Prognosis of Abundance and yield of Eastern
Newfoundland herring stocks

by

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INTRODUCTION

Prior to the early 1970's, herring landings along eastern Newfoundland were substantially below potential yields, peaking at 7000 m tons during the later 1940's and remaining at less than 2000 m tons during the 1950's and 1960's. During the early 1970's, however, an increased demand for herring as food together with the development of a small purse-seine fleet led to substantial increases in landings up to 1977 when a TAC of 22,000 m tons was imposed. An analytical assessment conducted at that time (Winters and Moores, 1977) indicated that these populations of herring were predominantly spring-spawners which had greatly increased in abundance during the early 1970's, as a result of the production of a very strong year-class in 1968 and a somewhat weaker one in 1969. Preliminary results of tagging studies at that time indicates a considerable intermix between White Bay and Notre Dame Bay (Fig. 1) and also between Conception Bay and the southern Avalon. For the purposes of stock assessment therefore, these areas were combined as unit stocks and it was assumed that the other Bays (Trinity and Bonavista) had resident populations which intermingled with adjacent bays only to an incidental degree.

This document summarizes the results of additional data collected since 1976 and presents a short-term prognosis of yield and abundance.

1. Recent catch statistics

Total landings peaked at nearly 26,000 m tons in 1977 (Table 1) and declined to just over 22,000 m tons in 1978. Landings have remained consistently higher in the Notre Dame Bay - White Bay stock complex, mainly due to a substantial increase in catches by inshore gears (gillnets, bar-seines and traps) from less than 3500 m tons in 1975 to nearly 5500 m tons in 1977 and to nearly 7700 m tons in 1978. In more southern areas, inshore landings have shown much less of an increase, although by 1978 inshore gears account for 50% of the total landings of herring along eastern Nfld.

2. Age composition data

Age compositions of commercial catches of herring in the various east coast bays are shown in Fig. 2. In areas A and B, the 1968 year-class continues to contribute strongly to the commercial catches as do the very old fish (age-groups 11+) which comprised about 25% of the total catches in 1978. The most recent year-class of any consequence is the 1974 year-class, but its relatively modest appearance in the commercial catches in

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1978 suggests that it is not strong. In Bonavista Bay (Area C) old fish also continue to be important in the commercial catches although the 1968 year-class is by far the largest contributor to fishery removals. South of Bonavista Bay the fishery continues to be virtually supported by the 1968 year-class, both older and younger fish contributing only in a insignificant manner to the commercial catches. It would appear, therefore, that all year-classes up to, and possibly including the 1976 year-classes are very weak.

3. Stock migrations and interrelationships

a. Recent liberties and recoveries of tagged herring along eastern Newfoundland support the preliminary conclusions as to stock interrelationships by Winters and Moores (1977) (Table 2). There is a substantial intermixing of the Notre Dame Bay and White Bay herring populations, the general migration pattern being a northwest migration after spawning to summer feeding areas in the Northern Strait of Belle Isle followed by a southward migration, beginning in late August to the main over-wintering area in the Bay of Exploits, Notre Dame Bay. Feeding resumes again during early spring at which time there is a general dispersal of herring to spawning areas to the North (Green Bay and White Bay) and to the south (Gander Bay - Cape Freels).

A similar northward migration after spawning in the spring and a corresponding southwest migration in early fall results in a significant, but not substantial, interchange between Bonavista and Trinity Bays. The southern Avalon (Area F) exhibits a wider degree of overlap with stocks as far north as Bonavista Bay and as far south as Placentia Bay (Area H). The largest interchange however, appears to be with the Conception Bay (Area E) herring populations and consequently these two adjacent areas have been defined as a unit stock for management purposes.

4. Assessment parameters

a. Age-specific weights: Average weights-at-age as derived from biological samples taken in the first two quarters of the year are given for each defined stock area in Table 3. In all areas there is a slight increase in age-specific weights compared with those presented by Winters and Moores (1977) from sampling data collected during 1973-75.

b. Partial recruitment rates: Trial runs of cohort analysis were used as a basis for evaluating the age-specific selectivity pattern for each defined stock. These were then compared with the values obtained by Winters and Moores (1977) and since no significant changes were discernible, the final partial recruitment rates used in initiating cohort analysis were identical to those used in the original assessment of this stock.

c. CPUE analysis: Detailed catch-rate information is not available in log-book form for the small purse-seine (ring-net) fleet operating along eastern Newfoundland. However, catch-per-trip data are available from sales slip records for each defined stock area for the period 1976-78 (Tables 4-7). The ring-net fleet has been broken down into four categories to allow more detailed evaluation of catch trends in relation to potential learning factors. These four categories are defined as follows:

Category A: These are three fairly large (60 - 65') ring-netters which were suitably equipped for purse-seining (sonar, power block, etc.) and which were crewed by experienced purse-seine fishermen and whose main learning factor would have been their introduction to new fishing areas along eastern Newfoundland in 1976. The learning factor between 1977 and 1978 showed therefore, have been minimal.

Category B: These are vessels which participated in the ring-net fishing for all three years (1976-78) and whose main learning factor would have occurred in 1976 is a result of exposure to new fishery areas, added instrumentation and increased purse-seine size. The learning factor between 1977 and 1978 would also be fairly small for this vessel category.

Category C: These are vessels which participated in the ring-net fishery for the first time in 1977 and also participated in the 1978 fishery. These vessels would have been fairly well equipped instrumentation wise in 1977 and therefore, the main learning factor would have been associated with the new fishing technique.

Category D: These are vessels which participated in the fishery in one year only and in general, the changes in instrumentation and gear size would have followed the same general pattern as the remainder of the fleet.

d. Calculation of terminal fishing mortality (F): The linear formula of Paloheimo (1961) has been used to calculate the total mortality coefficients ($\bar{Z}$) for age-groups 5+ for 1977-78 based on catch-per-trip by each vessel category according to common periods (months) fished in 1977-78. In addition, all available data for each vessel category and all months of the year have been used to calculate mortality coefficients. The results are shown in Table 8, and exhibit a genuine trend of lower estimates of $\bar{Z}$ according to the expectations of higher learning factors as one proceeds from Category A through Category D. The weighting factors attached to teach estimate of $\bar{Z}$ represent the subjective evaluation of the authors based on relative expected learning factors between 1977 and 1978. Fishing mortality in 1978 has therefore been chosen on the basis of the mean estimate of $\bar{Z}$, subtracting for the natural mortality rate (M = 0.2).

5. Results of Assessment

a. Trends in biomass and F: The trends in biomass and F are similar for all stock areas of the east coast of Newfoundland (Tables 9-12). The highest biomass levels occurred in 1973 in the 3 southern areas with the recruitment of the very strong 1968 year-class while peak biomass in the Notre Dame - White Bay area occurred in 1974 with the recruitment of the good 1969 year-class in addition to the 1968 year-class. The 1968 biomass levels, with the exception of Bonavista Bay are the lowest observed for the time series.

The level of fishing mortality (F_5+) has been increasing throughout the time series. Mortality values were low in the early years of the analysis but with the development of the small purse-seine fleet the fishing mortality increased rapidly. The highest F values are recorded for the two southern areas which were the first to be exploited by the fleet.

b. Trends in recruitment: Since the 1968 and 1969 year-classes, recruitment has been uniformly poor throughout the area. The 1972 and 1974 year-classes initially appeared to be of moderate strength but the present analysis indicates the 1972 year-class to be weak with the 1974 making a significant contribution only in the Notre Dame - White Bay area where it represents 10% of the strength of the 1968 year-class. The 1976 year-class has appeared in some strength in Trinity Bay and Bonavista Bay, but the exact strength of this year-class is yet to be determined.

c. Estimation of $F_{0.1}$: Yield per recruit curves were constructed for each area and $F_{0.1}$ level was estimated (Fig. 3). The $F_{0.1}$ values were 0.40 for areas E & F and C and 0.38 and 0.42 for areas D and A & B respectively. Due to the similarities between all areas, it was decided to use a value of $F_{0.1}$ = 0.40 for all east coast areas.

d. Catch projections: Catch projections were performed separately for each stock area, at the $F_{0.1}$ level, for 1979 to 1983. Recruitment was held constant at a level approximately the geometric mean recruitment at age 2 of all year-classes observed omitting the large 1968 year-class. These recruitment values were 10.0, 10.0, 1.0 and 1.0 million recruits at age 2 for areas A & B, C, D and E & F respectively.

