Northeast Fisheries Science Center Reference Document 99-04

A Report of the 28th Northeast Regional Stock Assessment Workshop

Status of the Cape Cod Yellowtail Flounder Stock for 1998

by

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

April 1999

Northeast Fisheries Science Center Reference Documents

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This report's publication history is as follows: manuscript submitted for review -- April 2, 1999; manuscript accepted through technical review -- April 7, 1999; manuscript accepted through policy review -- April 16, 1999; and camera-ready copy submitted for publication -- April 20, 1999. This report may be cited as:

Cadrin, S.X.; King, J.; Suslowicz, L.E. 1999. Status of the Cape Cod yellowtail flounder stock for 1998. *Northeast Fish. Sci. Cent. Ref. Doc.* 99-04; 99 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

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ABSTRACT

The Cape Cod yellowtail flounder stock was at a medium level of biomass and was over-exploited in 1997. Virtual population analysis of total catch, calibrated with research survey indices, indicated that total biomass since the early 1990s remained below the level that can produce maximum sustainable yield (1997 biomass was 2,700 mt, which is 44% of B_{MSY}, 6,100 mt). Fishing mortality generally decreased in the mid 1990s; fully-recruited F in 1997 was 0.64 (43% exploitation rate), and F on total biomass was 0.41 (31% exploitation). Age-1 recruitment averaged 7 million fish from 1988-1995, but the 1996 year class is about half the long term average. The estimated level of biomass in 1998 is 2,900 mt and fully-recruited F is projected to increase to 1.01. Relative to the Amendment 9 overfishing definition and its associated control rule, which is based on a surplus production model, the stock is overfished, and overfishing is occurring (threshold F = 0.13 on biomass, 0.23 on fully-recruited ages). Applying the Amendment 9 control rule to the 1998 total stock biomass implies a fishing mortality target rate of 0 in 1999. Projections suggest that catch and biomass will decline in 1999 as the apparently poor 1996 year class recruits to the fishery. Projected 2000 biomass remains below ½ B_{MSY} at status quo harvest rates, but can substantially increase at low F.

INTRODUCTION

Yellowtail flounder, *Limanda ferruginea,* inhabit the continental shelf of the northwest Atlantic from Labrador to Chesapeake Bay. Off the U.S. coast, commercially important concentrations are found on Georges Bank, off southern New England, and off Cape Cod (statistical areas 514 and 521; Figure 1). Cape Cod yellowtail inhabit relatively shallow water (10-60 m; Lux 1964). Spawning occurs during spring and summer, peaking in late May. Larvae are pelagic for a month or more, then develop demersal form and settle to the bottom. Yellowtail flounder on the Cape Cod grounds generally mature at age-3 (O'Brien et al. 1993) and grow to 58 cm total length.

A New England fishery for yellowtail flounder developed in the 1930s, coincident with a decline in winter flounder abundance (Royce et al. 1959, Lux 1964). On the Cape Cod grounds, yellowtail are generally caught in multi-species groundfish fisheries (principally by otter trawls) from late fall to spring, with some landings by gillnets in the winter and spring, but may also be specifically targeted in certain seasons (Royce et al. 1959).

Historically, landings from the Cape Cod grounds were a small portion of the total U.S. yellowtail landings. However, since the collapse of Georges Bank and southern New England stocks in the early 1990s (NEFSC 1994), the Cape Cod stock has been the most productive of the U.S. yellowtail stocks (Overholtz and Cadrin 1998).

Stock Identification

Geographic patterns of landings and survey data, larval distribution, tagging observations, and life history information indicate relatively discrete stocks of yellowtail flounder on Georges Bank, in Southern New England waters, and off Cape Cod. Survey catches off Cape Cod are not correlated with those from Georges Bank nor from southern New England waters (Figure 2). Concentrations of pelagic larvae are discontinuously distributed among the three geographic areas (Cape Cod grounds, Georges Bank, and southern New England; Silverman 1983). Larvae may be retained on the Cape Cod grounds, because vertical movement of larvae limits horizontal drift (Smith et al. 1978).

Royce et al. (1959) defined five 'more or less distinct' stocks of yellowtail flounder based on tagging observations and concentrations of fishing effort (southern New England, Georges Bank, Cape Cod, northern Gulf of Maine, and Nova Scotia). The Cape Cod stock was delineated as statistical reporting areas 514 and 521, "east and north of Cape Cod, in Cape Cod Bay, and north to the vicinity of Cape Ann and Ipswich Bay. It is limited in all directions by deep water, although to the south and north there are narrow strips of water of the preferred depth." Lux (1963a, 1963b) confirmed that yellowtail in the Cape Cod area comprise a relatively local and stationary group through additional tagging. Subsequent tagging information (Lux, unpublished) also confirms that movement from the Cape Cod area is rare. A summary of all documented yellowtail movements off the northeast U.S. indicates that 98% of fish recaptured from release sites on the Cape Cod grounds remained in the area (0.6% moved to the northern Gulf of Maine, 0.3% moved to Georges Bank, and 1.1% moved to southern New England), 0.8% of fish recaptured from southern New England release sites moved to the Cape Cod grounds, and none of the fish recaptured from Georges Bank release sites moved to the Cape Cod grounds (Table 1).

Life history information also suggests that yellowtail on the Cape Cod grounds are distinct from those in adjacent waters. Yellowtail on the Cape Cod grounds generally mature later (O'Brien et al. 1993), spawn later in the spring (Silverman 1983), grow to larger sizes (Lux and Nichy 1969), and are found in shallower water (10-60 m) than those in other areas off the northeast U.S. (Lux 1964). A large portion of yellowtail sampled from the Cape Cod area were infested with trematodes that depend on intertidal hosts, indicating that infested fish inhabited nearshore waters for a portion of their life. However, none of the samples from Georges Bank or southern New England were infested, suggesting that none had moved from inshore areas (Lux 1963a). A more extensive investigation confirmed geographic differences in the number of parasites and degree of infestation: there were two major communities (on the Cape Cod grounds and on Georges Bank), two intermediate communities (off southern New England and in the northern Gulf of Maine), and local aggregations (in Massachusetts Bay/Stellwagen Bank and off the north shore of Massachusetts; Testeverde 1987).

In summary, Cape Cod yellowtail appear to comprise a discrete group with minimal movement to and from other stock areas. Therefore, yellowtail flounder on the Cape Cod grounds are considered a single unit stock and interchange with adjacent stocks is assumed to be negligible for this assessment.

Management Summary

Over the past 25 years, the fishery for yellowtail flounder in federal waters has been managed under several regimes. From 1971 to 1976, national quotas were allocated by the International Commission for Northwest Atlantic Fisheries. From 1977 to 1982, the New England Fishery Management Council's Atlantic Groundfish Fishery Management Plan established optimum yield thresholds for yellowtail west of 69° longitude (which included Cape Cod and southern New England yellowtail stocks) and imposed minimum mesh size, spawning closures, and trip limits. In 1982, the Council adopted an Interim Groundfish Plan, which established a minimum size limit of 28 cm (11 in) and a minimum mesh size of 130 mm (5 1/8"; with exemptions). In 1983, the minimum mesh size was increased to 140 mm (5.5"; with exemptions) In 1986, the Council's Multispecies Fishery Management Plan increased the minimum legal size to 30 cm (12 in) and imposed seasonal area closures. Amendment #4 to the Plan further increased the minimum legal size to 33 cm (13 in) in 1989. In 1993, finfish exclusion devices were required in the northern shrimp fishery to reduce groundfish bycatch. Amendments #5, #6, and #7 (1994-1996), limited days at sea, closed areas year-round, further increased minimum mesh size to 142 mm (6 in diamond or square; with fewer exemptions), imposed trip limits for groundfish bycatch in the sea scallop fishery, and prohibited small-mesh fisheries from landing groundfish. Framework #25 was an annual adjustment to the Multispecies Plan which prohibited bottom trawling in two areas of yellowtail habitat on the Cape Cod grounds in 1998: Massachusetts Bay was closed in March, and the waters off Cape Ann were closed in April (Figure 3). The 'western Gulf of Maine closure' is too deep to protect yellowtail flounder. Amendment #9 was adopted in 1998 to revise the overfishing definition according to Sustainable Fisheries Act requirements.

The portion of the Cape Cod yellowtail stock found within the Massachusetts territorial sea is managed by the Massachusetts Division of Marine Fisheries under a suite of management measures. Since 1931, many coastal areas have been closed to bottom trawling year-round (e.g. Winthrop Head to Gloucester), or seasonally (e.g. Boston to Provincetown and Gloucester to New Hampshire). The state has had a succession of more stringent size limits beginning with a 11" minimum size in 1982. The size limit increased to 12" in 1986 and then to 13" in 1988. In 1986, 5" mesh codends were required for trawling within the 20 fathom contour in waters north of Cape Cod. In 1986, a winter flounder spawning closure to trawling and gillnetting extending approximately one to two miles from shore was established in waters from the New Hampshire border to Provincetown from February 1 to April 30 (extended to May 31 in 1990). In 1989, small mesh trawling was restricted to permitted fisheries targeting specific species. In 1991, minimum mesh size throughout the net was increased to 5 1/2" north and east of Cape Cod. Since November 1, 1992 a year-round night closure to mobile gear has abbreviated fishing effort by curtailing "trip fishing". Beginning in 1993, a Coastal Access Permit was required to fish mobile gear. The mesh size was increased again in 1994 to 6". A moratorium on new applicants for this permit was enacted in 1994 stemming an increase in effort into state waters. In 1995, the size limit for vessels fishing mobile gear was reduced from 90' registered length to 72' length over all. Current small mesh trawling in state waters north of Cape Cod is limited to an experimental whiting fishery with drastic ground gear modifications for bycatch reduction, prohibitions on groundfish retention and intensive sea sampling. Scallop dredge fisheries have been limited to 10' combined maximum dredge width since 1990. Gillnet fisheries in Massachusetts have a permit moratorium, 2400' maximum net length, 6" minimum mesh size and seasonally closed areas complementing federal closures to protect harbor porpoises. State waters from Marblehead to the New Hampshire border are closed to sink gillnets from November 1 - December 30. Massachusetts Bay and Cape Cod Bay are closed to sink gillnets from March 1 - 30. Right whale critical habitat in Cape Cod Bay is off limits to gillnets from January 1 - May 15.

Terms of Reference

The Steering Committee of the 28th Northeast Regional Stock Assessment Workshop issued the following objectives for the present investigation.

a. Update the status of the Cape Cod yellowtail flounder stock through 1997 and characterize the variability of estimates of stock size and fishing morality.
b. On the basis of anticipated catches and abundance indicators in 1998, estimate stock size at the beginning of 1999 and provide projected estimates of catch and spawning stock biomass for 1999-2000 at various levels of F.
c. Comment on and revise, if necessary, the overfishing definition reference points for Cape Cod yellowtail flounder recommended by the Overfishing Definition Review Panel.

The Cape Cod yellowtail stock has traditionally been assessed by descriptive summaries of catch, effort, catch samples, survey indices, yield per recruit modeling, and estimates of total mortality rate (Z) from survey and commercial age samples. The stock was more stable than the Georges Bank or southern New England stocks from the 1940s to the 1960s, based on patterns of landings and commercial catch rates (Royce et al. 1959, Lux 1964). However in the early 1970s, effort began to increase, and catch rates began to decline (Parrack 1974). Estimates of fishing mortality rate (F) during the 1970s were at or above the estimated level of maximum yield per recruit

(Howe 1975). Although yield remained stable relative to offshore stocks, catch rates were at the lowest levels observed by the late 1970s (Sissenwine et al. 1978). For a brief period in the mid 1970s, the stock appeared to be stable (McBride and Sissenwine 1979). However, by the late 1970s, peak catches produced high mortality rates, the age structure appeared to be truncated, and catch rates continued to decrease (McBride et al. 1980, McBride and Sissenwine 1980, Clark et al. 1981). Despite some indications of good recruitment in early 1980s (McBride and Clark 1983, Clark et al. 1984), landings and relative abundance generally decreased in the 1980s (NEFC 1986). Similar to other U.S. stocks of yellowtail, the 1987 year class was dominant and contributed to some rebuilding, however, the most recent descriptive assessment of Cape Cod yellowtail concluded that the stock was overexploited (Rago 1995). The present assessment updates catch and survey information through 1998 and provides quantitative estimates of stock size, mortality, and overfishing reference points.

A draft of this report was presented to the Southern Demersal Working Group of the SAW (October 13-16, 1998, Woods Hole) and reviewed by the following working group members.

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The assessment was then reviewed by the 28th Northeast Regional Stock Assessment Review Committee from November 30 to December 4, 1998. This report represents the SARC's consensus on analytical decisions, interpretation, and conclusions. The following people contributed as SARC members.

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METHODS AND RESULTS

Commercial Landings

U.S. commercial landings of yellowtail flounder were derived from dealer weighout reports. Previous to 1994, landings were allocated to statistical area, month, and gear type according to interview data collected by port agents (Burns et al. 1983). For 1994, landings reported by dealers were allocated to stock area using fishing vessel logbook data, by fishing gear, port, and season (Wigley, et al. 1998). For 1995-1997, dealers' reported landings were prorated to stock area using a modified proration that included dealer codes (NEFSC 1998).

Landings of Cape Cod yellowtail rapidly increased in the late 1930s to an annual average of 1,300 mt from 1940 to 1962 (Table 2, Figure 4). Landings increased sharply in 1963 to 3,600 mt, then decreased to an annual average of 1,500 mt from 1964 to 1973. Landings increased in the 1970s to a peak of 5,100 mt in 1980, then declined to an annual average of 1,000 from 1984 to 1989. Landings increased in 1990, then returned to an annual average of 1,000 since 1991.

Recent geographic and seasonal patterns of Cape Cod yellowtail landings can be inferred from logbook information. Most landings from 1995 to 1997 (72%) were from statistical area 514 (Figure 1), almost entirely in the first, second, and fourth quarters of the year. A large portion of area 521 landings during 1995 to 1997 (41%) were taken in the fourth quarter. The seasonal pattern of recent landings is similar to historical patterns reported by Royce et al. (1959): 90% of landings are taken in the fall, winter, and spring.

Otter trawls are the principal fishing gear used to catch yellowtail flounder. Until recently, small-mesh otter trawls (<127mm, 5" mesh) were the dominant gear landing Cape Cod yellowtail (averaging 51% of annual landings from 1982 to 1993), with most of the remaining landings coming from large-mesh otter trawls (39% of 1982-1993 landings; Table 3). Gill nets and scallop dredges generally contributed minor portions of landings. Large-mesh trawls have dominated landings (averaging 74% of total landings) since 1994, when landing groundfish with small-mesh trawls was prohibited. Since 1995, landings from gillnets have increased to greater than 20% of total landings.

A summary of port samples (each consisting of approximately 100 lengths and 1 age sample per cm) by market category, statistical area, and quarter shows that some market categories were not sampled in many half-years prior to 1985 (Table 4). The apparent truncation in age distribution in the late 1970s reported by McBride et al. (1980) may be an artifact of sampling only the large category in late 1977 and all of 1978 and only the small category in 1979. McBride and Clark (1983) concluded that biological sampling up to the early 1980s was inadequate for monitoring trends in age composition. Sampling improved substantially after 1984, however, each market category was not always sampled in each statistical area. Therefore, landings at age were estimated for 1985-1997, stratified by half-year and market category for the entire stock area. All strata were sampled, except for the unclassified category in the second half of 1985 to 1988 and second half of 1994 (unclassified landings were prorated to small and large categories for those half-years) and the small category in the second half of 1995 (all landings were characterized by unclassified samples for that half-year; Table 5)

Sample length frequencies were expanded to total landings at size using the ratio of landings to sample weight (predicted from length-weight relationships by sex and season; Lux 1969b), and portioned to age using pooled-sex age-length keys from commercial and survey samples. Despite sexually dimorphic growth of Cape Cod yellowtail (Lux and Nichy 1969, Libey 1973, Moseley 1986), sample sizes were too small to produce reliable age-length keys by sex. Estimated landings and mean weights at age indicate that the 1984 and 1987 cohorts dominated catches in the late 1980s and early 1990s, respectively (Table 6). Inconsistent catches and variable mean weights of yellowtail older than age-6 suggest that old fish are rarely landed or poorly sampled.

Discarded Catch

Estimates of discards for the Cape Cod yellowtail fishery for 1963-1969 were derived from interviews with vessel captains; historical discards were approximated by Brown and Hennemuth (1971) from the 1963-1969 average discard rate (Table 2; Figure 4). Discards for 1970-1977 were also based on interview data, however yellowtail interview data were suspect from 1978 to 1982 (particularly for the Cape Cod area) when trip limits were imposed (McBride et al. 1980, Clark et al. 1981). Discards during 1978-1982 were estimated from observer data when available (Sissenwine et al. 1978), derived directly from field selectivity studies (McBride et al. 1980), or from application of selectivity estimates to survey size frequencies (McBride and Clark 1983). Discards for 1983 were from interview data (Clark et al. 1984).

Neither sea sampling nor interview data were available to estimate Cape Cod yellowtail discards for 1984-1988. Using the method described by McBride and Clark (1983), selectivity at size was applied to survey size distributions to approximate the magnitude and size distribution of discards for 1984-1988, assuming a 28 cm cull-point for 1984-1985 and a 30 cm cull-point for 1986-88. The regulated mesh size during 1984-1988 was 140 mm (5.5"), but a large portion of Cape Cod yellowtail were landed in exempted small-mesh fisheries. The relative proportions of landings by gear type during 1984-1988 were similar to 1989-1991 (Table 3) under similar gear restrictions. The effective selectivity of the Cape Cod yellowtail fishery was approximated by the average ratio of cumulative commercial catch at length to cumulative survey catch at length, by half-year from 1989 to 1991 (Figure 5). By comparison, selectivity of yellowtail with 129 mm (5.1") and 145 mm (5.7") mesh was estimated by Lux (1968) and Hennemuth and Lux (1970), and selectivity of 102 mm (4") mesh and 133 mm (5.25") mesh was estimated by Smolwitz (1979) (Figure 5). The effective selectivity estimates for 1989-1991 fall between the retention reported for 102 mm and 129 mm mesh; which may result from the large portion of small-mesh landings. Therefore, selectivity for 1984-1988 was approximated from the effective selectivity during 1989-1991 (indicated as '1989-91 fit' in Figure 5). The survey-selectivity method was tested on 1989-1991 survey data and produced discard estimates within 7% of those from sea sampling. Length distributions were also similar from the two methods (Figure 6).

Cape Cod yellowtail discards for 1989-1997 were estimated using ratios of discarded to landed catch, by gear and half-year, observed at sea (as described by Mayo 1998), except for small-mesh and scallop dredge discards in recent years (described below). Since 1989, the Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MADMF) observers sampled 1,963 fishing trips in which yellowtail were caught on the Cape Cod grounds (Table 7). Discard ratios were significantly greater from small-mesh trips than from large-mesh trips in a two-factor analysis with half-year ($P=0.056$ from conventional ANOVA; $P=0.050$ from randomization test [RT], Manly 1997). Therefore, small-mesh and large-mesh trips were treated separately. However, there was no significant difference in discard ratios among small-mesh fisheries (i.e., shrimp trips vs. whiting trips: $P=0.691$ from ANOVA; $P=0.679$ from RT), and all small-mesh trips were treated as a group. Pooling small-mesh fisheries can be justified by the similar gear requirements from 1989 to 1992 (1.75", 44 mm codend mesh). Trimmed ratio estimates (which exclude data from the trips with maximum and minimum discard ratios), mean ratios (which exclude trips with discards, but no yellowtail landings), and trimmed mean ratios were calculated to investigate sensitivity of estimates to extreme observations and trips with no landings.

Estimated discard ratios from 145 large-mesh otter trawl trips (1989-1997) averaged 0.16 by weight (ranging from 0.02 to 0.62), and were generally greater in the first half of the year than the second half of the year (2 factor analysis with year; $P=0.010$, ANOVA; $P=0.012$ RT). Ratio estimates were robust to elimination of extreme observations and zero landings in most years. A ratio of 0.04 (average of 1995-1997 ratios for the 2nd half of the year) was used for the 2nd half of 1994, when no trips were sampled. Estimates of total discards from large-mesh otter trawls averaged 87 mt annually from 1989 to 1997, and ranged from 9 to 186 mt.

Discard estimates for gillnets were based on 1,527 sampled trips from 1989 to 1997. Discard ratios averaged 0.10 by weight (ranging from 0.00 to 0.34) and were robust to elimination of extreme observations and zero landings in most years. Estimates of total discards from gillnets averaged 12 mt annually from 1989 to 1997, decreasing from 36 mt in 1990 to 5 mt or less in recent years.

Estimated discard ratios from 61 small-mesh otter trawl trips averaged 1.01 from 1989 to 1992 (ranging from 0.06 to 2.39) and were quite sensitive to elimination of extreme observations in most years. Therefore, trimmed ratio estimates were used to approximate total discards for half-years with greater than 7 observed trips (i.e., trimmed estimates were based on at least 5 trips). Mean ratios were not used to estimate discards, because small-mesh trips with no groundfish landings may realistically represent the fishery. Estimates of total discards from small-mesh otter trawls averaged 409 mt annually from 1989 to 1992, ranging from 130 to 815 mt. Requirements for finfish exclusion devices and prohibitions on landing groundfish with small-mesh otter trawls precluded estimation of small-mesh discards for 1993-1997 using discard:kept ratios. Effort-based discard estimates for 1993-1997 small-mesh fisheries are described below.

Estimated discard ratios from 22 scallop dredge trips averaged 1.08 from 1989 to 1995 (ranging from 0.16 to 1.82). The number of observed trips per half-year were too few for calculation of trimmed estimates. Estimates of total discards from scallop dredges averaged 75 mt annually from 1989 to 1995, decreasing from 184 mt in 1991 to 13 mt in 1995. Trip limits for landing groundfish with scallop dredges decreased to 200 lb in 1996 and to 100 lb in 1997, precluding estimation of dredge discards using discard:kept ratios for 1996 and 1997. Effort-based discard estimates for 1996 and 1997 are described below.

Effort-based estimates of Cape Cod yellowtail discards were calculated for fisheries that had prohibitions or severe restrictions on groundfish landings: small mesh fisheries from 1993 to 1997 and the scallop fishery from 1996 to 1997 (Table 8). Total effort by fishery was estimated from interview data for 1993 and January-April of 1994, and from expanded logbook data from 1994 to 1997. Reported effort from logbooks were expanded by the portion of total target species landings reported by logbooks (Table 8). These effort-based discard estimates should be considered provisional, because logbook data remains partially unaudited (NEFSC 1996a, 1997).

Shrimp fisheries were treated separately from other small-mesh trips, because of different gear requirements since 1993 (e.g., finfish exclusion devices). The 'raised footrope' experimental whiting fishery was well sampled (15 trips sampled in 1996 and 51 trips sampled in 1997), and total annual yellowtail discards were estimated to be less than 1 mt (McKiernan et al. 1998; R. Johnston, personal communication). Therefore, effort in the experimental fishery was excluded from the total whiting effort in 1996 and 1997; yellowtail discards from earlier experimental fishing were assumed to be similar to exempted whiting fishing. The 'whiting grate' experimental fishery does not extend as far south as the Cape Cod grounds. Note that fishermen in the whiting fishery may also target dogfish, but small-mesh trips other than shrimp trips were not discriminated by target species. There were no observed trips in the exempted whiting fishery in 1996 and 1997; the 1993-1995 average (0.09 mt/df) was assumed, producing annual discard estimates of 31 to 117 mt.

Estimated discard rates from recent shrimp trips (1993-1997) were negligible (0.003 mt/df), averaged 0.05 mt/df (ranging from 0.01 to 0.12), and produced annual discard estimates of approximately 0.2 mt. Estimated discard rates from scallop trips averaged 0.03 mt/df (ranging from 0.02 to 0.05) and produced annual discard estimates of 66 mt in 1996 and 159 mt in 1997.

In summary, estimated discards of Cape Cod yellowtail averaged 22% of total catch by weight from 1963 to 1997 (Table 2, Figure 4) and 37% by number from 1985 to 1997. Recent discard estimates remain substantial (20% during 1994-1997; Table 2), with 40% from the large mesh fishery, 30% from the exempted whiting fishery, and 30% from the scallop fishery (Figure 7). Sample length frequencies from observed discards (1989-1997) were expanded to total discards at size using the ratio of landings to sample weight (predicted from length-weight relationships by sex and season; Lux 1969b). Discards at size for 1985-1988 were estimated from survey size distributions by half-year and estimated selectivity from 1989 to 1991 (Figure 5). Discards at size were portioned to age using pooled-sex age-length keys from commercial and survey samples. Discards from unsampled strata were characterized by samples from adjacent strata (Table 9) Estimated discards at age and mean weight of 1994-1996 discards are presented in Table 10.

Total catch at age and mean weight at age in the catch are reported in Table 11. Estimated catch at age indicates that the 1984 and 1987 cohorts dominated catches in the late 1980s and early 1990s, respectively.

Historical Catch Rates

Lux (1964) developed an index of fishing effort based on interviews from New Bedford trips with landings composed of greater than 50% yellowtail, standardized to a vessel size class of 26-50 tons. The standardization methods were used to derive a time series of standardized catch per unit effort (CPUE) from 1943-1987 (McBride 1988; Table 2, Figure 8). Despite the fact that a small portion of total Cape Cod yellowtail landings were represented in the analysis used to derive CPUE values in some years, "they provide a broad picture of abundance fluctuations on this ground" (Lux 1964), and the index was used as the sole basis for monitoring relative abundance of the stock for two decades (Brown and Hennemuth 1971, Parrack 1974, Sissenwine et al. 1978, McBride and Sissenwine 1979, McBride et al. 1980, McBride and Sissenwine 1980). However, standardized catch rates became difficult to interpret after trip limits were imposed in 1977 (Clark et al. 1981), and the interview process was discontinued in 1994 (NEFSC 1996a). The CPUE time series indicates that stock biomass generally decreased from high levels in the early 1960s.

Stock Abundance and Biomass Indices

The NEFSC spring and autumn bottom trawl surveys have sampled offshore strata since 1963 and 1968, respectively (Despres, et al. 1988; Figure 9). However, survey catches of Cape Cod yellowtail in offshore strata are too variable for reliable indices of relative abundance (McBride and Sissenwine 1980). Inshore strata in the Cape Cod stock area (56-66) were sampled since 1977, and inclusion of inshore data reduces some interannual variation in the overall index (offshore 25 and 26; inshore 56-66; Figure 10). However, inshore strata do not extend to nearshore yellowtail flounder habitat. McBride and Sissenwine included offshore stratum 24 and inshore stratum 55 in Cape Cod strata sets. However, much of the area and the majority of yellowtail caught in stratum 24 are in the Georges Bank stock area, and much of the area and most catches in stratum 55 are in the southern New England stock area. Therefore, both strata were excluded from the present analyses. Standardization coefficients, which compensate for survey door, vessel, and net changes in NEFSC groundfish surveys (1.22 for old doors, 0.85 for the Delaware II, and 1.76 for the 'yankee 41' net; NEFSC 1997) were applied to the catch of each tow.

Age-based indices for NEFSC spring and autumn surveys (Tables 12 and 13, respectively) were derived from dedicated age-length keys. The sampling design for yellowtail flounder weights, lengths, and ages for NEFSC surveys precludes estimation of sex specific biomass indices, abundance indices, or complete age-length keys.

The MADMF spring and autumn surveys have sampled inshore waters since 1978 (Figure 11; Howe 1989). The MADMF surveys catch more yellowtail than the NEFSC surveys within the Cape Cod area (strata 17-36; Figure 12). The MADMF surveys do not extend to offshore yellowtail flounder habitat. The aggregate number and weight per tow indices are slightly different than previously reported (NEFSC 1996b, Overholtz and Cadrin 1998), because short tows (<13 min) were excluded in the present analysis. MADMF age-based indices (Tables 14 and 15, respectively) were derived from dedicated age-length keys, where available. Age samples have been collected for yellowtail for both surveys since 1978. Age-based estimates for 1978-1983 were reported by Clark et al. (1984). Provisional age-based indices were extended using NEFSC keys for surveys that did not have age samples processed in time for this assessment (autumn 1984-1995, spring 1984).

Correspondence among NEFSC and MADMF survey indices was assessed using correlations among normalized observations [Ln(x/mean); Table 16]. Autumn survey indices were lagged to represent abundance at the beginning of the following year. Normalized indices of catch per tow at age are illustrated in Figure 13. Correlations varied widely with age: most indices of abundance at age 2-5 were moderate to strong, some indices of ages 1, 5, and 6 were negative.

Virtual Population Analysis

Virtual abundance estimates from catch at age of ages 1-6+, 1985-1997, were calibrated using an ADAPT algorithm (Gavaris 1988) that estimated age 2-5 survivors in 1998 and survey catchability coefficients (*q*) using nonlinear least squares of survey observation errors. Abundance at the start of the year was calibrated with 15 indices: NEFSC spring ages 2-5, NEFSC fall ages 1-4 (lagged to tune ages 2-5), MADMF spring ages 1-4, and MADMF fall ages 1-3 (lagged to tune ages 2-4).

The instantaneous rate of natural mortality (M) was assumed to be 0.2 based on tag returns (Lux 1969a), relationships of Z to effort (Brown and Hennemuth 1971), and the oldest individual sampled in the stock area (age-14). Although catches of yellowtail older than age-8 are rare in commercial or research catches, the stock has been heavily exploited for seven decades.

Maturity at age for Cape Cod yellowtail flounder was reported by O'Brien et al. (1993) from 1985-1990 NEFSC spring survey samples. Subsequent NEFSC spring samples (1986-1997) confirm the reported estimates. However, samples from the Massachusetts spring survey suggest significantly lower proportion mature at age-3, suggesting geographic patterns in maturity at age. The maturity schedule reported by O'Brien et al. (1993) was assumed for estimates of spawning stock biomass (SSB), because the NEFSC strata set was considered to best represent the entire stock area. Sex ratios also appear to have strong geographic patterns. Preliminary results from 1997-1998 Massachusetts surveys indicate that there are significant differences in sex ratio in the Massachusetts survey area. Several of the most populous yellowtail flounder survey strata and the northernmost region appear to be dominated by males in the spring. Sex ratios for the VPA time series were assumed to be 50%, because exploratory investigations on sex ratios are not definitive.

The mean residual for VPA calibration was 0.59 (Appendix A). The model generally fit the data well (Figure 14), but there was one statistical outlier (i.e., the standardized residual for MADMF spring age-1 in 1991 was 4.2). Residuals do not appear to be correlated among indices (only 5 of the 105 correlations among 15 time series of residuals [4.8%] were significant at the 5% level).

The VPA indicated that stock abundance increased in the late 1980s peaking at 29 million in 1988, and the 1987 cohort dominated the population through the early 1990s (Figure 15). The stock remained relatively stable through the 1990s, averaging 17 million from 1991 to 1996, but age-1 recruitment in 1997 appears to have been poor and total abundance decreased to 15 million. Age-1 recruitment peaked at 21 million in 1988, was relatively constant from 1989 to 1996 (averaging 7 million), but decreased to 3 million in 1997.

Estimates of fishing mortality on fully recruited ages (age-4+) from VPA has been extremely high and variable, peaked in 1988, and generally decreased to 0.64 in 1997 (Figure 16). The temporal pattern and approximate magnitude of F estimates from VPA are confirmed from the moving average of survey index log ratios [$Ln(n_{4+}/n_{5+})$-M], which peaked at approximately 2.0 in the late 1980s and gradually declined to approximately 1.0 in the late 1990s (Figure 16). Fishing mortality on total biomass averaged 0.55 for the VPA time series and was 0.41 in 1997.

Total stock biomass estimates peaked at 5,700 mt in 1990 and decreased to an annual average of 2,800 mt from 1991 to 1997. Spawning stock biomass peaked in 1990 at 2,100 mt when most of the 1987 cohort matured, decreased in 1991 and 1992, then generally increased to 1,700 mt in 1997 (Figure 17). The age distribution of SSB indicates that most of the current mature biomass is composed of fist-time spawners (Figure 17).

Survey residuals were randomly resampled for 1,000 bootstrap solutions. Bootstrap percentiles suggest that the 80% confidence interval of 1997 SSB is 1,390 mt to 2,120 mt, and the 80% CI of 1997 F is 0.47 to 0.92 (Figure 18). Bootstrap coefficients of variation (CVs) for abundance estimates ranged 29-39%. Estimates of q for each index were relatively precise (CV=19-25%).

Several alternative ADAPT configurations were inspected (Table 17). All age-6 indices were excluded, because they were composed mainly of large fish with few age samples at length, and survey catchability coefficients were poorly estimated (Tables 12-15). The MADMF fall age-1 index (which is based on young-of-the year observations the year before) was excluded, because age-0 fish were not caught in most years (Table 15). Calibration results were relatively robust to exclusion of age-1 and age-6+ tuning indices. However, results are sensitive to exclusion of age-5 indices.

Retrospective analysis was performed to assess consistency of estimates in the last year of the VPA calibration (Sinclair et al. 1990). Retrospective results from preliminary calibrations (e.g., run#9) suggested that terminal estimates of SSB were generally overestimated (the mean retrospective difference was +250 mt), age-1 recruitment was overestimated (mean difference was +1.4 million), and fully-recruited F was underestimated (mean difference was -0.18; Figure 19a). A revised run (run#14, Appendix A) without MADMF age-5 indices had much less of a retrospective pattern (mean retrospective differences were +130 mt SSB, +0.5 million recruits, and +0.07 fully-recruited F; Figure 19b). Therefore, age-5 indices from MADMF surveys were excluded, presumably because they don't sample offshore areas well. Conversely, NEFSC age-1 indices were excluded, because the surveys don't extend to nearshore concentrations of juveniles. The configuration reported in Appendix A was considered to include the most reliable information on relative stock size and to have the best properties for estimating abundance and mortality.

Biological Reference Points

Estimates of yield per recruit (Thompson and Bell 1934) and spawning biomass per recruit (Gabriel et al. 1989) are listed in Table 18. The fishing mortality pattern was based on geometric mean F at age from 1994 to 1997, and mean weights at age were based on 1994-1997 mean catch weight at age. The time period 1994-1997 was chosen, because Amendment 7 was the most significant regulatory change in the recent history of the fishery. Proportion mature was taken from O'Brien et al. (1993). The model indicates that maximum yield per recruit of 0.23 kg is produced at a fully-recruited F of 0.47 (F_{max}), however the yield curve is relatively flat, and the maximum was not well defined (Figure 20). The increase in yield per recruit per unit F is decreased to one-tenth the initial increase at an F of 0.21 ($F_{0.1}$). The present results are similar to previously reported estimates for the management area west of 69° longitude that were based on data for the southern New England stock (F_{max} = 0.55, $F_{0.1}$ = 0.21; Rago 1995, Overholtz and Cadrin 1998). Howe (1975) estimated F_{max} = 0.63 for a 114 mm (4.5") mesh size using a Beverton and Holt (1957) yield per recruit model. Spawning biomass per recruit (SSB/R) is 2.8 kg with no fishing, and is reduced to 40% of maximum at an F of 0.20.

A nonequilibrium surplus production analysis (ASPIC; Prager 1994, 1995) of total catch, standardized CPUE, and survey indices of stock biomass from 1963 to 1996 was attempted to provide perspective on historical stock levels, and offer guidance on SFA reference points (Appendix B). Initial biomass (B_I: B_{63}/B_{MSY}), maximum sustainable yield (MSY), intrinsic rate of increase (r), and catchability (q_i) of each biomass index (i) were estimated by nonlinear least squares of biomass index residuals. The model was calibrated with historical standardized CPUE index, the NEFSC spring and fall biomass indices, and the MADMF spring and fall indices. Biomass indices were well correlated (r=0.4 to 0.7) and fit the model moderately well (R^2=0.12 to 0.31). Estimates from the present analysis are very similar to those reported by Applegate et al. (1998). However, estimated biomass was approximately 2.5 times greater than from the VPA, suggesting that the estimates of q_i were not accurate. Therefore, the VPA suggests that absolute biomass levels from the production model can not be used for SFA reference points.

Most production models require a time series which encompasses a broad range of stock biomass and yield to provide dependable parameter estimates (Prager et al. 1996). In cases where the data series is not informative enough to reliably estimate all parameters, independent data can be used to fix certain parameters. For example, Prager (1993) fixed the value of r to provide guidance on MSY, but fixing r will determine the level of F_{MSY}. Application of ASPIC to other stocks in the northeast U.S. demonstrates that values of q can be fixed according to VPA estimates of stock biomass (Applegate et al. 1998). Catchability coefficients were fixed for a 'conditioned' analysis, forcing agreement between ASPIC and VPA, however biomass indices did not fit the conditioned model well (R^2<0, strong residual patterns).

Prager (1994, 1995) suggested that ratios of biomass and F to MSY reference points are more reliable than absolute biomass or F estimates. The production model indicates that biomass was approximately $1.5 \cdot B_{MSY}$ during the 1960s and early 1970s, but decreased to approximately $0.5 \cdot B_{MSY}$ in the late 1980s and early 1990s, then gradually increased to $0.7 \cdot B_{MSY}$ in 1998 (Figures 21 and 22). According to the average biomass ratio (B_t/B_{MSY}) from the production model and VPA estimates of biomass (1985-1994), B_{MSY} is approximately 6,100 mt. The ASPIC estimate of MSY (2,400 mt) and the rescaled estimate of B_{MSY} (6,100 mt) suggest that F_{MSY} is 0.40 on biomass, which is equivalent to a fully-recruited F of 0.54 (slightly greater than F_{max}).

