Assessment of the Nain Unit Arctic Charr Population in 1987

by

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Abstract

Reported landings of Arctic charr from the Nain assessment unit totaled 46 t in 1987, essentially achieving the total allowable catch of 47 t. This represented 47% of the total catch of Arctic charr from the Nain Fishing Region in 1987. Catch was 24% higher than in 1986, while catch per unit effort was 14% higher. Likelihood ratio statistics were used to examine temporal and spatial variation in the size composition of the catches from 1980 to 1987. Significant differences were found among years, inshore and offshore fishing zones, and specific time periods within the fishing season. However, no consistent trends have occurred in the mean length or age of catch since 1977, although mean size of the catch in 1986 and 1987 was smaller than in other years. Part of this difference could be related to the spatial distribution of fishing effort with more of the catch being taken in the offshore zone and generally later in the fishing season in comparison with earlier years. The 1977-79 year-classes represented 62% of the catch in 1987. A sequential population analysis was carried out on catch-at-age data from 1977 to 1987 and suggested a reference level catch in 1988 from 41.1 to 48.5 t.

RESUME

Les débarquements d'omble chevalier enregistrés pour l'unité d'évaluation de la Nain ont totalisé 46 t en 1987, ce qui atteint presque le TPA de 47 t. Cette quantité représentait 47 % du total des prises d'omble chevalier de la région de pêche de la Nain en 1987. Les prises étaient de 24 % supérieures à celles de 1986, tandis que les captures par unité d'effort étaient en hausse de 14 %. Les statistiques sur le rapport de vraisemblance ont servi à examiner la variation spatiale et temporelle dans la composition par taille des prises de 1980 à 1987. On a observé des différences significatives d'une année à l'autre, entre les zones de pêche côtières et hauturières et entre des périodes données pendant la saison de pêche. Cependant, on n'a relevé aucune tendance stable dans la longueur moyenne ou l'âge à la capture depuis 1977, bien que la taille moyenne des captures en 1986 et 1987 ait été inférieure à celle des autres années. Cette différence peut s'expliquer en partie par la distribution spatiale de l'effort de pêche, car une proportion plus grande des prises a eu lieu dans la zone hauturière, et de façon générale plus tard dans la saison de pêche que les années précédentes. Les classes annuelles 1977-1979 représentaient 62 % des captures en 1987. L'auteur a effectué une analyse séquentielle de population sur les données concernant l'âge à la capture entre 1977 et 1987, et juge que le niveau de référence des captures en 1988 serait de 41,1 à 48,5 t.

Introduction

The Nain assessment unit (Fig. 1) consists of an inshore zone made up of Anaktalik Bay, Nain Bay, Tikkoatokak Bay, and Webb Bay subareas, and an offshore island zone consisting of the Dog Island and Black Island subareas (Dempson et al. 1986). It was first assessed as a homogeneous unit in 1985 (Dempson and LeDrew 1986). Prior to this, individual assessments were conducted separately on Arctic charr populations from Nain-Tikkoatokak Bay and Anaktalik Bay. Annual landings from the Nain assessment unit have ranged from 34 to 76 t (mean = 54 t) (Table 1) and from 1977 to 1987 have represented 36% of the total commercial production from the Nain Fishing Region. In 1987, 47% of the commercial landings came from the Nain unit. The recommended TAC for 1987 was 47 t. This TAC was partially divided into specific inshore quotas of: Anaktalik Bay - 5.2 t; Nain-Tikkoatokak Bay - 15.5 t; Webb Bay - 8.4 t.

This paper summarizes results of the 1987 fishery and provides a forecast of available harvest, or reference level catch, for 1988.

Assessment

Catch and effort data

Catch and effort data for the Nain assessment unit are summarized in Table 1 for 1974-87. The highest catch of 76 t occurred in 1977, the lowest catch of 34 t was in 1975. The quotas listed in Table 1 for 1979-83 applied only to the specific subareas of Anaktalik Bay and Nain-Tikkoatokak Bay. In 1984 and 1985, an offshore component was included in the TAC. The quota area catch in Table 1 summarizes landings for those subareas specifically under quota restrictions only, prior to the derivation of assessment units in 1986. In 1986 and 1987, the TAC applies to the entire assessment unit.

