5.0 STATUS OF THE STOCKS and 1998 PROJECTION RESULTS

The following status of the stocks is based on updated assessments reviewed by 27th Northeast Regional Stock Assessment workshop. All stock assessments were based on a calendar year, January 1 through December 31. Calendar year 1998 forecasts were completed by projecting from January 1998 stock sizes in the SARC 27 assessments. Values for starting stock sizes on January 1, 1998, partial recruitment, maturity at age, catch mean weight, and stock mean weight at age vectors were used from the SARC 27 assessments in the forecasts. Projected 1998 calendar year landings (see section 2.0 for methodology) were used to forecast calendar year 1998 fishing mortality rate, spawning stock biomass and stock size on January 1, 1999. The 1999 Target TACs and spawning stock biomass were calculated by applying the 1998 target fishing mortality rates to projected January 1, 1999 stock sizes.

5.1 General summary of status of stocks through 1997

Stock status has improved for Georges Bank cod, Georges Bank haddock, Georges Bank yellowtail, and Southern New England yellowtail (Table 5.1). Fishing mortality in 1997 for these stocks are below the overfishing definitions and are near or slightly below the Amendment 7 fishing mortality targets for rebuilding the stocks (Table 5.16, Figures 5.1-5.5). Spawning stock biomass has increased for these stocks but, with the exception of Georges Bank yellowtail, remain below Amendment 7 spawning stock biomass thresholds (Table 5.17). In general, recruitment is below long term averages with the exception of Georges Bank yellowtail (Table 5.18).

The status of Gulf of Maine cod has worsened. The fishing mortality rate remains well above the overfishing definition ($F_{20\%}$=0.41) and Amendment 7 mortality target (F_{max}=0.29). Recruitment has been very poor since the 1992 year class, with each succeeding year class reaching a new timeseries low. Survival ratios (R/SSB) have declined in recent years and have reached a new record low. Spawning stock biomass is at a record low and is projected to decline further.

Table 5.1. Summary of status of stocks through 1997 for 5 major groundfish stocks. Taken from SAW 27 Advisory report (1998).

Stock	Current fishing Mortality	1995-1997 recruitment	1995-1997 SSB	Biomass Threshold
GB cod	Above target	Low	Low/increasing	Well below
GB haddock	Below target	Low	Low/increasing	Below
GB yellowtail	Below target	Average	Low/increasing	Above
SNE yellowtail	Below target	Low	Low/increasing	Below
GOM cod	Well above target	Low	Low/decreasing	Not defined

5.2 Stock status and projection results for Georges Bank/Southern New England stocks

5.2.1 Georges Bank cod

Fishing mortality increased to 0.26 and is above the Amendment 7 target level of 0.18 (Figure 5.1). Recruitment in recent years has been the lowest on record with poor year classes in 1994, 1995 and 1996 (Table 5.18, Figure 5.1). Spawning stock biomass has increased since reaching a record low in 1994 (Table 5.17). Spawning stock biomass in 1997 was 36,000 metric tons, well below the 70,000 metric ton Amendment 7 threshold.

The yield per recruit analysis was updated using arithmetic means of 1995-1997 stock and catch mean weights, an updated 1994-1997 maturity ogive (Tables 5.2) and partial recruitment vector from 1994-1997 (Table 5.3). The recalculated biological reference points were $F_{0.1}$= 0.18, F_{max}=0.34 and $F_{20\%}$=0.41 (Table 5.4).

Table 5.2. Comparison of maturity ogives used in the SARC 24 (1997) and SARC 27 (1998) Georges Bank cod assessments.

	Years	Age 1	Age 2	Age 3	Age 4
SARC 24	1994-1996	0.23	0.64	0.91	0.98
SARC 27	1994-1997	0.04	0.44	0.93	1.00

Table 5.3. Exploitation pattern used in Yield per recruit analyses for Georges Bank cod from SARC 24(1997) and SARC 27 (1998).

	Years	Age 1	Age 2	Age 3	Age 4+
SARC 24	1994-1996	0.0003	0.1318	0.5316	1.000
SARC 27	1995-1997	0.0001	0.1700	0.6600	1.000

Table 5.4. Comparison of biological references points from SARC 24(1997) and SARC 27 (1998) assessments of Georges Bank cod.

	$F_{0.1}$	F_{max}	$F_{20\%}$
SARC 24 (1997)	**0.17**	**0.34**	**0.43**
SARC 27 (1998)	**0.18**	**0.34**	**0.41**

Projection results

The projected fishing mortality rate for calendar year 1998 is 0.22 (Table 5.16). Spawning stock biomass is projected to increase to 39,272 metric tons in 1998, which is 56% of the Amendment 7 threshold of 70,000 metric ton (Table 5.17). Spawning stock biomass will increase slowly to 41,243 metric tons in 1999 at F=0.18. The increase in spawning stock biomass is being driven primarily by growth due to low fishing mortality. The probability of spawning stock biomass exceeding the 70,000 metric ton threshold in 1999 is zero. Recent recruitment (1992-1996 year classes) has been below the long-term median (Table 5.18). The 1994 and 1995 year classes are the lowest in the time series.

The 1999 total target TAC for this stock is 7,254 metric tons (Table 5.19). Assuming that the 1999 Canadian quota will be equal to the 1998 quota (1,900 metric tons), the 1999 US TTAC will be 5354 metric tons. This represents a 14% increase over the1998 US TTAC.

SFA implications

Beginning year biomass was 46,398 metric tons 1998. Biomass is projected to increase to 49,098 metric tons in 1999 at F_{98}=0.22 and F_{99}=0.18. This is well below the 108,000 metric ton B_{MSY} and the 54,000 metric ton ½ B_{MSY} benchmarks. There is less than a 19% probability that biomass will exceed ½ B_{MSY} in 1999. The proposed control rule recommends a biomass weighted target fishing mortality rate of 0.12 (fully recruited F = 0.14) for the projected 1999 biomass of 49,098 metric tons.

5.2.2 Georges Bank Haddock

The fishing mortality rate declined to 0.11, which is below the $F_{0.1}$ target of 0.26 (Table 5.16, Figure 5.2). Recent recruitment is moderate for the assessment time series (1963-1996), but below recruitment levels estimated prior to 1963 (Table 5.18). Spawning stock biomass has increased threefold since reaching a record low level in 1993 (Table 5.17). However, the 1997 estimate of 40,472 metric tons is well below the 80,000 metric ton Amendment 7 threshold and 120,000 metric ton average for 1931-1960 time period.

The yield per recruit analysis was not updated in SARC 27, but the maturity ogive and exploitation pattern used to derive current biological reference points are shown in Table 5.5 and Table 5.6. Biological reference points from SARC 24 were estimated as $F_{0.1}$= 0.26 and $F_{30\%}$=0.45 (Table 5.7).

Table 5.5. Maturity ogives used in the SARC 24 (1997) yield per recruit analysis for Georges Bank haddock. Yield per recruit analysis not updated in SARC 27 (1998) Georges Bank haddock assessments.

	Years	Age 1	Age 2	Age 3	Age 4
SARC 24	1994-1996	0.02	0.34	0.94	1.00
SARC 27	1995-1997	0.02	0.34	0.94	1.00

Table 5.6. Comparison of exploitation pattern used for yield per recruit analysis for Georges Bank haddock in SARC 20 (1994) and SARC 24 (1997). Yield per recruit was not updated in SARC 27.

