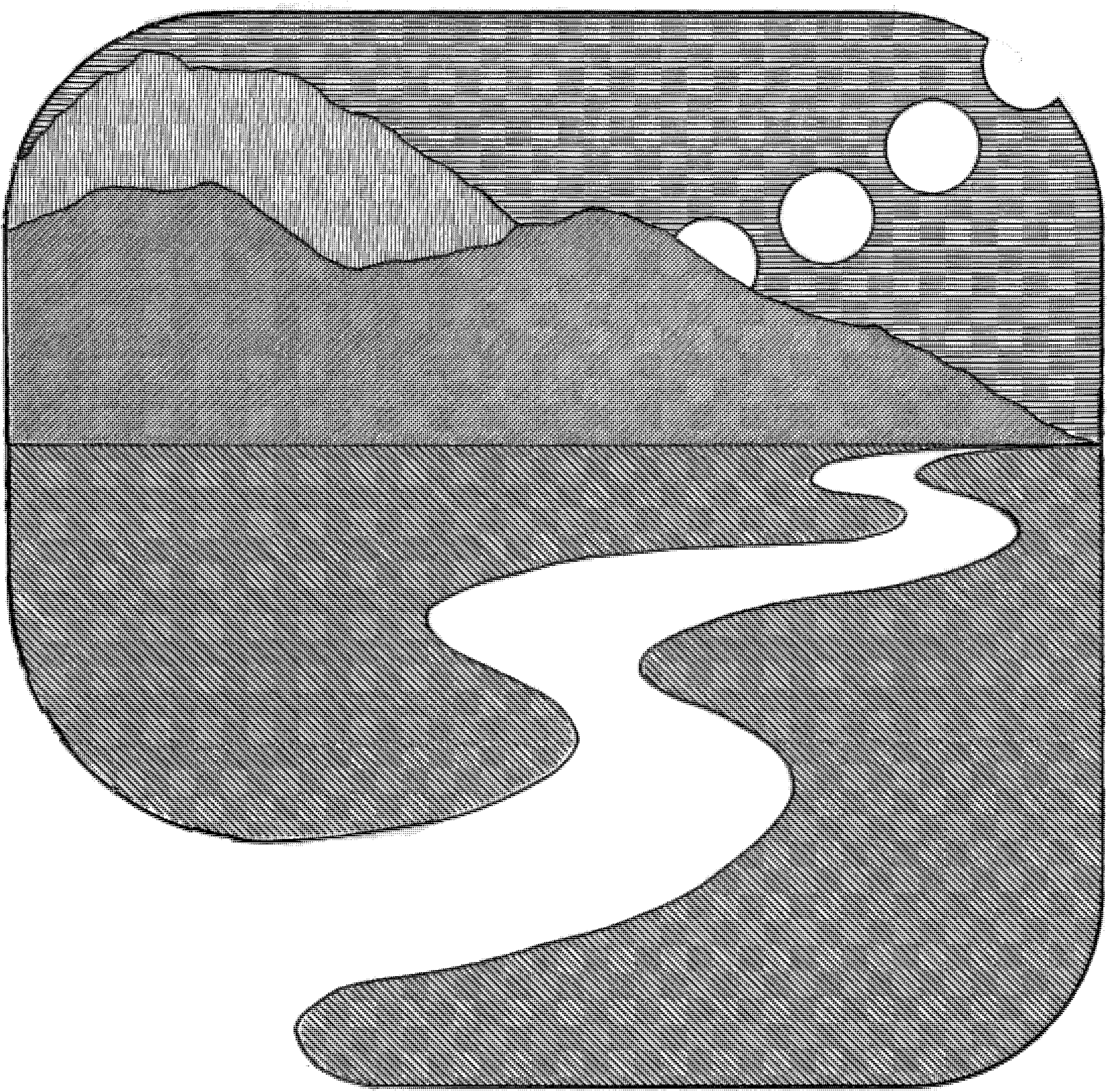
Life History and Habitat Utilization of Arctic Grayling (Thymallus arcticus) in Two Central Yukon Drainages

Project Report :
Fisheries No. 8

YUKON RIVER BASIN STUDY

This project was completed for the Yukon River Basin Study, an intergovernmental study funded by the governments of Canada, Yukon and British Columbia.

Yukon
Department of Renewable Resources



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Life History and Habitat Utilization of Arctic Grayling (*Thymallus arcticus*) in Two Central Yukon Drainages

by:

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November, 1983

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TERMS OF REFERENCE

This study is Project 60 of the Yukon River Basin Study. The terms of reference, as outlined in the Project Description, are as follows:

PROJECT DESCRIPTION:

Collect information on grayling spawning, movements, and habitat utilization to help refine a stream habitat evaluation methodology. This would include:

a) Collection of data on timing and location of grayling spawning, substrate utilization, and incubation period on sample streams in the Mayo area.

b) Collection of data on fish movements in sample streams in order to determine timing and relative numbers of fish utilizing different stream types.

c) Collection of age and growth information incidental to the above work.

ABSTRACT

A study to investigate the life history and movements of Arctic grayling (Thymallus arcticus) was carried out in the Stewart River drainage near Mayo, Yukon during spring and early summer, 1983. Grayling movements and spawning utilization were monitored in two tributaries in the South McQuesten and one tributary to the Mayo River as well as in the mainstems at the mouths of these streams.

No grayling spawning was detected in the smaller tributaries during the study. Spawning appeared to occur in both mainstems at approximately the same time and water temperature. Spawning began about May 15 at a water temperature of 5°C. and ended approximately May 31.

Very large numbers of grayling of all age classes migrated into a South McQuesten River tributary from the mainstem throughout June and early July. Over 1000 adult and sub-adult grayling (i.e. >approximately 200 mm) were captured while moving upstream at a weir on Lynx Creek during this period. A summer rearing population of approximately 11,000 grayling was estimated for an 18 km section of Lynx Creek from mark-recapture data.

Grayling from the Mayo River population were significantly larger than those from the South McQuesten population for a given age class. Growth in South McQuesten fish was slow, especially for ages 1-3 years. The maximum observed age for South McQuesten grayling was 15 years. Grayling matured first in both areas at age 5. The majority of fish were mature at age 6 in the Mayo population and at age 7 or 8 in the South McQuesten population.

ACKNOWLEDGEMENTS

The author wishes to acknowledge: Kevin Onclin for his assistance and enthusiasm in carrying out the field work; Clive Osborne and Dan Davies, who also assisted in data collection and preparation; Gordon Ennis, Gerry Whitley, and especially Gordon Hartman who reviewed the manuscript and contributed valuable comments and suggestions.

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1.0 INTRODUCTION

Fish distribution, habitat description, and habitat evaluation data were collected for portions of the Stewart River drainage, near Mayo, Yukon, in 1982 as a part of Yukon River Basin Study Fisheries Project No. 3 (Pendray 1983). Arctic grayling, (Thymallus arcticus) were found to be the predominant freshwater sport fish species present in the streams of this area and are the species most frequently affected by placer mining and related activities.

There is a general lack of information concerning grayling life history and patterns of movement within the Yukon River Basin. This information is necessary to more accurately determine the impacts of all types of resource development on grayling populations.

The purpose of this study was to improve our understanding of grayling spawning timing, movement patterns, and habitat utilization for spawning and summer rearing in the central Yukon area.

The study was necessarily somewhat limited in scope and duration due to constraints in report timing and funding. This work should, therefore, be viewed as a contribution toward future, more extensive study.

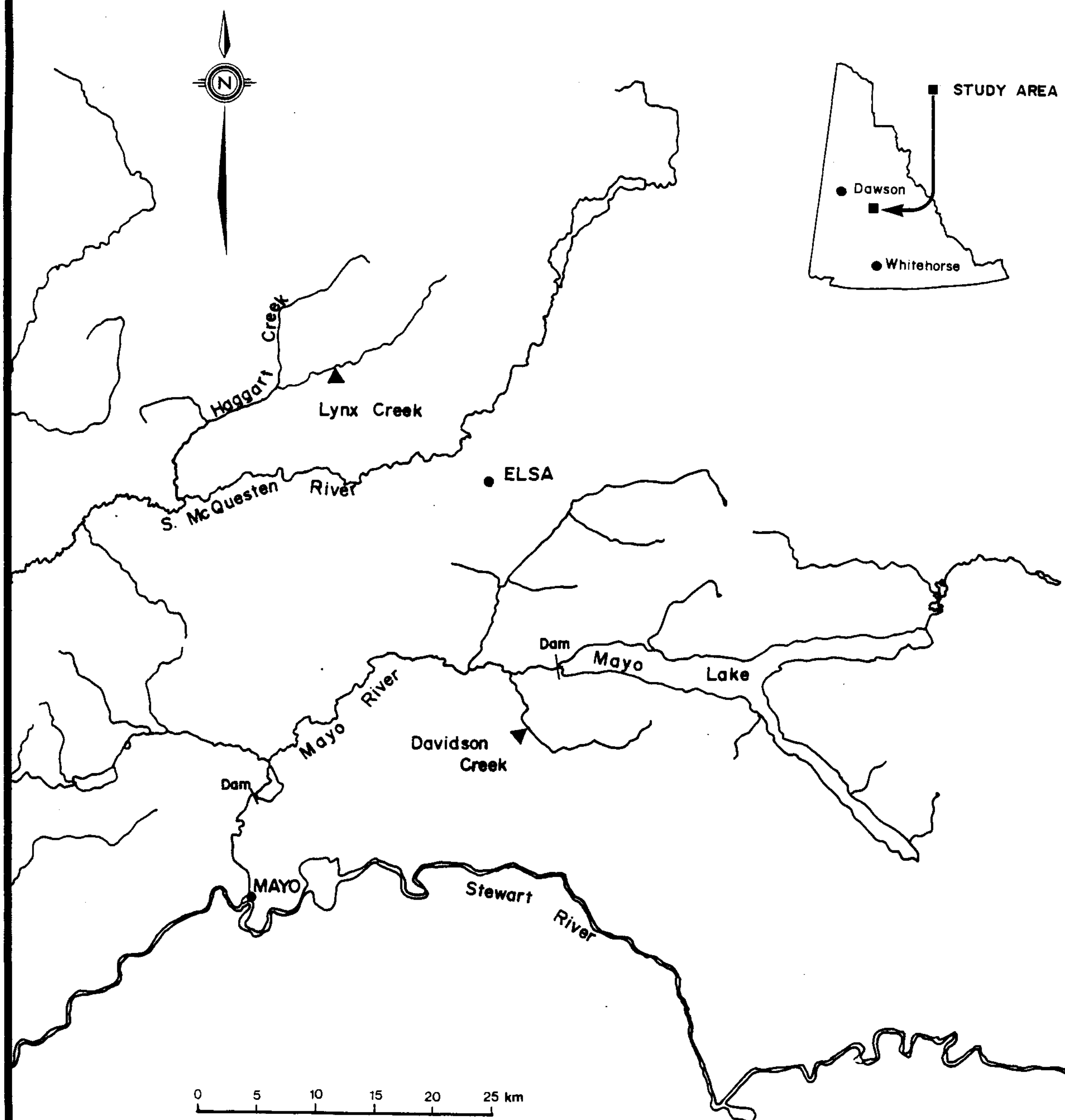

FIGURE 1. Key map of study area showing location of Lynx and Davidson Creeks.

