A FISHERIES INVENTORY

OF THE

GOSNELL CREEK WATERSHED

By

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TABLE OF CONTENTS

SUMMARY 1

INTRODUCTION 3

METHODS 7

RESULTS AND DISCUSSION 10

A. Gosnell Creek mainstem 10

B. Crystal Creek 13

C. Unnamed Tributaries to Gosnell Creek 14

D. North Fork (Cox Creek) 14

a. North Fork mainstem 14

b. "Wolf Creek" 17

c. Kluck Lake 18

ENHANCEMENT OPPORTUNITIES 20

AREAS OF SPECIAL CONCERN 24

SUGGESTED FUTURE WORK 25

CONCLUSIONS AND RECOMMENDATIONS 26

ACKNOWLEDGEMENTS 28

REFERENCES 29

APPENDIX A - Summary of Stream Descriptions, Sampling Information and Photographic Documentation.

APPENDIX B - Glossary of Terms.

APPENDIX C - Annual Salmon Escapement Records for Gosnell Creek.

SUMMARY

The Gosnell Creek watershed is a pristine wilderness area which has high fisheries and wildlife values. Northwood Pulp and Timber Limited is currently formulating long term forest harvesting plans for the Gosnell. It has been recognized by several government agencies as a unique area and this has resulted in the creation of a planning format called the Gosnell Special Planning Area. Although 3 previous studies have been done on the Gosnell, more information was required so Northwood Pulp and Timber and the Fish and Wildlife Branch agreed to jointly undertake another fisheries inventory. The main objective of the study was to obtain detailed fisheries information which could be incorporated into Northwood's long term development plans.

The project was completed in a total of 6 field days occurring in June, August and September, 1980. In addition to overhead flight observations of previously unsurveyed creeks, a total of 17 detailed sample points were done. In total, 38 sites have been intensively sampled within the Gosnell watershed to date. This report, along with 2 complimentary maps, includes information from all previous studies.

Important fish inhabiting the Gosnell drainage are coho salmon, Dolly Varden char, cutthroat trout, and steelhead trout,

especially in the North Fork tributary.

Many of the small tributary streams have important fish habitat, especially in the lower portions. It is stressed that during all stages of development the maintenance of water quality is of primary concern. All stream crossings should be constructed to allow for upstream and downstream passage of juveniles and adults under all flow conditions, at all times of the year.

Some areas of special concern have been identified and delineated in this report and on the maps. Habitat enhancement opportunities primarily entailing the removal of 2 waterfalls and possibly a steelhead fry colonization have been outlined. Recommendations for future studies have been included.

INTRODUCTION

Northwood Pulp and Timber Limited is currently formulating long term plans for timber extraction from Gosnell Creek, one of the major tributaries of the Morice River (see fig 1). In September 1978, a watershed pre—assessment meeting for the Gosnell was held in Houston with representatives from the following groups in attendance: Forest Service, Fish and Wildlife Branch, Fisheries & Oceans, Parks Branch, Water Management Branch, Heritage Conservation, and Northwood Pulp and Timber. During this meeting, some of the special features of the Gosnell watershed were identified: it is a vast (685 km2) undeveloped wilderness area which presently lacks road access; it contains a large unhunted moose population; it is especially valuable as a moose summer range and a calving ground; it has important fish values for coho salmon, steelhead trout, and Dolly Varden char; and it has good outdoor recreation potential with high scenic values in the upper portions of the valley.

The above agencies acknowledged the unique values of the Gosnell watershed and agreed that special considerations should be included into the long term forest harvesting plans. This agreement provided a theme for planning in which an area containing the most important fish and wildlife habitats was identified. This area was subsequently called the Gosnell Special Planning Area.

