Papers of the Northeast Regional
Stock Assessment Workshops

Assessment of the Georges Bank Haddock Stock

by

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Introduction:

The haddock (Melanogrammus aeglefinus) population within U.S. waters is assumed to consist of two major stocks. Haddock landed from Division 5Z and Statistical Area 6 constitute the Georges Bank stock; haddock from Division 5Y constitute the Gulf of Maine Stock. These stock definitions are based on tagging studies, meristic data, age composition and growth data (see Clark et al. 1982). Several authors have suggested that a separate stock may exist in the Nantucket Shoals area (Clark et al. 1982; Schroeder 1942; Bigelow and Schroeder 1953). No recent data are available, however, to substantiate the persistence of a reproductively isolated stock in this area.

The haddock fishery on Georges Bank developed during the mid-1800's as a bycatch in the cod handline fishery (Jensen 1967). With the introduction of the Vigneron-Dahl trawl near the turn of the century and improved technology for providing fresh and frozen fish products, a directed haddock fishery developed. After this development period, yields from the fishery stabilized. From 1935 to 1960, annual yields averaged approximately 46,000 mt (Clark et al. 1982). During the early 1960's, distant water fleets from the Soviet Union, Spain and other countries began to direct fishing effort toward haddock on Georges Bank. This increase in effort temporarily resulted in yields in excess of 100,000 mt (Clark et al. 1982). By 1969, landings had decreased to a level below that maintained during the 1935-1960 period, and continued to decline throughout much of the 1970's (Table 1). During the late 1970's and early 1980's landings increased, however the fishery did not recover to a pre-1960 level. Since 1980, landings have declined steadily to the current level of 5284 mt in 1990 (Table 1).

Haddock are currently managed under the New England Fishery Management Council's northeast multispecies fishery management plan. While some haddock are caught in gillnets, line trawls and other gear, the otter trawl is the predominant gear used, accounting for over 97% of the total landings during the past 5 years. Recreational landings are low; estimates for 1990 indicate that landings were less than 100 mt.

Commercial Landings

Commercial landings in 1990 were 5284 mt, 18% higher than in 1989. Increases in landings from 1989 were evident in both the USA and Canadian fisheries (Table 1). Current levels of landings are approximately one-half to one-fifth the landings observed during the late 1970's and early 1980's, and are roughly one-ninth that of the 1935 to 1960 average. Otter trawling accounted for over 99% of the landings in the USA fishery during 1990; in the Canadian fishery, otter trawls were also the predominant gear but line trawls accounted for 26% of landings (Gavaris and Van Eeckhaute 1991).

Length frequency sampling

In a departure from previous assessments, several of the standard 3-digit Northeast statistical areas have been combined to form two new strata. The impetus for aggregating landings and length frequency samples into two strata was the low number of length frequency samples available from George Bank during the latter part of the 1980's (Table 2). In many cases, only one or two samples were available for a market category within a given quarter. Thus, to avoid the process of applying single length frequency samples to unsampled strata, the strata were collapsed. For convenience, the new strata are referred to as Eastern Georges and Western Georges. Eastern Georges includes area 561, 562, 523 and 524; Western Georges includes areas 521, 522, 525, 526, 541, 542, 537, 538, 539 and statistical area 6. The choices for these new strata was based on grouping the old strata which had similar mean lengths across years and which were geographically adjacent (Table 3). Additional analyses on mean length at age (see section on age sampling) also indicated that these grouping are appropriate.

The number of samples taken within a market category/area/quarter combination (stratum) varied from 0 to 15. When no samples were available within a stratum, the length frequency from the other area was used. In 1989, quarter 3, no samples were available for market category 1470. The length frequency for this stratum was estimated as the average of the quarter 2 and 4 length frequencies for this market category.

It should be noted that while a point estimate of the length frequency can be estimated from a single sample, an unbiased estimate of the variance can not be computed from the sample. Further, when no samples within a stratum are available, the processes of applying the length frequency from the other area can bias estimates, and further, the mean square error can not be computed directly. With these considerations, a minimum of one sample is required for unbiased point estimates, and two samples are required for unbiased estimates of the variance. As such, it is recommended that at least two samples from Eastern and Western

Georges Bank be taken each quarter so that the variance of the catch at age matrix can be computed and the adequacy of sampling evaluated.

Age composition sampling

As indicated under the length frequency sampling section, the current 3-digit Northeast statistical areas were collapsed into two new strata. Plots of mean length at age of haddock collected in NEFC trawl surveys indicate substantial differences between Eastern and Western Georges Bank (Figure 1). An alternate way of depicting the differences between these regions is the mean age at length. Plots of mean age at length by quarter from commercial samples indicate that generally mean age at length was less in Western Georges Bank than Eastern Georges Bank (Figures 2-6). Because of these differences in age-length relationships, it is inappropriate to treat Georges Bank as a single sampling stratum.

Additional analyses were performed to evaluate the appropriateness of pooling age-length keys across quarter and pooling age-length data from the survey with commercial samples (Appendix B). These analyses indicate that the age at length of fish collected in NEFC trawl surveys does not differ substantially from haddock collected commercially, and age at length does not differ substantially between quarters one and two. Thus, age-length keys were computed using both commercial and survey age data, and age-length keys were computed for the first and second quarter combined and for the third and fourth quarters separately. The sample sizes resulting for each stratum are presented in Table 4.

Catch at age

Catch at age was computed for the USA fishery for the years 1982-1990 (Table 5). Catch at age for the Canadian fishery 1982-1990 was taken from Gavaris and Van Eeckhaute (1991) (Table 6). Catch at age prior to 1982 (Table 7) was taken from previous assessments (Clark et al. 1982; Overholtz et al. 1983). Catch at age was computed following the procedures outlined in Quinn et al (1983); computation of the variance of catch at age followed Gavaris and Gavaris (1983). Several approximations were made in the computation of variance, however. First, the effect of cluster sampling of the length frequency and age data was ignored, resulting in an underestimate of variance. Secondly, the variance of estimates of mean weight at length using length-weight regressions was also ignored, again resulting in underestimates of variance. Finally, the variance (and bias, contributing to mean square error) introduced by applying length frequency samples from one area to the other when no sample was available could not be estimated. This approximation also likely results in a underestimate of variance. As all of these sources

of bias are likely to be in the same direction, the estimates provided here are minimum estimates of variance, and the actual variance is potentially much larger.

Catch at age during the period from 1982-1990 has been dominated by the 1978, 1983, 1985, and 1987 year classes (Table 5). Coefficients of variation for these years classes was generally on the order of 5%, however this is a minimal estimate and the actual c.v. could be substantially larger.

Mean length and weight at age

Mean length and weight at age at capture were calculated for the USA fishery for 1982-1990 (Table 8). Mean weight at age for previous years (Table 9) and for the Canadian fishery 1982-1990 (Table 6) were taken from previous assessments and Gavaris and Van Eeckhaute (1991). Within the 1982-1990 period, no trend in mean length and weight at age is apparent. For all landings from 1963-1990, there was a trend for higher weight at age following the late 1960's.

Mean weight at age for stock biomass computations were calculated following Rivard (1980) and are provided in Table 10. Estimates of the proportion of female fish mature at age are provided in Table 11.

Commercial CPUE

Commercial CPUE indices were computed for the USA otter trawl fishery for 1964-1990. Before analysis, the data were filtered to include only those trips where total catch was at least 50% cod, haddock and winter flounder. A multispecies qualification level was used because at present very few trips can be considered to be directed haddock trips. The use of a multispecies qualification is based on the assumption that fishing effort that is directed toward cod, haddock or winter flounder is likely to catch the others since these species commonly co-occur (Gabriel 1989).

Commercial CPUE indices were computed in two ways; GLM (General Linear Model) analysis and means of cell means. GLM analysis with all interactions (except those involving year) and no interactions were estimated. Comparison of the results of these GLM models show very little difference in the time series for each index (Table 12). The detailed results of these GLM models are presented in Appendix C. Results of means of cell means (where a cell is defined as a quarter/area/tonnage class combination) for tonnage class 3 and 4 vessels show a broad similarity in the resulting time series (Table 13). Plots of these indices with the GLM (without interactions) CPUE index indicate that all three indices follow the same general trend, with high values during the mid 1960's, a sharp decline to a

minimum during the 1970's, a rebounding during the late 1970's and another decline after 1980 (Figure 7). However, there are discrepancies in the details of the trend in each index. In particular, the GLM index shows large jumps during 1977 and 1981 where the cell mean method shows a much more gradual trend during these time periods (Figure 7). Currently, all three indices are near record lows for the time series.

Research survey indices

Prior to using NEFC research vessel bottom trawl survey indices for VPA tuning or indices of abundance, mean catch/tow in numbers were adjusted to account for the changes in gear usage that have occurred during the time series. The details of the estimation procedure for the adjustment factors and of gear usage during the time series are provided in Appendix A. For convenience, both the adjusted and unadjusted stratified mean catch/tow (numbers) are presented (Tables 14 and 15; Figure 8). Stratified mean catch/tow in terms of weight was not adjusted for changes in gear usage at this point in time because further analysis is necessary to determine the effect that differential vulnerability by size class has on estimates of adjustment factors to adjust mean biomass catch/tow.

Catch of age 1+ haddock in the autumn survey shows four distinct periods since the beginning of the NEFC bottom trawl survey in 1963. During the early 1960's, mean catch/tow was at its highest level, reaching a maximum for the time series in 1964 (Figure 8). Following this, survey catch/tow dropped sharply and remained at a low level from 1969-1975. A resurgence in catch was observed in 1976, and relatively high catch rates were observed until 1979, when the mean catch/tow again declined. The fall survey catch/tow from 1982 to the present has remained at a low level, averaging 3.83 fish/tow. The 1990 value of 2.23 fish/tow is among the lowest in the time series. The three strongest year classes, based on the mean catch/tow of age 0 haddock in the survey, were the 1963, 1975, 1985 year classes. The 1966, 1972, 1975, 1978, 1980, 1983 and 1985 year classes were also relatively strong, all with adjusted mean catch/tow of greater than 6.0 fish/tow. The three most recent year classes (1988-1990) all appear weak, all with a mean catch/tow of less than 1.0.

Spring NEFC bottom trawl surveys were initiated in 1968. As with the autumn survey, relatively high index values were observed from 1976 to 1979, and low values (averaging 6.59 fish/tow) from 1982 to the present. The 1990 spring survey index at 7.98 fish/tow was relatively close to the 1982 to 1990 average.

In 1986, the Department of Fisheries and Oceans (DFO), Canada, initiated a bottom trawl survey on Georges Bank (Table

16). Details of this survey are provided in Gavaris and Van Eeckhaute (1991).

Estimation of fishing mortality rates and stock size

The ADAPT (Gavaris 1988) method of "tuning" the results of VPA was used to derive estimates of population abundance and fishing mortality (Appendix D). Canadian bottom trawl survey catch/tow at age and NEFC spring and autumn bottom trawl survey catch/tow at age indices (adjusted for gear changes) were used for calibrating the results of VPA. The NEFC spring survey and Canadian survey indices were applied to the year they were conducted; the NEFC autumn survey indices were lagged one year and ages were shifted by one year. The NEFC autumn index was lagged since it is conducted closer to Jan 1 of the following year than Jan 1 of the year it is conducted in. Mean catch at age 1 to 8 in the NEFC spring survey and Canadian survey and mean catch at age 0 to 7 (lagged one year) in the NEFC autumn survey were used. Commercial CPUE indices were not used in the calibration procedure; since the USA fishery covers only a portion of the stock area it was felt that commercial CPUE of the USA fishery could be biased with respect to the total population. Canadian CPUE could not be used since management measures (i.e. trip limits; Gavaris and Van Eeckhaute 1991) imposed on the haddock fishery could seriously bias CPUE indices. Commercial catch at age 1 through 8 and 9+ formed the basis for the VPA calculations.

As in previous assessments (i.e. Gavaris and Van Eeckhaute 1991) the natural mortality rate was assumed to be 0.2. Instantaneous fishing mortality rates (F) on the oldest age group, age 8, was calculated as the "full F" for ages 4 to 7. F on the age 9+ group was set equal to F on the oldest true age (8). The parameters estimated from the ADAPT procedure were stock abundance at ages 1-8 and Q for the Canadian survey and the NEFC spring survey ages 1 to 8 and Q for the NEFC autumn survey ages 0 to 7. Iterative reweighting (chi-weights) were not used since preliminary results had very high weight associated with a single survey/age group combination (Canadian survey age 3).

Results from ADAPT calibrations (Appendix D), showed low correlations ($-0.20 < r < 0.05$) among most parameter estimates. As expected, higher correlations were observed among estimates of Q for the Canadian survey due to the shortness of the time series. Estimates of stock size at age for 1991 were significant ($\alpha=0.05$), with c.v's ranging from 28-47%; estimates of research survey Q's were also significant ($\alpha=0.05$) with c.v.'s ranging from 15-34%. Currently, the 1987, 1989 and 1990 year classes dominate the population, accounting for 85% of stock numbers. During the 1980's, the strongest year classes were the 1983, 1985 and 1987 year classes, all with approximately 14-17 million fish at age 1 (Table 17, Figure 9). Although these year classes were

strong relative to the intervening year classes, they are weak compared to the dominant year classes of previous decades. During the 1970's, the 1978 and 1975 were the strongest, at 84 and 102 million fish, respectively (Table 17, Figure 9). During the 1960's, the 1963 year class at 471 million fish and the 1962 year class at 190 million fish were the two largest in the time series (Table 17, Figure 9).

Estimates of total population number (age 1+) show high population abundance during the mid-1960's, a decline to low levels during the early 1970's, moderate populations levels during the late 1970's and early 1980's, and low population abundance during the remainder of the 1980's (Figure 10). F on fully recruited age classes (ages 4-9+) show in general a decline from approximately 0.5 in 1965 to 0.12 in 1974 and a subsequent increase in F to approximately 0.6 in 1990 (Figure 10). F on individual age classes shows a similar trend to that for the fully recruited age classes, except that F on age 1 and 2 fish was relatively high during the period when distant water fleets were present in the fishery (Figure 11).

A comparison of estimates of F and population abundance obtained using adjusted and unadjusted NEFC bottom trawl survey indices indicates that the correction factors applied for changes in gear usage have a relatively minor effect on the overall trend in the estimates of population abundance (Figure 11). The effects on estimates of F of fully recruited age classes, however, was larger, resulting in an apparent stabilization of F from approximately 1980 to the present time when the unadjusted survey indices are used (Figure 11).

Yield per recruit

Yield per recruit analyses were conducted using the partial recruitment vector estimated from ADAPT for 1989 and 1990. Results from these years were chosen because of changes in regulatory measures imposed by DFO, Canada during 1989. Since the maturity schedule and mean weight at age have shown strong shifts over time for this stock (Tables 10 and 11), yield per recruit and percent MSP analyses were conducted using data from three time periods: 1963-1967; 1968-1983; and 1985-1990. Results of these analyses (Tables 19-21; Figure 12) indicate that $F_{0.1}$ is in the range 0.23-0.24; F_{max} is in the range 0.72-0.82; and $F_{30\%}$ is in the range 0.32-0.40 (Tables 19-21, Figure 12).

Projections

Projections were made using three levels of recruitment, corresponding to the geometric mean and ± 1 standard deviation of the recruitment for the past 5 years (Table 22, Figure 14). To begin the projections, numbers at age for the beginning of 1991

were taken from the ADAPT results. Fishing mortality for 1991 was taken to be status quo, and projections were made using status quo F for 1992 and 1993, and using $F_{0.1}$ and $F_{30\%}$ for 1992 and 1993. Projections to 1993 suggest a decline in landings and spawning stock biomass (SSB) for all choices of fishing mortality. Only for $F_{0.1}$ do SSB and landings show any stabilization over time. Fishing at $F_{30\%}$ and at status quo F results in a downward trend in both landings and SSB for the short term (Figure 14).

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Table 1. Commercial landings (metric tons, live) of haddock from Georges Bank and South (NAFO Division 5Z and Statistical Area 6).[1]

Year	USA	Canada	USSR	Spain	Other	Total
1960	40800	77	0	0	0	40877
1961	46384	266	0	0	0	46650
1962	49409	3461	1134	0	0	54004
1963	44150	8379	2317	0	0	54846
1964	46512	11625	5483	2	464	64086
1965	52823	14889	81882	10	758	150362
1966	52918	18292	48409	1111	544	121274
1967	34728	13040	2316	1355	30	51469
1968	25469	9323	1397	3014	1720	40923
1969	16456	3990	65	1201	540	22252
1970	8415	1978	103	782	22	11300
1971	7306	1630	374	1310	242	10862
1972	3869	609	137	1098	20	5733
1973	2777	1563	602	386	3	5331
1974	2396	462	109	764	559	4290
1975	3989	1358	8	61	4	5420
1976	2904	1361	4	46	9	4324
1977	7934	2909	0	0	0	10843
1978	12160	10179	0	0	0	22339
1979	14279	5182	0	0	0	19461
1980	17470	10017	0	0	0	27487
1981	19176	5658	0	0	0	24834
1982	12625	4872	0	0	0	17497
1983	8682	3208	0	0	0	11890
1984	8807	1463	0	0	0	10270
1985	4273	3484	0	0	0	7757
1986	3339	3415	0	0	0	6754
1987	2156	4703	0	0	0	6859
1988	2492	4046 [2]	0	0	0	6538
1989	1430	3059	0	0	0	4489
1990	2001	3283	0	0	0	5284

[1] All landings 1960-1979 are from Clark et al. (1982); USA landings 1980-1981 are from Overholtz et al. (1983); USA landings 1982-1991 are from NMFS, NEFC Detailed Weighout Files and Canvass data; Canadian landings 1980-1990 from Gavaris and Van Eeckhaute (1991).

[2] 1895 tons were excluded because of suspected misreporting (Gavaris and Van Eeckhaute 1991).

Table 2. USA sampling of commercial haddock landings for length composition from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1982-1990. Eastern Georges refers to samples from areas 561, 562, 523 and 524; Western Georges includes all samples from areas 521, 522, 525, 526, 541, 542, 537, 538, 539 and statistical area 6. Upper line for each year is number of samples collected; second line is number of fish measured; third line is landings (mt). Q1, Q2, Q3, Q4, denote quarters 1, 2, 3, and 4, respectively.

	MARKET CATEGORY 1470								MARKET CATEGORY 1475							
	EASTERN GEORGES				WESTERN GEORGES				EASTERN GEORGES				WESTERN GEORGES			
YEAR	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1982	3	9	8	4	1	4	7	7	6	7	6	3	1	4	15	4
	512	1384	961	334	162	475	748	624	329	560	263	204	57	208	819	211
	1172	1953	599	410	786	1468	1757	1014	503	887	499	220	273	284	503	247
1983	7	9	6	5	4	12	17	5	3	9	4	4	2	5	8	2
	675	992	669	548	397	1219	1736	366	171	563	225	246	113	288	604	143
	1394	1182	393	404	557	1444	1014	587	299	452	201	123	96	215	214	73
1984	9	7	1	5	3	3	2	3	11	4	2	1	0	1	2	3
	952	876	152	516	309	303	169	206	638	208	152	58	0	38	75	110
	1585	1541	646	313	623	1172	960	530	282	399	269	62	79	144	119	48
1985	7	1	1	0	1	0	4	1	7	4	2	0	0	1	2	1
	775	100	106	0	98	0	339	95	441	252	102	0	0	46	100	74
	563	745	60	80	273	931	596	226	45	109	48	29	25	128	308	84
1986	4	2	3	2	1	2	3	3	2	3	1	0	0	1	2	1
	345	205	224	169	43	184	235	314	82	193	53	0	0	54	108	67
	558	453	32	31	106	287	274	159	355	733	17	10	50	159	68	29
1987	3	4	1	3	2	1	6	2	2	7	0	1	0	0	3	1
	312	427	54	214	183	107	329	99	116	442	0	50	0	0	190	50
	231	495	84	72	98	173	193	107	85	369	37	22	15	51	80	19
1988	5	4	1	4	1	1	1	0	2	4	2	4	1	2	2	0
	498	430	118	338	21	98	94	0	98	231	106	227	33	137	113	0
	348	529	43	44	67	232	184	75	207	398	12	112	32	129	42	32
1989	2	2	0	1	1	1	0	0	4	1	1	1	0	1	7	0
	203	203	0	99	109	105	0	0	226	62	50	77	0	50	364	0
	117	274	11	31	72	166	96	44	98	195	12	45	19	75	125	45
1990	1	5	0	1	2	0	1	0	5	5	1	2	1	1	1	1
	102	523	0	101	201	0	117	0	292	277	50	138	50	50	50	50
	187	365	14	25	117	123	171	91	136	424	17	15	80	103	90	33

Table 3. Three-digit North Eastern statistical area with closest mean length fo areas 521, 522, 525, 526, 561, 562 for the years 1984-1990.

Market category 1470

AREA	1984	1985	1986	Year 1987	1988	1989	1990	Most Frequent
521	561	522	561	525	526	-	525	525
522	525	521	525	525	-	561	-	525
561	521	562	562	562	562	522	-	562
562	525	561	522	561	561	522	525	561
525	562	521	522	521	561	-	562	521,562
526	-	-	-	521	521	562	-	521

Market category 1475

AREA	1984	1985	1986	Year 1987	1988	1989	1990	Most Frequent
521	561	522	522	562	561	522	525	522
522	561	521	562	561	526	521	521	521
561	521	521	562	562	526	562	562	562
562	522	522	561	561	522	561	525	561
525	-	-	-	-	-	-	521	521
526	-	-	-	-	561	-	-	561

Table 4. Sample size used in forming age-length keys for commercial landings of haddock from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1984-1990. Eastern Georges refers to samples from areas 561, 562, 523 and 524; Western Georges includes all samples from areas 521, 522, 525, 526, 541, 542, 537, 538, 539 and statistical area 6. In each year, age-length keys were formed pooling quarter 1 and quarter 2 samples. Age-length keys also included data from fish collected in NMFS bottom trawl surveys.

	EASTERN GEORGES			WESTERN GEORGES		
	QUARTER			QUARTER		
YEAR	1+2	3	4	1+2	3	4
1982	662	257	296	205	402	245
1983	554	202	267	541	532	212
1984	597	79	304	153	110	132
1985	616	63	0	92	95	39
1986	422	80	182	140	93	85
1987	372	24	109	88	392	145
1988	486	150	267	127	201	3
1989	411	111	77	148	231	1
1990	461	50	214	142	130	49

Table 5. Commercial catch (numbers 000's) at age of haddock landed in the USA fishery from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1882-1990.

Catch (000's)

Year	Age Group 1	2	3	4	5	6	7	8	9+	TOTAL
1982	1	852	1164	2333	298	463	924	97	105	6237
1983	0	53	454	432	1560	196	152	711	72	3630
1984	0	81	259	664	345	1310	173	234	439	3506
1985	0	384	245	80	372	173	439	56	90	1840
1986	0	16	1109	137	76	121	121	226	39	1845
1987	0	9	39	525	63	41	59	78	67	881
1988	0	1	506	53	541	96	48	48	20	1313
1989	0	131	18	254	79	156	33	20	8	700
1990	0	5	375	117	367	84	55	17	10	1031

Standard error of catch at age (000's)

Year	1	2	3	4	5	6	7	8
1982	1.2	32.7	50.4	66.0	28.0	32.3	39.4	12.7
1983	0.0	6.7	19.2	22.2	38.9	16.2	12.9	26.1
1984	0.0	11.4	23.8	34.9	25.9	47.6	17.7	22.1
1985	0.0	29.4	28.0	14.7	33.6	24.8	29.3	8.6
1986	0.0	5.7	53.3	17.3	11.1	12.5	13.3	18.0
1987	0.0	5.4	5.9	17.2	6.7	5.4	6.4	6.7
1988	0.0	0.7	21.6	9.2	23.4	8.5	5.8	5.4
1989	0.0	6.4	2.9	12.4	6.9	10.7	4.2	4.3
1990	0.0	1.7	16.4	9.3	17.3	7.8	6.2	2.9

Coefficient of variation of catch at age

Year	1	2	3	4	5	6	7	8
1982	86.9	3.8	4.3	2.8	9.4	7.0	4.3	13.1
1983		12.7	4.2	5.1	2.5	8.3	8.5	3.7
1984		14.1	9.2	5.2	7.5	3.6	10.2	9.4
1985		7.6	11.4	18.4	9.0	14.4	6.7	15.3
1986		34.8	4.8	12.6	14.6	10.3	10.9	8.0
1987		58.4	15.2	3.3	10.7	13.4	10.8	8.5
1988		55.5	4.3	17.4	4.3	8.9	12.0	11.2
1989		4.9	15.7	4.9	8.7	6.8	12.6	21.3
1990		34.7	4.4	8.0	4.7	9.3	11.1	16.9

Table 6. Commercial catch (numbers 000's) at age of haddock landed in the Canadian fishery from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1982-1990.[1]

Catch (000's)

Year	Age Group 1	2	3	4	5	6	7	8	9+	TOTAL
1982	0	313	469	1400	93	106	195	9	5	2590
1983	0	161	359	258	679	76	34	89	4	1660
1984	0	12	38	63	52	172	61	33	104	535
1985	0	2022	305	114	89	55	87	22	62	2756
1986	6	38	1701	86	70	52	29	40	21	2043
1987	0	1986	90	1088	59	32	30	28	68	3381
1988	4	51	1878	81	390	53	7	16	86	2566
1989	0	1132	68	623	64	202	13	8	37	2147
1990	2	7	1062	43	505	13	120	23	33	1808

Mean weight (kg) at capture

Year	Age Group 1	2	3	4	5	6	7	8
1982	-	1.056	1.556	1.915	2.348	2.801	2.909	3.414
1983	-	1.031	1.401	1.822	2.200	2.543	2.821	3.007
1984	-	0.883	1.401	2.010	2.257	2.770	2.918	3.326
1985	-	0.948	1.264	2.068	2.169	2.942	3.289	3.238
1986	0.452	0.981	1.458	2.104	2.913	2.899	3.646	4.248
1987	-	0.832	1.391	2.073	2.253	2.598	2.906	3.623
1988	0.421	0.974	1.315	1.787	2.234	2.264	2.978	3.036
1989	-	0.861	1.449	1.789	2.215	2.604	2.795	3.014
1990	0.635	0.960	1.443	1.764	2.228	2.498	2.750	2.553

[1] Data from Gavaris and Van Eeckhaute (1991).

Table 7. Total commercial catch (numbers 000's) at age of haddock from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1963-1990.[1]

	Age Group									
Year	1	2	3	4	5	6	7	8	9+	TOTAL
1963	2910	4047	7418	11152	8198	2205	1405	721	1096	39152
1964	10101	15935	4554	4776	8722	5794	2082	1028	1332	54324
1965	9601	125818	44496	5356	4391	6690	3772	1094	1366	202584
1966	114	6843	100810	19167	2768	2591	2332	1268	867	136760
1967	1150	168	2891	20667	10338	1209	993	917	698	39031
1968	8	2994	709	1921	14519	3499	667	453	842	25612
1969	2	11	1698	448	654	5954	1574	225	570	11136
1970	46	158	16	570	186	214	2308	746	464	4708
1971	1	1375	223	40	289	246	285	1469	928	4856
1972	156	2	450	81	32	120	78	66	1236	2221
1973	2560	2075	3	386	53	30	77	15	447	5646
1974	46	4320[2]	657	2	70	2	2	53	249	5401
1975	192	1034	1864	375	4	42	4	4	88	3607
1976	144	473	550	880	216	0	23	4	112	2402
1977	1	19585[3]	187	680	515	357	4	39	111	21479
1978	1	761	14395[4]	305	567	517	139	14	67	16766
1979	1	26	1726	7169	525	410	315	96	46	10314
1980	8	31000[5]	347	975	6054	594	546	153	81	39758
1981	1	1743	10998	831	937	2572	331	158	94	17665
1982	1	1165	1633	3733	391	569	1119	106	110	8827
1983	0	214	813	690	2239	272	186	800	76	5290
1984	0	93	297	727	397	1482	234	267	543	4041
1985	0	2406	550	194	461	228	526	78	152	4596
1986	6	54	2810	223	146	173	150	266	60	3888
1987	0	1995	129	1613	122	73	89	106	135	4262
1988	4	52	2384	134	931	149	55	64	106	3879
1989	0	1263	86	877	143	358	46	28	45	2847
1990	2	12	1437	160	872	97	175	40	43	2839

[1] Data 1963-1979 from Clark et al. (1982); Data 1980-1981 from Overholtz et al. (1983); Data 1982-1990 current assessment and Gavaris and Van Eekhaute (1991)

[2] Of this total, approximately 1000000 fish were added to the catch at age to account for high discards that occurred during 1974 (W. Overholtz, personal communication).

[3] Of this total, approximately 12800000 fish were added to the catch at age to account for high discards that occurred during 1977 (W. Overholtz, personal communication).

[4] Of this total, approximately 5000000 fish were added to the catch at age to account for high discards that occurred during 1978 (W. Overholtz, personal communication).

[5] Of this total, approximately 20000000 fish were added to the catch at age to account for high discards that occurred during 1980 (W. Overholtz, personal communication).

Table 8. Mean length and weight at age of haddock landed in the USA fishery from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), 1882-1990.

Mean Length (cm)

	Age Group								
Year	1	2	3	4	5	6	7	8	9+
1982	27.0	44.4	51.5	56.8	61.9	65.3	69.7	74.8	74.8
1983	-	45.5	50.7	56.6	60.7	64.6	69.5	70.4	75.7
1984	-	44.7	50.3	56.1	60.4	64.4	67.7	70.5	72.7
1985	-	48.7	53.4	57.1	63.8	65.1	67.6	73.9	73.4
1986	-	43.5	49.3	54.5	60.5	65.7	66.1	70.2	73.1
1987	-	48.6	53.3	57.1	60.7	65.1	68.5	74.0	76.8
1988	-	46.8	51.9	53.3	58.3	64.2	67.9	72.5	74.3
1989	-	48.4	53.6	56.6	60.7	64.0	71.1	74.4	74.9
1990	-	44.9	52.4	56.9	58.6	64.7	67.8	75.4	76.4

Mean weight (kg) at capture

	Age Group								
Year	1	2	3	4	5	6	7	8	9+
1982	0.225	0.932	1.410	1.854	2.375	2.753	3.315	4.015	4.091
1983	-	0.996	1.345	1.839	2.213	2.691	3.345	3.408	4.275
1984	-	0.924	1.305	1.812	2.191	2.659	2.979	3.425	3.718
1985	-	1.194	1.553	1.861	2.532	2.649	3.013	3.909	3.798
1986	-	0.846	1.219	1.656	2.230	2.807	2.798	3.325	3.781
1987	-	1.182	1.515	1.838	2.239	2.662	3.074	3.817	4.287
1988	-	1.065	1.436	1.510	1.927	2.545	2.972	3.643	3.963
1989	-	1.174	1.603	1.806	2.200	2.519	3.415	3.783	3.818
1990	-	0.981	1.523	1.809	1.959	2.597	2.960	4.005	4.164

Table 9. Mean weight (kg round weight) at age of haddock landed from Georges Ba and South (NAFO Division 5Z and Statistical Area 6).[1] Values enclosed parentheses are averages from surrounding years.

	Age								
Year	1	2	3	4	5	6	7	8	9+
1963	0.57	0.87	1.18	1.47	1.68	2.15	2.35	3.04	3.10
1964	0.50	0.83	1.12	1.43	1.64	2.01	2.40	2.64	2.97
1965	0.58	0.69	1.03	1.35	1.67	1.99	2.26	2.66	3.11
1966	0.58	0.73	0.89	1.26	1.70	2.07	2.28	2.87	3.18
1967	0.66	0.70	0.95	1.18	1.42	2.05	2.31	2.66	3.10
1968	0.59	0.81	1.05	1.32	1.57	2.10	2.32	2.62	2.86
1969	0.52	0.78	1.10	1.69	1.75	1.99	2.52	2.99	3.63
1970	0.71	1.27	1.22	1.93	2.19	2.39	2.58	3.23	3.75
1971	(0.67)	1.03	1.31	1.74	2.39	2.81	2.92	3.10	3.72
1972	0.62	1.03	1.74	2.04	2.42	2.92	3.06	3.44	3.66
1973	0.60	1.03	1.58	2.13	2.41	3.29	3.42	3.86	3.94
1974	0.72	1.06	1.82	2.32	2.83	3.76	4.05	3.92	4.26
1975	0.62	0.98	1.63	2.21	2.20	2.94	4.00	4.05	4.33
1976	0.50	0.99	1.39	1.99	2.66	(3.08)	3.69	4.67	4.94
1977	(0.53)	1.07	1.44	2.17	2.73	3.21	4.15	4.00	4.99
1978	(0.53)	0.94	1.50	2.04	2.79	3.19	3.37	3.61	5.11
1979	(0.53)	1.00	1.28	2.02	2.51	3.14	3.78	3.79	4.87
1980	0.55	0.94	1.21	1.73	2.17	2.82	3.60	3.56	3.87
1981	0.39	0.87	1.24	1.83	2.30	2.72	3.71	4.04	4.44
1982	0.22	0.97	1.45	1.88	2.37	2.76	3.24	3.96	4.09
1983	(0.33)	1.02	1.37	1.83	2.21	2.65	3.25	3.36	4.27
1984	(0.33)	0.92	1.32	1.83	2.20	2.67	2.96	3.41	3.72
1985	(0.33)	0.99	1.39	1.98	2.46	2.72	3.06	3.72	3.80
1986	0.45	0.94	1.36	1.83	2.56	2.83	2.96	3.46	3.78
1987	(0.43)	0.83	1.43	2.00	2.25	2.63	3.02	3.77	4.29
1988	0.42	0.98	1.34	1.68	2.06	2.45	2.97	3.49	3.96
1989	(0.53)	0.89	1.48	1.79	2.21	2.57	3.24	3.56	3.82
1990	0.64	0.97	1.46	1.80	2.11	2.58	2.82	3.17	4.16

[1] Data 1963-1979 from Clark et al. (1982); data 1980-present current assessment Gavaris and Van Eeckhaute (1991).

Table 10. Mean weight at age at spawning for Georges Bank haddock. Mean weight at spawning was calculated from mean weight at capture in the commercial catch using the procedures described by Rivard (1980).

	Age								
Year	1	2	3	4	5	6	7	8	9+
1963	0.472	0.767	1.072	1.392	1.536	2.035	2.217	2.673	3.100
1964	0.426	0.688	0.987	1.299	1.553	1.838	2.272	2.491	2.970
1965	0.517	0.587	0.925	1.230	1.545	1.807	2.131	2.527	3.110
1966	0.528	0.651	0.784	1.139	1.515	1.859	2.130	2.547	3.180
1967	0.596	0.637	0.833	1.025	1.338	1.867	2.187	2.463	3.100
1968	0.513	0.731	0.857	1.120	1.361	1.727	2.181	2.460	2.860
1969	0.333	0.678	0.944	1.332	1.520	1.768	2.300	2.634	3.630
1970	0.589	0.813	0.975	1.457	1.924	2.045	2.266	2.853	3.750
1971	0.540	0.855	1.290	1.457	2.148	2.481	2.642	2.828	3.720
1972	0.481	0.831	1.339	1.635	2.052	2.642	2.932	3.169	3.660
1973	0.451	0.799	1.276	1.925	2.217	2.822	3.160	3.437	3.940
1974	0.617	0.797	1.369	1.915	2.455	3.010	3.650	3.661	4.260
1975	0.491	0.840	1.314	2.006	2.259	2.884	3.878	4.050	4.330
1976	0.342	0.783	1.167	1.801	2.425	2.603	3.294	4.322	4.940
1977	0.398	0.731	1.194	1.737	2.331	2.922	3.575	3.842	4.990
1978	0.386	0.706	1.267	1.714	2.461	2.951	3.289	3.871	5.110
1979	0.398	0.728	1.097	1.741	2.263	2.960	3.472	3.574	4.870
1980	0.437	0.706	1.100	1.488	2.094	2.660	3.362	3.668	3.870
1981	0.247	0.692	1.080	1.488	1.995	2.429	3.235	3.814	4.440
1982	0.102	0.615	1.123	1.527	2.083	2.520	2.969	3.833	4.090
1983	0.198	0.474	1.153	1.629	2.038	2.506	2.995	3.299	4.270
1984	0.191	0.551	1.160	1.583	2.006	2.429	2.801	3.329	3.720
1985	0.196	0.572	1.131	1.617	2.122	2.446	2.858	3.318	3.800
1986	0.331	0.557	1.160	1.595	2.251	2.639	2.837	3.254	3.780
1987	0.285	0.611	1.159	1.649	2.029	2.595	2.923	3.341	4.290
1988	0.289	0.649	1.055	1.550	2.030	2.348	2.795	3.247	3.960
1989	0.392	0.611	1.204	1.549	1.927	2.301	2.817	3.252	3.820
1990	0.571	0.717	1.140	1.632	1.943	2.388	2.692	3.205	4.160

Table 11. Percentage mature of female Georges Bank haddock.

Year	Age 1	2	3	4+	Source
1963	0	0	78	100	Clark (1959)
1964	0	0	78	100	Clark (1959)
1965	0	0	78	100	Clark (1959)
1966	0	0	78	100	Clark (1959)
1967	0	0	78	100	Clark (1959)
1968	0	28	76	100	Clark et al. (1982)
1969	0	28	76	100	Clark et al. (1982)
1970	0	28	76	100	Clark et al. (1982)
1971	0	28	76	100	Clark et al. (1982)
1972	0	28	76	100	Clark et al. (1982)
1973	0	34	92	100	Clark et al. (1982)
1974	0	34	92	100	Clark et al. (1982)
1975	0	34	92	100	Clark et al. (1982)
1976	0	34	92	100	Clark et al. (1982)
1977	0	61	100	100	Overholtz (1987)
1978	0	26	99	100	Overholtz (1987)
1979	0	8	71	100	Overholtz (1987)
1980	0	41	100	100	Overholtz (1987)
1981	0	52	94	100	Overholtz (1987)
1982	0	31	67	100	Overholtz (1987)
1983	0	11	39	100	Overholtz (1987)
1984	12	33	94	100	O'Brien (pers. comm.)
1985	26	77	97	100	O'Brien et al. (1991)
1986	26	77	97	100	O'Brien et al. (1991)
1987	26	77	97	100	O'Brien et al. (1991)
1988	26	77	97	100	O'Brien et al. (1991)
1989	26	77	97	100	O'Brien et al. (1991)
1990	26	77	97	100	O'Brien et al. (1991)

Table 12. Commercial CPUE indices derived from GLM analysis for Georges Bank haddock 1964-1990.

	No interaction model		All interactions except those involving year	
Year	$\log_e$	transformed	$\log_e$	transformed
1964	1.765	5.84	1.771	5.88
1965	1.500	4.48	1.520	4.57
1966	3.712	40.93	3.752	42.61
1967	2.653	14.20	2.681	14.60
1968	2.282	9.79	2.268	9.66
1969	0.517	1.68	0.527	1.69
1970	0.708	2.03	0.740	2.10
1971	0.102	1.11	0.115	1.12
1972	0.347	1.41	0.385	1.47
1973	-0.894	0.41	-0.871	0.42
1974	-2.852	0.06	-2.831	0.06
1975	-1.008	0.36	-0.997	0.37
1976	0.217	1.24	0.258	1.29
1977	2.547	12.77	2.604	13.51
1978	0.777	2.17	0.828	2.29
1979	1.007	2.74	1.056	2.87
1980	0.775	2.17	0.825	2.28
1981	2.572	13.09	2.651	14.17
1982	1.711	5.53	1.755	5.78
1983	1.384	3.99	1.439	4.21
1984	1.243	3.47	1.285	3.61
1985	0.715	2.04	0.750	2.12
1986	0.571	1.77	0.589	1.80
1987	0.076	1.08	0.087	1.09
1988	-0.030	0.97	-0.009	0.99
1989	-0.327	0.72	-0.314	0.73
1990	0.000	1.00	0.000	1.00

Table 13. Commercial CPUE indices computed from unweighted mean of cell means, Georges Bank haddock 1964-1990.

	CPUE (lbs/day fished)		Standardized CPUE	
Year	TC 3	TC 4	TC 3	TC 4
1964	28324	56257	15.83	23.96
1965	32516	65476	18.17	27.89
1966	32309	55015	18.05	23.43
1967	22638	41331	12.65	17.60
1968	20043	35450	11.20	15.10
1969	17612	29469	9.84	12.55
1970	9272	17090	5.18	7.28
1971	8066	14540	4.51	6.19
1972	5513	8662	3.08	3.69
1973	4381	7211	2.45	3.07
1974	3261	4419	1.82	1.88
1975	4739	7201	2.65	3.07
1976	3954	5153	2.21	2.20
1977	8538	10831	4.77	4.61
1978	11300	16099	6.31	6.86
1979	9825	14399	5.49	6.13
1980	8965	16076	5.01	6.85
1981	9873	16872	5.52	7.19
1982	6445	12695	3.60	5.41
1983	4705	8675	2.63	3.70
1984	4296	7311	2.40	3.11
1985	2633	4104	1.47	1.75
1986	2601	5561	1.45	2.37
1987	1865	2434	1.04	1.04
1988	1650	3352	0.92	1.43
1989	1254	1759	0.70	0.75
1990	1789	2348	1.00	1.00

Table 14. Stratified mean catch per tow (numbers) for haddock in NEFC offshore spring research vessel bottom trawl surveys on Georges Bank (Strata 13-25, 29-30), 1968-1990.

Unadjusted for changes in gear usage

Year	Age group 0	1	2	3	4	5	6	7	8	9+	Total	Total 1+
1968	0.00	0.27	1.90	0.31	0.47	4.51	1.13	0.17	0.30	0.23	9.29	9.29
1969	0.00	0.00	0.05	0.39	0.17	0.28	2.84	0.69	0.19	0.31	4.92	4.92
1970	0.00	0.45	0.17	0.00	0.22	0.31	0.31	1.34	0.66	0.57	4.03	4.03
1971	0.00	0.00	0.78	0.17	0.00	0.08	0.08	0.06	0.55	0.15	1.87	1.87
1972	0.00	2.70	0.06	0.41	0.08	0.02	0.03	0.09	0.02	0.87	4.28	4.28
1973	0.00	20.59	3.25	0.00	0.36	0.06	0.00	0.12	0.01	0.86	25.25	25.25
1974	0.00	1.43	8.92	1.92	0.00	0.16	0.00	0.01	0.07	0.25	12.76	12.76
1975	0.00	0.63	0.65	2.23	0.42	0.00	0.09	0.06	0.01	0.10	4.19	4.19
1976	0.00	54.22	0.20	0.40	0.62	0.29	0.00	0.03	0.00	0.07	55.83	55.83
1977	0.00	0.41	22.42	0.28	0.82	0.40	0.30	0.00	0.03	0.08	24.74	24.74
1978	0.00	0.05	0.65	10.69	0.24	0.63	0.55	0.11	0.04	0.07	13.03	13.03
1979	0.00	24.24	1.06	0.76	3.83	0.22	0.11	0.25	0.04	0.03	30.54	30.54
1980	0.00	3.49	31.34	0.34	0.70	3.27	0.45	0.25	0.31	0.16	40.31	40.31
1981	0.00	2.70	2.69	15.95	1.79	0.62	1.46	0.20	0.09	0.04	25.54	25.54
1982	0.00	0.62	1.25	0.77	3.33	0.34	0.23	0.50	0.00	0.00	7.04	7.04
1983	0.00	0.29	0.37	0.39	0.15	1.62	0.01	0.03	0.78	0.12	3.76	3.76
1984	0.00	1.40	0.79	0.43	0.42	0.39	0.48	0.05	0.03	0.20	4.19	4.19
1985	0.00	0.00	4.96	0.76	0.40	0.87	0.34	1.17	0.10	0.25	8.85	8.85
1986	0.00	2.49	0.18	2.06	0.24	0.11	0.21	0.12	0.33	0.11	5.85	5.85
1987	0.00	0.00	3.62	0.06	0.81	0.08	0.10	0.05	0.22	0.01	4.95	4.95
1988	0.00	1.55	0.04	0.99	0.13	0.32	0.12	0.11	0.12	0.00	3.38	3.38
1989	0.00	0.03	4.26	0.55	0.87	0.17	0.50	0.07	0.06	0.01	6.52	6.52
1990	0.00	1.05	0.00	6.97	0.40	0.71	0.07	0.16	0.00	0.01	9.37	9.37
1991	0.00	0.66	1.30	0.29	2.26	0.11	0.12	0.03	0.05	0.02	4.84	4.84

Adjusted for changes in gear usage

Year	0	1	2	3	4	5	6	7	8	9+	Total	Total 1+
1968	0.00	0.44	3.10	0.51	0.77	7.36	1.85	0.28	0.49	0.38	15.17	15.17
1969	0.00	0.00	0.08	0.64	0.28	0.46	4.64	1.13	0.31	0.51	8.03	8.03
1970	0.00	0.73	0.28	0.00	0.36	0.51	0.51	2.19	1.08	0.93	6.58	6.58
1971	0.00	0.00	1.27	0.28	0.00	0.13	0.13	0.10	0.90	0.24	3.05	3.05
1972	0.00	4.41	0.10	0.67	0.13	0.03	0.05	0.15	0.03	1.42	6.99	6.99
1973	0.00	33.62	5.31	0.00	0.59	0.10	0.00	0.20	0.02	1.40	41.23	41.23
1974	0.00	2.34	14.57	3.14	0.00	0.26	0.00	0.02	0.11	0.41	20.84	20.84
1975	0.00	1.03	1.06	3.64	0.69	0.00	0.15	0.10	0.02	0.16	6.84	6.84
1976	0.00	88.54	0.33	0.65	1.01	0.47	0.00	0.05	0.00	0.11	91.17	91.17
1977	0.00	0.67	36.61	0.46	1.34	0.65	0.49	0.00	0.05	0.13	40.40	40.40
1978	0.00	0.08	1.06	17.46	0.39	1.03	0.90	0.18	0.07	0.11	21.28	21.28
1979	0.00	39.58	1.73	1.24	6.25	0.36	0.18	0.41	0.07	0.05	49.87	49.87
1980	0.00	5.70	51.18	0.56	1.14	5.34	0.73	0.41	0.51	0.26	65.83	65.83
1981	0.00	3.76	3.74	22.19	2.49	0.86	2.03	0.28	0.13	0.06	35.53	35.53
1982	0.00	0.86	1.74	1.07	4.63	0.47	0.32	0.70	0.00	0.00	9.79	9.79
1983	0.00	0.47	0.60	0.64	0.24	2.65	0.02	0.05	1.27	0.20	6.14	6.14
1984	0.00	2.29	1.29	0.70	0.69	0.64	0.78	0.08	0.05	0.33	6.84	6.84
1985	0.00	0.00	4.96	0.76	0.40	0.87	0.34	1.17	0.10	0.25	8.85	8.85
1986	0.00	2.49	0.18	2.06	0.24	0.11	0.21	0.12	0.33	0.11	5.85	5.85
1987	0.00	0.00	3.62	0.06	0.81	0.08	0.10	0.05	0.22	0.01	4.95	4.95
1988	0.00	1.55	0.04	0.99	0.13	0.32	0.12	0.11	0.12	0.00	3.38	3.38
1989	0.00	0.03	3.63	0.47	0.74	0.14	0.43	0.06	0.05	0.01	5.56	5.56
1990	0.00	0.89	0.00	5.94	0.34	0.60	0.06	0.14	0.00	0.01	7.98	7.98
1991	0.00	0.56	1.11	0.25	1.93	0.09	0.10	0.03	0.04	0.02	4.13	4.13

Table 15. Stratified mean catch per tow (numbers) for haddock in NEFC offshore autumn research vessel bottom trawl surveys on Georges Bank (Strata 13-25, 29-30), 1963-1990.