Landings in 1987 totaled 46 t, essentially achieving the recommended TAC for this stock unit. This represented an increase of 24% over the catch in 1986. Effort increased by 8%, while catch per unit effort (CUE) was 14% higher than in the previous year.

In 1987, 61% of the catch from the Nain assessment unit occurred in the offshore zone, continuing the trend for increased catch and abundance of fish (CUE) which began in the early 1980s. Table 2 summarizes the mean date of the fishery as estimated by a migratory timing statistic (Mundy 1982; Dempson and Kristofferson 1987). Based on either catch or catch per unit effort, data suggest that Arctic charr have been more abundant at sea later in the summer during more recent years (1983-87) in comparison with earlier years. Regression analyses were used to examine the relationship between catch, effort, and timing of the fishery (Table 3). During the past nine years (1979-87), a total of 87% of the variation in catch can be explained by the two variables of effort and timing; effort explained 71% of the overall variation while timing explained an additional 16%. Years with earlier timing statistics generally coincided with higher landings of Arctic charr, a phenomenon which

has also been observed in catches of chinook salmon, Oncorhynchus tshawytscha, in the Yukon River, Alaska (Mundy 1982).

Variation in catches among years may also be a function of different catchability of fish as it relates to annual changes in the ocean migration patterns. Within the Nain stock unit it has been reported that of fish tagged and released within this unit (N = 3707), 97% of the subsequent recaptures (N = 1268) came from the same stock unit (Dempson and Kristofferson 1987). It was also noted, based on tagging data from 1982 to 1985, that fish from one particular subarea (Nain Bay-Fraser River) showed variable ocean migration patterns in different years. Using updated information from 1982 to 1987, the categorical data modeling procedure (Bishop et al. 1982; SAS 1985) now indicated that there is evidence to show that movement patterns at sea varied annually for both Nain Bay and Tikkoatokak Bay fish (Table 4). Differences in abundance of fish in specific subareas, as evidenced by CUE data, probably reflect a combined influence of changes in the distribution of fishing effort, variable movement patterns of fish, variability in the duration of fishing effort, as well as actual changes in stock abundance.

Size distribution of commercial landings

Since 1980, approximately 57,000 fish have been sampled from the Nain assessment unit to obtain information on the size distribution of the commercial landings. Length-frequency sampling is also used to weight the information from an age-length key to obtain representative information on catch at age. The length-frequency data were examined to determine any heterogeneity of samples which could be related to the effect of commercial exploitation on the stock. Likelihood ratio statistics were used to examine temporal and spatial variability in the size distributions following the method employed by Baird et al. (1987).

Arctic charr were measured for fork length and recorded in two-centimeter intervals. The smallest fish measured over the past eight years (1980-87) were in the 36 cm interval (36.0-37.9 cm), while the largest were from the 80 cm grouping. Analyses, however, were conducted on truncated data which excluded fish less than 42 cm in size and those fish which were in size categories 66 cm and higher. In total, 99.3% of all fish measured were within the 42-64 cm intervals. This truncation also removed the possibility of obtaining any zero values for expected cell counts.

There was a highly significant difference in the size distribution of catches between years ($G = 5650$, $df = 77$, $P = 0.000$, $N = 56,473$). As indicated in Table 5, modal size of fish has changed from the 52 cm interval in 1980 and 1982 to 50 cm in 1983-85, and then to the 48 cm interval during the past two years. Mean lengths are also summarized in Table 5. Mean length has decreased, particularly during the past two years, but not consistently. Significant differences also exist in the size distribution of catches between the inshore and offshore zones ($G = 1077$, $df = 11$, $P = 0.000$, $N = 56,473$). Within the two zones there are also differences among years (Table 6). The fishing season was stratified into four time periods: June 15-July 14, July 15-July 31, August 1-15, and August 16 to the end of the season. There is

a tendency for mean length of the catches to decrease as the fishing season progresses for both the total assessment unit and for separate inshore and offshore zones (Table 7). This is consistent with the observation for size of fish entering local rivers to decrease with time (Dempson and Green 1985). Within individual time periods, the size distribution of catches differs between zones. In addition, there are also size differences between years when comparisons are made by individual zones and time periods.