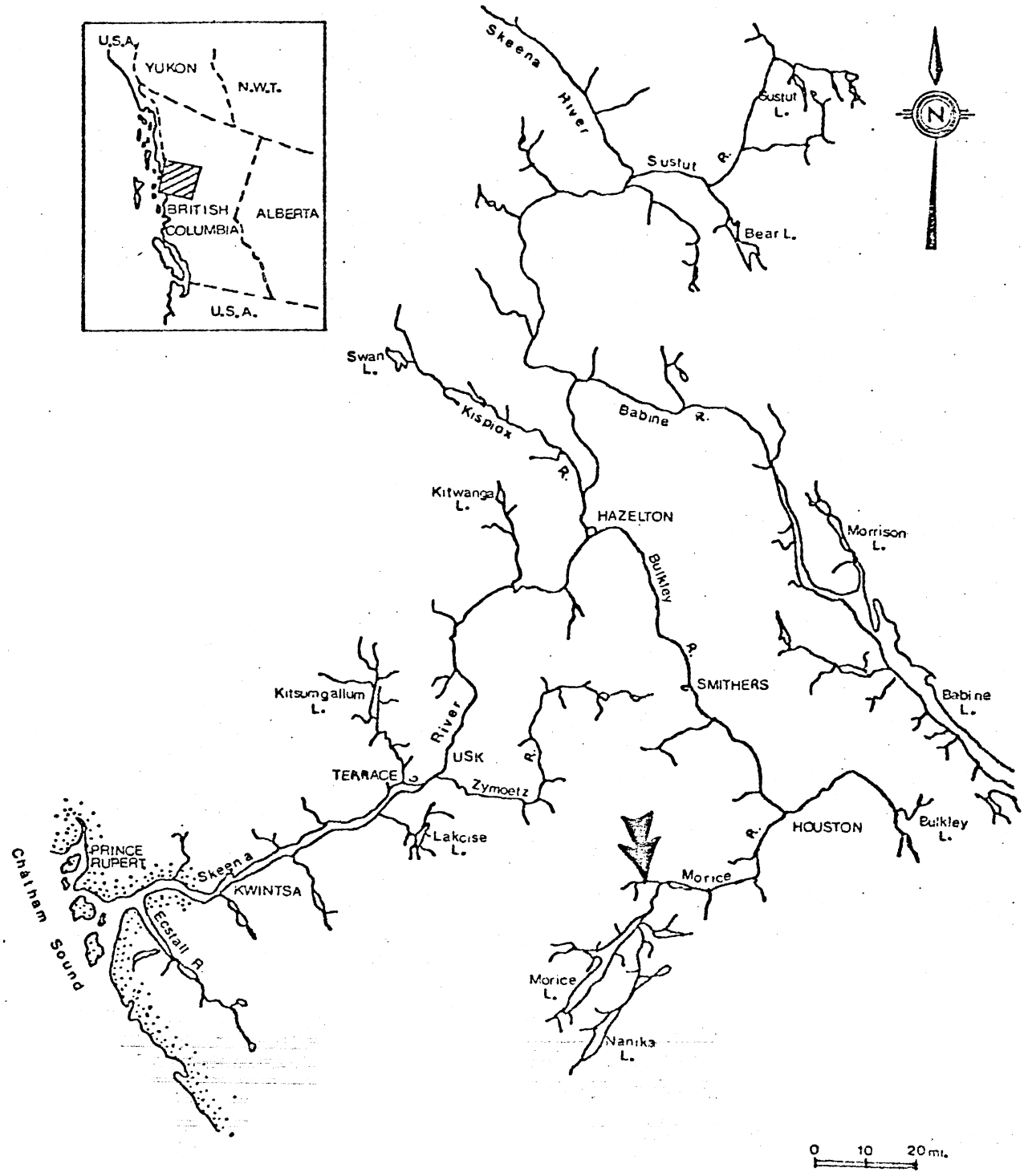

Fig 1. The location of Gosnell Creek.

There has already been some inventory work done on the Gosnell system. In August 1975, the Parks Branch studied the Kluck Lake area as part of a proposal for a provincial park to be centered on the Burnie Lakes (Osmond Jones, 1975). In June—July, 1978, a Fish and Wildlife Branch stream inventory crew from Victoria surveyed Gosnell Creek to "determine its physical attributes and fish characteristics" (Carswell, 1979). In September 1979, Envirocon Consultants, under contract to Alcan, conducted a survey on Gosnell Creek as part of an investigation into the possible effects of the Kemano Completion project (report in progress). However, with the creation of the Gosnell Creek Special Planning Area, it became apparent that more detailed fisheries information was required than was available from these previous studies.

In January 1980, discussions between Grant Hazelwood (Northwood Pulp and Timber Resource Biologist) and Mike Lough (Fisheries Biologist for Fish and Wildlife Branch) led to a commitment to jointly participate in a fisheries inventory of the Gosnell Creek watershed. Northwood offered to finance helicopter time and if necessary provide manpower. Fish and Wildlife agreed to provide the inventory team with related equipment and to prepare a report complete with working maps. The objectives of this joint project were as follows:

1. Provide Northwood with extensive fisheries information which could be incorporated into their harvesting and road building plans.

2. Provide Habitat Protection section of Fish and Wildlife Branch with fisheries inventory data upon which they could make specific protection recommendations.

3. Generally increase the Fish and Wildlife Branch level of fisheries information relevant to Gosnell Creek and Morice River.

4. Identify and delineate any fisheries enhancement opportunities for future considerations.

The results of the study are presented in this report and on two maps:

1. A "Fish Sampling Information Map." Biophysical features such as point sample locations, reach breaks, proposed road and bridge locations, waterfalls, etc. have been drawn onto a 1:50,000 topographic map composite of the entire Gosnell Creek watershed.

2. A "Fishery Resource Values Map" depicted on a mylar overlay, to fit over top of the map composite in 1. above.

This map indicates relative fishery values, by species, of streams and lakes within the study area.

Relevant information from the previous inventories has been included.

METHODS

All previous reports were studied and relevant information was plotted onto a 1:50,000 composite field map of the Gosnell watershed. Work for this study was planned so as to "fill in the gaps." It was hoped that time and money would allow for an examination of every stream tributary to the Gosnell.

A helicopter (Bell Jet Ranger 206) was chartered to transport crews and equipment from the Northern Mountain base in Houston to the Gosnell drainage. Creeks previously unsurveyed were flown at low altitudes and low to moderate speeds. Notes describing the general physical characteristics of the streams and a rough habitat evaluation were recorded with a Sony cassett—corder. Photographs were taken of interesting or unusual features. Streams were divided into "Reaches" (homogeneous lengths of a stream) and "Reach—breaks" were denoted on the field map. "Sample Points" were done on creeks which appeared to have potential fish habitat. The purpose of the

sample point was twofold:

1. To determine fish presence by species and relative densities.
2. To describe the physical features of that portion of the stream and evaluate the fish habitat.

Notes describing stream characteristics and habitat evaluations were made onto Resource Analysis Branch "Point Sample Cards" (See Fig. 2).

POINT SAMPLE

CHANNEL		BANK	
FLOOD/SIDE	Nil L M H	% SLOPING	
THREAD	S M	HT. THALWEG (m)	
SLOPE (%)		MAT. TEXTURE	
WETTED WIDTH (m)		VEGETATION (20m)	%
ROOTED WIDTH (m)		CONIFEROUS	
FLOOD PLAIN WIDTH (m)		DECIDUOUS	
VEL	AVG. DEPTH	SHRUBS	
FLOW CHARACTER	P S R B T	GRASSES	
TURB m cm		BARE	
TEMP. AIR WAT. DIEL		CROWN CLOSURE %	
pH D.O.		OVERHANG CLOSURE %	
SUBSTRATE		DEBRIS	L M H
COMP. % F G R		STABILITY	U S
ANG. CLASS R Rs As A			
D90 (cm)	COMPACTION L M H		
AQUATIC VEGETATION			
DOM.			
CODOM			
SAMPLE NUMBER			
ALGAE DENSITY	L M H		
INV. DOM.			
INV. CODOM.			

