Northeast Fisheries Science Center Reference Document 05-04

40th Northeast Regional Stock Assessment Workshop (40th SAW)

40th SAW Assessment Report

April 2005

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05-03 **Description of the 2004 Oceanographic Conditions on the Northeast Continental Shelf.** By M.H. Taylor, C. Bascuñán, and J.P. Manning. April 2005.

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A Report of the 40th Northeast Regional Stock Assessment Workshop (40th SAW)

40th SAW Assessment Report

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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The stock assessments presented in this document were peer reviewed by a panel of assessment experts known as the Stock Assessment Review Committee (SARC). Panelists were provided by the Center for Independent Experts (CIE), University of Miami. Reports from the SARC panelists and a summary report from the SARC Chairman can be found at *http://www.nefsc.noaa.gov/nefsc/saw*.

SAW ASSESSMENT REPORT

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40TH SAW ASSESSMENT REPORT

INTRODUCTION

The 40th SAW Assessment Report contains summary and detailed technical information on the assessments reviewed by the 40th Stock Assessment Review Committee. Although the agenda for the meeting included review of assessments of goosefish (monkfish) and weakfish, the weakfish assessment review represented an interim evaluation of the current information base and assessment modeling approaches and not a completed assessment. Thus, this report includes only information related to an assessment of monkfish.

An important aspect of any assessment is the determination of current stock status. The status of the stock relates to both the rate of removal of fish from the population
The 40th SAW Assessment Report contains summary and detailed technical information on the assessments reviewed by the 40th Stock Assessment Review Committee. Although the agenda for the meeting included review of assessments of goosefish (monkfish) and weakfish, the weakfish assessment review represented an interim evaluation of the current information base and assessment modeling approaches and not a completed assessment. Thus, this report includes only information related to an assessment of monkfish.

An important aspect of any assessment is the determination of current stock status. The status of the stock relates to both the rate of removal of fish from the population – the exploitation rate – and the current stock size. The exploitation rate is simply the proportion of the stock alive at the beginning of the year that is caught during the year. When that proportion exceeds the amount specified in an overfishing definition, overfishing is occurring. Fishery removal rates are usually expressed in terms of the instantaneous fishing mortality rate, F, and the maximum removal rate is denoted as $F_{THRESHOLD}$.

Another important factor for classifying the status of a resource is the current stock level, for example, spawning stock biomass (SSB) or total stock biomass (TSB). Overfishing definitions, therefore, characteristically include specification of a minimum biomass threshold as well as a maximum fishing threshold. If a stock's biomass falls below the biomass threshold ($B_{THRESHOLD}$) the stock is in an overfished condition. The Sustainable Fisheries Act mandates plans for rebuilding the stock should this situation arise.

Since there are two dimensions to the status of the stock– the rate of removal and the biomass level – it is possible that a stock not currently subject to overfishing in terms of exploitation rates is in an overfished condition, that is, has a biomass level less than the threshold level. This may be due to heavy exploitation in the past, or a result of other factors such as unfavorable environmental conditions. In this case, future recruitment to the stock is very important and the probability of improvement is increased greatly by increasing the stock size. Conversely, fishing down a stock that is at a high biomass level should generally increase the long-term sustainable yield. This philosophy is embodied in the Sustainable Fisheries Act — stocks should be managed on the basis of maximum sustainable yield

(MSY). The biomass that produces this yield is called BMSY and the fishing mortality rate that produces MSY is called FMSY. Given this, stocks under review are classified with respect to current overfishing definitions. A stock is overfished if its current biomass is below $B_{THRESHOLD}$ and overfishing is occurring if current F is greater than $F_{THRESHOLD}$. The schematic below depicts how status criteria are interpreted in this context. Overfishing guidelines are based on the precautionary approach to fisheries management and encourage the inclusion of a control rule in the overfishing definition. Control rules, when they exist, are discussed in the chapter for the stock under consideration. Generically, the control rules suggest actions at various levels of stock biomass and incorporate an assessment of risk, in that F targets are set so as to avoid exceeding F thresholds.

EXPLOITATION RATE	**BIOMASS**	$B<B_{THRESHOLD}$	$B_{THRESHOLD}<B<B_{MSY}$	$\mathbf{B>B_{MSY}}$
	$F>F_{THRESHOLD}$	Overfished, overfishing is occurring; reduce F, adopt and follow rebuilding plan	Not overfished, overfishing is occurring; reduce F, rebuild stock	F = Ftarget <= F_{MSY}
	$F<F_{THRESHOLD}$	Overfished, overfishing is not occurring; adopt and follow rebuilding plan	Not overfished, overfishing is not occurring; rebuild stock	F = Ftarget <= F_{MSY}

GLOSSARY

ADAPT. A commonly used form of computer program used to optimally fit a Virtual Population Assessment (VPA) to abundance data.

ASPM. Age-structured production models, also known as statistical catch-at-age (SCAA) models, are a technique of stock assessment that integrate fishery catch and fishery-independent sampling information. The procedures are flexible, allowing for uncertainty in the absolute magnitudes of catches as part of the estimation. Unlike virtual population analysis (VPA) that tracks the cumulative catches of various year classes as they age, ASPM is a forward projection simulation of the exploited population.

Availability. Refers to the distribution of fish of different ages or sizes relative to that taken in the fishery.

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Availability. Refers to the distribution of fish of different ages or sizes relative to that taken in the fishery.

Biological reference points. Specific values for the variables that describe the state of a fishery system which are used to evaluate its status. Reference points are most often specified in terms of fishing mortality rate and/or spawning stock biomass. The reference points may indicate 1) a desired state of the fishery, such as a fishing mortality rate that will achieve a high level of sustainable yield, or 2) a state of the fishery that should be avoided, such as a high fishing mortality rate which risks a stock collapse and long-term loss of potential yield. The former type of reference points are referred to as “target reference points” and the latter are referred to as “limit reference points” or “thresholds”. Some common examples of reference points are $F_{0.1}$, Fmax, and Fmsy, which are defined later in this glossary.

B_0. Virgin stock biomass, i.e., the long-term average biomass value expected in the absence of fishing mortality.

B_{MSY}. Long-term average biomass that would be achieved if fishing at a constant fishing mortality rate equal to FMSY.

Biomass Dynamics Model. A simple stock assessment model that tracks changes in stock using assumptions about growth and can be tuned to abundance data such as commercial catch rates, research survey trends or biomass estimates.

Catchability. Proportion of the stock removed by one unit of effective fishing effort (typically age-specific due to differences in selectivity and availability by age).

Control Rule. Describes a plan for pre-agreed management actions as a function of variables related to the status of the stock. For example, a control rule can specify how F or yield should vary with biomass. In the National Standard Guidelines (NSG), the “MSY control rule” is used to determine the limit fishing mortality, or Maximum Fishing Mortality Threshold (MFMT). Control rules are also known as “decision rules” or “harvest control laws."

Catch per Unit of Effort (CPUE). Measures the relative success of fishing operations, but also can be used as a proxy for relative abundance based on the assumption that CPUE is linearly related to stock size. The use of CPUE that has not been properly standardized for temporal-spatial changes in catchability should be avoided.

Exploitation pattern. The fishing mortality on each age (or group of adjacent ages) of a stock relative to the highest mortality on any age. The exploitation pattern is expressed as a series of values ranging from 0.0 to 1.0. The pattern is referred to as "flat-topped" when the values for all the oldest ages are about 1.0, and "dome-shaped" when the values for some intermediate ages are about 1.0 and those for the oldest ages are significantly lower. This pattern often varies by type of fishing gear, area, and seasonal distribution of fishing, and the growth and migration of the fish. The pattern can be changed by modifications to fishing gear, for example, increasing mesh or hook size, or by changing the proportion of harvest by gear type.

Mortality rates. Populations of animals decline exponentially. This means that the number of animals that die in an "instant" is at all times proportional to the number present. The decline is defined by survival curves such as:

$$N_{t+1} = N_t^{e-z}$$

where N_t is the number of animals in the population at time t and N_{t+1} is the number present in the next time period; Z is the total instantaneous mortality rate which can be separated into deaths due to fishing (fishing mortality or F) and deaths due to all other causes (natural mortality or M) and e is the base of the natural logarithm (2.71828).

To better understand the concept of an instantaneous mortality rate, consider the following example. Suppose the instantaneous total mortality rate is 2 (i.e., Z = 2) and we want to know how many animals out of an initial population of 1 million fish will be alive at the end of one year. If the year is apportioned into 365 days (that is, the 'instant' of time is one day), then 2/365 or 0.548% of the population will die each day. On the first day of the year, 5,480 fish will die (1,000,000 x 0.00548), leaving 994,520 alive. On day 2, another 5,450 fish die (994,520 x 0.00548) leaving 989,070 alive. At the end of the year, 134,593 fish [1,000,000 x (1 - 0.00548)365] remain alive. If, we had instead selected a smaller 'instant' of time, say an hour, 0.0228% of the population would have died by the end of the first time interval (an hour), leaving 135,304 fish alive at the end of the year [1,000,000 x (1 - 0.00228)8760]. As the instant of time becomes shorter and shorter, the exact answer to the number of animals surviving is given by the survival curve mentioned above, or, in this example:

$$N_{t+1} = 1{,}000{,}000e\text{-}2 = 135{,}335 \text{ fish}$$

Exploitation rate. The proportion of a population alive at the beginning of the year that is caught during the year. That is, if 1 million fish were alive on January 1 and 200,000 were caught during the year, the exploitation rate is 0.20 (200,000 / 1,000,000) or 20%.

F_{MAX}. The rate of fishing mortality that produces the maximum level of yield per recruit. This is the point beyond which growth overfishing begins.

$F_{0.1}$. The fishing mortality rate where the increase in yield per recruit for an increase in a unit of effort is only 10% of the yield per recruit produced by the first unit of effort on the unexploited stock (i.e., the slope of the yield-per-recruit curve for the F0.1 rate is only one-tenth the slope of the curve at its origin).

$F_{10\%}$. The fishing mortality rate which reduces the spawning stock biomass per recruit (SSB/R) to 10% of the amount present in the absence of fishing. More generally, Fx%, is the fishing mortality rate that reduces the SSB/R to x% of the level that would exist in the absence of fishing.

F_{MSY}. The fishing mortality rate that produces the maximum sustainable yield.

Fishery Management Plan (FMP). Plan containing conservation and management measures for fishery resources, and other provisions required by the MSFCMA, developed by Fishery Management Councils or the Secretary of Commerce.

Generation Time. In the context of the National Standard Guidelines, generation time is a measure of the time required for a female to produce a reproductively-active female offspring for use in setting maximum allowable rebuilding time periods.

Growth overfishing. The situation existing when the rate of fishing mortality is above FMAX and when fish are harvested before they reach their growth potential.

Limit Reference Points. Benchmarks used to indicate when harvests should be constrained substantially so that the stock remains within safe biological limits. The probability of exceeding limits should be low. In the National Standard Guidelines, limits are referred to as thresholds. In much of the international literature (e.g., FAO documents), "thresholds" are used as buffer points that signal when a limit is being approached.

Landings per Unit of Effort (LPUE). Analogous to CPUE and measures the relative success of fishing operations, but is also sometimes used a proxy for relative abundance based on the assumption that CPUE is linearly related to stock size.

MSFCMA. (Magnuson-Stevens Fishery Conservation and Management Act). U.S. Public Law 94-265, as amended through October 11, 1996. Available as NOAA Technical Memorandum NMFS-F/SPO-23, 1996.

Maximum Fishing Mortality Threshold (MFMT, Fthreshold). One of the Status Determination Criteria (SDC) for determining if overfishing is occurring. It will usually be equivalent to the F corresponding to the MSY Control Rule. If current fishing mortality rates are above Fthreshold, overfishing is occurring.
Minimum Stock Size Threshold (MSST, Bthreshold). Another of the Status Determination Criteria. The greater of (a) ½BMSY, or (b) the minimum stock size at which rebuilding to BMSY will occur within 10 years of fishing at the MFMT. MSST should be measured in terms of spawning biomass or other appropriate measures of productive capacity. If current stock size is below Bthreshold, the stock is overfished.

Maximum Spawning Potential (MSP). This type of reference point is used in some fishery management plans to define overfishing. The MSP is the spawning stock biomass per recruit (SSB/ R) when fishing mortality is zero. The degree to which fishing reduces the SSB/R is expressed as a percentage of the MSP (i.e., %MSP). A stock is considered overfished when the fishery reduces the %MSP below the level specified in the overfishing definition. The values of %MSP used to define overfishing can be derived from stock-recruitment data or chosen by analogy using available information on the level required to sustain the stock.

Maximum Sustainable Yield (MSY). The largest average catch that can be taken from a stock under existing environmental conditions.

Overfishing. According to the National Standard Guidelines, "overfishing occurs whenever a stock or stock complex is subjected to a rate or level of fishing mortality that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis." Overfishing is occurring if the MFMT is exceeded for 1 year or more.

Optimum Yield (OY). The amount of fish that will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities and taking into account the protection of marine ecosystems. MSY constitutes a "ceiling" for OY. OY may be lower than MSY, depending on relevant economic, social, or ecological factors. In the case of an overfished fishery, OY should provide for rebuilding to BMSY.

Partial Recruitment. Patterns of relative vulnerability of fish of different sizes or ages due to the combined effects of selectivity and availability.

Rebuilding Plan. A plan that must be designed to recover stocks to the BMSY level within 10 years when they are overfished (i.e. when B < MSST). Normally, the 10 years would refer to an expected time to rebuilding in a probabilistic sense.

Recruitment. This is the number of young fish that survive (from birth) to a specific age or grow to a specific size. The specific age or size at which recruitment is measured may correspond to when the young fish become vulnerable to capture in a fishery or when the number of fish in a cohort can be reliably estimated by a stock assessment.

Recruitment overfishing. The situation existing when the fishing mortality rate is so high as to cause a reduction in spawning stock which causes recruitment to become impaired.

Recruitment per spawning stock biomass (R/SSB). The number of fishery recruits (usually age 1 or 2) produced from a given weight of spawners, usually expressed as numbers of recruits per kilogram of mature fish in the stock. This ratio can be computed for each year class and is often used as an index of pre-recruit survival, since a high R/SSB ratio in one year indicates above-average numbers resulting from a given spawning biomass for a particular year class, and vice versa.

Reference Points. Values of parameters (e.g. BMSY, FMSY, F0.1) that are useful benchmarks for guiding management decisions. Biological reference points are typically limits that should not be exceeded with significant probability (e.g., MSST) or targets for management (e.g., OY).

Risk. The probability of an event times the cost associated with the event (loss function). Sometimes "risk" is simply used to denote the probability of an undesirable result (e.g. the risk of biomass falling below MSST).

Status Determination Criteria (SDC). Objective and measurable criteria used to determine if a stock is being overfished or is in an overfished state according to the National Standard Guidelines.

Selectivity. Measures the relative vulnerability of different age (size) classes to the fishing gears(s).

Spawning Stock Biomass (SSB). The total weight of all sexually mature fish in a stock.

Spawning stock biomass per recruit (SSB/R or SBR). The expected lifetime contribution to the spawning stock biomass for each recruit. SSB/R is calculated assuming that F is constant over the life span of a year class. The calculated value is also dependent on the exploitation pattern and rates of growth and natural mortality, all of which are also assumed to be constant.

Survival Ratios. Ratios of recruits to spawners (or spawning biomass) in a stock-recruitment analysis. The same as the recruitment per spawning stock biomass (R/SSB), see above.

TAC. Total allowable catch is the total regulated catch from a stock in a given time period, usually a year.

Target Reference Points. Benchmarks used to guide management objectives for achieving a desirable outcome (e.g., OY). Target reference points should not be exceeded on average.

Uncertainty. Uncertainty results from a lack of perfect knowledge of many factors that affect stock assessments, estimation of reference points, and management. Rosenberg and Restrepo (1994) identify 5 types:

measurement error (in observed quantities), process error (or natural population variability), model error (mis-specification of assumed values or model structure), estimation error (in population parameters or reference points, due to any of the preceding types of errors), and implementation error (or the inability to achieve targets exactly for whatever reason).

Virtual population analysis (VPA) (or cohort analysis). A retrospective analysis of the catches from a given year class which provides estimates of fishing mortality and stock size at each age over its life in the fishery. This technique is used extensively in fishery assessments.

Year class (or cohort). Fish born in a given year. For example, the 1987 year class of cod includes all cod born in 1987. This year class would be age 1 in 1988, age 2 in 1989, and so on.

Yield per recruit (Y/R or YPR). The average expected yield in weight from a single recruit. Y/R is calculated assuming that F is constant over the life span of a year class. The calculated value is also dependent on the exploitation pattern, rate of growth, and natural mortality rate, all of which are assumed to be constant

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A. Goosefish (Monkfish) Assessment Summary

State of Stock: Based on existing reference points, the resource is not overfished in either stock management area (north or south). Fishing mortality rates (F) estimated from NEFSC research and Cooperative survey data are currently not sufficiently reliable for evaluation of F with respect to the reference points.

Reported total landings (converted to live weight) steadily increased from an annual average of 2,500 metric tons (mt) in the 1970s to 8,700 mt in the 1980s, to an average of 23,000 mt in the 1990s and early 2000s (Figure 1). Biomass in the northern area has been above $B_{threshold}$ (1.25 kg/tow) since 1999 and in 2003 (mean of 2001-2003 = 2.03 kg/tow) was at about 81% of B_{target} (2.50 kg/tow; Figure 2). Given the variance in the survey biomass index, there is a 98% chance that the biomass index is above the northern area $B_{threshold}$ reference point (Figure 3). Biomass in the southern area increased to $B_{threshold}$ (0.93 kg/tow) in 2003 (mean of 2001-2003 = 0.93 kg/tow; Figure 4). Given the variance in the survey biomass index, there is a 56% chance that the biomass index is above the southern area $B_{threshold}$ reference point (Figure 5).

Size distributions in research surveys became truncated during the 1970s and 1980s, and were stable during the 1990s. Indices of egg production have declined by around 80% since the 1970s and the proportion of spawners below the age of full maturity has increased. Egg production indices in both areas show a recent increasing trend (Figures 6 and 7). Survey indices indicate recent improved recruitment in both the northern (1999 year class) and southern areas (2002 year class)(Figure 8).

Forecast for 2005: No forecast was made.

Catch and Status Table (weights in '000 mt): Monkfish

Year	1997	1998	1999	2000	2001	2002	2003	Max[1]	Min[1]	Mean[1]
USA Commercial landings										
Northern area	9.8	7.4	9.3	10.7	13.5	14.0	15.1	15.1	0.2	6.0
Southern area	18.5	19.3	16.0	10.2	9.8	8.9	11.0	19.3	0.1	7.0
Total	28.3	26.7	25.2	20.9	23.3	22.9	26.1	28.3	0.3	13.1
USA Commercial discards										
Northern area	1.3	0.7	0.7	0.9	4.3	2.8	2.8	4.3	0.7	1.9
Southern area	2.2	1.3	1.9	2.8	9.7	2.2	3.4	9.7	1.3	3.2
Total	3.4	2.0	2.6	3.6	13.9	5.0	6.2	13.9	2.0	5.1
Foreign landings[2]	0.2	0.2	0.2	0.2	0.2	0.3	0.3	6.8	0.0	0.9
Total Catch	31.8	28.7	27.8	24.5	37.2	27.9	32.3	37.2	24.5	30.1
Northern area										
Biomass index	0.67	0.97	0.83	2.50	2.05	2.10	1.93	5.57	0.67	2.10
Egg production index[3]	0.41	0.40	0.38	0.44	0.48	0.58	0.66	2.19	0.38	1.01
Southern area										
Biomass index	0.59	0.50	0.30	0.48	0.7	1.25	0.83	4.92	0.27	1.11
Egg production index[3]	0.14	0.17	0.15	0.17	0.19	0.23	0.25	0.11	0.11	0.45

[1] 1970-2003. Commercial fishery discard estimates not available before 1996; means calculated from 1996-2003.
[2] Foreign landings are for NAFO Areas 5 and 6.
[3] Egg production index is a function of mean number per tow at length, proportion mature at length and fecundity at length.

Stock Distribution and Identification: The monkfish resource in US waters is distributed from the Gulf of Maine through Cape Hatteras, NC. Data to definitively distinguish separate stock units of monkfish are unavailable. Differing recruitment patterns suggest the existence of two stock units. However, similar growth and maturity patterns along with genetic testing argue for a single stock unit. Assessment units, as described in previous SAW reports (north and south, separated along the middle axis of Georges Bank), are continued in this assessment.

Catches: Total reported landings (live weight) increased from several hundred mt in the early 1970s to a peak of 28,500 mt in 1997, and have since ranged from 21,100 mt in 2000 to 26,400 mt in 2003 (Figure 1). Landings declined substantially in the south from a peak of 19,300 mt in 1998 to 11,000 mt in 2003. Landings doubled in the north from 7,400 mt in 1998 to 15,100 mt in 2003, the peak of the northern area time series (Figure 1), likely due to changes in management. Landings in the early part of the time series are thought to be under-reported. The accuracy of landings data has likely improved with mandatory reporting beginning in 1994. During 1998-2000, trawls caught 54% of USA landings, scallop dredges 17%, and gill nets 29%. During 2001-2003, trawls caught 55% of USA landings, scallop dredges 8%, and gill nets 37% (Figure 9). While trawl gear still accounts for about 80% of the landings in the northern area (Figure 10), gillnets now account for the majority of the landings (66%) in the southern area (Figure 11). Discarding has increased since the implementation of the FMP in November 1999, likely due to the impact of quota and trip limits, and the recruitment of above average year classes in recent years (2002 year class in the southern area; 1999 year class in the northern area). Estimates of discard rates during 1996-2000 ranged from 7%-15% of the catch in the northern area and 6%-22% of the catch in the southern area. Estimates of discard rates during 2001-2003 ranged from 16%-24% of the catch in the northern area and 20%-50% of the catch in the southern area.

Data and Assessment: Monkfish were last assessed at SAW 34 in November 2001. Data used in the current assessment include NEFSC research survey data, data from Cooperative surveys conducted in 2001 and 2004, commercial fishery data from vessel trip reports, dealer landings records and on-board fishery observers. Fishing mortality rates were calculated from catch-per-tow-at-age indices from NEFSC research surveys and catch-to-biomass exploitation rates from Cooperative surveys. Surplus production modeling integrated fishery catch estimates, research survey indices and Cooperative survey biomass estimates to estimate stock biomass, exploitation rates, and reference points.

Biological Reference Points: The biological reference points for monkfish that were established in the original Fishery Management Plan (FMP) were calculated during SAW 23. These reference points for the Northern Fishery Management Area (northern area; NFMA) were: $F_{threshold}$ (average F during 1970-1979) = 0.05; $B_{threshold}$ (33^{rd} percentile of the 1963-1994 NEFSC autumn trawl survey catch (kg) per tow) = 1.46 kg/tow; B_{target} (the median of the 3-year moving average of the 1965-1981 NEFSC autumn trawl survey catch (kg) per tow) = 2.50 kg/tow. F_{target} is undefined. For the Southern Fishery Management Area (southern area; SFMA) the reference points were: $F_{threshold}$ = 0.21, $B_{threshold}$ (33^{rd} percentile of the 1967-1994 NEFSC autumn trawl survey) = 0.70 kg/tow, F_{target} ($F_{0.1}$) = 0.10, B_{target} =1.85 kg/tow.

Based on the conclusions of SAW 31 that the above F proxies were unreliable, SAW 34 recommended changing the fishing mortality rate reference points. In the SAW 34 assessment, a yield per recruit analysis indicated that for M=0.2, F_{max} = 0.2. The SAW 34 yield per recruit analysis was adopted in FMP Framework 2 to revise the fishing mortality reference points (F_{max} = $F_{threshold}$ = 0.2). Framework 2 also revised the biomass threshold reference points ($B_{threshold}$) to be consistent with National Standard 1 Guidelines ($B_{threshold}$ = ½*B_{target}), and to reflect a different year range of survey indices, as recommended by SAW 34. For the northern area, $B_{threshold}$ is one-half of the mean of 1965-1981 NEFSC autumn trawl survey catch (kg) per tow) = 1.25 kg/tow; for the southern area, $B_{threshold}$ is one-half of the mean of 1965-1981 NEFSC autumn trawl survey catch (kg) per tow) = 0.93 kg/tow. The revised overfishing definition does not include an F_{target} reference point. 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.

Fishing Mortality: The SAW 31 and SAW 34 reviews of the assessment concluded that instantaneous fishing mortality rates (F) estimated from NEFSC research survey length frequency distributions were not sufficiently reliable to allow evaluation of current F with respect to reference points. The 2004 Working Group judged that estimates of F from NEFSC survey age frequency distributions (1995-2003) likewise do not provide a clear indication of the magnitude or trend of F rates. Therefore, reliable evaluation of the current level of F with respect to reference points is still not possible using NEFSC research survey data, due mainly to small sample sizes and variable catch rates.

Under the assumptions adopted for this assessment (2001 intermediate net efficiencies and 2001/2004 nominal tow distances), estimates of exploitation rates using the 2001 and 2004 Cooperative survey swept area biomass estimates and estimates of corresponding fishery landings indicate that the exploitation rate increased in the northern area from 20% to 29% from 2000 to 2003, while the exploitation rate in the southern area declined from 23% to 14%. Given the standard conversion from exploitation rate to instantaneous fishing mortality rate, the current (2003) percentage biomass exploitation rates equate to F = 0.38 in the northern area and F = 0.17 in the southern area. Given the uncertainty of the 2004 Cooperative survey biomass estimates and potential for subsequent revision, the exploitation rates estimated from those data are not sufficiently precise to allow for evaluation of current F with respect to the fishing mortality reference points.

Recruitment: There is evidence of increased recruitment in the northern area during the 1990s, particularly for the 1999 year class (Figure 8). In the southern area, recruitment appears to have fluctuated without trend during the 1990s, although there is an indication that the 2002 year class may be above average (Figure 8).

Total Stock Biomass: The current biomass index (3 year moving average; 2001-2003) for the northern area is 2.03 kg/tow relative to a $B_{threshold}$ of 1.25 (Figures 2 and 3). The current southern area biomass index (3 year moving average; 2001-2003) is 0.93 kg/tow relative to a $B_{threshold}$ of 0.93 (Figures 4 and 5). The 2001 Cooperative survey estimated swept area total biomass of 68,680 mt in the northern area and 66,230 mt in the southern area (assuming 2001 intermediate net efficiencies and 2001 nominal tow distances). The 2004 Cooperative survey swept area biomass estimates are 51,766 mt in the northern area and 109,807 mt in the southern area (assuming 2001 intermediate net efficiencies and 2004 nominal tow distances).

Spawning Stock Biomass: Egg production indices for the northern area are at 44% of their 1970-1979 average and 30% of the maximum observed (Figure 6). For the southern area, egg production indices are at 31% of the 1970-1979 average and 11% of the maximum observed (Figure 7). The proportion of egg production generated by females smaller than the size at full maturity increased rapidly from the early 1980s through the mid-1990s and has since declined in the southern area, but remains high in both areas.

Surplus Production Modeling: This assessment extended a surplus production modeling approach first presented in the SAW 31 assessment. Model configuration was very similar to the configurations subsequently developed for the SAW 34 assessment. It was necessary to include estimates of catch during 1964-1979 and to implement a beta function (non-symmetrical) prior for the distribution of the intrinsic rate of population increase (r) in order for the current model to provide realistic results. When 2001 and 2004 biomass estimates were used as inputs for surplus production modeling, the median (50^{th} percentile) model results for the northern area indicated that F_{msy} = 0.18, B_{msy} = 60,100 mt, F_{2003} = 0.25, and B_{2003} = 72,100 mt. The median model results for the southern area indicated that F_{msy} = 0.20, B_{msy} = 82,300 mt, F_{2003} = 0.13, and B_{2003} = 107,300 mt. As noted above concerning the current uncertainty of the 2004 Cooperative survey biomass estimates and potential for subsequent revision, the surplus production model results should be considered preliminary and not sufficiently precise for evaluation of the status of the stock with respect to reference points. The Working Group plans to continue development of the surplus production model, since it appears to have the potential to serve as a valuable tool for an integrated estimation of stock biomass, mortality rates and reference points.

Special Comments: The Cooperative surveys conducted from February-April 2001 and March-June 2004 collected substantial new data that have proven valuable in the assessment of the stock. Some findings of note include:

- Growth rates were similar in northern and southern areas.
- Monkfish larger than about 70 cm were all females. The maximum age for males caught was age 8 and for females age 10.
- Nine incidences of cannibalism were detected among 2160 stomachs examined in 2001 (0.42%).
- Blackfin monkfish were not prevalent in 2001 catches, comprising less than 0.01% (8 of over 9000 monkfish examined).
- The size distribution of fish captured in the Cooperative surveys in the southern area was very similar to that observed in the NEFSC winter surveys.
- Catchability of 2001 NEFSC winter survey gear was approximately half that of the gear used to conduct the 2001 Cooperative survey.

- Given the late finish of the 2004 Cooperative survey, analysis of the 2004 Cooperative survey data are not complete. In particular, data collected from bottom contact sensors and experimental net efficiency tows have not been analyzed, and so 2004 biomass estimates were made assuming 2001 intermediate net efficiencies and 2004 nominal tow distances. Analyses of biological data are also incomplete.
- The Cooperative Monkfish Surveys have resulted in a great increase in knowledge of monkfish biology, and have helped improve the reliability and accuracy of the stock assessment. There is also great value in involving the fishing industry in monkfish assessment science by increasing industry confidence in the assessment. However, the Northeast Region's management and science agencies should carefully weigh the benefit and costs of the Cooperative Surveys in considering whether to undertake a survey for 2007. If a survey is conducted in 2007, it is critical that sampling protocols (including sampling intensity, net and ground gear designs, survey timing, and vessels) be examined and standardized to the greatest extent possible to maximize the value of annual cooperative survey estimates.

Sources of Information:

Chikarmane, H.M., Kuzirian, A.M, Kozlowksi, R, Kuzirian, M. and Lee, T. 2000. Population genetic structure of the goosefish, Lophius americanus. Biol. Bull. 199: 227-228.

NEFSC 1997. Report of the 23rd Northeast Regional Stock Assessment Workshop (23rd SAW). NEFSC Reference Document 97-05.

NEFSC 2000. Report of the 31st Northeast Regional Stock Assessment Workshop (31st SAW). NEFSC Reference Document 00-15.

NEFSC 2002. Report of the 34th Northeast Regional Stock Assessment Workshop (34th SAW): SARC Consensus Summary of Assessments. NEFSC Reference Document 02-06.

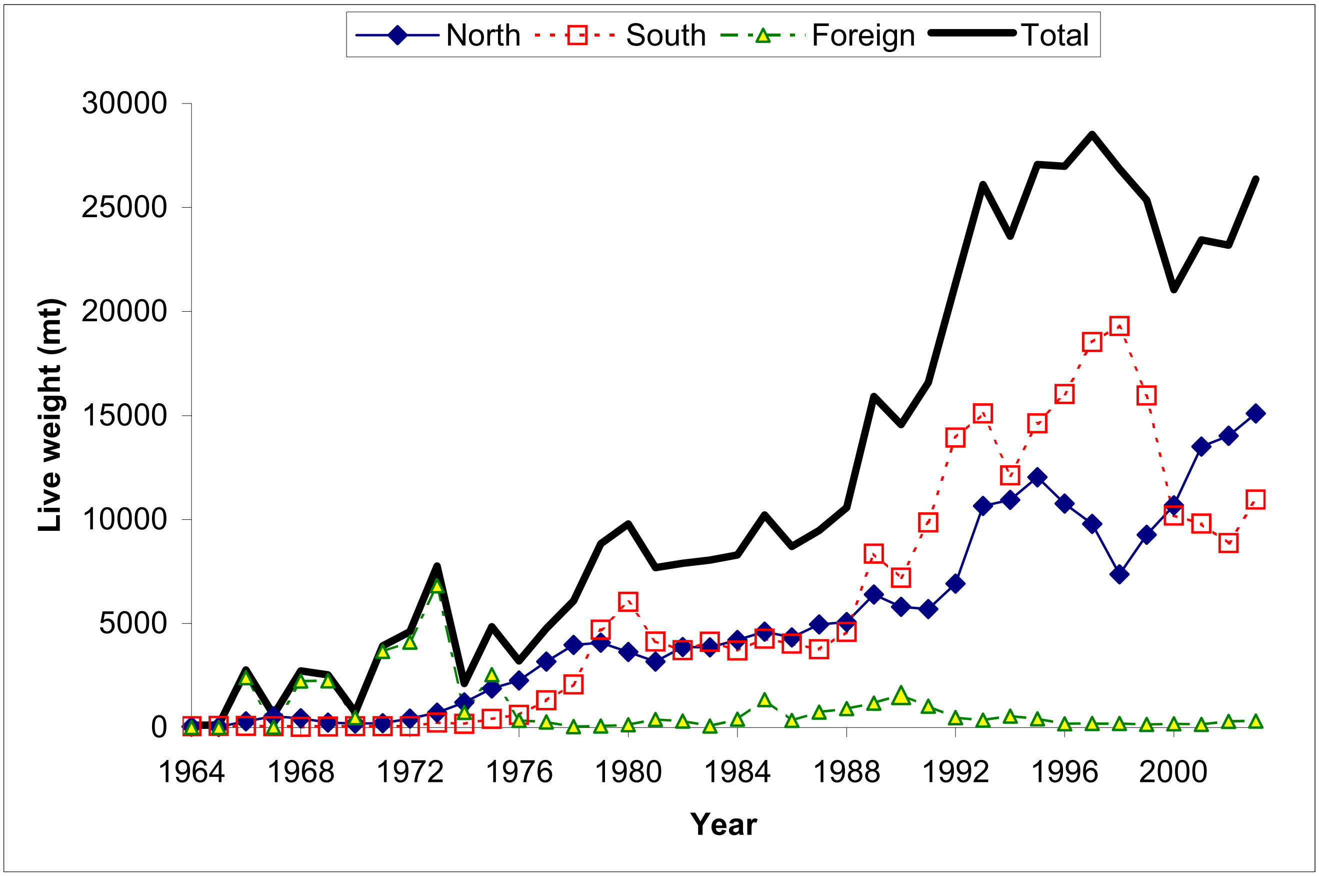
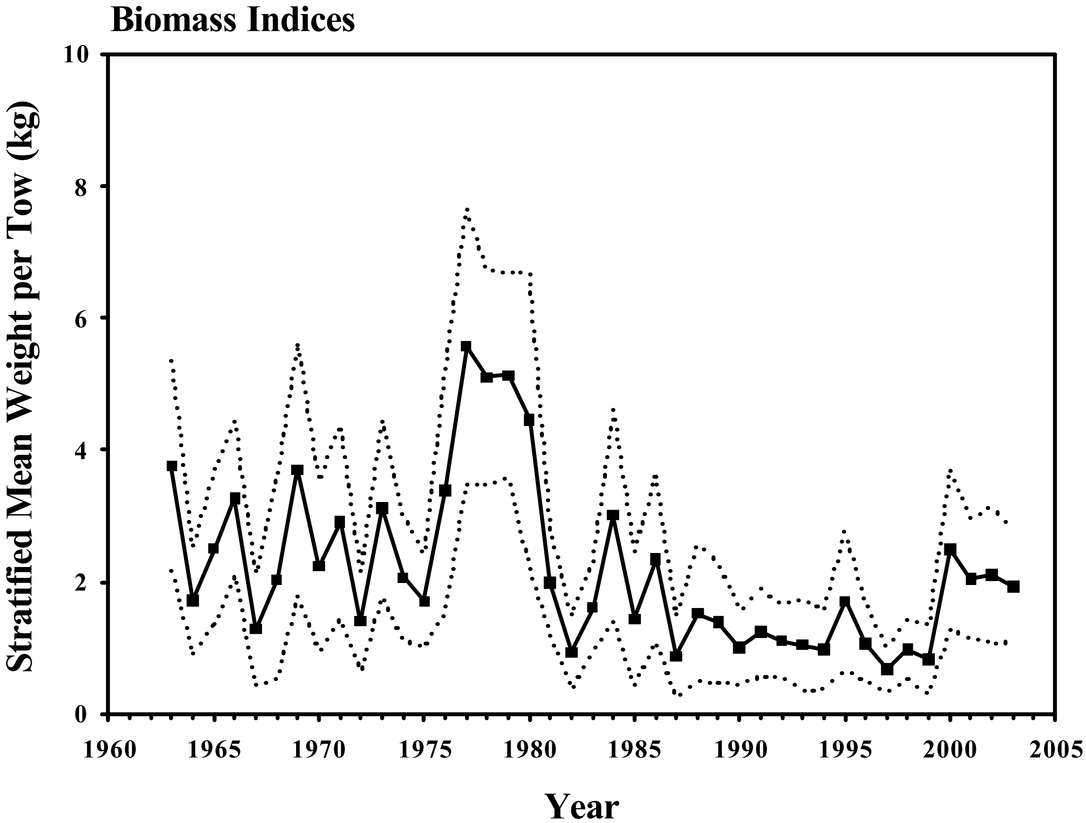


Figure 1. Total monkfish commercial landings.



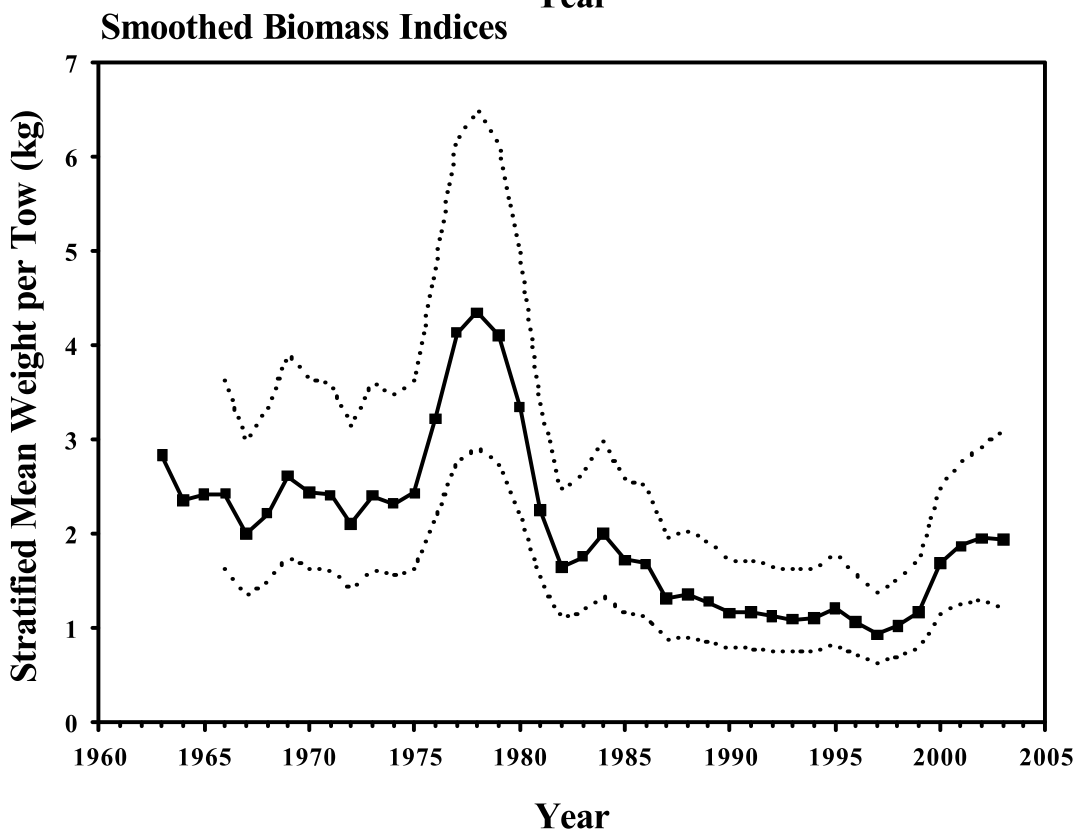


Figure 2. Northern area biomass index.

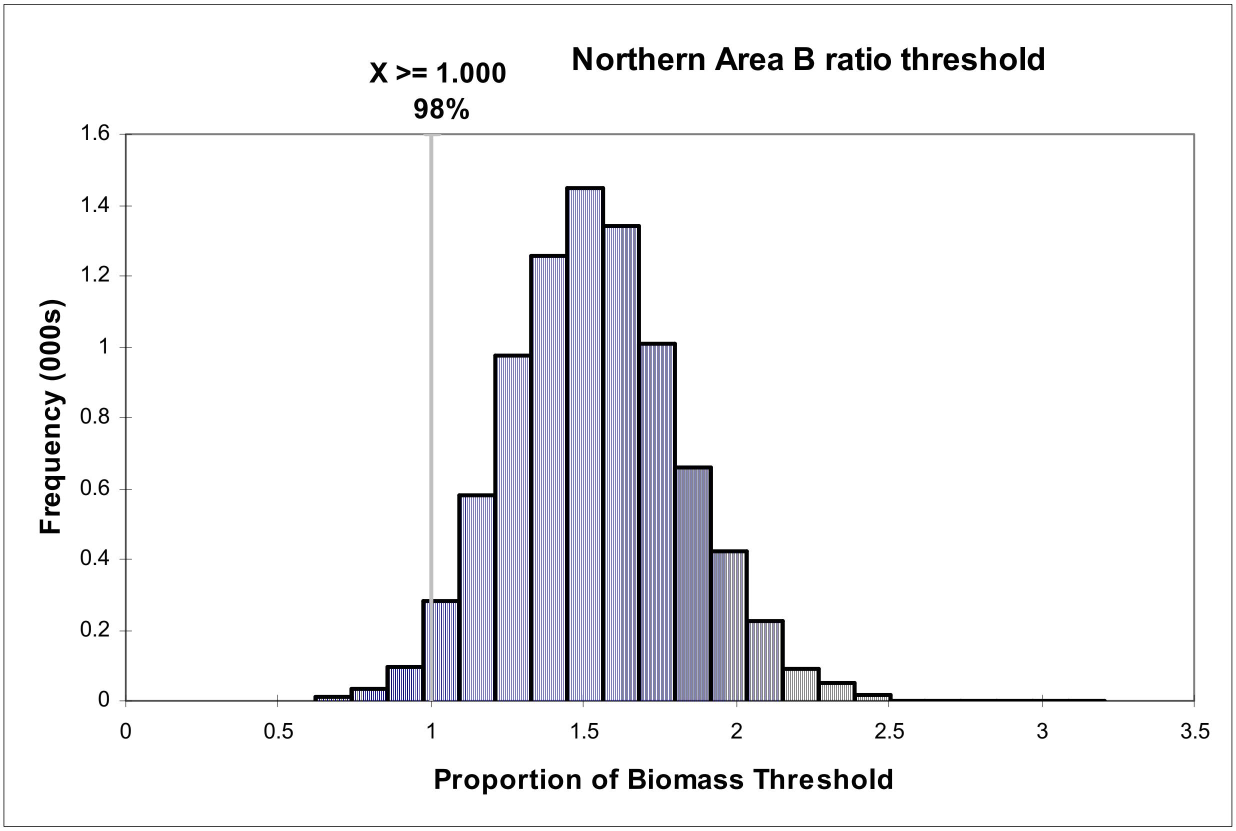


Figure 3. Northern area: probability distribution of 2003 biomass index (indexed to $B_{THRESHOLD}$ = 1.0).

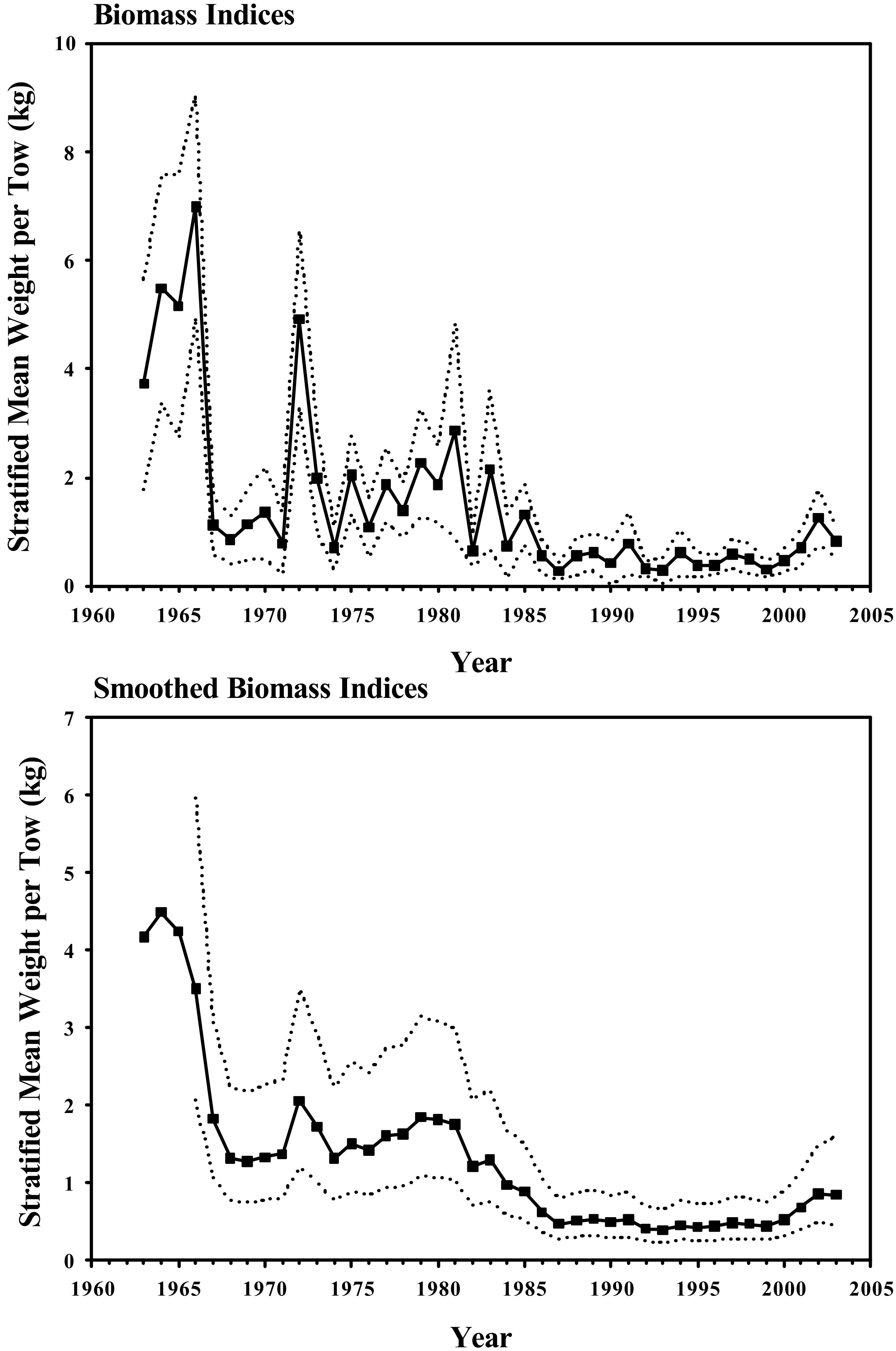
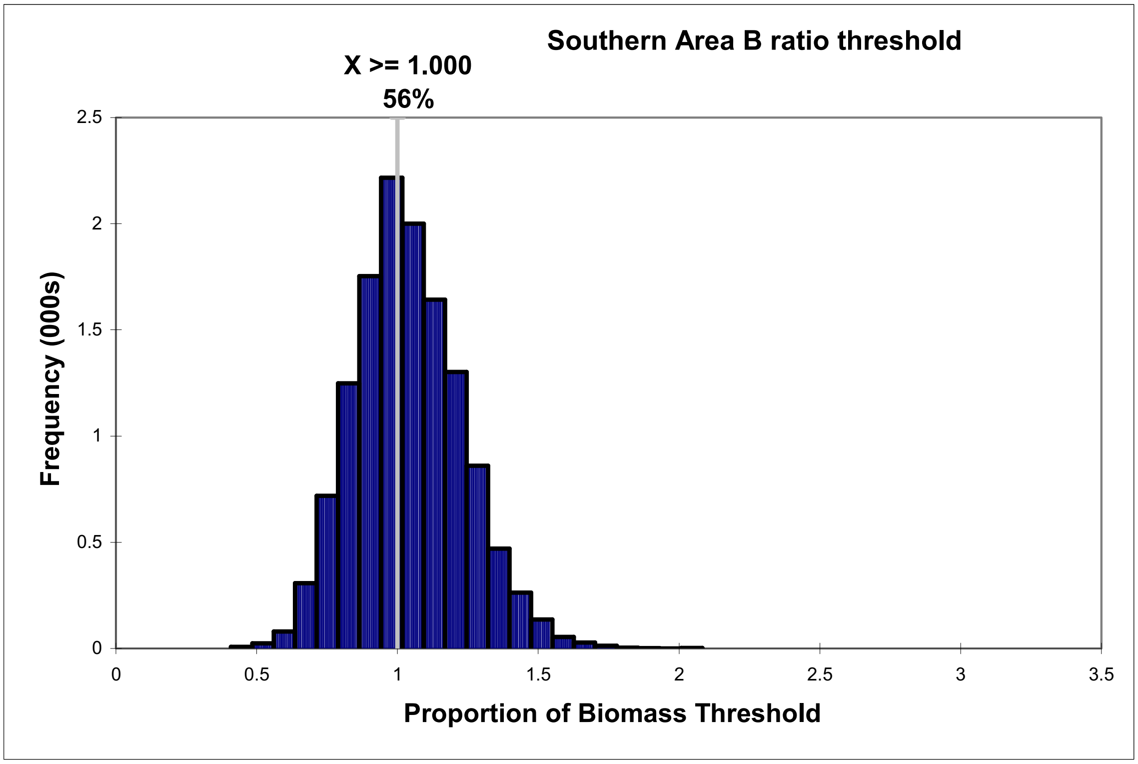
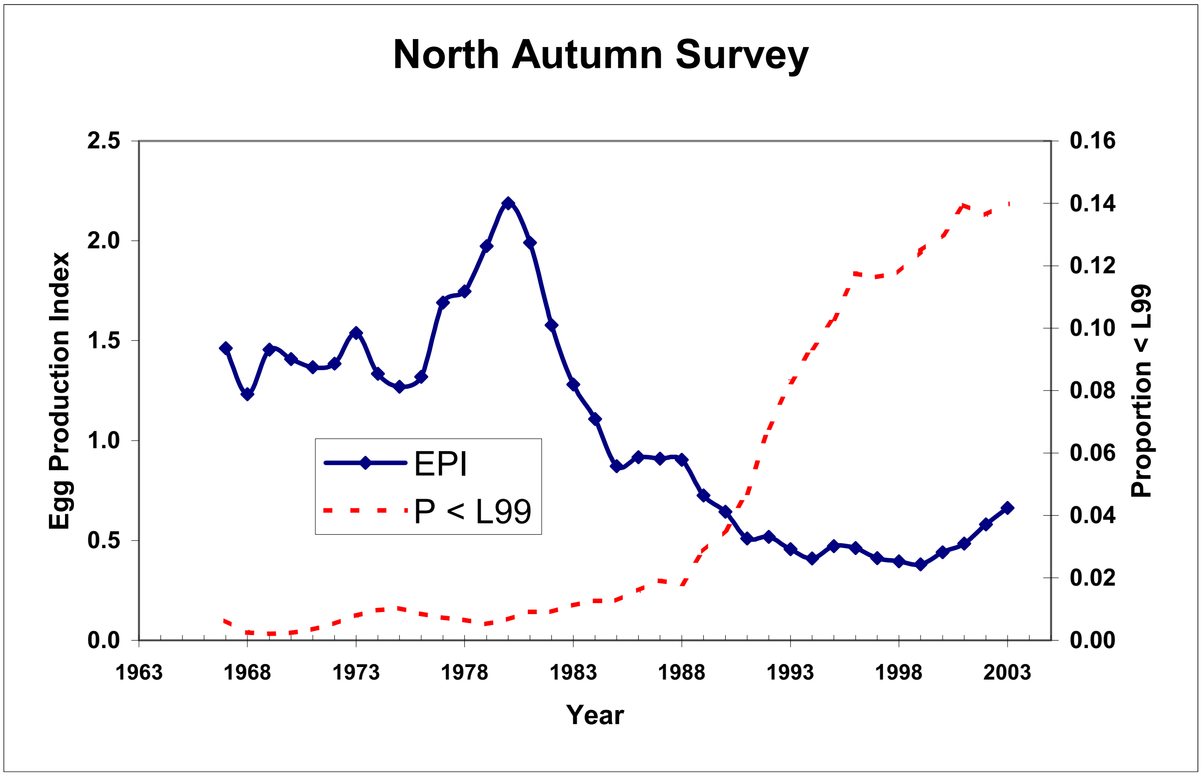


Figure 4. Southern area biomass index.

Figure 5. Southern area: probability distribution of 2003 biomass index (indexed to $B_{THRESHOLD}$ = 1.0).





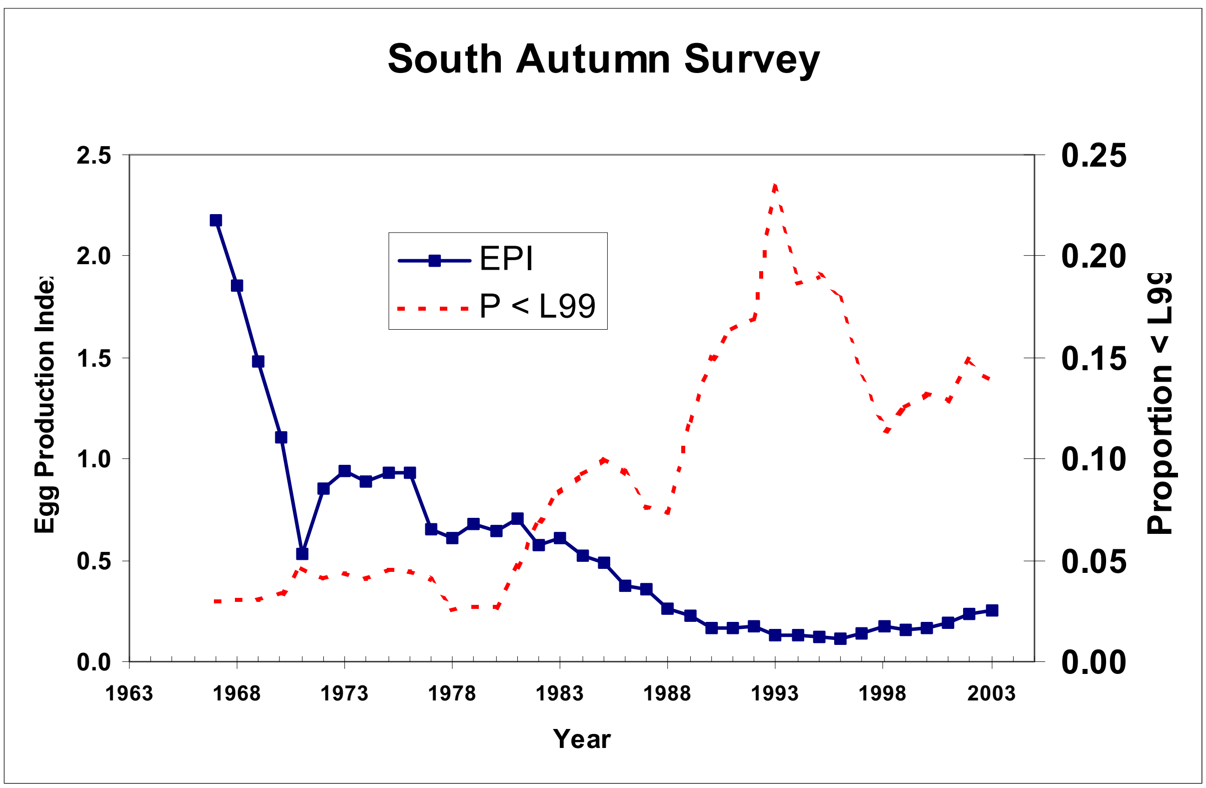


Figure 6 (upper panel). Northern area egg production.
Figure 7 (lower panel). Southern area egg productions.

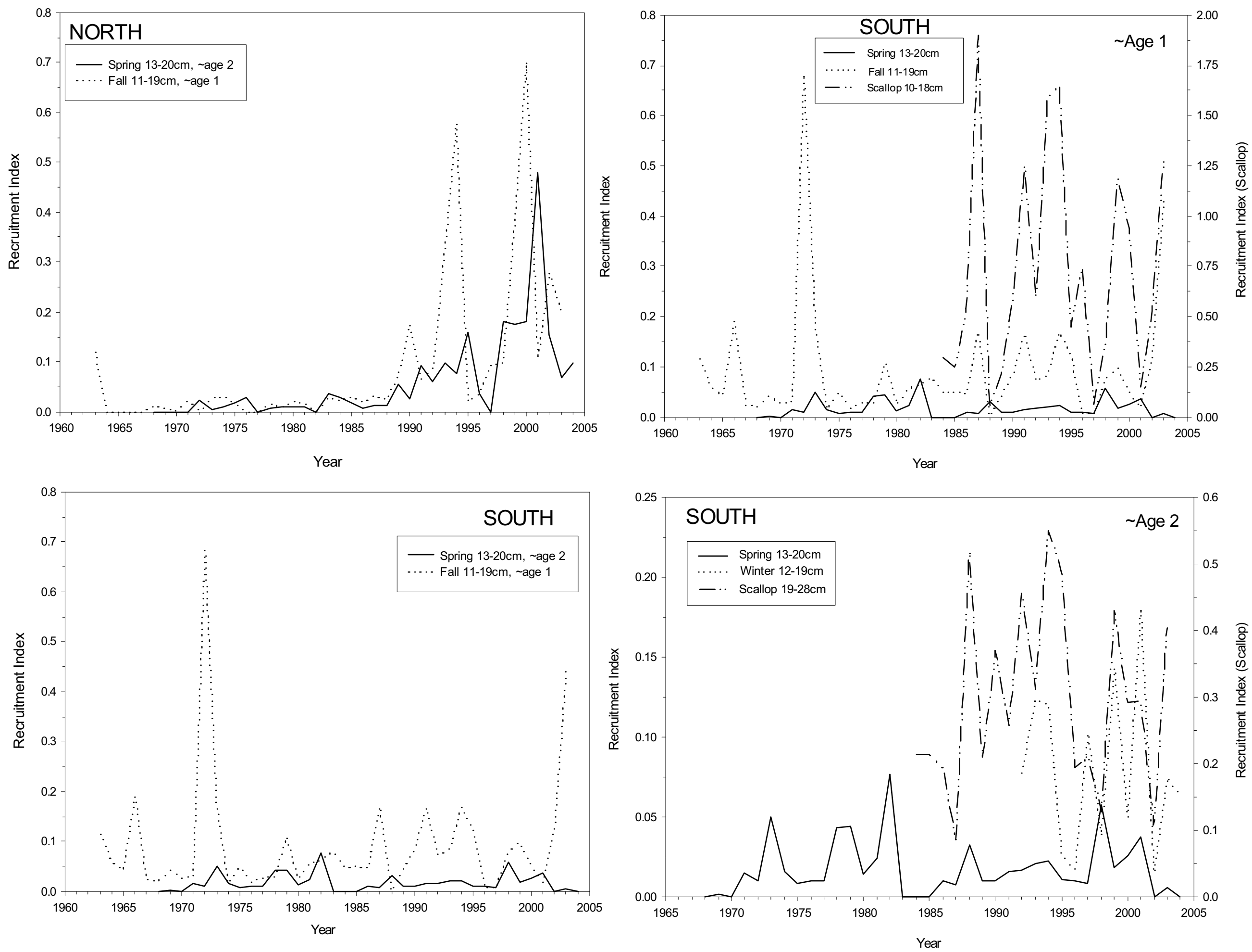


Figure 8. Recruitment indices at ages 1 and 2.

