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Fishery Resource Use in a Subarctic Indian Community

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Cree Indians of Fort George, James Bay, northern Canada, maintain a large and successful subsistence fishery. Methods used in the fishery, seasons and locations of catch, and yield levels were studied, together with the population biology of two sea-run Coregonus species, cisco and whitefish, that dominate the catch. The fishery was characterized by a high degree of order, social regulation of the fishing effort and the gillnet mesh size, and practices that were identified as adaptations to the subarctic ecosystem. Fishing methods used permit the Cree to control the magnitude of the harvest and the species and size composition of the catch. There is evidence that fishers can alter the scarcity-abundance patterns of the fish stocks, and have a biologically measurable effect on the populations.

KEY WORDS: fishery management; subsistence resources; subarctic; Cree Indians; James Bay.

INTRODUCTION

Many groups of Canadian northern native peoples still obtain much food from the wild, despite the fact that almost all of them now live, at least part of the year, in white-style permanent settlements. This article presents an in-depth study of one aspect of the subsistence economy, fisheries, of one relatively large native settlement, Fort George, in the eastern James Bay area (Fig. 1).

According to a detailed questionnaire study based on interviews with 307 of 338 adult males at Fort George, Weinstein (1976) estimated that about half of the wild food harvested in 1973-1974 came from waterfowl, mainly the Canada geese *Branta canadensis;* about one-quarter from mammals such as beaver; and the remaining one-quarter from fish. These findings were generally confirmed for the year 1974-1975, based on a one-third subsample of hunters at

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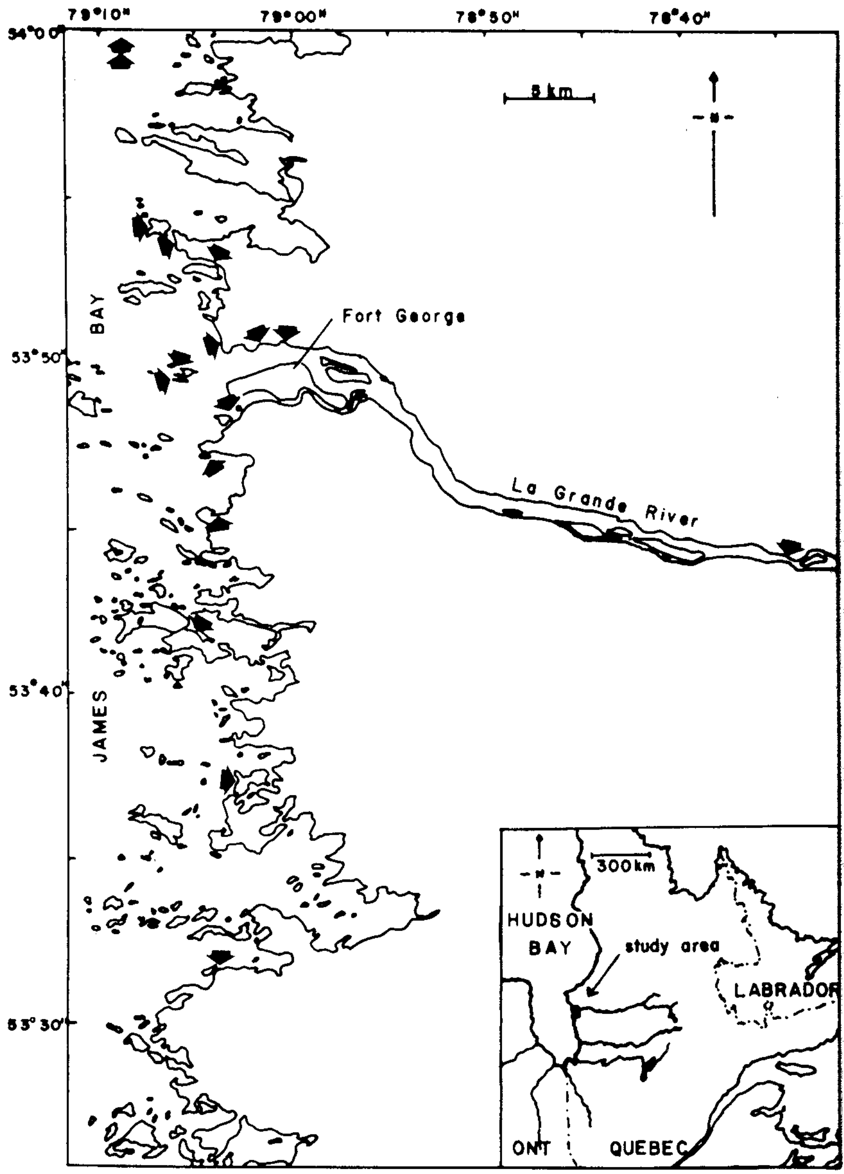


Fig. 1. Study area and sampling locations. The double arrow refers to three sampling locations off the map: mouth of the Capsaouis River (54°19′ N; 79°28′ W); mouth of the Seal River (54°32′ N; 29°33′ W); and Cape Jones area lakes (54°43′ N; 79°24′ W).

Fort George, in a more comprehensive questionnaire study that covered most native communities in northern Quebec (NHR, 1976).

Two species of *Coregonus*, whitefish *(C. clupeaformis)* and cisco *(C. artedii)*, are quantitatively the most important fish in Fort George (Weinstein, 1976). In most years these two species together provide the second most important source of wild food after Canada geese. The present catch levels of cisco and whitefish at Fort George are high. Weinstein (1976) estimated a catch of some 106,500 *Coregonus* out of a total community catch of 171,500 fish in 1973-1974, while the NHR (1976) study estimated a catch of some 85,700 *Coregonus* out of a total of 173,300 fish. In terms of "food weights," Weinstein (1976) projected 31,600 kg *Coregonus*, or about 60% of the total community fish harvest in 1973-1974; NHR (1976) projected 25,770 kg *Coregonus*, or about 39% of the total community fish harvest in 1974-1975.

