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CLYDE RIVER ARCTIC CHAR ENHANCEMENT PROGRAM 1991:

STREAM CHANNEL IMPROVEMENTS IN KUUQUTIGA CREEK

by

Aaron D. Sekerak

for

Renewable Resources
Indian and Northern Affairs Canada
Science Institute of the Northwest Territories

by

Clyde River Hunters and Trappers Association
Science Institute of the Northwest Territories
and
Applied Environmental Services

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The Hunters and Trappers Committee of Clyde River directed the overall study and the President, Manassie Audlakiak, is especially thanked. This study could not have been performed without the day-to-day help and guidance from James Qillaq, David Iqarialu and Solomon Natanine. They participated in field work and were essential in community coordination, Thanks are also extended to other field workers: William Kautuq, Joelie Audlakiak, Allan Natanine and Tommy Qillaq.

Day-to-day supervision and scientific skills were provided by Aaron D. Sekerak of Applied Environmental Services, Box 1148, Yellowknife. The report was ably translated by Jukeepa Hainnu, and typed by Nell Stallard.

INTRODUCTION

Fish resources near Clyde River, NWT, are extremely limited. Arctic char (*Salvelinus alpinus*) is the only species of freshwater fish that is present in the region. It occurs in two forms. Resident or landlocked char remain in fresh water throughout their lives. While this form is widely distributed and is present in most lakes in the region, it is seldom used as a food fish because of its poor quality. In contrast, sea-run Arctic char, the second form that occurs in the area is greatly prized as a food fish, Sea-run char spend their summers feeding in marine waters; however, they must return to fresh water to overwinter and spawn. Unfortunately, because of habitat limitations on northeastern Baffin Island, sea-run char do not occur in large numbers and they are sparsely distributed over the region.

In early 1991, the community of Clyde River prepared a document entitled "A Community Plan to Increase Fish Populations near Clyde River, N.W.T." The pian was a result of a series of community meetings, radio broadcasts, interviews with local residents and opinion polls. It was given overwhelming support in a house-to-house poll which took place 22-24 March 1991 and was formally approved by the Hunters and Trappers Association on 26 March 1991.

The community pian (Sekerak et al. 1991) focused on practical ways to improve Arctic char habitat and to overcome other natural limitations. It was found that one of the most important factors limiting the distribution of sea-run char was obstacles to their migrations between the sea and their overwintering areas. Such barriers as waterfalls, rapids or shallow water areas in streams often hinder or completely block the migrations of Arctic char that are necessary for the survival of sea-run populations.

One area of particular concern was identified by residents of the community. This was a small drainage (70°22'N;71"57'W) emptying into an embayment of Walker Arm on the northeast coast of Baffin Island. The drainage consists of a short stream which drains a lake. The latter serves as an overwintering and spawning area for sea-run Arctic char. While the small stream serves as the critical migratory link between the sea and the lake, migrations are sometimes severely limited due to shallow water, especially in cool dry summers. Residents of Clyde River reported that sea-run char are often found stranded between rocks in the streambed and that some mortality occurs from stranding and from seagull predation.

As a result of the above, the HTA of Clyde River and the Science Institute of the NWT proposed to undertake a project during the open-water period of 1991 to improve conditions for migrations of Arctic char in this problem area. Applied Environmental Services, a biological consulting company in Yellowknife specializing in renewable resource development projects, was subcontracted to supervise and coordinate the study and to prepare a report on the project. This report is a full description of those activities.

STUDY AREA

The study area is a relatively small drainage (125-150 km^2) which empties into a small bay off Walker Arm (Figure 1). Walker Arm is in turn a branch of Sam Ford Fiord, which extends inland for over 120 km in a north-south orientation. Headwater streams in the study area flow mostly easterly and empty into the lower drainage where the mainstem then flows northerly and enters the sea. A small lake (l-2 km^2) is located on the valley floor about 4 km from the sea (Plate 1).

Locations in the study area have not been officially named. Members of this study group proposed the name "Kuuqutiga Stream" for the mainstem of the stream draining the region and "Kuuqutiga Lake" for the oniy iake in the drainage (Figure 1). These names have been officially proposed to the Department of Culture and Communications and should appear on updated maps of the region (Mr. Randy Freeman, Department of Culture and Communications, c/o Prince of Wales Heritage Centre, Box 1320, Yellowknife, Xl A 2L9). The proposed names are used throughout the remainder of this report.

The terrain surrounding Kuuqutiga Creek is mountainous. Ridges encircling the drainage are commonly over 500 m high (Plate 2) and mountains extend up to 2200 m (Plate 3). Although no large glaciers are present, there are several small permanent snowfields and several small glacial remnants are present, mostly in the northwest portion of the drainage. Although the surrounding terrain is rock, the valley floor from the iake to the sea is mostly unsorted glacial till. This region is aiso broad-commoniy from 0.5 km to 2 km in width.

The remainder of this report deals with the primary study area, which consists of Kuuqutiga Lake and the mainstem of Kuuqutiga Creek from the iake to the sea.