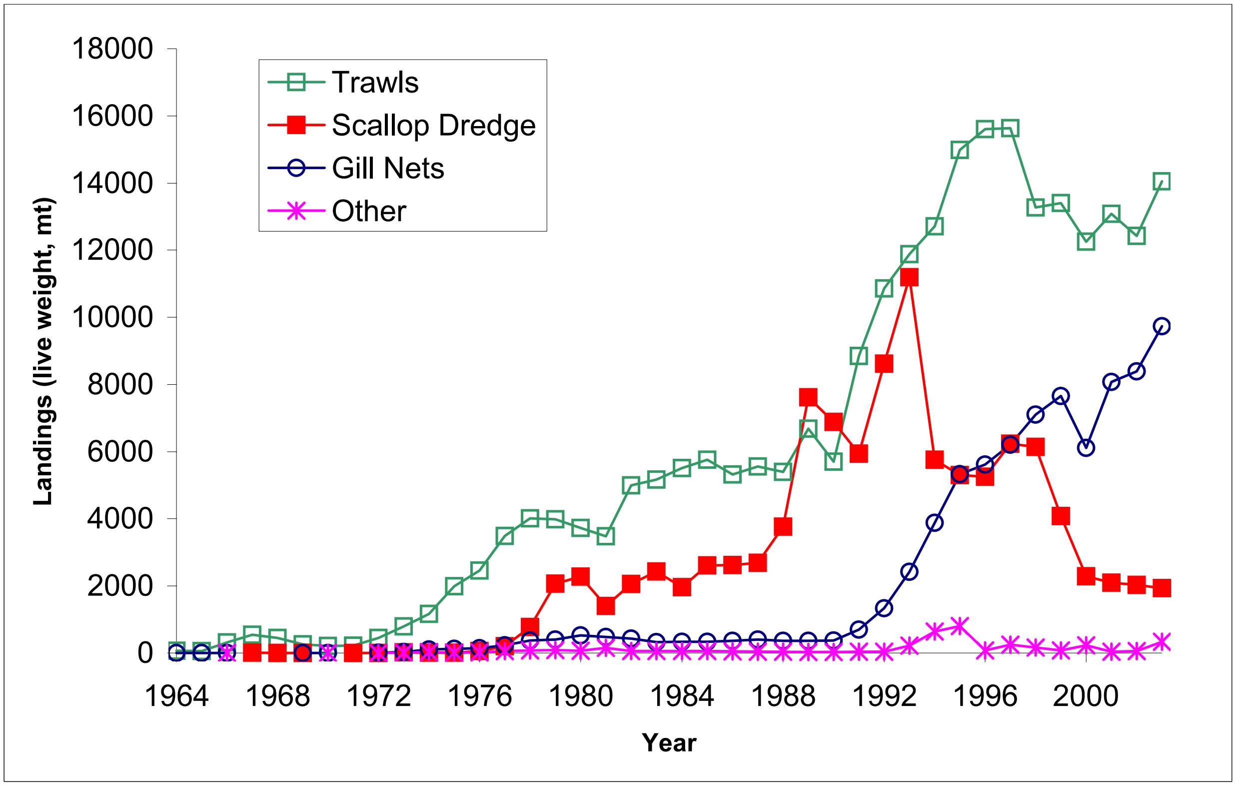


Figure 9. Total landings by gear type.

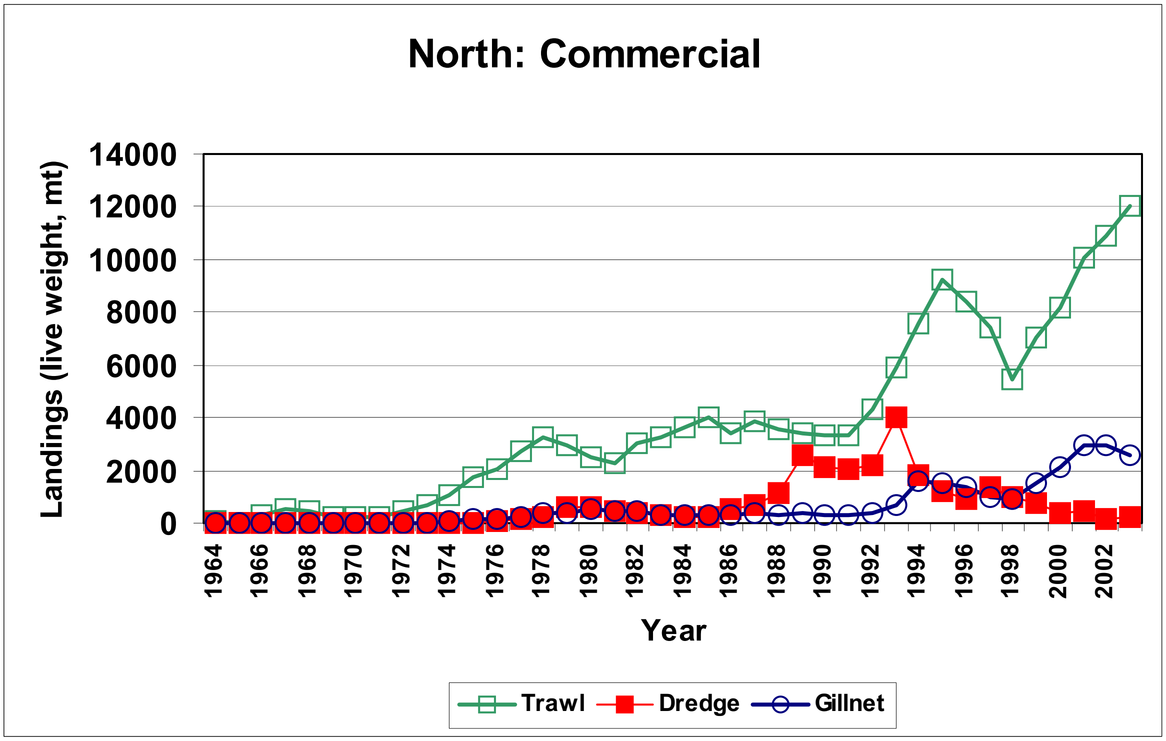


Figure 10. Northern area landings by gear type.

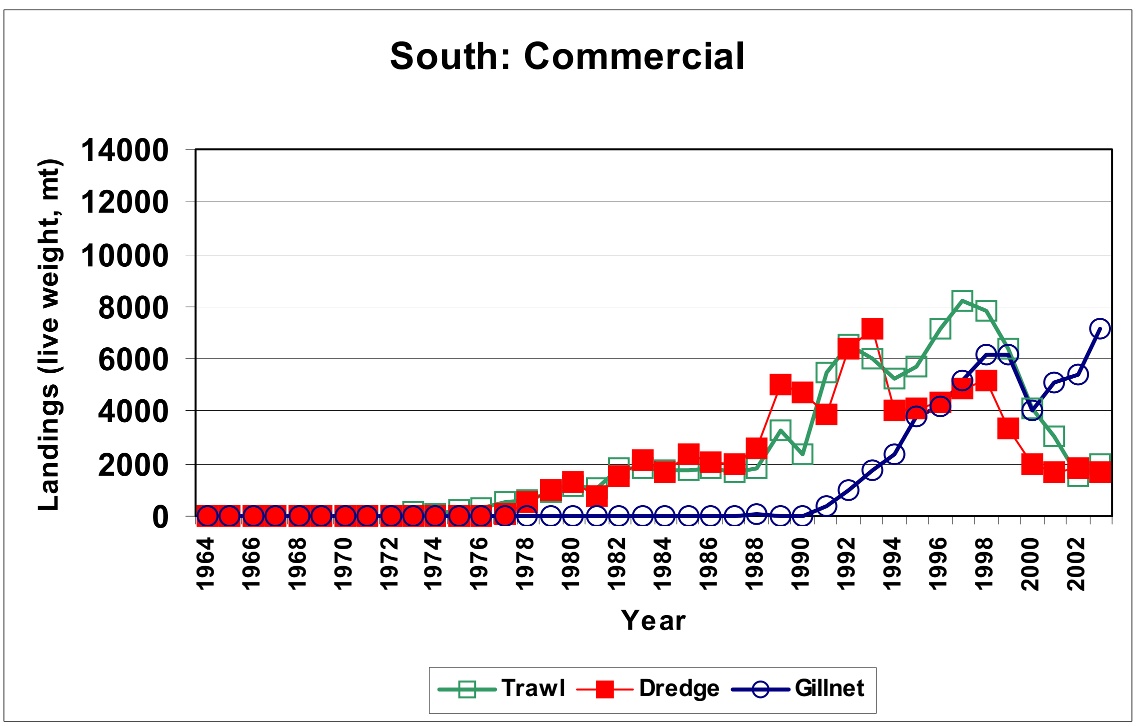


Figure 11. Southern area landings by gear type.

A. Goosefish (Monkfish)

Southern Demersal Working Group (WG) Meeting

The Southern Demersal Working Group met during October 25 - 27, 2004 at the Northeast Fisheries Science Center, Woods Hole. MA, USA, with the following participants:

Jay Burnett	NEFSC
Jon Brodziak	NEFSC
Matt Cieri	MEDMR
Allison Ferreira	NERO
Phil Haring	NEFMC
Jay Hermsen	NERO
Kathy Lang	NEFSC
Chris Legault	NEFSC
Paul Nitschke	NEFSC
Anne Richards	NEFSC (lead)
Kathy Sosebee	NEFSC
Mark Terceiro	NEFSC (chair)
Michele Traver	NEFSC

Goosefish / Monkfish Terms of Reference

1. Review results of the 2004 Cooperative Monkfish Survey; make comparison to the results of the 2001 survey.

WG Response: Given the late finish of the 2004 cooperative survey, and the time required for processing the survey data, analysis of the 2004 cooperative survey data is not complete. However, preliminary stock biomass and exploitation rate estimates from the 2004 survey were made and compared to 2001 survey results.

2. Characterize the commercial catch including landings and discards.

WG Response: This TOR was completed. The WG notes that discard estimates for 2001 and later may be subject to further revision.

3. Update other monkfish survey indices *(i.e.,* NEFSC and MADMF indices) and analyses based on those indices.

WG Response: This TOR was completed. The MADMF indices were not updated, as MADMF staff indicated that their indices were of little utility for monkfish due to low catch rates. Therefore the MADMF indices have been dropped from the assessment.

4. Evaluate the current status of the stock assessment units relative to existing reference points.

WG Response: This TOR was completed for the biomass reference point (neither management unit is overfished). The WG noted that the lack of reliable estimates of instantaneous fishing mortality rates precludes evaluation with respect to fishing mortality reference points.

5. Review, evaluate, and report on the status of the SARC/Working Group Research Recommendations offered in the previous SARC-reviewed assessment (i.e., SAW 34 in November 2001).

WG Response: This TOR was completed.

Introduction

Goosefish fisheries 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 FMP defines two management areas for monkfish (northern and southern), divided roughly by a line bisecting Georges Bank.

The FMP and its subsequent modifications define monkfish biological reference points as follows:

> Monkfish in the northern and southern management areas are defined as being overfished (below $B_{threshold}$) when the three-year moving average autumn survey weight per tow falls below one half of $B_{target..}$ $B_{target.}$ is defined as the median of the three-year moving average autumn survey weight per tow during 1965-1981. Thus $B_{threshold}$ = 1.25 for the northern management region and =0.93 for the southern management region. For both management areas, $F_{threshold}$ is set equal to F_{max}, currently estimated as F=0.2 (NEFSC 2002). The overfishing definition does not include an F_{target} reference point. Optimum yield is addressed by adjusting annual TACs and trip limits based on how biomass indices compared to annual biomass targets.

Table A1 provides a summary of recent regulatory measures affecting monkfish.

The two assessment and management areas for goosefish (northern and southern) were defined based on differences in temporal patterns of recruitment (NEFSC survey indices for 10-20 cm goosefish), the spatial and temporal distribution of all sizes of goosefish 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. 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 later available from the NEFSC surveys and the 2001 cooperative monkfish survey indicated only minor differences in age, growth, and maturity between the areas. A genetics study (Chickarmane et al. 2000) indicated no differences among goosefish collected from North Carolina to Maine in depths up to 300 m. There continue to be significant differences in the contribution of different gear types to the landings in the two 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 management areas to accommodate these differences.

The research survey strata and statistical areas used to define the northern and southern management regions are as follows:

Survey	Northern Area	Southern Area
NEFSC Offshore bottom trawl	**20-30, 34-40**	**1-19, 61-76**
ASMFC Shrimp	**1 -12**	
Shellfish	**49-54, 65-68, 71-72, 651,661**	**1-48, 55-64, 69-70 73-74, 621, 631**
Statistical areas	**511-515, 521-523 561**	**525-526, 562, 537-543, 611-636**

The southern deepwater extent of the range of American goosefish (*Lophius americanus*) overlaps with the northern extent of the range of blackfin goosefish (*Lophius gastrophysus*) (Caruso, 1983). These two species are very similar morphologically, and this may create a problem in identification of survey catches and landings from the southern extent of the range of goosefish. 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 goosefish and found none. The cooperative goosefish survey conducted in 2001 caught only 8 blackfin goosefish of a total of 6,364 goosefish captured in the southern management region.

The spatial distribution of goosefish catches in winter, spring, and autumn bottom trawl surveys and the summer scallop survey is shown in Figure A1. The winter and scallop surveys do not sample in the Gulf of Maine.

Larval distributions have been inferred from collections by the NEFSC Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey (Steimle et al. 1999). Larvae were collected during March-April over deeper (< 300 m) offshore waters of the Mid-Atlantic Bight. Later in the year, they were most abundant across the continental shelf at 30 to 90 m. Larvae were most abundant at integrated water column temperatures between 10-16^{o} C, and peak catches were at 11-15^{o} C regardless of month or area. Relatively few larvae were caught in the northern stock area.

Fishery Data

U.S. Landings

Landings statistics for goosefish 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 goosefish in the NEFSC weigh-out database is made by multiplying landed tail weight by a factor of 3.32.

For 1964 through 1989, there are two potential sources of landings information for goosefish; 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 A2). All landings of goosefish 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 years 1964 through 1981 when only tails were recorded in both databases. However, for years 1982 through 1989, the weigh-out database contains market category information which allows for improved conversions from landed 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 argue for use of the general canvass landings for years 1964 through 1981 while market category details available in the weigh-out system argue for use of this database for years 1982 through 1989. Until the mid-1970's, many of the goosefish caught were sold outside of dealers or used for personal consumption, introducing further uncertainty into the early estimates of landings.

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 goosefish 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 region, they have been added to the weigh-out data for the southern management region for 1977-1997 (TableA2).

Beginning in July 1994, the NEFSC commercial landings data collection system was redesigned to consist of vessel trip reports (VTR data) and dealer weigh-out records. The VTRs include area fished for each trip which is used to apportion dealer-reported landings to statistical areas. Each VTR trip should have a direct match in the dealer data base; however, this is not always true. For data with no matches, we dropped the record if there was a VTR with no dealer landings and retained the record if there were dealer landings but no VTR. For dealer landings with no matching VTR, we apportioned the landings to area using proportions calculated from successfully matched trips pooled over gear, state and quarter.

Total landings (live weight) remained at low levels until the middle 1970s, increasing from hundreds of metric tons to around 6,000 mt in 1978 (Table A2, Figure A2). Landings remained stable at between 8,000-10,000 mt until the late 1980s. Landings increased steadily from the late 1980s to a peak of 28,500 mt in 1997. Landings declined slightly from 1997 through 2000, but have increased since then, to over 26,000 mt in 2003. 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. Since 1998, landings in the south have declined while landings in the north have increased.

Trawls, scallop dredges and gill nets are the primary gear types that land goosefish (Table A3, Figure A3). During 1998-2000, trawls accounted for 54% of the total landings, scallop dredges about 17%, and gill nets 29%, but during the most recent 3-year period (2001-2003), gillnets increased to 36% and scallop dredges dropped to 8%, while trawls remained essentially constant at 55% of the landings. In recent years trawl landings have been greater in the northern than the southern area, while more scallop dredge and gill net landings have come from the south than from the north.

Until the late 1990s, total landings were dominated by landings of goosefish 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 A4). 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 A5, A6). 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 A4). 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.

Goosefish 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.

Foreign Landings

Landings (live wt) from NAFO areas 5 and 6 by countries other than the US are shown in Table A2 and Figure A2. Reported landings 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.

Size Composition of U.S. Landings and Catch

Table A7 shows the number of commercial samples taken through the port sampling program for 1996-2003. Length frequencies of the samples taken during 2001-2003 are shown in Figures A4-A6. Tail lengths were converted to total lengths using relations developed by Almeida et. al. (1995).

Length composition data collected by the NEFSC fishery observer program (sea sampling data) were summarized for 1996-2000. Sea sampling data for goosefish were collected aboard trawls, scallop dredges and gill nets (drift and sink). Figures A7 and A8 show length frequency distributions from sea sampling data by major gear type, stock region and year. Discards were generally between 20-40 cm, while kept fish were greater than 40 cm.

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 goosefish discards available for analysis varied widely among stocks and gear types (Tables A8 and A9). Discard ratios (kg discarded / kg kept) from the two data sources showed similar patterns even though the estimates based on observer data were generally higher than reported in VTRs (Figures A9, A10). 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. In the first half of 2001, the high discard ratio stems largely from estimates from the multispecies fishery. 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. The WG group recommends that in the future, attempts be made to stratify by component of the trawl fishery when estimating discards.

The total amount of goosefish discarded was derived by calculating discard ratios from the observer program on a management region, gear type and half-year basis. We applied the discard ratios to reported landings (live weight, by stock, gear type and half-year cells) to derive metric tons discarded and total catch (Tables A10 and A11, Figure A11). If no sampling data were available for a cell, we applied the overall mean discard ratio for all gears and years. The overall annual discard ratio (Table A11) ranged from 0.07 - 0.96 mt discarded per mt kept. The percentage of the catch discarded has ranged from 6-50%, with the highest rates occurring in 2001.

Catch per Unit Effort by Gear and Depth

Commercial catch per unit effort (CPUE) from the VTR database was examined by gear type in order to determine if a depth effect was present, especially in the deepest waters. Scallop dredge, large and small mesh gill net, and otter trawls were examined separately. Depth zones were categorized in 20 fathom increments starting with 0-20 fathoms (zone 1) and ending with zone

10 (greater than 180 fathoms). Obvious outliers were removed before analysis based on examination of the actual logbooks.

Table A12 presents the number of observations, median CPUE by depth zone and the estimated depth effect from a generalized linear model incorporating year, quarter, vessel ton class and depth zone. Dredge gear does not fish in deep waters and does not show changes in CPUE with depth. Large and small mesh gill nets fish in deeper waters, but do not show a trend in CPUE with depth. In contrast, trawls fish in deep waters and show an increasing trend in CPUE with depth. However, this apparent trend is due to a loss of low CPUE values at greater depths; maximum catch rate is consistent over all depths. Examining only directed trips (trips in which at least half of the catch (kg) was goosefish) removes the apparent trend with depth by removing most of the low catch rates in shallow water (Table A13). Thus catch per unit effort does not appear to have a depth effect associated with any gear. However, the low sample sizes in the deepest water do not allow definite conclusions to be reached.

During the examination of catch rates by depth, it was observed that few trawl trips fall into the directed category, as defined above. Table A14 shows the number of directed and total trips by gear and stock area and the associated landings. Although trawl trips are infrequently directed in both the north and south (6% and 7% of trips respectively) the proportion of catch associated with these trips is much higher in the south (30% north, 74% south). This difference between north and south was not apparent in either gill net fishery.

Research Survey Abundance and Biomass Indices

NEFSC Survey Indices

NEFSC spring and autumn bottom trawl survey indices were standardized to adjust for statistically significant effects of trawl type and vessel on catch rates as noted below. The trawl conversion coefficients apply only to the spring survey during 1973-1981.

Effect	Coefficient	Source
Trawl	Weight: 0.2985	
	Number: 0.4082	Sissenwine and Bowman, 1977
Vessel	Weight: Not significant	NEFSC, 1991
	Number: 0.83	

<u>Northern Region</u>

Indices from NEFSC autumn research trawl surveys indicate that biomass fluctuated without trend between 1963-1975, appears to have increased briefly in the late 1970's, but declined thereafter to near historic lows during the 1990's. In 2000 the index increased to its highest level since 1984 (Table A15, Figure A12). The three year moving average of the biomass index has remained above Bthreshold since 2000 and is currently at 81% of Btarget (Table A35).

Abundance (Table A15, Figure A13) 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, then increased sharply in 2000, reflecting a relatively strong 1999 yearclass (Figure A14). Abundance has declined steadily since 2000, but remains high relative to the earlier part of the time series.

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 and an increasing trend since then (Table A16, Figure A15). As in the autumn survey series, abundance in numbers fluctuated until the early 1980s (Table A16, Figure A16). Since 1996, numbers have trended upwards and reached the highest levels in the time series in 2001-2003.

Length distributions have become increasingly truncated over time (Figure A17). By 1990, fish greater than 60 cm long were uncommon in length frequency distributions. The minimum, mean and maximum lengths in the trawl surveys declined steadily from the early 1980s until around 2000, when they began to increase again (Figure A18).

Several modes potentially representing strong year classes have appeared consistently in survey distributions in recent years. Abundance indices were estimated for goosefish of lengths corresponding to ages 1 and 2 to help identify potential recruitment patterns (Figure A14, Table A17). 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 (Table A18) in the northern area.

Survey age data are available for 1993-2003 from the autumn trawl survey and for 1995-2004 for the spring trawl survey (Table A18). The mean length at age is shown in Table A19 and Figures A19 and A20. Within the range of ages observed in the surveys, growth is essentially linear and there are no obvious differences with gender or stock..

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 A20, Figure A21). A slight upward trend has been evident since 2000. The three year moving average of the index exceeded Bthreshold in 2003, and is currently at 50% of Btarget (Table A35). 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 (Figure A22).

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 A21, Figures A23 and A24). A spike was observed in 2003, but the 2004 index was low again.

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 A22, Figure A25). Abundance indices have fluctuated without trend (Table A22, Figure A26). 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. Age data are available for the winter survey for 1997-2004 (Table A23). The mean length at age for the winter survey samples is similar to mean length at age from NEFSC spring surveys (Figure A20).

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 A24, Figure A28). Length distributions from the southern region show increasing truncation over time (Figure A29), which is reflected in declines in minimum, mean and maximum length over time (Figures A30 and A31). 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.

ME-NH Survey Indices

Since 1999, the ME Department of Marine Resources, in conjunction with the state of New Hampshire, has been conducting an inshore trawl survey for groundfish. Surveys are performed each autumn and spring. A total of 5 regional areas are sampled; from the ME Canadian border to the MA/NH border. Each region is then further divided into 5 depth strata: 5-20 fathoms, 20-35 fathoms, 35-55 fathoms, and > 55 fathoms. Surveys utilize a modified shrimp bottom trawl that has 2" mesh with a ½ inch mesh liner in the cod end. The net has a sweep of 4" cookies, 70' footrope, and 59' headrope. A NetMind system is deployed for each tow. Normal protocol is to tow for 20 minutes at ~ 2.5 knots.

Figure A32 shows the distribution of catches for all survey years combined. Length frequency distributions suggest differences between autumn and spring surveys. The spring surveys seem to sample smaller monkfish, a difference which probably reflects growth from spring to fall (Figure A33). The modal size in both seasons approximates age two monkfish. These surveys (particularly the fall) may become useful indicators of recruitment as the time series develop (Figure A34).

Cooperative Goosefish Surveys

Summary of 2001 Cooperative Goosefish Survey

An industry-based survey for goosefish 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 goosefish 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 goosefish 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 goosefish (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 goosefish (25 million north, 23 million south). Bootstrapped estimates of the coefficient of variation for these estimates ranged 4-7%.

Biological results included the following:
- growth rates are similar in the northern and southern areas, and between males and females
- sex ratios are length- and age-dependent. Most fish larger than 70 cm and age 7 are females. In the southern area, sex ratios are skewed towards males in the 40-60 cm size range.
-Female maturity (L_{50}) is 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}) is 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).

2004 Cooperative Goosefish Survey

<u>Methods</u>

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) (Figure A35, Tables A25, A26). 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 (Figure A36). 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.

Provisional area-swept estimates of total biomass and abundance were developed using estimates of net efficiency from the 2001 survey, wingspread estimates from 2004 survey NetMind data, and nominal tow duration for each of the 2004 survey tows. Wingspread for each tow was estimated from relationships between wingspread and depth developed from tows with valid wingspread readings. Inclinometer data were not analyzed in time for the WG meeting; inclinometer data were used in 2001 to refine the estimates of tow duration.

Results – 2004 Cooperative Goosefish Survey

Due to severe weather during the spring, use of only one survey vessel, and the length of time needed for data loading and auditing, survey data were not available for analysis until approximately 2 weeks before the working group meeting. Therefore, only a limited set of results is available at this time, and all results should be considered preliminary as internal data checking (beyond standard audits) and refinement was limited.

Table A27 summarizes the general accomplishments of the survey and compares them to the 2001 cooperative survey.

Biology

Length-weight relationships are similar for males and females and between management regions (Figure A37). 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 are 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 (Figure A38). 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 (Figure A39).

Goosefish weight at age increases exponentially up through the oldest ages observed in the survey, and does not differ between management areas (Figure A40).

Sex ratio patterns are 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. The WG examined sex ratios and their spatial distribution in the NEFSC winter surveys during 1999-2004 (southern region) for comparison. The same pattern in sex ratio with length was observed (Figure A41). The spatial distribution of sex ratios for monkfish 50-65 cm showed a preponderance of males in the southern most strata, but no area where females dominated (Figure A42).

Population Estimates

Reliable wingspread measurements were available for 41 tows for the flat net and 6 tows for the rockhopper. A polynomial relation between wingspread and tow depth (Figure A43) was used to estimate wingspread for tows for which the mensuration gear did not operate properly. No wingspread measurements were obtained for the rockhopper net for tows shallower than about 200 m. To derive an estimate of the intercept for the rockhopper, we calculated expected wingspread for each net based on net geometry (expected wingspread=1/2[(headrope+footrope)/2]; H. Milliken, NEFSC personal communication) and added the difference to the intercept for the flat net. We assumed a polynomial relationship would apply to the rockhopper wingspread vs. depth relation, and fit the curve through the observed points and the estimated intercept. The resulting relation (Figure A43) was used to estimate wingspread for the rockhopper tows.

Swept area biomass and population size estimates are given in Table A28. Minimum biomass estimates (assuming 100% efficiency of nets) are 28.5 thousand mt (kt) in the north and 65.9 kt in the south (94.4 kt total). This compares with an estimated total of 71.8 kt in 2001, divided roughly equally between the areas (NEFSC 2002). Minimum population numbers are 14.4 million in the north and 36.6 million in the south (total 51 million). This compares with an estimated minimum number of 47.7 million in 2001 (25 million in the north, 22.6 million in the south). Assuming the 'intermediate' net efficiencies estimated for the 2001 survey (flat net = 0.60, rockhopper=0.432) and using nominal tow distances, the biomass estimates are 51.8 kt (north), 109.8 kt (south), and 161.6 kt total. The corresponding population number estimates are 25.7 million fish (north), 61.0 million (south), and 90.9 (areas combined).

The length composition of the population estimated from the cooperative survey (based on minimum population size and proportion at length within stratum) is shown in Figure A44. In the south, most of the population is below the minimum landing size required under the FMP (equivalent to 53 cm total length). Length frequencies from the NEFSC winter survey for 2004 are very similar to the length frequencies derived from the cooperative survey (Figure A45).

Egg Production Indices From NEFSC Survey Length Composition Data

NEFSC survey indices were used to develop indices of egg production. Composite length frequencies, based on a five year summation of catch per tow at length, $\bar{I}(L,t)$ were multiplied by predicted eggs at length Egg(L) and the fraction mature (PMAT(L)). The computational formula is:

$$SSB(t) = \sum_L SSB(L,t) = \sum PMAT(L) * Eggs(L) * \bar{I}(L,t)$$

where
$$PMAT(L) = \frac{1}{1 + e^{13.9568 - 0.03862325L}}$$

L = length(mm)

Parameters for PMAT(L) were derived by fitting the logistic function to derived percentiles of fraction mature described in Hartley (1995). The fecundity-length relationship was obtained from Armstrong (1987).

$$Eggs(L) = 0.0683L^{3.74}$$

Results for the indices of egg production (Figures A46 and A47, Table A29) mirror the progressive decline in mean length. The egg production indices declined steadily from the late 1970s until the late 1990s, when they began to increase slightly. Currently, about 14% of egg production is by fish less than L_{99}. This compares with 1-5% in the first decade of the time series.

Estimation of Mortality and Stock Size

Natural Mortality Rate

The instantaneous natural mortality rate for monkfish is assumed to be 0.2, based on an expected maximum age of 15-20 years given previous studies of age and growth (Armstrong 1987, Armstrong et al. 1992, Hartley 1995).

Mortality estimates from NEFSC Surveys

Mortality rates were estimated from NEFSC survey abundance at age data using cohort-based catch curves (Table A30, Figures A48-A56) and Heinke's method (Table A31). The annual estimates from both methods are highly variable and the Heinke method results in many unreasonable estimates. This is likely due to inter-annual variations in catchability coupled with the overall low catch rates of goosefish in the NEFSC surveys.

Exploitation ratios were calculated from the cooperative survey using the same methods as used for SARC 34. The estimates were produced using two methods: using landings and exploitable biomass from the cooperative survey (> 40 cm north, > 52 cm south), and using catch (landings plus discards) and total biomass from the cooperative survey. In each case, landings (catch) 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. The estimates were produced under assumptions of 100% and 'intermediate' net efficiencies (from 2001 cooperative survey) and using nominal tow distances. This produced the exploitation ratios shown in Table A32. The results from the catch and biomass method were very similar to the results from landings and exploitable biomass (Table A32).

An additional set of exploitation ratios was generated using survey biomass estimates and fishing year 2003 (May 2003-April 2004) landings and catch (Table A33). The results were very similar to the estimates derived above, with exploitation ratios somewhat lower in the north using fishing year landings.

For comparison with yield per recruit -based reference points adopted in Framework 2 of the Monkfish FMP, exploitation ratios were converted to F assuming M=0.2.

<u>Bayesian Surplus Production Model</u>

The Southern Demersal Working Group updated the Bayesian surplus production models developed for SARCs 31 and 34. SARC 34 felt the approach had value, but that data limitations were a significant impediment to its application at that time. The WG extended the SARC34 analyses (NEFSC 2002) using the same basic model structure, but with the following modifications (see Appendix I for documentation):

- A beta function prior was implemented for the distribution of r, the intrinsic rate of increase (mean = 0.5, CV = 20%)
- 2001 and 2004 estimates of biomass from the cooperative monkfish surveys were included as inputs

Estimates of the mean and quantiles of the posterior distributions of key model parameters and important outputs are listed in Table A34. There the variable BRATIO is the ratio of stock biomass in year 2003 to the biomass that would produce maximum surplus production. The variable HRATIO is the ratio of the harvest rate in year 2003 to the harvest rate that would produce maximum surplus production. The parameter K is the carrying capacity. The parameter M is the shape parameter for the production curve in the Pella-Thomlinson model. The variable B2004 is population biomass at the start of year 2004. The variable BMSP is the population biomass that would produce maximum surplus production (MSP). The variables qFALL and qSCALLOP are the catchability coefficients for the fall groundfish and the scallop survey biomass time series. The parameter r is the intrinsic growth rate of the stock. The parameter sigma2 is the process error variance, while the parameters tau2FALL and tau2SCALLOP are the observation error variances for the fall groundfish and the scallop survey biomass time series.

Model results indicated that fishing mortality has increased and stock biomass has decreased during the assessment time series of 1964-2003. When 2001 and 2004 biomass estimates were used as inputs for surplus production modeling, the median (50th percentile) model results for the northern area indicated that F_{msy} = 0.18, B_{msy} = 60,100 mt, F_{2003} = 0.25, and B_{2003} = 72,100 mt. The median model results for the southern area indicated that F_{msy} = 0.20, B_{msy} = 82,300 mt, F_{2003} = 0.13, and B_{2003} = 107,300 mt. Given the provisional nature of the 2004 cooperative survey biomass estimates and potential for subsequent revision, the 2004 WG considers the surplus production model results to be preliminary and not yet sufficient for evaluation of the status of the stock with respect to reference points.

Evaluation of Stock Status with Respect to Reference Points

Monkfish in the northern and southern management areas are defined as being overfished (below $B_{threshold}$) when the three-year moving average autumn survey weight per tow falls below one half of B_{target}.. B_{target}. is defined as the median of the three-year moving average autumn survey weight per tow during 1965-1981. Thus $B_{threshold}$ = 1.25 for the northern management region and 0.93 for the southern management region. For both management areas, $F_{threshold}$ is set equal to F_{max}, currently estimated as F=0.2 (NEFSC 2002). The overfishing definition does not include an Ftarget reference point. Optimum yield is addressed by adjusting annual TACs and trip limits based on how biomass indices compare to annual biomass targets.

Northern Region

The current three-year moving average catch per tow (kg/tow from NEFSC offshore autumn research vessel survey) of 2.025 kg/tow is above Bthreshold (=1.25) (Table A35). The three-year running average has been above Bthreshold since 2000. The moving average remains below the biomass target of 2.496 kg/tow (median of three-year moving average during 1965-1981). Re-sampling from the error distribution of the indices used in calculating the biomass threshold and the current 3-year running average indicates that the probability the current 3-year average is at or above the biomass threshold is equal to 0.98 (Figure A56). The WG concluded that current F estimates are too uncertain to be used for evaluation of stock status relative to fishing mortality reference points.

Southern Region

The current three-year moving average catch per tow (kg/tow from NEFSC offshore autumn research vessel survey) of 0.93 is equal to Bthreshold (=0.93) (Table A35). The moving average was below Bthreshold from1986-2002. Re-sampling from the error distribution of the indices used in calculating the biomass threshold and the current 3-year running average indicates that the probability the current 3-year average is at or above the biomass threshold is equal to 0.56 (Figure A57). The three-year average remains well below the biomass target of 1.848 kg/tow (median of three-year moving average during 1965-1981). The WG concluded that current F estimates are too uncertain to be used for evaluation of stock status relative to fishing mortality reference points.

Trends in Stock Biomass, Recruitment, and Mortality

For the northern component, NEFSC autumn and spring research survey indices show an overall decline in biomass between 1975 and 1999 and a somewhat higher level since then (Tables A15 and A16, Figures A12 and A13). The increases since 2000 reflect increases in both spring and autumn survey abundance indices since 1998 (numbers per tow, Figures A13 and A16). The improved recruitment during the 1990s reflects contributions from several year classes (particularly 1993 and 1999). The maximum and mean lengths of goosefish caught in NEFSC surveys have increased in the past 3-4 years, but remain low relative to the entire time series (Figure A18).

For the southern component, biomass and abundance indices from the NEFSC spring and autumn surveys have fluctuated around the time series low since the mid-1980s, but have increased slightly since 2000 (Tables A20 and A21, Figures A21-A24). The 2002 yearclass appears to be relatively strong (Figure A14). The NEFSC winter flatfish survey shows an increasing trend in biomass since 1999 (Table A22, Figure A25); however, the survey has only been conducted since 1992. The maximum and mean lengths of goosefish in NEFSC surveys have stabilized during the past decade, but remain low relative to the time series (Figures A30 and C31).

For both stock components, indices of egg production (Figures A46-A47) mirror the progressive decline in abundance of larger fish in survey catches and the slight recovery of biomass in the northern region especially.

The WG did not consider available mortality estimates sufficiently precise for evaluating trends in mortality.

Working Group Comments

The Working Group discussed the increase in discards in 2000 through 2003. Minimum size limits and trip limits went into effect in May 2000, after the FMP was implemented. This appears to have increased regulatory discards. The recent discard estimates in the trawl fishery also could be biased by relative sampling effort in the multispecies fisheries (monkfish taken as bycatch) and directed monkfish trips if there are differences in discard patterns between vessels fishing under a groundfish day-at-sea or a monkfish day-at-sea. In the southern management area, both the trip limit and the minimum size limit are more constraining than in the northern management area. A recommendation was made to stratify the observer data by type of trip (monkfish vs. groundfish) to better characterize the discards. A preliminary examination done by stratifying discard rates by mesh size (>6.5 in. and <= 6.5 in) as a proxy for fishery type revealed higher discard rates on trips with mesh <= 6.5 inches. A more complete investigation is needed; however, the WG anticipates that this will be hampered by difficulties associated with linking the various databases (observer, dealer, etc.).

The Working Group noted the disparity between apparent longevity of males and females as well as the shape of the sex ratio curve for the Southern Region. A J-shaped curve usually represents cases where one sex stops growing and accumulates numbers at a certain length while the other sex continues to grow and becomes the only sex at larger lengths. In the case of monkfish, no males have been found to be older than 7 years which should not result in a J-shaped sex ratio curve. A recommendation was made to implement a tagging study, to determine where males go after age 7 or where females are from age 5 to 7. Also a recommendation was made for a program which would pay fishermen for bringing in any monkfish over 120 cm for biological sampling.

Selection of appropriate models for the depth-wingspread relationships was discussed by the Working Group. A polynomial function gave a good fit and conformed to expectations that wingspread should show a convex relationship with depth. The lack of wingspread data for the rockhopper net at shallow depths was addressed by examining several assumed values for the intercept. The WG decided to use an intercept for the rockhopper equal to the intercept of the flatnet relationship plus the difference in expected wingspread between the two gears, and assumed the same shape curve applied to the rockhopper as the flat net. The resulting relationship was used to assign wingspread to the rockhopper tows.

The Working Group decided to use nominal tow distances and intermediate net efficiency estimates for comparison of the 2001 and 2004 biomass estimates. Net efficiency estimates for the 2004 cooperative survey were not yet available, so efficiency estimates from the 2001 survey were used to calculate biomass for the 2004 survey. The 2004 estimates are provisional and are likely to change when the net efficiency estimates for 2004 become available.

Bayesian surplus production analyses from SARC 34 were updated with three additional years of catch and NEFSC survey data plus the biomass estimates from the 2004 cooperative research survey. A run starting with 1980 (SARC 34 recommendation) and assuming a uniform prior for r (intrinsic rate of increase) gave unrealistic results. Using the entire time series (1964-2003) and use of a beta-distribution prior with mean=0.5 and CV=20% for r gave more realistic results. The Working Group, however, considered these results preliminary given the provisional nature of the 2004 cooperative survey biomass estimates.

Research Recommendations

SARC 34 Recommendations and Actions Taken

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.

WG Response: An elemental analysis project is underway by Jonathan Grabowski at the University of Maine. Samples for the study were collected during the 2004 cooperative monkfish survey and analysis is expected to be completed by 2006. A study on reproductive behavior has been completed by Chris Chambers of NEFSC Sandy Hook Lab.

2) The SARC recommends changing the overfishing definitions for goosefish. Research on yield per recruit for goosefish should examine the effect and possible causes of differential natural mortality rates by sex, methods to estimate gear selectivity, and the incorporation of discards.

WG Response: The recommendations of SARC 34 were implemented in Framework 2 of the FMP in May 2003. The WG plans to update the estimation of selectivity patterns and the yield per recruit analysis for the next assessment review, tentatively scheduled for 2007. The WG will also explore the feasibility of estimating discards by trawl fishery strata (multispecies bycatch, directed monkfish).

3) Surplus production modeling should continue with special emphasis placed on uncertainty in under-reported catches and population size prior to 1980.

WG Response: The Bayesian surplus production model for goosefish was updated for this assessment by including 2001-2003 fishery catch, trawl survey indices, and the 2004 cooperative survey biomass estimates. As noted above concerning the current uncertainty of the 2004 cooperative survey biomass estimates and potential for subsequent revision, the Southern Demersal WG considers the surplus production results to be preliminary and not yet sufficient for evaluation of the status of the stock with respect to reference points. The WG plans to continue development of the model in the next assessment, since it appears to have potential to serve as a valuable tool for integration of the estimation of population biomass and mortality rates and reference points.

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.

WG Response: A cooperative research project is underway to investigate fishery selectivity patterns in the trawl fishery the Gulf of Maine (6.5 inch vs. 10 inch square mesh; M. Raymond of Associate Fisheries of Maine and C. Glass of Manomet CCS).

5) Another cooperative survey for monkfish should be conducted in 2004.

WG Response: The 2004 cooperative survey has been conducted, but analytical results are not yet complete.

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.

WG Response: The overall commercial fishery landings sampling intensity (samples per mt) was 171 mt per length sample in 2000 and 149 mt per sample in 2001. Sampling intensity improved to 121 mt per sample in both 2002 and 2003.

7) Tagging studies should be considered as a basis to evaluate adult movement and rates of growth.

WG Response: A limited number goosefish (46 individuals) were tagged as part of the Rutgers/SMART/MADMF gillnets fishery project. No returns have yet been reported from this project.

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.

WG Response: Elimination of minimum size regulations were considered, but not adopted, in the development of Amendment 2 to the FMP as a means to reduce discards. Instead, the minimum size regulation was reduced in the southern area to be consistent with the northern area.

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.

WG Response: A Study Fleet-NMFS cooperative research project has been implemented in several New England ports. Information on patterns of monkfish landings and cpue are expected to result from this project; no results are available at present.

Recommendations of Southern Demersal Working Group

1) Explore the feasibility of estimating trawl fishery discards separately for monkfish caught as bycatch on multispecies DAS and on directed monkfish trips, since possession limits are different and annually variable for these components of the fishery.

2) Update the SARC 34 selectivity analysis and yield-per-recruit calculations for the next assessment review, tentatively scheduled for 2007.

3) Implement a reward program for large monkfish specimens (> 120 cm total length). The goal of this program would be to gain information on longevity and natural mortality rate of monkfish, and extend age and growth studies.

4) Tagging studies should be considered as a basis to evaluate adult movement, spatial segregation by sex, and growth rates.

5) Given the time needed for thorough analysis of data from the cooperative surveys, the WG recommends that if a cooperative survey is conducted in winter/spring 2007, review of the survey should not be scheduled until at least the SARC in Spring 2009.

6) The cooperative monkfish surveys have greatly increased knowledge of monkfish biology, and have helped improve the reliability and accuracy of the stock assessment. An additional benefit has been increased industry acceptance of assessment results. However, the Northeast Region=s management and science agencies should carefully weigh the benefit:cost of the

cooperative monkfish surveys in considering whether to undertake a survey for 2007. If a survey is conducted in 2007, it is critical that sampling protocols (e.g. net and ground gear designs, survey timing, vessels) be examined and standardized to the extent possible to maximize the value of annual cooperative survey estimates. Sampling intensity should be evaluated to determine optimal levels and allocation of sampling effort.

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Appendix I

Bayesian Surplus Production Documentation

See text for explanation of variables. WinBugs program statements used to produce Bayesian surplus production estimates are shown below for northern and southern management regions.

****

```
Northern Goosefish
Bayesian State-Space Implementation
of Pella-Thomlinson Production Model

#  Jon Brodziak, NEFSC, October 2004
###########################################################################
model NGOOSE
{

# Prior distributions
#########################################################

# Gamma prior for shape parameter, M
# as 1+gamma(2,2) with mean=1 and var=1/2
#(1)#######################################################
x ~ dgamma(2,2)
M <- x+1

# Lognormal prior for carrying capacity parameter, K
#(2)#######################################################
# Uniform prior for K from 10 kt to 10000 kt
K ~ dunif(10,10000)

# Beta prior for intrinsic growth rate parameter, r
# with mean=0.5 and CV=20%
#(3)#######################################################
 y ~ dbeta(12.0,12.0)
r <- 0.1+(0.9*y)

# Gamma priors for survey catchability coefficients
# within interval (0.0001,10)
#(4)#######################################################
iqFALL ~ dgamma(0.001,0.001)I(0.1,10000)
qFALL <- 1/iqFALL

# Gamma prior for process error variance, sigma2
#(6)#######################################################
isigma2 ~ dgamma(a0,b0)
sigma2 <- 1/isigma2

# Gamma priors for observation error variances, tau2
#(7)#######################################################
itau2FALL   ~ dgamma(c0FALL,d0FALL)
tau2FALL   <- 1/itau2FALL

# Lognormal priors for time series of proportions of K, p[]
#(8)#######################################################
# Time series starts in 1964 and ends in 2003
Pmean[1] <- 0
P[1] ~ dlnorm(Pmean[1],isigma2) I(0.001,4)
dlow[1] <- dlowpre*NomCatch[1]
dup[1] <- duppre*NomCatch[1]
Catch[1] ~ dunif(dlow[1],dup[1])

# Low precision catch during 1964-1992
for (i in 2:29) {
   Pmean[i] <- log(max(P[i-1]+r*P[i-1]*(1-pow(P[i-1],M-1.0))-Catch[i-1]/K,0.001))
```

```
   P[i]  ~ dlnorm(Pmean[i],isigma2)I(0.001,4)
   dlow[i] <- dlowpre*NomCatch[i]
   dup[i] <- duppre*NomCatch[i]
   Catch[i] ~ dunif(dlow[i],dup[i])
   }

# High precision catch during 1993-2003
for (i in 30:N) {
   Pmean[i] <- log(max(P[i-1]+r*P[i-1]*(1-pow(P[i-1],M-1.0))-Catch[i-1]/K,0.001))
   P[i]  ~ dlnorm(Pmean[i],isigma2)I(0.001,4)
   dlow[i] <- dlowcur*NomCatch[i]
   dup[i] <- dupcur*NomCatch[i]
   Catch[i] ~ dunif(dlow[i],dup[i])
   }

# Lognormal likelihood for cooperative survey biomass in 2001
# based on observed biomass (Bobs2001) and efficiency (eff)
#(9)##################################################
PREDmean2001 <- log(K*P[38])
SurveyB2001 <- Bobs2001/eff
SurveyB2001 ~ dlnorm(PREDmean2001, SurveyPrec2001)

# Lognormal likelihood for observed survey indices
#(10)#################################################
# FALL SURVEY LIKELIHOOD 1964-2003 P[1:40]
for (i in 1:NFALL) {
    ImeanFALL[i] <- log(qFALL*K*P[i])
    IFALL[i] ~ dlnorm(ImeanFALL[i],itau2FALL)
    RESIDFALL[i] <- IFALL[i] - qFALL*K*P[i]
          }

# Compute exploitation rate and biomass time series
#(11)#################################################
# 1964-2003 P[1:40]
for (i in 1:N) {
    B[i] <- P[i]*K
    H[i] <- Catch[i]/B[i]
   }
P2004 <- max(P[N]+r*P[N]*(1-pow(P[N],M-1.0))-Catch[N]/K,0.001)
B2004 <- P2004*K

# Lognormal likelihood for cooperative survey biomass in 2004
# based on observed biomass (Bobs2004) and efficiency (eff)
#(11.5)###############################################
PREDmean2004 <- log(B2004)
SurveyB2004 <- Bobs2004/eff
SurveyB2004 ~ dlnorm(PREDmean2004, SurveyPrec2004)

# Compute reference points
#(12)#################################################
BMSP <- K*pow((1.0/M),(1.0/(M-1.0)))
PMSP <- BMSP/K
MSP <- r*BMSP*(1.0-(1.0/M))
HMSP <- r*(1.0-(1.0/M))
INDEXMSPFALL <- qFALL*BMSP
BMSPRATIO <- B[N]/BMSP
BLIMITRATIO <- 2*B[N]/BMSP
HRATIO <- H[N]/HMSP

# END OF CODE
#####################################################
}
Data
# Vector C() is total catch in thousand mt, 1964-2003
# Catch is GC for 1964-1981, WO+NC for 1982-1995, WO+D for 1996-2003
# Vector IFALL() is autumn kg/tow index, 1964-2003 (NFALL = 40 yrs)
# Sigma is state equation error with parameters a0,b0
# TauFALL is autumn observation error with parameters c0FALL,d0FALL
# Observed cooperative survey swept-area biomass set using
```

```
# intermediate efficiency and inclinometer distances Table C35, part C).
#(13)######################################################
list(
NomCatch=c(0.0495,0.0407,0.3289,0.594,0.4939,0.264,0.2189,0.2343,0.4807,
0.7788,1.32,2.0647,2.4816,3.4837,4.3736,4.4748,3.9853,3.4881,
4.246,4.2339,4.6222,5.0776,4.7597,5.456,5.5726,7.0301,6.3822,
6.2623,7.6153,11.7095,12.045,13.2352,12.626,11.07,8.058,9.915,11.544,
17.78497751,16.8105705,17.89984931),
IFALL=c(1.71235,2.50877,3.26621,1.28262,2.03626,3.7046,2.23697,2.9139,1.40358,3.11401,2.06265,1.71083,3.38701,5.5675,5.10086,5.1329,
4.45818,1.98444,0.935873,1.61742,3.01021,1.44087,2.35346,0.873207,1.52452,1.38425,1.00069,1.23533,1.104,1.04435,0.973433,1.71112,1.07
1,0.669,0.974,0.825,2.495,2.048,2.103,1.925),
N=40,NFALL=40,
a0=4.0,b0=0.01,
c0FALL=2.0,d0FALL=0.01,
dlowpre=0.90,
duppre=1.10,
dlowcur=0.99,
dupcur=1.01,
Bobs2001=68.680, eff=1.0, SurveyPrec2001=10.0,
Bobs2004=51.766, eff=1.0, SurveyPrec2004=1.0)
# Use a highly precise hammer to nail down trend

# Bobserved=68.680, eff=1.0, SurveyPrec=0.021)
# Assume a CV of 10% on survey biomass to set SurveyPrec
# 0.1*68.68 = 13.74 = STDEV, PRECISION = 1/VARIANCE = 1/47.17 = 0.021

Inits
# P[1:40] from 1964-2003
#(14)######################################################
# Initial Condition 1
list(P=c(0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.75,
0.75,0.75,0.5,0.5,0.5,0.4,0.4,0.4,0.3,0.3,0.3,0.2,0.2,0.2,0.2,0.2,0.2,0.2,
0.2,0.2,0.3,0.3,0.3,0.4,0.4),
Catch=c(0.0495,0.0407,0.3289,0.594,0.4939,0.264,0.2189,0.2343,0.4807,
0.7788,1.32,2.0647,2.4816,3.4837,4.3736,4.4748,3.9853,3.4881,
4.246,4.2339,4.6222,5.0776,4.7597,5.456,5.5726,7.0301,6.3822,
6.2623,7.6153,11.7095,12.045,13.2352,12.626,11.07,8.058,9.915,11.544,
17.78497751,16.8105705,17.89984931),
K=150,
x=1.1,
y=0.5,
iqFALL=100,
isigma2=100,
itau2FALL=100)
# Initial Condition 2
list(P=c(0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.75,
0.75,0.75,0.5,0.5,0.5,0.4,0.4,0.4,0.3,0.3,0.3,0.2,0.2,0.2,0.2,0.2,0.2,0.2,
0.2,0.2,0.3,0.3,0.3,0.4,0.4),
Catch=c(0.0495,0.0407,0.3289,0.594,0.4939,0.264,0.2189,0.2343,0.4807,
0.7788,1.32,2.0647,2.4816,3.4837,4.3736,4.4748,3.9853,3.4881,
4.246,4.2339,4.6222,5.0776,4.7597,5.456,5.5726,7.0301,6.3822,
6.2623,7.6153,11.7095,12.045,13.2352,12.626,11.07,8.058,9.915,11.544,
17.78497751,16.8105705,17.89984931),
K=100,
x=1.1,
y=0.5,
iqFALL=100,
isigma2=100,
itau2FALL=100)
```

Southern Goosefish
Bayesian State-Space Implementation
of Pella-Thomlinson Production Model

```
#  Jon Brodziak, NEFSC, October 2004
####################################################################

model SGOOSE
{

# Prior distributions
####################################################

# Gamma prior for shape parameter, M
# as 1+gamma(2,2) with mean=1 and var=1/2
#(1)####################################################
x~dgamma(2,2)
M <- 1+x

# Lognormal prior for carrying capacity parameter, K
#(2)####################################################
# Uniform prior for K from 10 kt to 10000 kt
K ~ dunif(10,10000)

# Beta prior for intrinsic growth rate parameter, r
# with mean=0.5 and CV=20%
#(3)####################################################
 y ~ dbeta(12.0,12.0)
r <- 0.1+(0.9*y)

# Gamma priors for survey catchability coefficients
# within interval (0.0001,10)
#(4)####################################################
iqFALL ~ dgamma(0.001,0.001)I(0.1,10000)
qFALL <- 1/iqFALL
iqSCALLOP ~ dgamma(0.001,0.001)I(0.1,10000)
qSCALLOP <- 1/iqSCALLOP

# Gamma prior for process error variance, sigma2
#(6)####################################################
isigma2 ~ dgamma(a0,b0)
sigma2 <- 1/isigma2

# Gamma priors for observation error variances, tau2
#(7)####################################################
itau2FALL   ~ dgamma(c0FALL,d0FALL)
tau2FALL   <- 1/itau2FALL
itau2SCALLOP   ~ dgamma(c0SCALLOP,d0SCALLOP)
tau2SCALLOP   <- 1/itau2SCALLOP

# Lognormal priors for time series of proportions of K, p[]
#(8)####################################################
# Time series starts in 1964 and ends in 2003
Pmean[1] <- 0
P[1] ~ dlnorm(Pmean[1],isigma2) I(0.001,4)
dlow[1] <- dlowpre*NomCatch[1]
dup[1] <- duppre*NomCatch[1]
Catch[1] ~ dunif(dlow[1],dup[1])

# Low precision catch during 1964-1992
for (i in 2:29) {
   Pmean[i] <- log(max(P[i-1]+r*P[i-1]*(1-pow(P[i-1],M-1.0))-Catch[i-1]/K,0.001))
   P[i]  ~ dlnorm(Pmean[i],isigma2)I(0.001,4)
   dlow[i] <- dlowpre*NomCatch[i]
   dup[i] <- duppre*NomCatch[i]
   Catch[i] ~ dunif(dlow[i],dup[i])
   }
```

```
# High precision catch during 1993-2003
for (i in 30:N) {
   Pmean[i] <- log(max(P[i-1]+r*P[i-1]*(1-pow(P[i-1],M-1.0))-Catch[i-1]/K,0.001))
   P[i]  ~ dlnorm(Pmean[i],isigma2)I(0.001,4)
   dlow[i] <- dlowcur*NomCatch[i]
   dup[i] <- dupcur*NomCatch[i]
   Catch[i] ~ dunif(dlow[i],dup[i])
   }

# Lognormal likelihood for cooperative survey biomass in 2001
# based on observed biomass (Bobs2001) and efficiency (eff)
#(9)################################################
PREDmean2001 <- log(K*P[38])
SurveyB2001 <- Bobs2001/eff
SurveyB2001 ~ dlnorm(PREDmean2001, SurveyPrec2001)


# Lognormal likelihood for observed survey indices
#(10)################################################
# FALL SURVEY LIKELIHOOD 1964-2003 P[1:40]
for (i in 1:NFALL) {
    ImeanFALL[i] <- log(qFALL*K*P[i])
    IFALL[i] ~ dlnorm(ImeanFALL[i],itau2FALL)
    RESIDFALL[i] <- IFALL[i] - qFALL*K*P[i]
                }
# SCALLOP SURVEY LIKELIHOOD 1984-2003 P[20:40]
for (i in 1:NSCALLOP) {
    ImeanSCALLOP[i] <- log(qSCALLOP*K*P[i+20])
    ISCALLOP[i] ~ dlnorm(ImeanSCALLOP[i],itau2SCALLOP)
    RESIDSCALLOP[i] <- ISCALLOP[i] - qSCALLOP*K*P[i+20]
   }

# Compute exploitation rate and biomass time series
#(11)################################################
# 1964-2003 P[1:40]
for (i in 1:N) {
    B[i] <- P[i]*K
    H[i] <- Catch[i]/B[i]
   }
P2004 <- max(P[N]+r*P[N]*(1-pow(P[N],M-1.0))-Catch[N]/K,0.001)
B2004 <- P2004*K

# Lognormal likelihood for cooperative survey biomass in 2004
# based on observed biomass (Bobs2004) and efficiency (eff)
#(11.5)################################################
PREDmean2004 <- log(B2004)
SurveyB2004 <- Bobs2004/eff
SurveyB2004 ~ dlnorm(PREDmean2004, SurveyPrec2004)

# Compute reference points
#(12)################################################
BMSP <- K*pow((1.0/M),(1.0/(M-1.0)))
PMSP <- BMSP/K
MSP <- r*BMSP*(1.0-(1.0/M))
HMSP <- r*(1.0-(1.0/M))
INDEXMSPFALL <- qFALL*BMSP
INDEXMSPSCALLOP <- qSCALLOP*BMSP
BMSPRATIO <- B[N]/BMSP
BLIMITRATIO <- 2*B[N]/BMSP
HRATIO <- H[N]/HMSP
# END OF CODE
###################################################
}

Data
# Vector C() is total catch in k mt, 1964-2003
# Vector IFALL() is autumn kg/tow index, 1964-2003 (NFALL = 40 yrs)
# Vector ISCALLOP is scallop kg/tow index, 1984-2003 (NSCALLOP = 20 yrs)
# Sigma is state equation error with parameters a0,b0
```

```
# TauFALL is autumn observation error with parameters c0FALL,d0FALL
# TauSCALLOP is scallop survey observation error
# with parameters c0SCALLOP,d0SCALLOP
#(13)#########################################################
list(
NomCatch=c(0.0671,0.0869,0.0759,0.0649,0.0396,0.0473,0.0583,0.0583,0.0715,0.264,0.2013,0.4587,0.6688,1.4454,2.2803,5.1667,6.6385,4.556
2,
4.0942,4.5265,4.0689,4.6882,4.4407,4.1382,5.0545,9.1883,7.9244,10.8515,15.3362,16.6078,13.3386,16.0875,18.028,20.694,20.593,
17.849,12.96,19.45451328,11.0591012,14.38517574),
IFALL=c(5.48579,5.16263,6.98617,1.12164,0.849839,1.1379,1.35723,0.786386,4.91809,1.98611,0.710169,2.04263,1.08444,1.87322,1.39471,2.
27505,1.86779,2.8583,0.645644,2.15023,0.740248,1.31789,0.551995,0.274414,0.55434,0.625257,0.425785,0.783325,0.312131,0.293588,0.6109
56,0.385586,0.387,0.592,0.5,0.304,0.477,0.709,1.253,0.828),
ISCALLOP=c(1.06814,1.07323,0.934246,2.41766,1.44351,1.24137,1.40098,2.21551,1.87721,2.63923,3.09495,2.09344,1.81403,1.046,0.958,2.4
41,2.321,1.68,1.653,2.775),
N=40,NFALL=40,NSCALLOP=20,
a0=4.0,b0=0.01,
c0FALL=2.0,d0FALL=0.01,
c0SCALLOP=2.0,d0SCALLOP=0.01,
dlowpre=0.90,
duppre=1.10,
dlowcur=0.99,
dupcur=1.01,
Bobs2001=66.23, eff=1.0, SurveyPrec2001=10.0,
Bobs2004=109.807, eff=1.0, SurveyPrec2004=1.0)
# Use a highly precise hammer to nail down trend

# Bobserved=66.23, eff=1.0, SurveyPrec=0.0228)
# Assume a CV of 10% on survey biomass to set SurveyPrec
# 0.1*66.23 = 6.623 = STDEV, PRECISION = 1/VARIANCE = 1/43.864 = 0.0326

Inits
# P[1:40] from 1964-2003
#(14)#########################################################
# Initial Condition 1
list(
P=c(0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.75,
0.75,0.75,0.5,0.5,0.5,0.4,0.4,0.4,0.3,0.3,0.3,0.2,0.2,0.2,0.2,0.2,0.2,0.2,
0.2,0.2,0.3,0.3,0.3,0.4,0.4),
Catch=c(0.0671,0.0869,0.0759,0.0649,0.0396,0.0473,0.0583,0.0583,0.0715,0.264,0.2013,0.4587,0.6688,1.4454,2.2803,5.1667,6.6385,4.5562,
4.0942,4.5265,4.0689,4.6882,4.4407,4.1382,5.0545,9.1883,7.9244,10.8515,15.3362,16.6078,13.3386,16.0875,18.028,20.694,20.593,
17.849,12.96,19.45451328,11.0591012,14.38517574),
x=1.1,
y=0.5,
K=200,
iqFALL=100,iqSCALLOP=100,
isigma2=100,
itau2FALL=100,itau2SCALLOP=100)
# Initial Condition 2
list(
P=c(0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.9,0.75,
0.75,0.75,0.5,0.5,0.5,0.4,0.4,0.4,0.3,0.3,0.3,0.2,0.2,0.2,0.2,0.2,0.2,0.2,
0.2,0.2,0.3,0.3,0.3,0.4,0.4),
Catch=c(0.0671,0.0869,0.0759,0.0649,0.0396,0.0473,0.0583,0.0583,0.0715,0.264,0.2013,0.4587,0.6688,1.4454,2.2803,5.1667,6.6385,4.5562,
4.0942,4.5265,4.0689,4.6882,4.4407,4.1382,5.0545,9.1883,7.9244,10.8515,15.3362,16.6078,13.3386,16.0875,18.028,20.694,20.593,
17.849,12.96,19.45451328,11.0591012,14.38517574),
x=1.1,
y=0.5,
K=200,
iqFALL=100,iqSCALLOP=100,
isigma2=100,
itau2FALL=100,itau2SCALLOP=100)
```

Table A1.

