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THE KOKSOAK RIVER FISHERY 1977-1981

A SUMMARY REPORT

Prepared for

Caniapiscau-Koksoak Joint Study Group

By

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

In 1977 a five year study of the fish harvests obtained by the Inuit of Kuujjuaq from the Koksoak and Caniapiscau Rivers was initiated. The period from 1977 to 1981 covers the five years that immediately preceded the diversion of the upper Caniapiscau River. This document is the final report, and it contains a summary of the principal findings from the five years of pre-diversion studies. The data on which this final report is based, was collected by the Makivik Research Department in accordance with the Terms of Reference submitted to, and approved by, the Caniapiscau-Koksoak Joint Study Group prior to the start of the fishery for each year.

The primary objective for the five years of pre-diversion study was to gather baseline data that could be used to determine the impacts, if any, caused by the diversion of the upper Caniapiscau River on the Inuit fishery. Each of the annual studies was designed to:

1. Determine the total number of each species harvested by Inuit fishermen according to a code for each individual fisherman; date of catch; place of catch and method (net or rod) used for the harvests from 1977 to 1981.

2. Determine the level of effort measured in catch per unit of effort required for the gillnet fishery from 1977 to 1981.

3. Determine the distribution of the catch for commercial and subsistence purposes.

In addition to these three objectives, additional information on the impacts of weather, employment or other conditions that might affect Inuit participation in, or the success of, the fishery, was collected. The perceptions of individual fishermen about the year to year changes in the fishery were noted, and there was always concern with understanding the role of the Koksoak River fishery in the changing life of the community.

CHARACTERISTICS OF THE FISHERY AND SALMON STOCK

The Koksoak River is one of three major river systems of Ungava Bay utilized by Atlantic salmon. The Koksoak supports a population of both sea run salmon and a habit form that limits its migration between the estuary and fresh water. In addition to Atlantic salmon, the river supports sea run brook trout, whitefish and lake trout, and the estuary is important for arctic char. Sculpin and sucker can be found in large numbers and there are occasional reports of burbot and northern pike. The bearded seal frequents the estuary in late winter and spring, and harbour seals and beluga whales are sometimes found upriver from the community of Kuujjuaq. Tides of approximately 11 meters in the estuary carried salt water at high tide to the vicinity of Mackays Island which is approximately 15 kilometers north of the community, previous to the diversion.

The Koksoak River and its estuary has played an important role in the seasonal economy of the Inuit of southern Ungava Bay for centuries. The river was home territory for several family groups, and seasonal villages were well established along the coastline adjacent to the estuary. In 1829, the Moravian missionaries built a mission at the site of Old Fort Chimo and in 1830 the Hudson Bay Company established a post which closed in 1842 but reopened permanently in 1866. The presence of the missionaries and fur traders resulted in an increasing number of Inuit that utilized the Koksoak and surrounding territory. In 1942, the United States Air Force built a landing strip at the present site of Kuujjuaq and the Hudson Bay Company, mission and Inuit families gradually relocated to the new site. The Inuit population has grown through resettlement and natural increase to 976 in 1981.

The subsistence economy of the Inuit living in the region of the Koksoak River has always been based upon a seasonal cycle that included caribou hunting, fishing and marine mammal hunting. The Atlantic salmon has been a stable and seasonally dependable part of the subsistence

economy. In earlier times the harvest of salmon was important for the acquisition of winter dog food, although some of the harvest was always used for human consumption. Atlantic salmon were commercially exploited by the Hudson Bay Company from 1867 to 1910 (see figure 11) and in 1961 the Fort Chimo Cooperative began the commercial harvest and sale of salmon.

The Fishery: 1977-1981

The Koksoak River Inuit fishery operates for approximately four months each year. Fishing activity begins soon after breakup in early to mid-June, and continues until the freshwater ice forms in late October. After breakup when the river clears of debris, rod and net fishing begin for brook trout upriver and for arctic char in the estuary. In early May, families leave Kuujjuaq by snowmobile and establish spring camps near the mouth of the river. Other families depart by canoe after breakup and establish summer camps along the shoreline of the Koksoak north of Kuujjuaq. At this time, there is an active use of the river for short term camping as well, since open water travel offers the first opportunity since early May for people to move out of the community. Some of these families remain active in their camps throughout the summer while others return to Kuujjuaq after a few weeks of intensive fishing activity. All of the spring and summer camps are situated at preferred fishing areas in the river or estuary and most locations facilitate access to the marine hunting areas of Ungava Bay.

Fishing activity tends to decrease somewhat by late July or early August, although weekend use of the river for fishing, camping and travel to marine mammal hunting areas continues. The next major use of the river begins in early August, when individuals and their families begin preparations to harvest the upstream migration of the sea run Atlantic salmon. The traditional net sites are occupied by families, and newer camping and net sites are established by more recent participants in the commercial fishery. Net sites close to the communities are also utilized, usually by individuals seeking food for their own household. The timing of the run,

though regular, is not exact. Consequently, it is sometimes difficult for fishermen to schedule their time for commercial harvesting within the framework of other employment or work demands. From 1961 to 1977, the cooperative maintained a fish cleaning and packing operation, so that the harvest could be transported from the net site to the fish cleaning plant where they would be weighed for payment cleaned and packed. Women were hired for cleaning, and the group was notified as soon as fishermen began to arrive after their harvest on the rising tide. After 1977 there was the development of individual fishery operations that would sell directly to southern buyers. In every season, there was some sale of fish locally, but there were never attempts to smoke or process the salmon.

When the main run of salmon subsides, fishing activity decreases significantly. The commercial fishermen return, and activity once again turns towards weekend use of the river. If fishing takes place, it is usually carried out to the south of Fort Chimo and people may travel as far as the Caniapiscau or Larch Rivers for hunting, at which time they may also set nets. Little fishing takes place during the winter, at least in recent times. Fishermen note where it is possible to harvest through the ice with a spear, but serious winter fishing is carried out on inland lakes. Nevertheless, the Koksoak remains important for travel inland for caribou or to the open water of the estuary for marine mammal hunting. This intensity of marine mammal hunting is greatest from April to early June. Throughout the winter the willow bushes and coniferous trees that line the shores of the Koksoak south from Kuujjuaq, are important for the hunting of ptarmigan.

Biology of the Salmon Stock

Biological studies of the Koksoak River Atlantic salmon stock have revealed a heterogeneous mix of migratory habit forms which appears to be unique among documented salmon populations. The widely recognized classes of sea-going anadromous salmon comprise a major portion of the Koksoak stock. The other classes of salmon are distinguished by their estuarine

migratory habits. For these salmon, their summers are spent in the Koksoak estuary and winters in fresh water. A small group of Koksoak salmon exhibit both habits in their post-smolt life. All three classes of salmon contribute to the fishery in the Koksoak estuary and river. The significant differences in form and habit between the three classes of salmon, mean that there is the probability that some classes will be more susceptible to a particular type of impact than others. For the purposes of this report, the major distinguishing features of each class contributing to the Koksoak River fishery are reviewed in Table 1.

Table 1 - Classes of salmon encountered in the Koksoak estuary fishery stock and their distinguishing features.

SEALMON	1+ virgin (grilse)	One winter at sea
	2+ virgin (maiden)	Two winters at sea
	Previous spawn as 1+	Second migration, grilse previously
	Previous spawn as 2+	Second migration, 2+ maiden previously
	Multiple migrants	Third, or more, migration
	Kelts of all of above	Returning from spawning migration
ESTUARY	1+ virgin	One summer in estuary
	2+ virgin	Two summers in estuary
	3+ virgin	Three summers in estuary
	4+ virgin	Four summers in estuary
	Previously spawned	Second spawning migration completed
	Multiple migrants	Second + spawning migration
MIXED	2+ virgin	1+ in estuary, then 1+ at sea*
	3+ virgin	1+ in estuary, then 2+ at sea*
	Previous spawn as estuary	Estuary - Spawning migration - Sea
	Previous spawn as sea	Sea - Spawning migration - Estuary
	Multiple migrants	Second spawning migration completed
	Smolts	First seaward migration

* In rare instances, the sea phase precedes the estuary phase.

Kelts of all these classes are encountered in the summer Koksoak estuary fishery.

METHODS OF DATA COLLECTION AND ANALYSIS

In every fishery studied, the major parameters documented were the total harvest of each species and the total effort invested. Additional information on camp locations, fishing locations, and the temporal distributions of the harvests and the effort was also collected each year. Several more specialized studies into the utilizations of the catch (1977) and the details of individuals' harvesting operation (1981) were undertaken concurrently.

Collection of Field Data

The primary source of information throughout these studies has been a voluntary recording system in which all Inuit fishermen that utilized the Koksoak River were asked to record their harvests by species and location, to distinguish between harvests by rod and net, and to record the number of nets used. Booklets for recording this information were designed in consultation with the fishermen, and distributed at the beginning of each season. Individuals were periodically interviewed during the season to facilitate the recording of the information required. In each fishery from 1977 to 1980, the entire population of fishermen was censused. In 1981, the research design called for a sub-sample of fishermen. Supplementary information concerning the annual harvests, such as commercial records, were obtained wherever possible. In a widely dispersed fishery such as this, where the individuals' harvest can range from casual recreation to subsistance requirements to commercial sale, or more often some combination of these, the total harvest can only accurately be recorded at the source.

Problems are inherent in any voluntary recording system, and although individual cooperation was very high, it was never universal. Some people developed their own unique system for recording information which meant that interviewers always had to "interpret" some of the booklets. As one

would expect, booklets could be lost, damaged or left at home, so that recall of harvest level, location or dates was a constant factor that had to be clarified in the interviews. It was not uncommon for several individuals or even families to pool their harvesting efforts at least for part of the season. Additionally, there were tendencies to not record empty effort, or casual harvests during other activities. Nevertheless, the combination of individual recording of information, coupled with the interviews during and after the fishing season, has provided the only system that could possibly work in an activity that is so widely disbursed in both occurence and location. Over five years of study, this method has enabled a consistent body of data to be developed.

From 1977 to 1980, the processing of the booklet and interview data involved a simple collating of the information in order to determine harvest and effort totals. Interpretation of the 1981 results required more involved calculations which are fully described in the Annual Report for that year (Makivik Research Department, 1982 A). Further calculations involving the 1981 data have been carried out for this summary report and are described in the text.