	Years	Age 1	Age 2	Age 3	Age 4	Age 5+
SARC 20	1993-1994	0.00	0.07	0.65	1.00	1.00
SARC 24	1995-1996	0.00	0.04	0.38	0.72	1.00
SARC 27	Yield per recruit not updated					

Table 5.7. Comparison of biological references points from SARC 20 (1994) and SARC 24 (1997) for Georges Bank haddock. Reference points not updated in SARC 27.

	$F_{0.1}$	$F_{30\%}$
SARC 20	**0.24**	**0.35**
SARC 24	**0.26**	**0.45**
SARC 27	**not revised**	

Projection results

The 1998 calendar year fishing mortality rate is projected to be 0.18, which is below the Amendment 7 target of 0.26 (Table 5.16). Spawning stock biomass is projected to be 51,593 metric tons in 1998, which is 64% of the Amendment 7 threshold of 80,000 metric ton (Table 5.17). Spawning stock biomass will increase to 52,988 metric tons in 1999. The probability that spawning stock biomass exceeds the 80,000 metric ton threshold is less than 1%. Recent recruitment has been near the long term median, but remains well below the long-term average (Table 5.18).

The total 1999 target TAC is estimated to be 9550 metric tons (Table 5.19). Assuming that the 1999 Canadian quota equals the 1998 Canadian quota of 3,900 metric tons, the 1999 US target TAC will be 5,600 metric tons. This represents an increase of 17% from 1997's US target TAC.

SFA implications

A spawning stock biomass of 105,000 metric tons (SSB_{MSY}) is used as a proxy for $B_{MSY.}$ Spawning biomass was 51,593 metric tons in 1998 and is projected to increase to 52,988 metric tons in 1999 at F_{98}=0.18 and F_{99} = 0.26. This is well below the SSB_{MSY} but near the 53,000 metric ton ½ SSB_{MSY} benchmarks. There is a 50% probability that spawning stock biomass will exceed ½ B_{MSY} in 1999. Spawning stock biomass is projected to decline to 47,263 metric tons in 2000. The control law recommends zero fishing mortality for spawning biomass below ½ SSB_{MSY} (53,000 metric tons).

5.2.3 Georges Bank yellowtail

The 1997 fishing mortality rate of 0.08 remains below the $F_{0.1}$ reference point of 0.25 (Table 5.16). Recent recruitment has been slightly below average in 1995 and 1997 (Table 5.18). Spawning stock biomass has increased to 15,700 metric tons in 1997, and is above the 10,000 metric ton threshold (Table 5.17). However, current spawning biomass is well below historic levels.

Biological reference points were recalculated using updated estimates of weight at age, maturity at age (Table 5.8), and exploitation pattern (Table 5.9). Results were similar to those of the previous assessment: $F_{0.1}$= 0.25, and $F_{20\%}$=0.69 (Table 5.10).

Table 5.8. Comparison of maturity ogives used in the SARC 24 (1997) and SARC 27 (1998) assessments of Georges Bank yellowtail.

	Years	Age 1	Age 2	Age 3	Age 4	Age 5+
SARC 24	1994-1996	0.00	0.93	1.00	1.00	1.00
SARC 27	1994-1997	0.00	0.52	0.86	0.98	1.00

Table 5.9. Comparison of exploitation pattern on Georges Bank yellowtail for SARC 12(1991), SARC 18 (1994), SARC 24 (1997) and SARC 27 (1998).

	Years	Age 1	Age 2	Age 3	Age 4	Age 5+
SARC 12	1985-1989	0.13	0.44	1.00	1.00	1.00
SARC 18	1993	x.xx[1]	0.14	0.51	1.00	1.00
SARC 24	1994-1996	0.02	0.07	0.60	0.97	1.00
SARC 27	1994-1997	0.00	0.09	0.54	0.96	1.00

[1]F on age 1 not estimated

Table 5.10. Comparison of biological references points from SARC 12(1991), SARC 24(1997) and SARC 27(1998) for Georges Bank yellowtail.

	$F_{0.1}$	$F_{20\%}$	F_{max}
SARC 12	**0.25**[1]	**0.58**	**0.63**
SARC 18	**not revised from SARC 12**		
SARC 24	**0.24**	**0.64**	**0.61**
SARC 27	**0.25**	**0.69**	**0.82**[*]

[*] **F_{max} not well defined.**
[1]**$F_{0.1}$ was misreported as 0.28 in SARC 18 and 1996 MSMC report**

Projection results

The 1998 fishing mortality rate is projected to be 0.17, which is below the Amendment 7 target of F=0.25 (Table 5.16, Figure 5.3). Spawning stock biomass is projected to increase to 17,573 metric tons in 1998, which is 176% above the Amendment 7 biomass threshold of 10,000 metric ton (Table 5.17, Figure 5.3). Spawning stock biomass is projected to increase to 20,152 metric tons in 1999 at F=0.25. The probability spawning stock biomass exceeding the 10,000 metric ton threshold in 1999 is greater than 99%. With the exception of the 1995 year class, recent recruitment (1993-1996 year classes) has been near the long-term median (Table 5.18). The 1995 year class is near the 25th percentile.

The 1999 total target TAC is estimated to be 3,925 metric tons (Table 5.19). Assuming that the 1999 Canadian quota is equal to the 1998 Canadian quota (1,200 metric tons), the US target TAC will be 2,725 metric tons. This represents a 27% increase over 1997 target TAC.

SFA considerations

Beginning year biomass was 25,596 metric tons 1998. Biomass is projected to increase to 29,281 metric tons in 1999. This is below 44,000 metric ton B_{MSY} but above the 22,000 metric ton ½ B_{MSY} benchmarks. There is less than a 1% probability that biomass will exceed B_{MSY} in 1999 and a 96% probability that biomass will exceed ½ B_{MSY}. Biomass is projected to increase to 30,326 metric tons in 2000 at F_{99}=0.25. The proposed control law recommends a target biomass weighted F = 0.21 (equivalent to fully recruited F of 0.32) to allow rebuilding to B_{MSY} within 5 years.

5.2.4 Southern New England yellowtail

Fishing mortality declined to 0.07 in 1997 which is below the $F_{0.1}$=0.27 rebuilding threshold (Table 5.16). Recruitment has been poor: all recent year classes are well below the historic average (Table 5.18). Since 1994, spawning stock biomass has slowly increased to 4,200 metric tons in 1997 (Table 5.17). This is well below the 10,000 metric ton Amendment 7 threshold. Given the recent poor recruitment, SARC 27 projected spawning stock biomass to increase slowly under status quo F.

The exploitation pattern in 1997 is similar to the recent 1994-1996 reported in SARC 24 (Table 5.11). Biological reference points were not recalculated and remain as follows: $F_{0.1}$= 0.27, F_{max}= 0.65 and $F_{20\%}$= 0.94 (Table 5.12).

Table 5.11. Exploitation pattern for Southern New England yellowtail from SARC 12 (1991), SARC 17 (1992), SARC 24 (1997) and SARC 27 (1998).

	Years	Age 1	Age 2	Age 3	Age 4+
SARC 12	1985-1989	0.060	0.470	1.000	1.000
SARC 17	1992	0.020	0.350	1.000	1.000
SARC 24	1994-1996	0.010	0.118	0.287	1.000
SARC 27		0.010	0.118	0.287	1.000

Table 5.12. Comparison of biological references points for Southern New England yellowtail from SARC 12, SARC 17, SARC 24 and SARC 27.