Unadjusted for changes in gear usage

Year	Age group 0	1	2	3	4	5	6	7	8	9+	Total
1963	56.33	17.04	6.19	4.57	5.60	3.99	1.37	1.13	0.79	0.31	97.32
1964	1.59	75.75	42.78	3.91	1.20	2.56	1.05	0.46	0.17	0.22	129.69
1965	0.22	6.82	51.94	6.51	0.72	0.54	0.61	0.54	0.17	0.18	68.25
1966	4.12	0.64	1.94	12.34	2.25	0.35	0.33	0.22	0.08	0.05	22.32
1967	0.02	4.51	0.24	0.67	4.54	1.09	0.33	0.14	0.22	0.12	11.88
1968	0.06	0.04	0.64	0.09	0.22	2.59	0.85	0.18	0.11	0.26	5.04
1969	0.26	0.02	0.00	0.19	0.09	0.11	1.02	0.34	0.06	0.18	2.27
1970	0.03	2.77	0.14	0.01	0.19	0.18	0.34	0.92	0.32	0.27	5.17
1971	1.63	0.00	0.21	0.05	0.01	0.15	0.02	0.06	0.50	0.19	2.82
1972	4.53	1.69	0.00	0.35	0.06	0.00	0.06	0.04	0.02	0.87	7.62
1973	2.17	6.04	1.08	0.00	0.13	0.03	0.00	0.05	0.01	0.48	9.99
1974	0.50	1.19	0.66	0.21	0.00	0.01	0.00	0.00	0.00	0.15	2.72
1975	15.76	0.42	0.48	3.26	0.62	0.00	0.02	0.00	0.01	0.20	20.77
1976	2.90	43.07	0.35	0.36	0.55	0.20	0.00	0.03	0.07	0.17	47.70
1977	0.11	1.75	15.33	0.46	0.47	0.52	0.28	0.03	0.01	0.07	19.03
1978	10.82	0.69	0.85	7.59	0.15	0.21	0.37	0.01	0.00	0.01	20.70
1979	1.08	37.29	0.03	0.74	3.12	0.21	0.23	0.04	0.01	0.00	42.75
1980	9.56	2.22	10.41	0.37	0.15	1.39	0.39	0.38	0.07	0.05	24.99
1981	0.31	5.02	1.70	3.03	0.17	0.34	0.43	0.00	0.00	0.01	11.01
1982	0.91	0.00	0.89	0.23	0.94	0.09	0.05	0.14	0.01	0.07	3.33
1983	3.89	0.16	0.14	0.18	0.20	0.63	0.08	0.00	0.07	0.01	5.36
1984	0.02	2.23	0.59	0.16	0.19	0.04	0.30	0.00	0.00	0.08	3.61
1985	11.35	0.65	1.53	0.22	0.05	0.10	0.07	0.17	0.00	0.05	14.19
1986	0.00	5.11	0.09	1.21	0.06	0.13	0.13	0.02	0.03	0.03	6.81
1987	1.80	0.00	0.79	0.10	0.77	0.06	0.06	0.02	0.02	0.00	3.62
1988	0.07	3.02	0.18	1.30	0.12	0.40	0.12	0.11	0.00	0.03	5.35
1989	0.57	0.06	3.30	0.24	0.81	0.11	0.16	0.02	0.02	0.00	5.29
1990	0.94	0.82	0.03	1.45	0.06	0.21	0.05	0.00	0.00	0.00	3.56

Adjusted for changes in gear usage

Year	0	1	2	3	4	5	6	7	8	9+	Total
1963	91.98	27.83	10.11	7.46	9.14	6.52	2.24	1.85	1.29	0.51	158.92
1964	2.60	123.70	69.86	6.39	1.96	4.18	1.71	0.75	0.28	0.36	211.78
1965	0.36	11.14	84.82	10.63	1.18	0.88	1.00	0.88	0.28	0.29	111.45
1966	6.73	1.05	3.17	20.15	3.67	0.57	0.54	0.36	0.13	0.08	36.45
1967	0.03	7.36	0.39	1.09	7.41	1.78	0.54	0.23	0.36	0.20	19.40
1968	0.10	0.07	1.05	0.15	0.36	4.23	1.39	0.29	0.18	0.42	8.23
1969	0.42	0.03	0.00	0.31	0.15	0.18	1.67	0.56	0.10	0.29	3.71
1970	0.05	4.52	0.23	0.02	0.31	0.29	0.56	1.50	0.52	0.44	8.44
1971	2.66	0.00	0.34	0.08	0.02	0.24	0.03	0.10	0.82	0.31	4.61
1972	7.40	2.76	0.00	0.57	0.10	0.00	0.10	0.07	0.03	1.42	12.44
1973	3.54	9.86	1.76	0.00	0.21	0.05	0.00	0.08	0.02	0.78	16.31
1974	0.82	1.94	1.08	0.34	0.00	0.02	0.00	0.00	0.00	0.24	4.44
1975	25.74	0.69	0.78	5.32	1.01	0.00	0.03	0.00	0.02	0.33	33.92
1976	4.74	70.33	0.57	0.59	0.90	0.33	0.00	0.05	0.11	0.28	77.89
1977	0.15	2.43	21.32	0.64	0.65	0.72	0.39	0.04	0.01	0.10	26.47
1978	15.05	0.96	1.18	10.56	0.21	0.29	0.51	0.01	0.00	0.01	28.79
1979	1.50	51.87	0.04	1.03	4.34	0.29	0.32	0.06	0.01	0.00	59.47
1980	13.30	3.09	14.48	0.51	0.21	1.93	0.54	0.53	0.10	0.07	34.76
1981	0.43	6.98	2.36	4.21	0.24	0.47	0.60	0.00	0.00	0.01	15.31
1982	1.49	0.00	1.45	0.38	1.54	0.15	0.08	0.23	0.02	0.11	5.44
1983	6.35	0.26	0.23	0.29	0.33	1.03	0.13	0.00	0.11	0.02	8.75
1984	0.03	3.64	0.96	0.26	0.31	0.07	0.49	0.00	0.00	0.13	5.90
1985	11.35	0.65	1.53	0.22	0.05	0.10	0.07	0.17	0.00	0.05	14.19
1986	0.00	5.11	0.09	1.21	0.06	0.13	0.13	0.02	0.03	0.03	6.81
1987	1.08	0.00	0.79	0.10	0.77	0.06	0.06	0.02	0.02	0.00	3.62
1988	0.07	3.02	0.18	1.30	0.12	0.40	0.12	0.11	0.00	0.03	5.35
1989	0.49	0.05	2.81	0.20	0.69	0.09	0.14	0.02	0.02	0.00	4.51
1990	0.80	0.70	0.03	1.24	0.05	0.18	0.04	0.00	0.00	0.00	3.03

Table 16. **Stratified mean catch per tow (numbers) for haddock in Canadian offshore research vessel bottom trawl surveys on Georges Bank, 1986-1990.** [1]

	Age group											
Year	0	1	2	3	4	5	6	7	8	9+	Total	Total 1+
1986	0.00	4.06	0.22	6.05	1.07	0.19	0.29	0.34	0.37	0.42	13.01	13.01
1987	0.00	0.03	3.04	0.69	2.51	0.67	0.08	0.30	0.10	0.86	8.28	8.28
1988	0.00	1.47	0.05	8.50	0.17	2.88	0.18	0.17	0.11	0.50	14.03	14.03
1989	0.00	0.03	5.20	0.07	2.05	0.18	0.42	0.03	0.03	0.23	8.24	8.24
1990	0.00	0.93	0.11	9.86	0.13	3.36	0.23	1.09	0.13	0.34	16.18	16.18
1990	0.00	0.76	1.68	0.14	8.92	0.11	1.58	0.09	0.44	0.19	13.91	13.91

[1] S. Gavaris, personal communication.

Table 17. **Estimates of population abundance (000's) at age of Georges Bank had from ADAPT.**

	Age Group									
	1	2	3	4	5	6	7	8	9	Total 1+
1963	190696	32265	32742	45819	29030	9186	5595	2794	4217	352346
1964	471862	153496	22755	20095	27423	16350	5526	3309	4251	725066
1965	33152	377188	111253	14509	12131	14560	8144	2640	3258	576836
1966	4136	18455	194971	50825	7033	5959	5867	3254	2201	292702
1967	12948	3283	8918	68412	24269	3254	2534	2694	2031	128343
1968	422	9560	2536	4686	37311	10515	1570	1176	2163	69939
1969	988	338	5118	1435	2098	17410	5443	682	1711	35224
1970	4658	807	267	2654	769	1126	8867	3032	1873	24054
1971	368	3772	518	204	1657	462	728	5171	3241	16121
1972	8508	300	1844	222	131	1095	155	338	6301	18896
1973	19403	6825	244	1103	109	78	788	57	1676	30282
1974	10521	13569	3710	197	554	41	37	576	2695	31900
1975	7634	8572	7201	2443	160	390	32	28	621	27081
1976	103025	6077	6083	4209	1661	127	281	22	622	122106
1977	13704	84219	4547	4483	2650	1164	104	209	593	111673
1978	6018	11219	51232	3554	3055	1703	630	82	388	77881
1979	83600	4926	8497	28920	2634	1988	927	390	186	132067
1980	10011	68445	4010	5395	17191	1681	1257	474	249	108712
1981	7112	8189	27988	2969	3535	8597	839	535	316	60079
1982	2423	5822	5128	12963	1679	2046	4711	387	399	35558
1983	2849	1983	3712	2721	7236	1021	1160	2845	268	23794
1984	16570	2333	1430	2304	1603	3898	590	782	1575	31084
1985	1521	13566	1826	902	1228	953	1851	271	524	22642
1986	14253	1245	8930	997	563	588	574	1039	233	28423
1987	970	11664	971	4769	615	329	325	334	422	20398
1988	17153	794	7744	678	2445	393	203	186	305	29901
1989	320	14040	603	4183	434	1159	187	116	186	21229
1990	4573	262	10352	416	2632	226	625	111	118	19316
1991	4149	3743	204	7176	196	1366	97	354	113	17396

Table 18. Estimates of instantaneous fishing mortality (F) at age of Georges Bank haddock from ADAPT.

	Age Group								
	1	2	3	4	5	6	7	8	9
1963	0.02	0.15	0.29	0.31	0.37	0.31	0.33	0.34	0.34
1964	0.02	0.12	0.25	0.30	0.43	0.50	0.54	0.42	0.42
1965	0.39	0.46	0.58	0.52	0.51	0.71	0.72	0.61	0.61
1966	0.03	0.53	0.85	0.54	0.57	0.66	0.58	0.56	0.56
1967	0.10	0.06	0.44	0.41	0.64	0.53	0.57	0.47	0.47
1968	0.02	0.42	0.37	0.60	0.56	0.46	0.63	0.55	0.55
1969	0.00	0.04	0.46	0.42	0.42	0.47	0.39	0.45	0.45
1970	0.01	0.24	0.07	0.27	0.31	0.24	0.34	0.32	0.32
1971	0.00	0.52	0.65	0.24	0.21	0.89	0.57	0.38	0.38
1972	0.02	0.01	0.31	0.52	0.32	0.13	0.81	0.24	0.24
1973	0.16	0.41	0.01	0.49	0.78	0.55	0.11	0.35	0.35
1974	0.00	0.43	0.22	0.01	0.15	0.06	0.06	0.11	0.11
1975	0.03	0.14	0.34	0.19	0.03	0.13	0.15	0.17	0.17
1976	0.00	0.09	0.11	0.26	0.16	0.00	0.09	0.22	0.22
1977	0.00	0.30	0.05	0.18	0.24	0.41	0.04	0.23	0.23
1978	0.00	0.08	0.37	0.10	0.23	0.41	0.28	0.21	0.21
1979	0.00	0.01	0.25	0.32	0.25	0.26	0.47	0.32	0.32
1980	0.00	0.69	0.10	0.22	0.49	0.50	0.65	0.44	0.44
1981	0.00	0.27	0.57	0.37	0.35	0.40	0.57	0.40	0.40
1982	0.00	0.25	0.43	0.38	0.30	0.37	0.30	0.36	0.36
1983	0.00	0.13	0.28	0.33	0.42	0.35	0.20	0.37	0.37
1984	0.00	0.05	0.26	0.43	0.32	0.55	0.58	0.47	0.47
1985	0.00	0.22	0.40	0.27	0.54	0.31	0.38	0.38	0.38
1986	0.00	0.05	0.43	0.28	0.34	0.39	0.34	0.33	0.33
1987	0.00	0.21	0.16	0.47	0.25	0.28	0.36	0.43	0.43
1988	0.00	0.08	0.42	0.25	0.55	0.54	0.36	0.48	0.48
1989	0.00	0.10	0.17	0.26	0.45	0.42	0.32	0.31	0.31
1990	0.00	0.05	0.17	0.55	0.46	0.64	0.37	0.51	0.51

Table 19. Yield per recruit analysis for Georges Bank haddock using maturity and weight at age data from 1963-1967.

```
The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
 PC Ver.1.1 [Method of Thompson and Bell (1934)] 1-OCT-1991
          ----------------------------------
          Run Date: 28- 1-1992;  Time: 14:21:51.58
GEORGES BANK HADDOCK MATURITY 1963-1967
```

Proportion of F before spawning: .2500
Proportion of M before spawning: .2500
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 9
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> HADD1.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Stock	Catch
1	.0005	1.0000	.0000	.508	.578
2	.1758	1.0000	.0000	.666	.764
3	.4031	1.0000	.7800	.920	1.034
4	1.0000	1.0000	1.0000	1.217	1.338
5	1.0000	1.0000	1.0000	1.497	1.622
6	1.0000	1.0000	1.0000	1.881	2.054
7	1.0000	1.0000	1.0000	2.187	2.320
8	1.0000	1.0000	1.0000	2.540	2.774
9+	1.0000	1.0000	1.0000	3.092	3.092

Summary of Yield per Recruit Analysis for:
GEORGES BANK HADDOCK MATURITY 1963-1967

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Slope of the Yield/Recruit Curve at F=0.00: -->     6.7383
  F level at slope=1/10 of the above slope (F0.1): ----->     .233
    Yield/Recruit corresponding to F0.1: ----->      .5654
  F level to produce Maximum Yield/Recruit (Fmax): ----->     .819
    Yield/Recruit corresponding to Fmax: ----->      .6470
  F level at 30 % of Max Spawning Potential (F30): ----->     .320
    SSB/Recruit corresponding to F30: -------->     2.0667
```

1

Listing of Yield per Recruit Results for:
GEORGES BANK HADDOCK MATURITY 1963-1967

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.000	.00000	.00000	5.5167	8.4314	3.3773	6.8892	100.00
	.050	.12517	.25252	4.8934	6.7273	2.7547	5.2073	75.59
	.100	.20922	.39708	4.4756	5.6339	2.3376	4.1326	59.99
	.150	.26976	.48478	4.1752	4.8825	2.0381	3.3971	49.31
	.200	.31561	.54012	3.9483	4.3399	1.8120	2.8681	41.63
F0.1	.233	.34018	.56538	3.8269	4.0604	1.6912	2.5965	37.69
	.250	.35164	.57604	3.7703	3.9330	1.6349	2.4730	35.90
	.300	.38080	.59983	3.6267	3.6186	1.4922	2.1688	31.48
F30%	.320	.39095	.60694	3.5768	3.5128	1.4428	2.0667	30.00
	.350	.40495	.61580	3.5080	3.3695	1.3745	1.9287	28.00
	.400	.42534	.62662	3.4080	3.1680	1.2755	1.7352	25.19
	.450	.44283	.63396	3.3225	3.0021	1.1911	1.5763	22.88
	.500	.45804	.63894	3.2483	2.8633	1.1180	1.4439	20.96
	.550	.47142	.64227	3.1832	2.7456	1.0540	1.3320	19.33
	.600	.48330	.64446	3.1255	2.6446	.9975	1.2362	17.94
	.650	.49395	.64582	3.0739	2.5569	.9472	1.1534	16.74
	.700	.50357	.64660	3.0274	2.4801	.9019	1.0811	15.69
	.750	.51231	.64696	2.9852	2.4123	.8610	1.0175	14.77
	.800	.52032	.64702	2.9467	2.3518	.8238	.9610	13.95
Fmax	.819	.52316	.64698	2.9331	2.3308	.8107	.9413	13.66
	.850	.52768	.64686	2.9113	2.2976	.7898	.9105	13.22
	.900	.53449	.64653	2.8787	2.2486	.7585	.8650	12.56
	.950	.54081	.64610	2.8484	2.2041	.7297	.8239	11.96
	1.000	.54670	.64558	2.8203	2.1635	.7029	.7865	11.42

Table 20. Yield per recruit analysis for Georges Bank haddock using maturity and weight at age data from 1968-1983.

```
The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
 PC Ver.1.1 [Method of Thompson and Bell (1934)] 1-OCT-1991
          ----------------------------------------
          Run Date: 28- 1-1992;  Time: 14:22:30.63
GEORGES BANK HADDOCK MATURITY 1968-1983
```

Proportion of F before spawning: .2500
Proportion of M before spawning: .2500
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 9
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> HADD2.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Stock	Catch
1	.0005	1.0000	.0000	.408	.539
2	.1758	1.0000	.3200	.736	.987
3	.4031	1.0000	.8200	1.159	1.396
4	1.0000	1.0000	1.0000	1.623	1.929
5	1.0000	1.0000	1.0000	2.102	2.344
6	1.0000	1.0000	1.0000	2.558	2.861
7	1.0000	1.0000	1.0000	3.075	3.354
8	1.0000	1.0000	1.0000	3.457	3.638
9+	1.0000	1.0000	1.0000	4.171	4.171

Summary of Yield per Recruit Analysis for:
GEORGES BANK HADDOCK MATURITY 1968-1983

```
Slope of the Yield/Recruit Curve at F=0.00: -->     9.2776
  F level at slope=1/10 of the above slope (F0.1): ----->     .235
    Yield/Recruit corresponding to F0.1: ----->      .7915
  F level to produce Maximum Yield/Recruit (Fmax): ----->     .723
    Yield/Recruit corresponding to Fmax: ----->      .9048
  F level at 30 % of Max Spawning Potential (F30): ----->     .339
    SSB/Recruit corresponding to F30: -------->     2.8624
```

1

Listing of Yield per Recruit Results for:
GEORGES BANK HADDOCK MATURITY 1968-1983

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.000	.00000	.00000	5.5167	10.9880	3.6520	9.5412	100.00
	.050	.12517	.34904	4.8934	8.6786	3.0285	7.2607	76.10
	.100	.20922	.55072	4.4756	7.1946	2.6106	5.8010	60.80
	.150	.26976	.67425	4.1752	6.1733	2.3101	4.8005	50.31
	.200	.31561	.75296	3.9483	5.4349	2.0831	4.0798	42.76
F0.1	.235	.34187	.79147	3.8185	5.0284	1.9534	3.6844	38.62
	.250	.35164	.80450	3.7703	4.8805	1.9052	3.5408	37.11
	.300	.38088	.83887	3.6267	4.4517	1.7616	3.1252	32.75
F30%	.339	.40004	.85775	3.5321	4.1797	1.6671	2.8624	30.00
	.350	.40495	.86206	3.5080	4.1117	1.6430	2.7968	29.31
	.400	.42534	.87777	3.4080	3.8365	1.5432	2.5319	26.54
	.450	.44283	.88837	3.3225	3.6098	1.4579	2.3143	24.26
	.500	.45804	.89543	3.2483	3.4202	1.3839	2.1327	22.35
	.550	.47142	.89999	3.1832	3.2594	1.3191	1.9792	20.74
	.600	.48330	.90276	3.1255	3.1214	1.2618	1.8479	19.37
	.650	.49395	.90425	3.0739	3.0017	1.2106	1.7342	18.18
	.700	.50357	.90481	3.0274	2.8969	1.1645	1.6350	17.14
Fmax	.723	.50769	.90483	3.0075	2.8530	1.1448	1.5935	16.70
	.750	.51231	.90469	2.9852	2.8043	1.1228	1.5476	16.22
	.800	.52032	.90407	2.9467	2.7219	1.0848	1.4700	15.41
	.850	.52768	.90308	2.9113	2.6481	1.0499	1.4007	14.68
	.900	.53449	.90182	2.8787	2.5814	1.0179	1.3383	14.03
	.950	.54081	.90036	2.8484	2.5209	.9882	1.2819	13.43
	1.000	.54670	.89876	2.8203	2.4658	.9607	1.2305	12.90

Table 21. Yield per recruit analysis for Georges Bank haddock using maturity and weight at age data from 1985-1990.

```
The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
 PC Ver.1.1 [Method of Thompson and Bell (1934)] 1-OCT-1991
          ---------------------------------------
          Run Date: 28- 1-1992;  Time: 14:23:09.41
GEORGES BANK HADDOCK MATURITY 1985-1990
```

Proportion of F before spawning: .2500
Proportion of M before spawning: .2500
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 9
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> HADD3.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Stock	Catch
1	.0005	1.0000	.2600	.344	.467
2	.1758	1.0000	.7700	.620	.933
3	.4031	1.0000	.9700	1.142	1.410
4	1.0000	1.0000	1.0000	1.599	1.847
5	1.0000	1.0000	1.0000	2.050	2.275
6	1.0000	1.0000	1.0000	2.453	2.630
7	1.0000	1.0000	1.0000	2.820	3.012
8	1.0000	1.0000	1.0000	3.270	3.528
9+	1.0000	1.0000	1.0000	3.968	3.968

Summary of Yield per Recruit Analysis for:
GEORGES BANK HADDOCK MATURITY 1985-1990