Data Processing and Standardization

The data treatment required to describe and analyse the 1977-1981 fisheries, began with a review of all the available information and a standardization of the format of that data. Working directly from the reporting booklets, each year's catch data for each individual was grouped into a format where the harvest (number by species) and effort (gillnet-days) were totalled into 7-day blocks. This effected a reasonable degree of summarization of such a large data set while retaining sufficient resolution to allow meaningful temporal analyses to be made. To facilitate comparisons between years of data, each weekly block was assigned a week number (Table 2). There are 23 weekly blocks so numbered, spanning from the first week of June to the first week of November. The same week number in any one year will correspond to within several days of its counterparts in other years. These raw data tables were then stored on computer

Table 2 - Dates corresponding to week numbers; Koksoak River fishery, 1977-1981.

WEEK NO.	1981	1980	1979	1978	1977
1		June 2-8		June 4-10	June 1-7
2		June 9-15		June 11-17	June 8-14
3		June 16-22		June 18-24	June 15-21
4		June 23-29		June 25-July 1	June 22-28
5	July 1-7	June 30 -July 6		July 2-8	June 29-July 5
6	July 8-14	July 7-13		July 9-15	July 6-12
7	July 15-21	July 14-20	July 15-21	July 16-22	July 13-19
8	July 22-28	July 21-27	July 22-28	July 23-29	July 20-26
9	July 29-August 4	July 28-August 3	July 29-August 4	July 30-August 5	July 27-August 2
10	August 5-11	August 4-10	August 5-11	August 6-12	August 3-9
11	August 12-18	August 11-17	August 12-18	August 13-19	August 10-16
12	August 19-25	August 18-24	August 19-25	August 20-26	August 17-23
13	August 26-Sept.1	August 25-31	August 26-Sept 1	August 27-Sept 2	August 24-30
14	September 2-8	September 1-7	September 2-8	September 3-9	August 31-Sept 6
15	September 9-15	September 8-14	September 9-15	September 10-16	September 7-13
16	September 16-22	September 15-21		September 17-23	September 14-20
17	September 23-29	September 22-28		September 24-30	September 21-27
18		Sept 20-Oct 5		October 1-7	Sept 28-Oct 4
19		October 6-12		October 8-14	October 5-11
20		October 13-19		October 15-21	
21		October 20-26		October 22-28	
22				October 29-Nov 4	

facilities at McGill University in Montréal. An example of the format used to enter the field data is included in this report as Appendix B.

The units in this summarized data base are almost completely standardized as detailed in Table 3. As exceptions, effort data for the 1977 survey were recorded in fishing days rather than net-days while the 1981 data were, by design, those recorded by a sample of fishermen. Both of these inconsistencies will be dealt with in subsequent sections.

Table 3 - Summary of units of various parameters in the 1977 to 1981 raw data from the Koksoak River fisheries studies.

YEAR	1981	1980	1979	1978	1977
TYPE OF CENSUS	Sample	Complete	Complete	Complete	Complete
HARVEST DATA	#'s X species	#'s X species	#'s X species	#'s X species	#'s X species
EFFORT DATA	net-days + fishing days	net-days + fishing days	net-days + fishing days	net-days + fishing days	fishing days
TEMPORAL RESOLUTION	Weekly	Weekly	Weekly	Weekly	Weekly

Total harvests and total efforts

Table 4 is a summary of the findings for the major parameters that were determined for each year of the fishery: total harvests, total effort and overall catches per unit of effort (CPUE). The figures presented in table 4 provide the basic findings for each of the five years of the fishery and enable a comparison to be made for total gillnet harvest, and catch per unit of effort for gillnet, by major species groups. In order to insure a set of comparable figures for catch per unit of effort, it was necessary to correct inconsistencies in some of the data that were presented in the earlier Annual Reports for 1977 and 1981. The reported harvest totals, by major species, for each of the years 1977, 1978 and 1980 were considered to be acceptable estimates of actual harvests and were entered into Table 4. For seasons and by methods detailed below, harvest reported in 1979 and 1981 as well as the effort reported in every year required some adjustment to accurately describe their respective fisheries. Thus, Table 4 represents as comparable a set of figures as possible for the five fisheries censused, for total gillnet harvest, by major species group and total gillnet effort.

The 1981 census of harvest and effort was designed to provide an estimate of the totals based on the records of a sample of Koksoak fishermen. This was attempted in response to both the increasing resistance of some Koksoak fishermen to the census procedure and the research effort required to get a reliably complete census. This approach was incomplete, however, since the total number of active fishermen in 1981 was not determined. Several alternative methods of estimating the 1981 harvest and effort totals are fully explained in the 1981 Annual Report.

As shown in Table 3, the unit used in the 1977 survey to quantify fishing effort was the "fishing-day". While this unit is a viable one, particularly in the analysis of temporal participation in the fishery, the "net-day" is the unit most commonly used in catch per unit of effort (CPUE) calculations for the purpose of defining fishing success. This problem was corrected by assuming that the mean ratio of net-days to fishing-days over the years 1978 to 1980 (1981 not being a complete survey) could be applied to the total "fishing-days" recorded in 1977. The following calculations were made:

Table 4 - Comparison of total effort, total harvests by species (gillnets only), and CPUE (#fish/net-day) by species for the Koksoak River fisheries from 1977 to 1981.

		YEAR				
		1981 [1]	1980	1979 [6]	1978	1977
TOTAL EFFORT [3] (net-days)		1787.5-3576.0	2029.1	1974.2	3398.5	934.8 [2]
HARVEST (by nets) (numbers)	SALMON	4415-8840	8870	4436	4354	4095 [4]
	BROOK TROUT	1214 max.	1962	1268	1457	1750
	ARCTIC CHAR	1314 max.	728	226	552	557
	OTHER SPECIES	1715 max.	1660	730	785	1639
CPUE (numbers/ net-day)	SALMON	2.47	4.37	2.25	1.28	4.38 [5]
	BROOK TROUT	0.34	0.97	0.64	0.43	1.87
	ARCTIC CHAR	0.37	0.36	0.11	0.16	0.60
	OTHER SPECIES	0.48	0.82	0.37	0.23	1.75

[1] 1981 totals are estimated from a sample of fishermen, see text, p. 9.
[2] Estimated from fishing days; see text, p. 9.
[3] Corrected to reflect total harvest.
[4] May include harvests by other methods.
[5] Maximums; see text p. 10.
[6] Corrections applied to compensate for short recording season.

A. = Mean net-days per fishing day = 1.53
1978-1980 annual range (1.22 - 1.79)
B. = Fishing-days reported - 1977 = 611
A.X B. = 611 X 1.53 = 934.8 net-days

Since a "fishing-day" in 1977 was defined as any day where a harvest of any fish species occurred, it is obviously a minimum effort figure, as would be the "net-days" figure calculated from it. Consequently, CPUE calculations must be considered as maximum values.

Fish caught by rod or other methods have not been included in Table 4 with the exception of 1977, when they were not distinguished. While effort data on non-gillnet captures are lacking, the harvest totals are recorded in Table 5, for the years 1978 to 1981.

Table 5 - Harvests, and percentage of total harvests, of major species by rod and other methods, Koksoak River fishery 1978-1981.

SPECIES	1981 *	1980	1979	1978
SALMON	157 (1.7)	305 (3.3)	43 (1.0)	154 (3.4)
BROOK TROUT	1134 (48.3)	1059 (35.1)	349 (21.6)	1495 (50.6)
ARCTIC CHAR	46 (3.4)	61 (7.7)	117 (34.2)	40 (6.8)
OTHER SPECIES	1808 (51.3)	860 (34.1)	180 (19.8)	953 (54.8)

* Corrected totals.

Fewer rod catches of salmon and char are reported relative to brook trout and other species. In these latter groups, the total gillnet catch may not represent 50% of the total harvest reported (Tables 4 and 5). As a result, the 1977 CPUE values shown in Table 4 would be further inflated, significantly for brook trout and other species, but by a minor degree for salmon and char.

In the 1977 survey, every recorded harvest was reported with a corresponding amount of effort. In subsequent years, this was never the case. For the years 1978 to 1981, the effort reported was corrected upwards by a factor corresponding to the ratio between the harvest

reported with effort and the total reported harvest. As CPUE varies temporally, this correction process was carried out at the weekly level and the annual totals summed from those figures.

The temporal span of the 1979 records (Table 2) is shorter than other years. A correction was applied to total effort and the total harvest of each species based on the mean proportion of the annual harvests and efforts recorded during these uncensused periods in other seasons. The 1981 season was also slightly late starting but no correction was attempted in view of the previously described problems with the census that year.

Atlantic salmon

Figure 1 illustrates the fluctuations in total gillnet harvest, total gillnet effort and annual CPUE in the Atlantic salmon fisheries from 1977 to 1981. The harvests were consistent from 1977 to 1979 at near 4000 fish and then increased to over 9000 salmon in 1980. Effort and CPUE vary considerably from year to year. The results from 1977 to 1979 suggest a fishery where harvests are limited and fishing success (CPUE) is largely a function of effort. It would also appear, however, that the large 1980 harvest was a result of a significant increase in fishing success, essentially independent of increased effort. In this situation, the availability of the fish themselves must have been responsible for such a large increase in effort efficiency in 1980.

Other species

Harvest levels and catches per unit of effort are presented in Table 4 for the gillnet harvest of brook trout, arctic char and all other species combined. As shown, the level of return for each of these fisheries is significantly less than that of salmon. Catches per unit of effort were calculated by the same method as those for the salmon fishery. Since gillnet effort was not independantly recorded for each species, the application of total gillnet effort to a total gillnet harvest for a species other than salmon introduces an unavoidable bias. Fishermen note that some of their gillnet effort was directed specifically at other species, particularly arctic char and brook trout. Most of their total gillnet