	$F_{0.1}$	F_{max}	$F_{20\%}$
SARC 12	0.22	0.48	0.49
SARC 17	Not revised from SARC 12		
SARC 24	0.27	0.65	0.94
SARC 27	Not revised from SARC 24		

Projection results

The fishing mortality rate in 1998 is projected to be 0.07, which is below the Amendment 7 target of F=0.27 (Table 5.16, Figure 5.4). Spawning stock biomass is projected to increase to 6,584 metric tons in 1998, which is 66% of the Amendment 7 biomass threshold (Table 5.17). Spawning stock is projected to increase to 7,847 metric tons in 1999 at F=0.27. The probability of Spawning stock biomass exceeding the 10,000 metric ton threshold in 1999 is 11%. Recent recruitment (1993-1996 year classes) has all been below the long-term median (Table 5.18). The 1992 and 1995 year classes are below the 25th percentile of the time series.

The 1999 target TAC is estimated to be 1,115 metric tons (Table 5.19). This is a 37% increase from the 1998 target TAC.

SFA considerations

Beginning year biomass was 8,785 metric tons 1998. Biomass is projected to increase to 10,305 metric tons in 1999 at the F_{98}=0.07 and F_{99}=0.27. This is well below the 51,000 metric ton B_{MSY} and below the 12,800 metric ton ¼ B_{MSY} benchmarks. There is an 11% probability that biomass will exceed ¼ B_{MSY} in 1999. Biomass is projected to increase slightly to 10,375 in 2000 at F_{99}=0.27. There is only a 13% probability that biomass will rebuild to ¼ B_{MSY} by the year 2000. The proposed control law recommends zero fishing mortality for biomass below ¼ B_{MSY} (12,800 metric tons).

5.3 Gulf of Maine cod

The fishing mortality rate on Gulf of Maine cod declined from 1996 but remains at a very high rate ($F_{1996)}$ =0.75) in 1997, and must be reduced significantly (Table 5.16, Figure 5.5). The current mortality rate on GOM cod is nearly 2 times higher than the overfishing definition, and 2.6 times the 1997 F_{max} target of 0.29. The 1995, and 1996 year classes are the poorest in the time series (Table 5.18). The 1997 spawning stock biomass is at a record low (Table 5.17) and is projected to continue to decline through 1999 at $F_{status\ quo}$. The SARC advised that record low spawning stock biomass, high fishing mortality, record low recruitment, and record low levels of survival of pre-recruit fish indicate that the stock is collapsing. The SARC recommended an immediate reduction in fishing mortality to levels approaching zero.

The yield per recruit analysis was updated using a recent maturity ogive for 1994-1997 which reflects earlier maturation (Table 5.13). Exploitation on younger ages is similar to exploitation pattern seen in SARC 24 (Table 5.14). The recalculated biological reference points, $F_{0.1}$ = 0.16, F_{max}=0.29, and $F_{20\%}$=0.41 were similar to SARC 24 reference points (Table 5.15).

Table 5.13. Comparison of maturity ogives used in the SARC 24 (1997) and SARC 27 (1998) assessments of gulf of Maine cod.

	Years	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
SARC 24	**1994-1996**	**0.09**	**0.24**	**0.54**	**0.81**	**0.94**	**1.00**
SARC 27	**1994-1997**	**0.04**	**0.38**	**0.89**	**0.99**	**1.00**	**1.00**

Table 5.14. Comparison of exploitation pattern on Gulf of Maine cod from SARC 19 (1995) and SARC 24 (1997).

	Years	Age1	Age 2	Age 3	Age 4	Age 5+
SARC 19	**1988-1992**	**0.000**	**0.054**	**0.402**	**0.878**	**1.000**
SARC 24	**1994-1996**	**0.000**	**0.028**	**0.211**	**0.768**	**1.000**
SARC 27		**0.000**	**0.027**	**0.230**	**0.786**	**1.000**

Table 5.15. Comparison of biological references points for Gulf of Maine cod from SARC 19 (1995), SARC 24 (1997), and SARC 27 (1998).

	$F_{0.1}$	F_{max}	$F_{20\%}$
SARC 19	0.16	0.27	0.35
SARC 24	0.16	0.29	0.37
SARC 27	0.16	0.29	0.41

Projection results based on F_{max} fishing mortality target

Fishing mortality in 1998 was projected to be 0.82, and represents a slight increase from F=0.75 in 1997 (Table 5.16, Figure 5.5). The F=0.82 remains well above the overfishing definition of F=0.41. Spawning stock biomass is projected to decrease in 1998 to 6,565 metric tons, a new time series low (Table 5.17). Spawning stock biomass will decrease to 6015 metric tons if the 1999 mortality target of F=0.29 is achieved. This is still below any spawning stock observation in the 1982-1997 time series. Recent recruitment (1993-1995 year classes) has been well below the long-term median (Table 5.18) with the size of each new year class being half of its predecessor. The 1994 and 1995 year classes are below the 25th percentile, and the 1995 year class is the lowest in the time series. The distribution of recruitment in 1999 and 2000 was derived by resampling recruitment of the 1993, 1994 and 1996 yearclasses. The target TAC for 1999, based on F_{max}, is 1,340 metric tons (Table 5.19). This is a 25% decline from the 1998 target TAC and a 67% drop from the 1998 landings of 4,075 metric tons.

Projections based on $F_{0.1}$ fishing mortality target

MSMC also ran projections for 1999 using an $F_{0.1}$ as a fishing mortality target. Spawning stock biomass will decrease slightly to 6,122 metric tons in 1999 if a mortality target of $F_{0.1}$=0.16 is achieved. This is still below any spawning stock observation in the 1982-1997 time series. The target TAC for 1999, based on $F_{0.1}$, is 782 metric tons (Table 5.19). This represents an 81% drop from the projected 1998 landings of 4,075 metric tons.

SFA considerations

Beginning year biomass was 8,069 metric tons 1998. Biomass is projected to decrease to 7,762 metric tons in 1999 at the F_{98}=0.82 and F_{99}=0.16. This is well below the 33,000 metric ton B_{MSY} and below the 8,300 metric ton ¼ B_{MSY} benchmarks. There is a 42% probability that biomass will exceed ¼ B_{MSY} in 1999. Biomass is projected to increase slightly to 10,301 in 2000 at F_{99}=0.16. There is 77% probability that biomass will rebuild to ¼ B_{MSY} by the year 2000 but this is predicated on obtaining recruitment equal to average recruitment from the 1993, 1994 and 1995 year classes. Given the declining trend in recruitment and no evidence of improved recruitment in recent survey indices, this projection may be optimistic. The proposed control law recommends zero fishing mortality when biomass is below ¼ B_{MSY} (8,300 metric tons).

Preliminary 1998 Mass Division of Marine Fisheries Trawl spring and fall survey results.

SURVAN analyses of unaudited 1998 DMF survey data were produced for Gulf of Maine cod. Results should be considered preliminary and cautiously interpreted. The spring and fall age zero indices are highly variable and are not used in the tuning of the VPA. For example, the large 1987 year class was detected by the fall survey but not by the spring survey. Similarly, the 1993 spring and fall indices indicated a moderately good year class but this did not materialize in the VPA. However, the VPA does not include discards; substantial discarding may cause an underestimate of year class size.

