Northeast Fisheries Science Center Reference Document 07-13

Monkfish Assessment Summary for 2007

by Northeast Data Poor Stocks Working Group

August 2007

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National Marine Fisheries Serv, Woods Hole Lab, 166 Water St, Woods Hole MA 02543-1026

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Table of Contents

Tables

Figures

Monkfish Assessment Summary for 2007

State of Stock

Based on existing biomass reference points in the Monkfish Fishery Management Plan, the resource would be considered overfished in both the northern and southern stock management areas (Figure 1). In the northern area, the most recent biomass index, based on the 2004-2006 NEFSC fall survey 3-yr average, is 1.1 kg per tow. This is lower than the current $B_{threshold}$ value for the northern management area (1.30 kg/tow), and also lower than B_{target} (2.60 kg/tow). In the southern area, the most recent biomass index, based on the 2004-2006 NEFSC fall survey 3-yr average, is 0.87 kg per tow. This is lower than the $B_{threshold}$ (0.92 kg/tow) and B_{target} (1.84 kg/tow) for the southern area.

New reference points were developed as part of the 2007 assessment, based on a revised yield-per-recruit analysis (using a revised value of M) and results of a length-tuned model that incorporates multiple survey indices and catch data. Based on these new reference points, monkfish in both management regions are not overfished and overfishing is not occurring (Figure 2). New estimates of $B_{threshold}$ are 65,200 mt of total biomass in the north and 96,400 mt of total biomass in the south. Estimates of B_{target} are 92,200 mt in the north and 122,500 mt in the south. Estimates of total biomass for 2006 are 118,700 mt in the north and 135,500 mt in the south, both of which are greater than their respective biomass targets. The existing overfishing threshold is based on F_{max}, and this was retained, although new values were estimated. The new, updated estimates of F_{max} are 0.31 per year in the north and 0.40 per year in the south. Estimates of current F (2006) are 0.09 per year in the north and 0.12 per year in the south, both of which are lower than their respective overfishing thresholds.

The development of a new analytic model ("SCALE") for monkfish is a significant advance. However, the new assessment results are accompanied by substantial uncertainty, and therefore need to be viewed with caution. Reservations stem from: (a) input uncertainties (under-reported landings and unknown discards during the 1980s and incomplete understanding of key biological parameters such as age and growth, longevity, natural mortality and stock structure); (b) the shorter assessment time frame (1980-2006) than in previous assessments (1963-2006); and (c) the relatively recent development of the assessment model. Compared to the previous monkfish assessment approach, the new model integrates more types of information and incorporates temporal variation in fishery selectivity patterns. It was not possible to utilize all sources of information with the previous approach. (See "Special Comments" section below.)

As indicated by NEFSC survey recruit abundance indices for approximate ages 1 and 2 (inferred from lengths, Figure 3), the frequency of better than average recruitment events increased since the late 1980s in the northern area. Relatively strong year classes were

produced in 1993, 1999 and 2001. In the south, recruitment has varied without trend during 1963-2006; however, a relatively strong 2001 year class is apparent in the south (Figure 3).

The median size of monkfish in both regions declined as landings increased in the 1980s (Figure 4). Maximum sizes have also declined, from about 110 cm during the 1960s to 90 cm since the early 1990s in the north, and from about 100 cm in the 1960s to 75 cm since the 1990s in the south.

Projections

The SCALE (Statistical Catch-at-Length) assessment model was used to evaluate the impacts of TACs proposed in Framework 4 (5,000 mt in the north and 5,100 mt in the south), assuming long-term average recruitment. The results indicate that total biomass in both regions would continue to increase through 2009 and remain above B_{target} (Figure 5). These results did not incorporate any uncertainty associated with the stock size estimates for 2006. Further work is necessary to develop a complete forecasting approach.

Catches

Reported total landings (live weight) increased from an annual average of 2,500 mt in the 1970s to 8,700 mt in the 1980s, 23,000 mt in the 1990s, and 22,000 mt during 2000-2005. Total landings in 2006 declined to 14,500 mt, the lowest level since 1990, due to management regulations (Figure 6). 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, which began in 1994. In the northern area, landings peaked in 2003 (15,000 mt), and have since declined to 6,700 mt in 2006. In the southern area, landings peaked in 1998 (19,300 mt), and declined to 7,800 mt in 2006.

During 1990-1999, 53% of USA monkfish landings were taken in otter trawls, 28% in sea scallop dredges, and 18% in gillnets. During 2000-2006, 53% of USA monkfish landings were taken in otter trawls, 7% in sea scallop dredges, 35% in gillnets, and 6% other gear. While trawl gear accounts for most of the landings in the northern area (75% during 2000-2006, Figure 7), gillnets now account for the majority of the landings in the southern area (54% during 2000-2006, Figure 7).

Estimated total discards of monkfish have ranged between 1,600 mt (1992) and 7,500 mt (2001) per year, with a long-term discard/kept ratio of 0.15 (1989-2006, north and south combined). Discard rates have been highest in the sea scallop dredge fisheries in the southern area, particularly since 2000, and lowest in the gillnet fisheries. Discard ratios and discard levels (mt) increased in the southern area after 2000 (overall discard/kept ratio for 2001-2006 =0.34).

