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An Assessment of the East Coast Newfoundland Herring Stocks

by

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ABSTRACT

There are four recognized east coast Newfoundland stock complexes; 1) White Bay-Notre Dame Bay; 2) Bonavista Bay; 3) Trinity Bay; and 4) Conception Bay-Southern Shore. The assessment summarizes the results of data collected in 1980 for each stock and presents prognoses of yield and abundance for 1981-1985. Total landings dropped from 26,300 mt in 1979 to 11,400 mt in 1980 due to a reduction in the 1980 TAC. The 1968 and 1969 year-classes continue to sustain the fishery in all areas with over 85% of the catch age 10+. Age specific weights and partial recruitment rates have been changed from those used in previous assessments to reflect changes with declining stock sizes. Three sources of catch rate data were used: 1) ring net purchase slips; 2) ring net log records; and 3) gillnet purchase slips. The gillnet information was considered the most reliable and was used in the calculation of total mortality coefficients (Z). Estimates of terminal fishing mortality (F_t) were derived from trial runs of cohort analysis for

each of the Z's calculated. Results of the assessment showed a continuing decline in biomass levels in all stock areas primarily due to poor recruitment since 1969. Projections for 1981 at $F_{0.1}$ = 0.30 gave a total east coast Newfoundland TAC of 7,230 mt. Projections, made to 1985, assuming a continuation of the recent low levels of recruitment, showed that the 2+ biomass of all these stocks would decline in the early 1980's even in the absence of fishing.

RESUME

On reconnaît quatre complexes de stocks le long de la côte est de Terre-Neuve : 1) baie Blanche-baie Notre-Dame; 2) baie Bonavista; 3) baie de la Trinité; et 4) baie de la Conception-côte sud. Nous résumons dans la présente évaluation les données recueillies sur chaque stock en 1980 et présentons des prévisions de rendement et d'abondance pour 1981-85. Par suite d'une réduction du TPA de 1980, les débarquements totaux ont diminué, passant de 26 300 tm en 1979 à 11 400 tm en 1980. Les classes d'âge de 1968 et 1969 continuent de supporter la pêche dans toutes les régions, plus de 85 % des prises étant âgés de 10 ans et plus. Afin de refléter les changements qui se sont produits par suite de la réduction des effectifs des stocks, les poids par âge et les taux de recrutement partiel ont été également modifiés. Nous avons puisé à trois sources de données sur les taux de capture : 1) bordereaux d'achat des prises des bolinches; 2) journaux de bord des bateaux pêchant à la bolinche; et 3) bordereaux d'achat des prises des filets maillants. Les données des filets maillants ont été utilisées dans le calcul des coefficients de mortalité totale (Z) car elles étaient considérées comme étant les plus fiables. Des analyses de

cohortes ont été effectuées avec les Z et ont été utilisées pour estimer les mortalités par pêche de la dernière année (F_t). Les résultats de l'évaluation montrent une diminution régulière des niveaux de biomasse dans tous les stocks, en grande partie à cause d'un faible recrutement depuis 1969. Les projections pour 1981 à $F_{0,1}$ = 0,30 donnent, pour toute la côte est de Terre-Neuve un TPA de 7 230 tm. Les projections portées à 1985, en supposant que le recrutment demeurera aux mêmes bas niveaux des dernières années, indiquent que la biomasse d'âge 2+ de tous ces stocks diminuerait dans la première partie des années 1980, même en l'absence de pêche.

INTRODUCTION

Prior to 1970, herring landings along the east coast of Newfoundland were historically low (< 10,000 mt). With the recruitment of the large 1968 year-class in the mid-1970's and the development of a small (< 65 ft.) ring net fleet, landings increased to a peak of 26,400 mt in 1979. TAC's were first imposed on the ring net fleet in 1976 and then extended to include the fixed gear component in 1980.

This document follows last year's assessment (Wheeler and Winters 1980) and considers east coast Newfoundland herring as four stock complexes (Fig. 1): 1) White Bay-Notre Dame Bay (A&B); 2) Bonavista Bay (C): 3) Trinity Bay (D): and 4) Conception Bay-Southern Shore (E&F). It summarizes the results of data collected in 1980 and presents both short- and long-term prognoses of yield and abundance, assuming low levels of recruitment.

Recent Catch Statistics

Total landings peaked in 1979 (Table 1) at 26,363 mt and declined in 1980 to 11,492 mt. This decline was due to the reduction of the TAC in 1980 to 9,800 mt, the catch representing a 17% overrun of the TAC. Similar to 1979, inshore landings (gillnets, bar seines, and traps) represented approximately 70% of the total catch.

Age Composition Data

Age composition of commercial catches of herring from 1977 to 1980 are shown in Fig. 2. In all areas, the 1968 and 1969 year-classes continue to sustain the fishery, with fish age 10+ contributing 85% to the catch in White Bay-Notre Dame Bay, 93% in Bonavista Bay, 96% in Trinity Bay, and 97% in Conception Bay. All subsequent year-classes up to and possibly including the 1978 year-class are weak.

Assessment Parameters

(1) Age specific weights:

Average weights-at-age (Table 2) were derived from biological samples taken in the first two quarters of the year from each stock area. Age specific weights were changed from those used in last year's assessment to reflect a general increase in weight-at-age with declining stock sizes.

(2) Partial recruitment rates:

Evaluation of the fishing mortality matrices, from 1969 to 1978, of trial runs of cohort analysis, showed trends in the age specific selectivity patterns (Table 3) for each defined stock area. Consequently, the partial recruitment rates used in initiating cohort analysis were changed from those used in previous assessments of these stocks.

(3) CPUE analysis:

Three sources of catch rate data were used in this assessment: 1) ring net purchase slips, 2) ring net log records, and 3) gillnet purchase slips.

1. Ring net purchase slips: These have been the traditional sources of catch rate information, with data extending back to 1976. This year, only catch rates from those vessels with at least four years fishing experience were used. It was felt that this may help to alleviate the problem of "learning factors" as these vessels are beyond the initial major learning period. The data (Table 4) show a general increase in catch rates from 1978 to 1979 and a decrease from 1979 to 1980. The increase from 1978-79 may be partly attributed to a learning factor as the vessels had, at most, two years experience entering the fishery in 1979. The decrease from 1979 to 1980 may more truly reflect a decrease in stock abundance as in 1980 these vessels had four or more years fishing experience and learning factors would not be as important. One factor impossible to consider from ring net purchase slips is searching

time. Consequently, catch rate data derived from this source may not accurately represent stock abundance.

2. Ring net log records: Log books were distributed to the ring net fleet along the east coast for the first time in 1979. Therefore, detailed catch rate information is available only for 1979 and 1980. The data (Table 5) show decreased catch rates from 1979 to 1980 in White Bay-Notre Dame Bay and Bonavista Bay, increased catch rates in Trinity Bay, and similar rates in Conception Bay. These data should more accurately reflect stock abundance than purchase slip data as they include a measure of searching time.

3. Gillnet purchase slips: Gillnet catch rates were examined for three different categories: a) fishermen who have fished the same months each of the past three years; b) fishermen who have fished the same season each of the past three years; and, c) fishermen who have fished the same season each of the past four years. The first category represents the most concise sample and has smaller sample numbers. The second category is more general and includes the largest sample size. The third category, the four year fishermen, is a subsample of the third, but represents the longest time series of information.

To account for changes in the number of gillnets used over time, each of the fishermen included in the above categories was contacted and asked how many nets he had fished each year. Catches were standardized and catch-per-landing data were then calculated. The results (Tables 6 and 7) show a definite decline in catch per landing from 1979 to 1980 in all areas and a general decline over the three to four year period. Of the three sources of catch rate data, the gillnets are probably the most reliable as they are fished as a fixed gear and are not subject to searching time as are the ring netters. Change in amount of gear fished is also accounted for through the telephone surveys.