By comparison, the total commercial *Coregonus* catch in the entire province of Quebec, of which the Fort George area is a small part, was 14,000 kg whole weight in 1974, according to the Quebec Bureau of Statistics. (Some other provinces, such as Manitoba, obtain much larger catches, however.) None of the Quebec commercial catch came from the James Bay area.

The fishery at Fort George is a subsistence one, and its catch is not being sold but is locally consumed, and it is thus not subject to any government regulations. Its operations are small-scale and technologically simple. Most fishing is done by the use of gillnets, and cotton gillnets have been available in the area at least since the early 1700s (Ornstein, personal communication). Even though there have been technological changes such as the advent of nylon gillnets (mid-1950s) and outboard motors (mid- and late 1950s), the Cree people say that they consider the present fishing methods to be "traditional."

There is little doubt that the magnitude of the fish catch has fluctuated over the years. The introduction of the dog sled probably resulted in a large increase in the fish harvest, and the advent of the snowmobile reduced it. However, there is good evidence that the two *Coregonus* species have remained an important food source for a long time in the communities along the James Bay coast (Dymond, 1933), and no evidence that the stocks have ever collapsed. It thus appears that the Cree have not depleted their fish and, moreover, that the catch levels have remained high. By contrast, many fishing enterprises result in the overfishing of the stocks (e.g., Gulland, 1974); this is particularly true of commercial fisheries in Canada's north (Healey, 1975). The continued high catch level of the Cree therefore requires explanation. This article seeks to offer such an explanation by studying fishing practices at Fort George, the biological consequences of these practices on the fish populations, and evidence of adaptations that may lead to a balanced and hence ecologically successful relationship between the fishers and their prey resources.

A null hypothesis may be formulated that the Cree harvest the fish in a haphazard manner, catching what they can. If this is so, then the apparent success of the fishery may be explained simply on the basis that there are not enough Cree to overexploit the stocks with their present technology. Evidence from elsewhere (Nietschmann, 1972; Feit, 1973a, b) suggests that this is not so: hunting and fishing focus on a series of specific animals at specific times and places. To reject the null hypothesis, however, it needs to be shown not only that a high degree of order exists in the fishery, but also that Cree fishing has a demonstrable impact on fish populations and that the Cree have the capability to overfish the stocks.

THE ENVIRONMENT AND THE PEOPLE

The study area (Fig. 1), about 1000 km north of Montreal, lies in the Canadian subarctic, close to the fringe of the arctic zone. The exposed coastline and the islands have a typical tundra landscape; the interior consists of muskeg and open-crown forest dotted with thousands of lakes (not shown on map). The treeline dips farther south on the Hudson Bay coast than in any other continental region of the world. The indented, low-lying coast is a unique environment where the transition from the marine to the freshwater ecosystem is gradual, and where the arctic fauna and flora blend into assemblages characteristic of more southerly ecosystems.

The study area is the home of the Fort George band of the James Bay Cree Indian people. Fort George is also the name of the permanent settlement of 1,582 resident native people, including 1,399 Cree Indians, 106 nonstatus Indians (Metis), and 55 Inuit (Eskimo) according to a census in winter 1973-1974. With only some 225 nonnatives, mainly transient white people who are administrators, teachers, and hospital personnel, Fort George is one of the largest native-run communities in Canada's north.

Up until only about 1960, Fort George was essentially a trading post with a few permanent buildings. People came to the settlement principally after their winter trapping for trade and social exchanges (Weinstein, 1976). In Fort George today the Cree people live in fixed dwellings and there is a large variety of permanent structures, including a hospital, two schools, two missions, several stores, a restaurant, and a lodge. Hunting and trapping parties depart intermittently from the settlement for varying periods of time throughout the year. There is much harvesting on a commuter basis and on weekends (Weinstein, 1976).

The Fort George area, as with much of Canada's north, is being opened up for resource exploitation, and the original development plans for the area were contested in court by the Cree and Inuit. A long court case, followed by negotiations, resulted in a treaty (1975) involving four parties: the Cree of James Bay, the Inuit of Northern Quebec, and the governments of Quebec and Canada. According to this treaty, the native peoples were provided with some safeguards for the retention of local control and the retention of exclusive hunting, fishing, and trapping on a large part of the land (some 29,000 square miles for the 6,500 Cree) in exchange for relinguishing their land claims. They were "guaranteed" a harvest level equal to present levels of all species in the area of the treaty. The guaranteed levels would be established after 5 years of studies, of which NHR (1976) represents the first year.

The major component of the James Bay development plan is a large-scale hydroelectric power project affecting several river systems. The major power production potential will be centered on four dams along La Grande River (Fig. 1). The possible impact of this large undertaking, affecting a watershed area of 68,285 square miles and flooding 3,520 square miles to produce 10,340 MW of electricity (Environment Canada, 1975), prompted several studies on the ecology and the resources of the area. The project, announced in 1971 and still being built at the time of writing, will not only open up the area of development but also expose the communities to greatly increased southern influences. In the face of possible damage to traditional food resources, land-use patterns, and harvesting practices, there is a special significance to the study of human ecology of the area.

MATERIALS AND METHODS

The material for this study was collected mainly by traveling with fishing groups of local people, recording their catch, studying the fishing techniques used, and simultaneously collecting biological data on the fish. A total of 20 fishing groups or individuals cooperated with the study. One family group was followed for better than two-thirds of their fishing activities over 2 years.

At each fishing location the total numbers and weights of fish were recorded by species. The number of fishers in the party, the traveling time per trip, the type of fishing gear, and the fishing time were also noted. Fishing time is defined as the time span between setting and checking a gillnet. A "net set" is defined as one lift or one check of one gillnet.