Monkfish FMP Timeline

Nov. 1999	FMP implemented: multi-level limited access program two management areas target TACs effort limitations (DAS) – Year 3 default measures (0 DAS) trip limits bycatch allowances minimum fish sizes and minimum mesh size gear restrictions spawning season closures a framework adjustment process permitting and reporting requirements 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 – one-year postponement of default measures while the Councils prepared Amendment 2.
May. 2002	Emergency Rule – Framework 1 disapproved for non-compliance with F threshold in the original plan (which had been 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, and for calculating DAS and trip limits. Also eliminated the default measures.

FY MAY	Trip Limits (lbs. tail wt./DAS) SFMA only	
2000	A&C: 1,500 trawls, 300 gillnets B&D: 1,000 trawls, 300 gillnets	
2001	Gillnet trip limits set equal to trawl/permit category (11/01)	
2002	A&C: 550 B&D: 450	
2003	A&C: 1,250 B&D: 1,000	
2004	A&C: 550 (with 28 DAS in the SFMA) B&D: 450 (with 28 DAS in the SFMA)	

Table A2. Landings (calculated live weight, mt) of goosefish as reported in NEFSC weighout data base (1964-1993) and vessel trip reports (1994-2003) (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 suggested source for landings which are used in the total column at the far right (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	12,032	14,625	26,657				418	27,075
1996	10,762	16,032	26,794				184	26,978
1997	9,794	18,534	28,328				189	28,517
1998	7,367	19,309	26,676				190	26,866
1999	9,260	15,953	25,213				151	25,364
2000	10,685	10,191	20,876				176	21,052
2001	13,500	9,801	23,301				149	23,450
2002	14,029	8,866	22,895				294	23,189
2003	15,103	10,963	26,066				309	26,375

Table A3. U.S. landings of goosefish (calculated live weight) 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	44.93	0.02			44.95	18.99				18.99	63.92	0.02			63.94
1965	36.41	0.20			36.61	16.61				16.61	53.23	0.20			53.43
1966	298.80	0.17		0.05	299.03	12.63			0.08	12.71	311.43	0.17		0.14	311.74
1967	531.85		7.61		539.46	7.58				7.58	539.64		7.61		547.25
1968	447.19		4.11		451.30	2.07				2.07	449.26		4.11		453.37
1969	253.14	1.35	3.98		258.47	4.02				4.02	257.16	1.35	3.98		262.49
1970	198.25	0.32		0.06	198.63	12.16				12.16	210.41	0.32		0.06	210.79
1971	212.57		0.17		212.74	10.11				10.11	222.68		0.17		222.85
1972	426.45	7.74	1.30	1.57	437.06	24.43				24.43	450.87	7.74	1.30	1.57	461.48
1973	660.85	28.68	12.24	7.96	709.73	131.51		4.88	1.00	137.39	793.54	28.68	17.11	8.96	848.29
1974	1059.61	104.95	7.27	24.73	1196.56	98.03			0.10	98.13	1160.09	104.95	7.27	24.82	1297.13
1975	1711.64	122.83	9.51	8.57	1852.55	265.48	0.24	2.16	1.56	269.44	1989.84	123.07	11.67	10.13	2134.71
1976	2031.30	142.96	46.73	14.62	2235.61	333.09		6.97	0.24	340.30	2458.97	142.96	53.70	14.86	2670.49
1977	2736.74	230.22	142.08	27.56	3136.60	508.08		57.11	25.54	590.73	3487.32	230.22	202.46	53.11	3973.11
1978	3254.89	367.96	212.00	54.17	3889.02	604.78	0.14	507.29	25.50	1137.71	4016.02	368.10	774.35	79.66	5238.13
1979	2966.80	393.04	583.69	70.63	4014.16	943.68	6.13	1015.27	16.33	1981.41	3988.97	399.18	2069.76	86.96	6544.87
1980	2525.97	518.24	595.68	55.66	3695.55	1138.82	10.04	1273.50	6.81	2429.17	3723.11	528.28	2275.51	62.47	6589.37
1981	2266.33	460.64	443.42	46.77	3217.16	1100.10	16.03	781.53	105.45	2003.11	3483.30	477.28	1399.19	152.22	5511.99
1982	3039.51	420.92	367.07	32.41	3859.90	1805.81	11.88	1507.13	27.27	3352.09	4998.08	432.80	2060.73	59.68	7551.29
1983	3233.10	313.69	265.70	36.96	3849.45	1818.58	11.38	2118.86	17.16	3965.98	5165.97	325.07	2430.74	55.54	7977.32
1984	3647.80	314.93	196.37	42.84	4201.94	1714.49	15.46	1704.40	17.97	3452.32	5512.58	330.39	1967.53	60.81	7871.31
1985	3982.26	314.52	263.58	55.33	4615.69	1739.05	17.33	2347.22	2.88	4106.48	5756.74	331.85	2610.80	58.21	8757.60
1986	3412.10	326.21	552.69	35.64	4326.64	1841.10	32.11	2068.22	12.15	3953.58	5317.97	358.32	2620.90	47.79	8344.98
1987	3853.06	373.99	695.43	37.57	4960.05	1679.88	26.25	1996.95	3.42	3706.50	5560.79	400.24	2692.39	40.99	8694.41
1988	3553.90	304.08	1171.59	36.23	5065.80	1828.37	58.22	2593.83	3.02	4483.44	5399.48	362.50	3765.42	39.26	9566.66
1989	3428.68	348.65	2584.13	29.72	6391.18	3240.35	16.89	5035.79	3.47	8296.50	6679.05	366.02	7619.92	33.20	14698.19
1990	3297.60	338.43	2140.73	25.20	5801.97	2361.40	32.11	4744.23	4.75	7142.49	5697.44	371.82	6884.97	29.96	12984.19
1991	3298.76	337.64	2033.44	23.73	5693.57	5515.03	362.60	3907.06	15.72	9800.41	8847.11	700.47	5940.50	39.45	15527.53
1992	4329.96	358.97	2210.53	23.89	6923.36	6527.85	977.16	6408.94	10.80	13924.75	10859.54	1336.14	8619.48	34.69	20849.85
1993	5889.87	695.02	4034.08	26.26	10645.23	5986.62	1722.40	7158.01	192.14	15059.17	11878.65	2417.42	11192.09	218.40	25706.56
1994	7573.88	1571.26	1807.84	86.42	11039.40	5233.06	2342.47	3994.91	555.96	12126.40	12707.47	3883.88	5758.86	637.57	22987.78
1995	9257.30	1528.60	1188.90	56.80	12031.60	5725.40	3804.60	4109.40	742.80	14382.20	14982.76	5333.24	5298.25	799.62	26413.87
1996	8436.50	1391.00	889.30	45.00	10761.80	7173.20	4220.40	4362.30	32.70	15788.60	15609.69	5611.39	5251.52	77.67	26550.27
1997	7399.90	1004.00	1344.60	45.20	9793.70	8234.10	5201.80	4894.50	203.50	18533.90	15633.97	6205.74	6239.05	248.67	28327.43
1998	5443.70	905.50	990.40	26.90	7366.50	7831.90	6195.70	5148.00	133.70	19309.30	13275.58	7101.15	6138.46	160.65	26675.84
1999	7002.20	1492.30	739.50	25.80	9259.80	6398.70	6163.90	3339.10	51.80	15953.50	13400.93	7656.17	4078.59	77.58	25213.27
2000	8160.55	2097.49	347.72	79.33	10685.09	4091.38	4009.91	1942.79	146.52	10190.60	12251.93	6107.40	2290.51	225.85	20875.69
2001	10059.02	2975.60	454.22	10.66	13499.50	3022.36	5102.62	1645.94	30.32	9801.24	13081.38	8078.22	2100.16	40.98	23300.74
2002	10870.24	2969.91	176.00	13.06	14029.21	1552.76	5418.79	1851.90	42.80	8866.25	12423.00	8388.70	2027.90	55.86	22895.46
2003	12057.68	2553.44	237.76	253.62	15102.50	1995.97	7182.90	1701.40	82.80	10963.07	14053.65	9736.34	1939.16	336.42	26065.57

Table A4. Landed weight (mt) of goosefish by market category for 1964-2003 for combined assessment areas (SA 511-636), NEFSC weightout database and vessel trip reports (1994-2003).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	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	16.1	0.0	0.0	0.0	16.1
1966	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	164.8	0.0	0.0	0.0	164.8
1968	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	79.1	0.0	0.0	0.0	79.1
1970	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	67.1	0.0	0.0	0.0	67.1
1972	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	255.5	0.0	0.0	0.0	255.5
1974	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	642.8	0.0	0.0	0.0	642.8
1976	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	1194.4	0.0	0.0	0.0	1194.4
1978	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	2224.7	0.0	0.0	0.0	2224.7
1980	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	1654.2	0.0	0.0	0.0	1654.2
1982	0.0	0.0	10.2	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	2009.9	241.4	138.6	0.0	2390.0
1984	0.0	0.0	25.0	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	2467.0	86.7	73.4	0.0	2627.1
1986	0.0	0.0	36.3	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	2463.7	139.9	6.7	0.0	2610.3
1988	0.0	0.0	112.8	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	3501.8	557.4	360.0	0.0	4419.2
1990	0.0	0.0	179.7	0.0	217.7	2601.8	854.1	377.4	0.0	3833.3
1991	0.0	8.6	270.3	0.0	415.4	2229.1	1661.9	614.1	36.6	4541.6
1992	0.2	3.7	321.5	0.0	386.0	2778.7	1908.1	1293.0	183.3	6163.1
1993	0.0	1.7	459.9	98.2	528.7	3503.2	1933.0	1851.1	262.4	7549.8
1994	0.0	5.3	458.1	1453.6	2044.8	1256.9	2230.7	2063.3	258.0	5808.9
1995	2.3	1.0	500.1	2763.2	2652.6	895.6	2524.6	2424.4	363.5	6208.1
1996	0.4	0.6	571.6	3475.9	1064.3	1086.9	2094.1	3032.1	269.8	6482.9
1997	0.1	0.1	630.7	3210.0	795.2	675.5	3067.7	3295.7	151.6	7190.6
1998	0.0	0.5	607.4	3592.1	581.8	862.3	3013.6	2654.8	95.5	6626.2
1999	0.1	0.2	597.4	5748.1	1131.4	537.2	2388.3	2200.8	153.4	5279.8
2000	0.0	3.7	624.0	6914.1	1091.0	293.6	1580.0	1707.3	4.3	3585.1
2001	0.5	0.0	559.0	7028.2	531.4	245.3	1958.9	2140.3	0.4	4344.9
2002	0.2	0.1	507.8	7748.4	566.8	243.0	1669.0	2108.1	0.2	4020.3
2003	0.0	1.0	486.0	7271.8	665.3	329.0	2345.6	2430.5	0.7	5105.8

Table A5. Landed weight (mt) of goosefish by market category for 1964-2003 for northern assessment area (SA 511-523 and 561), NEFSC weightout database and vessel trip reports (1994-2003).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	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	11.0	0.0	0.0	0.0	11.0
1966	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	162.5	0.0	0.0	0.0	162.5
1968	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	77.8	0.0	0.0	0.0	77.8
1970	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	64.1	0.0	0.0	0.0	64.1
1972	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	213.8	0.0	0.0	0.0	213.8
1974	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	558.0	0.0	0.0	0.0	558.0
1976	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	944.7	0.0	0.0	0.0	944.7
1978	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	1209.1	0.0	0.0	0.0	1209.1
1980	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	969.0	0.0	0.0	0.0	969.0
1982	0.0	0.0	10.0	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	1152.3	4.8	2.4	0.0	1159.4
1984	0.0	0.0	14.7	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	1385.9	1.6	2.6	0.0	1390.2
1986	0.0	0.0	13.7	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	1491.5	1.7	0.7	0.0	1493.9
1988	0.0	0.0	47.4	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	1464.5	327.0	130.2	0.0	1921.6
1990	0.0	0.0	77.9	0.0	30.3	1173.7	410.7	154.0	0.0	1738.4
1991	0.0	3.3	70.0	0.0	0.3	1013.9	538.6	153.2	9.1	1714.8
1992	0.0	0.7	83.0	0.0	0.1	910.5	589.9	505.4	79.4	2085.3
1993	0.0	0.6	208.3	98.2	350.6	1034.3	867.9	1061.8	102.9	3067.0
1994	0.0	1.4	207.6	532.7	981.3	403.0	1205.7	1074.8	136.2	2819.7
1995	0.0	0.7	176.1	1213.4	1122.0	369.7	1178.6	1015.5	305.6	2869.3
1996	0.3	0.4	196.2	1114.2	756.3	92.5	933.0	1381.5	224.1	2631.0
1997	0.0	0.1	154.6	628.5	247.0	29.0	1142.6	1368.9	119.2	2659.6
1998	0.0	0.1	129.4	558.5	145.5	18.2	1067.2	818.7	79.2	1983.3
1999	0.0	0.1	173.2	1670.7	510.1	28.9	1021.8	871.7	139.4	2061.7
2000	0.0	0.1	286.6	3202.7	907.6	17.3	780.6	1044.6	2.7	1845.3
2001	0.0	0.0	270.2	3111.2	233.6	127.9	1136.1	1663.4	0.0	2927.4
2002	0.0	0.1	259.6	3789.6	24.1	79.7	1055.0	1782.4	0.0	2917.1
2003	0.0	0.4	221.5	2413.7	13.7	94.7	1582.4	2038.9	0.0	3716.0

Table A6. Landed weight (mt) of goosefish by market category for 1964-2003 for southern assessment area (SA 524-636 excluding 561), NEFSC weightout database and vessel trip reports (1994-2003).

Year	Belly Flaps	Cheeks	Livers	Gutted	Round	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	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	5.0	0.0	0.0	0.0	5.0
1966	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	2.3	0.0	0.0	0.0	2.3
1968	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	1.2	0.0	0.0	0.0	1.2
1970	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	3.0	0.0	0.0	0.0	3.0
1972	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	41.7	0.0	0.0	0.0	41.7
1974	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	84.8	0.0	0.0	0.0	84.8
1976	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	249.6	0.0	0.0	0.0	249.6
1978	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	1015.6	0.0	0.0	0.0	1015.6
1980	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	685.0	0.0	0.0	0.0	685.0
1982	0.0	0.0	0.2	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	857.7	236.6	136.2	0.0	1230.5
1984	0.0	0.0	10.3	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	1081.1	85.1	70.8	0.0	1236.9
1986	0.0	0.0	22.6	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	972.2	138.2	6.0	0.0	1116.4
1988	0.0	0.0	65.4	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	2037.4	230.4	229.8	0.0	2497.5
1990	0.0	0.0	101.8	0.0	187.3	1428.1	443.4	223.4	0.0	2094.9
1991	0.0	5.2	200.2	0.0	415.1	1215.2	1123.3	460.9	27.5	2826.8
1992	0.2	3.0	238.5	0.0	385.9	1868.2	1318.3	787.6	103.9	4077.9
1993	0.0	1.1	251.5	0.0	178.1	2468.9	1065.1	789.3	159.4	4482.8
1994	0.0	3.8	250.5	921.0	1063.5	853.9	1025.0	988.5	121.8	2989.2
1995	2.3	0.3	324.0	1549.8	1530.6	526.0	1346.0	1409.0	57.8	3338.8
1996	0.1	0.3	375.4	2361.7	308.0	994.4	1161.2	1650.6	45.7	3851.9
1997	0.1	0.0	476.1	2581.5	548.1	646.6	1925.2	1926.8	32.4	4531.0
1998	0.0	0.4	478.0	3033.6	436.3	844.1	1946.4	1836.1	16.3	4642.9
1999	0.1	0.1	424.2	4077.4	621.3	508.4	1366.5	1329.1	14.1	3218.0
2000	0.0	3.5	337.4	3711.3	183.4	276.3	799.3	662.6	1.6	1739.9
2001	0.5	0.0	289.1	3917.0	297.9	217.4	822.8	476.9	0.4	1517.5
2002	0.2	0.0	249.1	4012.1	551.3	166.9	628.9	330.9	0.2	1126.9
2003	0.0	0.6	264.7	4906.2	666.6	242.0	775.5	398.4	0.7	1416.5

Table A7. Number of commercial samples and length measurements 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	306	306	1	123	3,302	3,302	2	232	3,608	1,804
	tails large	13	1,383	3,097	238	6	618	3,856	643	19	2,001	6,953	366
	tails small	10	1,438	4,588	459	6	609	5,479	913	16	2,047	10,067	629
	tails peewee	9	1,258	744	83	4	415	152	38	13	1,673	896	69
	unclass round	2	252	752	376	-	-	313	-	2	252	1,065	533
	head on, gutted	3	478	1,284	428	7	1,287	2,679	383	10	1,765	3,963	396
	annual total	38	4,918	10,771	-	24	3,052	15,781	-	62	7,970	26,552	428
1997	tails only	-	-	104	-	-	-	2,139	-	-	-	2,243	-
	tails large	12	1,324	3,831	319	12	1,220	6,354	530	24	2,544	10,185	424
	tails small	12	1,262	4,529	377	14	1,451	6,413	458	26	2,713	10,942	421
	tails peewee	9	863	396	44	3	300	108	36	12	1,163	504	42
	unclass round	10	936	243	24	1	98	552	552	11	1,034	795	72
	head on, gutted	1	53	718	718	4	551	2,942	736	5	604	3,660	732
	annual total	44	4,438	9,821	-	34	3,620	18,508	-	78	8,058	28,329	363
1998	tails only	-	-	72	-	-	-	2,789	-	-	-	2,861	-
	tails large	6	713	3,548	591	5	487	6,457	1,291	11	1,200	10,005	910
	tails small	8	877	2,728	341	4	444	6,086	1,522	12	1,321	8,814	735
	tails peewee	1	136	263	263	-	-	54	-	1	136	317	317
	unclass round	-	-	142	-	-	-	440	-	-	-	582	-
	head on, gutted	-	-	659	-	-	-	3,436	-	-	-	4,095	-
	annual total	15	1,726	7,412	-	9	931	19,262	-	24	2,657	26,674	1,111
1999	tails only	-	-	158	-	-	-	1,224	-	-	-	1,382	-
	tails large	6	634	3,436	573	5	480	4,652	930	11	1,114	8,088	735
	tails small	19	1,997	2,926	154	8	814	4,533	567	27	2,811	7,459	276
	tails peewee	-	-	463	-	-	-	48	-	-	-	511	-
	unclass round	-	-	499	-	-	-	633	-	-	-	1,132	-
	head on, gutted	1	115	1,872	1,872	4	254	4,581	1,145	5	369	6,453	1,291
	annual total	26	2,746	9,354	-	17	1,548	15,671	-	43	4,294	25,025	582
2000	tails only	-	-	58	-	1	102	917	910	1	102	967	967
	tails large	6	567	2,592	431	7	667	2,654	380	13	1,234	5,243	403
	tails small	50	5,175	3,468	69	7	748	2,200	314	57	5,923	5,668	99
	tails peewee	-	-	9	-	-	-	5	-	-	-	14	-
	unclass round	16	1,839	908	57	-	-	183	-	16	1,839	1,091	68
	head on, gutted	21	2,095	3,651	174	14	1,175	4,231	302	35	3,270	7,881	225
	annual total	93	9,676	10,686	-	29	2,692	10,191	-	122	12,368	20,865	171
2001	tails only	-	-	425	-	-	-	722	-	-	-	1147	-
	tails large	47	5070	3772	80	6	612	2732	455	53	5682	6504	123
	tails small	54	5684	5523	102	8	741	1583	198	62	6425	7106	115
	tails peewee	-	-	0	-		-	1	-	-	-	1	-
	unclass round	-	-	234	-	1	113	298	298	1	113	532	532
	head on, gutted	31	3241	3547	114	39	4043	4465	114	70	7284	8012	114
	annual total	132	13995	13501	-	24	5509	9801	-	156	19504	23302	-
2002	tails only	1	51	265	265	-	-	554	-	1	51	819	-
	tails large	55	6081	3503	64	14	1012	2088	149	69	7093	5591	81
	tails small	59	7038	5918	100	7	580	1099	157	66	7618	7017	106
	tails peewee	-	-	0	-	-	-	1	-	-	-	1	-
	unclass round	-	-	24	-	1	91	551	551	1	91	575	575
	head on, gutted	23	2347	4320	188	29	2988	4574	158	52	5335	8894	171
	annual total	138	15517	14030	-	51	4706	8866	-	189	20223	22896	-
2003	tails only	-	-	314	-	-	-	803	-	-	-	1118	-
	tails large	54	5093	5254	97	9	706	2575	286	63	5799	7828	124
	tails small	63	5431	6769	107	7	566	1323	189	70	5997	8092	116
	tails peewee	-	-	0	-	-	-	2	-	-	-	2	-
	unclass round	1	100	14	14	2	162	667	333	3	262	680	227
	head on, gutted	59	3549	2752	47	21	1837	5593	266	80	5386	8345	104
	annual total	177	14173	15103	-	39	3271	10963	-	216	17444	26065	-

Table A8. Discard ratios (mt discarded / mt kept) of goosefish by gear and half year from fishery observer and VTR databases, northern area.

North			Observer Data				VTR Data			
GEAR	YEAR	HALF	No. Tows	Kept (mt)	Discard (mt)	Disc Ratio	No. Trips	Kept (mt)	Discard (mt)	Disc Ratio
Dredge	1996	1	150	0.680	0.324	0.476	10	2.074	0.696	0.336
		2	309	3.779	1.102	0.292	48	43.741	5.144	0.118
		Total	459	4.460	1.426	0.320	58	45.815	5.841	0.127
	1997	1	139	0.216	0.303	1.405	21	7.664	0.959	0.125
		2	437	9.421	1.210	0.128	31	39.441	3.562	0.090
		Total	576	9.637	1.514	0.157	52	47.105	4.521	0.096
	1998	1	79	0.470	0.061	0.131	21	3.540	1.511	0.427
		2	169	5.929	0.301	0.051	21	21.514	2.028	0.094
		Total	248	6.399	0.362	0.057	42	25.054	3.538	0.141
	1999	1	79	0.469	0.070	0.149	10	1.848	0.739	0.400
		2	28	0.164	0.000	0.000	23	11.530	0.742	0.064
		Total	107	0.633	0.070	0.110	33	13.378	1.481	0.111
	2000	1	2	0.044	0.006	0.140	13	3.180	0.356	0.112
		2	12	0.144	0.022	0.155	18	9.920	2.248	0.227
		Total	14	0.188	0.028	0.152	31	13.100	2.604	0.199
	2001	1	5	0.026	0.030	1.142	10	1.436	0.653	0.455
		2	0	-	-	-	31	13.559	3.124	0.230
		Total	5	0.026	0.030	1.142	41	14.995	3.777	0.252
	2002	1	0	-	-		67	2.123	0.606	0.285
		2	248	3.150	2.360	0.749	17	1.529	0.821	0.537
		Total	248	3.150	2.360	0.749	84	3.652	1.427	0.391
	2003	1	24	0.000	0.059	-	25	0.151	0.278	1.841
		2	392	4.988	3.993	0.801	11	3.502	0.324	0.093
		Total	416	4.988	3.993	0.801	36	3.653	0.602	0.165
Gillnet	1996	1	70	1.818	0.248	0.136	178	35.861	0.866	0.024
		2	102	2.240	0.305	0.136	335	120.794	2.814	0.023
		Total	172	4.058	0.553	0.136	513	156.655	3.680	0.023
	1997	1	55	1.770	0.068	0.038	109	3.747	0.196	0.052
		2	76	1.430	0.278	0.194	193	16.664	0.519	0.031
		Total	131	3.200	0.345	0.108	302	20.411	0.715	0.035
	1998	1	83	1.098	0.032	0.029	110	10.678	0.613	0.057
		2	160	4.808	0.209	0.044	135	10.422	0.382	0.037
		Total	243	5.906	0.242	0.041	245	21.100	0.995	0.047
	1999	1	80	1.236	0.084	0.068	118	21.803	0.923	0.042
		2	136	5.828	0.072	0.012	274	99.446	6.441	0.065
		Total	216	7.064	0.156	0.022	392	121.249	7.364	0.061
	2000	1	117	3.091	0.106	0.034	141	39.352	2.357	0.060
		2	226	15.921	1.244	0.078	550	283.340	19.810	0.070
		Total	343	19.011	1.350	0.071	691	322.692	22.167	0.069
	2001	1	470	9.398	0.217	0.023	170	70.505	2.329	0.033
		2	591	30.079	4.235	0.141	398	180.104	14.325	0.080
		Total	1061	39.477	4.452	0.113	568	250.609	16.654	0.066
	2002	1	394	13.322	0.321	0.024	95	25.543	0.970	0.038
		2	722	39.405	1.066	0.027	241	76.966	4.124	0.054
		Total	1116	52.727	1.388	0.026	336	102.509	5.094	0.050
	2003	1	332	13.424	0.831	0.062	65	48.492	1.746	0.036
		2	848	50.012	3.333	0.067	438	292.670	15.824	0.054
		Total	1180	63.436	4.164	0.066	503	341.162	17.570	0.052

Trawl	1996	1	388	38.342	7.550	0.197	750	352.498	26.965	0.076
		2	159	3.540	0.467	0.132	1339	348.205	23.180	0.067
		Total	547	41.883	8.017	0.191	2089	700.703	50.146	0.072
	1997	1	212	20.731	2.169	0.105	733	238.566	17.178	0.072
		2	169	14.472	1.112	0.077	1066	228.037	13.476	0.059
		Total	381	35.203	3.281	0.093	1799	466.603	30.654	0.066
	1998	1	86	5.498	0.666	0.121	588	156.483	8.120	0.052
		2	25	1.313	0.115	0.087	913	149.004	7.561	0.051
		Total	111	6.811	0.780	0.115	1501	305.487	15.681	0.051
	1999	1	47	4.042	0.398	0.098	609	268.948	12.686	0.047
		2	205	12.692	0.781	0.062	1207	246.484	21.044	0.085
		Total	252	16.734	1.179	0.070	1816	515.432	33.730	0.065
	2000	1	433	52.684	3.691	0.070	723	320.608	37.027	0.115
		2	479	61.414	5.436	0.089	1502	410.703	59.302	0.144
		Total	912	114.098	9.127	0.080	2225	731.311	96.329	0.132
	2001	1	831	34.753	13.861	0.399	890	499.266	60.278	0.121
		2	1172	48.370	13.656	0.282	1321	487.115	77.198	0.158
		Total	2003	83.123	27.516	0.331	2211	986.381	137.476	0.139
	2002	1	527	30.883	7.372	0.239	767	814.873	120.403	0.148
		2	2971	201.081	46.944	0.233	1515	527.205	99.363	0.188
		Total	3498	231.964	54.316	0.234	2282	1342.078	219.766	0.164
	2003	1	2164	278.848	66.410	0.238	523	730.155	78.438	0.107
		2	2059	165.082	24.174	0.146	1436	494.041	48.036	0.097
		Total	4223	443.930	90.583	0.204	1959	1224.196	126.474	0.103

Table A9. Discard ratios (mt discarded / mt kept) of goosefish by gear and half year from fishery observer and VTR databases, southern area.

South			Observer Data				VTR Data			
GEAR	YEAR	HALF	No. Tows	Kept (mt)	Discard (mt)	Disc Ratio	No. Trips	Kept (mt)	Discard (mt)	Disc Ratio
Dredge	1996	1	1284	12.781	4.117	0.322	107	73.882	10.078	0.136
		2	1270	23.726	4.387	0.185	96	120.084	12.570	0.105
		Total	2554	36.506	8.504	0.233	203	193.966	22.649	0.117
	1997	1	1268	21.852	4.735	0.217	68	49.945	4.450	0.089
		2	709	11.072	3.774	0.341	78	71.017	5.885	0.083
		Total	1977	32.924	8.509	0.258	146	120.962	10.335	0.085
	1998	1	574	11.001	0.525	0.048	64	52.556	5.127	0.098
		2	651	15.453	0.927	0.060	44	38.554	5.596	0.145
		Total	1225	26.454	1.451	0.055	108	91.110	10.723	0.118
	1999	1	373	3.304	1.553	0.470	38	19.313	19.493	1.009
		2	478	6.939	1.148	0.165	51	25.051	4.980	0.199
		Total	851	10.243	2.701	0.264	89	44.364	24.473	0.552
	2000	1	564	12.897	2.706	0.210	40	14.964	3.463	0.231
		2	533	5.331	1.778	0.333	59	37.653	6.109	0.162
		Total	1097	18.228	4.484	0.246	99	52.617	9.572	0.182
	2001	1	296	3.419	1.578	0.462	55	25.999	3.334	0.128
		2	-	-	-	-	83	32.462	14.111	0.435
		Total	296	3.419	1.578	0.462	138	58.461	17.445	0.298
	2002	1	-	-	-	-	72	32.438	10.782	0.332
		2	672	7.786	5.842	0.750	93	20.072	20.020	0.997
		Total	672	7.786	5.842	0.750	165	52.510	30.802	0.587
	2003	1	2022	18.712	18.659	0.997	90	16.633	9.571	0.575
		2	1513	10.226	11.338	1.109	65	24.001	11.085	0.462
		Total	3535	28.938	29.997	1.037	155	40.634	20.656	0.508
Gillnet	1996	1	403	37.871	2.720	0.072	309	204.625	7.884	0.039
		2	45	8.111	0.426	0.053	178	119.753	4.376	0.037
		Total	448	45.981	3.147	0.068	487	324.378	12.260	0.038
	1997	1	508	85.563	6.014	0.070	236	176.233	7.126	0.040
		2	141	25.777	0.381	0.015	93	77.095	1.940	0.025
		Total	649	111.341	6.395	0.057	329	253.328	9.066	0.036
	1998	1	386	77.076	6.185	0.080	149	154.552	3.627	0.023
		2	46	5.930	0.373	0.063	149	161.675	7.605	0.047
		Total	432	83.006	6.558	0.079	298	316.227	11.231	0.036
	1999	1	90	12.193	0.643	0.053	236	273.963	21.121	0.077
		2	28	2.495	0.128	0.051	161	231.345	14.164	0.061
		Total	118	14.688	0.772	0.053	397	505.308	35.285	0.070
	2000	1	97	13.471	1.278	0.095	299	234.134	56.230	0.240
		2	37	6.228	0.322	0.052	111	63.333	5.744	0.091
		Total	134	19.699	1.600	0.081	410	297.467	61.974	0.208
	2001	1	747	136.838	0.628	0.005	218	159.163	13.981	0.088
		2	173	28.758	0.284	0.010	174	194.088	9.144	0.047
		Total	920	165.596	0.912	0.006	392	353.251	23.125	0.065
	2002	1	326	64.125	0.212	0.003	279	314.151	27.816	0.089
		2	109	17.589	0.381	0.022	191	158.101	18.852	0.119
		Total	435	81.714	0.593	0.007	470	472.252	46.668	0.099
	2003	1	264	67.122	1.237	0.018	256	339.554	20.544	0.061
		2	422	65.390	3.278	0.050	163	186.278	7.597	0.041
		Total	686	132.512	4.515	0.034	419	525.832	28.141	0.054

Trawl	1996	1	276	6.422	1.084	0.169	268	139.753	8.706	0.062
		2	156	8.332	0.788	0.095	250	280.312	10.455	0.037
		Total	432	14.754	1.872	0.127	518	420.065	19.161	0.046
	1997	1	380	55.611	1.365	0.025	250	265.586	10.640	0.040
		2	152	24.789	2.153	0.087	177	125.820	4.496	0.036
		Total	532	80.399	3.518	0.044	427	391.406	15.136	0.039
	1998	1	209	4.439	0.480	0.108	194	149.583	3.439	0.023
		2	86	2.809	0.077	0.027	144	74.854	1.786	0.024
		Total	295	7.247	0.556	0.077	338	224.437	5.225	0.023
	1999	1	249	6.237	0.276	0.044	211	108.530	6.824	0.063
		2	77	12.318	1.460	0.119	118	54.879	2.036	0.037
		Total	326	18.556	1.736	0.094	329	163.409	8.859	0.054
	2000	1	344	3.536	2.547	0.720	182	54.788	8.693	0.159
		2	166	10.871	1.213	0.112	157	198.283	13.898	0.070
		Total	510	14.407	3.760	0.261	339	253.071	22.592	0.089
	2001	1	277	2.691	12.458	4.630	293	97.702	9.222	0.094
		2	90	1.050	0.433	0.412	186	35.619	7.349	0.206
		Total	367	3.741	12.891	3.446	479	133.321	16.571	0.124
	2002	1	199	2.539	1.145	0.451	198	20.233	6.580	0.325
		2	154	3.148	1.726	0.548	114	25.861	5.492	0.212
		Total	353	5.687	2.872	0.505	312	46.094	12.072	0.262
	2003	1	638	10.487	6.300	0.601	204	33.398	15.903	0.476
		2	330	4.462	3.493	0.783	102	21.238	4.026	0.190
		Total	968	14.949	9.792	0.655	306	54.636	19.929	0.365

Table A10. Calculation of total catch by stock area, gear, and half year using observer discard ratios.

North	Discard Ratio Jan-June	Discard Ratio July-Dec	Landings Live weight (mt) Jan-June	Landings Live weight (mt) July-Dec	Estimated Discards (mt) Jan-June	Estimated Discards (mt) July-Dec	Estimated Catch (mt) Jan-June	Estimated Catch (mt) July-Dec	Estimated Catch (mt) Total
Trawls									
1996	0.197	0.132	4411.5	4025.1	868.7	530.9	5280.2	4556.0	9836.2
1997	0.105	0.077	4087.1	3312.9	427.7	254.5	4514.7	3567.4	8082.1
1998	0.121	0.087	3173.5	2270.2	384.1	198.4	3557.6	2468.6	6026.2
1999	0.098	0.062	3958.3	3043.9	389.5	187.4	4347.9	3231.3	7579.2
2000	0.070	0.089	4011.6	4160.6	281.1	368.2	4292.7	4528.9	8821.5
2001	0.399	0.282	5229.3	4829.7	2086.5	1362.0	7315.8	6191.7	13507.5
2002	0.239	0.233	6026.5	4843.8	1440.3	1128.6	7466.8	5972.4	13439.2
2003	0.238	0.146	6991.1	5066.6	1663.9	739.7	8655.0	5806.3	14461.3
Scallop Dredges									
1996	0.476	0.292	38.9	850.3	18.5	247.9	57.5	1098.2	1155.7
1997	1.405	0.128	210.9	1133.7	296.3	145.7	507.1	1279.4	1786.5
1998	0.131	0.051	263.2	727.2	34.4	36.9	297.6	764.1	1061.7
1999	0.149	0.000	261.7	477.8	39.0	0.0	300.7	477.8	778.5
2000	0.140	0.155	97.9	248.0	13.7	38.5	111.7	286.5	398.1
2001	1.142	1.142	84.3	369.9	96.2	422.5	180.5	792.4	972.9
2002	0.749	0.749	61.8	114.3	46.3	85.6	108.0	199.8	307.8
2003	0.801	0.801	24.0	213.8	19.2	171.2	43.2	385.0	428.2
Gillnets									
1996	0.136	0.136	380.8	1010.2	51.9	137.7	432.6	1147.9	1580.5
1997	0.038	0.194	303.2	700.8	11.6	136.1	314.7	836.9	1151.6
1998	0.029	0.044	262.3	643.2	7.7	28.0	270.0	671.2	941.2
1999	0.068	0.012	349.2	1143.1	23.8	14.1	373.0	1157.2	1530.2
2000	0.034	0.078	383.6	1708.2	13.2	133.5	396.8	1841.7	2238.5
2001	0.023	0.141	879.0	2096.7	20.2	295.6	899.2	2392.3	3291.4
2002	0.024	0.027	751.5	2218.4	18.0	59.9	769.6	2278.3	3047.9
2003	0.062	0.067	774.0	1779.4	48.0	119.2	822.0	1898.6	2720.7
Other									
1996	0.199	0.196	34.2	10.8	6.8	2.1	41.0	12.9	53.9
1997	0.112	0.103	29.7	15.4	3.3	1.6	33.1	17.0	50.1
1998	0.107	0.052	14.3	12.7	1.5	0.7	15.8	13.3	29.1
1999	0.096	0.047	5.2	20.6	0.5	1.0	5.7	21.6	27.3
2000	0.068	0.087	20.9	58.3	1.4	5.0	22.3	63.3	85.6
2001	0.312	0.217	1.2	9.5	0.4	2.1	1.6	11.5	13.1
2002	0.174	0.207	1.4	11.7	0.2	2.4	1.7	14.1	15.7
2003	0.228	0.142	0.7	253.0	0.2	35.9	0.8	288.9	289.7

South

Trawls									
1996	0.169	0.095	3088.6	4084.6	521.4	386.2	3610.0	4470.7	8080.7
1997	0.025	0.087	3951.7	4282.4	97.0	371.9	4048.7	4654.3	8703.0
1998	0.108	0.027	3977.5	3854.4	429.8	105.2	4407.3	3959.6	8366.9
1999	0.044	0.119	4071.0	2327.7	180.0	275.9	4250.9	2603.6	6854.6
2000	0.720	0.112	2391.5	1677.1	1722.6	187.1	4114.1	1864.2	5978.3
2001	4.630	0.412	1803.2	1219.2	8348.9	502.3	10152.1	1721.5	11873.6
2002	0.451	0.548	1044.9	507.9	471.2	278.3	1516.1	786.2	2302.3
2003	0.601	0.783	980.7	1015.3	589.4	795.0	1570.1	1810.3	3380.3
Scallop Dredges									
1996	0.322	0.185	1790.9	2571.4	576.8	475.5	2367.7	3046.9	5414.6
1997	0.217	0.341	2226.9	2667.6	482.5	909.2	2709.5	3576.7	6286.2
1998	0.048	0.060	2492.7	2655.3	118.9	159.2	2611.6	2814.6	5426.1
1999	0.470	0.165	1831.9	1507.2	861.2	249.3	2693.2	1756.5	4449.6
2000	0.210	0.333	1074.4	870.2	225.5	290.2	1299.8	1160.4	2460.2
2001	0.462	0.462	713.2	932.8	329.5	430.9	1042.7	1363.7	2406.4
2002	0.750	0.750	1226.8	625.1	920.1	468.9	2146.8	1094.0	3240.8
2003	0.997	1.109	752.2	948.8	750.0	1052.2	1502.2	2001.0	3503.2
Gillnets									
1996	0.072	0.053	2770.6	1449.9	199.0	76.2	2969.6	1526.1	4495.7
1997	0.070	0.015	3712.6	1489.2	261.0	22.0	3973.6	1511.2	5484.7
1998	0.080	0.063	4133.3	2062.3	331.7	129.7	4465.0	2192.0	6657.0
1999	0.053	0.051	4375.3	1788.6	230.9	92.0	4606.2	1880.6	6486.8
2000	0.095	0.052	2810.5	1204.8	266.7	62.2	3077.2	1267.0	4344.2
2001	0.005	0.010	2214.7	2887.9	11.1	28.9	2225.8	2916.8	5142.6
2002	0.003	0.022	3576.7	1842.1	10.7	40.5	3587.4	1882.6	5470.0
2003	0.018	0.050	4462.5	2720.5	80.3	136.0	4542.8	2856.5	7399.3
Other									
1996	0.139	0.139	24.8	7.9	3.4	1.1	28.2	9.0	37.2
1997	0.074	0.102	151.3	52.2	11.2	5.3	162.6	57.5	220.1
1998	0.078	0.057	74.4	59.4	5.8	3.4	80.2	62.7	142.9
1999	0.114	0.126	6.8	44.9	0.8	5.7	7.6	50.6	58.2
2000	0.218	0.148	122.4	24.3	26.7	3.6	149.1	27.9	177.1
2001	0.100	0.024	12.7	17.6	1.3	0.4	13.9	18.1	32.0
2002	0.021	0.279	34.7	8.2	0.7	2.3	35.4	10.5	45.9
2003	0.277	0.226	19.0	63.7	5.3	14.4	24.2	78.1	102.3

Table A11. Annual landings, discards and total catch summarized from table A10.

	Reported Landings (live wt mt)	Estimated Discards (mt)	Overall Discard Ratio	Percent of Catch Discarded	Estimated Catch (mt)
North					
1996	10762	1865	0.173	14.8	12626
1997	9794	1277	0.130	11.5	11070
1998	7367	692	0.094	8.6	8058
1999	9260	655	0.071	6.6	9915
2000	10689	855	0.080	7.4	11544
2001	13500	4285	0.317	24.1	17785
2002	14029	2781	0.198	16.5	16811
2003	15103	2797	0.185	15.6	17900
South					
1996	15789	2240	0.142	12.4	18028
1997	18534	2160	0.117	10.4	20694
1998	19309	1284	0.066	6.2	20593
1999	15953	1896	0.119	10.6	17849
2000	10175	2785	0.274	21.5	12960
2001	9801	9653	0.985	49.6	19455
2002	8866	2193	0.247	19.8	11059
2003	10963	3423	0.312	23.8	14385
Total					
1996	26550	4104	0.155	13.4	30655
1997	28327	3437	0.121	10.8	31764
1998	26676	1975	0.074	6.9	28651
1999	25213	2551	0.101	9.2	27764
2000	20864	3639	0.174	14.9	24504
2001	23301	13939	0.598	37.4	37239
2002	22896	4974	0.217	17.8	27870
2003	26065	6220	0.239	19.3	32285

Table A12. Sample size, median CPUE and GLM-estimated CPUE at depth by gear and area: 1995-2003. Zones are 20 fathom depth increments starting with 0-20 fa (zone 1) and ending with >180 fa (zone 10).

		Depth Zone									
		1	2	3	4	5	6	7	8	9	10
Dredge											
All Areas	N	812	9161	818	15	3					
	Median	1.97	2.20	2.34	2.55	1.87					
	LSMEAN	1.79	1.99	2.11	2.14	1.58					
North	N	144	1647	319	3	2					
	Median	1.68	2.22	2.38	2.55	1.94					
	LSMEAN	1.60	1.84	1.98	2.08	1.25					
South	N	668	7514	499	12	1					
	Median	2.01	2.19	2.37	2.37	1.87					
	LSMEAN	1.78	1.97	2.10	2.04	1.66					
Small Mesh Gill Net											
All Areas	N	6678	14515	3947	1717	1497	359	47	50	20	28
	Median	1.54	1.48	1.48	1.65	2.00	2.04	1.29	1.32	1.37	1.77
	LSMEAN	1.92	1.81	1.78	1.95	2.21	2.31	1.82	1.65	1.60	2.18
North	N	4441	13692	3914	1701	1448	328	39	44	18	6
	Median	1.48	1.46	1.48	1.65	2.00	2.09	1.27	1.18	1.32	1.07
	LSMEAN	1.83	1.77	1.78	1.96	2.21	2.37	1.78	1.59	1.48	1.80
South	N	2237	823	33	16	49	31	8	6	2	22
	Median	1.75	1.91	1.77	1.43	2.12	1.48	1.56	1.74	2.23	1.95
	LSMEAN	1.73	1.86	2.03	1.63	2.13	1.54	1.54	1.81	2.16	1.88
Large Mesh Gill Net											
All Areas	N	10101	6678	1157	441	521	183	239	83	5	15
	Median	2.78	2.88	2.83	2.70	3.27	3.03	2.58	2.81	2.81	2.83
	LSMEAN	3.14	3.25	3.25	3.13	3.43	3.26	3.08	3.11	3.28	3.11
North	N	518	1447	688	126	119	15	7			7.00
	Median	2.76	2.66	2.70	2.72	3.31	2.76	3.29			2.83
	LSMEAN	2.93	2.74	2.80	2.91	3.26	2.98	3.39			2.77
South	N	9583	5231	469	315	402	168	232	83	5	8
	Median	2.78	2.97	3.05	2.69	3.25	3.08	2.54	2.81	2.81	2.73
	LSMEAN	3.20	3.37	3.38	3.12	3.41	3.30	3.11	3.16	3.32	3.05
Trawl											
All Areas	N	12860	25137	13807	5791	9474	3575	1167	300	115	321
	Median	1.81	2.03	2.10	2.43	2.60	2.78	2.97	3.12	3.20	3.31
	LSMEAN	1.91	2.05	2.23	2.47	2.63	2.79	2.86	3.00	2.96	3.19
North	N	4088	14247	12418	5369	9306	3532	1029	135	27	26
	Median	1.84	1.90	2.08	2.44	2.60	2.78	2.92	2.89	2.73	2.94
	LSMEAN	1.92	1.94	2.18	2.48	2.66	2.83	2.88	2.94	2.75	3.01
South	N	8772	10890	1389	422	168	43	138	165	88	295
	Median	1.79	2.21	2.47	2.33	2.55	3.08	3.31	3.27	3.28	3.34
	LSMEAN	1.90	2.17	2.42	2.29	2.44	2.85	3.13	3.03	2.98	3.11

Table A13. Sample size, median CPUE, and GLM-estimated CPUE at depth for directed trawl trips (directed trip defined by goosefish catch at least half of total catch in weight): 1995-2003.
Zones are 20 fathom depth increments starting with 0-20 fa (zone 1) and ending with > 180 fa (zone 10).

		Depth Zone									
		1	2	3	4	5	6	7	8	9	10
Directed Trawl											
All Areas	N	124	899	1134	643	738	414	307	165	78	265
	Median	3.26	3.19	3.01	3.09	3.32	3.39	3.39	3.32	3.33	3.39
	LSMEAN	3.28	3.18	3.17	3.26	3.27	3.31	3.29	3.32	3.29	3.34
North	N	59	290	893	593	709	389	201	28	3	9
	Median	3.30	3.04	2.94	3.08	3.31	3.40	3.41	3.38	3.32	3.49
	LSMEAN	3.25	3.16	3.18	3.27	3.27	3.32	3.28	3.28	3.35	3.44
South	N	65	609	241	50	29	25	106	137	75	256
	Median	3.21	3.24	3.20	3.24	3.41	3.22	3.35	3.32	3.34	3.39
	LSMEAN	3.34	3.25	3.23	3.21	3.25	3.27	3.36	3.39	3.36	3.39

Table A14. Sample size and associated reported catch for all trips and only “directed” trips (denoted subset) from VTR database for three gears. A “directed” trip is defined as one in which the catch of goosefish comprises at least half of the total catch for the trip. Data is summed over years 1995-2003.

Trawl

Area	N (all data)	N (subset)	subset/all	kept mt (all data)	kept mt (subset)	subset/all
All	72,700	4,767	7%	32,719	13,564	41%
North	50,309	3,174	6%	24,101	7,204	30%
South	22,391	1,593	7%	8,618	6,360	74%

Large Mesh Gill Net

Area	N (all data)	N (subset)	subset/all	kept mt (all data)	kept mt (subset)	subset/all
All	19,117	16,856	88%	18,338	17,668	96%
North	2,795	2,477	89%	2,812	2,674	95%
South	16,322	14,379	88%	15,526	14,994	97%

Small Mesh Gill Net

Area	N (all data)	N (subset)	subset/all	kept mt (all data)	kept mt (subset)	subset/all
All	29,266	784	3%	2,096	549	26%
North	25,865	557	2%	1,711	422	25%
South	3,401	227	7%	385	127	33%

Table A15. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for goosefish 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.

	Biomass						Abundance													Number	Number of	
	Raw Index			Smoothed			Raw Index			Smoothed				Length						of	Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1963	3.757	2.161	5.353	2.843			0.801	0.508	1.094	0.568			4.661	11	14	59	58.3	103	111	86	39	90
1964	1.712	0.896	2.528	2.357			0.392	0.219	0.564	0.451			4.354	21	21	58	59.4	92	102	32	23	87
1965	2.509	1.350	3.667	2.422			0.347	0.230	0.463	0.394			7.137	28	36	70	71.6	96	110	40	30	88
1966	3.266	2.102	4.431	2.432	1.628	3.631	0.492	0.331	0.653	0.375	0.258	0.544	6.532	37	48	73	73.1	90	96	55	33	86
1967	1.283	0.441	2.125	2.002	1.341	2.990	0.189	0.090	0.288	0.297	0.205	0.431	6.799	48	48	69	70.3	91	92	18	14	86
1968	2.036	0.521	3.552	2.223	1.489	3.320	0.286	0.115	0.457	0.319	0.220	0.463	7.121	11	26	72	71.4	105	106	32	16	86
1969	3.705	1.781	5.628	2.618	1.753	3.910	0.418	0.277	0.559	0.368	0.254	0.534	8.718	13	41	78	78.8	101	110	39	30	88
1970	2.237	0.947	3.527	2.442	1.635	3.647	0.395	0.222	0.569	0.391	0.269	0.567	5.754	22	36	67	67.2	90	98	41	21	92
1971	2.914	1.436	4.391	2.416	1.618	3.607	0.491	0.312	0.670	0.411	0.283	0.596	5.864	15	22	69	67.0	97	101	44	27	94
1972	1.404	0.651	2.157	2.106	1.410	3.145	0.318	0.195	0.442	0.384	0.264	0.557	4.354	21	21	61	56.9	97	99	29	22	94
1973	3.114	1.782	4.446	2.412	1.615	3.602	0.514	0.320	0.709	0.406	0.280	0.590	5.992	16	16	58	65.2	109	112	63	29	92
1974	2.063	1.114	3.011	2.327	1.558	3.475	0.313	0.189	0.436	0.367	0.253	0.533	6.362	13	13	69	64.9	109	111	37	23	97
1975	1.711	1.003	2.418	2.434	1.630	3.635	0.298	0.178	0.418	0.369	0.254	0.536	5.721	11	11	60	62.9	97	102	40	27	106
1976	3.387	1.555	5.219	3.227	2.161	4.819	0.422	0.244	0.601	0.429	0.296	0.623	7.620	29	30	71	72.1	106	121	32	24	87
1977	5.568	3.489	7.646	4.140	2.772	6.183	0.626	0.458	0.794	0.504	0.347	0.731	8.635	21	35	73	71.1	107	119	112	56	126
1978	5.101	3.487	6.714	4.353	2.915	6.501	0.579	0.429	0.729	0.511	0.352	0.742	8.106	10	24	70	67.6	104	116	146	78	201
1979	5.133	3.566	6.700	4.114	2.755	6.143	0.474	0.364	0.584	0.477	0.329	0.693	10.233	15	19	77	73.5	103	115	125	78	211
1980	4.458	2.234	6.682	3.350	2.244	5.003	0.535	0.366	0.703	0.448	0.309	0.650	7.549	6	16	66	63.9	101	111	65	39	97
1981	1.984	1.183	2.786	2.252	1.508	3.363	0.406	0.288	0.523	0.373	0.257	0.541	4.892	9	13	55	57.5	93	101	46	30	93
1982	0.936	0.379	1.492	1.648	1.104	2.461	0.142	0.070	0.213	0.293	0.202	0.425	6.606	29	29	71	68.9	97	100	17	14	95
1983	1.617	0.927	2.308	1.764	1.182	2.635	0.470	0.284	0.656	0.375	0.258	0.544	3.415	13	17	54	53.0	88	96	38	27	82
1984	3.010	1.413	4.607	2.003	1.341	2.991	0.483	0.353	0.613	0.412	0.284	0.599	5.803	11	26	63	62.7	102	106	36	29	88
1985	1.441	0.419	2.463	1.729	1.158	2.582	0.369	0.190	0.548	0.408	0.281	0.592	3.985	12	15	55	53.1	101	102	32	23	88
1986	2.353	1.099	3.608	1.687	1.130	2.520	0.604	0.379	0.829	0.431	0.297	0.626	3.703	19	23	52	53.8	82	100	46	26	90
1987	0.873	0.256	1.491	1.317	0.882	1.967	0.264	0.116	0.411	0.363	0.250	0.527	3.324	15	15	53	52.2	92	96	22	15	87
1988	1.525	0.484	2.565	1.355	0.907	2.023	0.313	0.130	0.496	0.379	0.261	0.550	4.870	11	11	53	57.1	92	93	26	17	89
1989	1.384	0.478	2.290	1.287	0.862	1.922	0.428	0.266	0.590	0.449	0.310	0.652	3.096	9	9	39	40.8	93	96	39	25	87
1990	1.001	0.439	1.562	1.165	0.790	1.716	0.593	0.383	0.804	0.551	0.384	0.790	1.705	9	10	25	32.3	72	89	55	35	89
1991	1.235	0.568	1.903	1.167	0.792	1.719	0.576	0.383	0.768	0.643	0.448	0.922	2.067	9	10	31	38.3	83	95	62	33	88
1992	1.104	0.557	1.651	1.125	0.763	1.657	0.938	0.602	1.274	0.808	0.563	1.159	1.183	9	9	26	33.0	79	86	78	37	86
1993	1.044	0.343	1.746	1.097	0.745	1.617	0.989	0.691	1.287	0.917	0.640	1.316	1.077	6	9	20	27.1	71	94	103	45	86
1994	0.973	0.378	1.569	1.108	0.752	1.632	1.351	0.969	1.732	0.991	0.691	1.421	0.668	9	9	19	24.9	55	98	110	51	87
1995	1.711	0.663	2.759	1.219	0.828	1.797	0.922	0.688	1.155	0.869	0.606	1.247	1.724	10	12	34	39.6	84	91	87	40	93
1996	1.071	0.498	1.645	1.069	0.726	1.575	0.630	0.407	0.853	0.732	0.511	1.050	1.688	8	11	38	40.3	63	95	51	30	88
1997	0.669	0.321	1.017	0.937	0.636	1.380	0.498	0.304	0.693	0.683	0.476	0.979	1.335	8	9	35	35.4	70	86	39	27	90
1998	0.974	0.522	1.425	1.028	0.698	1.515	0.609	0.397	0.820	0.787	0.549	1.129	1.531	10	10	30	35.5	68	77	56	38	104
1999	0.825	0.303	1.348	1.171	0.795	1.726	1.084	0.737	1.431	1.078	0.751	1.546	0.716	8	8	22	25.7	58	81	111	44	106
2000	2.495	1.284	3.707	1.689	1.145	2.490	2.398	1.564	3.232	1.470	1.024	2.110	1.032	9	11	25	30.3	70	88	165	43	87
2001	2.048	1.148	2.949	1.872	1.266	2.768	1.620	1.212	2.027	1.443	1.003	2.076	1.145	8	12	31	34.7	65	93	145	50	90
2002	2.103	1.068	3.138	1.955	1.304	2.930	1.283	0.922	1.645	1.310	0.899	1.910	1.425	9	9	34	35.1	65	93	114	45	86
2003	1.925	1.086	2.764	1.943	1.218	3.098	1.067	0.778	1.357	1.206	0.781	1.863	1.695	8	8	40	37.8	73	88	90	39	88

Table A16. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for goosefish 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.

	Biomass						Abundance													Number	Number of	
	Raw Index			Smoothed			Raw Index			Smoothed				Length						of	Nonzero	Number
	Mean	L95%CI	U95%CI	Mean	L95%CI	U95%CI	Mean	L95%CI	U95%CI	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1968	0.973	0.260	1.686	1.187			0.178	0.074	0.283	0.201			5.427	50	51	68	70.4	89	90	13	11	86
1969	1.309	0.141	2.476	1.357			0.186	0.046	0.325	0.219			7.044	33	33	71	71.5	99	100	15	10	87
1970	1.967	0.712	3.221	1.590			0.344	0.216	0.472	0.265			5.709	30	30	62	65.4	98	99	32	22	90
1971	1.021	0.414	1.629	1.614	1.052	2.478	0.158	0.072	0.245	0.269	0.177	0.409	6.366	45	53	69	72.6	99	100	20	15	96
1972	4.644	3.021	6.266	2.230	1.453	3.424	0.643	0.453	0.832	0.391	0.258	0.594	7.064	13	39	74	72.7	100	105	59	38	96
1973	1.908	0.956	2.860	1.882	1.226	2.889	0.435	0.184	0.686	0.407	0.268	0.619	4.313	17	26	68	65.7	99	106	91	36	87
1974	1.476	0.863	2.090	1.573	1.025	2.415	0.438	0.315	0.561	0.406	0.267	0.616	3.391	20	23	58	58.3	97	111	86	41	83
1975	0.934	0.593	1.275	1.373	0.894	2.108	0.339	0.228	0.450	0.384	0.253	0.583	2.760	16	19	53	54.0	87	109	73	36	87
1976	2.826	1.691	3.962	1.552	1.011	2.383	0.673	0.469	0.877	0.394	0.260	0.599	3.759	14	20	60	61.5	95	106	158	52	99
1977	1.012	0.563	1.462	1.173	0.764	1.801	0.259	0.159	0.360	0.283	0.186	0.430	3.594	10	31	66	63.4	93	106	61	37	107
1978	0.626	0.340	0.913	0.979	0.638	1.503	0.141	0.095	0.186	0.216	0.142	0.328	4.014	15	19	73	65.5	89	92	37	30	113
1979	0.893	0.274	1.513	1.104	0.719	1.694	0.144	0.102	0.185	0.219	0.144	0.332	4.652	12	14	67	62.5	100	118	48	40	139
1980	1.622	0.787	2.458	1.434	0.934	2.201	0.379	0.270	0.488	0.294	0.194	0.447	3.748	17	22	43	53.3	98	107	84	38	85
1981	1.744	0.913	2.576	1.715	1.118	2.633	0.376	0.282	0.470	0.333	0.219	0.506	4.444	11	21	52	57.7	95	120	95	42	87
1982	3.015	1.273	4.758	2.029	1.322	3.115	0.346	0.155	0.536	0.348	0.229	0.529	8.594	25	36	61	68.8	105	108	33	22	92
1983	1.587	0.530	2.643	1.840	1.199	2.824	0.418	0.191	0.645	0.365	0.240	0.554	3.663	12	13	49	49.9	96	112	34	22	90
1984	1.696	0.596	2.796	1.842	1.200	2.828	0.328	0.181	0.474	0.349	0.230	0.530	4.732	17	19	62	60.8	93	100	26	19	86
1985	2.113	1.094	3.133	1.951	1.271	2.994	0.346	0.199	0.492	0.347	0.229	0.528	6.122	13	13	68	66.9	104	108	25	21	81
1986	2.165	0.951	3.378	1.957	1.275	3.004	0.340	0.200	0.481	0.347	0.229	0.527	6.244	11	14	63	65.4	109	121	30	22	90
1987	1.728	0.726	2.730	1.834	1.195	2.816	0.245	0.138	0.352	0.352	0.232	0.534	7.052	16	16	66	64.2	99	100	21	16	83
1988	2.111	0.906	3.315	1.790	1.166	2.748	0.610	0.398	0.822	0.454	0.299	0.690	3.343	10	20	49	49.8	89	110	43	26	90
1989	1.631	0.611	2.650	1.563	1.018	2.400	0.625	0.321	0.929	0.481	0.317	0.731	2.590	10	11	40	43.2	80	94	48	24	85
1990	1.005	0.366	1.643	1.327	0.878	2.005	0.282	0.157	0.406	0.427	0.283	0.646	3.587	15	18	47	49.1	106	107	25	17	90
1991	1.827	0.478	3.175	1.358	0.899	2.052	0.592	0.374	0.811	0.502	0.332	0.758	2.723	12	15	35	42.3	78	100	48	28	86
1992	0.890	-0.217	1.997	1.138	0.754	1.720	0.492	0.158	0.825	0.528	0.350	0.798	1.793	16	17	35	40.6	82	101	36	20	83
1993	1.162	0.693	1.630	1.126	0.745	1.701	0.684	0.475	0.893	0.582	0.386	0.880	1.695	10	11	44	41.0	71	90	59	27	87
1994	0.948	0.376	1.520	1.091	0.722	1.648	0.452	0.275	0.629	0.576	0.382	0.871	2.159	10	13	40	41.0	83	89	45	24	88
1995	1.713	0.789	2.638	1.161	0.768	1.754	0.984	0.662	1.305	0.672	0.445	1.015	1.817	15	16	33	39.9	73	97	83	39	88
1996	1.006	0.449	1.563	0.951	0.629	1.437	0.668	0.344	0.992	0.606	0.401	0.915	1.466	15	17	41	43.0	60	70	49	20	82
1997	0.532	0.146	0.918	0.750	0.497	1.133	0.339	0.158	0.520	0.512	0.339	0.773	1.595	9	9	36	39.4	75	89	34	19	89
1998	0.444	0.187	0.701	0.746	0.493	1.126	0.414	0.288	0.540	0.570	0.377	0.861	1.065	11	11	19	31.3	67	78	46	33	115
1999	1.202	0.625	1.780	1.050	0.695	1.586	0.824	0.547	1.102	0.787	0.521	1.189	1.389	9	14	31	35.5	71	97	62	33	87
2000	1.430	0.837	2.023	1.349	0.893	2.038	1.128	0.843	1.413	1.053	0.697	1.591	1.236	15	17	29	34.5	75	87	99	42	89
2001	1.969	0.681	3.257	1.667	1.102	2.520	1.686	1.221	2.151	1.347	0.891	2.036	1.113	9	11	24	31.4	75	86	151	50	89
2002	1.997	1.335	2.659	1.841	1.214	2.792	1.756	1.334	2.178	1.480	0.976	2.244	1.102	12	15	34	36.6	60	73	155	50	91
2003	1.859	1.058	2.661	1.926	1.252	2.964	1.859	1.058	2.661	1.450	0.943	2.231	1.911	10	13	42	44.2	69	95	79	30	86
2004	2.285	0.914	3.656	2.063	1.255	3.390	0.910	0.577	1.243	1.203	0.732	1.976	2.495	9	11	48	46.7	81	85	69	36	88

Table A17. Indices of abundance (number per tow) for goosefish at lengths corresponding approximately to ages 1 and 2.