Technical guidance on defining overfishing according to the Sustainable Fisheries Act suggests that F_{max} is the most liberal of reference points that can be considered as a candidate for a F_{MSY} proxy, because it assumes no stock-recruit relationship (i.e., recruitment is not expected to increase at higher levels of stock biomass or lower levels of F; Restrepo et al. 1998). The stock-recruit relationship for Cape Cod yellowtail flounder appears to be 'flat' according to the short VPA time series (Figure 23), but there is no information for SSB less than 450 mt. Fitting a Beverton and Holt (1957) stock recruit function to VPA estimates suggests that for all observed levels of SSB, recruitment approaches an asymptote of approximately 8 million, but the slope at the origin is poorly defined. Applying an age-based approach to estimating MSY reference points (Sissenwine and Shepherd 1987) confirms that the production curve closely reflects the yield-per recruit curve, F_{MSY} is equivalent to F_{max}, and SSB_{MSY} and B_{MSY} are equivalent to the product of SSB/R and B/R with average observed recruitment (Figure 24). However, without more dynamic range in observed SSB and recruitment, age-based MSY reference points should be considered provisional.

The Amendment 9 control rule was developed to define overfishing thresholds and targets (Applegate et al. 1998). When the stock biomass exceeds B_{MSY}, the overfishing threshold is F_{MSY}, and target F is based on a 10% risk of exceeding the threshold. When the stock biomass is less than B_{MSY}, the overfishing threshold is based on maximum F that would allow rebuilding to B_{MSY} in five years, and target F is based on a 10% risk of exceeding the threshold (Cadrin 1998). The revised control rule (based on rescaled reference points) and recent stock status are illustrated in Figure 25. Note that F values pertain to F on biomass, not fully-recruited F, because the control rule was derived from a surplus production model.

Projections

Stochastic projections were performed using 1,000 bootstrap estimates of abundance at age for the ADAPT calibration, assuming 1998 landings of 1,320 mt (based on January-August 1998 landings and the portion of total 1997 landings reported during January-August, S. Correia, personal communication), a range of 1998 discards of approximately 300 mt (based on the 1994-1997 mean discard proportion at age), and 100 randomly drawn recruitment values from the VPA time series for each bootstrap realization. The fishing mortality pattern was based on geometric mean F at age from 1994 to 1997, and mean weights at age were based on 1994-1997 mean catch weight at age.

Fully-recruited F in 1998 is 1.01 (0.56 on biomass), and January 1, 1999 biomass is projected to be 2,700 mt (a decrease from 2,900 mt in 1998), based on VPA estimates of abundance for January 1, 1998, assumed mean weights at age, and the preliminary estimate of 1998 catch. According to the control rule and the 1999 level of biomass, threshold F (the overfishing definition) is 0.13 on biomass (Figure 25; 0.23 on fully-recruited ages) and target F is zero (Figure 25).

Projections that assume status quo F in 1999 (1.01 fully-recruited, 0.56 on biomass) indicate that landings will decrease to 1,100 mt and biomass in 2000 will slightly increase to the 1998 level (2,900 mt or 48% of B_{MSY}; Figure 26, Table 19). Projections that assume the target F in 1999 (0.00) indicate that biomass in 2000 will substantially increase to 4,200 mt (69% of B_{MSY}; Figure 26, Table 20). Projections that assume the maximum F which is expected to allow rebuilding to B_{MSY} within five years (derived from production model parameters, Cadrin 1998; 0.23 on fully-recruited ages, 0.13 on biomass) indicate that landings will significantly decrease to 300 mt and biomass in 2000 will substantially increase to 3,800 mt (62% of B_{MSY}; Figure 26, Table 21).

Long-term projections were performed to test the performance of the control rule. A target F of 0.00 was assumed for five years, and a long-term target F of 0.33 on fully-recruited ages, 0.26 on biomass was assumed for the next 20 years. Long-term projections suggest that there would be a high probability of attaining B_{MSY}, stock biomass would approach an equilibrium of approximately 7,000 mt (115% B_{MSY}) with high probability of exceeding B_{MSY}, and landings would approach 1,500 mt (63% of MSY; Figure 27).

DISCUSSION

Estimating total catch at age is the most important source of uncertainty in this assessment. The frequency and distribution of samples were inadequate to monitor spatial and temporal patterns in the age composition of catch. The estimates of catch at age by half-year and total stock area strata ignores geographic and seasonal differences. The spatial patterns of maturity at age and sex ratios suggest that there are important small-scale patterns that may effect the way we should sample the stock or make population estimates from historical data. Geographic differences in recruitment and growth, which are apparent for the Georges Bank yellowtail flounder stock (Cadrin et al. 1998) may also exist for the Cape Cod stock. Therefore, further analysis on geographic patterns of demographics may reveal better ways to analyze biological samples.

One area of concern is estimating the magnitude of discards. Despite the availability of observer data from nearly 2,000 trips that caught Cape Cod yellowtail since 1989, sampling may be inadequate to accurately represent discard rates for the many fisheries that catch yellowtail. Although there is a substantial amount of information for each gear-type (e.g., large-mesh otter trawl, small-mesh otter trawl, gillnet, scallop dredge), there are several different fisheries within gear-types (e.g., small-mesh fisheries for shrimp, whiting, and dogfish) and many fleets and actively fished grounds within fisheries (e.g., whiting fleets from Provincetown and Gloucester) which have potentially different discard rates. With a limited amount of data, there is little statistical power to detect different discard rates among fleets or even fisheries. More observer trips, allocated among all fleets, is necessary for more reliable estimates of discards.

Furthermore, application of analytical models that account for error in estimates of catch at age would be more appropriate for this stock. Unfortunately, such models may require better information on other aspects of the assessment (e.g., recruitment indices, fishery selectivity, natural mortality).

Redefinition of stock boundaries of the Cape Cod stock may improve the assessment, particularly the northern boundary with the putative Gulf of Maine stock and the potential mixing with the Georges Bank and southern New England stocks in the Great South Channel (area 521; Figure 1). Information on the productive capacity of the stock and recruitment dynamics may change considerably if Gulf of Maine commercial catches and survey data were included.

Calibration of the VPA may benefit from post-stratification of NEFSC survey data to include all data in the stock area (e.g., the western portion of stratum 23 in the Great South Channel) and exclude data outside the stock area (e.g., the northern area of stratum 26, Jeffreys Ledge). Also, post-stratifying NEFSC inshore stratum to represent the entire inshore strata set rather than the portion of area sampled during each survey may improve the performance of tuning indices.

The disagreement between biomass estimates from ASPIC and the VPA is not uncommon. Catchability estimates from production models are often poorly determined. Age-based estimates are generally more informative and reliable than those from production models. Perhaps historical catch data are not accurate enough to derive reliable estimates from ASPIC. Over time, VPA of this stock may provide a long enough series of stock and recruitment information to derive reliable MSY reference points from age-based analyses. Despite disagreements between the production model and the VPA, the determination of current stock status is similar from both models: biomass is well below B_{MSY}; and although fishing mortality appears to have decreased in the last several years, it is still too high to allow stock rebuilding.

ACKNOWLEDGMENTS

We thank all participants in the Southern Demersal Working Group and Stock Assessment Review Committee for their review and suggestions. Vaughn Silva processed a large volume of NEFSC age samples with short notice and assisted in checking Massachusetts age determinations. Susan Wigley summarized the SARC discussion and provided guidance on prorating landings, estimating effort from logbooks, and landings by gear-type. Steve Correia contributed the preliminary 1998 landings estimate. Mark Terceiro chaired the Working Group. Kathy Sosebee provided Figures 2 and 11. Arnie Howe and Terry Smith reviewed report drafts. Dan Schick offered information on small-mesh fisheries. Rob Johnston assisted with information on Massachusetts sea samples. Dave McCarron for provided information on effort in the experimental whiting fishery.

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Table 1. Observed movements of yellowtail flounder among stock areas (GOM: northern Gulf of Maine; CC: Cape Cod; GB: Georges Bank; SNE; southern New England; MA; mid-Atlantic) from Royce et al. (1959), Lux (1963a, 1963b), and Lux (unpublished).

release	recapture site						proportional recaptures				
site	GOM	CC	GB	SNE	MA	sum	GOM	CC	GB	SNE	MA
CC	2	345	1	4	0	352	0.006	0.980	0.003	0.011	0.000
GB	0	0	148	8	0	156	0.000	0.000	0.949	0.051	0.000
SNE	0	5	16	578	14	613	0.000	0.008	0.026	0.943	0.023
MA	0	0	0	64	28	92	0.000	0.000	0.000	0.696	0.304
sum	2	350	165	654	42	1213					

Table 2. Catch and effort of Cape Cod yellowtail flounder (1935-1959 from Brown and Hennemuth, 1971; 1960-1982 from McBride 1988).

year	Landings (mt)	Discards (mt)	Percent Discard	Total (mt)	Effort (thous d)	CPUE (mt/d)
1935	400	100	25	500		
1936	400	100	25	500		
1937	500	200	40	700		
1938	500	200	40	700		
1939	600	200	33	800		
1940	900	300	33	1,200		
1941	1,300	400	31	1,700		
1942	1,500	500	33	2,000		
1943	1,300	400	31	1,700	0.53	3.2
1944	1,500	500	33	2,000	1.01	2.0
1945	1,200	400	33	1,600	0.61	2.6
1946	1,200	400	33	1,600	0.62	2.6
1947	1,100	300	27	1,400	0.75	1.9
1948	700	200	29	900	0.47	1.9
1949	1,200	400	33	1,600	0.68	2.4
1950	1,300	400	31	1,700	0.95	1.8
1951	800	200	25	1,000	0.79	1.3
1952	800	200	25	1,000	0.76	1.3
1953	800	200	25	1,000	0.78	1.3
1954	1,100	300	27	1,400	0.89	1.6
1955	1,300	400	31	1,700	1.00	1.7
1956	1,400	400	29	1,800	1.34	1.3
1957	2,400	700	29	3,100	1.44	2.2
1958	1,600	500	31	2,100	0.92	2.3
1959	1,500	500	33	2,000	0.76	2.6
1960	1,500	500	33	2,000	1.12	1.8

Table 2 (continued).

year	Landings (mt)	Discards (mt)	Percent Discard	Total (mt)	Effort (thous d)	CPUE (mt/d)
1961	1,800	600	32	2,400	0.91	2.6
1962	1,900	600	32	2,500	1.01	2.5
1963	3,600	1,000	28	4,600	1.00	4.6
1964	1,851	600	32	2,451	0.71	3.5
1965	1,498	500	33	1,998	0.70	2.9
1966	1,808	300	17	2,108	1.37	1.5
1967	1,542	800	52	2,342	1.69	1.4
1968	1,569	600	38	2,169	0.99	2.2
1969	1,346	300	22	1,646	0.68	2.4
1970	1,185	400	34	1,585	0.53	3.0
1971	1,662	700	42	2,362	0.79	3.0
1972	1,364	300	22	1,664	0.67	2.5
1973	1,662	0	0	1,662	0.89	1.9
1974	2,054	200	10	2,254	1.21	1.9
1975	2,027	0	0	2,027	1.25	1.6
1976	3,587	100	3	3,687	2.31	1.6
1977	3,469	0	0	3,469	2.42	1.4
1978	3,683	400	11	4,083	2.05	2.0
1979	4,163	500	12	4,663	2.61	1.8
1980	5,106	600	12	5,706	3.25	1.8
1981	3,149	600	19	3,749	2.30	1.6
1982	3,150	400	13	3,550	2.02	1.8
1983	1,884	300	16	2,184	1.25	1.7
1984	1,121	20	2	1,141	1.01	1.1
1985	967	77	8	1,044	1.30	0.8
1986	1,041	305	29	1,346	1.46	0.9
1987	1,159	198	17	1,357	1.55	0.9
1988	1,085	283	26	1,368		
1989	909	390	43	1,299		
1990	2,984	1,141	38	4,125		
1991	1,472	405	28	1,877		
1992	828	637	77	1,465		
1993	628	90	14	718		
1994	978	192	20	1,170		
1995	1,207	233	19	1,440		
1996	1,064	182	17	1,246		
1997	1,040	257	25	1,297		
mean	1,593	367	26	1,960	1.19	2.0

Table 3. Cape Cod yellowtail flounder landings (mt) by gear type (small mesh: <5").

landings year	large mesh	small mesh	gill net	scallop dredge	other	sum
1982	881	2,228	8	30	3	3,150
1983	723	1,133	10	12	6	1,884
1984	544	571	2	1	2	1,121
1985	430	531	2	3	1	967
1986	437	555	31	16	1	1,041
1987	465	569	73	39	13	1,159
1988	484	488	65	45	3	1,085
1989	394	375	67	68	4	909
1990	1,580	1,109	181	113	2	2,984
1991	557	662	108	134	11	1,472
1992	227	416	121	60	4	828
1993	155	345	88	41	0	628
1994	832	36	50	16	43	978
1995	902	27	238	8	31	1,207
1996	754	20	268	13	9	1,064
1997	722	14	279	7	18	1,040
mean	630	567	99	38	10	1,345

annual % year	large mesh	small mesh	gill net	scallop dredge	other	sum
1982	28	71	0	1	0	100
1983	38	60	1	1	0	100
1984	49	51	0	0	0	100
1985	44	55	0	0	0	100
1986	42	53	3	2	0	100
1987	40	49	6	3	1	100
1988	45	45	6	4	0	100
1989	43	41	7	8	0	100
1990	53	37	6	4	0	100
1991	38	45	7	9	1	100
1992	27	50	15	7	1	100
1993	25	55	14	6	0	100
1994	85	4	5	2	4	100
1995	75	2	20	1	3	100
1996	71	2	25	1	1	100
1997	69	1	27	1	2	100
mean	48	39	9	3	1	100

Table 4. Number of port samples of Cape Cod yellowtail flounder by quarter, market category, and statistical area.

		area 514			area 521			stock area			
	qtr	uncl	sm	lg	uncl	sm	lg	uncl	sm	lg	all
1969	1	1			1			2	0	0	2
	2							0	0	0	0
	3							0	0	0	0
	4				1			1	0	0	1
all		1	0	0	2	0	0	3	0	0	3
1970	1	1			1			2	0	0	2
	2				1			1	0	0	1
	3				1			1	0	0	1
	4							0	0	0	0
all		1	0	0	3	0	0	4	0	0	4
1971	1				1			1	0	0	1
	2							0	0	0	0
	3				1			1	0	0	1
	4				1			1	0	0	1
all		0	0	0	3	0	0	3	0	0	3
1972	1							0	0	0	0
	2							0	0	0	0
	3							0	0	0	0
	4				1			1	0	0	1
all		0	0	0	1	0	0	1	0	0	1
1973	1		1	1	1			1	1	1	3
	2	1				1	1	1	1	1	3
	3							0	0	0	0
	4				1			1	0	0	1
all		1	1	1	2	1	1	3	2	2	7
1974	1							0	0	0	0
	2				1			1	0	0	1
	3				1		1	1	0	1	2
	4				1			1	0	0	1
all		0	0	0	3	0	1	3	0	1	4

Table 4 (cont.).

		area 514			area 521			stock area			
	qtr	uncl	sm	lg	uncl	sm	lg	uncl	sm	lg	all
1975	1							0	0	0	0
	2							0	0	0	0
	3				1			1	0	0	1
	4				1			1	0	0	1
	all	0	0	0	2	0	0	2	0	0	2
1976	1							0	0	0	0
	2							0	0	0	0
	3						1	0	0	1	1
	4						1	0	0	1	1
	all	0	0	0	0	0	2	0	0	2	2
1977	1			1		1		0	1	1	2
	2							0	0	0	0
	3						1	0	0	1	1
	4						1	0	0	1	1
	all	0	0	1	0	1	2	0	1	3	4
1978	1						1	0	0	1	1
	2						1	0	0	1	1
	3						1	0	0	1	1
	4				1			1	0	0	1
	all	0	0	0	1	0	3	1	0	3	4
1979	1					1		0	1	0	1
	2							0	0	0	0
	3							0	0	0	0
	4		1			1		0	2	0	2
	all	0	1	0	0	2	0	0	3	0	3
1980	1			1	1	1		1	1	1	3
	2							0	0	0	0
	3						1	0	0	1	1
	4						1	0	0	1	1
	all	0	0	1	1	1	2	1	1	3	5

Table 4 (cont.).

		area 514			area 521			stock area			
	qtr	uncl	sm	lg	uncl	sm	lg	uncl	sm	lg	all
1981	1				1		1	1	0	1	2
	2						1	0	0	1	1
	3							0	0	0	0
	4							0	0	0	0
	all	0	0	0	1	0	2	1	0	2	3
1982	1							0	0	0	0
	2							0	0	0	0
	3			1		1		0	1	1	2
	4							0	0	0	0
	all	0	0	1	0	1	0	0	1	1	2
1983	1	1		1				1	0	1	2
	2		2	1				0	2	1	3
	3	1	1			1	1	1	2	1	4
	4		1	1		2	1	0	3	2	5
	all	2	4	3	0	3	2	2	7	5	14
1984	1							0	0	0	0
	2							0	0	0	0
	3	1		1			1	1	0	2	3
	4		1	1			2	0	1	3	4
	all	1	1	2	0	0	3	1	1	5	7
1985	1	1				2	1	1	2	1	4
	2						1	0	0	1	1
	3					4	5	0	4	5	9
	4					2	1	0	2	1	3
	all	1	0	0	0	8	8	1	8	8	17
1986	1					1	1	0	1	1	2
	2					1	1	0	1	1	2
	3					2		0	2	0	2
	4		2	1			1	0	2	2	4
	all	0	2	1	0	4	3	0	6	4	10

Table 4 (cont.).

		area 514			area 521			stock area			
	qtr	uncl	sm	lg	uncl	sm	lg	uncl	sm	lg	all
1987	1		1	2				0	1	2	3
	2		1	1			1	0	1	2	3
	3					1	1	0	1	1	2
	4		1	1			1	0	1	2	3
all		0	3	4	0	1	3	0	4	7	11
1988	1		1			1	1	0	2	1	3
	2			1		1	1	0	1	2	3
	3						3	0	0	3	3
	4		2	1				0	2	1	3
all		0	3	2	0	2	5	0	5	7	12
1989	1		1	2				0	1	2	3
	2					1	2	0	1	2	3
	3		1				1	0	1	1	2
	4		1	1				0	1	1	2
all		0	3	3	0	1	3	0	4	6	10
1990	1		1			2	1	0	3	1	4
	2			2		1	1	0	1	3	4
	3					1	1	0	1	1	2
	4		1	1		1	1	0	2	2	4
all		0	2	3	0	5	4	0	7	7	14
1991	1		2	2				0	2	2	4
	2		2	2				0	2	2	4
	3		1			1	1	0	2	1	3
	4			1		2	1	0	2	2	4
all		0	5	5	0	3	2	0	8	7	15
1992	1			1			1	0	0	2	2
	2		1	1				0	1	1	2
	3			1				0	0	1	1
	4		1	2		1	2	0	2	4	6
all		0	2	5	0	1	3	0	3	8	11

Table 4 (cont.)

		area 514			area 521			stock area			
	qtr	uncl	sm	lg	uncl	sm	lg	uncl	sm	lg	all
1993	1			1		1		0	1	1	2
	2						1	0	0	1	1
	3							0	0	0	0
	4		2	1				0	2	1	3
	all	0	2	2	0	1	1	0	3	3	6
1994	1							0	0	0	0
	2		1	1		1	1	0	2	2	4
	3							0	0	0	0
	4		1	1		1		0	2	1	3
	all	0	2	2	0	2	1	0	4	3	7
1995	1							0	0	0	0
	2		1	1		1	1	0	2	2	4
	3		2	1				0	2	1	3
	4			1		1	1	0	1	2	3
	all	0	3	3	0	2	2	0	5	5	10
1996	1						1	0	0	1	1
	2							0	0	0	0
	3			1		1	1	0	1	2	3
	4	1	3	4			1	1	3	5	9
	all	1	3	5	0	1	3	1	4	8	13
1997	1		2	1		1	1	0	3	2	5
	2			2				0	0	2	2
	3					1	1	0	1	1	2
	4		2	4		4	5	0	6	9	15
	all	0	4	7	0	6	7	0	10	14	24

Table 5. Sample sizes used to estimate landings at age of Cape Cod yellowtail flounder.

		landings (mt)			port samples (trips)			observed	lengths			ages
year	half	unclass.	small	large	unclass.	small	large	trips	unclass.	small	large	all
1985	1	44	213	302	1	2	2	0	109	304	196	292
	2	23	177	209	0	6	6	0	*	825	543	357
1986	1	20	400	198	0	2	2	0	*	608	206	217
	2	57	164	203	0	4	2	0	*	321	172	240
1987	1	89	308	323	0	2	4	0	*	300	352	353
	2	20	228	192	0	2	3	0	*	284	269	207
1988	1	88	185	291	0	3	3	0	*	477	267	286
	2	19	289	213	0	1	4	0	*	291	364	252
1989	1	66	129	224	0	2	4	16	10	261	314	305
	2	19	256	215	0	2	2	40	97	262	173	200
1990	1	118	366	435	0	4	4	44	536	532	374	339
	2	36	1324	705	0	3	3	20	636	429	276	137
1991	1	104	250	395	0	4	4	69	811	501	332	610
	2	40	303	380	0	4	3	160	109	531	242	277
1992	1	84	193	226	0	1	3	190	707	126	254	339
	2	26	166	132	0	2	5	81	136	262	457	268
1993	1	59	121	124	0	1	2	144	170	145	182	177
	2	16	160	147	0	2	1	43	273	244	74	114
1994	1	96	170	195	0	2	2	127	100	261	170	273
	2	30	231	256	0	2	1	55	*	106	144	149
1995	1	84	279	284	0	2	2	203	39	276	201	196
	2	21	242	297	0	3	3	78	998	392	275	157
1996	1	66	330	231	0	0	1	189	2560	**	87	196
	2	27	186	225	1	4	7	60	118	495	640	485
1997	1	44	290	192	0	3	4	293	343	388	483	556
	2	21	174	319	0	7	10	45	317	996	869	634
sum		1316	7134	6911	2	70	87	1857	8069	9617	7916	7616

* unclassified landings prorated to large and small categories.

** entire catch characterized by unclassified samples.

Table 6. Landings at age (above) and mean weight at age (below) of landed Cape Cod yellowtail flounder.

Landings at age (thousands)				age					
	1	2	3	4	5	6	7	8+	sum
1985	5	738	700	522	268	89	3	7	2,332
1986	0	1,998	579	223	32	6	0	1	2,838
1987	0	609	1,786	268	100	29	12	5	2,808
1988	1	802	1,043	625	172	36	0	0	2,679
1989	0	726	989	231	31	3	2	2	1,986
1990	0	692	6,191	416	32	16	7	3	7,357
1991	0	311	903	1,455	249	33	27	1	2,978
1992	0	338	807	514	150	6	5	1	1,821
1993	0	25	684	573	90	24	15	7	1,418
1994	0	87	1,023	650	236	65	38	9	2,109
1995	0	233	1,730	808	152	78	5	0	3,006
1996	0	150	1,097	798	287	11	5	2	2,349
1997	0	481	1,086	702	160	13	0	1	2,443
mean	0	553	1,432	599	151	31	9	3	2,779

Landed weight at age (kg)				age				
	1	2	3	4	5	6	7	8+
1985	0.19	0.32	0.37	0.49	0.60	0.73	1.20	1.39
1986	----	0.32	0.46	0.57	0.73	0.90	----	1.40
1987	----	0.31	0.42	0.55	0.65	0.81	1.03	1.18
1988	0.11	0.31	0.37	0.53	0.70	0.85	----	----
1989	----	0.38	0.45	0.65	0.92	1.41	1.24	1.24
1990	----	0.31	0.41	0.56	0.82	0.90	0.99	1.17
1991	----	0.35	0.39	0.54	0.74	0.99	1.06	1.01
1992	----	0.32	0.41	0.53	0.61	0.73	1.53	1.91
1993	----	0.31	0.38	0.43	0.74	0.95	1.01	1.17
1994	----	0.29	0.38	0.50	0.62	0.68	1.04	1.11
1995	----	0.35	0.36	0.43	0.61	0.78	1.11	----
1996	----	0.32	0.42	0.50	0.53	0.91	1.19	1.18
1997	----	0.39	0.41	0.47	0.57	0.78	1.30	1.31
mean	0.15	0.33	0.40	0.52	0.68	0.88	1.16	1.28

Table 7. Observations of proportion discarded at sea and total discard estimates of Cape Cod yellowtail flounder.

large-mesh otter trawl year	half	trips	kg kept	kg disc	ratio*	trimmed ratio	mean ratio	trimmed mean	dealer landings	discards (mt)
1989	1	11	1083	675	0.62	0.62	0.50	0.39	160	100
	2	13	569	209	0.37	0.36	0.51	0.45	234	86
1990	1	8	1617	335	0.21	0.12	2.01	0.37	213	44
	2	10	4500	405	0.09	0.12	0.41	0.19	1367	123
1991	1	10	1156	101	0.09	0.07	0.07	0.05	158	14
	2	18	4624	348	0.08	0.06	0.20	0.18	399	30
1992	1	22	1855	345	0.19	0.17	0.27	0.25	91	17
	2	8	368	12	0.03	0.02	0.03	0.01	136	4
1993	1	1	19	1	0.05	--	0.05	--	53	3
	2	7	978	44	0.05	0.05	0.09	0.07	141	6
1994	1	5	15	5	0.30	--	0.58	--	81	25
	2	0	--	--	0.04 (<-- 2nd half average, '94-96)				751	34
1995	1	6	58	18	0.31	--	0.11	--	467	143
	2	7	6980	131	0.02	0.02	0.08	0.04	435	8
1996	1	4	288	35	0.12	--	0.08	--	375	46
	2	3	1473	97	0.07	--	0.20	--	379	25
1997	1	5	107	24	0.22	--	0.29	--	248	55
	2	7	9757	490	0.05	0.05	0.17	0.09	409	21
mean					0.16	0.15	0.33	0.19	339	43

gill net year	half	trips	kg kept	kg disc	ratio*	trimmed ratio	mean ratio	trimmed mean	dealer landings	discards (mt)
1989	1	1	0	0	0.00	--	0.00	--	65	0
	2	13	56	6	0.11	0.10	0.07	0.03	2	0
1990	1	34	2869	654	0.23	0.21	0.22	0.21	160	36
	2	4	23	0	0.00	--	0.00	--	21	0
1991	1	54	2355	246	0.10	0.10	0.16	0.14	103	11
	2	134	513	91	0.18	0.17	0.21	0.15	4	1
1992	1	154	5797	967	0.17	0.17	0.19	0.18	117	20
	2	57	71	16	0.22	0.19	0.17	0.15	4	1
1993	1	128	5769	1154	0.20	0.20	0.22	0.21	103	21
	2	24	79	27	0.34	0.25	0.20	0.15	7	3
1994	1	104	4357	109	0.03	0.02	0.10	0.07	36	1
	2	51	204	1	0.01	0.00	0.01	0.00	14	0
1995	1	189	22629	354	0.02	0.02	0.02	0.02	231	4
	2	46	109	16	0.15	0.05	0.14	0.04	7	1
1996	1	166	14465	276	0.02	0.02	0.02	0.01	257	5
	2	49	77	1	0.01	0.01	0.00	0.00	11	0
1997	1	282	23632	506	0.02	0.02	0.04	0.01	242	5
	2	37	170	4	0.02	0.00	0.01	0.00	6	0
mean					0.10	0.09	0.10	0.09	77	6

* ratio estimator used to derive total discards.

Table 7 (cont.).

small-mesh otter trawl year	half	trips	kg kept	kg disc	ratio	trimmed ratio**	mean ratio	trimmed mean	dealer landings	discards (mt)
1989	1	4	12	3	0.26	--	0.36	--	187	48
	2	14	368	215	0.58	0.43	0.75	0.71	189	82
1990	1	2	6	4	0.57	--	0.33	--	531	303
	2	6	8	7	0.88	--	0.67	--	579	512
1991	1	5	214	13	0.06	--	0.63	--	450	27
	2	7	40	97	2.39	0.65	3.73	0.65	212	139
1992	1	11	132	201	1.51	1.03	2.54	2.09	269	276
	2	12	34	61	1.78	1.70	1.67	1.54	147	250
1993	1	10	0	15	--	--	--	--	251	***
	2	12	30	228	7.61	7.34	6.90	5.55	183	***
1994	1	17	2	32	14.19	--	--	--	1	***
	2	16	0	205	--	--	--	--	35	***
1995	1	11	0	17	--	--	--	--	20	***
	2	27	0	187	--	--	--	--	8	***
1996	1	18	5	18	3.69	--	0.09	--	9	***
	2	18	3	1	0.35	--	0.08	--	12	***
1997	1	6	230	62	0.27	--	0.26	--	5	***
	2	52	0	0	--	--	--	--	9	***
mean					2.63	2.23	1.50	2.11	172	205

scallop dredge year	half	trips	kg kept	kg disc	ratio*	trimmed ratio	mean ratio	trimmed mean	dealer landings	discards (mt)
1989	1	0	--	--	1.08 (<-- '89-95 mean)			--	5	6
	2	0	--	--	1.08 (<-- '89-95 mean)			--	63	68
1990	1	0	--	--	1.08 (<-- '89-95 mean)			--	15	16
	2	0	--	--	1.08 (<-- '89-95 mean)			--	98	106
1991	1	0	--	--	1.08 (<-- '89-95 mean)			--	29	32
	2	1	16	23	1.46	--	1.46	--	105	153
1992	1	3	48	8	0.16	--	0.26	--	23	4
	2	4	97	176	1.82	--	0.85	--	36	66
1993	1	5	49	40	0.81	--	1.06	--	19	15
	2	0	--	--	1.08 (<-- '89-95 mean)			--	33	35
1994	1	1	413	157	0.38	--	0.38	--	5	2
	2	4	226	273	1.21	--	0.88	--	11	13
1995	1	0	--	--	1.08 (<-- '89-95 mean)			--	2	3
	2	4	132	228	1.73	--	2.00	--	6	10
1996	1	8	186	1217	6.53	5.65	19.97	7.61	9	***
	2	5	9	583	67.62	--	20.90	--	4	***
1997	1	6	79	1602	20.41	--	13.81	--	3	***
	2	2	0	397	--	--	--	--	3	***
mean					6.45	5.65	6.16	7.61	26	38

* ratio estimator used to derive total discards.
** trimmed ratio estimator used to derive total discards when n>7.
*** for total discards, see effort-based estimates (Table 8).

Table 8. Effort-based estimates of Cape Cod yellowtail flounder discards for fisheries prohibited or restricted from landing groundfish.

whiting fishery				Cape Cod area					
halfyear	wo mt	vtr mt	portion	vtr df	total df	obs df	disc (mt)	mt/df	disc mt
1993.25		--		--	7	(93-95 mean -->)		0.09	1
1993.75		--		--	406	2.7	0.202	0.07	30
1994.25	7922	2248	0.28	77	271	(93-95 mean -->)		0.09	23
1994.75	8136	5848	0.72	559	777	1.6	0.188	0.12	94
1995.25	7087	6182	0.87	331	379	(93-95 mean -->)		0.09	33
1995.75	7641	5383	0.70	390	554	7.0	0.450	0.06	36
1996.25	7941	6492	0.82	217	265	(93-95 mean -->)		0.09	23
1996.75	8258	7739	0.94	222	236	(93-95 mean -->)		0.09	20
1997.25	8204	6598	0.80	77	96	(93-95 mean -->)		0.09	8
1997.75	7358	6353	0.86	152	176	(93-95 mean -->)		0.09	15
mean	7818	5855	0.75	253	317	3.8	0.280	0.09	28

shrimp fishery				Cape Cod area					
halfyear	wo mt	vtr mt	portion	vtr df	total df	obs df	disc (mt)	mt/df	disc mt
1993.25		--		--	127	9.4	0.032	0.003	0.4
1993.75		--		--	14	1.1	0.003	0.003	0.0
1994.25		--		--	130	7.7	0.033	0.004	0.6
1994.75	1118	1143	1	31	31	0.8	0.010	0.013	0.4
1995.25	5348	5068	0.95	103	108	4.5	0.017	0.004	0.4
1995.75	1482	1572	1.00	29	29	0.9	0.001	0.001	0.0
1996.25	7684	7125	0.93	123	133	5.8	0.018	0.003	0.4
1996.75	1415	1521	1.07	38	36	1.3	0.001	0.001	0.0
1997.25	5699	5039	0.88	95	108	2.9	0.003	0.001	0.1
1997.75	650	972	1.00	16	16	0.2	0.000	0.000	0.0
mean	3342	3206	0.98	62	73	3.5	0.012	0.003	0.2

scallop fishery				Cape Cod area					
halfyear	wo mt	vtr mt	portion	vtr df	total df	obs df	disc (mt)	mt/df	disc mt
1996.25	4088	4057	0.99	1025	1032	58.6	1.217	0.021	21
1996.75	3805	3616	0.95	1770	1862	23.9	0.582	0.024	45
1997.25	3316	3546	1.00	1950	1950	32.2	1.602	0.050	97
1997.75	2688	2484	0.92	1871	2025	13.1	0.397	0.030	62
mean	3474	3426	0.97	1654	1717	31.9	0.950	0.031	56

Table 9. Sample sizes used to estimate discards at age of Cape Cod yellowtail flounder.

year	half	discards (mt)				observed trips				lengths				ages
1985	1	20												128
	2	57												63
1986	1	152												158
	2	153												48
1987	1	56												183
	2	142												85
1988	1	109												182
	2	174												86
		discards (mt)				observed trips				lengths				ages
year	half	LgMsh	SmMsh	gillnet	dredge	LgMsh	SmMsh	gillnet	dredge	LgMsh	SmMsh	gillnet	dredge	all
1989	1	100	48	0	6	11	4	1	0	1333	41	0	*	274
	2	86	82	0	68	13	14	13	0	283	90	0	*	205
1990	1	44	303	36	16	8	2	34	0	121	42	508	*	438
	2	123	512	0	106	10	6	4	0	621	12	0	*	199
1991	1	14	27	11	32	10	5	54	0	278	41	10	*	682
	2	30	139	1	153	18	7	134	1	195	112	18	167	292
1992	1	17	276	20	4	22	11	154	3	143	44	508	145	373
	2	4	250	1	66	8	12	57	4	8	100	1	52	120
1993	1	3	1	21	15	1	10	128	5	*	46	545	145	312
	2	6	30	3	35	7	12	24	0	201	695	45	*	84
1994	1	25	23	1	2	5	17	104	1	*	264	71	193	300
	2	34	94	0	13	0	16	51	4	*	454	0	205	168
1995	1	143	33	4	3	6	11	189	0	24	44	4306	145	248
	2	8	36	1	10	7	27	46	4	83	192	38	60	157
1996	1	46	23	5	21	4	18	166	8	52	59	1570	596	261
	2	25	20	0	45	3	18	49	5	20	3	0	124	529
1997	1	55	8	5	97	5	6	282	6	154	36	989	749	603
	2	21	15	0	62	7	52	37	2	176	3	0	208	708
	sum	783	2783	108	753	145	248	1527	43	3692	2278	8609	2789	6886

* samples from adjacent cells used to characterize discards at length.

Table 10. Discards at age (above) and mean weight at age (below) of discarded Cape Cod yellowtail flounder.

Discards at age (thousands)				age			
	1	2	3	4	5	6	sum
1985	340	184	34	0	0	0	558
1986	79	1,657	75	26	0	0	1,837
1987	14	877	168	0	0	0	1,059
1988	360	1,328	177	0	0	0	1,864
1989	114	1,405	396	1	0	0	1,917
1990	81	2,047	2,501	19	0	0	4,648
1991	460	895	561	100	7	0	2,023
1992	1,688	3,543	731	29	3	0	5,994
1993	138	324	173	30	0	0	665
1994	60	383	279	49	4	1	776
1995	453	469	652	50	2	0	1,627
1996	7	397	327	94	11	0	837
1997	1	399	351	117	22	1	891
mean	292	1,070	494	40	4	0	1,900

Discarded weight at age (kg)				age		
	1	2	3	4	5	6
1985	0.13	0.15	0.15	----	----	----
1986	0.10	0.17	0.19	0.18	----	----
1987	0.06	0.19	0.19	----	----	----
1988	0.12	0.15	0.20	----	----	----
1989	0.13	0.21	0.25	0.36	----	----
1990	0.08	0.24	0.27	0.33	----	----
1991	0.12	0.19	0.27	0.37	0.54	----
1992	0.05	0.11	0.22	0.31	0.36	----
1993	0.09	0.15	0.27	0.33	0.63	----
1994	0.08	0.20	0.29	0.32	0.38	0.34
1995	0.07	0.16	0.23	0.33	0.48	----
1996	0.04	0.15	0.28	0.36	0.50	----
1997	0.03	0.21	0.29	0.39	0.54	0.65
mean	0.09	0.17	0.24	0.33	0.49	0.49

Table 11. Total catch at age (above) and mean weight at age (below) of Cape Cod yellowtail flounder.

