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Assessment of several Northern Labrador Arctic charr stocks

by

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ABSTRACT

Catch and effort data from the 1980 northern Labrador Arctic charr fishery are presented. Landings decreased from the previous year by 4% and totalled 204 MT. The concentration of fishing in the Nain-Okak region appears to have reduced the proportion of larger sized fish in the commercial landings. Results of yield per recruit analyses indicated that catch rates in several areas should be reduced.

RESUME

On trouvera ici les données sur les prises et l'effort de pêche pour l'omble chevalier au Labrador septentrional en 1980. Les débarquements de 204 tm sont de 4 % inférieurs à ceux de l'année précédente. Il semble que la concentration de la pêche dans la région de Nain-Okak ait causé une diminution de la proportion des grands poissons dans les débarquements commerciaux. Des analyses de rendement par recrue indiquent que les taux de capture devraient être réduits dans plusieurs régions.

INTRODUCTION

Northern Labrador Arctic charr stocks were previously evaluated by the Beverton and Holt yield per recruit model based upon data collected during 1977 (Dempson 1978). The assessment indicated that several charr stocks in the vicinity of Nain, Labrador, were being overexploited while stocks further north remained underfished. Total annual mortalities in excess of 55%, in addition to the change in size composition of several populations (Dempson 1978), led to the establishment of quotas on Voisey, Anaktalik and Tikkoatokak Bays for the 1979 season. These quotas remained in effect for 1980 and were: Voisey Bay-22.5 MT; Anaktalik Bay-21.5 MT; Tikkoatokok Bay-39.5 MT.

Sufficient data are still lacking to perform virtual population analyses, therefore this document reassesses various charr stocks in the Nain fishing region (Fig. 1) using the yield per recruit model based upon data from 1977 to 1980.

MATERIALS AND METHODS

The Nain fishing region outlined in Fig. 1 was subdivided on a geographical basis into various bays and fiords in order to calculate separate catch and effort statistics (Fig. 2) (Coady and Best 1976; Dempson 1978). Catch and effort data were available from 1974 to 1980 while total Labrador production was available since 1942 (Coady and Best 1976; Dempson 1978). Commercial sampling for size and age composiion of individual stocks has been carried out since 1977.

Total instantaneous mortality rates were derived in two ways: catch curves, using age frequency data from 1977-80, and by the Paloheimo method (Ricker 1975) where catch per unit effort at age data are required. A natural mortaity rate of 0.17 was used in this assessment. This value was based on an estimate by Moore (1975) for an unexploited anadromous charr population in the Cumberland Sound area of Baffin Island.

The Beverton and Holt yield per recruit model was applied to the Tikkoatokak Bay charr stock using the parameters listed in Table 1. The method of Thompson and Bell (Ricker 1975) was applied to Voisey and Okak Bay stocks. Mean weight at age was obtained from commercial sampling data and partial recruitment values were derived from a matrix of fishing mortality values generated from a cohort analysis (Rivard 1980).

RESULTS AND DISCUSSION

CATCH AND EFFORT STATISTICS

Landings of Arctic charr decreased by 4% to 204 MT during 1980 (Fig. 3). Effort similarly declined by approximately 4%. Part of this decline can be attributed to the successful salmon fishery in the area which effectively removed some of the effort normally directed toward specific charr stocks. Quotas during the past two seasons may have also resulted in a slight change in the distribution of fishing effort. Both effort and apparent abundance of charr has increased in the outer island areas of Dog Island, Black Island and

Kiglapaits during the past two fishing seasons (Table 2). Tikkoatokak Bay remained the most exploited area with 175 MT of charr having been removed during the past 4 years (Table 2). Landings from this area in 1980 contributed 25% of the total catch within the Nain fishing region.

SIZE COMPOSITION

Size composition of commercial landings appears to have been altered from the concentration of fishing in the Nain-Okak area. Table 3 lists the size breakdown of commercial landings at the Nain Fish Plant for the period 1970-80. The proportion of charr under 2.3 kg (gutted head on weight) has increased from 75 to 88% since 1977.