Table 1. Catch and status table (weights in '000 mt): monkfish.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Max[1]	Min[1]	Mean[1]
USA Commercial landings													
Northern area	9.7	7.3	9.1	10.7	13.3	14.0	15.0	13.2	10.3	6.7	15.0	3.2	8.0
Southern area	18.5	19.3	16.1	10.1	10.0	8.9	11.1	8.0	8.8	7.8	19.3	3.7	9.4
Total	28.2	26.6	25.2	20.9	23.3	22.9	26.1	21.2	19.1	14.5	28.2	7.3	17.4
USA Commercial discards													
Northern area	1.3	0.9	0.8	1.0	2.9	1.4	1.3	0.9	0.9	0.5	2.9	0.4	1.1
Southern area	1.2	1.1	1.2	1.5	4.6	3.4	3.2	2.7	2.5	1.8	4.6	0.6	2.1
Total	2.5	2.0	2.0	2.5	7.5	4.8	4.5	3.6	3.4	2.3	7.5	1.6	3.2
Foreign landings[2]	0.2	0.2	0.2	0.2	0.1	0.3	0.3	-	-	-	0.3	0.1	0.5
Total Catch	30.9	28.8	27.4	23.6	30.9	28.0	30.9	24.7	22.5	16.7	31.0	16.7	25.5
Northern area													
Biomass index[3]	0.67	0.97	0.83	2.50	2.07	2.32	2.72	0.63	1.62	1.04	5.6	0.6	2.1
Southern area													
Biomass index[3]	0.59	0.50	0.30	0.48	0.71	1.32	0.83	0.97	0.80	0.83	7.0	0.3	1.5
Northern area													
Total Biomass[4]	65.3	69.1	78.3	88.3	97.9	103.0	108.3	110.1	112.9	118.7	65.2	127.3	92.2
Fishing Mortality rate (F)[4]	0.32	0.20	0.20	0.22	0.30	0.30	0.32	0.23	0.16	0.09	0.43	0.05	0.19
Southern area													
Total Biomass[4]	100.2	98.4	96.4	99.8	107.4	112.6	120.1	124.3	130.0	135.5	96.4	152.7	122.6
Fishing Mortality rate (F)[4]	0.37	0.36	0.29	0.19	0.23	0.19	0.20	0.15	0.15	0.12	0.37	0.04	0.16

[1] Landings data based on 1980-2006 . Commercial fishery discard estimates not available before 1989; discard means from 1989-2006. Biomass index time span is 1963-2006. Total biomass and F time span is 1980-2006.

[2] Foreign landings are for NAFO Areas 5 and 6. Foreign landings not available for 2004-2006.

[3] NEFSC fall survey, stratified mean weight (kg) per tow.

[4] Annual estimates from SCALE model ('000 mt for biomass).

Stock Distribution and Identification

The monkfish resource in US waters is distributed from the Gulf of Maine through Cape Hatteras, NC. Current management practice divides US waters into two regions north and south of Georges Bank to accommodate differences in fishery practices; however, there is no strong biological evidence (growth, maturity, and genetic information) of separate stocks.

Data and Assessment

Monkfish were last assessed at SAW-40 in November 2004. Data used in the current assessment include NEFSC research survey data, data from cooperative monkfish surveys conducted in 2001 and 2004, and commercial fishery data from (a) vessel trip reports, (b) dealer landings records, and (c) on-board fishery observers. The assessment assumed a natural

mortality rate (M) = 0.3; previous assessments used M=0.2. Fishing mortality rates were estimated from survey catch-per-tow-at-age from NEFSC research surveys, and using several length-based approaches (catch-survey analysis, statistical catch-at-length analysis (SCALE), length-based mortality, stage-based mortality). Although these methods were useful for exploratory data analysis, the only method deemed adequate for assessment was the SCALE model. The model could only be applied to the period from 1980 to the present, because the early (pre-1980) commercial catch data were too uncertain.

Biological Reference Points

Existing biological reference points (BRPs) for monkfish are from Framework 2 of the Fishery Management Plan for Monkfish (2003). For both management areas, the existing B_{target} was established as the median of the 3-year moving average of NEFSC fall survey biomass indices during 1965-1981. $F_{threshold}$ was set equal to F_{max} (F=0.2 per year). The Framework 2 overfishing definition did not include an F_{target} reference point.

New biomass reference points were developed as part of the new assessment, based on an updated age-based yield-per-recruit analysis, and results of the SCALE model, both of which assumed M=0.3 (previous assessments used M=0.2). The new B_{target} is the average of total biomass during the 1980 – 2006 period, estimated as 92,200 mt in the north and 122,500 mt in the south. The new $B_{threshold}$ is defined as the lowest value of total biomass in the assessment time series (1980 - 2006) from which the stock subsequently increased (termed "B_{Loss}"), estimated as 65,200 mt in the north and 96,400 mt in the south.

The existing overfishing threshold is based on F_{max}, and this was retained in the new assessment, although the value was updated. The revised estimates of F_{max} are 0.31 per year in the north and 0.40 per year in the south. The recommended F_{target} is F at 40% of maximum spawning potential ($F_{40\%}$), estimated to be 0.18 per year in the north and 0.31 per year in the south. $F_{40\%}$ was chosen to ensure some adequacy in spawning potential and because it has been used in managing other fisheries. The differences between areas in the $F_{40\%}$ estimates are due to different selectivity patterns of the predominant gears in the two regions (otter trawls in the north, large mesh gillnets in the south).

Monkfish is a data-poor species, and there are significant uncertainties associated with the assessment results. This should be considered when developing management measures.

Fishing Mortality

Previous assessment reviews (SAWs -31, -34 and -40) 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.

In the current assessment, fishing mortality in 2006, estimated using the SCALE assessment model (assuming M=0.3 per year), was F=0.09 per year in the north, and F=0.12 per year in the south. Fishing mortality has declined in both regions since 2003 (Figure 2).

Recruitment

Size-based indices of abundance indicate strong recruitment in the northern area in 1993, 1999 and 2001 (Figure 3). The strong recruitment in 1999 and 2001 led to rebuilding of stock biomass in the north. Recruitment has been stable in the south, with a strong year class produced in 2001 (Figure 3).

Stock Biomass

Total biomass in the northern region declined steadily from the early 1980s through the early 1990s, remained at a relatively low level during the 1990s, and then increased after 1999, reflecting strong recruitment and management efforts from 2000 onwards (Figure 2). Biomass in the north was estimated to be 118,700 mt in 2006. In the south, total biomass increased until the late 1980s and then declined during the 1990s. Since 2000, biomass has increased in the south, and was estimated to be 135,500 mt in 2006 (Figure 2).