Total catch at age (thousands)			age					
	1	2	3	4	5	6	7	8+	sum
1985	344	922	734	522	268	89	3	7	2,890
1986	79	3,655	654	250	32	6	0	1	4,676
1987	14	1,486	1,954	268	100	29	12	5	3,867
1988	361	2,130	1,219	625	172	36	0	0	4,543
1989	114	2,131	1,385	233	31	3	2	2	3,903
1990	81	2,738	8,692	435	32	16	7	3	12,005
1991	460	1,206	1,464	1,555	256	33	27	1	5,001
1992	1,688	3,881	1,538	543	153	6	5	1	7,815
1993	138	349	857	602	91	24	15	7	2,083
1994	60	471	1,301	699	240	66	38	9	2,885
1995	453	702	2,382	858	154	78	5	0	4,633
1996	7	547	1,425	892	298	11	5	2	3,186
1997	1	880	1,437	819	182	13	0	1	3,334
mean	292	1,623	1,926	638	155	32	9	3	4,678

weight at age (kg)			age					
	1	2	3	4	5	6	7	8+
1985	0.13	0.28	0.36	0.49	0.60	0.73	1.20	1.39
1986	0.10	0.25	0.43	0.53	0.73	0.90	----	1.40
1987	0.06	0.24	0.40	0.55	0.65	0.81	1.03	1.18
1988	0.12	0.21	0.34	0.53	0.70	0.85	----	----
1989	0.13	0.27	0.39	0.65	0.92	1.41	1.24	1.24
1990	0.08	0.26	0.37	0.55	0.82	0.90	0.99	1.17
1991	0.12	0.23	0.34	0.53	0.73	0.99	1.06	1.01
1992	0.05	0.13	0.32	0.52	0.61	0.73	1.53	1.91
1993	0.09	0.16	0.36	0.43	0.74	0.95	1.01	1.17
1994	0.08	0.22	0.36	0.49	0.62	0.68	1.04	1.11
1995	0.07	0.22	0.33	0.42	0.61	0.78	1.11	----
1996	0.04	0.19	0.39	0.49	0.53	0.91	1.19	1.18
1997	0.03	0.31	0.38	0.46	0.57	0.77	1.30	1.31
mean	0.09	0.23	0.37	0.51	0.68	0.88	1.16	1.28

Table 12. NEFSC spring survey indices of abundance at age and total biomass (offshore strata 25 and 26; inshore strata 56-66).

	age										mature
year	1	2	3	4	5	6	7	8+	sum	kg/tow	kg/tow
1979	0.55	0.71	1.33	0.85	0.04	0.03	0.00	0.00	3.51	1.20	1.00
1980	0.00	7.14	4.08	1.43	0.29	0.00	0.00	0.00	12.94	4.89	3.69
1981	0.10	6.30	4.27	0.93	1.06	0.51	0.66	0.00	13.83	4.41	3.55
1982	0.08	2.79	7.23	3.71	1.00	0.57	0.63	0.16	16.17	7.16	6.50
1983	2.36	6.33	5.09	2.09	0.22	0.15	0.00	0.00	16.24	4.78	4.03
1984	0.09	2.39	1.42	0.92	0.60	0.05	0.07	0.16	5.70	1.99	1.79
1985	0.13	1.86	1.81	0.43	0.25	0.10	0.00	0.00	4.58	1.37	1.14
1986	0.04	4.33	0.37	0.10	0.24	0.00	0.00	0.00	5.08	1.04	0.69
1987	0.15	3.44	5.15	0.84	1.30	1.31	1.52	0.74	14.45	7.14	7.16
1988	2.13	9.11	1.87	1.22	0.47	0.18	0.08	0.00	15.06	2.51	1.48
1989	0.53	6.33	3.88	0.35	0.17	0.00	0.00	0.00	11.26	1.93	1.36
1990	0.00	5.51	13.35	0.35	0.00	0.24	0.00	0.00	19.45	4.38	2.95
1991	0.96	8.23	5.67	1.80	0.42	0.00	0.11	0.00	17.19	3.76	2.44
1992	0.37	2.25	3.52	0.98	0.04	0.00	0.00	0.00	7.16	1.67	1.34
1993	0.15	1.51	1.75	0.87	0.00	0.00	0.00	0.00	4.28	0.93	0.66
1994	0.80	5.64	2.33	0.90	0.33	0.19	0.00	0.00	10.19	1.79	1.01
1995	0.32	2.10	7.33	4.74	0.46	0.11	0.00	0.00	15.06	3.68	3.00
1996	0.03	0.85	1.18	0.63	0.00	0.00	0.00	0.00	2.69	0.62	0.48
1997	0.05	1.98	3.15	2.54	0.56	0.00	0.00	0.00	8.28	2.43	2.05
1998	0.00	1.71	5.03	1.83	0.42	0.00	0.00	0.00	8.99	2.32	1.90
mean	0.44	4.03	3.99	1.38	0.39	0.17	0.15	0.05	10.61	3.00	2.41

Table 13. NEFSC autumn survey indices of abundance at age and total biomass (offshore strata 25 and 26; inshore strata 56-66).

	age									
year	1	2	3	4	5	6	7	8+	sum	kg/tow
1979	7.87	8.02	2.41	0.60	0.11	0.03	0.00	0.00	19.04	5.34
1980	20.70	17.63	8.00	3.04	0.67	0.00	0.07	0.00	50.11	13.52
1981	6.34	9.64	1.74	0.45	0.29	0.00	0.00	0.00	18.46	4.11
1982	1.13	5.39	5.18	0.63	0.70	0.06	0.00	0.00	13.09	4.32
1983	0.66	0.88	0.55	0.04	0.00	0.00	0.00	0.00	2.13	0.49
1984	0.64	2.25	1.04	1.31	0.93	0.30	0.15	0.15	6.77	2.79
1985	9.03	3.48	2.65	0.40	0.00	0.00	0.00	0.00	15.56	3.25
1986	2.62	7.14	0.60	0.00	0.00	0.00	0.00	0.00	10.36	1.98
1987	1.08	2.60	0.91	0.11	0.09	0.00	0.00	0.00	4.79	1.12
1988	6.16	9.01	0.89	0.17	0.00	0.00	0.00	0.00	16.23	2.29
1989	3.53	11.39	4.19	0.74	0.00	0.00	0.00	0.14	19.99	4.70
1990	7.01	11.90	5.58	0.09	0.02	0.00	0.00	0.00	24.60	4.76
1991	3.57	3.33	2.88	0.59	0.00	0.00	0.00	0.00	10.37	2.34
1992	4.82	5.29	3.68	1.52	0.36	0.27	0.00	0.00	15.94	3.81
1993	8.76	8.60	1.01	0.15	0.00	0.00	0.00	0.00	18.52	2.15
1994	4.78	14.27	5.13	1.40	0.43	0.00	0.00	0.00	26.01	5.38
1995	1.18	1.64	1.57	0.34	0.08	0.00	0.00	0.00	4.81	1.49
1996	2.07	5.36	8.78	2.31	0.26	0.00	0.00	0.00	18.78	5.12
1997	2.07	4.79	5.45	2.46	1.33	0.23	0.00	0.00	16.33	4.63
mean	4.95	6.98	3.28	0.86	0.28	0.05	0.01	0.02	16.42	3.87

Table 14. Massachusetts DMF spring survey indices of abundance at age and total biomass (strata 17-36).

year	age 1	2	3	4	5	6	7	8+	sum	kg/tow	mature kg/tow
1978	2.71	20.69	11.82	1.60	0.63	0.54	0.10	0.13	38.22	10.16	8.60
1979	2.63	22.58	13.85	3.68	0.86	0.00	0.17	0.00	43.77	11.38	9.01
1980	2.68	17.62	10.10	2.30	0.15	0.00	0.00	0.00	32.85	10.03	7.93
1981	5.61	58.83	9.00	2.26	1.59	0.27	0.00	0.00	77.56	16.35	10.34
1982	0.69	17.06	17.04	4.45	0.94	0.06	0.04	0.00	40.28	12.85	11.75
1983	3.13	8.50	11.51	4.28	0.04	0.17	0.03	0.00	27.66	9.00	7.09
1984*	0.57	15.38	8.17	3.51	1.48	0.04	0.06	0.04	29.26	7.37	5.68
1985	1.97	8.27	7.15	1.52	0.59	0.39	0.05	0.05	19.99	5.21	4.22
1986	1.73	15.39	1.74	0.24	0.21	0.04	0.00	0.00	19.36	4.52	2.92
1987	2.53	4.95	5.31	0.97	0.27	0.11	0.08	0.00	14.22	3.67	3.15
1988	3.10	14.46	2.52	0.60	0.05	0.02	0.00	0.00	20.74	3.83	2.06
1989	0.67	22.26	3.18	1.08	0.06	0.00	0.00	0.00	27.25	4.73	2.71
1990	0.63	11.77	15.57	0.63	0.14	0.01	0.02	0.01	28.77	6.60	4.73
1991	0.06	5.34	3.31	2.15	0.48	0.12	0.05	0.00	11.50	3.32	2.61
1992	1.30	11.03	9.71	2.38	1.45	0.03	0.03	0.00	25.94	6.54	5.18
1993	0.63	7.99	6.31	1.94	0.23	0.06	0.20	0.03	17.38	4.60	3.72
1994	2.67	24.02	7.53	1.49	0.33	0.12	0.00	0.00	36.15	6.23	3.72
1995	7.51	14.64	24.96	2.88	1.20	0.02	0.02	0.00	51.22	10.38	7.37
1996	1.17	18.03	14.70	6.78	1.74	0.00	0.04	0.00	42.46	9.25	6.50
1997	0.52	16.94	12.22	4.04	0.54	0.00	0.00	0.00	34.26	7.55	5.52
1998**	0.48	9.54	26.77	2.41	0.32	0.04	0.00	0.00	39.55	5.18	
mean	2.05	16.44	10.59	2.44	0.63	0.10	0.04	0.01	32.30	7.56	5.74

* provisional, based on NEFSC age-length key.

** preliminary estimates, based on unaudited data.

Table 15. Massachusetts DMF autumn survey indices of abundance at age and total biomass (strata 17-36).

	age										
year	0	1	2	3	4	5	6	7	8+	sum	kg/tow
1978	0.04	7.13	7.74	1.45	0.11	0.00	0.01	0.00	0.00	16.48	2.80
1979	0.03	24.11	22.82	1.78	0.06	0.00	0.00	0.00	0.00	48.80	7.33
1980	0.03	26.54	12.38	2.70	0.35	0.00	0.00	0.00	0.00	42.00	5.90
1981	0.00	2.93	6.54	1.54	0.23	0.17	0.00	0.00	0.00	11.41	2.76
1982	0.00	9.58	3.36	5.54	0.30	0.08	0.00	0.00	0.00	18.86	4.20
1983	0.00	9.68	6.68	1.60	0.13	0.00	0.00	0.00	0.00	18.09	3.39
1984*	0.04	1.91	3.00	0.86	0.39	0.10	0.02	0.00	0.04	6.37	1.18
1985*	0.04	5.70	1.63	1.03	0.00	0.00	0.00	0.00	0.02	8.42	1.17
1986*	0.01	2.60	4.95	0.20	0.03	0.01	0.00	0.00	0.00	7.80	1.36
1987*	0.44	5.85	2.30	0.49	0.07	0.02	0.00	0.00	0.00	9.17	1.09
1988*	0.00	8.96	11.24	2.27	0.15	0.00	0.00	0.00	0.00	22.62	3.71
1989*	0.00	2.64	5.22	0.96	0.10	0.00	0.00	0.00	0.00	8.92	1.52
1990*	0.00	5.20	11.93	4.84	0.01	0.00	0.00	0.00	0.00	21.98	4.16
1991*	0.00	3.76	5.14	5.03	0.86	0.00	0.00	0.00	0.00	14.78	3.23
1992*	0.20	7.18	3.62	2.08	0.47	0.20	0.00	0.00	0.00	13.75	2.00
1993*	0.00	8.39	7.29	5.80	1.43	0.00	0.00	0.00	0.00	22.91	3.99
1994*	0.00	3.56	8.39	3.06	0.96	0.12	0.00	0.00	0.00	16.09	3.27
1995*	0.00	11.54	11.97	4.71	1.18	0.00	0.00	0.00	0.00	29.40	5.75
1996	0.01	1.87	3.94	2.18	0.17	0.00	0.00	0.00	0.00	8.17	1.56
1997	0.00	1.01	7.38	1.14	0.16	0.10	0.00	0.00	0.00	9.79	2.10
mean	0.04	7.51	7.38	2.46	0.36	0.04	0.00	0.00	0.00	17.79	3.12

* provisional, based on NEFSC age-length key.

Table 16. Correlations among normalized indices of Cape Cod yellowtail flounder abundance at age.

age-1	NMFSs1	MASSs1	MASSf1	
NMFSs1	1.00			
MASSs1	-0.09	1.00		
MASSf1	0.61	-0.02	1.00	

age-2	NMFSs2	NMFSf2	MASSs2	MASSf2
NMFSs2	1.00			
NMFSf2	0.41	1.00		
MASSs2	0.03	0.14	1.00	
MASSf2	0.20	0.37	0.42	1.00

age-3	NMFSs3	NMFSf3	MASSs3	MASSf3
NMFSs3	1.00			
NMFSf3	0.69	1.00		
MASSs3	0.52	0.13	1.00	
MASSf3	0.53	0.41	0.41	1.00

age-4	NMFSs4	NMFSf4	MASSs4	MASSf4
NMFSs4	1.00			
NMFSf4	0.42	1.00		
MASSs4	0.66	0.33	1.00	
MASSf4	0.25	0.38	0.57	1.00

age-5	NMFSs5	NMFSf5	MASSs5	MASSf5
NMFSs5	1.00			
NMFSf5	0.16	1.00		
MASSs5	-0.19	0.35	1.00	
MASSf5	-0.43	0.24	0.46	1.00

age-6	NMFSs6	NMFSf6	MASSs6	MASSf6
NMFSs6	1.00			
NMFSf6	0.25	1.00		
MASSs6	0.02	0.29	1.00	
MASSf6	-0.51	0.13	0.29	1.00

Table 17. Summary of results from alternative ADAPT calibrations of the Cape Cod yellowtail flounder virtual population analysis.

run#	2	3	4	6	7	9	10	11	12	13	14*
tuning indices											
NMFSs	1-6+	1-5	1-4	1-5	2-4	1-5	1-4	1-5	1-4	2-5	2-5
NMFSf	2-6+	2-5	2-4	2-5	2-4	2-5	2-5	2-5	2-4	2-5	2-5
MASSs	1-6+	1-5	1-4	1-6+	1-5	1-5	1-5	---	1-4	1-4	1-4
MASSf	1-6+	1-5	1-4	2-5	2-5	2-5	2-5	---	2-4	2-4	2-4
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
results											
N 2	2163	2161	2257	2384	2751	2364	2372	2271	2454	3278	2780
N 3	3063	3059	3217	3053	3767	2998	3010	1989	3124	4163	3776
N 4	1688	1684	1834	1669	1633	1591	1602	1376	1711	1744	1617
N 5	472	449	1547	322	281	438	512	646	1309	841	821
CV(N2)	36%	35%	30%	37%	37%	36%	36%	50%	31%	36%	36%
CV(N3)	34%	33%	28%	32%	31%	32%	32%	46%	27%	29%	29%
CV(N4)	37%	35%	30%	35%	33%	35%	34%	49%	29%	31%	32%
CV(N5)	33%	40%	39%	38%	53%	39%	42%	50%	42%	38%	39%
mean square	0.817	0.753	0.562	0.742	0.637	0.714	0.702	0.676	0.526	0.579	0.586
retro pattern	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
F4+,97	0.94	0.98	0.39	1.19	1.29	0.99	0.90	0.76	0.45	0.61	0.64
SSB97	1454	1435	2255	1333	1307	1392	1451	1437	2047	1851	1697

* configuration accepted by SARC and reported in Appendix A.

Table 18. Yield and spawning biomass per recruit estimates for Cape Cod yellowtail flounder.

The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992

Run Date: 10-12-1998; Time: 09:01:00.96
CAPE COD YELLOWTAIL FLOUNDER - SAW28

Proportion of F before spawning: .4167
Proportion of M before spawning: .4167
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 8
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> CCYT8.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Average Weights Stock
1	.0200	1.0000	.0000	.056	.056
2	.1400	1.0000	.0800	.235	.235
3	.6600	1.0000	.8100	.365	.365
4	1.0000	1.0000	1.0000	.463	.463
5	1.0000	1.0000	1.0000	.582	.582
6	1.0000	1.0000	1.0000	.785	.785
7	1.0000	1.0000	1.0000	1.162	1.162
8+	1.0000	1.0000	1.0000	1.198	1.198

Summary of Yield per Recruit Analysis for:
CAPE COD YELLOWTAIL FLOUNDER - SAW28

Slope of the Yield/Recruit Curve at F=0.00: --> 2.6950
F level at slope=1/10 of the above slope (F0.1): -----> .208
Yield/Recruit corresponding to F0.1: -----> .2098
F level to produce Maximum Yield/Recruit (Fmax): -----> .469
Yield/Recruit corresponding to Fmax: -----> .2316
F level at 20 % of Max Spawning Potential (F20): -----> .448
SSB/Recruit corresponding to F20: --------> .5515

Listing of Yield per Recruit Results for:
CAPE COD YELLOWTAIL FLOUNDER - SAW28

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.00	.00000	.00000	5.5167	3.2772	3.3453	2.7580	100.00
F0.1	.21	.33681	.20978	3.8432	1.5182	1.6792	1.0526	38.17
	.25	.36734	.21882	3.6925	1.3771	1.5300	.9191	33.32
Fmax	.47	.46798	.23161	3.1988	.9563	1.0449	.5276	19.13
F20%	.45	.46109	.23157	3.2324	.9825	1.0777	.5515	20.00
	.50	.47740	.23147	3.1529	.9213	1.0003	.4957	17.97
	.75	.53284	.22697	2.8849	.7344	.7430	.3279	11.89
	1.00	.56749	.22201	2.7196	.6357	.5888	.2418	8.77
	1.25	.59190	.21809	2.6046	.5744	.4852	.1900	6.89
	1.50	.61044	.21497	2.5181	.5321	.4104	.1553	5.63
	1.75	.62525	.21234	2.4495	.5006	.3535	.1303	4.72
	2.00	.63753	.21002	2.3931	.4759	.3087	.1114	4.04
	2.25	.64798	.20789	2.3453	.4557	.2724	.0966	3.50
	2.50	.65706	.20590	2.3039	.4388	.2425	.0847	3.07
	2.75	.66509	.20402	2.2674	.4242	.2174	.0749	2.72
	3.00	.67228	.20222	2.2347	.4115	.1960	.0667	2.42
	3.25	.67878	.20049	2.2052	.4002	.1776	.0597	2.16
	3.50	.68473	.19882	2.1782	.3900	.1616	.0537	1.95
	3.75	.69020	.19720	2.1533	.3808	.1477	.0486	1.76
	4.00	.69526	.19563	2.1302	.3724	.1354	.0440	1.60
	4.25	.69998	.19411	2.1086	.3646	.1245	.0401	1.45
	4.50	.70440	.19263	2.0884	.3574	.1148	.0366	1.33
	4.75	.70856	.19118	2.0693	.3506	.1062	.0335	1.22
	5.00	.71248	.18977	2.0512	.3443	.0985	.0308	1.12

Table 19. Stochastic projection of Cape Cod yellowtail flounder, assuming <u>status quo F</u> in 1999.

PROJECTION RUN: Cape Cod yellowtail
INPUT FILE: ccytfsq.in
OUTPUT FILE: ccytfsq.out
RECRUITMENT MODEL: 3
NUMBER OF SIMULATIONS: 100

MIXTURE OF F AND QUOTA BASED CATCHES

YEAR	F	QUOTA (THOUSAND MT)
1998		1.320
1999	1.010	
2000	1.010	

JAN 1 STOCK BIOMASS (THOUSAND MT)

YEAR	AVG B (000 MT)	STD
1998	2.919	.456
1999	2.786	.685
2000	3.062	.795

PERCENTILES OF JAN 1 STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.985	2.214	2.357	2.604	2.884	3.197	3.512	3.722	4.116
1999	1.512	1.800	1.975	2.306	2.702	3.176	3.717	4.109	4.692
2000	1.902	2.170	2.317	2.570	2.863	3.248	4.360	4.890	5.430

ANNUAL PROBABILITY THAT B EXCEEDS THRESHOLD: 6.100000 THOUSAND MT

YEAR	Pr(B > Threshold Value)
1998	.000
1999	.000
2000	.005

RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	8001.269	4129.533
1999	8018.301	4130.094
2000	8013.215	4136.996

PERCENTILES OF RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
1999	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
2000	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	1.319	.001
1999	1.090	.322
2000	1.182	.343

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320
1999	.424	.595	.691	.867	1.065	1.294	1.521	1.623	1.971
2000	.670	.799	.870	.979	1.116	1.269	1.497	2.116	2.329

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1998	.274	.037
1999	.263	.073
2000	.340	.112

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.200	.222	.230	.247	.271	.298	.322	.341	.372
1999	.151	.181	.195	.217	.249	.286	.348	.450	.502
2000	.189	.222	.242	.280	.308	.352	.528	.612	.661

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	1.078	.341
1999	1.010	.000
2000	1.010	.000

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.579	.678	.731	.850	1.010	1.229	1.493	1.702	2.330
1999	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010
2000	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010

Table 20. Stochastic projection of Cape Cod yellowtail flounder, assuming target F in 1999.

PROJECTION RUN: Cape Cod yellowtail
INPUT FILE: ccytf0.in
OUTPUT FILE: ccytf0.out
RECRUITMENT MODEL: 3
NUMBER OF SIMULATIONS: 100

MIXTURE OF F AND QUOTA BASED CATCHES

YEAR	F	QUOTA (THOUSAND MT)
1998		1.320
1999	.000	
2000	.000	

JAN 1 STOCK BIOMASS (THOUSAND MT)

YEAR	AVG B (000 MT)	STD
1998	2.919	.456
1999	2.786	.685
2000	4.392	1.020

PERCENTILES OF JAN 1 STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.985	2.214	2.357	2.604	2.884	3.197	3.512	3.722	4.116
1999	1.512	1.800	1.975	2.306	2.702	3.176	3.717	4.109	4.692
2000	2.658	3.071	3.291	3.708	4.201	4.851	5.870	6.508	7.386

ANNUAL PROBABILITY THAT B EXCEEDS THRESHOLD: 6.100000 THOUSAND MT

YEAR	Pr(B > Threshold Value)
1998	.000
1999	.000
2000	.081

RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	8001.269	4129.533
1999	8018.301	4130.094
2000	8013.215	4136.996

PERCENTILES OF RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
1999	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
2000	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	1.319	.001
1999	.000	.000
2000	.000	.000

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320
1999	.000	.000	.000	.000	.000	.000	.000	.000	.000
2000	.000	.000	.000	.000	.000	.000	.000	.000	.000

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1998	.274	.037
1999	.000	.000
2000	.000	.000

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.200	.222	.230	.247	.271	.298	.322	.341	.372
1999	.000	.000	.000	.000	.000	.000	.000	.000	.000
2000	.000	.000	.000	.000	.000	.000	.000	.000	.000

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	1.078	.341
1999	.000	.000
2000	.000	.000

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.579	.678	.731	.850	1.010	1.229	1.493	1.702	2.330
1999	.000	.000	.000	.000	.000	.000	.000	.000	.000
2000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Table 21. Stochastic projection of Cape Cod yellowtail flounder, assuming '5-year' F in 1999.

PROJECTION RUN: Cape Cod yellowtail
INPUT FILE: ccytfth.in
OUTPUT FILE: ccytfth.out
RECRUITMENT MODEL: 3
NUMBER OF SIMULATIONS: 100

MIXTURE OF F AND QUOTA BASED CATCHES

YEAR	F	QUOTA (THOUSAND MT)
1998		1.320
1999	.230	
2000	.230	

JAN 1 STOCK BIOMASS (THOUSAND MT)

YEAR	AVG B (000 MT)	STD
1998	2.919	.456
1999	2.786	.685
2000	3.991	.946

PERCENTILES OF JAN 1 STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.985	2.214	2.357	2.604	2.884	3.197	3.512	3.722	4.116
1999	1.512	1.800	1.975	2.306	2.702	3.176	3.717	4.109	4.692
2000	2.443	2.811	3.009	3.366	3.795	4.365	5.397	6.023	6.803

ANNUAL PROBABILITY THAT B EXCEEDS THRESHOLD: 6.100000 THOUSAND MT

YEAR	Pr(B > Threshold Value)
1998	.000
1999	.000
2000	.045

RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	8001.269	4129.533
1999	8018.301	4130.094
2000	8013.215	4136.996

PERCENTILES OF RECRUITMENT UNITS ARE: 1000.000000 FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
1999	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000
2000	3397.000	3397.000	4712.000	6554.000	6839.000	7700.000	9891.000	21230.000	21230.000

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	1.319	.001
1999	.332	.101
2000	.521	.134

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320	1.320
1999	.123	.175	.207	.262	.324	.396	.464	.502	.607
2000	.290	.344	.374	.433	.501	.582	.703	.810	.930

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1998	.274	.037
1999	.071	.019
2000	.107	.034

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.200	.222	.230	.247	.271	.298	.322	.341	.372
1999	.041	.048	.052	.059	.068	.078	.095	.115	.130
2000	.062	.072	.078	.089	.099	.112	.153	.195	.210

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	1.078	.341
1999	.230	.000
2000	.230	.000

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	.579	.678	.731	.850	1.010	1.229	1.493	1.702	2.330
1999	.230	.230	.230	.230	.230	.230	.230	.230	.230
2000	.230	.230	.230	.230	.230	.230	.230	.230	.230

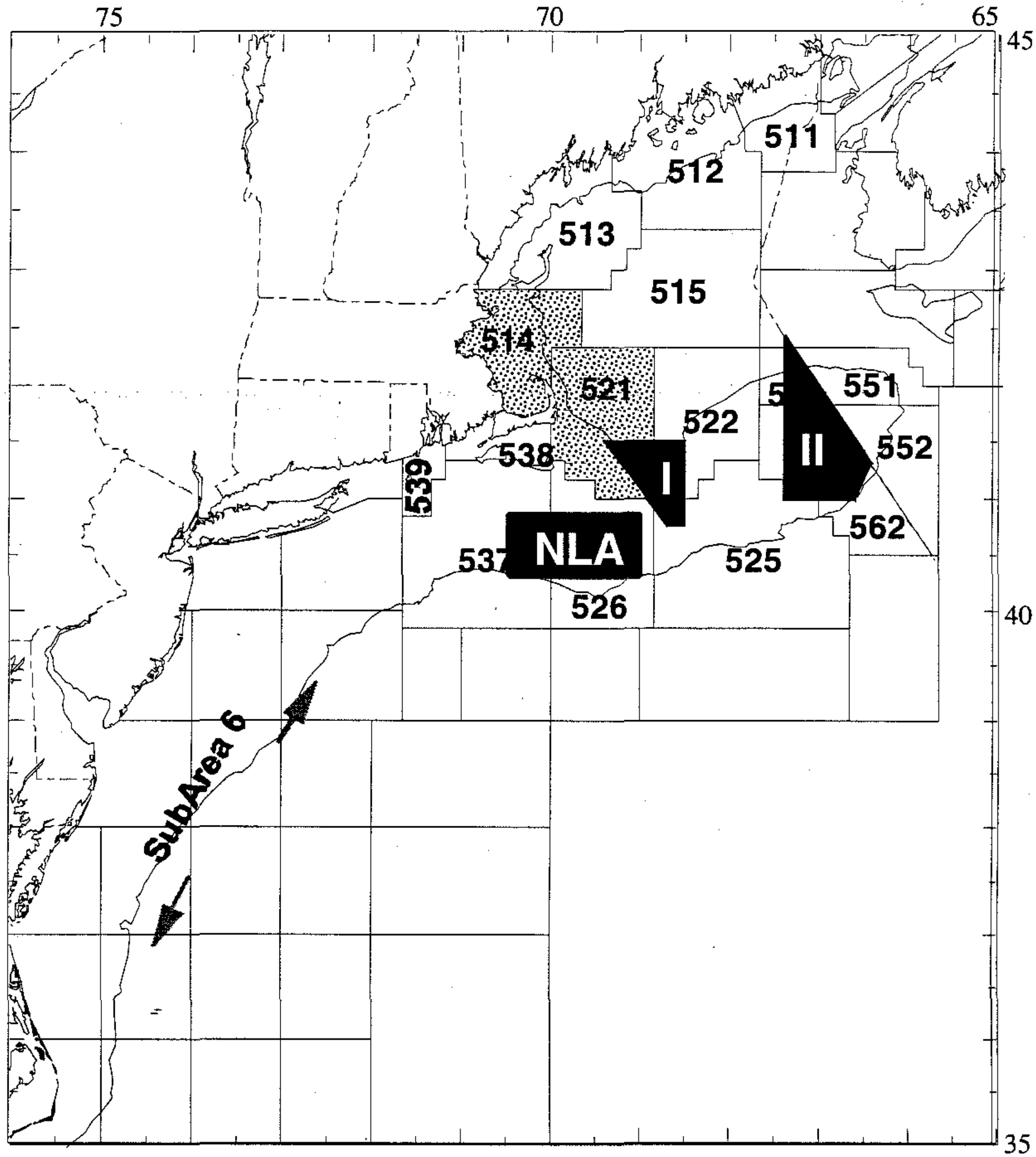
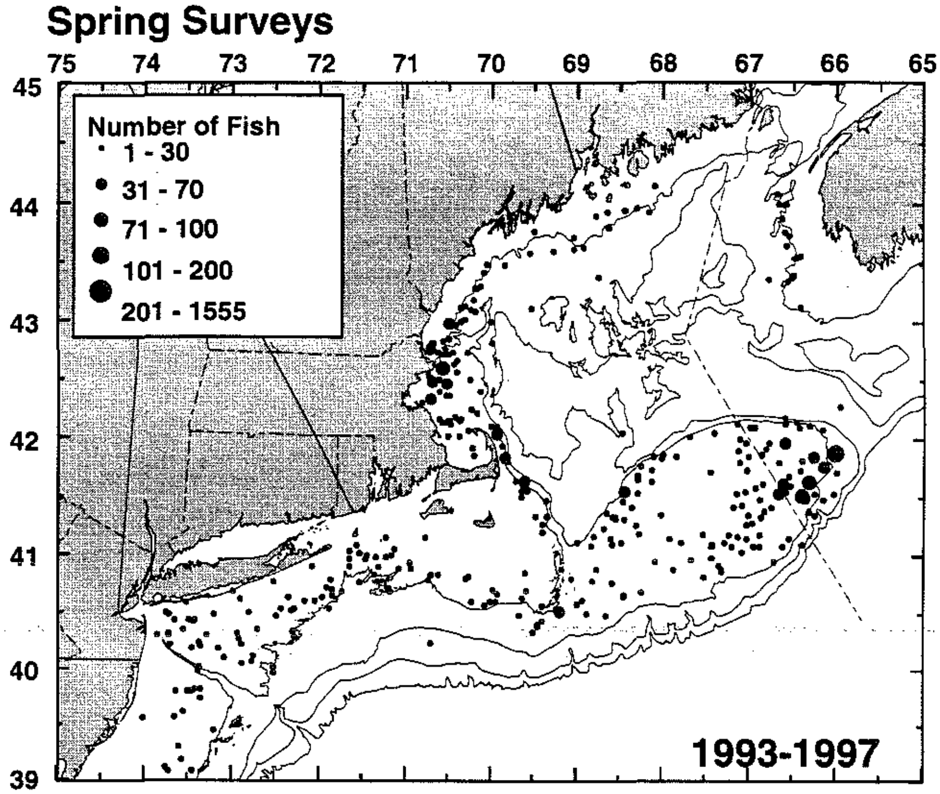


Figure 1. Statistical areas used for monitoring northeast fisheries. Catches from stippled areas are included in the Cape Cod yellowtail flounder assessment.



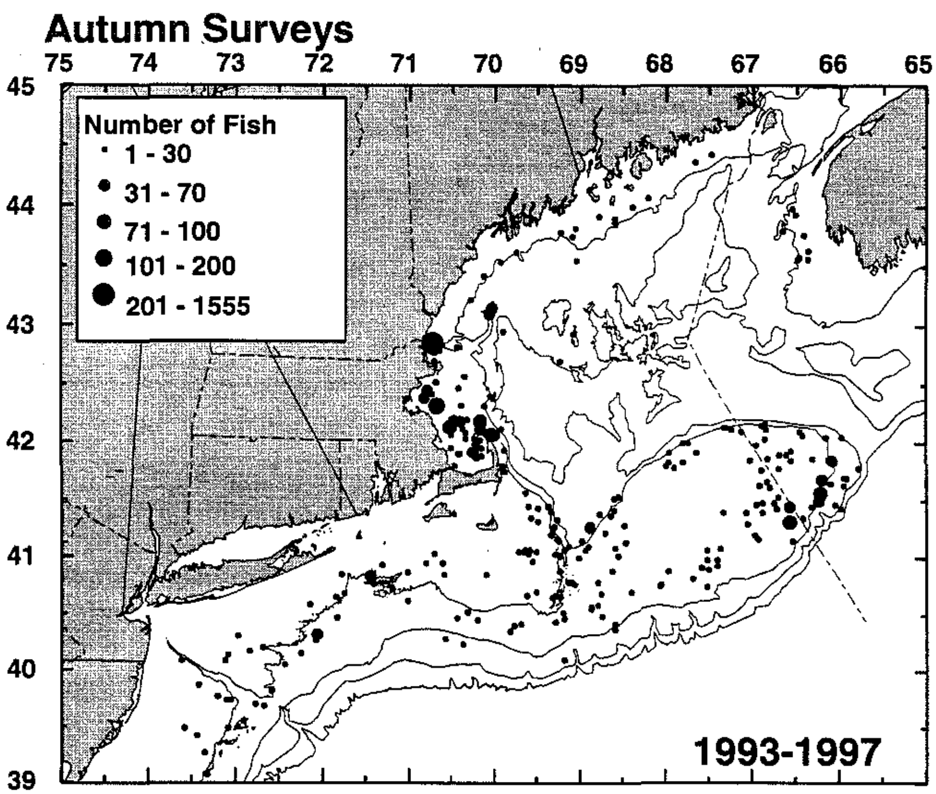


Figure 2. Distribution of yellowtail flounder in the NEFSC spring and autumn bottom trawl surveys.

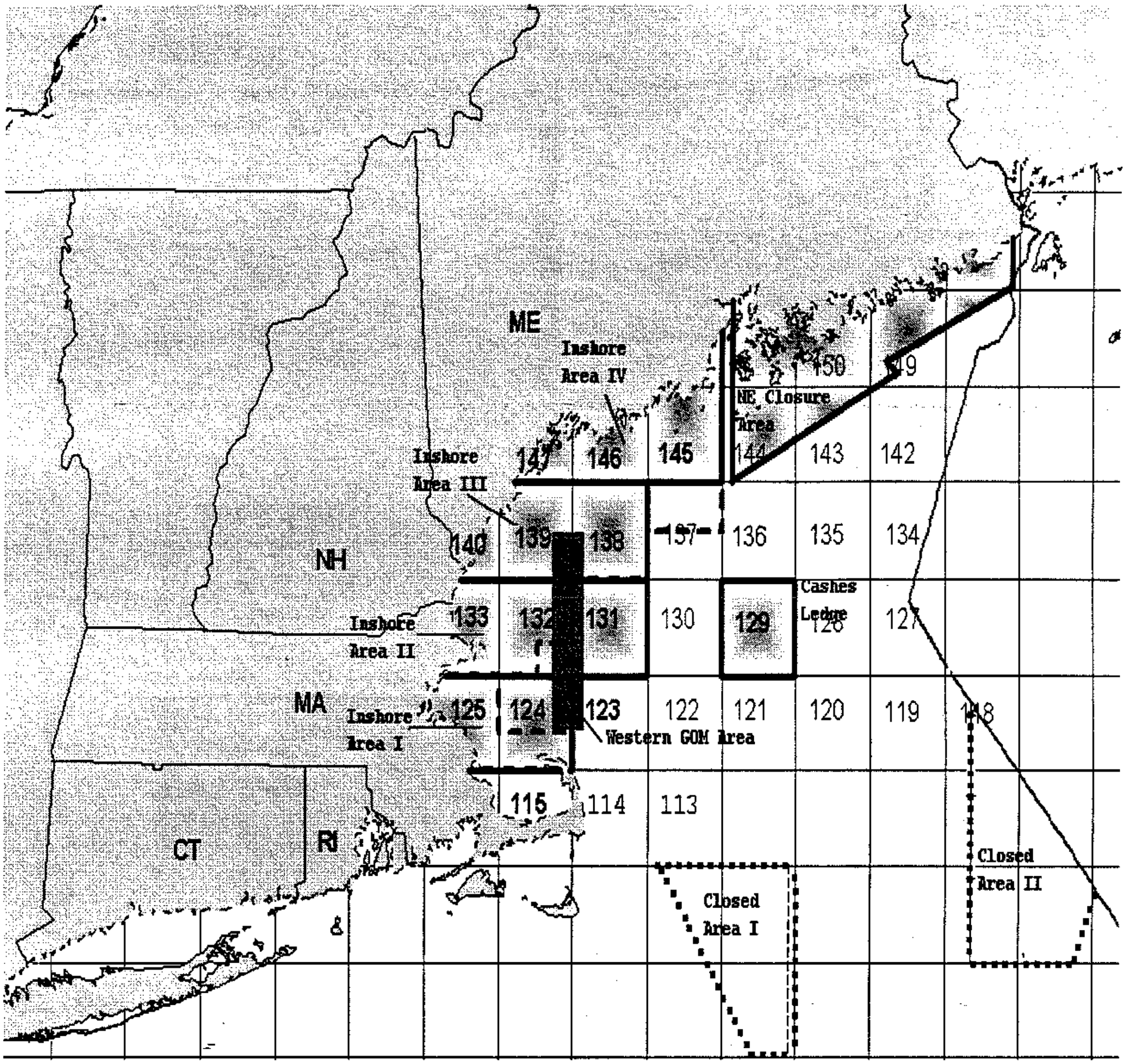


Figure 3. Boundaries of 1998 Multispecies FMP area closures. Quarter-degree square blocks are numbered sequentially to describe and evaluate proposed area closures. Shaded blocks represent the Gulf of Maine Inshore Closure Areas, the Cashes Ledge Closure Area, and the Northeast Closure Area. Dashed lines in the Gulf of Maine indicate the boundaries of the Massachusetts Bay and Mid-Coast Closure Areas.