With respect to individual stocks, the five areas with the greatest landings during the past 5 years (Tikkoatokak, Okak, Voisey, Cutthroat, Anaktalik) have undergone substantial changes in size composition of their landings. Whereas landings for those areas in 1976-1977 had approximately 30% of the charr over 2.3 kg, in 1980 less than 12% of the catch was composed of these larger charr (Table 3).

YIELD PER RECRUIT ANALYSIS

Numbers at age in the commercial catch and total instantaneous mortality rates derived from the Paloheimo method are outlined in Table 4. Total instantaneous mortality rates in Tikkoatokak, Voisey and Okak Bay were 0.78, 0.79 and 0.69 respectively. Due to the considerable variation in these mortality rates, yield per recruit analyses were also carried out using mortality estimates derived from catch curves. The latter estimates, however, represent mortality rates in effect during the period of time these fish were recruited into the fishery (Ricker 1975) but are assumed to represent current conditions in this analysis. These rates were 0.68 for Voisey Bay, 0.83 for Tikkoatokak Bay and 0.48 for Okak Bay (Fig. 4). Differences between the two mortality rates in relation to effort changes are indicated in Table 5. In comparison, total instantaneous mortality derived from age frequency data from experimental fishing carried out in the Hebron area during 1980 was 0.32.

Results from the yield per recruit analyses are summarized in Table 6. Landings of Arctic charr for Okak Bay were relatively close to the level suggested by fishing at $F_{0.1}$. If catch curve mortality rates are used, landings could increase by approximately 40% over the 1980 level. Rate of fishing in Voisey and Tikkoatokak Bay is in excess of the optimal mortality rates, although the catch curve rate of fishing mortality in Voisey Bay would yield landings closer to the level indicated by fishing at $F_{0.1}$.

The Hebron Fiord has been virtually unexploited since 1969. Efforts to initiate fishing in this area in 1981 appear promising at the present time.

SUMMARY

1. Landings of Arctic charr in northern Labrador decreased by approximately 4% to 204 MT during 1980. Total effort similarly declined by the same amount.

2. The Tikkoatokak Bay area remained the most exploited area again in 1980 with landings representing 25% of the total catch in the Nain fishing region.

3. Considerable changes in the size distribution of landings has occurred in several areas since 1976.

4. Rate of fishing in Voisey and Tikkoatokak Bay exceeded optimal levels as indicated by the yield per recruit analysis. Fishing in Okak Bay is at an acceptable level while northern areas still remain unexploited.

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Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.

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Table 1. Parameters used in the yield per recruit assessment for Tikkoatokak Bay.

Parameter	Tikkoatokak
W_β - asymptotic weight (kg)	3.95
K - growth coefficient	0.26
t_o - theoretical age for $l_t = 0$	1.37
t_p - age at recruitment	6.0
t'_p - mean selection age	6.5
t_λ - age at last significant contribution to fishery	14

Table 2. Summary of catch (kg round) effort, and size composition statistics for various areas in northern Labrador. Size composition expressed in proportion of landings greater than 2.3 kg (gutted head on).

