

Not to be cited without  
permission of the authors.<sup>1</sup>

Canadian Atlantic Fisheries  
Scientific Advisory Committee

CAFSAC Research Document 83/14

Ne pas citer sans  
autorisation des auteurs.<sup>1</sup>

Comité scientifique consultatif des  
pêches canadiennes dans l'Atlantique

CSCPCA Document de Recherche 83/14

Status of the Arctic Charr Stock (Salvelinus alpinus) in Tikkoatokak Bay  
and Stock projections for 1983

by

J. B. Dempson, and L. J. LeDrew  
Fisheries Research Branch  
Department of Fisheries and Oceans  
P.O. Box 5667  
St. John's, Newfoundland A1C 5X1

<sup>1</sup> This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the timeframes required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author.

<sup>1</sup> Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte Atlantique du Canada. Comme tel, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de Recherche qu'elle contient ne doivent pas être considérés comme étant des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur des études en cours.

Les Documents de Recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscrit envoyé au secrétariat.

## Abstract

A cohort analysis was performed on the Tikkoatokak Bay Arctic charr, Salvelinus alpinus, stock using data from 1977 to 1982. Stock projections using population numbers generated from terminal fishing mortalities of 0.4-0.6 indicated an  $F_{0.1}$  yield in 1983 between 24.0 and 38.0 t. The long term projected yield (recruits x yield per recruit at  $F_{0.1}$ ) is 31.8 t based on an  $F_T = 0.5$  in 1982 and resultant calculated mean recruitment at age 6 in 1977-81 of 41,780 fish.

The commercial fishery for Arctic charr in Nain Bay is scheduled to reopen in 1983. This stock is considered to be part of the same stock complex as Tikkoatokak Bay charr. Since Nain Bay charr are already exploited both domestically in Nain Bay and commercially in Tikkoatokak Bay, further commercial exploitation may result in decreasing present stock size of this resource.

## Résumé

Des données recueillies entre 1977 et 1982 ont été utilisées dans une analyse des cohortes sur le stock d'ombles chevaliers (Salvelinus alpinus) de la baie Tikkoatokak. Les projections de stock, fondées sur les nombres dans la population engendrés par des mortalités par pêche de dernière année de 0,4-0,6 indiquent, pour 1983, un rendement à  $F_{0.1}$  compris entre 24,0 et 38,0 t. Le rendement prévu à long terme (recrues x rendement par recrue à  $F_{0.1}$ ) est de 31,8 t, fondé sur un  $F_T = 0,5$  un 1982 et un recrutement moyen calculé résultant à l'âge 6 en 1977-81 de 41 780 poissons.

La pêche commerciale d'omble chevalier dans la baie de Nain doit être permise de nouveau en 1983. On considère ce stock comme faisant partie du même complexe de stocks que celui de la baie Tikkoatokak. Comme cette espèce dans la baie de Nain est déjà exploitée à la fois domestiquement dans cette baie et commercialement dans la baie Tikkoatokak, il se peut qu'une exploitation commerciale plus intensive cause une diminution d'abondance de cette ressource.

## Introduction

The 1982 commercial fishing season marked the ninth year in which catch statistics have been available from individual fishing areas for the northern Labrador Arctic charr, Salvelinus alpinus, fishery. Tikkoatokak Bay has been one of the most important charr producing areas during this period (Fig. 1). The largest catches of charr from 1975-80 were from this stock although it ranked third in total production for the 1981 fishery (Table 1). This stock has been under quota management since 1979. The total allowable catch (TAC) for 1982 was 35t and represented a potential increase in yield of 22.8% from the 1981 TAC of 28.5t (Dempson 1982).

### Tagging studies

Beginning in 1979 Arctic charr have been tagged during the period of their spring migration in Nain and Tikkoatokak Bay in order to provide information on within season movement and relative exploitation ( $\mu = R/M$ , Ricker 1975). While a number of assumptions pertaining to tagging studies must be met for reliable information (Ricker 1975), the data do at least provide an index of the rate of fishing occurring on these stocks. A problem for Tikkoatokak Bay had been the small numbers of fish tagged at the beginning of the season. The weighted mean (weighted to number of fish tagged) within season exploitation over three years on Tikkoatokak Bay was 0.39 (95% C.L. = 0.28-0.52) although this was based on a recapture of only 41 of 106 fish that were tagged. In order to obtain better information on fishing mortality a considerably larger number of fish were tagged during 1982. It is hoped that more applicable methods can later be used in calculating exploitation. Nevertheless results for 1982 are presented. Within season exploitation for Tikkoatokak Bay Arctic charr was:

$$\mu = 97/277 = 0.35 \text{ (95\% C.L. = 0.29 - 0.43)}$$

This estimate fell well within the confidence limit based on the combination of three years data. For Nain Bay charr,

$$\mu = 35/210 = 0.17 \text{ (95\% C.L. = 0.12-0.23)}.$$

In comparison with the previous estimate for Nain Bay of 0.22, the current estimate would suggest a decreased exploitation on Nain Bay (Fraser River) fish during the 1982 season.