SYSTEM

SYSTEM NO

REACH NO POINT OF

PHOTO ACCESS

DATE INITIALS

yr mo day time

POINT LOCATION

METHOD	SAMPLE	NO	SPECIES	SIZE RANGE

SAMPLE NUMBER | LENGTH SAMPLED (m)

SHOCKING TIME (sec) | DIFFICULTY L M H

COMMENTS (FISH HABITAT SUITABILITY, STABILITY ETC.)

Fig. 2. Point Sample Card developed by Resource Analysis Branch (Victoria) for inventory of aquatic systems.

Fish presence was determined primarily by electoshocking with a Smith-Root type VIII A Electrofisher. Additional methods

were visual observation and when feasible, angling. Other types of equipment used are listed as follows: a pocket thermometer for air and water temperatures; a Suunto clinometer for determining stream gradient; a 30 meter cloth Eslom tape measure for determining rooted and wetted widths; a 3 meter tape rule for measuring water depths and size of rocks in substrate; and a KONICA C-35 camera for photographic documentation.

Starting June 3, two days were spent walking the North Fork (the major tributary to the Gosnell) from the falls downstream to the Gosnell junction and then down the Gosnell for several miles. The purpose was to locate steelhead spawning sites, by visual observation and/or angling. Northwood was working in the area with a helicopter, so an opportunity was provided to obtain a quick overview of part of the study area, as well as the search for steelhead spawning zones.

The field work schedule was drawn up so that some inventory could be done in the summer with additional work planned later in the fall when stream flows would be lower making sampling easier. Also, it was hoped that adult coho salmon would be spawning and that important sites could be documented. Field inventory dates were August 12-14 and September 23.

RESULTS AND DISCUSSIONS

This section of the report is a brief summarization of information available from previous reports and from this study. More detailed physical descriptions of streams, point sample information and photographic documentation is presented in Appendix A. For brevity, the Point Sample Cards are not included in this report. They are on file in the Smithers Fish and Wildlife office and are available for examination. A glossary of terms used in describing physical characteristics of streams is included in Appendix B.

A. Gosnell Creek Mainstem

The Gosnell is a low gradient, slow-flowing creek which in some portions, meanders extensively. It is often multi—channeled with many side and back channels. In the lower portions, debris accumulations are frequent. The middle to upper regions have extensive swamp—meadow areas.

A total of 17 sample points were done on the Gosnell, with the following species noted: coho, chinooks, cutthroats, Dolly Varden, rainbow trout, whitefish, lampreys, steelhead, and sculpins. The sampling information is summarized in Table 1. Coho were the most abundant species while Dolly Varden were the most evenly distributed having been obtained throughout the length of the mainstem. Pink salmon are present in odd years. (T. Turnbull, pers. com).

Table 1. Electroshocking results of the mainstem Gosnell Creek, taken from three separate studies, June 1978 to September 1980.

REACH	REACH LENGTH (km)	NO. OF POINT SAMPLES	NUMBER OF SPORT FISH SAMPLES BY SPECIES						
			Co	Ch	Ct	DV	Rb	Wt	TOTAL
1	3.2	3	22		1	1	6		30
2	8.3	3	14	2		1	2		19
3	16.5	3	61			6	43	1	111
4	6.4	2				11			11
5	10.2	3	6			22			28
6	8.3	3				13			13
TOTAL	52.9	17	103	2	1	54	51	1	212

* Co — coho salmon
  Ch - chinook salmon
  Ct - cutthroat trout
  DV - Dolly Varden char
  Rb — rainbow trout
  Wt - mountain whitefish

The Gosnell, with its many side and back channels, undercut banks, and slow flows, offers excellent rearing habitat for coho. Gravelled stretches providing good spawning habitat are numerous and scattered through the entire length of the stream.

Appendix C presents a record of annual salmon spawning escapements for Gosnell Creek from 1957 to 1980, (Anon, 1980). It denotes the start of coho spawning on September 15 with a peak on September 30. On September 23, the last day of field work for this project it was hoped that important spawning sites could be identified. However, despite clear water conditions, no adults were observed in the Gosnell from the helicopter. However, several schools of coho salmon, estimated between 800 and 1,000 fish, were seen in the Morice River, slightly downstream from the junction of Gosnell Creek. It is assumed these fish were probably destined for the Gosnell and were waiting for ideal flow conditions to trigger their migration.

A 3 meter waterfall found within the lower end of Reach 5 (Appendix A, Photos 5 & 6) is of particular interest. While it was not considered to be a definite barrier, it could be a difficult point of passage. During adverse flows (stream either too high or too low) it could become a complete barrier to all upstream fish migration. About 15 km of stream offering good rearing and spawning habitat would be provided for coho

and possibly for steelhead if the falls were removed. Angling below the falls during mid-August produced about 15 large Dolly Vardens, up to 2.3 kg (5 lbs), nearly all of which were in spawning condition. (They are late summer—early fall spawners). The water was very clear and many more could be seen in pools for about 100 meters downstream. This vicinity was checked again on September 23, but Dolly Vardens were not present. It was concluded that this area provided important spawning habitat for Dolly Varden char.