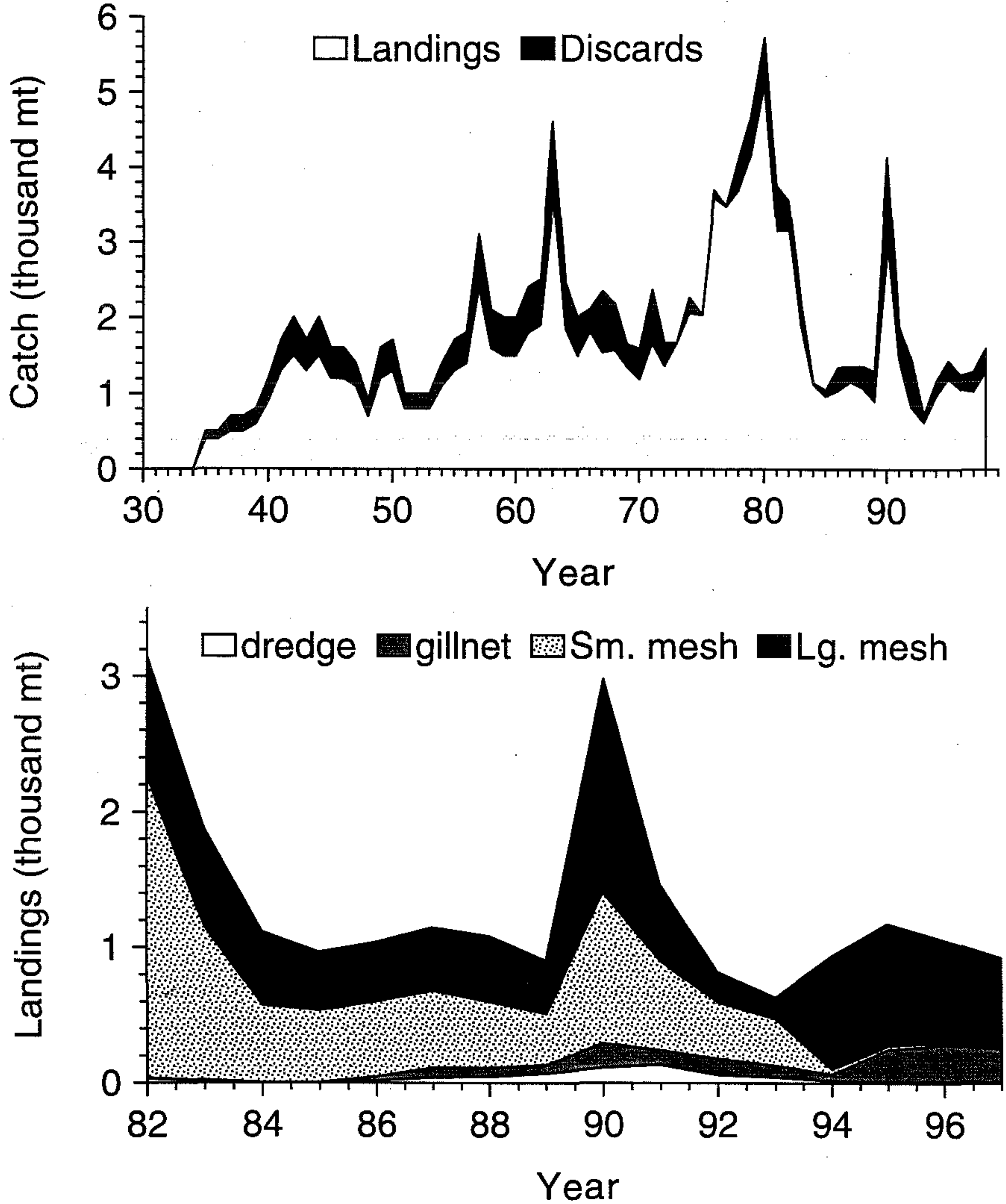


Figure 4. Landings and discards of Cape Cod yellowtail flounder (above) and landings by gear type (below).

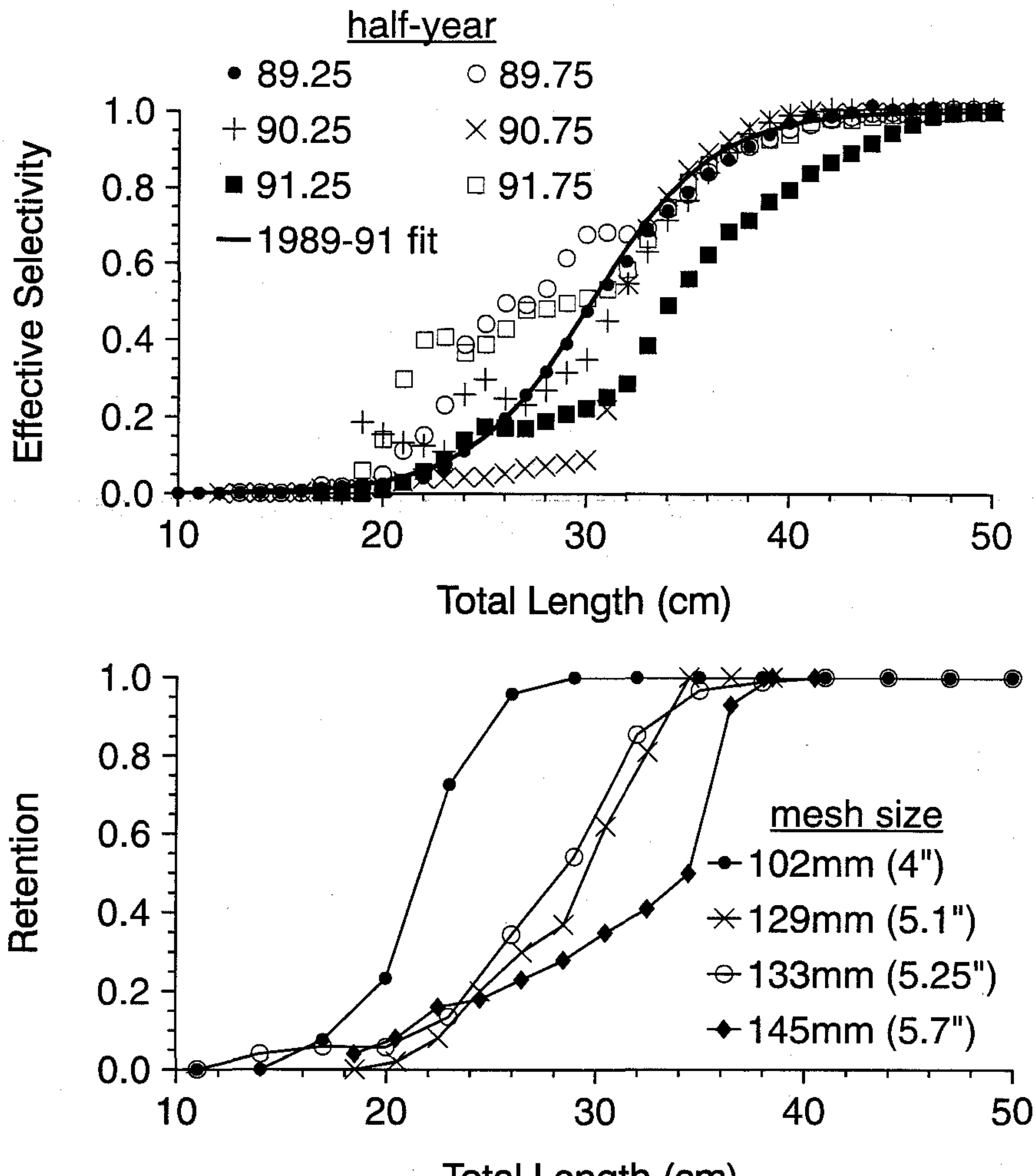


Figure 5. Effective selectivity of the Cape Cod yellowtail fishery, 1989-1993, by half-year (above) and retention of yellowtail flounder by several mesh sizes from Smolwitz (1979) and Lux (1968) (below).

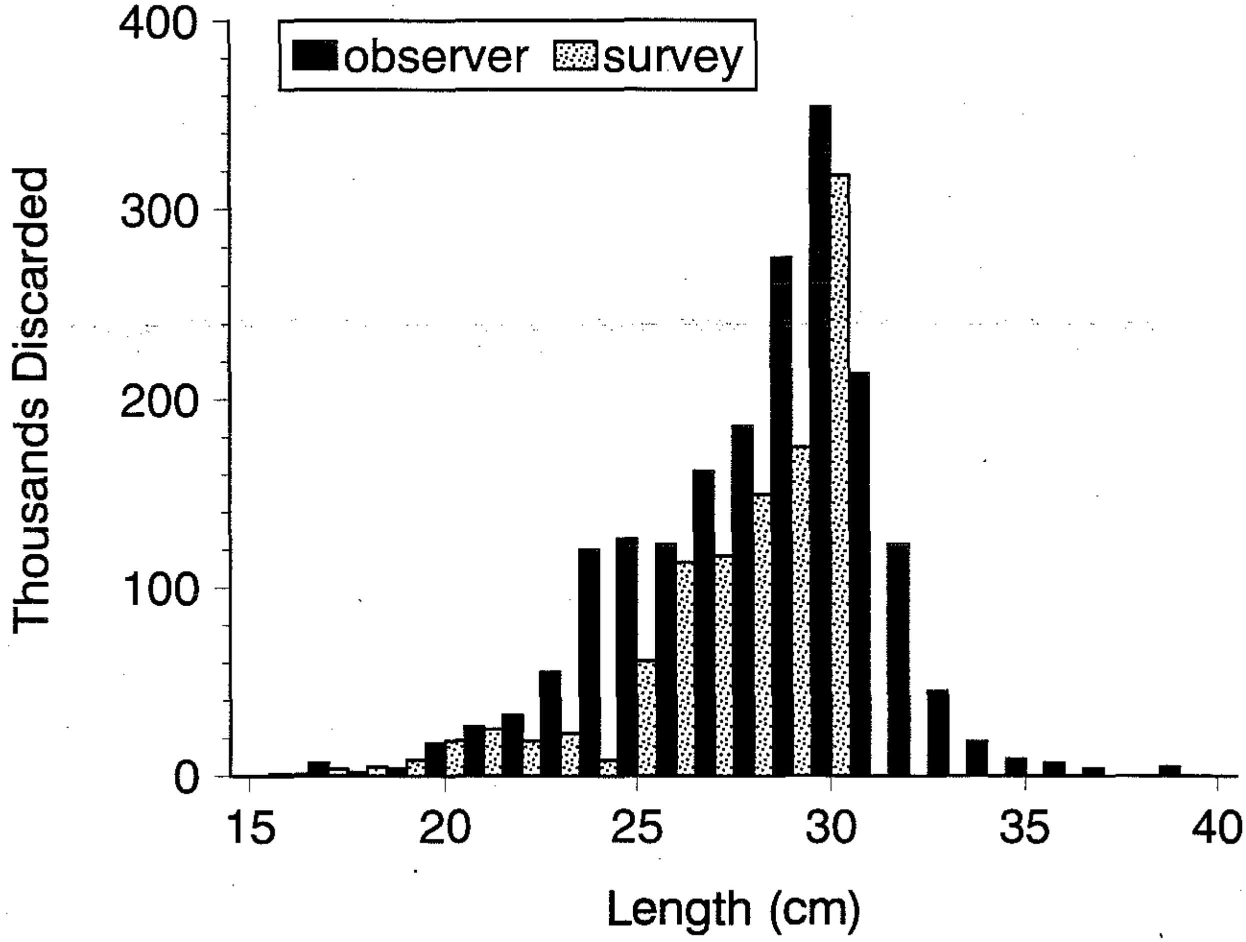


Figure 6. Estimates of discards at length of Cape Cod yellowtail flounder in 1989 using two estimation methods for all gear types combined.

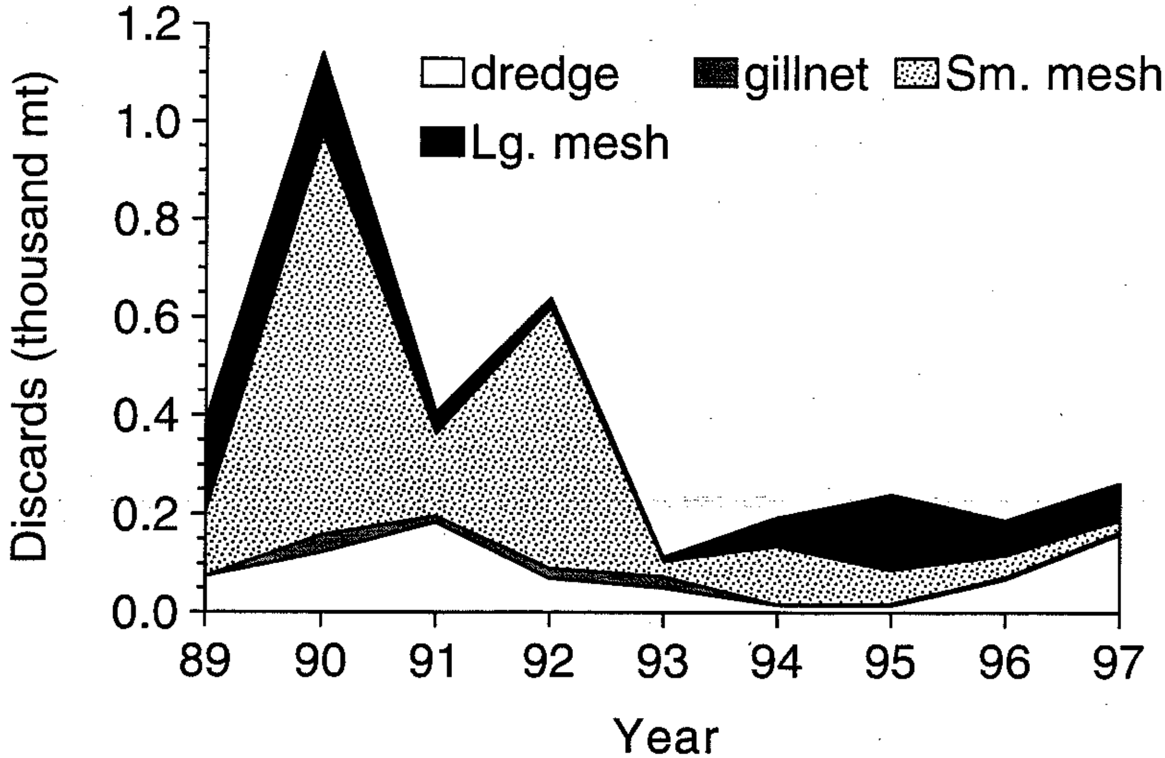


Figure 7. Discards of Cape Cod yellowtail flounder by gear type.

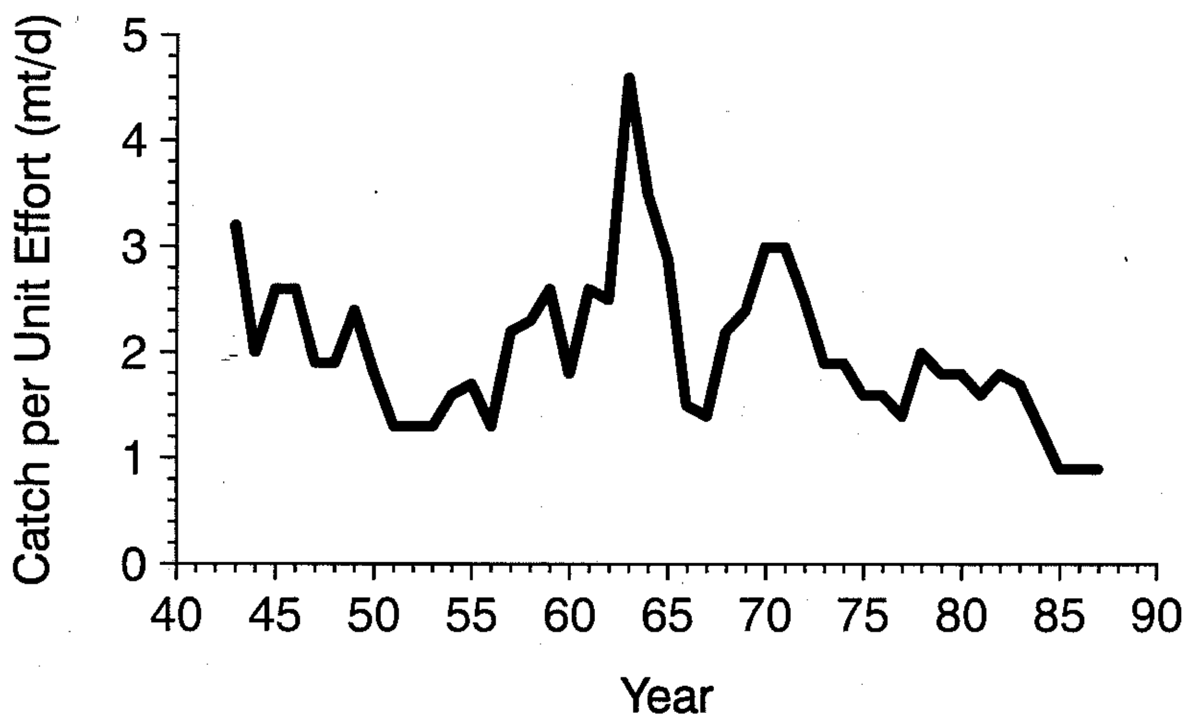


Figure 8. Standardized catch per unit effort of Cape Cod yellowtail flounder.

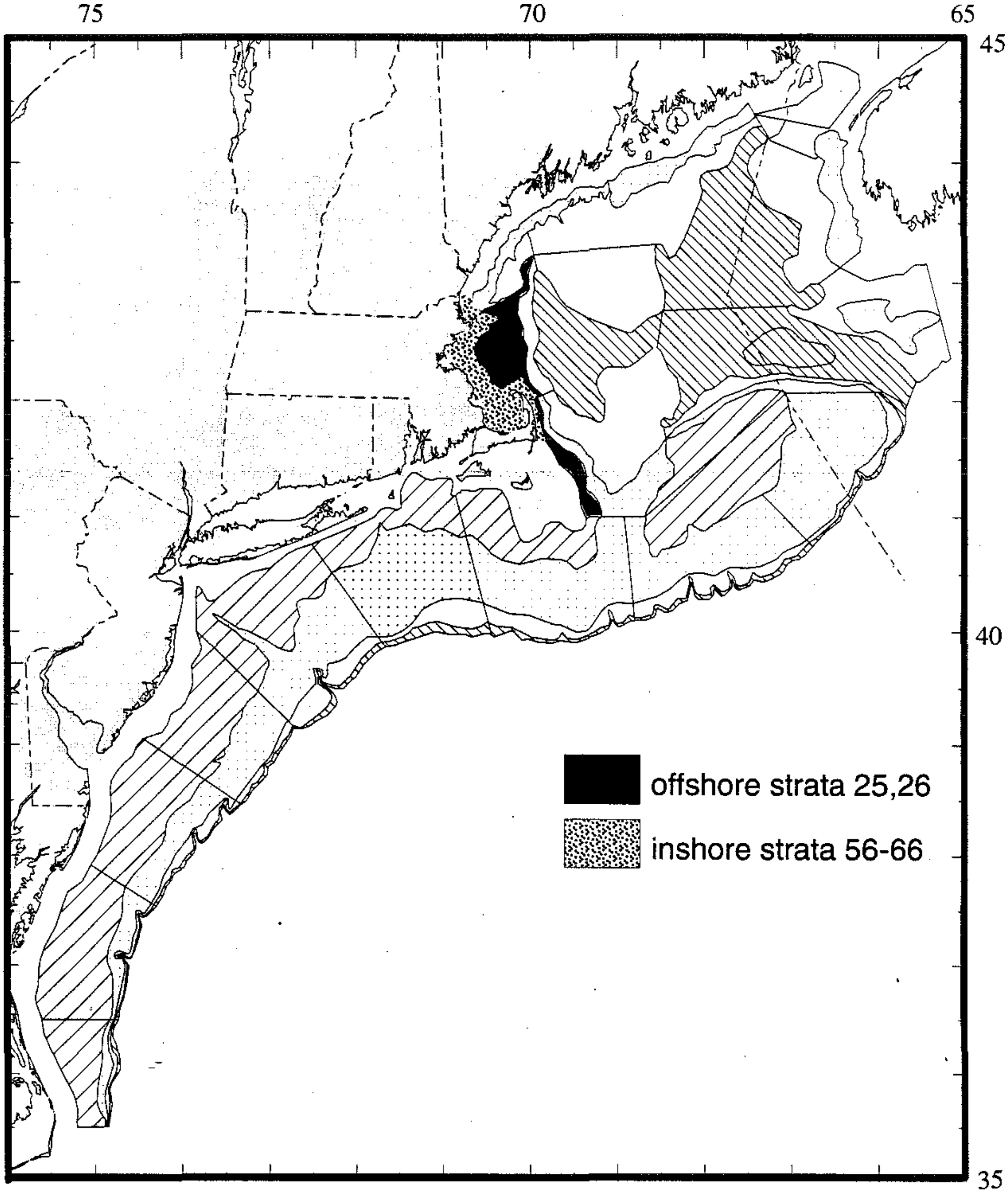


Figure 9. NEFSC bottom trawl survey strata. Stations in the shaded strata are included in the Cape Cod yellowtail flounder assessment

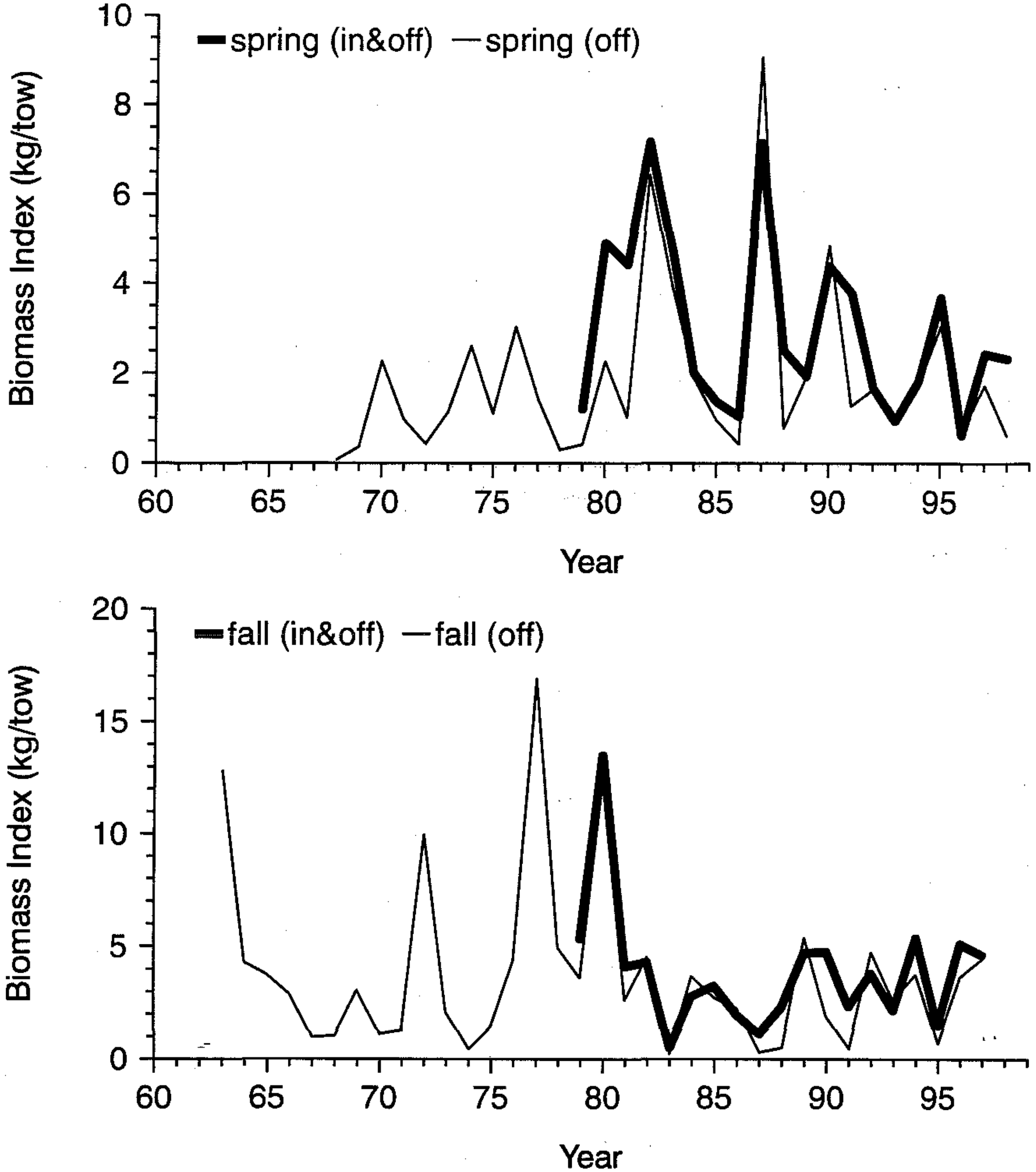


Figure 10. NEFSC survey indices of Cape Cod yellowtail flounder biomass (offshore strata: 25 and 26; inshore strata 56-66.

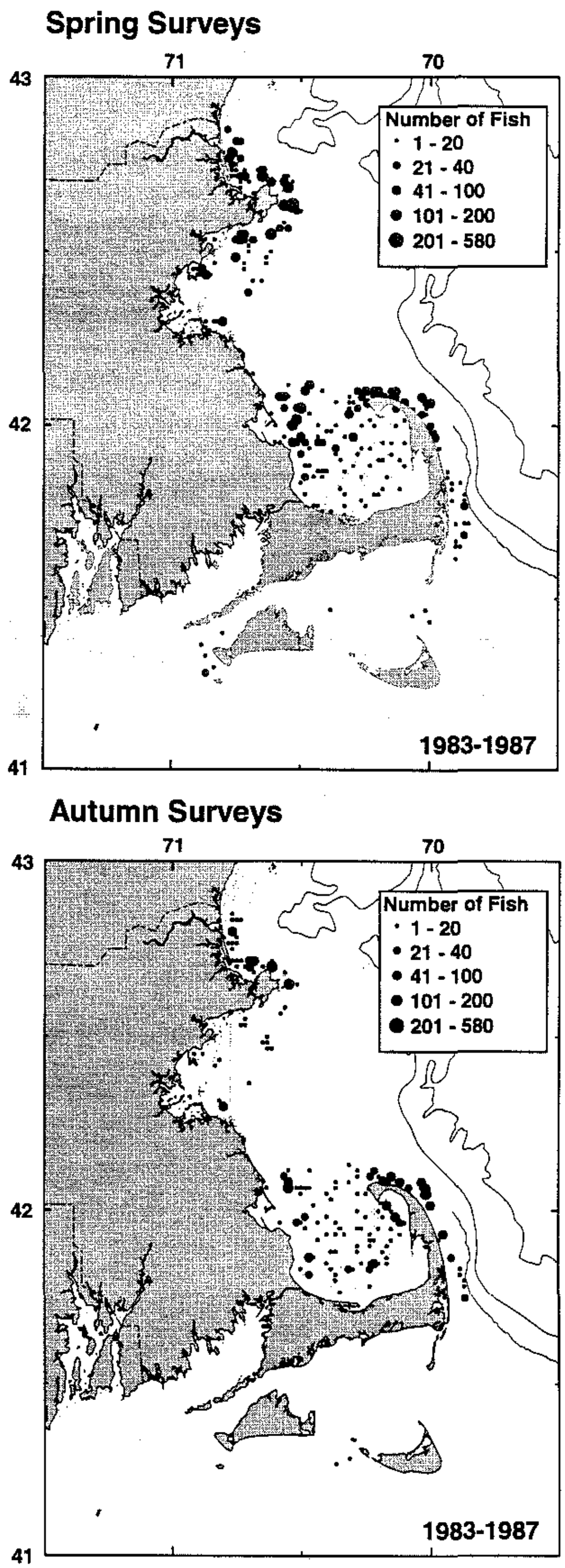


Figure 11. Distribution of Cape Cod yellowtail flounder in the MADMF spring and autumn bottom trawl surveys.

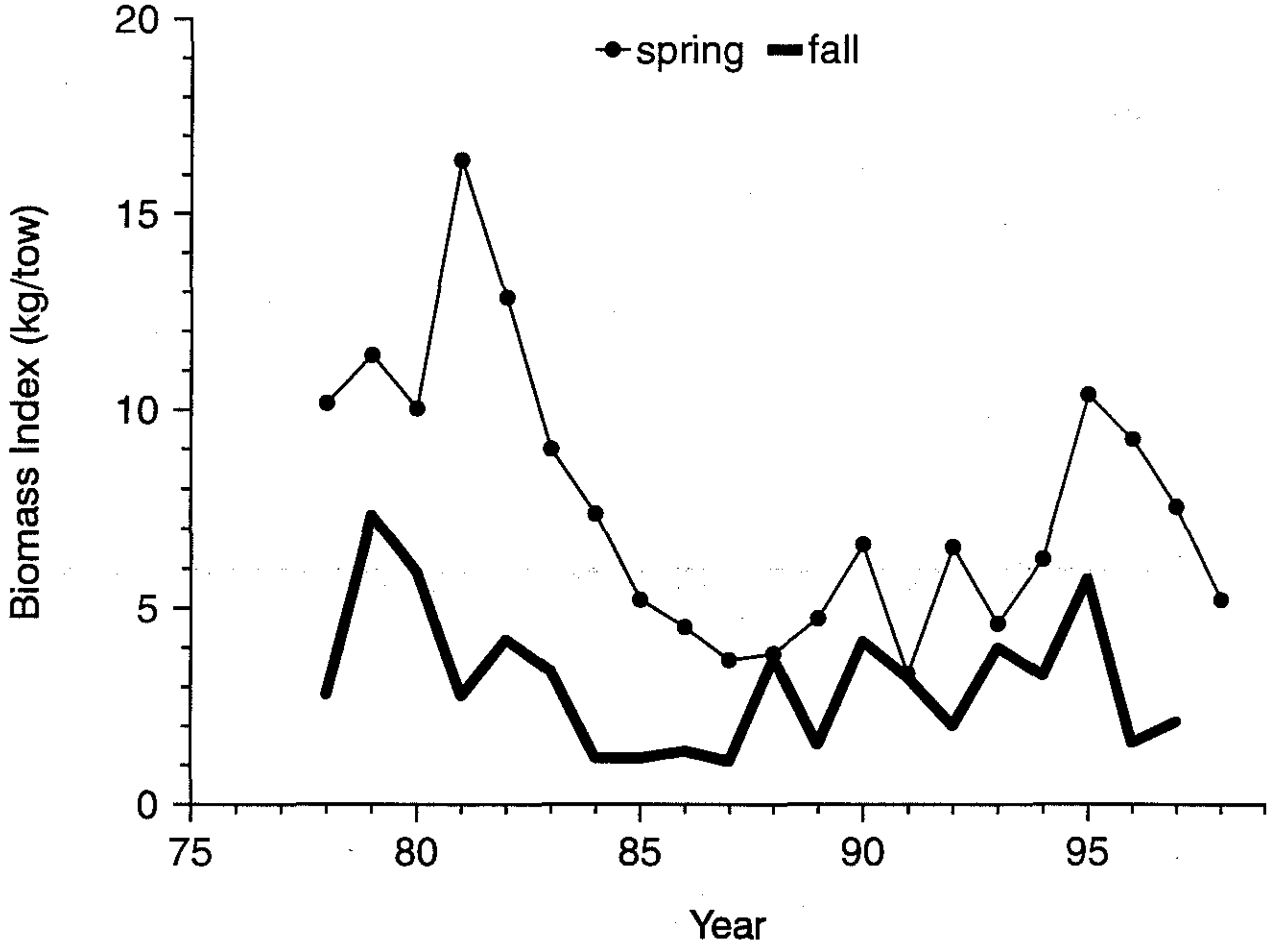


Figure 12. Massachusetts survey indices of Cape Cod yellowtail flounder biomass (strata 17-36).

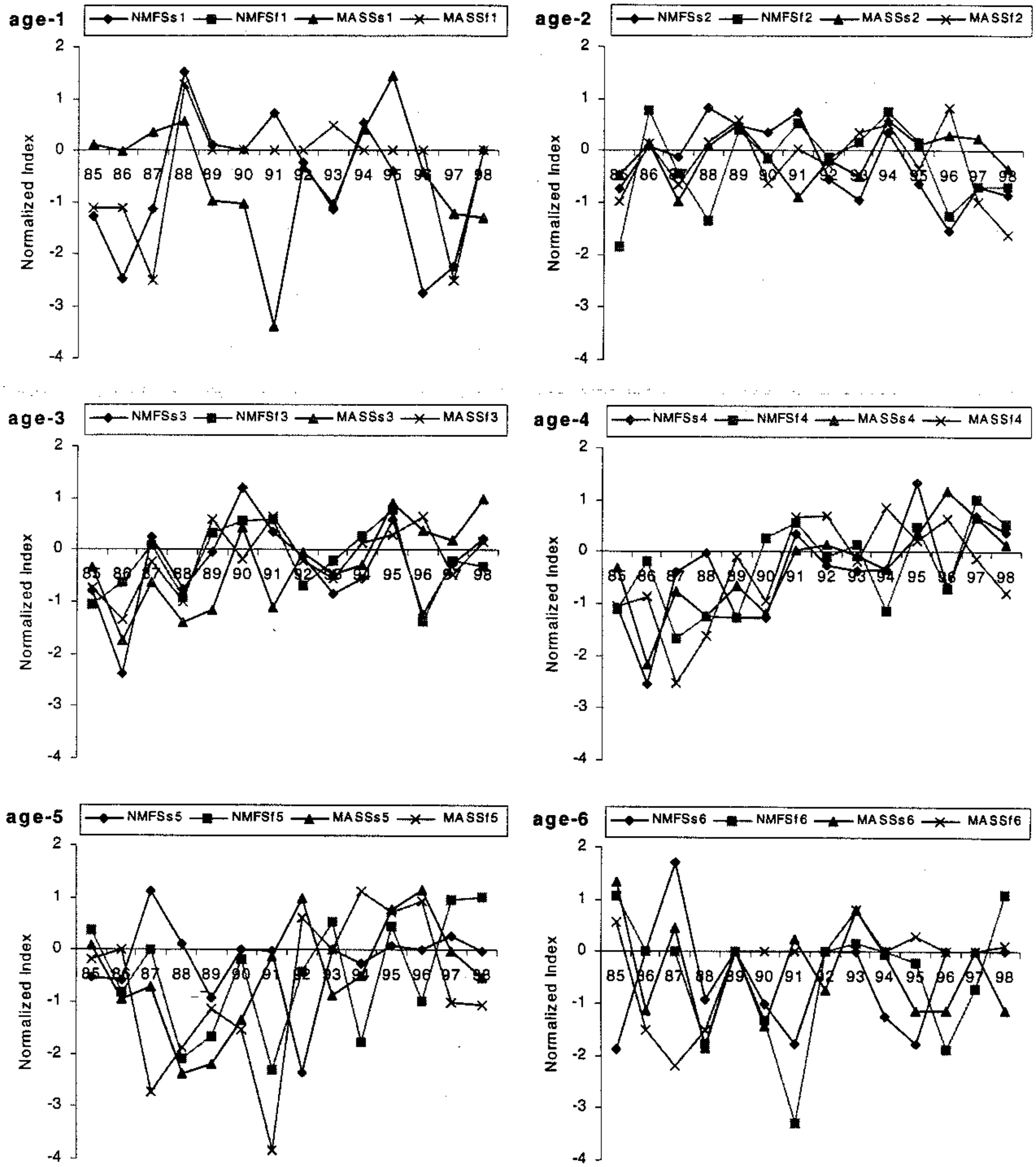


Figure 13. Normalized indices of Cape Cod yellowtail flounder abundance at age.

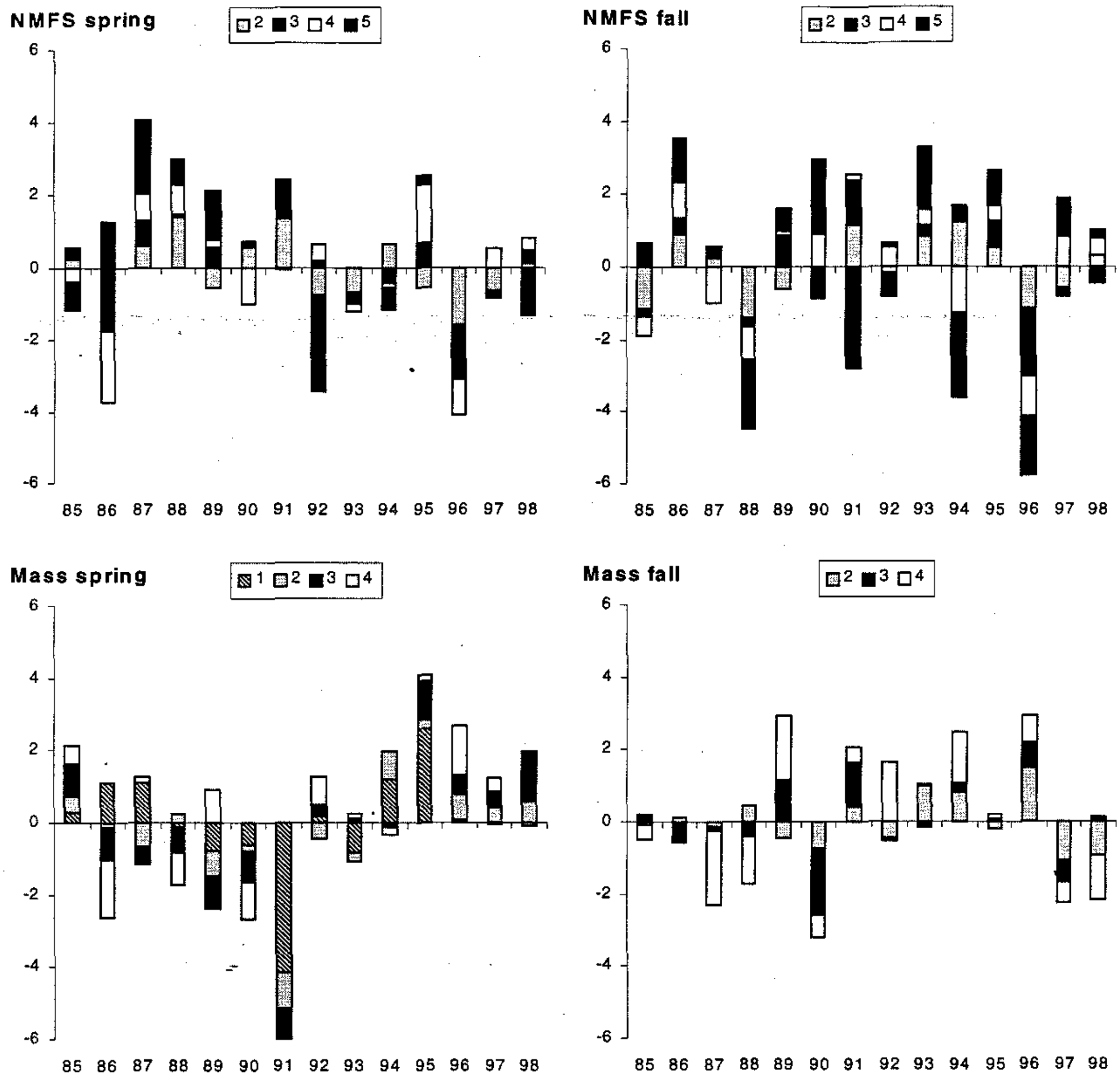


Figure 14. Standardized residuals from ADAPT calibration of Cape Cod yellowtail flounder virtual population analysis.