The principal gear used in the fishery was a 50 m long multifilament nylon gillnet measuring 2½ in. (63.5 mm), 3 in. (76.2 mm), or 3½ in. (88.9 mm) mesh (stretched measure), referred to as a No. 2½, No. 3, and No. 3½ nets, respectively. In water, the nets measured about 35 m long and 1.3 m deep. There were weighted with small rocks and buoyed by about 1 m-long floats of dry cedar wood. The nets were usually set perpendicular to the coastline in shallow water, almost never deeper than about 3 m so that the tips of the floats showed above water. On the coast, fishing boats were mostly 24 ft canoes powered with 20, 25, or 40 HP outboard motors.

Nets were set and relocated easily. Once set, nets remained in one location until the catch dropped off or until nets were grown over with algae and needed to be dried and cleaned. Nets were usually lifted once a day, but were checked more frequently when large catches were expected or when they were set near temporary camp sites. Fishing times of over 24 hr were usually not deliberate but reflected the consequences of adverse weather conditions or social commitments.

Each fishing group usually set one to three nets, up to a maximum of five in the present study. It took only two individuals to manage the net and the boat, but others, usually women and children, were often taken along as well. Women occasionally led fishing groups and some were as skillful as men. Each person had a series of favorite fishing spots, some but usually not all of which were visited in the course of a fishing season. There was no territoriality, and fishing success in one area often quickly attracted others, but each fisher maintained a respectable distance from the others so as not to interfere with the catch.

The above general description applies to most coastal and inland sites where gillnets were used. The gear and methods of ice fishing, following freezeup in November, were similar, but somewhat different skills were involved in setting the nets, and the nets had not long but small flat cedar buoys to minimize loss by icing.

The gillnet was not the only fishing gear used in Fort George. In the August fishery at First Rapids, marked on Fig. 1 upstream on La Grande, a hand-drawn seine was used in small bays at the foot of the rapids to harvest concentrations of fish (Berkes, 1976). Some harvesting was done also by angling, mainly for sea-run trout *(Salvelinus fontinalis)* in spring.

In data analysis, a distinction is made between fish obtained on the James Bay coast in brackish or partially salty water and those obtained in lakes. Since these fish represent different stocks (subpopulations considered resource management units), biological data based on them cannot be lumped. This distinction is identified in the various tables.

Biological data were collected on the populations of the two *Coregonus* species. The length and weight and state of reproductive maturity of the individual fish were recorded and scale samples were taken for age determination. Biological data collected from the local catch were supplemented by the use of an experimental monofilament gang net of 2 in. (51 mm) to 5 in. (127 mm) mesh size.

CATCH LEVELS AND THE BIOLOGY OF THE FISH

Almost 2 metric tons of fish were sampled over the 2 year study period, representing no less than 1% of the total community fish catch at Fort George, but probably not more than 2%.

Table I shows the importance of cisco and whitefish in the total coastal catch by the people of Fort George during the study period. Whitefish is a larger fish (average weight 525.7 g) than the more abundant cisco (average weight 277.5 g). The reason for the size differences may be seen in Fig. 2, which shows the growth curves of the two species. The two species are of similar sizes and have similar growth rates between the ages of 3 and 5 years. After 5 years, whitefish grows more rapidly than does cisco, attains a larger size, and probably lives longer. The age at maturity of whitefish could not be determined conclusively for lack of mid- and late-summer samples. Among the cisco examined, all of those 5 years and older were reproductively mature, as were some of the 4-year-olds, but not the younger fish.

The length-weight relationships of the two species were similar and the weight increased exponentially with the length of the fish. The curves fitted to the data in Fig. 3 indicate a relationship in the form of:

$$Y = Ae^{Bx}$$

where Y is the weight in grams, and X is the length in millimeters. The equation for the whitefish gives $A = 18.7075$ and $B = 8.9583$, with a correlation of +0.975; for cisco, $A = 8.4246$ and $B = 1.1811$ with a correlation coefficient of +0.757. Both correlation coefficients are highly significant. The curves are based on 63 points for whitefish and 119 for cisco. Some of the points on the curve represent the mean of several measurements of fish of similar lengths. Almost all the fish to the far left of the curves come from summer samples; those to the far right, from early spring; that is, summer fish are fatter than spring fish. Correlation coefficients for spring samples alone are +0.983 for whitefish and +0.979 for cisco.

The two species together make up 64% of the samples by weight and 69% by numbers (Table I). Two other species, brook trout and longnose sucker *(Catostomus catostomus)* account for most of the rest, with only seven other species represented in the catch, four of them strictly freshwater. The total catch figure excludes one species or group of species, sculpins *(Myoxocephalus* sp.) which were not utilized and were thrown out immediately by the fishers and thus could not be recorded.

Table II presents a summary of the catch data by areas and by time periods over the seasonal cycle: numbers of net sets and fishers, numbers of cisco, whitefish, and total fish, as well as the average catch per net set. The predominant fish in the Capsaouis samples was sea-run brook trout, in June and July Fort George samples it was longnose sucker; in all other areas and at all other times, whitefish and cisco made up the bulk of the catch.

The study covered the full seasonal cycle of the coastal fishery, from the spring breakup to the late fall ice fishery, but some aspects of the community's total fishery effort were not as well represented as others. From openended interviews, it would seem that there was a considerable fishery effort beyond a radius of about 15 km "commuting distance" from Fort George: family groups camped out in the islands in spring and summer and their catch was underepresented in the data. The predominant species in the catch would be whitefish.

