in two management areas. The lengths were taken from Gedamke and Hoenig (2006).

Northern management area.

Period	$\hat{Z}$ from lengths	$\hat{Z}$ from (4)	average of $\hat{Z}$ from (1)
1963-1977	0.14	0.18	0.07
1978-1988	0.29	0.28	0.19
1989-2002	0.55	0.48	0.39

Southern management area

Period	$\hat{Z}$ from lengths	$\hat{Z}$ from (4)	average of $\hat{Z}$ from (1)
1963-1976	0.33	0.55	0.37
1977-2002	0.58	0.56	0.47

Table 25. Age length key used for estimating mean lengths at age and variation from ages in the spring, winter, 2001 & 2004 cooperative, and fall surveys.

	age										
length	1	2	3	4	5	6	7	8	9	10	total
8	1										1
9	4										4
10	19										19
11	25	3									28
12	26	9									35
13	23	21									44
14	24	18									42
15	27	28									55
16	15	48									63
17	22	43									65
18	26	56	2								84
19	8	54	16								78
20	4	50	34								88
21		25	72								97
22		29	82								111
23		32	81	1							114
24		22	120								142
25		23	127								150
26		27	149								176
27		22	174	5							201
28		20	140	53							213
29		6	89	130							225
30		4	46	163							213
31		3	26	178							207
32			26	183							209
33			22	154							176
34		1	19	192							212
35			23	203							226
36			25	184							209
37			20	197	6						223
38			20	173	31						224
39			11	104	84						199
40			8	63	140						211
41			3	29	171						203
42				26	200						226
43			1	22	209						232
44				26	197						223
45				19	200						219
46				24	179						203
47				28	184	4					216
48				17	197	32					246
49				12	123	81					216
50				13	98	141					252
51				2	33	157					192
52				1	28	186					215
53					24	186					210
54					20	184					204
55					19	198					217
56					15	191	1				207
57					12	179	1				192
58					20	143	3				166
59					19	117	25				161
60					8	68	87				163
61					2	37	99				138
62						19	113				132
63					1	13	81				95
64						9	101				110
65						12	86				98
66						7	60				67
67						5	63				68
68						3	66				69
69						8	53	2			63
70						3	38	23			64
71						3	27	32			62
72							16	52			68
73							2	52			54
74							4	51			55
75							1	38			39
76							4	42			46
77							4	31			35
78							2	41			43
79							1	26			27
80							3	40	9		52
81							2	18	9		29
82							1	18	20		39
83								5	20		25
84								2	25		27
85								2	18		20
86								3	10	1	14
87								1	15		16
88								4	12		16
89								2	7		9
90									2	1	3
91									7		7
92									3	2	5
93									4		4
94									2		2
95								1	2	2	5
96									1	2	3
97									2		2
98									1	1	2
102										2	2
103										1	1
105										2	2
107										1	1
110										1	1
total	224	544	1336	2202	2220	1986	944	486	169	16	10127

Table 26. Northern management area monkfish runs of residual sum of squares, input weights & effective sample sizes, estimated Qs, Fstart, age1 recruitment in year 1, input natural mortality, and the estimated logistic selectivity parameters. First column under each run are the weights. Residual sum of square are in the second column.

Run number	1		2		3		4		5		6		7		8		9		10		11	
Discription	Vrec 3 fit fo 94 catch len freq		Vrec 1		Vrec 10		Vrec 20		Vrec 50		separate sexes males=0.4 females=0.3		constant recruitment		single selectivity block (Vrec5)		fix Fstart		m=0.2, single selectivity block		m=0.2, single selectivity block vrec 30	
total objective function		463.39		443.47		491.73		512.70		535.93		494.12		561.06		472.81		476.05		474.14		536.79
total catch	10	0.07	10	0.10	10	0.04	10	0.05	10	0.14	10	0.03	10	0.40	10	0.05	10	0.08	10	0.16	10	0.36
catch len freq 1+	400	12.50	400	9.47	400	9.16	400	9.60	400	15.28	400	9.49	400	17.39	400	9.31	400	9.42	400	9.75	400	10.79
Vrec	3	7.02	1	10.81	10	2.98	20	1.48	50	0.39	10	2.96	10	0.00	5	5.15	5	5.15	5	6.30	30	1.04
Fall age 1	2	15.06	2	13.40	2	19.52	2	22.75	2	26.93	2	19.60	2	32.32	2	16.72	2	16.69	2	15.63	2	24.08
Spring age 2	2	13.13	2	11.10	2	17.48	2	20.56	2	23.99	2	17.53	2	28.24	2	14.72	2	14.78	2	13.66	2	21.86
Spring age 3	2	15.10	2	14.60	2	16.83	2	18.60	2	20.93	2	16.89	2	24.05	2	15.62	2	15.85	2	15.18	2	19.51
Shrimp age 2	2	11.41	2	11.40	2	11.55	2	11.72	2	11.98	2	11.56	2	12.85	2	11.50	2	11.53	2	11.53	2	11.80
Shrimp age 3	2	3.76	2	3.77	2	3.98	2	4.45	2	5.22	2	4.03	2	6.53	2	3.80	2	3.86	2	3.72	2	4.75
Fall adult 40+	3	5.35	3	5.68	3	4.89	3	4.60	3	4.54	3	4.84	3	4.60	3	5.18	3	5.15	3	4.75	3	4.74
Spring adult 40+	3	4.09	3	4.17	3	4.01	3	4.01	3	3.52	3	3.97	3	3.69	3	4.12	3	3.59	3	3.49	3	3.95
Shrimp adult 40+	3	4.96	3	4.65	3	5.59	3	6.44	3	6.83	3	5.74	3	7.49	3	5.17	3	5.26	3	5.87	3	8.16
fall len freq 30+	200	108.81	200	109.47	200	108.84	200	109.07	200	111.38	200	109.78	200	114.37	200	108.68	200	110.80	200	108.11	200	109.52
spring len freq 30+	200	103.51	200	104.61	200	103.60	200	103.90	200	106.59	200	104.77	200	110.04	200	103.40	200	105.37	200	101.50	200	103.24
Shrimp len freq 30+	300	56.06	300	55.27	300	56.94	300	57.87	300	57.89	300	56.47	300	58.67	300	56.31	300	55.74	300	59.26	300	62.98
Coop len freq 30+	300	0.70	300	0.75	300	0.72	300	0.81	300	0.91	300	0.75	300	1.25	300	0.69	300	0.71	300	0.67	300	1.05
Q Fall age 1		0.03		0.03		0.02		0.02		0.02		0.01		0.02		0.02		0.03		0.07		0.07
Q Spring age 2		0.04		0.04		0.03		0.03		0.03		0.02		0.04		0.04		0.04		0.09		0.09
Q Spring age 3		0.06		0.06		0.04		0.04		0.05		0.03		0.05		0.05		0.06		0.11		0.11
Q Shrimp age 2		0.03		0.03		0.02		0.02		0.03		0.02		0.03		0.02		0.03		0.07		0.08
Q Shrimp age 3		0.04		0.04		0.04		0.04		0.04		0.03		0.05		0.04		0.04		0.09		0.11
Q Fall adult 40+		0.05		0.06		0.04		0.04		0.05		0.03		0.06		0.05		0.06		0.08		0.08
Q Spring adult 40+		0.05		0.06		0.04		0.04		0.05		0.03		0.06		0.05		0.06		0.08		0.08
Q Shrimp adult 40+		0.04		0.05		0.03		0.03		0.04		0.03		0.05		0.04		0.05		0.07		0.06
Fstart		0.00		0.00		0.01		0.03		0.20		0.00		0.30		0.00		0.30		0.19		0.28
recruitment year 1		17.7		14.6		24.1		25.5		26.2		35.6		24.6		20.4		18.1		7.3		8.2
natural mortality		0.3		0.3		0.3		0.3		0.3		0.3&0.4		0.3		0.3		0.3		0.2		0.2
fit to 94 catch len freq		yes		no		no		no		no		no		no		no		no		no		no
lifespan		15		15		15		15		15		15		15		15		15		20		20
Selectivity																						
block 1 (1980-1995)																						
alpha		60.0		60.0		30.0		27.3		33.7		40.7		13.2		41.8		48.5		40.8		38.6
beta		0.06		0.09		0.26		0.32		0.00		0.18		0.00		0.16		0.13		0.16		0.19
block 2 (1996-2006)																						
alpha		43.3		44.6		42.0		42.4		45.4				49.0								
beta		0.16		0.15		0.17		0.17		0.16				0.15								

Table 27. Southern management area monkfish runs of residual sum of squares, input weights & effective sample sizes, estimated Qs, Fstart, age1 recruitment in year 1 (1980), input natural mortality, and the estimated logistic selectivity parameters. First column under each run are the weights. Residual sum of square are in the second column.

Run number	1		2		3		4		5		6		7		8		9		10	
Discription	Vrec 3		Vrec 20		separate sexes males=0.4 females=0.3		fix Fstart		constant recruitment		single selectivity block		single selectivity block (Vrec30)		double mean length at age variation		m=0.2		m=0.2, single selectivity block	
total objective function		542.05		563.50		540.71		551.37		590.03		548.06		575.65		525.48		557.65		582.52
total catch	10	0.08	10	0.11	10	0.05	10	0.18	10	0.15	10	0.10	10	0.11	10	0.08	10	0.86	10	1.55
catch len freq 1+	400	9.23	400	8.84	400	9.03	400	8.97	400	9.35	400	9.97	400	10.01	400	7.31	400	10.02	400	9.27
Vrec	3	2.43	20	0.68	3	2.39	3	2.68	3	0.00	3	2.50	30	0.44	3	3.32	3	2.53	10	1.34
Fall age 1	2	15.55	2	18.13	2	15.72	2	16.01	2	22.13	2	15.81	2	18.99	2	14.15	2	15.40	2	17.09
Spring age 2	2	8.89	2	8.87	2	8.76	2	8.90	2	9.56	2	8.81	2	8.89	2	8.92	2	9.07	2	8.96
Spring age 3	2	17.87	2	17.95	2	17.48	2	17.71	2	18.70	2	18.07	2	18.18	2	17.77	2	18.12	2	18.36
Winter age 2	2	3.42	2	3.88	2	3.43	2	3.46	2	5.04	2	3.47	2	4.08	2	3.23	2	3.39	2	3.66
Winter age 3	2	5.73	2	6.36	2	5.76	2	5.84	2	7.88	2	5.88	2	6.64	2	5.86	2	5.67	2	6.05
Scallop age 1	3	10.92	3	12.63	3	11.03	3	11.00	3	15.95	3	10.94	3	13.18	3	9.56	3	10.81	3	11.73
Scallop age 2	3	5.02	3	6.35	3	5.09	3	5.14	3	8.92	3	5.07	3	6.80	3	4.48	3	4.95	3	5.72
Fall adult 40+	3	5.95	3	6.54	3	5.94	3	7.22	3	7.50	3	6.36	3	7.25	3	5.95	3	7.62	3	8.97
Spring adult 40+	3	7.63	3	7.73	3	7.74	3	9.89	3	8.00	3	8.19	3	8.44	3	7.66	3	10.67	3	12.43
winter adult 40+	3	1.28	3	1.14	3	1.31	3	1.36	3	1.07	3	1.43	3	1.30	3	1.26	3	1.25	3	1.40
Scallop adult 40+	3	5.43	3	6.03	3	5.22	3	5.08	3	7.00	3	5.26	3	6.03	3	5.26	3	4.48	3	4.08
fall len freq 30+	200	100.45	200	99.34	200	100.67	200	99.03	200	98.88	200	100.11	200	98.94	200	100.06	200	98.82	200	96.90
spring len freq 30+	200	133.34	200	131.67	200	133.81	200	133.19	200	130.52	200	133.18	200	131.29	200	131.31	200	132.50	200	131.96
winter len freq 30+	300	22.05	300	21.72	300	22.25	300	21.39	300	22.67	300	22.21	300	22.13	300	19.85	300	21.35	300	20.56
Coop len freq 30+	300	0.91	300	0.79	300	0.97	300	0.89	300	0.86	300	0.97	300	0.84	300	0.88	300	0.75	300	0.75
Scallop len freq 30+	300	56.38	300	54.85	300	55.00	300	55.11	300	54.32	300	57.32	300	55.56	300	52.90	300	55.30	300	52.88
Q Fall age 1		0.03		0.03		0.02		0.03		0.03		0.03		0.02		0.03		0.07		0.07
Q Spring age 2		0.05		0.05		0.03		0.05		0.05		0.05		0.05		0.05		0.11		0.12
Q Spring age 3		0.05		0.05		0.04		0.06		0.05		0.05		0.04		0.05		0.11		0.11
Q Winter age 2		0.04		0.04		0.03		0.05		0.04		0.04		0.04		0.04		0.10		0.10
Q Winter age 3		0.05		0.05		0.04		0.06		0.05		0.05		0.05		0.05		0.11		0.11
Q Scallop age 1		0.03		0.03		0.02		0.03		0.03		0.03		0.03		0.03		0.07		0.08
Q Scallop age 2		0.04		0.04		0.03		0.05		0.04		0.04		0.04		0.04		0.10		0.11
Q Fall adult 40+		0.04		0.03		0.03		0.04		0.03		0.03		0.03		0.04		0.08		0.08
Q Spring adult 40+		0.03		0.03		0.03		0.04		0.03		0.03		0.03		0.03		0.07		0.08
Q winter adult 40+		0.04		0.04		0.03		0.05		0.04		0.04		0.04		0.04		0.08		0.08
Q Scallop adult 40+		0.04		0.04		0.03		0.05		0.04		0.04		0.03		0.04		0.08		0.08
Fstart		0.00		0.00		0.00		0.30		0.00		0.00		0.00		0.00		0.23		0.78
recruitment year 1		28.1		28.00		42.4		25.6		28.5		28.4		29.4		26.9		10.6		9.8
natural mortality		0.3		0.30		0.3 & 0.4		0.3		0.3		0.3		0.3		0.3		0.2		0.2
lifespan		15		15		15		15		15		15		15		15		20		20
Selectivity																				
block 1 (1980-1995)																				
alpha		24.83		25.34		25.53		40.97		25.56		44.21		43.32		24.45		22.74		46.31
beta		0.30		0.34		0.28		0.13		0.42		0.16		0.17		0.30		0.39		0.15
block 2 (1996-2006)																				
alpha		49.05		49.37		48.78		52.06		49.80						49.05		53.82		
beta		0.15		0.15		0.15		0.14		0.15						0.15		0.13		

Table 28. Northern management unit monkfish working group runs of residual sum of squares, input weights & effective sample sizes, estimated Qs, fixed Fstart, age1 recruitment in year 1 (1980), input natural mortality, and the estimated logistic selectivity parameters. First column under each run are the weights. Residual sum of square are in the second column.

Run number	1		3	
Discription	North M=0.3		North M=0.2	
total objective function		241.34		243.46
total catch	10	0.07	10	0.06
catch len freq 1+	400	9.57	400	10.89
Vrec	5	4.99	5	5.78
Fall age 1	2	16.20	2	15.18
Spring age 2	2	14.72	2	13.97
Spring age 3	2	15.39	2	14.97
Shrimp age 2	2	10.77	2	10.58
Shrimp age 3	2	3.26	2	3.09
Fall adult 40+	3	5.32	3	5.18
Spring adult 40+	3	4.28	3	4.36
Shrimp adult 40+	3	5.04	3	5.50
fall len freq 30+	25	13.82	25	13.59
spring len freq 30+	25	13.18	25	12.72
Shrimp len freq 30+	75	14.28	75	15.67
Coop len freq 30+	100	0.26	100	0.28
Q Fall age 1		0.02		0.05
Q Spring age 2		0.04		0.07
Q Spring age 3		0.05		0.09
Q Shrimp age 2		0.02		0.05
Q Shrimp age 3		0.04		0.07
Q Fall adult 40+		0.04		0.05
Q Spring adult 40+		0.04		0.05
Q Shrimp adult 40+		0.13		0.15
Fstart		0.01		0.01
recruitment year 1		20.5		9.2
natural mortality		0.3		0.2
fit to 94 catch len freq		no		no
lifespan		12		15
Selectivity				
block 1 (1980-2009)				
alpha		42.7		37.1
beta		0.16		0.19

Table 29. Southern management unit monkfish working group runs of residual sum of squares, input weights & effective sample sizes, estimated Qs, fixed Fstart, age1 recruitment in year 1 (1980), input natural mortality, and the estimated logistic selectivity parameters. First column under each run are the weights. Residual sum of square are in the second column.

Run number	1		3	
Discription	South M=0.3		South M=0.2	
total objective function		287.71		299.26
total catch	10	0.09	10	0.24
catch len freq 1+	400	9.22	400	10.41
Vrec	5	2.72	5.0	2.79
Fall age 1	2	14.75	2.00	14.51
Spring age 2	2	8.47	2.00	8.69
Spring age 3	2	18.16	2.0	18.65
Winter age 2	2	3.43	2.00	3.39
Winter age 3	2	6.14	2.00	6.04
Scallop age 1	3	9.77	3	9.57
Scallop age 2	3	4.52	3	4.42
Fall adult 40+	3	6.91	3	7.99
Spring adult 40+	3	9.29	3	10.49
winter adult 40+	3	1.36	3.00	1.29
Scallop adult 40+	3	5.55	3.00	5.71
fall len freq 30+	25	12.60	25	12.68
spring len freq 30+	25	16.84	25	16.79
winter len freq 30+	75	5.64	75	5.99
Coop len freq 30+	100	0.33	100	0.34
Scallop len freq 30+	75	14.46	75	15.80
Q Fall age 1		0.02		0.06
Q Spring age 2		0.04		0.10
Q Spring age 3		0.05		0.09
Q Winter age 2		0.04		0.09
Q Winter age 3		0.0463		0.0952
Q Scallop age 1		0.03		0.07
Q Scallop age 2		0.0		0.1
Q Fall adult 40+		0.0		0.0
Q Spring adult 40+		0.0177		0.027
Q winter adult 40+		0.2488		0.3726
Q Scallop adult 40+		0.5103		0.762
Fstart		0.2		0.2
recruitment year 1		31.05		11.91
natural mortality		0.3		0.2
lifespan		12		15
Selectivity				
block 1 (1980-1995)				
alpha		40.238		28.215
beta		0.1304		0.2733
block 2 (1996-2003)				
alpha		48.323		46.665
beta		0.1469		0.1531
block 2 (1994-2009)				
alpha		50.981		48.397
beta		0.134		0.1334

Table 30. Estimates of age-1 recruitment, biomass and fishing mortality rates from SCALE model final runs.

North					South				
Year	Age-1 Recruitment	Exploitable Biomass (kt)	Total Biomass (kt)	F	Year		Exploitable Biomass (kt)	Total Biomass (kt)	F
1980	20.50	110.83	127.27	0.05	1980	31.05	86.81	107.91	0.09
1981	14.77	107.23	123.28	0.05	1981	29.96	95.23	116.80	0.06
1982	15.30	104.22	119.68	0.05	1982	24.51	105.52	127.14	0.05
1983	14.84	101.03	115.55	0.05	1983	22.13	115.81	136.88	0.05
1984	13.53	98.12	111.38	0.06	1984	21.65	124.73	144.67	0.04
1985	10.42	94.16	106.18	0.08	1985	20.58	132.02	150.44	0.05
1986	15.11	88.66	99.93	0.07	1986	23.80	134.99	152.10	0.04
1987	14.15	83.50	94.26	0.09	1987	36.12	135.61	152.67	0.04
1988	17.42	76.51	87.14	0.11	1988	14.49	133.23	150.35	0.05
1989	23.66	68.89	80.34	0.15	1989	25.93	127.90	145.58	0.12
1990	27.30	60.25	73.29	0.17	1990	34.10	115.54	133.81	0.10
1991	21.38	53.53	68.36	0.18	1991	39.77	108.04	127.04	0.13
1992	23.33	49.53	66.24	0.22	1992	32.57	98.67	118.80	0.20
1993	36.49	49.15	67.62	0.34	1993	43.95	88.04	110.42	0.26
1994	33.13	46.75	66.12	0.34	1994	35.49	80.43	104.39	0.23
1995	15.48	46.35	66.26	0.41	1995	29.88	79.52	104.05	0.28
1996	20.10	44.93	65.23	0.43	1996	23.35	67.98	101.55	0.35
1997	34.47	45.51	65.33	0.32	1997	24.53	67.39	100.18	0.37
1998	40.99	49.87	69.09	0.20	1998	43.85	67.26	98.37	0.36
1999	52.82	56.78	78.25	0.20	1999	39.26	66.61	96.42	0.29
2000	52.57	61.83	88.35	0.22	2000	34.85	69.21	99.76	0.19
2001	32.21	66.90	97.95	0.30	2001	16.56	74.60	107.38	0.23
2002	26.24	70.35	103.03	0.30	2002	33.33	77.92	112.56	0.19
2003	26.10	77.35	108.33	0.32	2003	50.37	85.27	120.07	0.20
2004	27.85	83.57	110.08	0.23	2004	25.71	86.74	124.26	0.15
2005	22.79	90.33	112.87	0.16	2005	17.44	93.82	129.99	0.15
2006	27.05	97.94	118.70	0.09	2006	30.60	98.25	135.45	0.12
2007	20.50	109.52	129.62	0.06	2007	31.05	104.87	142.74	0.07
2008	20.50	119.88	139.31	0.06	2008	31.05	116.07	151.76	0.07
2009	20.50	125.40	144.02	0.05	2009	31.05	125.14	158.82	0.06

Table 31. Length-based yield per recruit for monkfish, management areas combined.
NFT Length-Based YPR, ver. 1.3.

Logisitic maturity		a= -8.7058	b=0.2045	data source: 2001 coop survey
Length-weight		ln(a)= -10.8461	b=2.94676	data source: 2004 coop survey, N+S, females
Selectivity	North	a=-6.75	0.157839	SCALE results
	South	a=-6.8	b=0.1339	SCALE results

North

	Von B	Linf=130	k=0.1276	t0=1.5103	data source: 2001, 2004 coop + big monks			
	m=0.2	max age=15			m=0.3	max age=12		
Reference Point	F	YPR	SSBR	Total B / R	F	YPR	SSBR	Total B / R
Fzero	0.00	0.00	20.12	21.04	0.00	0.00	7.83	8.58
F-01	0.15	1.28	8.28	9.14	0.24	0.75	3.22	3.91
F-Max	0.23	1.34	5.63	6.46	0.41	0.79	2.04	2.70
F at 40% MSP	0.16	1.29	8.05	8.90	0.25	0.75	3.13	3.83

North

	Von B	Linf=158	k=0.095	t0=0.162	Armstrong et al. (1992)			
	m=0.2	max age=15			m=0.3	max age=12		
Reference Point	F	YPR	SSBR	Total B / R	F	YPR	SSBR	Total B / R
Fzero	0	0	21.91	22.84	0.00	0.00	8.05	8.80
F-01	0.14	1.32	9.10	9.97	0.23	0.74	3.33	4.03
F-Max	0.22	1.39	6.31	7.15	0.38	0.79	2.16	2.82
F at 40% MSP	0.15	1.34	8.76	9.62	0.24	0.75	3.22	3.91

South

	Von B	Linf=130	k=0.1276	t0=1.5103	data source: 2001, 2004 coop + big monks			
	m=0.2	max age=15			m=0.3	max age=12		
Reference Point	F	YPR	SSBR	Total B / R	F	YPR	SSBR	Total B / R
Fzero	0.00	0.00	20.12	21.04	0.00	0.00	7.83	8.58
F-01	0.18	1.40	8.59	9.48	0.28	0.79	3.41	4.12
F-Max	0.29	1.49	5.77	6.64	0.51	0.85	2.16	2.85
F at 40% MSP	0.20	1.43	8.05	8.93	0.32	0.81	3.13	3.84

South

	Von B	Linf=158	k=0.095	t0=0.162	Armstrong et al. (1992)			
	m=0.2	max age=15			m=0.3	max age=12		
Reference Point	F	YPR	SSBR	Total B / R	F	YPR	SSBR	Total B / R
Fzero	0.00	0.00	21.91	22.84	0.00	0.00	8.05	8.80
F-01	0.17	1.46	9.41	10.30	0.27	0.78	3.52	4.23
F-Max	0.27	1.54	6.46	7.33	0.47	0.84	2.28	2.97
F at 40% MSP	0.19	1.49	8.77	9.65	0.30	0.81	3.22	3.93

Table 32. Recruits of age-based yield-per-recruit analysis for M=0.3 and area-specific selectivity patterns estimated from SCALE model outputs.

A. North

Reference Point	F	YPR	SSBR	Total B / R
Fzero	0.00	0.00	7.97	9.94
F-01	0.18	0.56	3.22	4.81
F-Max	0.31	0.60	2.06	3.51
F at 40% MSP	0.18	0.56	3.19	4.77

B. South

Reference Point	F	YPR	SSBR	Total B / R
Fzero	0.00	0.00	5.32	6.41
F-01	0.25	0.50	2.43	3.39
F-Max	0.40	0.53	1.72	2.61
F at 40% MSP	0.31	0.52	2.13	3.06

Table 33a. Stratified mean catch per tow in weight (kg), and 3-year moving averages, NEFSC offshore autumn research vessel bottom trawl in the northern region (survey strata 20-30, 34-40). (A) revised data, May 2007, (B) un-revised data. BTARGET is the median of the 3-year moving average for 1965-1981. BTHRESHOLD is half of BTARGET. Data revisions include audit of historical data (1963-1971) and increase in precision (2001-2006).

A. Revised data

	Northern Management Area			
	Mean Weight/Tow	$B_{THRESHOLD}$	Three-year Moving Ave	B_{TARGET}
1963	3.757			
1964	1.892			
1965	2.537	1.302	2.729	2.604
1966	3.382	1.302	2.604	2.604
1967	1.226	1.302	2.382	2.604
1968	2.050	1.302	2.219	2.604
1969	3.757	1.302	2.344	2.604
1970	2.274	1.302	2.694	2.604
1971	2.914	1.302	2.982	2.604
1972	1.404	1.302	2.197	2.604
1973	3.114	1.302	2.477	2.604
1974	2.063	1.302	2.193	2.604
1975	1.711	1.302	2.296	2.604
1976	3.387	1.302	2.387	2.604
1977	5.568	1.302	3.555	2.604
1978	5.101	1.302	4.685	2.604
1979	5.133	1.302	5.267	2.604
1980	4.458	1.302	4.897	2.604
1981	1.984	1.302	3.859	2.604
1982	0.936	1.302	2.459	2.604
1983	1.617	1.302	1.513	2.604
1984	3.010	1.302	1.855	2.604
1985	1.441	1.302	2.023	2.604
1986	2.353	1.302	2.268	2.604
1987	0.873	1.302	1.556	2.604
1988	1.525	1.302	1.584	2.604
1989	1.384	1.302	1.261	2.604
1990	1.001	1.302	1.303	2.604
1991	1.235	1.302	1.207	2.604
1992	1.102	1.302	1.113	2.604
1993	1.044	1.302	1.127	2.604
1994	0.973	1.302	1.040	2.604
1995	1.711	1.302	1.243	2.604
1996	1.07	1.302	1.252	2.604
1997	0.669	1.302	1.150	2.604
1998	0.974	1.302	0.904	2.604
1999	0.825	1.302	0.823	2.604
2000	2.495	1.302	1.431	2.604
2001	2.070	1.302	1.797	2.604
2002	2.320	1.302	2.295	2.604
2003	2.723	1.302	2.371	2.604
2004	0.626	1.302	1.890	2.604
2005	1.623	1.302	1.657	2.604
2006	1.042	1.302	1.097	2.604

B. Un-revised data

	Northern Management Area			
	Mean Weight/Tow	$B_{THRESHOLD}$	Three-Year Moving Ave	B_{TARGET}
1963	3.757			
1964	1.712			
1965	2.509	1.250	2.659	2.496
1966	3.266	1.250	2.496	2.496
1967	1.283	1.250	2.353	2.496
1968	2.036	1.250	2.195	2.496
1969	3.705	1.250	2.341	2.496
1970	2.237	1.250	2.659	2.496
1971	2.914	1.250	2.952	2.496
1972	1.404	1.250	2.185	2.496
1973	3.114	1.250	2.477	2.496
1974	2.063	1.250	2.193	2.496
1975	1.711	1.250	2.296	2.496
1976	3.387	1.250	2.387	2.496
1977	5.568	1.250	3.555	2.496
1978	5.101	1.250	4.685	2.496
1979	5.133	1.250	5.267	2.496
1980	4.458	1.250	4.897	2.496
1981	1.984	1.250	3.859	2.496
1982	0.936	1.250	2.459	2.496
1983	1.617	1.250	1.513	2.496
1984	3.010	1.250	1.855	2.496
1985	1.441	1.250	2.023	2.496
1986	2.353	1.250	2.268	2.496
1987	0.873	1.250	1.556	2.496
1988	1.525	1.250	1.584	2.496
1989	1.384	1.250	1.261	2.496
1990	1.001	1.250	1.303	2.496
1991	1.235	1.250	1.207	2.496
1992	1.102	1.250	1.113	2.496
1993	1.044	1.250	1.127	2.496
1994	0.973	1.250	1.040	2.496
1995	1.711	1.250	1.243	2.496
1996	1.07	1.250	1.252	2.496
1997	0.669	1.250	1.150	2.496
1998	0.974	1.250	0.904	2.496
1999	0.825	1.250	0.823	2.496
2000	2.495	1.250	1.431	2.496
2001	2.048	1.250	1.789	2.496
2002	2.103	1.250	2.215	2.496
2003	1.925	1.250	2.025	2.496
2004	0.638	1.250	1.555	2.496
2005	1.078	1.250	1.214	2.496
2006	1.066	1.250	0.927	2.496

Table 33b. Stratified mean catch per tow in weight (kg), and 3-year moving averages, NEFSC offshore autumn research vessel bottom trawl in the southern region (survey strata 1-19, 61-76). BTARGET is the median of the 3-year moving average for 1965-1981. BTHRESHOLD is half of BTARGET. Data revisions include audit of historical data (1963-1971) and increase in precision (2001-2006).

A. Revised data

	Southern Management/ Assessment Area			
	Mean Weight/To	$B_{THRESHOLD}$	Three-Year Moving Aver	B_{TARGET}
1963	3.614			
1964	5.490			
1965	5.068	0.924	4.724	1.848
1966	7.044	0.924	5.867	1.848
1967	1.114	0.924	4.409	1.848
1968	0.882	0.924	3.013	1.848
1969	1.340	0.924	1.112	1.848
1970	1.343	0.924	1.188	1.848
1971	0.779	0.924	1.154	1.848
1972	4.918	0.924	2.347	1.848
1973	1.986	0.924	2.561	1.848
1974	0.710	0.924	2.538	1.848
1975	2.043	0.924	1.580	1.848
1976	1.084	0.924	1.279	1.848
1977	1.873	0.924	1.667	1.848
1978	1.395	0.924	1.451	1.848
1979	2.275	0.924	1.848	1.848
1980	1.868	0.924	1.846	1.848
1981	2.858	0.924	2.334	1.848
1982	0.646	0.924	1.791	1.848
1983	2.150	0.924	1.885	1.848
1984	0.740	0.924	1.179	1.848
1985	1.318	0.924	1.403	1.848
1986	0.552	0.924	0.870	1.848
1987	0.274	0.924	0.715	1.848
1988	0.554	0.924	0.460	1.848
1989	0.625	0.924	0.485	1.848
1990	0.426	0.924	0.535	1.848
1991	0.783	0.924	0.611	1.848
1992	0.312	0.924	0.507	1.848
1993	0.294	0.924	0.463	1.848
1994	0.611	0.924	0.406	1.848
1995	0.386	0.924	0.430	1.848
1996	0.387	0.924	0.461	1.848
1997	0.592	0.924	0.455	1.848
1998	0.500	0.924	0.493	1.848
1999	0.304	0.924	0.465	1.848
2000	0.477	0.924	0.427	1.848
2001	0.712	0.924	0.498	1.848
2002	1.315	0.924	0.835	1.848
2003	0.827	0.924	0.951	1.848
2004	0.969	0.924	1.037	1.848
2005	0.804	0.924	0.867	1.848
2006	0.834	0.924	0.869	1.848

B. Un-revised data

	Southern Management/ Assessment Area			
	Mean Weight/Tow	$B_{THRESHOLD}$	Three-Year Moving Aver	B_{TARGET}
1963	3.724			
1964	5.486			
1965	5.163	0.924	4.791	1.848
1966	6.986	0.924	5.878	1.848
1967	1.122	0.924	4.423	1.848
1968	0.895	0.924	3.001	1.848
1969	1.138	0.924	1.051	1.848
1970	1.357	0.924	1.130	1.848
1971	0.786	0.924	1.094	1.848
1972	4.918	0.924	2.354	1.848
1973	1.986	0.924	2.564	1.848
1974	0.710	0.924	2.538	1.848
1975	2.043	0.924	1.580	1.848
1976	1.084	0.924	1.279	1.848
1977	1.873	0.924	1.667	1.848
1978	1.395	0.924	1.451	1.848
1979	2.275	0.924	1.848	1.848
1980	1.868	0.924	1.846	1.848
1981	2.858	0.924	2.334	1.848
1982	0.646	0.924	1.791	1.848
1983	2.150	0.924	1.885	1.848
1984	0.740	0.924	1.179	1.848
1985	1.318	0.924	1.403	1.848
1986	0.552	0.924	0.870	1.848
1987	0.274	0.924	0.715	1.848
1988	0.554	0.924	0.460	1.848
1989	0.625	0.924	0.485	1.848
1990	0.426	0.924	0.535	1.848
1991	0.783	0.924	0.611	1.848
1992	0.312	0.924	0.507	1.848
1993	0.294	0.924	0.463	1.848
1994	0.611	0.924	0.406	1.848
1995	0.386	0.924	0.430	1.848
1996	0.387	0.924	0.461	1.848
1997	0.592	0.924	0.455	1.848
1998	0.500	0.924	0.493	1.848
1999	0.304	0.924	0.465	1.848
2000	0.477	0.924	0.427	1.848
2001	0.709	0.924	0.496	1.848
2002	1.253	0.924	0.813	1.848
2003	0.828	0.924	0.930	1.848
2004	0.742	0.924	0.941	1.848
2005	0.765	0.924	0.778	1.848
2006	0.807	0.924	0.771	1.848

Table 34. Time series of the index three year moving average and catch for various values of r when initial catches are set equal to the equilibrium catch. Note the index value corresponding to Bmsy is 10.

	Index 3 Year Average										
Time	r=0.1	r=0.2	r=0.3	r=0.4	r=0.42	r=0.5	r=0.6	r=0.7	r=0.8	r=0.9	r=1.0
0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
1	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
2	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
3	4.5	4.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
4	4.6	4.6	4.7	4.7	4.7	4.8	4.8	4.9	4.9	5	5.1
5	4.6	4.8	4.9	5.1	5.1	5.2	5.4	5.5	5.7	5.9	6
6	4.8	5	5.3	5.6	5.7	5.9	6.2	6.6	6.9	7.3	7.6
7	4.9	5.4	5.9	6.4	6.5	6.9	7.5	8	8.6	9.2	9.7
8	5.2	5.8	6.6	7.4	7.5	8.2	9	9.8	10.5	11.2	11.9
9	5.4	6.4	7.4	8.5	8.7	9.6	10.6	11.6	12.4	13	13.5
10	5.7	7	8.4	9.8	10.1	11.1	12.2	13.1	13.7	14	14

	Catch										
Time	r=0.1	r=0.2	r=0.3	r=0.4	r=0.42	r=0.5	r=0.6	r=0.7	r=0.8	r=0.9	r=1.0
0	35	70	105	140	147	175	210	245	280	315	350
1	35	70	105	140	147	175	210	245	280	315	350
2	31.2	62.4	93.7	124.9	131.1	156.1	187.3	218.5	249.8	281	312.2
3	28.2	56.4	84.5	112.7	118.3	140.9	169.1	197.2	225.4	253.6	281.8
4	23.1	46.6	70.4	94.7	99.6	119.3	144.3	169.7	195.4	221.6	248.1
5	19.4	39.8	61.2	83.6	88.2	107.1	131.7	157.6	184.7	213	242.7
6	15.1	32.1	51	72.1	76.6	95.5	121.4	149.9	181.3	215.7	253.3
7	12.3	27.3	45.5	67.4	72.2	93.3	123.8	159.2	200.1	246.9	300
8	9.3	22.3	39.9	62.9	68.3	92.4	129.4	174.6	229	293.1	367.1
9	7.4	19.5	37.8	64.1	70.5	100.2	147.8	208.1	281.9	368.8	467.9
10	5.6	16.6	35.5	65.3	72.8	108.9	168.7	245.7	339	445.9	561.7

Table 35. Time series of the index three year moving average and catch for various values of r when initial catches are set equal to the equilibrium catch. Note the index value corresponding to Bmsy is 10.

	Index 3 Year Average										
Time	r at=0.2	r at=0.4	ıt=0.43	r at=0.6	r at=0.8	r at=1.0	r at=1.2	r at=1.4	r at=1.6	r at=1.8	r at=2.0
0	4.7	4.7	4.7	4.6	4.6	4.5	4.5	4.4	4.4	4.3	4.3
1	5.1	5	4.9	4.8	4.7	4.5	4.4	4.2	4.1	3.9	3.8
2	5.7	5.4	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.1
3	6.4	5.9	5.8	5.5	5	4.5	4.1	3.7	3.2	2.8	2.4
4	7.1	6.4	6.4	5.8	5.2	4.6	4	3.5	3	2.4	1.9
5	7.8	7	6.9	6.2	5.5	4.8	4.1	3.5	2.8	2.3	1.7
6	8.6	7.6	7.5	6.7	5.8	5	4.3	3.6	2.9	2.3	1.7
7	9.4	8.3	8.1	7.2	6.3	5.4	4.6	3.8	3.1	2.5	1.9
8	10.2	8.9	8.7	7.8	6.8	5.8	5	4.2	3.5	2.8	2.2
9	11	9.6	9.4	8.4	7.3	6.4	5.5	4.7	4	3.2	2.5
10	11.7	10.2	10	9	8	7	6.2	5.4	4.5	3.7	2.9

	Catch										
Time	r at=0.2	r at=0.4	ıt=0.43	r at=0.6	r at=0.8	r at=1.0	r at=1.2	r at=1.4	r at=1.6	r at=1.8	r at=2.0
0	14	28	30.1	42	56	70	84	98	112	126	140
1	15.1	29.7	31.8	43.7	57.1	70	82.2	93.9	104.8	115.2	124.8
2	15.2	29.1	31.1	41.7	52.8	62.4	70.6	77.3	82.3	85.8	87.6
3	16.7	30.6	32.4	41.7	50.3	56.4	60	61.4	60.6	57.8	53
4	17.1	30	31.5	38.9	44.3	46.6	46.2	43.6	39.3	33.5	26.9
5	19.1	31.5	32.9	38.3	40.8	39.8	36.4	31.4	25.4	19.2	13.3
6	20.1	31.1	32.2	35.6	35.3	32.1	27.1	21.3	15.7	10.5	6.3
7	22.8	33	33.8	35.2	32.5	27.3	21.2	15.3	10.2	6.1	3.2
8	24.3	33	33.4	32.9	28.4	22.3	16.1	10.8	6.5	3.5	1.6
9	28	35.4	35.4	32.9	26.6	19.5	13.2	8.1	4.5	2.2	0.9
10	30.1	35.7	35.4	31.3	23.9	16.6	10.5	6.1	3.1	1.4	0.5

Monkfish Figures

Figure 1. Statistical areas used to define the northern and southern monkfish management areas (from Richards 2006).

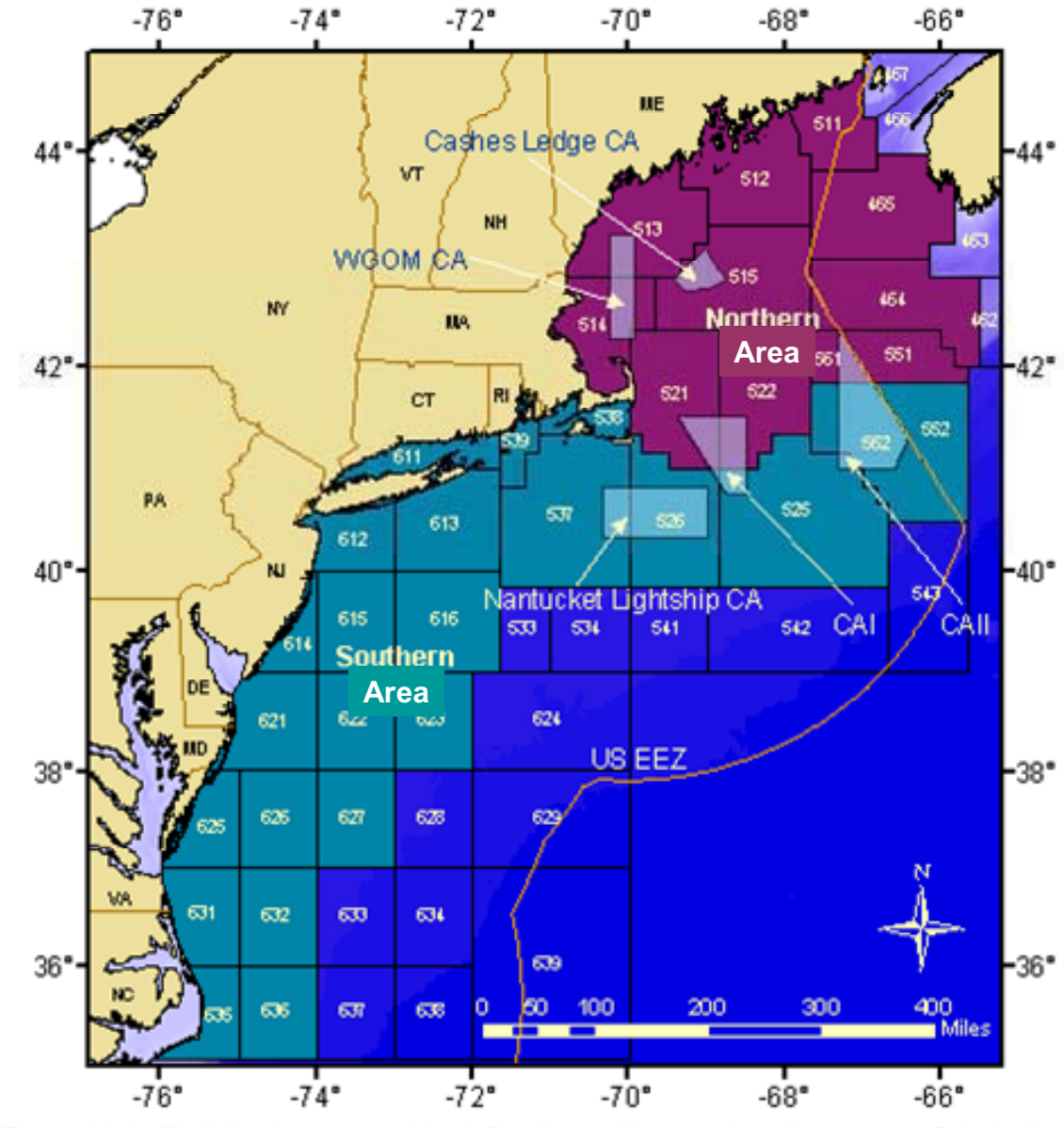


Figure 2. Reported monkfish landings, by management area and total, 1964-2006.

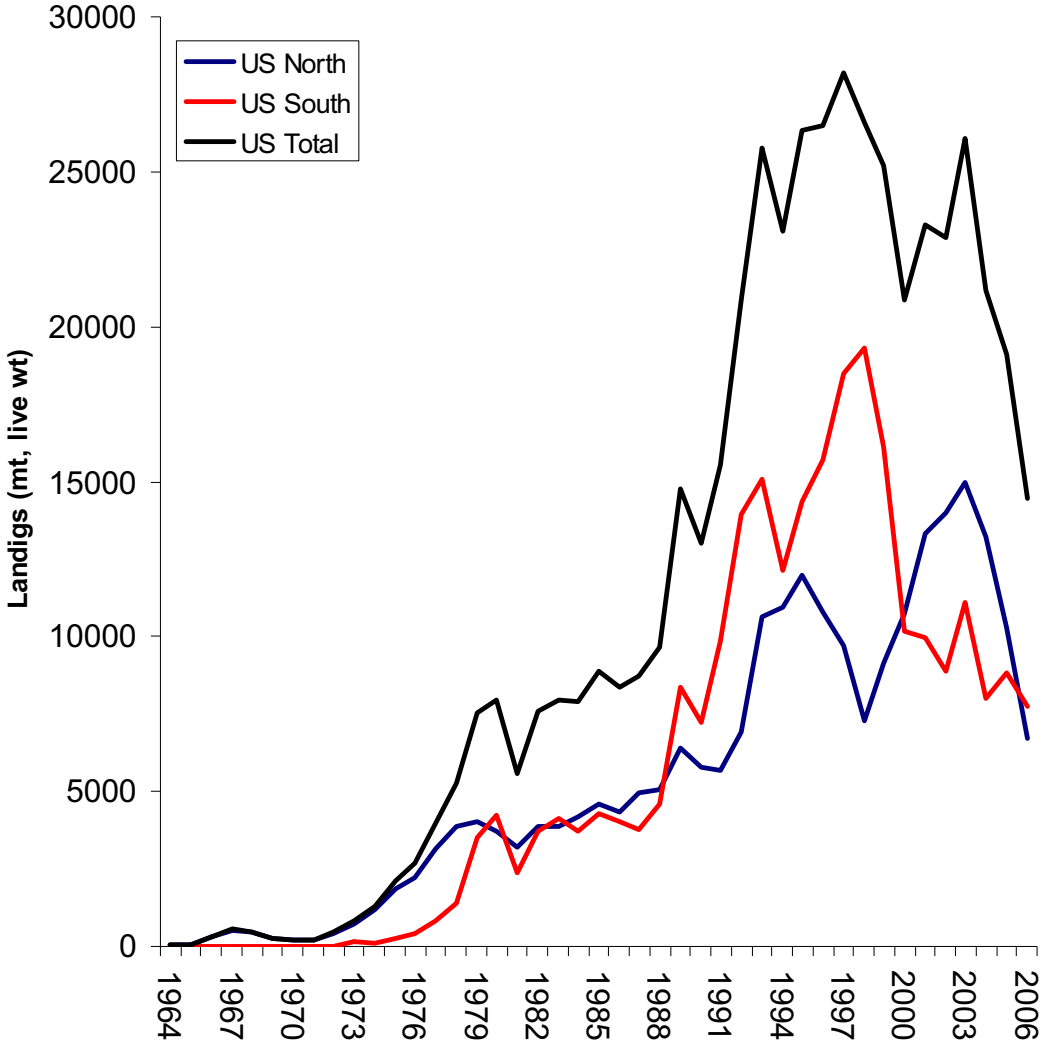
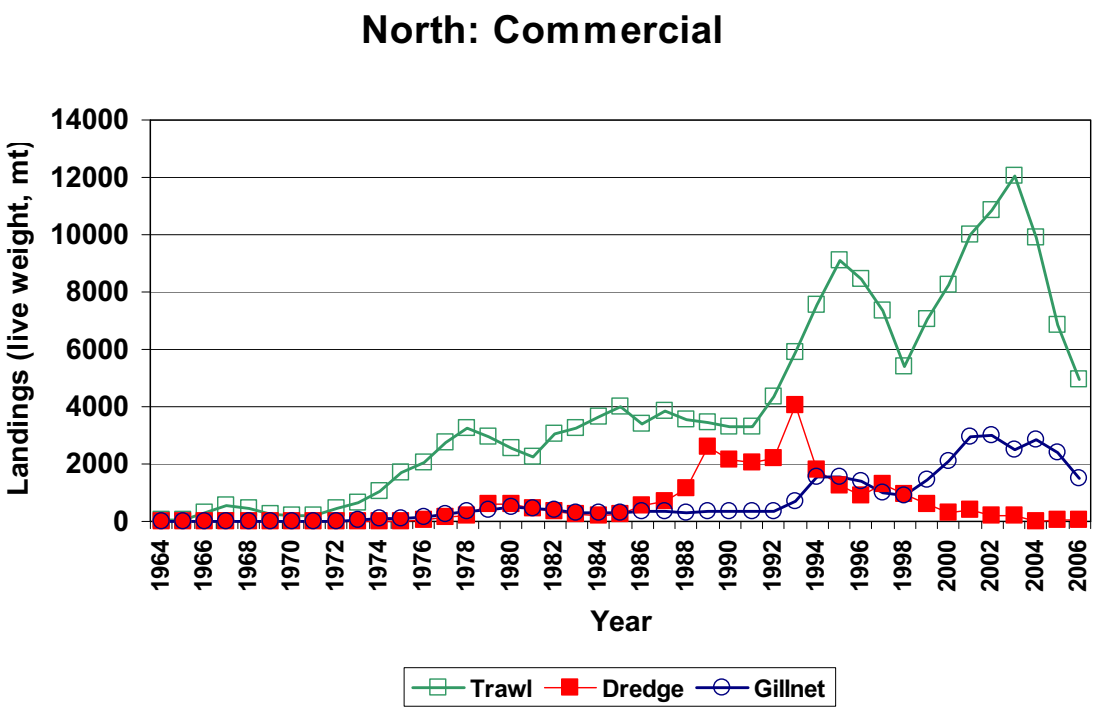


Figure 3. Reported commercial landings for monkfish by gear type and area.



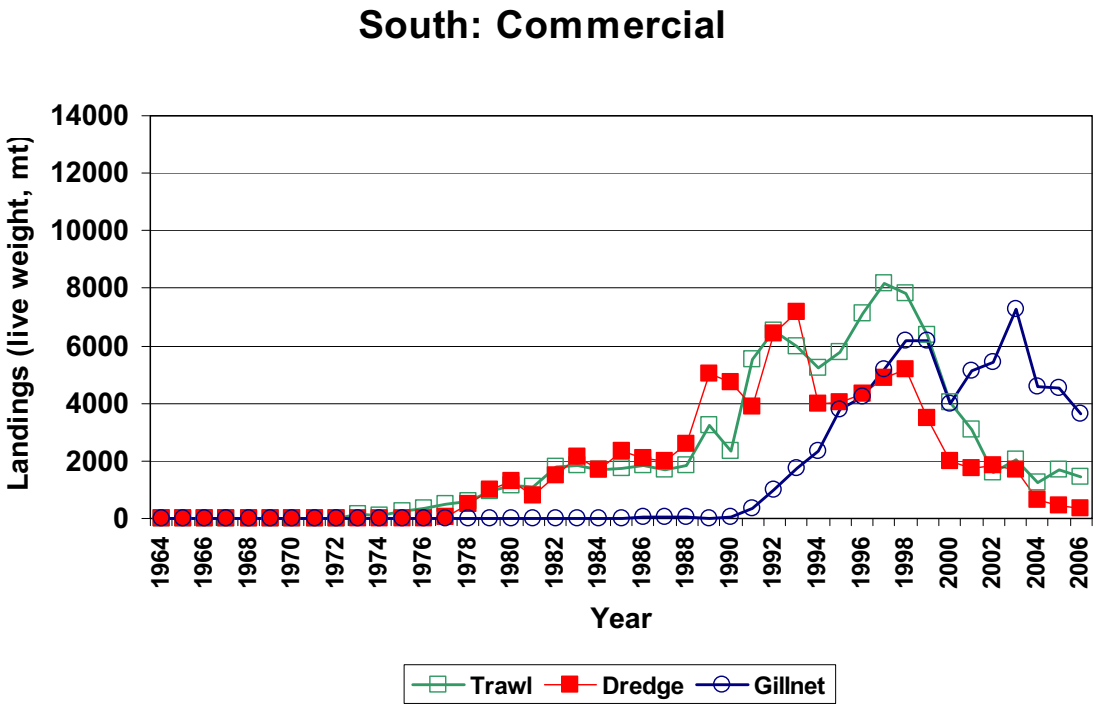


Figure 4. Monkfish landings (live weight) by market category, 2001-2006.

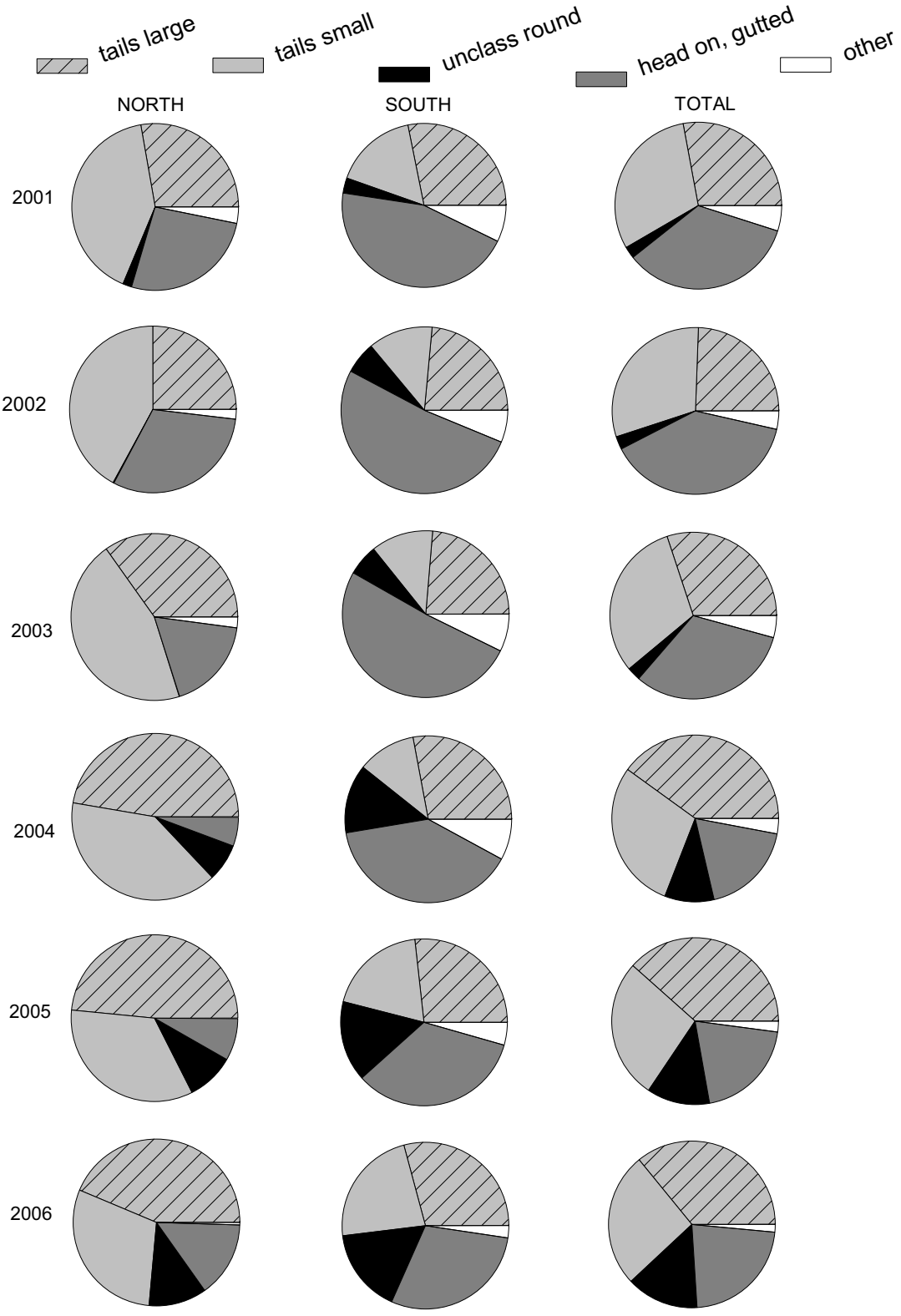


Figure 5a. Discard ratios (discard/kept monkfish) in the northern management area, by gear and half-year from VTR and observer databases.

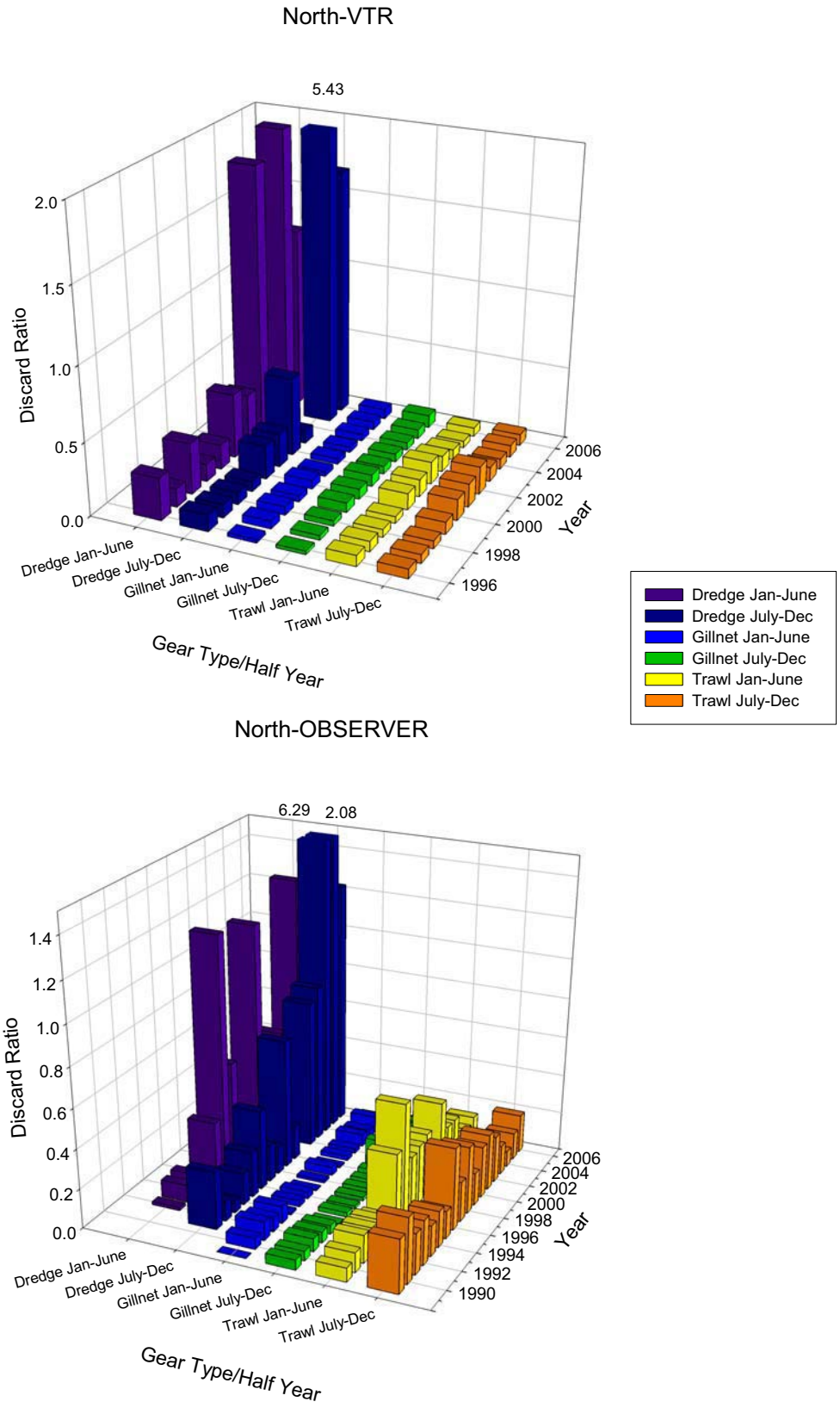


Figure 5b. Discard ratios (discard/kept monkfish) in the southern management area, by gear and half-year from VTR and observer databases.

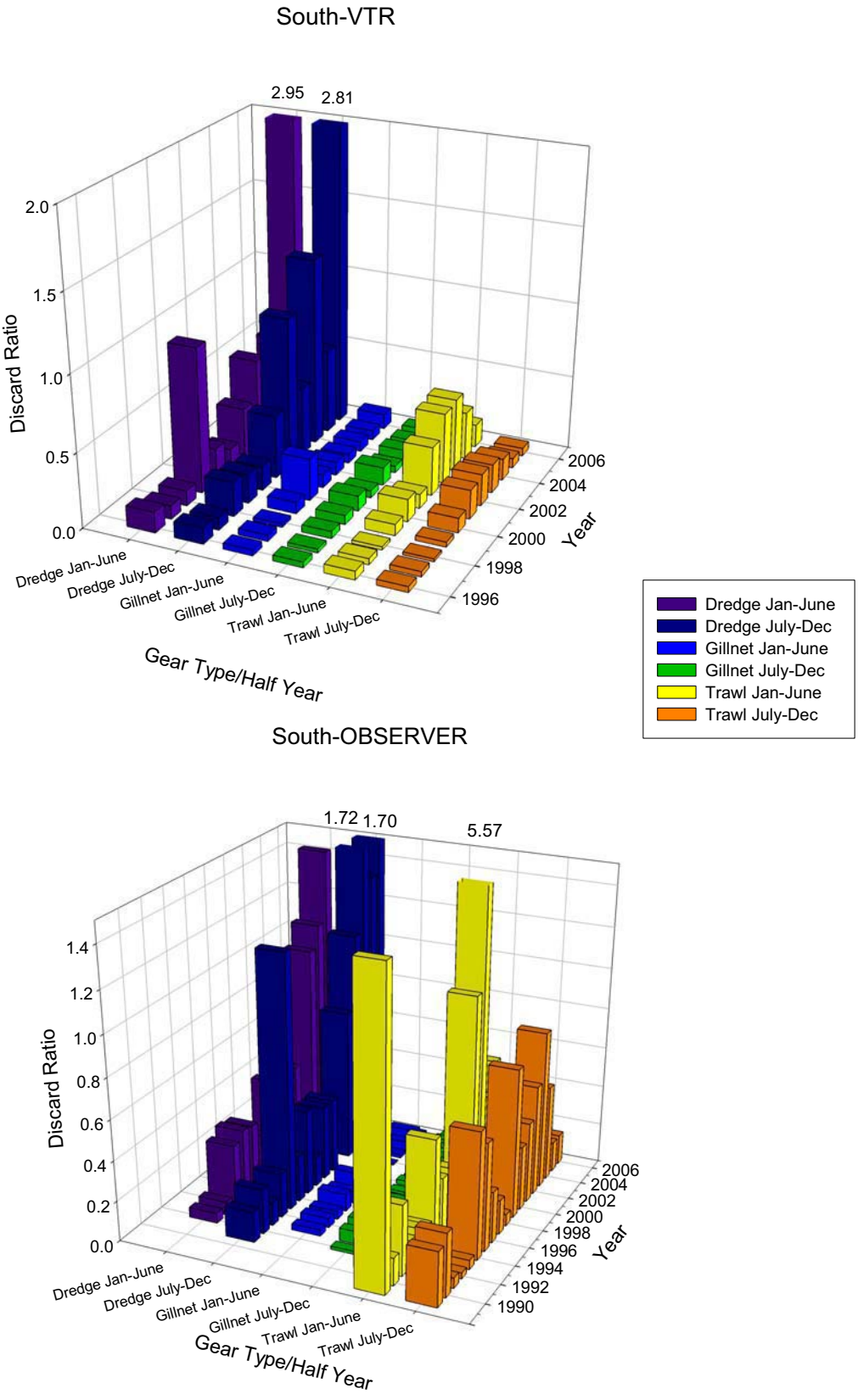


Figure 6a. Relationship between monkfish discards (y-axis) and kept monkfish (x-axis) by gear and year.

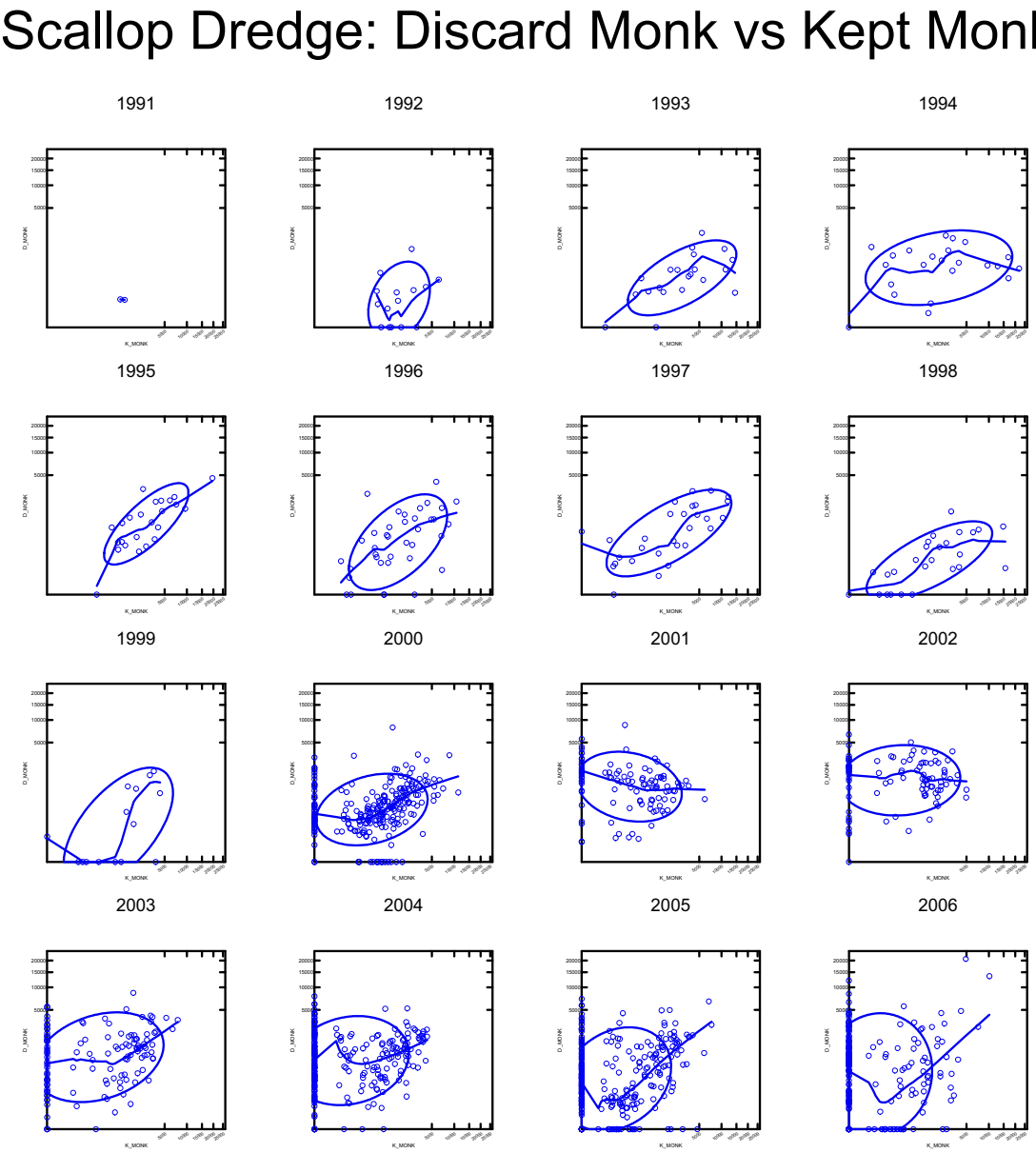


Figure 6b. Relationship between monkfish discards (y-axis)and kept monkfish (x-axis) by gear and year.