## Stock Assessment

### Catch and effort data

Catch and effort data for the Tikkoatokak Bay charr fishery are summarized in Table 1 for 1974-82. The highest catch occurred in 1978 when more than 55t were removed. Commercial landings for 1982 totalled 28.3t and were second only to the Hebron Fiord in terms of commercial production. This figure includes an estimate for discards which was obtained, after consulting with the fish plant manager, by increasing the total landings during the first three weeks of the fishing season by 25%.

Catch per unit of effort increased by 7.4% in 1982 although it has remained remarkably stable since 1974 with a mean of 367 kg/man-week (C.V. = 7.4%). Catch and effort are very closely related in this fishery with an  $r^2$  value of 0.95.

With respect to the weight composition of the landings, the proportion of charr over 2.3 kg (gutted head-on weight) increased slightly from 5.0% in 1981 to 6.7% in 1982. Mean weight of fish as derived from commercial landings information was 1.89 kg and was the highest value since 1979.

Length distribution of landings continues to remain quite constant with mean length in 1982 of 53.3 cm. Mean length of catches from 1974 and 1977-82 was 52.2 cm with a coefficient of variation of less than 2.0%

Numbers at age were available since 1977 and summarized in Table 2. Data were derived from annual commercial sampling programs.

Weights at age were calculated from commercial samples (1980-82) and converted from gutted head-on to whole weight using the conversion factor 1.24 (Coady and Best 1976) (Table 3).

Partial recruitment rates were calculated using Fraser River counting fence data as an index of the population. The percent at age in the Tikkoatokak Bay catch (1981-82) was compared to the percent at age from the Fraser River fence data (1975-79) (Table 4). The ratio of these percentages provides a measure of selectivity with the highest value assigned the value of 1.0 for fully recruited fish. It is assumed, therefore, that Fraser River Arctic charr are representative of the total available stock in Tikkoatokak Bay.

Yield per recruit was calculated by the method of Thompson and Bell (Ricker 1975) using partial recruitment rates and mean weight at age. Natural mortality was assumed constant at 0.2.  $F_{0.1}$  was 0.532 at a yield per recruit of 0.761 kg.

Total mortality (Z) was calculated using the Paloheimo method where catch per unit effort at age data are required (Table 2). Average Z calculated from 1978-79 to 81-82 was 0.58. With natural mortality at 0.2, an estimate of fish mortality is 0.38. A separate estimate of fishing mortality was derived from tag recaptures of Tikkoatokak Bay charr. Assuming a Type I fishery:

$$\mu = 1 - e^{-F} \quad (\text{Ricker 1975}).$$

Rate of fishing mortality was 0.43 (95% C.L. = 0.34-0.56).

Stock projections were performed using a range of terminal fishing mortality rates ( $F_T$ ) from 0.4 to 0.6. Regressions of F on effort produced  $r^2$  values of 0.92, 0.91 and 0.89 for terminal F's of 0.4, 0.5 and 0.6 respectively (Table 5). Recruitment estimates for the projections were calculated from the geometric mean of age six population numbers for the years 1977-81.

Results of projections are shown in Table 6. Fishing at  $F_{0.1}$  indicates a catch of 24.0 to 38.0t is available in 1983.

### Discussion

Projections of available harvest for Tikkoatokak Bay in 1983 were based upon the current most usable data (MUD). With only six years of consecutive sampling and ages in the fishery ranging from 6-14 years, the technique is still subject to errors, particularly in deriving estimates of terminal fishing mortality. Despite the simple approach used at this stage to analyze tagging data, results do compare reasonably well with the  $F_T$ 's used in this assessment.

Paloheimo Z's for the last several years and particularly for the last year gave results which appear unreasonably low. Part of this may be explained by the greater mean age of fish caught in Tikkoatokak Bay during 1982. Mean age in 1982 was 9.7 years in comparison with 9.0 and 9.2 for 1980 and 1981 respectively. This resulted in higher catch per unit effort on older aged fish in 1982.