4. Calculation of total mortality ($\bar{z}$): The linear formula of Paloheimo (1961) has been used to calculate the total mortality coefficients ($\bar{z}$) for age groups 5+ for 1979-80 based on catch rate data from the three sources.

Effort (f) values were calculated from catch rate data based upon catches of that particular gear component. For example, the effort value for ring nets in area C in April, 1980, was calculated from catch rate of ring nets in area C in April, 1980, and the total catch of ring nets in area C in April, 1980.

The ring net purchase slip data (Table 8) gave variable values of Z for each of the stock areas. The ring net log record data (Table 9) gave generally higher values of Z, reflecting the inclusion of searching time on the catch rates.

The three year monthly gillnet data (Table 10) gave a further range of Z values. For areas A&B and C, the Z values were generally lower than those derived from ring net data; for areas D and E&F they were higher.

The three and four year seasonal gillnet data (Tables 11 and 12) showed similar trends to the three year monthly data (Table 10). For areas A&B, the seasonal (winter and spring) values of Z approximated those for each of the individual months combined. The Z value calculated from catch rates of four year seasonal fishermen (0.48) was lower than that of three year seasonal fishermen (0.60). For area C, the seasonal (fall) value of Z (0.18) was the same as the Z calculated for November (0.18) but much lower than the Z for October (0.63). October and November catch rates (Table 10) were combined and a Z calculated (0.42). This allowed the catch rate to be averaged over a longer time period and allowed the November gillnet catch, which was larger than the October catch, to be included in the calculation of effort. For

area D, the catch rate data for three year and four year seasonal gillnet fishermen were the same since they represented the same sample. All fishermen, who had fished three years, had also fished four. The Z value calculated from their catch rates (0.51), lower than that calculated for all months in Table 10 (0.80), possibly represents a truer estimate of mortality as it was calculated over the same time period both in 1979 and 1980. For areas E&F, there was only one catch rate source (all months - three year gillnet fishermen) from which a reasonable estimate of Z (0.26) could be calculated.

Trial runs of the cohort analysis were made to obtain the best estimates of terminal fishing mortality (F_t) for each of the Z's calculated. These data are summarized in Table 13. In choosing the best estimates of mortality for cohort analysis, estimates obtained from ring net purchase slips were considered unreliable as they included no measure of searching time. Log records included such measures but were available for too short a time series (two years). Gillnet catch rates were available over a longer time series and tended to include larger sample sizes. Searching time did not have to be considered and changes in amount of gear used could be determined. Hence, the gillnet catch rate data were considered the best indicators of changes in stock abundance.

For areas A&B, the F_t (0.31) derived from winter and spring - four year gillnet fishermen was considered to be the best estimate as it included catches over several months by the most experienced fishermen. For area C, the combined F_t estimate for October/ November - three year gillnet fishermen (0.24) was used. It was considered the best estimate as it combined two months of substantial gillnet landings by relatively experienced fishermen. Similar to areas A&B, a F_t = 0.31 was chosen as the best estimate for area D. This was derived from catch rates of the spring fishery - four year gillnet fishermen. For areas E&F, F_t = 0.08 was the only estimate of terminal fishing mortality derived from any of the catch rate sources. Based upon the knowledge of the fishery by the authors, it was felt that this estimate was too low. Estimates of F_t derived from Paloheimo $\bar{Z}$'s for the past three years were compared with estimates of F generated by cohort analysis (Table 14) to try to obtain a more realistic estimate of F_t for areas E&F. For areas A - D, estimates of F for 1978 generated by cohort analysis using the aforementioned F_t's coincided with the F's for 1978 derived from $\bar{Z}$'s. Trial runs of cohort analysis conducted for areas E&F to obtain a similar fit produced a F_t = 0.30. Therefore, the estimates of F for 1980 used in this assessment are as follows:

	Area			
	A&B	C	D	E&F
F_t	0.31	0.24	0.31	0.30

Results of the Assessment

Trends in Biomass and F:

Biomass levels continue to decrease in all stock areas along the east coast of Newfoundland (Tables 15-18). Peak biomass levels occurred in 1972-73 with the recruitment of the very strong 1968-69 year-classes. The 1980 biomass levels are the lowest observed for the time series.

The level of fishing mortality (F_5+) shows a decrease in all areas from the peak levels in 1979 (Tables 15-18) and is at or below the F opt. (0.30) projected in last year's assessment.

Trends in Recruitment:

Recruitment has been very poor in each stock area since that of the large 1968 and 1969 year-classes. The 1974 and 1976 year-classes, which initially appeared to be of moderate strength, contribute 5% each to the catch in areas A&B and less than 2% each in areas C, D, and E&F.

Estimation of $F_{0.1}$:

Since both the average weight-at-age and mean recruitment rates were changed from last year's assessment, new yield per recruit curves were constructed. Estimates of $F_{0.1}$ derived are as follows:

	Area			
	A&B	C	D	E&F
$F_{0.1}$	0.32	0.30	0.33	0.30

Projections were made at F = 0.30 for all areas.

Catch Projections:

Catch projections were performed separately for each stock area for 1981-85 (Tables 19-26) using two options: 1) using the appropriate F_t and $F_{0.1} = 0.30$, and 2) assuming no fishery, i.e. F = 0.00.

Recruitment was held constant at a level equal to the average recruitment for the last five years (1976-80). The recruitment values were as follows:

	Area			
	A&B	C	D	E&F
Recruitment ($x10^{-6}$)	6.2	1.2	0.2	0.4

The catch projections were adjusted by the following correction factors to account for seasonal changes in weight:

	Area			
	A&B	C	D	E&F
Correction factor	1.13	1.16	1.09	1.07

The correction factors were calculated as the ratio of actual 1980 catch to the calculated 1980 catch.

The first catch projection option provides the following (adjusted) 1981 TAC levels by area:

	Area			
	A&B	C	D	E&F
B_2+ (mt)	14295	9227	3102	1132
TAC (mt)	3659	2499	792	280

Using this option the total east coast of Newfoundland TAC for 1981 would be 7230 mt.

The second catch projection option shows that, if poor recruitment continues, abundance of all these stocks (2+ biomass) will continue to decline in the early 1980's even in the absence of fishing.

DISCUSSION

For the first time in 1980, both inshore and ring net components of the east coast Newfoundland herring fishery were under quota restrictions; in previous years only the ring net component was affected by quotas. Although this caused some serious management problems, due to small quota (9,800 mt) and large numbers of fishermen, it did reduce the previous problem of overriding of quotas. For example, in 1979 the quota was overtaken by 27%; in 1980, this was reduced to 17%. With a new management plan in effect for 1981, this problem should be further alleviated.

In the past, all catch rate information was derived from either ring net or gillnet purchase slips. In this year's assessment, ring net log records were used for the first time. These logs should prove valuable in future if an adequate time series can be established. However, as quotas have decreased, the ring net fleet allocation has become smaller, reducing the sample size of log records which can be used. To help offset this problem, an experimental program was established in the spring of 1981 whereby selected gillnet fishermen were asked to keep detailed catch rate information in log book form. Initial log returns from this program look favourable and will be compared to purchase slip information to determine if the program should be expanded to include all gillnet fishermen.

One further positive step towards the assessment of east coast Newfoundland herring stocks has been the establishment of the research gillnet program in the fall of 1980. Fishermen in each of the stock areas (three in A&B, two in C, one in D, and one in E&F) were contracted in October-November to fish five experimental gillnets (mesh sizes 2", 2 1/4", 2 1/2", 2 3/4", and 3"), keep detailed catch rate information, and provide samples of their catch. Analyses of these data are not yet complete, but initial observations (Table 27) for areas A&B show different trends in age composition of the experimental catch from commercial catches. Results from samples aged thus far for area C show even greater percentages of younger fish being caught, (24% age 2, 13% age 4, 4% age 6, and 59% age 10 and 11+). It is proposed to expand this program in the fall of 1981 to include more fishermen in each stock area. Two years of data should be available for comparison in next years assessment.