Table I. Importance of Whitefish *(Coregonus clupeaformis)* and Cisco *(Coregonus artedii)*, by Weight and by Numbers, in the Coastal Fishery of the People of Fort George

	Weight, %		Numbers, %	
	1975	1976	1975	1976
Whitefish	17.3	12.2	11.2	10.4
Cisco	45.2	52.8	55.2	61.8
All other species	37.5	35.0	33.6	27.8
Total	100.0	100.0	100.0	100.0

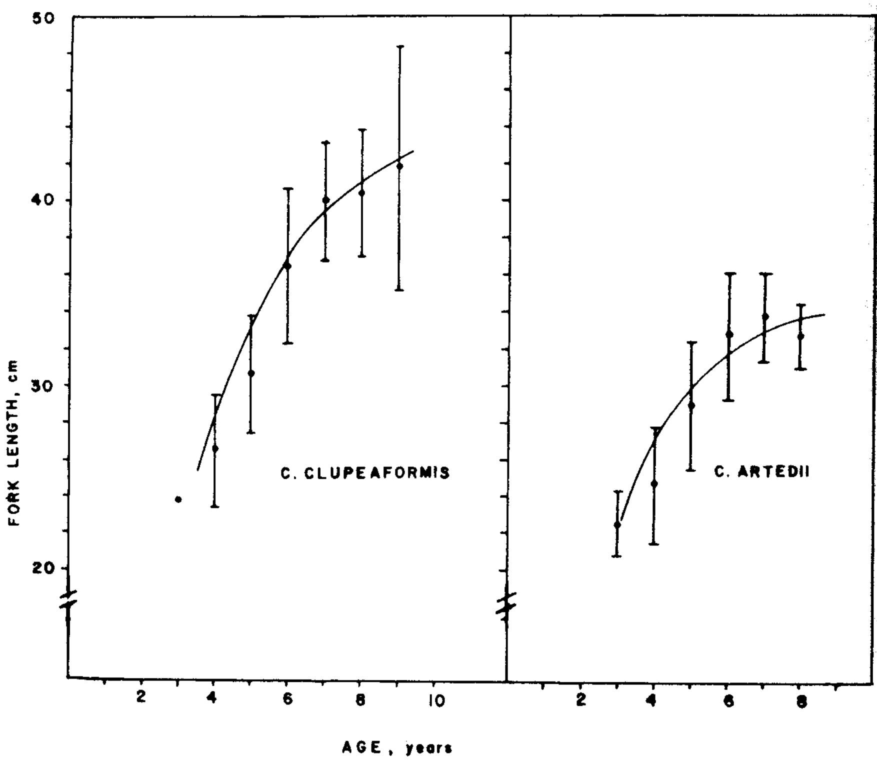
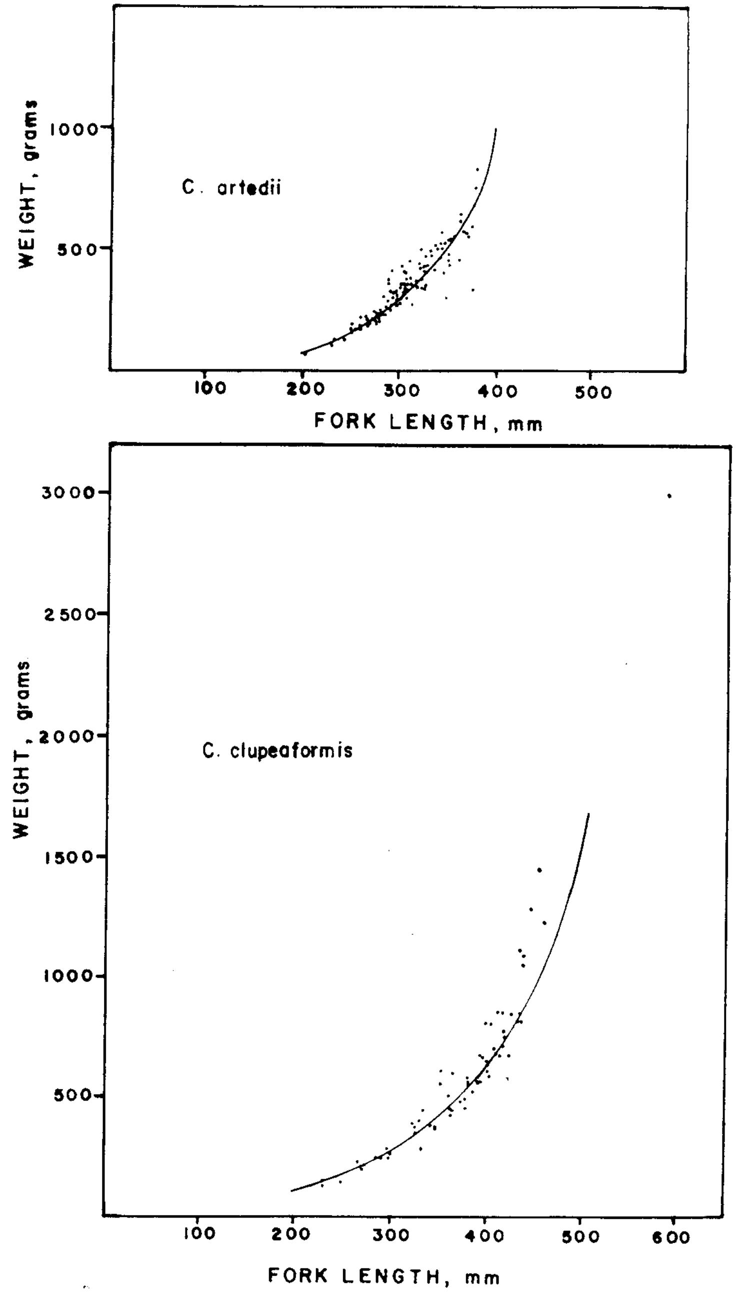


Fig. 2. Growth rates of whitefish *(C. clupeaformis)* and cisco *(C. artedii)*. Fork length (mean ± SD) is given against age of fish.