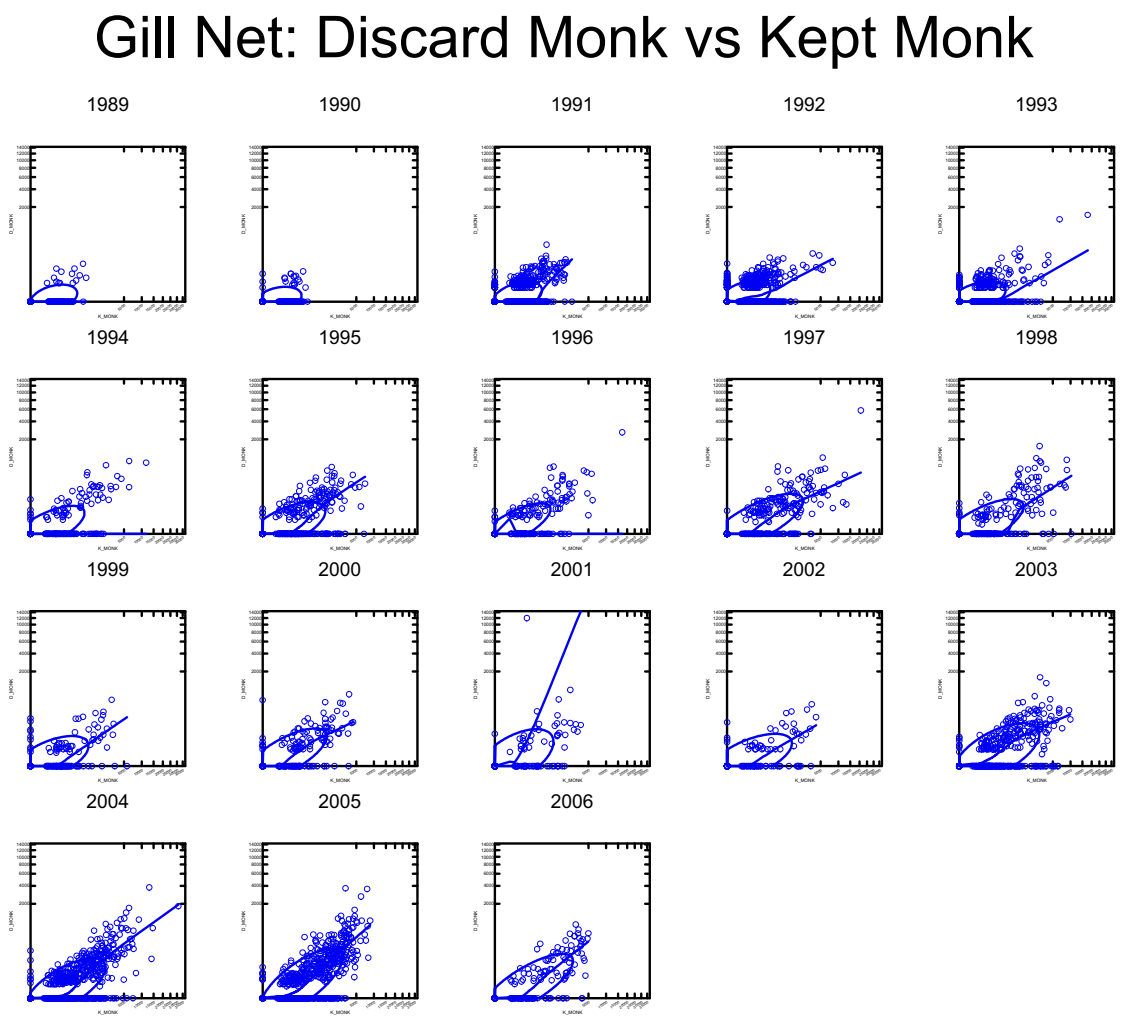


Figure 6c. Relationship between monkfish discards (y-axis) and kept monkfish (x-axis) by gear and year.

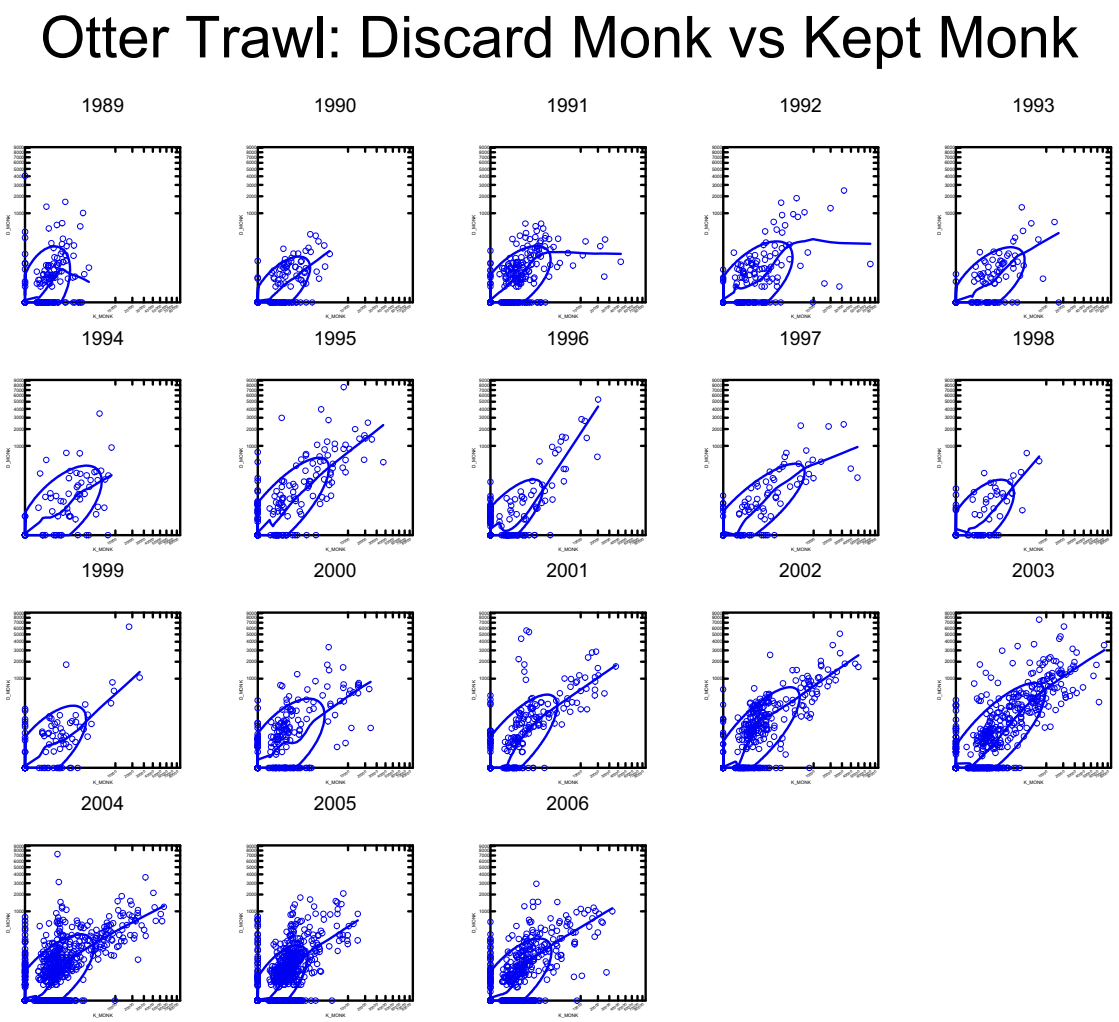


Figure 6d. Relationship between monkfish discards (y-axis) and all kept catch (x-axis) by gear and year.

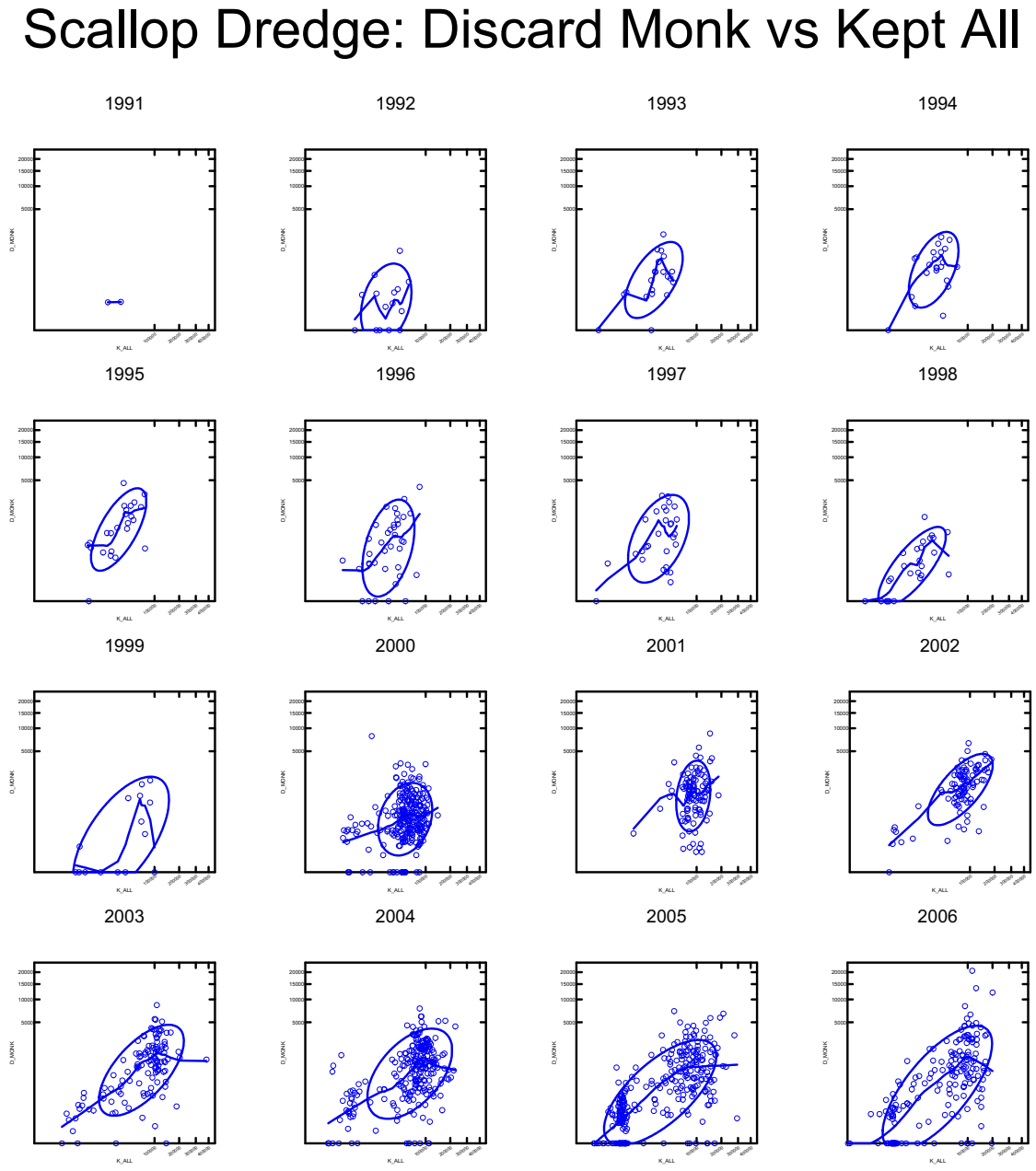


Figure 6e. Relationship between monkfish discards (y-axis)and all kept catch(x-axis) by gear and year.

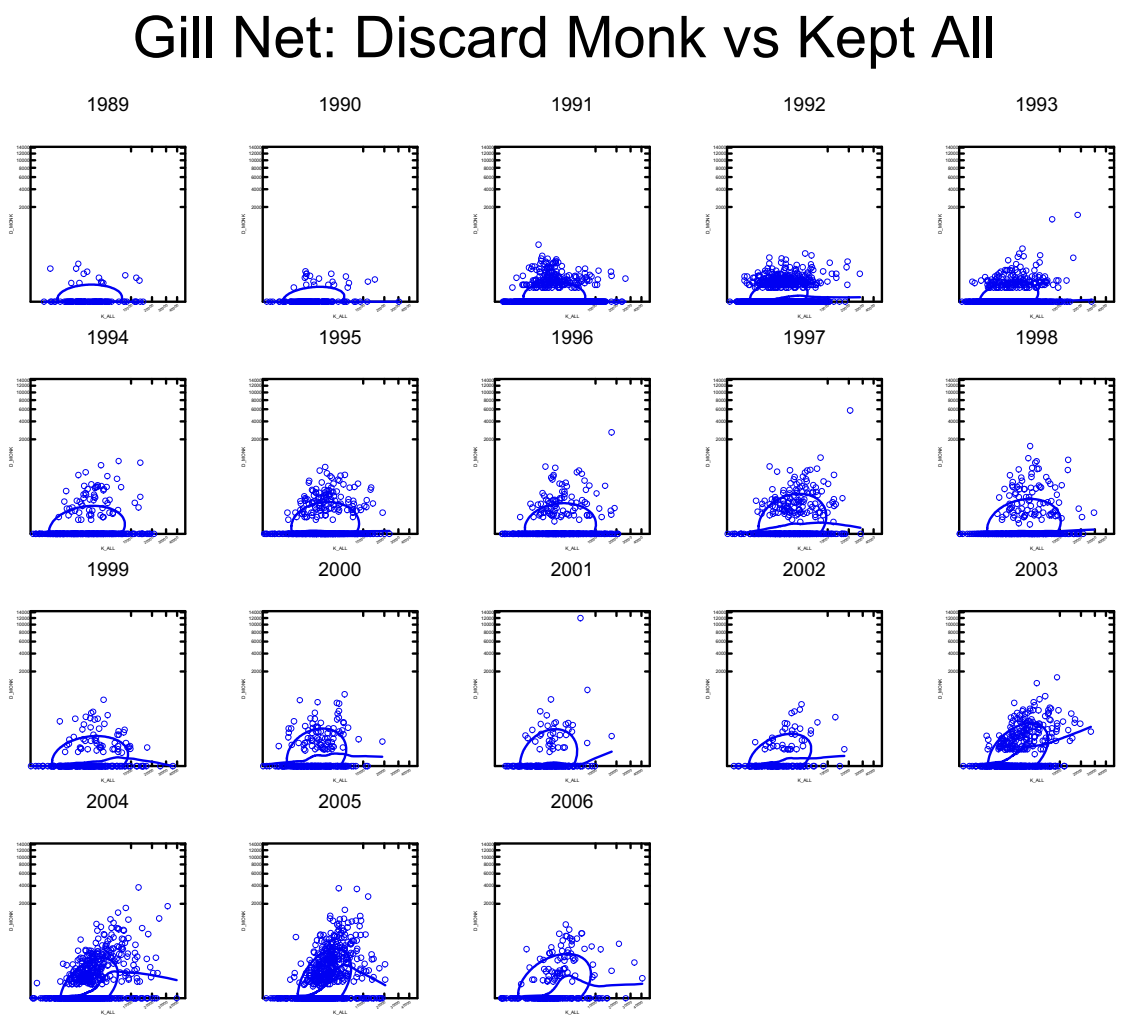


Figure 6f. Relationship between monkfish discards (y-axis) and all kept catch (x-axis) by gear and year.

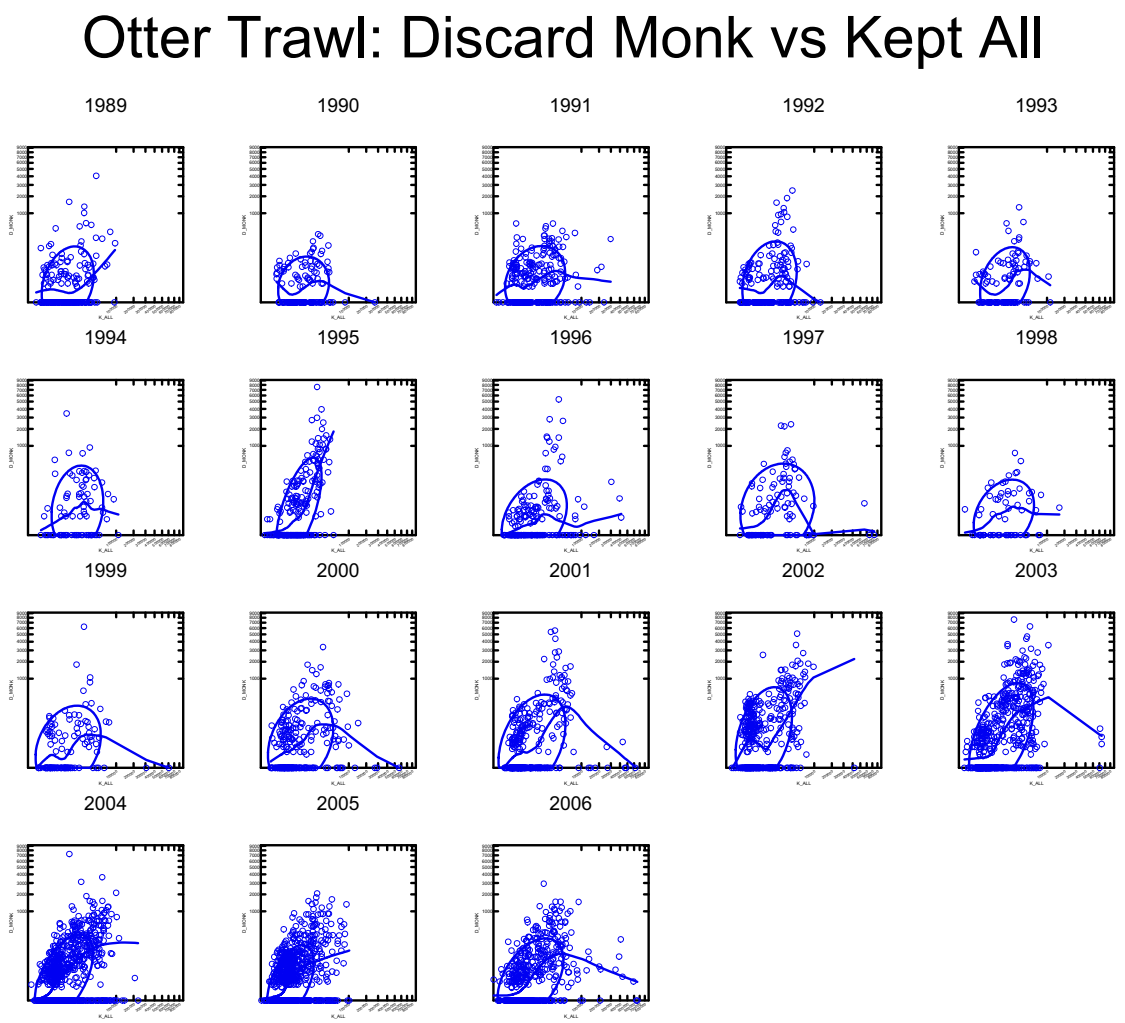
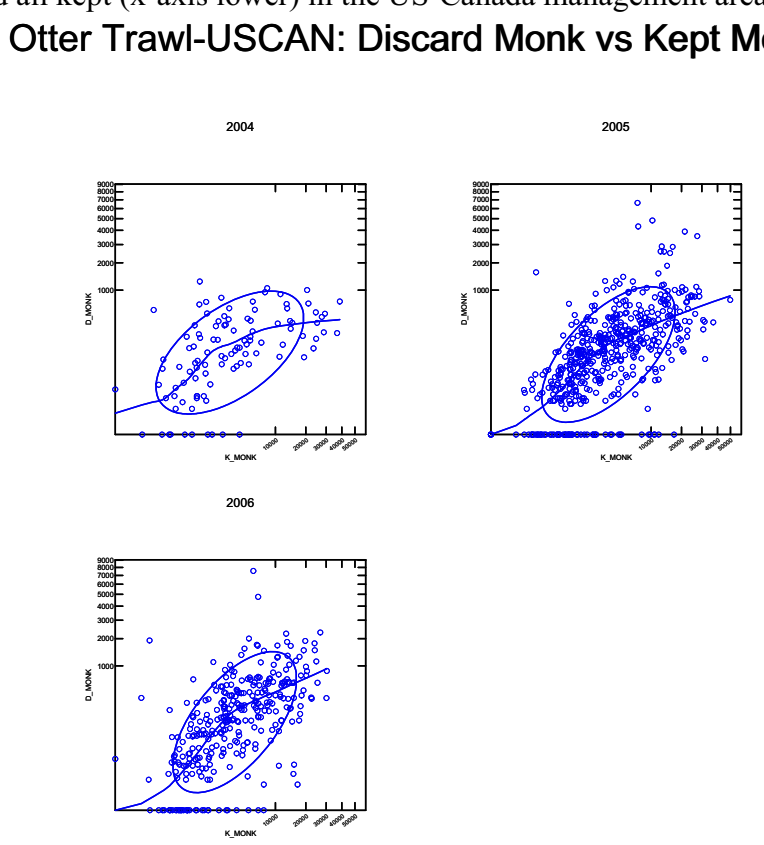


Figure 6g. Relationships between monkfish discards(y-axis) and kept monkfish (x-axis upper) and all kept (x-axis lower) in the US-Canada management area.



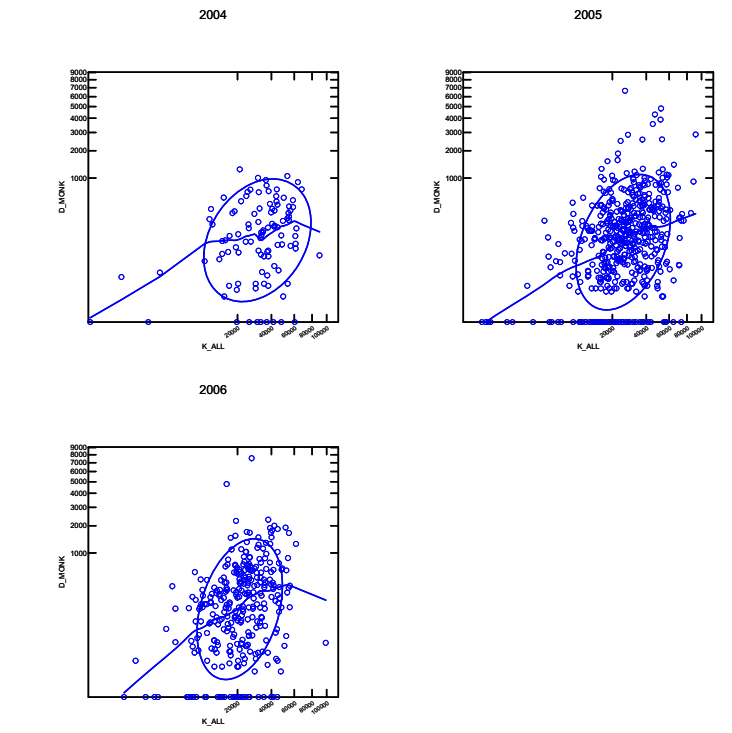
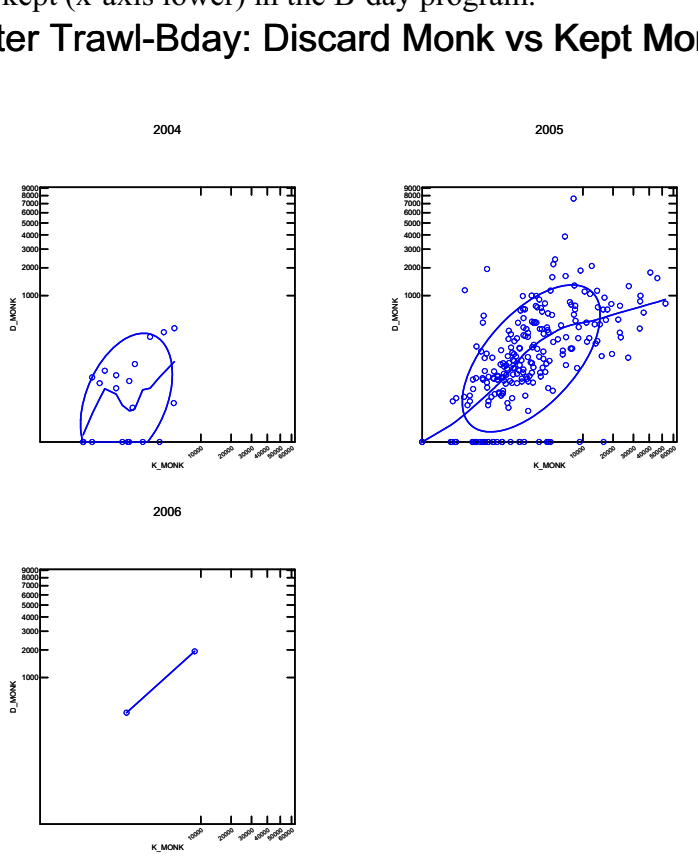


Figure 6h. Relationships between monkfish discards (y-axis) and kept monkfish (x-axis upper) and all kept (x-axis lower) in the B-day program.



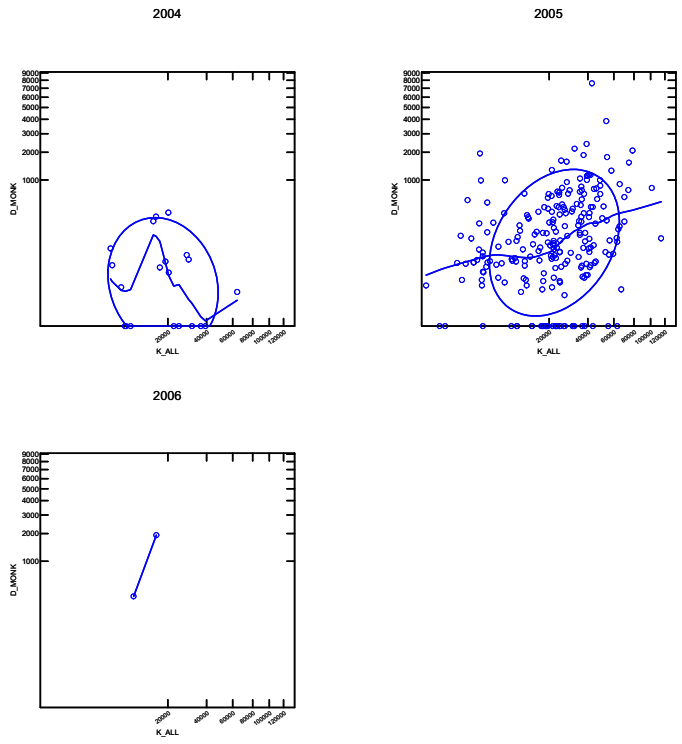


Figure 7a. Annual catch (mt) of monkfish by management area.

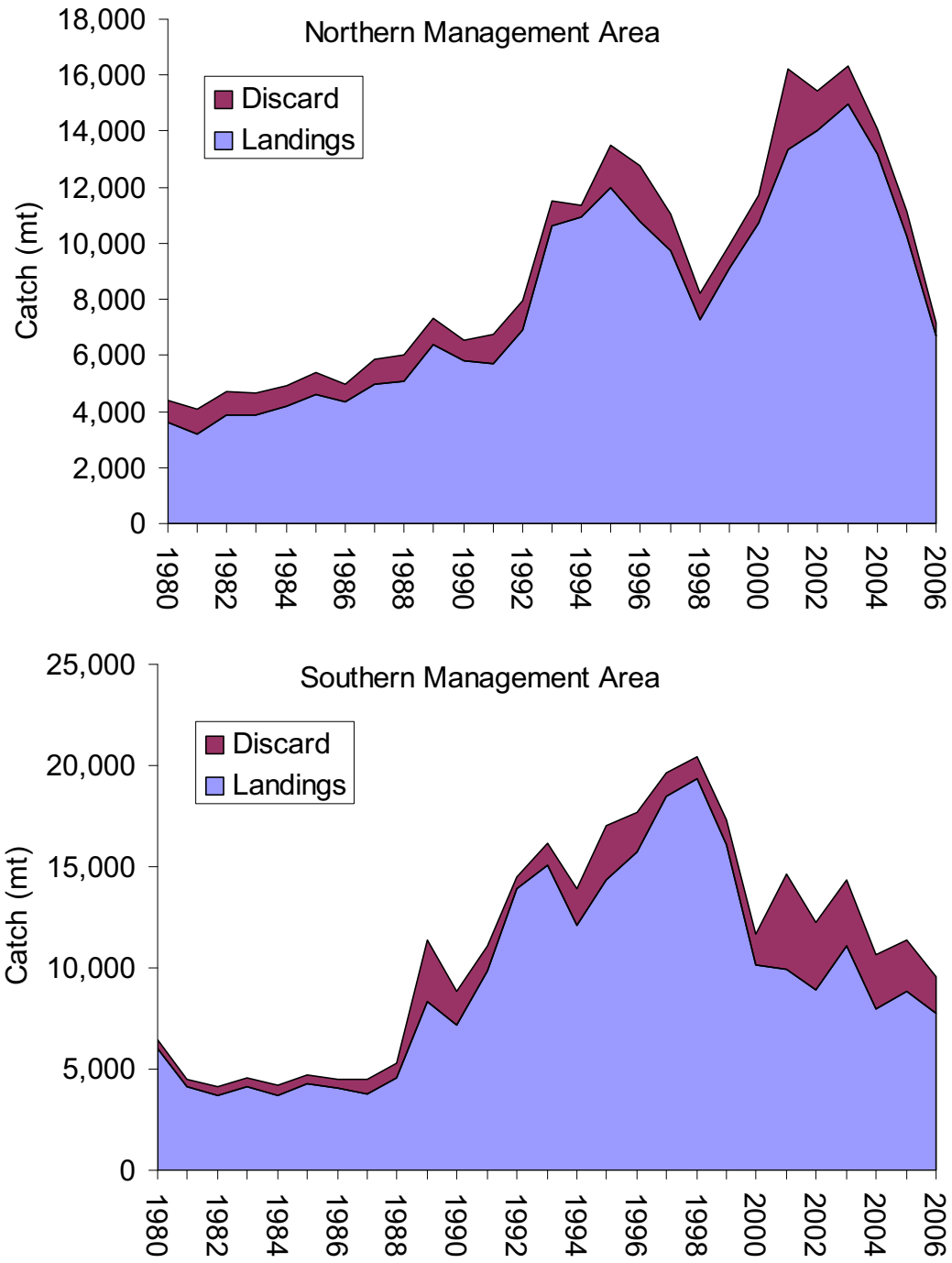


Figure 8a. Estimated length frequency of monkfish commercial landings from port samples in the northern management area.

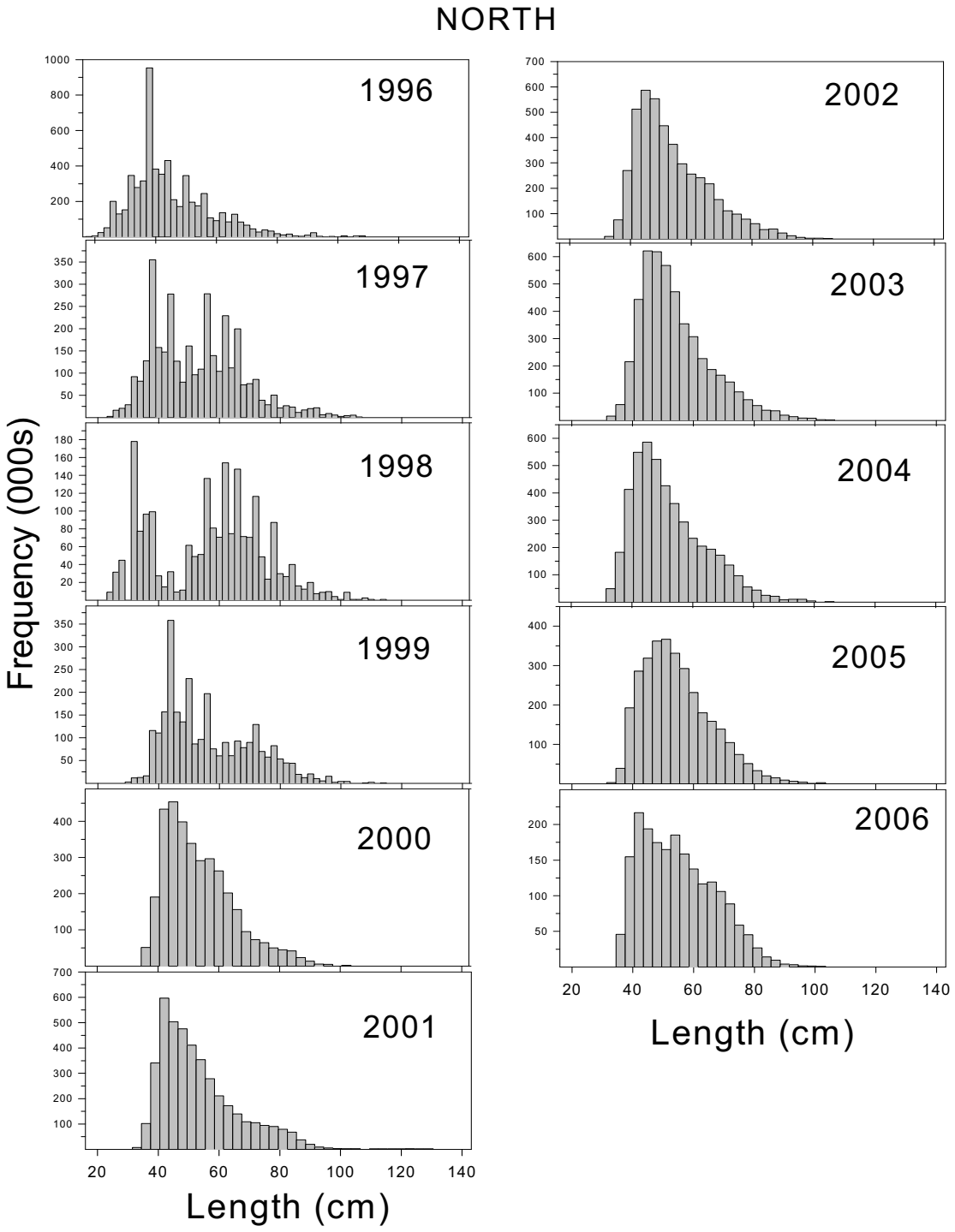


Figure 8b. Estimated length frequency of monkfish commercial landings from observer samples in the northern management area.

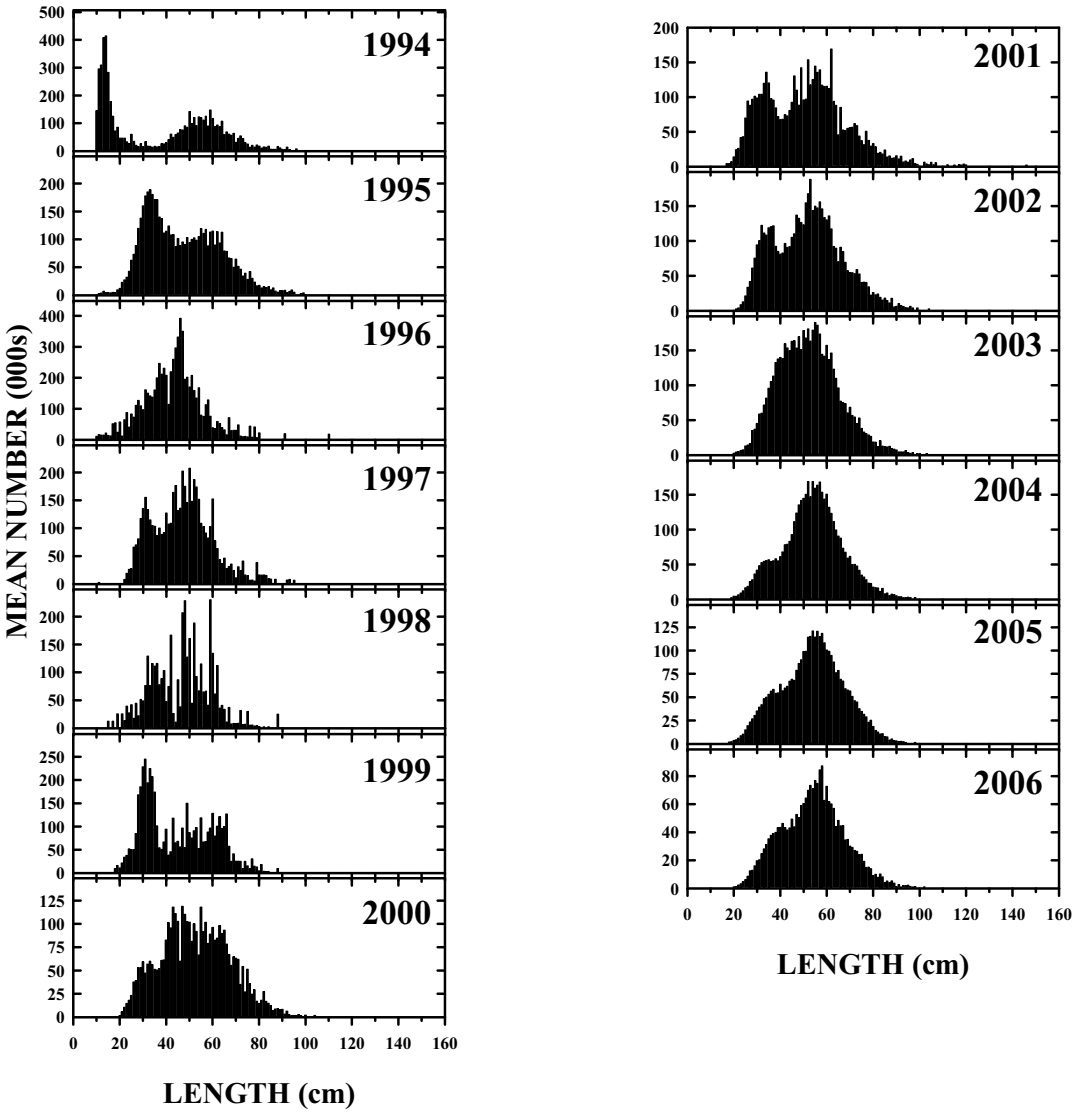


Figure 8c. Comparison of port samples (black, bold line) and observer samples (thin, red line) of monkfish lengths in the northern management area.

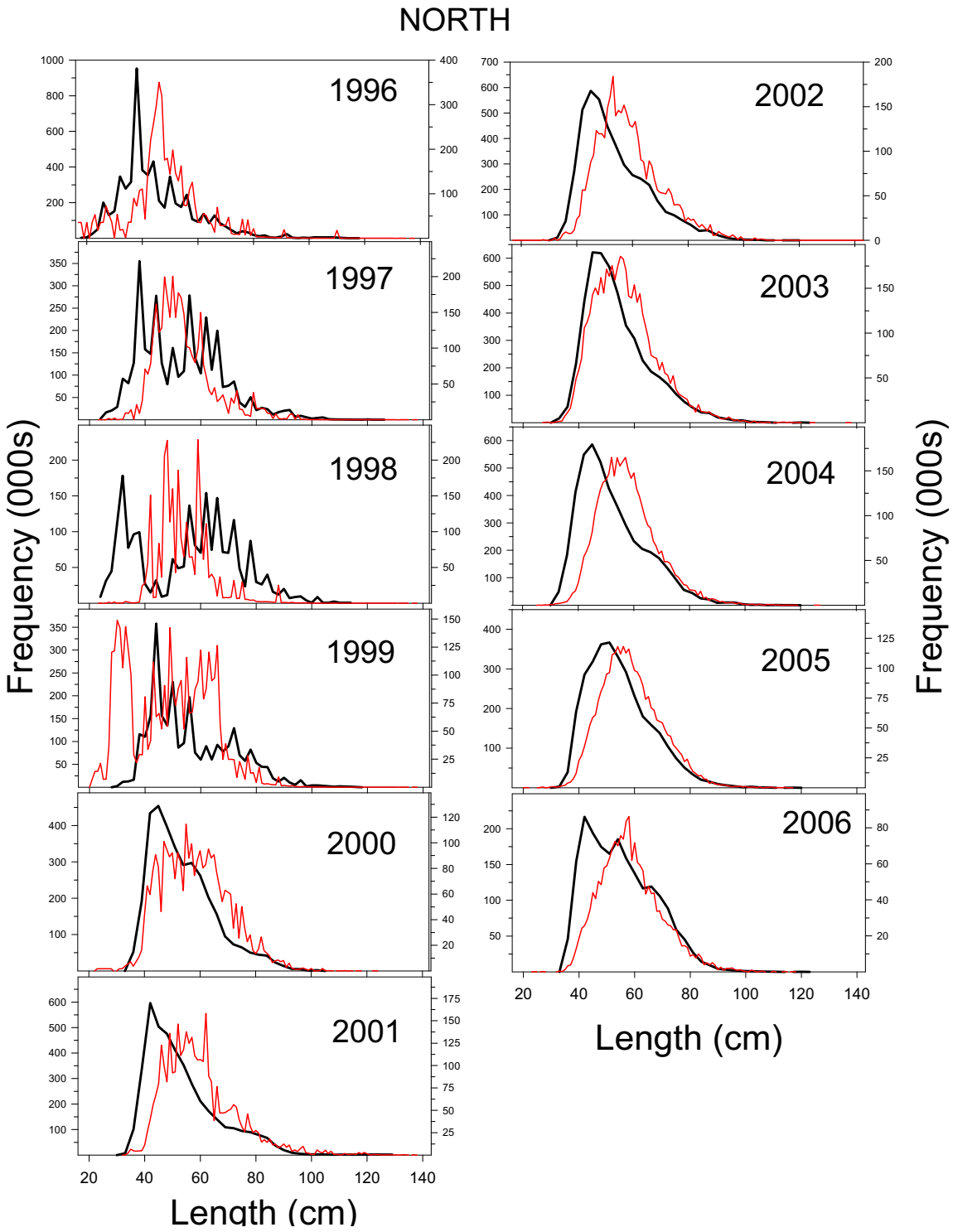


Figure 8d. Estimated length frequency of monkfish commercial landings from port samples in the southern management area.

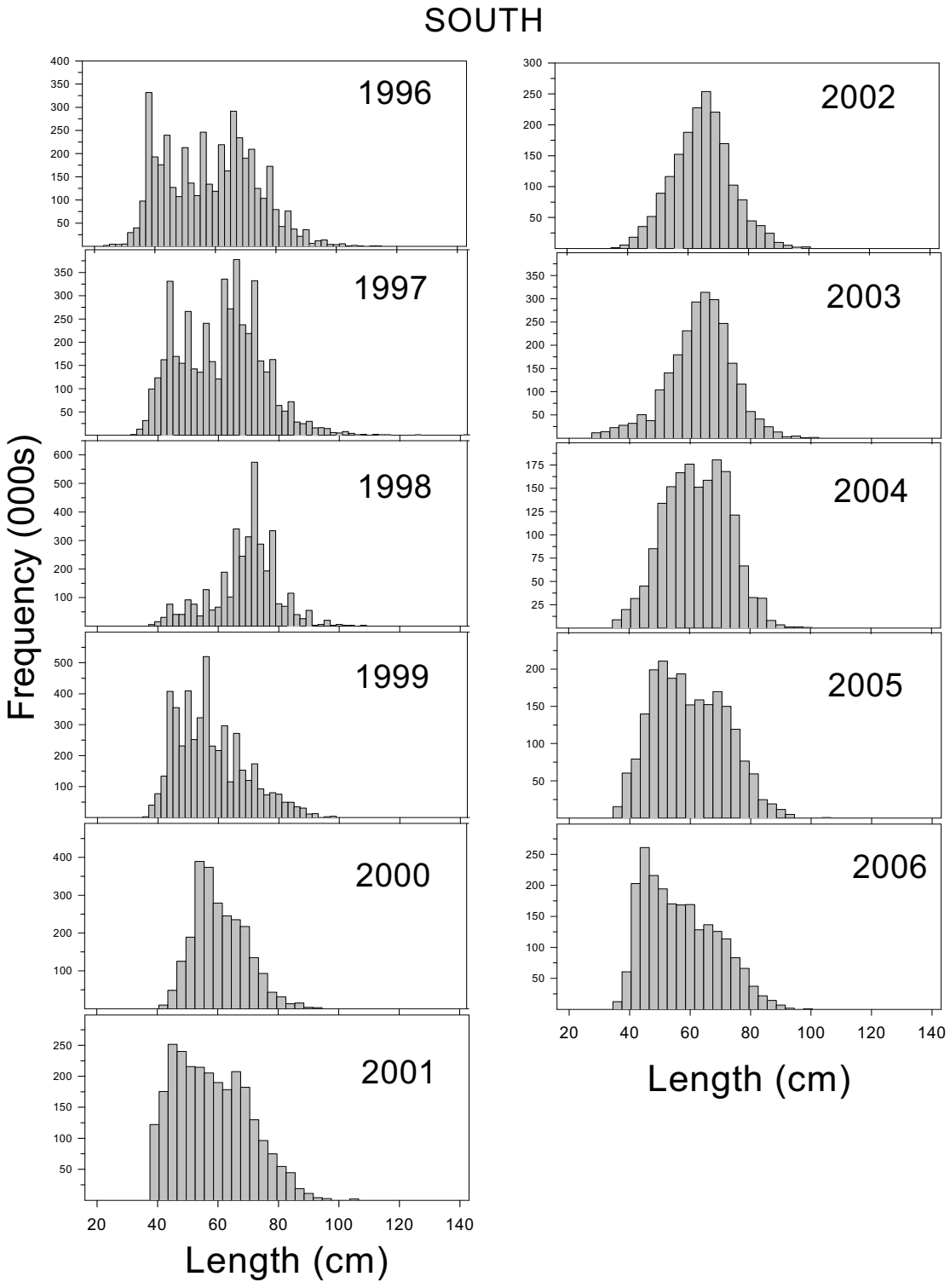


Figure 8e. Estimated length frequency of monkfish commercial landings from observer samples in the southern management area.

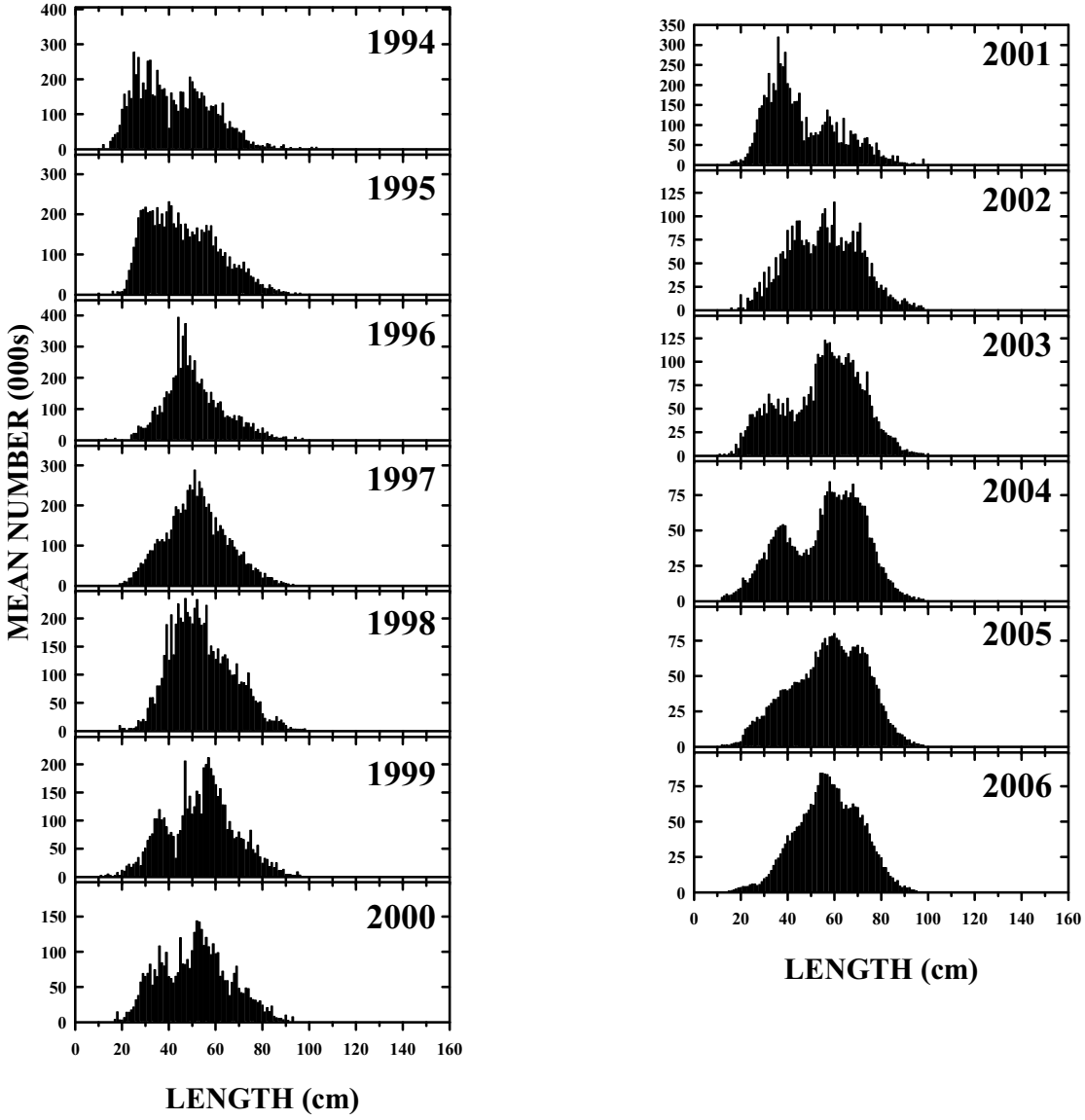


Figure 8f. Comparison of port samples (black, bold line) and observer samples (thin, red line) of monkfish lengths in the southern management area.

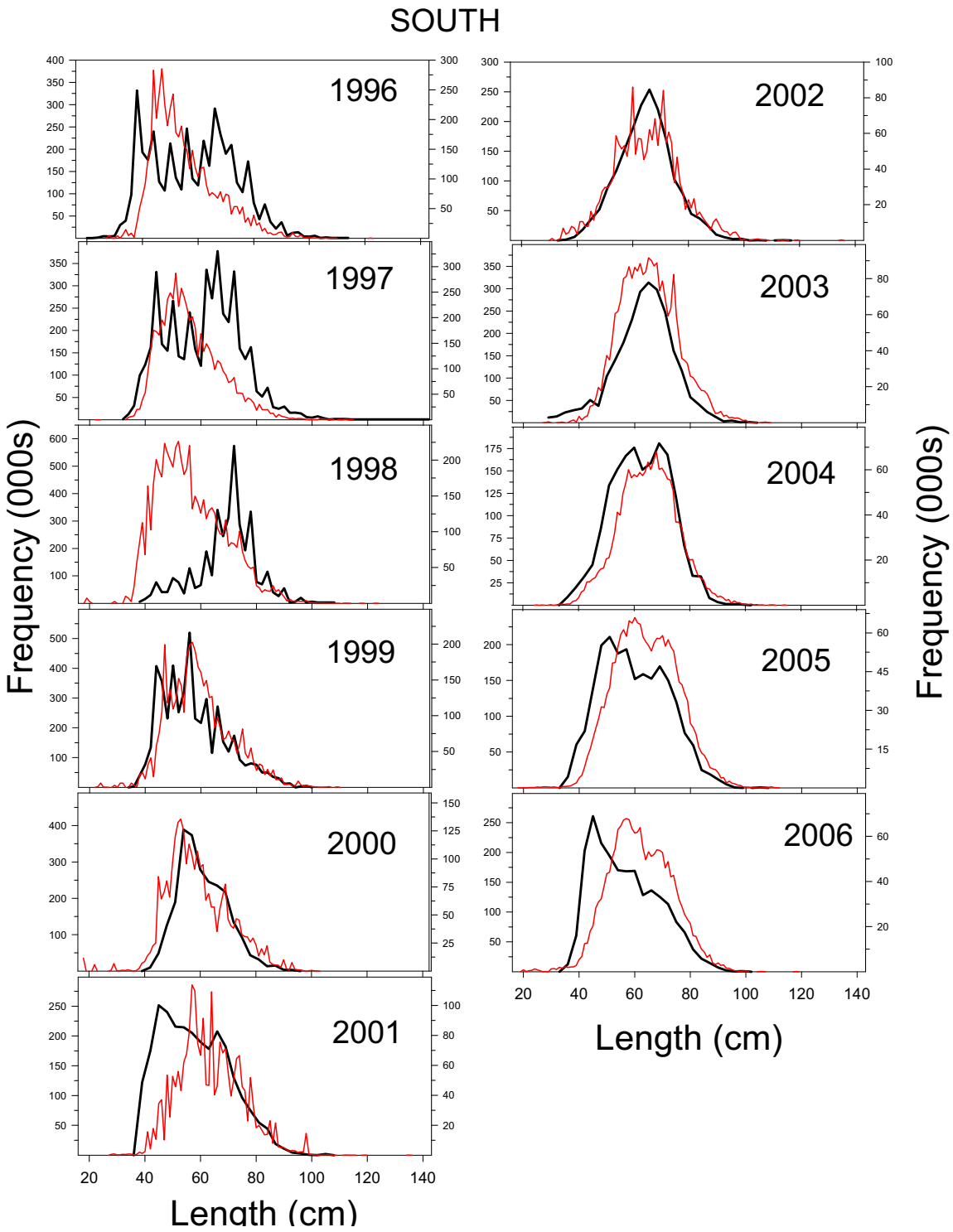


Figure 9a. Landings at length from observer samples in the northern management area, 1994-2001 by gear (red: trawls, green: gillnets, blue: scallop dredges).

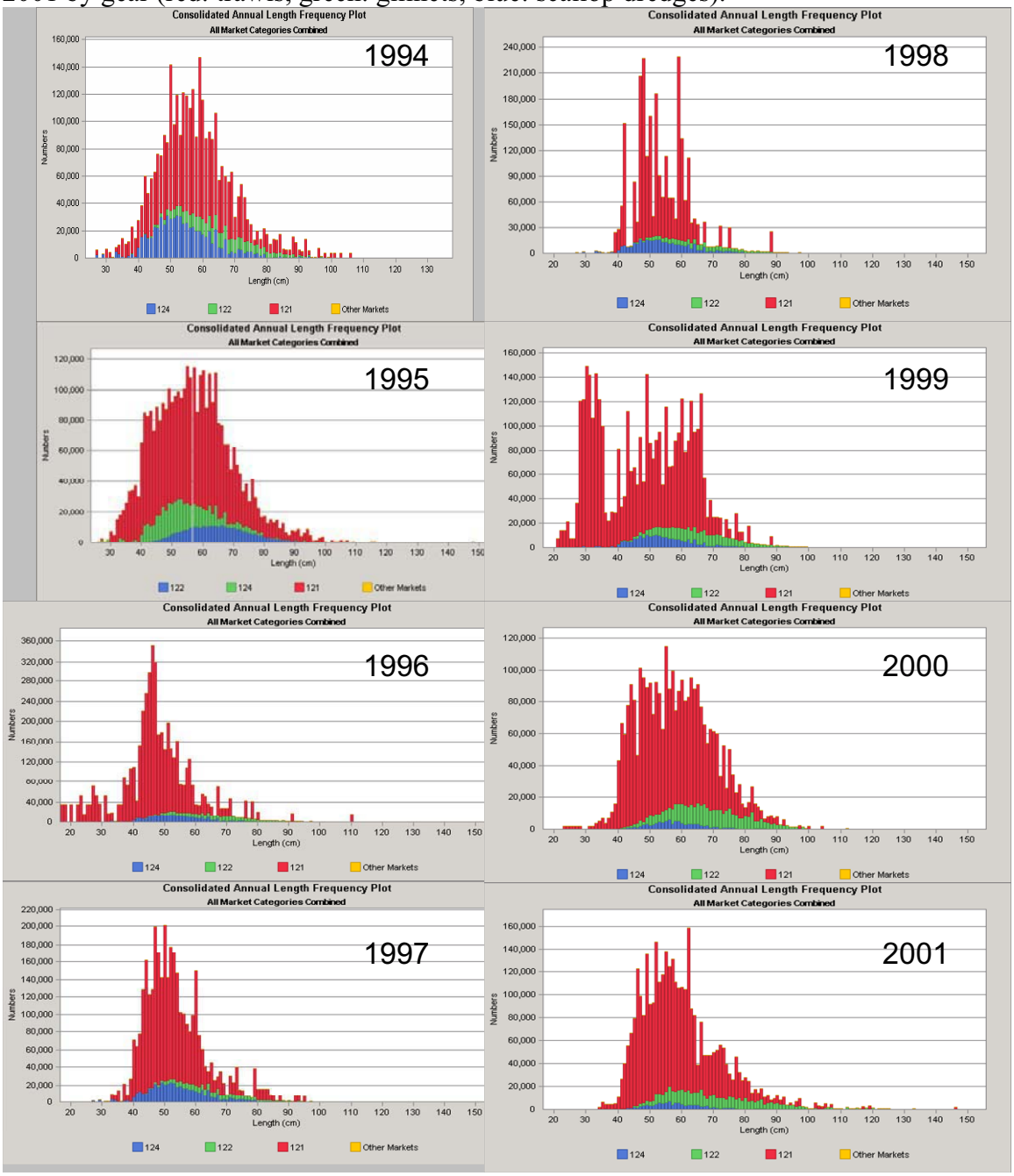


Figure 9b. Landings at length from observer samples in the northern management area, 2002-2006 by gear (red: trawls, green: gillnets, blue: scallop dredges).

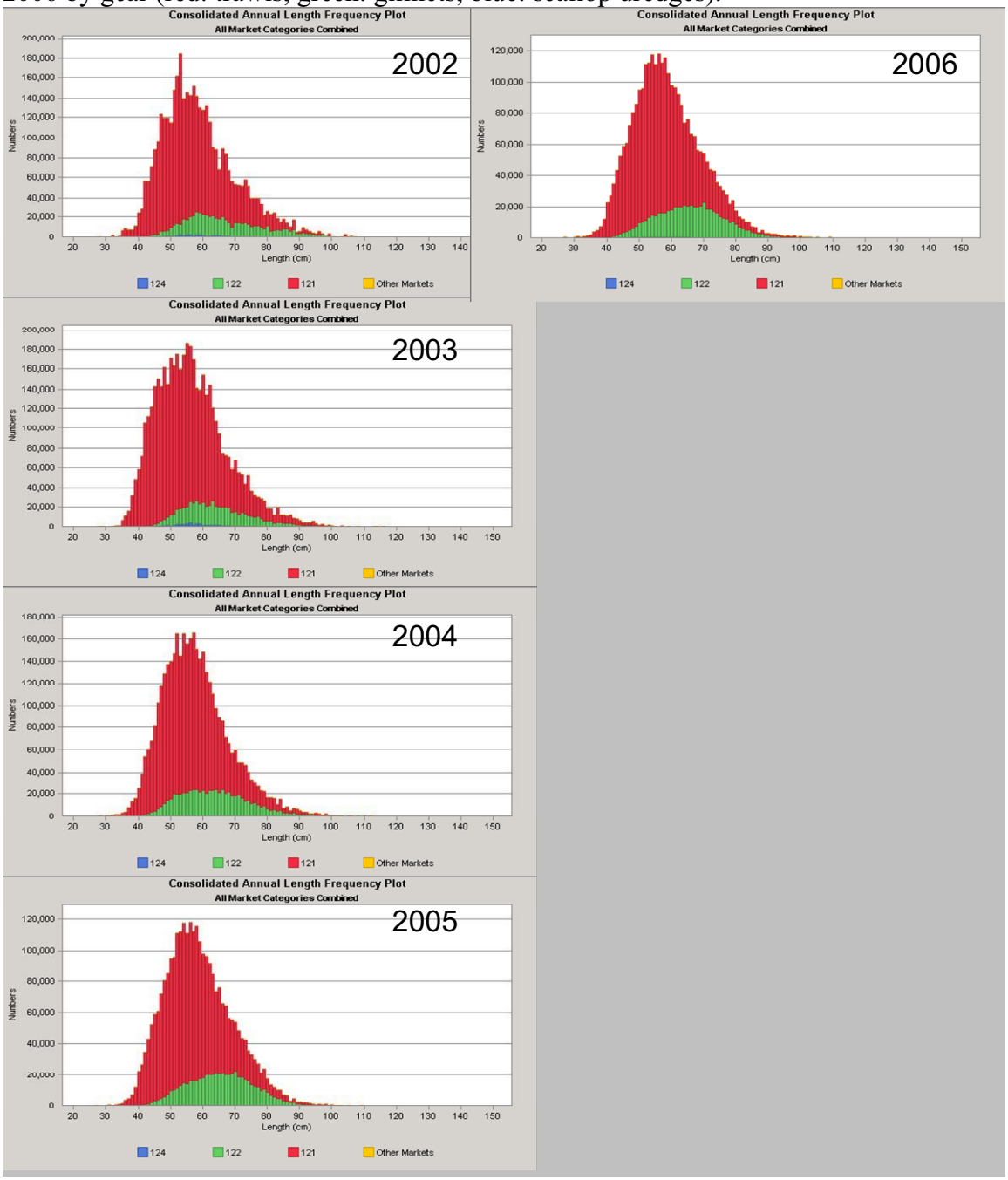


Figure 9c. Landings at length from observer samples in the southern management area, 1994-2001 by gear (red: trawls, green: gillnets, blue: scallop dredges).

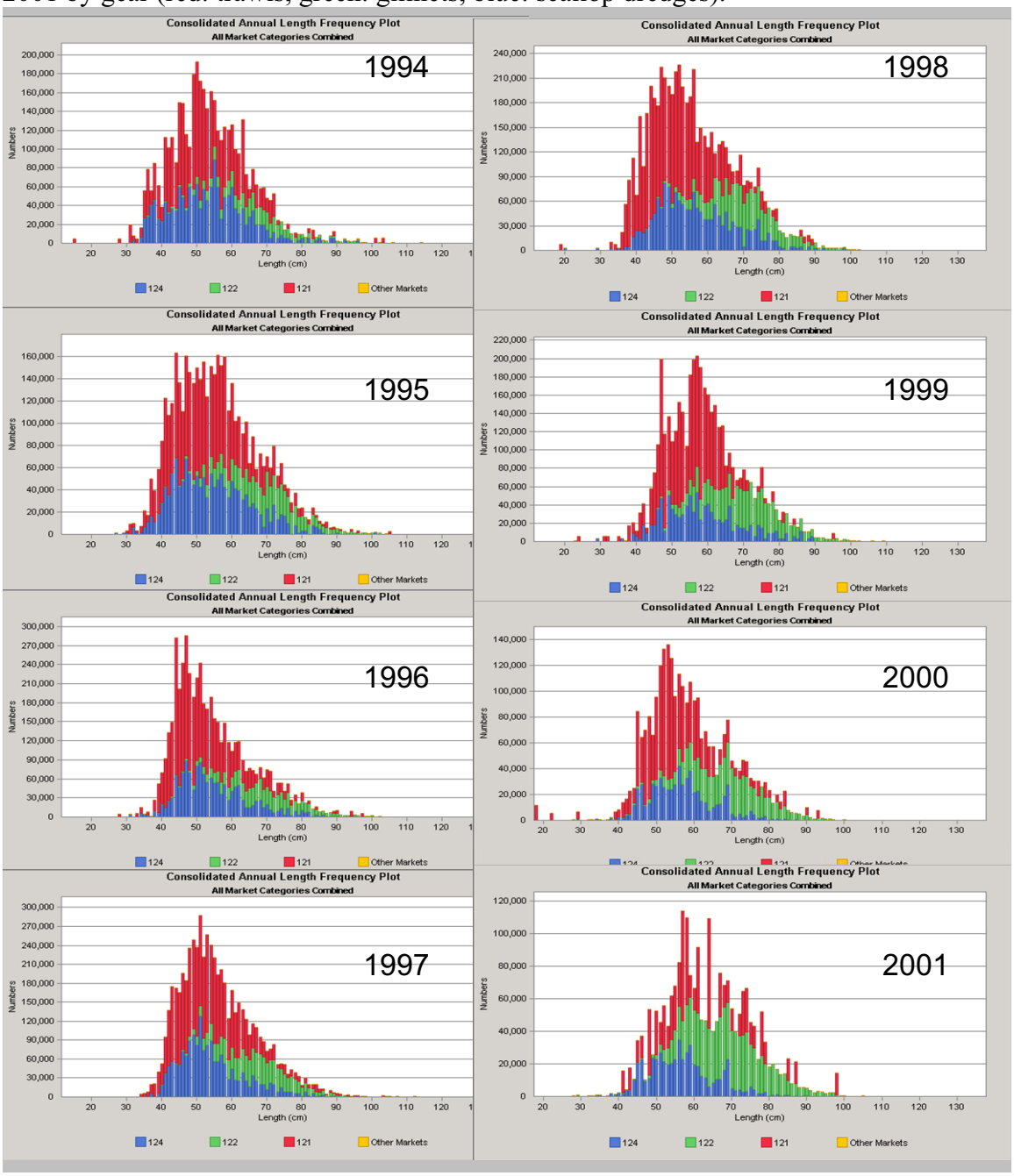


Figure 9d. Landings at length from observer samples in the southern management area, 2002-2006 by gear (red: trawls, green: gillnets, blue: scallop dredges).

