6.0 Status of the other large mesh regulated species

Seven other large mesh regulated species are managed through Amendment 7. The status of these species at the time of their last assessment is listed in Table 6.1. The committee decided to examine these stocks using a relative exploitation index consisting of catch divided by the survey biomass index. Relative exploitation does not provide the absolute magnitude of exploitation because survey catchability is unknown. Thus, relative exploitation is not useful for determining whether exploitation is above or below overfishing thresholds. However, trends in the relative exploitation index, combined with the stock status derived from the previous assessment, may allow general statements about current exploitation and stock abundance to be made.

Caution is advised in interpreting these relative exploitation indices because total survey biomass indices are used in lieu of exploitable biomass. Increases in recruitment may inflate total biomass but not exploitable biomass and may bias the relative exploitation index low. The annual variation in survey indices due to sampling error and annual variation in catchability and availability affects the point estimates of relative exploitation. Loess (a localized weighted regression scatterplot-smoothing algorithm) was used to smooth the relative exploitation index. This smoothing technique facilitates the detection of patterns and trends in scatterplot data.

Table 6.1. Most recent assessments for 10 principle groundfish species. Stock area abbreviations are SNE= Southern New England, GOM= Gulf of Maine, MA= Mid-Atlantic. N/a= not applicable. * = formal assessment does not exist or terminal year is earlier than 1990 and data are from the Status of Fishery Resources of the Northeastern United States for 1993.

Stock	Source	Assessment Type	Terminal year	Terminal Year F	Overfishing F[1]	Status[2] Biomass	Status[2] exploitation
GOM-GB white hake[4]	SAW 19	DeLury	1993	0.42	unknown	Medium	fully exploited
Pollock	SAW 16	VPA	1992	0.72	$F_{20\%}$= 0.65	Medium	fully exploited
GOM-GB redfish	SAW 15	VPA index	1992	< 0.06	$F_{20\%}$= 0.12	Low	overexploited
American plaice[4]	SAW 14	VPA	1991	0.58	$F_{20\%}$ = 0.49	Low	overexploited
GOM-GB witch fld	SAW 18	VPA	1993	0.45	$F_{20\%}$ = 0.46	Low	overexploited
GB winter flounder[4]	*	Index	1992	unknown	$F_{20\%}$> 0.48	Low	overexploited
SNE -MA winter fld	SAW 21	VPA	1993	0.83	$F_{20\%}$ > 0.57[3]	Low	overexploited
GOM winter flounder	SAW 21	Index	1994	1.20	unknown[2]	Low	overexploited
GOM-GB windowpane fld	*	Index	1992	unknown	unknown	Med-low	likely overexploited
SNE-MA windowpane fld[4]	*	Index	1992	unknown	unknown	Low	overexploited
Cape Cod yellowtail fld[4]	*	Index	1993	unknown	unknown	Low	overexploited

[1] Amendment 7 overfishing definitions
[2] Status at the time of the assessment
[3] The ASMFC plan has a rebuilding target of F40% for SNE-MA (F40%= 0.21) and Gulf of Maine (F40%=0.49) winter flounder stocks.
[4] Stocks are scheduled for review at SARC 28 to be held November 30 – December 4 1998.

In general, stock biomass has not significantly changed in recent years for these stocks (Table 6.2). Biomass is increasing slowly for seven of the eleven stocks, while declining for white hake, American plaice, Southern New England/Mid-Atlantic winter flounder, and Cape Cod yellowtail. Stock biomass is low for 5 stocks, low to medium for three stocks and medium for two stocks. Relative exploitation has declined for all species except white hake witch flounder, and Southern New England winter flounder. Relative exploitation remains at a high level, but does not seem to be increasing for white hake and southern New England winter flounder. This analysis suggests that Amendment 7 has allowed slight increases in biomass for 7 of 11 of these stocks, and has allowed slight increase for most stocks through 1996. The analysis also suggests that effort has not shifted from cod, haddock, and yellowtail stocks to these species.

Table 6. 2. Summary of stock status for 10 principle groundfish species. Stock area abbreviations are SNE= Southern New England, GOM= Gulf of Maine, MA= Mid-Atlantic. Relative exploitation = commercial landings/ survey biomass index.

Stock	Recent trends Survey biomass	Survey biomass	Recent trend in relative exploitation index
GOM-GB white hake	Declines	low	remains flat at high level
Pollock	Slight increase	low	declines, but relatively high
GOM-GB redfish	increase since 95	medium	declines to timeseries lows[1]
American plaice	Decline since 94	low	declines to long-term average
GOM-GB witch fld	Slow increase	low-medium	slight decline but above average
GB winter flounder	Steady increase	low-medium	declines to near long-term average
SNE winter fld	decrease	low	flat since 1991[1]
GOM winter flounder	Slight increase	medium	declines to timeseries low[1]
GOM-GB windowpane fld	Slight increase	low-medium	declines to near timeseries low
SNE-MA windowpane fld	Slight increase	low	declines to timeseries low
Cape Cod yellowtail	Slight decline from 95	medium	declines to timeseries low[1]

[1]survey data indicates that increase in pre-recruits are contributing to increase survey biomass. Declines in relative exploitation may be exaggerating actual declines in exploitation.

6.1 White Hake

The stock, defined as a Gulf of Maine-Georges Bank complex, was last assessed in SAW 19 using a DeLury Analysis with a terminal year of 1993. Biomass was considered to be at a medium level of abundance and the stock was fully exploited. An updated assessment of this stock is scheduled for review at SARC 28, scheduled for November 30 – December 4, 1998. Commercial landings have declined since 1992 (Figure 6.1). The NEFSC Autumn survey biomass index has also generally declined since 1991, and the biomass index is below the 25th percentile, suggesting that the stock is at a low biomass. The smoothed relative exploitation index has appeared stable at a high level since the late 1980's, suggesting that exploitation has not decreased on this stock.

6.2 Pollock

This transboundary stock, defined as a Scotian shelf-Gulf of Maine-Georges Bank complex, was last assessed at SAW 16 with a tuned VPA. The terminal year was 1992. The stock was at a medium level of abundance and fully exploited. USA commercial landings have declined from the late 1980 through 1996 (Figure 6.2). Landings increased slightly in 1997, although US landings are an insignificant portion of total landings. Survey biomass indices have shown a declining trend from the late 1970's although they increased slightly since 1995. The biomass index is at the 25th percentile and the stock is at a low level of abundance. Relative exploitation has declined in recent years, but remains near the timeseries average.

6.3 Redfish

The Gulf of Maine-Georges Bank stock was last assessed at SAW 15. The stock was characterized as low in abundance and overexploited. Commercial landings have declined greatly since 1980 (Figure 6.3). Biomass indices also declined from the mid-1970's through 1982 before slowly increasing through the 1980's. The biomass index declined to near record lows in 1994 and 1995 but increased sharply in 1996, based on increased catches of 4-6 year old fish. The index slightly declined in 1997 but remains above the median, suggesting that the stock is at a medium level of abundance. Good recruitment appears to be the cause of the increased biomass. Relative exploitation appears to have declined since the early 1980's and currently is at low levels relative to the timeseries.

6.4 American Plaice

This stock is defined as a Gulf of Maine-Georges Bank stock. The stock was last assessed at SAW 14 using a tuned VPA. The stock biomass was classified as low and the stock was considered overexploited. An update of the SAW 14 assessment is scheduled for review at SARC 28,which is scheduled for November 30 through December 4, 1998. Commercial landings have declined since 1992 (Figure 6.4). The NEFSC Autumn biomass index has increased slightly since 1987 with a small downturn since 1994. The biomass index is at the 25th percentile, suggesting that the stock is at a low level of abundance. Relative exploitation has declined from a peak around 1985, but remains above pre-1978 levels.

6.5 Witch flounder

The Gulf of Maine-Georges Bank stock was last assessed at SAW 18 using a tuned VPA with a terminal year of 1993. The stock was classified as low in abundance and overexploited. Commercial landings have declined a peak in 1985 to near record low in 1989 (Figure 6.5). Landings increased again until 1994 before declining again. The Autumn biomass index was near record lows from 1987 through 1994. The index has increased since 1994 but remains low compared to historical levels. The 1997 biomass index is just above the 25th percentile and suggesting that the stock is medium-low in biomass. The relative exploitation index reached a peak around 1988 and has slightly declined the peak relative exploitation in 1989 but remains

above the timeseries average.

6.6 Winter flounder

Georges Bank winter flounder

Georges Bank winter flounder was assessed at SAW 21 using an index assessment. The stock was assessed as low in abundance and overexploited. A benchmark assessment is scheduled for review this December at SARC 28. Commercial landings have generally declined since the early 1980's through 1995 (Figure 6.6). Landings have increased in 1996 and 1997. The NEFSC autumn index has increased steadily since a record low in 1991 and has remained flat in 1996 and 1997. The 1997 biomass index is between the 25th and 50th percentile. Relative exploitation appears to have declined since the late 1980's and is currently near the long-term average.

Southern New England/ Mid-Atlantic winter flounder

Southern New England/ Mid-Atlantic stock was last assessed at SAW 21 using a tuned VPA with a terminal year of 1993. An update of the SARC 21 assessment is schedule for review this December at SARC 28. The ASMFC's Winter Flounder Technical Committee assessed this stock using the ASPIC surplus production model, relative exploitation indices and total mortality estimates from various research trawl surveys (ASMFC, 1998A). Results were not peered reviewed. The committee concluded that fishing mortality had declined to below the NEFMC $F_{20\%}$ overfishing definition but remained above the ASMFC's F_{30} overfishing definition and $F_{40\%}$ rebuilding target. Increased biomass coincided with decline in fishing mortality and improved recruitment.

Commercial landings of Southern New England/ Mid-Atlantic winter flounder steadily declined from a peak in the early 1980's to a record low in 1993 (Figure 6.7). Landings have increased since 1994. The NEFSC autumn biomass index slightly increased from 1993 through 1995 and but has since declined. The 1997 NEFSC autumn biomass index ranks below the 25th percentile, suggesting that stock biomass is low. Relative exploitation appears to be flat since 1991.

Gulf of Maine winter flounder

Gulf of Maine winter flounder was also assessed at SAW 21 using an index level assessment. The stock was classified as low in abundance and overexploited. Overall landings have declined from a record high in 1982 through 1994 (Figure 6.8). Landings have slightly increased since 1994. The Massachusetts Division of Marine Fisheries Spring biomass index (1978-1997) declined from the early 1980's until 1988, fluctuated near this low through 1993 and increased slightly from 1994 through 1997. The 1997 biomass index is just above the median. Relative exploitation shows a declining trend since 1991, reaching a timeseries low around 1997. Examination of the MADMF survey's catch at age indicates that much of the increase biomass is due to increases in age 1 and 2 since 1992. It is not certain whether this is due to improved recruitment or improved survival due to restrictions on small mesh fisheries. However, the increase in the age 2 index does not follow through to older ages suggesting that exploitation is higher than suggested by the relative exploitation index.

The ASMFC Winter Flounder Technical Committee assessed this stock using the ASPIC surplus production model, relative exploitation indices, and total mortality estimates from the MADMF survey catch at age. Results were not peered review. That Committee concluded "…biomass to be relatively low and strongly suggest that the fully recruited F remains high" (ASMFC, 1998).

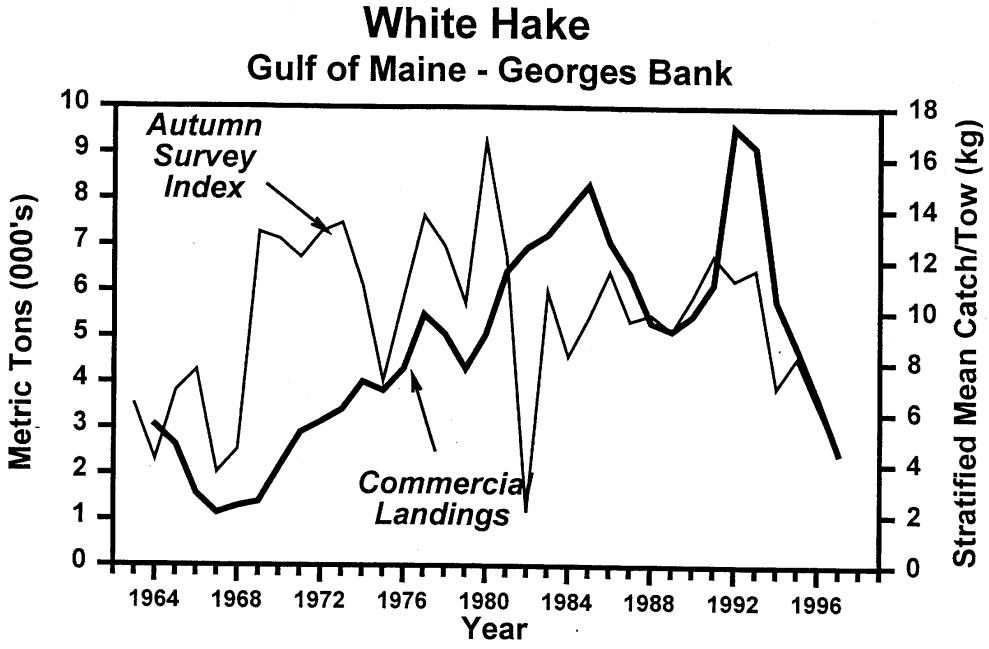
6.6 Windowpane flounder

The Gulf of Maine-Georges Bank stock of Windowpane flounder has yet to be formally assessed. The 1994 Status of the Fishery Resources of the Northeastern United States listed the stock as in decline and likely overexploited. Commercial landings declined from a record high in 1992 to a record low in 1994 (Figure 6.9). Landings increased in 1995 and 1996, but declined in 1997. The NEFSC Autumn biomass survey is highly variable throughout the timeseries. The 1997 biomass index is between the 25th and 50th percentile, suggesting that biomass is at a low to medium level Relative exploitation has declined since the late 1980's.

The Southern New England/ Mid-Atlantic stock of Windowpane has not been formally assessed. The 1993 Status of the Fishery Resources of the Northeastern United States listed the stock as low in abundance and overexploited. The NEFSC autumn biomass index has increased slightly since reaching a record low in 1993, but remains low (Figure 6.10). The 1997 biomass index is below the 25th percentile and is amongst the lowest in the timeseries. Landings have declined to very low levels since 1993. Relative exploitation has declined since 1992 and is near timeseries lows.

6.8 Cape Cod yellowtail stock

The Cape Cod stock of yellowtail flounders has not been formally assessed. A benchmark assessment is scheduled for review at SARC 28. Commercial landings declined from a peak in the early 1980's to a low in 1989 (Figure 6.11). Landings spiked again in 1990 before returning to 1989 levels. The Massachusetts Division of Marine Fisheries spring survey index (1978-1997) declined from a high point in the early 1980's to a record low in 1988. The biomass index increased to above in 1995. Biomass has declined since 1995 but remains slightly above the time-series median in 1997. Relative exploitation has steadily declined from a high in the late 1980's to recent timeseries lows. Examination of the MADMF survey catch at age shows an increase in ages 1-3 in the survey. These age groups contribute to the unexploitable biomass. Total mortality estimates from survey catch at age do not support a decline in exploitation.



