B1. SOUTHERN NEW ENGLAND/MID-ATLANTIC (SNE/MA) WINTER FLOUNDER

TERMS OF REFERENCE

The following terms of reference were addressed for the Southern New England/Mid Atlantic (SNE/MA) stock complex of winter flounder:

1) Update the status of SNE/MA winter flounder stock through 2001 providing estimates of fully recruited fishing mortality rate, biomass weighted fishing mortality rate, stock size, mean biomass, spawning stock biomass, and recruitment as appropriate. Characterize uncertainty in SSB and fishing mortality rates.

2) Provide short-term (2003) and medium term projections (2009) of catch and biomass (mean biomass, SSB) under status quo F, and ASMFC's $F_{40\%}$ target, and NEFMC's F_{MSY}.

3) Develop research recommendations for improving the assessment of SNE/MA winter flounder.

4) Comment on and revise, where necessary, the ASMFC and the NEFMC overfishing definitions for this stock. (Note: Currently ASMFC and the NEFMC have different overfishing definitions. The ASMFC Board had recommended that the Winter Flounder Technical Committee develop a single overfishing definition for this stock).

INTRODUCTION

The current assessment of the SNE/MA stock complex of winter flounder is an update of the previous assessment completed in 1998 at SARC 28 (NEFSC 1999). The SARC 28 assessment included catch through 1997, research survey abundance indices through 1998, catch at age analyzed by Virtual Population Analysis (VPA) for 1981-1997, and biological reference points based on a production model conditioned on VPA results. The SARC 28 assessment concluded that the stock complex was fully exploited and at a medium level of biomass. Total biomass in 1997 was estimated to be 17,900 mt, spawning stock biomass was estimated to be 8,600 mt, and the fully recruited fishing mortality rate was estimated to be F = 0.31. Subsequent to the SARC 28 assessment, the status of SNE/MA winter flounder has been evaluated annually by projection methods to provide advice to the New England Fishery Management Council (NEFMC). The last such status update was provided in 2001, and projected total biomass to be 25,300 mt, spawning stock biomass to be 13,800 mt, and fully recruited F = 0.29, in 1999 (NEFSC 2001). The current assessment updates landings and discard estimates, research survey abundance indices, and assessment models through 2001-2002, as applicable.

Winter flounder (*Pleuronectes americanus*) is a demersal flatfish species commonly found in estuaries and on the continental shelf. The species is distributed between the Gulf of St. Lawrence and North Carolina, although it is not abundant south of Delaware Bay. Within the SNE/MA stock complex, winter flounder undergo migrations from estuaries, where spawning occurs in the late winter and spring, to offshore shelf areas of less than 60 fathoms. Winter flounder reach a maximum size of around 2.25 kg (5 pounds) and 65 cm, with the exception of Georges Bank where growth rate is higher and fish may reach a maximum weight up to 3.6 kg (8 pounds; Bigelow and Schroeder 1953).

Current fishery management is coordinated by the Atlantic States Marine Fisheries Commission (ASMFC) in state waters and the NEFMC in federal waters. Winter flounder fisheries in state waters have been managed by Interstate Agreement under the auspices of the ASMFC Fishery Management Plan (FMP) for Inshore Stocks of Winter Flounder since approval in May, 1992. The plan includes states from Delaware to Maine, with Delaware granted *de minimus* status (habitat regulations applicable but fishery management not required). The Plan's goal is to rebuild spawning stock abundance and achieve a fishing mortality-based management target of $F_{40\%}$ (fishing rate that preserves 40% of the maximum spawning potential of the stock) in three steps: $F_{25\%}$ in 1993-1994, $F_{30\%}$ in 1995-1998, and $F_{40\%}$ in 1999 and later years through implementation of compatible, state-specific regulations. Coastal states from New Jersey to New Hampshire have promulgated a broad suite of indirect catch and effort controls. State agencies have set or increased minimum size limits for recreationally and commercially landed flounder (10-12 inches and 12 inches, respectively); enacted limited recreational closures and bag limits; and instituted seasonal, areal, or state-wide commercial landings/gear restrictions. Minimum codend mesh regulations have been promulgated in directed winter flounder fisheries: 5 inch for NJ and NY, 5.5 inch for CT, 5 inch for RI, and 6 inch for MA.

Winter flounder in the Exclusive Economic Zone (EEZ) are managed under the Northeast Multispecies Fishery FMP developed by the NEFMC. The principle catch of winter flounder in the EEZ has recently occurred as bycatch in directed trawl fisheries for Atlantic cod, haddock, and yellowtail flounder. The management unit encompasses the multispecies finfish fishery that operates from eastern Maine through Southern New England (72°30'). At least one offshore stock, on Georges Bank, has been identified. The FMP extends authority over vessels permitted under the FMP even while fishing in state waters if federal regulations are more restrictive than the state regulations.

The Multispecies FMP was implemented in September, 1986, imposing a codend minimum mesh size of 5.5 inches (previously 5.1 inches) in the large-mesh regulatory area of Georges Bank and the offshore portion of Gulf of Maine. There were closed areas and seasons for haddock and yellowtail flounder. In the western Gulf of Maine, vessels were required to enroll in an Exempted Fisheries Program in order to target small-mesh species such as shrimp, dogfish, or whiting. The bycatch restrictions specified area and season and limited groundfish bycatch to 25% of trip and 10% for the reporting period. In southern New England waters, the groundfish bycatch on vessels fishing with small mesh was not limited in any way. There was a 11 inch minimum size for winter flounder which corresponded with the length at first capture (near zero percent retention) for 5.5 inch diamond mesh. Although the Multispecies FMP was amended four times by 1991, it was widely recognized that many stocks, including winter flounder, were being overfished.

Time-specific stock rebuilding schedules were a part of Multispecies FMP Amendment 5 which took effect in May, 1994. The rebuilding target for winter flounder, a so-called "large-mesh" species, was $F_{20\%}$ within 10 years. Along with a moratorium on issuance of additional vessel permits, the cornerstone of Amendment 5 was an effort reduction program that required "large-mesh" groundfish vessels to limit days at sea, which would be reduced each year. There was an exemption from effort reduction requirements for groundfishing vessels less than 45 feet in length and for "day boats" (from 2:1 layover day ratio requirement). Draggers retaining more than the "possession limit" of groundfish (10%, by weight, up to 500 lbs) were required to fish with either 5.5 inch diamond or square mesh in Southern New England or 6 inch throughout the net in the regulated mesh area of Georges Bank/ Gulf of Maine, respectively. The possession limit was allowed when using small mesh within the western Gulf of Maine (except Jeffreys Ledge and Stellwagon Bank) and in Southern New England. Vessels fishing in the EEZ west of 72° 30' (the longitude of Shinnecock Inlet, NY) were required to abide by 5.5 inch diamond or 6 inch square codend mesh size restrictions consistent with the Summer Flounder FMP. The minimum landed size of winter flounder increased to 12 inches, appropriate for the increased mesh size in order to reduce discards. There were many additional rules including time/area closures for sink gillnet vessels, seasonal netting closures of prime fishing areas on Georges Bank (Areas I and II), and on Nantucket Shoals to protect juvenile yellowtail flounder.

At the end of 1994, the NEFMC reacted to collapsed stocks of Atlantic cod, haddock, and yellowtail flounder on Georges Bank by recommending a number of emergency actions to tighten existing regulations reducing fishing mortality. Prime fishing areas on Georges Bank (Areas I & II), and the Nantucket Lightship Area were closed. The NEFMC also addressed expected re-direction of fishing effort into Gulf of Maine and Southern New England while, at the same time, developing Amendment 7 to the Multispecies FMP. Under Amendment 7, days-at-sea controls were extended, and any fishing by an EEZ-permitted vessel required use of not less than 6 inch diamond or square mesh in Southern New England east of 72° 30'. Framework 27 in 1999 increased the square mesh minimum size to 6.5 inches in the Gulf of Maine, Georges Bank, and Southern New England mesh areas. Amendment 9 revised the overfishing definitions for New England groundfish, and new overfishing definitions for SNE/MA winter flounder were recommended by SARC 28 (NEFSC 1999).