B. Crystal Creek

This creek is very unstable and is characterized by extreme fluctuations in water flows and frequent channel relocations in the lower end. A few areas of side channels and debris accumulation provide some rearing habitat for cohos. Further upstream the valley walls become narrower; the stream is more entrenched; gradient is steeper, and fish habitat becomes very marginal. This stream is glacial fed and the water often exhibits a glacial flour colour.

The lower 5 km (Reach 1) provides some limited rearing habitat for cohos and possible Dolly Varden and whitefish. One sample point produced 7 coho salmon. The remainder of this creek offers a very unstable environment in which fish values are considered to be very low.

C. Unnamed Tributaries to Gosnell Creek

An effort was made to examine every tributary which could be seen from the air. Some of the stream beds were dry, and could not be sampled. Others were so small or had such unsuitable fish habitat (gradient too steep, 100% organic substrate) that they were judged to be of little importance. Table 2 summarizes the sampling data of the 14 small creeks which were considered worthy of evaluation. Note that neither rainbows nor whitefish were sampled. Creeks F, G and H were considered to have the highest fishery values. They all contain excellent rearing habitat and potential spawning habitat. Creek E was rated as the next most important stream. It contained good rearing habitat and possibly could support some spawning. Although Creek L had little fishery value, the small lake within this system was found to offer excellent cutthroat fishing. Creek C was assessed as providing moderate fishery values. Creeks A, D, J, K, and N provided limited fish productivity and habitat values were rated low. Creeks, B, I and M, were considered to have no fishery values.

D. North Fork (Cox Creek)

a. North Fork mainstem

The North Fork, also known as Cox Creek, was flown to the headwaters and divided into 6 reaches. The lower portion is braided with some areas of debris accumulations. Further

Table 2. Electroshocking results of the unnamed tributaries to Gosnell Creek, taken from three separate studies June 1978 to September, 1980.

UNNAMED CREEK	NO. OF SAMPLE POINTS	NO. OF FISH SAMPLED BY SPECIES			
		Co+	Ct	DV	L
A	1			3	
B	1	NIL	IL		
C	2	8	10		
D	-				
E	2		2	5	
F	2	8	1	10	6
G	2	4	3	6	4
H	2	14*		2	
I	—				
J	-				
K	1				
L	Lake Angling		15-20		
M	-				
N	-				
TOTALS	13+Angling	34	31-36	26	10

+ Co – coho salmon

Ct – cutthroat trout

DV – dolly varden

L - lamprey

*An estimated 300 juvenile coho salmon were seen in several small pools

upstream the channel becomes straighter, more confined and deeply entrenched. A canyon, several km long, with very high sidewalls is in this area. It has a fairly steep gradient (1½% to 2½%), frequent white water zones, but no barriers. However, just below the Kluck Lake juncture with the mainstem, there is a barrier in the form of a 4 meter bedrock waterfalls. Beyond this, the North Fork meanders through extensive swamp areas then again becomes a single confined channel. It is noticeably smaller beyond the Kluck Lake Tributary. Overall, it has a higher average gradient than the mainstem Gosnell Creek.

The waterfalls have been mapped as a Reach break between Reaches 2 and 3. They are considered a barrier under all flows and mark the uppermost limit of anadromous species like coho salmon and steelhead trout. The water tumbles down in several stages forming a steep cascade. The bedrock is in layers and looks like it would fracture easily. The area around Kluck Lake abounds in slow moving deep pools, with many slackwater side channels which appear to offer good rearing potential for coho salmon. Beyond Kluck Lake, frequent gravel bars, offering potential spawning habitat are scattered throughout the mainstem. There is approximately 16 km of stream above the falls. Removal of the falls offers an opportunity for a stream enhancement project and is discussed in more detail under “Enhancement Opportunities.”

Lough (1980) tracked 2 radio tagged steelhead to their spawning sites on the lower North Fork (Reach 1). They were first recorded on May 19 and were in the North Fork until June 12. The areas they utilized have been depicted on the Fishery Value map as "suspected steelhead spawning zones."

As previously mentioned, the North Fork was walked on June 3 and 4 in an attempt to locate steelhead spawning sites by visual observation and angling. One steelhead was angled from the pool below the falls, but otherwise the river was too high and coloured and little information was obtained.

b. Wolf Creek

"Wolf Creek" was flown to the headwater lakes (where a wolf sighting prompted the naming of this drainage) and was divided into 2 Reaches. Sampling in the lower reach produced cutthroat trout and Dolly Varden. Cutthroats were also sampled in the tributary from the small lake to the north. Just above the confluence to the North Fork the stream becomes confined by bedrock and for about 1 km there are several minor barriers scattered throughout. The gradient is quite steep, and whitewater zones are frequent. In the upper portion of Wolf Creek, the channel becomes less confined and swamp meadow are evident in places. There are a few beaver dams which could further restrict fish movement. Cutthroat trout were angled from

"Wolf Lake" and are suspected in the adjacent lake to the east (fish were seen rising while flying overhead).

Anadromous fish are not suspected in the Wolf Creek drainage because of the lengthy, steep gradient bedrock section in the lower reach.

c. Kluck Lake

Much of the Kluck Lake watershed is typified by deep slow moving pools (especially the Kluck Lake outlet stream), beaver created ponds, abundant debris accumulations, and undercut banks. Cutthroat trout are present throughout most of the drainage (at the lower elevations). In 1975, the Parks Branch netted Kluck Lake and in addition to obtaining 28 cutthroat trout they also got 26 mountain whitefish. The overall fish productivity of the lake is considered to be moderate (Osmond-Jones, 1975).

The inlet stream to Kluck Lake provides good rearing habitat and appears to have some potential spawning habitat. Unnamed Creek 0, with some beaver activity, provides good rearing habitat, but limited spawning potential. The lake in the headwaters of this stream is a shallow swamp, and no signs of fish were seen while flying overhead. Unnamed Creek P exhibited frequent signs of beaver activity and overall fish productivity was rated low.