Median body size of monkfish, in fall NEFSC bottom trawl surveys of the northern area, declined rapidly during the 1980s, but since 1990, has stabilized at a relatively small body size (20-40 cm recently, compared to 60-80 cm before 1982) (Figure 4). Maximum size has also declined, from approximately 100-120 cm to 80-100 cm. In the southern area, median size has been more variable, but shows a gradual decline over time (Figure 4), and maximum size has declined from around 100 cm before 1982 to 60-80 cm since 1990.

Special Comments

This assessment is uncertain for a number of reasons, including poor quality of some data and uncertainties in life history parameters. The assessment hinges critically on assumptions regarding growth, longevity, and natural mortality of monkfish, all of which are poorly known. In addition, commercial catches prior to 1993 are not well characterized. Model results are sensitive to the assumed value of natural mortality, revised in this assessment from 0.2 to 0.3 per year. This decision was based on the observed longevity of male and female fish in the resource; however, the actual lifespan of monkfish may be greater than that which has been thus far observed. Uncertainties in key life history parameters and historical catches are unlikely to be resolved in the short term.

In developing management alternatives, it should be recognized that monkfish is a "data-poor" species and this assessment has significant uncertainty. Landings on the order of 5,000 mt in

each management area (roughly the proposed TACs in FMP Framework Adjustment 4) are unlikely to result in a change in stock status, and should allow monkfish resources in both regions to increase.

The SCALE model used for assessment could only be applied to the period from 1980 to the present. Monkfish biomass indices in NEFSC surveys were approximately twice as high prior to 1980 than after this time. As such, the productivity of the resource may be higher than reflected in this assessment and thus, the possibility of attaining higher biomass levels in the future should not be discounted. Reconsideration of the newly proposed biomass reference points might thus be justified in the future.

Sources of Information

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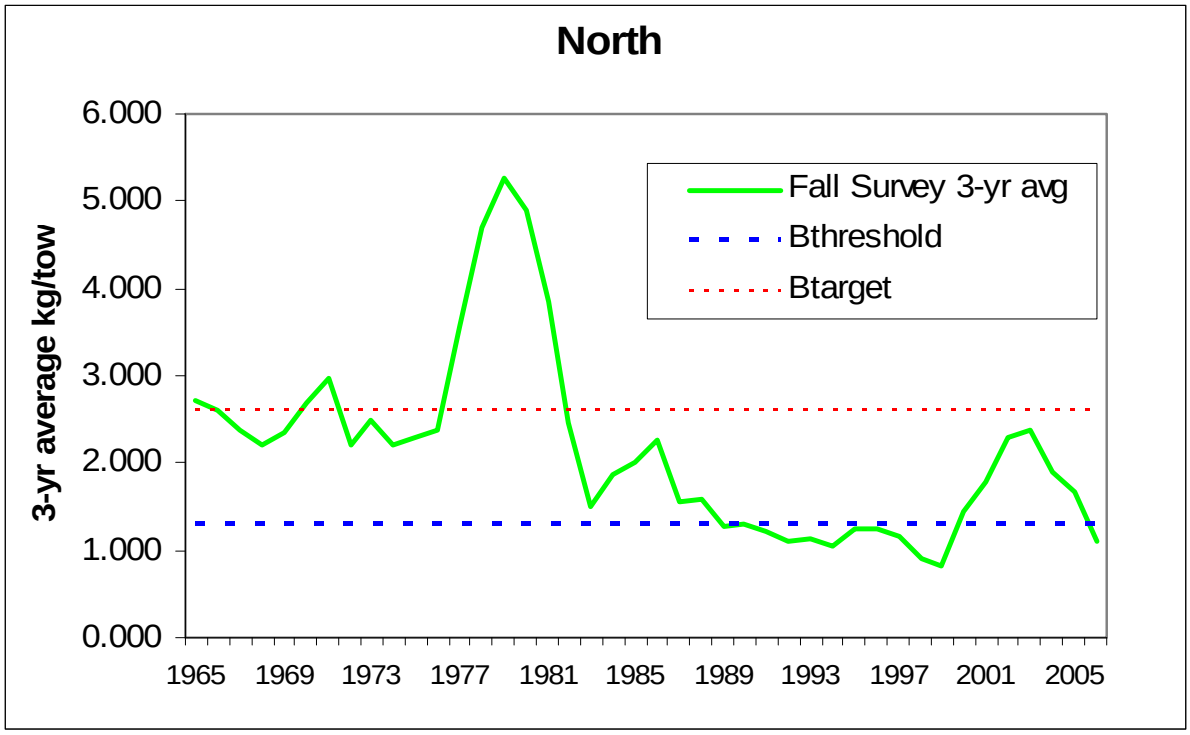
Figure 1. Trends in NEFSC fall survey biomass indices (3-year moving average) of monkfish relative to existing biomass overfishing definitions, in the northern and southern management regions.