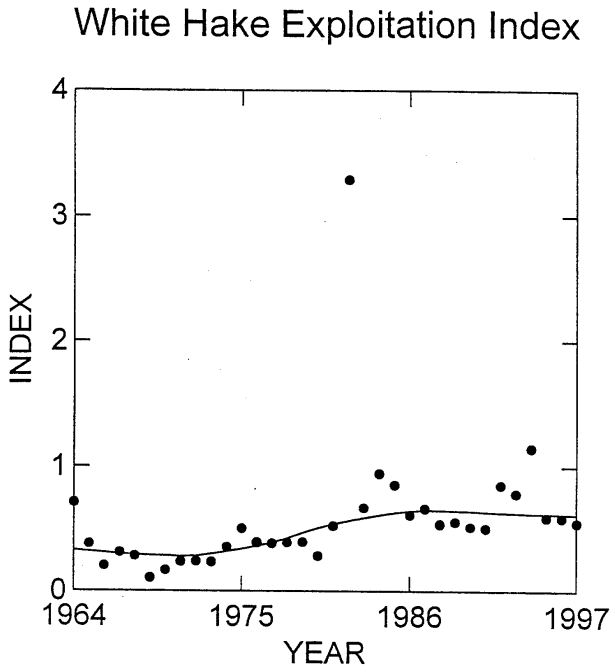


Figure 6.1 Top panel: White hake commercial landings during 1964-1997(USA) and NEFSC autumn survey biomass index during 1963-1997.
Bottom panel: Relative exploitation index and time-trend graph for Gulf of Maine windowpane flounder during 1964-1997.

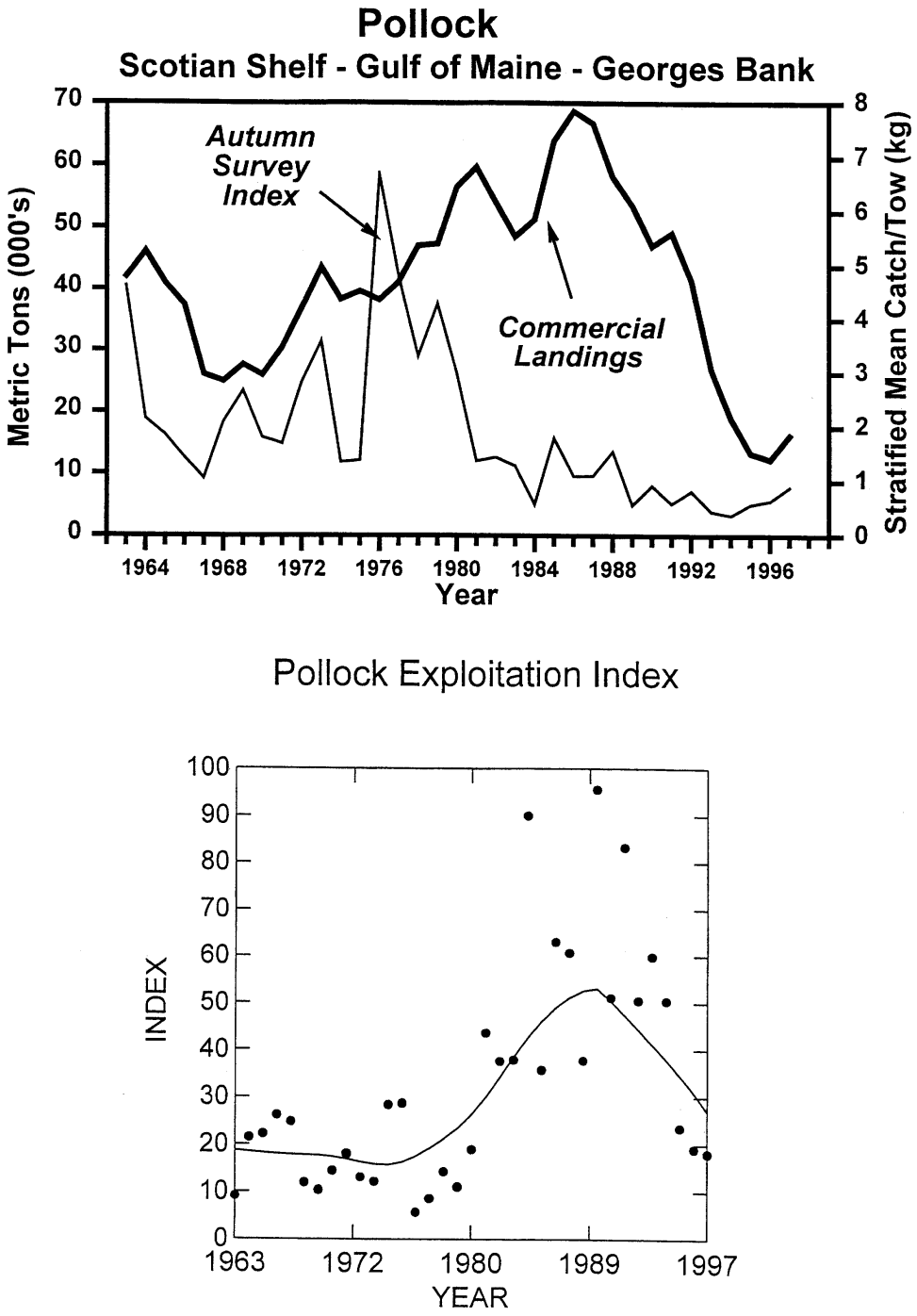
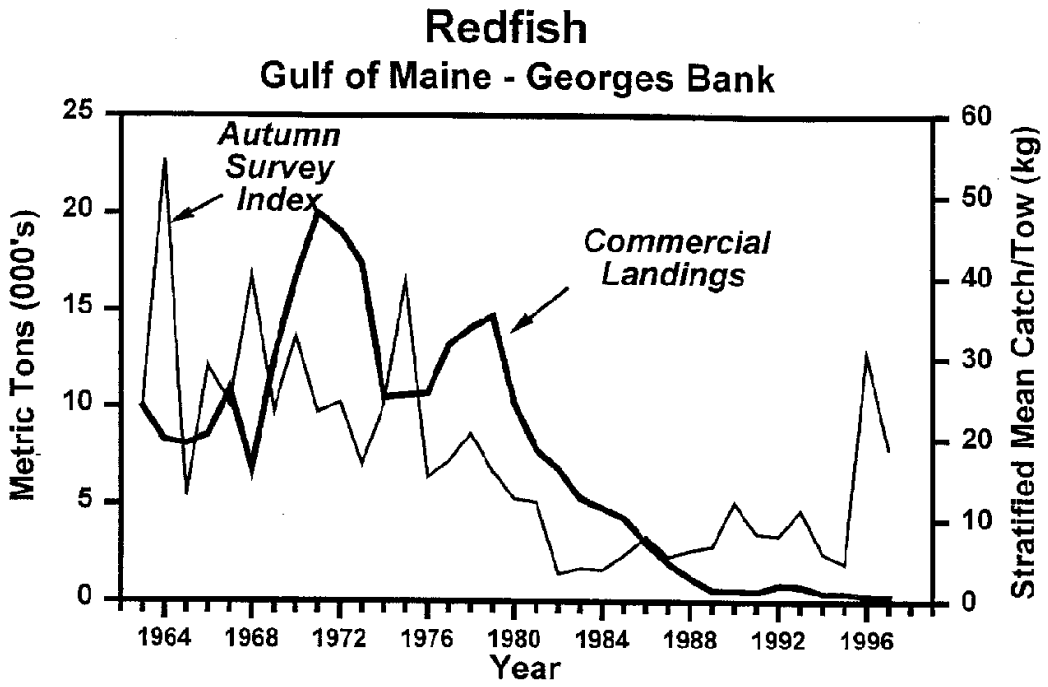


Figure 6.2 Top panel: Pollock commercial landings during 1963-1997 (USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for pollock during 1963-1997.



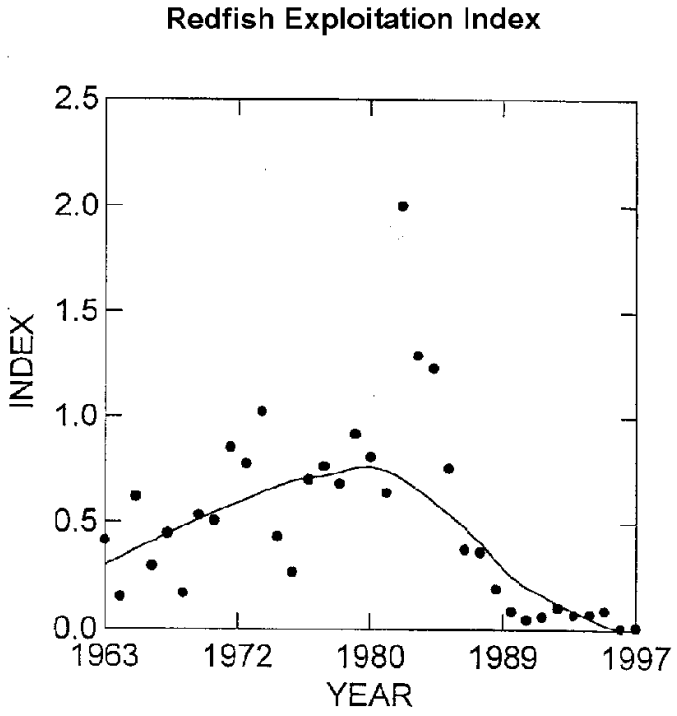
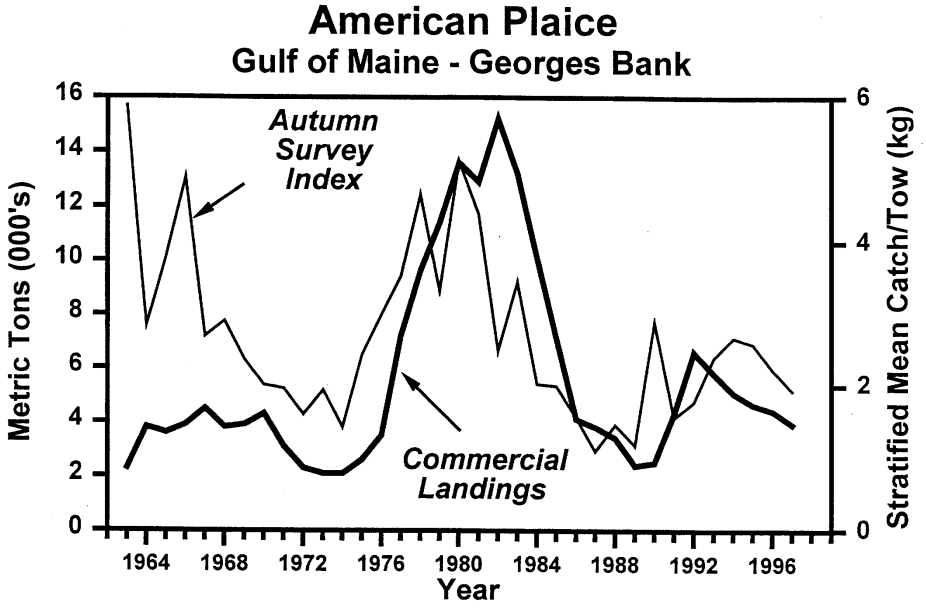


Figure 6.3 Top panel: Redfish commercial landings during 1963-1997 (USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for redfish during 1963-1997.



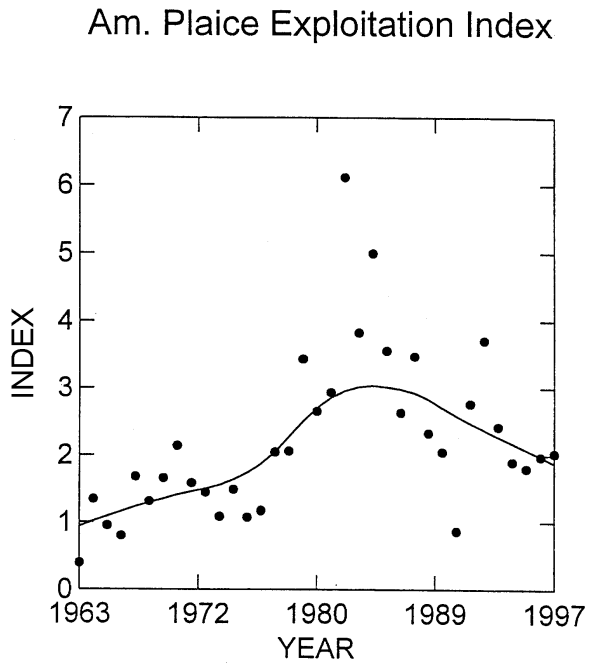


Figure 6.4 Top panel: American plaice commercial landings during 1963-1997 (USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for American plaice during 1963-1997.

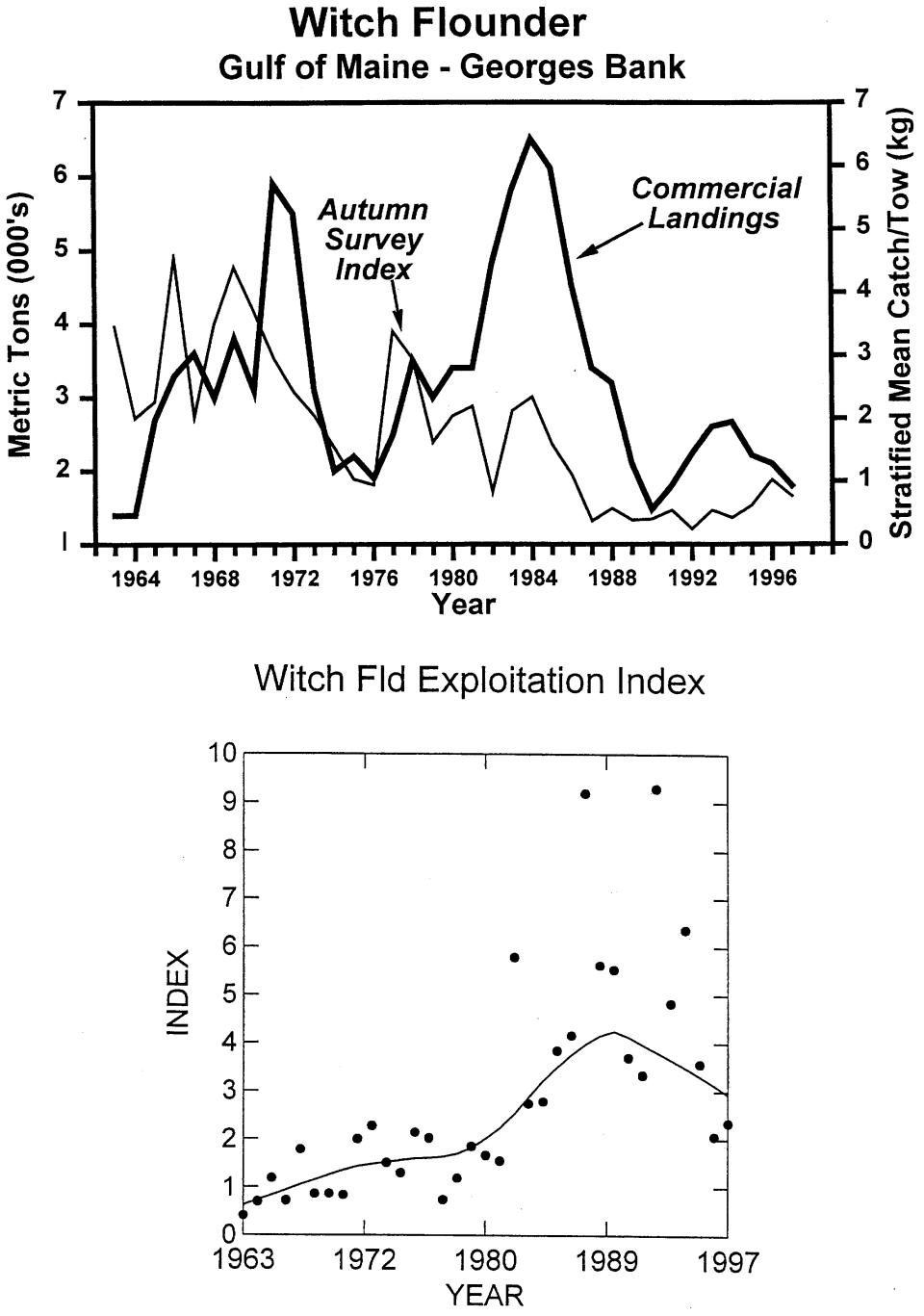
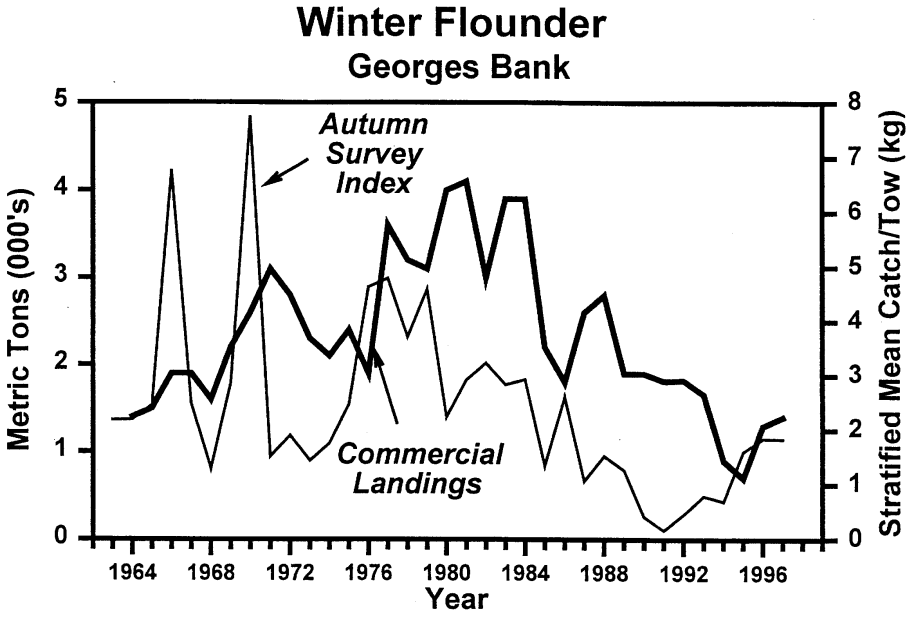