The 1998 spring biomass index (5.7 kgs/tow) represents a near doubling from the 1997 record low value of 2.97. This is not inconsistent with reports of increased CPUE in the commercial fishery in the western Gulf of Maine. However, the 1998 value is the 5th lowest in the 21 year time series and is nearly half the median (9.67). The spring 1998 survey index suggests that biomass for GOM cod remains low.

The spring 1998 age 0 index increased to 18.53 and is well above the median but substantially below the 1979 (56.4) and 1993 (69.0) values. The spring age 1 index was 8.51 and is near the time series median. This is the highest value since 1989. However, the Mass spring age 1 index is not used in the tuning because of poor fit with VPA age 1 stock size estimates.

MDMF Fall survey for GOM cod

The **fall age 0 index** increased to 2.7 per tow, which is slightly above the 1997 value and is near the 1995 value. This is well below the median (4.7) and is the 6th lowest value in the 21 year time series. Thus the spring and fall surveys are providing inconsistent information on the size of the 1998 year class. The 1998 fall survey does not suggest the presence of a moderate year class. The **fall age 1 index** of 0.68 showed a slight improvement over the 1996 and 1997 values but remains well below the median value of 2.3. The fall age 0 is not used in tuning the VPA because of a poor fit with VPA stock size estimates.

Fall biomass (0.56 kg/tow) increased over 1997 and 1996 values, but remains below the median value of 0.8. However, the fall index is not a good index of abundance as the bulk of the catch consists of age 0 and 1.

NEFSC 1998 spring survey results

The spring 1998 NEFSC index of total stock biomass declined between 1997 and 1998, although it remained slightly higher than the low 1994 and 1995 indices. Abundance indices for age 2 Gulf of Maine cod rose slightly between 1997 (1995 year class) and 1998 (1996 year class), but the 1998 index of recruitment remained relatively low compared to the long-term mean.

Conclusions: Preliminary information from the Mass Division of Marine Fisheries and the NEFSC spring 98 surveys is consistent with the conclusion of low stock biomass and poor recruitment for Gulf of Maine cod.

Table 5.16. Fishing mortality rates for 5 major stocks of groundfish along with target mortality rates. GB= Georges Bank, SNE= Southern New England GOM= Gulf of Maine, yt=yellowtail, hdk= haddock. F_{1996}, F_{1997} and biological reference points estimated from the SARC 27 assessments.

	GB cod	GB hdk	GB yt	SNE yt	GOM cod
F_{1996}	0.20	0.15	0.19	0.42	0.95
F_{1997}	0.26	0.11	0.13	0.07	0.75
Projected F_{1998}	0.22	0.18	0.17	0.07	0.82
Target F_{1998}	0.18	0.26	0.25	0.27	0.29
Overfishing F[1]	0.41	0.45	0.69	0.94	0.41

[1]Amendment 7 overfishing definitions

Table 5.17. Spawning stock biomass (000's metric tons) for 5 major stocks of groundfish. Projected SSB 1998 values assume achieving 1998 target F. GB=Georges Bank, SNE= Southern New England, GOM= Gulf of Maine, hdk= haddock, yt= yellowtail, SSB= spawning stock biomass. SSB_{1996} values are from SARC 27 assessments.

	GB cod	GB hdk	GB yt	SNE yt	GOM cod
SSB_{1996}	34.2	33.5	10.7	2.9	12.6
SSB_{1997}	36.0	40.5	15.7	4.3	8.6
projected SSB_{1998}	39.3	51.6	17.6	6.6	6.6
Threshold	70.0	80.0	10.0	10.0	n/a
1998 SSB as %threshold	56%	64%	176%	66%	n/a
Projected SSB_{1999}	41.2	52.3	20.2	7.8	6.0
Mean SSB (years)	61.2 (78-97)	48.8 (63-97)	7.6 (73-97)	7.4 (73-97)	15.8 (82-96)

Table 5.18. Recent recruitment (millions) for Georges Bank cod, Georges Bank haddock and Gulf of Maine cod compared to long term means and medians.

Year class	GB cod (Age 1)	GB haddock (Age 1)	GB yt (Age 1)	SNE yt (Age 1)	GOM cod (Age 2)
1993	10.1	13.4	27.0	6.5	2.8
1994	3.5	10.1	20.9	7.0	1.3
1995	6.2	8.9	14.8	5.6	0.9
1996	6.5	13.8	21.1	12.5	xx
Mean (93-96)	6.6	11.5	21.0	7.9	1.7
Longterm Mean	17.4	32.3	23.5	28.1	5.5
Median	16.1	10.0	20.9	14.6	4.7
year classes	(77-96)	(62-96)	(72-96)	(72-96)	(80-95)

Table 5.19. Projected 1999 US target TACs in 000's of metric tons for Georges Bank cod, Georges Bank haddock, Georges yellowtail, Southern New England yellowtail and Gulf of Maine cod. US TACs assume that the 1999 Canadian quota will equal the 1999 Canadian quota for GB cod, haddock and GB yellowtail. n/a= not applicable.

	GB cod	GB hdk	GB yt	SNE yt	GOM Cod
1998 US landings	6.3	3.4	1.1	0.2	4.1
1999 Target TAC (entire stock)	7.3	9.6	3.9	1.1	1.3*
Assumed 1999 Canadian quota	1.9	3.9	1.2	n/a	n/a
1999 US TTAC	5.4	5.6	2.7	1.1	1.3*
Mean US landings	23.6	12.5	6.5	4.0	10.3
Metric tons (years)	(78-97)	(63-97)	(73-97)	(73-97)	(82-97)

*Target TAC for GOM cod is 782 based on $F_{0.1}$ target mortality rate.

5.4 Commercial Catch per unit effort as a metric of population biomass

Commercial catch per unit effort is affected by many factors including exploitable stock size, changes in the temporal and geographic species distribution, improvements in gear technology, and fishermen behavior. For example, changes in distribution and density of a species may increase vulnerability to fishing gear, i.e., fishing effort on localized dense aggregations of fish may produce some periods of higher or stable commercial catch rates even though stock size is declining. This pattern of maintaining high catch rates despite declining biomass is termed hyperstability. This pattern can occur when effort concentrates in the center of abundance and fish remain concentrated as abundance declines (Hilborn and Walters, 1992). The literature is rich with examples of stable CPUE concurrent with declining stock abundance subsequent to stock collapse. Use of commercial catch rates as an indicator of stock abundance contributed to the failure to recognize the magnitude of the decline of Northern cod biomass in the mid-1980's (Hutchings, 1996). Commercial CPUE data suggested a threefold increase in abundance from 1978-1988 while fishery independent surveys suggested little change (Hutchings et. al, 1994).

Public testimony presented at recent Council and Groundfish Oversight Committee meetings suggests increasing catch rates of cod in the Western Gulf of Maine. Both the NEFSC and the MADMF trawl surveys strongly suggests that Gulf of Maine cod biomass is at or near a record low. The MADMF survey is limited to the Massachusetts territorial waters within statistical areas 514 and 513. The NEFSC survey, which covers the entire Gulf of Maine area, indicates a contraction in the distribution of high cod catches in the Gulf of Maine (Figures 5.6 and 5.7). High cod catches were more widely distributed in 1979-1983 (Figure 5.6) than in 1994-1998 (Figure 5.7). Survey catches greater than 100 kgs are now restricted to inshore areas of statistical areas 514 and 513, the historic center of abundance for Gulf of Maine cod. Thus, the inshore Gulf of Maine cod fishery has the necessary elements to create hyperstability. Effort is concentrated where the highest density of the stock now occurs, the VPA and survey indices indicate the stock is declining, the distribution of the fish appears to be contracting, and local distribution and movement of cod are well known to local fishers.