```
Slope of the Yield/Recruit Curve at F=0.00: -->     8.8052
  F level at slope=1/10 of the above slope (F0.1): ----->     .240
    Yield/Recruit corresponding to F0.1: ----->      .7584
  F level to produce Maximum Yield/Recruit (Fmax): ----->     .819
    Yield/Recruit corresponding to Fmax: ----->      .8729
  F level at 30 % of Max Spawning Potential (F30): ----->     .395
    SSB/Recruit corresponding to F30: -------->     2.8530
```

1

Listing of Yield per Recruit Results for:
GEORGES BANK HADDOCK MATURITY 1985-1990

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPWSTKN	SPWSTKW	% MSP
	.000	.00000	.00000	5.5167	10.3935	4.3454	9.5115	100.00
	.050	.12517	.33138	4.8934	8.1989	3.7199	7.3420	77.19
	.100	.20922	.52319	4.4756	6.7888	3.2998	5.9527	62.58
	.150	.26976	.64111	4.1752	5.8183	2.9973	4.9995	52.56
	.200	.31561	.71671	3.9483	5.1164	2.7683	4.3121	45.34
F0.1	.240	.34519	.75836	3.8022	4.6819	2.6206	3.8877	40.87
	.250	.35164	.76667	3.7703	4.5892	2.5883	3.7972	39.92
	.300	.38080	.80044	3.6267	4.1811	2.4427	3.3995	35.74
	.350	.40495	.82365	3.5080	3.8572	2.3222	3.0845	32.43
F30%	.395	.42865	.83841	3.4173	3.6188	2.2299	2.8530	30.00
	.400	.42534	.83977	3.4080	3.5948	2.2204	2.8297	29.75
	.450	.44288	.85104	3.3225	3.3785	2.1331	2.6199	27.54
	.500	.45804	.85890	3.2483	3.1972	2.0573	2.4444	25.70
	.550	.47142	.86435	3.1832	3.0433	1.9906	2.2955	24.13
	.600	.48330	.86805	3.1255	2.9111	1.9313	2.1677	22.79
	.650	.49395	.87047	3.0739	2.7962	1.8782	2.0567	21.62
	.700	.50357	.87194	3.0274	2.6955	1.8303	1.9595	20.60
	.750	.51231	.87269	2.9852	2.6064	1.7868	1.8735	19.70
	.800	.52032	.87291	2.9467	2.5270	1.7469	1.7970	18.89
Fmax	.819	.52316	.87288	2.9331	2.4993	1.7328	1.7703	18.61
	.850	.52768	.87272	2.9113	2.4557	1.7103	1.7283	18.17
	.900	.53449	.87221	2.8787	2.3913	1.6764	1.6663	17.52
	.950	.54081	.87145	2.8484	2.3328	1.6450	1.6099	16.93
	1.000	.54670	.87051	2.8203	2.2793	1.6157	1.5585	16.39

Table 22. Projections for Georges Bank haddock using partial recruitment from 1989-1990 and maturity and mean weight at age schedules from 1985-1990.

		Landings (MT)			SSB (MT)		
Recruitment	F(1992,1993)	1991	1992	1993	1991	1992	1993
- 1 STD	0.51	7363	5163	4351	16545	13355	10860
Average	0.51	7363	5163	4454	16545	13503	11637
+ 1 STD	0.51	7363	5163	4677	16545	13821	13317
- 1 STD	0.24	7363	2708	2773	16545	14073	13612
Average	0.24	7363	2708	2823	16545	14221	14397
+ 1 STD	0.24	7363	2709	2930	16545	14539	16094
- 1 STD	0.40	7363	4229	3853	16545	13643	11886
Average	0.40	7363	4230	3935	16545	13790	12666
+ 1 STD	0.40	7363	4230	4111	16545	14109	14353

Figure 1. Mean length (cm) at age of haddock sampled in the spring and autumn NEFC bottom trawl surveys on Eastern Georges Bank (areas 561, 562, 551, 552, 523, 524) and Western Georges Bank (areas 521, 522, 525, 526, 541, 542, 537, 538, 539 and Statistical Area 6), 1982-1990.

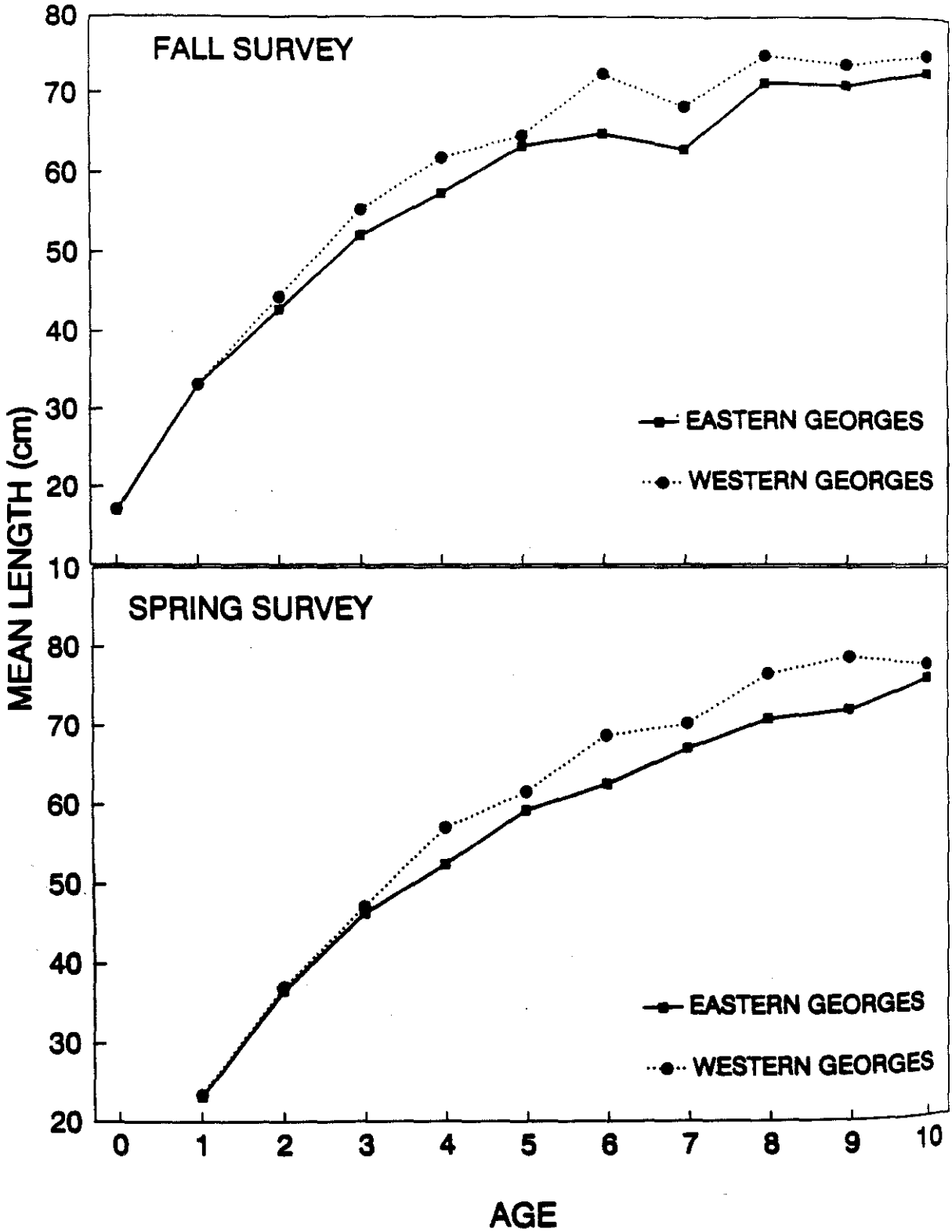


Figure 2. Quarterly mean age at length (cm) of haddock sampled from the USA commercial catch, 1984. Eastern refers to areas 561 and 562; Western refers to areas 521, 522, 525, 526, 541, 542, 537, 538, 539, and Statistical Area 6.

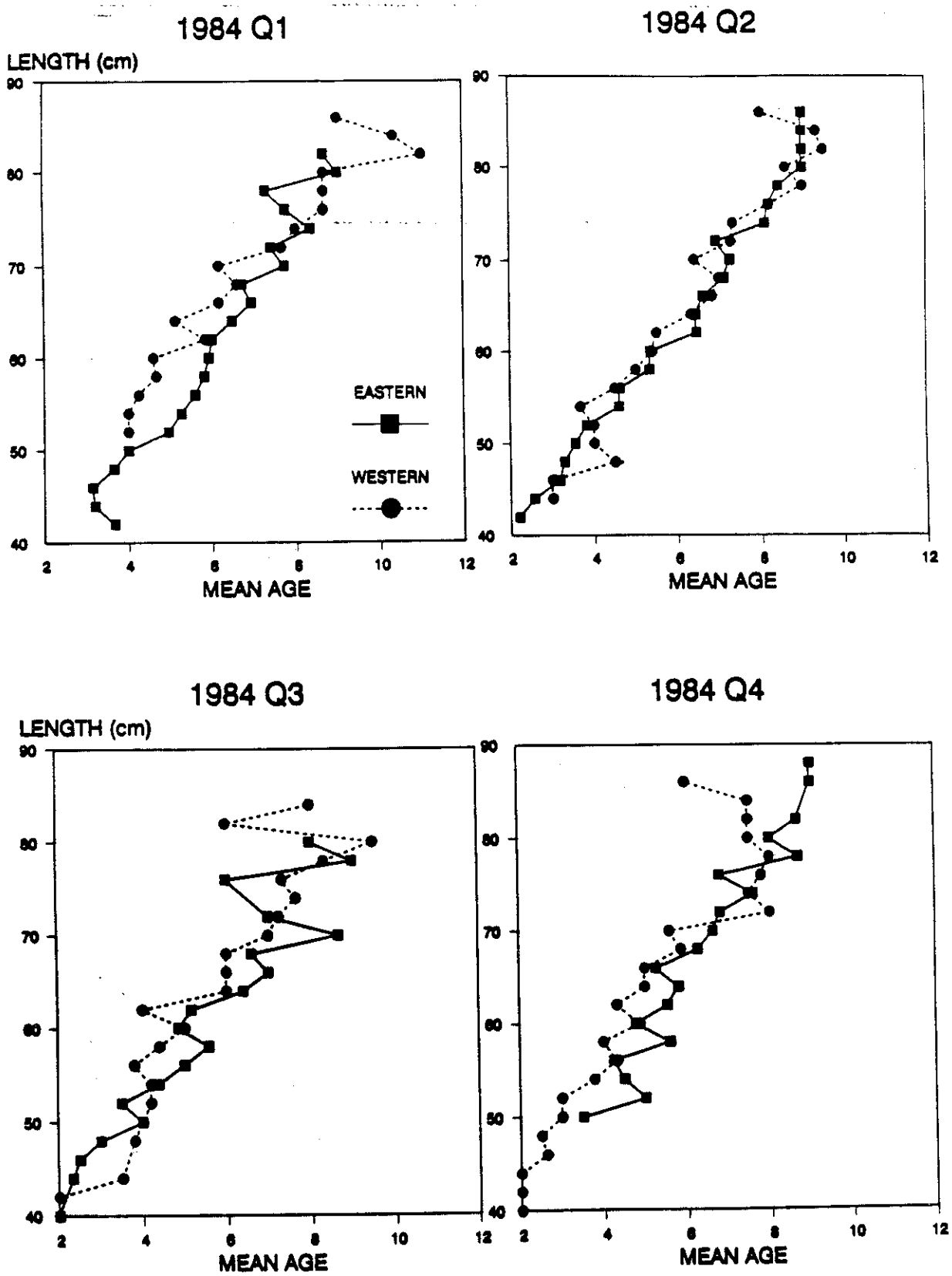


Figure 3. Quarterly mean age at length (cm) of haddock sampled from the USA commercial catch, 1985. Eastern refers to areas 561 and 562; Western refers to areas 521, 522, 525, 526, 541, 542, 537, 538, 539, and Statistical Area 6.

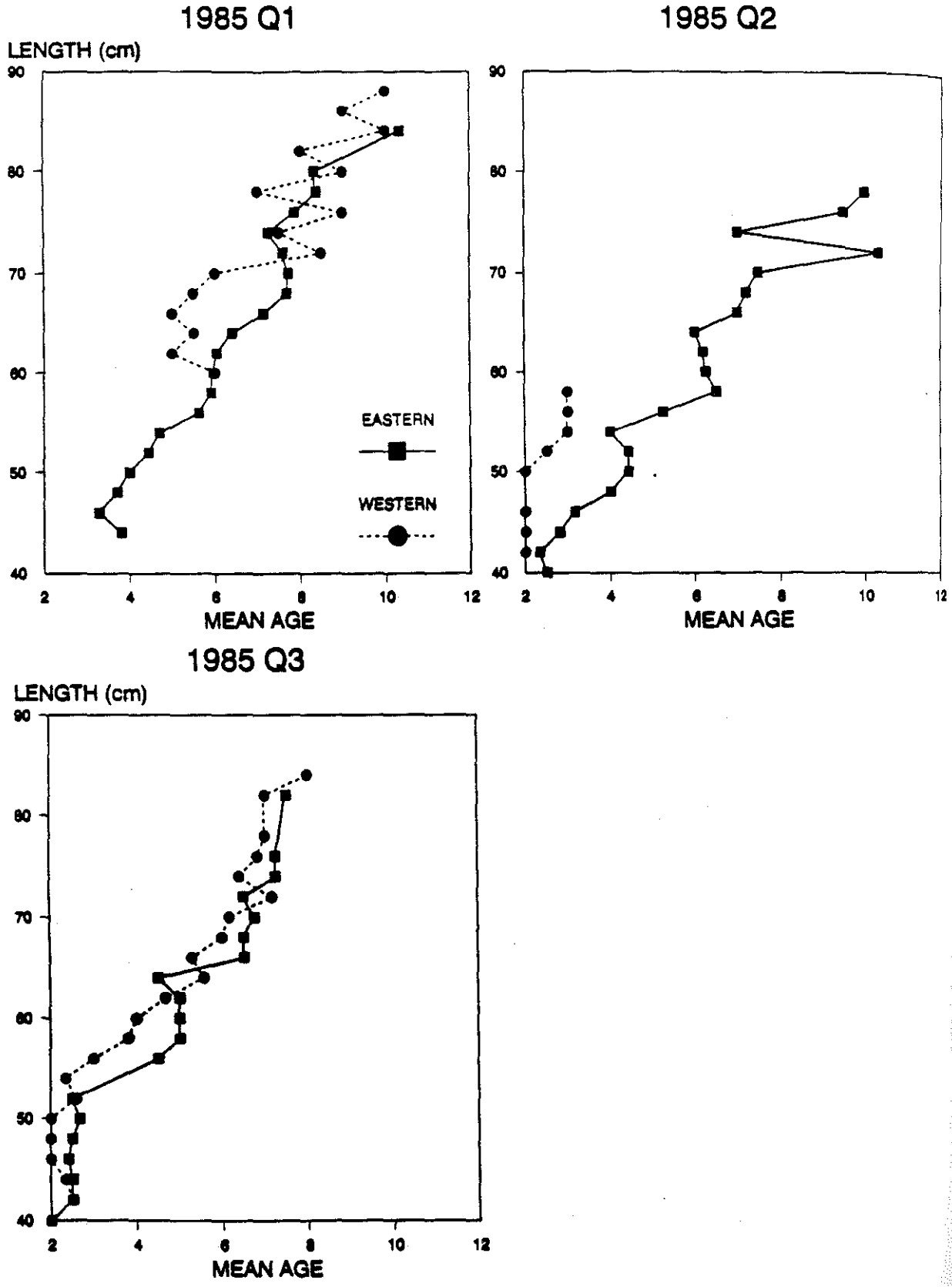


Figure 4. Quarterly mean age at length (cm) of haddock sampled from the USA commercial catch, 1986. Eastern refers to areas 561 and 562; Western refers to areas 521, 522, 525, 526, 541, 542, 537, 538, 539, and Statistical Area 6.

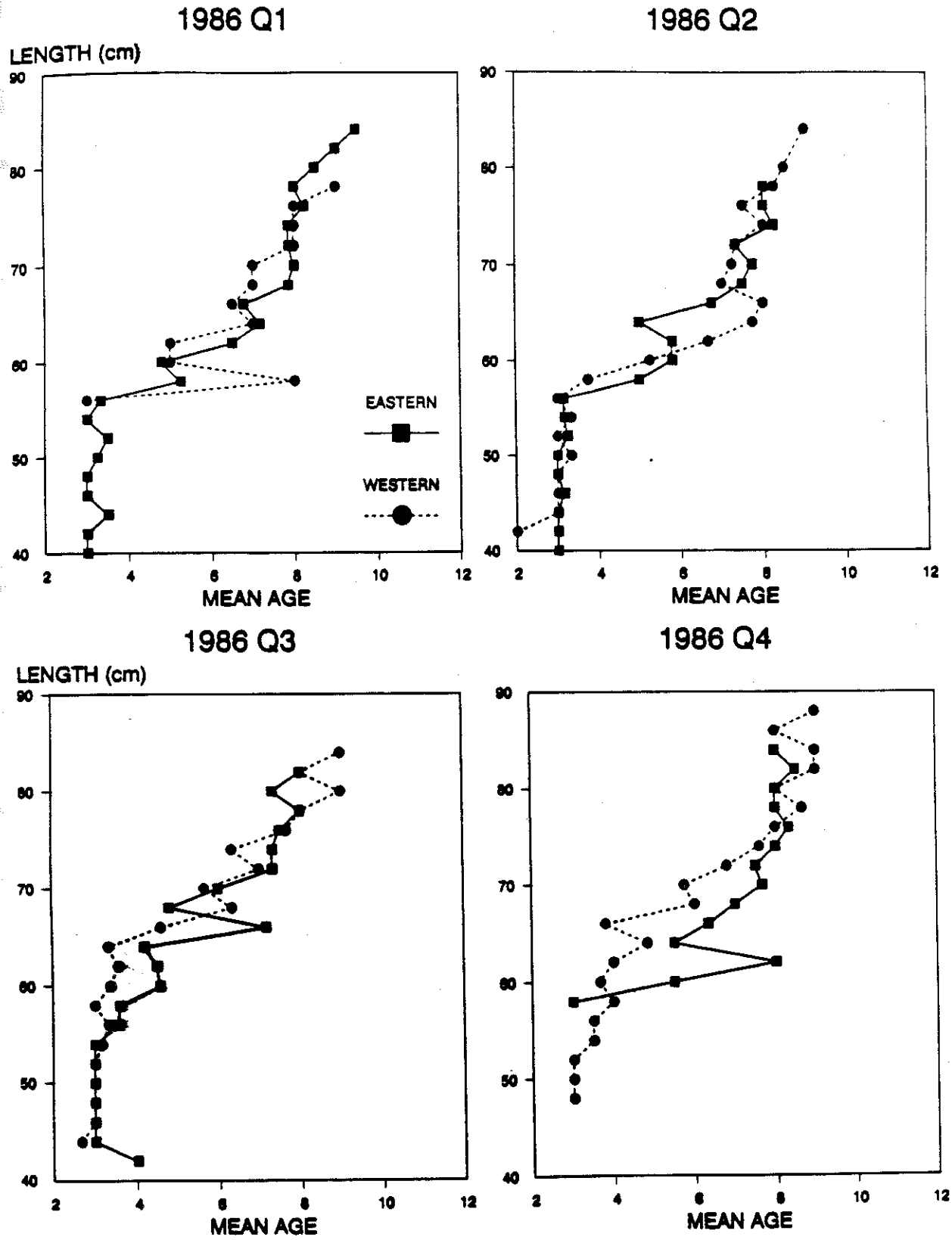


Figure 5. Quarterly mean age at length (cm) of haddock sampled from the USA commercial catch, 1987. Eastern refers to areas 561 and 562; Western refers to areas 521, 522, 525, 526, 541, 542, 537, 538, 539, and Statistical Area 6.

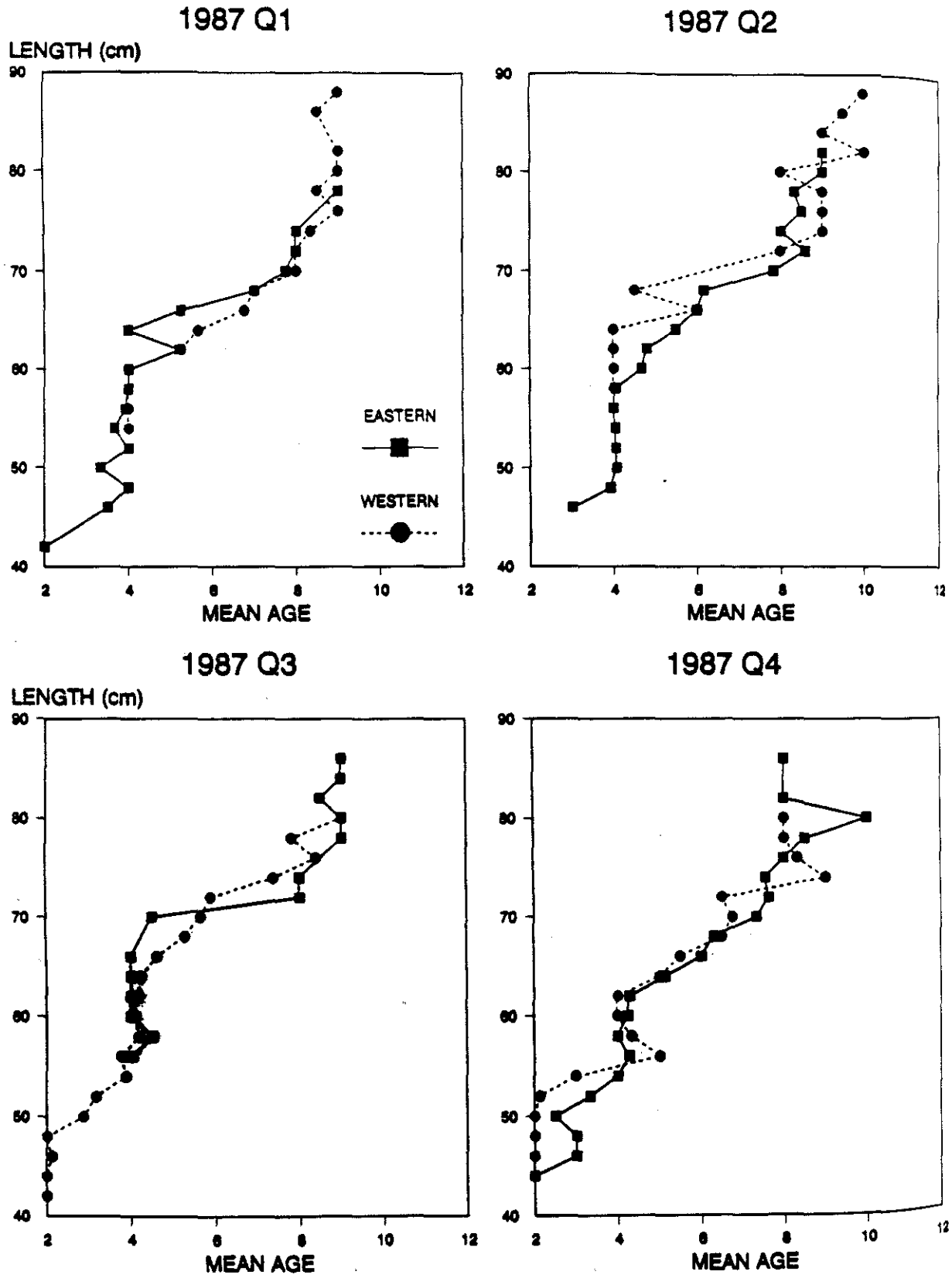


Figure 6. Quarterly mean age at length (cm) of haddock sampled from the USA commercial catch, 1988. Eastern refers to areas 561 and 562; Western refers to areas 521, 522, 525, 526, 541, 542, 537, 538, 539, and Statistical Area 6.

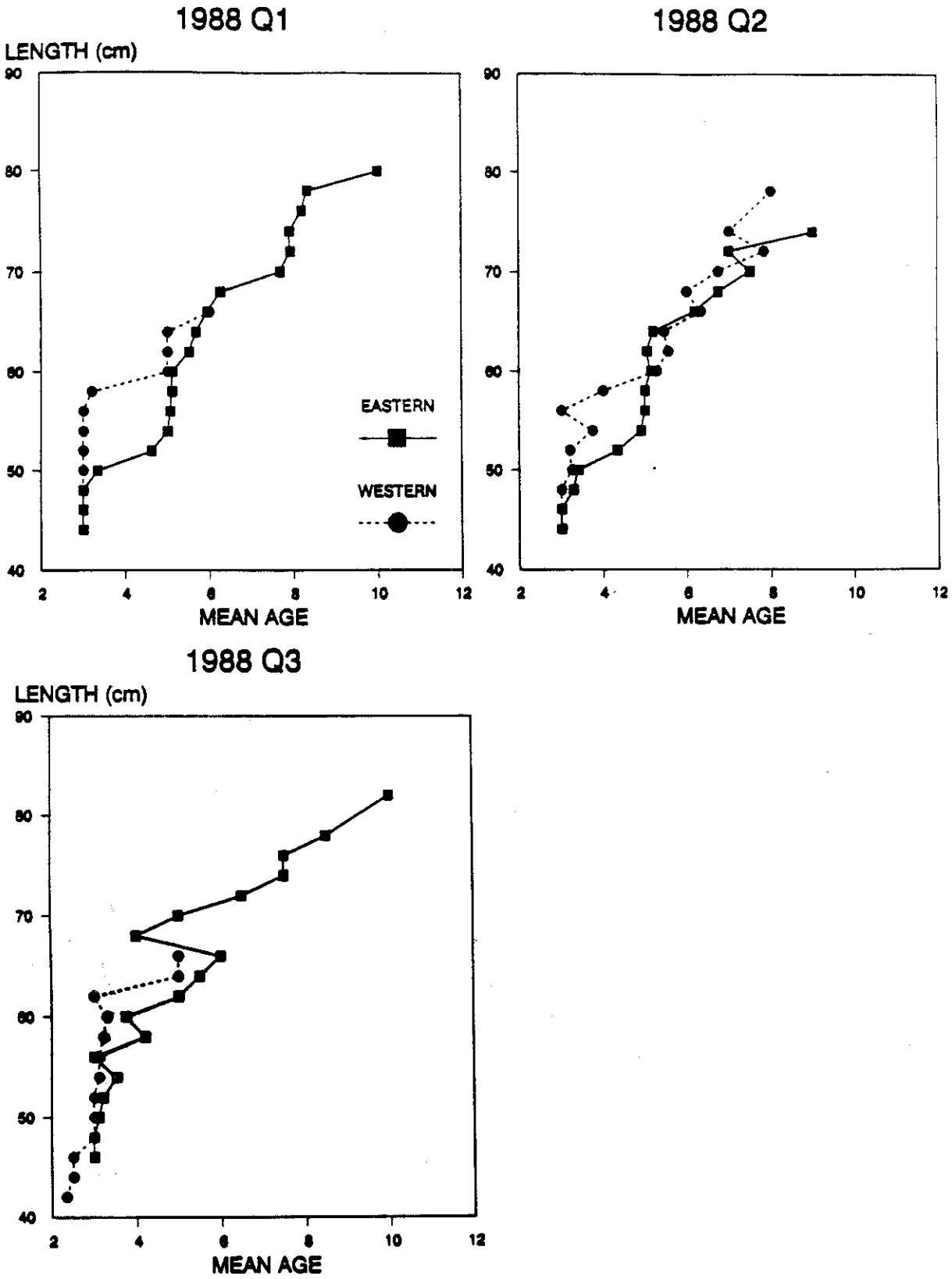


Figure 7. Catch per unit effort indices for the USA commercial otter trawl fishery, 1964-1990. Index values are standardized as ratios of the 1990 catch (1990=1.0). GLM refers to CPUE index computed from a General Linear Model of CPUE with no interaction terms and including quarter, area and tonnage class as main effects. TC 3 refers to unweighted mean of cell means for tonnage class 3 boats, where cell means are quarter/area/year combinations. TC 4 refers to the same for tonnage class 4 boats.

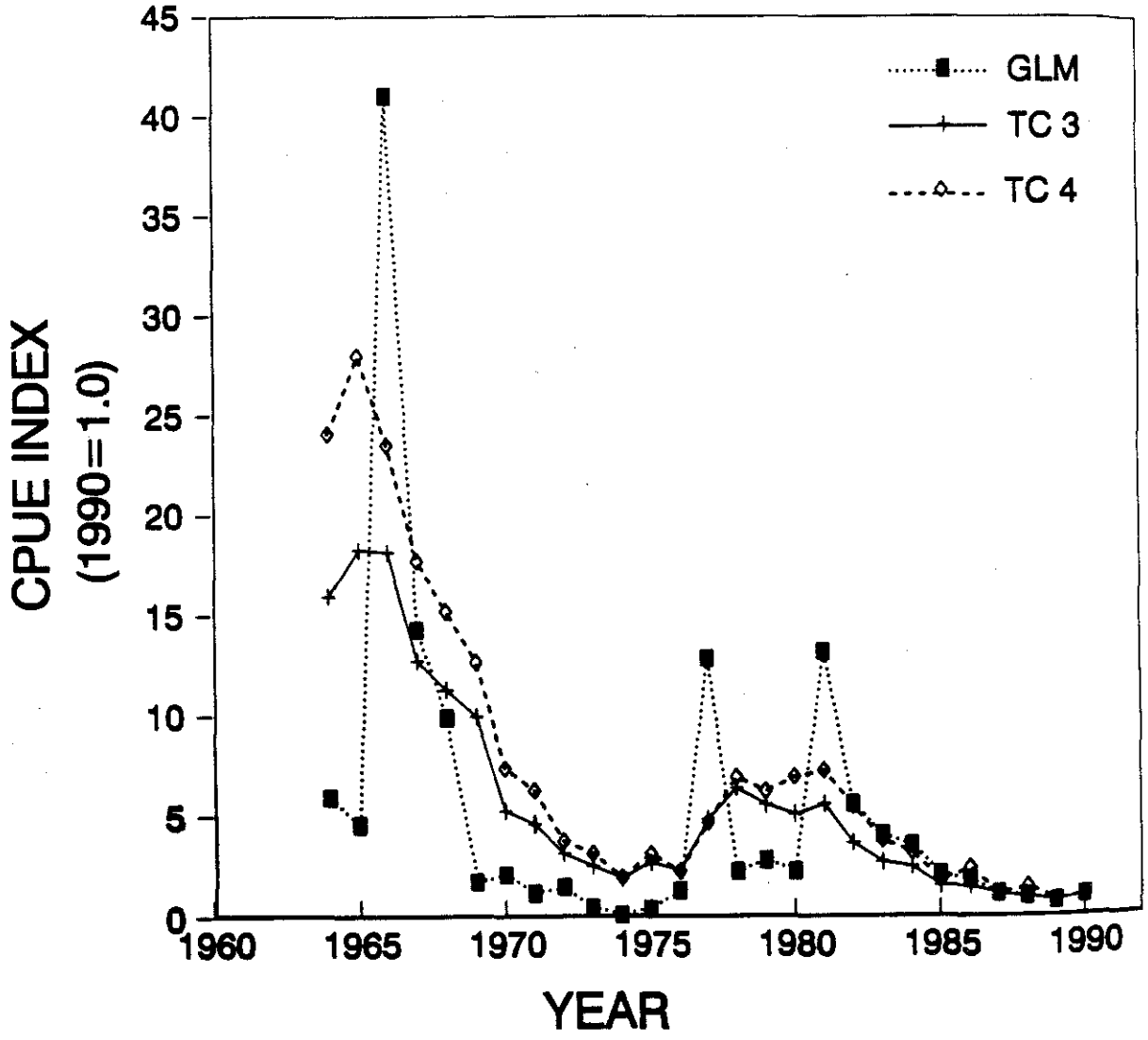


Figure 8. Stratified mean catch/tow (numbers) of age I+ haddock in the NEFC spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25, 29-30).

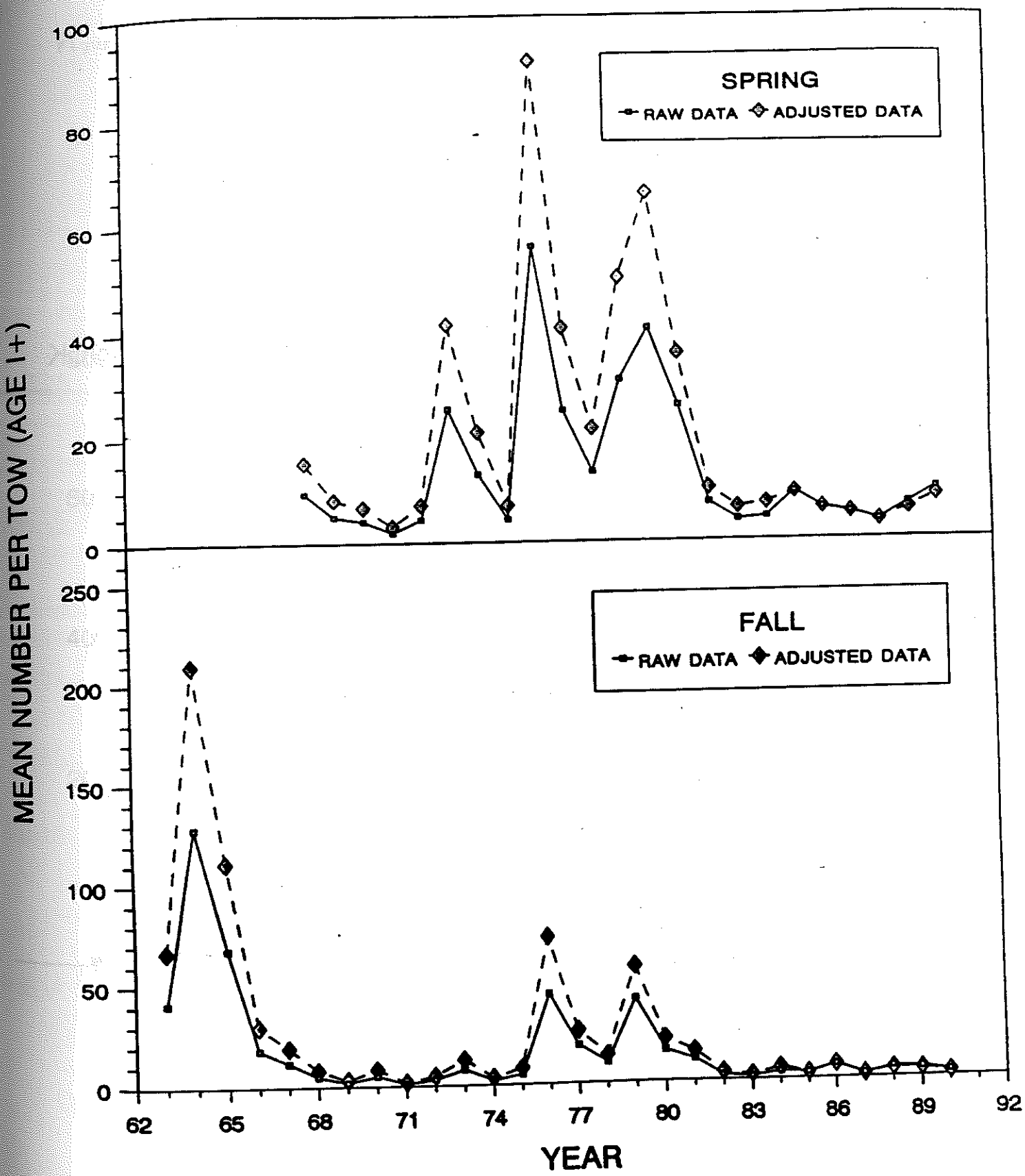


Figure 9. Year class strength (at age 2) of Georges Bank haddock, 1961-1989.

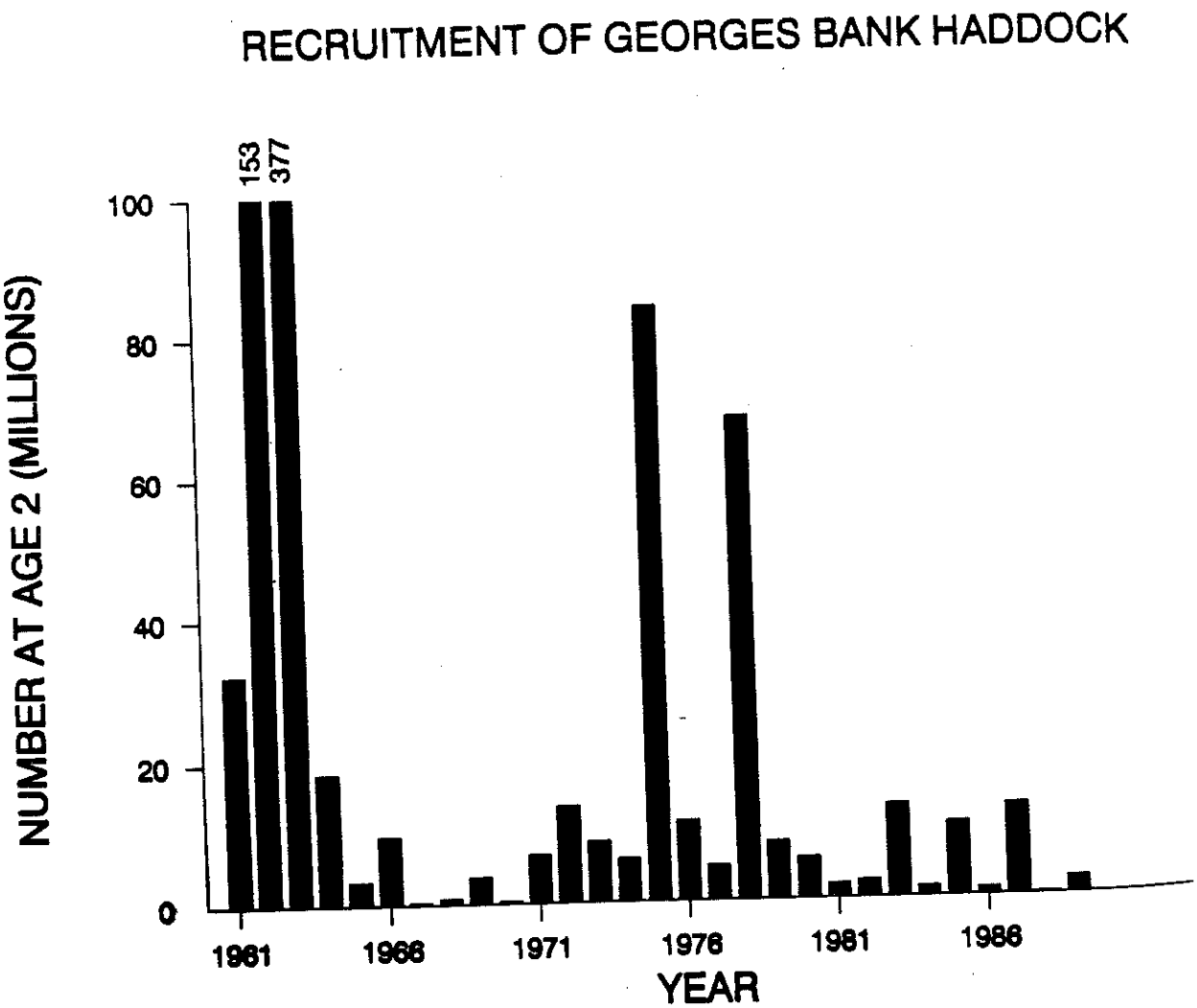


Figure 10. Population abundance (age 1+) and F on fully recruited age groups (ages 4-9) of Georges Bank haddock.

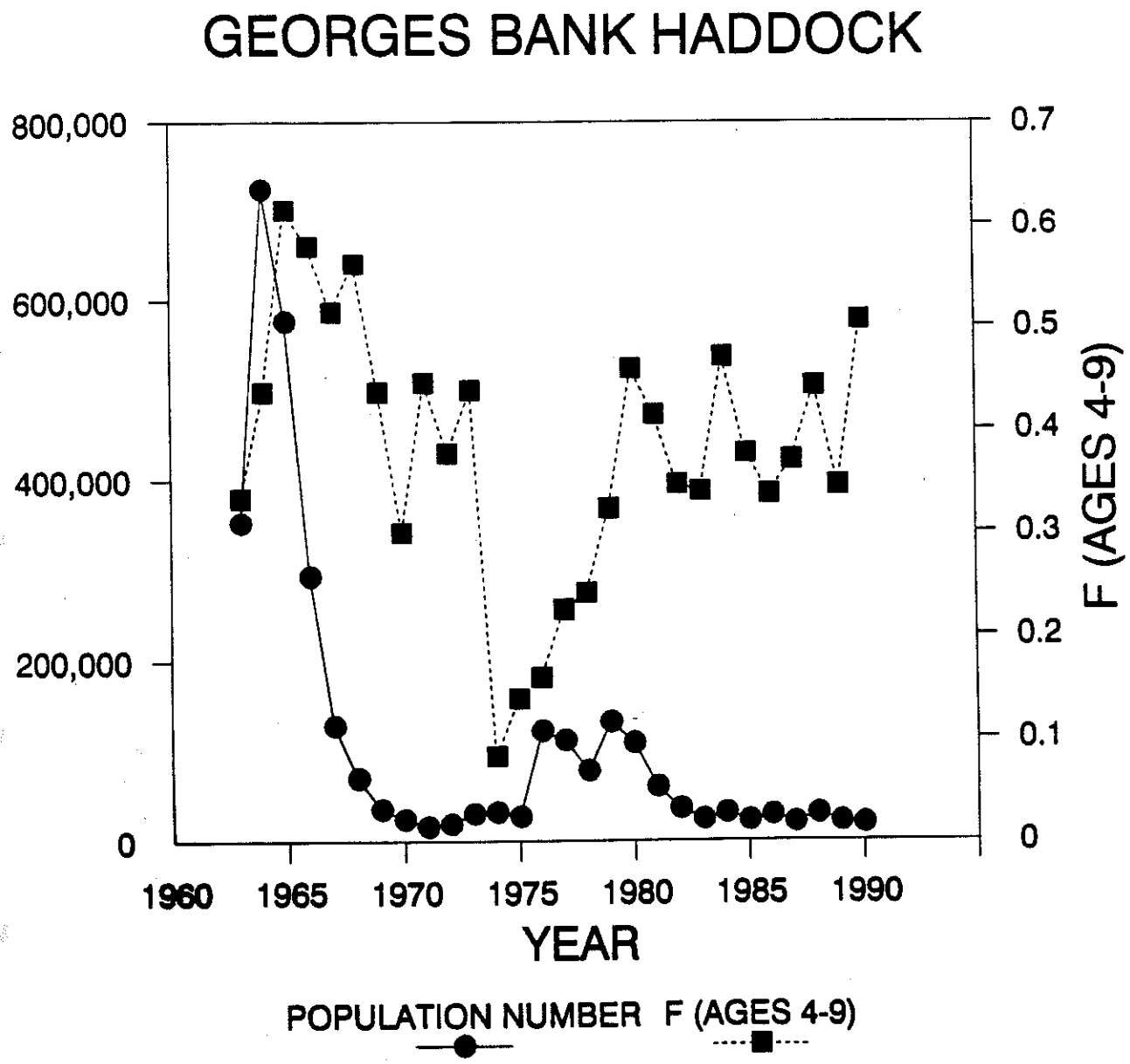


Figure 11. Trends in F at age estimated using ADAPT for Georges Bank haddock, 1963-1990.

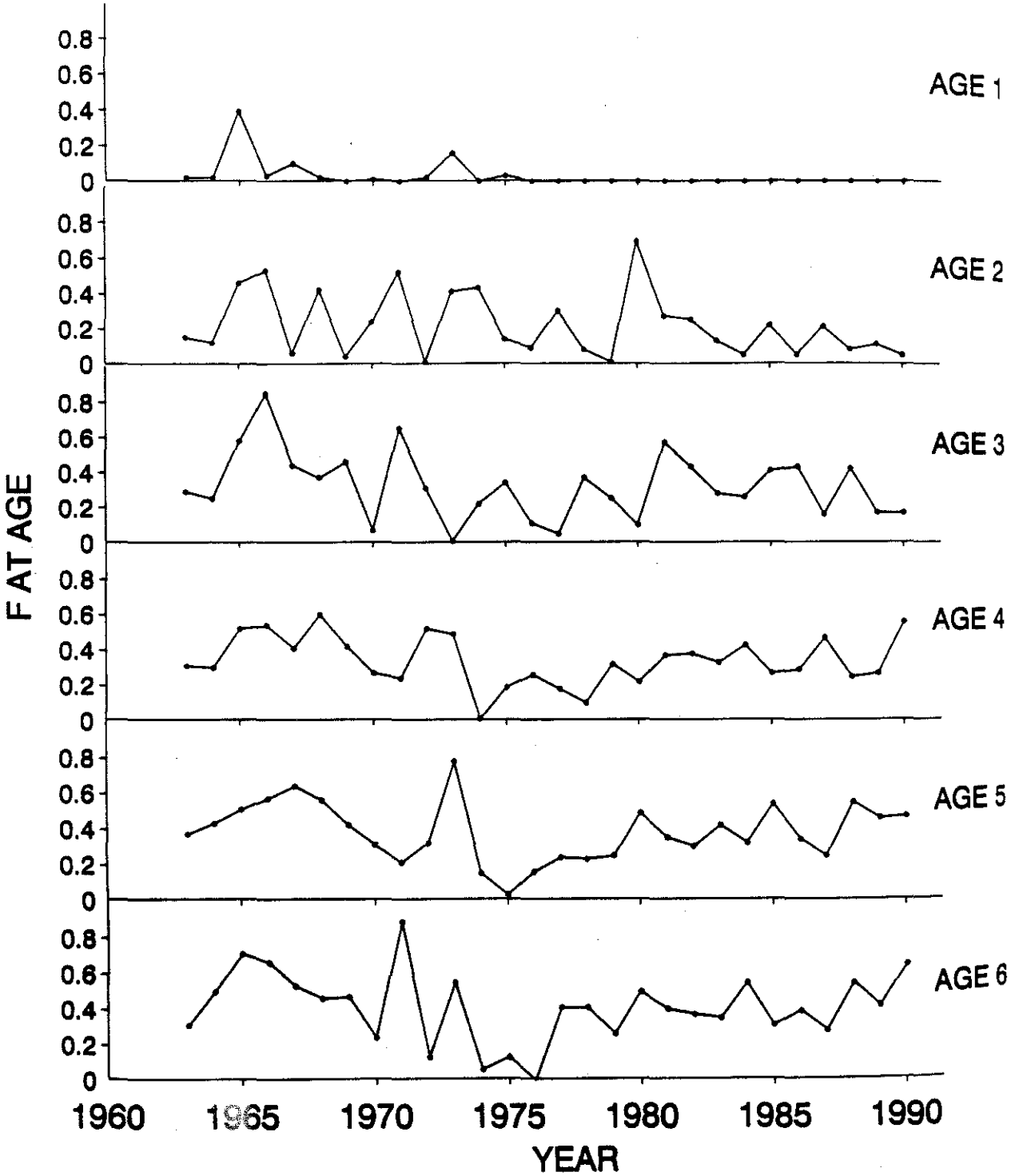


Figure 12. Comparison of estimates of F on fully recruited age groups (ages 4-9) and population abundance (age 1+) derived from ADAPT using adjusted (for gear changes) and unadjusted NEFSC research vessel survey indices.

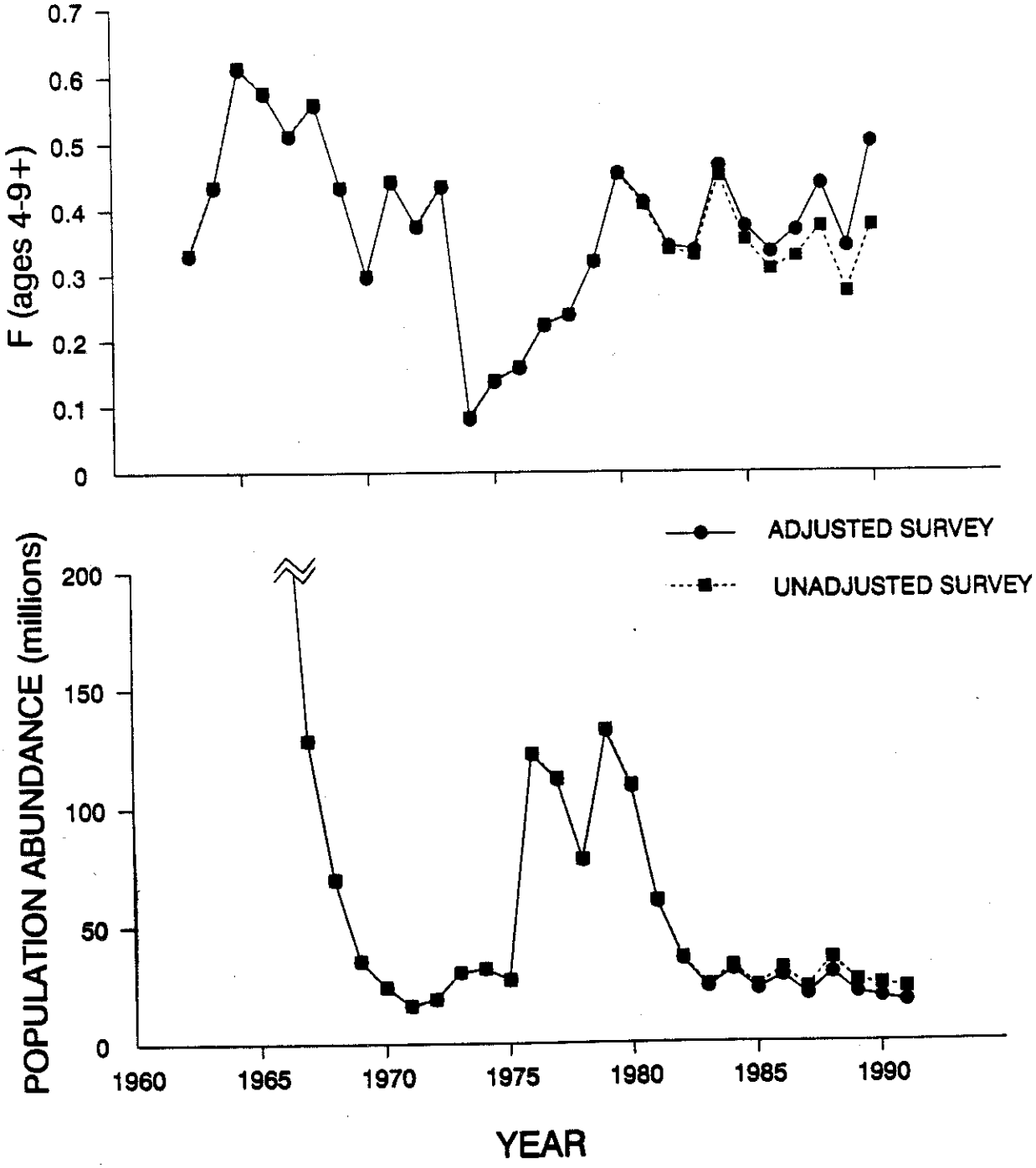


Figure 13. Yield per recruit and spawning stock biomass per recruit for Georges Bank haddock.

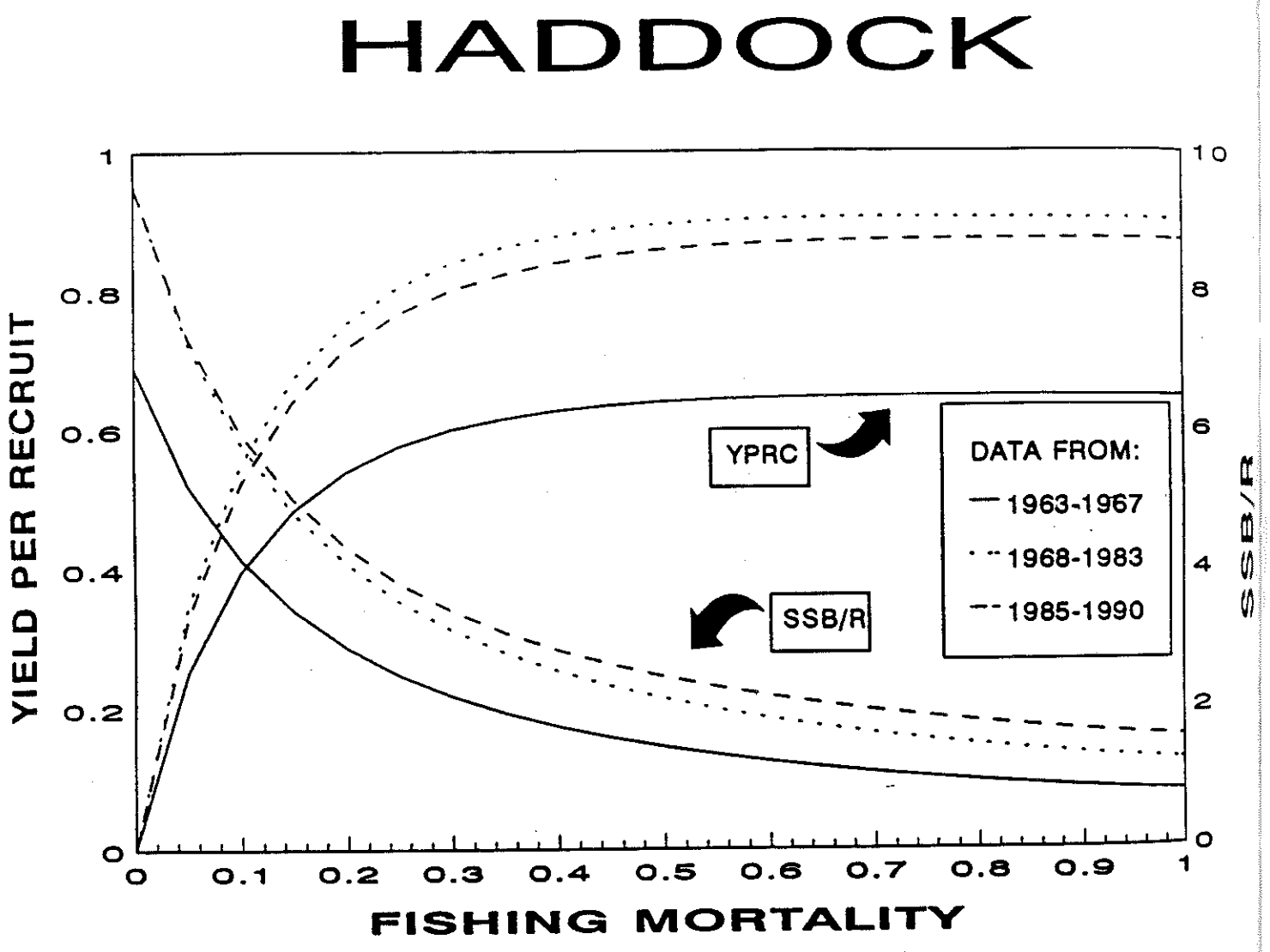
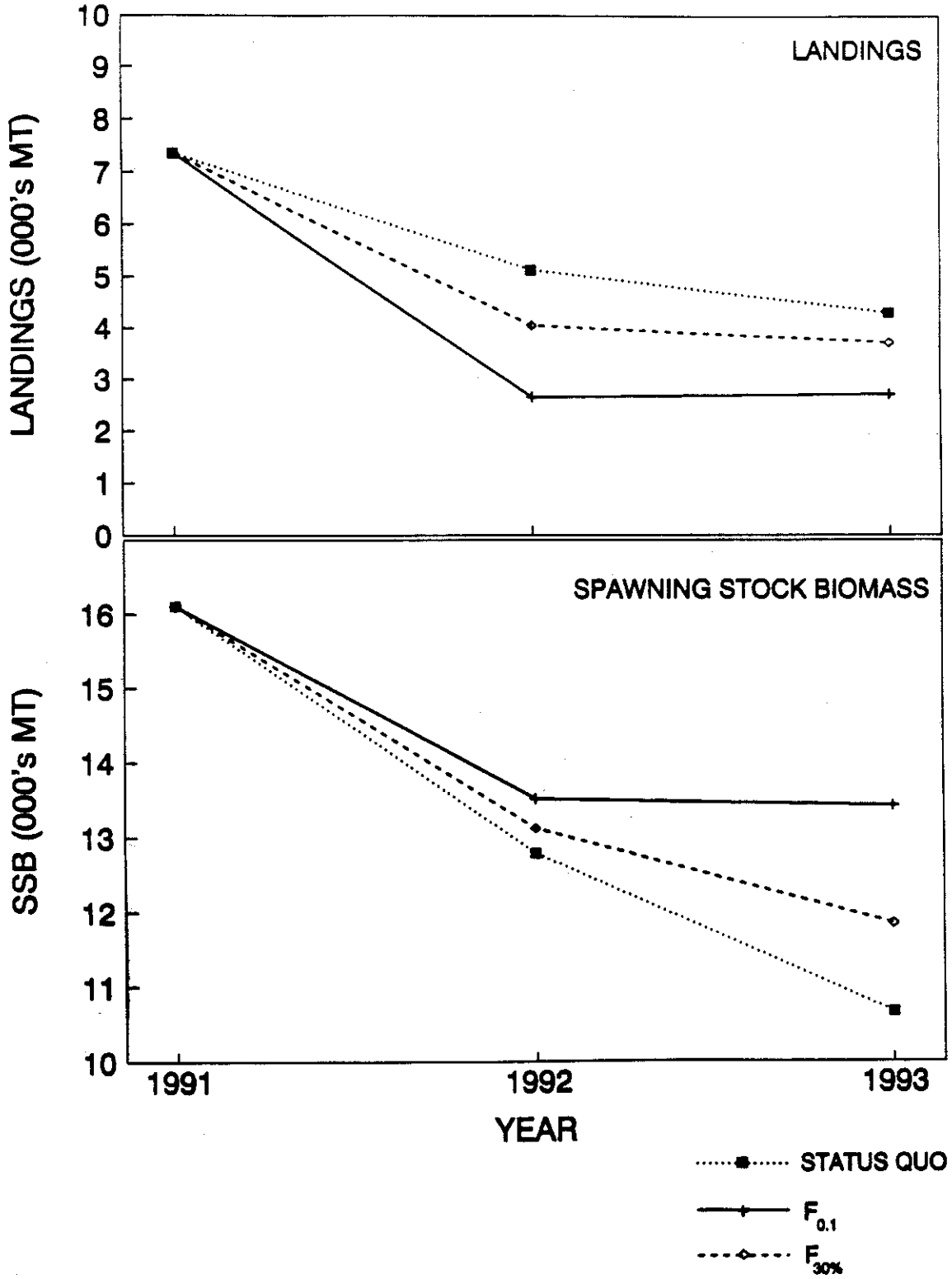


Figure 14. Three-year projections of landings and spawning stock biomass for Georges Bank haddock using average recruitment and mean weight and partial maturity vectors from 1985-1990.



Appendix A. Estimates of correction factors used to account for changes in survey gear, including vessels, nets and doors.

Introduction

Since the inception of the NMFS/NEFC bottom trawl survey series several changes in the gear configuration have been made. Within the time series the gear configuration has included:

1. Use of BMV oval doors from 1963-1984 and Portuguese polyvalent doors from 1985-present

2. Use of a 36 Yankee net in all surveys except the spring surveys conducted from 1973-1981 when a 41 Yankee net was used.

3. From 1963 to the present, the Albatross IV has performed most of the surveys. Beginning in 1977, however, the Delaware II has performed approximately 50% of the cruise/area combinations.

To account for these changes in gear use, several gear comparison cruises have been conducted. These gear comparison cruises have focused primarily on the effects that vessel and door used have on catch. These experiments were designed as matched-pair experiments where tows using one gear configuration were approximately replicated in space and time of day with the alternative gear being studied.

A limited set of experiments have been conducted to evaluate the difference in fishing power of the 36 Yankee net versus the 41 Yankee net. These experiments, however, were mostly conducted in Southern New England where the catch of haddock was very low. Because of this, the effects of changes in net usage have been analyzed using intervention analysis.

Methods

In the matched-paired experiments, conversion coefficients were estimated as the ratio in mean catch (numbers) with one gear (the standard) to the alternative gear. These ratios were computed using the following formula from Cochran (1977):

$$R = \frac{\Sigma y}{\Sigma x} = \frac{\bar{y}}{\bar{x}}$$

The variance of this estimate was approximated as (Cochran 1977):

$$s(\hat{R}) = \frac{1}{\sqrt{n\bar{x}}} \frac{\sqrt{\Sigma y^2 - 2\hat{R}\,\Sigma yx + \hat{R}^2 \Sigma x^2}}{n-1}$$

Before computation of these estimates, the data were filtered to include only those pairs of tows where at least one haddock was captured. This filtering was used in order to avoid artificially inflating sample size by the inclusion of pairs where both tows contained no haddock.

Conversion coefficients were computed for three size classes of haddock in order to evaluate the possiblity of differences in fishing power by size class. The size classes used were: 0-20 cm, 20-40 cm, and >40 cm.

Intervention analysis was used to estimate and evaluate the significance of differences in catch rates between the 36 Yankee net and the 41 Yankee net. Since the 41 Yankee was not used in the fall survey, the data used were the difference between the $\log_e$ of the mean catch in the spring and fall survey. This difference was computed on only 1+ aged fish since fish in the age 0 group are vulnerable during the fall survey and not in the spring. In addition to the intervention analysis, a alternative estimate of the conversion coefficient was calculated as the difference between the time periods when the 41 Yankee net was and was not used, in terms of the mean $\log_e$ differences between the spring and fall survey catches of age 1+ haddock.

Results

Results of the door conversion experiments indicate that the use of polyvalent doors had a significant effect on the catch rate of haddock, with the polyvalent doors being approximately 1.6 times more effective than the BMV doors (Table A1). When the conversion coefficients were computed for each size class, however, no discernable effect on catch rates of haddock 0-20 cm was apparent (Table A1). Catches of haddock 20-40 cm and >40 cm were higher using the polyvalent doors, and were approximately equivalent. As no difference was detectable in the ratio for haddock 20-40 cm and >40 cm, a ratio for all haddock >20 cm was computed (Table A1). Catches of haddock <20 cm occured less frequently than for haddock >20 cm, and consequently the precision of the estimated ratio is much less. Since the estimates for larger haddock were within approximately ± 1.5 SE of the ratio estimated for haddock <20 cm, the estimate for haddock >20 cm was used. For future applications, the properties of these estimates should be investigated further.

The vessel comparison experiments indicated a significant effect of vessel on the catch rate of haddock, with the Albatross IV catching approximately 68% as many haddock as the Delaware II (Table A2). As in the results for door conversion factors, the estimates of conversion coefficients for hadodck in the 0-20 cm size class differed from that for the 20-40 cm and >40 cm size classes. The estimates for haddock <20 cm had relatively low presion and as with the door conversion coefficients, a single conversion coefficient was applied to all size classes of haddock (Table A2).

The time series of differences between the spring and fall surveys indicated no trend over time (Figure A1) for either the Gulf of Maine or Georges Bank, and regressions of differences in catch over time were not significant (α=0.05). Thus, the time series was assumed to be stationary, and the intervention analysis was performed on data undifferenced in time (years). Results of the intervention analysis indicated no significant difference in catch rates using the 41 Yankee net as compared to the 36 Yankee net. (Table A3). Estimates of conversion coefficients calculated as the difference between time periods in the mean differences between spring and fall surveys were very similar to those obtained in the intervention analysis. Variances were not computed for this second set of estimates because of the similarity to point estimates obtained with the intervention analysis.

Gear usage and correction factors applied

Tables A4 to A7 detail the gear configurations used during the NEFC bottom trawl surveys in the Gulf of Maine and Georges Bank and the correction factors applied. In all cases, the net and door used was consistent across the entire survey within a year/season combination. In some cases, however, the Albatross IV and the Delaware II each performed some portion of a given survey area. When this occurred, the vessel performing the majority of tows within the principal strata for haddock was chosen as the principal vessel for the purposes of applying correction factors. While it may have been more appropriate to compute the mean catch per tow for each individual vessel and then apply the correction factors to these subsets of the survey, the computational difficulties associated with applying the correction factors in this manner were prohibitive.

The conversion coefficients applied were simply the product of each of the individual conversion coefficients, with the gear configuration Albatross IV, polyvalent door and 36 Yankee net being the standard. The application of conversion coefficients in this manner makes the tacit assumption that the interaction between vessel and doors is not significant.

Table A1. Estimates of ratio of catch using polyvalent doors to BMV doors for various size classes of haddock.

Size class	Ratio	Standard Deviation	N
all haddock	1.627	0.214	141
0-20 cm	0.970	0.403	25
20-40 cm	1.609	0.190	99
>40 cm	1.637	0.232	124
>20 cm	1.633	0.218	136

Table A2. Estimates of ratio of catch in Albatross IV to Delaware II for various size classes of haddock.

Size class	Ratio	Standard Deviation	N
all haddock	0.688	0.087	158
0-20 cm	0.363[1]	0.139	61
20-40 cm	0.794	0.129	89
>40 cm	0.877	0.063	117
>20 cm	0.852	0.063	135

[1] Three pairs in this data set had very large catches (>500 individuals) of age-0 haddock in at least one of the tows within the pair. When these data points were deleted, the ratio estimate was 0.549, std=0.182, N=58.

Table A3. Estimates of conversion coefficients (± 1SE) for changes in net from a 36 Yankee to a 41 Yankee.

	Intervention Analysis	T ratio	Difference Method
Gulf of Maine	1.21 ± 0.34	0.58	1.21
Georges Bank	1.02 ± .217	0.09	1.03

Table A4. Gear used in fall survey on Georges Bank, and conversion coefficients used.

Year	Vessel	Net	Door	Conversion Coefficient
1963	ALBATROSS IV	36 Yankee	BMV	1.633
1964	ALBATROSS IV	36 Yankee	BMV	1.633
1965	ALBATROSS IV	36 Yankee	BMV	1.633
1966	ALBATROSS IV	36 Yankee	BMV	1.633
1967	ALBATROSS IV	36 Yankee	BMV	1.633
1968	ALBATROSS IV	36 Yankee	BMV	1.633
1969	ALBATROSS IV	36 Yankee	BMV	1.633
1970	ALBATROSS IV	36 Yankee	BMV	1.633
1971	ALBATROSS IV	36 Yankee	BMV	1.633
1972	ALBATROSS IV	36 Yankee	BMV	1.633
1973	ALBATROSS IV	36 Yankee	BMV	1.633
1974	ALBATROSS IV	36 Yankee	BMV	1.633
1975	ALBATROSS IV	36 Yankee	BMV	1.633
1976	ALBATROSS IV	36 Yankee	BMV	1.633
1977	DELAWARE II	36 Yankee	BMV	1.391
1978	DELAWARE II	36 Yankee	BMV	1.391
1979	DELAWARE II [1]	36 Yankee	BMV	1.391
1980	DELAWARE II	36 Yankee	BMV	1.391
1981	DELAWARE II [1]	36 Yankee	BMV	1.391
1982	ALBATROSS IV	36 Yankee	BMV	1.633
1983	ALBATROSS IV	36 Yankee	BMV	1.633
1984	ALBATROSS IV	36 Yankee	BMV	1.633
1985	ALBATROSS IV [1]	36 Yankee	POLY	1.000
1986	ALBATROSS IV [1]	36 Yankee	POLY	1.000
1987	ALBATROSS IV	36 Yankee	POLY	1.000
1988	ALBATROSS IV	36 Yankee	POLY	1.000
1989	DELAWARE II	36 Yankee	POLY	0.852
1990	DELAWARE II	36 Yankee	POLY	0.852
1991	DELAWARE II	36 Yankee	POLY	0.852

[1] Both vessels performed some portion of this cruise, but the indicated vessel conducted most of the tows in the primary strata where haddock were captured.

Table A5. Gear used in spring survey on Georges Bank, and conversion coefficients used.

Year	Vessel	Net	Door	Conversion Coefficient
1968	ALBATROSS IV	36 Yankee	BMV	1.633
1969	ALBATROSS IV	36 Yankee	BMV	1.633
1970	ALBATROSS IV	36 Yankee	BMV	1.633
1971	ALBATROSS IV	36 Yankee	BMV	1.633
1972	ALBATROSS IV	36 Yankee	BMV	1.633
1973	ALBATROSS IV	41 Yankee	BMV	1.633
1974	ALBATROSS IV	41 Yankee	BMV	1.633
1975	ALBATROSS IV	41 Yankee	BMV	1.633
1976	ALBATROSS IV	41 Yankee	BMV	1.633
1977	ALBATROSS IV	41 Yankee	BMV	1.633
1978	ALBATROSS IV	41 Yankee	BMV	1.633
1979	ALBATROSS IV [1]	41 Yankee	BMV	1.633
1980	ALBATROSS IV [1]	41 Yankee	BMV	1.633
1981	DELAWARE II	41 Yankee	BMV	1.391
1982	DELAWARE II	36 Yankee	BMV	1.391
1983	ALBATROSS IV	36 Yankee	BMV	1.633
1984	ALBATROSS IV	36 Yankee	BMV	1.633
1985	ALBATROSS IV	36 Yankee	POLY	1.000
1986	ALBATROSS IV	36 Yankee	POLY	1.000
1987	ALBATROSS IV [1]	36 Yankee	POLY	1.000
1988	ALBATROSS IV	36 Yankee	POLY	1.000
1989	DELAWARE II	36 Yankee	POLY	0.852
1990	DELAWARE II	36 Yankee	POLY	0.852
1991	DELAWARE II	36 Yankee	POLY	0.852

[1] Both vessels performed some portion of this cruise, but the indicated vessel conducted most of the tows in the primary strata where haddock were captured.

Table A6. Gear used in fall survey in the Gulf of Maine and conversion coefficients used.

Year	Vessel	Net	Door	Conversion Coefficient
1963	ALBATROSS IV	36 Yankee	BMV	1.633
1964	ALBATROSS IV	36 Yankee	BMV	1.633
1965	ALBATROSS IV	36 Yankee	BMV	1.633
1966	ALBATROSS IV	36 Yankee	BMV	1.633
1967	ALBATROSS IV	36 Yankee	BMV	1.633
1968	ALBATROSS IV	36 Yankee	BMV	1.633
1969	ALBATROSS IV	36 Yankee	BMV	1.633
1970	ALBATROSS IV	36 Yankee	BMV	1.633
1971	ALBATROSS IV	36 Yankee	BMV	1.633
1972	ALBATROSS IV	36 Yankee	BMV	1.633
1973	ALBATROSS IV	36 Yankee	BMV	1.633
1974	ALBATROSS IV	36 Yankee	BMV	1.633
1975	ALBATROSS IV	36 Yankee	BMV	1.633
1976	ALBATROSS IV	36 Yankee	BMV	1.633
1977	DELAWARE II	36 Yankee	BMV	1.391
1978	DELAWARE II	36 Yankee	BMV	1.391
1979	ALBATROSS IV [1]	36 Yankee	BMV	1.633
1980	DELAWARE II	36 Yankee	BMV	1.391
1981	ALBATROSS IV [1]	36 Yankee	BMV	1.633
1982	ALBATROSS IV	36 Yankee	BMV	1.633
1983	ALBATROSS IV	36 Yankee	BMV	1.633
1984	ALBATROSS IV	36 Yankee	BMV	1.633
1985	ALBATROSS IV [1]	36 Yankee	POLY	1.000
1986	ALBATROSS IV	36 Yankee	POLY	1.000
1987	ALBATROSS IV	36 Yankee	POLY	1.000
1988	ALBATROSS IV	36 Yankee	POLY	0.852
1989	DELAWARE II	36 Yankee	POLY	0.852
1990	DELAWARE II	36 Yankee	POLY	0.852
1991	DELAWARE II	36 Yankee	POLY	0.852

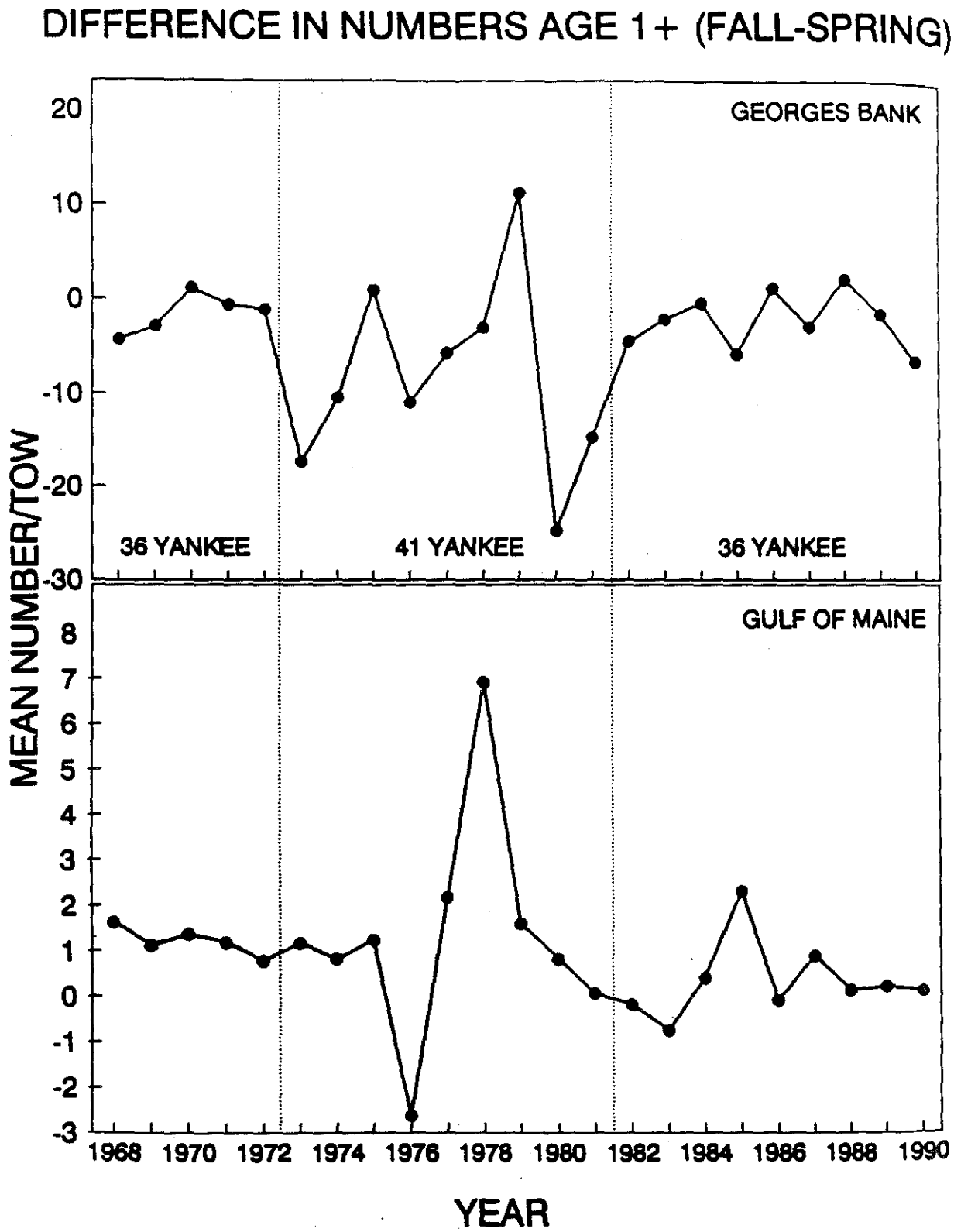
[1] Both vessels performed some portion of this cruise, but the indicated vessel conducted most of the tows in the primary strata where haddock were captured.

Table A7. Gear used in spring survey in the Gulf of Maine and conversion coefficients used.

Year	Vessel	Net	Door	Conversion Coefficient
1968	ALBATROSS IV	36 Yankee	BMV	1.633
1969	ALBATROSS IV	36 Yankee	BMV	1.633
1970	ALBATROSS IV	36 Yankee	BMV	1.633
1971	ALBATROSS IV	36 Yankee	BMV	1.633
1972	ALBATROSS IV	36 Yankee	BMV	1.633
1973	ALBATROSS IV	41 Yankee	BMV	1.633
1974	ALBATROSS IV	41 Yankee	BMV	1.633
1975	ALBATROSS IV	41 Yankee	BMV	1.633
1976	ALBATROSS IV	41 Yankee	BMV	1.633
1977	ALBATROSS IV	41 Yankee	BMV	1.633
1978	ALBATROSS IV	41 Yankee	BMV	1.633
1979	DELAWARE II [1]	41 Yankee	BMV	1.391
1980	DELAWARE II	41 Yankee	BMV	1.391
1981	DELAWARE II	41 Yankee	BMV	1.391
1982	DELAWARE II	36 Yankee	BMV	1.391
1983	ALBATROSS IV	36 Yankee	BMV	1.633
1984	ALBATROSS IV	36 Yankee	BMV	1.633
1985	ALBATROSS IV	36 Yankee	POLY	1.000
1986	ALBATROSS IV	36 Yankee	POLY	1.000
1987	DELAWARE II	36 Yankee	POLY	0.852
1988	ALBATROSS IV	36 Yankee	POLY	1.000
1989	DELAWARE II	36 Yankee	POLY	0.852
1990	DELAWARE II	36 Yankee	POLY	0.852
1991	DELAWARE II	36 Yankee	POLY	0.852

[1] Both vessels performed some portion of this cruise, but the indicated vessel conducted most of the tows in the primary strata where haddock were captured.

Figure A1. Difference in stratified mean catch per tow (numbers) of age 1+ haddock on Georges Bank in the spring and autumn NEFC bottom trawl survey.



Appendix B.

A statistical method for evaluating differences between age-length keys with application to Georges Bank haddock

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Abstract:

Age-length keys are widely used to convert the length frequency of the catch to an age frequency. Time intervals for aggregating data used to construct age-length keys have generally been determined on a subjective basis. In this paper, a method utilizing Fisher's exact test is presented for statistically determining if two age-length keys differ significantly, allowing one to objectively decide if combining age-length keys from two time periods is appropriate. Results of this test applied to Georges Bank haddock indicate that age-length keys derived from the first and second quarters within a year do not differ significantly. Further, age at length of fish sampled in research bottom trawl surveys showed no directional difference from the age at length of fish captured in commercial fishing gear. Pooling age-length keys across these quarters and from these two sources results in increased precision of catch at age without introducing bias into the estimates.

Age-length keys are a critical component of many methods used to estimate catch at age (Southward 1976; Kimura 1977; Gavaris and Gavaris 1983; Quinn et al. 1983; Lai 1987; Martin and Cook 1990). When formulating age-length keys for use in stock assessment work, an important consideration involves appropriate time scales for data aggregation. The most accurate representation of age at length in the population is obtained from age-length keys derived from intensive sampling of brief time intervals (Kimura 1977; Westrheim and Ricker 1978). In practice, however, such a strategy is expensive to implement due to the labor-intensive nature of collecting and processing age structures. For the efficient and cost-effective use of sampling resources, one would like to sample and age the smallest number of fish that gives adequate precision in estimates of catch at age while avoiding biased results. It follows that ageing requirements can be considerably reduced if appropriate time intervals for age-length keys can be defined.

A further problem facing assessment scientists is the need for evaluation of samples drawn from different sources. For example, most of the commercially important fish stocks off the northeastern United States are sampled in spring and autumn bottom trawl surveys by the Northeast Fisheries Center (NEFC) of the National Marine Fisheries Service. Since codend liners are employed in these trawls, the fish collected in these surveys have a substantially different size and age composition than the commercial catch. However, it is unknown if for a fish of a

given length the research survey trawl selects for fish of a different age than commercial harvesting gear, and if age-length keys including data from research surveys will impart a bias into estimates of catch at age.

In this paper, I present a method for statistically evaluating the differences between age-length keys from different time intervals and/or different sampling regimes for the purpose of aggregating into a single key. The primary reason for combining age-length keys across time intervals or from separate sources is to improve the precision of estimates of catch at age for a given sample size, or to reduce the number of samples necessary to achieve a given level of precision. Also, a combined key will be less likely to contain unsampled size intervals (commonly called holes in the age-length key) than either individual key. Thus, the investigator can minimize the problem of having to subjectively "fill" these holes based on data from surrounding length intervals or his/her own experience.

Methods

Age-length keys are commonly formed by first obtaining a matrix of numbers at age by length interval (Table 1), and then converting this to a matrix of proportion at age for each length interval. For the statistical tests between age-length keys, however, I have utilized the matrix of numbers at age by length.

Statistical comparisons between age-length keys are based on

making tests of significance separately for each length interval present in both keys. Each of these comparisons tests the hypothesis that the proportion at age within each length class is no different among keys than would be obtained by random chance. Formally, the hypothesis tested is for length class i,

Ho: $p_{ij1} = p_{ij2}$ for all age classes j from source 1 and source 2

Ha: $p_{ij1} \neq p_{ij2}$ for all age classes j from source 1 and source 2

Consider as an example haddock (Melanogrammus aeglefinus) in the 54 cm size class sampled from the commercial catch from the first and second quarter of 1983. The vectors of numbers at age from each of these samples are:

	Age									
	0	1	2	3	4	5	6	7	8	Total
Quarter 1	0	0	0	1	8	14	0	0	0	23
Quarter 2	0	0	0	7	10	24	1	0	0	42

The question asked with the above hypothesis is whether the two samples are likely to be drawn from the same population or if they differ sufficiently to indicate that the populations from which they were sampled also are different. Assuming fixed marginal totals, an appropriate test of this hypothesis is Fisher's exact test (Siegel 1956). Previously this test was impractical for contingency tables greater than 2 x 2 because of the amount of computational power required by the algorithms

available for its solution. Recent improvements (Pagano and Halvorsen 1981; Mehta and Patel 1983; implemented in Version 6.04 of SAS) allow problems of this size to be readily solved.