Figure 6.5 Top panel: Witch flounder commercial landings during 1963-1997(USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for witch flounder during 1963-1997.



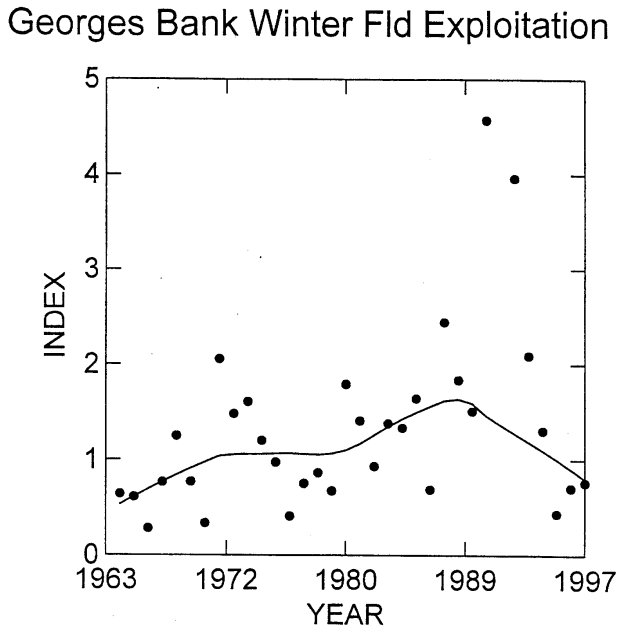
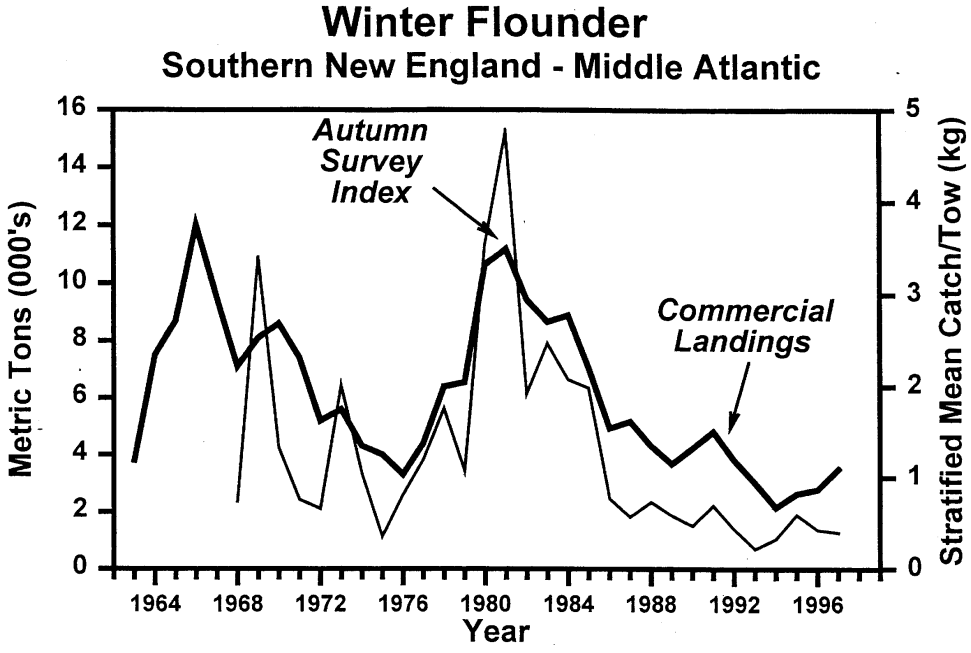


Figure 6.6 Top panel: Georges Bank winter flounder commercial landings during 1964-1997 (USA) and NSFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for Georges Bank winter flounder during 1964-1997.



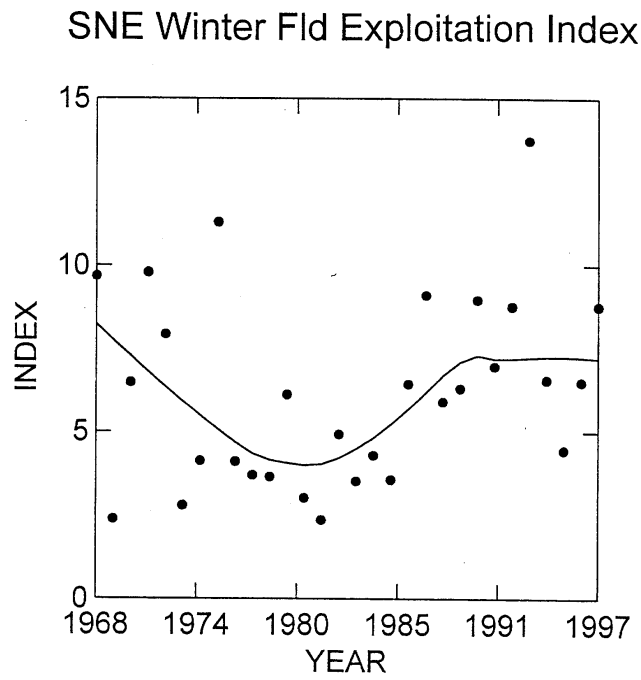


Figure 6.7 Top panel: Southern New England winter flounder commercial landings during 1963-1997 (USA) and NEFSC autumn survey biomass index during 1968-1997. Bottom panel: Relative exploitation index and time-trend graph for Southern New England winter flounder during 1968-1997.

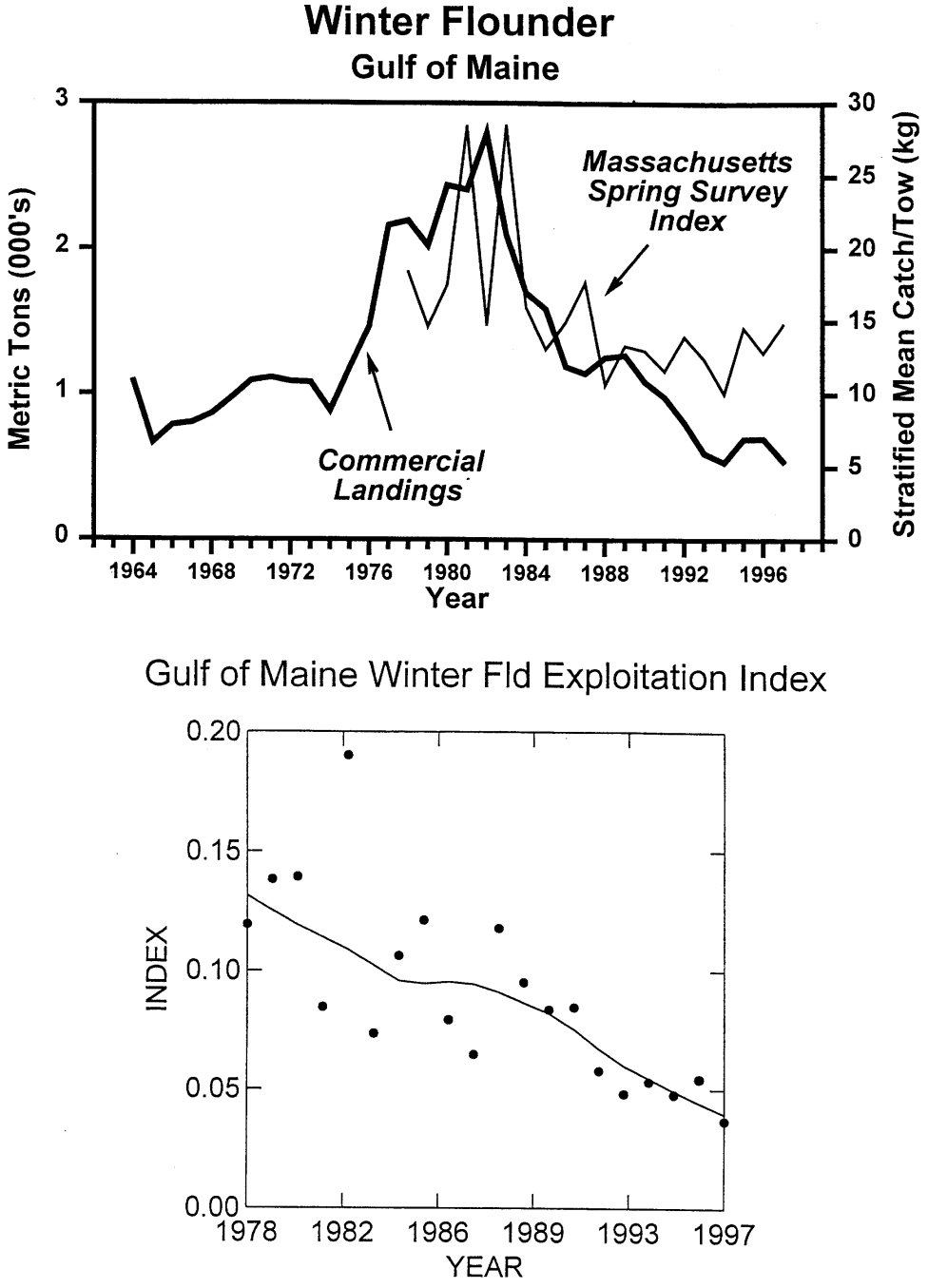
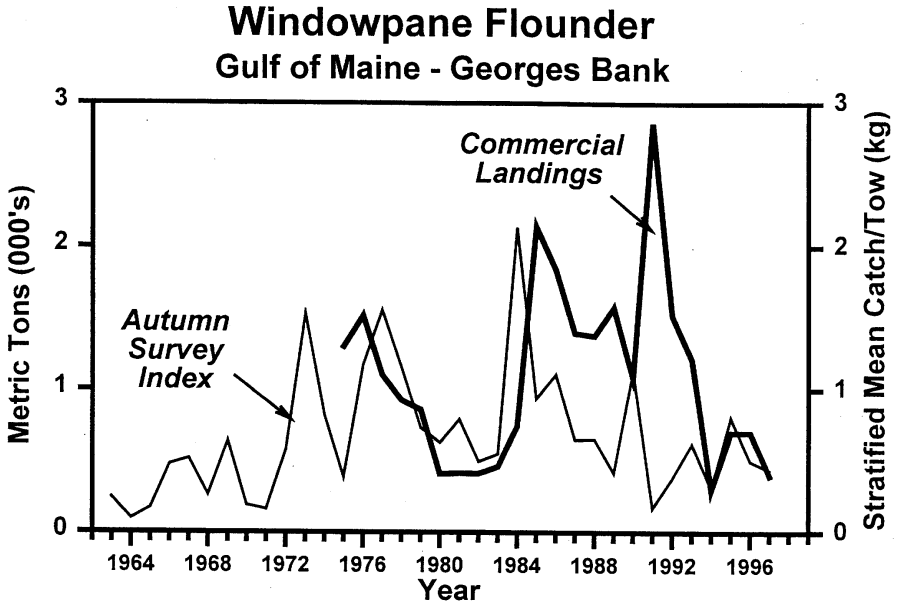


Figure 6.8 Top panel: Gulf of Maine winter flounder commercial landings during 1964-1997 (USA) and MA DMF spring survey biomass index during 1978-1997. Bottom panel: Relative exploitation index and time-trend graph for Gulf of Maine winter flounder during 1978-1997.



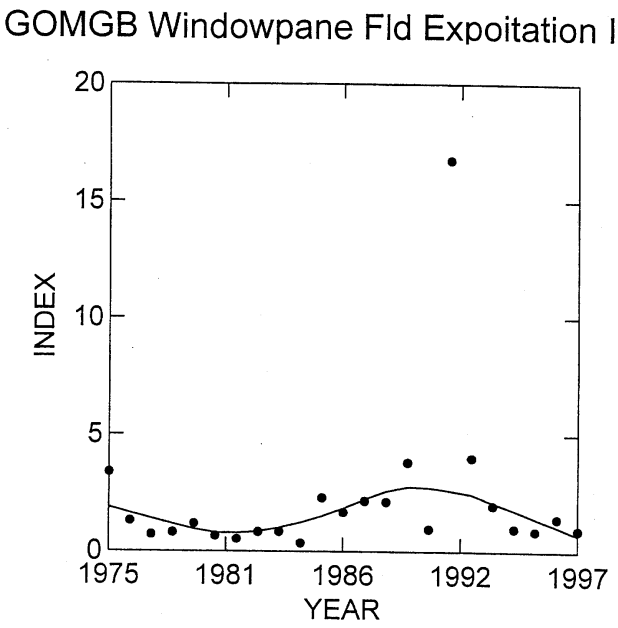
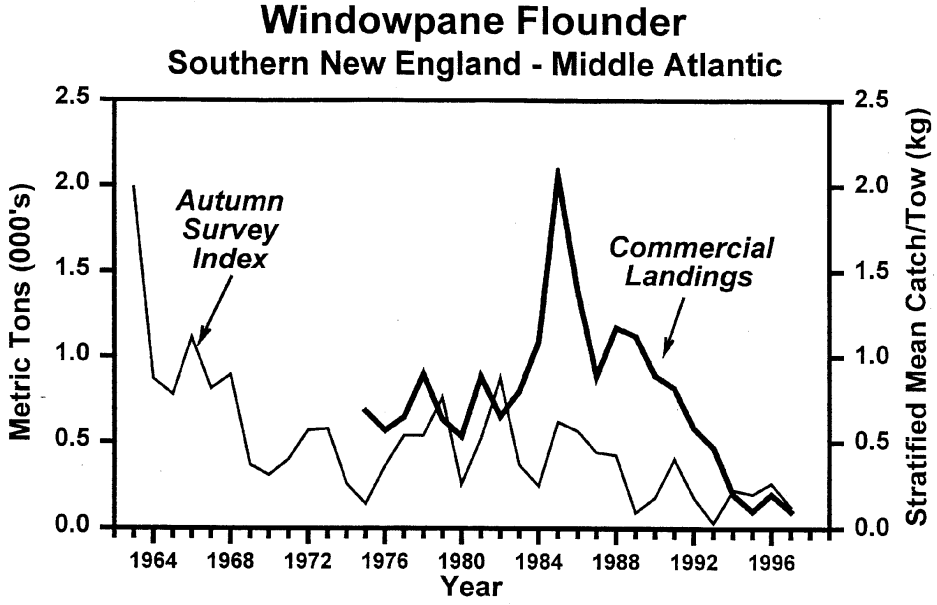


Figure 6.9 Top panel: Gulf of Maine windowpane flounder commercial landings during 1975-1997(USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for Gulf of Maine windowpane flounder during 1975-1997.