The Kluck Lake drainage appears to provide the type of habitat which would be readily utilized by rearing coho juveniles. However, beaver dams could result in a restriction of fish movements. If the falls were blown on the mainstem North Fork, allowing cohos access into Kluck Lake area, it may be necessary to monitor beaver activity to allow fish passage at critical times.

ENHANCEMENT OPPORTUNITIES

1. Removal of waterfalls on mainstem Gosnell Creek

The waterfalls in the lower end of Reach 5 present a point of difficult passage for fish (Appendix A, photos 5-7). Under certain flow conditions, they could even be a barrier. The falls are about 3 meters high and 5 meters wide and are primarily bedrock controlled. A debris jam has accumulated on the left bank (looking downstream) and a large log extends part way across the top of the falls. It appears to create an additional ½ meter of height. Removal of the debris jam or even just the log could result in lowering the water column. A deep plunge-pool (estimated depth 4-5 meters) is at the base of the falls and would enable fish to gain momentum for leaps.

There is about 15 km of stream beyond the falls which offers potentially good rearing and spawning habitat for coho and steelhead. To date, 6 sample points above the falls have produced a total of 35 Dolly Varden and one of them yielded 6 coho salmon (juveniles). The area immediately below the falls is a very important section of Gosnell Creek. It is utilized in August by large spawning Dolly Varden (up to 2.5 kg). This should be kept in mind when considering the relative merits of this proposal. There is the possibility that removal of the

falls could alter stream flows and subsequently have an adverse effect upon the quality of the spawning habitat.

A dynamite expert should be brought in to examine the falls and determine the feasibility of removal. The Department of Fisheries and Oceans has expressed an interest and is presently considering to undertake the project. (D. Meyers, pers. com.)

2. Removal of waterfalls on the North Fork

The falls are located at the Reach 2 map symbol, about 9 km from the mouth of the North Fork (see Appendix A, Photos 17-19). They are a series of cascades about 4 meters high and 7 meters across. The rock is in a series of layers, and looks like it would easily fracture. They are considered to be a complete barrier to fish. To date, anadromous fish have been found up to, but not beyond the falls.

There is about 16 km of stream above the falls which has good rearing habitat and many gravel patches potentially suitable for spawning. The Kluck Lake system, which abounds in slack water and deep pools, offers especially good rearing habitat for coho salmon. However, cutthroat trout, up to 40 cm length, are plentiful in this area. They are quite predaceous and could be a limiting factor the survival of newly introduced coho or steelhead juveniles. Additionally, beavers are fairly

active in this area and could result in a restriction of fish movement.

Removal of these falls in a manner which will allow upstream fish passage appears to be a much more difficult task than removal of the previously described falls on the Gosnell mainstem. This is primarily because they are not a single vertical drop, but as mentioned, are a series of cascades or steps. Although vertical height is estimated at 4 meters, the sloping, distance could be as much as 7 meters. None of the steps hold enough water to allow fish to rest while leaping upstream from ledge to ledge. It would appear that a large, deep, pool would have to be blasted out about half way up so that fish could negotiate the falls with 2 leaps, resting in between each jump. This might prove to be a very difficult task.

The falls should be examined by a dynamite expert to determine the possibility of blasting to allow for fish passage.

3. Steelhead Colonization above the waterfalls after their removal.

A. North Fork

Removal of a barrier waterfalls will not necessarily mean that steelhead will immediately utilize the newly accessible habitat. Unlike coho salmon which often ascend as far

upstream as they can get, steelhead are unpredictable and may not move beyond the site of the old barrier. Consequently a fry colonization above the removed barrier is desirable to ensure creating a race of steelhead which will return as adults.

A previous Fish and Wildlife study revealed that 2 radio-tagged steelhead spawned in 2 different locations on the lower North Fork Creek in Reach 1, and that for steelhead it was one of the more important streams in the Morice River watershed (Lough, 1980). This spring, a steelhead was angled from the pool at the base of the falls. This information is cited as concrete evidence that steelhead trout presently utilize the North Fork as far upstream as the falls. On the basis of this evidence, it would seem that a steelhead fry colonization above the falls could be a viable enhancement project. This is, of course, assuming the falls can be successfully altered to allow upstream fish passage.

B. Gosnell Mainstem

It is not presently known to what degree steelhead utilize the Gosnell mainstem beyond the North Fork junction. More work is needed to answer this question before colonization above these falls should be considered.

AREAS OF SPECIAL CONCERNS

Despite all the work that has been done so far within the Gosnell system, there is still much that is unknown. However, a great deal of valuable information has been gathered and some areas of special importance to fish have been identified.

1. The Gosnell junction with the Morice

This area comprises a stretch of the Morice River for about 1 km both above and below the Gosnell confluence. It is a special area because anadromous fish which are destined to ascend Gosnell Creek will "hold" in this water until conditions are favourable for their departure. Additionally, there are several good deep pools within this stretch which are utilized by overwintering adult steelhead. It would be desirable to avoid any road access into this area.

2. The lower portion of the North Fork (Reach 1)

A radio-telemetry study has traced 2 steelhead to their spawning sites on the North Fork (Lough, 1980). These areas are depicted as steelhead spawning zones on the mylar overlay map and should be protected accordingly.

3. The waterfalls on the North Fork

These falls are a barrier so consequently fish tend to "stack up" in the 1arge pool immediately downstream. Here,

they are quite vulnerable to angling. Roads should be kept away from this spot.

4. The North Fork junction with the Gosnell

This is the same type of situation as described in 1. above and the same rationale for protection can be applied.

