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Assessment of Summer Flounder (*Paralichthys dentatus*), 1993: Report of the Stock Assessment Workshop Summer Flounder Working Group

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This document was presented to and reviewed by the Stock Assessment Review Committee (SARC) of the 16th Northeast Regional Stock Assessment Workshop (16th SAW)

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Nine documents associated with the 16th Northeast Regional Stock Assessment Workshop (16th SAW) have been published as Northeast Fisheries Science Center reference documents. For copies of these documents, contact the NMFS/NEFSC, Information Services Unit, 166 Water St., Woods Hole, MA 02543-1097, (508)548-5123.

Reports Associated with the 16th Northeast Regional Stock Assessment Workshop (16th SAW)

CRD 93-13	Assessment of pollock, *Pollachius virens*, L., in Divisions 4VWX and Subareas 5 and 6, 1993 by R. K. Mayo and B. F. Figuerido
CRD 93-14	Assessment of summer flounder *(Paralichthys dentatus)*, 1993: Report of the Stock Assessment Workshop (SAW) Summer Flounder Working Group M. Terceiro, ed.
CRD 93-15	Analytical assessment of the Atlantic herring coastal stock complex by D. Stevenson, D. Libby, and K. Friedland
CRD 93-16	Report of the Workshop on Atlantic Herring Science and Assessment in the Gulf of Maine/Georges Bank Area NOAA/NMFS/NEFSC
CRD 93-17	Evaluation of available data for the development of overfishing definition for tilefish in the Middle Atlantic by G. Shepherd
CRD 93-18	Report of the 16th Northeast Regional Stock Assessment Workshop (16th SAW), Stock Assessment Review Committee (SARC) Consensus Summary of Assessments NOAA/NMFS/NEFSC
CRD 93-19	Report of the 16th Northeast Regional Stock Assessment Workshop (16th SAW), The Plenary NOAA/NMFS/NEFSC
CRD 93-20	Calculating biological reference points for American lobsters by J. Idoine and M. Fogarty
CRD 93-21	Assessment of American lobster stock status off the Northeast United States, 1993 S. Murawski, ed.

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INTRODUCTION

The Thirteenth Stock Assessment Workshop (SAW) (NEFSC 1992) directed the summer flounder Working Group (WG) to provide a complete, updated assessment of the status of summer flounder for review during 1993. The SAW Steering Committee, meeting after the Fifteenth SAW, likewise directed the Southern Demersal Subcommittee (SDS) to provide an update of the status of the coastwide stock of summer flounder for review at the Sixteenth SAW, including:

1) catch and spawning stock biomass (SSB) options at various levels of F,
2) an evaluation of the utility of Northeast Fisheries Science Center (NEFSC) winter surveys in providing indices of relative recruitment strength and population size, and recommendations on the design and conduct of future surveys, and
3) an evaluation of NEFSC and North Carolina sea sampling data for area and time coverage, with recommendations for appropriate sea sampling coverage to improve the estimates of fishery discards.

The SAW WG and its successor, the SDS, met in October 1992 and again in May 1993 to assess the status of summer flounder in response to the directions from the SAW Steering Committee. The following scientists and managers participated in those two meetings:

A. Applegate	NEFMC
S. Correia	MADMF
T. Currier	MADMF
L. DiTommaso	NYDEC
W. Gabriel, Chairman	NEFSC
M. Gibson	RIDFW
H. Goodale	NERO
A. Lange	MDDNR
M. Lambert	NEFSC
S. Michels	DEDFW
R. Monaghan	NCDMF
C. Moore	MAFMC
J. Musick	VIMS
P. Rago	NEFSC
L. Rugolo	MDDNR
G. Shepherd	NEFSC
D. Simpson	CTDEP
M. Terceiro	NEFSC

The WG accepted the previous definition of Wilk *et al.* (1980) of a unit stock extending from Cape Hatteras north to New England. The Mid-Atlantic Fishery Management Council (MAFMC) fishery management plan (FMP) for summer flounder has as a management unit all summer flounder from the southern border of North Carolina, northeast to the U.S.-Canadian border. Amendment 2 to the FMP was accepted by the Secretary of Commerce in August, 1992. The FMP has set a target fishing mortality rate (F_{tgt}) of 0.53 for 1993-1995, with a target of F_{max} = 0.23 for 1996 and beyond. Major regulations enacted under Amendment 2 to meet these fishing mortality rate targets include:

1) an annual commercial fishery quota, to be distributed to the states based on their share of commercial landings during 1980-1989,
2) commercial fish size limitation to remain at a 13 in (33 cm) minimum size, which may be changed annually if needed,
3) a minimum mesh size of 5.5 in (140 mm) diamond or 6.0 in (152 mm) square mesh for commercial vessels using otter trawls that possess 100 lb (45 kg) or more of summer flounder, with exemptions for the flynet fishery and vessels fishing in an exempted area off southern New England during 1 November to 30 April,
4) permit requirements for the sale and purchase of summer flounder, and
5) annually adjustable regulations for the recreational fishery that for 1993 include a fishing season from 15 May through 30 September, a 14 in. (36 cm) minimum size limit, and a 6 fish possession limit.

Summer flounder is a prohibited species for foreign fisheries in U.S. waters. Consequently, there are no directed foreign or joint venture fisheries for summer flounder and no retention of summer flounder is permitted. Incidental catch in foreign directed fisheries was estimated at under 100 mt in the early 1980s, and has since been reduced to negligible amounts.

FISHERY DATA

COMMERCIAL LANDINGS

Total U.S. commercial landings of summer flounder from Maine to North Carolina peaked in 1979 at nearly 18,000 mt (40 million lb, Table 1, Figure 1). The reported landings in 1992 of about 7,300 mt (about 16 million lb) were a 74% increase over 1990 and a 17% increase over 1991,

Table 1. Summer flounder commercial landings by state (thousands of pounds) and coastwide (thousands of pounds, metric tons), 1940-1992[1,2,3]

												Total	
Year	**ME**	**NH**	**MA**	**RI**	**CT**	**NY**	**NJ**	**DE**	**MD+**	**VA+**	**NC+**	**1000 lb**	**mt**
1940	0	0	2847	258	149	1814	3554	3	444	1247	498	10814	4905
1941	na	na	na	na	na	na	na	na	183	764	na	947	430
1942	0	0	193	235	126	1286	987	2	143	475	498	3945	1789
1943	0	0	122	202	220	1607	2224	11	143	475	498	5502	2496
1944	0	0	719	414	437	2151	3159	8	197	2629	498	10212	4632
1945	0	0	1730	467	270	3182	3102	2	460	1652	1204	12297	5578
1946	0	0	1579	625	478	3494	3310	22	704	2889	1204	14305	6489
1947	0	0	1467	333	813	2695	2302	46	532	1754	1204	11146	5056
1948	0	0	2370	406	518	2308	3044	15	472	1882	1204	12219	5542
1949	0	0	1787	470	372	3560	3025	8	783	2361	1204	13570	6155
1950	0	0	3614	1036	270	3838	2515	25	543	1761	1840	15442	7004
1951	0	0	4506	1189	441	2636	2865	20	327	2006	1479	15469	7017
1952	0	0	4898	1336	627	3680	4721	69	467	1671	2156	19625	8902
1953	0	0	3836	1043	396	2910	7117	53	1176	1838	1844	20213	9168
1954	0	0	3363	2374	213	3683	6577	21	1090	2257	1645	21223	9627
1955	0	0	5407	2152	385	2608	5208	26	1108	1706	1126	19726	8948
1956	0	0	5469	1604	322	4260	6357	60	1049	2168	1002	22291	10111
1957	0	0	5991	1486	677	3488	5059	48	1171	1692	1236	20848	9456
1958	0	0	4172	950	360	2341	8109	209	1452	2039	892	20524	9310
1959	0	0	4524	1070	320	2809	6294	95	1334	3255	1529	21230	9630
1960	0	0	5583	1278	321	2512	6355	44	1028	2730	1236	21087	9565
1961	0	0	5240	948	155	2324	6031	76	539	2193	1897	19403	8801
1962	0	0	3795	676	124	1590	4749	24	715	1914	1876	15463	7014
1963	0	0	2296	512	98	1306	4444	17	550	1720	2674	13617	6177
1964	0	0	1384	678	136	1854	3670	16	557	1492	2450	12237	5551
1965	0	0	431	499	106	2451	3620	25	734	1977	272	10115	4588
1966	0	0	264	456	90	2466	3830	13	630	2343	4017	14109	6400
1967	0	0	447	706	48	1964	3035	0	439	1900	4391	12930	5865
1968	0	0	163	384	35	1216	2139	0	350	2164	2602	9053	4106
1969	0	0	78	267	23	574	1276	0	203	1508	2766	6695	3037
1970	0	0	41	259	23	900	1958	0	371	2146	3163	8861	4019
1971	0	0	89	275	34	1090	1850	0	296	1707	4011	9352	4242
1972	0	0	93	275	7	1101	1852	0	277	1857	3761	9223	4183
1973	0	0	506	640	52	1826	3091	*	495	3232	6314	16156	7328
1974	*	0	1689	2552	26	2487	3499	0	709	3111	10028	22581	10243
1975	0	0	1768	3093	39	3233	4314	5	893	3428	9539	26311	11934
1976	*	0	4019	6790	79	3203	5647	3	697	3303	9627	33368	15135
1977	0	0	1477	4058	64	2147	6566	5	739	4540	10332	29927	13575
1978	0	0	1439	2238	111	1948	5414	1	676	5940	10820	28586	12966
1979	5	0	1175	2825	30	1427	6279	6	1712	10019	16084	39561	17945
1980	4	0	367	1277	48	1246	4805	1	1324	8504	13643	31216	14159
1981	3	0	598	2861	81	1985	4008	7	403	3652	7459	21056	9551
1982	18	*	1665	3983	64	1865	4318	8	360	4332	6315	22928	10400
1983	84	0	2341	4599	129	1435	4826	5	937	8134	7057	29548	13403
1984	2	*	1488	4479	131	2295	6364	9	813	9673	12510	37765	17130
1985	3	*	2249	7533	183	2517	5634	4	577	5037	8614	32352	14675
1986	0	*	2954	7042	160	2738	4017	4	316	3712	5924	26866	12186
1987	8	*	3327	4774	609	2641	4451	4	319	5791	5128	27052	12271
1988	5	0	2421	4719	741	3439	6006	7	514	7756	6770	32377	14686
1989	9	0	1878	3083	513	1464	2865	3	204	3689	4206	17913	8125
1990	3	0	628	1408	343	405	1458	2	138	2144	2728	9257	4199
1991	0	0	1124	1672	399	719	2341	4	232	3715	3516	13722	6224
1992	*	*	1374	2532	na	1233	2871	na	319	5172	2576	16099	7302

[1] * = less than 500 lb; na = not available; + = NMFS did not identify flounders to species prior to 1978 for NC and 1957 for both MD and VA and thus the numbers represent all unclassified flounders
[2] Numbers may not total due to rounding and preliminary nature of 1992 data by state.
[3] Sources: 1940-1977 USDC 1984; 1978-1992 unpublished NMFS General Canvas data

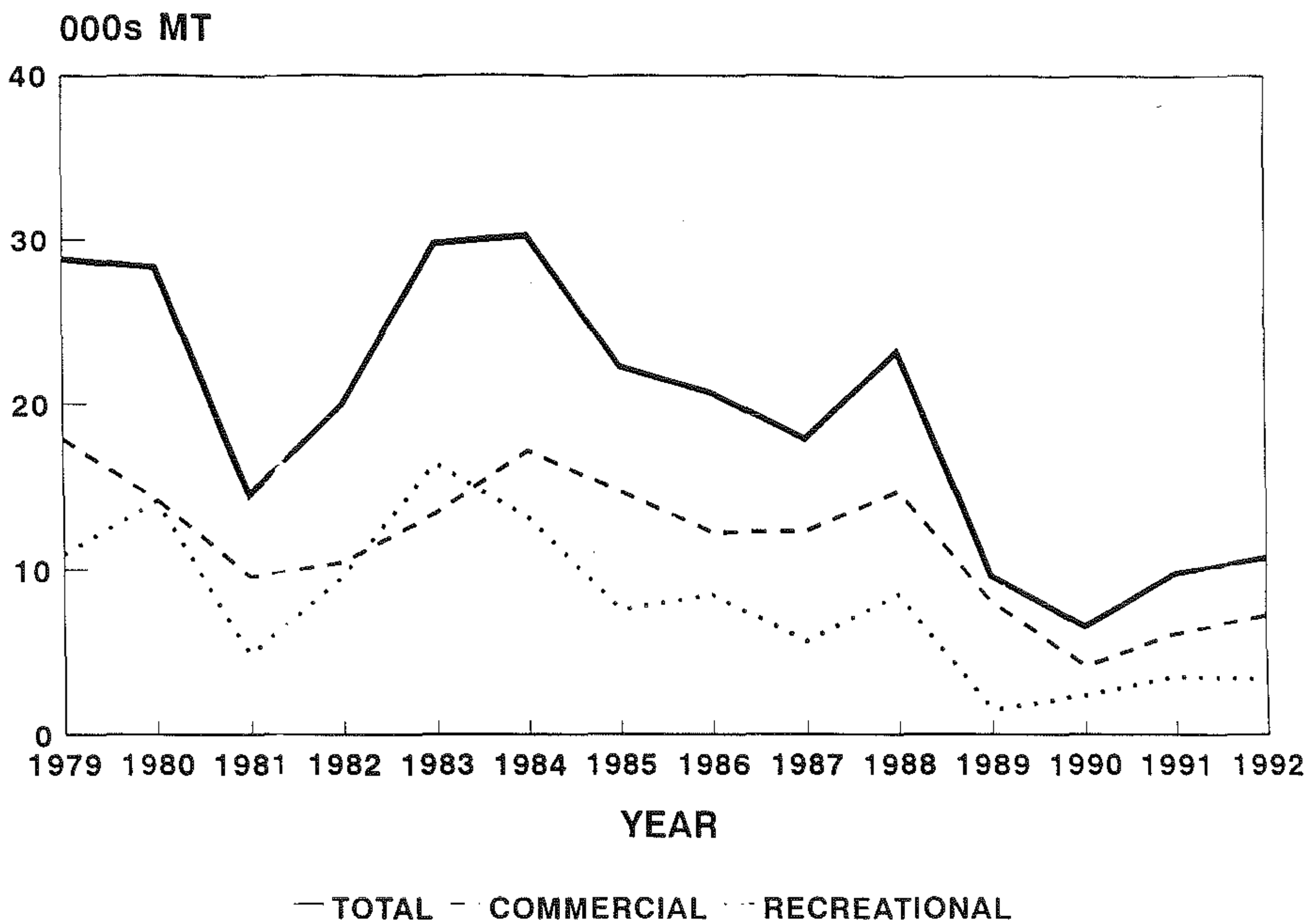

Figure 1. Commercial, recreational, and total landings of summer flounder, Maine to North Carolina, 1979-1992.

but still less than one half the peak amount. Since 1980, 70% of the commercial landings of summer flounder have come from the Exclusive Economic Zone (EEZ), waters more than 3 miles from shore. The percentage of landings attributable to the EEZ was at its lowest in 1983 and 1990 with 63%, and was the highest in 1989 at 77%. Large variability in summer flounder landings exist among the states, over time, and the percent of total summer flounder landings taken from the EEZ has varied widely among the states (SAW Summer Flounder Working Group 1990, 1991, 1992).

Northeast Region Trawl Fishery

A summary of length frequency and age sampling of summer flounder landings sampled by the NEFSC commercial fishery weighout system in the Northeast Region (NER), Maine to Virginia, is presented in Table 2. For comparison with the

Table 2. Summary of NEFSC sampling of commercial fishery for summer flounder, Maine to Virginia, 1982-1992[1]

Year	Lengths	Ages	Sampled Weighout Landings (mt)	Sampling Intensity (mt/100 lengths)
1982	8,194	2,288	6,183	75
1983	6,893	1,347	7,597	110
1984	5,340	1,794	9,427	176
1985	6,473	1,611	8,688	134
1986	7,840	1,967	7,702	98
1987	6,605	1,788	7,947	120
1988	9,048	2,302	9,111	101
1989	8,411	1,325	4,868	58
1990	3,419	853	2,419	71
1991	4,627	1,089	4,626	100
1992	3,385	899	6,060	179
Mean	6,385	1,569	6,785	106

[1] Does not include unclassified market category landings

Table 3. Commercial landings at age of summer flounder (thousands), Maine to Virginia, 1982-1992[1]

Year	Age 0	1	2	3	4	5	6	7	8	9	Total
1982	1,441	6,879	5,630	232	61	97	57	22	2	0	14,421
1983	1,956	12,119	4,352	554	30	62	13	17	4	2	19,109
1984	1,403	10,706	6,734	1,618	575	72	3	5	1	4	21,121
1985	840	6,441	10,068	956	263	169	25	4	2	1	18,769
1986	407	7,041	6,374	2,215	158	93	29	7	2	0	16,326
1987	332	8,908	7,456	935	337	23	24	27	11	0	18,053
1988	305	11,116	8,992	1,280	327	79	18	9	5	0	22,131
1989	96	2,491	4,829	841	152	16	3	1	1	0	8,430
1990	0	2,670	861	459	81	18	6	1	1	0	4,096
1991	0	3,755	3,256	142	61	11	1	1	0	0	7,227
1992	110	5,555	3,448	326	19	21	0	1	0	0	9,479

[1]Does not include discards, assumes catch not sampled by NEFSC weighout has same biological characteristics as weighout catch.

Table 4. Mean weight (kilograms) at age of summer flounder landed in the commercial fishery, Maine to Virginia, 1982-1992

Year	Age 0	1	2	3	4	5	6	7	8	9
1982	0.26	0.42	0.62	1.84	2.33	2.94	2.71	4.04	5.99	0.00
1983	0.31	0.46	0.80	1.40	2.35	1.85	2.76	3.30	4.17	4.37
1984	0.28	0.39	0.60	1.09	1.43	2.16	3.21	3.62	4.64	4.03
1985	0.33	0.44	0.59	1.08	1.73	2.22	2.59	4.71	4.78	4.80
1986	0.30	0.44	0.63	1.11	1.76	1.89	3.14	2.96	4.81	0.00
1987	0.27	0.45	0.62	1.06	2.00	2.85	3.08	3.02	4.14	0.00
1988	0.36	0.46	0.60	1.21	2.07	2.88	3.98	3.91	4.50	0.00
1989	0.36	0.55	0.74	1.06	1.83	2.47	3.57	3.59	2.25	0.00
1990	0.00	0.52	0.86	1.37	1.84	2.13	3.21	3.92	5.03	0.00
1991	0.00	0.48	0.75	1.54	2.26	3.01	3.91	3.87	0.00	0.00
1992	0.34	0.50	0.77	1.58	2.51	3.10	0.00	4.85	0.00	0.00

Table 5. Summary of North Carolina Division of Marine Fisheries (NCDMF) sampling of the commercial winter trawl fishery for summer flounder, 1982-1992

Year	Lengths	Ages	Total Landings (mt)	Sampling Intensity (mt/100 lengths)
1982	5,403	0	2,864	53
1983	8,491	0	3,201	38
1984	14,920	0	5,674	38
1985	13,787	0	3,907	28
1986	15,754	0	2,687	17
1987	12,126	0	2,326	19
1988	13,377	189	3,071	23
1989	15,785	106	1,908	12
1990	15,787	191	1,238	8
1991	24,590	534	1,582	6
1992	?	407	1,168	?

length frequency sampling in the recreational fishery, sampling intensity is expressed in terms of metric tons of landings (mt) per 100 fish lengths measured. On that basis, NER commercial length frequency sampling averaged 106 mt of weighout landings per 100 lengths from 1982-1992. The sampling is proportionally stratified by market category (jumbo, large, medium, small, and pee-wee), with the sampling distribution generally reflecting the distribution of weighout landings by market category.

Age composition of the NER commercial landings for 1982 to 1992 was estimated semiannually by market category and statistical area, using standard NEFSC procedures (market category length frequency samples converted to mean weights by length-weight relationships; mean weights in turn divided into landings to calculate numbers landed by market category; market category numbers at length apportioned to age by application of age-length keys, on semiannual statistical area basis). The NER commercial landings at age matrix does not include the unclassified market category or landings from states not participating in the NEFSC weighout system (*e.g.*, North Carolina). Northeast Region landed numbers at age were raised to total NER (general canvas) commercial landings by assuming that landings not accounted for in the weighout system had the same age composition as those sampled, as follows: calculate proportion at age by weight; apply proportions at age by weight to total NER commercial landings to derive total NER commercial catch at age by weight; divide by weighout mean weight at age to derive total NER commercial landed numbers at age (Table 3). Mean weights at age are presented in Table 4.

North Carolina Winter Trawl Fishery

The North Carolina winter trawl fishery accounts for about 99% of summer flounder commercial landings in North Carolina. A separate landings at age matrix for this component of the commercial fishery was developed from North Carolina Division of Marine Fisheries (NCDMF) length and age frequency sampling data.

The NCDMF program sampled about 10% of the winter trawl fishery landings annually, at a rate of between 53 and 6 mt of landings per 100 lengths measured (Table 5). All length frequency data used in construction of the North Carolina winter trawl fishery landings at age matrix were collected in the NCDMF program; age length keys from NEFSC commercial data and NEFSC spring survey data (1982 to 1987) and NCDMF commercial fishery data (1988 to 1992) were combined by appropriate statistical area and quarter to resolve lengths to age. Landings at age frequency and mean weight at age from this fishery are shown in Tables 6 and 7. The WG noted that 1992 estimates of landings at age were developed from provisional reported landings, age-length data for quarters 1 and 4 only, and mean weights from 1991. Thus, the North Carolina catch at age for 1992 may be revised somewhat in future assessments as data are finalized.

COMMERCIAL DISCARDS

Examination of sea sample data for summer flounder began with analysis of variance of logged kept and discard rates to identify factors that might be used as stratification variables in a ratio estimator expansion procedure to estimate total landings and discard in the otter trawl fishery. Initial models included year, quarter, fisheries statistical division, area (divisions north and south of Delaware Bay), and tonnage class as main effects, with quarter and division emerging (along with year) as consistently significant main effects without significant interaction with the year. The kept and discard estimation procedure expanded logged kept and discard rates in year, quarter, and division strata by total days fished (days fished on trips landing any summer flounder) to estimate fishery landings for comparison with reported landings. For strata with no sea sampling, catch rates from adjacent or comparable strata were substituted as appropriate (except for Division 51, which generally has very low catch rates and negligible catch). Figure 2 shows corrected, retransformed logged kept and discard rates, weighted by the number of trips in each strata, for 1989 to 1992. Discard as a proportion of the total catch was higher in 1990 and 1991 than in 1989 and 1992. Results summarized in Tables 8 to 11 show that the expansion procedure provided estimates of landings ranging from within 5 to 35% of reported landings, with discard estimated to be 11%, 41%, 23%, and 16% of 1989, 1990, 1991, and 1992 reported landings, respectively.

The WG noted that these discard estimates were based only on the days fished data for ports in the NER weighout system. The group concluded that it was necessary to raise the discard estimate to account for discarding that occurs in components of the commercial fishery outside

Table 6. Number (thousands) of summer flounder at age landed in the North Carolina commercial winter trawl fishery, 1982-1992[1]

Year	Age 0	1	2	3	4	5	6	7	8	Total
1982	981	3,463	1,022	142	52	19	6	4	2	5,692
1983	492	3,778	1,581	287	135	41	3	3	<1	6,321
1984	907	5,658	3,889	550	107	18	<1	0	0	11,130
1985	198	2,974	3,529	338	85	24	5	<1	0	7,154
1986	216	2,478	1,897	479	29	32	1	1	<1	5,134
1987	233	2,420	1,299	265	28	1	0	0	0	4,243
1988	0	2,917	2,225	471	228	39	1	6	<1	5,878
1989	2	49	1,437	716	185	37	1	2	0	2,429
1990	2	142	730	418	117	12	1	<1	0	1,424
1991	0	382	1,641	521	116	20	2	<1	0	2,682
1992	0	49	1,316	963	147	26	1	1	0	2,503

[1] The 1982-1987 NCDMF length samples were aged using NEFSC age-lengths keys for comparable times and areas (*i.e.*, same quarter and statistical areas). The 1988-1992 NCDMF length samples were aged using NCDMF age-lengths keys.

Table 7. Mean weight (kilograms) at age of summer flounder landed in the North Carolina commercial winter trawl fishery, 1982-1992[1]

Year	Age 0	1	2	3	4	5	6	7	8
1982	0.34	0.46	0.76	1.28	1.66	2.05	2.12	2.23	2.58
1983	0.32	0.45	0.75	1.14	1.26	1.49	1.73	2.43	2.70
1984	0.33	0.48	0.70	1.06	1.50	2.17	3.48	0.00	0.00
1985	0.38	0.46	0.66	1.20	1.66	2.49	3.07	4.57	0.00
1986	0.36	0.51	0.67	1.09	1.62	1.96	3.40	3.23	3.63
1987	0.33	0.51	0.66	1.09	1.88	2.94	0.00	0.00	0.00
1988	0.00	0.41	0.60	0.93	1.19	1.70	2.24	2.98	3.41
1989	0.08	0.31	0.54	0.97	1.17	2.33	3.67	2.86	3.41
1990	0.05	0.42	0.61	0.83	1.34	2.33	2.07	4.94	0.00
1991	0.00	0.43	0.62	1.17	1.97	2.49	2.73	3.69	0.00
1992[1]	0.00	0.43	0.62	1.17	1.97	2.49	2.73	3.69	0.00

[1] Since 1992 data were not available to the committee, 1991 values were used for 1992.

the NER weighout system (*i.e.*, NER general canvas and North Carolina). To determine the proper raising factor, landings accounted for by the NER weighout system (those that result from the fishing effort on which the sea sample discard estimate is based) were compared with total weighout and general canvas landings, plus that portion of North Carolina landings removed from the EEZ. The WG assumed that only the North Carolina fishery in the EEZ would experience significant discard, as mesh regulations in state waters have resulted in very low discards in state waters since implementation of the regulation in 1989 (R. Monaghan, personal communication)[1]. Table 12 shows the result of this exercise, with total discard estimates raised by 16 to 45%.

Existing sea sample data were adequate to develop estimates of commercial fishery discard for 1989 to 1992. However, adequate data (*e.g.*, interviewed trip data, survey data) were not available for summer flounder to develop discard estimates for 1982 to 1988. The WG considered the implications of failing to incorporate commercial fishery discard mortality in some years in the VPA in terms of the effect on estimates of fishing mortality and stock size, and in terms of biological reference points. The WG has assumed that discard numbers were small relative to landings

[1] R. Monaghan, North Carolina Department of Marine Fisheries, Morehead City, NC 28557.