5.5 Recent declines in landings of Gulf of Maine cod.

Landings of Gulf of Maine cod have declined steadily over the past 6 years from 10,900 metric tons in 1992 to an estimated 4,075 metric tons in 1998, a 62% reduction. This reduction occurred partially in response to management measures first implemented in 1994, but the decline also reflects reductions in stock biomass over the same period. Since 1994, spawning stock biomass has fluctuated due to recruitment but, overall, SSB has declined from 12,000 metric tons to 6,565 metric tons in 1998, a 46% reduction. Commercial landings declined 48% over the same period.

Measures to reduce fishing mortality on groundfish stocks were initially implemented in 1994 under Amendment 5, but the fully recruited fishing mortality for Gulf of Maine cod has remained high throughout this period, either close to or exceeding 1.0. The lack of a substantial decline in F, commensurate with the decline in landings, is due to similar percent reduction in landings and exploitable biomass. Without implementation of previous management measures, fishing mortality would have likely increased on this stock.

Fig. 5.1. MSMC 1998 projection and SARC 27 assessment results for Georges Bank cod (+ SARC 27 VPA, * MSMC projections).

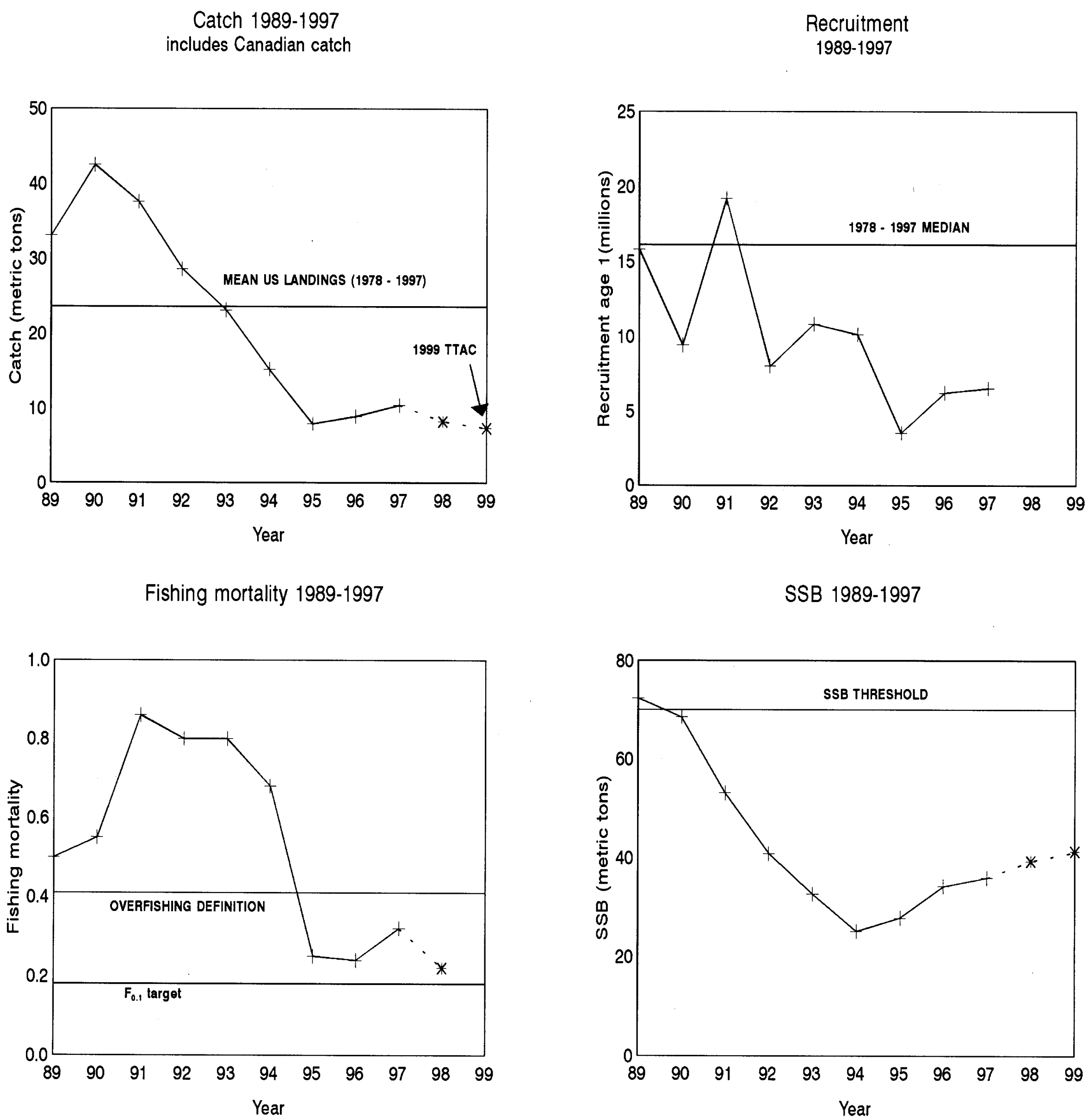


Fig. 5.2. MSMC 1998 projection and SARC 27 assessment results for Georges Bank haddock (+ SARC 27 VPA, * MSMC projections).

