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*A Report of the 21st Northeast Regional Stock Assessment Workshop*

# Assessment of Winter Flounder in Southern New England and the Mid-Atlantic

by

**G. Shepherd[1], S. Cadrin[2], S. Correia[2], W. Gabriel[1], M. Gibson[3], A. Howe[2], P. Howell[4], D. Grout[5], N. Lazar[6], M. Lambert[1], and W. Ling[1]**

*[1]National Marine Fisheries Serv., Woods Hole, MA 02543*
*[2]Massachusetts Div. of Marine Fisheries, Sandwich MA 02563*
*[3]Rhode Island Div. of Fish, Wildlife & Estuaries, W. Kingston, RI 02892*
*[4]Connecticut Dept. of Environmental Protection, Old Lyme, CT 06371*
*[5]New Hampshire Fish & Game Dept., Durham, NH 03824*
*[6]Atlantic States Marine Fisheries Comm., Wakefield, RI 02879*

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This report is a product of the 21st Northeast Regional Stock Assessment Workshop (21st SAW). Proceedings and products of the 21st SAW are scheduled to be documented and released as subissues (denoted by a lower case letter) of *Northeast Fisheries Science Center Reference Document* 96-05 ( *e.g.*, 96-05a) . Tentative titles for the 21st SAW are:

An index-based assessment of winter flounder populations in the Gulf of Maine

Assessment of winter flounder in Southern New England and the Mid-Atlantic

Influence of temperature and depth on the distribution and catches of yellowtail flounder, Atlantic cod, and haddock in the NEFSC bottom trawl survey

Predicting spawning stock biomass for Georges Bank and Gulf of Maine Atlantic cod stocks with research vessel survey data

Preliminary results of a spatial analysis of haddock distribution applying a generalized additive model

Report of the 21st Northeast Regional Stock Assessment Workshop (21st SAW): Public Review Workshop

Report of the 21st Northeast Regional Stock Assessment Workshop (21st SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments

Stock assessment of northern shortfin squid in the Northwest Atlantic during 1993

The Lorenz curve method applied to NEFSC bottom trawl survey data

## Table of Contents

# INTRODUCTION

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. Winter flounder undergo migrations in and out of coastal estuaries where spawning occurs in the spring of the year. Winter flounder reach a maximum size of around 2.25 kg (5 pounds: Bigelow and Schroeder, 1953) 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).

Current fishery management (described in next section) is controlled by the Atlantic States Marine Fisheries Commission (ASMFC) in state waters and the New England Fishery Management Council in federal waters. Previous assessments have been confined to local populations in state waters and the results were the basis for the current ASMFC Fishery Management Plan (FMP). This report is a joint effort of the Stock Assessment Review Committee's Southern Demersal Subcommittee and the ASMFC Winter Flounder Technical Committee.

### *Management Summary*

Winter flounder fisheries in state waters are managed by Interstate Agreement under the auspices of the Atlantic States Marine Fisheries Commission's 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% MSP) in three steps - $F_{25\%}$ in 1993, $F_{30\%}$ in 1995, and $F_{40\%}$ in 1999 through implementation of compatible, state-specific regulations.

Coastal states from New Jersey to New Hampshire, inclusive, are currently in compliance with the Plan, having 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" and 12", 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" in NJ and NY, 5.5" in CT, 5" in RI, and 6" in MA. In Massachusetts, several regulations preceded the Plan and, in general, the suite of regulations are the most restrictive.

Winter flounder in the Exclusive Economic Zone are managed under the Northeast Multispecies Fishery FMP developed by the New England Fishery Management Council. This was an appropriate grouping for management purposes because the principal catch of winter flounder occurs as bycatch in directed demersal fisheries for Atlantic cod, haddock, and yellowtail flounder primarily of the northeast EEZ. 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 Plan extends authority over vessels permitted under the Plan even while fishing in state waters if federal regulations are more restrictive than the state regulations.

The Multispecies Plan was implemented in September, 1986, imposing a codend minimum mesh size of 5.5" (previously 5.1") 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 inner 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 by-catch 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 constrained but there was a 11" minimum size for winter flounder which corresponded with the length at first capture for 5.5" diamond mesh. Though the Plan 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 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; however, there was an exemption from effort reduction requirements for groundfishing vessels < 45' 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" diamond or square mesh in Southern New England or 6" 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 inner Gulf of Maine (except Jeffreys Ledge and Stellwagon Bank) and in Southern New England. Those boats fishing in EEZ West of 72° 30' (longitude of Shinnecock Inlet, NY) were required to abide by 5.5" diamond or 6" square codend mesh size restrictions consistent with the Summer Flounder FMP. The minimum landed size of winter flounder was increased to 12" to be consistent with the increased mesh size and 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 Council reacted to collapsed stocks of Atlantic cod, haddock, and yellowtail flounder on Georges Bank by voting 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 Council 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 FMP. Days-at-sea controls were extended. Currently, any fishing by an EEZ-permitted vessel must be conducted with not less than 6" diamond or square mesh in Southern New England east of 72° 30'. Winter flounder less than 12" in length may not be retained.

## STOCK STRUCTURE

Although stock groups consist of an assemblage of adjacent estuarine spawning units, the ASMFC Fishery Management Plan defined three coastal management units based on similar growth, maturity and seasonal movement patterns: Gulf of Maine, Southern New England and the Mid-Atlantic. In the initial phase of the Subcommittee assessment, the criteria for separation of the Southern New England and Mid-Atlantic stock boundaries were reconsidered in light of recent data available since the original stock designations.

Boundaries for four stock units were originally defined in the ASMFC management plan (Howell et al., 1992):

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

The Subcommittee retained a definition of a separate Gulf of Maine complex, based on results of tagging studies, and large differences in growth rates consistent with discrete oceanographic regimes between the Gulf of Maine and Southern New England (Howe and Coates, 1975). Additional analyses of life history characteristics and mixing within the Gulf of Maine may lead to refinement of the complex's definition within the Gulf of Maine.

The Subcommittee combined the Southern New England and Mid-Atlantic units into a single stock complex for assessment purposes. Review of tagging studies (Gibson, 1996b (Appendix IV, this report); Perlmutter, 1947; Saila, 1961; Saila, 1962; Poole, 1969; Howe and Coates, 1975; NUSCo., 1987; Powell, 1989; Crawford, 1990; Black et al., 1988; and Phelan, 1992) indicated that dispersion (and hence mixing) occurs between the previously defined Southern New England and Mid-Atlantic units. The Subcommittee considered that differences in growth and maturity among samples from Southern New England to the Mid-Atlantic reflected discrete sampling along a gradient of changing growth and maturity rates over the range of the stock complex. The group also observed that differences in growth rates within the Mid-Atlantic units were greater than differences between Mid-Atlantic and Southern New England units (Appendix I, Howell, 1996). In offshore areas, 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 (> 3 mi.) regions, which are not considered in the ASMFC management units (Table 2).

*Stock Boundaries and associated Statistical Areas*

The Gulf of Maine stock complex extends along the coast of eastern Maine alongshore to Provincetown, MA, corresponding to U. S. 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 winter flounder 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. Commercial 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.

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

## SOUTHERN NEW ENGLAND - MID-ATLANTIC STOCK COMPLEX

### Data Sources

***FISHERY DATA***

*Landings*

Total U.S. commercial landings peaked at 11,200 mt in 1981 and have since steadily (Table 1). Landings in 1993 reached a record low of 3,000 mt. 1994 landings by stock area are not currently available. Since 1989, 42% of the commercial landings have been taken from statistical area 521, 13% apiece from areas 526 and 536, and 11% from area 539 (Table 2) . The remaining landings (21%) have been obtained from area 538 and divisions 61-62. Most landings have been from the EEZ (86%, 1989-1993 average) with the remainder from state waters. The primary gear is the otter trawl which since 1989 has accounted for 93.7% of the landings. Scallop dredges have accounted for 4.4% with such gears as handlines, pound nets, fyke nets, and gill nets each accounting for less than 1% of total landings.

Recreational landings (Table 3) reached a peak in 1985 of 13.3 million fish (peak weight of 5,772 mt in 1984) but declined thereafter. Landings from 1986 to 1994 averaged 3.7 million fish (1,674 mt) with a record low of 0.8 million fish (393 mt) in 1992. Landings in 1994 from the complex were 1.1 million fish (548 mt). The principal mode of fishing is private/rental boats. With the exception of 1986, 65 - 85% of recreational landings have been taken during January to June.

*Discards*

Commercial discards for 1985 to 1993 were estimated from length frequency data from NMFS and the Massachusetts Division of Marine Fisheries (MADMF) bottom trawl surveys, commercial port sampling of landings at length, and sea sampling of landings and discard at length. The method follows the approach described by Mayo et al. (1992). Each year was divided into half year periods. Survey length frequency data (MADMF survey in spring and NEFSC in autumn) were smoothed using a three point moving average, then filtered through a mesh selection ogive (Simpson 1989) for 4.5" mesh (1984-1989), 5" mesh (1990-1992, fall 1993) and 5.5" mesh (spring, 1993). The 5.5" mesh selection curve was calculated using the 5" curve adjusted to an $L_{50}$ for 5.5". The choice of mesh sizes was based on those used in the yellowtail assessment for southern New England (Rago et al. 1994) and by comparison to length frequencies of winter flounder in the 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 sea sampling data (Figures 1-2), 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 survey numbers per tow at length "kept" were then regressed against commercial (weighout) numbers landed at length (Table 4). 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 (commercial) per half year. The number of discards (dead) at length was adjusted by the ratio of weighout landings to total commercial landings and summed across seasons and lengths to produce the annual total number of commercial discards.

Total commercial discards (number) ranged from 11% (1987) to 21% (1989) of the annual catch of winter flounder between 1985 and 1993 (Table 5). An average of 13.0% of the commercial catch (number) was discarded per year. In absolute numbers, discards ranged from a low of 1.6 million fish in 1993 to a high of 5.8 million fish in 1989. Weight of discards ranged from 1,534 mt in 1985 to a low of 457 mt in 1993. There did not appear to be any trend in the proportion discarded.

A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al., 1992. Recreational discards peaked in 1984-1985 at 0.7 million fish (Tables 3 and 5). Discards have since declined reaching a low in 1992 of 83,000 fish. In 1994, 121,271 fish were estimated to have been discarded. If recreational discards are assumed to have the same average weight per fish as spring commercial discards, the total weight of recreational discards ranged from 15 mt in 1992 to a high of 230 mt in 1985.

### *Total Catch*

Estimates of the total catch of winter flounder during 1985-1993 are given in Table 5. These estimates include commercial and recreational landings and discards. The total catch during this period varied from a high of over 14,000 mt in 1985 to a low of 4,041 mt in 1993. The total catch has declined continuously since 1985.

### *Sampling Intensity*

Length samples of winter flounder are available from both commercial and recreational landings. In the commercial fishery, annual sampling intensity varied from 96 to 224 mt landed per 100 lengths measured. With the exception of 1984, sampling rates exceeded the informal criterion of 100 lengths sampled per 200 mt (Table 6).

In the recreational fishery, sampling intensity varied from 36 to 231 mt per 100 lengths. With the exception of 1985 and 1987, all years exceeded the minimum level of sampling (Table 7).

### *Age Compositions*

Numbers at age were estimated for 1985-1993 for commercial landings, recreational landings, commercial discards and recreational discards. Quarterly commercial age-length samples were applied to corresponding commercial landings at length, with the exception of winter flounder in the unclassified market category. Unclassified landings (annual average of 23% of total landings) and landings not represented in the weighout database (annual average of 6% of total landings) were assumed to have the same age composition as the initial weighout commercial landings at age (Table 8). Landings at lengths with no associated age data within the quarter were assigned ages based on age at length from adjacent quarters. Commercial discard at length was converted to discard at age by half year periods using NEFSC survey age-length keys.

A comparison was undertaken of ageing 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. Details of the analysis are presented in Appendix I (p.58).

Recreational landings at length were estimated seasonally and geographically. Spring landings were divided into 2 regions; 1) Massachusetts and Rhode Island and 2) Connecticut and south. 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 for which a combined NJ/CT age-length key was used. Age composition of fall recreational data was developed using the

NEFSC autumn survey age-length keys for all areas combined. Recreational discard age data were developed using state survey age data (Appendix II, p. 65).

About 90-94% of commercial landings (in numbers) between 1985-1993 were comprised of fish aged 2-4, with the contribution of age 2 fish declining in the 1990's compared to the mid-1980's (Table 8). Commercial discards were predominately fish aged 2-3. Between 55-85% (average = 74%) of recreational landings were composed of fish aged 2-4 from 1985-1993, with proportionately more fish contributed by ages 5-6 compared to the commercial fishery. Recreational discards were predominately age 2 with some age 1 and age 3 fish. No conspicuous year classes were observed in the total catch at age matrix.

*Mean Weight at Age*

Mean weights at age were determined for the landings and discards in the commercial and recreational fisheries (Table 9). Length frequencies (cm) for each component were converted to weight (kg) using length-weight equations derived from NEFSC survey samples:

Spring surveys: $wt = 0.00001911 * length^{3.1087}$
Fall surveys: $wt = 0.00001826 * length^{3.1091}$

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.

## Stock Abundance and Biomass Indices

### ***Fishery-Dependent Indices***

*Commercial LPUE*

A general linear model (GLM, SAS 1985) of commercial landings per unit effort (LPUE) was used to develop a standardized index of winter flounder abundance. Landings of winter flounder per day fished were calculated from interviewed trips which landed winter flounder, as recorded in the Northeast Region commercial weighout data base from 1982-1993. The GLM included effects of year, quarter, depth, division, and ton class with 1993, quarter 3, depth ≤ 30 fathoms, division 62 and ton class 3 serving as the standard cell. The model explained 20% of the variance in observed LPUE over the period.

The LPUE indices for 1982-1993 are presented in Figure 3 and indicate a relatively rapid decline in the landings rate from 1982-1988. Since 1988, the landings rate and abundance index have remained relatively stable at low levels.

*Recreational LPUE*

As an index of winter flounder abundance, mean recreational landings per angler per trip from 1981-1994 was calculated. LPUE declined steadily from a high of 6.69 fish per angler per trip in 1982 to 3.16 fish per angler per trip in 1994 (Figure 4). However, increasing state management restrictions, such as bag limits, has likely affected the catch rate over this period.

### *Fishery-Independent 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 number-per-tow and weight-per-tow indices were determined from autumn (1963-1995) and spring (1968-1995) NEFSC bottom trawl surveys. Indices from the spring and autumn surveys were based on tows in offshore strata 1-12, 25, 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.

Mean weight-per-tow and number-per-tow indices for the spring and autumn time series are presented in Table 10. Although the indices exhibit considerable year-to-year variability, both surveys follow a trend similar to commercial landings. Indices dropped from the beginning of the time series to a low point in the early to mid- 1970's then rose to a peak in the early 1980's. Following several years of high indices, abundance once again declined to below the low levels of the 1970's. After reaching near- or record low levels for the time series in the late 1980's-1990's, indices in the spring and autumn 1995 survey have only increased slightly.

*Massachusetts*

The Massachusetts Division of Marine Fisheries (MADMF) spring survey from 1978-1994 was used to characterize abundance of winter flounder. Survey areas from east and south of Cape Cod were used in the analysis. The MADMF mean number-per-tow indices steadily declined from a high value of 56.39 in 1983 to a low of 10.57 in 1992 (Table 11). Indices in 1994 have shown an increase to 48.43 fish per tow.

In addition, the MADMF 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 0.6 fish per haul in 1977 to a low of 0.05 fish per haul in 1995 (Table 12). Generally there have been lower levels of production in recent years.

*Rhode Island*

The Rhode Island Division of Fish, Wildlife and Estuarine Resources (RIDFW) has conducted a spring and autumn survey since 1979 based on a stratified random sampling design. Three major fishing grounds are considered in the spatial stratification, including Narragansett Bay, Rhode Island Sound and Block Island Sound.

Survey results are expressed as unweighted arithmetic mean number per tow (Table 11). Indices from 1979-1995 have shown a steady decline from a high value of 130.2 fish per tow in 1979 to a low of 8.22 fish per tow in 1993. Recent indices have shown an increase to 32.47 fish per tow.

The autumn survey, conducted since 1978, 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 low levels of recruitment.

*Connecticut*

The Connecticut Department of Environmental Protection (CTDEP) trawl survey program was initiated in May 1984 and encompasses both New York and Connecticut waters of Long Island Sound. Spring indices of mean number per tow were used as indices of winter flounder abundance (Table 11). CTDEP indices experienced several years of high values between 1988 and 1991, peaking at 223.0 fish per tow in 1990. Index values in 1995 declined to 48.1.

*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 (Table 11). Young of the year indices (age 0; Table 12) have increased in recent years from 0.7 in 1985 to the 1994 index of 2.4. The 1992 index indicated a large year class with an index of 11.4. The corresponding age 1 indices also indicated an increasing abundance with a strong 1992 year class (Table 14).

*New Jersey*

The New Jersey Department of Environmental Protection (NJDEP) have conducted a bottom trawl survey in coastal waters since 1988. Surveys are conducted bi-monthly from April to January, although the time sequence has undergone some modifications since 1988. Survey indices (Table 11), exemplified as mean number per tow in April, tended to decline between 1988 and 1994, but markedly increased in 1995.

### *Delaware*

The Delaware Division of Fish and Game 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 12, indicate variable annual recruitment with a large year class in 1990. The 1994 index indicates above average recruitment.

### *Coherence among surveys*

The surveys conducted by NEFSC and several states have each produced indices of winter flounder abundance. Since each of these surveys sample distinct geographical regions, it is possible that they provide indices for different components of the stock. The coherence among surveys was examined and results are presented in Appendix III (p. 73). The surveys all indicate declining trends in abundance, although performance of individual surveys in terms of tracking year class strength varies because of interannual differences in availability.

## Mortality and Stock Size Estimates

### *Natural Mortality*

Instantaneous natural mortality (M) for winter flounder was assumed to be 0.20 and constant across ages. (This represents a lower estimate of M than in previous ASMFC assessments). Commercial catch at age included fish to age 13, 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 Subcommittee felt an M=0.2, which represents a maximum age of 15, was more representative of the stock complex throughout its range.

### *Total Mortality*

Total mortality in two components of the stock were evaluated using recent tag and recapture data (Table 13). Northeast Utilities Co. marked and recaptured winter flounder in Long Island Sound from 1983 to 1994 and the RIDFW conducted winter flounder tagging in Narragansett Bay from 1986 to 1990. Mortality estimates were made using a Brownie model of survivorship (Brownie et al. 1985). Average estimates of fishing mortality for Long Island Sound averaged 0.72 for 1984-1988 and 0.99 for 1989-1993 (dropping the negative mortality estimate of 1991 from the mean). Narragansett Bay estimates of fishing mortality ranged from 0.81 to 1.92 and averaged 1.19 from 1986 to 1989.

### Virtual Population Analysis

#### Tuning

Total catch at age was calibrated using ADAPT (Conser and Powers 1990) with abundance at age indices (Table 14) from several bottom trawl surveys: NEFSC spring bottom trawl ages 1-7+, NEFSC autumn ages 1-4 (advanced to tune January 1 abundance of ages 2-5), Massachusetts spring ages 1-7+, Rhode Island autumn age 0 (advanced to tune age 1), Rhode Island spring ages 1-7+, Connecticut spring ages 1-7+, New York ages 0-1, Massachusetts summer seine index of age-0 (advanced to tune age 1), and Delaware juvenile trawl survey age-0 (advanced to tune age 1). NEFSC autumn survey catch of ages 5+ were not used because there was little contrast in this series and poor correspondence with other indices. New Jersey trawl survey indices were excluded from calibration because the series began in 1992, although the survey may be useful in future assessments. New York indices were excluded from the final calibration because residuals in preliminary ADAPT runs were strongly trended and the survey covers a small geographic range. Estimated F varied little for eight alternative calibrations, which suggests that final results (Table 15) are stable and relatively robust to choice of tuning indices.

Parameter estimates in the final calibration were moderately precise (initial coefficients of variation ranged from 0.22 to 0.37) and were not significantly correlated. There were, however, some patterns in residuals. Nearly all surveys had years in which all observations deviated from predicted values in the same direction. For example, in 1987, all seven NEFSC spring residuals were negative. Similar residual patterns existed for NEFSC autumn 1993, Massachusetts 1991, and 1994; Rhode Island 1986, 1987, 1991-1994; and Connecticut 1985, 1986, and 1989-1991. As illustrated by a priori analyses of tuning indices, there are strong year effects in survey indices, due to annual distribution patterns or local recruitment events. However, in concert, the surveys appear to provide geographically balanced tuning. Although Connecticut age 1 residuals showed a negative trend over time, the index was included in the final calibration because it represented the Long Island Sound component of the stock complex. There was one extreme residual, NEFSC autumn age 4 in 1987, but there was no extrinsic justification for excluding the observation from the analysis.

#### Exploitation Pattern

The exploitation pattern has been somewhat variable from year to year, but age 4 fish have been over 90% recruited since 1986. An average exploitation pattern was calculated as the ratio of the geometric mean fishing mortality rates at ages 1-3 to the geometric mean of the fishing mortality rates at age 4-6. The resulting pattern indicates, on average, 0.5% recruitment at age 1, 19% at age 2 and 74% at age 3, from years 1992-1993, to reflect potential effects of recent changes in management measures. For purposes of yield-per-recruit calculations and catch and stock biomass projections, full (100%) recruitment was assumed at ages 4 and older.

### *Fishing Mortality*

Fishing mortality averaged over ages 4-5 has fluctuated without trend between 0.57 and 1.38 since 1985 and has averaged 1.07. Mean F in 1993 was 0.83 (Figure 5).

### *Spawning Stock Biomass*

With maturity as estimated in O'Brien et al. (1993), spawning stock biomass has steadily declined over the period 1985 to 1993. Estimated spawning stock biomasses in 1992 and 1993 were 4,000 and 3,800 mt, respectively, the lowest in the time series, and about 60% less than in 1985 (Figure 6).

### *Recruitment*

Recruitment estimates, at age 1 winter flounder, have followed a steady downward trend, from 35 million fish in 1985 to 11 million fish in 1994 (1993 year class) (Figure 6). The 1994 year class, was estimated to be about 11.5 million fish. The sole exception to the declining recruitment trend is the 1992 year class, with 39 million recruits at age 1 in 1993. Historical young-of-the year survey indices indicate year classes this size or larger occurred prior to 1985 (Tables 12).

### *Precision of F and SSB estimates*

The precision of the 1993 F and SSB estimates from VPA was evaluated using bootstrap techniques (Efron 1982). Two hundred bootstrap iterations were performed in which errors (differences between predicted and observed survey values) were resampled. Estimates of precision and bias are presented in Table 16. Bootstrapped estimates of spawning stock biomass indicate a CV of 9%, with low bias (bootstrap mean estimate of spawning stock biomass of 3,728 mt compared with VPA estimate of 3,792 mt). There is an 80% probability that spawning stock biomass in 1993 was between 3,700 mt and 4,600 mt (Figure 7).

The bootstrap estimates of standard error associated with fishing mortality rates indicate high precision. Coefficients of variation for bias-corrected F estimates ranged from 16% at age 4 to 25% at age 6. There is an 80% probability that F in 1993 was between 0.72 and 1.00 (Figure 8).

### *Projections*

Stochastic projections were based on 200 bootstrapped realizations of numbers at age in 1994. Weights at age in the landings were estimated as the weighted (by number landed) geometric mean weights at age in 1992-1993, to reflect any effects of increased minimum fish sizes. Percentage discarded was similarly estimated as the mean of percentages from 1992-1993. Recruitment was primarily treated deterministically: a Shepherd stock recruitment curve was fitted to all points excluding the 1992 year class (Figure 9). At random, but in about 9 cases of

10, recruitment was generated from the stock-recruitment curve, but a recruitment of 39 million fish at age 1 was allowed randomly in about 10% of the cases.

Under the status quo (1993) level of fishing mortality (F=0.83, Figure 10), median spawning stock biomass would be expected to increase during 1995 as the 1992 year class recruited to the spawning stock, decline slightly during 1996-1997, and reach about 8,000 mt in 1999-2000, well below 1984 levels. Landings would similarly increase in 1995, decline during 1996 and 1997 and stabilize around 6,000 mt in 1999-2000 (Figure 11).

If fishing mortality rates were reduced to $F_{0.1}$ (F=0.22) in 1996 and maintained at $F_{0.1}$ thereafter (Figure 10), median spawning stock biomass would increase continuously, exceeding 1984 levels by 1997. Landings in 1996 would decline to 2,000 mt (70% lower than in 1995) but would thereafter increase, exceeding the 1994 level (4,000 mt) by 1999 (Figure 11)

If fishing mortality was reduced to a lower level (F=0.14) during 1996-2000 (Figure 10), median spawning stock biomass would markedly increase beginning in 1997. Landings in 1996 would decline to only 1,000 mt but increase to 3,000 mt by the year 2000 (Figure 11).

## Biological Reference Points

### *Yield and Spawning Stock Biomass per Recruit*

Biological reference points were calculated using the Thompson-Bell yield per recruit model (Thompson and Bell, 1934). Input parameters are summarized in Table 17. Natural mortality was assumed constant at 0.2. The partial recruitment at age was determined from the 1992-1993 exploitation pattern in the VPA. The proportion mature was based on the maturity ogive from O'Brien et al., 1993 (MA DMF spring survey). These proportions were intermediate among survey data from New Jersey, Connecticut, New York, Massachusetts, and NEFSC. Average stock weight was based on the geometric mean weight at age from 1992-1993 from the total catch. Due to low sample sizes among older ages, a curve was fitted to the data set and the fitted mean weights at age were used for ages 7 and greater. The average catch weight was the geometric mean weight at age of the catch for the period 1992-1993, with fitted mean weights used for ages 7 and greater. The proportion of the fishing and natural mortality assumed to occur prior to spawning was equal to 20% of the annual total. The model was applied using a maximum age of 15.

The calculated fishing mortality corresponding to maximum yield per recruit ($F_{max}$) was 0.536 and $F_{0.1}$ was 0.217 (Table 17). At $F_{max}$, 16.9% of the maximum spawning potential is achieved. The $F_{40\%}$ target defined in the ASMFC FMP occurs at an F equal to 0.207. At the 1993 F of 0.83, the spawning stock biomass per recruit is less than 11% of the maximum (Figure 12).

## Conclusions

The winter flounder complex in the Southern New England - Mid-Atlantic region is over-exploited and at record low levels of spawning stock biomass. Recent recruitment, except for the 1992 year class, has been poor. Significant rebuilding opportunities will be foregone unless fishing mortality is reduced.

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Table 1. Winter flounder commercial landings (metric tons) 1964 - 1993 for Southern New England/Mid-Atlantic stock complex area (U.S. statistical reporting areas 521, 526, divisions 53, 61-63) as reported by NEFSC weighout, state bulletin and general canvas data.

| Year | Metric Tons |
|---|---|
| 1964 | 7,474 |
| 1965 | 8,678 |
| 1966 | 11,977 |
| 1967 | 9,478 |
| 1968 | 7,070 |
| 1969 | 8,107 |
| 1970 | 8,603 |
| 1971 | 7,367 |
| 1972 | 5,190 |
| 1973 | 5,573 |
| 1974 | 4,259 |
| 1975 | 3,982 |
| 1976 | 3,265 |
| 1977 | 4,413 |
| 1978 | 6,327 |
| 1979 | 6,543 |
| 1980 | 10,627 |
| 1981 | 11,176 |
| 1982 | 9,438 |
| 1983 | 8,659 |
| 1984 | 8,882 |
| 1985 | 7,052 |
| 1986 | 4,929 |
| 1987 | 5,172 |
| 1988 | 4,312 |
| 1989 | 3,670 |
| 1990 | 4,232 |
| 1991 | 4,823 |
| 1992 | 3,816 |
| 1993 | 3,010 |

Table 2. Distribution of commercial landings (percentage of annual total) of winter flounder from Southern New England/Mid-Atlantic stock complex area by U.S. statistical reporting area and distance from shore, 1989-1993.

| | Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 521 | 526 | 537 | 538 | 539 | 611 | 612 | 613 | 614-622 |
| 1989 | 33.2 | 10.8 | 18.9 | 7.0 | 12.1 | 7.1 | 5.5 | 4.2 | 1.2 |
| 1990 | 45.2 | 16.8 | 6.1 | 4.9 | 9.5 | 11.1 | 4.1 | 2.0 | 0.1 |
| 1991 | 46.4 | 14.7 | 10.8 | 1.7 | 13.7 | 5.7 | 3.6 | 2.9 | 0.4 |
| 1992 | 37.0 | 12.5 | 17.4 | 2.4 | 9.4 | 10.1 | 4.5 | 3.4 | 3.4 |
| 1993 | 46.6 | 10.0 | 10.8 | 2.4 | 8.2 | 7.7 | 4.2 | 8.0 | 2.1 |
| AVG. | 41.7 | 13.0 | 12.8 | 3.7 | 10.6 | 8.3 | 4.4 | 4.1 | 1.4 |

| | Distance from Shore | | | |
|---|---|---|---|---|
| Year | Inland | < 3 miles | 3-12 miles | > 12 miles |
| 1989 | 0.0 | 16.8 | 13.6 | 69.6 |
| 1990 | 0.0 | 16.9 | 10.9 | 72.1 |
| 1991 | 0.0 | 9.1 | 16.3 | 74.5 |
| 1992 | 0.0 | 14.7 | 10.9 | 74.5 |
| 1993 | 0.0 | 13.9 | 12.4 | 73.7 |
| AVG. | 0.0 | 14.3 | 12.8 | 72.9 |

Table 3. Estimated number (000's) and weight (mt) of winter flounder caught and discarded in recreational fishery, Southern Massachusetts to New Jersey, 1981-1994.

Number (000's)

| | Catch A+B1+B2 | Landings A+B1 | Release B2 | 15% Release Mortality |
|---|---|---|---|---|
| 1981 | 11005.7 | 8089.4 | 2916.2 | 437.4 |
| 1982 | 10664.7 | 8392.2 | 2272.5 | 340.9 |
| 1983 | 11010.0 | 8365.0 | 2645.0 | 396.7 |
| 1984 | 17723.3 | 12756.0 | 4967.3 | 745.1 |
| 1985 | 18056.0 | 13297.4 | 4758.6 | 713.8 |
| 1986 | 9368.4 | 6994.5 | 2373.9 | 356.1 |
| 1987 | 9213.2 | 6900.4 | 2312.8 | 346.9 |
| 1988 | 10133.7 | 7358.4 | 2775.3 | 416.3 |
| 1989 | 5917.9 | 3681.7 | 2236.2 | 335.4 |
| 1990 | 3826.6 | 2486.3 | 1340.3 | 201.0 |
| 1991 | 4324.8 | 2795.0 | 1529.9 | 229.5 |
| 1992 | 1360.3 | 805.6 | 554.7 | 83.2 |
| 1993 | 2210.8 | 1180.3 | 1030.5 | 154.6 |
| 1994 | 1883.8 | 1075.3 | 808.5 | 121.3 |

| | Landings (A+B1) Metric Tons |
|---|---|
| 1981 | 3049.5 |
| 1982 | 2457.1 |
| 1983 | 3523.9 |
| 1984 | 5772.0 |
| 1985 | 5197.8 |
| 1986 | 2940.2 |
| 1987 | 3140.7 |
| 1988 | 3423.1 |
| 1989 | 1802.1 |
| 1990 | 1062.6 |
| 1991 | 1214.3 |
| 1992 | 393.1 |
| 1993 | 542.6 |
| 1994 | 548.1 |

Table 4. Results of linear regressions of number at length from commercial winter flounder landings by season and survey mean #/tow at length (Spring: MADMF survey, Fall: NEFSC survey).

SPRING

| | 1985 | **1986** | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| Standard Error of Y Estimate | 49753.45 | 43503.52 | 40700.68 | 40971.60 | 42896.13 | 18991.13 | 65506.22 | 47813.22 | 11988.18 |
| R Squared | 0.93 | 0.87 | 0.90 | 0.76 | 0.88 | 0.94 | 0.73 | 0.58 | 0.67 |
| DF | 30 | 25 | 30 | 26 | 24 | 21 | 14 | 15 | 20 |
| Coefficient | 482016.04 | 392722.74 | 332715.91 | 450332.93 | 379398.33 | 493964.29 | 1002218.12 | 174763.16 | 1519347.38 |
| Standard Error of Coefficient | 16553.13 | 18914.07 | 15542.53 | 31344.39 | 20969.03 | 18368.42 | 102173.28 | 21027.32 | 30868.35 |

FALL

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| Standard Error of Y Estimate | 104586.13 | 48916.93 | 64800.97 | 47295.78 | 55013.55 | 61680.50 | 77833.65 | 54452.27 | 42038.90 |
| R Squared | 0.67 | 0.82 | 0.78 | 0.88 | 0.70 | 0.75 | 0.83 | 0.81 | 0.94 |
| DF | 28 | 20 | 17 | 22 | 18 | 25 | 17 | 19 | 19 |
| X Coefficient | 3211138.16 | 5056901.10 | 6965849.05 | 4560440.09 | 10721275.34 | 6700488.49 | 5738827.10 | 3675354.23 | 8846877.98 |
| Standard Error of Coefficient | 274686.46 | 327156.19 | 517121.81 | 259089.62 | 1004650.61 | 504141.09 | 364187.48 | 247869.16 | 381224.43 |

Table 5. Total winter flounder recreational and commercial catch, 1985-1993 for Southern New England/Mid-Atlantic stock in MT and (number (000's)).

| Year | Commercial Landings | Commercial Discards | Recreational Landings | Recreational Discards | Total Catch | % Discards |
|---|---|---|---|---|---|---|
| 1985 | 7052 (14,211) | 1534 (4,531) | 5198 (13,297) | 230 (714) | 14014 (32,753) | 12.6 (16.0) |
| 1986 | 4929 (9,460) | 1273 (4,902) | 2940 (6,994) | 66 (356) | 9208 (21,712) | 14.5 (24.2) |
| 1987 | 5172 (10,524) | 950 (3,545) | 3141 (6,900) | 61 (347) | 9324 (21,316) | 10.8 (18.3) |
| 1988 | 4312 (8,377) | 904 (3,728) | 3423 (7,358) | 69 (416) | 8708 (19,879) | 11.2 (20.9) |
| 1989 | 3670 (7,888) | 1404 (5,761) | 1802 (3,682) | 49 (335) | 6925 (17,666) | 21.0 (34.5) |
| 1990 | 4232 (7,202) | 673 (2,567) | 1063 (2,486) | 31 (201) | 5999 (12,456) | 11.7 (22.2) |
| 1991 | 4823 (9,063) | 784 (2,701) | 1214 (2,795) | 51 (229) | 6872 (14,788) | 12.2 (19.8) |
| 1992 | 3816 (6,759) | 511 (1,811) | 393 (806) | 15 (83) | 4735 (9,459) | 11.1 (20.0) |
| 1993 | 3010 (5,336) | 457 (1,580) | 543 (1,180) | 31 (155) | 4041 (8,251) | 12.1 (21.1) |

Table 6. Sampling intensity of commercial winter flounder fishery by year, quarter and market category for the Southern New England/Mid-Atlantic stock complex.

| | | PeeWee | Small | Med | Large | Lmnsole | Unc. | Total | Landings MT | MT per 100 lengths |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 1 | | 689 | | 215 | | | | | |
| | 2 | | 1144 | | 1125 | | 281 | | | |
| | 3 | 135 | 941 | 878 | 1256 | 172 | 219 | | | |
| | 4 | 165 | 442 | 100 | 164 | | 116 | 8042 | 9438 | 117 |
| 1983 | 1 | | 102 | 201 | 164 | | 272 | | | |
| | 2 | 401 | 583 | 137 | 691 | 96 | 353 | | | |
| | 3 | 146 | 285 | 505 | 671 | 116 | 153 | | | |
| | 4 | 152 | 252 | 201 | 306 | | 149 | 5936 | 8659 | 146 |
| 1984 | 1 | | | | 85 | | 274 | | | |
| | 2 | 270 | 419 | | 319 | 200 | | | | |
| | 3 | 119 | 240 | | 345 | | 153 | | | |
| | 4 | 275 | 116 | 637 | 389 | | 124 | 3965 | 8882 | 224 |
| 1985 | 1 | 165 | 271 | 530 | 197 | | 363 | | | |
| | 2 | 242 | 591 | 408 | 618 | | 255 | | | |
| | 3 | 726 | 451 | 515 | 581 | | 98 | | | |
| | 4 | 134 | 52 | 210 | | | | 6407 | 7052 | 110 |
| 1986 | 1 | 190 | 92 | 200 | 195 | | 388 | | | |
| | 2 | 310 | 385 | 299 | 409 | | 240 | | | |
| | 3 | 243 | 522 | 218 | 297 | | 171 | | | |
| | 4 | 159 | 305 | 307 | 190 | | | 5120 | 4929 | 96 |
| 1987 | 1 | 64 | 306 | 163 | 343 | 159 | | | | |
| | 2 | 260 | 604 | 200 | 686 | 188 | | | | |
| | 3 | 425 | 358 | 104 | 291 | 22 | 99 | | | |
| | 4 | 247 | 260 | 203 | 289 | | | 5271 | 5172 | 98 |
| 1988 | 1 | 47 | 122 | 101 | 104 | | 269 | | | |
| | 2 | 216 | 221 | 250 | 474 | 104 | | | | |
| | 3 | 251 | 385 | 212 | 269 | | | | | |
| | 4 | 186 | 203 | 395 | 299 | | | 4208 | 4312 | 102 |
| 1989 | 1 | | 192 | 100 | 191 | | | | | |
| | 2 | 359 | 423 | 517 | 338 | 123 | 106 | | | |
| | 3 | | 174 | 300 | 215 | | | | | |
| | 4 | | 76 | 303 | 108 | | | 3525 | 3670 | 104 |
| 1990 | 1 | | 51 | 101 | 100 | | | | | |
| | 2 | 263 | 396 | 501 | 511 | | | | | |
| | 3 | 148 | 296 | 407 | 245 | 32 | | | | |
| | 4 | 142 | 177 | 497 | 119 | | 102 | 4088 | 4232 | 104 |
| 1991 | 1 | | 125 | 207 | 155 | | | | | |
| | 2 | 137 | 229 | 410 | 388 | | | | | |
| | 3 | 131 | 239 | | 96 | 29 | | | | |
| | 4 | 149 | 210 | 304 | 205 | 44 | | 3058 | 4823 | 158 |
| 1992 | 1 | | 78 | 200 | 102 | | 102 | | | |
| | 2 | 139 | 352 | 422 | 362 | | 236 | | | |
| | 3 | 88 | 380 | 206 | 320 | 25 | 64 | | | |
| | 4 | | | | | | | 3076 | 3816 | 124 |