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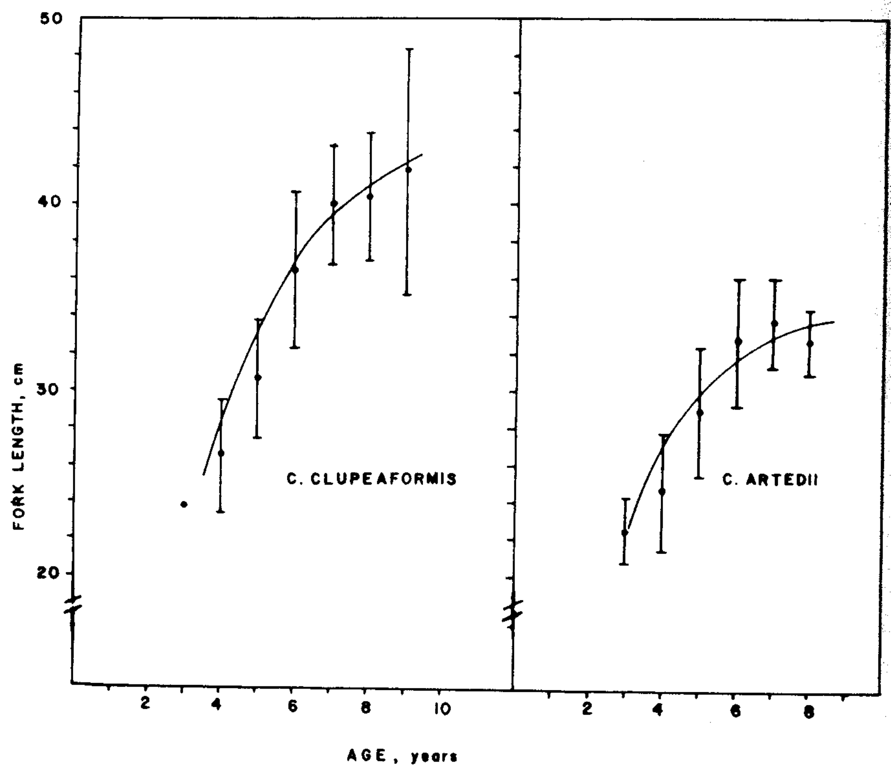

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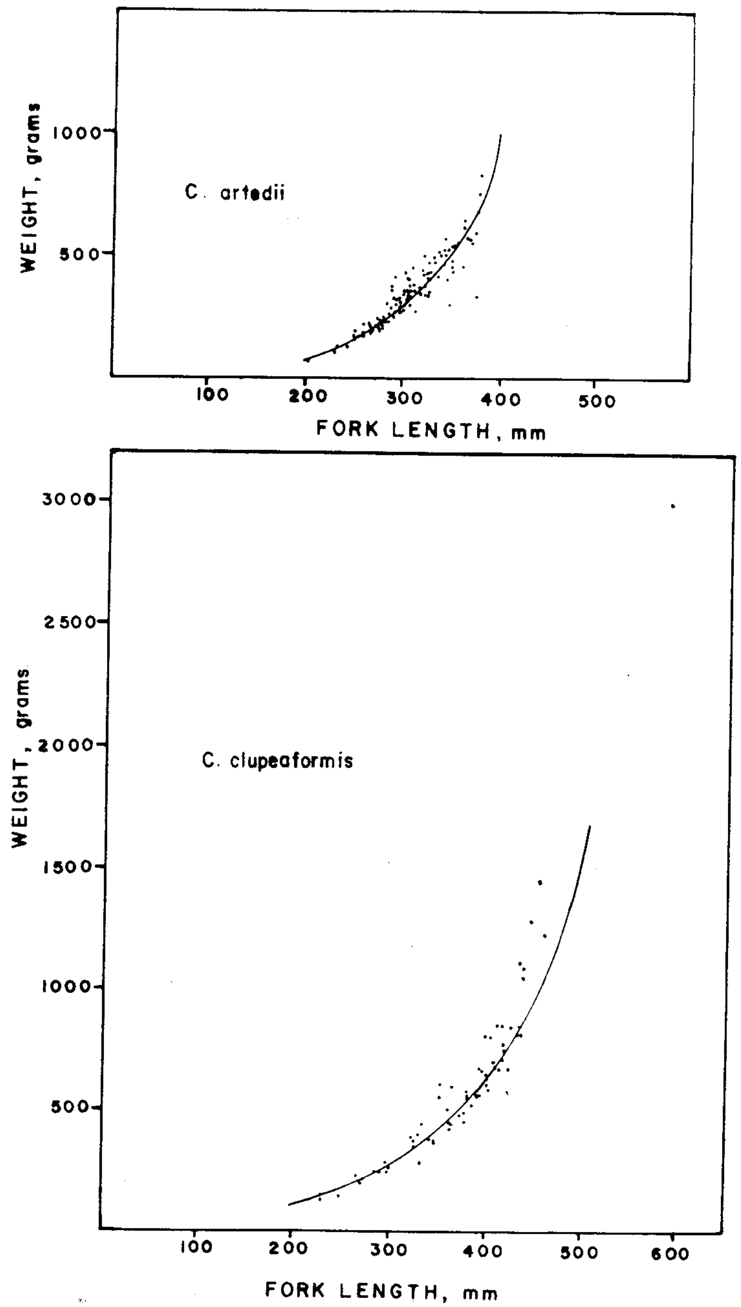

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Table II. Distribution of Whitefish, Cisco, and Total Fish Catches, and the Average Catch per Net Set in Space and Time During the 2-Year Study Period

Area	Sampling period	No. of net sets	No. of fishers	No. of fish: Whitefish	No. of fish: Cisco	No. of fish: All species	Mean catch per net set, g
Fort George	24/v-27/v/1975	9	4	66	59	142	6,197
Capsaouis River	31/v-1/vi	7	3	31	27	114	9,471
Fort George	1/vi-20/vi	35	2	50	253	530	4,743
South Coast	20/vi-15/vii	7	2	20	0	36	3,832
Fort George	29/vi-20/vii	7	3	7	3	180	10,319
First Rapids (seining)	21/viii	(5)	1	6	135	141	10,796
Fort George	11/viii-24/viii	39	1	9	86	238	2,171
Fort George	17/x-23/x	14	1	13	228	255	4,293
Fort George	28/xi-1/xii	11	2	12	266	280	5,790
Fort George	3/vi-8/vi/1976	23	1	15	144	293	4,151
Capsaouis River	9/vi-11/vi	10	3	41	12	151	9,693
Fort George	12/vi-16/vi	14	1	14	22	210	4,853
Fort George	19/vi-27/vi	22	1	35	152	269	3,493
Fort George	28/vii-9/viii	37	1	8	118	271	2,738
Fort George	10/viii-31/viii	41	1	12	68	221	1,854
Seal River	28/ix-2/x	9	2	32	10	62	4,734
Fort George	19/x-23/x	13	1	72	419	526	10,215
Fort George	21/xi-29/xi	42	2	82	898	981	5,268
Lake catches:							
South Coast	24/vi-23/vii/1975	7	2	28	6	84	9,226
Cape Jones	30/vi-4/vii/1976	37	5	104	0	161	8,367