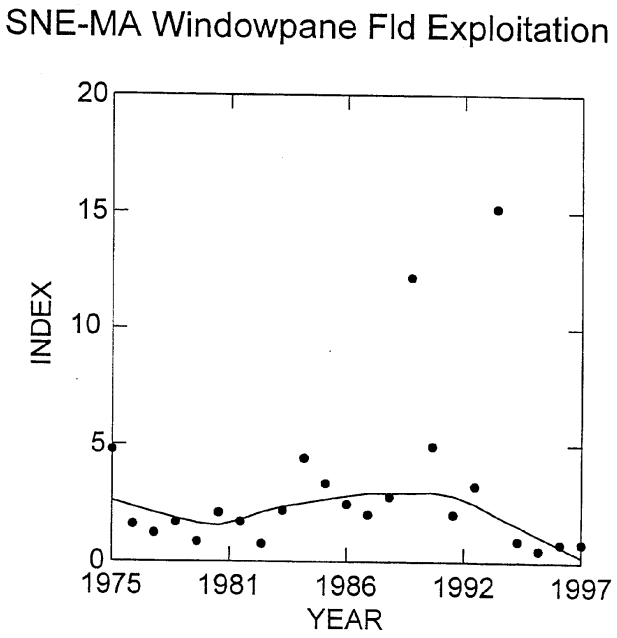


Figure 6.10 Top panel: Southern New England windowpane flounder commercial landings during 1975-1997(USA) and NEFSC autumn survey biomass index during 1963-1997. Bottom panel: Relative exploitation index and time-trend graph for southern New England windowpane flounder during 1975-1997.

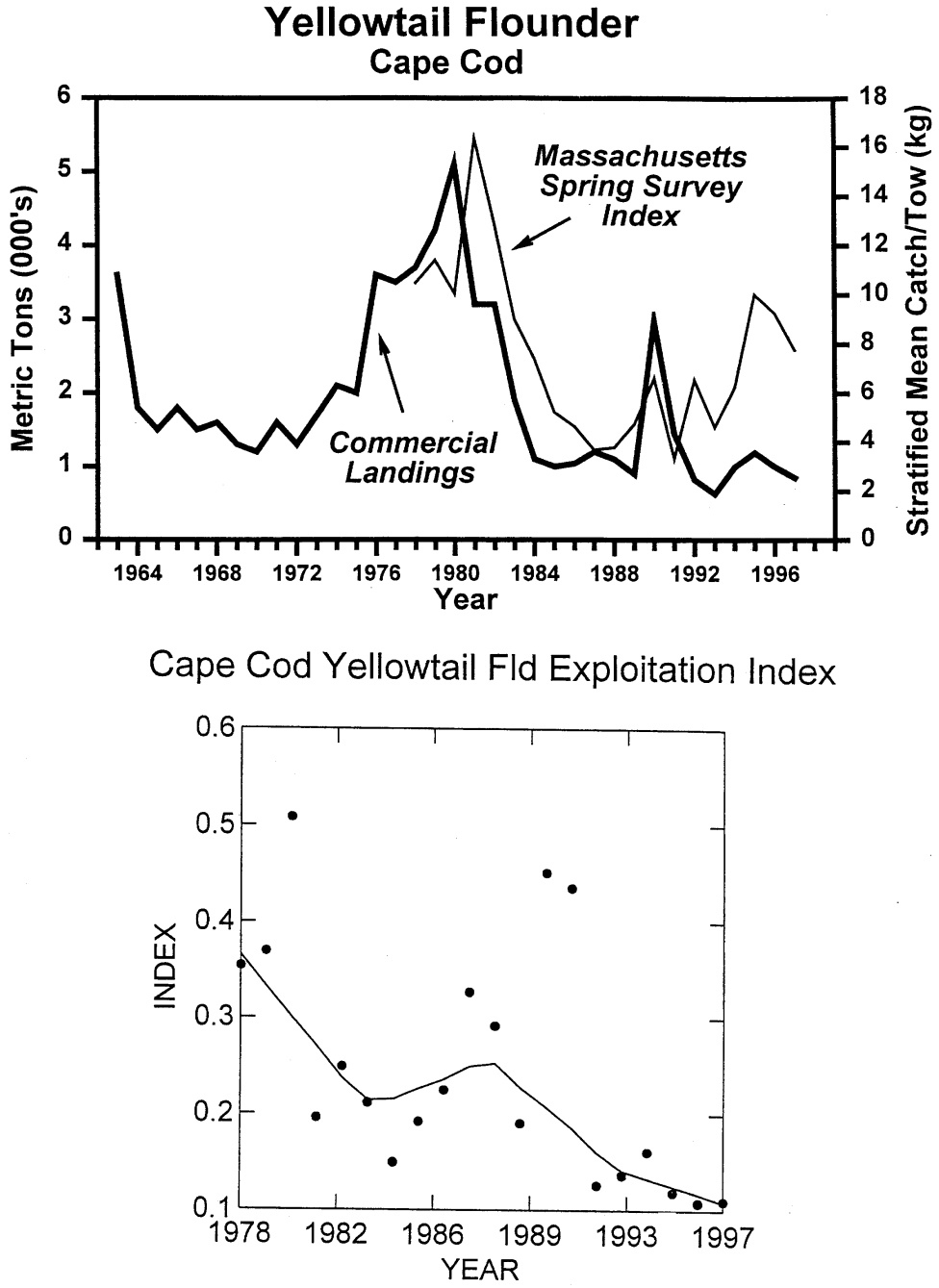


Figure 6.11 Top panel: Cape Cod yellowtail flounder commercial landings during 1978-1997(USA) and MA DMF Spring survey biomass index during 1978-1997. Bottom panel: Relative exploitation index and time-trend graph for Cape Cod yellowtail flounder during 1978-1997.

7.0 FISHING MORTALITY OBJECTIVES AND DAYS-AT-SEA (DAS) REDUCTIONS

The MSMC examined DAS utilization rates in 1996 and 1997 to estimate expected DAS usage in 1999 under status quo DAS. Day-at-sea reports were also examined for the period between May 1998 and September 1998 to determine if the 1998 management adjustments had a significant influence on total fishing effort. Median fishing mortality rates for fishing year 1998 were estimated using 1997 and 1998 calendar year mortality rates. We also provided estimates of the additional mortality reductions that would be necessary to reduce fishing mortality from 1997-1998 levels to the Amendment 7 targets in the fishing year 1999 (May 1 to April 30).

7.1 DAS Utilization During 1997 and 1998

DAS allocations continue to greatly exceed the actual usage, even though the annual allocations of days for a vessel have significantly declined since the implementation of Amendment 7. These reductions in days allocated have been more constraining on the larger, more active vessels in the Individual day-at-sea permit categories. The day-at-sea restrictions have been less restraining for the greater number of vessels in the fleet permit categories, so the percent of days actually used has risen but the number of days fished has not changed. Since Amendment 7, the number of days used by vessels in the fleet category have remained around 30,000 days (Figure 7.1), while the number of days used by Individual days-at-sea vessels declined by 29 percent between 1996 and 1997. This decline is due to reductions in the amount of days available and due to the removal of vessels by the Vessel Capacity Reduction program.

In general, vessels with Individual DAS allocations utilized more of their DAS (85 percent in 1996, 82 percent in 1997) than the 1,299 Fleet DAS vessels that reported using DAS during 1996 (Figure 7.1). The fleet vessel category, on the other hand, used 27 percent of the 1996 DAS allocations, and 43 percent of the 1997 DAS allocation. The 60 percent increase in days-at-sea utilization by the fleet category almost exactly matches the percent decrease in days-at-sea allocated in 1997.

Vessel capacity reduction (buyout) program and vessel attrition

There are 80 vessels (54 Amendment 5 vessels and 26 Amendment 7 vessels) that have been bought-out by the vessel capacity reduction program. Sixty-seven (64) vessels reported DAS usage during 1997. Despite the decline in the number of vessels with Multispecies permits, the days used only declined for vessels with Individual Multispecies permits and then only by the same ratio as the reduction in the number of days allocated per vessel.

This result implies that some vessels either increased their fishing effort over previous levels or some inactive vessels began using their days. In 1996, 725 (42 percent) of the 1,718 permitted vessels reported using days-at-sea through the call-in/VMS

program. In 1997, there were 1,712 vessels that received DAS allocations but the number of inactive vessels that reported no DAS use declined to 623 (36 percent of permitted day-at-sea vessels, a decline from 993 inactive vessels in 1996). The number of inactive vessels during the 1998 fishing year cannot be determined because the year is incomplete. Only 1,532 vessels are allocated 1998 DAS, but the expected DAS use is only 7.4 percent below 1997 amounts.

Of the 183 vessels that were not permitted for the 1998 fishing year, there were 101 that reported using a total of 3,979 days (39 days/vessel) during the 1997 fishing year. Of the 101 vessels, 66 were removed from the fleet due to factors other than the vessel capacity reduction program. Thus, fleet attrition accounted for 1,679 days used in 1997 being removed from the multispecies fleet, while the buyout program accounted for 2,300 days. Twenty-seven vessels had Category A (Individual day-at-sea) permits and reported using 1,818 days during 1997. Fifty-six had Category B (Fleet day-at-sea) permits and reported using 1,653 days during 1997. Removal of days via attrition (42% and due to the vessel capacity reduction program (58%) appears to have removed about eight percent of the total days used during 1997. This is consistent with the estimated 7.4 percent reduction in projected days used during 1998.

In last year's report, the MSMC estimated that the 80 buyout vessels that had been processed or enrolled in the program used 6,487 DAS during 1996. It was assumed that there would be no replacement of those DAS removed by the vessel capacity reduction program. Since the actual DAS used in 1997 declined by 2,524 days and the 1997 days removed by the program totaled 2,300, the majority of the projected benefit was dissipated by increased fishing activity by remaining vessels, some of the inactive vessels in 1996 becoming active in 1997.

Predicting DAS usage in 1999

The MSMC examined the 1997 DAS usage by multispecies vessels to estimate the efficacy of DAS caps for reducing nominal fishing effort. These estimates were calculated much like one would estimate the results of recreational bag limits.

Various DAS caps were compared with the estimated 1998 DAS usage for each vessel in the call-in data. These trial values of effort reduction (Table 7.1) ranged from 7% (100 fleet DAS, 43% reduction from 1993 baseline for individual DAS vessels) to 76% (13 fleet DAS, 92% reduction from the 1993 baseline for individual DAS vessels). A more complete version of this Table is found in Appendix VII. It was necessary to estimate the effect of higher DAS allocations than the status quo because 763 vessels were allocated up to 10 additional DAS in 1998 when they had more than 10 days unused in 1997. For comparison, five-hundred and fifteen vessels were allocated 88 days for the 1998 fishing year. It is unknown whether this additional allocation of days during 1998 will actually increase fishing effort during this fishing year. The basic assumption used by the MSMC is that the vessels with a greater allocation of days will fish the days remaining in October 1998 to April 1999 in the same ratio as the vessel demonstrated during the

same period of time for the 1997 fishing year. This assumption results in a very small increase in the projected days used and appears to be consistent with fishing effort patterns during May to September 1998.

Unlike last year's review, the MSMC was able to use monthly days-at-sea reports to estimate seasonal changes in fishing effort in the current fishing year. The ratio of days-at-sea in May 1, 1998 to September 30, 1998 compared to May 1, 1997 to September 30, 1997 was estimated and applied to the October 1, 1997 to April 30, 1998 days-at-sea use for each vessel in the data to estimate the expected days-at-sea that will be used during the 1998 fishing year. This procedure was necessary to account for the effects of the new management restrictions in place for the first time in 1998, especially the running clock. For some vessels, the expected days-at-sea use would equal the 1998 day-at-sea allocation and the MSMC assumed that fishing by this vessel would stop for the remainder of the fishing year.

Vessels that used few of their 1997 DAS, would be unaffected by the 1999 DAS limits, as long as the fishermen did not increase their groundfish fishing effort. The MSMC assumed no increases in effort for vessels that used a small proportion of their allocated DAS, even though increased effort might be expected in response to higher prices and/or decrease competition from more active vessels. The 1999 DAS effort estimates are, therefore, not very conservative in this regard, although there is evidence that some vessels did increase their fishing activity during 1997 compared to 1996.

Fleet or individual DAS vessels that fished for more days in 1997 than those examined in Table 7.1 were assumed to fish at the limit. As indicated above, this procedure also applied to the projected days-at-sea use by individual vessels during 1998. A vessel that fished for 88 days in 1997, for example, was assumed to fish for 88 days in 1999 if the limit on DAS use will be 88 DAS. Vessels that fished less during May to September of 1998 than in 1997 were estimated to fish at lower levels in 1999.

Results

Across all fleets, the MSMC expects a 7.4 percent reduction in nominal fishing effort from 47,477 DAS[1] in fishing year 1997 to 43,854 expected DAS in 1998 based on a cap of 88 fleet DAS in 1998 and a 50 percent reduction in DAS allocations for individual and combination DAS vessels from the baseline (Table 7.1). This table shows expected total DAS in 1999 for a various combinations of DAS reductions for fleet and individual DAS vessels. The estimated effects of total groundfish day-at-sea allocations ranges from 47,477 DAS to 17,252 days-at-sea with an 88 percent reduction in individual days-at-sea relative to the 1993 baseline and 22 Fleet days-at-sea. The status quo allocation of days-at-sea, including the effects of carry-forward days (up to 10 unused days-at-sea can be carried into the next fishing year by active vessels), is shaded and is expected to generate 43,959 days used in 1999, a 7.4 percent reduction from fishing year 1997.

1 Excludes DAS used by hook vessels.

The MSMC also discussed the relative contribution to fishing mortality of a DAS by a fleet versus an individual DAS vessel. The MSMC could not, however, make the appropriate linkage between call-in and dealer data to investigate this possibility. Although presented side-by-side in Table 7.1 so that the status quo day-at-sea allocations coincide, there are many permutations of days-at-sea allocations to fleet and individual days-at-sea vessels. Alternative combinations of days-at-sea allocations for fleet and individual day-at-sea vessels are given in Appendix VII.