2.0 STUDY AREA

The study was carried out in the McQuesten and Mayo River drainages north of Mayo, Yukon.

The principal study site was Lynx Creek, a tributary to Haggart Creek and the South McQuesten River. Supplemental observations were also made on the Mayo River system at Davidson Creek (see Figure 1).

These streams were chosen because they met the following criteria:

1. small enough to permit effective fish sampling, including the possible installation of a counting weir;
2. reasonable access to a potential weir site;
3. inventory information documenting previous grayling use of the stream.

Lynx Creek flows into Haggart Creek approximately 20 km upstream from the South McQuesten River (see Figure 2). Haggart Creek enters the South McQuesten River 135 km upstream from the Stewart River and 75 km below McQuesten Lake.

Lynx Creek has a total length of 22.5 km and drains an area of approximately 100 km^2. The creek occupies a fairly broad, gently sloping valley with a NE-SW orientation. The lower reaches (Reaches 1 and 2 on Figure 2) have low gradient (0.85%), a large percentage of pool/glide habitat (60-70%), and an average wetted width of 5-6 m. Streamflows in 1983 were estimated to be 3.4 CMS during high flows in May and were

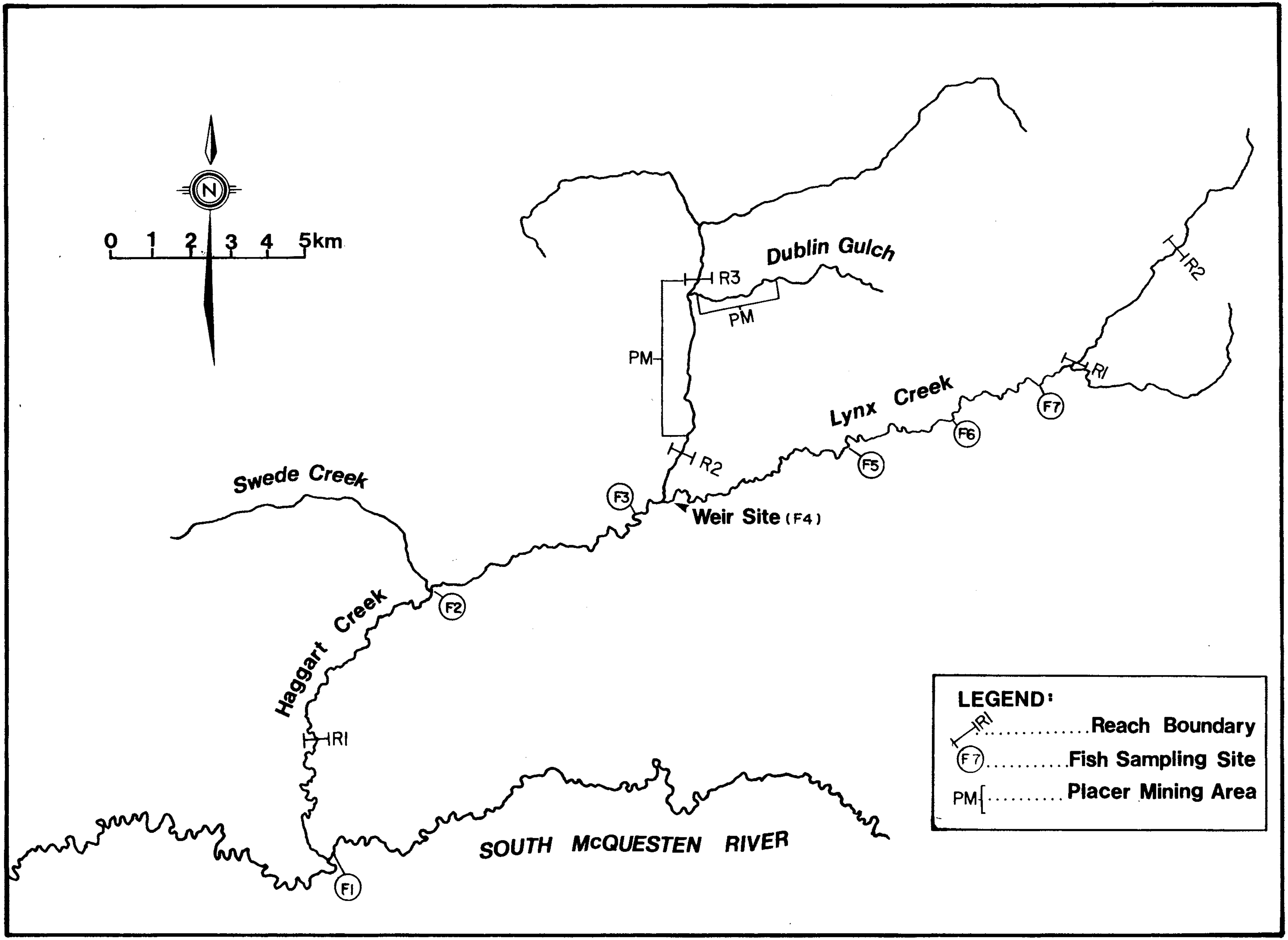

Figure 2. Key map of South McQuesten River area showing location of Lynx Creek weir.

undoubtedly greater at their peak. Summer low flows were estimated at approximately 0.5 CMS. Water temperatures ranged from less than 1°C in early May to a maximum 11°C in late June.

The lower reaches of Haggart Creek also have low gradient (0.5%), but the stream channel is generally wider and shallower than Lynx Creek. The habitat is mainly riffle and shallow glide. The average wetted width is 8-10 m.

Portions of Haggart Creek (especially above Lynx Creek) have had extensive channel alterations due to placer mining activity. Lower Haggart Creek shows distinct signs of channel instability (ie. rapidly shifting bars and channel configuration) due to the addition of bed materials. Current placer mining occurs in Reach 3 and Dublin Gulch (see Figure 2). Water turbidity (and related suspended sediment loads) were frequently high in Haggart Creek, depending on upstream placer mining activity and runoff events. Suspended sediment levels were monitored periodically in 1983 and were measured as high as 2080 mg/l in Haggart at Lynx Creek.

In contrast, Lynx Creek, which has no placer activity, appears to have stable channel characteristics. Turbidities were generally very low and increased only slightly during peak runoff and rainfall events. The maximum suspended sediment level measured in Lynx Creek in 1983 was 12 mg/l during runoff in May.

Summer water temperatures in Haggart Creek were significantly higher than in Lynx, probably due to the infusion of warm water from placer settling ponds. The maximum temperature recorded in Haggart Ceek at Lynx Creek was 18°C in 1983.

The South McQuesten River near the mouth of Haggart Creek has very low gradient (0.1%). The average wetted width is approximately 25 m. Summer water temperatures are consistently quite high in this system - averaging 18°C in early July, 1983. There is a large pool immediately upstream from the mouth of Haggart Creek which is known to be used as overwintering habitat for grayling (local residents, pers. comm.).

Four fish species have been captured in Lynx Creek: Arctic grayling; round whitefish (Prosopium cylindraceum); burbot (Lota lota); and slimy sculpin (Cottus cognatus). Fish sampling conducted in 1982 suggested that grayling were particularly abundant in Lynx Creek during summer. In addition to the above species, northern pike (Esox lucius) were captured in the South McQuesten River and may be present in lower Haggart Creek. Longnose suckers (Catostomus catostomus) are probably also present in the South McQuesten and possibly lower Haggart. Chinook salmon (Oncorhynchus tshawytscha), which are present in the McQuesten River, may travel upstream into the South McQuesten River, but none were sampled or observed in 1982 or 1983.

Davidson Creek enters Mayo River 3 km downstream from the dam at the outlet of Mayo Lake (see Figure 1). The creek has a total length of 21.1 km and drains an area of 95 km^2. Unlike Lynx Creek, which has a relatively even gradient, Davidson Creek has a series of gradient "breaks" as follows: Reach 1 (3.1 km) @ 1.2%; Reach 2 (6.0 km) @ 2.9%; Reach 3 (4.7 km) @ 0.5%; Reach 4 (1.9 km) @ 6.1%. The overall gradient is 2.1%. The lower reaches have an average wetted width of 5-6 m. Stream flow was estimated at 3.9 CMS during the spring high flow period. Summer low flows are likely less than 0.5 CMS. There has been some placer mining activity in Reach 2 of Davidson Creek, although channel alterations are not extensive.

Mayo River at the mouth of Davidson Creek has an average wetted width of approximately 35-40 m. The flow is generally swift, but there is a large low gradient area 200 m upstream from Davidson Creek which likely provides good overwintering habitat for grayling. Streamflow and water temperatures in Mayo River are undoubtedly moderated by the presence of the Mayo lake just upstream.

Grayling were captured in small numbers in Reaches 1 and 2 of Davidson Creek in 1982. No fish were found above Reach 2. No other species were captured in Davidson Creek, although slimy sculpins are probably present. Grayling, round whitefish, burbot, northern pike, sculpins, and probably longnose suckers are present in Mayo River.

Both grayling populations for which observations were made (ie. the South McQuesten/Lynx Creek population, and the Mayo River population) would appear to be exclusively stream-dwelling populations. The dam at the outlet blocks access to Mayo Lake for upper Mayo River fish and there are no lakes in the immediately area of Lynx Creek.

3.0 METHODS

Fish sampling to detect spawning grayling and grayling movements in the two study areas was begun on May 3, 1983 and was carried out over the following periods: May 3 - 5; May 11 - 19; May 25 - 31; June 7 to July 6; and August 31 - September 1.

A variety of fish sampling methods was used, depending on the habitat and streamflow conditions. Electrofishing (Smith-Root type VIIIA), beach seining, and angling (spinners and flies) were carried out in all areas. A portion of the Mayo River was also surveyed by an observer using mask and snorkel to assess fish populations. Gillnets (2 and 2.5 inch mesh) were used in Lynx and Haggart Creeks and the South McQuesten River.

In addition, a weir with combination upstream/downstream fish trap was installed near the mouth of Lynx Creek to monitor fish movements. Construction of the weir was begun on May 11, but water conditions were not suitable for completion of the structure until June 8. The weir and trap were constructed with chicken wire (1 inch mesh) supported by 1/2" reinforcing bar and anchored with sandbags (see Plate 1). The weir was in place continuously from June 8 - July 6, but was breached on two occasions following rainfall events.