As stated in a previous assessment (Dempson 1982) it is assumed that a surplus of pre-recruit juveniles was built up in the Nain-Tikkoatokak system during years of low commercial exploitation (pre-1976). As a result, many of these juveniles are still being recruited into the fishery and maintaining the high catch rates on 8-10 year old fish. If current TAC's are overestimates, and recruitment overfishing has been occurring, then results of this still may not be apparent for several more years.

Cohort runs at  $F_T = 0.4-0.6$  are presented and resulting populations projected to 1983. Results of these projections indicate that an  $F_{0.1}$  catch of 24.0-38.0t is available in 1983. Average mortality rate derived from the Paloheimo method and from tag recaptures ( $F_T \approx 0.4$ ) suggest a 1983 TAC of 38t. The long term projection of  $F_T$  at 0.5 and yield of 0.761 kg (age 6 population number of 41,780) is 31.8t. Similarly, the long-term projections at  $F_T = 0.4$  and 0.6 are 36.8t and 28.3t respectively. The average of these values is 32t and it reasonably approximates the 1982 TAC of 35t. It is recommended, therefore, that the 1983 TAC remain the same as 1982 at 35t round weight.

Nain Bay was closed to commercial fishing for a period of five years beginning in 1978. This area is scheduled to reopen in 1983. Tagging results during the past several years have shown that even without the directed commercial fishery in Nain Bay, this stock is still commercially exploited, particularly in Tikkoatokak Bay, and are consequently considered as part of this stock complex (Dempson 1982). They also contribute to the offshore fishery in the Black Island region. In addition an escalating domestic fishery occurs on the Nain Bay stock during the spring at the mouth of the Fraser River. No information is available on the characteristics of these fish which are domestically exploited. However, catches in some years are reported to total several thousand fish.

Results obtained from the Fraser River project before its premature termination after the 1979 season, suggested that the closure of the directed commercial fishery in Nain Bay resulted in a substantial increase in escapement after only two years of no fishing. Undoubtedly these Nain Bay charr are contributing to the stability of the Tikkoatokak fishery. It is recommended, therefore, that the closure of Nain Bay remain in effect indefinitely. A portion of this stock will still be exploited in Tikkoatokak Bay. This may also ensure a healthy stock for the annual domestic fishery.

#### References

- Coady, L., and C. W. Best. 1976. Biological and management implications of the Arctic char fishery at Nain, Labrador. Fish. Mar. Serv. Res. Dev. Tech. Rept. No. 624, 103 p.
- Dempson, J. B. 1982. Stock assessment of Tikkoatokak Bay Arctic charr. CAFSAC Res. Doc. 82/5, 19 p.
- Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.

TABLE 1, ARCTIC CHARR CATCH STATISTICS FOR TIKKOATOKAK BAY , 1974-1982,  
SUMMARY OF CATCH, EFFORT, AND SIZE COMPOSITION

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982
TIKKOATOKAK BAY									
QUOTAS (kg)						39500	39500	28500	35000
CATCH (KG)	9960	27695	31568	39483	55061	37919	42131	28066	28283
EFFORT (MAN-WEEKS)	28	76	81	94	147	108	130	80	75
C/E (KG)	356	364	390	420	374	351	324	351	377
B/O : 2.3KG			19.0	20.0	18.0	14.0	10.0	5.0	7.0

Table 2. Estimated numbers at age and catch per unit effort at age for Tikkoatokak Bay Arctic charr, 1977-82.

Age	1977	1978	1979	1980	1981	1982
6	1,365	209	257	0	67	86
7	6,197	3,973	2,508	489	522	339
8	6,670	10,037	7,395	7,260	2,850	2,321
9	3,887	6,273	5,402	9,143	6,774	3,996
10	1,996	3,555	1,865	4,663	4,355	4,833
11	735	1,951	772	1,837	1,287	2,291
12	368	1,394	772	349	171	1,068
13	105	209	129	253	64	92
14	53	209	129	84	8	54
15		70			30	
16		70				
17				11		
Total	21,376	27,950	19,229	24,089	16,128	15,080
Effort	94	147	108	130	80	75

## CATCH PER UNIT EFFORT AT AGE

6	14.5	1.4	2.4	-	0.8	1.2
7	65.9	27.0	23.2	3.8	6.5	4.5
8	71.0	68.3	68.5	55.8	35.6	31.0
9	41.4	42.7	50.0	70.3	84.7	53.3
10	21.2	24.2	17.3	34.3	54.4	64.4
11	7.8	13.3	7.1	14.1	16.1	30.6
12	3.9	9.5	7.1	2.7	2.1	14.2
13	1.1	1.4	1.2	1.2	0.8	1.2
14	0.6	1.4	1.2	0.6	0.1	0.7
15		0.5			0.4	

$$\frac{\sum_{10-14} \text{year } i+1}{\sum_{9-13} \text{year } i} = \frac{1978-79}{1979-80} = \frac{33.9}{91.1} = \frac{52.9}{82.7} = \frac{73.5}{122.6} = \frac{111.10}{158.10}$$

$$Z = 0.99 = 0.45 = 0.51 = 0.35$$

Average Z = 0.58  
1978-79 to 1981-82



Table 3. Summary of weight at age and partial recruitment rates for Tikkoatokak Bay Arctic charr.