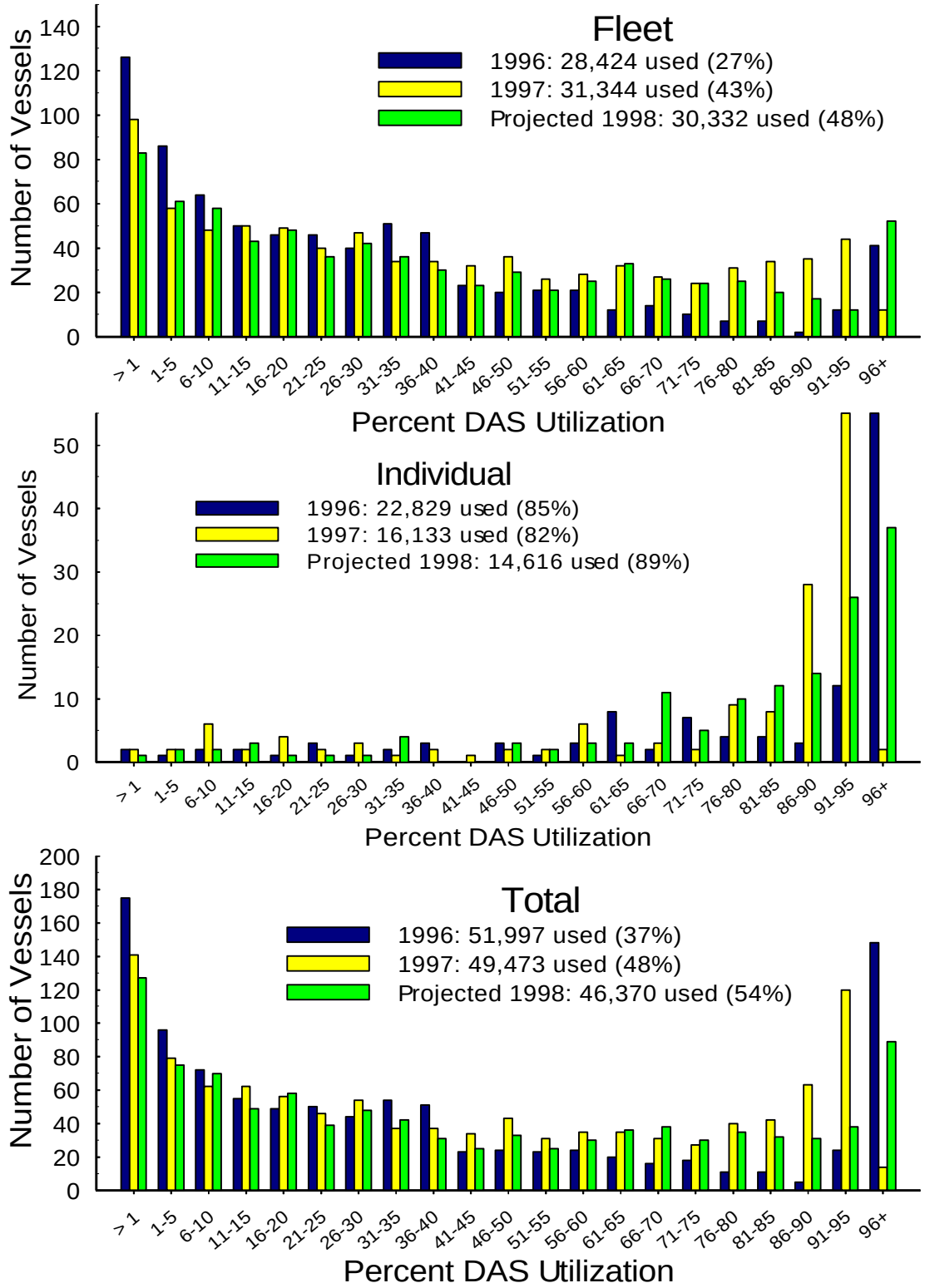


Figure 7.1. Percent of allocated DAS used by multispecies vessels in each permit category, 1996-1998, derived from NMFS VMS/call-in data. DAS for 1998 were expanded to an annual total based on DAS reports from May 1 to September 30, compared to the seasonal DAS data for each vessel during 1997.

Table 7.1. Expected change in DAS usage for 1999 DAS allocation options based on 1997 VMS/call-in data. Shaded areas represent the status quo allocation of DAS.

Total		Individual			Fleet			
Expected DAS usage	Effective reduction from 1997	Nominal reduction form 1993	Expected 1999 DAS	Effective reduction from 1997	Nominal effort reduction from 1996	DAS allocation	Expected 1999 DAS	Effective effort reduction
47,477	0%	1997 DAS	16,133	0%	1997 DAS used		31,344	0%
43,996	7%	43%	14,636	9%	114%	100	29,360	6%
43,989	7%	45%	14,636	9%	110%	97	29,353	6%
43,982	7%	47%	14,636	9%	106%	93	29,346	6%
43,959	7%	50%	14,631	9%	100%	88	29,328	6%
43,601	8%	53%	14,427	11%	95%	84	29,173	7%
42,841	10%	55%	13,987	13%	90%	79	28,854	8%
41,778	12%	58%	13,411	17%	85%	74	28,367	9%
40,813	14%	60%	12,911	20%	81%	71	27,902	11%
39,373	17%	62%	12,193	24%	75%	66	27,180	13%
37,782	20%	65%	11,433	29%	70%	62	26,349	16%
36,038	24%	67%	10,651	34%	65%	57	25,387	19%
34,159	28%	70%	9,864	39%	60%	53	24,295	22%
32,121	32%	73%	9,050	44%	55%	48	23,072	26%
30,494	36%	75%	8,433	48%	51%	45	22,061	30%
28,181	41%	77%	7,600	53%	46%	40	20,582	34%
25,699	46%	80%	6,757	58%	40%	35	18,942	40%
23,056	51%	82%	5,901	63%	35%	31	17,155	45%
20,240	57%	85%	5,039	69%	30%	26	15,201	52%
17,252	64%	87%	4,176	74%	25%	22	13,076	58%
14,061	70%	90%	3,307	80%	20%	17	10,755	66%
11,535	76%	92%	2,654	84%	15%	13	8,882	72%

7.2 Fishing Mortality Reduction to Achieve the 1997 Targets

Methods

The mortality estimates for the five critical groundfish stocks were compared to the Amendment 7 targets for 1999 by the MSMC. An iterative simulation that used the distribution of fishing mortality estimates in calendar year 1997 and 1998 to derive a combined median estimate for each stock. The results for each stock are given in Table 7.2. In addition to these estimates, Table 7.2 also includes the mortality reduction needed to reach an appropriate rebuilding target ($F_{0.1}$) for Gulf of Maine cod. The following estimates are derived from the projection model described in Chapter 5.

Random samples from the distributions of the estimated F for the five stocks in 1997 and 1998 were drawn in 10000 iterations via Latin-Hypercube re-sampling. The percent reduction in F needed to meet the mortality target was calculated for each iteration to estimate the reduction in total DAS needed for each stock and combination of stocks. For iterations that contained a derived F that was less than the target, the model assumed that no additional reduction was needed and a zero value was included in the output distribution and the average values for the combined stocks. Median values of these distributions are summarized in Table 7.2.

For 1997, the SAW 27 assessment used a bootstrap procedure (Efron 1982) to evaluate the uncertainty associated with the estimates of fishing morality and spawning stock biomass from the final VPA. The results from 1,000 bootstrap iterations were randomly selected for 10,000 times in the current estimate of median fishing mortality for the 1997 fishing year, equivalent to 47,477 days-at-sea used. Thus each bootstrap iteration of the 1997 F was drawn on average ten times and combined with a random draw from the distribution of 1998 fishing mortality rate estimated by the MSMC projection (Chapter 5). The randomly selected 1998 fishing mortality rates were forced to have the same distribution as the MSMC projection estimates by fitting a cumulative distribution that had the same parameters as the projection results. Each of the 10,000 random selected fishing mortalities for 1997 and 1998 were weighted by the proportion of the fishing year occurring in the assessment calendar year to give a median fishing mortality rate that corresponds to the fishing year. Thus the 1997 fishing mortality was given twice the weight (8 months) compared to the 1998 estimate (4 months). Due to the asymmetrical distribution of the uncertainty of the fishing mortality estimates, this median fishing mortality estimate does not always result in an estimate that is $^{2}/_{3}^{rds}$ between the 1997 and 1998 fishing mortality medians.

The 7.4% percent reduction in total DAS anticipated from DAS usage in fishing year 1997 to status quo 1999 DAS schedule was applied to the 1997 fishing year mortality rate to estimate the expected mortality in 1999 if there are no changes in days-at-sea allocations. The ratio of the threshold fishing mortality rate and the adjusted status quo fishing mortality represents the effort reduction shortfall, assuming a 1:1 ratio between nominal fishing effort and fishing mortality.

Unlike last year, fishing year 1997-1998 F of 0.25 is above the Amendment 7 target for Georges Bank cod ($F_{0.1}$ = 0.18). If effort reductions have the same proportionality over all five stocks, it would require that the days-at-sea used by vessels in 1999 would have to decline to 37,078 DAS to achieve the $F_{0.1}$ target.

For Gulf of Maine cod, fishing mortality is well above the Amendment 7 threshold (F_{max}=0.29) and $F_{0.1}$ (=0.16). The effort reduction shortfall for Gulf of Maine cod is 56.2% to achieve the Amendment 7 mortality threshold of $F_{max,}$ and 72.5% to achieve $F_{0.1}$ and promote rebuilding. If effort reductions have the same proportionality over all five stocks, it would require that the days-at-sea used by vessels in 1999 would have to decline to 20,813 DAS to achieve F_{max} and 13,037 DAS to achieve $F_{0.1}$ for Gulf of Maine cod. Achieving this reduction of day-at-sea by only changing the days-at-sea allocations would allow for only about 15 fleet days and an equivalent amount of individual days (Appendix Table VII).

Table 7.2. Simulation results from stock abundance projections through January 1, 1999 and status quo DAS (88 fleet DAS, Individual DAS at 50% of baseline, both adjusted for carry-forward DAS).

Stock	Median 1997 F	Median 1998 F	Median 97-98 F	F adjusted for estimated 7.4% effort reduction in Fishing year 1999	Threshold F	Effort reduction shortfall[1]	DAS equivalent
Georges Bank cod	0.27	0.22	0.25	0.24	0.18	21.9%	37,078
Georges Bank haddock	0.11	0.18	0.14	0.13	0.26	0.0%	47,477
Georges Bank yellowtail	0.13	0.17	0.15	0.14	0.25	0.0%	47,477
SNE Yellowtail	0.08	0.07	0.07	0.07	0.27	0.0%	47,477
Gulf of Maine cod F_{max}	0.75	0.82	0.80	0.74	0.29	56.2%	20,813
Gulf of Maine cod $F_{0.1}$	0.75	0.82	0.80	0.74	0.16	72.5%	13,037

[1]Median reduction prior to applying the estimated 7.4% reduction is 29.3% for Georges Bank cod, 63.6% for Gulf of Maine cod with F_{max} as a target, and 80.0% for Gulf of Maine cod with $F_{0.1}$ as a threshold (see Figure 7.2).

Estimation of the average mortality reduction needed to meet Amendment 7 targets

Georges Bank cod

Georges Bank cod require a 29 percent reduction in F from a median fishing year 1997 fishing mortality rate of 0.25 to the Amendment 7 mortality target, $F_{0.1}$=0.18 (Table 7.2). Accounting for the uncertainty of the estimates, the estimated reduction ranges from 8 to 55 percent and there is an 80 percent probability that the mortality reduction is between 22 and 36 percent (Figure 7.2, top panel). The status quo DAS allocations (43,959 expected DAS used in 1999) would reduce F by 7.4 percent and has a zero percent probability of achieving $F_{0.1}$. The **effort reduction shortfall is 21.9%** after accounting for the expected 7.4% reduction in DAS in fishing year 1999.

Georges Bank haddock

The median estimate of fishing mortality was 0.11 in calendar year 1997. The projected fishing mortality rate based on estimated landings and discards during calendar year 1998 was 0.18. Combining the 1996 and 1997 mortality rates as described above to estimate the mortality rate over the 1997 fishing year yields a median value of 0.14 (Table 7.2) which is below the $F_{0.1}$ target of 0.24. The fishing mortality estimates are relatively well estimated and no iterations indicated that Georges Bank haddock was over-exploited relative to the target.

Georges Bank yellowtail

The median estimate of fishing mortality was 0.13 in calendar year 1997. The projected fishing mortality rate based on estimated landings and discards during calendar year 1998 was 0.17. Combining the 1996 and 1997 mortality rates to estimate the mortality rate in fishing year 1996 yields a median value of 0.15 (Table 7.2). All of the 10,000 iterations indicated that Georges Bank yellowtail flounder mortality was below the target (Figure 7.2, second plot).

Southern New England yellowtail

The updated mortality estimates are low and well estimated. The median estimate of fishing mortality was 0.08 in 1997. The projected fishing mortality rate based on estimated landings and discards during 1998 was 0.07. Combining the 1997 and 1998 mortality rates to estimate the fishing year 1997 mortality rate yields a median value of 0.07 (Table 8.5). All of the 10,000 iterations indicated that Southern New England yellowtail flounder mortality was below the target (Figure 7.2, second plot).

Gulf of Maine cod

The median mortality reduction estimate to achieve the Amendment 7 target of F_{max} is 64

percent. The percent reduction to achieve the target ranges from 28 to 84 percent, but there is an 80 percent probability that the true value lies between 54 and 73 percent (Figure 7.2, fourth panel). The probability that a 7.4 percent reduction in effort (status quo) and mortality would achieve the target, F_{max}, is zero. The effort reduction shortfall to reach F_{max} after accounting for the expected 7.4% reduction in DAS is 56.2%. In other words, even after accounting for the expected decline in fishing effort during 1999, Gulf of Maine cod would be significantly above its target mortality rate, as long as fishing patterns remained unchanged. Stock size appears to be well-estimated and the range of effort reduction is narrow.