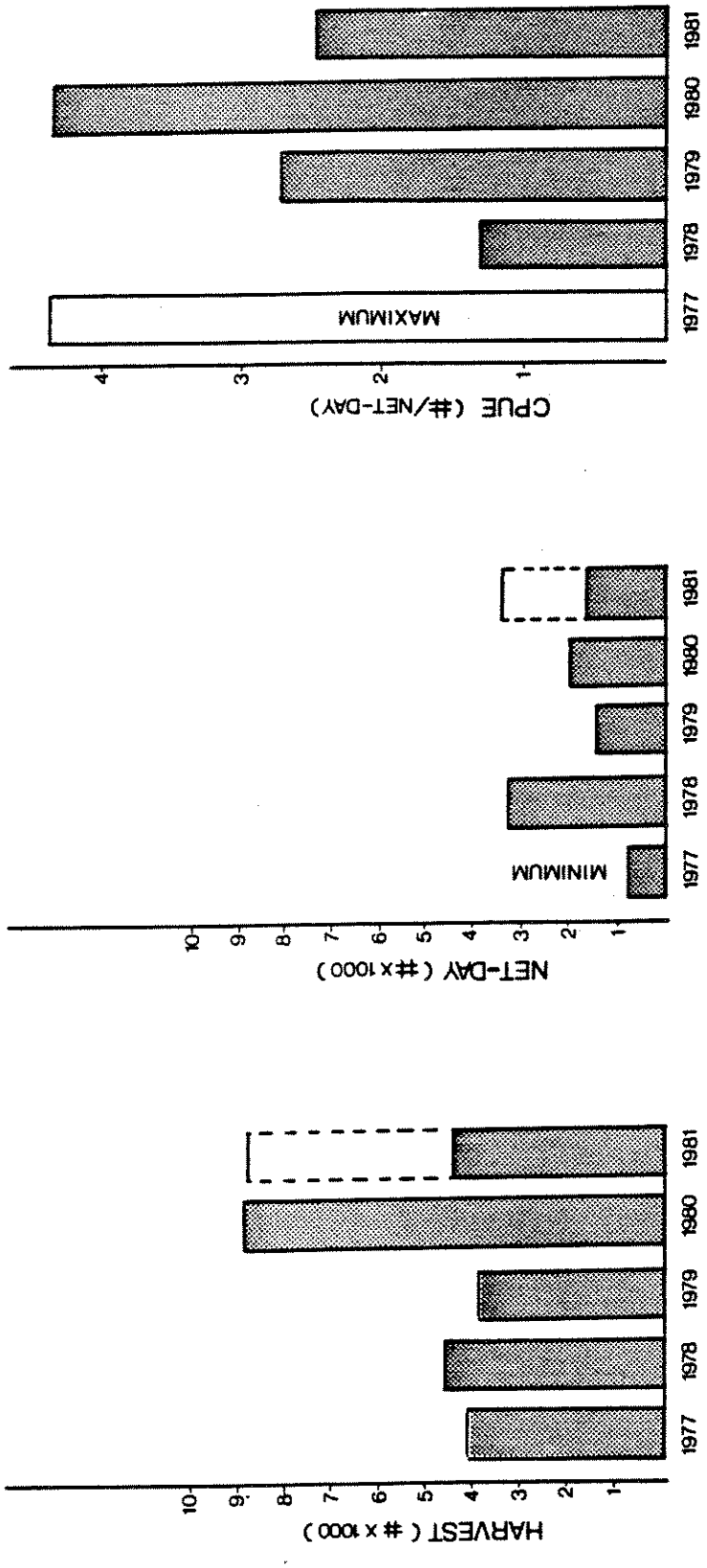

FIGURE 1. ANNUAL TOTALS FOR SALMON HARVEST, GILLNET EFFORT, AND SALMON CATCH PER UNIT EFFORT IN THE KOKSOAK RIVER FISHERIES, 1977 TO 1981.

effort was, however, directed at salmon. Thus, by effectively treating all other harvests as bycatches in the salmon fishery, absolute CPUE values for these other species are underestimated. Since it is likely that the ratio of these variously directed efforts does not change significantly from year to year, the relative changes in CPUE values for species other than salmon remain an important indicator of variations in the fishery.

Brook Trout. Anadromous brook trout are taken from the Koksoak River predominantly in July. Harvest, by gillnet, usually ranged from 1000 to 2000 fish annually (Table 4). The annual CPUE declined from a value of 0.97 in 1980 to a five-year low of 0.34 in 1981. This drop was accompanied by complaints from local fishermen that the anadromous run was very weak. It should be noted that the proportion of brook trout taken annually by rod (Table 5) is quite high, relative to salmon and char, and that the 1977 harvest totals in Table 4 also include captures by both methods. The 1977 CPUE value for brook trout, and "other species" as well, are most certainly over-estimated, possibly by as much as 50% (Table 5).

Arctic char. Arctic char catches are, like those of brook trout, largely recorded early in the season, but the harvest is greatest in the seaward sections of the estuary. This supports a local contention, that the Koksoak system itself presently supports only those char from adjacent systems which are at the extent of their summer foraging migration. Such spatio-temporal restrictions on their availability within the Koksoak fishery likely introduces sufficient apparent fluctuations in CPUE values to mask any actual change in their abundance from year to year.

Temporal distributions of harvest and effort

The maximum length of the fishing season on the Koksoak River is closely defined by the length of the ice-free season. Variations occur

from year to year, but the season usually runs from mid-June to late October. A small amount of activity can take place in May in the outer estuary since that area is usually ice-free by May. Loose ice, sedimentation, debris and the generally poor quality and quantity of the catch combine to delay the investment of significant effort until late June (Figure 2).

When described by effort, the fishing season is characterized by two peaks in gillnet activity; a poorly-developed peak in late June and early July, followed by a lull of several weeks duration before the majority of the season's activity takes place in mid-August. The first peak corresponds to the anadromous brook trout fishery in the upper and middle estuary superimposed on a low intensity arctic char and salmon fishery occurring in the outer estuary. A comparison of the temporal distribution of species' catches from 1977 to 1981 (Appendix A) illustrates that catches of brook trout, lake trout, whitefish, sucker species and arctic char are significant in the early part of the fishery. Brook trout is the primary species of intent, and lake trout, whitefish and sucker usually represent bycatches. Arctic char are taken with a small bycatch of anadromous brook trout. Both these fisheries take a number of salmon, predominantly the estuary habit forms and kelts, which, owing to their poor condition, have little commercial value, although they are used for subsistence. Some effort continues to be directed at kelts and estuary salmon through the period of low activity that precedes the main run of salmon.

The second and major peak in effort represents the commercial fishery of sea salmon. This peak was of consistent magnitude and timing for three of four years surveyed. In 1978, the early peak (July) was marked by the highest weekly effort but it was of a much shorter duration than the August peak. A low level of fishing activity usually persists after early September, with the only important harvest confined to late running estuary and sea-run salmon as they proceed upriver.

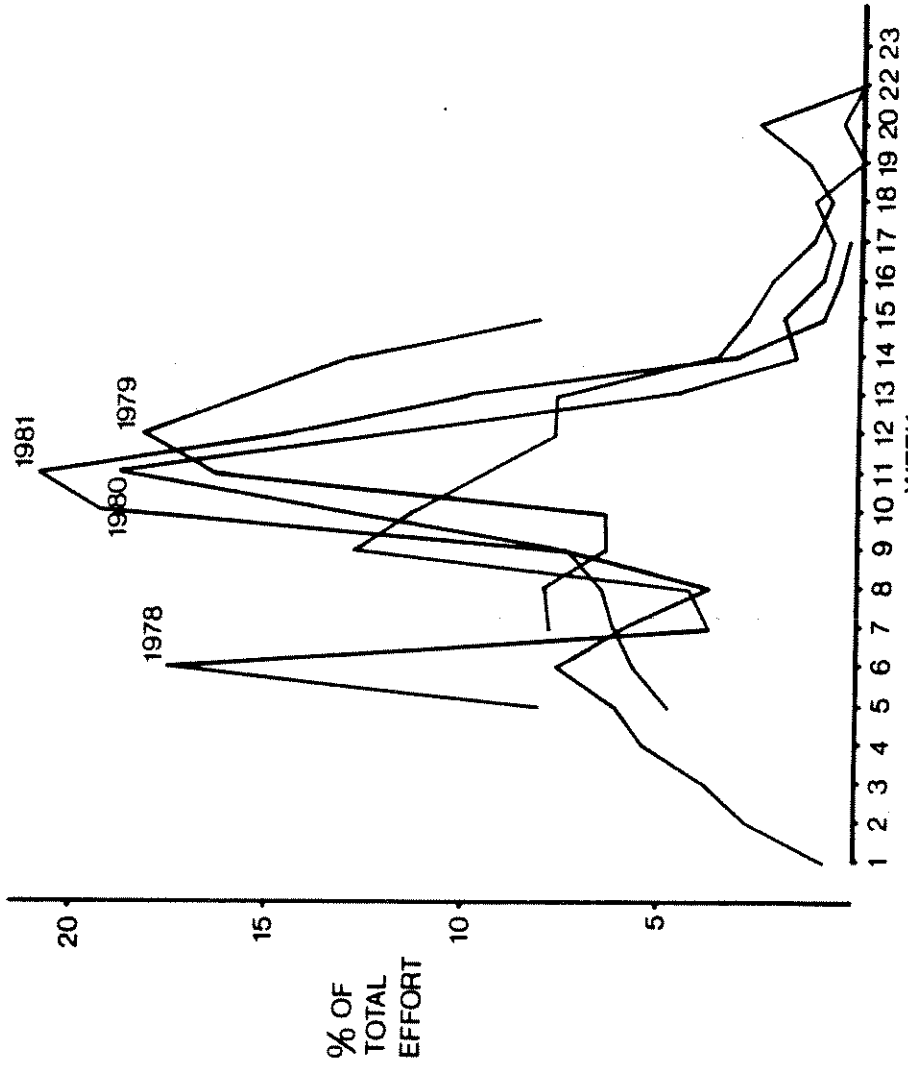

FIGURE 2 TEMPORAL DISTRIBUTION OF TOTAL EFFORT IN THE KOKSOAK RIVER GILLNET FISHERY, 1978 TO 1981.

Atlantic salmon

Integration of the weekly gillnet effort levels, with the percentage of the corresponding harvest of salmon which was reported with that effort, permits the temporal distributions of CPUE of salmon to be evaluated annually. While the average level of CPUE varies annually (Figure 3, Table 4), similarities in the temporal distribution of this effort exist between years. A central peak corresponding to the major sea run salmon fishery is obvious in all years. Though it is not always the situation, these peaks were observed at about the same time in the 1978 to 1981 fisheries. Less obvious, but usually indicated, are two plateaus in CPUE; one preceding and one following the primary peak. In Figure 4, the effects of annual fluctuations in CPUE were eliminated by standardizing each weekly CPUE value to an annual CPUE of 1.0 then plotting the mean standardized weekly CPUE for the four years 1978-81. This curve reflects the heterogeneous nature of the salmon stock, specifically the variable abundance of the different classes throughout the season.

The distribution of class specific temporal catch per unit of effort is only available for 1981 (Figure 5-6). Kelts and estuary fish were recorded throughout the fishery and were most dominant in the catch to week 9. After week 9, the sea salmon classes, which clearly represent most of the mid-August CPUE peak, dominated the catch. On the basis of minimal biological data (Figure 5) and the descriptions provided by local fishermen, estuary fish may dominate the post peak fishery after week 15, with a relatively low overall level of CPUE. The peak in CPUE of sea salmon responsible for much of the fishery activity was comprised of three types (Figure 6). The 2+ maiden sea salmon migrated upstream several weeks in advance of the 1+ grilse salmon while the numerically smaller mixed growth class of sea salmon were more uniformly represented over the same period.

