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A FISHING PLAN FOR ARCTIC CHARR
(Salvelinus alpinus) STOCKS OF THE WESTERN
MACKENZIE DELTA AND YUKON NORTH SLOPE

by

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1.0 INTRODUCTION

The purpose of this report is to evaluate the present condition of the anadromous Arctic charr (Salvelinus alpinus) stocks of the western Mackenzie delta region of the Northwest Territories and Yukon north slope and to develop a fishing plan for these stocks. A fishing plan assesses historical and present use, resource allocation, total allowable catch limits and resource development of individual charr stocks. The plan also recommends appropriate enforcement and monitoring measures to ensure the perpetuity of the stock and maximize the long-term cultural, social and traditional benefits of the fishery to the communities concerned.

The Rat and Big Fish rivers of the western Mackenzie delta region and the Babbage and Firth Rivers of the Yukon north slope each contain breeding populations of anadromous Arctic charr. All of these populations or "stocks" have been fished to varying degrees by native Indian and Inuit fishermen from communities of the western delta, primarily Aklavik and Ft. Macpherson. The Firth and Babbage Rivers have sustained relatively little fishing pressure (D.V. Gillman, Dept. Fisheries and Oceans, Inuvik, personal communication) while the Big Fish and Rat Rivers have been heavily exploited for a number of years and are believed to be threatened (McCart 1980, Gillman and Sparling 1985, A. Kristopherson, DFO Winnipeg, unpublished data).

Implementation of a fishing plan, in addition to addressing the above parameters will also identify information gaps and research requirements and provide a foundation upon which a more comprehensive fisheries management strategy for western Arctic fish and marine mammals can be developed.

2.0 FISHERIES MANAGEMENT AND STOCK IDENTIFICATION

Proper fisheries management is concerned with the maintenance of long-term high yield and genetic variability of an exploited stock. Ideally, management techniques and considerations should only be applied to a single stock or unit. Anadromous fishes such as salmon and Arctic charr which return to their natal streams to reproduce maintain a genetic isolation and therefore constitute discrete stock units. However, it is seldom possible to manage the population of each river discretely.

Pacific chum salmon which enter the Johnstone Strait in B.C. are considered as a single stock unit for management purposes despite the fact that there may be coincidental migrations of salmon into numerous rivers (Beacham et al. 1985). Salmon from each river can be identified by their differing allelic frequencies and the potential exists for using these differences to estimate stock composition in mixed stock fisheries. Dempson (1984) has also observed significant differences in morphometric characters such as growth rate and maturation in adjacent populations of Arctic charr from northern Labrador. Caution must be exercised as exploitation of a mixed stock

fishery can lead to the extinction of less productive stocks when the level of exploitation exceeds sustained stock productivity (Beacham et al. 1985).

Effective management of a fishery requires fulfillment of three basic information requirements: 1) the spatial and temporal extent of each stock 2) the actual total catch of each stock from all sources (domestic, commercial and recreational) and 3) the cause and effect relationship between changing population parameters and harvest levels, in order that exploitation rates can be adjusted accordingly (Corkum and McCart 1981). Failure to appropriately determine stock structure of exploited populations will result in erroneous assessment of population parameters, poor management decisions and a reduction in genetic variability.

From tagging studies performed during the early 1970's Jessop et al. (1973), Stein et al. (1973) and Jessop and Lilley (1975) established that the Rat River and Big Fish Arctic charr stocks maintain separate breeding areas and therefore represent discrete populations. The relative degree of difference between these stocks either in morphology or allelic frequency is not known at this time (J.R. Reist, DFO, Winnipeg, personal communication). Similarly, charr of the Babbage (Bain 1974) and Firth Rivers (Glova and McCart 1974) also represent discrete stocks. Arctic charr from all of these rivers are characteristic of the "western" form of Arctic charr as described by McPhail (1961).