All east coast Newfoundland herring stocks have been declining since 1973 when the 1968 and 1969 year-classes became fully recruited to the fishery. With the poor recruitment pattern the decline will continue at least for the immediate future. There have been consistent reports of small "mudge" herring in Notre Dame and Bonavista bays for the past couple of years. There has been no evidence of recruitment in commercial catches but a definite sign in the experimental research nets. Comparison of two years of such data will be most valuable next year.

REFERENCES

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Table 1. East Coast herring landings (metric tons) by area and gear, 1973-80.

Year	Gear	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
	TOTAL	1779	9815	9248	2693	2177	25712
1978	Inshore	1704	6476	1473	1282	714	11649
	Ring net	1254	3980	4239	1055	1231	11759
	TOTAL	2958	10456	5712	2337	1945	23408
1979	Inshore	1051	11843	2755	2350	451	18450
	Ring net	832	1968	3490	1181	442	7913
	TOTAL	1883	13811	6245	3531	893	26363
1980	Inshore	1451	3515	1937	750	159	7812
	Ring net	485	792	1439	644	320	3680
	TOTAL	1936	4307	3376	1394	479	11492

1980 figures are provisional.
No purse seine landings after 1976.

Table 2. Average weight at age (gm) of Newfoundland East Coast herring in 1979-80.

Age	Area			
	A&B	C	D	E&F
2	90	59	90	95
3	160	140	150	126
4	199	212	208	250
5	297	265	268	280
6	282	284	320	310
7	295	291	330	335
8	299	307	328	356
9	307	316	343	337
10	305	307	316	319
11+	328	334	362	379

Table 3. Age specific selectivity patterns for each defined stock, used to initiate cohort analysis.

Age	Area			
	A&B	C	D	E&F
2	0.10	0.15	0.15	0.30
3	0.35	0.40	0.25	0.45
4	0.55	0.70	0.40	0.60
5	1.00	1.00	0.65	0.80
6	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00
11+	1.00	1.00	1.00	1.00

Table 4. Catch per unit effort (mt/op. day), from purchase slips, for ring net vessels with at least four years experience.

Area	Year	Catch per operating day (m tons)										Unwgt. ave.	Wgt. ave.
		Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.		
E&F	1978	38.5	-	-	-	-	15.2	2.0*	-	-	-	26.9	33.9
(336)	1979	13.6	-	-	-	-	-	-	-	-	-	13.6	14.6
	1980	16.4	-	-	-	-	-	-	-	-	-	16.4	16.4
D	1978	14.4	-	-	0.2*	3.2*	9.2	-	16.6*	-	22.7	15.4	13.3
(337)	1979	16.1	0.9*	-	-	-	-	-	20.0	11.8	-	16.0	15.1
	1980	20.5	-	-	-	-	-	15.3	8.2	-	-	14.7	16.3
C	1978	19.8	-	-	-	0.3*	2.7	16.5	-	-	-	13.0	16.3
(338)	1979	17.4	-	-	-	-	-	11.0	-	-	-	14.2	13.4
	1980	15.4	-	-	-	-	-	9.7	-	-	-	12.6	11.4
A&B	1978	12.5	7.0	7.3	2.2*	4.5	27.9	20.3	-	-	-	13.3	17.1
(339-	1979	24.8	-	11.4	-	33.4	-	24.9	-	-	-	23.6	25.6
341)	1980	16.6	12.0	16.4*	-	-	-	18.1	-	-	-	15.6	16.6

* indicates < 3 trips.

Table 5. Catch per unit effort (mt/set op. day), from log records for ring net vessels with at least four years experience.

Area	Year	Catch/set op. day		Average	
		Apr.	Oct.	Unweighted	Weighted
E&F	1979	1.6	-	1.6	-
(336)	1980	1.7	-	1.7	-
D	1979	2.5	-	2.5	-
(337)	1980	4.0	-	4.0	-
C	1979	6.1	2.5	4.3	4.0
(338)	1980	2.4	1.1	1.8	2.2
A&B	1979	7.8	-	7.8	-
(339)	1980	4.8	-	4.8	-

Table 6. Catch per unit effort (mt/landing), from purchase slips, for gillnet fishermen who have fished the same months for the past three years.

Area	Year	Month									Weighted average
		Feb.	Mar.	Apr.	May	June	July	Sept.	Oct.	Nov.	
E&F	1978	-	-	(0.86)	0.75	-	-	-	-	-	0.77
(336)	1979	-	-	0.39	0.90	(0.15)	-	-	-	-	0.50
	1980	-	-	0.29	(0.14)	(0.39)	-	-	-	-	0.27
D	1978	-	-	0.36	-	-	-	-	-	-	0.36
(337)	1979	-	-	0.92	(0.34)	-	-	-	-	-	0.89
	1980	-	-	0.57	(0.24)	-	-	-	-	-	0.56
C	1978	-	-	(0.54)	-	-	(0.06)	-	0.29	0.63	0.50
(338)	1979	-	(0.41)	1.11	-	-	0.13	-	0.44	0.59	0.60
	1980	-	(0.05)	0.89	-	-	0.14	-	0.23	0.47	0.50
A&B	1978	1.18	-	0.52	0.32	0.20	-	(0.14)	0.59	-	0.42
(339-	1979	0.92	-	0.78	0.33	0.39	-	0.57	0.34	-	0.47
341)	1980	0.75	-	0.46	0.24	0.17	-	1.06	0.46	-	0.40

( ) indicate <5 landings.

Table 7. Catch per unit effort (mt/landing), from purchase slips, for gillnet fishermen who have fished the same seasons for A) the past three years, and B) the past four years.

Area	Season	Year	3 Yr. Fishermen	4 Yr. Fishermen
E&F (336)	Spring	1977	-	1.30
		1978	0.56	0.96
		1979	0.50	0.49
		1980	0.46	0.56
D (337)	Spring	1977	-	0.23
		1978	-	0.39
		1979	-	0.33
		1980	-	0.29
C (338)	Fall	1977	-	1.74
		1978	0.62	0.78
		1979	0.50	0.52
		1980	0.28	0.36
A&B (339-341)	Winter & Spring	1977	-	1.23
		1978	0.58	0.88
		1979	0.62	0.91
		1980	0.39	0.65

Table 8. Calculation of instantaneous total mortality rates ($\bar{z}$), by month, from catch per unit effort indices (from purchase slips) for ring net vessels with at least four years experience.

Area	Month	Catch/op. day			f			$\bar{z}$	F_t
		1978	1979	1980	1978	1979	1980	79-80	79-80
A&B	Apr.	12.5	24.8	16.6	8	28	35	1.31	-
	Oct.	20.3	24.9	18.1	84	51	30	0.56	0.39
	ALL	17.1	25.6	16.6	306	109	77	0.74	0.57
C	Apr.	19.8	17.4	15.4	75	96	37	-0.28	-
	Oct.	16.5	11.0	9.7	161	166	89	0.05	-
	ALL	16.3	13.4	11.4	260	260	126	-0.05	-
D	Apr.	14.4	16.1	20.5	18	42	20	0.31	0.11
	ALL	13.3	15.1	16.3	79	78	40	0.38	0.18
E&F	Apr.	38.5	13.6	16.4	11	33	20	0.02	-
	ALL	33.9	14.6	16.4	36	30	20	0.12	-

Table 9. Calculation of instantaneous total mortality rates (Z), by month, from catch per unit effort indices (from logs) for ring net vessels with at least four years experience.

Area	Month	Catch/op. day set 1979	Catch/op. day set 1980	f 1979	f 1980	Z 79-80	F_t 79-80
A&B	Apr.	7.8	4.8	88	121	1.41	-
C	Apr.	6.1	2.4	273	238	0.54	0.36
	Oct.	2.5	1.1	730	789	0.76	0.58
	ALL	(4.3)	(1.8)	812	799	0.66	0.48
D	Apr.	2.5	4.0	268	104	0.10	-
E&F	Apr.	1.6	1.7	270	188	0.16	-

( ) unweighted averages.