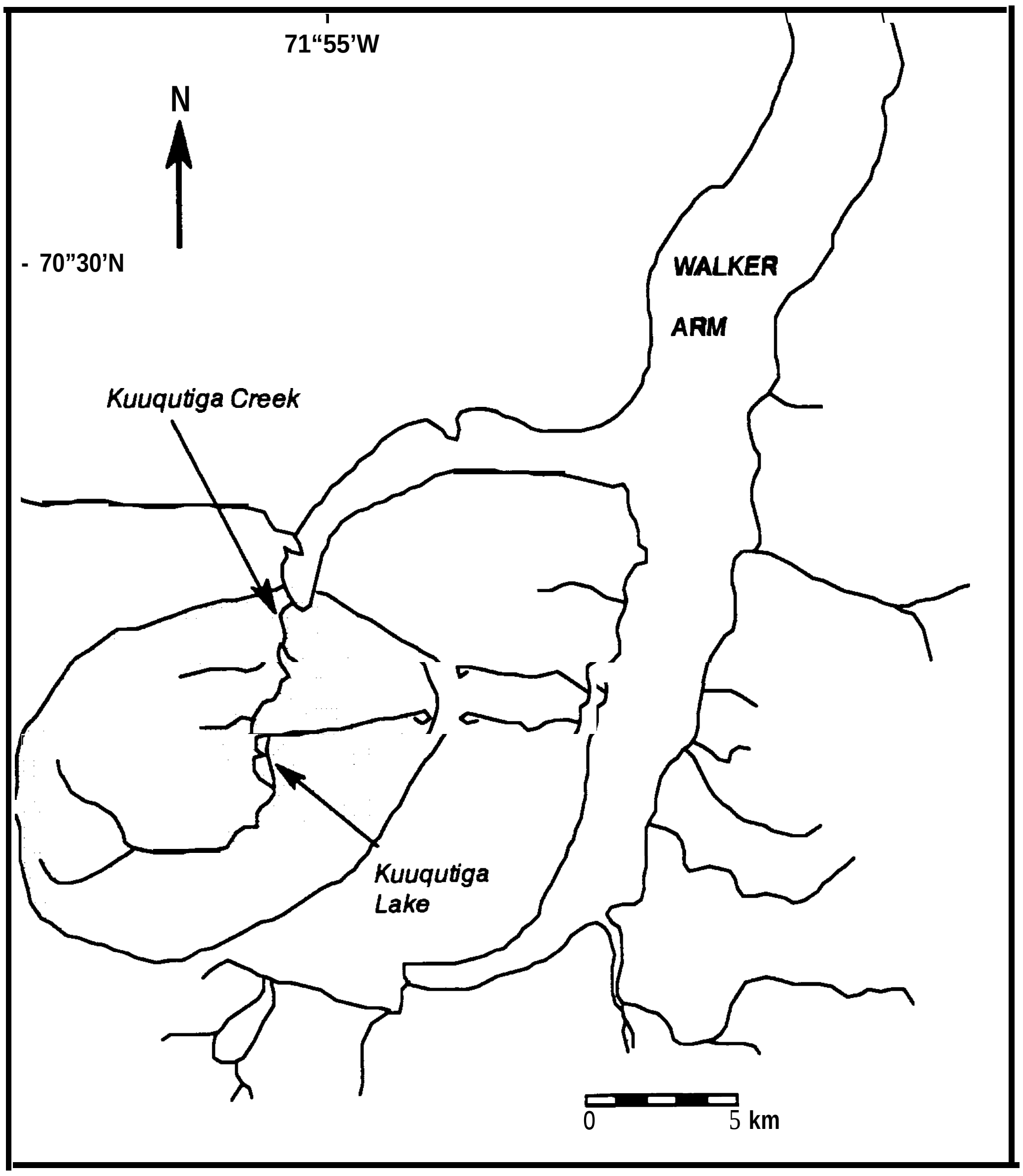

Figure 1. The **Kuuqutiga** Creek drainage study area.

Physical Habitat

Kuuqutiga Lake

Kuuqutiga Lake is approximately 1.75 km long and 0.5 km wide. The shoreline is mostly smooth (Plate 4) with few irregularities except for a narrow peninsula which extends over half way across the lake from the west shore.

Although bedrock is absent, substrate around the margin of the lake is mostly hard and normally consists of cobble-sized rock and boulders (Table 1; Figure 2; Plates 5 and 6). Most are well-rounded and worn but more angular large cobbles and boulders are present, especially along the southeast shoreline (Figure 2). Gravel is scarce except for small deposits, usually mixed with small cobbles, along the west-central shoreline. Sandy deposits occur only in two areas: one at the mouth of the inlet stream which enters the southern extremity of the lake; the other along the northwestern shore near the lake's outlet (Plate 7).

While most hard substrate was relatively clean, some accumulations of soft silt were noted, primarily in protected areas such as Sample Site 11 (Plate 8). Vegetated shoreline areas are rare, except for the inlet and outlet areas where the terrain is more flattened and vegetated to the water's edge (Plate 7). Other areas of shoreline are more abrupt, unstable and have little or no soil development.

Due to the large, broken nature of most of the shoreline substrate, numerous microhabitats are present in the form of cracks and crevices. These offer shelter and resting areas for juvenile char, as well as habitats for larval insects-an important food item for small char. Nursery and rearing habitat for char is thus judged to be excellent in ail areas except for the sandy regions which occupy less than 5% of the available habitat.