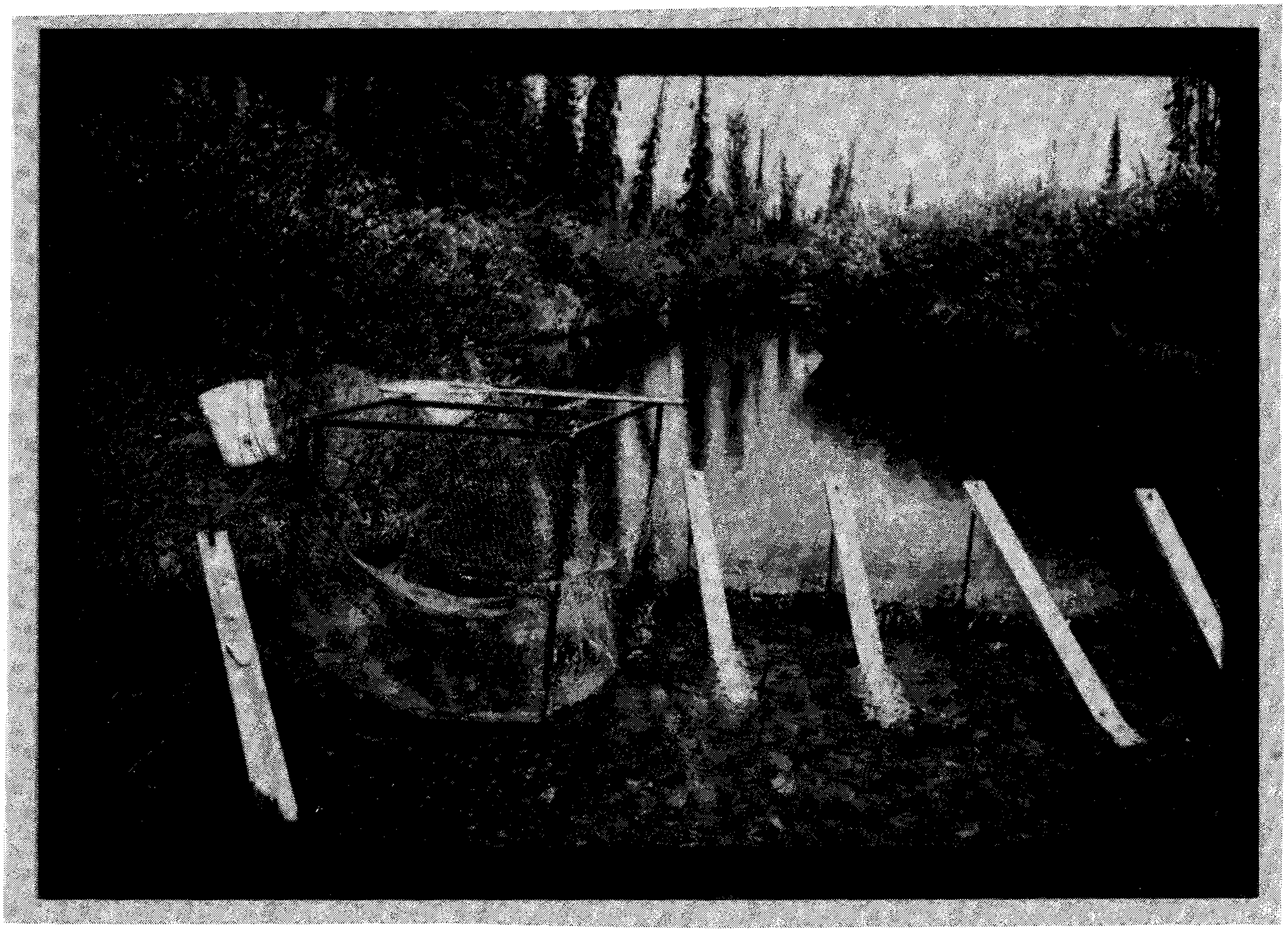

PLATE 1. Lynx Creek weir and fish trap - June, 1983.

During May and early June, a portion of the grayling sampled were sacrificed to determine sex and gonad maturity. The maturity of live grayling during this time period was described using these criteria:

Ripe - Fish in spawning colouration; eggs or milt expelled under gentle finger pressure.

Spent - Fish in spawning colouration; little or no sex products expelled; abdomen visibly sunken.

Immature - No spawning colouration apparent; no sex products expelled.

Fish captured by various sampling methods were tagged to provide additional data on movement patterns. Fish larger than approximately 180 mm fork length were tagged with Floy FD67 Anchor Tags (tube length 16 mm, overall length 32 mm) applied with a Floy Mark II tagging gun. Tags were inserted into the dorsal musculature at the base of the dorsal fin.

Scale samples were taken from all fish sampled in the Mayo River and South McQuesten River mainstems and a portion of those captured at the Lynx Creek weir. Scales were dry-mounted between microscope slides and read under magnification. Otoliths were taken from those fish which were sacrificed and were aged to compare with the scale results.

At the Lynx Creek weir, water temperatures and water levels were monitored during the sampling period. Water temperatures were measured with pocket thermometers. Water levels were recorded on a calibrated staff and were used as an indication of streamflow fluctuations.

Water samples were collected in Lynx Creek, Haggart Creek, Davidson Creek, and Mayo River and analyzed for pH, conductivity, nitrate nitrogen, nitrite nitrogen, and total phosphates. Lynx Creek and Haggart Creek were also sampled periodically for total suspended solids.

4.0 RESULTS AND DISCUSSION

4.1 Streamflow and Temperature Patterns

During the first week of May, 1983, ice was still present in the smaller streams (especially anchor ice), while Mayo and South McQuesten Rivers were mainly ice-free. Water temperatures ranged from 0.5° to 1.5°C in the smaller streams (Lynx, Haggart, and Davidson Creeks) to 3.0°C in Mayo River. Streamflows were low, and access to the smaller streams appeared to be blocked by ice.

By May 11, all ice was gone from Lynx, Haggart and Davidson Creeks, and flows had become very high. Streamflows remained high throughout the month of May, which made effective fish sampling and observation difficult.

Streamflows dropped rapidly during the first week in June. Flows remained fairly low for the rest of the observation period, with the exception of two major rainfall events on June 10 and 21.

Water temperatures remained higher in the mainstem rivers than in the smaller tributaries throughout the study period (see Figure 3).

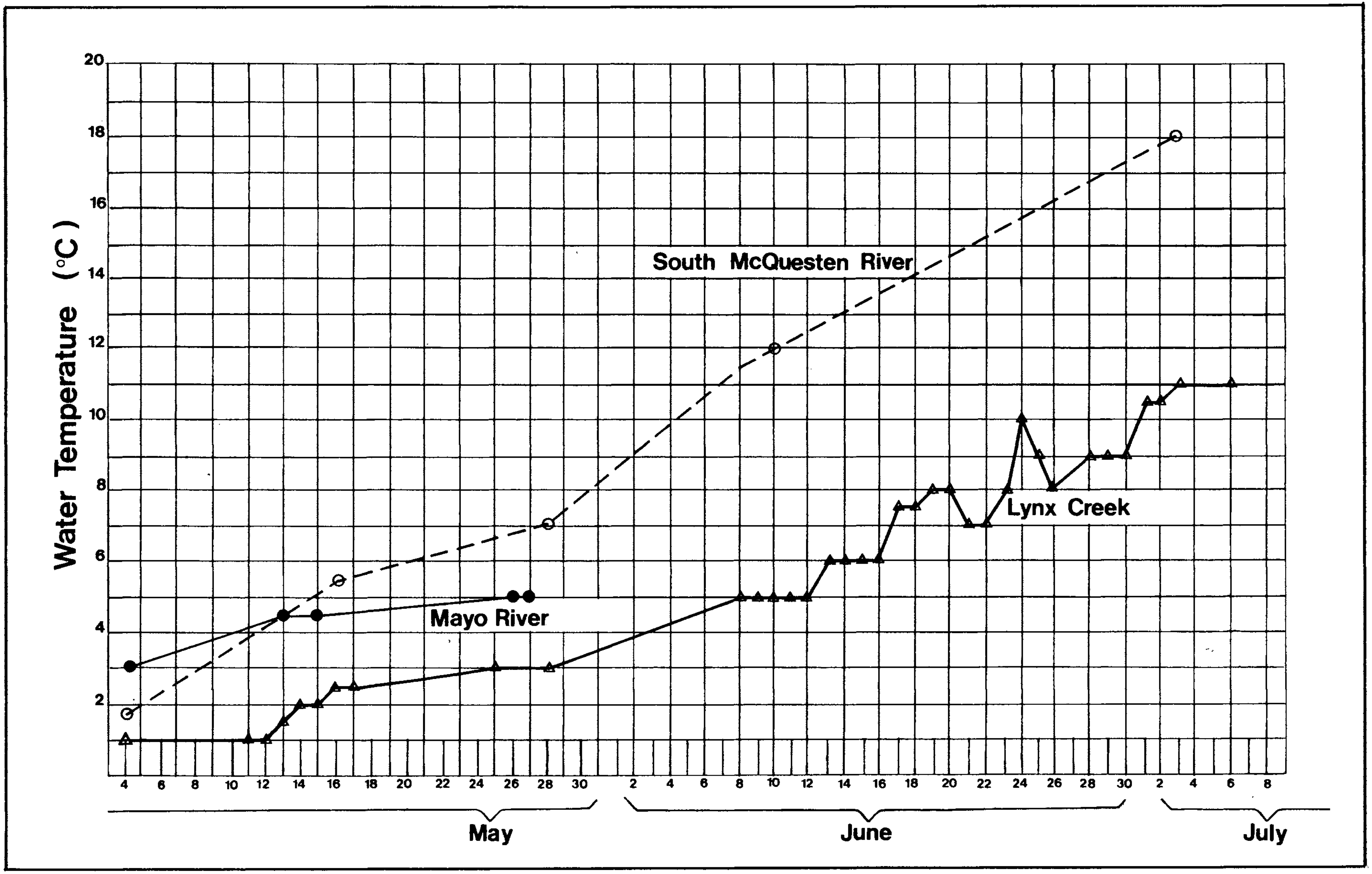

FIGURE 3. Water temperature measurements for Lynx Creek, Mayo River, and South McQuesten River - May - July, 1983.

4.2 Spawning Timing and Location

4.2.1 Results

The results of fish sampling in Davidson Creek, Mayo River, Lynx Creek, Haggart Creek, and South McQuesten River are summarized in Tables A1 - A5 in Appendix A. These sampling results were analysed to derive information on grayling spawning timing and location.

No ripe grayling were captured, nor was any spawning observed in any of the smaller tributaries (ie. Lynx, Haggart, and Davidson Creeks). Moreover, no young-of-the-year were detected in any of these streams, with the exception of the extreme lower portion of Haggart Creek (where fry may have moved up from South McQuesten River).

Ripe and partially spent grayling were found in both Mayo and South McQuesten Rivers throughout the latter part of May. Although spawning was not actually observed due to high stream flows, it appears that spawning did occur in these larger rivers.