Assuming that charr of the Firth, Babbage, Rat and Big Fish Rivers represent discrete stocks, attempts should therefore be made to manage each stock separately and to develop fishing plans on a per stock basis. However, due to the spatial and temporal overlap in distribution of the stocks, the delta charr fishery can be considered to be a mixed stock fishery. Consequently, management techniques to be employed will necessarily overlap and similar fishing plans will of course result.

3.0 STOCK EVALUATION

Each of the following sub-sections, 3.1, 3.2, 3.3 and 3.4 will address the Rat, Big Fish, Babbage and Firth Rivers charr stocks respectively. Life histories, resource partitioning, historical exploitation, information gaps and research requirements and recommendations will be discussed on a per stock basis. This will be followed by a general discussion which integrates the individual fishing plans developed for the rivers of the Mackenzie delta and Yukon north slope area, providing a more comprehensive policy.

3.1 Rat River

3.1.1 Life History

3.1.1.1 Physical Description

The Rat River is located between $135^{\circ}00'$ W and $136^{\circ}30'$ W longitude and between $67^{\circ}15'$ N and $68^{\circ}00'$ N latitude in the Richardson Mountains of the western Mackenzie delta (Fig. 1). One hundred and thirty km in length, it empties into Husky channel and eventually into the Mackenzie River proper. The physical condition of the river is varied, ranging from a single to multi-channeled system and a sand-silt to gravel and boulder bottom. The river is also subject to flooding, making depth and turbidity extremely variable (Jessop et al. 1973).

3.1.1.2 Biology

Up to 14 species of fish were captured from the Rat River in 1972, of which Arctic charr comprised 75% (Jessop et al. 1973). The current year, non-spawning proportion of the population leaves the Rat River system by early to mid June and migrates up the Mackenzie to spend 6 - 8 weeks feeding in the nearshore, brackish waters of Mackenzie Bay, perhaps as far as Shingle Point (Fig. 1). This is followed by an upstream migration to spawning and overwintering areas on the Rat River during mid-August to early September (Jessop et al. 1973). Jessop and Lilley (1975) reported that in 1974, upstream migrants had reached Aklavik by September 12, Big Eddy in Husky Channel by September 19 and into Fish Creek by September 29, two weeks

later than in 1973.

The only known spawning and nursery area for charr of the Rat River is Fish Creek, a tributary of the Rat (Fig. 1). The charr spawn in pools of about 4° - 6°C from late August to late September, about one month earlier than charr of the Big Fish River (Jessop et al. 1974).

There appears to be two color phases of charr inhabiting Fish Creek. "Light", silvery charr which are the immature, virgin fish and mature, current year non-spawners and "dark" fish, which are small (<300 mm), sexually mature, resident male fish. The "dark" resident charr remain in the Rat River throughout the summer and do not migrate to sea with the non-spawning segment of the population (Jessop et al. 1973). Anadromous, current year spawners move out of Fish Creek to the Rat and Mackenzie Rivers to feed during the summer, as a significant proportion (57%) of the early upstream migration in 1983 consisted of mature fish (Gillman and Sparling 1985).

Most of the charr overwinter in the "fish holes" of Fish Creek which are spring fed, keeping much of it open throughout the winter. Some charr may also overwinter in parts of Husky and Peel Channels and at the mouth of the Peel River, as indicated from tag returns (Jessop et al. 1973, 1974, Jessop and Lilley 1975).

Charr of the Rat River are relatively younger and of a smaller size than other western Arctic charr populations (McCart 1980). Jessop et al. (1973) found that the 884 charr captured in 1972 ranged from one to only eight years of age (50mm to a maximum of 610mm respectively, with a modal size of 445mm), maturing between five and

six years of age with a mean female : male sex ratio of 1.34:1. Data collected in 1983 by Gillman and Sparling (1985) showed little change in biological parameters. Mean length was 441mm with an age range of three to eleven years. Continued heavy exploitation of the Rat River stock since the early 1970's has not allowed for recovery of the fishery, as indicated by population abundance estimates and biological parameters. Additionally, the lack of biological information on the stock prior to 1972 does not allow for any comparison to its original state.