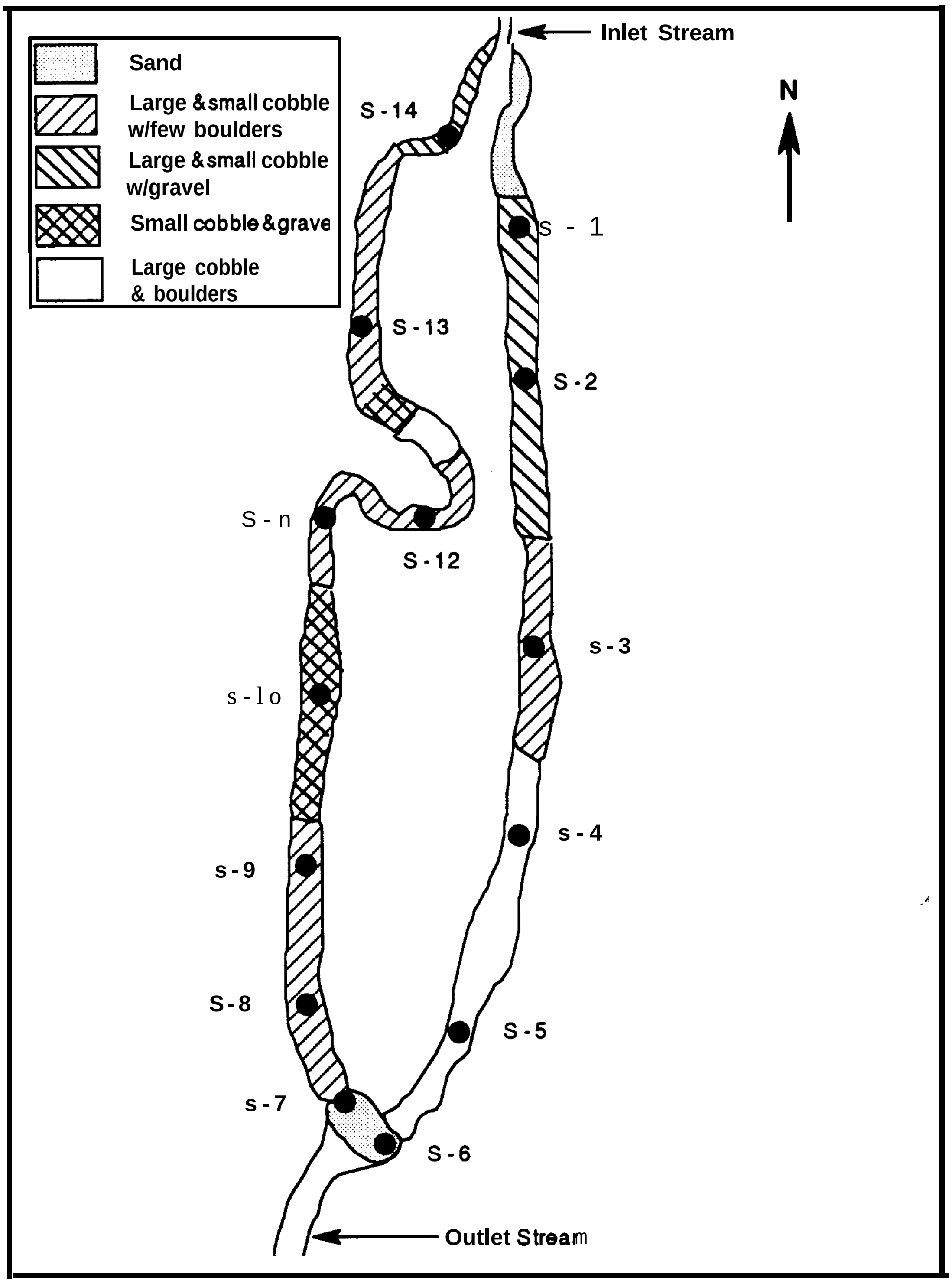

Figure 2. Sampling sites and lake shoreline substrate type, Kuuqutiga Lake.

Table 1. Measurements (cm) of lake shoreline substrate, 30 August 1991. Each average represents measurements of 10 representative rocks within a 2 m^2 sample site. Rocks were measured to the nearest cm along their longest axis.

Site No.	Average	Minimum	Maximum
1	34.9	24	59
2	19.8	14	31
3	28.9	19	50
4	47.2	32	64
5	53.4	19	121
6	Mostly sand with some small cobble		
7	Sand		
8	38,7	23	69
9	61.5	30	127
10	Gravei		
11	46,3	28	67*
12	30.6	15	49
13	34.2	25	56
14	24.1	8	40

* some vegetation
Gravei = less than 5 cm
Small cobble = 5-25 cm
Large cobble =25 -50 cm
Boulder = greater than 50 cm

Small char, from 2-5 cm long, were commoniy observed, singly and in small schools, in shallow shoreline regions. While no quantitative estimates of their abundance were possible, they appeared to be quite common. For example, from 10 to 30 small char were commoniy visible atone time at a number of locations and it was unusual not to observe small char at any site where visibility was good.

Kuuqutiga Creek

Kuuqutiga Creek flows from the lake (Plate 9) northerly for about 4-5 km to empty into a small bay (Plate 10) off Walker Arm. The stream consists of two reaches (Tables 2 and 3; Figure 3); the lowermost, Reach 1, is approximately 2.5 km long. This portion of the stream flows through a thick deposit of usually unsorted, unconsolidated glacial till (Plates 2b and 11). The stream in this region is actively eroding its banks and the stream valley is usually moderately incised with a relatively narrow bed, from 10 to 30 m in width (Plate 11). The streambed is normally composed of loose cobbles with occasional boulders and minor amounts of gravei. Soft substrates are uncommon and siit is rare. One unusual area in Reach 1 is at Point Sample Site 3, where the east bank consists of a steep slope, 75-100 m high, composed of sand and gravei (Plate 12).

flow in Reach 1 is typically swirling and broken (Plate 13) although severe rapids are absent. Weii developed pools are uncommon.

