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Canadian Science Advisory Secretariat
Science Advisory Report 2005/028

STOCK ASSESSMENT REPORT ON KIPISA ARCTIC CHAR

Kipisa Char
Photo by Tracey Loewen

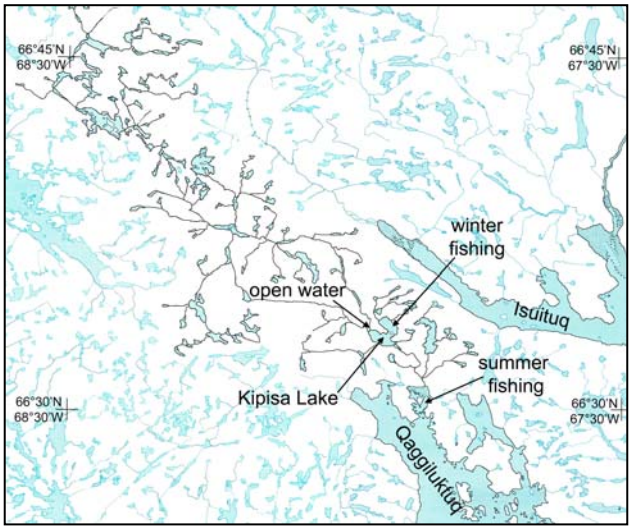

Figure 1: Map of the Kipisa area. Usual areas of winter and summer fisheries are marked.

Context

Anadromous Arctic char, Salvelinus alpinus (Linnaeus) occur in the Kipisa Lake system at the head of Qaggiluktuq (Kangilo Fjord) in Cumberland Sound, Baffin Island (Figure 1). This stock provides an important source of char for the residents of the community of Pangnirtung, NU, an Inuit community located on the northeast side of Cumberland Sound on Baffin Island (Appendix 1). Non-anadromous or resident char are also found in this system.

The Kipsa system has a long history of fisheries exploitation. Char have been harvested at the Kipisa system since before the community was first settled in the 1940s. Commercial/test/exploratory harvest statistics are available from 1975. Historically, it was a source of high quality subsistence fish and continues to be harvested for food to the present day. The ongoing subsistence fishery and exploratory fisheries occur simultaneously at Kipisa. Sport fishing is not generally undertaken because of the distance from the community.

Since 1997, the Pangnirtung Hunters and Trappers Organization (HTO) have consistently identified this stock of arctic char for further study in consultations with Fisheries and Oceans Canada (DFO) researchers. It is one of a number of stocks fished by the community and there is a general desire to convert the exploratory licence for this area to a commercial licence. As a result, DFO researchers began a scientific sampling program in 1998 to support an assessment of the stock.

The Nunavut land claim agreement (NLCA 1993) stipulated that the Nunavut Wildlife Management Board (NWMB), the main instrument of wildlife management in the Nunavut Settlement Area would undertake a harvest study to establish current harvesting levels, determine the basic needs level (BNL) and assist in establishing levels of total allowable harvest (TAH) for stocks in Nunavut. Since the results of the harvest study were recently published (Priest and Usher 2004), it is expected that a TAH would be established for this stock. The current assessment should support the establishment of the TAH.

SUMMARY

- The Kipisa system is an important source of Arctic char for residents of Pangnirtung, Nunavut.
- The Kipisa system has been fished under exploratory licence and for subsistence purposes for many years.
- Most fishing has occurred during the summer in recent years in the near-shore area at the mouth of the river although Kipisa Lake has been fished in the past during the winter.
- Current harvest levels appear to be stable and sustainable.
- A review of existing biological and harvest information resulted in a recommended TAH from this system of 3000 kg based on an exploratory harvest of 2400 kg and 600 kg subsistence harvest.

DESCRIPTION OF THE ISSUE

A Regional Advisory Process meeting was held in Pangnirtung, March 23-24, 2005 to assess the status of the Kipisa Arctic char stock. Participants included DFO scientists and fishery managers, members of the Pangnirtung HTO, municipal and territorial governments and local fishers.

Species Biology

Kipisa char are easily identified by community members because of their shape, colour and flavour. They are distinctive from other populations in that they have a light body colouration, a small head relative to the body and a deeper body than char from other locations in the Cumberland Sound area. Male char tend to be longer and heavier than females from about age 9 onwards (Figure 2).