Table III. Relationship Between the Catch per Net Set and Duration of Fishing of that Net[a]

Duration of fishing	N	Yield per net set, g: Mean	Yield per net set, g: Standard deviation
7 hr or less	7	6,434	±3,633
7 hr-14 hr	12	4,902	±2,767
14 hr up to 24 hr	19	6,363	±3,622
24 hr	23	5,517	±4,488
24 hr up to 48 hr	9	5,592	±5,325
48 hr	12	4,582	±3,083
Over 48 hr	9	6,589	±3,300

[a]Samples from 1975 only. Excludes August Fort George catches in which the mean yields were 3,722 g at 14-24 hr (N = 4), 1,803 g at 24 hr (N = 18), and 2,196 g at 24-48 hr (N = 17).

Similarly, the First Rapids fishery in August and, in particular, inland lake fisheries were underrepresented.

One major problem in the recording of catch levels concerns the choice of units. The catch per unit efforts were calculated in Table II on a "catch per net set" basis rather than, for example, on a catch per fisher or a catch per day basis. The justification for this choice of units may be found in Table III, which shows that the mean catch per net set did not vary in any systematic way over a wide range of fishing times, from less than 7 hr to over 48 hr. The Cree recognize that leaving the net in the water longer does not necessarily give larger catches. As algae and debris collect in the nets, and as more fish are caught in the net, the avoidance factor seems to increase. At some point in time, the number of new fish caught by the gillnet is just balanced by the loss due to escaping and loss to predators such as gulls. Furthermore, in warmer weather, fish not removed from the net within 24 hr start to spoil.

As the catch did not vary with fishing time or with the number of fishers in the party, and the size of the nets was uniform or nearly so, the yield per net set was taken as the standard measure of "catch per unit of effort" (CPE).

CHOICE OF PRODUCTION STRATEGIES

Table IV summarizes the data on net selectivity. A smaller mesh net catches relatively greater numbers of the smaller fish, and, conversely, a larger mesh net catches relatively greater numbers of the larger fish (cf. Fig. 2). The No. 2½ net was found to select strongly for cisco; whitefish: cisco ratio was

Table IV. Selectivity of Different Mesh Sizes of Gillnets for Whitefish and Cisco

Net	No. of net sets	Whitefish No.	Whitefish Avg. wt., g	Cisco No.	Cisco Avg. wt., g	Ratio of white fish to cisco
2½	219	273	250	2,536	250	1:9.3
3	86	130	563	196	378	1:1.5
3½ and 4	30	102	694	22	552	4.6:1

about 1:10. The No. 3 net, however, caught almost equal numbers of the two species. Larger nets (3½ and 4) sampled only 30 times during the study caught mainly whitefish and sea-run trout; the ratio of whitefish to cisco was about 5:1.

The choice of production strategies in the Fort George fishery appeared to be related to net selectivity. There were two basic strategies with respect to the mix of mesh sizes used. In the area "near Fort George," defined as the area within a 15 km radius, the usual limit of commuting distance, the No. 2½ net was most commonly used. The use of this net was recorded 216 times in samples near Fort George; all other mesh sizes were recorded 86 times (Table V). "Away from Fort George," or beyond a 15 km radius, the largest mesh nets (3½ and 4) were most commonly used (recorded 21 times). The use of the No. 3 net was recorded nine times, the No. 2½ net only three times.

The two strategies may be related to the relative availability of the two *Coregonus* species in the two areas. And the adaptive significance of the two strategies may be studied by examining the catch per net set for different mesh sizes in the two areas. Near Fort George, the No. 2½ nets produced an average

Table V. Catch per Net Set (g) for the Four Mesh Sizes of Gillnets in the "Near Fort George" Fishery vs the "Away from Fort George" Fishery

	Near Fort George	Away from Fort George
No. 2½ nets		
Whitefish	293	1,612
Cisco	2,915	1,423
Total catch	4,839	6,602
	(N = 216)	(N = 3)
No. 3 nets		
Whitefish	697	2,172
Cisco	884	664
Total catch	2,628	5,517
	(N = 77)	(N = 9)
Nos. 3½ and 4 nets		
Whitefish	1,053	2,918
Cisco	50	644
Total catch	2,135	7,772
	(N = 9)	(N = 21)

catch of 4,839 g of fish per net set, 2,915 g of which was cisco. The No. 3 net, however, produced only 2,628 of fish, 884 g of which was cisco (Table V). The predominant use of the No. 2½ net thus maximized the total catch, consisting mainly of cisco.

Away from Fort George, the No. 2½ nets produced a mean catch of 6,602 g of fish, No. 3 nets produced 5,517 g and No. 3¼ and 4 nets produced 7,772 g. As the mean catch of all fish does not vary significantly, the critical difference seems to be in the size of the whitefish catch: No. 2½ nets caught a mean of 1,612 g of whitefish, No. 3 caught 2,172 g, and the No. 3½ and 4 caught 2,918 g. Thus, the predominant use of the larger-mesh nets away from Fort George maximizes not the total fish catch, but the whitefish catch.

Table V presents a summary of all gillnet samples in the study. As there are a number of uncontrolled variables, the catches of No. 2½ nets vs those of No. 3 nets are not strictly comparable. The test came from an experiment suggested by the accompanying fishers who set two replicates of two paired nets, one of the 2½ and one of No. 3, which were fished side by side for 9 consecutive days, just across the river from Fort George.