Results from these analyses indicate significant variation in the length composition of catches between years, inshore and offshore zones, and among specific time periods during the fishing season. The decrease in the mean and modal size of the catch during the past several years may be due to a selective removal of larger fish from the population. However, it may also be related to the spatial distribution of fishing effort with a greater proportion of the catch now being taken in the offshore zone and generally later in the fishing season in comparison with earlier years. Thus it is important to obtain representative samples throughout the entire fishing season and from both inshore and offshore subareas if possible.

Cohort analyses

Numbers at age were available since 1977 and are summarized in Table 8. Data were derived from annual commercial sampling programs. Mean age has ranged from 8.5 to 9.8 years with no consistent increasing or decreasing trend. On average, over 60% of the catch is made up of three age-classes of fish represented by 8-, 9-, and 10-year-olds. The 1977-79 year-classes represented 62% of the catch in 1987.

Weights at age were calculated from commercial samples obtained from 1977 to 1987. Gutted head-on weights were converted to whole weight using the conversion factor 1.22 (Dempson 1984). For yield-per-recruit analysis, mean weight at age for the period 1977-79 was used, similar to previous assessments. For stock projections, mean weight at age for the period 1984-87 was used (Table 9).

Total mortality ($\bar{Z}$) was calculated using the Paloheimo method (Ricker 1975) and the average value from all years (1977-78 to 1986-87) was 0.55. The average $\bar{Z}$ for the past four years was 0.54. Assuming a natural mortality rate of 0.2 yields an estimate of fishing mortality of about 0.35. An estimate of total mortality was also derived from a catch curve using catch per unit effort at age data from 1985 to 1987. This also indicated a $\bar{Z}$ of 0.55.

As in past years, an estimate of fishing mortality was derived from:

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

where μ was estimated from tag recaptures. Using last year's value of 10% for an estimate of tagging mortality, tag loss or non-reporting of tags results in a value of μ of

$$\mu = \frac{126}{374} = 0.3369,$$

which translates into an estimate of fishing mortality (F) of 0.41 (95% CL = 0.33 - 0.51).

An initial cohort analysis was run using partial recruitment values and terminal fishing mortality (F_T = 0.4) from last year's assessment (Dempson and LeDrew 1987). An iterative procedure was used to obtain estimates of F for the oldest age group (F_B) (Rivard 1982). Following this, partial recruitment rates were calculated using the historical averaging method from the matrix of fishing mortality rates generated by the cohort analysis using years 1981-85. These values were then applied to the value for terminal fishing mortality and the procedure repeated until the partial recruitment values stabilized (Table 9).

Yield per recruit was calculated by the method of Thompson and Bell (Ricker 1975) using partial recruitment rates and mean weight at age. $F_{0.1}$ was 0.40 at a yield per recruit of 0.89 kg.

Cohort analyses were run using a range of terminal fishing mortality rates from 0.2 to 0.7. In each run, fishing mortality rates for the oldest age group (F_B) were re-evaluated using the iterative procedure. Regressions of F (weighted mean F for fully-recruited fish) on fishing effort and mean mid-year population biomass on catch per unit of effort of fully-recruited fish were used in tuning the analysis to key in on an appropriate value for F_T in 1987. Data from 1977 to 1987 were included in the regression analyses.

Regressions of F on effort showed a decrease in the correlation coefficient with an increase in F (Table 10). The residual from the last point (1987) to the regression line was smallest when F_T = 0.375 while the intercept value was closest to 0 when F_T = 0.4. The sum of the residuals for the last three years was the smallest when F_T = 0.6, but the sum of squares of residuals for the last three years (1985-87) was the lowest when F_T = 0.35 (Table 10).