Year	1974	1975	1976	1977	1978	1979	1980
Voisey Bay							
Catch (kg)	20,045	238	12,232	22,490	33,594	21,881	11,557
Effort (man-weeks)	64	2	45	56	91	59	52
C/E (kg)	313	119	272	402	369	371	222
% > 2.3 kg			41.9	34.6	33.9	32.0	16.8
Anaktalik							
Catch (kg)	7,821	2,548	14,670	21,604	13,073	14,914	8,403
Effort (man-weeks)	28	10	45	60	56	78	43
C/E (kg)	279	255	326	360	233	191	187
% > 2.3 kg			34.6	37.7	27.1	20.5	11.9
Tikkoatokak							
Catch (kg)	9,960	27,695	31,568	39,489	55,065	37,920	42,138
Effort (man-weeks)	28	76	81	85	145	110	116
C/E (kg)	356	364	390	465	380	345	363
% > 2.3 kg			18.7	20.0	18.5	14.3	10.3
Dog Island							
Catch	2,659	653	212	2,038	386	1,438	3,049
Effort (man-weeks)	38	40	11	45	25	62	95
C/E (kg)	70	16	19	45	15	23	32
% > 2.3 kg			11.0	8.6	7.9	14.7	11.3
Black Island							
Catch	4,264	2,101	2,725	3,391	2,966	10,638	20,058
Effort (man-weeks)	60	62	48	67	84	91	130
C/E (kg)	71	34	57	51	35	117	154
% > 2.3 kg			8.4	10.3	14.4	6.7	6.1
Kiglapaits							
Catch	5,131	1,504	6,089	5,439	12,105	17,615	16,543
Effort (man-weeks)	26	32	59	54	105	116	97
C/E (kg)	197	47	103	101	115	152	171
% > 2.3 kg			25.2	24.7	34.1	14.5	17.9
Okak							
Catch (kg)	34,250	2,354	17,812	27,598	36,134	26,176	17,434
Effort (man-weeks)	105	15	52	110	104	121	59
C/E (kg)	326	157	343	251	347	216	296
% > 2.3 kg			28.7	25.9	17.8	10.8	8.2
Cutthroat							
Catch	12,641	2,703	7,526	15,498	41,161	17,803	32,402
Effort (man-weeks)	95	47	103	120	264	158	214
C/E (kg)	133	58	73	129	156	113	151
% > 2.3 kg			16.9	25.2	24.6	12.1	11.9
Napartok							
Catch (kg)	-	-	28,972	28,047	8,553	2,486	752
Effort (man-weeks)	-	-	124	125	125	33	12
C/E (kg)	-	-	234	224	68	75	63
% > 2.3 kg			15.1	22.1	19.9	15.6	13.0

Table 3. Size breakdown of commercial charr and salmon landings at the Nain Fish Plant.

	Size category (kg)[1]	
	Arctic charr	
	under 2.3 (%)	over 2.3 (%)
1970	35.3	64.7
1971	62.0	38.0
1972	82.7	17.2
1973	58.4	41.6
1974	79.5	20.5
1975	78.3	21.7
1976	76.5	23.5
1977	74.8	25.2
1978	75.6	24.4
1979	82.7	17.3
1980	88.0	12.0

[1] gutted head on weight

	Size category (kg)[2]	
	Atlantic salmon	
	under 2.72 (%)	over 2.72 (%)
1976	18.3	81.7
1977	21.9	78.±
1978	23.8	76.2
1979	18.3	81.7
1980	25.1	74.9

[2] gutted head off weight

Table 4.1 a) Estimated numbers at age for Arctic charr caught in Tikkoatokak Bay, 1977-80.
b) Catch per unit effort by age.
c) Paloheimo total mortality rates.

	A				B					C		
Age	1977	1978	1979	1980	1977	1978	1979	1980	Age	1977	1978	1979
6	1365	209	257	0	16.1	1.4	2.3	0				
7	6197	3973	2508	489	72.9	27.4	22.8	4.2				
8	6670	10037	7395	7260	78.5	69.2	67.2	62.6				
9	3887	6273	5402	9143	45.7	43.3	49.1	78.8	9	0.62	0.93	0.20
10	1996	3555	1865	4663	23.5	24.5	17.0	40.2	10	0.55	1.25	0.07
11	735	1951	772	1837	8.6	13.5	7.0	15.8	11	-0.11	0.66	0.85
12	368	1394	772	349	4.3	9.6	7.0	3.0	12	1.12	2.08	1.16
13	105	209	129	253	1.2	1.4	1.2	2.2				
14	53	209	129	84	0.6	1.4	1.2	0.7				
15		70				0.5						
16		70				0.5						
17				11				0.1				
Total	21376	27950	19229	24089				Average Ż 9-13		0.55	1.23	0.57
Effort	85	145	110	116				Average Ż 1977-79			0.78	

Table 4.2 a) Estimated numbers at age for Arctic charr caught in Voisey Bay, 1977-80
b) Catch per unit effort by age.
c) Paloheimo total mortality rates.