Alternative tests exists in the Chi-square test of homogeneity (Hennemuth 1965) and the G^2 test (Bishop et al. 1975). These tests have the advantage in that age-length keys could be compared in their entirety. However, these tests are often inappropriate for comparing age-length keys because the expected value is frequently less than 5, and sometimes less than 1 in some of the cells in the contingency table (Sokal and Rohlf 1981). With Fisher's exact test, there are no restrictions on the expected values for any cell within the contingency table (Siegel 1956). In practice, however, each source (i.e., time period) should contain at least six observations as sample sizes less than six per source do not have sufficient power to resolve even major discrepancies between sources (personal observation).

Estimation of Catch at Age and Variance

For the purposes of evaluating the effects of pooling age-length keys, length frequency samples were treated as simple random samples from the entire stock area. Following Gavaris and Gavaris (1983), the proportion at age for unpooled samples was estimated as:

$$\hat{P}_{iq} = \sum P_{jq} \; P_{ijq}$$

Where,

$\hat{P}_{iq}$ = *Estimated proportion at age i in quarter q*
P_{jq} = *Proportion at length j in quarter q*
P_{ijq} = *Proportion at age i at length j in quarter q*

For samples where age-length keys were pooled across quarters, the proportion at age was estimated as:

$$\hat{P}_{iq} = \sum P_{jq} \; P^{*}_{ijq}$$

Where,

P^{*}_{ijq} = *Pooled porportion at age i at length j for appropriate quarters*

Estimates of the variance of proportion at age were derived following Gavaris and Gavaris (1983):

$$Var\left(\hat{P}_{iq}\right) = \sum_{j} \frac{P_{jq}^{2} \; P_{ijq} \; (1 - P_{ijq})}{n_{jq} - 1} + \frac{P_{jq} \; (P_{ijq} - \hat{P}_{iq})^{2}}{n_{q}}$$

Where,

n_{jq} = *# of fish at length j in quarter q*
n_{q} = *# of fish aged in quarter q*

Estimates of the variance of proportion at age when age-length keys were pooled were computed with the above formulae, except P^{*}_{ijq} was substituted for P_{ijq}. Catch at age and variance for each quarter were computed following Gavaris and Gavaris (1983).

Since these computations do not depend on whether pooled or unpooled age-length keys are used, the formulae are not repeated.

Results and Discussion

Graphs of mean length at age by month for Georges Bank haddock sampled from the commercial fishery from 1980 to 1988 (Figure 1) indicate that most of the annual growth takes place during the third quarter, from June through September. From this pattern of annual growth, it was expected that age-length keys would not be significantly different between the first and second quarters, but would differ significantly betweens the second and third quarters, and the third and fourth quarters. Accordingly, tests were conducted between these pairs of quarters to determine if age-length keys could be pooled across any adjacent quarters. Summary statistics of these tests are presented in Tables 2-4.

Care must be exercised in interpreting the significance of differences between a single length class since many tests of significance were conducted for each age-length key comparison. For example, comparisons between the first and second quarters yielded 9 of 94 tests significant at the 0.05 level. This number of "significant" results, however, is not substantially different than the number of "significant" results that would be expected based on random chance. Further, these differences occurred sporadically among the length classes, suggesting that no consistent deviation in age at length was present between fish collected during the first and second quarter within a year.

Thus, it appears that first and second quarter age-length keys within each year can be treated as samples drawn from the same population and thus can be combined.

Differences between the second and third quarters and the third and fourth quarters were much stronger than that between the first and second quarters. Tests between the second and third quarters resulted in 45 of 95 comparisons significant at the 0.05 level. Tests between the third and fourth quarters yielded 21 of 85 comparisons exceeding the 0.05 level. Further, differences in these age-length keys occurred in contiguous blocks rather than sporadically as occurred between quarters one and two. From these results, it appears that age-length keys should not be combined across the second and third quarters or across the third and fourth quarters for haddock.

Similar tests were performed comparing age-length keys derived from NEFC bottom trawl surveys and the pooled first and second quarter age-length key derived from fish sampled from the commercial catch. As presented in Table 5, 10 of 71 tests had probabilities less than 0.05. As in the tests comparing first and second quarter commercial age keys, no consistent pattern among these differences was apparent. Although more "significant" results were obtained than would be expected by random chance, it should be noted that half of these differences occurred among the 66 to 76 cm size classes. For these size classes, the sample size from the bottom trawl survey was generally small (<10 fish), while that from commercial was often

large (>50 fish). Examination of the contingency tables for these size classes indicated that the difference in proportion at age between commercial and survey age-length keys were small and were often due to a broader representation of age classes in the commercial data. A broader representation of age classes in the commercial samples would be expected, however, given the larger sample size available from the commercial fishery for fish in these length classes. Based on the lack of pattern among the significance tests, it appears that the survey gear does not consistently select for fish of a different age at a given length than the fishing gears used to harvest haddock commercially. Accordingly data on age at length obtained from fish collected in the research surveys can be combined with data collected from fish sampled from the commercial catch.

As a further check on the potential for introducing bias by combining age-length keys, estimates of the age composition of the commercial catch for each year from 1982 to 1988 were made using age-length keys combined in four different ways. First, age-length keys were constructed for each quarter using only fish sampled during that quarter from the commercial catch. These age-length keys served as a basis for comparison since estimates of catch at age derived from the age-length keys correspond to the level of temporal aggregation (quarterly) that has commonly been used in Georges Bank haddock assessments (Clark et al. 1982; Gavaris and Van Eeckhaute 1990). The second set of age-length keys were formed by combining age-length data from all haddock

sampled from the commercial catch during the first half of the year into a single age-length key that was then applied to the first and second quarter length frequency distributions. The third set of age-length keys were constructed for quarterly intervals, but included data from haddock sampled in the commercial catch and from the NEFC bottom trawl surveys. The final set of age-length keys contained data from haddock caught both commercially and in trawl surveys, but data were combined for the first half of the year.

Comparison of the estimates of catch at age averaged over the period of 1982-1988 reveals only minor variations between results obtained with the various age-length keys, with no indication of systematic bias (Figure 2). This is as expected, based on the results of statistical tests of the age-length keys which indicated little or no difference. The precision of these estimates, as indicated by the average coefficient of variation, however, did show a trend among the different levels of aggregation (Figure 3). Combining first and second quarter age-length keys derived solely from commercially caught haddock showed an increased precision for all age groups, but particularly for older age classes that typically had small samples sizes within any single quarter (i.e., the 82 and 84 cm length classes in Table 1). The inclusion of survey age data had a relatively smaller effect on the precision of estimates for most age classes except for age 2 fish (Figure 3). This occurred because the sample size of small haddock was generally low in the

commercial samples whereas small fish were more common in the research survey samples.

In summary, Fisher's exact test provides a means of testing differences between age-length keys derived from different sources or from different time periods. When age-length keys are pooled across time periods and/or sources that are determined not to differ significantly, the resulting estimates of catch at age are more precise and importantly the estimates do not appear to be biased due to the pooling procedure.

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Figure Legends

Figure 1. Monthly mean length at age of Georges Bank haddock in the commercial catch, 1980-1988.

Figure 2. Mean catch at age of Georges Bank haddock, 1982-1988, using different levels of aggregation in the age-length key. Unpooled commercial refers to quarterly age-length keys derived solely from commercial samples. Pooled commercial refers to age-length keys derived solely from commercial samples, but with quarter 1 and quarter 2 data pooled into a single age-length key. Pooled and unpooled commercial and survey refers to the same levels of temporal aggregation as above, but including age at length data obtained from fish collected in the NEFC bottom trawl surveys. Vertical lines indicate 2 SE of the mean catch at age.

Figure 3. Mean coefficient of variation of estimates of catch at age for Georges Bank haddock, 1982-1988, using different levels of aggregation in the age-length key. Symbol definitions are as in Figure 2.

Table 1. Number sampled at age by 2 cm length groups from the commercial catch of Georges Bank haddock, January to March 1983.

Length (cm)	Age 2	3	4	5	6	7	8	9+	Total
42	1	2	0	0	0	0	0	0	3
44	0	6	0	0	0	0	0	0	6
46	0	4	2	0	0	0	0	0	6
48	0	4	1	1	0	0	0	0	6
50	0	3	5	4	0	0	0	0	12
52	0	2	5	6	1	0	0	0	14
54	0	1	8	14	0	0	0	0	23
56	0	0	9	11	0	0	0	0	20
58	0	0	5	12	1	0	0	0	18
60	0	0	3	8	2	0	6	0	19
62	0	0	3	8	4	0	6	0	21
64	0	0	0	12	3	1	2	1	19
66	0	0	0	9	3	0	7	0	19
68	0	0	0	8	0	0	6	1	15
70	0	0	0	4	1	4	8	0	17
72	0	0	0	0	1	3	9	0	13
74	0	0	0	2	0	2	10	1	15
76	0	0	0	0	1	1	9	0	11
78	0	0	0	0	1	1	6	1	9
80	0	0	0	0	0	1	7	1	9
82	0	0	0	0	0	0	7	1	8
84	0	0	0	0	0	0	1	1	2
86	0	0	0	0	0	0	1	0	1

Table 2. Results of Fisher's exact test comparing first and second quarter age-length keys from Georges Bank Haddock, 1982-1988. Entries are probability of difference observed occurring by random chance. Dashes indicate comparisons where the sample size was less than seven within one of the two quarters being compared.

Length	Year						
(cm)	1982	1983	1984	1985	1986	1987	1988
42	-	-	-	-	-	-	-
44	0.307	0.676	-	-	-	-	-
46	0.782	0.117	0.559	1.000	-	-	-
48	1.000	0.804	0.892	0.661	-	-	1.000
50	0.888	0.033*	0.653	0.289	-	-	-
52	0.786	0.819	0.022*	0.363	-	-	0.724
54	0.176	0.434	0.143	0.008*	-	0.018*	0.026*
56	0.051	0.284	0.207	0.451	-	1.000	0.067
58	0.562	0.749	0.002*	0.074	0.753	0.434	0.744
60	0.177	0.002*	0.950	0.889	0.432	0.303	0.870
62	0.153	0.123	0.163	-	1.000	0.799	0.406
64	0.136	0.372	0.223	-	0.644	0.389	0.464
66	0.300	0.694	0.849	-	0.230	0.950	0.811
68	0.352	0.497	0.373	-	0.418	0.461	0.704
70	0.182	0.032*	0.676	-	1.000	1.000	0.799
72	0.097	0.119	0.584	-	0.143	1.000	0.439
74	0.730	0.808	0.036*	-	0.128	-	-
76	0.488	0.589	0.096	-	-	-	-
78	-	0.852	0.249	-	-	-	-
80	-	1.000	0.161	-	-	-	-
82	-	0.466	-	-	-	-	-

* $P<0.05$

Table 3. Results of Fisher's exact test comparing second and third quarter age-length keys from Georges Bank Haddock, 1982-1988. Entries are probability of difference observed occurring by random chance. Dashes indicate comparisons where the sample size was less than seven within one of the two quarters being compared.

Length	Year						
(cm)	1982	1983	1984	1985	1986	1987	1988
42	0.219	0.170	-	-	-	-	-
44	0.001*	0.075	-	0.592	-	-	-
46	0.001*	0.017*	-	0.020*	-	-	-
48	0.001*	0.110	0.620	0.013*	-	0.001*	0.832
50	0.001*	0.026*	0.747	0.108	-	0.001*	0.773
52	0.001*	0.001*	1.000	0.115	1.000	0.003*	0.001*
54	0.001*	0.001*	0.688	0.011*	0.582	0.012*	0.001*
56	0.042*	0.001*	1.000	0.321	0.429	0.488	0.001*
58	0.046*	0.001*	0.146	0.053	0.115	0.335	0.001*
60	0.038*	0.001*	0.863	-	0.001*	0.075	0.001*
62	0.011*	0.011*	0.106	-	0.002*	0.055	0.001*
64	0.523	0.015*	0.662	-	0.004*	0.010*	-
66	0.246	0.032*	0.354	-	0.292	0.004*	-
68	0.068	0.016*	0.192	-	0.046*	0.122	-
70	0.544	0.002*	0.700	-	0.011*	0.046*	-
72	0.379	0.022*	0.738	-	0.590	0.058	-
74	0.185	0.544	-	-	0.020*	0.755	-
76	0.686	0.407	-	-	0.569	-	-
78	-	0.427	-	-	-	-	-
80	-	0.206	-	-	-	-	-
82	-	0.537	-	-	-	-	-

* $P<0.05$

Table 4. Results of Fisher's exact test comparing second and third quarter age-length keys from Georges Bank Haddock, 1982-1988. Entries are probability of difference observed occurring by random chance. Dashes indicate comparisons where the sample size was less than seven within one of the two quarters being compared.

Length	Year						
(cm)	1982	1983	1984	1985	1986	1987	1988
42	0.286	1.000	-	-	-	-	-
44	0.298	0.014*	-	-	-	-	-
46	0.158	0.003*	-	-	-	1.000	-
48	0.051	0.001*	-	-	-	0.192	0.124
50	0.001*	0.123	0.123	-	-	0.053	1.000
52	0.159	0.315	0.212	-	-	0.024*	0.832
54	0.146	0.049*	0.720	-	-	0.754	0.211
56	0.205	0.765	1.000	-	-	0.050*	0.791
58	0.143	0.009*	0.154	-	0.477	0.675	0.016*
60	0.292	0.174	0.939	-	0.794	0.540	0.014*
62	0.028*	0.032*	0.758	-	0.272	0.244	0.001*
64	0.265	0.042*	0.132	-	0.085	0.022*	-
66	0.014*	0.034*	0.079	-	0.785	0.001*	-
68	0.484	0.937	0.759	-	0.068	0.107	-
70	0.011*	0.038*	0.218	-	0.207	0.046*	-
72	1.000	0.813	0.550	-	1.000	0.408	-
74	0.756	0.162	-	-	0.054	0.922	-
76	0.282	0.612	-	-	0.713	-	-
78	0.355	0.499	-	-	1.000	-	-
80	0.765	-	-	-	-	-	-
82	-	-	-	-	-	-	-

* $P<0.05$

Table 5. Results of Fisher's exact test comparing age-length keys for Georges Bank haddock derived from fish sampled in NEFC bottom trawl surveys to commercially sampled fish from the first and second quarters, 1982-1986. Entries are probability of difference observed occurring by random chance. Dashes indicate comparisons where the sample size was less than seven within one of the two sources being compared.

Length	Year						
(cm)	1982	1983	1984	1985	1986	1987	1988
38	0.209	-	-	-	-	-	-
40	0.214	-	-	-	-	-	-
42	-	-	0.054	-	0.350	-	-
44	-	-	0.151	-	1.000	-	-
46	0.087	-	-	0.699	0.232	-	1.000
48	0.038*	1.000	-	-	0.243	-	1.000
50	0.388	1.000	0.344	-	0.095	-	-
52	0.151	0.175	-	-	0.220	0.241	-
54	0.107	0.479	0.547	0.123	-	0.360	-
56	0.020*	0.014*	0.146	0.068	0.033*	0.465	1.000
58	0.139	0.127	0.057	0.549	-	-	-
60	0.019*	0.839	1.000	0.102	0.273	-	-
62	0.268	0.470	0.554	0.165	0.179	0.079	-
64	-	0.526	0.163	0.391	0.641	0.302	-
66	0.821	0.302	0.026*	0.786	0.003*	-	-
68	-	0.191	0.128	0.001*	-	-	-
70	0.625	0.139	0.423	0.008*	-	-	-
72	0.777	0.682	-	-	-	-	-
74	-	-	-	0.001*	-	-	-
76	0.927	0.194	-	-	-	-	-

* $P<0.05$

Figure 1. Monthly mean length at age of Georges Bank haddock in the commercial catch, 1980-1988.

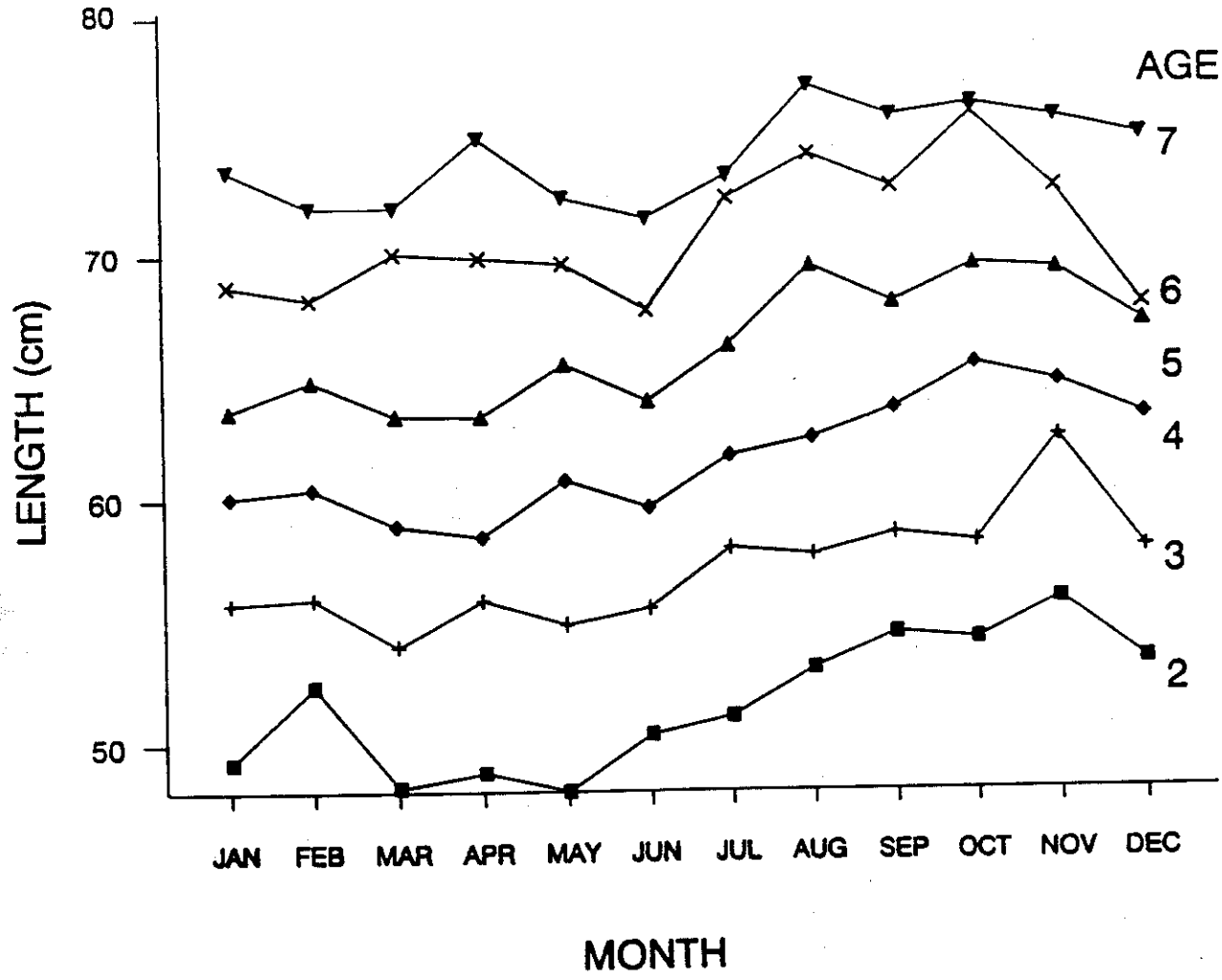


Figure 2. Mean catch at age of Georges Bank haddock, 1982-1988, using different levels of aggregation in the age-length key. Unpooled commercial refers to quarterly age-length keys derived solely from commercial samples. Pooled commercial refers to age-length keys derived solely from commercial samples, but with quarter 1 and quarter 2 data pooled into a single age-length key. Pooled and unpooled commercial and survey refers to the same levels of aggregation as above, but including age at length data obtained from fish collected in the NEFC bottom trawl surveys. Vertical lines indicate 2 SE of the mean catch at age.

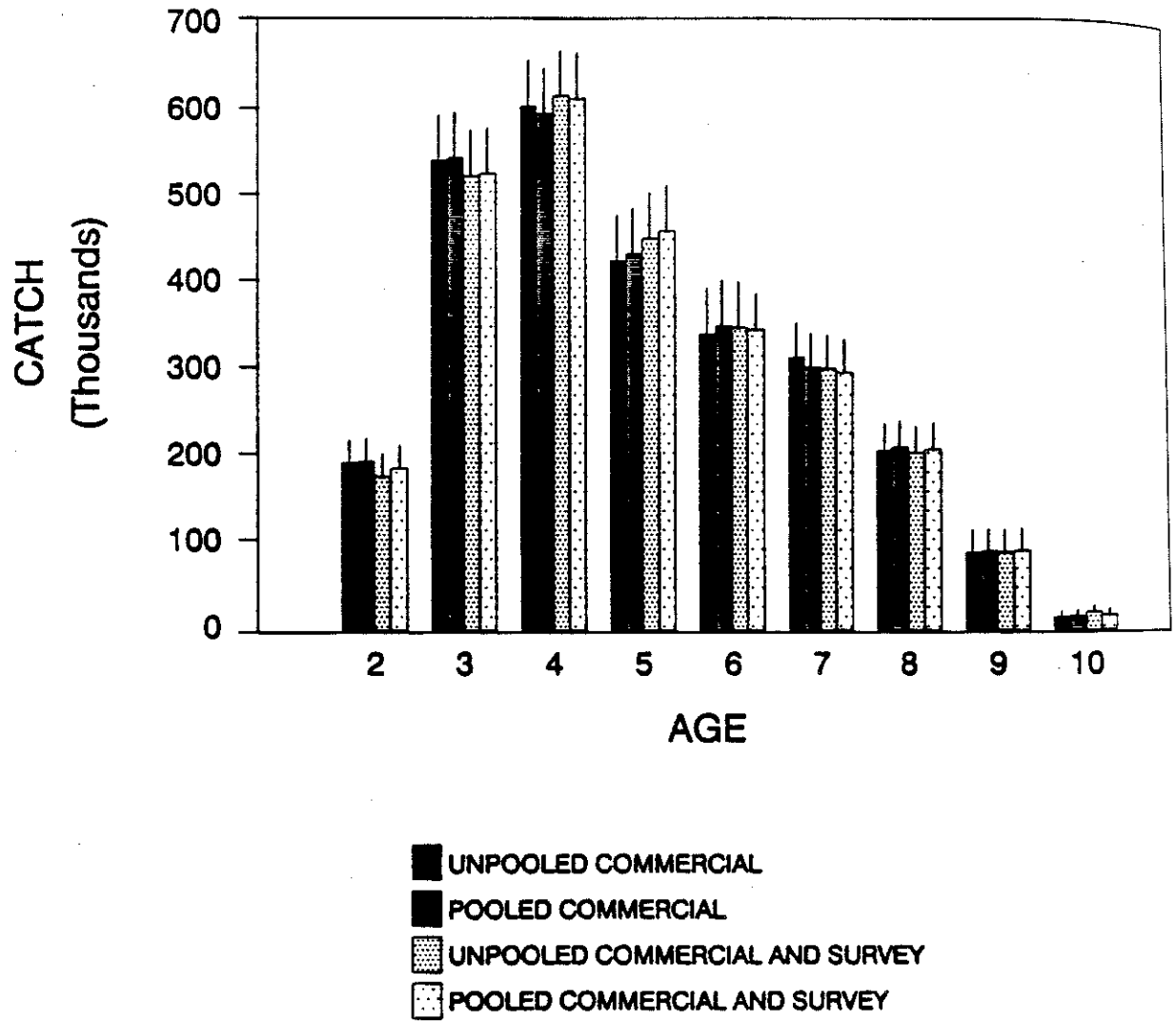
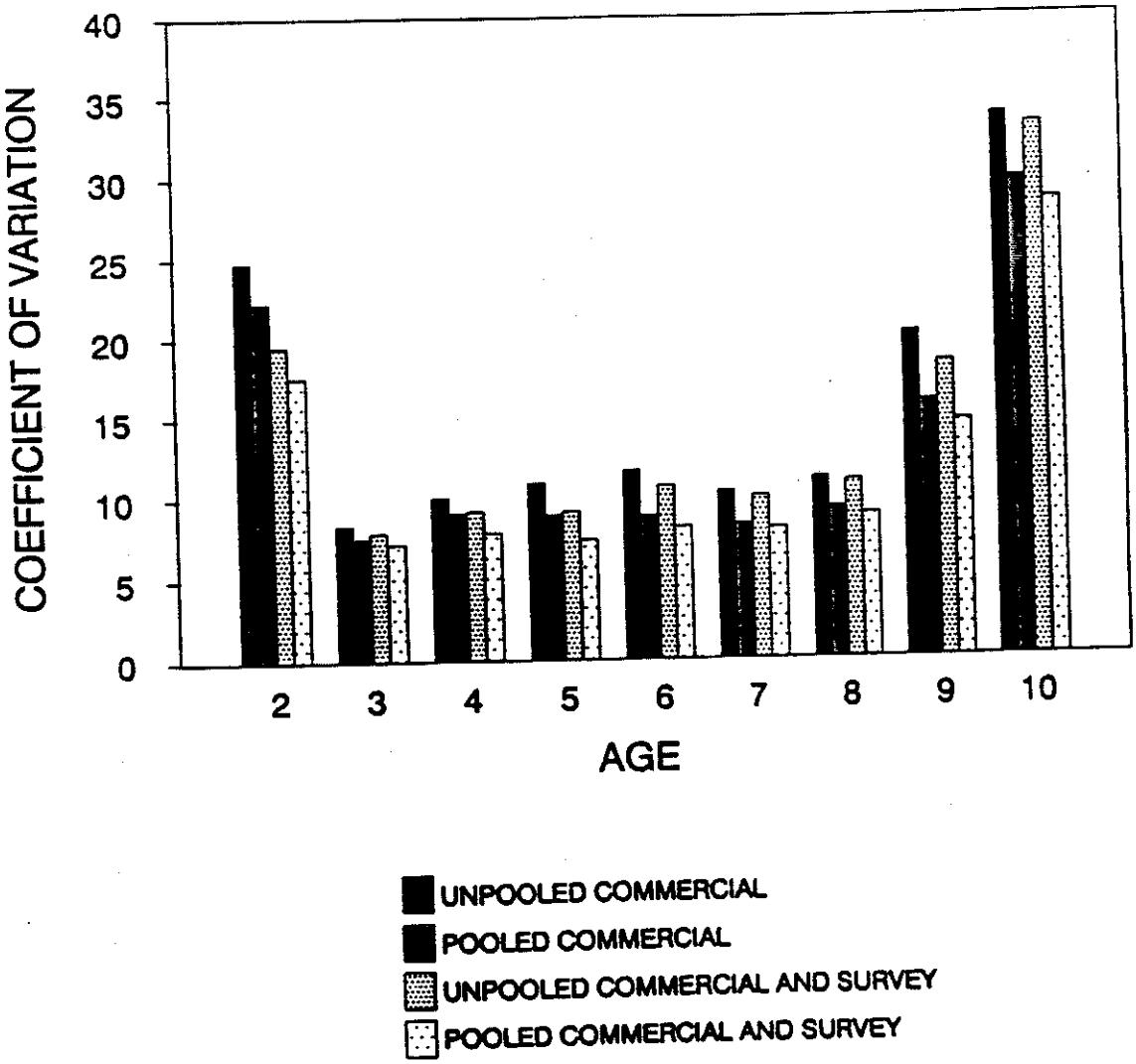


Figure 3. Mean coefficient of variation of estimates of catch at age for Georges Bank haddock, 1982-1988, using different levels of aggregation in the age-length key. Symbol definitions are as in Figure 2.



Appendix C.

Output of GLM analysis of Georges Bank haddock CPUE in the USA otter trawl fishery.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	27	64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
AREA	6	521 522 525 526 561 562
QTR	4	1 2 3 4
TC	2	3 4

Number of observations in data set = 44652

General Linear Models Procedure

Dependent Variable: LOGHAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	35	77998.36733651	2228.52478104	1358.74	0.0001
Error	44616	73176.53598047	1.64014111		
Corrected Total	44651	151174.90331699			

R-Square	C.V.	Root MSE	LOGHAD Mean
0.515948	19.30971	1.28067994	6.63231211

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	26	65789.35955168	2530.35998276	1542.77	0.0001
AREA	5	7101.31054140	1420.26210828	865.94	0.0001
QTR	3	847.45763955	282.48587985	172.23	0.0001
TC	1	2916.78554208	2916.78554208	1778.37	0.0001

Source	DF	Type IV SS	Mean Square	F Value	Pr > F
YEAR	26	65789.35955168	2530.35998276	1542.77	0.0001
AREA	5	7101.31054140	1420.26210828	865.94	0.0001
QTR	3	847.45763955	282.48587985	172.23	0.0001
TC	1	2916.78554208	2916.78554208	1778.37	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		5.977838580 B	147.52	0.0001	0.04052218
YEAR	64	1.765379863 B	40.12	0.0001	0.04399854
	65	1.500280145 B	33.81	0.0001	0.04437721
	66	3.711857248 B	85.08	0.0001	0.04362827
	67	2.652966992 B	59.85	0.0001	0.04432736
	68	2.281566740 B	49.55	0.0001	0.04604503
	69	0.516734264 B	10.65	0.0001	0.04854078
	70	0.708081640 B	13.59	0.0001	0.05208875
	71	0.102033930 B	1.99	0.0467	0.05128872
	72	0.346872512 B	6.27	0.0001	0.05536662
	73	-0.893715241 B	-14.88	0.0001	0.06007925
	74	-2.852155276 B	-49.19	0.0001	0.05798117
	75	-1.008030813 B	-18.26	0.0001	0.05519832
	76	0.217048403 B	3.78	0.0002	0.05748054
	77	2.546801337 B	51.68	0.0001	0.04927983
	78	0.776452725 B	16.56	0.0001	0.04687346
	79	1.006533707 B	22.84	0.0001	0.04406358
	80	0.775394303 B	18.10	0.0001	0.04283332
	81	2.571768649 B	59.54	0.0001	0.04319051
	82	1.710464408 B	38.60	0.0001	0.04431426
	83	1.383603846 B	29.65	0.0001	0.04665737
	84	1.243014785 B	27.48	0.0001	0.04522783

General Linear Models Procedure

Dependent Variable: LOGHAD

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
YEAR	85	0.714790014 B	15.23	0.0001	0.04693615
	86	0.570761824 B	10.67	0.0001	0.05349268
	87	0.076335542 B	1.41	0.1577	0.05403140
	88	-0.029523922 B	-0.60	0.5480	0.04913919
	89	-0.326836244 B	-6.51	0.0001	0.05022619
	90	0.000000000 B	.	.	.
AREA	521	-0.666907115 B	-34.77	0.0001	0.01917811
	522	-0.349540481 B	-17.83	0.0001	0.01960306
	525	-0.374234185 B	-13.98	0.0001	0.02677165
	526	-1.516635579 B	-51.66	0.0001	0.02935923
	561	0.226990443 B	10.22	0.0001	0.02220852
	562	0.000000000 B	.	.	.
QTR	1	0.243847666 B	12.42	0.0001	0.01962774
	2	0.404291731 B	22.32	0.0001	0.01811573
	3	0.172542746 B	9.33	0.0001	0.01850218
	4	0.000000000 B	.	.	.
TC	3	-0.576190765 B	-42.17	0.0001	0.01366327
	4	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

General Linear Models Procedure

Dependent Variable: LOGHAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	73	79918.83946196	1094.77862277	684.90	0.0001
Error	44578	71256.06385503	1.59845807		
Corrected Total	44651	151174.90331699			

R-Square	C.V.	Root MSE	LOGHAD Mean
0.528652	19.06276	1.26430142	6.63231211

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	26	64807.87066261	2492.61041010	1559.38	0.0001
AREA	5	3503.51563474	700.70312695	438.36	0.0001
QTR	3	482.76005100	160.92001700	100.67	0.0001
TC	1	1944.19687466	1944.19687466	1216.30	0.0001
AREA*QTR	15	805.71618036	53.71441202	33.60	0.0001
AREA*TC	5	156.31655866	31.26331173	19.56	0.0001
QTR*TC	3	46.02639955	15.34213318	9.60	0.0001
AREA*QTR*TC	15	139.30252412	9.28683494	5.81	0.0001

Source	DF	Type IV SS	Mean Square	F Value	Pr > F
YEAR	26	64807.87066261	2492.61041010	1559.38	0.0001
AREA	5	3503.51563474	700.70312695	438.36	0.0001
QTR	3	482.76005100	160.92001700	100.67	0.0001
TC	1	1944.19687466	1944.19687466	1216.30	0.0001
AREA*QTR	15	805.71618036	53.71441202	33.60	0.0001
AREA*TC	5	156.31655866	31.26331173	19.56	0.0001
QTR*TC	3	46.02639955	15.34213318	9.60	0.0001
AREA*QTR*TC	15	139.30252412	9.28683494	5.81	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		5.854715477 B	75.30	0.0001	0.07775178
YEAR	64	1.770780047 B	40.34	0.0001	0.04389182
	65	1.519597017 B	34.43	0.0001	0.04413949
	66	3.752249725 B	86.55	0.0001	0.04335354
	67	2.681305642 B	60.91	0.0001	0.04401857
	68	2.267663356 B	49.54	0.0001	0.04577797
	69	0.527022990 B	10.97	0.0001	0.04805818
	70	0.739629821 B	14.34	0.0001	0.05159104
	71	0.114627759 B	2.26	0.0238	0.05072827
	72	0.384650351 B	7.02	0.0001	0.05479377
	73	-0.871096158 B	-14.66	0.0001	0.05944011
	74	-2.831128142 B	-49.33	0.0001	0.05738644
	75	-0.997452159 B	-18.28	0.0001	0.05457630
	76	0.258198881 B	4.54	0.0001	0.05683338

General Linear Models Procedure

Dependent Variable: LOGHAD

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
YEAR	77	2.603703702 B	53.30	0.0001	0.04884914
	78	0.828438715 B	17.85	0.0001	0.04641847
	79	1.055786116 B	24.14	0.0001	0.04373139
	80	0.825474793 B	19.43	0.0001	0.04248399
	81	2.651253230 B	61.82	0.0001	0.04288959
	82	1.754544121 B	39.97	0.0001	0.04389551
	83	1.438634707 B	31.09	0.0001	0.04627525
	84	1.284796872 B	28.67	0.0001	0.04480644
	85	0.749912107 B	16.12	0.0001	0.04652058
	86	0.589193899 B	11.13	0.0001	0.05293901
	87	0.086502360 B	1.62	0.1053	0.05340592
	88	-0.008796664 B	-0.18	0.8565	0.04863008
	89	-0.311355623 B	-6.27	0.0001	0.04964478
	90	0.000000000 B	.	.	.
AREA	521	-0.450252665 B	-5.69	0.0001	0.07906505
	522	-0.256901287 B	-3.00	0.0027	0.08564511
	525	0.062556608 B	0.40	0.6915	0.15765193
	526	-1.043561361 B	-7.20	0.0001	0.14489294
	561	0.241512846 B	2.74	0.0061	0.08813154
	562	0.000000000 B	.	.	.
QTR	1	0.295689344 B	3.78	0.0002	0.07832667
	2	0.576594449 B	7.39	0.0001	0.07803098
	3	0.057839510 B	0.58	0.5646	0.10041529
	4	0.000000000 B	.	.	.
TC	3	-0.755811586 B	-8.54	0.0001	0.08846464
	4	0.000000000 B	.	.	.
AREA*QTR	521 1	-0.024074431 B	-0.23	0.8208	0.10626518
	521 2	-0.567026259 B	-5.33	0.0001	0.10628435
	521 3	0.058327663 B	0.52	0.6043	0.11254651
	521 4	0.000000000 B	.	.	.
	522 1	-0.423775383 B	-4.01	0.0001	0.10576937
	522 2	-0.225422386 B	-2.24	0.0253	0.10074909
	522 3	0.158292023 B	1.28	0.1994	0.12334710
	522 4	0.000000000 B	.	.	.
	525 1	-0.606055688 B	-3.35	0.0008	0.18081141
	525 2	-0.465976680 B	-2.67	0.0077	0.17477906
	525 3	-0.441891394 B	-1.79	0.0733	0.24674753
	525 4	0.000000000 B	.	.	.
	526 1	0.137189853 B	0.60	0.5515	0.23036447
	526 2	0.163165850 B	0.87	0.3850	0.18782520
	526 3	0.642406040 B	3.03	0.0024	0.21185969
	526 4	0.000000000 B	.	.	.
	561 1	0.022979638 B	0.22	0.8236	0.10309851
	561 2	-0.211230225 B	-2.05	0.0401	0.10288505
	561 3	0.269667667 B	2.21	0.0274	0.12221884
	561 4	0.000000000 B	.	.	.
	562 1	0.000000000 B	.	.	.
	562 2	0.000000000 B	.	.	.
	562 3	0.000000000 B	.	.	.
	562 4	0.000000000 B	.	.	.

General Linear Models Procedure

Dependent Variable: LOGHAD

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
AREA*TC	521 3	0.147555510 B	1.49	0.1364	0.09906624
	521 4	0.000000000 B	.	.	.
	522 3	0.175126525 B	1.63	0.1030	0.10740803
	522 4	0.000000000 B	.	.	.
	525 3	-0.400842627 B	-2.04	0.0417	0.19677621
	525 4	0.000000000 B	.	.	.
	526 3	-0.551440198 B	-3.33	0.0009	0.16574149
	526 4	0.000000000 B	.	.	.
	561 3	0.103998701 B	0.85	0.3935	0.12187154
	561 4	0.000000000 B	.	.	.
	562 3	0.000000000 B	.	.	.
	562 4	0.000000000 B	.	.	.
QTR*TC	1 3	0.229418086 B	2.28	0.0224	0.10044901
	1 4	0.000000000 B	.	.	.
	2 3	0.353353784 B	3.58	0.0003	0.09882771
	2 4	0.000000000 B	.	.	.
	3 3	-0.336537584 B	-2.67	0.0076	0.12598623
	3 4	0.000000000 B	.	.	.
	4 3	0.000000000 B	.	.	.
	4 4	0.000000000 B	.	.	.
AREA*QTR*TC	521 1 3	-0.070860517 B	-0.55	0.5833	0.12918132
	521 1 4	0.000000000 B	.	.	.
	521 2 3	-0.497513268 B	-3.90	0.0001	0.12753008
	521 2 4	0.000000000 B	.	.	.
	521 3 3	0.301327908 B	2.16	0.0305	0.13924549
	521 3 4	0.000000000 B	.	.	.
	521 4 3	0.000000000 B	.	.	.
	521 4 4	0.000000000 B	.	.	.
	522 1 3	-0.037952387 B	-0.29	0.7751	0.13282468
	522 1 4	0.000000000 B	.	.	.
	522 2 3	-0.187775725 B	-1.51	0.1322	0.12472314
	522 2 4	0.000000000 B	.	.	.
	522 3 3	0.374878171 B	2.47	0.0136	0.15197033
	522 3 4	0.000000000 B	.	.	.
	522 4 3	0.000000000 B	.	.	.
	522 4 4	0.000000000 B	.	.	.
	525 1 3	0.416487168 B	1.87	0.0614	0.22263397
	525 1 4	0.000000000 B	.	.	.
	525 2 3	0.327803010 B	1.52	0.1274	0.21504912
	525 2 4	0.000000000 B	.	.	.
	525 3 3	0.855012127 B	2.94	0.0033	0.29073489
	525 3 4	0.000000000 B	.	.	.
	525 4 3	0.000000000 B	.	.	.
	525 4 4	0.000000000 B	.	.	.
	526 1 3	0.119068517 B	0.47	0.6406	0.25505655
	526 1 4	0.000000000 B	.	.	.
	526 2 3	-0.666421181 B	-3.18	0.0015	0.20976215
	526 2 4	0.000000000 B	.	.	.
	526 3 3	0.589300411 B	2.46	0.0141	0.23999201
	526 3 4	0.000000000 B	.	.	.

General Linear Models Procedure

Dependent Variable: LOGHAD

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
AREA*QTR*TC 526 4 3	0.000000000 B	.	.	.
526 4 4	0.000000000 B	.	.	.
561 1 3	-0.096710791 B	-0.66	0.5103	0.14689481
561 1 4	0.000000000 B	.	.	.
561 2 3	0.038727961 B	0.27	0.7839	0.14122310
561 2 4	0.000000000 B	.	.	.
561 3 3	0.197528213 B	1.19	0.2335	0.16579564
561 3 4	0.000000000 B	.	.	.
561 4 3	0.000000000 B	.	.	.
561 4 4	0.000000000 B	.	.	.
562 1 3	0.000000000 B	.	.	.
562 1 4	0.000000000 B	.	.	.
562 2 3	0.000000000 B	.	.	.
562 2 4	0.000000000 B	.	.	.
562 3 3	0.000000000 B	.	.	.
562 3 4	0.000000000 B	.	.	.
562 4 3	0.000000000 B	.	.	.
562 4 4	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Appendix D. Results of ADAPT tuning.