With respect of the regressions of population biomass on CUE, the correlation coefficient had the highest value when F_T = 0.4 (Table 10). The residual of the last year (1987) to the regression line was lowest when F_T = 0.375, while the sum of the residuals or the sum of squares of residuals for the last three years (1985-87) was lowest when F_T = 0.4

Catch projections

Projections were run with F_T varying from 0.375 to 0.45. Recruitment for the projections was estimated from the geometric mean of population numbers for age 6- and 7-year-old fish for years 1977-85. Weights at age were based on 1984-87 data. Table 11 summarizes the population numbers and fishing mortality matrix for the cohort analysis run with F_T = 0.4.

Results of the projections are summarized in Table 12. The reference level catch in 1988 ranges from 41.1 to 48.5 t with the highest value occurring with F_T = 0.375. Owing to the similarity in the 1987 recommended catch (47 t) with the values projected with F_T = 0.375 and 0.4, it is suggested that the reference level catch of 47 t remain in effect for the Nain assessment unit in in 1988 with no additional changes to the individual quotas assigned to the inshore subareas of Anaktalik Bay, Nain-Tikkoatokak Bay, and Webb Bay.

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Table 1. Summary of catch and effort statistics for the Nain assessment unit, 1974-87. Quotas and landings are in kg round weight, effort is expressed as man-weeks fished. Refer to text for information on quotas and quota area catch.

	Inshore			Offshore				Total				
	Catch	Effort	CUE	Catch	Effort	CUE	% Catch offshore	Catch	Effort*	CUE	Quota	Quota area catch
1974	30,822			6,923			18.1	37,745				
1975	31,076			2,754			8.1	33,830				
1976	50,813	146	348	2,500	52	48	4.7	53,313	196	272		
1977	70,908	183	387	5,347	114	47	7.0	76,255	291	262		
1978	70,465	212	332	3,298	106	31	4.5	73,763	314	235		
1979	54,967	189	291	11,877	152	78	17.8	66,844	336	199	61,000	52,832
1980	52,328	183	286	22,727	215	106	30.3	75,055	390	192	61,000	50,176
1981	49,956	157	318	15,676	131	120	23.9	65,632	278	236	37,160	37,223
1982	43,108	119	362	12,509	117	107	22.2	55,617	235	237	43,660	39,119
1983	33,603	147	229	17,599	149	118	34.4	51,202	289	177	51,000	19,102
1984	24,558	131	187	14,342	128	112	36.9	38,900	244	159	43,200	29,063
1985	21,527	125	172	19,631	130	151	47.7	41,158	252	163	30,500	36,019
1986	16,347	91	180	20,748	101	205	55.9	37,095	185	201	43,000	
1987	17,840	71	251	28,032	135	208	61.1	45,872	200	229	47,000	

*Total effort should be equal to or less than the sum of the inshore and offshore effort.

Table 2. Mean date of catch for Arctic charr from the Nain stock unit as estimated from a migratory timing statistic based on catch and catch per unit effort data (CUE) with 95% confidence intervals (CI) for the grand mean from all years.

Year	Catch	CUE
1977	Jul 18	Jul 22
1978	Jul 13	Jul 17
1979	Jul 9	Jul 13
1980	Jul 23	Jul 25
1981	Jul 14	Jul 17
1982	Jul 19	Jul 19
1983	Jul 28	Jul 30
1984	Aug 1	Aug 5
1985	Aug 4	Aug 4
1986	Aug 6	Aug 4
1987	Aug 1	Jul 28
1977-87	Jul 22 (Jul 11-Aug 1)	Jul 26 (Jul 12-Aug 8)

Table 3. Summary of regression analyses on catch, effort, and timing of the fishery for Arctic charr from the Nain assessment unit.