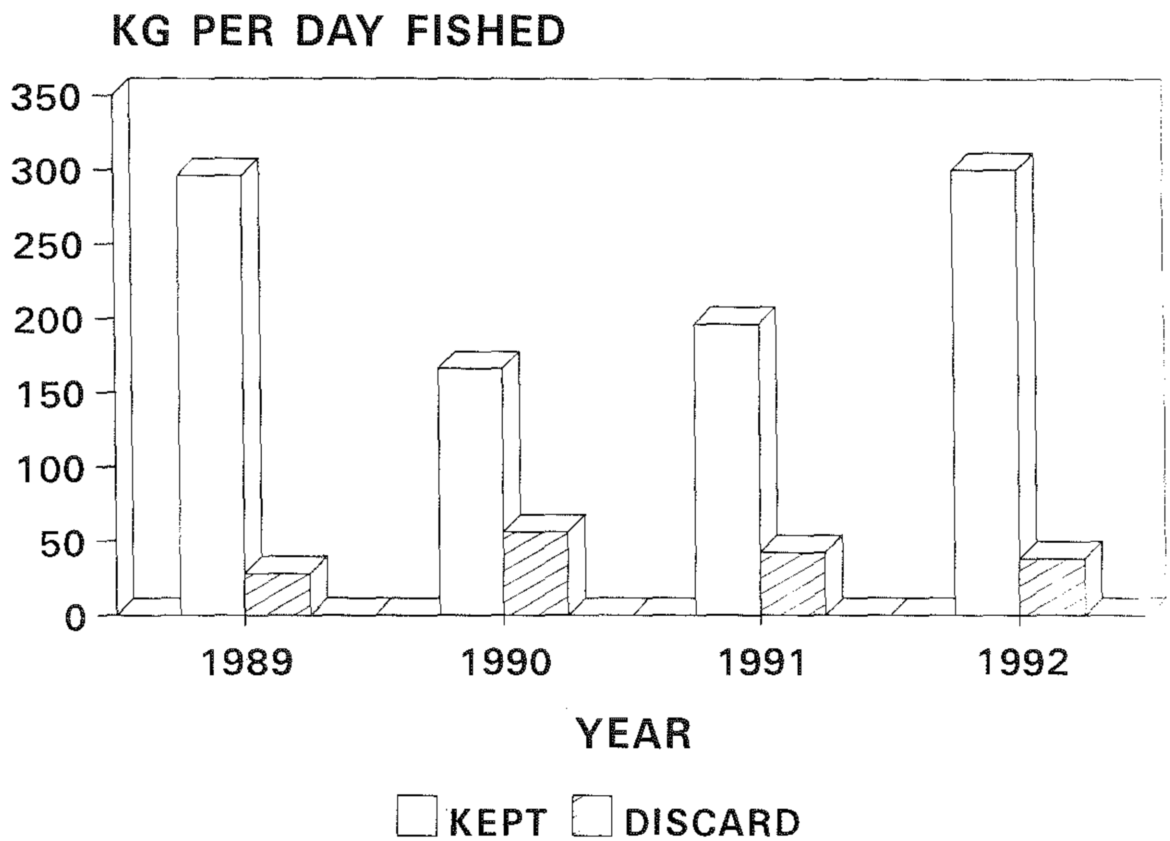

Figure 2. Summary of NER sea sample data for summer flounder used to estimate discards by the commercial otter trawl fisheries, geometric mean (kilograms per day fished), weighted by number of trips.

during 1982 to 1988 (because of the lack of a minimum size limit in the EEZ), but increased in 1989 to 1992 with the implementation of the EEZ minimum size limit in 1989. It was recognized that not accounting directly for commercial fishery discards would result in an underestimation of fishing mortality and population sizes in 1982 to 1988.

Length frequency distributions for summer flounder discard sampled in 1989, 1990, and 1991 are presented in Figures 3 to 5. Lengths for 1992 are not yet available, but preliminary (January and February) data for the first quarter of 1992 suggest discards in 1992 were mainly age 1 fish smaller than the regulated minimum size, and so mean values from 1989 to 1991 were used to estimated 1992 discard proportions, mean lengths, and weights at age. For 1989 to 1991, the estimated discard was sampled at a rate of about 23 mt per 100 fish measured (Table 13).

Classification to age for 1989 to 1991 was done by semiannual periods (quarters 1 and 2 pooled, quarters 3 and 4 pooled) using sea sample age-length data, except for 1989, when first period lengths were aged using combined commercial (quarters 1 and 2) and NEFSC spring survey age-length data. Length frequency samples were converted to sample numbers at age and sample weight at age frequencies by application of NEFSC survey length-weight relationships and the age-length keys. Sample weight proportions at age were next applied to the raised fishery discard estimates to derive fishery total discard weight at age. Fishery discard weights at age were then divided by sea sample mean weights at age to derive fishery discard numbers at age (Table 13). After discussion of ongoing work for other species in other geographic regions, which has indicated highly variable discard mortality rates depending on species, depth, temperature, and fishing practices, the WG assumed a commercial fishery discard mortality rate of 100%.

COMMERCIAL FISHERY-BASED LPUE INDICES

A standardized index of abundance for summer flounder was initially developed based on NER commercial weighout data base for 1982 to 1992 (Kimura 1981, 1988). Tonnage class 4

Table 8. Summary of sea sample data for summer flounder by NAFO division and quarter for 1989[1]

DIV	QTR	SSTRIPS	KDF	DDF	WODF	SS EST LAND (mt)	WO LAND (mt)	SS EST DISC (mt)
51	1	0	0	0	85	0	2	0
	2	1	66	<1	137	9	4	<1
	3	0	0	0	75	0	3	0
	4	1	19	<1	157	3	3	<1
52	1	1	756	48	1319	998	687	64
	2	5	3	8	1250	4	129	10
	3	2	280	<1	536	150	9	<1
	4	1	35	40	1545	54	98	61
53	1	4	588	41	689	405	473	29
	2	10	68	<1	2045	138	224	2
	3	5	260	2	1619	421	298	4
	4	3	91	6	898	82	330	6
61	1	4	544	51	1661	904	528	84
	2	5	107	4	1391	149	165	5
	3	0	213	24	513	109	106	13
	4	5	142	38	575	82	125	22
62	1	5	934	84	1867	1744	1460	158
	2	2	244	101	922	225	85	93
	3	8	213	24	216	46	104	5
	4	1	672	17	1118	752	361	19
63	1	2	1116	110	490	546	323	54
	2	0	244	101	41	10	9	4
	3	0	213	24	40	9	<1	1
	4	0	672	17	616	415	292	10
Total/Mean		65	296	28	19,805	7,255	5,817	642

[1] DIV =NAFO Division; QTR = Quarter; SSTRIPS = Number of sea sampling trips; trips in more than one statistical area are split KDF, DDF = kept and discard rates, kilograms per day fished); WODF = NEFSC weighout database days fished on trips landing any summer flounder; SS EST LAND MT = Estimate of landings calculated from sea sampling kept rates and NEFSC weighout database days fished; WO LAND MT = Landings as recorded in the NEFSC weighout database; SS EST DISC MT = Sea sampling estimate of discard in mt

Table 9. Summary of sea sample data for summer flounder by NAFO division and quarter for 1990[1]

DIV	QTR	SSTRIPS	KDF	DDF	WODF	SS EST LAND (mt)	WO LAND (mt)	SS EST DISC (mt)
51	1	0	0	0	9	0	<1	0
	2	0	0	0	78	0	<1	0
	3	0	0	0	29	0	<1	0
	4	0	0	0	82	0	<1	0
52	1	1	15	5	581	9	148	3
	2	2	12	7	1107	13	31	8
	3	2	14	205	332	5	9	68
	4	3	12	<1	818	10	40	<1
53	1	6	113	3	577	65	129	2
	2	3	50	1	1212	60	51	1
	3	0	92	6	1194	110	187	7
	4	8	92	6	1052	97	288	6

[1] DIV =NAFO Division; QTR = Quarter; SSTRIPS = Number of sea sampling trips; trips in more than one statistical area are split KDF, DDF = kept and discard rates, kilograms per day fished); WODF = NEFSC weighout database days fished on trips landing any summer flounder; SS EST LAND MT = Estimate of landings calculated from sea sampling kept rates and NEFSC weighout database days fished; WO LAND MT = Landings as recorded in the NEFSC weighout database; SS EST DISC MT = Sea sampling estimate of discard in mt

Table 9. Continued.

DIV	QTR	SSTRIPS	KDF	DDF	WODF	SS EST LAND (mt)	WO LAND (mt)	SS EST DISC (mt)
61	1	10	222	40	716	159	84	29
	2	5	14	23	1153	16	22	27
	3	0	91	55	580	53	150	32
	4	3	367	115	535	197	131	62
62	1	4	446	253	2040	911	333	517
	2	9	19	49	558	11	8	27
	3	7	221	74	227	50	126	17
	4	8	360	43	1779	641	368	77
63	1	1	505	321	650	328	258	209
	2	0	19	49	47	1	1	2
	3	0	221	74	0	0	0	0
	4	0	360	43	625	225	384	27
Total/Mean		72	166	56	15,980	2,959	2,749	1,121

Table 10. Summary of sea sample data for summer flounder by NAFO division and quarter for 1991[1]

DIV	QTR	SSTRIPS	KDF	DDF	WODF	SS EST LAND (mt)	WO LAND (mt)	SS EST DISC (mt)
51	1	0	0	<1	29	0	<1	0
	2	0	0	<1	79	0	1	0
	3	0	0	<1	43	0	1	0
	4	1	31	<1	188	6	2	<1
52	1	3	218	128	1254	274	79	161
	2	2	88	3	1756	154	44	5
	3	1	13	<1	706	9	17	<1
	4	1	26	<1	1721	44	53	<1
53	1	7	117	9	806	94	242	7
	2	9	55	1	1688	92	147	2
	3	6	92	1	1401	128	279	1
	4	10	163	4	1475	240	259	6
61	1	6	173	49	2763	477	384	134
	2	5	43	37	2983	128	184	111
	3	1	577	1	572	330	260	1
	4	15	187	24	1855	347	225	45
62	1	5	97	9	1981	192	673	19
	2	4	169	143	1203	203	78	172
	3	4	953	177	555	529	236	98
	4	4	10	249	38	1935	482	602 73
63	1	0	97	9	382	37	231	4
	2	0	169	143	2	<1	<1	<1
	3	0	953	177	19	18	12	3
	4	4	492	212	702	346	346	149
Total/Mean		94	196	42	26,096	4,133	4,355	993

[1] DIV =NAFO Division; QTR = Quarter; SSTRIPS = Number of sea sampling trips; trips in more than one statistical area are split KDF, DDF = kept and discard rates, kilograms per day fished); WODF = NEFSC weighout database days fished on trips landing any summer flounder; SS EST LAND MT = Estimate of landings calculated from sea sampling kept rates and NEFSC weighout database days fished; WO LAND MT = Landings as recorded in the NEFSC weighout database; SS EST DISC MT = Sea sampling estimate of discard in mt

Table 11. Summary of sea sample data for summer flounder by NAFO division and quarter for 1992

DIV	QTR	SSTRIPS	KDF	DDF	WODF	SS EST LAND (mt)	WO LAND (mt)	SS EST DISC (mt)
51	1	0	0	0	41	0	<1	0
	2	0	0	0	85	0	2	0
	3	0	0	0	37	0	1	0
	4	1	17	<1	245	4	5	<1
52	1	1	427	26	1402	598	111	37
	2	1	85	<1	3321	283	118	2
	3	0	11	<1	839	10	12	<1
	4	1	11	<1	1702	19	84	<1
53	1	12	157	11	861	135	387	9
	2	1	21	<1	1842	38	215	1
	3	0	236	13	1611	380	311	21
	4	7	236	13	1855	438	384	24
61	1	16	313	17	2505	785	367	43
	2	2	169	36	2259	381	316	82
	3	1	1009	23	1105	1115	417	25
	4	5	130	6	1901	248	264	12
62	1	13	350	23	2589	906	754	60
	2	3	150	71	1348	203	95	96
	3	6	502	164	803	403	725	132
	4	4	606	131	2405	1458	674	315
63	1	4	420	90	714	300	204	65
	2	0	150	71	315	47	5	22
	3	0	502	164	1	1	<1	<1
	4	2	381	7	1195	455	609	9
Total/Mean		80	300	38	30,981	8,207	6,060	956

[1] DIV -NAFO Division; QTR - Quarter; SSTRIPS - Number of sea sampling trips; trips in more than one statistical area are split KDF, DDF - kept and discard rates, kilograms per day fished); WODF - NEFSC weighout database days fished on trips landing any summer flounder; SS EST LAND MT - Estimate of landings calculated from sea sampling kept rates and NEFSC weighout database days fished; WO LAND MT - Landings as recorded in the NEFSC weighout database; SS EST DISC MT - Sea sampling estimate of discard in mt

Table 12. Summary of exercise to raise 1989-1992 commercial fishery discard estimates (metric tons, MT) based on NER sea sample (SS) and weighout system (WO) data to account for discard by the General Canvas (GC) and North Carolina winter trawl fishery (NC) components of the commercial fishery, which are not sampled by the NER system

Year	A SS WO	B WO+GC	C NC EEZ	D = B+C	E = D/A	F SS Discard	E*F Raised discard
1989	5,817	6,212	1,813	8,025	1.380	642	886
1990	2,749	2,961	755	3,716	1.352	1,121	1,516
1991	4,355	4,642	1,123	5,765	1.324	993	1,315
1992[1]	6,060	6,134	909	7,043	1.162	956	1,111

[1] North Carolina EEZ 1992 landings calculated as mean EEZ proportion for 1989-1991 (0.778)

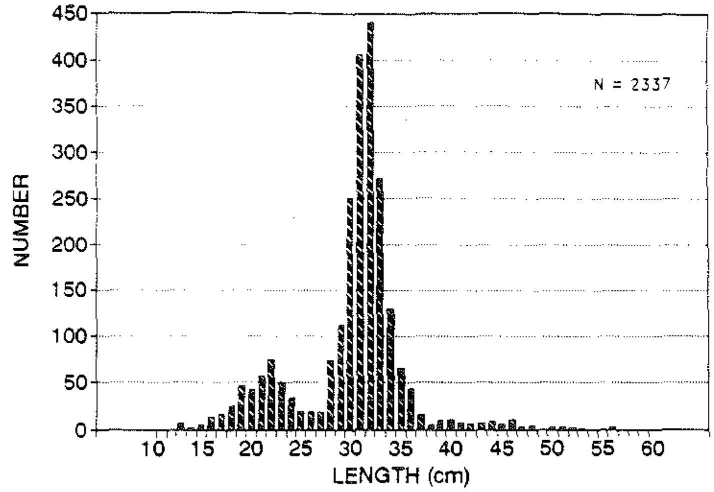

Figure 3. Summer flounder sample length frequency distribution of 1989 discarded catch, NER sea sample data.

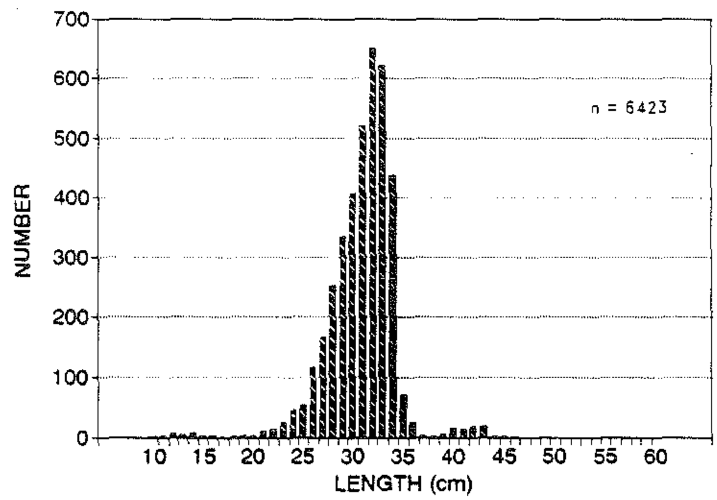

Figure 4. Summer flounder sample length frequency distribution of 1990 discarded catch, NER sea sample data.

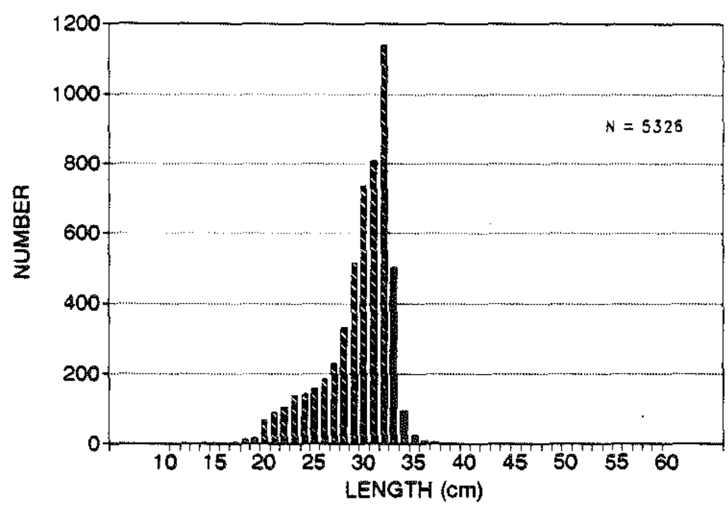

Figure 5. Summer flounder sample length frequency distribution of 1991 discarded catch, NER sea sample data.

Table 13. Summary of Northeast Region sea sample data to estimate summer flounder discard at age in the commercial fishery, 1989-1992[1]

Year	Lengths	Ages	Sea Sample (mt)	Discard Discard Estimate (mt/100 lengths)	Raised Discard Estimate (mt)
1989	2,337	54	642	26	886
1990	3,891	453	1,121	29	1,516
1991	5,326	190	993	19	1,315
1992	-----	---	956	--	1,111

Discard Numbers at Age (thousands)

Year	0	1	2	Total
1989	969	2,035	118	3,122
1990	1,800	3,441	84	5,325
1991	1,114	4,280	<1	5,394
1992	1,160	2,916	60	4,137

Discard Mean Length at Age

Year	0	1	2	All
1989	25.9	31.5	44.2	30.2
1990	29.0	31.7	38.9	30.9
1991	24.0	30.9	37.0	29.5
1992	26.8	31.3	42.0	30.2

Discard mean weight at age

Year	0	1	2	All
1989	0.182	0.296	0.909	0.284
1990	0.235	0.304	0.559	0.285
1991	0.124	0.275	0.491	0.244
1992[2]	0.190	0.290	0.763	0.269

[1] Estimates developed using sea sample length samples, age-length data, and estimates of total discard in mt. Age-length keys applied on semi-annual basis because of length frequency sample size limitations. The 1989 quarter 1 and 2 lengths were aged with combined commercial and survey keys, due to lack of discard age samples.

[2] Because 1992 length data were not available to the committee, mean 1989-1991 proportions, mean lengths, and mean weights at age were assumed for the 1992 discard.

vessels (greater than 150 gross registered tons) fishing in areas south of Delaware Bay in 1991 were set as the standard cell. A general linear model, GLM (SAS 1985), incorporating year, tonnage class, and fishing area main effects explained 27% of the variance in the observed landings per unit effort (LPUE), and indicated a recent pattern of decreasing stock size through 1990, with some minor recovery suggested since then (Table 14).

Until this assessment, no discards were included in the commercial fishery catch at age matrix; therefore, both the catch at age and the standardized LPUE index were based on landings at age. If discards are included in the catch at age matrix for 1989 to 1992, the standardized index for 1982 to 1992 no longer reflects the same components of the catch (landings only, 1982 to 1992) as the catch at age matrix (landings from 1982 to 1988, landings plus discard from 1989 to 1992). To overcome this problem, the standardized LPUE index has been split into two time series: 1) 1982 to 1988 (Table 15), in which the proportions at age in the fishery are applied to the

Table 14. General Linear Model (GLM) of commercial weighout landings and effort (10% trips) data to develop standardized index of abundance for years 1982-1992[1]

Dependent variable: LN LPUE

Source	DF	SS	MSE	F	PR > F	R-Square
Model	13	9485.6	729.7	1051.6	0.0	0.27
Error	36382	25243.1	0.7			
Total	36395	34728.7				

MODEL SS

Variable	DF	Type III SS	F	PR > F
YR	10	4945.9	712.8	0.0
TC	2	3244.7	2338.3	0.0
AREA	1	1294.9	1866.4	0.0

Corrected, retransformed YR parameter estimates

Year	Estimate	Lower 95% CI	Upper 95% CI
1982	3.104	2.963	3.252
1983	2.908	2.788	3.033
1984	2.666	2.560	2.776
1985	2.092	2.011	2.175
1986	1.849	1.777	1.923
1987	1.726	1.659	1.796
1988	1.657	1.592	1.725
1989	1.096	1.049	1.145
1990	0.834	0.793	0.876
1991	0.990	0.944	1.037
1992	1.000		

NER commercial LPUE at age (numbers)

Year	Age 0	Age 1	Age 2	Age 3
1982	0.573	2.713	2.223	0.091
1983	0.525	3.281	1.178	0.150
1984	0.324	2.502	1.573	0.379
1985	0.158	1.222	1.911	0.182
1986	0.074	1.269	1.147	0.398
1987	0.051	1.442	1.208	0.151
1988	0.037	1.394	1.130	0.160
1989	0.033	0.590	0.849	0.103
1990	0.000	0.752	0.242	0.129
1991	0.000	0.801	0.695	0.045
1992	0.018	0.912	0.528	0.045

[1] Variation in LPUE is modeled as a result of year (YR), vessel tonnage class (TC), and fishing area (AREA; north and south of Delaware Bay) main effects, with no interactions. The corrected, transformed YR parameter estimates are used as indices of stock biomass (mt per day fished). Index is disaggregated to numbers at age using proportions and mean weights at age from the NER commercial landings.

LPUE index with the assumption that both the catch at age and LPUE index reflect nearly all removals from the stock by the commercial fishery (based on landings only, but discards were probably low), and 2) 1989 to 1992 (Table 16), with the catch at age including discards, and the LPUE index based on landings rates therefore valid only for the ages not discarded (age 2 and older).

A second commercial fishery index of abundance, based on mean catch per trip, was calculated for summer flounder harvested from the North Carolina winter trawl fishery. Vessels in this fishery are tonnage classes 2 and 3. Landings are not partitioned by size composition or trawl type. Thus, a few trips, but not more than 1% of the total trips sampled in any year, are included from the flynet fishery (the flynet is a high-profile high-rising otter trawl used for schooling fish swimming higher in the water column than typical groundfish). Recent index estimates are lower relative to peak levels observed in 1983 and 1984, but show an increasing trend since 1989 (Table 17). The same caveats noted for the

Table 15. General Linear Model (GLM) of commercial weighout landings and effort (10% trips) data to develop standardized index of abundance for years 1982-1988[1]

Dependent variable: LN LPUE

Source	DF	SS	MSE	F	PR > F	R-Square
Model	9	5282.1	586.9	840.5	0.0	0.22
Error	26934	18806.8	0.7			
Total	26943	31945.7				

MODEL SS

Variable	DF	TYPE III SS	F	PR > F
YR	6	1440.7	343.9	0.0
TC	2	2525.0	1808.1	0.0
AREA	1	1316.3	1885.2	0.0

Corrected, retransformed YR parameter estimates

	Estimate	Lower 95% CI	Upper 95% CI
1982	1.875	1.796	1.958
1983	1.748	1.683	1.816
1984	1.599	1.541	1.658
1985	1.265	1.221	1.310
1986	1.129	1.090	1.170
1987	1.050	1.013	1.088
1988	1.000		

NER commercial LPUE at cge (numbers)

	Age 0	Age 1	Age 2	Age 3
1982	0.346	1.639	1.343	0.055
1983	0.316	1.972	0.708	0.090
1984	0.194	1.501	0.943	0.227
1985	0.096	0.739	1.156	0.110
1986	0.045	0.775	0.701	0.243
1987	0.031	0.877	0.735	0.092
1988	0.022	0.841	0.682	0.097

[1] Variation in LPUE is modeled as a result of year (YR), vessel tonnage class (TC), and fishing area (AREA; north and south of Delaware Bay) main effects, with no interactions. The corrected, transformed YR parameter estimates are used as indices of stock biomass (mt per day fished). Index is disaggregated to numbers at age using proportions and mean weights at age from the NER commercial landings.

NER commercial fishery index, concerning the appropriate time periods and ages to use for tuning given inclusion of discards in 1989 to 1991, apply for this index.

RECREATIONAL LANDINGS

Recreational landings (catch type A+B1, National Marine Fisheries Service, Marine Recreational Fishery Statistics Surveys, MRFSS) in 1992, at 3,364 mt (7.4 million lb) were well below the 1979 to 1991 average of 8,200 mt (18.1 million lb; Figure 1). The share of total landings taken by the recreational sector was 32% in 1992. Summary catch and effort statistics for the recreational fishery are presented in Tables 18 to 24.

The length frequency sampling intensity for the recreational fishery for summer flounder was calculated by MRFSS regions (North: Maine to Connecticut; Mid: New York to Virginia; South: North Carolina) on a metric tons of landings per hundred lengths measured basis (Burns *et al.* 1983). For 1992, aggregate sampling intensity averaged 61 mt per 100 fish measured (Table 25). Generally, the South region was the "best" sampled, and the North region the "worst."

Marine Recreational Fishery Statistics Surveys sample length frequency data, NEFSC commercial age-length data, and NEFSC survey age-length data were examined in terms of number of fish measured/aged on various temporal and geographical bases. Correspondences were made between MRFSS intercept date (quarter), commercial quarter, and survey season (spring and summer/fall) on temporal bases, and between

Table 16. General Linear Model (GLM) of commercial weighout landings and effort (10% trips) data to develop standardized index of abundance for years 1989-1992[1]

Dependent variable: LN LPUE

Source	DF	SS	MSE	F	PR > F	R-Square
Model	6	901.7	150.30	224.8	0.0	0.12
Error	9445	6313.6	0.67			
Total	9451	7215.2				

MODEL SS

Variable	DF	Type III SS	F	PR>F
YR	2	80.6	40.2	0.0001
TC	2	722.0	540.0	0.0000
AREA	1	99.1	148.3	0.0001

Corrected, retransformed YR parameter estimates

	Estimate	Lower 95% CI	Upper 95% CI
1989	1.100	1.054	1.149
1990	0.845	0.805	0.887
1991	1.006	0.961	1.053
1992	1.000		

NER commercial LPUE at age (numbers)

	Age			
	0	1	2	3
1989	0.034	0.592	0.852	0.104
1990	0.000	0.762	0.247	0.131
1991	0.000	0.814	0.706	0.020
1992	0.018	0.912	0.528	0.045

[1] Variation in LPUE is modeled as a result of year (YR), vessel tonnage class (TC), and fishing area (AREA; north and south of Delaware Bay) main effects, with no interactions. The corrected, transformed YR parameter estimates are used as indices of stock biomass (mt per day fished). Index is disaggregated to numbers at age using proportions and mean weights at age from the NER commercial landings.

MRFSS region, commercial statistical areas, and survey depth strata on geographic bases in order to integrate data from the different sources. Based on the number, size range, and distribution of lengths and ages, a semiannual (quarters 1 and 2, quarters 3 and 4), regional basis of aggregation was adopted for matching commercial and survey age-length keys with recreational length frequency distributions for conversion of the lengths to ages.

The MRFSS intercept age-length data were then aggregated to bimonthly/regional/fishing mode (shore, party and charter boat, private and rental boat)/distance from shore (area: < 3 mi, > 3 mi) strata, with intercept sample proportions at age within each stratum applied to corresponding estimates of recreational landings in numbers (catch types A + B1), and summed to provide annual totals. The recreational landings are dominated by relatively young fish. Over the 1982 to 1992 time series, age 1 fish accounted for an average of 50% of the landings by number; summer flounder of ages 0 to 4 account for an average of more than 99% of landings by number. No fish from the recreational landings were determined to be older than age 7 (Table 26).

Small intercept length sample sizes for larger fish resulted in a high degree of variability in mean length for older fish, especially at ages 5 and older. Attempts to estimate length-weight relationships from MRFSS biological sample data for use in estimating weight at age provided unsatisfactory results. As a result, quarterly length (mm) to weight (g) relationships from Lux and Porter (1966), which are employed in the conversion of length to weight in NEFSC compilation of commercial fishery statistics for summer flounder, were used to calculate annual mean weights at age from the estimated age-length frequency distribution of the landings.