```
ADAPT        Run Number 184          1992 2-13
HADDOCK:  GEORGES BANK STOCK
GBHAD

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 8

For all yrs prior to the terminal year (1990), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 8:    4 5 6 7 8
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 9+ is then calculated from the following
ratios of F[age 9+] to F[age 8]
      1963    1.0000
      1964    1.0000
      1965    1.0000
      1966    1.0000
      1967    1.0000
      1968    1.0000
      1969    1.0000
      1970    1.0000
      1971    1.0000
      1972    1.0000
      1973    1.0000
      1974    1.0000
      1975    1.0000
      1976    1.0000
      1977    1.0000
      1978    1.0000
      1979    1.0000
      1980    1.0000
      1981    1.0000
      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
Stock size of the 9+ group is then calculated
using the following method:  CATCHEQ

Partial recruitment estimate for 1990
         1    0.0010
         2    0.4100
         3    0.8400
         4    1.0000
         5    1.0000
         6    1.0000
         7    1.0000
         8    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).

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	3.8000000E3	0.0000000E0	1.0000000E6
N 2	3.6000000E3	0.0000000E0	1.0000000E6
N 3	2.0000000E2	0.0000000E0	1.0000000E6
N 4	7.5000000E3	0.0000000E0	1.0000000E6
N 5	2.0000000E2	0.0000000E0	1.0000000E6
N 6	1.3000000E3	0.0000000E0	1.0000000E6
N 7	1.0000000E2	0.0000000E0	1.0000000E6
N 8	3.0000000E2	0.0000000E0	1.0000000E6
qRV SPR 1	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 2	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 3	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 4	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 5	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 6	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 7	1.0000000E-5	0.0000000E0	1.0000000E0
qRV SPR 8	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 1	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 2	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 3	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 4	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 5	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 6	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 7	1.0000000E-5	0.0000000E0	1.0000000E0
qRV FAL 8	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 1	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 2	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 3	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 4	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 5	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 6	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 7	1.0000000E-5	0.0000000E0	1.0000000E0
qCANADA 8	1.0000000E-5	0.0000000E0	1.0000000E0

The following indices of abundance are available:

1	RV SPR 1
2	RV SPR 2
3	RV SPR 3
4	RV SPR 4
5	RV SPR 5
6	RV SPR 6
7	RV SPR 7
8	RV SPR 8
9	RV FAL 1
10	RV FAL 2
11	RV FAL 3
12	RV FAL 4
13	RV FAL 5
14	RV FAL 6
15	RV FAL 7
16	RV FAL 8
17	RV FAL 9
18	CANADA 1
19	CANADA 2
20	CANADA 3
21	CANADA 4
22	CANADA 5
23	CANADA 6
24	CANADA 7
25	CANADA 8

Indices that will be used in this run are: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.000	0.000	0.000	0.000	0.000	0.440	0.000	0.730	0.000	4.410	33.620	2.340	1.030	88.540	0.670	0.080
2	0.000	0.000	0.000	0.000	0.000	3.100	0.080	0.280	1.270	0.100	5.310	14.570	1.060	0.330	36.610	1.060
3	0.000	0.000	0.000	0.000	0.000	0.510	0.640	0.000	0.280	0.670	0.000	3.140	3.640	0.650	0.460	17.460
4	0.000	0.000	0.000	0.000	0.000	0.770	0.280	0.360	0.000	0.130	0.590	0.000	0.690	1.010	1.340	0.390
5	0.000	0.000	0.000	0.000	0.000	7.360	0.460	0.510	0.130	0.030	0.100	0.260	0.000	0.470	0.650	1.030
6	0.000	0.000	0.000	0.000	0.000	1.850	4.640	0.510	0.130	0.050	0.000	0.000	0.150	0.000	0.490	0.900
7	0.000	0.000	0.000	0.000	0.000	0.280	1.130	2.190	0.100	0.150	0.200	0.020	0.100	0.050	0.000	0.180
8	0.000	0.000	0.000	0.000	0.000	0.490	0.310	1.080	0.900	0.030	0.020	0.110	0.020	0.000	0.050	0.070
9	0.000	91.980	2.596	0.359	6.727	0.032	0.097	0.424	0.048	2.661	7.397	3.543	0.816	25.730	4.735	0.153
10	0.000	27.830	123.700	11.140	1.050	7.360	0.070	0.030	4.520	0.000	2.760	9.860	1.940	0.690	70.330	2.430
11	0.000	10.110	69.860	84.820	3.170	0.390	1.050	0.000	0.230	0.340	0.000	1.760	1.080	0.780	0.570	21.320
12	0.000	7.460	6.390	10.630	20.150	1.090	0.150	0.310	0.020	0.080	0.570	0.000	0.340	5.320	0.590	0.640
13	0.000	9.140	1.960	1.180	3.670	7.410	0.360	0.150	0.310	0.020	0.100	0.210	0.000	1.010	0.900	0.650
14	0.000	6.520	4.180	0.880	0.570	1.780	4.230	0.180	0.290	0.240	0.000	0.050	0.020	0.000	0.330	0.720
15	0.000	2.240	1.710	1.000	0.540	0.540	1.390	1.670	0.560	0.030	0.100	0.000	0.000	0.030	0.000	0.390
16	0.000	1.850	0.750	0.880	0.360	0.230	0.290	0.560	1.500	0.100	0.070	0.080	0.000	0.000	0.050	0.040
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991********
1	39.580	5.700	3.760	0.860	0.470	2.290	0.000	2.490	0.000	1.550	0.030	0.890	0.560	9.502
2	1.730	51.180	3.740	1.740	0.600	1.290	4.960	0.180	3.620	0.040	3.630	0.000	1.110	5.982
3	1.240	0.560	22.190	1.070	0.640	0.700	0.760	2.060	0.060	0.990	0.470	5.940	0.250	2.926
4	6.250	1.140	2.490	4.630	0.240	0.690	0.400	0.240	0.810	0.130	0.740	0.340	1.930	1.163
5	0.360	5.340	0.860	0.470	2.650	0.640	0.870	0.110	0.080	0.320	0.140	0.600	0.090	1.023
6	0.180	0.730	2.030	0.320	0.020	0.780	0.340	0.210	0.100	0.120	0.430	0.060	0.100	0.673
7	0.410	0.410	0.280	0.700	0.050	0.080	1.170	0.120	0.050	0.110	0.060	0.140	0.030	0.348
8	0.070	0.510	0.130	0.000	1.270	0.050	0.100	0.330	0.220	0.120	0.050	0.000	0.040	0.284
9	15.050	1.502	13.290	0.431	1.486	6.352	0.032	11.350	0.000	1.800	0.070	0.485	0.800	7.405
10	0.960	51.870	3.090	6.980	0.000	0.260	3.640	0.650	5.110	0.000	3.020	0.050	0.700	13.602
11	1.180	0.040	14.480	2.360	1.450	0.230	0.960	1.530	0.090	0.790	0.180	2.810	0.030	8.523
12	10.560	1.030	0.510	4.210	0.380	0.290	0.260	0.220	1.210	0.100	1.300	0.200	1.240	2.787
13	0.210	4.340	0.210	0.240	1.540	0.330	0.310	0.050	0.060	0.770	0.120	0.690	0.050	1.333
14	0.290	0.290	1.930	0.470	0.150	1.030	0.070	0.100	0.130	0.060	0.400	0.090	0.180	0.968
15	0.510	0.320	0.540	0.600	0.080	0.130	0.490	0.070	0.130	0.060	0.120	0.140	0.040	0.537
16	0.010	0.060	0.530	0.000	0.230	0.000	0.000	0.170	0.020	0.020	0.110	0.020	0.000	0.360
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.060	0.030	1.470	0.030	0.930	0.760	1.213
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	3.040	0.050	5.200	0.110	1.680	1.717
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.050	0.690	8.500	0.700	9.860	0.140	4.323
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.070	2.510	0.170	2.050	0.130	8.920	2.475
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.190	0.670	2.880	0.180	3.360	0.110	1.232
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.290	0.080	0.180	0.420	0.230	1.580	0.463
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.340	0.300	0.170	0.030	1.090	0.090	0.337
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.370	0.100	0.110	0.030	0.130	0.440	0.197

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	-99.00	1.00	-99.00	1.00	1.00	1.00	1.00	1.00
2	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	-99.00	1.00	1.00	-99.00	1.00	1.00	1.00
4	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	-99.00	1.00	1.00	-99.00	1.00	1.00
5	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
6	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	-99.00
7	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
9	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00
11	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	-99.00	1.00	1.00	1.00
12	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00
13	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
14	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	-99.00
15	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00
16	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00
18	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
19	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
23	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
24	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	-99.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
3	1.00	1.00	1.00	1.00	1.00	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	1.00	1.00	1.00	1.00	1.00	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	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	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	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1.00	1.00	1.00	1.00	-99.00	1.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	-99.00
18	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
19	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
23	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
24	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00	1.00

Negative weights in the above table indicate missing values

DOWNWEIGHTS BY YEAR (delta)

1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1980	1981	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	1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

19	20	21	22	23	24	25
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	-99.0000	1.0000	-99.0000	1.0000	1.0000	1.0000
2	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	-99.0000	1.0000
4	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	-99.0000
5	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000
7	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000
11	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	-99.0000	1.0000
12	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
13	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000
15	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
16	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
19	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
23	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
24	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	-99.0000	1.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	-99.0000	-99.0000	1.0000
18	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
19	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
23	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
24	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.0000

	1987	1988	1989	1990	1991
1	-99.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	-99.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	-99.0000	1.0000
9	-99.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	-99.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000
16	1.0000	1.0000	1.0000	1.0000	-99.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000

Negative weights in the above table indicate missing values

CATCH AT AGE (millions) - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	2910.000	10101.000	9601.000	114.000	1150.000	8.000	2.000	46.000	1.000	156.000	2560.000
2	4047.000	15935.000	125818.000	6843.000	168.000	2994.000	11.000	158.000	1375.000	2.000	2075.000
3	7418.000	4554.000	44496.000	100810.000	2891.000	709.000	1698.000	16.000	223.000	450.000	3.000
4	11152.000	4776.000	5356.000	19167.000	20667.000	1921.000	448.000	570.000	40.000	81.000	386.000
5	8198.000	8722.000	4391.000	2768.000	10338.000	14519.000	654.000	186.000	289.000	32.000	53.000
6	2205.000	5794.000	6690.000	2591.000	1209.000	3499.000	5954.000	214.000	246.000	120.000	30.000
7	1405.000	2082.000	3772.000	2332.000	993.000	667.000	1574.000	2308.000	285.000	78.000	77.000
8	721.000	1028.000	1094.000	1268.000	917.000	453.000	225.000	746.000	1469.000	66.000	15.000
9	1096.000	1332.000	1366.000	867.000	698.000	842.000	570.000	464.000	928.000	1236.000	447.000
1+	39152.000	54324.000	202584.000	136760.000	39031.000	25612.000	11136.000	4708.000	4856.000	2221.000	5646.000

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	46.000	192.000	144.000	1.000	1.000	1.000	8.000	1.000	1.000	0.001	0.001
2	4320.000	1034.000	473.000	19585.000	761.000	26.000	31000.000	1743.000	1165.000	214.000	93.000
3	657.000	1864.000	550.000	187.000	14395.000	1726.000	347.000	10998.000	1633.000	813.000	297.000
4	2.000	375.000	880.000	680.000	305.000	7169.000	975.000	831.000	3733.000	690.000	727.000
5	70.000	4.000	216.000	515.000	567.000	525.000	6054.000	937.000	391.000	2239.000	397.000
6	2.000	42.000	0.001	357.000	517.000	410.000	594.000	2572.000	569.000	272.000	1482.000
7	2.000	4.000	23.000	4.000	139.000	315.000	546.000	331.000	1119.000	186.000	234.000
8	53.000	4.000	4.000	39.000	14.000	96.000	153.000	158.000	106.000	800.000	267.000
9	249.000	88.000	112.000	111.000	67.000	46.000	81.000	94.000	110.000	76.000	543.000
1+	5401.000	3607.000	2402.001	21479.000	16766.000	10314.000	39758.000	17665.000	8827.000	5290.001	4040.001

	1985	1986	1987	1988	1989	1990
1	0.001	6.000	0.001	4.000	0.001	2.000
2	2406.000	54.000	1995.000	52.000	1263.000	12.000
3	550.000	2810.000	129.000	2384.000	86.000	1437.000
4	194.000	223.000	1613.000	134.000	877.000	160.000
5	461.000	146.000	122.000	931.000	143.000	872.000
6	228.000	173.000	73.000	149.000	358.000	97.000
7	526.000	150.000	89.000	55.000	46.000	175.000
8	78.000	266.000	106.000	64.000	28.000	40.000
9	152.000	60.000	135.000	106.000	45.000	43.000
1+	4595.001	3888.000	4262.001	3879.000	2846.001	2838.000

CAA summary for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
2	36242.000	44223.000	192983.000	136646.000	37881.000	25604.000	11134.000	4662.000	4855.000	2065.000	3086.000
3	32195.000	28288.000	67165.000	129803.000	37713.000	22610.000	11123.000	4504.000	3480.000	2063.000	1011.000
4	24777.000	23734.000	22669.000	28993.000	34822.000	21901.000	9425.000	4488.000	3257.000	1613.000	1008.000
5	13625.000	18958.000	17313.000	9826.000	14155.000	19980.000	8977.000	3918.000	3217.000	1532.000	622.000
6	5427.000	10236.000	12922.000	7058.000	3817.000	5461.000	8323.000	3732.000	2928.000	1500.000	569.000

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	5355.000	3415.000	2258.001	21478.000	16765.000	10313.000	39750.000	17664.000	8826.000	5290.000	4040.000
3	1035.000	2381.000	1785.001	1893.000	16004.000	10287.000	8750.000	15921.000	7661.000	5076.000	3947.000
4	378.000	517.000	1235.001	1706.000	1609.000	8561.000	8403.000	4923.000	6028.000	4263.000	3650.000
5	376.000	142.000	355.001	1026.000	1304.000	1392.000	7428.000	4092.000	2295.000	3573.000	2923.000
6	306.000	138.000	139.001	511.000	737.000	867.000	1374.000	3155.000	1904.000	1334.000	2526.000

	1985	1986	1987	1988	1989	1990
2	4595.000	3882.000	4262.000	3875.000	2846.000	2836.000
3	2189.000	3828.000	2267.000	3823.000	1583.000	2824.000
4	1639.000	1018.000	2138.000	1439.000	1497.000	1387.000
5	1445.000	795.000	525.000	1305.000	620.000	1227.000
6	984.000	649.000	403.000	374.000	477.000	355.000

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.570	0.500	0.580	0.580	0.660	0.590	0.520	0.710	0.670	0.620	0.600	0.720	0.620	0.500	0.530	0.530	0.530
2	0.870	0.830	0.690	0.730	0.700	0.810	0.780	1.270	1.030	1.030	1.030	1.060	0.980	0.990	1.070	0.940	1.000
3	1.180	1.120	1.030	0.890	0.950	1.050	1.100	1.220	1.310	1.740	1.580	1.820	1.630	1.390	1.440	1.500	1.280
4	1.470	1.430	1.350	1.260	1.180	1.320	1.690	1.930	1.740	2.040	2.130	2.320	2.210	1.990	2.170	2.040	2.020
5	1.680	1.640	1.670	1.700	1.420	1.570	1.750	2.190	2.390	2.420	2.410	2.830	2.200	2.660	2.730	2.790	2.510
6	2.150	2.010	1.990	2.070	2.050	2.100	1.990	2.390	2.810	2.920	3.290	3.760	2.940	3.080	3.210	3.190	3.140
7	2.350	2.400	2.260	2.280	2.310	2.320	2.520	2.580	2.920	3.060	3.420	4.050	4.000	3.690	4.150	3.370	3.780
8	3.040	2.640	2.660	2.870	2.660	2.620	2.990	3.230	3.100	3.440	3.860	3.920	4.050	4.670	4.000	3.610	3.790
9	3.100	2.970	3.110	3.180	3.100	2.860	3.630	3.750	3.720	3.660	3.940	4.260	4.330	4.940	4.990	5.110	4.870

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.550	0.390	0.220	0.330	0.330	0.330	0.450	0.430	0.420	0.530	0.640
2	0.940	0.870	0.970	1.020	0.920	0.990	0.940	0.830	0.980	0.890	0.970
3	1.210	1.240	1.450	1.370	1.320	1.390	1.360	1.430	1.340	1.480	1.460
4	1.730	1.830	1.880	1.830	1.830	1.980	1.830	2.000	1.680	1.790	1.800
5	2.170	2.300	2.370	2.210	2.200	2.460	2.560	2.250	2.060	2.210	2.110
6	2.820	2.720	2.760	2.650	2.670	2.720	2.830	2.630	2.450	2.570	2.580
7	3.600	3.710	3.240	3.250	2.960	3.060	2.960	3.020	2.970	3.240	2.820
8	3.560	4.040	3.960	3.360	3.410	3.720	3.460	3.770	3.490	3.560	3.170
9	3.870	4.440	4.090	4.270	3.720	3.800	3.780	4.290	3.960	3.820	4.160

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.472	0.426	0.517	0.528	0.596	0.513	0.333	0.589	0.540	0.481	0.451	0.617	0.491	0.342	0.398	0.386	0.398
2	0.767	0.688	0.587	0.651	0.637	0.731	0.678	0.813	0.855	0.831	0.799	0.797	0.840	0.783	0.731	0.706	0.728
3	1.072	0.987	0.925	0.784	0.833	0.857	0.944	0.975	1.290	1.339	1.276	1.369	1.314	1.167	1.194	1.267	1.097
4	1.392	1.299	1.230	1.139	1.025	1.120	1.332	1.457	1.457	1.635	1.925	1.915	2.006	1.801	1.737	1.714	1.741
5	1.536	1.553	1.545	1.515	1.338	1.361	1.520	1.924	2.148	2.052	2.217	2.455	2.259	2.425	2.331	2.461	2.263
6	2.035	1.838	1.807	1.859	1.867	1.727	1.768	2.045	2.481	2.642	2.822	3.010	2.884	2.603	2.922	2.951	2.960
7	2.217	2.272	2.131	2.130	2.187	2.181	2.300	2.266	2.642	2.932	3.160	3.650	3.878	3.294	3.575	3.289	3.472
8	2.673	2.491	2.527	2.547	2.463	2.460	2.634	2.853	2.828	3.169	3.437	3.661	4.050	4.322	3.842	3.871	3.574
9	3.100	2.970	3.110	3.180	3.100	2.860	3.630	3.750	3.720	3.660	3.940	4.260	4.330	4.940	4.990	5.110	4.870

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.437	0.247	0.102	0.198	0.191	0.196	0.331	0.285	0.289	0.392	0.571	0.375
2	0.706	0.692	0.615	0.474	0.551	0.572	0.557	0.611	0.649	0.611	0.717	0.717
3	1.100	1.080	1.123	1.153	1.160	1.131	1.160	1.159	1.055	1.204	1.140	1.312
4	1.488	1.488	1.527	1.629	1.583	1.617	1.595	1.649	1.550	1.549	1.632	1.870
5	2.094	1.995	2.083	2.038	2.006	2.122	2.251	2.029	2.030	1.927	1.943	1.985
6	2.660	2.429	2.520	2.506	2.429	2.446	2.639	2.595	2.348	2.301	2.388	2.291
7	3.362	3.235	2.969	2.995	2.801	2.858	2.837	2.923	2.795	2.817	2.692	2.788
8	3.668	3.814	3.833	3.299	3.329	3.318	3.254	3.341	3.247	3.252	3.205	2.954
9	3.870	4.440	4.090	4.270	3.720	3.800	3.780	4.290	3.960	3.820	4.160	4.160

Weights at age at the start of the spawning season are assumed
to be the same as the Jan1 weight at age estimates.

PERCENT MATURE (females) - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	26	26
2	0	0	0	0	0	28	28	28	28	28	34	34	34	34	61	26	8	41	52	31	11	44	77	77
3	78	78	78	78	78	76	76	76	76	76	92	92	92	92	100	99	71	100	94	67	39	68	97	97
4	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

	1987	1988	1989	1990
1	26	26	26	26
2	77	77	77	77
3	97	97	97	97
4	100	100	100	100
5	100	100	100	100
6	100	100	100	100
7	100	100	100	100
8	100	100	100	100
9	100	100	100	100

SEX RATIO (Percent Female) - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
5	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
7	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
8	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
9	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

	1987	1988	1989	1990
1	50	50	50	50
2	50	50	50	50
3	50	50	50	50
4	50	50	50	50
5	50	50	50	50
6	50	50	50	50
7	50	50	50	50
8	50	50	50	50
9	50	50	50	50

SUMMARY OF RESIDUALS

Index 1 RV 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
1968	-3.0725	-4.6067	1.0000	1.5342	1.9725	421.702
1970	-2.5662	-2.2047	1.0000	-0.3615	-0.4648	4658.061
1972	-0.7676	-1.6022	1.0000	0.8346	1.0730	8508.401
1973	1.2636	-0.7778	1.0000	2.0415	2.6247	19402.982
1974	-1.4014	-1.3899	1.0000	-0.0115	-0.0147	10521.114
1975	-2.2219	-1.7106	1.0000	-0.5113	-0.6574	7634.201
1976	2.2320	0.8917	1.0000	1.3403	1.7231	103024.629
1977	-2.6520	-1.1256	1.0000	-1.5264	-1.9625	13704.311
1978	-4.7772	-1.9485	1.0000	-2.8287	-3.6368	6018.020
1979	1.4268	0.6828	1.0000	0.7440	0.9566	83599.850
1980	-0.5110	-1.4395	1.0000	0.9285	1.1938	10011.438
1981	-0.9271	-1.7815	1.0000	0.8545	1.0986	7111.586
1982	-2.4023	-2.8583	1.0000	0.4560	0.5863	2422.820
1983	-3.0065	-2.6962	1.0000	-0.3103	-0.3990	2849.309
1984	-1.4230	-0.9357	1.0000	-0.4873	-0.6265	16569.942
1986	-1.3392	-1.0863	1.0000	-0.2529	-0.3252	14252.813
1988	-1.8132	-0.9011	1.0000	-0.9122	-1.1728	17153.331
1989	-5.7581	-4.8827	1.0000	-0.8754	-1.1255	320.008
1990	-2.3680	-2.2230	1.0000	-0.1450	-0.1864	4573.352
1991	-2.8313	-2.3203	1.0000	-0.5110	-0.6570	4149.244

Partial variance for this index is 1.305543

Index 2 RV 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
1968	-0.6574	-0.7908	1.0000	0.1334	0.1715	9560.474
1969	-4.3145	-4.1331	1.0000	-0.1814	-0.2332	338.022
1970	-3.0617	-3.2629	1.0000	0.2012	0.2587	806.962
1971	-1.5498	-1.7208	1.0000	0.1711	0.2199	3772.075
1972	-4.0914	-4.2516	1.0000	0.1602	0.2060	300.255
1973	-0.1192	-1.1279	1.0000	1.0087	1.2968	6824.935
1974	0.8902	-0.4406	1.0000	1.3308	1.7110	13569.435
1975	-1.7305	-0.8999	1.0000	-0.8306	-1.0679	8572.337
1976	-2.8974	-1.2440	1.0000	-1.6534	-2.1258	6076.627
1977	1.8115	1.3850	1.0000	0.4266	0.5484	84219.136
1978	-1.7305	-0.6308	1.0000	-1.0997	-1.4139	11219.236
1979	-1.2407	-1.4539	1.0000	0.2132	0.2741	4926.233
1980	2.1466	1.1776	1.0000	0.9690	1.2458	68444.863
1981	-0.4697	-0.9456	1.0000	0.4759	0.6119	8189.434
1982	-1.2349	-1.2869	1.0000	0.0520	0.0668	5821.569
1983	-2.2996	-2.3640	1.0000	0.0644	0.0828	1982.732
1984	-1.5341	-2.2014	1.0000	0.6672	0.8578	2332.816
1985	-0.1874	-0.4409	1.0000	0.2535	0.3259	13566.320
1986	-3.5036	-2.8293	1.0000	-0.6743	-0.8670	1245.077
1987	-0.5023	-0.5920	1.0000	0.0897	0.1153	11663.788
1988	-5.0077	-3.2792	1.0000	-1.7285	-2.2223	793.956
1989	-0.4996	-0.4065	1.0000	-0.0930	-0.1196	14040.341
1991	-1.6844	-1.7287	1.0000	0.0443	0.0569	3742.534

Partial variance for this index is 0.597133

Index 3 RV 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
1968	-1.7471	-1.4027	1.0000	-0.3444	-0.4428	2536.211
1969	-1.5200	-0.7005	1.0000	-0.8195	-1.0537	5118.371
1971	-2.3467	-2.9917	1.0000	0.6449	0.8292	517.720
1972	-1.4742	-1.7213	1.0000	0.2471	0.3177	1844.163
1974	0.0705	-1.0222	1.0000	1.0927	1.4049	3710.247
1975	0.2182	-0.3591	1.0000	0.5774	0.7423	7200.816
1976	-1.5045	-0.5279	1.0000	-0.9767	-1.2557	6082.834

1977	-1.8503	-0.8188	1.0000	-1.0314	-1.3261	4547.133
1978	1.7862	1.6030	1.0000	0.1831	0.2355	51231.556
1979	-0.8586	-0.1936	1.0000	-0.6650	-0.8550	8496.953
1980	-1.6536	-0.9446	1.0000	-0.7090	-0.9115	4009.733
1981	2.0259	0.9984	1.0000	1.0274	1.3210	27987.955
1982	-1.0061	-0.6987	1.0000	-0.3074	-0.3953	5127.809
1983	-1.5200	-1.0217	1.0000	-0.4983	-0.6407	3712.162
1984	-1.4304	-1.9759	1.0000	0.5454	0.7013	1429.689
1985	-1.3482	-1.7313	1.0000	0.3831	0.4926	1825.799
1986	-0.3511	-0.1439	1.0000	-0.2071	-0.2663	8930.125
1987	-3.8872	-2.3633	1.0000	-1.5239	-1.9593	970.522
1988	-1.0838	-0.2864	1.0000	-0.7974	-1.0252	7744.351
1989	-1.8288	-2.8392	1.0000	1.0104	1.2991	602.984
1990	0.7079	0.0039	1.0000	0.7041	0.9052	10352.449
1991	-2.4601	-3.9247	1.0000	1.4646	1.8831	203.649

Partial variance for this index is 0.691769

Index 4 RV 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
1968	-0.4125	0.0506	1.0000	-0.4631	-0.5954	4685.712
1969	-1.4241	-1.1328	1.0000	-0.2913	-0.3745	1434.944
1970	-1.1728	-0.5178	1.0000	-0.6550	-0.8421	2654.154
1972	-2.1914	-2.9986	1.0000	0.8072	1.0378	222.094
1973	-0.6788	-1.3962	1.0000	0.7174	0.9223	1102.696
1975	-0.5222	-0.6006	1.0000	0.0784	0.1008	2443.215
1976	-0.1412	-0.0567	1.0000	-0.0845	-0.1086	4208.912
1977	0.1415	0.0063	1.0000	0.1353	0.1739	4482.543
1978	-1.0928	-0.2260	1.0000	-0.8668	-1.1144	3553.673
1979	1.6814	1.8706	1.0000	-0.1892	-0.2432	28919.715
1980	-0.0201	0.1915	1.0000	-0.2117	-0.2721	5394.967
1981	0.7611	-0.4057	1.0000	1.1669	1.5002	2968.913
1982	1.3814	1.0682	1.0000	0.3132	0.4027	12963.197
1983	-1.5783	-0.4930	1.0000	-1.0852	-1.3953	2720.696
1984	-0.5222	-0.6595	1.0000	0.1372	0.1764	2303.629
1985	-1.0674	-1.5973	1.0000	0.5299	0.6812	901.793
1986	-1.5783	-1.4968	1.0000	-0.0815	-0.1048	997.177
1987	-0.3619	0.0682	1.0000	-0.4300	-0.5529	4768.775
1988	-2.1914	-1.8827	1.0000	-0.3086	-0.3968	677.872
1989	-0.4523	-0.0628	1.0000	-0.3895	-0.5007	4183.406
1990	-1.2300	-2.3713	1.0000	1.1414	1.4674	415.866
1991	0.5064	0.4768	1.0000	0.0296	0.0381	7175.617

Partial variance for this index is 0.359863

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

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1968	1.9733	2.3197	1.0000	-0.3464	-0.4454	37310.680
1969	-0.7993	-0.5585	1.0000	-0.2408	-0.3096	2098.144
1970	-0.6961	-1.5616	1.0000	0.8655	1.1128	769.466
1971	-2.0630	-0.7944	1.0000	-1.2686	-1.6310	1657.280
1972	-3.5293	-3.3337	1.0000	-0.1956	-0.2515	130.792
1973	-2.3254	-3.5202	1.0000	1.1948	1.5362	108.544
1974	-1.3699	-1.8910	1.0000	0.5211	0.6700	553.544
1976	-0.7778	-0.7922	1.0000	0.0143	0.0184	1661.021
1977	-0.4536	-0.3251	1.0000	-0.1284	-0.1651	2649.709
1978	0.0068	-0.1829	1.0000	0.1897	0.2439	3054.706
1979	-1.0444	-0.3313	1.0000	-0.7132	-0.9169	2633.526
1980	1.6524	1.5448	1.0000	0.1077	0.1384	17190.681
1981	-0.1736	-0.0369	1.0000	-0.1367	-0.1757	3534.809
1982	-0.7778	-0.7815	1.0000	0.0037	0.0047	1678.821
1983	0.9518	0.6794	1.0000	0.2723	0.3502	7235.610
1984	-0.4691	-0.8276	1.0000	0.3585	0.4610	1603.180
1985	-0.1620	-1.0940	1.0000	0.9320	1.1982	1228.235
1986	-2.2301	-1.8744	1.0000	-0.3556	-0.4572	562.788
1987	-2.5485	-1.7863	1.0000	-0.7622	-0.9800	614.641
1988	-1.1622	-0.4056	1.0000	-0.7566	-0.9728	2444.840
1989	-1.9889	-2.1349	1.0000	0.1460	0.1877	433.746

1990	-0.5336	-0.3320	1.0000	-0.2016	-0.2592	2631.541
1991	-2.4307	-2.9307	1.0000	0.5000	0.6428	195.708

Partial variance for this index is 0.347472

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

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1968	1.0107	1.2193	1.0000	-0.2086	-0.2682	10515.347
1969	1.9302	1.7235	1.0000	0.2067	0.2657	17410.066
1970	-0.2778	-1.0148	1.0000	0.7370	0.9475	1126.051
1971	-1.6447	-1.9064	1.0000	0.2617	0.3364	461.685
1972	-2.6002	-1.0424	1.0000	-1.5578	-2.0028	1095.368
1975	-1.5016	-2.0755	1.0000	0.5739	0.7378	389.865
1977	-0.3178	-0.9812	1.0000	0.6634	0.8529	1164.484
1978	0.2902	-0.6009	1.0000	0.8910	1.1456	1703.407
1979	-1.3193	-0.4464	1.0000	-0.8729	-1.1222	1987.939
1980	0.0808	-0.6140	1.0000	0.6949	0.8934	1681.109
1981	1.1036	1.0179	1.0000	0.0857	0.1102	8596.653
1982	-0.7439	-0.4175	1.0000	-0.3264	-0.4197	2046.224
1983	-3.5165	-1.1130	1.0000	-2.4035	-3.0901	1020.711
1984	0.1471	0.2270	1.0000	-0.0799	-0.1028	3898.086
1985	-0.6833	-1.1813	1.0000	0.4980	0.6402	953.352
1986	-1.1651	-1.6637	1.0000	0.4986	0.6411	588.464
1987	-1.9071	-2.2462	1.0000	0.3391	0.4360	328.665
1988	-1.7247	-2.0679	1.0000	0.3431	0.4411	392.835
1989	-0.4485	-0.9857	1.0000	0.5373	0.6907	1159.262
1990	-2.4179	-2.6219	1.0000	0.2040	0.2623	225.730
1991	-1.9071	-0.8220	1.0000	-1.0851	-1.3951	1365.505

Partial variance for this index is 0.715261

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

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1968	-0.2182	0.2481	1.0000	-0.4663	-0.5995	1569.794
1969	1.1770	1.4915	1.0000	-0.3145	-0.4044	5443.212
1970	1.8387	1.9795	1.0000	-0.1408	-0.1810	8866.755
1971	-1.2478	-0.5199	1.0000	-0.7279	-0.9359	728.297
1972	-0.8423	-2.0645	1.0000	1.2222	1.5714	155.406
1973	-0.5546	-0.4408	1.0000	-0.1139	-0.1464	788.231
1974	-2.8572	-3.5045	1.0000	0.6473	0.8322	36.821
1975	-1.2478	-3.6547	1.0000	2.4069	3.0945	31.686
1976	-1.9409	-1.4715	1.0000	-0.4694	-0.6035	281.191
1978	-0.6600	-0.6643	1.0000	0.0043	0.0055	630.372
1979	0.1632	-0.2788	1.0000	0.4420	0.5683	926.831
1980	0.1632	0.0256	1.0000	0.1376	0.1769	1256.603
1981	-0.2182	-0.3785	1.0000	0.1603	0.2061	838.902
1982	0.6981	1.3471	1.0000	-0.6490	-0.8344	4711.103
1983	-1.9409	-0.0540	1.0000	-1.8869	-2.4260	1160.454
1984	-1.4709	-0.7312	1.0000	-0.7397	-0.9511	589.571
1985	1.2118	0.4126	1.0000	0.7992	1.0275	1850.513
1986	-1.0655	-0.7375	1.0000	-0.3079	-0.3959	574.236
1987	-1.9409	-1.3260	1.0000	-0.6150	-0.7907	325.256
1988	-1.1525	-1.7972	1.0000	0.6447	0.8289	203.035
1989	-1.7586	-1.8805	1.0000	0.1219	0.1567	186.805
1990	-0.9113	-0.6725	1.0000	-0.2388	-0.3070	625.191
1991	-2.4518	-2.5354	1.0000	0.0837	0.1076	97.043

Partial variance for this index is 0.700637

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

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1968	0.5444	0.2708	1.0000	0.2737	0.3518	1176.268
1969	0.0866	-0.2747	1.0000	0.3613	0.4645	681.712
1970	1.3347	1.2178	1.0000	0.1170	0.1504	3032.311

1971	1.1524	1.7515	1.0000	-0.5991	-0.7703	5171.120
1972	-2.2488	-0.9751	1.0000	-1.2737	-1.6375	338.401
1973	-2.6542	-2.7623	1.0000	0.1080	0.1389	56.658
1974	-0.9495	-0.4438	1.0000	-0.5057	-0.6502	575.676
1975	-2.6542	-3.4552	1.0000	0.8009	1.0297	28.337
1977	-1.7380	-1.4550	1.0000	-0.2829	-0.3637	209.408
1978	-1.4015	-2.3986	1.0000	0.9971	1.2820	81.510
1979	-1.4015	-0.8323	1.0000	-0.5692	-0.7318	390.333
1980	0.5844	-0.6385	1.0000	1.2230	1.5723	473.801
1981	-0.7824	-0.5175	1.0000	-0.2650	-0.3407	534.779
1983	1.4968	1.1539	1.0000	0.3429	0.4409	2844.612
1984	-1.7380	-0.1377	1.0000	-1.6002	-2.0574	781.800
1985	-1.0448	-1.1973	1.0000	0.1525	0.1961	270.968
1986	0.1491	0.1468	1.0000	0.0023	0.0030	1039.128
1987	-0.2564	-0.9869	1.0000	0.7306	0.9393	334.419
1988	-0.8625	-1.5748	1.0000	0.7123	0.9159	185.767
1989	-1.7380	-2.0417	1.0000	0.3038	0.3906	116.465
1991	-1.9611	-0.9314	1.0000	-1.0297	-1.3239	353.517

Partial variance for this index is 0.557728

Index 9 RV FAL 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
1964	2.5194	2.4410	1.0000	0.0783	0.1007	471862.130
1965	-1.0482	-0.2145	1.0000	-0.8337	-1.0719	33152.206
1966	-3.0266	-2.2958	1.0000	-0.7308	-0.9396	4136.347
1967	-0.0961	-1.1547	1.0000	1.0586	1.3610	12948.136
1968	-5.4442	-4.5791	1.0000	-0.8651	-1.1123	421.702
1969	-4.3353	-3.7279	1.0000	-0.6074	-0.7809	987.835
1970	-2.8602	-2.1770	1.0000	-0.6832	-0.8784	4658.061
1971	-5.0388	-4.7158	1.0000	-0.3230	-0.4153	367.837
1972	-1.0235	-1.5746	1.0000	0.5511	0.7085	8508.401
1973	-0.0011	-0.7502	1.0000	0.7491	0.9631	19402.982
1974	-0.7372	-1.3623	1.0000	0.6250	0.8036	10521.114
1975	-2.2056	-1.6830	1.0000	-0.5225	-0.6718	7634.201
1976	1.2454	0.9193	1.0000	0.3261	0.4193	103024.629
1977	-0.4472	-1.0979	1.0000	0.6507	0.8366	13704.311
1978	-3.8795	-1.9209	1.0000	-1.9586	-2.5182	6018.020
1979	0.7092	0.7104	1.0000	-0.0012	-0.0016	83599.850
1980	-1.5954	-1.4119	1.0000	-0.1835	-0.2359	10011.438
1981	0.5848	-1.7539	1.0000	2.3387	3.0068	7111.586
1982	-2.8439	-2.8307	1.0000	-0.0131	-0.0169	2422.820
1983	-1.6061	-2.6686	1.0000	1.0624	1.3660	2849.309
1984	-0.1534	-0.9081	1.0000	0.7546	0.9702	16569.942
1985	-5.4442	-3.2964	1.0000	-2.1478	-2.7614	1520.742
1986	0.4270	-1.0587	1.0000	1.4857	1.9101	14252.813
1988	-1.4144	-0.8735	1.0000	-0.5410	-0.6955	17153.331
1989	-4.6615	-4.8551	1.0000	0.1936	0.2489	320.008
1990	-2.7258	-2.1954	1.0000	-0.5304	-0.6819	4573.352
1991	-2.2254	-2.2927	1.0000	0.0674	0.0866	4149.244

Partial variance for this index is 0.957542

Index 10 RV FAL 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
1964	0.7159	1.2806	1.0000	-0.5647	-0.7260	153495.768
1965	2.2077	2.1797	1.0000	0.0280	0.0359	377188.274
1966	-0.1996	-0.8377	1.0000	0.6380	0.8203	18455.387
1967	-2.5614	-2.5642	1.0000	0.0028	0.0035	3283.403
1968	-0.6141	-1.4954	1.0000	0.8813	1.1330	9560.474
1969	-5.2694	-4.8377	1.0000	-0.4318	-0.5551	338.022
1970	-6.1167	-3.9675	1.0000	-2.1492	-2.7632	806.962
1971	-1.1017	-2.4254	1.0000	1.3237	1.7019	3772.075
1973	-1.5950	-1.8324	1.0000	0.2375	0.3053	6824.935
1974	-0.3217	-1.1452	1.0000	0.8235	1.0588	13569.435
1975	-1.9475	-1.6045	1.0000	-0.3430	-0.4410	8572.337

1976	-2.9813	-1.9486	1.0000	-1.0327	-1.3277	6076.627
1977	1.6430	0.6804	1.0000	0.9626	1.2376	84219.136
1978	-1.7223	-1.3354	1.0000	-0.3869	-0.4974	11219.236
1979	-2.6510	-2.1585	1.0000	-0.4926	-0.6333	4926.233
1980	1.3386	0.4730	1.0000	0.8656	1.1128	68444.863
1981	-1.4820	-1.6502	1.0000	0.1682	0.2162	8189.434
1982	-0.6671	-1.9915	1.0000	1.3243	1.7027	5821.569
1984	-3.9573	-2.9060	1.0000	-1.0513	-1.3516	2332.816
1985	-1.3182	-1.1454	1.0000	-0.1728	-0.2221	13566.320
1986	-3.0410	-3.5338	1.0000	0.4929	0.6337	1245.077
1987	-0.9790	-1.2965	1.0000	0.3176	0.4083	11663.788
1989	-1.5049	-1.1111	1.0000	-0.3938	-0.5063	14040.341
1990	-5.6059	-5.0924	1.0000	-0.5135	-0.6602	261.999
1991	-2.9669	-2.4333	1.0000	-0.5336	-0.6860	3742.534

Partial variance for this index is 0.676585

Index 11 RV FAL 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
1964	0.1707	-0.5193	1.0000	0.6900	0.8871	22754.721
1965	2.1037	1.0678	1.0000	1.0359	1.3319	111253.121
1966	2.2977	1.6288	1.0000	0.6689	0.8600	194970.806
1967	-0.9891	-1.4560	1.0000	0.4669	0.6002	8918.190
1968	-3.0844	-2.7134	1.0000	-0.3711	-0.4771	2536.211
1969	-2.0940	-2.0112	1.0000	-0.0828	-0.1065	5118.371
1971	-3.6125	-4.3024	1.0000	0.6899	0.8870	517.720
1972	-3.2216	-3.0320	1.0000	-0.1896	-0.2438	1844.163
1974	-1.5775	-2.3330	1.0000	0.7554	0.9713	3710.247
1975	-2.0659	-1.6699	1.0000	-0.3960	-0.5091	7200.816
1976	-2.3913	-1.8386	1.0000	-0.5527	-0.7106	6082.834
1977	-2.7049	-2.1296	1.0000	-0.5754	-0.7398	4547.133
1978	0.9168	0.2923	1.0000	0.6245	0.8029	51231.556
1979	-1.9773	-1.5043	1.0000	-0.4730	-0.6081	8496.953
1980	-5.3617	-2.2553	1.0000	-3.1064	-3.9938	4009.733
1981	0.5299	-0.3123	1.0000	0.8422	1.0828	27987.955
1982	-1.2842	-2.0094	1.0000	0.7252	0.9324	5127.809
1983	-1.7713	-2.3324	1.0000	0.5612	0.7215	3712.162
1984	-3.6125	-3.2866	1.0000	-0.3259	-0.4190	1429.689
1985	-2.1836	-3.0420	1.0000	0.8584	1.1036	1825.799
1986	-1.7176	-1.4546	1.0000	-0.2629	-0.3380	8930.125
1987	-4.5508	-3.6740	1.0000	-0.8768	-1.1273	970.522
1988	-2.3785	-1.5971	1.0000	-0.7815	-1.0047	7744.351
1989	-3.8576	-4.1499	1.0000	0.2923	0.3758	602.984
1990	-1.1096	-1.3068	1.0000	0.1972	0.2535	10352.449
1991	-5.6494	-5.2354	1.0000	-0.4140	-0.5322	203.649

Partial variance for this index is 0.755507

Index 12 RV FAL 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
1964	0.9846	0.5224	1.0000	0.4621	0.5941	20094.852
1965	0.8298	0.1968	1.0000	0.6330	0.8138	14509.360
1966	1.3387	1.4504	1.0000	-0.1117	-0.1436	50824.706
1967	1.9782	1.7475	1.0000	0.2307	0.2966	68411.934
1968	-0.9388	-0.9335	1.0000	-0.0053	-0.0068	4685.712
1969	-2.9221	-2.1169	1.0000	-0.8052	-1.0352	1434.944
1970	-2.1962	-1.5019	1.0000	-0.6943	-0.8926	2654.154
1971	-4.9370	-4.0679	1.0000	-0.8691	-1.1174	203.957
1972	-3.5507	-3.9827	1.0000	0.4320	0.5554	222.094
1973	-1.5871	-2.3803	1.0000	0.7932	1.0197	1102.696
1975	-2.1038	-1.5847	1.0000	-0.5191	-0.6674	2443.215
1976	0.6465	-1.0408	1.0000	1.6873	2.1693	4208.912
1977	-1.5526	-0.9778	1.0000	-0.5748	-0.7390	4482.543
1978	-1.4713	-1.2100	1.0000	-0.2612	-0.3359	3553.673
1979	1.3321	0.8865	1.0000	0.4456	0.5729	28919.715
1980	-0.9954	-0.7926	1.0000	-0.2029	-0.2608	5394.967
1981	-1.6983	-1.3898	1.0000	-0.3085	-0.3966	2968.913
1982	0.4125	0.0841	1.0000	0.3284	0.4222	12963.197

1983	-1.9926	-1.4771	1.0000	-0.5154	-0.6627	2720.696
1984	-2.2629	-1.6435	1.0000	-0.6193	-0.7962	2303.629
1985	-2.3721	-2.5814	1.0000	0.2093	0.2691	901.793
1986	-2.5391	-2.4808	1.0000	-0.0583	-0.0749	997.177
1987	-0.8344	-0.9159	1.0000	0.0816	0.1049	4768.775
1988	-3.3276	-2.8668	1.0000	-0.4608	-0.5924	677.872
1989	-0.7626	-1.0469	1.0000	0.2843	0.3655	4183.406
1990	-2.6344	-3.3554	1.0000	0.7210	0.9270	415.866
1991	-0.8099	-0.5073	1.0000	-0.3025	-0.3890	7175.617

Partial variance for this index is 0.348575

Index 13 RV FAL 5
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1964	1.9253	1.4532	1.0000	0.4720	0.6069	27423.029
1965	0.3855	0.6376	1.0000	-0.2521	-0.3241	12130.770
1966	-0.1219	0.0925	1.0000	-0.2144	-0.2756	7032.950
1967	1.0128	1.3311	1.0000	-0.3183	-0.4092	24268.731
1968	1.7154	1.7611	1.0000	-0.0457	-0.0588	37310.680
1969	-1.3091	-1.1171	1.0000	-0.1920	-0.2468	2098.144
1970	-2.1845	-2.1202	1.0000	-0.0643	-0.0827	769.466
1971	-1.4586	-1.3530	1.0000	-0.1056	-0.1358	1657.280
1972	-4.1994	-3.8923	1.0000	-0.3071	-0.3949	130.792
1973	-2.5900	-4.0787	1.0000	1.4887	1.9141	108.544
1974	-1.8481	-2.4496	1.0000	0.6015	0.7733	553.544
1976	-0.2775	-1.3507	1.0000	1.0733	1.3799	1661.021
1977	-0.3928	-0.8837	1.0000	0.4909	0.6312	2649.709
1978	-0.7182	-0.7415	1.0000	0.0233	0.0299	3054.706
1979	-1.8481	-0.8898	1.0000	-0.9582	-1.2320	2633.526
1980	1.1805	0.9862	1.0000	0.1942	0.2497	17190.681
1981	-1.8481	-0.5955	1.0000	-1.2526	-1.6104	3534.809
1982	-1.7145	-1.3400	1.0000	-0.3745	-0.4815	1678.821
1983	0.1444	0.1209	1.0000	0.0235	0.0302	7235.610
1984	-1.3961	-1.3861	1.0000	-0.0099	-0.0128	1603.180
1985	-1.4586	-1.6526	1.0000	0.1940	0.2494	1228.235
1986	-3.2831	-2.4330	1.0000	-0.8501	-1.0930	562.788
1987	-3.1008	-2.3449	1.0000	-0.7560	-0.9719	614.641
1988	-0.5488	-0.9642	1.0000	0.4154	0.5341	2444.840
1989	-2.4077	-2.6934	1.0000	0.2858	0.3674	433.746
1990	-0.6585	-0.8906	1.0000	0.2321	0.2984	2631.541
1991	-3.2831	-3.4893	1.0000	0.2061	0.2650	195.708

Partial variance for this index is 0.346829

Index 14 RV FAL 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1964	1.9069	1.3333	1.0000	0.5736	0.7375	16350.013
1965	1.4624	1.2174	1.0000	0.2450	0.3150	14560.085
1966	-0.0958	0.3239	1.0000	-0.4197	-0.5396	5958.693
1967	-0.5301	-0.2812	1.0000	-0.2489	-0.3200	3253.502
1968	0.6087	0.8919	1.0000	-0.2833	-0.3642	10515.347
1969	1.4742	1.3961	1.0000	0.0781	0.1004	17410.066
1970	-1.6828	-1.3422	1.0000	-0.3405	-0.4378	1126.051
1971	-1.2058	-2.2338	1.0000	1.0280	1.3216	461.685
1972	-1.3951	-1.3698	1.0000	-0.0252	-0.0324	1095.368
1974	-2.9637	-4.6573	1.0000	1.6936	2.1774	40.912
1975	-3.8800	-2.4029	1.0000	-1.4771	-1.8991	389.865
1977	-1.0766	-1.3086	1.0000	0.2320	0.2983	1164.484
1978	-0.2965	-0.9283	1.0000	0.6318	0.8123	1703.407
1979	-1.2058	-0.7738	1.0000	-0.4320	-0.5554	1987.939
1980	-1.2058	-0.9415	1.0000	-0.2644	-0.3399	1681.109
1981	0.6896	0.6904	1.0000	-0.0009	-0.0011	8596.653
1982	-0.7230	-0.7449	1.0000	0.0220	0.0282	2046.224
1983	-1.8651	-1.4404	1.0000	-0.4246	-0.5460	1020.711
1984	0.0616	-0.1004	1.0000	0.1620	0.2083	3898.086
1985	-2.6272	-1.5087	1.0000	-1.1185	-1.4381	953.352
1986	-2.2705	-1.9912	1.0000	-0.2794	-0.3592	588.464
1987	-2.0082	-2.5736	1.0000	0.5655	0.7270	328.665

1988	-2.7814	-2.3953	1.0000	-0.3861	-0.4964	392.835
1989	-0.8842	-1.3131	1.0000	0.4289	0.5514	1159.262
1990	-2.3759	-2.9493	1.0000	0.5734	0.7373	225.730
1991	-1.6828	-1.1494	1.0000	-0.5334	-0.6857	1365.505

Partial variance for this index is 0.423594

Index 15 RV FAL 7
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1964	1.4279	0.9861	1.0000	0.4418	0.5680	5525.899
1965	1.1579	1.3739	1.0000	-0.2160	-0.2777	8143.630
1966	0.6214	1.0461	1.0000	-0.4247	-0.5460	5867.427
1967	0.0052	0.2065	1.0000	-0.2013	-0.2588	2534.132
1968	0.0052	-0.2724	1.0000	0.2776	0.3569	1569.794
1969	0.9507	0.9710	1.0000	-0.0203	-0.0261	5443.212
1970	1.1342	1.4589	1.0000	-0.3247	-0.4175	8866.755
1971	0.0416	-1.0404	1.0000	1.0820	1.3911	728.297
1972	-2.8852	-2.5851	1.0000	-0.3001	-0.3858	155.406
1973	-1.6812	-0.9613	1.0000	-0.7199	-0.9255	788.231
1976	-2.8852	-1.9921	1.0000	-0.8931	-1.1482	281.191
1978	-0.3202	-1.1848	1.0000	0.8646	1.1116	630.372
1979	-0.0520	-0.7993	1.0000	0.7474	0.9609	926.831
1980	-0.5180	-0.4950	1.0000	-0.0231	-0.0297	1256.603
1981	0.0052	-0.8990	1.0000	0.9042	1.1625	838.902
1982	0.1106	0.8266	1.0000	-0.7160	-0.9205	4711.103
1983	-1.9043	-0.5746	1.0000	-1.3298	-1.7097	1160.454
1984	-1.4188	-1.2517	1.0000	-0.1671	-0.2149	589.571
1985	-0.0920	-0.1079	1.0000	0.0159	0.0205	1850.513
1986	-2.0379	-1.2781	1.0000	-0.7598	-0.9769	574.236
1987	-1.4188	-1.8465	1.0000	0.4277	0.5498	325.256
1988	-2.1920	-2.3177	1.0000	0.1257	0.1616	203.035
1989	-1.4989	-2.4011	1.0000	0.9022	1.1599	186.805
1990	-1.3447	-1.1931	1.0000	-0.1517	-0.1950	625.191
1991	-2.5975	-3.0560	1.0000	0.4585	0.5895	97.043

Partial variance for this index is 0.400509

Index 16 RV FAL 8
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1964	1.6356	0.7360	1.0000	0.8996	1.1566	3309.095
1965	0.7327	0.5102	1.0000	0.2225	0.2860	2640.352
1966	0.8926	0.7193	1.0000	0.1732	0.2227	3254.394
1967	-0.0013	0.5302	1.0000	-0.5315	-0.6834	2693.762
1968	-0.4493	-0.2983	1.0000	-0.1509	-0.1941	1176.268
1969	-0.2175	-0.8438	1.0000	0.6264	0.8053	681.712
1970	0.4406	0.6486	1.0000	-0.2081	-0.2675	3032.311
1971	1.4259	1.1824	1.0000	0.2435	0.3130	5171.120
1972	-1.2822	-1.5442	1.0000	0.2620	0.3369	338.401
1973	-1.6389	-3.3314	1.0000	1.6925	2.1761	56.658
1974	-1.5053	-1.0129	1.0000	-0.4924	-0.6331	575.676
1977	-1.9753	-2.0242	1.0000	0.0488	0.0628	209.408
1978	-2.1985	-2.9677	1.0000	0.7692	0.9890	81.510
1979	-3.5848	-1.4014	1.0000	-2.1833	-2.8071	390.333
1980	-1.7930	-1.2077	1.0000	-0.5854	-0.7526	473.801
1981	0.3855	-1.0866	1.0000	1.4721	1.8927	534.779
1983	-0.4493	0.5847	1.0000	-1.0340	-1.3294	2844.612
1986	-0.7516	-0.4223	1.0000	-0.3293	-0.4233	1039.128
1987	-2.8916	-1.5561	1.0000	-1.3356	-1.7171	334.419
1988	-2.8916	-2.1440	1.0000	-0.7477	-0.9613	185.767
1989	-1.1869	-2.6109	1.0000	1.4240	1.8308	116.465
1990	-2.8916	-2.6560	1.0000	-0.2356	-0.3029	111.321

Partial variance for this index is 0.887379

Index 18 CANADA 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
1986	1.2078	0.3226	1.0000	0.8852	1.1381	14252.813
1987	-3.6999	-2.3651	1.0000	-1.3349	-1.7162	969.741
1988	0.1919	0.5078	1.0000	-0.3160	-0.4062	17153.331
1989	-3.6999	-3.4738	1.0000	-0.2262	-0.2908	320.008
1990	-0.2659	-0.8141	1.0000	0.5482	0.7048	4573.352
1991	-0.4678	-0.9114	1.0000	0.4436	0.5703	4149.244

Partial variance for this index is 0.688645

Index 19 CANADA 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
1986	-2.0545	-1.7387	1.0000	-0.3158	-0.4060	1245.077
1987	0.5715	0.4986	1.0000	0.0729	0.0937	11663.788
1988	-3.5361	-2.1886	1.0000	-1.3475	-1.7324	793.956
1989	1.1083	0.6840	1.0000	0.4242	0.5454	14040.341
1990	-2.7477	-3.2973	1.0000	0.5497	0.7067	261.999
1991	-0.0216	-0.6381	1.0000	0.6165	0.7927	3742.534

Partial variance for this index is 0.596358

Index 20 CANADA 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
1986	0.3360	0.5735	1.0000	-0.2374	-0.3052	8930.125
1987	-1.8351	-1.6459	1.0000	-0.1892	-0.2432	970.522
1988	0.6760	0.4310	1.0000	0.2451	0.3151	7744.351
1989	-1.8207	-2.1218	1.0000	0.3011	0.3872	602.984
1990	0.8245	0.7212	1.0000	0.1032	0.1327	10352.449
1991	-3.4301	-3.2073	1.0000	-0.2228	-0.2865	203.649

Partial variance for this index is 0.06497

Index 21 CANADA 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
1986	-0.8386	-1.5112	1.0000	0.6727	0.8648	997.177
1987	0.0140	0.0537	1.0000	-0.0396	-0.0510	4768.775
1988	-2.6782	-1.8972	1.0000	-0.7810	-1.0041	677.872
1989	-0.1884	-0.0773	1.0000	-0.1111	-0.1429	4183.406
1990	-2.9465	-2.3858	1.0000	-0.5607	-0.7208	415.866
1991	1.2821	0.4623	1.0000	0.8198	1.0540	7175.617

Partial variance for this index is 0.442007

Index 22 CANADA 5
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-1.8691	-1.1244	1.0000	-0.7447	-0.9574	562.788
1987	-0.6088	-1.0363	1.0000	0.4274	0.5495	614.641
1988	0.8494	0.3444	1.0000	0.5050	0.6493	2444.840
1989	-1.9232	-1.3848	1.0000	-0.5383	-0.6921	433.746
1990	1.0036	0.4180	1.0000	0.5856	0.7528	2631.541
1991	-2.4156	-2.1807	1.0000	-0.2350	-0.3021	195.708

Partial variance for this index is 0.360032

Index 23 CANADA 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-0.4686	-0.3862	1.0000	-0.0823	-0.1059	588.464
1987	-1.7564	-0.9687	1.0000	-0.7877	-1.0128	328.665
1988	-0.9455	-0.7903	1.0000	-0.1551	-0.1995	392.835
1989	-0.0982	0.2918	1.0000	-0.3900	-0.5014	1159.262
1990	-0.7004	-1.3444	1.0000	0.6440	0.8280	225.730
1991	1.2267	0.4555	1.0000	0.7712	0.9915	1365.505

Partial variance for this index is 0.388492

Index 24 CANADA 7
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	0.0099	0.1788	1.0000	-0.1690	-0.2172	574.236
1987	-0.1153	-0.3896	1.0000	0.2743	0.3527	325.256
1988	-0.6833	-0.8609	1.0000	0.1776	0.2283	203.035
1989	-2.4179	-0.9442	1.0000	-1.4737	-1.8947	186.805
1990	1.1748	0.2638	1.0000	0.9110	1.1713	625.191
1991	-1.3193	-1.5991	1.0000	0.2798	0.3597	97.043