Years	Dependent variable	Independent variable	Partial R^2	Model R^2	P
1979-87	Catch	Effort	0.7135	0.7135	0.0042
		Timing	0.1618	0.8753	0.0316
		Total		0.8753	0.0019

Table 4. Summary of results for the long-linear modeling procedure testing the hypothesis that ocean movements of a specific population vary annually for Arctic charr tagged and released during the spring outward migration from both the Nain Bay and Tikkoatokak Bay subareas (1982-87).

	Nain Bay subarea			Tikkoatokak Bay subarea		
Source	df	χ^2	P	df	χ^2	P
Area	5	284	0.0001	5	549	0.0001
Year	5	129	0.0001	5	172	0.0001
State	1	4,993	0.0001	1	6,859	0.0001
Area x Year	25	40,959	0.0001	25	40,972	0.0001
Area x State	5	12	0.0320	5	97	0.0001
Year x State	5	50	0.0001	5	23	0.0003
Year x State x Area	20	67	0.0001	20	33	0.0374

Table 5. Length-frequency distributions of Nain assessment unit catches from 1980 to 1987. Mean lengths are also shown for the total unit and for inshore and offshore zones.

Fork length interval (cm)	Years								
	1980	1981	1982	1983	1984	1985	1986	1987	Total
42	59	88	13	49	47	62	203	345	866
44	118	172	72	226	324	337	752	1,169	3,170
46	253	349	272	540	689	940	1,483	1,971	6,497
48	502	628	499	933	1,086	1,565	1,795	2,156	9,164
50	684	927	874	1,168	1,321	2,049	1,596	1,957	10,576
52	741	880	960	1,062	1,285	1,930	1,155	1,402	9,415
54	562	725	812	858	1,066	1,520	697	833	7,073
56	425	516	520	549	689	1,076	313	476	4,564
58	274	302	326	272	392	687	163	209	2,625
60	173	171	151	175	209	403	78	101	1,461
62	94	77	77	65	106	195	29	59	702
64	38	28	44	27	69	112	19	23	360
Total	3,923	4,863	4,620	5,924	7,283	10,876	8,283	10,701	56,473
Mean length									
Total	53.2	52.8	53.5	52.4	52.5	52.9	50.3	50.1	51.9
Inshore	53.2	52.8	53.5	53.0	53.3	53.6	50.4	50.2	52.1
Offshore			52.4	51.0	51.8	52.0	50.2	49.8	51.1

Table 6. Summary of likelihood ratio statistics comparing size distribution of commercial Arctic charr catches from the Nain assessment unit, 1980-87. Time periods 1-4 are defined in the text.

Comparison	G	df	P	N
Years	5,650	77	0.000	56,473
Zones	1,077	11	0.000	56,473
Zones:				
Period 1	32	11	0.001	19,478
Period 2	414	11	0.000	13,131
Period 3	134	11	0.000	16,353
Period 4	32	11	0.000	7,611
Years:				
Inshore zone	4,925	77	0.000	39,482
Offshore zone	871	55	0.000	16,991
Period 1	818	77	0.000	19,478
Period 2	1,688	77	0.000	13,131
Period 3	1,558	66	0.000	16,253
Period 4	612	55	0.000	7,611
Time period	5,431	33	0.000	56,473
Time period:				
Inshore zone	3,819	33	0.000	39,482
Offshore zone	1,146	33	0.000	16,991

Table 7. Summary of mean length of Arctic charr catches by time period for inshore and offshore fishing zones of the Nain assessment unit.

Time period	Fork length (cm)	
	Inshore zone	Offshore zone
1 - Jun 15-Jul 14	53.4	53.4
2 - Jul 15-Jul 31	53.0	51.7
3 - Aug 1-Aug 15	51.1	50.8
4 - Aug 16-end	49.8	49.5

Table 8. Estimated catch at age for Arctic charr from the Nain assessment unit, 1977-87.