	Northern Area		Southern Area				
	Autumn	Spring	Scallop	Autumn	Winter	Spring	Scallop
	(11 -19cm)	(13 - 20cm)	(10 - 18cm)	(11 -19cm)	(12 - 19cm)	(13 - 20cm)	(19 - 28cm)
Year	~age 1	~age 2	~age 1	~age 1	~age 2	~age 2	~age 2
1963	0.12			0.12			
1964	0.00			0.06			
1965	0.00			0.04			
1966	0.00			0.19			
1967	0.00			0.02			
1968	0.01	0.00		0.02		0.00	
1969	0.01	0.00		0.04		0.00	
1970	0.00	0.00		0.03		0.00	
1971	0.02	0.00		0.03		0.01	
1972	0.00	0.02		0.68		0.01	
1973	0.03	0.00		0.17		0.05	
1974	0.03	0.01		0.01		0.02	
1975	0.02	0.02		0.05		0.01	
1976	0.00	0.03		0.02		0.01	
1977	0.00	0.00		0.03		0.01	
1978	0.02	0.01		0.03		0.04	
1979	0.01	0.01		0.11		0.04	
1980	0.02	0.01		0.02		0.01	
1981	0.02	0.01		0.06		0.02	
1982	0.00	0.00	0.08	0.06		0.08	0.08
1983	0.03	0.04	0.83	0.08		0.00	0.19
1984	0.02	0.03	0.29	0.05		0.00	0.21
1985	0.03	0.02	0.25	0.05		0.00	0.21
1986	0.02	0.01	0.54	0.05		0.01	0.19
1987	0.03	0.01	1.90	0.17		0.01	0.08
1988	0.02	0.01	0.06	0.00		0.03	0.52
1989	0.07	0.06	0.21	0.04		0.01	0.21
1990	0.17	0.03	0.60	0.09		0.01	0.37
1991	0.06	0.09	1.25	0.17		0.02	0.26
1992	0.09	0.06	0.60	0.07	0.08	0.02	0.46
1993	0.32	0.10	1.59	0.08	0.12	0.02	0.31
1994	0.58	0.08	1.65	0.17	0.12	0.02	0.55
1995	0.02	0.16	0.45	0.12	0.03	0.01	0.49
1996	0.04	0.04	0.74	0.01	0.02	0.01	0.19
1997	0.09	0.00	0.07	0.01	0.10	0.01	0.21
1998	0.10	0.18	0.38	0.08	0.04	0.06	0.13
1999	0.38	0.18	1.19	0.10	0.14	0.02	0.43
2000	0.70	0.18	0.94	0.05	0.05	0.03	0.29
2001	0.11	0.48	0.15	0.02	0.18	0.04	0.29
2002	0.28	0.15	0.53	0.12	0.01	0.00	0.11
2003	0.20	0.07	1.30	0.44	0.07	0.01	0.40
2004		0.10			0.06	0.00	

Table A18. Delta distribution stratified mean number per tow at age, NEFSC autumn and spring offshore surveys.

Autumn Surveys

North

Age	0	1	2	3	4	5	6	7	8	9	Total
1993	0.149	0.308	0.176	0.104	0.094	0.102	0.000	0.031	0.013	0.012	0.989
1994	0.065	0.560	0.287	0.208	0.086	0.089	0.019	0.024	0.011	0.000	1.351
1995	0.000	0.059	0.163	0.285	0.234	0.092	0.021	0.014	0.054	0.000	0.922
1996	0.012	0.048	0.062	0.152	0.206	0.093	0.034	0.011	0.012	0.000	0.630
1997	0.039	0.094	0.016	0.122	0.136	0.052	0.031	0.000	0.007	0.000	0.498
1998	0.000	0.116	0.150	0.090	0.048	0.052	0.135	0.018	0.000	0.000	0.609
1999	0.192	0.310	0.292	0.179	0.015	0.033	0.020	0.040	0.003	0.000	1.084
2000	0.080	0.703	0.626	0.448	0.271	0.105	0.059	0.062	0.044	0.000	2.398
2001	0.000	0.166	0.482	0.365	0.369	0.149	0.049	0.023	0.000	0.016	1.620
2002	0.027	0.322	0.118	0.300	0.230	0.175	0.050	0.027	0.029	0.004	1.283
2003	0.100	0.159	0.147	0.074	0.244	0.206	0.074	0.036	0.027	0.000	1.067

South

Age	0	1	2	3	4	5	6	7	8	9	Total
1993	0.007	0.060	0.064	0.076	0.062	0.014	0.000	0.007	0.000	0.000	0.290
1994	0.015	0.095	0.295	0.056	0.066	0.036	0.021	0.007	0.008	0.000	0.598
1995	0.000	0.102	0.151	0.120	0.053	0.049	0.017	0.000	0.000	0.000	0.493
1996	0.000	0.007	0.030	0.054	0.059	0.060	0.026	0.000	0.000	0.000	0.235
1997	0.017	0.008	0.041	0.055	0.035	0.105	0.031	0.016	0.000	0.000	0.308
1998	0.000	0.070	0.072	0.037	0.059	0.044	0.034	0.008	0.008	0.000	0.332
1999	0.005	0.101	0.172	0.118	0.040	0.014	0.000	0.000	0.000	0.000	0.450
2000	0.007	0.061	0.118	0.106	0.067	0.023	0.041	0.000	0.000	0.000	0.422
2001	0.018	0.018	0.036	0.119	0.079	0.048	0.045	0.015	0.000	0.000	0.378
2002	0.016	0.099	0.163	0.069	0.233	0.184	0.058	0.000	0.007	0.000	0.829
2003	0.060	0.354	0.178	0.105	0.058	0.156	0.041	0.000	0.000	0.000	0.951

Spring Surveys

North

Age	0	1	2	3	4	5	6	7	8	9	Total
1995	0.000	0.000	0.153	0.174	0.247	0.110	0.076	0.163	0.053	0.008	0.984
1996	0.000	0.000	0.036	0.014	0.231	0.263	0.059	0.065	0.000	0.000	0.668
1997	0.028	0.000	0.000	0.074	0.197	0.004	0.000	0.024	0.012	0.000	0.339
1998	0.000	0.040	0.162	0.045	0.044	0.045	0.025	0.046	0.008	0.000	0.414
1999	0.000	0.012	0.182	0.194	0.229	0.066	0.000	0.079	0.057	0.004	0.824
2000	0.000	0.000	0.238	0.386	0.254	0.121	0.033	0.012	0.060	0.024	1.128
2001	0.000	0.058	0.505	0.371	0.290	0.207	0.087	0.060	0.071	0.036	1.686
2002	0.000	0.000	0.153	0.434	0.486	0.405	0.183	0.095	0.000	0.000	1.756
2003	0.000	0.056	0.176	0.087	0.334	0.623	0.321	0.188	0.037	0.038	1.859
2004	0.000	0.016	0.162	0.060	0.055	0.135	0.148	0.200	0.086	0.047	0.910

South

Age	0	1	2	3	4	5	6	7	8	9	
1995	0.000	0.000	0.000	0.058	0.043	0.014	0.031	0.018	0.032	0.000	0.196
1996	0.000	0.009	0.010	0.013	0.028	0.016	0.036	0.012	0.012	0.000	0.135
1997	0.000	0.000	0.008	0.031	0.052	0.025	0.005	0.000	0.003	0.000	0.124
1998	0.000	0.001	0.041	0.054	0.087	0.042	0.011	0.013	0.005	0.000	0.254
1999	0.000	0.000	0.018	0.073	0.061	0.104	0.024	0.020	0.034	0.001	0.335
2000	0.000	0.000	0.025	0.056	0.077	0.051	0.025	0.006	0.001	0.000	0.242
2001	0.000	0.007	0.018	0.056	0.070	0.039	0.041	0.003	0.000	0.000	0.234
2002	0.000	0.000	0.000	0.028	0.161	0.089	0.035	0.006	0.000	0.000	0.318
2003	0.000	0.000	0.007	0.011	0.021	0.078	0.083	0.108	0.049	0.013	0.371
2004	0.000	0.000	0.000	0.049	0.009	0.018	0.029	0.012	0.000	0.000	0.116

Table A19. Mean length (cm) at age for goosefish caught in NEFSC surveys

NEFSC Fall Offshore Survey

North	Age 0	1	2	3	4	5	6	7	8	9	10
1993	9.49	13.02	23.38	31.73	43.50	52.93		73.59	83.50	94.00	
1994	9.45	14.20	21.79	30.87	42.82	53.36	64.00	68.85	98.00		
1995		11.01	24.85	32.89	41.54	54.78	65.36	73.86	85.50	91.00	
1996	8.00	12.88	23.85	35.16	42.15	54.19	60.35	82.00	95.00		
1997	9.02	12.44	28.00	34.73	43.26	54.38	67.43		86.00		
1998		13.00	25.58	33.18	43.38	51.38	63.39	76.61			
1999	10.37	15.06	26.92	35.98	40.55	56.50	60.08	73.32	79.00		
2000	10.33	14.90	24.82	34.03	45.28	56.79	66.24	78.47	85.60		
2001		15.49	24.38	32.66	43.06	52.32	66.59	71.36		93.00	
2002	9.41	12.25	26.32	33.36	43.96	54.29	63.61	74.51	86.29	93.00	
2003	9.36	11.94	23.08	36.76	43.49	53.90	63.49	74.46	86.29		
2004											
mean	**9.43**	**13.29**	**24.82**	**33.76**	**43.00**	**54.07**	**64.05**	**74.70**	**87.24**	**92.75**	

NEFSC Fall Offshore Survey

South	Age 0	1	2	3	4	5	6	7	8	9	10
1993		16.21	19.85	34.27	43.31	51.54		68.00			
1994	8.19	14.89	21.13	34.48	44.47	51.97	60.29	68.00	83.00		
1995		14.51	21.09	34.00	40.84	52.15	65.00				
1996		18.00	22.58	33.08	44.53	51.84	64.67				
1997	9.53	11.00	24.83	35.36	47.82	54.37	64.38	71.00			
1998		14.02	21.92	32.26	45.09	53.96	62.73	72.00	87.00		
1999		17.08	25.11	36.09	46.61	55.00					
2000	5.00	17.66	22.45	36.00	45.42	55.74	64.07				
2001	8.00	14.76	25.96	33.66	45.30	56.61	66.08	78.12			
2002	6.58	16.07	23.19	33.92	44.76	53.69	63.94		81.00		
2003	7.67	15.69	19.96	34.27	45.38	54.27	63.31				
2004											
mean	**7.50**	**15.44**	**22.55**	**34.31**	**44.87**	**53.74**	**63.83**	**71.42**	**83.67**		

NEFSC Winter Survey

South	Age 0	1	2	3	4	5	6	7	8	9	10
1997		10.81	16.42	25.16	34.28	45.54	54.30	63.66	76.03	91.00	
1998		10.32	17.36	24.86	35.72	43.17	53.62	64.42	71.98	84.00	
1999		10.67	16.73	24.91	32.82	43.92	53.60	64.04	76.65	87.00	
2000			14.37	24.97	34.62	43.53	53.36	63.95	74.29		96.00
2001		9.66	16.77	26.41	34.43	45.18	53.88	64.92	76.49	82.73	
2002			15.51	26.77	33.73	43.43	52.85	63.77	74.78	85.34	86.00
2003			14.93	25.82	32.99	45.72	54.75	64.30	73.96	83.72	
2004			15.05	24.81	33.11	43.40	54.65	63.41	74.40	87.19	
mean		**10.37**	**15.89**	**25.46**	**33.96**	**44.24**	**53.88**	**64.06**	**74.82**	**85.85**	**91.00**

NEFSC Spring Survey

North	Age 0	1	2	3	4	5	6	7	8	9	10
1995			16.96	25.77	32.91	43.48	53.59	62.84	76.14	97.00	
1996			15.00	28.48	34.80	46.09	57.34	64.56			
1997				27.36	32.00				89.00		
1998		12.12	16.76	25.10	36.07	45.84	53.74	65.99	78.00		
1999		9.00	17.04	26.63	35.50	47.98		63.58	73.81	97.00	
2000			19.08	25.77	36.51	48.65	56.15	67.00	75.37	86.03	
2001		10.69	15.69	23.47	33.88	44.04	51.79	62.78	76.94	83.28	
2002			15.29	25.14	33.19	46.05	55.54	65.33			
2003		10.70	15.26	26.61	36.13	43.91	56.33	66.95	73.00	89.00	95.00
2004		9.00	13.92	24.16	34.27	42.41	52.38	64.01	74.37	83.40	
mean		**10.30**	**16.11**	**25.85**	**34.53**	**45.38**	**54.61**	**64.78**	**77.08**	**89.29**	**95.00**

NEFSC Spring Survey

South	Age 0	1	2	3	4	5	6	7	8	9	10
1995				25.18	35.75	46.35	55.69	63.70	79.03		
1996		9.00	16.14	22.88	38.07	46.24	52.57	61.85	79.85		
1997			18.00	24.25	35.89	45.00	59.00		73.50		
1998		12.00	17.78	25.31	35.95	48.52	57.01	64.84	77.00		
1999			17.80	24.62	33.71	47.56	53.39	64.54	74.60	94.00	
2000			15.59	26.35	37.93	46.68	57.74	71.00	78.00		
2001		11.00	16.51	22.67	35.07	44.75	55.02	63.71			
2002				27.00	35.45	44.22	52.72	62.00			
2003			15.00	28.79	32.40	46.92	55.12	63.38	75.18	85.11	
2004				24.25	32.00	42.42	57.03	61.23			
mean		**10.67**	**16.69**	**25.13**	**35.22**	**45.87**	**55.53**	**64.03**	**76.74**	**89.56**	

Table A20. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for goosefish 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.

	Biomass						Abundance													Number	Number of	
	Raw Index			Smoothed			Raw Index			Smoothed				Length						of	Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1963	3.724	1.786	5.663	4.168			1.257	0.745	1.769	1.304			2.926	7	17	53	50.4	91	97	102	36	73
1964	5.486	3.391	7.581	4.496			1.636	0.907	2.366	1.337			3.467	14	21	53	52.0	86	101	132	34	83
1965	5.163	2.731	7.594	4.242			1.148	0.778	1.519	1.197			4.199	10	15	59	56.3	91	104	83	39	85
1966	6.986	4.936	9.037	3.507	2.061	5.969	1.926	1.364	2.488	1.102	0.634	1.915	3.563	7	7	51	49.6	87	98	101	56	87
1967	1.122	0.588	1.655	1.825	1.072	3.105	0.519	0.324	0.715	0.697	0.401	1.211	2.173	14	19	31	40.6	83	100	98	42	163
1968	0.850	0.413	1.287	1.317	0.774	2.240	0.399	0.206	0.591	0.537	0.309	0.933	2.131	12	17	45	46.3	75	86	77	39	164
1969	1.138	0.483	1.793	1.275	0.749	2.169	0.497	0.281	0.714	0.505	0.291	0.878	2.273	10	14	41	45.4	88	96	101	43	163
1970	1.357	0.512	2.203	1.332	0.782	2.266	0.350	0.235	0.466	0.481	0.277	0.836	3.566	4	13	55	53.3	84	104	58	35	161
1971	0.786	0.196	1.377	1.374	0.807	2.337	0.282	0.150	0.414	0.567	0.326	0.985	2.813	5	8	39	42.3	95	98	55	28	168
1972	4.918	3.295	6.541	2.062	1.212	3.509	4.113	1.281	6.944	1.067	0.614	1.856	1.298	12	16	23	31.8	74	99	604	85	161
1973	1.986	0.994	2.978	1.725	1.014	2.936	1.176	0.857	1.494	0.812	0.467	1.411	1.568	13	14	32	37.7	77	93	280	70	154
1974	0.710	0.322	1.098	1.314	0.772	2.235	0.218	0.116	0.320	0.482	0.277	0.837	3.277	14	16	54	52.9	81	101	56	26	153
1975	2.043	1.326	2.759	1.512	0.889	2.573	0.653	0.434	0.871	0.486	0.280	0.845	3.030	8	17	45	46.3	87	105	127	51	158
1976	1.084	0.539	1.630	1.422	0.836	2.420	0.314	0.189	0.438	0.403	0.232	0.701	3.166	11	11	51	50.7	77	95	60	34	165
1977	1.873	1.192	2.554	1.605	0.943	2.731	0.372	0.265	0.479	0.395	0.227	0.687	5.024	5	16	55	53.1	95	106	94	50	172
1978	1.395	0.883	1.906	1.633	0.960	2.779	0.259	0.178	0.340	0.403	0.232	0.700	5.384	13	17	61	56.5	87	101	68	39	219
1979	2.275	1.278	3.272	1.847	1.085	3.143	0.694	0.483	0.905	0.553	0.318	0.961	2.779	7	16	34	40.5	84	109	182	70	205
1980	1.868	1.166	2.570	1.816	1.067	3.091	0.726	0.427	1.025	0.652	0.375	1.133	2.664	3	16	34	41.6	85	104	113	42	159
1981	2.858	0.883	4.834	1.752	1.030	2.982	0.965	0.578	1.352	0.714	0.411	1.241	2.363	6	17	38	40.7	71	99	176	59	146
1982	0.646	0.350	0.941	1.217	0.715	2.071	0.610	0.373	0.847	0.638	0.367	1.110	1.060	13	15	26	32.5	66	73	98	42	143
1983	2.150	0.693	3.608	1.294	0.760	2.201	0.776	0.470	1.080	0.589	0.339	1.023	2.304	7	16	45	44.4	72	100	109	49	146
1984	0.740	0.148	1.332	0.977	0.574	1.663	0.311	0.114	0.508	0.451	0.259	0.784	2.445	5	13	47	45.7	68	93	42	25	146
1985	1.318	0.752	1.884	0.890	0.523	1.514	0.524	0.356	0.692	0.443	0.255	0.770	2.444	17	17	40	42.0	72	96	100	46	145
1986	0.552	0.237	0.867	0.622	0.366	1.059	0.325	0.169	0.481	0.389	0.224	0.676	1.681	7	14	34	37.6	68	78	60	33	146
1987	0.274	0.117	0.432	0.472	0.277	0.802	0.482	0.307	0.657	0.385	0.222	0.670	0.575	12	13	20	25.0	56	61	67	27	132
1988	0.554	0.210	0.899	0.515	0.302	0.876	0.230	0.097	0.364	0.328	0.189	0.571	2.391	19	27	36	45.1	87	91	27	19	129
1989	0.625	0.278	0.972	0.535	0.314	0.910	0.382	0.181	0.583	0.356	0.205	0.618	1.646	7	7	42	38.0	57	77	57	23	129
1990	0.426	0.017	0.834	0.500	0.296	0.845	0.294	0.113	0.474	0.367	0.213	0.632	1.265	9	13	24	33.1	61	81	47	22	136
1991	0.783	0.206	1.360	0.520	0.308	0.880	0.690	0.245	1.136	0.440	0.256	0.758	1.085	14	15	23	30.8	57	81	106	27	131
1992	0.312	0.170	0.454	0.412	0.244	0.696	0.342	0.220	0.463	0.390	0.226	0.671	0.919	8	11	30	32.2	54	74	46	21	129
1993	0.294	0.055	0.532	0.392	0.232	0.663	0.290	0.135	0.445	0.377	0.219	0.649	0.944	10	13	32	30.4	52	68	46	24	130
1994	0.611	0.175	1.047	0.454	0.269	0.768	0.598	0.344	0.852	0.434	0.252	0.748	0.906	8	12	25	29.2	59	83	85	31	135
1995	0.386	0.160	0.612	0.430	0.255	0.727	0.493	0.258	0.728	0.404	0.235	0.696	0.777	11	13	25	29.4	54	66	72	29	129
1996	0.387	0.214	0.560	0.439	0.259	0.742	0.235	0.131	0.338	0.329	0.191	0.566	1.638	18	19	42	42.3	62	68	31	21	131
1997	0.592	0.325	0.858	0.486	0.288	0.822	0.308	0.186	0.430	0.335	0.195	0.577	1.914	9	9	49	44.6	70	71	43	24	131
1998	0.500	0.226	0.774	0.472	0.279	0.799	0.332	0.146	0.519	0.361	0.210	0.623	1.525	11	11	36	37.0	68	87	45	20	131
1999	0.304	0.167	0.441	0.442	0.261	0.747	0.450	0.289	0.612	0.413	0.240	0.711	0.672	12	14	27	29.2	52	55	109	44	106
2000	0.477	0.261	0.694	0.531	0.314	0.898	0.422	0.270	0.575	0.445	0.258	0.767	1.102	5	15	33	34.3	63	70	64	30	132
2001	0.709	0.366	1.052	0.685	0.403	1.164	0.378	0.236	0.521	0.496	0.287	0.859	1.722	4	11	39	41.69	70	80	51	30	130
2002	1.253	0.749	1.757	0.864	0.499	1.496	0.829	0.560	1.097	0.665	0.377	1.173	1.512	6	14	41	39.12	61	81	110	47	130
2003	0.828	0.524	1.131	0.850	0.451	1.599	0.951	0.620	1.282	0.768	0.399	1.477	0.858	6	7	18	28.25	59	70	128	41	130
2004																						

Table A21. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for goosefish 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.

	Biomass						Abundance							Length						Number	Number of	Number
	Raw Index			Smoothed			Raw Index			Smoothed										of	Nonzero	
	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Mean	L95%	U95%	Ind wt	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1968	1.142	0.552	1.731	1.067			0.211	0.126	0.297	0.216			5.344	21	23	63	62.5	94	95	65	31	150
1969	0.938	0.427	1.448	1.020			0.221	0.138	0.305	0.220			4.064	7	25	47	54.3	91	111	41	31	155
1970	1.005	0.460	1.549	1.031			0.175	0.103	0.247	0.223			5.699	22	22	65	63.9	102	108	40	31	166
1971	0.762	0.313	1.211	1.061	0.679	1.658	0.204	0.104	0.304	0.265	0.173	0.406	3.675	13	16	50	53.3	101	115	42	24	160
1972	1.883	1.161	2.604	1.364	0.873	2.131	0.371	0.272	0.469	0.375	0.244	0.576	5.071	14	22	59	59.1	103	123	79	48	165
1973	1.857	1.494	2.220	1.412	0.903	2.205	1.051	0.854	1.249	0.536	0.349	0.822	1.744	11	19	32	41.1	80	110	589	128	187
1974	1.129	0.728	1.530	1.215	0.778	1.898	0.486	0.368	0.604	0.486	0.317	0.746	2.367	14	21	44	49.1	93	117	201	70	132
1975	0.936	0.562	1.310	1.098	0.703	1.716	0.447	0.326	0.568	0.442	0.288	0.678	2.044	10	22	44	47.6	87	107	169	61	134
1976	1.209	0.833	1.585	1.105	0.707	1.727	0.403	0.307	0.500	0.398	0.259	0.610	2.777	13	22	48	51.5	91	110	259	78	162
1977	1.205	0.754	1.657	1.047	0.670	1.637	0.302	0.232	0.372	0.355	0.231	0.545	3.803	16	21	51	56.8	95	116	173	75	160
1978	0.735	0.512	0.959	0.903	0.578	1.411	0.335	0.265	0.405	0.353	0.230	0.542	2.184	11	17	39	45.9	90	104	196	66	161
1979	0.733	0.441	1.026	0.895	0.573	1.398	0.281	0.164	0.397	0.364	0.237	0.559	2.589	10	14	37	44.4	98	124	125	50	194
1980	0.799	0.494	1.104	1.013	0.649	1.583	0.451	0.354	0.548	0.446	0.291	0.685	1.636	18	21	34	40.8	83	106	346	99	204
1981	1.816	1.145	2.486	1.347	0.862	2.104	0.784	0.540	1.029	0.544	0.354	0.834	2.259	12	22	40	44.6	89	113	345	74	141
1982	2.803	1.584	4.021	1.463	0.937	2.286	0.942	0.657	1.226	0.517	0.337	0.794	2.800	11	14	38	42.4	89	104	251	68	150
1983	0.955	0.421	1.489	1.027	0.658	1.605	0.270	0.176	0.365	0.329	0.215	0.505	3.514	24	24	47	51.8	97	112	55	36	147
1984	0.747	0.223	1.272	0.758	0.485	1.184	0.182	0.090	0.274	0.239	0.156	0.367	4.067	21	21	47	50.9	96	97	35	22	149
1985	0.327	0.089	0.565	0.564	0.361	0.881	0.159	0.072	0.247	0.209	0.136	0.321	2.052	22	22	39	42.3	85	90	31	21	147
1986	0.823	0.342	1.303	0.606	0.388	0.946	0.283	0.125	0.442	0.219	0.143	0.336	2.917	15	24	43	48.7	90	102	65	36	149
1987	0.496	-0.014	1.007	0.529	0.339	0.827	0.108	0.054	0.162	0.194	0.126	0.297	4.612	15	15	59	52.7	102	103	30	21	150
1988	0.427	0.264	0.590	0.483	0.309	0.755	0.440	0.280	0.601	0.253	0.165	0.389	0.971	17	18	30	34.0	61	82	67	33	132
1989	0.365	0.122	0.608	0.480	0.307	0.749	0.202	0.097	0.306	0.229	0.149	0.351	1.807	15	24	41	41.4	69	79	36	18	129
1990	1.005	0.431	1.579	0.572	0.344	0.949	0.205	0.099	0.311	0.224	0.145	0.347	4.861	16	21	53	56.5	86	93	39	23	128
1991	0.582	0.236	0.927	0.466	0.281	0.774	0.319	0.142	0.495	0.234	0.151	0.362	1.819	15	23	33	37.6	69	101	61	31	132
1992	0.210	0.067	0.353	0.328	0.197	0.544	0.177	0.089	0.266	0.198	0.128	0.306	1.235	14	19	28	35.0	69	85	28	17	128
1993	0.264	0.097	0.431	0.311	0.187	0.516	0.195	0.096	0.295	0.180	0.116	0.279	1.319	17	19	38	38.6	56	72	29	18	128
1994	0.321	0.117	0.525	0.328	0.198	0.545	0.114	0.057	0.172	0.156	0.101	0.241	2.866	13	13	41	43.8	91	93	24	18	131
1995	0.526	0.031	1.021	0.352	0.212	0.585	0.196	0.100	0.292	0.166	0.107	0.257	2.637	18	19	38	45.7	80	81	32	20	129
1996	0.284	0.112	0.457	0.289	0.174	0.479	0.135	0.070	0.200	0.158	0.102	0.245	2.083	9	9	44	43.7	80	81	27	20	143
1997	0.132	0.035	0.228	0.239	0.144	0.397	0.124	0.050	0.198	0.168	0.109	0.260	1.064	18	18	37	35.9	58	75	38	14	130
1998	0.282	0.157	0.407	0.295	0.178	0.490	0.254	0.164	0.344	0.218	0.141	0.338	1.110	12	16	35	35.9	64	77	40	30	131
1999	0.629	0.342	0.916	0.376	0.226	0.623	0.335	0.217	0.453	0.256	0.166	0.397	1.899	16	19	41	42.8	74	94	63	32	131
2000	0.293	0.163	0.424	0.338	0.204	0.561	0.242	0.153	0.330	0.251	0.162	0.389	1.222	14	14	38	37.9	61	78	32	25	131
2001	0.244	0.089	0.399	0.335	0.201	0.556	0.234	0.131	0.336	0.253	0.163	0.392	1.098	11	15	34	35.8	57	68	44	50	89
2002	0.376	0.132	0.619	0.409	0.246	0.683	0.318	0.095	0.541	0.268	0.173	0.416	1.183	22	23	37	39.3	53	62	50	50	91
2003	1.425	0.688	2.162	0.531	0.313	0.901	0.371	0.218	0.524	0.253	0.160	0.400	3.726	15	29	57	56.7	80	87	65	30	86
2004	0.194	0.047	0.341	0.354	0.192	0.652	0.116	0.050	0.182	0.185	0.109	0.313	1.565	22	21	37	39.7	61	62	24	36	88

Table A22. Stratified mean weight (kg), number, individual fish weight, and length (cm) per tow for goosefish from NEFSC winter flatfish surveys in the southern management region (strata 1-19, 61-76); confidence limits for indices; minimum and maximum lengths; number of fish caught, number of positive tows, and total number of tows completed.

	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
1992	5.395	3.515	7.275	5.176	3.665	6.687	0.986	11	22	34	36.0	52	95	583	66	110
1993	6.317	4.565	8.070	5.002	3.941	6.062	1.188	9	21	36	37.7	53	98	585	77	109
1994	2.787	1.958	3.617	2.534	1.855	3.212	1.078	8	16	31	35.1	61	78	278	56	82
1995	3.398	2.249	4.457	2.738	1.859	3.617	1.245	19	21	36	37.9	57	101	390	76	123
1996	5.701	4.683	6.720	3.779	3.035	4.523	1.498	10	24	39	41.1	61	100	554	87	123
1997	5.390	3.781	6.998	3.172	2.445	3.900	1.667	10	20	43	42.0	62	91	455	89	119
1998	2.851	2.061	3.641	1.416	1.105	1.726	1.983	10	20	42	44.9	69	103	240	77	134
1999	3.792	2.869	4.715	2.803	2.183	3.423	1.340	10	18	35	38.3	61	87	459	83	138
2000	5.786	4.135	7.438	4.516	3.263	5.769	1.261	11	22	37	39.1	57	96	664	93	123
2001	7.324	4.892	9.755	4.346	3.126	5.565	1.451	8	19	37	40.0	60	84	1042	115	167
2002	7.435	5.592	9.279	3.978	3.126	4.830	1.824	15	28	43	45.2	66	96	737	113	153
2003	7.103	4.657	9.548	3.458	2.484	4.432	2.050	12	23	47	46.5	67	92	698	72	99
2004	8.068	5.201	10.935	4.673	3.142	6.204	1.675	13	22	40	42.5	66	88	896	103	135

Table A23. NEFSC winter offshore survey, delta distribution stratified mean number per tow at age.

South	Age											
	0	1	2	3	4	5	6	7	8	9	10	Total
1997	0.000	0.052	0.111	0.672	0.459	0.800	0.830	0.188	0.043	0.017	0.000	3.172
1998	0.000	0.015	0.049	0.063	0.341	0.492	0.267	0.110	0.059	0.010	0.010	1.416
1999	0.000	0.026	0.143	0.654	0.730	0.534	0.532	0.133	0.044	0.008	0.000	2.803
2000	0.000	0.000	0.045	0.833	1.484	1.489	0.464	0.130	0.050	0.000	0.020	4.516
2001	0.000	0.019	0.195	0.743	1.379	0.982	0.803	0.151	0.060	0.014	0.000	4.346
2002	0.000	0.000	0.029	0.094	1.082	1.307	1.045	0.322	0.069	0.023	0.005	3.978
2003	0.000	0.000	0.089	0.436	0.445	0.924	1.175	0.255	0.105	0.030	0.000	3.458
2004	0.000	0.000	0.058	0.835	1.129	1.023	1.106	0.393	0.110	0.019	0.000	4.673

Table A24. Stratified mean number and length (cm) per tow for goosefish from NEFSC summer scallop surveys in the southern management region (shellfish strata 1-48,55-64,69-70,73-74); 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.

	Abundance												Number	Number of	
	Raw Index			Smoothed			Length						of	Nonzero	Number
	Mean	L95%	U95%	Mean	L95%	U95%	Min	5%	50%	Mean	95%	Max	Fish	Tows	of Tows
1984	1.068	0.911	1.225	1.111			6	12	28	30.6	60	82	523	232	389
1985	1.073	0.921	1.226	1.141			7	10	30	32.8	64	113	594	234	404
1986	0.934	0.714	1.155	1.221			8	10	16	22.1	53	95	465	203	371
1987	2.418	1.927	2.909	1.564	1.102	2.219	8	9	13	18.7	51	90	1429	313	433
1988	1.444	1.182	1.705	1.494	1.053	2.120	7	12	29	30.3	49	97	725	234	435
1989	1.241	1.078	1.405	1.461	1.029	2.073	6	10	34	33.7	54	101	373	175	352
1990	1.401	1.222	1.580	1.594	1.147	2.215	6	10	18	25.6	57	94	579	211	342
1991	2.216	1.935	2.496	1.897	1.365	2.636	7	9	14	21.0	45	94	809	242	323
1992	1.877	1.608	2.146	2.033	1.463	2.825	5	9	25	27.3	52	97	644	235	324
1993	2.639	2.387	2.892	2.299	1.654	3.194	8	10	15	22.4	49	79	1012	270	325
1994	3.095	2.738	3.452	2.369	1.704	3.292	8	10	15	22.5	51	87	1151	271	338
1995	2.093	1.826	2.361	2.039	1.467	2.834	7	9	28	30.0	58	92	776	252	338
1996	1.814	1.580	2.048	1.725	1.242	2.398	7	9	24	29.9	59	81	639	227	307
1997	1.046	0.904	1.188	1.411	1.016	1.961	7	13	33	37.2	65	76	398	204	336
1998	0.958	0.827	1.089	1.412	1.016	1.962	6	11	22	31.5	63	79	380	188	339
1999	2.441	2.047	2.835	1.834	1.319	2.549	6	9	17	24.6	60	84	859	250	311
2000	2.321	2.043	2.599	1.965	1.413	2.732	8	9	19	28.2	57	99	844	237	320
2001	1.680	1.458	1.902	1.882	1.350	2.623	7	8	36	36.9	64	99	570	227	358
2002	1.653	1.441	1.864	1.946	1.380	2.744	7	11	35	35.1	62	99	620	202	331
2003	2.775	2.396	3.153	2.244	1.510	3.335	6	9	16	25.0	58	87	840	213	311
2004	2.443	2.125	2.760				9	11	26	29.9	60	86	873	282	369

Table A25. Net measurements for the 2004 cooperative survey flat net.

2004 Survey flat net	
Backstraps	14' + 15' extension = 29'
Belly	182 x 60 x 100 deep
Codend	6" 50 deep x 25 across, double 5mm
Corners	5' each side from center sq hung in 10'
Droppers	2 links with shackles
Floats	48 - orange - 8" center hole
Footrope	148'
Headrope	128'
Legs	64' 1/2" wire top, 64' 1/2" trawlex chain
Square	226 x 182 - 29 1/2 deep
Sweep	148' 6" cookies in center - 5" cookies on wings
Tickler	one
Twine	green ployethyene (4mm)
Up and Down line	7'
Wing Extensions	none

Table A26. Net measurements for the 2004 cooperative survey rockhopper net.

2004 Survey rockhopper

Backstraps	14' + 15' extension = 29'
Belly	186 x 60 x meshes 100 deep
Codend	50 x 25 across 6" double 5mm
Corners	sq hung in 10' 5' each side from center headrope
Droppers	1 5/8" shackle
Floats	74 - 8" orange center hole
Footrope	178.6'
Headrope	151'
Legs	10 fathom (60') top 1/2" wire, bottom leg 60' 1/2" trawlex chain
Square	226 x 184 x 29 1/2 deep
Sweep	178.6'
Tickler	none
Twine	5mm 4 rows lower wings (poly) 4mm poly
Up and Down line	13'
Wing Extensions	none

Table A28. 2004 cooperative survey swept area biomass and population number estimates.										
A. Minimum biomass/numbers										
			mt					**Thousands**		
		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc
	North		28,536					14,441		
	South		65,877					36,579		
	Combined		94,413					51,020		
B. Under High Efficiency Assumptions										
			mt					**Thousands**		
		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc
	North									
	South									
	Combined									
C. Under Intermediate Efficiency Assumptions										
			mt					**Thousands**		
		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc
	North		51,766					25,698		
	South		109,807					60,972		
	Combined		161,573					86,670		
D. Under Low Efficiency Assumptions										
			mt					**Thousands**		
		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc		Using Inclinometer Distance	Using nominal distance	nominal minus inclinom	% difference nom-inc
	North									
	South									
	Combined									

Table A29. Indices of egg production by goosefish 1967-2004 by region. Egg production index is a function of numbers at length, proportion mature at length, and fecundity at length, pooled over a 5-year interval. Proportion < L_{99} is proportion of egg production generated by fish smaller than the length at 99% maturity. Maturity rates derived from Hartley (1995).

Year	North Spring EPI	North Spring P < L_{99}	North Autumn EPI	North Autumn P < L_{99}	South Spring EPI	South Spring P < L_{99}	South Autumn EPI	South Autumn P < L_{99}
1967	-	-	1.46	0.01	-	-	2.18	0.03
1968	-	-	1.23	0.00	-	-	1.86	0.03
1969	-	-	1.46	0.00	-	-	1.48	0.03
1970	-	-	1.41	0.00	-	-	1.11	0.03
1971	-	-	1.37	0.00	-	-	0.53	0.05
1972	1.15	0.01	1.39	0.01	0.63	0.02	0.86	0.04
1973	1.31	0.01	1.54	0.01	0.72	0.03	0.94	0.04
1974	1.40	0.01	1.33	0.01	0.77	0.04	0.89	0.04
1975	1.28	0.01	1.27	0.01	0.76	0.05	0.93	0.05
1976	1.54	0.01	1.32	0.01	0.81	0.05	0.93	0.04
1977	1.13	0.01	1.69	0.01	0.74	0.05	0.66	0.04
1978	0.94	0.02	1.75	0.01	0.64	0.05	0.61	0.03
1979	0.83	0.01	1.97	0.01	0.58	0.04	0.68	0.03
1980	0.88	0.01	2.19	0.01	0.54	0.04	0.64	0.03
1981	0.71	0.02	1.99	0.01	0.58	0.07	0.70	0.05
1982	0.86	0.01	1.58	0.01	0.63	0.08	0.57	0.07
1983	0.93	0.01	1.28	0.01	0.63	0.08	0.61	0.08
1984	1.00	0.02	1.11	0.01	0.62	0.07	0.53	0.09
1985	1.05	0.01	0.87	0.01	0.57	0.08	0.48	0.10
1986	1.12	0.01	0.92	0.02	0.48	0.06	0.38	0.09
1987	1.00	0.01	0.91	0.02	0.33	0.05	0.36	0.08
1988	1.05	0.01	0.90	0.02	0.26	0.07	0.26	0.07
1989	1.01	0.02	0.73	0.03	0.20	0.13	0.23	0.12
1990	0.88	0.02	0.64	0.04	0.26	0.09	0.17	0.15
1991	0.74	0.03	0.51	0.05	0.22	0.10	0.17	0.16
1992	0.67	0.05	0.52	0.07	0.18	0.13	0.17	0.17
1993	0.56	0.08	0.46	0.08	0.17	0.13	0.13	0.23
1994	0.50	0.08	0.41	0.09	0.18	0.09	0.13	0.19
1995	0.55	0.09	0.47	0.10	0.14	0.12	0.13	0.19
1996	0.49	0.12	0.46	0.12	0.12	0.10	0.11	0.18
1997	0.44	0.13	0.41	0.12	0.12	0.12	0.14	0.14
1998	0.38	0.13	0.40	0.12	0.12	0.10	0.17	0.11
1999	0.40	0.12	0.38	0.12	0.15	0.10	0.15	0.13
2000	0.36	0.12	0.44	0.13	0.13	0.14	0.17	0.13
2001	0.43	0.10	0.48	0.14	0.12	0.17	0.19	0.13
2002	0.52	0.12	0.58	0.14	0.13	0.21	0.23	0.15
2003	0.65	0.13	0.66	0.14	0.23	0.12	0.25	0.14
2004	0.79	0.11			0.19	0.12		

Table A30. Z estimate from catch curve analysis based on NEFSC survey indices. Catch curve estimates with $r^2<0.20$ are not included (-). N/A indicated insufficient data.

NORTH	90	91	92	93	94	95	96	97	98	99
Fall	0.33	0.84	0.43	0.37	0.25	---	0.49	0.62	0.29	N/A
Fall Smoot	0.24	0.76	0.49	0.53	0.34	---	0.41	0.42	0.17	N/A
Spring	N/A	N/A	---	0.33	---	0.33	0.22	0.14	0.60	N/A
Mean	0.29	0.80	0.46	0.41	0.30	0.33	0.37	0.39	0.35	N/A
SOUTH										
Fall	0.47	0.44	0.32	0.10	0.37	---	0.25	---	0.14	N/A
Fall Smoot	0.45	0.33	0.26	0.23	0.40	---	0.26	0.33	0.11	N/A
Spring	N/A	N/A	0.65	0.75	0.54	---	---	0.53	0.86	0.23
Winter	---	---	---	0.83	0.76	1.07	0.80	0.62	N/A	N/A
Mean	0.46	0.39	0.41	0.48	0.52	1.07	0.44	0.49	0.37	0.23

Table A31. Estimates of total mortality from NEFSC offshore surveys.

	NEFSC Fall Survey							NEFSC Spring Survey							NEFSC Winter Survey						
North	Numbers at Age				Total Mortality (Z)			Numbers at Age				Total Mortality (Z)			Numbers at Age				Total Mortality (Z)		
	Age 3+	Age 4+	Age 5+	Age 6+	3+/4+	4+/5+	5+/6+	Age 3+	Age 4+	Age 5+	Age 6+	3+/4+	4+/5+	5+/6+	Age 3+	Age 4+	Age 5+	Age 6+	3+/4+	4+/5+	5+/6+
1993	0.36	0.25	0.16	0.06	0.44	0.57	1.07														
1994	0.44	0.23	0.14	0.05	0.05	0.23	0.47														
1995	0.70	0.42	0.18	0.09	0.67	1.01	1.16	0.83	0.66	0.41	0.30	0.30	0.53	1.20							
1996	0.51	0.36	0.15	0.06	0.81	1.37	1.37	0.63	0.62	0.39	0.12	0.98	2.73	2.37							
1997	0.35	0.23	0.09	0.04	0.32	0.10	-0.53	0.31	0.24	0.04	0.04	0.62	0.65	-0.67							
1998	0.34	0.25	0.20	0.15	1.12	0.97	1.17	0.21	0.17	0.12	0.08	-0.72	-0.21	-0.13							
1999	0.29	0.11	0.10	0.06	-0.62	-0.88	-0.54	0.63	0.44	0.21	0.14	0.22	0.55	0.47							
2000	0.99	0.54	0.27	0.16	0.49	0.82	1.12	0.89	0.50	0.25	0.13	0.17	0.09	-0.02							
2001	0.97	0.61	0.24	0.09	0.63	0.75	0.76	1.12	0.75	0.46	0.25	-0.04	0.09	0.50							
2002	0.82	0.51	0.29	0.11	0.33	0.41	0.73	1.60	1.17	0.68	0.28	0.04	-0.03	0.16							
2003	0.66	0.59	0.34	0.14				1.63	1.54	1.21	0.58	0.89	0.92	0.92							
2004								0.73	0.67	0.62	0.48										
Mean					0.43	0.54	0.68					0.27	0.59	0.53							
South																					
1993	0.16	0.08	0.02	0.01	0.15	0.15	-0.52														
1994	0.19	0.14	0.07	0.04	0.49	0.73	1.45														
1995	0.24	0.12	0.07	0.02	0.51	0.33	0.95	0.20	0.14	0.10	0.08	0.64	0.60	0.46							
1996	0.20	0.14	0.09	0.03	0.06	-0.05	0.60	0.12	0.10	0.08	0.06	0.31	1.14	2.26							
1997	0.24	0.19	0.15	0.05	0.46	0.69	1.11	0.12	0.09	0.03	0.01	-0.31	0.18	0.16	3.01	2.34	1.88	1.08	0.85	0.90	1.42
1998	0.19	0.15	0.09	0.05	1.26	2.37		0.21	0.16	0.07	0.03	-0.14	-0.15	-0.11	1.35	1.29	0.95	0.46	-0.38	0.03	0.28
1999	0.17	0.05	0.01	0.00	0.28	-0.16	-1.05	0.32	0.24	0.18	0.08	0.68	1.08	1.74	2.63	1.98	1.25	0.72	-0.23	0.01	0.73
2000	0.24	0.13	0.06	0.04	0.23	0.19	0.06	0.22	0.16	0.08	0.03	0.34	0.66	0.64	4.47	3.64	2.15	0.66	0.28	0.59	0.74
2001	0.31	0.19	0.11	0.06	-0.46	-0.29	0.50	0.21	0.15	0.08	0.04	-0.33	0.17	0.72	4.13	3.39	2.01	1.03	0.07	0.20	0.32
2002	0.55	0.48	0.25	0.07	0.77	0.90	1.81	0.32	0.29	0.13	0.04	-0.10	-0.13	-0.67	3.95	3.85	2.77	1.47	0.30	0.44	0.57
2003	0.36	0.25	0.20	0.04				0.36	0.35	0.33	0.25	1.68	1.79	2.08	3.37	2.93	2.49	1.56	-0.12	0.10	0.42
2004								0.12	0.07	0.06	0.04				4.62	3.78	2.65	1.63			
Mean					0.37	0.49	0.54					0.31	0.59	0.81					0.11	0.32	0.64

Table A33. Additional exploitation ratios numbers for the 2004 cooperative survey, using the fishing year landings.

Nominal distances
A. Using landings and exploitable biomass

		100% efficiency			Intermediate Efficiency		
Management Area	Fishing year 2003 landings (mt)	2004 Survey Exploitable Biomass	Ldgs+2004 Survey B	Exploit. ratio	2004 Survey Exploitable Biomass	Ldgs+2004 Survey B	Exploit. ratio
North	14349	24494	38843	0.36941019	45237	59586	0.2408116
South	11764	47226	58990	0.199423631	78720	90484	0.130011936
Combined	26113	71720	97833	0.266914027	123957	150070	0.174005464

Nominal distances
B. Using catch and total biomass

		100% efficiency			Intermediate Efficiency		
Management Area	Fishing year 2003 catch (mt)	2004 Survey Biomass	Ldgs+2004 Survey B	Exploit. ratio	2004 Survey Biomass	Ldgs+2004 Survey B	Exploit. ratio
North	17899.84931	28536	46435.84931	0.385474791	51766	69665.84931	0.256938651
South	14385.17574	65877	80262.17574	0.179227334	109807	124192.1757	0.115829968
Combined	32285.02505	94413	126698.0251	0.254818692	161573	193858.0251	0.166539533

Table A34. Monkfish surplus production results using cooperative survey biomass estimates from 2001 and 2004 and assuming a beta function prior for the distribution of r, for northern and southern monkfish stock units.

B[40] is stock biomass at the start of 2003 (000 mt), B2004 is stock biomass at the start of 2004 (000 mt), BMSP is biomass that would maximize surplus production (000 mt), BMSPRATIO is the ratio of B2004 to BMSP, H[40] is the exploitation rate in 2003, HMSP is the exploitation rate that would maximize surplus production, K is carrying capacity (000 mt), M is the shape parameter of the production curve, MSP is maximum surplus production (000 mt), qFALL is autumn survey catchability, r is the intrinsic growth rate, sigma2 is process error variance parameter, and tau2FALL is the survey **error variance parameter.**

Northern monkfish

node	mean	stdev	0.1	0.25	median	0.75	0.9
B[40]	76.37	25.77	0.3435	38.53	47.77	72.13	109.6
B2004	68.69	25.51	0.3287	30.65	40.24	64.73	101.8
BMSP	62.22	15.06	0.2496	39.38	45.06	60.06	81.91
BMSPRATIO	1.22	0.2457	0.003301	0.7991	0.9287	1.203	1.519
H[40]	0.2607	0.08665	0.001156	0.1289	0.1631	0.2483	0.3751
HMSP	0.192	0.06754	0.001413	0.07879	0.1118	0.1846	0.2817
HRATIO	1.49	0.6796	0.01103	0.6593	0.8549	1.359	2.232
K	139.1	41.52	0.7601	76.98	91.52	133.1	193.8
M	1.624	0.3729	0.00754	1.171	1.263	1.537	2.088
MSP	11.27	3.004	0.05185	6.164	7.903	10.98	14.89
qFALL	0.01766	0.005069	0.00008139	0.009626	0.01173	0.01704	0.02454
r	0.5423	0.08911	0.0005017	0.3714	0.427	0.5415	0.6583
sigma2	0.00825	0.01219	0.0002869	0.001363	0.001891	0.004413	0.01772
tau2FALL	0.2004	0.06097	0.000999	0.09353	0.1282	0.1954	0.278

Southern monkfish

node	mean	stdev	0.1	0.25	median	0.75	0.9
B[40]	113.4	35.24	0.8673	62.71	75.04	107.3	159.1
B2004	112.7	35.77	0.9038	62.04	74.21	106.3	158.9
BMSP	98.08	50.28	2.24	49.55	57.61	82.34	158.2
BMSPRATIO	1.268	0.3409	0.01356	0.5413	0.7782	1.327	0.8727
H[40]	0.1383	0.04029	0.0009495	0.07234	0.09038	0.1341	0.1918
HMSP	0.2204	0.11	0.00486	0.0519	0.08748	0.2035	0.379
HRATIO	0.8203	0.7	0.01995	0.2924	0.3751	0.6525	1.42
K	218.9	137.3	6.223	85.59	105.6	176.6	385.1
M	1.865	0.7239	0.02968	1.108	1.198	1.624	2.897
MSP	18.05	6.19	0.169	8.128	11.03	17.47	25.62
qFALL	0.007852	0.002442	0.00007322	0.004075	0.005047	0.007507	0.01114
r	0.5498	0.09102	0.001276	0.3736	0.4311	0.5497	0.6686
sigma2	0.02588	0.03351	0.001292	0.001358	0.001982	0.01096	0.06897

Table A35. Stratified mean catch per tow in weight (kg), and 3-year moving averages, NEFSC offshore autumn research vessel bottom trawl in northern region (survey strata 20-30, 34-40); and southern region (survey strata 1-19, 61-76). B_{TARGET} is the median of the 3-year moving average (1965-1981 north, 1967-1981 south). $B_{THRESHOLD}$ equals half of B_{TARGET}.

	Northern Management/ Assessment Area				Southern Management/ Assessment Area			
	Mean Weight/Tow	$B_{THRESHOLD}$	Three-year Moving Average	B_{TARGET}	Mean Weight/Tow	$B_{THRESHOLD}$	Three-Year Moving Average	B_{TARGET}
1963	3.757				3.724			
1964	1.712				5.486			
1965	2.509	1.250	2.659	2.496	5.163	0.930	4.791	1.848
1966	3.266		2.496		6.986		5.878	
1967	1.283		2.353		1.122		4.423	
1968	2.036		2.195		0.895		3.001	
1969	3.705		2.341		1.138		1.051	
1970	2.237		2.659		1.357		1.130	
1971	2.914		2.952		0.786		1.094	
1972	1.404		2.185		4.918		2.354	
1973	3.114		2.477		1.986		2.564	
1974	2.063		2.193		0.710		2.538	
1975	1.711		2.296		2.043		1.580	
1976	3.387		2.387		1.084		1.279	
1977	5.568		3.555		1.873		1.667	
1978	5.101		4.685		1.395		1.451	
1979	5.133		5.267		2.275		1.848	
1980	4.458		4.897		1.868		1.846	
1981	1.984		3.859		2.858		2.334	
1982	0.936		2.459		0.646		1.791	
1983	1.617		1.513		2.150		1.885	
1984	3.010		1.855		0.740		1.179	
1985	1.441		2.023		1.318		1.403	
1986	2.353		2.268		0.552		0.870	
1987	0.873		1.556		0.274		0.715	
1988	1.525		1.584		0.554		0.460	
1989	1.384		1.261		0.625		0.485	
1990	1.001		1.303		0.426		0.535	
1991	1.235		1.207		0.783		0.611	
1992	1.102		1.113		0.312		0.507	
1993	1.044		1.127		0.294		0.463	
1994	0.973		1.040		0.611		0.406	
1995	1.711		1.243		0.386		0.430	
1996	1.07		1.252		0.387		0.461	
1997	0.669		1.150		0.592		0.455	
1998	0.974		0.904		0.500		0.493	
1999	0.825		0.823		0.304		0.465	
2000	2.495		1.431		0.477		0.427	
2001	2.048		1.789		0.709		0.496	
2002	2.103		2.215		1.253		0.813	
2003	1.925		2.025		0.828		0.930	

Figure A1. Distribution of goosefish catches in NEFSC winter surveys (1992-1999), spring surveys (1968-1999), scallop surveys (1984-1999), and autumn surveys (1963-1999).

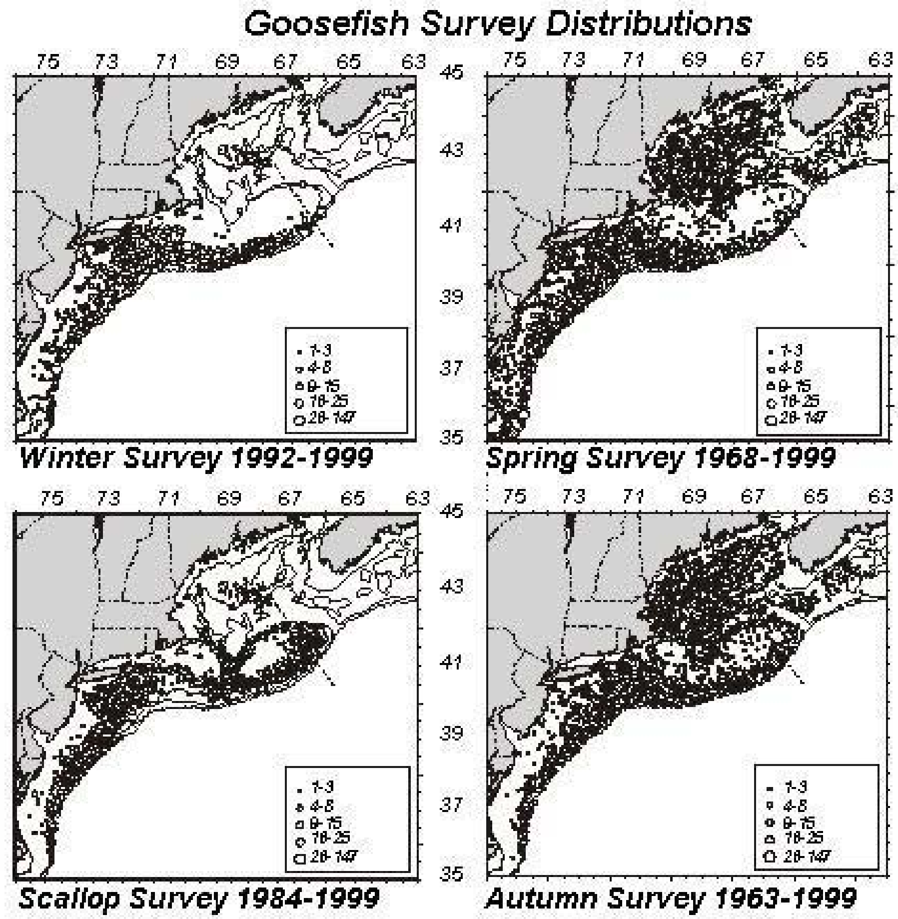


Figure A2. Monkfish commercial landings (live weight, mt) by management area.

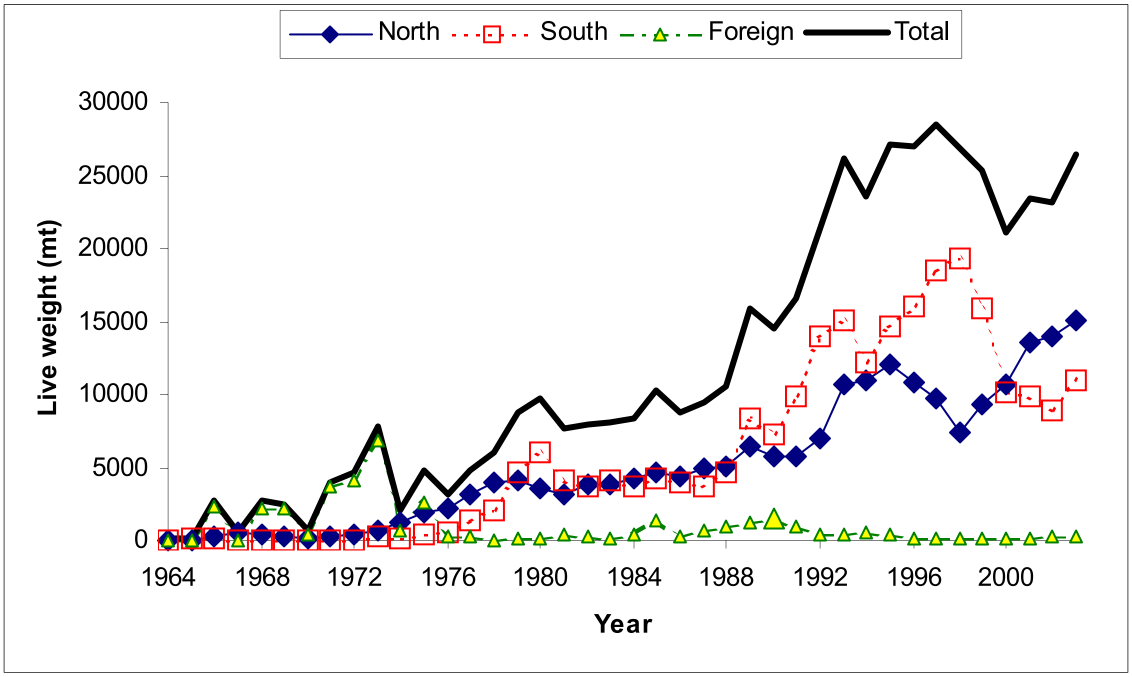
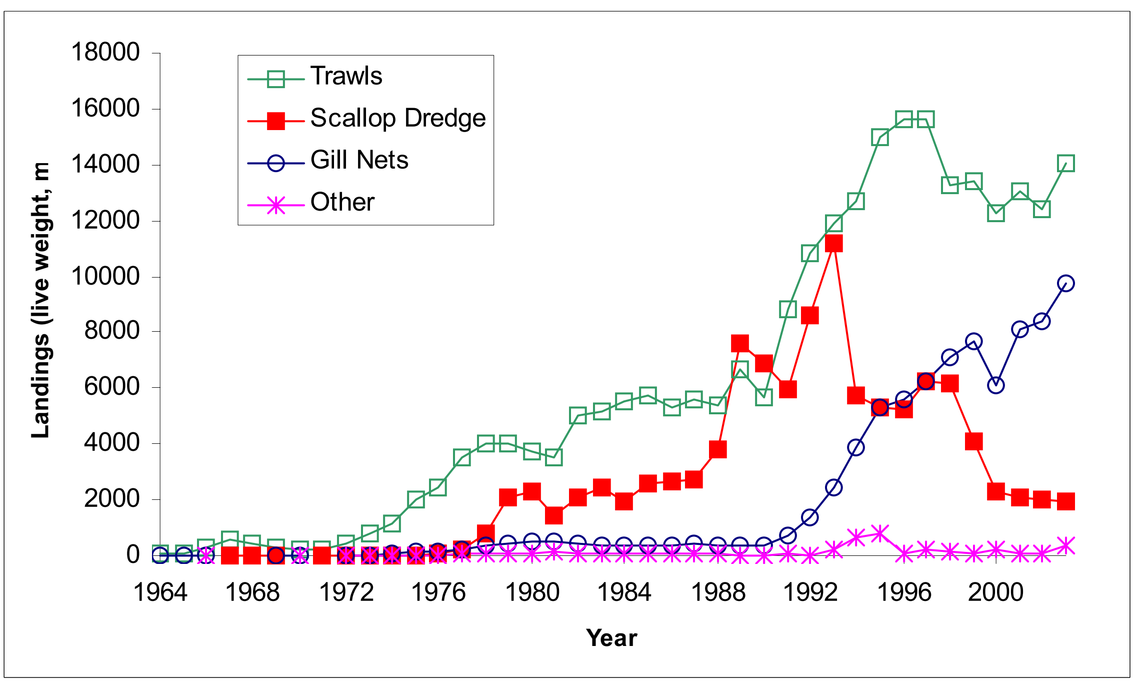


Figure A3. Monkfish commercial landings (live weight, mt) by gear type.