In the South McQuesten River, grayling were first sampled on May 16, near the mouth of Haggart Creek (sample site F1, Figure 2). All the adult fish caught (10 out of 10) were either spent or partially spent. The water temperature was 5.5°C. On May 17 and 18, another 6 adult fish were captured at this site - 3 were considered spent and 3 were ripe.

No further sampling was done in the South McQuesten River until May 28 when 17 adult grayling were captured at site F1. 15 were considered spent, while 2 males were still ripe. The water temperature was 7.0°C. No other ripe grayling were captured after May 28.

These sampling results indicate that spawning in this area had begun by May 16 at water temperatures of 5.5°C and was probably virtually completed by May 28.

Grayling fry were first observed in the South McQuesten River at site F1 on June 18 at water temperatures of approximately 14°C. Relatively small numbers were observed (30-40 individuals) and none were captured. The average total length was estimated to be 20-25 mm. It was assumed that these fry were recently emerged, but this cannot be confirmed.[1]

In Mayo River, 9 adult grayling were captured on May 13 at water temperatures of 4.5°C. These fish appeared to be near spawning condition, but none were considered ripe. The first ripe grayling (a 390 mm male) was captured on May 17, but no spent fish were noted. The water temperature was approximately 5°C.

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[1] Other studies indicate that newly-emerged grayling fry are smaller than 20 mm. Grayling fry from the Sukunka River drainage, B.C. were 14 mm at emergence (Stuart and Chislett 1979).

Mayo River was not sampled again until May 26 and 27. Of 16 adult fish for which maturity was noted, 13 were spent and 3 were considered ripe. The water temperature on May 27 reached a maximum of 5.5°C.

Fry emergence was not monitored in Mayo River.

Specific spawning areas in the two larger systems were not positively determined. In the South McQuesten River, however, a small area at the mouth of Haggart Creek was identified as a probable spawning site. Ripe and spent fish, often in male/female pairs, were caught consistently in a gillnet fished in this area on May 16, 17 and 18. Water depth in this area ranged from 1 to 1.5 m and the substrate was almost exclusively small gravel (2 - 16 mm grain size).

4.2.2 Discussion

The fact that no ripe adult grayling or grayling young-of-the-year were captured in Lynx or Davidson Creeks, implies that spawning likely did not occur in these smaller streams in 1983. The sampling results indicate that spawning did occur in the two larger systems in low gradient over-wintering areas near the mouths of Haggart and Davidson Creeks.

While these results are preliminary, it seems possible that most grayling which overwinter in river habitats may spawn in these larger rivers while few grayling utilize the smaller tributaries. [1] The theory that grayling tend to spawn in the mainstems in the McQuesten/Mayo area is also supported by the results of stream sampling conducted in 1982 (Pendray 1983). Grayling fry were found only in the mainstem rivers (eg. McQuesten, South McQuesten) or in the outlets of lakes (eg. Minto).

There is a possibility that smaller tributaries in this area were utilized historically, but have since been abandoned due to the effects of placer mining. Stuart and Chislett (1979) and deBruyn and McCart (1974), however, have also noted that mainstem spawning may be prevalent in the Sukunka and Firth Rivers, which lack extensive placer activity.

It is perhaps significant that the two "mainstems" studied are actually medium-sized rivers with habitat and flow conditions which are quite different from very large systems such as the Stewart or Yukon Rivers. Both Mayo and South McQuesten Rivers appeared to have ample areas suitable for grayling spawning.

There are two possible reasons for grayling to naturally select mainstems over tributaries for spawning in this area. The first is the fact that the larger rivers were free of ice earlier and warmed up much

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[1] Different patterns may exist, however, for lake-influenced populations.

more quickly than the tributaries. The maximum temperature recorded in Lynx Creek during the month of May was only 3°C, while maximum temperatures in the South McQuesten River were 7-8°C by the end of May. The second reason is that streamflow velocities tended to be very high in the tributaries during May and the available area for fish to hold and rest appeared much diminished. The low gradient areas and side channels of the mainstems seemed to provide much more favourable flow regimes for spawning during this high water period.

Spawning timing and temperatures appear to have been very similar in the two systems, with spawning beginning in mid-May at approximately 5°C. The sampling results from both areas indicate that spawning was virtually completed by the end of May.

According to Butcher (1981), the time to hatching for fertilized grayling eggs from several different studies of northern populations varied from 13-32 days, depending on water temperatures. Kratt and Smith (1977) reported incubation times of 31 and 32 days under natural conditions with temperatures of 1.0 - 11.5°C. These authors also noted the existences of a further 3-4 day sub-gravel stage for grayling alevins following hatching. Sukunka River grayling had an incubation time of 25 days with an average temperature of 10.7°C (approximately 268 degree days) (Stuart and Chislett 1979). Grayling in the Liard River drainage had incubation periods of 17 and 20 days at 7.9°C and 9.2°C mean temperatures (Butcher 1981). Daily maximum temperatures in the South McQuesten River ranged from approximately 5-14°C for the period May 15 - June 15. The average temperature for this period is estimated to have been approximately 9°C.

From this literature, it seems likely that the total incubation and sub-gravel period in the Mayo area would fall between 20 and 30 days. If we conclude that spawning began in South McQuesten and Mayo Rivers about May 15 and was completed by May 31, the maximum period of sensitivity for grayling egg and alevin disturbance was approximately May 15 to June 30. Breakup was slightly earlier than normal in 1983, so that the period of sensitivity may be as much as a week later in "normal" years. If spawning does take place in the smaller tributaries it would likely begin later and the incubation period would be longer than in the mainstems (due to the colder water temperatures).

4.3 Movements and Abundance

4.3.1 Movement Patterns

A total of 87 grayling were tagged in the Mayo River near the mouth of Davidson Creek between May 13 and May 27. Seven of these fish have been recaptured in the Mayo River (see Table 1). Five were recaptured near the mouth of Davidson Creek (ie. near the tagging site), while 2 were recaptured 3 km upstream, below the Mayo Lake dam.

Davidson Creek was sampled periodically between May 13 and June 22. Only 2 grayling were captured and no tags were recovered. No spawning was detected in Davidson Creek and it appears that very few grayling moved into the creek to rear following spawning.

Sixty-nine grayling were tagged in the South McQuesten River at site F1 between May 16 and June 18 (see Figure 4). Five of these fish have been recaptured - 2 in the South McQuesten River near the tagging site and 3 at the Lynx Creek weir (see Table 2 for recovery data).

Haggart Creek was sampled periodically during the study. Beach seining on May 18 at site F3, approximately 19 km upstream from the mouth, produced 9 juvenile grayling ranging in size from 72 - 140 mm. These fish were aged 1 - 3 years. This finding was significant, because it may indicate that these fish overwintered in Haggart Creek. At this time, streamflow velocities were still very high, and it is doubtful that grayling in this size range could have moved 19 km upstream from the South McQuesten River against such steamflows.

Nine grayling were tagged in Haggart Creek at the mouth of Swede Creek on June 9 and June 10. One of these fish was later recaptured 1.5 km upstream in Swede Creek, indicating that grayling move into this small stream for summer rearing.

Table 1. Mayo River grayling tag recoveries

Tag No.	Fork Length (mm) (when tagged)	Date Recovered	Location Recovered	Date Tagged	Location Tagged	Approximate Distance Travelled
0004	305	83/05/26	Nr. mouth Davidson Creek	83/05/13	Nr. mouth Davidson Creek	0
0007	338	83/05/26	Nr. mouth Davidson Creek	83/05/13	Nr. mouth Davidson Creek	0
0052	295	83/06/12	Nr. mouth Davidson Creek	83/05/26	Nr. mouth Davidson Creek	0
0078	305	83/06/12	Nr. mouth Davidson Creek	83/05/27	Nr. mouth Davidson Creek	0
0060	288	83/07/21	Nr. mouth Davidson Creek	83/05/26	Nr. mouth Davidson Creek	0
0108	317	83/08/01	Mayo Lake Dam	83/05/27	Nr. mouth Davidson Creek	3 km upstream
0018	395	83/09/20	Mayo Lake Dam	83/05/15	Nr mouth Davidson Creek	3 km upstream

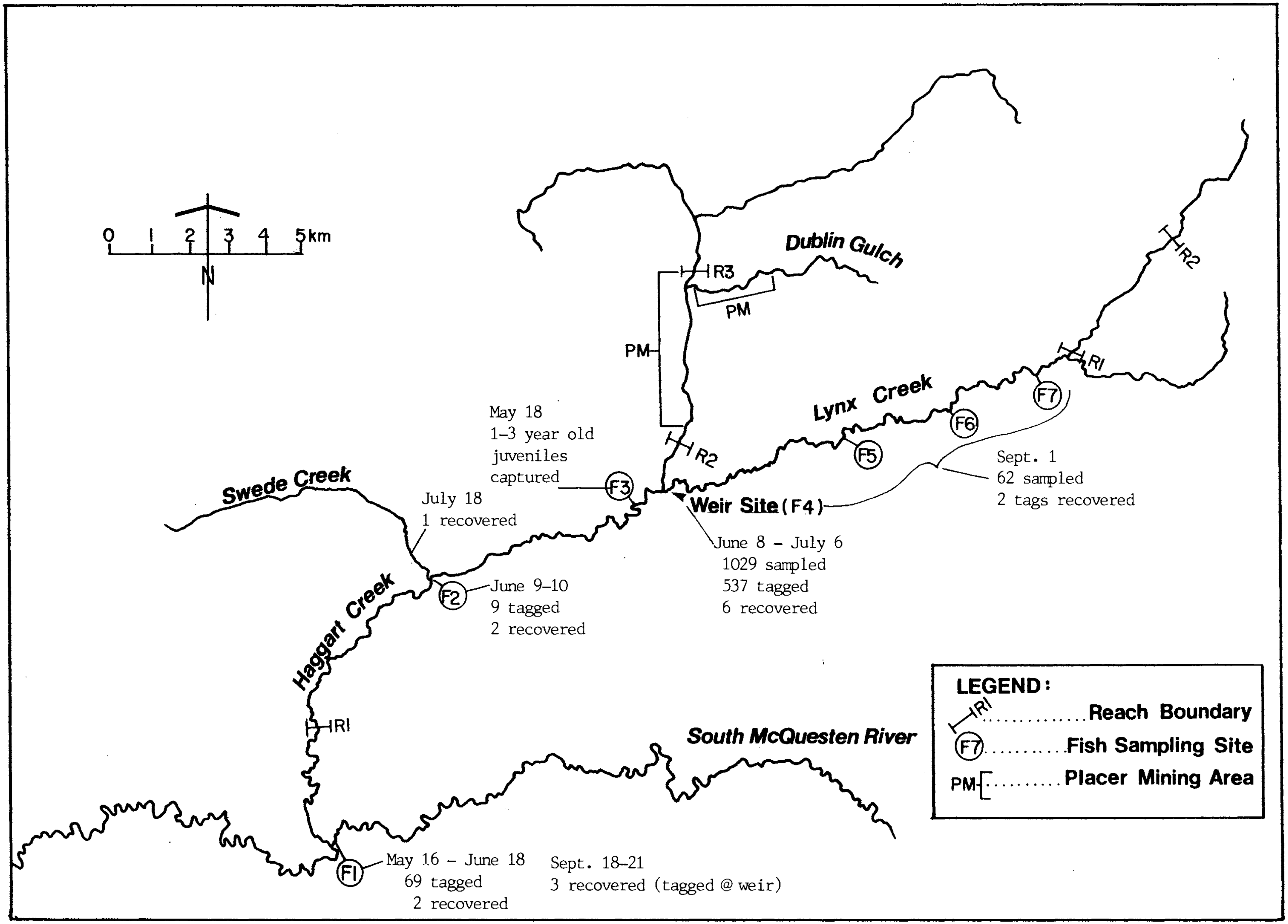

FIGURE 4. Summary of fish sampling and tag recovery data for South McQuesten system.