Table 7. Sampling intensity of recreational winter flounder fishery, Southern New England/Mid-Atlantic stock complex.

| Year | Recreational Landings (MT) | Number Lengths | MT per 100 lengths |
|---|---|---|---|
| 1981 | 3050 | 1725 | 177 |
| 1982 | 2457 | 1972 | 125 |
| 1983 | 3524 | 2587 | 136 |
| 1984 | 5772 | 3123 | 185 |
| 1985 | 5198 | 2357 | 221 |
| 1986 | 2940 | 2237 | 131 |
| 1987 | 3141 | 1360 | 231 |
| 1988 | 3423 | 1944 | 176 |
| 1989 | 1802 | 2810 | 64 |
| 1990 | 1063 | 2548 | 42 |
| 1991 | 1214 | 1755 | 69 |
| 1992 | 393 | 1083 | 36 |
| 1993 | 543 | 1288 | 42 |

Table 8. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

Commercial Landings

Age

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 27 | 3936 | 5688 | 3052 | 1014 | 326 | 104 | 32 | 17 | 7 | 5 | 2 | 0 |
| 1986 | 0 | 2122 | 4187 | 2206 | 551 | 271 | 84 | 27 | 6 | 3 | 1 | 2 | 0 |
| 1987 | 0 | 2488 | 5465 | 1895 | 465 | 122 | 40 | 20 | 14 | 12 | 2 | 0 | 0 |
| 1988 | 0 | 2241 | 3929 | 1607 | 412 | 122 | 37 | 24 | 3 | 2 | 1 | 0 | 0 |
| 1989 | 0 | 1542 | 4057 | 1747 | 431 | 58 | 34 | 13 | 5 | 1 | 0 | 0 | 0 |
| 1990 | 0 | 1003 | 3977 | 1757 | 315 | 95 | 37 | 16 | 0 | 3 | 0 | 0 | 0 |
| 1991 | 0 | 1406 | 4756 | 2239 | 447 | 143 | 48 | 16 | 5 | 1 | 1 | 0 | 0 |
| 1992 | 0 | 484 | 3416 | 2127 | 574 | 111 | 32 | 11 | 3 | 0 | 0 | 0 | 0 |
| 1993 | 13 | 885 | 2516 | 1377 | 361 | 102 | 71 | 7 | 0 | 0 | 2 | 0 | 1 |

Commercial Discards

Age

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 22 | 1504 | 2516 | 442 | 43 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 78 | 2220 | 2389 | 205 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 11 | 1600 | 1755 | 170 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 6 | 887 | 2540 | 276 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 315 | 2724 | 2131 | 555 | 33 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 16 | 781 | 1433 | 322 | 14 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 17 | 1238 | 1205 | 227 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 15 | 845 | 787 | 150 | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 201 | 849 | 467 | 57 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Total Commercial Catch

Age

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 49 | 5440 | 8204 | 3494 | 1057 | 330 | 104 | 32 | 17 | 7 | 5 | 2 | 0 |
| 1986 | 78 | 4341 | 6576 | 2411 | 561 | 271 | 84 | 27 | 6 | 3 | 1 | 2 | 0 |
| 1987 | 11 | 4089 | 7220 | 2065 | 474 | 123 | 40 | 20 | 14 | 12 | 2 | 0 | 0 |
| 1988 | 6 | 3127 | 6468 | 1883 | 432 | 122 | 37 | 24 | 3 | 2 | 1 | 0 | 0 |
| 1989 | 315 | 4266 | 6187 | 2301 | 464 | 60 | 35 | 13 | 5 | 1 | 0 | 0 | 0 |
| 1990 | 16 | 1784 | 5410 | 2079 | 328 | 95 | 37 | 16 | 0 | 3 | 0 | 0 | 0 |
| 1991 | 17 | 2644 | 5962 | 2465 | 460 | 144 | 49 | 16 | 5 | 1 | 1 | 0 | 0 |
| 1992 | 15 | 1328 | 4203 | 2277 | 588 | 112 | 32 | 11 | 3 | 0 | 0 | 0 | 0 |
| 1993 | 214 | 1735 | 2983 | 1435 | 367 | 103 | 71 | 7 | 0 | 0 | 2 | 0 | 1 |

Table 8 con't. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

Recreational Landings

| | | | | | | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 219 | 1585 | **4270** | 2558 | 1895 | 1513 | 878 | 0 | 335 | 44 | 0 | 0 | 0 |
| 1986 | 106 | 1765 | **2432** | 1797 | 491 | 171 | 81 | 77 | 51 | 8 | 17 | 0 | 0 |
| 1987 | 16 | 926 | **1736** | 1023 | 2229 | 633 | 82 | 115 | 64 | 77 | 0 | 0 | 0 |
| 1988 | 21 | 534 | **2858** | 2078 | 775 | 857 | 128 | 51 | 37 | 20 | 0 | 0 | 0 |
| 1989 | 99 | 739 | 944 | 1200 | 385 | 161 | 91 | 36 | 16 | 8 | 3 | 1 | 0 |
| 1990 | 7 | 189 | 814 | 851 | 439 | 101 | 52 | 20 | 3 | 3 | 0 | 2 | 5 |
| 1991 | 13 | 232 | 1122 | 879 | 399 | 107 | 38 | 0 | 1 | 0 | 3 | 0 | 0 |
| 1992 | 3 | 123 | 235 | 303 | 85 | 50 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 31 | 233 | 321 | 289 | 218 | 54 | 20 | 10 | 4 | 2 | 0 | 0 | 0 |

Recreational Discards

| | | | | | | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 9 | 340 | 363 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 32 | 222 | 93 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 47 | 254 | 43 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 57 | 279 | 76 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 49 | 240 | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 12 | 136 | 51 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 22 | 151 | 56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 7 | 51 | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 29 | 95 | 26 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Total Recreational Catch

| | | | | | | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 228 | 1926 | 4633 | 2560 | 1895 | 1513 | 878 | 0 | 335 | 44 | 0 | 0 | 0 |
| 1986 | 138 | 1986 | 2526 | 1805 | 491 | 171 | 81 | 77 | 51 | 8 | 17 | 0 | 0 |
| 1987 | 62 | 1180 | 1779 | 1025 | 2230 | 633 | 82 | 115 | 64 | 77 | 0 | 0 | 0 |
| 1988 | 78 | 814 | 2934 | 2081 | 775 | 857 | 128 | 51 | 37 | 20 | 0 | 0 | 0 |
| 1989 | 148 | 980 | 988 | 1202 | 385 | 161 | 91 | 36 | 16 | 8 | 3 | 1 | 0 |
| 1990 | 20 | 325 | 865 | 853 | 439 | 101 | 52 | 20 | 3 | 3 | 0 | 2 | 5 |
| 1991 | 35 | 383 | 1179 | 879 | 399 | 107 | 38 | 0 | 1 | 0 | 3 | 0 | 0 |
| 1992 | 10 | 174 | 254 | 304 | 85 | 50 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 60 | 328 | 346 | 293 | 218 | 55 | 20 | 10 | 4 | 2 | 0 | 0 | 0 |

Table 8 con't. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

Total Landings

| | Age | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 246 | 5521 | 9958 | 5610 | 2910 | 1839 | 982 | 32 | 352 | 52 | 5 | 2 | 0 |
| 1986 | 106 | 3886 | 6619 | 4003 | 1042 | 442 | 165 | 104 | 57 | 10 | 19 | 2 | 0 |
| 1987 | 16 | 3414 | 7201 | 2918 | 2694 | 755 | 122 | 135 | 78 | 89 | 2 | 0 | 0 |
| 1988 | 21 | 2775 | 6787 | 3684 | 1188 | 979 | 165 | 75 | 39 | 22 | 1 | 0 | 0 |
| 1989 | 99 | 2281 | 5000 | 2947 | 816 | 220 | 125 | 49 | 21 | 9 | 3 | 1 | 0 |
| 1990 | 7 | 1193 | 4791 | 2608 | 754 | 196 | 88 | 36 | 4 | 5 | 0 | 2 | 5 |
| 1991 | 13 | 1638 | 5879 | 3117 | 846 | 250 | 87 | 16 | 6 | 1 | 4 | 0 | 0 |
| 1992 | 3 | 607 | 3650 | 2431 | 659 | 161 | 38 | 11 | 3 | 0 | 0 | 0 | 0 |
| 1993 | 44 | 1118 | 2836 | 1666 | 579 | 157 | 91 | 17 | 4 | 2 | 2 | 0 | 1 |

Total Discards

| | Age | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 31 | 1845 | 2878 | 444 | 43 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 110 | 2441 | 2483 | 213 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 58 | 1854 | 1797 | 173 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 63 | 1166 | 2615 | 280 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 364 | 2965 | 2175 | 556 | 33 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 29 | 917 | 1484 | 324 | 14 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 39 | 1389 | 1262 | 227 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 22 | 896 | 806 | 151 | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 230 | 945 | 492 | 61 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Total Catch

| | Age | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 277 | 7366 | 12836 | 6054 | 2953 | 1843 | 982 | 32 | 352 | 52 | 5 | 2 | 0 |
| 1986 | 215 | 6327 | 9102 | 4216 | 1053 | 442 | 165 | 104 | 57 | 10 | 19 | 2 | 0 |
| 1987 | 73 | 5268 | 8999 | 3091 | 2703 | 755 | 122 | 135 | 78 | 89 | 2 | 0 | 0 |
| 1988 | 84 | 3941 | 9402 | 3964 | 1207 | 979 | 165 | 75 | 39 | 22 | 1 | 0 | 0 |
| 1989 | 463 | 5246 | 7176 | 3503 | 849 | 222 | 126 | 49 | 21 | 9 | 3 | 1 | 0 |
| 1990 | 36 | 2109 | 6275 | 2931 | 767 | 196 | 89 | 36 | 4 | 5 | 0 | 2 | 5 |
| 1991 | 53 | 3027 | 7140 | 3344 | 858 | 251 | 87 | 16 | 6 | 1 | 4 | 0 | 0 |
| 1992 | 25 | 1503 | 4457 | 2581 | 674 | 162 | 38 | 11 | 3 | 0 | 0 | 0 | 0 |
| 1993 | 274 | 2062 | 3329 | 1728 | 585 | 157 | 91 | 17 | 4 | 2 | 2 | 0 | 1 |

Table 9. Winter flounder mean weight at age (kg) for Southern New England/Mid-Atlantic stock complex.

COMMERCIAL DISCARDS

SPRING

| | AGE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1985 | 0.16 | 0.27 | 0.37 | 0.49 | 0.55 | 0.97 | | |
| 1986 | 0.03 | 0.17 | 0.26 | 0.37 | 0.59 | 0.79 | | |
| 1987 | 0.03 | 0.18 | 0.29 | 0.38 | 0.57 | 0.84 | | 0.99 |
| 1988 | 0.04 | 0.17 | 0.25 | 0.32 | 0.46 | 0.90 | 1.14 | |
| 1989 | 0.02 | 0.15 | 0.25 | 0.35 | 0.45 | 0.60 | 0.58 | 0.77 |
| 1990 | 0.03 | 0.12 | 0.26 | 0.37 | 0.51 | 0.92 | 0.64 | |
| 1991 | 0.04 | 0.23 | 0.27 | 0.37 | 0.49 | 0.70 | 0.68 | 0.79 |
| 1992 | 0.03 | 0.16 | 0.30 | 0.39 | 0.44 | 0.66 | | |
| 1993 | 0.03 | 0.21 | 0.32 | 0.43 | 0.51 | 0.71 | 0.83 | |

FALL

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1985 | 0.11 | 0.24 | 0.31 | 0.48 | 0.50 | | |
| 1986 | 0.15 | 0.27 | 0.33 | | | | |
| 1987 | 0.11 | 0.26 | 0.29 | 0.58 | 0.71 | | |
| 1988 | 0.06 | 0.21 | 0.27 | 0.42 | 0.65 | 0.00 | 0.55 |
| 1989 | 0.13 | 0.22 | 0.29 | 0.35 | 0.55 | 0.65 | |
| 1990 | 0.12 | 0.24 | 0.27 | 0.31 | 0.55 | | |
| 1991 | 0.13 | 0.28 | 0.33 | 0.57 | | | |
| 1992 | 0.11 | 0.23 | 0.32 | 0.40 | 0.71 | | |
| 1993 | 0.17 | 0.28 | 0.35 | 0.32 | | | |

COMMERCIAL LANDINGS

| | AGE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 0.24 | 0.31 | 0.43 | 0.59 | 0.82 | 0.93 | 1.27 | 1.76 | 1.88 | 1.66 | 2.21 | 2.38 | |
| 1986 | | 0.34 | 0.45 | 0.59 | 0.86 | 1.13 | 1.30 | 1.64 | 1.86 | 2.13 | 2.26 | 2.02 | |
| 1987 | | 0.34 | 0.43 | 0.66 | 0.89 | 1.15 | 1.58 | 1.73 | 1.70 | 2.01 | 2.51 | | |
| 1988 | | 0.35 | 0.46 | 0.66 | 0.83 | 1.00 | 1.11 | 1.36 | 1.61 | 1.89 | 1.49 | | |
| 1989 | | 0.36 | 0.45 | 0.61 | 0.78 | 1.14 | 1.57 | 1.57 | 1.90 | 2.65 | 2.80 | 2.80 | |
| 1990 | | 0.39 | 0.47 | 0.63 | 0.91 | 1.17 | 1.24 | 1.50 | 1.99 | 2.18 | | 1.90 | |
| 1991 | | 0.38 | 0.48 | 0.60 | 0.76 | 1.01 | 1.32 | 1.40 | 1.91 | 2.72 | 2.35 | | |
| 1992 | | 0.40 | 0.46 | 0.64 | 0.84 | 1.09 | 1.24 | 1.74 | 2.22 | | 2.92 | | |
| 1993 | 0.30 | 0.41 | 0.50 | 0.63 | 0.84 | 1.07 | 1.29 | 1.75 | | | 2.02 | | 1.46 |

Table 9 con't. Winter flounder mean weight at age (kg) for Southern New England/Mid-Atlantic stock complex.

### RECREATIONAL SPRING LANDINGS, CT and SOUTH

| | AGE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | 0.01 | 0.09 | 0.20 | 0.30 | 0.36 | 0.36 | 0.37 | 0.00 | 0.71 | 1.31 | | | |
| 1986 | 0.05 | 0.12 | 0.22 | 0.32 | 0.38 | 0.48 | 0.60 | 0.43 | 0.73 | 0.40 | 2.15 | | |
| 1987 | | 0.24 | 0.26 | 0.32 | 0.38 | 0.42 | 0.56 | 0.46 | 0.51 | 0.97 | | | |
| 1988 | | 0.23 | 0.26 | 0.37 | 0.49 | 0.44 | 0.53 | 0.62 | 0.84 | 0.93 | | | |
| 1989 | 0.02 | 0.20 | 0.27 | 0.37 | 0.48 | 0.52 | 0.54 | 0.67 | 0.71 | 1.13 | 1.40 | 2.13 | |
| 1990 | | 0.15 | 0.25 | 0.35 | 0.47 | 0.47 | 0.59 | 0.44 | | 1.22 | | | |
| 1991 | | 0.23 | 0.28 | 0.36 | 0.41 | 0.55 | 0.60 | | | | 1.14 | | 2.38 |
| 1992 | | 0.19 | 0.29 | 0.38 | 0.57 | 0.59 | 0.88 | | | | | | |
| 1993 | 0.12 | 0.23 | 0.28 | 0.39 | 0.44 | 0.50 | 0.57 | 0.59 | 0.67 | 0.92 | | | |

### SPRING RECREATIONAL LANDINGS , MA and RI

| | AGE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1985 | | 0.10 | 0.26 | 0.42 | 0.52 | 0.68 | | | | | | | |
| 1986 | | 0.12 | 0.32 | 0.50 | 0.70 | 0.73 | 0.97 | 1.17 | 0.86 | | | | |
| 1987 | | | 0.31 | 0.40 | 0.54 | 0.57 | 0.92 | 1.07 | | | | | |
| 1988 | | 0.14 | 0.33 | 0.45 | 0.67 | | 0.59 | | | | | | |
| 1989 | | 0.17 | 0.37 | 0.49 | 0.70 | 0.78 | 0.97 | 0.98 | 1.13 | 1.34 | 1.40 | | |
| 1990 | | 0.22 | 0.37 | 0.49 | 0.69 | 0.86 | 0.73 | | | | | 1.40 | 1.69 |
| 1991 | | 0.12 | 0.41 | 0.57 | 0.73 | 0.80 | | | | | | | |
| 1992 | | 0.34 | 0.38 | 0.50 | 0.66 | 0.86 | 0.92 | | | | | | |
| 1993 | | | 0.40 | 0.53 | 0.59 | 0.92 | 1.22 | 1.22 | 1.59 | | | | |

### FALL RECREATIONAL LANDINGS, ALL AREAS COMBINED

| | AGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1985 | 0.10 | 0.24 | 0.42 | 0.66 | | | | | | |
| 1986 | 0.15 | 0.32 | 0.48 | 0.90 | 1.15 | | 0.66 | | | |
| 1987 | 0.07 | 0.27 | 0.42 | 0.71 | 0.80 | 1.01 | | | | |
| 1988 | 0.03 | 0.13 | 0.35 | 0.48 | 0.81 | 0.72 | | | | 2.63 |
| 1989 | 0.12 | 0.27 | 0.47 | 0.60 | 1.05 | 0.60 | | | | |
| 1990 | 0.12 | 0.25 | 0.30 | 0.36 | 0.57 | | 0.82 | 1.08 | 1.24 | 1.76 |
| 1991 | 0.15 | 0.27 | 0.44 | 0.66 | 0.96 | | 1.46 | | 1.56 | |
| 1992 | 0.05 | 0.29 | 0.36 | 0.54 | 0.96 | 1.28 | 1.56 | | | |
| 1993 | 0.22 | 0.29 | 0.49 | 0.62 | | 1.11 | 1.19 | | 1.99 | 2.36 |

### RECREATIONAL DISCARDS

| | AGE | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1985 | 0.16 | 0.27 | 0.37 | 0.49 | 0.55 | 0.97 |
| 1986 | 0.03 | 0.17 | 0.26 | 0.37 | 0.59 | 0.79 |
| 1987 | 0.03 | 0.18 | 0.29 | 0.38 | 0.57 | 0.84 |
| 1988 | 0.04 | 0.17 | 0.25 | 0.32 | 0.46 | 0.90 |
| 1989 | 0.02 | 0.15 | 0.25 | 0.35 | 0.45 | 0.60 |
| 1990 | 0.03 | 0.12 | 0.26 | 0.37 | 0.51 | 0.92 |
| 1991 | 0.04 | 0.23 | 0.27 | 0.37 | 0.49 | 0.70 |
| 1992 | 0.03 | 0.16 | 0.30 | 0.39 | 0.44 | 0.66 |
| 1993 | 0.03 | 0.21 | 0.32 | 0.43 | 0.51 | 0.71 |

Table 10. Winter flounder NEFSC survey index stratified mean number and mean weight (kgs) per tow for the Southern New England- Mid-Atlantic stock complex, strata set (offshore 1-12, 25, 69-76 ; inshore 1-29, 45 - 56).

| | Spring | | Fall | |
|---|---|---|---|---|
| YEAR | Number | Weight | Number | Weight |
| 1963 | | | 8.554 | 3.283 |
| 1964 | | | 13.673 | 4.894 |
| 1965 | | | 15.537 | 4.435 |
| 1966 | | | 9.843 | 3.275 |
| 1967 | | | 9.109 | 2.745 |
| 1968 | 2.444 | 0.734 | 8.106 | 2.191 |
| 1969 | 5.640 | 3.414 | 6.842 | 1.939 |
| 1970 | 2.729 | 1.326 | 5.110 | 2.376 |
| 1971 | 2.035 | 0.756 | 3.862 | 1.232 |
| 1972 | 1.866 | 0.656 | 7.687 | 3.054 |
| 1973 | 7.459 | 2.013 | 2.691 | 0.776 |
| 1974 | 3.362 | 1.043 | 2.032 | 0.821 |
| 1975 | 1.136 | 0.354 | 2.358 | 0.742 |
| 1976 | 3.085 | 0.805 | 2.375 | 1.251 |
| 1977 | 4.168 | 1.190 | 4.722 | 1.735 |
| 1978 | 6.696 | 1.758 | 3.743 | 1.430 |
| 1979 | 2.965 | 1.069 | 10.058 | 2.606 |
| 1980 | 15.250 | 3.533 | 10.471 | 3.307 |
| 1981 | 18.234 | 4.762 | 10.205 | 3.109 |
| 1982 | 6.986 | 1.918 | 4.928 | 1.683 |
| 1983 | 6.262 | 2.469 | 8.757 | 2.691 |
| 1984 | 5.523 | 2.072 | 2.681 | 0.887 |
| 1985 | 5.360 | 1.983 | 2.727 | 0.991 |
| 1986 | 2.266 | 0.766 | 1.538 | 0.487 |
| 1987 | 1.763 | 0.568 | 1.167 | 0.419 |
| 1988 | 2.126 | 0.730 | 1.246 | 0.530 |
| 1989 | 2.485 | 0.582 | 1.435 | 0.341 |
| 1990 | 1.992 | 0.472 | 1.979 | 0.546 |
| 1991 | 2.473 | 0.692 | 1.950 | 0.708 |
| 1992 | 1.579 | 0.435 | 2.963 | 0.829 |
| 1993 | 0.961 | 0.219 | 1.382 | 0.392 |
| 1994 | 1.510 | 0.329 | 4.134 | 1.482 |
| 1995 | 2.097 | 0.592 | 2.248 | 0.672 |

NOTE: 1968-1972 spring index does not include inshore strata

1963-1971 fall index does not include inshore strata

Table 11. Winter flounder mean number per tow for annual state surveys.

| Year | MADMF spring | RIDFW spring | CTDEP | NYDEC (age 0-1) | NJDEP (April) |
|---|---|---|---|---|---|
| 1978 | 51.50 | | | | |
| 1979 | 53.61 | 130.19 | | | |
| 1980 | 38.92 | 68.41 | | | |
| 1981 | 46.05 | 98.03 | | | |
| 1982 | 40.23 | 41.48 | | | |
| 1983 | 56.39 | 62.98 | | | |
| 1984 | 36.64 | 45.55 | 110.76 | | |
| 1985 | 38.36 | 44.13 | 83.26 | 2.71 | |
| 1986 | 36.51 | 49.74 | 63.73 | | |
| 1987 | 37.84 | 59.53 | 79.83 | 2.62 | |
| 1988 | 27.57 | 34.93 | 137.63 | 2.02 | |
| 1989 | 24.42 | 21.60 | 148.18 | 4.72 | 86.25 |
| 1990 | 25.75 | 20.36 | 222.96 | 4.53 | 32.59 |
| 1991 | 10.57 | 32.04 | 150.28 | 6.17 | 51.77 |
| 1992 | 28.69 | 9.82 | 61.25 | 12.54 | 18.24 |
| 1993 | 46.92 | 8.22 | 63.57 | 10.20 | 23.39 |
| 1994 | 48.43 | 10.05 | 84.59 | 5.61 | 17.88 |
| 1995 | | 32.47 | 48.13 | | 49.37 |

Table 12. State survey indices for young-of-year winter flounder in Southern New England/ Mid-Atlantic stock complex.

| | CTDEP | RIDFW | DEL | MADMF | NYDEC |
|---|---|---|---|---|---|
| 1975 | | | | 0.30 | |
| 1976 | | | | 0.32 | |
| 1977 | | | | 0.60 | |
| 1978 | | | | 0.34 | |
| 1979 | | 29.61 | | 0.49 | |
| 1980 | | 1.64 | | 0.40 | |
| 1981 | | 8.56 | | 0.32 | |
| 1982 | | 10.10 | | 0.37 | |
| 1983 | | 1.98 | | 0.23 | |
| 1984 | | 3.06 | | 0.32 | |
| 1985 | | 5.08 | | 0.34 | 0.75 |
| 1986 | | 7.24 | 0.17 | 0.32 | |
| 1987 | | 0.63 | 0.09 | 0.27 | 0.97 |
| 1988 | 15.50 | 0.41 | 0.02 | 0.18 | 0.69 |
| 1989 | 1.90 | 1.15 | 0.29 | 0.42 | 1.67 |
| 1990 | 2.90 | 1.01 | 0.63 | 0.33 | 2.73 |
| 1991 | 5.20 | 1.44 | 0.03 | 0.27 | 2.48 |
| 1992 | 11.90 | 6.27 | 0.27 | 0.29 | 11.43 |
| 1993 | 5.60 | 0.16 | 0.04 | 0.07 | 4.66 |
| 1994 | 14.20 | 0.07 | 0.31 | 0.15 | 2.44 |
| 1995 | 10.10 | 0.98 | | 0.05 | |

Table 13. Results of tagging programs for winter flounder conducted in Long Island Sound and Narragansett Bay.

NUSCo. CT (Long Island Sound)

| Year | # Tagged | Survival | SE | F |
|---|---|---|---|---|
| 1983 | 5615 | | | |
| 1984 | 3973 | 0.308 | 0.041 | 0.977 |
| 1985 | 3350 | 0.531 | 0.068 | 0.432 |
| 1986 | 2887 | 0.313 | 0.041 | 0.962 |
| 1987 | 2463 | 0.653 | 0.079 | 0.226 |
| 1988 | 4106 | 0.430 | 0.064 | 0.643 |
| 1989 | 2589 | 0.365 | 0.046 | 0.808 |
| 1990 | 2135 | 0.358 | 0.042 | 0.828 |
| 1991 | 4067 | 0.872 | 0.108 | -0.063 |
| 1992 | 2119 | 0.146 | 0.023 | 1.728 |
| 1993 | 830 | 0.448 | 0.109 | 0.603 |
| 1994 | 959 | | | |

Rhode Island DFW (Narragansett Bay)

| Year | # Tagged | Survival | SE | F |
|---|---|---|---|---|
| 1986 | 939 | 0.366 | 0.054 | 0.805 |
| 1987 | 2829 | 0.207 | 0.031 | 1.377 |
| 1988 | 1875 | 0.120 | 0.024 | 1.919 |
| 1989 | 814 | 0.302 | 0.084 | 0.997 |
| 1990 | 580 | | | |

Table 14. NEFSC and state surveys mean number per tow at age for winter flounder in the Southern New England/Mid-Atlantic stock complex.

NEFSC Spring AGE

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | | 0.41 | 1.21 | 2.16 | 0.72 | 0.51 | 0.20 | 0.14 | 0.01 | | |
| 1986 | | 0.10 | 0.49 | 1.14 | 0.31 | 0.15 | 0.05 | 0.01 | | | 0.02 |
| 1987 | | 0.14 | 0.54 | 0.70 | 0.28 | 0.06 | 0.02 | | 0.01 | 0.01 | |
| 1988 | | 0.09 | 0.48 | 0.98 | 0.37 | 0.16 | 0.02 | 0.02 | | | |
| 1989 | | 0.14 | 0.94 | 0.90 | 0.34 | 0.11 | 0.02 | 0.02 | 0.01 | | |
| 1990 | | 0.23 | 0.49 | 0.91 | 0.28 | 0.05 | 0.04 | 0.01 | | | |
| 1991 | | 0.14 | 0.60 | 1.23 | 0.41 | 0.05 | 0.02 | 0.02 | 0.01 | | |
| 1992 | | 0.14 | 0.39 | 0.62 | 0.36 | 0.05 | 0.02 | | | | |
| 1993 | | 0.14 | 0.36 | 0.27 | 0.12 | 0.07 | 0.01 | 0.01 | | | |
| 1994 | | 0.16 | 0.76 | 0.43 | 0.11 | 0.04 | 0.02 | 0.01 | | | |

NEFSC Autumn AGE

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | | 0.16 | 1.18 | 0.99 | 0.30 | 0.09 | 0.01 | | | | |
| 1986 | | 0.22 | 0.90 | 0.36 | 0.03 | 0.01 | | 0.01 | | | |
| 1987 | | 0.03 | 0.64 | 0.36 | 0.12 | 0.02 | | | | | |
| 1988 | | 0.03 | 0.29 | 0.63 | 0.22 | 0.04 | 0.01 | 0.01 | | | |
| 1989 | | 0.28 | 0.82 | 0.26 | 0.05 | 0.01 | 0.01 | | | | |
| 1990 | | 0.07 | 0.88 | 0.84 | 0.15 | 0.01 | | | | | |
| 1991 | | 0.06 | 1.02 | 0.73 | 0.12 | 0.01 | | | | | |
| 1992 | | 0.15 | 1.74 | 0.79 | 0.26 | 0.03 | 0.01 | | | | |
| 1993 | | 0.42 | 0.50 | 0.34 | 0.08 | | | | | | |
| 1994 | | 0.44 | 2.22 | 1.08 | 0.30 | 0.04 | 0.03 | | | | |

Table 14 con't. Mean number per tow at age from NEFSC and state surveys for Southern New England-Mid Atlantic winter flounder stock complex.

Connecticut DEP Spring AGE

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | | 3.45 | 46.42 | 27.70 | 13.17 | 6.59 | 1.43 | 0.46 | 0.44 | 0.05 | 0.01 | 0.04 |
| 1985 | | 4.38 | 30.75 | 28.82 | 14.12 | 3.10 | 0.38 | 0.39 | 0.17 | 0.12 | 0.02 | 0.01 |
| 1986 | | 6.75 | 26.03 | 16.73 | 10.41 | 2.53 | 0.68 | 0.24 | 0.23 | 0.10 | 0.01 | 0.02 |
| 1987 | | 7.04 | 34.64 | 21.33 | 11.50 | 3.66 | 0.96 | 0.30 | 0.26 | 0.12 | 0.01 | 0.01 |
| 1988 | | 15.21 | 69.95 | 39.50 | 9.12 | 1.81 | 1.69 | 0.22 | 0.04 | 0.07 | 0.02 | 0.00 |
| 1989 | | 13.57 | 77.13 | 41.59 | 11.66 | 2.74 | 1.09 | 0.29 | 0.06 | 0.03 | 0.02 | 0.00 |
| 1990 | | 15.91 | 127.97 | 63.42 | 9.40 | 4.04 | 1.91 | 0.22 | 0.07 | 0.00 | 0.02 | 0.00 |
| 1991 | | 9.49 | 66.33 | 58.92 | 10.12 | 4.36 | 0.88 | 0.17 | 0.00 | 0.00 | 0.00 | 0.01 |
| 1992 | | 6.51 | 31.78 | 12.88 | 8.60 | 1.10 | 0.33 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1993 | | 18.73 | 20.21 | 15.32 | 5.06 | 3.17 | 0.76 | 0.16 | 0.11 | 0.04 | 0.01 | 0.00 |
| 1994 | | 9.97 | 63.49 | 6.33 | 2.90 | 1.19 | 0.47 | 0.17 | 0.05 | 0.01 | 0.01 | 0.00 |

Rhode Island DFW spring AGE

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1979 | 29.61 | 52.81 | 31.04 | 10.88 | 2.7 | 2.27 | 0.54 | 0.16 | 0.08 | 0.08 | 0.02 |
| 1980 | 1.64 | 16.48 | 33.51 | 12.88 | 1.93 | 1.52 | 0.27 | 0.09 | 0.04 | 0.04 | 0.01 |
| 1981 | 8.56 | 22.42 | 36.35 | 18.92 | 5.3 | 4.68 | 1.1 | 0.34 | 0.15 | 0.16 | 0.05 |
| 1982 | 10.10 | 8.86 | 8.55 | 6.44 | 3.1 | 2.85 | 0.85 | 0.36 | 0.15 | 0.16 | 0.06 |
| 1983 | 1.98 | 20.6 | 17.23 | 10.37 | 5.21 | 4.82 | 1.51 | 0.66 | 0.26 | 0.27 | 0.07 |
| 1984 | 3.06 | 4.11 | 16.51 | 11.63 | 4.33 | 3.98 | 1.08 | 0.41 | 0.18 | 0.2 | 0.06 |
| 1985 | 5.08 | 5.48 | 15.21 | 10.71 | 3.47 | 3.01 | 0.71 | 0.22 | 0.11 | 0.1 | 0.03 |
| 1986 | 7.24 | 10.77 | 14.04 | 8.81 | 3.61 | 3.37 | 1.01 | 0.47 | 0.18 | 0.19 | 0.05 |
| 1987 | 0.63 | 13.75 | 21.24 | 13.62 | 4.45 | 4.07 | 1.06 | 0.36 | 0.16 | 0.16 | 0.03 |
| 1988 | 0.41 | 6.66 | 10.3 | 11.46 | 3.8 | 1.23 | 0.81 | 0.19 | 0 | 0.04 | 0.03 |
| 1989 | 1.15 | 5.56 | 7 | 5.18 | 1.66 | 0.57 | 0.31 | 0.07 | 0.03 | 0.02 | 0.05 |
| 1990 | 1.01 | 4.28 | 6.04 | 5.75 | 2.14 | 0.74 | 0.25 | 0.08 | 0.02 | 0 | 0.05 |
| 1991 | 1.44 | 5.88 | 10.13 | 9.95 | 2.9 | 1.11 | 0.43 | 0.15 | 0 | 0 | 0.05 |
| 1992 | 6.27 | 0.92 | 0.98 | 0.84 | 0.57 | 0.16 | 0.05 | 0 | 0.01 | 0.01 | 0.01 |
| 1993 | 0.16 | 4.85 | 2.19 | 0.53 | -0.27 | 0.16 | 0.04 | 0.01 | 0.01 | 0 | 0 |
| 1994 | 0.07 | 1.81 | 4.77 | 1.66 | 1.18 | 0.34 | 0.16 | 0.05 | 0.01 | 0 | 0 |
| 1995 | 0.98 | 4.66 | 12.73 | 7.63 | 4.35 | 1.38 | 0.55 | 0.13 | 0.06 | 0 | 0 |

Table 14 con't. Mean number per tow at age from NEFSC and state surveys for Southern New England-Mid Atlantic winter flounder stock complex.