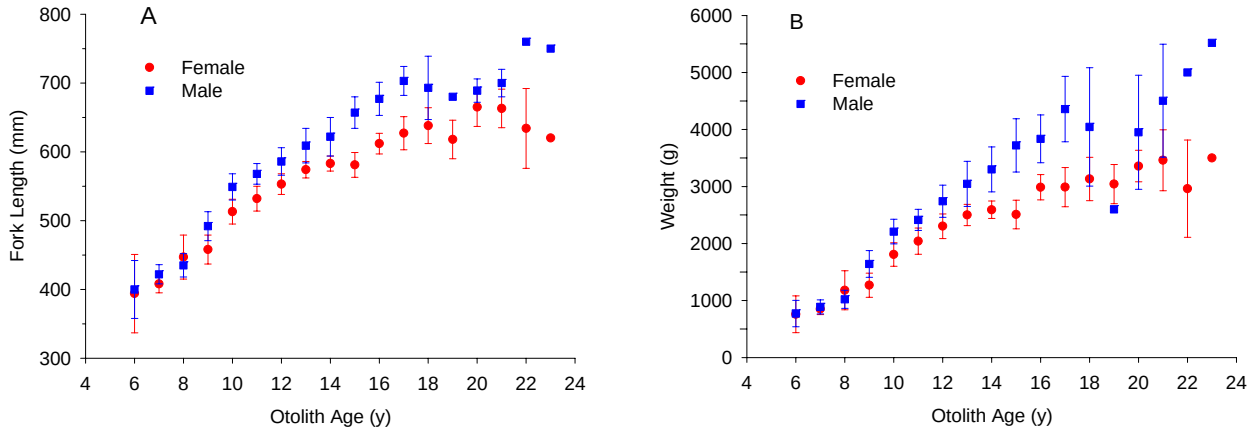

Figure 2. Mean length and weight at age (± 2 x standard error) of male and female char from the Kipisa system from research samples collected from 1998 to 2004.

Resident char also occur in the Kipisa system. They are darker, almost brown in colour with a yellow under-belly and attain a larger size (approximately 30 cm) in comparison to resident char from other systems. The resident fish have white muscle tissue whereas it is red coloured in anadromous fish. Community members have observed that resident char often appear senescent (very old) even though they are not large compared to the anadromous (sea-run) form. During spawning anadromous adults are a brilliant red and males develop a kype. The white along the leading edges of the pectoral, pelvic and anal fins becomes more intense during spawning.

At ice-out in the spring, adult char leave their over-wintering areas and make their annual migration to the sea. Moore (1975b) found the downstream run for two rivers in the Pangnirtung area began in the middle of May and was completed in about two weeks. The spawning migration from salt water to freshwater began in early August and extended over 5-6 weeks (Moore 1975b). Spawning began in September (Moore 1975a) and likely was completed by the time ice formed on the lakes (November). Adult char do not spawn every year taking one or more years to rest between spawning. The frequency of spawning is likely variable according to the condition of the fish. Age at first spawning is thought to be 8 or 9 years for the Kipisa stock.

Arctic char are carnivorous and feed mainly a variety of aquatic invertebrates and occasionally fish (Moore and Moore 1974). The anadromous form takes most of its energy from the marine system and those from the Kipisa area feed mainly on marine invertebrates (T. Loewen DFO pers. comm.).

Critical Habitats

The specific locations for over-wintering in the Kipisa system are not known although Kipisa Lake is sufficiently deep in many places to allow successful over-wintering. Critical habitats are not well defined in this system. It is expected that spawning habitat occurs in the lakes although the exact locations for spawning and overwintering are not known. Similarly, the rearing areas for the young char are not known but presumably they rear in the lake and the lower river reaches above the tidal influence.

The community members identified that Kipisa char utilize an open water area late in the season (December and up to early January) in the river system above the lake (Fig. 1). By late January, this area is covered by ice. It is thought that the char utilize the upper river, above the lake, for spawning (reproduction). Fish may also migrate upstream of Kipisa Lake.

Fishery

The Kipisa area has a long history of fisheries harvest. Commercial/test/exploratory harvest statistics exist from 1975 (Table 1). Subsistence fishing and fishing under an exploratory licence continues to the present. Sport fishing is not generally undertaken because of the distance from the community.