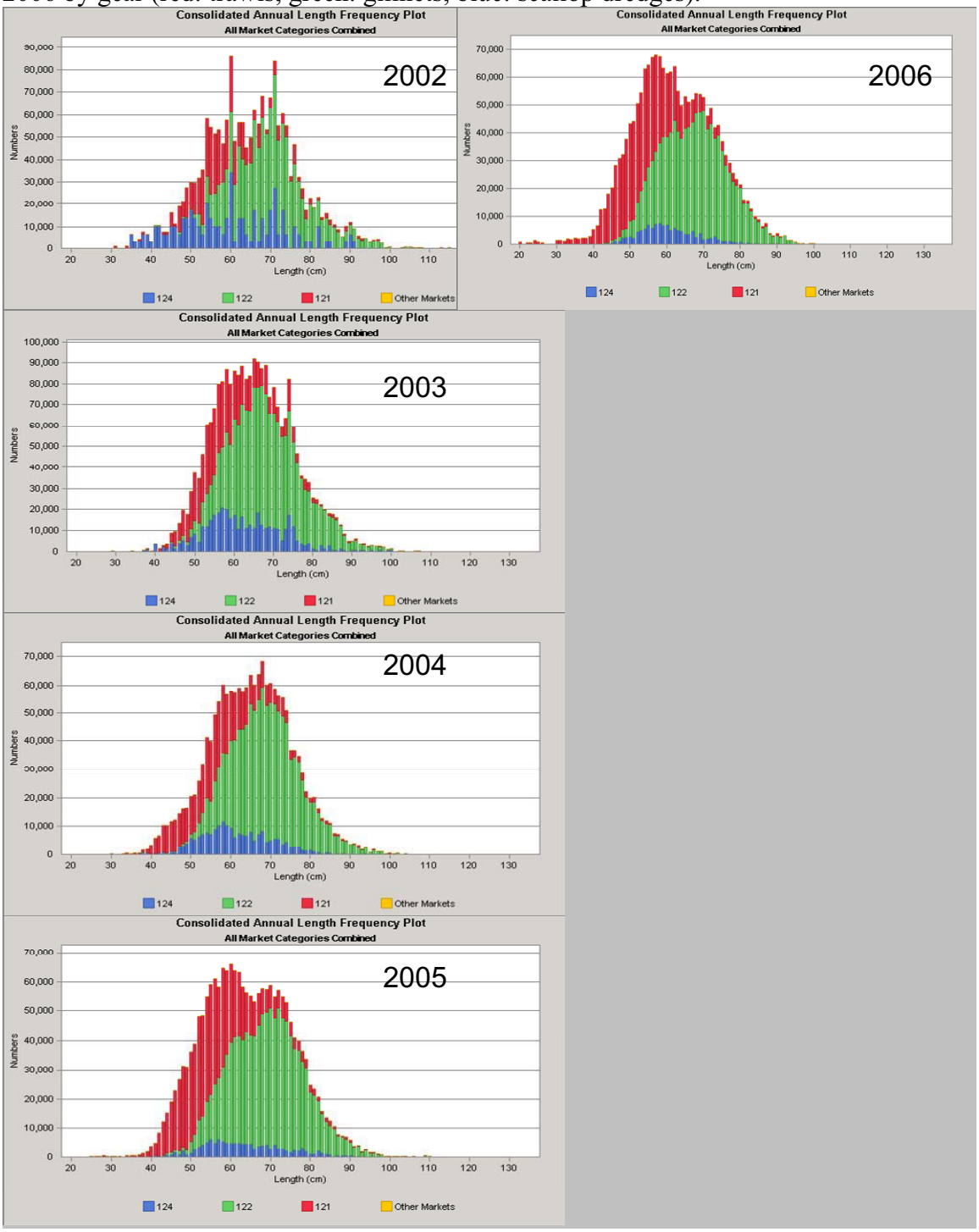


Figure 10a. Discards at length from observer samples in the northern management area, 1994-2001 by gear (red: trawls, green: gillnets, blue: scallop dredges).

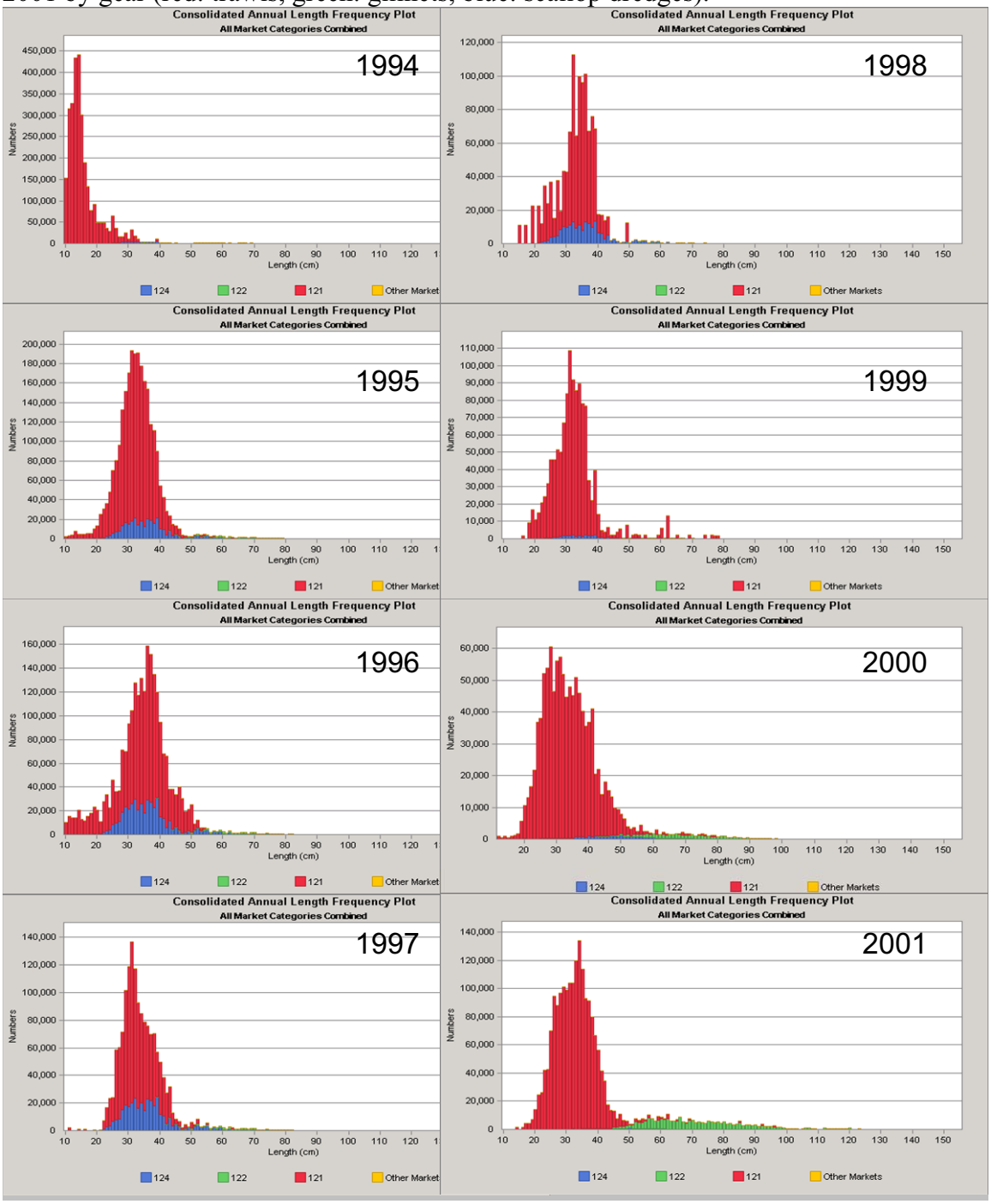


Figure 10b. Discards at length from observer samples in the northern management area, 2002-2006 by gear (red: trawls, green: gillnets, blue: scallop dredges).

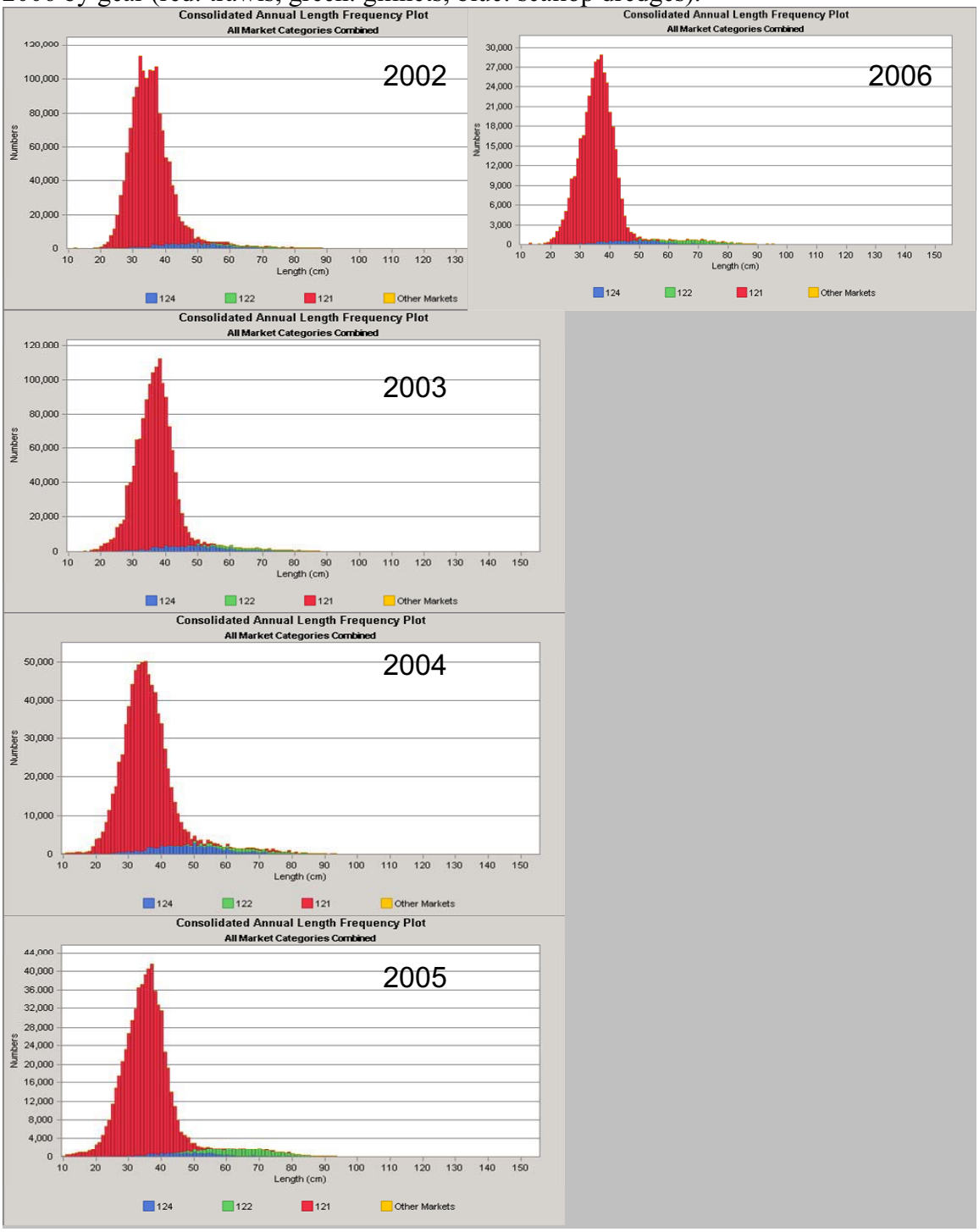


Figure 10c. Discards at length from observer samples in the southern management area, 1994-2001 by gear (red: trawls, green: gillnets, blue: scallop dredges).

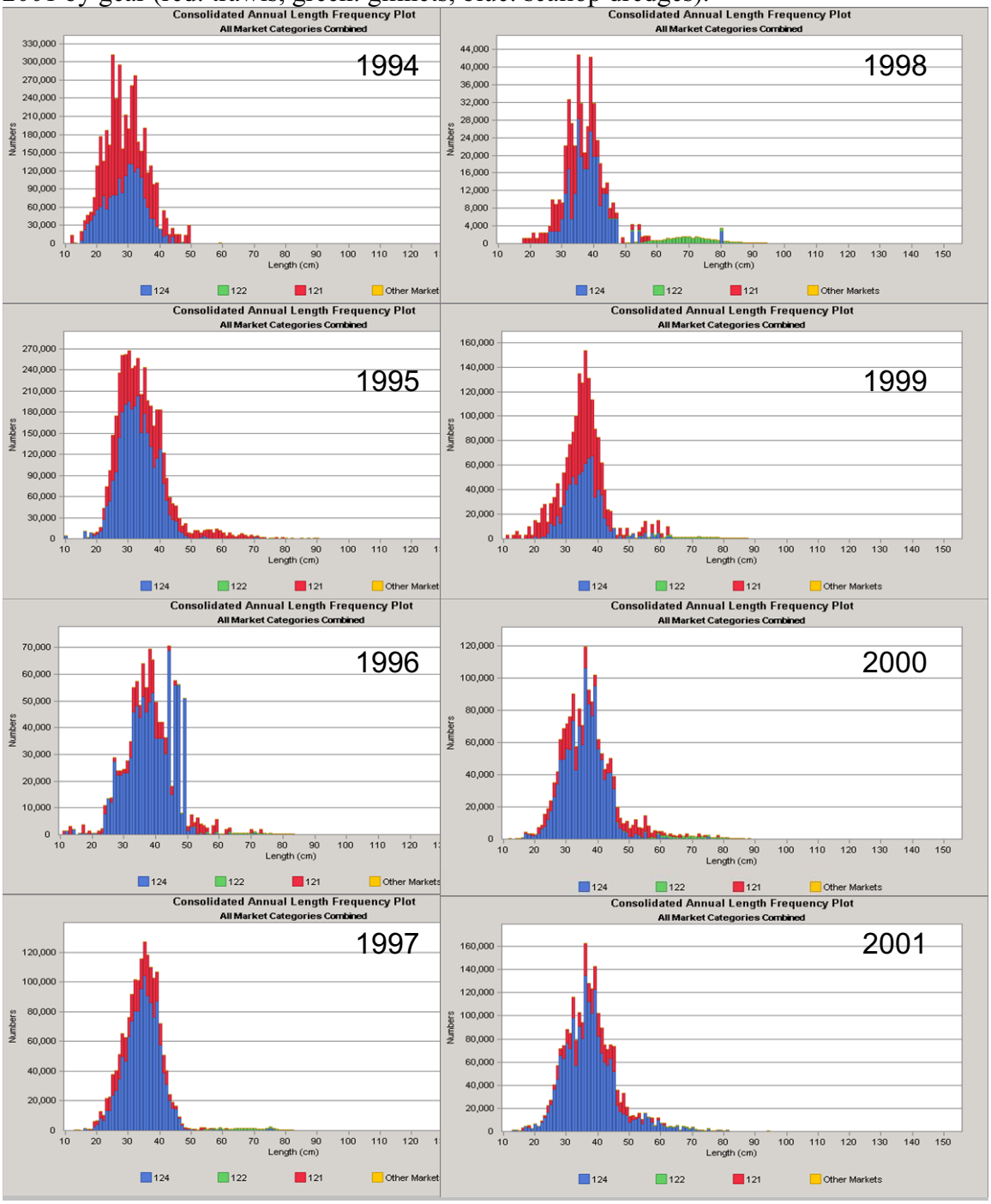


Figure 10d. Discards at length from observer samples in the southern management area, 2002-2006 by gear (red: trawls, green: gillnets, blue: scallop dredges).

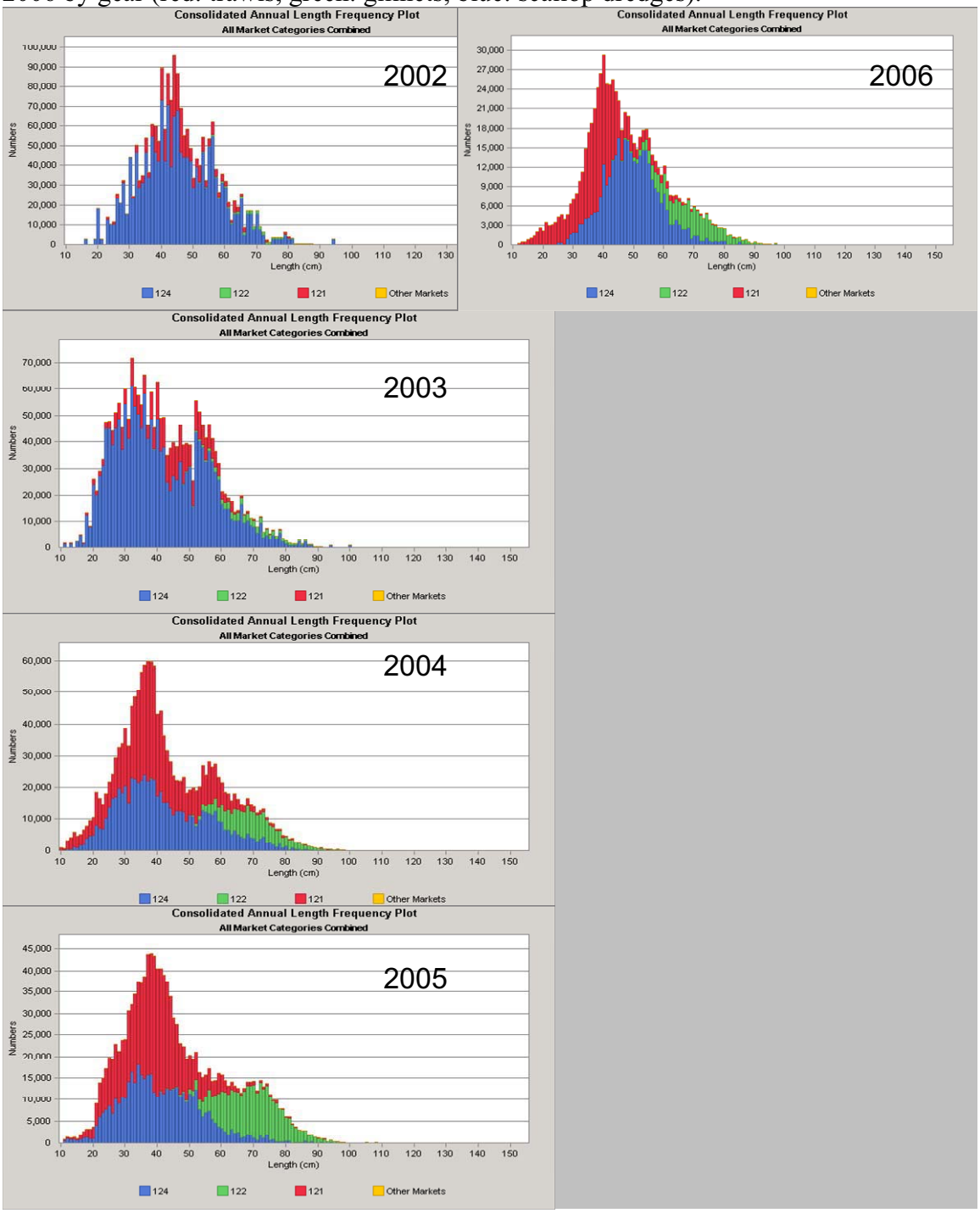


Figure 11a. Estimated age composition of monkfish commercial landings in the northern management area.

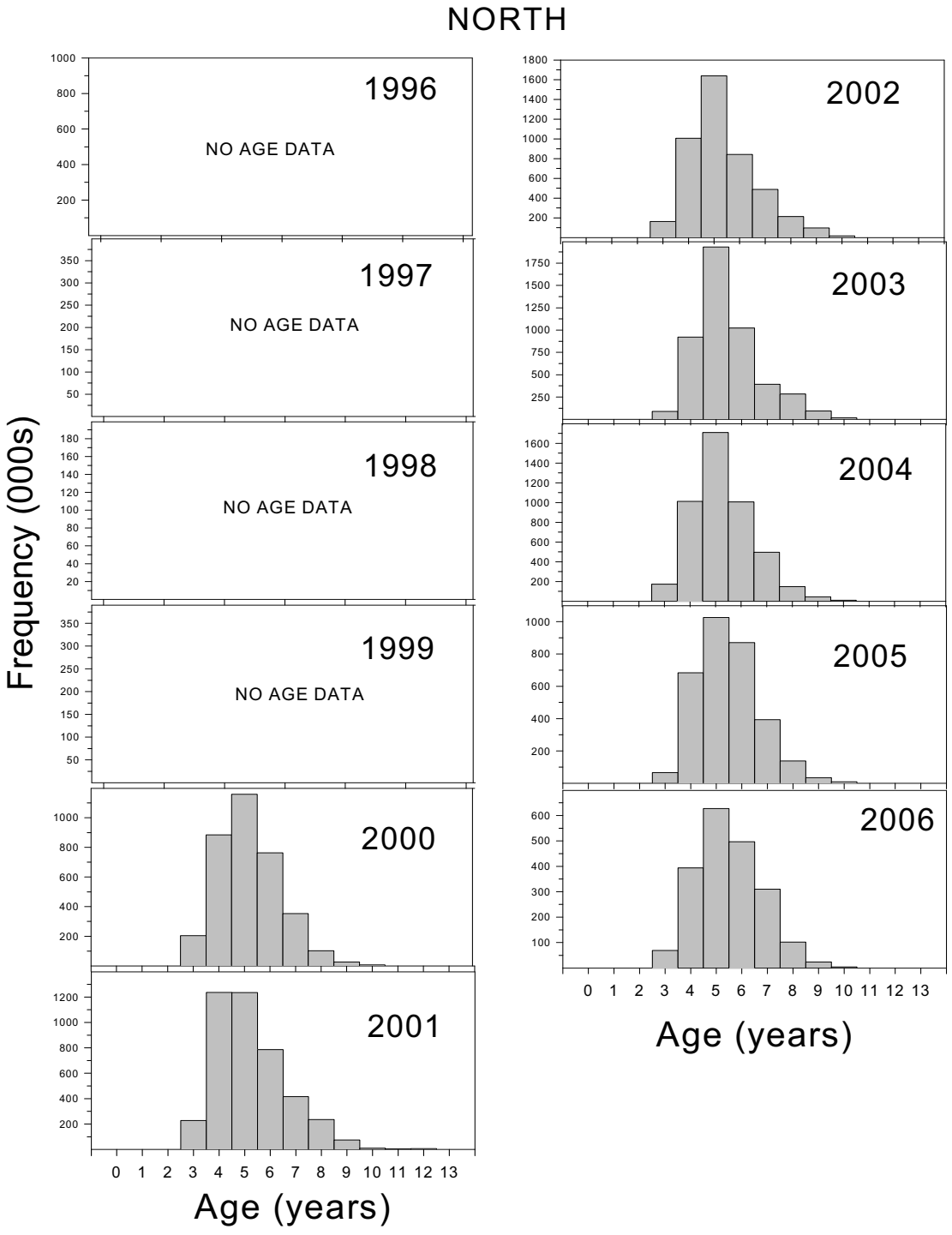


Figure 11b. Estimated age composition of monkfish commercial landings in the southern management area.

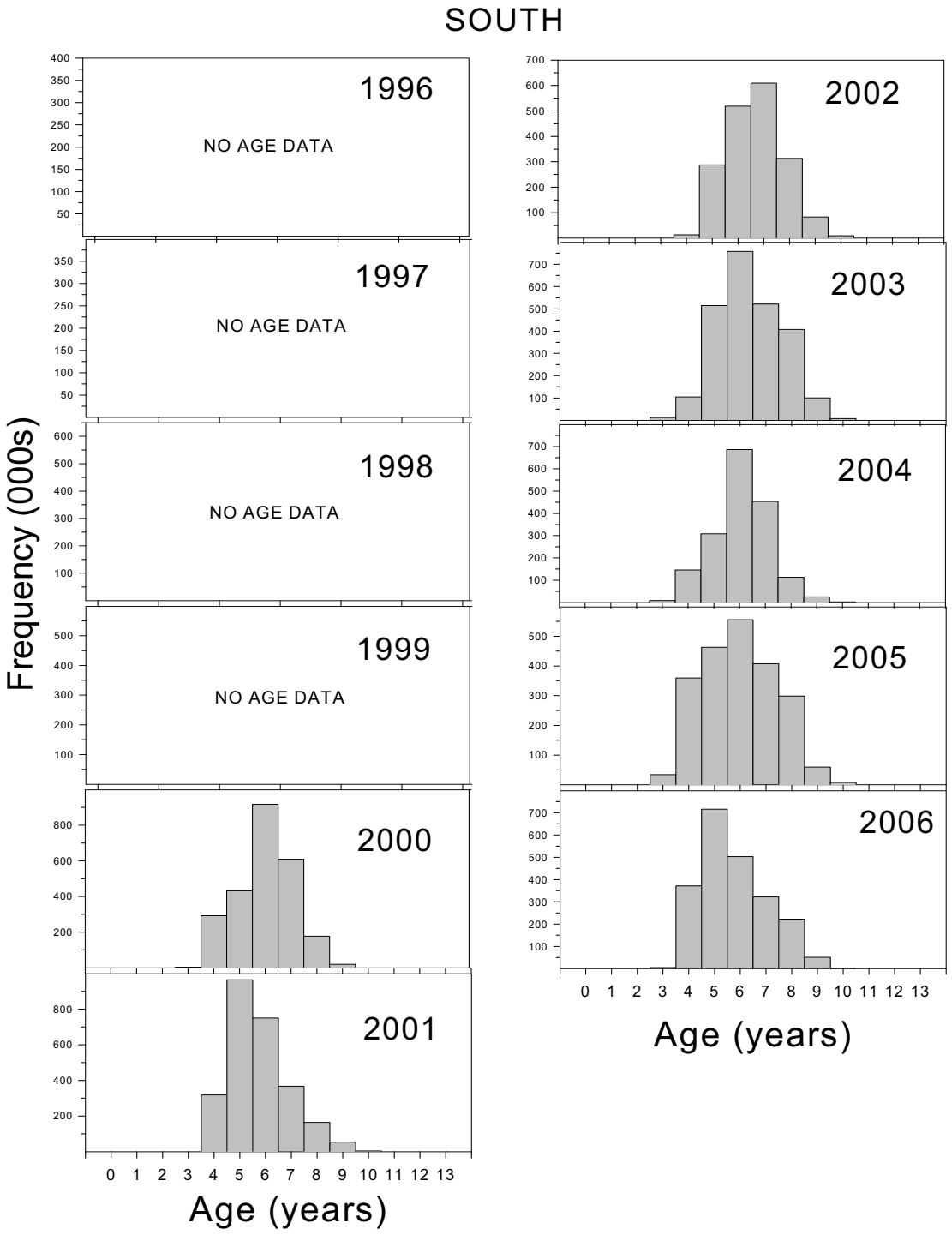


Figure 12a. Catch rates of monkfish in the northern management area from observed tows that caught monkfish by gear-type.

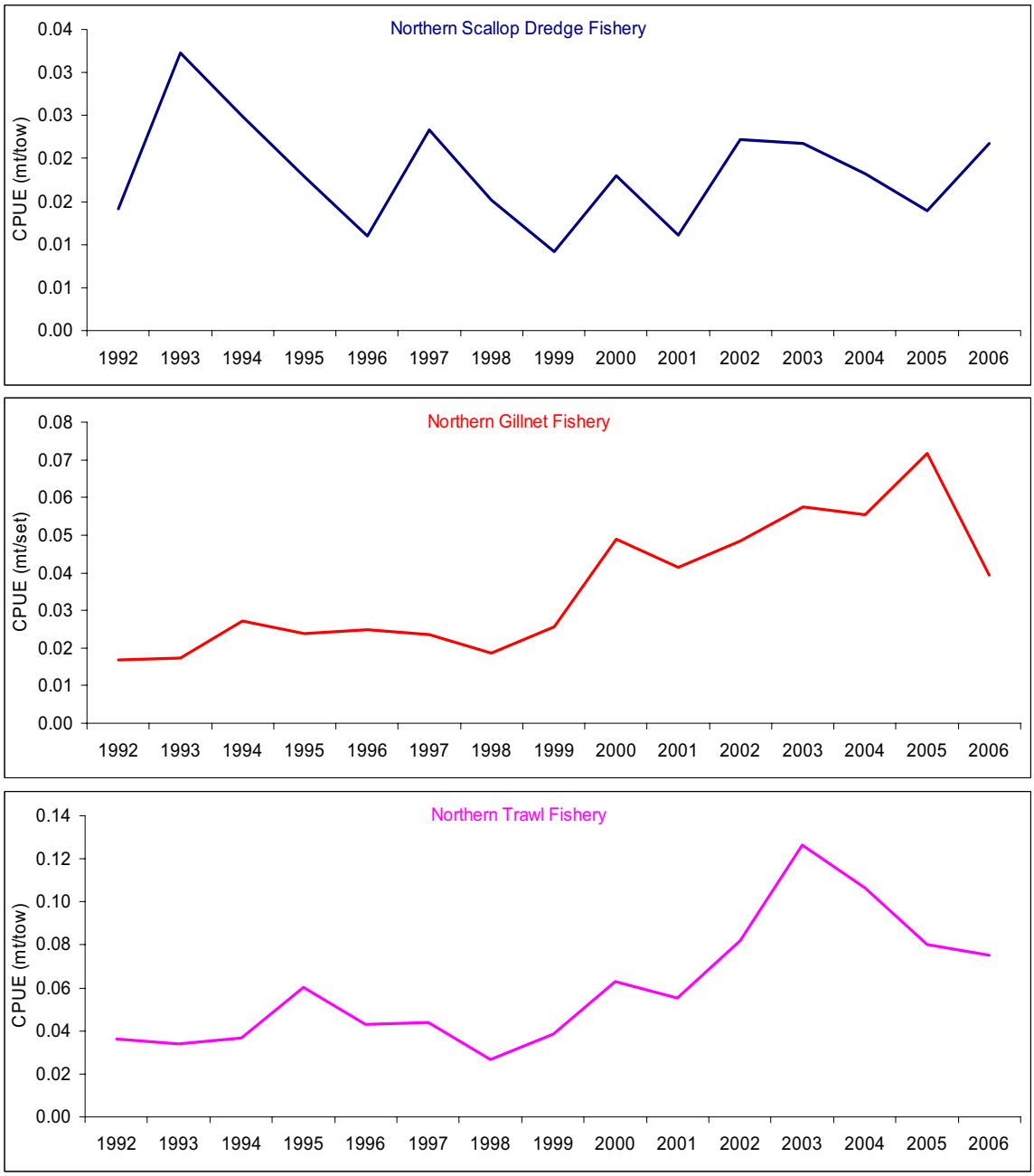


Figure 12b. Catch rates of monkfish in the southern management area from observed tows that caught monkfish by gear-type.

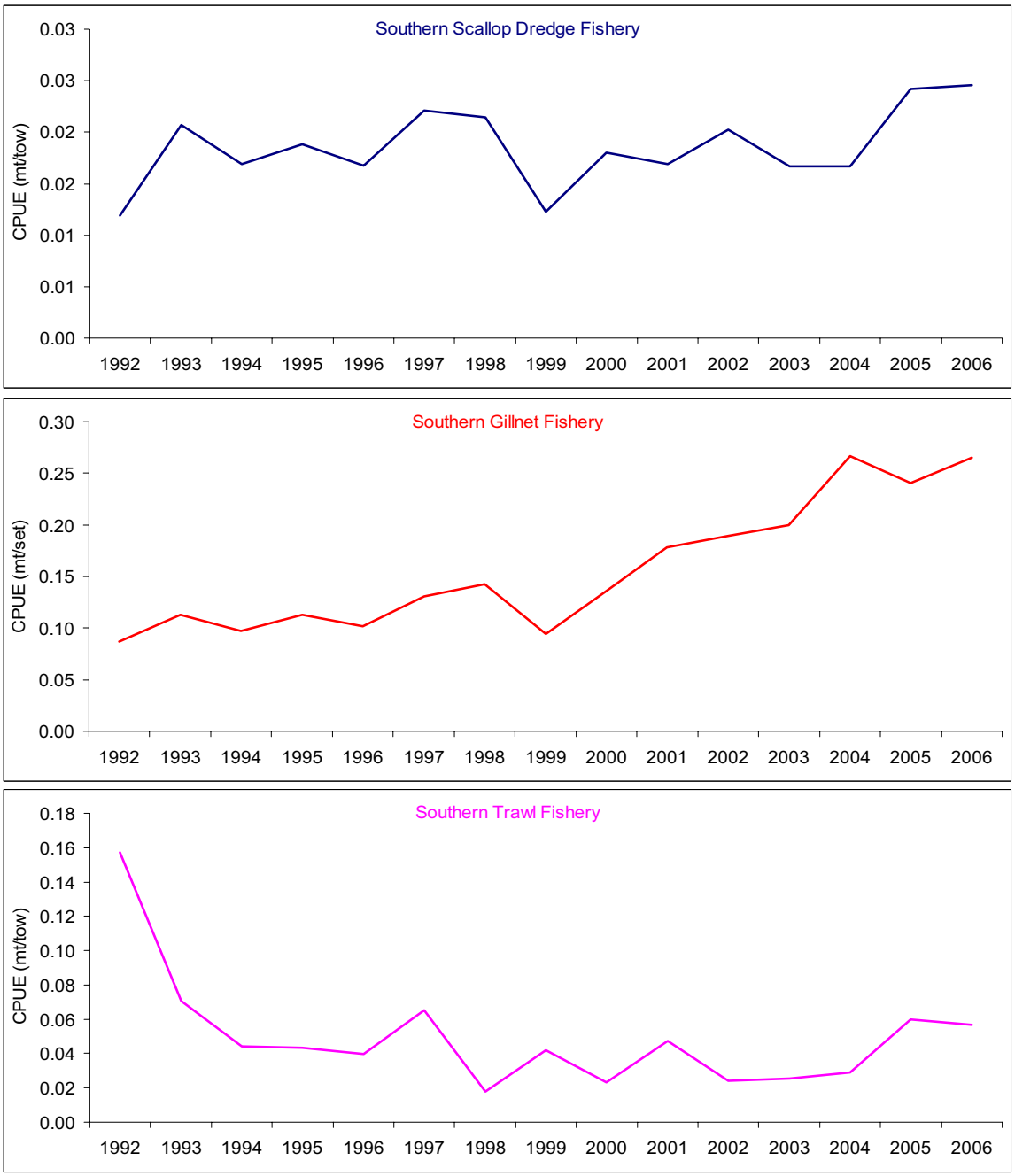


Figure 13a. Distribution of monkfish from the NEFSC fall survey, 1963-1980 (from www.nefsc.noaa.gov/sos).

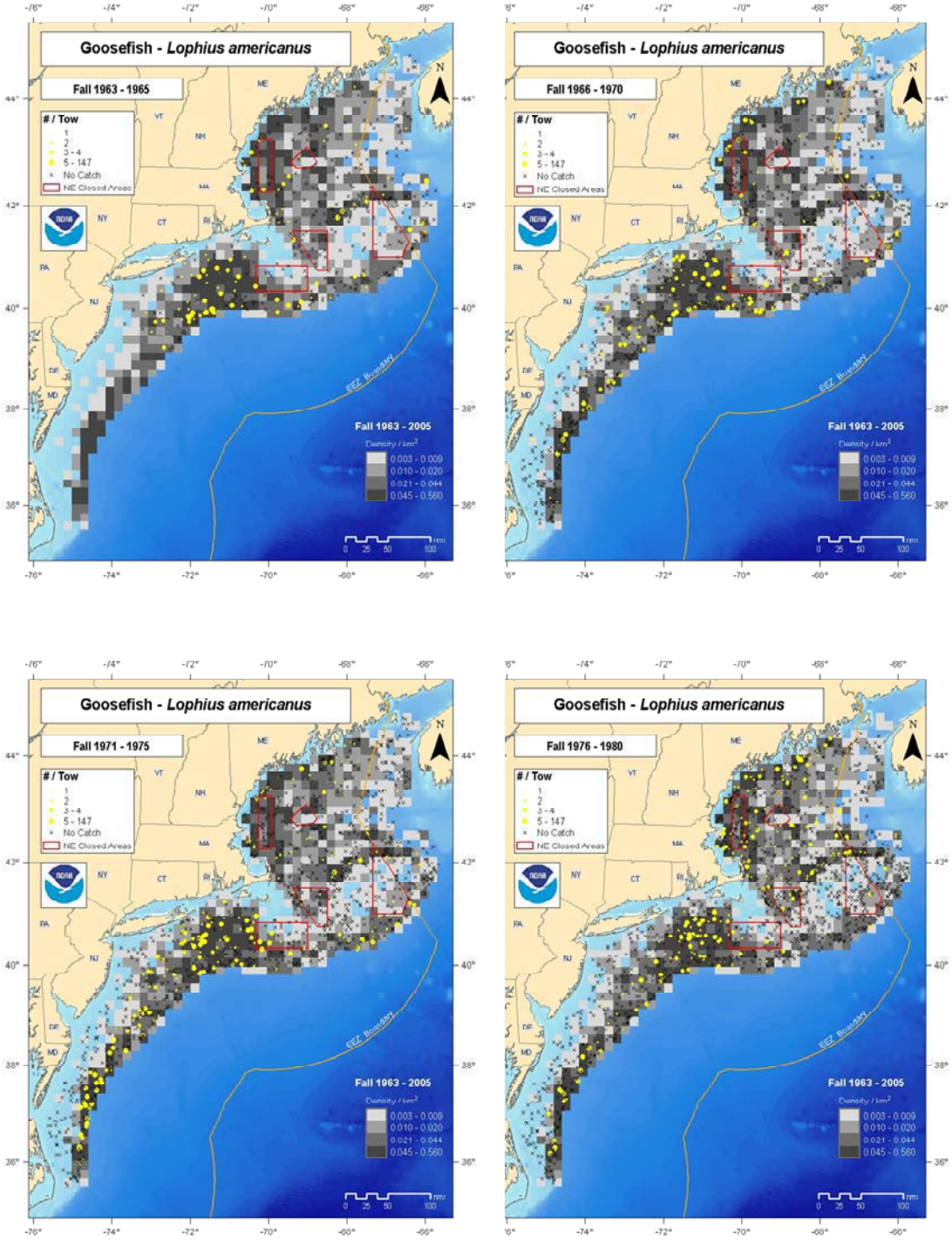


Figure 13b. Distribution of monkfish from the NEFSC fall survey, 1981-2000 (from www.nefsc.noaa.gov/sos).

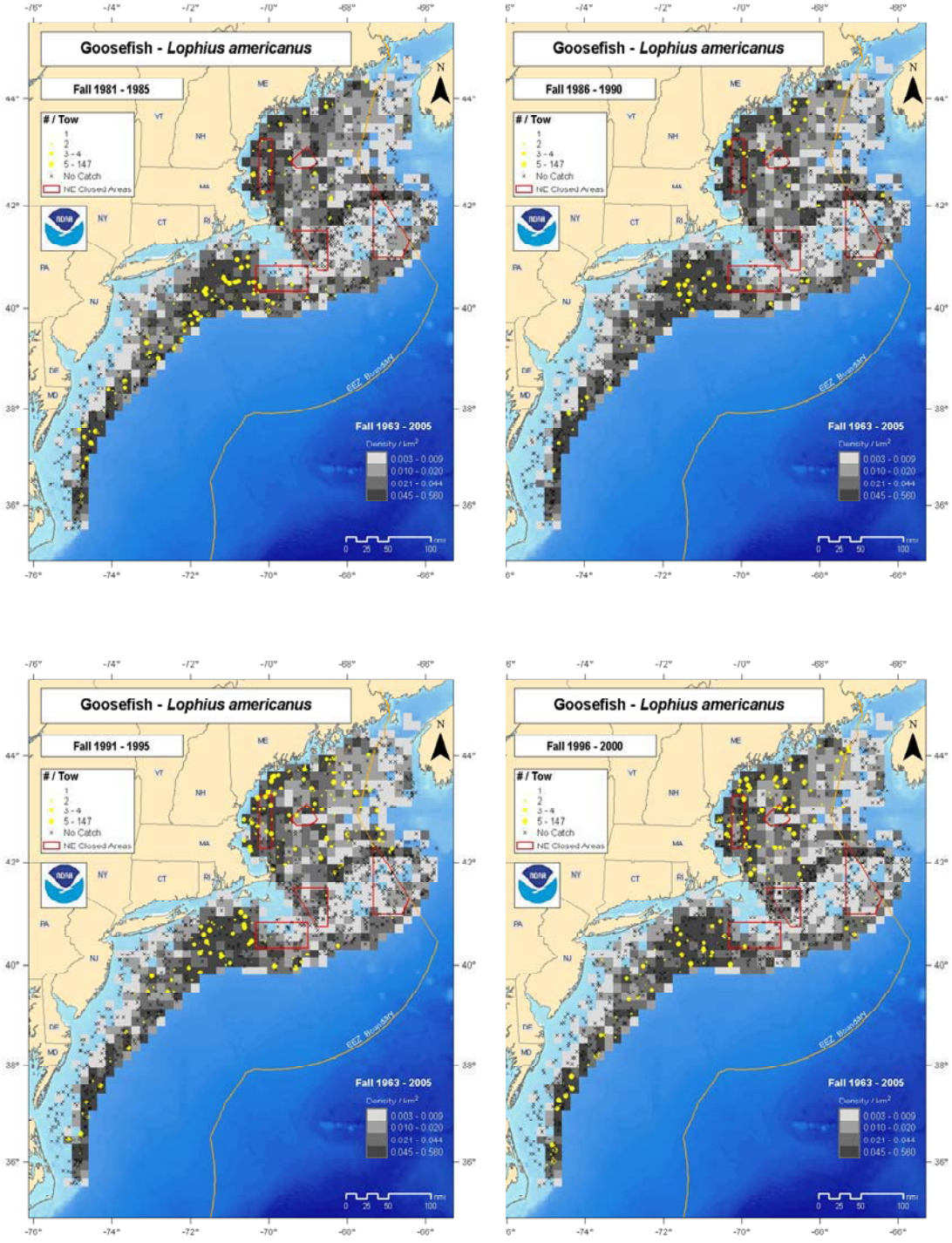


Figure 13c. Distribution of monkfish from the NEFSC fall survey, 2001-2005 (from www.nefsc.noaa.gov/sos).

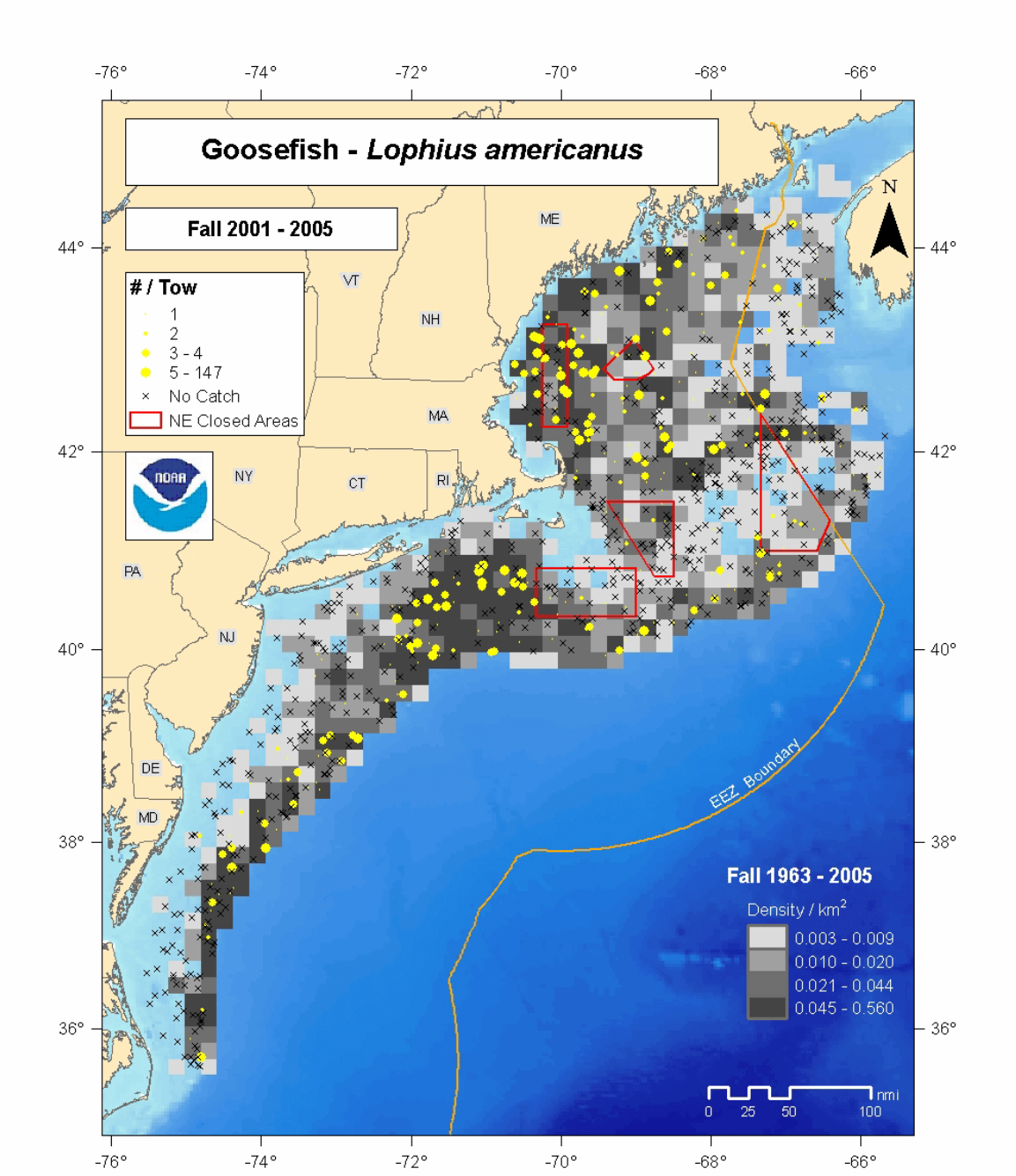


Figure 14a. Distribution of monkfish from the NEFSC spring survey, 1968-1997 (from Sosebee and Cadrin 2006).

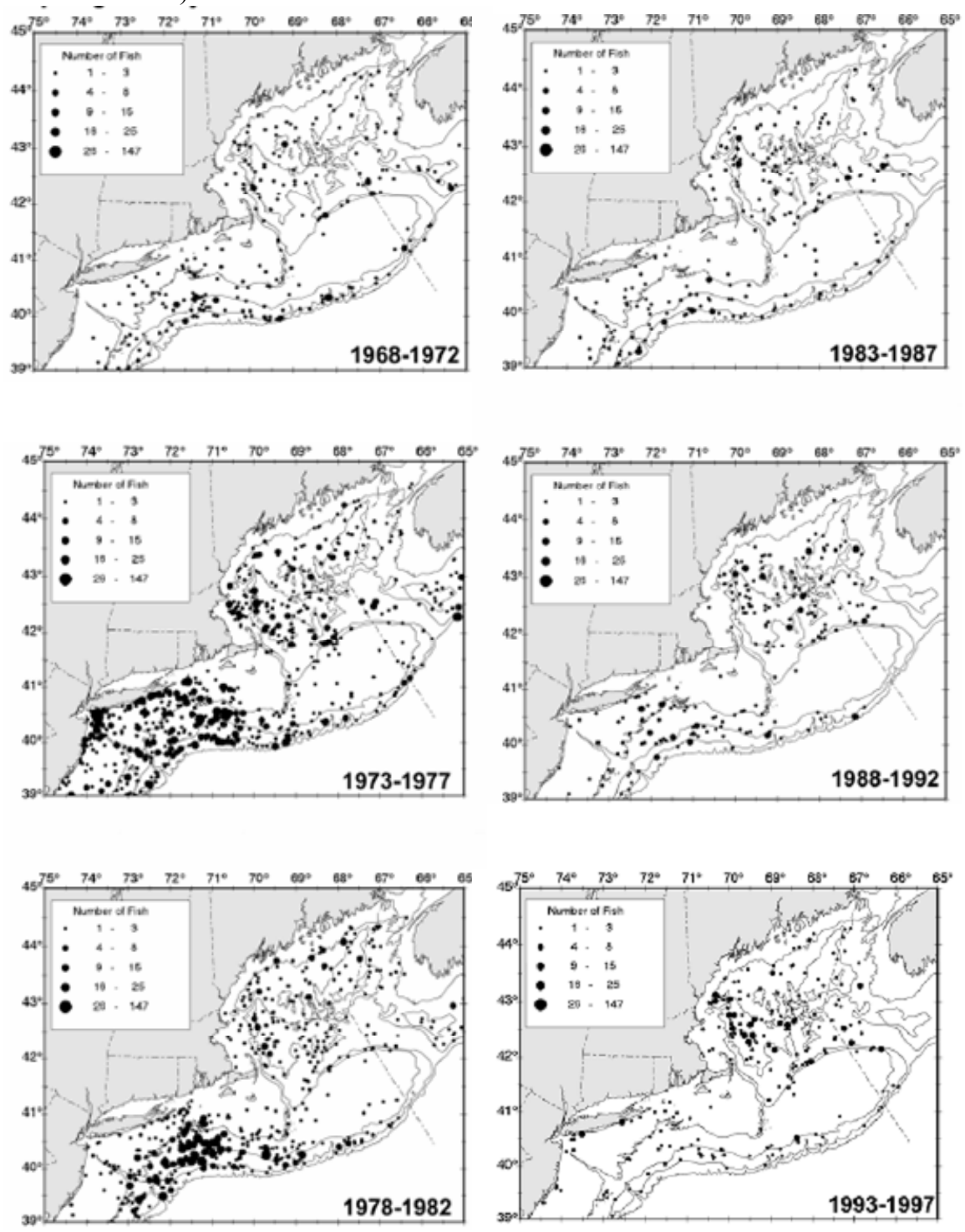
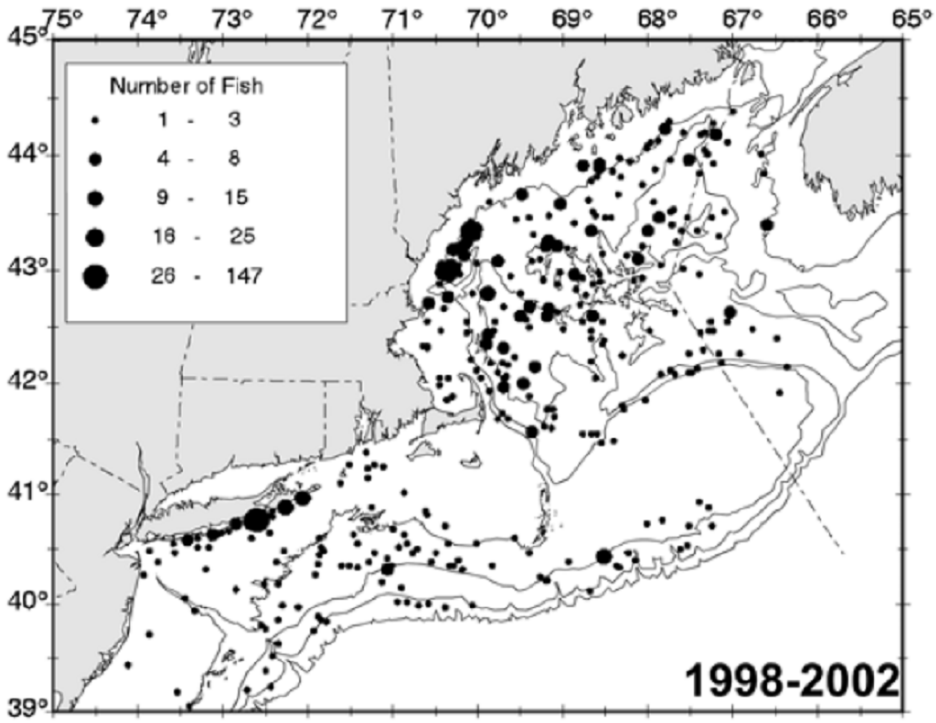


Figure 14b. Distribution of monkfish from the NEFSC spring survey, 1998-2002 (from Sosebee and Cadrin 2006), 2003-2006 from SAGA.



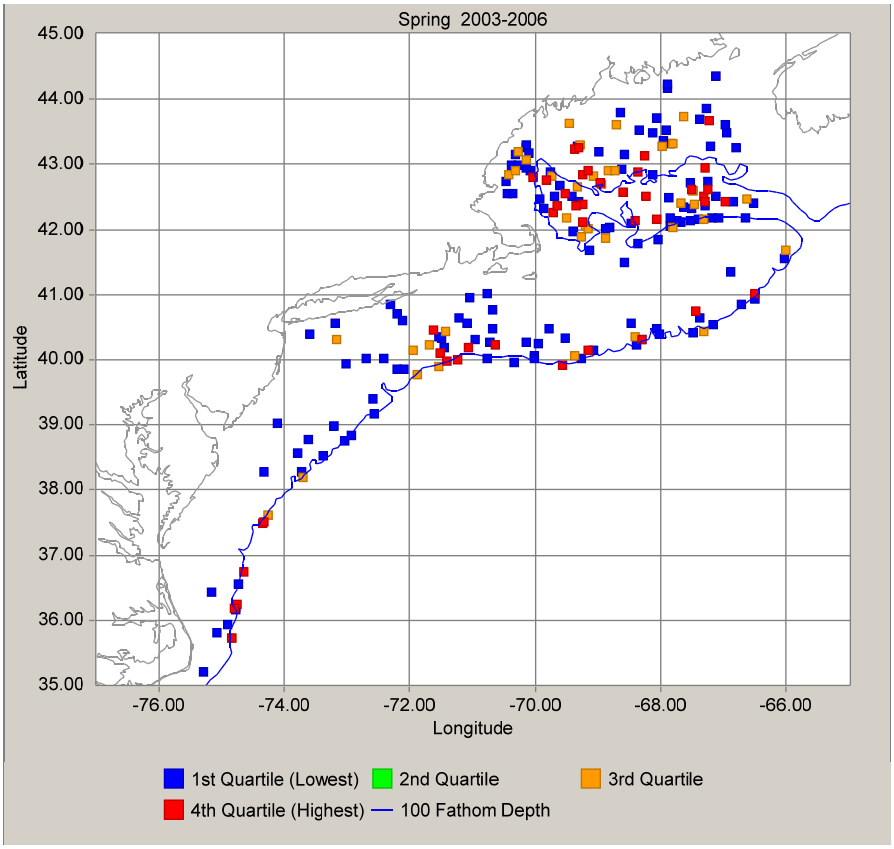


Figure 15. Distribution of monkfish from the NEFSC winter survey, 1998-2002 (from SAGA).

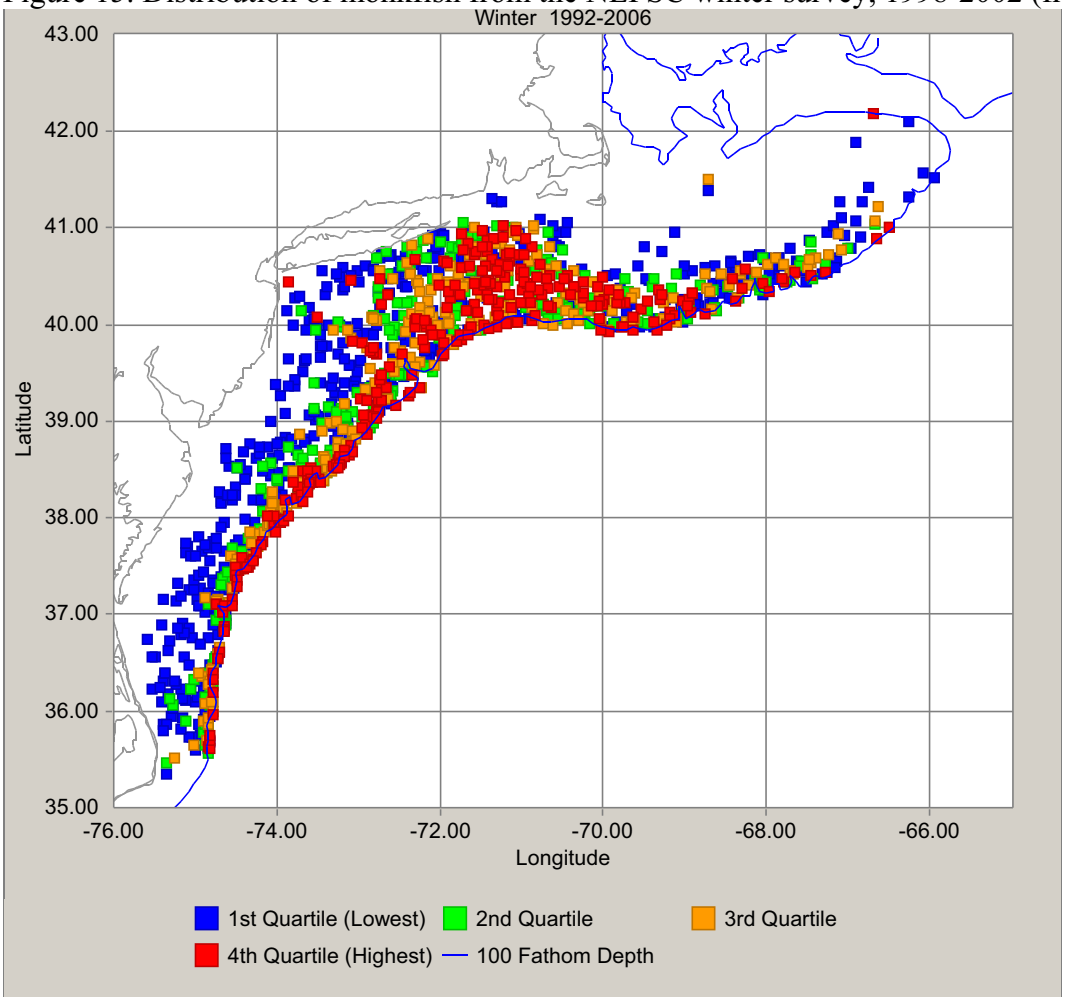


Figure 16. Distribution of monkfish from the ASMFC shrimp survey, 1991-2006 (from SAGA.

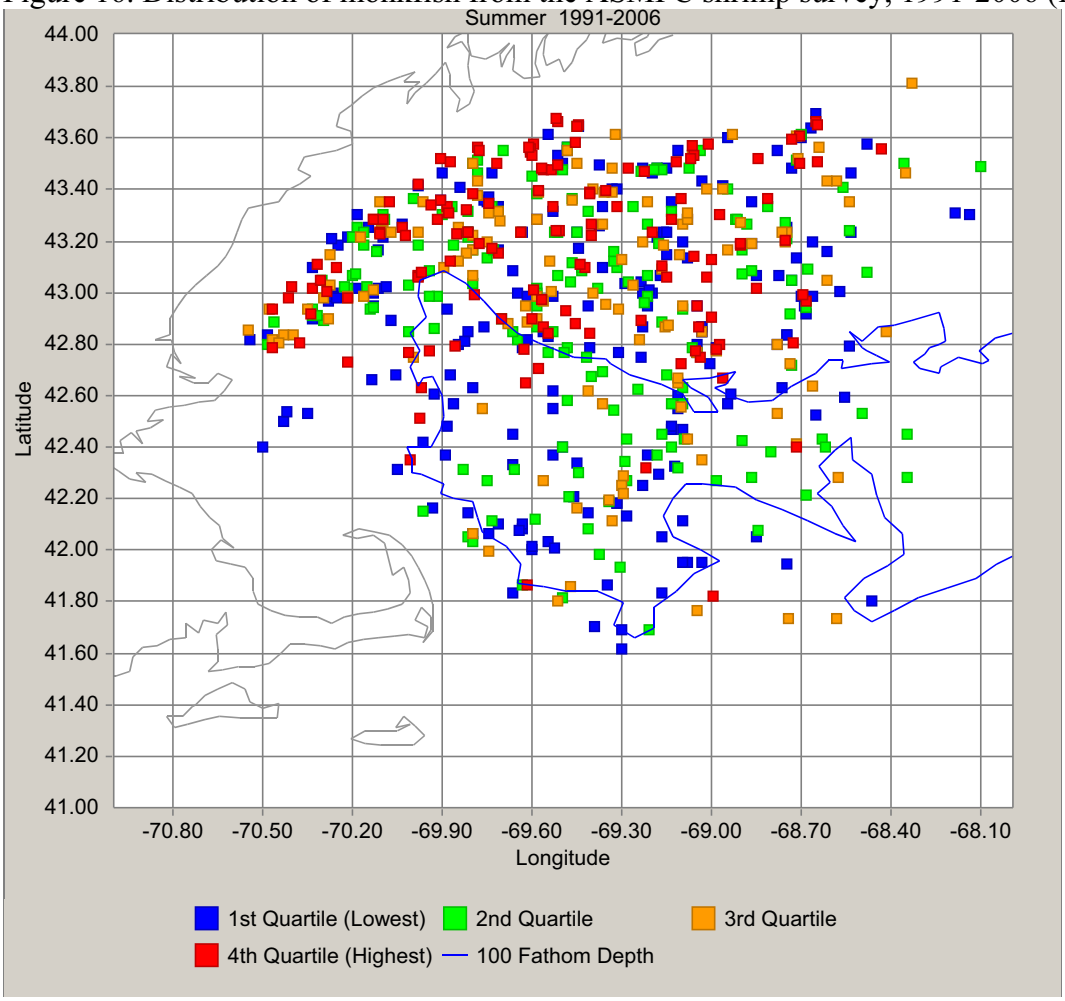


Figure 17. NEFSC spring and autumn bottom trawl surveys of monkfish biomass in the northern management area.

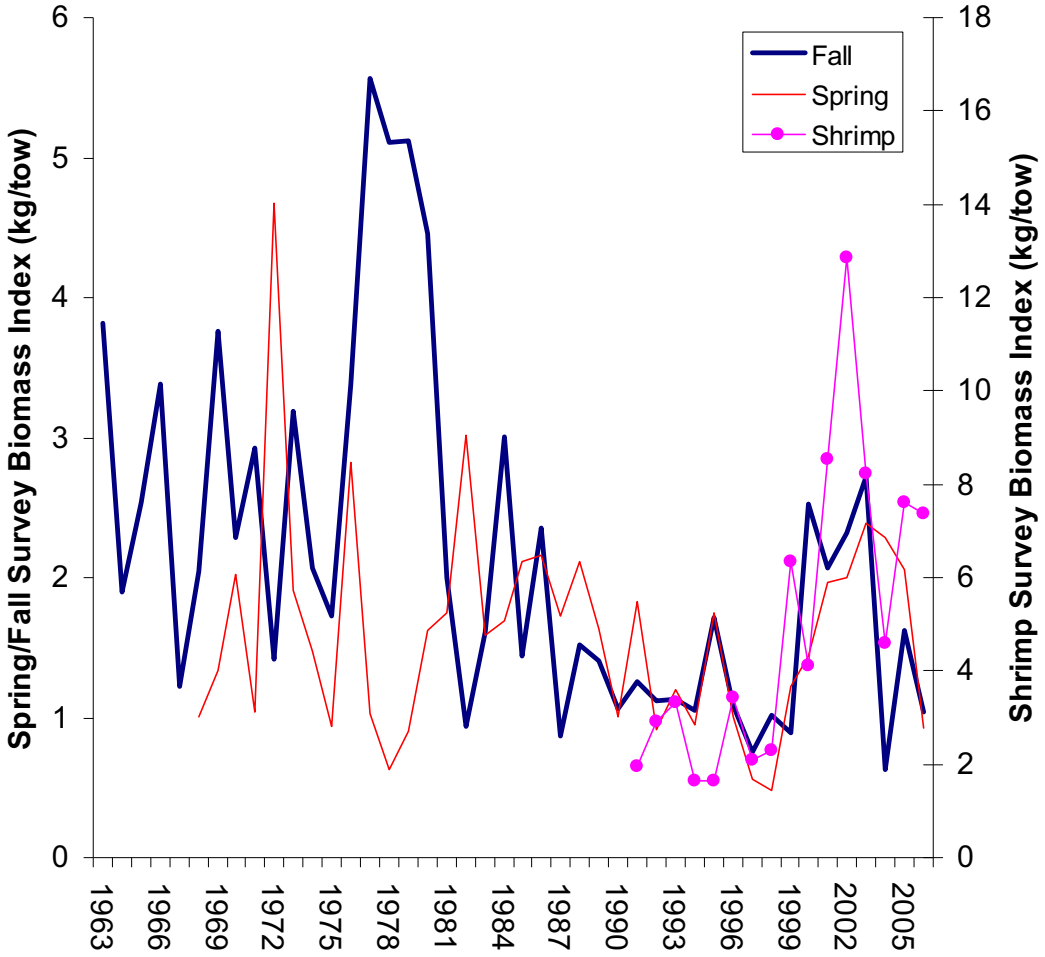


Figure 18a. 95% confidence limits from the NEFSC fall bottom trawl survey of monkfish in the northern management area.