Table 17. Catch per unit effort (kilograms per trip) for summer flounder from the North Carolina winter trawl fishery, 1982-1991

Year	Number of Trips	Mean kg per Trip	Standard Deviation	Standard Error	CV	Relative to 1991
1982	24	3,875	3,402	694	88	1.198
1983	30	5,489	5,998	1,095	109	1.697
1984	62	5,575	6,805	864	122	1.724
1985	60	3,185	3,219	416	101	0.985
1986	72	2,306	2,576	304	112	0.713
1987	91	2,435	3,091	324	127	0.753
1988	71	3,217	3,215	382	100	0.995
1989	76	2,772	2,679	307	97	0.857
1990	93	2,494	1,999	207	82	0.771
1991	80	3,234	2,134	239	65	1.000
Mean		3,458				1.069

NC Commercial LPUE at age (numbers)

	Age			
Year	0	1	2	3
1982	0.389	1.374	0.056	0.021
1983	0.231	1.773	0.742	0.135
1984	0.240	1.497	1.029	0.146
1985	0.044	0.664	0.787	0.075
1986	0.047	0.541	0.414	0.105
1987	0.070	0.728	0.391	0.080
1988	0.000	0.872	0.665	0.141
1989	0.001	0.023	0.687	0.342
1990	0.002	0.106	0.541	0.310
1991	0.000	0.196	0.842	0.267

RECREATIONAL DISCARDS

MRFSS catch estimates were aggregated on a regional basis for calculation of the proportion of live discard (catch type B2) to total catch (catch types A+B1+B2) in the recreational fishery for summer flounder. Examination of catch data in this manner shows that the live discard has varied from about 12% (1979) to about 62% (1991) of the total catch (Table 21). To account for all removals from the summer flounder stock by the recreational fishery, some assumptions about the biological characteristics and hooking mortality rate of the recreational live discard needed to be made, because no biological samples are taken from catch type B2. In previous assessments, data available from New York Department of Environmental Conservation (NYDEC) surveys of New York party boats suggested the following for this component (Mid-Atlantic subregion, anglers fishing from boats) of the recreational fishery:

1) nearly all (>95%) of the fish released alive were below the minimum regulated size (currently 14 in [36 cm] in New York state waters), and
2 nearly all of these fish were age 0 and age 1 summer flounder, and 3) age 0 and 1 summer flounder occurred in approximately the same proportions in the live discard as in the landings (SAW Summer Flounder Working Group 1991).

The WG assumed that all B2 catch would be of lengths below regulated size limits, and so either age 0 or age 1 in all three regions. Catch type B2 was therefore allocated on a regional basis in the same ratio as the annual age 0 to age 1 proportion observed in the landings. Mean weights at age were assumed to be the same as in the landings.

The NYDEC data have recently been revised and updated through 1992 (Table 27). The revised data suggest that it is reasonable to assume that the recreational fishery discard is dominated by age 0 and 1 fish, but the further assumption that they occur in the subregional discard in the same relative proportions as the age 0 and 1 fish in subregional landings seems

Table 18. Estimated total landings (catch types A + B1, [thousands]) of summer flounder by recreational fishermen, MRFSS 1979-92[1]

Region Mode	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
North (Maine to Connecticut)														
Shore	47	27	54	172	152	63	9	92	51	56	4	19	11	31
P/C	24	9	<1	170	189	5	2	71	6	<1	<1	1	4	1
P/R	492	928	180	1,430	1,236	723	487	2,756	700	462	142	105	182	227
Total	563	964	234	1,772	1,577	791	498	2,919	757	518	146	125	197	259
Mid (New York to Virginia)														
Shore	7,511	2,709	2,188	725	4,338	1,318	286	464	274	733	95	96	447	192
P/C	571	849	1,431	5,232	4,155	3,140	1,337	1,681	1,190	1,522	145	422	328	339
P/R	11,152	17,145	4,759	6,425	15,309	19,002	11,105	5,706	6,178	9,165	1,255	2,860	4,794	4,294
Total	19,234	20,703	8,378	12,382	23,802	23,460	12,728	7,851	7,642	11,420	1,495	3,378	5,569	4,825
South (North Carolina)														
Shore	440	230	502	305	588	336	1,074	960	113	233	68	162	47	47
P/C	4	7	<1	89	156	313	529	6	<1	<1	<1	<1	<1	1
P/R	587	309	218	1,441	417	1,328	282	234	162	317	112	362	155	160
Total	1,031	546	720	1,835	1,161	1,977	1,885	1,200	275	550	180	525	202	208
All Regions														
Shore	7,999	2,966	2,744	1,203	5,078	1,717	1,369	1,516	438	1,022	167	277	504	270
P/C	599	865	1,431	5,491	4,500	3,457	1,868	1,759	1,196	1,523	145	423	333	341
P/R	12,230	18,382	5,158	9,295	16,962	21,053	11,873	8,695	7,040	9,944	1,509	3,328	5,131	4,681
Total	20,828	22,213	9,333	15,989	26,540	26,227	15,110	11,970	8,674	12,489	1,821	4,028	5,968	5,292

[1] Shore = Fish taken from beach/bank and man-made structures; P/C = Catch taken from party/charter boats; P/R = Fish taken from private/rental boats.

Table 19. Estimated total landings (catch types A + B1, mt) of summer flounder by recreational fishermen, MRFSS 1979-92[1]

Region Mode	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
North (Maine to Connecticut)														
Shore	28	20	15	92	42	13	6	32	19	38	2	20	6	24
P/C	22	7	<1	4	82	1	<1	17	1	1	<1	1	1	<1
P/R	334	849	134	1,105	772	494	232	2,886	671	385	130	105	152	174
Total	384	876	149	1,201	896	508	238	2,935	691	424	132	126	159	198
Mid (New York to Virginia)														
Shore	1,561	1,188	692	304	1,660	499	143	319	125	404	56	41	277	116
P/C	710	705	959	3,789	3,130	1,929	886	1,125	717	1,035	123	247	201	222
P/R	7,753	10,990	2,827	3,571	10,394	9,551	5,516	3,474	4,031	6,393	1,037	1,774	2,793	2,710
Total	10,024	12,883	4,478	7,664	15,184	11,979	6,545	4,918	4,873	7,832	1,216	2,062	3,271	3,048
South (North Carolina)														
Shore	165	128	160	103	156	108	506	568	39	81	44	84	25	24
P/C	1	4	<1	21	34	67	131	<1	<1	<1	<1	<1	<1	<1
P/R	340	258	66	632	87	485	137	76	55	150	68	163	79	94
Total	506	390	226	756	277	660	774	644	94	231	112	247	104	118
All Regions														
Shore	1,755	1,336	866	499	1,858	620	655	919	183	523	102	145	308	164
P/C	733	716	959	3,814	3,246	1,998	1,018	1,141	718	1,036	123	248	201	222
P/R	8,427	12,097	3,027	5,308	11,253	10,529	5,885	6,437	4,757	6,928	1,235	2,042	3,024	2,978
Total	10,915	14,149	4,852	9,621	16,357	13,147	7,558	8,497	5,658	8,487	1,460	2,435	3,533	3,364

[1] Shore = Fish taken from beach/bank and man-made structures; P/C = Catch taken from party/charter boats; P/R = Fish taken from private/rental boats.

Table 20. Estimated total catch (catch types A + B1 + B2, [thousands]) of summer flounder by recreational fishermen, MRFSS 1979-92[1]

Region	Year													
Mode	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
North (Maine to Connecticut)														
Shore	56	46	110	228	319	77	16	126	71	119	8	35	22	55
P/C	27	9	1	170	190	5	2	81	9	<1	<1	2	9	1
P/R	615	1,010	205	1,542	1,250	1,228	518	4,099	924	592	175	188	247	406
Total	698	1,065	316	1,941	1,759	1,310	536	4,306	1,004	712	183	225	278	465
Mid (New York to Virginia)														
Shore	7,834	3,701	2,850	1,398	8,151	2,113	510	1,197	960	1,335	175	477	1,345	767
P/C	581	977	1,837	9,110	5,450	4,953	1,517	2,916	2,402	2,373	182	740	760	769
P/R	13,398	22,120	7,693	8,129	23,338	32,546	13,209	14,248	16,953	15,246	1,797	6,819	12,310	10,134
Total	21,813	26,799	12,381	18,637	36,939	39,612	15,236	18,361	20,315	18,954	2,154	8,036	14,415	11,670
South (North Carolina)														
Shore	480	290	660	499	778	516	1,368	1,117	235	574	155	606	379	119
P/C	4	7	4	224	333	433	712	6	<1	<1	<1	<1	2	<1
P/R	642	317	312	2,009	591	1,465	320	349	245	516	218	687	503	289
Total	1,127	614	976	2,733	1,702	2,414	2,400	1,472	480	1,090	373	1,293	884	408
All Regions														
Shore	8,370	4,038	3,620	2,126	9,248	2,706	1,893	2,440	1,266	2,028	338	1,118	1,746	941
P/C	613	994	1,841	9,504	5,973	5,390	2,231	3,003	2,411	2,373	182	742	771	770
P/R	14,655	23,446	8,212	11,681	25,179	35,240	14,047	18,696	18,122	16,354	2,1900	7,554	13,060	10,828
Total	23,638	28,478	13,673	23,311	40,400	43,336	18,171	24,13	21,799	20,755	2,710	9,554	15,576	12,539

[1] Shore= Fish taken from beach/bank and man-made structures; P/C =catch taken from party/charterboats; P/R - Fish taken from private/rental boats

less likely. The data suggest this assumption will tend to underestimate the relative proportion of age 0 fish in the recreational discard. The WG considered three options for treating recreational fishery live discard:

1) omit them from the catch at age matrix,
2) assume the NYDEC party boat sample data to be characteristic of the age frequency of the discard in all subregions, or
3) continue with the assumptions made in the past.

The WG accepted option 3, because option 1 seemed unacceptable given the large proportion of recreational catch that may be discarded, and because it seemed likely that options 2 and 3 would provide similar VPA results, given the limited recruitment of age 0 fish to the recreational fishery. The WG recognized that the assumption employed for recreational fishery discards likely underestimates the relative proportion of age 0 fish in the discarded catch, and overestimates the relative proportion of age 1 fish.

Studies conducted cooperatively by the NEFSC and the state of Massachusetts to estimate hooking mortality for striped bass and black sea bass suggest a hooking mortality rate of 8% for striped bass (Diodati 1991) and 5% for black sea bass (Bugley and Shepherd 1991). Work by the states of Washington and Oregon with Pacific halibut (potentially a much larger flatfish species, but otherwise morphologically similar to summer flounder) found "average hooking mortality...between eight and 24 percent" (IPHC 1988). An unpublished tagging study by the NYDEC (Weber 1984) on survival of released sublegal summer flounder caught by hook-and-line suggested a total nonfishing mortality rate of 53%, which included hooking plus tagging mortality as well as deaths by natural causes (*i.e.*, predation, disease, senescence). Assuming deaths by natural causes to be about 18% (an instantaneous rate of 0.20), the WG noted that an annual hooking plus tagging mortality rate of about 35% could be derived from the NYDEC results. After much discussion of the results of these four studies, the WG assumed a 25% hooking mortality rate was reasonable for summer flounder released alive by anglers, so 25% of the total B2 catch at age was added to estimates of summer flounder landings at age to provide estimates of summer flounder recreational fishery discard at

Table 21. Estimated summer flounder landings (catch types A + B1), live discard (catch type B2), and total catch (catch types A + B1 + B2) in numbers (thousands), and live discard (catch type B2) as a proportion of total catch, MRFSS 1979-1992.

Year	Region	A+B1	B2	A+B1+B2	B2 / (A+B1+B2)	Year	Region[1]	A+B1	B2	A+B1+B2	B2 / (A+B1+B2)
1979	North	563	135	698	.193	1986	North	2,919	1,387	4,306	.322
	Mid	19,234	2,579	21,813	.118		Mid	7,851	10,510	18,361	.572
	South	1,031	96	1,127	.085		South	1,200	272	1,472	.185
	Total	20,828	2,811	23,638	.119		Total	11,970	12,169	24,139	.504
1980	North	964	101	1,065	.095	1987	North	757	247	1,004	.246
	Mid	20,703	6,096	26,799	.227		Mid	7,642	12,673	20,315	.624
	South	546	68	614	.111		South	275	205	480	.427
	Total	22,213	6,265	28,478	.220		Total	8,674	13,125	21,799	.602
1981	North	234	82	316	.259	1988	North	519	192	712	.270
	Mid	8,378	4,003	12,381	.323		Mid	11,420	7,534	18,954	.397
	South	720	256	976	.262		South	550	540	1,090	.495
	Total	9,333	4,340	13,673	.317		Total	12,489	8,266	20,756	.398
1982	North	1,772	169	1,941	.087	1989	North	146	37	183	.202
	Mid	12,382	6,255	18,637	.336		Mid	1,495	659	2,154	.306
	South	1,835	898	2,733	.329		South	180	193	373	.517
	Total	15,989	7,322	23,311	.314		Total	1,821	889	2,710	.328
1983	North	1,577	182	1,759	.103	1990	North	125	100	225	.444
	Mid	23,802	13,137	36,939	.356		Mid	3,378	4,658	8,036	.580
	South	1,161	541	1,702	.318		South	525	768	1,293	.594
	Total	26,540	13,860	40,400	.343		Total	4,028	5,525	9,554	.578
1984	North	791	520	1,310	.397	1991	North	197	80	278	.288
	Mid	23,460	16,152	39,612	.408		Mid	5,568	8,847	14,415	.614
	South	1,977	437	2,414	.181		South	202	681	884	.770
	Total	26,227	17,109	43,336	.395		Total	5,968	9,608	15,576	.617
1985	North	498	38	536	.071	1992	North	259	203	462	.439
	Mid	12,728	2,508	15,236	.165		Mid	4,825	6,844	11,669	.587
	South	1,885	515	2,400	.215		South	208	201	409	.491
	Total	15,110	3,061	18,171	.168		Total	5,292	7,248	12,540	.578

age (Table 28), total catch at age in numbers (Table 29) and mean weights at age (Table 30).

RECREATIONAL FISHERY-BASED CPUE INDICES

The raw intercept sample data from the 1982 to 1992 MRFSS were used to provide indices of abundance. A simple total catch rate (mean total catch number per angler per trip; CPUE) was calculated for the Mid-Atlantic private/rental boat component of the fishery. This intercept index included both landed fish and live discard. This index suggested a variable trend in summer flounder abundance since 1987 (Table 31).

A GLM (SAS 1985) was used to analyze the variation in MRFSS intercept CPUE for all intercepts coastwide, and produce a standardized index of abundance based on year category regression coefficients. Since intercepts from the Mid-Atlantic, private/rental boat, inshore waters (inland and territorial sea) stratum were the major component of the fishery in terms of catch and total intercepts, that subregion/fishing mode/fishing area stratum was selected as the standard for the procedure. A weighted least-squares regression procedure (with each CPUE estimate weighted by the inverse of the variance of logged CPUE) was employed because of the highly variable coefficients of variation of the stratum CPUE

Table 22. Number of recreational fishing trips (thousands) for all species in bimonthly state/fishing mode/fishing area cells with summer flounder catch, compared with numbers of summer flounder recreational trips (thousands) in these cells (as defined in the text), aggregated at the regional level, MRFSS 1979-1992

Year	Region	All Species Trips	Nominal Summer Flounder Trips	Proportion of Summer Flounder Trips to All Species Trips
1979				
	North	3,414	481	0.141
	Mid	15,355	5,760	0.375
	South	3,036	687	0.226
	Total	21,805	6,928	0.318
1980				
	North	2,626	277	0.106
	Mid	21,097	9,295	0.441
	South	2,270	287	0.126
	Total	25,992	9,859	0.379
1981				
	North	1,701	196	0.115
	Mid	10,919	4,532	0.415
	South	1,740	623	0.358
	Total	14,361	5,351	0.373
1982				
	North	3,607	551	0.153
	Mid	11,463	5,541	0.483
	South	2,905	1,010	0.358
	Total	17,974	7,102	0.395
1983				
	North	4,792	745	0.155
	Mid	19,407	10,100	0.520
	South	3,396	855	0.252
	Total	27,595	11,700	0.424
1984				
	North	2,996	667	0.223
	Mid	17,018	9,075	0.533
	South	3,811	1,348	0.354
	Total	23,826	11,090	0.465
1985				
	North	3,369	388	0.115
	Mid	12,152	5,311	0.437
	South	3,584	1,501	0.419
	Total	19,105	7,200	0.377
1986				
	North	4,653	670	0.144
	Mid	17,428	6,578	0.377
	South	2,090	666	0.318
	Total	24,172	7,914	0.327
1987				
	North	3,396	505	0.149
	Mid	13,910	5,611	0.403
	South	2,333	244	0.105
	Total	19,639	6,360	0.324

Table 22. Continued.

Year	Region	All Species Trips	Nominal Summer Flounder Trips	Proportion of Summer Flounder Trips to All Species Trips
1988				
	North	3,780	586	0.155
	Mid	15,305	8,164	0.533
	South	3,572	767	0.215
	Total	22,657	9,517	0.420
1989				
	North	2,370	230	0.120
	Mid	11,082	3,017	0.272
	South	2,732	285	0.104
	Total	16,184	3,531	0.218
1990				
	North	4,074	246	0.060
	Mid	12,048	4,543	0.377
	South	3,556	1,090	0.307
	Total	19,678	5,879	0.299
1991				
	North	5,175	425	0.082
	Mid	14,078	5,684	0.404
	South	2,598	466	0.179
	Total	19,678	6,575	0.301
1992				
	North	4,635	432	0.093
	Mid	11,200	5,091	0.455
	South	2,540	456	0.180
	Total	18,375	5,979	0.325

coefficients. A main effects (year, subregion, fishing mode) model accounted for about 41% of the variation in intercept CPUE. This coastwide index also suggests a variable trend in summer flounder abundance since 1987. Both recreational fishery-based indices reached a low point in 1989, probably reflecting the influence of the poor 1988 year class on catches of age 1 fish. As with the commercial fishery indices, the annual proportions at age were applied to the standardized index to provide indices of abundance at age (Table 31).

NYDEC staff have surveyed the catches of anglers aboard party boats fishing from ports along the Long Island coast since 1985. Samples of catch per angler, total effort in angler hours, and length and age frequency of the kept and discarded catch are taken. An index of abundance at age for summer flounder was developed from data for Great South Bay, N.Y. for 1985 to 1992 (Table 32).

TOTAL CATCH COMPOSITION

NER total commercial landings and discards at age, North Carolina winter trawl landings and discards at age, and MRFSS recreational landings and discards at age totals were summed to provide a total fishery catch at age matrix for 1982 to 1992. The numbers and proportions at age of fish age 4 and older are low and quite variable, reflecting the limited numbers of fish available to be sampled. For the total catch at age during 1982-1992, the average catch composition at age was: age 0: 12%, age 1: 51%, age 2: 29%, and age 3: 6%. Summer flounder age 4 and

Table 23. Estimated number (thousands) of summer flounder fishing trips by annual region/mode strata, MRFSS 1979-1992[1]

Region Mode	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
North (Maine to Connecticut)														
SHORE	43	28	86	219	196	123	48	155	63	283	31	98	196	146
P/C	9	19	<1	31	21	10	16	19	10	6	<1	3	5	4
P/R	429	230	110	301	528	534	324	496	432	297	198	145	224	282
Total	481	277	196	551	745	667	388	670	505	586	229	246	425	432
Mid (New York to Virginia)														
SHORE	924	2,276	1,316	1,292	2,662	1,558	731	1,785	1,126	1,635	534	563	1,146	947
P/C	332	341	476	1,113	1,649	814	814	788	668	715	242	642	221	325
P/R	4,504	6,678	2,740	3,136	5,789	6,703	3,766	4,005	3,817	5,814	2,241	3,338	4,317	3,819
Total	5,760	9,295	4,532	5,541	10,100	9,075	5,311	6,578	5,611	8,164	3,017	4,543	5,684	5,091
South (North Carolina)														
SHORE	284	96	306	412	343	621	669	376	94	545	181	567	309	300
P/C	5	9	4	77	91	243	548	<1	<1	<1	<1	2	<1	<1
P/R	398	182	313	521	421	484	284	289	150	222	104	521	157	156
Total	687	287	623	1,010	855	1,348	1,501	666	244	767	285	1,090	466	456
All Regions														
SHORE	1,251	2,400	1,708	1,923	3,201	2,302	1,448	2,316	1,283	2,463	746	1,228	1,651	1,393
P/C	346	369	480	1,221	1,761	1,067	1,378	808	678	721	242	647	226	329
P/R	5,331	7,090	3,163	3,958	6,738	7,721	4,374	4,790	4,399	6,333	2,543	4,004	4,698	4,257
Total	6,928	9,859	5,351	7,102	11,700	11,090	7,200	7,914	6,360	9,517	3,531	5,879	6,575	5,979

[1] SHORE =Fish taken from beach/bank and man-made structures; P/C = Catch taken from party/charter boats; P/R = Fish taken from private/rental boats

Table 24. Precision of key summer flounder fishery statistics: estimated total catch (catch types A + B1 + B2, [thousands]) of summer flounder caught by recreational fishermen and estimated number (thousands) of summer flounder recreational fishing trips, and respective approximate 95% confidence intervals (L95, U95), for the Mid-Atlantic private/rental boat (P/R) fishery, and for all fishery strata (ALL), MRFSS 1979-1992

Region Mode	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Catch														
Mid P/R	13,398	22,120	7,693	8,129	23,338	32,546	13,209	14,248	16,953	14,736	1,797	6,819	12,310	10,134
CV	7	4	12	10	10	14	18	10	6	6	5	5	5	5
L95	11,703	20,231	5,831	6,580	19,046	23,742	8,597	11,368	15,089	13,078	1,971	6,203	11,095	9,192
U95	15,092	24,009	9,557	9,677	27,630	41,350	17,821	17,129	18,817	16,395	1,623	7,433	13,531	11,076
ALL	23,638	28,478	13,673	23,311	40,400	43,336	18,171	24,139	21,799	19,239	2,710	9,554	15,719	12,420
CV (%)	26	4	10	35	12	11	14	8	5	5	4	2	4	4
L95	11,554	26,329	11,014	7,419	31,338	34,112	13,248	20,577	19,793	17,455	2,510	9,234	14,225	11,43
U95	35,723	30,628	16,332	39,203	49,461	52,561	23,095	27,701	23,807	21,023	2,910	9,875	17,918	13,402
Trips														
Mid P/R	4,504	6,678	2,740	3,136	5,789	6,703	3,766	4,005	3,817	5,814	2,241	3,338	4,317	3,819
CV (%)	2	2	11	10	12	14	12	9	6	6	5	5	5	5
L95	4,367	6,419	1,266	2,531	4,486	4,921	2,854	3,336	3,445	5,119	2,472	3,044	3,881	3,416
U95	4,661	6,992	3,327	3,742	7,093	8,489	4,675	4,673	4,190	6,509	2,010	3,631	4,753	4,222
ALL	6,928	9,859	5,351	7,102	11,700	11,090	7,200	7,914	6,360	9,517	3,531	5,879	6,575	5,678
CV (%)	4	2	7	7	8	8	7	5	3	4	3	2	3	3
L95	6,481	9,642	4,632	6,186	9,769	9,400	6,224	7,075	5,948	8,789	3,760	5,723	6,143	5,309
U95	7,406	10,147	5,073	8,013	13,632	12,758	8,181	8,733	6,773	10,244	3,302	6,034	7,008	6,047

Table 25. Intercept sampling intensity for summer flounder by region, MRFSS

Year	Region	Landings (A+B1) (mt)	Number of Summer Flounder Measured	Mt/100 Lengths
1979	North	384	175	219
	Mid	10,024	2,367	423
	South	506	170	298
	Total	10,915	2,712	402
1980	North	876	104	842
	Mid	12,883	4,027	320
	South	390	169	231
	Total	14,149	4,300	329
1981	North	149	56	266
	Mid	4,478	2,670	168
	South	226	178	127
	Total	4,852	2,904	167
1982	North	1,201	228	527
	Mid	7,664	2,902	264
	South	756	562	135
	Total	9,621	3,692	243
1983	North	896	310	289
	Mid	15,184	4,704	323
	South	277	150	185
	Total	16,357	5,164	317
1984	North	508	168	302
	Mid	11,979	2,193	546
	South	660	244	270
	Total	13,147	2,605	505
1985	North	238	78	305
	Mid	6,545	1,930	339
	South	781	274	285
	Total	7,558	2,282	331
1986	North	2,935	266	1103
	Mid	4,918	1,809	272
	South	644	281	229
	Total	8,497	2,356	361
1987	North	691	218	317
	Mid	4,873	1,897	257
	South	94	474	20
	Total	5,658	2,589	219
1988	North	424	309	137
	Mid	7,832	2,865	273
	South	231	717	32
	Total	8,487	3,891	218
1989	North	132	107	123
	Mid	1,216	1,582	77
	South	112	338	33
	Total	1,460	2,027	48
1990	North	126	110	115
	Mid	2,062	2,667	77
	South	247	1,285	19
	Total	2,435	4,062	60
1991	North	159	182	87
	Mid	3,271	4,452	73
	South	104	752	14
	Total	3,533	5,386	66
1992	North	198	425	47
	Mid	3,048	4,504	68
	South	118	569	21
	Total	3,364	5,498	61

Table 26. Estimated recreational landings at age of summer flounder (thousands), MRFSS 1982-1992 (catch type A+B1)

Year	Age 0	1	2	3	4	5	6	7	8	Total
1982	2,363	7,336	5,678	440	167	<1	5	0	0	15,989
1983	8,328	15,122	2,857	231	2	<1	0	0	10	26,540
1984	8,078	12,641	3,619	1,233	393	157	106	0	0	26,227
1985	1,269	6,877	3,913	1,511	1,315	120	105	0	0	15,110
1986	2,693	4,704	2,394	1,472	108	371	120	12	0	11,874
1987	1,197	5,060	1,671	451	247	4	8	37	0	8,674
1988	2,475	5,750	3,187	693	289	44	44	7	0	12,489
1989	109	507	747	427	19	12	0	0	0	1,821
1990	179	3,159	566	118	4	1	1	0	0	4,028
1991	399	2,983	2,443	96	37	10	<1	0	0	5,968
1992	122	3,196	1,667	276	<1	31	0	0	0	5,292

Table 27. Age composition of discarded and kept summer flounder in Great South Bay, Western South Shore, and Eastern Long Island regions of New York waters, NYDEC party boat survey, 1985-1992

Age	1985	1986	1987	1988	1989	1990	1991	1992	Total	Percent	Age 0+1I Percent
Great South Bay: Discard											
0	24	45	2	5	113	26	37	50	232	15	16
1	89	167	176	155	5	162	135	339	1228	80	84
2	41	4	15	3	3	1	3	0	70	5	
									1530	100	100
Great South Bay: Kept											
0	18	1	1	0	0	0	0	0	20	1	1
1	111	264	138	232	31	267	200	238	1481	63	99
2	196	73	131	102	119	21	88	59	789	34	
3	4	14	10	4	2	14	1	2	51	2	
4	0	1	1	1	0	1	0	1	5	<1	
								2046	100		

Western South Shore: Discard

Age	1987	1988	1989	1990	Total	Percent	Age 0+1I Percent
0	2	1	0	0	3	2	1
1	80	78	1	45	204	91	99
2	7	2	6	1	16	7	
					223	100	100

Western South Shore: Kept

Age	1987	1988	1989	1990	Total	Percent	Age 0+1I Percent
0	1	0	0	0	1	<1	2
1	138	232	31	267	668	62	98
2	131	102	119	21	373	35	
3	10	4	2	14	30	3	
4	1	1	0	1	3	<1	
					1075	100	100

Eastern Long Island: Discard

Age	1987	1988	1989	1990	Total	Percent	Age 0+1I Percent
0	4	1	0	10	15	14	14
1	45	24	0	21	90	82	86
2	1	2	2	0	5	4	
					110	100	10

Eastern Long Island: Kept

0	0	0	0	0	0	0	0
1	21	17	2	46	88	35	100
2	33	54	27	4	118	47	
3	9	16	4	4	33	13	
4	6	2	0	4	11	5	
					251	100	100

Table 28. Estimated recreational fishery discard at age of summer flounder, MRFSS 1982-1992 (catch type B2)[1]

Year	Numbers at Age (thousands) 0	1	Total	Metric Tons at Age 0	1	Total
1982	439	1,392	1,831	97	612	709
1983	1,213	2,252	3,465	230	991	1,221
1984	1,668	2,609	4,277	350	991	1,341
1983	122	641	763	29	257	286
1986	1,095	1,947	3,042	274	876	1,150
1987	631	2,650	3,281	139	1,113	1,252
1988	629	1,438	2,067	176	719	895
1989	41	181	222	11	98	109
1990	71	1,310	1,381	22	629	651
1991	278	2,124	2,402	78	956	1,034
1992	65	1,747	1,812	15	896	911

[1] Discards allocated to age groups in same relative proportions as ages 0 and 1 in the subregional catch, and assuming 25% hooking mortality.