Fishing is by monofilament gillnets (5.5” or 139.7 mm mesh), 150 ft (45.7 m) in length and 9 ft (2.74 m) in depth. The summer nets are floated and set perpendicular to the shoreline with ropes attaching them to shore. When nets are set in the lake, in winter under the ice, they are set on the bottom. Winter fishing requires that the nets are strung between two holes cut in the ice by ice-auger or chisel. A jig is used to pull a rope between the two holes. This long rope is then attached to one end of the net. This is used to pull the net into the water under the ice and into position near the lake bottom. When the net is hauled in, it is pulled in by the end of the net

with the shorter rope. The long rope remains between the holes and is then used to reset the net.

Table 1. Harvest of Arctic char from the Kipisa system 1975 to 2004. Commercial harvest data are from Yaremchuk et al. (1989), subsistence data from the Nunavut Wildlife Harvest Study (Priest and Usher 2004). Harvest is reported in kg round weight.

Year	Commercial		Test / Exploratory		Subsistence	Total
	Quota (kg)	Harvest (kg)	Quota (kg)	Harvest (kg)	Harvest (kg)	Harvest (kg)
1975	-	505				505
1976			-	737		737
1977						
1978	-	588				588
1979			1361	1360		1360
1980						
1981						
1982	-	4500				4500
1983	1440	2273				2273
1984	1440	2716				2716
1985	1440	159				159
1986	1440	1049				1049
1987	1440	1791				1791
1988/1989	1440	2172	1440	804		2976
1989/1990			2400	2080		2080
1990/1991						
1991/1992			2400	1333		1333
1992/1993			2400	4165		4165
1993/1994			2400	2640		2640
1994/1995			2400	3035		3035
1995/1996			2400	2128		2182
1996/1997			2400	142	267.5	409.5
1997/1998					857.5	857.5
1998/1999			2400	2162	2350	4512
1999/2000			2400	2320	1357.5	3675.5
2000/2001			2400	3944	2950	6894
2001/2002			2400	511		511
2002/2003			2400			
2003/2004						
2004/2005			2400	2094		2094

Catch statistics are highly variable in the exploratory fishery ranging from lows in 1985 and 1996 of around 100 kg reported, to a high in 1982 of close to 4500 kg. The exploratory quota has also varied, fluctuating from under 1500 kg to over 3500 kg. There are several instances where no catch has been reported but these may be a result of errors in reporting rather than a reflection of no fishing. The high variability in the catch statistics is in part related to the process of issuing exploratory licences. The fishery remains closed until a licence is issued each year. In some years, the fish have already left the area by the time a licence is issued and therefore

little catch is attained. In addition, the local fish plant has a limited capacity to process and store char. The fishery may stop abruptly because capacity at the plant is reached and there is no other place to sell the catch.

The fishery has frequently caught more than the quota. When combined with the reported subsistence harvest (according to the NWMB harvest study), the total harvest has probably been close to double the existing quotas. However, the reliability of the harvest study results has been questioned by many communities.

There have never been concerns expressed that the stock was being over-harvested and fishers have often reported good catches at this site. Subsistence fishing has also been stable and there have been no reports of a significant reduction in catch or catch-per-unit-effort in the subsistence fishery. Although community knowledge indicates that there have been some natural fluctuations in the abundance of fish over the last century, observations from local fishers suggest that char in the Kipisa area, in recent years, are both abundant and of large size.

Assuming a constant subsistence catch at 2340 kg (based on the NWMB basic needs level) the estimated annual total harvest averaged 1628 char (4071 kg) with 58% being used for subsistence purposes. Between 1975 and 1989, mean total catch (subsistence and commercial fishery) was 1428 char (3695 kg), between 1990 and 1996, it was 1831 char (4577 kg) and between 1998 and 2004, it was 1719 char (4298 kg) (Table 1). The highest overall catch was estimated at 6524 kg in 1992. The largest subsistence catch was 2950 kg in 2000.

According to the harvest study, the subsistence fishery from 1996 to 2000 took place between February and November but most of the catch occurred in February-/March and July-August (Table 2). The majority of the harvest (54%) occurred at the mouth of the river in July and August when the char were preparing to move upstream, while the remainder came from under-ice fishing in winter at Kipisa Lake.