New York DEC

|  | AGE |  |
|---|---|---|
|  | 0 | 1 |
| 1985 | 0.75 | 1.96 |
| 1986 | - | - |
| 1987 | 0.97 | 1.65 |
| 1988 | 0.69 | 1.33 |
| 1989 | 1.67 | 3.05 |
| 1990 | 2.73 | 1.8 |
| 1991 | 2.48 | 3.69 |
| 1992 | 11.43 | 1.11 |
| 1993 | 4.66 | 5.54 |
| 1994 | 2.44 | 3.17 |

Massachusetts DMF spring

|  | AGE |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1978 |  | 9.90 | 9.70 | 15.71 | 9.31 | 3.14 | 1.09 | 1.33 | 0.51 | 0.81 |
| 1979 |  | 4.63 | 12.86 | 21.03 | 8.90 | 2.93 | 1.00 | 0.95 | 0.46 | 0.85 |
| 1980 |  | 1.63 | 8.21 | 14.48 | 9.13 | 3.01 | 0.96 | 0.79 | 0.28 | 0.43 |
| 1981 |  | 8.33 | 8.72 | 13.15 | 9.38 | 3.68 | 1.16 | 0.75 | 0.32 | 0.56 |
| 1982 |  | 2.68 | 6.23 | 15.98 | 9.22 | 3.32 | 1.00 | 0.83 | 0.41 | 0.56 |
| 1983 |  | 2.31 | 15.70 | 19.47 | 12.43 | 3.54 | 1.08 | 0.84 | 0.45 | 0.57 |
| 1984 |  | 1.23 | 6.92 | 14.12 | 10.14 | 2.64 | 0.72 | 0.51 | 0.17 | 0.19 |
| 1985 |  | 4.34 | 9.93 | 14.26 | 6.96 | 1.77 | 0.52 | 0.27 | 0.12 | 0.19 |
| 1986 |  | 3.62 | 8.07 | 17.42 | 5.37 | 1.21 | 0.35 | 0.27 | 0.08 | 0.12 |
| 1987 |  | 9.19 | 8.24 | 11.50 | 6.14 | 1.61 | 0.47 | 0.41 | 0.13 | 0.15 |
| 1988 |  | 2.91 | 7.06 | 13.71 | 3.05 | 0.53 | 0.15 | 0.08 | 0.02 | 0.06 |
| 1989 |  | 1.63 | 4.95 | 10.90 | 4.80 | 1.14 | 0.31 | 0.28 | 0.13 | 0.28 |
| 1990 |  | 4.18 | 10.66 | 7.60 | 2.87 | 0.30 | 0.02 | 0.10 | 0.00 | 0.02 |
| 1991 |  | 1.56 | 2.79 | 4.68 | 1.15 | 0.23 | 0.12 | 0.02 | 0.00 | 0.02 |
| 1992 |  | 7.78 | 7.55 | 6.68 | 4.16 | 1.64 | 0.59 | 0.07 | 0.08 | 0.14 |
| 1993 |  | 14.17 | 17.56 | 11.70 | 2.71 | 0.62 | 0.14 | 0.02 | 0.00 | 0.00 |
| 1994 |  | 11.37 | 16.12 | 14.65 | 4.66 | 0.61 | 0.58 | 0.37 | 0.05 | 0.02 |

Table 15. Virtual population analysis of winter flounder in Southern New England - Mid Atlantic stock complex.

```
INPUT PARAMETERS AND OPTIONS SELECTED
-----------------------------------
Natural mortality is 0.2  Oldest age (not in the plus group) is 6

For all yrs prior to the terminal year (1993), backcalculated stock sizes for the following ages used to estimate
total mortality (Z) for age 6:    4 5 6
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 7+ is then calculated from the ratio of F[age 7+] to F[age 6]= 1.000
Stock size of the 7+ group is then calculated using the following method:  CATCHEQ

Partial recruitment estimate for 1993
         1     0.0500
         2     0.2000
         3     0.5000
         4     1.0000
         5     1.0000
         6     1.0000

Objective function is     SUM w*( LOG(OBS) - LOG(PRED) )**2

Indices normalized (by dividing by mean observed value) before tuning to VPA stocksizes.
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).

The following indices of abundance are available:
         1      NEFSC (RV) SPRING AGE 1       19       MA SPRING AGE 7
         2      NEFSC (RV) SPRING AGE 2       20       RI FALL AGE 0
         3      NEFSC (RV) SPRING AGE 3       21       RI SPRING AGE 1
         4      NEFSC (RV) SPRING AGE 4       22       RI SPRING AGE 2
         5      NEFSC (RV) SPRING AGE 5       23       RI SPRING AGE 3
         6      NEFSC (RV) SPRING AGE 6       24       RI SPRING AGE 4
         7      NEFSC (RV) SPRING AGE 7       25       RI SPRING AGE 5
         8      NEFSC (RV) FALL AGE 1         26       RI SPRING AGE 6
         9      NEFSC (RV) FALL AGE 2         27       RI SPRING AGE 7
        10      NEFSC (RV) FALL AGE 3         28       CT SPRING AGE 1
        11      NEFSC (RV) FALL AGE 4         29       CT SPRING AGE 2
        13      MA SPRING AGE 1               30       CT SPRING AGE 3
        14      MA SPRING AGE 2               31       CT SPRING AGE 4
        15      MA SPRING AGE 3               32       CT SPRING AGE 5
        16      MA SPRING AGE 4               33       CT SPRING AGE 6
        17      MA SPRING AGE 5               34       CT SPRING AGE 7
        18      MA SPRING AGE 6               44       MA SEINE AGE 0
                                              45       DEL SURVEY AGE 0

            Obs Indices (before transformation) by index & yr; with index means

   ■   1985    1986    1987    1988    1989     1990    1991    1992    1993    1994    *****
---+------------------------------------------------------------------------------------------
 1 ■   0.410   0.100   0.140   0.090   0.140    0.230   0.140   0.140   0.140   0.160   0.169
 2 ■   1.210   0.490   0.540   0.480   0.940    0.490   0.600   0.390   0.360   0.760   0.626
 3 ■   2.160   1.140   0.700   0.980   0.900    0.910   1.230   0.620   0.270   0.430   0.934
 4 ■   0.720   0.310   0.280   0.370   0.340    0.280   0.410   0.360   0.120   0.110   0.330
 5 ■   0.510   0.150   0.060   0.160   0.110    0.050   0.050   0.050   0.070   0.040   0.125
 6 ■   0.200   0.050   0.020   0.020   0.020    0.040   0.020   0.020   0.010   0.020   0.042
 7 ■   0.150   0.030   0.020   0.020   0.030    0.010   0.030   0.000   0.010   0.010   0.034
 8 ■   0.000   0.160   0.220   0.030   0.030    0.280   0.070   0.060   0.150   0.420   0.158
 9 ■   0.000   1.180   0.900   0.640   0.290    0.820   0.880   1.020   1.740   0.500   0.886
10 ■   0.000   0.990   0.360   0.360   0.630    0.260   0.840   0.730   0.790   0.340   0.589
11 ■   0.000   0.300   0.030   0.120   0.220    0.050   0.150   0.120   0.260   0.080   0.148
13 ■   4.340   3.620   9.190   2.910   1.630    4.180   1.560   7.780  14.170  11.370   6.075
14 ■   9.930   8.070   8.240   7.060   4.950   10.660   2.790   7.550  17.560  16.120   9.293
15 ■  14.260  17.420  11.500  13.710  10.900    7.600   4.680   6.680  11.700  14.650  11.310
16 ■   6.960   5.370   6.140   3.050   4.800    2.870   1.150   4.160   2.710   4.660   4.187
17 ■   1.770   1.210   1.610   0.530   1.140    0.300   0.230   1.640   0.620   0.610   0.966
18 ■   0.520   0.350   0.470   0.150   0.310    0.020   0.120   0.590   0.140   0.580   0.325
19 ■   0.580   0.470   0.690   0.160   0.690    0.120   0.040   0.290   0.020   0.440   0.350
20 ■   3.060   5.080   7.240   0.630   0.410    1.150   1.010   1.440   6.270   0.160   2.645
21 ■   5.580  10.770  13.750   6.660   5.560    4.280   5.880   0.920   4.850   1.810   6.006
22 ■  15.210  14.040  21.240  10.300   7.000    6.040  10.130   0.980   2.190   4.770   9.190
23 ■  10.710   8.810  13.620  11.460   5.180    5.750   9.950   0.840   0.530   1.660   6.851
24 ■   3.470   3.610   4.450   3.800   1.660    2.140   2.900   0.570   0.270   1.180   2.405
25 ■   3.010   3.370   4.070   1.230   0.570    0.740   1.110   0.160   0.160   0.340   1.476
26 ■   0.710   1.010   1.060   0.810   0.310    0.250   0.430   0.050   0.040   0.160   0.483
27 ■   0.460   0.890   0.710   0.260   0.170    0.150   0.200   0.030   0.020   0.060   0.295
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28 ▪    4.880    6.750    7.040   15.210   13.570    15.910    9.490    6.510   18.730    9.970    10.806
29 ▪   30.750   26.030   34.640   69.950   77.130   127.970   66.330   31.780   20.210   63.490    54.828
30 ▪   28.820   16.730   21.330   39.500   41.590    63.420   58.920   12.880   15.320    6.330    30.484
31 ▪   14.120   10.410   11.500    9.120   11.660     9.400   10.120    8.600    5.060    2.900     9.289
32 ▪    3.100    2.530    3.660    1.810    2.740     4.040    4.360    1.100    3.170    1.190     2.770
33 ▪    0.880    0.680    0.960    1.690    1.090     1.910    0.880    0.330    0.760    0.470     0.965
34 ▪    0.710    0.600    0.700    0.350    0.400     0.310    0.180    0.050    0.320    0.240     0.386
44 ▪    0.318    0.335    0.323    0.274    0.181     0.421    0.325    0.268    0.292    0.066     0.280
45 ▪    0.000    0.000    0.170    0.090    0.020     0.290    0.630    0.030    0.270    0.040     0.193

WEIGHTING USED IN THE OBJECTIVE FUNCTION BY INDEX AND YR (omega)= 1.00
DOWNWEIGHTS BY YEAR (delta) 1985 TO 1994 = 1.00
ITERATIVE RE-WEIGHTS BY INDEX (chi) = 1.00

                 CATCH AT AGE (thousands)

   ▪   1985   1986   1987   1988   1989   1990   1991   1992   1993
---+-----------------------------------------------------------------
1  ▪    277    215     73     84    463     36     53     25    274
2  ▪   7366   6327   5268   3941   5246   2109   3027   1503   2062
3  ▪  12836   9102   8999   9402   7176   6275   7140   4457   3329
4  ▪   6054   4216   3091   3964   3503   2931   3344   2581   1728
5  ▪   2953   1053   2703   1207    849    767    858    674    585
6  ▪   1843    442    755    979    222    196    251    162    157
7  ▪   1424    357    426    303    209    141    115     53    116
---+-----------------------------------------------------------------
1+▪   32753  21712  21316  19879  17667  12456  14788   9454   8251

                CAA summary for ages 2-5 3-5 4-5 5-5

   ▪   1985   1986   1987   1988   1989   1990   1991   1992   1993
---+-----------------------------------------------------------------
2  ▪  29208  20698  20061  18514  16774  12083  14370   9214   7703
3  ▪  21843  14371  14793  14573  11528   9974  11343   7712   5641
4  ▪   9006   5269   5794   5171   4352   3699   4203   3255   2312
5  ▪   2953   1053   2703   1207    849    767    858    674    585

               WT AT AGE (MID-YR) in kg.

   ▪  1985  1986  1987  1988   1989  1990   1991   1992   1993
---+------------------------------------------------------------
 1 ▪ 0.111 0.129 0.046 0.039  0.118 0.082  0.093  0.079  0.169
 2 ▪ 0.282 0.292 0.287 0.279  0.258 0.295  0.317  0.287  0.334
 3 ▪ 0.364 0.398 0.384 0.351  0.378 0.394  0.420  0.427  0.460
 4 ▪ 0.482 0.480 0.551 0.508  0.508 0.525  0.534  0.599  0.592
 5 ▪ 0.522 0.685 0.475 0.634  0.660 0.672  0.603  0.802  0.689
 6 ▪ 0.467 0.879 0.564 0.517  0.716 0.808  0.823  0.945  0.878
 7 ▪ 0.613 0.961 0.853 0.827  1.073 0.990  1.168  1.395  1.167

                  WT AT AGE (JAN 1) in kg.

   ▪  1985  1986  1987  1988   1989  1990   1991   1992   1993   1994
---+-------------------------------------------------------------------
 1 ▪ 0.068 0.086 0.019 0.015  0.075 0.042  0.053  0.038  0.176  0.050
 2 ▪ 0.237 0.180 0.192 0.113  0.100 0.187  0.161  0.163  0.162  0.162
 3 ▪ 0.317 0.335 0.335 0.317  0.325 0.319  0.352  0.368  0.363  0.687
 4 ▪ 0.404 0.418 0.468 0.442  0.422 0.445  0.459  0.502  0.503  0.582
 5 ▪ 0.402 0.575 0.477 0.591  0.579 0.584  0.563  0.654  0.642  0.697
 6 ▪ 0.494 0.677 0.622 0.496  0.674 0.730  0.744  0.755  0.839  0.739
 7 ▪ 0.613 0.961 0.853 0.827  1.073 0.990  1.168  1.395  1.167  1.167

            PERCENT MATURE (females)

   ▪ 1985 1986 1987 1988 1989 1990 1991 1992 1993
---+---------------------------------------------
 1 ▪    0    0    0    0    0    0    0    0    0
 2 ▪    0    0    0    0    0    0    0    0    0
 3 ▪   53   53   53   53   53   53   53   53   53
 4 ▪   95   95   95   95   95   95   95   95   95
 5 ▪  100  100  100  100  100  100  100  100  100
 6 ▪  100  100  100  100  100  100  100  100  100
 7 ▪  100  100  100  100  100  100  100  100  100

                 SEX RATIO (Percent Female)

              ▪ 1985 1986 1987 1988 1989 1990 1991 1992 1993
           ---+---------------------------------------------
AGES 1-7+ ▪     50   50   50   50   50   50   50   50   50
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RESULTS
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APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES ..............      160.028936
ORTHOGONALITY OFFSET.........        0.001730
MEAN SQUARE RESIDUALS .......        0.531658
               PAR. EST.        STD. ERR.        T-STATISTIC        C.V.
               ---------        ---------        -----------        ----
N 1            1.13863E4        3.36138E3        3.38740E0          0.30
N 2            3.19974E4        7.26557E3        4.40398E0          0.23
N 3            8.17072E3        1.77745E3        4.59688E0          0.22
N 4            3.83582E3        9.78661E2        3.91946E0          0.26
N 5            9.95556E2        3.12932E2        3.18138E0          0.31
N 6            5.15184E2        1.58402E2        3.25237E0          0.31
N 7            1.10696E2        4.14315E1        2.67178E0          0.37
qRV SPR 1      4.07078E-5       9.63515E-6       4.22492E0          0.24
qRV SPR 2      4.58066E-5       1.07319E-5       4.26826E0          0.23
qRV SPR 3      6.45843E-5       1.50762E-5       4.28385E0          0.23
qRV SPR 4      1.60543E-4       3.75108E-5       4.27991E0          0.23
qRV SPR 5      3.94543E-4       9.26076E-5       4.26037E0          0.23
qRV SPR 6      1.03675E-3       2.44153E-4       4.24633E0          0.24
qRV SPR 7      1.62308E-3       4.09160E-4       3.96687E0          0.25
qRV FAL 1      3.56164E-5       8.80646E-6       4.04435E0          0.25
qRV FAL 2      7.21348E-5       1.77640E-5       4.06074E0          0.25
qRV FAL 3      1.76514E-4       4.35130E-5       4.05659E0          0.25
qRV FAL 4      4.96510E-4       1.23018E-4       4.03607E0          0.25
qMA SPR 1      3.48712E-5       8.25369E-6       4.22492E0          0.24
qMA SPR 2      4.36873E-5       1.02354E-5       4.26826E0          0.23
qMA SPR 3      6.95378E-5       1.62325E-5       4.28385E0          0.23
qMA SPR 4      1.64247E-4       3.83764E-5       4.27991E0          0.23
qMA SPR 5      4.54889E-4       1.06772E-4       4.26037E0          0.23
qMA SPR 6      1.12782E-3       2.65600E-4       4.24633E0          0.24
qMA SPR 7      1.79700E-3       4.29208E-4       4.18679E0          0.24
qRI FAL 0      2.49809E-5       5.91275E-6       4.22492E0          0.24
qRI SPR 1      3.56451E-5       8.43687E-6       4.22492E0          0.24
qRI SPR 2      3.62829E-5       8.50062E-6       4.26826E0          0.23
qRI SPR 3      4.86152E-5       1.13485E-5       4.28385E0          0.23
qRI SPR 4      1.37897E-4       3.22197E-5       4.27991E0          0.23
qRI SPR 5      3.23864E-4       7.60178E-5       4.26037E0          0.23
qRI SPR 6      9.90564E-4       2.33276E-4       4.24633E0          0.24
qRI SPR 7      8.76000E-4       2.06296E-4       4.24633E0          0.24
qCT SPR 1      4.09188E-5       9.68510E-6       4.22492E0          0.24
qCT SPR 2      4.21006E-5       9.86363E-6       4.26826E0          0.23
qCT SPR 3      5.98792E-5       1.39779E-5       4.28385E0          0.23
qCT SPR 4      1.68385E-4       3.93432E-5       4.27991E0          0.23
qCT SPR 5      5.09461E-4       1.19581E-4       4.26037E0          0.23
qCT SPR 6      1.39870E-3       3.29391E-4       4.24633E0          0.24
qCT SPR 7      2.32618E-3       5.55600E-4       4.18679E0          0.24
qMA SEI 0      4.08999E-5       9.68063E-6       4.22492E0          0.24
qDEL SV 0      2.77800E-5       7.38940E-6       3.75945E0          0.27

CATCHABILITY ESTIMATES IN ORIGINAL UNITS
               ESTIMATE         STD. ERR.             C.V.
               ----------       ----------            ------
qRV SPR 1      6.87961E-6       1.62834E-6            0.24
qRV SPR 2      2.86749E-5       6.71817E-6            0.23
qRV SPR 3      6.03218E-5       1.40812E-5            0.23
qRV SPR 4      5.29791E-5       1.23786E-5            0.23
qRV SPR 5      4.93179E-5       1.15760E-5            0.23
qRV SPR 6      4.35436E-5       1.02544E-5            0.24
qRV SPR 7      5.59062E-5       1.40933E-5            0.25
qRV FAL 1      5.61948E-6       1.38946E-6            0.25
qRV FAL 2      6.38794E-5       1.57310E-5            0.25
qRV FAL 3      1.03947E-4       2.56243E-5            0.25
qRV FAL 4      7.33731E-5       1.81794E-5            0.25
qMA SPR 1      2.11842E-4       5.01411E-5            0.24
qMA SPR 2      4.05986E-4       9.51174E-5            0.23
qMA SPR 3      7.86472E-4       1.83590E-4            0.23
qMA SPR 4      6.87704E-4       1.60682E-4            0.23
qMA SPR 5      4.39423E-4       1.03142E-4            0.23
qMA SPR 6      3.66543E-4       8.63200E-5            0.24
qMA SPR 7      6.28951E-4       1.50223E-4            0.24
qRI FAL 0      6.60745E-5       1.56392E-5            0.24
qRI SPR 1      2.14085E-4       5.06719E-5            0.24
qRI SPR 2      3.33440E-4       7.81207E-5            0.23
qRI SPR 3      3.33062E-4       7.77483E-5            0.23
qRI SPR 4      3.31643E-4       7.74885E-5            0.23
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qRI SPR 5    4.78024E-4      1.12202E-4         0.23
qRI SPR 6    4.78443E-4      1.12672E-4         0.24
qRI SPR 7    2.58420E-4      6.08573E-5         0.24
qCT SPR 1    4.42169E-4      1.04657E-4         0.24
qCT SPR 2    2.30829E-3      5.40803E-4         0.23
qCT SPR 3    1.82536E-3      4.26102E-4         0.23
qCT SPR 4    1.56413E-3      3.65459E-4         0.23
qCT SPR 5    1.41121E-3      3.31240E-4         0.23
qCT SPR 6    1.34975E-3      3.17862E-4         0.24
qCT SPR 7    8.97905E-4      2.14462E-4         0.24
qMA SEI 0    1.14642E-5      2.71348E-6         0.24
qDEL SV 0    5.34766E-6      1.42246E-6         0.27

CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

      N 1 * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 2 . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 3 . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 4 . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 5 . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 6 . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      N 7 . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 1 . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 2 . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 3 . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 4 . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 5 . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 6 . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV SPR 7 . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV FAL 1 . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV FAL 2 . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . . .
qRV FAL 3 . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . . .
qRV FAL 4 . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . . .
qMA SPR 1 . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . .
qMA SPR 2 . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . .
qMA SPR 3 . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . .
qMA SPR 4 . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . .
qMA SPR 5 . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . .
qMA SPR 6 . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . .
qMA SPR 7 . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . .
qRI FAL 0 . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . .
qRI SPR 1 . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . .
qRI SPR 2 . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . .
qRI SPR 3 . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . .
qRI SPR 4 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . .
qRI SPR 5 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . .
qRI SPR 6 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . .
qRI SPR 7 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . .
qCT SPR 1 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . .
qCT SPR 2 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . .
qCT SPR 3 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . . .
qCT SPR 4 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . .
qCT SPR 5 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . .
qCT SPR 6 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . .
qCT SPR 7 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * . .
qMA SEI 0 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . * .
qDEL SV 0 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *

SYMBOLS:  =  LARGE NEGATIVE CORRELATION     whenever  -1 <= R <  -L
          -  MODERATE NEGATIVE CORRELATION  whenever  -L <= R <  -M
          .  SMALL CORRELATION              whenever  -M <= R <= +M
          +  MODERATE POSITIVE CORRELATION  whenever  +M <  R <= +L
          *  LARGE POSITIVE CORRELATION     whenever  +L <  R <= +1
Where R is the estimated correlation, M is 0.2 and L is 0.5
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SUMMARY OF STANDARDIZED RESIDUALS

NEFSC SPRING  Index is tuned to the sum of Jan1 full stock sizes (in number) for ages 1 @ 1, ETC.
                                          AGE
 Year      1        2         3         4         5         6         7
 1985    0.7450   0.5283    0.3900    0.4101    1.1101    0.6099    0.2541
 1986   -1.1161  -0.6816    0.1583   -0.7948    0.1265    0.0629   -0.6701
 1987   -0.3349  -0.4767   -0.5457   -0.0671   -1.8645   -1.4457   -0.9787
 1988   -0.9811  -0.3242   -0.0670    0.2080    0.8485   -1.5603   -0.2603
 1989   -0.1778   0.5578    0.1076    0.2216    0.7127    0.4185    0.7465
 1990    0.9141  -0.1125    0.1911    0.1318   -0.3418    1.4556   -0.3035
 1991    0.4588   0.5489    0.5883    0.5809   -0.3178    0.2945    1.6145
 1992    0.4182   0.1859    0.2219    0.5928   -0.1393    0.7295      -
 1993   -0.9056   0.0327   -0.8574   -0.4415    0.1466   -0.4074   -0.3118
 1994    0.9795  -0.2583   -0.1872   -0.8418   -0.2811   -0.1574   -0.0908

Partial variance:
   1        2         3         4         5          6          7
 0.3569   0.1090    0.1023    0.1514    0.3800     0.4836     0.3340
----------------------------------------------------------------------------------------------
NEFSC FALL Index is tuned to the sum of Jan1 full stock sizes (in number) (i.e. age 1 index tuned to age 2 catch)
                          AGE
 Year      1        2         3         4
 1986    0.0184   0.1270   -0.1267    0.5323
 1987    0.5270  -0.2796   -0.6468   -3.3600
 1988   -1.8915  -0.7300   -0.7539   -0.0909
 1989   -1.9313  -1.5242    0.1431    1.1184
 1990    1.3552  -0.0303   -0.8941   -0.8866
 1991   -0.1625   0.0505    0.6402    0.6441
 1992   -0.1460   0.8261    0.6380    0.5165
 1993    1.0672   1.6193    1.2187    1.4014
 1994    1.1635  -0.0589   -0.2185    0.1247

Partial variance:
   1        2         3         4
 0.8154   0.4268    0.2844    1.1096
----------------------------------------------------------------------------------------------
MASS SPRING Index is tuned to the sum of Jan1 full stock sizes (in number): index age 1 to catch age 1.
                                   AGE
Year         1         2         3         4         5          6         7
 1985     -0.7195   -0.2196   -0.5433    0.0058   -0.1830    -1.0014   -1.2106
 1986     -0.8942   -0.4744    0.3760   -0.3991   -0.0098    -0.1901   -0.2159
 1987      0.7032   -0.3740   -0.2287    0.6520   -0.3525    -0.0377    0.5581
 1988     -0.9141   -0.2719    0.0296   -0.4147   -0.5085    -1.7186   -0.7278
 1989     -1.5117   -0.7986    0.0065    0.3368    0.9199     1.2557    1.7273
 1990      0.1909    0.4766   -0.4198   -0.1921   -0.8441    -2.4167   -0.2150
 1991     -0.9353   -0.9782   -1.1008   -1.5203   -1.2245    -0.1699   -1.3104
 1992      1.2279    0.6150   -0.0396    0.4333    1.6480     2.4494    2.2953
 1993      0.7264    1.7291    0.7898    0.3179    0.1385     0.2903   -2.6807
 1994      2.1264    0.2960    1.1302    0.7804    0.4559     1.5390    1.7796

Partial variance:
    1         2         3         4         5          6          7
  0.7492    0.3483    0.2284    0.2487    0.3919     1.2018     1.3728
----------------------------------------------------------------------------------------------
RI FALL Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1
          AGE
Year       0
 1985    0.3991
 1986    1.1683
 1987    1.9740
 1988   -1.4149
 1989   -1.8067
 1990    0.0188
 1991    0.0663
 1992    0.5122
 1993    1.2060
 1994   -2.1231

Partial variance : 1.0220
----------------------------------------------------------------------------------------------
RI SPRING Index is tuned to the sum of Jan1 full stock sizes (in number) for ages 1 to catch at age 1.
                                       AGE
Year        1         2         3          4         5         6         7
 1985   -0.3893    0.6352    0.2425     0.0515    0.4297   -0.9396   -0.6901
 1986    0.5866    0.5550    0.6194     0.0565    1.2795    0.8980    1.5693
 1987    1.2414    1.1946    1.1818     1.2107    0.8039    0.7123    1.0074
 1988    0.2070    0.5160    0.9622     0.8870    0.5307    0.2289   -0.4849
 1989    0.1567   -0.0534    0.1646    -0.1192   -0.1462    0.8903    0.9111
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 1990   0.2089  -0.0325   0.3761   0.4056    0.2387   0.6819   0.8260
 1991   0.8700   1.0603   1.1121   0.7484    0.8187   1.2151   1.0100
 1992  -1.7145  -1.9152  -1.7049  -1.2925   -1.6592  -1.3009  -1.1568
 1993  -0.7584  -0.8559  -2.2758  -1.8448   -1.8347  -1.7932  -1.8991
 1994  -0.4083  -1.1040  -0.6779  -0.1031   -0.4612  -0.5927  -1.0931

Partial variance :
     1        2          3         4          5         6         7
  0.3979   0.5530    0.7682   0.4883    0.5939    0.6188    0.7770
--------------------------------------------------------------------------------
CT SPRING Index is tuned to the sum of Jan1 full stock sizes (in number) for ages to catch at age 1.
                                   AGE
Year       1          2          3          4          5          6          7
 1985  -1.5678   -1.0529    -0.7331    -0.1509    -1.0145    -2.0676    -1.4215
 1986  -1.0489   -1.2518    -0.8342    -0.6182    -0.5984    -1.0670    -0.3693
 1987  -0.6715   -0.7881    -0.5361     0.3857    -0.8264    -0.8460     0.0896
 1988   0.3448    0.4998     0.3261    -0.0395    -0.4242    -0.1849    -0.1426
 1989   0.3856    0.5840     0.6883     0.4270     0.5225     1.1924     0.4913
 1990   1.0148    1.5016     1.3353     0.3081     1.0819     2.0482     0.5984
 1991   0.5318    0.9839     1.2182     0.3353     1.2104     0.7749     0.2641
 1992  -0.0257    0.2027    -0.2939     0.3024    -0.4998    -0.1353    -0.6037
 1993   0.0999   -0.4616     0.0047     0.0473     0.7763     0.8226     0.6336
 1994   0.9370   -0.2075    -1.1754    -0.9971    -0.2277    -0.5372     0.4601

 Partial variance:
   1          2          3          4          5          6          7
 0.3914    0.4469     0.4130     0.1228     0.3663     0.8074     0.2315
--------------------------------------------------------------------------------
MASS SEINE Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1.
           AGE
Year        0
 1985     -0.3039
 1986     -0.1584
 1987      0.1113
 1988     -0.1546
 1989     -0.5259
 1990      1.0428
 1991      0.9134
 1992      0.6084
 1993     -0.5978
 1994     -0.9353

Partial variance : 0.2389
--------------------------------------------------------------------------------
DELAWARE SURVEY Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1.
          AGE
Year       0
 1987    0.2768
 1988   -0.6356
 1989   -2.5011
 1990    1.5774
 1991    2.8670
 1992   -1.3490
 1993    0.3407
 1994   -0.5763

Partial l variance : 1.5412
--------------------------------------------------------------------------------
         Percent of total sum of squares by index & yr; with row/column sums

  ■     1985     1986   1987  1988   1989  1990   1991    1992   1993   1994   *******
---+-----------------------------------------------------------------------------
 1 ■    0.18     0.41   0.04  0.32   0.01  0.28   0.07    0.06   0.27   0.32   1.96
 2 ■    0.09     0.15   0.08  0.03   0.10  0.00   0.10    0.01   0.00   0.02   0.60
 3 ■    0.05     0.01   0.10  0.00   0.00  0.01   0.11    0.02   0.24   0.01   0.56
 4 ■    0.06     0.21   0.00  0.01   0.02  0.01   0.11    0.12   0.06   0.24   0.83
 5 ■    0.41     0.01   1.15  0.24   0.17  0.04   0.03    0.01   0.01   0.03   2.09
 6 ■    0.12     0.00   0.69  0.81   0.06  0.70   0.03    0.18   0.06   0.01   2.66
 7 ■    0.02     0.15   0.32  0.02   0.19  0.03   0.87  -99.00   0.03   0.00   1.63
 8 ■  -99.00     0.00   0.09  1.19   1.24  0.61   0.01    0.01   0.38   0.45   3.97
 9 ■  -99.00     0.01   0.03  0.18   0.77  0.00   0.00    0.23   0.87   0.00   2.08
10 ■  -99.00     0.01   0.14  0.19   0.01  0.27   0.14    0.14   0.49   0.02   1.39
11 ■  -99.00     0.09   3.75  0.00   0.42  0.26   0.14    0.09   0.65   0.01   5.41
13 ■    0.17     0.27   0.16  0.28   0.76  0.01   0.29    0.50   0.18   1.50   4.12
14 ■    0.02     0.07   0.05  0.02   0.21  0.08   0.32    0.13   0.99   0.03   1.92
15 ■    0.10     0.05   0.02  0.00   0.00  0.06   0.40    0.00   0.21   0.42   1.26
16 ■    0.00     0.05   0.14  0.06   0.04  0.01   0.77    0.06   0.03   0.20   1.37
17 ■    0.01     0.00   0.04  0.09   0.28  0.26   0.50    0.90   0.01   0.07   2.16
18 ■    0.33     0.01   0.00  0.98   0.52  1.94   0.01    1.99   0.03   0.79   6.61
```

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19 ■     0.49     0.02    0.10  0.18   0.99  0.02   0.57    1.75   2.39   1.05   7.55
20 ■     0.05     0.45    1.29  0.67   1.08  0.00   0.00    0.09   0.48   1.50   5.62
21 ■     0.05     0.11    0.51  0.01   0.01  0.01   0.25    0.98   0.19   0.06   2.19
22 ■     0.13     0.10    0.47  0.09   0.00  0.00   0.37    1.22   0.24   0.40   3.04
23 ■     0.02     0.13    0.46  0.31   0.01  0.05   0.41    0.97   1.72   0.15   4.22
24 ■     0.00     0.00    0.49  0.26   0.00  0.05   0.19    0.55   1.13   0.00   2.68
25 ■     0.06     0.54    0.21  0.09   0.01  0.02   0.22    0.91   1.12   0.07   3.27
26 ■     0.29     0.27    0.17  0.02   0.26  0.15   0.49    0.56   1.07   0.12   3.40
27 ■     0.16     0.82    0.34  0.08   0.28  0.23   0.34    0.44   1.20   0.40   4.27
28 ■     0.82     0.37    0.15  0.04   0.05  0.34   0.09    0.00   0.00   0.29   2.15
29 ■     0.37     0.52    0.21  0.08   0.11  0.75   0.32    0.01   0.07   0.01   2.46
30 ■     0.18     0.23    0.10  0.04   0.16  0.59   0.49    0.03   0.00   0.46   2.27
31 ■     0.01     0.13    0.05  0.00   0.06  0.03   0.04    0.03   0.00   0.33   0.68
32 ■     0.34     0.12    0.23  0.06   0.09  0.39   0.49    0.08   0.20   0.02   2.01
33 ■     1.42     0.38    0.24  0.01   0.47  1.39   0.20    0.01   0.22   0.10   4.44
34 ■     0.67     0.05    0.00  0.01   0.08  0.12   0.02    0.12   0.13   0.07   1.27
44 ■     0.03     0.01    0.00  0.01   0.09  0.36   0.28    0.12   0.12   0.29   1.31
45 ■   -99.00   -99.00    0.03  0.13   2.08  0.83   2.73    0.60   0.04   0.11   6.55
** ■     6.66     5.74   11.85  6.50  10.63  9.91  11.41   12.91  14.85   9.54 100.00
```

```
            Partial variance (and proportion of total) by index

   ■   1       2       3       4       5       6       7       8       9       10      11      13
---+------------------------------------------------------------------------------------------------
** ■ 0.3569  0.1090  0.1023  0.1514  0.3800  0.4836  0.3340  0.8154  0.4268  0.2844  1.1096  0.7492
** ■ 0.0189  0.0058  0.0054  0.0080  0.0201  0.0256  0.0177  0.0432  0.0226  0.0151  0.0588  0.0397

   ■   14      15      16      17      18      19      20      21      22      23      24      25
---+------------------------------------------------------------------------------------------------
** ■ 0.3483  0.2284  0.2487  0.3919  1.2018  1.3728  1.0220  0.3979  0.5530  0.7682  0.4883  0.5939
** ■ 0.0185  0.0121  0.0132  0.0208  0.0637  0.0727  0.0542  0.0211  0.0293  0.0407  0.0259  0.0315

   ■   26      27      28      29      30      31      32      33      34      44      45    *********
---+--------------------------------------------------------------------------------------------------
** ■ 0.6188  0.7770  0.3914  0.4469  0.4130  0.1228  0.3663  0.8074  0.2315  0.2389  1.5412  18.8729
** ■ 0.0328  0.0412  0.0207  0.0237  0.0219  0.0065  0.0194  0.0428  0.0123  0.0127  0.0817   1.0000
```

```
            STOCK NUMBERS (Jan 1) in thousands

   ■    1985   1986   1987   1988   1989   1990   1991   1992   1993   1994
---+----------------------------------------------------------------------------
 1 ■   34619  32799  25979  26752  23167  17168  14564  15001  39385  11386
 2 ■   28706  28093  26659  21203  21827  18549  14023  11877  12259  31997
 3 ■   26945  16838  17275  17060  13794  13124  13278   8743   8364   8171
 4 ■   10078  10446   5550   6001   5460   4801   5067   4410   3125   3836
 5 ■    4603   2773   4738   1747   1327   1301   1278   1122   1275    996
 6 ■    2944   1097   1318   1433    339    318    371    270    309    515
 7 ■    2229    875    730    432    311    223    165     86    225    191
---+-------------------------------------------------------------------------
 1+■  110125  92921  82249  74629  66225  55483  48747  41509  64942  57092
```

```
               Summaries for ages 2-5  3-5  4-5  5-5

   ■   1985   1986   1987   1988   1989   1990   1991   1992   1993   1994
---+----------------------------------------------------------------------------
 2 ■  70332  58150  54222  46012  42407  37774  33646  26152  25024  45000
 3 ■  41626  30058  27563  24808  20580  19225  19623  14275  12765  13002
 4 ■  14681  13219  10288   7749   6787   6101   6345   5533   4401   4831
 5 ■   4603   2773   4738   1747   1327   1301   1278   1122   1275    996
```

```
            FISHING MORTALITY
   ■  1985  1986  1987  1988  1989  1990  1991  1992  1993
---+----------------------------------------------------
 1 ■  0.01  0.01  0.00  0.00  0.02  0.00  0.00  0.00  0.01
 2 ■  0.33  0.29  0.25  0.23  0.31  0.13  0.27  0.15  0.21
 3 ■  0.75  0.91  0.86  0.94  0.86  0.75  0.90  0.83  0.58
 4 ■  1.09  0.59  0.96  1.31  1.23  1.12  1.31  1.04  0.94
 5 ■  1.23  0.54  1.00  1.44  1.23  1.06  1.36  1.09  0.71
 6 ■  1.18  0.59  1.00  1.41  1.29  1.15  1.38  1.09  0.83
 7 ■  1.18  0.59  1.00  1.41  1.29  1.15  1.38  1.09  0.83
```

```
          Avg F for ages 2-5  3-5  4-5  5-5

   ■  1985  1986  1987  1988  1989  1990  1991  1992  1993
---+-----------------------------------------------------
 2 ■  0.85  0.58  0.76  0.98  0.91  0.77  0.96  0.78  0.61
 3 ■  1.02  0.68  0.94  1.23  1.11  0.98  1.19  0.99  0.74
 4 ■  1.16  0.57  0.98  1.38  1.23  1.09  1.33  1.07  0.83
 5 ■  1.23  0.54  1.00  1.44  1.23  1.06  1.36  1.09  0.71

          BACKCALCULATED PARTIAL RECRUITMENT

   ■ 1985  1986  1987  1988  1989  1990  1991  1992  1993
---+------------------------------------------------------
 1 ■ 0.01  0.01  0.00  0.00  0.02  0.00  0.00  0.00  0.01
 2 ■ 0.27  0.31  0.25  0.16  0.24  0.12  0.20  0.14  0.22
 3 ■ 0.61  1.00  0.85  0.65  0.66  0.65  0.65  0.76  0.61
 4 ■ 0.88  0.65  0.95  0.91  0.96  0.98  0.95  0.96  1.00
 5 ■ 1.00  0.60  0.99  1.00  0.95  0.92  0.98  1.00  0.75
 6 ■ 0.95  0.65  1.00  0.98  1.00  1.00  1.00  1.00  0.88
 7 ■ 0.95  0.65  1.00  0.98  1.00  1.00  1.00  1.00  0.88

                        MEAN BIOMASS (MT)

   ■    1985    1986    1987    1988    1989    1990    1991   1992    1993
---+----------------------------------------------------------------------
 1 ■    3468    3821    1081     944    2451    1274    1225   1073    6010
 2 ■    6274    6496    6172    4808    4414    4651    3543   2875    3366
 3 ■    6338    4048    4095    3574    3221    3335    3379   2332    2672
 4 ■    2729    3465    1813    1573    1473    1398    1397   1514    1102
 5 ■    1276    1340    1313     544     466     498     391    506     578
 6 ■     747     667     432     369     126     141     153    143     170
 7 ■     742     581     362     178     174     121      97     68     164
---+----------------------------------------------------------------------
1+■    21573   20419   15268   11990   12325   11419   10186   8511   14061


              Summaries for ages 2-5  3-5  4-5  5-5

   ■    1985    1986    1987    1988   1989   1990   1991   1992   1993
---+-----------------------------------------------------------------
 2 ■   16616   15350   13392   10500   9573   9882   8710   7226   7718
 3 ■   10343    8854    7220    5691   5160   5231   5168   4351   4352
 4 ■    4005    4805    3126    2118   1939   1895   1788   2019   1680
 5 ■    1276    1340    1313     544    466    498    391    506    578


                 CATCH BIOMASS (MT)

   ■    1985   1986   1987   1988   1989   1990   1991   1992   1993
---+--------------------------------------------------------------
 1 ■      31     28      3      3     55      3      5      2     46
 2 ■    2092   1859   1521   1106   1363    625    965    433    692
 3 ■    4738   3683   3510   3357   2755   2507   3049   1932   1549
 4 ■    2975   2047   1733   2060   1818   1570   1827   1575   1040
 5 ■    1575    729   1307    784    573    526    530    551    408
 6 ■     879    393    434    518    162    162    212    156    140
 7 ■     873    343    364    250    224    139    134     74    135
---+--------------------------------------------------------------
1+■    13163   9082   8872   8079   6950   5532   6721   4723   4012
```

```
          Catch Biomass Summaries for ages 2-5  3-5  4-5  5-5

   ■   1985  1986  1987  1988  1989  1990  1991  1992  1993
---+-------------------------------------------------------
 2 ■  11380  8318  8071  7307  6509  5227  6371  4491  3690
 3 ■   9288  6459  6550  6201  5146  4603  5405  4058  2997
 4 ■   4550  2776  3040  2844  2391  2095  2357  2126  1449
 5 ■   1575   729  1307   784   573   526   530   551   408

         SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)

   ■   1985  1986  1987  1988  1989  1990  1991  1992  1993
---+-------------------------------------------------------
 1 ■      0     0     0     0     0     0     0     0     0
 2 ■      0     0     0     0     0     0     0     0     0
 3 ■   3865  2485  2570  2373  1991  1892  2061  1436  1414
 4 ■   3122  3636  2036  1958  1724  1629  1717  1709  1234
 5 ■   1458  1408  1853   786   605   616   555   592   704
 6 ■   1156   651   670   543   178   185   212   164   219
 7 ■   1086   737   510   274   261   176   148    97   221
---+-------------------------------------------------------
 1+■  10687  8917  7640  5934  4760  4500  4694  3999  3792
```

The above SSBs by age (a) and year (y) are calculated following the algorithm used in the NEFSC projection program, i.e.

$$SSB(a,y) = W(a,y) \times P(a,y) \times N(a,y) \times \exp[-Z(a,y)]$$

where $Z(a,y) = 0.1667 \times M(a,y) + 0.1667 \times F(a,y)$
$N(a,y)$ - Jan 1 stock size estimates (males & females)
$P(a,y)$ - proportion mature (generally females)
$W(a,y)$ - weight at age at the beginning of the spawning season

The W(a,y) are assumed to be the same as the Jan1 weight at age estimates (see "WT AT AGE" table in input section). Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

```
            MEAN STOCK NUMBERS (thousands)

   ■   1985   1986   1987   1988   1989   1990   1991   1992   1993
---+--------------------------------------------------------------
 1 ■  31242  29623  23510  24206  20773  15543  13175  13584  35563
 2 ■  22247  22247  21504  17234  17108  15767  11176  10018  10077
 3 ■  17412  10171  10663  10182   8521   8466   8046   5461   5809
 4 ■   5661   7220   3290   3097   2899   2662   2617   2527   1862
 5 ■   2444   1956   2763    858    706    741    648    631    839
 6 ■   1599    758    766    713    176    174    186    152    193
 7 ■   1210    605    425    215    162    122     83     49    140
---+--------------------------------------------------------------
 1+■  81816  72581  62922  56506  50345  43475  35931  32420  54483
```

Table 16. Results of bootstrap analysis of virtual population analysis of winter flounder in Southern New England/Mid-Atlantic stock.