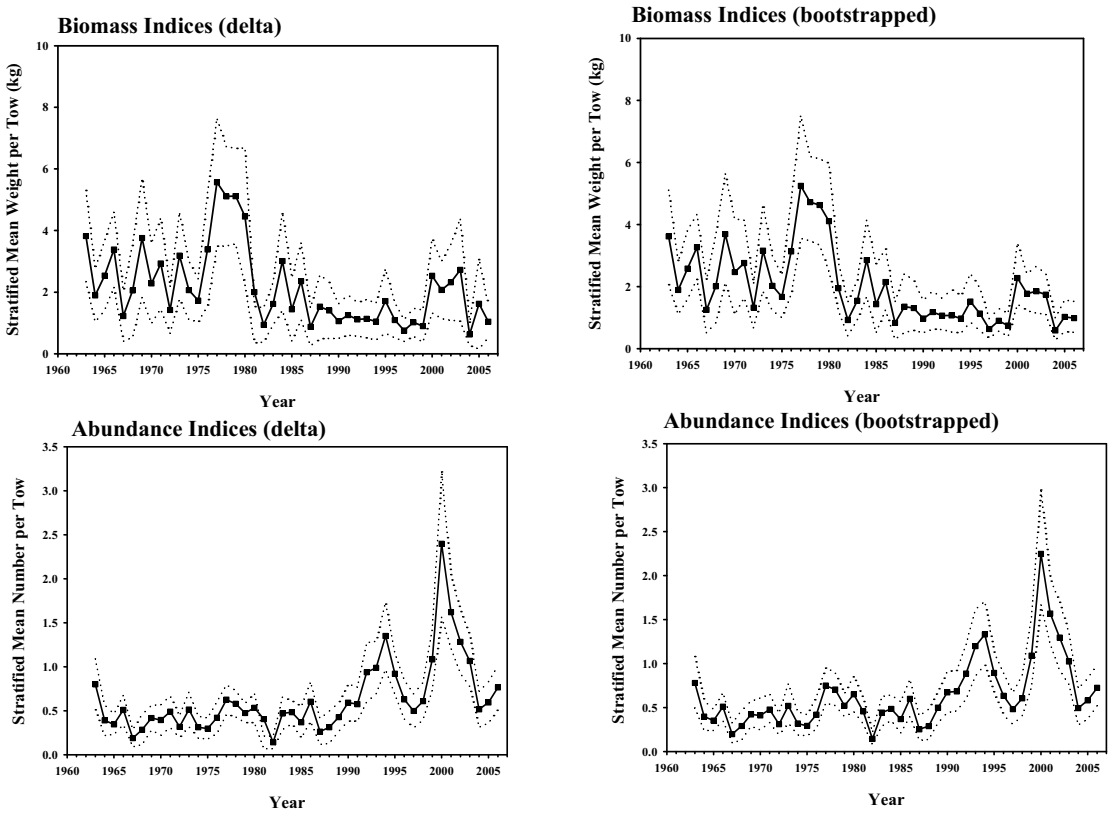


Figure 18b. 95% confidence limits from the NEFSC spring bottom trawl survey of monkfish in the northern management area.

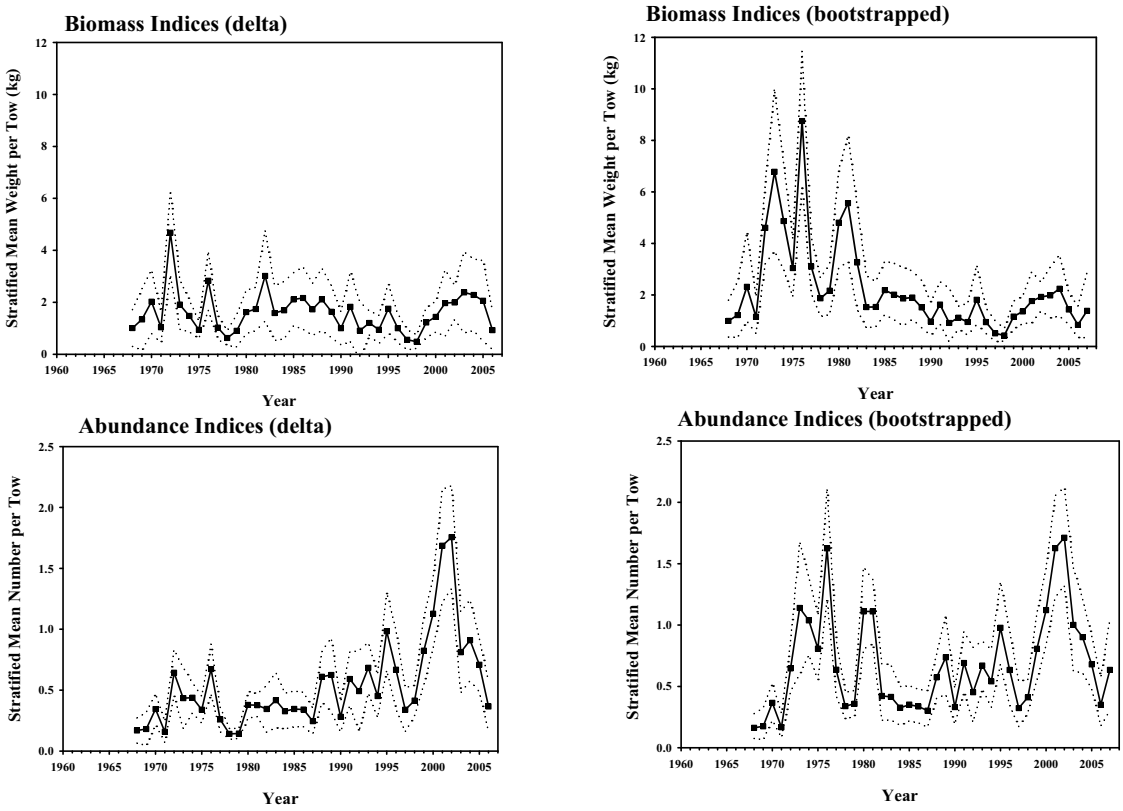


Figure 18c. 95% confidence limits from the ASMFC shrimp bottom trawl survey of monkfish in the northern management area.

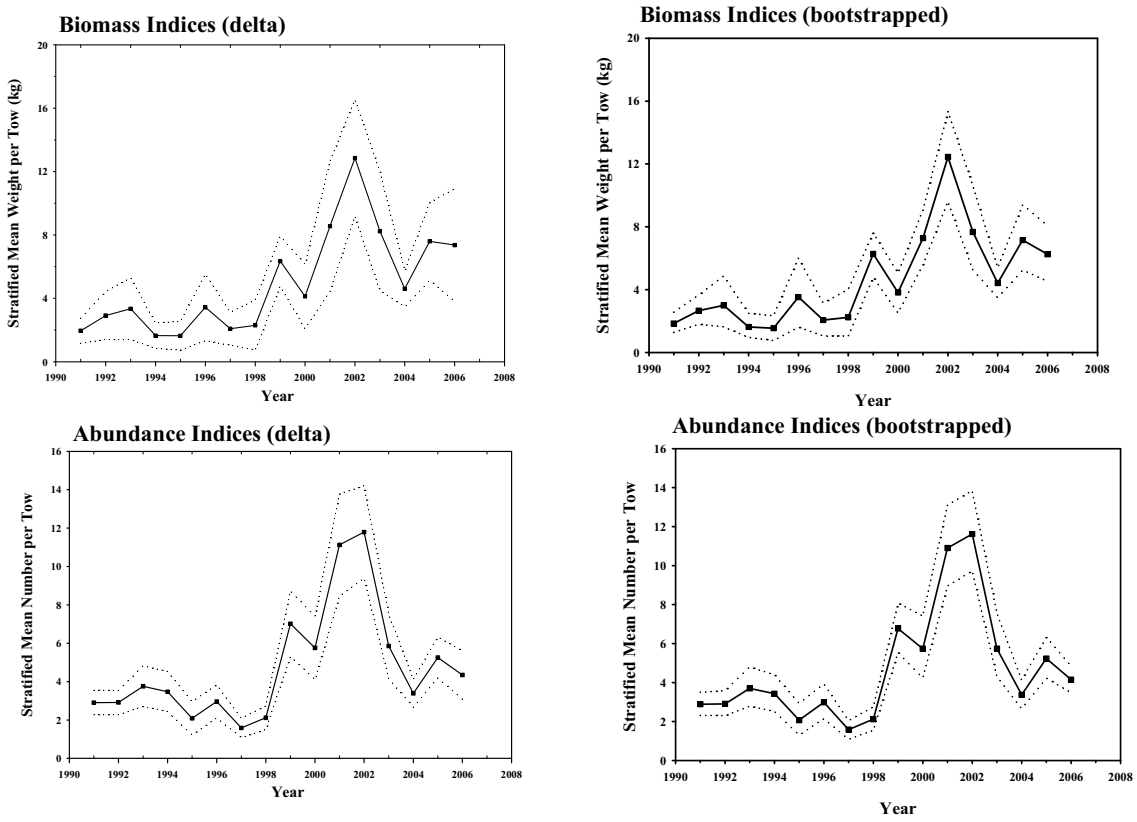


Figure19a. Correlations for numbers per tow among surveys of monkfish in the northern management area. Fal_North_N=NEFSC Fall survey, northern management area, numbers per tow, Spr_North_N=NEFSC Spring survey, northern management area, numbers per tow, Shr_North_N=ASMFC Shrimp survey, northern management area, numbers per tow.

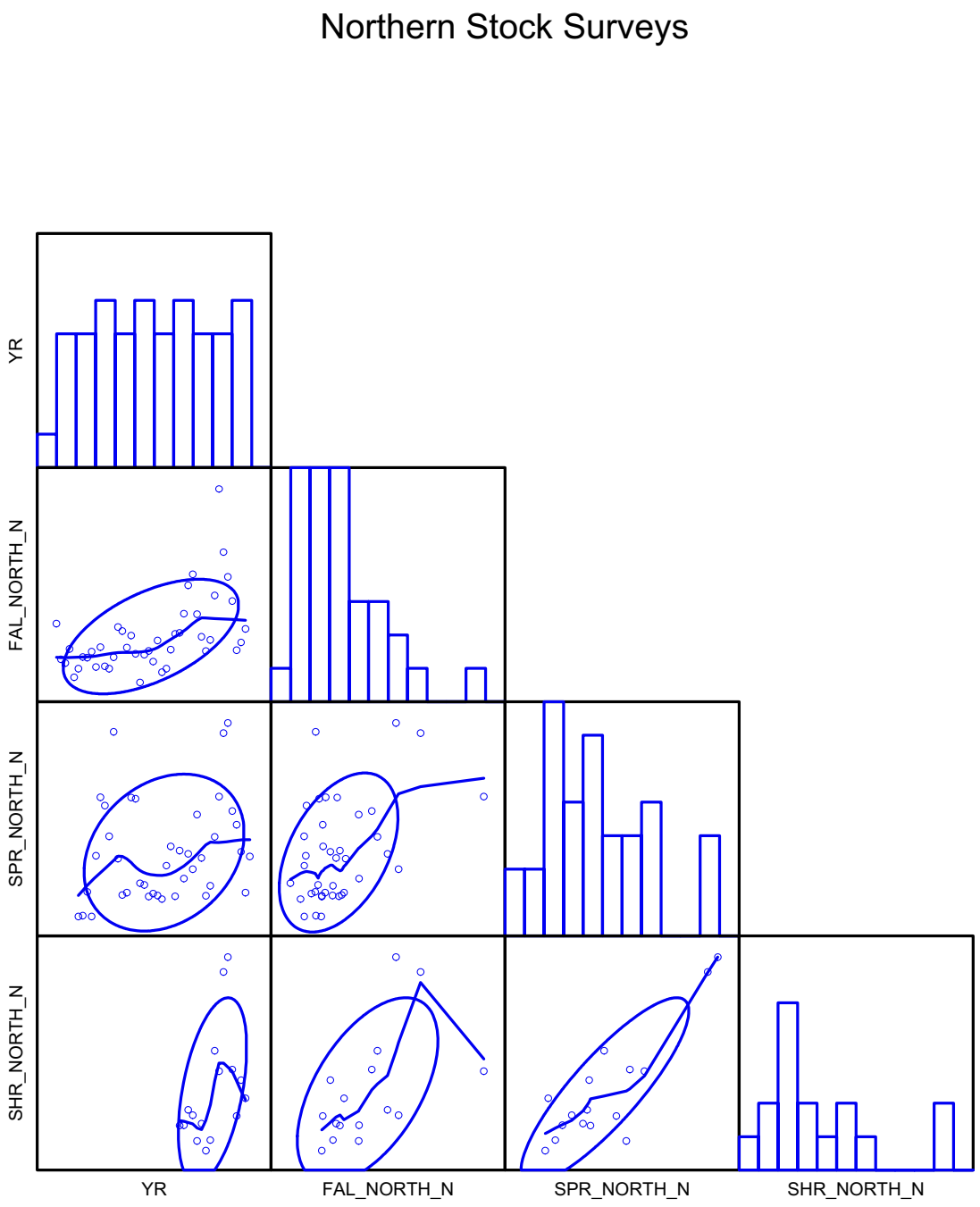


Figure 19b. Correlations among surveys of monkfish in the northern management area since 1980. Fal_North_N=NEFSC Fall survey, northern management area, numbers per tow, Spr_North_N=NEFSC Spring survey, northern management area, numbers per tow, Shr_North_N=ASMFC Shrimp survey, northern management area, numbers per tow.

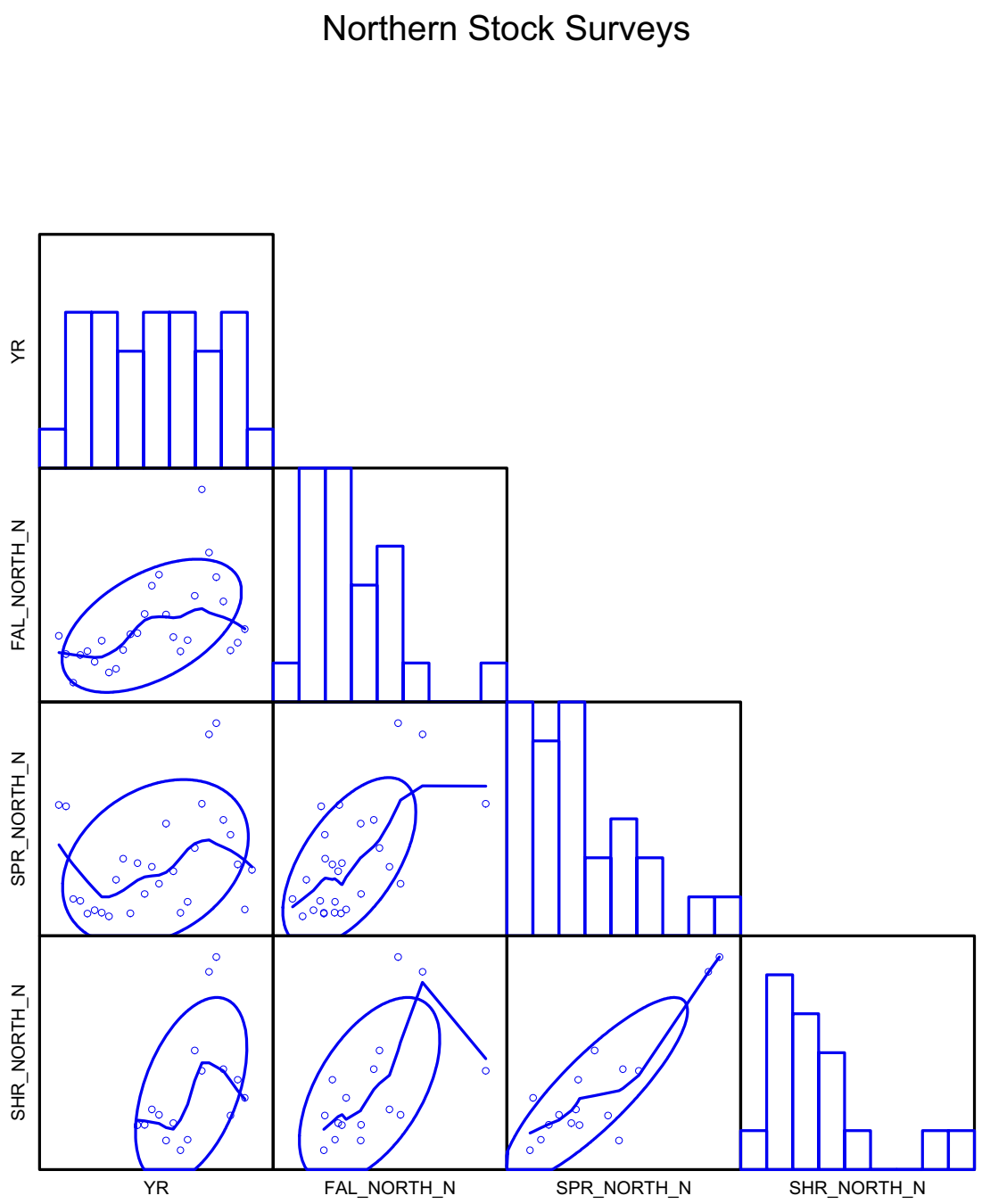


Figure 20a. Monkfish length composition from the NEFSC spring and autumn surveys in the northern management area.

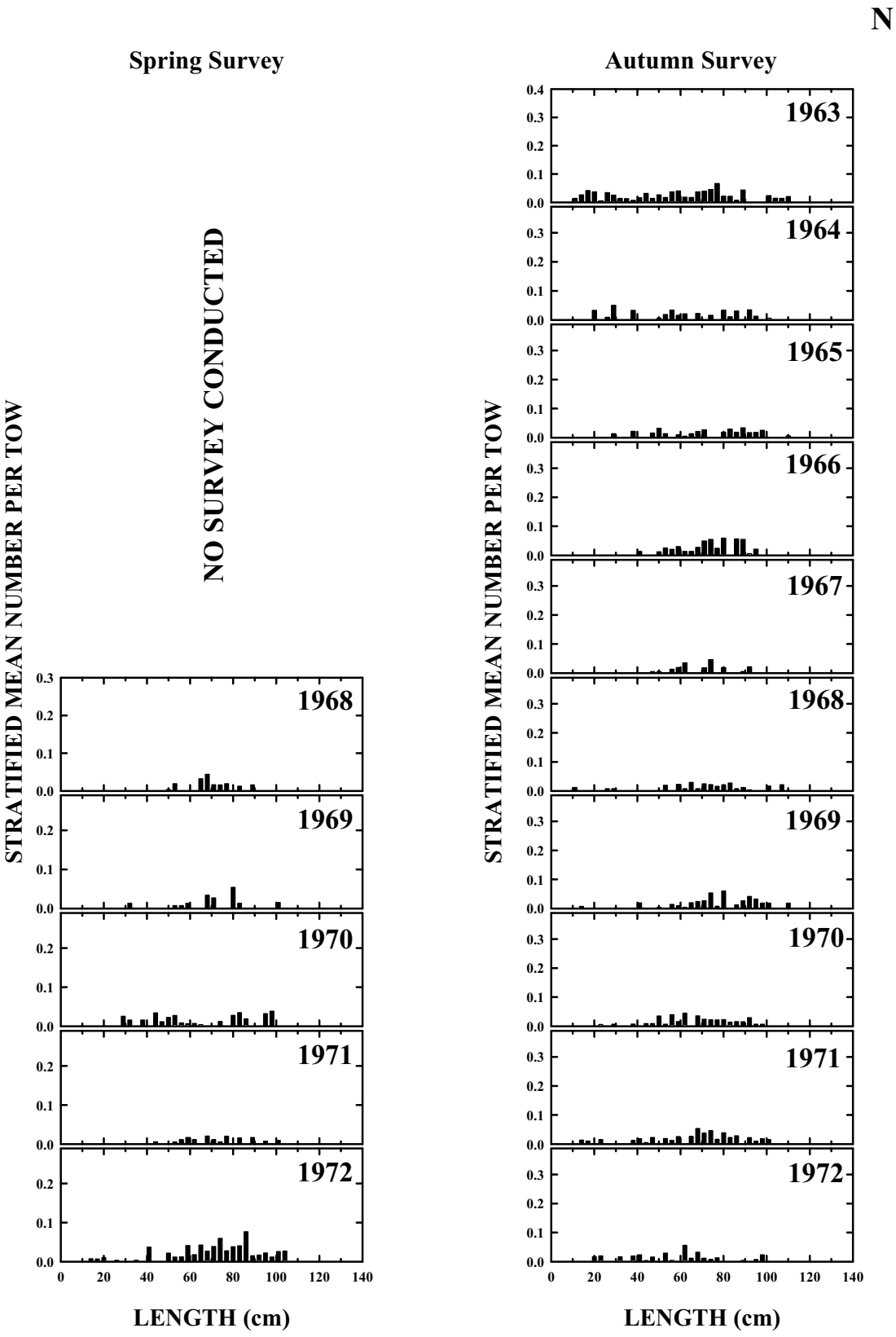


Figure 20b.

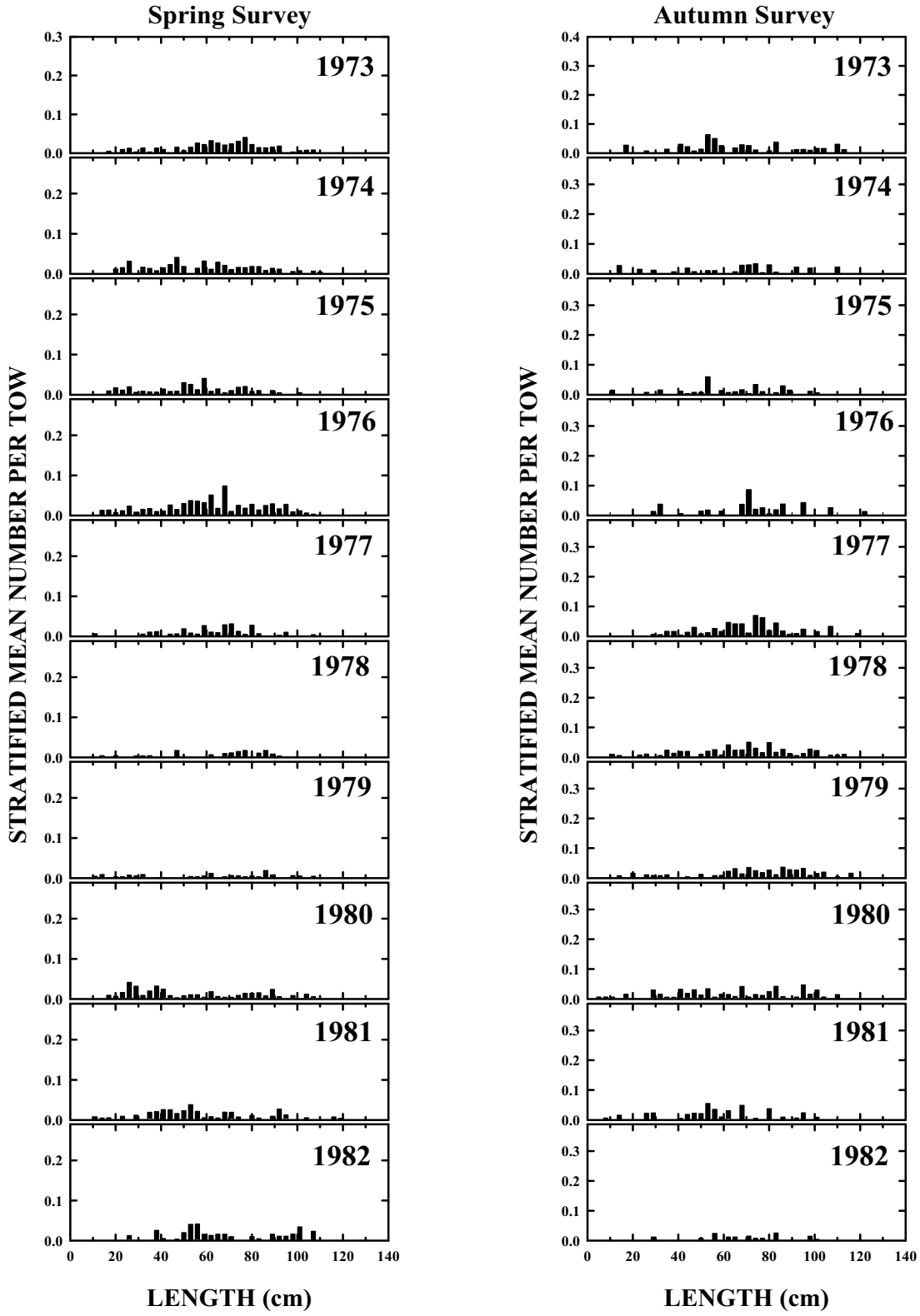

Spring Survey
Autumn Survey
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
0
20
40
60
80
100
120
140

Figure 20c.

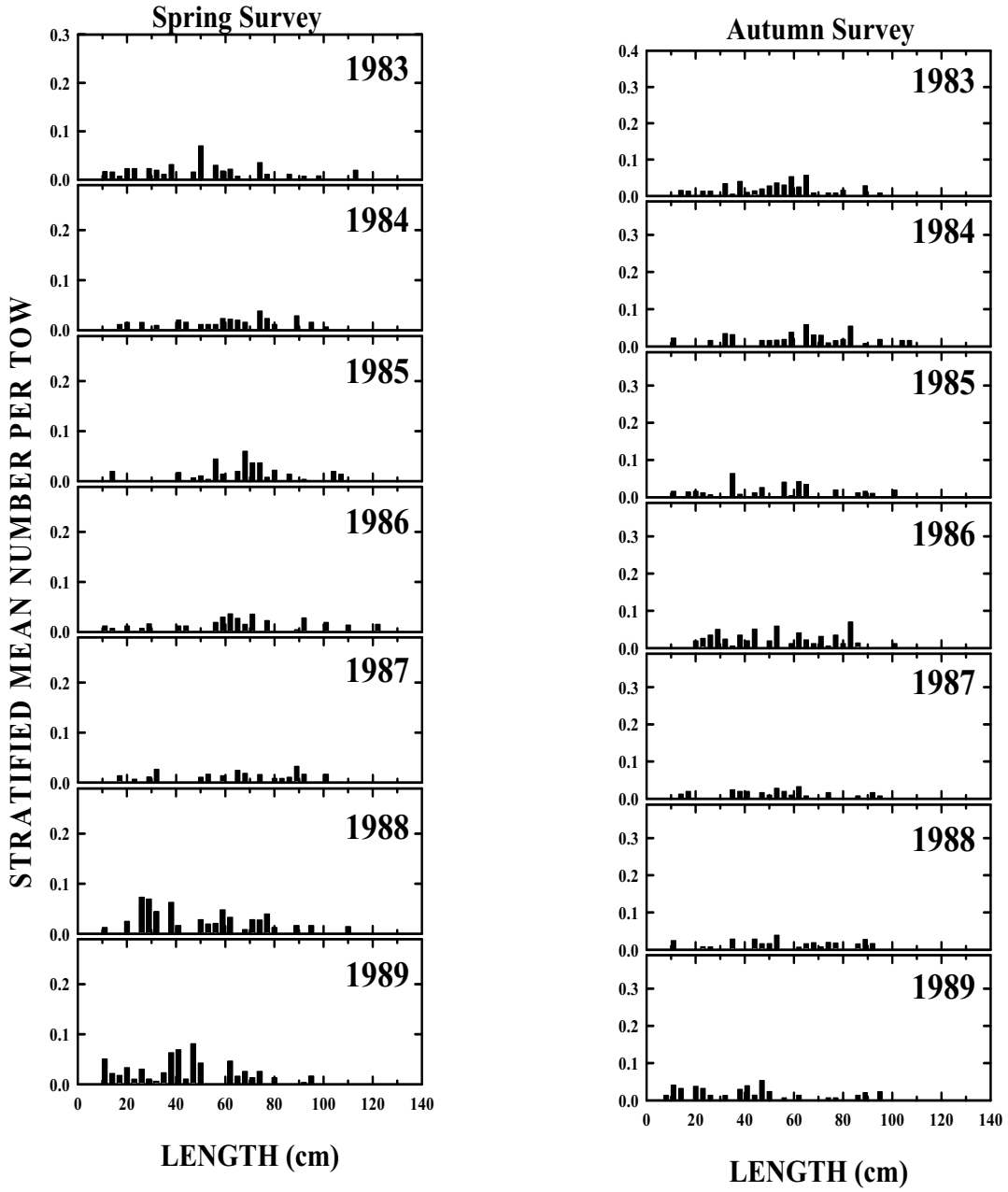

Spring Survey
Autumn Survey
STRATIFIED MEAN NUMBER PER TOW
1983
1984
1985
1986
1987
1988
1989
LENGTH (cm)
LENGTH (cm)

Figure 20d.

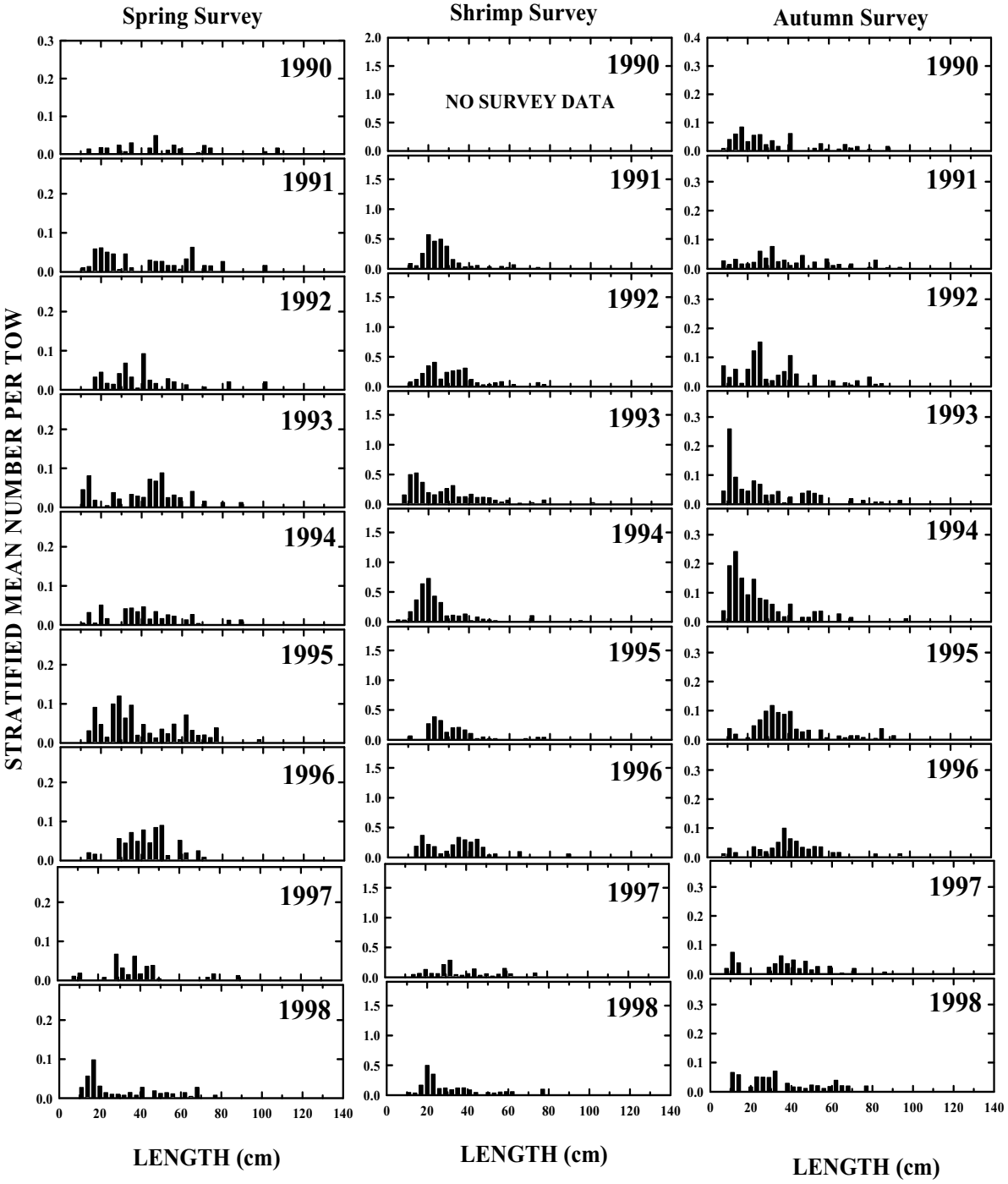
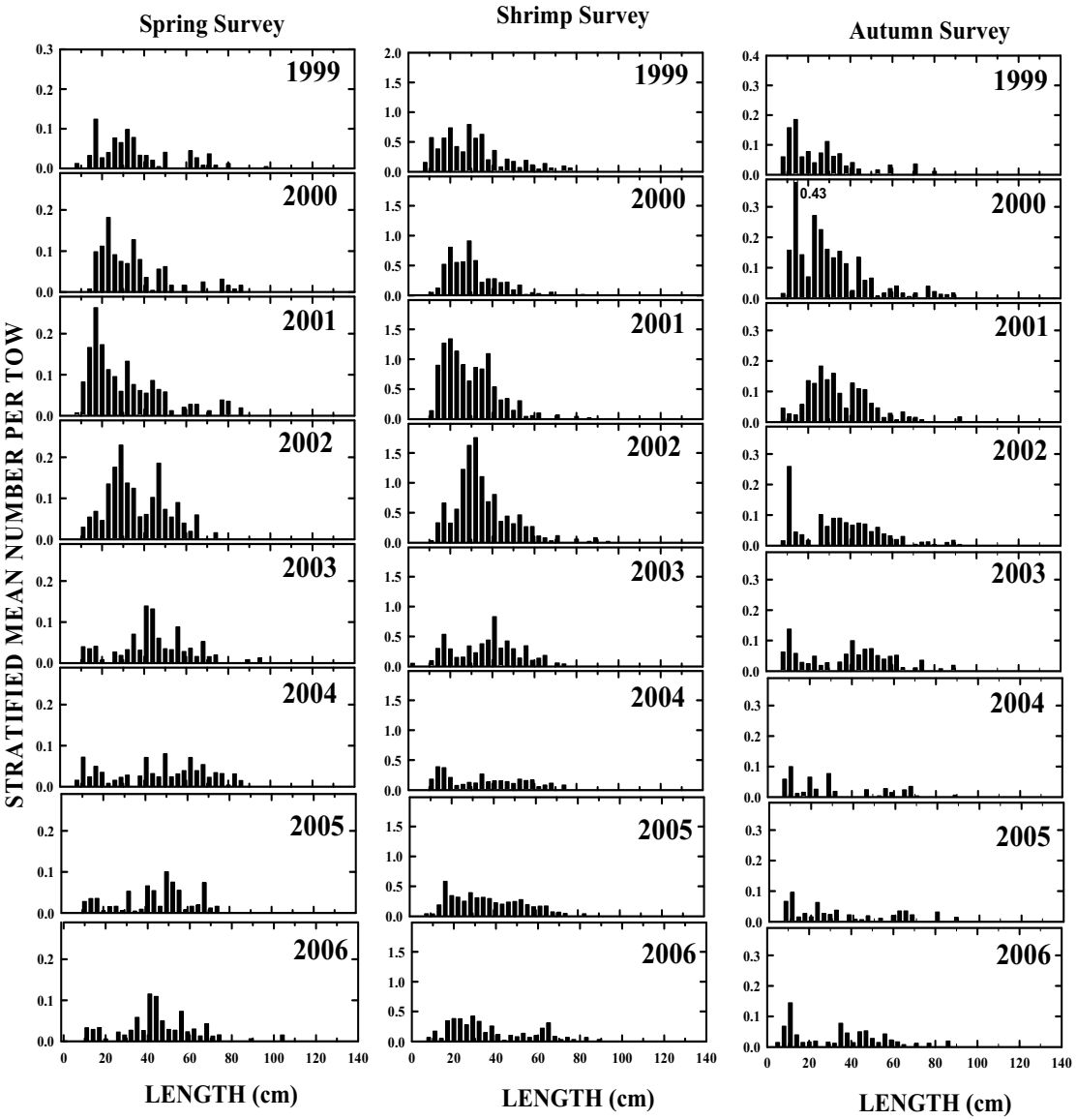

Spring Survey
Shrimp Survey
Autumn Survey
NO SURVEY DATA
1990
1991
1992
1993
1994
1995
1996
1997
1998
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)
LENGTH (cm)
LENGTH (cm)

Figure 20e.


Spring Survey
Shrimp Survey
Autumn Survey
STRATIFIED MEAN NUMBER PER TOW
1999
2000
2001
2002
2003
2004
2005
2006
0.43
LENGTH (cm)
LENGTH (cm)
LENGTH (cm)

.Figure 21. Minimum, median and maximum size of monkfish sampled in the northern management area by the NEFSC fall (A) and spring (B) surveys.

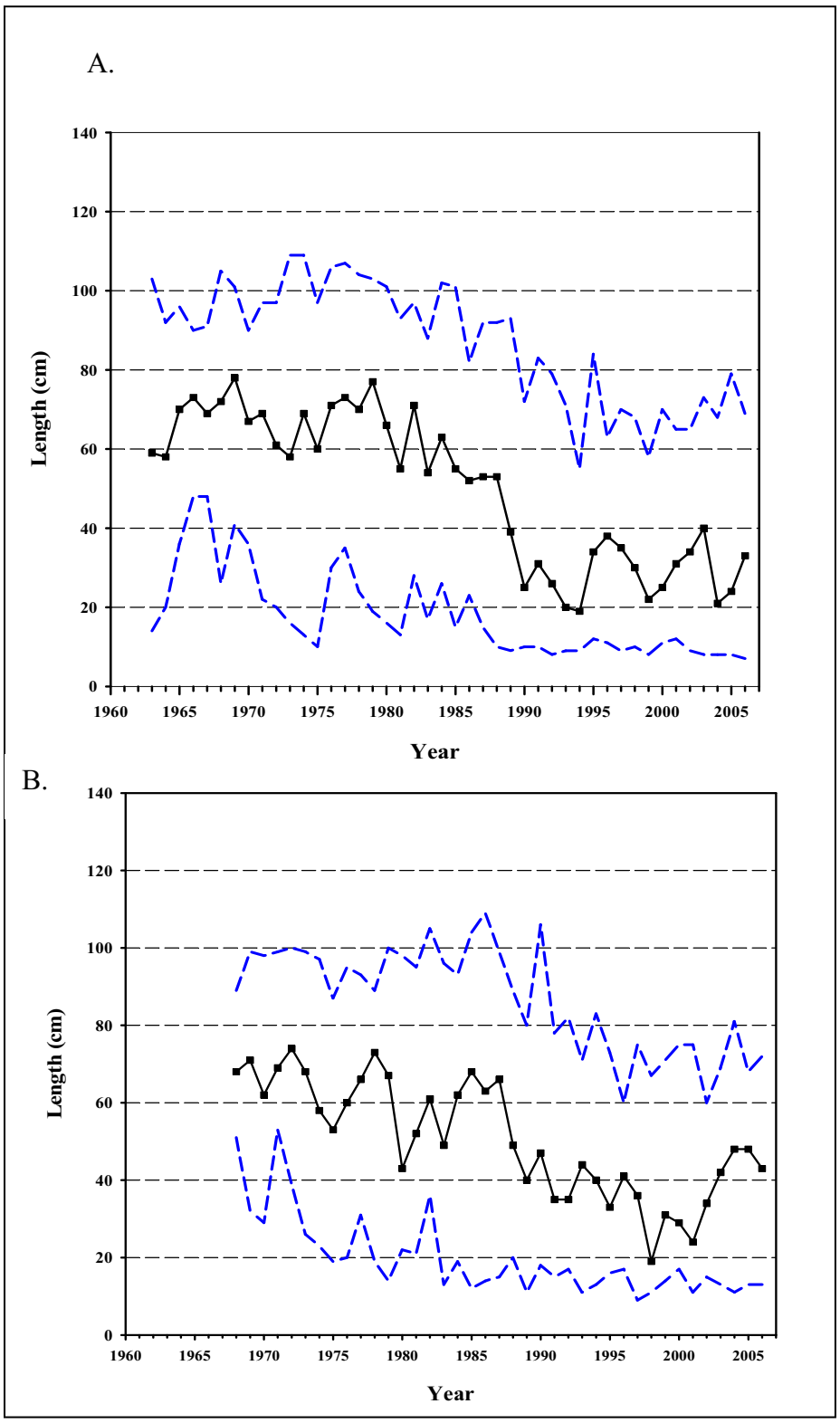


Figure 22. NEFSC spring, autumn and winter surveys of monkfish biomass indicess in the southern management area.

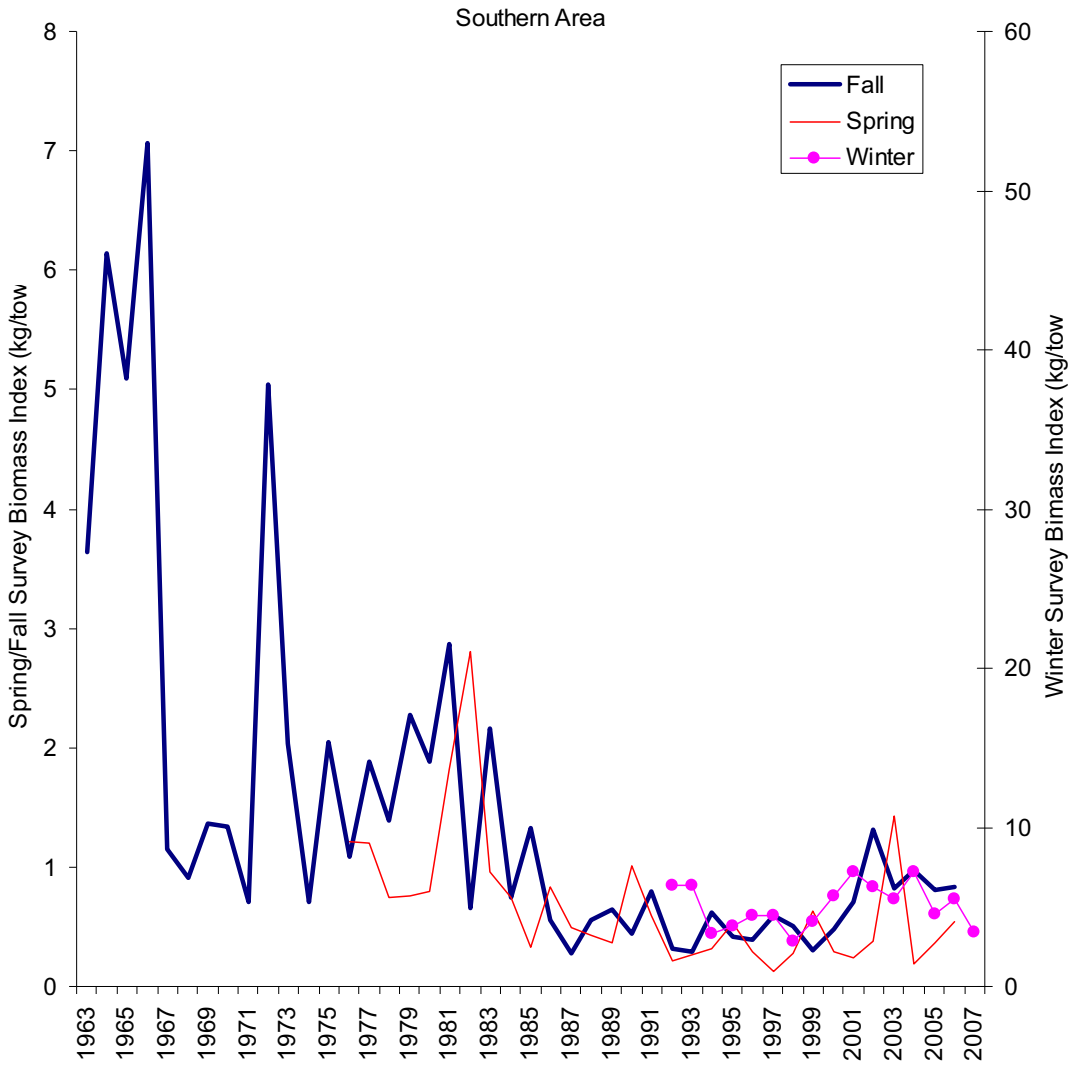


Figure 23a. 95% confidence limits from the NEFSC fall survey of monkfish in the southern management area.

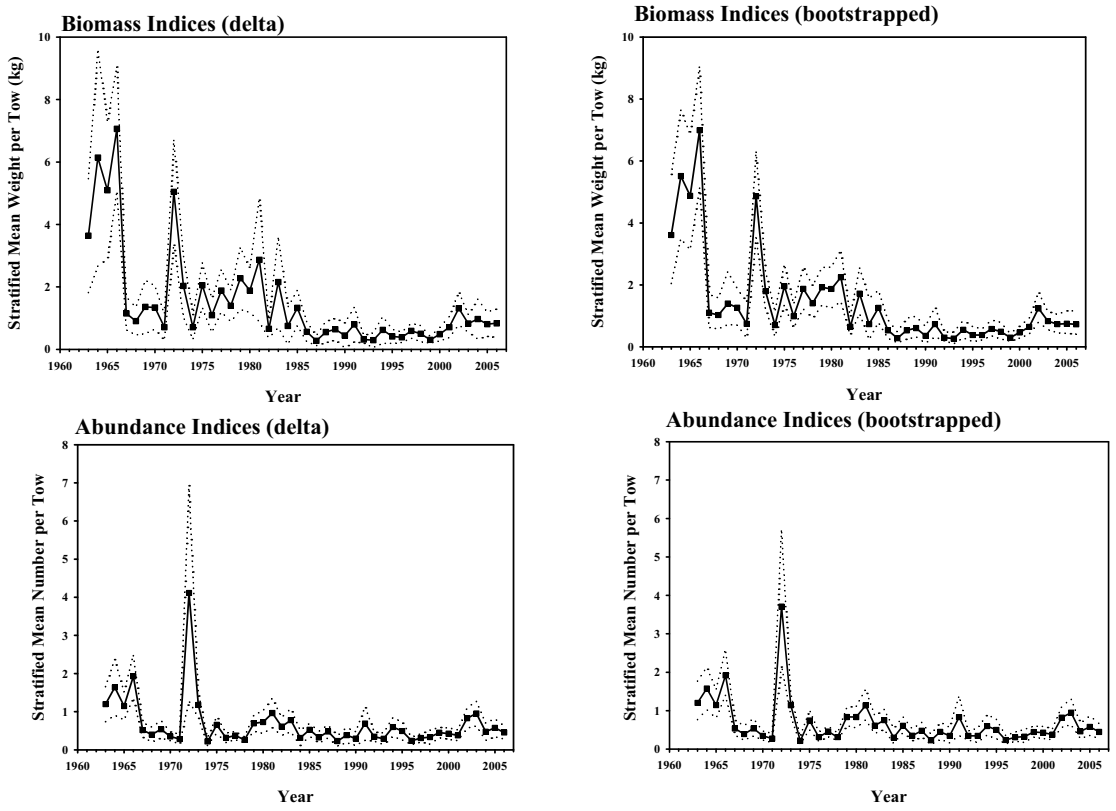


Figure 23b. 95% confidence limits from the NEFSC spring survey of monkfish in the southern area.

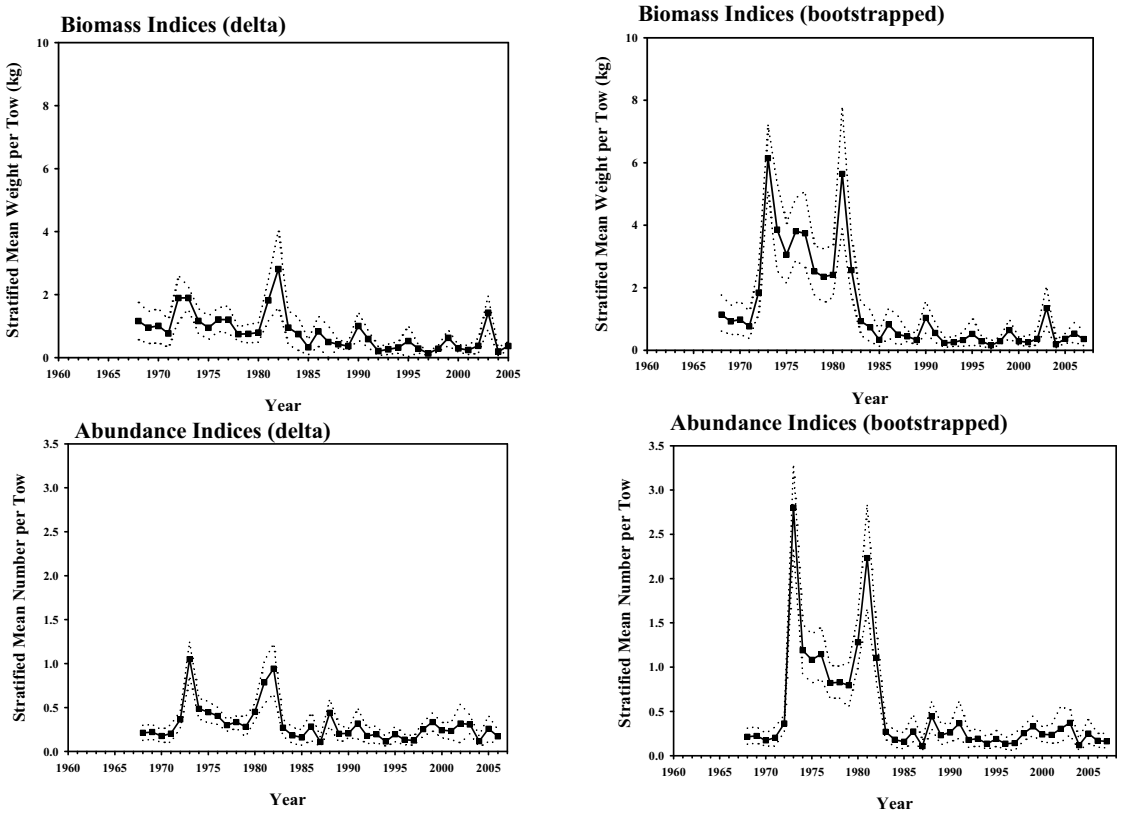


Figure 23c. 95% confidence limits from the NEFSC winter survey of monkfish in the southern area.

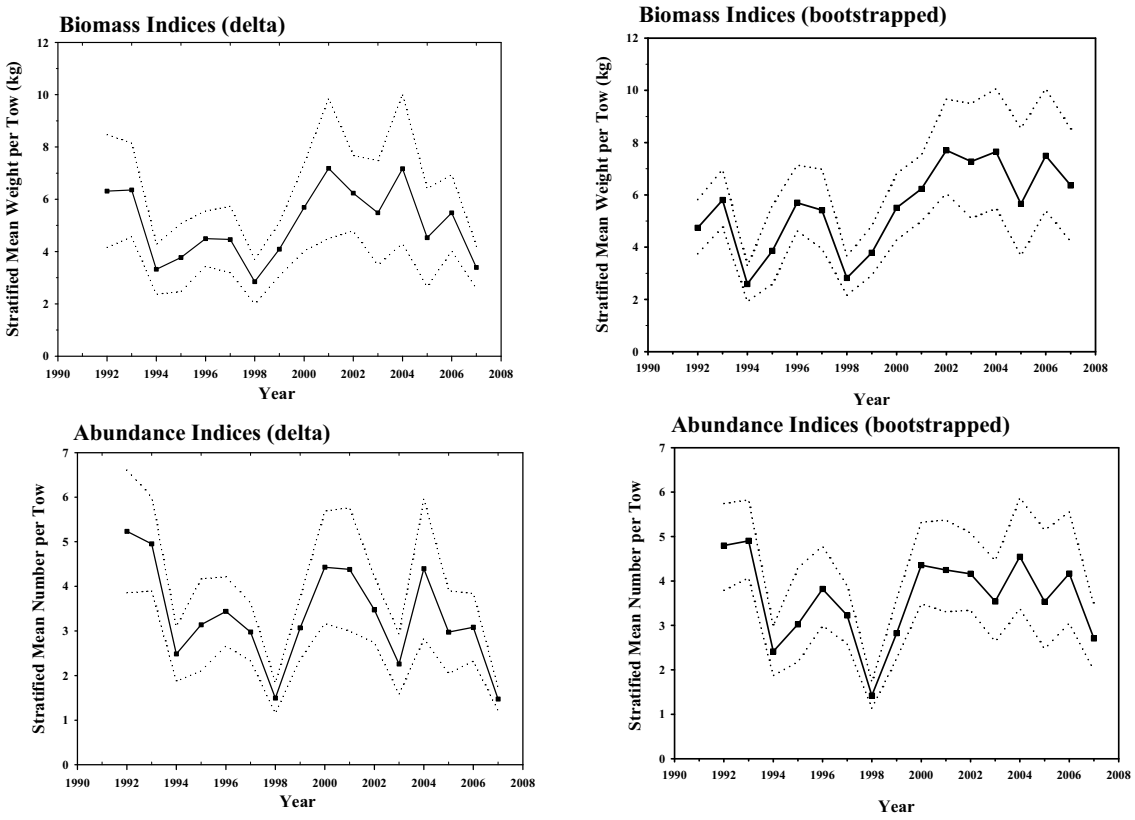


Figure 23d. 95% confidence limits from the NEFSC scallop survey of monkfish in the southern management area. “Biomass Indices (delta)” were not computed for this survey/area.

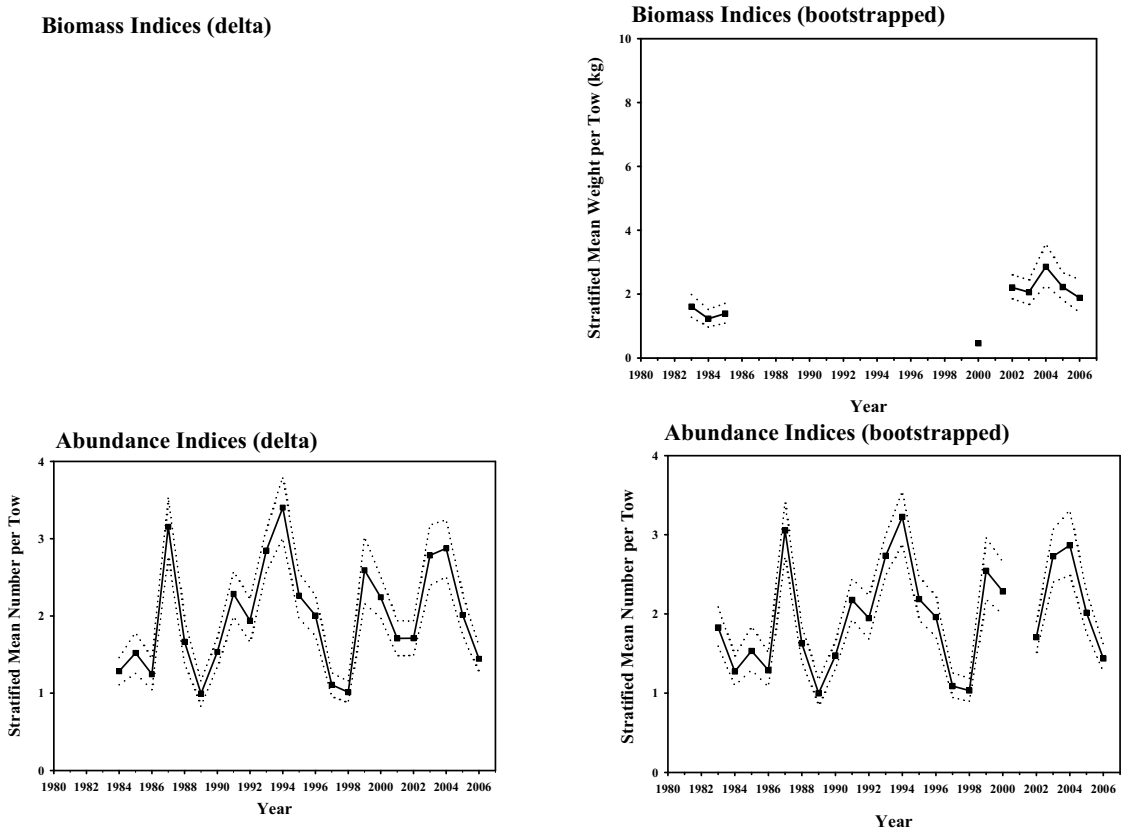


Figure 24a. Correlations among surveys of monkfish in the southern management area. Fal_South_N=NEFSC Fall survey, southern management area, numbers per tow, Spr_South_N=NEFSC Spring survey, southern management area, numbers per tow, Win_South_N=NEFSC Winter survey, southern management area, numbers per tow,. Scal_South_N=NEFSC Scallop survey, southern management area, numbers per tow.

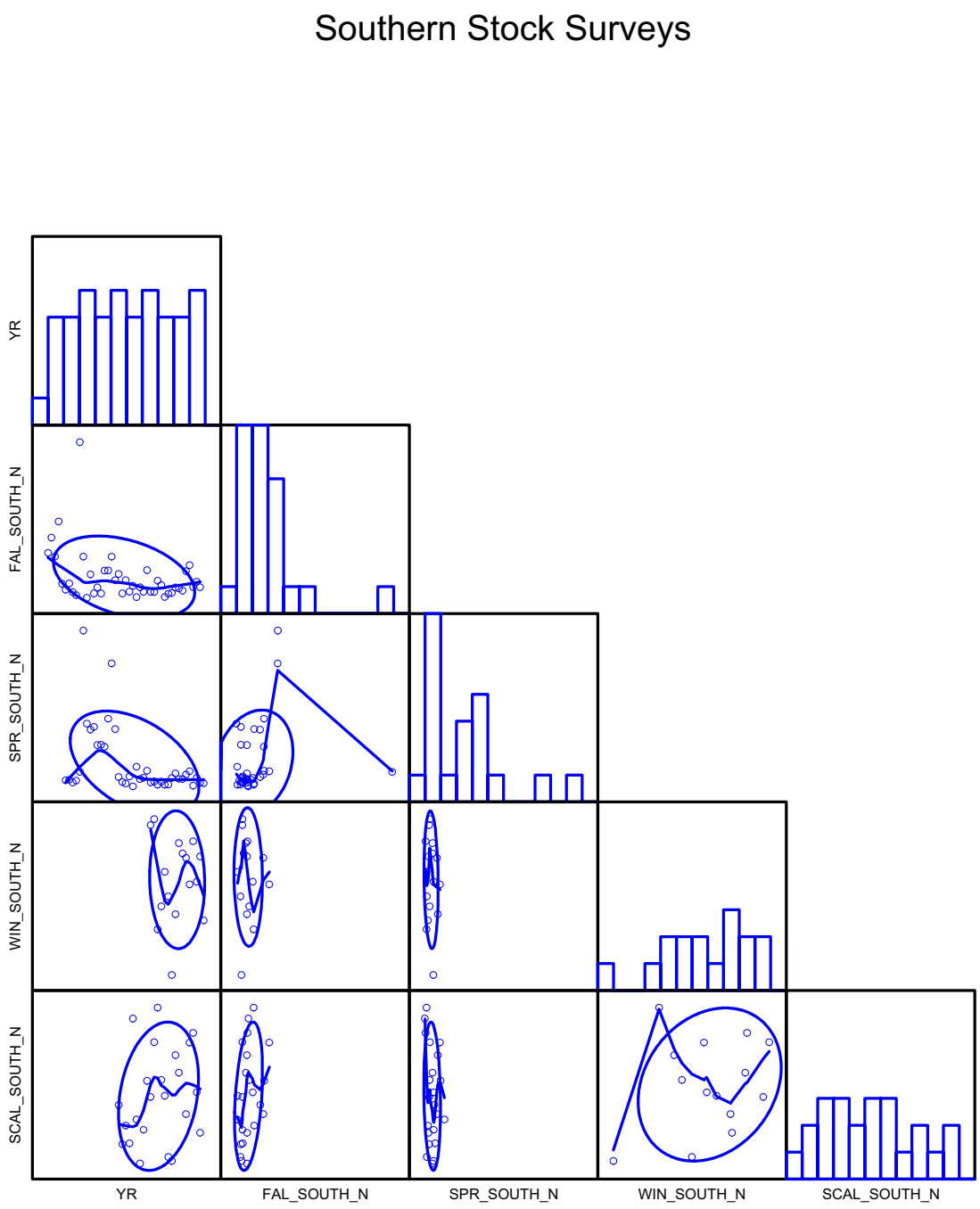


Figure 24b. Correlations among surveys of monkfish in the southern management area since 1980. Fal_South_N=NEFSC Fall survey, southern management area, numbers per tow, Spr_South_N=NEFSC Spring survey, southern management area, numbers per tow, Win_South_N=NEFSC Winter survey, southern management area, numbers per tow,. Scal_South_N=NEFSC Scallop survey, southern management area, numbers per tow.

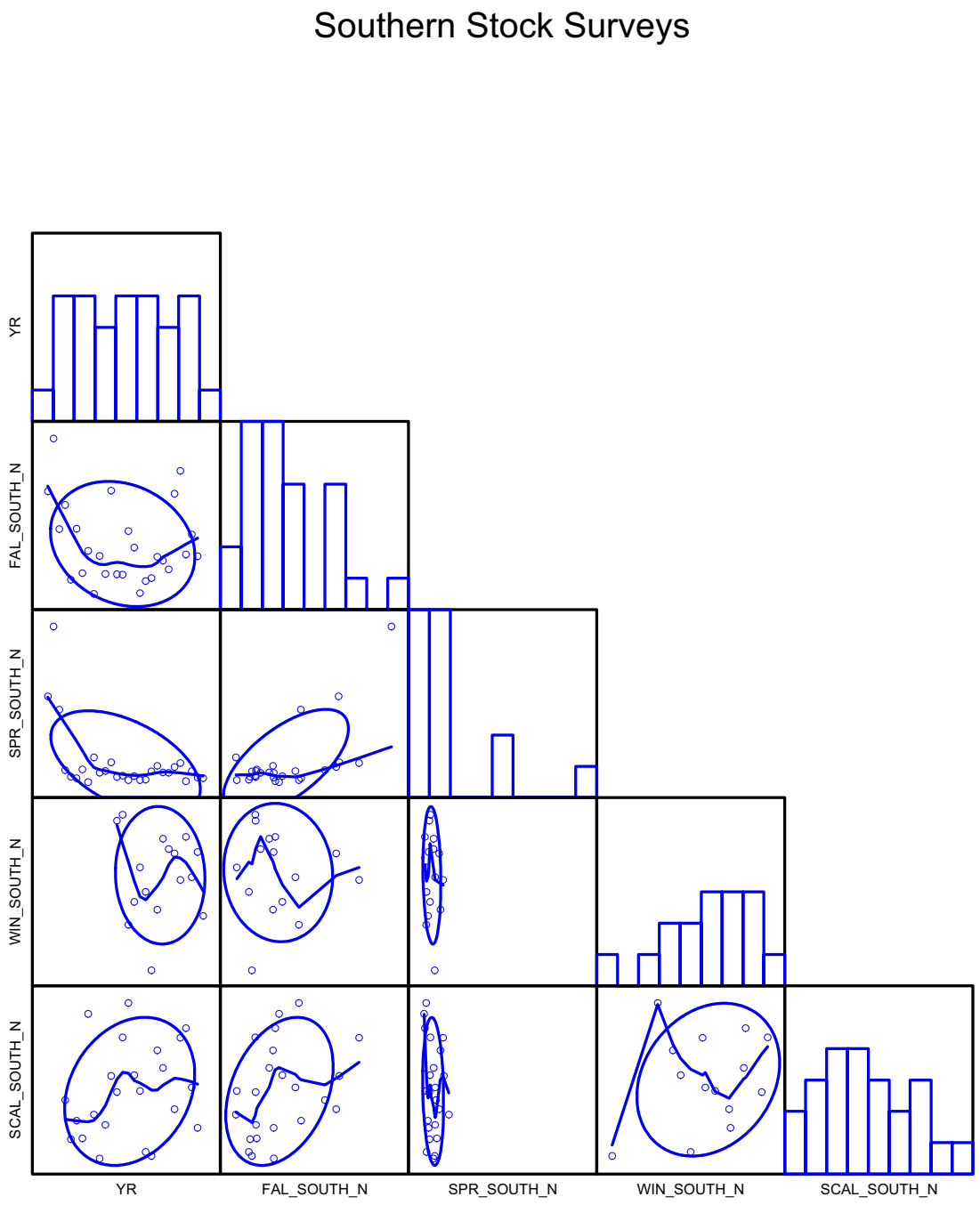


Figure 25. Correlations among NEFSC surveys of monkfish (numbers/tow) in the northern and southern management areas.

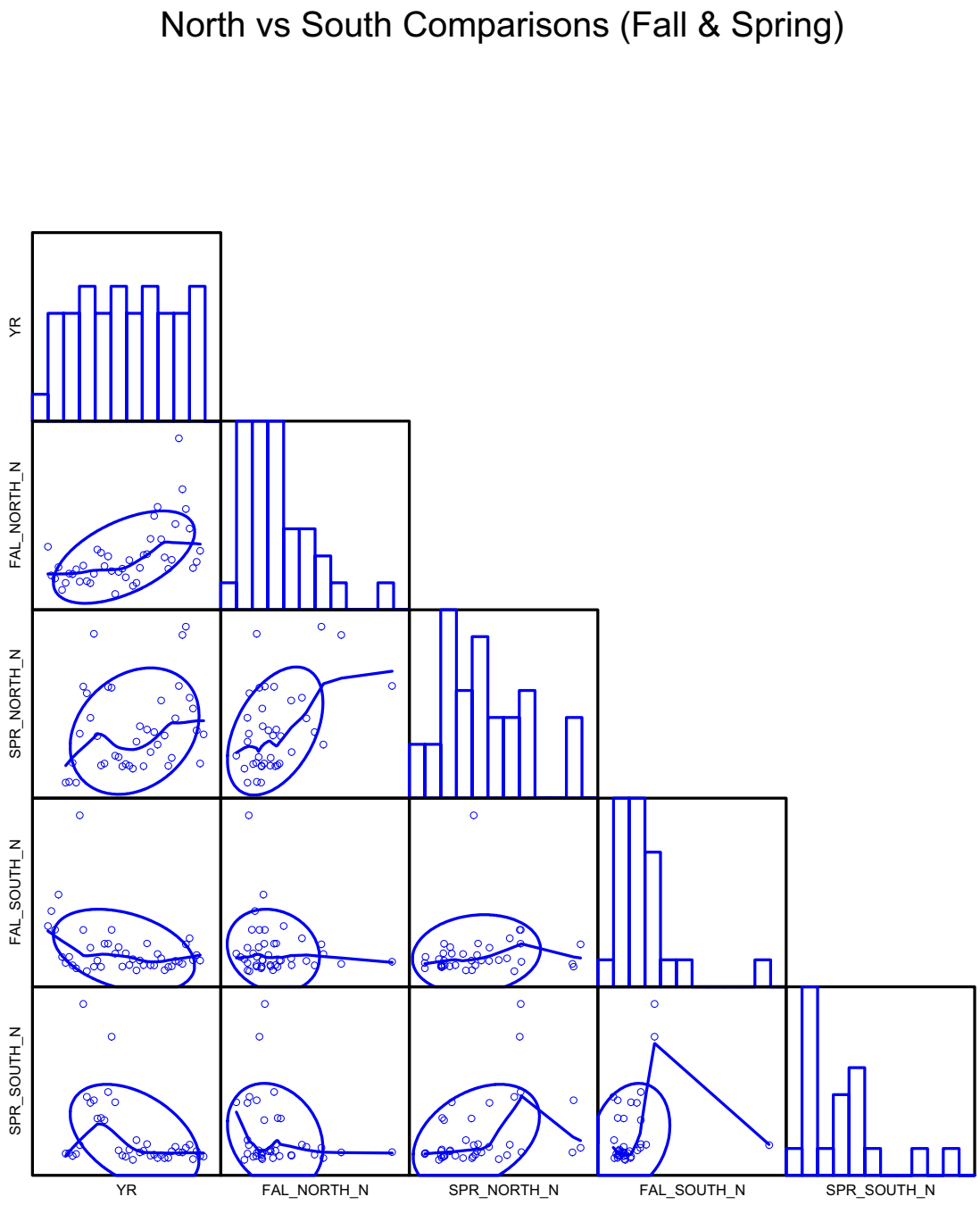


Figure 26a. Monkfish length composition from NEFSC spring, autumn, winter and scallop surveys in the southern management area.