CATCH AT AGE

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
6	2003	371	430	113	145	145	210	83	174	190	423
7	9250	6703	4306	1023	1557	641	1689	2009	2862	3766	4799
8	12453	13122	11568	11930	6570	4425	4797	3850	7277	7034	5529
9	7630	7984	9593	16725	15180	7746	6732	5692	4510	5346	6630
10	5052	4406	4208	8541	9784	8624	5389	5085	3706	2605	3951
11	2454	2367	2168	3543	3286	5020	5285	2362	2133	1174	1768
12	988	1688	1573	946	673	2604	3378	1539	1324	572	1209
13	358	312	418	764	232	412	865	575	828	218	787
14	180	272	312	349	80	259	306	142	442	181	270
15	1	118	34	39	57	47	1	29	214	185	314
16	1	97	14	2	10	17	1	1	30	47	159
17	1	1	1	16	1	25	15	1	41	1	77
6+	40371	37441	34625	43991	37575	29965	28668	21368	23541	21319	25916
7+	38368	37070	34195	43878	37430	29820	28458	21285	23367	21129	25493
8+	29118	30367	29889	42855	35873	29179	26769	19276	20505	17363	20694
9+	16665	17245	18321	30925	29303	24754	21972	15426	13228	10329	15165
10+	9035	9261	8728	14200	14123	17008	15240	9734	8718	4983	8535

Table 9. Summary of weight (kg-round) at age data, partial recruitment rates, and calculated $F_{0.1}$ for the Nain assessment unit Arctic charr population.

Age	Weight 1977-79	Weight 1984-87	Partial recruitment
6	1.05	1.15	0.01
7	1.52	1.38	0.09
8	1.83	1.74	0.40
9	2.12	1.96	0.75
10	2.45	2.06	1.0
11	2.59	2.10	1.0
12	2.63	2.04	1.0
13	2.74	2.10	1.0
14	3.13	2.14	1.0
15	3.05	2.04	1.0
16	3.05	2.10	1.0
17	3.05	2.10	1.0

$F_{0.1}$ = 0.40 at a Y/R of 0.892 kg.

Table 10. Results of regressions (1977-87) of F on effort and population biomass on catch per unit effort for various terminal fishing mortality rates (F_T) for the Nain assessment unit.

Regression	Parameter	Terminal F 0.2	0.25	0.3	0.35	0.375	0.4	0.45	0.5	0.55	0.6	0.65	0.7
F (weighted mean for fully-recruited fish) on effort	r	0.91	0.91	0.90	0.89	0.88	0.88	0.85	0.82	0.77	0.70	0.61	0.52
	residual - 1987	-0.05	-0.04	-0.02	-0.01	0.00	0.02	0.04	0.06	0.09	0.11	0.14	0.17
	normalized	-0.11	-0.82	-0.05	-0.01	0.01	0.03	0.07	0.11	0.15	0.20	0.24	0.29
	intercept	-0.32	-0.23	-0.15	-0.07	-0.04	-0.01	0.06	0.12	0.18	0.24	0.30	0.35
	normalized	0.0.69	-0.48	-0.30	-0.14	-0.08	-0.01	0.11	0.22	0.32	0.42	0.51	0.59
	$\sum$ residuals (1985-87)	-0.21	-0.19	-0.16	-0.14	-0.13	-0.11	-0.09	-0.06	-0.03	0.00	0.02	0.04
	$\sum$ (residuals)^2 (1985-87)	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05
Population biomass (fully-recruited fish) on CUE	r	0.35	0.56	0.75	0.86	0.89	0.90	0.89	0.86	0.84	0.81	0.79	0.77
	residual (t) 1987	30.6	17.7	9.0	2.9	-0.4	-1.8	-5.4	-8.3	-10.6	-12.6	-14.3	-15.7
	normalized	0.54	0.34	0.18	0.06	0.01	-0.04	-0.12	-0.19	-0.25	-0.30	-0.35	-0.39
	intercept (t)	38	30	25	22	20	19	17	15	14	13	12	11
	normalized	0.66	0.58	0.51	0.46	0.44	0.42	0.38	0.35	0.33	0.30	0.28	0.27
	Σ residuals (t) (1985-87)	57	35	20	10	6	2	-4	-9	-13	-17	-20	-22
	Σ (residuals)^2(t) (1985-87)	1343	492	163	44	23	18	35	73	120	169	219	267

Table 11. Summary of population numbers and fishing mortality matrix for the cohort analysis run at F_T = 0.40 on the catch at age data for the Nain assessment unit Arctic charr population.