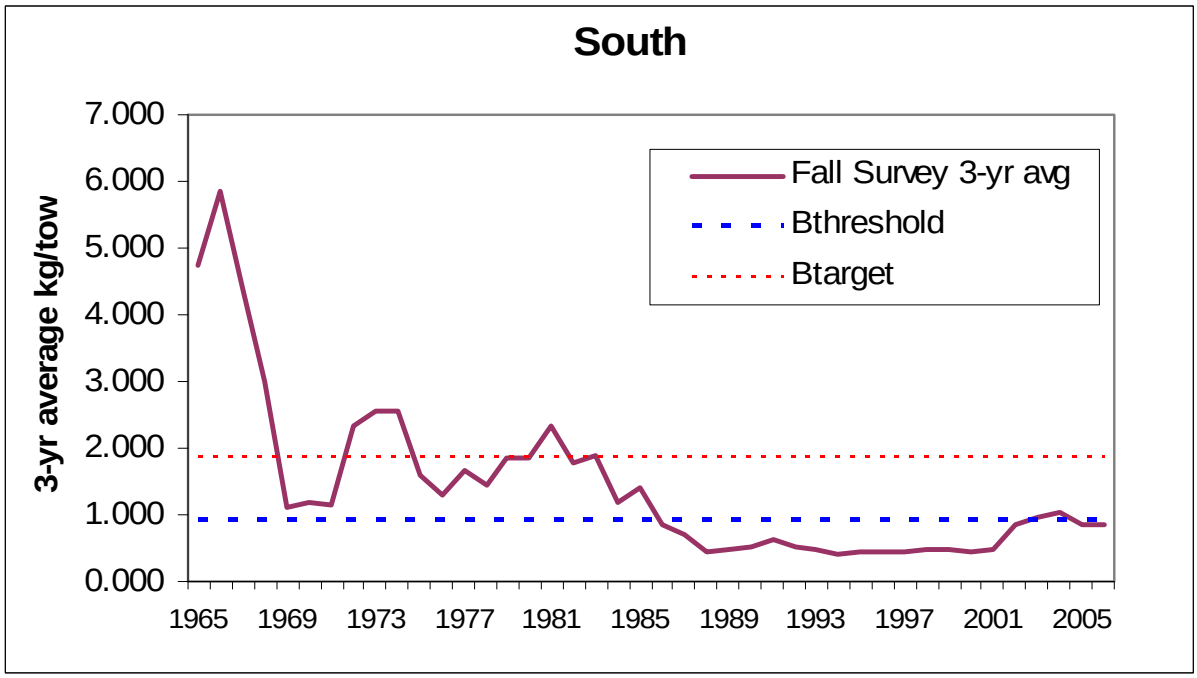
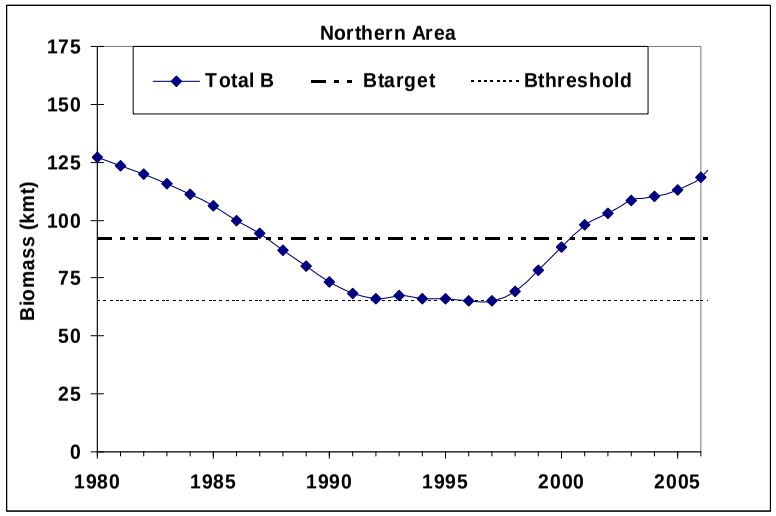
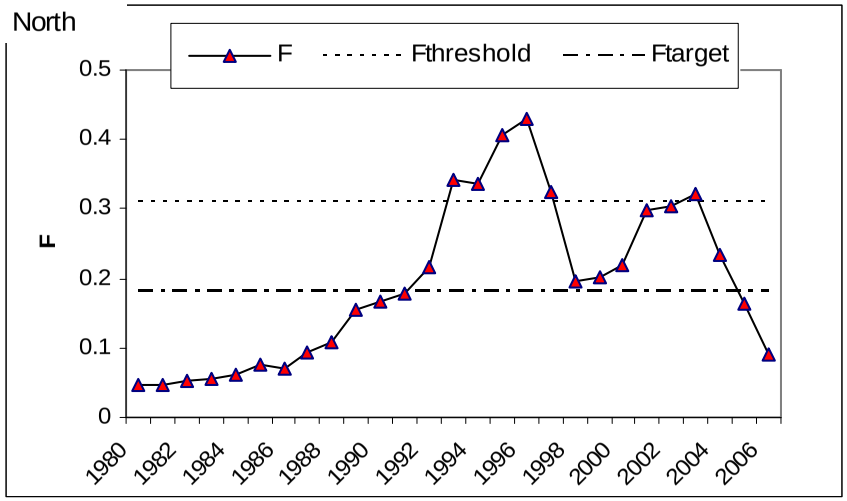


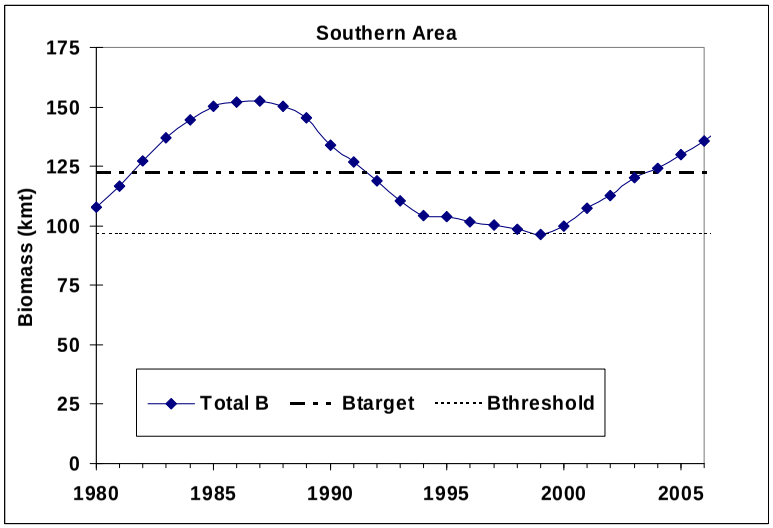
Figure 2. Trends in total biomass and fishing mortality rate (F), from the assessment model (SCALE), along with new (proposed) biological reference points for monkfish from the 2007 assessment. (A) northern management region, (B) southern management region.