S

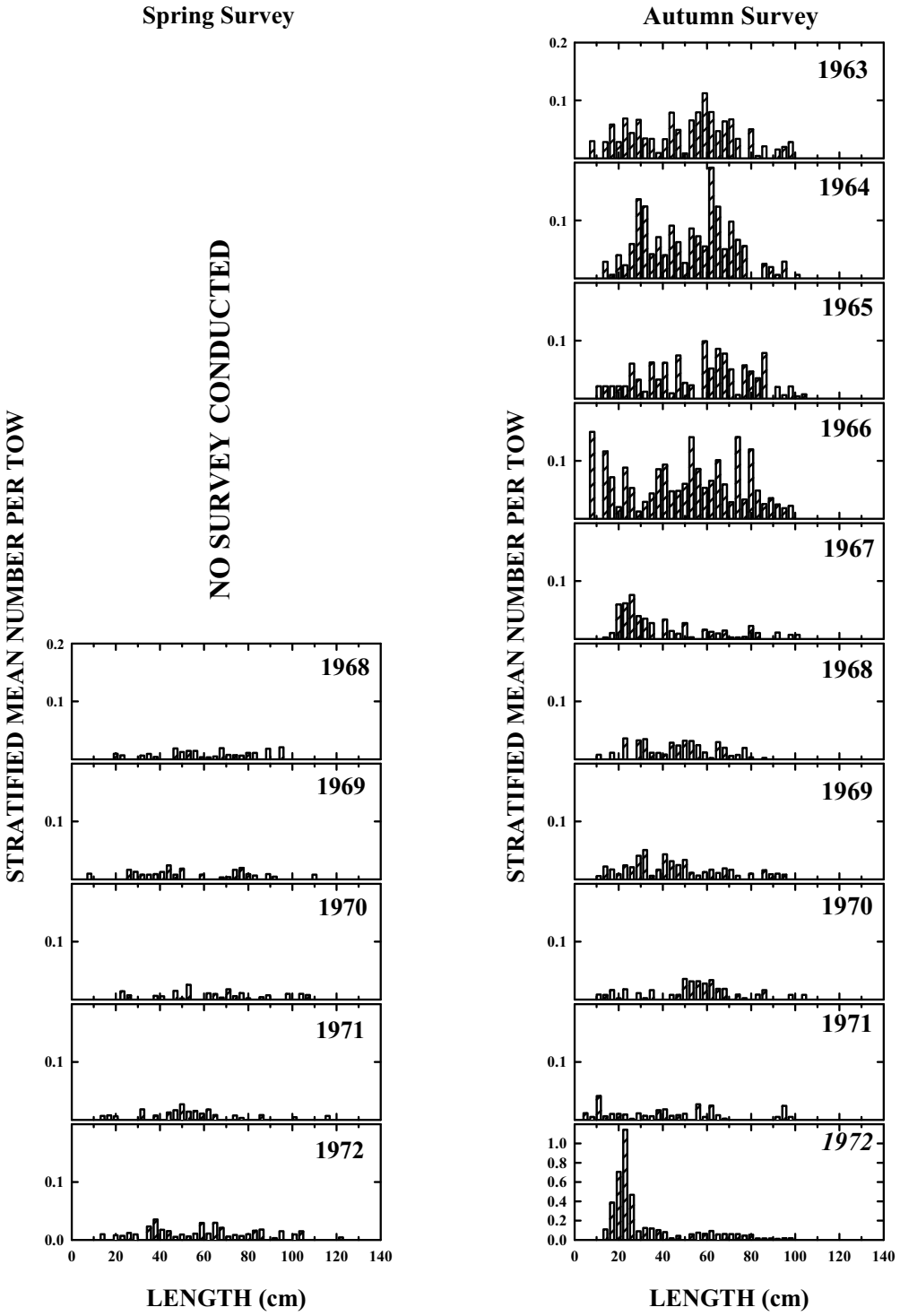


Figure 26b.

S

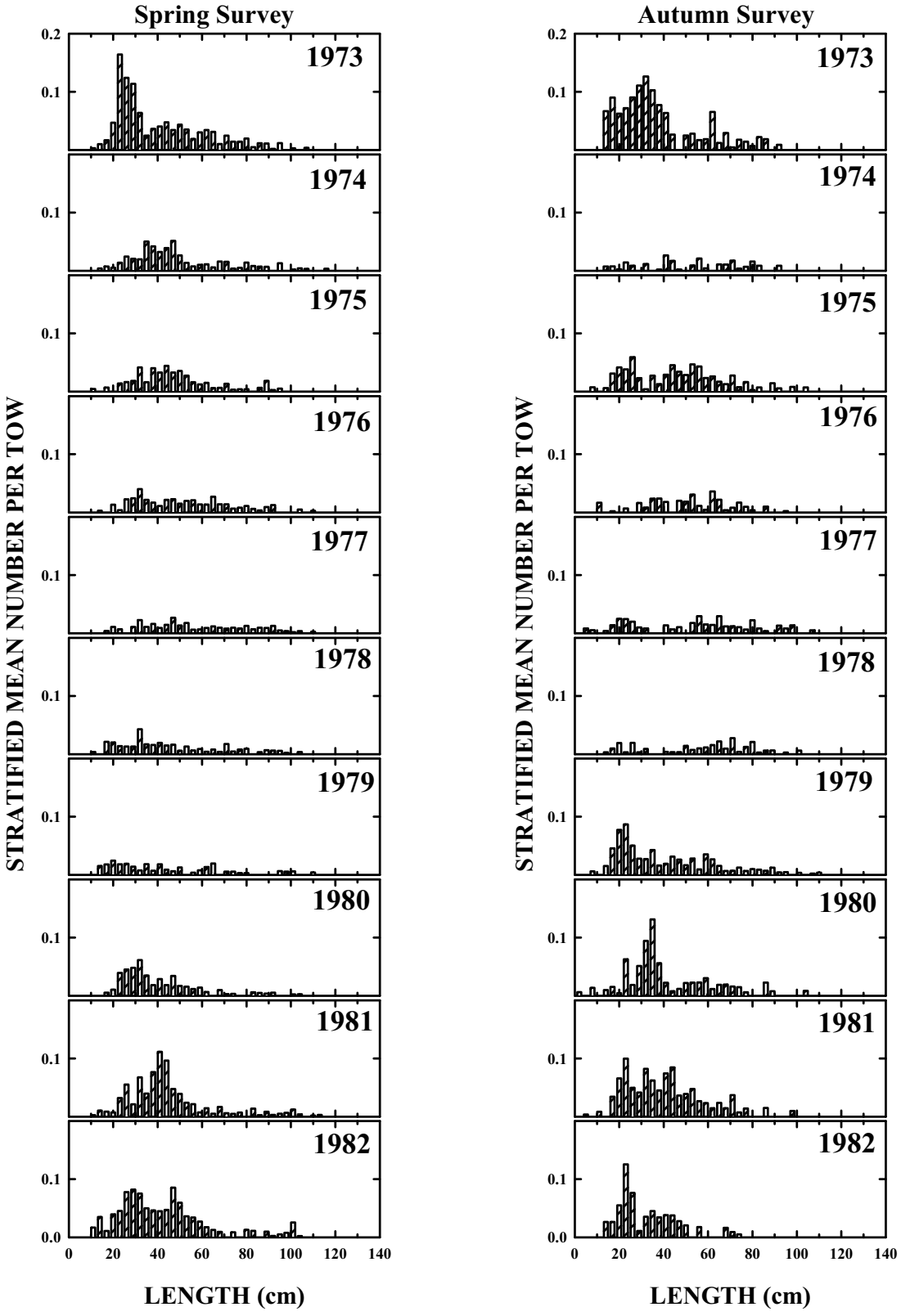

Spring Survey
Autumn Survey
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)
0.0
0.1
0.2
0
20
40
60
80
100
120
140

Figure 26c.

S

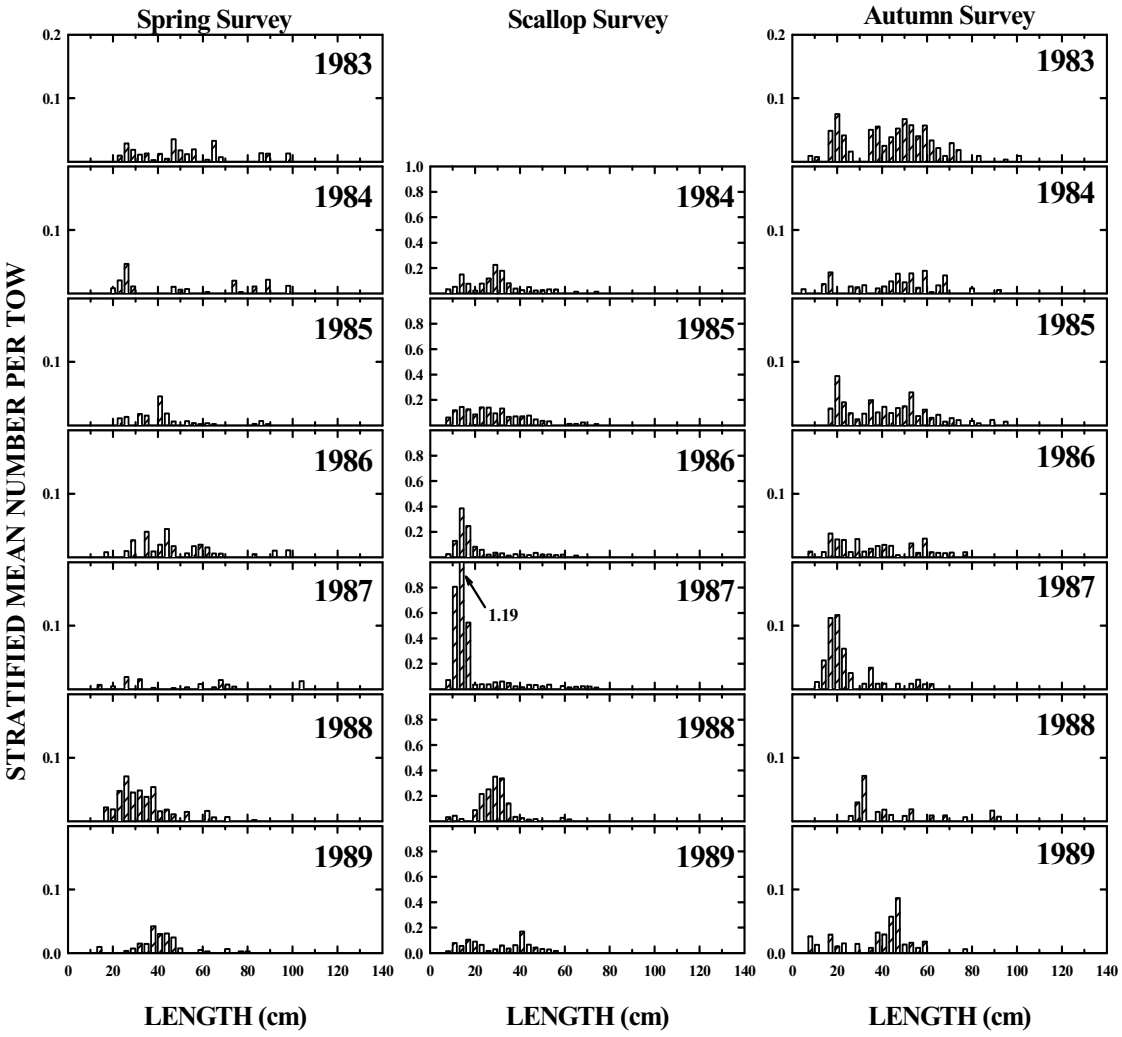

Spring Survey
Scallop Survey
Autumn Survey
1983
1984
1985
1986
1987
1988
1989
1.19
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)
LENGTH (cm)
LENGTH (cm)

Figure 26d.

S

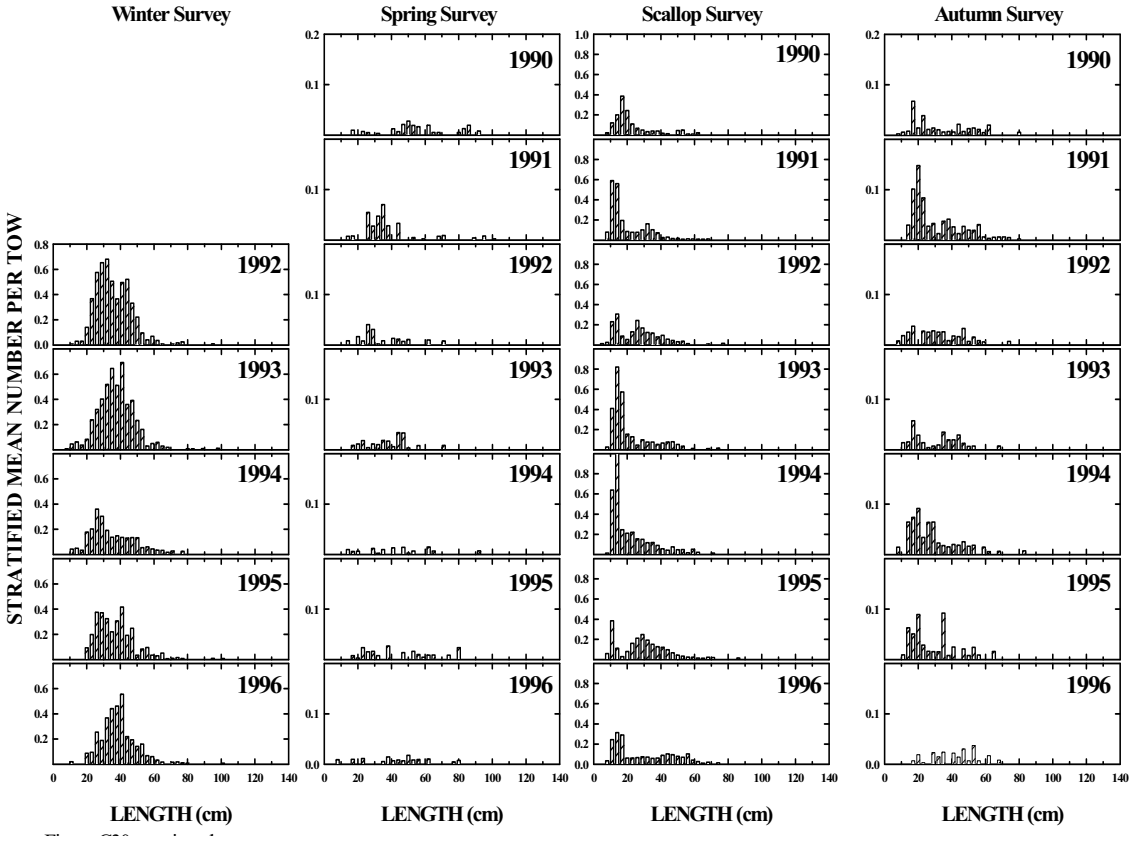

Winter Survey
Spring Survey
Scallop Survey
Autumn Survey
STRATIFIED MEAN NUMBER PER TOW
1990
1991
1992
1993
1994
1995
1996
LENGTH (cm)

Figure 26e.

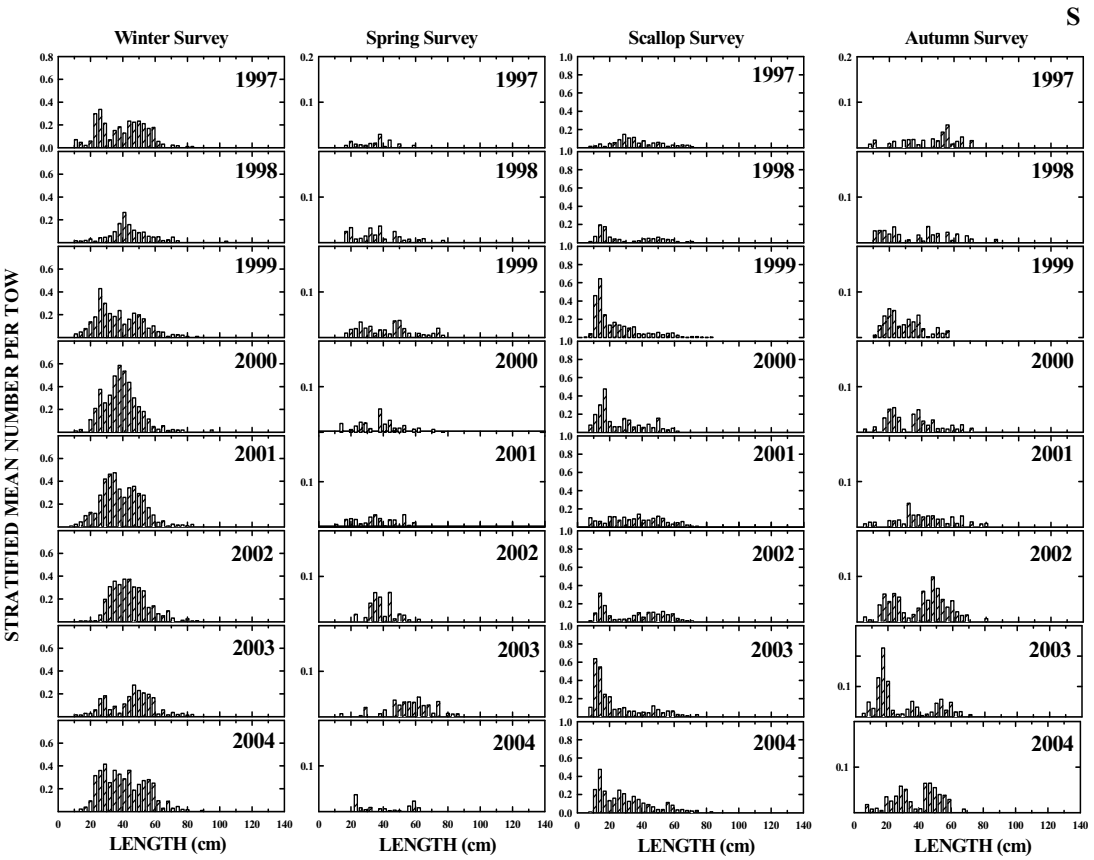

S
Winter Survey
Spring Survey
Scallop Survey
Autumn Survey
1997
1998
1999
2000
2001
2002
2003
2004
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)

Figure 26f.

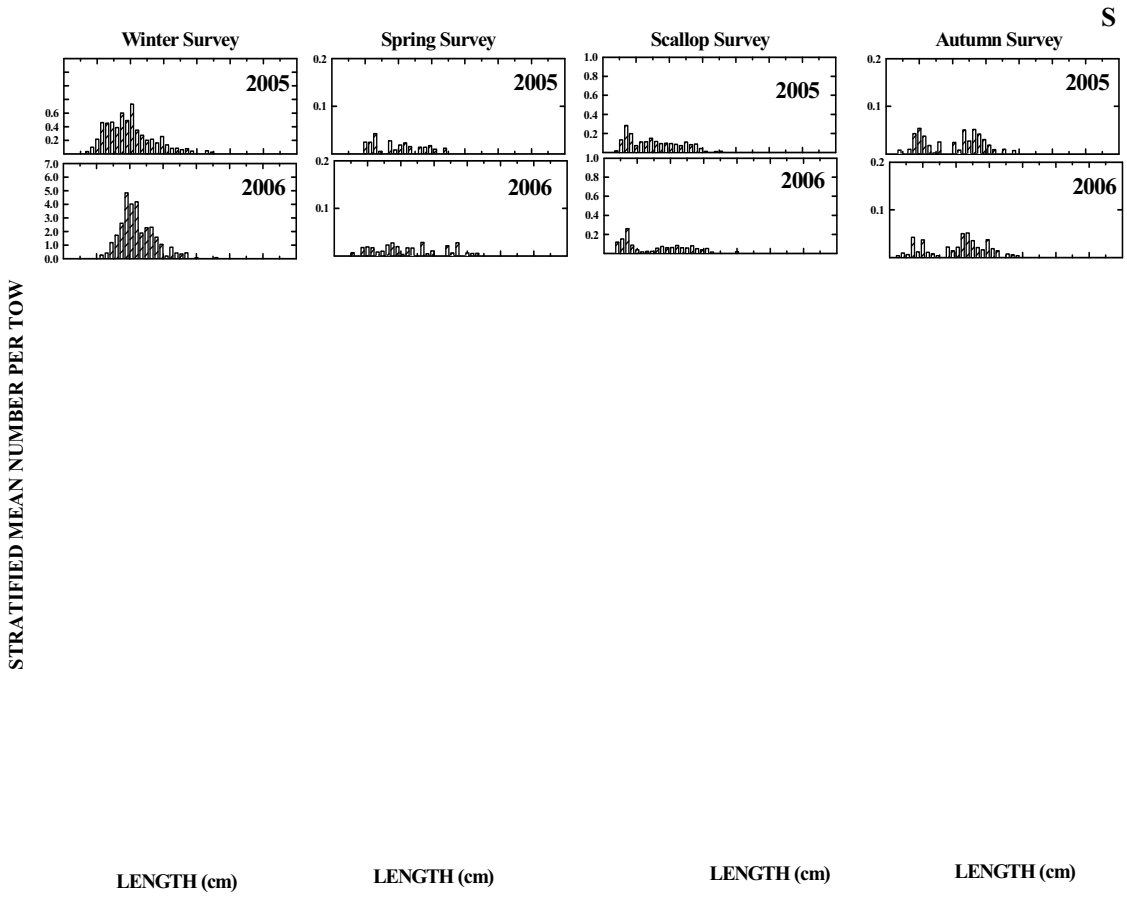

S
Winter Survey
Spring Survey
Scallop Survey
Autumn Survey
2005
2006
STRATIFIED MEAN NUMBER PER TOW
LENGTH (cm)
LENGTH (cm)
LENGTH (cm)
LENGTH (cm)

Figure 27. Minimum, median and maximum size of monkfish sampled in the southern management area by the NEFSC fall (A) and spring (B) surveys.

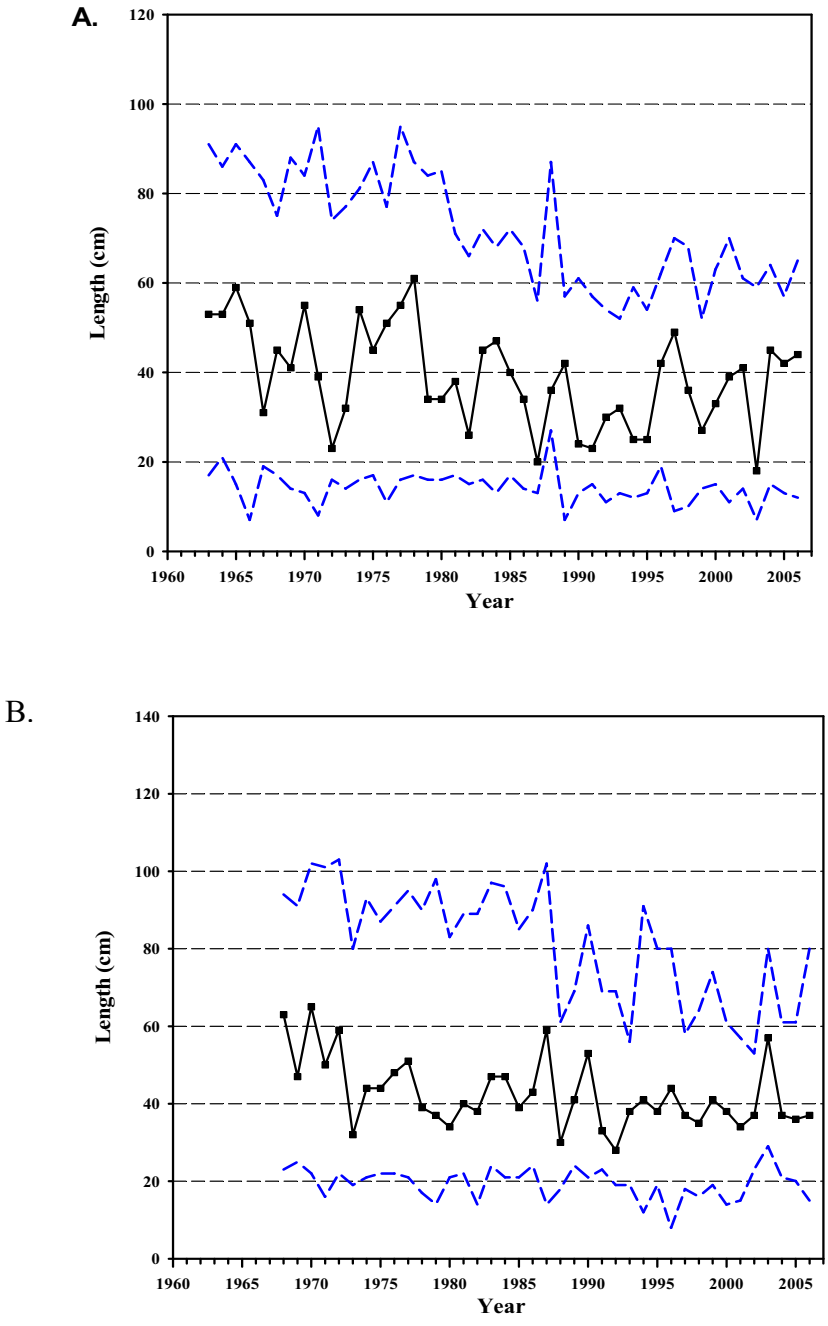


Figure 28. Observations of length at age from NEFSC surveys and cooperative monkfish surveys.

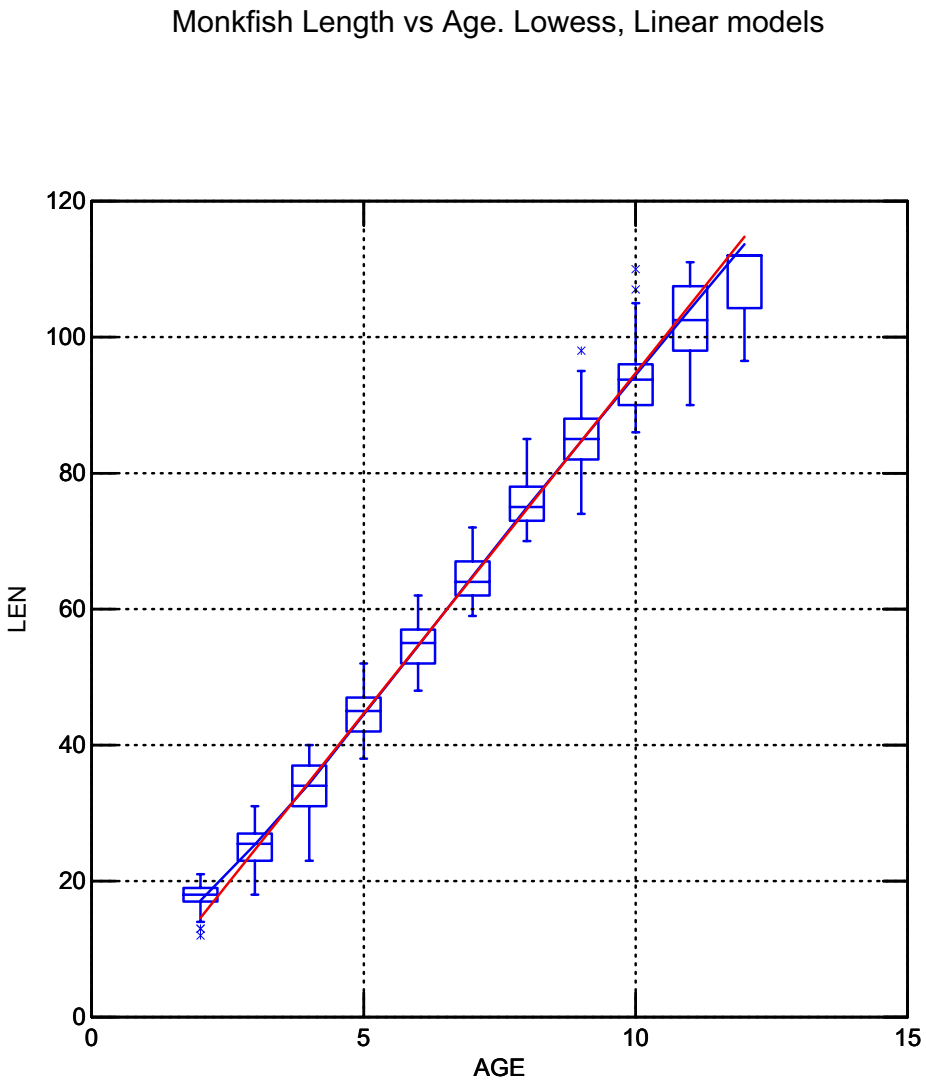


Figure 29a. AIM analysis of catch and the NEFSC fall survey of monkfish in the northern management area.

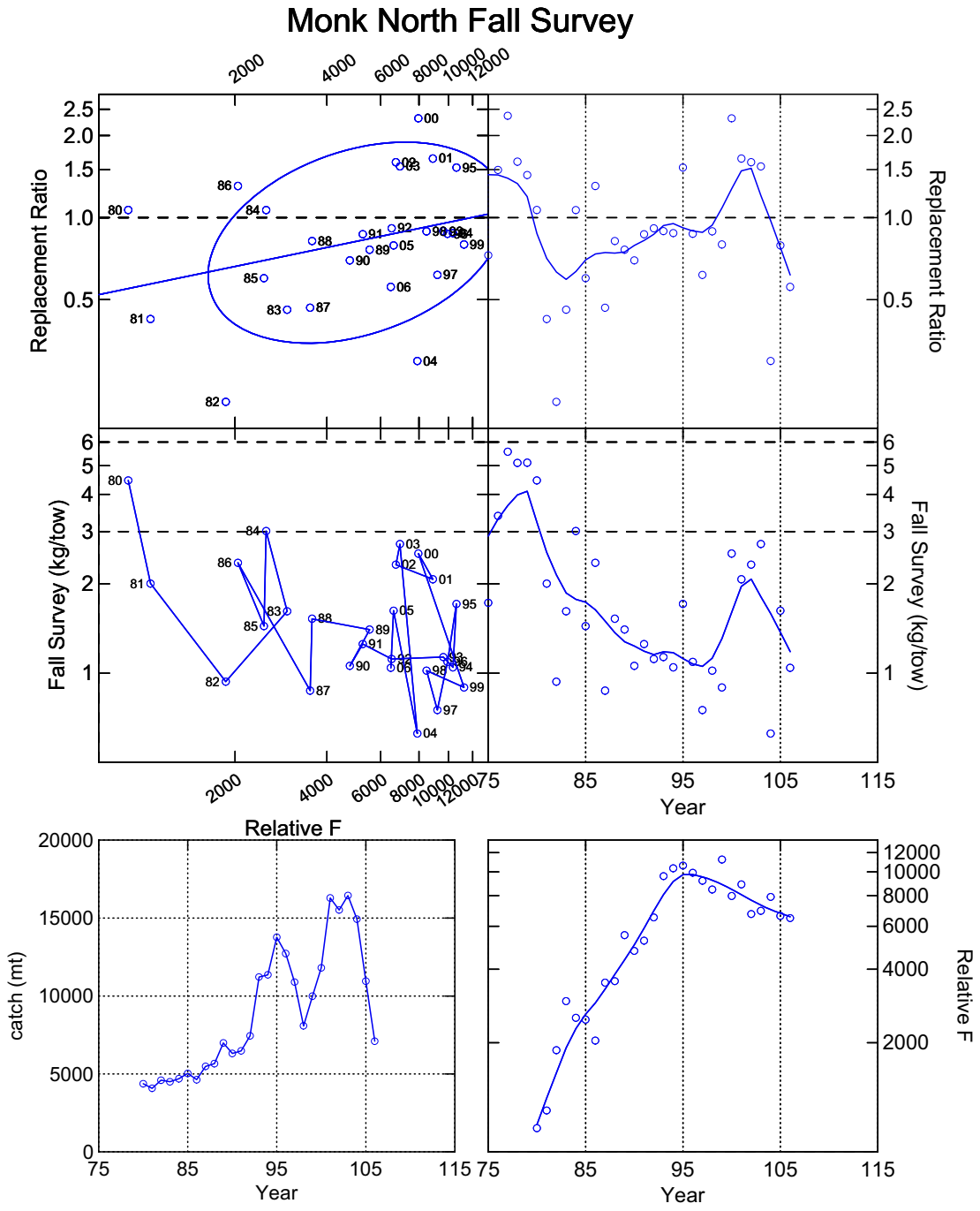


Figure 29b. AIM analysis of catch and the NEFSC spring survey of monkfish in the northern management area.

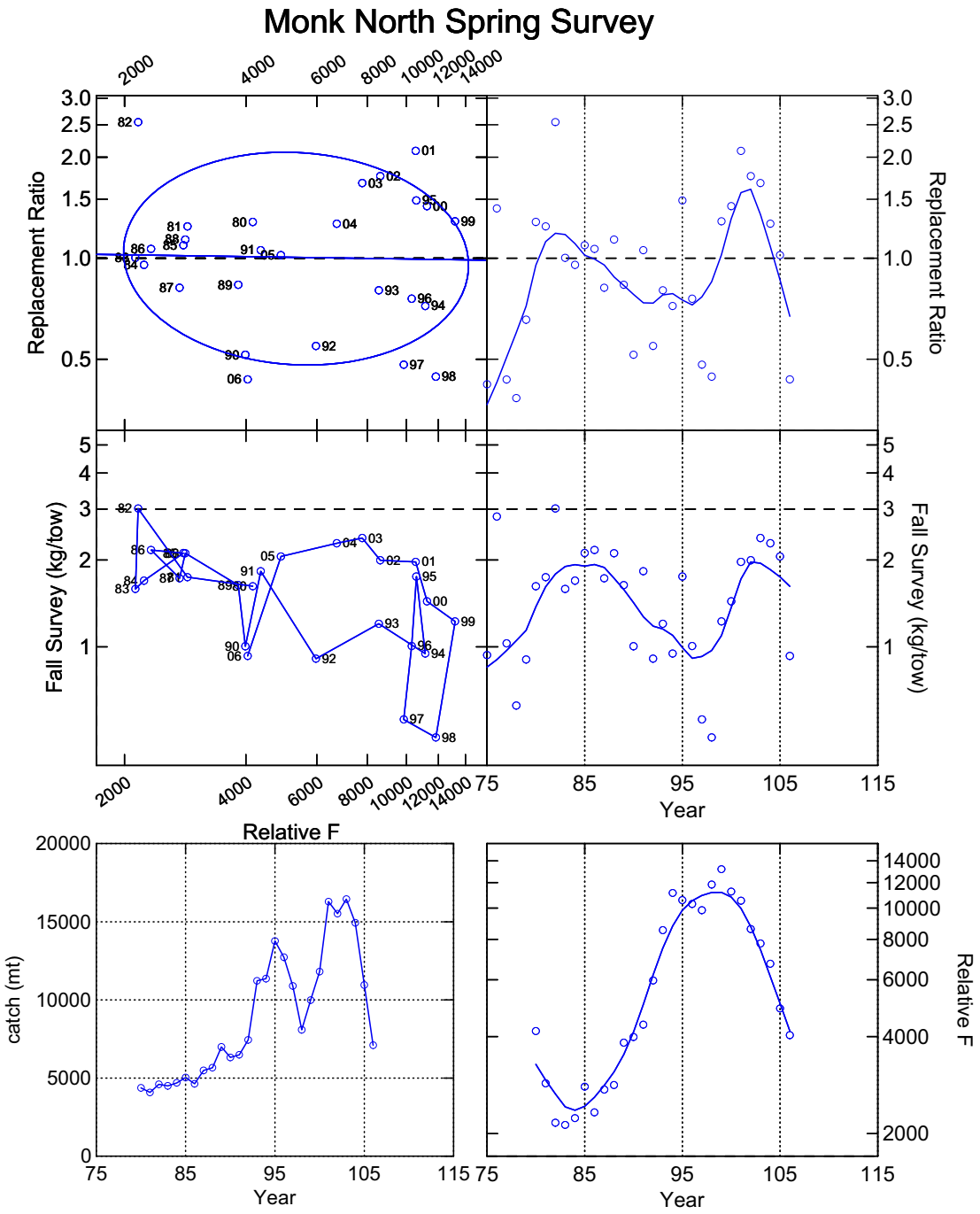


Figure 29c. AIM analysis of catch and the ASMFC shrimp survey of monkfish in the northern management area.

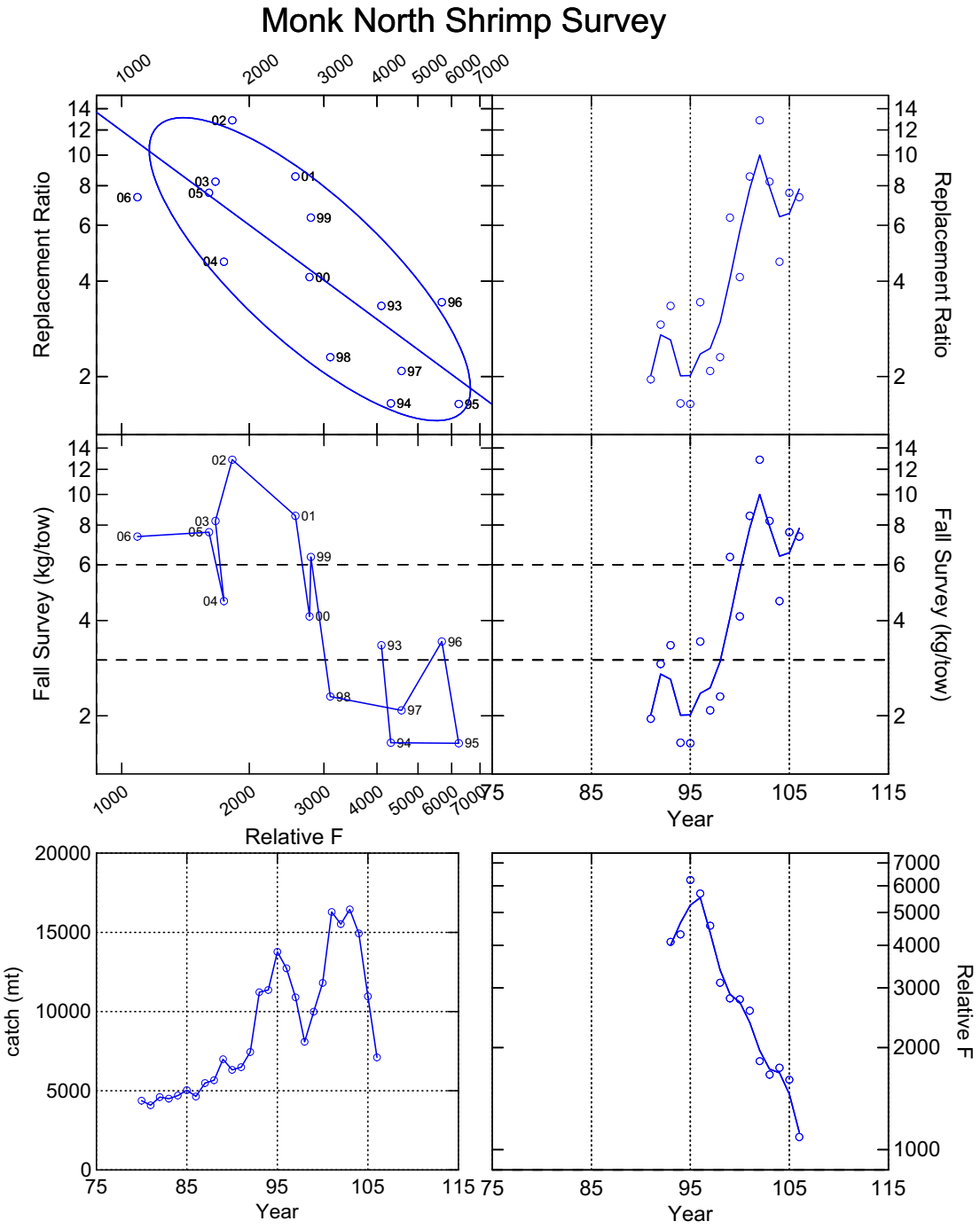


Figure 29d. AIM analysis of catch and the NEFSC fall shrimp survey of monkfish in the southern management area.

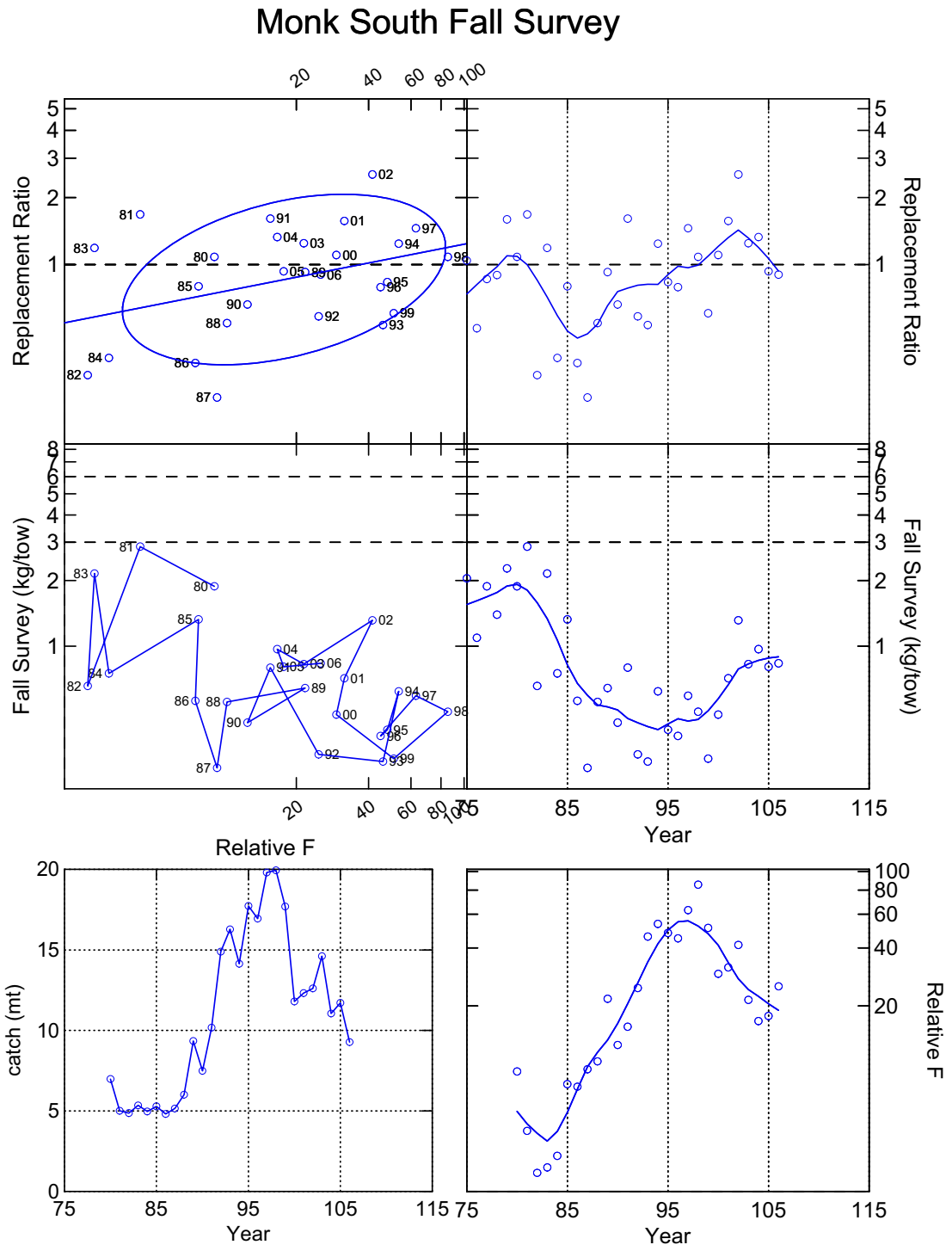


Figure 29e. AIM analysis of catch and the NEFSC shrimp survey of monkfish in the southern management area.

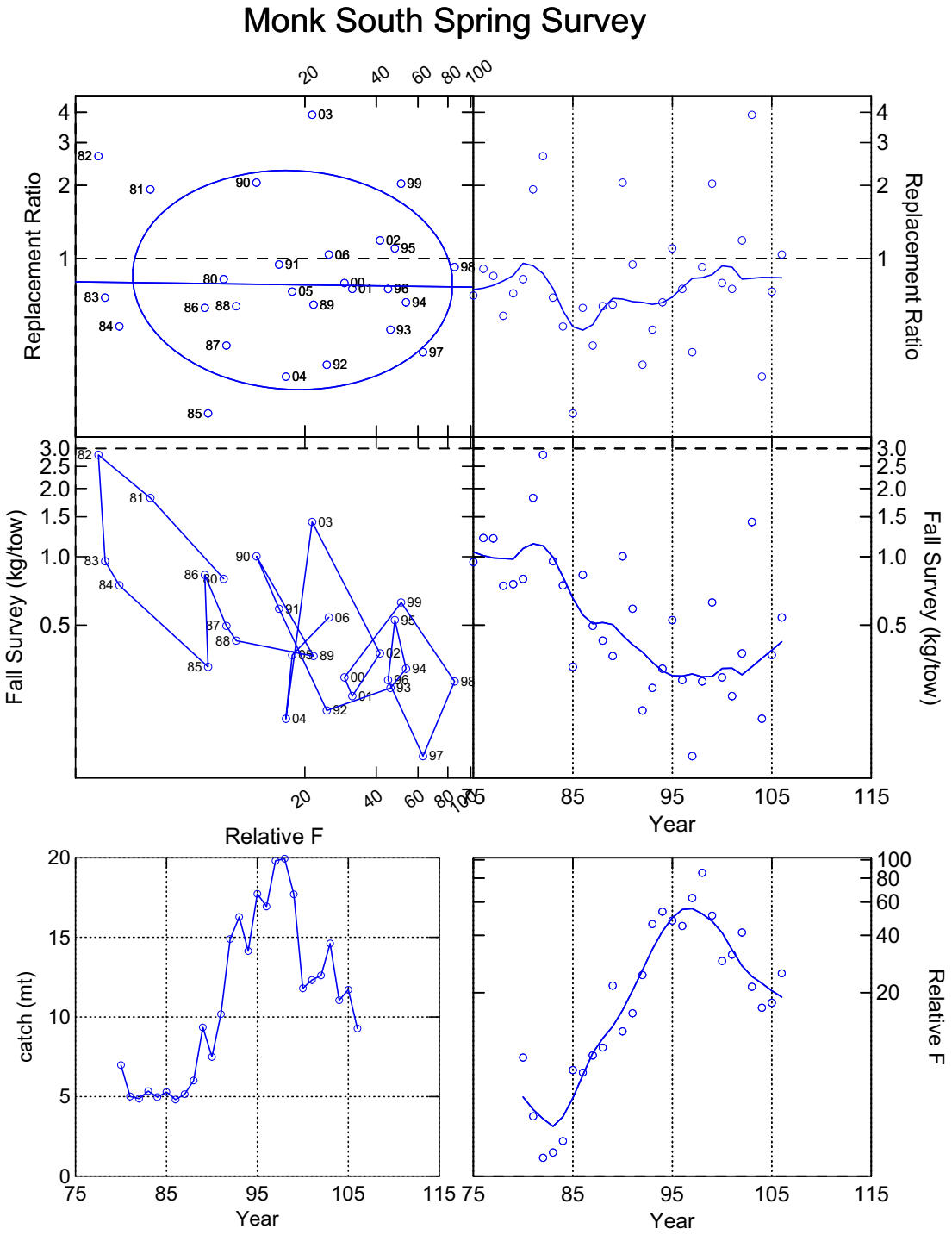


Figure 29f. AIM analysis of catch and the NEFSC winter survey of monkfish in the southern management area.

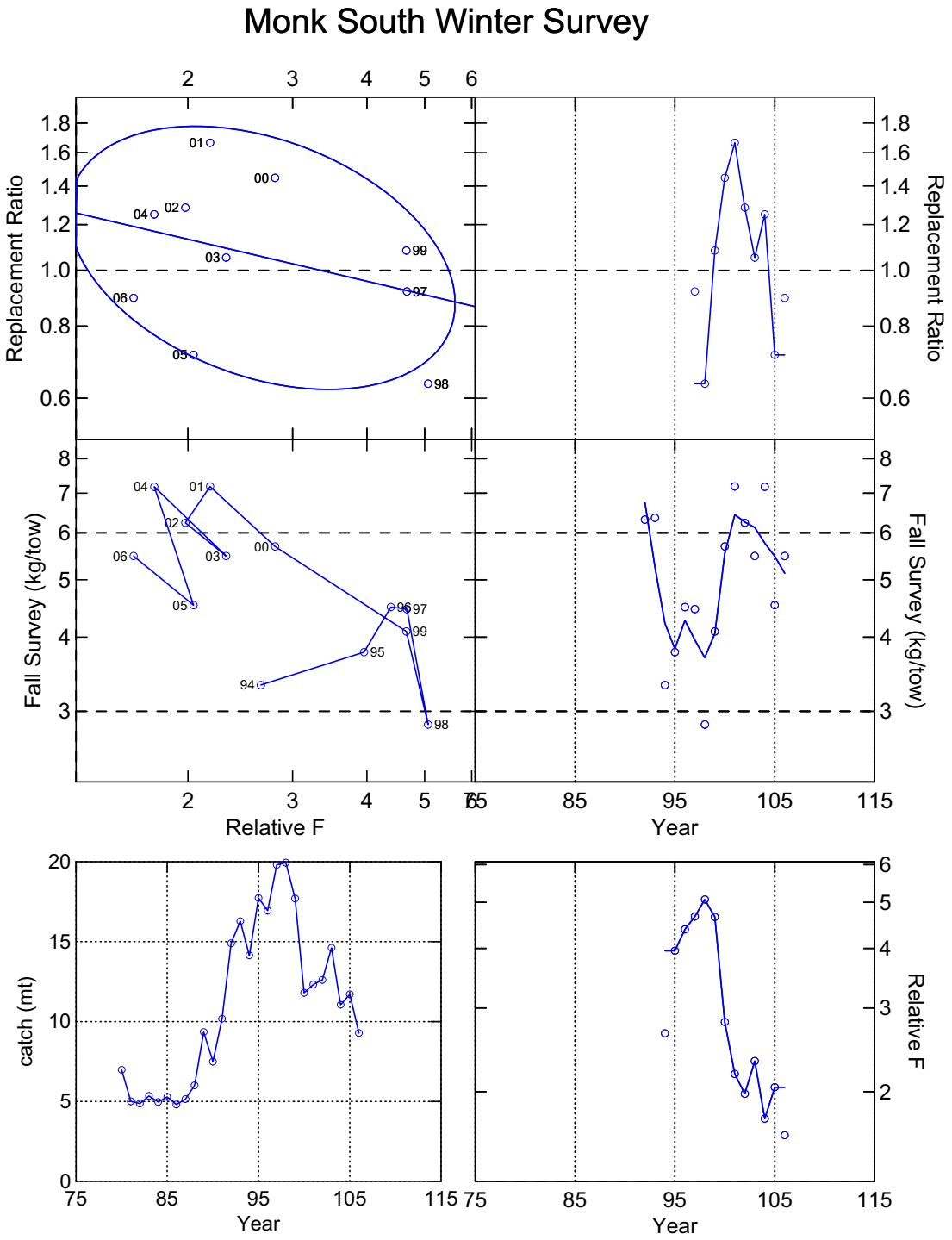


Figure 30. Prior and posterior distributions for *r* (left) and *K* (right) for northern management area of monkfish, when the prior mean for r was 0.4 (top), 0.5 (middle), or 0.6 (bottom).

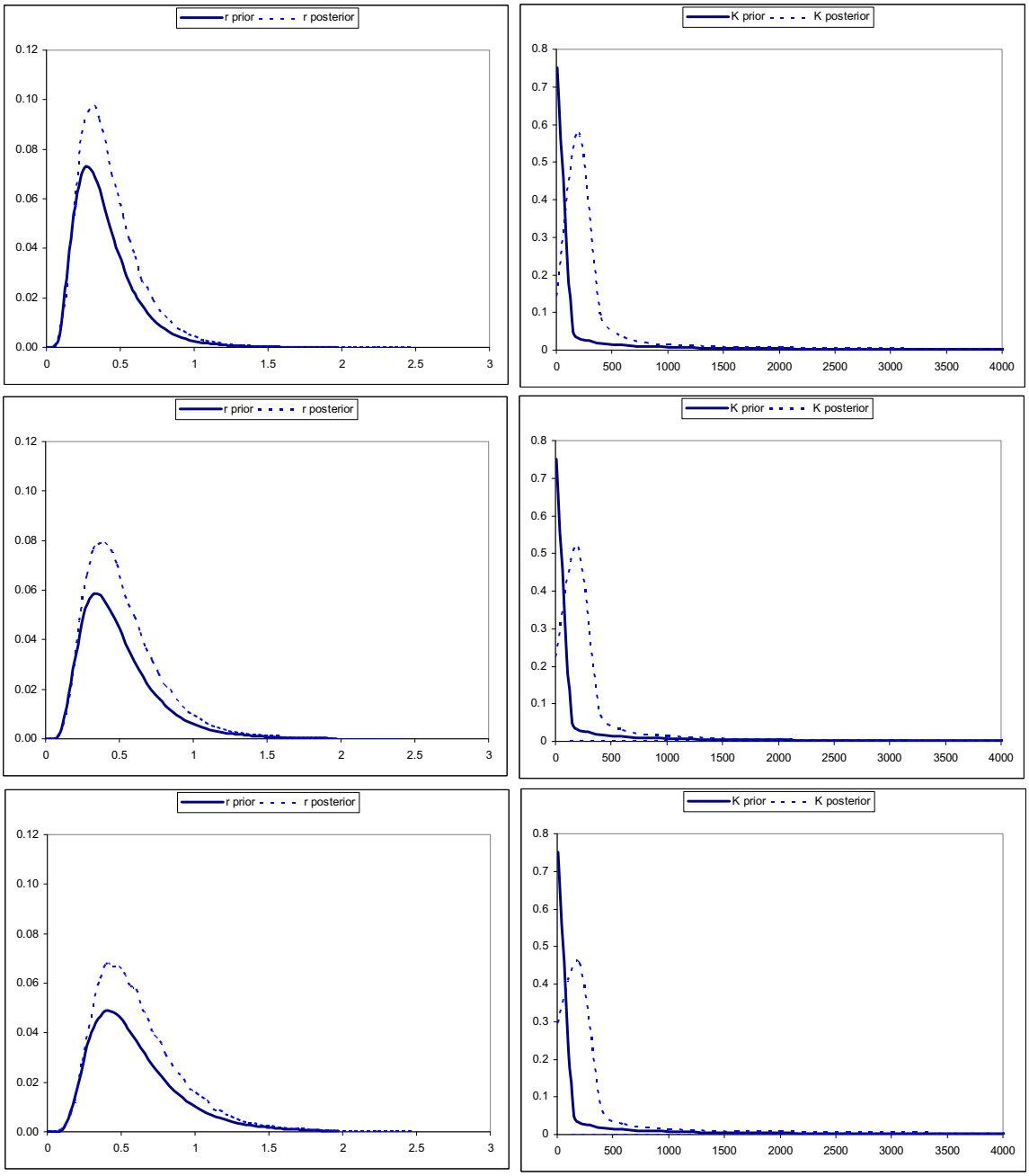


Figure 31. Prior and posterior distributions for r (left) and K (right) for South stock of monkfish, when the prior mean for r was 0.4 (top), 0.5 (middle), or 0.6 (bottom).

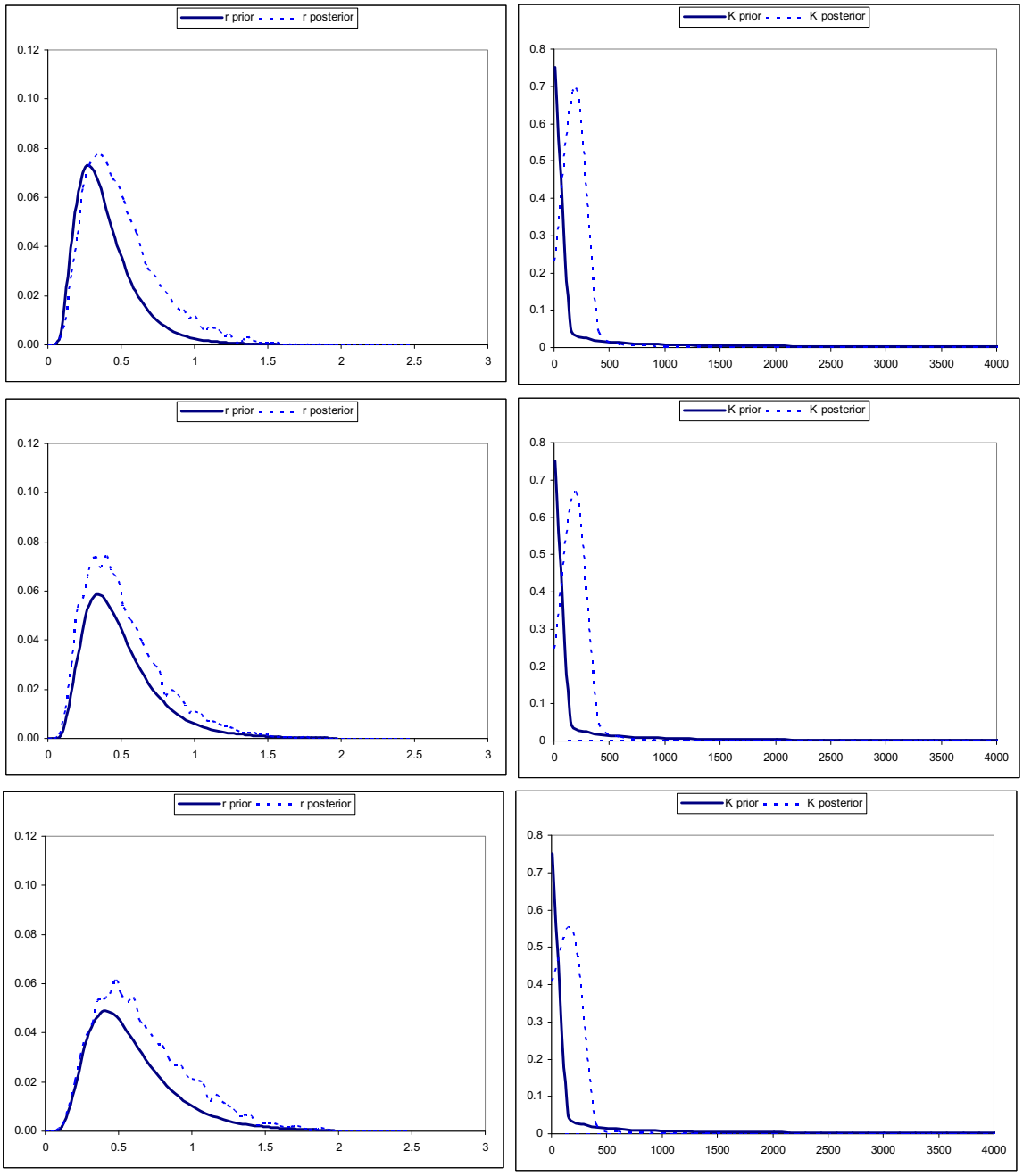


Figure 32. Results of estimating the mortality rate from monkfish mean length data collected in the northern management area when changes in mortality are estimated (indicated by vertical dashed lines).

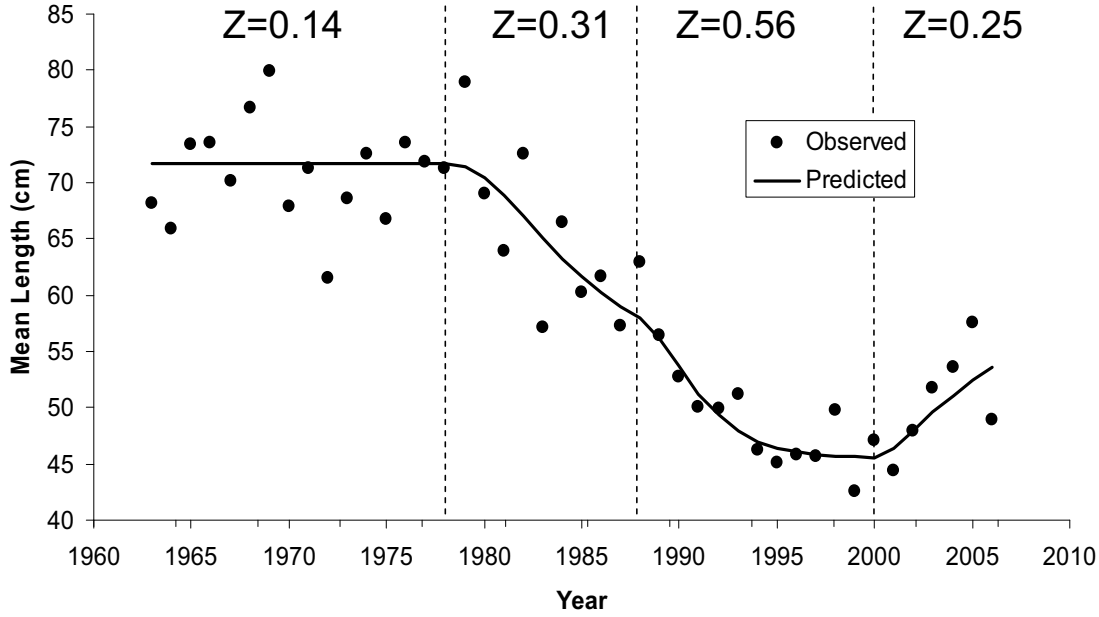


Figure 33. Results of estimating the mortality rate from monkfish mean length data collected in the southern management area when a change in mortality is estimated (indicated by the vertical dashed line).

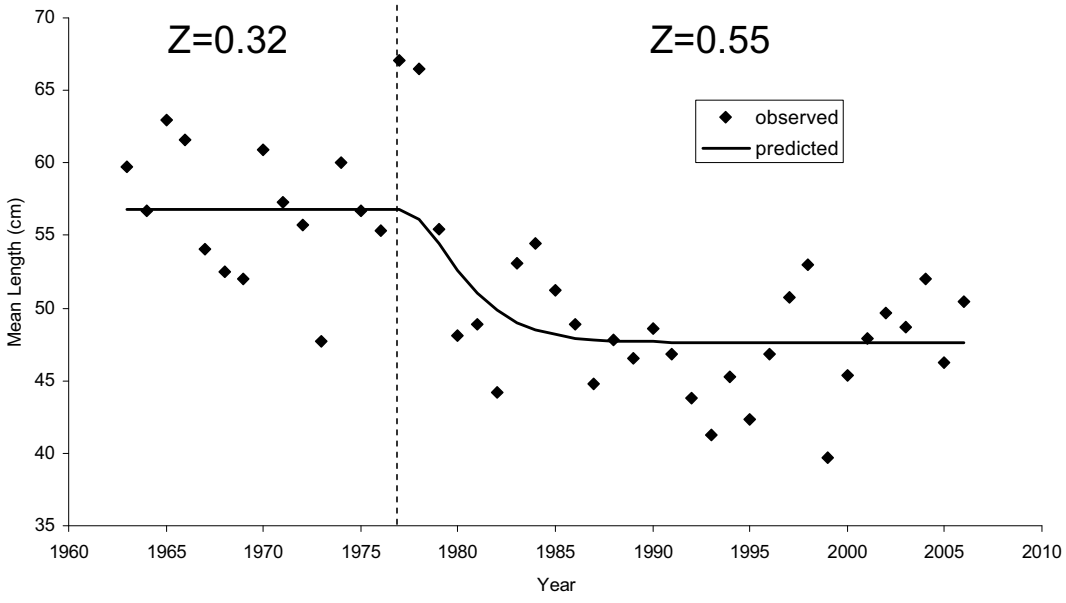


Figure 34. Estimates of total mortality from catch curves of NEFSC fall survey data for monkfish in the northern management area, ages 3+ and 4+.