ASSESSMENT

Stock Delineation

Anadromous char that spawn and overwinter in the Kipisa system are assumed to be a discrete stock, geographically isolated and thus confined to the Kipisa system. This assumption is based on the physical geography of Cumberland Sound that features freshwater systems suitable for char at the base of long inlets or fjords. The region is mountainous and there is little shallow marine habitat where char might forage along the edges of the fjords except the estuarine flats at the mouths of the rivers at the head of the fjord. Thus it is thought that each river comprises a distinct stock. However, this assumption is untested by scientific studies such as tagging or genetic analysis.

Stock Size

There have been no direct estimates of stock size either by weir or mark-recapture tagging studies. However, insight from other northern systems has shown that population size has remained relatively stable when exploitation rates were in the range of 5 to 10%. Owing to relatively stable size and age distributions in the Kipisa Arctic char stock, similar exploitation

rates if applied to current harvests would indicate population sizes between 17,200 and 34,400 char.

Table 2. Harvest data, reported as number of char and converted to kg round weight, from the NWMB harvest study for Kipisa searun arctic char (Priest and Usher 2004).

Harvest Study data from Kipisa			
Year	Date	Number	Estimated Wt (kg) assume fish average 2.5 kg
1996	July	27	67.5
	23 Sep	80	200
Total		**107**	**267.5**
1997	20 Feb	20	50
	23 Mar	210	525
	22 Aug	100	250
	26 Aug	13	32.5
Total		**343**	**857.5**
1998	14 Feb	500	1250
	21 Mar	110	275
	16 May	50	125
	29 Jun	25	62.5
	30 Jun	25	62.5
	24 Jul	20	50
	14 Aug	210	525
Total		**940**	**2350**
1999	14 Apr	50	125
	06 Jul	38	95
	14 Jul	75	187.5
	13 Aug	350	875
	19 Aug	30	75
Total		**543**	**1357.5**
2000	20 May	20	50
	13 July	650	1625
	14 July	366	915
	11 Aug	80	200
	18 Aug	34	85
	17 Nov	30	75
Total		**1180**	**2950**

An alternate method to infer estimates of stock size was carried out by cohort analysis of catch-at-age information using the ADAPT framework (Gavaris 1988, 1991). Catch-at-age data were derived from commercial-sized net research sampling and applied to the commercial/exploratory catch. Catch-per-unit effort information from the exploratory gill net fishery was used in the calibration process. Arctic char in this area are relatively long-lived with fish aged 17 to 20+ years common. Consequently, approximations were run with natural mortality (M) varying between 0.05 and 0.20. Various simulations resulted in estimates of

fishing mortality that were low across all age groups, consistent with low observed catches in the fishery. Resultant estimates suggested population sizes in excess of 30,000 fish. However, owing to the lack of consistent catch and catch-at-age data, and the relatively short time series of information available, little weight or confidence was applied to these results. Nevertheless, it is noted that both indirect approaches to infer stock size are suggestive of rather substantive numbers of char in the Kipisa stock at least at current harvesting levels.

Stock trends

There is no available data that directly measures the catch-per-unit-effort (CPUE) from either the subsistence fishery or the exploratory fishery. The research CPUE between 1998 and 2004 (Figure 3) showed a correlation between the variance and the mean (Figure 4) and therefore a multiplicative model was applied (Figure 5).

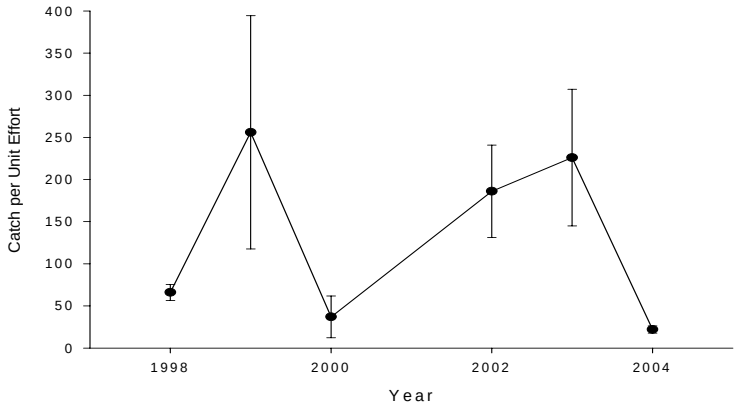

Figure 3. Catch-per-Unit-Effort (CPUE) for research gillnet sets from 1998-2004 reported as the average CPUE with standard error.