Partial variance for this index is 0.689021

Index 25 CANADA 8
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	0.6320	1.0402	1.0000	-0.4083	-0.5249	1039.128
1987	-0.6763	-0.0935	1.0000	-0.5828	-0.7493	334.419
1988	-0.5810	-0.6814	1.0000	0.1004	0.1290	185.767
1989	-1.8803	-1.1483	1.0000	-0.7320	-0.9411	116.465
1990	-0.4140	-1.1935	1.0000	0.7795	1.0022	111.321
1991	0.8053	-0.0380	1.0000	0.8432	1.0841	353.517

Partial variance for this index is 0.508059

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.9725	-99.0000	-0.4648	-99.0000	1.0730	2.6247	-0.0147
2	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	0.1715	-0.2332	0.2587	0.2199	0.2060	1.2968	1.7110
3	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.4428	-1.0537	-99.0000	0.8292	0.3177	-99.0000	1.4049
4	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.5954	-0.3745	-0.8421	-99.0000	1.0378	0.9223	-99.0000
5	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.4454	-0.3096	1.1128	-1.6310	-0.2515	1.5362	0.6700
6	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.2682	0.2657	0.9475	0.3364	-2.0028	-99.0000	-99.0000
7	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.5995	-0.4044	-0.1810	-0.9359	1.5714	-0.1464	0.8322
8	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	0.3518	0.4645	0.1504	-0.7703	-1.6375	0.1389	-0.6502
9	-99.0000	0.1007	-1.0719	-0.9396	1.3610	-1.1123	-0.7809	-0.8784	-0.4153	0.7085	0.9631	0.8036
10	-99.0000	-0.7260	0.0359	0.8203	0.0035	1.1330	-0.5551	-2.7632	1.7019	-99.0000	0.3053	1.0588
11	-99.0000	0.8871	1.3319	0.8600	0.6002	-0.4771	-0.1065	-99.0000	0.8870	-0.2438	-99.0000	0.9713
12	-99.0000	0.5941	0.8138	-0.1436	0.2966	-0.0068	-1.0352	-0.8926	-1.1174	0.5554	1.0197	-99.0000
13	-99.0000	0.6069	-0.3241	-0.2756	-0.4092	-0.0588	-0.2468	-0.0827	-0.1358	-0.3949	1.9141	0.7733
14	-99.0000	0.7375	0.3150	-0.5396	-0.3200	-0.3642	0.1004	-0.4378	1.3216	-0.0324	-99.0000	2.1774
15	-99.0000	0.5680	-0.2777	-0.5460	-0.2588	0.3569	-0.0261	-0.4175	1.3911	-0.3858	-0.9255	-99.0000
16	-99.0000	1.1566	0.2860	0.2227	-0.6834	-0.1941	0.8053	-0.2675	0.3130	0.3369	2.1761	-0.6331
18	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
19	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
23	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
24	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
**	1.0000	0.4906	0.1386	-0.0677	0.0738	-0.0362	-0.2327	-0.3399	0.1425	0.0572	0.9854	0.7587

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	-0.6574	1.7231	-1.9625	-3.6368	0.9566	1.1938	1.0986	0.5863	-0.3990	-0.6265	-99.0000	-0.3252
2	-1.0679	-2.1258	0.5484	-1.4139	0.2741	1.2458	0.6119	0.0668	0.0828	0.8578	0.3259	-0.8670
3	0.7423	-1.2557	-1.3261	0.2355	-0.8550	-0.9115	1.3210	-0.3953	-0.6407	0.7013	0.4926	-0.2663
4	0.1008	-0.1086	0.1739	-1.1144	-0.2432	-0.2721	1.5002	0.4027	-1.3953	0.1764	0.6812	-0.1048
5	-99.0000	0.0184	-0.1651	0.2439	-0.9169	0.1384	-0.1757	0.0047	0.3502	0.4610	1.1982	-0.4572
6	0.7378	-99.0000	0.8529	1.1456	-1.1222	0.8934	0.1102	-0.4197	-3.0901	-0.1028	0.6402	0.6411
7	3.0945	-0.6035	-99.0000	0.0055	0.5683	0.1769	0.2061	-0.8344	-2.4260	-0.9511	1.0275	-0.3959
8	1.0297	-99.0000	-0.3637	1.2820	-0.7318	1.5723	-0.3407	-99.0000	0.4409	-2.0574	0.1961	0.0030
9	-0.6718	0.4193	0.8366	-2.5182	-0.0016	-0.2359	3.0068	-0.0169	1.3660	0.9702	-2.7614	1.9101
10	-0.4410	-1.3277	1.2376	-0.4974	-0.6333	1.1128	0.2162	1.7027	-99.0000	-1.3516	-0.2221	0.6337
11	-0.5091	-0.7106	-0.7398	0.8029	-0.6081	-3.9938	1.0828	0.9324	0.7215	-0.4190	1.1036	-0.3380
12	-0.6674	2.1693	-0.7390	-0.3359	0.5729	-0.2608	-0.3966	0.4222	-0.6627	-0.7962	0.2691	-0.0749
13	-99.0000	1.3799	0.6312	0.0299	-1.2320	0.2497	-1.6104	-0.4815	0.0302	-0.0128	0.2494	-1.0930
14	-1.8991	-99.0000	0.2983	0.8123	-0.5554	-0.3399	-0.0011	0.0282	-0.5460	0.2083	-1.4381	-0.3592
15	-99.0000	-1.1482	-99.0000	1.1116	0.9609	-0.0297	1.1625	-0.9205	-1.7097	-0.2149	0.0205	-0.9769
16	-99.0000	-99.0000	0.0628	0.9890	-2.8071	-0.7526	1.8927	-99.0000	-1.3294	-99.0000	-99.0000	-0.4233
18	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	1.1381
19	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.4060
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.3052
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	0.8648
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.9574
23	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.1059
24	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.2172
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-0.5249
**	-0.0174	-0.1308	-0.0468	-0.1787	-0.3984	-0.0133	0.6053	0.0770	-0.6138	-0.2105	0.1273	-0.1253

	1987	1988	1989	1990	1991********
1	-99.0000	-1.1728	-1.1255	-0.1864	-0.6570 0.0000
2	0.1153	-2.2223	-0.1196	-99.0000	0.0569 0.0000
3	-1.9593	-1.0252	1.2991	0.9052	1.8831 -0.0000
4	-0.5529	-0.3968	-0.5007	1.4674	0.0381 0.0000
5	-0.9800	-0.9728	0.1877	-0.2592	0.6428 0.0000
6	0.4360	0.4411	0.6907	0.2623	-1.3951 0.0000
7	-0.7907	0.8289	0.1567	-0.3070	0.1076 0.0000
8	0.9393	0.9159	0.3906	-99.0000	-1.3239 0.0000
9	-99.0000	-0.6955	0.2489	-0.6819	0.0866 0.0000
10	0.4083	-99.0000	-0.5063	-0.6602	-0.6860 0.0000
11	-1.1273	-1.0047	0.3758	0.2535	-0.5322 0.0000
12	0.1049	-0.5924	0.3655	0.9270	-0.3890 0.0000
13	-0.9719	0.5341	0.3674	0.2984	0.2650 -0.0000
14	0.7270	-0.4964	0.5514	0.7373	-0.6857 0.0000
15	0.5498	0.1616	1.1599	-0.1950	0.5895 0.0000
16	-1.7171	-0.9613	1.8308	-0.3029	-99.0000 0.0000
18	-1.7162	-0.4062	-0.2908	0.7048	0.5703 -0.0000
19	0.0937	-1.7324	0.5454	0.7067	0.7927 -0.0000
20	-0.2432	0.3151	0.3872	0.1327	-0.2865 0.0000
21	-0.0510	-1.0041	-0.1429	-0.7208	1.0540 0.0000
22	0.5495	0.6493	-0.6921	0.7528	-0.3021 0.0000
23	-1.0128	-0.1995	-0.5014	0.8280	0.9915 0.0000
24	0.3527	0.2283	-1.8947	1.1713	0.3597 -0.0000
25	-0.7493	0.1290	-0.9411	1.0022	1.0841 -0.0000
**	-0.3452	-0.3774	0.0767	0.3107	0.0985 -0.0000

-99 in the above table indicates a missing value

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	-99.00	-99.00	-99.00	-99.00	-99.00	0.98	-99.00	0.05	-99.00	0.29	1.74	0.00	0.11	0.75	0.97
2	-99.00	-99.00	-99.00	-99.00	-99.00	0.01	0.01	0.02	0.01	0.01	0.42	0.74	0.29	1.14	0.08
3	-99.00	-99.00	-99.00	-99.00	-99.00	0.05	0.28	-99.00	0.17	0.03	-99.00	0.50	0.14	0.40	0.44
4	-99.00	-99.00	-99.00	-99.00	-99.00	0.09	0.04	0.18	-99.00	0.27	0.21	-99.00	0.00	0.00	0.01
5	-99.00	-99.00	-99.00	-99.00	-99.00	0.05	0.02	0.31	0.67	0.02	0.60	0.11	-99.00	0.00	0.01
6	-99.00	-99.00	-99.00	-99.00	-99.00	0.02	0.02	0.23	0.03	1.01	-99.00	-99.00	0.14	-99.00	0.18
7	-99.00	-99.00	-99.00	-99.00	-99.00	0.09	0.04	0.01	0.22	0.62	0.01	0.17	2.42	0.09	-99.00
8	-99.00	-99.00	-99.00	-99.00	-99.00	0.03	0.05	0.01	0.15	0.68	0.00	0.11	0.27	-99.00	0.03
9	-99.00	0.00	0.29	0.22	0.47	0.31	0.15	0.19	0.04	0.13	0.23	0.16	0.11	0.04	0.18
10	-99.00	0.13	0.00	0.17	0.00	0.32	0.08	1.93	0.73	-99.00	0.02	0.28	0.05	0.45	0.39
11	-99.00	0.20	0.45	0.19	0.09	0.06	0.00	-99.00	0.20	0.02	-99.00	0.24	0.07	0.13	0.14
12	-99.00	0.09	0.17	0.01	0.02	0.00	0.27	0.20	0.32	0.08	0.26	-99.00	0.11	1.19	0.14
13	-99.00	0.09	0.03	0.02	0.04	0.00	0.02	0.00	0.00	0.04	0.93	0.15	-99.00	0.48	0.10
14	-99.00	0.14	0.03	0.07	0.03	0.03	0.00	0.05	0.44	0.00	-99.00	1.20	0.91	-99.00	0.02
15	-99.00	0.08	0.02	0.08	0.02	0.03	0.00	0.04	0.49	0.04	0.22	-99.00	-99.00	0.33	-99.00
16	-99.00	0.34	0.02	0.01	0.12	0.01	0.16	0.02	0.02	0.03	1.20	0.10	-99.00	-99.00	0.00
18	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
19	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
23	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
24	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
**	0.00	1.07	1.00	0.77	0.78	2.09	1.15	3.24	3.51	3.25	5.84	3.77	4.61	5.00	2.69

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991*******
1	3.34	0.23	0.36	0.30	0.09	0.04	0.10	-99.00	0.03	-99.00	0.35	0.32	0.01	0.11	10.17
2	0.50	0.02	0.39	0.09	0.00	0.00	0.19	0.03	0.19	0.00	1.25	0.00	-99.00	0.00	5.40
3	0.01	0.18	0.21	0.44	0.04	0.10	0.12	0.06	0.02	0.97	0.27	0.43	0.21	0.90	5.97
4	0.31	0.01	0.02	0.57	0.04	0.49	0.01	0.12	0.00	0.08	0.04	0.06	0.54	0.00	3.10
5	0.02	0.21	0.00	0.01	0.00	0.03	0.05	0.36	0.05	0.24	0.24	0.01	0.02	0.10	3.14
6	0.33	0.32	0.20	0.00	0.04	2.41	0.00	0.10	0.10	0.05	0.05	0.12	0.02	0.49	5.87
7	0.00	0.08	0.01	0.01	0.18	1.49	0.23	0.27	0.04	0.16	0.17	0.01	0.02	0.00	6.34
8	0.42	0.14	0.62	0.03	-99.00	0.05	1.07	0.01	0.00	0.22	0.21	0.04	-99.00	0.44	4.58
9	1.60	0.00	0.01	2.28	0.00	0.47	0.24	1.93	0.92	-99.00	0.12	0.02	0.12	0.00	10.26
10	0.06	0.10	0.31	0.01	0.73	-99.00	0.46	0.01	0.10	0.04	-99.00	0.06	0.11	0.12	6.68
11	0.16	0.09	4.03	0.30	0.22	0.13	0.04	0.31	0.03	0.32	0.25	0.04	0.02	0.07	7.78
12	0.03	0.08	0.02	0.04	0.05	0.11	0.16	0.02	0.00	0.00	0.09	0.03	0.22	0.04	3.73
13	0.00	0.38	0.02	0.65	0.06	0.00	0.00	0.02	0.30	0.24	0.07	0.03	0.02	0.02	3.72
14	0.17	0.08	0.03	0.00	0.00	0.08	0.01	0.52	0.03	0.13	0.06	0.08	0.14	0.12	4.36
15	0.31	0.23	0.00	0.34	0.21	0.74	0.01	0.00	0.24	0.08	0.01	0.34	0.01	0.09	3.96
16	0.25	1.99	0.14	0.90	-99.00	0.45	-99.00	-99.00	0.05	0.74	0.23	0.85	0.02	-99.00	7.66
18	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.33	0.74	0.04	0.02	0.13	0.08	1.34
19	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.04	0.00	0.76	0.08	0.13	0.16	1.16
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.02	0.01	0.03	0.04	0.00	0.02	0.13
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.19	0.00	0.25	0.01	0.13	0.28	0.86
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.23	0.08	0.11	0.12	0.14	0.02	0.70
23	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.00	0.26	0.01	0.06	0.17	0.25	0.76
24	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.01	0.03	0.01	0.91	0.35	0.03	1.34
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.07	0.14	0.00	0.22	0.25	0.30	0.99
**	7.51	4.16	6.38	5.99	1.66	6.59	2.70	3.75	3.00	4.55	4.63	3.89	2.77	3.64	100.00

-99 in the above table indicates a missing value

Partial variance (and proportion of total) by index

	1	2	3	4	5	6	7	8	9	10
**	1.30554294	0.59713279	0.69176917	0.35986326	0.34747173	0.71526086	0.70063704	0.55772776	0.95754196	0.67658452
**	0.09453941	0.04324069	0.05009368	0.02605909	0.02516177	0.05179480	0.05073583	0.04038722	0.06933931	0.04899410

	11	12	13	14	15	16	18	19	20	21	22
**	0.75550748	0.34857523	0.34682855	0.42359435	0.40050923	0.88737924	0.68864520	0.59635789	0.06496993	0.44200744	0.36003201
**	0.05470921	0.02524168	0.02511519	0.03067410	0.02900242	0.06425856	0.04986746	0.04318458	0.00470472	0.03200747	0.02607131

	23	24	25**********
**	0.38849207	0.68902135	0.50805871	13.80951073
**	0.02813221	0.04989470	0.03679049	1.00000000

STOCK NUMBERS (Jan 1) in millions - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	190696.201	471862.130	33152.206	4136.347	12948.136	421.702	987.835	4658.061	367.837	8508.401
2	32265.305	153495.768	377188.274	18455.387	3283.403	9560.474	338.022	806.962	3772.075	300.255
3	32742.065	22754.721	111253.121	194970.806	8918.190	2536.211	5118.371	266.796	517.720	1844.163
4	45819.430	20094.852	14509.360	50824.706	68411.934	4685.712	1434.944	2654.154	203.957	222.094
5	29030.142	27423.029	12130.770	7032.950	24268.731	37310.680	2098.144	769.466	1657.280	130.792
6	9186.251	16350.013	14560.085	5958.693	3253.502	10515.347	17410.066	1126.051	461.685	1095.368
7	5594.502	5525.899	8143.630	5867.427	2534.132	1569.794	5443.212	8866.755	728.297	155.406
8	2794.446	3309.095	2640.352	3254.394	2693.762	1176.268	681.712	3032.311	5171.120	338.401
9	4217.236	4250.791	3258.240	2200.925	2031.087	2162.804	1711.221	1873.016	3240.956	6301.299
1+	352345.579	725066.297	576836.040	292701.635	128342.878	69938.992	35223.527	24053.570	16120.927	18896.179

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	19402.982	10521.114	7634.201	103024.629	13704.311	6018.020	83599.850	10011.438	7111.586	2422.820
2	6824.935	13569.435	8572.337	6076.627	84219.136	11219.236	4926.233	68444.863	8189.434	5821.569
3	244.018	3710.247	7200.816	6082.834	4547.133	51231.556	8496.953	4009.733	27987.955	5127.809
4	1102.696	197.071	2443.215	4208.912	4482.543	3553.673	28919.715	5394.967	2968.913	12963.197
5	108.544	553.544	159.538	1661.021	2649.709	3054.706	2633.526	17190.681	3534.809	1678.821
6	78.129	40.912	389.865	127.000	1164.484	1703.407	1987.939	1681.109	8596.653	2046.224
7	788.231	36.821	31.686	281.191	103.978	630.372	926.831	1256.603	838.902	4711.103
8	56.658	575.676	28.337	22.323	209.408	81.510	390.333	473.801	534.779	387.334
9	1675.954	2695.273	620.622	621.718	592.742	388.075	185.742	248.594	315.555	398.891
1+	30282.147	31900.091	27080.617	122106.254	111673.443	77880.555	132067.122	108711.789	60078.585	35557.768

	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	2849.309	16569.942	1520.742	14252.813	969.741	17153.331	320.008	4573.352	4149.244
2	1982.732	2332.816	13566.320	1245.077	11663.788	793.956	14040.341	261.999	3742.534
3	3712.162	1429.689	1825.799	8930.125	970.522	7744.351	602.984	10352.449	203.649
4	2720.696	2303.629	901.793	997.177	4768.775	677.872	4183.406	415.866	7175.617
5	7235.610	1603.180	1228.235	562.788	614.641	2444.840	433.746	2631.541	195.708
6	1020.711	3898.086	953.352	588.464	328.665	392.835	1159.262	225.730	1365.505
7	1160.454	589.571	1850.513	574.236	325.256	203.035	186.805	625.191	97.043
8	2844.612	781.800	270.968	1039.128	334.419	185.767	116.465	111.321	353.517
9	268.128	1574.901	523.825	232.712	422.174	304.737	185.909	118.475	113.428
1+	23794.414	31083.613	22641.547	[illegible]22.518	20397.980	29900.724	21228.926	19315.923	17396.244

Summaries for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
2	161649.377	253204.167	543683.834	288565.288	115394.742	69517.289	34235.692	19395.510	15753.090	10387.778
3	129384.072	99708.400	166495.559	270109.901	112111.339	59956.815	33897.670	18588.548	11981.015	10087.523
4	96642.006	76953.679	55242.438	75139.095	103193.149	57420.605	28779.299	18321.752	11463.295	8243.360
5	50822.577	56858.827	40733.078	24314.390	34781.214	52734.893	27344.355	15667.599	11259.338	8021.266
6	21792.435	29435.798	28602.308	17281.440	10512.483	15424.213	25246.212	14898.133	9602.058	7890.474

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	10879.165	21378.978	19446.416	19081.625	97969.132	71862.535	48467.272	98700.351	52966.999	33134.948
3	4054.230	7809.543	10874.079	13004.998	13749.996	60643.299	43541.038	30255.488	44777.566	27313.378
4	3810.212	4099.297	3673.263	6922.164	9202.863	9411.743	35044.086	26245.755	16789.611	22185.569
5	2707.516	3902.226	1230.048	2713.252	4720.321	5858.070	6124.371	20850.788	13820.698	9222.372
6	2598.972	3348.682	1070.510	1052.231	2070.612	2803.364	3490.845	3660.107	10285.889	7543.551

	1984	1985	1986	1987	1988	1989	1990	1991
2	14513.671	21120.805	14169.705	19428.239	12747.392	20908.918	14742.571	13247.000
3	12180.854	7554.485	12924.627	7764.451	11953.437	6868.578	14480.572	9504.466
4	10751.166	5728.686	3994.503	6793.930	4209.086	6265.593	4128.123	9300.817
5	8447.537	4826.893	2997.326	2025.155	3531.214	2082.187	3712.257	2125.200
6	6844.358	3598.658	2434.538	1410.515	1086.374	1648.441	1080.717	1929.492

FISHING MORTALITY - GBHAD

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.0170	0.0239	0.3858	0.0309	0.1033	0.0212	0.0022	0.0110	0.0030	0.0205	0.1576	0.0048	0.0282	0.0015	0.0001	0.0002	0.0000
2	0.1492	0.1219	0.4599	0.5273	0.0582	0.4248	0.0366	0.2438	0.5156	0.0074	0.4095	0.4336	0.1431	0.0900	0.2971	0.0779	0.0059
3	0.2882	0.2500	0.5834	0.8473	0.4436	0.3695	0.4567	0.0686	0.6463	0.3143	0.0137	0.2178	0.3370	0.1053	0.0465	0.3718	0.2542
4	0.3133	0.3047	0.5242	0.5392	0.4063	0.6035	0.4232	0.2709	0.2443	0.5159	0.4892	0.0113	0.1859	0.2628	0.1835	0.0997	0.3202
5	0.3741	0.4331	0.5109	0.5709	0.6364	0.5622	0.4223	0.3108	0.2141	0.3153	0.7757	0.1505	0.0281	0.1552	0.2418	0.2296	0.2489
6	0.3083	0.4970	0.7089	0.6550	0.5288	0.4585	0.4747	0.2358	0.8888	0.1291	0.5523	0.0555	0.1268	0.0000	0.4137	0.4086	0.2587
7	0.3251	0.5385	0.7172	0.5785	0.5675	0.6341	0.3850	0.3392	0.5665	0.8090	0.1142	0.0619	0.1503	0.0947	0.0434	0.2793	0.4710
8	0.3357	0.4206	0.6123	0.5632	0.4720	0.5545	0.4538	0.3173	0.3768	0.2428	0.3461	0.1073	0.1696	0.2207	0.2305	0.2105	0.3172
9	0.3357	0.4206	0.6123	0.5632	0.4720	0.5545	0.4538	0.3173	0.3768	0.2428	0.3461	0.1073	0.1696	0.2207	0.2305	0.2105	0.3172

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0009	0.0002	0.0005	0.0000	0.0000	0.0000	0.0005	0.0000	0.0003	0.0000	0.0005
2	0.6943	0.2682	0.2500	0.1270	0.0451	0.2182	0.0491	0.2095	0.0751	0.1047	0.0519
3	0.1005	0.5697	0.4338	0.2771	0.2608	0.4048	0.4273	0.1589	0.4158	0.1715	0.1665
4	0.2228	0.3701	0.3831	0.3289	0.4289	0.2715	0.2839	0.4681	0.2465	0.2636	0.5537
5	0.4930	0.3467	0.2976	0.4185	0.3198	0.5358	0.3379	0.2476	0.5462	0.4531	0.4560
6	0.4951	0.4015	0.3672	0.3489	0.5450	0.3069	0.3929	0.2817	0.5433	0.4175	0.6442
7	0.6543	0.5728	0.3045	0.1950	0.5774	0.3771	0.3406	0.3601	0.3558	0.3177	0.3701
8	0.4414	0.3953	0.3602	0.3722	0.4739	0.3829	0.3325	0.4313	0.4792	0.3088	0.5060
9	0.4414	0.3953	0.3602	0.3722	0.4739	0.3829	0.3325	0.4313	0.4792	0.3088	0.5060

Avg F for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.3037	0.3733	0.5911	0.6056	0.4481	0.5202	0.3883	0.2630	0.4787	0.3221	0.3809	0.1432	0.1638	0.1437	0.2109	0.2360	0.2741
3	0.3258	0.4092	0.6099	0.6167	0.5038	0.5338	0.4385	0.2657	0.4734	0.3670	0.3768	0.1017	0.1667	0.1513	0.1986	0.2586	0.3125
4	0.3320	0.4357	0.6143	0.5783	0.5138	0.5612	0.4355	0.2986	0.4446	0.3758	0.4373	0.0823	0.1384	0.1590	0.2239	0.2397	0.3222
5	0.3358	0.4620	0.6323	0.5861	0.5353	0.5527	0.4379	0.3041	0.4846	0.3478	0.4269	0.0965	0.1289	0.1383	0.2320	0.2677	0.3226
6	0.3262	0.4692	0.6627	0.5900	0.5101	0.5504	0.4418	0.3024	0.5522	0.3559	0.3397	0.0830	0.1541	0.1340	0.2295	0.2772	0.3410

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.4429	0.4149	0.3446	0.3050	0.3906	0.3600	0.3121	0.3236	0.3927	0.2932	0.4068
3	0.4069	0.4359	0.3581	0.3304	0.4400	0.3803	0.3497	0.3398	0.4380	0.3201	0.4575
4	0.4580	0.4136	0.3455	0.3393	0.4698	0.3762	0.3367	0.3700	0.4417	0.3449	0.5060
5	0.5051	0.4223	0.3379	0.3414	0.4780	0.3971	0.3473	0.3504	0.4808	0.3612	0.4965
6	0.5081	0.4412	0.3480	0.3221	0.5176	0.3625	0.3497	0.3761	0.4644	0.3382	0.5066

Avg F (weighted by N) for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.2875	0.2238	0.5002	0.7510	0.4573	0.5246	0.4466	0.3095	0.4238	0.2519	0.3819	0.3337	0.2199	0.1425	0.2793	0.3054	0.2731
3	0.3220	0.3808	0.5915	0.7663	0.4690	0.5406	0.4507	0.3124	0.3950	0.2592	0.3354	0.1599	0.2804	0.1671	0.1706	0.3475	0.3033
4	0.3334	0.4195	0.6078	0.5562	0.4712	0.5481	0.4496	0.3159	0.3836	0.2468	0.3560	0.1076	0.1696	0.2214	0.2319	0.2153	0.3153
5	0.3515	0.4601	0.6376	0.5916	0.5989	0.5432	0.4510	0.3235	0.3861	0.2394	0.3018	0.1125	0.1372	0.1572	0.2779	0.2855	0.2921
6	0.3214	0.4852	0.6913	0.6000	0.5126	0.4971	0.4534	0.3242	0.4158	0.2381	0.2820	0.1062	0.1534	0.1604	0.3241	0.3464	0.3247

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.6036	0.4669	0.3505	0.3316	0.3831	0.2792	0.3670	0.2840	0.4160	0.1678	0.2483
3	0.3984	0.5033	0.3728	0.3530	0.4479	0.3888	0.3976	0.3960	0.4387	0.2969	0.2519
4	0.4439	0.3926	0.3577	0.3714	0.4727	0.3836	0.3312	0.4299	0.4807	0.3090	0.4659
5	0.5011	0.3975	0.3219	0.3806	0.4847	0.4046	0.3469	0.3398	0.5256	0.4002	0.4561
6	0.5392	0.4149	0.3273	0.3289	0.5233	0.3598	0.3490	0.3800	0.4793	0.3862	0.4563

Avg F (wt by catch) for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.3049	0.3009	0.5069	0.7698	0.4813	0.5312	0.4522	0.3151	0.4548	0.2847	0.4099	0.3846	0.2540	0.1740	0.2914	0.3483	0.3068
3	0.3244	0.4017	0.5950	0.7826	0.4832	0.5453	0.4526	0.3176	0.4308	0.2850	0.4107	0.1800	0.3022	0.1963	0.2327	0.3612	0.3076
4	0.3353	0.4309	0.6178	0.5575	0.4865	0.5510	0.4519	0.3185	0.4160	0.2768	0.4119	0.1143	0.1767	0.2369	0.2531	0.2658	0.3183
5	0.3533	0.4626	0.6468	0.5932	0.6036	0.5460	0.4533	0.3255	0.4182	0.2642	0.3640	0.1148	0.1524	0.1727	0.2992	0.3047	0.3090
6	0.3218	0.4878	0.6929	0.6019	0.5148	0.5027	0.4558	0.3262	0.4383	0.2631	0.3256	0.1067	0.1560	0.1998	0.3570	0.3625	0.3454

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.6418	0.4918	0.3596	0.3542	0.4572	0.3055	0.3976	0.3239	0.4436	0.2212	0.3157
3	0.4562	0.5163	0.3762	0.3638	0.4669	0.4014	0.4025	0.4245	0.4486	0.3142	0.3169
4	0.4708	0.3969	0.3606	0.3803	0.4837	0.4003	0.3341	0.4405	0.5028	0.3223	0.4726
5	0.5034	0.4024	0.3241	0.3902	0.4973	0.4176	0.3482	0.3557	0.5291	0.4055	0.4620
6	0.5492	0.4189	0.3295	0.3428	0.5252	0.3622	0.3505	0.3884	0.4866	0.3912	0.4768

BACKCALCULATED PARTIAL RECRUITMENT

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.05	0.04	0.54	0.04	0.16	0.03	0.00	0.03	0.00	0.03	0.20	0.01	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.40	0.23	0.64	0.62	0.09	0.67	0.08	0.72	0.58	0.01	0.53	1.00	0.42	0.34	0.72	0.19	0.01	1.00	0.47	0.58	0.30	0.08	0.41	0.11
3	0.77	0.46	0.81	1.00	0.70	0.58	0.96	0.20	0.73	0.39	0.02	0.50	1.00	0.40	0.11	0.91	0.54	0.14	0.99	1.00	0.66	0.45	0.76	1.00
4	0.84	0.57	0.73	0.64	0.64	0.95	0.89	0.80	0.27	0.64	0.63	0.03	0.55	1.00	0.44	0.24	0.68	0.32	0.65	0.88	0.79	0.74	0.51	0.46
5	1.00	0.80	0.71	0.67	1.00	0.89	0.89	0.92	0.24	0.39	1.00	0.35	0.08	0.59	0.58	0.56	0.53	0.71	0.61	0.69	1.00	0.55	1.00	0.79
6	0.82	0.92	0.99	0.77	0.83	0.72	1.00	0.70	1.00	0.16	0.71	0.13	0.38	0.00	1.00	1.00	0.55	0.71	0.70	0.85	0.83	0.94	0.57	0.92
7	0.87	1.00	1.00	0.68	0.89	1.00	0.81	1.00	0.64	1.00	0.15	0.14	0.45	0.36	0.11	0.68	1.00	0.94	1.00	0.70	0.47	1.00	0.70	0.88
8	0.90	0.78	0.85	0.66	0.74	0.87	0.96	0.94	0.42	0.30	0.45	0.25	0.50	0.84	0.56	0.52	0.67	0.64	0.69	0.83	0.89	0.82	0.71	0.78
9	0.90	0.78	0.85	0.66	0.74	0.87	0.96	0.94	0.42	0.30	0.45	0.25	0.50	0.84	0.56	0.52	0.67	0.64	0.69	0.83	0.89	0.82	0.71	0.78

	1987	1988	1989	1990
1	0.00	0.00	0.00	0.00
2	0.45	0.14	0.23	0.08
3	0.34	0.76	0.38	0.26
4	1.00	0.45	0.58	0.86
5	0.53	1.00	1.00	0.71
6	0.60	0.99	0.92	1.00
7	0.77	0.65	0.70	0.57
8	0.92	0.88	0.68	0.79
9	0.92	0.88	0.68	0.79

MEAN BIOMASS (MT)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	97711.553	211379.943	14552.475	2142.216	7371.414	223.209	465.063	2981.647	223.045	4734.173
2	23693.406	108931.989	190530.499	9573.086	2025.623	5758.798	234.785	827.631	2774.944	279.300
3	30569.037	20522.759	79447.600	107550.006	6247.684	2030.269	4127.602	285.445	457.586	2508.719
4	52681.447	22564.336	13937.206	45266.243	60533.460	4251.076	1804.695	4085.303	286.533	323.547
5	37105.722	33320.571	14499.163	8334.773	23351.153	40990.148	2733.510	1319.542	3243.204	247.346
6	15483.663	23665.715	19032.903	8291.042	4736.088	16176.197	25196.665	2181.534	790.422	2725.506
7	10227.782	9377.112	12046.787	9295.011	4086.837	2470.171	10384.633	17682.477	1485.362	299.472
8	6577.008	6508.838	4808.657	6533.089	5217.566	2163.863	1496.295	7646.748	12181.404	940.558
9	10121.589	9406.251	6937.832	4895.521	4584.766	4343.157	4559.926	5483.696	9161.510	18634.037
1+	284171.207	445677.515	355793.121	201880.987	118154.591	78406.888	51003.174	42494.023	30604.010	30692.659

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	9787.641	6849.707	4232.009	46653.124	6582.794	2890.581	40158.060	4988.475	2513.579	482.994
2	5263.676	10654.142	7111.421	5222.225	71010.038	9207.419	4452.272	42526.488	5689.461	4547.395
3	347.141	5519.598	9081.737	7286.435	5803.222	58527.249	8741.044	4190.588	24206.406	5507.045
4	1697.244	412.135	4479.730	6705.100	8079.135	6264.139	45549.112	7611.207	4141.117	18466.592
5	167.046	1321.419	313.832	3718.914	5847.195	6928.269	5325.745	26910.807	6262.990	3134.534
6	180.652	135.746	977.767	354.524	2793.604	4070.356	5006.461	3416.735	17572.002	4310.280
7	2313.276	131.196	106.927	898.659	382.997	1687.699	2552.153	3041.700	2167.836	11987.087
8	168.516	1942.861	95.944	85.097	680.660	241.338	1155.038	1245.035	1628.102	1174.366
9	5088.024	9885.290	2246.598	2507.071	2403.489	1626.456	706.256	710.128	1055.806	1249.107
1+	25013.217	36852.095	28645.966	73431.150	103583.134	91443.506	113646.142	94641.164	65237.297	50859.400

	1983	1984	1985	1986	1987	1988	1989	1990
1	852.212	4955.974	454.845	5811.785	377.936	6528.867	153.720	2652.206
2	1724.989	1903.447	10976.264	1035.979	7943.667	680.215	10771.576	224.652
3	4044.380	1512.113	1904.265	9021.308	1166.113	7748.250	745.395	12654.133
4	3866.628	3129.189	1423.659	1446.694	6956.745	918.550	5992.453	525.758
5	11924.950	2750.540	2138.894	1114.324	1114.855	3549.054	703.876	4071.877
6	2081.627	7338.058	2034.141	1256.324	685.975	679.076	2222.840	393.292
7	3115.762	1213.111	4302.408	1312.981	752.084	462.610	472.461	1343.776
8	7277.989	1939.542	763.860	2787.556	934.856	470.559	324.959	253.109
9	871.804	4262.315	1508.419	682.006	1342.956	875.872	556.603	353.501
1+	35760.342	29004.288	25506.756	24468.958	21275.186	21913.053	21943.881	22472.304

Summaries for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
2	186459.654	234297.572	341240.646	199738.771	110783.177	78183.678	50538.110	39512.376	30380.965	25958.485
3	162766.247	125365.583	150710.147	190165.686	108757.554	72424.880	50303.326	38684.745	27606.021	25679.185
4	132197.211	104842.823	71262.547	82615.679	102509.870	70394.611	46175.724	38399.300	27148.435	23170.466
5	79515.763	82278.487	57325.341	37349.436	41976.410	66143.536	44371.030	34313.997	26861.902	22846.919
6	42410.042	48957.916	42826.178	29014.663	18625.257	25153.388	41637.520	32994.455	23618.698	22599.573

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	15225.576	30002.387	24413.956	26778.025	97000.340	88552.925	73488.081	89652.688	62723.718	50376.406	34908.130
3	9961.900	19348.245	17302.536	21555.800	25990.302	79345.506	69035.809	47126.200	57034.258	45829.011	33183.141
4	9614.759	13828.647	8220.798	14269.365	20187.080	20818.257	60294.765	42935.612	32827.852	40321.966	29138.761
5	7917.515	13416.512	3741.068	7564.265	12107.946	14554.118	14745.653	35324.405	28686.734	21855.374	25272.133
6	7750.469	12095.093	3427.236	3845.352	6260.751	7625.849	9419.908	8413.598	22423.745	18720.840	13347.183

	1984	1985	1986	1987	1988	1989	1990
2	24048.314	25051.911	18657.173	20897.250	15384.186	21790.161	19820.098
3	22144.868	14075.647	17621.194	12953.583	14703.971	11018.586	19595.446
4	20632.755	12171.383	8599.886	11787.470	6955.721	10273.191	6941.313
5	17503.565	10747.723	7153.192	4830.725	6037.171	4280.738	6415.555
6	14753.025	8608.829	6038.868	3715.870	2488.117	3576.862	2343.677

CATCH BIOMASS (MT)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	1661.937	5060.939	5613.660	66.264	761.574	4.730	1.042	32.720	0.671	96.914	1542.601
2	3535.527	13274.999	87623.954	5047.536	117.910	2446.344	8.600	201.811	1430.761	2.064	2155.394
3	8809.905	5130.252	46351.748	91127.394	2771.318	750.276	1885.119	19.575	295.752	788.408	4.749
4	16506.419	6875.770	7305.712	24407.280	24592.789	2565.375	763.719	1106.906	70.000	166.934	830.245
5	13881.473	14431.114	7407.535	4758.106	14859.574	23045.933	1154.460	410.130	694.329	77.976	129.584
6	4773.023	11761.686	13491.809	5430.634	2504.385	7416.244	11961.857	514.324	702.561	351.739	99.771
7	3325.152	5049.891	8640.317	5376.954	2319.298	1566.316	3998.544	5998.242	841.426	242.273	264.281
8	2207.760	2737.459	2944.497	3679.305	2462.452	1199.782	678.955	2426.346	4590.090	228.338	58.331
9	3397.600	3956.040	4248.260	2757.060	2163.800	2408.120	2069.100	1740.000	3452.160	4523.760	1761.180
1+	58098.795	68278.149	183627.492	142650.534	52553.100	41403.121	22521.395	12450.054	12077.749	6478.407	6846.135

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	33.178	119.294	72.122	0.531	0.531	0.531	4.407	0.391	0.220	0.000	0.000
2	4619.908	1017.429	469.754	21094.703	717.463	26.046	29524.197	1525.721	1136.646	219.107	85.767
3	1202.078	3060.455	767.118	269.938	21762.310	2222.333	421.274	13789.418	2388.906	1120.815	394.399
4	4.649	832.702	1761.795	1482.578	624.272	14582.827	1695.832	1532.646	7074.545	1271.729	1342.133
5	198.928	8.819	577.005	1413.966	1590.626	1325.418	13266.878	2171.147	932.814	4990.939	879.513
6	7.540	123.947	0.003	1155.779	1663.207	1295.101	1691.676	7054.298	1582.669	726.193	3999.406
7	8.122	16.067	85.146	16.640	471.393	1202.022	1990.229	1241.752	3650.014	607.474	700.443
8	208.478	16.273	18.780	156.860	50.802	366.371	549.592	643.589	422.980	2709.157	919.171
9	1060.740	381.040	553.280	553.890	342.370	224.020	313.470	417.360	449.900	324.520	2019.960
1+	7343.620	5576.026	4305.002	26144.885	27222.975	21244.668	49457.557	28376.320	17638.694	11969.936	10340.792

	1985	1986	1987	1988	1989	1990
1	0.000	2.705	0.000	1.683	0.001	1.282
2	2394.581	50.886	1664.399	51.109	1127.908	11.669
3	770.931	3855.175	185.267	3222.016	127.857	2107.348
4	386.500	410.703	3256.521	226.421	1579.348	291.132
5	1146.058	376.488	276.092	1938.480	318.941	1856.960
6	624.368	493.612	193.212	368.957	927.993	253.354
7	1622.358	447.262	270.841	164.591	150.078	497.367
8	292.495	926.997	403.157	225.514	100.360	128.079
9	577.600	226.800	579.150	419.760	171.900	178.880
1+	7814.892	6790.627	6828.639	6618.532	4504.385	5326.072

Summaries for ages 2 9 3 9 4 9 5 9 6 9

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
2	56436.859	63217.210	178013.832	142584.270	51791.526	41398.391	22520.354	12417.334	12077.078	6381.493	5303.5[illegible]
3	52901.331	49942.211	90389.878	137536.733	51673.616	38952.047	22511.754	12215.523	10646.317	6379.429	3148.1[illegible]
4	44091.427	44811.959	44038.130	46409.339	48902.298	38201.771	20626.636	12195.948	10350.564	5591.020	3143.3[illegible]
5	27585.008	37936.189	36732.418	22002.059	24309.509	35636.396	19862.916	11089.042	10280.565	5424.086	2313.1[illegible]
6	13703.535	23505.075	29324.883	17243.953	9449.935	12590.463	18708.456	10678.912	9586.236	5346.110	2183.5[illegible]

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	7310.442	5456.731	4232.880	26144.354	27222.444	21244.137	49453.149	28375.930	17638.474	11969.935	10340.792
3	2690.535	4439.303	3763.127	5049.651	26504.981	21218.092	19928.953	26850.209	16501.828	11750.829	10255.025
4	1488.456	1378.848	2996.009	4779.713	4742.670	18995.759	19507.678	13060.791	14112.922	10630.014	9860.626
5	1483.808	546.146	1234.214	3297.134	4118.398	4412.932	17811.846	11528.145	7038.377	9358.284	8518.493
6	1284.880	537.327	657.209	1883.169	2527.772	3087.514	4544.968	9356.998	6105.563	4367.345	7638.980

	1985	1986	1987	1988	1989	1990
2	7814.892	6787.922	6828.638	6616.849	4504.385	5324.790
3	5420.311	6737.036	5164.239	6565.740	3376.476	5313.120
4	4649.380	2881.861	4978.973	3343.724	3248.620	3205.772
5	4262.880	2471.159	1722.452	3117.303	1669.272	2914.640
6	3116.822	2094.670	1446.360	1178.823	1350.330	1057.680

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

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	1674.230	60.518	164.333	755.250	66.311	1592.275
3	24229.829	15655.932	65963.719	91722.167	4931.957	1433.194	3115.895	184.952	410.730	1649.948	3140.322
4	56088.031	23008.840	14886.633	48130.659	60248.078	4292.292	1635.730	3437.704	265.921	303.568	2247.031
5	38626.227	36346.127	15693.878	8786.831	26337.264	41972.594	2729.430	1302.848	3209.331	235.950	1505.476
6	16462.907	25240.372	20957.204	8946.722	5062.038	15402.292	25996.678	2065.208	872.372	2665.163	33185.563
7	10877.979	10436.204	13800.134	10287.730	4573.931	2779.094	10817.945	17557.233	1588.473	354.104	1920.717
8	6532.898	7057.761	5445.157	6848.635	5608.039	2396.338	1524.754	7601.681	12660.441	960.128	272.517
9	11434.812	10810.557	8270.764	5783.240	5322.721	5122.341	5275.115	6171.735	10437.333	20646.108	15839.233
1+	164252.684	128555.793	145017.489	180505.985	112084.027	75072.373	51156.065	38485.694	30199.852	26881.279	2620.401

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	1592.275	3140.322	2247.031	1505.476	33185.563	1920.717	272.517	15839.233	2620.401	991.897	95.2[illegible]
3	271.492	4210.025	7614.008	6051.581	5104.715	55696.047	5907.066	4091.463	23431.982	3293.346	1481.2[illegible]
4	1786.875	357.895	4449.353	6752.231	7073.314	5651.176	44201.814	7222.892	3831.046	17107.740	3882.9[illegible]
5	188.577	1245.017	340.451	3685.121	5530.140	6750.871	5326.650	30266.187	6150.348	3087.298	12635.5[illegible]
6	182.658	115.533	1036.341	314.466	2918.722	4317.334	5246.489	3759.120	17969.750	4473.942	2230.0[illegible]
7	2302.710	125.889	112.580	860.372	349.790	1839.178	2721.389	3412.387	2236.745	12328.341	3148.7[illegible]
8	169.872	1951.953	104.635	86.849	722.440	284.722	1225.789	1480.556	1757.446	1290.624	8134.5[illegible]
9	5760.520	10632.787	2450.111	2764.677	2656.013	1789.645	794.852	819.519	1207.324	1418.262	992.2[illegible]
1+	12254.979	21779.420	18354.510	22020.772	57540.696	78249.689	65696.565	66891.357	59205.042	43991.450	32600.6[illegible]

	1984	1985	1986	1987	1988	1989	1990
1	390.394	73.540	1167.854	68.313	1223.934	31.006	646.066
2	531.958	5378.067	501.719	4954.639	370.477	6124.976	135.819
3	1005.319	1721.693	8592.185	997.802	6791.793	641.924	10444.564
4	3116.847	1295.794	1409.183	6655.063	939.707	5770.042	562.192
5	2824.794	2168.124	1107.642	1115.155	4117.957	709.864	4340.589
6	7859.834	2054.510	1338.773	756.059	765.913	2285.807	436.454
7	1359.567	4578.811	1423.379	826.624	493.837	462.425	1459.498
8	2199.102	777.224	2959.695	954.048	508.904	333.467	299.035
9	4950.251	1720.601	769.997	1546.721	1018.291	625.341	413.107
1+	24238.065	19768.364	19270.426	17874.424	16230.813	16984.851	18737.323

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) = 0.25 x M(a,y) + 0.25 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 Jan1 weight at age estimates (see "WT AT AGE" table in input section).
Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

MEAN STOCK NUMBERS (millions) - GBHAD

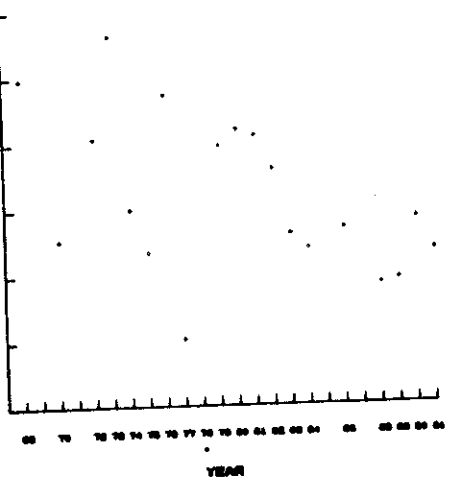
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	171423.777	422759.886	25090.474	3693.476	11168.808	378.321	894.352	4199.503	332.904	7635.764
2	27233.800	131243.360	276131.158	13113.816	2893.747	7109.627	301.006	651.678	2694.120	271.165
3	25905.963	18323.892	77133.592	120842.704	6576.509	1933.589	3752.365	233.971	349.302	1441.792
4	35837.719	15779.256	10323.856	35925.590	51299.542	3220.512	1067.867	2116.738	164.674	158.602
5	22086.739	20317.421	8682.134	4902.807	16444.474	26108.374	1562.006	602.531	1356.989	102.209
6	7201.704	11773.988	9564.273	4005.334	2310.287	7702.951	12661.641	912.776	281.289	933.393
7	4352.248	3907.130	5330.437	4076.759	1769.193	1064.729	4120.886	6853.673	508.686	97.867
8	2163.490	2465.469	1807.766	2276.337	1961.491	825.902	500.433	2367.414	3929.485	273.418
9	3265.029	3167.088	2230.814	1539.472	1478.957	1518.586	1256.178	1462.319	2462.772	5091.267
1+	299470.469	629737.491	416294.502	190376.296	95903.009	49862.592	26116.734	19400.602	12080.221	16005.476

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	16312.735	9513.482	6825.821	93306.248	12420.367	5453.926	75769.925	9069.955	6445.075	2195.429
2	5110.365	10051.077	7256.552	5274.975	66364.521	9795.127	4452.272	45240.945	6539.610	4688.037
3	219.709	3032.746	5571.618	5242.040	4030.015	39018.166	6828.941	3463.296	19521.295	3797.962
4	796.828	177.644	2027.027	3369.397	3723.104	3070.656	22549.065	4399.542	2262.906	9822.655
5	69.314	466.933	142.651	1398.088	2141.830	2483.250	2121.811	12401.294	2723.039	1322.588
6	54.909	36.103	332.574	115.105	870.282	1275.974	1594.414	1211.608	6460.295	1561.696
7	676.397	32.394	26.732	243.539	92.289	500.801	675.173	844.917	584.322	3699.718
8	43.657	495.628	23.690	18.222	170.165	66.853	304.759	349.729	402.995	296.557
9	1291.377	2320.491	518.845	507.504	481.661	318.289	145.022	183.496	237.794	305.405
1+	24575.291	26126.498	22725.509	109475.118	90294.233	61983.042	114441.382	77164.781	45177.331	27690.047

	1983	1984	1985	1986	1987	1988	1989	1990
1	2582.460	15018.104	1378.318	12915.079	878.920	15544.921	290.037	4144.072
2	1691.166	2068.964	11087.135	1102.106	9570.683	694.097	12102.894	231.600
3	2952.102	1145.540	1369.975	6633.315	815.463	5782.276	503.645	8667.215
4	2112.911	1709.939	719.020	790.543	3478.373	546.756	3347.739	292.088
5	5395.905	1250.245	869.469	435.283	495.491	1722.842	318.496	1929.800
6	785.520	2748.336	747.846	443.931	260.827	277.174	864.918	152.439
7	958.696	409.835	1406.016	443.575	249.034	155.761	145.821	476.516
8	2166.068	568.781	205.339	805.652	247.972	134.831	91.281	79.845
9	204.169	1145.784	396.952	180.425	313.043	221.180	145.708	84.976
1+	18848.999	26065.528	18180.070	23749.907	16309.807	25079.837	17810.539	16058.550