Age	Weight (kg) Round	Partial Recruitment
6	0.78	0.02
7	1.14	0.04
8	1.48	0.20
9	1.88	0.64
10	2.02	1.00
11	2.07	1.00
12	2.37	1.00
13	2.07	1.00
14	2.38	1.00

Table 4. Partial recruitment values derived from comparisons of percent at age in the commercial catch from Tikkoatokak Bay with percent at age from the Fraser River counting fence.

Age	Percent at Age		Ratio A/B	Partial recruitment
	Tikkoatokak (A) 1981-82	Fraser River (B) 1975-79		
6	0.5	9.2	0.05	0.02
7	2.8	23.9	0.12	0.04
8	16.6	27.8	0.60	0.20
9	34.5	17.7	1.95	0.64
10	29.4	9.7	3.03	1.00
11	11.5	5.1	2.25	1.00
12	4.0	5.1	0.78	1.00
13	0.5	0.6	0.83	1.00
14	0.3	0.9	0.33	1.00

Table 5. Regressions of average F on effort for terminal fishing mortalities of 0.4-0.6.

Year	Effort (man-weeks)	$F_T$		
		0.4	0.5	0.6
1977	94	0.366	0.370	0.373
1978	147	1.069	1.084	1.094
1979	108	0.629	0.643	0.653
1980	130	0.730	0.799	0.853
1981	80	0.381	0.441	0.492
1982	75	0.400	0.500	0.600
	$r^2$ (1977-81)	0.92	0.91	0.89

Table 6. Projection to 1983 from cohort analyses run at (A)  $F_T = 0.4$ , (B)  $F_T = 0.5$ , (C)  $F_T = 0.6$ .

	POPULATION NUMBERS		POPULATION BIOMASS (AVERAGE)		CATCH BIOMASS				
	1982	1983	1982	1983	1982	1983			
(A)	6	48447	48447	6	34217.18	34073.76	6	67	363
	7	23558	39587	7	24153.68	40484.47	7	386	863
	8	33264	18982	8	42939.10	24194.40	8	3435	2579
	9	19438	25140	9	29345.87	36501.72	9	7512	12451
	10	16068	12320	10	24407.45	17639.09	10	9763	9402
	11	7617	8818	11	11856.77	12938.13	11	4742	6896
	12	3551	4180	12	6328.72	7022.29	12	2531	3743
	13	306	1949	13	476.37	2859.42	13	190	1524
	14	91	168	14	124.50	283.35	14	129	151
	6+	152340	159592	6+	173849.64	175996.62	6+	28756	37973
	7+	103893	111145	7+	139632.46	141922.87	7+	28689	37609
	8+	80335	71558	8+	115478.78	101438.40	8+	28303	36746
	9+	47071	52576	9+	72539.68	77244.00	9+	24868	34167
(B)	6	41780	41780	6	29503.94	29384.72	6	67	313
	7	18883	34129	7	19323.20	34902.29	7	386	744
	8	26865	15154	8	34350.38	19315.70	8	3435	2059
	9	16014	19902	9	23475.86	28896.07	9	7512	9857
	10	13441	9521	10	19526.05	13630.91	10	9763	7265
	11	6371	6675	11	9484.19	9792.97	11	4742	5220
	12	2970	3164	12	5062.07	5314.32	12	2531	2833
	13	256	1475	13	381.16	2163.82	13	190	1153
	14	76	127	14	88.50	214.53	14	129	114
	6+	126656	131926	6+	141195.33	143615.32	6+	28756	29559
	7+	84876	90146	7+	111691.40	114230.60	7+	28689	29245
	8+	65993	56017	8+	92368.20	79328.31	8+	28303	28501
	9+	39128	40863	9+	58017.82	60012.61	9+	24868	26442
(C)	6	37215	37215	6	26276.71	26174.06	6	67	279
	7	15766	30391	7	16102.49	31080.09	7	386	663
	8	22601	12602	8	28625.53	16062.89	8	3435	1712
	9	13739	16412	9	19563.81	23828.35	9	7512	8128
	10	11702	7662	10	16270.94	10969.57	10	9763	5847
	11	5547	5258	11	7903.62	7714.41	11	4742	4112
	12	2586	2492	12	4218.74	4186.69	12	2531	2232
	13	223	1162	13	317.87	1704.84	13	190	909
	14	72	100	14	78.30	169.18	14	129	90
	6+	109451	113294	6+	119358.00	121890.07	6+	28756	23971
	7+	72236	76079	7+	93081.29	95716.01	7+	28689	23692
	8+	56470	45688	8+	76978.81	64635.92	8+	28303	23030
	9+	33869	33086	9+	48353.27	48573.03	9+	24868	21317