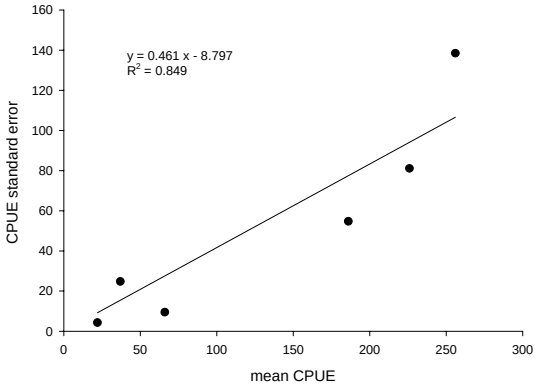

Figure 4. Relationship between mean CPUE and its standard error.

The adjusted CPUE from these nets showed that there was no trend in the stock index from 1998 to 2004 (Figure 5).

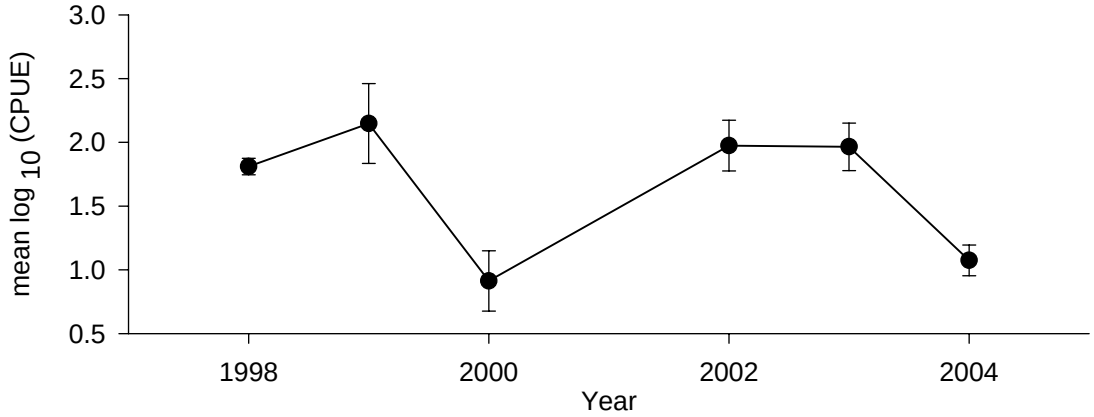

Figure 5. Adjusted Catch-per-Unit-Effort (CPUEA) ± standard error for research gillnet sets from 1998-2004.

However, the CPUE was highly variable ranging from under 10 char/45.72 meters nets/24 hours to over 100 char/45.72 meters net/24 hours. CPUE from the fishery needs to be recovered in the future to assist in the evaluation of this stock.

From 1998 to 2002, the length and age frequencies of Kipisa char were similar (Figure 6). Beginning in 2003, slightly more younger fish were caught than had been caught previously. In 2004, this was even more pronounced although in both years older fish were still being caught. Age and length frequency distributions were different among years (Kolmogorov-Smirnov test) but when the 2004 data were removed there were no differences. The length frequency of the 2004 sample was unusual in that it was bimodal compared to those from 1998-2003 (Figure 6).

A reduction in age classes and an increase in the smaller fish, as was found in 2004 (Figure 6), might signal that the fishery is having an impact on the stock. However, scientific sampling of the Kipisa stock is done over a very short period of time and as a result, the 2004 sample may be an anomaly. Notes taken during the sampling period suggest that it was colder and more difficult than usual to catch the fish. There was lots of multi-year ice coming into Cumberland Sound in 2004 affecting both the air and water temperatures, which may have been a factor. Local fishers found it a very good year for fishing at Kipisa but they fished after the scientific sampling was complete. The year was colder than normal, which may have delayed the normal staging of the run and may have resulted in fish moving into the area in a pulse. The scientific sampling may have occurred ahead of the pulse and the exploratory harvest occurred at peak of the pulse. Discounting the sample from 2004 there does not seem to be much evidence that a sufficient number of large fish are removed to change the length distribution.