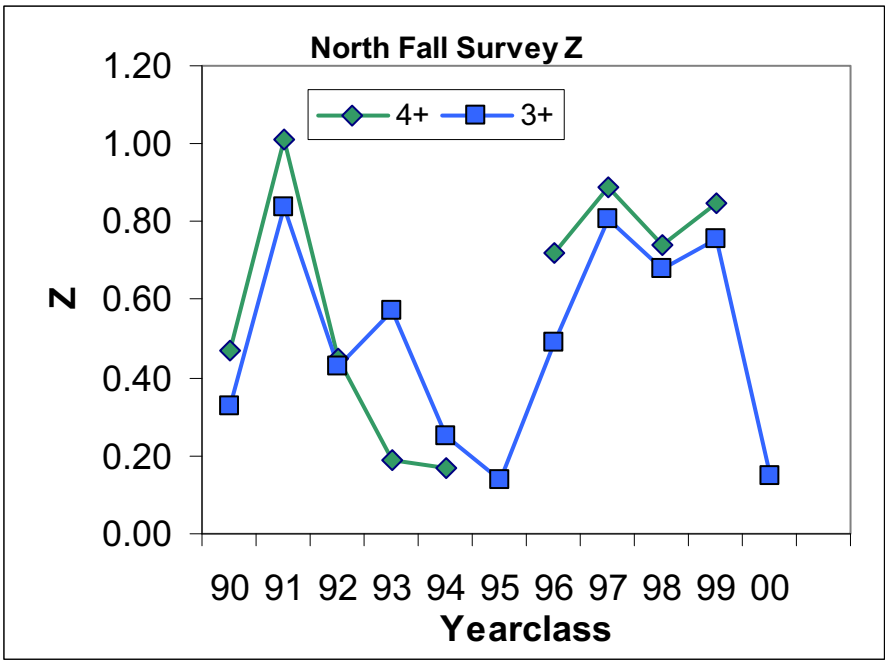


Figure 35. Estimates of total mortality from catch curves of NEFSC fall survey data for monkfish in the southern management area, ages 3+ and 4+.

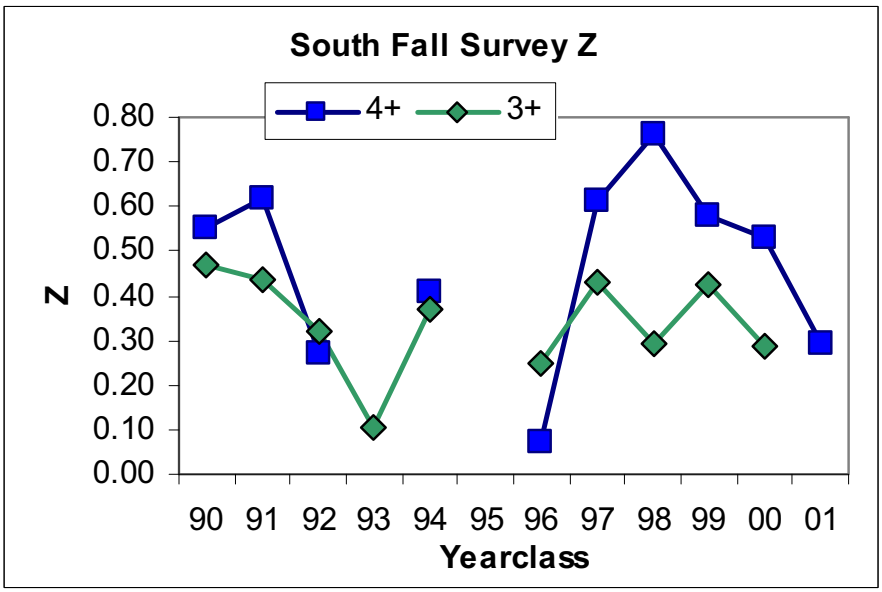


Figure 36. Estimates of total mortality from catch curves of NEFSC winter survey data for monkfish in the southern management area, ages 3+, 4+ and 5+.

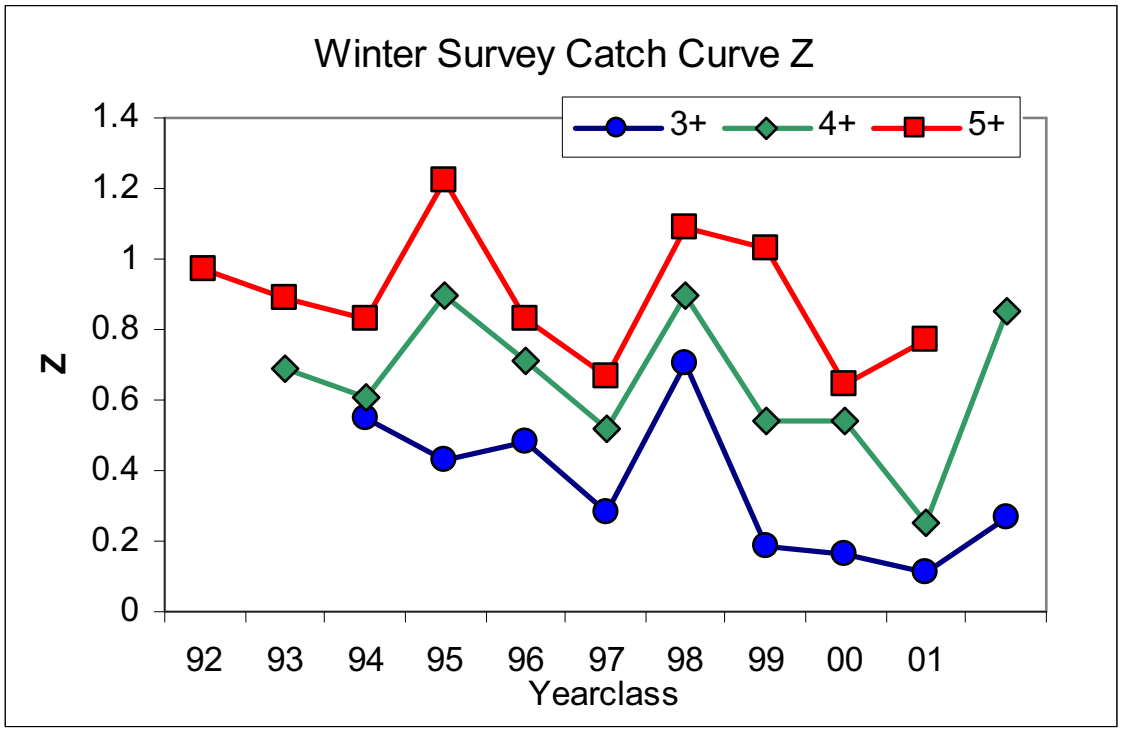


Figure 37. Estimates of total mortality from log catch-ratios of NEFSC winter survey data for monkfish in the southern management area for 3+ to 5+ age groups.

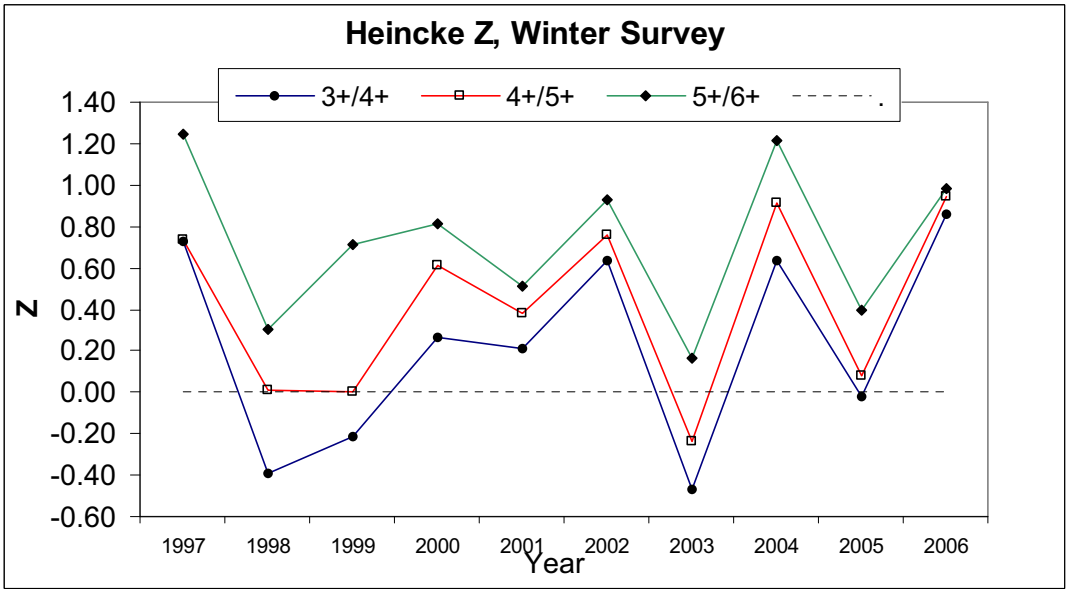
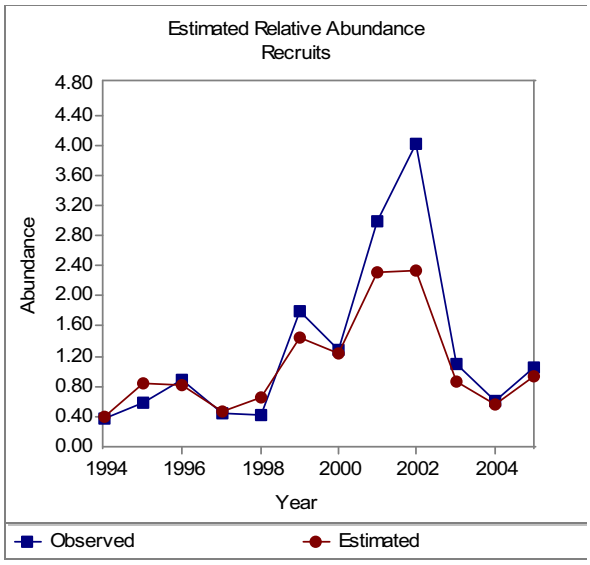
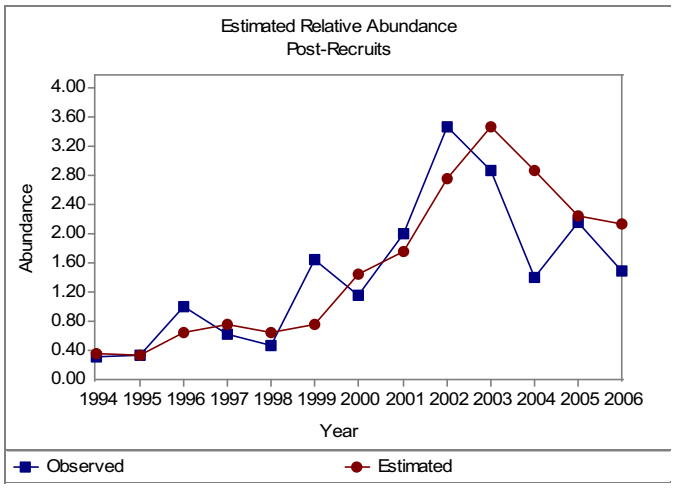
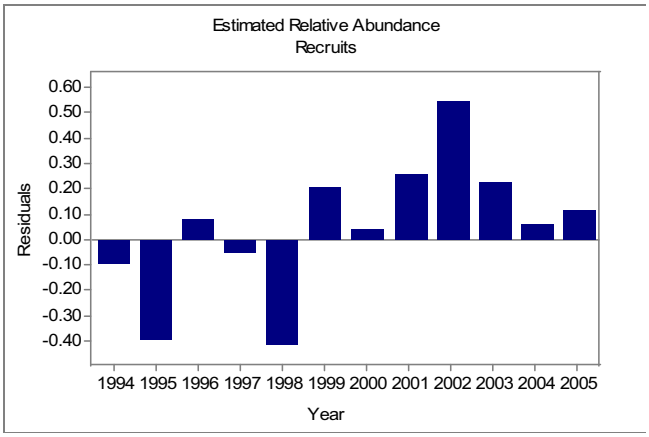


Figure 38a. Abundance estimates from CSA of monkfish in the northern area using shrimp survey indices and assuming M=0.3; recruits (left) and post-recruits (right).







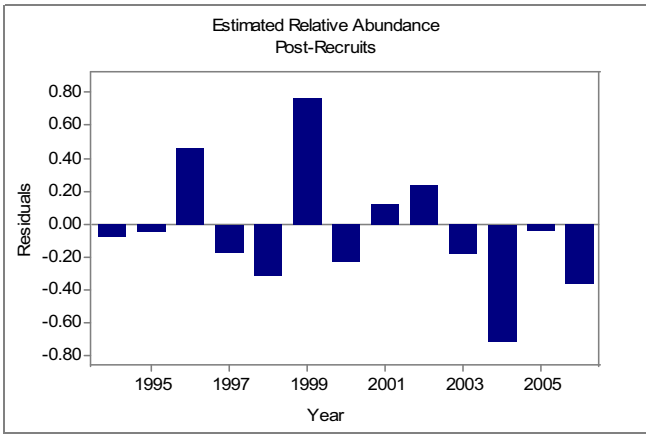
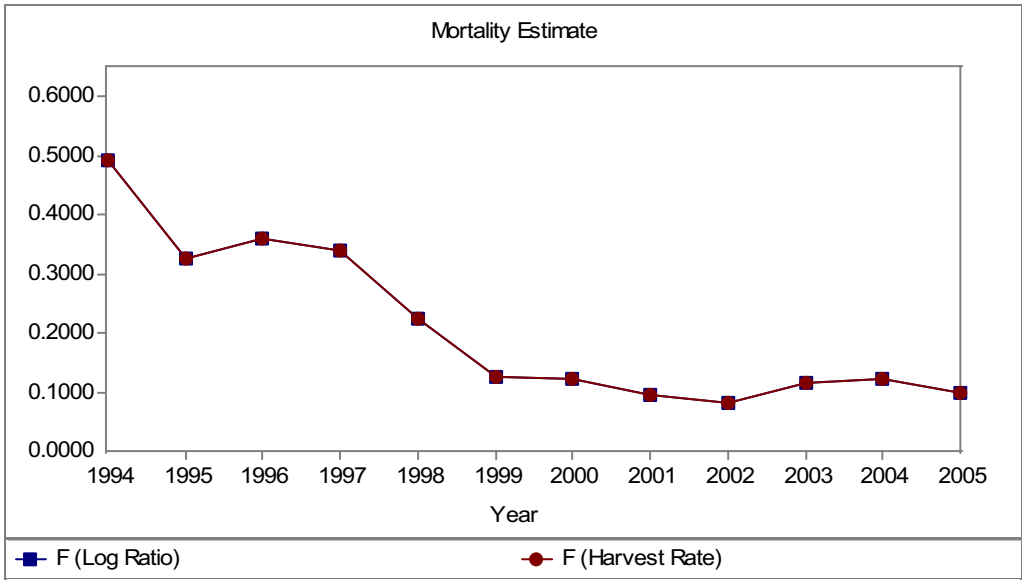


Figure 38b. Estimates of fishing mortality from CSA of monkfish in the northern area using shrimp survey indices and assuming M=0.3.



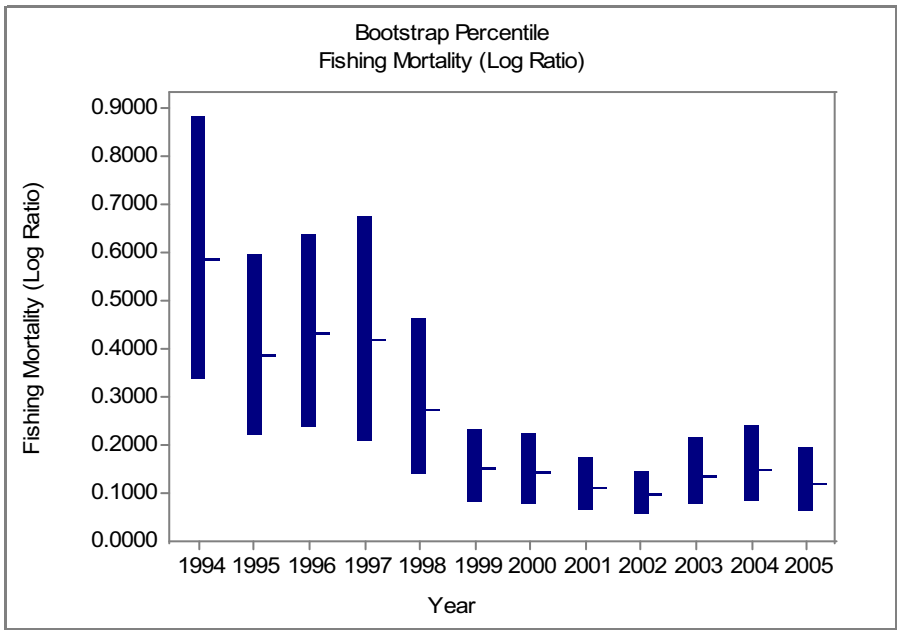


Figure 38c. Bootstrap estimates from CSA of monkfish in the northern area using shrimp survey indices and assuming M=0.3.

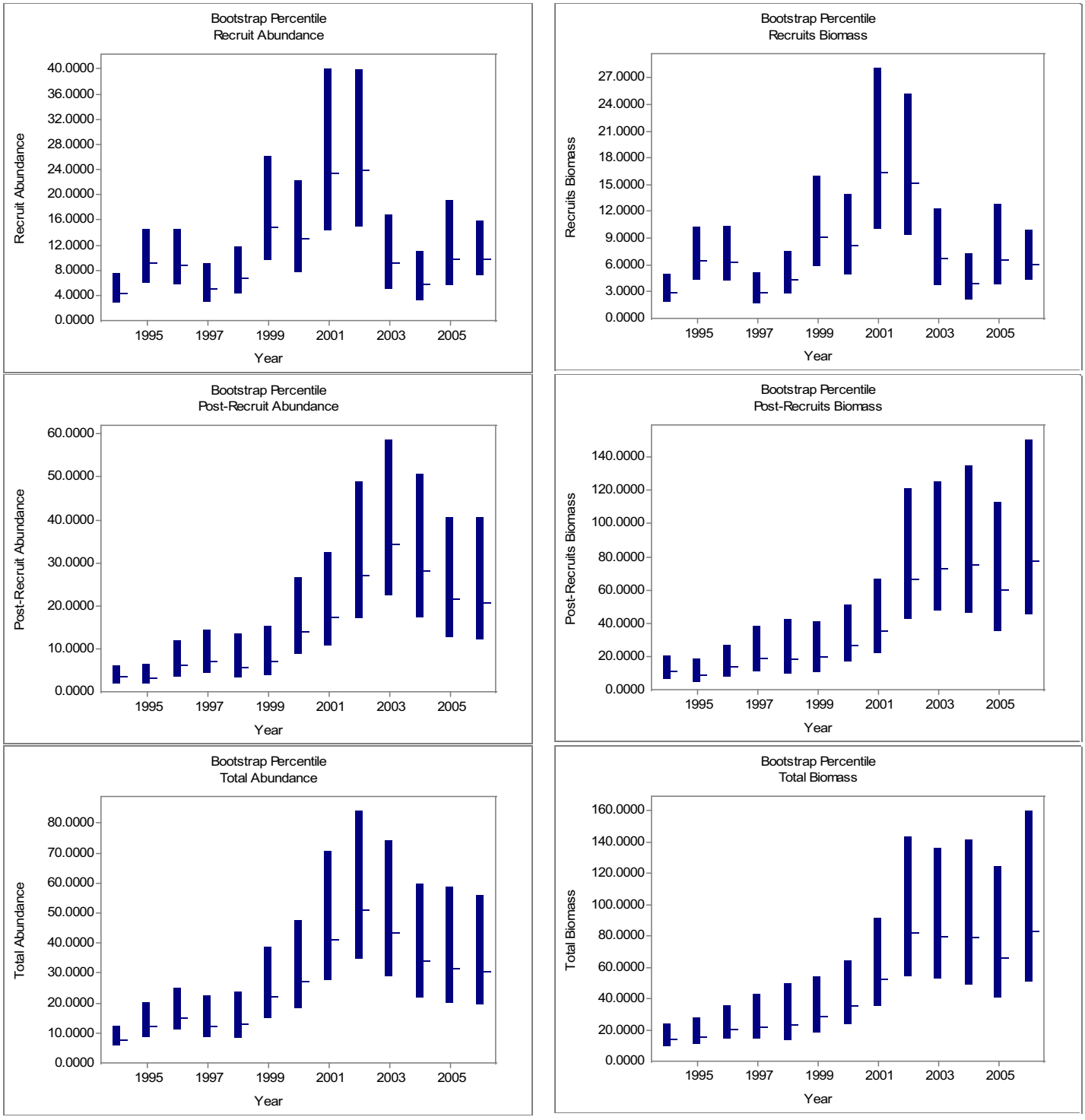
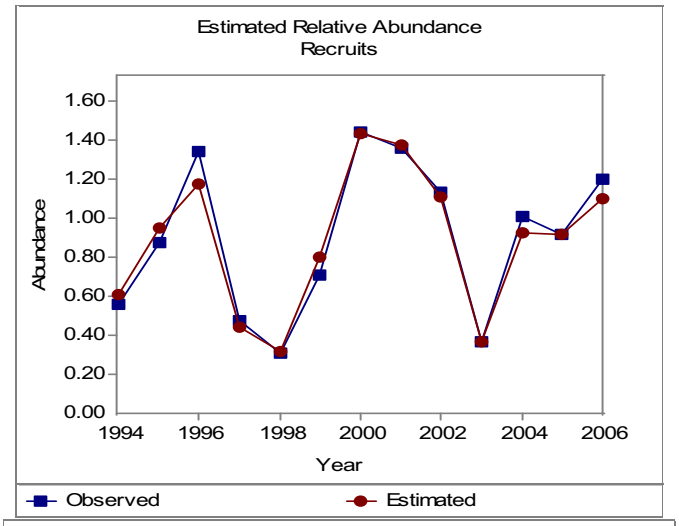
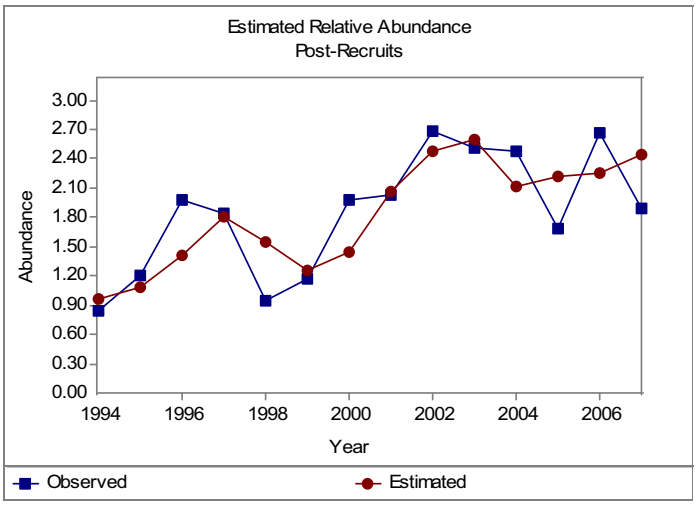
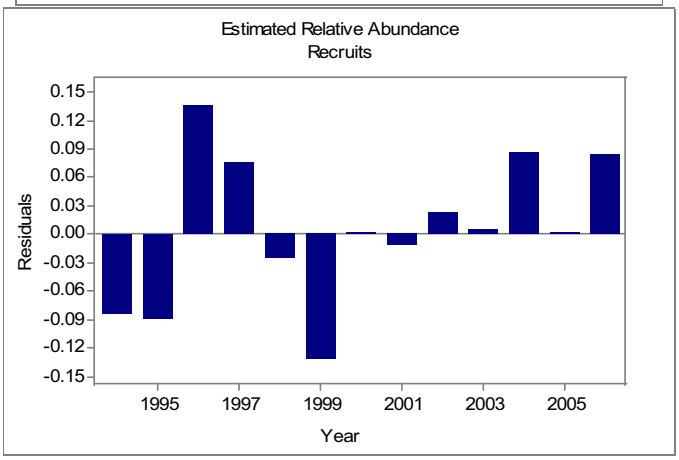


Figure 39a. Abundance estimates of CSA of monkfish in the southern area using NEFSC winter survey indices and assuming M=0.3; recruits (left) and post-recruits (right).







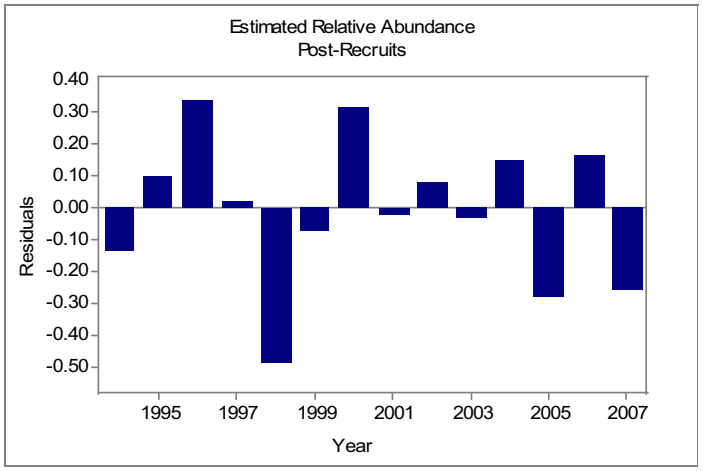
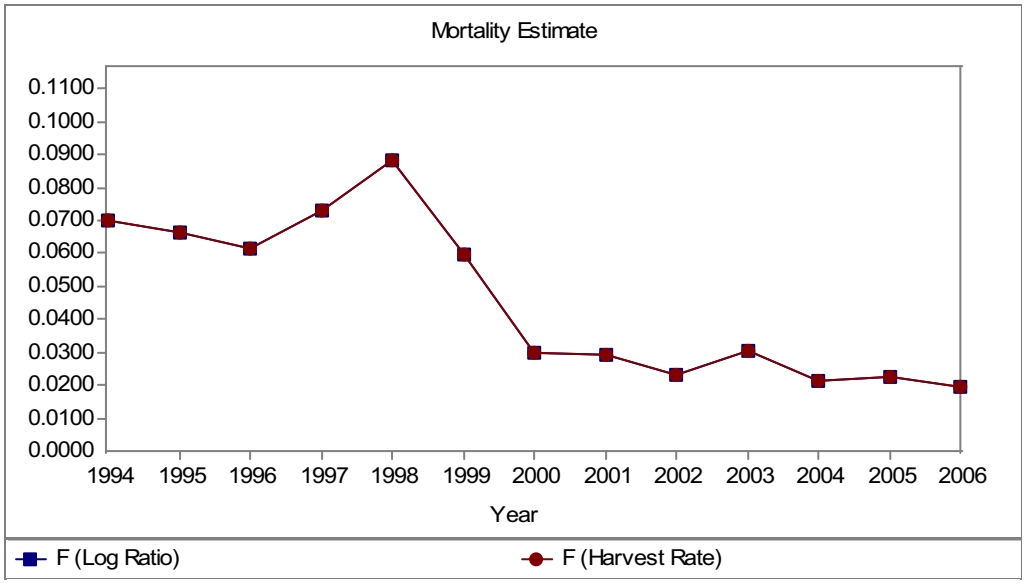


Figure 39b. Estimates of fishing mortality from CSA of monkfish in the southern area using NEFSC winter survey indices and assuming M=0.3.



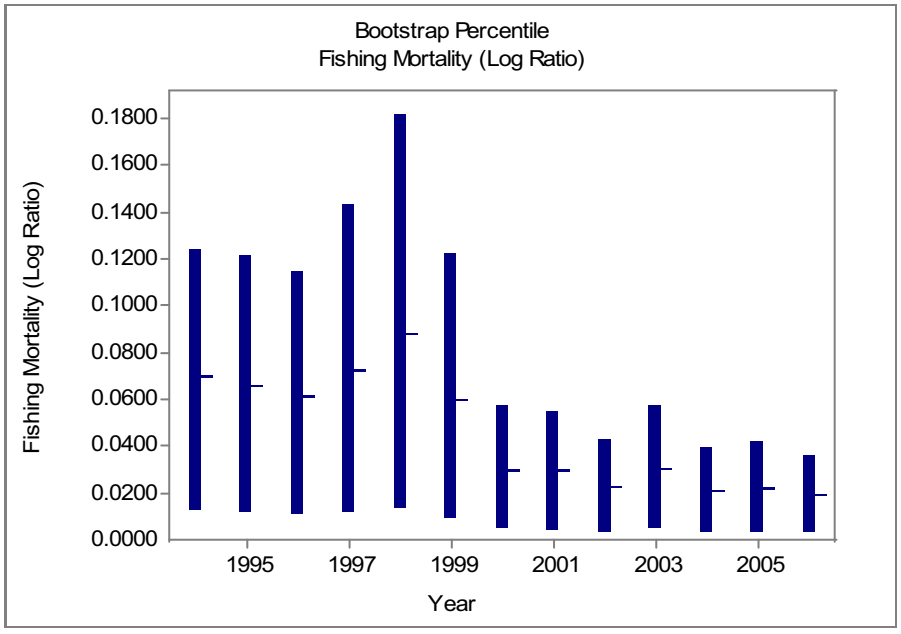
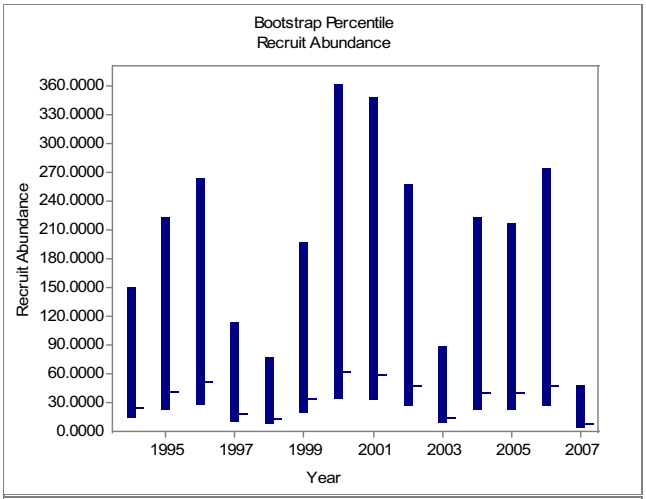
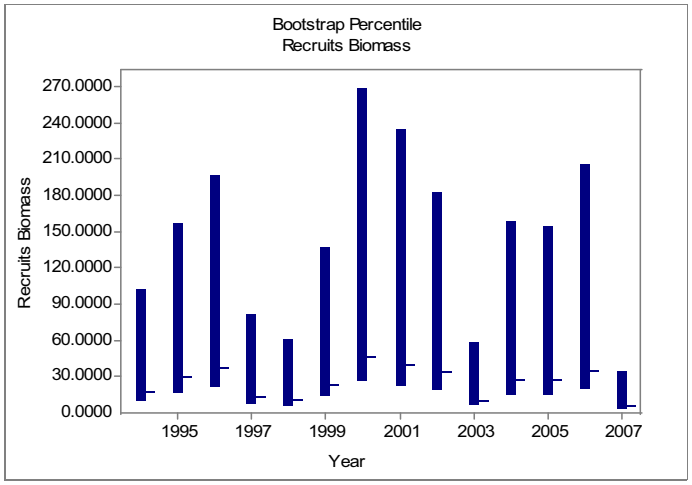
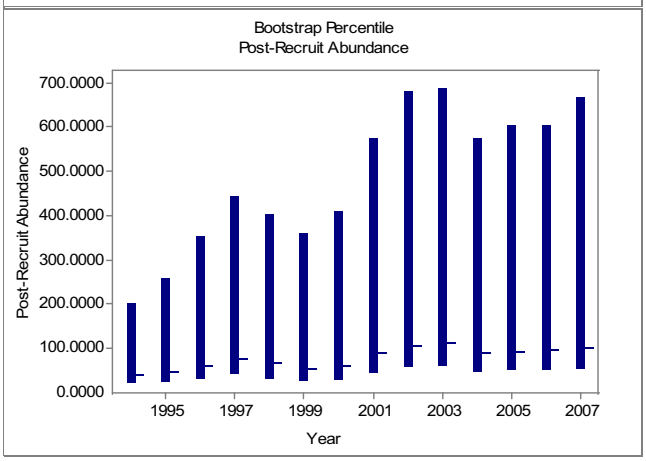
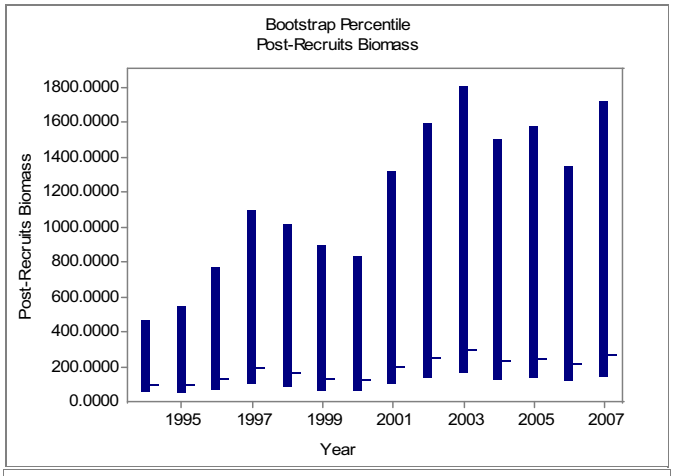


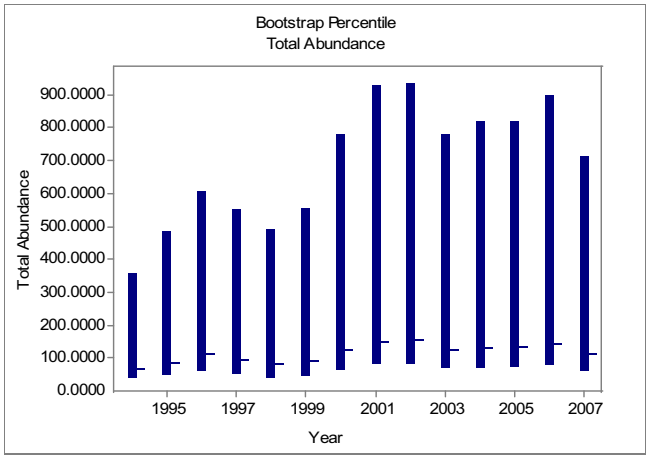
Figure 39c. Bootstrap estimates from CSA of monkfish in the southern area using NEFSC winter survey indices and assuming M=0.3.











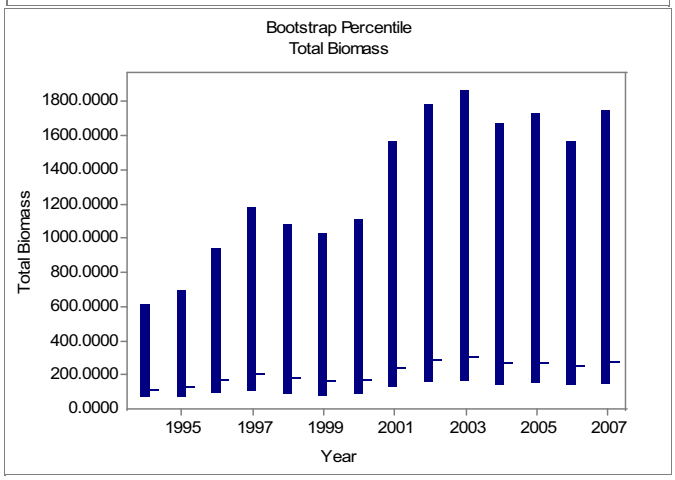


Figure 40. Mean lengths at age from Armstrong et al (1992) von Bertalanffy growth model and age data from the spring, winter, cooperative, fall surveys and the large monkfish study.

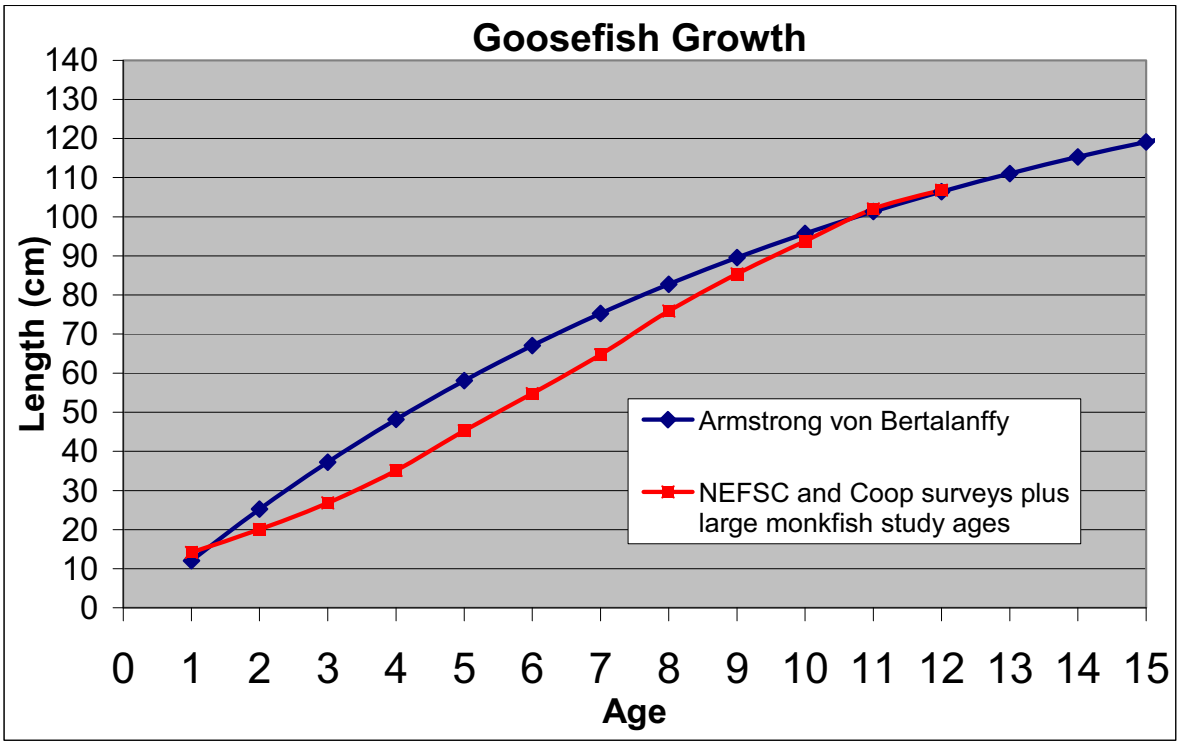
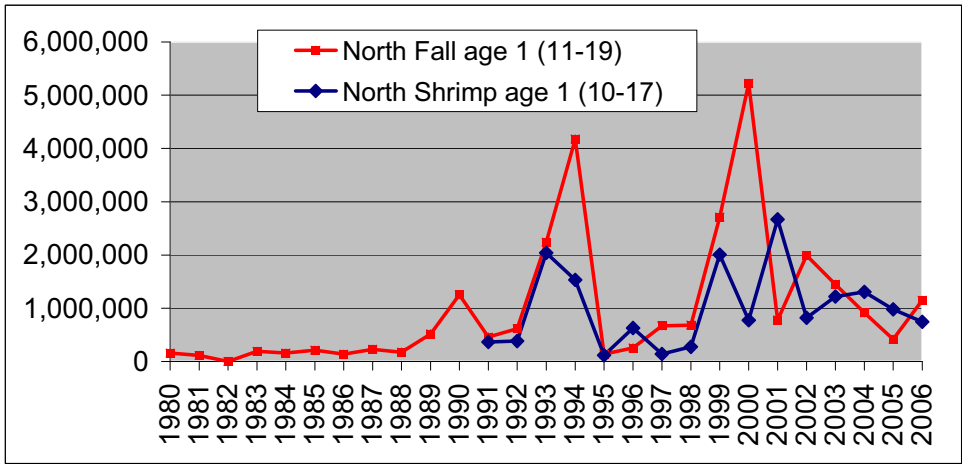
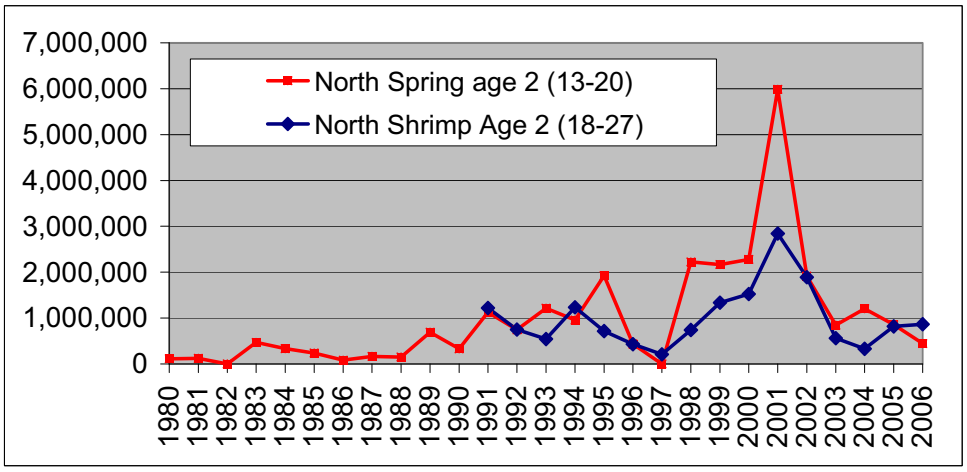


Figure 41. Northern management area monkfish recruitment indices at age. Centimeter interval used to estimate recruitment ages are also given in parenthesis.





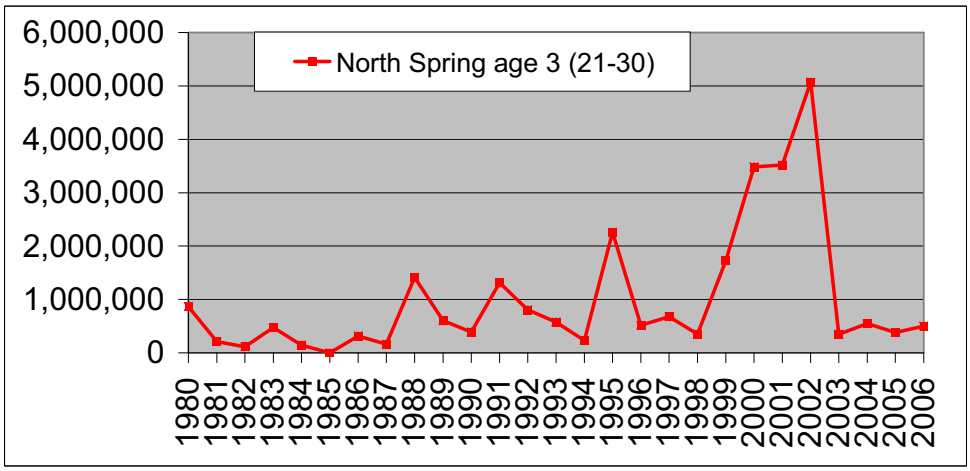


Figure 42. Adult 40+ cm abundance indices for the northern management area.

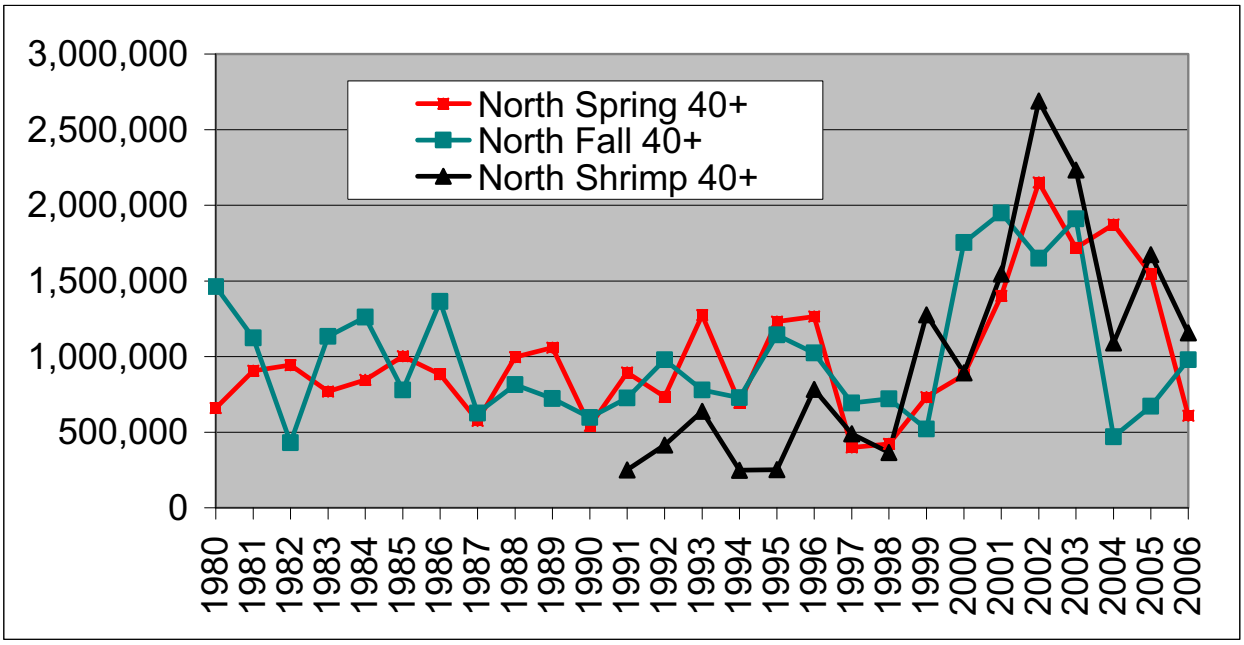
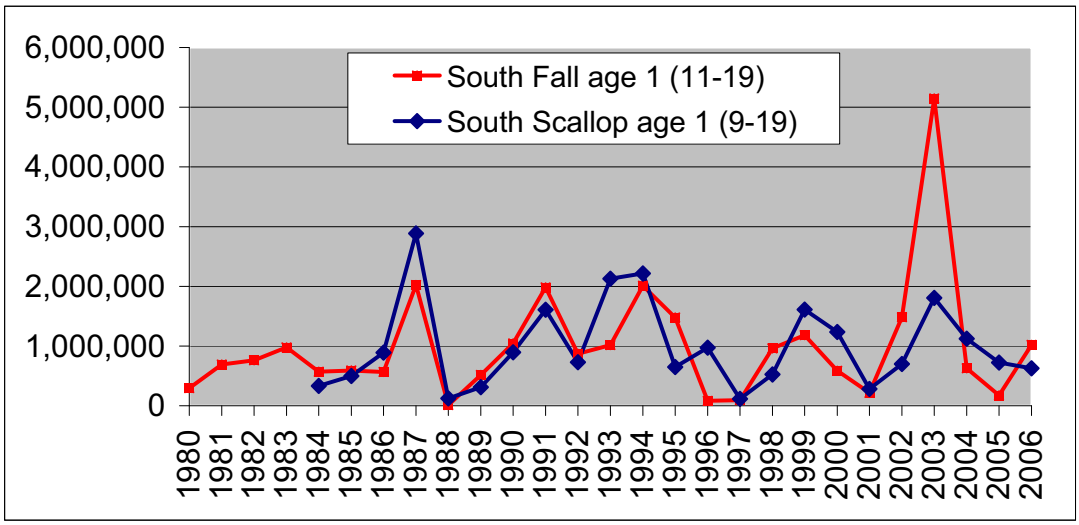
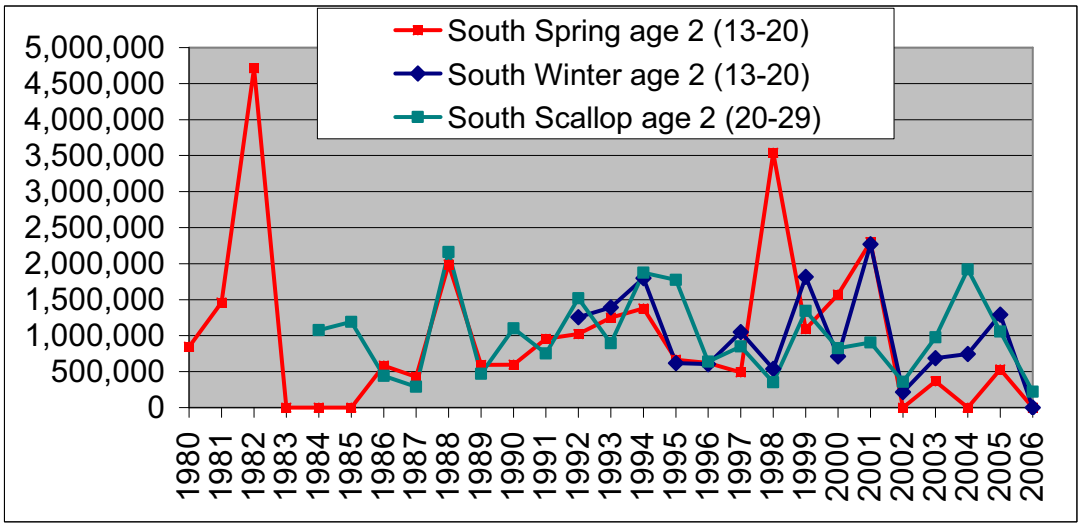


Figure 43. Southern management area monkfish recruitment indices at age. Centimeter interval used to estimate recruitment ages are also given in parenthesis.





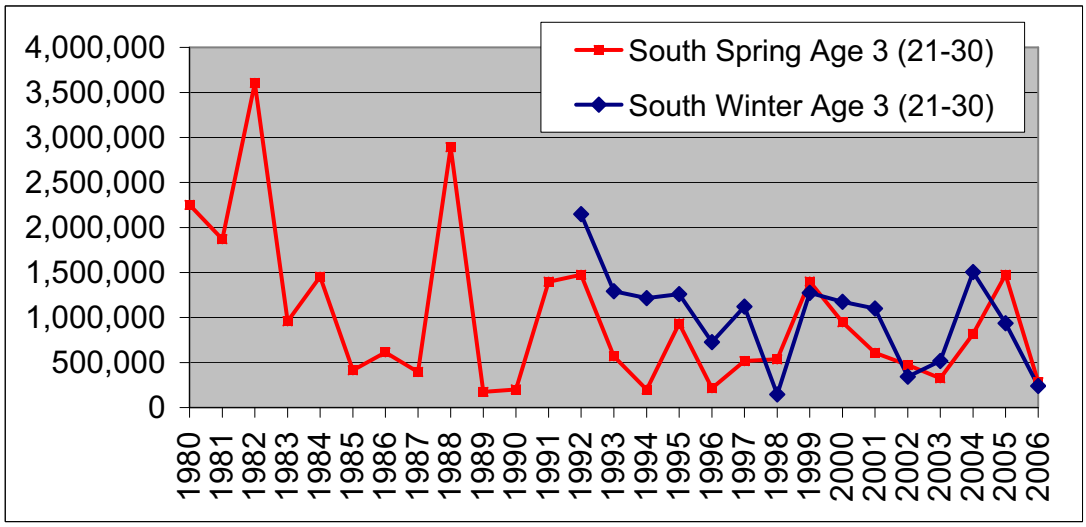


Figure 44. Adult 40+ cm abundance indices for the southern management area.

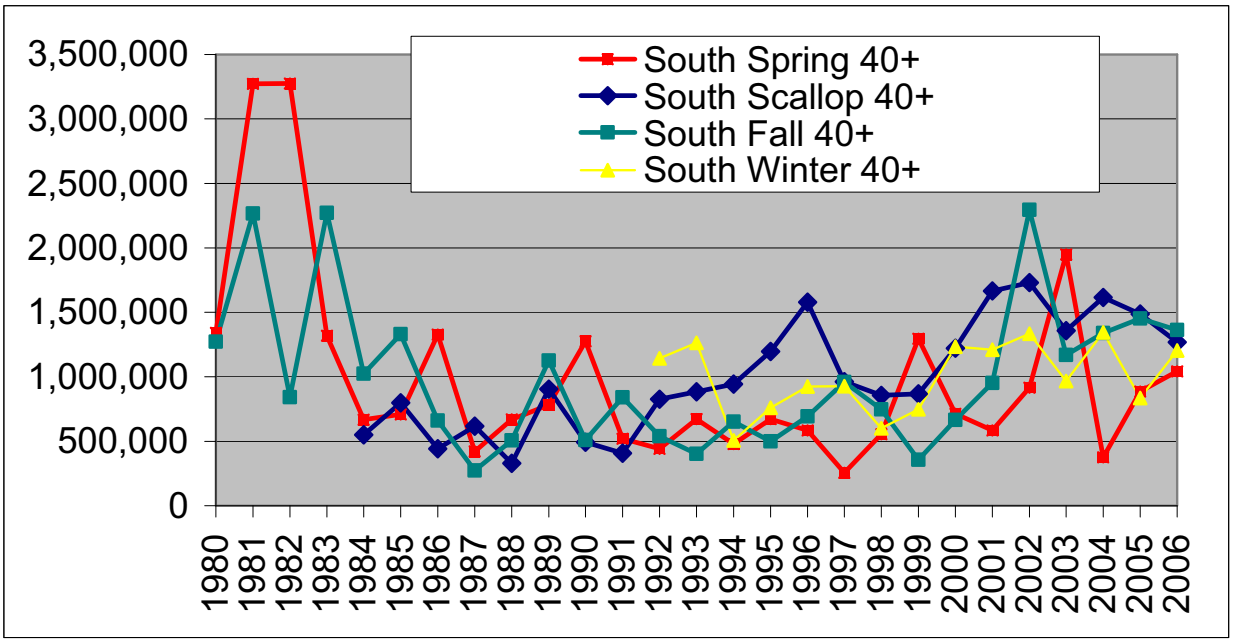


Figure 45. Northern management area monkfish sensitivity runs.

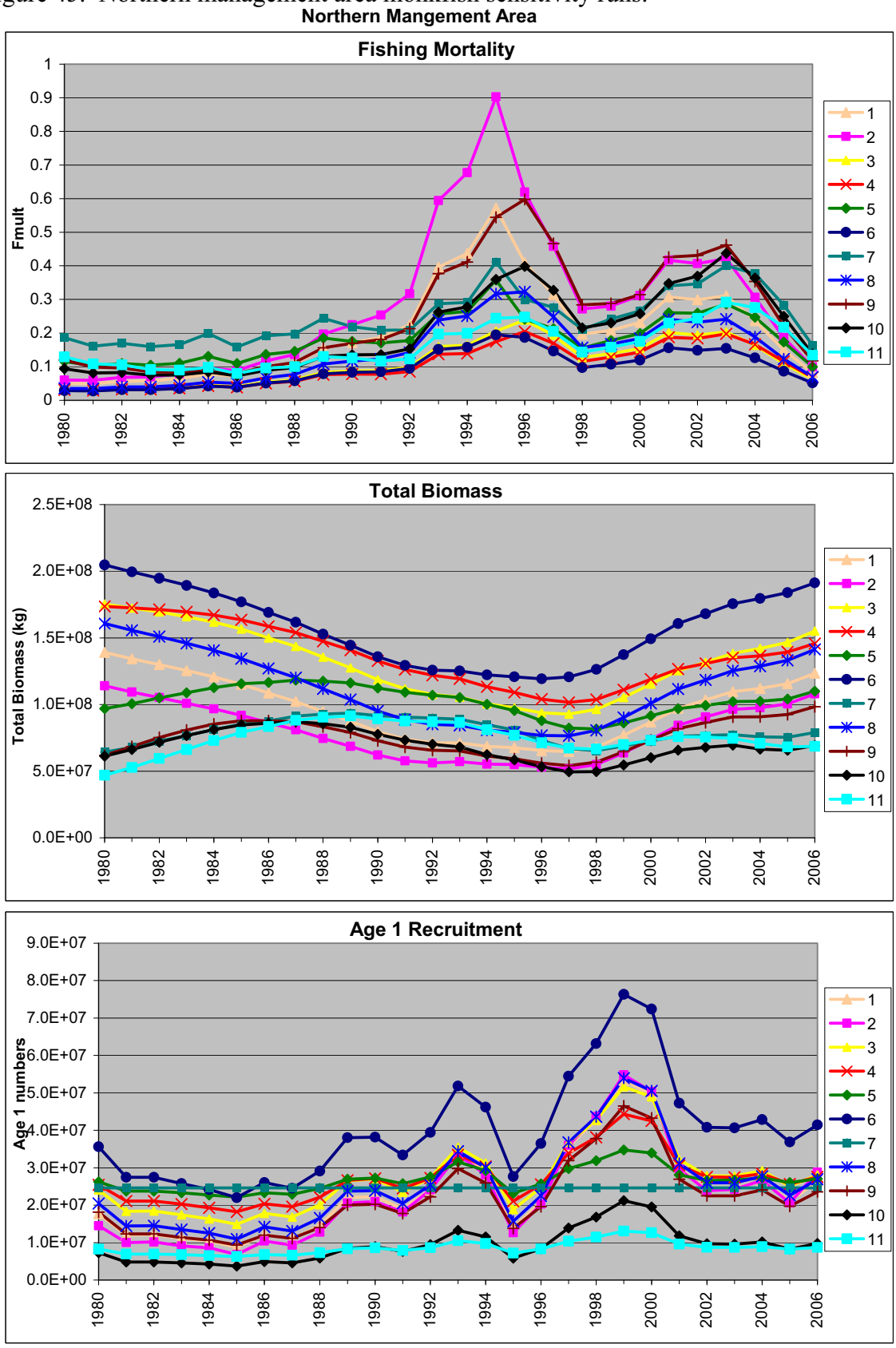


Figure 46. Southern management area monkfish sensitivity runs.

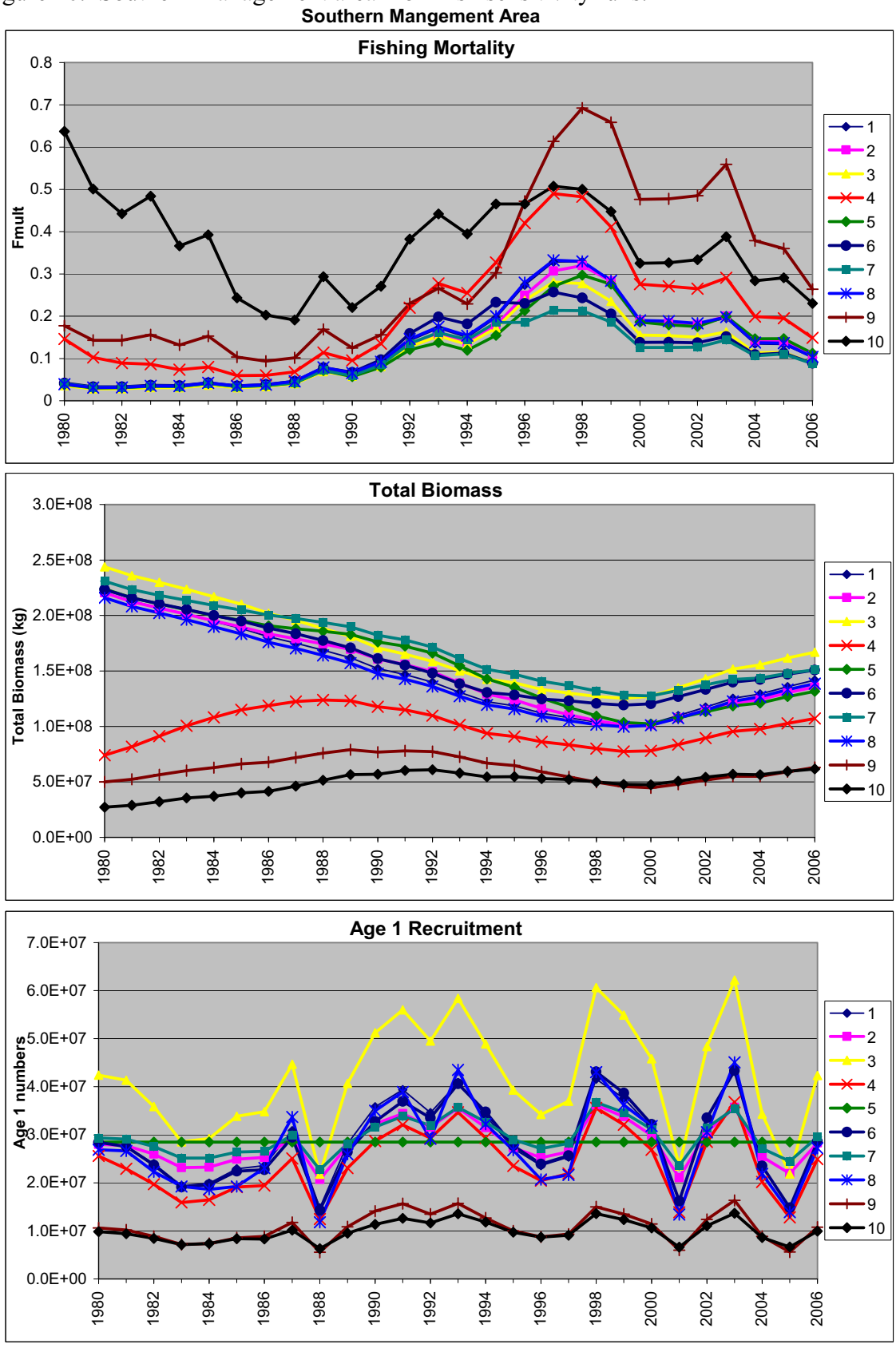


Figure 47. Northern management area monkfish final working group projection runs.

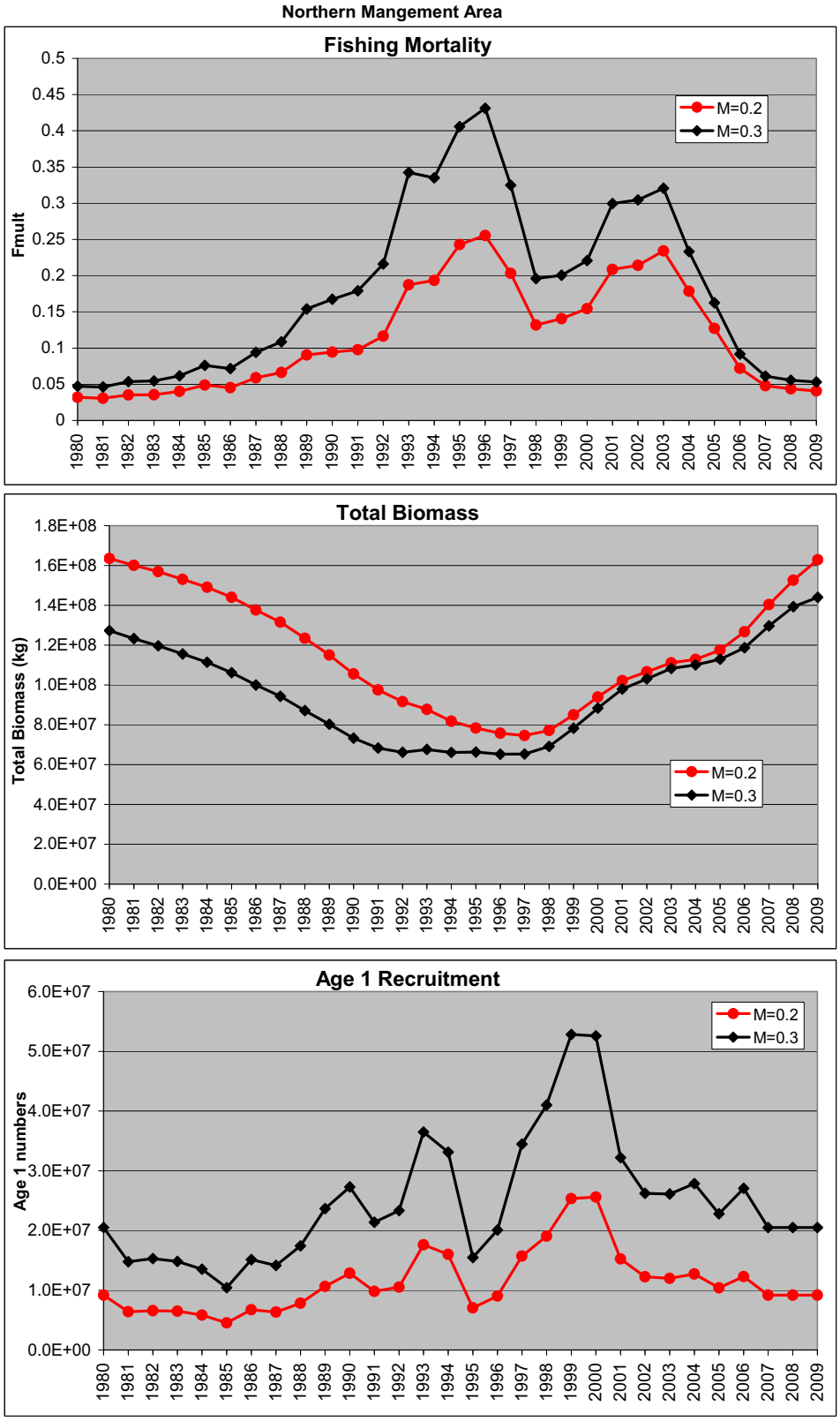


Figure 48. Southern management area monkfish final working group projection runs.