```
SEED FOR THE RANDOM NUMBER GENERATOR:     74747        MAIN LOOP LIMIT IN MARQUARDT ALGORITHM:  50
NUMBER OF BOOTSTRAP REPLICATIONS ATTEMPTED:  200       NUMBER FOR WHICH NLLS CONVERGED:  200

Results from the converged replications are used for computing the statistics that follow.  Other replications are ignored.

N hat Age-specific stocksizes (on Jan 1, 1994) estimated by NLLS
                                                                                  NLLS EST       C.V FOR
NLLS        BOOTSTRAP      BOOTSTRAP      C.V. FOR      BIAS        BIAS     PERCENT   CORRECTED      CORRECTED
ESTIMATE      MEAN         STD ERROR      NLLS SOLN   ESTIMATE   STD ERROR     BIAS     FOR BIAS       ESTIMATE

1.139E4     1.173E4        2.982E3         0.26       3.389E2    2.109E2      2.98     1.105E4          0.27
3.200E4     3.359E4        6.837E3         0.21       1.594E3    4.835E2      4.98     3.040E4          0.22
8.171E3     8.436E3        1.766E3         0.22       2.651E2    1.249E2      3.24     7.906E3          0.22
3.836E3     3.914E3        9.118E2         0.24       7.812E1    6.448E1      2.04     3.758E3          0.24
9.956E2     1.067E3        2.661E2         0.27       7.093E1    1.882E1      7.12     9.247E2          0.29
5.152E2     5.122E2        1.378E2         0.27      -2.991E0    9.744E0     -0.58     5.182E2          0.27
1.107E2     1.154E2        3.912E1         0.35       4.655E0    2.766E0      4.20     1.061E2          0.37


q unscaled Catchability estimates (q) for each index of abundance used in the ADAPT run.  Note that these q's have been
re-scaled to original units.
                                                                                  NLLS EST     C.V FOR
NLLS       BOOTSTRAP      BOOTSTRAP      C.V. FOR      BIAS        BIAS      PERCENT   CORRECTED    CORRECTED
ESTIMATE     MEAN         STD ERROR      NLLS SOLN   ESTIMATE    STD ERROR   BIAS      FOR BIAS       ESTIMATE