Since fishing mortality is high, spawning stock biomass has fallen to new record lows, and recruitment is the lowest on record, the SAW 27 report declared the Gulf of Maine stock to be in a state of collapse. It is therefore necessary to afford Gulf of Maine cod the same protection as management has applied to the other four primary groundfish stocks. Once these mortality reductions have been achieved, rebuilding has been observed for all four stocks and only the recovery of historic recruitment is hindering the achievement of the biomass targets. To achieve $F_{0.1}$ for Gulf of Maine cod, mortality must be reduced by 80 percent. There is an 80 percent probability that the needed mortality reduction is between 73 and 85 percent. Obviously, the status quo DAS allocations (43,959 expected DAS used in 1999) would reduce F by 7.4 percent and has a zero percent probability of achieving $F_{0.1}$. The effort reduction shortfall to reach $F_{0.1}$ after accounting for the expected 7.4% reduction in DAS is 72.5%

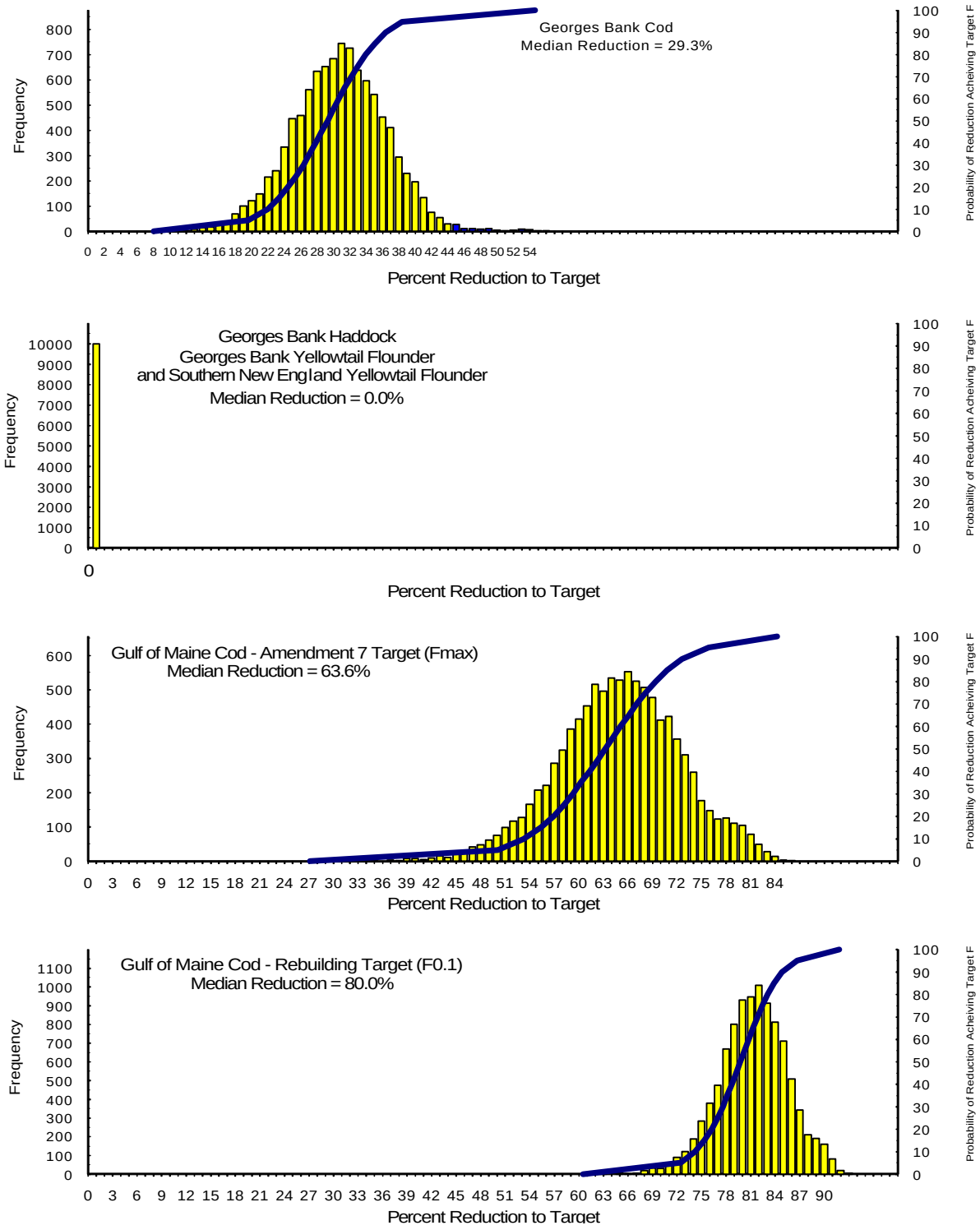


Figure 7.2. Percent fishing mortality (F) reduction from fishing year 1997-98 needed to achieve Amendment 7 targets in fishing year 1999-2000 for four of the five principal multispecies stocks. No results indicated that mortality reduction was needed for Southern New England yellowtail flounder to achieve Amendment 7 targets. To address SFA objectives, the bottom chart indicates the reduction needed to reduce Gulf of Maine cod fishing mortality to $F_{0.1}$.

8.0 Evaluation of area closures for reducing Gulf of Maine cod catches

The MSMC compared Gulf of Maine cod landings by quarter degree square for 1996 and 1997. In both 1996 and 1997, the western GOM closed area (block 156) was the number one ranked block for cod landings. The top ten blocks accounted for slightly more than 79% of the Gulf of Maine cod landings in 1997, as compared to 78% in 1996 (Table 8.1). Additionally, two inshore blocks (124 and 133) showed a large percentage increase in cod landings between 1996 and 1997, although in absolute terms, cod landings in block 133 declined by three metric tons. Block 124 accounted for 15% of the total in 1997, versus 7% in 1996, while block 133 accounted for 10% in 1997, versus 8% in 1996. Most of the other blocks saw their catches decline slightly in percentage terms between 1996 and 1997.

The MSMC modeled the current management measures in place to estimate total Gulf of Maine cod landings for calendar year 1999. This is needed to ascertain whether additional measures will be needed during the year to meet the mortality targets established by the Council. The MSMC chose the "two-bin" effort displacement model to evaluate all options. The two-bin model assumes that effort from the closed areas (first bin) is displaced to the open areas (second bin). The total effort in the system is then applied to the landings per unit effort (LPUE) in open areas to obtain a projected catch, and the percent reduction in landings from 1997 levels is then calculated. This percent reduction is then subtracted from the projected catch at each trip limit increment to arrive at a projected catch that is based on both the area closure and the trip limit.

Results from the area closure analysis depend on results from the trip level analysis, and therefore **the assumptions behind the models need to be re-emphasized**. The first critical assumption is that landings per unit effort (LPUE) are linearly related to stock size, and will decline 37% between 1997 and 1999 because of the projected decline in stock biomass. If fishery operators are able to focus their effort on remaining concentrations of Gulf of Maine Cod, this assumption may not hold. This would result in much higher landings than projected in this analysis. The second major assumption which impacted the results was the 7.4% reduction in days at sea expected for fishing year 1999. This assumption may overestimate the mortality reduction slightly, because the expected 7.4% reduction in days at sea applies to all groundfish days, and not just those fishing in the Gulf of Maine. Additionally, the 7.4% reduction is applied to the entire calendar year, and not just the fishing year portion of calendar year 1999.

The two assumptions outlined above contributed over 40% of the mortality reduction from 1997 levels found in all analyses contained in this section, and resulted in a projected catch of approximately 3,234 metric tons due to the projected reduction in stock biomass. Results from the trip limit analysis, and the application of a 400 pound per day trip limit, reduced the projected catch further to 1,681 tons (Table 8.2). The MSMC concluded that coupling the two-bin modeling approach with the trip limit analysis worked fairly well for small area closures over a short duration. However, the MSMC questioned whether this approach worked as well for large area closures which were long in duration, primarily because it was felt that smaller vessels would have a more difficult time shifting their effort to open areas.

8.1 Framework 26 area closure analyses

In addition to examining the status-quo scenario, the MSMC also evaluated the area closures under consideration for Framework 26 (Table 8.2). Our first conclusion is that the modeling exercise showed no real difference among alternatives, including the status quo. This is due to the uncertainty present in the model, which is driven by both the assumptions outlined above and by the compensating behavior of fishing vessel operators. Therefore, the MSMC concludes that the Framework 26 options will provide no additional reduction in Gulf of Maine cod mortality over the status quo management measures that already exist. Further, none of the options would result in the landings reductions needed to achieve the 1999 mortality objectives of F_{max} (1340 metric tons) or $F_{0.1}$ (782 metric tons) with a 400 pound trip limit. However, Framework 26 may provide some benefit in reducing the disturbance of the aggregations of spawning fish, although these benefits may never materialize without further reductions in fishing effort.

8.2 MSMC area closure analyses

The MSMC crafted three area closures alternatives based on the landings and LPUE's in given blocks and months, and making the closures large enough for enforcement purposes (Table 8.3). These alternatives were evaluated using the same assumptions and two-bin modeling approach coupled with a trip limit analysis as in the previous section.

Two other MSMC sets were modeled which combined further days at sea reductions with the proposed area closures. The second set of analyses were for closure alternative 1, 2 or 3 with an assumed a 50% effort reduction by counting DAS at a 2-for-1 rate in the Gulf of Maine only. This option would only affect vessels that choose to fish in the Gulf of Maine. Results are shown in Table 8.4 under closure alternatives listing "2 x DAS".

The third set of analyses incorporated a 21.9% reduction in days at sea combined with either closure alternatives 1, 2 or 3, which would affect all vessels with groundfish days. This option specifically addresses the reduction in F needed for Georges Bank cod and would benefit all Georges Bank stocks. However, it may also overestimate the reduction in mortality for Gulf of Maine cod, because the days at sea reductions could potentially alter where vessels fish. For example, vessels may choose to fish more in the Gulf of Maine and reduce their fishing time in other areas. Possible behavioral changes were not modeled by the MSMC because of time limitations. Results for all three options at different daily trip limit increments are shown in Table 8.5.

The fourth set of analyses was for the status quo area closure combined with reductions in DAS. One analysis is status quo area closure and a 56% reduction in DAS throughout the range. The other option is status quo area closure and count DAS 3-for-1 for vessels in the Gulf of Maine cod Trip Limit Exemption Program. Results are shown in Table 8.6.

The MSMC also analyzed various Alliance proposals under various trip limits. Results are shown in Appendix 5. Given the uncertainty in the models, results suggest that the Alliance proposals for any given trip limit yield roughly the same mortality reduction as the Status Quo and

Framework 26 alternatives. Additionally, as with the Status quo scenario and the Framework 26 alternatives, the Alliance proposals with trip limits greater than 200 - 300 lbs do not produce expected landings consistent with achieving F_{max}.

Table 8.1. Gulf of Maine Cod Landings by block in 1996 and 1997.								
Block	1997 Cod	1997 Cumulative Total	1997 Percent	1997 Cumulative Percent	1996 Cod	1996 Cumulative Total	1996 Percent	1996 Cumulative Percent
156	1040	1040	20.27%	20%	1606	1606	23.10%	23%
124	752	1792	14.66%	35%	464	2070	6.67%	30%
133	531	2324	10.36%	45%	534	2604	7.68%	37%
132	438	2762	8.54%	54%	689	3293	9.91%	47%
129	303	3065	5.90%	60%	817	4110	11.75%	59%
125	250	3314	4.86%	65%	457	4567	6.57%	66%
130	206	3520	4.01%	69%	255	4822	3.67%	69%
139	190	3710	3.70%	72%	235	5057	3.38%	73%
127	173	3883	3.38%	76%	143	5200	2.06%	75%
137	171	4054	3.33%	79%	241	5441	3.47%	78%
119	146	4200	2.85%	82%	36	5477	0.52%	79%
136	134	4335	2.62%	84%	221	5698	3.18%	82%
138	124	4459	2.42%	87%	206	5904	2.96%	85%
135	96	4555	1.87%	89%	88	5992	1.27%	86%
131	89	4643	1.73%	90%	139	6131	2.00%	88%
123	82	4725	1.60%	92%	62	6193	0.89%	89%
120	63	4788	1.23%	93%	57	6250	0.82%	90%
121	63	4851	1.22%	95%	39	6289	0.56%	90%
128	61	4912	1.20%	96%	141	6430	2.03%	92%
122	35	4947	0.68%	96%	22	6452	0.32%	93%
144	32	4979	0.63%	97%	35	6487	0.50%	93%
145	27	5006	0.53%	98%	43	6530	0.62%	94%
146	26	5032	0.51%	98%	49	6579	0.70%	95%
152	18	5051	0.36%	98%	4	6583	0.06%	95%
142	18	5069	0.35%	99%	31	6614	0.45%	95%
143	17	5086	0.33%	99%	77	6691	1.11%	96%
118	15	5102	0.30%	99%	11	6702	0.16%	96%
141	7	5109	0.14%	100%	19	6721	0.27%	97%
149	6	5115	0.12%	100%	71	6792	1.02%	98%
147	6	5121	0.11%	100%	16	6808	0.23%	98%
134	3	5124	0.06%	100%	37	6845	0.53%	98%
115	2	5126	0.05%	100%	17	6862	0.24%	99%
140	2	5128	0.04%	100%	1	6863	0.01%	99%
150	1	5129	0.02%	100%	16	6879	0.23%	99%
148	1	5130	0.02%	100%	55	6934	0.79%	100%
155	0	5131	0.01%	100%	1	6935	0.01%	100%
126	0	5131	0.01%	100%	6	6941	0.09%	100%
151	0	5131	0.01%	100%	4	6945	0.06%	100%
116	0	5131	0.00%	100%	7	6952	0.10%	100%
117	0	5131	0.00%	100%	0	6952	0.00%	100%
153	0	5131	0.00%	100%	0	6952	0.00%	100%
154	0	5131	0.00%	100%	0	6952	0.00%	100%

Table 8.2. Expected Calendar Year 1999 Landings of Gulf of Maine Cod under Framework 26.							
	Trip Limit (Pounds per day)						
	700	**600**	**500**	**400**	**300**	**200**	**100**
Status Quo Area Closure	2,253	2,096	1,909	1,681	1,404	1,062	628
Framework 26 Alternative 1	2,220	2,066	1,881	1,657	1,384	1,047	619
Alternative 2 (1 month)	2,259	2,102	1,914	1,686	1,408	1,065	630
Alternative 2 (2 month)	2,256	2,099	1,912	1,683	1,406	1,063	629
Alternative 3	2,143	1,994	1,816	1,599	1,336	1,010	598

Table 8.3. Current closures in the Gulf of Maine and MSMC closure Alternatives 1, 2 and 3. Closures replace current closures and proposed Framework 26 closures in Gulf of Maine.

Current closures in the Gulf of Maine	
Blocks	**Months**
124, 125	March
131, 132, 133	April
138, 139, 140	May
129, 145, 146, 147, 152	June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 1	
Blocks	**Months**
124, 125	October-April
131, 132, 133	April-June
129, 130	September-December
138, 139, 140	June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 2	
Blocks	**Months**
124, 125	October-April
128, 129, 130	September-December
132, 133	March – June
139, 140	May – June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 3	
Blocks	**Months**
125	April-May
133	April-June
139, 140	May-June
124, 127, 128, 129, 130, 131, 132	Year-round
156 (Western Gulf of Maine closure)	Year-round

Table 8.4. Expected Calendar Year 1999 Landings of Gulf of Maine Cod under three MSMC area closure alternatives. Assumes 7.4% reduction in DAS. Alternatives with (2x DAS) also have DAS counted at a rate of 2 for 1 in the Gulf of Maine area.