Reach 2 contrasts with Reach 1 in most characteristics (Tables 2 and 3). This portion of the stream is about 1.5 km iong and flows across a broad valley, 1–2 km in width. In this region, the stream banks are iow and stable, usually iess than 0.5 m high and the streambed is broad, 30 to 80 m in width (Plate 14), Banks are normally well covered with typical Arctic tundra vegetation. Stream gradients in Reach 2 are iow and large, shallow, sandy pools are common, Pooi areas are normally connected by broad, boulder-cobble portions of the streambed through which the stream percolates. The latter areas are severe hindrances to fish movements and are complete blocks to large fish in iow flow conditions. Except for sandy areas, the streambed is compact and loose rocks are uncommon. These conditions are developed by soft sediments filling interstices over long periods of time and “cementing” individual rocks into the surrounding substrate. Signs of overtopping of banks by freshets were absent in this region.

Table 2. Characteristics of Kuuqutiga Creek, northeastern Baffin Island,
of reaches and point sample sites.

Reach	Point Sample Site	Stream Width (m)	Maximum Water Depth (m)	Water Temp. (°C)	Clarity	Flow Charact
1	1	10	0.30	4	Clear	Rolling a broken
1	2	35	0.35	4	Clear	Broken
1	3	18	0.15	4	Clear	Placid-swirling
1	4	8	0.24	4	Clear	Rolling a broken
2	5	65	0.31	4	Clear	Placid
2	6	80	0.18	4	Clear	Placid
2	7	36	0.35	4	Clear	Placid-swirling

Table 3. Summary of reach characteristics of Kuuqutiga Creek.

Reach	Percentage Pools	Flow	Stream Channel and Banks	Stream Valley
1	< 5%	Rapid	Mostly unstable	Narrow-incise
2	60-70%	Slow and placid	Stable	Broad (200-40 flat-bottomed

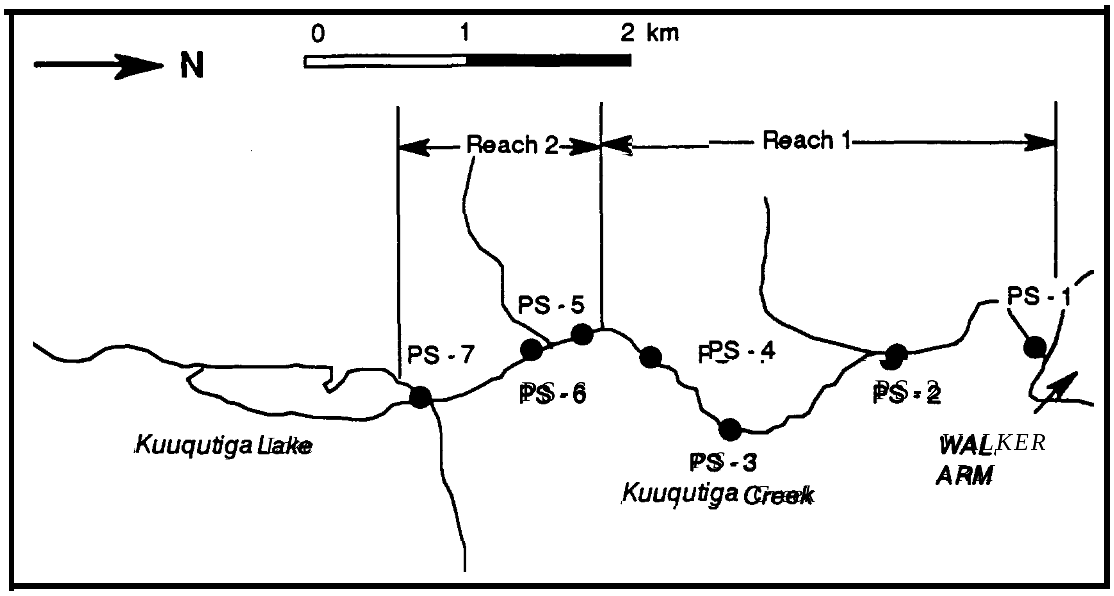

Figure 3. Reaches and point sample sites **(PS-#)** of **Kuuqutiga** Creek.

Stream Flow

Kuuqutiga Creek is a relatively small stream which, according to residents of the region, is nearly dry when freeze-up occurs. Spring run-off normally occurs slowly in the region, As a consequence, streams in the area, especially those with small drainages, are not characterised by severe flooding. **Kuuqutiga** Lake also undoubtedly **serves** to dampen stream discharge.

Water levels were recorded daily in **Kuuqutiga** Creek from 25 August to 4 **September** 1991. As shown in Table 4, water levels tended to decrease during this period as a direct response to colder air temperatures. This decrease represents the onset of freeze-up as run-off from higher elevations is sharply reduced due to freezing over most of a 24-hour cycle.

Table 4. Temperatures and water levels in Kuuqutiga Creek 25 August to 4 September 1991.