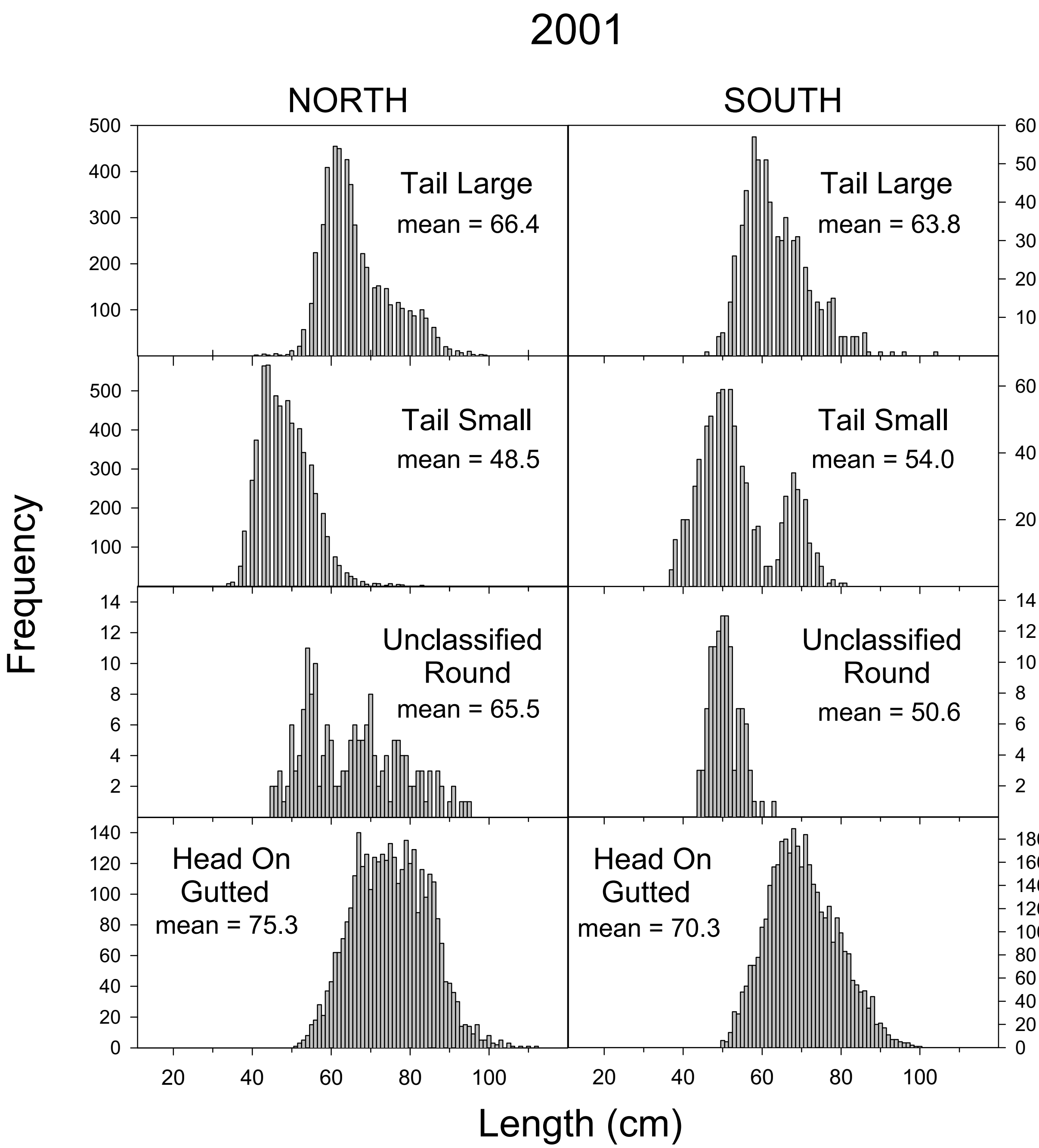


Figure A4. Commercial goosefish length frequency samples taken during 2001

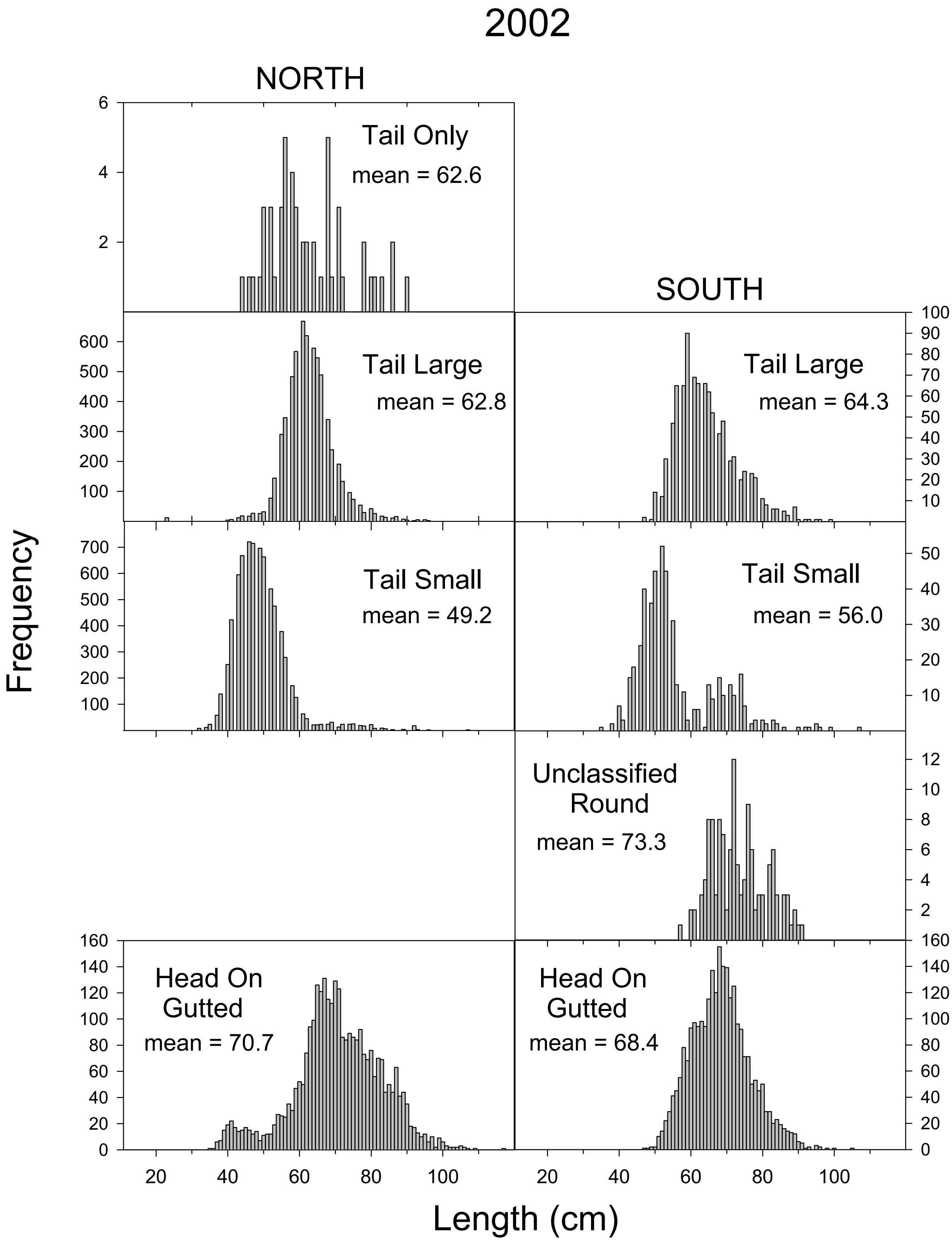


Figure A5. Commercial goosefish length frequency samples taken during 2002

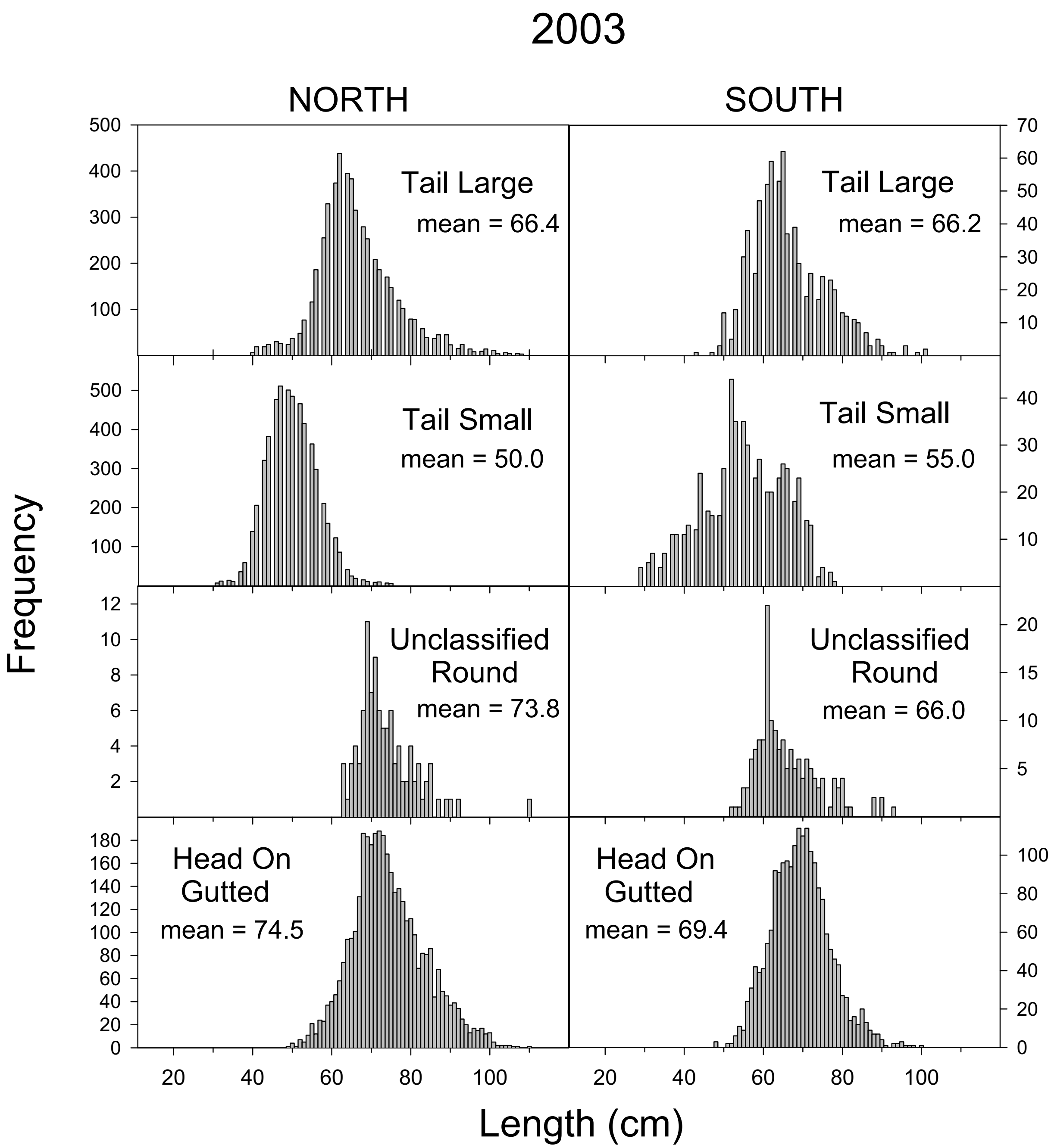


Figure A6. Commercial goosefish length frequency samples taken during 2003

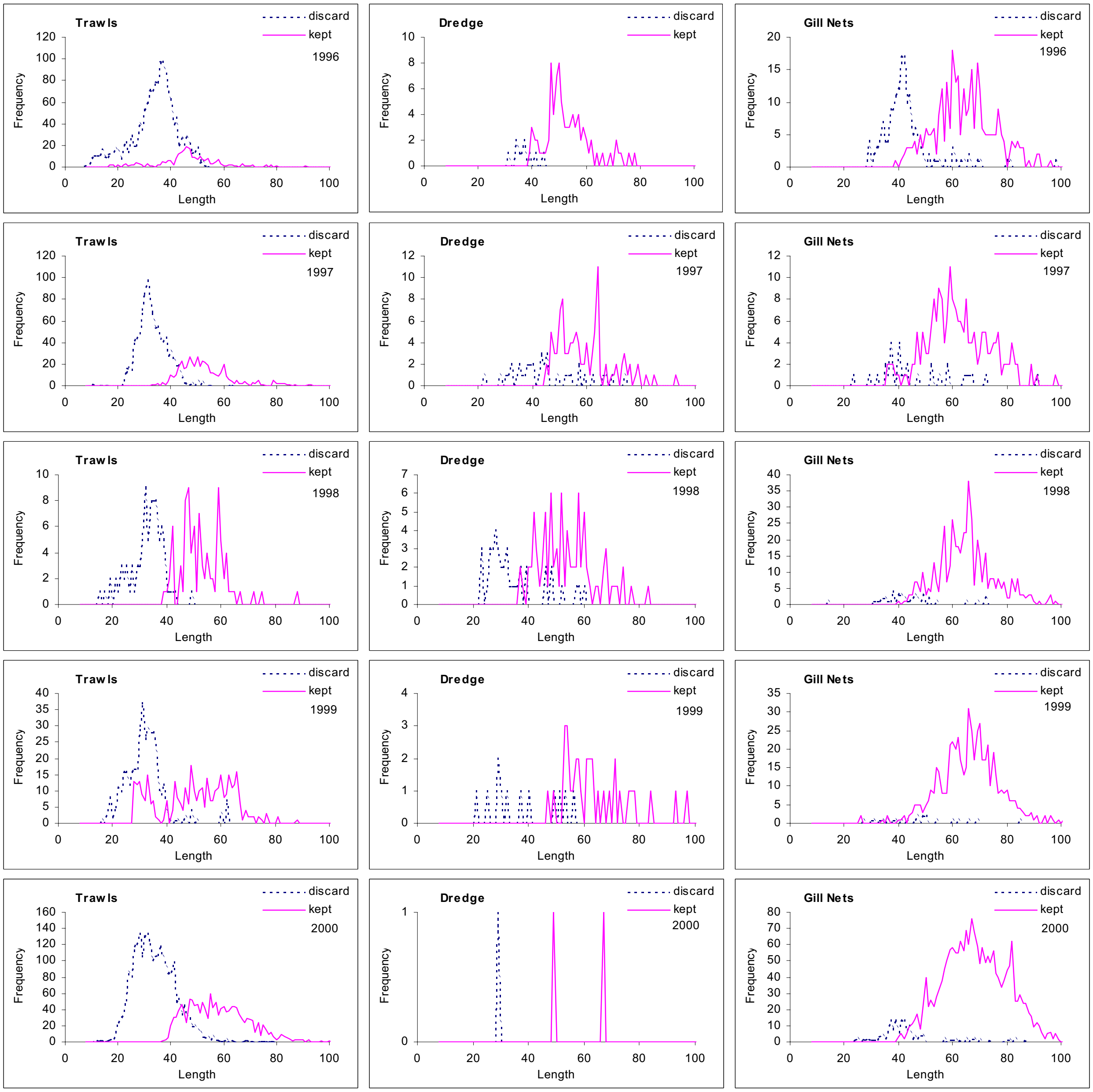


Figure A7. Size composition of kept and discarded goosefish estimated from sea sampling observations, northern region.

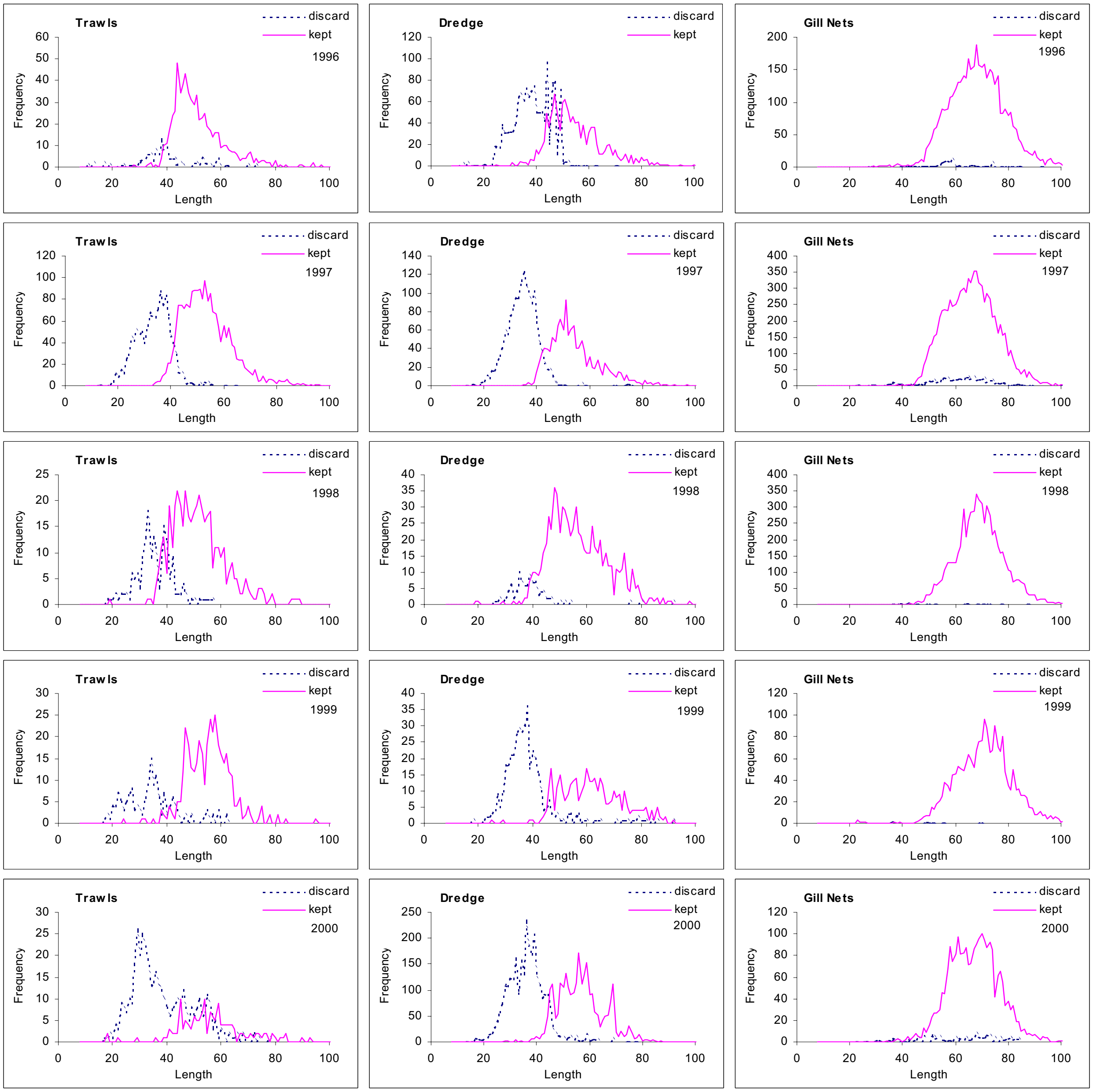


Figure A8. Size composition of kept and discarded goosefish estimated from sea sampling observations, southern region..

Figure A9. Discard ratios by major gear type and half year for goosefish, northern region.

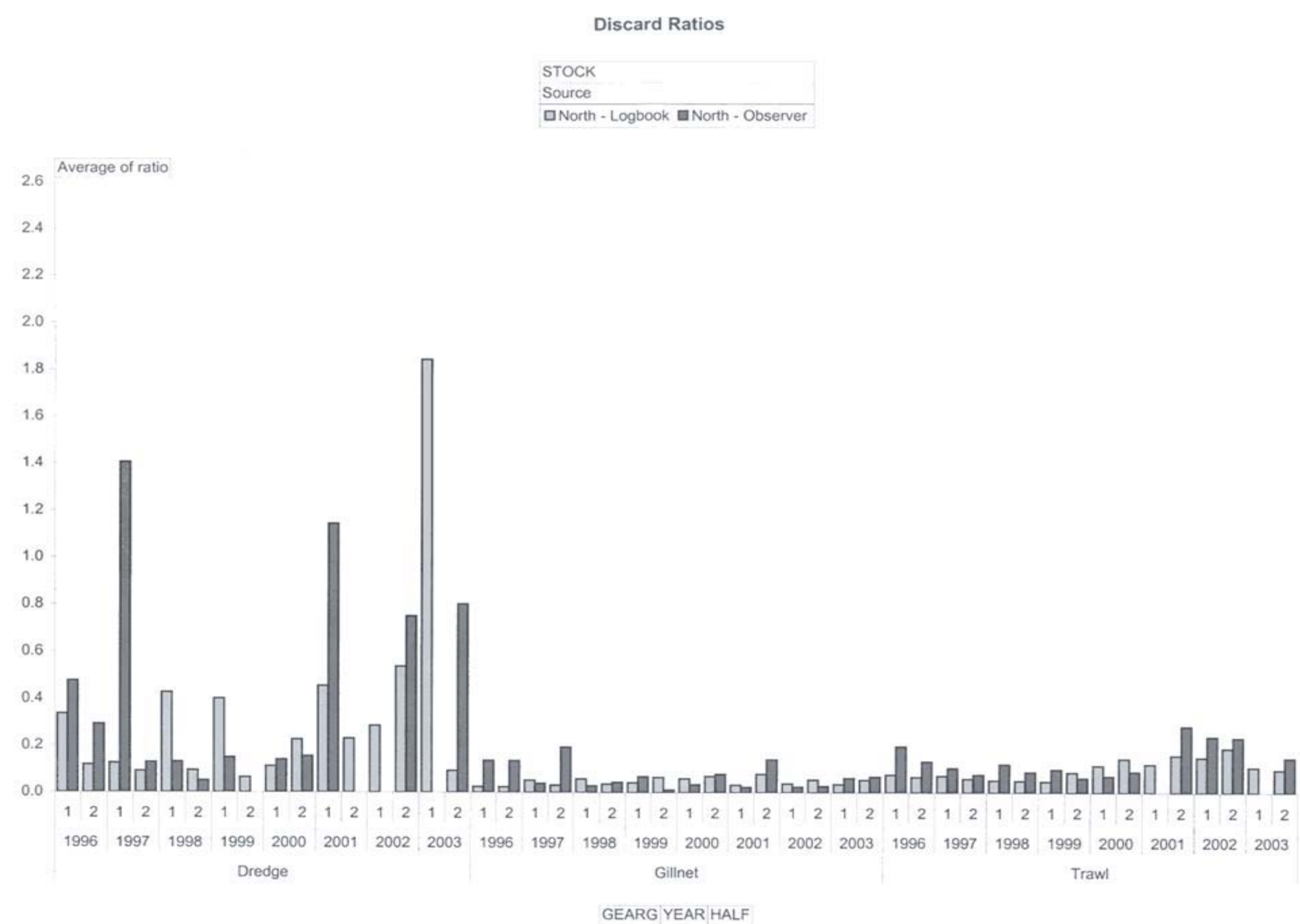
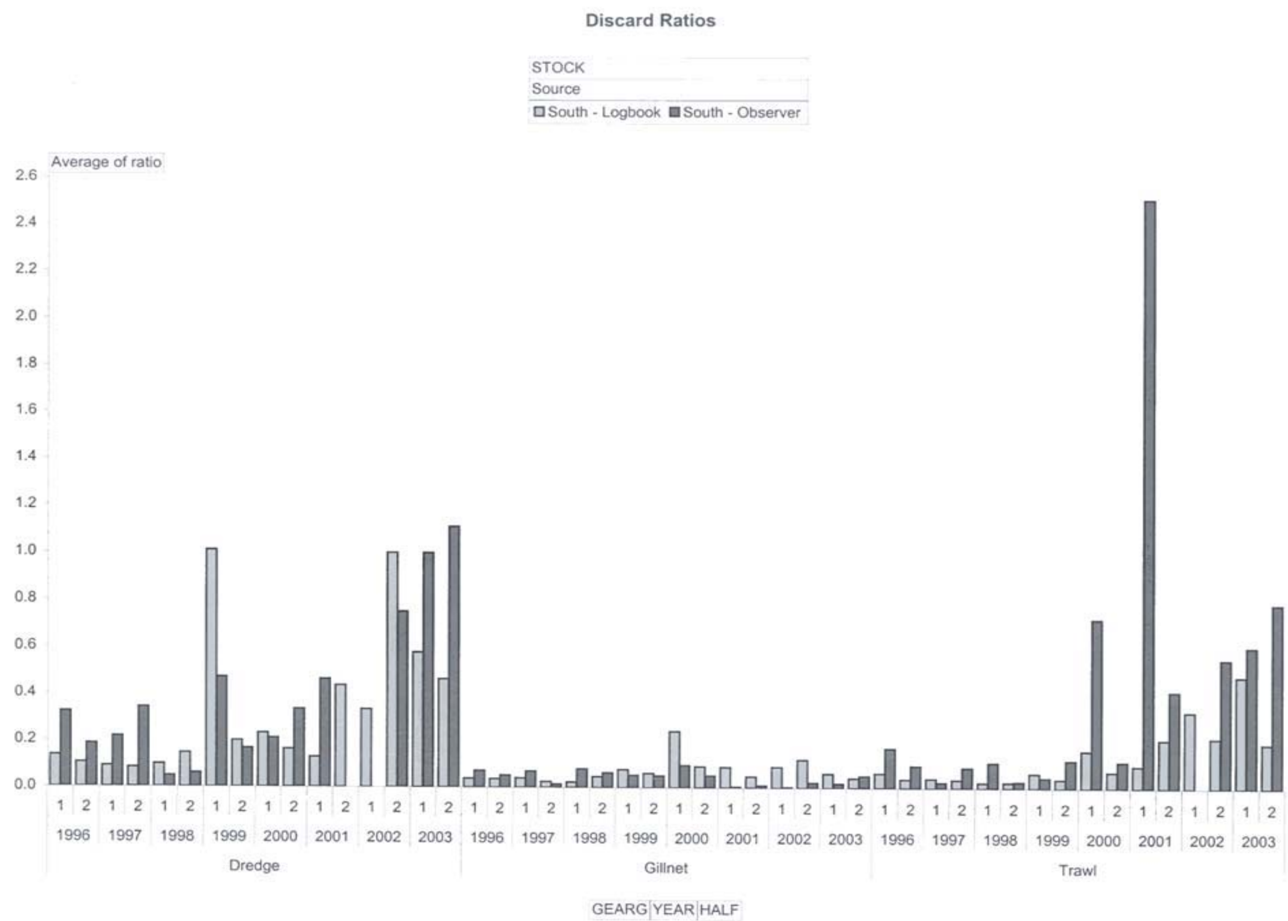


Figure A10. Discard ratios by major gear type and half year for goosefish, southern region.



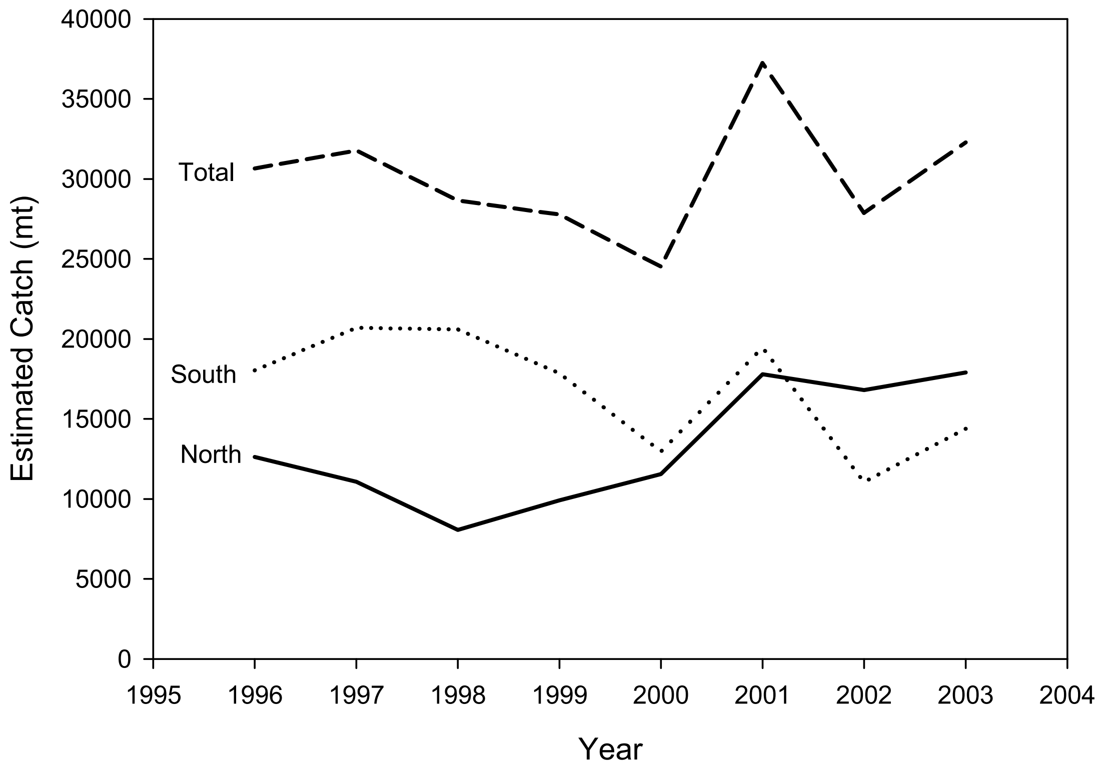
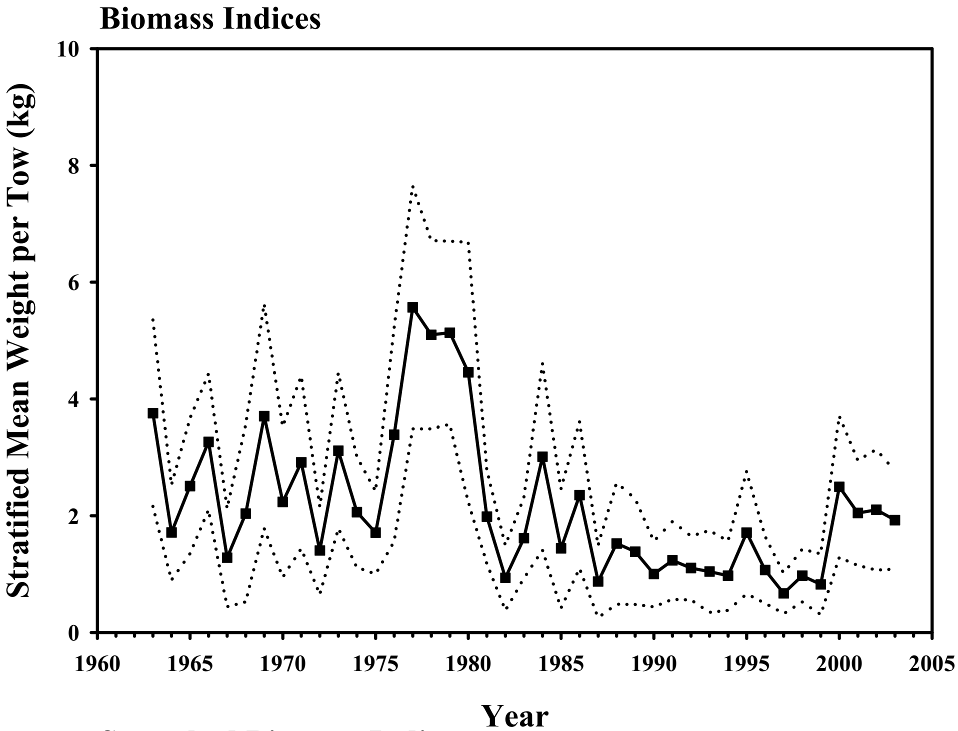


Figure A11. Estimated total catch (landings + discards) by management area.



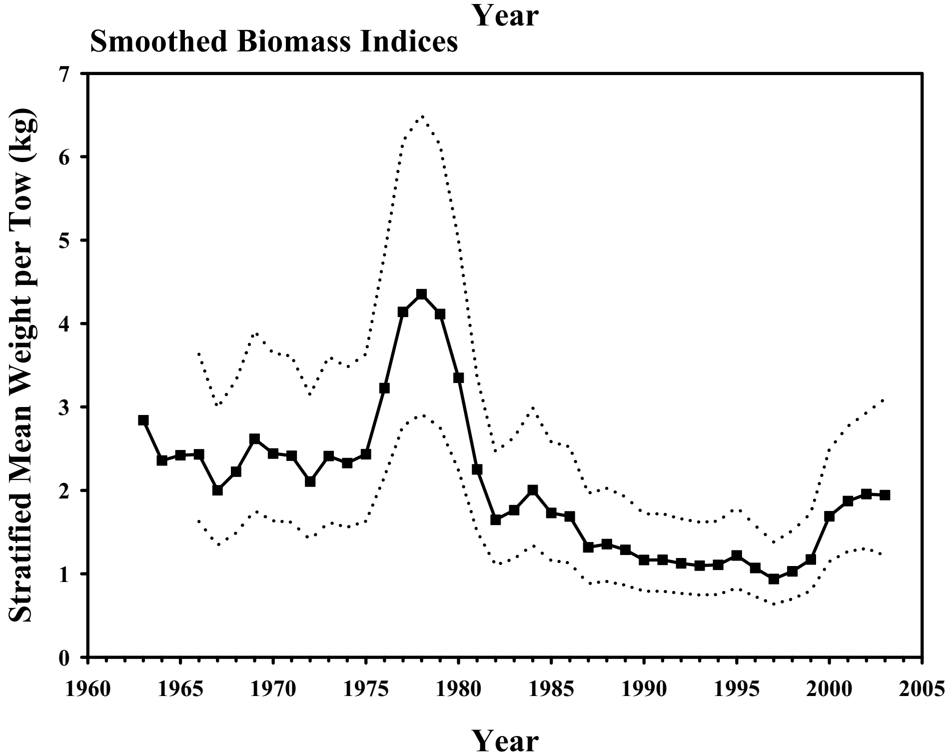


Figure A12. Biomass indices and smoothed indices from the NEFSC autumn bottom trawl survey for the northern management region from 1963-2003. The 95% confidence limits are shown by the dashed line.

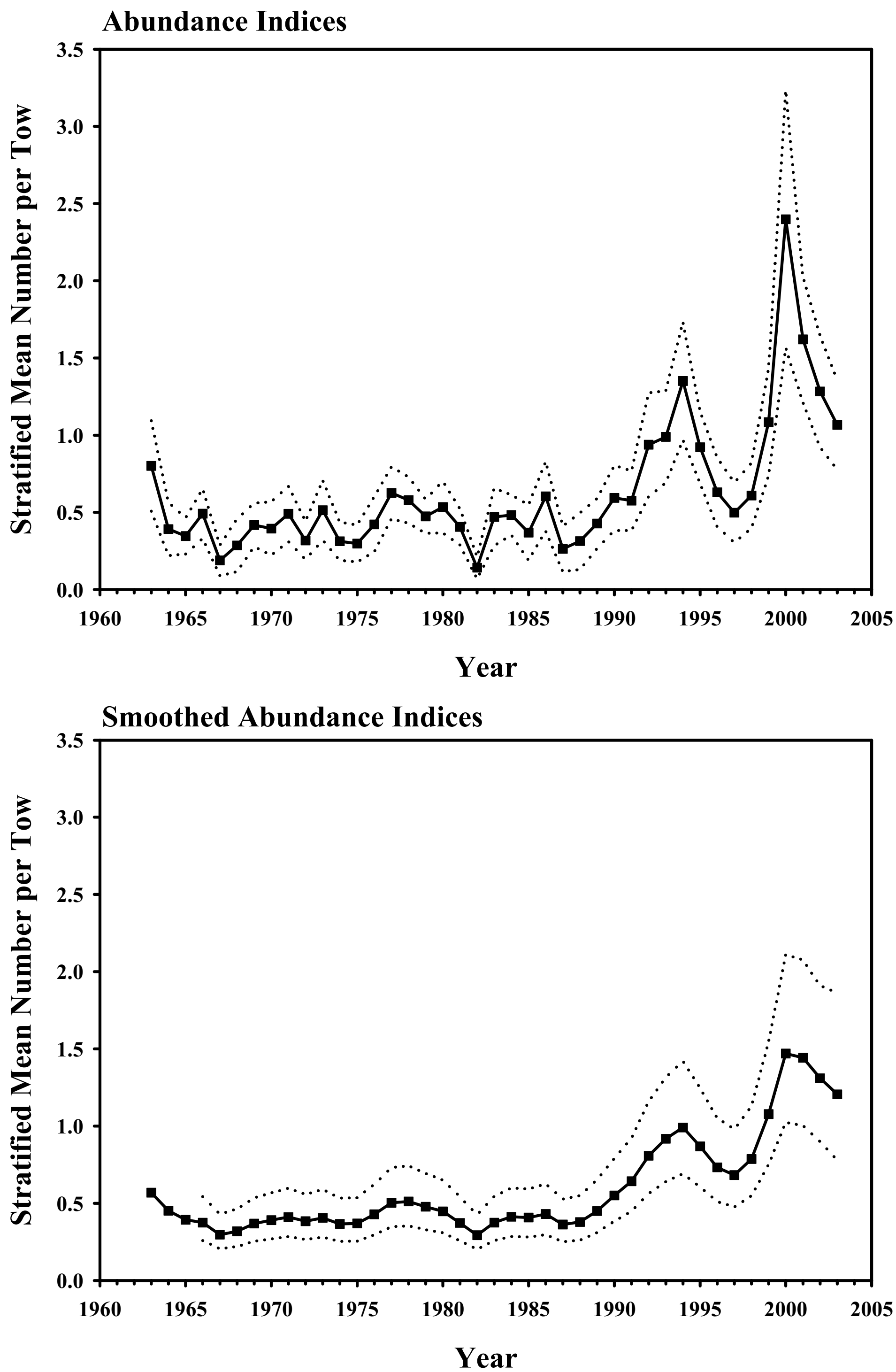


Figure A13. Abundance indices and smoothed indices from the NEFSC autumn bottom trawl survey for the northern management region from 1963-2003. The 95% confidence limits are shown by the dashed line.

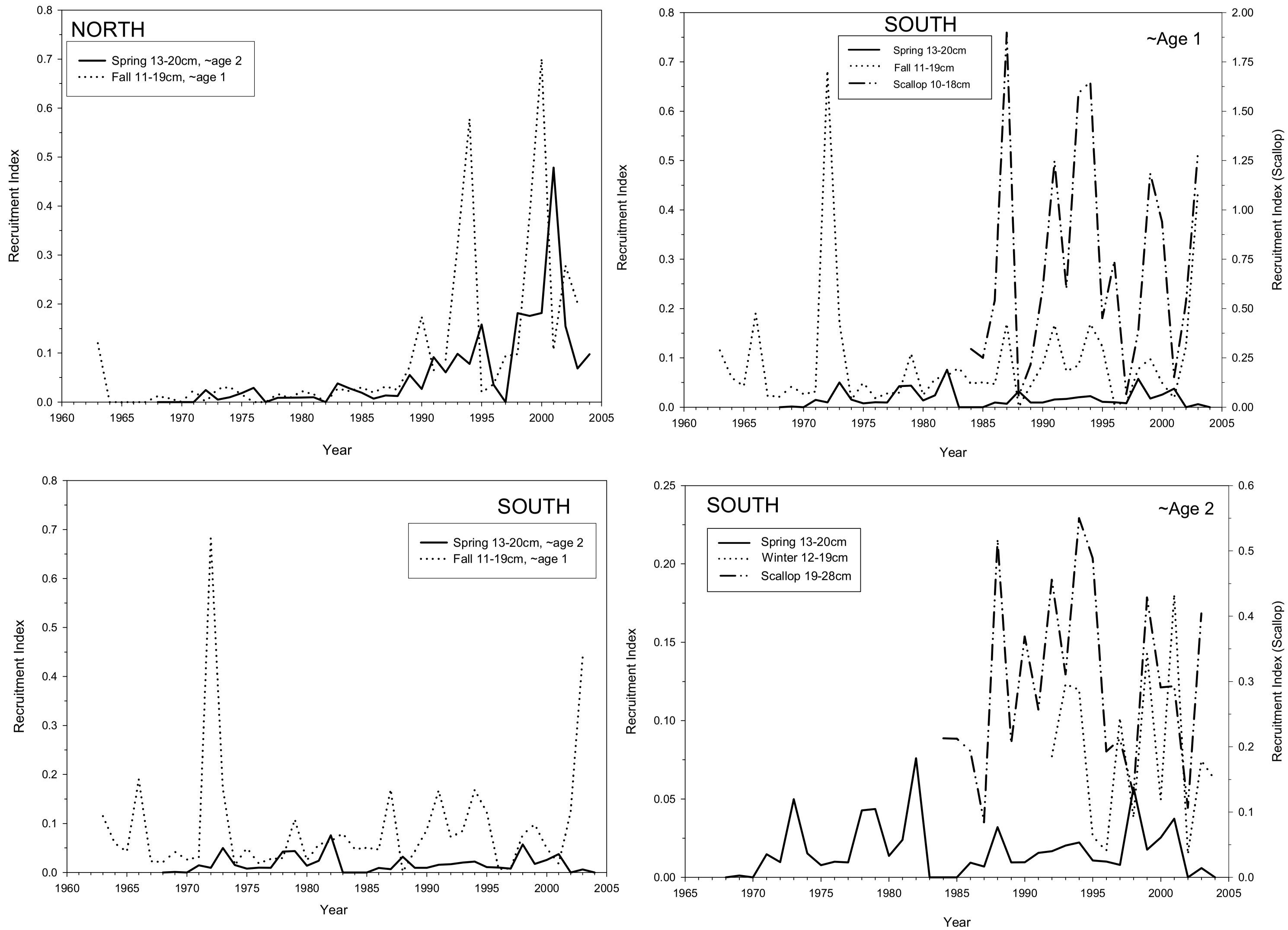


Figure A14. Abundance indices (number per tow) for monkfish at lengths corresponding to ages 1 and 2.

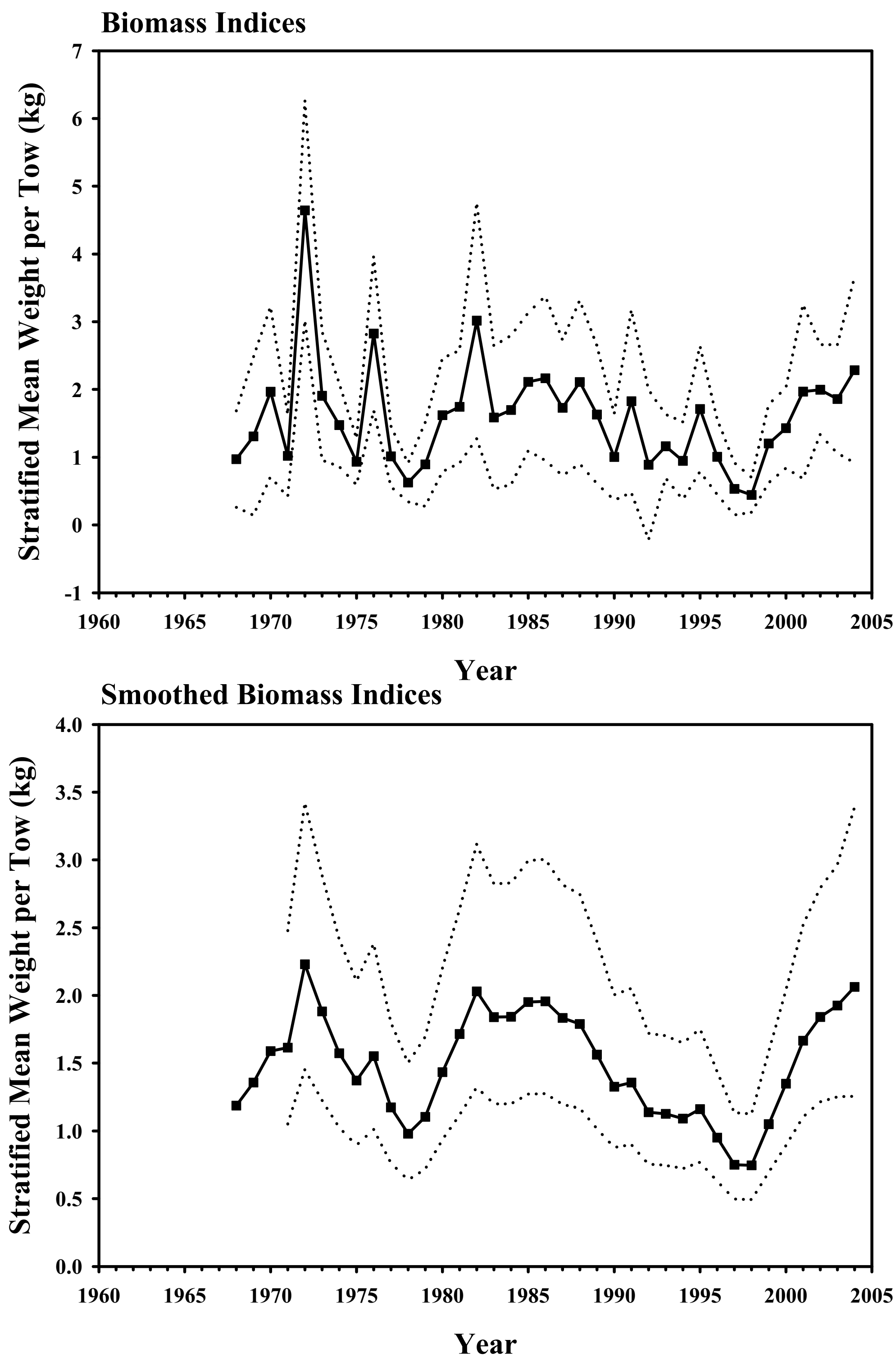
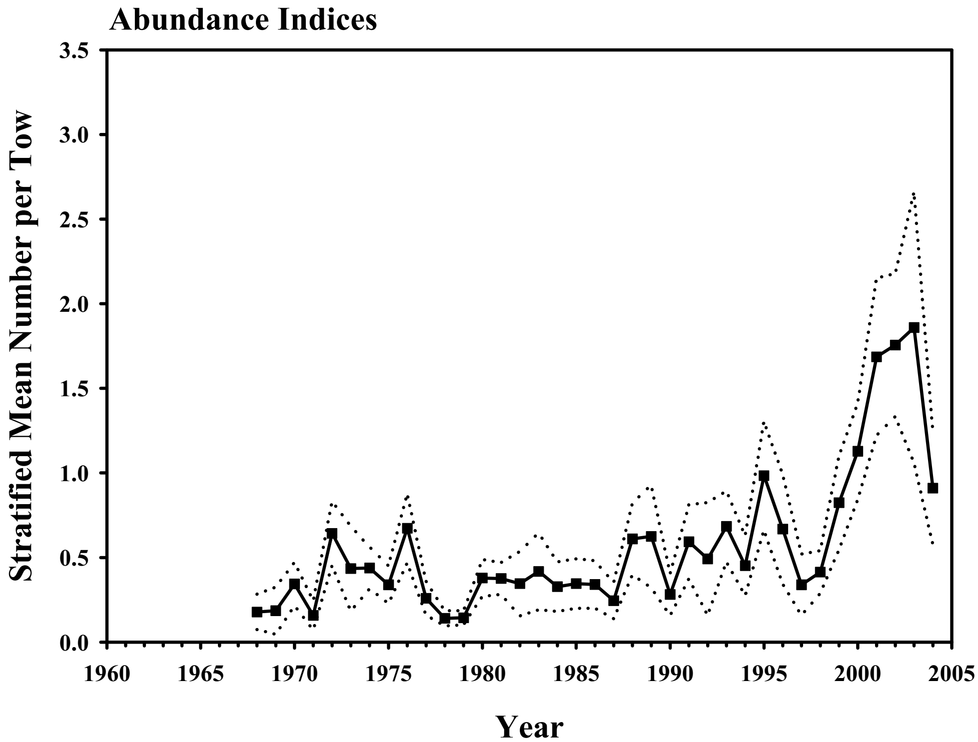


Figure A15. Biomass indices and smoothed indices from the NEFSC spring bottom trawl survey for the northern management region from 1968-2004. The 95% confidence limits are shown by the dashed line.



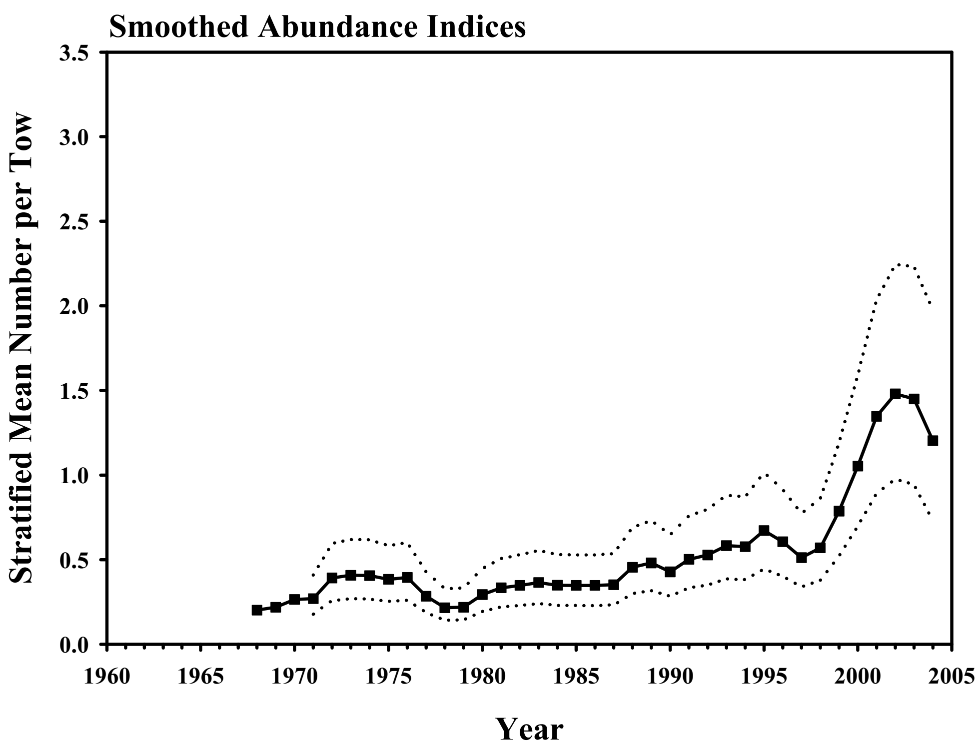


Figure A16. Abundance indices and smoothed indices from the NEFSC spring bottom trawl survey for the northern management region from 1968-2004. The 95% confidence limits are shown by the dashed line.

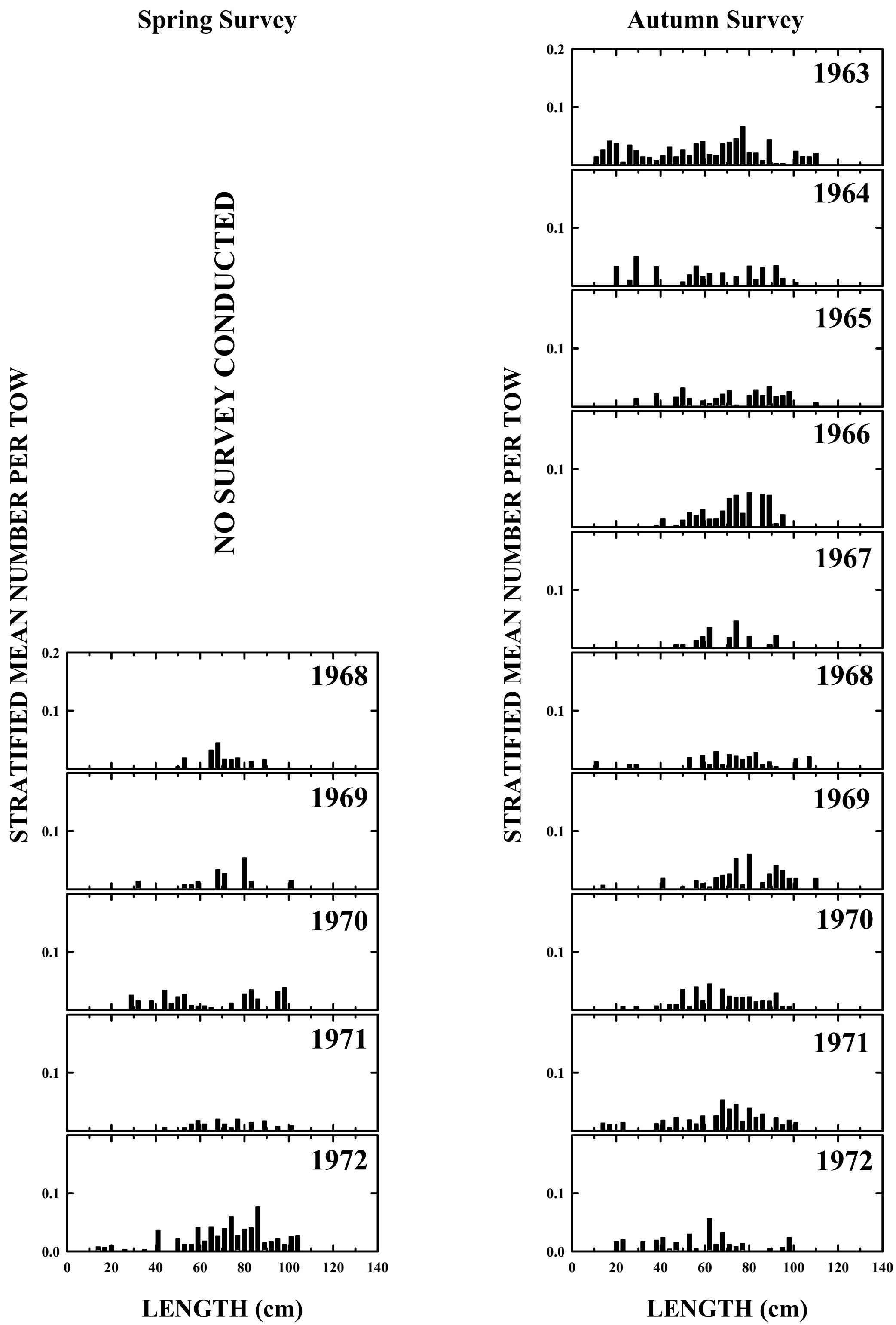
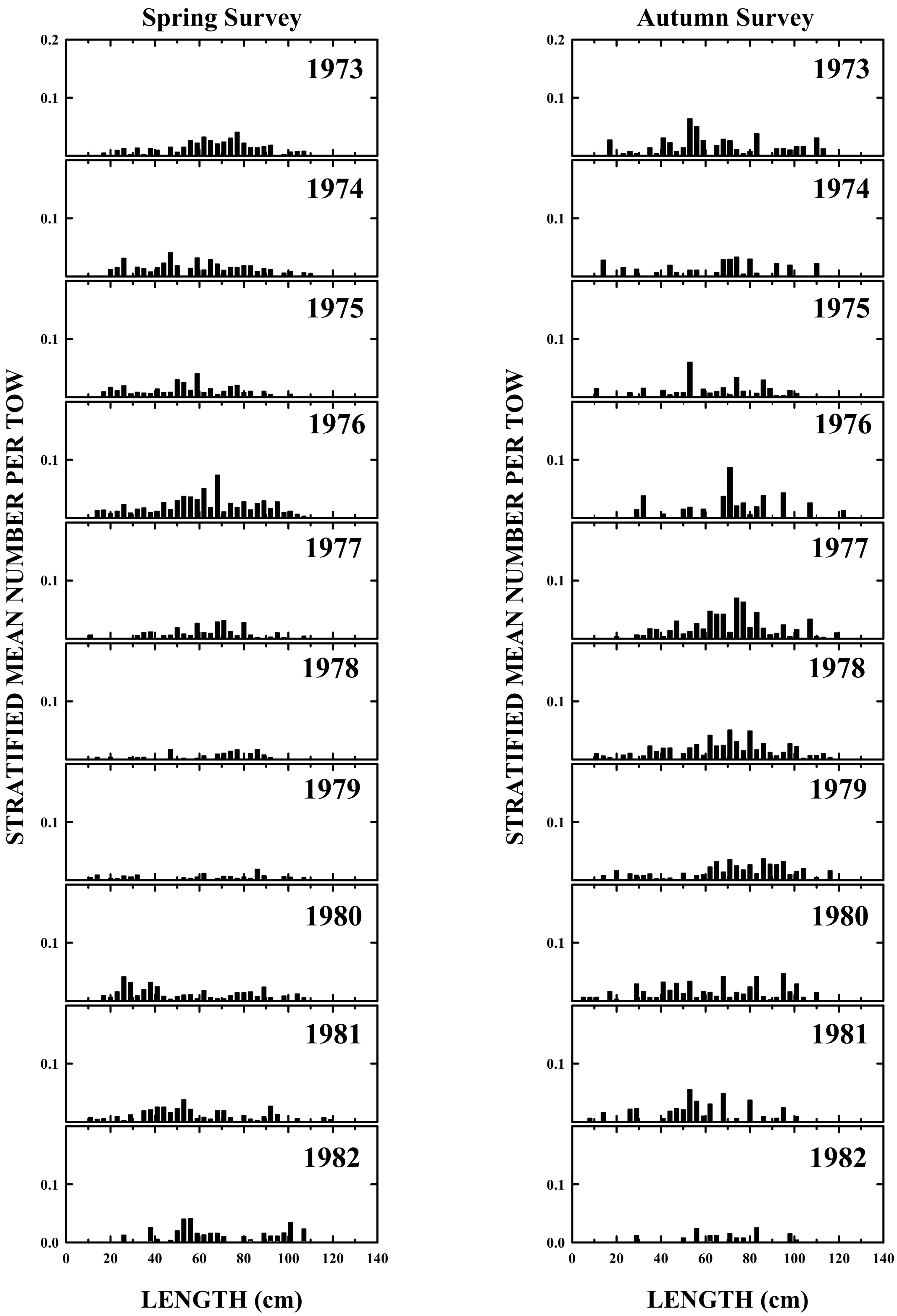


Figure A17. Goosefish length composition from the NEFSC spring and autumn bottom trawl surveys in the northern management region, 1963-2004.