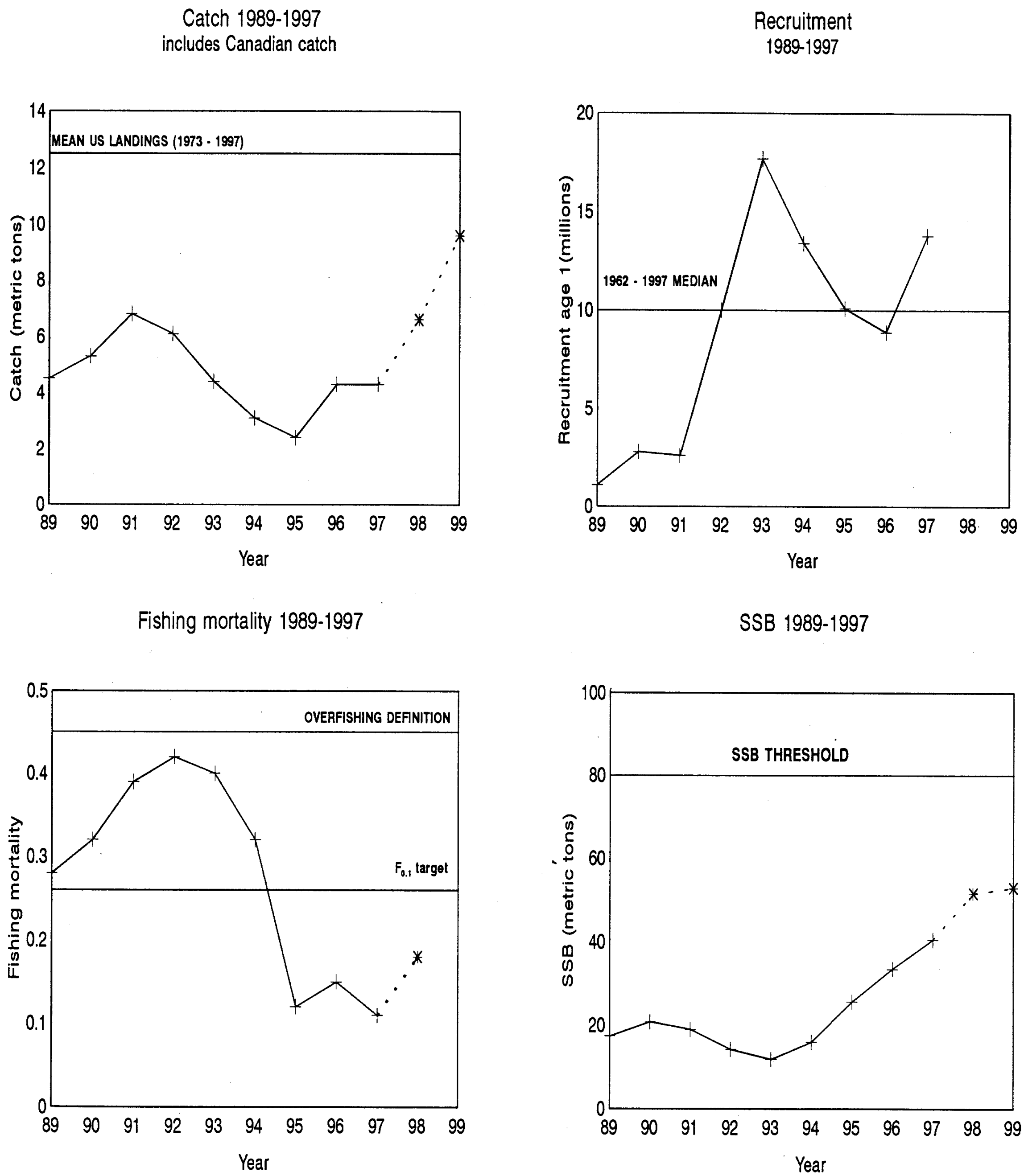


Fig. 5.3. MSMC 1998 projection and SARC 27 assessment results for Georges Bank yellowtail(+ SARC 27 VPA, * MSMC projections).

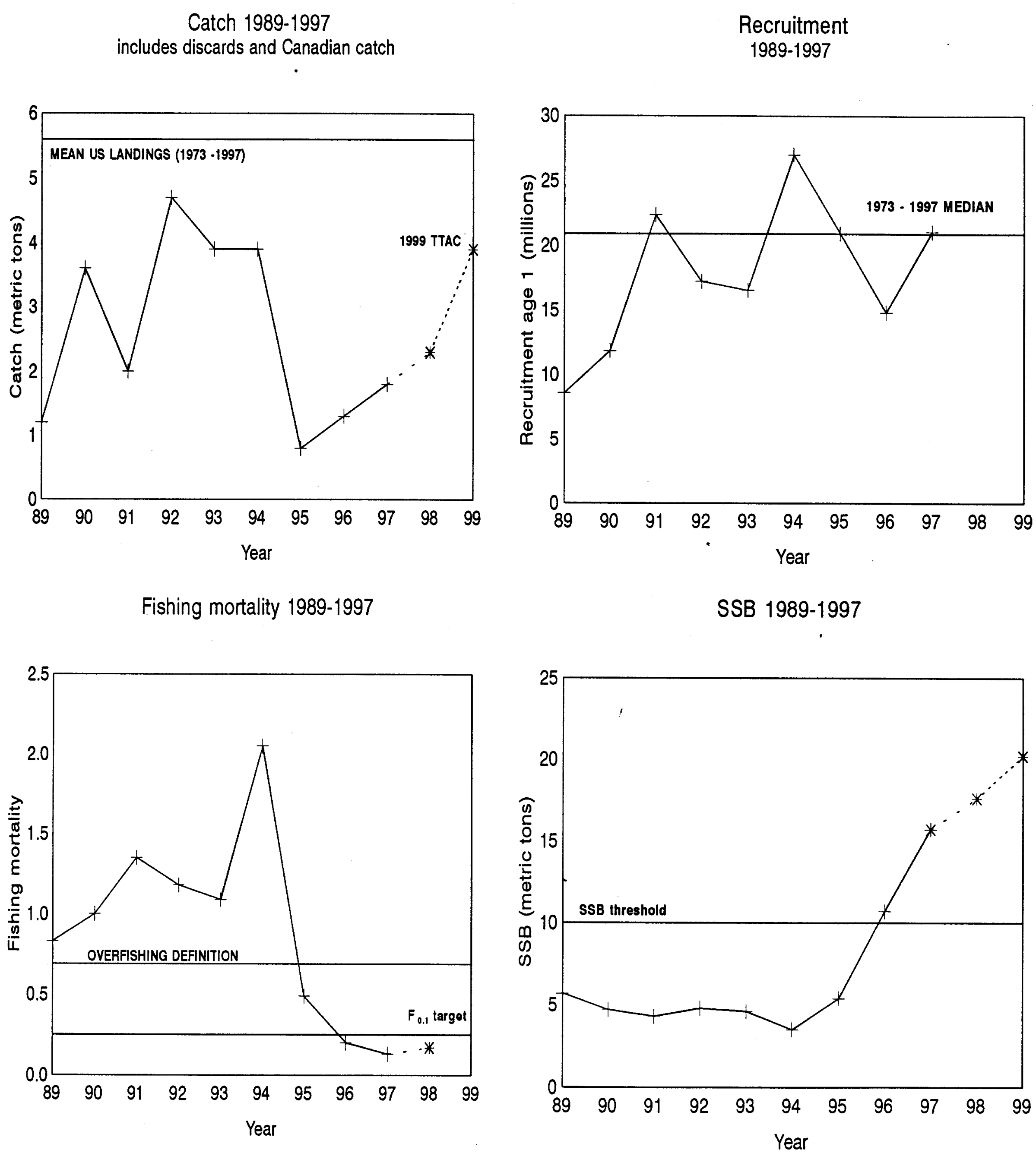


Fig. 5.4. MSMC 1997 projection and SARC 24 assessment results for southern New England yellowtail (+ SARC 24 VPA, * MSMC projections).