The results (Table VI) confirm the general findings in Table V. The No. 2½ net caught twice as much total fish as the No. 3 net, and the difference was significant by the t test ($p < 0.05$). The No. 2½ net caught twice as much cisco as the No. 3 net, but the results were reversed for whitefish. Thus, even though the No. 3 caught twice as much whitefish as the No. 2½, the catch per net set was very low near Fort George. But the use of the No. 2½ maximized the catch, consisting mainly of cisco.

The existence of the two strategies is not a "new finding" as such, but merely a numerical documentation of a phenomenon well known to the Cree people of Fort George, who say that they use small nets and catch small fish (cisco) near the settlement, and use large nets and catch large fish (whitefish) when they are out in the bay along the coast; larger whitefish are generally preferred because they are easier to clean and to prepare than are the smaller. Further, there is evidence that Cree fishers in other communities, such as Wemin-

Table VI. Fort George, August, Catch per Lift with Paired No. 2½ and No. 3 Nets

	Catch per net set, g No. 2½	No. 3
Whitefish	110	226
Cisco	1,211	649
Total fish	3,164	1,439
No. of net sets	18	18

dji (Paint Hills), just south of Fort George on the James Bay coast, use similar fishing strategies (Berkes, field notes).

ADAPTATIONS OF THE FISHERS TO THE ECOSYSTEM

One characteristic of the Fort George subsistence fishery is that it is opportunistic. Fishers concentrated heavily on a segment of the fish stock that happened to be readily available at a given time. For example, one fishing group concentrated its efforts in a small inlet, perhaps 100 m X 400 m at low tide, removing a total of 34,170 g of fish between June 7 and 12, 1975. The initial catch per net set was 6,440 g, but the final catch was 2,200 g, suggesting that a large fraction of the fishable stock in the inlet was removed over that brief period. The fishing goup then relocated their nets elsewhere, but indicated that the inlet was a traditional fishing site for the family and that they would be back the following year.

Secondly, an initial high success of fishing group in one area seemed to encourage others to converge on that area. On May 24, 1975, in another small inlet on the coast just north of Fort George, 40,850 g of fish were caught by five net sets. By May 27, there were about 20 nets in the inlet, three of which were sampled and found to have caught a combined total of 8,000 g. As the catches fell off, nets were relocated.

Thirdly, year-to-year variations in fish availability in different seasons and areas were compensated for by an appropriate distribution of the fishing effort. For example, on the basis of openended interviews, it seemed that the early spring fishery had been quite good in 1975, the First Rapids August fishery moderately good, Fort George October fishery quite good, but the South Channel November fishery rather poor due to a late freezeup. Consequently, many people were fishing in early spring but very few in November. In 1973, however, the November fishery had been spectacularly good, and according to one informant, over 100 nets had been set in a small part of the southern branch of the estuary alone. But the same year the First Rapids fishery was very poor.

Further, it seemed that the allocation of effort for the harvest of other resources also played a role in the distribution of the fishing effort, but that was beyond the scope of this paper.

Fourthly, seasonal fluctuation in fish availability was also subject to a compensating mechanism for the allocation of effort. Table VII shows that the catch per lift in June was 4,379 g as compared to only 2,171 g in August for one fishing group setting nets near Fort George. Field data, collected on 12 days in June and 9 days in August, showed that the mean net lifts per day was 2.67 in June and 4.33 in August. Data based on fewer days' observation in October and November were consistent with these results; fewer nets were set when the catch per effort was high.

Table VII. Relationship Between the Fishing Effort and the Catch per Net Set for One Fishing Group Setting Nets near Fort George in June, August, October, and November, 1975

	June	August	October	November
Total fish catch, g	140,135	84,682	60,100	44,105
Number of net sets	32	39	14	8
Catch per net set, g	4,379	2,171	4,293	5,513
Number of days	12	9	7	4
Net sets per day	2.67	4.33	2.00	2.00

In conclusion, fishing practices of Fort George seem well adapted for subartic ecosystems characterized by unpredictability and large seasonal and year-to-year environmental fluctuations which, according to one current ecological theory, contribute to the low species diversity observed in these ecosystems (Pianka, 1966).

The opportunistic nature of the fishery, the rapid communication of fishing success which permits the redistribution of fishers, and the ability to compensate for year-to-year and seasonal variations may all be identified as adaptations to the subartic environment. Two aspects of Fort George fishery practices seem particularly relevant for the support of these adaptations. First, the lack of a rigid territorial system has an ecological basis in allowing for more flexibility in the distribution of effort to optimize yields than would otherwise be possible. By contrast, the beaver *(Castor canadensis),* a stationary resource, is harvested on a territorial basis (Feit, 1973b). Secondly, the simplicity of fishing technology and the small size of nets permit a highly mobile fishery by allowing rapid net setting, checking, cleaning, relocation, or removal. These adaptations result in a sophisticated resource exploitation system in which great knowledge of the environment and cooperation in animal harvesting are both highly important.

SOCIAL PRACTICES REGULATING THE FISHERY

Although no government regulation applies to Cree subsistence fisheries, there are "social practices" limiting the size of the catch, the mesh size, the depth and areal extent of fishing, and ensuring the full utilization of the catch.

When fish were abundant, as in the spring and fall in the coastal fishery, two small nets of 50 m each were sufficient, according to informants, to catch enough for the needs of the average family in the study. But in midsummer, the mean catch per net set decreased to about half of that in the spring months.

Fishers compensated for this by setting about twice as many nets so that the catch remained constant (Table VII). An extra net took only about half an hour to set and minutes to check. Thus, even in midsummer the people could have set many more nets than they actually did. When questioned about it, informants said that they would set no more nets than were required to catch what they needed; there was no incentive to create a surplus.