6.880E-6   7.108E-6       1.570E-6         0.23     2.280E-7      1.110E-7    3.31      6.652E-6        0.24
2.867E-5   2.991E-5       6.578E-6         0.23     1.240E-6      4.651E-7    4.32      2.744E-5        0.24
6.032E-5   6.033E-5       1.272E-5         0.21     5.019E-9      8.994E-7    0.01      6.032E-5        0.21
5.298E-5   5.402E-5       1.232E-5         0.23     1.039E-6      8.708E-7    1.96      5.194E-5        0.24
4.932E-5   4.918E-5       1.171E-5         0.24    -1.422E-7      8.283E-7   -0.29      4.946E-5        0.24
4.354E-5   4.532E-5       1.093E-5         0.25     1.778E-6      7.728E-7    4.08      4.176E-5        0.26
5.590E-5   5.623E-5       1.355E-5         0.24     3.288E-7      9.584E-7    0.59      5.558E-5        0.24
5.619E-6   5.838E-6       1.301E-6         0.23     2.187E-7      9.201E-8    3.89      5.401E-6        0.24
6.388E-5   6.547E-5       1.421E-5         0.22     1.588E-6      1.005E-6    2.49      6.229E-5        0.23
1.039E-4   1.056E-4       2.228E-5         0.21     1.663E-6      1.576E-6    1.60      1.023E-4        0.22
7.337E-5   7.332E-5       1.720E-5         0.23    -5.027E-8      1.216E-6   -0.07      7.342E-5        0.23
2.118E-4   2.188E-4       4.850E-5         0.23     6.972E-6      3.429E-6    3.29      2.049E-4        0.24
4.060E-4   4.161E-4       8.751E-5         0.22     1.015E-5      6.188E-6    2.50      3.958E-4        0.22
7.865E-4   7.886E-4       1.751E-4         0.22     2.116E-6      1.238E-5    0.27      7.843E-4        0.22
6.877E-4   7.110E-4       1.451E-4         0.21     2.329E-5      1.026E-5    3.39      6.644E-4        0.22
4.394E-4   4.492E-4       9.421E-5         0.21     9.822E-6      6.662E-6    2.24      4.296E-4        0.22
3.665E-4   3.636E-4       7.321E-5         0.20    -2.977E-6      5.177E-6   -0.81      3.695E-4        0.20
6.289E-4   6.622E-4       1.381E-4         0.22     3.324E-5      9.766E-6    5.28      5.957E-4        0.23
6.607E-5   6.822E-5       1.560E-5         0.24     2.146E-6      1.103E-6    3.25      6.393E-5        0.24
2.141E-4   2.234E-4       5.016E-5         0.23     9.277E-6      3.547E-6    4.33      2.048E-4        0.24
3.334E-4   3.358E-4       7.744E-5         0.23     2.365E-6      5.476E-6    0.71      3.311E-4        0.23
3.331E-4   3.478E-4       7.448E-5         0.22     1.478E-5      5.266E-6    4.44      3.183E-4        0.23
3.316E-4   3.395E-4       6.888E-5         0.21     7.815E-6      4.871E-6    2.36      3.238E-4        0.21
4.780E-4   4.810E-4       1.098E-4         0.23     3.025E-6      7.766E-6    0.63      4.750E-4        0.23
4.784E-4   4.840E-4       1.092E-4         0.23     5.541E-6      7.719E-6    1.16      4.729E-4        0.23
2.584E-4   2.641E-4       5.758E-5         0.22     5.732E-6      4.072E-6    2.22      2.527E-4        0.23
4.422E-4   4.550E-4       1.043E-4         0.24     1.283E-5      7.373E-6    2.90      4.293E-4        0.24
2.308E-3   2.338E-3       5.228E-4         0.23     2.927E-5      3.697E-5    1.27      2.279E-3        0.23
1.825E-3   1.851E-3       4.032E-4         0.22     2.541E-5      2.851E-5    1.39      1.800E-3        0.22
1.564E-3   1.591E-3       3.561E-4         0.23     2.697E-5      2.518E-5    1.72      1.537E-3        0.23
1.411E-3   1.435E-3       3.036E-4         0.22     2.333E-5      2.147E-5    1.65      1.388E-3        0.22
1.350E-3   1.373E-3       3.140E-4         0.23     2.338E-5      2.220E-5    1.73      1.326E-3        0.24
8.979E-4   9.234E-4       2.010E-4         0.22     2.549E-5      1.421E-5    2.84      8.724E-4        0.23
1.146E-5   1.182E-5       3.028E-6         0.26     3.548E-7      2.141E-7    3.09      1.111E-5        0.27
5.348E-6   5.553E-6       1.236E-6         0.23     2.059E-7      8.740E-8    3.85      5.142E-6        0.24
```

### N t1 Full vector of age-specific stocksizes on Jan 1, 1994

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 1.139E4 | 1.173E4 | 2.982E3 | 0.26 | 3.389E2 | 2.109E2 | 2.98 | 1.105E4 | 0.27 |
| 3.200E4 | 3.359E4 | 6.837E3 | 0.21 | 1.594E3 | 4.835E2 | 4.98 | 3.040E4 | 0.22 |
| 8.171E3 | 8.436E3 | 1.766E3 | 0.22 | 2.651E2 | 1.249E2 | 3.24 | 7.906E3 | 0.22 |
| 3.836E3 | 3.914E3 | 9.118E2 | 0.24 | 7.812E1 | 6.448E1 | 2.04 | 3.758E3 | 0.24 |
| 9.956E2 | 1.067E3 | 2.661E2 | 0.27 | 7.093E1 | 1.882E1 | 7.12 | 9.247E2 | 0.29 |
| 5.152E2 | 5.122E2 | 1.378E2 | 0.27 | -2.991E0 | 9.744E0 | -0.58 | 5.182E2 | 0.27 |
| 1.912E2 | 1.992E2 | 6.780E1 | 0.35 | 8.093E0 | 4.794E0 | 4.23 | 1.831E2 | 0.37 |

### F t Full vector of age-specific terminal F's (in 1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 7.721E-3 | 7.664E-3 | 1.591E-3 | 0.21 | -5.759E-5 | 1.125E-4 | -0.75 | 7.779E-3 | 0.20 |
| 2.057E-1 | 2.071E-1 | 3.911E-2 | 0.19 | 1.358E-3 | 2.765E-3 | 0.66 | 2.044E-1 | 0.19 |
| 5.795E-1 | 5.894E-1 | 1.057E-1 | 0.18 | 9.896E-3 | 7.474E-3 | 1.71 | 5.696E-1 | 0.19 |
| 9.440E-1 | 9.290E-1 | 1.548E-1 | 0.16 | -1.498E-2 | 1.095E-2 | -1.59 | 9.589E-1 | 0.16 |
| 7.065E-1 | 7.371E-1 | 1.437E-1 | 0.20 | 3.064E-2 | 1.016E-2 | 4.34 | 6.758E-1 | 0.21 |
| 8.267E-1 | 8.501E-1 | 1.993E-1 | 0.24 | 2.335E-2 | 1.409E-2 | 2.82 | 8.034E-1 | 0.25 |
| 8.267E-1 | 8.501E-1 | 1.993E-1 | 0.24 | 2.335E-2 | 1.409E-2 | 2.82 | 8.034E-1 | 0.25 |

### F full t Fully-recruited F in the terminal year (1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 8.257E-1 | 8.387E-1 | 1.071E-1 | 0.13 | 1.300E-2 | 7.571E-3 | 1.57 | 8.127E-1 | 0.13 |

### PR t Partial recruitment vector in the terminal year (1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 8.180E-3 | 7.845E-3 | 2.105E-3 | 0.26 | -3.351E-4 | 1.489E-4 | -4.10 | 8.515E-3 | 0.25 |
| 2.179E-1 | 2.116E-1 | 5.086E-2 | 0.23 | -6.347E-3 | 3.597E-3 | -2.91 | 2.243E-1 | 0.23 |
| 6.139E-1 | 6.005E-1 | 1.339E-1 | 0.22 | -1.337E-2 | 9.471E-3 | -2.18 | 6.273E-1 | 0.21 |
| 1.000E0 | 9.333E-1 | 1.085E-1 | 0.11 | -6.671E-2 | 7.673E-3 | -6.67 | 1.067E0 | 0.10 |
| 7.484E-1 | 7.459E-1 | 1.486E-1 | 0.20 | -2.500E-3 | 1.051E-2 | -0.33 | 7.509E-1 | 0.20 |
| 8.758E-1 | 8.511E-1 | 1.508E-1 | 0.17 | -2.469E-2 | 1.067E-2 | -2.82 | 9.005E-1 | 0.17 |
| 8.758E-1 | 8.511E-1 | 1.508E-1 | 0.17 | -2.469E-2 | 1.067E-2 | -2.82 | 9.005E-1 | 0.17 |

### PR mean Average partial recruitment over 1991-1993

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 3.439E-3 | 3.326E-3 | 4.295E-4 | 0.12 | -1.132E-4 | 3.037E-5 | -3.29 | 3.552E-3 | 0.12 |
| 1.811E-1 | 1.757E-1 | 1.741E-2 | 0.10 | -5.420E-3 | 1.231E-3 | -2.99 | 1.865E-1 | 0.09 |
| 6.730E-1 | 6.541E-1 | 5.384E-2 | 0.08 | -1.889E-2 | 3.807E-3 | -2.81 | 6.919E-1 | 0.08 |
| 9.668E-1 | 9.337E-1 | 4.851E-2 | 0.05 | -3.311E-2 | 3.430E-3 | -3.42 | 9.999E-1 | 0.05 |
| 9.020E-1 | 8.848E-1 | 5.585E-2 | 0.06 | -1.727E-2 | 3.949E-3 | -1.91 | 9.193E-1 | 0.06 |
| 9.558E-1 | 9.322E-1 | 5.584E-2 | 0.06 | -2.365E-2 | 3.948E-3 | -2.47 | 9.795E-1 | 0.06 |
| 9.558E-1 | 9.322E-1 | 5.584E-2 | 0.06 | -2.365E-2 | 3.948E-3 | -2.47 | 9.795E-1 | 0.06 |

B mean_t  Mean stock biomass during the terminal year (1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 1.406E4 | 1.455E4 | 1.713E3 | 0.12 | 4.878E2 | 1.212E2 | 3.47 | 1.357E4 | 0.13 |

SSBæf mean_t  Mean female SSB during the terminal year (1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 1.687E3 | 1.723E3 | 1.817E2 | 0.11 | 3.553E1 | 1.285E1 | 2.11 | 1.652E3 | 0.11 |

SSB spawn_t  SSB (males & females) at start of spawning season (1993)

| NLLS ESTIMATE | BOOTSTRAP MEAN | BOOTSTRAP STD ERROR | C.V. FOR NLLS SOLN | BIAS ESTIMATE | BIAS STD ERROR | PERCENT BIAS | NLLS EST CORRECTED FOR BIAS | C.V FOR CORRECTED ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| 3.792E3 | 3.856E3 | 3.254E2 | 0.09 | 6.365E1 | 2.301E1 | 1.68 | 3.728E3 | 0.09 |

Table 17. Yield per recruit and spawning stock biomass per recruit for winter flounder in Southern New England/ Mid-Atlantic stock complex.

Proportion of F before spawning: .200
Proportion of M before spawning: .200
Natural Mortality is Constant at: .200
Last age is a True Age;

Age-specific Input data for Yield per Recruit Analysis

| Age | Fish Mort Pattern | Nat Mort Pattern | Proportion Mature | Average Weights Stock | Average Weights Catch |
|---|---|---|---|---|---|
| 1 | .0050 | 1.0000 | .0000 | .116 | .116 |
| 2 | .1890 | 1.0000 | .0000 | .309 | .309 |
| 3 | .7390 | 1.0000 | .5300 | .443 | .443 |
| 4 | 1.0000 | 1.0000 | .9500 | .595 | .595 |
| 5 | 1.0000 | 1.0000 | 1.0000 | .743 | .743 |
| 6 | 1.0000 | 1.0000 | 1.0000 | .911 | .911 |
| 7 | 1.0000 | 1.0000 | 1.0000 | 1.095 | 1.095 |
| 8 | 1.0000 | 1.0000 | 1.0000 | 1.291 | 1.291 |
| 9 | 1.0000 | 1.0000 | 1.0000 | 1.467 | 1.467 |
| 10 | 1.0000 | 1.0000 | 1.0000 | 1.620 | 1.620 |
| 11 | 1.0000 | 1.0000 | 1.0000 | 1.748 | 1.748 |
| 12 | 1.0000 | 1.0000 | 1.0000 | 1.855 | 1.855 |
| 13 | 1.0000 | 1.0000 | 1.0000 | 1.941 | 1.941 |
| 14 | 1.0000 | 1.0000 | 1.0000 | 2.011 | 2.011 |
| 15 | 1.0000 | 1.0000 | 1.0000 | 2.067 | 2.067 |

Summary of Yield per Recruit Analysis for:
WINTER FLOUNDER

| | | |
|---|---|---|
| Slope of the Yield/Recruit Curve at F=0.00: --------> | | 3.053 |
| F level at slope=1/10 of the above slope (F0.1): ---> | | .217 |
| Yield/Recruit corresponding to F0.1: ---> | .2554 | |
| F level to produce maximum Yield/Recruit (Fmax): ---> | | .536 |
| Yield/Recruit corresponding to Fmax: ---> | .2821 | |

WINTER FLOUNDER YPR

| Fishing Mortality | Total Catch Number | Total Catch Weight | Total Stock Number | Total Stock Weight | Spawn Stock Number | Spawn Stock Weight | Percent Max. Spawn Potential |
|---|---|---|---|---|---|---|---|
| .000 | .00000 | .00000 | 5.2420 | 3.7669 | 2.9600 | 3.1148 | 1.0000 |
| .100 | .21893 | .18573 | 4.3519 | 2.5417 | 2.0732 | 1.9041 | .6113 |
| .200 | .33474 | .24961 | 3.8327 | 1.9001 | 1.5624 | 1.2787 | .4105 |
| F0.1 .217 | .34949 | .25545 | 3.7640 | 1.8208 | 1.4953 | 1.2020 | .3859 |
| .300 | .40491 | .27218 | 3.5016 | 1.5329 | 1.2409 | .9253 | .2970 |
| .400 | .45211 | .27992 | 3.2742 | 1.3048 | 1.0232 | .7086 | .2275 |
| .500 | .48630 | .28200 | 3.1086 | 1.1528 | .8670 | .5662 | .1818 |
| Fmax .536 | .49652 | .28211 | 3.0592 | 1.1099 | .8209 | .5264 | .1690 |
| .600 | .51244 | .28184 | 2.9823 | 1.0455 | .7499 | .4671 | .1500 |
| .700 | .53320 | .28076 | 2.8824 | .9660 | .6588 | .3948 | .1267 |
| .800 | .55020 | .27934 | 2.8010 | .9049 | .5860 | .3401 | .1092 |
| .900 | .56444 | .27780 | 2.7332 | .8563 | .5265 | .2974 | .0955 |
| 1.000 | .57659 | .27627 | 2.6757 | .8168 | .4770 | .2633 | .0845 |
| 1.100 | .58714 | .27479 | 2.6261 | .7840 | .4352 | .2354 | .0756 |
| 1.200 | .59640 | .27338 | 2.5827 | .7562 | .3994 | .2123 | .0682 |
| 1.300 | .60464 | .27205 | 2.5444 | .7323 | .3684 | .1928 | .0619 |
| 1.400 | .61202 | .27080 | 2.5102 | .7116 | .3414 | .1762 | .0566 |
| 1.500 | .61870 | .26962 | 2.4794 | .6933 | .3175 | .1619 | .0520 |
| 1.600 | .62478 | .26850 | 2.4514 | .6770 | .2963 | .1494 | .0480 |
| 1.700 | .63035 | .26746 | 2.4259 | .6625 | .2774 | .1385 | .0444 |
| 1.800 | .63549 | .26647 | 2.4025 | .6494 | .2604 | .1288 | .0413 |
| 1.900 | .64025 | .26553 | 2.3809 | .6374 | .2450 | .1202 | .0386 |
| 2.000 | .64468 | .26464 | 2.3608 | .6265 | .2311 | .1125 | .0361 |

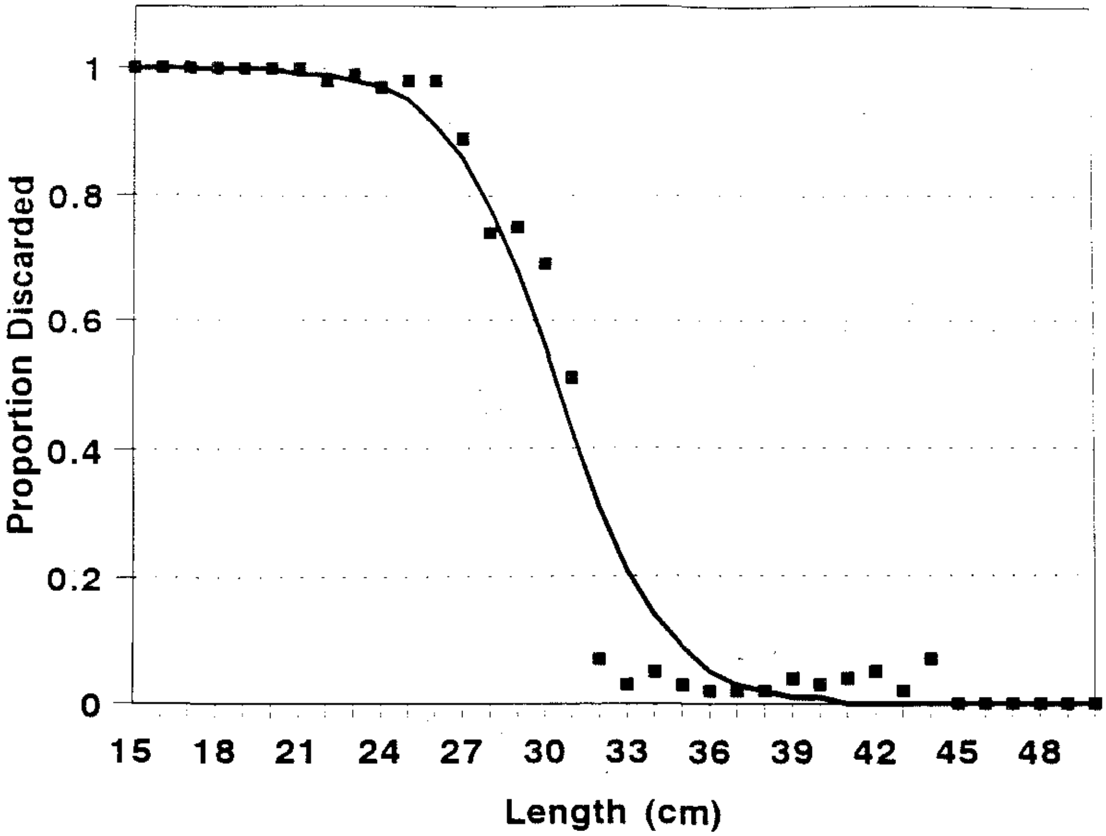


Figure 1. Proportion of winter flounder discarded at length, quarters 1 and 2, as estimated from 1989-1992 sea sampling data; logistic regression smoothing.

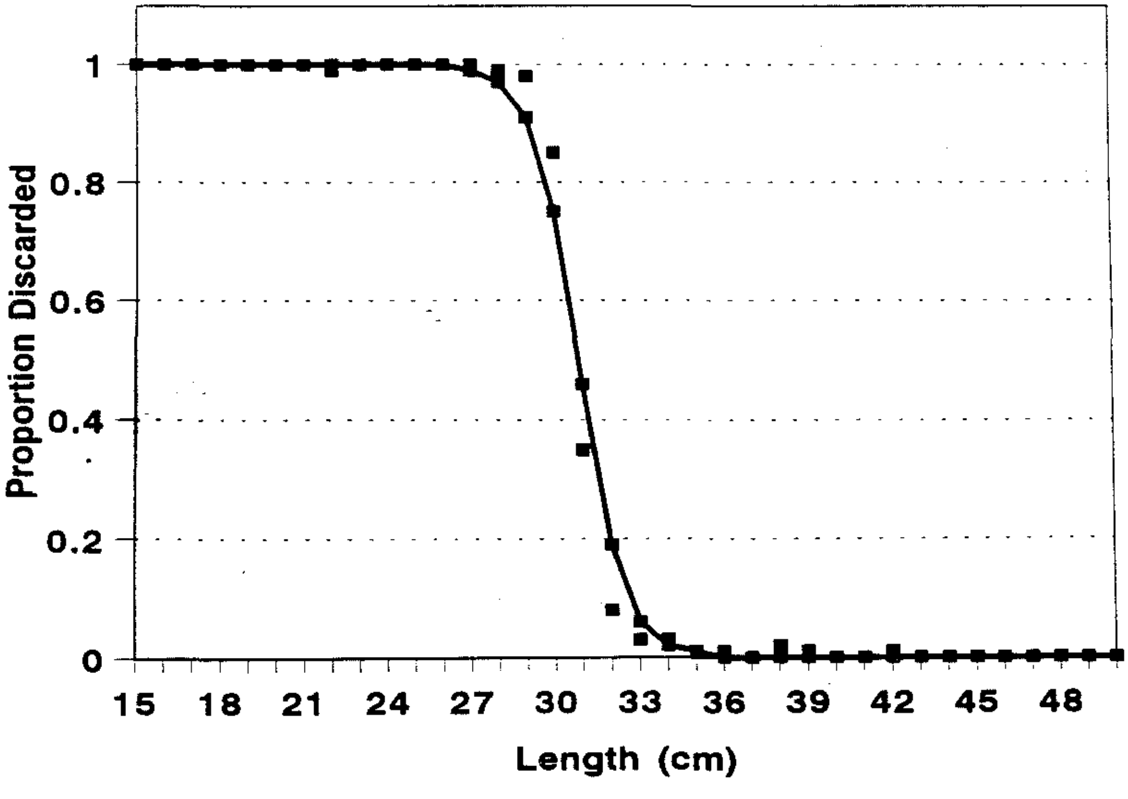


Figure 2. Proportion of winter flounder discarded at length, quarters 3 and 4, as estimated from 1989-1992 sea sampling data; logistic regression smoothing.

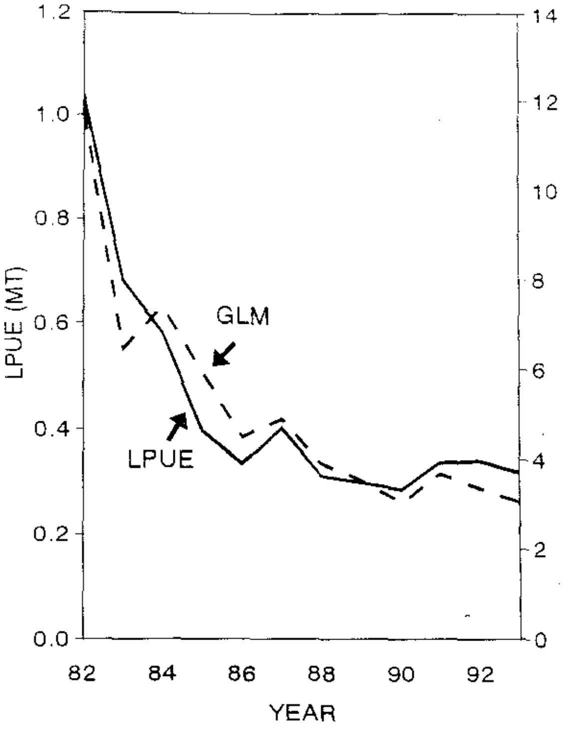


Figure 3. Commercial weighout landings per unit effort of winter flounder from otter trawl trips landing winter flounder, Southern New England/Mid-Atlantic stock complex, 1982-1993: raw LPUE and standardized index of abundance based on retransformed year coefficient, GLM.

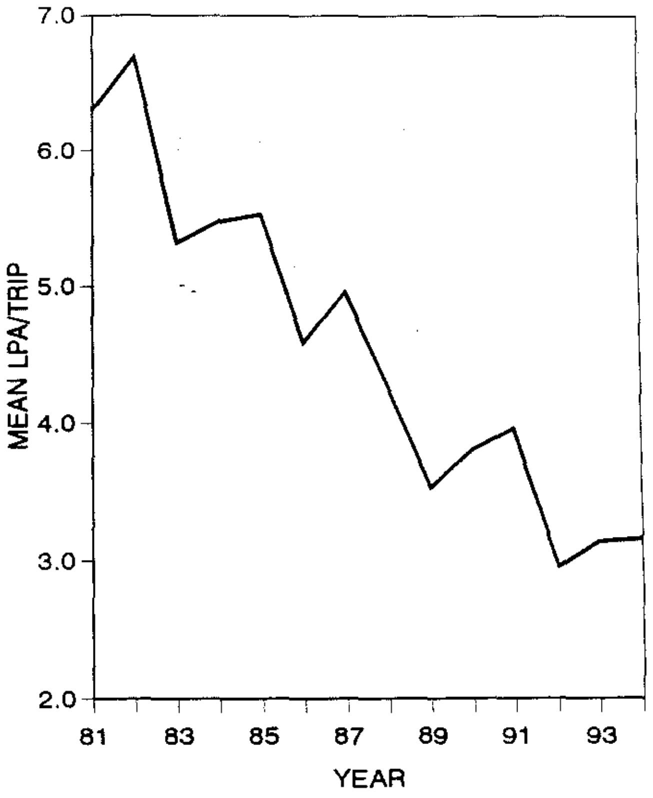


Figure 4. Recreational landings per unit effort of winter flounder as number landed per angler per trip, Southern New England/ Mid-Atlantic stock complex, 1981-1994.

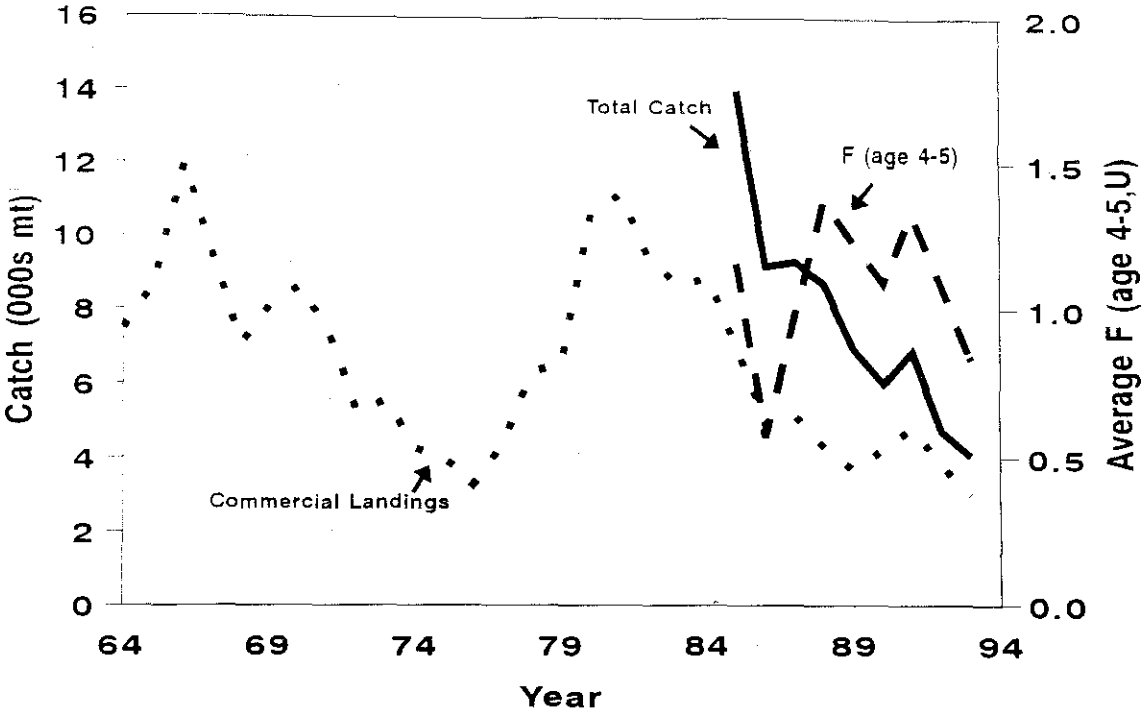


Figure 5. Trends in landings, catch, and fishing mortality rates (unweighted average F at ages 4-5), Southern New England/Mid-Atlantic stock complex of winter flounder, 1964-1993.

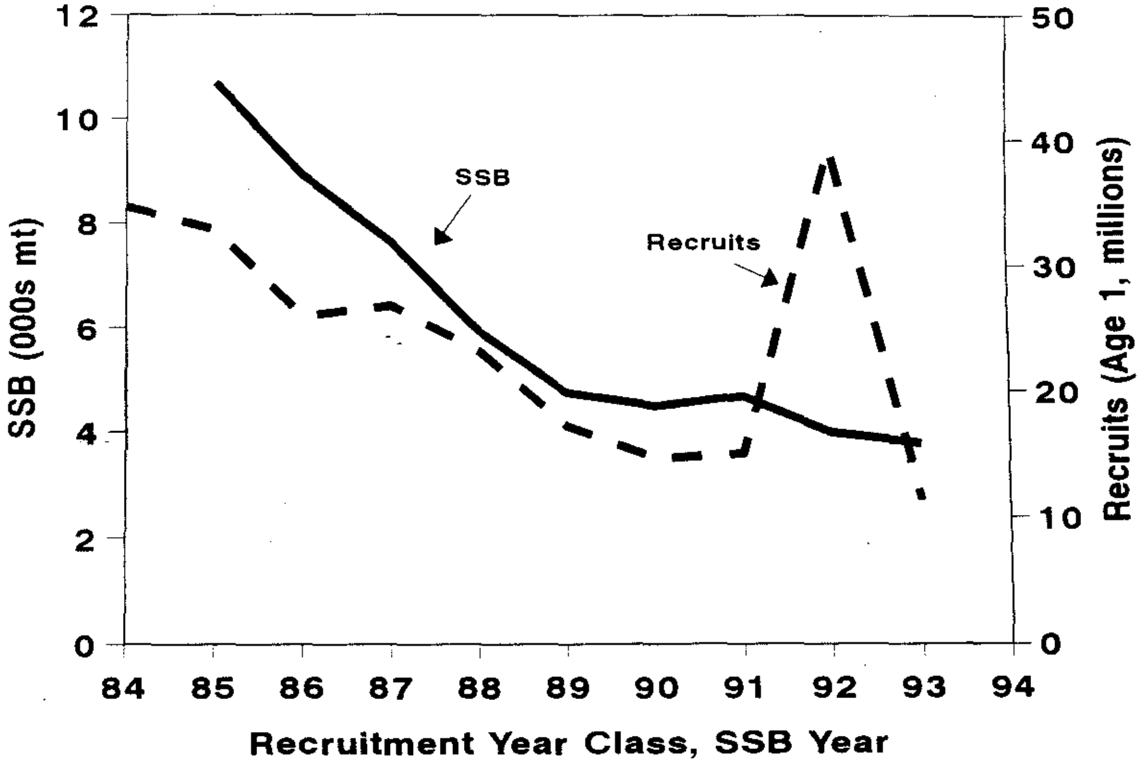


Figure 6. Trends in spawning stock biomass (000 mt) and recruitment (millions age 1), Southern New England/ Mid-Atlantic stock complex of winter flounder, 1985-1993.

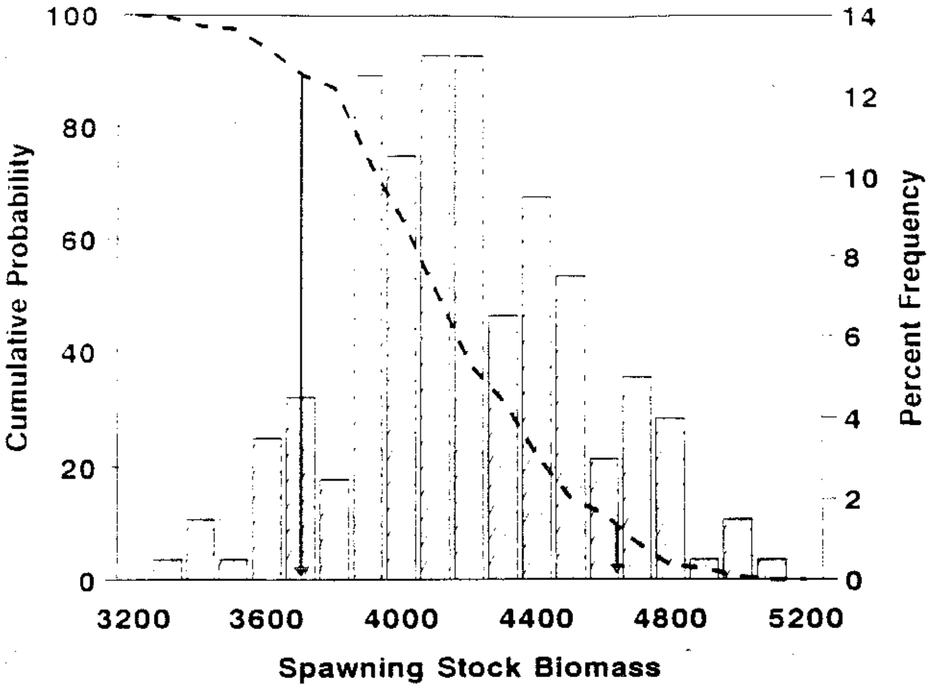


Figure 7. Precision of estimates of spawning stock biomass for Southern New England/ Mid-Atlantic stock complex of winter flounder derived from bootstrap procedure. The vertical bars give the range and probability of individual values within that range. The dashed line gives the probability that SSB is less than any selected value on the x-axis.

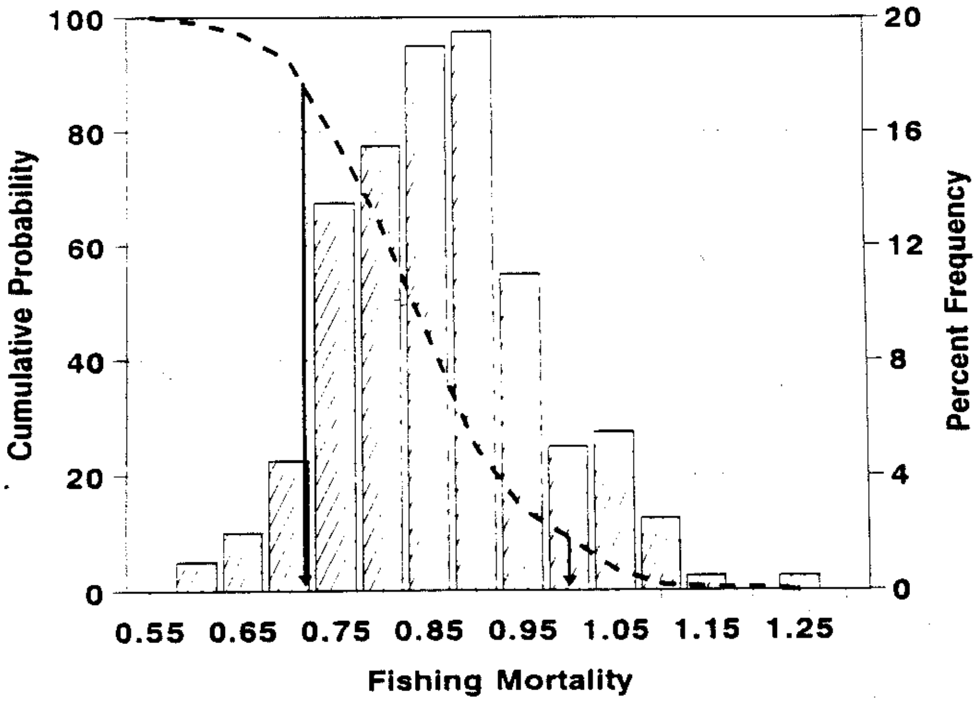


Figure 8. Precision of fishing mortality for Southern New England/Mid-Atlantic stock complex of winter flounder derived from bootstrap procedure. The vertical bars give the range and probability of individual values within that range. The dashed line gives the probability that F is less than any selected value on the x-axis.

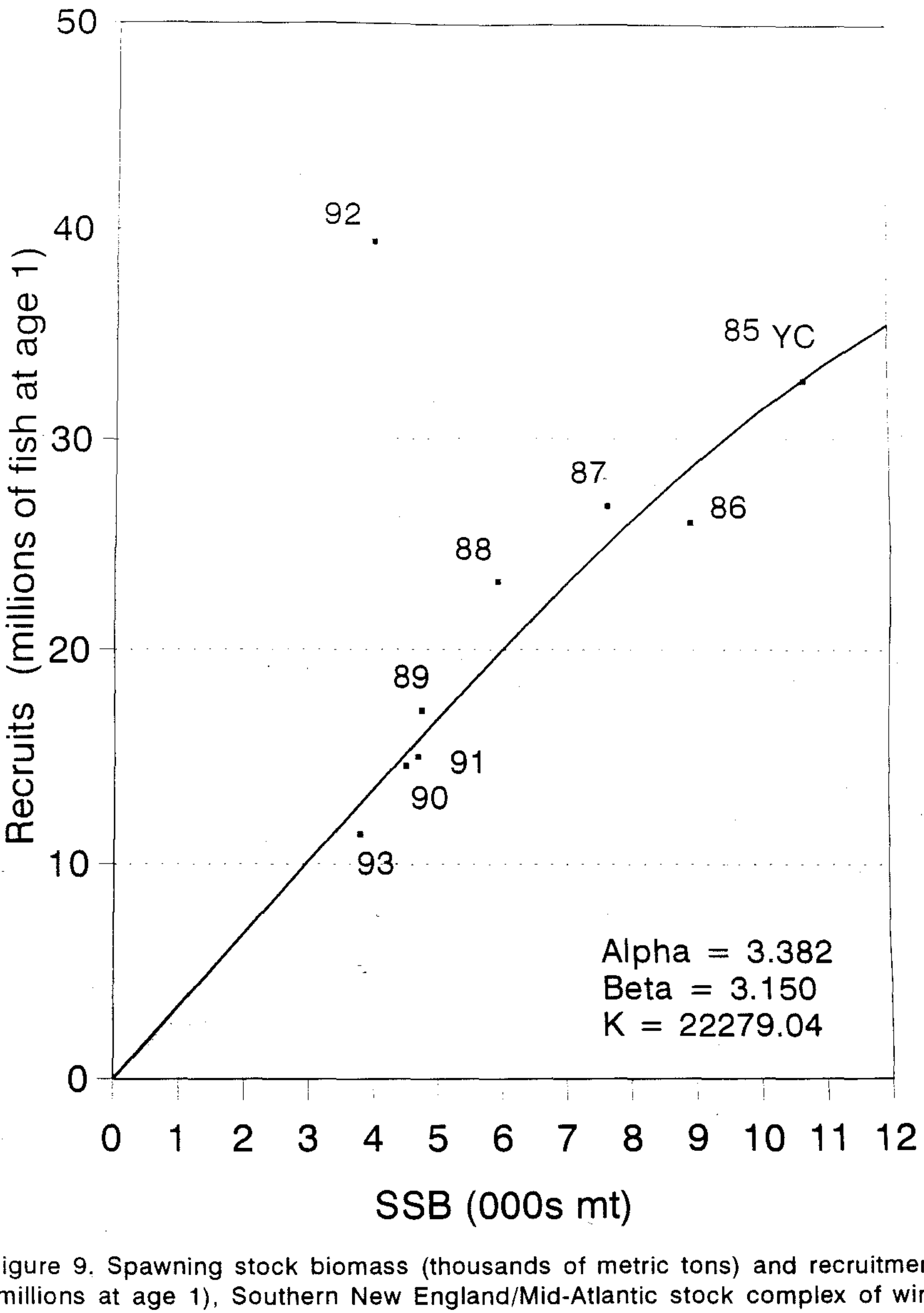


Figure 9. Spawning stock biomass (thousands of metric tons) and recruitment (millions at age 1), Southern New England/Mid-Atlantic stock complex of winter flounder, 1985-1993. Points are labelled by year class. Shepherd stock-recruitment curve fitted excluding the 1992 year class: alpha=3.382, beta=3.150, K=22279.04.

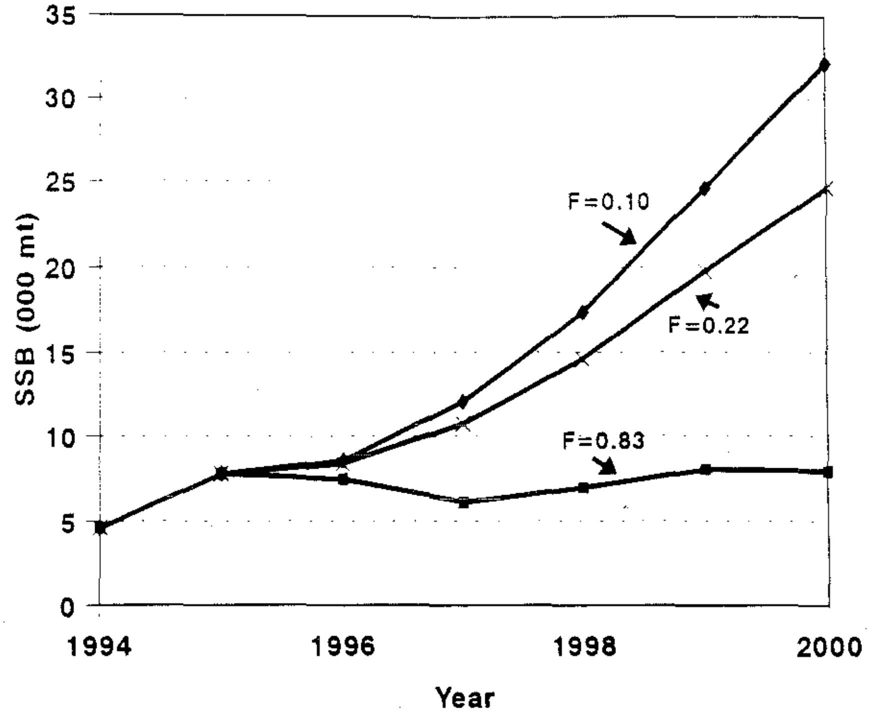


Figure 10. Medium term projections of median spawning stock biomass,, Southern New England/ Mid-Atlantic stock complex of winter flounder, 1994-2000, assuming F=0.83 (status quo), F=0.22 (F0.1), and F=0.10.

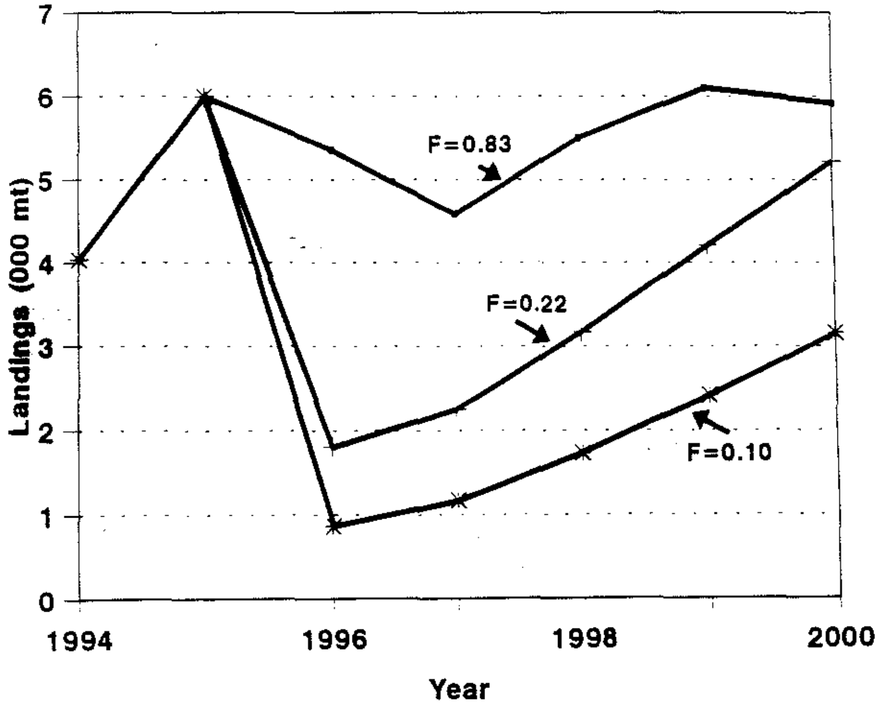


Figure 11. Medium term projections of median landings, Southern New England/ Mid-Atlantic stock complex of winter flounder, 1994-2000, assuming F=0.83 (status quo), F=0.22 (F0.1), and F=0.10.

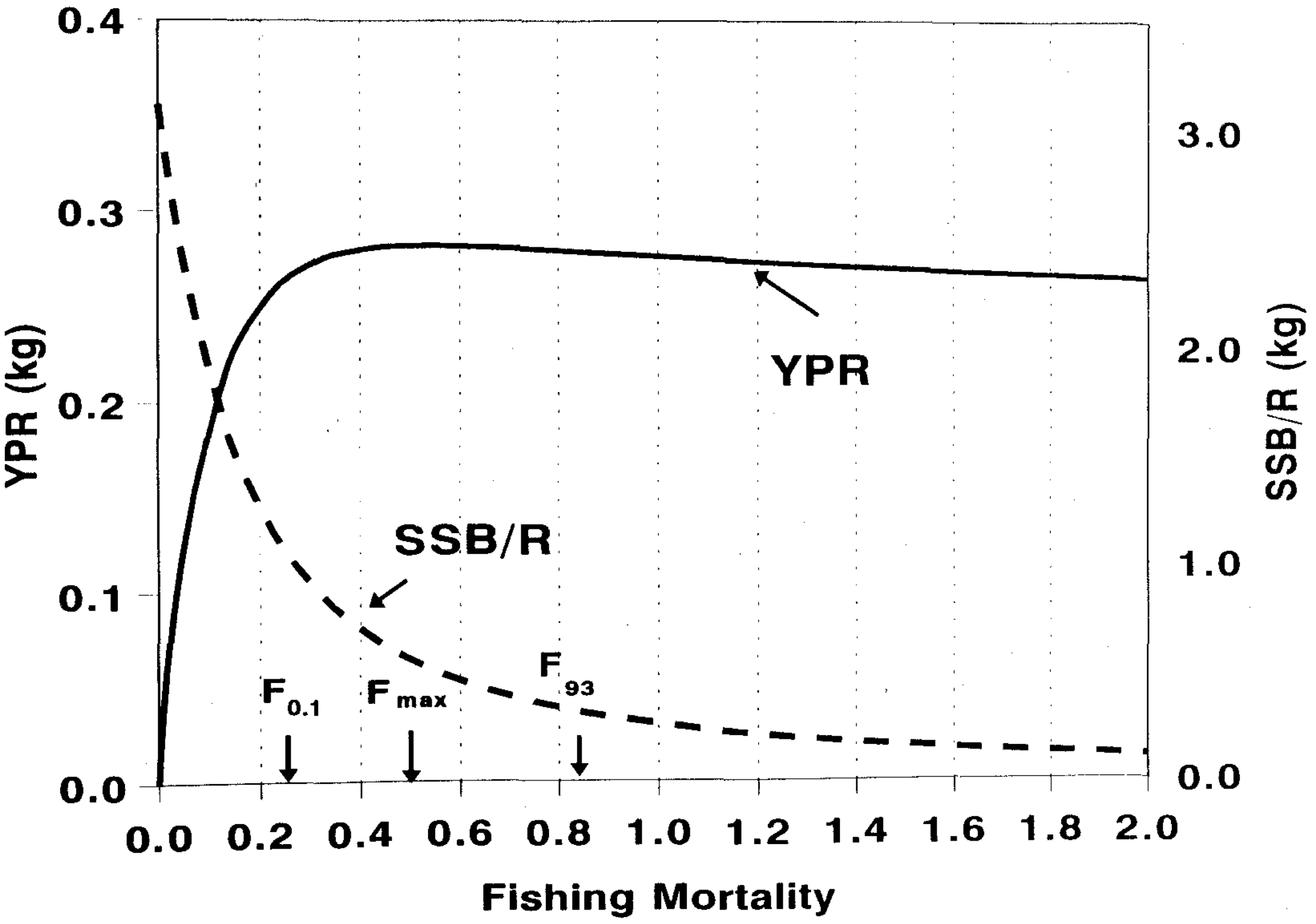


Figure 12. Yield per recruit and spawning stock biomass per recruit of winter flounder in the Southern New England/ Mid-Atlantic stock complex.

# Appendix I.  Identification of Stock Units

By

P. Howell
Connecticut Department of Environmental Protection

## Introduction

The Species Profile presented within the ASMFC Plan discusses in detail the relatively large biological variablility among inshore winter flounder populations. The Plan divides these populations into three management units based on available data describing growth, seasonal movements, and female maturity schedules. Since adoption of the Plan, new data have become available which more fully measure the variability found in the southern populations. These data are summarized below. Based on this new information, the Mid-Atlantic and Southern New England management units were combined. The two other units, Gulf of Maine and Georges Bank, remain unchanged.

### *Seasonal Movements*

Phelan (1992) collected and tagged 7,346 flounder from 14 inshore and 22 offshore stations associated with a sewage sludge dumpsite 22 km (12 mi) off the New Jersey coast. Previous tagging studies in this region had only tagged fish from inshore sites. Movement of the 206 fish recaptured with tags showed that while the majority returned to inshore spawning areas, a component of the population remained on the dumpsite during the winter spawning season. Tag returns from these overwintering adults (N=44) were equally divided between fish moving to local inshore areas less than 40 km (22 mi) from the dumpsite and those moving longer distances to the east, including Block Island and Vineyard Sounds. These results indicate that there is intermixing of flounder from the New York Bight and Block Island Sound-Southern Massachusetts region through gradual dispersion of a segment of the population which may not spawn every winter.

### *Growth*

Length-at-age data from coastal New Jersey were gathered in April 1993 and 1994. Previous age data from this area were available only from inshore samples. These new data show that growth is more variable than previous studied had indicated. Earlier work documented the relatively slow growth of the inshore fish, but had not included the faster growing fish at each age found in the coastwide survey. Length frequency distributions for age 3,4 and 5 fish collected from New Jersey, Connecticut and Massachusetts waters during the same years and seasons are depicted in Figures 1-3. Although these new data show no statistical difference between the New Jersey and Connecticut growth patterns, differences were detected between New Jersey and southern Massachusetts, primarily because the Massachusetts samples had few fish in the smallest length intervals for each age, resulting in a higher mean (Table 1). However, all three areas have a similar proportion of the largest fish at each age. Based on the similarity of growth and maximum age, the estimate of natural mortality was revised downward to reflect the oldest fish aged (MA DMF, age 17, m=0.20).

### *Maturity*

Female flounder captured throughout Long Isand Sound in April and May, 1991-1993, were examined to determine percent maturity at age (CTDEP 1995). Previous data had examined fish from small areas in western and eastern portions of the Sound. These new data showed a larger percentage of age-three fish to be mature (66% versus 38-47%), comparable to the 70% maturity reported by Danilla (1978) for age-three flounder captured in New Jersey. Percent maturity for age-four fish was also higher (97% versus 79-80%), similar to the 99% previously reported for New Jersey. This maturity schedule is not significantly different from that reported for southern Massachusetts (53% for age three and 95% for age four).

## Literature Cited

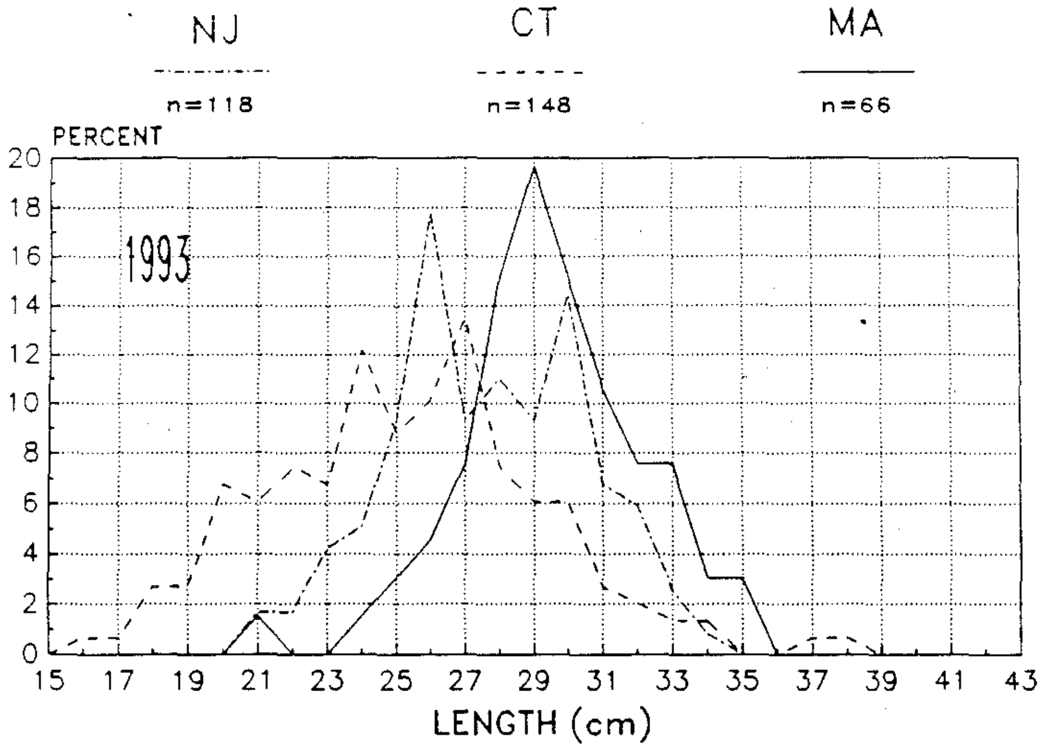
Danilla, D. 1978. Age, growth, and other aspects of the life history of the winter flounder *Pseudopleuronectes americanus* (Walbaum) in the southern New Jersey. M.S. Rutgers University, New Brunswick, NJ. 79 pp.

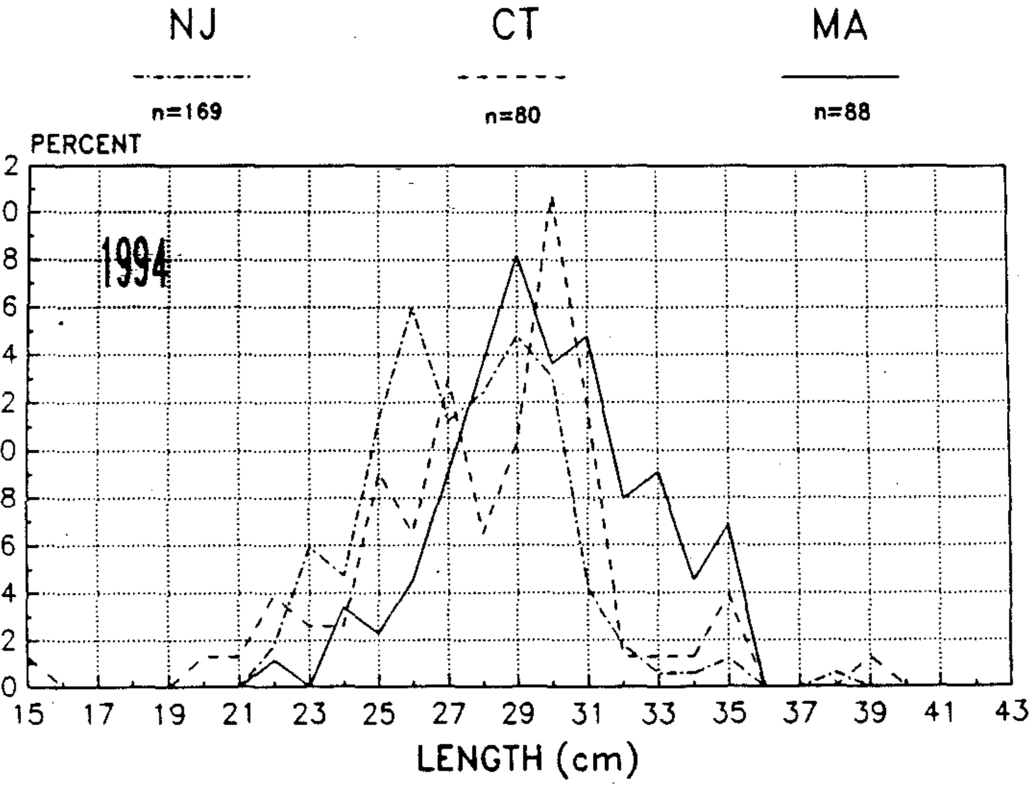
Phalen, B. 1992. Winter flounder movements in the inner New York Bight. Transactions of the American Fisheries Society 121:777-784.

Table 1. Mean lengths at age (with standard error, sample size) for New Jersey, Connecticut and Massachusetts.

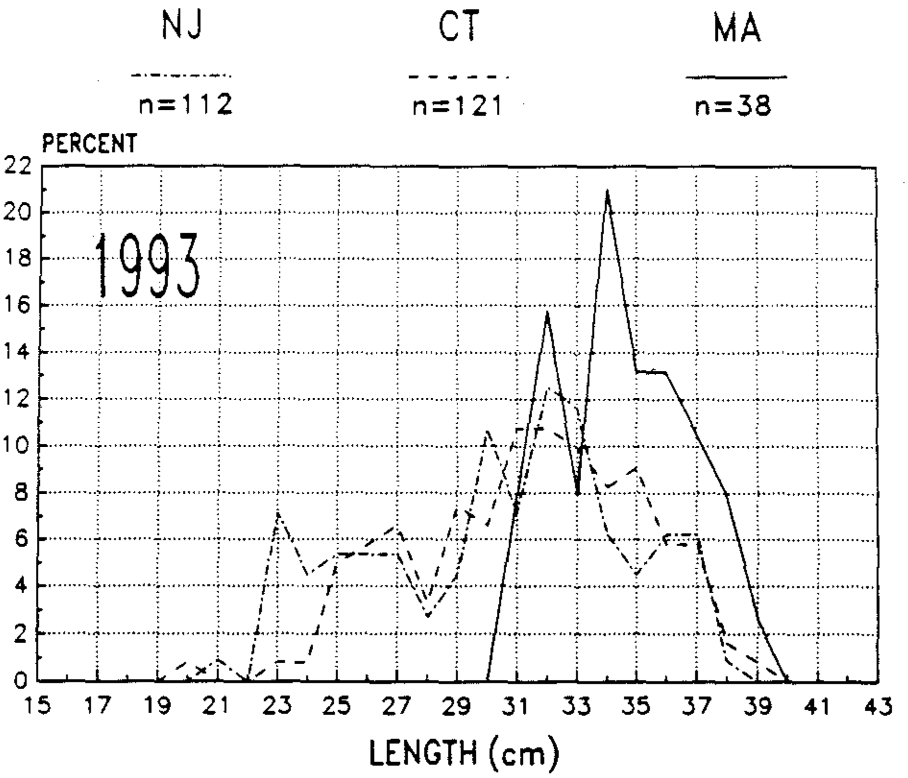
| AGE 3 | New Jersey | Connecticut | Massachusetts | P-value |
|---|---|---|---|---|
| 1993 | 27.6 (0.85, 118) | 25.3 (0.74, 148) | 29.5 (1.14, 66) | 0.01* |
| 1994 | 27.4 (0.63, 169) | 28.3 (0.94, 80) | 29.8 (0.84, 88) | 0.09 |
| AGE 4 | | | | |
| 1993 | 30.4 (0.92, 112) | 31.4 (0.89, 121) | 34.5 (1.59, 38) | 0.10 |
| 1994 | 30.8 (1.06, 76) | 31.6 (1.36, 135) | 35.0 (1.36, 46) | 0.05* |
| AGE 5 | | | | |
| 1993 | 33.0 (0.88, 100) | 33.4 (0.80, 120) | 38.1 (2.35, 14) | 0.13 |
| 1994 | 35.2 (1.42, 25) | 34.7 (0.81, 78) | 39.4 (2.36, 9) | 0.18 |

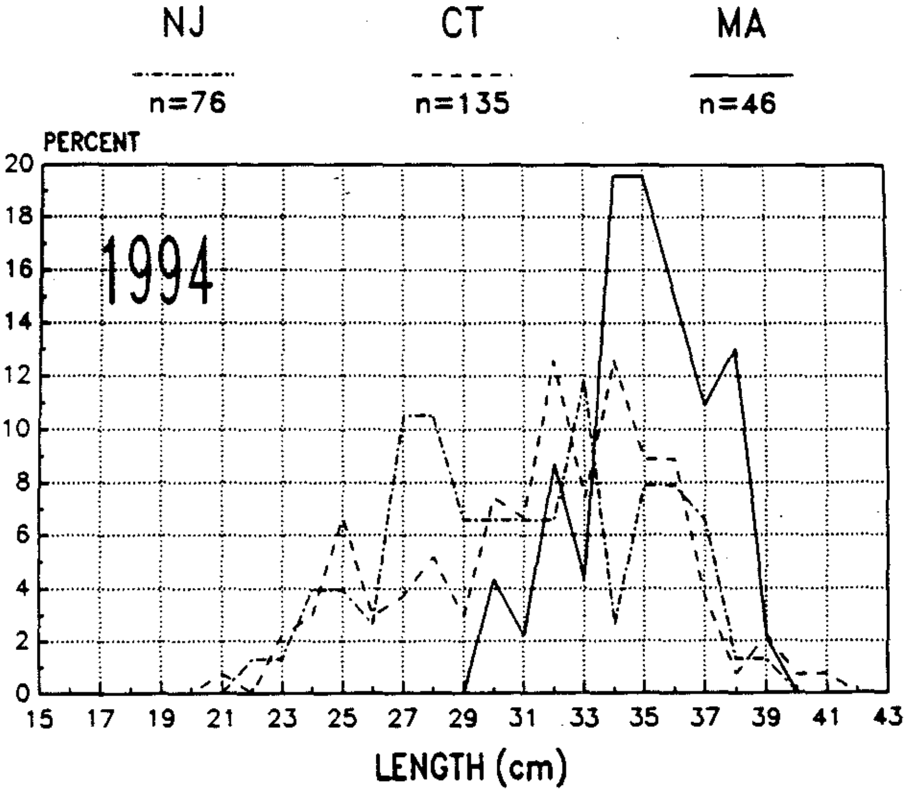
# LENGTH FREQUENCIES OF AGE THREE WINTER FLOUNDER



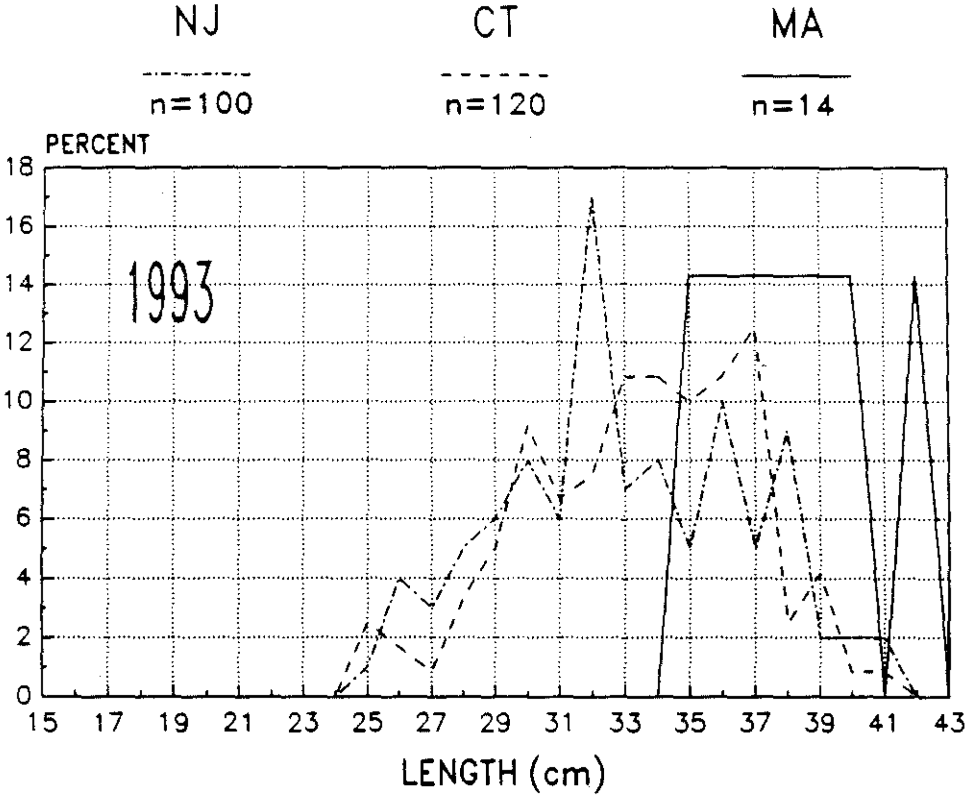


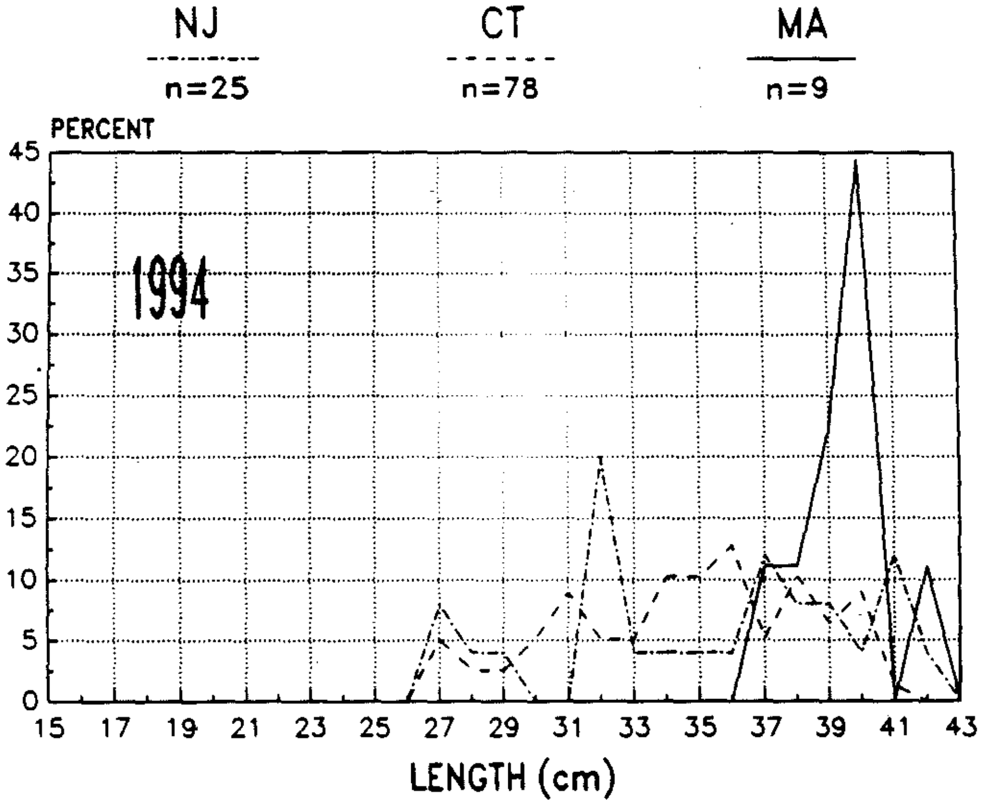
# LENGTH FREQUENCIES OF AGE FOUR WINTER FLOUNDER





# LENGTH FREQUENCIES OF AGE FIVE WINTER FLOUNDER





# Appendix II. Age Structure of Winter Flounder B2 Type Recreational Discards Estimated from Inshore Trawl Survey Lengths, Age-Length Keys, and Minimum Size Regulations.

By
Mark R. Gibson
Principal Fisheries Biologist
RI Division Fish and Wildlife
Marine Fisheries Office
Wickford, RI 02852

## Introduction

Accurate assessment of valuable commercial and recreational species using age structured methods, requires a complete catch at age matrix which characterizes all removals the stock (Megrey 1989). Failure to account for discarded fish can result in biased low estimates of selectivity at age and recruitment (Rivard 1989). Sustainable fishing rates on fully recruited stock can be overestimated. Recreational discards can comprise a large fraction of a catch at age. Winter flounder along the Atlantic coast from Maine to New Jersey are subject to a substantial recreational fishery. From 1978 to 1988, recreational landings accounted for 31% by weight of all winter flounder landed (ASMFC 1992). With the development and implementation of the Atlantic States Marine Fisheries Commission (ASMFC) fishery management plan in state waters and Fishery Management Council regulations in the EEZ, minimum size regulations for winter flounder have increased in the past decade. This has resulted in an increasing fraction of B2 type catch (fish caught but subsequently released alive) in the recreational data base. For example in Rhode Island, B2 catch has increased from 10% of total to over 30% of total from 1979 to 1994 as size limits were instituted and advanced.

Unlike the commercial fishery, there are no sampling programs for the recreational fishery to characterize discarded fish by size. However, most states conduct inshore trawl surveys to monitor abundance of fishery resources in state waters. These surveys generally employ small mesh bottom trawl gear which catch a wide size range of fish. As an alternative to sea sampling of recreational winter flounder discards, state research trawl surveys were used to characterize the size structure of sublegal fish available to the recreational fishery. In addition to length frequencies and relative abundance, age-length keys are available from several states to assign ages to the recreational length samples.

## Methods and Data Sources

Winter flounder length frequency data were obtained from the Massachusetts Division of Marine Fisheries (MADMF), the Rhode Island Division of Fish and Wildlife (RIDFW), the Connecticut Department of Environmental Protection (CTDEP), the New York Department of Environmental Conservation (NYDEC), and the New Jersey Department of Environmental Protection (NJDEP). MADMF data covered years 1980 to 1994 and were collected from spring and fall cruises state waters south and east of Cape Cod. RIDFW spring and fall trawl data from 1979 to 1994 covered Narragansett Bay and Rhode Island coastal waters. The CTDEP survey conducted in Long Island Sound dates from 1984 with both spring and fall cruises. Data from the summer and autumn trawl surveys of Peconic Bay by the NYDEC were available from 1985 and 1987-1994. A trawl survey in coastal waters off New Jersey has been conducted by the NJDEP since 1988. The survey is done bimonthly but only fall data were available for 1988.

Estimates of B2 length structure were limited to years 1985 to 1993, the period covered by the assessment. Spring survey length data were used except for the NYDEC survey. Length samples to characterize B2 discards were restricted to a size range which corresponded to a minimum hookable size and the minimum legal size by year and state. Minimum hookable size was set at 13 cm based on examination of MRFSS A length samples (fish caught and retained) in years without size limits. For states without minimum size regulations, an effective minimum retention size of 20 cm (7.9") was assumed based on NYDEC party boat measurements and American Littoral Society tagging data. A history of recreational size limit regulations was obtained from each state. Massachusetts had an 11" minimum size in 1985 which increased to 12" in 1986. Rhode Island had no minimum size up to 1985 but implemented an 11" minimum in 1986. This increased to 11.5" in 1990 and 12" in 1991. Connecticut had a 10" minimum size from 1985 to 1993 and recently increased it to 11" in 1994. New York had no minimum size in 1985-1986, an 8" minimum from 1987 to 1990, a 9" size in 1991, 10" from 1992-1993, and finally 11" in 1994. The state of New Jersey had no minimum size from 1985 to 1991 and implemented a 10" minimum in 1992.

In addition to length frequency data, survey age-length keys were available from MADMF, CTDEP, and NJDEP. MADMF annual keys from the spring survey cruise were available from 1984 to 1993. CTDEP age-length keys also began in 1984 and a NJDEP key was available for 1993. MADMF survey length samples were aged from 1985 to 1993 using the MADMF keys. RIDFW lengths from 1985 to 1993 were aged with the MADMF keys after examination of 1987-1988 Rhode Island age data (Hass and Recksiek 1995) indicated a closer match to Massachusetts rather than Connecticut data. CTDEP survey lengths were aged with the CTDEP keys. NYDEC lengths from 1985 to 1993 were aged with the CTDEP keys. No lengths were available in 1986 from the NYDEC survey so 1985 and 1987 data were substituted. The same CTDEP keys were used to age the NJDEP trawl survey lengths from 1988 to 1992. In 1993, a combined CTDEP and NJDEP key was applied to the NJDEP lengths. To complete the NJDEP series, length frequencies from the NMFS/NEFSC spring trawl survey in the southern New England region were substituted for years 1985 to 1987. These were the same length data employed in initial estimation of winter flounder discards (Shepherd 1994) and most resembled the NJDEP length frequencies.

## Results

Length frequency data from the various surveys is summarized in Tables 1 and 2. There were some notable differences in the size structure of winter flounder sampled in the spring surveys. First, state surveys in inshore waters had a much higher fraction of catch in small size classes (10-20 cm) than did the NMFS/NEFSC survey (Figure 1). Dominance of juvenile fish was most pronounced in the RIDFW survey in Narragansett Bay. This reflects the tendency of juvenile winter flounder to inhabit estuarine areas. Secondly, the RIDFW and CTDEP surveys had very few fish in excess of 40 cm. It is unclear whether this represents high mortality rates or movement of larger individuals from Narragansett Bay and Long Island Sound to more offshore locations. Fall survey data, which included New York waters, also exhibited regional variation (Figure 2). The MADMF, RIDFW, CTDEP, and NYDEC had substantial numbers of fish in length classes less than 20 cm. In fact, the New York Peconic Bay survey contained few fish larger than 20 cm. Both the NMFS/NEFSC and

NJDEP survey had few fish smaller than 20 cm and more fish exceeding 40 cm. Again, these differences probably represent different spatial distributions and mortality rates by size.

Estimated proportions at age for B2 discards by state are given in Table 3. Most discarded fish are age 1 to 3. Massachusetts, Rhode Island, New York, and New Jersey had a few fish age 4. Connecticut had fish as old as 5 and 6 as a result of slow growth in the age samples from Western Long Island Sound. The extension of the discard age structure with size limit regulation is very clear in the New York estimates. Application of proportion at age estimates based on trawl survey lengths in sublegal classes to recreational B2 type catch will produce discards dominated by juvenile fish. This will produce more realistic discard estimates at age than the past practice of assuming that B2 proportion at age was similar to the A and B1 landed age structure. These discard estimates will be important in establishing selection patterns from VPA runs and estimating biological reference points.

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Atlantic States Marine Fisheries Commission (ASMFC). 1992. Fishery management plan for inshore stocks of winter flounder. Fisheries Management Report No. 21. Atlantic States Marine Fisheries Commission.

Hass, R.E., and C.W. Recksiek. 1995. Age verification of winter flounder in Narragansett Bay. Trans. Am. Fish. Soc. 124: 103-111.

Megrey, B.A. 1989. Review and comparison of age-structured stock assessment models from theoretical and applied points of view. American Fisheries Society Symposium 6:8-48.

Rivard, D. 1989. Overview of the systematic, structural, and sampling errors in cohort analysis. American Fisheries Society Symposium 6:49-65.

Shepherd, G.R. 1994. Estimation of discards in the winter flounder commercial fishery. National Marine Fisheries Service, Woods Hole. Report to the ASMFC winter flounder technical committee.

Table 1. Winter flounder length frequencies (in 1 cm size intervals) from spring trawl surveys in the New England and Mid-Atlantic region. Sample sizes standardized to NMFS.

| Length (cm) | NMFS | MADMF | RIDFW | CTDEP | NJDEP | TOTAL |
|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 2 | 0 | 0 | 2 |
| 3 | 0 | 0 | 1 | 0 | 0 | 1 |
| 4 | 0 | 0 | 1 | 0 | 0 | 1 |
| 5 | 0 | 0 | 5 | 0 | 1 | 6 |
| 6 | 6 | 0 | 10 | 1 | 1 | 18 |
| 7 | 12 | 6 | 40 | 3 | 1 | 61 |
| 8 | 5 | 13 | 109 | 10 | 1 | 138 |
| 9 | 10 | 51 | 217 | 35 | 0 | 313 |
| 10 | 39 | 149 | 452 | 93 | 13 | 745 |
| 11 | 40 | 279 | 709 | 229 | 32 | 1288 |
| 12 | 53 | 379 | 876 | 456 | 62 | 1827 |
| 13 | 110 | 422 | 828 | 716 | 115 | 2191 |
| 14 | 104 | 400 | 666 | 855 | 210 | 2234 |
| 15 | 134 | 363 | 598 | 1034 | 287 | 2415 |
| 16 | 166 | 333 | 569 | 1056 | 363 | 2487 |
| 17 | 251 | 290 | 593 | 1093 | 403 | 2629 |
| 18 | 256 | 298 | 635 | 1055 | 428 | 2672 |
| 19 | 232 | 307 | 611 | 1028 | 457 | 2635 |
| 20 | 339 | 380 | 633 | 904 | 358 | 2615 |
| 21 | 436 | 428 | 521 | 795 | 413 | 2593 |
| 22 | 464 | 442 | 511 | 711 | 427 | 2555 |
| 23 | 708 | 507 | 441 | 605 | 487 | 2749 |
| 24 | 744 | 571 | 426 | 514 | 584 | 2839 |
| 25 | 812 | 593 | 456 | 442 | 732 | 3035 |
| 26 | 871 | 695 | 433 | 403 | 891 | 3293 |
| 27 | 993 | 661 | 454 | 324 | 982 | 3415 |
| 28 | 919 | 689 | 435 | 263 | 952 | 3258 |
| 29 | 757 | 650 | 367 | 216 | 843 | 2833 |
| 30 | 751 | 711 | 396 | 164 | 765 | 2788 |
| 31 | 594 | 598 | 313 | 126 | 889 | 2520 |
| 32 | 598 | 597 | 281 | 95 | 559 | 2130 |
| 33 | 440 | 502 | 243 | 72 | 540 | 1797 |
| 34 | 386 | 439 | 189 | 55 | 446 | 1516 |
| 35 | 353 | 396 | 142 | 41 | 332 | 1264 |
| 36 | 266 | 309 | 97 | 30 | 245 | 946 |
| 37 | 242 | 226 | 75 | 16 | 176 | 736 |
| 38 | 210 | 195 | 53 | 11 | 124 | 592 |
| 39 | 195 | 138 | 38 | 8 | 96 | 475 |
| 40 | 200 | 125 | 21 | 6 | 81 | 433 |
| 41 | 117 | 90 | 13 | 2 | 58 | 279 |
| 42 | 134 | 62 | 6 | 2 | 44 | 248 |
| 43 | 134 | 43 | 3 | 1 | 19 | 200 |
| 44 | 77 | 40 | 3 | 1 | 20 | 141 |
| 45 | 67 | 26 | 1 | 0 | 12 | 106 |
| 46 | 40 | 21 | 0 | 0 | 8 | 69 |
| 47 | 60 | 11 | 1 | 0 | 7 | 80 |
| 48 | 48 | 13 | 1 | 0 | 5 | 67 |
| 49 | 36 | 7 | 0 | 0 | 2 | 45 |
| 50 | 10 | 6 | 0 | 0 | 0 | 16 |
| 51 | 7 | 4 | 0 | 0 | 1 | 11 |
| 52 | 5 | 2 | 0 | 0 | 0 | 7 |
| 53 | 13 | 2 | 0 | 0 | 0 | 15 |
| 54 | 14 | 1 | 0 | 0 | 0 | 14 |
| 55 | 4 | 1 | 0 | 0 | 0 | 5 |
| 56 | 7 | 0 | 0 | 0 | 0 | 7 |
| 57 | 3 | 2 | 0 | 0 | 0 | 5 |
| 58 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 2 | 0 | 0 | 0 | 0 | 2 |
| Total | 12085 | 13472 | 13472 | 13472 | 13472 | 67360 |

Table 2. Winter flounder length frequencies (in 1 cm size intervals) from fall trawl surveys in the New England and Mid-Atlantic region. Sample sizes standardized to NMFS.

| Length (cm) | NMFS | MADMF | RIDFW | CTDEP | NYDEC | NJDEP | TOTAL |
|---|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 0 | 0 | 13 | 0 | 13 |
| 3 | 0 | 0 | 1 | 0 | 26 | 0 | 27 |
| 4 | 0 | 0 | 7 | 0 | 397 | 0 | 404 |
| 5 | 0 | 16 | 42 | 0 | 755 | 0 | 812 |
| 6 | 20 | 0 | 151 | 0 | 1687 | 0 | 1858 |
| 7 | 25 | 6 | 296 | 2 | 1891 | 0 | 2221 |
| 8 | 15 | 9 | 462 | 18 | 2094 | 0 | 2589 |
| 9 | 53 | 59 | 520 | 25 | 1207 | 0 | 1857 |
| 10 | 20 | 86 | 370 | 62 | 691 | 0 | 1192 |
| 11 | 2 | 152 | 218 | 270 | 235 | 0 | 669 |
| 12 | 3 | 84 | 245 | 670 | 238 | 2 | 843 |
| 13 | 17 | 86 | 352 | 948 | 240 | 2 | 1368 |
| 14 | 1 | 171 | 545 | 1089 | 235 | 10 | 1909 |
| 15 | 16 | 138 | 749 | 1131 | 288 | 10 | 2289 |
| 16 | 63 | 284 | 966 | 1090 | 430 | 22 | 2895 |
| 17 | 108 | 609 | 1038 | 1079 | 406 | 45 | 3297 |
| 18 | 102 | 719 | 953 | 1026 | 381 | 50 | 3284 |
| 19 | 210 | 699 | 786 | 966 | 214 | 194 | 3129 |
| 20 | 305 | 683 | 702 | 826 | 161 | 256 | 3073 |
| 21 | 484 | 750 | 505 | 678 | 122 | 607 | 3295 |
| 22 | 558 | 587 | 427 | 515 | 100 | 588 | 2937 |
| 23 | 668 | 505 | 337 | 414 | 78 | 921 | 3025 |
| 24 | 781 | 460 | 392 | 310 | 37 | 1074 | 3158 |
| 25 | 745 | 477 | 297 | 230 | 33 | 1074 | 2936 |
| 26 | 759 | 516 | 299 | 198 | 32 | 904 | 2740 |
| 27 | 841 | 412 | 273 | 132 | 27 | 871 | 2620 |
| 28 | 831 | 593 | 235 | 105 | 22 | 775 | 2588 |
| 29 | 727 | 656 | 186 | 86 | 11 | 603 | 2287 |
| 30 | 793 | 623 | 190 | 57 | 8 | 572 | 2271 |
| 31 | 591 | 690 | 138 | 43 | 6 | 615 | 2096 |
| 32 | 611 | 618 | 118 | 36 | 5 | 421 | 1815 |
| 33 | 607 | 351 | 93 | 21 | 4 | 505 | 1596 |
| 34 | 462 | 320 | 67 | 19 | 2 | 385 | 1258 |
| 35 | 293 | 231 | 39 | 11 | 2 | 366 | 950 |
| 36 | 308 | 140 | 30 | 7 | 2 | 306 | 796 |
| 37 | 229 | 51 | 19 | 6 | 1 | 199 | 506 |
| 38 | 164 | 60 | 12 | 4 | 1 | 179 | 423 |
| 39 | 152 | 129 | 8 | 1 | 1 | 163 | 456 |
| 40 | 126 | 23 | 6 | 1 | 1 | 122 | 279 |
| 41 | 65 | 55 | 5 | 1 | 1 | 77 | 203 |
| 42 | 76 | 6 | 3 | 0 | 0 | 65 | 151 |
| 43 | 49 | 11 | 4 | 0 | 0 | 38 | 103 |
| 44 | 53 | 0 | 0 | 0 | 0 | 19 | 73 |
| 45 | 32 | 2 | 1 | 0 | 0 | 12 | 47 |
| 46 | 31 | 9 | 0 | 0 | 0 | 22 | 61 |
| 47 | 8 | 0 | 0 | 0 | 0 | 5 | 13 |
| 48 | 15 | 6 | 0 | 0 | 0 | 2 | 23 |
| 49 | 6 | 0 | 0 | 0 | 0 | 7 | 13 |
| 50 | 19 | 0 | 0 | 0 | 0 | 0 | 19 |
| 51 | 7 | 0 | 0 | 0 | 0 | 0 | 7 |
| 52 | 25 | 2 | 0 | 0 | 0 | 0 | 27 |
| 53 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 6 | 0 | 0 | 0 | 0 | 0 | 6 |
| 56 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| 59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 12085 | 12085 | 12085 | 12085 | 12085 | 12085 | 67360 |

Table 3. Proportion at age estimates for B2 discarded recreational winter flounder from state trawl and age-length keys.

Massachusetts

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.012 | 0.048 | 0.180 | 0.088 | 0.081 | 0.130 | 0.344 | 0.228 | 0.267 |
| 2 | 0.408 | 0.307 | 0.361 | 0.335 | 0.383 | 0.557 | 0.401 | 0.588 | 0.478 |
| 3 | 0.550 | 0.627 | 0.440 | 0.576 | 0.517 | 0.295 | 0.251 | 0.179 | 0.255 |
| 4 | 0.030 | 0.019 | 0.020 | 0.000 | 0.018 | 0.019 | 0.004 | 0.005 | 0.000 |
| 5 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Rhode Island

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.107 | 0.104 | 0.097 | 0.118 | 0.206 | 0.120 | 0.419 | 0.125 | 0.464 |
| 2 | 0.893 | 0.586 | 0.569 | 0.604 | 0.563 | 0.496 | 0.384 | 0.614 | 0.461 |
| 3 | 0.000 | 0.310 | 0.327 | 0.278 | 0.232 | 0.349 | 0.195 | 0.256 | 0.075 |
| 4 | 0.000 | 0.000 | 0.007 | 0.000 | 0.000 | 0.035 | 0.002 | 0.006 | 0.000 |
| 5 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Connecticut

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.010 | 0.075 | 0.099 | 0.097 | 0.075 | 0.071 | 0.052 | 0.110 | 0.166 |
| 2 | 0.252 | 0.489 | 0.668 | 0.590 | 0.598 | 0.590 | 0.525 | 0.626 | 0.524 |
| 3 | 0.705 | 0.258 | 0.159 | 0.285 | 0.282 | 0.288 | 0.406 | 0.199 | 0.272 |
| 4 | 0.034 | 0.166 | 0.040 | 0.026 | 0.045 | 0.052 | 0.013 | 0.059 | 0.032 |
| 5 | 0.000 | 0.014 | 0.035 | 0.000 | 0.000 | 0.002 | 0.005 | 0.005 | 0.006 |
| 6 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

New York

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.006 | 0.086 | 0.140 | 0.182 | 0.159 | 0.070 | 0.102 | 0.137 | 0.198 |
| 2 | 0.507 | 0.674 | 0.766 | 0.728 | 0.754 | 0.724 | 0.682 | 0.717 | 0.649 |
| 3 | 0.488 | 0.212 | 0.090 | 0.087 | 0.088 | 0.206 | 0.216 | 0.133 | 0.136 |
| 4 | 0.000 | 0.027 | 0.004 | 0.003 | 0.000 | 0.000 | 0.000 | 0.014 | 0.015 |
| 5 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

New Jersey

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.013 | 0.105 | 0.124 | 0.032 | 0.061 | 0.026 | 0.066 | 0.031 | 0.150 |
| 2 | 0.418 | 0.572 | 0.740 | 0.618 | 0.777 | 0.672 | 0.664 | 0.542 | 0.569 |
| 3 | 0.569 | 0.262 | 0.124 | 0.328 | 0.162 | 0.301 | 0.270 | 0.317 | 0.224 |
| 4 | 0.000 | 0.061 | 0.012 | 0.022 | 0.000 | 0.000 | 0.000 | 0.000 | 0.058 |
| 5 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

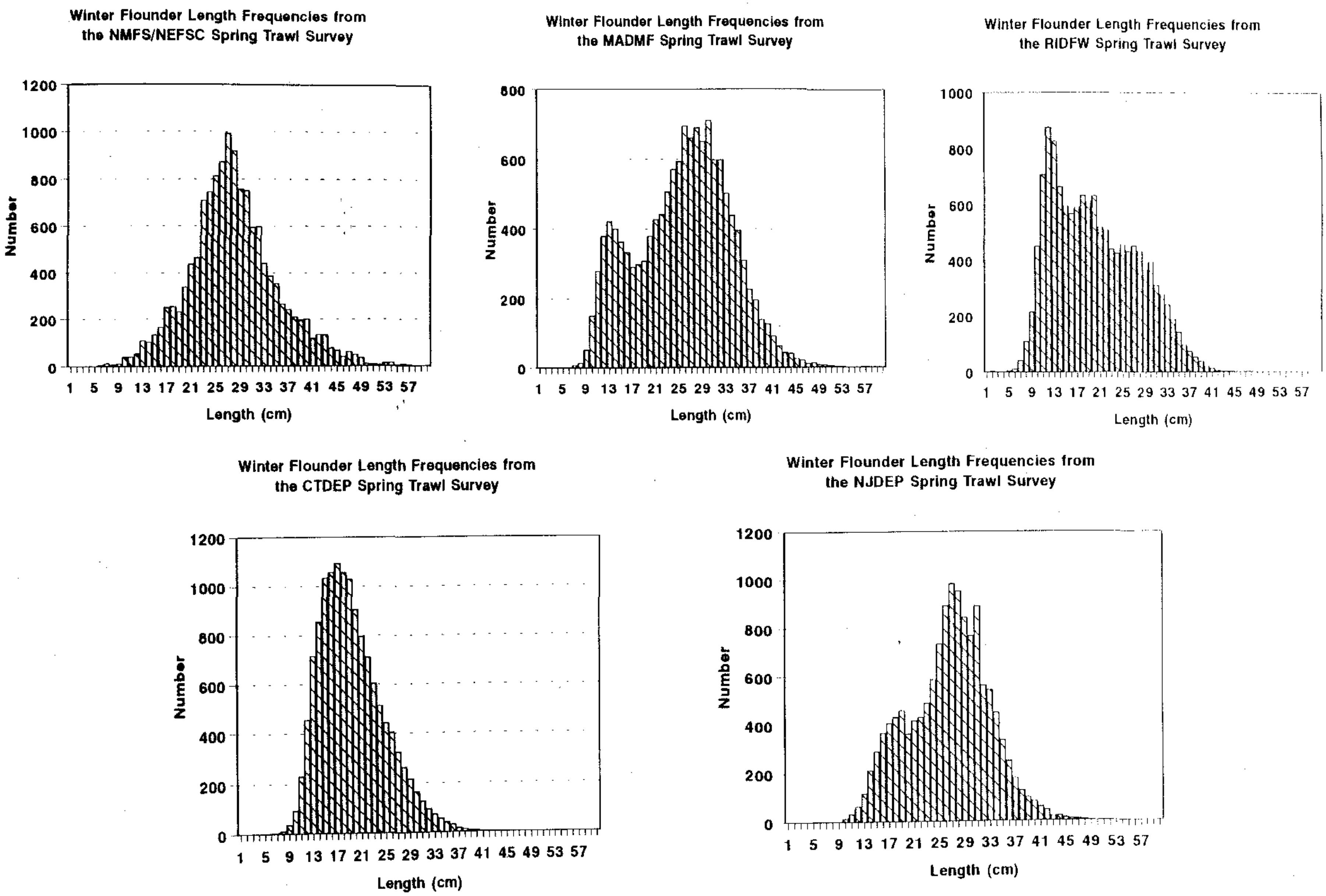
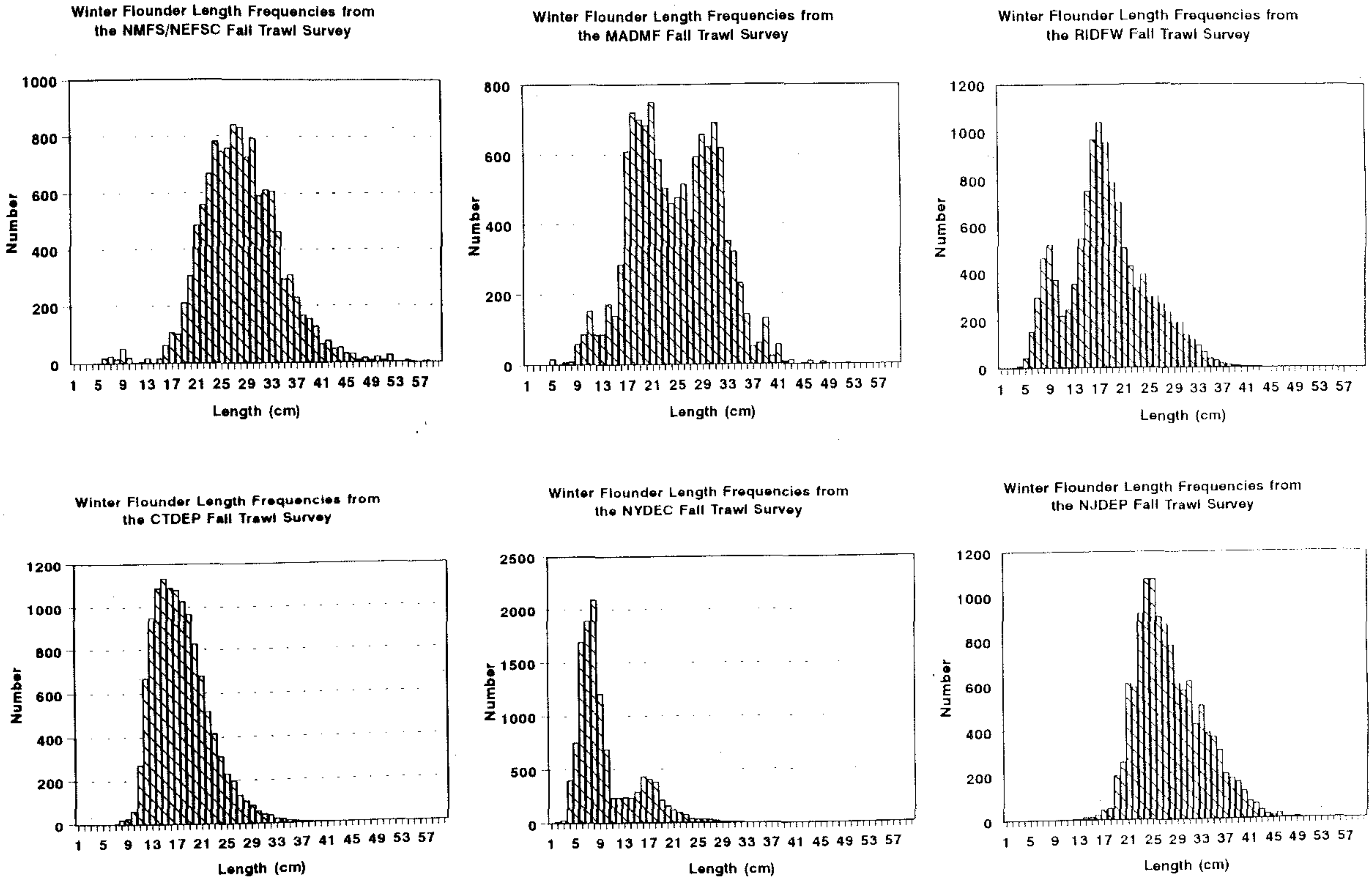


Figure 1. Length frequencies from spring trawl surveys in Southern New England/Mid-Atlantic.



Winter Flounder Length Frequencies from the NMFS/NEFSC Fall Trawl Survey

Winter Flounder Length Frequencies from the MADMF Fall Trawl Survey

Winter Flounder Length Frequencies from the RIDFW Fall Trawl Survey

Winter Flounder Length Frequencies from the CTDEP Fall Trawl Survey

Winter Flounder Length Frequencies from the NYDEC Fall Trawl Survey

Winter Flounder Length Frequencies from the NJDEP Fall Trawl Survey

Figure 2. Length frequencies of fall trawl surveys in Southern New England / Mid-Atlantic area.

# Appendix III. A Priori Evaluation of Fishery-Independent Indices for the Winter Flounder Assessment

Steven Correia
Massachusetts Division of Marine Fisheries
Sandwich, MA

## Introduction

Fishery independent indices are used in VPA analysis to estimate either terminal F or terminal populations in the final year of the VPA. Tuning affects population and mortality estimates through the unconverged portion of the VPA. In addition, the coherency of the tuning indices affects the precision of the terminal estimates.

Eleven different state and federal survey indices are age-disaggregated into 62 potential tuning indices. These surveys vary in areal coverage, seasonality, survey methodology and time-series length. Evaluation of the coherency of these indices before tuning may be useful in interpreting diagnostics from a VPA analysis and reducing coefficients of variation in estimates.

The NMFS spring and fall surveys have the widest geographic coverage but age specific abundance indices are only available from 1985 onwards. Connecticut, Rhode Island and Massachusetts cover inshore coastal waters and have a slightly longer time-series. The age zero surveys (MA seine, DEL trawl, NY Peconic Bay Trawl, and RI trawl) cover relatively small areas and vary in longevity.

## Methods and Materials

Eleven fishery independent surveys were available for analysis (Table 1). Age-disaggregated indices were visually examined for contrast and presence of years with zero catches. Age-disaggregated survey indices were transformed to z-scores and plotted to assist in visually evaluating indices for coherency (Figure 1-16). Pairwise correlation analyses among surveys by age were performed on indices from 9 of the 11 surveys. The New Jersey trawl survey and Connecticut embayment young-of-the-year surveys were not included in the analysis because of small sample sizes (N=3 and 4, respectively). Correlation analyses were also performed on log-transformed data with years with "zero" data excluded from the analysis. Age 0 indices were advanced one year and one age, and were tested for correlations with age 1 indices. Correlation analyses using the NMFS Fall survey indices were examined for both actual year and age indices and the indices advanced one year and one age. The NMFS Fall survey and NMFS Fall survey advanced an age and a year were not tested for correlation. Two tailed significance of correlation was tested at the (p=.05) level and probability of significance was not adjusted for multiple comparisons.

Two way ANOVAs testing for year and cohort effects with no interactions were run with all CT, RI, NMFS spring, NMFS Fall, and MA spring z-score indices except age 0. Two way ANOVAs were also run for RI and MA for years using a pooled age-length key (1978-1989) and annual keys (1990-1994). The following indices were excluded from the analysis because of a general lack of contrast in the indices: CT (ages 8-10), RI (ages 8-10), NMFS spring (ages 6-8), NMFS fall (ages 5-7) and MA (age 8).

## Results and Discussion

The Connecticut indices for ages 8-10 have zero catches and indices for ages 10 and 11 show little contrast. The Rhode Island trawl indices for ages 7-10 have years that contain zero catches and the age 8-10 indices show little contrast after 1988. The NMFS spring indices for ages 7-8 have years that contain zero catches and ages 6-8 show little contrast. As well, NMFS fall indices for ages 5, 6, and 7 also have years with zero catches and show little contrast. The Mass age 8 index has years with zero catches and has little contrast after 1990. The above mentioned indices may not be useful for tuning with the exception of possibly using a series truncated to earlier years when the index showed more contrast.

Results from the correlation analyses are shown in Appendix Tables 1 and 2. Of the 145 paired comparisons with untransformed indices, only 18 significant positive correlations were detected (Tables 2 and 3). Based upon the number of positive correlations, the CT, RI, and MA surveys produced the most coherent indices. The NMFS fall age 1 index was negatively correlated with the MA age 0 index. Ages with the most coherency were age 4 and age 7+. No significant correlations were found in ages 3, 6, 9 and 10.

Transforming the data reduced the number of significant correlations to 14 (Tables 4 and 5). Nine correlations that were significant before transformation were not significant after transformation. Four insignificant correlations were significant after ln transformation. The most coherent surveys were the RI and CT. Ages with the most coherency were age 4, 7+ and 7.

The results of the correlation analysis should be interpreted with caution because of the small sample sizes involved and the collinear downward trend in some of the indices. Positive correlation, particularly in the older indices, may arise from the collinearity rather than coherency in cohort strength.

Plots of surveys z-score indices by age and survey are provided and may help interpret coherency among surveys. Examination of z-score plots for RI and Mass indices suggest the presence of strong year effects but the ability to track cohort strength was not apparent. Results from two-way ANOVAs using year and cohort main effects are shown in Table 6. Results from the two way ANOVA analyses indicate that the RI and NMFS spring survey do not contain significant cohort effects and suggest that they may not be useful as a tuning indices. The inability to detect cohorts may be a function of large inter-annual availability effects, very high mortality rates or, in the case of RI, use of a pooled key age-length key. The results from testing the Mass survey for years using the pooled key and annual keys suggest that the pooled keys may remove cohort effects. A significant cohort effect was not found for RI data for the years using annual keys.

Table 1. Fishery independent surveys.

| Survey | Abbreviation | Year s in tables | N | Ages | First Age (Year) with catch = 0 |
|---|---|---|---|---|---|
| CT embayment | | 90-94 | 4 | 0 | |
| CT intertidal | CT_0 | 88-94 | 6 | 0 | |
| Del | DEL_0 | 86-94 | 8 | 0 | |
| Ma seine | MA_0 | 75-95 | 21 | 0 | |
| CT trawl | (CT) | 84-94 | 11 | 1-11 | age 8, (1990) |
| RI trawl | (RI) | 79-95 | 17 | 0-10 | age 7, (1992) |
| NMFS spring | (NSP) | 85-94 | 10 | 1-8 | age 7, (1992) |
| NMFS fall | (NSF) | 85-94 | 10 | 1-7 | age 5, (1993) |
| NMFS fall A* | (NFA) | 86-95 | 10 | 2-8 | age 6, (1994) |
| Ma spring | (MA) | 78-94 | 17 | 1-8 | age 8, (1990) |
| NY Peconic | (NY_0) | 85, 87-94 | 9 | 0 | |
| NY Peconic | (NY_1) | 85, 87-94 | 9 | 1 | |
| NJ trawl | | 93-95 | 3 | 1-11 | age 9, (1992) |

* NMFS fall A is the NMFS fall survey advanced 1 age and 1 year.

Table 2. Number of significant correlations among trawl survey indices, ages 0-10. +: number of positive correlations, -: number of negative correlations.

| | CT_0 | RI_0 | DEL_0 | MA_0 | NY_0 | CT | RI | NSP | MA | NSF | NY1 | NFA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CT_0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| RI_0 | 0 | X | 0 | 1+ | 0 | 0 | 1+ | 0 | 0 | 0 | 0 | X | 2+ |
| DEL_0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| MA_0 | 0 | 1+ | 0 | X | 0 | 0 | 0 | 0 | 0 | -1 | 0 | X | 1+, -1 |
| NY_0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 1 | 0 | 1+ | X | 2+ |
| CT | 0 | 0 | 0 | 0 | 0 | X | 3+ | 2+ | 3+ | 0 | 0 | X | 8+ |
| RI | 0 | 1+ | 0 | 0 | 0 | 3+ | X | 0 | 3+ | 0 | 0 | 0 | 7+ |
| NSP | 0 | 0 | 0 | 0 | 0 | 2+ | 0 | X | 0 | 1+ | 1+ | 0 | 4+ |
| MA | 0 | 0 | 0 | 0 | 1+ | 3+ | 3+ | 0 | X | 0 | 0 | 1+ | 8+ |
| NSF | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 1+ | 0 | X | 0 | X | 1+, -1 |
| NY_1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1+ | 0 | 0 | X | X | 2+ |
| NFA | X | X | X | X - | X | 0 | 0 | 0 | 1+ | X | X | X | 1+ |
| Total | 0 | 2+ | 0 | 1+, -1 | 2+ | 8+ | 7+ | 4+ | 8+ | 1+, -1 | 2+ | 1+ | |

Table 3. Number of significant correlations among indices by age.

| age | 0-1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 7+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| positive | 3 | 1 | 1 | 1 | 0 | 4 | 2 | 0 | 2 | 1 | 0 | 0 | 3 |
| negative | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N | 30 | 10 | 15 | 14 | 14 | 14 | 14 | 14 | 7 | 3 | 3 | 1 | 6 |

Table 4. Number of significant correlations among log-transformed trawl survey indices, ages 1-10. +: number of positive correlations, -: number of negative correlations.

|  | CT_0 | RI_0 | DEL_0 | MA_0 | NY_0 | CT | RI | NSP | MA | NSF | NY_1 | NFA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CT_0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| RI_0 | 0 | X | 0 | 1+ | 0 | 0 | 1+ | 0 | 0 | 0 | 0 | X | 2+ |
| DEL_0 | 0 | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| MA_0 | 0 | 1+ | 0 | X | 0 | 0 | 1+ | 0 | 0 | 0 | 0 | X | 2+ |
| NY_0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 1+ | 0 | 0 | X | 1+ |
| CT | 0 | 0 | 0 | 0 | 0 | X | 4+ | 2+ | 0 | 0 | 0 | 0 | 6+ |
| RI | 0 | 1+ | 0 | 1+ | 0 | 4 | X | 1+ | 3+ | 0 | 0 | 0 | 10+ |
| NSP | 0 | 0 | 0 | 0 | 0 | 2+ | 1+ | X | 0 | 0 | 0 | 0 | 3+ |
| MA | 0 | 0 | 0 | 0 | 1+ | 0 | 3+ | 0 | X | 0 | 0 | 0 | 4+ |
| NSF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | X | 0 |
| NY_1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | X | 0 |
| NFA | X | X | X | X | X | 0 | 0 | 0 | 0 | X | X | X | 0 |
| TOTAL | 0 | 2+ | 0 | 2+ | 1+ | 6+ | 10+ | 3+ | 4+ | 0 | 0 | 0 |  |

Table 5. Number of significant correlations among log-transformed indices by age.

| age | 0-1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 7+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| positive | 3 | 1 | 0 | 0 | 1 | 2 | 1 | 0 | 3 | 1 | 0 | 0 | 2 |
| negative | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N | 30 | 10 | 15 | 14 | 14 | 14 | 14 | 14 | 7 | 3 | 3 | 1 | 6 |

Table 6. Summary of two way ANOVA testing year and yearclass main effects with no interactions on Z-transformed survey indices . *: significant (P<.05); ns: not significant.

| Survey | Year effect | Cohort effect |
|---|---|---|
| CT | * | * |
| RI | * | ns |
| NMFS spring | * | ns |
| NMFS fall | * | * |
| MA spring (78-94) | * | * |
| MA spring (78-89) | * | ns |
| MA spring (90-94) | ns | * |
| RI (78-89) | * | ns |
| RI (90-95) | * | ns |

Appendix I: Table 1. Winter flounder survey indices correlation analysis using untransformed data. * - Signif. LE 0.05, ** - Signif. LE 0.01 (2-tailed), "." printed if a coefficient cannot be computed.

Age 0 and 1 indices

- - Correlation Coefficients - -

| | CT_0 | RI_0 | DEL_0 | MA_0 | NY_0 |
|---|---|---|---|---|---|
| CT_0 | 1.0000 | .1322 | -.3131 | -.5035 | .1508 |
| RI_0 | .1322 | 1.0000 | .0588 | .5846* | .5812 |
| DEL_0 | -.3131 | .0588 | 1.0000 | .4338 | .1418 |
| MA_0 | -.5035 | .5846* | .4338 | 1.0000 | -.0816 |
| NY_0 | .1508 | .5812 | .1418 | -.0816 | 1.0000 |
| CT1 | .4028 | -.1185 | .0807 | .0322 | .4722 |
| RI1 | .3427 | .5123* | .1575 | .3954 | -.2771 |
| NSP1 | -.5228 | -.0315 | .1937 | .2071 | .0954 |
| MA1 | .1342 | -.1941 | -.2331 | -.0445 | .8626** |
| NSF1 | .5968 | .0276 | -.3137 | -.6582* | .6433 |
| NY1 | .4643 | .2457 | .3961 | -.2060 | .8054* |

Age 0 and 1 indices continued

| | CT1 | RI1 | NSP1 | MA1 | NSF | NY1 |
|---|---|---|---|---|---|---|
| CT_0 | .4028 | .3427 | -.5228 | .1342 | .5968 | .4643 |
| RI_0 | -.1185 | .5123* | -.0315 | -.1941 | .0276 | .2457 |
| DEL_0 | .0807 | .1575 | .1937 | -.2331 | -.3137 | .3961 |
| MA_0 | .0322 | .3954 | .2071 | -.0445 | -.6582* | -.2060 |
| NY_0 | .4722 | -.2771 | .0954 | .8626** | .6433 | .8054* |
| CT1 | 1.0000 | -.2041 | -.3076 | .1873 | .2376 | .4909 |
| RI1 | -.2041 | 1.0000 | -.1891 | -.0919 | -.4031 | -.1226 |
| NSP1 | -.3076 | -.1891 | 1.0000 | -.0767 | -.0468 | -.1544 |
| MA1 | .1873 | -.0919 | -.0767 | 1.0000 | .5917 | .4117 |
| NSF | .2376 | -.4031 | -.0468 | .5917 | 1.0000 | .6804* |
| NY1 | .4909 | -.1226 | -.1544 | .4117 | .6804* | 1.0000 |

Age 2 indices

- - Correlation Coefficients - -

| | CT | RI | NSP | NFA | MA | NSF |
|---|---|---|---|---|---|---|
| CT | 1.0000 | -.2205 | .0244 | .1863 | -.1682 | -.0388 |
| RI | -.2205 | 1.0000 | .3003 | .1435 | -.0522 | -.3569 |
| NSP | .0244 | .3003 | 1.0000 | .0974 | -.1171 | .2392 |
| NFA | .1863 | .1435 | .0974 | 1.0000 | .6688* | . |
| MA | -.1682 | -.0522 | -.1171 | .6688* | 1.0000 | .2347 |
| NSF | -.0388 | -.3569 | .2392 | . | .2347 | 1.0000 |

Age 3 indices

- - Correlation Coefficients - -

| | CT | RI | NSP | NFA | MA | NSF |
|---|---|---|---|---|---|---|
| CT | 1.0000 | .3330 | .3508 | -.3048 | -.5476 | .0374 |
| RI | .3330 | 1.0000 | .6103 | -.0912 | .2768 | -.1383 |
| NSP | .3508 | .6103 | 1.0000 | -.3264 | .1378 | .2888 |
| NFA | -.3048 | -.0912 | -.3264 | 1.0000 | .0117 | |
| MA | -.5476 | .2768 | .1378 | .0117 | 1.0000 | -.1216 |
| NSF | .0374 | -.1383 | .2888 | . | -.1216 | 1.0000 |

Age 4 indices

- - Correlation Coefficients - -

| | CT | RI | NSP | NFA | MA | NSF |
|---|---|---|---|---|---|---|
| CT | 1.0000 | .7049* | .8269** | .1437 | .6922* | -.1656 |
| RI | .7049* | 1.0000 | .4745 | .0989 | .5687* | -.0949 |
| NSP | .8269** | .4745 | 1.0000 | .2135 | .3528 | .3042 |
| NFA | .1437 | .0989 | .2135 | 1.0000 | -.1319 | . |
| MA | .6922* | .5687* | .3528 | -.1319 | 1.0000 | .2109 |
| NSF | -.1656 | -.0949 | .3042 | . | .2109 | 1.0000 |

Age 5 indices

- - Correlation Coefficients - -

| | CT | RI | NSP | NFA | MA | NSF |
|---|---|---|---|---|---|---|
| CT | 1.0000 | .5371 | .0368 | -.0437 | .3653 | -.2681 |
| RI | .5371 | 1.0000 | .4441 | -.0234 | .6936** | .1831 |
| NSP | .0368 | .4441 | 1.0000 | .5275 | .4852 | .8347** |
| NFA | -.0437 | -.0234 | .5275 | 1.0000 | .0397 | . |
| MA | .3653 | .6936** | .4852 | .0397 | 1.0000 | .4280 |
| NSF | -.2681 | .1831 | .8347** | . | .4280 | 1.0000 |

Age 6 indices

- - Correlation Coefficients - -

| | CT | RI | NSP | NFA | MA | NSF |
|---|---|---|---|---|---|---|
| CT | 1.0000 | .3015 | -.0114 | -.2566 | -.4509 | -.4362 |
| RI | .3015 | 1.0000 | .2861 | .3751 | .4463 | -.4124 |
| NSP | -.0114 | .2861 | 1.0000 | .5920 | .2954 | -.2500 |
| NFA | -.2566 | .3751 | .5920 | 1.0000 | .1052 | . |
| MA | -.4509 | .4463 | .2954 | .1052 | 1.0000 | .4345 |
| NSF | -.4362 | -.4124 | -.2500 | . | .4345 | 1.0000 |