A. North





B. South



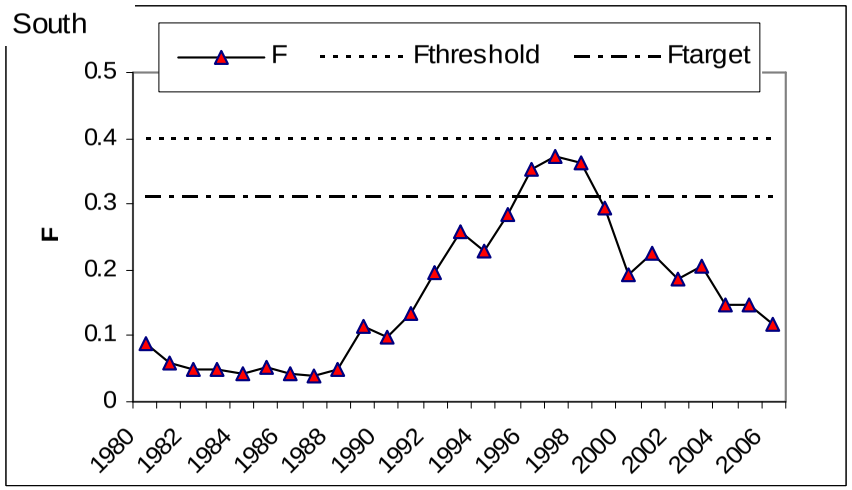
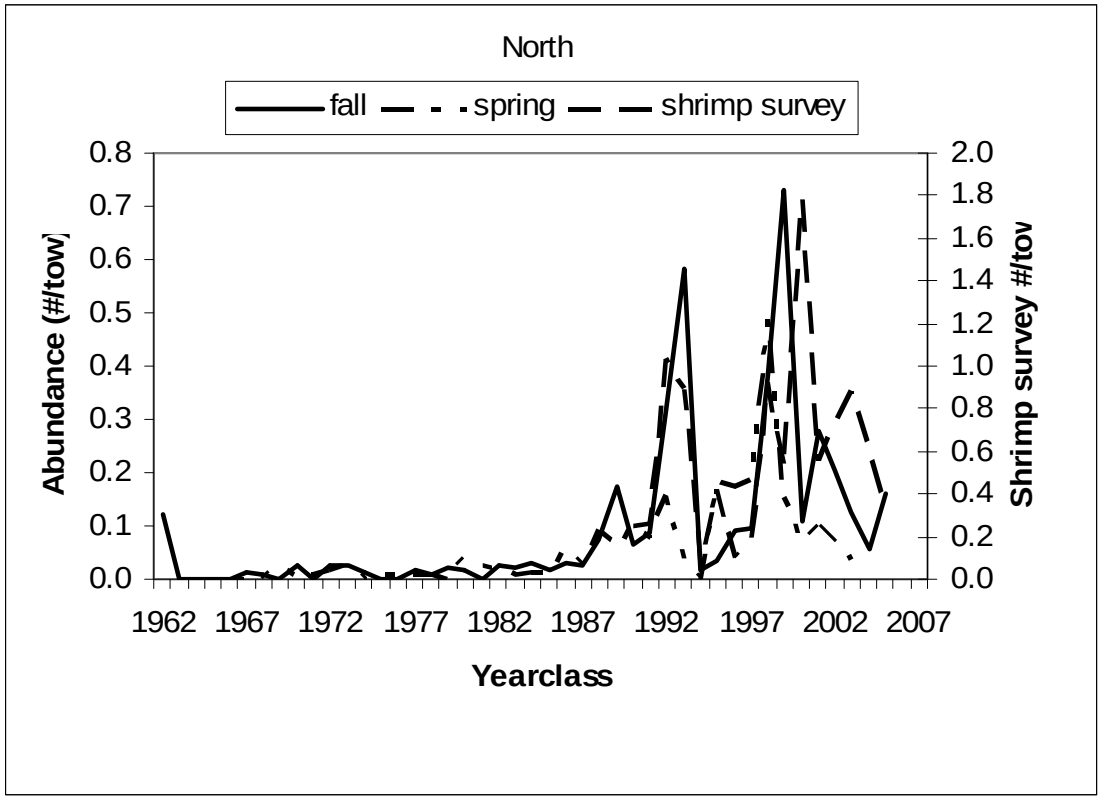


Figure 3. Recruitment indices (stratified mean number per tow) for monkfish from winter, spring, summer (shrimp, scallop), and autumn NEFSC surveys for the northern and southern management regions.