STOCK STRUCTURE

Although stock groups consist of an assemblage of adjacent estuarine spawning units, the ASMFC FMP originally defined three coastal management units based on similar growth, maturity and seasonal movement patterns: Gulf of Maine, Southern New England and Mid-Atlantic. Boundaries for a total of four winter flounder stock units as originally defined in the ASMFC management plan (Howell et al., 1992) were:

> Gulf of Maine: Coastal Maine, New Hampshire, and Massachusetts north of Cape Cod
>
> Southern New England: Coastal Massachusetts east and south of Cape Cod, including Nantucket Sound, Vineyard Sound, Buzzards Bay, Narragansett Bay, Block Island Sound, Rhode Island Sound, Rhode Island coastal ponds and eastern Long Island Sound to the Connecticut River, including Fishers Island Sound, NY.
>
> Mid-Atlantic: Long Island Sound west of the Connecticut River to Montauk Point, NY, including Gardiners and Peconic Bays, coastal Long Island, NY, coastal New Jersey and Delaware.
>
> Georges Bank

In the current and three previous assessments (e.g., NEFSC 1996, ASMFC 1998, NEFSC 1999) the Southern New England and Mid-Atlantic units have been combined into a single stock complex for assessment purposes. A review of tagging studies for winter flounder (Howell 1996) indicates dispersion (and hence mixing) has occurred between the previously defined Southern New England and Mid-Atlantic units. Howell (1996) noted that differences in growth and maturity among samples from Southern New England to the Mid-Atlantic may reflect discrete sampling along a gradient of changing growth and maturity rates over the range of a stock complex. Differences in growth rates within the Mid-Atlantic unit were observed to be greater than differences between Mid-Atlantic and Southern New England units (Howell, 1996). In offshore waters, the length structure of winter flounder caught in NEFSC research surveys is similar from Southern New England to New Jersey. Most commercial landings are obtained in these offshore regions (greater than 3 miles from shore).

<u>Stock Boundaries and associated Statistical Areas</u>
The Gulf of Maine stock complex extends along the coast of eastern Maine to Provincetown, MA, corresponding to NEFSC commercial fishery statistical division 51. Recreational landings from Maine, New Hampshire and northern Massachusetts (northern half of Barnstable County and north to New Hampshire border) are associated with this stock complex.

The Southern New England/Mid-Atlantic stock complex extends from the coastal shelf east of Provincetown, MA southward along the Great South Channel (separating Nantucket Shoals and Georges Bank) to the southern geographic limits of winter flounder. NEFSC commercial fishery statistical areas within this boundary are 521 and 526, and statistical divisions 53, 61, 62, and 63. The corresponding recreational areas are southern Massachusetts (the southern half of Barnstable County; Dukes, Nantucket and Bristol counties), Rhode Island, Connecticut, New York, New

Jersey, Delaware, Maryland and Virginia. NEFSC survey strata included for this stock extend from the waters of outer Cape Cod to the south and west.

The Georges Bank stock extends eastward of the Great South Channel, including statistical areas 522, 525, and 551-562.

FISHERY DATA

Landings

After reaching an historical peak of 11,977 metric tons (mt) in 1966, then declining through the 1970s, total U.S. commercial landings again peaked at 11,176 mt in 1981, and then steadily declined to a record low of 2,159 mt in 1994. Landings have increased since 1994 to 4,448 mt in 2001 (Table B1.1, Figure B1.1). During 1989-1996, an average of 43% of commercial landings were taken from statistical area 521, 13% from area 526, 13% from area 537, and 11% from area 539, with the remaining landings (20%) obtained from area 538 and divisions 61-62 (Table B1. 2). Since 1993, a larger percentage of the commercial landings has been taken from area 521. An unusually high proportion of the commercial landings for the stock complex was reported from NEFSC statistical area 521 in 1997 and 2001, with 62% in 1997 and 56% in 2001. When considered along with the distribution of survey catches, this factor indicates that the commercial fishery is focused on winter flounder along the western side of the Great South Channel. The primary gear in the fishery is the otter trawl which accounts for an average of 95% of landings since 1989. Scallop dredges account for 4%, with handlines, pound nets, fyke nets, and gill nets each accounting for about 1% of total landings.

Recreational landings reached a peak in 1984 of 5,772 mt but declined substantially thereafter (Table B1.3, Figure B1.1). Landings have been less than 1,000 mt since 1991, with the lowest estimated landings in 1998 of 290 mt. Landings in 2001 from the Southern New England/Mid Atlantic stock complex were 552 mt. The principal mode of fishing is private/rental boats, with most recreational landings occurring during January to June.

Sampling Intensity

Length samples of winter flounder are available from both the commercial and recreational landings. In the commercial fishery, annual sampling intensity varied from 63 to 264 mt landed per 100 lengths measured during 1981-1997 (Table B1.4). Overall sampling intensity was 90 mt per 100 lengths in 1998, 75 mt per 100 lengths in 1999, 59 mt per 100 lengths in 2000, and 71 mt per 100 lengths in 2001 (Table B1.5). In the recreational fishery, annual sampling intensity varied from 36 to 231 mt landed per 100 lengths measured during 1981-1997 (Table B1.6). Overall sampling intensity was 47 mt per 100 lengths in 1998, 81 mt per 100 lengths in 1999, 519 mt per 100 lengths in 2000, and 109 mt per 100 lengths in 2001 (Table B1.7).

Landed Age Compositions

Commercial fishery

In the SARC 21 assessment (NEFSC 1996), numbers at age were estimated for 1985-1993 for commercial landings, recreational landings, commercial discards, and recreational discards. Quarterly or half-year commercial age-length samples were applied to corresponding commercial market category landings at length. Unsampled unclassified landings and landings not represented in the weighout database (i.e., state canvas landings) were assumed to have the same age composition as the initial weighout commercial landings at age. Landings at lengths with no associated age data within the quarter were assigned ages based on age at length from adjacent quarters. A comparison was undertaken among age data collected from inshore regions (where the recreational fishery is prosecuted), to determine if all age data were comparable within the stock complex. Data for ages 3-5 from New Jersey, Connecticut, Massachusetts and NEFSC were compared for 1993-1994. Distributions of length at age from New Jersey and Connecticut were similar, while distributions of length at age from Massachusetts lacked smaller fish at age (Howell 1996).

In the ASMFC 1998 assessment (ASMFC 1998), the Technical Committee attempted to update the catch at age matrix for VPA for 1994-1996. Two key market categories of commercial landings were found to lack port samples: medium fish in the second half of 1995 and large fish in the first half of 1996. In addition, several market categories were poorly sampled: medium fish in the first and second half-year of 1996, and large fish in the second half of 1995. The Technical Committee concluded then that the port sampling was insufficient to characterize the length and age frequency of the commercial landings for 1995-1996, and elected to use a non-age dependent model (ASPIC) to assess the stock complex (ASMFC 1998).