The 1979 catch is adjusted by the correction factor required to make the calculated 1978 catch weight equivalent to the actual 1978 catch weight.

Area	A&B	C	D	E&F	Total
1979 catch (adj) t	12975	5735	3100	1000	22810
1978 TAC	6500	5500	1800	1600	15400

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The total projected 1979 catch would represent a 3% increase over
the 1978 catch and a 48% increase above the 1978 TAC levels. The
overall increase is due primarily to increases in the average
weight-at-age and the recalculation of the $F_{0.1}$ level from 0.30 to
0.40.

The long-term projection to 1983 (Tables 13-16) shows a very rapid
decline in both population numbers and biomass. The results should be
viewed with caution however due to the use of constant recruitment
which in all probability cannot realistically portray the recruitment
situation in herring.

Discussion: While the declining nature of the herring stocks along
the east coast of Newfoundland requires consideration, of greater
importance to the maintenance of these stocks is the current pattern
of exploitation. The current management strategy of establishing
TAC levels and implementing quota restrictions is effective with
regard to only one component of the east coast fishery, the ring-net
fleet. The non-mobile component is currently unregulated with the
consequence that it has been rapidly expanding taking an ever larger
proportion of the total catch. The potential for exceeding catch
levels when a large segment of the catching capacity is unregulated
represents a serious problem to the management of a stock on the basis
of implementing catch levels.

Table 1. East coast herring catches (metric tons) by area and gear 1973-78.

Year	Gears	A	B	C	D	E & F	Total
1973	Inshore	816	1658	504	544	1098	4620
	Ring net	-	-	-	-	-	-
	Purse Seine	1	1	5	156	211	374
	TOTAL	817	1659	509	700	1309	4994
1974	Inshore	1423	2588	642	1223	536	6412
	Ring net	8	6	-	428	2107	2549
	Purse seine	-	-	-	-	48	48
	TOTAL	1431	2594	642	1651	2691	9009
1975	Inshore	1584	1852	450	743	893	5522
	Ring net	-	108	-	1790	2596	4494
	Purse seine	828	1183	1559	1370	13	4953
	TOTAL	2412	3143	2009	3903	3502	14969
1976	Inshore	773	3184	491	914	737	6099
	Ring net	487	3412	3052	1054	1748	9753
	Purse seine	1724	2908	2812	1614	-	9058
	TOTAL	2984	9504	6355	3582	2485	24910
1977	Inshore	552	4893	2808	1145	461	9859
	Ring net	1227	4922	6204	1548	1716	15617
	Pair trawl	-	-	236	-	-	236
	Purse seine	-	-	-	-	-	-
	TOTAL	1779	9815	9248	2693	2177	25712
1978	Inshore	1750	5918	1338	1242	778	11026
	Ring net	1148	3467	4203	1045	1255	11118
	Purse seine	-	-	-	-	-	-
	TOTAL	2898	9385	5541	2287	2033	22144

1978 Figures are provisional.

Table 2. Summary of East Coast Tagging experiments since 1975.

Area Tagged	No. Tagged	No. Recaptures	Area of Recapture							
			A	B	C	D	E	F	G	H
A	19200	833	499	323	8					
B	16286	349	30	311	5	2				
C	9100	628	-	3	577	45	1	1		1
D	18225	591	-	2	84	497	7		1	
E	9450	215	-	-	10	8	166	10	17	4
F	11525	941	-	-	5	6	89	793	43	5

Table 3. Average weight-at-age (gm) of Nfld. East Coast herring
in 1978 (based on samples from Quarter 1+2).

Age	Area			
	A+B	C	D	E+F
2	80	80	80	80
3	133	133	146	170
4	201	191	220	236
5	242	253	248	264
6	253	258	259	276
7	266	264	272	292
8	271	270	278	297
9	275	285	286	307
10	279	287	305	331
11+	311	322	348	361

Table 4. Catch-per-unit effort indices for the various vessel categories (see text) for statistical areas 335-336 (Conception Bay - Southern Shore).

Vessel Category	Year	Catch-per-trip (m tons)									Unweighted average
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
A	1976	-	47.4	53.0*	-	-	-	-	-	-	47.4
	1977	37.6	12.0	11.5*	-	-	-	-	-	-	24.8
	1978	22.2	-	-	-	-	-	-	-	-	22.2
B	1976	-	15.0	13.5	7.6	6.7	6.5	-	14.8	12.0*	10.7
	1977	13.0	18.2	19.7	-	-	3.0*	14.0*	-	-	17.0
	1978	-	-	-	-	-	8.5	-	-	-	8.5
C	1977	-	15.7	21.0	-	-	-	-	-	-	18.4
	1978	7.0	-	-	-	-	11.0	2.0*	-	-	9.5
D	1976	-	13.9	14.4	21.0	9.5	5.7	-	14.0	-	13.1
	1977	-	9.0*	14.0*	-	-	-	-	-	-	-
	1978	11.0	-	-	-	-	10.3	-	-	-	10.7
Unweighted average		18.2	20.4	17.2	14.3	8.1	8.4	-	14.4	-	-

* less than 3 trips

Table 5. Catch-per-unit effort indices for the various vessel categories (see text) for statistical areas 337 (Trinity Bay).

Vessel Category	Year	Catch-per-trip (m tons)										Unweighted average
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	
A	1976	-	-	-	-	-	-	-	-	-	-	
	1977	-	-	-	-	-	-	-	-	48.0	-	48.0
	1978	-	-	-	-	-	-	-	-	-	20.5	20.5
B	1976	3.0	5.5	-	-	-	6.0*	8.4	13.5	16.9		9.5
	1977	11.6	11.8	4.3	-	3.0	6.6	9.0	8.2	-		7.8
	1978	5.3	-	-	-	-	8.5	9.0*	12.0*	-		8.6
C	1977	-	-	-	-	-	-	-	12.0*	-		
	1978	-	-	-	0.2*	-	-	-	-	-	-	
D	1976	1.0	-	7.5	-	-	-	8.0	14.6	4.0*	-	7.8
	1977	-	-	-	-	-	8.0	-	11.0*	-	-	
	1978	3.8	1.9	-	-	4.0	2.7	-	-	-	-	3.10
Unweighted average		4.9	6.4	5.9	-	3.5	5.9	8.5	12.1	32.5	20.5	

* less than 3 trips

Table 6. Catch-per-unit effort indices for the various vessel categories (per text) for statistical area 338 (Bonavista Bay).

Vessel Category	Year	Catch-per-trip (m tons)									Unweighted Average
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
A	1976	-	-	-	-	-	-	-	-	-	-
	1977	-	-	-	-	-	-	27.2	36.0	-	31.6
	1978	-	-	-	-	-	-	16.9	-	-	16.9
B	1976	-	-	-	-	-	1.0	11.9	13.4	6.0	8.1
	1977	10.7	12.0	24.0	-	-	4.7	15.1	15.4	29.5	15.9
	1978	11.5	6.1	-	-	-	2.1	9.0	5.3	-	6.8
C	1977	2.0	3.7	-	-	-	3.5	16.9	15.4	-	8.3
	1978	9.9	-	-	-	-	2.8	12.1	-	-	8.3
D	1976	-	-	-	-	-	-	9.1	19.1	-	14.1
	1977	-	-	-	-	-	-	9.6	10.6	-	10.1
	1978	16.6	-	-	-	-	-	8.7	-	-	12.7
Unweighted average		10.1	7.4	24.0	-	-	2.8	13.7	16.4	17.8	

Table 7. Catch-per-unit effort indices for the various vessel categories (see text) for statistical areas 339-341 (Notre Dame - White Bay).