Sources of Uncertainty

There is no reliable estimate of current stock size, current subsistence harvest levels (for recent years) or catch-per-unit-effort for the exploratory and subsistence fisheries for the Kipisa Arctic char.

Critical habitats are not well defined in this system. The location where spawning takes place and the over-wintering areas used in this system are uncertain and not thoroughly documented. Similarly, the extent of the sea migrations of this stock and degree of interaction with other char stocks is poorly understood. Although it is thought that the fish from Kipisa are a distinct stock this assumption is untested.

The role of resident char in the stock structure is unknown although they could be part of the same reproductive population as the anadromous char stock.

Recommendations

Continuing assessment of this stock requires that catch statistics are recorded for the harvest. The total removal from the population from all sources provides the best data with which to assess the successfulness and sustainability of the fishery. Effort (Catch-per-Unit-Effort) and biological samples from catch to provide the tools to understand the catch structure. Research sampling provides an independent comparison.

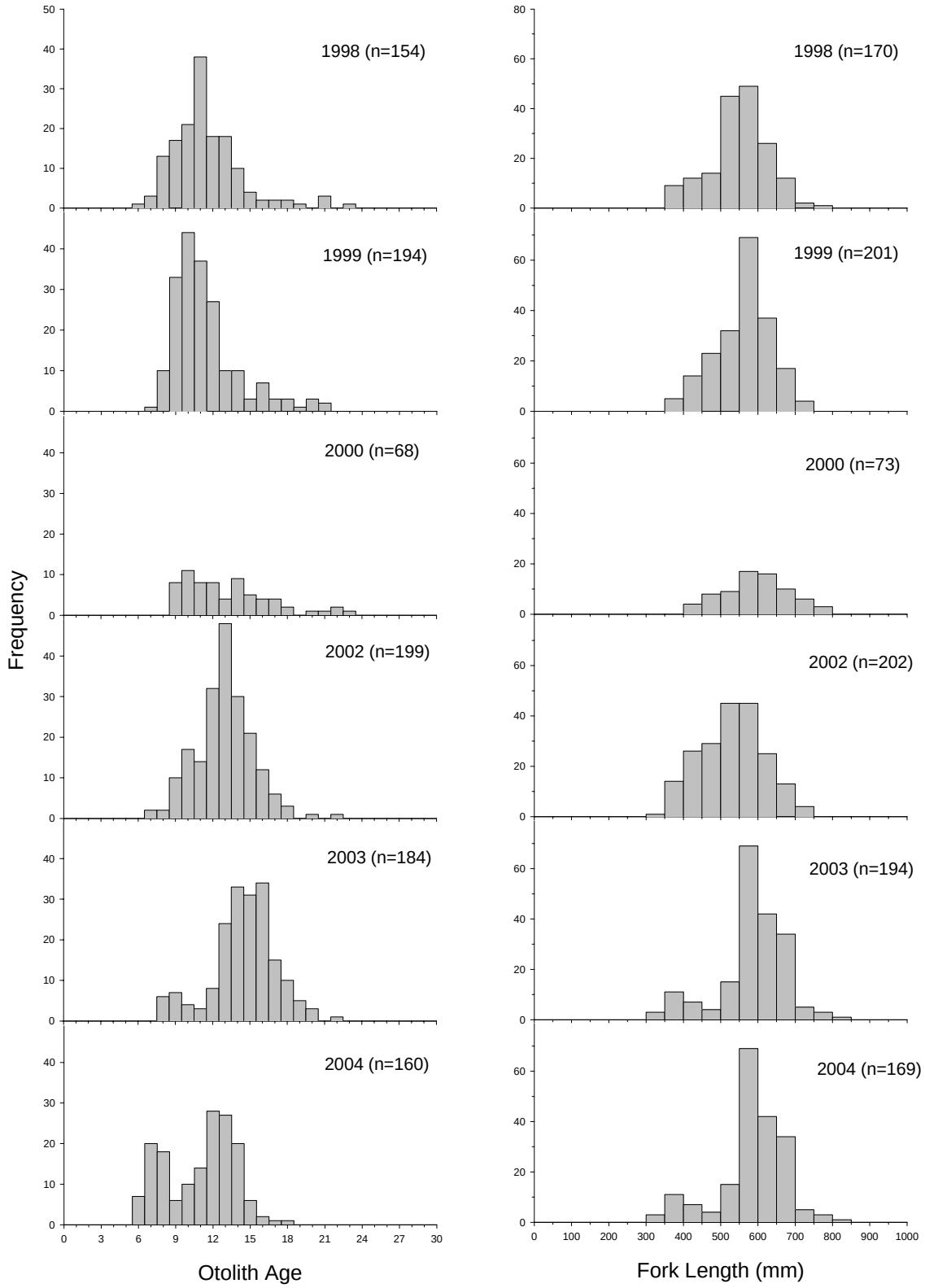

Figure 6. Age and length frequencies for Kipisa char from 1998 to 2004. Tagging and genetic studies to delineate the stock structure of the population and to determine patterns of movement for fish in the Kipisa system should be undertaken.

Traditional knowledge from the older fishers in the community is being lost as the local population ages. These fishers have a wealth of information that could help the community develop successful fisheries. It is recommended that an Inuit Qaujimajatuqangit (IQ) or Traditional knowledge (TK) study of the char stocks in the area be undertaken.

A collaborative approach between DFO and the HTO to develop long term research planning should be undertaken with multi-year projects being identified.

ADDITIONAL STAKEHOLDER PERSPECTIVES

The fishers of the region view the Kipisa as a reliable and stable source of large char. It is considered to be one of the best stocks in the Cumberland Sound Region. Since the opening of the exploratory fishery, there has been a shift in fishing from the lake to the near-shore marine area. Fishers have experienced good catches in recent years. Last year's harvest (Billy Evic, Pangnirtung HTO, pers. comm.) was the best in five years. The fishers noted that for the exploratory fishery, the variability in the time of the spring and fall runs, effort, and economic issues rather than biological changes in the stock drive duration of harvest.

CONCLUSIONS AND ADVICE

Sustainable harvest rate