If these observed annual fluctuations in the average CPUE are actually a manifestation of the availability of fish to the harvester then in view of the variety and diversity of habit forms in the Koksoak salmon

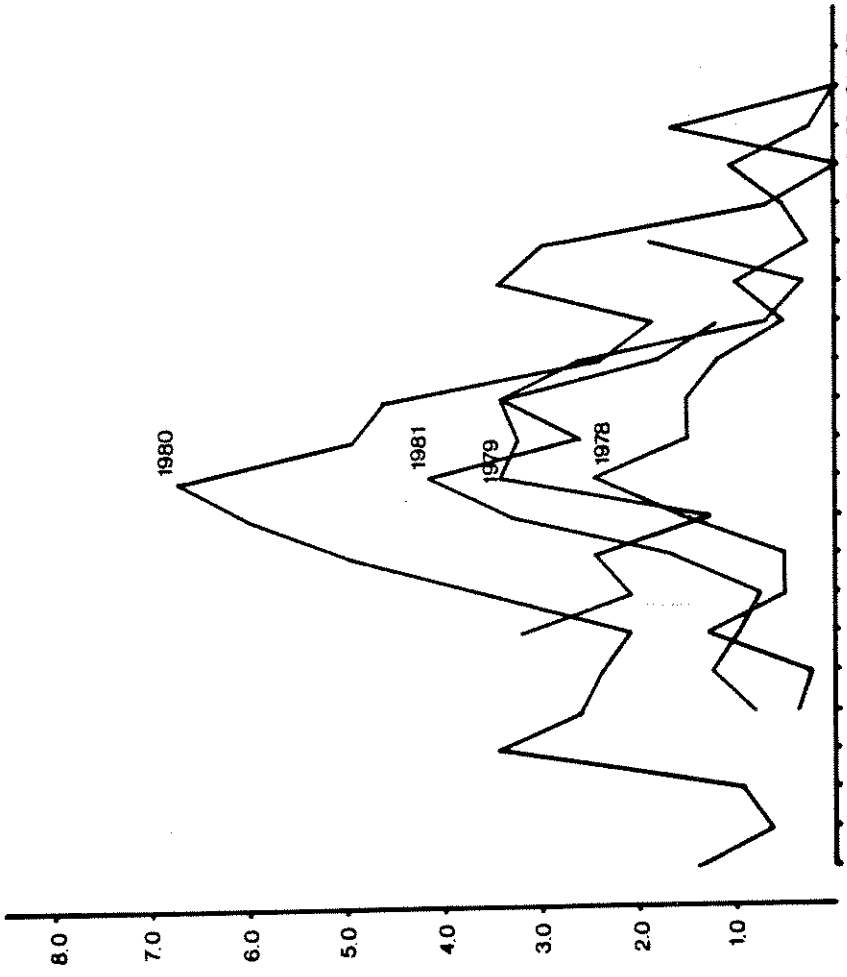

FIGURE 3 TEMPORAL VARIATIONS IN ATLANTIC SALMON CATCH PER UNIT EFFORT IN THE KOKSOAK RIVER GILLNET FISHERIES, 1978 TO 1981.

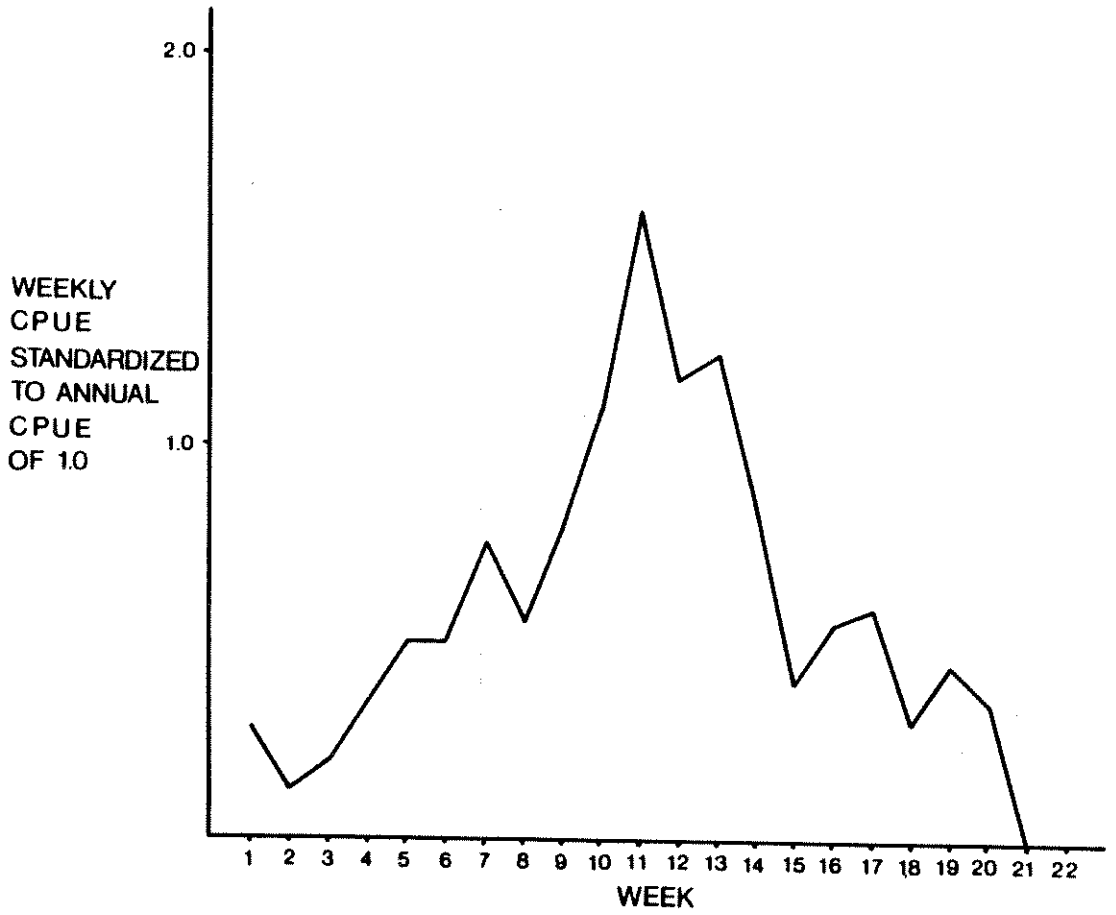

FIGURE 4 TEMPORAL VARIATION OF MEAN STANDARDIZED WEEKLY CPUE (SALMON) FROM THE KOKSOAK RIVER FISHERIES, 1978 TO 1981.

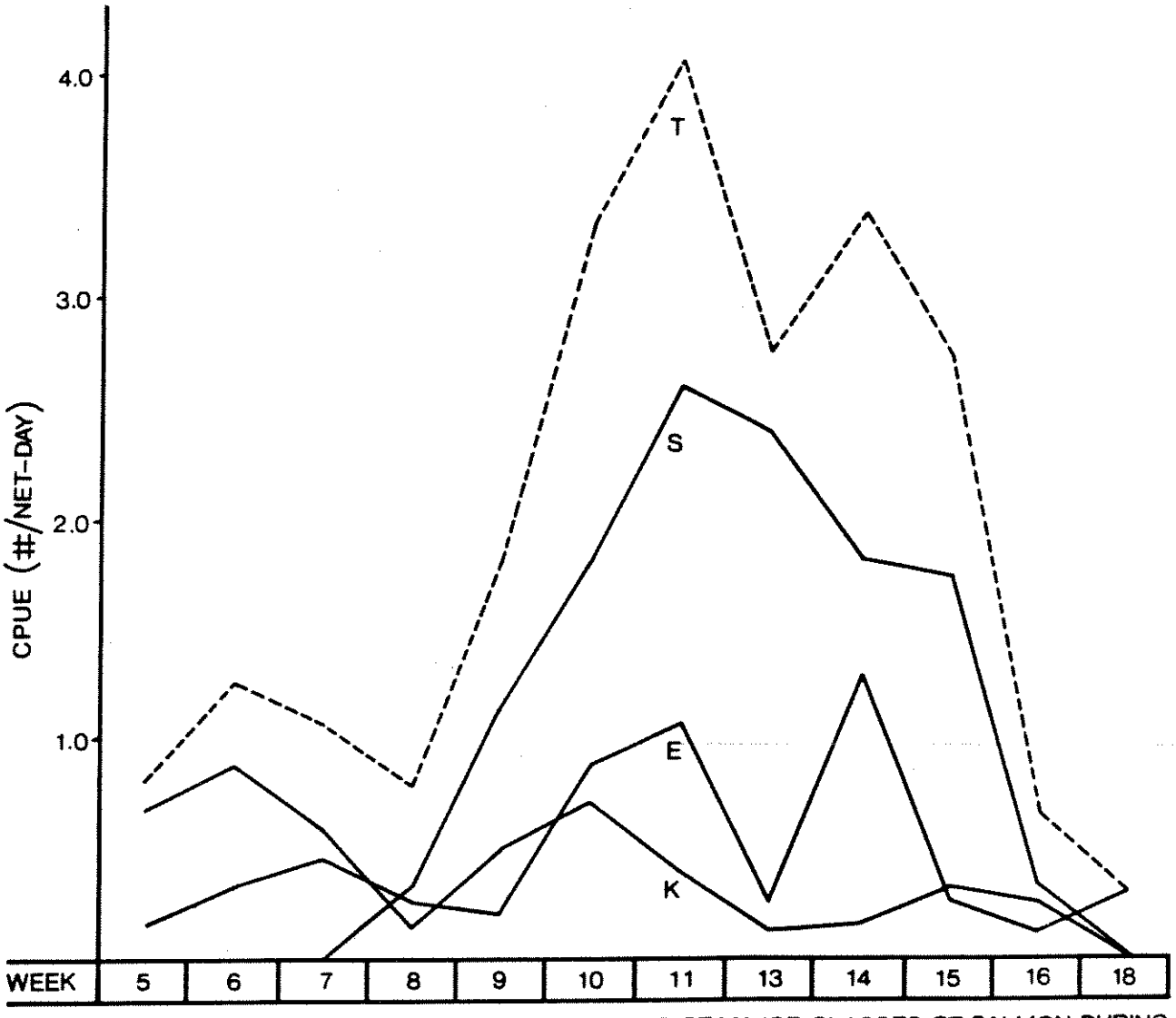

FIGURE 5 TEMPORAL FLUCTUATIONS IN CPUE OF MAJOR CLASSES OF SALMON DURING THE 1981 KOKSOAK RIVER GILLNET FISHERY. T= TOTAL CATCH, S= SEA SALMON, E= ESTUARY SALMON, K= KELTS (EX ESTUARY KELTS).