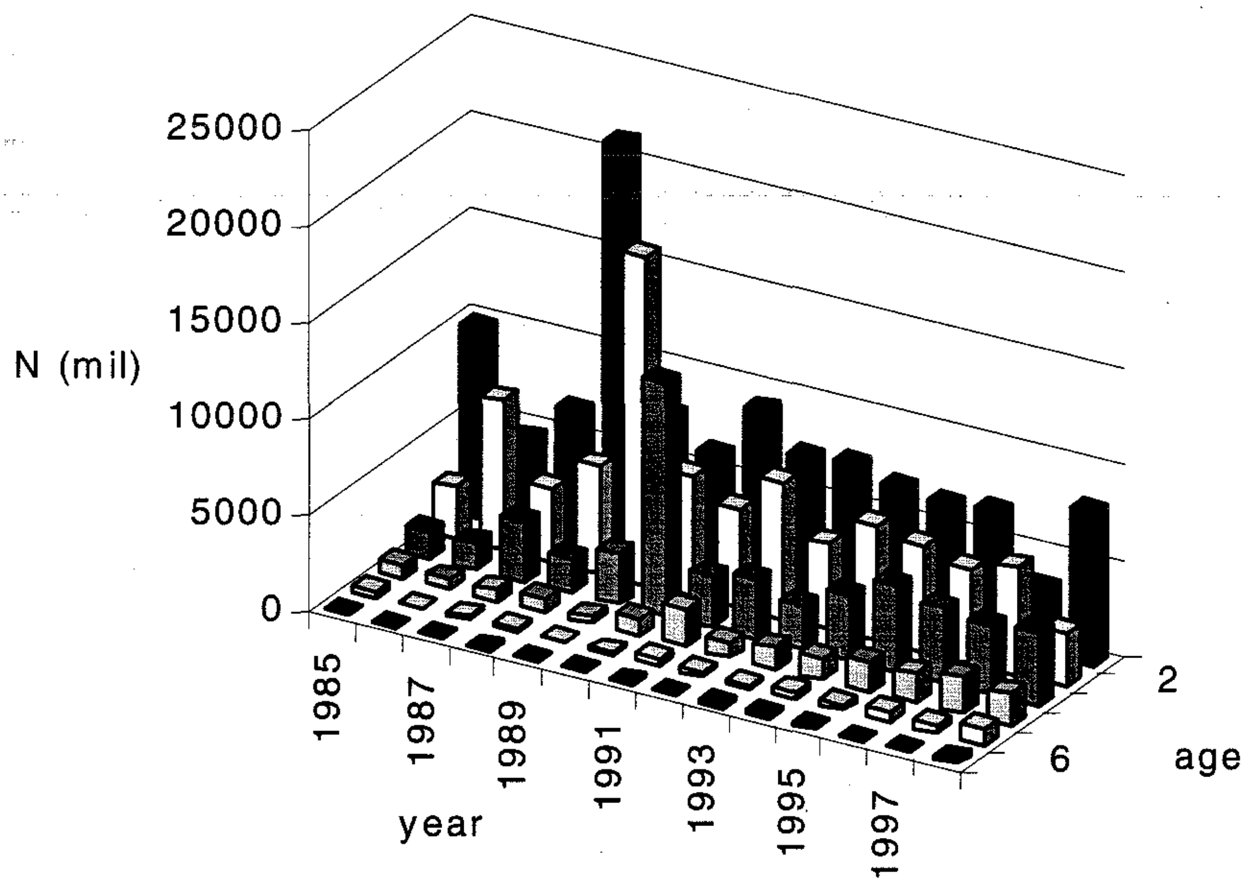


Figure 15. Estimated abundance at age of Cape Cod yellowtail flounder from VPA.

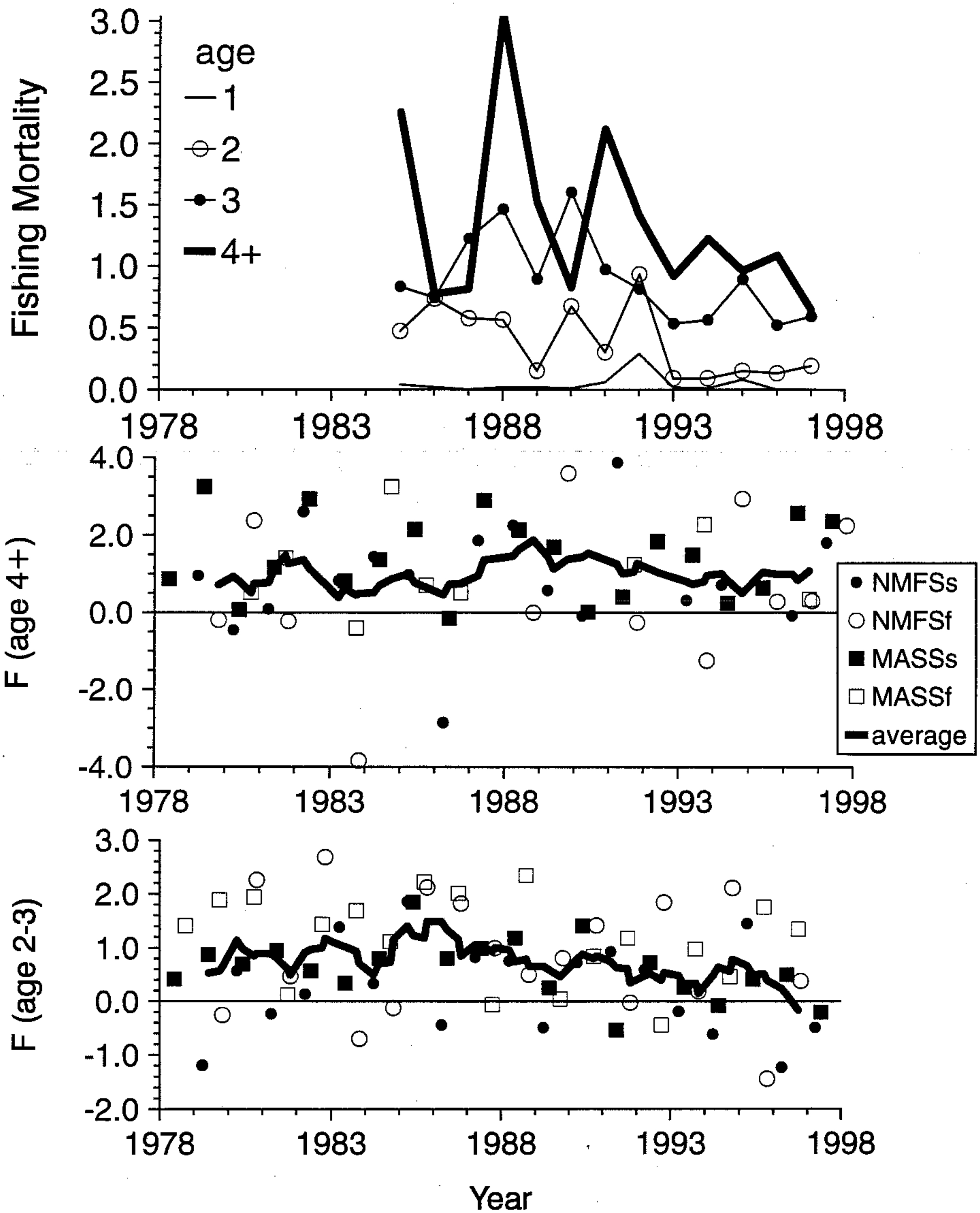
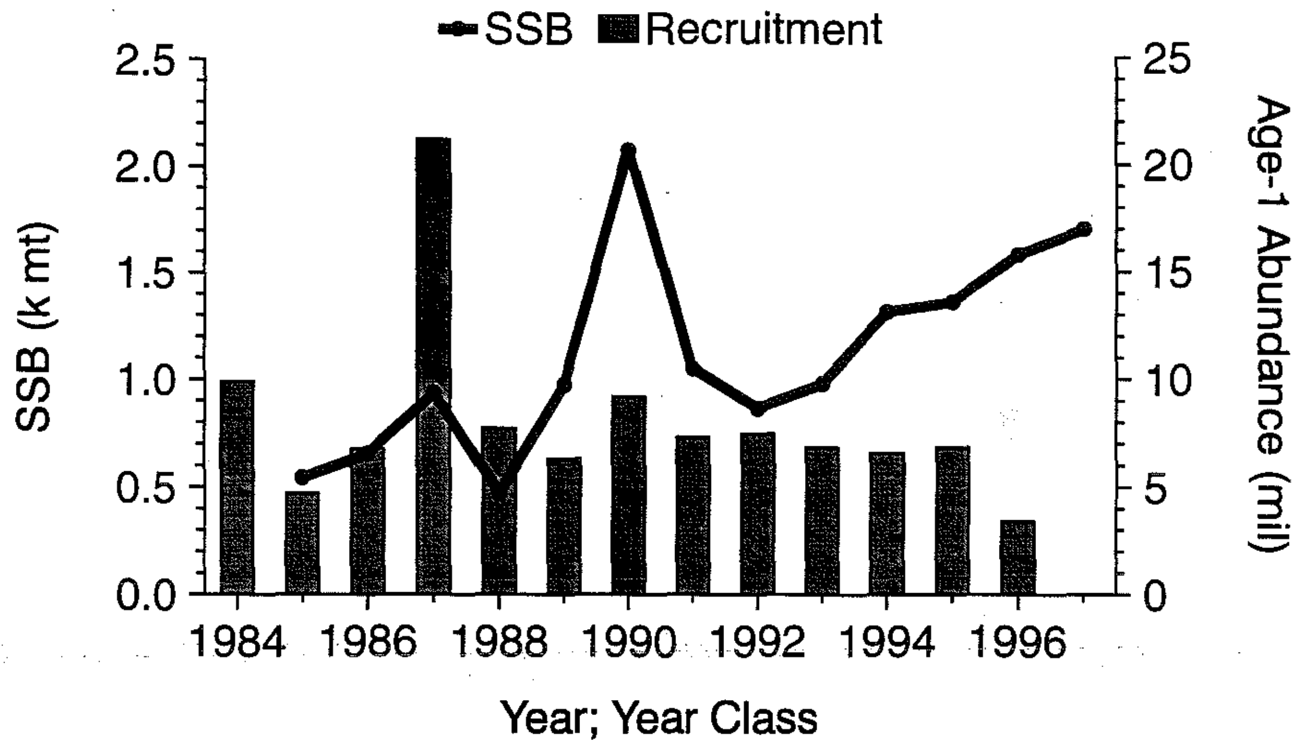


Figure 16. Instantaneous rate of fishing mortality of Cape Cod yellowtail flounder from VPA (above) and log ratios of survey indices (below).



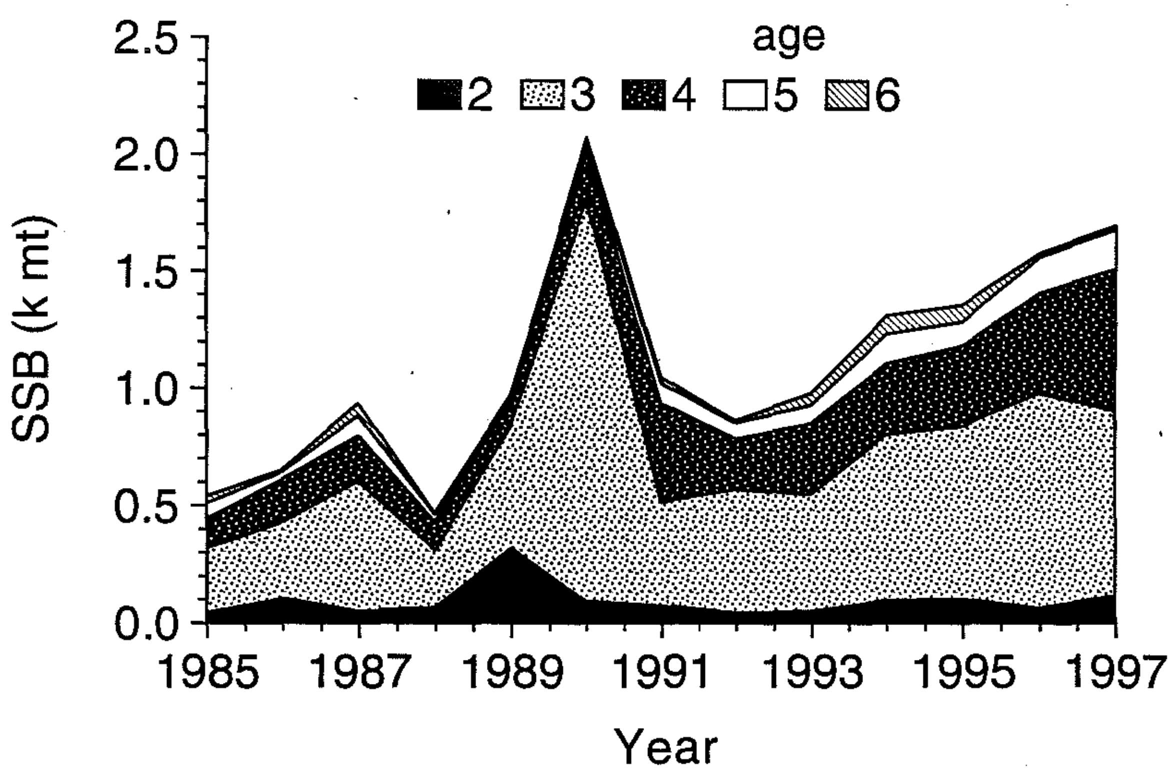


Figure 17. Spawning stock biomass and age-1 recruitment (above) and age distribution of mature biomass (below) of Cape Cod yellowtail flounder.

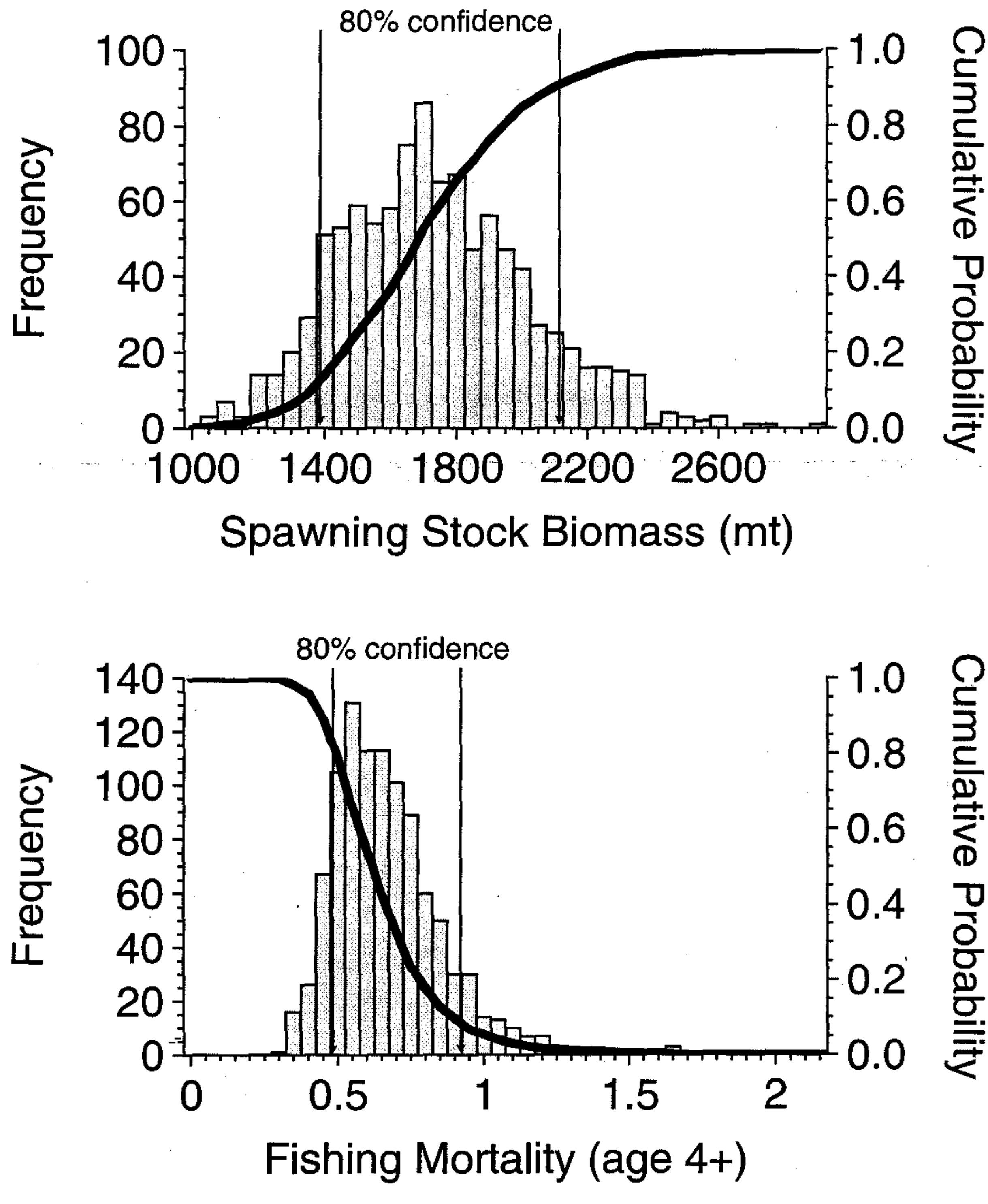


Figure 18. Bootstrap distributions of fully-recruited fishing mortality (above) and spawning stock biomass (below) of Cape Cod yellowtail flounder in 1997.

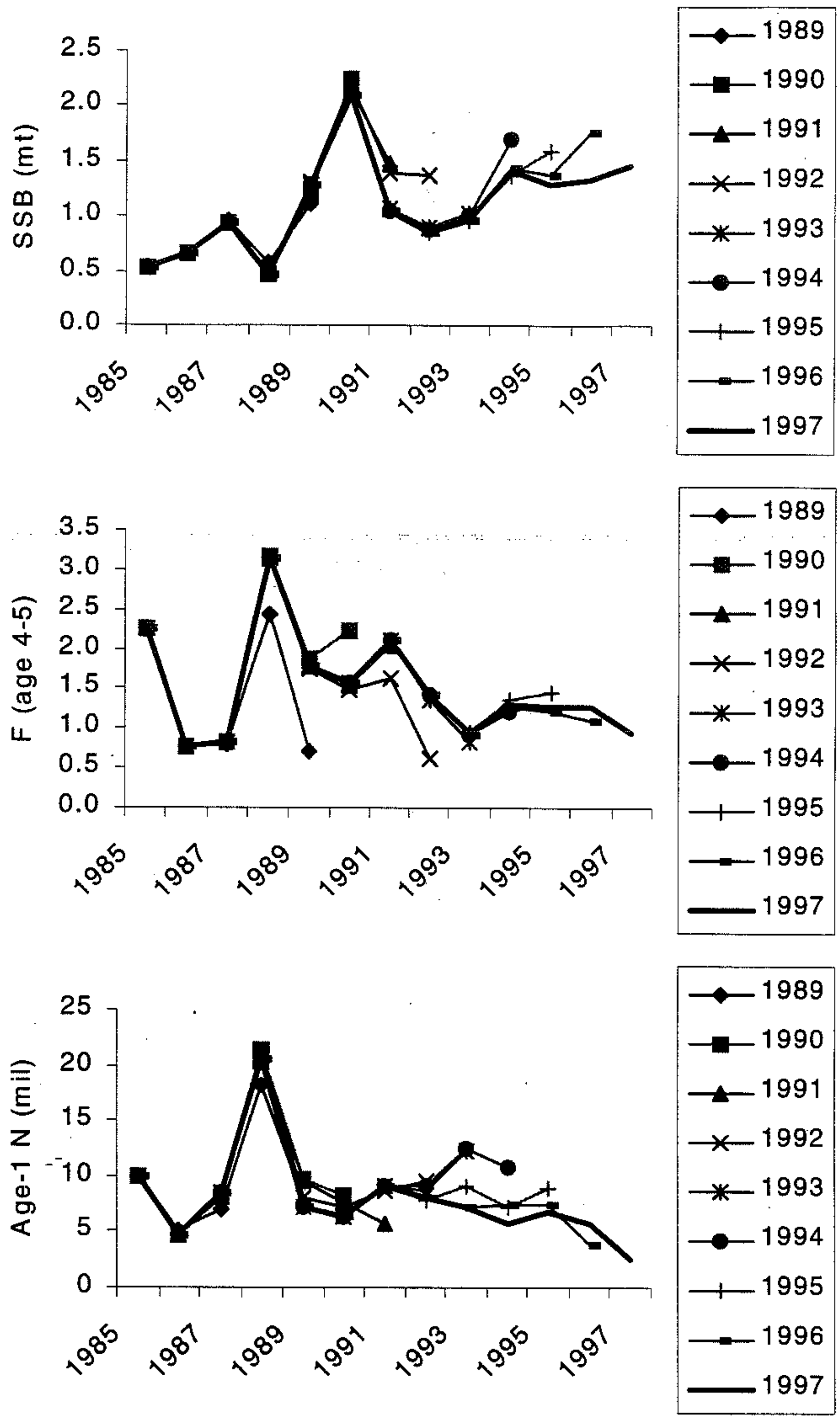


Figure 19a. Retrospective estimates of spawning stock biomass, fully-recruited fishing mortality and recruitment from preliminary VPA of Cape Cod yellowtail flounder (run #9).

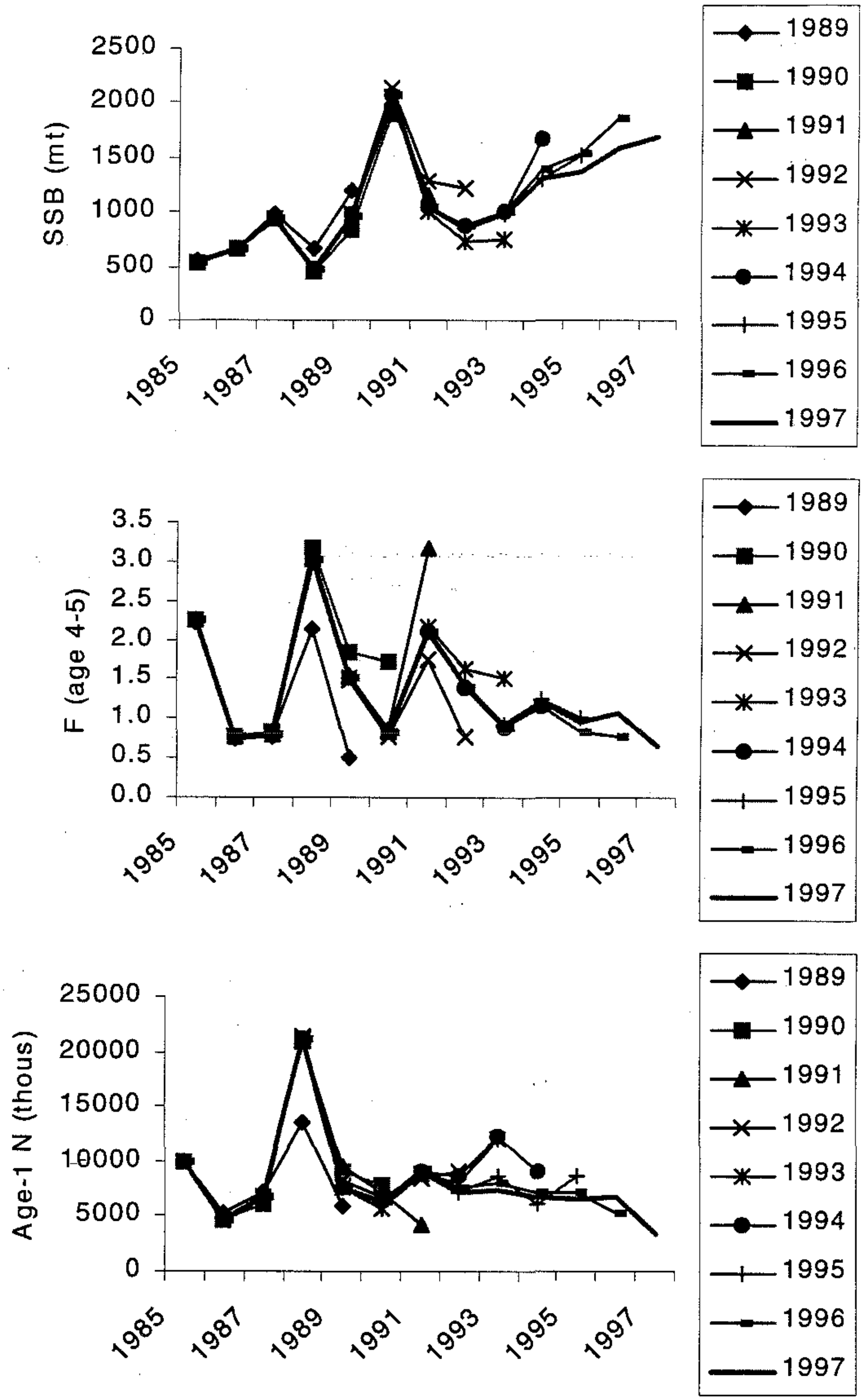


Figure 19b. Retrospective estimates of spawning stock biomass, fully-recruited fishing mortality and recruitment from final VPA of Cape Cod yellowtail flounder (run #14).

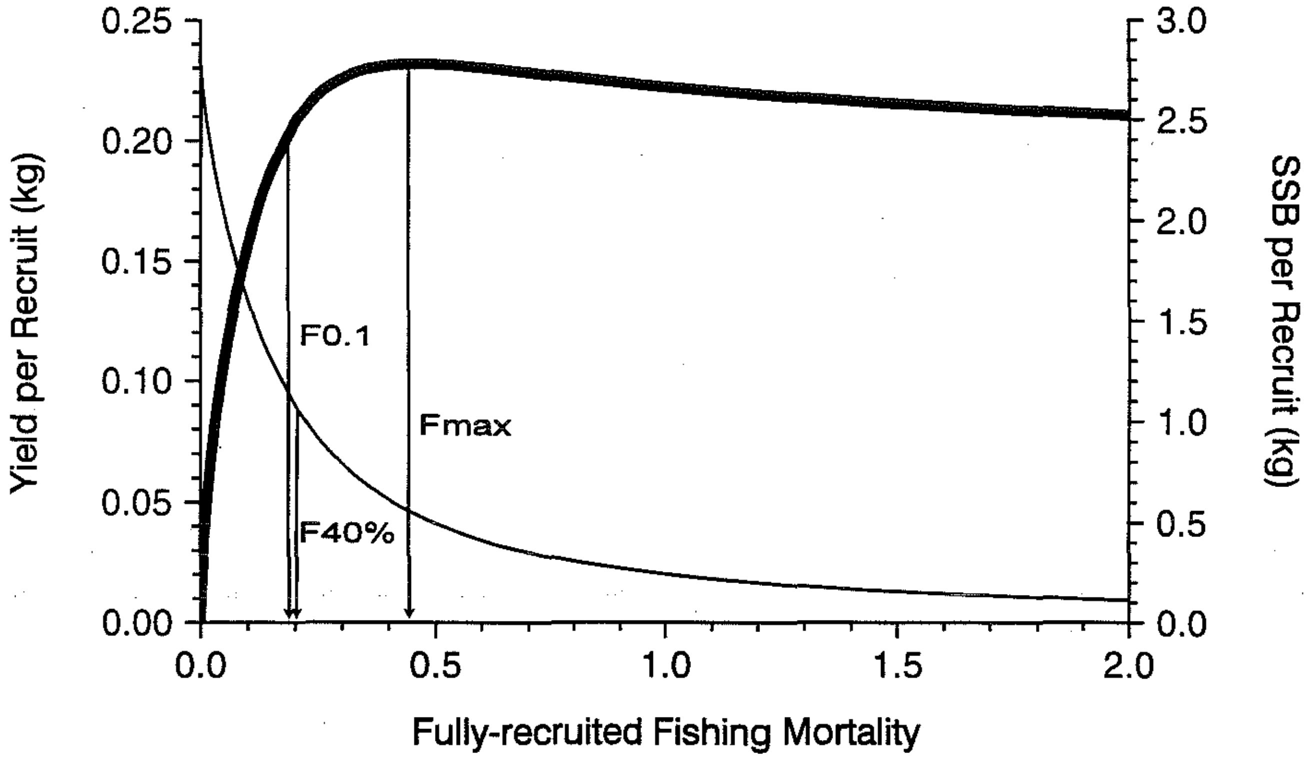


Figure 20. Yield and spawning biomass per recruit estimates for Cape Cod yellowtail flounder.

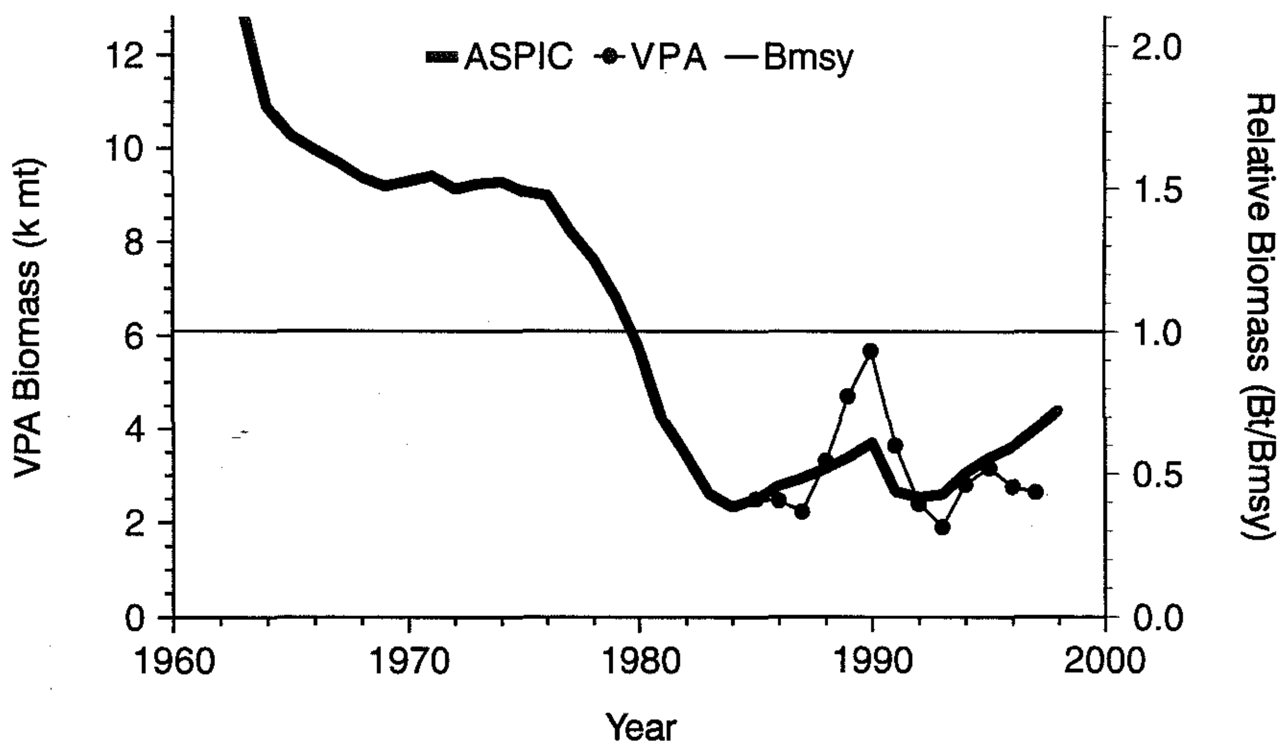


Figure 21. Predicted biomass of Cape Cod yellowtail from surplus production analysis, 1963-1997 and VPA 1985-1997.

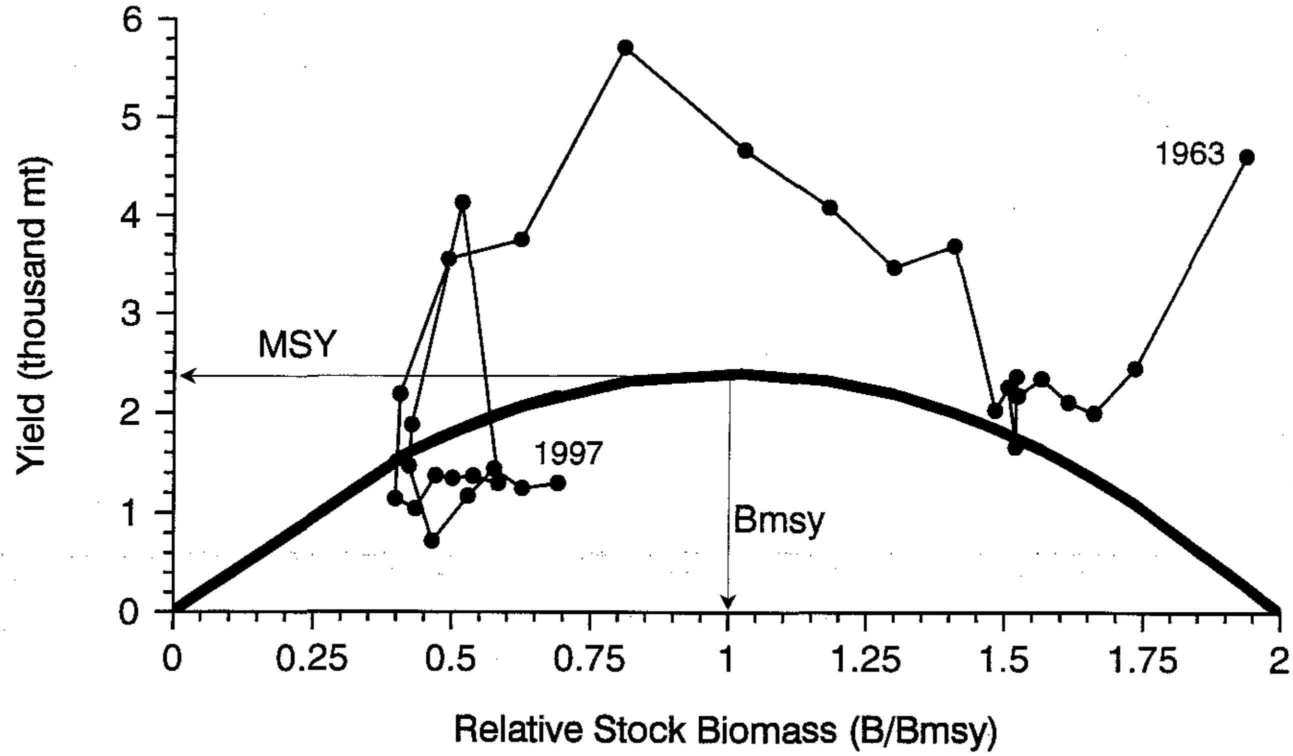


Figure 22. Biomass dynamics of Cape Cod yellowtail flounder.

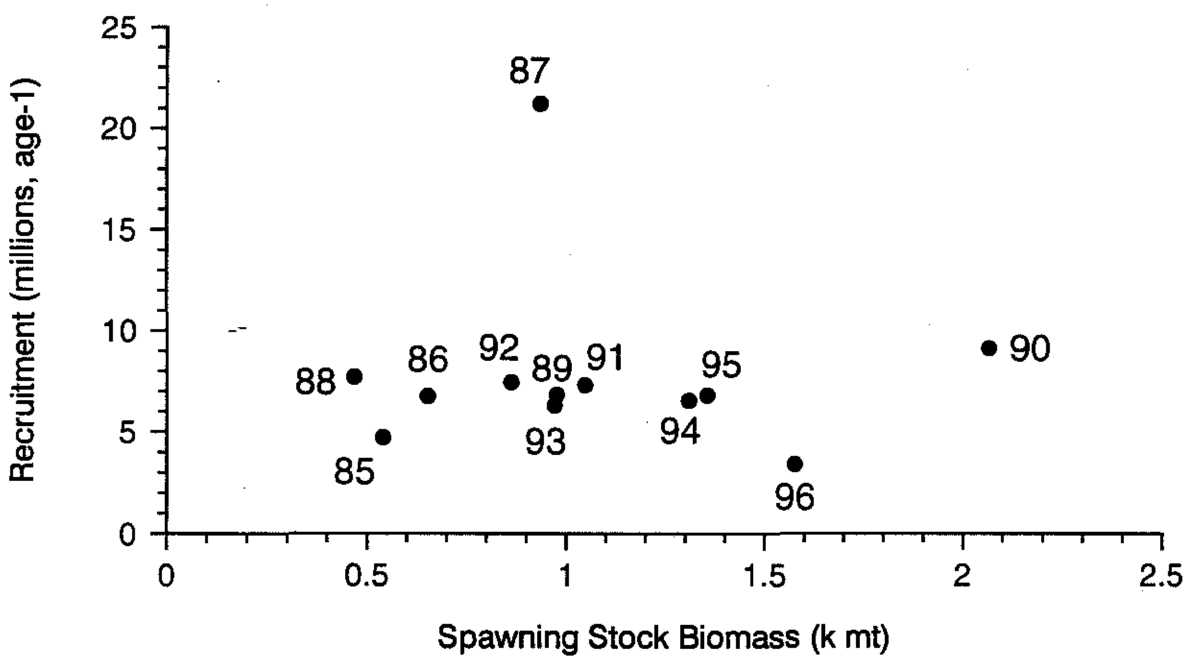


Figure 23. Spawning stock and recruitment of Cape Cod yellowtail flounder.