Table 2. South McQuesten River system grayling tag recoveries

Tag No.	Fork Length (mm) (when tagged)	Date Recovered	Location Recovered	Date Tagged	Location Tagged	Approximate Distance Travelled
0153	380	83/05/29	S. McQuesten River F1	83/05/29	S. McQuesten River F1	0
0195	315	83/06/10	Swede Creek (F2)	83/06/09	Haggart Creek F2	.02 km upstream
0198	330	83/06/10	Haggart Creek F2	83/06/09	Haggart Creek F2	0
0151	290	83/06/10	Lynx Creek weir*	83/05/29	S. McQuesten River F1	20 km upstream
0461	295	83/06/17	Lynx Creek weir*	83/06/16	Lynx Creek below weir	.02 km upstream
0255	258	83/06/25	Lynx Creek weir*	83/06/10	S. McQuesten River F1	20 km upstream
4139	275	83/06/30	Lynx Creek weir	83/06/18	S. McQuesten River F1	20 km upstream
0258	258	83/07/06	Lynx Creek below weir	83/06/10	Lynx Creek weir*	.2 km downstream
0029	285	83/07/07	S. McQuesten River F1	83/05/16	S. McQuesten River F1	0
0199	280	83/07/18	Swede Creek 1.5 km	83/06/09	Haggart Creek F2	1.5 km upstream
5399	326	83/08/31	Lynx Creek below weir	83/06/25	Lynx Creek weir*	.2 km downstream
0171	313	83/09/01	Lynx Creek F6	83/06/09	Lynx Creek weir*	13 km upstream
4830	255	83/09/01	Lynx Creek F6	83/06/21	Lynx Creek weir*	13 km upstream
0398	310	83/09/18	S. McQuesten River F1	83/06/15	Lynx Creek weir*	20 km downstream
0202	345	83/09/21	S. McQuesten River F1	83/06/09	Lynx Creek weir*	20 km downstream
0386	398	83/09/21	S. McQuesten River F1	83/06/15	Lynx Creek weir*	20 km downstream

* Trapped while moving upstream

Young-of-the-year grayling were observed in large numbers in the lower 500 m of Haggart Creek in early July. It was felt that these fry probably originated in South McQuesten River and were moving up into Haggart Creek, although this could not be confirmed.

Grayling were first captured in Lynx Creek by gillnet on May 18. These were subadult fish (ages 5 and 6), which appeared large enough to be able to move upstream against the high flows. No very small, 1 - 3 year grayling were captured in Lynx Creek in May, indicating that over-wintering may not have taken place.

Although monitoring was difficult in May due to the high stream flows, it appears that large numbers of fish did not begin to enter Lynx Creek until the flows decreased in early June.

The weir on Lynx Creek was established on June 8, allowing a more precise monitoring of movements. The establishment of the weir coincided fairly closely with a sharp drop in streamflows which began in the first week of June. A large upstream migration of grayling was noted immediately upon completion of the weir and continued throughout the monitoring period (see Figure 6). A total of 877 grayling and 11 round whitefish were captured in the upstream trap of the weir between June 8 and July 6. Another 152 grayling, 3 round whitefish, and 1 burbot were sampled by electrofisher from pools below the weir during this period. 537 grayling and all of the whitefish were tagged.

These fish were of all size classes between approximately 200 mm (the smallest size which could be held in the trap) and 420 mm (see Figure 5). Numerous grayling in the 100-200 mm range were also observed passing upstream through the fence.

During this time, downstream migration was negligible, with only 31 grayling being captured in the downstream trap.[1]

Figure 6 shows the number of fish passing through the weir daily and the water level as recorded on a calibrated staff.[2] There appears to be a direct relationship between streamflows and grayling movements with the largest numbers of fish caught in the upstream trap corresponding to the peak flow periods. The total numbers of fish caught in the upstream trap, however, may not accurately reflect the natural movement patterns. The presence of the weir itself seemed to upset the usual migration of fish, especially at low water levels. Migrating fish were "backed up" below the weir as they attempted to negotiate the obstruction, and in low water conditions they appeared particularly reluctant to enter the trap. As many as 400-500 grayling were observed holding in a series of pools below the weir on July 6, following about a week of very low flows. The fact that

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1 This includes only uninjured fish. Fish which had been injured in the trap or during tagging were not included. Of the 31 fish caught in the downstream trap, 21 may have escaped into this trap due to a hole in the mesh between the upstream and downstream traps.

2 Water levels should not be taken as an absolutely accurate indication of streamflows. The water levels were influenced slightly by ponding of water behind the weir. The figures on the graph should be taken only as an indication of gross streamflow fluctuations.

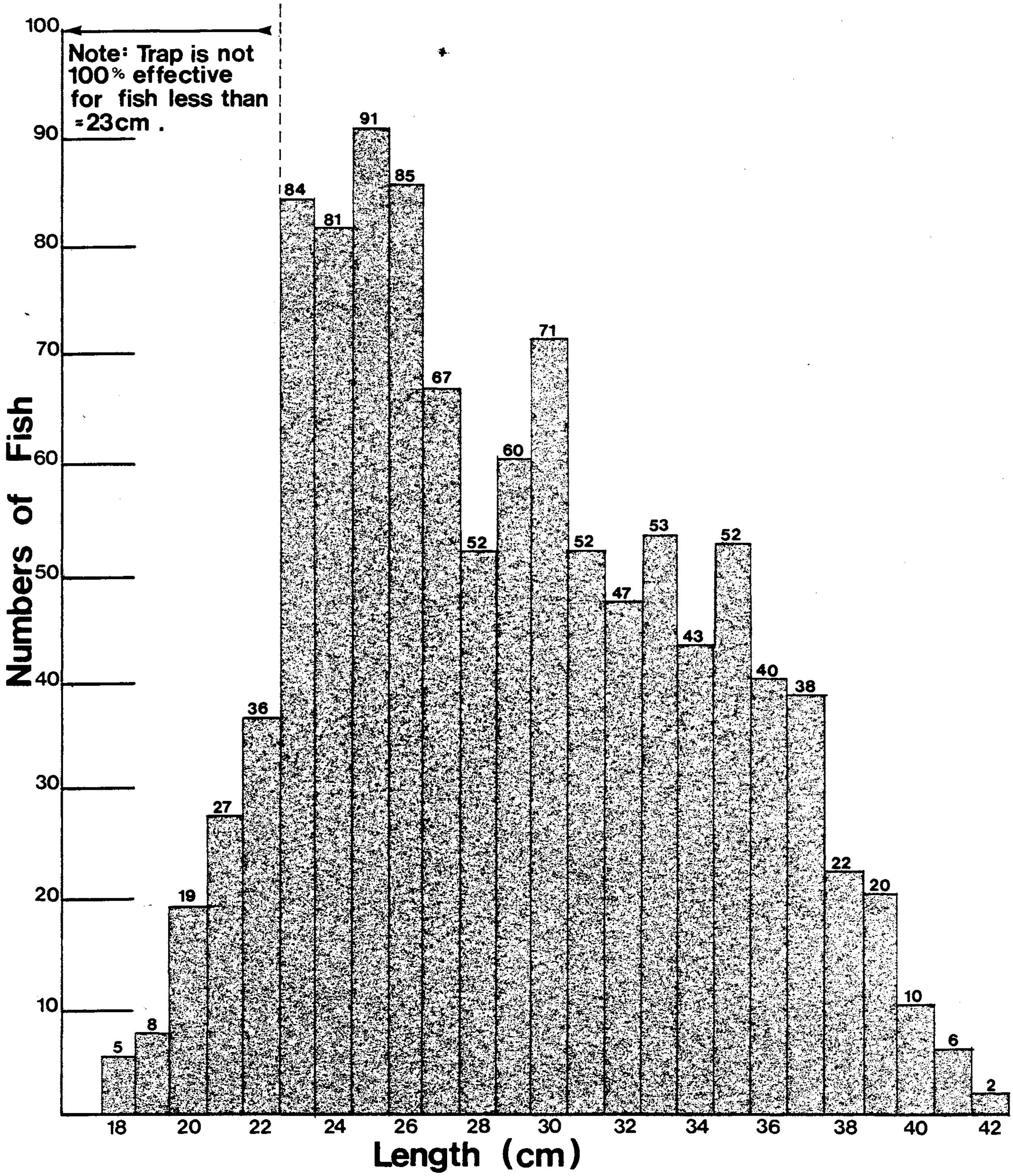

Figure 5. Length - frequency of Arctic grayling passing through Lynx Creek weir - May - July, 1983.