Vessel Category	Year	Catch-per-trip (m tons)									Unweighted Average
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
A	1976	-	-	-	-	-	8.0*	34.3	39.2	43.1	38.9
	1977	-	28.6	-	-	-	-	38.8	-	-	33.7
	1978	-	-	-	-	-	39.9	26.1	-	-	33.0
B	1976	-	15.1	23.9	-	-	26.5	20.5	19.0	28.0	22.2
	1977	2.0*	15.6	26.3	-	3.7	21.8	15.4	-	-	16.6
	1978	4.2	4.7	15.3	-	3.7	18.2	15.3	10.8	-	10.3
C	1977	12.2	11.9	9.8	-	4.8	11.2	15.7	-	-	10.9
	1978	11.3	7.9	7.2	-	2.6	12.2	12.4	-	-	8.9
D	1976	-	7.5	15.0	-	-	-	7.7	16.8	-	11.8
	1977	4.0*	12.6	28.0	-	-	8.5	12.8	-	-	15.5
	1978	-	1.8	18.9	-	4.2	3.3	11.7	11.0	-	8.5
Unweighted Average		9.4	11.7	18.1	-	3.7	17.7	21.1	21.5	35.6	

* less than 3 trips

Table 8. Calculation of instantaneous total mortality rates ($\bar{Z}$) from catch-per-unit indices of the ring-net fleet operation along eastern Newfoundland. 1977-78

Unit Area (s)	Vessel Category	Month Selection	Catch-per-trip (M.tons) 1977	Catch-per-trip (M.tons) 1978	Effort (no. trips) 1977	Effort (no. trips) 1978	$\bar{Z}$	Weighting Factor	Mean $\bar{Z}$
335-336	A	April	37.6	22.2	57.9	91.6	0.71	4	} 0.67
	ALL	ALL	15.7	10.3	138.7	197.4	0.60	2.5	
337	B	April,Sept.	9.1	6.9	295.9	331.5	0.26	3	} 0.40
	ALL	ALL	13.4	7.5	201.0	304.9	0.56	2.5	
338	A	Oct.	27.2	16.9	340.0	327.9	0.48	4	}
	B	April-May,Sept.-Nov.	11.6	6.8	797.2	814.9	0.54	3	}
	C	Sept.-Oct.	10.2	7.5	906.7	738.8	0.31	2	} 0.44
	D	Oct.	9.6	8.7	963.3	636.9	0.10	1	}
	ALL	ALL	14.8	9.2	625.0	602.3	0.48	2.5	}
39-341	A	Oct.	38.8	26.1	298.8	470.6	0.51	4	}
	B	May-June,Aug-Oct.	16.6	11.4	698.4	1077.5	0.49	3	}
	C	Apr-June,Aug-Oct.	10.9	8.9	1063.7	1380.1	0.32	2	} 0.45
	D	May-June,Sept-Oct	15.5	8.9	748.0	1380.1	0.67	1	}
	ALL	ALL	14.2	11.7	816.5	1049.8	0.31	2.5	}

Table 9. Results of cohort analysis for Areas A+B, 1969-78.

HERRING   AREA A&B 1969-78   SS X10-3   AGES 2-20

NATURAL MORTALITY=   0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.25

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	46533.	419631.	271423.	43281.	7224.	12051.	3752.	45992.	5155.	442.
3	151040.	38097.	343556.	222222.	35431.	5914.	9866.	3070.	37545.	4174.
4	70126.	123612.	31191.	281005.	181675.	28349.	4837.	7961.	2485.	29198.
5	89146.	57321.	101193.	25490.	227852.	147391.	23103.	3765.	5965.	1936.
6	181175.	72970.	46908.	82706.	20542.	183890.	117799.	18499.	2861.	4461.
7	17421.	148209.	59720.	38354.	67651.	16109.	145558.	91507.	14408.	2176.
8	6293.	14262.	120451.	48505.	31287.	54721.	12105.	112758.	65618.	11077.
9	24603.	5054.	11667.	89447.	39343.	25001.	44165.	8895.	77500.	47045.
10	25657.	20135.	4060.	9340.	71974.	31832.	19102.	35403.	6111.	51963.
11	17573.	20953.	16339.	3073.	7458.	57383.	25283.	14908.	25996.	4048.
12	44.	14351.	17004.	12347.	2455.	5946.	45577.	19730.	10947.	17222.
13	35.	35.	11645.	12853.	9860.	1959.	4723.	35567.	14487.	7252.
14	28.	28.	28.	8792.	10265.	7861.	1556.	3686.	26116.	9597.
15	22.	22.	22.	22.	7019.	8184.	6243.	1215.	2706.	17301.
16	17.	17.	17.	17.	17.	5595.	6501.	4872.	892.	1793.
17	13.	13.	13.	13.	13.	13.	4443.	5074.	3577.	591.
18	10.	10.	10.	10.	10.	10.	10.	3467.	3726.	2369.
19	7.	7.	7.	7.	7.	7.	7.	7.	2544.	2469.
20	5.	5.	5.	5.	5.	5.	5.	5.	5.	1684.

TOTAL POPULATION

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	131101.9	157134.6	176923.9	178693.4	171059.1	151557.4	126794.3	106032.9	81004.4	59077.2
NO	629749.	934733.	1035258.	877487.	720089.	592221.	474635.	416378.	308643.	216796.

POPULATION AT AGE 5 TO 20

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	93195.6	93651.2	103247.9	89193.7	129252.2	144108.6	124209.7	100345.1	75099.1	52618.0
NO	362050.	353393.	389089.	330980.	495759.	545907.	456180.	359355.	263458.	182983.

**WEIGHTED F
AGE 5 TO 20**

0.001	0.005	0.042	0.011	0.018	0.032	0.049	0.133	0.175

Table 10. Results of cohort analysis for Area C, 1969-78.

HERRING   AREA C   1969-78   SS X10-3   AGES 2-20

NATURAL MORTALITY=   0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.25

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	29524.	351386.	87749.	9789.	2224.	4854.	1782.	8168.	2622.	4419.
3	34438.	24172.	287689.	71842.	8014.	1820.	3973.	1458.	6685.	2131.
4	29161.	28194.	19789.	235443.	58810.	6559.	1489.	2934.	1133.	5276.
5	7227.	23874.	23083.	16140.	192423.	48132.	5369.	1148.	2130.	822.
6	74850.	5916.	19546.	18891.	13028.	156818.	39406.	4307.	846.	1093.
7	954.	61242.	4843.	15998.	15461.	10395.	128273.	31235.	3438.	527.
8	14742.	780.	49946.	3936.	13060.	12648.	8467.	101760.	22487.	2777.
9	1471.	12059.	638.	40571.	3183.	10620.	10331.	6809.	71627.	13963.
10	3764.	1203.	9811.	521.	32934.	2532.	8607.	8040.	4994.	42530.
11	10457.	3071.	980.	7955.	423.	26421.	2059.	6844.	6018.	3462.
12	44.	8535.	2498.	795.	6455.	340.	21489.	1637.	5123.	4173.
13	35.	35.	6946.	2025.	645.	5179.	277.	17085.	1225.	3552.
14	28.	28.	28.	5632.	1642.	518.	4212.	220.	12788.	849.
15	22.	22.	22.	22.	4571.	1317.	422.	3349.	165.	8867.
16	17.	17.	17.	17.	17.	3668.	1071.	335.	2507.	114.
17	13.	13.	13.	13.	13.	13.	2983.	851.	251.	1739.
18	10.	10.	10.	10.	10.	10.	10.	2372.	637.	174.
19	7.	7.	7.	7.	7.	7.	7.	7.	1775.	442.
20	5.	5.	5.	5.	5.	5.	5.	5.	5.	1232.

TOTAL POPULATION

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	42809.3	68219.4	81095.4	86570.4	86927.4	76499.9	64521.4	53309.6	40717.8	27130.8
NO	206771.	520570.	513619.	429614.	352925.	291856.	240232.	198563.	146456.	98139.

POPULATION AT AGE 5 TO 20

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	30297.4	31509.0	32033.5	31263.2	74451.1	74616.7	63566.0	51901.9	39402.7	25486.2
NO	113647.	116819.	118392.	112540.	283877.	278623.	232987.	186003.	136017.	86313.

WEIGHTED F
AGE 5 TO 20

	1969	1970	1971	1972	1973	1974	1975	1976	1977	
	0.001	0.004	0.005	0.007	0.008	0.002	0.031	0.129	0.264	

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Table 11.   Results of cohort analysis for Area D, 1969-78.