```
Age 7 indices
                         - -  Correlation Coefficients  - -

               CT          RI          NSP         NFA         MA

CT          1.0000       .5789       .8417**        .         .7164*
RI           .5789      1.0000       .1726      -.0673        .4415
NSP          .8417**     .1726      1.0000         .          .2510
NFA                     -.0673         .         1.0000
MA           .7164*      .4415       .2510         .         1.0000

Age 8 indices
                         - -  Correlation Coefficients  - -

               CT          RI        MA

CT          1.0000       .8780**    .7326
RI           .8780**    1.0000      .4097
MA           .7326       .4097     1.0000

Age 9 indices
                         - -  Correlation Coefficients  - -

               CT          RI          MA

CT          1.0000       .3873       .1290
RI           .3873      1.0000       .1909
MA           .1290       .1909      1.0000


Age 10 indices
                         - -  Correlation Coefficients  - -

               CT          RI

CT          1.0000       -.2843
RI          -.2843       1.0000


Age 7+ indices
                         - -  Correlation Coefficients  - -

               CT          RI          NSP         MA

CT          1.0000       .8556**      .5780       .7600**
RI           .8556**    1.0000        .2463       .5063*
NSP          .5780       .2463       1.0000       .3639
MA           .7600**     .5063*       .3639      1.0000
```

Appendix Table 2. Winter flounder survey indices correlation analysis using log-transformed data. * - Signif. LE .05, ** - Signif. LE .01 (2-tailed), " . " printed if a coefficient cannot be computed.