Age	A 1977	A 1978	A 1979	A 1980	B 1977	B 1978	B 1979	B 1980	Age	C 1977	C 1978	C 1979
5	0	42	0	0		0.5						
6	290	506	242	74	5.2	5.6	4.1	1.4				
7	1902	3876	2506	374	34.0	42.6	42.5	7.2				
8	3675	4761	4042	1880	65.6	52.3	68.5	36.3				
9	1902	2065	1724	2294	34.0	22.7	29.2	44.1	9	1.04	0.81	0.70
10	1128	1096	593	753	20.1	12.0	10.1	14.5	10	0.59	0.78	0.59
11	548	1011	323	292	9.8	11.1	5.5	5.6	11	0.97	1.82	0.68
12	354	337	108	146	6.3	3.7	1.8	2.8	12	0.53	0.97	0.00
13	193	337	81	93	3.4	3.7	1.4	1.8				
14	97	169	27	18	1.7	1.9	0.5	0.3				
15		84		14		0.9		0.3				
16		42				0.5						
17												
18												
19				4				0.1				
								Average Ż				
Total	10089	14326	9646	5942				9-13		0.78	1.10	0.49
								Average Ż				
Effort	56	91	59	52				1977-79			0.79	

Table 4.3 a) Estimated numbers at age for Arctic charr caught in Okak Bay, 1977-80
b) Catch per unit effort by age.
c) Paloheimo total mortality rates.

	A				B					C		
Age	1977	1978	1979	1980	1977	1978	1979	1980	Age	1977	1978	1979
6	84	102	0	26	0.8	1.0		0.4				
7	84	1228	1227	353	0.8	11.8	10.1	6.0				
8	251	4040	4546	2126	2.3	38.8	37.6	36.0				
9	752	2762	3067	3305	6.8	26.6	25.3	56.0				
10	1839	2813	2020	2517	16.7	27.0	16.7	42.7	10	-0.09	1.01	0.13
11	2173	1892	1191	867	19.8	18.2	9.8	14.7	11	0.06	1.40	0.40
12	3595	1944	541	391	32.7	18.7	4.5	6.6	12	0.90	1.57	0.72
13	1505	1381	469	129	13.7	13.3	3.9	2.2	13	1.70	1.59	0.37
14	1087	256	325	162	9.9	2.5	2.7	2.7	14	0.70	0.17	-0.32
15	920	511	253	219	8.4	4.9	2.1	3.7				
16	501	153	216	0	4.6	1.5	1.8					
17	84	205	144	0	0.8	2.0	1.2					
18	84	51	72	0	0.8	0.5	0.6					
19	84	51	36		0.8	0.5	0.3					
20			36				0.3					
								Average $\bar{z}$				
Total	13043	17389	14143	10095				10-14		0.65	1.15	0.26
								Average $\bar{z}$				
Effort	110	104	121	59				1977-79			0.69	

Table 5. Comparison of present (Paloheimo) and historical (catch curve) fishing mortality rates in relation to effort changes.

	Voisey	Tikkoatokak	Okak
$\bar{F}_{73-78}$	0.51	0.66	0.31
$\tilde{f}_{74-78}$	52	85	74
$\bar{F}_{78-80}$	0.62	0.61	0.52
$\tilde{f}_{78-80}$	67	124	95

Table 6. Landings of Arctic charr for 1980 with respect to catches corresponding to $F_{0.1}$. Bracketed figures based upon historical mortality rates.