Date	Temp (°C) at 9:00 a.m. Air	Temp (°C) at 9:00 a.m. Water	Water Level (cm)	Point Sample Site #
Aug 25	4	4	26	1
26	3	4	26	1
27	1	4	53	4
28	1	4	52	4
29	1	4	52	4
30	1	4	47	4
31	-0.5	3	46	4
Sept 1	0	3	43.5	4
2	3	4	41	4
3	6	5	43	4
4	3	5	42	4

Discharge (measured by timing the travel of an orange over a measured linear distance [in metres] and measuring the stream depth at 0.5 m intervals) on 4 September was estimated to be 0.686 m^3 /sec. Direct extrapolation to the higher water level on 27 August suggests a discharge of 0.866 m^3 /see on that date.

STREAM CHANNEL IMPROVEMENTS

Reconnaissance of Kuuqutiga Creek indicated that three areas (Point Sample Sites 5, 6 and 7) in Reach 2 were potential blocks to migrating sea-run Arctic char depending on water level. The lowermost (Point Sample Site 5) and most severe is well known to local residents of the region and was of most concern. The following sections of the report describe these problem areas and the improvements that were performed in each area. All improvements were by hand or with hand tools.

Site 5

Site 5 is located about 100 m above the reach break between Reach 1 and Reach 2 (Figure 3). The streambed in this region is wide, over 60 m in many areas, and is composed of small boulders and cobbles of various sizes. Within the broad streambed there is no defined channel and the water flows over or between the rocks, depending on stream discharge and exact elevations. The severest barrier to fish migrations consists of a small shelf of boulders and cobbles which forms a short (30 to 40 m in length) area of slightly higher gradient. At this point, the stream percolates between boulders and cobbles and much of the flow is below the level of the boulder/cobble field (Table 5; Plates 15,16 and 19).

Stream channel improvements at Site 5 consisted of construction of a channel through the boulder-cobble field and the addition of a deflector wing leading to the mouth of the channel (Plates 17 and 18). The constructed channel was 36 m in length; width varied from about 0.75 *m* to 2.0 m (Plate 19). Depth of the channel averaged 35.6 cm (20–50 cm) on 31 August 1991. The channel was broadly sinuous with numerous boulders left in the sides of the channel to create back-eddies and small areas of calmer water. Elevation change from the head of the channel to its tail was 21.5 cm, which approximates a drop of 0.60 cm over 1 m (an average gradient of 0.60%).

Table 5. Water depths (cm) at 1 metre intervals across streambed transects and in constructed channels at Site 5 on 31 August 1991.

West to East Transect 1			West to East Transect 2		Max, Depth in Channel Proceeding Downstream	
start			start		start	
o	26	o	0	0	39	37
0	0	0	0	0	43	36
0	0	0	0	0	29	35
0	0	0	0	0	34	40
1	15	“ o	o	0	38	31
0	12	1	0	0	29	40
10	8	0	0	0	29	39
0	9	End at 64 m	1	0	20	39
3	0		8	0	35	End at 36 m
3	3		0	2	27	
6	0		0	3	27	
0	0		0	0	40	
0	12		0	20	24	
0	0		0	6	44	
o	14		0	0	38	
0	0		0	0	50	
0	0		5	0	42	
0	31		0	0	31	
0	18		12	0	27	
0	0		0	0	64	
0	0		0	0	49	
0	10		0	0	36	
7	8		0	0	36	
0	19		0	0	26	
1	5		0	0	38	
18	4		0	0	34	
20	5		0	End at 55 m	30	
0	3		o		34	

A 25-m long deflector wall was constructed of cobbles and small boulders along the eastern side of the streambed, diagonal to stream flow. The downstream end of this wall connected to the upper portion of the channel and directed water into the channel,

Site 6

Site 6 is located approximately 0.5 km upstream of Site 5 (Figure 3 and Plate 14). In this area, the wetted channel is very broad (i.e., 80 m) and flow is over or between boulders and large cobbles (Table 6). Several low vegetated islands, which appear to be stable, are present in the area. Although water depths in this area were greater and hindrances to fish movement were less severe than at Site 5, low water conditions could also limit fish movement in this region.

Channel improvements at Site 6 consisted of construction of a long (90 m) channel and an equally long deflector wall. The latter structure began on the eastern bank of the stream and extended diagonally across the streambed for 95 m (Plates 20 to 23). The potential existed for some fish to move upstream and become trapped behind the deflector wall; hence a gap was left in the structure near the eastern bank to permit fish movement (Plate 21). The deflector wall was quite effective in diverting water from the eastern portion of the streambed into the 90 m long channel that was constructed immediately downstream.

The constructed channel consisted of two basically straight portions connected by a 25 to 30° bend. Flow in the channel was basically short riffles interrupted by numerous small boulders, which created eddies and small pools. Average depth in the channel was 35.4 cm with minimum and maximum depths at 22 cm and 52 cm, respectively. Elevation change from the head to the tail of the channel was 88.5 cm, for an average gradient of about 0.98%.

Table 6. Water depths (cm) at 1 metre intervals across streambed transects and in constructed channels at Site 6,2 September 1991.