Table 29. Estimated recreational catch at age of summer flounder (thousands), MRFSS 1982-1992 (catch type A+B1+B2)[1]

Year	Age 0	1	2	3	4	5	6	7	8	Total
1982	2,802	8,728	5,678	440	167	<1	5	0	0	17,820
1983	9,541	17,374	2,857	231	2	<1	0	0	0	30,005
1984	9,746	15,250	3,619	1,233	393	157	106	0	0	30,504
1985	1,391	7,518	3,913	1,511	1,315	120	105	0	0	15,873
1986	3,788	6,651	2,394	1,472	108	371	120	12	0	14,916
1987	1,828	7,710	1,671	451	247	4	8	37	0	11,955
1988	3,104	7,188	3,187	693	289	44	44	7	0	14,556
1989	150	688	747	427	19	12	0	0	0	2,043
1990	250	4,469	566	118	4	1	1	0	0	5,409
1991	677	5,107	2,443	96	37	10	<1	0	0	8,371
1992	187	4,943	1,667	276	<1	31	0	0	0	7,105

[1] Includes catch type B2 (fish released alive) allocated to age groups 0 and 1 with 25% hooking mortality.

Table 30. Mean weight (kilograms) at age of summer flounder landed in the recreational fishery, 1982-1992

Year	Age 0	1	2	3	4	5	6	7	8
1982	0.22	0.44	0.67	1.74	2.21	2.09	2.21	0.00	0.00
1983	0.19	0.44	0.79	1.25	2.02	2.57	0.00	0.00	0.00
1982	0.21	0.38	0.64	1.01	1.85	2.29	4.34	0.00	0.00
1985	0.24	0.40	0.62	1.07	1.80	2.49	3.97	0.00	0.00
1986	0.25	0.45	0.72	1.29	1.88	2.70	3.30	5.96	0.00
1987	0.22	0.42	0.77	1.25	1.85	2.85	4.27	4.64	0.00
1988	0.28	0.50	0.73	1.05	1.94	2.45	4.78	3.95	0.00
1989	0.27	0.54	0.83	1.12	2.16	2.82	0.00	0.00	0.00
1990	0.31	0.48	1.00	1.64	2.52	4.07	2.91	0.00	0.00
1991	0.28	0.45	0.71	1.19	1.39	2.55	3.97	0.00	0.00
1992	0.24	0.51	0.75	1.90	2.28	3.34	3.80	0.00	0.00

Table 31. Indices of abundance (mean total catch number per angler per trip with upper and lower 95% confidence intervals) for summer flounder calculated from MRFSS 1982-1991 intercept data catch types A + B1 + B2)[1]

	Mid-Atlantic, New York to Virginia (Private/Rental Boat)			Coastwide GLM Index		
Year	**Mean**	**L95**	**U95**	**Mean**	**L95**	**U95**
1982	4.421	4.137	4.705	1.825	1.393	2.392
1983	5.243	4.929	5.557	1.827	1.347	2.478
1984	5.307	4.931	5.683	1.295	1.021	1.642
1985	3.324	3.106	3.542	1.152	0.876	1.514
1986	4.503	4.250	4.756	1.801	1.362	2.384
1987	5.965	5.632	6.298	1.583	1.179	2.126
1988	4.756	4.495	5.017	1.554	1.122	2.154
1989	2.145	1.992	2.229	1.022	0.799	1.309
1990	3.704	3.499	3.909	1.227	0.996	1.511
1991	2.650	2.306	2.994	1.598	1.183	2.158
1992	4.512	4.324	4.700	1.000		

Coastwide GLM index
Recreational CPUE at age (numbers)

	Age			
Year	**0**	**1**	**2**	**3**
1982	0.287	0.894	0.582	0.046
1983	0.581	1.058	0.174	0.011
1984	0.413	0.648	0.154	0.052
1985	0.101	0.546	0.284	0.109
1986	0.456	0.798	0.288	0.177
1987	0.242	0.988	0.218	0.059
1988	0.337	0.763	0.337	0.076
1989	0.075	0.343	0.372	0.213
1990	0.056	1.012	0.129	0.027
1991	0.128	0.975	0.463	0.016
1992	0.026	0.696	0.235	0.039

[1] Indices calculated for the Mid-Atlantic private/rental boat strata, and for all region/mode strata coastwide. Coastwide indices are corrected, retransformed year category regression coefficients estimated by a weighted least-squares regression model of log transformed mean total catch number per angler per trip (year, region, and fishing mode main effects) with the catch rate for the 1991, Mid-Atlantic, private/rental boat stratum designated as the standard. Coastwide index disaggregated to age using recreational fishery proportions and mean weights at age.

older constituted an average of less than 3% of the catch during 1982-1992. Inclusion of commercial fishery discards for 1989 to 1992 provides a more complete estimate of total summer flounder catch at age for use in this assessment as input to the VPA (Tables 33 and 34). Overall mean lengths and weights at age for the total catch were calculated as weighted means (by number in the catch at age) of the respective mean values at age from the NER commercial (Maine to Virginia), North Carolina commercial winter trawl, and recreational (Maine to North Carolina) fisheries (Tables 35 to 36).

RESEARCH SURVEY ABUNDANCE AND BIOMASS INDICES

NEFSC SPRING

Long-term trends in summer flounder abundance were derived from a stratified random bottom trawl survey conducted in spring by NEFSC between Cape Hatteras and Nova Scotia since 1968 (Clark 1978). Recent NEFSC survey

Table 32. Party boat survey index of abundance for summer flounder, Great South Bay, New York, 1985-1992, New York Department of Environmental Conservation

Party Boat Angler CPUE at Age (Numbers)

Year	Age			
	0	1	2	3
1985	0.060	0.289	0.285	0.009
1986	0.069	0.604	0.087	0.013
1987	0.005	0.524	0.285	0.017
1988	0.006	0.502	0.156	0.005
1989	0.046	0.027	0.087	0.002
1990	0.023	0.501	0.028	0.018
1991	0.036	0.485	0.160	0.002
1992	0.030	0.339	0.035	0.001

indices (1991 to 1992) appear to be about one-half (in number) to one-third (in weight) of the level of indices from the mid- to late 1970s: catch number/tow (fitted delta mean) averaged 1.15 fish/tow between 1991 and 1992 compared with 2.20 fish/tow between 1975 and 1978, while catch kg/tow (fitted delta mean) averaged 0.41 kg/tow between 1991 and 1992 compared to 1.54 kg/tow between 1975 and 1978 (Tables 37 to 38). Age composition data from the NEFSC survey (Table 39) indicate a substantial reduction in the number of ages in the stock between 1976 and 1992, years for which age data are available. Between 1976 and 1981, fish of ages 5 to 8 were captured regularly in the survey, with the oldest individuals aged 8 to 10 years. Between 1982 and 1986, fish aged 5 and older were only occasionally observed in the survey and by 1986, the oldest fish observed in the survey were age 5. In 1990, only three ages (1 to 3) were observed in the survey catch, and there was an indication that the 1988 year class was very weak. In 1991 and 1992, no fish from the 1988 year class were captured.

NEFSC WINTER

A new series of NEFSC winter trawl surveys started in February 1992 specifically to provide improved indices of abundance for flatfish, including summer flounder. This survey targets flatfish during the winter when they are concentrated offshore. A modified 36 Yankee trawl is used in the winter survey that differs from the standard trawl employed during the spring and autumn surveys in that 1) long trawl sweeps (wires) are added before the trawl doors, to better herd fish to the mouth of the net, and 2) the large rollers used on the standard gear are absent, and only a chain "tickler" and small spacing "cookies" are present on the footrope.

Based on a comparison of summer flounder catches during the two winter surveys completed to date with recent spring and autumn surveys, the current design and conduct of the winter survey (timing, strata sampled, and the use of the modified 36 Yankee trawl gear) has resulted in greater catchability of summer flounder compared to the other surveys. Most fish have been taken in survey strata 61 to 76 (27 to 110 m; 15 to 60 fathoms), off the Delaware and Chesapeake Bays. Other concentrations of fish were found in strata 1 to 12, south of the New York and Rhode Island coasts, in slightly deeper waters. A few large summer flounder were captured along the southern flank of Georges Bank.

The performance of the winter trawl survey indices as tuning indices cannot be assessed at this point, because only two observations are available. Based on the characteristics mentioned above, however, the performance is likely to be superior to NEFSC spring survey indices currently used for tuning. The length distribution sampled from fish available at the time of the survey indicates that fish aged 1 and older are available to the survey. Although fishery-independent estimation of relative abundance of age 0 fish will remain problematic in future assessments, the quality of abundance indices of fish of aged 1 and older may improve as the time series available from the winter trawl survey lengthens (Table 40, Figure 6).

MASSACHUSETTS DMF

Fishery-independent bottom trawl surveys conducted by the Massachusetts Division of Marine Fisheries (MADMF) during spring and fall show a decline in abundance in numbers of summer flounder from recent high levels in 1986 to record lows in 1990 (MADMF fall survey), and 1991 (MADMF spring survey). The MADMF fall survey showed increased abundance in 1992, with the highest index value since 1987 (Table 41).

CONNECTICUT DEP

A spring to fall bottom trawl survey con-

Table 33. Total catch at age of summer flounder (thousands), Maine to North Carolina, 1982-1992

Year	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1982	5,225	19,070	12,329	814	280	116	68	26	4	0	37,932
1983	11,989	33,271	8,790	1,072	167	103	16	20	5	2	55,436
1984	12,056	31,614	14,242	3,401	1,075	247	110	5	1	4	62,755
1985	2,427	16,933	17,510	2,805	1,663	313	135	5	2	1	41,794
1986	4,411	16,170	10,665	4,166	295	496	150	20	86	0	36,458
1987	2,393	19,038	10,426	1,651	609	28	32	63	11	0	34,251
1988	3,409	21,221	14,404	2,444	843	162	63	22	6	0	42,574
1989	1,217	5,263	7,131	1,984	356	65	8	3	7	0	16,034
1990	2,052	10,723	2,241	995	202	36	8	2	1	0	16,259
1991	1,791	13,524	7,340	759	214	40	4	1	0	0	23,674
1992	1,457	13,463	6,491	1,565	167	78	2	1	0	0	23,223

Table 34. Total fishery percentage age composition of summer flounder (numbers), Maine to North Carolina, 1982-1992

Year	Age									
	0	1	2	3	4	5	6	7	8	9
1982	13.8	50.3	32.5	2.1	0.7	0.3	0.2	0.1	<0.1	0.0
1983	21.6	60.0	15.9	1.9	0.3	0.2	<0.1	<0.1	<0.1	<0.1
1984	19.2	50.4	22.7	5.4	1.7	0.4	0.2	<0.1	<0.1	<0.1
1985	5.8	40.5	41.9	6.7	4.0	0.7	0.3	<0.1	<0.1	<0.1
1986	12.1	44.4	29.3	11.4	0.8	1.4	0.4	0.1	0.2	0.0
1987	7.0	55.6	30.4	4.8	1.8	0.1	0.1	0.2	<0.1	0.0
1988	8.0	49.8	33.8	5.7	2.0	0.4	<0.1	<0.1	<0.1	0.0
1989	7.6	32.8	44.5	12.4	2.2	0.4	<0.1	<0.1	<0.1	0.0
1990	12.6	65.9	13.8	6.1	1.2	0.2	<0.1	<0.1	<0.1	0.0
1991	7.6	57.1	31.0	3.2	0.9	0.2	<0.1	<0.1	0.0	0.0
1992	6.3	58.0	27.9	6.7	0.7	0.3	<0.1	<0.1	0.0	0.0
Mean	12.4	51.3	28.6	5.5	1.5	0.4	0.2	<0.1	<0.1	<0.1

Table 35. Mean length (cm) at age of summer flounder catch, Maine to North Carolina, 1982-1992

Year	Age										Mean Length
	0	1	2	3	4	5	6	7	8	9	All Ages
1982	29.1	34.8	39.3	52.5	56.8	61.0	60.3	68.0	70.6		36.2
1983	28.0	35.1	41.9	48.9	50.3	53.6	60.6	65.1	69.4	72.0	35.0
1984	28.8	33.8	39.1	46.0	51.9	58.3	70.8	68.4	74.0	70.7	35.2
1985	30.3	34.6	38.7	46.5	54.5	58.9	68.1	74.5	73.3	75.0	38.0
1986	29.8	35.4	39.6	47.6	54.3	59.3	65.2	72.4	77.8		38.0
1987	29.2	35.3	39.6	46.5	55.6	63.1	66.5	70.6	73.5		37.2
1988	31.3	35.8	39.1	46.2	54.3	60.0	72.7	68.7	72.8		37.7
1989	27.0	35.5	40.7	45.7	50.8	58.7	60.0	63.1	59.0		38.9
1990	29.3	35.1	42.0	47.0	51.4	59.3	64.2	71.4	75.2		36.3
1991	26.7	34.3	40.6	47.0	54.4	60.9	65.6	68.4			36.3
1992	26.9	35.9	41.2	48.7	54.6	63.4	61.4	74.0			37.9

Table 36. Mean weight (kg) at age of summer flounder catch, Maine to North Carolina, 1982-1992

Year	Age										Mean Weight
	0	1	2	3	4	5	6	7	8	9	All Ages
1982	0.254	0.435	0.654	1.687	2.135	2.795	2.621	3.762	4.284		0.534
1983	0.218	0.447	0.786	1.297	1.466	1.706	2.567	3.169	3.875	4.370	0.475
1984	0.228	0.399	0.640	1.055	1.592	2.245	3.476	3.620	4.640	4.030	0.484
1985	0.282	0.426	0.612	1.092	1.782	2.343	2.670	4.682	4.780	4.800	0.610
1986	0.256	0.454	0.659	1.173	1.790	2.503	3.268	2.994	4.415		0.622
1987	0.239	0.446	0.648	1.117	1.934	2.853	3.080	3.020	4.140		0.559
1988	0.287	0.468	0.628	1.109	1.787	2.480	3.888	3.701	4.319		0.581
1989	0.206	0.451	0.711	1.041	1.504	2.454	2.577	3.105	2.251		0.655
1990	0.244	0.432	0.800	1.176	1.561	2.519	3.026	4.555	5.029		0.525
1991	0.184	0.402	0.700	1.167	1.892	2.674	3.394	3.817			0.520
1992	0.208	0.458	0.756	1.380	1.955	3.005	2.878	4.590			0.607

Table 37. NEFSC spring trawl survey (offshore strata), mean number of summer flounder per tow[1]

Year	Delta Mean	Fitted Mean	Fitted Upper 95% ci	Fitted Lower 95% ci
1968	0.15	0.15		
1969	0.19	0.17		
1970	0.09	0.13		
1971	0.22	0.23	0.417	0.124
1972	0.47	0.44	0.813	0.243
1973	0.75	0.75	1.382	0.412
1974	1.40	1.30	2.386	0.712
1975	1.98	1.89	3.463	1.033
1976	2.72	2.46	4.502	1.343
1977	2.82	2.51	4.590	1.369
1978	2.58	1.92	3.524	1.051
1979	0.40	0.73	1.336	0.399
1980	1.31	1.18	2.154	0.643
1981	1.50	1.46	2.681	0.800
1982	2.23	1.72	3.149	0.939
1983	0.95	1.08	1.979	0.590
1984	0.66	0.93	1.697	0.506
1985	2.38	1.80	3.292	0.982
1986	2.15	1.78	3.252	0.970
1987	0.93	1.11	2.029	0.605
1988	1.46	1.08	1.920	0.627
1989	0.32	0.51	0.899	0.307
1990	0.71	0.71	1.270	0.401
1991	1.11	1.00	1.789	0.564
1992	1.19	1.14	2.157	0.598

[1] Delta values fitted to an ARIMA model with theta value = 0.240.

Table 38. NEFSC spring trawl survey (offshore strata) mean weight (kilograms) of summer flounder per tow[1]

Year	Delta Mean	Fitted Mean	Fitted Upper 95% ci	Fitted Lower 95% ci
1968	0.16	0.16		
1969	0.16	0.15		
1970	0.09	0.13		
1971	0.28	0.23	0.390	0.136
1972	0.21	0.26	0.447	0.156
1973	0.52	0.53	0.892	0.311
1974	1.27	1.08	1.833	0.639
1975	1.63	1.51	2.563	0.894
1976	1.94	1.77	2.999	1.045
1977	1.84	1.66	2.816	0.982
1978	1.50	1.22	2.071	0.722
1979	0.35	0.55	0.931	0.324
1980	0.79	0.73	1.241	0.432
1981	0.81	0.81	1.378	0.480
1982	1.15	0.91	1.546	0.539
1983	0.52	0.59	0.996	0.347
1984	0.38	0.51	0.863	0.301
1985	1.21	0.89	1.514	0.528
1986	0.85	0.76	1.281	0.446
1987	0.39	0.48	0.817	0.285
1988	0.66	0.51	0.864	0.311
1989	0.24	0.30	0.491	0.182
1990	0.27	0.30	0.485	0.180
1991	0.37	0.36	0.597	0.220
1992	0.45	0.42	0.734	0.244

[1] Delta values fitted to an ARIMA model with theta value = 0.240.

Table 39. NEFSC spring trawl survey (offshore strata) mean number of summer flounder per tow at age (delta values)[1]

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10	
1976	0.03	1.70	0.68	0.28	0.01	0.01	0.01				2.72
1977	0.61	1.30	0.70	0.10	0.09	0.01		0.01			2.82
1978	0.70	0.95	0.66	0.19	0.04	0.03	0.03			0.02	2.62
1979	0.06	0.18	0.08	0.04	0.03			0.01			0.40
1980	0.01	0.71	0.31	0.14	0.02	0.06	0.03	0.01		0.01	1.31
1981	0.59	0.53	0.17	0.08	0.05	0.03	0.02	0.01			1.48
1982	0.69	1.41	0.12	0.03							2.24
1983	0.32	0.39	0.19	0.04	0.01				0.01		0.95
1984	0.17	0.33	0.09	0.05		0.01	0.01				0.66
1985	0.55	1.56	0.21	0.04	0.02						2.38
1986	1.49	0.43	0.20	0.02	0.01						2.15
1987	0.46	0.43	0.02	0.02							0.92
1988	0.59	0.79	0.07	0.03							1.47
1989	0.06	0.23	0.02	0.01							0.32
1990	0.62	0.03	0.06								0.71
1991	0.81	0.28		0.02							1.11
1992	0.75	0.41	0.01		0.01						1.19

[1] Totals may not exactly match those in Table 31 due to round-off error.

ducted by the Connecticut Department of Environmental Protection (CTDEP) shows a decline in abundance in numbers of summer flounder from recent high levels in 1986 to record lows in 1989. The CTDEP survey also shows increased abundance in 1992, with the third largest value in the 1984 to 1992 time series (Table 42).

RHODE ISLAND DFW

A standardized bottom trawl survey has been conducted during the fall months in Narragansett Bay and state waters of Rhode Island Sound by the Rhode Island Department of Fish and Wildlife (RIDFW) since 1979. Indices of abundance for ages 0 and 1 summer flounder have been developed from these data for the 1980 to 1992 year classes (stratified mean number per tow, age 0 fish separated by visual inspection, fish less than 30 cm total length; age 1 fish separated by visual inspection, fish between 30 and 40 cm total length). The 1988, 1989, and 1992 year classes are the weakest in recent years in this time series, and the index shows the 1984 to 1987 year classes to have been the strongest (Table 43).

DELAWARE DFW

The Delaware Division of Fish and Wildlife (DEDFW) has conducted a standardized bottom trawl survey (16 ft headrope trawl with 0.5 in. stretch mesh) since 1980. A recruitment index (age 0 fish) has been developed from these data for the 1980 to 1992 year classes. The index incorporates data collected from June through October (arithmetic mean number per tow), with age 0 summer flounder separated from older fish by visual inspection of the length frequency. This index shows very low recruitment in 1988, and improved recruitment since then, with the highest value of the time series recorded in 1992 (Table 44).

MARYLAND DNR

The Maryland Department of Natural Resources (MDDNR) has conducted a standardized trawl survey in the seaside bays and estuaries around Ocean City since 1972. Samples collected during May to October with a 16 ft bottom trawl have been used to develop a

Table 40. Summary of NEFSC trawl survey data for summer flounder, spring 1991 to winter 1993 surveys, Great South Channel to Cape Hatteras (offshore strata 1-12, 61-76)

Survey	Stations in Strata (#)	Stations withFluke (%)	Stratified Mean (kg/tow)	CV	Stratified Mean (#/tow)	CV	Mean Length (cm)	Length Range (cm)	Largest Tow (kg)	Largest Tow (#)
Spring 1991	96	33.3	0.35	17.1	1.08	17.0	30.4	21-63	3.5	11
Autumn 1991	95	10.5	0.13	32.6	0.39	34.0	30.2	19-45	1.7	6
Winter 1992	92	71.2	5.96	15.5	15.01	15.6	32.8	19-71	44.5	128
Spring 1992	92	38.0	0.46	17.9	1.19	17.5	32.0	21-72	5.0	9
Autumn 1992	93	14.0	0.38	42.0	0.67	32.7	35.4	25-66	10.3	10
Winter 1993	98	68.0	6.02	10.1	15.03	13.1	33.1	20-69	58.3	220

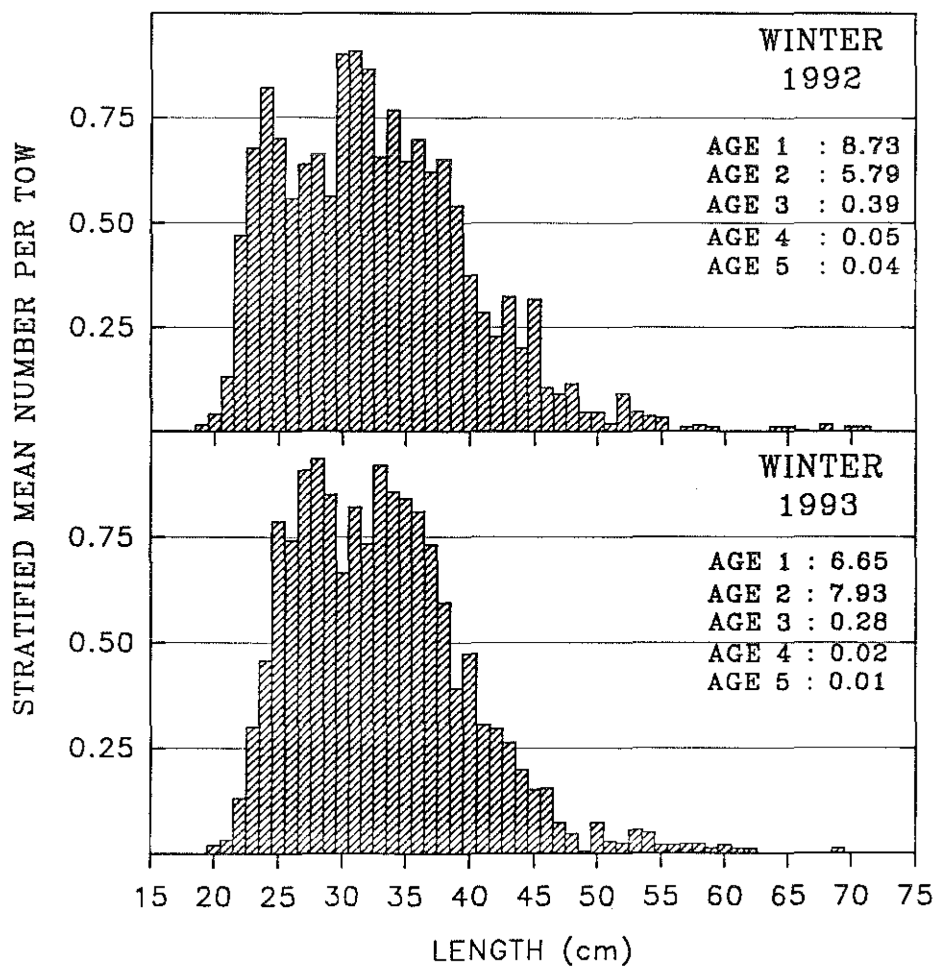

Figure 6. Summary of NEFSC winter trawl survey results for summer flounder.

Table 41. Stratified mean number per tow at age from MADMF Spring and Fall survey cruises, 1978-1992

	Age									Total
	0	1	2	3	4	5	6	7	8+	
Spring										
1978		0.097	0.520	0.274	0.221		0.042			1.15
1979			0.084	0.087	0.147	0.048	0.011			0.37
1980		0.055	0.061	0.052	0.075	0.053	0.055	0.011		0.36
1981	0.010	0.395	0.558	0.074	0.031	0.043	0.060		0.031	1.20
1982		0.376	1.424	0.118	0.084	0.020		0.010		2.03
1983		0.241	1.304	0.544	0.021	0.009	0.003			2.12
1984		0.042	0.073	0.063	0.111	0.010				0.30
1985		0.142	1.191	0.034	0.042					1.41
1986		0.966	0.528	0.140	0.008					1.64
1987		0.615	0.583	0.012			0.011			1.22
1988		0.153	0.966	0.109	0.012					1.24
1989			0.338	0.079			0.010			0.43
1990		0.247	0.021	0.079	0.012					0.36
1991		0.029	0.048	0.010						0.09
1992		0.274	0.320	0.080		0.011	0.011			0.70
Fall										
1978		0.011	0.124	0.024		0.007				0.17
1979			0.047	0.101		0.019				0.17
1980		0.114	0.326	0.020	0.020	0.010				0.49
1981	0.009	0.362	0.367	0.011						0.75
1982		0.255	1.741	0.016						2.01
1983		0.026	0.583	0.140	0.004					0.75
1984	0.033	0.453	0.249	0.120	0.008					0.86
1985	0.051	0.108	1.662	0.033						1.85
1986	0.128	2.149	0.488	0.128						2.89
1987		1.159	0.598	0.010	0.004					1.77
1988		0.441	0.414	0.018						0.87
1989			0.286	0.024						0.31
1990		0.108		0.012						0.12
1991	0.021	0.493	0.262	0.010						0.79
1992		1.055	0.233							1.29

Table 42. Summer flounder index of abundance from the CTDEP spring to fall (April to September) trawl survey, 1984-1992[1]

Year	Age								Total
	1	2	3	4	5	6	7	8	
1984	0.609	0.201	0.042	0.027	0.014	0.005			0.98
1985	0.496	0.344	0.061	0.024	0.016	0.012			0.95
1986	1.775	0.278	0.107	0.020			0.004	0.004	2.19
1987	1.347	0.205	0.031	0.021	0.003	0.007			1.61
1988	0.680	0.382	0.064	0.034	0.006				1.17
1989	0.021	0.082	0.023	0.009	0.003	0.003			0.15
1990	0.524	0.205	0.037	0.013	0.007				0.78
1991	0.780	0.324	0.118	0.009	0.003	0.006			1.23
1992	0.821	0.411	0.127	0.028	0.006	0.004	0.004		1.40

[1] Delta mean number per tow at age.