	Trip Limit (Pounds per day)						
	700	**600**	**500**	**400**	**300**	**200**	**100**
MSMC Alternative 1	1,864	1,735	1,580	1,391	1,162	879	520
MSMC Alternative 1 (2 x DAS)	932	867	790	696	581	439	260
MSMC Alternative 2	1,859	1,729	1,575	1,387	1,159	876	518
MSMC Alternative 2 (2 x DAS)	929	865	788	694	579	438	259
MSMC Alternative 3	1,898	1,765	1,608	1,416	1,183	894	529
MSMC Alternative 3 (2 x DAS)	949	883	804	708	591	447	265

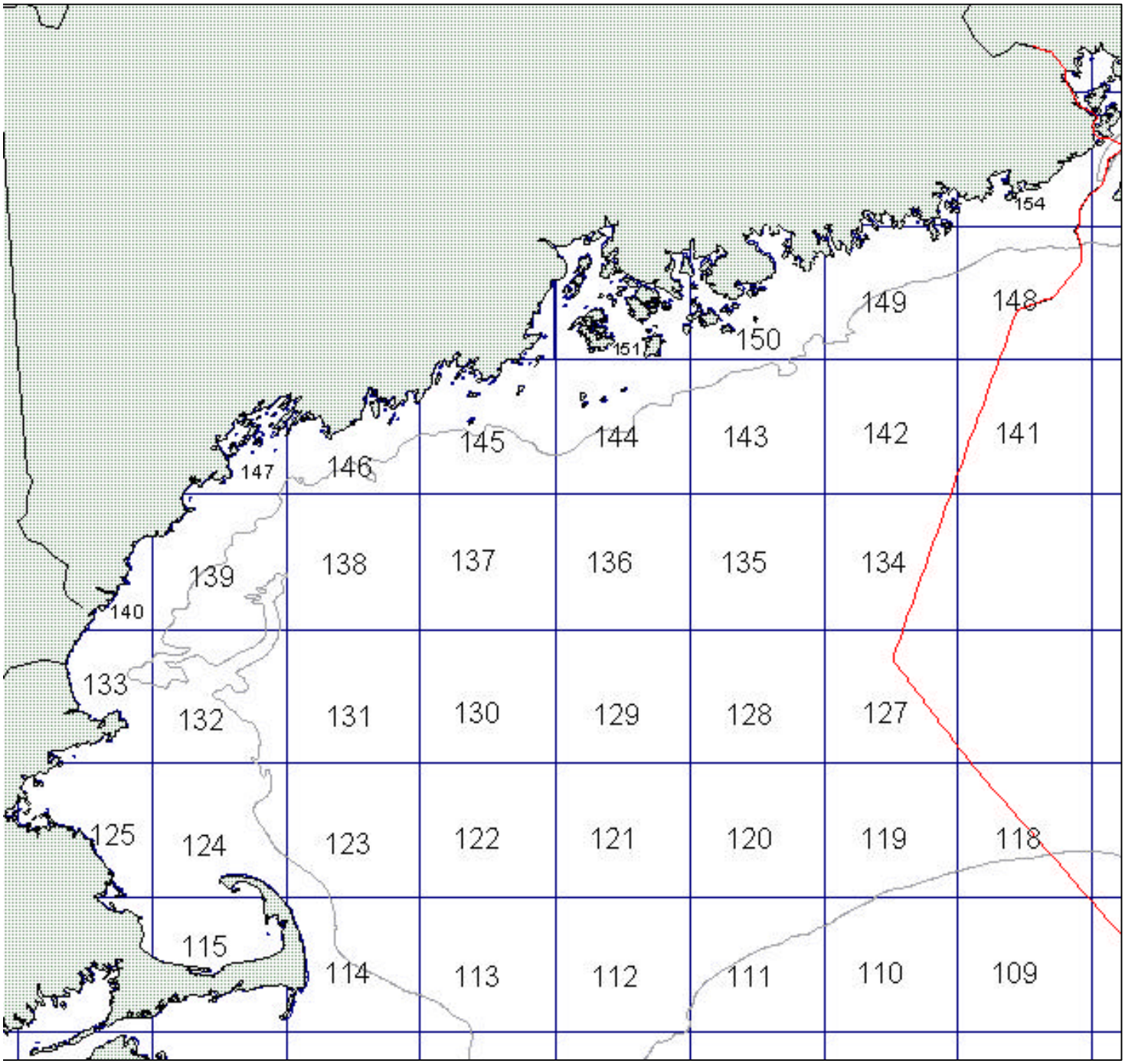
Table 8.5. Expected Calendar Year 1999 Landings of Gulf of Maine Cod under three MSMC area closure alternatives. Assumes the expected 7.4% reduction in DAS and an additional 21.9% reduction in DAS.

	Trip Limit (Pounds per day)						
	700	**600**	**500**	**400**	**300**	**200**	**100**
MSMC Alternative 1	1,456	1,355	1,234	1,087	908	686	406
MSMC Alternative 2	1,453	1,352	1,232	1,085	906	685	405
MSMC Alternative 3	1,481	1,378	1,255	1,105	923	698	413

Table 8.6. Expected Calendar Year 1999 Landings of Gulf of Maine Cod under status quo area closures and reductions in DAS. DAS reductions are either 56% reduction over all or count DAS 3-for-1 in the Gulf of Maine Cod Trip Limit Exemption Program. Assumes the expected 7.4% reduction in DAS.

	Trip Limit (Pounds per day)						
	700	**600**	**500**	**400**	**300**	**200**	**100**
Status quo	2,253	2,096	1,909	1,681	1,404	1,062	628
56% reduction in DAS	991	922	840	740	618		
Count DAS at 3-for-1 in GOM	743	692	630				

Figure 8.1. Gulf of Maine divided into thirty minute squares used in describing area closures.



9.0 MSMC Options

9.1 Importance of Required Reductions in GOM Cod Mortality

Stock status based on the MSMC's projection results for Gulf of Maine cod are similar to that provide by SARC 27**.** Spawning stock biomass is projected to decline in 1999 at either F_{max} or $F_{0.1}$. Biomass is projected to decline below ¼ B_{MSY} in 1999. The proposed control law recommends zero fishing mortality when biomass is below ¼ B_{MSY}. Based on stock condition, continued high fishing mortality rates, poor recent recruitment, and decline in the survival ratios (recruit/spawning stock biomass), **the Amendment 7 objective of F_{max} is no longer appropriate for stock rebuilding.** SARC 27 recommended "an immediate reduction in fishing mortality to near zero. Measures should be implemented to immediately to cease all directed fishing and minimize bycatch on this stock". There is nothing in the projections results to suggest altering SARC 27's advice.

9.2 MSMC Options for Fishing Year 1999

The MSMC has developed the following six options to achieve the plan objectives for the 1999 fishing year. Included are options based on the primary management measures: DAS, trip limits and area closures, individually and in combination with each other, as well as discussion of some pros and cons of each alternative. Options 1 and 2 uses DAS as the primary measure to achieve needed reductions. Option 3 uses a trip limit to illustrate the magnitude of the reduction; this option is **not recommended by the MSMC** because of the likelihood of creating significant discards. Option 4 uses area closures as the primary measure. Options 5 and 6 are combinations of area closures and DAS. MSMC has not identified a preferred option. Also provided are general recommendations for improving the effectiveness of the plan. Analyses supporting these options can be found in Tables 8.4, 8.5 and 8.6 in Chapter 8.

The MSMC has developed three alternative closure models that are equivalent in effectiveness. These closures replace current closures in the Gulf of Maine but maintain the year-round closure in the Western Gulf of Maine within each of the MSMC's proposed closure alternatives. Alternatives 1 and 2 use more extensive rolling closure to achieve reductions. Alternative 3 expands the year-round closure and has smaller seasonal closures. Although these closures provide equivalent conservation for cod, they may have different impacts on fleet components or other fisheries. For example, Alternative 3 expands the year round closure and provides more benefits to habitat than the other two alternatives. However, the year-round closures may disproportionately impact smaller vessels that are home-ported near the year round closures.

<u>Option 1</u>: Reduce DAS by 56% overall. Maintain 400 lbs Gulf of Maine cod trip limit and current area closures. Total DAS are reduced to 20,813 (for example, 22 fleet DAS and 77% reduction in individual vessel DAS from the baseline).

A) Pros:

- **Achieves the $F_{0.1}$ target for Gulf of Maine cod**.
- Achieves Amendment 7 targets for all 5 stocks **including Georges Bank cod**.
- Lowest impact on discard mortality.
- Reduces mortality on other regulated species.
- Lower administrative and enforcement burdens.

B) Cons:

- Increases pressure on non-regulated species.
- Amount of reduction driven by Gulf of Maine Cod.
- Measure is not stock specific, lost yield from stocks outside Gulf of Maine.
- Negative economic impact on vessels not in Gulf of Maine

<u>Option 2</u>: Count DAS on vessels not in the Gulf of Maine Cod Trip Limit Exemption Program at a rate of three to one. Increase Gulf of Maine trip limit to 700 lbs. and current area closures.

A) Pros:

- **Achieves the $F_{0.1}$ target for the Gulf of Maine cod**
- Applies equally across all vessels in Gulf of Maine region
- Reduces mortality on other regulated species within the Gulf of Maine.
- Lowest impact on discard mortality.
- Lower enforcement burdens than area closures, administrative mechanisms already in place.

B) Cons:

- Increases pressure on non-regulated species. May increase mortality on Georges Bank groundfish.
- Greatest impact on vessels which can't leave Gulf of Maine.
- Does not achieve target for Georges Bank cod

<u>Option 3</u>: Trip limit of 100 pounds per day for all vessels not in the Gulf of Maine Cod Trip Limit Exemption Program. Maintain current area closures.

A) Pros:

- **Achieves $F_{0.1}$ objective for Gulf of Maine cod**
- Impact specific to vessels fishing in the Gulf of Maine.
- Achieves the target for the stock in the worst condition **<u>if significant discarding does not occurs</u>**.

B) Cons:

- Potential for significant discard problems including both high-grading problems and regulatory discard. This option is **<u>not recommended</u>** by the MSMC because of the strong likelihood of increased discards.
- **Does not achieve target for Georges Bank cod**.
- Increases pressure on both regulated and non-regulated species in the Gulf of Maine.
- Shifts effort to Georges Bank groundfish.

<u>Option 4</u>: Status Quo DAS, Closure Alternative 1, 2 or 3, and a 400 pound per day cod trip limit for all vessels not in the Gulf of Maine Cod Trip Limit Exemption Program (south of 42^{o} 20').

A) Pros:

- **Achieves the F_{max} target for Gulf of Maine cod**
- Protects other species and habitat in closed areas.
- Closed areas may mitigate discard problems.

B) Cons:

- **Does not achieve target for Georges Bank cod**
- Disproportionate impacts on vessels which are restricted geographically to fish near the closed areas.
- May shift effort to Georges Bank stocks.
- Increases pressure on non-regulated species.

<u>Option 5</u>: Reduce DAS by 22% overall and closure alternative 1, 2 or 3. Increase Gulf of Maine cod trip limit to 600 lbs. Total DAS are reduced to 37,078 (for example, 62 days fleet and 67% reduction from baseline for individual vessels).

A) Pros:

- **Achieves the F_{max} target for Gulf of Maine cod**.
- **Achieves target for Georges Bank cod**.
- Low discard mortality.
- Protects other species and habitat within closed areas.
- DAS reduction reduces potential for effort shifts onto other regulated species that would otherwise be caused by area closures.

B) Cons:

- Increases pressure on non-regulated species.
- Could have a disproportionate impact on vessels in ports nearest to area closures.
- May be below break-even levels for fleet

<u>Option 6</u>: Count DAS 2 for 1 and a 500 pound per day Gulf of Maine cod trip limit for vessels not in the Gulf of Maine Cod Trip Limit Exemption Program (south of $42^{o}\ 20^{'}$). Include closure alternatives 1, 2 or 3.

A) Pros:

- **Achieves the $F_{0.1}$ "target" for Gulf of Maine cod**.
- Protects other species and habitat within closed areas.
- DAS reduction reduces potential for effort shifts onto other regulated species that would otherwise be caused by area closures.

B) Cons:

- Increases pressure on non-regulated.
- Increases effort on Georges Bank stocks
- **Does not achieve target for Georges Bank cod**
- Could have a disproportionate impact on small vessels that can not fish in the Cod Trip Exemption area.

Table 9.1. Current closures in the Gulf of Maine and closure Alternatives 1, 2 and 3. Closures Alternatives replace current closures in Gulf of Maine.

Current Closures in the Gulf of Maine	
Blocks	**Months**
124, 125	March
131, 132, 133	April
138, 139, 140	May
129, 145, 146, 147, 152	June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 1	
Blocks	**Months**
124, 125	October-April
131, 132, 133	April-June
129, 130	September-December
138, 139, 140	June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 2	
Blocks	**Months**
124, 125	October-April
128, 129, 130	September-December
132, 133	March – June
139, 140	May – June
156 (Western Gulf of Maine closure)	Year-round

Closure Alternative # 3	
Blocks	**Months**
125	April-May
133	April-June
139, 140	May-June
124, 127, 128, 129, 130, 131, 132	Year-round
156 (Western Gulf of Maine closure)	Year-round

Summary of Pros and cons for MSMC Options 1 through 6.

An overall DAS reduction that applies to all limited access multispecies vessels, whether singly (Option 1) or in combination with other measures (Option 5), achieves the fishing mortality goals for all five stocks of concern, and reduces mortality on other regulated species. An overall DAS reduction affects all multispecies vessels and regions where multispecies fisheries occur. It also results in the lowest rate of discard mortality, and has lower administrative and enforcement costs in comparison to other management alternatives. However, because the level of required DAS reductions is driven by Gulf of Maine cod, DAS allocations could be below break-even levels for much the fleet and, in response, vessels would shift effort to other fisheries or become insolvent. Furthermore, severely reducing DAS may encourage adaptive changes in fishing technology and behavior that would mitigate its conservation impact.

Counting DAS at a higher rate for vessels fishing in the Gulf of Maine (3-to-1, Option 2, or 2-to-1, Option 6) shares many of the pros and cons of a general DAS reduction option stated above, except that the impacts will primarily affect vessels fishing in the Gulf of Maine. Also, in addition to increasing pressure on non-regulated species in the Gulf of Maine, these options would provide an incentive for those vessels capable of shifting to redirect their effort to Georges Bank stocks.

A Gulf of Maine cod trip limit reduction alone (Option 3) is area specific and could achieve the target mortality reductions needed for Gulf of Maine cod, but could cause significant discarding, both regulatory discards and high-grading. For this reason, the MSMC does not recommend adoption of Option 3. A trip limit reduction on cod may also increase pressure on other regulated species and on non-regulated species in the Gulf of Maine, as well as shift effort onto Georges Bank in order to maintain viable trip revenues.

Area closures protect species and habitat within the closure, but may cause increased fishing pressure on areas left open. The net impact of an area closure depends on the relative abundance of species outside the closure area and the amount of effort that is displaced. Combining area closures with trip limits and/or DAS reductions addresses the problems associated with the individual management strategies. For example, when combined with a trip limit, an area closure may forestall increased discards if the closed areas cover the grounds where highest cod catches occur. When combined with DAS reductions, the amount of effort displaced to open areas is reduced, increasing the potential net conservation benefit of the closure.

Options 1, 2 and 3 include current (status quo) area closures in combination with reduced DAS or GOM cod trip limits. Options 4, 5 and 6 include three options for expanding Gulf of Maine area closures in different combinations with trip limits and DAS allocations. The trip limit and DAS allocations remain at the status quo level in Option 4 (GOM cod trip limit of 400 pounds per day). The trip limit increases to 700 lbs in combination with counting DAS at 3-for 1 in the Gulf of Maine in Option 2, increases to 600 pounds in Option 5 in combination with an overall DAS reduction of 22 percent from current levels, and increases to 500 pounds in Option 6 in combination with counting DAS at a rate of 2-for-1 in the Gulf of Maine. Because the area closures and trip limits are focused on Gulf of Maine cod, Options 4 and 6 which do not include overall

DAS reductions, do not achieve the target for Georges Bank cod. Furthermore, Options 4 and 5 achieve the plan objective of F_{MAX} for Gulf of Maine cod, while Option 6 achieves a more conservative $F_{0.1}$ target.

The MSMC has included three area closure options for the Gulf of Maine, to help address the issues associated with the distribution of economic impacts of area closures. Section 8.0 of this report contains a description of the different options and an analysis of their conservation impacts. All options retain the current Western Gulf of Maine Closed Area (year-round). The options differ in the proportion of inshore and offshore areas closed and the duration of the closures. Since Gulf of Maine cod is caught predominantly in inshore grounds, options which include more offshore grounds also include closures of longer duration, including, in Option 6, year-round closure of seven 30-minute-square blocks.