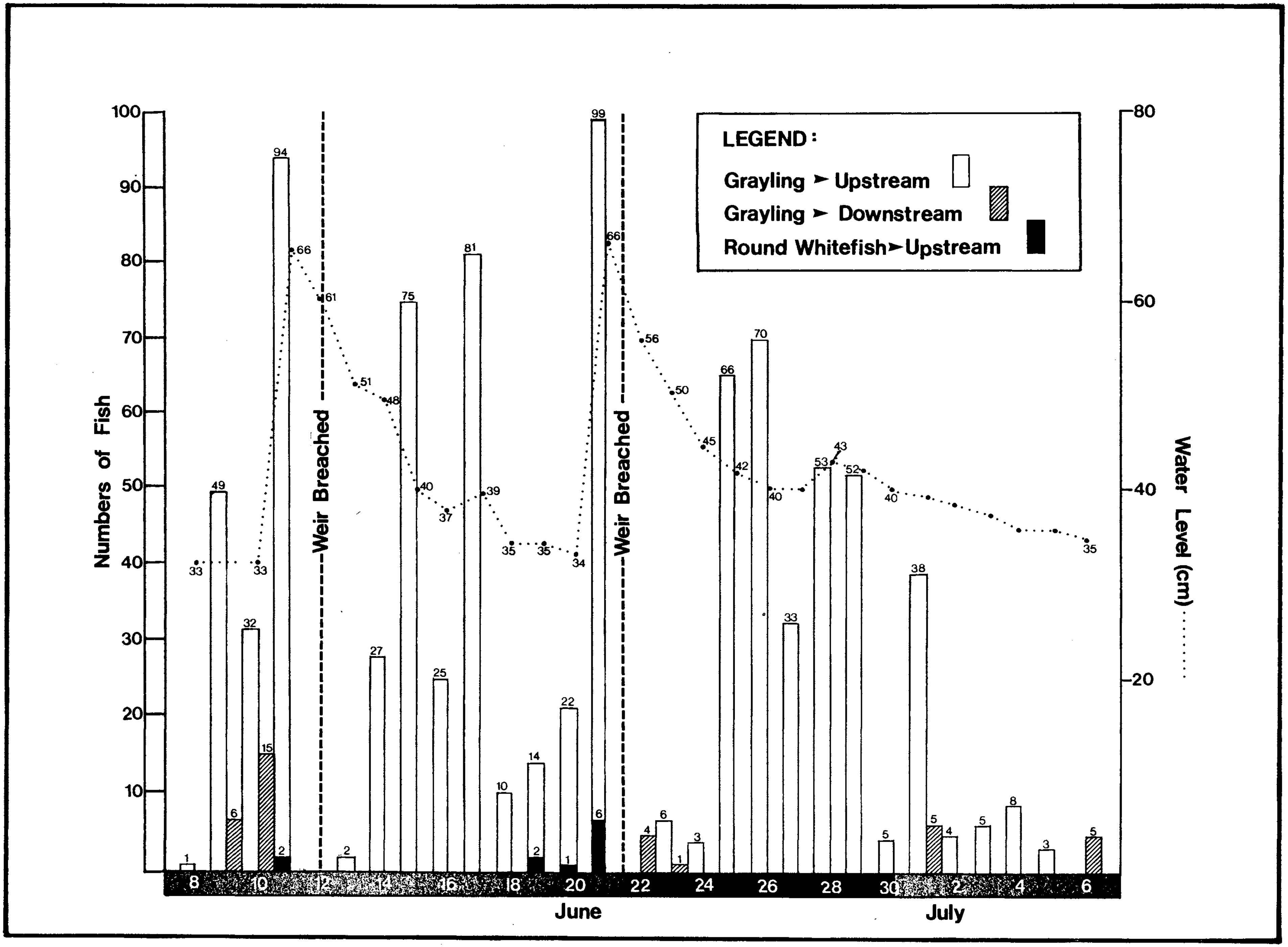

Figure 6. Daily fish movements through Lynx Creek weir with corresponding water levels, June - July, 1983.

the catch went up at high streamflows, therefore, may simply mean that the trap itself was more effective at higher water levels. Also, because the trap was checked (and water levels recorded) an average of only twice per day, it is not clear exactly when fish were moving. Our observations indicated that fish did not tend to move at very high flows. While peak grayling movements seem to be triggered by rising water levels, the actual movements may occur at intermediate water levels (ie. when the water is rising or falling). This view tends to be supported by the existence of the intermediate peaks (see Figure 6) in grayling catches which do correspond to these intermediate water levels.

The impact of suspended sediment levels in Haggart Creek on migrations into Lynx Creek was very difficult to assess. Suspended sediment levels appeared to change very rapidly as a result of placer mining activity, so that accurate monitoring was not possible. Generally, however, suspended sediment levels were very high in Haggart Creek during rainfall events and may have been a contributing factor in the increased grayling movements at peak flows.

Our observations suggested that most movement occurred during afternoon and early evening (when water temperatures were also slightly higher). Very few fish appeared to move overnight and during the morning hours.

Monitoring of movements at the weir ceased on July 6, so the timing and pattern of out-migration was not accurately determined. Sampling done in Lynx Creek on September 1, however, indicated that large numbers of grayling were still present in the upper part of Reach 1 (see population figures, Section 4.3.2). Recent tag recaptures show that some adult grayling from Lynx Creek had migrated out and begun to congregate in the South McQuesten River overwintering areas by mid-September. Three grayling tagged in Lynx Creek were recaptured at site F1 on September 18 and 21, 1983 (see Table 1).

4.3.2 Population Estimate for Lynx Creek

On September 1, fish sampling was conducted at 3 sites upstream from Lynx Creek weir. These sites were approximately 13 km, 8 km, and 100 m upstream from the weir. Electrofishing with a downstream stop net in place was carried out at each site.

A total of 62 grayling were captured, of which only 2 were tagged. A large portion (approximately 66%) were juveniles which were too small to have been captured in the fish trap.

Although the tag recapture rate was very low, the following calculation was made using the Adjusted Petersen Estimate (Ricker, 1975):

$$n = \frac{(m + 1)\ \ (c + 1)}{r + 1}$$

where n = population estimate
m = number of fish marked
c = catch or sample taken for census

and r = number of recaptures in sample

so m = 516 = total number of tagged grayling estimated to be above the weir as of July 6 (from weir sampling records)

c = 62 = total number of grayling captured on September 1

r = 2 = number recaptured on September 1

therefore $$n = \frac{(516 + 1)\ \ (62 + 1)}{2 + 1} = 10,857$$

The confidence limits are extremely wide, however, for a sample with such a low recapture rate. The 95% confidence limits (from Poisson distribution table, Ricker 1975) are 27,143 and 3972. Ricker (1975) also points out that the probability of statistical bias is relatively high when only 2 tags are recovered.

If we take the estimated population of 10,857, however, and assume a useable stream length of 18 km (ie. the lower 2 reaches) with an average wetted width of 5 m, the summer grayling density for this section would be 0.12 fish/m^2.

4.3.3 Discussion

A significant result of the study was the identification at the extremely large migration of grayling of all size classes into Lynx Creek for summer rearing. Such a large migration of adults for rearing purposes has rarely been documented, although some authors (eg. Craig and Poulin 1975) note that tributaries may sometimes be used as summer feeding areas for adult grayling.

It appears that not all small tributaries in the area are important rearing areas - Davidson Creek, for instance, appeared to have very few fish. Fish sampling done in 1982 (Pendray 1983) indicated that most small streams in the area (both mined and unmined) did have summer residents in varying abundance. This exceptionally large influx of grayling into Lynx Creek, however, appears to be unique in the Mayo/McQuesten area.

No single factor has been identified which would explain why Lynx Creek is so heavily utilized for summer rearing. The fact that Lynx Creek has no placer mining activity and is therefore more stable and has lower turbidities than some other streams in the area is undoubtedly significant, but may be too simplistic an explanation. There are other unmined streams in the McQuesten area (sampled in 1982) which do not appear to have the same high levels of utilization. A combination of factors is involved, including, perhaps, such things as the proximity to heavily used overwintering areas and the availability of other suitable rearing streams. Lynx Creek does have a long (18 km) section with favourable gradient (0.85%), meandering pattern, and stable channel characteristics. The pool/glide:riffle ratio of 70:30 in Reach 1 may afford an optimum combination of holding habitat and invertebrate production.

The limited water quality testing conducted during the study (see Table B1, Appendix B) did not reveal any obvious differences which could explain the Lynx Creek productivity.

The possibility that small juvenile grayling may have overwintered in Haggart Creek would, if confirmed, be another significant finding. Haggart Creek is generally broad and shallow and has very few deep pools which might be expected to hold water during winter. Stuart and Chislett (1979), however, indicate that fry and juveniles appeared to overwinter among cobbles and boulders in fairly small tributaries in the Sukunka drainage.

4.4 Age and Growth

Ages were obtained for a total of 94 grayling from Mayo River and 183 grayling from the South McQuesten system.

The majority of fish were aged from scales, but 44 scale ages were checked by reading the corresponding otoliths. Several authors (deBruyn and McCart 1974, Craig and Poulin 1975, etc.) have indicated that aging by scales tends to underestimate grayling ages, especially in older fish. Otoliths are considered to give more accurate ages for fish over approximately 6 years.

In this study, aging of scales was found to be quite difficult, particularly for fish from the South McQuesten system. Growth rates for these fish tended to be very slow during the first 3 years, and the annuli near the focus were very difficult to identify. In older fish, annuli near the margins were difficult to distinguish due to very slow yearly growth and scale resorption. It was found, however, that when extreme care was taken in aging the scales, these ages agreed quite closely with the otolith-based ages, even for older fish. In 44 comparisons between scale and otolith ages, the scale ages were identical on 31 occasions, one year less on 6 occasions, 2 years less on one occasion, and 3 years less on one occasion. Scale ages were one year greater than the otolith age on 5 occasions.

For the following analysis, otolith ages have been used in those cases where there is a discrepancy between otolith and scale aging.

Mean fork lengths for each age class of the Mayo River and South McQuesten populations (including Lynx and Haggart Creek fish) are presented in Table 3 and Figure 7. A comparison of mean fork lengths between this sample area and other northern populations is presented in Table 4.

Table 3 . Mean fork length and standard deviation for Arctic grayling age classes from Mayo River and South McQuesten River populations (May-June,1983)

Age		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mayo River	Mean (mm)				272.7	292.7	311.0	333.7	360.2	379.2	306.0					
	SD				19.1	19.0	17.9	8.3	23.7	13.2	0					
	(n)				7	39	28	8	5	6	1					
S. McQuesten River	Mean (mm)	76.9	114.3	141.5	217.5	246.3	286.8	306.2	331.9	345.7	361.1	375.2	389.0	408.7		410.0
	SD	3.6	8.4	2.1	20.5	20.0	25.2	18.0	21.0	16.5	20.1	26.2	15.3	7.2		0
	(n)	9	4	2	15	19	31	21	23	20	14	12	9	3		1
Significant difference between means (p 0.05)					*	*	*		*	*	*					

Table 4 . Comparison of mean age class lengths for Arctic grayling from Northern Canada and Alaska.