Table 10. Calculation of instantaneous total mortality rates ($\hat{Z}$), by month, from catch per unit effort indices of gillnet fishermen who have fished for the past three years, 1978-80.

Area	Month	Catch/landing			f			$\hat{Z}$	F_t
		1978	1979	1980	1978	1979	1980	79-80	79-80
A&B	Feb.	1.18	0.92	0.75	170	387	1129	2.16	-
	Apr.	0.52	0.78	0.46	1469	5227	2348	0.29	0.12
	May	0.32	0.33	0.24	9019	6545	4275	0.66	0.49
	June	0.20	0.39	0.17	4690	1203	2153	1.67	-
	Oct.	0.59	0.34	0.46	1570	2106	904	0.24	0.07
	ALL	0.42	0.47	0.40	16648	21168	10373	0.38	0.21
C	Apr.	0.54	1.11	0.89	46	354	810	1.51	-
	Oct.	0.29	0.44	0.23	303	659	630	0.63	0.45
	Nov.	0.63	0.59	0.47	340	869	528	0.18	-
	Oct./Nov.	0.52	0.52	0.33	581	1544	1191	0.42	0.24
	ALL	0.50	0.60	0.50	2640	3957	2586	0.25	0.07
D	Apr.	0.36	0.92	0.57	219	150	544	2.34	-
	ALL	0.36	0.89	0.56	856	764	596	0.80	0.60
E&F	Apr.	0.86	0.39	0.29	90	172	345	1.22	-
	May	0.75	0.90	0.14	355	90	14	-1.34	-
	ALL	0.77	0.50	0.27	640	518	396	0.26	0.08

Table 11. Calculation of instantaneous total mortality (Z), by season, from catch per unit effort indices of gillnet fishermen who have fished for the past three years, 1978-80.

Area	Season	Catch/landing			f			Z	F_t
		1978	1979	1980	1978	1979	1980	79-80	79-80
A&B	Winter & Spring	0.58	0.62	0.39	9338	13839	8518	0.60	0.43
C	Fall	0.62	0.50	0.28	569	2336	1414	0.18	-
D	Spring	0.39	0.33	0.29	579	1900	1114	0.51	0.31
E&F	Spring	0.56	0.50	0.46	709	502	233	-0.24	-

Table 12. Calculation of instantaneous total mortality ($\bar{Z}$), by season, from catch per unit effort indices of gillnet fishermen who have fished the past four years, 1977-80.

Area	Season	Catch/landing				f				$\bar{Z}$	F_t
		1977	1978	1979	1980	1977	1978	1979	1980	79-80	79-80
A&B	Winter & Spring	1.23	0.88	0.91	0.65	1437	6155	9429	5111	0.48	0.31
C	Fall	1.74	0.78	0.52	0.36	100	453	2246	1100	-0.04	-
D	Spring	0.23	0.39	0.33	0.29	278	579	1900	1114	0.51	0.31
E&F	Spring	1.30	0.96	0.49	0.56	143	414	512	191	-0.46	-

Table 13. Summary of total mortality coefficient ($\bar{Z}$) values and resultant estimates of terminal fishing mortality (F_t) calculated from the various sources of catch rate data.

Area	$\bar{Z}$	F_t	Catch rate source
A&B (339-341)	0.24	0.07	October - 3 year gillnet fishermen
	0.29	0.12	April - 3 year gillnet fishermen
	0.38	0.21	All months - 3 year gillnet fishermen
	0.48	0.31	Winter & Spring - 4 year gillnet fishermen
	0.56	0.39	October - ring net purchase slips
	0.60	0.43	Winter & Spring - 3 year gillnet fishermen
	0.66	0.49	May - 3 year gillnet fishermen
	0.74	0.57	All months - ring net purchase slips
C (338)	0.25	0.07	All months - 3 year gillnet fishermen
	0.42	0.24	Oct.-Nov. - 3 year gillnet fishermen
	0.54	0.36	April - ring net log records
	0.63	0.45	October - 3 year gillnet fishermen
	0.66	0.48	All months - ring net log records
	0.76	0.58	October - ring net log records
D (337)	0.31	0.11	April - ring net purchase slips
	0.38	0.18	All months - ring net purchase slips
	0.51	0.31	Spring - 4 year gillnet fishermen
	0.80	0.60	All months - 3 year gillnet fishermen
E&F (335-336)	0.26	0.08	All months - 3 year gillnet fishermen

Table 14. Comparison of fishing mortality (F) estimates derived from Paloheimo Z's and cohort analysis.

Area	Year	F	
		Paloheimo	Cohort
A&B	77-78	0.25	0.25
	78-79	0.40	0.50
	79-80	0.31	0.28
C	77-78	0.23	0.19
	78-79	0.30	0.29
	79-80	0.24	0.22
D	77-78	0.20	0.19
	78-79	0.30	0.49
	79-80	0.31	0.31
E&F	77-78	0.47	0.46
	78-79	0.20	0.10
	79-80	?	0.30

Table 15. Results of cohort analysis for areas A&B, 1969-80, F_t = 0.31.

Age	Population numbers ($\times 10^{-5}$)											
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	474	4317	3247	539	95	150	21	203	6	80	1	22
3	1546	388	3535	2658	441	77	123	17	165	4	65	1
4	716	1266	318	2891	2174	354	63	99	14	120	3	53
5	912	586	1036	260	2345	1766	289	50	76	10	80	2
6	1848	746	479	847	209	1893	1417	232	39	58	5	39
7	178	1512	611	392	693	164	1500	1111	183	30	38	2
8	64	146	1229	496	320	560	124	1164	817	143	20	18
9	370	51	119	914	403	256	453	91	805	602	94	9
10	345	302	41	95	736	326	196	363	63	544	395	57
11+	194	440	604	497	475	967	1030	959	978	700	771	562
Total	6647	9754	11218	9589	7889	6515	5215	4290	3144	2291	1471	763
B_2+ ($\times 10^{-2}$ mt)	1399	1659	1893	1926	1858	1658	1391	1145	866	630	436	234
B_5+ ($\times 10^{-2}$ mt)	1011	1008	1100	948	1355	1564	1360	1107	841	599	429	222
F_5+	.001	.005	.040	.011	.018	.029	.045	.120	.154	.247	.495	.280

Table 16. Results of cohort analysis for area C, 1969-80, F_t = 0.24.

Age	Population numbers ($\times 10^{-5}$)											
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	318	3890	1085	254	36	75	12	34	5	14	1	4
3	372	260	3185	888	208	29	61	9	28	4	12	1
4	315	305	213	2607	727	170	24	47	7	21	3	7
5	77	258	250	174	2131	595	140	19	36	5	14	1
6	808	63	211	204	140	1737	487	113	15	23	3	6
7	10	661	52	173	167	112	1421	389	92	10	16	2
8	160	9	539	42	141	137	92	1131	287	75	7	11
9	83	131	7	438	34	115	112	74	809	191	56	5
10	128	68	106	6	356	27	93	87	55	502	130	43
11+	139	217	231	274	227	469	403	396	367	301	525	383
TOTAL	2410	5862	5879	5060	4167	3467	2844	2299	1700	1145	767	463
B_2+ ($\times 10^{-2}$ mt)	514	789	935	1005	1012	899	763	629	485	331	245	151
B_5+ ($\times 10^{-2}$ mt)	379	385	384	369	843	857	749	616	479	325	243	149
F_5+	.001	.003	.005	.006	.007	.002	.027	.107	.210	.190	.293	.222

Table 17. Results of cohort analysis for area D, 1969-80, F_t = 0.31.