Table 43. Summer flounder index of abundance, RIDFW fall trawl survey

Year	Mean #/tow	Mean kg/tow	Proportion[1] Age 0	Mean Age 0 #/tow	Proportion[2] Age 1	Mean Age 1 #/tow
1979	0.24	0.13	0.00	0.00	0.67	0.16
1980	0.81	1.37	0.10	0.08	0.31	0.25
1981	3.24	2.13	0.05	0.16	0.65	2.13
1982	0.83	0.68	0.00	0.00	0.43	0.36
1983	0.62	0.57	0.03	0.02	0.40	0.25
1984	1.35	0.95	0.12	0.16	0.63	0.85
1985	0.95	0.52	0.35	0.33	0.35	0.33
1986	3.49	2.05	0.18	0.63	0.63	2.20
1987	1.41	0.90	0.31	0.44	0.51	0.72
1988	0.57	0.42	0.03	0.02	0.71	0.40
1989	0.07	0.10	0.00	0.00	0.60	0.04
1990	0.83	0.54	0.07	0.06	0.57	0.47
1991	0.23	0.23	0.19	0.04	0.31	0.07
1992	1.26	1.11	0.00	0.00	0.56	0.71

[1] Proportion of catch < 30 cm
[2] Proportion of 30 cm ≤ catch < 40 cm

Table 44. Summer flounder index of recruitment, DEDFW Delaware Bay trawl survey

Year	Mean Number Per Tow
1980	0.18
1981	0.06
1982	0.19
1983	0.04
1984	0.07
1985	0.11
1986	0.14
1987	0.18
1988	0.01
1989	0.21
1990	0.41
1991	0.14
1992	0.66

recruitment index for summer flounder for the period 1972 to 1991.

This index suggests that weakest year class in the time series recruited to the stock in 1988, and the strongest in 1986 (Table 45).

VIRGINIA INSTITUTE OF MARINE SCIENCE

The Virginia Institute of Marine Science (VIMS) has conducted a juvenile fish survey using trawl gear in Virginia rivers since 1979. An index of recruitment developed from these data suggests weak year classes recruited to the stock during 1987 to 1989, with strong year classes recruiting during 1980 to 1983. The 1992 index suggests another weak year class (Table 46).

Table 45. Summer flounder index of abundance, MDDNR trawl survey

Year	Geometric Mean (#/tow)	Standard Deviation	Proportion Age 0	Geometric Mean Age 0 (#/tow)
1972	21.82	1.25	0.54	11.68
1973	7.27	2.02	0.59	4.29
1974	10.33	1.50	0.69	6.31
1975	3.91	1.36	0.39	1.53
1976	3.68	1.51	0.71	2.62
1977	3.50	1.08	0.55	1.93
1978	4.01	1.30	0.70	2.81
1979	4.90	1.56	0.86	4.20
1980	6.80	1.42	0.69	4.71
1981	5.46	1.31	0.84	4.56
1982	1.79	1.68	0.90	1.61
1983	16.35	2.40	0.76	12.46
1984	19.83	2.10	0.89	17.72
1985	8.20	1.80	0.89	7.31
1986	27.98	2.84	0.94	26.24
1987	12.76	2.68	0.84	10.72
1988	0.51	0.70	0.89	0.46
1989	2.05	1.55	0.93	1.90
1990	4.28	1.88	0.90	3.87
1991	6.40	1.90	0.93	5.96

Table 46. Summer flounder index of recruitment, VIMS juvenile fish trawl survey

Year	Number of Hauls	Lower 95% Confidence Limit	Geometric Mean Mean Catch per Trawl	Upper 95% Confidence Limit
1979	80	0.66	0.83	3.02
1980	62	3.79	4.89	8.24
1981	59	3.20	4.16	7.33
1982	81	1.94	2.47	5.08
1983	106	1.62	1.96	4.35
1984	98	0.68	0.84	3.02
1985	53	0.55	0.72	2.91
1986	85	0.63	0.81	3.01
1987	67	0.40	0.52	2.66
1988	85	0.25	0.35	2.44
1989	85	0.39	0.50	2.62
1990	85	0.88	1.12	3.40
1991	85	0.98	1.24	3.53
1992	85	0.34	0.44	2.54

NORTH CAROLINA DMF

The NCDMF has conducted a trawl survey in Pamlico Sound since 1987. A index of recruitment developed from these data suggest a weak year class in 1988, and strongest year classes in 1987 and 1992.

SUMMARY OF RECRUITMENT TRENDS IN RESEARCH SURVEYS

Indices of abundance for summer flounder from research surveys were used to qualitatively detect recent trends in recruitment. Most surveys agreed that the 1980, 1983, 1985, and 1986 year classes were the largest of the past decade, with the 1988 year class the poorest since 1980. Most surveys reflect a trend of improved recruitment since 1988 (Table 47).

Five indices (MADMF, RIDFW, DEDFW, VIMS, and NCDMF) are available to estimate the strength of the 1992 year class. The MADMF beach seine survey caught no age 0 summer flounder in 1992. A value of 1 was added to each value of the series when used in the VPA tuning so that the information content of the 1992 data point could be included in the estimation of the size of the 1992 year class (observations were the value equals 0 are treated as missing in the VPA tuning procedure, because the natural logarithm of 0 is undefined). The RIDFW recruitment index from the trawl survey had several observations with a value of 0 (1979, 1982, 1989, and 1992), and so as with the MADMF time series a value of 1 was added to each observation in the VPA tuning (Table 47).

The DEDFW survey indicates that recruitment in 1992 was the best since that time series began in 1980. The NCDMF survey suggests recruitment was stronger in 1992 than in 1991, and was the best since 1987. The VIMS index suggests that recruitment is 1992 was relatively poor, at less than 50% of the 1991 level, with 1991 the best year class since 1983 (Table 47).

ESTIMATES OF MORTALITY AND STOCK SIZE

NATURAL MORTALITY RATE

Instantaneous natural mortality rate (M) was assumed to be 0.2 (Henderson 1979) in all analyses, although alternative estimates of M have been considered by the WG in previous assessments (SAW Summer Flounder Working Group 1991). Estimates were derived with the methods described by 1) Pauly (1980) using growth parameters derived from NCDMF age-length data and a mean annual bottom temperature (17.5°C) from NC coastal waters, and 2) Hoenig (1983) using a maximum age for summer flounder of 15 years. These methods provided alternative values for M of 0.27 and 0.28, respectively (Monaghan, personal communication 1992).

Table 47. Summary of recruitment indices from state, federal and university research surveys, North Carolina to Massachusetts

Survey	Year Class												
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
NEFSC[1] (age 1)	0.59	0.69	0.32	0.17	0.55	1.49	0.46	0.59	0.06	0.62	0.81	0.75	
NEFSC[1] (age 2)	1.41	0.39	0.33	1.56	0.43	0.43	0.79	0.23	0.03	0.28	0.41		
MA[2] (age 1)	0.40	0.38	0.24	0.04	0.14	0.97	0.62	0.15	0.00	0.25	0.03	0.27	
MA[2] (age 2)	1.42	1.30	0.07	1.19	0.53	0.58	0.97	0.34	0.02	0.05	0.32		
CT[3] (age 1)					0.50	1.78	1.35	0.68	0.02	0.52	0.78	0.82	
RI[4] (age 1)	2.13	0.36	0.25	0.85	0.33	2.20	0.72	0.40	0.04	0.47	0.07	0.71	
RI[5] (age 0)	0.08	0.16	0.00	0.02	0.16	0.33	0.63	0.44	0.02	0.00	0.06	0.04	0.00
MA[6] (age 0)			3.00	3.00	1.00	19.00	5.00	5.00	2.00	3.00	11.00	4.00	0.00
DE[7] (age 0)	0.18	0.06	0.19	0.04	0.07	0.11	0.14	0.18	0.01	0.21	0.41	0.14	0.66
MD[8] (Age 0)	4.71	4.56	1.61	12.46	17.72	7.31	26.24	10.72	0.46	1.90	3.87	5.96	
VIMS[9] (age 0)	4.89	4.16	2.47	1.96	0.84	0.72	0.81	0.52	0.35	0.50	1.12	1.24	0.44
NC[10] (age 0)								13.25	1.70	4.77	4.56	5.92	10.97

[1] Number per tow (fitted delta stratified mean number per tow), NEFSC spring offshore trawl survey
[2] Number per tow (stratified mean number per tow), MADMF spring trawl survey
[3] Number per tow (delta mean number per tow), CTDEP trawl survey
[4] Number per tow (stratified mean number per tow), RIDFW fall trawl survey
[5] Number per tow (stratified mean number per tow), RIDFW fall trawl survey - value of 1 was added to each observation in VPA tuning
[6] Total number, MADMF beach seine survey (fixed stations) - value of 1 was added to each observation in VPA tuning
[7] Number per tow, DEDFW 16 foot headrope trawl survey
[8] Geometric mean number per tow, MDDNR Seaside trawl survey
[9] Geometric mean number per tow, VIMS young fish survey (fixed stations)
[10] Number per tow (stratified mean number per tow), NCDMF Pamlico Sound trawl survey

VIRTUAL POPULATION ANALYSIS AND TUNING

Terminal F values in 1992 were estimated using the ADAPT method for calibration of the VPA (Parrack 1986, Gavaris 1988, Conser and Powers 1990). Because an average of less than 1% of the catch was older than age 4, ages 0 to 4 were included in the analysis as true ages, with ages 5 and older combined as a plus group. The selection at age pattern used in the terminal year was 0.05 for age 0, 0.50 for age 1, and 1.00 for age 2 and older in the VPA (NEFSC 1992).

Indices initially included in tuning were:

1) MADMF beach seine survey (age 0),
2) DEDFW 16 foot headrope trawl survey (age 0)
3) MDDNR Seaside trawl survey (age 0),
4) VIMS juvenile fish trawl survey (age 0)
5) NCDMF Pamlico Sound trawlsurvey (age 0)
6) RIDFW fall trawl survey (ages 0to 1)
7) NEFSC spring offshore survey(ages 1 to 4)
8) NEFSC winter offshore survey (ages 1 to 4)
9) MADMF spring survey (ages 1 to 4)
10) MADMF fall survey (ages 1 to 3)
11) CTDEP trawl survey (ages 1 to 4)
12) standardized LPUE index for NER commercial fishery (weighout) (ages 0 to 3)
13) commercial LPUE index for the North Carolina winter trawl fishery (ages 0 to 3)
14) standardized CPUE index from MRFSS data, collected coastwide, from the recreational fishery (ages 0 to 3), and
15) NYDEC party boat survey in Great South Bay, NY (ages 0 to 3).

Winter and spring survey indices and all survey recruitment indices were compared to population numbers of the same age at the beginning of the same year. Fall survey indices were compared to population numbers one year older at the beginning of the next year. Indices derived from fishery data were compared with population numbers of the same age at mid-year of the same year.

Stock sizes in 1993 were directly estimated for ages 1 to 3, while ages 4 and 5+ were calculated from F's estimated in 1992 and the input partial recruitment pattern. Stock size at age 0 in 1993 was not estimated because no recruitment indices were yet available. Indices were weighted by the inverse of their variance. Fishing mortality at the oldest age (4) in the years prior to the terminal year was estimated from back-calculated stock sizes for ages 2 to 4. F on the age 5+ group was assumed equal to the F for age 4.

The WG performed several preliminary VPA runs to examine how individual abundance indices can influence results. The NEFSC spring trawl survey indices for ages 1 to 4 were used in 3 different runs with the DEDFW, VIMS, and NCDMF recruitment indices, respectively, with special focus on how VPA estimated the size of the 1992 year class. Next, all four data sources were included in unweighted and weighted runs, to help the WG better understand how the weighting of indices influences VPA results (SAW Summer Flounder Working Group 1992).

An unweighted ADAPT run incorporating all fishery and research survey tuning indices was performed ("all indices" run) and compared with an unweighted run using only research survey indices ("survey indices" run). Results were comparable, with the "all indices" run providing slightly more precise estimates of 1993 stock sizes (coefficients of variation of 33% for age 1, 37% for age 2, 61% for age 3) than the "survey indices" run (coefficients of variation ranging from 39 to 80%). Fully recruited F in 1992 (age 2 to 4,u) was 1.9 in the "all indices" run, and 1.4 in the "survey indices" run. Absolute values of the correlations among estimated parameters in both runs were generally small ($r<0.26$). Examination of standardized residuals for the "all indices" run revealed trends in residuals for some of the indices of abundance derived from fishery data (*e.g.*, NER LPUE at ages 0 and 1, North Carolina LPUE at ages 0, 1, and 3, and MRFSS CPUE at age 1). The WG felt these trends indicated significant changes in the catchability coefficient for these indices over the time series, possibly reflecting 1) changing catchability in the fisheries due to declining stock size and/or 2) varying discard levels that may be only partially accounted for in the catch at age matrix and in the fishery indices. The indices that demonstrated trends in residuals are also among the best fitting, and so tended to have high weight in the estimation process. The WG felt these trends might cause biased estimation of fishing mortality rates in the "all indices" VPA. The WG also noted that because proportions at age from the individual fisheries are used to disaggregate the fishery indices to age, they are not independent of the catch at age matrix.

Given the trends in residuals of some indices based on fishery data, and their lack of independence from the catch at age matrix, the WG adopted the "survey indices" run for further adopted the "survey indices" run for further evaluation. Next, the NEFSC winter trawl indices were dropped because only two years of data were available, and the WG felt the resulting small residuals for this index might unduly influence the results (F in 1992 was estimated at 1.7 in the "survey indices" run including the winter indices, and at 1.1 with the winter indices excluded; precision of the estimates of numbers at age in 1993 was very similar).

A "survey indices" run incorporating one iterative re-weight was adopted as the final VPA. Estimates of stock size in 1993 from the "survey indices" run were comparable in precision to those from the "all indices" run (ranging from 26 to 69%; coefficients of variation for survey catchability coefficients ranged from 13 to 47%). Absolute values of the correlations among estimated parameters were all less than 0.26. Examination of standardized residuals for this run revealed no trends. This final VPA, including input data and assumptions, solution statistics, residuals, and estimates of F at age, stock number, and biomass at age is presented in Table 48.

Table 48. Summer flounder VPA tuned with survey indices only, one iterative reweight

```
Output option selected for input parameters:  full
Output option selected for results:  full


INPUT PARAMETERS AND OPTIONS SELECTED
-------------------------------------

Natural mortality is 0.2

Oldest age (not in the plus group) is 4

For all yrs prior to the terminal year (1992), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 4:     2 3 4
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 5+ is then calculated from the following
ratios of F[age 5+] to F[age 4]

      1982    1.0000
      1983    1.0000
      1984    1.0000
      1985    1.0000
      1986    1.0000
      1987    1.0000
      1988    1.0000
      1989    1.0000
      1990    1.0000
      1991    1.0000
      1992    1.0000

Stock size of the 5+ group is then calculated
using the following method:  CATCHEQ

Partial recruitment estimate for 1992
         0    0.0500
         1    0.5000
         2    1.0000
         3    1.0000
         4    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

The residuals for years prior to the terminal year are downweighted
using the following algorithm:  NONE

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).
```

Table 48. Continued.

Initial estimates of parameters for the Marquardt algorithm
and lower and upper bounds on the parameter estimates:

Par.	Initial Est	Lower Bnd	Upper Bnd
N 1	1.0000000E5	0.0000000E0	1.0000000E6
N 2	5.0000000E4	0.0000000E0	1.0000000E6
N 3	2.5000000E4	0.0000000E0	1.0000000E6
qMA FAL 1	1.0000000E-4	0.0000000E0	1.0000000E0
qMA FAL 2	1.0000000E-4	0.0000000E0	1.0000000E0
qMA FAL 3	1.0000000E-4	0.0000000E0	1.0000000E0
qMA SPR 1	1.0000000E-4	0.0000000E0	1.0000000E0
qMA SPR 2	1.0000000E-4	0.0000000E0	1.0000000E0
qMA SPR 3	1.0000000E-4	0.0000000E0	1.0000000E0
qSV SPR 1	1.0000000E-4	0.0000000E0	1.0000000E0
qSV SPR 2	1.0000000E-4	0.0000000E0	1.0000000E0
qSV SPR 3	1.0000000E-4	0.0000000E0	1.0000000E0
qSV SPR 4	1.0000000E-4	0.0000000E0	1.0000000E0
qCT 1	1.0000000E-4	0.0000000E0	1.0000000E0
qCT 2	1.0000000E-4	0.0000000E0	1.0000000E0
qCT 3	1.0000000E-4	0.0000000E0	1.0000000E0
qCT 4	1.0000000E-4	0.0000000E0	1.0000000E0
qMASS YOY	1.0000000E-4	0.0000000E0	1.0000000E0
qVA YOY	1.0000000E-4	0.0000000E0	1.0000000E0
qRI AGE 1	1.0000000E-4	0.0000000E0	1.0000000E0
qRI AGE 0	1.0000000E-4	0.0000000E0	1.0000000E0
qNC YOY	1.0000000E-4	0.0000000E0	1.0000000E0
qMD YOY	1.0000000E-3	0.0000000E0	1.0000000E0
qDE YOY	1.0000000E-4	0.0000000E0	1.0000000E0

The following indices of abundance are available:

1	MA FAL 1
2	MA FAL 2
3	MA FAL 3
4	MA SPR 1
5	MA SPR 2
6	MA SPR 3
7	SV SPR 1
8	SV SPR 2
9	SV SPR 3
10	SV SPR 4
11	CT 1
12	CT 2
13	CT 3
14	CT 4
27	MASS YOY
28	VA YOY
29	RI AGE 1
30	RI AGE 0
31	NC YOY
32	MD YOY
33	DE YOY

Indices that will be used in this run are: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 2
7 28 29 30 31 32 33

Table 48. Continued.

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

	1982	1983	1984	1985	1986	1987	1988	1989
1	-999.000	0.255	0.026	0.453	0.108	2.149	1.159	0.441
2	-999.000	1.741	0.583	0.249	1.662	0.488	0.598	0.414
3	-999.000	0.016	0.140	0.120	0.033	0.128	0.010	0.018
4	0.376	0.241	0.042	0.142	0.966	0.615	0.153	0.000
5	1.424	1.304	0.073	1.191	0.528	0.583	0.966	0.338
6	0.118	0.544	0.063	0.034	0.140	0.012	0.109	0.079
7	0.690	0.320	0.170	0.550	1.490	0.460	0.590	0.060
8	1.410	0.390	0.330	1.560	0.430	0.430	0.790	0.230
9	0.120	0.190	0.090	0.210	0.200	0.020	0.070	0.020
10	0.030	0.040	0.050	0.040	0.020	0.020	0.030	0.010
11	-999.000	-999.000	0.609	0.496	1.775	1.347	0.680	0.021
12	-999.000	-999.000	0.201	0.344	0.278	0.205	0.382	0.082
13	-999.000	-999.000	0.043	0.061	0.107	0.031	0.064	0.023
14	-999.000	-999.000	0.027	0.024	0.020	0.021	0.034	0.009
27	4.000	4.000	2.000	20.000	6.000	6.000	3.000	3.000
28	2.470	1.960	0.840	0.720	0.810	0.520	0.350	0.500
29	2.130	0.360	0.250	0.850	0.330	2.200	0.720	0.400
30	1.000	1.020	1.160	1.330	1.630	1.440	1.020	1.000
31	-999.000	-999.000	-999.000	-999.000	-999.000	13.250	1.700	4.770
32	1.610	12.460	17.720	7.310	26.240	10.720	0.460	1.900
33	0.190	0.040	0.070	-999.000	0.140	0.180	0.010	0.210

	1990	1991	1992	1993	*******
1	0.000	0.108	0.493	-999.000	0.577
2	0.286	0.000	0.262	-999.000	0.698
3	0.024	0.012	0.010	-999.000	0.051
4	0.247	0.029	0.274	-999.000	0.308
5	0.021	0.048	0.320	-999.000	0.618
6	0.079	0.010	0.080	-999.000	0.115
7	0.620	0.810	0.750	-999.000	0.592
8	0.030	0.250	0.410	-999.000	0.569
9	0.060	0.000	0.010	-999.000	0.099
10	0.000	0.020	0.000	-999.000	0.029
11	0.524	0.780	0.821	-999.000	0.784
12	0.205	0.324	0.127	-999.000	0.239
13	0.037	0.118	0.028	-999.000	0.057
14	0.013	0.090	0.060	-999.000	0.033
27	12.000	5.000	1.000	-999.000	6.000
28	1.120	1.240	0.440	-999.000	0.997
29	0.040	0.470	0.070	-999.000	0.711
30	1.060	1.040	1.000	-999.000	1.155
31	4.560	5.920	10.970	-999.000	6.862
32	3.870	5.960	9.280	-999.000	8.866
33	0.410	0.140	0.660	-999.000	0.205

Table 48. Continued.

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
2	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
3	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
11	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
29	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
31	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
33	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00

	1992	1993
1	1.00	-99.00
2	1.00	-99.00
3	1.00	-99.00
4	1.00	-99.00
5	1.00	-99.00
6	1.00	-99.00
7	1.00	-99.00
8	1.00	-99.00
9	1.00	-99.00
10	-99.00	-99.00
11	1.00	-99.00
12	1.00	-99.00
13	1.00	-99.00
14	1.00	-99.00
27	1.00	-99.00
28	1.00	-99.00
29	1.00	-99.00
30	1.00	-99.00
31	1.00	-99.00
32	1.00	-99.00
33	1.00	-99.00

Negative weights in the above table indicate missing values

Table 48. Continued.

DOWNWEIGHTS BY YEAR (delta)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1992	1993
1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

1	2	3	4	5	6	7	8	9	10
0.0124	0.0595	0.0450	0.0189	0.0187	0.0191	0.0362	0.0602	0.0207	0.0561

11	12	13	14	27	28	29	30	31	32
0.0287	0.0743	0.0373	0.0191	0.0273	0.1565	0.0262	0.1045	0.1344	0.0266

33
0.0185

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989
1	-99.0000	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
2	-99.0000	0.0595	0.0595	0.0595	0.0595	0.0595	0.0595	0.0595
3	-99.0000	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450
4	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	-99.0000
5	0.0187	0.0187	0.0187	0.0187	0.0187	0.0187	0.0187	0.0187
6	0.0191	0.0191	0.0191	0.0191	0.0191	0.0191	0.0191	0.0191
7	0.0362	0.0362	0.0362	0.0362	0.0362	0.0362	0.0362	0.0362
8	0.0602	0.0602	0.0602	0.0602	0.0602	0.0602	0.0602	0.0602
9	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207
10	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561
11	-99.0000	-99.0000	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287
12	-99.0000	-99.0000	0.0743	0.0743	0.0743	0.0743	0.0743	0.0743
13	-99.0000	-99.0000	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373
14	-99.0000	-99.0000	0.0191	0.0191	0.0191	0.0191	0.0191	0.0191
27	0.0273	0.0273	0.0273	0.0273	0.0273	0.0273	0.0273	0.0273
28	0.1565	0.1565	0.1565	0.1565	0.1565	0.1565	0.1565	0.1565
29	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262	0.0262
30	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045
31	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	0.1344	0.1344	0.1344
32	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266
33	0.0185	0.0185	0.0185	-99.0000	0.0185	0.0185	0.0185	0.0185

	1990	1991	1992	1993
1	-99.0000	0.0124	0.0124	-99.0000
2	0.0595	-99.0000	0.0595	-99.0000
3	0.0450	0.0450	0.0450	-99.0000
4	0.0189	0.0189	0.0189	-99.0000
5	0.0187	0.0187	0.0187	-99.0000
6	0.0191	0.0191	0.0191	-99.0000
7	0.0362	0.0362	0.0362	-99.0000
8	0.0602	0.0602	0.0602	-99.0000
9	0.0207	-99.0000	0.0207	-99.0000
10	-99.0000	0.0561	-99.0000	-99.0000
11	0.0287	0.0287	0.0287	-99.0000
12	0.0743	0.0743	0.0743	-99.0000
13	0.0373	0.0373	0.0373	-99.0000
14	0.0191	0.0191	0.0191	-99.0000
27	0.0273	0.0273	0.0273	-99.0000
28	0.1565	0.1565	0.1565	-99.0000
29	0.0262	0.0262	0.0262	-99.0000
30	0.1045	0.1045	0.1045	-99.0000
31	0.1344	0.1344	0.1344	-99.0000
32	0.0266	0.0266	0.0266	-99.0000
33	0.0185	0.0185	0.0185	-99.0000

Negative weights in the above table indicate missing values

Table 48. Continued.

CATCH AT AGE (thousands) - SAW16

	1982	1983	1984	1985	1986	1987
0	5225.000	11989.000	12056.000	2427.000	4411.000	2393.000
1	19070.000	33271.000	31614.000	16933.000	16170.000	19038.000
2	12329.000	8790.000	14242.000	17510.000	10665.000	10426.000
3	814.000	1072.000	3401.000	2805.000	4166.000	1651.000
4	280.000	167.000	1075.000	1663.000	295.000	609.000
5+	214.000	146.000	367.000	456.000	752.000	134.000
0+	37932.000	55435.000	62755.000	41794.000	36459.000	34251.000

	1988	1989	1990	1991	1992
0	3409.000	1217.000	2052.000	1791.000	1457.000
1	21221.000	5263.000	10723.000	13524.000	13463.000
2	14404.000	7131.000	2241.000	7340.000	6491.000
3	2444.000	1984.000	995.000	759.000	1565.000
4	843.000	356.000	202.000	214.000	167.000
5+	253.000	83.000	47.000	45.000	81.000
0+	42574.000	16034.000	16260.000	23673.000	23224.000

CAA summary for ages 2-5+

1982	1983	1984	1985	1986	1987
13637.000	10175.000	19085.000	22434.000	15878.000	12820.000

1988	1989	1990	1991	1992
17944.000	9554.000	3485.000	8358.000	8304.000

Table 48. Continued.

WT AT AGE (MID-YR) in kg. - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.254	0.218	0.228	0.282	0.256	0.239	0.287	0.207	0.244	0.184	0.208
1	0.435	0.447	0.399	0.426	0.454	0.446	0.468	0.452	0.432	0.402	0.458
2	0.654	0.786	0.640	0.612	0.659	0.648	0.628	0.711	0.800	0.700	0.756
3	1.687	1.297	1.055	1.092	1.173	1.117	1.109	1.041	1.176	1.167	1.380
4	2.135	1.466	1.592	1.782	1.790	1.934	1.787	1.504	1.561	1.892	1.955
5+	2.888	2.112	2.324	2.425	2.692	3.104	2.803	2.473	2.727	2.762	3.025

WT AT AGE (JAN 1) in kg. - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.191	0.161	0.167	0.222	0.194	0.171	0.229	0.143	0.190	0.117	0.149	0.173
1	0.324	0.337	0.295	0.312	0.358	0.338	0.334	0.360	0.299	0.313	0.290	0.290
2	0.464	0.585	0.535	0.494	0.530	0.542	0.529	0.577	0.601	0.550	0.551	0.723
3	1.810	0.921	0.911	0.836	0.847	0.858	0.848	0.809	0.914	0.966	0.983	1.037
4	1.898	1.573	1.437	1.371	1.398	1.506	1.413	1.291	1.275	1.492	1.510	1.938
5+	2.888	2.112	2.324	2.425	2.692	3.104	2.803	2.473	2.727	2.762	3.025	3.025

Weights at age at the start of the spawning season are assumed to be the same as the mid-year weight at age estimates.

PERCENT MATURE (females) - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	38	38	38	38	38	38	38	38	38	38	38
1	72	72	72	72	72	72	72	72	72	72	72
2	90	90	90	90	90	90	90	90	90	90	90
3	100	100	100	100	100	100	100	100	100	100	100
4	100	100	100	100	100	100	100	100	100	100	100
5+	100	100	100	100	100	100	100	100	100	100	100

SEX RATIO (Percent Female) - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	50	50	50	50	50	50	50	50	50	50	50
1	50	50	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	50	50	50
3	50	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50	50
5+	50	50	50	50	50	50	50	50	50	50	50

Table 48. Continued.