Location	Authors	Mean Fork Length/Age Class (mm)																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mayo R., Y.T.	Pendray, 1983				273	293	311	334	360	379	306												
S. McQuesten System, Y.T.	Pendray, 1983	77	114	142	218	246	287	306	332	346	361	375	389	409		410							
Weir Cr/Kavik R., AK.	Craig and Poulin, 1975	94	133	183	208	258	312	336	355	370	370	382	388	405	373	398	418						
Firth R., Y.T.	DeBruyn and McCart, 1974	82	121	137	225	232	294	311		338	348	355	351	357	351	350	358	380	393		350		388
Trout Lk., Y.T.	DeBruyn and McCart, 1974	99	144		212	293	284	307	331	343	359	364	379	382	381	367							
Sukunka Drainage, B.C.	Stuart and Chislett, 1979	102	181	225	273	314	345	362	392														
Geddes Cr., B.C.	Butcher, 1981	117	157	202	243	277	310																

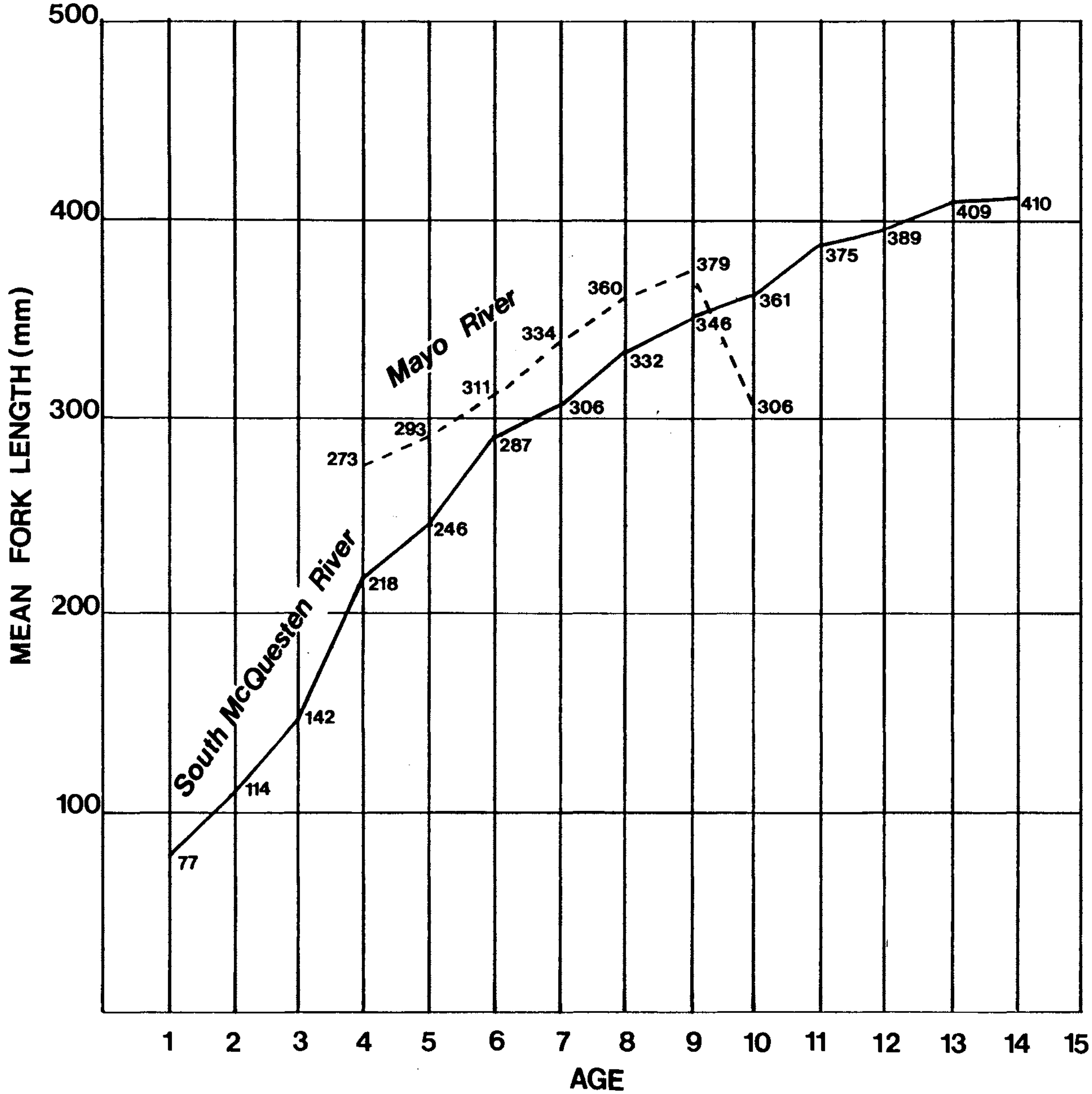

Figure 7. Comparison of mean fork lengths for Arctic grayling from Mayo River and the South McQuesten system.

The data indicate that there is a difference in growth rate between the Mayo River and South McQuesten River grayling populations. Mayo River fish were consistently larger for all age classes for which there were sufficient data (age 4-9). Using a one-way analysis of variance and Duncan's Multiple Range Test (Nie, et al 1975), the differences in mean fork length were found to be significant ($p < 0.05$) for all age classes except age 7.

The major difference in growth appears to occur during the first three or four years. By age 4 Mayo River fish have a mean length of 272.7 mm while South McQuesten River fish have a mean length of only 217.5 mm. This increased growth in the younger age classes in Mayo River may be attributable to the presence of Mayo Lake, just upstream. As well as moderating water temperatures, the lake may also produce greater numbers of plankters, which would improve juvenile growth.

Fish aged up to 15 years were found in South McQuesten River, while the oldest grayling captured in Mayo River was aged 10 years.

The comparison of age-length data with those from other northern studies indicates that growth in the South McQuesten population may be comparable to North Slope populations, while growth in the Mayo River population may approach that of northern British Columbia.

4.5 Age at Maturity

Data describing age at maturity for South McQuesten and Mayo River populations is presented in Table 5. Although our data from the critical age classes (ages 4 - 8) are quite scarce, they indicate that grayling in both areas begin to mature at age 5. In Mayo River, virtually all fish are mature at age 7, while in the South McQuesten population, maturity may not occur until age 9. Maturity is probably roughly related to fish size, although one female as small as 240 mm (age 5) was considered to be spent. As a general rule, it appeared that most fish greater than 300 mm in both areas were mature.

These results are comparable to those obtained from North Slope grayling populations. Craig and Poulin (1975) noted that grayling in Weir Creek (Alaska) also matured first at age 5 and were all mature at age 8. In northern B.C., on the other hand, the majority of grayling mature at age 4 (Butcher 1981, Stuart and Chislett 1979).

Grayling from this study area are therefore relatively late maturing, particularly those from the South McQuesten population.

TABLE 5. Maturity[1] of age classes for a sample of South McQuesten and Mayo River grayling.

South McQuesten System

Age	Male N	Male % Mature	Female N	Female % Mature	Unsexed N	Unsexed % Mature	Total N	Total % Mature
4	3	0%	1	0%	2	0%	6	0%
5	2	0%	7	40%	1	0%	10	20%
6	7	40%	3	0%	1	0%	11	18%
7	4	50%	2	50%			6	50%
8	4	100%	7	86%			11	91%

Mayo River

Age	Male N	Male % Mature	Female N	Female % Mature	Unsexed N	Unsexed % Mature	Total N	Total % Mature
4			1	0%	1	0%	2	0%
5	3	33%	9	11%			12	17%
6			6	67%			6	67%
7	4	100%	1	100%			5	100%
8	2	100%	1	100%			3	100%

[1] NB - Fish were considered mature if gonads or external appearance indicated that spawning had occurred in Spring, 1983.

5.0 Conclusions and Recommendations

The usual pattern of grayling movement and habitat utilization as outlined in other studies of northern populations (Butcher 1981, Craig and Poulin 1975, Bishop 1971, Reed 1964), is generally as follows:

1. Adult grayling overwinter in lakes or larger rivers and move into smaller tributaries to spawn immediately after spring breakup;

2. After spawning, adults tend to return to the mainstem rivers;

3. Fry remain in the tributaries during the summer months (exceptions to this are noted, however - eg. Butcher (1981)), and migrate out to the mainstems in the fall;

4. Some studies (Butcher 1981, Craig and Poulin 1975, Reed 1964) also indicate a migration of juvenile (1, 2, and 3 year old) grayling into tributaries for summer rearing.

The results of this study indicate that in the Central Yukon, there may be some significant exceptions to this general pattern.

The pattern of grayling spawning and migration observed in the South McQuesten and Mayo study areas had the following characteristics:

1. Adults and sub-adults overwintered in low gradient pool areas in the larger river systems. There is a possibility that some small juveniles (in the 0+, 1+ and 2+ age classes), however, may have overwintered in one of the larger tributaries.

2. The majority of grayling spawning appeared to occur in the mainstem overwintering areas. No spawning was detected in the two smaller tributaries.

3. Spawning began in both mainstems in mid-May at a water temperature of approximately 5°C appeared to be virtually completed by the end of May.

4. For these mainstem spawners, the period when eggs and alevins were in the gravel and therefore susceptible to disturbance, was approximately May 15 to June 30. If spawning did occur in the smaller tributaries, this period would likely begin later and be longer in duration due to colder water temperatures.

5. There was a general (post-spawning) migration of all age classes into the smaller tributaries, with fish continuing to move upstream at least as late as July. The numbers of fish utilizing individual streams appeared to vary considerably. Lynx Creek, for example, was identified as having a very large summer

rearing population, with many mature adult fish. A fairly small number of streams, such as Lynx Creek, may be extremely important to the grayling population of an entire system.

Growth rates were significantly different in the two study areas with Mayo River fish being consistently larger for a given age class. The Mayo River population appeared to grow much more quickly during the first 3-4 years, perhaps reflecting the contribution of plankters from the nearby lake. The South McQuesten population is slow growing (especially for ages 1-3) and long-lived, with fish up to 15 years of age present. Grayling from the study area are relatively late maturing, particularly those from the South McQuesten system, which may not mature until age 9.

The pattern of slow growth and very late maturity observed in the South McQuesten system may be typical of completely river-dwelling grayling populations in the central Yukon, while the more rapid growth in the Mayo system may be characteristic of lake-influenced populations.

Grayling populations with slow growth and late maturity are particularly susceptible to over-exploitation. The presence of very old fish in the South McQuesten system probably indicates that current levels of exploitation are light.

The results of this study indicate that grayling life history patterns in this study area differ somewhat from those observed in other areas. It is obvious, however, that many gaps in our knowledge of grayling life history still exist. It seems that it is particularly difficult to generalize about grayling behaviour in different locations and situations. This study was limited in terms of both timing and extent and further work is necessary before results can be confirmed and applied to a wider area. The following further study is recommended:

1. More work on other systems in the region to determine the relative utilization of tributaries vs. mainstems, especially for spawning.

2. Study of a lake-influenced system to determine spawning and migration patterns.

3. Continuation of a tagging program, including winter follow-up, to identify overwintering areas and determine their utilization.

One of the goals of future inventory work should be to identify and flag streams, such as Lynx Creek, which may be extremely important to the well-being of an entire population.