East to West Transect 1			East to West Transect 2				Max. Depth in Channel Proceeding Downstream		
start			start				Start		
0	0	2	0	9	0	11	37	38	34
0	1	14	0	5	4	0	36	32	34
2	0	0	0	9	24	11	40	31	36
0	0	1	0	9	28	0	39	29	27
5	1	0	0	0	8	8	36	32	36
12	0	0	1	0	0	1	40	26	38
2	0	0	9	13	0	0	37	24	28
8	5	End at 78 m	12	0	0	0	34	32	44
12	0		8	0	5	0	38	25	50
0	1		8	12	8	0	22	26	46
15	0		20	0	2	1	38	29	30
6	0		5	7	9	0	33	33	52
0	0		11	4	7	0	40	29	53
5	0		8	9	1	0	31	30	37
3	0		0	12	10	0	37	28	33
13	5		9-mwide	13	7	End at 94 m	34	36	32
0	0		island	8	0		37	49	38
7	15		o	3	14		36	30	46
5	8		2	27	14		34	32	End at 90 m
7	6-m wide island		23	10	7		48	40	
9	0		0	19	0		35	29	
0	4		0	2	10		33	34	
6	0		1	0	0		30	36	
5	0		0	30	4		36	29	
0	0		0	12	5		33	40	
0	4		0	13	3		42	31	
0	0		12	19	0		35	40	
10	5		0	5	8		32	39	
18	0		0	18	0		32	38	
0	0		0	5	3		39	43	
0	0		5	0	3		38	45	
1	2		6	0	7		26	37	
3	0		1	0	15		32	35	
1	0		15	0	8		32	45	
0	1		0	0	0		39	27	
0	0		4	0	2		31	40	

Site 7

Site 7 is located 50 m downstream of Kuuqutiga Lake (Plate 24). In this region, the stream again enters a cobble-boulder field from 40 to 70 m wide (Table 7), which forms a broad fan before emptying into a large shallow sandy pool (Plates 25 to 27). Water flow through this region is broken into many small rivulets which flow between boulders and cobbles even during periods of moderate high water levels. Iqarialu (pers. comm.) has observed fish stranding in this area during their downstream migration in mid-June. Observations suggest that the fish have difficulty in locating the best area for downstream passage and become stranded, especially in the eastern portion of the boulder-cobble field.

An 85-m long channel was constructed through the problem area in the western portion of the streambed at Site 7. Channel width was normally from 50 to 150 cm and average depth was 32.0 cm on 29 August 1991 (Table 7). Elevation change in the channel was 124 cm for an average gradient of 1.45%. Flow in the channel was mostly unbroken riffles with numerous back-eddies and small pools. A deflector wall, 65 m long, was constructed diagonally, partially across the eastern portion of the streambed to divert water into the channel. It is hoped that this wall should also aid downstream-migrating fish in finding the entrance of the channel.

Most of the channel at Site 7 was constructed 25 to 27 August and depth measurements in the channel on 29 August represent a period of at least moderate flow. After the considerable decrease in stream flow in early September (Table 4), flow in the recently constructed channel was considerably reduced-spot measurements in shallowest portions of the channel revealed water depths of less than 10 cm (Plate 27). As a consequence, additional work to deepen the channel was performed on 3 September (Plates 27 and 28).

Table 7. Water depths (cm) at 1 metre intervals across streambed transects and in constructed channels at Site 7,29 August 1991.

East to West Transect 1	East to West Transect 2		East to West Transect 3		Max. Depth in Channel Proceeding Downstream		
start	start		start		start		
0	0	0	0	19	29	23	38
0	9	0	0	0	23	42	32
0	8	5	26	0	29	48	41
0	4	2	0	14	19	49	40
0	0	0	0	16	24	45	38
0	0	9	4	15	23	41	38
10	0	0	0	0	30	18	32
5	0	0	10	0	25	24	35
0	9	0	10	0	27	42	30
8	0	2	9	2	21	32	28
0	5	0	10	0	35	26	30
15	0	0	20	7	30	42	End at 85 m
8	0	0	18	0	23	40	
0	0	0	10	0	38	49	
2	3	0	11	9	33	30	
10	9	0	14	0	41	24	
0	0	End at 55 m	6	0	35	38	
19	25		0	0	22	38	
15	28		11	11	21	21	
33	9		8	7	30	36	
26	0		12	0	33	56	
2	3		1	0	25	34	
34	1		12	0	32	23	
33	40		11	8	32	39	
20	4		4	6	32	23	
24	35		20	0	25	34	
30	18		31	0	41	26	
26	0		28	3	39	27	
35	17		1	6	20	33	
23	18		9	0	29	30	
23	0		0	End at 67 m	29	27	
10	32		8		44	40	
10	0		3		28	28	
0	23		0		18	32	
0	2		23		33	23	
0	0		0		29	35	
End at 36 m	0		6		35	34	

MONITORING OF FALL FISH MIGRATIONS

Counts of upstream migrating char were proposed to be obtained during this study. To this end, a fish trap, composed of a partial rock wall across the stream and a trap constructed of 2" X 4" panels covered with 1/4" mesh hardware cloth, was installed in the stream from 25 to 27 August. The trap was checked daily but no char, other than the stream-rearing juveniles, were present in or near the trap. No large char were observed during a reconnaissance of the entire length of Kuuqutiga Creek on 25 August.

Two char, approximately 30-40 cm long were observed immediately downstream of the cobble field barrier at Site 5 on 25 August. Another char of similar size was seen in the same area on 27 August. These fish were likely late sea-run migrants with their further upstream movement blocked by low water flow through the cobble field barrier at Site 5.

On the basis of the above information, it was concluded that the fall migration of Arctic char in Kuuqutiga Creek had proceeded upstream before initiation of our work in the system on 24 August 1991.