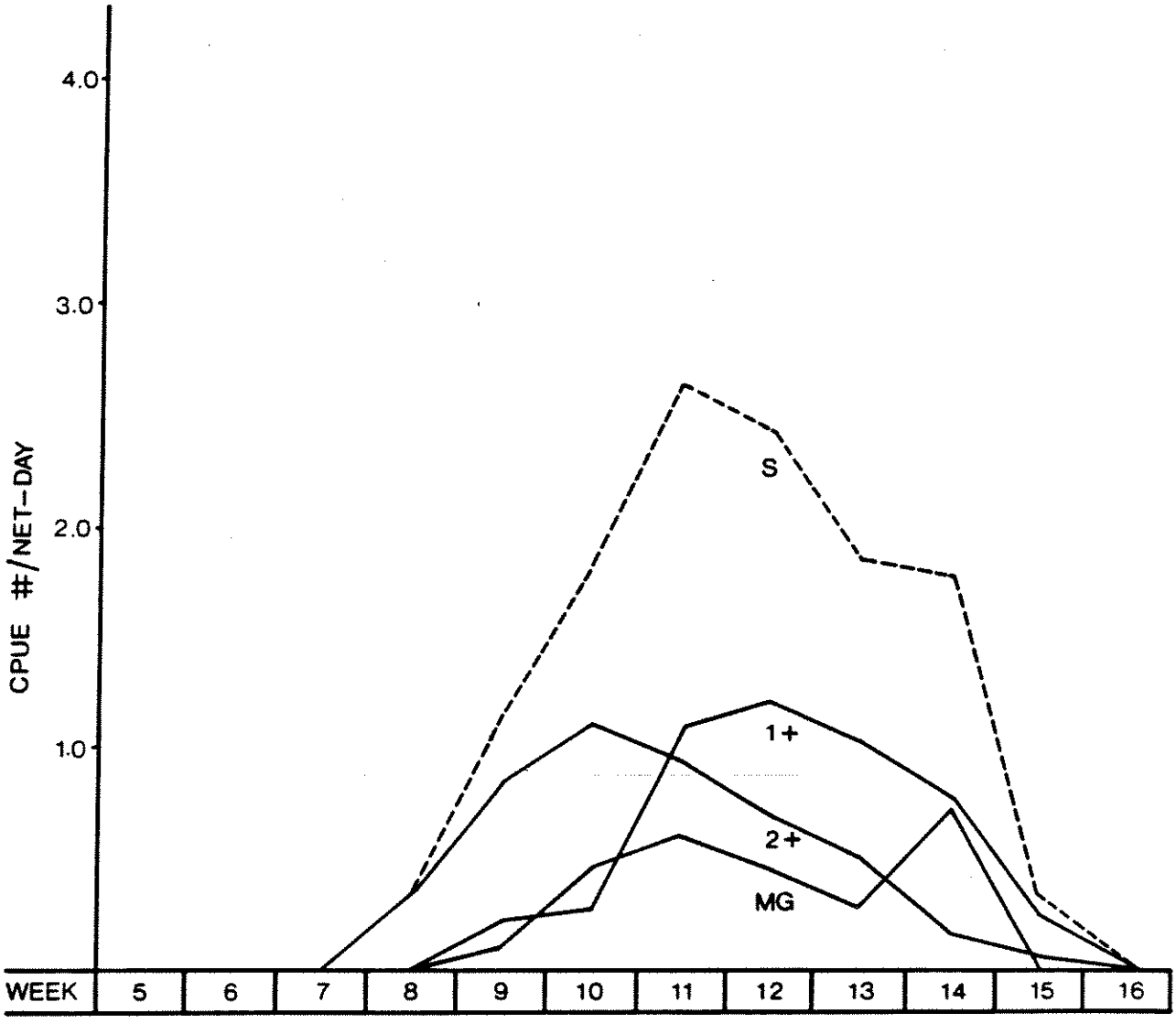

FIGURE 6 TEMPORAL FLUCTUATIONS IN CPUE OF THE CLASSES OF SEA SALMON DURING THE 1981 KOKSOAK RIVER GILLNET FISHERY. S = SEA SALMON, 1+ = GRILSE, 2+ = MAIDENS, MG = MIXED GROWTH SALMON.

population, it is unlikely that every class would be equally influenced by whatever factors are controlling that availability. For example, virgin sea salmon in the Koksoak fishery are far removed from any local factor which may affect the estuary salmon. It must be assumed that if a significant fraction of the change in CPUE observed between different years could be attributed to changes in the relative abundance of one or two classes of salmon, this would be verified during concurrent biological studies. Several years of concurrent harvest and biological information may be required to study any such correlation.

Other harvests

The temporal distributions of CPUE for brook trout and arctic char are shown in figures 7 and 8. While the relative changes in the seasonal and annual levels remain valid, the reporting system does introduce an error in the absolute CPUE values. Both species are most available in the early part of the season, but both show a weak resurgence after the peak of the salmon fishery. For char, this seems unusual since it is generally accepted that there is no spawning population within the Koksoak system. It may be that some fishing effort near the mouth of the estuary resumes after the main salmon run. In the case of both species, it is likely a combination of redirection of effort, changes in gillnet mesh sizes, a tendency for other species harvests to go unreported during the peak of the salmon fishery along with actual changes in the species' availability that are reflected in these temporal changes in CPUE.

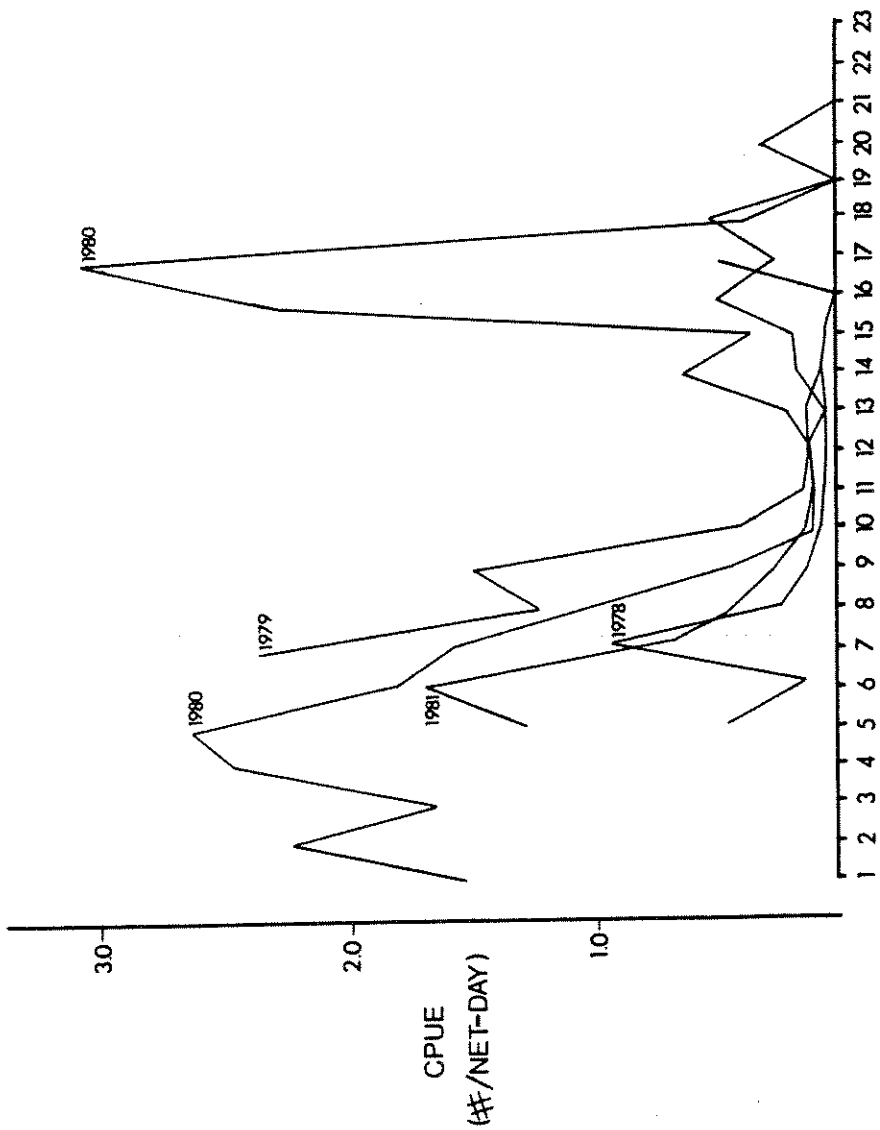

FIGURE 7. TEMPORAL VARIATIONS IN BROOK TROUT CATCH PER UNIT EFFORT IN THE KOKSOAK RIVER GILLNET FISHERIES, 1978 TO 1981.