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES	4.514738
ORTHOGONALITY OFFSET.........	0.000635
MEAN SQUARE RESIDUALS	0.024537

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 1	3.28868E4	8.44856E3	3.89260E0	0.26
N 2	2.20004E4	8.00997E3	2.74663E0	0.36
N 3	3.04197E3	2.09730E3	1.45043E0	0.69
qMA FAL 1	3.33459E-5	1.57575E-5	2.11620E0	0.47
qMA FAL 2	2.34228E-4	5.08403E-5	4.60714E0	0.22
qMA FAL 3	9.53526E-4	2.26138E-4	4.21657E0	0.24
qMA SPR 1	1.59383E-5	5.79228E-6	2.75164E0	0.36
qMA SPR 2	3.86881E-5	1.34966E-5	2.86652E0	0.35
qMA SPR 3	2.10987E-4	7.26555E-5	2.90394E0	0.34
qSV SPR 1	2.16454E-5	5.43350E-6	3.98368E0	0.25
qSV SPR 2	4.91118E-5	9.61995E-6	5.10521E0	0.20
qSV SPR 3	2.19941E-4	7.63023E-5	2.88250E0	0.35
qSV SPR 4	1.32439E-3	2.93673E-4	4.50976E0	0.22
qCT 1	2.05743E-5	6.41321E-6	3.20811E0	0.31
qCT 2	6.91063E-5	1.35442E-5	5.10229E0	0.20
qCT 3	2.90303E-4	7.95298E-5	3.65024E0	0.27
qCT 4	1.20848E-3	4.61198E-4	2.62030E0	0.38
qMASS YOY	1.55743E-5	4.51042E-6	3.45297E0	0.29
qVA YOY	1.76512E-5	2.21368E-6	7.97371E0	0.13
qRI AGE 1	4.08718E-5	1.20413E-5	3.39429E0	0.29
qRI AGE 0	2.08631E-5	3.15703E-6	6.60846E0	0.15
qNC YOY	2.30430E-5	4.32289E-6	5.33046E0	0.19
qMD YOY	1.31055E-5	3.84671E-6	3.40694E0	0.29
qDE YOY	1.30915E-5	4.81822E-6	2.71708E0	0.37

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qMA FAL 1	1.92369E-5	9.09032E-6	0.47
qMA FAL 2	1.63517E-4	3.54922E-5	0.22
qMA FAL 3	4.87252E-5	1.15556E-5	0.24
qMA SPR 1	4.91696E-6	1.78692E-6	0.36
qMA SPR 2	2.39022E-5	8.33842E-6	0.35
qMA SPR 3	2.43211E-5	8.37520E-6	0.34
qSV SPR 1	1.28101E-5	3.21565E-6	0.25
qSV SPR 2	2.79491E-5	5.47463E-6	0.20
qSV SPR 3	2.17742E-5	7.55393E-6	0.35
qSV SPR 4	3.82603E-5	8.48387E-6	0.22
qCT 1	1.61234E-5	5.02582E-6	0.31
qCT 2	1.64934E-5	3.23254E-6	0.20
qCT 3	1.65150E-5	4.52436E-6	0.27
qCT 4	4.00140E-5	1.52708E-5	0.38
qMASS YOY	9.34461E-5	2.70625E-5	0.29
qVA YOY	1.76031E-5	2.20764E-6	0.13
qRI AGE 1	2.90561E-5	8.56030E-6	0.29
qRI AGE 0	2.40874E-5	3.64494E-6	0.15
qNC YOY	1.58113E-4	2.96622E-5	0.19
qMD YOY	1.16198E-4	3.41063E-5	0.29
qDE YOY	2.68376E-6	9.87735E-7	0.37

Table 48. Continued.

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CORRELATION BETWEEN PARAMETERS ESTIMATED

 1.00  0.12  0.09 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.02 -0.01 -0.01 -0.00 -
    0.02 -0.02 -0.01 -0.01 -0.09 -0.21 -0.01 -0.17 -0.26 -0.09 -0.08
 0.12  1.00  0.09 -0.01 -0.01 -0.01 -0.07 -0.01 -0.01 -0.09 -0.01 -0.01 -0.00 -
    0.09 -0.02 -0.01 -0.01 -0.08 -0.20 -0.01 -0.16 -0.24 -0.08 -0.07
 0.09  0.09  1.00 -0.07 -0.13 -0.14 -0.05 -0.09 -0.09 -0.07 -0.15 -0.07 -0.04 -
    0.06 -0.19 -0.13 -0.10 -0.06 -0.14 -0.10 -0.12 -0.17 -0.06 -0.05
-0.01 -0.01 -0.07  1.00  0.01  0.01  0.00  0.01  0.01  0.00  0.01  0.01  0.00
    0.00  0.01  0.01  0.01  0.00  0.01  0.01  0.01  0.01  0.00  0.00
-0.01 -0.01 -0.13  0.01  1.00  0.02  0.01  0.01  0.01  0.01  0.02  0.01  0.00
    0.01  0.03  0.02  0.01  0.01  0.02  0.01  0.02  0.02  0.01  0.01
-0.01 -0.01 -0.14  0.01  0.02  1.00  0.01  0.01  0.01  0.01  0.02  0.01  0.01
    0.01  0.03  0.02  0.01  0.01  0.02  0.01  0.02  0.02  0.01  0.01
-0.01 -0.07 -0.05  0.00  0.01  0.01  1.00  0.00  0.00  0.01  0.01  0.00  0.00
    0.01  0.01  0.01  0.00  0.01  0.02  0.00  0.02  0.02  0.01  0.01
-0.01 -0.01 -0.09  0.01  0.01  0.01  0.00  1.00  0.01  0.01  0.01  0.01  0.00
    0.01  0.02  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.00
-0.01 -0.01 -0.09  0.01  0.01  0.01  0.00  0.01  1.00  0.01  0.01  0.01  0.00
    0.01  0.02  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.00
-0.02 -0.09 -0.07  0.00  0.01  0.01  0.01  0.01  0.01  1.00  0.01  0.00  0.00
    0.01  0.01  0.01  0.01  0.01  0.02  0.01  0.02  0.03  0.01  0.01
-0.01 -0.01 -0.15  0.01  0.02  0.02  0.01  0.01  0.01  0.01  1.00  0.01  0.01
    0.01  0.03  0.02  0.02  0.01  0.02  0.02  0.02  0.03  0.01  0.01
-0.01 -0.01 -0.07  0.01  0.01  0.01  0.00  0.01  0.01  0.00  0.01  1.00  0.00
    0.00  0.01  0.01  0.01  0.00  0.01  0.01  0.01  0.01  0.00  0.00
-0.00 -0.00 -0.04  0.00  0.00  0.01  0.00  0.00  0.00  0.00  0.01  0.00  1.00
    0.00  0.01  0.00  0.00  0.00  0.01  0.00  0.00  0.01  0.00  0.00
-0.02 -0.09 -0.06  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00
    1.00  0.01  0.01  0.01  0.01  0.02  0.01  0.02  0.03  0.01  0.01
-0.02 -0.02 -0.19  0.01  0.03  0.03  0.01  0.02  0.02  0.01  0.03  0.01  0.01
    0.01  1.00  0.03  0.02  0.01  0.03  0.02  0.02  0.03  0.01  0.01
-0.01 -0.01 -0.13  0.01  0.02  0.02  0.01  0.01  0.01  0.01  0.02  0.01  0.00
    0.01  0.03  1.00  0.01  0.01  0.02  0.01  0.02  0.02  0.01  0.01
-0.01 -0.01 -0.10  0.01  0.01  0.01  0.00  0.01  0.01  0.01  0.02  0.01  0.00
    0.01  0.02  0.01  1.00  0.01  0.01  0.01  0.01  0.02  0.01  0.01
-0.09 -0.08 -0.06  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00
    0.01  0.01  0.01  0.01  1.00  0.04  0.01  0.03  0.04  0.02  0.01
-0.21 -0.20 -0.14  0.01  0.02  0.02  0.02  0.01  0.01  0.02  0.02  0.01  0.01
    0.02  0.03  0.02  0.01  0.04  1.00  0.01  0.07  0.10  0.04  0.03
-0.01 -0.01 -0.10  0.01  0.01  0.01  0.00  0.01  0.01  0.01  0.02  0.01  0.00
    0.01  0.02  0.01  0.01  0.01  0.01  1.00  0.01  0.02  0.01  0.01
-0.17 -0.16 -0.12  0.01  0.02  0.02  0.02  0.01  0.01  0.02  0.02  0.01  0.00
    0.02  0.02  0.02  0.01  0.03  0.07  0.01  1.00  0.09  0.03  0.03
-0.26 -0.24 -0.17  0.01  0.02  0.02  0.02  0.01  0.01  0.03  0.03  0.01  0.01
    0.03  0.03  0.02  0.02  0.04  0.10  0.02  0.09  1.00  0.04  0.04
-0.09 -0.08 -0.06  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00
    0.01  0.01  0.01  0.01  0.02  0.04  0.01  0.03  0.04  1.00  0.01
-0.08 -0.07 -0.05  0.00  0.01  0.01  0.01  0.00  0.00  0.01  0.01  0.00  0.00
    0.01  0.01  0.01  0.01  0.01  0.03  0.01  0.03  0.04  0.01  1.00
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Table 48. Continued.

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CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

N 1         * . . . . . . . . . . . . . . . . . - . . - . .
N 2         . * . . . . . . . . . . . . . . . . . . . - . .
N 3         . . * . . . . . . . . . . . . . . . . . . . . .
qMA FAL 1   . . . * . . . . . . . . . . . . . . . . . . . .
qMA FAL 2   . . . . * . . . . . . . . . . . . . . . . . . .
qMA FAL 3   . . . . . * . . . . . . . . . . . . . . . . . .
qMA SPR 1   . . . . . . * . . . . . . . . . . . . . . . . .
qMA SPR 2   . . . . . . . * . . . . . . . . . . . . . . . .
qMA SPR 3   . . . . . . . . * . . . . . . . . . . . . . . .
qSV SPR 1   . . . . . . . . . * . . . . . . . . . . . . . .
qSV SPR 2   . . . . . . . . . . * . . . . . . . . . . . . .
qSV SPR 3   . . . . . . . . . . . * . . . . . . . . . . . .
qSV SPR 4   . . . . . . . . . . . . * . . . . . . . . . . .
qCT 1       . . . . . . . . . . . . . * . . . . . . . . . .
qCT 2       . . . . . . . . . . . . . . * . . . . . . . . .
qCT 3       . . . . . . . . . . . . . . . * . . . . . . . .
qCT 4       . . . . . . . . . . . . . . . . * . . . . . . .
qMASS YOY   . . . . . . . . . . . . . . . . . * . . . . . .
qVA YOY     - . . . . . . . . . . . . . . . . . * . . . . .
qRI AGE 1   . . . . . . . . . . . . . . . . . . . * . . . .
qRI AGE 0   . . . . . . . . . . . . . . . . . . . . * . . .
qNC YOY     - - . . . . . . . . . . . . . . . . . . . * . .
qMD YOY     . . . . . . . . . . . . . . . . . . . . . . * .
qDE YOY     . . . . . . . . . . . . . . . . . . . . . . . *

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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Table 48. Continued.

SUMMARY OF RESIDUALS

Index 1 MA FAL 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1983	-0.8164	-0.5173	0.1113	-0.0333	-0.2126	17877.227
1984	-3.0996	-0.3979	0.1113	-0.3008	-1.9203	20144.535
1985	-0.2418	-0.1294	0.1113	-0.0125	-0.0799	26349.066
1986	-1.6755	-0.6513	0.1113	-0.1140	-0.7280	15635.632
1987	1.3151	-0.6588	0.1113	0.2198	1.4030	15518.228
1988	0.6977	-0.4516	0.1113	0.1280	0.8169	19091.520
1989	-0.2686	-1.1281	0.1113	0.0957	0.6109	9706.089
1991	-1.6755	-0.9744	0.1113	-0.0781	-0.4984	11318.631
1992	-0.1571	-1.0131	0.1113	0.0953	0.6084	10889.139

Partial variance for this index is 0.024659

Index 2 MA FAL 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1983	0.9138	-0.3083	0.2439	0.2981	1.9030	3136.734
1984	-0.1802	0.4481	0.2439	-0.1533	-0.9784	6683.115
1985	-1.0309	-0.1688	0.2439	-0.2103	-1.3425	3606.256
1986	0.8674	0.2941	0.2439	0.1398	0.8927	5729.087
1987	-0.3581	-0.3036	0.2439	-0.0133	-0.0847	3151.281
1988	-0.1548	-0.2662	0.2439	0.0272	0.1735	3271.415
1989	-0.5225	-0.4969	0.2439	-0.0062	-0.0399	2597.536
1990	-0.8924	-1.0498	0.2439	0.0384	0.2451	1494.278
1992	-0.9800	-0.4862	0.2439	-0.1204	-0.7689	2625.405

Partial variance for this index is 0.024571

Index 3 MA FAL 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1983	-1.1612	-1.0945	0.2120	-0.0141	-0.0902	351.004
1984	1.0079	0.4213	0.2120	0.1244	0.7940	1598.155
1985	0.8537	0.8255	0.2120	0.0060	0.0382	2394.319
1986	-0.4373	-0.9283	0.2120	0.1041	0.6647	414.484
1987	0.9182	-0.1299	0.2120	0.2222	1.4187	921.027
1988	-1.6312	0.0351	0.2120	-0.3533	-2.2554	1086.164
1989	-1.0434	-0.8090	0.2120	-0.0497	-0.3172	466.986
1990	-0.7557	-1.1518	0.2120	0.0840	0.5361	331.485
1991	-1.4489	-1.1774	0.2120	-0.0576	-0.3675	323.098
1992	-1.6312	-1.3200	0.2120	-0.0660	-0.4212	280.155

Partial variance for this index is 0.024605

Index 4 MA SPR 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1979	-0.3799	0.1374	0.0794	0.5069	42910.904
1983	-0.2469	-0.0220	0.1374	-0.0309	-0.1973	61374.733
1984	-1.9941	0.0675	0.1374	-0.2833	-1.8085	67121.695
1985	-0.7759	-0.5064	0.1374	-0.0370	-0.2364	37811.263
1986	1.1414	-0.5329	0.1374	0.2301	1.4688	36824.620
1987	0.6899	-0.3467	0.1374	0.1425	0.9094	44358.679
1988	-0.7013	-0.5749	0.1374	-0.0174	-0.1109	35307.875
1990	-0.2223	-0.8935	0.1374	0.0922	0.5888	25675.355
1991	-2.3644	-0.7981	0.1374	-0.2152	-1.3741	28246.356
1992	-0.1186	-0.4073	0.1374	0.0397	0.2533	41750.275

Partial variance for this index is 0.024706

Table 48. Continued.

Index 5 MA SPR 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.8350	-0.3925	0.1366	0.1676	1.0703	17456.868
1983	0.7470	-0.3687	0.1366	0.1524	0.9728	17877.227
1984	-2.1357	-0.2493	0.1366	-0.2576	-1.6448	20144.535
1985	0.6564	0.0192	0.1366	0.0870	0.5555	26349.066
1986	-0.1571	-0.5027	0.1366	0.0472	0.3013	15635.632
1987	-0.0580	-0.5102	0.1366	0.0618	0.3943	15518.228
1988	0.4470	-0.3030	0.1366	0.1024	0.6539	19091.520
1989	-0.6031	-0.9795	0.1366	0.0514	0.3281	9706.089
1990	-3.3817	-1.8863	0.1366	-0.2042	-1.3037	3919.173
1991	-2.5550	-0.8258	0.1366	-0.2362	-1.5077	11318.631
1992	-0.6579	-0.8645	0.1366	0.0282	0.1801	10889.139

Partial variance for this index is 0.024624

Index 6 MA SPR 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.0234	-1.2720	0.1384	0.1792	1.1442	1328.326
1983	1.5516	-0.4128	0.1384	0.2718	1.7351	3136.734
1984	-0.6042	0.3436	0.1384	-0.1311	-0.8371	6683.115
1985	-1.2209	-0.2733	0.1384	-0.1311	-0.8370	3606.256
1986	0.1943	0.1896	0.1384	0.0007	0.0042	5729.087
1987	-2.2624	-0.4081	0.1384	-0.2565	-1.6378	3151.281
1988	-0.0560	-0.3707	0.1384	0.0436	0.2780	3271.415
1989	-0.3779	-0.6014	0.1384	0.0309	0.1974	2597.536
1990	-0.3779	-1.1543	0.1384	0.1074	0.6858	1494.278
1991	-2.4447	-1.3896	0.1384	-0.1460	-0.9319	1181.007
1992	-0.3653	-0.5907	0.1384	0.0312	0.1991	2625.405

Partial variance for this index is 0.024639

Index 7 SV SPR 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1535	-0.0738	0.1902	0.0432	0.2760	42910.904
1983	-0.6149	0.2840	0.1902	-0.1710	-1.0914	61374.733
1984	-1.2474	0.3735	0.1902	-0.3083	-1.9680	67121.695
1985	-0.0733	-0.2004	0.1902	0.0242	0.1543	37811.263
1986	0.9233	-0.2268	0.1902	0.2187	1.3964	36824.620
1987	-0.2520	-0.0407	0.1902	-0.0402	-0.2566	44358.679
1988	-0.0031	-0.2689	0.1902	0.0505	0.3227	35307.875
1989	-2.2889	-1.4718	0.1902	-0.1554	-0.9920	10603.403
1990	0.0465	-0.5874	0.1902	0.1206	0.7697	25675.355
1991	0.3138	-0.4920	0.1902	0.1533	0.9784	28246.356
1992	0.2369	-0.1013	0.1902	0.0643	0.4105	41750.275

Partial variance for this index is 0.024859

Table 48. Continued.

Index 8 SV SPR 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.9073	-0.1539	0.2453	0.2603	1.6616	17456.868
1983	-0.3779	-0.1301	0.2453	-0.0608	-0.3879	17877.227
1984	-0.5449	-0.0107	0.2453	-0.1310	-0.8364	20144.535
1985	1.0084	0.2578	0.2453	0.1841	1.1753	26349.066
1986	-0.2803	-0.2641	0.2453	-0.0040	-0.0253	15635.632
1987	-0.2803	-0.2716	0.2453	-0.0021	-0.0135	15518.228
1988	0.3280	-0.0644	0.2453	0.0962	0.6144	19091.520
1989	-0.9060	-0.7409	0.2453	-0.0405	-0.2584	9706.089
1990	-2.9428	-1.6478	0.2453	-0.3176	-2.0277	3919.173
1991	-0.8226	-0.5872	0.2453	-0.0577	-0.3685	11318.631
1992	-0.3279	-0.6259	0.2453	0.0731	0.4666	10889.139

Partial variance for this index is 0.024649

Index 9 SV SPR 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1924	-1.2305	0.1439	0.2047	1.3071	1328.326
1983	0.6519	-0.3712	0.1439	0.1472	0.9399	3136.734
1984	-0.0953	0.3852	0.1439	-0.0691	-0.4414	6683.115
1985	0.7520	-0.2317	0.1439	0.1416	0.9037	3606.256
1986	0.7032	0.2312	0.1439	0.0679	0.4336	5729.087
1987	-1.5994	-0.3666	0.1439	-0.1774	-1.1325	3151.281
1988	-0.3466	-0.3292	0.1439	-0.0025	-0.0160	3271.415
1989	-1.5994	-0.5598	0.1439	-0.1496	-0.9550	2597.536
1990	-0.5008	-1.1128	0.1439	0.0881	0.5622	1494.278
1992	-2.2925	-0.5492	0.1439	-0.2509	-1.6015	2625.405

Partial variance for this index is 0.024564

Index 10 SV SPR 4
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.0377	-0.6602	0.2368	0.1653	1.0551	390.184
1983	0.3254	-0.7660	0.2368	0.2585	1.6500	351.004
1984	0.5486	0.7498	0.2368	-0.0477	-0.3042	1598.155
1985	0.3254	1.1541	0.2368	-0.1962	-1.2527	2394.319
1986	-0.3677	-0.5998	0.2368	0.0550	0.3508	414.484
1987	-0.3677	0.1987	0.2368	-0.1341	-0.8563	921.027
1988	0.0377	0.3636	0.2368	-0.0772	-0.4926	1086.164
1989	-1.0609	-0.4805	0.2368	-0.1374	-0.8774	466.986
1991	-0.3677	-0.8488	0.2368	0.1139	0.7274	323.098

Partial variance for this index is 0.024657

Index 11 CT 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1984	-0.2522	0.3228	0.1693	-0.0973	-0.6214	67121.695
1985	-0.4574	-0.2511	0.1693	-0.0349	-0.2230	37811.263
1986	0.8176	-0.2775	0.1693	0.1854	1.1836	36824.620
1987	0.5417	-0.0914	0.1693	0.1072	0.6842	44358.679
1988	-0.1419	-0.3196	0.1693	0.0301	0.1921	35307.875
1989	-3.6195	-1.5225	0.1693	-0.3550	-2.2663	10603.403
1990	-0.4025	-0.6382	0.1693	0.0399	0.2547	25675.355
1991	-0.0047	-0.5427	0.1693	0.0911	0.5815	28246.356
1992	0.0465	-0.1520	0.1693	0.0336	0.2146	41750.275

Partial variance for this index is 0.024754

Table 48. Continued.

Index 12 CT 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1984	-0.1718	0.3308	0.2726	-0.1370	-0.8747	20144.535
1985	0.3656	0.5993	0.2726	-0.0637	-0.4068	26349.066
1986	0.1526	0.0774	0.2726	0.0205	0.1307	15635.632
1987	-0.1521	0.0699	0.2726	-0.0605	-0.3863	15518.228
1988	0.4704	0.2771	0.2726	0.0527	0.3363	19091.520
1989	-1.0683	-0.3994	0.2726	-0.1824	-1.1644	9706.089
1990	-0.1521	-1.3062	0.2726	0.3147	2.0088	3919.173
1991	0.3057	-0.2457	0.2726	0.1503	0.9596	11318.631
1992	-0.6309	-0.2843	0.2726	-0.0945	-0.6031	10889.139

Partial variance for this index is 0.024625

Index 13 CT 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1984	-0.2799	0.6628	0.1933	-0.1822	-1.1630	6683.115
1985	0.0698	0.0458	0.1933	0.0046	0.0295	3606.256
1986	0.6317	0.5087	0.1933	0.0238	0.1518	5729.087
1987	-0.6071	-0.0890	0.1933	-0.1001	-0.6392	3151.281
1988	0.1178	-0.0516	0.1933	0.0327	0.2090	3271.415
1989	-0.9056	-0.2823	0.1933	-0.1205	-0.7691	2597.536
1990	-0.4302	-0.8352	0.1933	0.0783	0.4997	1494.278
1991	0.7296	-1.0705	0.1933	0.3479	2.2208	1181.007
1992	-0.7089	-0.2716	0.1933	-0.0845	-0.5395	2625.405

Partial variance for this index is 0.024649

Index 14 CT 4
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1984	-0.2040	0.6582	0.1382	-0.1191	-0.7605	1598.155
1985	-0.3218	1.0625	0.1382	-0.1912	-1.2209	2394.319
1986	-0.5041	-0.6914	0.1382	0.0259	0.1651	414.484
1987	-0.4553	0.1071	0.1382	-0.0777	-0.4961	921.027
1988	0.0265	0.2720	0.1382	-0.0339	-0.2165	1086.164
1989	-1.3026	-0.5721	0.1382	-0.1009	-0.6443	466.986
1990	-0.9349	-0.9148	0.1382	-0.0028	-0.0177	331.485
1991	0.9999	-0.9404	0.1382	0.2681	1.7114	323.098
1992	0.5945	-1.0831	0.1382	0.2318	1.4796	280.155

Partial variance for this index is 0.024741

Index 27 MASS YOY
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.4055	0.2291	0.1652	-0.1048	-0.6693	80737.786
1983	-0.4055	0.3942	0.1652	-0.1321	-0.8434	95232.518
1984	-1.0986	-0.0760	0.1652	-0.1689	-1.0785	59506.721
1985	1.2040	-0.2980	0.1652	0.2481	1.5842	47659.942
1986	0.0000	-0.0837	0.1652	0.0138	0.0882	59054.722
1987	0.0000	-0.3385	0.1652	0.0559	0.3570	45769.811
1988	-0.6931	-1.3456	0.1652	0.1078	0.6882	16718.554
1989	-0.6931	-0.6746	0.1652	-0.0031	-0.0196	32704.943
1990	0.6931	-0.5575	0.1652	0.2066	1.3191	36767.988
1991	-0.1823	-0.1923	0.1652	0.0017	0.0106	52973.262
1992	-1.7918	-0.4298	0.1652	-0.2250	-1.4365	41778.275

Partial variance for this index is 0.023012

Table 48. Continued.

Index 28 VA YOY
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.9069	0.3543	0.3956	0.2186	1.3957	80737.786
1983	0.6757	0.5194	0.3956	0.0618	0.3947	95232.518
1984	-0.1716	0.0491	0.3956	-0.0873	-0.5575	59506.721
1985	-0.3258	-0.1729	0.3956	-0.0605	-0.3862	47659.942
1986	-0.2080	0.0415	0.3956	-0.0987	-0.6301	59054.722
1987	-0.6512	-0.2133	0.3956	-0.1732	-1.1058	45769.811
1988	-1.0471	-1.2204	0.3956	0.0686	0.4377	16718.554
1989	-0.6904	-0.5494	0.3956	-0.0558	-0.3560	32704.943
1990	0.1161	-0.4323	0.3956	0.2169	1.3848	36767.988
1991	0.2178	-0.0672	0.3956	0.1127	0.7197	52973.262
1992	-0.8182	-0.3046	0.3956	-0.2032	-1.2972	41778.275

Partial variance for this index is 0.021458

Index 29 RI AGE 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	1.0973	-0.3376	0.1620	0.2324	1.4837	17456.868
1983	-0.6804	-0.3138	0.1620	-0.0594	-0.3791	17877.227
1984	-1.0451	-0.1944	0.1620	-0.1378	-0.8796	20144.535
1985	0.1787	0.0741	0.1620	0.0169	0.1081	26349.066
1986	-0.7675	-0.4478	0.1620	-0.0518	-0.3306	15635.632
1987	1.1297	-0.4553	0.1620	0.2567	1.6388	15518.228
1988	0.0127	-0.2481	0.1620	0.0422	0.2696	19091.520
1989	-0.5751	-0.9246	0.1620	0.0566	0.3614	9706.089
1990	-2.8777	-1.8314	0.1620	-0.1695	-1.0818	3919.173
1991	-0.4138	-0.7709	0.1620	0.0578	0.3692	11318.631
1992	-2.3180	-0.8095	0.1620	-0.2443	-1.5598	10889.139

Partial variance for this index is 0.024564

Index 30 RI AGE 0
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.1437	0.5214	0.3232	-0.2150	-1.3724	80737.786
1983	-0.1239	0.6865	0.3232	-0.2619	-1.6722	95232.518
1984	0.0047	0.2163	0.3232	-0.0684	-0.4366	59506.721
1985	0.1415	-0.0057	0.3232	0.0476	0.3036	47659.942
1986	0.3449	0.2087	0.3232	0.0440	0.2810	59054.722
1987	0.2209	-0.0461	0.3232	0.0863	0.5511	45769.811
1988	-0.1239	-1.0533	0.3232	0.3004	1.9175	16718.554
1989	-0.1437	-0.3822	0.3232	0.0771	0.4922	32704.943
1990	-0.0854	-0.2651	0.3232	0.0581	0.3708	36767.988
1991	-0.1045	0.1000	0.3232	-0.0661	-0.4219	52973.262
1992	-0.1437	-0.1374	0.3232	-0.0020	-0.0130	41778.275

Partial variance for this index is 0.023847

Index 31 NC YOY
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1987	0.6580	0.0532	0.3666	0.2217	1.4156	45769.811
1988	-1.3953	-0.9539	0.3666	-0.1618	-1.0332	16718.554
1989	-0.3636	-0.2829	0.3666	-0.0296	-0.1890	32704.943
1990	-0.4086	-0.1658	0.3666	-0.0890	-0.5684	36767.988
1991	-0.1476	0.1994	0.3666	-0.1272	-0.8122	52973.262
1992	0.4692	-0.0380	0.3666	0.1860	1.1872	41778.275

Partial variance for this index is 0.027781

Table 48. Continued.