```
Age 0 and 1 transformed indices
                            - -  Correlation Coefficients  - -

              CT_0        RI_0       DEL_0        MA_0        NY_0


CT_0         1.0000      -.2463      -.3380      -.4254       .0301
RI_0         -.2463      1.0000       .2070       .6245**     .0886
DEL_0        -.3380       .2070      1.0000       .4690       .3669
MA_0         -.4254       .6245**     .4690      1.0000      -.2286
NY_0          .0301       .0996       .3669      -.2286      1.0000
CT1           .2282      -.2909       .2214      -.0611       .2362
RI1           .1612       .5472*      .4786       .5518*     -.4156
NSP1         -.6673       .0671       .1994       .0889       .3502
MA1           .1484      -.1246      -.0527      -.1066       .7439*
NSF1          .8099      -.1617      -.4166      -.5304       .4037
NY1           .4243      -.0171       .3085      -.2665       .5611

              CT1         RI1         NSP1        MA1         NSF1        NY1


CT_0          .2282       .1612      -.6673       .1484       .8099       .4243
RI_0         -.2909       .5472*      .0671      -.1246      -.1617      -.0171
DEL_0         .2214       .4786       .1994      -.0527      -.4166       .3085
MA_0         -.0611       .5518*      .0889      -.1066      -.5304      -.2665
NY_0          .2362      -.4156       .3502       .7439*      .4037       .5611
CT1          1.0000       .0185      -.3333      -.0191       .0483       .4211
RI1           .0185      1.0000      -.1498      -.1764      -.4138       .1549
NSP1         -.3333      -.1498      1.0000       .0904       .1494      -.0003
MA1          -.0191      -.1764       .0904      1.0000       .3048       .0439
NSF1          .0483      -.4138       .1494       .3048      1.0000       .5865
NY1           .4211       .1549      -.0003       .0439       .5865      1.0000
```

```
Age 2 transformed indices
                            - -  Correlation Coefficients  - -

              CT          RI          NSP         NFA         MA          NSF


CT           1.0000       .1307       .2241      -.0941      -.3146       .0073
RI            .1307      1.0000       .4821       .1720      -.0706      -.3068
NSP           .2241       .4821      1.0000      -.0914      -.1622       .3280
NFA          -.0941       .1720      -.0914      1.0000       .6410       .4069
MA           -.3146      -.0706      -.1622       .6410      1.0000       .0833
NSF           .0073      -.3068       .3280       .4069       .0833      1.0000
```

```
Age 3 transformed indices
                              - -  Correlation Coefficients  - -

                  CT          RI          NSP         NFA         MA          NSF

CT              1.0000       .3391       .5916      -.1331      -.4333      -.0847
RI               .3391      1.0000       .8026**    -.1488       .2839      -.0267
NSP              .5916       .8026**    1.0000      -.3032      -.0325       .2301
NFA             -.1331      -.1488      -.3032      1.0000      -.0914      -.0248
MA              -.4333       .2839      -.0325      -.0914      1.0000      -.0250
NSF             -.0847      -.0267       .2301      -.0248      -.0250      1.0000
```

```
Age 4 transformed indices
                              - -  Correlation Coefficients  - -

                  CT          RI          NSP         NFA         MA          NSF

CT              1.0000       .6367*      .8921**     .1802       .3378      -.2441
RI               .6367*     1.0000       .5989      -.1055       .4181      -.0487
NSP              .8921**     .5989      1.0000       .1717       .0970       .0960
NFA              .1802      -.1055       .1717      1.0000      -.1954      -.5794
MA               .3378       .4181       .0970      -.1954      1.0000       .0201
NSF             -.2441      -.0487       .0960      -.5794       .0201      1.0000
```

```
Age 5 transformed indices
                              - -  Correlation Coefficients  - -

                  CT          RI          NSP         NFA         MA          NSF

CT              1.0000       .5731       .1382      -.0881       .0131      -.4629
RI               .5731      1.0000       .5302      -.1762       .5465*     -.0029
NSP              .1382       .5302      1.0000       .5168       .4488       .4689
NFA             -.0881      -.1762       .5168      1.0000       .0233      -.2913
MA               .0131       .5465*      .4488       .0233      1.0000       .4059
NSF             -.4629      -.0029       .4689      -.2913       .4059      1.0000
```

```
Age 6 transformed indices
                              - -  Correlation Coefficients  - -

                  CT          RI          NSP         NFA         MA          NSF

CT              1.0000       .5383       .1264      -.0655      -.5506      -.4086
RI               .5383      1.0000       .4950       .2110       .3219      -.2540
NSP              .1264       .4950      1.0000       .2224       .1133      -.2500
NFA             -.0655       .2110       .2224      1.0000       .2549        .
MA              -.5506       .3219       .1133       .2549      1.0000       .3948
NSF             -.4086      -.2540      -.2500        .           .3948      1.0000
```

```
Age 7 transformed indices
                          - -  Correlation Coefficients  - -

              CT          RI          NSP         NFA       MA

CT          1.0000      .6424*      .7687*       .          .5540
RI           .6424*    1.0000       .3648       .1920       .5669*
NSP          .7687*     .3648      1.0000        .          .2072
NFA           .         .1920        .         1.0000        .
MA           5540       .5669*      .2072        .         1.0000

Age 8 transformed indices
                          - -  Correlation Coefficients  - -

              CT          RI         MA

CT          1.0000      .8658**     .7347
RI           .8658**   1.0000       .5581
MA           .7347      .5581      1.0000

Age 9 transformed indices
                          - -  Correlation Coefficients  - -

              CT          RI          MA

CT          1.0000      .6294       .5864
RI           .6294     1.0000       .2698
MA           .5864      .2698      1.0000

Age 10 transformed indices
                          - -  Correlation Coefficients  - -

              CT          RI

CT          1.0000      -.2563
RI          -.2563     1.0000

Age 7+ transformed indices
                          - -  Correlation Coefficients  - -