	Voisey	Tikkoatokak	Okak
Present F	0.62 (0.51)	0.61 (0.66)	0.52 (0.31)
Landings (kg)	11,557	42,138	17,434
$F_{0.1}$	0.37	0.32	0.44
Catch at $F_{0.1}$ (kg)	6,897 (8,384)	22,105 (20,431)	14,752 (24,745)

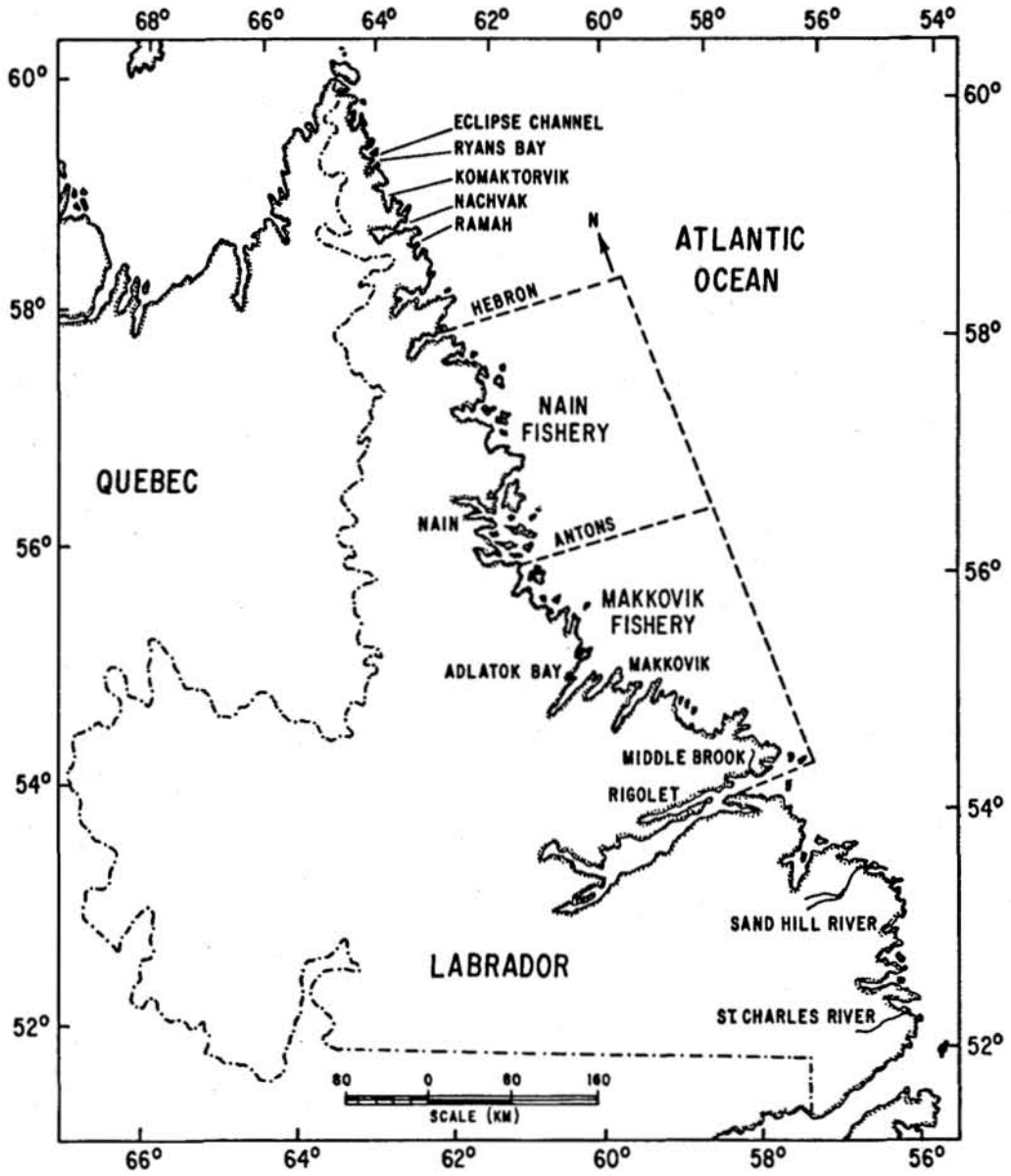

Fig. 1. Extent of the major Arctic charr fishing regions in Labrador.