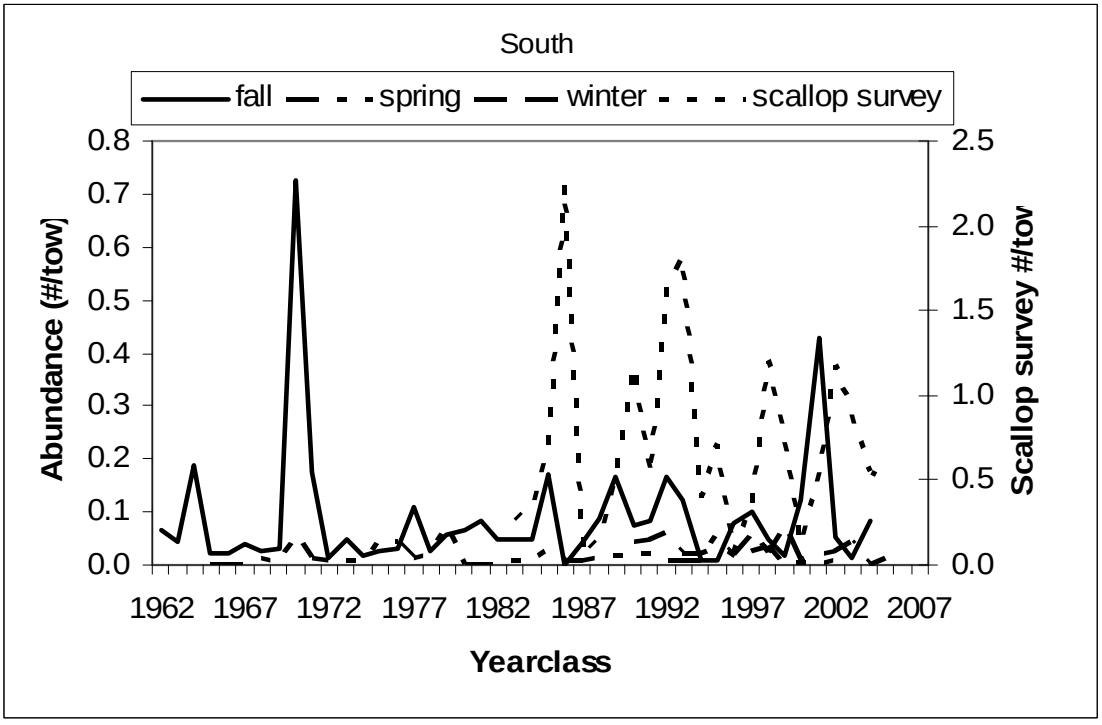
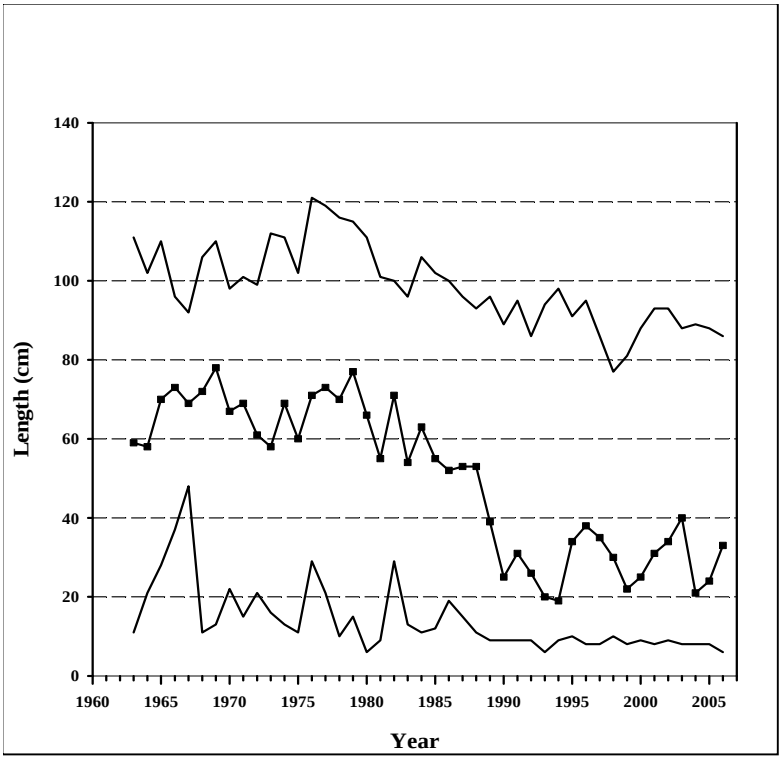


Figure 4. Body length of monkfish (minimum, median, maximum) over time in the NEFSC autumn bottom trawl survey. (A) northern management region and (B) southern management region.

A.



B.

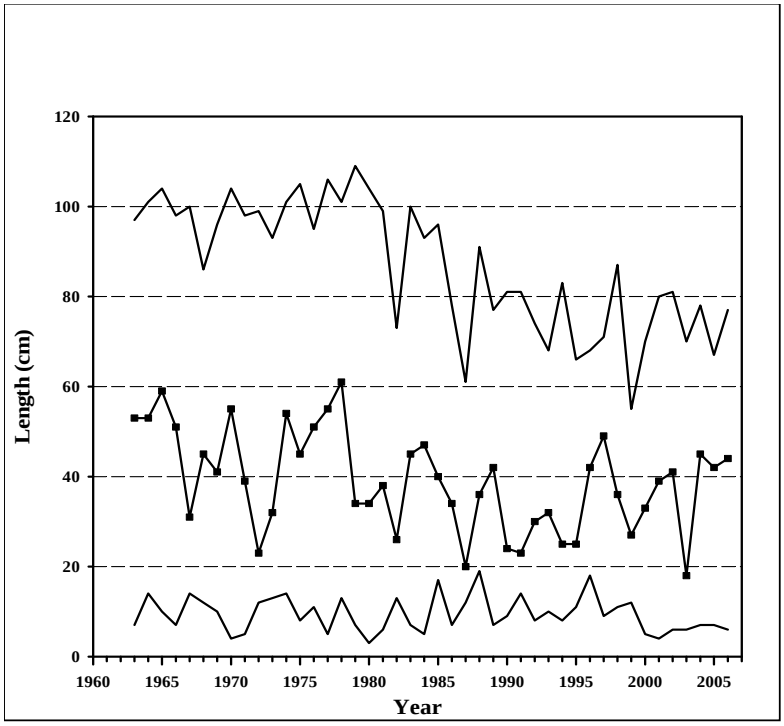


Figure 5. Projection of total biomass to 2009 based on the Statistical Catch-At-Length (SCALE) model in the northern and southern management regions.