Index 32 MD YOY
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-1.7060	0.0565	0.1630	-0.2872	-1.8338	80737.786
1983	0.3403	0.2216	0.1630	0.0193	0.1235	95232.518
1984	0.6924	-0.2486	0.1630	0.1534	0.9791	59506.721
1985	-0.1930	-0.4706	0.1630	0.0452	0.2888	47659.942
1986	1.0850	-0.2563	0.1630	0.2186	1.3955	59054.722
1987	0.1898	-0.5111	0.1630	0.1142	0.7293	45769.811
1988	-2.9588	-1.5182	0.1630	-0.2348	-1.4988	16718.554
1989	-1.5404	-0.8472	0.1630	-0.1130	-0.7212	32704.943
1990	-0.8290	-0.7301	0.1630	-0.0161	-0.1029	36767.988
1991	-0.3972	-0.3649	0.1630	-0.0053	-0.0336	52973.262
1992	0.0456	-0.6023	0.1630	0.1056	0.6741	41778.275

Partial variance for this index is 0.025221

Index 33 DE YOY
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 0
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.0760	0.0554	0.1361	-0.0179	-0.1141	80737.786
1983	-1.6341	0.2205	0.1361	-0.2524	-1.6111	95232.518
1984	-1.0745	-0.2497	0.1361	-0.1122	-0.7165	59506.721
1986	-0.3814	-0.2573	0.1361	-0.0169	-0.1078	59054.722
1987	-0.1301	-0.5122	0.1361	0.0520	0.3319	45769.811
1988	-3.0204	-1.5193	0.1361	-0.2043	-1.3040	16718.554
1989	0.0241	-0.8483	0.1361	0.1187	0.7578	32704.943
1990	0.6931	-0.7312	0.1361	0.1938	1.2373	36767.988
1991	-0.3814	-0.3660	0.1361	-0.0021	-0.0133	52973.262
1992	1.1692	-0.6034	0.1361	0.2412	1.5399	41778.275

Partial variance for this index is 0.026098

Table 48. Continued.

Standardized residuals by index & yr; with row/column/grand means

■	1982	1983	1984	1985	1986	1987	1988
1 ■	-99.0000	-0.2126	-1.9203	-0.0799	-0.7280	1.4030	0.8169
2 ■	-99.0000	1.9030	-0.9784	-1.3425	0.8927	-0.0847	0.1735
3 ■	-99.0000	-0.0902	0.7940	0.0382	0.6647	1.4187	-2.2554
4 ■	0.5069	-0.1973	-1.8085	-0.2364	1.4688	0.9094	-0.1109
5 ■	1.0703	0.9728	-1.6448	0.5555	0.3013	0.3943	0.6539
6 ■	1.1442	1.7351	-0.8371	-0.8370	0.0042	-1.6378	0.2780
7 ■	0.2760	-1.0914	-1.9680	0.1543	1.3964	-0.2566	0.3227
8 ■	1.6616	-0.3879	-0.8364	1.1753	-0.0253	-0.0135	0.6144
9 ■	1.3071	0.9399	-0.4414	0.9037	0.4336	-1.1325	-0.0160
10 ■	1.0551	1.6500	-0.3042	-1.2527	0.3508	-0.8563	-0.4926
11 ■	-99.0000	-99.0000	-0.6214	-0.2230	1.1836	0.6842	0.1921
12 ■	-99.0000	-99.0000	-0.8747	-0.4068	0.1307	-0.3863	0.3363
13 ■	-99.0000	-99.0000	-1.1630	0.0295	0.1518	-0.6392	0.2090
14 ■	-99.0000	-99.0000	-0.7605	-1.2209	0.1651	-0.4961	-0.2165
27 ■	-0.6693	-0.8434	-1.0785	1.5842	0.0882	0.3570	0.6882
28 ■	1.3957	0.3947	-0.5575	-0.3862	-0.6301	-1.1058	0.4377
29 ■	1.4837	-0.3791	-0.8796	0.1081	-0.3306	1.6388	0.2696
30 ■	-1.3724	-1.6722	-0.4366	0.3036	0.2810	0.5511	1.9175
31 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.4156	-1.0332
32 ■	-1.8338	0.1235	0.9791	0.2888	1.3955	0.7293	-1.4988
33 ■	-0.1141	-1.6111	-0.7165	-99.0000	-0.1078	0.3319	-1.3040
** ■	0.4547	0.0771	-0.8027	-0.0444	0.3543	0.1536	-0.0008

■	1989	1990	1991	1992	1993********	
1 ■	0.6109	-99.0000	-0.4984	0.6084	-99.0000	-0.0000
2 ■	-0.0399	0.2451	-99.0000	-0.7689	-99.0000	-0.0000
3 ■	-0.3172	0.5361	-0.3675	-0.4212	-99.0000	-0.0000
4 ■	-99.0000	0.5888	-1.3741	0.2533	-99.0000	-0.0000
5 ■	0.3281	-1.3037	-1.5077	0.1801	-99.0000	-0.0000
6 ■	0.1974	0.6858	-0.9319	0.1991	-99.0000	-0.0000
7 ■	-0.9920	0.7697	0.9784	0.4105	-99.0000	-0.0000
8 ■	-0.2584	-2.0277	-0.3685	0.4666	-99.0000	-0.0000
9 ■	-0.9550	0.5622	-99.0000	-1.6015	-99.0000	-0.0000
10 ■	-0.8774	-99.0000	0.7274	-99.0000	-99.0000	-0.0000
11 ■	-2.2663	0.2547	0.5815	0.2146	-99.0000	-0.0000
12 ■	-1.1644	2.0088	0.9596	-0.6031	-99.0000	-0.0000
13 ■	-0.7691	0.4997	2.2208	-0.5395	-99.0000	-0.0000
14 ■	-0.6443	-0.0177	1.7114	1.4796	-99.0000	-0.0000
27 ■	-0.0196	1.3191	0.0106	-1.4365	-99.0000	-0.0000
28 ■	-0.3560	1.3848	0.7197	-1.2972	-99.0000	-0.0000
29 ■	0.3614	-1.0818	0.3692	-1.5598	-99.0000	-0.0000
30 ■	0.4922	0.3708	-0.4219	-0.0130	-99.0000	-0.0000
31 ■	-0.1890	-0.5684	-0.8122	1.1872	-99.0000	-0.0000
32 ■	-0.7212	-0.1029	-0.0336	0.6741	-99.0000	-0.0000
33 ■	0.7578	1.2373	-0.0133	1.5399	-99.0000	-0.0000
** ■	-0.3411	0.2821	0.1026	-0.0514	1.0000	-0.0000

-99 in the above table indicates a missing value

Table 48. Continued.

Percent of total sum of squares by index & yr; with row/column sums

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-99.00	0.02	2.00	0.00	0.29	1.07	0.36	0.20	-99.00	0.13
2	-99.00	1.97	0.52	0.98	0.43	0.00	0.02	0.00	0.03	-99.00
3	-99.00	0.00	0.34	0.00	0.24	1.09	2.76	0.05	0.16	0.07
4	0.14	0.02	1.78	0.03	1.17	0.45	0.01	-99.00	0.19	1.03
5	0.62	0.51	1.47	0.17	0.05	0.08	0.23	0.06	0.92	1.24
6	0.71	1.64	0.38	0.38	0.00	1.46	0.04	0.02	0.26	0.47
7	0.04	0.65	2.10	0.01	1.06	0.04	0.06	0.53	0.32	0.52
8	1.50	0.08	0.38	0.75	0.00	0.00	0.21	0.04	2.23	0.07
9	0.93	0.48	0.11	0.44	0.10	0.70	0.00	0.50	0.17	-99.00
10	0.61	1.48	0.05	0.85	0.07	0.40	0.13	0.42	-99.00	0.29
11	-99.00	-99.00	0.21	0.03	0.76	0.25	0.02	2.79	0.04	0.18
12	-99.00	-99.00	0.42	0.09	0.01	0.08	0.06	0.74	2.19	0.50
13	-99.00	-99.00	0.74	0.00	0.01	0.22	0.02	0.32	0.14	2.68
14	-99.00	-99.00	0.31	0.81	0.01	0.13	0.03	0.23	0.00	1.59
27	0.24	0.39	0.63	1.36	0.00	0.07	0.26	0.00	0.95	0.00
28	1.06	0.08	0.17	0.08	0.22	0.66	0.10	0.07	1.04	0.28
29	1.20	0.08	0.42	0.01	0.06	1.46	0.04	0.07	0.64	0.07
30	1.02	1.52	0.10	0.05	0.04	0.17	2.00	0.13	0.07	0.10
31	-99.00	-99.00	-99.00	-99.00	-99.00	1.09	0.58	0.02	0.18	0.36
32	1.83	0.01	0.52	0.05	1.06	0.29	1.22	0.28	0.01	0.00
33	0.01	1.41	0.28	-99.00	0.01	0.06	0.92	0.31	0.83	0.00
**	9.91	10.35	12.94	6.10	5.60	9.78	9.07	6.78	10.36	9.59

	1992	1993	*******
1	0.20	-99.00	4.29
2	0.32	-99.00	4.28
3	0.10	-99.00	4.83
4	0.03	-99.00	4.85
5	0.02	-99.00	5.38
6	0.02	-99.00	5.38
7	0.09	-99.00	5.43
8	0.12	-99.00	5.38
9	1.39	-99.00	4.82
10	-99.00	-99.00	4.29
11	0.03	-99.00	4.31
12	0.20	-99.00	4.29
13	0.16	-99.00	4.29
14	1.19	-99.00	4.31
27	1.12	-99.00	5.02
28	0.91	-99.00	4.68
29	1.32	-99.00	5.36
30	0.00	-99.00	5.21
31	0.77	-99.00	2.99
32	0.25	-99.00	5.51
33	1.29	-99.00	5.12
**	9.53	0.00	100.00

-99 in the above table indicates a missing value

Table 48. Continued.

Partial variance (and proportion of total) by index

	1	2	3	4	5	6
**	0.02465926	0.02457071	0.02460507	0.02470605	0.02462388	0.02463869
**	0.04767077	0.04749957	0.04756600	0.04776122	0.04760238	0.04763099

	7	8	9	10	11	12
**	0.02485874	0.02464942	0.02456438	0.02465705	0.02475351	0.02462539
**	0.04805639	0.04765174	0.04748735	0.04766649	0.04785296	0.04760529

	13	14	27	28	29	30
**	0.02464871	0.02474097	0.02301239	0.02145766	0.02456401	0.02384657
**	0.04765037	0.04782873	0.04448707	0.04148150	0.04748662	0.04609968

	31	32	33	************
**	0.02778117	0.02522093	0.02609812	0.51728267
**	0.05370597	0.04875658	0.05045234	1.00000000

Table 48. Continued.

STOCK NUMBERS (Jan 1) in thousands - SAW 16

	1982	1983	1984	1985	1986	1987
0	80737.786	95232.518	59506.721	47659.942	59054.722	45769.811
1	42910.904	61374.733	67121.695	37811.263	36824.620	44358.679
2	17456.868	17877.227	20144.535	26349.066	15635.632	15518.228
3	1328.326	3136.734	6683.115	3606.256	5729.087	3151.281
4	390.184	351.004	1598.155	2394.319	414.484	921.027
5+	290.356	302.619	532.925	640.327	1029.214	198.091
0+	143114.423	178274.834	155587.146	118461.173	118687.759	109917.117

	1988	1989	1990	1991	1992	1993
0	16718.554	32704.943	36767.988	52973.262	41778.275	0.000
1	35307.875	10603.403	25675.355	28246.356	41750.275	32886.810
2	19091.520	9706.089	3919.173	11318.631	10889.139	22000.408
3	3271.415	2597.536	1494.278	1181.007	2625.405	3041.973
4	1086.164	466.986	331.485	323.098	280.155	733.429
5+	315.716	105.596	75.613	66.406	133.306	115.504
0+	75791.244	56184.553	68263.892	94108.760	97456.555	58778.125

Summaries for ages 2-5+

	1982	1983	1984	1985	1986	1987
	19465.734	21667.584	28958.730	32989.968	22808.417	19788.627

	1988	1989	1990	1991	1992	1993
	23764.815	12876.207	5820.549	12889.142	13928.005	25891.314

Table 48. Continued.

FISHING MORTALITY - SAW16

	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0742	0.1498	0.2535	0.0579	0.0862	0.0595	0.2553	0.0420	0.0637
1	0.6756	0.9141	0.7351	0.6831	0.6642	0.6431	1.0914	0.7953	0.6191
2	1.5166	0.7839	1.5203	1.3259	1.4017	1.3568	1.7947	1.6711	0.9995
3	1.1309	0.4743	0.8265	1.9634	1.6278	0.8652	1.7467	1.8587	1.3314
4	1.5754	0.7462	1.3602	1.4593	1.5445	1.3121	1.9502	1.8484	1.1192
5+	1.5754	0.7462	1.3602	1.4593	1.5445	1.3121	1.9502	1.8484	1.1192

	1991	1992
0	0.0381	0.0393
1	0.7532	0.4406
2	1.2612	1.0753
3	1.2388	1.0753
4	1.3168	1.0753
5+	1.3168	1.0753

Avg F for ages 2-4,u

	1982	1983	1984	1985	1986	1987	1988	1989	1990
	1.4076	0.6681	1.4582	1.5829	1.5247	1.1780	1.8305	1.7927	1.1150

	1991	1992
	1.2723	1.0753

BACKCALCULATED PARTIAL RECRUITMENT

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.05	0.16	0.17	0.03	0.05	0.04	0.13	0.02	0.05	0.03	0.04
1	0.43	1.00	0.48	0.35	0.41	0.47	0.56	0.43	0.46	0.57	0.41
2	0.96	0.86	1.00	0.68	0.86	1.00	0.92	0.90	0.75	0.96	1.00
3	0.72	0.52	0.54	1.00	1.00	0.64	0.90	1.00	1.00	0.94	1.00
4	1.00	0.82	0.89	0.74	0.95	0.97	1.00	0.99	0.84	1.00	1.00
5+	1.00	0.82	0.89	0.74	0.95	0.97	1.00	0.99	0.84	1.00	1.00

Table 48. Continued.

MEAN BIOMASS (MT)

	1982	1983	1984	1985	1986	1987
0	17936.046	17518.329	10907.956	11846.721	13147.323	9634.769
1	12436.810	16542.926	17397.843	10697.887	11193.760	13366.899
2	5455.921	8942.152	6152.838	8270.280	5136.395	5097.618
3	1238.839	2959.278	4407.934	1611.089	3085.560	2165.631
4	389.717	332.714	1288.115	2082.088	350.981	918.304
5+	392.293	413.252	627.040	757.745	1310.703	316.988
0+	37849.625	46708.651	40781.726	35265.809	34224.723	31500.209

	1988	1989	1990	1991	1992
0	3854.334	6013.045	7886.117	8673.634	7728.323
1	9278.361	3035.556	7572.025	7320.197	14119.268
2	5192.922	3120.392	1826.185	4164.519	4651.961
3	1597.650	1145.829	899.353	730.685	2047.369
4	797.572	298.665	287.375	314.598	309.504
5+	363.638	111.047	114.516	94.391	227.875
0+	21084.477	13724.534	18585.570	21298.023	29084.300

Summaries for ages 2-5+

	1982	1983	1984	1985	1986	1987	1988
	7476.770	12647.395	12475.927	12721.201	9883.640	8498.541	7951.782

	1989	1990	1991	1992
	4675.933	3127.429	5304.193	7236.709

CATCH BIOMASS (MT)

	1982	1983	1984	1985	1986	1987
0	1331.006	2624.493	2764.973	686.217	1132.722	573.449
1	8402.287	15121.313	12788.711	7307.241	7434.350	8595.773
2	8274.183	7010.142	9353.931	10965.371	7199.908	6916.411
3	1400.975	1403.681	3643.092	3163.198	5022.742	1873.610
4	613.973	248.257	1752.112	3038.455	542.091	1204.951
5+	618.032	308.352	852.908	1105.800	2024.384	415.936
0+	20640.457	26716.239	31155.727	26266.281	23356.198	19580.129

	1988	1989	1990	1991	1992
0	984.181	252.516	502.055	330.303	303.760
1	10125.964	2414.161	4687.700	5513.562	6221.585
2	9319.637	5214.519	1825.296	5252.355	5002.065
3	2790.582	2129.793	1197.437	905.157	2201.453
4	1555.409	552.053	321.638	414.248	332.797
5+	709.159	205.259	128.169	124.290	245.025
0+	25484.933	10768.300	8662.294	12539.915	14306.685

Summaries for ages 2-5+

	1982	1983	1984	1985	1986	1987	1988
	10907.164	8970.433	15602.043	18272.823	14789.126	10410.907	14374.788

	1989	1990	1991	1992
	8101.624	3472.540	6696.050	7781.340

Table 48. Continued.

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

■	1982	1983	1984	1985	1986	1987	1988
0 ■	6206.571	5901.057	3538.509	4123.002	4530.322	3351.300	1249.479
1 ■	6497.816	7835.176	8873.751	5572.544	5875.310	7075.406	4073.458
2 ■	2471.901	5588.414	2782.827	4090.109	2453.985	2485.944	2060.778
3 ■	742.482	2324.582	3007.599	653.813	1474.072	1454.083	721.039
4 ■	190.847	234.633	696.884	1076.366	174.393	507.754	325.804
5+■	192.109	291.430	339.235	391.727	651.253	175.271	148.544
0+■	16301.725	22175.291	19238.804	15907.562	15159.336	15049.758	8579.102

■	1989	1990	1991	1992
0 ■	2104.442	2739.064	3039.753	2707.301
1 ■	1510.595	4046.532	3706.183	8089.610
2 ■	1314.279	1042.666	2120.403	2570.823
3 ■	489.679	492.956	417.536	1257.158
4 ■	128.285	173.115	173.588	190.046
5+■	47.698	68.984	52.083	139.924
0+■	5594.977	8563.316	9509.545	14954.861

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) x P(a,y) x N(a,y) x exp[-Z(a,y)]

where Z(a,y) = 0.83 x M(a,y) + 0.83 x 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 mid-year weight at age estimates (see "WT AT AGE" table in input section).

MEAN STOCK NUMBERS (thousands) - SAW16

■	1982	1983	1984	1985	1986	1987
0 ■	70614.353	80359.309	47841.913	42009.648	51356.731	40312.841
1 ■	28590.367	37008.784	43603.616	25112.411	24655.858	29970.625
2 ■	8342.387	11376.783	9613.809	13513.530	7794.227	7866.695
3 ■	734.344	2281.633	4178.137	1475.356	2630.486	1938.792
4 ■	182.537	226.953	809.118	1168.400	196.079	474.821
5+■	135.835	195.669	269.811	312.472	486.888	102.123
0+■	108599.825	131449.131	106316.403	83591.816	87120.269	80665.897

■	1988	1989	1990	1991	1992
0 ■	13429.735	29048.527	32320.152	47139.313	37155.397
1 ■	19825.558	6715.833	17527.835	18209.445	30828.096
2 ■	8268.984	4388.737	2282.731	5949.313	6153.388
3 ■	1440.622	1100.701	764.756	626.122	1483.601
4 ■	446.319	198.580	184.097	166.278	158.314
5+■	129.732	44.904	41.993	34.175	75.331
0+■	43540.950	41497.281	53121.563	72124.647	75854.127

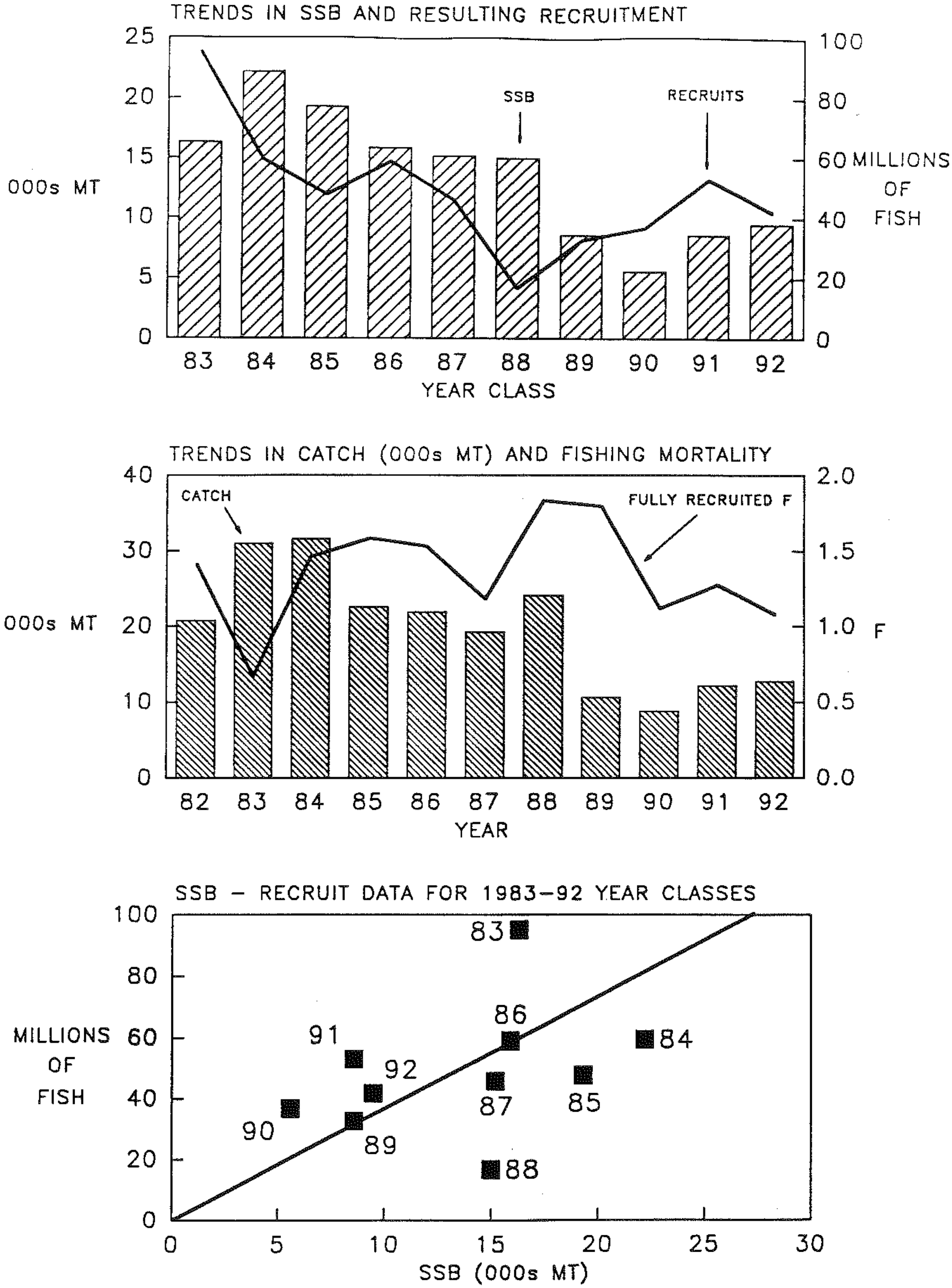

Figure 7. Summary of summer flounder 1982-1992 final VPA results.

Table 49. Commercial and recreational fishery landings, estimated discard, and total catch statistics (metric tons) as used in the assessment of summer flounder, Maine to North Carolina, 1982-1992, compared with VPA estimates of total catch biomass

	Commercial[1]			Recreational			Total			VPA Calculated
	Landings	Discard	Catch	Landings	Discard	Catch	Landings	Discard	Catch	Catch Biomass
1982	10,400	N/A	10,400	9,621	709	10,330	20,021	709	20,730	20,640
1983	13,403	N/A	13,403	16,357	1,221	17,578	29,760	1,221	30,981	26,716
1984	17,130	N/A	17,130	13,147	1,341	14,488	30,277	1,341	31,618	31,156
1985	14,675	N/A	14,675	7,558	286	7,844	22,233	286	22,519	26,266
1986	12,186	N/A	12,186	8,497	1,150	9,647	20,683	1,150	21,833	23,356
1987	12,271	N/A	12,271	5,658	1,252	6,910	17,929	1,252	19,181	19,580
1988	14,686	N/A	14,686	8,487	895	9,382	23,173	895	24,068	25,484
1989	8,125	886	9,011	1,460	109	1,569	9,585	995	10,580	10,768
1990	4,199	1,516	5,715	2,435	651	3,086	6,634	2,167	8,801	8,662
1991	6,224	1,315	7,539	3,533	1,034	4,567	9,757	2,349	12,106	12,539
1992	7,302	1,111	8,413	3,364	911	4,275	10,666	2,022	12,688	14,307

[1] Includes foreign catch (directed foreign and joint venture fishing)
[2] N/A = not available

A comparison between catch biomass as calculated in the VPA and reported landings plus estimated discard is made in Table 49.

ESTIMATES OF FISHING MORTALITY RATES

Fishing mortality rates on fully recruited ages have on average exceeded 1.0 between 1982 and 1992 (except for 1983), varying between 1.1 and 1.8, but with a declining trend since 1988. The WG concluded that F on fully recruited ages (2 to 4,u) was about 1.1 in 1992.

RECRUITMENT, STOCK SIZE, AND SSB ESTIMATES

Summer flounder spawn in the late autumn and into early winter (peak spawning on November 1), and age 0 fish recruit to the fishery the autumn after they are spawned. For example, summer flounder spawned in autumn 1990 (from the 1990 spawning stock biomass) recruit to the fishery in autumn 1991, and appear in VPA tables as age 0 fish in 1991. This assessment indicates that the 1982 and 1983 year classes were the largest of the VPA series, at 81 and 95 million fish, respectively. The 1988 year class was the smallest of the series, at only 17 million fish. The size of the 1992 year class, as estimated from the recruitment indices, was about 42 million fish. Total stock size in 1992 (ages 0 and older) was estimated at about 97 million fish, about 55% of the peak abundance estimated for 1983 (178 million). Spawning stock biomass on November 1, 1992 was estimated to be about 15,000 mt, about 68% of the peak estimated for 1983 (22,200 mt).

In summary, the VPA results indicate that fishing mortality rates on summer flounder have declined since 1989, but remained above 1.0 during 1992, well above the fishing mortality target for 1993 (F_{tgt} = 0.53) and the overfishing definition (F_{max} = 0.23). Improved recruitment since 1988 has resulted in an increase in spawning stock biomass, but this biomass continues to be concentrated in a few age classes (Table 48, Figure 7).

PRECISION OF F AND SSB ESTIMATES

To evaluate the precision of the final VPA estimates, a bootstrap procedure (Efron 1982) with 200 iterations was used to generate distributions of the 1992 fishing mortality rate and spawning stock biomass. This method accounts for random variation in the tuning data (survey, LPUE, and CPUE indices). The distribution of the estimates indicates the amount of uncertainty by visually depicting variability. The cumulative probability can be used to evaluate the risk of making a management decision based on the estimated value. It expresses the probability (chance) that the fishing mortality rate was greater than a given level when measurement errors are considered (*e.g.*, some target fishing mortality rate). For spawning stock biomass, the cumulative plot indicates the probability that it was less than a given level (*e.g.*, some desired minimum spawning stock biomass).

The precision and bias of the fishing mortality rates are presented in Table 50. The bootstrap coefficients of variation on the F's of individual ages are ranged from 25% for age 0, to 34% for age 1, to 149% for fully recruited ages. The fully recruited F was imprecise because of the highly skewed distribution of the bootstrap estimates (Figure 8). This distribution also results in the bootstrap mean (1.4) being higher than the point estimate from the VPA (1.1), although the mode of the bootstrap distribution (about 1.0) was slightly lower than the VPA value. There is almost no chance that F in 1992 was less than the target value of 0.53.

The bootstrap estimate of spawning stock biomass was relatively precise, with a CV of 26% (Table 50). The bootstrap mean (15,450 mt) was slightly higher than the VPA point estimate (14,950 mt). The bootstrap results suggest a high probability that spawning stock biomass in 1992 was at least 10,000 mt (Figure 9), a substantial increase over the VPA estimate of 5,600 mt in 1989.