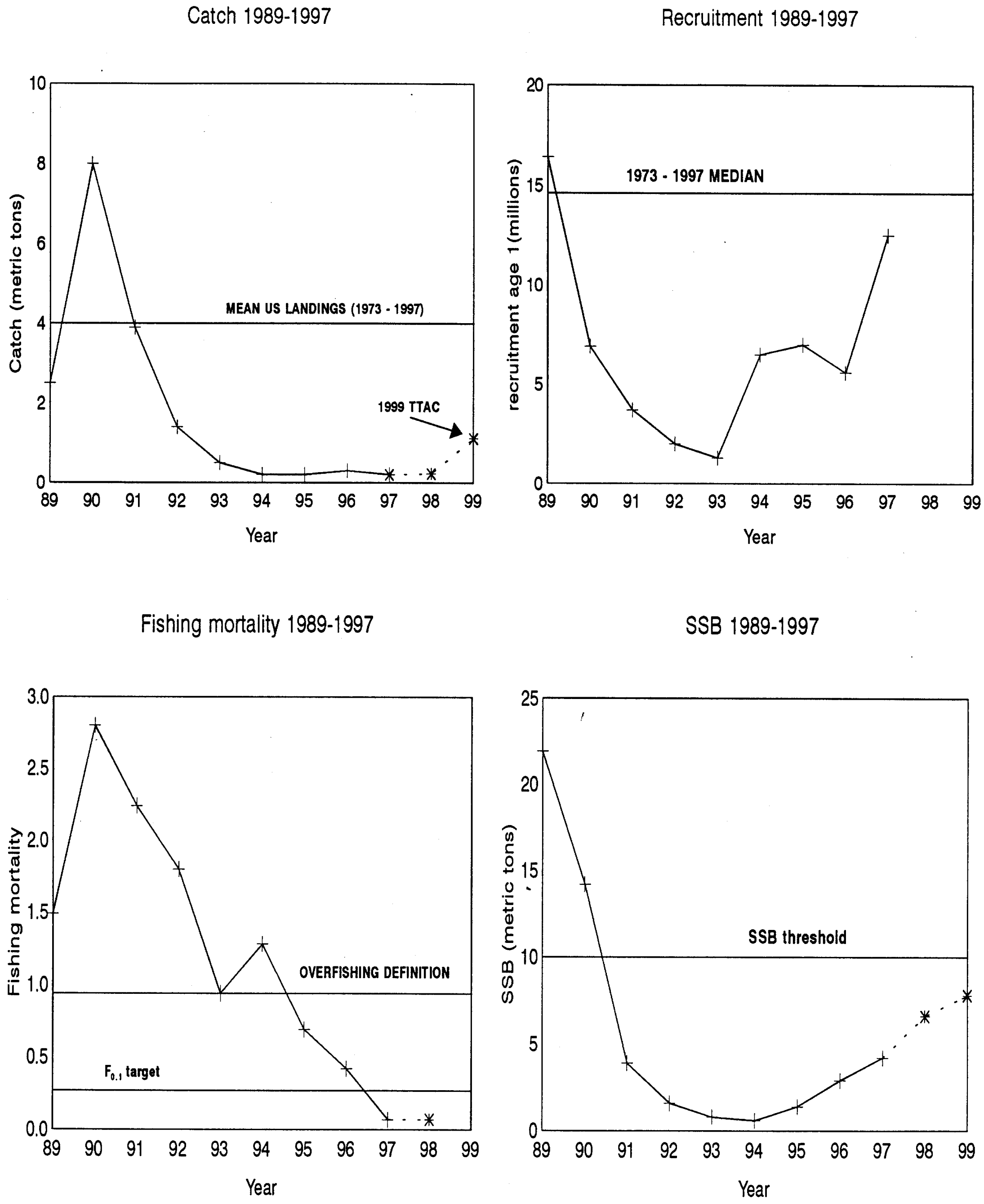
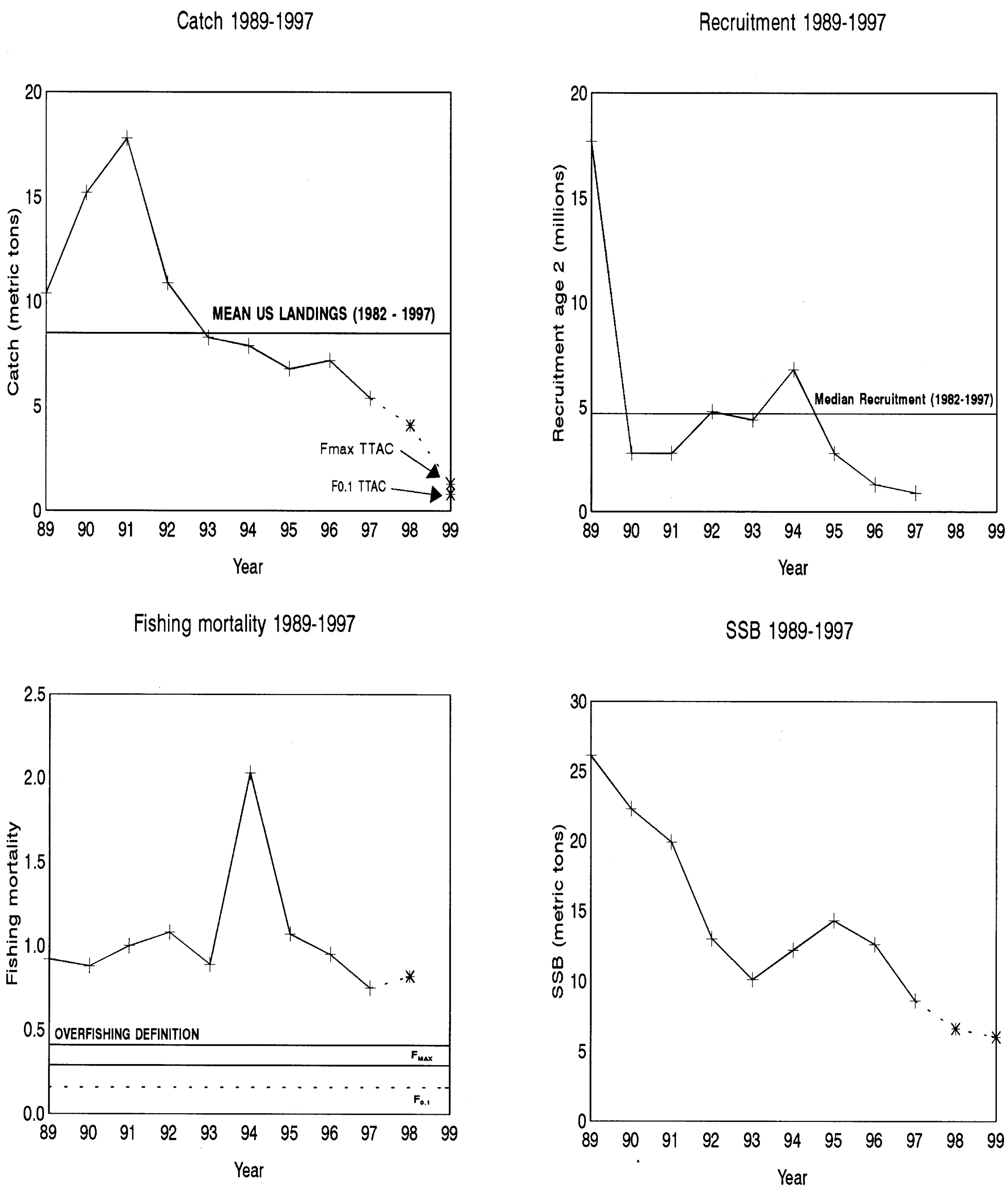


Fig. 5.5. MSMC 1998 projection and SARC 27 assessment results for Gulf of Maine cod (+ SARC 27 VPA, * MSMC projections).