Age	Population numbers ($\times 10^{-5}$)											
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	104	2303	524	57	3	15	1	9	1	1	1	1
3	80	85	1886	429	47	3	12	1	7	1	1	1
4	177	66	69	1541	351	38	2	10	1	6	1	1
5	29	145	54	55	1253	287	31	1	6	1	5	1
6	300	24	118	44	44	1000	233	25	1	5	1	3
7	4	244	19	97	35	35	776	178	20	1	3	1
8	3	3	193	14	79	28	25	538	132	16	1	2
9	6	3	2	152	11	65	22	18	369	96	13	1
10	3	5	2	1	123	9	51	13	12	255	66	9
11+	18	15	14	10	7	105	87	100	75	52	204	134
TOTAL	724	2891	2882	2400	1954	1585	1241	893	623	434	294	149
B_2+ ($\times 10^{-2}$ mt)	155	328	441	509	481	415	341	252	180	131	98	53
B_5+ ($\times 10^{-2}$ mt)	96	117	109	102	397	405	338	249	179	130	98	53
F_5+	.017	.027	.038	.019	.023	.047	.140	.162	.166	.191	.486	.308

Table 18. Results of cohort analysis for areas E&F, 1969-80, F_t = 0.30.

Age	Population numbers ($\times 10^{-5}$)											
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	36	1434	247	13	4	14	1	17	1	1	1	1
3	113	30	1174	202	11	2	11	1	5	1	1	1
4	70	92	24	961	166	9	2	5	1	3	1	1
5	9	58	75	20	772	135	7	1	4	1	1	1
6	234	7	47	61	15	591	110	6	1	2	1	1
7	11	191	6	38	50	10	398	71	5	1	1	1
8	4	9	154	4	31	37	7	246	37	4	1	1
9	4	3	7	123	3	24	29	4	158	22	3	1
10	7	4	3	6	98	2	20	19	3	91	11	2
11+	15	17	15	14	14	89	68	62	58	41	67	47
TOTAL	504	1844	1752	1443	1162	913	653	433	273	167	88	57
B_2+ ($\times 10^{-2}$ mt)	119	226	314	341	311	256	193	129	85	54	31	19
B_5+ ($\times 10^{-2}$ mt)	81	84	89	79	270	253	190	126	84	53	31	19
F_5+	.003	.021	.017	.036	.066	.142	.247	.250	.309	.455	.309	.293

Table 19. Catch projection for areas A&B, 1981-85 with M = 0.20, F_t = 0.31 and $F_{0.1}$ = 0.30.

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1981	2	6200	496	166	13
	3	1721	229	156	21
	4	8	2	1	0
	5	3644	882	860	208
	6	129	33	30	8
	7	2324	618	549	146
	8	94	25	22	6
	9	1105	304	261	72
	10	559	156	132	37
	11	3417	1063	807	251
	12	11593	3605	2737	851
	13	9953	3095	2350	731
	14	767	239	181	56
	15	3259	1014	769	239
	16	1372	427	324	101
	17	1818	565	429	133
	18	3274	1018	773	240
	19	339	105	80	25
	20	1348	419	318	99
	Total	52924	14295	10946	3238
1982	2	6200	496	166	13
	3	4926	655	446	59
	4	1269	255	175	35
	5	6	1	1	0
	6	2210	559	522	132
	7	78	21	18	5
	8	1410	382	333	90
	9	57	16	13	4
	10	670	187	158	44
	11	339	105	80	25
	12	2073	645	489	152
	13	7032	2187	1660	516
	14	6037	1877	1425	443
	15	465	145	110	34
	16	1977	615	467	145
	17	832	259	196	61
	18	1103	343	260	81
	19	1986	618	469	146
	20	1023	318	242	75
	Total	39691	9683	7232	2062

Table 19. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1983	2	6200	496	166	13
	3	4926	655	446	59
	4	3631	730	502	101
	5	881	213	208	50
	6	3	1	1	0
	7	1341	357	316	84
	8	47	13	11	3
	9	855	235	202	56
	10	35	10	8	2
	11	407	126	96	30
	12	206	64	49	15
	13	1257	391	297	92
	14	4265	1326	1007	313
	15	3662	1139	864	269
	16	282	88	67	21
	17	1199	373	283	88
	18	505	157	119	37
	19	669	208	158	49
	20	1825	568	431	134
	Total	32194	7149	5230	1417
1984	2	6200	496	166	13
	3	4926	655	446	59
	4	3631	730	502	101
	5	2521	610	595	144
	6	534	135	126	32
	7	2	1	0	0
	8	813	220	192	52
	9	29	8	7	2
	10	519	145	122	34
	11	21	7	5	2
	12	247	77	58	18
	13	125	39	29	9
	14	762	237	180	56
	15	2587	804	611	190
	16	2221	691	524	163
	17	171	53	40	13
	18	727	226	172	53
	19	306	95	72	22
	20	1513	470	357	111
	Total	27854	5699	4206	1075

Table 19. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1985	2	6200	496	166	13
	3	4926	655	446	59
	4	3631	730	502	101
	5	2521	610	595	144
	6	1529	387	361	91
	7	324	86	76	20
	8	1	0	0	0
	9	493	136	116	32
	10	17	5	4	1
	11	315	98	74	23
	12	13	4	3	1
	13	150	47	35	11
	14	76	24	18	6
	15	462	144	109	34
	16	1569	488	370	115
	17	1347	419	318	99
	18	104	32	25	8
	19	441	137	104	32
	20	1103	343	260	81
	Total	25222	4840	3584	872

Table 20. Catch projection for areas A&B, 1981-85, with M = 0.20, F_t = 0.31 and F = 0.00.

Year	Age	Population numbers	Population weight
1981	2	6200	496
	3	1721	229
	4	8	2
	5	3644	882
	6	129	33
	7	2324	618
	8	94	25
	9	1105	304
	10	559	156
	11	3417	1063
	12	11593	3605
	13	9953	3095
	14	767	239
	15	3259	1014
	16	1372	427
	17	1818	565
	18	3274	1018
	19	339	105
	20	1348	419
	Total	52924	14295
1982	2	6200	496
	3	5076	675
	4	1409	283
	5	7	2
	6	2983	755
	7	106	28
	8	1903	516
	9	77	21
	10	905	252
	11	458	142
	12	2798	870
	13	9492	2952
	14	8149	2534
	15	628	195
	16	2668	830
	17	1123	349
	18	1488	463
	19	2681	834
	20	1381	430
	Total	49531	12627

Table 20. (Continued)

Year	Age	Population numbers	Population weight
1983	2	6200	496
	3	5076	675
	4	4156	835
	5	1154	279
	6	5	1
	7	2443	650
	8	86	23
	9	1558	428
	10	63	18
	11	741	230
	12	375	117
	13	2290	712
	14	7771	2417
	15	6672	2075
	16	514	160
	17	2185	679
	18	920	286
	19	1219	379
	20	3325	1034
	Total	46752	11496
1984	2	6200	496
	3	5076	675
	4	4156	835
	5	3403	823
	6	945	239
	7	4	1
	8	2000	542
	9	71	19
	10	1275	356
	11	52	16
	12	606	189
	13	307	95
	14	1875	583
	15	6362	1979
	16	5462	1699
	17	421	131
	18	1789	556
	19	753	234
	20	3720	1157
	Total	44477	10626

Table 20. (Continued)

Year	Age	Population numbers	Population weight
1985	2	6200	496
	3	5076	675
	4	4156	835
	5	3403	823
	6	2786	705
	7	773	206
	8	4	1
	9	1637	450
	10	58	16
	11	1044	325
	12	42	13
	13	497	154
	14	251	78
	15	1535	477
	16	5209	1620
	17	4472	1391
	18	345	107
	19	1464	455
	20	3662	1139
	Total	42615	9968

Table 21. Catch projection for area C, 1981-85, with M = 0.20, F_t = 0.24 and $F_{0.1}$ = 0.30.