HERRING AREA D 1969- 78   SSX10-3   AGES 2-20

NATURAL MORTALITY=   0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.20

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	12019.	243019.	48819.	856.	319.	789.	62.	828.	137.	6074.
3	9261.	9839.	198966.	39969.	700.	260.	645.	50.	668.	111.
4	21191.	7576.	8055.	162620.	32723.	572.	212.	489.	32.	520.
5	3388.	17347.	6194.	6452.	132259.	26739.	467.	123.	224.	10.
6	35187.	2766.	14194.	5059.	5115.	105722.	21679.	322.	85.	146.
7	364.	28593.	2213.	11608.	4064.	4115.	82291.	16446.	201.	30.
8	382.	295.	22819.	1660.	9474.	3281.	3014.	57629.	12084.	158.
9	498.	288.	208.	18061.	1317.	7756.	2572.	2179.	40038.	8730.
10	119.	385.	176.	54.	14630.	1056.	6165.	1617.	1540.	28027.
11	1395.	84.	254.	113.	35.	11837.	816.	4591.	1111.	1025.
12	50.	930.	59.	157.	81.	27.	9140.	608.	3151.	740.
13	40.	40.	624.	41.	110.	66.	21.	6806.	418.	2099.
14	32.	32.	32.	307.	31.	89.	51.	15.	4671.	279.
15	25.	25.	25.	25.	209.	25.	69.	38.	10.	3112.
16	20.	20.	20.	20.	20.	170.	19.	52.	27.	6.
17	15.	15.	15.	15.	15.	15.	130.	14.	36.	18.
18	12.	12.	12.	12.	12.	12.	12.	96.	10.	24.
19	9.	9.	9.	9.	9.	9.	9.	12.	64.	6.
20	6.	6.	6.	6.	6.	6.	6.	6.	6.	42.

TOTAL POPULATION

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	17870.7	36029.9	47364.7	53636.8	50213.1	43076.7	35288.3	26163.2	18834.4	14312.4
NO	84011.	311279.	302698.	247044.	201128.	162546.	127380.	91918.	64511.	51158.

POPULATION AT AGE 5 TO 20

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
WT	10895.1	13485.0	12638.0	11956.4	42886.3	42849.7	35142.4	25982.0	18718.9	13695.9
NO	41540.	50845.	46858.	43599.	167386.	160924.	126460.	90550.	63674.	44453.

WEIGHTED F
AGE 5 TO 20

0.015	0.023	0.032	0.016	0.021	0.045	0.135	0.156	0.160

Table 12.　Results of cohort analysis for Area E+F, 1969-78.

	Population Numbers									
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	3567	144946	25247	435	756	1411	274	2856	66	235
3	11915	2919	118671	20669	356	558	1152	213	1383	47
4	7519	9744	2389	97151	16916	290	456	560	160	1013
5	948	6154	7962	1928	78070	13829	233	346	381	121
6	24797	775	5020	6507	1456	59824	11205	176	262	196
7	1217	20243	604	4104	5277	954	40343	7314	118	44
8	448	994	16295	458	3334	3896	645	25052	3849	12
9	157	366	790	13063	303	2606	3121	423	16190	2230
10	640	128	286	617	10370	212	2097	2110	276	9392
11	866	522	90	222	444	8320	161	1485	1524	175
12	27	706	388	68	161	356	6283	115	1073	966
13	21	21	501	303	47	129	269	4445	83	680
14	16	16	16	379	221	38	98	191	3210	53
15	12	12	12	12	257	177	28	69	138	2035
16	9	9	9	9	9	204	134	19	50	88
17	7	7	7	7	7	7	147	95	14	32
18	5	5	5	5	5	5	5	95	69	9
19	3	3	3	3	3	3	3	3	63	44
20	1	1	1	1	1	1	1	1	1	31
Total	52176	187571	178297	145941	117993	92820	66655	45568	28911	17403
F_5+	.003	.021	.017	.037	.064	.139	.243	.242	.335	
Biomass 5+	8191.8	8669.5	9213.2	8218.1	27485.9	25803.8	19351.6	12897.3	8659.4	5380.6

Table 13a. Catch projection for Areas A+B in terms of biomass and numbers.

	Catch Biomass					
	1978	1979	1980	1981	1982	1983
2	0	3	3	3	3	3
3	6	1	19	19	19	19
4	323	59	5	114	114	114
5	59	1055	117	10	228	228
6	227	104	1101	123	11	238
7	117	228	60	635	71	6
8	604	113	127	33	355	40
9	2605	584	63	71	19	198
10	2919	2517	325	35	39	10
11	253	3099	1540	199	21	24
12	1078	241	1701	845	109	12
13	454	1027	133	934	464	60
14	601	433	564	73	512	255
15	1083	572	237	309	40	281
16	112	1032	314	130	170	22
17	37	107	566	172	72	93
18	148	35	59	311	95	39
19	155	141	19	32	171	52
20	105	147	78	11	18	94
Total	10887	11500	7032	4059	2529	1787

	Catch Numbers					
	1978	1979	1980	1981	1982	1983
2	1	36	36	36	36	36
3	47	6	146	146	146	146
4	1605	292	25	565	565	565
5	245	4360	485	42	941	941
6	898	410	4350	484	42	939
7	438	856	225	2388	266	23
8	2230	417	470	124	1310	146
9	9471	2124	229	258	68	719
10	10461	9023	1166	126	141	37
11	815	9966	4952	640	69	78
12	3467	776	5470	2718	351	38
13	1460	3303	426	3002	1491	193
14	1932	1391	1813	234	1647	819
15	3483	1841	763	995	128	904
16	361	3318	1010	419	546	70
17	119	344	1821	554	230	300
18	477	113	189	999	304	126
19	497	454	62	104	548	167
20	339	474	249	34	57	301
Total	38346	39506	23888	13867	8889	6549

Table 13b. Projection of population numbers and biomass for area A+B.

	Population Numbers					
	1978	1979	1980	1981	1982	1983
2	442	10000	10000	10000	10000	10000
3	4174	361	8155	8155	8155	8155
4	29198	3375	290	6544	6544	6544
5	1936	22457	2500	215	4848	4848
6	4461	1364	14463	1610	138	3122
7	2176	2845	749	7938	884	76
8	11077	1388	1561	411	4356	485
9	47045	7063	761	857	226	2391
10	51963	29997	3876	418	470	124
11	4048	33133	16463	2127	229	258
12	17222	2581	18184	9035	1168	126
13	7252	10981	1417	9980	4959	641
14	9597	4624	6027	777	5477	2721
15	17301	6119	2538	3308	427	3006
16	1793	11032	3358	1393	1815	234
17	591	1143	6054	1843	764	996
18	2369	377	627	3323	1012	419
19	2469	1510	207	344	1824	555
20	1684	1574	829	113	189	1001
Total	216798	151925	98059	68390	53483	45702

	Population Biomass					
	1978	1979	1980	1981	1982	1983
2	35.36	800.00	800.00	800.00	800.00	800.00
3	555.14	48.01	1084.56	1084.56	1084.56	1084.56
4	5868.80	678.36	58.23	1315.39	1315.39	1315.39
5	468.51	5434.58	605.05	51.94	1173.24	1173.24
6	1128.63	345.17	3659.16	407.39	34.97	789.95
7	578.82	756.64	199.17	2111.38	235.07	20.18
8	3001.87	376.02	423.06	111.36	1180.53	131.43
9	12937.37	1942.33	209.41	235.61	62.02	657.45
10	14497.68	8369.22	1081.48	116.60	131.19	34.53
11	1258.93	10304.41	5119.94	661.60	71.33	80.25
12	5356.04	802.71	5655.18	2809.88	363.09	39.15
13	2255.37	3415.19	440.54	3103.63	1542.10	199.27
14	2984.67	1438.08	1874.30	241.77	1703.31	846.32
15	5380.61	1903.12	789.23	1028.64	132.69	934.79
16	557.62	3430.83	1044.45	433.14	564.53	72.82
17	183.80	355.55	1882.88	573.21	237.71	309.82
18	736.76	117.19	195.13	1033.35	314.58	130.46
19	767.86	469.76	64.32	107.09	567.11	172.65
20	523.72	489.62	257.81	35.30	58.77	311.24
Total	59077.57	41476.78	25443.89	16261.82	11572.18	9103.51

Table 14a. Catch projection for Area C.