Natural mortality in this species may be low in adults compared to other species and optimum sustainable harvest rate is also probably lower than other harvested species in the north such as whitefish.

Harvests of char on the Hornaday River near Paulatuk, NT, between 1987 and 1998, were estimated to be at a rate of 16% to 18% of the available stock and were not sustainable (DFO 1999). Johnson (1980) found an annual exploitation rate of 11% to be excessive for char at Nauyuk Lake in the Central Arctic. This rate led to a steady decline in the size of the stock.

The annual harvest rate is probably below 5% in this fishery. F-values, fishing mortality, calculated from simulations were quite low (under 5% annual fishing mortality rate) but these must be considered with caution.

Assuming that the final year of sampling is not consistent with the other years because of sampling problems then an initial estimate of sustainable total allowable harvest could be approximately 4800kg per year. However, there are many assumptions in this estimate and therefore it must be used with caution. For example, the local fishers estimated that subsistence harvest would be closer to 600 kg rather than 2400 kg. Therefore, the proposed sustainable harvest level has a great amount of uncertainty attached to it and further monitoring and sampling of the stock may reduce the uncertainty. The stock appears healthy. Based on the advice of the local fishers regarding subsistence harvest the recommended TAH is 3000 kg. This is based on approximately 2400 kg for the exploratory/commercial fishery and 600 kg for subsistence use. This value would represent a total exploitation rate of less than 10% of the lowest possible estimate of stock size and probably less than 5% of the lower bound for stock size range based on two different analyses. This level of TAH follows a precautionary approach to managing the fishery.

Outlook

There is no indication that the Kipisa stock has been adversely impacted by the total level of harvest. Except for 2004, the indications from the biological sampling are that the age structure is relatively stable with many older aged fish in the population. Based on this, the risk of overfishing at the current level of harvest is low to moderate. If the 2004 data represents a change in the stock structure or a trend towards fewer age classes then there may be some concern for the level of harvest.

It is recommend that the annual monitoring and sampling program continue with increased efforts to obtain catch-per-unit-effort and biological samples from the fishery. Sampling of the catch at the fish plant in Pangnirtung and in the field is recommended. Further data is required to: 1) monitor the status of the stock; 2) and collect relevant information to manage the stock.