DISCUSSION

Stream Improvement

Background

To our knowledge, the present initiative is the only organized and reported attempt to improve migratory passages for Arctic char in the N.W.T. This is unfortunate, because we believe that Arctic char have difficulty in successfully completing their migrations in a considerable number of areas in the Clyde River region on Baffin Island, and throughout the Northwest Territories. In many cases, waterfalls and rapids are complete barriers to upstream char movement. If such barriers were removed, sea-run populations of Arctic char would undoubtedly develop in the systems if sufficient spawning and overwintering habitat were present upstream of the barrier.

The Makivik Corporation has sponsored a moderately large program to improve channels for Arctic char migrations in northern Québec (Dumas 1990). Over a five-year program, 37 rivers were identified where upstream fish passage needed improvement. Work was performed in five of the drainages; this consisted of building deflector walls and deepening stream channels with hand tools as in the present study. Two of the systems were revisited and it was found that high water in spring had greatly reduced the effectiveness of channel improvements. Repeated maintenance of constructed channels and deflector walls is obviously necessary in such systems. No attempts were made within the program to monitor the effects of channel improvements on sea-run Arctic char populations.

Kuuqutiga Creek

It is thought that Kuuqutiga Creek might be an ideal system as a pilot project to determine the effectiveness of channel improvements on a sea-run Arctic char population. Such information would be new to the scientific community, as well as to local residents. The system has the following attributes:

1. small drainage area where spring floods and summer periods of high water are believed to be minor events;

2. the stream substrate where barriers occur is large cobble and small boulders, giving constructed channels and deflector walls stability;

3. small size of the system facilitates monitoring numbers of migrating char; and

4. remoteness of the region discourages fishing activities which would complicate monitoring studies.

Work completed in 1991 (this study) is thought to be effective in "removing" the physical barriers to Arctic char migrations in Kuuqutiga Creek. Minor improvements may be necessary after the spring-summer break-up of 1992 when small movements in the recently constructed channel muld occur. In addition, observations of fish use of the improved channels would be valuable to determine if migrating fish have difficulty in locating channel entrances during both upstream and downstream migrations. In this particular instance, facilitation of the downstream migration may be especially important, especially at Site 7.

Monitoring Sea-run Arctic Char in Kuuqutiga Creek

As previously stated, the 1991 fall upstream migration of Arctic char in Kuuqutiga Creek had obviously been completed by late August. Future attempts to monitor the fall migration should be timed earlier in the season, no later than early August.

The exact timing of Arctic char migrations varies with geographic region and specific characteristics of each drainage. Without previous information, accurate predictions cannot be made with certainty. In addition, timing of migrations can vary annually because of differences in water levels which are, in turn, affected by local precipitation and air temperatures, In 1991, mid-August was characterised by a considerable amount of rain which raised water levels to abnormal heights (pers. ohs.; Dan Pike, DFO, Iqaluit, pers. comm.). Arctic char in Kuuqutiga Creek, as well as in other areas affected by this rainfall, could have taken advantage of this freshet to complete their fall migration at a somewhat earlier date than normal.

Timing of Arctic char migrations rivers and streams in the N.W.T. is poorly known because only a few systems have been systematically studied (Table 8). The most detailed information on Arctic char biology, including migrations, has been collected in the central Arctic on the Kent Peninsula (Nauyuk Lake and River) and reported by Johnson (1980, 1989), Intense studies revealed that migrants were segregated into size groups as follows:

1. largest fish move downstream first-normally between 16 to 22 June;
2. intermediate-sized fish move downstream from late June to mid-July;
3. the smallest size group, smelts with a modal size of about 22 cm, move downstream in a brief 4-5 day period in mid-July;
4. upstream migrants of all sizes (except smelts) moved together from about 1 to 26 August; and
5. returning smelts moved upstream together normally from late '-- August to mid-September.

It is felt that migrations in Kuuqutiga Creek are likely to be much more contracted than those reported by Johnson (1980) or Hunter (1976), simply because the stream becomes completely impassable after the onset of freezing weather in early September.

Table 8. Timing of Arctic char migrations as reported by scientific investigations.

	D	m Do m	m	th	
Cumberland Sound Baffin Island	Unnamed	Starts in mid-May; completed in 2 weeks	Begins 7-14 August; completed in 5-6 weeks	Moore 975	Move downstream, sometimes over river ice
Western Arctic	Firth River	13-` 5 June	30 Aug to 21 Sept	Glova and McCart 1974	
Central Arctic	Creswell Bay	Not reported	Peak 17 Aug to 2 Sept 1976; peak 10 Aug 1975	de March et al. 1978	Varies annually by at least 2 weeks
Central Arctic, Kent Peninsula	Nauyuk Lake	4-week period, mid-June to mid-July	early Aug to mid-Sept	Johnson 1989	Varies annually by 1 or 2 weeks, normally peaks in late June and mid-August
Alaska	Ivishak R	Not reported	Spawners peak 21 Aug, non-spawners peak 1-6 Sept	Yoshihara` 974	
Alaska	Lupine River	Not reported	Spawners peak 25 Aug, non-spawners peak 2-4 Sept	Yoshihara` 974	
Eastern Arctic	Sylvia Grinnell	early to mid-June	mid-Aug to late Sept	Hunter 1976	

Factors to Consider in Design of Monitoring Programs

Because the life history and movement patterns of sea-run Arctic char are complex (Johnson 1980; McCart 1980; Sekerak 1990), design of monitoring programs to document changes in the distribution and abundance of the population is not as straightforward as might first appear, The following factors could be pertinent to monitoring in Kuuqutiga Creek:

1. relatively distinct populations of resident Arctic char normally reside in lakes along with sea-run populations;
2. sea-run char in Arctic latitudes do not spawn every year; spawning every second or third year is normal;
3. non spawners may "stray" into other systems to overwinter;
4. most spawners will return to their birthplace;
5. spawners of any particular year normally remain in fresh water for at least that year; they do not go to sea;
6. smelts are normally from 3 to 7 years of age;
7, maturity is attained relatively late in life—first-time spawners are 6 to 10 years old; and
8. juvenile char in their freshwater habitats are normally mixtures of unknown proportions of resident and sea-run char.