Further, the catch was utilized fully. Often the entire fish, excluding the larger bones, the gall bladder, and the contents of the stomach, but including the rest of the internal organs, was eaten. The Cree indicate much concern over not wasting any fish or other wild food. This point was noted by Speck (1935: 117) for the Mistassini Cree, and the general notion of catching only enough for the needs has been documented for beaver trapping and moose hunting among the Waswanipi Cree by Feit (1973a,b).

Two other practices have biological consequences with respect to maintaining the fish stocks: the limitation of fishing activity to shallow waters, and the limitation of fishing to a relatively few traditional sites. According to informants, only a small number of traditional fishing sites are actually used along a long and very indented coastline. For example, there are only about a dozen or so sites, in bays, inlets, and estuaries, from the limits of the "near Fort George" area to Cape Jones in the north, a straight-line distance of about 80 km.

Gillnets used in the coastal fishery almost never reach as deep as 3 m. The depth range of the fish is almost certainly greater than this, and commercial fisheries elsewhere operate much deeper for the same species. In the Southern Indian Lake whitefish fisheries, for example, nets are usually set in water 15-21 m deep as well as in shallower water (Weagle and Baxter, 1974).

Fishing only a small part of a species range, by both depth and geographical area, and thus maintaining a large unfished sanctuary for the stocks, is thought to be a good conservation measure. It is difficult to document the effect of this practice, but the consequences can be evaluated from circumstantial evidence, as Cucin and Regier (1965) have done. These authors suggested that the only hypothesis that might explain the relative success of the Georgian Bay whitefish fishery was the presence of unfished refuges which were either legally closed or unsuitable for fishing, and concluded that the presence of unfished sanctuaries may be very important for the conservation of a population (Cucin and Regier, 1965).

Perhaps a key social practice in the Fort George Cree fishery that helps the conservation of stocks is the limitation of the mesh size. As shown in Table V, the No. 2½ net catches more fish than does the No. 3 net near Forth George. It seemed possible that a net of even smaller mesh size might catch yet more fish. To test this hypothesis, an experimental 2 in. mesh gillnet was used. Large catches were obtained but the experiment had to be terminated prematurely because of social pressure from disapproving Cree fishers, who quickly noted both the unusually small netting and the undersized fish it caught.

There is a good biological reason for not using the 2 in. mesh: it catches immature fish only. As shown by Regier and Robson (1966, Fig. 9) for whitefish and confirmed in the present study for both species, the 2 in. net would catch mostly fish of the 20-25 cm size group; almost all cisco of that size group are reproductively immature. However, the 2½ in. net catches fish mostly of the 25-30 cm size group; most cisco of that size group are 4- and 5-year-old fish (Fig. 2), and most are reproductively mature.

Whitefish, however, matures at a larger size than does cisco, and the use of the No. 2½ net, while optimizing cisco yields, simultaneously removes immature whitefish with a mean weight of 250 g (Table IV). This may be the explanation of the lack of whitefish in the "near Fort George" area, as confirmed by independent biological investigations (Kidd *et al.*, 1975).

DO THE CREE MANAGE THEIR FISH RESOURCES?

The answer to the question of management depends on the definition used. If management of a fishery is defined as controlling how much fish is harvested, where, when, of what species, and of what sizes (Gulland, 1974: 1), the Cree fishermen of Fort George may be said to be managing their cisco and whitefish resources. Whether there is "conscious" manipulation of the resource is outside the scope of the present study, but may perhaps be best investigated by "tapping the cognitive world of the informants" (Frake, 1962).

Whether "conscious," fortuitous, or common-sense consequence of detailed knowledge of the biotic and abiotic environment, there is biological evidence of what might be called good management. The apparent depletion of whitefish near Fort George, paradoxically, provides a good example of a Cree "solution" to the classical dilemma of a multispecies fishery. In fisheries theory and practice, the curves of yield against fishing effort and against mesh size are different for each species. It is therefore impossible to harvest more than one species at the optimum level for each (Gulland, 1974: 121). In commercial fisheries, the choice of management strategies usually represents a compromise and the results are often less than successful. The Cree fishery employs a solution with a clear choice: away from Fort George, the effort is directed primarily at one species, whitefish; near Fort George, it is directed at another species, cisco. The high yields and the maintenance of stocks attest the success of this approach.

In much of the literature on subsistence hunting and fishing, there is an assumption that hunters do not have control over the scarcity and abundance patterns of animals they catch, and have no impact on these populations. This assumption seems to be as well entrenched as the assumption that early subsistence hunters had a short, brutish life, full of hardships, once was (e.g., Sahlins, 1972). The abundance of cisco relative to whitefish near Fort George indicates that fishers with simple technology can alter the abundance patterns of the species they harvest.

The age structures of whitefish and cisco in the Fort George catches (Fig. 2) provide further biological evidence that the Cree have a measurable impact on these stocks. The relative abundance of different age goups in the catch indicates a "youthful" age structure. Results of biological studies are in general agreement with this finding (Kidd *et al.*, 1975). Such age structures are characteristic of moderately exploited fish populations, and clearly differ from the age structures of unfished or very lightly fished northern stocks, for example of whitefish, in which fish older than 10 years dominate the population (e.g., Healey, 1975). A similar argument may be made with respect to growth rates (compare Fig. 2 here with Fig. 4 in Healey, 1975). This finding, inconsistent with the earlier assumption of much of human ecology, is hardly surprising to biologists who know that natural and laboratory populations of animal predators often do have an impact on the age structure of their prey (e.g., Slobodkin, 1968).

All evidence points to the conclusion that the apparent success of the Fort George fishery *cannot* be explained simply on the basis of too few Cree to overexploit the fish stocks. With population growth and/or the provision of an incentive to accumulate a surplus catch (such as external market demand), the situation could be different in the future. At the time of the study, however, the fishery was characterized by a high degree of order, for example, in the choice of gillnet mesh sizes, resulting in identifiable production strategies. Social practices regulating the fishing intensity, locations, and the minimum mesh size provided a control against the overfishing of stocks.

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