In the SARC 28 assessment (NEFSC 1999), commercial fishery port samples for 1995 and 1996 were supplemented with commercial fishery sea sample length data for the second half of 1995 and 1996, to continue the catch at age series. For the second half-year of 1995, 2,979 sea sample lengths (unclassified by market category) were used in place of the available 702 port sample lengths to construct an unclassified length frequency for the second half-year of 1995 landings. For the first half-year of 1996, 55 sea sample lengths were combined with 752 port sample lengths to create an unclassified frequency of 807 lengths for the first-half year of 1996 landings. Also, archived NEFSC research survey and commercial fishery age samples were aged, allowing extension of the NEFSC survey catch at age series back to 1980 and of the fishery catch at age matrix back to 1981 (Table B1.4). Since 1997, port sampling has been adequate to develop the commercial fishery landings at age on a half-year, market category basis across all statistical areas (Tables B1.5 and B1.10).

Recreational fishery

Recreational landings at length were estimated seasonally (January-June and July-December) and geographically. Landings were divided into two geographic regions; 1) Massachusetts and Rhode Island (SNE) and 2) Connecticut and south (MA). For the 1981-1984 period, NEFSC spring age-length keys were used to age both area length frequencies. For 1985-1996, MADMF survey age-length keys were applied to MA-RI data while CTDEP age-length keys were applied to CT-south data, with the exception of 1993 landings which used a combined NJ/CT age-length key. Since 1997, NEFSC spring and fall keys have been used to age all length frequencies (Tables B1.6, B1.7, and B1.10). For the 1998-1999 recreational catch at age, sample lengths were applied to catch numbers on an annual basis for the two regions, due to low samples size. For the 2000-2001 recreational catch at age, sample lengths were applied to catch numbers on an annual basis for the regions combined, due to low sample sizes in the SNE region (Table B1.7).

Discard estimates and age compositions

Commercial fishery

In the SARC 21 assessment (NEFSC 1996), the Working Group and the SARC concluded that there were too few Fishery Observer sampled trips in which winter flounder were caught to adequately characterize the overall ratio of discards to landings in the commercial fishery. The Fishery Observer sample length frequency data, however, were judged adequate to help characterize the proportion discarded at length. In the SARC 21 assessment, commercial discards for 1985 to 1993 were estimated from length frequency data from NEFSC and the Massachusetts Division of Marine Fisheries (MADMF) bottom trawl surveys, commercial port sampling of landings at length and Fishery Observer sampling of landings and discard at length. The method follows an approach described by Mayo et al. (1992). The year was divided into half year periods. Survey length frequency data (MADMF survey in spring and NEFSC in fall) were smoothed using a three point moving average, then filtered through a mesh selection ogive (Simpson 1989) for 4.5 inch mesh (1984-1989), 5 inch mesh (1990-1992, fall 1993) or 5.5 inch mesh (spring, 1993). The 5.5 inch mesh selection curve was calculated using the 5 inch curve adjusted to an L_{50} for 5.5 inch mesh. The choice of mesh sizes was based on sizes used in the yellowtail assessment for southern New England (Rago et al. 1994) and comparison to length frequencies of commercial landings. The mesh filtering process resulted in a survey length frequency of retained winter flounder. A logistic regression was used to model the percent discarded at length from 1989-1992 sea sampling data, and the resulting percentages at length were applied to the survey numbers at length data to produce the survey-based equivalent of commercial kept and discarded winter flounder. The 1989-1992 average percentage discard at length was applied to 1985-1988. The survey numbers per tow at length "kept" were then regressed against commercial (weighout) numbers landed at length. The linear relationship was calculated for those lengths common to both length frequencies and fitted with an intercept of zero. The slope of the regression provided a conversion factor to re-scale the survey "discard" numbers per tow at length to equivalent commercial numbers at length. The resulting vector of number of fish discarded at length was multiplied by a discard mortality rate of 50% (as averaged in Howell et al., 1992) to produce the vector of fish discarded dead at length per half year. The number of dead discards at length was adjusted by the ratio of weighout landings to total commercial landings and summed across seasons and lengths (and corresponding weight at length) to produce the annual total number and weight of commercial fishery discards for 1985-1993 (Tables B1.10-11, Figure B1.1). In the SARC 28 assessment (NEFSC 1999), this same method using the 4.5 inch mesh ogive and 1989-1992 average discard percentage at length was used to estimate commercial fishery discards for 1981-1984. NEFSC spring and fall survey age-length keys were applied to convert discard length frequencies to age.

During ASMFC Winter Flounder Technical Committee meetings since 1995, the group has considered the SARC 21 survey length-mesh selection method, NEFSC Fishery Observer data (OB), and NER Vessel Trip Report (VTR) data as sources of information to use in the estimation of commercial fishery discards, with a focus on the latter two sources. The Committee examined the characteristics of both the Fishery Observer and VTR discard data (number of trip samples, frequency distributions of discards to landings ratio per trip, mean and variance of annual half-year discards to landings ratio), and concluded that the VTR mean discard to landed ratio aggregated over all trips in annual half-year season strata (January to June, July to December) provided the most reliable data from which to estimate commercial fishery discards. VTR trawl gear fishery discards to landings ratios on a half-year basis (January to June; July to December) were applied to corresponding commercial fishery landings (all gears) to estimate discards in weight (Table B1.8, Figure B1.1). The Fishery Observer length frequency samples were judged adequate to directly characterize the proportion discarded at length (Table B1.9). The sample proportion at length, converted to weight, was used to convert the discard estimate in weight to numbers at length. As in the SARC 28 assessment (NEFSC 1999), the resulting number of fish discarded at length was multiplied by a discard mortality rate of 50% (as averaged in Howell et al., 1992) to produce the number of fish discarded dead at length. For 1998, discard estimates at length were made by half-year; for 1999-2001, samples length were applied on an annual basis due to low sample sizes (Table B1.9). NEFSC Spring and Fall survey age-length keys were used to convert the discard length frequency to age (Table B1.10).

Recreational fishery
A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al. (1992). Discard losses peaked in 1984-1985 at 0.7 million fish Discards have since declined reaching a low in 1999 of 62,000 fish. In 2001, 81,000 fish were estimated to have been discarded (Table B1.3). In the SARC 21 assessment (NEFSC 1996), recreational discards for 1985-1993 were assumed to have the same average weight per fish as spring commercial discards, providing estimates of the total weight of recreational discards ranging from 15 mt in 1992 to 230 mt in 1985. Estimates of recreational discard at age for 1985-1993 were developed using state survey length and age data in a manner similar to that for the commercial discard estimates (Tables B1.10-11; see Gibson (1996) for complete description of computation of 1985-1993 recreational discard numbers at length and age).

The SARC was unable to apply the 1985-1993 method to the 1994-1997 or 1981-1984 periods for the SARC 28 assessment, due to data availability problems (NEFSC 1999). Instead, for 1994-1997, the average proportion at age in the 1991-1993 recreational discard was used to apportion the recreational fishery estimate of discard in numbers to length and age. These discards at age were assumed to have the same mean weight as the landed portion at the same ages, and so this method probably slightly overestimates the discard in weight. For 1981-1984, before implementation of the 12 inch (30 cm) minimum landing size in most states (which encompasses fish up to age 3), it was assumed that all recreational discard would be age 1 and age 2 fish, and so the discard was allocated to ages 1 and 2 in the same relative proportion as those in the landings, and assumed to have the same mean weight at age. SARC 28 (NEFSC 1999) concluded that since the magnitude of the recreational discard is relatively small compared to the total landings and commercial discards, error in estimation of recreational discard at age due to different methods over the time series and/or error is allocation among ages 1 and 2 would have a minimal effect in terms of estimation of population sizes in the VPA.