6.0 References

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APPENDIX A

Fish Sampling Summaries

for

Mayo River, Davidson Creek,
South McQuesten River, Haggart Creek
and Lynx Creek

Abbreviations Used:

Methods		Species	
AG	Angling	AG	Arctic grayling
DSTP	Downstream trap	BB	Burbot
EL	Electrofisher	CCG	Slimy sculpin
GN	Gillnet	RW	Round whitefish
SN	Beach Seine	Ø	No fish caught
USTP	Upstream trap		
VO	Visual observation		

Table A1. Lynx Creek fish sampling summary, May - September, 1983

Date	Location	Method(s)	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/05/04	Weir site	AG/VO	CCG	1				Anchor ice still present. CCG observed under ice.
83/05/14	Weir site	AG/GN	Ø					Overnight GN set. Very high flows.
83/05/16	Weir site	GN	Ø					48 hr. GN set. Very high flows.
83/05/18	Weir site	GN	AG	2	300-312	0	0	48 hr. GN set. Flows lower. AG not spawners.
83/05/19	8-13 km above mouth	AG/EL/GN	Ø					Two sample sites in upper Reach 1.
83/05/25	Weir site	GN	AG	3	228-261	0	0	7 day GN set. AG immature.
83/05/28	Weir site	AG/GN	Ø					3 day GN set. Flows extremely high.

NB Fish Trap installed 83/06/08

Table A1. Lynx Creek fish sampling summary, May - September, 1983 (continued)

Date	Location	Method(s)	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/06/08	Weir	USTP	AG	1	368	0	0	Trap completed 1600 hr. Very low flows.
83/06/09	Weir	USTP	AG	49	210-406	45	0	Very low flows.
		DSTP	AG	6		6	2	Suspect hole allowed fish into DSTP.
83/06/10	Weir	USTP	AG	32	232-365	29	1	Very low flows
		DSTP	AG	15	220-400	9	4	Suspect hole allowed fish into DSTP.
83/06/11	Weir	USTP	AG	94	215-410	78	0	Flows rising due to rain. Weir breached @ 1700 hr.
			RW	2	350-390	2	0	
83/06/12	---/---/---/---/---/---/---/---/---/---/---/---/---/---/---/ Weir Breached /---/---/---/---/---/---/---/---/---/---/---/---/---/---/---/---							
83/06/13	Weir	USTP	AG	2	353-373	2	0	Fence repaired 0100 hr. Flows dropping.
		Weir	AG	2		0	0	2 AG recovered dead in fence.
83/06/14	Weir	USTP	AG	27	195-395	25	0	Water dropping.
83/06/15	Weir	USTP	AG	75	215-398	70	0	
83/06/16	Weir	USTP	AG	25	220-381	23	0	
83/06/17	Weir	USTP	AG	81	196-367	71	0	Water up slightly due to rain.

Table A1. Lynx Creek fish sampling summary, May - September, 1983 (continued)

Date	Location	Method(s)	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/06/18	Weir	USTP	AG	10	215-295	6	0	Water dropping.
83/06/19	Weir	USTP	AG	14	230-363	12	0	Water very low.
			RW	2	300-327	2	0	
83/06/20	Weir	USTP	AG	22	198-390	19	0	
			RW	1	355	1	0	
83/06/21	Weir	USTP	AG	99	193-382	91	0	Water rising rapidly due to rain.
			RW	6	296-383	6	0	Weir breached @ 2000 hr.
/---/---/---/ Weir Breached /---/---/---/								
83/06/22	Weir	DSTP	AG	4	240-298	3	0	Water still over weir.
83/06/23	Weir	USTP	AG	6	227-297	4	0	Weir repaired, water dropping.
		DSTP	AG	1	313	1	0	
83/06/24	Weir	USTP	AG	3	237-252	1	0	Water dropping.
83/06/25	Weir	USTP	AG	66	205-406	40	1	All tags now used. Moderate water height.
		AG	AG	5	283-392	3	0	AG angled below weir-released above.

Table A1. Lynx Creek fish sampling summary, May - September, 1983 (continued)

Date	Location	Method(s)	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/06/26	Weir	USTP	AG	71	208-425	1	0	Water dropping slowly.
		DSTP	AG	3	209-225	0	0	
83/06/27	Weir	USTP	AG	33	210-408	0	0	Water quite low.
83/06/28	Weir	USTP	AG	53	189-412	0	0	Water up slightly after rain.
83/06/29	Weir	USTP	AG	52	200-412	0	0	Water quite low and dropping.
		DSTP	AG	2	202-225	0	0	
83/06/30	Weir	USTP	AG	5	245-395	0	0	
		EL	AG	127	185-417	0	1	Electroshocked below weir and released above.
			RW	3	310-340	0	0	
			BB	1	340	0	0	
83/07/01	Weir	USTP	AG	38	205-375	0	0	Water very low and dropping.
		DSTP	AG	5	230-250	0	0	
			BB	1	340	0	0	
83/07/02	Weir	USTP	AG	4	185-335	0	0	
		DSTP	AG	1	215	0	0	
		AG	AG	12	260-370	0	0	AG angled below weir-released above.

Table A1. Lynx Creek fish sampling summary, May - September, 1983 (continued)

Date	Location	Method(s)	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/07/03	Weir	USTP	AG	5	213-360	0	0	Water still dropping.
		AG	AG	3	220-350	0	0	AG angled below weir-released above.
83/07/04	Weir	USTP	AG	8	220-355	0	0	
83/07/05	Weir	USTP	AG	3	220-240	0	0	Water very low.
		EL	AG	25	185-365	0	0	Electroshocked below weir-released above.
83/07/06	Weir	DSTP	AG	5		0	0	Water very low. Weir dismantled at 1400 hr.
				NB Fish Trap dismantled 83/07/06				
83/09/01	13 km from mouth	EL	AG	54	110-380	0	2	Downstream stop net used.
83/09/01	8 km from mouth	EL/AG	AG	4	190-357	0	0	
83/09/01	0.5 km from mouth	EL	AG	4	285-335	0	0	
	TOTALS		AG	1161	110-425	537	11	
			RW	15	296-390	11	0	
			BB	1	340	0	0	

Table A2. South McQuesten River fish sampling summary, May - June, 1983

Date	Location	Method	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/05/16	Mouth Haggart Creek	GN	AG	17	268-357	8	0	All mature fish appeared spent.
			RW	1	307	0	0	
			NP	1	500	0	0	
83/05/17	Mouth Haggart Creek	GN	AG	5	300-345	5	0	2 fish ripe; the remainder spent.
83/05/18	Mouth Haggart Creek	GN	AG	1	310	1	0	Ripe female.
		SN	AG	1	80	0	0	
83/05/28	100 m U.S. Haggart Creek	AG	AG	32	285-445	32	0	Most mature fish appeared spent. 2 males expelled sex products.
83/05/29	100 m U.S. Haggart Creek	AG	AG	17	290-405	16	1	Mature fish appeared spent.
83/06/10	100 m U.S. Haggart Creek	AG	AG	6	258-365	5	0	
83/06/18	Mouth Haggart Creek	AG	AG	3	143-304	2	0	
		TOTALS	AG	82	80-445	69	1	
			RW	1	307	0	0	
			NP	1	500	0	0	

Table A3. Haggart Creek fish sampling summary, May - July, 1983

Date	Location	Method	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/05/18	1 km D.S. Lynx Creek	SN	AG	9	72-140	0	0	
83/05/25	Mouth Lynx Creek	SN	AG	5	72-204	1	0	
83/05/25	100 m D.S. Lynx Creek	SN	AG	3	74-76	0	0	
83/06/09	Mouth Swede Creek	AG	AG	6	280-371	6	0	
83/06/10	Mouth Swede Creek	AG	AG	4	238-330	2	2	
83/06/18	Mouth Swede Creek	AG	AG	2	185-208	1	0	
83/07/02	200 m U.S. mouth	VO	AG	300-400	40-50	0	0	Large number of fry observed in lower Haggart Creek, but none observed 2 km upstream.
		TOTALS	AG (excluding fry)	29	72-370	10	2	

Table A4. Mayo River fish sampling summary, May, 1983

Date	Location	Method	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/05/13	Nr. mouth Davidson Ck	AG	AG	9	292-400	6	0	No ripe fish sampled.
83/05/15	Nr. mouth Davidson Ck	AG	AG	8	280-395	8	0	No ripe fish sampled.
			RW	1	390	1	0	
83/05/26	Nr. mouth Davidson Ck	AG	AG	34	260-337	29	2	2 females ripe. Several others appeared spent. Catch was mainly immature fish (<30 cm).
83/05/27	Nr. mouth Davidson Ck	AG	AG	45	250-375	44	0	Most mature fish appeared spent.
		TOTALS	AG	96	250-400	87	2	
			RW	1	390	1	0	

Table A5. Davidson Creek fish sampling summary, May - June, 1983

Date	Location	Method	Species	No. Sampled	Size Range(mm)	No. Tagged	No. Tags Recovered	Comments
83/05/13	Near mouth	AG	∅	0	-	-	-	
83/05/26	Near mouth	AG/SN	∅	0	-	-	-	
83/06/09	Approx. 2 km from mouth	AG/EL	∅	0	-	-	-	
83/06/22	Approx. 8 km from mouth	AG/EL	∅	0	-	-	-	Water is fairly high.
83/06/22	Approx. 2 km from mouth	AG/EL	∅	0	-	-	-	
83/06/22	From 2 km downstream to mouth	AG	AG	2	270-285	2	0	Angled 2 km section upstream from mouth.
		TOTALS	AG	2	270-285	2	0	

APPENDIX B

Water Quality Data

WATER QUALITY DATA

Lynx C., Haggart C., Mayo R., and Davidson C..

Location	Date	pH	Conductivity (umhos/cm)	Total Suspended Solids (mg/L)*	Nitrate Nitrogen N (mg/L)	Nitrite Nitrogen N (mg/L)	Total Phosphate P (mg/L)
Lynx C. Weir	83/05/16	6.90	65.6	12.0	L0.010	L0.002	0.062
"	83/06/06	7.80	165	1.0	0.042	L0.002	0.39
"	83/06/08	7.70	242	1.0	0.069	L0.002	0.13
Lynx C 13Km U.S.	83/06/09	7.75	-	0.5	0.088	L0.002	0.094
Haggart C. @ Lynx	83/05/16	7.00	111	346	-	-	-
"	83/06/03	-	-	173	-	-	-
"	83/06/08	7.70	194	907	12.7	L0.002	0.36
"	83/06/11	-	-	2080	-	-	-
"	83/06/12	-	-	263	-	-	-
"	83/06/13	-	-	40.0	-	-	-
"	83/06/17	-	-	6.0	-	-	-
"	83/06/21	-	-	198		-	-
"	83/06/22	-	-	124	-	-	-
"	83/06/23	-	-	21.0	-	-	-
"	83/06/25	-	-	62.0	-	-	-
"	83/06/26	-	-	20.5	-	-	-
"	83/06/27	-	-	16.0	-	-	-
Mayo R. @ Davidson	83/05/27	7.80	139	8.5	0.10	L0.002	0.10
Davidson C. @ mouth	83/05/26	7.70	72.2	12.0	L0.010	L0.002	0.078
"	83/07/14	7.75	269	3.0	L0.010	L0.002	0.036
Davidson C. 1.5km U.S	83/06/09	8.00	177	1.5	0.021	L0.002	0.12

* Filtered on a 0.45 micron membrane

L= less than