v



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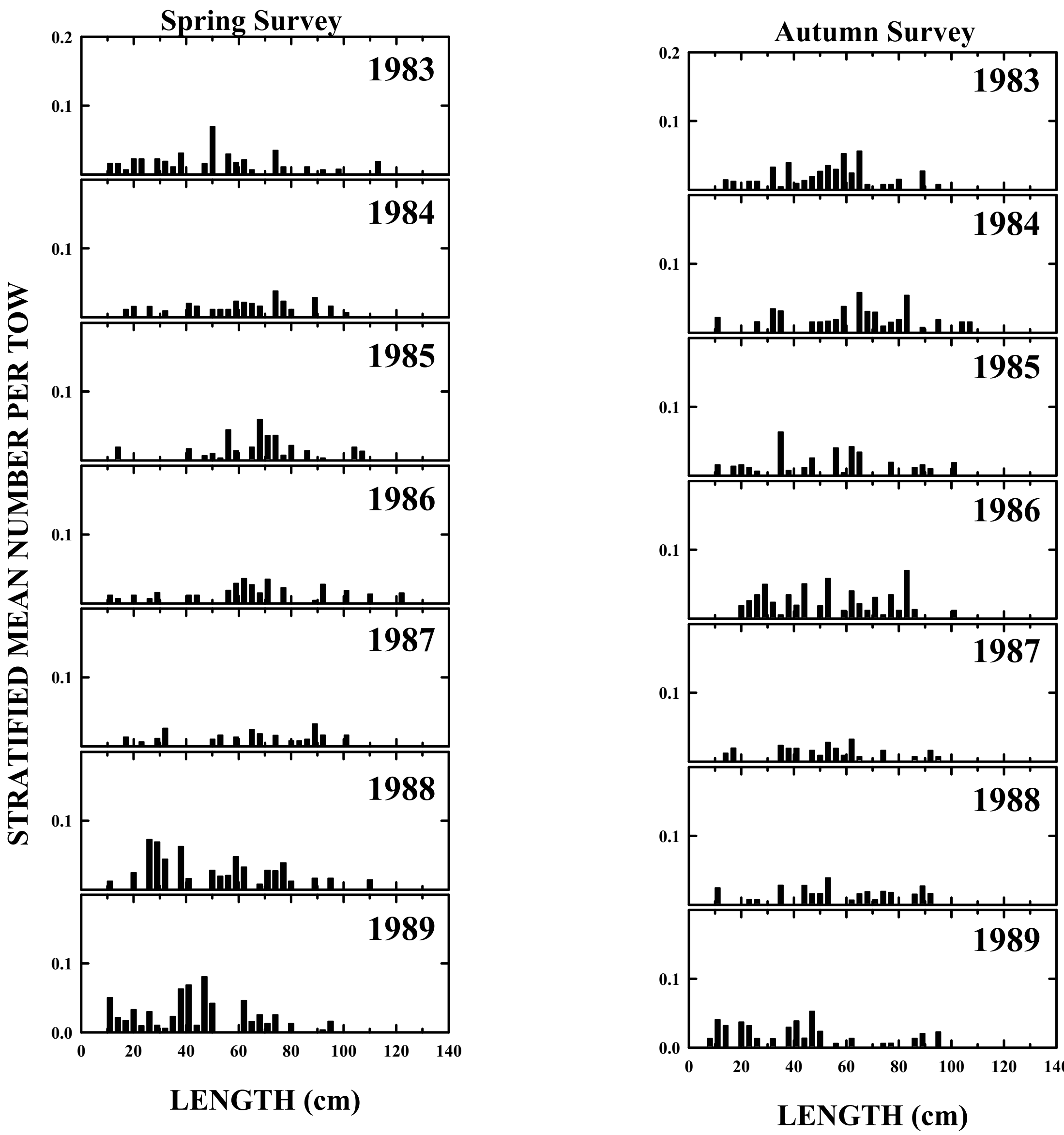

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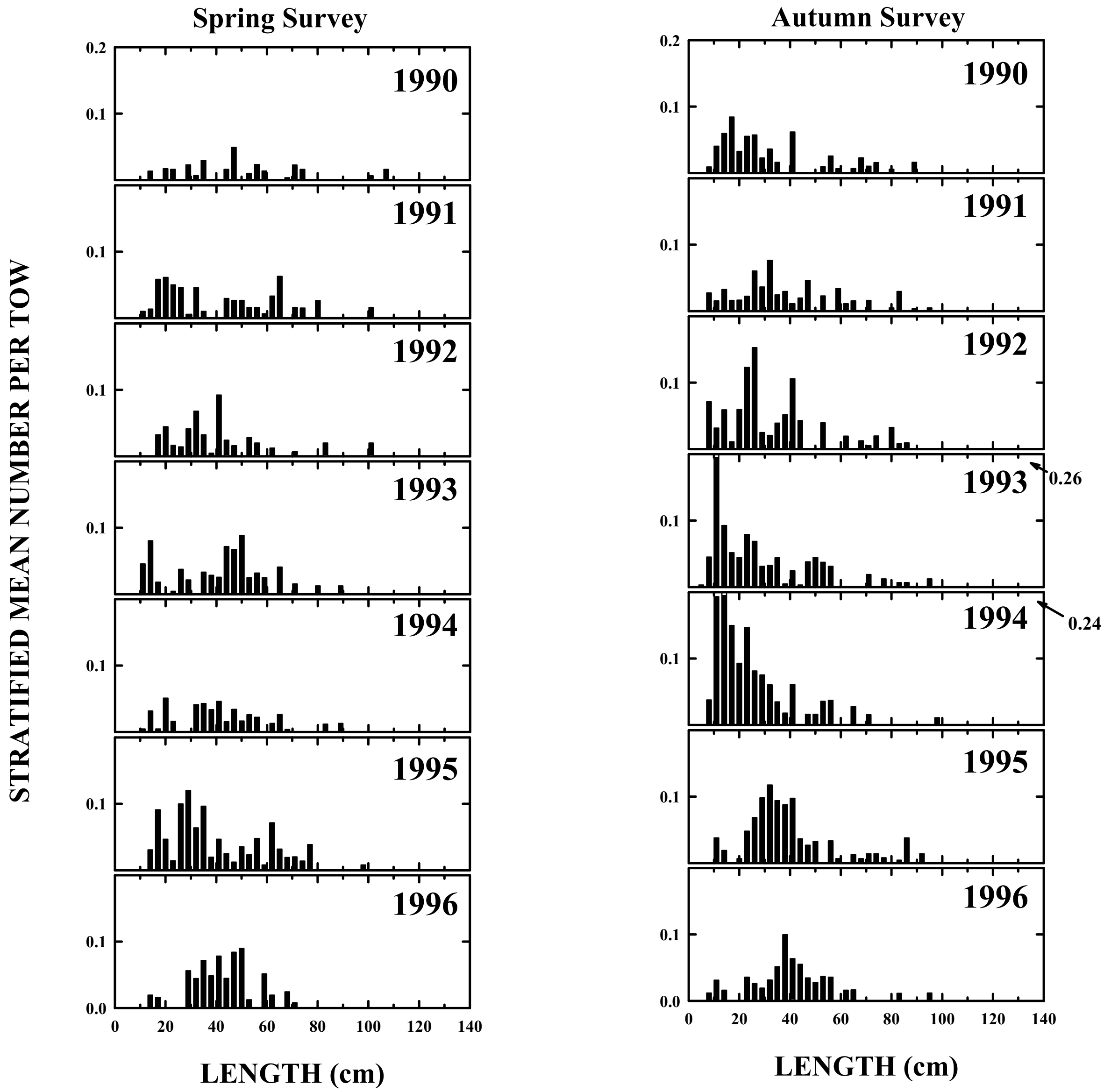
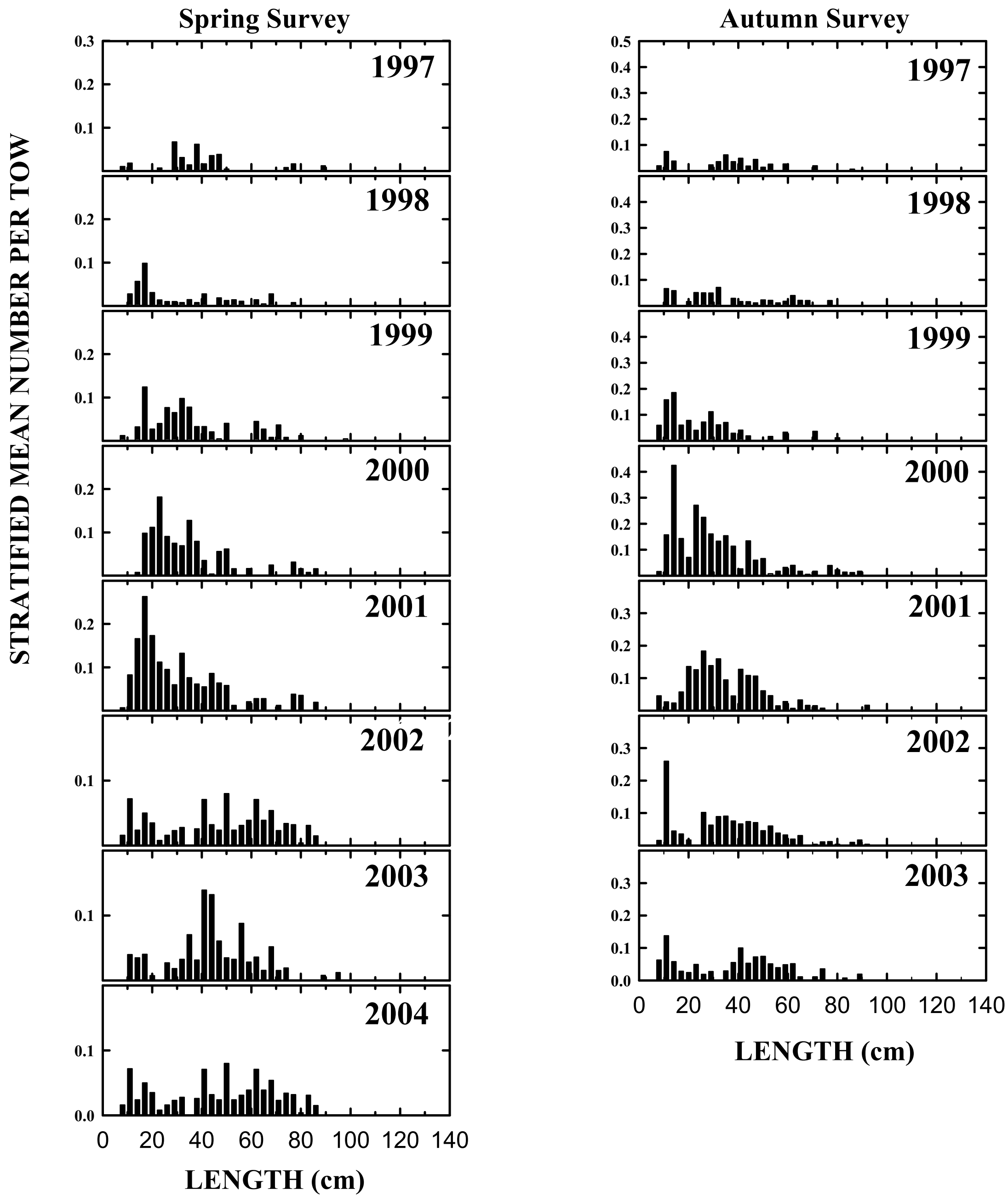


Figure A17, continued.

NOTE: Y-AXIS SCALE CHANGES ON THIS PAGE



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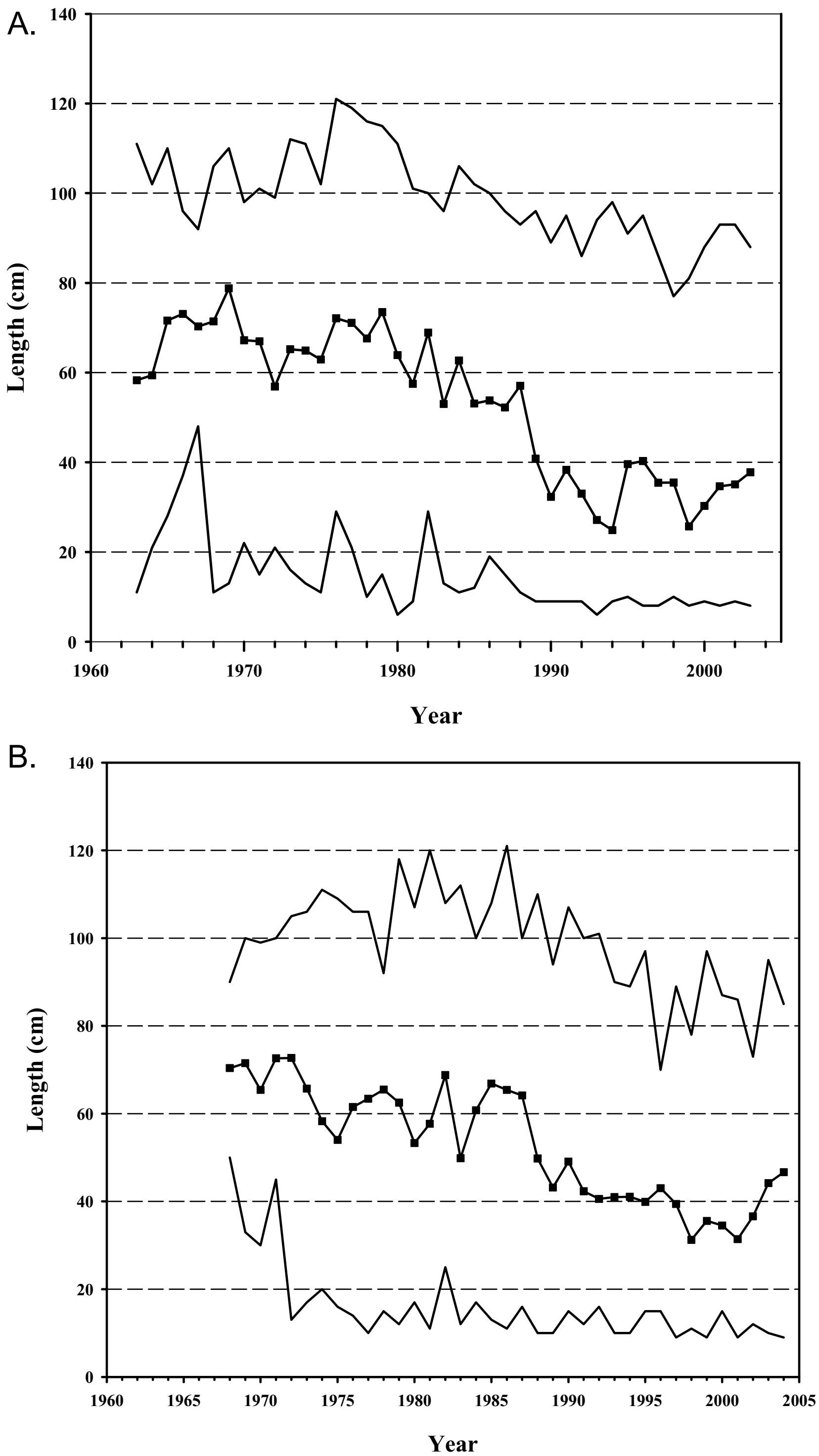
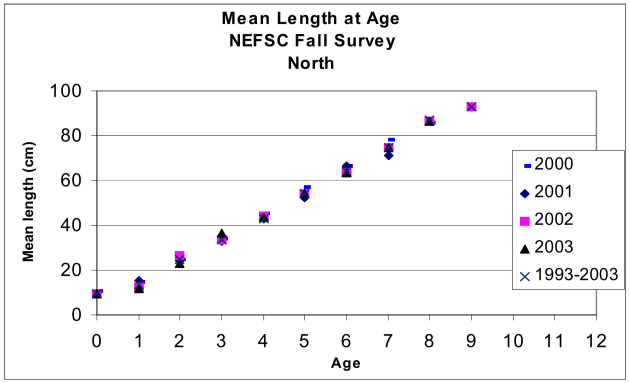
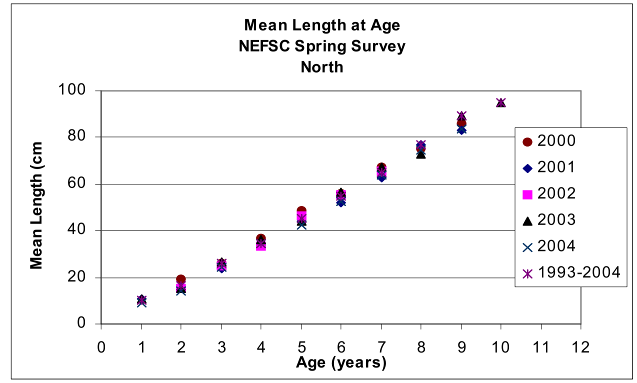
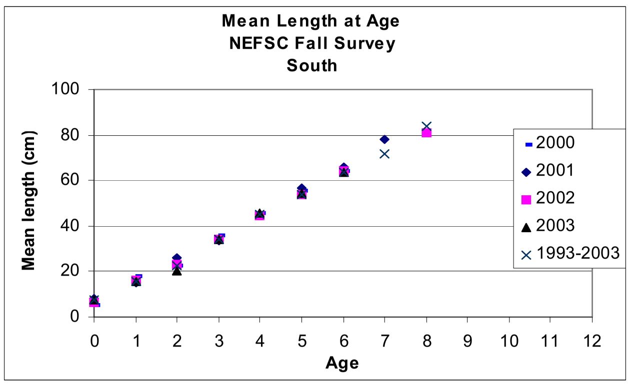
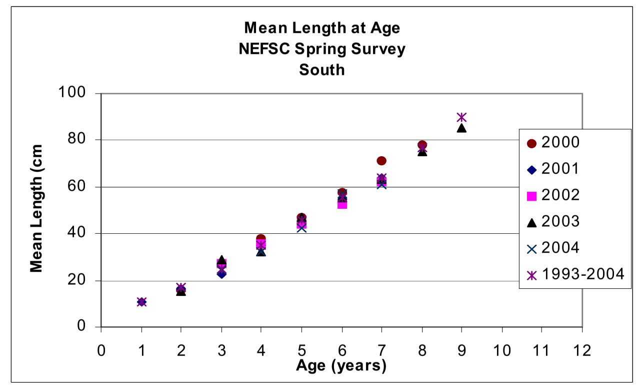


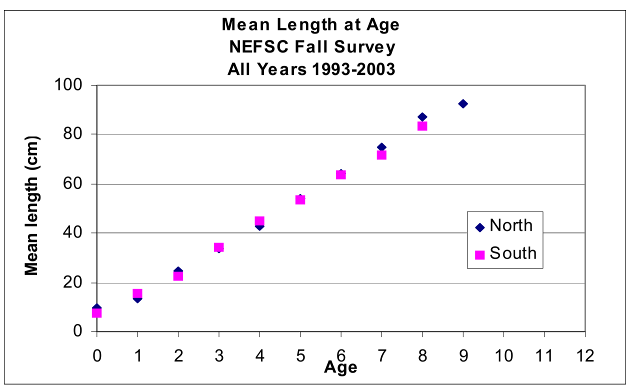
Figure A18. Minimum, mean, and, maximum lengths for the northern management region from (A) NEFSC autumn surveys and (B) NEFSC spring surveys.

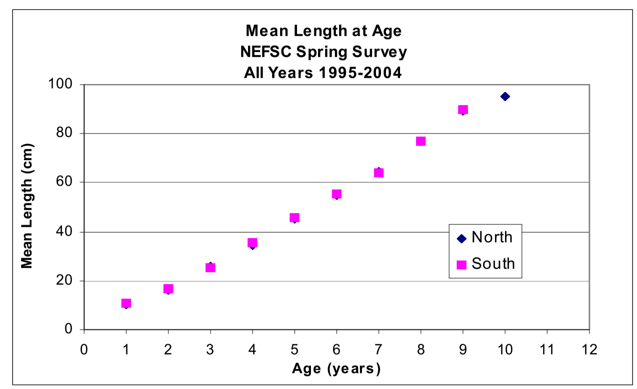

Mean Length at Age
NEFSC Fall Survey
North
Mean length (cm)
Age
2000
2001
2002
2003
1993-2003

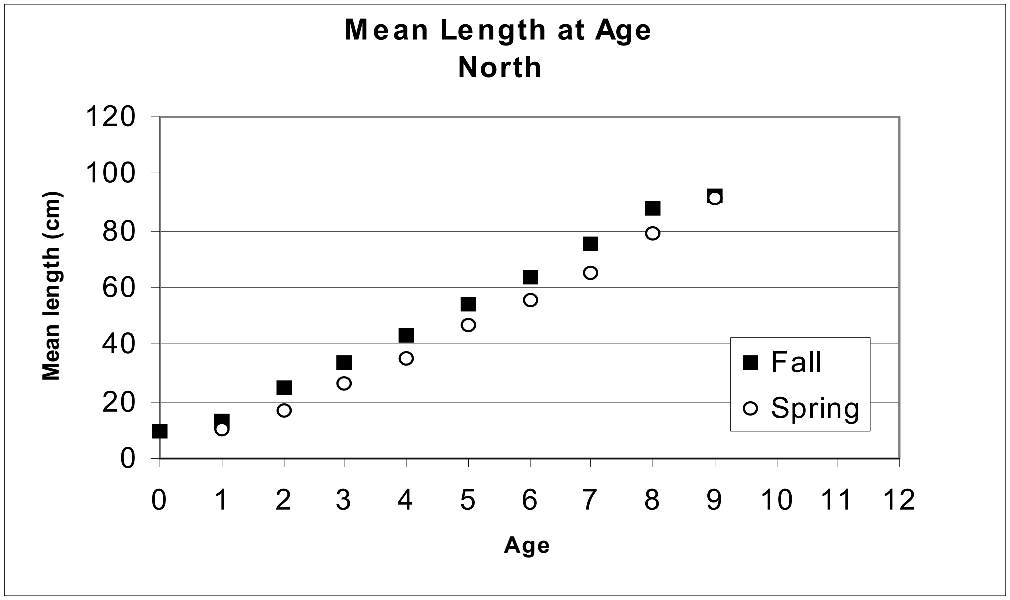

Mean Length at Age
NEFSC Spring Survey
North
Mean Length (cm
Age (years)
2000
2001
2002
2003
2004
1993-2004


Mean Length at Age
NEFSC Fall Survey
South
Mean length (cm)
Age
2000
2001
2002
2003
1993-2003


Mean Length at Age
NEFSC Spring Survey
South
Mean Length (cm
Age (years)
2000
2001
2002
2003
2004
1993-2004


Mean Length at Age
NEFSC Fall Survey
All Years 1993-2003
Mean length (cm)
Age
North
South


Mean Length at Age
NEFSC Spring Survey
All Years 1995-2004
Mean Length (cm)
Age (years)
North
South



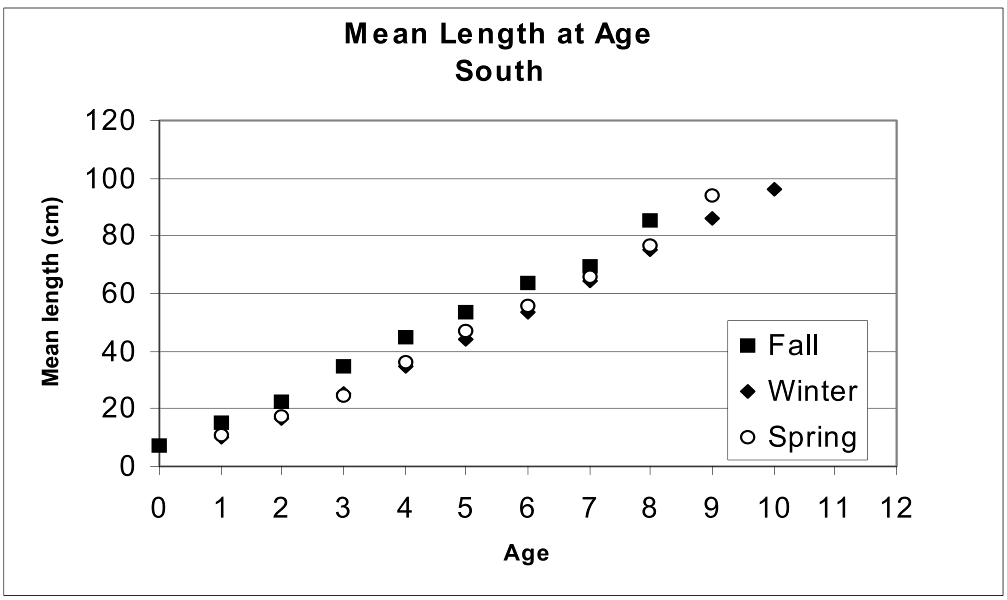
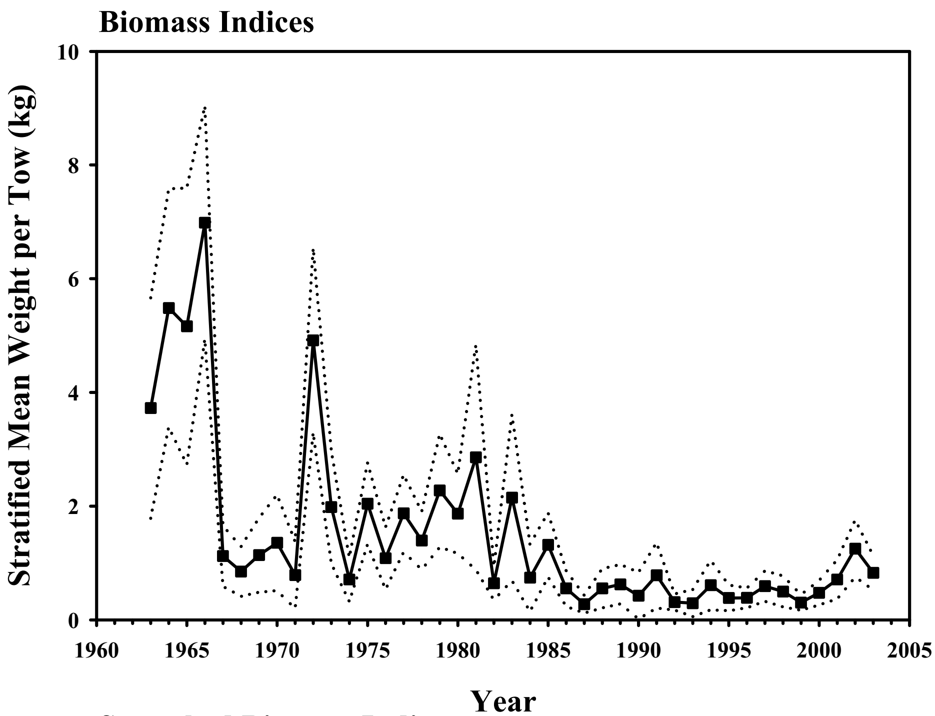


Figure A20. Comparison of seasonal mean lengths at age in the northern and southern management regions, NEFSC fall, spring, and winter surveys.



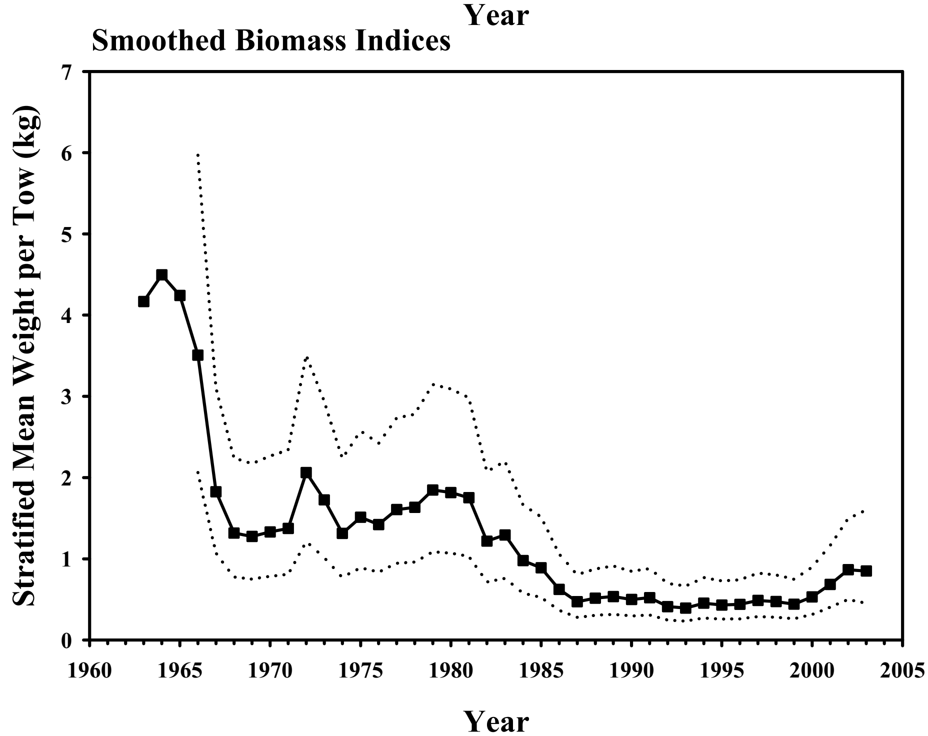


Figure A21. Biomass indices and smoothed indices from the NEFSC autumn bottom trawl survey for the southern management region from 1963-2003. The 95% confidence limits are shown by the dashed line.

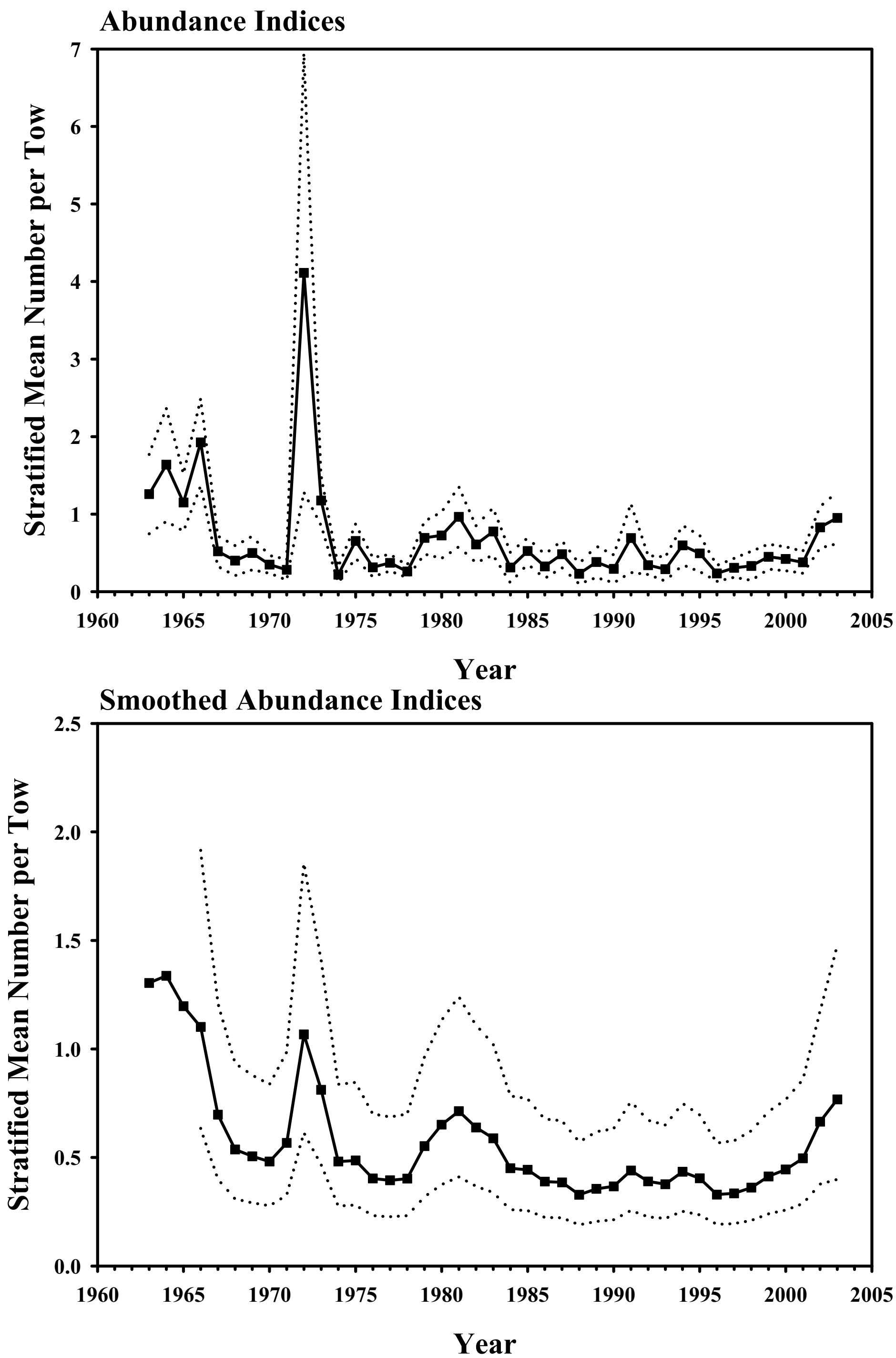


Figure A22. Abundance indices and smoothed indices from the NEFSC autumn bottom trawl survey for the southern management region from 1963-2003. The 95% confidence limits are shown by the dashed line.

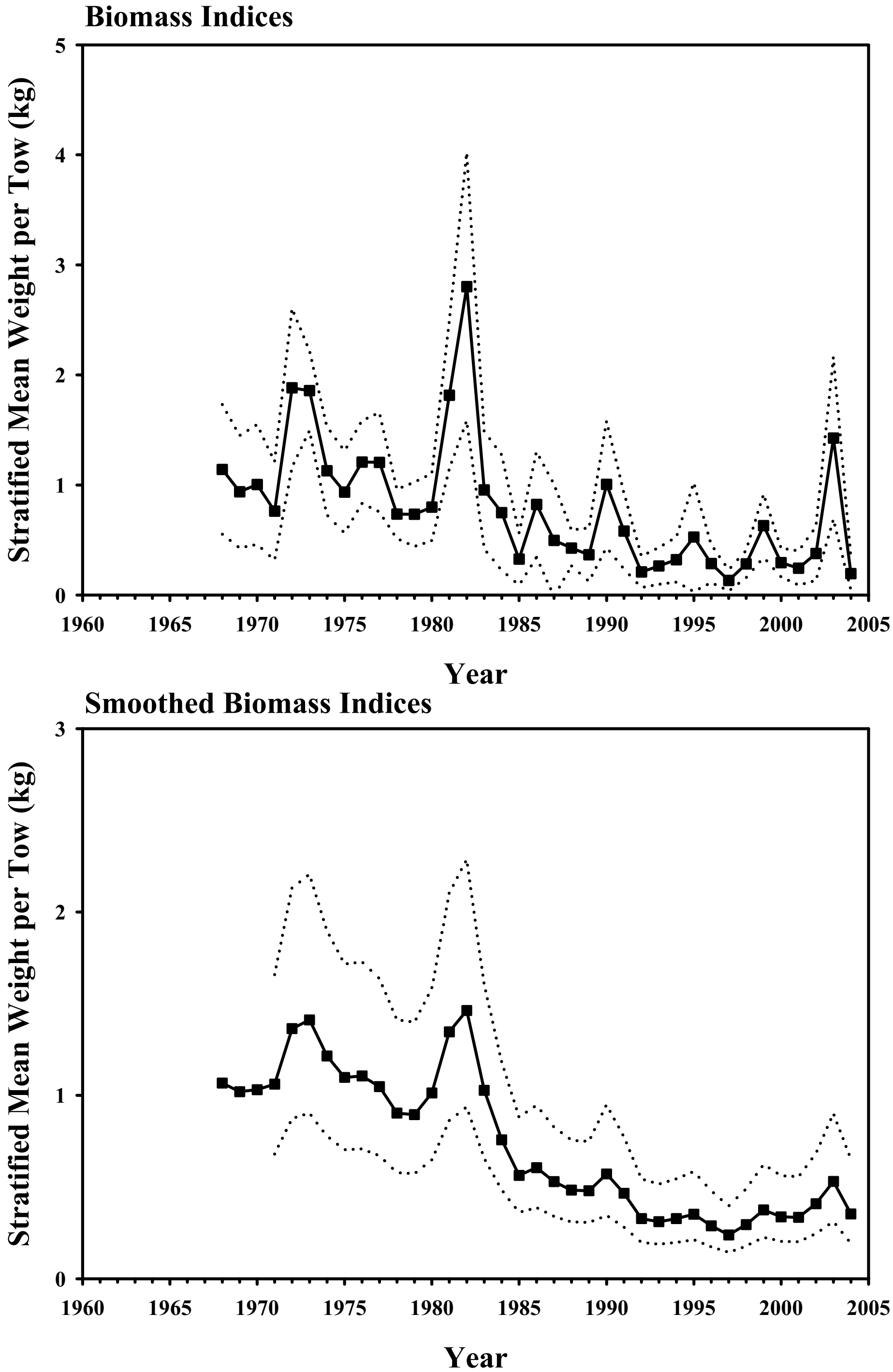
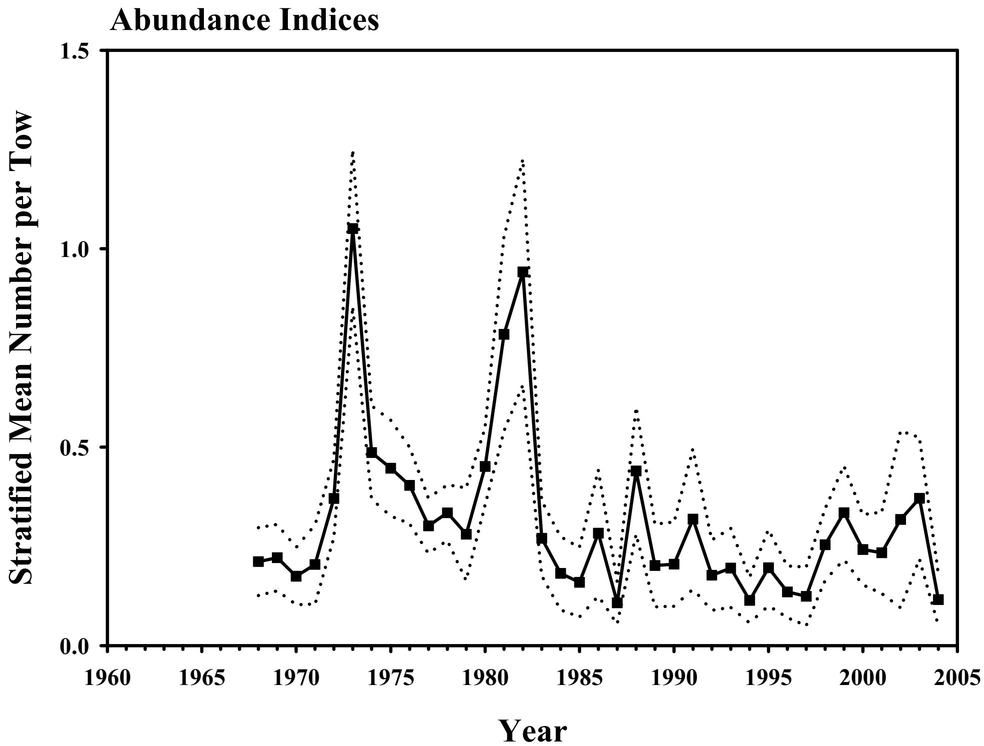


Figure A23. Biomass indices and smoothed indices from the NEFSC spring bottom trawl survey for the southern management region from 1968-2004. The 95% confidence limits are shown by the dashed line.



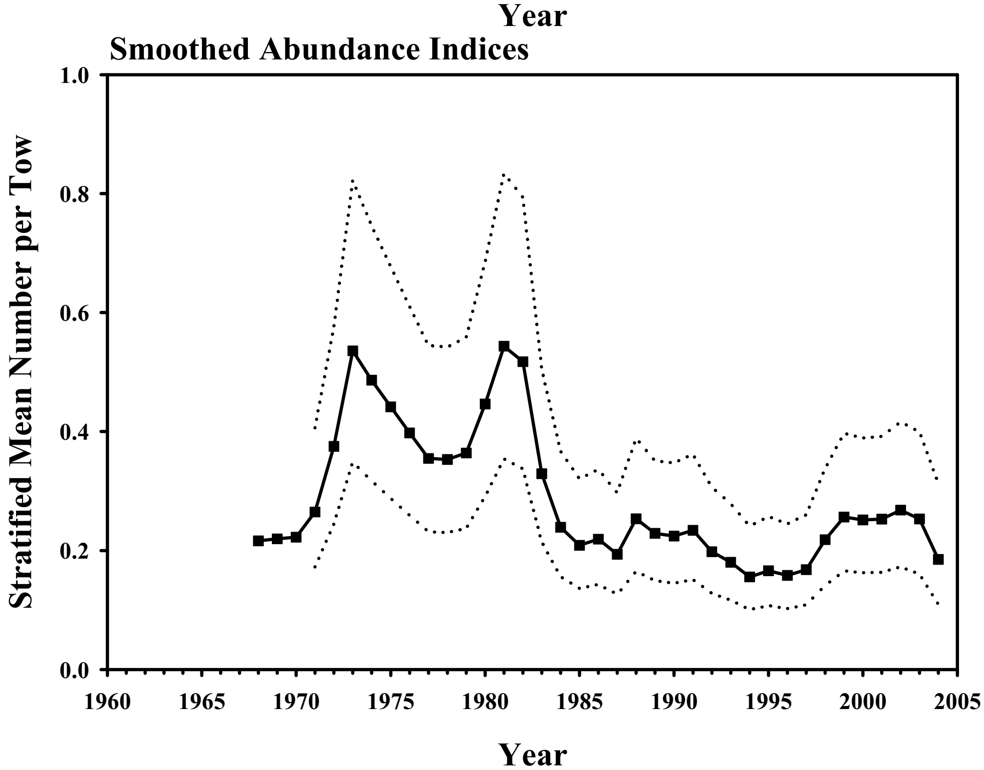


Figure A24. Abundance indices and smoothed indices from the NEFSC spring bottom trawl survey for the southern management region from 1968-2004. The 95% confidence limits are shown by the dashed line.

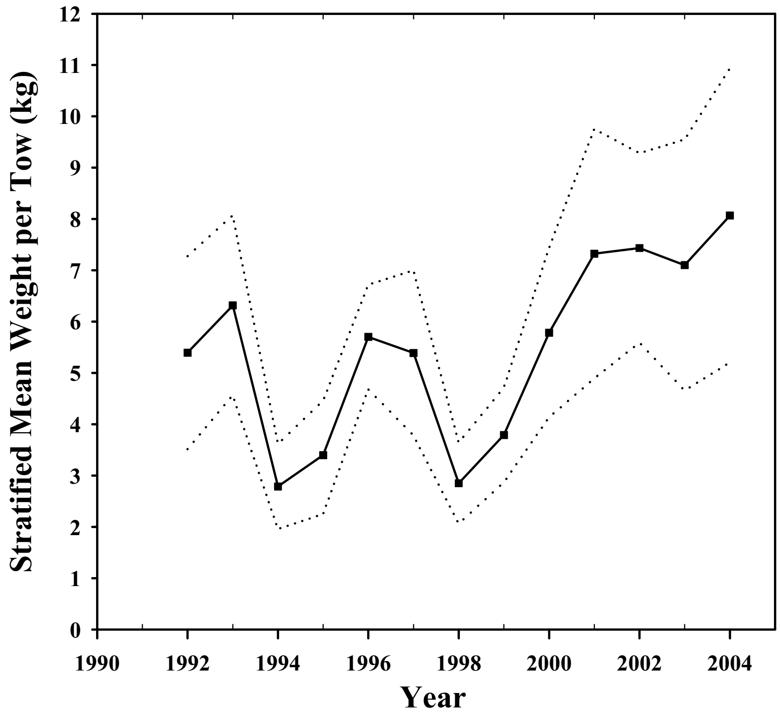


Figure A25. Biomass indices from the NEFSC winter flatfish survey for the southern management region from 1992-2004. The 95% confidence limits are shown by the dashed line.

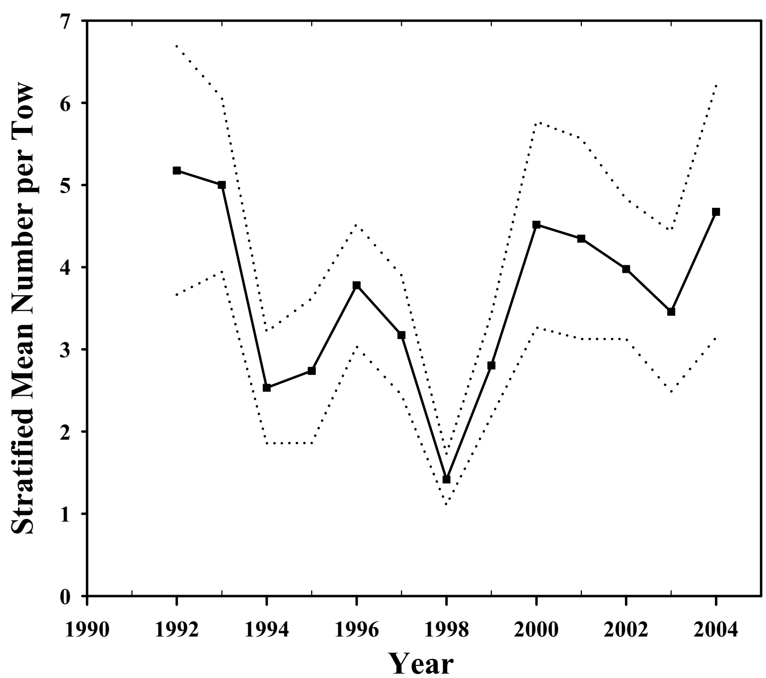


Figure A26. Abundance indices from the NEFSC winter flatfish survey for the southern management region from 1992-2004. The 95% confidence limits are shown by the dashed line.

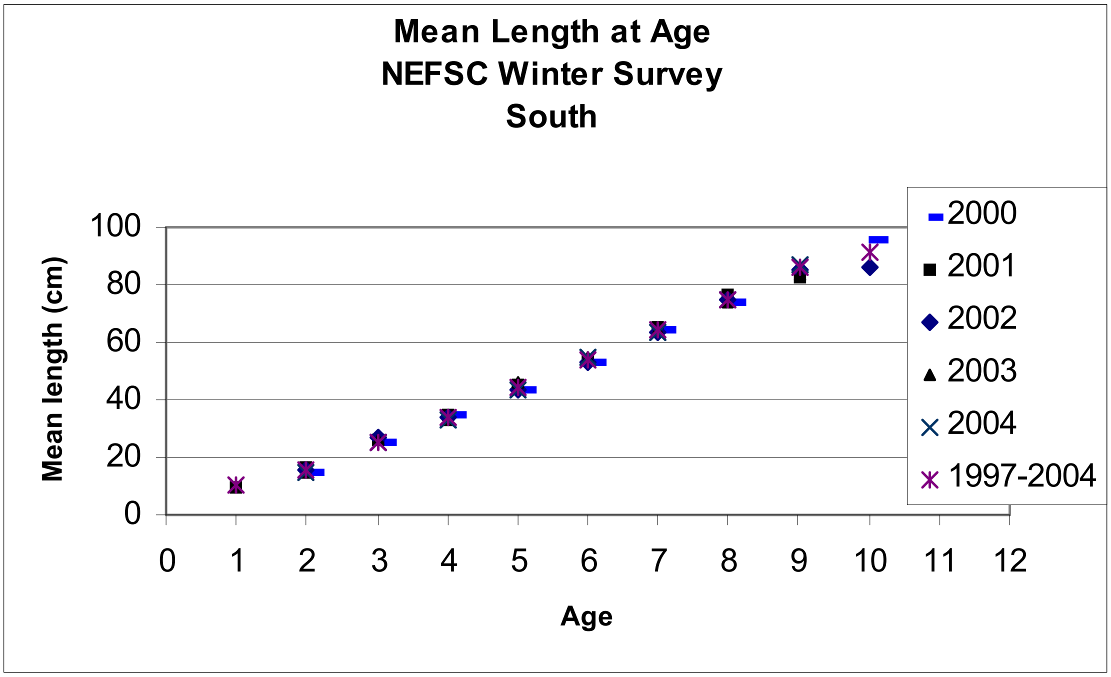
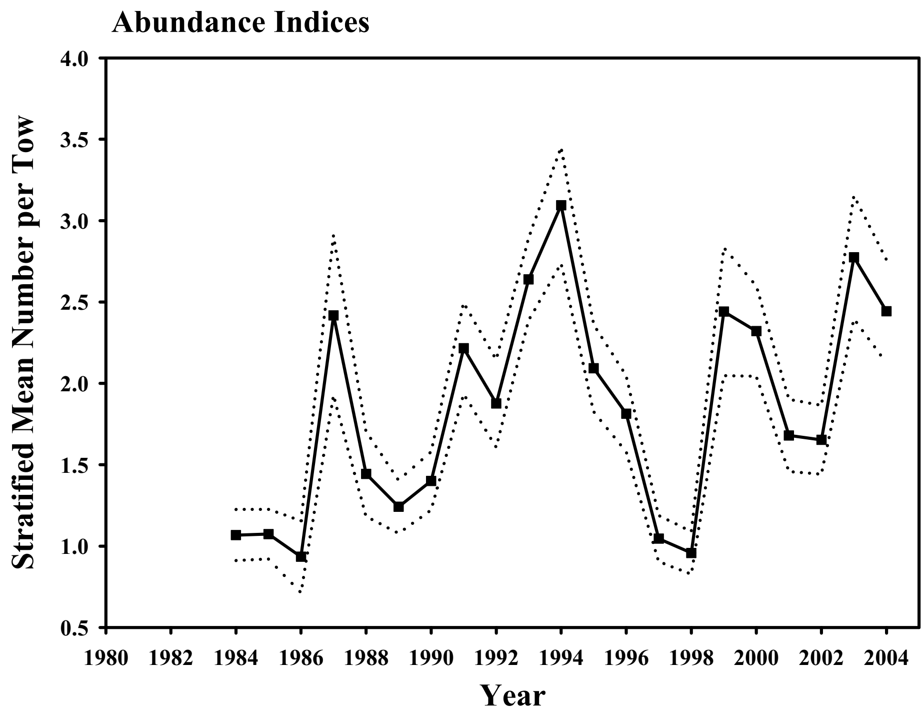


Figure A27. Mean length at age for goosefish in NEFSC winter surveys, southern management region.



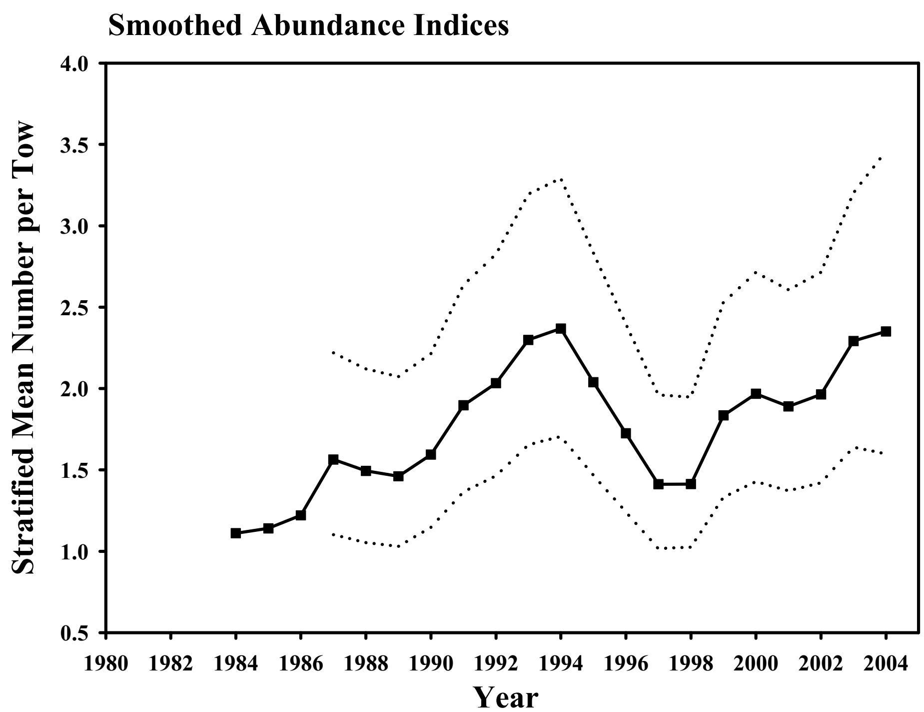


Figure A28. Abundance indices and smoothed indices from the NEFSC scallop dredge survey for the southern management region from 1984-2003. The 95% confidence limits are shown by the dashed line.

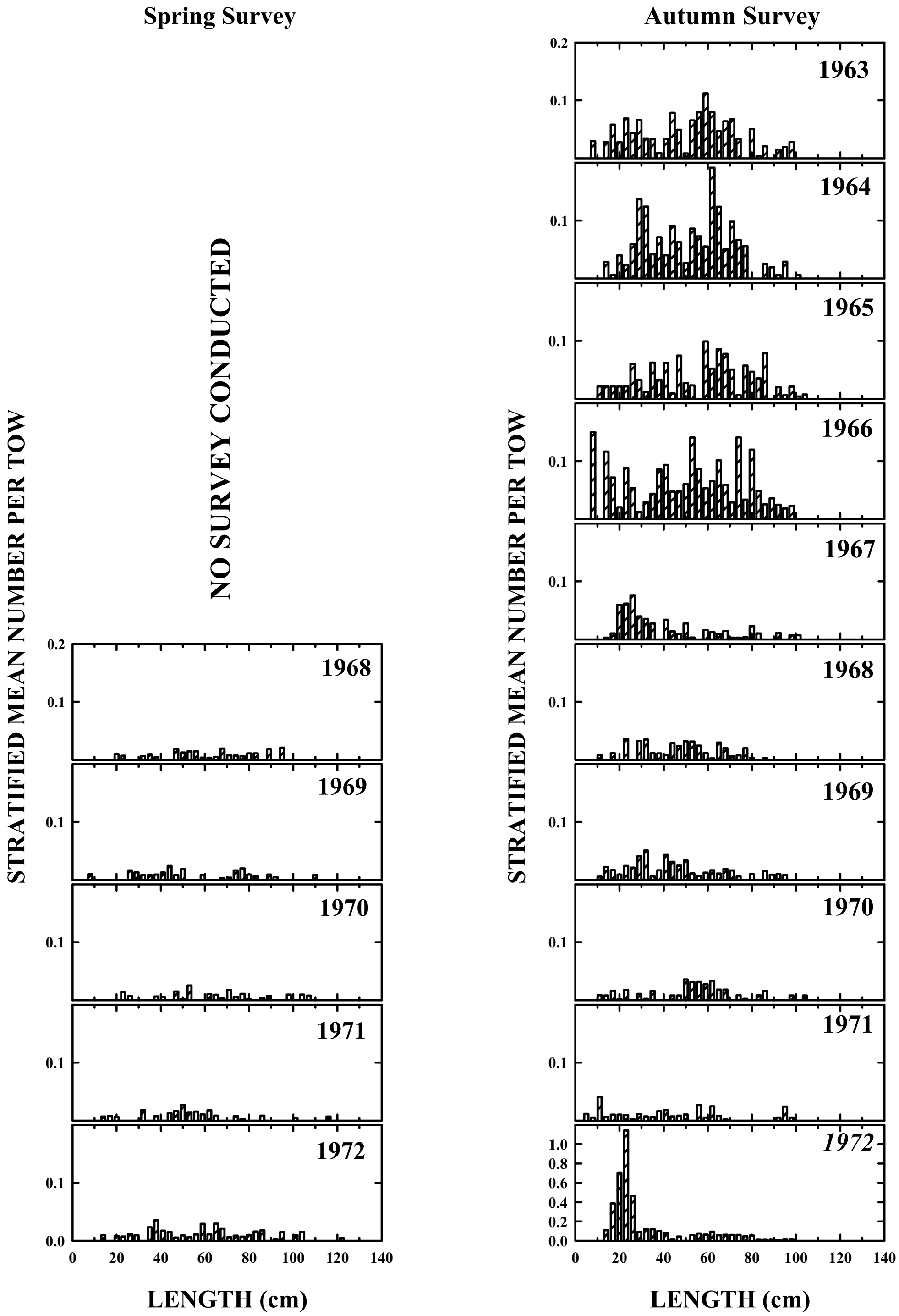


Figure A29. Goosefish length composition from the NEFSC spring bottom trawl (March-April), winter flatfish (February), summer scallop (July-August), and autumn (September-October) bottom trawl surveys in the southern management region, 1963-2004.

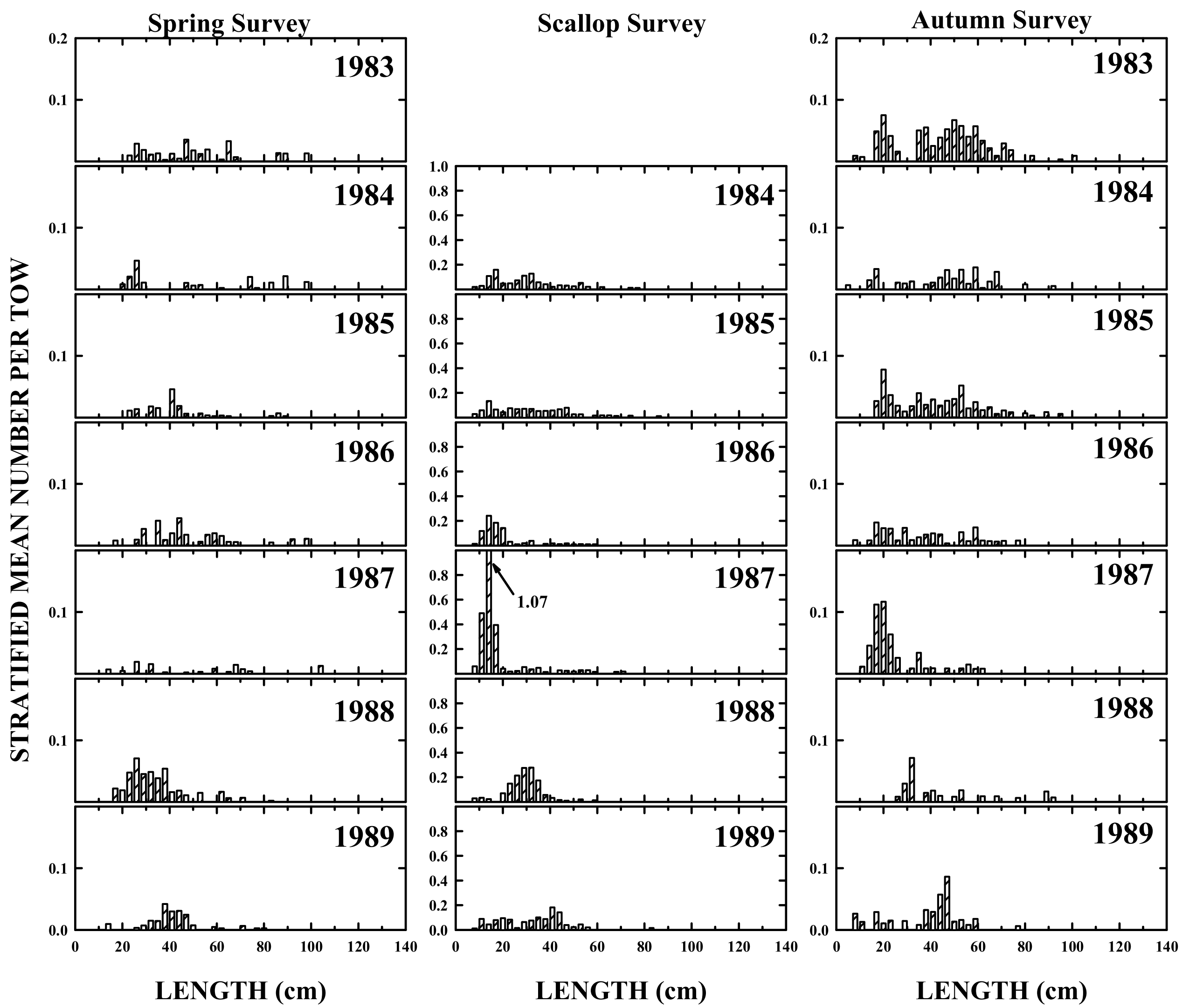
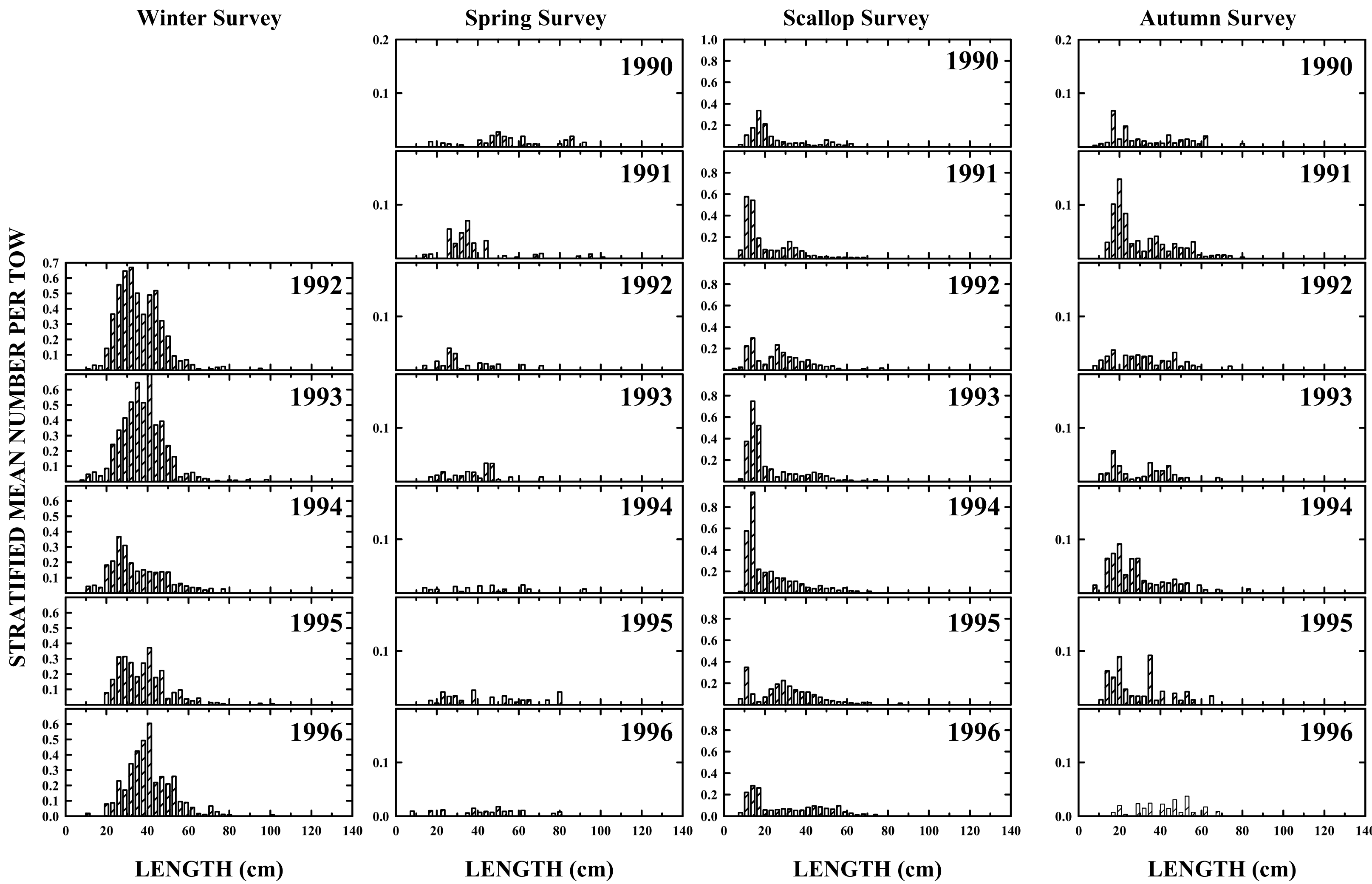


Figure A29, continued.