Since 1997, irregular sampling of the recreational fisheries by state fisheries agencies has indicated that the discard is usually of fish below the minimum landing size of 12 inches (30 cm). For 1998-2001, the recreational discard has been assumed to have the same length frequency as the landed portion of the catch below 12 inches, and so is still predominantly ages 1, 2, and 3 fish. As with the recreational landings, sample lengths were applied to catch numbers on an annual basis for the two regions for 1998-1999, and on an annual basis for the regions combined for 2000-2001. The recreational discard for 1998-2001 is aged using NEFSC survey spring and fall keys (Table B1.10).

Mean Weights at Age in the Catch

Mean weights at age were determined for the landings and discards in the commercial and recreational fisheries. Length frequencies (cm) for each component were converted to weight (kg) using length-weight equations derived from NEFSC survey samples:

Spring surveys: $wt = 0.00000997 * length^{3.055236}$

Fall surveys: $wt = 0.00000925 * length^{3.095188}$

The equations from the spring and fall surveys were applied to catches during the corresponding time periods. The annual mean weights at age from the commercial and recreational fisheries were used in the virtual population analysis and yield per recruit calculations.

Total Catch

Estimates of the total catch of winter flounder during 1981-2001 are presented in Table B1.11. These estimates include commercial and recreational landings and discards. The total catch during this period has varied from a high of 15,788 mt (34.6 million fish) in 1984 to a low of 3,095 mt (3.6 million fish) in 1994. The total catch has increased since 1995 to 5,102 mt (9.0 million fish) in 2001 (Table B1.11, Figure B1.1). Total catch and mean weights at age as aggregated for input to the VPA (ages 1-7+) are presented in Tables B1.12-13, and Figures B1.2-3.

RESEARCH SURVEY ABUNDANCE AND BIOMASS INDICES

State and federal surveys were evaluated as fishery independent indices of winter flounder abundance and biomass. Survey methods (with the exception of Rhode Island and the young-of-year surveys) are reviewed in the proceedings of a 1989 trawl survey workshop sponsored by the ASMFC (Azarovitz et al., 1989).

NEFSC

Mean weight and number per tow abundance indices were determined from fall (1963-2001) and spring (1968-2002) NEFSC bottom trawl surveys. Indices from the spring and fall surveys were based on tows in offshore strata 1-12, 25, and 69-76 and inshore strata 1-29 and 45-56. Spring indices prior to 1973 and fall indices prior to 1972 do not include inshore strata. In addition, offshore surveys from 1963-1966 were not conducted south of Hudson Canyon.

A new series of NEFSC winter trawl surveys was begun in February 1992 specifically to provide improved indices of abundance for flatfish, including winter flounder. A modified 36 Yankee trawl is used in the winter survey that differs from the standard trawl employed during the spring and fall surveys in that 1) long trawl sweeps (wires) are added before the trawl doors, to better herd fish to the mouth of the net, and 2) the large rollers used on the standard gear are absent, and only a chain "tickler" and small spacing "cookies" are present on the footrope. This gear is intended to better target flatfish than the gear used in the spring and fall surveys. The geographical coverage of the winter survey is more limited than the spring and fall surveys, due to time limitations and the use of the flatfish net. Inshore strata and offshore deep strata are irregularly sampled, strata east of the Great South Channel are irregularly sampled, and the Gulf of Maine has never been sampled. For winter flounder, the winter survey indices include offshore strata 1-2, 5-6, 9-10, 69, and 73; generally the offshore between 27 to 110 meters depth (15 to 60 fathoms).

Mean weight per tow and number per tow indices for the spring, fall, and winter time series are presented in Table B1.14. Indices dropped from the beginning of the time series in the 1960s to a low point in the early to mid- 1970s, then rose to a peak by the early 1980s. Following several years of high indices, abundance once again declined to below the low levels of the 1970s. NEFSC survey indices reached near- or record low levels for the time series in the late 1980s-1990s. Indices from the three survey series generally increased during 1993-1998/1999, but have since declined (Figure B1.4).

Massachusetts

The Massachusetts Division of Marine Fisheries (MADMF) spring survey from 1978-2001 was used to characterize the abundance of winter flounder. Survey areas from east and south of Cape Cod were used in the analysis (strata 11-21). The MADMF mean number per tow indices steadily declined from a high value of 53.79 in 1979 to a low of 10.66 in 1991, and then increased to 30-40 fish per tow during 1995-1998, before falling again to 16.00 in 2001. Mean weight per tow indices have varied in a similar manner over the time series, ranging from 15-20 kg/tow in the early 1980s to about 5 kg/tow during 2000-2001 (Tables B1.15-16, Figure B1.4).

The MADMF also conducts an annual juvenile winter flounder seine survey during June. The survey has been conducted since 1975 in coastal ponds and estuaries. The index has shown a general decline in production, with a high of 0.60 fish per haul in 1977 to a low of 0.07 fish per haul in 1993. The 1997 value was 0.39 fish per haul, and has since declined to 0.10 in 2002 (Table B1.17, Figure B1.5).

Rhode Island

The Rhode Island Division of Fish and Wildlife (RIDFW) conducts a number of research surveys in Narragansett Bay and Rhode Island coastal waters. A seasonal trawl survey was initiated in 1979 to monitor finfish stocks in Narragansett Bay, Rhode Island Sound and Block Island Sound. The survey employs a stratified random design and collects length, weight, and abundance information. Survey results are expressed as un-weighted catch per tow (Tables B1.15-16). Spring survey indices from 1979-2001 showed a steady decline from high values during 1979-1981 (12-13 kg per tow, 63-88 fish per tow) to a low of 0.22 kg per tow and 2.92 fish per tow in 1993. Spring indices increased to 5.83 kg per tow and 31.78 fish per tow in 1995, before declining again to 3.56 kg per tow and 12.49 fish per tow in 2001 (Figure B1. 4). Fall survey indices show simliar trends, with peak abundance and biomass during the early and mid 1980s, a decline to low values in the mid-1990s, some rebound during 1995-1997, and a recent decline (Tables B1.15-16).

A juvenile finfish beach seine survey, conducted from June to October since 1986, takes monthly samples at 17 fixed stations in Narragansett Bay. This seine survey provides an index of young-of-year winter flounder. The index shows a great deal of annual variability, although in recent years there have been consistently high levels of recruitment. The index of the 2000 year class is the highest of the time series (Table B1.17, Figure B1.5).

Connecticut

The Connecticut Department of Environmental Protection (CTDEP) Long Island Sound Trawl Survey (1984-present) uses a stratified-random design to sample Connecticut and New York waters of the Sound from Groton to Norwalk. Forty sites are sampled monthly (Apr-June, Sept-Oct) across three sediment (mud, sand , transitional) and four depth intervals (<30 ft, 30-60 ft, 60-90 ft, 90+ft). A 14 m otter trawl with 51 mm codend is towed for 30 min at 3.5 kts from a 15.2 m research vessel.

Winter flounder abundance indices are based on April and May sampling. Winter flounder are counted and measured from each tow. Since 1992 composite biomass (0.1kg) has also been recorded from each tow. Otoliths are collected for aging each spring. Aging samples are stratified by month, area (east/west) and size. Subsamples of 5-7 fish per centimeter are collected from fish up to 36 cm and all fish over 36 cm are retained for aging. Aged fish are measured and weighed in the lab and gonad condition is recorded. Gonad weights were also recorded in some years. In recent years approximately 800 flounder have been aged annually. Otoliths are generally aged whole, however larger fish and difficult bones are sectioned for reading. Indices at age are calculated as a proportion of the overall index. Age length keys are applied by area (east-west) and year where possible and any remaining unaged fish are aged using a pooled area/year key as necessary.

CTDEP indices exhibited several years of high values between 1988 and 1991, declined to a minimum in 1995, and have since increased to about one-half the time series average during 2000-2002 (Tables B1.15-16, Figure B1.4). A separate young of the year survey index shows above average recruitment during 1994-1996, and below average recruitement since. The 2001 year class index is the smallest of the time series (Table B1.17, Figure B1.5).