	Catch Numbers					
	1978	1979	1980	1981	1982	1983
2	10	36	36	36	36	36
3	24	65	146	146	146	146
4	290	149	250	565	565	565
5	104	788	248	417	941	941
6	220	174	786	247	416	939
7	106	210	96	431	136	228
8	559	101	115	52	237	74
9	2811	533	55	63	29	130
10	8562	2678	292	30	35	16
11	697	8157	1470	160	17	19
12	840	664	4477	807	88	9
13	715	800	364	2457	443	48
14	171	681	439	200	1348	243
15	1785	163	374	241	110	740
16	23	1701	89	205	132	60
17	350	22	933	49	113	73
18	35	334	12	512	27	62
19	89	33	183	7	281	15
20	248	85	18	100	4	154
Total	17639	17373	10385	6728	5103	4500

	Catch Biomass					
	1978	1979	1980	1981	1982	1983
2	1	3	3	3	3	3
3	3	9	19	19	19	19
4	55	28	48	108	108	108
5	26	199	63	105	238	238
6	57	45	203	64	107	242
7	28	55	25	114	36	60
8	151	27	31	14	64	20
9	801	152	16	18	8	37
10	2457	769	84	9	10	5
11	224	2627	473	52	5	6
12	270	214	1441	260	28	3
13	230	258	117	791	143	16
14	55	219	141	64	434	78
15	575	52	120	78	35	238
16	7	548	29	66	43	19
17	113	7	301	16	36	23
18	11	107	4	165	9	20
19	29	11	59	2	91	5
20	80	27	6	32	1	50
Total	5175	5357	3184	1980	1419	1191

Table 14b. Population projection for Area C.

| | Population Numbers | | | | | |
	1978	1979	1980	1981	1982	1983
2	4419	10000	10000	10000	10000	10000
3	2131	3609	8155	8155	8155	8155
4	5276	1723	2896	6544	6544	6544
5	822	4058	1276	2146	4848	4848
6	1093	579	2613	822	1382	3122
7	527	697	318	1434	451	758
8	2777	336	383	174	787	248
9	13963	1771	184	210	96	432
10	42530	8903	972	101	115	53
11	3462	27118	4886	533	56	63
12	4173	2207	14883	2682	293	30
13	3552	2661	1211	8168	1472	161
14	849	2265	1460	665	4483	808
15	8867	541	1243	801	365	2460
16	114	5654	297	682	440	200
17	1739	73	3103	163	374	241
18	174	1109	40	1703	89	205
19	442	111	609	22	935	49
20	1232	282	61	334	12	513
Total	98142	73697	54591	45340	40896	38891

| | Population Biomass | | | | | |
	1978	1979	1980	1981	1982	1983
2	353.52	800.00	800.00	800.00	800.00	800.00
3	283.42	479.99	1084.56	1084.56	1084.56	1084.56
4	1007.72	329.10	553.18	1249.95	1249.95	1249.95
5	207.97	1026.66	322.94	542.83	1226.57	1226.57
6	281.99	149.46	674.27	212.10	356.51	805.57
7	139.13	184.00	83.93	378.65	119.11	200.21
8	749.79	90.75	103.28	47.11	212.53	66.85
9	3979.45	504.66	52.57	59.83	27.29	123.12
10	12206.11	2555.22	278.91	29.05	33.06	15.08
11	1114.76	8732.11	1573.35	171.74	17.89	20.36
12	1343.71	710.79	4792.29	863.47	94.25	9.82
13	1143.74	856.81	390.09	2630.06	473.88	51.73
14	273.38	729.31	470.23	214.09	1443.41	260.07
15	2855.17	174.29	400.25	258.07	117.49	792.16
16	36.71	1820.56	95.65	219.66	141.63	64.48
17	559.96	23.39	999.15	52.50	120.55	77.73
18	56.03	357.07	12.84	548.34	28.81	66.16
19	142.41	35.76	196.09	7.05	301.12	15.82
20	396.70	90.74	19.61	107.55	3.87	165.16
Total	27131.68	19650.68	12903.19	9476.61	7852.50	7095.40

Table 15a. Catch projections for Area D.

Catch Numbers

	1978	1979	1980	1981	1982	1983
2	11	4	4	4	4	4
3	1	89	15	15	15	15
4	23	8	344	57	57	57
5	1	79	13	573	94	94
6	24	2	78	13	572	94
7	5	29	1	43	7	314
8	26	6	16	1	24	4
9	1439	32	3	9	0	13
10	4620	1760	17	2	5	0
11	169	5651	966	10	1	3
12	122	207	3101	530	5	1
13	346	149	113	1702	291	3
14	46	423	82	62	934	160
15	513	56	232	45	34	513
16	1	627	31	127	25	19
17	3	1	344	17	70	14
18	4	4	1	189	9	38
19	1	5	2	0	104	5
20	7	1	3	1	0	57
Total	7362	9134	5367	3399	2250	1405

Catch Biomass

	1978	1979	1980	1981	1982	1983
2	1	0	0	0	0	0
3	0	13	2	2	2	2
4	5	2	76	12	12	12
5	0	20	3	142	23	23
6	6	1	20	3	148	24
7	1	8	0	12	2	85
8	7	2	4	0	7	1
9	412	9	1	3	0	4
10	1409	537	5	1	1	0
11	59	1967	336	3	0	1
12	42	72	1079	184	2	0
13	120	52	39	592	101	1
14	16	147	28	22	325	56
15	179	20	81	16	12	178
16	0	218	11	44	9	7
17	1	0	120	6	24	5
18	1	1	0	66	3	13
19	0	2	1	0	36	2
20	2	0	1	0	0	20
Total	2264	3070	1809	1109	709	435

Table 15b. Population projection for Area D.

	Population Numbers					
	1978	1979	1980	1981	1982	1983
2	6074	1000	1000	1000	1000	1000
3	111	4963	815	815	815	815
4	520	90	3983	654	654	654
5	10	405	67	2951	485	485
6	146	7	261	43	1900	312
7	30	98	4	143	24	1043
8	158	20	54	2	79	13
9	8730	106	11	29	1	43
10	28027	5852	58	6	16	1
11	1025	18787	3212	32	3	9
12	740	687	10311	1763	18	2
13	2099	496	377	5659	967	10
14	279	1407	272	207	3105	531
15	3112	187	772	149	114	1704
16	6	2086	103	424	82	62
17	18	4	1145	56	233	45
18	24	12	2	628	31	128
19	6	16	7	1	345	17
20	42	4	9	4	1	189
Total	51157	36227	22461	14567	9873	7063

	Population Biomass					
	1978	1979	1980	1981	1982	1983
2	485.92	80.00	80.00	80.00	80.00	80.00
3	16.21	724.60	119.06	119.06	119.06	119.06
4	114.40	19.79	876.24	143.97	143.97	143.97
5	2.48	100.44	16.53	731.76	120.23	120.23
6	37.81	1.89	67.55	11.12	492.18	80.87
7	8.16	26.64	1.09	38.93	6.41	283.67
8	43.92	5.58	14.94	0.61	21.84	3.59
9	2496.78	30.30	3.15	8.44	0.34	12.33
10	8548.23	1784.84	17.73	1.84	4.94	0.20
11	356.70	6537.89	1117.64	11.11	1.15	3.09
12	257.52	239.09	3588.07	613.37	6.09	0.63
13	730.45	172.62	131.22	1969.17	336.63	3.34
14	97.09	489.64	94.73	72.01	1080.71	184.74
15	1082.98	65.08	268.72	51.99	39.52	593.10
16	2.09	725.93	35.72	147.48	28.53	21.69
17	6.26	1.40	398.40	19.60	80.94	15.66
18	8.35	4.19	0.77	218.65	10.76	44.42
19	2.09	5.58	2.30	0.42	120.00	5.90
20	14.62	1.40	3.07	1.26	0.23	65.86
Total	14312.07	11016.89	6836.92	4240.79	2693.53	1782.38