POPULATION NUMBERS

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
6	125694	110213	58919	54703	46384	40255	54940	66724	66663	182997	116903
7	83006	101097	89899	47849	44685	37845	32826	44791	54554	54421	149654
8	42933	59590	76706	69707	38250	35176	30405	25348	34854	42075	41149
9	21510	23883	36915	52335	46277	25372	24796	20553	17269	21952	28084
10	13258	10707	12329	21543	27715	24153	13764	14210	11677	10058	13135
11	6639	6283	4779	6287	9910	13838	11971	6393	7033	6207	5878
12	2223	3215	3003	1951	1941	5140	6787	5019	3097	3828	4019
13	826	926	1105	1035	742	981	1852	2500	2717	1337	2616
14	419	352	476	526	156	397	430	734	1527	1475	898
15	134	180	42	108	115	55	91	75	472	850	1044
16	3	109	41	4	53	43	3	74	35	193	529
17	1	1	1	21	1	34	20	1	59	2	115
6+	296646	316557	284215	256068	216228	183287	177885	186421	199956	325396	364024
7+	170952	206344	225297	201366	169844	143033	122944	119697	133294	142398	247121
8+	87946	105247	135398	153516	125159	105188	90118	74906	78740	87977	97467
9+	45013	45657	58691	83809	86909	70012	59713	49558	43886	45902	56318
10+	23503	21774	21777	31475	40633	44641	34918	29005	26616	23950	28235

FISHING MORTALITY

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
6	0.018	0.004	0.008	0.002	0.003	0.004	0.004	0.001	0.003	0.001	0.004
7	0.131	0.076	0.054	0.024	0.039	0.019	0.059	0.051	0.060	0.080	0.036
8	0.386	0.279	0.182	0.210	0.211	0.150	0.192	0.184	0.262	0.204	0.160
9	0.498	0.461	0.339	0.436	0.450	0.412	0.357	0.365	0.341	0.314	0.300
10	0.547	0.607	0.474	0.577	0.495	0.502	0.567	0.503	0.432	0.337	0.400
11	0.525	0.538	0.696	0.975	0.456	0.512	0.669	0.525	0.408	0.235	0.400
12	0.675	0.868	0.865	0.767	0.483	0.821	0.799	0.414	0.640	0.180	0.400
13	0.652	0.466	0.542	1.692	0.424	0.624	0.726	0.293	0.411	0.199	0.400
14	0.644	1.918	1.288	1.320	0.835	1.275	1.544	0.241	0.386	0.146	0.400
15	0.008	1.288	2.177	0.512	0.792	2.766	0.012	0.556	0.695	0.275	0.400
16	0.524	4.196	0.479	0.825	0.235	0.580	0.490	0.015	2.796	0.313	0.400
17	0.553	0.635	0.585	0.690	0.485	0.546	0.658	0.463	0.448	0.261	0.400
10+	0.555	0.664	0.601	0.717	0.485	0.554	0.666	0.467	0.453	0.264	0.400

Table 12. Summary of projected reference level catch (t) for 1988 and 1989 with F_T in 1987 varying from 0.375 to 0.45. The percent difference from the 1987 reference level catch (47 t) is also shown.