BIOLOGICAL REFERENCE POINTS

The calculation of biological reference points for summer flounder using the Thompson and Bell (1934) model was detailed in the Report of the Eleventh SAW (NEFC 1990). Since the partial recruitment pattern has remained stable (in spite of the addition of commercial discards in the catch at age matrix for 1989 to 1992), no revised analysis was performed. The 1990 analysis indicated $F_{0.1}$ = 0.136, F_{max} = 0.232, and $F_{20\%}$ = 0.270.

A scatter plot of spawning stock biomass and subsequent recruitment is presented in Figure 7. The plot shows that recruitment in recent (1990 to 1992) years has been sufficient, in spite of high fishing mortality rates, to slowly increase stock size from the low levels reached during 1989-1990.

PROJECTIONS

Yield and stock size projections were made for 1993 to 1995 assuming that the 1993 quota would be landed, and that fishing mortality targets in 1994-1995 would be achieved. Thus, fishing mortality in 1993 (F_{93}) was assumed to be the F realized if total 1993 landings were 9,400 mt (5,600 mt commercial, 3,800 mt recreational). Fishing mortality in 1994-1995 was assumed to be 0.53. The projections also assume that patterns of discarding, currently due to the impact of minimum size regulations, will continue over the time span of the projections. Different patterns that could develop during 1993 to 1995, due to trip and bag limits and fishery closures, have not been evaluated. The partial recruitment pattern (including discards) used in the projections was estimated as the geometric mean of F at age for 1990 to 1992. Mean weights at age were estimated as the geometric means of 1990 to 1992 values. Separate mean weight at age vectors were developed for the spawning stock, landings, and discards (Table 51).

Three options for initial stock sizes in 1993 were evaluated. Recruitment at age 0 in 1993 was assumed equal to the geometric mean of VPA estimates during 1988-1992, ± one standard error. Stock size at age 1 in 1993 was assumed equal to the VPA point estimate, ± one standard error. Stock sizes at ages 2 to 5+ were assumed equal to the VPA point estimates. These combinations of starting stock sizes in 1993 provided worst, average, and best case scenarios that bracket the range of uncertainty about the estimates of stock sizes at ages 0 and 1 in 1993.

Projection results under these three options are summarized in Table 51. If the 1993 catch quotas are landed and current relative discard levels remain stable, F in 1993 will be about 0.48 with average recruitment in 1993. Given average recruitment again in 1994 and 1995, the fishing mortality target in 1994-1995 (F_{tgt} = 0.53) could be met with a total landings quota of about 14,400 mt (31.7 million pounds) in 1994 and 16,200 mt (35.7 million pounds) in 1995. Assumption of the worst and best case scenarios will result in landings 20% below or 20 to 30% above the average case in 1994-1995.

CONCLUSIONS AND DISCUSSION

MAJOR DATA AND ANALYTIC NEEDS

The WG identified the following major data and analysis needs for future assessments:

1) Examine the North Carolina sea sampling data (Observer Program to estimate turtle by-catch) to see how discard rates and total discard estimates from those data compare with estimates from the NEFSC sea sampling program.
2) Develop a standardized index

Table 50. Bootstrap results for summer flounder VPA, 1982-1992, tuned with research survey indices only, and one iterative reweight

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.

BOOTSTRAP OUTPUT VARIABLE: N_hat
Age-specific stocksizes (on Jan 1, 1993) estimated by NLLS

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1	3.289E4	3.453E4	8.395E3	0.26
2	2.200E4	2.251E4	7.467E3	0.34
3	3.042E3	3.256E3	1.926E3	0.63

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	1.641E3	5.936E2	4.99	3.125E4	0.27
2	5.137E2	5.280E2	2.34	2.149E4	0.35
3	2.142E2	1.362E2	7.04	2.827E3	0.68

BOOTSTRAP OUTPUT VARIABLE: 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.

INDEX NO.	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1	1.924E-5	2.202E-5	1.025E-5	0.53
2	1.635E-4	1.700E-4	3.381E-5	0.21
3	4.873E-5	4.950E-5	1.152E-5	0.24
4	4.917E-6	5.190E-6	1.778E-6	0.36
5	2.390E-5	2.494E-5	8.772E-6	0.37
6	2.432E-5	2.598E-5	8.406E-6	0.35
7	1.281E-5	1.305E-5	3.138E-6	0.24
8	2.795E-5	2.792E-5	4.653E-6	0.17
9	2.177E-5	2.407E-5	8.587E-6	0.39
10	3.826E-5	3.887E-5	7.467E-6	0.20
11	1.612E-5	1.634E-5	4.768E-6	0.30
12	1.649E-5	1.678E-5	3.014E-6	0.18
13	1.652E-5	1.694E-5	4.271E-6	0.26
14	4.001E-5	4.430E-5	1.583E-5	0.40
27	9.345E-5	9.634E-5	2.714E-5	0.29
28	1.760E-5	1.762E-5	2.005E-6	0.11
29	2.906E-5	2.874E-5	8.444E-6	0.29
30	2.409E-5	2.454E-5	3.607E-6	0.15
31	1.581E-4	1.575E-4	2.779E-5	0.18
32	1.162E-4	1.181E-4	3.029E-5	0.26
33	2.684E-6	2.847E-6	1.088E-6	0.41

Table 50. Continued.

INDEX NO.	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	2.785E-6	7.250E-7	14.48	1.645E-5	0.62
2	6.439E-6	2.391E-6	3.94	1.571E-4	0.22
3	7.735E-7	8.144E-7	1.59	4.795E-5	0.24
4	2.730E-7	1.257E-7	5.55	4.644E-6	0.38
5	1.041E-6	6.203E-7	4.35	2.286E-5	0.38
6	1.660E-6	5.944E-7	6.82	2.266E-5	0.37
7	2.421E-7	2.219E-7	1.89	1.257E-5	0.25
8	-2.737E-8	3.290E-7	-0.10	2.798E-5	0.17
9	2.291E-6	6.072E-7	10.52	1.948E-5	0.44
10	6.103E-7	5.280E-7	1.60	3.765E-5	0.20
11	2.177E-7	3.371E-7	1.35	1.591E-5	0.30
12	2.872E-7	2.131E-7	1.74	1.621E-5	0.19
13	4.253E-7	3.020E-7	2.58	1.609E-5	0.27
14	4.287E-6	1.119E-6	10.71	3.573E-5	0.44
27	2.894E-6	1.919E-6	3.10	9.055E-5	0.30
28	1.187E-8	1.417E-7	0.07	1.759E-5	0.11
29	-3.168E-7	5.971E-7	-1.09	2.937E-5	0.29
30	4.572E-7	2.551E-7	1.90	2.363E-5	0.15
31	-6.604E-7	1.965E-6	-0.42	1.588E-4	0.18
32	1.855E-6	2.142E-6	1.60	1.143E-4	0.26
33	1.636E-7	7.695E-8	6.10	2.520E-6	0.43

BOOTSTRAP OUTPUT VARIABLE: N_t1
Full vector of age-specific stocksizes on Jan 1, 1993

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
0	4.725E4	4.738E4	1.526E3	0.03
1	3.289E4	3.453E4	8.395E3	0.26
2	2.200E4	2.251E4	7.467E3	0.34
3	3.042E3	3.256E3	1.926E3	0.63
4	7.333E2	7.850E2	4.644E2	0.63
5+	1.155E2	1.237E2	7.336E1	0.64

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
0	1.224E2	1.079E2	0.26	4.713E4	0.03
1	1.641E3	5.936E2	4.99	3.125E4	0.27
2	5.137E2	5.280E2	2.34	2.149E4	0.35
3	2.142E2	1.362E2	7.04	2.827E3	0.68
4	5.164E1	3.284E1	7.04	6.817E2	0.68
5+	8.223E0	5.187E0	7.12	1.073E2	0.68

Table 50. Continued.

BOOTSTRAP OUTPUT VARIABLE: F_t
Full vector of age-specific terminal F's (in 1992)

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
0	3.930E-2	3.965E-2	9.663E-3	0.25
1	4.406E-1	4.687E-1	1.416E-1	0.32
2	1.075E0	1.387E0	1.134E0	1.05
3	1.075E0	1.387E0	1.134E0	1.05
4	1.075E0	1.387E0	1.134E0	1.05
5+	1.075E0	1.387E0	1.134E0	1.05

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
0	3.445E-4	6.833E-4	0.88	3.896E-2	0.25
1	2.810E-2	1.001E-2	6.38	4.125E-1	0.34
2	3.120E-1	8.020E-2	29.01	7.634E-1	1.49
3	3.120E-1	8.020E-2	29.01	7.634E-1	1.49
4	3.120E-1	8.020E-2	29.01	7.634E-1	1.49
5+	3.120E-1	8.020E-2	29.01	7.634E-1	1.49

BOOTSTRAP OUTPUT VARIABLE: F_full_t
Fully-recruited F in the terminal year (1992)

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
2-4,u	1.075E0	1.387E0	1.134E0	1.05

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
2-4,u	3.120E-1	8.020E-2	29.01	7.634E-1	1.49

Table 50. Continued.

BOOTSTRAP OUTPUT VARIABLE: PR_t
Partial recruitment vector in the terminal year (1992)

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
0	3.655E-2	3.710E-2	1.686E-2	0.46
1	4.098E-1	4.412E-1	2.152E-1	0.53
2	1.000E0	9.980E-1	2.088E-2	0.02
3	1.000E0	9.980E-1	2.088E-2	0.02
4	1.000E0	9.980E-1	2.088E-2	0.02
5+	1.000E0	9.980E-1	2.088E-2	0.02

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
5.501E-4	1.192E-3	1.50	3.600E-2	0.47
3.138E-2	1.521E-2	7.66	3.784E-1	0.57
-1.993E-3	1.476E-3	-0.20	1.002E0	0.02
-1.993E-3	1.476E-3	-0.20	1.002E0	0.02
-1.993E-3	1.476E-3	-0.20	1.002E0	0.02
-1.993E-3	1.476E-3	-0.20	1.002E0	0.02

BOOTSTRAP OUTPUT VARIABLE: PR_mean
Average partial recruitment over 1990-1992

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
0	3.697E-2	3.652E-2	7.023E-3	0.19
1	4.777E-1	4.745E-1	8.092E-2	0.17
2	8.959E-1	8.948E-1	6.852E-3	0.01
3	9.799E-1	9.789E-1	7.481E-3	0.01
4	9.438E-1	9.430E-1	7.757E-3	0.01
5+	9.438E-1	9.430E-1	7.757E-3	0.01

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
0	-4.520E-4	4.966E-4	-1.22	3.743E-2	0.19
1	-3.177E-3	5.722E-3	-0.67	4.808E-1	0.17
2	-1.047E-3	4.845E-4	-0.12	8.969E-1	0.01
3	-1.005E-3	5.290E-4	-0.10	9.809E-1	0.01
4	-8.141E-4	5.485E-4	-0.09	9.446E-1	0.01
5+	-8.141E-4	5.485E-4	-0.09	9.446E-1	0.01

BOOTSTRAP OUTPUT VARIABLE: B_mean_t
Mean stock biomass during the terminal year (1992)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
2.908E4	2.985E4	5.409E3	0.19

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
7.708E2	3.824E2	2.65	2.831E4	0.19

Table 50. Continued.

BOOTSTRAP OUTPUT VARIABLE: SSB_f_mean_t
Mean female SSB during the terminal year (1992)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
9.937E3	1.017E4	2.049E3	0.21

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
2.291E2	1.449E2	2.31	9.708E3	0.21

BOOTSTRAP OUTPUT VARIABLE: SSB_spawn_t
SSB (males & females) at start of spawning season (1992)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1.495E4	1.545E4	3.712E3	0.25

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
5.002E2	2.625E2	3.34	1.445E4	0.26

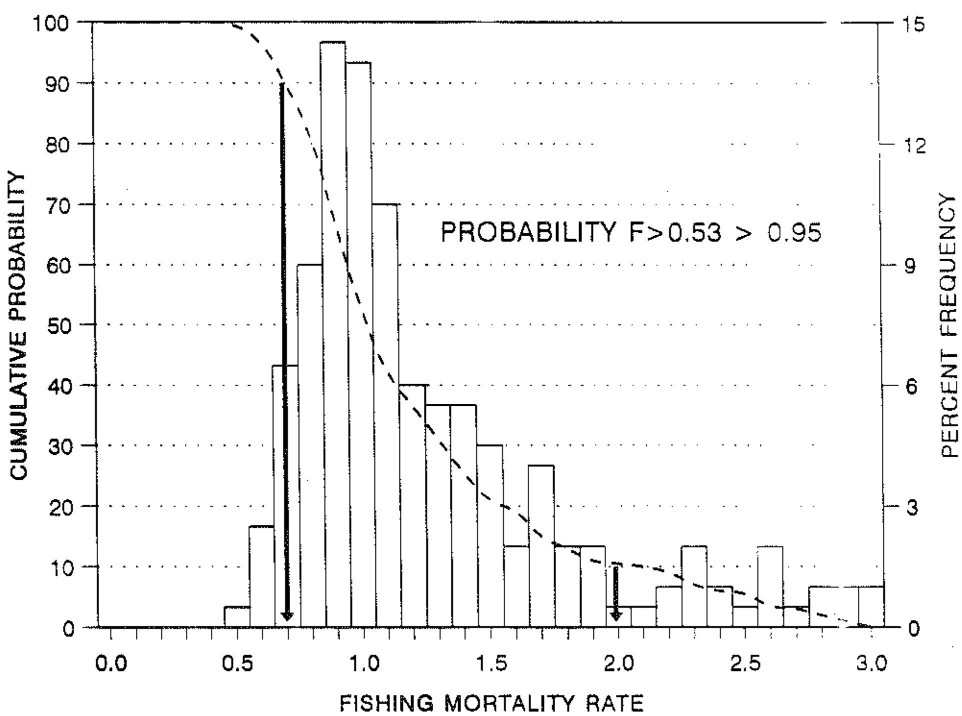

Figure 8. Precision of the estimates of fully recruited F (ages 2-4,u) in 1992 for summer flounder. Vertical bars display the range of the bootstrap estimate and the probability of individual values in that range. The dashed line gives the probability that F is greater than any value along the X axis.

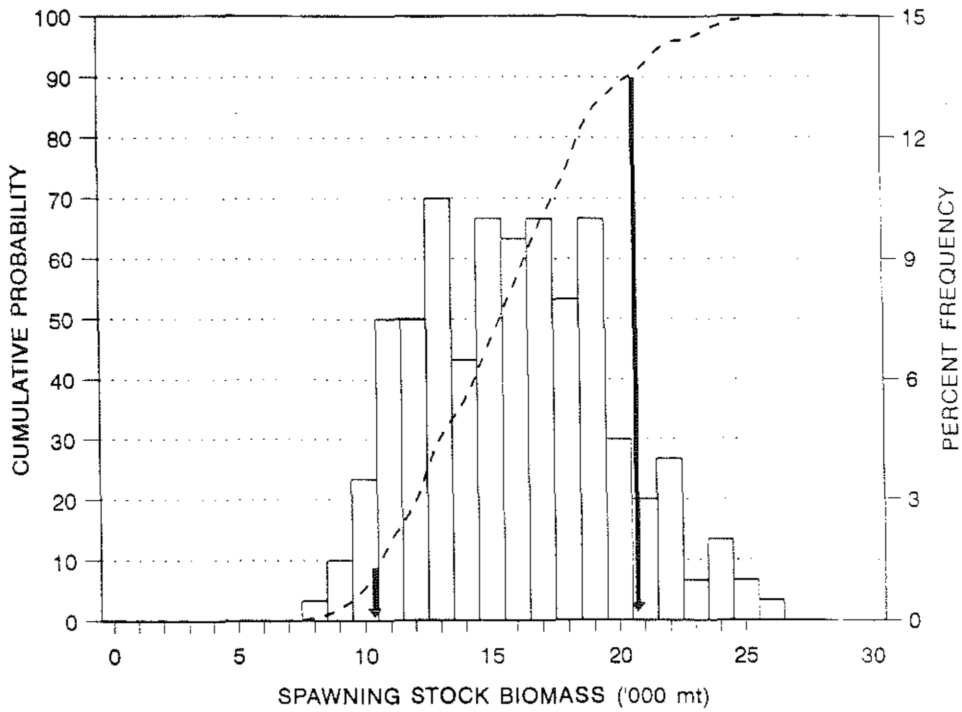

Figure 9. Precision of the estimates of spawning stock biomass on November 1, 1992 for summer flounder. Vertical bars display the range of the bootstrap estimate and the probability of individual values in that range. The dashed line gives the probability that SSB is less than any value along the X axis.

of abundance from existing NEFSC sea sample data (catch = kept + discard) to provide a commercial fishery index that accounts for all removals by the fishery.

3) Continue the NEFSC sea sampling program collection of data for summer flounder, with special emphasis on a) improved areal and temporal coverage, b) adequate length and age sampling, and c) continued sampling after commercial fishery quotas are reached. Maintaining adequate sea sampling will be especially important in the next few years, in order to monitor a) the effects of implementation of gear and closed/exempted area regulations, both in terms of the response of the stock and the fishermen, b) potential continuing changes in "directivity" in the summer flounder fishery, as a results of changes in stock levels and regulations, and c) discards of summer flounder in the otter trawl fishery once quota levels have been attained and the summer flounder fishery is closed or restricted by trip limits.

4) The 1989 to 1992 NEFSC sea sample data show that summer flounder landings and discard occur in many different components of the Southern New England (SNE) and Mid-Atlantic (MA) otter trawl fishery, as characterized by area and time strata (fisheries statistical division and calendar quarter). In the current estimation procedure, the geometric mean discard rate (kg/day fished) from the sea sampling data is multiplied by the number of days fished recorded by the weighout sampling program, within division/quarter strata, to estimate total discard. The basis for combining the two sampling programs to estimate discards rests with the good agreement between a) landings estimated from the sea sample landings rates and days fished recorded in the weighout database (SS_est), and b) landings reported directly in the weighouts (WO_est).

Consideration of the variation in catch and discard rates in the different area/time strata has proven necessary to obtain what appear to be reasonable estimates of summer flounder discard during 1989 to 1992. Valuable

Table 51. Input parameters and projection results for summer flounder, landings, discard, and spawning stock biomass (mt)[1]

	Stock Size in 1993	Fishing Mortality Pattern	Proportion Landed	Proportion Mature	Mean Weights Spawning Stock	Mean Weights Landings	Mean Weights Discards
0	22721,33858, 50453	0.04	0.150	0.38	0.211	0.282	0.192
1	24492, 32887,41282	0.49	0.580	0.72	0.430	0.491	0.352
2	22000	0.91	0.990	0.90	0.751	0.801	0.604
3	3042	1.00	1.000	1.00	1.237	1.237	1.237
4	733	1.00	1.000	1.00	1.794	1.794	1.794
5+	116	1.00	1.000	1.00	2.835	2.835	2.835

F_{93} = F realized if 1993 quota is taken

F_{93}	Stock size at age 0 in 1993-95	Stock size at age 1 in 1993	1993 000s mt Land.	1993 000s mt Disc.	1993 000s mt SSB	$F_{1994\text{-}95}$	1994 000s mt Land.	1994 000s mt Disc.	1994 000s mt SSB	1995 000s mt Land.	1995 000s mt Disc.	1995 000s mt SSB
0.52	22721	24492	9.4	0.9	18.2	F_{tgt}=0.53	12.1	0.6	21.0	12.6	0.7	21.8
0.48	33858	32887	9.4	1.1	21.1	F_{tgt}=0.53	14.4	1.0	26.1	16.2	1.0	28.8
0.46	50453	41282	9.4	1.3	24.4	F_{tgt}=0.53	17.0	1.5	32.6	20.8	1.5	38.1

[1] Starting stock sizes on 1 January 1993 are as estimated by VPA, except age 0 which is the geometric mean of VPA estimated numbers at age 0 (thousands) for 1988-92, + 1 standard error. Stock size at age 1 is also examined for a range of values (VPA point estimate + 1 standard error). Fishing mortality was apportioned among landings and discard based on the proportion of F associated with landings and discard at age during 1990-92. Mean weights at age (spawning stock, landings, and discards) are geometric means of 1990-92 values. Recruitment levels in 1994-95 are also estimated as the geometric mean of numbers at age 0 (thousands), + 1 standard error, during 1988-92. F_{93} is the F realized if fishery landings quotas, plus associated discard, are caught in 1993 (commercial landings = 5600 mt, recreational landings = 3800 mt). F_{tgt} = 0.53 is the target designated by the MAFMC. Proportion of F, M before spawning = 0.83 (spawning peak at 1 November).

information on summer flounder catch and discard rates is received from sea sample trips that do not target summer flounder. Current sea sampling effort (*i.e.*, number of trips) for summer flounder varies considerably across division and quarter. To evaluate the efficacy of the current allocation of sea sampling in the SNE/MA otter trawl fishery for summer flounder, the WG examined the relative error between landings estimated from data collected by the sea sampling and weighout systems.

Relative error was defined as $(SS\_est_{y,d,q} - WO\_est_{y,d,q})/WO\_est_{y,d,q}$ where $SS\_est_{y,d,q}$ is the sea sampling estimate of landings for year y, division d, and quarter q and $WO\_est_{y,d,q}$ is the associated weighout estimate. Standard sampling theory suggests that the accuracy of estimate should improve with the number of representative samples per cell. A plot of relative error versus the number of sea sampling trips per division/quarter stratum illustrates the expected pattern of decreasing error with increasing number of trips (Figure 10). When no sample trips were conducted in a given cell, estimates were imputed from appropriate adjacent cells. The analysis suggests that little reduction in relative error occurs at sampling intensities grater than six trips per cell, and that the overall relative error of the discard estimates could be minimized by doubling the current sea sampling effort in the SNE/MA otter trawl fishery (from the

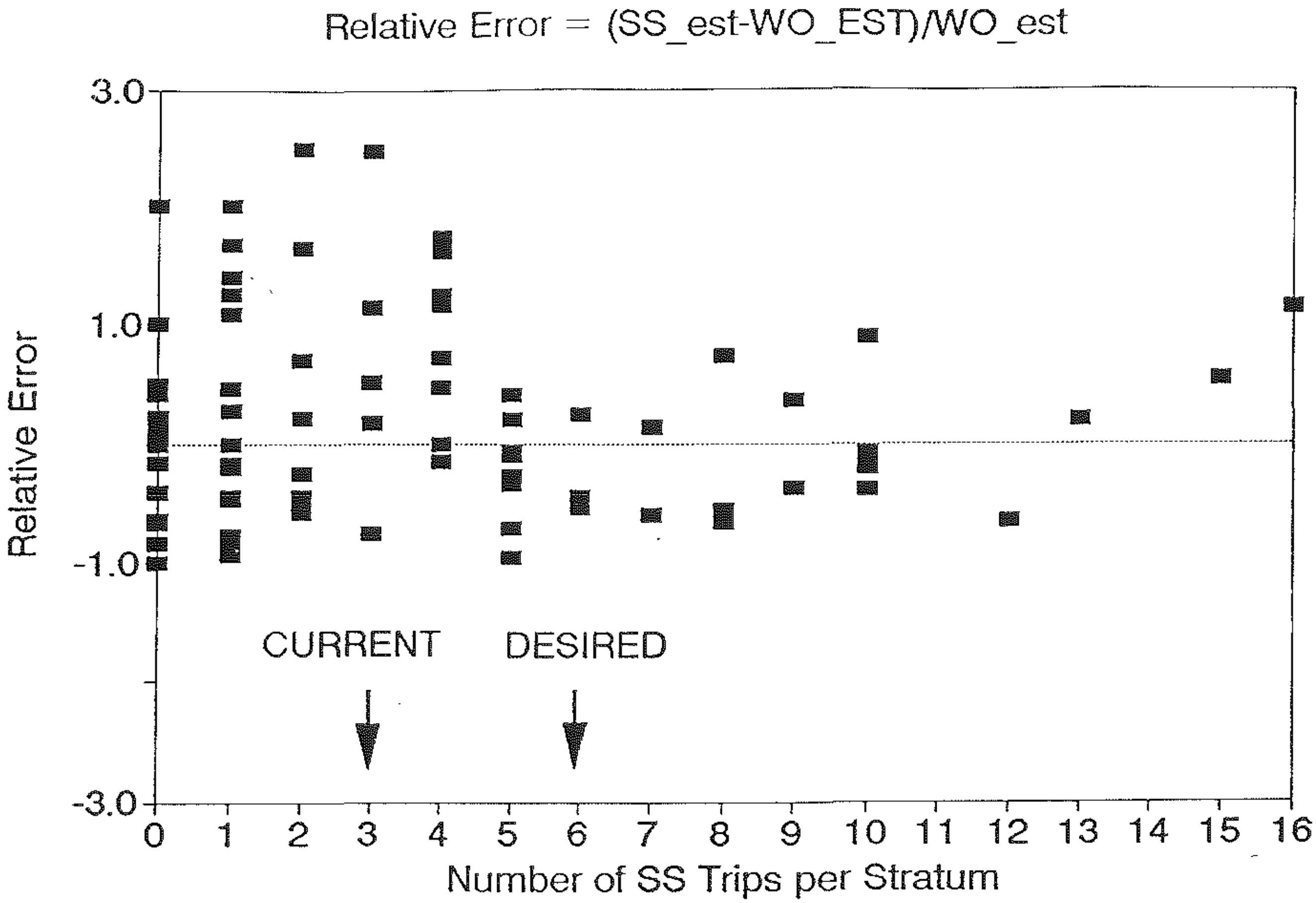

Figure 10. Relative error in the estimates of landings from sea sample and weighout data versus the number of sea sampling trips per year in division/quarter stratum. Sea sampling trips are those catching any summer flounder, split by division, in the Southern New England/Mid-Atlantic otter trawl fishery, 1989-1992.

1989 to 1992 average of 78 trips per year, split by division, which caught any summer flounder, to 156 trips per year). A preliminary examination of a GLM (SAS 1985) with year, division, quarter, and number of sea sampling trips as factors showed significant division and division by sea sampling trip interaction effects, suggesting varying allocation of trips by division will be necessary to optimize sampling effort. Allocation of effort among cells should be investigated further.

5) The WG encourages continuing research to determine length and age frequency and discard mortality rates of commercial and recreational fishery summer flounder discards.
6) The WG encourages review of available information on mesh selectivity of diamond and square mesh for summer flounder. This information will be important in the future to make accurate projections of landings, discard, and spawning stock biomass under various mesh size/minimum length/quota combinations.
7) The WG urges continuation of the NEFSC winter trawl survey, as initial analyses of winter survey data suggest that this series will provide more reliable and precise indices of abundance for use in mortality estimation and VPA tuning than those provided by the NEFSC spring and autumn survey time series.

MAJOR SOURCES OF ASSESSMENT UNCERTAINTY

The WG identified the following major sources of uncertainty in the current assessment:

1) VPA estimates of stock size in 1993

are not precise because they depend on imprecise survey indices. Projected landings should be considered with caution.

2) Indices of recruitment are not available for 1993, and so estimates of age 0 in 1993 for projections are based on a geometric mean, ± 1 standard error.
3) Sea sampling length frequency data for 1992 are unavailable, and so 1989 to 1991 mean proportions at age, length at age, and weights at age have been used to characterize the 1992 commercial fishery discard. Effects of quota restrictions on discard patterns in 1993 cannot be incorporated into projections.
4) North Carolina commercial landings at age for 1992 are based on provisional length frequency data (data for quarters 1 and 4 only), and may be revised somewhat in the future.
5) The current assumptions accepted to allow characterization of the age composition of the recreational live discard are based on data from a limited geographic area (Long Island, New York).
6) The present maturity ogive for summer flounder is based on simple gross examination of ovaries, and may not accurately reflect the spawning potential of summer flounder, especially age 0 and age 1 fish.

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