Mesh options

The MSMC considered proposals by the Groundfish Advisory Panel to increase the square mesh minimum size in the Gulf of Maine to 6.5 inches, either throughout the codend or as part of a composite net, or to require 6-inch diamond mesh only. It endorses the square mesh increase but does not support the proposal for 6-inch diamond mesh only. The MSMC recognizes the qualitative benefits of the proposal but cannot provide quantitative estimates of the impacts on the resource. The MSMC concluded that this proposal does not address the primary problem in the Gulf of Maine, and that if mesh size is meant to address overfishing, the mesh sizes would have to be significantly larger. Note that at the November 16th meeting, Groundfish Committee voted to recommend the Council include 6 inch diamond or 6.5 inch square or composite 6 inch diamond/ 6.5 inch square cod end in the annual plan adjustment framework.

The MSMC also discussed the conservation benefit of 8 inch mesh as an auxiliary measure to increase age at entry for Gulf of Maine cod. However, the data on mesh selectivity for 8 inch mesh were not available for cod. The MSMC could not quantify the effect of 8 inch on improving exploitation pattern and reducing catch. Use of 8 inch mesh will reduce discarding of sublegal fish and should reduce mortality on first time spawners. The effects on exploitation pattern for other species were also not quantifiable.

Option for notice action to phase-in additional restrictions

Following the process used with the haddock trip limit (reverting to the 1,000-pound possession limit upon landing or 1000 pounds per day fished/ 10,000 pound per trip at 75 percent of the TAC), the Council can identify time/catch levels to implement more restrictive measures as protection against greatly exceeding the target TAC for GOM cod. If, at a specified point in the year landings are above a specified level, the Regional Administrator could implement more restrictive trip limit, area closures or DAS reductions by notice action. Such backstop measures and trigger points should be identified at the start of the year.

Table 9.2 shows points where action should be taken based on the landings patterns for 1997 fishing year, and the target TAC for GOM cod for the 1999 fishing year. For example, for options

containing a trip limit, the trip limit of 700 lbs could decrease to 400 lbs if landings indicate that the TTAC is likely to be exceeded by the year's end (e.g., landings greater than 203 metric tons by July 31).

Table 9.2. Catch limit as percent of fishing year 1999 Gulf of Maine cod TTAC based on monthly proportion of 1997 landings.

	$F_{0.1}$ TTAC=782	F_{max} TTAC =1,340	
Date	Landings Metric tons	Landings Metric tons	% of TTAC
July 31, 1999	203	434	32%
October 31, 1999	402	688	51%
January 31, 1999	584	1,000	75%
April 30, 1999	782	1,340	100%

A) Pros:

- provides assurance against greatly exceeding the target TAC
- allows for less restrictive measures earlier in the year if the backstop measures and thresholds are appropriately set.

B) Cons:

- promotes a race-for-fish attitude and could cause earlier implementation of the more restrictive measures than if the year's rules are clearly defined at the start
- makes planning a fishing year strategy more difficult because of uncertainty about the timing of the rule change

Option for notice action to increase flexibility

The MSMC noted that a reversal of the preceding options would allow for relaxing of restrictions by notice action if landings remain below specified time/catch levels. Such a system should be based on a conservative tracking of catches relative to the annual pattern of landings. By notice action the Regional Administrator could increase the trip limit, open closed areas or increase DAS if the criteria are met. The course of action to be taken at the trigger points, however, depends on the final management measures selected by the Council for 1999 and should be specified at the start of the year.

Table 9.3 shows points where action could be taken based on the landings patterns for 1997 fishing year, and the target TAC for GOM cod for the 1999 fishing year with the application of a 25 prevent conservation buffer for first three quarters of the fishing year.

Table 9.3. Catch limit with a 25% conservation buffer as percent of fishing year 1999 Gulf of Maine cod TTAC based on monthly proportion of 1997 landings.

	$F_{0.1}$ TTAC=782	F_{max} TTAC =1,340	
Date	Landings Metric tons	Landings Metric tons	% of TTAC
July 31, 1999	190	326	24%
October 31, 1999	307	516	39%
January 31, 1999	438	750	56%
April 30, 1999	782	1,340	100%

For example for options containing a trip limit, the trip limit of 400 lbs could increase to 600 lbs if the landings indicate that the TTAC was not likely to be exceeded by the year's end (e.g., landings less than 190 metric tons by July 31).

A) Pros:

- reduces the potential for unnecessarily restrictive measures
- allows for the most fishing opportunity without compromising the plan objectives for GOM cod.

B) Cons:

- increased risk that GOM cod TAC could be exceeded if effort patterns change under the relaxed restrictions
- may make planning a fishing year strategy more difficult for some individual fishermen because of uncertainty about the full year's management measures, but since the rules would be relaxed under this system, the effect on the overall industry would likely be positive

Recommendations for the Recreational Fishery:

The MSMC compared the trends in landings for the recreational fishery and commercial fishery for Gulf of Maine cod. Recreational landings for 1998 were not available. From 1994 to 1996, recreational landings declined at a slower rate than commercial landings. However, recreational landings declined 67% from 1996 to 1997 while commercial landings declined by 25%. Overall, commercial landings have declined 48% from 1994 to 1998 and recreational landings have declined 67% from 1994 to 1997. If proportionality of decline in landings is used as the criterion for imposing further regulations on the recreational fishery, then the recreational fishery appears to have already reduced to landings "consistent with F_{max} target".

The MSMC recommends monitoring recreational fishery to ensure that landings from the recreational fishery are consistent with achieving the fishing mortality target for Gulf of Maine cod. The MSMC recommends using the Option for notice action to phase-in additional restrictions if recreational landings appear to be increasing in either 1998 or 1999.

General Recommendations:

The NEFMC **should continue to monitor technological improvements** in the fishery, and the potential that these improvements could compromise management based on Days at Sea. Technological improvements that increase fishery catch per unit effort will require more restrictive management measures to achieve and maintain mortality rates at or below rebuilding targets.

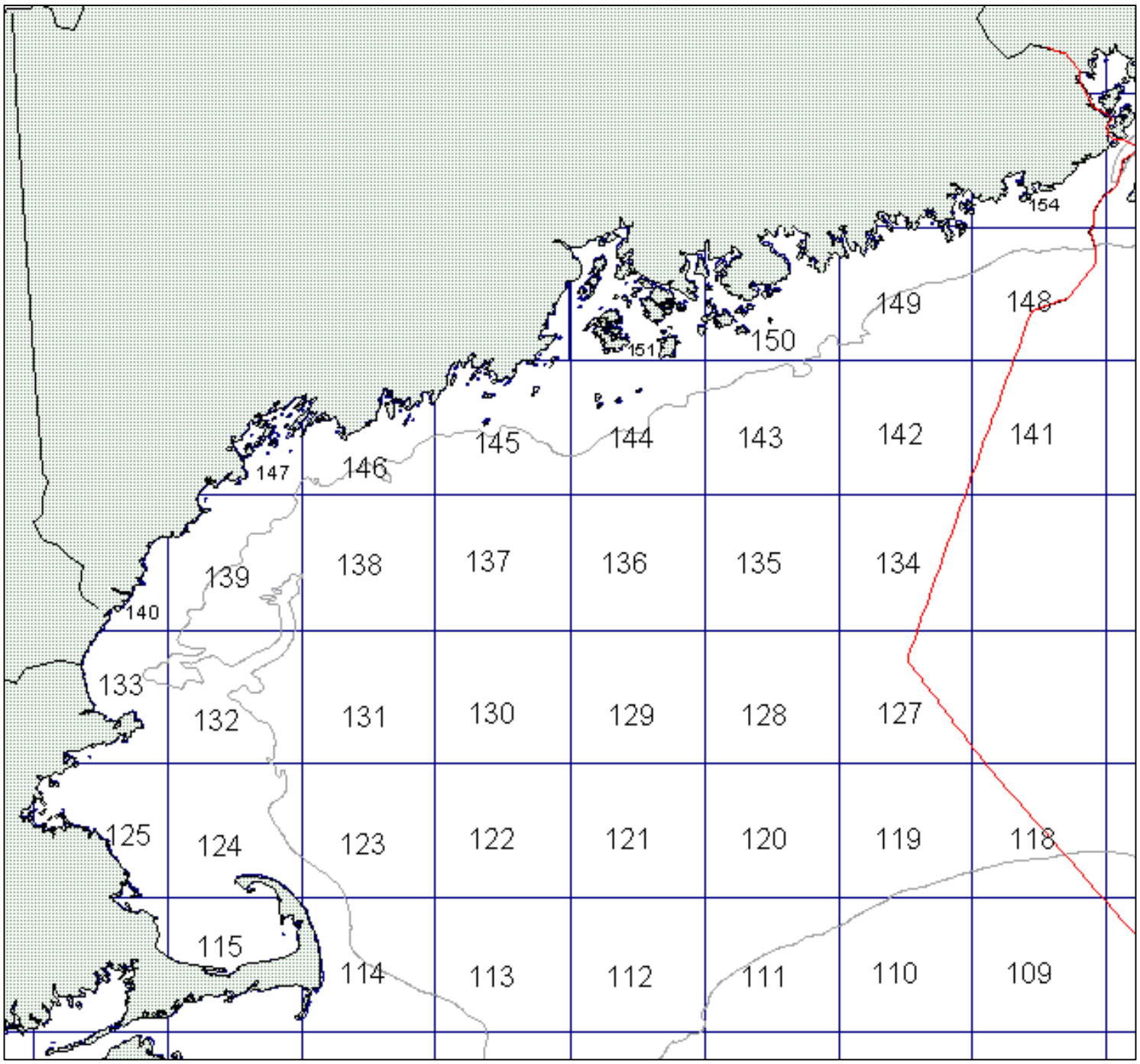
The MSMC **supports further experimentation of gear configuration** to improve size and species selectivity. Size-selectivity will become more important as stock biomass and recruitment improves. Current gear is capable of generating significant discards of pre-recruits. Regulatory discarding will increase as recruitment improves, leading to loss of potential yield and revenue. Improvements in species selectivity may also prove useful for providing protection to a "weak stock" while simultaneously allowing exploitation on species with co-occurring distributions. Additionally, small mesh fisheries may have a more difficult time achieving certification as the large mesh regulated species' distribution expands and recruitment improves.

The MSMC **recommends that additional at-sea sampling be conducted** to provide more precise estimates of discarding.

Comment on the Haddock Trip Limit

The MSMC did not evaluate the effectiveness of the haddock trip limit liberalization. However, USA landings increased threefold in 1998 and fishing mortality is projected to increase from 0.11 to 0.18 in 1998. Although fishing mortality remains below the Amendment 7 $F_{0.1}$ target, spawning stock biomass is not projected to be reach the proposed SFA ½ SSB_{MSY} threshold in 1999 and is projected to decline in year 2000 at the $F_{0.1}$ target. According to the proposed control rule, the projected spawning stock biomass in 1999 and 2000 indicate a fishing mortality rate approaching zero. If the Council chooses to continue the status quo trip limit for the 1999 fishing year, the liberalization provision should only apply to vessels possessing a GOM Cod Trip Limit Exemption Certificate.

Figure 9.1. Gulf of Maine divided into thirty minute squares used in defining area closures.



GLOSSARY

B_{MSY} – The stock biomass that would produce MSY when fished at a level equal to F_{MSY}. For most stocks, B_{MSY} is about ½ of the carrying capacity. The proposed overfishing definition control rules call for action when biomass is below ½ or ½ B_{MSY}, depending on the species.

Days absent – an estimate by port agents of trip length. This data was collected as part of the NMFS weighout system prior to May 1, 1994.

Days-at-sea (DAS) - the total days, including steaming time that a boat spends at sea to fish.

Exempt fisheries - Any fishery determined by the Regional Director to have less than 5 percent regulated species as a bycatch, by weight, of total catch according to 50 CFR §648.80(a)(7).

Exploitation rate - the percentage of catchable fish killed by fishing every year. If a fish stock has 1,000,000 fish large enough to be caught by fishing gear and 550,000 are killed by fishing during the year, the annual exploitation rate is 55%.

Fishing effort - the amount of time and fishing power used to harvest fish. Fishing power includes gear size, boat size and horsepower.

Fishing mortality (F) - (see *Mortality*)

Framework adjustments - adjustments within a range of measures previously specified in a fishery management plan (FMP). A change usually can be made more quickly and easily by a framework adjustment than through an amendment. For plans developed by the New England Council, the procedure requires at least two Council meetings including at least one public hearing and an evaluation of environmental impacts not already analyzed as part of the FMP.

Limited-access permits - permits issued to vessels that met certain qualification criteria by a specified date (the "control date").

Mortality: (see Fishing mortality, below)

Fishing mortality (F) - (also see *exploitation rate*) a measurement of the rate of removal of fish from a population by fishing. Fishing mortality (F) is the rate at which fish are harvested at any given point in time. ("Exploitation rate" is an annual rate of removal, "F" is an instantaneous rate).

$F_{0.1}$ - a conservative fishing mortality rate calculated as the F associated with 10 percent of the slope at origin of the yield-per-recruit curve.

F_{MAX} – a fishing mortality rate that maximizes yield per recruit. F_{MAX} is less conservative than $F_{0.1}$.

F_{MSY} – a fishing mortality rate that would produce MSY when the stock biomass is at a level capable of producing MSY on a continuing basis.

Natural mortality - a measurement of the rate of fish deaths from all causes other than fishing such as predation, disease, starvation and pollution. The rate of natural mortality may vary from species to species, but is assumed to be M=0.2 for the five critical stocks.

Minimum spawning stock threshold - the minimum spawning stock size (or biomass) below which there is a significantly lower chance that the stock will produce enough new fish to sustain itself over the long term.

Multispecies - the group of species managed under the Northeast Multispecies Fishery Management Plan. This group includes whiting, red hake and ocean pout plus the regulated species (cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, windowpane flounder, white hake and redfish).

Open access - describes a fishery or permit for which there is no qualification criteria to participate. Open-access permits may be issued with restrictions on fishing (for example, the type of gear that may be used or the amount of fish that may be caught).

Overfished - A measure of stock biomass that is below a threshold level that would provide adequate spawning activity, ie. the stock's productive capacity.

Overfishing - A level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis.

Possession-limit-only permit - an open-access permit (see above) that restricts the amount of multispecies a vessel may retain (currently 500 pounds of "regulated species").

Recruitment - the amount of fish added to the fishery each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to fishing gear in one year would be the recruitment to the fishery. “Recruitment” also refers to new year classes entering the population (prior to recruiting to the fishery).

Regulated groundfish species - cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, windowpane flounder, white hake and redfish. (These species are usually caught with large-mesh net gear.)

Relative exploitation – an index of exploitation derived by dividing landings by trawl survey biomass. This measure does not provide an absolute magnitude of exploitation but allows for general statements about trends in exploitation.

Spawning stock biomass (SSB) - the total weight of fish in a stock that are old enough to reproduce.

Stock - a grouping of fish usually based on genetic relationship, geographic distribution and movement patterns. A region may have more than one stock of a species (for example, Gulf of Maine cod and Georges Bank cod).

Survival ratio (R/SSB) – an index of the survivability from egg to age-of-recritment. Declining ratios suggest that the survival rate from egg to age-of-recruitment is also declining.

TAC - Total allowable catch. This value is calculated by applying a target fishing mortality rate to exploitable biomass.

Two-bin (displacement) model – a model used to estimate the effects of area closures. This model assumes that effort from the closed areas (first bin) is displaced to the open areas (second bin). The total effort in the system is then applied to the landings-per-unit-effort (LPUE) in open areas to obtain a projected catch. The percent reduction in catch is calculated as a net result.

Yield-per-recruit (YPR) – the expected yield (weight) of individual fish calculated for a given fishing mortality rate and exploitation pattern and incorporating the growth characteristics and natural mortality.