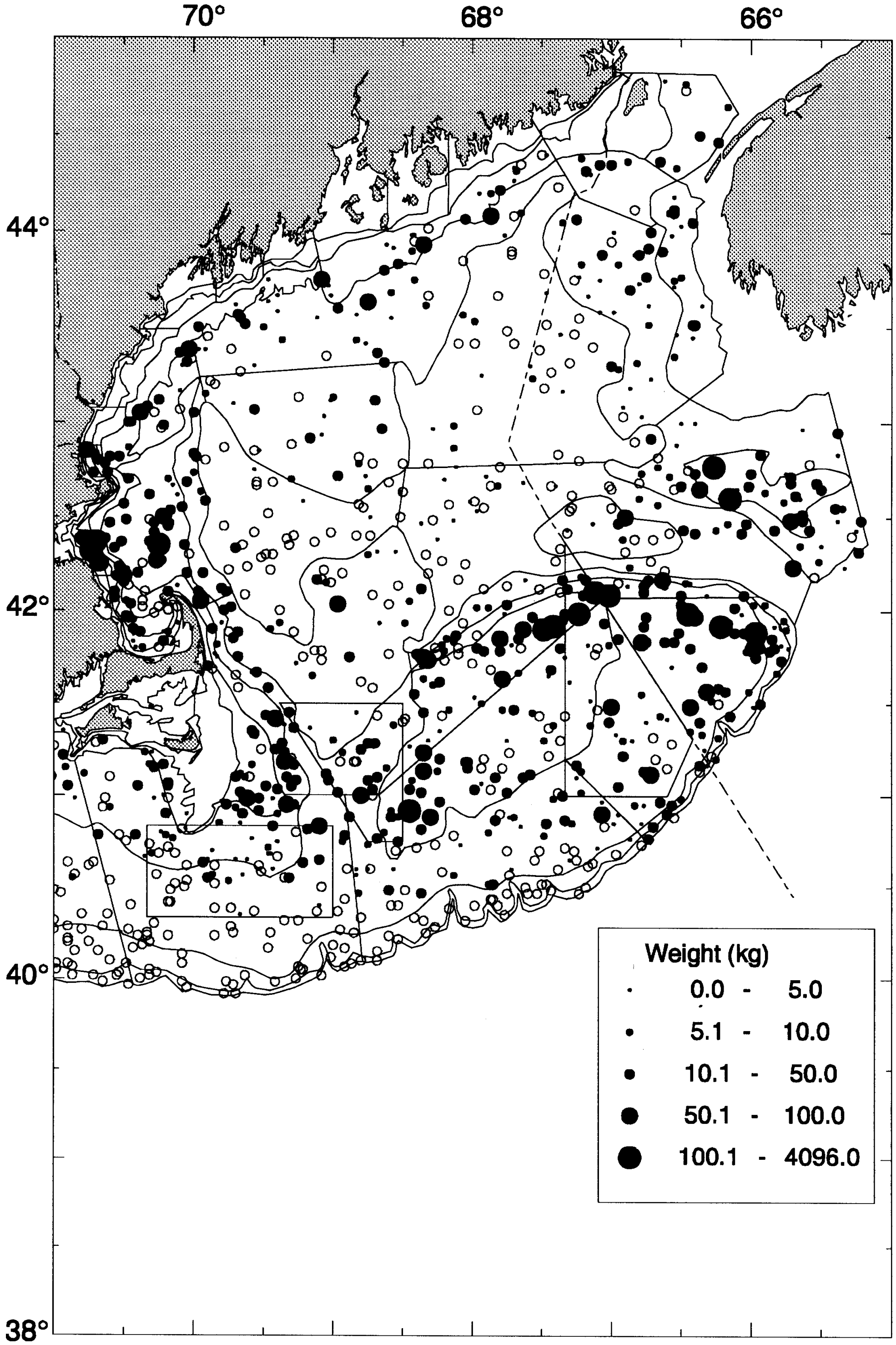


Figure 5.6 NEFSC spring survey cod catches (kgs), 1979-1983.

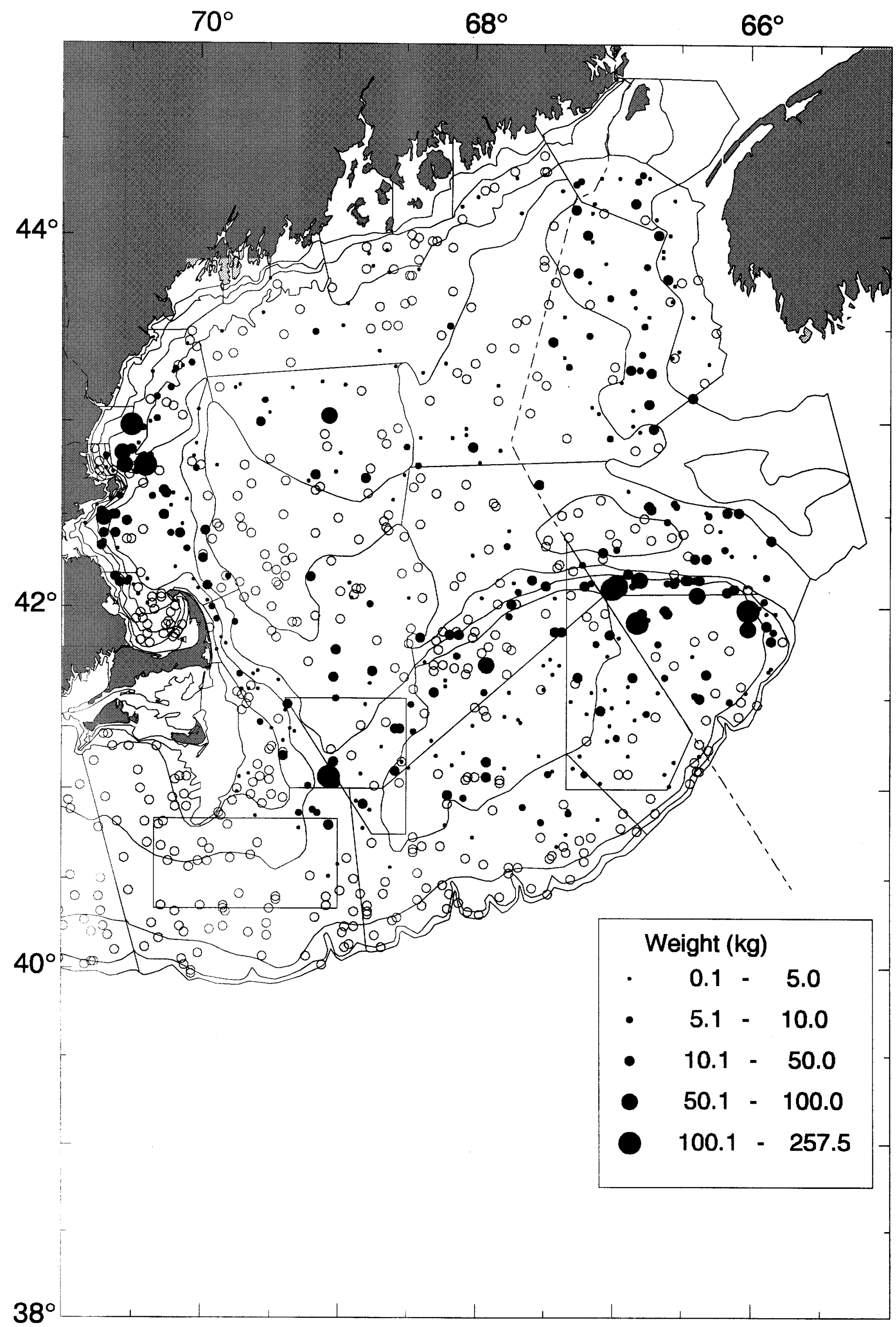


Figure 5.7 NEFSC spring survey cod catches (kgs), 1994-1998.