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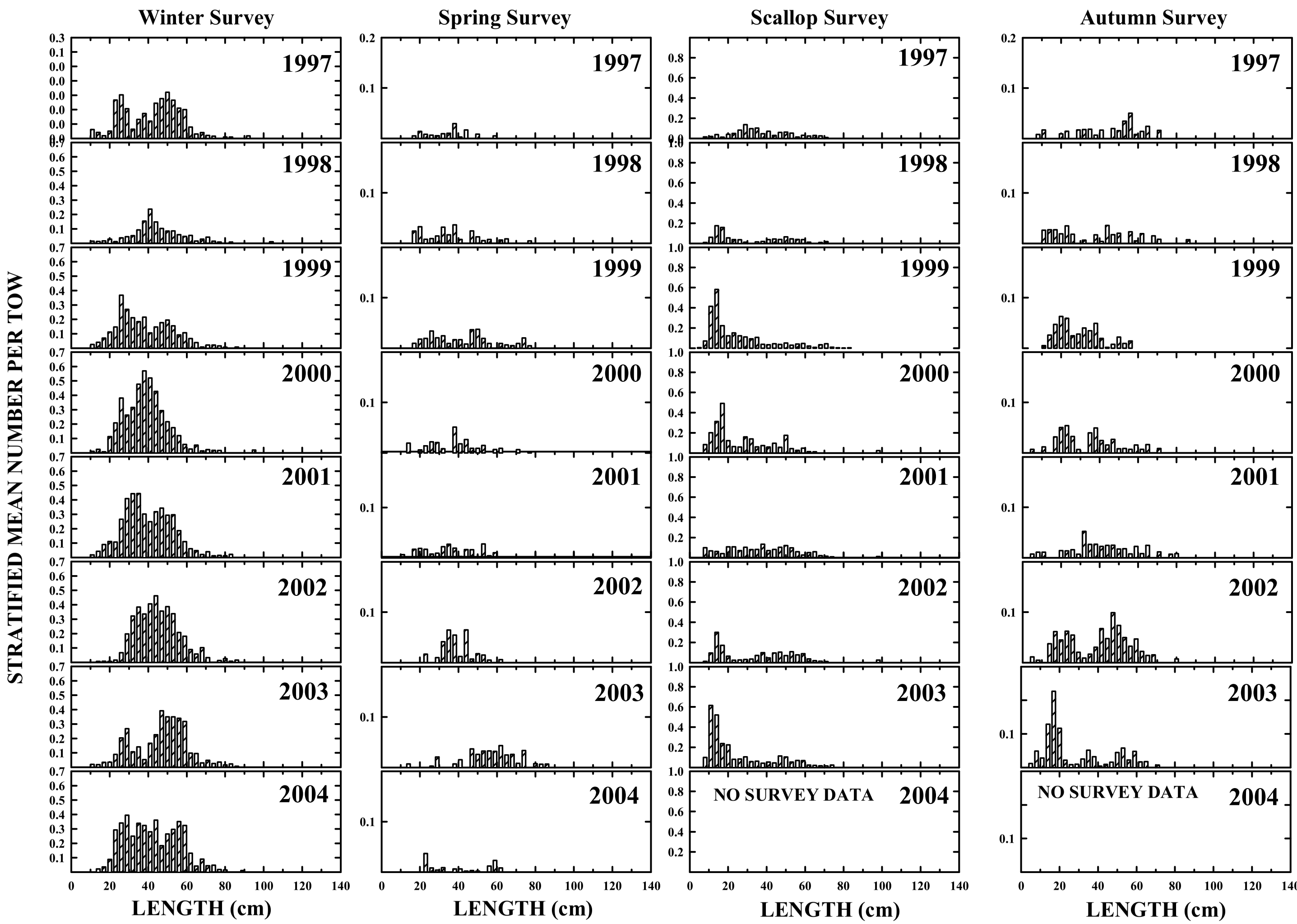


Figure A29, continued.

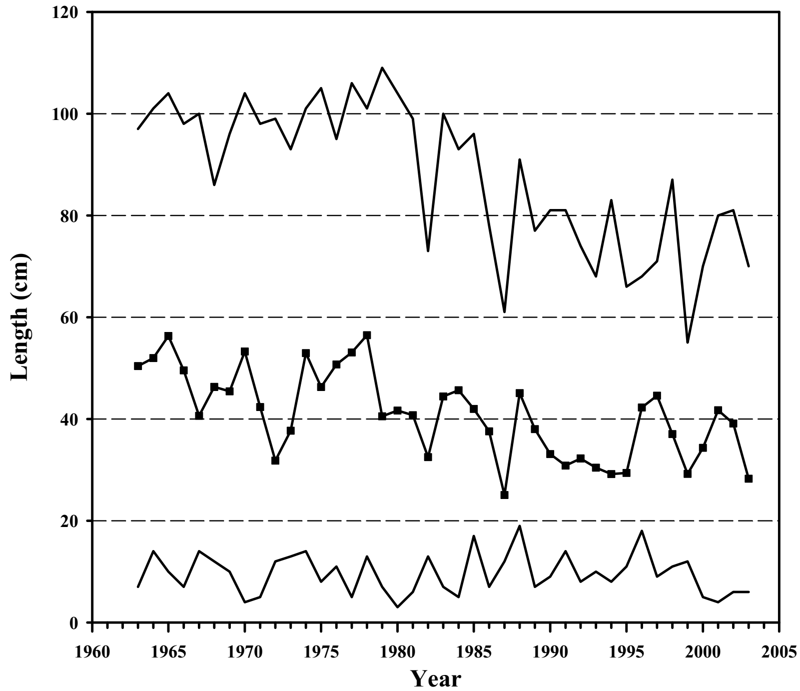


Figure A30. Minimum, mean, and, maximum lengths for the southern management region from the NEFSC autumn surveys.

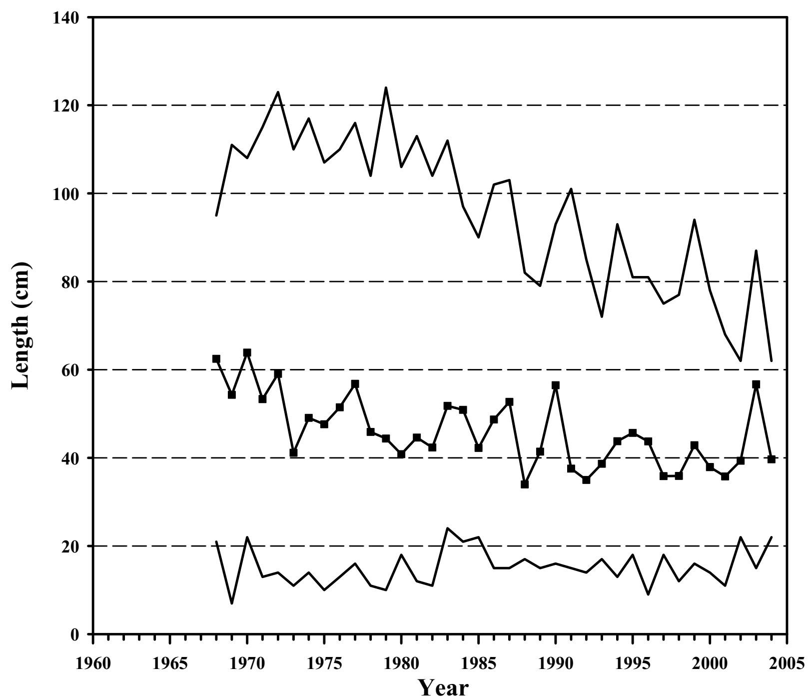
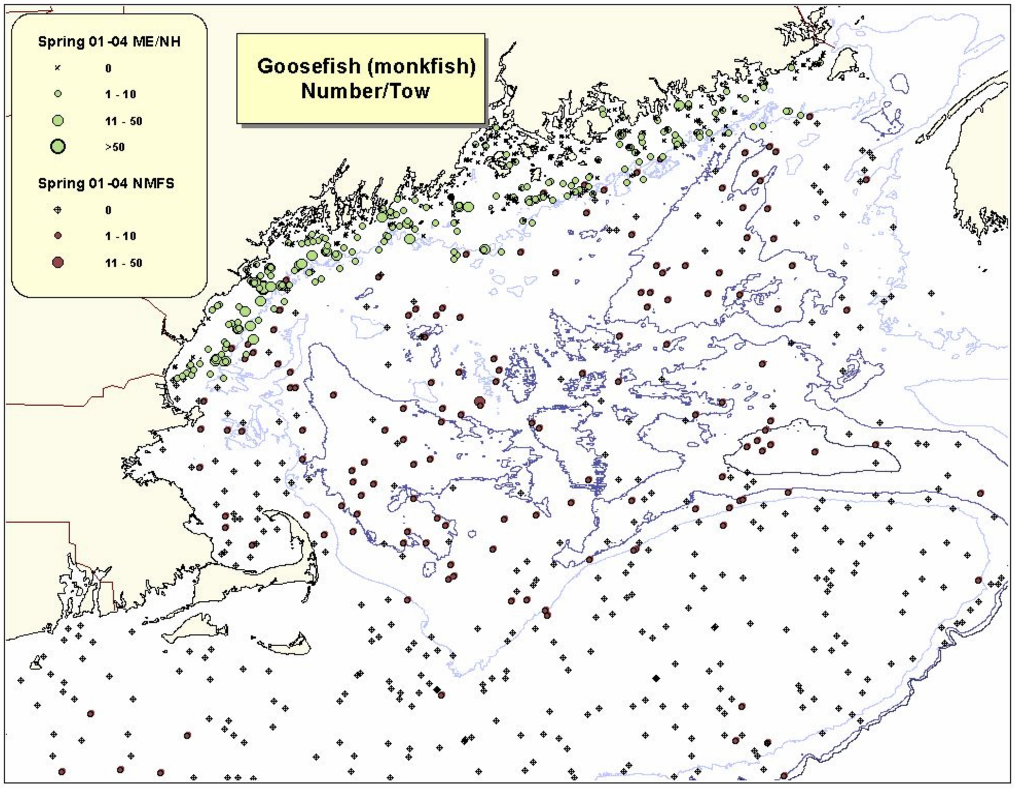


Figure A31. Minimum, mean, and, maximum lengths for the southern management region from the NEFSC spring surveys.



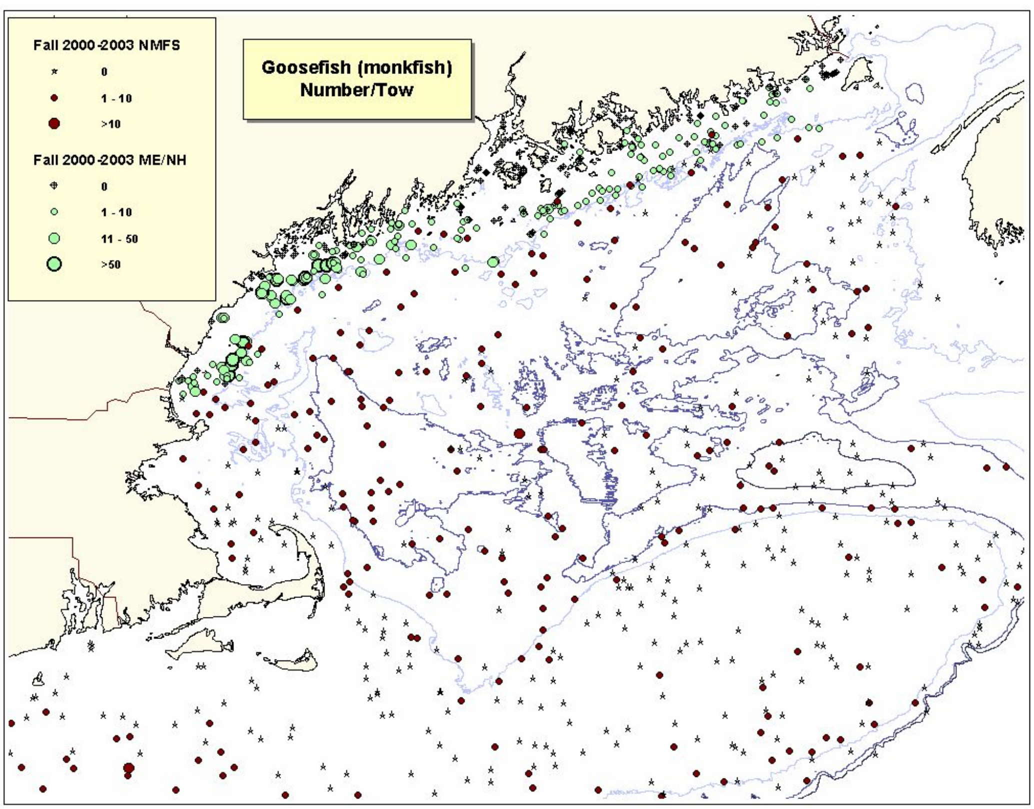


Figure A32. Distribution of goosefish catches in inshore surveys conducted by the states of Maine and New Hampshire, and in NMFS surveys, autumn and spring, 2001-2004.

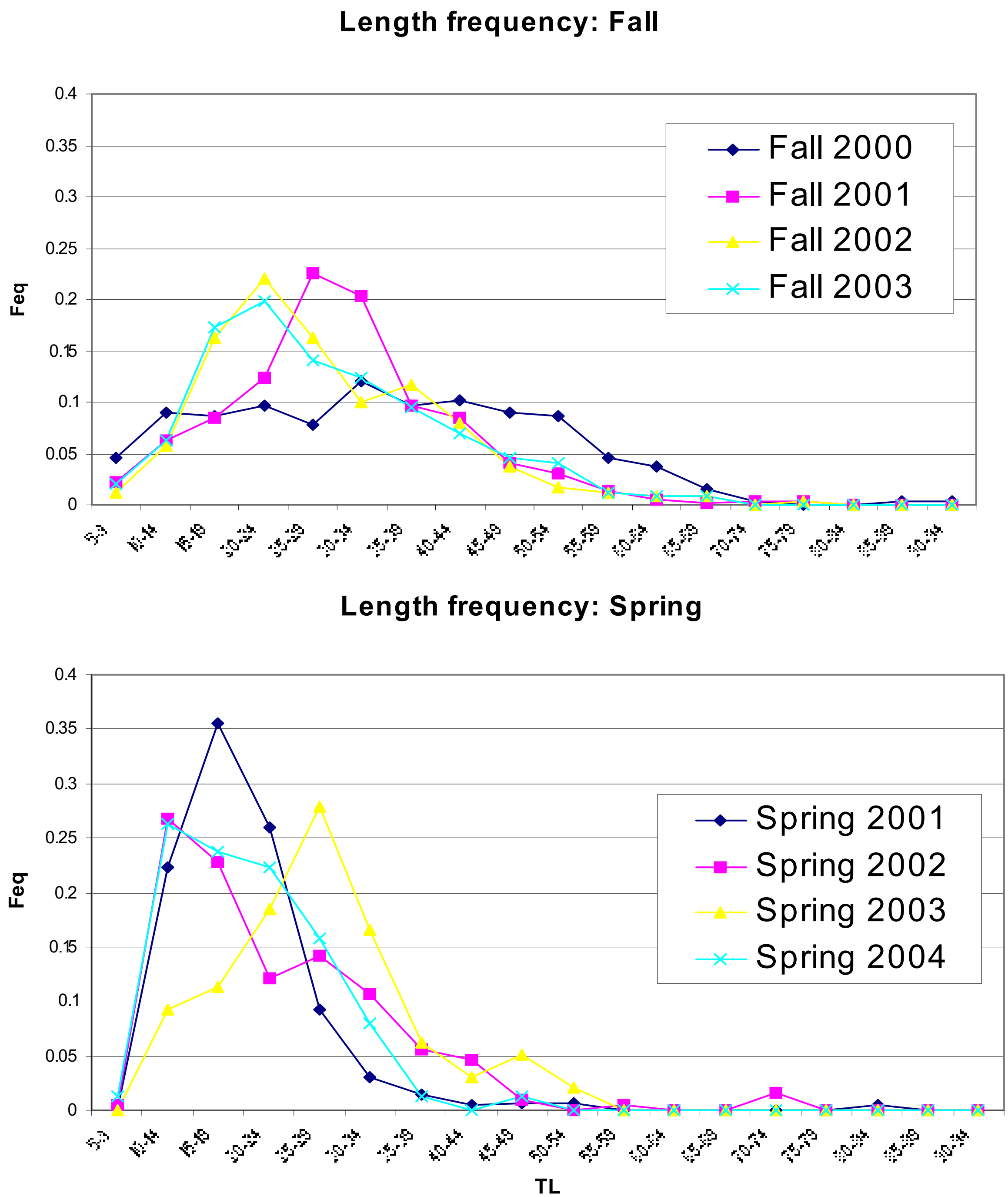


Figure A33. Length frequency distributions of monkfish caught in Maine/New Hampshire inshore surveys, fall and spring.

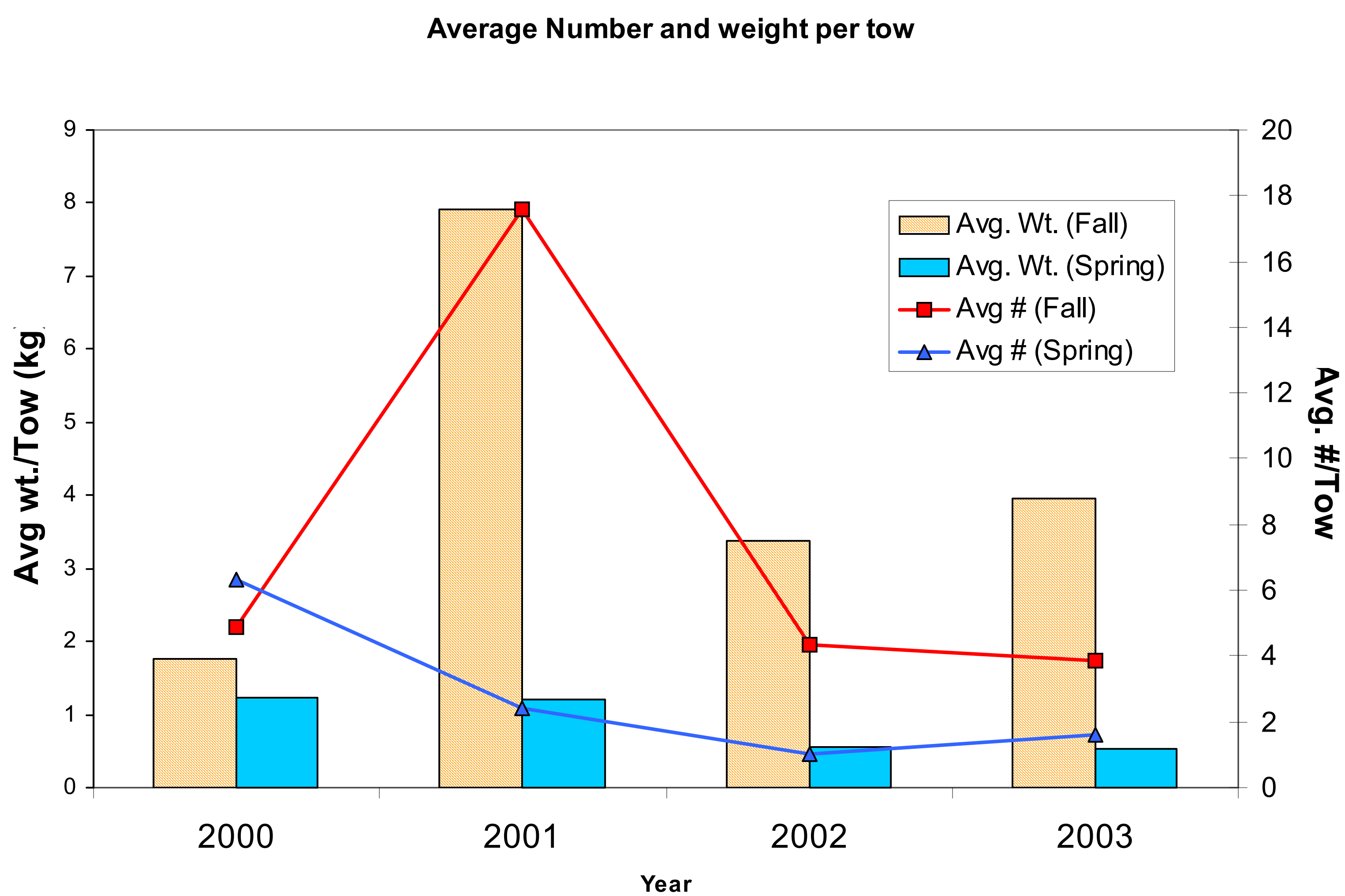


Figure A34. Mean number and weight per tow for goosefish in Maine/New Hampshire inshore surveys.

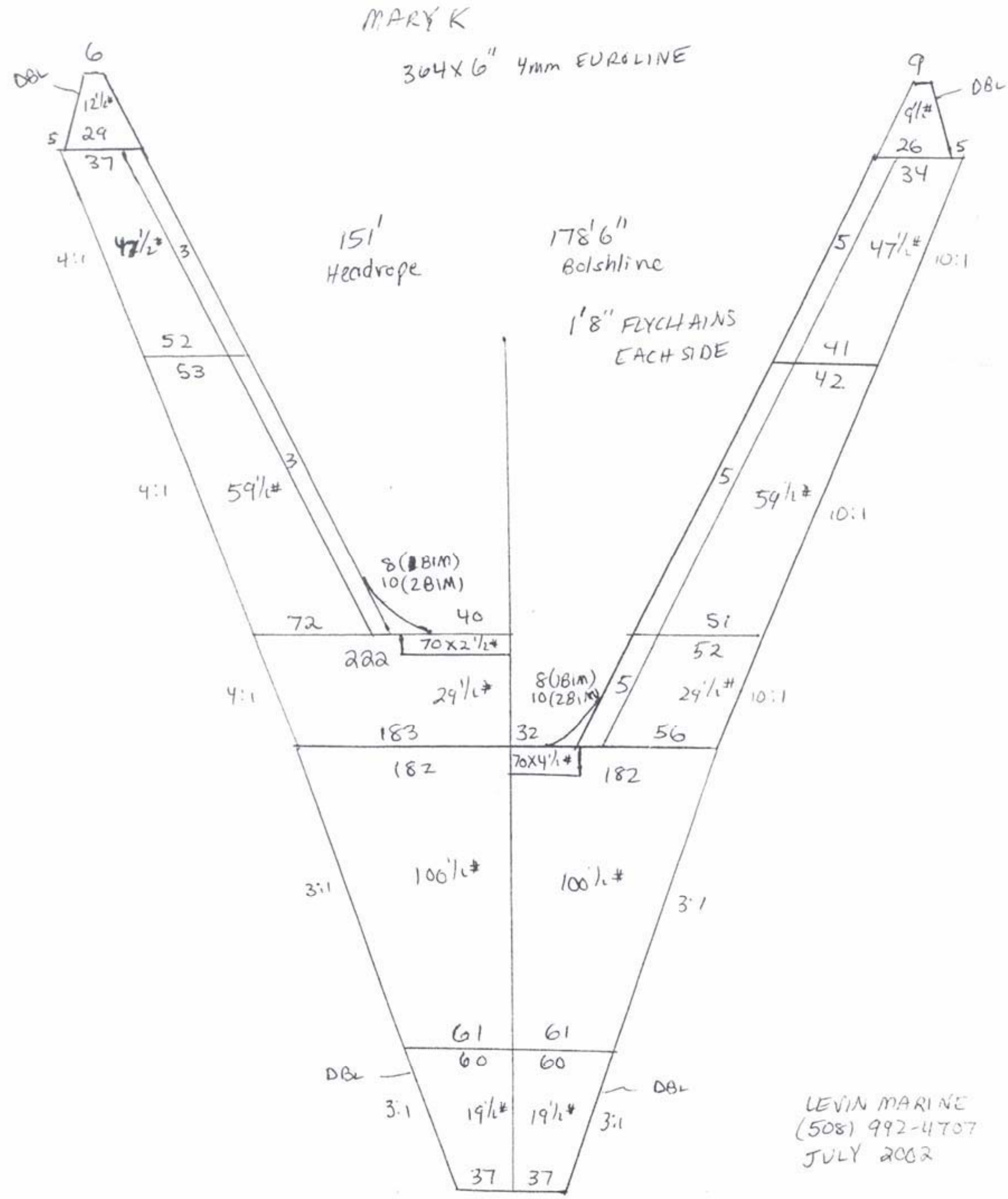


Figure A35. Net plan for the rockhopper net used on the Mary K for the 2004 cooperative monkfish survey.

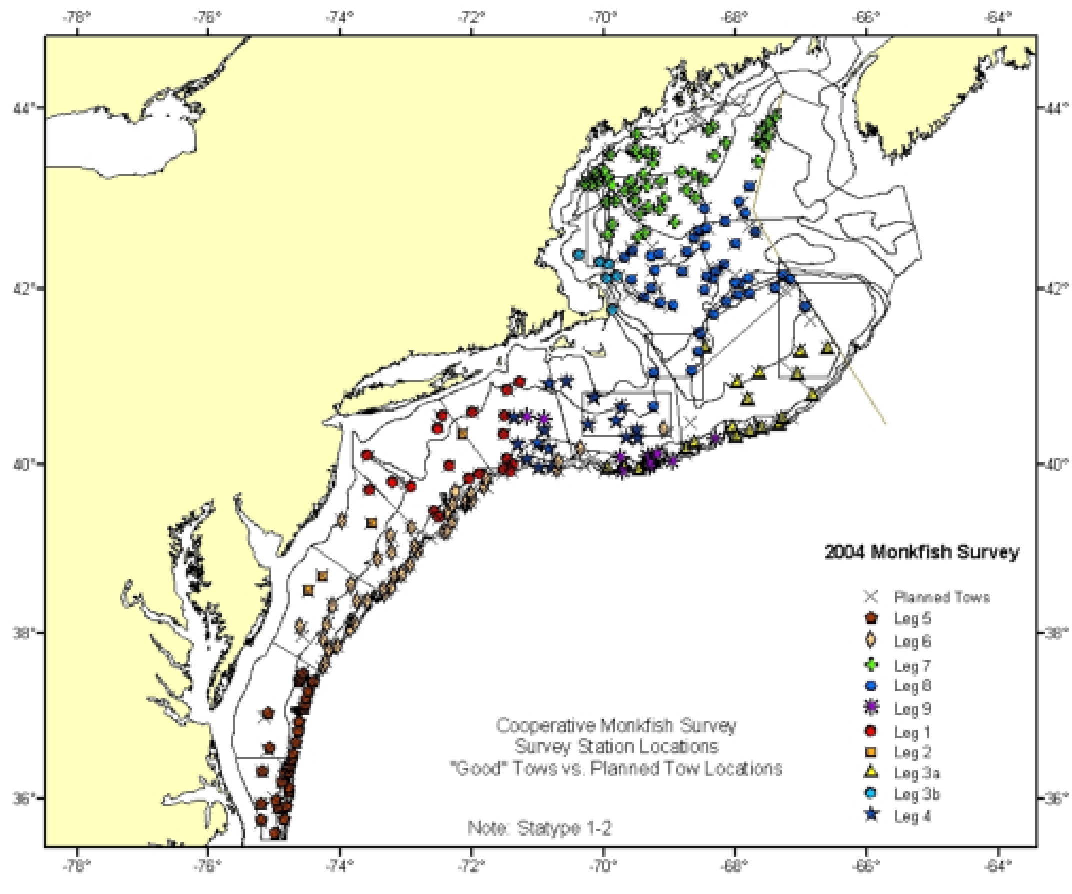


Figure A36. 2005 monkfish cooperative survey stations. Planned station locations that were not sampled are also shown (X).

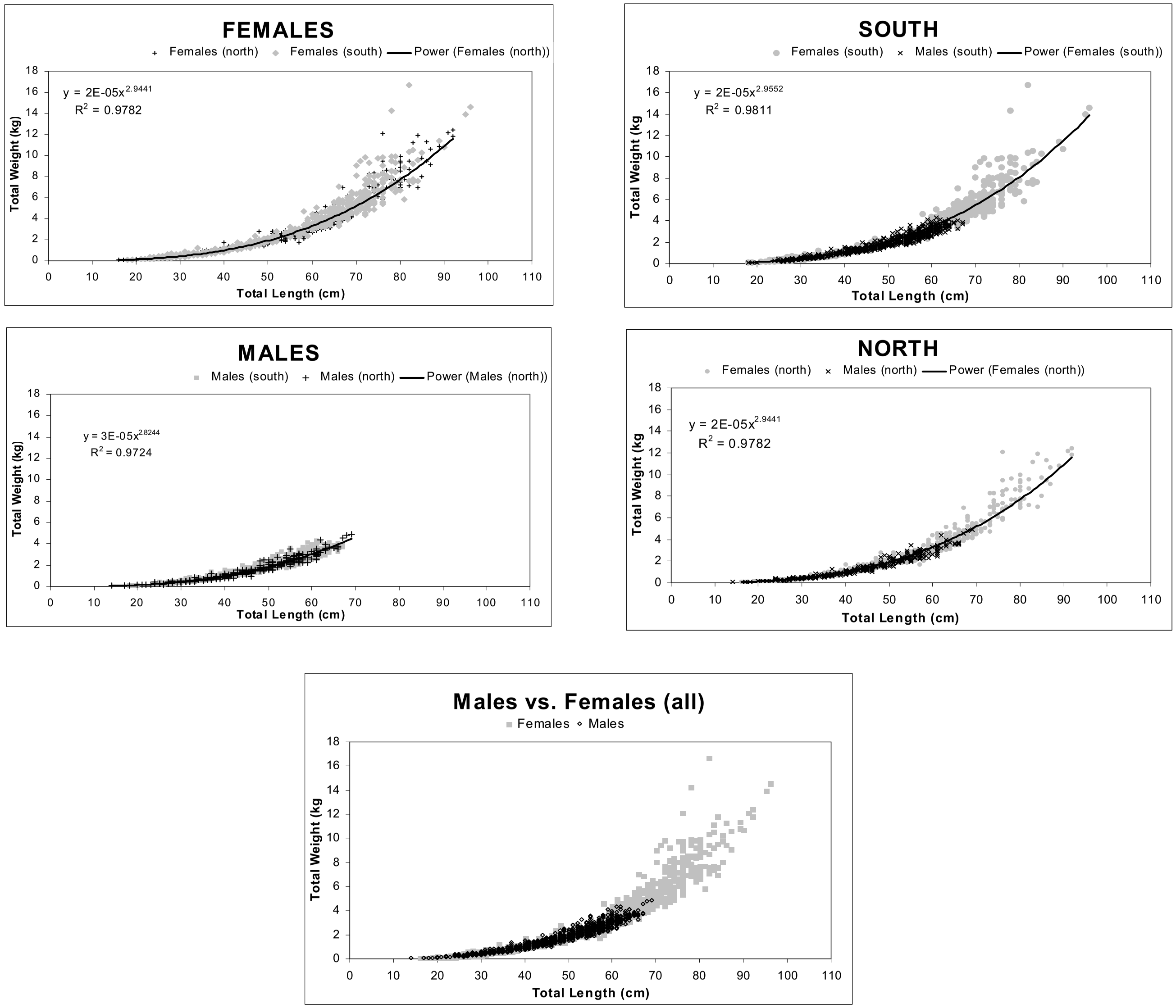
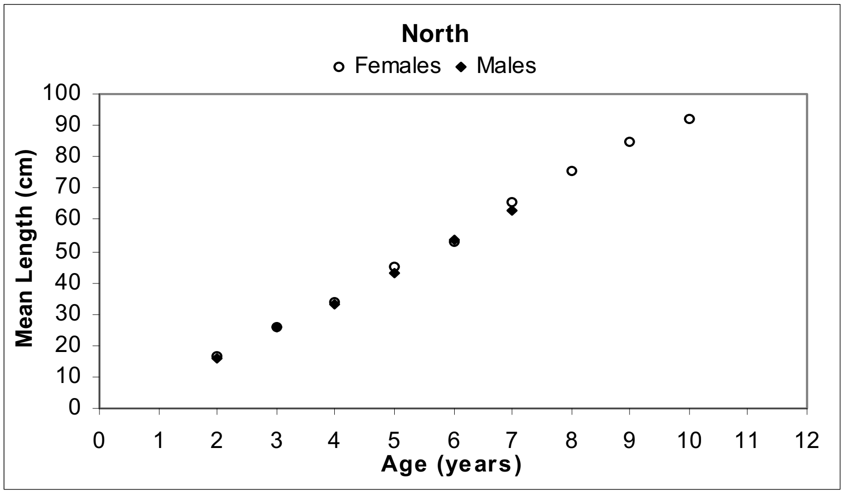
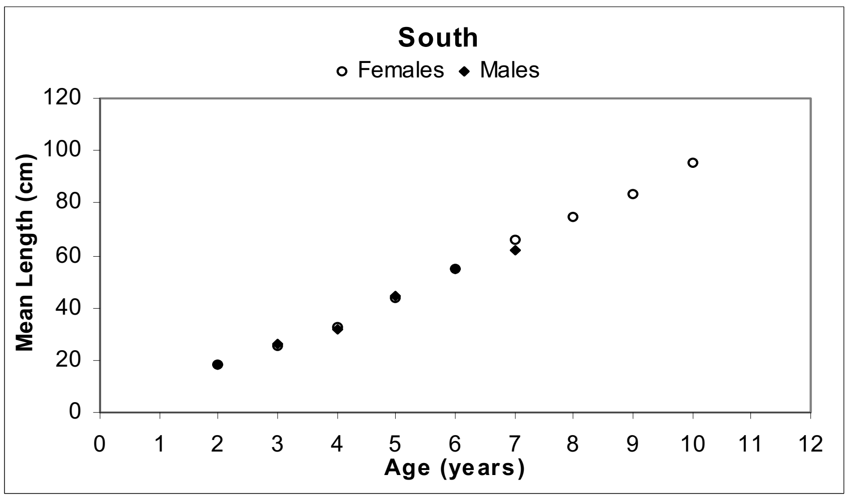


Figure A37. Length-weight relationships for monkfish captured during the 2004 cooperative survey.





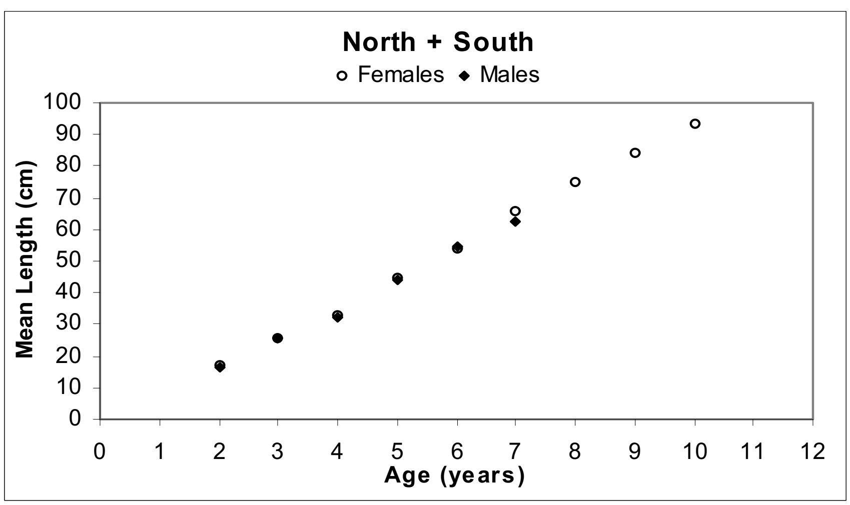
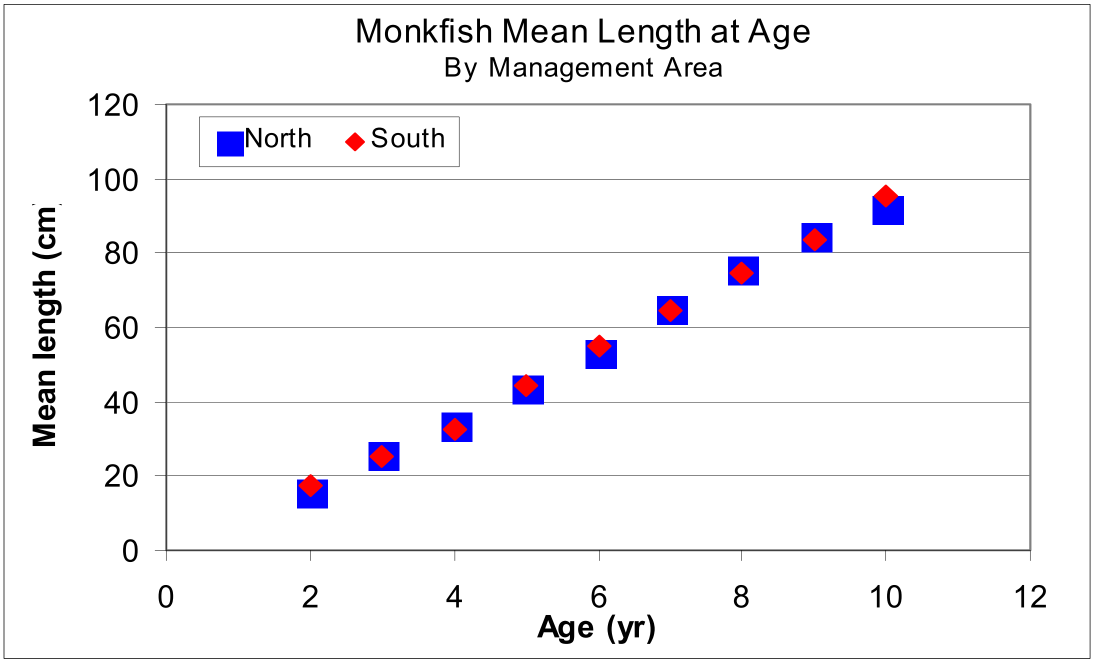


Figure A38. Monkfish age-length relationships from 2004 cooperative monkfish survey samples, by gender and management region.



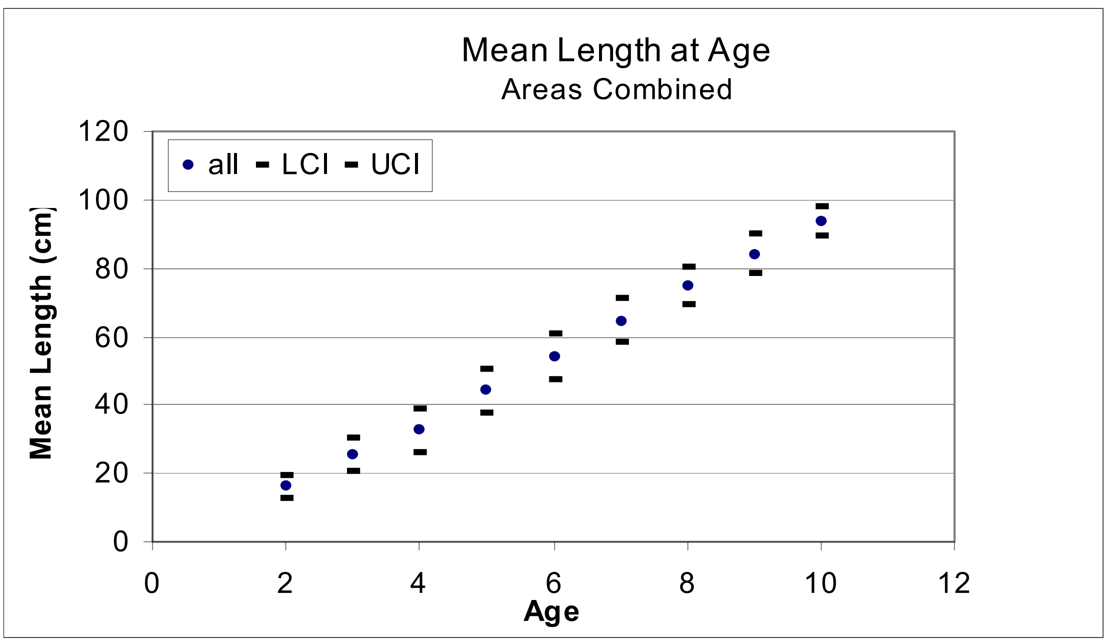
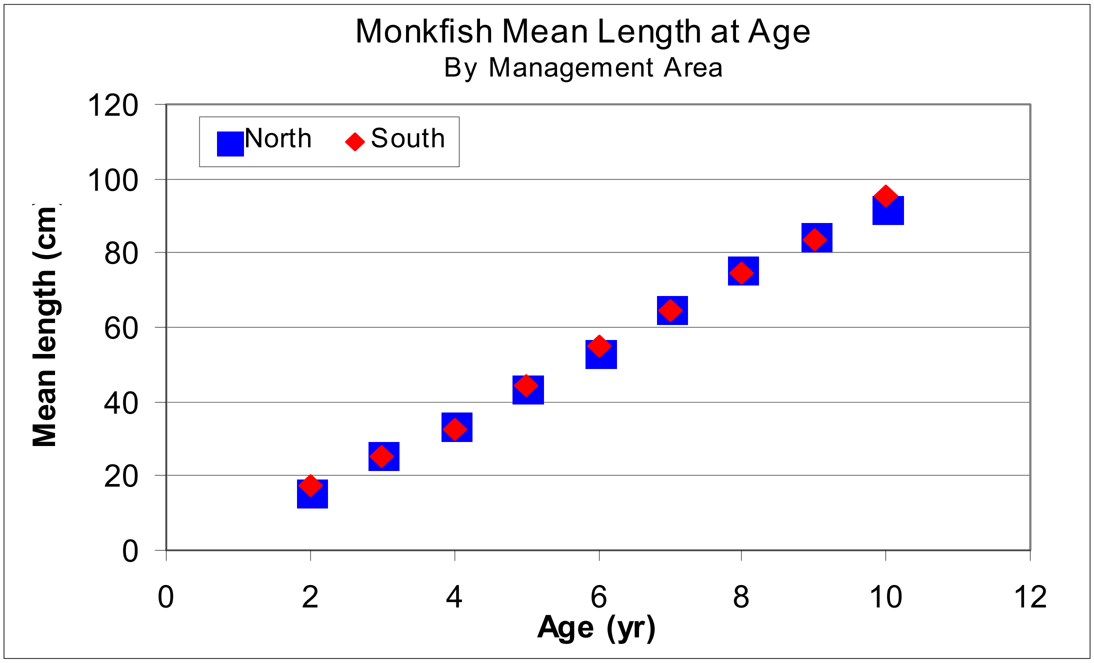


Figure A39. Mean length at age in samples from 2004 cooperative survey. LCI = lower 95% confidence interval, UCI = upper 95% confidence interval.



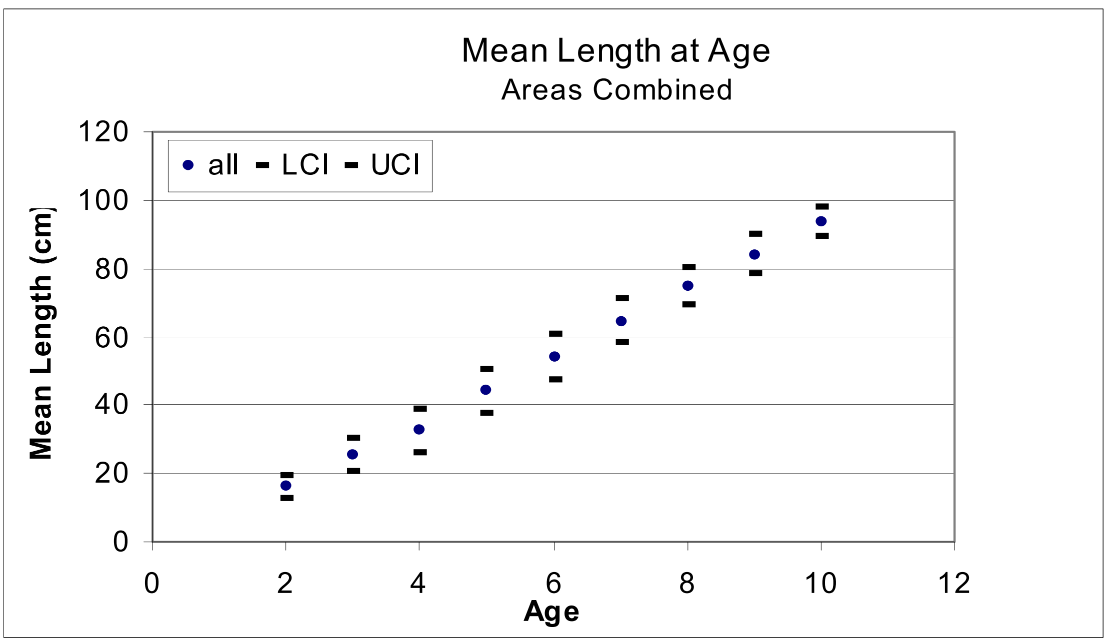
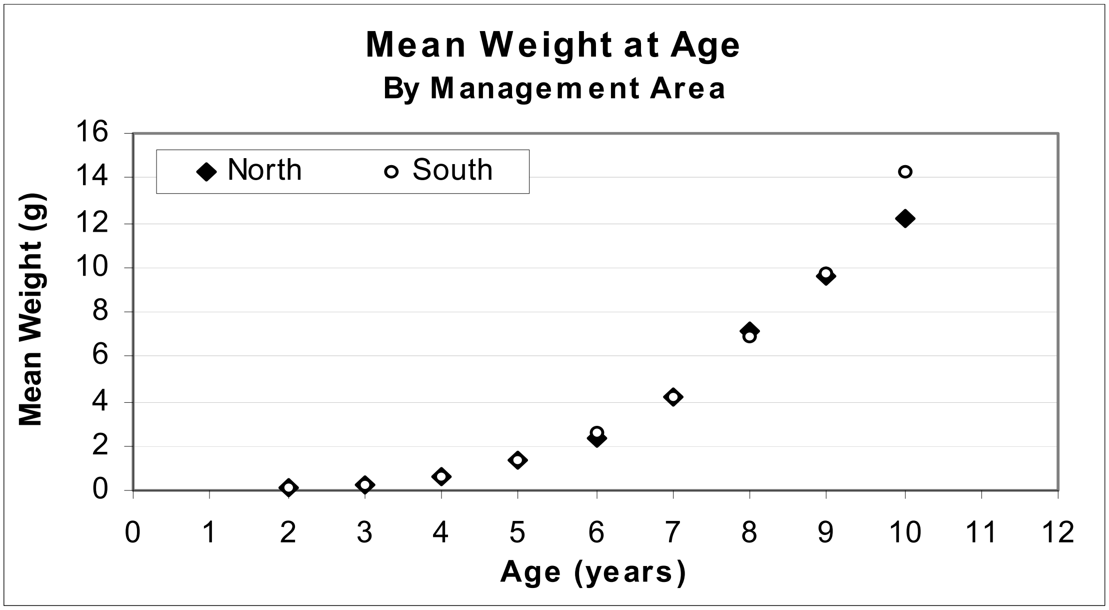


Figure A39. Mean length at age in samples from 2004 cooperative survey. LCI = lower 95% confidence interval, UCI = upper 95% confidence interval.



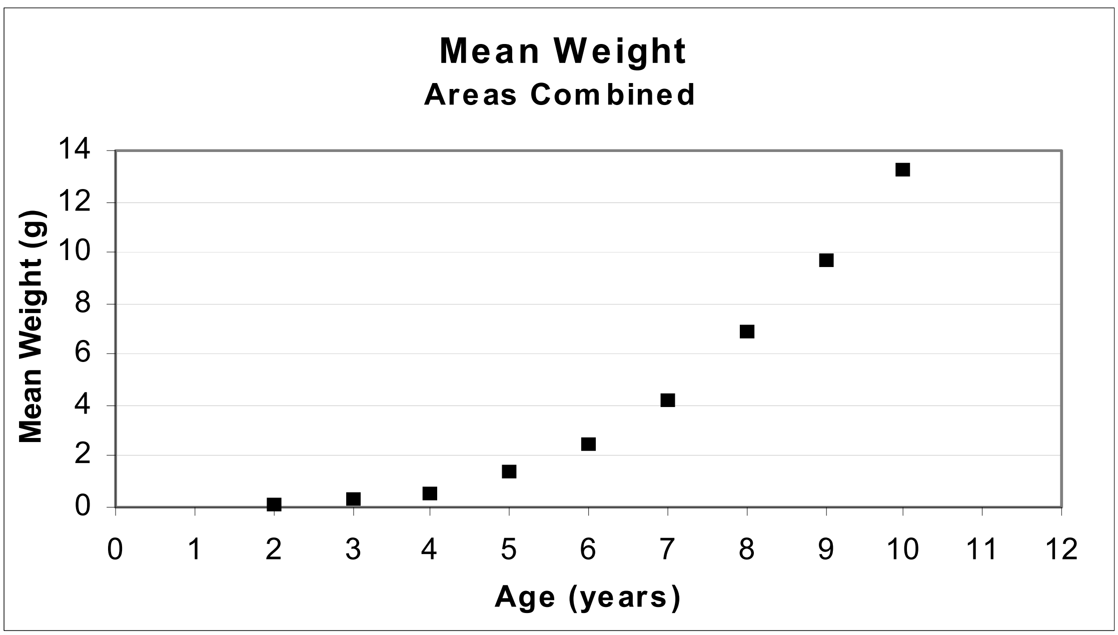
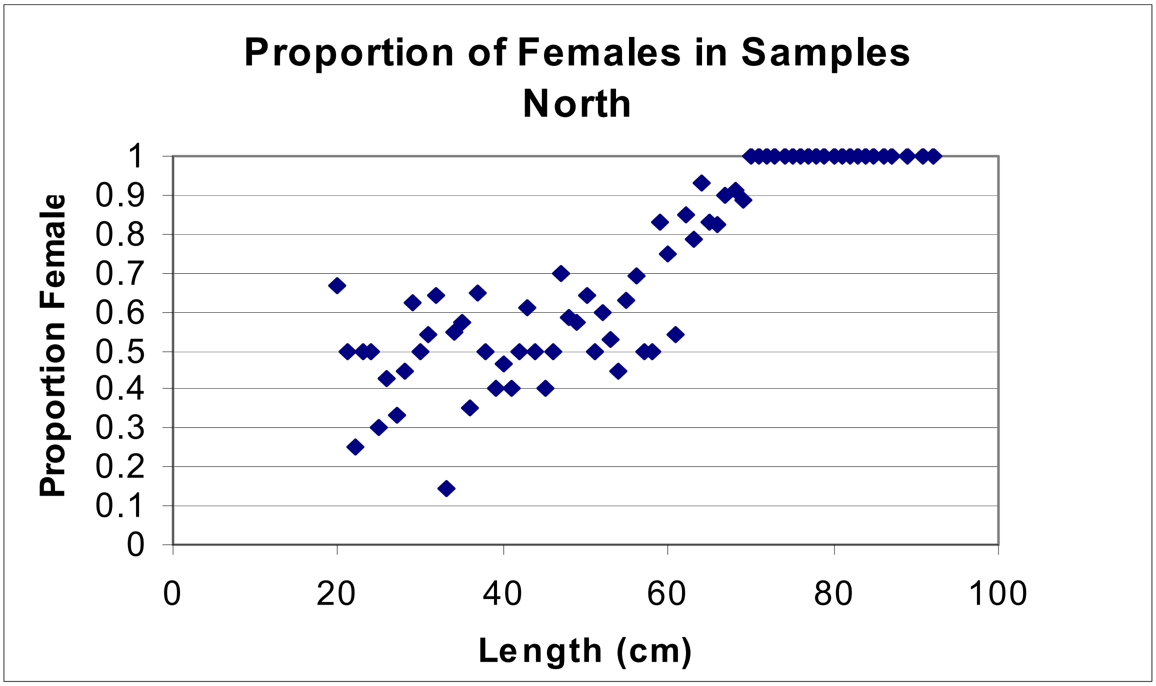


Figure A40. Monkfish mean weight at age from samples taken during 2004 cooperative monkfish survey.



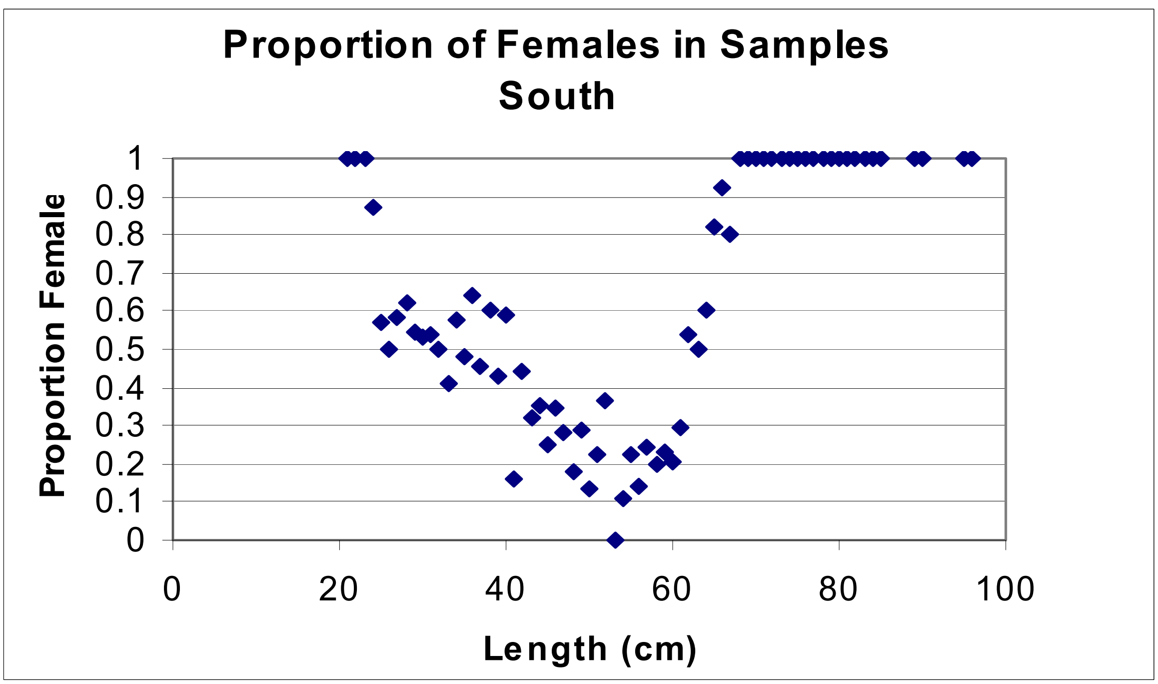


Figure A41. Sex ratios at length (proportion female) from 2004 monkfish survey.

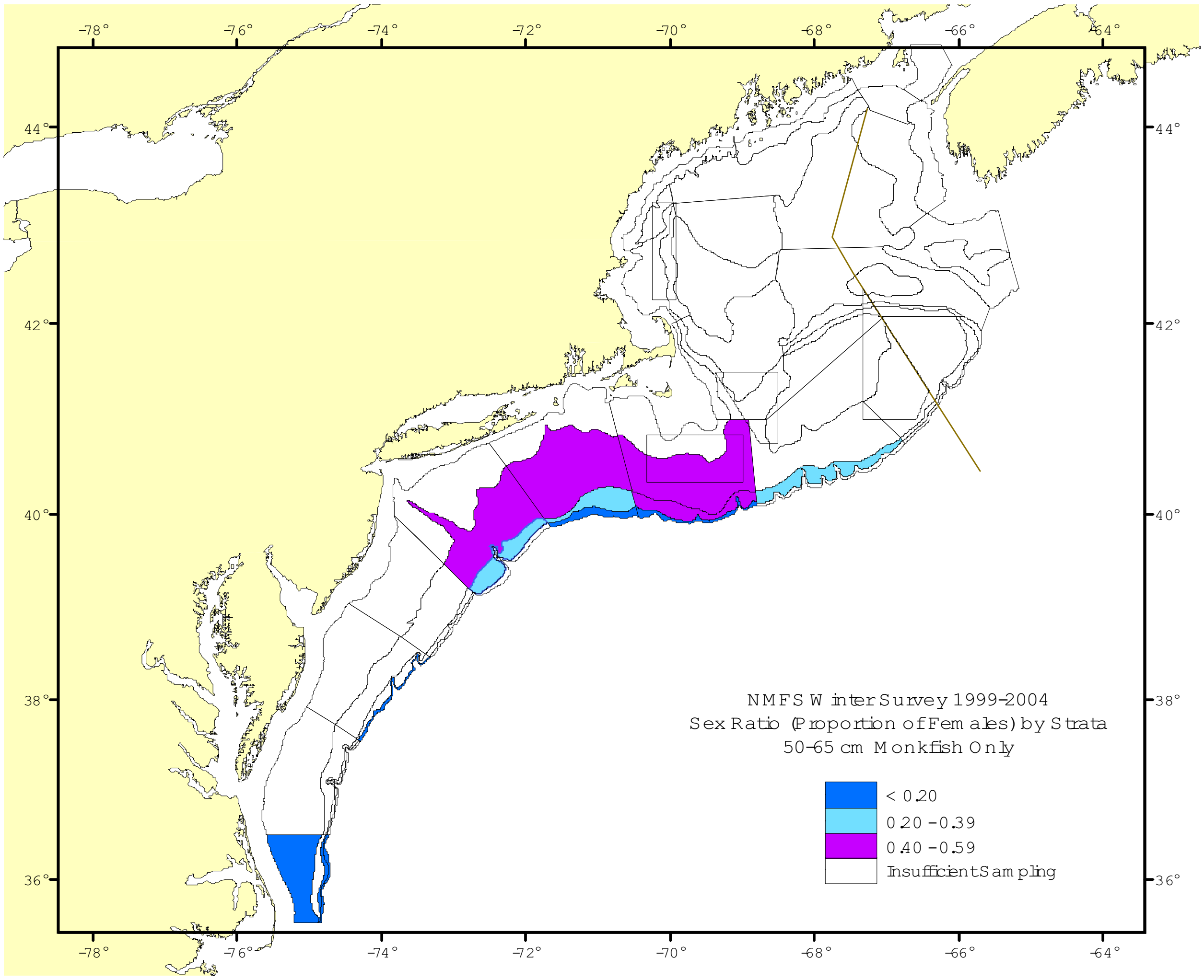
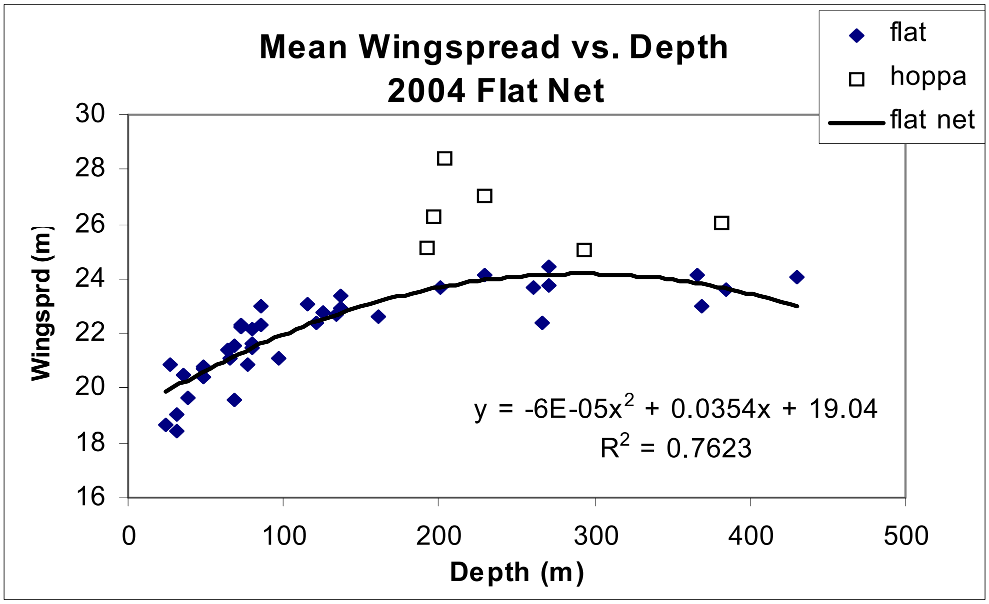


Figure A42. Spatial distribution of sex ratios for monkfish 50-65 cm from NEFSC winter surveys, 1999-2004.