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1981	2	1160	93	46	4
	3	320	43	33	4
	4	27	5	5	1
	5	483	122	114	29
	6	56	14	13	3
	7	381	101	90	24
	8	143	39	34	9
	9	693	198	164	47
	10	338	97	80	23
	11	2773	893	655	211
	12	4982	1604	1176	379
	13	12754	4107	3011	970
	14	975	314	230	74
	15	1178	379	278	90
	16	1002	323	237	76
	17	239	77	56	18
	18	2504	806	591	190
	19	33	11	8	3
	20	1018	2	240	0
	Total	31059	9227	7060	2154
1982	2	1160	93	46	4
	3	908	121	93	12
	4	232	44	40	8
	5	18	5	4	1
	6	293	76	69	18
	7	34	9	8	2
	8	231	62	55	15
	9	87	25	20	6
	10	420	121	99	28
	11	205	66	48	16
	12	1682	542	397	128
	13	3022	973	713	230
	14	7736	2491	1826	588
	15	591	190	140	45
	16	714	230	169	54
	17	608	196	143	46
	18	145	47	34	11
	19	1519	489	359	115
	20	637	1	150	0
	Total	20242	5779	4415	1327

Table 21. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1983	2	1160	93	46	4
	3	908	121	93	12
	4	659	126	114	22
	5	154	39	36	9
	6	11	3	3	1
	7	178	47	42	11
	8	21	6	5	1
	9	140	40	33	9
	10	53	15	12	4
	11	255	82	60	19
	12	124	40	29	9
	13	1020	328	241	78
	14	1833	590	433	139
	15	4692	1511	1108	357
	16	359	115	85	27
	17	433	140	102	33
	18	369	119	87	28
	19	88	28	21	7
	20	1308	3	309	1
	Total	13764	3445	2859	771
1984	2	1160	93	46	4
	3	908	121	93	12
	4	659	126	114	22
	5	438	111	103	26
	6	94	24	22	6
	7	7	2	2	0
	8	108	29	25	7
	9	12	4	3	1
	10	85	24	20	6
	11	32	10	8	2
	12	155	50	37	12
	13	75	24	18	6
	14	619	199	146	47
	15	1112	358	262	85
	16	2846	916	672	216
	17	218	70	51	17
	18	263	85	62	20
	19	224	72	53	17
	20	847	2	200	0
	Total	9859	2319	1937	505

Table 21. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1985	2	1160	93	46	4
	3	908	121	93	12
	4	659	126	114	22
	5	438	111	103	26
	6	265	68	63	16
	7	57	15	13	4
	8	4	1	1	0
	9	65	19	15	4
	10	8	2	2	1
	11	52	17	12	4
	12	19	6	5	1
	13	94	30	22	7
	14	46	15	11	3
	15	375	121	89	29
	16	674	217	159	51
	17	1726	556	407	131
	18	132	42	31	10
	19	159	51	38	12
	20	649	1	153	0
	Total	7490	1612	1378	338

Table 22. Catch projection for area C, 1981-85, with M = 0.20, F_t = 0.24 and F = 0.00.

Year	Age	Population numbers	Population weight
1981	2	1160	93
	3	320	43
	4	27	5
	5	483	122
	6	56	14
	7	381	101
	8	143	39
	9	693	198
	10	338	97
	11	2773	893
	12	4982	1604
	13	12754	4107
	14	975	314
	15	1178	379
	16	1002	323
	17	239	77
	18	2504	806
	19	33	11
	20	1018	2
	Total	31059	9227
1982	2	1160	93
	3	950	126
	4	262	50
	5	22	6
	6	395	102
	7	46	12
	8	312	84
	9	117	33
	10	567	163
	11	277	89
	12	2270	731
	13	4079	1313
	14	10442	3362
	15	798	257
	16	964	311
	17	820	264
	18	196	63
	19	2050	660
	20	860	2
	Total	26589	7722

Table 22. (Continued)

Year	Age	Population numbers	Population weight
1983	2	1160	93
	3	950	126
	4	778	149
	5	215	54
	6	18	5
	7	324	85
	8	38	10
	9	255	73
	10	96	28
	11	465	150
	12	227	73
	13	1859	599
	14	3340	1075
	15	8549	2753
	16	654	210
	17	790	254
	18	672	216
	19	160	52
	20	2383	5
	Total	22929	6009
1984	2	1160	93
	3	950	126
	4	778	149
	5	637	161
	6	176	45
	7	15	4
	8	265	72
	9	31	9
	10	209	60
	11	78	25
	12	380	122
	13	185	60
	14	1522	490
	15	2734	880
	16	7000	2254
	17	535	172
	18	647	208
	19	550	177
	20	2082	4
	Total	19933	5112

Table 22. (Continued)

Year	Age	Population numbers	Population weight
1985	2	1160	93
	3	950	126
	4	778	149
	5	637	161
	6	521	134
	7	144	38
	8	12	3
	9	217	62
	10	25	7
	11	171	55
	12	64	21
	13	311	100
	14	152	49
	15	1246	401
	16	2239	721
	17	5731	1845
	18	438	141
	19	529	170
	20	2155	4
	Total	17480	4282

Table 23. Catch projection for area D, 1981-85, with M = 0.20, F_t = 0.31 and $F_{0.1}$ = 0.30.

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1981	2	235	19	9	1
	3	19	3	1	0
	4	11	2	1	0
	5	48	12	8	2
	6	28	7	7	2
	7	151	41	36	10
	8	7	2	2	0
	9	109	31	26	7
	10	7	2	2	1
	11	534	186	126	44
	12	1976	688	466	162
	13	5005	1742	1182	411
	14	148	52	35	12
	15	106	37	25	9
	16	299	104	71	25
	17	40	14	9	3
	18	445	155	105	37
	19	2	1	0	0
	20	15	5	4	1
	Total	9185	3102	2114	727
1982	2	235	19	9	1
	3	184	27	12	2
	4	14	3	1	0
	5	8	2	1	0
	6	32	8	8	2
	7	17	5	4	1
	8	92	25	22	6
	9	4	1	1	0
	10	66	20	16	5
	11	4	1	1	0
	12	324	113	76	27
	13	1199	417	283	98
	14	3036	1056	717	249
	15	90	31	21	7
	16	64	22	15	5
	17	181	63	43	15
	18	24	8	6	2
	19	270	94	64	22
	20	10	4	2	1
	Total	5855	1921	1302	445

Table 23. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1983	2	235	19	9	1
	3	184	27	12	2
	4	140	31	14	3
	5	10	3	2	0
	6	5	1	1	0
	7	20	5	5	1
	8	10	3	2	1
	9	56	16	13	4
	10	3	1	1	0
	11	40	14	9	3
	12	3	1	1	0
	13	196	68	46	16
	14	727	253	172	60
	15	1841	641	435	151
	16	54	19	13	4
	17	39	14	9	3
	18	110	38	26	9
	19	15	5	3	1
	20	170	59	40	14
	Total	3858	1217	814	275
1984	2	235	19	9	1
	3	184	27	12	2
	4	140	31	14	3
	5	101	25	16	4
	6	7	2	2	0
	7	3	1	1	0
	8	12	3	3	1
	9	6	2	1	0
	10	34	10	8	2
	11	2	1	0	0
	12	24	8	6	2
	13	2	1	0	0
	14	119	41	28	10
	15	441	153	104	36
	16	1117	389	264	92
	17	33	11	8	3
	18	24	8	6	2
	19	67	23	16	5
	20	112	39	26	9
	Total	2662	795	525	173

Table 23. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1985	2	235	19	9	1
	3	184	27	12	2
	4	140	31	14	3
	5	101	25	16	4
	6	68	18	16	4
	7	4	1	1	0
	8	2	1	0	0
	9	7	2	2	0
	10	4	1	1	0
	11	20	7	5	2
	12	1	0	0	0
	13	15	5	3	1
	14	1	0	0	0
	15	72	25	17	6
	16	267	93	63	22
	17	677	236	160	56
	18	20	7	5	2
	19	14	5	3	1
	20	108	38	26	9
	Total	1943	541	355	113

Table 24. Catch projection for area D, 1981-85, with M = 0.20, F_t = 0.31 and F = 0.00.