3.1.1.3 Abundance

Enumeration of the total population of the Rat River charr has thus far been unsuccessful. No attempt to enumerate the population was made during the Mackenzie Valley Fish Resources survey by Jessop et al. (1973, 1974), or by Jessop and Lilley (1975). During the summers of 1983 and 1985 a weir was erected on the river in an attempt to enumerate the upstream migrants, however on both occasions high water levels caused the fence to collapse before a total count could be obtained.

Rough Peterson estimates of population size based on re-captures of tagged fish in 1984 and 1985 suggested population sizes of 2,000 to 3,000 and 1,200 to 2,400 fish respectively (A. Kristofferson, unpublished data). Historically, stock and harvest levels were considerably higher. In 1972 an estimated 6,500 charr were harvested from the Rat River, while in 1985 and 1986 fewer than 200 charr were taken by the fishery. It is evident that sustained heavy exploitation rates have prevented recovery of the stock.

3.1.1.4 Fish Health

Fish health investigations have been carried out on Arctic charr stocks of the Mackenzie delta since 1980 when infectious pancreatic necrosis virus (IPNV) was detected in charr taken from Fish Creek. Souter et al. (1986) have reported that IPNV is enzootic in Arctic charr populations of the Mackenzie delta and Yukon north slope. Forty-three percent of the charr collected from the Rat River since 1982 have tested positive for the IPN virus. The impact of the virus upon the population, or how it originated is unknown (Souter et al. 1986).

3.1.2 Historical Exploitation and Resource Partitioning

There are two primary communities which harvest Rat River Arctic charr: Aklavik (population 900) and Ft. McPherson (population 750). Traditional domestic fishing sites include the west channel near Aklavik, the Peel and Husky Channels, north and south channels at the mouth of the Rat and on the spawning grounds at Fish Creek, although this site has not recently been fished. Occasionally charr are captured near Shingle Point in Mackenzie Bay, some of which may be Rat River charr. Fishermen from Ft. McPherson take charr primarily from the Rat River, while Aklavik fishermen exploit both the Rat and Big Fish River stocks. The relative degree of exploitation by each of the communities on these stocks is not known.

3.1.2.1 Domestic Fisheries

Domestic fisheries account for the vast majority of fish harvested from the Mackenzie River delta (at least 80%) and takes precedence over all other uses (Corkum and McCart 1980). Domestic fisheries have been unregulated and are largely undocumented, which has inhibited the development of a sophisticated management strategy for any species in the delta. Little information exists on quantities of fish taken, species composition, life history stage or effects of domestic harvest on stock abundance. Until such information can be obtained it will be impossible to effectively manage the fishery.

Recent investigations have shown that the estimated domestic harvest of Arctic charr had declined significantly since monitoring of the stocks began in 1972, when concerns that the fishery was threatened were first expressed. Estimated total domestic harvest from the Rat River in 1972 was 6604 kg, while in 1985, only 125 kg of charr were taken (Table 1). In 1986, a domestic fisheries survey by Sparling and Stewart (1986) concluded that approximately 670 kg of charr (1064 fish) were harvested from the Rat, which is probably more representative of the total annual domestic harvest. Even at this apparently low level of harvest, this still represents an estimated rate of exploitation as high as 40%, which is far greater than the population can withstand.

Table 1. Estimated total domestic and commercial harvest (kg) of Arctic charr from the western Mackenzie delta area between 1965 and 1986.