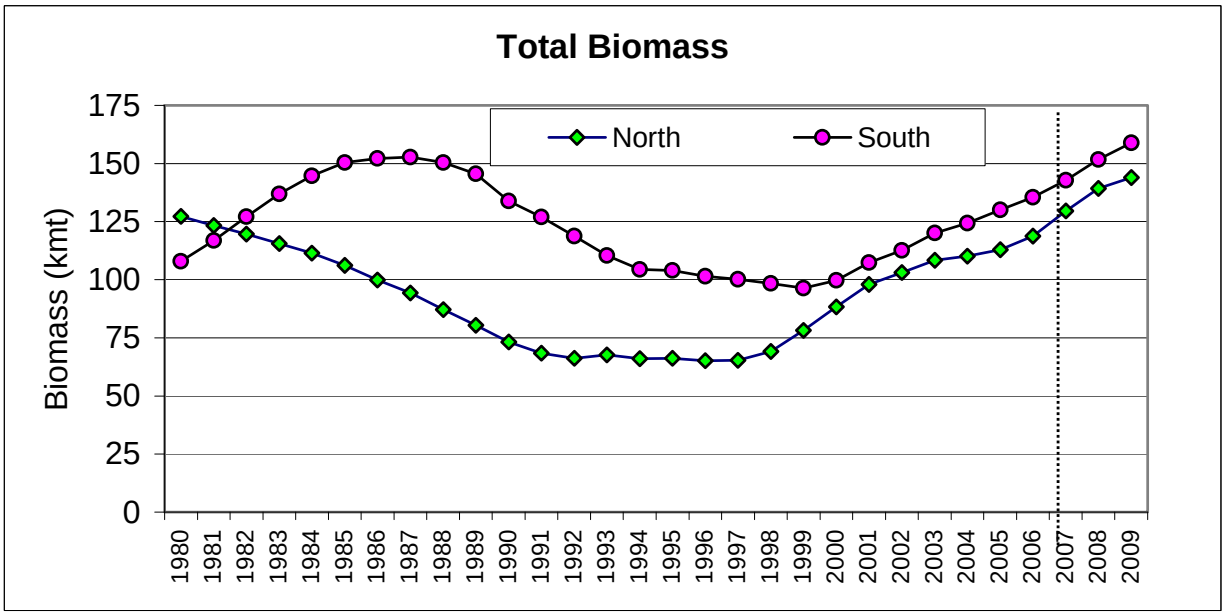


Figure 6. Monkfish commercial fishery landings, by management region and total, 1964-2006.