Table 16a.   Catch projection for Areas E+F.

| | Catch Numbers | | | | | |
	1978	1979	1980	1981	1982	1983
2	1	4	4	4	4	4
3	1	3	15	15	15	15
4	102	3	13	57	57	57
5	27	143	5	22	94	94
6	67	22	143	5	22	94
7	15	30	12	78	3	12
8	4	7	17	7	43	2
9	764	2	4	9	4	24
10	3217	343	1	2	5	2
11	60	1446	188	1	1	3
12	331	27	793	103	0	1
13	233	149	15	435	57	0
14	18	105	82	8	239	31
15	697	8	57	45	4	131
16	30	313	4	32	25	2
17	11	14	172	2	17	13
18	3	5	7	94	1	9
19	15	1	3	4	52	1
20	22	7	1	1	2	28
Total	5618	2632	1536	925	645	523

| | Catch Biomass | | | | | |
	1978	1979	1980	1981	1982	1983
2	0	0	0	0	0	0
3	0	1	2	2	2	2
4	24	1	3	13	13	13
5	7	38	1	6	25	25
6	18	6	39	1	6	26
7	4	9	4	23	1	4
8	1	2	5	2	13	0
9	235	1	1	3	1	7
10	1065	114	0	1	2	1
11	22	522	68	0	0	1
12	119	10	286	37	0	0
13	84	54	5	157	20	0
14	6	38	29	3	86	11
15	252	3	21	16	2	47
16	11	113	2	11	9	1
17	4	5	62	1	6	5
18	1	2	3	34	0	3
19	5	1	1	1	19	0
20	8	2	0	1	1	10
Total	1868	919	534	314	207	158

Table 16b. Population projection for Areas E+F.

| | Population Numbers | | | | | |
	1978	1979	1980	1981	1982	1983
2	235	1000	1000	1000	1000	1000
3	47	191	815	815	815	815
4	1013	38	154	654	654	654
5	121	737	28	114	485	485
6	196	75	475	18	73	312
7	44	100	41	261	10	40
8	12	23	55	23	143	5
9	2230	6	12	30	12	79
10	9392	1141	3	7	17	7
11	175	4806	626	2	4	9
12	966	89	2638	344	1	2
13	680	494	49	1448	189	1
14	53	348	271	27	794	104
15	2035	27	191	149	15	436
16	88	1041	15	105	82	8
17	32	45	572	8	58	45
18	9	16	25	314	5	32
19	44	5	9	14	172	2
20	31	23	3	5	7	94
Total	17403	10207	6982	5336	4536	4131

| | Population Biomass | | | | | |
	1978	1979	1980	1981	1982	1983
2	18.80	80.00	80.00	80.00	80.00	80.00
3	7.99	32.55	138.63	138.63	138.63	138.63
4	239.07	8.87	36.27	154.44	154.44	154.44
5	31.94	194.68	7.35	30.06	127.99	127.99
6	54.10	20.64	131.08	4.95	20.24	86.18
7	12.85	29.32	11.99	76.11	2.87	11.75
8	3.56	6.71	16.37	6.69	42.48	1.60
9	684.61	1.92	3.80	9.29	3.80	24.10
10	3108.75	377.66	1.13	2.25	5.49	2.25
11	63.17	1734.98	226.05	0.68	1.35	3.29
12	348.73	32.31	952.17	124.06	0.37	0.74
13	245.48	178.41	17.73	522.56	68.09	0.20
14	19.13	125.59	97.91	9.73	286.79	37.37
15	734.63	9.84	68.92	53.74	5.34	157.39
16	31.77	375.94	5.40	37.83	29.49	2.93
17	11.55	16.30	206.32	2.96	20.76	16.18
18	3.25	5.90	8.95	113.23	1.63	11.39
19	15.88	1.69	3.24	4.91	62.14	0.89
20	11.19	8.15	0.93	1.78	2.69	34.10
Total	5646.46	3241.45	2014.24	1373.89	1054.60	891.44
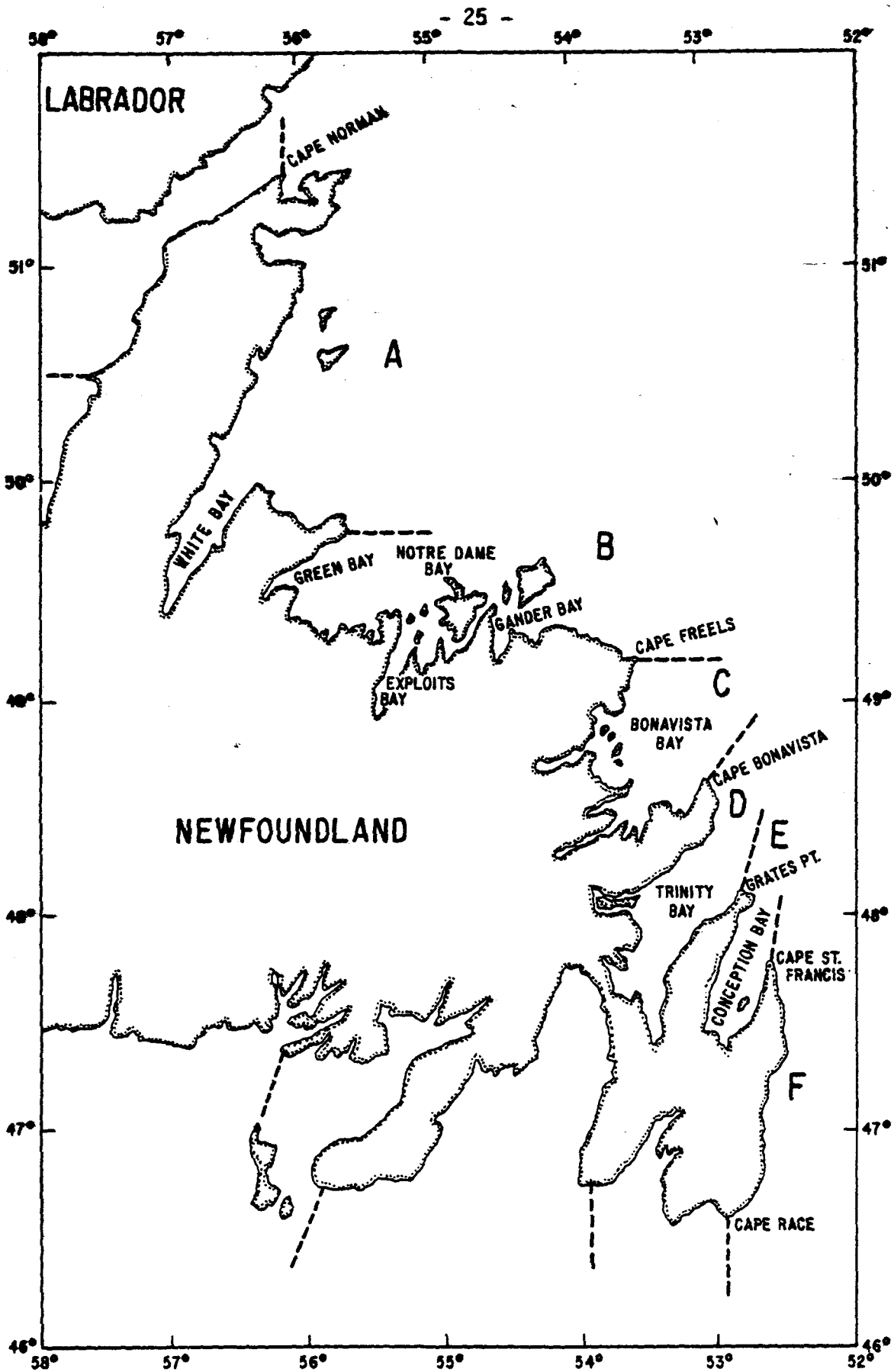
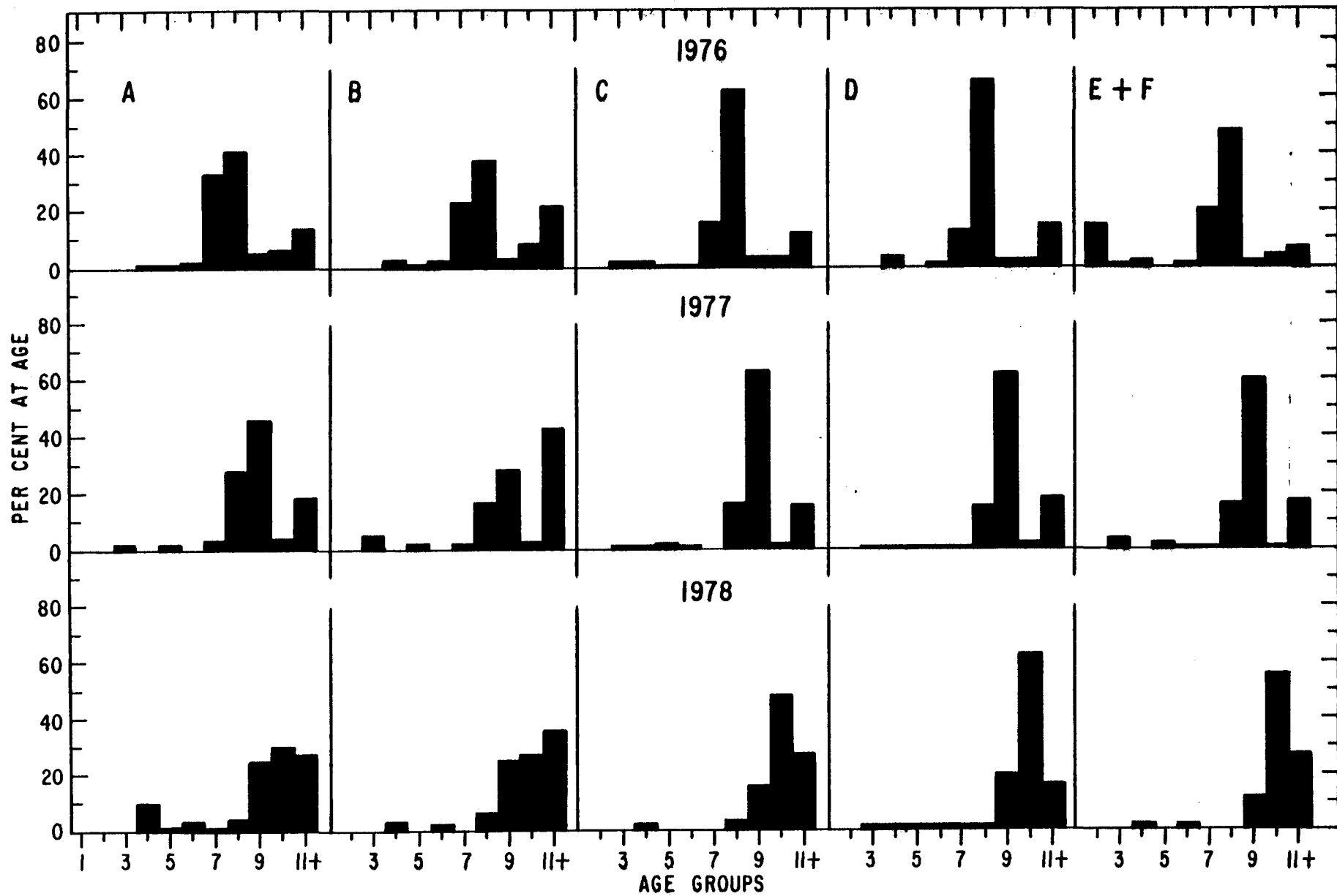Fig. 1 Area Map of the east coast of Newfoundland.