New York

The New York Department of Environmental Conservation (NYDEC) has conducted a small-mesh trawl survey in Peconic Bay since 1985. Winter flounder indices for ages 0 and 1 were evaluated for trends in winter flounder abundance (Tables B1.16-17, Figure B1.5). Young of the year indices have increased in recent years from 0.7 in 1985 to the 1993 index of 4.7 and 1996 index of 3.80. The 1992 index indicated the strongest recent year class with an index of 11.4. The corresponding age 1 indices also indicated strong 1992, 1993, and 1996 year classes.

New Jersey

The New Jersey Division of Fish, Game and Wildlife (NJDFW) has conducted a bottom trawl survey in near-shore ocean waters of the state since 1989, and in inshore waters in the Shark and Manasquan Rivers since 1995. Ocean survey samples are collected via a stratified random bottom trawl survey. Surveys are usually conducted in January, April, June, August, and October. Inshore samples are collected via a random station trawl survey in the main channel of the Shark and Manasquan Rivers. Sampling is conducted in March, April and May and results are pooled to calculate mean number per tow indices. Aging of NJDFW samples started in 1993. During both surveys, a sub-sample of fish are aged(fish are aged from April ocean survey only). Age/length keys are constructed, and all lengths are transformed to ages by applying all lengths to the age/length keys. Number at each age are divided by the number of tows to derive catch at age per tow.

Ocean survey indices (mean number per tow in April) tended to decline between 1989 and 1993, and have been quite variable since 1994, with a time series low in 1996, increasing to above the time series mean in 2002 (Tables B1.15-16, Figures B1.4-5). River survey indices exhibit no trend over the short time series (Table B1.16, Figure B1.5).

Delaware

The Delaware Division of Fish and Game (DEDFG) conducts monthly surveys from April to October using a 16 ft. semi-balloon otter trawl with a 0.5 inch stretch mesh liner. An index of young-of-year winter flounder was developed from stations sampled within Indian River and Rehoboth Bays. The re-transformed annual geometric means, presented in Table B1.17, indicate variable annual recruitment with a large year class in 1990. The 1994 index indicates above average recruitment (Table B1.17, Figure B1.5).

ESTIMATES OF MORTALITY AND STOCK SIZE

Natural Mortality and Maturity

Instantaneous natural mortality (M) for winter flounder was assumed to be 0.20 and constant across ages. Commercial catch at age included fish to age 14, under conditions of relatively high fishing mortality. If M = 0.25, less than 5% of the population would reach age 12 under conditions of no fishing mortality. Therefore, the SARC judged that M = 0.20, which represents a maximum age of 15, was representative of the stock complex throughout its range.

In the SARC 28 review of the SNE/MA winter flounder stock assessment (NEFSC 1999), the SARC recommended re-examination of the maturity schedule used in the yield per recruit (YPR) and virtual population analyses (VPA) to incorporate any recent research results. The SARC 28 and previous assessments used the maturity schedule as published in O'Brien et al. (1993) for winter flounder south of Cape Cod, based on data from the MADMF spring trawl survey for strata 11-21 (state waters east of Cape Cod, Nantucket sound, Vineyard Sound, and Buzzards Bay) sampled during 1985-1989 (n = 301 males, n = 398 females). Those data provided estimates of lengths and ages of 50% maturity of 29.0 cm and 3.3 yr for males, and 27.6 cm and 3.0 yr for females, and the following estimated proportions mature at age. The female schedule (with the proportion at age 2 rounded down to 0.00) was used in the SARC 28 assessment YPR and VPA (NEFSC 1999).

Age	1	2	3	4	5	6	7+
Males	0.00	0.04	0.32	0.83	0.98	1.00	1.00
Females	0.00	0.06	0.53	0.95	1.00	1.00	1.00

In response to the SARC 28 recommendation, the SARC has examined NEFSC spring trawl survey data over the 1981-2001 period in an attempt to better characterize the maturity characteristics of the SNE/MA winter flounder stock complex. Data from the NEFSC survey included those judged in the SARC 28 assessment to comprise the SNE/MA complex from Delaware Bay to Nantucket Shoals: NEFSC offshore strata 1-12, 25 and 69-76, and inshore strata 1-29, 45-46. Note that this is a much larger geographic area than that included in the MADMF survey data used in O'Brien et al. (1993). Data were analyzed in 5-6 year blocks (1981-1985, 1986-1990, 1991-1995, and 1996-2001) and for the entire time period (1981-2001), for each sex and combined sexes. Observed proportions mature at age were tabulated, and from those data maturity ogives at length and age were calculated to provide estimated proportions mature at age.

In general, the NEFSC maturity data indicated earlier maturity than the MADMF data, with L50% values ranging from 22-25 cm, rather than from 28-29 cm, and with ~50% maturity for age 2 fish, rather than ~50% maturity for age 3 fish. To investigate the apparent inconsistency between the MADMF and NEFSC maturity data, the SARC compared the two data sets over the same time periods (1985-1989, 1990-1995, 1996-2001) for common/adjacent survey strata (MADMF strata 11-12; NEFSC inshore strata 50-56 and offshore strata 10-12 and 25). Note that the MAMDF data now have about 160 observations for the 1985-1989 period that were added subsequent to the O'Brien et al. (1993) work. For comparable time periods and geographic areas, the NEFSC maturity data still consistently indicated a smaller size and younger age of 50% maturity than the MADMF data. NEFSC L50% and A50% values range from 22-26 cm and about 2.0 yr, while the MADMF values range from 27-30 cm and about 3.0 yr. The difference in values from this comparison was not as large as for the full NEFSC data set extending southward to Delaware Bay, which incorporates components of the stock complex that mature at smaller sizes and younger ages. However, the difference is still nearly a full age class difference at 50% maturity.

Given that both length and age vary in the same direction, it seems unlikely that the differences could be attributed to aging differences between the two data sets. Since the MADMF and NEFSC geographic areas in this comparison do not match exactly, the difference in maturity rates may be due to the extension of the NEFSC strata to somewhat deeper waters inhabited by fish that mature at a smaller size and younger age (inclusion of fish in offshore strata were necessary for sufficient sample size). Alternatively, for the size range of fish in question (20 to 30 cm length), it may be that immature and mature fish are segregated by area, with mature fish in that size interval tending to occupy inshore areas during the spring, with immature fish tending to remain offshore. Finally, there may be differences in the accuracy and consistency of interpretation of maturity stage between MADMF and NEFSC survey staff.

The SARC considered these data and analyses and the possible causes for the noted inconsistencies, and concluded that more detailed spatial and temporal analyses are needed before revisions to the maturity schedule can be adopted. Therefore, the maturity at age schedule used in the SARC 28 assessment (see above) has been retained for this assessment.

<u>Total Mortality from Mark and Recapture Data</u>

Total mortality in two components of the stock were evaluated using recent tag and recapture data. Northeast Utilities Co. marked and recaptured winter flounder in eastern Long Island Sound from 1983-1998 and the RIDFW has conducted winter flounder tagging programs in Narragansett Bay from 1986-1990 and again from 1996-1998. Mortality estimates were made by maximum likelihood methods using the Brownie class of survivorship models (Brownie et al. 1985). Average estimates of fishing mortality for Long Island Sound averaged 0.59 from 1984-1988 and 0.77 from 1989-1993, and 0.65 from 1993-1996. Fishing mortality in 1996 was estimated to be 0.56. Narragansett Bay estimates of fishing mortality ranged from 0.81 to 1.92 and averaged 1.19 from 1986 to 1989. The most recent tag releases in Narragansett Bay indicate that F had dropped to 0.37 in 1996-1997.