Year	Total Domestic Harvest (kg)			Total Commercial Harvest from the Mackenzie Delta (kg)			Source
	Rat River	Big Fish River	Mackenzie Delta				
1965	-	-	-	7311			Corkum & McCart (1981)
1966	-	-	-	364			Corkum & McCart (1981)
1972	6 604	8-12 000	14-18 604	-			Gillman & Sparling (1985)
1973	2 640	4 000	6 640	-			
1975	2 200	?	>2 200	-			
1978	-	-	1 800 ^{1,2}	4 500 ²	268 ¹	1 405 ²	516 ³
1979	-	-	3 653 ¹	64 ²	682 ¹	131 ²	640 ³
1980	-	-	2 040 ¹	1 958 ²	6 215 ²	4 493 ⁴	319 ⁵
1981	-	-	-	-	162 ⁵	4 723 ⁵	See Footnotes
1982	-	-	-	-	1 950 ⁵		
1983	315 ⁶	?	>315 ⁶	2 940 ⁵			
1984	252 ⁶	325 ⁷	577 ⁶	0 ⁵			
1985	125 ⁶	890 ⁶	1 015 ⁶	?			
1986	670 ⁸	1 653 ⁸	2 351 ⁸	95 ⁴			

¹Corkum & McCart (1981).
²Gillman & Sparling (1985).
³B. Wong, DFO, Yellowknife (from Corkum & McCart 1981).
⁴R. Barnes, DFO, Inuvik, GNWT Field Services Annual Reports.
⁵A. Kristoferson, DFO, Winnipeg, Commercial Fishing Quotas for Arctic Charr NWT Reports, 1979-1986.
⁶A. Kristoferson, DFO, Winnipeg, Fisheries Investigations - Arctic Charr, Western Mackenzie Delta, Internal Report (weights calculated from estimates of total numbers of fish harvested).
⁷Gillman et al. (1985).
⁸Sparling & Stewart (1986).

It is very difficult to obtain reliable information on domestic fisheries due to the large areas being fished, the number of fishermen and communities involved and the lack of monitoring and regulatory measures. Estimates of the cumulative domestic and commercial harvest from the entire delta between 1978 and 1980 varied considerably depending upon the source of information (Table 1). The paucity and potential unreliability of current information will hinder development of an effective management strategy.

Generally, the number of charr which have been harvested from the Rat River and the delta has declined significantly during the past 15 years. This is due in part to a combination of the decline in the stock itself, reduced effort expended in the harvest due to low numbers of fish and possibly because of alternative employment available in the area as a result of oil and gas exploration activities in the Beaufort Sea. However, the recent decline in exploration activity has reduced employment and will result in increased pressure on all natural resources, both for food and for commercial sale to supplement personal income.

3.1.2.2 Commercial Fisheries

The total annual commercial harvest of Arctic charr from the Mackenzie delta is extremely variable and is virtually unregulated. The difficulty in regulating the fishery and in obtaining reliable information from the fishermen and retail outlets, is reflected in the conflicting commercial harvest statistics within particular years as obtained from various sources (Table 1).

Charr fisheries of the Mackenzie delta are not managed on an individual stock basis, rather the Rat, Big Fish, Firth and Babbage Rivers are managed as a region (N.W.T. Field Services Annual Reports). Because Arctic charr sold commercially are collected coincidentally with the domestic harvest, their origins are unknown and gear and area restrictions are ineffective. A single commercial quota of 900 kg of Arctic charr has been applied to the entire delta region, however the volume of charr available for commercial sale is strongly dependent upon fishing success. Consequently the quota is frequently, greatly exceeded (Table 1).

Generally, the commercial harvest of charr since 1983 has been very low. This is due to the reduced effort and catch of charr as a result of reduced numbers of fish and increased retention of charr for domestic purposes. Charr which is sold commercially within the region is marketed locally through retail outlets such as Ulu Foods, Inuvik and in restaurants and hotels. A history of commercial fishing efforts in the delta since 1960 is presented by Barlishen and Webber (1973) and summarized by Corkum and McCart (1981).

3.1.2.3 Sport and Recreational Fisheries

Presently, sport fishing has the least impact on Arctic charr stocks of the western delta (Corkum and McCart 1981). Itinerant fishing by boaters, canoeists and hikers on the Rat have had minimal impact, however slightly greater fishing pressure has been exerted on the Fish Creek spawning grounds from fishermen flying into the area. Details of the fishery such as catch and effort are unknown. Sport fishing pressure can be expected to increase given the profitability

of sport fishing to the community and the accessibility of remote or sensitive areas (such as spawning grounds) by aircraft.