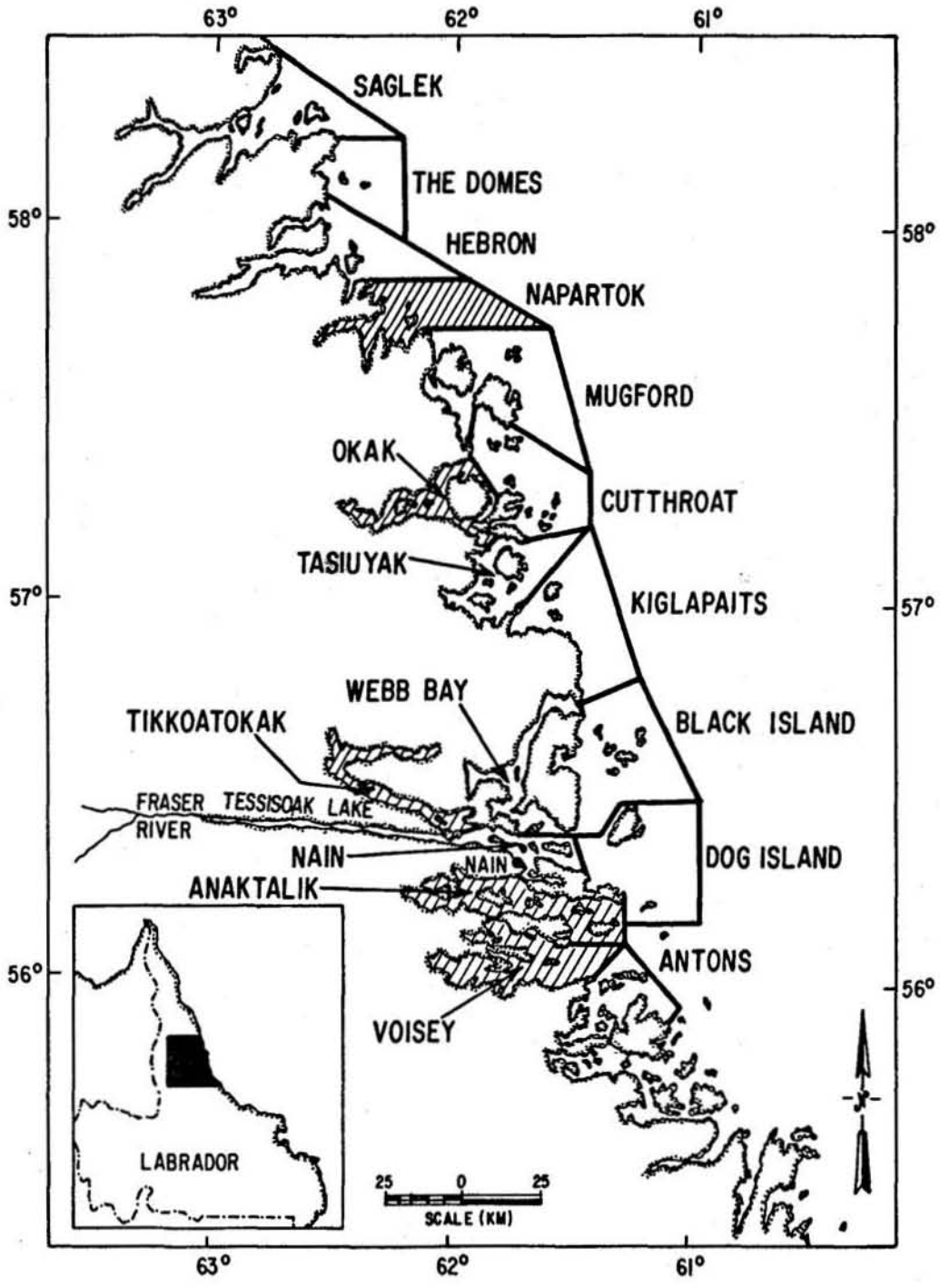

Fig. 2. Coastal breakdown of Nain commercial fishing areas.