<u>Virtual Population Analysis</u>

Tuning

The Virtual Population Analysis (VPA) was tuned (calibrated) using the NEFSC Woods Hole Fisheries Assessment Compilation Toolbox (FACT) version 1.50 of the ADAPT VPA (Conser and Powers 1990). Abundance indices at age (Tables B1.18-25) were available from several bottom trawl surveys: NEFSC spring bottom trawl ages 1-7+, NEFSC fall ages 1-5 (advanced to tune January 1 abundance of ages 2-6), NEFSC winter ages 1-5, MADMF spring ages 1-7+, RIDFW fall seine age 0 (advanced to tune age-1), RIDFW spring ages 1-7+, CTDEP spring ages 1-7+, NYDEC age 0 (advanced to tune age-1) and age-1, MADMF summer seine index of age-0 (advanced to tune age-1), DEDFG juvenile trawl survey age-0 (advanced to tune age-1), NJDFW Ocean trawl survey ages 1-7+, and NJDFW River trawl survey ages 1-7+. The indices from the NEFSC winter trawl survey, NYDEC, and NJDFW were included in the VPA tuning for the first time. Survey indices were selected for inclusion in VPA tuning based on consideration of the partial variance in a VPA trial run including all indices, residual error patterns from the various trail runs, and on the significance of the correlation among indices and with VPA abundance estimates from the trial run including all indices.

The SARC considered eight different configurations of tuning indices. In general, tuning indices were excluded if they exhibited high partial variance (indicating a lack of fit within the VPA model) and low correlation with other indices with similar spatial and temporal characteristics and with the VPA estimates of 2002 stock size. Run W36ALL was the initial trial including all indices. Run W36_28 used the same suite of indices as that selected for the SARC 28 VPA (NEFSC 1999), and therefore did not include new indices available from the NEFSC Winter trawl survey, the NYDEC indices, or the two NJDFW index series. Run W36_1 excluded eight indices with high partial variance within the VPA and low correlation with other indices and/or the VPA estimates of stock size, resulting in improvements both in overall fit (Mean Square Residual (MSR) reduced by 14%) and in the precision of the stock size estimates, relative to the W36ALL configuration. Run W36_2 dropped an additional seven indices from the W36_1 configuration, resulting in further improvements in fit (21% improvement over run W36_1) and precision. This was the run adopted as final by the SARC, and is the basis for all further analyses (Table B1.26).

Run W36_3 dropped an additional two indices (from W36_2) to exam the trade-off between overall model fit (MSR) and the precision of the 2002 stock size estimates as degrees of freedom were further reduced. The SARC concluded that the improvement of run W36_3 in overall fit (7%) was balanced by the decrease in precision at ages 6 and 7+, and so retained run W36_2 as final. Two additional runs excluded all state agency indices (W36NEC) and excluded all NEFSC indices (W36STATE). The W36NEC exhibited a better fit than the W36_2 run, but much lower precision of the 2002 stock size estimates, reflecting the fewer degrees of freedom available. The W36STATE run exhibited the poorest fit of the eight considered, along with the lowest precision of the 2002 stock sizes at ages 4 and older. Run W36_28 provided results intermediate to those from the W36_2 and W36STATE runs. Finally, run W36_2IR was the same as run W36_2, but incorporated the iterative re-weighting option of the VPA tuning, which in a second step of tuning gives more influence to indices that fit best within the analysis (tuning weight in inverse proportion to initial fitted variance). The W36_2IR results were very similar to those of runs W36_2 and W36_3 (Figure B1.6).

Stock size estimates for 2002 in the final W36_2 calibration were moderately precise (initial coefficients of variation ranged from 0.21 at age-3 to 0.38 at age-1). Nearly all surveys had years in which all observations deviated from predicted values in the same direction. For example, most surveys exhibited blocks of negative residuals during the late 1980s, and then blocks of positive residuals during the mid to late 1990s, when residuals for all ages are summed within year and survey series. Residuals by age exhibit a similar pattern of blocking, and a tendency for blocks of positive residuals at younger ages during the mid-1990s to move to older ages later in the VPA time series. This pattern of residuals (i.e., overestimation of stock size by the surveys during the mid-to late 1990s) is reflective of the retrospective pattern of VPA estimates evident for terminal years 1995-1999 (see the following Retrospective Analysis section). The correlation analysis of tuning indices also indicated that there are strong year effects in survey indices, due to annual distribution patterns or local recruitment events. However, in concert, the SARC concluded that the surveys appear to provide geographically balanced tuning.

Exploitation Pattern

The exploitation pattern has been variable from year to year, but with the exception of 1996-1997, age-4 fish have been 80%-100% recruited since 1993 (Table B1.26). The SARC noted a recent tendency for partial recruitment at age to decrease substantially at ages 5 and 6 in the terminal year, but further noted that the retrospective analysis indicates that this tendency does not persist, with the expected, flat-topped partial recruitment pattern becoming evident as the VPA converges. For this reason, the average exploitation pattern to be used in yield per recruit analysis and stock projections was calculated as the geometric mean fishing mortality rates for 1998-2000, normalized to age 4. The resulting pattern indicates 1% recruitment at age-1, 27% at age-2 and 75% at age-3. For purposes of yield per recruit and stock projections, full (100%) recruitment was assumed at ages 4 and older. For consistency with the partial recruitment averages, mean weights at age in the landings, discards, and spawning stock biomass were also averaged over 1998-2000.

Fishing Mortality, Spawning Stock Biomass, and Recruitment

During 1981-1993, fishing mortality (fully recruited F, ages 4-5) has varied between 0.4 (1982) and 1.4 (1988), and was as high as 1.2 as recently as 1997. Fishing mortality has been in the range of 0.5-0.6 during 1999-2001 (Table B1.26, Figure B1.7). Accounting for the uncertainty of the 2001 estimate, there is an 80% probability that F in 1997 was between 0.44 and 0.58 (Figure B1.8).

SSB declined from 14,800 mt in 1983 to a record low of 2,700 mt in 1994. SSB has increased since 1994 to 7,600 mt in 2001 (Table B1.26, Figure B1.9). Accounting for the uncertainty of the 2001 estimate, there is an 80% probability that SSB in 2001 was between 6,800 mt and 8,400 mt (Figure B1.8). Recruitment declined from 62.9 million age-1 fish in 1981 to 7.8 million in 1992. Recruitment then averaged 14.7 million fish during 1993-2001, below the VPA time series average of 23.9 million. The 2001 year class is estimated to be the smallest in 22 years, at only 5.7 million fish (Table B1.26, Figure B1.9).

Retrospective analysis
A retrospective analysis of the VPA was conducted back to a terminal catch year of 1997. The VPA exhibits a retrospective pattern of underestimation of F and overestimation of SSB during the late 1990s. The most likely cause of this pattern is a combination of factors including under-reporting of the landings, mis-classification of the landings by stock area, and underestimation of the discards. For 1995-1999, retrospective fishing mortality rates underestimate the current values by an average of 128%, ranging from 232% for 1997 to 44% for 1995. The pattern reversed for 2000 (i.e., F was overestimated), and fishing mortality appears to have been overestimated for 2000 by 7%. The retrospective pattern for spawning stock biomass has been a tendency for overestimation since 1991. The overestimation of SSB averaged 76% from 1995-1999, and was largest for the 1997 and 1998 terminal years (115% and 98% overestimation). The retrospective estimation of age-1 recruits indicated a tendency for overestimation during 1993-2000, with recruitment apparently underestimated for 2001 (2000 year class; Table B1.26, Figure B1.10).