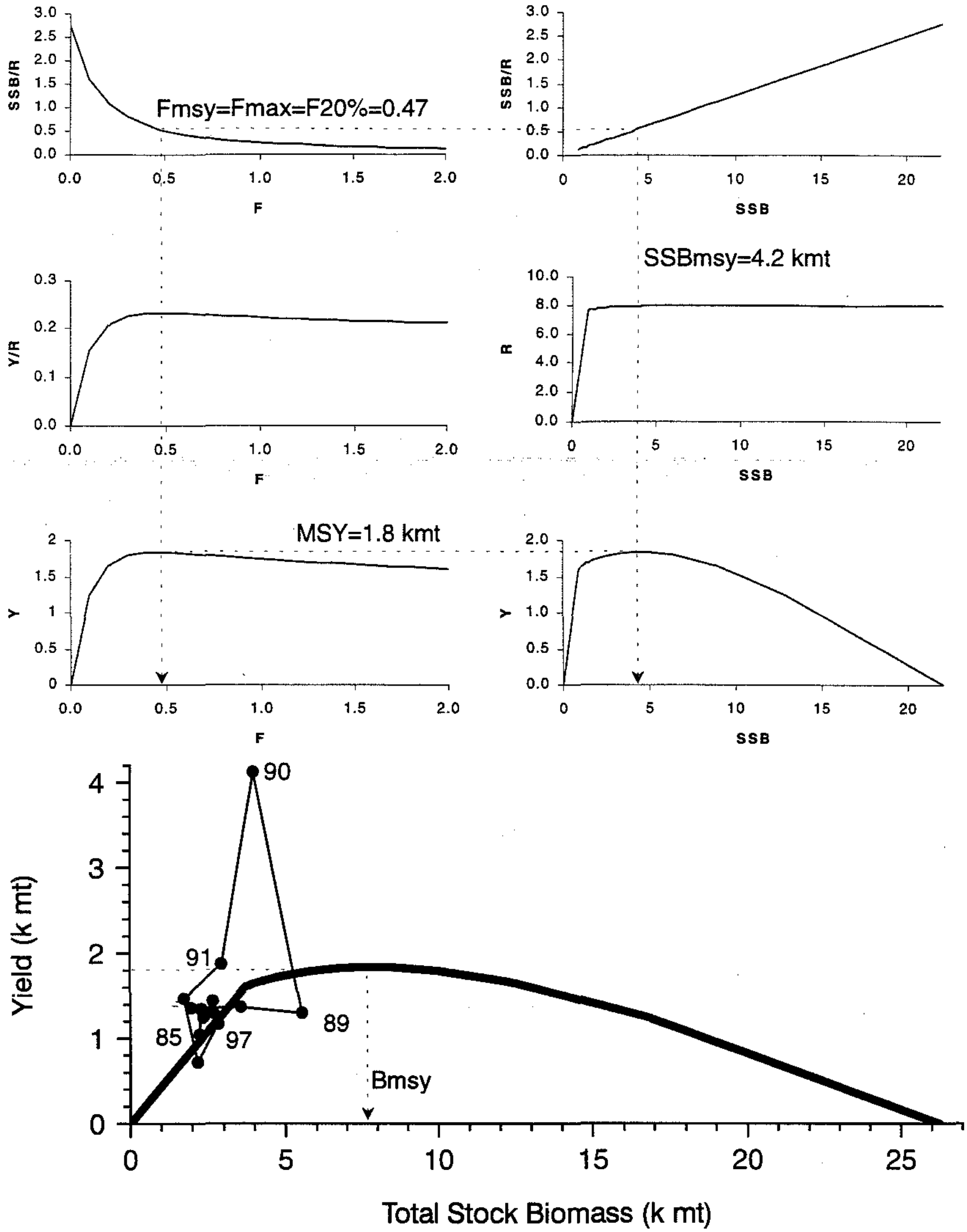


Figure 24. Age-based estimates of MSY reference points for Cape Cod yellowtail flounder.

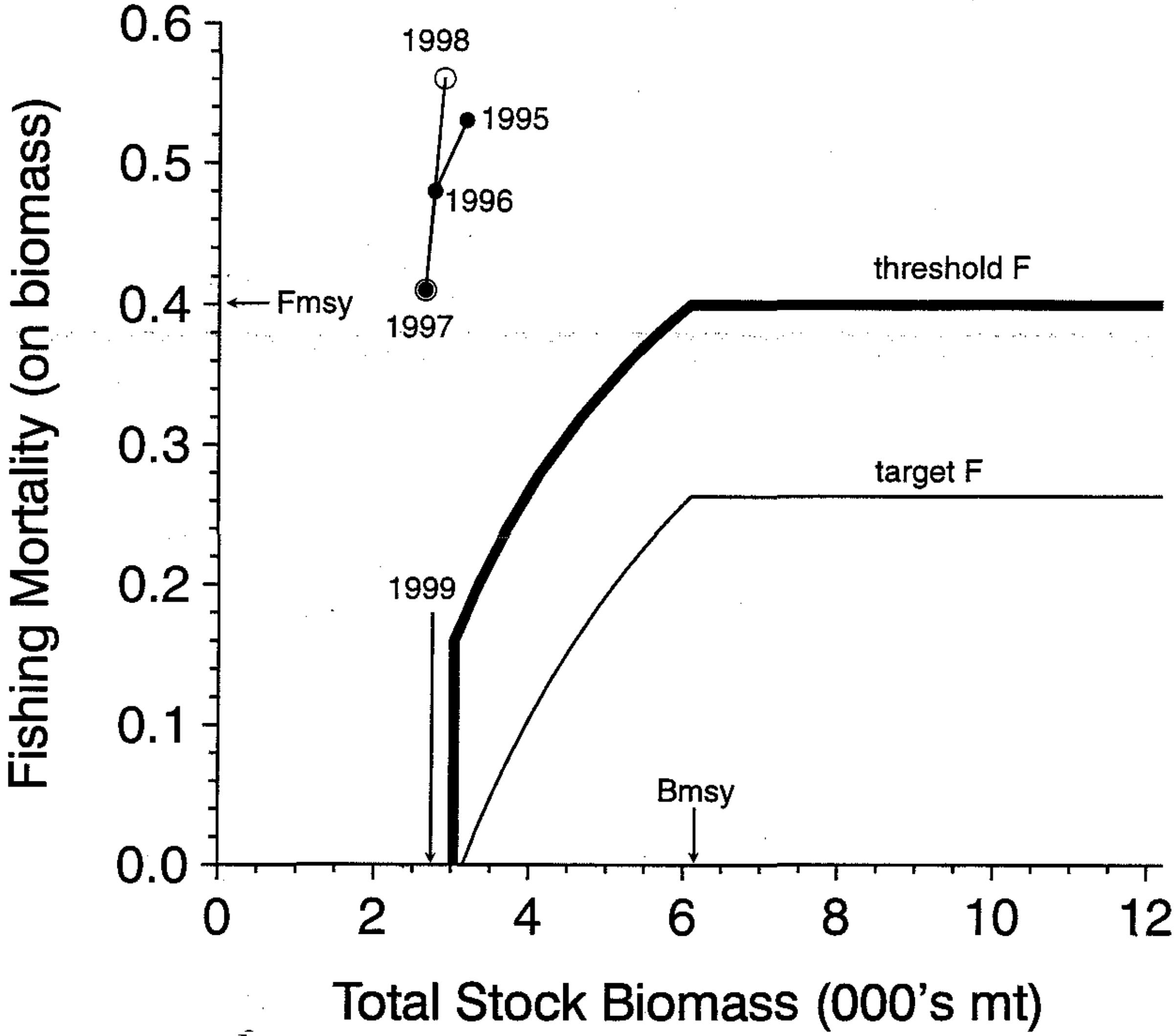
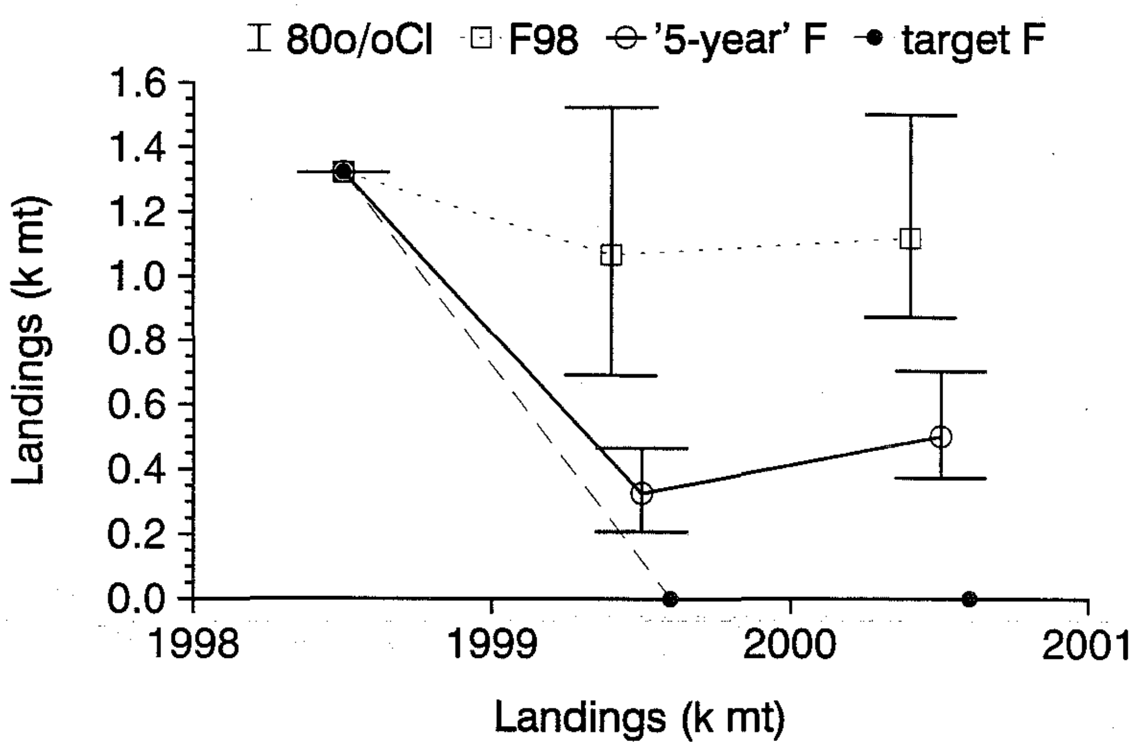


Figure 25. Amendment 9 control rule for Cape Cod yellowtail flounder rescaled to VPA biomass levels.



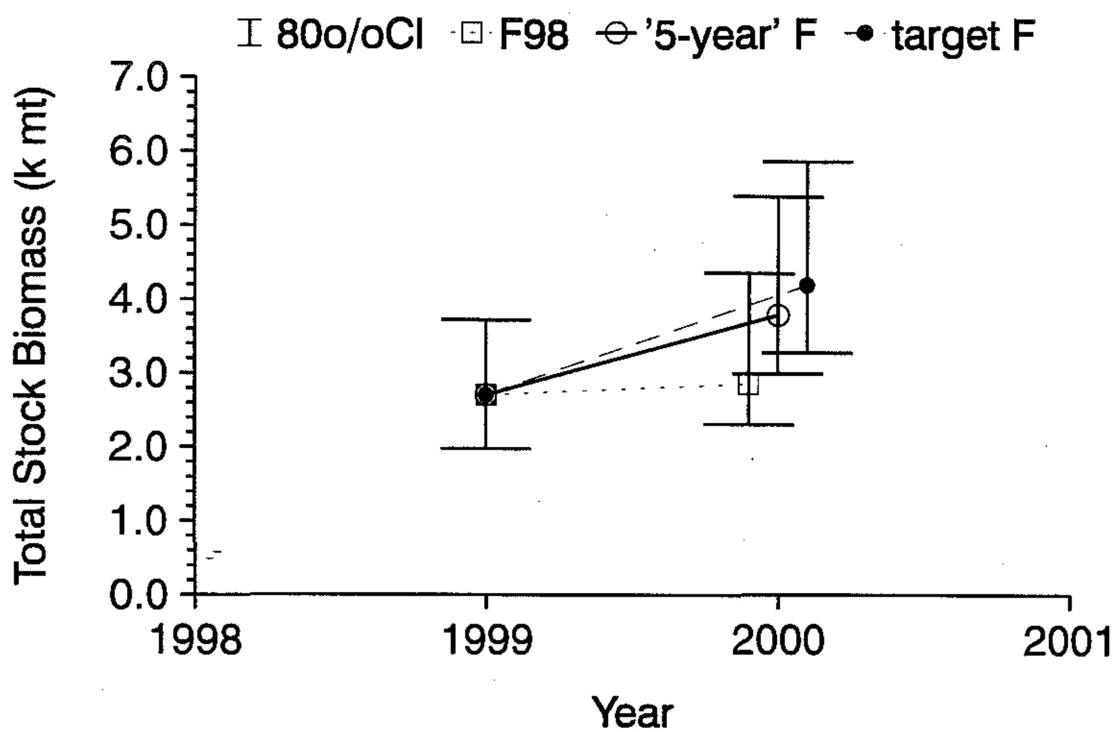


Figure 26. Stochastic projection of Cape Cod yellowtail flounder landings (above) and spawning stock biomass (below) assuming status quo F (F98=1.01), '5-year' F (the F that allows rebuilding to Bmsy in 5 years, 0.23), and target F (0.00) from the Amendment 9 control rule.

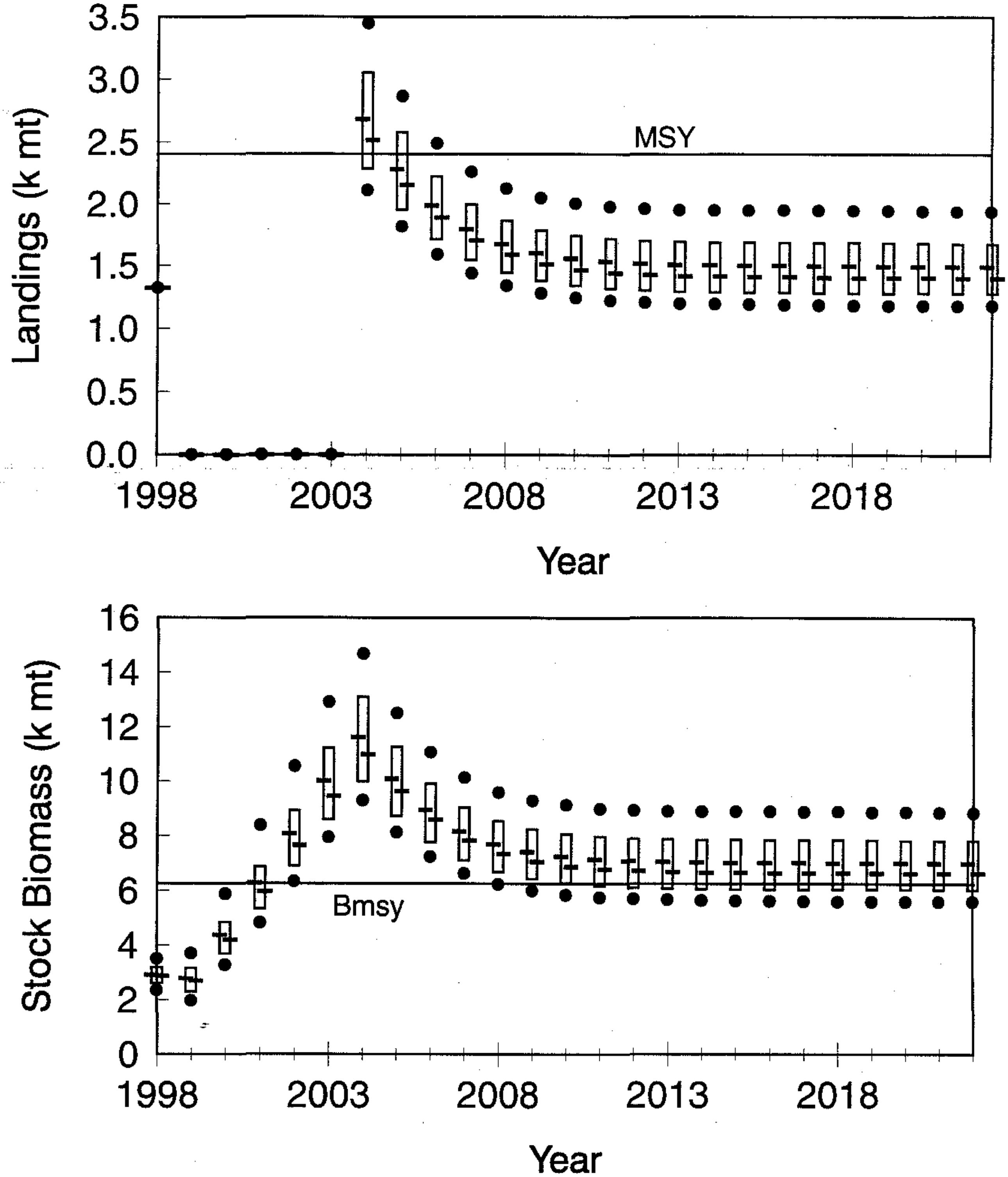


Figure 27. Long-term projection of Cape Cod yellowtail flounder landings (above) and spawning stock biomass (below) at target F from the control rule (five years of 0.00 and 20 years of 0.33). Dots indicate 80% confidence limit, bars indicate interquartile range, and vertical bars indicate mean (left) and median (right).

Woods Hole Assessment Toolbox Cape Cod Yellowtail Flounder Run Number 14 12/1/98 7:38:58 PM
Cape Cod Yellowtail Flounder 1985 - 1998
Input Parameters and Options Selected

Natural mortality is 0.2
Oldest age (not in the plus group) is 5
For all years prior to the terminal year (1997), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 5 : 4 5
This method for estimating F on the oldest age is generally used when a
flat-topped partial recruitment curve is thought to be characteristic of the stock.
F for age 6 + is then calculated from the following
ratios of F[age 6 +] to F[age 5]

1985	1
1986	1
1987	1
1988	1
1989	1
1990	1
1991	1
1992	1
1993	1
1994	1
1995	1
1996	1
1997	1

Stock size of the 6 + group is then calculated using
the following method: CATCH EQUATION
Partial recruitment estimate for 1998

1	0.01
2	0.1
3	0.5
4	1
5	1

Objective function is Sum w*(LOG(OBS)-LOG(PRED))**2
Indices normalized (by dividing by mean observed value)
before tuning to VPA stocksizes
Downweighting is not used
Biomass estimates (other than SSB) reflect mean stock sizes.
SSB calculated as in the NEFSC projection program
(see note below SSB table for description of the algorithm).
Initial estimates of parameters for the Marquardt algorithm
and lower and upper bounds on the parameter estimates:

Par.	Initial Est	Lower Bnd	Upper Bnd
N 2	1.00E+03	1.00E+00	1.00E+06
N 3	1.00E+03	1.00E+00	1.00E+06
N 4	1.00E+03	1.00E+00	1.00E+06
N 5	1.00E+03	1.00E+00	1.00E+06
q NMFSs2	1.00E-03	0.00E+00	1.00E+00
q NMFSs3	1.00E-03	0.00E+00	1.00E+00
q NMFSs4	1.00E-03	0.00E+00	1.00E+00
q NMFSs5	1.00E-03	0.00E+00	1.00E+00
q NMFSf2	1.00E-03	0.00E+00	1.00E+00
q NMFSf3	1.00E-03	0.00E+00	1.00E+00
q NMFSf4	1.00E-03	0.00E+00	1.00E+00
q NMFSf5	1.00E-03	0.00E+00	1.00E+00
q MASSs1	1.00E-03	0.00E+00	1.00E+00
q MASSs2	1.00E-03	0.00E+00	1.00E+00
q MASSs3	1.00E-03	0.00E+00	1.00E+00
q MASSs4	1.00E-03	0.00E+00	1.00E+00
q MASSf2	1.00E-03	0.00E+00	1.00E+00
q MASSf3	1.00E-03	0.00E+00	1.00E+00
q MASSf4	1.00E-03	0.00E+00	1.00E+00

The following indices of abundance are available

1	NMFSs1
2	NMFSs2
3	NMFSs3
4	NMFSs4
5	NMFSs5
6	NMFSs6
7	NMFSf2
8	NMFSf3
9	NMFSf4
10	NMFSf5
11	NMFSf6
12	MASSs1
13	MASSs2
14	MASSs3
15	MASSs4
16	MASSs5
17	MASSs6
18	MASSf1
19	MASSf2
20	MASSf3
21	MASSf4
22	MASSf5
23	MASSf6

The Indices that will be used in this run are:

1	NMFSs2
2	NMFSs3
3	NMFSs4
4	NMFSs5
5	NMFSf2
6	NMFSf3
7	NMFSf4
8	NMFSf5
9	MASSs1
10	MASSs2
11	MASSs3
12	MASSs4
13	MASSf2
14	MASSf3
15	MASSf4

Obs Indices (before transformation) by index and year; with Index means

	1985	1986	1987	1988	1989	1990	1991
NMFSs2	1.86	4.33	3.44	9.11	6.33	5.51	8.23
NMFSs3	1.81	0.37	5.15	1.87	3.88	13.35	5.67
NMFSs4	0.43	0.10	0.84	1.22	0.35	0.35	1.80
NMFSs5	0.25	0.24	1.30	0.47	0.17	0.00	0.42
NMFSf2	0.64	9.03	2.62	1.08	6.16	3.53	7.01
NMFSf3	2.25	3.48	7.14	2.60	9.01	11.39	11.90
NMFSf4	1.04	2.65	0.60	0.91	0.89	4.19	5.58
NMFSf5	1.31	0.40	0.00	0.11	0.17	0.74	0.09
MASSs1	1.97	1.73	2.53	3.10	0.67	0.63	0.06
MASSs2	8.27	15.39	4.95	14.46	22.26	11.77	5.34
MASSs3	7.15	1.74	5.31	2.52	3.18	15.57	3.31
MASSs4	1.52	0.24	0.97	0.60	1.08	0.63	2.15
MASSf2	1.91	5.70	2.60	5.85	8.96	2.64	5.20
MASSf3	3.00	1.63	4.95	2.30	11.24	5.22	11.93
MASSf4	0.86	1.03	0.20	0.49	2.27	0.96	4.84

	1992	1993	1994	1995	1996	1997	1998
NMFSs2	2.25	1.51	5.64	2.10	0.85	1.98	1.71
NMFSs3	3.52	1.75	2.33	7.33	1.18	3.15	5.03
NMFSs4	0.98	0.87	0.90	4.74	0.63	2.54	1.83
NMFSs5	0.04	0.00	0.33	0.46	0.00	0.56	0.42
NMFSf2	3.57	4.82	8.76	4.78	1.18	2.07	2.07
NMFSf3	3.33	5.29	8.60	14.27	1.64	5.36	4.79
NMFSf4	2.88	3.68	1.01	5.13	1.57	8.78	5.45
NMFSf5	0.59	1.52	0.15	1.40	0.34	2.31	2.46
MASSs1	1.30	0.63	2.67	7.51	1.17	0.52	0.48
MASSs2	11.03	7.99	24.02	14.64	18.03	16.94	9.54
MASSs3	9.71	6.31	7.53	24.96	14.70	12.22	26.77
MASSs4	2.38	1.94	1.49	2.88	6.78	4.04	2.41
MASSf2	3.76	7.18	8.39	3.56	11.54	1.87	1.01
MASSf3	5.14	3.62	7.29	8.39	11.97	3.94	7.38
MASSf4	5.03	2.08	5.80	3.06	4.71	2.18	1.14

	Average
NMFSs2	3.918
NMFSs3	4.028
NMFSs4	1.256
NMFSs5	0.424
NMFSf2	4.094
NMFSf3	6.504
NMFSf4	3.169
NMFSf5	0.892
MASSs1	1.784
MASSs2	13.188
MASSs3	10.070
MASSs4	2.079
MASSf2	5.012
MASSf3	6.286
MASSf4	2.475

Catch at age (thousands) - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	344	79	14	361	114	81	460
2	922	3655	1486	2130	2131	2738	1206
3	734	654	1954	1219	1385	8692	1464
4	522	250	268	625	233	435	1555
5	268	32	100	172	31	32	256
6	99	07	46	36	08	26	61
1+	2889	4677	3868	4543	3902	12004	5002

	1992	1993	1994	1995	1996	1997
1	1688	138	60	453	07	01
2	3881	349	471	702	547	880
3	1538	857	1301	2382	1425	1437
4	543	602	699	858	892	819
5	153	91	240	154	298	182
6	12	46	113	83	18	14
1+	7815	2083	2884	4632	3187	3333

Weight at age (mid year) in kg - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	0.130	0.100	0.060	0.120	0.130	0.080	0.120
2	0.280	0.250	0.240	0.210	0.270	0.260	0.230
3	0.360	0.430	0.400	0.340	0.390	0.370	0.340
4	0.490	0.530	0.550	0.530	0.650	0.550	0.530
5	0.600	0.730	0.650	0.700	0.920	0.820	0.730
6	0.790	0.990	0.910	0.850	1.310	0.960	1.020

	1992	1993	1994	1995	1996	1997
1	0.050	0.090	0.080	0.070	0.040	0.030
2	0.130	0.160	0.220	0.220	0.190	0.310
3	0.320	0.360	0.360	0.330	0.390	0.380
4	0.520	0.430	0.490	0.420	0.490	0.460
5	0.610	0.740	0.620	0.610	0.530	0.570
6	1.150	1.000	0.830	0.800	1.020	0.810

January 1 Biomass Weights - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	0.094	0.065	0.032	0.080	0.090	0.047	0.115
2	0.226	0.180	0.155	0.112	0.180	0.187	0.136
3	0.297	0.347	0.316	0.286	0.286	0.316	0.303
4	0.401	0.437	0.486	0.460	0.470	0.375	0.443
5	0.542	0.598	0.587	0.620	0.698	0.721	0.513
6	0.790	0.990	0.910	0.850	1.310	0.960	1.020

	1992	1993	1994	1995	1996	1997
1	0.028	0.056	0.052	0.042	0.014	0.008
2	0.125	0.089	0.144	0.156	0.115	0.111
3	0.271	0.216	0.240	0.271	0.324	0.269
4	0.420	0.371	0.420	0.360	0.392	0.419
5	0.569	0.620	0.516	0.542	0.437	0.518
6	1.150	1.000	0.830	0.800	1.020	0.810

SSB Weights - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	0.130	0.100	0.060	0.120	0.130	0.080	0.120
2	0.280	0.250	0.240	0.210	0.270	0.270	0.230
3	0.360	0.430	0.400	0.340	0.390	0.370	0.340
4	0.490	0.530	0.550	0.530	0.650	0.360	0.530
5	0.600	0.730	0.650	0.700	0.920	0.800	0.730
6	0.790	0.990	0.910	0.850	1.310	0.960	1.020

	1992	1993	1994	1995	1996	1997
1	0.050	0.090	0.090	0.070	0.040	0.030
2	0.130	0.160	0.230	0.270	0.190	0.310
3	0.320	0.360	0.360	0.320	0.390	0.380
4	0.520	0.430	0.490	0.360	0.480	0.450
5	0.610	0.740	0.620	0.600	0.530	0.560
6	1.150	1.000	0.830	0.800	1.020	0.810

Percent Mature (females)- C:\Program Files\WHAT\ccyt98.14

	1985-1997
1	00
2	08
3	81
4	100
5	100
6	100

Sex Ratio (Percent Female) - C:\Program Files\WHAT\ccyt98.14

	1985-1997
1	0.5
2	0.5
3	0.5
4	0.5
5	0.5
6	0.5

pF is 0.416
pM is 0.416

Residual Sum of Squares from Marquardt Algorithm

Number 1
RSS 480.215964715797
Lambda 1.00E-02

Number 2
RSS 402.953087764411
Lambda 1.00E-03

Number 3
RSS 343.115124241402
Lambda 1.00E-01

Number 4
RSS 300.409003821905
Lambda 1.00E-02

Number 5
RSS 132.134051711145
Lambda 1.00E+00

Number 6
RSS 111.036836733445
Lambda 1.00E-01

Number 7
RSS 109.538849296714
Lambda 1.00E+01

Number 8

RSS 109.528024662002
Lambda 1.00E+00

Number 9
RSS 109.528023828957
Lambda 1.00E-01

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 109.528023828957
Mean Square Residuals: 0.58571

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 2	2.78E+03	9.96E+02	2.79E+00	0.36
N 3	3.78E+03	1.11E+03	3.40E+00	0.29
N 4	1.62E+03	5.13E+02	3.15E+00	0.32
N 5	8.21E+02	3.22E+02	2.55E+00	0.39
q NMFSs2	1.47E-04	3.07E-05	4.79E+00	0.21
q NMFSs3	2.44E-04	5.06E-05	4.82E+00	0.21
q NMFSs4	7.06E-04	1.47E-04	4.80E+00	0.21
q NMFSs5	3.32E-03	7.93E-04	4.18E+00	0.24
q NMFSf2	1.41E-04	2.95E-05	4.79E+00	0.21
q NMFSf3	2.75E-04	5.70E-05	4.82E+00	0.21
q NMFSf4	7.63E-04	1.59E-04	4.80E+00	0.21
q NMFSf5	2.72E-03	6.00E-04	4.54E+00	0.22
q MASSs1	8.89E-05	1.93E-05	4.61E+00	0.22
q MASSs2	1.66E-04	3.48E-05	4.79E+00	0.21
q MASSs3	2.45E-04	5.09E-05	4.82E+00	0.21
q MASSs4	7.70E-04	1.60E-04	4.80E+00	0.21
q MASSf2	1.50E-04	3.14E-05	4.79E+00	0.21
q MASSf3	2.83E-04	5.88E-05	4.82E+00	0.21
q MASSf4	7.25E-04	1.51E-04	4.80E+00	0.21

Catchability Estimates in Original Units

	Estimate	Std.Err.	C.V.
q NMFSs2	5.76E-04	1.20E-04	0.21
q NMFSs3	9.82E-04	2.04E-04	0.21
q NMFSs4	8.87E-04	1.85E-04	0.21
q NMFSs5	1.41E-03	3.36E-04	0.24
q NMFSf2	5.79E-04	1.21E-04	0.21
q NMFSf3	1.79E-03	3.71E-04	0.21
q NMFSf4	2.42E-03	5.03E-04	0.21
q NMFSf5	2.43E-03	5.35E-04	0.22
q MASSs1	1.59E-04	3.44E-05	0.22
q MASSs2	2.20E-03	4.58E-04	0.21
q MASSs3	2.47E-03	5.13E-04	0.21
q MASSs4	1.60E-03	3.33E-04	0.21
q MASSf2	7.53E-04	1.57E-04	0.21
q MASSf3	1.78E-03	3.70E-04	0.21
q MASSf4	1.79E-03	3.74E-04	0.21

Summary of Residuals
NMFSs
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.860	0.397	-0.745	-0.924	1	0.179	0.233	2702
1986	4.330	1.144	0.100	0.135	1	-0.035	-0.046	7787
1987	3.440	0.557	-0.130	-0.586	1	0.456	0.596	3787
1988	9.110	0.811	0.844	-0.209	1	1.053	1.376	5518
1989	6.330	2.507	0.480	0.919	1	-0.439	-0.574	17055
1990	5.510	0.911	0.341	-0.093	1	0.434	0.567	6201
1991	8.230	0.747	0.742	-0.292	1	1.035	1.352	5079
1992	2.250	1.043	-0.555	0.042	1	-0.597	-0.780	7097
1993	1.510	0.655	-0.953	-0.424	1	-0.530	-0.692	4455
1994	5.640	0.879	0.364	-0.129	1	0.494	0.645	5979
1995	2.100	0.815	-0.624	-0.205	1	-0.419	-0.548	5545
1996	0.850	0.728	-1.528	-0.317	1	-1.211	-1.583	4956
1997	1.980	0.821	-0.682	-0.197	1	-0.485	-0.634	5585
1998	1.710	0.409	-0.829	-0.895	1	0.066	0.086	2780

Partial Variance: 0.437

NMFSs
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.810	0.352	-0.800	-1.045	1	0.245	0.320	1443
1986	0.370	0.336	-2.387	-1.091	1	-1.297	-1.694	1378
1987	5.150	0.748	0.246	-0.290	1	0.536	0.700	3068
1988	1.870	0.428	-0.767	-0.848	1	0.081	0.106	1756
1989	3.880	0.632	-0.037	-0.459	1	0.422	0.551	2591
1990	13.350	2.935	1.198	1.077	1	0.122	0.159	12035
1991	5.670	0.634	0.342	-0.456	1	0.798	1.042	2599
1992	3.520	0.748	-0.135	-0.290	1	0.156	0.203	3067
1993	1.750	0.561	-0.834	-0.579	1	-0.255	-0.333	2299
1994	2.330	0.812	-0.547	-0.208	1	-0.340	-0.444	3331
1995	7.330	1.090	0.599	0.086	1	0.513	0.670	4469
1996	1.180	0.952	-1.228	-0.049	1	-1.179	-1.540	3905
1997	3.150	0.869	-0.246	-0.141	1	-0.105	-0.138	3563
1998	5.030	0.921	0.222	-0.082	1	0.305	0.398	3776

Partial Variance: 0.379

NMFSs
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	0.430	0.464	-1.072	-0.769	1	-0.303	-0.396	657
1986	0.100	0.365	-2.530	-1.008	1	-1.522	-1.989	517
1987	0.840	0.379	-0.402	-0.971	1	0.569	0.744	536
1988	1.220	0.525	-0.029	-0.644	1	0.615	0.804	744
1989	0.350	0.236	-1.278	-1.444	1	0.166	0.217	334
1990	0.350	0.613	-1.278	-0.490	1	-0.788	-1.029	868
1991	1.800	1.404	0.360	0.339	1	0.021	0.027	1989
1992	0.980	0.567	-0.248	-0.567	1	0.319	0.417	803
1993	0.870	0.790	-0.367	-0.235	1	-0.132	-0.172	1120
1994	0.900	0.781	-0.333	-0.247	1	-0.086	-0.113	1107
1995	4.740	1.094	1.328	0.090	1	1.238	1.618	1550
1996	0.630	1.062	-0.690	0.060	1	-0.749	-0.979	1504
1997	2.540	1.347	0.704	0.298	1	0.407	0.531	1908
1998	1.830	1.141	0.377	0.132	1	0.244	0.319	1617

Partial Variance: 0.487

NMFSs
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	0.250	1.081	-0.527	0.078	1	-0.605	-0.791	326
1986	0.240	0.216	-0.568	-1.530	1	0.962	1.257	65
1987	1.300	0.654	1.121	-0.425	1	1.546	2.020	197
1988	0.470	0.652	0.104	-0.428	1	0.532	0.695	196
1989	0.170	0.144	-0.913	-1.939	1	1.026	1.340	43
1990	0.000	0.000	0	0	1	0.000	0.000	00
1991	0.420	1.051	-0.009	0.050	1	-0.058	-0.076	317
1992	0.040	0.733	-2.360	-0.310	1	-2.050	-2.678	221
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.330	1.234	-0.250	0.210	1	-0.460	-0.601	372
1995	0.460	0.907	0.082	-0.097	1	0.180	0.235	274
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.560	1.406	0.279	0.341	1	-0.062	-0.081	424
1998	0.420	2.723	-0.009	1.002	1	-1.010	-1.320	821

Partial Variance: 1.078

NMFSf
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	0.640	0.382	-1.856	-0.962	1	-0.894	-1.168	2702
1986	9.030	1.101	0.791	0.096	1	0.694	0.907	7787
1987	2.620	0.536	-0.446	-0.624	1	0.178	0.233	3787
1988	1.080	0.780	-1.333	-0.248	1	-1.085	-1.417	5518
1989	6.160	2.412	0.408	0.881	1	-0.472	-0.617	17055
1990	3.530	0.877	-0.148	-0.131	1	-0.017	-0.022	6201
1991	7.010	0.718	0.538	-0.331	1	0.868	1.135	5079
1992	3.570	1.004	-0.137	0.004	1	-0.141	-0.184	7097
1993	4.820	0.630	0.163	-0.462	1	0.625	0.817	4455
1994	8.760	0.846	0.761	-0.168	1	0.928	1.213	5979
1995	4.780	0.784	0.155	-0.243	1	0.398	0.520	5545
1996	1.180	0.701	-1.244	-0.355	1	-0.889	-1.161	4956
1997	2.070	0.790	-0.682	-0.236	1	-0.446	-0.583	5585
1998	2.070	0.393	-0.682	-0.933	1	0.251	0.328	2780