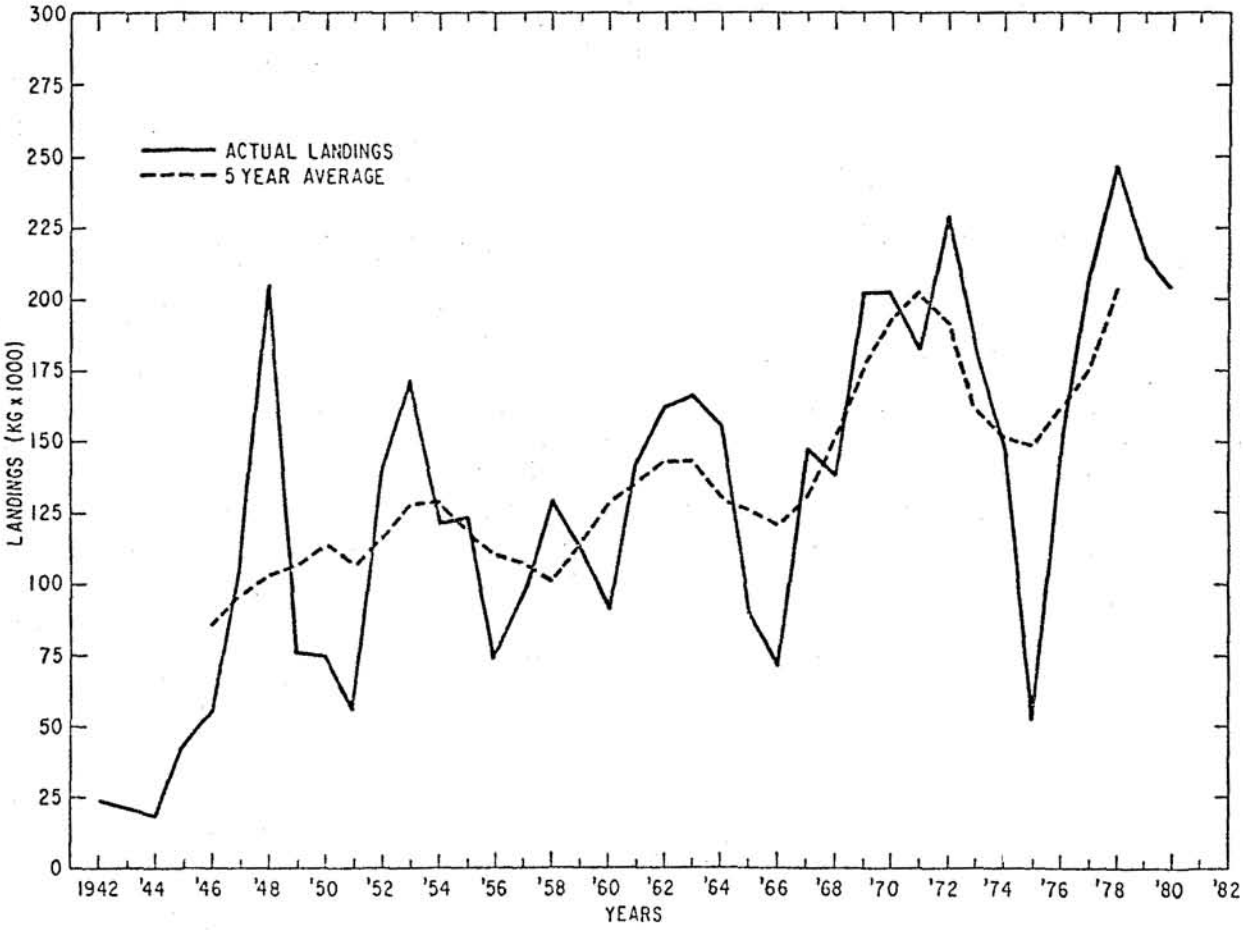

Fig. 3. Summary of Labrador Arctic charr production, 1942-1980.