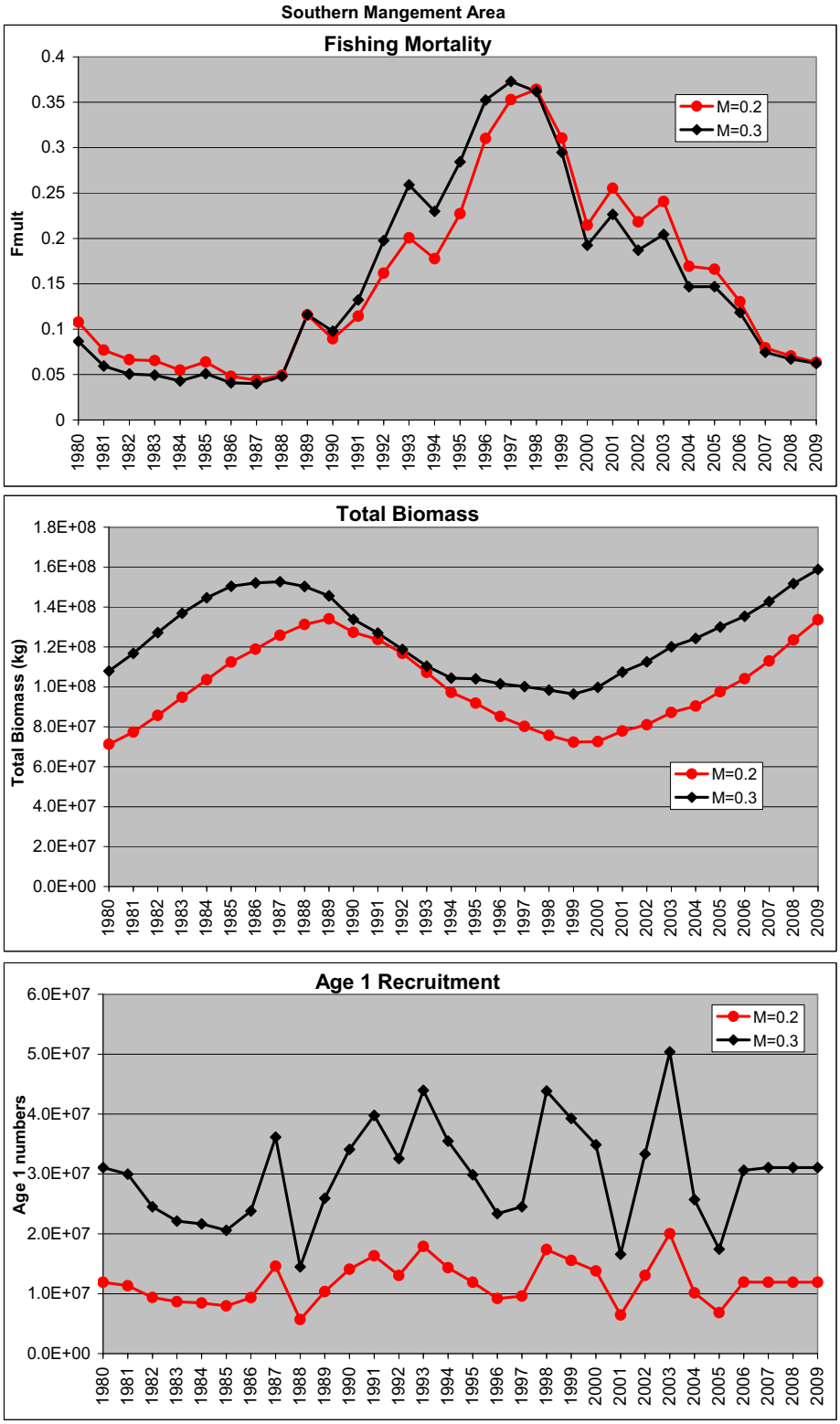


Figure 49. Northern monkfish shift in selectivity (1980-1995, 1996-2003, 2004-2006) with changes in assumed natural mortality.

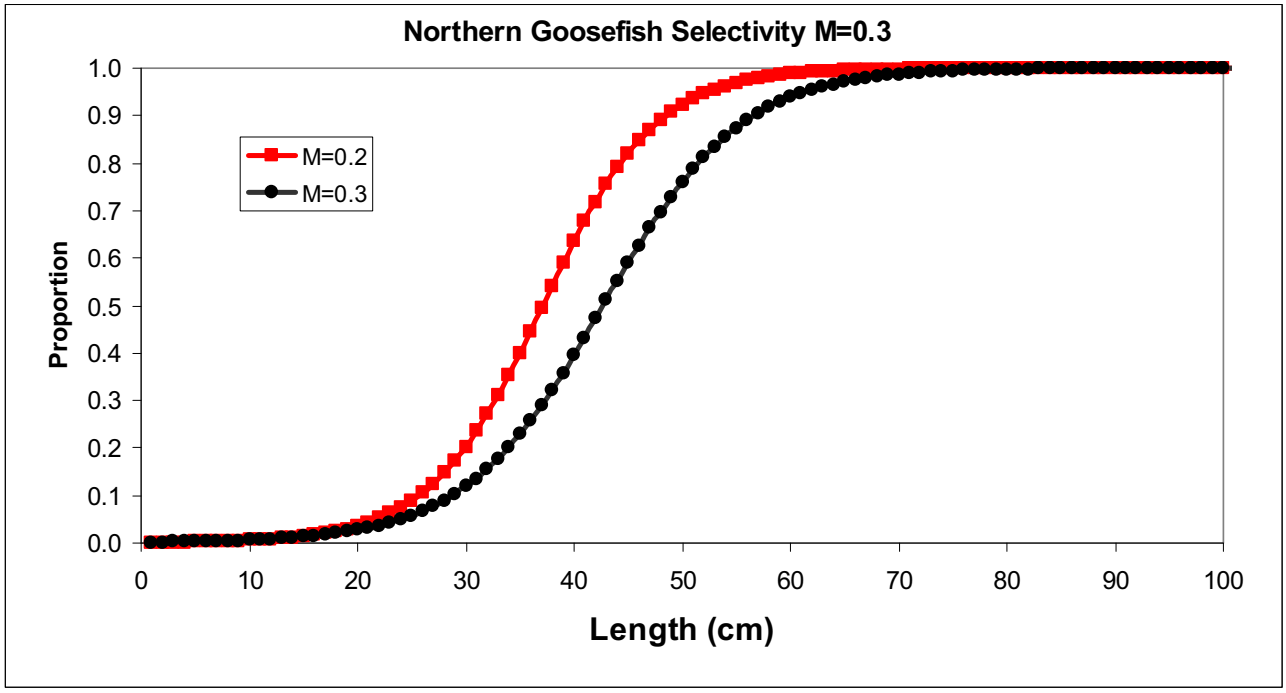


Figure 50. Southern monkfish shift in selectivity (1980-2006) with changes in assumed natural mortality.

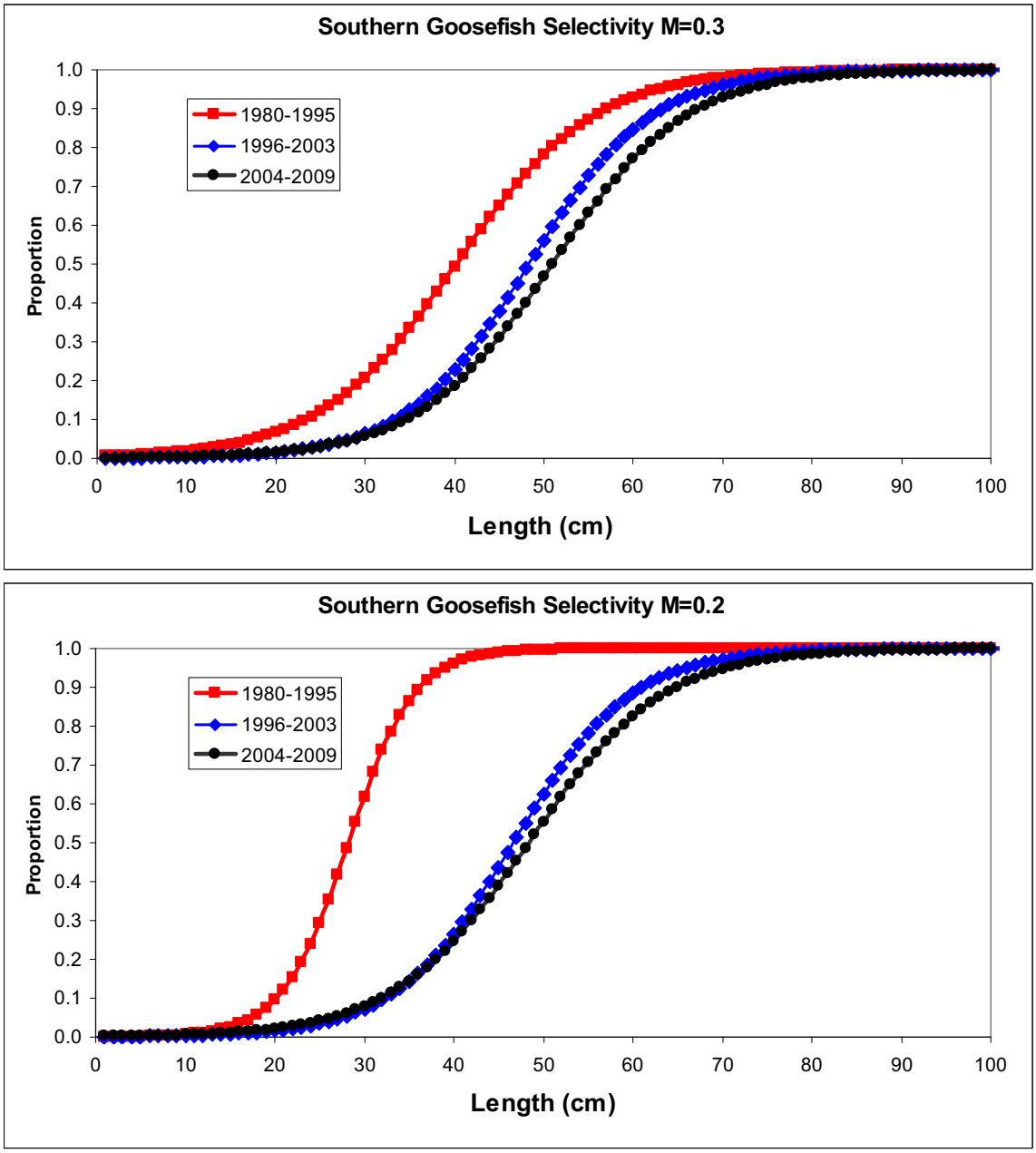


Figure 51. Likelihood profile for natural mortality (M) from SCALE model.

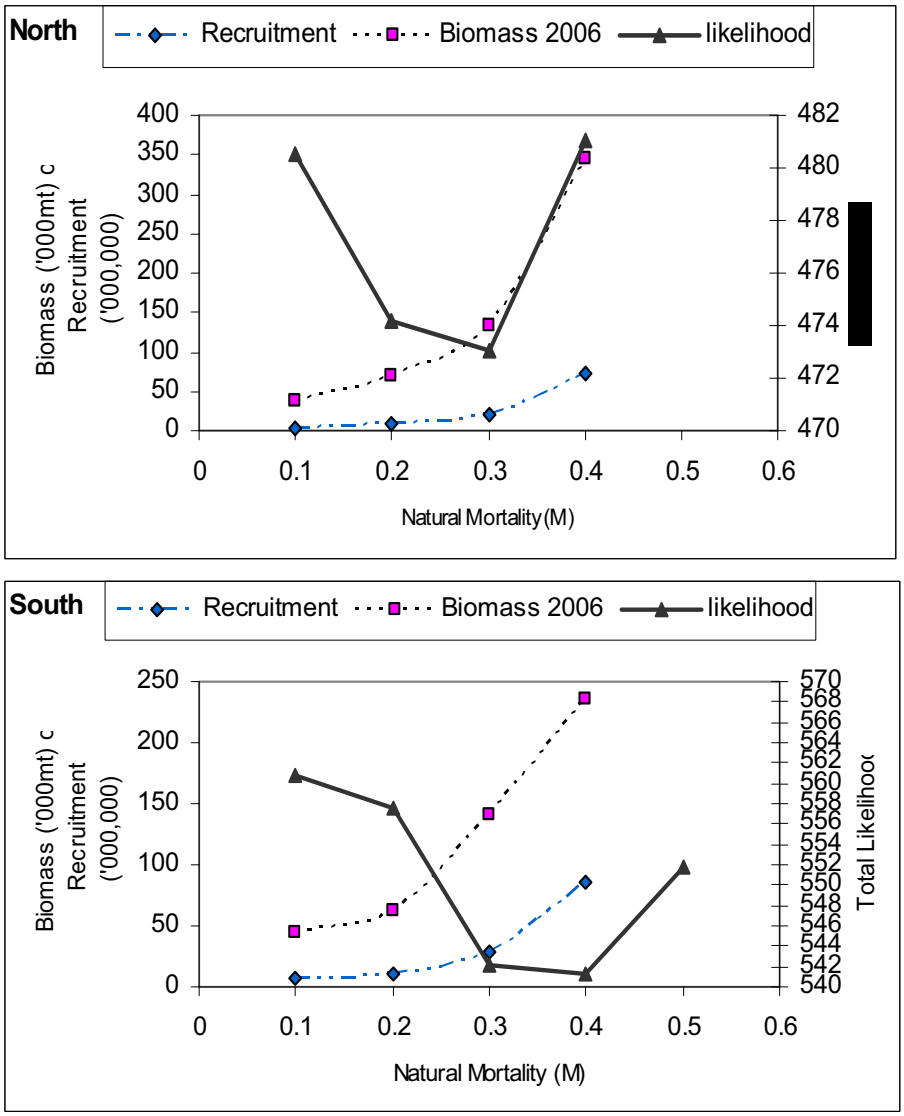


Figure 52. Total biomass estimates from final SCALE runs compared to NEFSC autumn survey biomass indices.

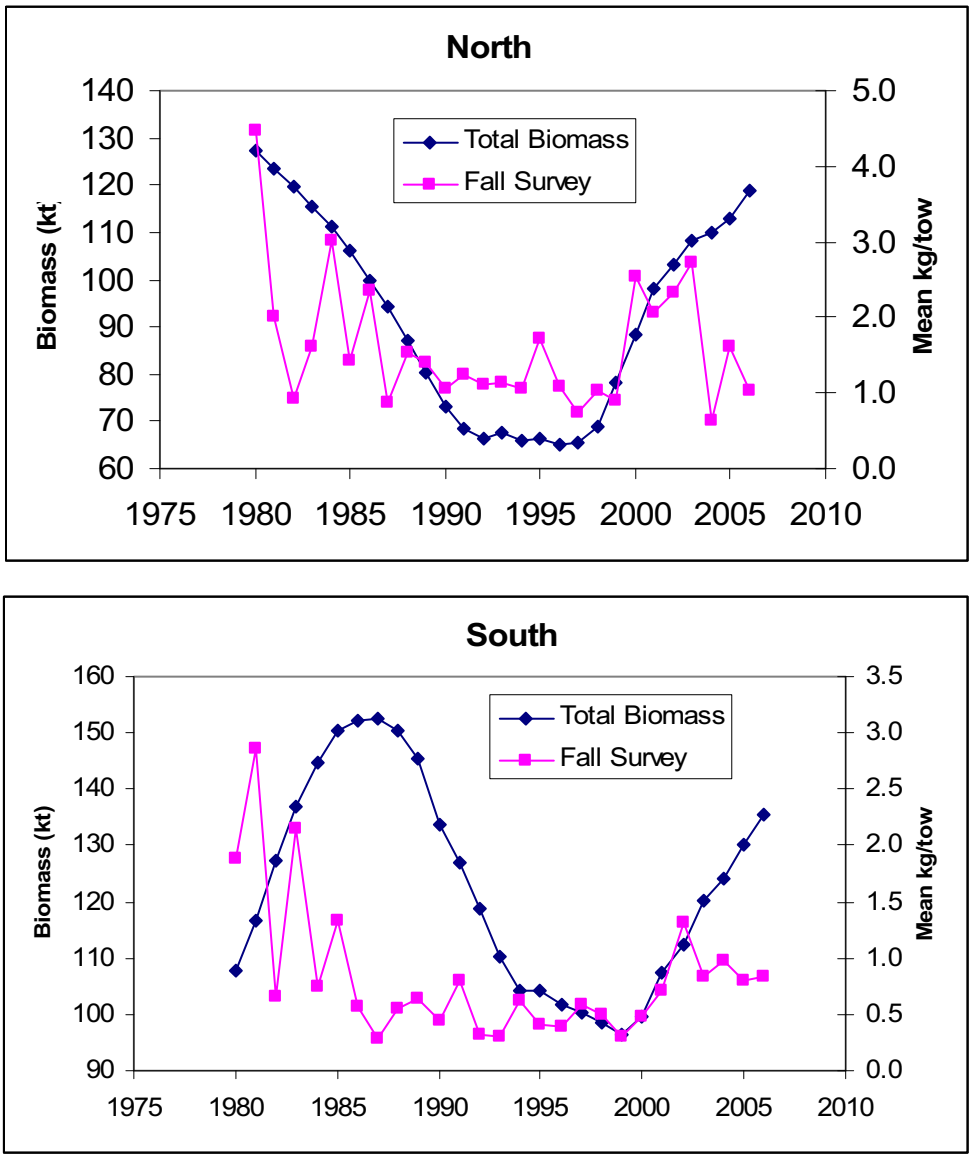
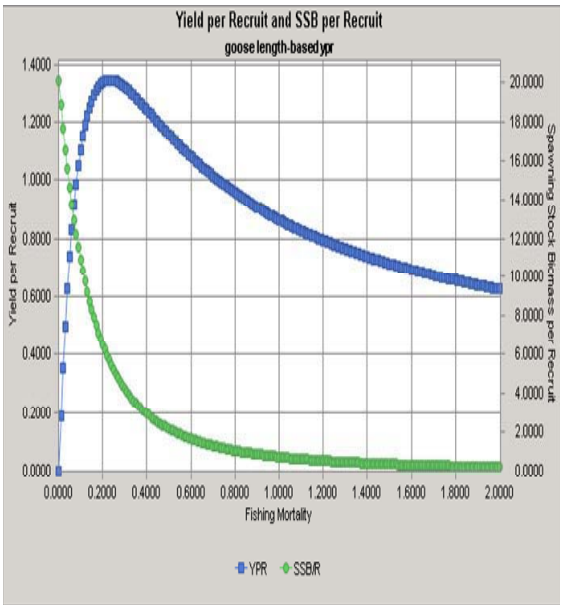
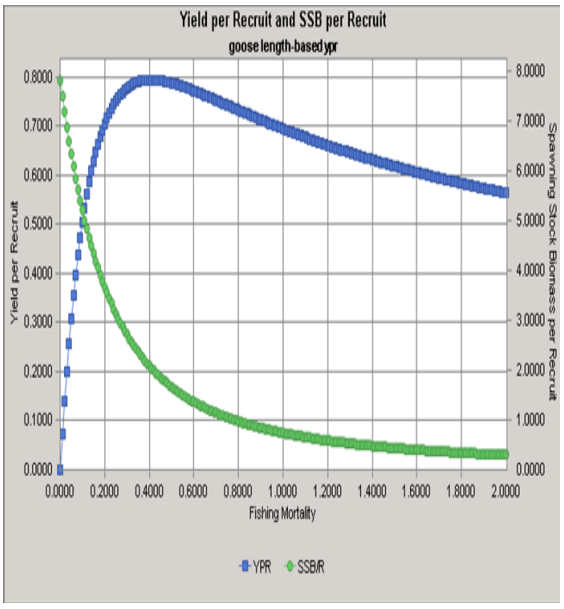


Figure 53a. Length-based yield-per-recruit and spawning biomass per recruit for the Northern management region. (A) Linf=130 (coop data), m=0.2; (B) Linf=130 (coop data), m=0.3; Linf=158 (Armstrong et al. 1992), m=0.2, (D) Linf=158 (Armstrong et al. 1992), m=0.3.

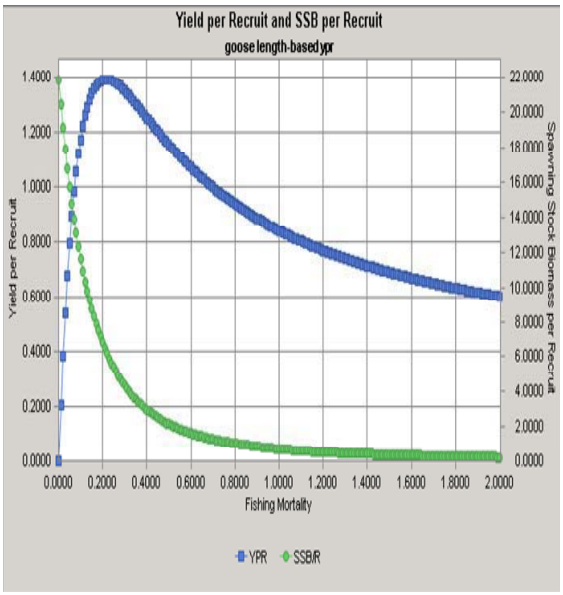
A



B



C



D

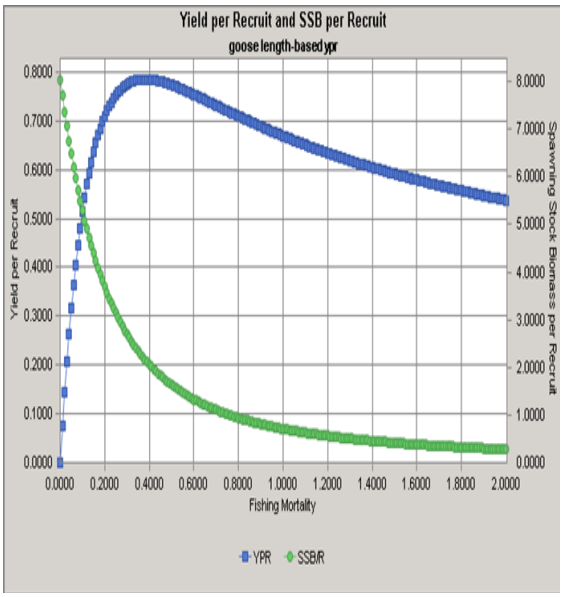
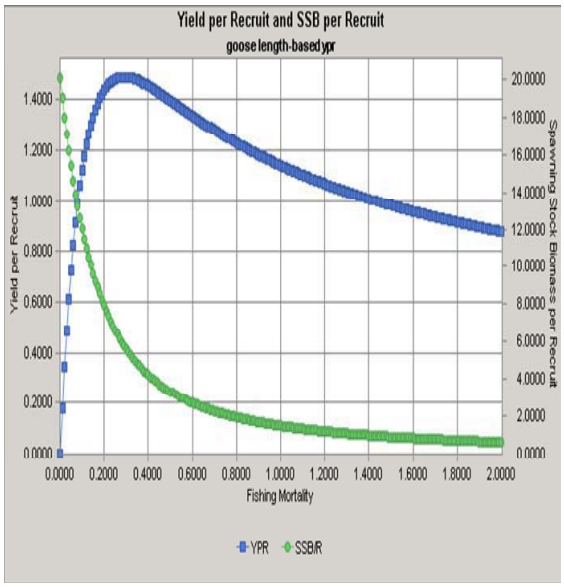
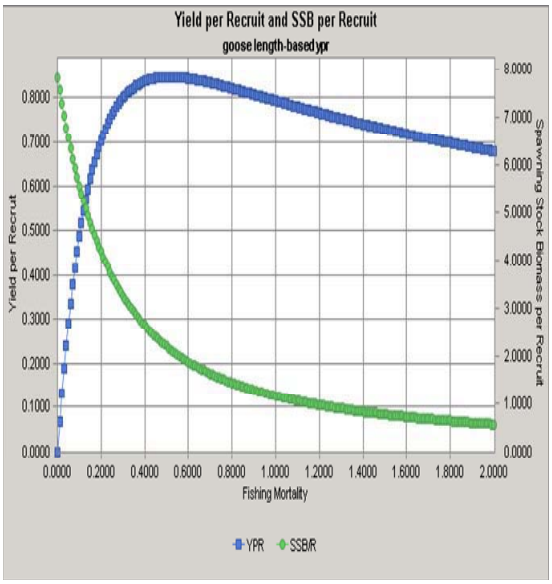


Figure 53b. Length-based yield-per-recruit and spawning biomass per recruit for the Southern management region. (A) Linf=130 (coop data), m=0.2; (B) Linf=130 (coop data), m=0.3; Linf=158 (Armstrong et al. 1992), m=0.2, (D) Linf=158 (Armstrong et al. 1992), m=0.3.

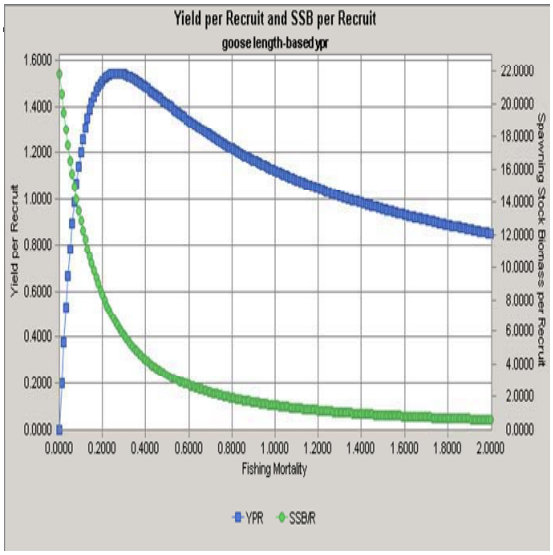
A



B



C



D

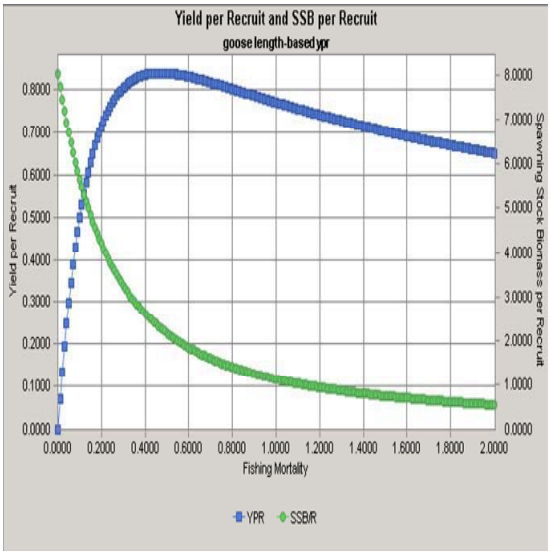
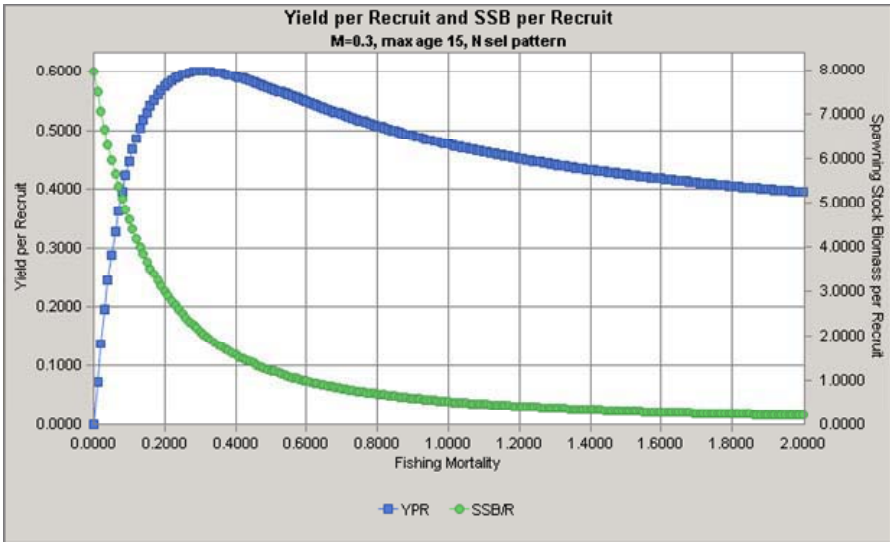


Figure 54. Yield per recruit and spawning biomass per recruit based on working group final runs with M=0.3 and inputs derived from SCALE estimates of selectivity and mean weights, A. North and B. South.

A. North



B. South

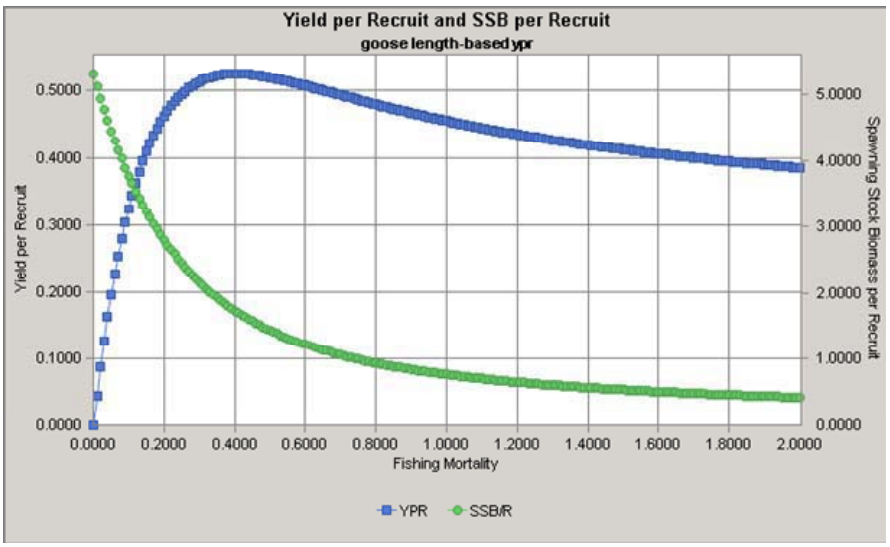


Figure 55a. Current stock status of monkfish in the northern area, based on the NEFSC fall survey and the current overfished definition.

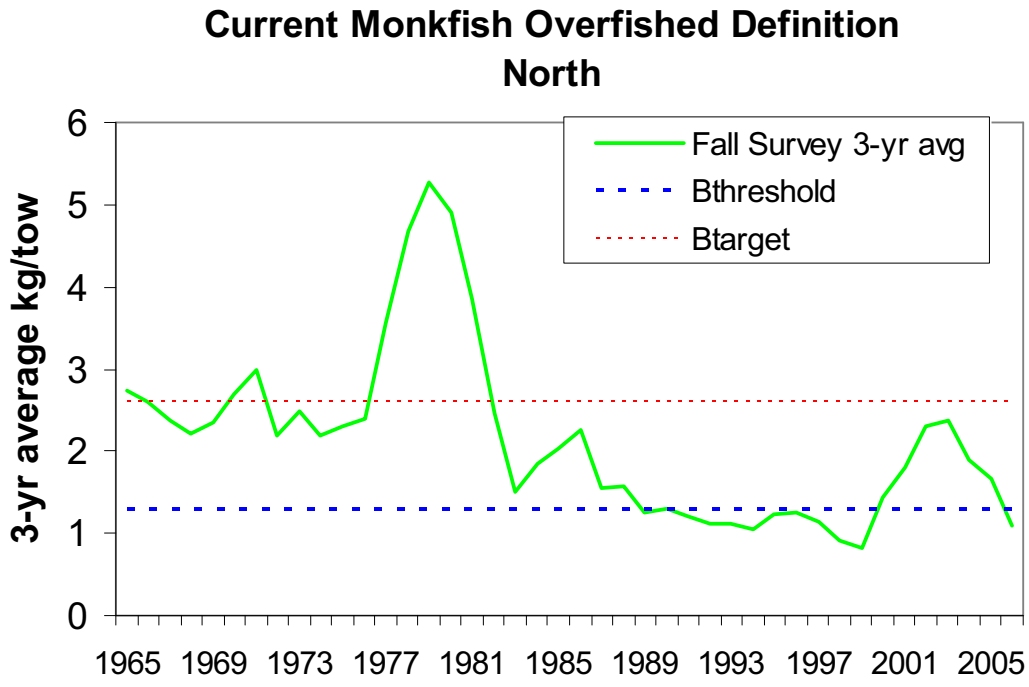


Figure 55b. Current stock status of monkfish in the southern area, based on the NEFSC fall survey and the current overfished definition.

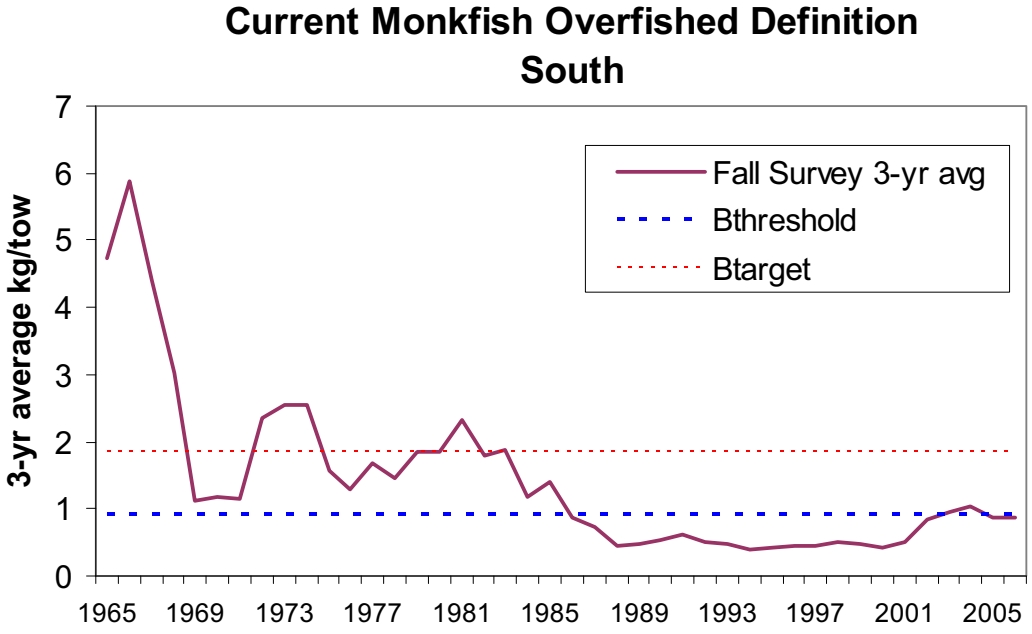


Figure 56a. Timeseries of northern stock's relative exploitation and relative exploitation associated with various TAC. Blue line is robust loess fit with span= 0.50, degree=2.

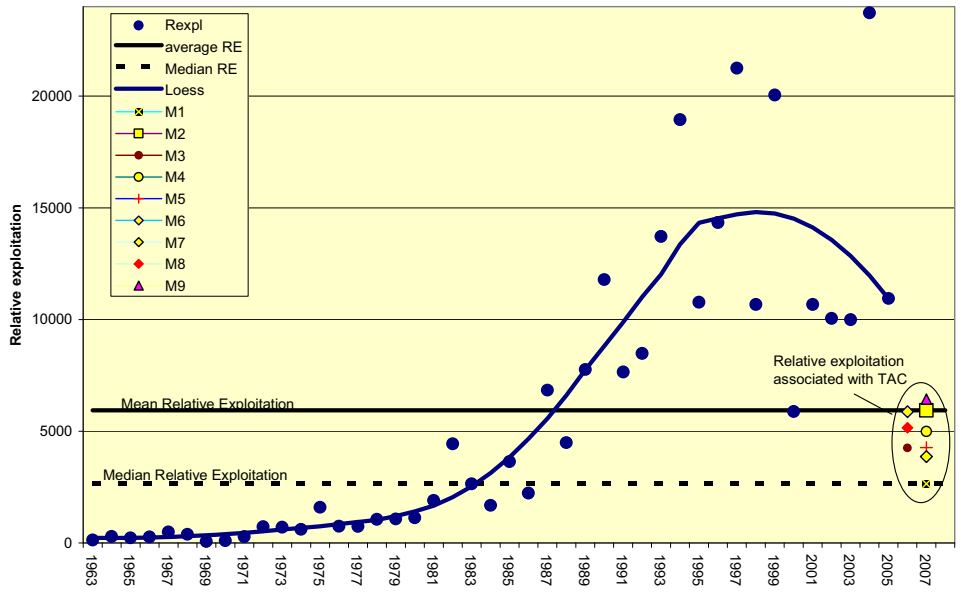


Figure 56b. Timeseries of southern stock's relative exploitation and relative exploitation associated with various TAC. Blue line is robust loess fit with span= 0.33 and degree=1

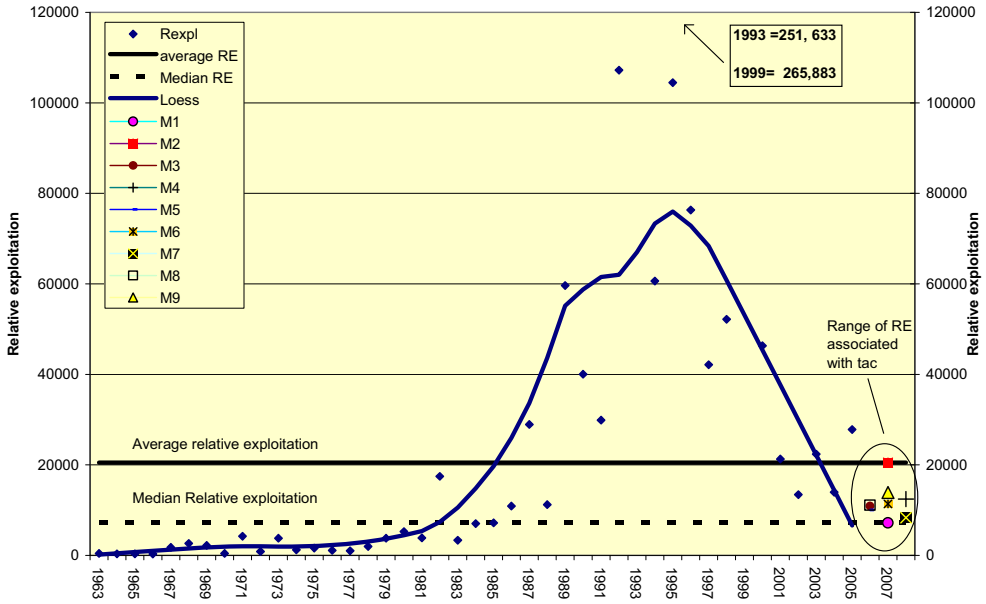


Figure 57a. Rebuild, Index, three year moving average of the index, and Catch time series when r=0.42 and initial catch is set equal to the equilibrium catch for both years zero and minus one.

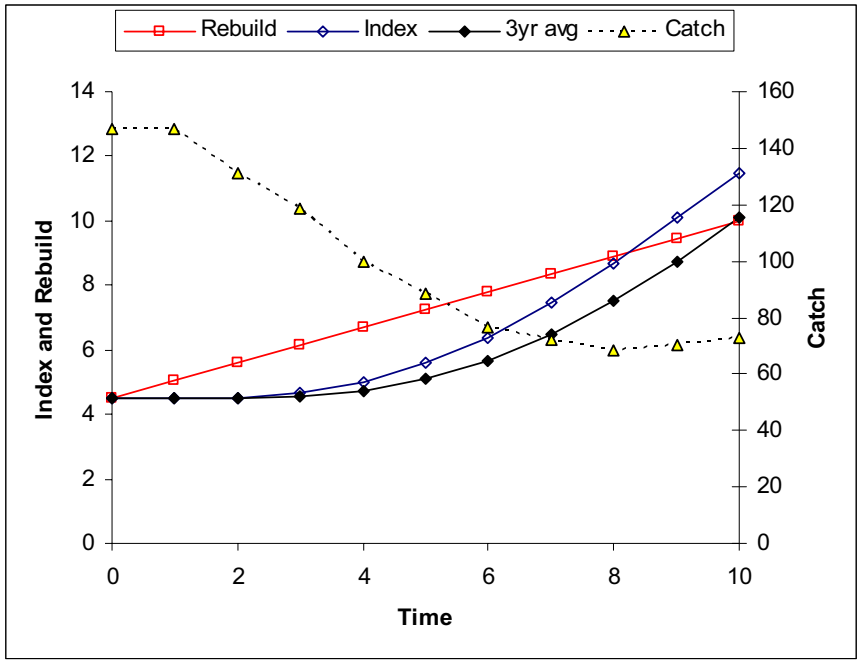


Figure 57b. Time series when r is 0.2 and initial catch/equilibrium catch is 1.2 for both years zero and minus one.

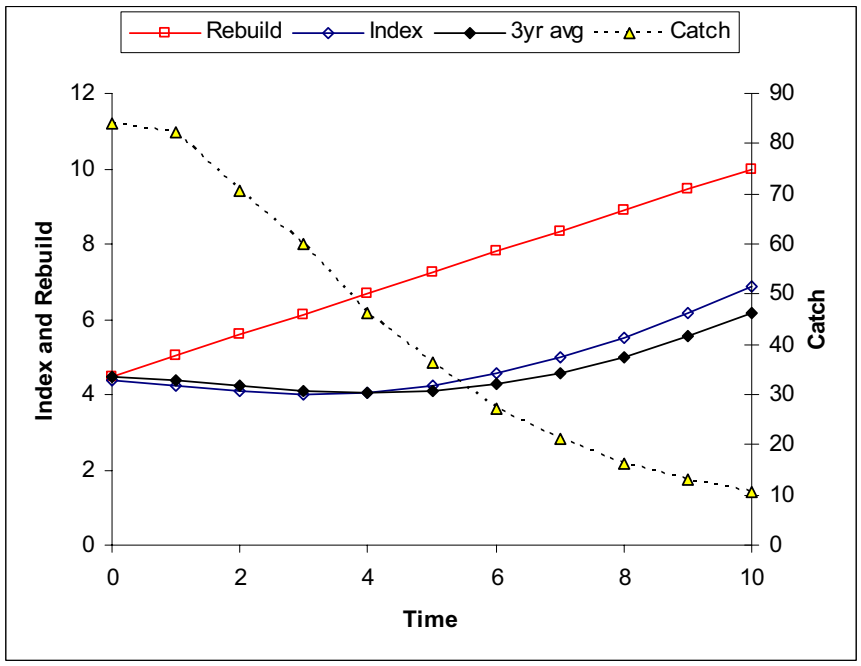


Figure 57c. Time series when r is 0.2 and initial catch/equilibrium catch is 0.42 for both years zero and minus one.

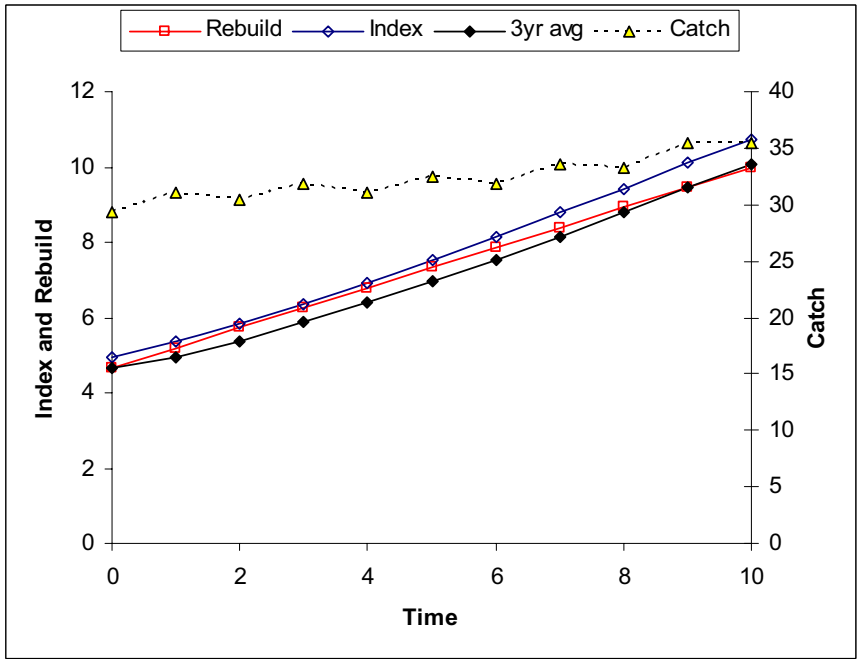


Figure 57d. Time series when r is 0.4 and initial catch/equilibrium catch is 0.8 for year minus one and 1.2 for year zero.

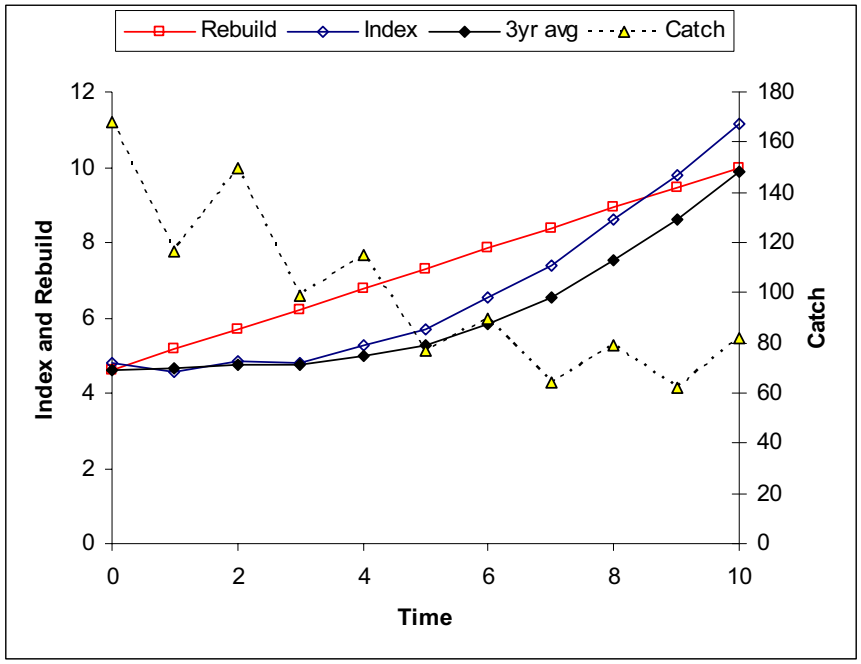
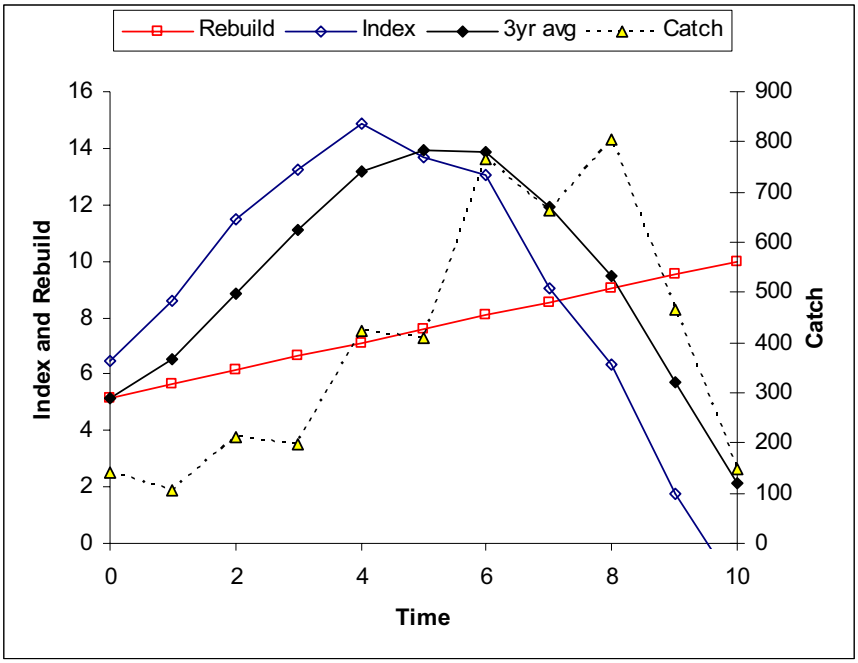


Figure 57e. Time series when r is 0.8 and initial catch/equilibrium catch is 0.3 for year minus one and 0.5 for year zero.



Monkfish Appendix A:
Collie-Sissenwine Analysis of Monkfish in the Northern Management Area

```
MODEL ID: shrimp sv north catch

 CSA Version 3.04

 Input File: H:\GOOSE\CSA\SHRIMP_SV\WG2\SHRIMP_M=3_NONPARAM.DAT
 Date of Run: 21-JUN-2007                          Time of Run: 13:32


 Model Type:  Observed Error Only

 Process Equation Uses Exact Catch Equation


           Estimated Relative Abundance

                        Recruits
 Year       Observed      Estimated       Residual
 1994   0.370000E+00   0.406800E+00  -0.948190E-01
 1995   0.574000E+00   0.852450E+00  -0.395485E+00
 1996   0.882000E+00   0.817522E+00   0.759146E-01
 1997   0.450000E+00   0.473544E+00  -0.509969E-01
 1998   0.430000E+00   0.647551E+00  -0.409412E+00
 1999   0.178800E+01   0.145570E+01   0.205611E+00
 2000   0.129300E+01   0.124325E+01   0.392325E-01
 2001   0.298800E+01   0.231309E+01   0.256018E+00
 2002   0.402900E+01   0.233440E+01   0.545763E+00
 2003   0.109100E+01   0.868856E+00   0.227672E+00
 2004   0.596000E+00   0.561734E+00   0.592118E-01
 2005   0.104700E+01   0.932383E+00   0.115941E+00
 2006   0.994000E+00             NA             NA


                  Post-Recruits
 Year       Observed      Estimated       Residual
 1994   0.320000E+00   0.346953E+00  -0.808697E-01
 1995   0.325000E+00   0.341797E+00  -0.503913E-01
 1996   0.101000E+01   0.637787E+00   0.459701E+00
 1997   0.632000E+00   0.753551E+00  -0.175907E+00
 1998   0.473000E+00   0.648411E+00  -0.315429E+00
 1999   0.164500E+01   0.766678E+00   0.763428E+00
 2000   0.115200E+01   0.145141E+01  -0.231036E+00
 2001   0.199300E+01   0.176713E+01   0.120287E+00
 2002   0.346700E+01   0.274934E+01   0.231928E+00
 2003   0.288000E+01   0.346852E+01  -0.185938E+00
 2004   0.140600E+01   0.286399E+01  -0.711468E+00
 2005   0.215900E+01   0.224811E+01  -0.404441E-01
 2006   0.149200E+01   0.213534E+01  -0.358510E+00
```

Input Catchability Ratio

Year	SRINIT
1994	1.0000
1995	1.0000
1996	1.0000
1997	1.0000
1998	1.0000
1999	1.0000
2000	1.0000
2001	1.0000
2002	1.0000
2003	1.0000
2004	1.0000
2005	1.0000
2006	1.0000

Catchability Coefficient

Initial Guess: 0.300000E+00
First Pass: 0.830202E-01

Minimum Bound 0.100000E-02
Maximum Bound 0.200000E+02

Post-Bootstrap: 0.101002

Normalized Sum of Squares = 0.101744E+00
Residual Sum of Squares = 0.254361E+01
Variance = 0.231237E+00
Standard Deviation = 0.480871E+00

Weighting Factors for Residuals

Recruits = 1.0000
Post-Recruits = 1.0000

Population Estimates

Year	Recruits	Post-Recruits	Total
1994	0.490001E+01	0.417914E+01	0.907916E+01
1995	0.102680E+02	0.411703E+01	0.143850E+02
1996	0.984726E+01	0.768231E+01	0.175296E+02
1997	0.570396E+01	0.907671E+01	0.147807E+02
1998	0.779991E+01	0.781027E+01	0.156102E+02
1999	0.175343E+02	0.923484E+01	0.267691E+02
2000	0.149753E+02	0.174826E+02	0.324579E+02
2001	0.278618E+02	0.212855E+02	0.491473E+02
2002	0.281185E+02	0.331165E+02	0.612350E+02
2003	0.104656E+02	0.417792E+02	0.522448E+02
2004	0.676623E+01	0.344975E+02	0.412638E+02
2005	0.112308E+02	0.270790E+02	0.383098E+02
2006	0.119730E+02	0.257208E+02	0.376937E+02

Year	Biomass Estimates Recruits	Post-Recruits	Total
1994	0.323675E+01	0.140859E+02	0.173227E+02
1995	0.727056E+01	0.120158E+02	0.192864E+02
1996	0.702573E+01	0.174159E+02	0.244416E+02
1997	0.323960E+01	0.240536E+02	0.272932E+02
1998	0.499925E+01	0.246468E+02	0.296460E+02
1999	0.107901E+02	0.251433E+02	0.359334E+02
2000	0.935144E+01	0.336956E+02	0.430471E+02
2001	0.195320E+02	0.437404E+02	0.632724E+02
2002	0.177971E+02	0.816680E+02	0.994651E+02
2003	0.769597E+01	0.887111E+02	0.964071E+02
2004	0.451334E+01	0.919704E+02	0.964838E+02
2005	0.756394E+01	0.752841E+02	0.828480E+02
2006	0.745355E+01	0.954521E+02	0.102906E+03

Year	Catch Estimate Landings Numbers	Discards Numbers	Total Numbers
1994	0.304128E+01	0.385172E-01	0.307980E+01
1995	0.326676E+01	0.230264E+00	0.349702E+01
1996	0.402722E+01	0.572792E+00	0.460001E+01
1997	0.340517E+01	0.286993E+00	0.369216E+01
1998	0.261220E+01	0.119681E+00	0.273188E+01
1999	0.265199E+01	0.953716E-01	0.274736E+01
2000	0.295363E+01	0.274804E+00	0.322844E+01
2001	0.336937E+01	0.479625E+00	0.384899E+01
2002	0.383616E+01	0.352968E+00	0.418913E+01
2003	0.451736E+01	0.402199E+00	0.491956E+01
2004	0.385346E+01	0.228779E+00	0.408224E+01
2005	0.287621E+01	0.233332E+00	0.310954E+01

Year	Catch Estimate Landings Weight	Discards Weight	Total Weight
1994	0.107032E+02	0.131911E+00	0.108351E+02
1995	0.113765E+02	0.413959E+00	0.117904E+02
1996	0.982835E+01	0.940686E+00	0.107690E+02
1997	0.950548E+01	0.531548E+00	0.100370E+02
1998	0.714879E+01	0.203547E+00	0.735233E+01
1999	0.836275E+01	0.254775E+00	0.861752E+01
2000	0.105132E+02	0.588734E+00	0.111019E+02
2001	0.123081E+02	0.175670E+01	0.140648E+02
2002	0.136954E+02	0.647949E+00	0.143434E+02
2003	0.146189E+02	0.694099E+00	0.153130E+02
2004	0.129339E+02	0.466410E+00	0.134003E+02
2005	0.100860E+02	0.517659E+00	0.106036E+02

Mortality Estimates

Year	Total Mortality	Natural Mortality	Fishing Mortality
1994	0.790849	0.300000	0.490849
1995	0.627266	0.300000	0.327266
1996	0.658177	0.300000	0.358177
1997	0.637880	0.300000	0.337880
1998	0.524941	0.300000	0.224941
1999	0.426042	0.300000	0.126042
2000	0.421920	0.300000	0.121920
2001	0.394789	0.300000	0.094789
2002	0.382319	0.300000	0.082319
2003	0.415053	0.300000	0.115053
2004	0.421225	0.300000	0.121225
2005	0.398408	0.300000	0.098408

Average Mortality (1994 - 2005)

Z	F
0.508239	0.208239

Harvest Rate Estimates

Year	Combined	Landings	Derived F
1994	0.339216E+00	0.334974E+00	0.490849
1995	0.243102E+00	0.227095E+00	0.327266
1996	0.262414E+00	0.229738E+00	0.358177
1997	0.249797E+00	0.230380E+00	0.337880
1998	0.175006E+00	0.167339E+00	0.224940
1999	0.102632E+00	0.990691E-01	0.126042
2000	0.994653E-01	0.909988E-01	0.121920
2001	0.783154E-01	0.685565E-01	0.094789
2002	0.684107E-01	0.626466E-01	0.082319
2003	0.941635E-01	0.864652E-01	0.115053
2004	0.989303E-01	0.933860E-01	0.121225
2005	0.811683E-01	0.750776E-01	0.098408

Surplus Production

Average Adjustment Factor (Delta) = 1.0000

Year	Biomass	Delta Biomass	Catch Biomass	Surplus Production
1994	17.323	1.964	10.835	12.799
1995	19.286	5.155	11.790	16.946
1996	24.442	2.852	10.769	13.621
1997	27.293	2.353	10.037	12.390
1998	29.646	6.287	7.352	13.640
1999	35.933	7.114	8.618	15.731
2000	43.047	20.225	11.102	31.327
2001	63.272	36.193	14.065	50.257
2002	99.465	-3.058	14.343	11.285
2003	96.407	0.077	15.313	15.390
2004	96.484	-13.636	13.400	-0.235
2005	82.848	20.058	10.604	30.661
2006	102.906			

Levenburg-Marquadt NLLS Parameter Statistical Summary

	Parameter	Parameter Est.	Std. Error	CV
1	R 1994	0.406800E+00	0.167205E+00	0.411025E+00
2	R 1995	0.852450E+00	0.318006E+00	0.373049E+00
3	R 1996	0.817522E+00	0.335165E+00	0.409977E+00
4	R 1997	0.473544E+00	0.212068E+00	0.447832E+00
5	R 1998	0.647551E+00	0.274789E+00	0.424351E+00
6	R 1999	0.145570E+01	0.552807E+00	0.379753E+00
7	R 2000	0.124325E+01	0.533027E+00	0.428735E+00
8	R 2001	0.231309E+01	0.913560E+00	0.394952E+00
9	R 2002	0.233440E+01	0.938213E+00	0.401908E+00
10	R 2003	0.868856E+00	0.404397E+00	0.465436E+00
11	R 2004	0.561734E+00	0.265335E+00	0.472350E+00
12	R 2005	0.932383E+00	0.429791E+00	0.460960E+00
13	N 1994	0.346953E+00	0.149602E+00	0.431187E+00
14	Q	0.830202E-01	0.363879E-01	0.438301E+00

Model Type: Observed Error Only

Error Type: Non-Parametric Log-Normal Error

Number of Bootstraps: 1000

-- Non-Linear Least Squares Fit --
Maximum Monte-Carlo Iterations = 300
Scaled Gradient Tolerance = 0.3450E-13
Scaled Step Tolerance = 0.2420E-04
Relative Function Tolerance = 0.2420E-15
Absolute Function Tolerance = 0.1420E-15

Bootstrap Summary Report
Number of Bootstrap Repitions Requested = 1000
Number of Bootstrap Repititions Completed = 1000
Number of Bootstrap Repititions Not Converged = 0
Number of Bootstrap Repititions Infeasible F = 0

Bootstrap Output Variable: Recruit Abundance

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.490001E+01	0.470735E+01	0.153231E+01	0.325515E+00
1995	0.102680E+02	0.961828E+01	0.265855E+01	0.276406E+00
1996	0.984726E+01	0.936664E+01	0.292709E+01	0.312501E+00
1997	0.570396E+01	0.539733E+01	0.196894E+01	0.364800E+00
1998	0.779991E+01	0.733821E+01	0.253947E+01	0.346061E+00
1999	0.175343E+02	0.159758E+02	0.559579E+01	0.350266E+00
2000	0.149753E+02	0.139274E+02	0.514429E+01	0.369365E+00
2001	0.278618E+02	0.251938E+02	0.864201E+01	0.343021E+00
2002	0.281185E+02	0.253684E+02	0.908321E+01	0.358052E+00
2003	0.104656E+02	0.999642E+01	0.399153E+01	0.399296E+00
2004	0.676623E+01	0.641698E+01	0.249579E+01	0.388935E+00
2005	0.112308E+02	0.107168E+02	0.446980E+01	0.417084E+00
2006	0.119730E+02	0.105420E+02	0.330214E+01	0.313237E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.1927E+00	0.4884E-01	-3.931873	0.5093E+01	0.3009E+00
1995	-0.6497E+00	0.8655E-01	-6.327383	0.1092E+02	0.2435E+00
1996	-0.4806E+00	0.9380E-01	-4.880737	0.1033E+02	0.2834E+00
1997	-0.3066E+00	0.6301E-01	-5.375721	0.6011E+01	0.3276E+00
1998	-0.4617E+00	0.8162E-01	-5.919373	0.8262E+01	0.3074E+00
1999	-0.1558E+01	0.1837E+00	-8.887944	0.1909E+02	0.2931E+00
2000	-0.1048E+01	0.1660E+00	-6.997645	0.1602E+02	0.3211E+00
2001	-0.2668E+01	0.2860E+00	-9.575818	0.3053E+02	0.2831E+00
2002	-0.2750E+01	0.3001E+00	-9.780306	0.3087E+02	0.2943E+00
2003	-0.4692E+00	0.1271E+00	-4.483040	0.1093E+02	0.3650E+00
2004	-0.3493E+00	0.7969E-01	-5.161744	0.7115E+01	0.3508E+00
2005	-0.5140E+00	0.1423E+00	-4.576688	0.1174E+02	0.3806E+00
2006	-0.1431E+01	0.1138E+00	-11.951894	0.1340E+02	0.2464E+00

Year	10. % Percentile	90. % Percentile
1994	0.309942E+01	0.665272E+01
1995	0.676566E+01	0.129267E+02
1996	0.645171E+01	0.124725E+02
1997	0.339008E+01	0.781008E+01
1998	0.477252E+01	0.104565E+02
1999	0.104584E+02	0.220822E+02
2000	0.871538E+01	0.198806E+02
2001	0.161287E+02	0.359956E+02
2002	0.163152E+02	0.354383E+02
2003	0.570279E+01	0.149377E+02
2004	0.380536E+01	0.941078E+01
2005	0.638419E+01	0.157941E+02
2006	0.755557E+01	0.140358E+02

Bootstrap Output Variable: Post-Recruit Abundance

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.417914E+01	0.370805E+01	0.143255E+01	0.386335E+00
1995	0.411703E+01	0.363179E+01	0.168900E+01	0.465059E+00
1996	0.768231E+01	0.684643E+01	0.274880E+01	0.401494E+00
1997	0.907671E+01	0.810835E+01	0.354192E+01	0.436824E+00
1998	0.781027E+01	0.687265E+01	0.360485E+01	0.524521E+00
1999	0.923484E+01	0.820171E+01	0.410712E+01	0.500764E+00
2000	0.174826E+02	0.155645E+02	0.652483E+01	0.419212E+00
2001	0.212855E+02	0.190901E+02	0.780377E+01	0.408786E+00
2002	0.331165E+02	0.295154E+02	0.109777E+02	0.371930E+00
2003	0.417792E+02	0.370758E+02	0.133676E+02	0.360549E+00
2004	0.344975E+02	0.306683E+02	0.120620E+02	0.393305E+00
2005	0.270790E+02	0.239862E+02	0.102630E+02	0.427869E+00
2006	0.257208E+02	0.230504E+02	0.101000E+02	0.438168E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.4711E+00	0.4769E-01	-11.272480	0.4650E+01	0.3081E+00
1995	-0.4852E+00	0.5557E-01	-11.786144	0.4602E+01	0.3670E+00
1996	-0.8359E+00	0.9086E-01	-10.880580	0.8518E+01	0.3227E+00
1997	-0.9684E+00	0.1161E+00	-10.668590	0.1005E+02	0.3526E+00
1998	-0.9376E+00	0.1178E+00	-12.004977	0.8748E+01	0.4121E+00
1999	-0.1033E+01	0.1339E+00	-11.187313	0.1027E+02	0.4000E+00
2000	-0.1918E+01	0.2151E+00	-10.971527	0.1940E+02	0.3363E+00
2001	-0.2195E+01	0.2564E+00	-10.313962	0.2348E+02	0.3323E+00
2002	-0.3601E+01	0.3654E+00	-10.874102	0.3672E+02	0.2990E+00
2003	-0.4703E+01	0.4482E+00	-11.257911	0.4648E+02	0.2876E+00
2004	-0.3829E+01	0.4002E+00	-11.099963	0.3833E+02	0.3147E+00
2005	-0.3093E+01	0.3390E+00	-11.421393	0.3017E+02	0.3402E+00
2006	-0.2670E+01	0.3304E+00	-10.382045	0.2839E+02	0.3557E+00

Year	10. % Percentile	90. % Percentile
1994	0.224839E+01	0.525102E+01
1995	0.206478E+01	0.546041E+01
1996	0.409760E+01	0.102366E+02
1997	0.496285E+01	0.119500E+02
1998	0.377065E+01	0.110428E+02
1999	0.454916E+01	0.129188E+02
2000	0.958485E+01	0.225387E+02
2001	0.119767E+02	0.280477E+02
2002	0.187025E+02	0.421544E+02
2003	0.246642E+02	0.516662E+02
2004	0.194984E+02	0.434591E+02
2005	0.145404E+02	0.349132E+02
2006	0.137112E+02	0.339660E+02

Bootstrap Output Variable: Total Abundance

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.907916E+01	0.841540E+01	0.229239E+01	0.272404E+00
1995	0.143850E+02	0.132501E+02	0.372042E+01	0.280785E+00
1996	0.175296E+02	0.162131E+02	0.479451E+01	0.295719E+00
1997	0.147807E+02	0.135057E+02	0.487838E+01	0.361210E+00
1998	0.156102E+02	0.142109E+02	0.555041E+01	0.390575E+00
1999	0.267691E+02	0.241776E+02	0.881082E+01	0.364421E+00
2000	0.324579E+02	0.294919E+02	0.105376E+02	0.357304E+00
2001	0.491473E+02	0.442839E+02	0.148216E+02	0.334694E+00
2002	0.612350E+02	0.548838E+02	0.180473E+02	0.328827E+00
2003	0.522448E+02	0.470722E+02	0.162870E+02	0.346001E+00
2004	0.412638E+02	0.370853E+02	0.138584E+02	0.373689E+00
2005	0.383098E+02	0.347030E+02	0.136365E+02	0.392950E+00
2006	0.376937E+02	0.335924E+02	0.132656E+02	0.394898E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.6638E+00	0.7547E-01	-0.3832E+01	0.9743E+01	0.2353E+00
1995	-0.1135E+01	0.1230E+00	-0.5885E+01	0.1552E+02	0.2397E+00
1996	-0.1316E+01	0.1572E+00	-0.5386E+01	0.1885E+02	0.2544E+00
1997	-0.1275E+01	0.1595E+00	-0.4671E+01	0.1606E+02	0.3038E+00
1998	-0.1399E+01	0.1810E+00	-0.4720E+01	0.1701E+02	0.3263E+00
1999	-0.2592E+01	0.2904E+00	-0.7212E+01	0.2936E+02	0.3001E+00
2000	-0.2966E+01	0.3462E+00	-0.6890E+01	0.3542E+02	0.2975E+00
2001	-0.4863E+01	0.4933E+00	-0.7686E+01	0.5401E+02	0.2744E+00
2002	-0.6351E+01	0.6050E+00	-0.6385E+01	0.6759E+02	0.2670E+00
2003	-0.5173E+01	0.5404E+00	-0.5365E+01	0.5742E+02	0.2837E+00
2004	-0.4178E+01	0.4577E+00	-0.4331E+01	0.4544E+02	0.3050E+00
2005	-0.3607E+01	0.4461E+00	-0.4354E+01	0.4192E+02	0.3253E+00
2006	-0.4101E+01	0.4391E+00	-0.3986E+01	0.4180E+02	0.3174E+00