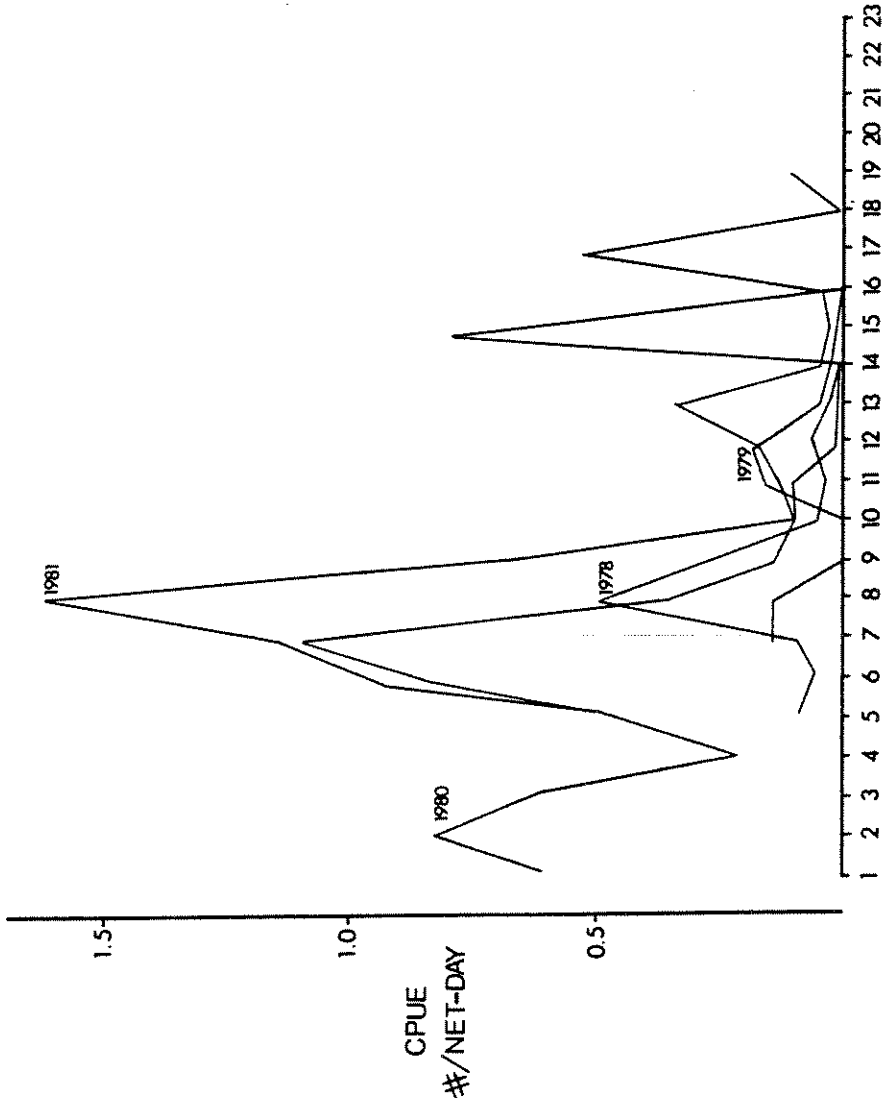

FIGURE 8. TEMPORAL VARIATIONS IN ARCTIC CHAR CATCH PER UNIT EFFORT IN THE KOKSOAK RIVER GILLNET FISHERIES, 1978 TO 1981.

THE INDIVIDUAL IN THE FISHERIES

User types

A pronounced heterogeneity of harvesting strategies among the Koksoak fishermen has been observed throughout the last five years. The level and pattern of the contribution of any individual fishermen to the overall harvest can vary tremendously from year to year. Although there are not clear distinctions between the various types of users, three broad categories can be identified.

There is a large group of users who, for a multitude of reasons, utilize Koksoak River resources in a sporadic, low intensity fashion. Typically, most of this activity takes place during evenings or on weekends. These people often have jobs which restrict their time available for harvesting. A second major type of user is the subsistence hunter and fisherman. These individuals spend a relatively large amount of their available time in subsistence activity, within which the Koksoak River fisheries may play a significant role, during the summer. A third, much smaller, group of users are the commercial operators. These fishermen typically exert a heavy effort for a relatively short time during the period of highest rate of return (i.e. the peak of the sea salmon migration) with the intent of selling to southern markets the catch remaining after meeting their own immediate requirements.

Obviously, individuals can, and do, participate in this harvest for two or even all of these basic reasons within a relatively short time frame, commonly within the same season.

The harvest and effort surveys during the years 1977 to 1980 circumvented difficulties in sampling arising out of this heterogeneity as they took into account most of the fishing populations. Such was not the case, however, in 1981, when the harvest and effort census was based on a

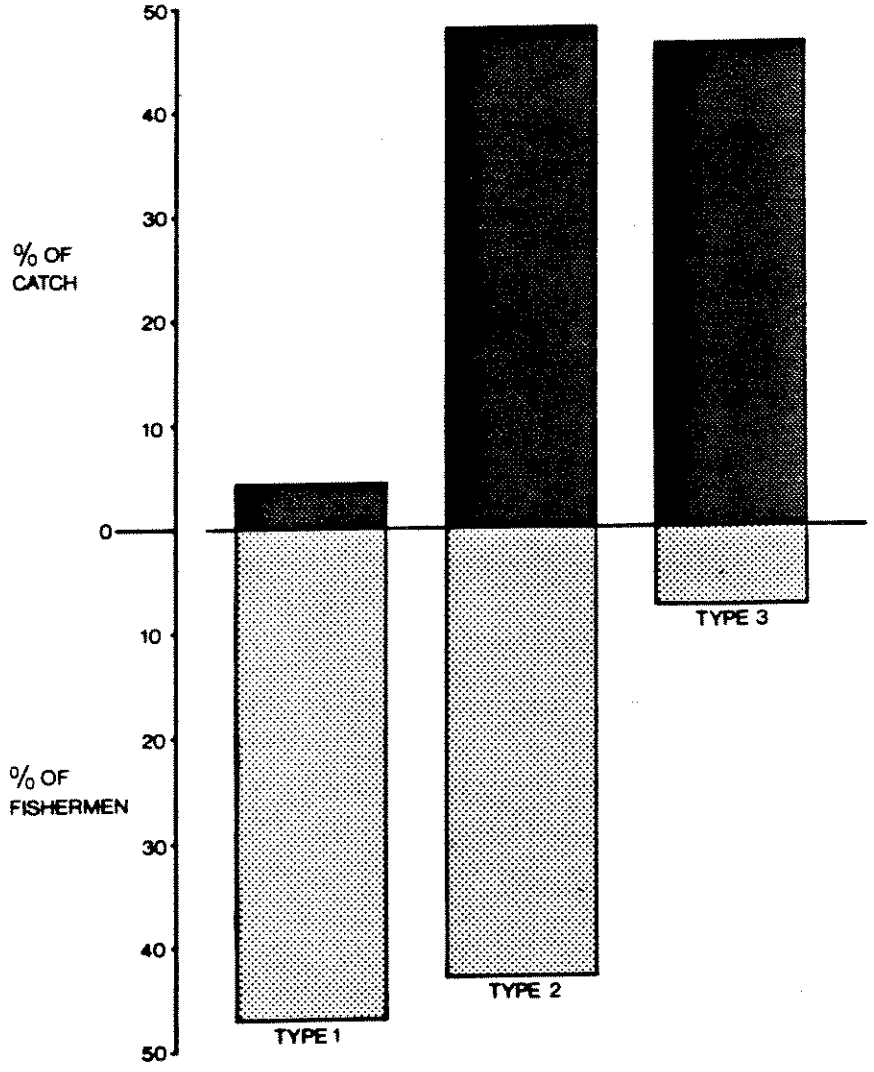

FIGURE 9 CONTRIBUTION TO TOTAL CATCH AND TOTAL PARTICIPANTS, BY %, OF EACH FISHERMAN TYPE IN THE KOKSOAK RIVER SALMON FISHERY, 1977 TO 1981.

Table 6 - Generalized characteristics and assigned catch boundaries of major user-types in the Koksoak fishery and the mean percent occurence and range of these types in the fisheries from 1977 to 1980.

TYPE	GENERALIZED CHARACTERISTICS	CATCH BOUNDARIES	MEAN % - OF FISHERMEN 1977-80	RANGE
I	Weekend fishermen: sporadic effort, evenings and weekends; based at or near Kuujjuaq.	0-20	47.9%	31.4 - 57.5
II	Subsistence fishermen: uniform, moderate effort; concurrent with other subsistence harvests*.	20-200	43.7%	33.8 - 54.9
III	Commercial fishermen: effort intense and concentrated on peak; sale of catch a priority.	200+	8.4%	3.9 - 13.7

* This group also includes the spillover from types I and III i.e. the successful and determined "weekender" and the less successful and/or less determined "commercial fisherman".

Table 7 - History of participation and level of harvest for individual fishermen in the Koksoak River salmon fishery, 1977-1981.

Type 1 = 0-20 fish
Type 2 = 20-200 fish
Type 3 = 200 + fish
- = did not report

	TYPE OF SAMPLE				
	REPRESENTATIVE	COMPLETE	COMPLETE	COMPLETE	COMPLETE
NO.	1981	1980	1979	1978	1977
01	2	3		2	1
02	-	2	3	2	2
03		1		1	1
04	-	1	2	2	1
05					2
06				2	1
07		1			1
08	-	2	3	1	2
09		2		2	1
10		2		1	2
11		1		2	1
12		2			1
13		2	2	2	2
14		1		2	2
15			2	1	1
16			1		1
17				1	1
18		1	2	2	2
19		2	1	1	1
20		1	2	1	2
22					

NO.	1981	1980	1979	1978	1977
23		1		1	1
24					1
25		1	1	1	1
26	1	1	1	1	1
27		1			2
28	2	2		2	1
29		2	3		2
30				1	
31		1			1
32					
33	1	2	1		1
34		2	1	1	2
35	1	2			1
36		1		2	2
37		2		1	1
38				2	2
39		1		1	1
40		1			1
41	1	1		1	1
42					1
43	2	3	2	2	3
44	2	2	1	2	3
45		2			1
46	2	2	2	2	2
47	-	2		2	2
48		2	1	1	2
49	-	2	2	1	1
50		3		2	2
51				2	2
52	3	3			3
53	1	1		1	1
54					1
55	1	2	1	2	2
56				1	1
57	2	2		2	2
58	3	3	3	2	3
60		1		1	1

NO.	1981	1980	1979	1978	1977
62		1		2	1
63				1	1
64		1		1	1
65				2	1
66		1		1	1
67	1	2	2		1
68		1	2	1	1
69		1		1	1
70	2	3	2	3	3
71		2		2	1
72		1	3	3	2
73		2	3	2	2
74		1	2	2	2
75	1	1	2	1	2
76	2	2		2	2
77		1		1	1
78	1	2	2	3	3
79		1		2	2
80					1
81	1	2	2	1	1
82	2		2		2
83				1	
84		2		1	3
99		1		2	
100				1	
101		2		1	
102	2	2		1	
103		1		1	
104				1	
105		1		1	
106	2	3			
107			1	1	
108	–	2	3	3	
109		1	1	1	
110		1		1	
111				1	
112		1	1	1	
113		2	2		
114	2	2		2	
115	2	2		1	
116		2		2	
117	3	3	2	2	
118		1			
119		2		2	
120		1			
121					
122	2	2	2	2	
123				1	

NO.	1981	1980	1979	1978	1977
124				1	
125	1	1			
126		2		1	
127	1	2	1	2	
128		2		2	
129				2	
130				2	
131	2	3	2	2	
132		2	1	2	
133	1	2	2	1	
134		2	2	2	
135	3		2	1	
136		1		1	
137		1		1	
138		1			
139				1	
140		2		2	
141		1		1	
142	1	2		1	
143	1	2	1	2	
144		1		1	
145		1		1	
146				1	
147		1			
148		3	2		
149		1			
150	2	2			
151	–	0			
152					
153		1			
154					
155					
156					
157		2			
158		1			
159					
160					
161		1			
162		2	1		
163					
164					
165					
166					
167					
168		1			
169					
170	2	3	2		
171		1			
172					
173					

NO.	1981	1980	1979	1978	1977
174	-	2	2		
175					
176			2		
177					
178		1			
179					
180					
181	2	2			
182					
183					
184					
185					
186		1			
187		1			
188		1			
189		1			
190		1			
191	2	3			
192		1			
193		1			
194*			2		

* No. 13 in 1979.