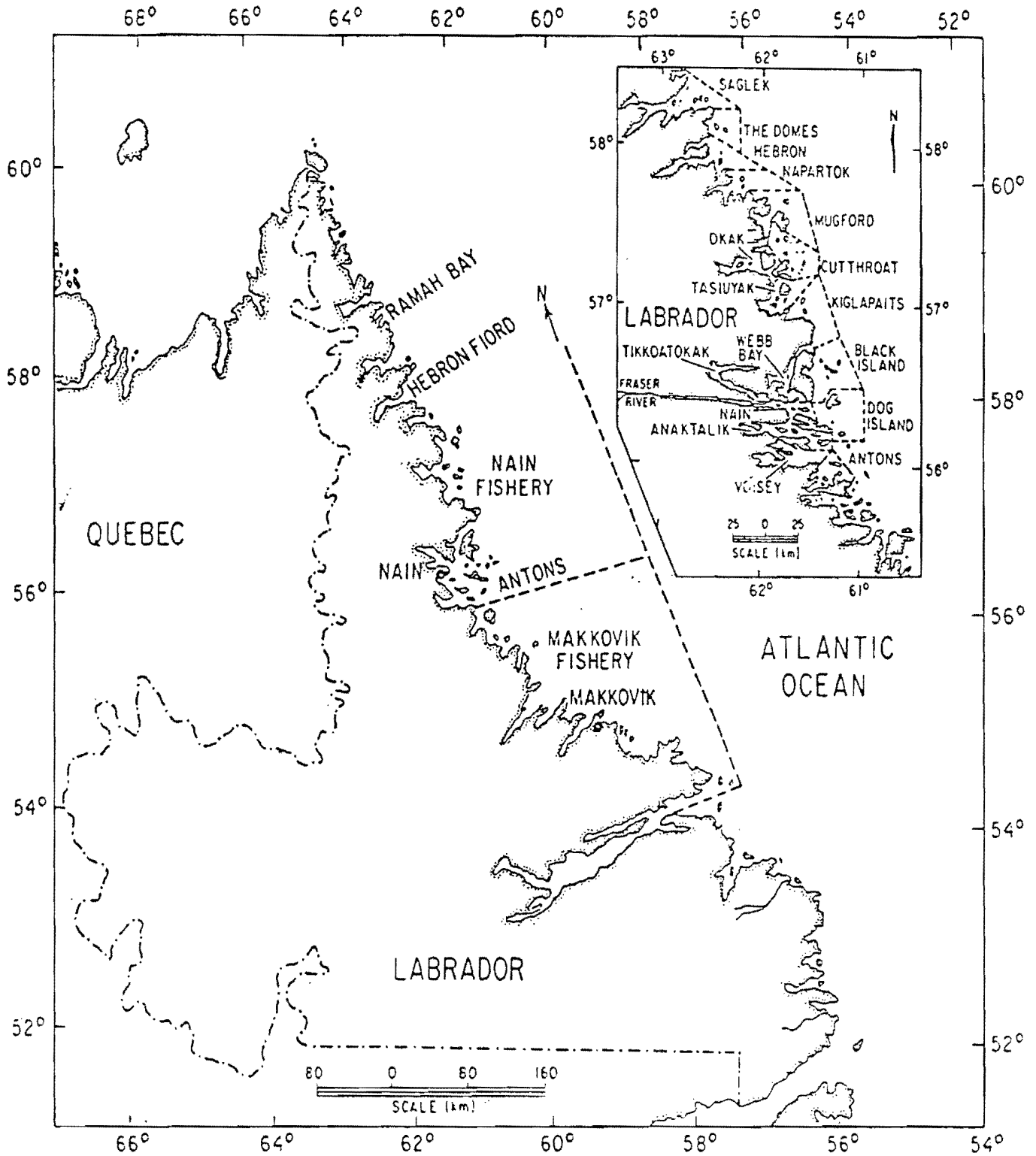


Fig. 1. Major Arctic charr commercial fishing regions in northern Labrador. Insert shows area breakdown within Nain fishing region.