3.1.3 Present Status and Value

The present status of the Rat River Arctic charr stock can only be inferred from the limited information available. The low mean size and age of the population, an apparently high mortality rate (Sparling and Stewart 1986), poor catch per unit effort and a low estimated population size (1,200 - 2,400, A. Kristofferson, unpublished data), suggest that the stock is threatened. Up to 70 families, primarily from Aklavik and Ft. Macpherson can fish for charr domestically each year. Arctic charr is an incidental species in the catch, from the delta comprising less than 5% of the total catch as broad and lake whitefish and inconnu make up the bulk of the harvest. However, during the brief fall migration additional effort is expended to capture the returning charr, resulting in continued high exploitation rates which have been estimated to reach 30 - 40% (A. Kristofferson, unpublished data).

A total allowable catch (TAC), which corresponds roughly to the optimum sustainable yield, has never been calculated for charr stocks of the Mackenzie delta and Yukon north slope due to the paucity of information regarding population size, natural and fishing mortality and recruitment rates. This is further complicated by the fact that several communities exploit several stocks concurrently. Until estimates of the biological parameters of the Rat River charr are known, application of a TAC to this fishery would be inappropriate.

The value of the Arctic charr fishery to the communities of the delta is difficult to quantify. Besides the economic value, cultural, social and traditional values must also be considered. Historically, the native people of the delta have fished for charr for domestic consumption for centuries. Charr fishing has become firmly entrenched as a socio-cultural activity of the community exceeding any commercial value of the fishery. Commercial sales of charr are of incidental value and an insignificant sport fishery for charr in the delta does not provide income or direct employment to the communities. All of the charr which is harvested, aside from the small amount sold commercially, is consumed fresh or is dried for future use and is not used as dog food, unlike whitefish where 50% of the catch is used to feed dogs (Gillman and Kristofferson 1987, unpublished). Therefore, Arctic charr is a preferred food item and an integral part of the diet and culture. The reduced numbers of charr have necessitated a reduced consumption, which is not to be construed as a reduced requirement. It is this desire for charr which has caused the stocks to become threatened.

3.1.4 Information Gaps

From the previous discussion it is apparent there are many areas where information on the Rat River charr stock is lacking. Information gaps specific to the Rat River population also generally apply to other charr stocks of the Mackenzie delta and north slope. A brief point summary of the data gaps which exist for the Rat River charr stock will be given in order of priority.

1) Knowledge of the spatial and temporal distribution of charr during their summer migration is unknown.

2) Enumeration of the population using a weir has proven unsuccessful but remains a priority. Another attempt at a weir designed for mountain streams, or use of a multiple mark recapture estimate (Schnabel) should be made.

3) The total annual harvest from all sources and exploitation rate must be determined. This includes harvest from domestic, commercial and recreational fisheries. This should be performed on a per stock basis and not on a community basis. This will require discrimination between Rat River and other Mackenzie delta or north slope Arctic charr stocks.

4) All potential resource users must be identified including native communities, fishing lodges, recreational anglers, employees of oil companies, and DEW line sites and biologists.

5) Natural and fishing mortality and recruitment rates must be determined. Without knowledge of these rates, TAC's cannot be calculated.

6) The relationship between exploitation rate and population status is unknown. Knowledge of the present state of the stock will assist in future management but will not provide any information as to the original state of the stock. Because no quantifiable relationship between exploitation rate and changes in biological parameters exists, future fisheries management will remain difficult.

3.1.5 Research Requirements

Effective management of the Rat River Arctic charr fishery can only be achieved providing each of the above information gaps are fulfilled. Following is a brief summary of the research required to satisfy these information gaps.