Year	Age	Population numbers	Population weight
1981	2	235	19
	3	19	3
	4	11	2
	5	48	12
	6	28	7
	7	151	41
	8	7	2
	9	109	31
	10	7	2
	11	534	186
	12	1976	688
	13	5005	1742
	14	148	52
	15	106	37
	16	299	104
	17	40	14
	18	445	155
	19	2	1
	20	15	5
	Total	9185	3102
1982	2	235	19
	3	192	28
	4	16	3
	5	9	2
	6	39	10
	7	23	6
	8	124	34
	9	6	2
	10	89	27
	11	6	2
	12	437	152
	13	1618	563
	14	4098	1426
	15	121	42
	16	87	30
	17	245	85
	18	33	11
	19	364	127
	20	14	5
	Total	7755	2576

Table 24. (Continued)

Year	Age	Population numbers	Population weight
1983	2	235	19
	3	192	28
	4	158	35
	5	13	3
	6	7	2
	7	32	9
	8	19	5
	9	101	29
	10	5	1
	11	73	25
	12	5	2
	13	358	125
	14	1325	461
	15	3355	1168
	16	99	35
	17	71	25
	18	200	70
	19	27	9
	20	310	108
	Total	6584	2157
1984	2	235	19
	3	192	28
	4	158	35
	5	129	32
	6	10	3
	7	6	2
	8	26	7
	9	15	4
	10	83	25
	11	4	1
	12	60	21
	13	4	1
	14	293	102
	15	1084	377
	16	2747	956
	17	81	28
	18	58	20
	19	164	57
	20	276	96
	Total	5626	1815

Table 24. (Continued)

Year	Age	Population numbers	Population weight
1985	2	235	19
	3	192	28
	4	158	35
	5	129	32
	6	106	27
	7	9	2
	8	5	1
	9	22	6
	10	13	4
	11	68	24
	12	3	1
	13	49	17
	14	3	1
	15	240	83
	16	888	309
	17	2249	783
	18	67	23
	19	48	17
	20	360	125
	Total	4841	1537

Table 25. Catch projection for areas E&F, 1981-85, with M = 0.20 F_t = 0.30 and $F_{0.1}$ = 0.30.

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1981	2	370	30	29	2
	3	10	2	1	0
	4	6	1	1	0
	5	14	4	3	1
	6	3	1	1	0
	7	49	14	12	3
	8	3	1	1	0
	9	31	10	7	2
	10	3	1	1	0
	11	126	45	30	11
	12	401	145	95	34
	13	1691	610	399	144
	14	36	13	8	3
	15	172	62	41	15
	16	121	44	29	10
	17	8	3	2	1
	18	365	132	86	31
	19	15	5	4	1
	20	26	9	6	2
	Total	3450	1132	754	262
1982	2	370	30	29	2
	3	277	47	32	5
	4	7	2	1	0
	5	4	1	1	0
	6	9	2	2	1
	7	2	1	0	0
	8	30	9	7	2
	9	2	1	0	0
	10	19	6	4	1
	11	2	1	0	0
	12	76	28	18	7
	13	243	88	57	21
	14	1026	370	242	87
	15	22	8	5	2
	16	104	38	25	9
	17	73	26	17	6
	18	5	2	1	0
	19	221	80	52	19
	20	25	9	6	2
	Total	2517	747	501	166

Table 25. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1983	2	370	30	29	2
	3	277	47	32	5
	4	198	47	30	7
	5	5	1	1	0
	6	3	1	1	0
	7	5	2	1	0
	8	1	0	0	0
	9	18	6	4	1
	10	1	0	0	0
	11	11	4	3	1
	12	1	0	0	0
	13	46	17	11	4
	14	148	53	35	13
	15	622	225	147	53
	16	13	5	3	1
	17	63	23	15	5
	18	45	16	11	4
	19	3	1	1	0
	20	149	54	35	13
	Total	1980	531	358	111
1984	2	370	30	29	2
	3	277	47	32	5
	4	198	47	30	7
	5	135	36	26	7
	6	3	1	1	0
	7	2	0	0	0
	8	3	1	1	0
	9	1	0	0	0
	10	11	4	3	1
	11	1	0	0	0
	12	7	2	2	1
	13	1	0	0	0
	14	28	10	7	2
	15	89	32	21	8
	16	377	136	89	32
	17	8	3	2	1
	18	38	14	9	3
	19	27	10	6	2
	20	92	33	22	8
	Total	1669	407	279	80

Table 25. (Continued)

Year	Age	Population numbers	Population weight	Catch numbers	Catch weight
1985	2	370	30	29	2
	3	277	47	32	5
	4	198	47	30	7
	5	135	36	26	7
	6	87	24	21	6
	7	2	1	0	0
	8	1	0	0	0
	9	2	1	0	0
	10	0	0	0	0
	11	7	2	2	1
	12	0	0	0	0
	13	4	2	1	0
	14	0	0	0	0
	15	17	6	4	1
	16	54	20	13	5
	17	229	83	54	20
	18	5	2	1	0
	19	23	8	5	2
	20	72	26	17	6
	Total	1485	334	236	63

Table 26. Catch projection for areas E&F, 1981-85, with M = 0.20, F_t = 0.30 and F = 0.00.

Year	Age	Population numbers	Population weight
1981	2	370	30
	3	10	2
	4	6	1
	5	14	4
	6	3	1
	7	49	14
	8	3	1
	9	31	10
	10	3	1
	11	126	45
	12	401	145
	13	1691	610
	14	36	13
	15	172	62
	16	121	44
	17	8	3
	18	365	132
	19	15	5
	20	26	9
	Total	3450	1132
1982	2	370	30
	3	303	51
	4	8	2
	5	5	1
	6	11	3
	7	2	1
	8	40	12
	9	2	1
	10	25	8
	11	2	1
	12	103	37
	13	328	119
	14	1384	500
	15	29	11
	16	141	51
	17	99	36
	18	7	2
	19	299	108
	20	34	12
	Total	3195	985

Table 26. (Continued)

Year	Age	Population numbers	Population weight
1983	2	370	30
	3	303	51
	4	248	59
	5	7	2
	6	4	1
	7	9	3
	8	2	1
	9	33	10
	10	2	1
	11	21	8
	12	2	1
	13	84	30
	14	269	97
	15	1134	409
	16	24	9
	17	115	42
	18	81	29
	19	5	2
	20	272	98
	Total	2986	881
1984	2	370	30
	3	303	51
	4	248	59
	5	203	54
	6	5	2
	7	3	1
	8	8	2
	9	2	1
	10	27	9
	11	2	1
	12	17	6
	13	2	1
	14	69	25
	15	220	79
	16	928	335
	17	20	7
	18	94	34
	19	66	24
	20	227	82
	Total	2814	801

Table 26. (Continued)

Year	Age	Population numbers	Population weight
1985	2	370	30
	3	303	51
	4	248	59
	5	203	54
	6	166	46
	7	4	1
	8	3	1
	9	6	2
	10	1	0
	11	22	8
	12	1	0
	13	14	5
	14	1	0
	15	57	20
	16	180	65
	17	760	274
	18	16	6
	19	77	28
	20	240	87
	Total	2674	738

Table 27. Comparison of age compositions from experimental gillnet and commercial catches in areas A&B, 1980.