5. The waterfalls on the mainstem Gosnell Creek.

This area is vitally important for 2 reasons:

a. As a point of difficult passage, fish will tend to congregate in the pools below the falls, and are vulnerable to angling.

b. The stream below the falls, for at least 100 meters is utilized by many large spawning Dolly Varden in August.

It is strongly recommended that this area be avoided by developments and that no type of access should be provided.

SUGGESTED FUTURE WORK

1. The barrier waterfalls on the mainstem Gosnell Creek and on the North Fork should be examined to determine the feasibility of removal.

2. Additional work should be undertaken to learn the extent to which steelhead utilize the mainstem Gosnell beyond the North Fork junction. This would likely entail a radio telemetry study which would be expensive and time consuming.

3. The stream below the falls on the mainstem Gosnell Creek should be examined in August to determine the full extent to which it is utilized by spawning Dolly Varden.

4. More work should be done on the North Fork to identify steelhead spawning zones and to quantify numbers of steelhead using the stream.

CONCLUSIONS AND RECOMMENDATIONS

1. The Gosnell Creek is an undeveloped watershed which has high fishery values for coho salmon, Dolly Varden char, cutthroat trout and steelhead trout. It is strongly recommended that through all stages of development the water quality be maintained and that all stream crossings be constructed to allow for fish passage under all flow conditions at all times of the year.

2. Many of the small tributary streams to the mainstem Gosnell provide good fish habitat. Too often in the past, the value of small streams has been overlooked or neglected. It is important to understand they are necessary, even critical, to the survival of fish through various development stages. They should be stringently protected, especially in the lower reaches. The Fish Sampling map shows the approximate location of main haul roads well away from the valley bottom. It is hoped these locations are approved.

3. A waterfall on the upper portion of the mainstem Gosnell presents a point of difficult fish passage. Removal by dynamite presents a habitat enhancement opportunity and should be further investigated.

4. The Gosnell below the falls in 3. above is an important area for large spawning Dolly Varden. All development access (roads, trails, clear—cuts) should avoid this area in order to protect the spawning fish. Further work is recommended to determine an estimate of the spawning population and the length of stream being utilized.

5. Crystal Creek appeared to a wildly fluctuating stream and the road crossing should be constructed to accommodate great extremes in stream flows.

6. The North Fork has been identified as an important spawning stream for steelhead. Further work is recommended to obtain more information regarding verification of key spawning and rearing, areas, and estimates of the numbers of fish utilizing, the system.

7. The waterfalls in the North Fork are a barrier to upstream fish movement. Their removal appears to be a possible habitat enhancement project and should be further investigated.

8. If the falls are successfully removed as per 7 above, another enhancement project to be considered is a steelhead fry colonization. There is a good population of large

cutthroats above the falls, however, and their effect upon transplanted steelhead fry would have to be considered.

9. The Morice River at the Gosnell confluence; and the Gosnell Creek at the North Fork confluence are of special importance because coho and steelhead “hold” in these two areas prior to migrating upstream to spawn. Additionally, the Morice near the Gosnell confluence is utilized by overwintering adult steelhead. It would be desirable to avoid road construction in these areas.

ACKNOWLEDGEMENTS

M. O'Neil collected field data and helped compile the two complementary maps. B. Allan provided information, made recommendations regarding map format and reviewed the maps. D. Meyers and T. Turnbull provided information. Northwood Pulp and Timber Limited provided financial assistance to make the study possible. Special thanks are extended to G. Hazelwood who was primarily responsible for initiating the project. M. Whately reviewed this report and the maps. Colleen Mushta worked extra hours to type this report.

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APPENDIX A

SUMMARY OF STREAM DESCRIPTIONS, SAMPLING INFORMATION AND PHOTOGRAPHIC DOCUMENTATION

A. GOSNELL CREEK MAINSTEM

Reach 1 - (mouth to R1)

- length 3.2 km

— great degree of lateral movement of stream bed resulting in a braided multi-channelled stream

— many areas of debris jams and dead snags as a result of constant channel movement

— many back and side channels

— good coho rearing habitat in slackwater areas

- navigation by river boat would be very difficult

- 3 point samples yielded 22 coho, 1 cutthroat, 1 Dolly Varden, 6 rainbows and "many" lampreys

Reach 2 — (R1 to R2)

- length 8.3 km

— single, confined, channel

— mostly moderate entrenchment, but some zones of steep sidewalls

— many deep runs and pools -

- flow mainly placid

- Northwood proposed bridge crossing sites in this reach

- 3 sample points produced 14 coho, 2 chinooks, 1 Dolly Varden, 2 rainbows and 2 lampreys

Reach 3 (R2 to R3)