Due to the above factors, it is obvious that runs in any particular year are composed of individuals that were born in the drainage and others which are residing in the system, probably on a temporary basis. Because factors governing the number of emigrants and immigrants are largely unknown, changes in the total numbers of migrating fish may or may not reflect changes in the population of sea-run char native to a particular system. In addition, because recruitment to the population as smelts or adults takes considerable periods of time, the effects of habitat enhancement will also take a considerable length of time to be transmitted to the migrant population. For example, if the improved channel in Kuuqutiga Creek results in decreased mortality in 1992, the following scenario can be hypothesized:

1. decreased mortality in 1992 leads to an increased number of spawners in 1993;

2. increased spawning in 1993 leads to increased numbers of young-of-the-year (YOY) in 1994; and

3. increased numbers of YOY in 1994 results in increased numbers of smolts beginning in 1997 at the earliest.

Results are, of course, more immediate at the individual level. Decreases in mortality during migration results in more individuals being available for reproductive processes, for harvesting, or as prey for predators. Johnson (1 980) and Moore (1 975) believe that mortality of adult char due to predation is extremely iow or non-existent in most Arctic drainages, and that most char die of old age or as a result of spawning. Consequently, most if not aii of the additional char individuals saved by channel improvement should be available for harvesting or reproduction.

It is aiso obvious from the above information that:

1. monitoring juvenile char in their freshwater habitats may not be appropriate to document changes in the sea-run population, since the former are mixtures of land-locked and sea-run populations;

2. monitoring total numbers of char may aiso not be appropriate, because runs are composed of fish native to the drainage and immigrants, most of which wiii use the system for 1 or 2 years before departing;

3. monitoring the numbers of smolts and/or post-spawners in downstream runs may be the most appropriate and easiest way to measure changes in the sea-run population in a particular drainage; without iong-term tagging studies, these fish are the oniy members of the "run" which can be positively identified as being part of the breeding sea-run char population of the drainage.

Social Benefits

Problems of fish passage in Kuuqutiga Creek were well known to a number of residents of Clyde River. Seeing or hearing about stranded, dying fish in the system resulted in the selection of this area as the first priority for enhancement work during development of the community fish enhancement plan (Sekerak et al. 1991).

The stream channel improvements performed in 1991 could be considered premature from a scientific point of view, because it is normally best to gather a good foundation of basic knowledge before changing a system so that the effects of changes can be documented easily and fully at a later date. However, such studies are time-consuming and beyond the abilities and resources of residents. They are also normally the responsibility of government agencies to perform or contract. Our discussions with numerous government agencies, both at the federal (Fisheries and Oceans Canada, Indian and Northern Affairs Canada, Environment Canada) and territorial level (Department of Renewable Resources, Department of Economic Development and Tourism, Science Institute of the N.W,T.) indicated that they were not prepared to perform or support years of study to obtain basic information in the case of Kuuqutiga Creek. As a consequence, a small-scale, one-year program was proposed and supported by a number of agencies and was performed in 1991.

While it is difficult to measure social benefits, it is obvious that development of the fish enhancement community plan in Clyde River and performance of this project has:

1. introduced the topic of resource enhancement—a new concept to most residents of Clyde River;
2. provided an opportunity for community participation in renewable resource management
3. helped in the development of a conservation and management ethic in residents of the Clyde River area; and

4. provided significant economic benefits to the community through the purchase of goods and services and employment of local people.

Most experiences in community resource management and conservation have eventually led to proposed or real constraints and limitations in the form of quotas for certain species or changes in preferred hunting patterns. Although necessary, these experiences can, and in many cases do, develop negative feelings in participants and residents. In contrast, the approach demonstrated by our studies tends to foster positive feelings while, at the same time, instilling in participants the desire to ensure that renewable resources are wisely used and perpetuated. It is felt that the latter is a social benefit of immeasurable value. To this end, we will pursue this and other programs which will benefit the residents of Clyde River and the renewable resources upon which they depend.

RECOMMENDATIONS

The following recommendations recognise that the present report and initiative forms only part of a much more broadly-based initiative to enhance fish populations in the Clyde River area.

1. A detailed proposal and plan should be developed for further work in Kuuqutiga Creek. This should include observations of stream improvements to determine their durability, to perform minor repairs if necessary and to obtain the necessary data to assess changes in the sea-run char population.

2. Plans should proceed to establish a new population of sea-run Arctic char in the previously identified drainage emptying into Inugsuin Fiord. To our knowledge, this has never been previously performed for Arctic char although the technique has worked in hundreds of cases with other migratory fishes.

3. Investigations should proceed on how to make Ayr Lake accessible to sea-run Arctic char. Development of a sea-run char population in Ayr Lake has the potential to increase sea-run char production in the Clyde River area several times over the present production of char in all nearby areas combined. Economic benefits of this project would dwarf other identified opportunities. This project would, however, be costly and the effectiveness of techniques should first be demonstrated in other systems.

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