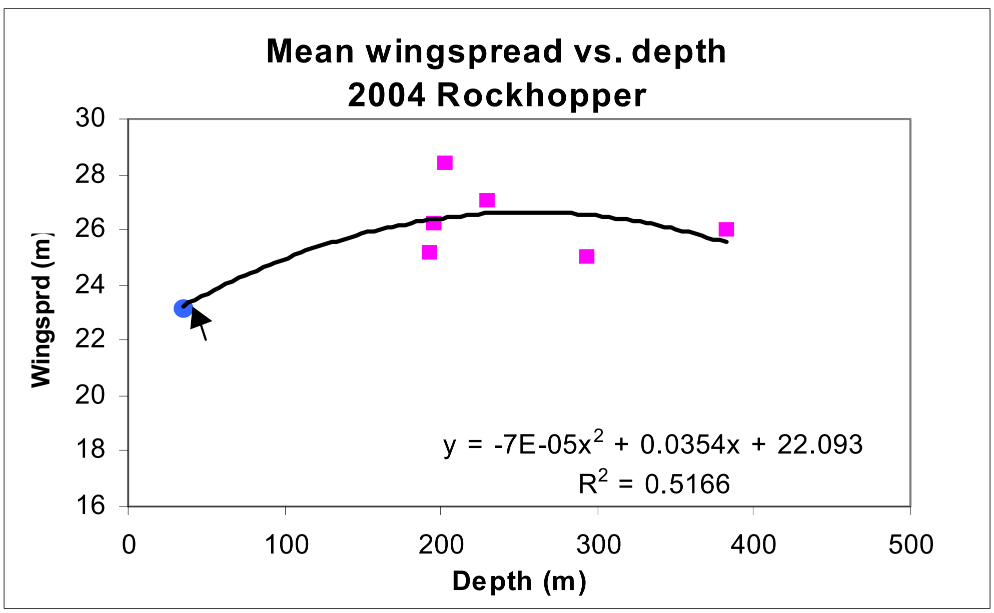
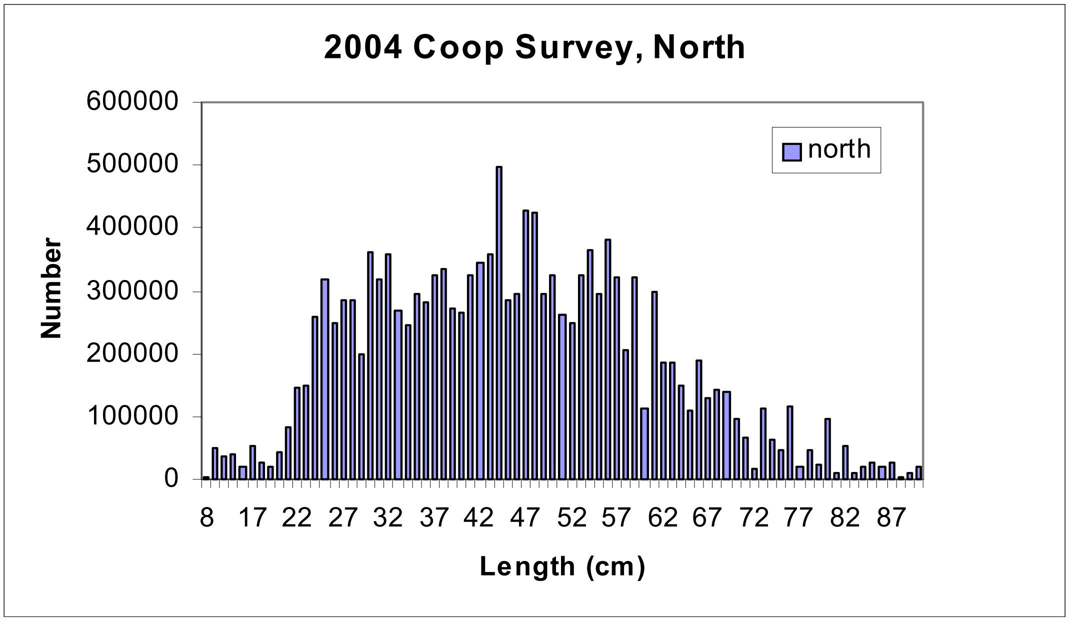


Figure A43. Relationships between wingspread and depth used to estimate wingspread for each survey tow for the 2004 cooperative goosefish survey.



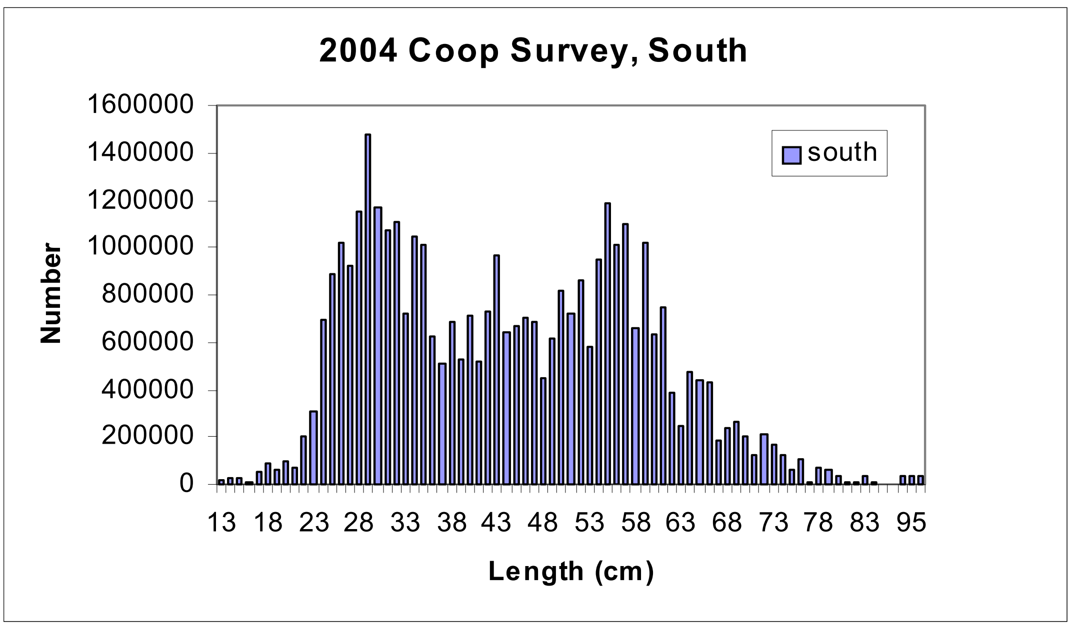
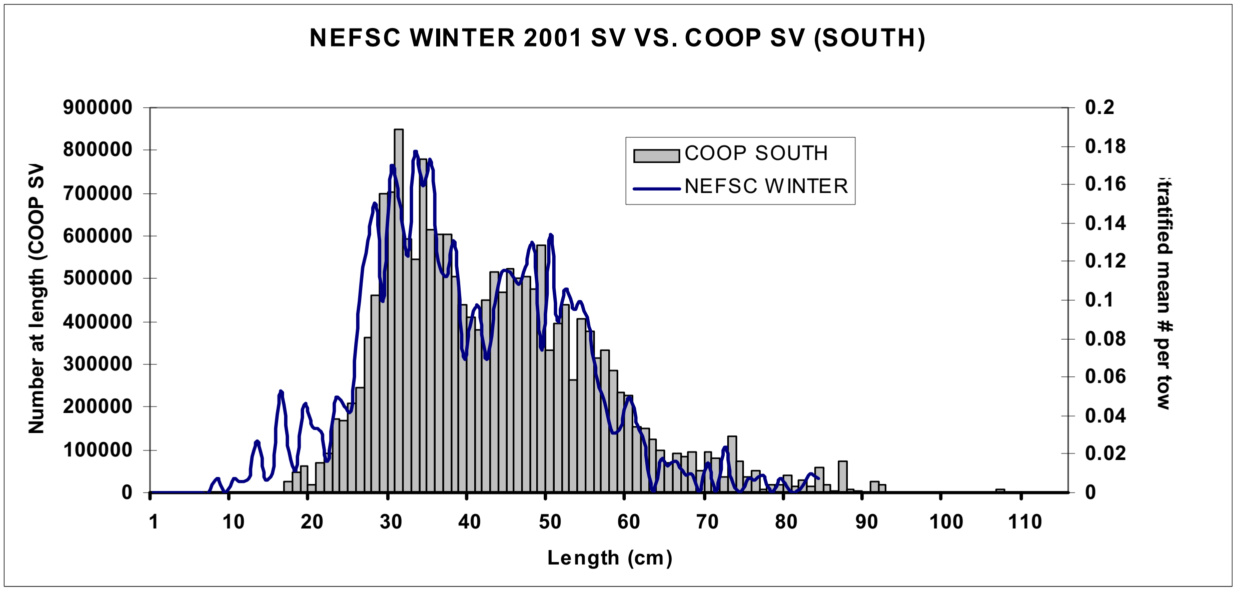


Figure A44. Length frequency distributions for the northern and southern management regions from the 2004 cooperative survey. Numbers at length are based on minimum population size estimates.



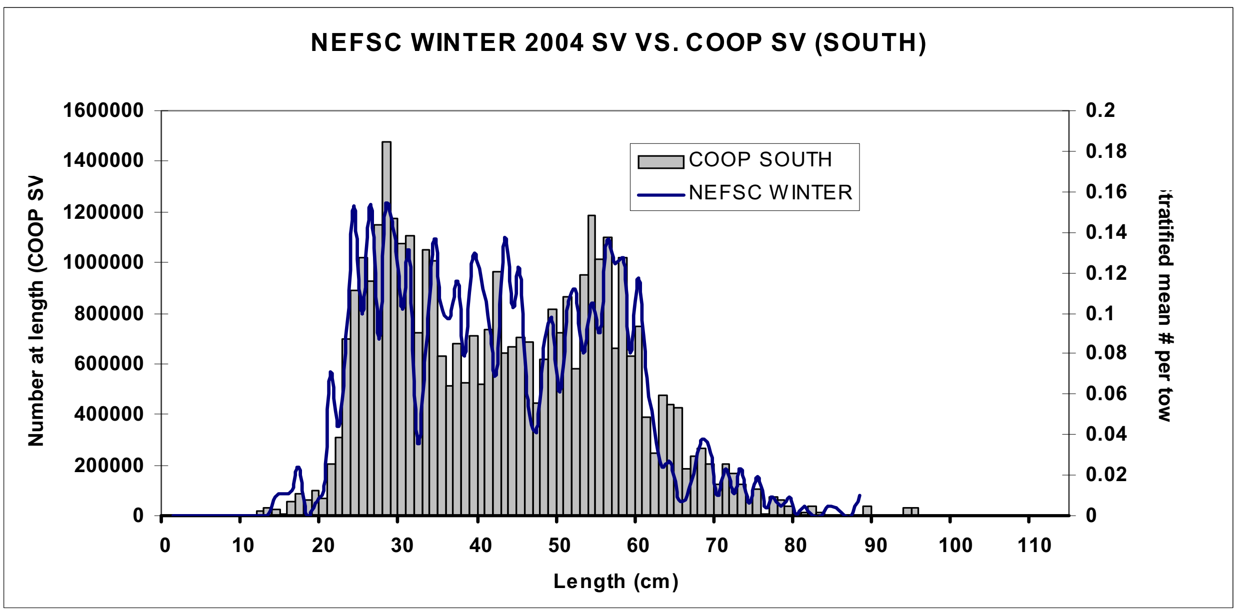
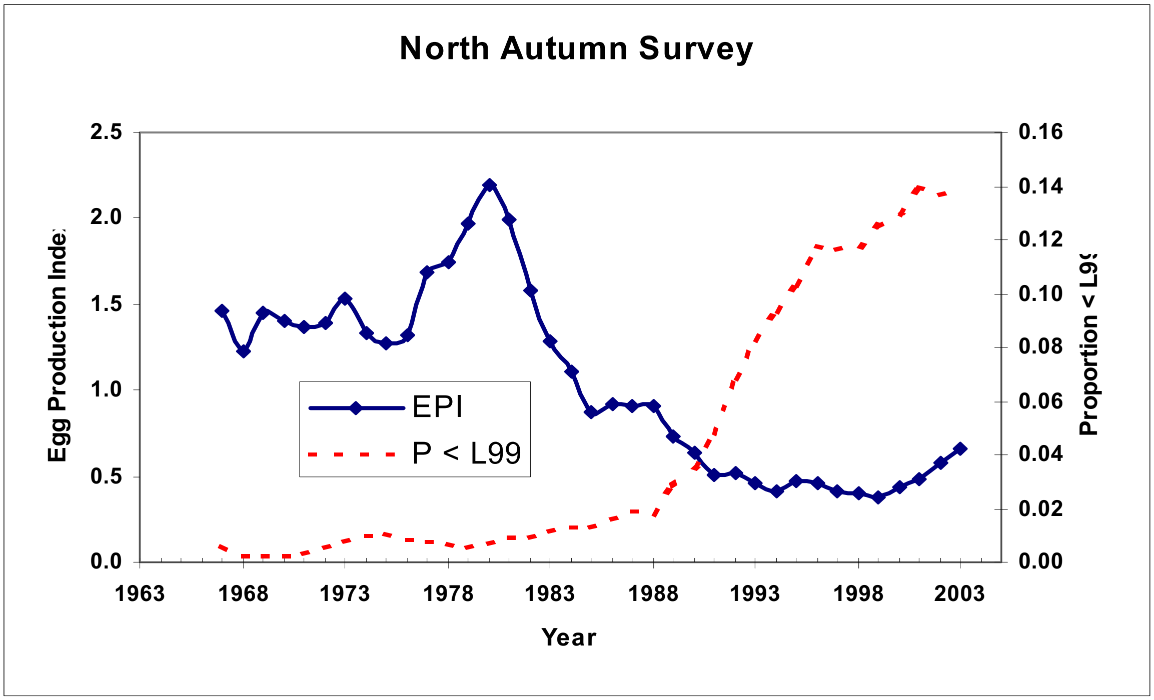


Figure A45. Length frequency distributions of monkfish estimated from NEFSC winter surveys and cooperative surveys, 2001 and 2004. Cooperative survey estimates are minimum numbers at length, NEFSC survey estimates are stratified mean number per tow at length



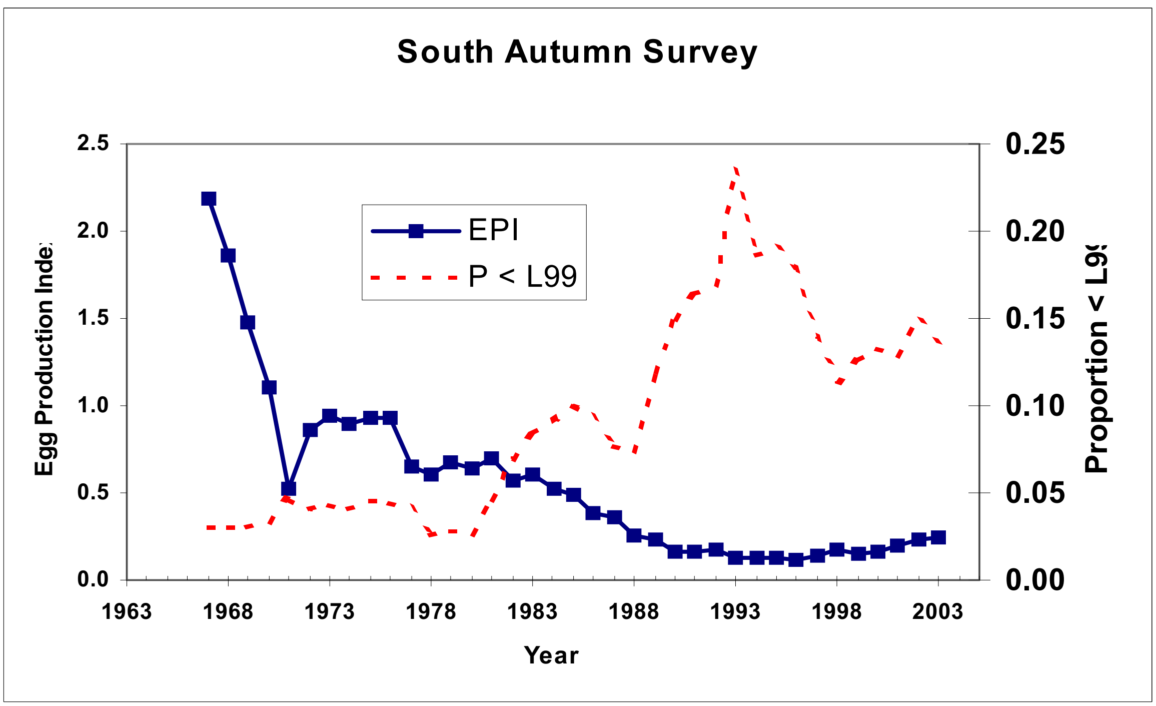
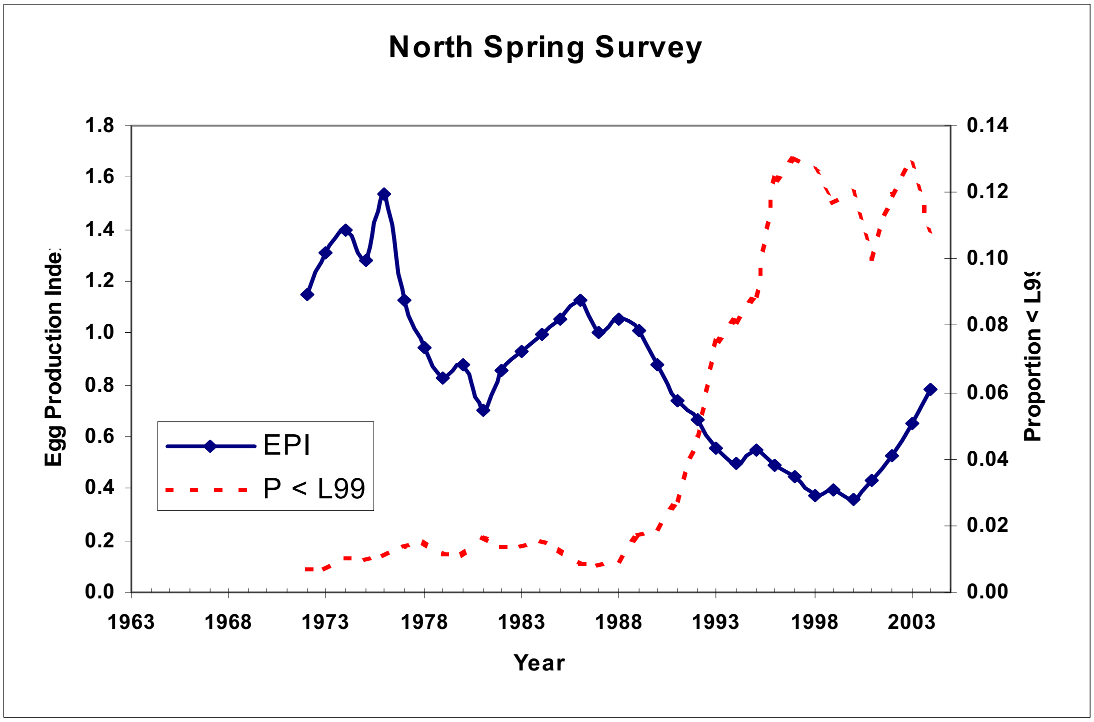


Figure A46. Indices of egg production by goosefish based on composite length frequency distributions from survey indices (number per tow at length), proportion mature at length, and fecundity at length. Year represents the terminal year of a 5-year pooled length frequency sample. Proportion < L99 is the fraction of egg production from goosefish smaller than the size at 99% maturity.



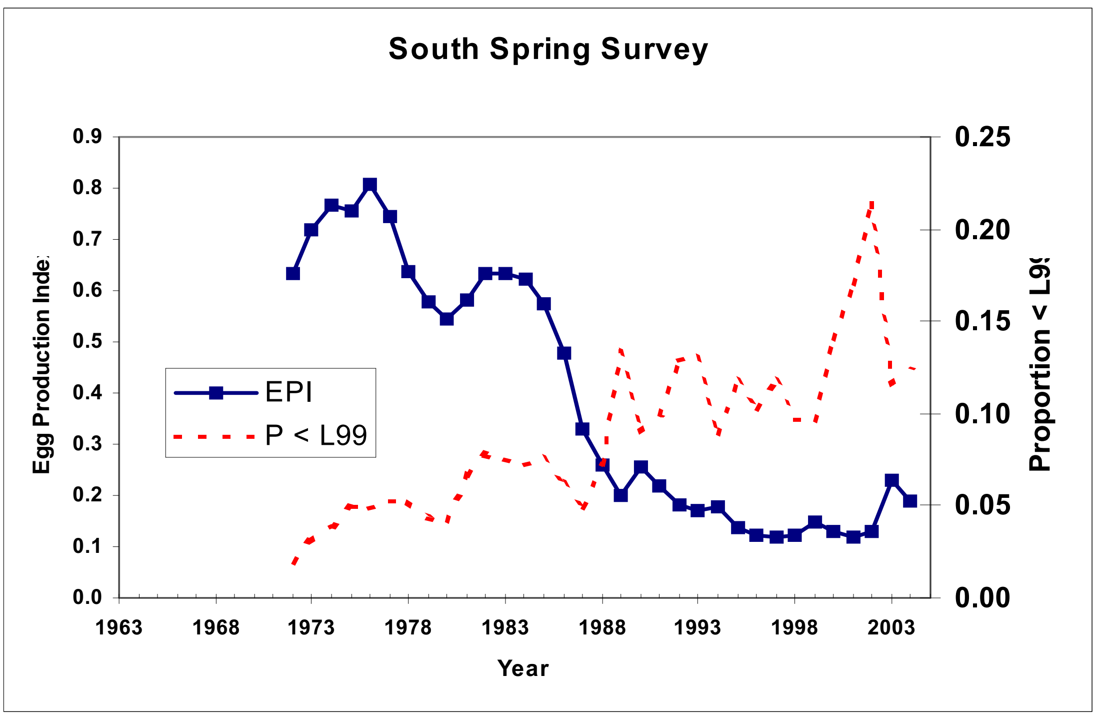


Figure A47. Indices of egg production by goosefish based on composite length frequency distributions from survey indices (number per tow at length), proportion mature at length, and fecundity at length. Year represents the terminal year of a 5-year pooled length frequency sample. Proportion < L99 is the fraction of egg production from goosefish smaller than the size at 99% maturity

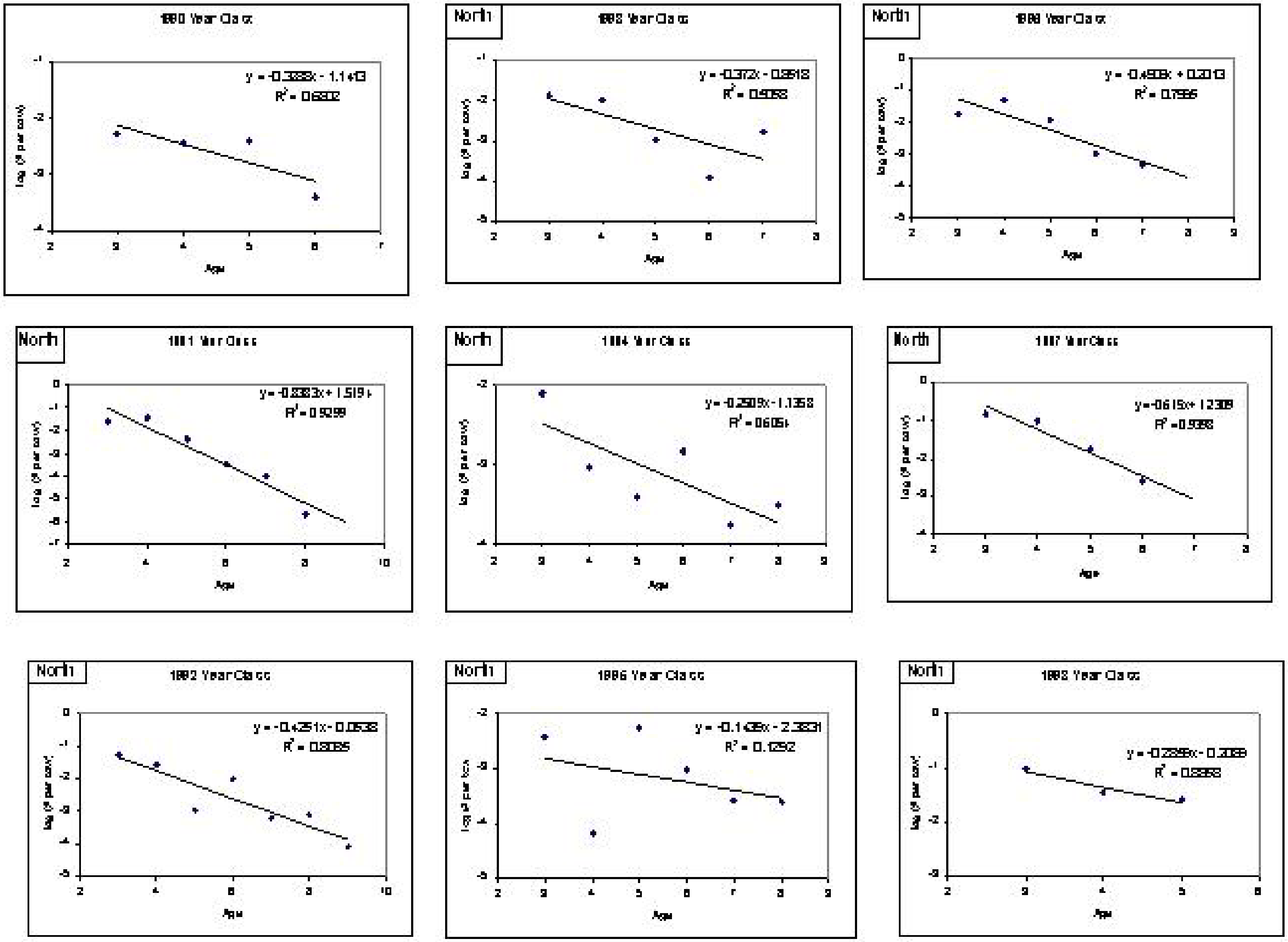


Figure A48. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the northern region.

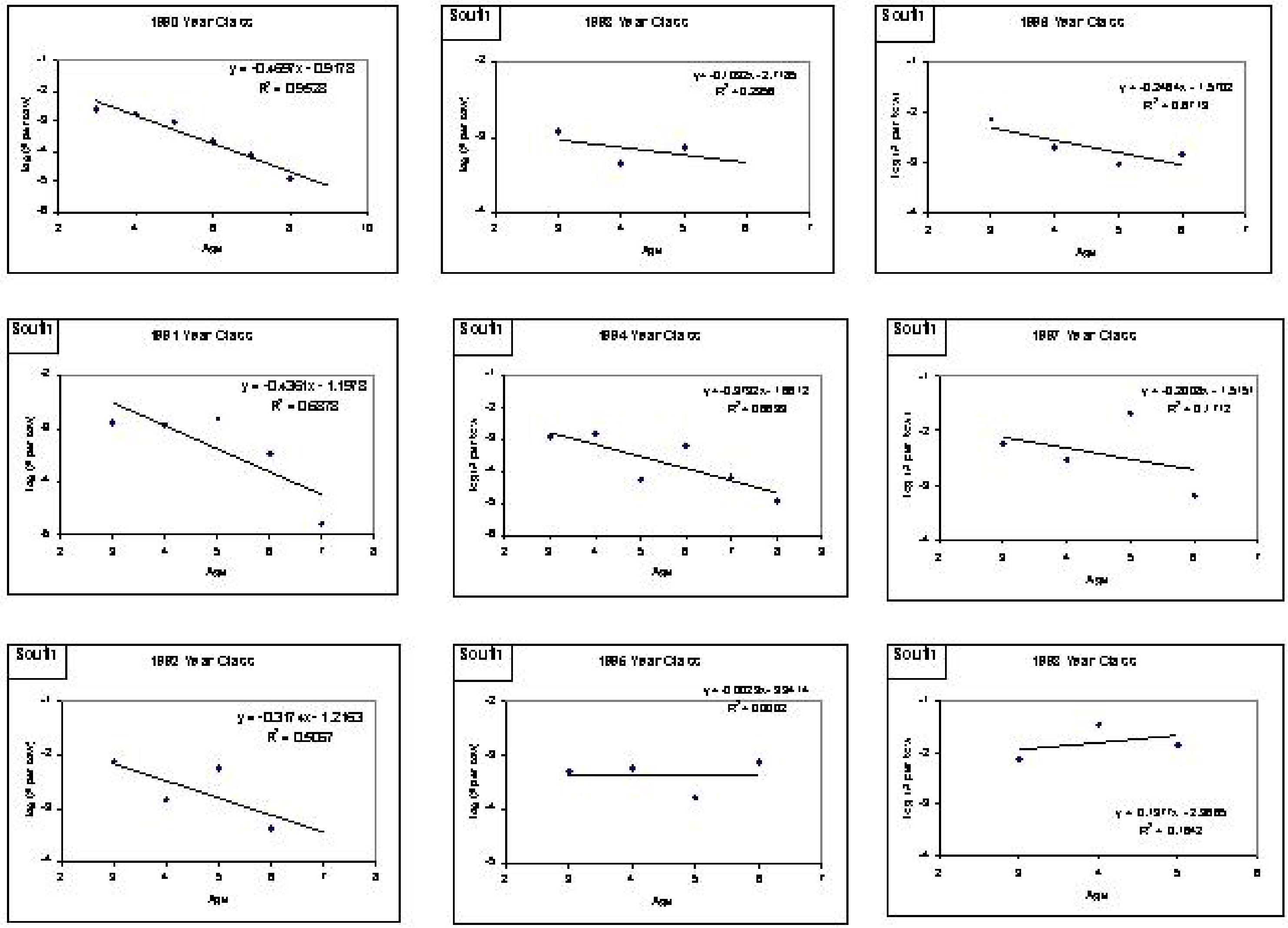


Figure A49. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the southern region.

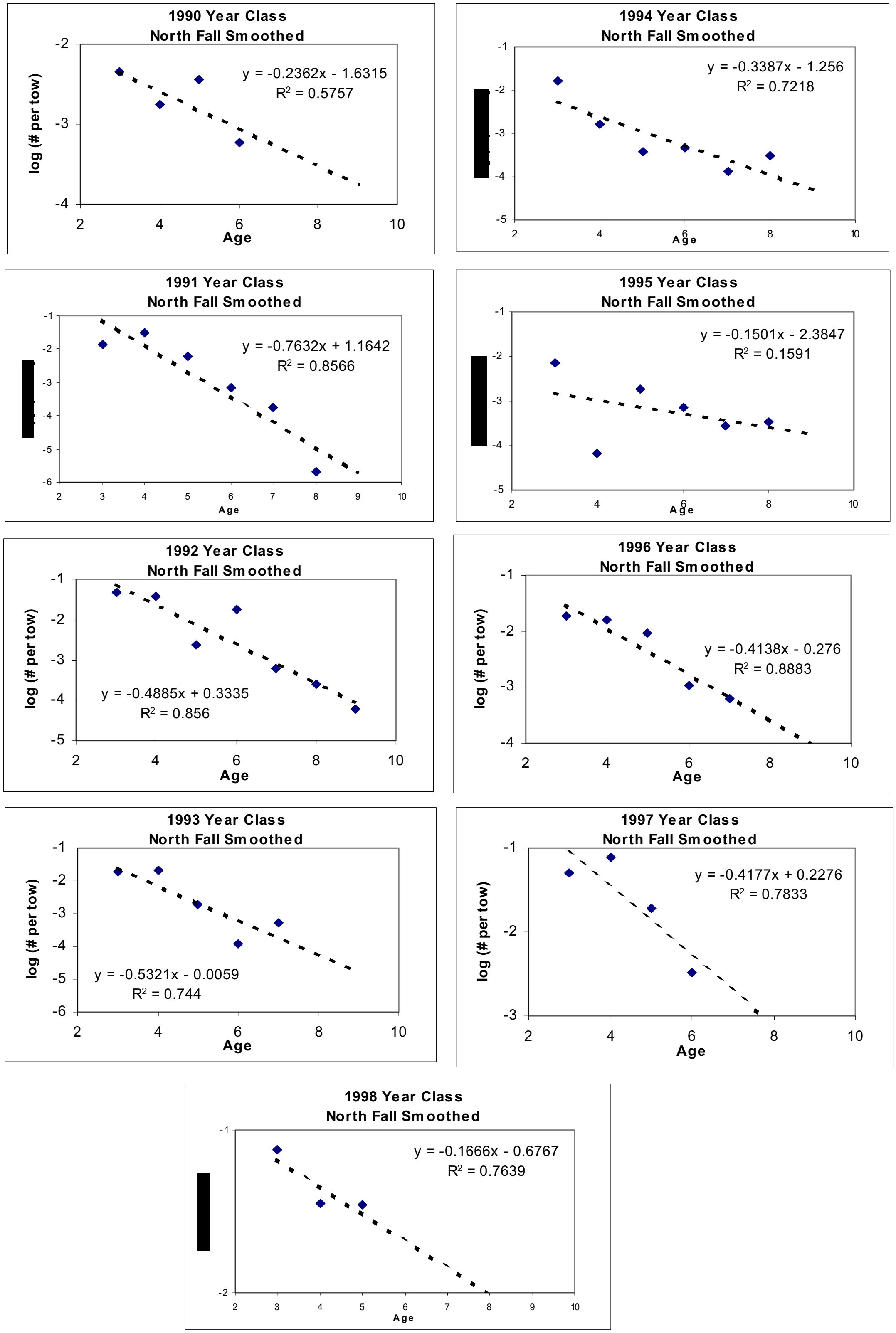


Figure A50. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the northern region, smoothed survey indices.

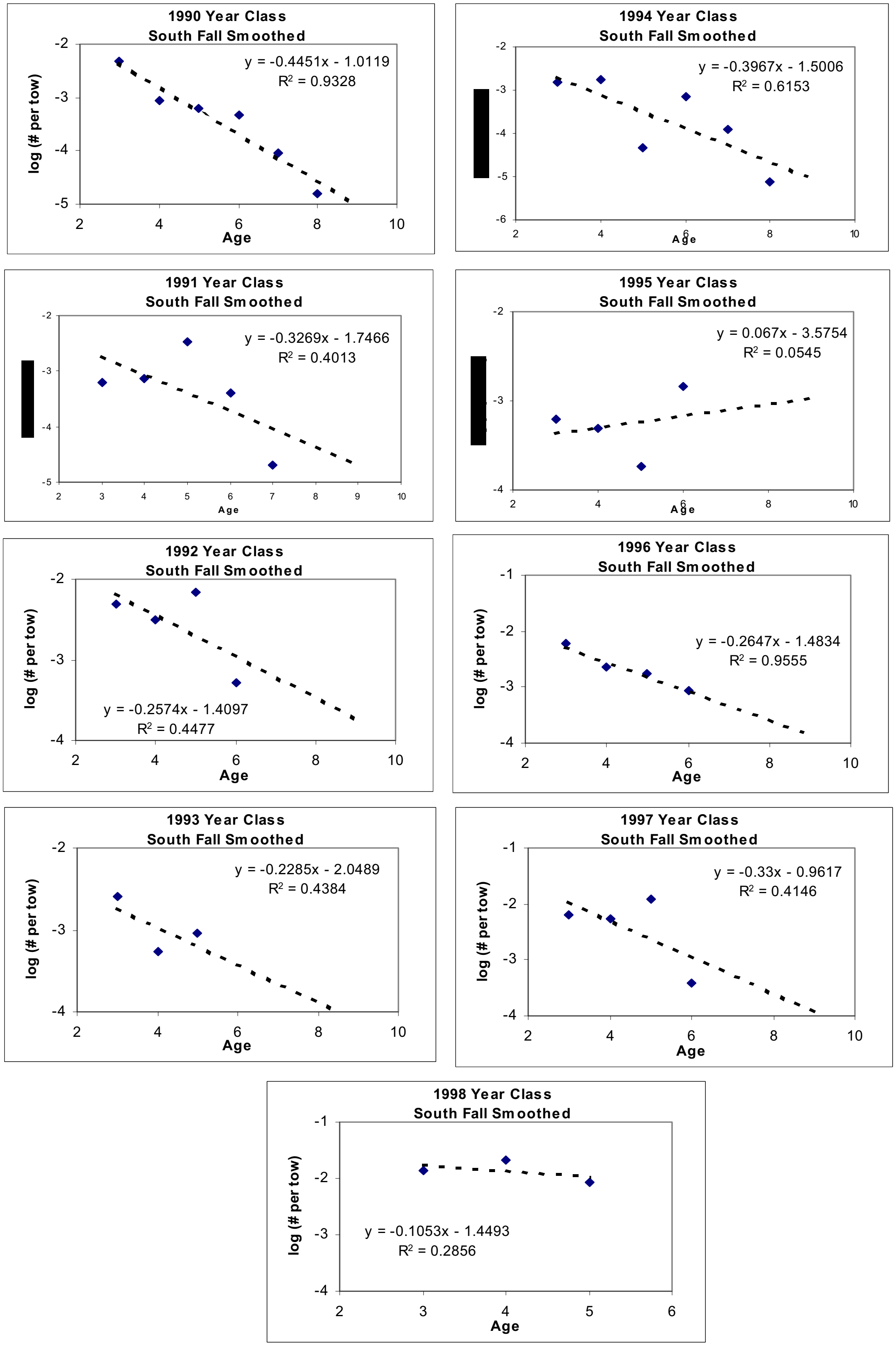


Figure A51. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the southern region, smoothed survey indices.

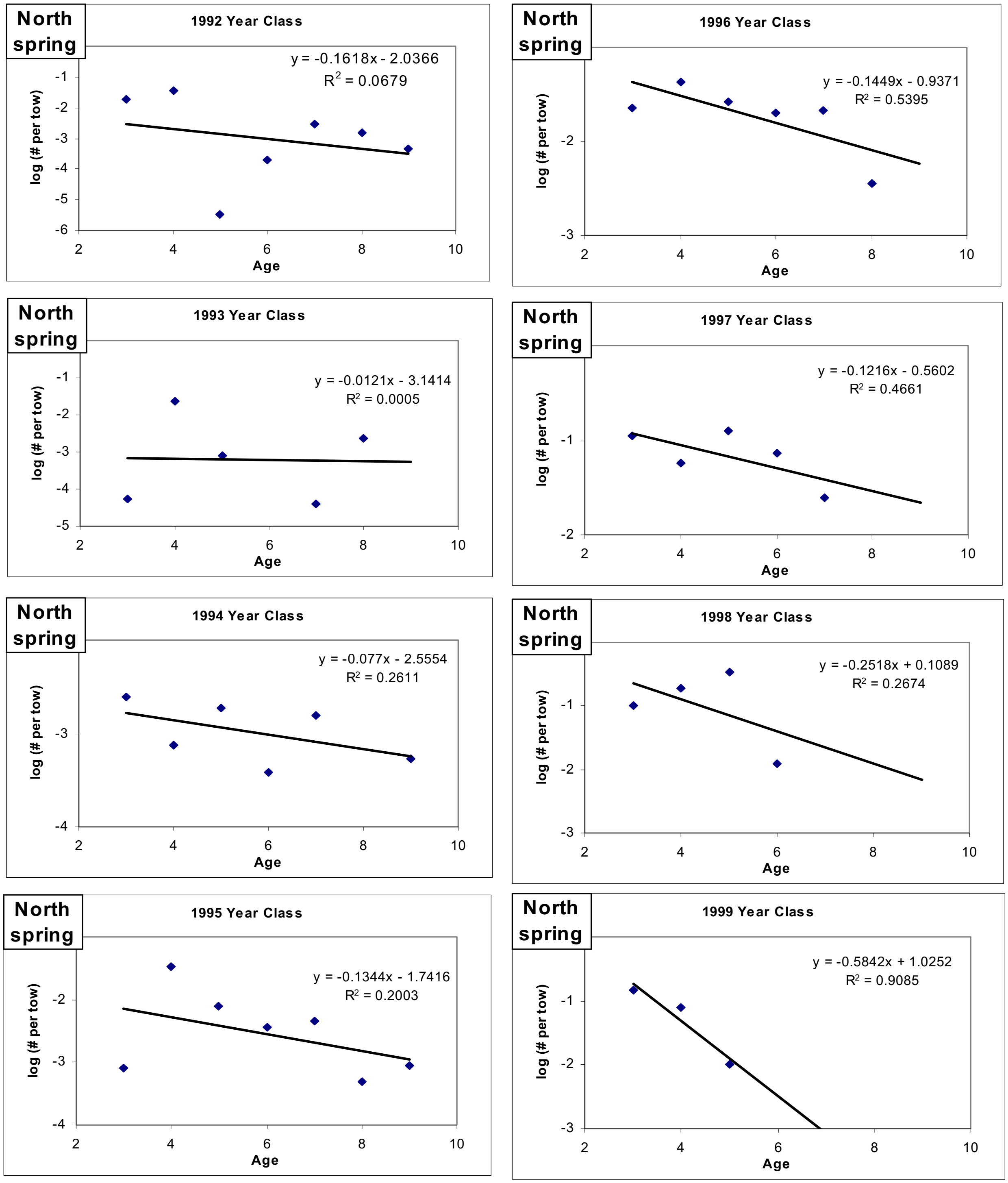


Figure A52. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the northern region, spring.

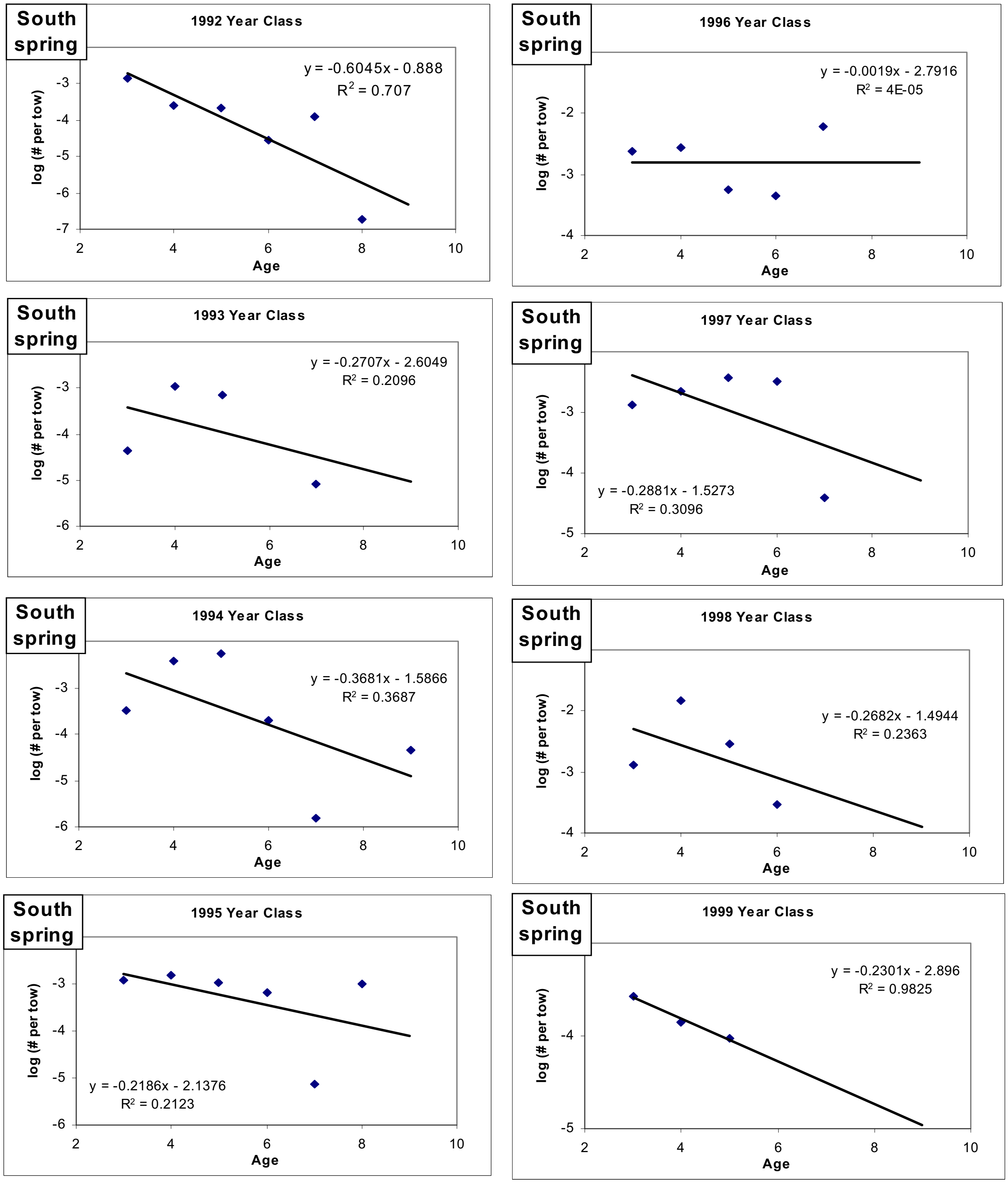


Figure A53. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the southern region, spring.

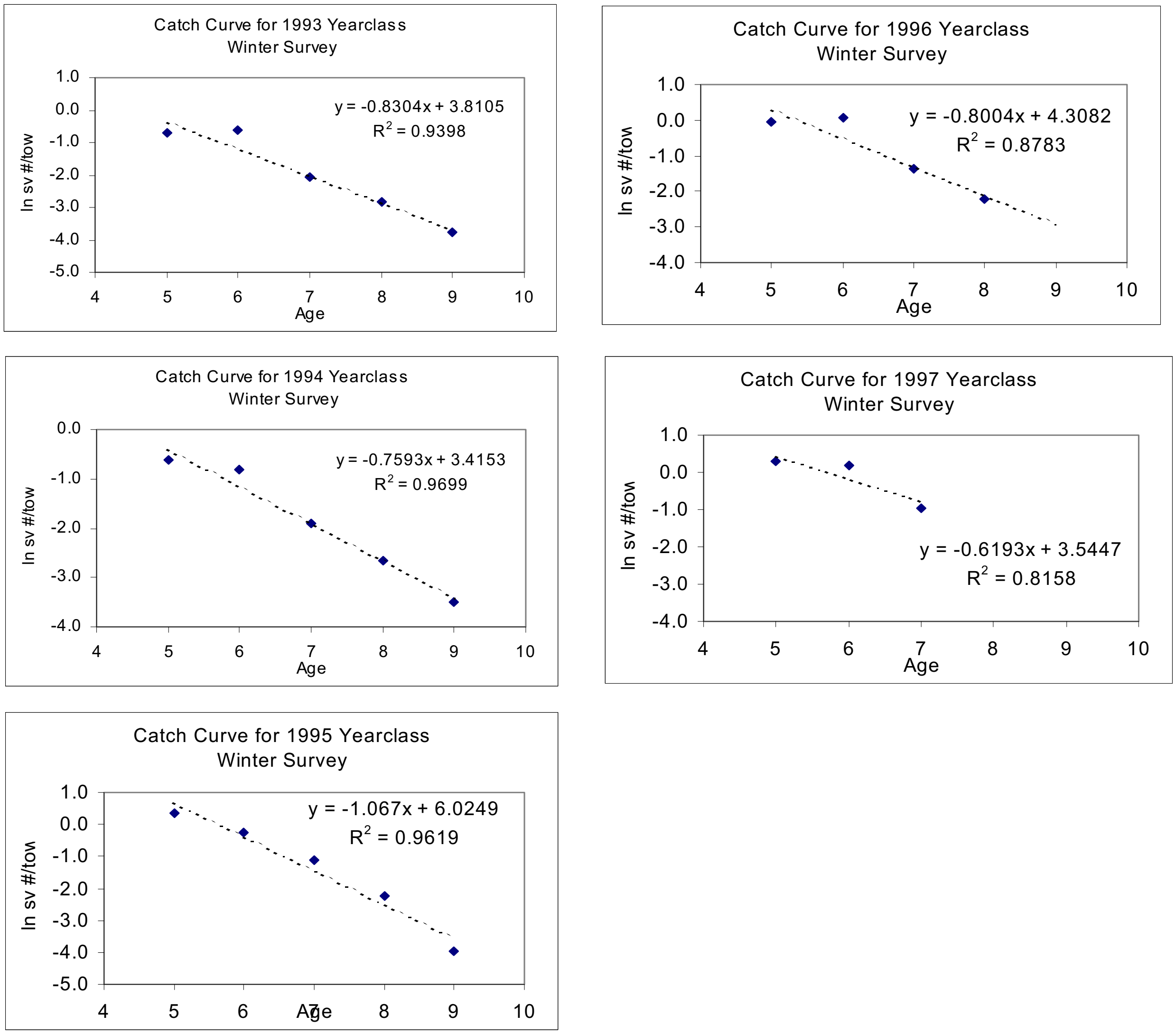


Figure A54. Estimated mortality rates from NEFSC survey abundance at age data using cohort-based catch curves for the southern region, winter.

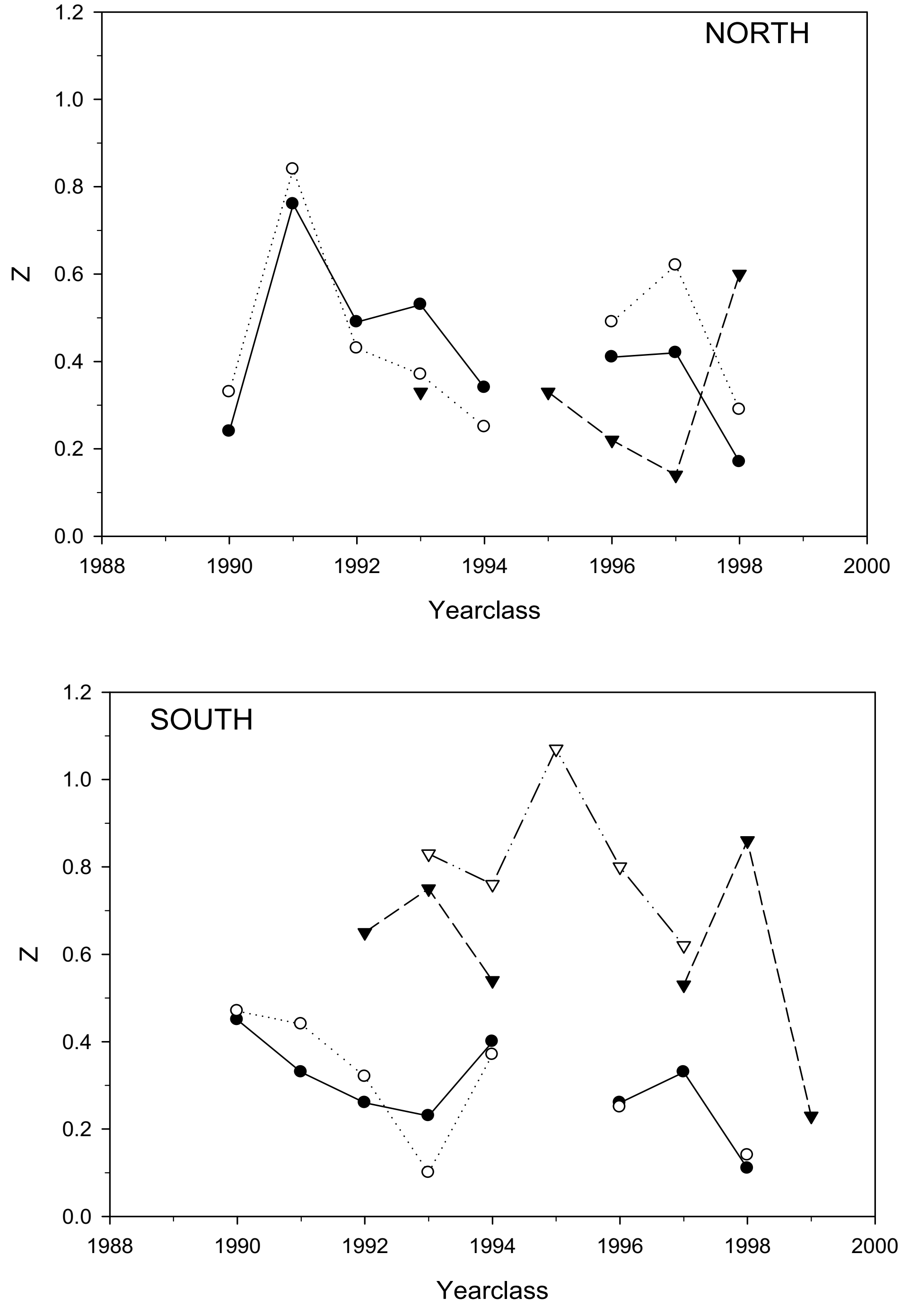


Figure A55. Summary of Z estimates from catch curves based on NEFSC survey indices. Catch curves estima with $r^2 < 0.20$ are not included.

Figure A56. Probability that 2003 3-year running average biomass index is above the biomass threshold (indexed at 1.0), northern region.

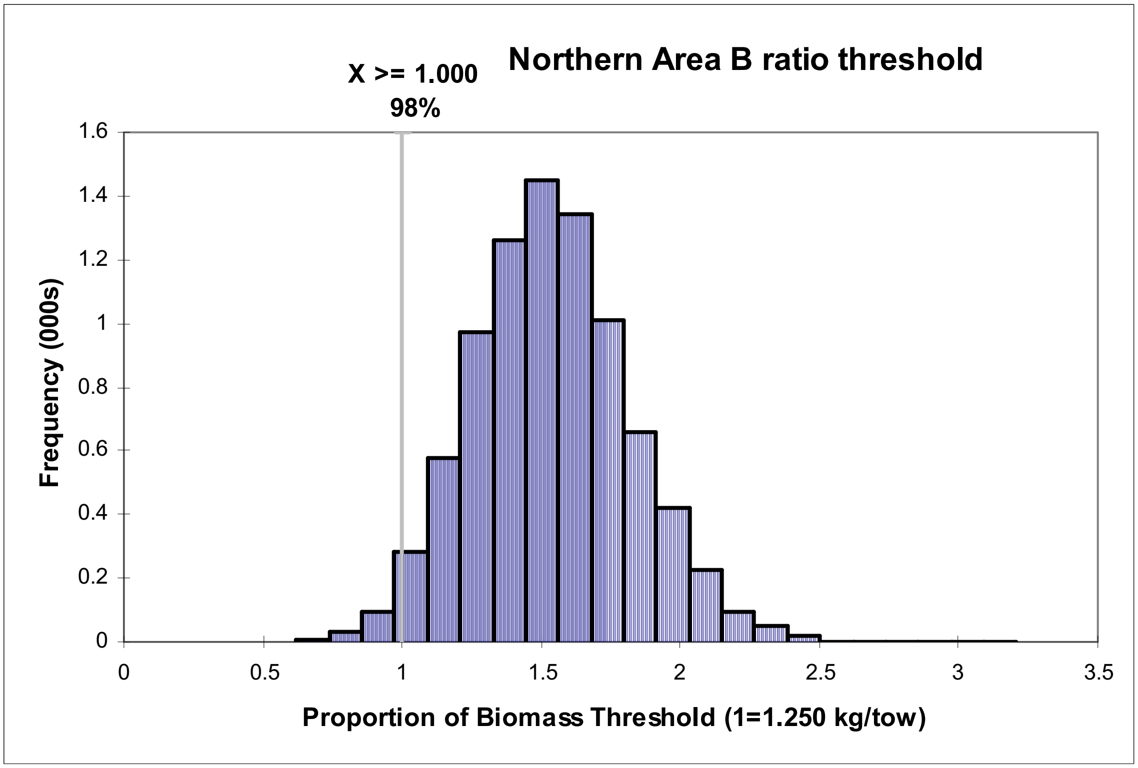
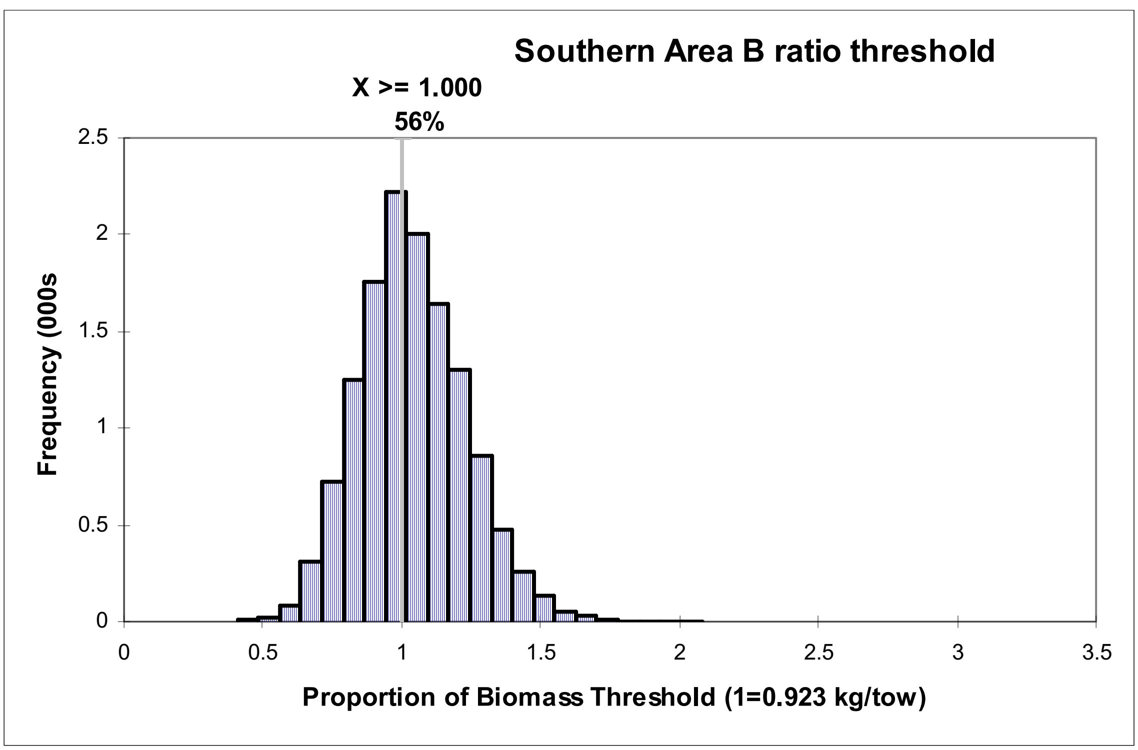


Figure A57. Probability that 2003 3-year running average biomass index is above the biomass threshold (indexed at 1.0), southern region.



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