Table 8 - Comparison of various characteristics of individual fishermen studied during the 1981 Koksoak River Fishery.

FISHERMAN NO.	150	43	52
OPERATING BASE	Kuujjuaq	seasonal camps	one permanent camp
ORGANIZATION OF ACTIVITY	small family unit	sharing camp with several small family units	one large extended family
MAXIMUM NETS USED	3	10 (families combined)	10
NUMBER OF WEEKS ACTIVE AND DATES	9 July 1 - Sept.15 intermittant	11 July 1 - Sept.15	5 Aug.5 - Sept.8
TOTAL EFFORT NET-DAYS	102	129	152
TOTAL CATCH - NUMBER OF SALMON - OTHER SPECIES	32 174	104 226	764 -
FISHERMAN TYPE	Type II	Type II	Type III
HARVESTING STRATEGY	Fully employed at Kuujjuaq - fishing evenings and weekends for personal use	Subsistence hunter-participates in salmon and char fishery concurrently with other hunting activity, especially marine mammals	Commercial fisherman. Other harvests incidental. Maximizes commercial value of fish catch
CPUE IN NET DAYS	0.10	0.73	2.68
CPUE IN NUMBER PER MAN HOUR	0.13	2.33	2.53

collectively are responsible for only a slightly higher fraction of the catch, but outnumber type III fishermen by over 4 to 1. Type I represent the largest single group of users but collectively account for less than 5% of all fish caught.

Harvesting strategies

Further insights into the various harvesting strategies are possible when the efficiencies of three different fishing operations, representing the three major types of fishermen, are compared using several different effort units. The pertinent characteristics of each operation are given in Table 8. The inadequacy of this typing system for this application is reflected in table 8 as, while fisherman 150 was known to be characteristically a casual fisherman, his total catch in 1981 placed him technically in type II. Over a comparable period, the CPUE in number of salmon/net-day was quite different for each individual. The commercial fisherman was more efficient than the subsistence hunter while the casual fisherman based at Kuujjuaq was quite inefficient by comparison. Interpreting the same catch figures in light of effort in man-hours showed that, while the casual fisherman still received little return for his efforts, the CPUE for the subsistence hunter and commercial fisherman was nearly the same (Table 8). The ratios suggest that different priorities concerning the investment of available time into the fishery may exist between these types of users. These differences are depicted in Figure 10 in the ratio of man-hours to gillnet days, and relate directly and logically back to the different harvesting strategies represented by these individuals and their diverse goals.

The type I user appeared to invest a moderate amount of time in the fishery although comparisons with the other two operations can be misleading as proportionally more time was consumed simply in accessing the nets from a base in the community of Kuujjuaq than from a camp on the river. Nevertheless, the fact that this time is invested for such a relatively small return is significant in itself. It is most interesting to compare the type II and type III users. The type III user, for whom

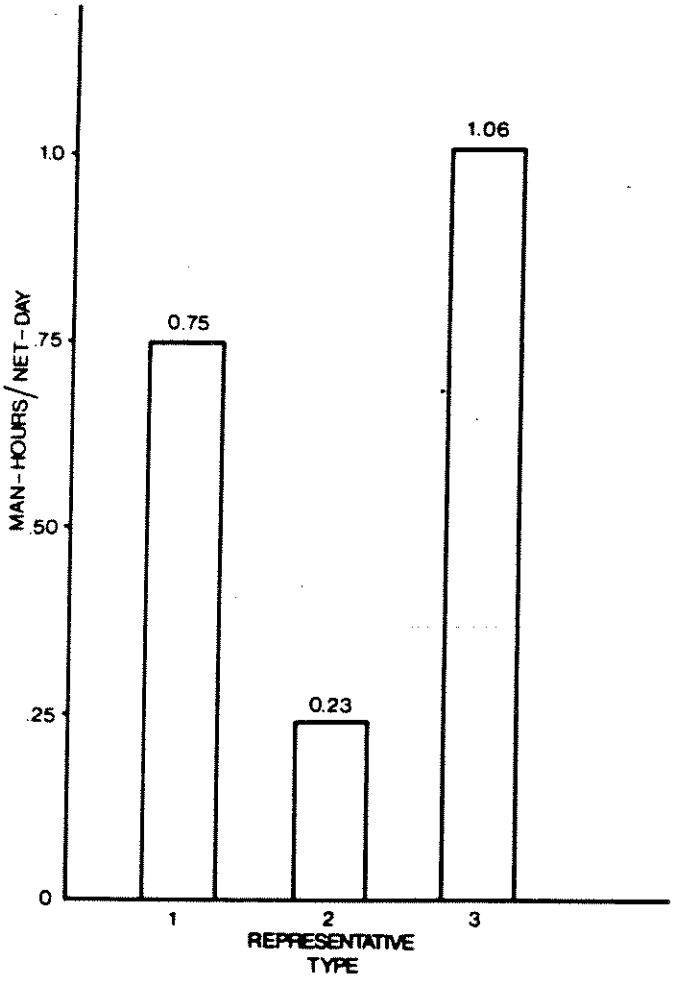

FIGURE 10 COMPARISON OF TIME INVESTMENTS BETWEEN THREE FISHING OPERATIONS. KOKSOAK RIVER FISHERY, 1981.

the fish harvest, specifically of salmon, was of major importance, invested more time than the subsistence hunter by a factor of four. The latter divided his time available for harvesting between a number of food sources including various marine mammals and birds.

This analysis provides only a glimpse at a complex problem. Depending on their harvesting strategy, the fishery is important to individual participants in different ways. This importance usually has some economic basis but often has an important traditional and cultural basis as well, the fishery being a part of a complex of seasonal subsistence activities. A true and accurate assessment of the effects, of changes to the Koksoak River fishery resources, on the users of those resources must somehow consider these non-economic values as well as the economic ones.

A PERSPECTIVE ON FINDINGS

Baseline studies on the Inuit fisheries of the Koksoak River have completed for the five years that preceded the diversion of the upper Caniapiscau River. The findings for each year, and the particular methods used to derive these findings are available in the yearly reports that have been submitted to the Caniapiscau-Koksoak Joint Study Group by the Makivik Research Department. This final report provides a summary and comparison between the years of the 1977 to 1981 data.

Previous studies on the Inuit commercial harvests of salmon between 1961 and 1969 (Power) and data from the commercial harvest of salmon for the Hudson's Bay Company between 1869 and 1910 (Power 1976) allow values of CPUE to be calculated. These data and the 1977-1981 data are presented for comparison in figure 11. Although the comparisons presented in figure 11 must be viewed with caution, the graph clearly illustrates that the variations in the catch per unit of effort for the 1977 to 1981 fishery are well within the range of variations that have previously been recorded.

Section 8.10 of the James Bay and Northern Québec Agreement which describes the special provisions related to the diversion of the upper Caniapiscau Rivers states that "the Fort Chimo people are guaranteed the same harvest of fish for equal effort". On this basis, the identification of potential effects and the assessment of the severity of their impact must be established through a comparative study of harvest per unit of effort (CPUE) between pre-diversion and post-diversion fisheries.

The problem with relying exclusively on catch per unit of effort are clearly illustrated in the 1977 to 1981 data. If catch per unit of effort is deleted for 1977 because of the methods of calculation that were used in that year, then the mean level of CPUE for the 1978-1981 fisheries is 2.59 salmon per net-day, with a standard deviation of 1.29. This magnitude of standard deviation means that if changes in the catch per unit of

effort for the post-diversion fisheries do in fact occur, they must be severe before they would become statistically significant, even after a number of years.

The highest recorded harvests occurred in the 1880's (Power, 1976) when the harvest of salmon exceeded 40,000 kg for several years. Unfortunately, there are no records in subsequent years with which to assess the impact, if any, from this harvest level. From his 1961 to 1969 studies, Power concluded that a commercial harvest of 2000 to 2500 salmon controlled by enforcing a 20,000 lb (9090 kg) commercial quota, was having no recognizable effect on the stocks. This assessment included, inherently, the effects on this stock of both the Greenland fishery, and the Koksoak subsistence fisheries. Without being able to measure it directly, Power (1965) estimated local consumption and spoilage to be at least 5% of the commercial catch and felt that the maximum may be somewhat higher (Power pers. comm.).

The utilization of each fish for commercial subsistence or spoilage was directly recorded as part of the 1977 survey of the Inuit fishery (Makivik Corp. 1977). In a year when the size of the commercial harvest was characteristic of the 1960's (2,367), a significant fraction of the total harvest (1867 or 43 percent) was consumed locally, and a smaller number (136 or 3 percent) were spoiled during the harvest. The non-commercial catch was primarily taken before or after the main salmon run by casual and subsistence-oriented fishermen whoe individual contributions to the total harvest tended to be in the lower range (Kemp, 1977). With the exception of the 1980 and 1981 fisheries, the total annual harvests were consistently near 4,000 fish (15,450 kg).

There is no evidence of significant change in local consumption patterns during the study period. Unless there was a major shift in local consumption patterns between 1969 and 1977, the commercial harvests observed by Power of 2,000 to 2,500 salmon actually represented total harvests of about 4,000 salmon. Powers' conclusion that this harvest level does not have a recognizable impact on the fishery is still valid. In spite of the fact that he underestimated the total catch.