If the present management system continues we would recommend that this fishery be moved from the exploratory status to a commercial status.

OTHER CONSIDERATIONS

Management Considerations

The Kipisa fishery is co-managed by DFO, NWMB and HTO as established under the Nunavut Land Claim Agreement (NLCA 1993). DFO Fisheries Management and the Pangnirtung HTO are currently developing a fishery management plan for the Cumberland Sound char fisheries, which will set fisheries management objectives and strategies for the stocks including Kipisa char. Final approval of the proposed management plan will come from the NWMB.

Under the Nunavut Land Claim Agreement, the NWMB is obliged to undertake a Harvest Study, the purpose of which is to furnish data, to establish current harvesting levels and assist the NWMB in establishing levels of total allowable harvest (NLCA 1993). The NWMB is responsible for establishing the TAH within the Nunavut Settlement Area and where this has been done, the NWMB will strike a basic needs level as described in section 5.6.19 (NLCA 1993).

The roles and responsibilities, of the various stakeholders and agencies involved in the management of the fishery (DFO, NWMB, HTO), for implementing the new plan to manage using BNL and TAH are not clear. There are concerns with our ability to effectively analyze, monitor and manage the fishery in the future if these roles are not clearly defined. The responsibility for data collection and archiving also needs to be defined. This should be addressed in the management plan and should be addressed more globally by the NWMB.

Other Considerations

Climate change and its impacts on the char stocks and fisheries are of concern to the residents of Pangnirtung. IQ studies that document environmental change in several communities including Pangnirtung, have provided indications that the weather, with winds as a focus, are changing resulting in considerable changes in sea ice conditions (G.Laidler, Univ. of Toronto, pers. comm.). The effects that climate change may have on the fish and fish habitat in the Pangnirtung area are not well understood.

SOURCES OF INFORMATION

DFO, 1999. Hornaday River Arctic Charr. DFO Science Stock Status Report D5-68 (1999).

Gavaris, S. 1988. An adaptive framework for the estimation of populations size. Canadian Atlantic Fisheries Science Advisory Committee. Research Document 88/29. 12 p.

Gavaris, S. 1991. Progress and problems in fish abundance estimation : experience with the adaptive framework as a calibration tool for finfish stock assessments in CAFSAC. International Council for the Exploration of the Sea Statistics Committee (ICES C.M.) 1991/D:19. 8 p.

Johnson, L. 1980. The arctic charr, *Salvelinus alpinus.* pp: 15-98. *In* E.K. Balon [ed.]. Charrs; Salmonid fishes of the genus *Salvelinus.* Dr. W. Junk, Publ. The Hague, Netherlands. 928 p.

Minister of Indian Affairs and Northern Development and Tungavik Federation of Nunavut. 1993. Nunavut Land Claims Agreement: Agreement between the Inuit of the Nunavut Settlement Area and her Majesty the Queen in right of Canada. Ottawa: Supply and Services Canada.

Moore, J.W. 1975a. Reproductive biology of anadromous arctic char, *Salvelinus alpinus* (L.), in the Cumberland Sound area of Baffin Island. J. Fish. Biol. 7: 143-151.

Moore, J.W. 1975b. Distribution, movements, and mortality of anadromous arctic char, *Salvelinus alpinus* L., in the Cumberland Sound area of Baffin Island. J. Fish. Biol. 7: 339-348.

Moore, J.W. and I.A. Moore 1974. Food and growth of arctic char, *Salvelinus alpinus* (L.) in the Cumberland Sound area of Baffin Island. J. Fish Biol. 6: 79-92.

NLCA. 1993. See Minister of Indian Affairs and Northern Development and Tungavik Federation of Nunavut. 1993.

Priest, H. and P.J. Usher. 2004. The Nunavut Wildlife Harvest Study - Final Report, prepared for the Nunavut Wildlife Management Board. 822 p.

Yaremchuk, G.C.B., M.M. Roberge, D.K. McGowan, G.W. Carder, B. Wong, and C.J. Read. 1989. Commercial harvests of major fish species from the Northwest Territories, 1945 to 1987. Can. Data Rep. Fish. Aquat. Sci. 751: iv + 129 p.

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Appendix 1. Cumberland Sound Arctic Char Fisheries.