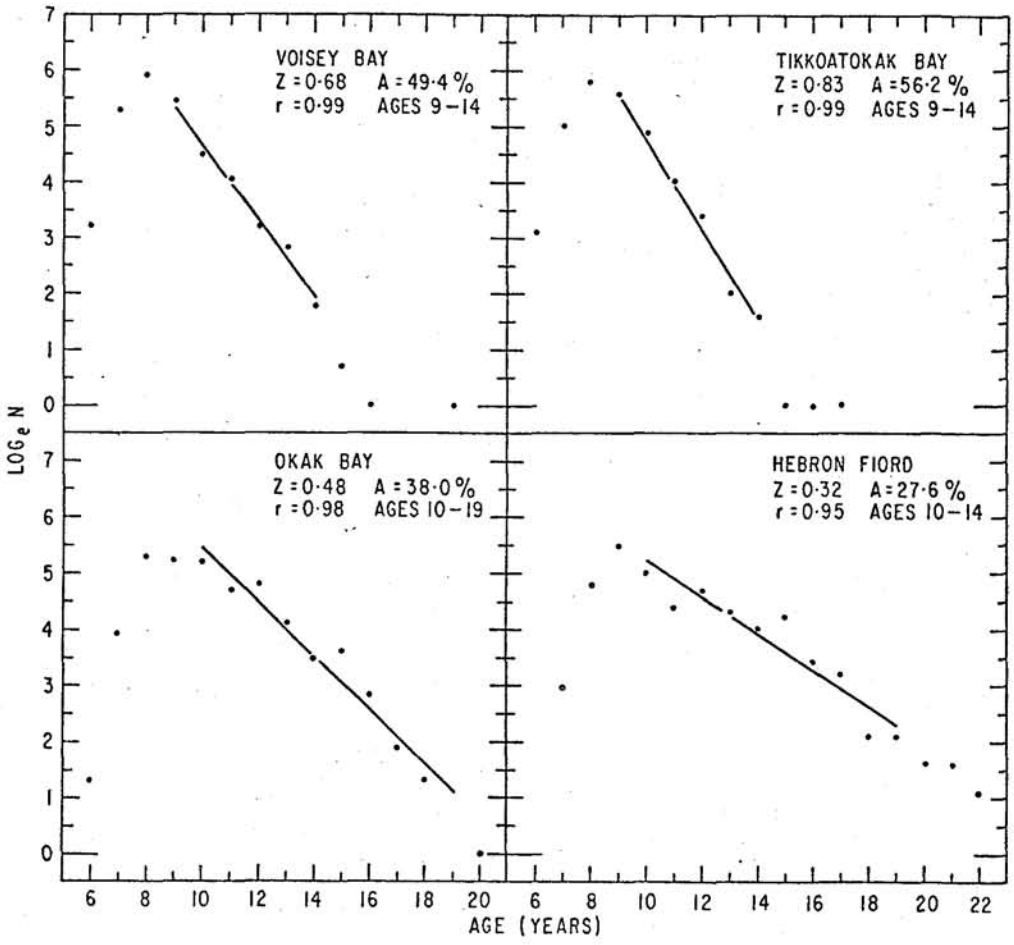

Fig. 4. Catch curves of Arctic charr age frequency distribution from various areas taken by commercial gillnets, 1977-1980. Hebron data 1980 only.