	Areas A&B			
	Experimental catches		Commercial catches	
Age	No. caught	%	No. caught	%
2	99	3.9	60	0.3
3	105	4.1	1	0.0
4	330	13.0	752	4.3
5	37	1.5	52	0.3
6	208	8.2	940	5.4
7	24	0.9	38	0.2
8	60	2.4	447	2.5
9	22	0.9	226	1.3
10	83	3.3	1382	7.9
11+	1571	61.9	13637	77.8
TOTALS	2539	100.0	17535	100.0

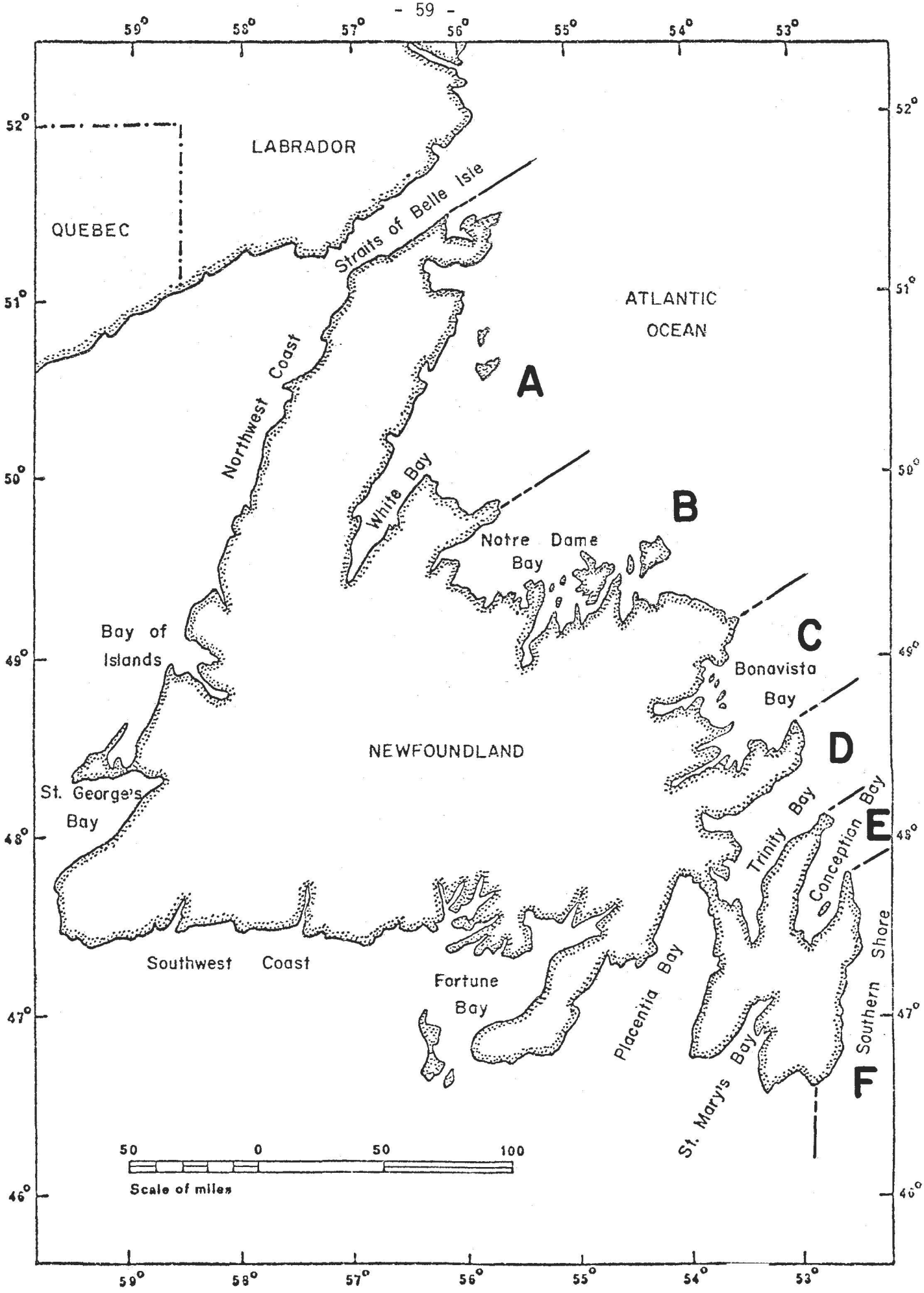

Fig. 1. Area map of the east coast of Newfoundland.

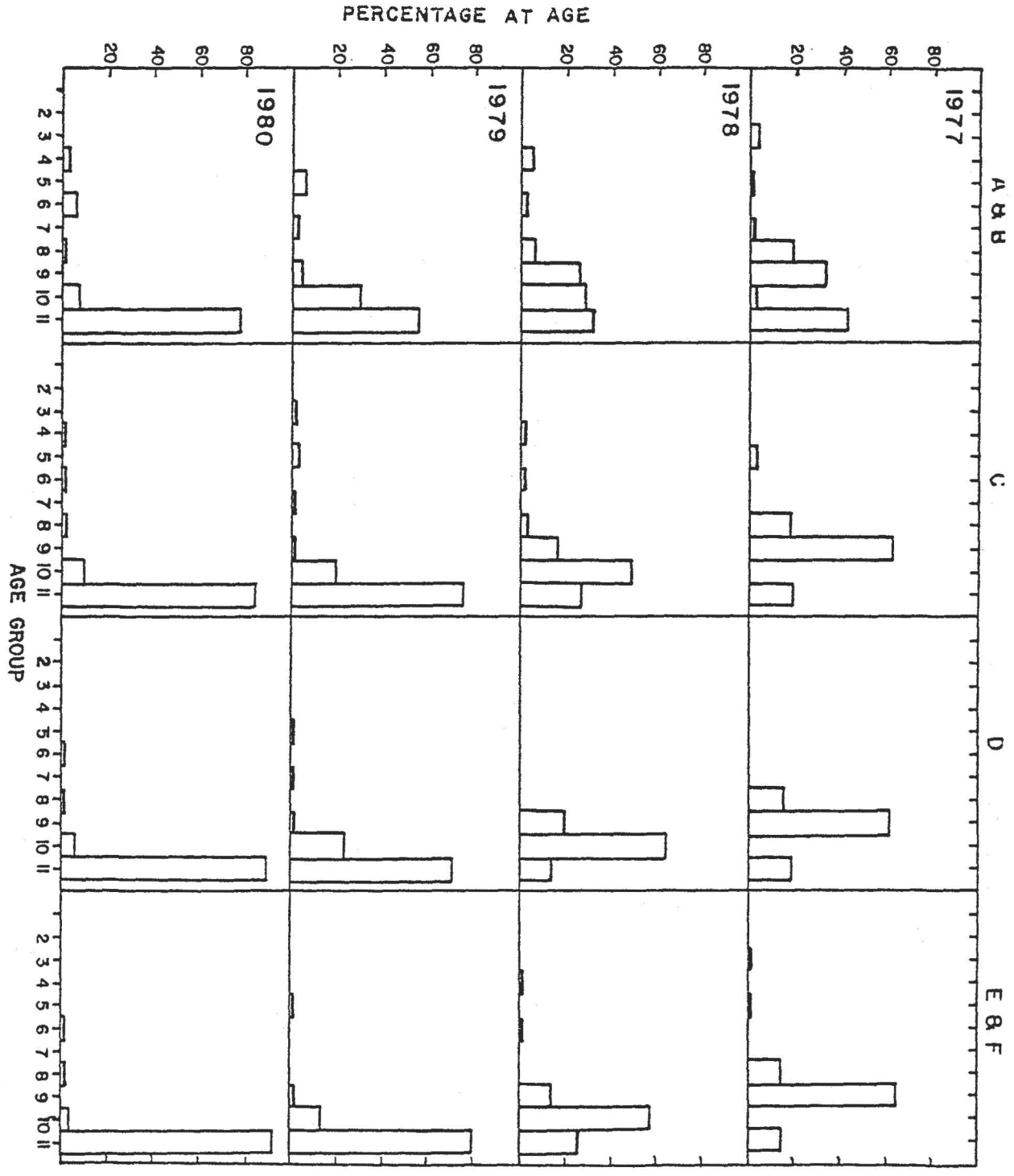

Fig. 2. Age distribution of herring in the landings from east coast Newfoundland herring stocks, 1977-80.