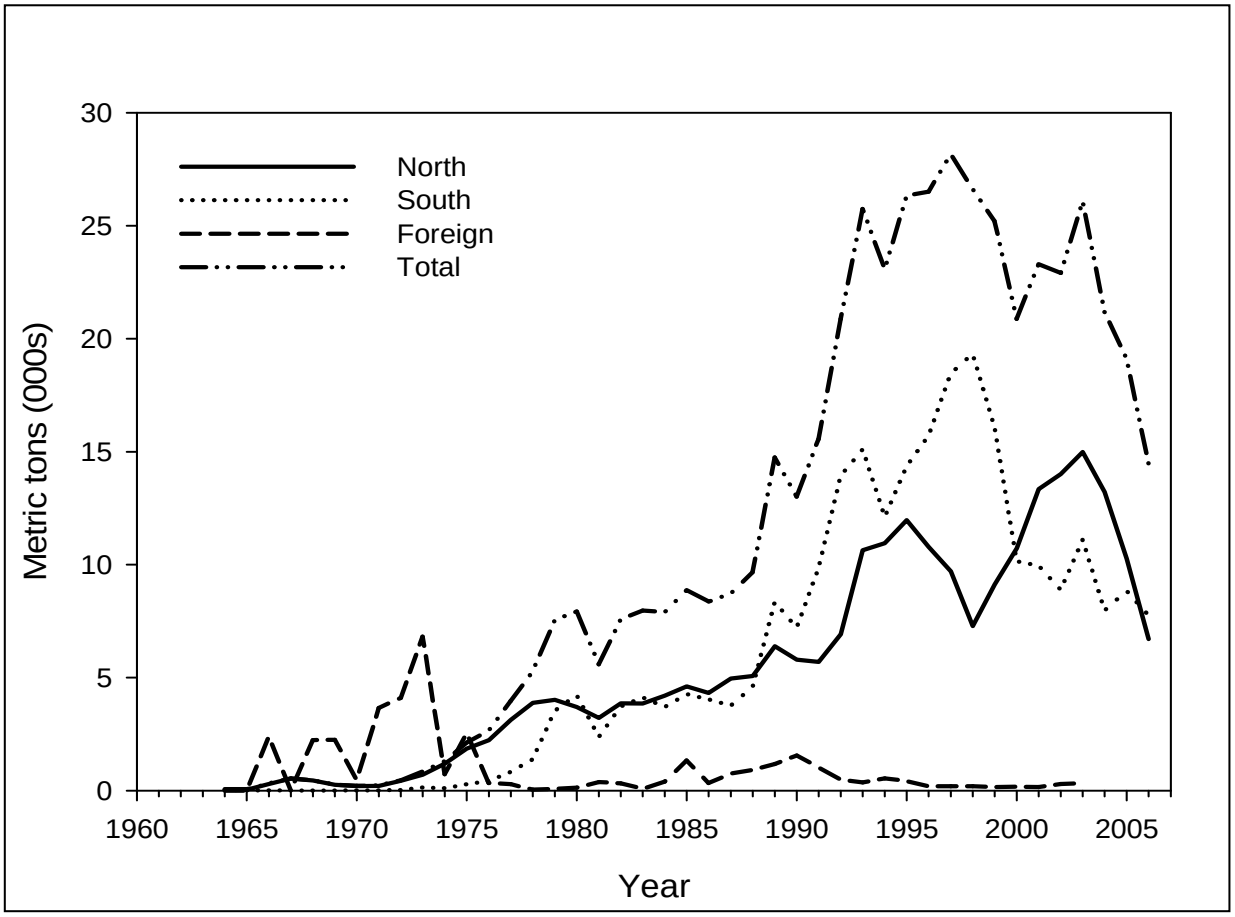
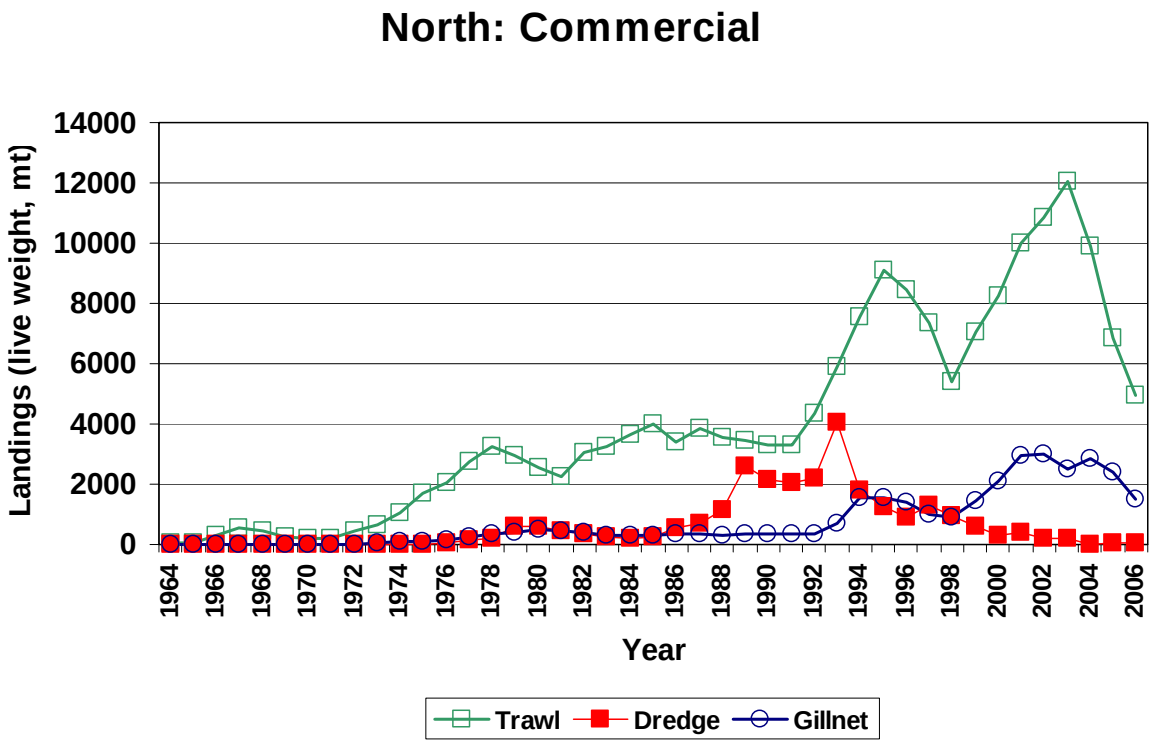
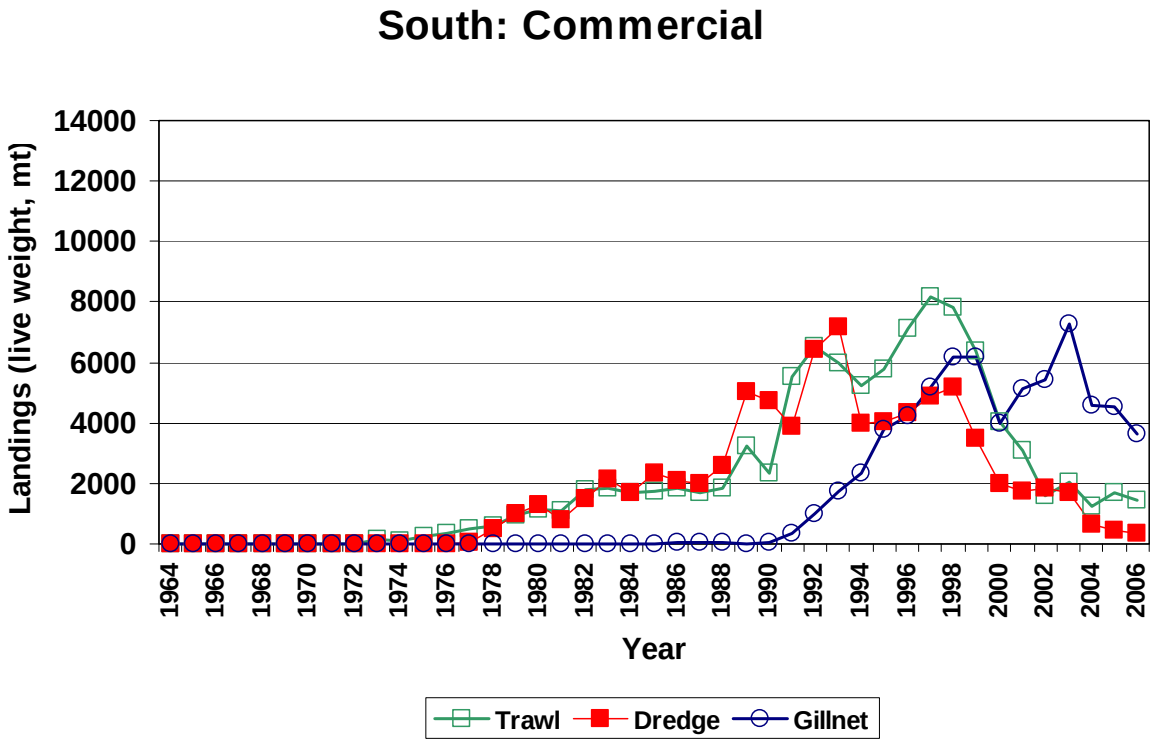


Figure 7. Monkfish commercial fishery landings by major gear type, northern and southern management regions.





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