— length 16.5 km
— wide valley bottom

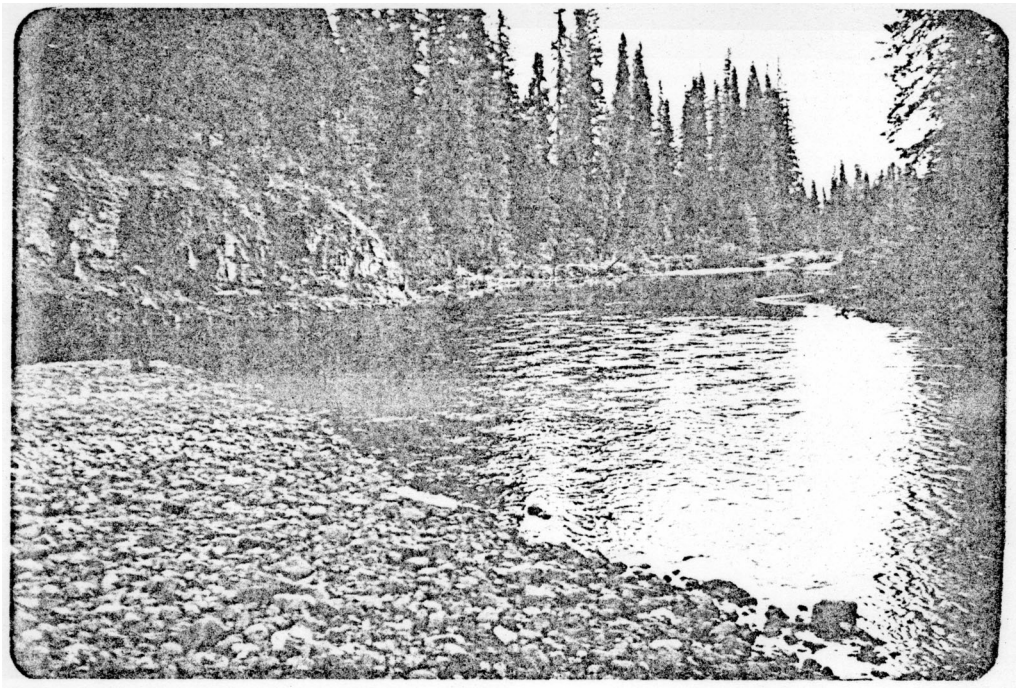


Photo 1. Gosnell Creek. Looking downstream at Northwood proposed bridge site No. 1. (August 13, 1980).

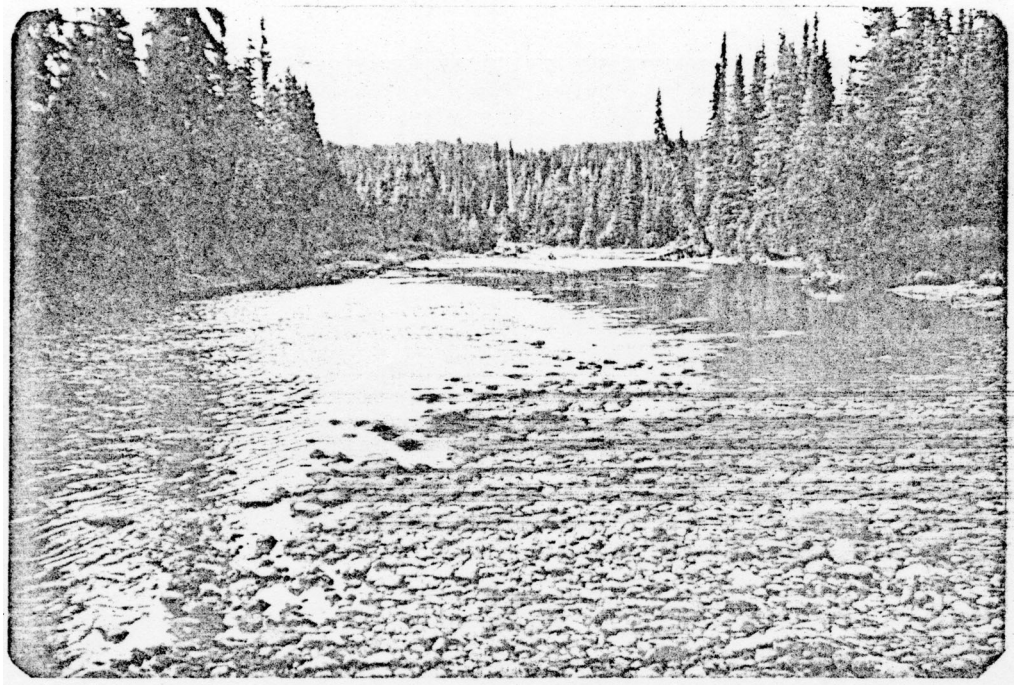


Photo 2. Gosnell Creek. Looking upstream from Northwood proposed bridge site. No. 1. (August 13, 1980).

Reach 3 (con't)

- frequent meandering, some ox-bows
- abundant back and side channels
- good rearing habitat for coho
- many areas of in-stream debris accumulations
- gravel bars frequent
- many areas suitable for spawning
- extensive swamp meadows adjacent to stream
- 3 point samples produced 6.1 coho, 6 Dolly Varden, 43 rainbows and 1 whitefish

Photo 3. A portion of Reach 3 on Gosnell Creek. Note the debris accumulation and the swamp meadow. (August 12, 1980).

Photo 4. Within Reach 3, about 2 km downstream from mouth of North Fork. Note the high flows at this time of the year. (June 4, 1980)

Reach 4 (R3 to R4)

- Length 6.4 km
- frequent debris accumulations
- stream noticeably smaller
- slow moving flow, with some deep pools
- gravel bars abundant
- 2 point samples yielded 11 Dolly Varden

Reach 5 (R4 to R5)

- length 10.2 km
- stream channel becomes narrower, more confined and more deeply entrenched

- coniferous trees right to stream edge

- steeper gradient

- substrate contains a greater proportion of large rocks

- 3 meter falls at lower end of reach; not considered a barrier, but certainly a point of difficult fish passage; removal of falls is a possible habitat enhancement project

- many large Dolly Vardens seen and angled below falls for as far as was walked (about 100 meters). They were in spawning condition. This area is very important Dolly Varden spawning habitat.

- 3 point samples (electroshocking) produced 6 coho (above the falls) and 22 Dolly Varden.

Photo 5. Aerial view of 3 meter falls at lower end of Reach 5, on Gosnell Creek. (August 12, 1980).

Photo 6. Ground view of falls at lower end of Reach 5, on Gosnell Creek. (August 14, 1980).