Precision of Stock Size, F, and SSB estimates
The precision of the 2002 stock size, fishing mortality at age in 2001, and SSB estimates from VPA was evaluated using bootstrap techniques (Efron 1982). Five hundred bootstrap iterations were realized in which errors (differences between predicted and observed survey values) were resampled. Estimates of precision and bias are presented in Table B1.27. Bootstrap estimates of stock size at age indicate low bias (<6%) for ages 1-7+ and bootstrap standard errors provide stock size CVs ranging from 18% at age 3 to 34% at age 1.

Bootstrapped estimates of spawning stock biomass indicate a CV of 9%, with low bias (bootstrap mean estimate of spawning stock biomass of 7,705 mt compared with VPA estimate of 7,643 mt; Table B1.27). There is an 80% probability that spawning stock in 2001 was between 6,800 mt and 8,400 mt (Figure B1.8).

The bootstrap estimates of standard error associated with fishing mortality rates at age indicate good precision. Coefficients of variation for F estimates ranged from 16% at age 3 to 21% at ages 1, 6 and 7+ (Table B1.27). There is an 80% probability that fully recruited F for ages 4-5 in 2001 was between 0.44 and 0.58 (Figure B1.8).

BIOLOGICAL REFERENCE POINTS

Yield and Spawning Stock Biomass per Recruit; Stock-recruitment model
NEFSC (2002) re-estimated the biological reference points for SNE/MA winter flounder in 2002 using yield and SSB per recruit (Thompson and Bell 1936) and Beverton-Holt stock-recruitment models (Beverton and Holt 1957, Brodziak et al. 2001, Mace and Doonan 1988) based on the SARC 28 assessment (NEFSC 1999). The yield and SSB per recruit analyses indicate that $F_{40\%}$ =

0.21 and F0.1 = 0.25 (Figure B1.11). The parametric stock-recruitment model indicated that MSY = 10,600 mt, F_{msy} = 0.32, and SSB_{msy} = 30,100 mt (Figure B1.12).

Biological reference points estimated in NEFSC (2002) were updated by the SARC with the partial recruitment pattern and mean weights at age for 1998-2000 (as noted earlier, the 2001 estimates were not included in the averages due to the retrospective variability of the partial recruitment pattern in the terminal year of the VPA). Given the stability of the input data to these analyses and the consistency of the results with the previous work, the SARC elected to retain the NEFSC (2002) estimates of biological reference points for this assessment. The SARC recommends that these parametric stock-recruitment model reference points be adopted as the basis for the ASMFC and NEFMC FMP overfishing definitions.

PROJECTIONS FOR 2002-2013

Stochastic projections were made based on 500 bootstrapped VPA realizations of stock size in numbers at age in 2002. The stochastic forecasts only incorporate uncertainty in 2002 stock sizes due to survey variability, assume current discard to landings proportions, and are not adjusted for the retrospective pattern in VPA stock size estimates. Partial recruitment to the fishery and percentage discarded were estimated as the geometric mean of VPA estimates for 1998-2000. The 2001 estimates were not included in the averages due to the retrospective variability of the partial recruitment pattern in the terminal year of the VPA. For consistency with the partial recruitment averages, mean weights at age in the stock, landings, and discards were similarly estimated as the weighted (by number landed) geometric mean weight at age from 1998-2000. Age-1 recruitment levels in 2003 and later years are estimated from the stochastic, parametric stock-recruitment relationship estimated in NEFSC (2002). Projections were made through 2013 to respond both to the ASMFC terms of reference and more recent NEFMC Plan Development Team requirements.

If F in 2002 is assumed to be 15% less than F in 2001 (F2002 = 0.43), due to the impact of management measures implemented in response to court orders during 2002, then landings are expected to be about 3,000 mt in 2002. At this reduced F, spawning stock biomass is projected to fall to 5,900 mt in 2002. Given F = 0.43 in 2002, a fishing mortality rate of Freb = 0.24 will be necessary to rebuild the spawning stock to 30,100 mt by 2013 with 50% probability (Table B1.28, Figure B1.13).

POTENTIAL SENSITIVITY OF VPA ESTIMATES TO HYPOTHETICAL NEFSC SURVEY ADJUSTMENTS

Acting on the advice of industry members, NEFSC staff inspected the trawl cables (warp) on the NOAA Ship Albatross IV' s sampling equipment on September 3, 2002. It was determined that the marks on the cable attaching scientific survey gear to the vessel were not at true 50 m length intervals they are intended to indicate. The marks are used by the vessel crew to determine how much cable is deployed. The cable was most recently replaced in February 2000, and used in eight bottom trawl surveys, beginning with Winter 2000 and ending with Spring 2002.

Therefore, it is likely that at times more cable was deployed on one side of the NEFSC trawl survey net than on the other. This is a matter of inches at shorter lengths, and more pronounced as more cable is deployed. For example, with 100 m (328 ft) of cable deployed, just under 1 inch more cable was out on one side; at 300 m (984 ft) the difference was just under 6 ft. Of all tows made in the surveys, 75% deploy 300 m of cable or less. As a result, the NEFSC trawl survey gear may have fished differently during the Winter 2000 through Spring 2002 survey compared to prior surveys, and the data collected (catch per tow, for example) may have been influenced in a way that should be accounted for.

During September 24-27, 2002, video and net sensor equipment were used in experimental tows to both directly and numerically document net performance. Individuals from the region's commercial industry and the fishery management councils were part of the scientific crew during these observations. During October 2-3, 2002, a workshop was convened to examine the data collected and produce a report. The workshop was open to the public, with invited members to include scientists familiar with fishery survey practices, commercial fishermen and gear providers, the region's fishery management councils. As of this writing, the workshop was in progress, and was expected to produce a report detailing correction factors that can then be used in adjusting the NEFRSC survey indices used in this assessment, if needed.

In the interim, to examine the potential sensitivity of the SNE/MA winter flounder VPA to such corrections, hypothetical adjustments have been applied to the NEFSC winter, spring, and fall survey indices used in the SNE/MA winter flounder VPA. NEFSC indices from the Winter 2000 through Spring 2002 surveys were increased by 10%, 25%, and 100% to explore a range of the potential positive adjustments to the indices that might be necessary to account for reduced catch efficiency of the NEFSC survey gear during those surveys. The effect is nearly linear, with F in 2001 ranging from 0.51 for the baseline, W36_2 VPA to 0.36 for the VPA with all NEFSC survey indices increased by 100% (doubled); SSB in 2001 ranged from 7,600 mt for the baseline to 11,300 mt for NEFSC indices increased 100%. In all cases, the fishing mortality rate remained above Fmsy, and SSB remained below one-half Bmsy (Figure B1.14).

CONCLUSIONS

The Southern New England/Mid-Atlantic winter flounder stock complex is overfished and overfishing is occurring (Figure B1.15). Fully recruited fishing mortality in 2001 was 0.51 (exploitation rate = 37%), about 60% above Fmsy =0.32. The current VPA indicates there is an 80% chance that the 2001 F was between 0.44 and 0.58. Spawning stock biomass was estimated to be 7,600 mt in 2001, about 25% of SSBmsy = 30,100 mt. There is an 80% chance that the spawning stock biomass was between 6,800 mt and 8,400 mt in 2001.

The current assessment provides a much more pessimistic evaluation of stock status than the SARC 28 assessment in 1998 (NEFSC 1999). This is mainly due to the retrospective pattern of underestimating F and overestimating SSB in the current VPA. However, while the SNE/MA winter flounder VPA provides uncertain estimates of current F and SSB, it provides a better determination of stock status than reliance on survey indices alone. Managers should recognize that given the estimation uncertainty in the assessment, current fishing mortality rates are likely much higher than the 2001 estimate of 0.51, potentially by nearly 100%. Current SSB may in turn be substantially overestimated.