Fig. 2 Age distribution of herring in the landings from the
subunits of the east coast herring stocks for the
years   1976 - 78

Fig. 3 Yield per recruit curves for the east coast
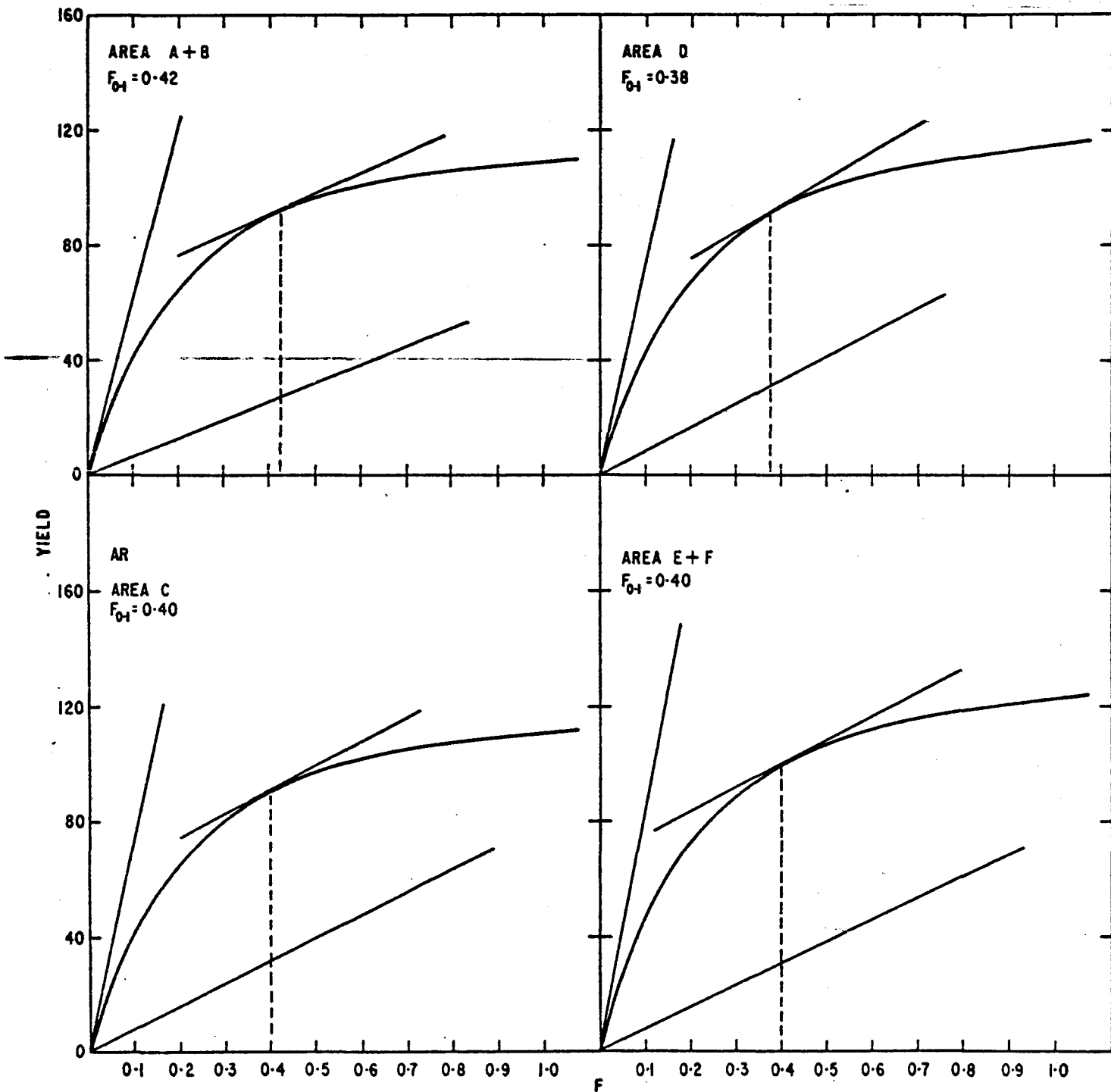Newfoundland herring stocks.

Appendix

Herring East Coast Nfld.