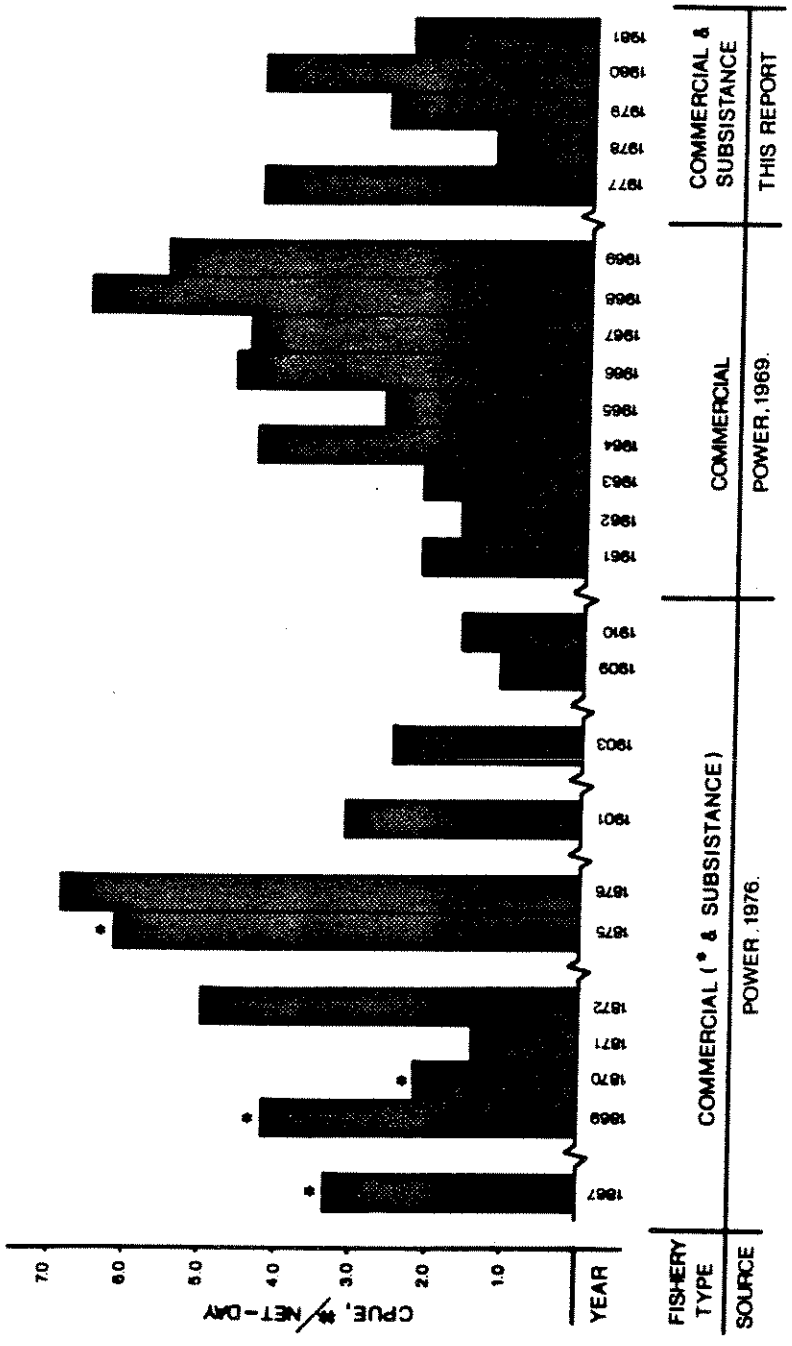

FIGURE 11 AVAILABLE RECORDS OF CPUE FROM THE KOKSOAK RIVER FISHERIES, 1867 TO 1981.

In the last two years, harvests were above recent recorded levels, dramatically so in 1980. In 1981, the sampling does not allow for a precise figure to be established but the total harvest was not as high as in 1980. It appears that in 1980, the fluctuation was primarily caused by an increase in fishing success and not by an increase in effort. Gillnet effort in 1980 (2030 net-days) was close to the characteristic level of the three previous fisheries (mean, 1934.2 net-days, range 934.8 to 3398.5), while the CPUE was substantially higher (4.37 vs. mean 2.78, range 1.28 to 4.38). Any effects on subsequent fisheries relating to these harvests increases will not be evident for at least one generation of salmon.

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APPENDICES

A - Weekly distribution of catch by year

1977 - TOTAL FISH %

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	un-dated
Salmon	0	.6	.7	2.6	1.4	.2	2.4	1.7	5.0	17.4	36.1	16.6	7.0	4.3	1.0	.7	.5	.3	.4	.04	0	0	
Brook trout	0	2.9	1.0	11.4	5.0	17.4	11.4	5.2	8.4	10.4	12.6	2.5	2.8	2.0	.2	.2	4.2	.2	.6	.1	0	.5	.05
Arctic char	0	1.8	.7	2.1	2.1	16.1	31.6	5.2	4.3	6.5	14.7	9.6	1.4	1.4	.9	0	.9	0	0	0	0	0	
Lake trout	0	7.8	0	0	0	17.1	0	.4	0	23.0	15.1	5.3	.9	1.4	.4	7.8	5.3	1.9	2.4	0	0	10.2	
Whitefish	0	2.4	11.7	0	1.7	3.5	12.0	4.2	2.1	15.9	23.0	10.6	3.1	3.1	2.4	2.8	.7	0	0	0	0	0	
Sucker	0	0	0	0	0	0	0	0	7.0	21.2	3.3	6.2	16.2	18.7	10.4	0	16.6	0	0	0	0	0	
Sculpin	0	0	0	0	0	8.7	4.2	3.4	1.6	7.8	9.8	12.0	10.8	6.1	9.2	9.4	0	16.3	0	0	0	0	
TOTAL	0																						

1978 - TOTAL FISH %

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	un-dated
Salmon	.4	.1	.8	1.5	2.5	3.4	4.1	1.5	5.2	14.2	20.8	11.7	9.2	4.5	1.3	2.0	.3	.3	1.1	.7	.1	0	13.1
Brook trout	.7	1.0	5.4	6.9	10.0	6.6	9.4	3.0	5.4	2.5	1.6	1.0	1.0	.7	1.5	1.3	1.4	.5	1.7	.1	.3	0	37.1
Arctic char	1.2	.5	2.2	.6	5.4	5.9	2.7	15.1	23.0	4.1	2.2	5.2	3.6	1.2	.3	0	.1	0	.1	1.9	0	0	23.7
Lake trout	4.	.4	2.3	5.0	2.7	8.3	3.2	2.7	6.4	12.0	.9	3.7	.4	.4	0	1.8	0	3.7	2.7	3.7	2.7	.4	35.1
Whitefish	0	0	13.7	5.3	10.1	7.1	7.8	2.3	6.3	1.4	.4	.1	.5	5.1	2.9	.7	2.1	1.8	.9	5.7	1.5	.2	23.1
Sucker	0	4.2	19.7	12.6	1.4	0	2.8	9.8	7.0	4.2	9.8	9.8	0	0	0	0	0	0	0	0	0	0	18.3
Sculpin	0	0	0	4.5	0	0	0	0	7.5	9.0	6.8	4.4	11.7	11.0	4.2	0	0	1.4	9.9	3.5	1.4	.1	24.1
TOTAL																							

1979

Week	7	8	9	10	11	12	13	14	15	un-dated
Salmon	8.0	5.0	5.3	2.2	19.9	21.3	19.2	9.7	3.9	5.1
Brook trout	32.0	16.8	15.5	4.2	4.4	4.3	4.2	2.0	.7	15.4
Arctic char	11.3	9.3	.4	0	22.1	29.0	6.4	3.9	.9	16.2
Lake trout	0	0	0	0	11.1	22.2	22.2	44.4	0	0
Whitefish	23.2	21.0	9.6	3.9	5.7	5.7	6.5	5.2	12.2	6.5
Sucker	0	22.2	11.1	33.3	0	0	0	0	0	33.3
Sculpin	.3	18.0	6.6	3.0	15.3	13.3	12.4	7.2	21.8	1.8
TOTAL										

1980

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
Salmon	.2	.3	.8	4.5	3.5	4.2	2.8	3.0	7.9	18.8	29.8	14.7	5.6	.7	.8	.5.	.5	.1	.07	.2	0		
Brook trout	4.1	7.3	7.1	14.8	17.4	15.1	10.5	4.4	3.3	1.9	2.4	2.0	1.1	.9	.8	1.8	2.4	.4	.1	.2	.8		
Arctic char	1.5	7.3	6.9	3.6	8.9	18.7	19.6	4.0	3.0	4.1	7.6	6.3	5.3	.2	.1	.1	1.1	0	0	0	.8		
Lake trout	28.1	9.7	6.7	0	1.9	12.6	7.7	0	3.8	6.7	10.6	3.8	3.8	0	0	.9	0	1.9	0	0	.9		
Whitefish	1.2	13.0	9.7	13.1	10.9	8.2	9.0	1.7	5.0	1.0	11.5	3.0	2.3	1.7	3.6	1.2	1.0	.8	0	.8	.1		
Sucker	.7	34.8	8.1	8.1	9.6	2.2	11.8	8.1	4.4	3.7	0	4.4	.7	0	0	.7	1.4	.7	0	0	0		
Sculpin	.2	.4	0	4.2	1.2	1.0	12.3	5.2	5.3	9.9	17.5	21.2	2.4	6.9	3.2	5.4	1.8	.9	0	0	0		
TOTAL																							

1981

Week	5	6	7	8	9	10	11	12	13	14	15	16	17						
Salmon	1.5	2.5	6.2	2.8	8.8	22.5	28.4	13.3	10.6	2.9	.1	0	0						
Brook trout	19.1	28.2	13.3	9.2	5.7	8.2	6.0	6.8	1.7	.8	.1	0	.1						
Arctic char	6.9	14.5	20.0	28.2	14.5	5.4	6.9	1.0	.2	0	2.0	0	0						
Lake trout	4.0	22.9	24.3	25.6	5.4	0	0	2.7	12.1	0	0	0	2.7						
Whitefish	19.3	10.0	7.4	8.0	5.4	10.3	8.3	9.3	8.0	9.0	3.8	0	.6						
Sucker	39.1	11.5	7.2	1.4	24.6	1.4	2.8	1.4	5.7	4.3	0	0	0						
Sculpin	.2	6.5	14.6	21.7	1.0	5.9	11.2	9.3	5.1	2.0	0	4.3	17.5						
TOTAL																			

B - Field data summary format

WEEK NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	UNEARNED
PRECISE WEEKLY PERIODS	GEAR																							
6-7		8-10	11-13	14-16	17-19	20-22	23-25	26-28	29-31	32-34	35-37	38-40	41-43	44-46	47-49	50	51-55	56-58	59-61	62-64	65-67	68-70	71-73	74-76
ATLANTIC SALMON	NET																							
	ROD																							
BROOK TROUT	NET																							
	ROD																							
ARCTIC CHAR	NET																							
	ROD																							
LAKE TROUT	NET																							
	ROD																							
WHITEFISH SP.	NET																							
	ROD																							
SUCKER SP.	NET																							
	ROD																							
SCULPIN SP.	NET																							
	ROD																							
NORTHERN PIKE	NET																							
	ROD																							
	NET																							
	ROD																							
	NET																							
	ROD																							
GEAR TOTALS	NET																							
	ROD																							
TOTAL HARVESTS																								
HARVESTS WITH EFFORT																								
GILLNET EFFORT																								

NET TOTALS	ROD TOTALS	SPECIES TOTALS
77	80	

YEAR 4-5

FISHERMAN NUMBER 1-3

NAME

TYPE