Spawning stock biomass declined substantially from 13,000-14,000 mt during the early 1980s to 2,700 mt during 1994-1996. SSB has increased since the mid 1990s to about 7,600 mt in 2001 due to reduced fishing mortality rates since 1997. Recruitment to the stock has been below average since 1989, and early indications are that the 2001 year class is the smallest in 22 years. Forecasts indicate that it will be necessary to reduce the fishing mortality rate to Freb = 0.24 in 2003 and later years to rebuild to spawning stock to the target (SSBmsy = 30,100 mt) by 2013 with 50% probability.

The SARC elected to retain the NEFSC (2002) estimates of biological reference points for SNE/MA winter flounder for this assessment. The SARC recommends that these parametric stock-recruitment model reference points be adopted as the basis for the ASMFC and NEFMC FMP overfishing definitions. These reference points are a technical improvement over the ASMFC's yield per recruit reference points, as they include the estimates of Bmsy, MSY, and Fmsy required by the Sustainable Fisheries Act of 1996.

SARC COMMENTS

The SARC noted that while three of the major research recommendations from the SARC 28 assessment had been addressed, three more dealing mainly with the estimates of fishery discards remain unresolved, and should be addressed before the next assessment. The SARC discussed the use of surveys with different recent trends for tuning the VPA. A VPA run using only NEFSC surveys produced a more optimistic view of stock status than a run using only State indices. It was noted that the different trends among State surveys are likely tracking real trends in different portions of the stock complex. Therefore, combining the indices on a spatial scale or weighting them by survey area before tuning the VPA should be explored. The SARC reviewed a run using iterative re-weighting of the indices, which provided results very similar to the final, accepted VPA.

The SARC discussed the process of selecting indices used to tune the VPA, because the current VPA includes three new tuning series for ages 1-7+ (NEFSC winter, NJDFW river, and NJDFW ocean) and two more recruitment indices (NYDEC) not available for the SARC 28 assessment. The SARC reviewed a VPA run using the same suite of indices as in the last assessment (SARC 28) to determine how the addition of the new series had influenced the VPA results. That run provided results similar to the final VPA. An examination of the utility of a randomization test on survey indices for determining the influence of the indices on VPA results could be informative.

The SARC noted that the current assessment provides a much more pessimistic evaluation of stock status than the SARC 28 assessment in 1998 (NEFSC 1999). This is mainly due to the retrospective pattern of underestimating F and overestimating SSB in the current VPA. It was noted that an increase in the catchability of the survey could produce the observed retrospective pattern. However, there was no reason to suspect an increase in the catchability of the NEFSC and State research surveys used in the VPA tuning. The mis-classification of landings by stock area could also be a cause of the retrospective pattern. However, the SARC noted a similar retrospective pattern in the Gulf of Maine winter flounder assessment, suggesting that significant SNE-MA landings had not been mis-classified into the Gulf of Maine stock area. An underestimation of the discarded proportion of the catch could also produce the observed retrospective pattern. The use of VTR data in estimating commercial fishery discards is a source of uncertainty. Possible significant discarding in the commercial scallop dredge fishery was noted, but current data provide generally small (less than the trawl fishery) and extremely variable estimates of winter flounder discards in the dredge fishery. Finally, the observed retrospective pattern might be caused by under-reporting or underestimation of the commercial or recreational landings. Given the retrospective pattern, the utility of the current SNE-MA winter flounder VPA was evaluated. The SARC concluded that, while the SNE-MA winter flounder VPA provides uncertain estimates of current F and SSB, it still provides the best available determination of stock status.

As one illustration of the possible magnitude of potential missing catch, the SARC noted that it would take roughly a trebling of the catch during the period 1996-1998 to significantly reduce the magnitude of the retrospective pattern in fishing mortality. The SARC noted that retrospective patterns are evident in several of the New England groundfish stock assessments (e.g. GOM winter flounder, SNE-MA, CC/GOM, and GB yellowtail flounder, GB and GOM cod, and witch flounder). Investigation to determine a common cause for this pattern should be pursued. Alternative assessment methods for dealing with retrospective patterns, such as statistical catch at age models, should be explored.

SOURCES OF UNCERTAINTY

1) Stock-specific landings data for 1994 and later are derived by proration from Vessel Trip Report data and are considered provisional.

2) Length frequency sampling intensity of the commercial and recreational fishery landings has been low in some recent years, and likely increases the uncertainty of the estimated landings at age.

3) Commercial fishery discard estimates are based on rates provided by fishers in the Vessel Trip Reports, owing to inadequate Fishery Observer sampling.

4) The SNE-MA winter flounder VPA exhibits a retrospective pattern of underestimating F and overestimating SSB during the late 1990s, increasing the uncertainty of current estimates of F and SSB.

RESEARCH RECOMMENDATIONS

New

1) Evaluate the maturity at age of fish sampled in the NEFSC fall and winter surveys.

2) Consider fieldwork to record ovary weights along with maturity stage data from 20-30 cm fish in the NEFSC and State agency surveys for 1-2 years to help resolve age/size at maturity differences between State and NEFSC surveys.

3) Conduct periodic maturity staging workshops involving State and NEFSC trawl survey staff.

4) Examine sources of the differences between NEFSC, MA and CT survey maturity (validity of evidence for smaller size or younger age at 50% maturity in the NEFSC data). Compare NEFSC inshore against offshore strata for differences in maturity. Compare confidence intervals for maturity ogives. Calculate annual ogives and investigate for progression of maturity changes over time. Examine maturity data from NEFSC strata on Nantucket Shoals and near George's Bank separately from more inshore areas. Consider methods for combining maturity data from different survey programs.

5) Increase the intensity of commercial fishery discard length sampling.

6) Consider post-stratification of NEFSC survey offshore stratum 23, to facilitate inclusion of survey catches from this stratum (east of Cape Cod) in the SNE-MA winter flounder assessment.

7) Incorporate State samples (e.g. NY DEC Party Boat Survey and CT DEP Volunteer Angler Survey) in the estimation of recreational fishery landings and discards, if possible.

8) Attempt use of a forward projection (statistical catch at age model) in the next assessment.

Old: Pending

1) Continue to consider the effects of catch-and-release components of recreational fishery on discard at age (i.e., develop mortality estimates from the American Littoral Society tagging database, if feasible).

2) Compare commercial fishery discard estimates from the Mayo survey/mesh algorithm with those from VTR data for comparable time periods.

3) Maintain or increase sampling levels (currently supported by individual state funding) and collect age information from MRFSS samples.

4) Examine the implications of anthropogenic mortalities caused by pollution and power plant entrainment in estimating yield per recruit, if feasible.

5) Examine the implications of stock mixing from data from Great South Channel region.

6) Expand sea sampling for estimation of commercial discards.

7) Revise the recreational fishery discard estimates by applying a consistent method across all years, if feasible (i.e., the Gibson 1996 method).

Old: Work In Progress

1) Re-examine the maturity ogive to incorporate any recent research results.

2) Explore the feasibility of stratification of the commercial fishery discard estimation by fishery (e.g., mesh, gear, area).

Old: Completed

1) Further examine the comparability of age-length keys from different areas within the stock. Current comparisons are based on two years and three ages. Conduct an age structure exchange between NEFSC, CT DEP, and MADMF, to ensure consistency in ageing protocol.

2) Age the archived MA DMF survey age samples for 1978-1989.

3) Compile NEFSC Winter Survey abundance indices for winter flounder and evaluate their utility.

4) Evaluate the utility of MADMF sea sample data for winter flounder in estimating commercial fishery discards.

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