A. Partial Recruit Rates:

Age	2	3	4	5	6	7	8 →
%	.01	.05	.25	.60	1.0	1.0	1.0 →

B. Assumed Catches 1979

Area	Catch (mt)
A+B	14,000
C	5,500
D	3,000
E+F	1,800

$F_T = 0.25$

HERRING AREA 4&B 1969-78 SS X10-3 AGES 2-20

KNOWN CATCHES

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	1.	10.	1.	5.	1.	1.	2.	121.	52.	1.
3	54.	1.	304.	292.	728.	5.	128.	32.	1704.	47.
4	103.	13.	51.	2448.	1495.	119.	216.	611.	109.	1605.
5	19.	25.	159.	362.	2939.	3176.	460.	245.	468.	245.
6	137.	25.	57.	70.	784.	5524.	5468.	818.	184.	898.
7	1.	987.	430.	126.	737.	1198.	7090.	10280.	796.	438.
8	108.	11.	10134.	409.	679.	704.	1123.	16377.	7381.	2230.
9	9.	86.	235.	1391.	419.	1511.	836.	1295.	12697.	9471.
10	59.	161.	278.	208.	1707.	861.	809.	3304.	1055.	10461.
11	41.	167.	1139.	67.	177.	1552.	1072.	1391.	4489.	818.
12	1.	116.	1181.	275.	57.	161.	1932.	1842.	1890.	3467.
13	1.	1.	820.	285.	234.	52.	200.	3320.	2502.	1460.
14	1.	1.	1.	198.	243.	213.	66.	344.	4510.	1932.
15	1.	1.	1.	1.	168.	221.	265.	113.	467.	3483.
16	1.	1.	1.	1.	1.	152.	275.	455.	154.	361.
17	1.	1.	1.	1.	1.	1.	189.	473.	618.	119.
18	1.	1.	1.	1.	1.	1.	1.	325.	643.	477.
19	1.	1.	1.	1.	1.	1.	1.	1.	441.	497.
20	1.	1.	1.	1.	1.	1.	1.	1.	1.	339.

ESTIMATED FISHING MORTALITY

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977
2	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001	0.0006	0.0029	0.0112
3	0.0004	0.0000	0.0010	0.0015	0.0230	0.0009	0.0144	0.0116	0.0515
4	0.0016	0.0001	0.0018	0.0097	0.0091	0.0046	0.0506	0.0886	0.0497
5	0.0002	0.0005	0.0017	0.0158	0.0144	0.0241	0.0223	0.0746	0.0907
6	0.0008	0.0004	0.0013	0.0009	0.0431	0.0338	0.0526	0.0499	0.0737
7	0.0001	0.0074	0.0080	0.0036	0.0121	0.0858	0.0553	0.1326	0.0629
8	0.0191	0.0009	0.0976	0.0094	0.0243	0.0143	0.1082	0.1750	0.1327
9	0.0004	0.0190	0.0225	0.0173	0.0118	0.0691	0.0211	0.1754	0.1997
10	0.0025	0.0089	0.0787	0.0249	0.0266	0.0303	0.0479	0.1089	0.2117
11	0.0026	0.0088	0.0802	0.0244	0.0266	0.0303	0.0480	0.1088	0.2118
12	0.0252	0.0090	0.0799	0.0249	0.0260	0.0304	0.0480	0.1089	0.2117
13	0.0317	0.0317	0.0810	0.0248	0.0266	0.0298	0.0479	0.1089	0.2118
14	0.0402	0.0402	0.0402	0.0252	0.0265	0.0304	0.0480	0.1089	0.2118
15	0.0513	0.0513	0.0513	0.0513	0.0268	0.0303	0.0480	0.1085	0.2116
16	0.0665	0.0665	0.0665	0.0665	0.0665	0.0305	0.0479	0.1089	0.2117
17	0.0878	0.0878	0.0878	0.0878	0.0878	0.0878	0.0482	0.1087	0.2119
18	0.1188	0.1188	0.1188	0.1188	0.1188	0.1188	0.1188	0.1094	0.2116
19	0.1673	0.1673	0.1673	0.1673	0.1673	0.1673	0.1673	0.1673	0.2127
20	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500

Nfld. East Coast - Yield Per Recruit

	Fishing Mortality	Catch Number	Yield (kg)	Avg. Weight (kg)	Yield Per Unit Effort
	.300	.33686	.087	.257	1.000
F0.1 ---	.386	.37217	.094	.253	.845
	.600	.42988	.105	.245	.609
	.900	.47742	.113	.237	.436
	1.200	.50813	.118	.231	.340
	1.500	.53051	.120	.226	.277
	1.800	.54804	.122	.222	.234
	2.100	.56241	.123	.218	.203
	2.400	.57458	.123	.215	.178
	2.700	.58512	.124	.211	.159
	3.000	.59441	.124	.209	.143
	3.300	.60272	.124	.206	.130
FMAX ---	3.518	.60825	.124	.204	.122
	3.600	.61023	.124	.203	.120
	3.900	.61708	.124	.201	.110
	4.200	.62338	.124	.199	.102
	4.500	.66920	.124	.197	.095
	4.800	.63461	.124	.195	.089
	5.100	.63967	.123	.193	.084
	5.400	.64441	.123	.191	.079
	5.700	.64888	.123	.190	.075
	6.000	.65311	.123	.188	.071

Area A+B

Fixed Catch in 1979

	F = 0.30			F = 0.386		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	216798	59078	10887	216798	59078	10887
1979	151925	41477	14000	151925	41477	14000
1980	90491	23177	4983	90491	23177	6168
1981	68394	16244	3177	64828	15180	3625

Fixed Recruitment

	F = 0.30			F = 0.40		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	216798	59078	10887	216798	59078	10887
1979	151925	41477	9010	151925	41477	11500
1980	105615	27710	6050	98059	25444	7032
1981	77476	18998	3826	68390	16262	4059

Average Recruitment
F = 0.30

Year	Pop. No.	Pop. Bio.	Catch Bio.
1978	216798	59078	10887
1979	187038	44286	9017
1980	180245	35199	6111
1981	254851	37973	4224

Area C

Fixed Catch in 1979

	F = 0.30			F = 0.386		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	98142	27132	5175	98142	27132	5175
1979	73697	19651	5500	73697	19651	5500
1980	54179	12774	2465	54179	12774	3054
1981	47094	10019	1675	45379	9487	1925

Fixed Recruitment

	F = 0.30			F = 0.40		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	98142	27132	5175	98142	27132	5175
1979	73697	19651	4201	73697	19651	5357
1980	57926	13953	2742	54591	12903	3184
1981	49370	10739	1844	45340	9477	1980

Average Recruitment
F = 0.30

Year	Pop. No.	Pop. Bio.	Catch Bio.
1978	98142	27132	5175
1979	113976	22873	4210
1980	122633	20872	2808
1981	127126	21280	2229

Area D

Fixed Catch in 1979

	F = 0.30			F = 0.386		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	51157	14312	2264	51157	14312	2264
1979	36227	11016	3000	36227	11016	3000
1980	22647	6900	1433	22647	6900	1775
1981	15719	4631	959	14810	4323	1101

Fixed Recruitment

	F = 0.30			F = 0.40		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	51157	14312	2264	51157	14312	2264
1979	36227	11016	2409	36227	11016	3070
1980	24218	7443	1560	22461	6836	1809
1981	16674	4961	1036	14567	4240	1109

Average Recruitment
F = 0.30

Year	Pop. No.	Pop. Bio.	Catch Bio.
1978	51157	14312	2264
1979	46046	11802	2411
1980	37541	9038	1577
1981	36402	7730	1140

Area E+F

	Fixed Catch in 1979					
	F = 0.30			F = 0.386		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	17403	5646	1868	17403	5646	1868
1979	10207	3241	1800	10207	3241	1800
1980	4761	1229	234	4761	1229	290
1981	4283	999	158	4138	949	181

	Fixed Recruitment					
	F = 0.30			F = 0.30		
Year	Pop. No.	Pop. Bio.	Catch Bio.	Pop. No.	Pop. Bio.	Catch Bio.
1978	17403	5646	1868	17403	5646	1868
1979	10207	3241	721	10207	3241	919
1980	7488	2193	461	6982	2014	534
1981	5939	1586	296	5336	1373	314

	Average Recruitment		
	F = 0.30		
Year	Pop. No.	Pop. Bio.	Catch Bio.
1978	17403	5646	1868
1979	11964	3382	
1980	16694	3058	
1981	23854	3771	