              CT          RI          NSP         MA

CT          1.0000      .7268*      .5304       .4008
RI           .7268*    1.0000       .5862       .6584**
NSP          .5304      .5862      1.0000       .4104
MA           .4008      .6584**     .4104      1.0000
```

## Age Zero Indices
## Z-scores

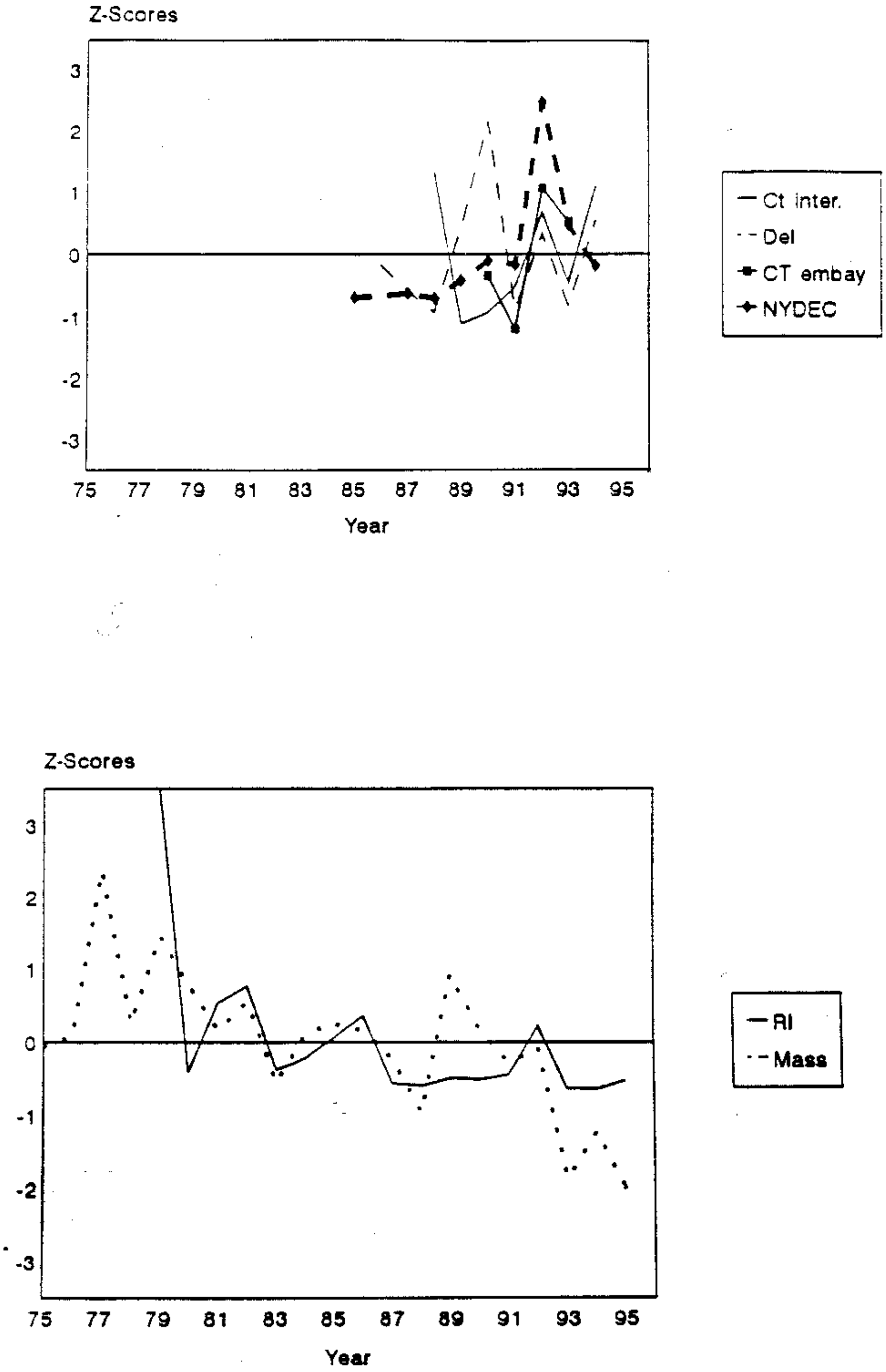


Figure 1. Standardized age zero winter flounder survey indices for coastal Connecticut, Delaware, Connecticut bays, New York, Rhode Island and Massachusetts.

Age One Indices
Z-scores

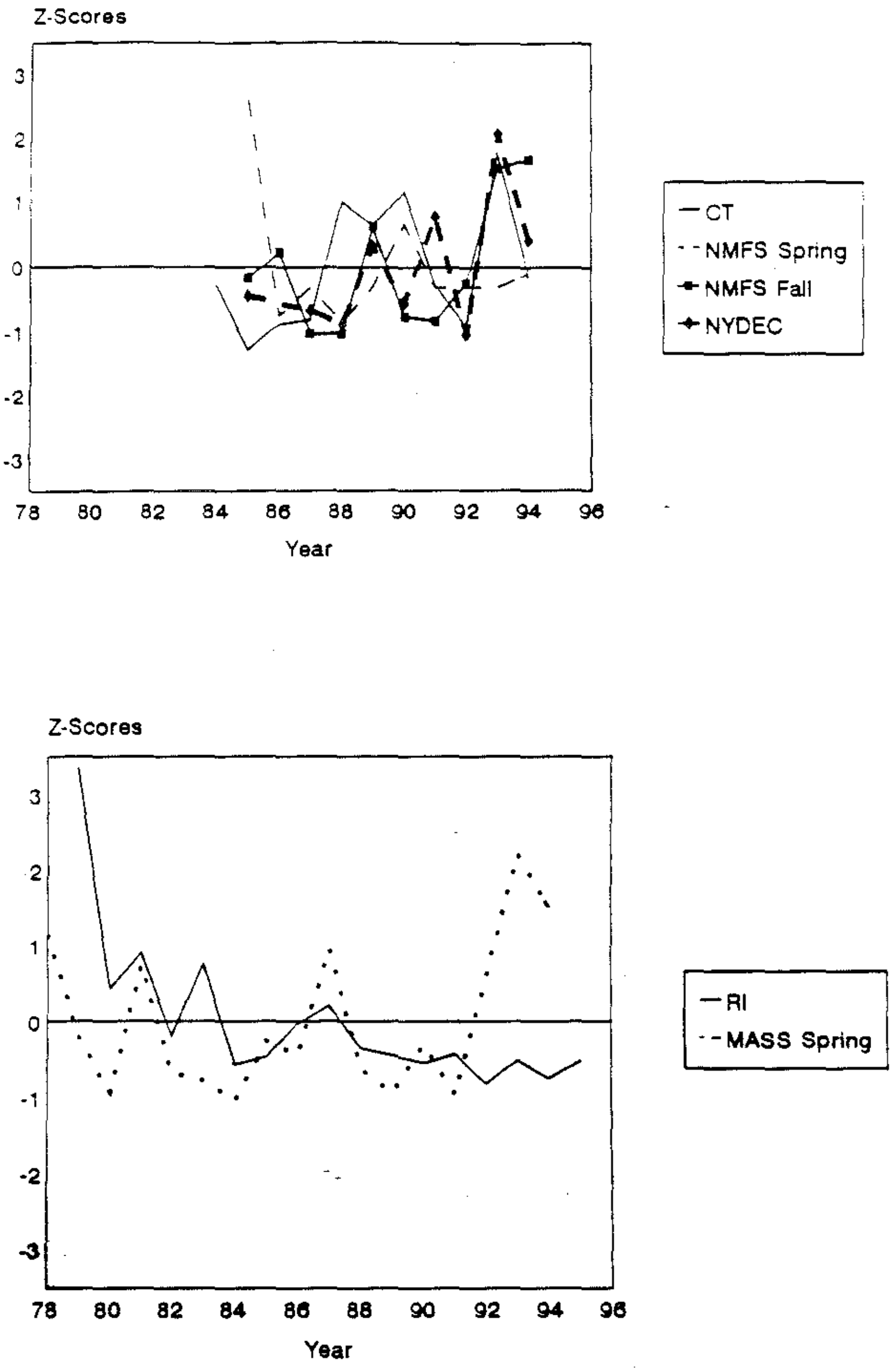


Figure 2. Standardized age one winter flounder survey indices for Connecticut, NMFS spring and fall, New York, Rhode Island and Massachusetts.

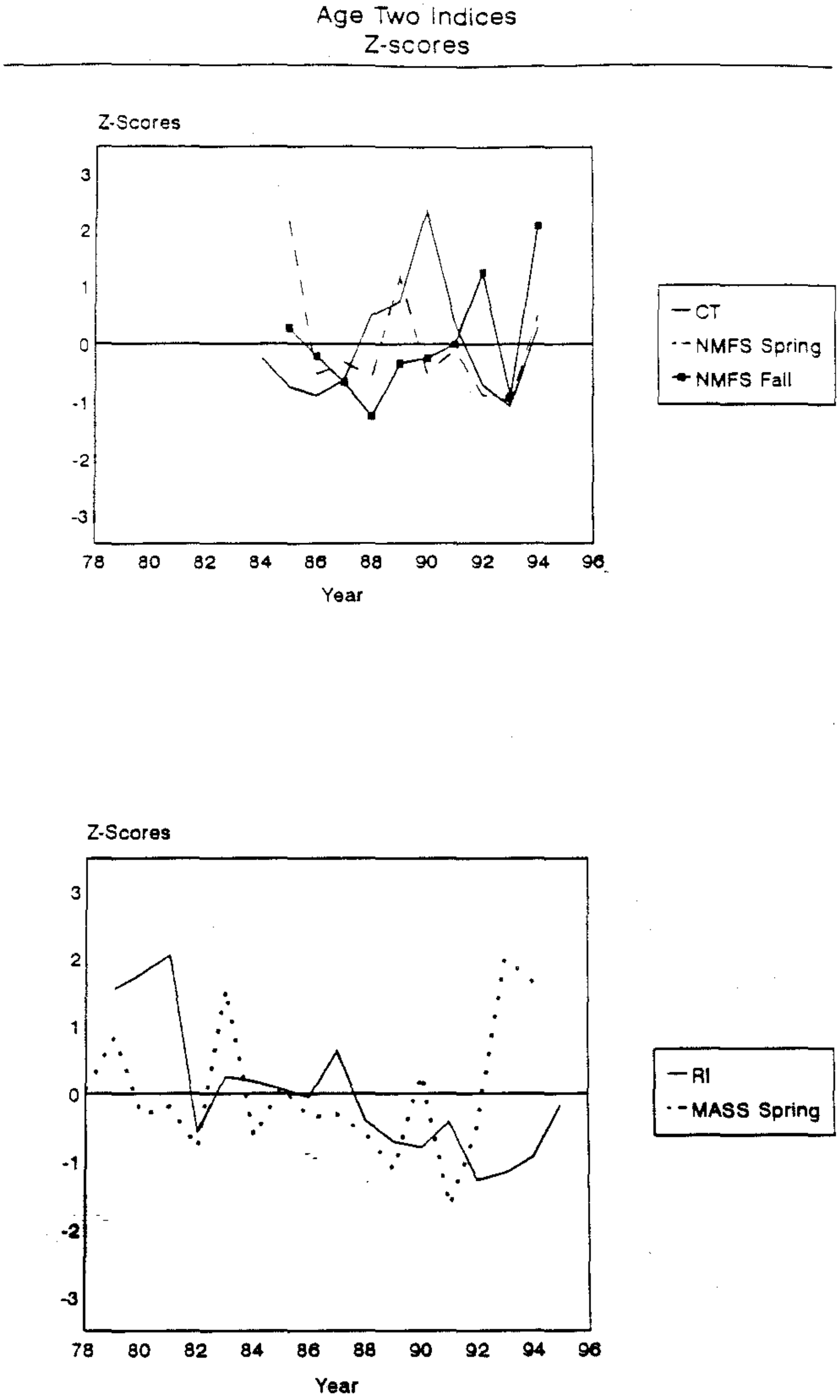


Figure 3. Standardized age two winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Three Indices
Z-scores

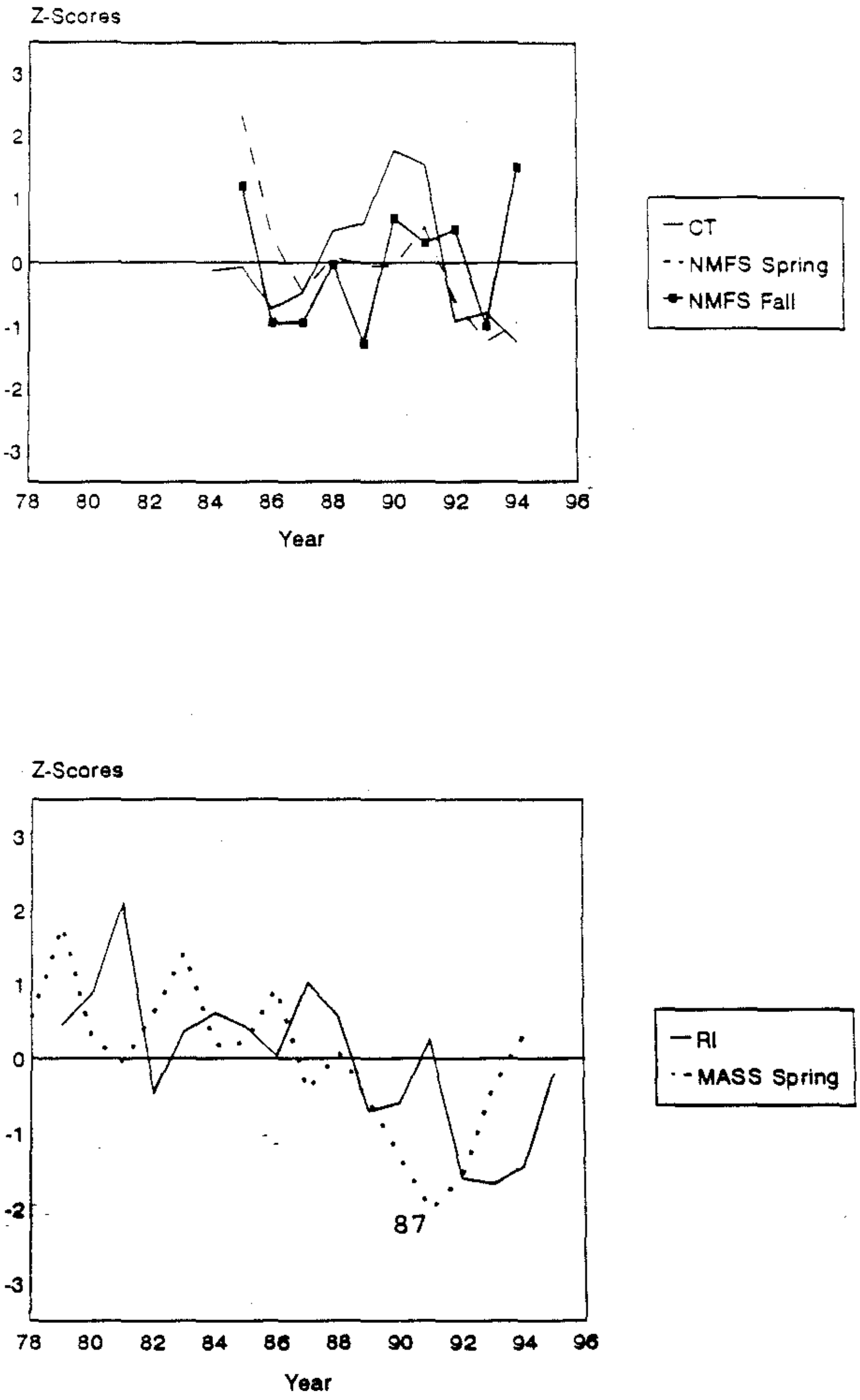


Figure 4. Standardized age three winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

## Age Four Indices
## Z-scores

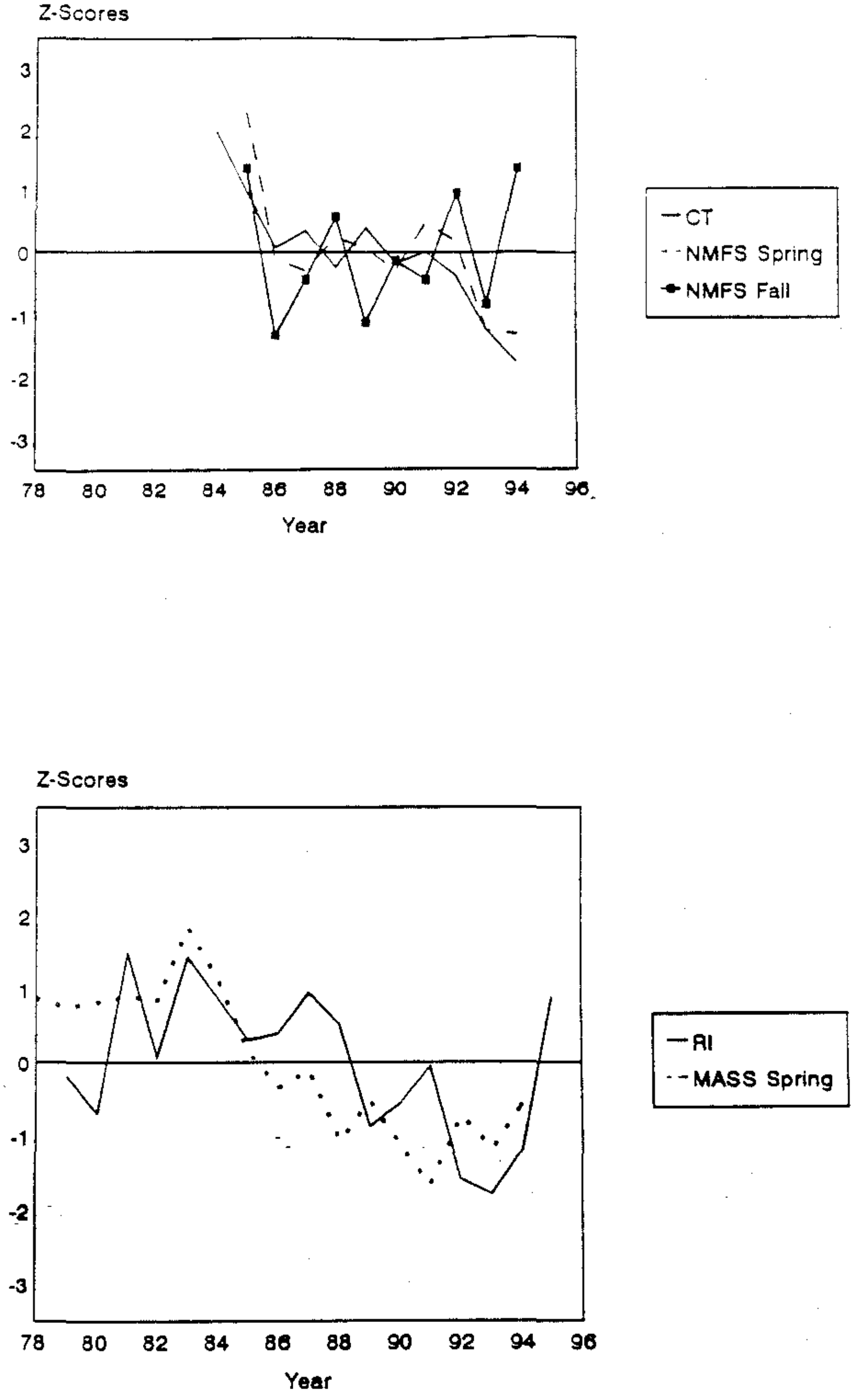


Figure 5. Standardized age four winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

## Age Five indices
## Z-scores

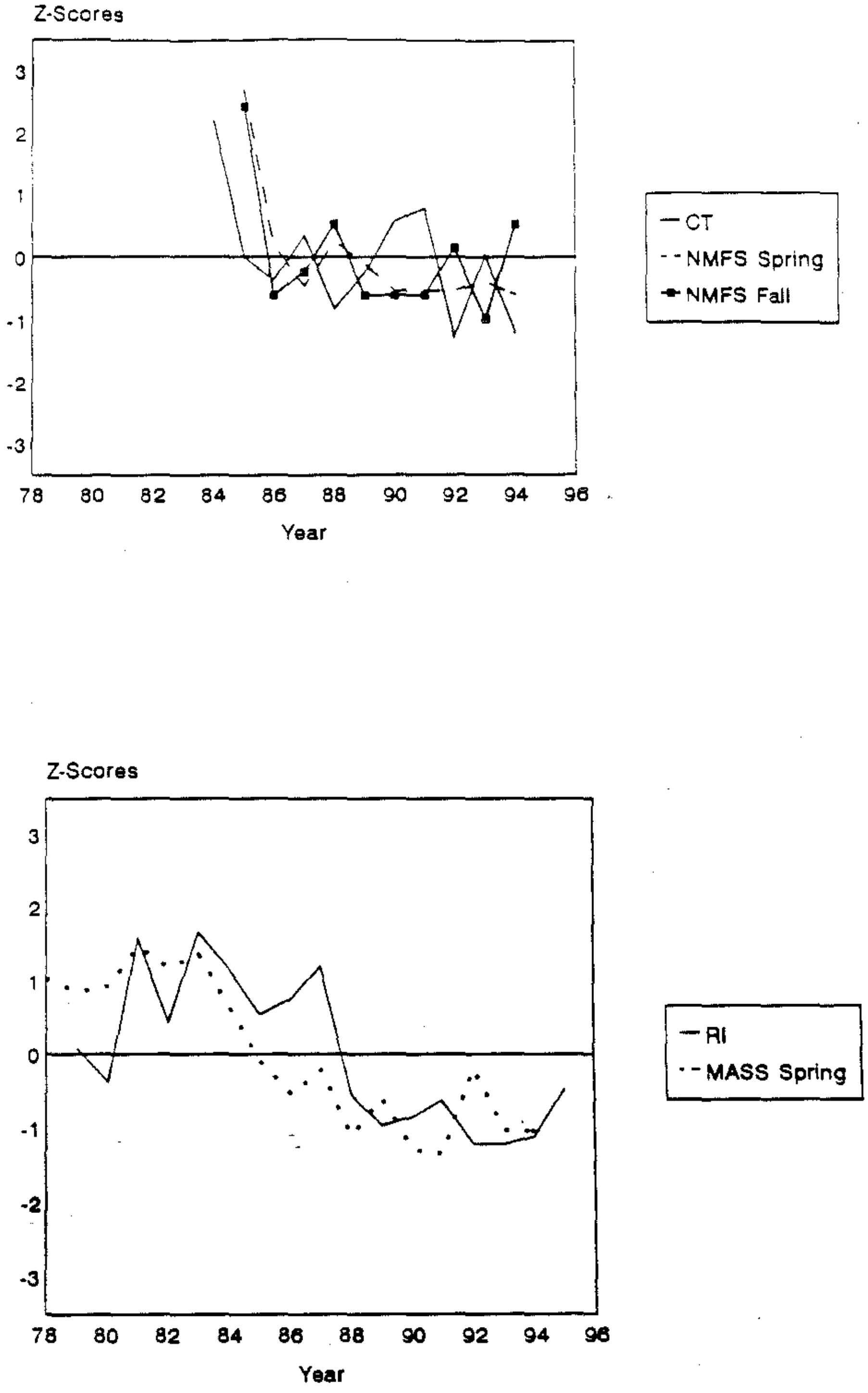
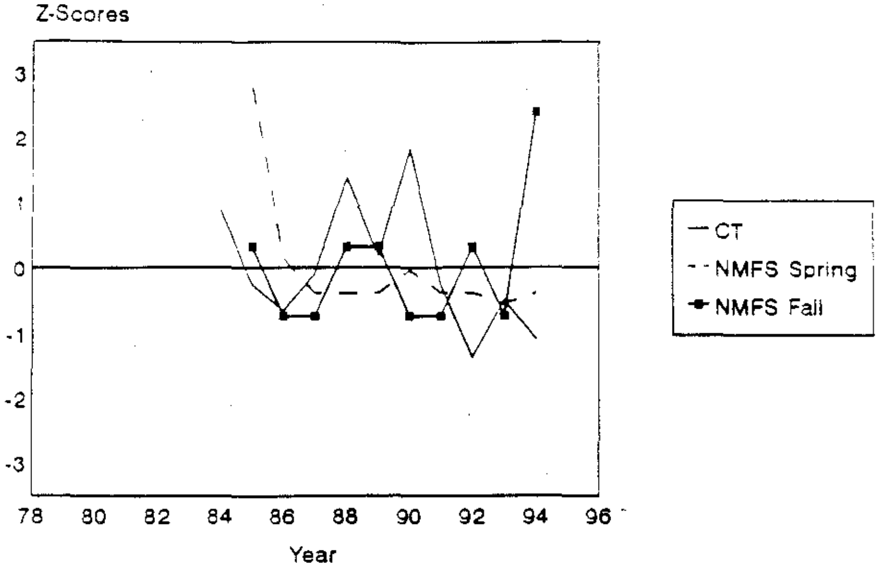


Figure 6. Standardized age five winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Six indices
Z-scores



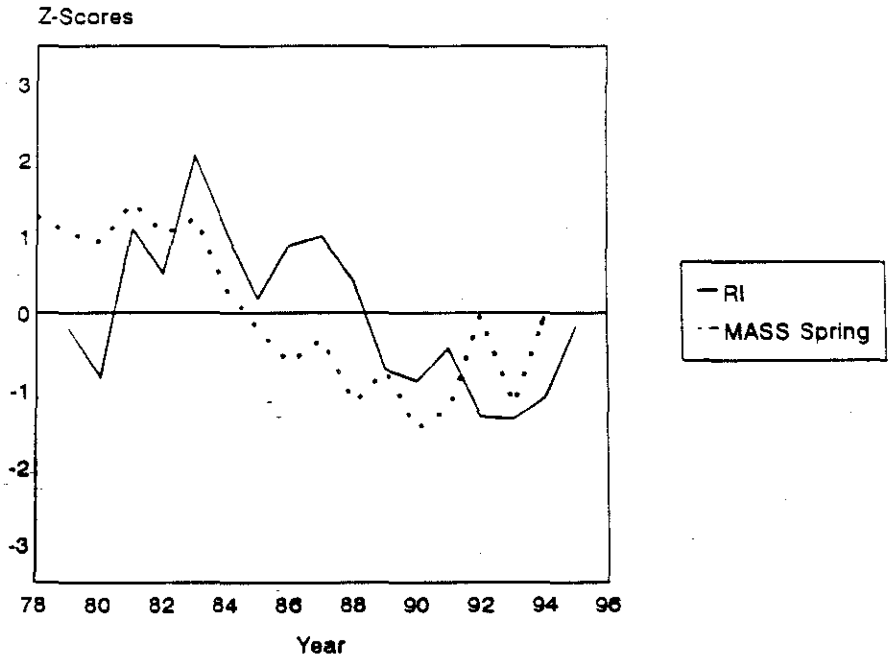


Figure 7. Standardized age six winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island, Massachusetts.

## Age Seven Indices
## Z-scores

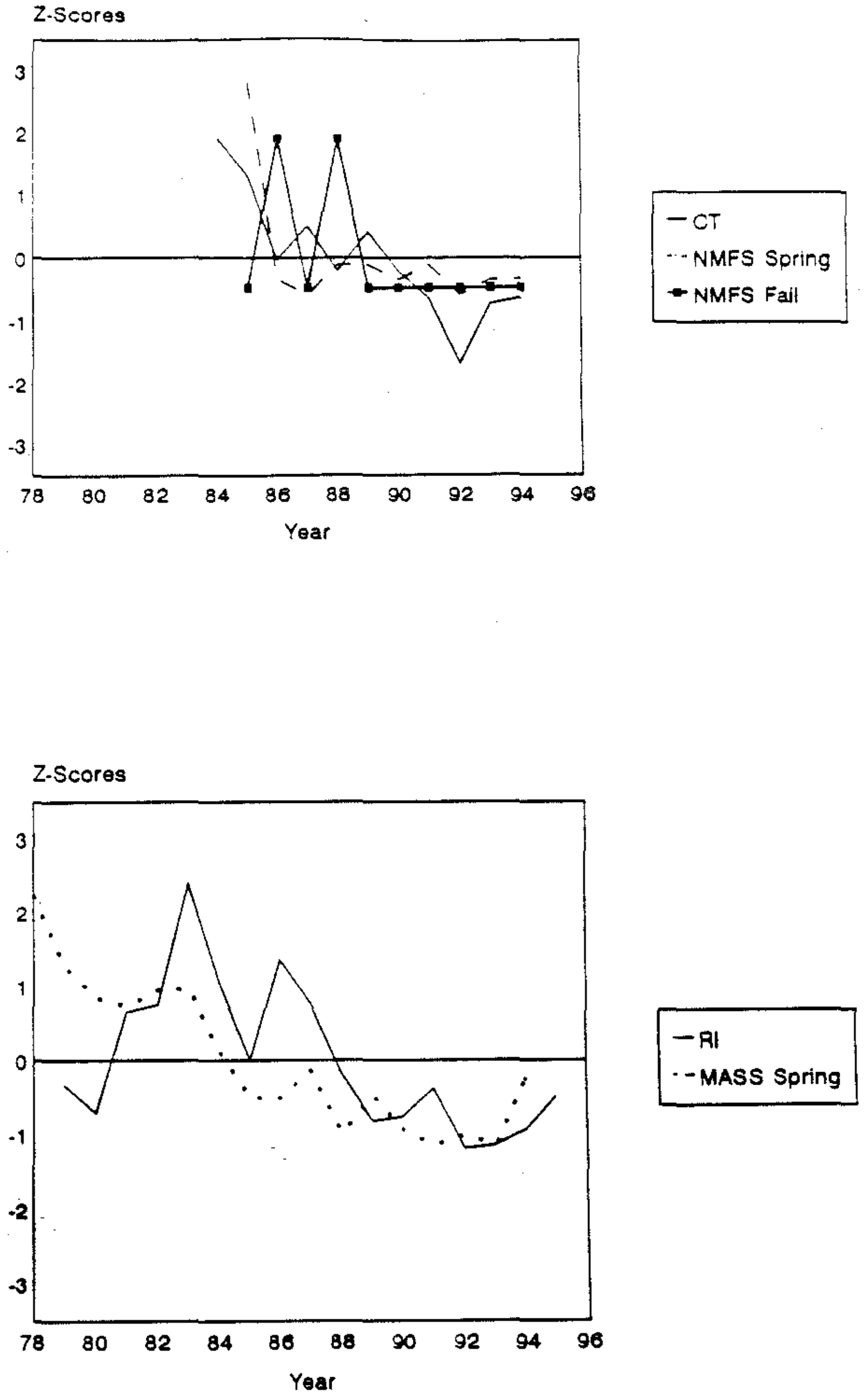


Figure 8. Standardized age seven winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

## Age Eight Indices
## Z-scores

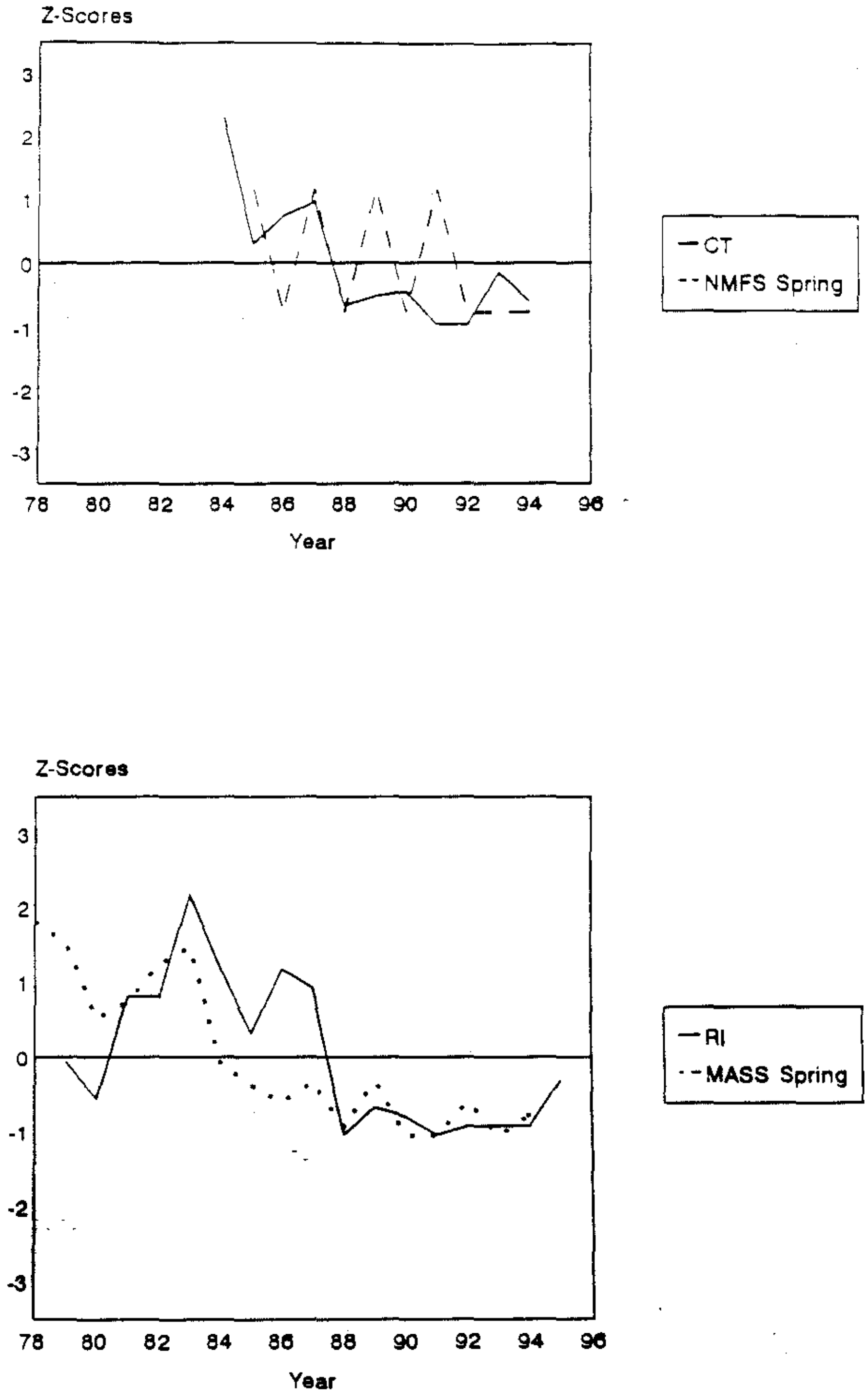


Figure 9. Standardized age eight winter flounder survey indices for Connecticut, NMFS spring, Rhode Island and Massachusetts.

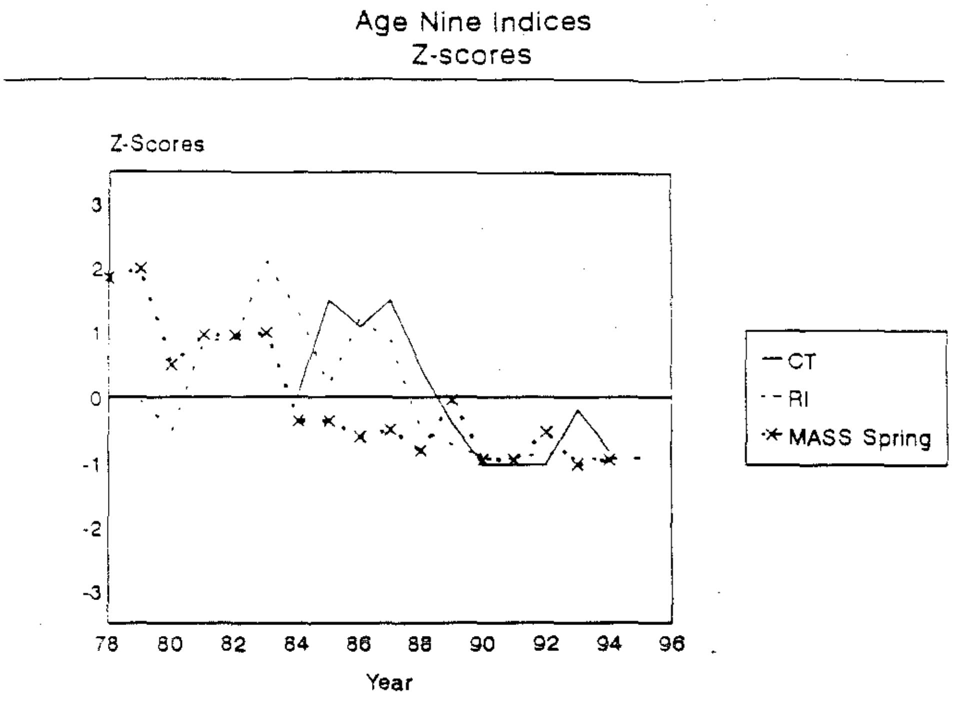


Figure 10. Standardized age nine winter flounder survey indices for Connecticut, Rhode Island and Massachusetts.

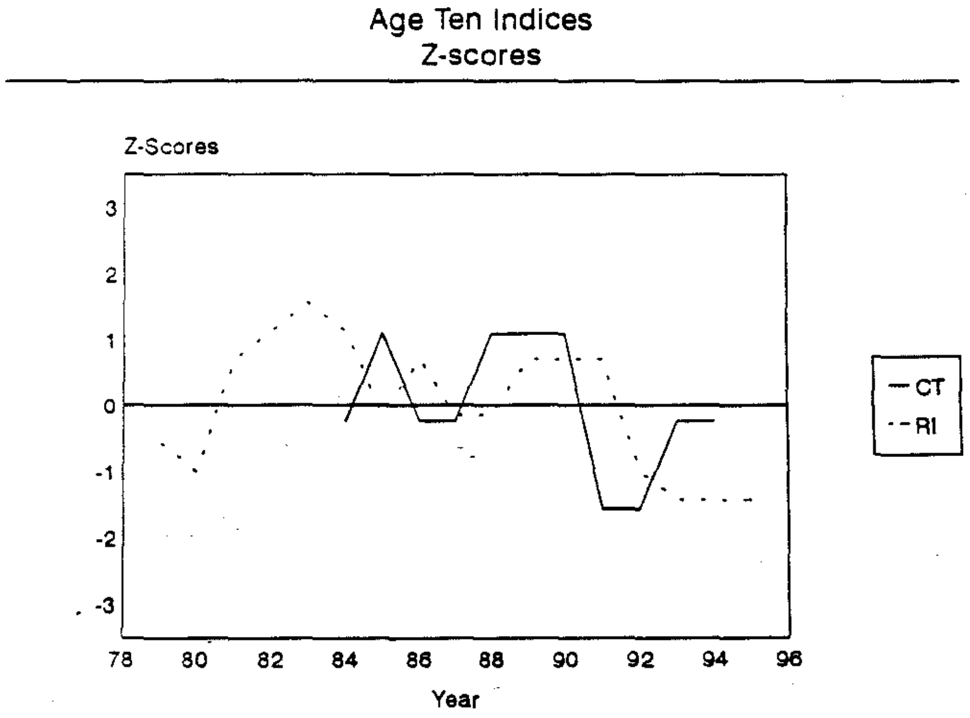


Figure 11. Standardized age ten winter flounder survey indices for Connecticut and Rhode Island.

CT Winter Flounder Survey
Transformed Z scores by age group

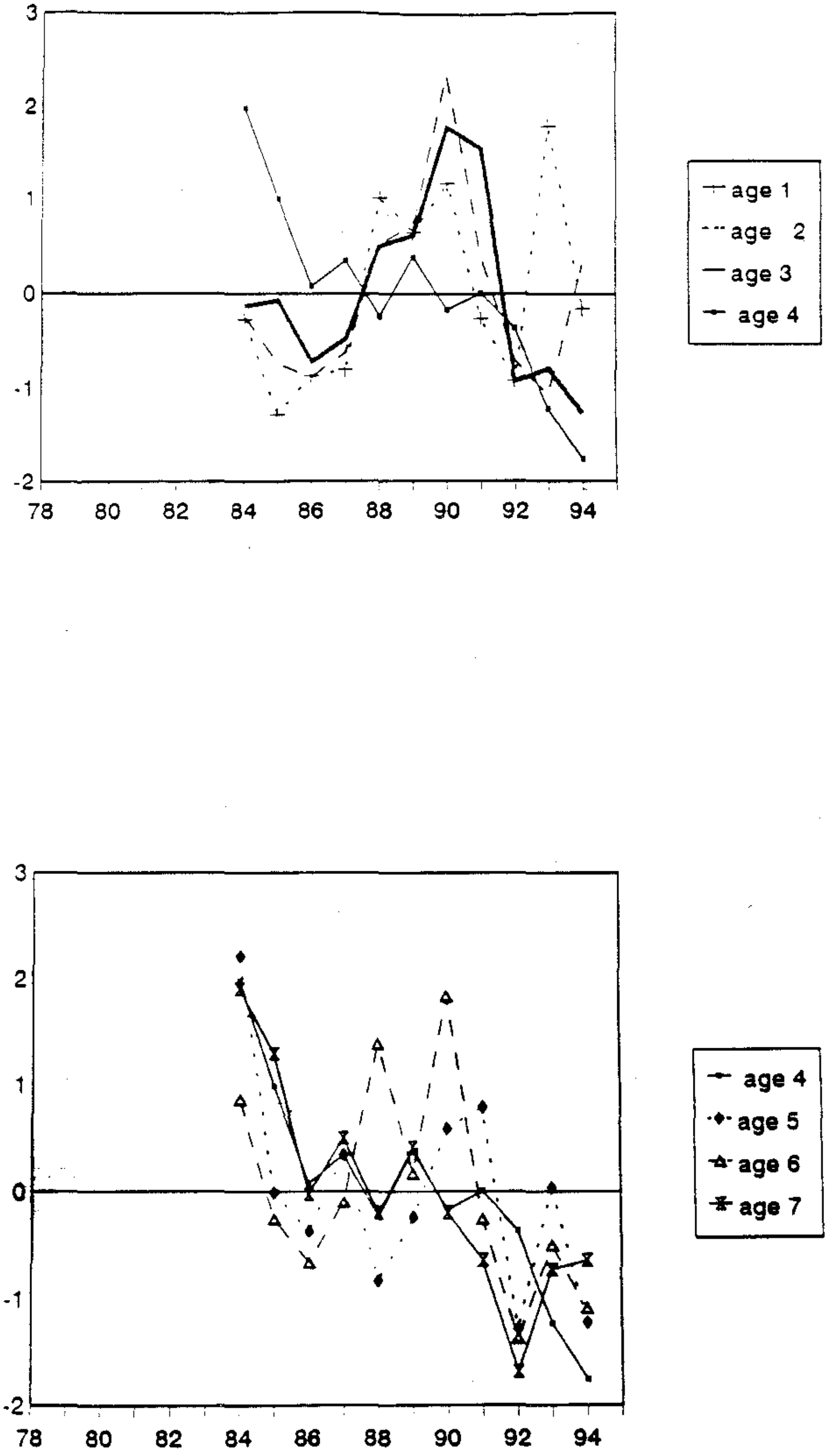


Figure 12. Standardized winter flounder survey indices by age group from Connecticut survey.

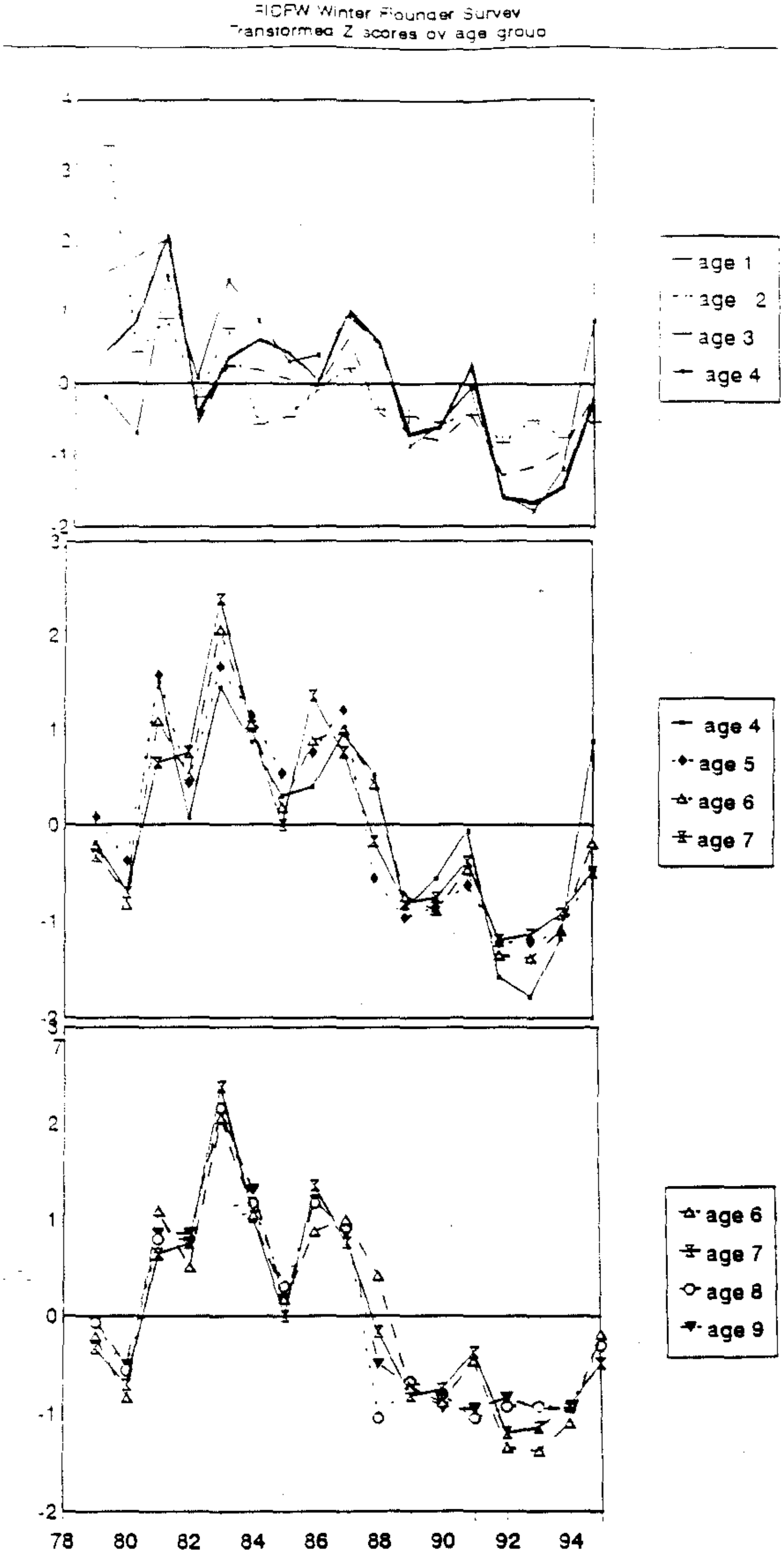


Figure 13. Standardized winter flounder survey indices by age group from Rhode Island survey.

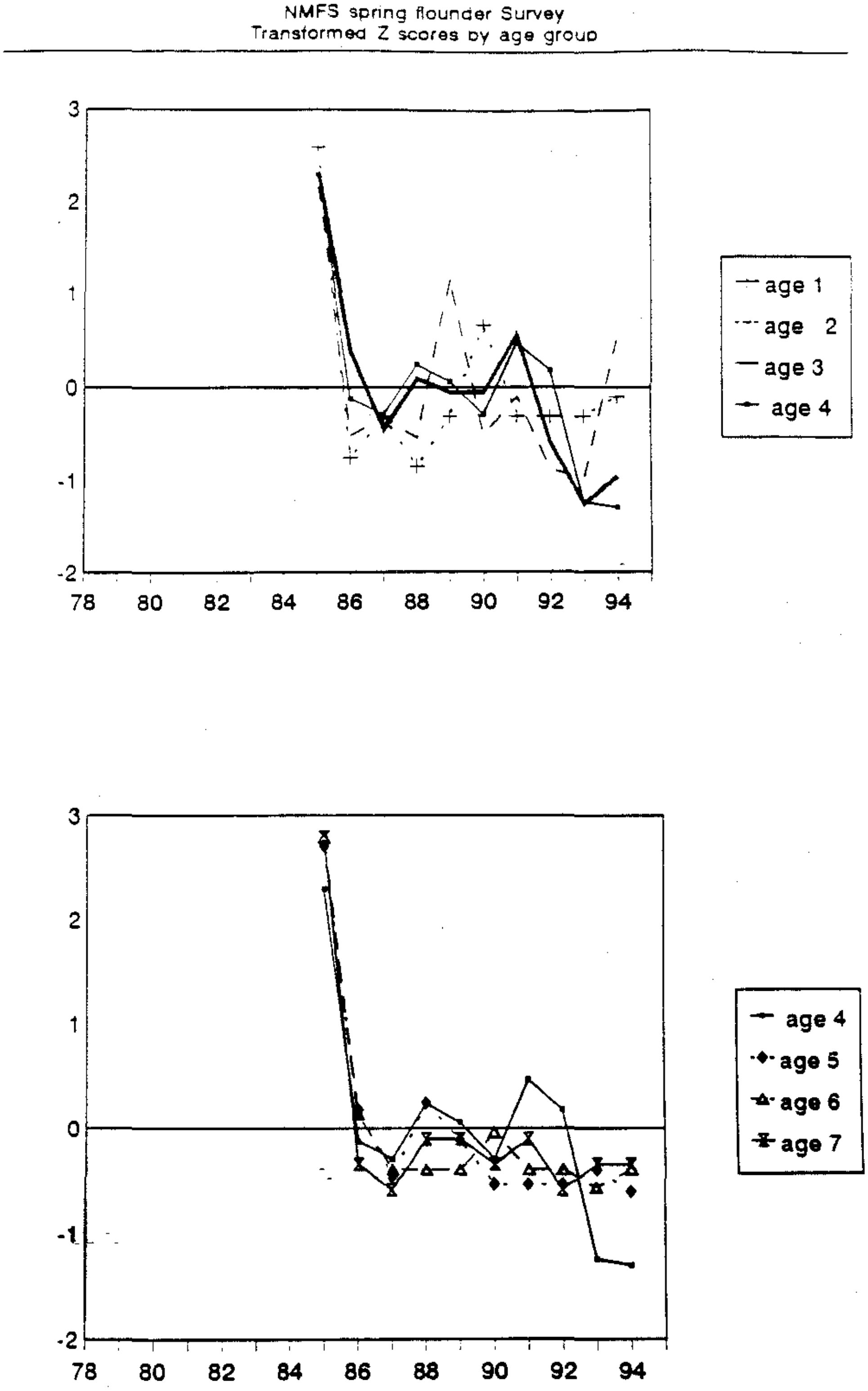

NMFS spring flounder Survey
Transformed Z scores by age group

Figure 14. Standardized winter flounder survey indices by age group from NMFS spring survey.

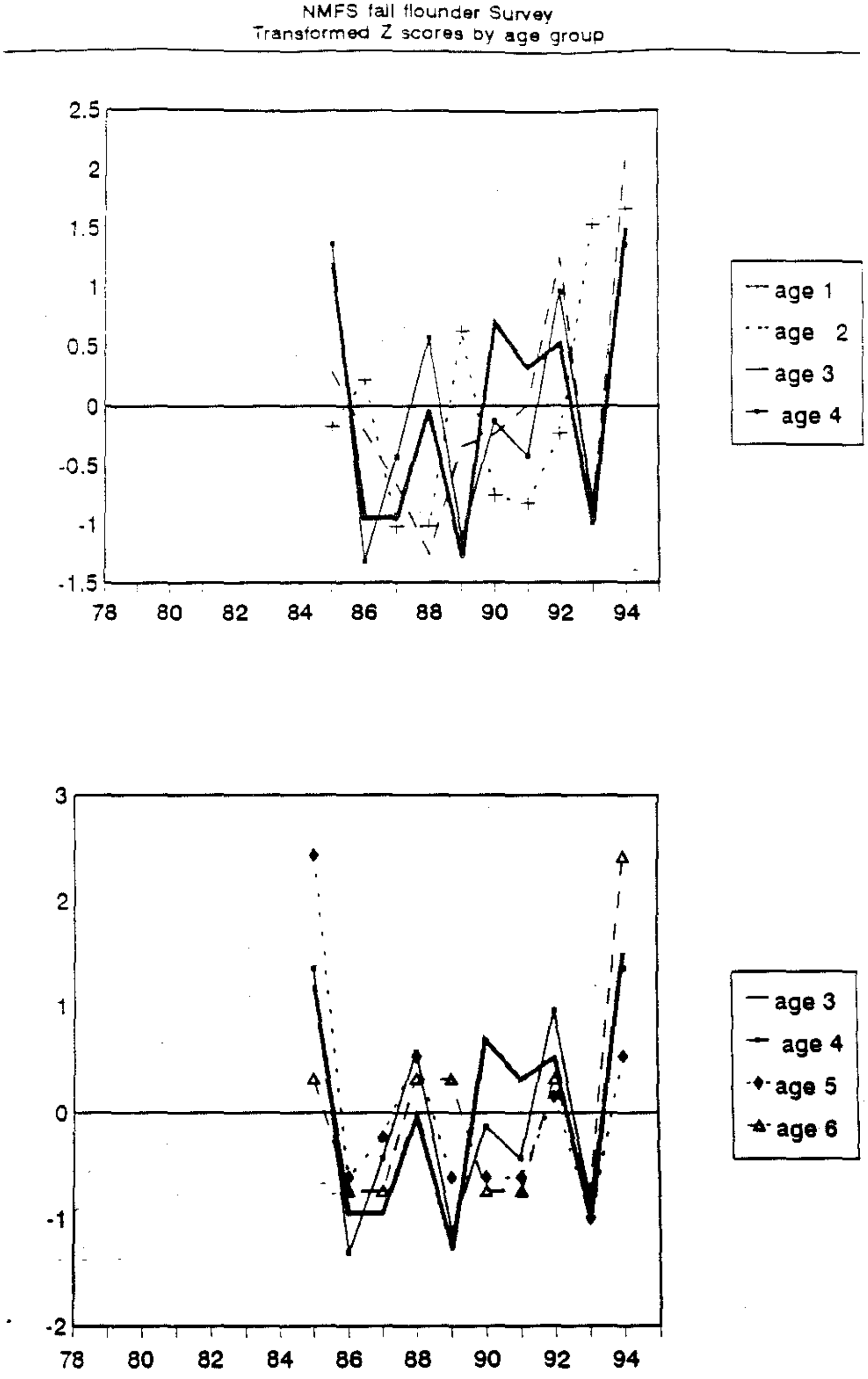

NMFS fall flounder Survey
Transformed Z scores by age group

Figure 15. Standardized winter flounder survey indices by age group from NMFS fall survey.

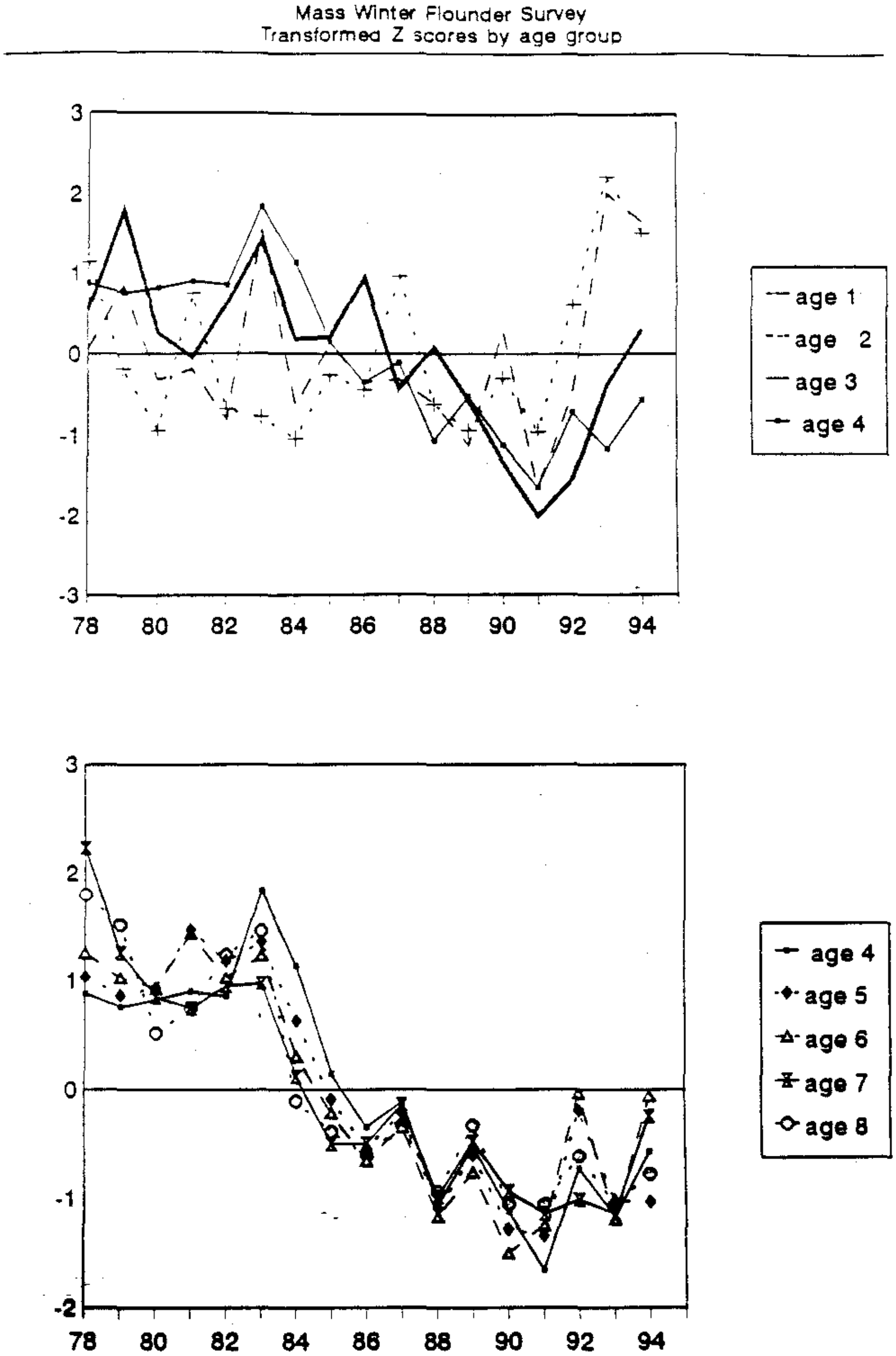


Figure 16. Standardized winter flounder survey indices by age group from Massachusetts survey.

# Appendix IV. Summary of Winter Flounder Tag Return Studies, Southern New England - Mid-Atlantic Region

M. Gibson
RI Division of Fish and Wildlife
Marine Fisheries Office
Wickford, RI 02852

Table 1- Winter Flounder Tag Returns by Area for Several Tagging Studies in the Southern New England Region. Tag Recovery Zones Refer to Those of Perlmutter (1947). References for the Data Source are Also Given.

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Great S.Bay | 2 | 2013 | 1 | 1 | 0.2 | (1) |
| | | | 2 | 518 | 95.6 | |
| | | | 3 | 5 | 0.9 | |
| | | | 4 | 2 | 0.4 | |
| | | | 5 | 10 | 1.8 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 6 | 1.1 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Shinnecock Bay | 2 | 319 | 1 | 0 | 0 | (1) |
| | | | 2 | 62 | 91.2 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 2 | 2.9 | |
| | | | 5 | 4 | 5.9 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 0 | 0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Matinicock Pt. | 4 | 564 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 128 | 96.2 | |
| | | | 5 | 3 | 2.3 | |
| | | | 6 | 1 | 0.7 | |
| | | | 7 | 1 | 0.8 | |
| | | | 8 | 0 | 0 | |
| Port Jefferson | 4 | 532 | 1 | 0 | 0 | (1) |
| | | | 2 | 3 | 2.5 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 89 | 73.9 | |
| | | | 5 | 28 | 23.1 | |
| | | | 6 | 1 | 0.8 | |
| | | | 7 | 0 | 0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Grt. Peconic Bay | 5 | 202 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 1 | 1.0 | |
| | | | 5 | 93 | 98.0 | |
| | | | 6 | 1 | 1.0 | |
| | | | 7 | 0 | 0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Gardiners Bay | 5 | 480 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 9 | 11.3 | |
| | | | 5 | 70 | 87.5 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 1 | 1.2 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Mystic River | 5 | 632 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 2 | 1.8 | |
| | | | 5 | 105 | 92.1 | |
| | | | 6 | 3 | 2.6 | |
| | | | 7 | 4 | 3.5 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Watch Hill/Quono | 5 | 307 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 1 | 2.0 | |
| | | | 5 | 38 | 74.5 | |
| | | | 6 | 6 | 11.7 | |
| | | | 7 | 6 | 11.8 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Block Island | 5 | 115 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 1 | 14.3 | |
| | | | 6 | 1 | 14.3 | |
| | | | 7 | 5 | 71.4 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Block Isld Snd | 5 | 675 | 1 | 0 | 0 | (1) |
| | | | 2 | 1 | 3.0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 3 | 9.2 | |
| | | | 5 | 20 | 60.6 | |
| | | | 6 | 4 | 12.1 | |
| | | | 7 | 4 | 12.1 | |
| | | | 8 | 1 | 3.0 | |
| | | | 9 | 0 | 0 | |
| Pt.Judith Pond | 5 | 279 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 79 | 90.8 | |
| | | | 6 | 7 | 8.0 | |
| | | | 7 | 1 | 1.2 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| RI Sound | 6 | 263 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 1 | 5.6 | |
| | | | 5 | 4 | 22.2 | |
| | | | 6 | 8 | 44.4 | |
| | | | 7 | 5 | 27.8 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Narragansett Bay | 6 | 980 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 3 | 2.2 | |
| | | | 6 | 135 | 97.1 | |
| | | | 7 | 1 | 0.7 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Woods Hole | 7 | 4171 | 1 | 0 | 0 | (1) |
| | | | 2 | 4 | 1.7 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 3 | 1.3 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 3 | 1.2 | |
| | | | 7 | 227 | 94.4 | |
| | | | 8 | 2 | 0.8 | |
| | | | 9 | 0 | 0.4 | |
| Nantucket Shoal | 7 | 494 | 1 | 0 | 0 | (1) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 45 | 97.8 | |
| | | | 8 | 1 | 2.2 | |
| | | | 9 | 0 | 0 | |
| Charlestown Pnd | 5 | 952 | 1 | 0 | 0 | (2) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 134 | 94.4 | |
| | | | 6 | 6 | 4.2 | |
| | | | 7 | 2 | 1.4 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Narragansett Bay | 6 | 980 | 1 | 0 | 0 | (3) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 310 | 96.0 | |
| | | | 7 | 13 | 4.0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Great S. Bay | 2 | 2993 | 1 | 0 | 0 | (4) |
| | | | 2 | 845 | 100.0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 0 | 0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Buzzards Bay | 7 | 336 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 1 | 1.6 | |
| | | | 6 | 17 | 26.6 | |
| | | | 7 | 40 | 62.4 | |
| | | | 8 | 6 | 9.4 | |
| | | | 9 | 0 | 0 | |
| Tarpaulin Cove | 7 | 500 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 6 | 4.5 | |
| | | | 6 | 27 | 20.5 | |
| | | | 7 | 95 | 72.0 | |
| | | | 8 | 4 | 3.0 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Miacomet Rip | 7 | 440 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 1 | 0.8 | |
| | | | 7 | 127 | 97.7 | |
| | | | 8 | 2 | 1.5 | |
| | | | 9 | 0 | 0 | |
| Rodgers Shoal | 7 | 500 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 1 | 0.4 | |
| | | | 7 | 226 | 91.9 | |
| | | | 8 | 19 | 7.7 | |
| | | | 9 | 0 | 0 | |
| Nantucket Shoal | 7 | 326 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 123 | 100.0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Provincetown | 8 | 318 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 10 | 9.3 | |
| | | | 8 | 98 | 90.7 | |
| | | | 9 | 0 | 0 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Georges Bank | 9 | 250 | 1 | 0 | 0 | (5) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 0 | 0 | |
| | | | 7 | 1 | 0.9 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 108 | 99.1 | |
| Niantic River | 5 | 4978 | 1 | 0 | 0 | (6) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 64 | 5.3 | |
| | | | 5 | 1065 | 88.9 | |
| | | | 6 | 55 | 4.6 | |
| | | | 7 | 12 | 1.0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 2 | 0.2 | |
| Narragansett Bay | 6 | 6128 | 1 | 0 | 0 | (7) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 5 | 0.6 | |
| | | | 6 | 781 | 97.5 | |
| | | | 7 | 13 | 1.6 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 2 | 0.3 | |

Table 1- Continued

| Tag Site | Tag Zone | Number Tagged | Return Zone | Number Tags | % | Reference |
|---|---|---|---|---|---|---|
| Pt.Judith Pd. | 5 | NA | 1 | 0 | 0 | (8) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 1 | 1.2 | |
| | | | 5 | 62 | 75.6 | |
| | | | 6 | 19 | 18.3 | |
| | | | 7 | 4 | 4.9 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |
| Narrag. Bay | 6 | 995 | 1 | 0 | 0 | (9) |
| | | | 2 | 0 | 0 | |
| | | | 3 | 0 | 0 | |
| | | | 4 | 0 | 0 | |
| | | | 5 | 0 | 0 | |
| | | | 6 | 162 | 97.0 | |
| | | | 7 | 5 | 3.0 | |
| | | | 8 | 0 | 0 | |
| | | | 9 | 0 | 0 | |

References-
(1) Perlmutter 1947
(2) Saila 1961
(3) Saila 1962
(4) Poole 1969
(5) Howe and Coates 1975
(6) NUSCo. 1987
(7) Powell 1989
(8) Crawford 1990
(9) Black et al. 1988

Table 2- Transition Probability Matrix for Winter Flounder Tagged in Various Locations in Southern New England. Zones Refer to Those of Perlmutter (1947)

| Recovery Zone | Tagging Zone | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 92.5 | 0 | 2.5 | 2.8 | 0 | 1.7 | 0 | 0 |
| 3 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 1.6 | 0 | 83.0 | 4.1 | 5.2 | 1.4 | 0 | 0 |
| 5 | 0 | 3.8 | 0 | 12.8 | 71.3 | 7.7 | 1.7 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0.8 | 7.8 | 80.0 | 7.1 | 0 | 0 |
| 7 | 0 | 1.1 | 0 | 0.8 | 11.1 | 6.9 | 83.9 | 9.3 | 0.9 |
| 8 | 0 | 0 | 0 | 0 | 2.8 | 0 | 4.3 | 90.7 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0.2 | 0.3 | 0 | 0 | 90.1 |

Table 3- Percent Compostion, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 5 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

| | Percent Composition | | |
|---|---|---|---|
| Tagging Location | Spring | Fall | All |
| Nantucket Shoals | 0 | 0 | 0 |
| Woods Hole | 0 | 0 | 0 |
| Narr./Mt. Hope Bay | 0.67 | 1.14 | 0.77 |
| RI Sound | 1.51 | 0 | 1.15 |
| Block Island | 0 | 2.80 | 0.66 |
| Pt. Judith Pond | 18.40 | 31.60 | 21.38 |
| Block Island Sound | 1.34 | 4.80 | 2.24 |
| Watch Hill/Quonochontaug | 9.82 | 8.50 | 9.35 |
| Mystic River | 11.92 | 9.85 | 12.35 |
| Gardiners Bay | 10.26 | 14.27 | 11.00 |
| Peconic Bay | 42.78 | 12.90 | 35.13 |
| Port Jefferson, LIS | 2.27 | 9.81 | 4.00 |
| Matinicock Point, LIS | 0.20 | 1.30 | 0.45 |
| Shinnecock Bay | 0.63 | 2.05 | 0.94 |
| Great South Bay | 0.20 | 0.98 | 0.38 |

Table 4- Percent Compostion, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 6 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

| | Percent Composition | | |
|---|---|---|---|
| Tagging Location | Spring | Fall | All |
| Nantucket Shoals | 0 | 0 | 0 |
| Woods Hole | 0.68 | 0 | 0.31 |
| Narr./Mt. Hope Bay | 61.66 | 49.30 | 57.20 |
| RI Sound | 14.14 | 11.90 | 12.40 |
| Block Island | 0 | 6.90 | 3.60 |
| Pt. Judith Pond | 10.40 | 11.40 | 10.36 |
| Block Island Sound | 1.40 | 3.50 | 2.50 |
| Watch Hill/Quonochontaug | 9.10 | 7.80 | 8.10 |
| Mystic River | 2.98 | 1.30 | 1.90 |
| Gardiners Bay | 0 | 0 | 0 |
| Peconic Bay | 0 | 4.00 | 2.10 |
| Port Jefferson, LIS | 0 | 1.40 | 0.70 |
| Matinicock Point, LIS | 0 | 2.50 | 0.83 |
| Shinnecock Bay | 0 | 0 | 0 |
| Great South Bay | 0 | 0 | 0 |

Table 5- Percent Compostion, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 4 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

| Tagging Location | Percent Composition Spring | Fall | All |
|---|---|---|---|
| Nantucket Shoals | 0 | 0 | 0 |
| Woods Hole | 0.06 | 0 | 0.03 |
| Narr./Mt. Hope Bay | 0.00 | 0.00 | 0.00 |
| RI Sound | 1.00 | 0.00 | 0.50 |
| Block Island | 0.00 | 0.00 | 0.00 |
| Pt. Judith Pond | 0.00 | 0.00 | 0.00 |
| Block Island Sound | 1.13 | 0.00 | 0.56 |
| Watch Hill/Quonochontaug | 0.85 | 0.00 | 0.42 |
| Mystic River | 0.82 | 0.00 | 0.41 |
| Gardiners Bay | 4.29 | 3.40 | 3.85 |
| Peconic Bay | 1.28 | 0.00 | 0.64 |
| Port Jefferson, LIS | 31.67 | 37.70 | 34.69 |
| Matinicock Point, LIS | 58.00 | 52.27 | 55.14 |
| Shinnecock Bay | 0.80 | 0.50 | 0.65 |
| Great South Bay | 1.30 | 0.81 | 1.06 |

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