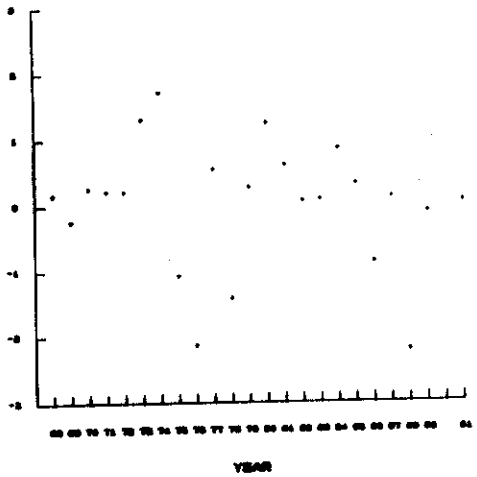
STANDARDIZED RESIDUALS

GBHAD INDEX 1 RV SPR 1 Run 188



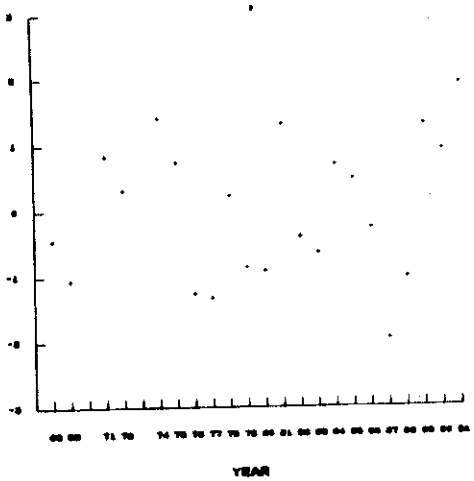
STANDARDIZED RESIDUALS

GBHAD INDEX 2 RV SPR 2 Run 188



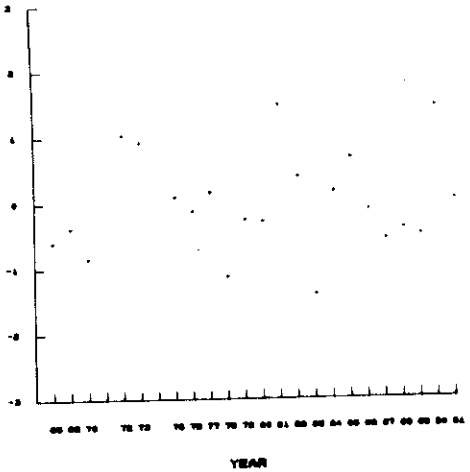
STANDARDIZED RESIDUALS

GBHAD INDEX 3 RV SPR 3 Run 188



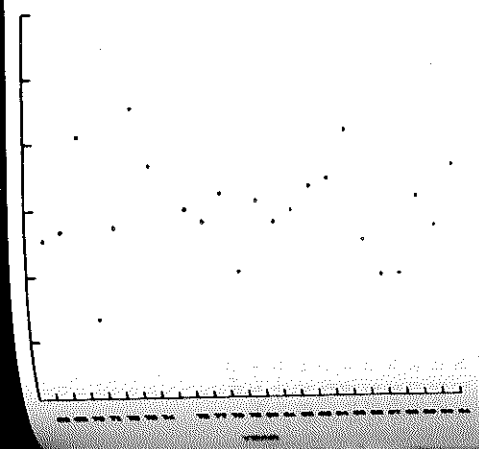
STANDARDIZED RESIDUALS

GBHAD INDEX 4 RV SPR 4 Run 188



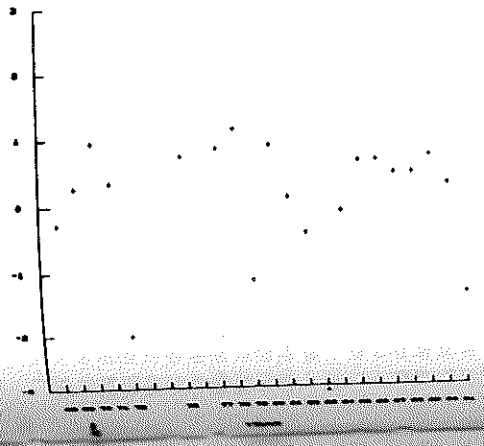
STANDARDIZED RESIDUALS

GBHAD INDEX 5 RV SPR 5 Run 188



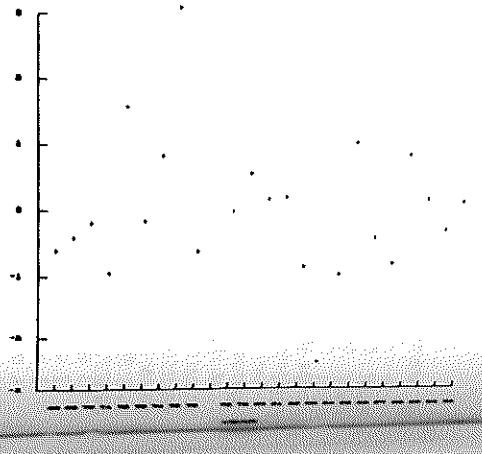
STANDARDIZED RESIDUALS

GBHAD INDEX 6 RV SPR 6 Run 188



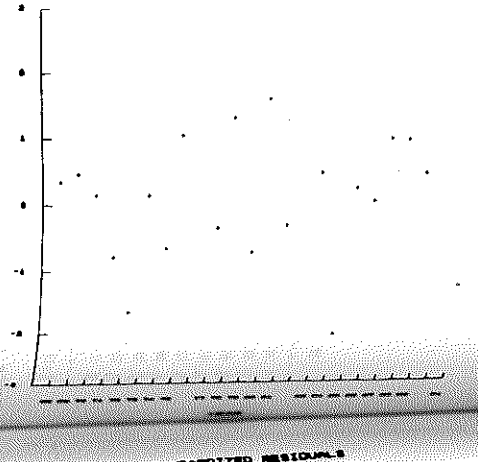
STANDARDIZED RESIDUALS

GBHAD INDEX 7 RV SPR 7 Run 188



STANDARDIZED RESIDUALS

GBHAD INDEX 8 RV SPR 8 Run 188



STANDARDIZED RESIDUALS

STANDARDIZED RESIDUALS

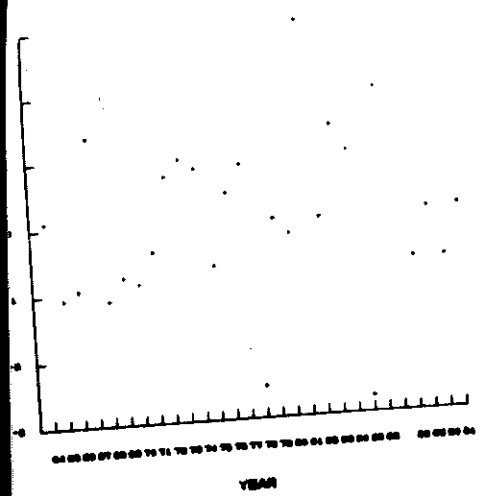
INDEX 11 RV FAL 3 Run 188

STANDARDIZED RESIDUALS

GBHAD INDEX 12 RV FAL 4 Run 188

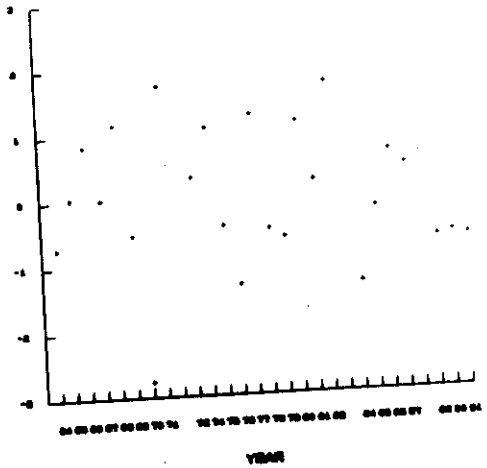
STANDARDIZED RESIDUALS

GSHAD INDEX 8 RV FAL 1 Run 188



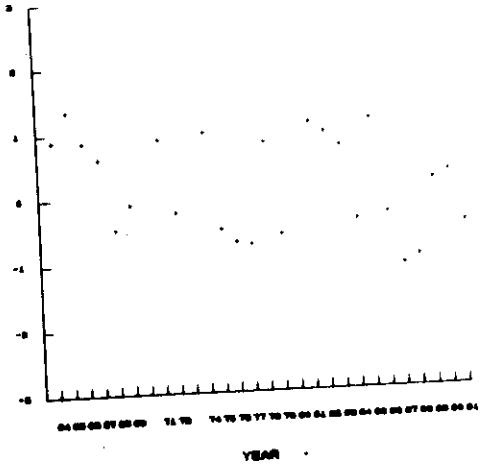
STANDARDIZED RESIDUALS

GSHAD INDEX 10 RV FAL 2 Run 188



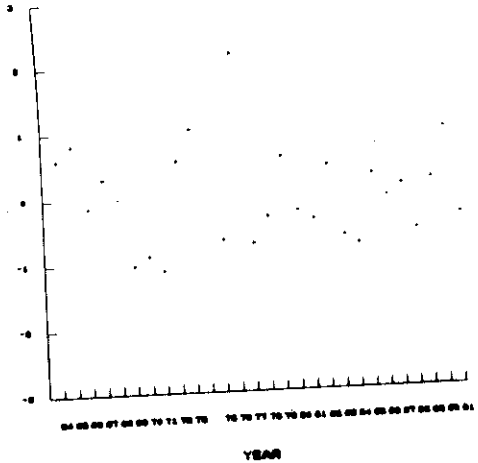
STANDARDIZED RESIDUALS

GSHAD INDEX 11 RV FAL 3 Run 188



STANDARDIZED RESIDUALS

GSHAD INDEX 12 RV FAL 4 Run 188



STANDARDIZED RESIDUALS

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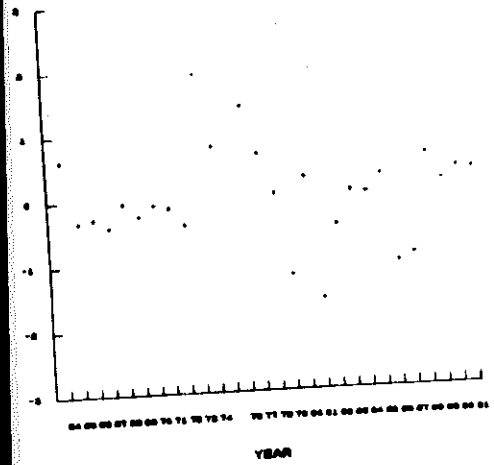
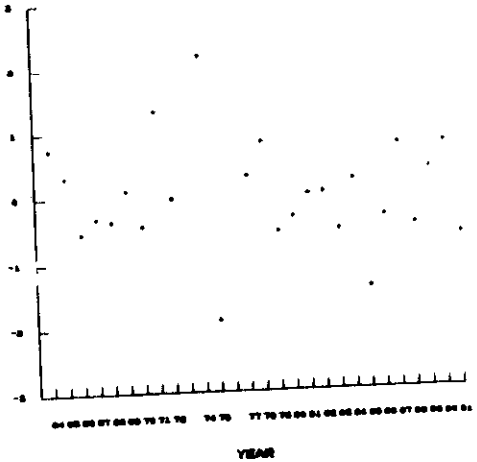


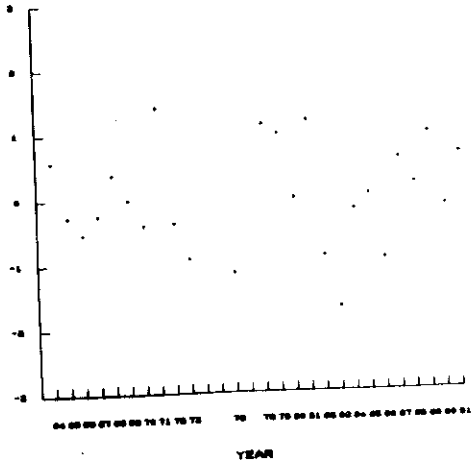
STANDARDIZED RESIDUALS

GSHAD INDEX 14 RV FAL 6 Run 188



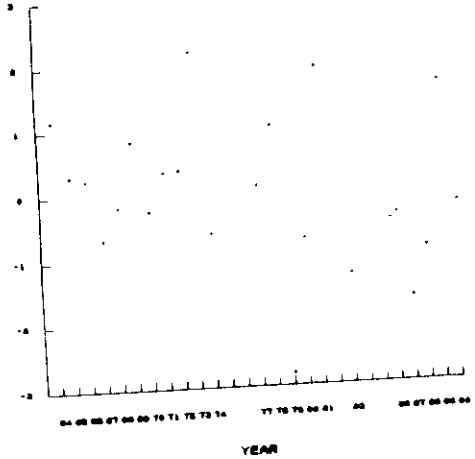
STANDARDIZED RESIDUALS

GSHAD INDEX 15 RV FAL 7 Run 188



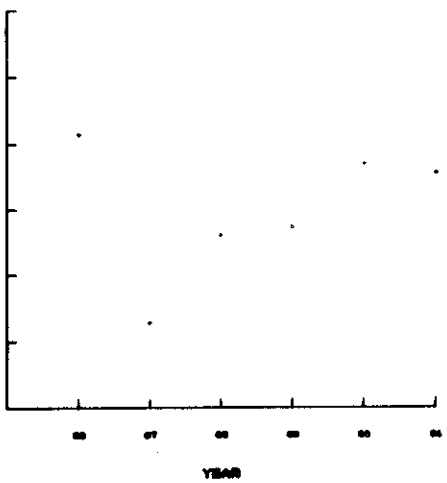
STANDARDIZED RESIDUALS

GSHAD INDEX 16 RV FAL 8 Run 188



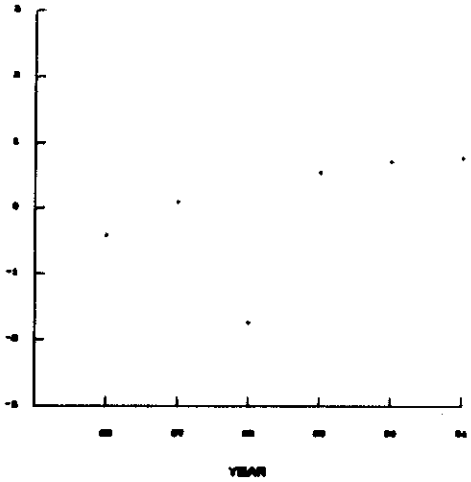
STANDARDIZED RESIDUALS

GBHAD INDEX 18 CANADA 1 Run 188



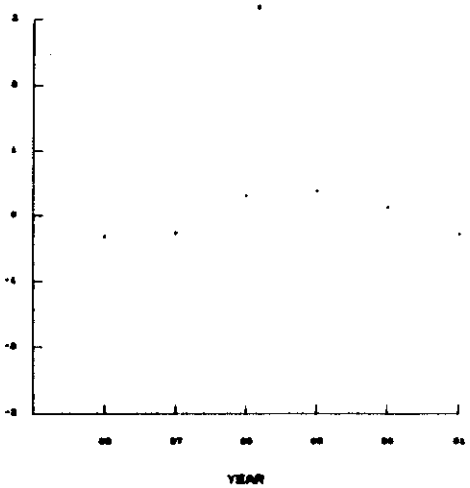
STANDARDIZED RESIDUALS

GBHAD INDEX 19 CANADA 2 Run 188



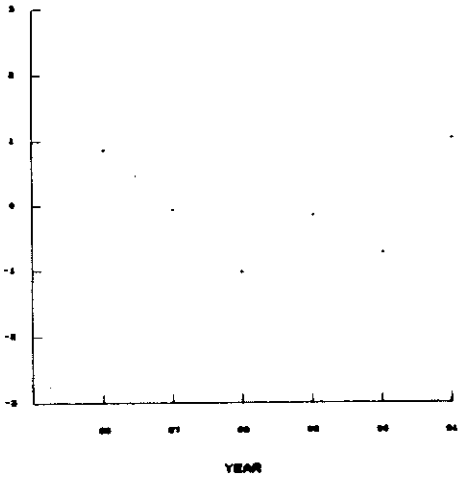
STANDARDIZED RESIDUALS

GBHAD INDEX 20 CANADA 3 Run 188



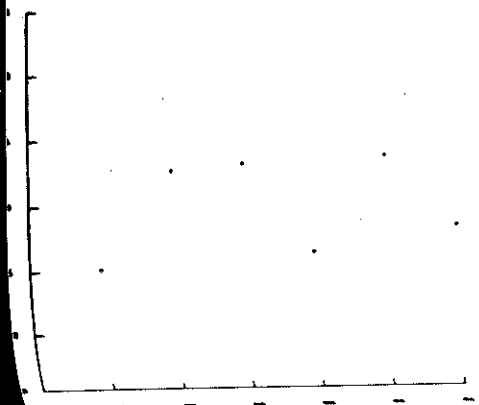
STANDARDIZED RESIDUALS

GBHAD INDEX 21 CANADA 4 Run 188



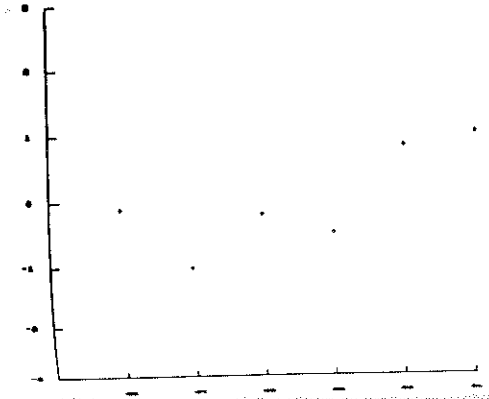
STANDARDIZED RESIDUALS

GBHAD INDEX 22 CANADA 5 Run 188



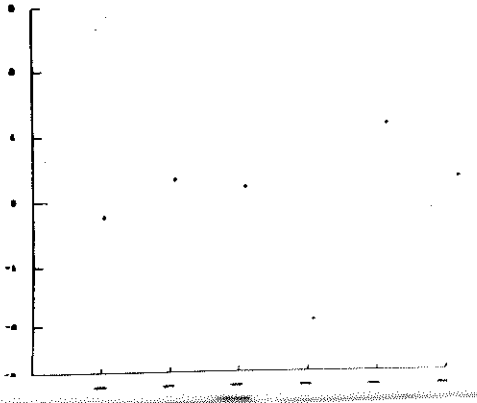
STANDARDIZED RESIDUALS

GBHAD INDEX 23 CANADA 6 Run 188



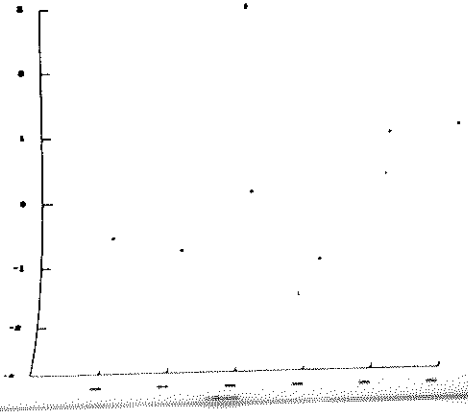
STANDARDIZED RESIDUALS

GBHAD INDEX 24 CANADA 7 Run 188



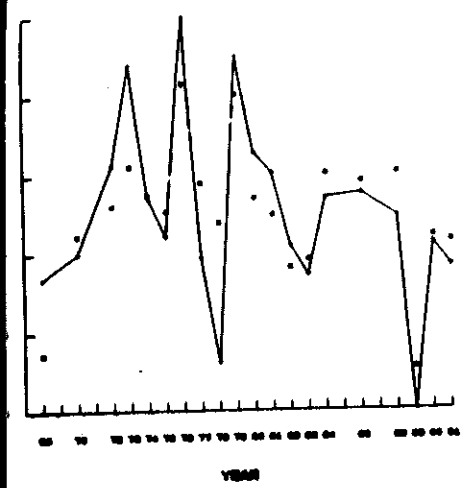
STANDARDIZED RESIDUALS

GBHAD INDEX 25 CANADA 8 Run 188



OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 1 RU SPR 1 Run 100



OBS (+) & PRED (*) INDEX OF ABUNDANCE

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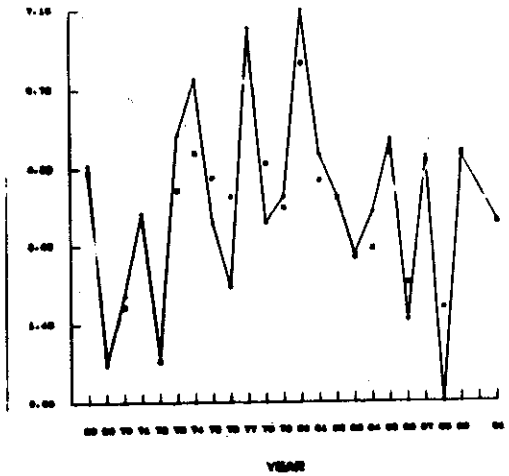

OBS (+) & PRED (*) INDEX OF ABUNDANCE

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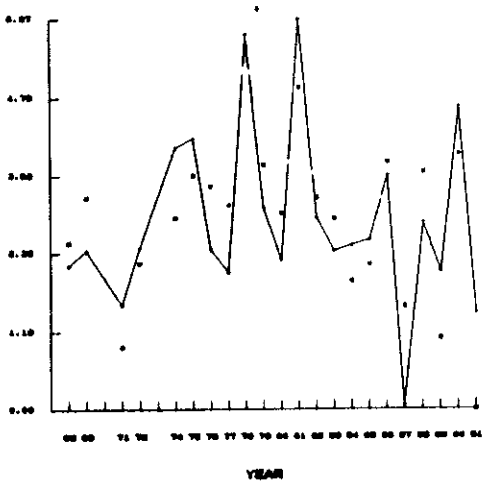

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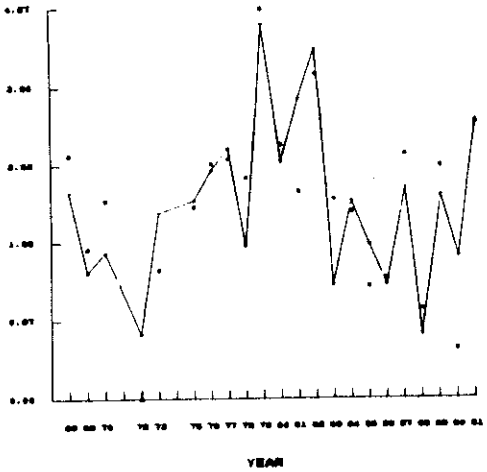
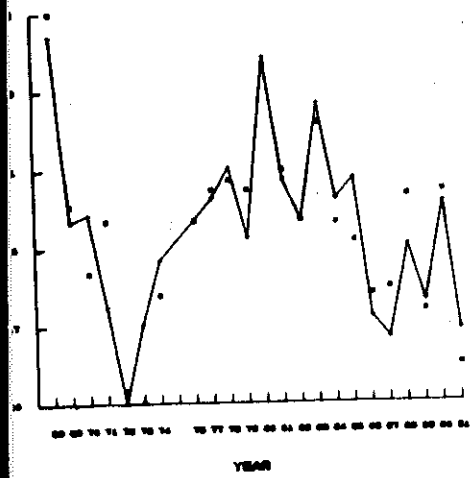


OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 5 RU SPR 5 Run 100



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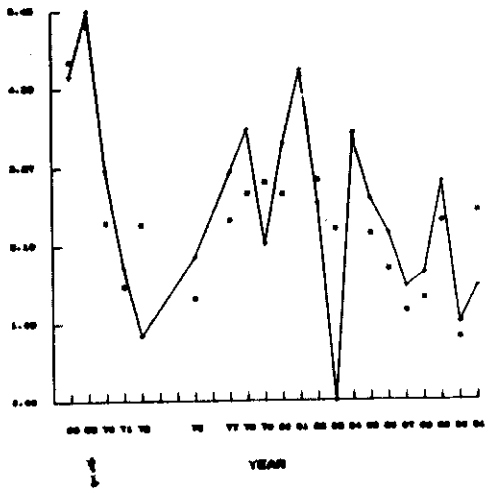
GBHAD INDEX 6 RU SPR 6 Run 100



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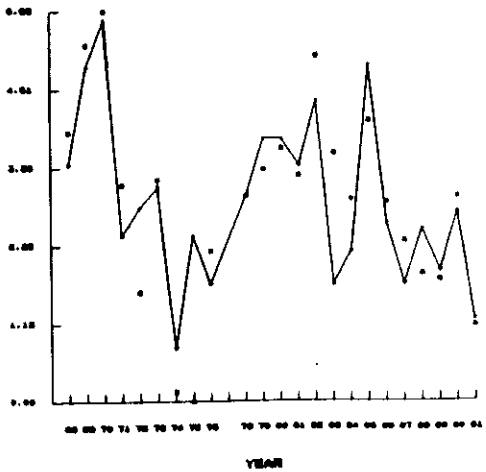

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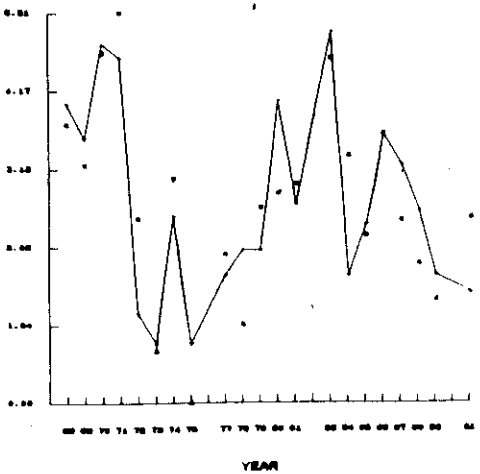
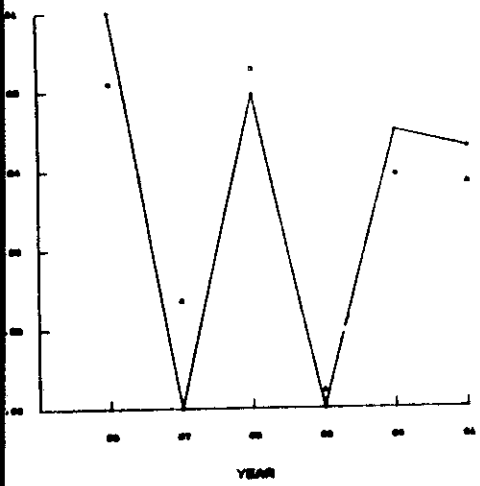


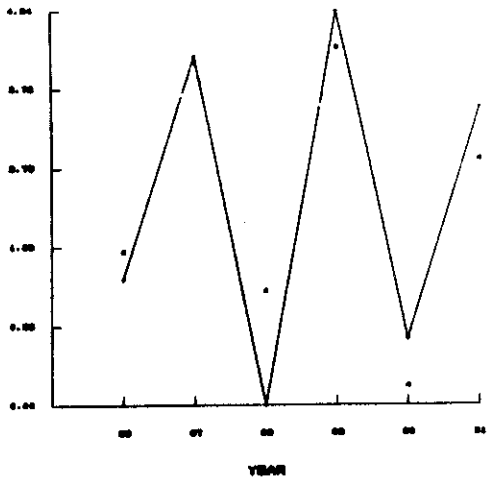
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 18 CANADA 1 Run 106



OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 19 CANADA 2 Run 106



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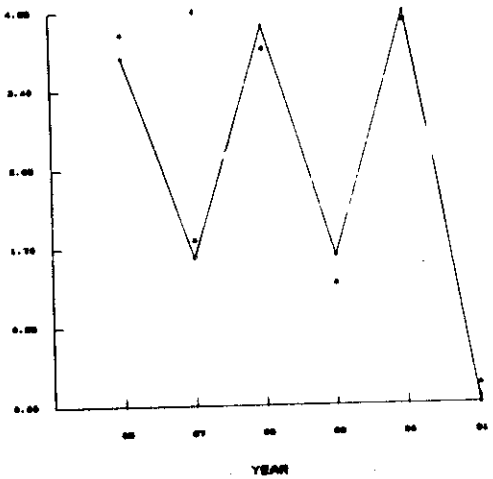

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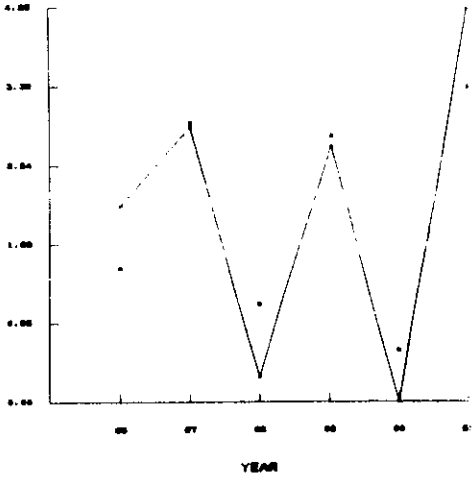
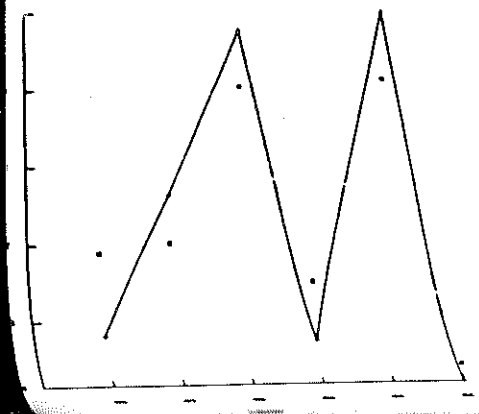
GBHAD INDEX 21 CANADA 4 Run 106



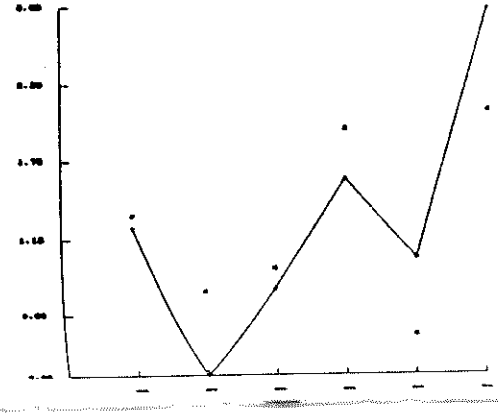
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 22 CANADA 5 Run 106



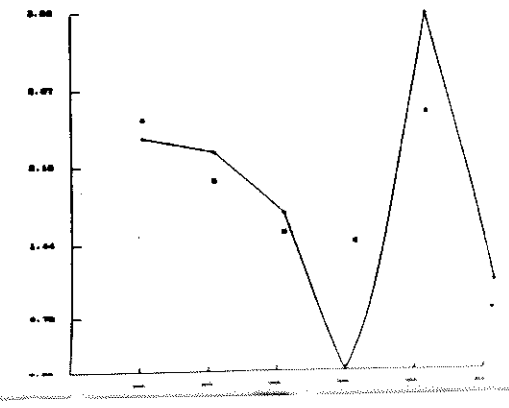
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 23 CANADA 6 Run 106



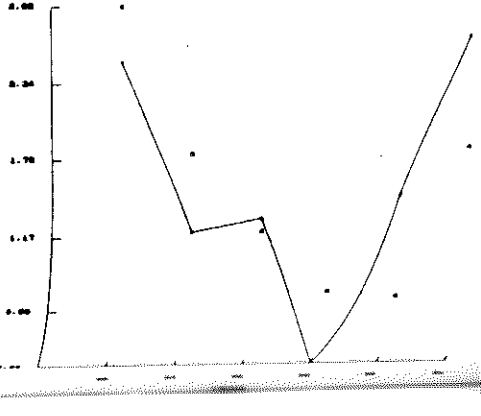
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 24 CANADA 7 Run 106



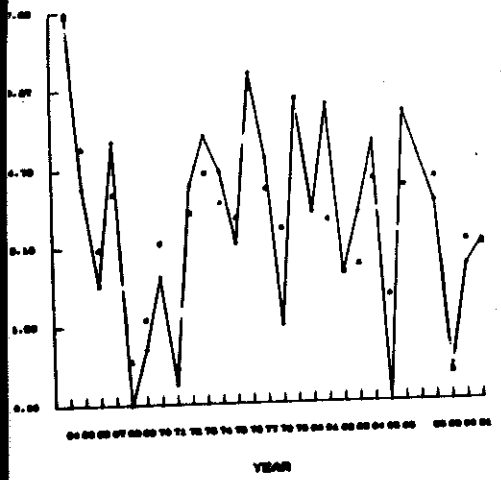
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 25 CANADA 8 Run 106



OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 9 RV FAL 1 Run 186



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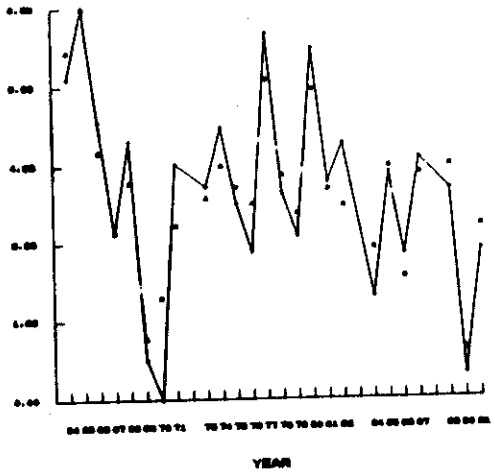
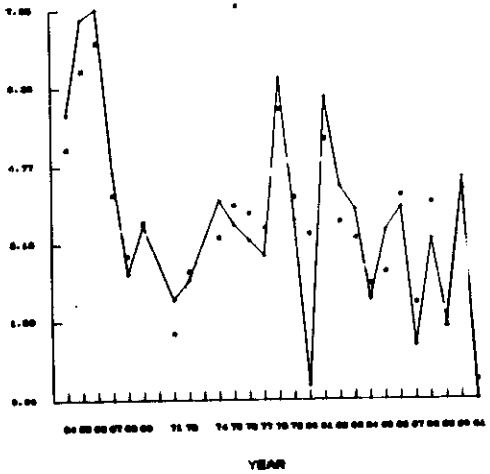


OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 11 RV FAL 3 Run 186



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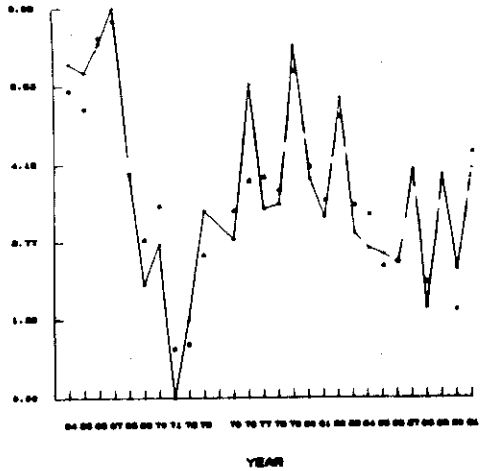
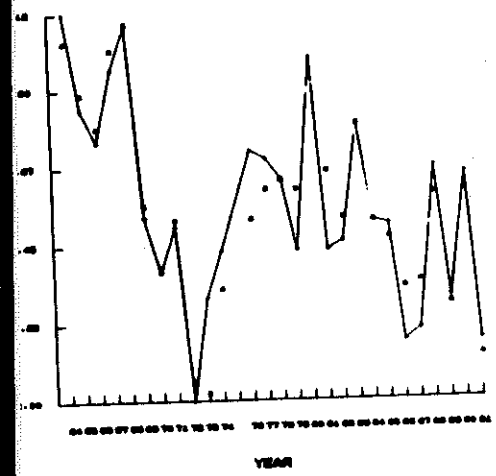


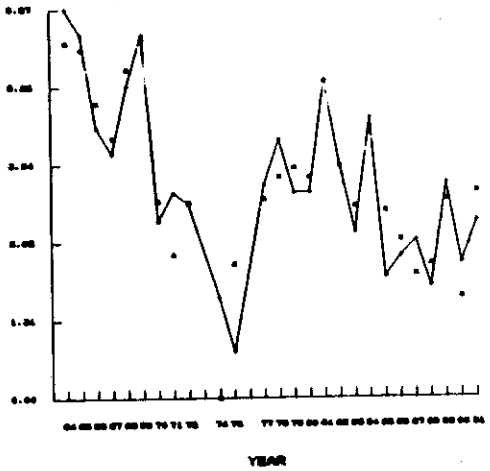
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 13 RV FAL 5 Run 186



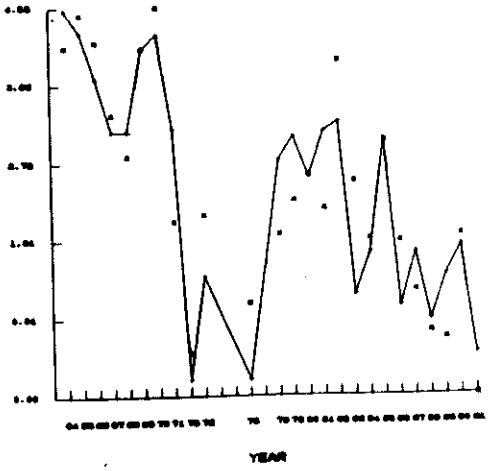
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 14 RV FAL 6 Run 186



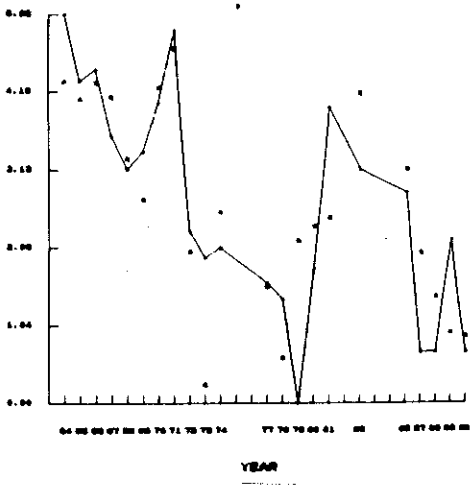
OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 15 RV FAL 7 Run 186



OBS (+) & PRED (*) INDEX OF ABUNDANCE

GBHAD INDEX 16 RV FAL 8 Run 186



Appendix E. Brief status of Gulf of Maine haddock resources.

Table E1. Landings (mt live weight) of haddock from the Gulf of Maine (Division 5Y).

Year	USA	Canada	Other	Total
1956	7278	29	0	7307
1957	6141	25	0	6166
1958	7082	285	0	7367
1959	4497	163	0	4660
1960	4541	383	0	4924
1961	5297	112	0	5409
1962	5003	107	0	5110
1963	4742	3	44	4789
1964	5383	70	0	5453
1965	4204	159	0	4363
1966	4579	1125	0	5704
1967	4907	589	0	5496
1968	3437	120	0	3557
1969	2423	59	231	2713
1970	1457	38	67	1562
1971	1194	85	27	1306
1972	909	23	4	936
1973	509	49	0	558
1974	622	198	9	829
1975	1180	79	4	1263
1976	1865	91	0	1956
1977	3296	26	0	3322
1978	4538	641	0	5179
1979	4622	257	0	4879
1980	7270	203	0	7473
1981	5987	513	0	6500
1982	5694	1278	0	6972
1983	5593	2003	0	7596
1984	2792	1245	0	4037
1985	2234	791	0	3025
1986	1589	225	0	1814
1987	828	90	0	918
1988	414	0	0	414
1989	263	0	0	263
1990	433	0	0	433

Note: Landings 1956-1979 from Clark et al (1982). Landings 1980-1990 from NAFO and NEFSC data files

Table E2. Stratified mean catch per tow in numbers for haddock in NEFC offshore spring research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-28, 36-40), 1968-1990.

Unadjusted for changes in gear usage

	Age group											
Year	0	1	2	3	4	5	6	7	8	9+	Total	Total 1+
1968	0.00	0.00	0.00	0.00	0.31	2.97	0.64	0.05	0.00	0.13	4.10	4.10
1969	0.00	0.00	0.00	0.05	0.01	0.13	1.82	0.47	0.00	0.05	2.53	2.53
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.41	0.06	0.04	0.61	0.61
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.43	0.12	0.59	0.59
1972	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.57	0.57
1973	0.00	0.09	0.53	0.00	0.04	0.00	0.00	0.00	0.00	0.23	0.89	0.89
1974	0.00	0.59	0.06	0.22	0.00	0.00	0.00	0.00	0.00	0.09	0.96	0.96
1975	0.00	0.03	1.31	0.10	0.25	0.00	0.01	0.00	0.00	0.16	1.86	1.86
1976	0.00	3.46	0.07	1.21	0.12	0.61	0.00	0.02	0.00	0.10	5.59	5.59
1977	0.00	0.60	2.39	0.02	0.90	0.27	0.39	0.00	0.00	0.00	4.57	4.57
1978	0.00	0.06	0.47	0.22	0.05	0.09	0.03	0.00	0.00	0.00	0.92	0.92
1979	0.00	0.25	0.00	1.10	0.78	0.06	0.11	0.04	0.00	0.00	2.34	2.34
1980	0.00	0.86	0.12	0.14	0.36	0.28	0.05	0.00	0.00	0.00	1.81	1.81
1981	0.00	0.88	0.98	0.50	0.00	0.18	0.22	0.00	0.00	0.18	2.94	2.94
1982	0.00	0.04	0.35	0.75	0.35	0.13	0.04	0.01	0.00	0.00	1.67	1.67
1983	0.00	1.00	0.06	0.86	0.21	0.21	0.00	0.08	0.00	0.06	2.48	2.48
1984	0.00	0.01	0.35	0.08	0.19	0.08	0.00	0.00	0.03	0.00	0.74	0.74
1985	0.00	0.01	0.31	1.09	0.06	0.17	0.06	0.05	0.02	0.00	1.77	1.77
1986	0.00	0.05	0.00	0.14	0.39	0.00	0.04	0.07	0.02	0.00	0.71	0.71
1987	0.00	0.04	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.10	0.10
1988	0.00	0.04	0.00	0.00	0.01	0.12	0.01	0.00	0.00	0.00	0.18	0.18
1989	0.00	0.00	0.04	0.04	0.00	0.01	0.01	0.01	0.00	0.00	0.11	0.11
1990	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03

Adjusted for changes in gear usage

	Age group											
Year	0	1	2	3	4	5	6	7	8	9+	Total	Total 1+
1968	0.00	0.00	0.00	0.00	0.51	4.85	1.05	0.08	0.00	0.21	6.70	6.70
1969	0.00	0.00	0.00	0.08	0.02	0.21	2.97	0.77	0.00	0.08	4.13	4.13
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.67	0.10	0.07	1.00	1.00
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.70	0.20	0.96	0.96
1972	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.93	0.93
1973	0.00	0.15	0.87	0.00	0.07	0.00	0.00	0.00	0.00	0.38	1.45	1.45
1974	0.00	0.96	0.10	0.36	0.00	0.00	0.00	0.00	0.00	0.15	1.57	1.57
1975	0.00	0.05	2.14	0.16	0.41	0.00	0.02	0.00	0.00	0.26	3.04	3.04
1976	0.00	5.65	0.11	1.98	0.20	1.00	0.00	0.03	0.00	0.16	9.13	9.13
1977	0.00	0.98	3.90	0.03	1.47	0.44	0.64	0.00	0.00	0.00	7.46	7.46
1978	0.00	0.10	0.77	0.36	0.08	0.15	0.05	0.00	0.00	0.00	1.50	1.50
1979	0.00	0.35	0.00	1.53	1.08	0.08	0.15	0.06	0.00	0.00	3.25	3.25
1980	0.00	1.20	0.17	0.19	0.50	0.39	0.07	0.00	0.00	0.00	2.52	2.52
1981	0.00	1.22	1.36	0.70	0.00	0.25	0.31	0.00	0.00	0.25	4.09	4.09
1982	0.00	0.06	0.49	1.04	0.49	0.18	0.06	0.01	0.00	0.00	2.32	2.32
1983	0.00	1.63	0.10	1.40	0.34	0.34	0.00	0.13	0.00	0.10	4.05	4.05
1984	0.00	0.02	0.57	0.13	0.31	0.13	0.00	0.00	0.05	0.00	1.21	1.21
1985	0.00	0.01	0.31	1.09	0.06	0.17	0.06	0.05	0.02	0.00	1.77	1.77
1986	0.00	0.05	0.00	0.14	0.39	0.00	0.04	0.07	0.02	0.00	0.71	0.71
1987	0.00	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.09	0.09
1988	0.00	0.04	0.00	0.00	0.01	0.12	0.01	0.00	0.00	0.00	0.18	0.18
1989	0.00	0.00	0.03	0.03	0.00	0.01	0.01	0.01	0.00	0.00	0.09	0.09
1990	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03

Table E3. Stratified mean catch per tow in numbers for haddock in NEFC offshore autumn research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-28, 36-40), 1963-1990.

Unadjusted for changes in gear usage

Year	Age group 0	1	2	3	4	5	6	7	8	9+	Total
1963	23.89	8.18	1.14	2.02	4.66	3.31	1.12	0.88	0.70	0.78	46.68
1964	0.02	3.34	1.52	0.48	0.82	1.62	0.96	0.32	0.22	0.21	9.51
1965	0.00	0.29	5.39	3.40	0.17	0.98	0.77	0.44	0.21	0.05	11.70
1966	0.00	0.01	0.38	4.88	1.60	0.17	0.42	0.28	0.05	0.02	7.81
1967	0.00	0.00	0.00	0.88	5.52	1.21	0.33	0.09	0.11	0.03	8.17
1968	0.00	0.00	0.00	0.00	0.13	4.19	0.95	0.17	0.20	0.09	5.73
1969	0.00	0.00	0.00	0.02	0.02	0.02	2.78	0.57	0.09	0.15	3.65
1970	0.00	0.03	0.00	0.00	0.00	0.03	0.06	1.38	0.41	0.06	1.97
1971	0.18	0.00	0.04	0.00	0.03	0.00	0.07	0.12	1.31	0.19	1.94
1972	0.00	0.80	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.52	1.34
1973	0.74	0.02	0.64	0.00	0.22	0.02	0.02	0.03	0.01	1.09	2.79
1974	0.01	1.13	0.12	0.30	0.00	0.00	0.00	0.00	0.02	0.21	1.79
1975	0.59	0.14	1.29	0.37	0.93	0.00	0.03	0.03	0.00	0.31	3.69
1976	1.10	1.20	0.05	0.86	0.11	0.55	0.00	0.13	0.00	0.06	4.06
1977	0.03	2.74	2.65	0.10	0.85	0.13	0.21	0.00	0.00	0.07	6.78
1978	0.13	0.01	1.65	3.78	0.38	0.93	0.78	0.12	0.01	0.19	7.98
1979	0.59	0.30	0.01	0.79	1.97	0.41	0.30	0.09	0.05	0.02	4.53
1980	3.24	0.42	0.26	0.00	0.24	0.88	0.55	0.11	0.08	0.08	5.86
1981	0.02	0.28	0.40	0.60	0.28	0.55	0.72	0.00	0.13	0.05	3.03
1982	0.25	0.03	0.42	0.51	0.34	0.02	0.03	0.15	0.00	0.00	1.75
1983	0.00	0.37	0.04	0.41	0.35	0.26	0.11	0.05	0.12	0.04	1.75
1984	0.00	0.14	0.35	0.01	0.17	0.00	0.34	0.00	0.00	0.14	1.15
1985	0.00	0.09	0.47	2.73	0.02	0.18	0.15	0.39	0.00	0.05	4.08
1986	0.00	0.01	0.00	0.07	0.30	0.14	0.02	0.03	0.06	0.00	0.63
1987	0.02	0.00	0.13	0.13	0.17	0.06	0.25	0.16	0.00	0.10	1.02
1988	0.00	0.00	0.00	0.04	0.02	0.08	0.00	0.04	0.14	0.00	0.32
1989	0.00	0.07	0.07	0.02	0.01	0.04	0.06	0.06	0.00	0.00	0.33
1990	0.01	0.03	0.00	0.09	0.00	0.00	0.00	0.02	0.02	0.00	0.17

Adjusted for changes in gear usage

Year	Age group 0	1	2	3	4	5	6	7	8	9+	Total
1963	30.01	13.36	1.86	3.30	7.61	5.41	1.83	1.44	1.14	1.27	67.23
1964	0.03	5.45	2.48	0.78	1.34	2.65	1.57	0.52	0.36	0.34	15.53
1965	0.00	0.47	8.80	5.55	0.28	1.60	1.26	0.72	0.34	0.08	19.11
1966	0.00	0.02	0.62	7.97	2.61	0.28	0.69	0.46	0.08	0.03	12.75
1967	0.00	0.00	0.00	1.44	9.01	1.98	0.54	0.15	0.18	0.05	13.34
1968	0.00	0.00	0.00	0.00	0.21	6.84	1.55	0.28	0.33	0.15	9.36
1969	0.00	0.00	0.00	0.03	0.03	0.03	4.54	0.93	0.15	0.24	5.96
1970	0.00	0.05	0.00	0.00	0.00	0.05	0.10	2.25	0.67	0.10	3.22
1971	0.29	0.00	0.07	0.00	0.05	0.00	0.11	0.20	2.14	0.31	3.16
1972	0.00	1.31	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.85	2.19
1973	1.21	0.03	1.05	0.00	0.36	0.03	0.03	0.05	0.02	1.78	4.56
1974	0.02	1.85	0.20	0.49	0.00	0.00	0.00	0.00	0.03	0.34	2.93
1975	0.96	0.23	2.11	0.60	1.52	0.00	0.05	0.05	0.00	0.51	6.02
1976	1.80	1.96	0.08	1.40	0.18	0.90	0.00	0.21	0.00	0.10	6.63
1977	0.04	3.81	3.69	0.14	1.18	0.18	0.29	0.00	0.00	0.10	9.43
1978	0.18	0.01	2.30	5.26	0.53	1.29	1.08	0.17	0.01	0.26	11.10
1979	0.96	0.49	0.02	1.29	3.22	0.67	0.49	0.15	0.08	0.03	7.39
1980	4.51	0.58	0.36	0.00	0.33	1.22	0.77	0.15	0.11	0.11	8.15
1981	0.03	0.46	0.65	0.98	0.46	0.90	1.18	0.00	0.21	0.08	4.95
1982	0.41	0.05	0.69	0.83	0.56	0.03	0.05	0.24	0.00	0.00	2.86
1983	0.00	0.60	0.07	0.67	0.57	0.42	0.18	0.08	0.20	0.07	2.86
1984	0.00	0.23	0.57	0.02	0.28	0.00	0.56	0.00	0.00	0.23	1.88
1985	0.00	0.09	0.47	2.73	0.02	0.18	0.15	0.39	0.00	0.05	4.08
1986	0.00	0.01	0.00	0.07	0.30	0.14	0.02	0.03	0.06	0.00	0.63
1987	0.02	0.00	0.13	0.13	0.17	0.06	0.25	0.16	0.00	0.10	1.02
1988	0.00	0.00	0.00	0.04	0.02	0.08	0.00	0.04	0.14	0.00	0.32
1989	0.00	0.06	0.06	0.02	0.01	0.03	0.05	0.05	0.00	0.00	0.28
1990	0.00	0.03	0.00	0.08	0.00	0.00	0.00	0.02	0.02	0.00	0.14

Table E4. Estimate of Z for Gulf of Maine haddock based on NEFSC spring research vessel bottom trawl surveys.