Year	10. % Percentile	90. % Percentile
1994	0.628160E+01	0.109011E+02
1995	0.952488E+01	0.178400E+02
1996	0.119480E+02	0.214178E+02
1997	0.930032E+01	0.191532E+02
1998	0.927069E+01	0.205876E+02
1999	0.161010E+02	0.335963E+02
2000	0.198845E+02	0.415886E+02
2001	0.296829E+02	0.613493E+02
2002	0.381257E+02	0.745829E+02
2003	0.319869E+02	0.643449E+02
2004	0.243275E+02	0.518417E+02
2005	0.220916E+02	0.494418E+02
2006	0.214009E+02	0.479842E+02

Bootstrap Output Variable: Recruit Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.323675E+01	0.310948E+01	0.101218E+01	0.325515E+00
1995	0.727056E+01	0.681052E+01	0.188247E+01	0.276406E+00
1996	0.702573E+01	0.668283E+01	0.208839E+01	0.312501E+00
1997	0.323960E+01	0.306545E+01	0.111828E+01	0.364800E+00
1998	0.499925E+01	0.470332E+01	0.162764E+01	0.346061E+00
1999	0.107901E+02	0.983104E+01	0.344347E+01	0.350266E+00
2000	0.935144E+01	0.869706E+01	0.321239E+01	0.369365E+00
2001	0.195320E+02	0.176617E+02	0.605834E+01	0.343021E+00
2002	0.177971E+02	0.160565E+02	0.574907E+01	0.358052E+00
2003	0.769597E+01	0.735096E+01	0.293521E+01	0.399296E+00
2004	0.451334E+01	0.428037E+01	0.166479E+01	0.388935E+00
2005	0.756394E+01	0.721776E+01	0.301041E+01	0.417084E+00
2006	0.745355E+01	0.656271E+01	0.205568E+01	0.313237E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.1273E+00	0.3226E-01	-0.3932E+01	0.3364E+01	0.3009E+00
1995	-0.4600E+00	0.6128E-01	-0.6327E+01	0.7731E+01	0.2435E+00
1996	-0.3429E+00	0.6693E-01	-0.4881E+01	0.7369E+01	0.2834E+00
1997	-0.1742E+00	0.3579E-01	-0.5376E+01	0.3414E+01	0.3276E+00
1998	-0.2959E+00	0.5232E-01	-0.5919E+01	0.5295E+01	0.3074E+00
1999	-0.9590E+00	0.1130E+00	-0.8888E+01	0.1175E+02	0.2931E+00
2000	-0.6544E+00	0.1037E+00	-0.6998E+01	0.1001E+02	0.3211E+00
2001	-0.1870E+01	0.2005E+00	-0.9576E+01	0.2140E+02	0.2831E+00
2002	-0.1741E+01	0.1900E+00	-0.9780E+01	0.1954E+02	0.2943E+00
2003	-0.3450E+00	0.9346E-01	-0.4483E+01	0.8041E+01	0.3650E+00
2004	-0.2330E+00	0.5316E-01	-0.5162E+01	0.4746E+01	0.3508E+00
2005	-0.3462E+00	0.9583E-01	-0.4577E+01	0.7910E+01	0.3806E+00
2006	-0.8908E+00	0.7085E-01	-0.1195E+02	0.8344E+01	0.2464E+00

Year	10. % Percentile	90. % Percentile
1994	0.204735E+01	0.439451E+01
1995	0.479064E+01	0.915314E+01
1996	0.460311E+01	0.889878E+01
1997	0.192542E+01	0.443579E+01
1998	0.305888E+01	0.670193E+01
1999	0.643579E+01	0.135887E+02
2000	0.544238E+01	0.124146E+02
2001	0.113068E+02	0.252341E+02
2002	0.103264E+02	0.224301E+02
2003	0.419360E+01	0.109846E+02
2004	0.253832E+01	0.627735E+01
2005	0.429975E+01	0.106373E+02
2006	0.470358E+01	0.873775E+01

Bootstrap Output Variable: Post-Recruit Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.140859E+02	0.124981E+02	0.482845E+01	0.386335E+00
1995	0.120158E+02	0.105996E+02	0.492944E+01	0.465059E+00
1996	0.174159E+02	0.155209E+02	0.623157E+01	0.401494E+00
1997	0.240536E+02	0.214874E+02	0.938620E+01	0.436824E+00
1998	0.246468E+02	0.216880E+02	0.113758E+02	0.524521E+00
1999	0.251433E+02	0.223305E+02	0.111823E+02	0.500764E+00
2000	0.336956E+02	0.299987E+02	0.125758E+02	0.419212E+00
2001	0.437404E+02	0.392290E+02	0.160363E+02	0.408786E+00
2002	0.816680E+02	0.727874E+02	0.270718E+02	0.371930E+00
2003	0.887111E+02	0.787241E+02	0.283839E+02	0.360549E+00
2004	0.919704E+02	0.817618E+02	0.321573E+02	0.393305E+00
2005	0.752841E+02	0.666856E+02	0.285327E+02	0.427869E+00
2006	0.954521E+02	0.855422E+02	0.374818E+02	0.438168E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.1588E+01	0.1607E+00	-0.1127E+02	0.1567E+02	0.3081E+00
1995	-0.1416E+01	0.1622E+00	-0.1179E+02	0.1343E+02	0.3670E+00
1996	-0.1895E+01	0.2060E+00	-0.1088E+02	0.1931E+02	0.3227E+00
1997	-0.2566E+01	0.3077E+00	-0.1067E+02	0.2662E+02	0.3526E+00
1998	-0.2959E+01	0.3717E+00	-0.1200E+02	0.2761E+02	0.4121E+00
1999	-0.2813E+01	0.3646E+00	-0.1119E+02	0.2796E+02	0.4000E+00
2000	-0.3697E+01	0.4145E+00	-0.1097E+02	0.3739E+02	0.3363E+00
2001	-0.4511E+01	0.5268E+00	-0.1031E+02	0.4825E+02	0.3323E+00
2002	-0.8881E+01	0.9010E+00	-0.1087E+02	0.9055E+02	0.2990E+00
2003	-0.9987E+01	0.9516E+00	-0.1126E+02	0.9870E+02	0.2876E+00
2004	-0.1021E+02	0.1067E+01	-0.1110E+02	0.1022E+03	0.3147E+00
2005	-0.8598E+01	0.9424E+00	-0.1142E+02	0.8388E+02	0.3402E+00
2006	-0.9910E+01	0.1226E+01	-0.1038E+02	0.1054E+03	0.3557E+00

Year	10. % Percentile	90. % Percentile
1994	0.757825E+01	0.176987E+02
1995	0.602619E+01	0.159365E+02
1996	0.928929E+01	0.232064E+02
1997	0.131517E+02	0.316678E+02
1998	0.118990E+02	0.348476E+02
1999	0.123858E+02	0.351734E+02
2000	0.184737E+02	0.434407E+02
2001	0.246113E+02	0.576364E+02
2002	0.461218E+02	0.103956E+03
2003	0.523702E+02	0.109704E+03
2004	0.519828E+02	0.115862E+03
2005	0.404248E+02	0.970642E+02
2006	0.508835E+02	0.126051E+03

Bootstrap Output Variable: Total Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.173227E+02	0.156076E+02	0.512266E+01	0.328216E+00
1995	0.192864E+02	0.174101E+02	0.599550E+01	0.344369E+00
1996	0.244416E+02	0.222038E+02	0.736853E+01	0.331860E+00
1997	0.272932E+02	0.245528E+02	0.100227E+02	0.408208E+00
1998	0.296460E+02	0.263913E+02	0.124515E+02	0.471805E+00
1999	0.359334E+02	0.321615E+02	0.136470E+02	0.424328E+00
2000	0.430471E+02	0.386958E+02	0.147995E+02	0.382457E+00
2001	0.632724E+02	0.568907E+02	0.203718E+02	0.358087E+00
2002	0.994651E+02	0.888439E+02	0.309425E+02	0.348279E+00
2003	0.964071E+02	0.860750E+02	0.304066E+02	0.353257E+00
2004	0.964838E+02	0.860421E+02	0.332955E+02	0.386967E+00
2005	0.828480E+02	0.739034E+02	0.306062E+02	0.414138E+00
2006	0.102906E+03	0.921049E+02	0.394310E+02	0.428110E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.1715E+01	0.1708E+00	-0.9901E+01	0.1904E+02	0.2691E+00
1995	-0.1876E+01	0.1987E+00	-0.9728E+01	0.2116E+02	0.2833E+00
1996	-0.2238E+01	0.2435E+00	-0.9156E+01	0.2668E+02	0.2762E+00
1997	-0.2740E+01	0.3286E+00	-0.1004E+02	0.3003E+02	0.3337E+00
1998	-0.3255E+01	0.4070E+00	-0.1098E+02	0.3290E+02	0.3785E+00
1999	-0.3772E+01	0.4478E+00	-0.1050E+02	0.3971E+02	0.3437E+00
2000	-0.4351E+01	0.4878E+00	-0.1011E+02	0.4740E+02	0.3122E+00
2001	-0.6382E+01	0.6751E+00	-0.1009E+02	0.6965E+02	0.2925E+00
2002	-0.1062E+02	0.1035E+01	-0.1068E+02	0.1101E+03	0.2811E+00
2003	-0.1033E+02	0.1016E+01	-0.1072E+02	0.1067E+03	0.2849E+00
2004	-0.1044E+02	0.1104E+01	-0.1082E+02	0.1069E+03	0.3114E+00
2005	-0.8945E+01	0.1008E+01	-0.1080E+02	0.9179E+02	0.3334E+00
2006	-0.1080E+02	0.1293E+01	-0.1050E+02	0.1137E+03	0.3468E+00

Year	10. % Percentile	90. % Percentile
1994	0.106178E+02	0.210823E+02
1995	0.118313E+02	0.239435E+02
1996	0.154255E+02	0.309020E+02
1997	0.157326E+02	0.357928E+02
1998	0.156822E+02	0.404186E+02
1999	0.201424E+02	0.470395E+02
2000	0.252271E+02	0.544222E+02
2001	0.378664E+02	0.795741E+02
2002	0.585443E+02	0.124503E+03
2003	0.578626E+02	0.118975E+03
2004	0.553450E+02	0.121196E+03
2005	0.459775E+02	0.106239E+03
2006	0.558765E+02	0.134941E+03

Bootstrap Output Variable: Fishing Mortality

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.490849E+00	0.594193E+00	0.168123E+00	0.282944E+00
1995	0.327266E+00	0.394610E+00	0.113768E+00	0.288305E+00
1996	0.358177E+00	0.430793E+00	0.118196E+00	0.274369E+00
1997	0.337880E+00	0.428139E+00	0.140039E+00	0.327088E+00
1998	0.224941E+00	0.286226E+00	0.977223E-01	0.341416E+00
1999	0.126042E+00	0.156425E+00	0.478936E-01	0.306177E+00
2000	0.121920E+00	0.149820E+00	0.452946E-01	0.302327E+00
2001	0.947890E-01	0.116150E+00	0.332730E-01	0.286465E+00
2002	0.823194E-01	0.100406E+00	0.269879E-01	0.268787E+00
2003	0.115053E+00	0.141614E+00	0.410554E-01	0.289912E+00
2004	0.121225E+00	0.152180E+00	0.481384E-01	0.316326E+00
2005	0.984082E-01	0.123271E+00	0.401343E-01	0.325579E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.1033E+00	0.6241E-02	0.2105E+02	0.3875E+00	0.4339E+00
1995	0.6734E-01	0.4181E-02	0.2058E+02	0.2599E+00	0.4377E+00
1996	0.7262E-01	0.4387E-02	0.2027E+02	0.2856E+00	0.4139E+00
1997	0.9026E-01	0.5269E-02	0.2671E+02	0.2476E+00	0.5655E+00
1998	0.6129E-01	0.3648E-02	0.2725E+02	0.1637E+00	0.5971E+00
1999	0.3038E-01	0.1794E-02	0.2410E+02	0.9566E-01	0.5007E+00
2000	0.2790E-01	0.1682E-02	0.2288E+02	0.9402E-01	0.4818E+00
2001	0.2136E-01	0.1251E-02	0.2254E+02	0.7343E-01	0.4531E+00
2002	0.1809E-01	0.1028E-02	0.2197E+02	0.6423E-01	0.4202E+00
2003	0.2656E-01	0.1547E-02	0.2309E+02	0.8849E-01	0.4639E+00
2004	0.3095E-01	0.1810E-02	0.2554E+02	0.9027E-01	0.5333E+00
2005	0.2486E-01	0.1493E-02	0.2526E+02	0.7355E-01	0.5457E+00

Year	10. % Percentile	90. % Percentile
1994	0.389965E+00	0.811656E+00
1995	0.254880E+00	0.543180E+00
1996	0.283204E+00	0.577141E+00
1997	0.250517E+00	0.601886E+00
1998	0.165652E+00	0.410946E+00
1999	0.988455E-01	0.218121E+00
2000	0.936659E-01	0.206957E+00
2001	0.752296E-01	0.161639E+00
2002	0.668911E-01	0.135361E+00
2003	0.921253E-01	0.194835E+00
2004	0.950733E-01	0.214616E+00
2005	0.751677E-01	0.176961E+00

Bootstrap Output Variable: Total Mortality

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.790849E+00	0.894193E+00	0.168123E+00	0.188017E+00
1995	0.627266E+00	0.694610E+00	0.113768E+00	0.163787E+00
1996	0.658177E+00	0.730793E+00	0.118196E+00	0.161737E+00
1997	0.637880E+00	0.728139E+00	0.140039E+00	0.192325E+00
1998	0.524941E+00	0.586226E+00	0.977223E-01	0.166697E+00
1999	0.426042E+00	0.456425E+00	0.478936E-01	0.104932E+00
2000	0.421920E+00	0.449820E+00	0.452946E-01	0.100695E+00
2001	0.394789E+00	0.416150E+00	0.332730E-01	0.799543E-01
2002	0.382319E+00	0.400406E+00	0.269879E-01	0.674012E-01
2003	0.415053E+00	0.441614E+00	0.410554E-01	0.929669E-01
2004	0.421225E+00	0.452180E+00	0.481384E-01	0.106459E+00
2005	0.398408E+00	0.423271E+00	0.401343E-01	0.948196E-01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.1033E+00	0.6241E-02	0.1307E+02	0.6875E+00	0.2445E+00
1995	0.6734E-01	0.4181E-02	0.1074E+02	0.5599E+00	0.2032E+00
1996	0.7262E-01	0.4387E-02	0.1103E+02	0.5856E+00	0.2019E+00
1997	0.9026E-01	0.5269E-02	0.1415E+02	0.5476E+00	0.2557E+00
1998	0.6129E-01	0.3648E-02	0.1167E+02	0.4637E+00	0.2108E+00
1999	0.3038E-01	0.1794E-02	0.7131E+01	0.3957E+00	0.1210E+00
2000	0.2790E-01	0.1682E-02	0.6613E+01	0.3940E+00	0.1150E+00
2001	0.2136E-01	0.1251E-02	0.5411E+01	0.3734E+00	0.8910E-01
2002	0.1809E-01	0.1028E-02	0.4731E+01	0.3642E+00	0.7410E-01
2003	0.2656E-01	0.1547E-02	0.6399E+01	0.3885E+00	0.1057E+00
2004	0.3095E-01	0.1810E-02	0.7349E+01	0.3903E+00	0.1233E+00
2005	0.2486E-01	0.1493E-02	0.6240E+01	0.3735E+00	0.1074E+00

Year	10. % Percentile	90. % Percentile
1994	0.689965E+00	0.111166E+01
1995	0.554880E+00	0.843180E+00
1996	0.583204E+00	0.877141E+00
1997	0.550517E+00	0.901886E+00
1998	0.465652E+00	0.710946E+00
1999	0.398845E+00	0.518121E+00
2000	0.393666E+00	0.506957E+00
2001	0.375230E+00	0.461639E+00
2002	0.366891E+00	0.435361E+00
2003	0.392125E+00	0.494835E+00
2004	0.395073E+00	0.514616E+00
2005	0.375168E+00	0.476961E+00

Bootstrap Output Variable: F Derived From Harvest Rate

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.490849E+00	0.594193E+00	0.168123E+00	0.282944E+00
1995	0.327266E+00	0.394610E+00	0.113768E+00	0.288305E+00
1996	0.358177E+00	0.430793E+00	0.118196E+00	0.274369E+00
1997	0.337880E+00	0.428139E+00	0.140039E+00	0.327088E+00
1998	0.224940E+00	0.286226E+00	0.977223E-01	0.341416E+00
1999	0.126042E+00	0.156425E+00	0.478936E-01	0.306177E+00
2000	0.121920E+00	0.149820E+00	0.452946E-01	0.302327E+00
2001	0.947890E-01	0.116150E+00	0.332730E-01	0.286465E+00
2002	0.823194E-01	0.100406E+00	0.269879E-01	0.268787E+00
2003	0.115053E+00	0.141613E+00	0.410554E-01	0.289912E+00
2004	0.121225E+00	0.152180E+00	0.481384E-01	0.316326E+00
2005	0.984081E-01	0.123271E+00	0.401343E-01	0.325579E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.1033E+00	0.6241E-02	0.2105E+02	0.3875E+00	0.4339E+00
1995	0.6734E-01	0.4181E-02	0.2058E+02	0.2599E+00	0.4377E+00
1996	0.7262E-01	0.4387E-02	0.2027E+02	0.2856E+00	0.4139E+00
1997	0.9026E-01	0.5269E-02	0.2671E+02	0.2476E+00	0.5655E+00
1998	0.6129E-01	0.3648E-02	0.2725E+02	0.1637E+00	0.5971E+00
1999	0.3038E-01	0.1794E-02	0.2410E+02	0.9566E-01	0.5007E+00
2000	0.2790E-01	0.1682E-02	0.2288E+02	0.9402E-01	0.4818E+00
2001	0.2136E-01	0.1251E-02	0.2254E+02	0.7343E-01	0.4531E+00
2002	0.1809E-01	0.1028E-02	0.2197E+02	0.6423E-01	0.4202E+00
2003	0.2656E-01	0.1547E-02	0.2309E+02	0.8849E-01	0.4639E+00
2004	0.3095E-01	0.1810E-02	0.2554E+02	0.9027E-01	0.5333E+00
2005	0.2486E-01	0.1493E-02	0.2526E+02	0.7355E-01	0.5457E+00

Year	10. % Percentile	90. % Percentile
1994	0.389965E+00	0.811655E+00
1995	0.254880E+00	0.543180E+00
1996	0.283204E+00	0.577141E+00
1997	0.250517E+00	0.601886E+00
1998	0.165652E+00	0.410946E+00
1999	0.988454E-01	0.218121E+00
2000	0.936659E-01	0.206957E+00
2001	0.752296E-01	0.161639E+00
2002	0.668911E-01	0.135361E+00
2003	0.921253E-01	0.194835E+00
2004	0.950732E-01	0.214616E+00
2005	0.751677E-01	0.176961E+00

Bootstrap Output Variable: Harvest Estimate

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.339216E+00	0.386339E+00	0.821899E-01	0.212740E+00
1995	0.243102E+00	0.280916E+00	0.662528E-01	0.235846E+00
1996	0.262414E+00	0.301885E+00	0.678079E-01	0.224615E+00
1997	0.249797E+00	0.298876E+00	0.796653E-01	0.266550E+00
1998	0.175006E+00	0.213655E+00	0.633061E-01	0.296301E+00
1999	0.102632E+00	0.124788E+00	0.353502E-01	0.283281E+00
2000	0.994653E-01	0.119933E+00	0.336578E-01	0.280638E+00
2001	0.783154E-01	0.946091E-01	0.256439E-01	0.271051E+00
2002	0.684107E-01	0.824690E-01	0.211417E-01	0.256360E+00
2003	0.941635E-01	0.113881E+00	0.308364E-01	0.270776E+00
2004	0.989303E-01	0.121609E+00	0.356606E-01	0.293240E+00
2005	0.811683E-01	0.999221E-01	0.305912E-01	0.306151E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.4712E-01	0.2996E-02	0.1389E+02	0.2921E+00	0.2814E+00
1995	0.3781E-01	0.2413E-02	0.1555E+02	0.2053E+00	0.3227E+00
1996	0.3947E-01	0.2481E-02	0.1504E+02	0.2229E+00	0.3041E+00
1997	0.4908E-01	0.2959E-02	0.1965E+02	0.2007E+00	0.3969E+00
1998	0.3865E-01	0.2346E-02	0.2208E+02	0.1364E+00	0.4643E+00
1999	0.2216E-01	0.1319E-02	0.2159E+02	0.8048E-01	0.4393E+00
2000	0.2047E-01	0.1246E-02	0.2058E+02	0.7900E-01	0.4261E+00
2001	0.1629E-01	0.9609E-03	0.2081E+02	0.6202E-01	0.4135E+00
2002	0.1406E-01	0.8030E-03	0.2055E+02	0.5435E-01	0.3890E+00
2003	0.1972E-01	0.1158E-02	0.2094E+02	0.7445E-01	0.4142E+00
2004	0.2268E-01	0.1337E-02	0.2292E+02	0.7625E-01	0.4677E+00
2005	0.1875E-01	0.1135E-02	0.2310E+02	0.6241E-01	0.4901E+00

Year	10. % Percentile	90. % Percentile
1994	0.281697E+00	0.489909E+00
1995	0.195615E+00	0.366977E+00
1996	0.214583E+00	0.384280E+00
1997	0.192648E+00	0.396545E+00
1998	0.132434E+00	0.294112E+00
1999	0.815123E-01	0.170230E+00
2000	0.774281E-01	0.162344E+00
2001	0.627268E-01	0.129465E+00
2002	0.559928E-01	0.109744E+00
2003	0.762094E-01	0.153687E+00
2004	0.785398E-01	0.167763E+00
2005	0.626770E-01	0.140740E+00

Bootstrap Output Variable: Catchability (Q)

NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
0.8302E-01	0.1010E+00	0.2396E-01	0.2373E+00

Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
0.1798E-01	0.9476E-03	0.2166E+02	0.6504E-01	0.3685E+00

10. % Percentile	90. % Percentile
0.705866E-01	0.131384E+00

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Monkfish Appendix B:
Collie-Sissenwine Analysis of Monkfish in the Southern Management Area

MODEL ID: winter sv south catch

CSA Version 3.04

Input File: H:\GOOSE\CSA\WINTER_SV\WG2\WINTER_M=3_NONPARM.DAT
Date of Run: 22-JUN-2007 Time of Run: 10:36

Model Type: Observed Error Only

Process Equation Uses Exact Catch Equation

Estimated Relative Abundance

Recruits

Year	Observed	Estimated	Residual
1994	0.556400E+00	0.604717E+00	-0.832734E-01
1995	0.872600E+00	0.952616E+00	-0.877343E-01
1996	0.134330E+01	0.117193E+01	0.136479E+00
1997	0.475700E+00	0.441029E+00	0.756777E-01
1998	0.311400E+00	0.319447E+00	-0.255143E-01
1999	0.703800E+00	0.802318E+00	-0.131011E+00
2000	0.143520E+01	0.143280E+01	0.167116E-02
2001	0.135440E+01	0.137066E+01	-0.119326E-01
2002	0.113240E+01	0.110658E+01	0.230636E-01
2003	0.364800E+00	0.362565E+00	0.614522E-02
2004	0.100950E+01	0.925066E+00	0.873452E-01
2005	0.914000E+00	0.911158E+00	0.311372E-02
2006	0.119490E+01	0.109737E+01	0.851434E-01
2007	0.197100E+00	NA	NA

Post-Recruits

Year	Observed	Estimated	Residual
1994	0.840900E+00	0.959709E+00	-0.132158E+00
1995	0.119550E+01	0.108028E+01	0.101340E+00
1996	0.197950E+01	0.140973E+01	0.339447E+00
1997	0.184560E+01	0.179848E+01	0.258616E-01
1998	0.953800E+00	0.154198E+01	-0.480372E+00
1999	0.117730E+01	0.126270E+01	-0.700258E-01
2000	0.198290E+01	0.144088E+01	0.319308E+00
2001	0.202340E+01	0.206685E+01	-0.212475E-01
2002	0.268020E+01	0.247267E+01	0.805943E-01
2003	0.251700E+01	0.259101E+01	-0.289807E-01
2004	0.247010E+01	0.212217E+01	0.151821E+00
2005	0.168030E+01	0.221032E+01	-0.274163E+00
2006	0.266700E+01	0.226129E+01	0.165018E+00
2007	0.189010E+01	0.244060E+01	-0.255614E+00

Input Catchability Ratio

Year	SRINIT
1994	1.0000
1995	1.0000
1996	1.0000
1997	1.0000
1998	1.0000
1999	1.0000
2000	1.0000
2001	1.0000
2002	1.0000
2003	1.0000
2004	1.0000
2005	1.0000
2006	1.0000
2007	1.0000

Catchability Coefficient

Initial Guess: 0.100000E-02
First Pass: 0.226974E-01

Minimum Bound 0.100000E-03
Maximum Bound 0.200000E+02

Post-Bootstrap: 0.023095

Normalized Sum of Squares = 0.278601E-01
Residual Sum of Squares = 0.752222E+00
Variance = 0.626851E-01
Standard Deviation = 0.250370E+00

Weighting Factors for Residuals

Recruits = 1.0000
Post-Recruits = 1.0000

Population Estimates

Year	Recruits	Post-Recruits	Total
1994	0.266425E+02	0.422827E+02	0.689252E+02
1995	0.419702E+02	0.475950E+02	0.895652E+02
1996	0.516326E+02	0.621096E+02	0.113742E+03
1997	0.194308E+02	0.792372E+02	0.986679E+02
1998	0.140742E+02	0.679365E+02	0.820106E+02
1999	0.353484E+02	0.556317E+02	0.909801E+02
2000	0.631262E+02	0.634819E+02	0.126608E+03
2001	0.603882E+02	0.910610E+02	0.151449E+03
2002	0.487536E+02	0.108940E+03	0.157694E+03
2003	0.159738E+02	0.114154E+03	0.130128E+03
2004	0.407564E+02	0.934980E+02	0.134254E+03
2005	0.401437E+02	0.973817E+02	0.137525E+03
2006	0.483479E+02	0.996275E+02	0.147975E+03
2007	0.868380E+01	0.107528E+03	0.116211E+03

	Biomass Estimates		
Year	Recruits	Post-Recruits	Total
1994	0.182981E+02	0.993559E+02	0.117654E+03
1995	0.295302E+02	0.990309E+02	0.128561E+03
1996	0.383888E+02	0.135219E+03	0.173608E+03
1997	0.137920E+02	0.196722E+03	0.210514E+03
1998	0.110257E+02	0.169991E+03	0.181016E+03
1999	0.244399E+02	0.138745E+03	0.163185E+03
2000	0.470101E+02	0.129617E+03	0.176627E+03
2001	0.407319E+02	0.209632E+03	0.250363E+03
2002	0.344249E+02	0.254201E+03	0.288626E+03
2003	0.104900E+02	0.299004E+03	0.309494E+03
2004	0.289982E+02	0.244264E+03	0.273262E+03
2005	0.286425E+02	0.253504E+03	0.282147E+03
2006	0.361449E+02	0.221233E+03	0.257378E+03
2007	0.619242E+01	0.277830E+03	0.284022E+03

	Catch Estimate		
Year	Landings Numbers	Discards Numbers	Total Numbers
1994	0.382657E+01	0.222625E+00	0.404920E+01
1995	0.429448E+01	0.660580E+00	0.495506E+01
1996	0.509595E+01	0.773287E+00	0.586923E+01
1997	0.578193E+01	0.244904E+00	0.602684E+01
1998	0.567573E+01	0.312205E+00	0.598793E+01
1999	0.428711E+01	0.288609E+00	0.457571E+01
2000	0.275199E+01	0.437101E+00	0.318909E+01
2001	0.223948E+01	0.156050E+01	0.379997E+01
2002	0.184281E+01	0.127059E+01	0.311340E+01
2003	0.237368E+01	0.101469E+01	0.338837E+01
2004	0.169653E+01	0.726242E+00	0.242277E+01
2005	0.194277E+01	0.687031E+00	0.262980E+01
2006	0.184619E+01	0.598583E+00	0.244477E+01

	Catch Estimate		
Year	Landings Weight	Discards Weight	Total Weight
1994	0.114820E+02	0.323882E+00	0.118059E+02
1995	0.139410E+02	0.117775E+01	0.151187E+02
1996	0.154055E+02	0.127343E+01	0.166789E+02
1997	0.180188E+02	0.424715E+00	0.184435E+02
1998	0.188285E+02	0.701657E+00	0.195301E+02
1999	0.158266E+02	0.572770E+00	0.163993E+02
2000	0.100271E+02	0.852325E+00	0.108794E+02
2001	0.983924E+01	0.280902E+01	0.126483E+02
2002	0.870528E+01	0.300794E+01	0.117132E+02
2003	0.109714E+02	0.272748E+01	0.136989E+02
2004	0.788311E+01	0.228769E+01	0.101708E+02
2005	0.872223E+01	0.223995E+01	0.109622E+02
2006	0.765990E+01	0.163054E+01	0.929044E+01

Mortality Estimates

Year	Total Mortality	Natural Mortality	Fishing Mortality
1994	0.370295	0.300000	0.070295
1995	0.366066	0.300000	0.066066
1996	0.361489	0.300000	0.061489
1997	0.373187	0.300000	0.073187
1998	0.388097	0.300000	0.088097
1999	0.359885	0.300000	0.059885
2000	0.329567	0.300000	0.029567
2001	0.329450	0.300000	0.029450
2002	0.323104	0.300000	0.023104
2003	0.330579	0.300000	0.030579
2004	0.321098	0.300000	0.021098
2005	0.322370	0.300000	0.022370
2006	0.319299	0.300000	0.019299

Average Mortality (1994 - 2006)

Z	F
0.345730	0.045730

Harvest Rate Estimates

Year	Combined	Landings	Derived F
1994	0.587477E-01	0.555177E-01	0.070294
1995	0.553236E-01	0.479481E-01	0.066066
1996	0.516012E-01	0.448026E-01	0.061489
1997	0.610820E-01	0.585999E-01	0.073187
1998	0.730141E-01	0.692072E-01	0.088096
1999	0.502936E-01	0.471214E-01	0.059885
2000	0.251887E-01	0.217363E-01	0.029567
2001	0.250907E-01	0.147870E-01	0.029450
2002	0.197433E-01	0.116860E-01	0.023104
2003	0.260387E-01	0.182411E-01	0.030579
2004	0.180461E-01	0.126366E-01	0.021098
2005	0.191223E-01	0.141266E-01	0.022370
2006	0.165215E-01	0.124763E-01	0.019299

Surplus Production

Average Adjustment Factor (Delta) = 1.0000

Year	Biomass	Delta Biomass	Catch Biomass	Surplus Production
1994	117.654	10.907	11.806	22.713
1995	128.561	45.046	15.119	60.165
1996	173.608	36.906	16.679	53.585
1997	210.514	-29.498	18.444	-11.054
1998	181.016	-17.831	19.530	1.699
1999	163.185	13.442	16.399	29.842
2000	176.627	73.736	10.879	84.615
2001	250.363	38.263	12.648	50.911
2002	288.626	20.868	11.713	32.581
2003	309.494	-36.233	13.699	-22.534
2004	273.262	8.885	10.171	19.056
2005	282.147	-24.769	10.962	-13.807
2006	257.378	26.644	9.290	35.935
2007	284.022			

Levenburg-Marquadt NLLS Parameter Statistical Summary

	Parameter	Parameter Est.	Std. Error	CV
1	R 1994	0.604717E+00	0.142794E+00	0.236133E+00
2	R 1995	0.952616E+00	0.217155E+00	0.227957E+00
3	R 1996	0.117193E+01	0.268332E+00	0.228967E+00
4	R 1997	0.441029E+00	0.108903E+00	0.246929E+00
5	R 1998	0.319447E+00	0.792372E-01	0.248045E+00
6	R 1999	0.802318E+00	0.189066E+00	0.235650E+00
7	R 2000	0.143280E+01	0.314888E+00	0.219771E+00
8	R 2001	0.137066E+01	0.309406E+00	0.225735E+00
9	R 2002	0.110658E+01	0.257079E+00	0.232318E+00
10	R 2003	0.362565E+00	0.898985E-01	0.247951E+00
11	R 2004	0.925066E+00	0.217857E+00	0.235504E+00
12	R 2005	0.911158E+00	0.216719E+00	0.237850E+00
13	R 2006	0.109737E+01	0.261804E+00	0.238574E+00
14	N 1994	0.959709E+00	0.204126E+00	0.212696E+00
15	Q	0.226974E-01	0.161714E-01	0.712476E+00

Model Type: Observed Error Only

Error Type: Non-Parametric Log-Normal Error

Number of Bootstraps: 1000

```
-- Non-Linear Least Squares Fit --
Maximum Monte-Carlo Iterations =       200
Scaled Gradient Tolerance      =      0.3450E-13
Scaled Step Tolerance          =      0.2420E-04
Relative Function Tolerance    =      0.2420E-13
Absolute Function Tolerance    =      0.1420E-13

Bootstrap Summary Report
Number of Bootstrap Repitions Requested       =  1000
Number of Bootstrap Repititions Completed     =  1000
Number of Bootstrap Repititions Not Converged =     0
Number of Bootstrap Repititions Infeasible F  =     0


Bootstrap Output Variable: Recruit Abundance
```

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.266425E+02	0.262046E+03	0.117069E+04	0.446748E+01
1995	0.419702E+02	0.406799E+03	0.181112E+04	0.445213E+01
1996	0.516326E+02	0.492643E+03	0.218998E+04	0.444537E+01
1997	0.194308E+02	0.185752E+03	0.823396E+03	0.443277E+01
1998	0.140742E+02	0.133742E+03	0.593028E+03	0.443412E+01
1999	0.353484E+02	0.341370E+03	0.151819E+04	0.444735E+01
2000	0.631262E+02	0.602609E+03	0.267219E+04	0.443437E+01
2001	0.603882E+02	0.582246E+03	0.258879E+04	0.444622E+01
2002	0.487536E+02	0.467258E+03	0.207120E+04	0.443266E+01
2003	0.159738E+02	0.157297E+03	0.701299E+03	0.445845E+01
2004	0.407564E+02	0.389547E+03	0.172945E+04	0.443966E+01
2005	0.401437E+02	0.390978E+03	0.173912E+04	0.444812E+01
2006	0.483479E+02	0.482301E+03	0.215300E+04	0.446402E+01
2007	0.868380E+01	0.835365E+02	0.370290E+03	0.443268E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.2354E+03	0.3776E+02	883.563221	-0.2088E+03	-0.5608E+01
1995	0.3648E+03	0.5842E+02	869.256202	-0.3229E+03	-0.5610E+01
1996	0.4410E+03	0.7064E+02	854.132102	-0.3894E+03	-0.5624E+01
1997	0.1663E+03	0.2656E+02	855.969188	-0.1469E+03	-0.5606E+01
1998	0.1197E+03	0.1913E+02	850.267383	-0.1056E+03	-0.5616E+01
1999	0.3060E+03	0.4898E+02	865.729217	-0.2707E+03	-0.5609E+01
2000	0.5395E+03	0.8621E+02	854.610287	-0.4764E+03	-0.5610E+01
2001	0.5219E+03	0.8351E+02	864.170731	-0.4615E+03	-0.5610E+01
2002	0.4185E+03	0.6682E+02	858.408566	-0.3698E+03	-0.5602E+01
2003	0.1413E+03	0.2262E+02	884.714911	-0.1253E+03	-0.5595E+01
2004	0.3488E+03	0.5579E+02	855.793078	-0.3080E+03	-0.5614E+01
2005	0.3508E+03	0.5610E+02	873.946656	-0.3107E+03	-0.5598E+01
2006	0.4340E+03	0.6945E+02	897.564260	-0.3856E+03	-0.5583E+01
2007	0.7485E+02	0.1195E+02	861.981279	-0.6617E+02	-0.5596E+01

Year	10. % Percentile	90. % Percentile
1994	0.161413E+02	0.685834E+02
1995	0.258684E+02	0.106257E+03
1996	0.320417E+02	0.133224E+03
1997	0.117995E+02	0.500240E+02
1998	0.862394E+01	0.360383E+02
1999	0.213861E+02	0.913510E+02
2000	0.397512E+02	0.166076E+03
2001	0.370579E+02	0.154428E+03
2002	0.299651E+02	0.129356E+03
2003	0.959161E+01	0.418232E+02
2004	0.248854E+02	0.106180E+03
2005	0.242067E+02	0.104637E+03
2006	0.297038E+02	0.123748E+03
2007	0.527567E+01	0.226454E+02

Bootstrap Output Variable: Post-Recruit Abundance

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.422827E+02	0.374464E+03	0.166978E+04	0.445913E+01
1995	0.475950E+02	0.468072E+03	0.208834E+04	0.446159E+01
1996	0.621096E+02	0.643878E+03	0.287999E+04	0.447288E+01
1997	0.792372E+02	0.836931E+03	0.375009E+04	0.448077E+01
1998	0.679365E+02	0.752464E+03	0.338563E+04	0.449939E+01
1999	0.556317E+02	0.651395E+03	0.294601E+04	0.452262E+01
2000	0.634819E+02	0.731540E+03	0.330314E+04	0.451532E+01
2001	0.910610E+02	0.985630E+03	0.442257E+04	0.448705E+01
2002	0.108940E+03	0.115825E+04	0.518803E+04	0.447918E+01
2003	0.114154E+03	0.120153E+04	0.537226E+04	0.447117E+01
2004	0.934980E+02	0.100374E+04	0.449773E+04	0.448095E+01
2005	0.973817E+02	0.103008E+04	0.460901E+04	0.447440E+01
2006	0.996275E+02	0.105049E+04	0.469971E+04	0.447384E+01
2007	0.107528E+03	0.113340E+04	0.507121E+04	0.447433E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.3322E+03	0.5384E+02	785.620222	-0.2899E+03	-0.5760E+01
1995	0.4205E+03	0.6737E+02	883.448364	-0.3729E+03	-0.5601E+01
1996	0.5818E+03	0.9291E+02	936.680916	-0.5197E+03	-0.5542E+01
1997	0.7577E+03	0.1210E+03	956.234772	-0.6785E+03	-0.5527E+01
1998	0.6845E+03	0.1092E+03	1007.598816	-0.6166E+03	-0.5491E+01
1999	0.5958E+03	0.9505E+02	1070.906296	-0.5401E+03	-0.5454E+01
2000	0.6681E+03	0.1066E+03	1052.360393	-0.6046E+03	-0.5464E+01
2001	0.8946E+03	0.1427E+03	982.384122	-0.8035E+03	-0.5504E+01
2002	0.1049E+04	0.1674E+03	963.201243	-0.9404E+03	-0.5517E+01
2003	0.1087E+04	0.1733E+03	952.552701	-0.9732E+03	-0.5520E+01
2004	0.9102E+03	0.1451E+03	973.545152	-0.8167E+03	-0.5507E+01
2005	0.9327E+03	0.1487E+03	957.780371	-0.8353E+03	-0.5518E+01
2006	0.9509E+03	0.1516E+03	954.413555	-0.8512E+03	-0.5521E+01
2007	0.1026E+04	0.1636E+03	954.055043	-0.9183E+03	-0.5522E+01

Year	10. % Percentile	90. % Percentile
1994	0.270203E+02	0.107868E+03
1995	0.289850E+02	0.127840E+03
1996	0.367805E+02	0.172708E+03
1997	0.469697E+02	0.221946E+03
1998	0.381056E+02	0.196244E+03
1999	0.295412E+02	0.166736E+03
2000	0.341179E+02	0.187034E+03
2001	0.523383E+02	0.258549E+03
2002	0.631236E+02	0.307399E+03
2003	0.665699E+02	0.323771E+03
2004	0.535203E+02	0.266991E+03
2005	0.567786E+02	0.269472E+03
2006	0.577032E+02	0.275392E+03
2007	0.633295E+02	0.293452E+03

Bootstrap Output Variable: Total Abundance

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.689252E+02	0.636510E+03	0.281897E+04	0.442879E+01
1995	0.895652E+02	0.874871E+03	0.388758E+04	0.444361E+01
1996	0.113742E+03	0.113652E+04	0.506210E+04	0.445403E+01
1997	0.986679E+02	0.102268E+04	0.457012E+04	0.446876E+01
1998	0.820106E+02	0.886206E+03	0.397670E+04	0.448733E+01
1999	0.909801E+02	0.992764E+03	0.445878E+04	0.449127E+01
2000	0.126608E+03	0.133415E+04	0.596984E+04	0.447464E+01
2001	0.151449E+03	0.156788E+04	0.700310E+04	0.446662E+01
2002	0.157694E+03	0.162551E+04	0.725185E+04	0.446127E+01
2003	0.130128E+03	0.135883E+04	0.607130E+04	0.446803E+01
2004	0.134254E+03	0.139329E+04	0.622161E+04	0.446541E+01
2005	0.137525E+03	0.142106E+04	0.634401E+04	0.446427E+01
2006	0.147975E+03	0.153279E+04	0.684557E+04	0.446609E+01
2007	0.116211E+03	0.121694E+04	0.544127E+04	0.447129E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.5676E+03	0.9093E+02	0.4824E+03	-0.4987E+03	-0.5653E+01
1995	0.7853E+03	0.1254E+03	0.6108E+03	-0.6957E+03	-0.5588E+01
1996	0.1023E+04	0.1633E+03	0.5891E+03	-0.9090E+03	-0.5569E+01
1997	0.9240E+03	0.1474E+03	0.4389E+03	-0.8253E+03	-0.5537E+01
1998	0.8042E+03	0.1283E+03	0.4443E+03	-0.7222E+03	-0.5506E+01
1999	0.9018E+03	0.1439E+03	0.5526E+03	-0.8108E+03	-0.5499E+01
2000	0.1208E+04	0.1926E+03	0.6837E+03	-0.1081E+04	-0.5523E+01
2001	0.1416E+04	0.2259E+03	0.5657E+03	-0.1265E+04	-0.5536E+01
2002	0.1468E+04	0.2340E+03	0.5086E+03	-0.1310E+04	-0.5535E+01
2003	0.1229E+04	0.1959E+03	0.3970E+03	-0.1099E+04	-0.5527E+01
2004	0.1259E+04	0.2007E+03	0.4607E+03	-0.1125E+04	-0.5531E+01
2005	0.1284E+04	0.2047E+03	0.4549E+03	-0.1146E+04	-0.5536E+01
2006	0.1385E+04	0.2209E+03	0.5380E+03	-0.1237E+04	-0.5535E+01
2007	0.1101E+04	0.1756E+03	0.3875E+03	-0.9845E+03	-0.5527E+01

Year	10. % Percentile	90. % Percentile
1994	0.437994E+02	0.177250E+03
1995	0.553683E+02	0.238863E+03
1996	0.701789E+02	0.306385E+03
1997	0.583912E+02	0.271873E+03
1998	0.467799E+02	0.231995E+03
1999	0.513364E+02	0.257764E+03
2000	0.743359E+02	0.352695E+03
2001	0.896009E+02	0.419342E+03
2002	0.934601E+02	0.440649E+03
2003	0.761617E+02	0.364321E+03
2004	0.794449E+02	0.366553E+03
2005	0.809322E+02	0.374783E+03
2006	0.883134E+02	0.398948E+03
2007	0.684349E+02	0.316192E+03

Bootstrap Output Variable: Recruit Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.182981E+02	0.179973E+03	0.804027E+03	0.446748E+01
1995	0.295302E+02	0.286223E+03	0.127430E+04	0.445213E+01
1996	0.383888E+02	0.366280E+03	0.162825E+04	0.444537E+01
1997	0.137920E+02	0.131847E+03	0.584447E+03	0.443277E+01
1998	0.110257E+02	0.104774E+03	0.464578E+03	0.443412E+01
1999	0.244399E+02	0.236023E+03	0.104968E+04	0.444735E+01
2000	0.470101E+02	0.448763E+03	0.198998E+04	0.443437E+01
2001	0.407319E+02	0.392725E+03	0.174614E+04	0.444622E+01
2002	0.344249E+02	0.329931E+03	0.146247E+04	0.443266E+01
2003	0.104900E+02	0.103297E+03	0.460543E+03	0.445845E+01
2004	0.289982E+02	0.277163E+03	0.123051E+04	0.443966E+01
2005	0.286425E+02	0.278963E+03	0.124086E+04	0.444812E+01
2006	0.361449E+02	0.360568E+03	0.160958E+04	0.446402E+01
2007	0.619242E+01	0.595699E+02	0.264054E+03	0.443268E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.1617E+03	0.2593E+02	0.8836E+03	-0.1434E+03	-0.5608E+01
1995	0.2567E+03	0.4111E+02	0.8693E+03	-0.2272E+03	-0.5610E+01
1996	0.3279E+03	0.5252E+02	0.8541E+03	-0.2895E+03	-0.5624E+01
1997	0.1181E+03	0.1886E+02	0.8560E+03	-0.1043E+03	-0.5606E+01
1998	0.9375E+02	0.1499E+02	0.8503E+03	-0.8272E+02	-0.5616E+01
1999	0.2116E+03	0.3386E+02	0.8657E+03	-0.1871E+03	-0.5609E+01
2000	0.4018E+03	0.6420E+02	0.8546E+03	-0.3547E+03	-0.5610E+01
2001	0.3520E+03	0.5633E+02	0.8642E+03	-0.3113E+03	-0.5610E+01
2002	0.2955E+03	0.4718E+02	0.8584E+03	-0.2611E+03	-0.5602E+01
2003	0.9281E+02	0.1486E+02	0.8847E+03	-0.8232E+02	-0.5595E+01
2004	0.2482E+03	0.3970E+02	0.8558E+03	-0.2192E+03	-0.5614E+01
2005	0.2503E+03	0.4003E+02	0.8739E+03	-0.2217E+03	-0.5598E+01
2006	0.3244E+03	0.5192E+02	0.8976E+03	-0.2883E+03	-0.5583E+01
2007	0.5338E+02	0.8519E+01	0.8620E+03	-0.4719E+02	-0.5596E+01

Year	10. % Percentile	90. % Percentile
1994	0.110859E+02	0.471031E+02
1995	0.182010E+02	0.747624E+02
1996	0.238230E+02	0.990522E+02
1997	0.837529E+01	0.355070E+02
1998	0.675599E+01	0.282324E+02
1999	0.147864E+02	0.631601E+02
2000	0.296027E+02	0.123677E+03
2001	0.249956E+02	0.104162E+03
2002	0.211583E+02	0.913382E+02
2003	0.629881E+01	0.274653E+02
2004	0.177060E+02	0.755472E+02
2005	0.172715E+02	0.746584E+02
2006	0.222066E+02	0.925138E+02
2007	0.376208E+01	0.161484E+02

Bootstrap Output Variable: Post-Recruit Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.993559E+02	0.879916E+03	0.392366E+04	0.445913E+01
1995	0.990309E+02	0.973918E+03	0.434522E+04	0.446159E+01
1996	0.135219E+03	0.140179E+04	0.627003E+04	0.447288E+01
1997	0.196722E+03	0.207785E+04	0.931036E+04	0.448077E+01
1998	0.169991E+03	0.188281E+04	0.847151E+04	0.449939E+01
1999	0.138745E+03	0.162458E+04	0.734734E+04	0.452262E+01
2000	0.129617E+03	0.149366E+04	0.674436E+04	0.451532E+01
2001	0.209632E+03	0.226902E+04	0.101812E+05	0.448705E+01
2002	0.254201E+03	0.270267E+04	0.121057E+05	0.447918E+01
2003	0.299004E+03	0.314718E+04	0.140716E+05	0.447117E+01
2004	0.244264E+03	0.262228E+04	0.117503E+05	0.448095E+01
2005	0.253504E+03	0.268152E+04	0.119982E+05	0.447440E+01
2006	0.221233E+03	0.233271E+04	0.104362E+05	0.447384E+01
2007	0.277830E+03	0.292848E+04	0.131030E+05	0.447433E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.7806E+03	0.1265E+03	0.7856E+03	-0.6812E+03	-0.5760E+01
1995	0.8749E+03	0.1402E+03	0.8834E+03	-0.7759E+03	-0.5601E+01
1996	0.1267E+04	0.2023E+03	0.9367E+03	-0.1131E+04	-0.5542E+01
1997	0.1881E+04	0.3004E+03	0.9562E+03	-0.1684E+04	-0.5527E+01
1998	0.1713E+04	0.2733E+03	0.1008E+04	-0.1543E+04	-0.5491E+01
1999	0.1486E+04	0.2371E+03	0.1071E+04	-0.1347E+04	-0.5454E+01
2000	0.1364E+04	0.2176E+03	0.1052E+04	-0.1234E+04	-0.5464E+01
2001	0.2059E+04	0.3285E+03	0.9824E+03	-0.1850E+04	-0.5504E+01
2002	0.2448E+04	0.3906E+03	0.9632E+03	-0.2194E+04	-0.5517E+01
2003	0.2848E+04	0.4540E+03	0.9526E+03	-0.2549E+04	-0.5520E+01
2004	0.2378E+04	0.3791E+03	0.9735E+03	-0.2134E+04	-0.5507E+01
2005	0.2428E+04	0.3871E+03	0.9578E+03	-0.2175E+04	-0.5518E+01
2006	0.2111E+04	0.3367E+03	0.9544E+03	-0.1890E+04	-0.5521E+01
2007	0.2651E+04	0.4228E+03	0.9541E+03	-0.2373E+04	-0.5522E+01

Year	10. % Percentile	90. % Percentile
1994	0.634922E+02	0.253469E+03
1995	0.603090E+02	0.265997E+03
1996	0.800748E+02	0.376002E+03
1997	0.116612E+03	0.551024E+03
1998	0.953479E+02	0.491041E+03
1999	0.736758E+02	0.415839E+03
2000	0.696619E+02	0.381887E+03
2001	0.120488E+03	0.595205E+03
2002	0.147293E+03	0.717285E+03
2003	0.174366E+03	0.848054E+03
2004	0.139822E+03	0.697514E+03
2005	0.147806E+03	0.701490E+03
2006	0.128136E+03	0.611535E+03
2007	0.163631E+03	0.758222E+03

Bootstrap Output Variable: Total Biomass

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.117654E+03	0.105989E+04	0.470687E+04	0.444091E+01
1995	0.128561E+03	0.126014E+04	0.560746E+04	0.444986E+01
1996	0.173608E+03	0.176807E+04	0.789010E+04	0.446256E+01
1997	0.210514E+03	0.220969E+04	0.989206E+04	0.447666E+01
1998	0.181016E+03	0.198759E+04	0.893438E+04	0.449509E+01
1999	0.163185E+03	0.186060E+04	0.839205E+04	0.451040E+01
2000	0.176627E+03	0.194242E+04	0.872863E+04	0.449368E+01
2001	0.250363E+03	0.266174E+04	0.119198E+05	0.447819E+01
2002	0.288626E+03	0.303260E+04	0.135617E+05	0.447197E+01
2003	0.309494E+03	0.325048E+04	0.145305E+05	0.447026E+01
2004	0.273262E+03	0.289944E+04	0.129759E+05	0.447529E+01
2005	0.282147E+03	0.296048E+04	0.132354E+05	0.447068E+01
2006	0.257378E+03	0.269328E+04	0.120390E+05	0.447002E+01
2007	0.284022E+03	0.298805E+04	0.133669E+05	0.447345E+01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	0.9422E+03	0.1518E+03	0.8009E+03	-0.8246E+03	-0.5708E+01
1995	0.1132E+04	0.1809E+03	0.8802E+03	-0.1003E+04	-0.5591E+01
1996	0.1594E+04	0.2546E+03	0.9184E+03	-0.1421E+04	-0.5553E+01
1997	0.1999E+04	0.3191E+03	0.9497E+03	-0.1789E+04	-0.5530E+01
1998	0.1807E+04	0.2883E+03	0.9980E+03	-0.1626E+04	-0.5496E+01
1999	0.1697E+04	0.2708E+03	0.1040E+04	-0.1534E+04	-0.5470E+01
2000	0.1766E+04	0.2816E+03	0.9997E+03	-0.1589E+04	-0.5493E+01
2001	0.2411E+04	0.3846E+03	0.9632E+03	-0.2161E+04	-0.5516E+01
2002	0.2744E+04	0.4376E+03	0.9507E+03	-0.2455E+04	-0.5523E+01
2003	0.2941E+04	0.4688E+03	0.9503E+03	-0.2631E+04	-0.5522E+01
2004	0.2626E+04	0.4187E+03	0.9610E+03	-0.2353E+04	-0.5515E+01
2005	0.2678E+04	0.4270E+03	0.9493E+03	-0.2396E+04	-0.5524E+01
2006	0.2436E+04	0.3884E+03	0.9464E+03	-0.2179E+04	-0.5526E+01
2007	0.2704E+04	0.4313E+03	0.9520E+03	-0.2420E+04	-0.5523E+01

Year	10. % Percentile	90. % Percentile
1994	0.756746E+02	0.299382E+03
1995	0.786658E+02	0.341368E+03
1996	0.104005E+03	0.471794E+03
1997	0.124803E+03	0.591254E+03
1998	0.102341E+03	0.519049E+03
1999	0.893473E+02	0.478719E+03
2000	0.996682E+02	0.503807E+03
2001	0.145450E+03	0.707360E+03
2002	0.168451E+03	0.803827E+03
2003	0.180331E+03	0.875302E+03
2004	0.158487E+03	0.771708E+03
2005	0.165355E+03	0.780327E+03
2006	0.150513E+03	0.702153E+03
2007	0.167323E+03	0.775207E+03

Bootstrap Output Variable: Fishing Mortality

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.702945E-01	0.700314E-01	0.332091E-01	0.474203E+00
1995	0.660661E-01	0.666297E-01	0.323448E-01	0.485442E+00
1996	0.614886E-01	0.623076E-01	0.307737E-01	0.493900E+00
1997	0.731869E-01	0.751986E-01	0.388353E-01	0.516437E+00
1998	0.880966E-01	0.923102E-01	0.503719E-01	0.545680E+00
1999	0.598853E-01	0.627199E-01	0.341842E-01	0.545029E+00
2000	0.295670E-01	0.304002E-01	0.157642E-01	0.518555E+00
2001	0.294504E-01	0.301063E-01	0.153087E-01	0.508489E+00
2002	0.231044E-01	0.235779E-01	0.119131E-01	0.505265E+00
2003	0.305794E-01	0.313770E-01	0.160638E-01	0.511960E+00
2004	0.210982E-01	0.216625E-01	0.110528E-01	0.510225E+00
2005	0.223699E-01	0.229489E-01	0.116836E-01	0.509114E+00
2006	0.192993E-01	0.197150E-01	0.993959E-02	0.504165E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.2631E-03	0.1050E-02	-0.3743E+00	0.7056E-01	0.4707E+00
1995	0.5636E-03	0.1023E-02	0.8531E+00	0.6550E-01	0.4938E+00
1996	0.8190E-03	0.9735E-03	0.1332E+01	0.6067E-01	0.5072E+00
1997	0.2012E-02	0.1230E-02	0.2749E+01	0.7118E-01	0.5456E+00
1998	0.4214E-02	0.1598E-02	0.4783E+01	0.8388E-01	0.6005E+00
1999	0.2835E-02	0.1085E-02	0.4733E+01	0.5705E-01	0.5992E+00
2000	0.8332E-03	0.4992E-03	0.2818E+01	0.2873E-01	0.5486E+00
2001	0.6559E-03	0.4845E-03	0.2227E+01	0.2879E-01	0.5317E+00
2002	0.4735E-03	0.3770E-03	0.2049E+01	0.2263E-01	0.5264E+00
2003	0.7976E-03	0.5086E-03	0.2608E+01	0.2978E-01	0.5394E+00
2004	0.5643E-03	0.3500E-03	0.2675E+01	0.2053E-01	0.5383E+00
2005	0.5790E-03	0.3699E-03	0.2588E+01	0.2179E-01	0.5362E+00
2006	0.4157E-03	0.3146E-03	0.2154E+01	0.1888E-01	0.5264E+00

Year	10. % Percentile	90. % Percentile
1994	0.266863E-01	0.112823E+00
1995	0.242343E-01	0.108902E+00
1996	0.221438E-01	0.101224E+00
1997	0.255956E-01	0.126644E+00
1998	0.301051E-01	0.159413E+00
1999	0.206585E-01	0.108143E+00
2000	0.104773E-01	0.508529E-01
2001	0.105414E-01	0.501968E-01
2002	0.820937E-02	0.392764E-01
2003	0.107881E-01	0.526817E-01
2004	0.761014E-02	0.358973E-01
2005	0.815133E-02	0.382930E-01
2006	0.710667E-02	0.325135E-01

Bootstrap Output Variable: Total Mortality

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.370295E+00	0.370031E+00	0.332091E-01	0.897468E-01
1995	0.366066E+00	0.366630E+00	0.323448E-01	0.882221E-01
1996	0.361489E+00	0.362308E+00	0.307737E-01	0.849381E-01
1997	0.373187E+00	0.375199E+00	0.388353E-01	0.103506E+00
1998	0.388097E+00	0.392310E+00	0.503719E-01	0.128398E+00
1999	0.359885E+00	0.362720E+00	0.341842E-01	0.942440E-01
2000	0.329567E+00	0.330400E+00	0.157642E-01	0.477124E-01
2001	0.329450E+00	0.330106E+00	0.153087E-01	0.463751E-01
2002	0.323104E+00	0.323578E+00	0.119131E-01	0.368167E-01
2003	0.330579E+00	0.331377E+00	0.160638E-01	0.484758E-01
2004	0.321098E+00	0.321663E+00	0.110528E-01	0.343613E-01
2005	0.322370E+00	0.322949E+00	0.116836E-01	0.361779E-01
2006	0.319299E+00	0.319715E+00	0.993959E-02	0.310889E-01

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.2631E-03	0.1050E-02	-0.7106E-01	0.3706E+00	0.8962E-01
1995	0.5636E-03	0.1023E-02	0.1540E+00	0.3655E+00	0.8849E-01
1996	0.8190E-03	0.9735E-03	0.2266E+00	0.3607E+00	0.8532E-01
1997	0.2012E-02	0.1230E-02	0.5391E+00	0.3712E+00	0.1046E+00
1998	0.4214E-02	0.1598E-02	0.1086E+01	0.3839E+00	0.1312E+00
1999	0.2835E-02	0.1085E-02	0.7876E+00	0.3571E+00	0.9574E-01
2000	0.8332E-03	0.4992E-03	0.2528E+00	0.3287E+00	0.4795E-01
2001	0.6559E-03	0.4845E-03	0.1991E+00	0.3288E+00	0.4656E-01
2002	0.4735E-03	0.3770E-03	0.1466E+00	0.3226E+00	0.3692E-01
2003	0.7976E-03	0.5086E-03	0.2413E+00	0.3298E+00	0.4871E-01
2004	0.5643E-03	0.3500E-03	0.1758E+00	0.3205E+00	0.3448E-01
2005	0.5790E-03	0.3699E-03	0.1796E+00	0.3218E+00	0.3631E-01
2006	0.4157E-03	0.3146E-03	0.1302E+00	0.3189E+00	0.3117E-01

Year	10. % Percentile	90. % Percentile
1994	0.326686E+00	0.412823E+00
1995	0.324234E+00	0.408902E+00
1996	0.322144E+00	0.401224E+00
1997	0.325596E+00	0.426644E+00
1998	0.330105E+00	0.459413E+00
1999	0.320658E+00	0.408143E+00
2000	0.310477E+00	0.350853E+00
2001	0.310541E+00	0.350197E+00
2002	0.308209E+00	0.339276E+00
2003	0.310788E+00	0.352682E+00
2004	0.307610E+00	0.335897E+00
2005	0.308151E+00	0.338293E+00
2006	0.307107E+00	0.332514E+00

Bootstrap Output Variable: F Derived From Harvest Rate

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.702944E-01	0.700313E-01	0.332091E-01	0.474204E+00
1995	0.660660E-01	0.666296E-01	0.323448E-01	0.485443E+00
1996	0.614885E-01	0.623075E-01	0.307737E-01	0.493901E+00
1997	0.731868E-01	0.751985E-01	0.388353E-01	0.516437E+00
1998	0.880965E-01	0.923101E-01	0.503719E-01	0.545681E+00
1999	0.598852E-01	0.627199E-01	0.341842E-01	0.545029E+00
2000	0.295670E-01	0.304002E-01	0.157642E-01	0.518556E+00
2001	0.294503E-01	0.301063E-01	0.153087E-01	0.508489E+00
2002	0.231043E-01	0.235779E-01	0.119131E-01	0.505266E+00
2003	0.305793E-01	0.313769E-01	0.160638E-01	0.511961E+00
2004	0.210982E-01	0.216625E-01	0.110527E-01	0.510225E+00
2005	0.223698E-01	0.229489E-01	0.116836E-01	0.509115E+00
2006	0.192993E-01	0.197149E-01	0.993958E-02	0.504165E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.2631E-03	0.1050E-02	-0.3743E+00	0.7056E-01	0.4707E+00
1995	0.5636E-03	0.1023E-02	0.8531E+00	0.6550E-01	0.4938E+00
1996	0.8190E-03	0.9735E-03	0.1332E+01	0.6067E-01	0.5072E+00
1997	0.2012E-02	0.1230E-02	0.2749E+01	0.7118E-01	0.5456E+00
1998	0.4214E-02	0.1598E-02	0.4783E+01	0.8388E-01	0.6005E+00
1999	0.2835E-02	0.1085E-02	0.4733E+01	0.5705E-01	0.5992E+00
2000	0.8332E-03	0.4992E-03	0.2818E+01	0.2873E-01	0.5486E+00
2001	0.6559E-03	0.4845E-03	0.2227E+01	0.2879E-01	0.5317E+00
2002	0.4735E-03	0.3770E-03	0.2049E+01	0.2263E-01	0.5264E+00
2003	0.7976E-03	0.5086E-03	0.2608E+01	0.2978E-01	0.5394E+00
2004	0.5643E-03	0.3500E-03	0.2675E+01	0.2053E-01	0.5383E+00
2005	0.5790E-03	0.3699E-03	0.2588E+01	0.2179E-01	0.5362E+00
2006	0.4157E-03	0.3146E-03	0.2154E+01	0.1888E-01	0.5264E+00

Year	10. % Percentile	90. % Percentile
1994	0.266862E-01	0.112822E+00
1995	0.242342E-01	0.108902E+00
1996	0.221437E-01	0.101224E+00
1997	0.255955E-01	0.126644E+00
1998	0.301050E-01	0.159413E+00
1999	0.206584E-01	0.108143E+00
2000	0.104773E-01	0.508529E-01
2001	0.105414E-01	0.501967E-01
2002	0.820934E-02	0.392763E-01
2003	0.107880E-01	0.526816E-01
2004	0.761011E-02	0.358972E-01
2005	0.815131E-02	0.382929E-01
2006	0.710664E-02	0.325135E-01

Bootstrap Output Variable: Harvest Estimate

Year	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For Bootstrap
1994	0.587477E-01	0.581131E-01	0.268200E-01	0.461514E+00
1995	0.553236E-01	0.553793E-01	0.261924E-01	0.472964E+00
1996	0.516012E-01	0.519036E-01	0.250053E-01	0.481765E+00
1997	0.610820E-01	0.621293E-01	0.310814E-01	0.500270E+00
1998	0.730141E-01	0.754125E-01	0.394423E-01	0.523021E+00
1999	0.502936E-01	0.521559E-01	0.276093E-01	0.529361E+00
2000	0.251887E-01	0.257896E-01	0.131975E-01	0.511737E+00
2001	0.250907E-01	0.255485E-01	0.128265E-01	0.502044E+00
2002	0.197433E-01	0.200864E-01	0.100493E-01	0.500305E+00
2003	0.260387E-01	0.266053E-01	0.134402E-01	0.505169E+00
2004	0.180461E-01	0.184744E-01	0.934066E-02	0.505601E+00
2005	0.191223E-01	0.195569E-01	0.986118E-02	0.504230E+00
2006	0.165215E-01	0.168336E-01	0.841964E-02	0.500169E+00

Year	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
1994	-0.6346E-03	0.8484E-03	-0.1080E+01	0.5938E-01	0.4516E+00
1995	0.5570E-04	0.8283E-03	0.1007E+00	0.5527E-01	0.4739E+00
1996	0.3024E-03	0.7908E-03	0.5860E+00	0.5130E-01	0.4874E+00
1997	0.1047E-02	0.9834E-03	0.1715E+01	0.6003E-01	0.5177E+00
1998	0.2398E-02	0.1250E-02	0.3285E+01	0.7062E-01	0.5585E+00
1999	0.1862E-02	0.8751E-03	0.3703E+01	0.4843E-01	0.5701E+00
2000	0.6009E-03	0.4178E-03	0.2386E+01	0.2459E-01	0.5367E+00
2001	0.4577E-03	0.4059E-03	0.1824E+01	0.2463E-01	0.5207E+00
2002	0.3431E-03	0.3180E-03	0.1738E+01	0.1940E-01	0.5180E+00
2003	0.5666E-03	0.4254E-03	0.2176E+01	0.2547E-01	0.5276E+00
2004	0.4283E-03	0.2957E-03	0.2373E+01	0.1762E-01	0.5302E+00
2005	0.4346E-03	0.3121E-03	0.2273E+01	0.1869E-01	0.5277E+00
2006	0.3121E-03	0.2664E-03	0.1889E+01	0.1621E-01	0.5194E+00

Year	10. % Percentile	90. % Percentile
1994	0.227655E-01	0.924340E-01
1995	0.206977E-01	0.893851E-01
1996	0.189310E-01	0.833809E-01
1997	0.218463E-01	0.103093E+00
1998	0.256405E-01	0.127813E+00
1999	0.176736E-01	0.887938E-01
2000	0.900683E-02	0.428898E-01
2001	0.906165E-02	0.423495E-01
2002	0.706479E-02	0.333073E-01
2003	0.927261E-02	0.443940E-01
2004	0.655097E-02	0.304903E-01
2005	0.701504E-02	0.324884E-01
2006	0.611903E-02	0.276604E-01

Bootstrap Output Variable: Catchability (Q)

NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
0.2270E-01	0.2309E-01	0.1096E-01	0.4747E+00

Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
0.3971E-03	0.3469E-03	0.1749E+01	0.2230E-01	0.4916E+00

10. % Percentile	90. % Percentile
0.869567E-02	0.373221E-01

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