Partial Variance: 0.467

NMFSf
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	2.250	0.396	-1.061	-0.925	1	-0.136	-0.178	1443
1986	3.480	0.378	-0.625	-0.972	1	0.346	0.452	1378
1987	7.140	0.843	0.093	-0.171	1	0.264	0.345	3068
1988	2.600	0.482	-0.917	-0.729	1	-0.188	-0.245	1756
1989	9.010	0.712	0.326	-0.340	1	0.666	0.870	2591
1990	11.390	3.306	0.560	1.196	1	-0.635	-0.830	12035
1991	11.900	0.714	0.604	-0.337	1	0.941	1.229	2599
1992	3.330	0.843	-0.669	-0.171	1	-0.498	-0.651	3067
1993	5.290	0.632	-0.207	-0.460	1	0.253	0.331	2299
1994	8.600	0.915	0.279	-0.089	1	0.368	0.481	3331
1995	14.270	1.228	0.786	0.205	1	0.581	0.759	4469
1996	1.640	1.073	-1.378	0.070	1	-1.448	-1.892	3905
1997	5.360	0.979	-0.193	-0.021	1	-0.172	-0.225	3563
1998	4.790	1.037	-0.306	0.037	1	-0.343	-0.448	3776

Partial Variance: 0.393

NMFSf
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.040	0.501	-1.114	-0.692	1	-0.422	-0.552	657
1986	2.650	0.394	-0.179	-0.931	1	0.752	0.983	517
1987	0.600	0.409	-1.664	-0.894	1	-0.770	-1.006	536
1988	0.910	0.567	-1.248	-0.567	1	-0.680	-0.889	744
1989	0.890	0.255	-1.270	-1.367	1	0.097	0.127	334
1990	4.190	0.662	0.279	-0.413	1	0.692	0.905	868
1991	5.580	1.516	0.566	0.416	1	0.150	0.195	1989
1992	2.880	0.613	-0.095	-0.490	1	0.394	0.515	803
1993	3.680	0.854	0.150	-0.158	1	0.308	0.402	1120
1994	1.010	0.844	-1.143	-0.170	1	-0.974	-1.272	1107
1995	5.130	1.182	0.482	0.167	1	0.315	0.411	1550
1996	1.570	1.147	-0.702	0.137	1	-0.839	-1.096	1504
1997	8.780	1.455	1.019	0.375	1	0.644	0.842	1908
1998	5.450	1.233	0.542	0.209	1	0.333	0.435	1617

Partial Variance: 0.38

NMFSf
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.310	0.888	0.385	-0.119	1	0.504	0.659	326
1986	0.400	0.178	-0.801	-1.727	1	0.926	1.210	65
1987	0.000	0.000	0	0	1	0.000	0.000	00
1988	0.110	0.535	-2.092	-0.625	1	-1.467	-1.917	196
1989	0.170	0.118	-1.657	-2.136	1	0.478	0.625	43
1990	0.740	0.171	-0.186	-1.764	1	1.578	2.062	63
1991	0.090	0.863	-2.293	-0.147	1	-2.146	-2.804	317
1992	0.590	0.602	-0.413	-0.507	1	0.094	0.123	221
1993	1.520	0.454	0.534	-0.791	1	1.324	1.730	167
1994	0.150	1.014	-1.782	0.013	1	-1.796	-2.346	372
1995	1.400	0.745	0.451	-0.294	1	0.745	0.974	274
1996	0.340	1.343	-0.964	0.295	1	-1.259	-1.645	493
1997	2.310	1.155	0.952	0.144	1	0.808	1.056	424
1998	2.460	2.236	1.015	0.805	1	0.210	0.275	821

Partial Variance: 1.569

MASSs
Tuned to: 1-Jan
For ages: 1

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.970	0.880	0.099	-0.128	1	0.228	0.298	9891
1986	1.730	0.419	-0.030	-0.870	1	0.839	1.097	4712
1987	2.530	0.601	0.350	-0.510	1	0.859	1.123	6755
1988	3.100	1.888	0.553	0.635	1	-0.083	-0.108	21230
1989	0.670	0.685	-0.979	-0.379	1	-0.600	-0.784	7700
1990	0.630	0.560	-1.041	-0.580	1	-0.460	-0.601	6293
1991	0.060	0.816	-3.392	-0.203	1	-3.189	-4.166	9176
1992	1.300	0.650	-0.316	-0.431	1	0.115	0.150	7306
1993	0.630	0.663	-1.041	-0.411	1	-0.630	-0.823	7455
1994	2.670	0.608	0.403	-0.497	1	0.901	1.177	6839
1995	7.510	0.583	1.438	-0.540	1	1.978	2.584	6554
1996	1.170	0.607	-0.422	-0.499	1	0.077	0.101	6829
1997	0.520	0.302	-1.233	-1.197	1	-0.035	-0.046	3397
1998	0.480	0.000	-1.313	0	1	0.000	0.000	00

Partial Variance: 1.365

MASSs
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	8.270	0.450	-0.467	-0.799	1	0.332	0.434	2702
1986	15.390	1.296	0.154	0.259	1	-0.105	-0.137	7787
1987	4.950	0.630	-0.980	-0.461	1	-0.518	-0.677	3787
1988	14.460	0.919	0.092	-0.085	1	0.177	0.231	5518
1989	22.260	2.839	0.523	1.044	1	-0.520	-0.679	17055
1990	11.770	1.032	-0.114	0.032	1	-0.146	-0.190	6201
1991	5.340	0.846	-0.904	-0.168	1	-0.736	-0.962	5079
1992	11.030	1.181	-0.179	0.167	1	-0.345	-0.451	7097
1993	7.990	0.742	-0.501	-0.299	1	-0.202	-0.264	4455
1994	24.020	0.995	0.600	-0.005	1	0.604	0.790	5979
1995	14.640	0.923	0.104	-0.080	1	0.184	0.241	5545
1996	18.030	0.825	0.313	-0.192	1	0.505	0.660	4956
1997	16.940	0.930	0.250	-0.073	1	0.323	0.422	5585
1998	9.540	0.463	-0.324	-0.770	1	0.447	0.584	2780

Partial Variance: 0.186

MASSs
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	7.150	0.354	-0.342	-1.039	1	0.696	0.910	1443
1986	1.740	0.338	-1.756	-1.085	1	-0.671	-0.877	1378
1987	5.310	0.753	-0.640	-0.284	1	-0.356	-0.465	3068
1988	2.520	0.431	-1.385	-0.842	1	-0.543	-0.710	1756
1989	3.180	0.636	-1.153	-0.453	1	-0.699	-0.914	2591
1990	15.570	2.953	0.436	1.083	1	-0.647	-0.845	12035
1991	3.310	0.638	-1.113	-0.450	1	-0.663	-0.866	2599
1992	9.710	0.753	-0.036	-0.284	1	0.248	0.324	3067
1993	6.310	0.564	-0.467	-0.573	1	0.105	0.138	2299
1994	7.530	0.817	-0.291	-0.202	1	-0.089	-0.116	3331
1995	24.960	1.096	0.908	0.092	1	0.816	1.066	4469
1996	14.700	0.958	0.378	-0.043	1	0.421	0.550	3905
1997	12.220	0.874	0.194	-0.135	1	0.328	0.429	3563
1998	26.770	0.927	0.978	-0.076	1	1.054	1.377	3776

Partial Variance: 0.38

MASSs
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.520	0.506	-0.313	-0.682	1	0.369	0.482	657
1986	0.240	0.398	-2.159	-0.921	1	-1.238	-1.618	517
1987	0.970	0.413	-0.762	-0.885	1	0.122	0.160	536
1988	0.600	0.573	-1.243	-0.558	1	-0.685	-0.895	744
1989	1.080	0.257	-0.655	-1.357	1	0.702	0.917	334
1990	0.630	0.668	-1.194	-0.403	1	-0.791	-1.033	868
1991	2.150	1.531	0.033	0.426	1	-0.393	-0.513	1989
1992	2.380	0.619	0.135	-0.480	1	0.615	0.804	803
1993	1.940	0.862	-0.069	-0.148	1	0.079	0.103	1120
1994	1.490	0.852	-0.333	-0.160	1	-0.173	-0.226	1107
1995	2.880	1.194	0.326	0.177	1	0.149	0.194	1550
1996	6.780	1.158	1.182	0.146	1	1.035	1.353	1504
1997	4.040	1.469	0.664	0.385	1	0.280	0.365	1908
1998	2.410	1.245	0.148	0.219	1	-0.071	-0.093	1617

Partial Variance: 0.394

MASSf
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	1.910	0.406	-0.965	-0.902	1	-0.063	-0.082	2702
1986	5.700	1.170	0.129	0.157	1	-0.028	-0.037	7787
1987	2.600	0.569	-0.656	-0.564	1	-0.092	-0.120	3787
1988	5.850	0.829	0.155	-0.188	1	0.342	0.447	5518
1989	8.960	2.562	0.581	0.941	1	-0.360	-0.470	17055
1990	2.640	0.931	-0.641	-0.071	1	-0.570	-0.745	6201
1991	5.200	0.763	0.037	-0.271	1	0.307	0.402	5079
1992	3.760	1.066	-0.287	0.064	1	-0.351	-0.459	7097
1993	7.180	0.669	0.359	-0.402	1	0.761	0.995	4455
1994	8.390	0.898	0.515	-0.107	1	0.623	0.814	5979
1995	3.560	0.833	-0.342	-0.183	1	-0.159	-0.208	5545
1996	11.540	0.744	0.834	-0.295	1	1.129	1.475	4956
1997	1.870	0.839	-0.986	-0.176	1	-0.810	-1.059	5585
1998	1.010	0.418	-1.602	-0.873	1	-0.729	-0.952	2780

Partial Variance: 0.334

MASSf
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	3.000	0.409	-0.740	-0.895	1	0.155	0.203	1443
1986	1.630	0.390	-1.350	-0.941	1	-0.409	-0.534	1378
1987	4.950	0.869	-0.239	-0.140	1	-0.099	-0.129	3068
1988	2.300	0.497	-1.005	-0.698	1	-0.307	-0.401	1756
1989	11.240	0.734	0.581	-0.309	1	0.891	1.164	2591
1990	5.220	3.410	-0.186	1.227	1	-1.412	-1.846	12035
1991	11.930	0.736	0.641	-0.306	1	0.947	1.237	2599
1992	5.140	0.869	-0.201	-0.140	1	-0.061	-0.080	3067
1993	3.620	0.651	-0.552	-0.429	1	-0.123	-0.161	2299
1994	7.290	0.944	0.148	-0.058	1	0.206	0.269	3331
1995	8.390	1.266	0.289	0.236	1	0.053	0.069	4469
1996	11.970	1.106	0.644	0.101	1	0.543	0.710	3905
1997	3.940	1.009	-0.467	0.009	1	-0.476	-0.623	3563
1998	7.380	1.070	0.160	0.068	1	0.093	0.121	3776

Partial Variance: 0.359

MASSf
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1985	0.860	0.476	-1.057	-0.743	1	-0.314	-0.411	657
1986	1.030	0.375	-0.877	-0.982	1	0.105	0.137	517
1987	0.200	0.389	-2.516	-0.945	1	-1.570	-2.052	536
1988	0.490	0.539	-1.620	-0.618	1	-1.001	-1.308	744
1989	2.270	0.242	-0.086	-1.418	1	1.331	1.740	334
1990	0.960	0.629	-0.947	-0.464	1	-0.483	-0.631	868
1991	4.840	1.441	0.671	0.365	1	0.305	0.399	1989
1992	5.030	0.582	0.709	-0.541	1	1.250	1.633	803
1993	2.080	0.811	-0.174	-0.209	1	0.035	0.046	1120
1994	5.800	0.802	0.852	-0.221	1	1.072	1.401	1107
1995	3.060	1.123	0.212	0.116	1	0.096	0.125	1550
1996	4.710	1.090	0.643	0.086	1	0.558	0.729	1504
1997	2.180	1.382	-0.127	0.324	1	-0.451	-0.589	1908
1998	1.140	1.171	-0.775	0.158	1	-0.933	-1.220	1617

Partial Variance: 0.769

Partial variance (and proportion of total) by index

0.437	0.379	0.487	1.078	0.467	0.393	0.38	1.569	1.365	0.186
0.38	0.394	0.334	0.359	0.769					
0.049	0.042	0.054	0.12	0.052	0.044	0.042	0.175	0.152	0.021
0.042	0.044	0.037	0.04	0.086					

Standardized residuals by index and year; with row/column/grand means

	1985	1986	1987	1988	1989	1990	1991
NMFSs2	0.233	-0.046	0.596	1.376	-0.574	0.567	1.352
NMFSs3	0.320	-1.694	0.700	0.106	0.551	0.159	1.042
NMFSs4	-0.396	-1.989	0.744	0.804	0.217	-1.029	0.027
NMFSs5	-0.791	1.257	2.020	0.695	1.340	0.000	-0.076
NMFSf2	-1.168	0.907	0.233	-1.417	-0.617	-0.022	1.135
NMFSf3	-0.178	0.452	0.345	-0.245	0.870	-0.830	1.229
NMFSf4	-0.552	0.983	-1.006	-0.889	0.127	0.905	0.195
NMFSf5	0.659	1.210	0.000	-1.917	0.625	2.062	-2.804
MASSs1	0.298	1.097	1.123	-0.108	-0.784	-0.601	-4.166
MASSs2	0.434	-0.137	-0.677	0.231	-0.679	-0.190	-0.962
MASSs3	0.910	-0.877	-0.465	-0.710	-0.914	-0.845	-0.866
MASSs4	0.482	-1.618	0.160	-0.895	0.917	-1.033	-0.513
MASSf2	-0.082	-0.037	-0.120	0.447	-0.470	-0.745	0.402
MASSf3	0.203	-0.534	-0.129	-0.401	1.164	-1.846	1.237
MASSf4	-0.411	0.137	-2.052	-1.308	1.740	-0.631	0.399
Col Avg	-0.003	-0.059	0.105	-0.282	0.234	-0.291	-0.158

	1992	1993	1994	1995	1996	1997	1998
NMFSs2	-0.780	-0.692	0.645	-0.548	-1.583	-0.634	0.086
NMFSs3	0.203	-0.333	-0.444	0.670	-1.540	-0.138	0.398
NMFSs4	0.417	-0.172	-0.113	1.618	-0.979	0.531	0.319
NMFSs5	-2.678	0.000	-0.601	0.235	0.000	-0.081	-1.320
NMFSf2	-0.184	0.817	1.213	0.520	-1.161	-0.583	0.328
NMFSf3	-0.651	0.331	0.481	0.759	-1.892	-0.225	-0.448
NMFSf4	0.515	0.402	-1.272	0.411	-1.096	0.842	0.435
NMFSf5	0.123	1.730	-2.346	0.974	-1.645	1.056	0.275
MASSs1	0.150	-0.823	1.177	2.584	0.101	-0.046	0.000
MASSs2	-0.451	-0.264	0.790	0.241	0.660	0.422	0.584
MASSs3	0.324	0.138	-0.116	1.066	0.550	0.429	1.377
MASSs4	0.804	0.103	-0.226	0.194	1.353	0.365	-0.093
MASSf2	-0.459	0.995	0.814	-0.208	1.475	-1.059	-0.952
MASSf3	-0.080	-0.161	0.269	0.069	0.710	-0.623	0.121
MASSf4	1.633	0.046	1.401	0.125	0.729	-0.589	-1.220
Col Avg	-0.074	0.151	0.111	0.581	-0.308	-0.022	-0.007

Percent of total sum of squares by index and year; with row/column sums

	1985	1986	1987	1988	1989	1990	1991
NMFSs2	0.029	0.001	0.190	1.013	0.176	0.172	0.977
NMFSs3	0.055	1.535	0.262	0.006	0.162	0.013	0.581
NMFSs4	0.084	2.116	0.296	0.346	0.025	0.566	0.000
NMFSs5	0.334	0.845	2.183	0.258	0.961	0.000	0.003
NMFSf2	0.729	0.440	0.029	1.074	0.203	0.000	0.689
NMFSf3	0.017	0.109	0.064	0.032	0.405	0.369	0.808
NMFSf4	0.163	0.516	0.541	0.423	0.009	0.438	0.020
NMFSf5	0.232	0.783	0.000	1.966	0.209	2.273	4.205
MASSs1	0.047	0.643	0.674	0.006	0.329	0.193	9.283
MASSs2	0.101	0.010	0.245	0.029	0.247	0.019	0.495
MASSs3	0.442	0.411	0.116	0.269	0.447	0.382	0.401
MASSs4	0.124	1.400	0.014	0.429	0.450	0.571	0.141
MASSf2	0.004	0.001	0.008	0.107	0.118	0.297	0.086
MASSf3	0.022	0.153	0.009	0.086	0.724	1.821	0.818
MASSf4	0.090	0.010	2.251	0.915	1.618	0.213	0.085
++	2.473	8.974	6.881	6.960	6.084	7.328	18.594

	1992	1993	1994	1995	1996	1997	1998
NMFSs2	0.325	0.256	0.222	0.160	1.339	0.215	0.004
NMFSs3	0.022	0.059	0.105	0.240	1.269	0.010	0.085
NMFSs4	0.093	0.016	0.007	1.400	0.513	0.151	0.055
NMFSs5	3.837	0.000	0.193	0.029	0.000	0.003	0.932
NMFSf2	0.018	0.357	0.787	0.144	0.721	0.182	0.058
NMFSf3	0.227	0.058	0.124	0.308	1.914	0.027	0.107
NMFSf4	0.142	0.086	0.865	0.090	0.643	0.379	0.101
NMFSf5	0.008	1.601	2.944	0.507	1.447	0.596	0.040
MASSs1	0.012	0.362	0.741	3.570	0.005	0.001	0.000
MASSs2	0.109	0.037	0.333	0.031	0.233	0.095	0.182
MASSs3	0.056	0.010	0.007	0.607	0.162	0.098	1.014
MASSs4	0.346	0.006	0.027	0.020	0.979	0.071	0.005
MASSf2	0.113	0.529	0.354	0.023	1.164	0.599	0.485
MASSf3	0.003	0.014	0.039	0.003	0.269	0.207	0.008
MASSf4	1.427	0.001	1.050	0.008	0.284	0.185	0.796
++	6.737	3.393	7.799	7.142	10.942	2.822	3.871

STOCK NUMBERS (Jan 1) in thousands - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	9891	4712	6755	21230	7700	6293	9176
2	2702	7787	3787	5518	17055	6201	5079
3	1443	1378	3068	1756	2591	12035	2599
4	657	517	536	744	334	868	1989
5	326	65	197	196	43	63	317
6	116	14	89	39	11	50	73
1+	15133	14473	14432	29483	27734	25510	19233

	1992	1993	1994	1995	1996	1997	1998
1	7306	7455	6839	6554	6829	3397	00
2	7097	4455	5979	5545	4956	5585	2780
3	3067	2299	3331	4469	3905	3563	3776
4	803	1120	1107	1550	1504	1908	1617
5	221	167	372	274	493	424	821
6	17	83	171	145	29	32	196
1+	18512	15578	17800	18537	17716	14908	9190

FISHING MORTALITY - C:\Program Files\WHAT\ccyt98.14

	1985	1986	1987	1988	1989	1990	1991
1	0.04	0.02	0.00	0.02	0.02	0.01	0.06
2	0.47	0.73	0.57	0.56	0.15	0.67	0.30
3	0.83	0.74	1.22	1.46	0.89	1.60	0.97
4	2.11	0.76	0.80	2.64	1.47	0.81	2.00
5	2.40	0.78	0.82	3.43	1.56	0.83	2.23
6	2.40	0.78	0.82	3.43	1.56	0.83	2.23

	1992	1993	1994	1995	1996	1997
1	0.29	0.02	0.01	0.08	0.00	0.00
2	0.93	0.09	0.09	0.15	0.13	0.19
3	0.81	0.53	0.56	0.89	0.52	0.59
4	1.37	0.90	1.20	0.95	1.07	0.64
5	1.45	0.93	1.25	0.97	1.10	0.64
6	1.45	0.93	1.25	0.97	1.10	0.64

Average F for 4,5

	1985	1986	1987	1988	1989	1990	1991
4,5	2.25	0.77	0.81	3.03	1.52	0.82	2.12

	1992	1993	1994	1995	1996	1997
4,5	1.41	0.91	1.22	0.96	1.08	0.64

Biomass Weighted F

	1985	1986	1987	1988	1989	1990	1991
	0.48	0.61	0.72	0.40	0.24	1.09	0.66

	1992	1993	1994	1995	1996	1997
	0.86	0.34	0.40	0.53	0.48	0.41

BACKCALCULATED PARTIAL RECRUITMENT

	1985	1986	1987	1988	1989	1990	1991
1	0.02	0.02	0.00	0.01	0.01	0.01	0.03
2	0.20	0.94	0.47	0.16	0.10	0.42	0.14
3	0.34	0.95	1.00	0.43	0.57	1.00	0.44
4	0.88	0.98	0.66	0.77	0.94	0.50	0.89
5	1.00	1.00	0.68	1.00	1.00	0.52	1.00
6	1.00	1.00	0.68	1.00	1.00	0.52	1.00

	1992	1993	1994	1995	1996	1997
1	0.20	0.02	0.01	0.08	0.00	0.00
2	0.64	0.10	0.07	0.15	0.12	0.30
3	0.56	0.57	0.45	0.91	0.47	0.92
4	0.95	0.97	0.96	0.97	0.97	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00

MEAN BIOMASS (using catch mean weights at age)

	1985	1986	1987	1988	1989	1990	1991
1	1144	423	367	2288	900	453	971
2	551	1267	634	813	3888	1077	918
3	325	383	656	291	614	2065	520
4	126	176	186	131	106	301	427
5	70	30	80	37	19	32	87
6	33	09	51	09	07	30	28
1+	2247	2288	1974	3569	5533	3958	2950

	1992	1993	1994	1995	1996	1997	
1	288	602	494	400	248	92	
2	553	619	1141	1029	802	1433	
3	619	587	838	898	1087	936	
4	210	292	292	388	418	593	
5	66	74	122	98	146	163	
6	10	50	75	68	17	18	
1+	1746	2223	2962	2882	2717	3235	00

Catch BIOMASS (using catch mean weights)

	1985	1986	1987	1988	1989	1990	1991
1	45	08	01	43	15	07	55
2	261	926	361	452	578	721	279
3	268	285	799	425	549	3304	507
4	265	134	150	345	155	243	852
5	167	24	66	127	29	27	194
6	78	07	42	31	11	25	62
1+	1084	1385	1417	1423	1337	4326	1949

	1992	1993	1994	1995	1996	1997
1	85	12	05	32	00	00
2	513	56	104	155	104	274
3	500	312	474	799	562	552
4	289	263	350	367	446	381
5	96	69	152	96	161	105
6	14	46	94	66	18	11
1+	1496	758	1178	1514	1291	1324

Jan 1 BIOMASS (using Jan 1 mean weights)

	1985	1986	1987	1988	1989	1990	1991
1	930	306	216	1698	693	296	1055
2	611	1402	587	618	3070	1160	691
3	429	478	969	502	741	3803	788
4	263	226	261	342	157	325	881
5	177	39	116	122	30	45	163
6	92	14	81	33	14	48	74
1+	2500	2465	2230	3316	4705	5678	3652

	1992	1993	1994	1995	1996	1997
1	205	418	356	275	96	27
2	887	397	861	865	570	620
3	831	497	800	1211	1265	958
4	338	415	465	558	589	799
5	126	103	192	148	215	220
6	20	83	142	116	30	26
1+	2406	1912	2815	3174	2765	2651

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1985	1986	1987	1988	1989	1990	1991
1	00	00	00	00	00	00	00
2	46	106	53	68	319	93	76
3	275	324	551	243	519	1706	439
4	123	183	194	121	108	205	423
5	66	32	84	30	19	33	84
6	31	09	53	07	07	32	27
1+	541	654	935	469	972	2069	1049

	1992	1993	1994	1995	1996	1997
1	00	00	00	00	00	00
2	46	51	97	104	66	118
3	523	495	707	736	916	789
4	217	304	303	346	426	604
5	68	77	126	101	152	167
6	10	52	78	71	17	18
1+	864	978	1311	1358	1577	1697

The number of bootstraps: 1000
Bootstrap Output Variable: N hat

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
N 2	2780	2981	1000	0.36
N 3	3777	3895	1060	0.28
N 4	1617	1659	461	0.29
N 5	821	852	301	0.37

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
N 2	201	32	7.22	2579	0.387572
N 3	119	34	3.14	3658	0.289809
N 4	42	15	2.61	1575	0.293024
N 5	31	10	3.73	790	0.380510

Bootstrap Output Variable: Q_unscaled

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
q NMFSs2	0.0005758	0.0005894	0.0001136	0.20
q NMFSs3	0.0009823	0.0010031	0.0001932	0.20
q NMFSs4	0.0008865	0.0008949	0.0001725	0.19
q NMFSs5	0.0014052	0.0014613	0.0003403	0.24
q NMFSf2	0.0005791	0.0005900	0.0001141	0.20
q NMFSf3	0.0017866	0.0018593	0.0003525	0.20
q NMFSf4	0.0024161	0.0024578	0.0004701	0.19
q NMFSf5	0.0024288	0.0025131	0.0005169	0.21
q MASSs1	0.0001586	0.0001625	0.0000326	0.21
q MASSs2	0.0021954	0.0022406	0.0004281	0.20
q MASSs3	0.0024706	0.0025037	0.0004665	0.19
q MASSs4	0.0016009	0.0016205	0.0003139	0.20
q MASSf2	0.0007529	0.0007724	0.0001495	0.20
q MASSf3	0.0017808	0.0018084	0.0003574	0.20
q MASSf4	0.0017934	0.0018397	0.0003575	0.20

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
q NMFSs2	0.00001355	0.000003592	2.353	0.000562267	0.20
q NMFSs3	0.00002077	0.000006110	2.114	0.000961516	0.20
q NMFSs4	0.00000842	0.000005456	0.950	0.000878068	0.20
q NMFSs5	0.00005609	0.000010763	3.992	0.001349118	0.25
q NMFSf2	0.00001093	0.000003607	1.887	0.000568153	0.20
q NMFSf3	0.00007263	0.000011147	4.065	0.001713997	0.21
q NMFSf4	0.00004163	0.000014865	1.723	0.002374508	0.20
q NMFSf5	0.00008434	0.000016344	3.472	0.002344435	0.22
q MASSs1	0.00000385	0.000001030	2.431	0.000154745	0.21
q MASSs2	0.00004523	0.000013538	2.060	0.002150191	0.20
q MASSs3	0.00003302	0.000014752	1.337	0.002437608	0.19
q MASSs4	0.00001960	0.000009927	1.224	0.001581352	0.20
q MASSf2	0.00001953	0.000004727	2.594	0.000733336	0.20
q MASSf3	0.00002759	0.000011301	1.549	0.001753211	0.20
q MASSf4	0.00004634	0.000011307	2.584	0.001747032	0.20

Bootstrap Output Variable: N t1

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	7304.0	7323.4	260.8	0.0357
Age 2	2780.1	2980.9	999.7	0.3596
Age 3	3776.5	3895.1	1060.1	0.2807
Age 4	1616.8	1659.0	461.4	0.2854
Age 5	821.0	851.6	300.8	0.3663
Age 6	196.3	203.6	72.0	0.3665

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	19.45	8.25	0.266	7284.51	0.04
Age 2	200.78	31.61	7.222	2579.31	0.39
Age 3	118.52	33.52	3.138	3658.00	0.29
Age 4	42.20	14.59	2.610	1574.58	0.29
Age 5	30.61	9.51	3.728	790.41	0.38
Age 6	7.33	2.28	3.732	188.98	0.38

Bootstrap Output Variable: F t

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0003	0.0003	0.0001	0.39
Age 2	0.1913	0.1979	0.0510	0.27
Age 3	0.5901	0.6056	0.1296	0.22
Age 4	0.6432	0.6761	0.2018	0.31
Age 5	0.6432	0.6761	0.2018	0.31
Age 6	0.6432	0.6761	0.2018	0.31

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	0.0000158	0.0000040	4.850	0.0003096	0.41
Age 2	0.0065531	0.0016137	3.425	0.1847643	0.28
Age 3	0.0154775	0.0040972	2.623	0.5746518	0.23
Age 4	0.0329014	0.0063802	5.115	0.6103278	0.33
Age 5	0.0329014	0.0063802	5.115	0.6103278	0.33
Age 6	0.0329014	0.0063802	5.115	0.6103278	0.33

Bootstrap Output Variable: F full t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
0.6432	0.6761	0.2018	0.31

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
0.03290	0.00638	5.12	0.61033	0.33

Bootstrap Output Variable: PR t

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0005	0.0005	0.0002	0.44
Age 2	0.2974	0.2866	0.0959	0.32
Age 3	0.9174	0.8577	0.1669	0.18
Age 4	1.0000	0.9293	0.1178	0.12
Age 5	1.0000	0.9293	0.1178	0.12
Age 6	1.0000	0.9293	0.1178	0.12

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	-0.00001	0.000007	-1.98	0.00051595	0.43
Age 2	-0.01086	0.003031	-3.65	0.30829294	0.31
Age 3	-0.05978	0.005276	-6.52	0.97722624	0.17
Age 4	-0.07070	0.003726	-7.07	1.07069979	0.11
Age 5	-0.07070	0.003726	-7.07	1.07069979	0.11
Age 6	-0.07070	0.003726	-7.07	1.07069979	0.11

Bootstrap Output Variable: PR mean

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0035	0.0034	0.0006	0.18
Age 2	0.1758	0.1716	0.0200	0.11
Age 3	0.7320	0.7119	0.0478	0.07
Age 4	0.9792	0.9534	0.0430	0.04
Age 5	1.0000	0.9738	0.0452	0.05
Age 6	1.0000	0.9738	0.0452	0.05

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	-0.00006	0.0000196	-1.83	0.0035515	0.17
Age 2	-0.00417	0.0006332	-2.38	0.1799341	0.11
Age 3	-0.02013	0.0015113	-2.75	0.7521478	0.06
Age 4	-0.02583	0.0013596	-2.64	1.0050391	0.04
Age 5	-0.02617	0.0014289	-2.62	1.0261728	0.04
Age 6	-0.02617	0.0014289	-2.62	1.0261728	0.04

Bootstrap Output Variable: B mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
3234.9509	3318.3010	489.5410	0.15

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
83.3501	15.4806	2.58	3151.6007	0.16

Bootstrap Output Variable: SSB f mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
815.4096	841.3635	141.7657	0.17

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
25.954	4.483	3.18	789.456	0.18

Bootstrap Output Variable: SSB spawn t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
1697.2510	1732.5992	288.9024	0.17

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
35.35	9.14	2.08	1661.90	0.17

Cape Cod Yellowtail Flounder - biomass and yield in k mt units

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FIT Mode

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.65)

Author: Michael H. Prager
National Marine Fisheries Service
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Tiburon, California 94920 USA

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	35	Number of bootstrap trials:	0
Number of data series:	4	Lower bound on MSY:	1.000E+00
Objective function computed:	in EFFORT	Upper bound on MSY:	3.000E+01
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	1.000E-01
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	1.000E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	1964285
Maximum F allowed in fitting:	5.000	Monte Carlo search trials:	50000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

	1	2	3	4
1 Std. Effort (k df)	1.000 15			
2 NMFS Fall SV	0.000 0	1.000 19		
3 MA Spr SV (lagged)	0.000 1	0.675 19	1.000 21	
4 Mass Fall Survey	0.000 0	0.368 19	0.549 20	1.000 20

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	2.901E-02	1	N/A	1.000E+01	N/A	
Loss(1) Std. Effort (k df)	1.190E+00	15	9.151E-02	1.000E+00	2.021E+00	0.306
Loss(2) NMFS Fall SV	7.210E+00	19	4.241E-01	1.000E+00	4.361E-01	0.128
Loss(3) MA Spr SV (lagged)	3.042E+00	21	1.601E-01	1.000E+00	1.155E+00	0.115
Loss(4) Mass Fall Survey	5.486E+00	20	3.048E-01	1.000E+00	6.069E-01	0.127

TOTAL OBJECTIVE FUNCTION: 1.69559334E+01

NOTE: B1-ratio constraint term contributing to loss. Sensitivity analysis advised.

Number of restarts required for convergence:	2
Est. B-ratio coverage index (0 worst, 2 best):	1.6174
Est. B-ratio nearness index (0 worst, 1 best):	1.0000

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1963	2.111E+00	2.000E+00	1	1
MSY	Maximum sustainable yield	2.405E+00	2.400E+00	1	1
r	Intrinsic rate of increase	3.626E-01	3.400E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Std. Effort (k df)	1.061E-01	1.000E-01	1	1
q(2)	NMFS Fall SV	4.423E-01	5.000E-01	1	1
q(3)	MA Spr SV (lagged)	9.055E-01	1.000E+00	1	1
q(4)	Mass Fall Survey	3.612E-01	4.000E-01	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	2.405E+00	Kr/4	
K	Maximum stock biomass	2.652E+01		
Bmsy	Stock biomass at MSY	1.326E+01	K/2	
Fmsy	Fishing mortality at MSY	1.813E-01	r/2	
F(0.1)	Management benchmark	1.632E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	2.380E+00	0.99*MSY	
B-ratio	Ratio of B(1998) to Bmsy	7.234E-01		
F-ratio	Ratio of F(1997) to Fmsy	7.812E-01		
Y-ratio	Proportion of MSY avail in 1998	9.235E-01	2*Br-Br^2	Ye(1998) = 2.221E+00
....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	Std. Effort (k df)	1.709E+00	r/2q(1)	f(0.1) = 1.539E+00

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1963	0.179	2.799E+01	2.565E+01	4.600E+00	4.600E+00	2.859E-01	9.891E-01	2.111E+00
2	1964	0.107	2.368E+01	2.297E+01	2.451E+00	2.451E+00	1.115E+00	5.886E-01	1.785E+00
3	1965	0.091	2.234E+01	2.200E+01	1.998E+00	1.998E+00	1.359E+00	5.008E-01	1.685E+00
4	1966	0.099	2.170E+01	2.138E+01	2.108E+00	2.108E+00	1.502E+00	5.437E-01	1.636E+00
5	1967	0.113	2.110E+01	2.073E+01	2.342E+00	2.342E+00	1.642E+00	6.231E-01	1.591E+00
6	1968	0.107	2.040E+01	2.018E+01	2.169E+00	2.169E+00	1.751E+00	5.929E-01	1.538E+00
7	1969	0.076	1.998E+01	2.158E+01	1.646E+00	1.646E+00	1.878E+00	4.206E-01	1.506E+00
8	1970	0.072	2.021E+01	2.194E+01	1.585E+00	1.585E+00	1.835E+00	3.984E-01	1.524E+00
9	1971	0.117	2.046E+01	2.014E+01	2.362E+00	2.362E+00	1.757E+00	6.467E-01	1.543E+00
10	1972	0.077	1.986E+01	2.149E+01	1.664E+00	1.664E+00	1.904E+00	4.271E-01	1.497E+00
11	1973	0.083	2.010E+01	2.014E+01	1.662E+00	1.662E+00	1.757E+00	4.550E-01	1.515E+00
12	1974	0.113	2.019E+01	1.995E+01	2.254E+00	2.254E+00	1.793E+00	6.232E-01	1.522E+00
13	1975	0.103	1.973E+01	1.964E+01	2.027E+00	2.027E+00	1.849E+00	5.693E-01	1.488E+00
14	1976	0.198	1.955E+01	1.866E+01	3.687E+00	3.687E+00	2.003E+00	1.090E+00	1.474E+00
15	1977	0.202	1.787E+01	1.720E+01	3.469E+00	3.469E+00	2.191E+00	1.113E+00	1.347E+00
16	1978	0.261	1.659E+01	1.566E+01	4.083E+00	4.083E+00	2.322E+00	1.438E+00	1.251E+00
17	1979	0.342	1.483E+01	1.363E+01	4.663E+00	4.663E+00	2.397E+00	1.887E+00	1.118E+00
18	1980	0.532	1.256E+01	1.073E+01	5.706E+00	5.706E+00	2.304E+00	2.933E+00	9.473E-01
19	1981	0.453	9.160E+00	8.271E+00	3.749E+00	3.749E+00	2.061E+00	2.500E+00	6.907E-01
20	1982	0.543	7.472E+00	6.535E+00	3.550E+00	3.550E+00	1.782E+00	2.996E+00	5.634E-01
21	1983	0.406	5.704E+00	5.379E+00	2.184E+00	2.184E+00	1.554E+00	2.239E+00	4.301E-01
22	1984	0.217	5.074E+00	5.269E+00	1.141E+00	1.141E+00	1.531E+00	1.194E+00	3.826E-01
23	1985	0.181	5.464E+00	5.758E+00	1.044E+00	1.044E+00	1.634E+00	9.999E-01	4.120E-01
24	1986	0.220	6.055E+00	6.234E+00	1.372E+00	1.372E+00	1.729E+00	1.214E+00	4.566E-01
25	1987	0.203	6.412E+00	6.642E+00	1.346E+00	1.346E+00	1.805E+00	1.118E+00	4.835E-01
26	1988	0.192	6.871E+00	7.133E+00	1.368E+00	1.368E+00	1.891E+00	1.058E+00	5.181E-01
27	1989	0.168	7.393E+00	7.738E+00	1.299E+00	1.299E+00	1.987E+00	9.258E-01	5.575E-01
28	1990	0.602	8.081E+00	6.856E+00	4.125E+00	4.125E+00	1.838E+00	3.318E+00	6.094E-01
29	1991	0.332	5.794E+00	5.660E+00	1.877E+00	1.877E+00	1.614E+00	1.829E+00	4.369E-01
30	1992	0.262	5.531E+00	5.600E+00	1.465E+00	1.465E+00	1.602E+00	1.443E+00	4.171E-01
31	1993	0.117	5.668E+00	6.160E+00	7.180E-01	7.180E-01	1.714E+00	6.429E-01	4.274E-01
32	1994	0.167	6.664E+00	7.014E+00	1.170E+00	1.170E+00	1.870E+00	9.200E-01	5.025E-01
33	1995	0.189	7.364E+00	7.631E+00	1.440E+00	1.440E+00	1.971E+00	1.041E+00	5.553E-01
34	1996	0.150	7.895E+00	8.307E+00	1.246E+00	1.246E+00	2.068E+00	8.273E-01	5.953E-01
35	1997	0.142	8.717E+00	9.157E+00	1.297E+00	1.297E+00	2.173E+00	7.812E-01	6.573E-01
36	1998		9.593E+00						7.234E-01

Cape Cod Yellowtail Flounder - biomass and yield in k mt units

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Std. Effort (k df)

Data type CE: Effort-catch series Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed yield	Model yield	Resid in log effort	Resid in yield
1	1963	1.000E+00	1.691E+00	0.1793	4.600E+00	4.600E+00	-0.52526	0.000E+00
2	1964	7.100E-01	1.006E+00	0.1067	2.451E+00	2.451E+00	-0.34859	0.000E+00
3	1965	7.000E-01	8.561E-01	0.0908	1.998E+00	1.998E+00	-0.20129	0.000E+00
4	1966	1.370E+00	9.294E-01	0.0986	2.108E+00	2.108E+00	0.38798	0.000E+00
5	1967	1.690E+00	1.065E+00	0.1130	2.342E+00	2.342E+00	0.46152	0.000E+00
6	1968	9.900E-01	1.014E+00	0.1075	2.169E+00	2.169E+00	-0.02348	0.000E+00
7	1969	6.800E-01	7.190E-01	0.0763	1.646E+00	1.646E+00	-0.05583	0.000E+00
8	1970	5.300E-01	6.810E-01	0.0722	1.585E+00	1.585E+00	-0.25068	0.000E+00
9	1971	7.900E-01	1.106E+00	0.1173	2.362E+00	2.362E+00	-0.33609	0.000E+00
10	1972	6.700E-01	7.301E-01	0.0774	1.664E+00	1.664E+00	-0.08593	0.000E+00
11	1973	8.900E-01	7.778E-01	0.0825	1.662E+00	1.662E+00	0.13470	0.000E+00
12	1974	1.210E+00	1.065E+00	0.1130	2.254E+00	2.254E+00	0.12736	0.000E+00
13	1975	1.250E+00	9.732E-01	0.1032	2.027E+00	2.027E+00	0.25026	0.000E+00
14	1976	2.310E+00	1.863E+00	0.1976	3.687E+00	3.687E+00	0.21516	0.000E+00
15	1977	2.420E+00	1.902E+00	0.2017	3.469E+00	3.469E+00	0.24083	0.000E+00
16	1978	*	2.458E+00	0.2607	4.083E+00	4.083E+00	0.00000	0.000E+00
17	1979	*	3.226E+00	0.3421	4.663E+00	4.663E+00	0.00000	0.000E+00
18	1980	*	5.014E+00	0.5318	5.706E+00	5.706E+00	0.00000	0.000E+00
19	1981	*	4.273E+00	0.4533	3.749E+00	3.749E+00	0.00000	0.000E+00
20	1982	*	5.122E+00	0.5433	3.550E+00	3.550E+00	0.00000	0.000E+00
21	1983	*	3.828E+00	0.4060	2.184E+00	2.184E+00	0.00000	0.000E+00
22	1984	*	2.042E+00	0.2165	1.141E+00	1.141E+00	0.00000	0.000E+00
23	1985	*	1.709E+00	0.1813	1.044E+00	1.044E+00	0.00000	0.000E+00
24	1986	*	2.075E+00	0.2201	1.372E+00	1.372E+00	0.00000	0.000E+00
25	1987	*	1.911E+00	0.2026	1.346E+00	1.346E+00	0.00000	0.000E+00
26	1988	*	1.808E+00	0.1918	1.368E+00	1.368E+00	0.00000	0.000E+00
27	1989	*	1.583E+00	0.1679	1.299E+00	1.299E+00	0.00000	0.000E+00
28	1990	*	5.672E+00	0.6016	4.125E+00	4.125E+00	0.00000	0.000E+00
29	1991	*	3.127E+00	0.3316	1.877E+00	1.877E+00	0.00000	0.000E+00
30	1992	*	2.466E+00	0.2616	1.465E+00	1.465E+00	0.00000	0.000E+00
31	1993	*	1.099E+00	0.1166	7.180E-01	7.180E-01	0.00000	0.000E+00
32	1994	*	1.573E+00	0.1668	1.170E+00	1.170E+00	0.00000	0.000E+00
33	1995	*	1.779E+00	0.1887	1.440E+00	1.440E+00	0.00000	0.000E+00
34	1996	*	1.414E+00	0.1500	1.246E+00	1.246E+00	0.00000	0.000E+00
35	1997	*	1.335E+00	0.1416	1.297E+00	1.297E+00	0.00000	0.000E+00

* Asterisk indicates missing value(s).