	F_T in 1987		
	0.375	0.40	0.45
1988	48.5	45.7	41.1
% difference from 1987	+3.2	-2.7	-12.6
1989	49.6	47.6	43.9

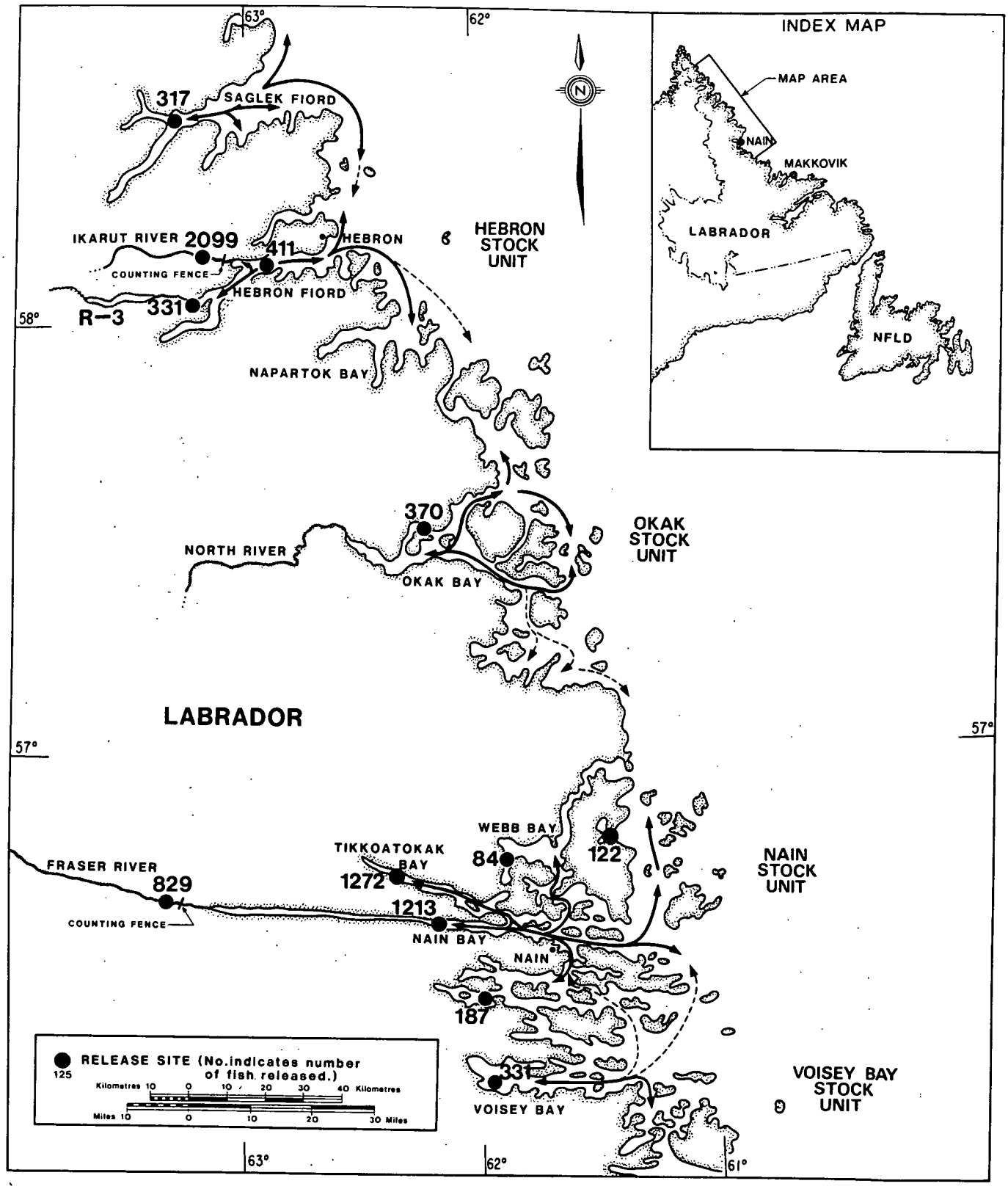

Fig. 1. General patterns of ocean movements of anadromous Arctic charr in northern Labrador showing number of fish tagged and release locations. Stock unit areas are also indicated.