3.1.5.1 Genetics

Distinction of Rat River Arctic charr from other charr stocks is essential to proper management. The relative contribution of Rat River charr to the total harvest of charr from the mixed stock fishery of the delta can be determined from tag returns, morphometric indices or electrophoretic analysis of isoenzymes, which is more accurate. Dr. J.D. Reist of DFO, Winnipeg has initiated population genetic studies using electrophoretic techniques on Arctic charr stocks of the delta and western Arctic. Pending results of this study it may be possible to more accurately estimate the relative proportion each stock comprises in the total catch within the delta. Reist (1986) has demonstrated that allelic frequencies for two enzymes differed substantially between two non-isolated populations of broad whitefish in the Mackenzie delta, as well as between years within populations. Future management schemes should therefore consider spatial as well as temporal stock differences.

3.1.5.2 Tagging

Tagging studies should be continued for charr stocks of the Rat and Big Fish Rivers in order that spatial and temporal distributions can be determined. This will also provide further evidence as to the relative mixing of stocks as well as determining what proportion of the Rat River stock is harvested by fishermen from Aklavik versus Ft. Macpherson. Additionally, a multiple mark-recapture program using tags may provide an estimate of population size.

3.1.5.3 Abundance

Determination of the number of Arctic charr in the Rat River remains a priority. Enumeration can be achieved directly using a weir or hydroacoustic means, or indirectly based on results from multiple mark and recapture experiments.

3.1.5.4 Harvest Level and Exploitation Rate

A program to determine the quantity of fish taken from the Rat River by domestic, commercial and sport fisheries should be established. From this exploitation rates can be calculated based upon population abundance, and the relationship between exploitation rate and abundance, elucidated. TAC's can only be applied given this and a knowledge of recruitment rates.

3.1.6 Summary

Arctic charr of the Rat River have been subject to continuous, heavy exploitation from the domestic fisheries of Aklavik and Ft. Macpherson for over two decades. All available information suggests that population levels have declined considerably during recent years, as indicated by low catch per unit effort, significantly reduced harvest and the absence of large, older fish in the stock. Continued exploitation will inevitably lead to severe reductions of mature individuals, particularly anadromous females which comprise the majority of individuals in the harvest (McCart 1980). The subsequent loss of recruitment could result in a complete collapse of the population. It has been known for several years that the stock is threatened and that some remedial action must be taken (Corkum and McCart 1981, Gillman and Sparling 1985).

3.1.7 Recommendations

The following discussion will outline the steps to be taken in an attempt to restore the viability and ensure the perpetuity of the Arctic charr population of the Rat River. Because of the critical nature of the situation, several immediate and severe steps must be taken. These are outlined as "Short Term Recommendations". "Long Term Recommendations" will suggest remedial and mitigative measures to ensure that maximum, long term economic, cultural and social benefits from the Rat River Arctic charr fishery are realized.

3.1.7.1 Short Term Recommendations

1) Elimination of the commercial quota for charr until such time as the stock has recovered and TAC limits can be calculated.

2) Temporary, severe temporal and spatial restrictions on the domestic harvest of Arctic charr should be instituted. This includes elimination of the domestic harvest of charr for a 2-3 year period. This can be achieved by restricting fishing within the Rat River from Husky Channel to Fish Creek and by reducing or eliminating fishing for charr in and around the Aklavik townsite during the two week period when the charr are "running".

3) A monitoring and enforcement program should be established with the full and complete co-operation of the Aklavik and Ft. Macpherson Hunter's and Trapper's Committee's which would encourage all members of the community not to fish for charr.

3.1.7.2 Long Term Recommendations

1) A long term monitoring program should be instituted to monitor changes in: domestic, commercial and recreational harvest, biological parameters (mean age, length, mortality etc.), catch per unit effort (CPUE), and population level.

2) Prohibition of fishing in sensitive or vulnerable areas such as spawning, nursery and overwintering areas.

3) Restriction or elimination of the spring fishery for charr to protect current year spawners and to prevent the harvest of fish in poor condition.

4) Standardization of commercial and domestic fishing gear. This would facilitate monitoring of changes in CPUE and biological parameters.

5) Establishment of mesh size restrictions for commercial and domestic fishing gear.

6) Establish provisional domestic and/or commercial quota's which vary on an annual basis in response to changes in biological parameters, stock size and CPUE.