Cape Cod Yellowtail Flounder - biomass and yield in k mt units

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                   -1        -0.75     -0.5      -0.25     0         0.25      0.5       0.75      1
                   |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1963    -0.5253                        =====================|
1964    -0.3486                               ==============|
1965    -0.2013                                     ========|
1966     0.3880                                             |================
1967     0.4615                                             |==================
1968    -0.0235                                            =|
1969    -0.0558                                           ==|
1970    -0.2507                                   ==========|
1971    -0.3361                                ============|
1972    -0.0859                                          ===|
1973     0.1347                                             |=====
1974     0.1274                                             |=====
1975     0.2503                                             |==========
1976     0.2152                                             |=========
1977     0.2408                                             |==========
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) NMFS Fall SV

Data type I2: End-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	1.047E+01	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	9.881E+00	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	9.599E+00	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	9.331E+00	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	9.021E+00	0.00000	0.0
6	1968	0.000E+00	0.000E+00	0.0	*	8.836E+00	0.00000	0.0
7	1969	0.000E+00	0.000E+00	0.0	*	8.939E+00	0.00000	0.0
8	1970	0.000E+00	0.000E+00	0.0	*	9.050E+00	0.00000	0.0
9	1971	0.000E+00	0.000E+00	0.0	*	8.782E+00	0.00000	0.0
10	1972	0.000E+00	0.000E+00	0.0	*	8.888E+00	0.00000	0.0
11	1973	0.000E+00	0.000E+00	0.0	*	8.930E+00	0.00000	0.0
12	1974	0.000E+00	0.000E+00	0.0	*	8.726E+00	0.00000	0.0
13	1975	0.000E+00	0.000E+00	0.0	*	8.647E+00	0.00000	0.0
14	1976	0.000E+00	0.000E+00	0.0	*	7.902E+00	0.00000	0.0
15	1977	0.000E+00	0.000E+00	0.0	*	7.337E+00	0.00000	0.0
16	1978	0.000E+00	0.000E+00	0.0	*	6.558E+00	0.00000	0.0
17	1979	1.000E+00	1.000E+00	0.0	5.342E+00	5.556E+00	-0.03931	-2.142E-01
18	1980	1.000E+00	1.000E+00	0.0	1.352E+01	4.051E+00	1.20519	9.470E+00
19	1981	1.000E+00	1.000E+00	0.0	4.106E+00	3.305E+00	0.21713	8.014E-01
20	1982	1.000E+00	1.000E+00	0.0	4.317E+00	2.523E+00	0.53721	1.794E+00
21	1983	1.000E+00	1.000E+00	0.0	4.910E-01	2.244E+00	-1.51971	-1.753E+00
22	1984	1.000E+00	1.000E+00	0.0	2.787E+00	2.417E+00	0.14252	3.702E-01
23	1985	1.000E+00	1.000E+00	0.0	3.252E+00	2.678E+00	0.19424	5.741E-01
24	1986	1.000E+00	1.000E+00	0.0	1.984E+00	2.836E+00	-0.35722	-8.518E-01
25	1987	1.000E+00	1.000E+00	0.0	1.118E+00	3.039E+00	-0.99996	-1.921E+00
26	1988	1.000E+00	1.000E+00	0.0	2.292E+00	3.270E+00	-0.35539	-9.781E-01
27	1989	1.000E+00	1.000E+00	0.0	4.704E+00	3.574E+00	0.27464	1.130E+00
28	1990	1.000E+00	1.000E+00	0.0	4.763E+00	2.563E+00	0.61986	2.200E+00
29	1991	1.000E+00	1.000E+00	0.0	2.336E+00	2.446E+00	-0.04618	-1.104E-01
30	1992	1.000E+00	1.000E+00	0.0	3.811E+00	2.507E+00	0.41882	1.304E+00
31	1993	1.000E+00	1.000E+00	0.0	2.147E+00	2.947E+00	-0.31684	-8.004E-01
32	1994	1.000E+00	1.000E+00	0.0	5.382E+00	3.257E+00	0.50223	2.125E+00
33	1995	1.000E+00	1.000E+00	0.0	1.494E+00	3.492E+00	-0.84896	-1.998E+00
34	1996	1.000E+00	1.000E+00	0.0	5.119E+00	3.855E+00	0.28349	1.264E+00
35	1997	1.000E+00	1.000E+00	0.0	4.631E+00	4.243E+00	0.08752	3.881E-01

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2

```
                  -2       -1.5        -1      -0.5         0        0.5         1        1.5         2
                   |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual   ---------------------------------------------------------------------------------
1963     0.0000                                           |
1964     0.0000                                           |
1965     0.0000                                           |
1966     0.0000                                           |
1967     0.0000                                           |
1968     0.0000                                           |
1969     0.0000                                           |
1970     0.0000                                           |
1971     0.0000                                           |
1972     0.0000                                           |
1973     0.0000                                           |
1974     0.0000                                           |
1975     0.0000                                           |
1976     0.0000                                           |
1977     0.0000                                           |
1978     0.0000                                           |
1979    -0.0393                                          =|
1980     1.2052                                           |========================
1981     0.2171                                           |====
1982     0.5372                                           |===========
1983    -1.5197             ==============================|
1984     0.1425                                           |===
1985     0.1942                                           |====
1986    -0.3572                                    =======|
1987    -1.0000                        ====================|
1988    -0.3554                                    =======|
1989     0.2746                                           |=====
1990     0.6199                                           |============
1991    -0.0462                                          =|
1992     0.4188                                           |========
1993    -0.3168                                     ======|
1994     0.5022                                           |==========
1995    -0.8490                         =================|
1996     0.2835                                           |======
1997     0.0875                                           |==
                  ---------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) MA Spr SV (lagged)

Data type I2: End-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	2.144E+01	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	2.023E+01	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	1.965E+01	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	1.910E+01	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	1.847E+01	0.00000	0.0
6	1968	0.000E+00	0.000E+00	0.0	*	1.809E+01	0.00000	0.0
7	1969	0.000E+00	0.000E+00	0.0	*	1.830E+01	0.00000	0.0
8	1970	0.000E+00	0.000E+00	0.0	*	1.853E+01	0.00000	0.0
9	1971	0.000E+00	0.000E+00	0.0	*	1.798E+01	0.00000	0.0
10	1972	0.000E+00	0.000E+00	0.0	*	1.820E+01	0.00000	0.0
11	1973	0.000E+00	0.000E+00	0.0	*	1.828E+01	0.00000	0.0
12	1974	0.000E+00	0.000E+00	0.0	*	1.786E+01	0.00000	0.0
13	1975	0.000E+00	0.000E+00	0.0	*	1.770E+01	0.00000	0.0
14	1976	0.000E+00	0.000E+00	0.0	*	1.618E+01	0.00000	0.0
15	1977	1.000E+00	1.000E+00	0.0	1.016E+01	1.502E+01	-0.39103	-4.862E+00
16	1978	1.000E+00	1.000E+00	0.0	1.138E+01	1.343E+01	-0.16543	-2.047E+00
17	1979	1.000E+00	1.000E+00	0.0	1.003E+01	1.138E+01	-0.12585	-1.345E+00
18	1980	1.000E+00	1.000E+00	0.0	1.635E+01	8.294E+00	0.67865	8.056E+00
19	1981	1.000E+00	1.000E+00	0.0	1.285E+01	6.766E+00	0.64149	6.084E+00
20	1982	1.000E+00	1.000E+00	0.0	9.000E+00	5.165E+00	0.55535	3.835E+00
21	1983	1.000E+00	1.000E+00	0.0	7.370E+00	4.595E+00	0.47249	2.775E+00
22	1984	1.000E+00	1.000E+00	0.0	5.210E+00	4.948E+00	0.05161	2.621E-01
23	1985	1.000E+00	1.000E+00	0.0	4.520E+00	5.482E+00	-0.19305	-9.625E-01
24	1986	1.000E+00	1.000E+00	0.0	3.670E+00	5.806E+00	-0.45867	-2.136E+00
25	1987	1.000E+00	1.000E+00	0.0	3.830E+00	6.222E+00	-0.48516	-2.392E+00
26	1988	1.000E+00	1.000E+00	0.0	4.730E+00	6.695E+00	-0.34742	-1.965E+00
27	1989	1.000E+00	1.000E+00	0.0	6.600E+00	7.318E+00	-0.10323	-7.177E-01
28	1990	1.000E+00	1.000E+00	0.0	3.320E+00	5.246E+00	-0.45758	-1.926E+00
29	1991	1.000E+00	1.000E+00	0.0	6.540E+00	5.009E+00	0.26679	1.531E+00
30	1992	1.000E+00	1.000E+00	0.0	4.600E+00	5.133E+00	-0.10955	-5.325E-01
31	1993	1.000E+00	1.000E+00	0.0	6.230E+00	6.034E+00	0.03193	1.958E-01
32	1994	1.000E+00	1.000E+00	0.0	1.038E+01	6.668E+00	0.44252	3.712E+00
33	1995	1.000E+00	1.000E+00	0.0	9.250E+00	7.149E+00	0.25768	2.101E+00
34	1996	1.000E+00	1.000E+00	0.0	7.550E+00	7.893E+00	-0.04445	-3.432E-01
35	1997	1.000E+00	1.000E+00	0.0	5.180E+00	8.687E+00	-0.51698	-3.507E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 3

```
                -1       -0.75     -0.5      -0.25      0        0.25      0.5       0.75       1
                |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year  Residual  ---------------------------------------------------------------------------------
1963    0.0000                                          |
1964    0.0000                                          |
1965    0.0000                                          |
1966    0.0000                                          |
1967    0.0000                                          |
1968    0.0000                                          |
1969    0.0000                                          |
1970    0.0000                                          |
1971    0.0000                                          |
1972    0.0000                                          |
1973    0.0000                                          |
1974    0.0000                                          |
1975    0.0000                                          |
1976    0.0000                                          |
1977   -0.3910                          ================|
1978   -0.1654                                   =======|
1979   -0.1259                                     =====|
1980    0.6786                                          |===========================
1981    0.6415                                          |==========================
1982    0.5553                                          |======================
1983    0.4725                                          |===================
1984    0.0516                                          |==
1985   -0.1930                                  ========|
1986   -0.4587                        ==================|
1987   -0.4852                       ===================|
1988   -0.3474                            ==============|
1989   -0.1032                                      ====|
1990   -0.4576                        ==================|
1991    0.2668                                          |===========
1992   -0.1095                                      ====|
1993    0.0319                                          |=
1994    0.4425                                          |==================
1995    0.2577                                          |==========
1996   -0.0444                                        ==|
1997   -0.5170                     =====================|
                ---------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 4 (NON-BOOTSTRAPPED) Mass Fall Survey

Data type I1: Year-average biomass index Series weight: 1.000

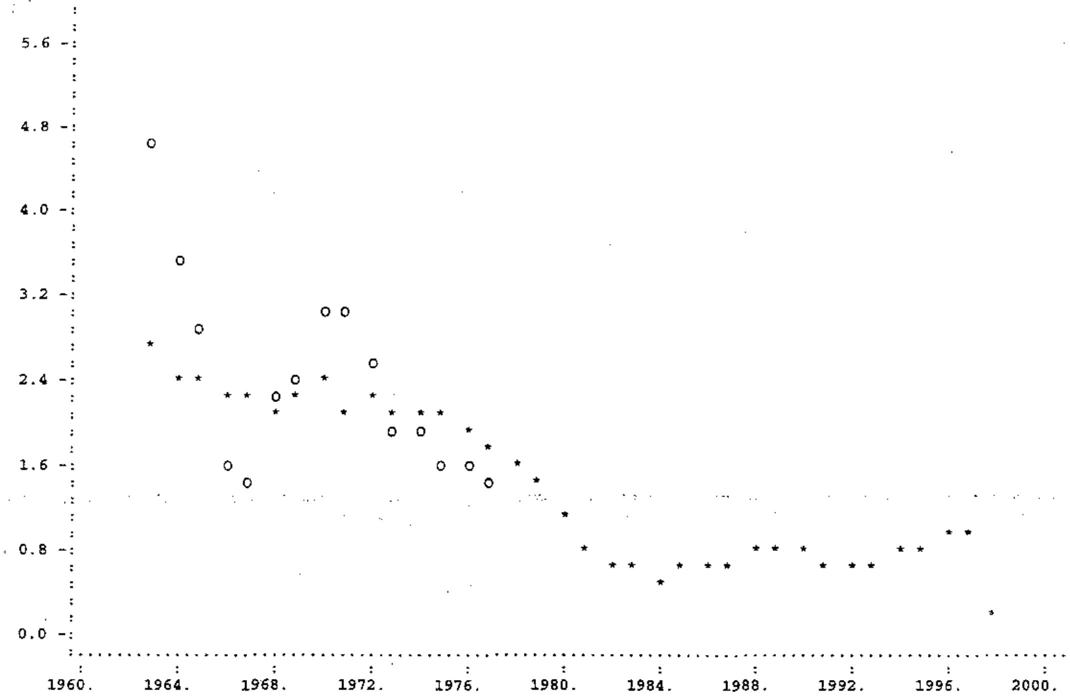
Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	9.263E+00	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	8.295E+00	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	7.947E+00	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	7.723E+00	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	7.486E+00	0.00000	0.0
6	1968	0.000E+00	0.000E+00	0.0	*	7.287E+00	0.00000	0.0
7	1969	0.000E+00	0.000E+00	0.0	*	7.795E+00	0.00000	0.0
8	1970	0.000E+00	0.000E+00	0.0	*	7.925E+00	0.00000	0.0
9	1971	0.000E+00	0.000E+00	0.0	*	7.275E+00	0.00000	0.0
10	1972	0.000E+00	0.000E+00	0.0	*	7.761E+00	0.00000	0.0
11	1973	0.000E+00	0.000E+00	0.0	*	7.276E+00	0.00000	0.0
12	1974	0.000E+00	0.000E+00	0.0	*	7.205E+00	0.00000	0.0
13	1975	0.000E+00	0.000E+00	0.0	*	7.092E+00	0.00000	0.0
14	1976	0.000E+00	0.000E+00	0.0	*	6.740E+00	0.00000	0.0
15	1977	0.000E+00	0.000E+00	0.0	*	6.210E+00	0.00000	0.0
16	1978	1.000E+00	1.000E+00	0.0	2.802E+00	5.656E+00	-0.70241	-2.854E+00
17	1979	1.000E+00	1.000E+00	0.0	7.326E+00	4.922E+00	0.39768	2.404E+00
18	1980	1.000E+00	1.000E+00	0.0	5.901E+00	3.875E+00	0.42049	2.026E+00
19	1981	1.000E+00	1.000E+00	0.0	2.755E+00	2.987E+00	-0.08093	-2.322E-01
20	1982	1.000E+00	1.000E+00	0.0	4.204E+00	2.360E+00	0.57732	1.844E+00
21	1983	1.000E+00	1.000E+00	0.0	3.393E+00	1.943E+00	0.55763	1.450E+00
22	1984	1.000E+00	1.000E+00	0.0	1.177E+00	1.903E+00	-0.48049	-7.260E-01
23	1985	1.000E+00	1.000E+00	0.0	1.171E+00	2.080E+00	-0.57435	-9.087E-01
24	1986	1.000E+00	1.000E+00	0.0	1.361E+00	2.251E+00	-0.50337	-8.905E-01
25	1987	1.000E+00	1.000E+00	0.0	1.086E+00	2.399E+00	-0.79249	-1.313E+00
26	1988	1.000E+00	1.000E+00	0.0	3.705E+00	2.576E+00	0.36335	1.129E+00
27	1989	1.000E+00	1.000E+00	0.0	1.521E+00	2.795E+00	-0.60840	-1.274E+00
28	1990	1.000E+00	1.000E+00	0.0	4.162E+00	2.476E+00	0.51925	1.686E+00
29	1991	1.000E+00	1.000E+00	0.0	3.229E+00	2.044E+00	0.45721	1.185E+00
30	1992	1.000E+00	1.000E+00	0.0	1.998E+00	2.023E+00	-0.01224	-2.460E-02
31	1993	1.000E+00	1.000E+00	0.0	3.986E+00	2.225E+00	0.58321	1.761E+00
32	1994	1.000E+00	1.000E+00	0.0	3.269E+00	2.533E+00	0.25504	7.359E-01
33	1995	1.000E+00	1.000E+00	0.0	5.750E+00	2.756E+00	0.73542	2.994E+00
34	1996	1.000E+00	1.000E+00	0.0	1.557E+00	3.000E+00	-0.65589	-1.443E+00
35	1997	1.000E+00	1.000E+00	0.0	2.098E+00	3.307E+00	-0.45512	-1.209E+00

* Asterisk indicates missing value(s).

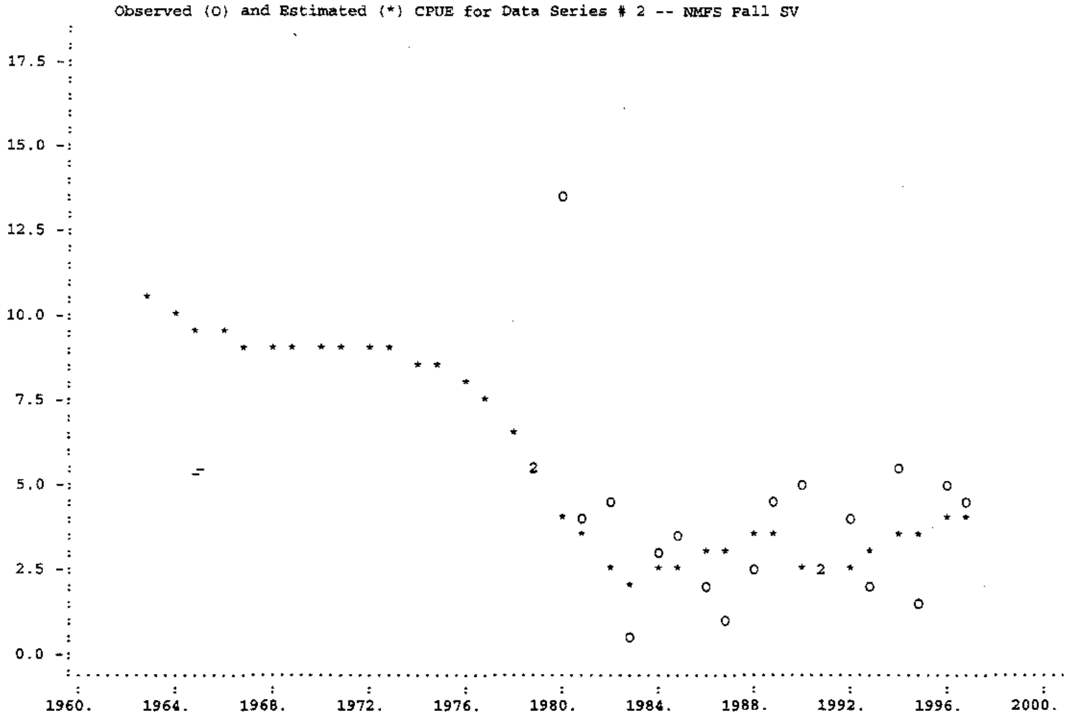
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 4

```
                -1       -0.75     -0.5      -0.25      0        0.25      0.5       0.75      1
                |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year  Residual  ---------------------------------------------------------------------------------
1963    0.0000                                          |
1964    0.0000                                          |
1965    0.0000                                          |
1966    0.0000                                          |
1967    0.0000                                          |
1968    0.0000                                          |
1969    0.0000                                          |
1970    0.0000                                          |
1971    0.0000                                          |
1972    0.0000                                          |
1973    0.0000                                          |
1974    0.0000                                          |
1975    0.0000                                          |
1976    0.0000                                          |
1977    0.0000                                          |
1978   -0.7024              ============================|
1979    0.3977                                          |================
1980    0.4205                                          |=================
1981   -0.0809                                       ===|
1982    0.5773                                          |=======================
1983    0.5576                                          |======================
1984   -0.4805                       ===================|
1985   -0.5743                   =======================|
1986   -0.5034                      ====================|
1987   -0.7925          ================================|
1988    0.3634                                          |===============
1989   -0.6084                  ========================|
1990    0.5193                                          |=====================
1991    0.4572                                          |==================
1992   -0.0122                                          |
1993    0.5832                                          |=======================
1994    0.2550                                          |==========
1995    0.7354                                          |=============================
1996   -0.6559                ==========================|
1997   -0.4551                      ==================|
                ---------------------------------------------------------------------------------
```

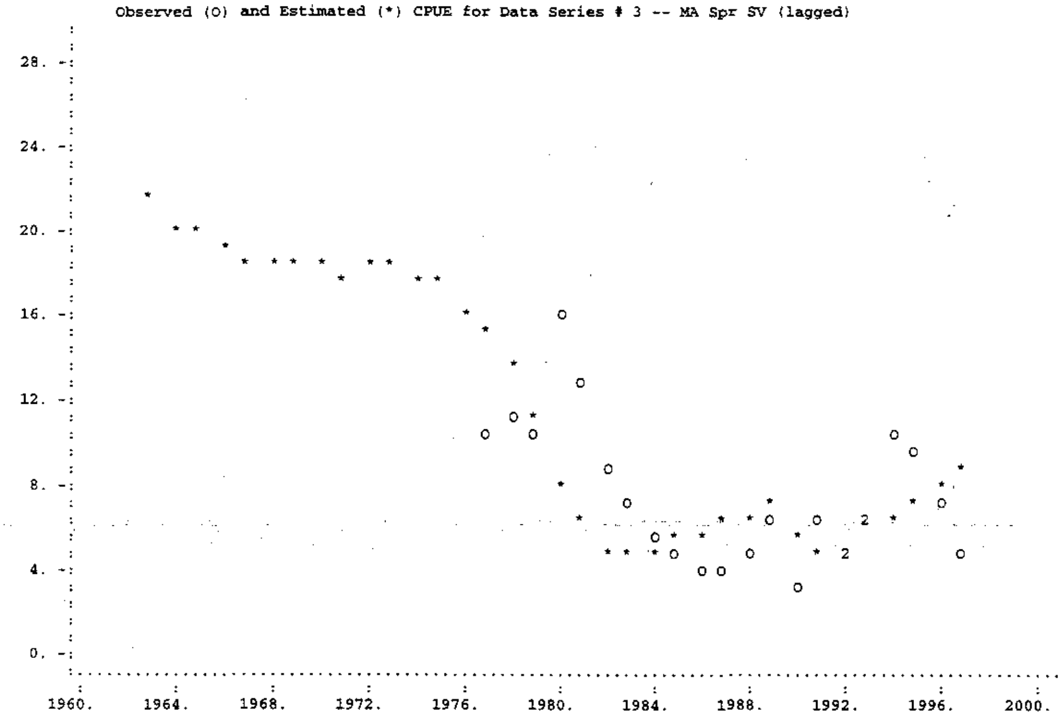
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Std. Effort (k df)



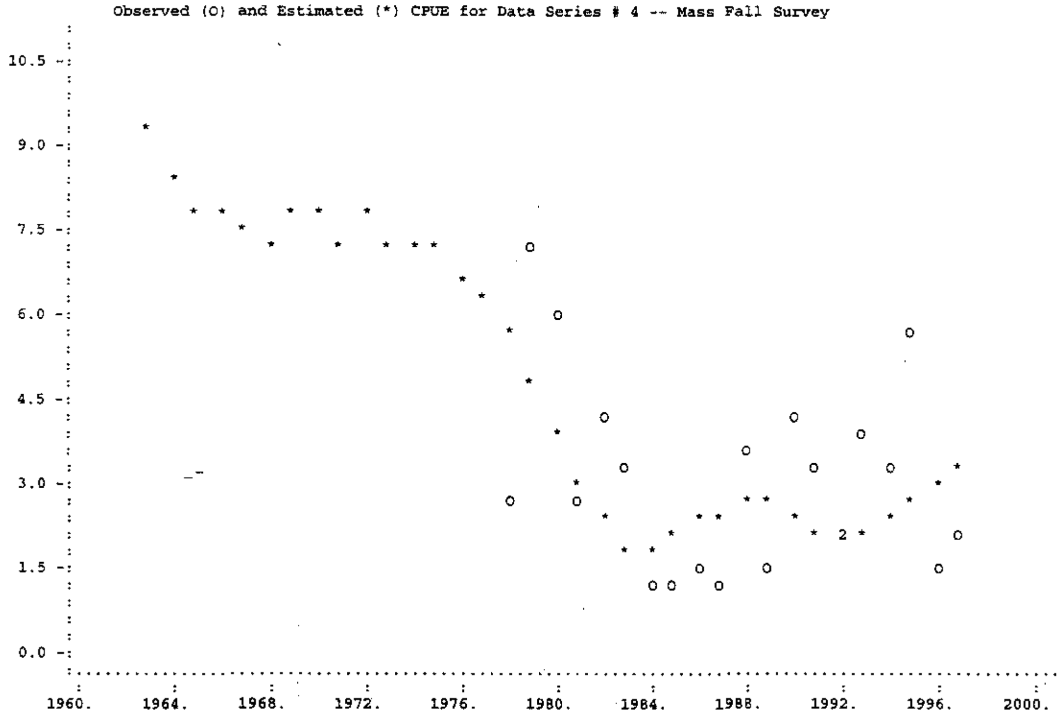
Observed (O) and Estimated (*) CPUE for Data Series # 2 -- NMFS Fall SV

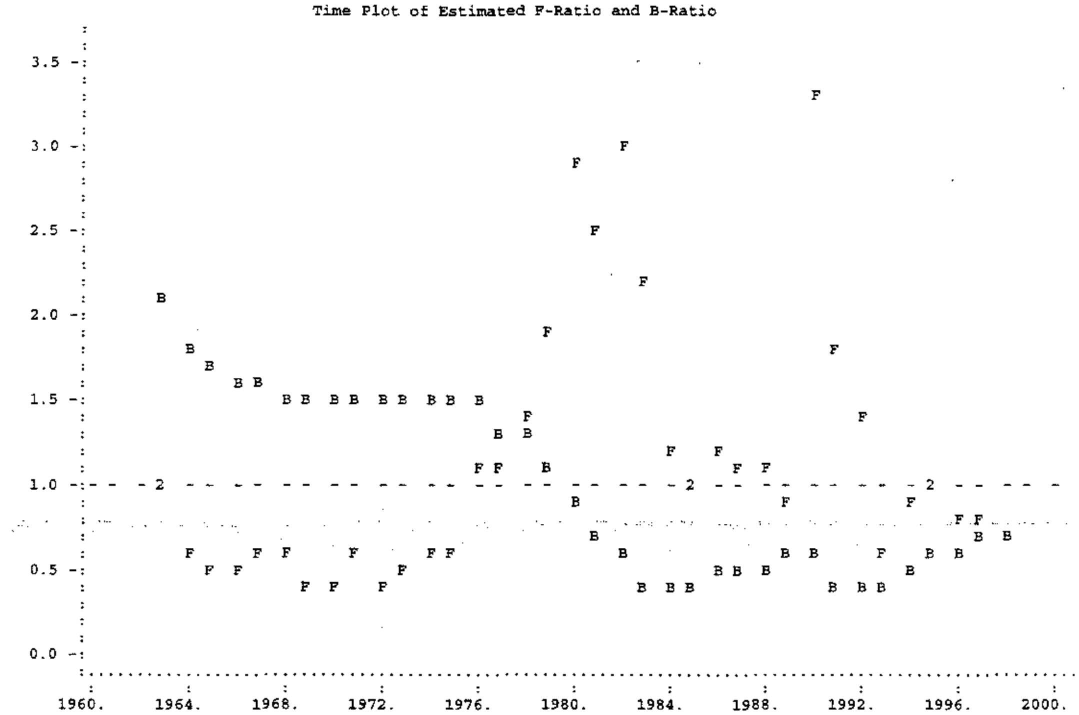


Observed (O) and Estimated (*) CPUE for Data Series # 3 -- MA Spr SV (lagged)



Observed (O) and Estimated (*) CPUE for Data Series # 4 -- Mass Fall Survey




Time Plot of Estimated F-Ratio and B-Ratio
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1960.
1964.
1968.
1972.
1976.
1980.
1984.
1988.
1992.
1996.
2000.

Cape Cod Yellowtail Flounder - biomass and yield in k mt units Page 14

RESULTS OF BOOTSTRAPPED ANALYSIS

Param name	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
B1ratio	2.218E+00	2.111E+00	-4.86%	2.111E+00	2.248E+00	2.166E+00	2.248E+00	8.202E-02	0.037
K	2.620E+01	2.652E+01	1.23%	2.144E+01	3.454E+01	2.337E+01	2.991E+01	6.540E+00	0.250
r	3.602E-01	3.626E-01	0.66%	2.485E-01	4.836E-01	2.959E-01	4.242E-01	1.283E-01	0.356
q(1)	9.992E-02	1.061E-01	6.15%	7.456E-02	1.378E-01	8.652E-02	1.180E-01	3.153E-02	0.315
q(2)	4.394E-01	4.423E-01	0.66%	2.823E-01	6.289E-01	3.439E-01	5.315E-01	1.876E-01	0.427
q(3)	8.970E-01	9.055E-01	0.96%	5.733E-01	1.267E+00	7.289E-01	1.070E+00	3.409E-01	0.380
q(4)	3.611E-01	3.612E-01	0.02%	2.446E-01	5.144E-01	2.917E-01	4.393E-01	1.476E-01	0.409
MSY	2.349E+00	2.405E+00	2.38%	2.072E+00	2.622E+00	2.191E+00	2.489E+00	2.976E-01	0.127
Ye(1998)	2.200E+00	2.221E+00	0.91%	1.767E+00	2.519E+00	2.014E+00	2.360E+00	3.461E-01	0.157
Bmsy	1.310E+01	1.326E+01	1.23%	1.072E+01	1.727E+01	1.168E+01	1.495E+01	3.270E+00	0.250
Fmsy	1.801E-01	1.813E-01	0.66%	1.242E-01	2.418E-01	1.479E-01	2.121E-01	6.414E-02	0.356
fmsy(1)	1.803E+00	1.709E+00	-5.20%	1.423E+00	2.257E+00	1.615E+00	2.026E+00	4.111E-01	0.228
fmsy(2)	4.079E-01	4.100E-01	0.51%	3.389E-01	4.954E-01	3.708E-01	4.515E-01	8.067E-02	0.198
fmsy(3)	2.038E-01	2.002E-01	-1.77%	1.755E-01	2.499E-01	1.898E-01	2.260E-01	3.621E-02	0.178
fmsy(4)	5.053E-01	5.020E-01	-0.64%	4.267E-01	6.107E-01	4.621E-01	5.611E-01	9.906E-02	0.196
F(0.1)	1.621E-01	1.632E-01	0.60%	1.118E-01	2.176E-01	1.331E-01	1.909E-01	5.773E-02	0.356
Y(0.1)	2.325E+00	2.380E+00	2.35%	2.051E+00	2.596E+00	2.170E+00	2.464E+00	2.946E-01	0.127
B-ratio	7.300E-01	7.234E-01	-0.91%	5.587E-01	9.272E-01	6.532E-01	8.356E-01	1.824E-01	0.250
F-ratio	7.818E-01	7.812E-01	-0.08%	6.093E-01	1.055E+00	6.843E-01	8.932E-01	2.088E-01	0.267
Y-ratio	9.272E-01	9.235E-01	-0.40%	8.052E-01	9.939E-01	8.798E-01	9.730E-01	9.322E-02	0.101
f0.1(1)	1.623E+00	1.539E+00	-4.68%	1.280E+00	2.032E+00	1.453E+00	1.823E+00	3.700E-01	0.228
f0.1(2)	3.671E-01	3.690E-01	0.46%	3.050E-01	4.458E-01	3.337E-01	4.063E-01	7.261E-02	0.198
f0.1(3)	1.835E-01	1.802E-01	-1.59%	1.579E-01	2.249E-01	1.708E-01	2.034E-01	3.259E-02	0.178
f0.1(4)	4.548E-01	4.518E-01	-0.58%	3.840E-01	5.497E-01	4.159E-01	5.050E-01	8.916E-02	0.196
q2/q1	4.444E+00	4.170E+00	-6.16%	3.354E+00	6.080E+00	3.897E+00	5.269E+00	1.372E+00	0.309
q3/q1	9.126E+00	8.537E+00	-6.45%	6.730E+00	1.166E+01	7.739E+00	1.051E+01	2.770E+00	0.303
q4/q1	3.673E+00	3.405E+00	-7.28%	2.753E+00	4.748E+00	3.120E+00	4.314E+00	1.194E+00	0.325

NOTES ON BOOTSTRAPPED ESTIMATES:

- The bootstrapped results shown were computed from 500 trials.
- These results are conditional on the constraints placed upon MSY and r in the input file (ASPIC.INP).
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- The bias corrections used here are based on medians. This is an accepted statistical procedure, but may estimate nonzero bias for unbiased, skewed estimators.

Trials replaced for lack of convergence:	9
Trials replaced for MSY out-of-bounds:	0
Trials replaced for r out-of-bounds:	1
Residual-adjustment factor:	1.0502