Year	Stratified mean catch per tow 3+	Stratified mean catch per tow 4+	Z	3 year running average
1968	6.70	6.70	0.50	0.630
1969	4.13	4.05	1.42	0.813
1970	1.00	1.00	0.04	0.196
1971	0.96	0.96	1.20	0.073
1972	0.29	0.29	-0.44	-0.763
1973	0.45	0.45	1.10	-0.971
1974	0.51	0.15	-0.30	-0.037
1975	0.85	0.69	-0.49	0.196
1976	3.37	1.39	0.28	0.245
1977	2.58	2.55	2.22	0.582
1978	0.64	0.28	-0.76	0.190
1979	2.90	1.37	1.11	0.486
1980	1.15	0.96	0.35	0.409
1981	1.51	0.81	0.71	0.806
1982	1.78	0.74	0.67	0.726
1983	2.31	0.91	1.55	1.155
1984	0.62	0.49	0.54	0.975
1985	1.45	0.36	1.03	1.117
1986	0.66	0.52	4.19	1.528
1987	0.03	0.01	-1.54	0.302
1988	0.14	0.14	1.54	1.897
1989	0.06	0.03	-	-
1990	0.00	0.00	-	-

Table E5. Estimate of Z for Gulf of Maine haddock based on NEFSC autumn research vessel bottom trawl surveys.

Year	Stratified mean catch per tow 3+	Stratified mean catch per tow 4+	Z	3 year running average
1963	22.00	18.70	1.18	0.373
1964	7.56	6.78	0.57	-0.006
1965	9.83	4.28	0.86	0.119
1966	12.12	4.15	0.02	0.137
1967	13.35	11.91	0.36	0.299
1968	9.36	9.36	0.46	0.371
1969	5.95	5.92	0.63	0.271
1970	3.17	3.17	0.12	0.085
1971	2.81	2.81	1.20	0.059
1972	0.88	0.85	-0.95	-0.429
1973	2.27	2.27	1.81	0.038
1974	0.86	0.37	-0.91	-0.300
1975	2.73	2.13	0.67	-0.406
1976	2.79	1.39	0.47	0.067
1977	1.89	1.75	-0.57	0.196
1978	8.60	3.34	0.62	0.445
1979	5.93	4.64	0.79	0.451
1980	2.69	2.69	-0.05	0.265
1981	3.81	2.83	1.47	0.593
1982	1.71	0.88	0.12	0.239
1983	2.19	1.52	0.72	0.770
1984	1.09	1.07	0.32	0.813
1985	3.52	0.79	1.86	1.099
1986	0.62	0.55	-0.18	0.417
1987	0.87	0.74	1.29	1.130
1988	0.27	0.24	0.66	1.117
1989	0.16	0.14	1.39	1.946
1990	0.12	0.04	-	-

BEGIN MARQUARDT ALGORITHM

LAMBDA 1.00000E-2
RSS 4.25023E3
NPHI 4.25023E3

par

3.80000E3	3.60000E3	2.00000E2	7.50000E3	2.00000E2	1.30000E3	1.00000E2	3.00000E2	1.
00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1
.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	
1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	1.00000E-5	

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LAMBDA 1.00000E-5
RSS 2.39569E2
NPHI 2.39569E2

par

4.14924E3	3.74253E3	2.03649E2	7.17562E3	1.95708E2	1.36551E3	9.70427E1	3.53517E2	2.
36766E-5	4.74324E-5	9.69715E-5	2.24487E-4	2.72644E-4	3.21904E-4	8.16426E-4	1.11452E-3	2
.43397E-5	2.34466E-5	2.61462E-5	8.39095E-5	1.55963E-4	2.32022E-4	4.85118E-4	6.30848E-4	
9.68736E-5	1.41155E-4	1.98696E-4	2.21263E-4	5.77208E-4	1.15491E-3	2.08240E-3	2.72335E-3	

ORTHOGONALITY OFFSET LESS THAN 0.001
RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

RESULTS

APPROX STATISTICS ASSUMING LINEARITY IN THE NEIGHBORHOOD OF SOLUTION

SUM OF SQUARES 239.568786
ORTHOGONALITY OFFSET..... 0.000449
MEAN SQUARE RESIDUALS 0.604972

PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 1	4.14924E3	1.96942E3	2.10684E0	0.47
N 2	3.74253E3	1.25987E3	2.97057E0	0.34
N 3	2.03649E2	6.15400E1	3.30921E0	0.30
N 4	7.17562E3	2.01637E3	3.55868E0	0.28
N 5	1.95708E2	6.97078E1	2.80755E0	0.36
N 6	1.36551E3	4.55533E2	2.99760E0	0.33
N 7	9.70427E1	3.70657E1	2.61813E0	0.38
N 8	3.53517E2	1.43731E2	2.45957E0	0.41
QRV SPR 1	2.36766E-5	4.23960E-6	5.58464E0	0.18
QRV SPR 2	4.74324E-5	7.80459E-6	6.07750E0	0.16
QRV SPR 3	9.69715E-5	1.63315E-5	5.93771E0	0.17
QRV SPR 4	2.24487E-4	3.77818E-5	5.94166E0	0.17
QRV SPR 5	2.72644E-4	4.50047E-5	6.05814E0	0.17
QRV SPR 6	3.21904E-4	5.58433E-5	5.76441E0	0.17
QRV SPR 7	8.16426E-4	1.35816E-4	6.01124E0	0.17
QRV SPR 8	1.11452E-3	1.93790E-4	5.75120E0	0.17
QRV FAL 1	2.43397E-5	3.73017E-6	6.52510E0	0.15
QRV FAL 2	2.34466E-5	3.70477E-6	6.32876E0	0.16
QRV FAL 3	2.61462E-5	4.04408E-6	6.46531E0	0.15
QRV FAL 4	8.39095E-5	1.27248E-5	6.59417E0	0.15
QRV FAL 5	1.55963E-4	2.37171E-5	6.57598E0	0.15
QRV FAL 6	2.32022E-4	3.60597E-5	6.43439E0	0.16
QRV FAL 7	4.85118E-4	7.72774E-5	6.27762E0	0.16
QRV FAL 8	6.30848E-4	1.05750E-4	5.96549E0	0.17
QCANADA 1	9.68736E-5	3.34482E-5	2.89623E0	0.35
QCANADA 2	1.41155E-4	4.71633E-5	2.99290E0	0.33
QCANADA 3	1.98696E-4	6.54917E-5	3.03391E0	0.33
QCANADA 4	2.21263E-4	7.26706E-5	3.04473E0	0.33
QCANADA 5	5.77208E-4	1.91684E-4	3.01125E0	0.33
QCANADA 6	1.15491E-3	3.86271E-4	2.98989E0	0.33
QCANADA 7	2.08240E-3	7.07585E-4	2.94297E0	0.34
QCANADA 8	2.72335E-3	9.29614E-4	2.92955E0	0.34

Variance estimates via linearization assume that at the solution, the norm of the residuals will be small relative to the norm of the J'J matrix (where J is the Jacobian)

PARAMETER	|| residuals ||	norms of the cols of J'J	Quotient
N 1	1.54780E1	1.42742E1	1.08434E0
N 2		2.03010E1	7.62425E-1
N 3		3.92178E2	3.94668E-2
N 4		9.51852E0	1.62609E0
N 5		1.34922E2	1.14718E-1
N 6		2.52256E1	6.13584E-1
N 7		2.17780E2	7.10717E-2
N 8		5.28870E1	2.92662E-1
qRV SPR 1		3.53236E10	4.38178E-10
qRV SPR 2		1.01217E10	1.52919E-9
qRV SPR 3		2.31638E9	6.68198E-9
qRV SPR 4		4.32230E8	3.58096E-8
qRV SPR 5		3.06344E8	5.05249E-8
qRV SPR 6		2.00651E8	7.71388E-8
qRV SPR 7		3.41641E7	4.53049E-7
qRV SPR 8		1.67385E7	9.24695E-7
qRV FAL 1		4.51241E10	3.43010E-10
qRV FAL 2		4.50253E10	3.43763E-10
qRV FAL 3		3.76557E10	4.11041E-10
qRV FAL 4		3.79679E9	4.07660E-9
qRV FAL 5		1.09900E9	1.40838E-8
qRV FAL 6		4.78179E8	3.23687E-8
qRV FAL 7		1.05177E8	1.47162E-7
qRV FAL 8		5.47329E7	2.82792E-7
qCANADA 1		6.33017E8	2.44512E-8
qCANADA 2		2.98149E8	5.19137E-8
qCANADA 3		1.50469E8	1.02865E-7
qCANADA 4		1.21342E8	1.27557E-7
qCANADA 5		1.78304E7	8.68068E-7
qCANADA 6		4.45380E6	3.47524E-6
qCANADA 7		1.36992E6	1.12984E-5
qCANADA 8		8.00974E5	1.93240E-5

Frobenius Norm of J'J is 8.278705684E10
Std Natural Norm of J'J is 4.512413423E10

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qRV SPR 1	2.24975E-4	4.02847E-5	0.18
qRV SPR 2	2.83749E-4	4.66884E-5	0.16
qRV SPR 3	2.83774E-4	4.77918E-5	0.17
qRV SPR 4	2.61119E-4	4.39472E-5	0.17
qRV SPR 5	2.78927E-4	4.60417E-5	0.17
qRV SPR 6	2.16749E-4	3.76012E-5	0.17
qRV SPR 7	2.84329E-4	4.72996E-5	0.17
qRV SPR 8	3.16843E-4	5.50916E-5	0.17
qRV FAL 1	1.80245E-4	2.76234E-5	0.15
qRV FAL 2	3.18911E-4	5.03907E-5	0.16
qRV FAL 3	2.22856E-4	3.44696E-5	0.15
qRV FAL 4	2.33859E-4	3.54645E-5	0.15
qRV FAL 5	2.07893E-4	3.16140E-5	0.15
qRV FAL 6	2.24704E-4	3.49224E-5	0.16
qRV FAL 7	2.60605E-4	4.15134E-5	0.16
qRV FAL 8	2.27392E-4	3.81179E-5	0.17
qCANADA 1	1.17540E-4	4.05838E-5	0.35
qCANADA 2	2.42316E-4	8.09636E-5	0.33
qCANADA 3	8.59029E-4	2.83142E-4	0.33
qCANADA 4	5.47625E-4	1.79860E-4	0.33
qCANADA 5	7.10928E-4	2.36091E-4	0.33
qCANADA 6	5.35108E-4	1.78972E-4	0.33
qCANADA 7	7.01076E-4	2.38220E-4	0.34
qCANADA 8	5.35593E-4	1.82824E-4	0.34

CORRELATION BETWEEN PARAMETERS ESTIMATED

1.00	0.08	0.07	0.05	0.03	0.03	0.01	0.01	-0.15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.13	-0.02	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.26	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01
0.08	1.00	0.09	0.07	0.05	0.04	0.03	0.02	-0.12	-0.10	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.10	-0.10	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.20	-0.19	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01
0.07	0.09	1.00	0.09	0.06	0.05	0.03	0.02	-0.11	-0.02	-0.09	-0.02	-0.01	-0.01	-0.01	-0.01	-0.09	-0.09	-0.09	-0.01	-0.01	-0.01	-0.01	-0.01	-0.18	-0.18	-0.17	-0.03	-0.02	-0.02	-0.02	-0.02
0.05	0.07	0.09	1.00	0.08	0.07	0.05	0.04	-0.08	-0.07	-0.08	-0.09	-0.02	-0.02	-0.01	-0.01	-0.07	-0.07	-0.07	-0.09	-0.02	-0.01	-0.01	-0.01	-0.15	-0.14	-0.15	-0.16	-0.03	-0.03	-0.02	-0.02
0.03	0.05	0.06	0.08	1.00	0.09	0.05	0.05	-0.03	-0.05	-0.07	-0.07	-0.11	-0.03	-0.03	-0.02	-0.02	-0.02	-0.06	-0.07	-0.10	-0.02	-0.03	-0.03	-0.11	-0.11	-0.11	-0.13	-0.21	-0.04	-0.05	-0.06
0.03	0.04	0.05	0.07	0.08	1.00	0.09	0.09	-0.05	-0.05	-0.06	-0.08	-0.09	-0.14	-0.06	-0.06	-0.05	-0.04	-0.05	-0.07	-0.09	-0.12	-0.06	-0.06	-0.09	-0.07	-0.08	-0.12	-0.16	-0.23	-0.10	-0.13
0.01	0.03	0.03	0.05	0.05	0.09	1.00	0.12	-0.02	-0.04	-0.04	-0.05	-0.08	-0.09	-0.14	-0.04	-0.04	-0.04	-0.04	-0.05	-0.06	-0.08	-0.14	-0.06	-0.02	-0.06	-0.07	-0.08	-0.11	-0.16	-0.26	-0.10
0.01	0.02	0.02	0.04	0.06	0.09	0.12	1.00	-0.03	-0.03	-0.04	-0.05	-0.07	-0.11	-0.15	-0.19	-0.03	-0.03	-0.04	-0.05	-0.07	-0.10	-0.14	-0.08	-0.02	-0.02	-0.05	-0.07	-0.10	-0.16	-0.25	-0.33
-0.15	-0.12	-0.11	-0.08	-0.03	-0.05	-0.02	-0.03	1.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.08	0.05	0.03	0.02	0.02	0.02	0.02	0.02
-0.01	-0.10	-0.02	-0.07	-0.06	-0.05	-0.04	-0.03	0.02	1.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02
-0.01	-0.02	-0.09	-0.08	-0.07	-0.06	-0.04	-0.04	0.02	0.01	1.00	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.03	0.03	0.04	0.03	0.03	0.02	0.02	0.02
-0.01	-0.01	-0.02	-0.09	-0.07	-0.08	-0.05	-0.05	0.01	0.01	0.02	1.00	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
-0.01	-0.01	-0.01	-0.01	-0.02	-0.11	-0.09	-0.06	-0.07	0.01	0.01	0.02	0.02	1.00	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.04
-0.01	-0.01	-0.01	-0.02	-0.03	-0.14	-0.09	-0.11	0.01	0.01	0.01	0.02	0.02	1.00	0.03	0.03	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.05
-0.00	-0.01	-0.01	-0.01	-0.03	-0.06	-0.14	-0.15	0.01	0.01	0.01	0.02	0.02	0.03	1.00	0.03	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.02	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.06
-0.00	-0.01	-0.01	-0.01	-0.02	-0.06	-0.04	-0.19	0.01	0.01	0.01	0.01	0.02	0.03	0.03	1.00	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07
-0.13	-0.10	-0.09	-0.07	-0.02	-0.05	-0.04	-0.03	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	1.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.02
-0.02	-0.10	-0.09	-0.07	-0.02	-0.04	-0.04	-0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	1.00	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.03	0.02	0.01	0.02	0.02	0.02
-0.01	-0.02	-0.09	-0.07	-0.06	-0.05	-0.04	-0.04	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	1.00	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
-0.01	-0.01	-0.01	-0.08	-0.07	-0.07	-0.05	-0.05	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	1.00	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
-0.01	-0.01	-0.01	-0.01	-0.02	-0.10	-0.09	-0.06	-0.07	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	1.00	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.03
-0.01	-0.01	-0.01	-0.01	-0.02	-0.12	-0.08	-0.10	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.02	1.00	0.03	0.02	0.01	0.01	0.02	0.02	0.03	0.05	0.05	0.05
-0.00	-0.01	-0.01	-0.01	-0.03	-0.06	-0.14	-0.14	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.03	0.01	0.01	0.01	0.02	0.02	0.03	1.00	0.02	0.01	0.01	0.02	0.02	0.03	0.05	0.07	0.06
-0.00	-0.01	-0.01	-0.01	-0.03	-0.06	-0.05	-0.08	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	1.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	
-0.26	-0.20	-0.18	-0.15	-0.11	-0.08	-0.02	-0.02	0.08	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.07	0.04	0.03	0.02	0.02	0.01	0.01	0.01	1.00	0.09	0.06	0.04	0.03	0.02	0.02	0.02
-0.03	-0.19	-0.18	-0.14	-0.11	-0.07	-0.06	-0.02	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.09	1.00	0.06	0.04	0.04	0.03	0.03	0.02
-0.02	-0.03	-0.17	-0.15	-0.11	-0.08	-0.07	-0.05	0.03	0.02	0.04	0.03	0.02	0.02	0.02	0.01	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.06	0.06	1.00	0.05	0.04	0.03	0.03	0.03
-0.02	-0.02	-0.03	-0.16	-0.13	-0.12	-0.08	-0.07	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.04	0.04	0.05	1.00	0.05	0.04	0.04	0.04
-0.01	-0.02	-0.02	-0.03	-0.21	-0.16	-0.11	-0.10	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.03	0.02	0.01	0.02	0.03	0.04	0.03	0.03	0.02	0.03	0.04	0.04	0.05	1.00	0.06	0.06	0.06
-0.01	-0.01	-0.02	-0.03	-0.04	-0.23	-0.16	-0.16	0.02	0.02	0.02	0.03	0.04	0.05	0.05	0.04	0.02	0.02	0.02	0.03	0.04	0.05	0.05	0.03	0.02	0.03	0.03	0.04	0.06	1.00	0.09	0.08
-0.01	-0.01	-0.02	-0.02	-0.05	-0.10	-0.26	-0.25	0.02	0.02	0.02	0.03	0.04	0.05	0.07	0.05	0.02	0.02	0.02	0.03	0.03	0.05	0.07	0.03	0.02	0.03	0.03	0.04	0.06	0.09	1.00	0.10
-0.01	-0.01	-0.02	-0.02	-0.06	-0.13	-0.10	-0.33	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.04	0.02	0.02	0.03	0.04	0.06	0.08	0.10	1.00

CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

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N 1        * . . . . . . . . . . . . . . . . . . . . . . . - . . . . . . .
N 2        . * . . . . . . . . . . . . . . . . . . . . . . - . . . . . . .
N 3        . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
N 4        . . . * . . . . . . . . . . . . . . . . . . . . . . . . . . . .
N 5        . . . . * . . . . . . . . . . . . . . . . . . . . . . - . . . .
N 6        . . . . . * . . . . . . . . . . . . . . . . . . . . . . - . . .
N 7        . . . . . . * . . . . . . . . . . . . . . . . . . . . . . - . .
N 8        . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . - .
QRV SPR 1  . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . . .
QRV SPR 2  . . . . . . . . . * . . . . . . . . . . . . . . . . . . . . . .
QRV SPR 3  . . . . . . . . . . * . . . . . . . . . . . . . . . . . . . .
QRV SPR 4  . . . . . . . . . . . * . . . . . . . . . . . . . . . . . . .
QRV SPR 5  . . . . . . . . . . . . * . . . . . . . . . . . . . . . . . .
QRV SPR 6  . . . . . . . . . . . . . * . . . . . . . . . . . . . . . . .
QRV SPR 7  . . . . . . . . . . . . . . * . . . . . . . . . . . . . . . .
QRV SPR 8  . . . . . . . . . . . . . . . * . . . . . . . . . . . . . . .
QRV FAL 1  . . . . . . . . . . . . . . . . * . . . . . . . . . . . . . .
QRV FAL 2  . . . . . . . . . . . . . . . . . * . . . . . . . . . . . . .
QRV FAL 3  . . . . . . . . . . . . . . . . . . * . . . . . . . . . . . .
QRV FAL 4  . . . . . . . . . . . . . . . . . . . * . . . . . . . . . . .
QRV FAL 5  . . . . . . . . . . . . . . . . . . . . * . . . . . . . . . .
QRV FAL 6  . . . . . . . . . . . . . . . . . . . . . * . . . . . . . . .
QRV FAL 7  . . . . . . . . . . . . . . . . . . . . . . * . . . . . . . .
QRV FAL 8  . . . . . . . . . . . . . . . . . . . . . . . * . . . . . . .
QCANADA 1  - - . . . . . . . . . . . . . . . . . . . . . . . * . . . . . .
QCANADA 2  . . . . . . . . . . . . . . . . . . . . . . . . . * . . . . .
QCANADA 3  . . . . . . . . . . . . . . . . . . . . . . . . . . * . . . .
QCANADA 4  . . . . . . . . . . . . . . . . . . . . . . . . . . . * . . .
QCANADA 5  . . . . . - . . . . . . . . . . . . . . . . . . . . . . * . .
QCANADA 6  . . . . . . - . . . . . . . . . . . . . . . . . . . . . . * .
QCANADA 7  . . . . . . . - - . . . . . . . . . . . . . . . . . . . . . *
QCANADA 8  . . . . . . . . - . . . . . . . . . . . . . . . . . . . . . .
```

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

SAW13 RESEARCH DOCUMENTS

(Appendix to CRD-92-02)

SAW13/1	Assessment of the Georges Bank Haddock Stock 1991	D. Hayes N. Buxton
SAW13/2	BIOREF - A Model to Estimate the Effects of Discard Mortality on Biological Reference Points	S. Correia
SAW13/3	Estimating Total Effort in the Gulf of Maine Sink Gillnet Fishery	K. Bisack G. DiNardo
SAW13/4	Report of the Stock Assessment Workshop (SAW) Summer Flounder Working Group (WG#21)	Working Group

Papers of the Northeast Regional
Stock Assessment Workshops

BIOREF
A Model to Estimate the Effects of Discard Mortality on Biological Reference Points

by

Steven J. Correia

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Sandwich, MA 02563

Appendix to CRD-92-02 SAW 13

Fall 1991 Research Document SAW13/2

BIOREF

A Model to Estimate the Effects of Discard Mortality on Biological Reference Points

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BIOREF was developed to estimate the biological reference points $F_{0.1}$, F_{max}, and F_{msy} when VPA estimates of F at age are unavailable. Partial F at age coefficients are derived as a function of mesh selectivity ogives, minimum legal size, length at age data, discard mortality rate, and partial fishing mortality for two fleets. BIOREF utilizes a Thompson-Bell yield per recruit model to calculate YPR, SSB/R, and sustainable yields. This allows fishery managers to observe the effects of minimum mesh size, minimum legal size, and discard mortality assumptions on estimating biological reference points. The model also produces a table that list deaths at age by user group i.e., harvest by fleet, discard deaths by fleet, and natural deaths. BIOREF allows the user to independently reduce each fleet's effort and to examine the effects on YPR, %MSP, catch, and discard by fleets.

Parameters needed to run the model include: proportion mature at age, mean weight of mature fish at age, mean weight of legal size fish at age, and natural mortality rate at age. Also needed are: proportion of legal size fish that are retained in the mesh, proportion of sublegal size fish that are retained in the mesh, and a hooking mortality discard rate (proportion of fish discarded from the hook and line fishery that die). The proportion of legal size fish and sublegal size fish at age retained by a given mesh is calculated using a mesh selectivity ogive and length frequency at age. If sustainable yields are desired, then a spawner recruit function is needed. The model utilizes the Shepherd spawner recruit model for maximum flexibility. A flow chart for BIOREF is shown in Figure 1.

The partial fishing mortality for each fleet (F_{fleet}) is calculated using the ratio of the fleet's catch (C_{fleet}) to the total catch (C_{total}): $F_{fleet} = F_{total}\, C_{fleet} / C_{total}$. The catches do not include discards.

Partial F at age coefficients are estimated as follows. The population length frequency is decomposed into a length frequency for each age using an age length key. Each length distribution at age can be further divided into a length frequency for legal size and a length frequency of sublegal size fish. The model assumes that all legal size fish are potentially harvested (no discarding) and sublegal fish are potentially discarded but not harvested. For each age, the length frequency can be partitioned into 4 exclusive groups via a mesh selection ogive: legal size fish retained at a given mesh size and potentially harvested by both fleets (P_1), legal size fish not retained in the net and potentially harvested by the hook and line fleet (P_2), sublegal size fish retained at a given mesh and potentially discarded by both fleets (P_3), and sublegal fish size not retained by the net and potentially discarded by the hook and line fleet only (P_4).

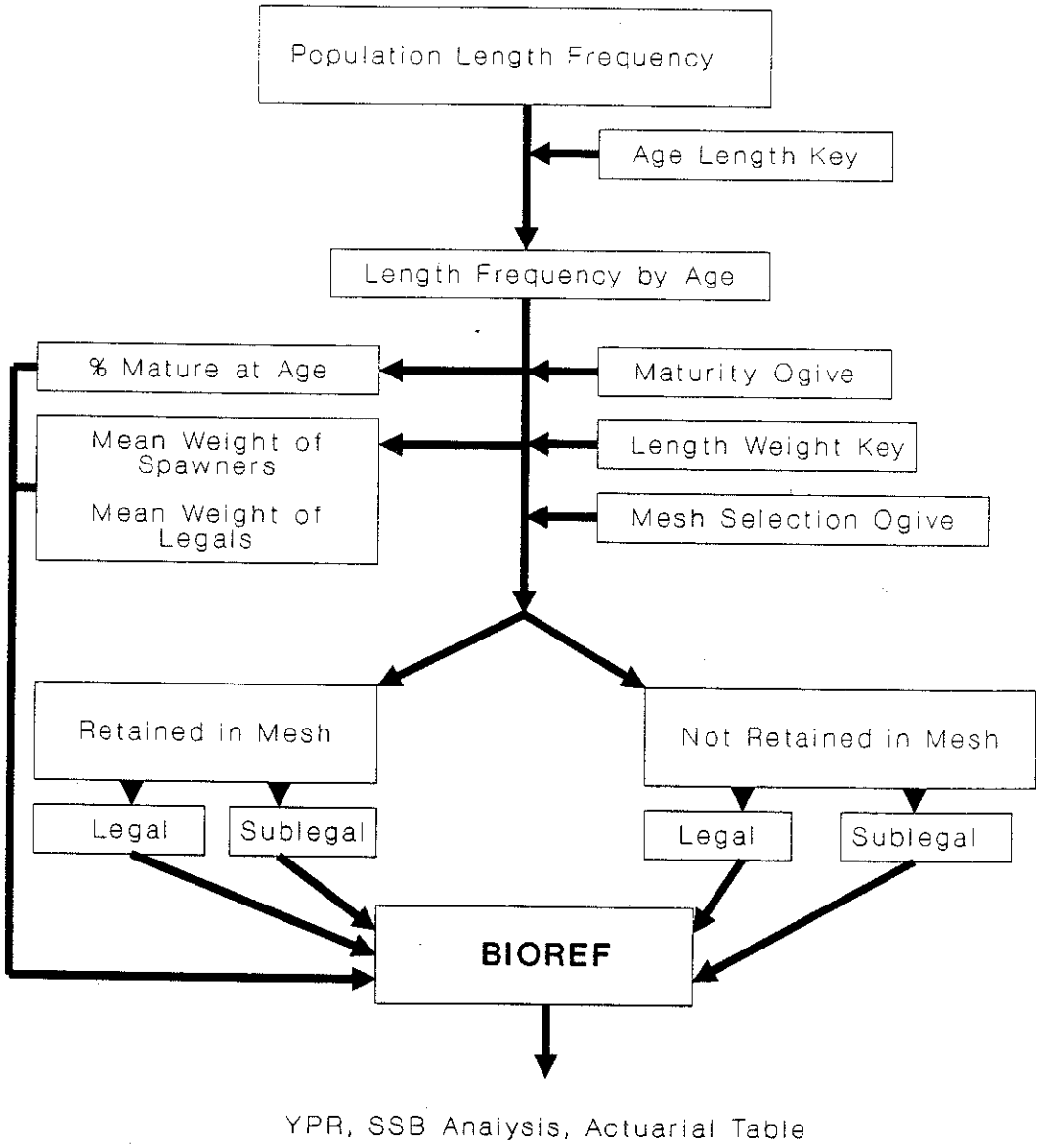


Figure 1. Bioref Flow Chart

The partial F at age coefficient (a) can then be calculated as follows:

$$a = \frac{\ln(P_1 e^{Ft+Fr} + P_2 e^{Fr} + P_3 e^{dFt+hFr} + P_4 e^{hFr})}{F}$$

where d= discard mortality rate
h= hooking discard mortality rate
F= Fully recruited F
Ft= F for the trawler fleet
Fr= F for the hook and line fleet
P1=proportion of fish that are legal and retained in the mesh.
P2=proportion of fish that are legal and escape the net
P3=proportion of fish that are sublegal and retained in the mesh
P4=proportion of fish that are sublegal and escape the net.

The model's most important assumption is that equilibrium conditions exist: recruitment, growth rates, and maturation schedule are all constant. Spawning occurs at the beginning of the year before any fishing and natural mortality occurs. The model also assumes that effort for each fleet (f_{fleet}) is constant for all ages. Catchability is constant at all ages for the hook and line fleet, and varies as a function of length at age and mesh selectivity for the trawler fleet.

Using BIOREF:

BIOREF is written in GWBASIC and runs interactively. GWBASIC only recognizes commands written in upper case. To run BIOREF, type GWBASIC at the A:> prompt, then hit F3 and type BIOREF. Hit F2 to run the Program. The data file containing parameters by age is created in BIOREF on an age by age basis. The data file is stored for future use or editing.

A BIOREF run using data for the Cape Cod/Massachusetts Bay winter flounder fishery is shown in Appendix 1. An effective mesh size of 4½" is assumed, and landings are distributed as follows: 48% hook and line fleet and 52% otter trawl fleet. Length frequency, age-length key, maturity at age, and length-weight keys are region specific and were derived from data from the MDMF spring trawl surveys. Natural mortality was assumed to be 0.28 at all ages, with a maximum fishable age of 13. A hooking discard mortality rate of 0.15 was assumed for ages 2 and older. The discard mortality rate in the model's output and Table 1 refers to discarding mortality rate from the otter trawl fishery independent of hooking mortality.

For comparative purposes, a YPR analysis that assumes all fish ≥ minimum legal size are fully recruited and fish less than minimum legal size are not recruited to the fishery was used.

Partial recruitment at age was assumed to be proportional to the number of legal size fish at age. The partial recruitment coefficients are 1.0 for ages 5 and older, 0.62 for age 4, 0.04 for age 3, and 0.0 for all younger ages. In this "reference standard" analysis, $F_{0.1}$= 0.39, F_{MSY}=2.04, and F_{MAX} was undefined for values of F up to 2.0. All reference points and yield curves derived using BIOREF were lower than those derived from the reference standard analysis (Table 1 and Figure 2) The reference points for the BIOREF run with no otter trawl discard mortality are lower than the standard run because of the 15% hooking discard mortality from the hook and line fishery. Reference points for a BIOREF run with absolutely no discard mortality would be higher than those of reference standard because some legal size fish are not fully recruited to the fishery as a result of the 4½" mesh.

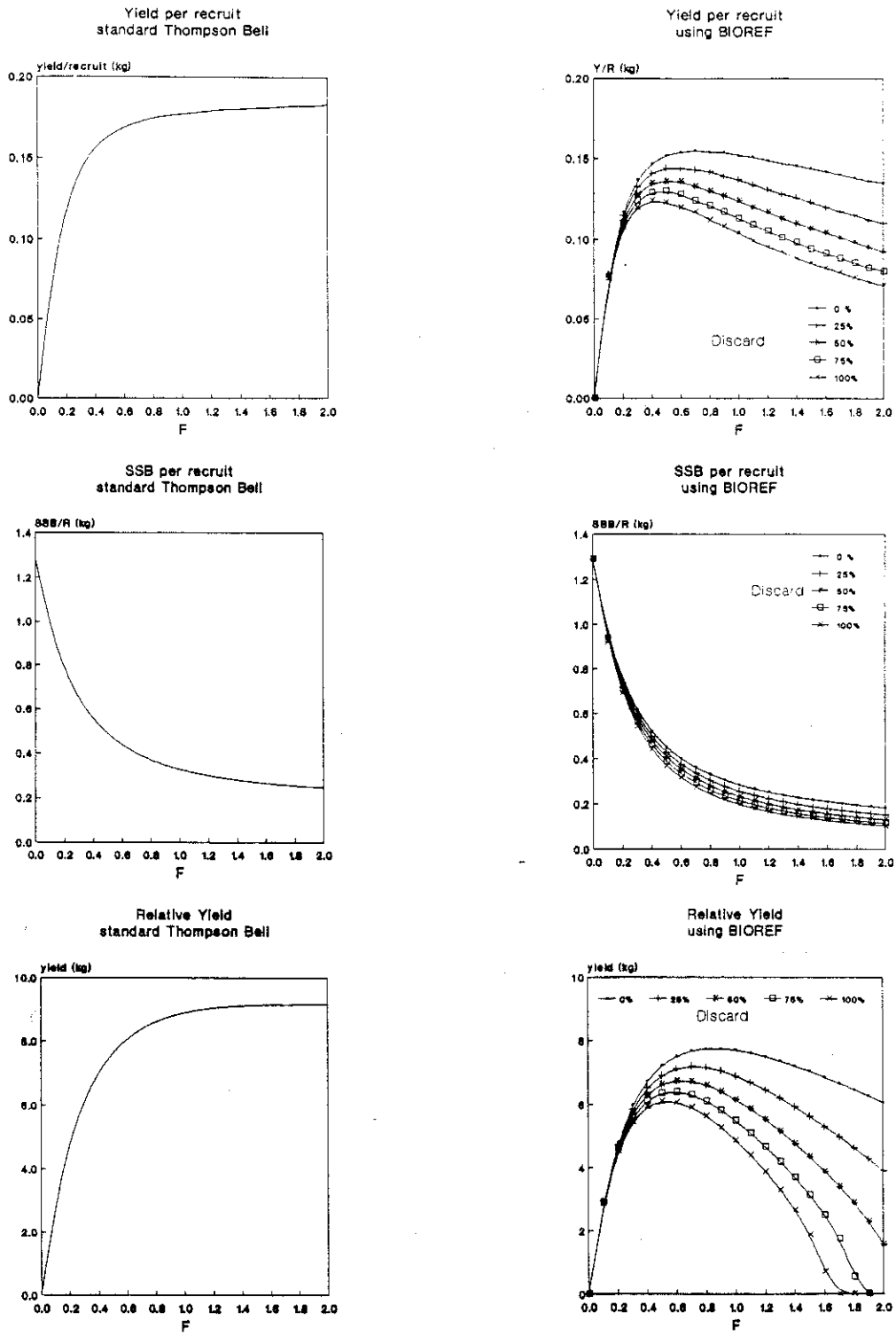
Table 1. Comparison of biological reference points from standard reference model and BIOREF model.

	discard mortality %	$F_{0.1}$	F_{max}	F_{msy}
Reference standard	0	0.39	>2.0	2.04
BIOREF	0*	0.35	0.70	0.90
	25	0.32	0.60	0.72
	50	0.30	0.51	0.66
	75	0.29	0.50	0.60
	100	0.27	0.45	0.56

* includes 15% hooking discard mortality

BIOREF's reference points are sensitive to assumptions about discard mortality. Although accuracy of the model's reference points are unknown, these results suggest that ignoring discard mortality in a YPR analysis could lead to significant error in estimating biological reference points. When reference points are needed, but data are insufficient for determining partial recruitment vectors, rejecting the hypothesis of no discard mortality may be acceptable. This is particularly true when ancillary information, such as sea sampling data, suggests that significant discard mortality probably occurs in the fishery.

Figure 2. "Standard" Thompson Bell and BIOREF Comparisons



Appendix 1. Example of BIOREF run using data from Cape Cod/Massachusetts winter flounder fishery.

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                    BIOREF
            VERSION 1.2  11/15/91

    THIS PROGRAM DOES A YIELD PER RECRUIT AND SPAWNING STOCK
 BIOMASS ANALYSIS BASED ON A MODIFIED THOMPSON-BELL Y/R MODEL.
 THIS MODEL PARTITIONS THE FISHERY INTO  COMMERCIAL (OTTER TRAWL)
 AND RECREATIONAL (HOOK AND LINE) COMPONENTS AND THEN INCORPORATES
 HOOKING AND DISCARD MORTALITY INTO A THOMPSON-BELL ANALYSIS

 THE FOLLOWING PARAMETERS ARE NEEDED TO RUN THIS MODEL:

 PROPORTION OF LEGAL SIZE FISH AT AGE, (PL).
 PROPORTION MATURE AT AGE, (PM).
 PROPORTION OF LEGALS AT AGE RETAINED IN MESH SIZE X, (PLR)
 PROPORTION OF SUBLEGALS AT AGE RETAINED IN MESH SIZE X, (PSR)
 HOOKING MORTALITY RATE AT AGE, EXPRESSED AS %, (HM)
 NATURAL MORTALITY RATE AT AGE, EXPRESSED AS M, (M)
 MEAN WEIGHT OF LEGAL SIZE FISH AT AGE, (MLW)
 MEAN WEIGHT OF SPAWNERS AT AGE, (MSW)
 MAXIMUM AGE THAT THE FISH ATTAIN,  ALL FISH DIE OF SENESCENCE
 BEYOND THAT AGE.
 SHEPHERD SPAWNER-RECRUITMENT FUNCTION PARAMETERS A,K, AND B

 PRESS ANY KEY TO CONTINUE?
1LIST   2RUN   3LOAD"  4SAVE"  5CONT  6,"LPT1 7TRON  8TROFF 9KEY    0SCREEN

 PRESS ANY KEY TO CONTINUE?


 THE  PROGRAM CALCULATES YPR, SSB/R AND RELATIVE YIELD VALUES
 FOR DISCARD MORTALITY RATES OF 0, 25, 50, 75, AND 100% AND
 F FROM 0 TO 2.0 IN 0.1 INCREMENTS.  THE PROGRAM ALSO CALCULATES
 F0.1, FMAX, AND FMSY AND %MSP.

 A WORD OF CAUTION ***** LOCALIZED MINIMA AND MAXIMA MAY
 EXIST IN THE YPR, SSB/R, AND RELATIVE YIELD CURVES.
 THE PROGRAM CALCULATES F0.1, FMAX, AND FMSY BY SEARCHING FOR THE
 CHANGES IN SLOPE. THIS MAY CAUSE AN UNDERESTIMATION OF THE
 BIOLOGICAL REFERENCE POINTS.  PLOT THE YPR, SSB/R AND RELATIVE
 YIELD  CURVES AND CHECK THE LOCATION OF THESE POINTS



 MAXIMUM AGE ATTAINED? 13
 YOU CAN EITHER CREATE A NEW DATA FILE OR RECALL A  DATAFILE
 PREVIOUSLY CREATED USING THIS PROGRAM.  FILES WILL BE STORED
 ON THE A DRIVE.  NEW FILES WILL OVERWRITE OLD FILES WITH THE SAME NAME.

 INPUT NAME OF DATA FILE TO BE CREATED, OR RECALLED? N1245
```

DO YOU WISH TO CREATE A DATAFILE, Y/N? N
DO YOU WISH TO EDIT THE DATAFILE, Y/N? N

CURRENT DATA FILE

AGE	PL	PM	PLR	PSR	HM	M	MLW	MSW
1	0.000	0.000	0.000	0.002	.00	.28	0.00	0.00
2	0.000	0.000	0.000	0.100	.15	.28	0.00	0.15
3	0.059	0.161	0.973	0.633	.15	.28	0.40	0.33
4	0.792	0.803	0.984	0.911	.15	.28	0.46	0.45
5	1.000	0.984	0.998	1.000	.15	.28	0.61	0.61
6	1.000	0.987	1.000	1.000	.15	.28	0.86	0.86
7	1.000	1.000	1.000	1.000	.15	.28	0.96	0.96
8	1.000	1.000	1.000	1.000	.15	.28	1.04	1.04
9	1.000	1.000	1.000	1.000	.15	.28	1.09	1.09
10	1.000	1.000	1.000	1.000	.15	.28	1.13	1.13
11	1.000	1.000	1.000	1.000	.15	.28	1.16	1.16
12	1.000	1.000	1.000	1.000	.15	.28	1.18	1.18
13	1.000	1.000	1.000	1.000	.15	.28	1.19	1.19

DO YOU WISH TO RE-EDIT THE DATAFILE? N
SPECIES NAME? WINTER FLOUNDER
STOCK UNIT? CAPE COD /MASS BAY REGION
LEGAL SIZE ? 12"
MESH SIZE? 4.5" DIAMOND
PROPORTION OF CATCH DUE TO RECREATIONAL FISHING=? .48
INPUT SHEPHERD RECRUITMENT FUNCTION PARAMETERS

SSB=K ((A*SSB/R) -1)^1/B

K=? 12.57
A=? 7.99
B=? 1.8
DO YOU WANT TO RUN A YPR, SSB/R ANALYSIS ? Y

PROGRAM IS RUNNING, APPROXIMATE RUNNING TIME = 1 MINUTE
******

YIELD PER RECRUIT

F	0	.25	.50	.75	1
0.0	0.000	0.000	0.000	0.000	0.000
0.1	0.079	0.078	0.077	0.076	0.075
0.2	0.117	0.115	0.112	0.110	0.108
0.3	0.137	0.133	0.128	0.124	0.120
0.4	0.147	0.141	0.135	0.129	0.124
0.5	0.152	0.144	0.136	0.130	0.123
0.6	0.154	0.144	0.136	0.128	0.120
0.7	0.155	0.143	0.133	0.124	0.117
0.8	0.154	0.142	0.130	0.121	0.112
0.9	0.154	0.139	0.127	0.117	0.108
1.0	0.152	0.137	0.124	0.113	0.104
1.1	0.151	0.134	0.120	0.109	0.099
1.2	0.149	0.131	0.117	0.105	0.095
1.3	0.147	0.128	0.113	0.101	0.092
1.4	0.146	0.126	0.110	0.098	0.088
1.5	0.144	0.123	0.107	0.094	0.085
1.6	0.142	0.120	0.104	0.091	0.082
1.7	0.140	0.117	0.101	0.088	0.079
1.8	0.138	0.115	0.098	0.085	0.076
1.9	0.136	0.112	0.095	0.082	0.073
2.0	0.135	0.110	0.092	0.080	0.071

HIT RETURN TO CONTINUE

SPAWNING STOCK BIOMASS PER RECRUIT

F	0	.25	.50	.75	1
0.0	1.289	1.289	1.289	1.289	1.289
0.1	0.959	0.949	0.939	0.929	0.919
0.2	0.752	0.736	0.720	0.705	0.691
0.3	0.615	0.595	0.577	0.559	0.542
0.4	0.520	0.498	0.478	0.459	0.441
0.5	0.451	0.428	0.407	0.387	0.369
0.6	0.400	0.376	0.354	0.334	0.316
0.7	0.361	0.335	0.313	0.293	0.275
0.8	0.330	0.303	0.281	0.261	0.244
0.9	0.305	0.278	0.255	0.235	0.218
1.0	0.284	0.256	0.233	0.214	0.198
1.1	0.267	0.239	0.215	0.196	0.181
1.2	0.252	0.223	0.200	0.182	0.166
1.3	0.239	0.210	0.187	0.169	0.154
1.4	0.229	0.199	0.176	0.158	0.144
1.5	0.219	0.189	0.166	0.149	0.135
1.6	0.211	0.180	0.158	0.140	0.127
1.7	0.203	0.172	0.150	0.133	0.120
1.8	0.196	0.165	0.143	0.126	0.114
1.9	0.190	0.159	0.136	0.120	0.108
2.0	0.185	0.153	0.131	0.115	0.103

HIT RETURN TO CONTINUE

% OF MAXIMUM SPAWNING STOCK BIOMASS/RECRUIT

F	0	.25	.50	.75	1
0.0	100.0	100.0	100.0	100.0	100.0
0.1	74.4	73.6	72.8	72.0	71.3
0.2	58.3	57.1	55.9	54.7	53.6
0.3	47.7	46.2	44.7	43.4	42.1
0.4	40.3	38.6	37.1	35.6	34.2
0.5	35.0	33.2	31.5	30.0	28.6
0.6	31.0	29.1	27.4	25.9	24.5
0.7	28.0	26.0	24.3	22.7	21.4
0.8	25.6	23.5	21.8	20.2	18.9
0.9	23.6	21.5	19.7	18.2	16.9
1.0	22.0	19.9	18.1	16.6	15.3
1.1	20.7	18.5	16.7	15.2	14.0
1.2	19.5	17.3	15.5	14.1	12.9
1.3	18.6	16.3	14.5	13.1	12.0
1.4	17.7	15.4	13.7	12.3	11.1
1.5	17.0	14.7	12.9	11.5	10.4
1.6	16.3	14.0	12.2	10.9	9.8
1.7	15.8	13.4	11.6	10.3	9.3
1.8	15.2	12.8	11.1	9.8	8.8
1.9	14.8	12.3	10.6	9.3	8.4
2.0	14.3	11.9	10.1	8.9	8.0

HIT RETURN TO CONTINUE

RELATIVE YIELD

F	0	.25	.50	.75
0.0	0.00	0.00	0.00	0.00
0.1	2.96	2.94	2.92	2.90
0.2	4.81	4.73	4.66	4.60
0.3	5.98	5.84	5.70	5.57
0.4	6.73	6.51	6.30	6.11
0.5	7.21	6.90	6.62	6.34
0.6	7.50	7.10	6.73	6.38
0.7	7.67	7.17	6.71	6.29
0.8	7.74	7.14	6.59	6.09
0.9	7.74	7.04	6.40	5.81
1.0	7.69	6.88	6.14	5.48
1.1	7.61	6.68	5.85	5.09
1.2	7.49	6.45	5.52	4.67
1.3	7.35	6.20	5.16	4.21
1.4	7.20	5.92	4.77	3.70
1.5	7.03	5.62	4.35	3.14
1.6	6.85	5.31	3.90	2.51
1.7	6.66	4.99	3.42	1.75
1.8	6.47	4.65	2.90	0.55
1.9	6.27	4.29	2.30	0.00
2.0	6.07	3.92	1.58	0.00

HIT RETURN TO CONTINUE

PROGRAM IS CALCULATING BIOLOGICAL REFERENCE POINTS
APPROXIMATE RUNNING TIME IS 2 MINUTES

PROGRAM IS CALCULATING F0.1
****
****

PROGRAM IS CALCULATING FMAX
****

PROGRAM IS CALCULATING FMSY
****

SPECIES IS WINTER FLOUNDER

STOCK UNIT IS CAPE COD /MASS BAY REGION
LEGAL SIZE IS 12"
MESH SIZE IS 4.5" DIAMOND
% OF CATCH DUE TO RECREATIONAL FISHING .48
% OF CATCH DUE TO COMMERCIAL FISHING .52
SHEPHERD PARAMETERS ARE K= 12.57 A= 7.99 B= 1.8

DISCARD MORTALITY	F0.1	(%MSP)	FMAX	(%MSP)	FMSY	(%MSP)
0.00	0.35	(43.7)	0.70	(27.7)	0.90	(23.4)
0.25	0.32	(44.4)	0.60	(28.8)	0.72	(25.2)
0.50	0.30	(44.7)	0.51	(30.6)	0.66	(25.1)
0.75	0.29	(44.3)	0.50	(29.5)	0.60	(25.5)
1.00	0.27	(45.0)	0.45	(30.7)	0.56	(25.6)

PRESS ANY KEY TO CONTINUE

********** DEATH AT AGE TABLE**********

THIS PROGRAM PRODUCES A TABLE OF DEATHS AT AGE PARTITIONED
INTO FISHING MORTALITY BY USER GROUP, INCLUDING COMMERCIAL
DISCARD, RECREATIONAL DISCARD, RECREATION AND COMMERCIAL
HARVESTS; AND NATURAL MORTALITY

DO YOU WANT TO PRODUCE THIS TABLE? Y

DISCARD MORTALITY IS (VALUES RANGES FROM 0-1)? .5
CURRENT F IS ? 1
INPUT PERCENT REDUCTION IN RECREATIONAL EFFORT? 0
INPUT PERCENT REDUCTION IN COMMERCIAL EFFORT? 0
1LIST 2RUN 3LOAD" 4SAVE" 5CONT 6,"LPT1 7TRON 8TROFF 9KEY 0SCREEN

SPECIES IS WINTER FLOUNDER
STOCK UNIT IS CAPE COD /MASS BAY REGION

LEGAL SIZE IS 12"
MESH SIZE IS 4.5" DIAMOND
% OF EFFORT DUE TO RECREATIONAL FISHING .48
% OF EFFORT DUE TO COMMERCIAL FISHING .52

SHEPHERD PARAMETERS ARE K= 12.57 A= 7.99 B= 1.8

F BEFORE EFFORT REDUCTION WAS 1
REDUCTION IN RECREATION EFFORT IS 0 %
REDUCTION IN COMMERCIAL EFFORT IS 0 %
DISCARD MORTALITY IS .5

YIELD PER RECRUIT IS 0.124
SSB/R IS 0.233
%MSP IS 18.1

ACTUARIAL TABLE BASED ON 10000 RECRUITS AT AGE 1

AGE	COMMERCIAL HARVEST	REC HAR	# HOOKING DEATHS	# DISCARD DEATHS	NATURAL DEATHS	# ALIVE T+1	F AT AGE
1	0	0	0	40	24416	75544	0.00
2	0	0	4533	1466	17630	51914	0.10
3	874	835	2754	6009	11195	30249	0.26
4	6916	6511	343	1115	5130	10234	0.80
5	2994	2772	0	0	1617	2850	1.00
6	836	772	0	0	450	793	1.00
7	233	215	0	0	125	220	1.00
8	65	60	0	0	35	61	1.00
9	18	17	0	0	10	17	1.00
10	5	5	0	0	3	5	1.00
11	1	1	0	0	1	1	1.00
12	0	0	0	0	0	0	0.00
13	0	0	0	0	0	0	0.00
TOTAL	11942	11187	7630	8630	60612		

DO YOU WANT TO PRODUCE ANOTHER ACTUARY TABLE ? N