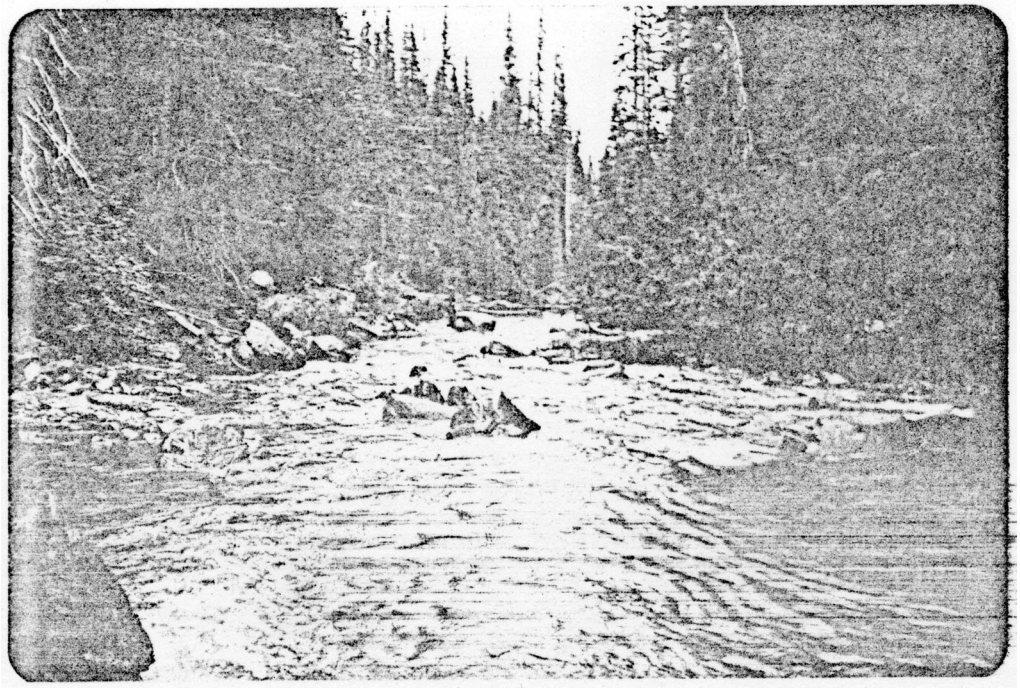


Photo 7. Looking downstream from the falls on Gosnell Creek. This area is critical spawning habitat for Dolly Varden. Note the gravels in the lower right portion of photo. (August 14, 1980)

Reach 6 (R5 to headwaters)

- length 8.3 km
- for the most part, valley bottom is wide, swampy meadows abundant
- frequent side channels
- meandering stream
- low gradient
- 3 point samples yielded 13 Dolly Varden

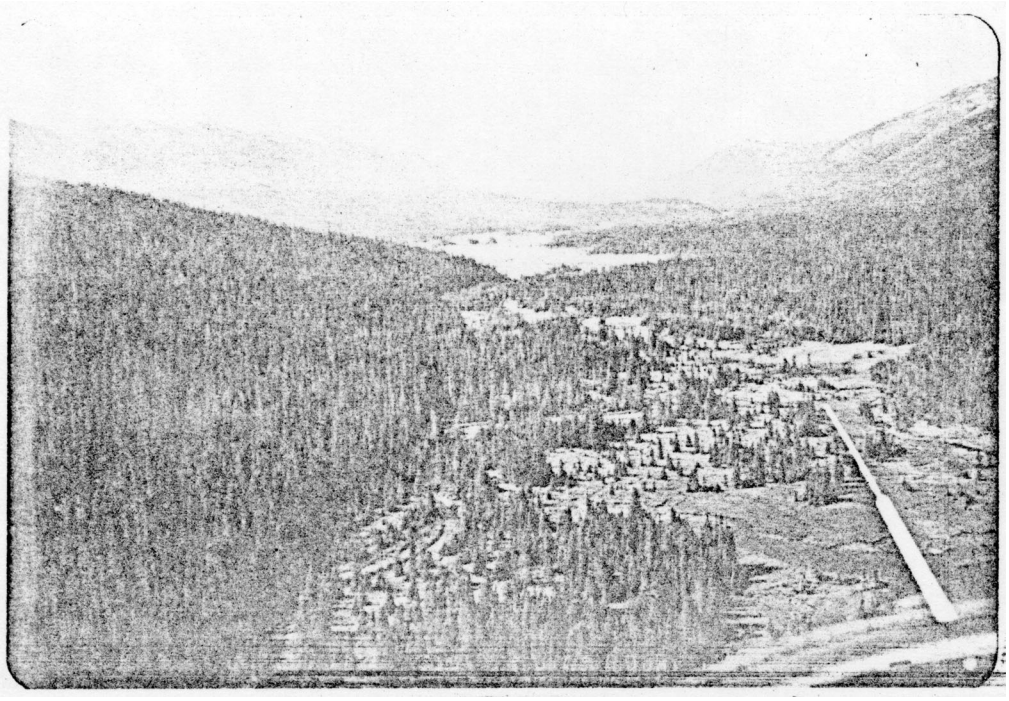


Photo 8. Near the headwaters of Gosnell Creek (August 12, 1980)

B. CRYSTAL CREEK

Reach 1 - (mouth to R1)

- creek is a delta where it joins Gosnell
- wetted width occupies about 20% of total channel width, indicating extreme fluctuations of stream flows and great lateral movement of stream bed.
- water "glacial – flour" coloured
- low entrenchment
- few flood or side channels
- frequent, unstable debris accumulations
- Northwood proposed bridge crossing site in this reach
- limited rearing habitat for coho and possibly Dolly Varden and whitefish
- 1 sample point produced 7 cohos

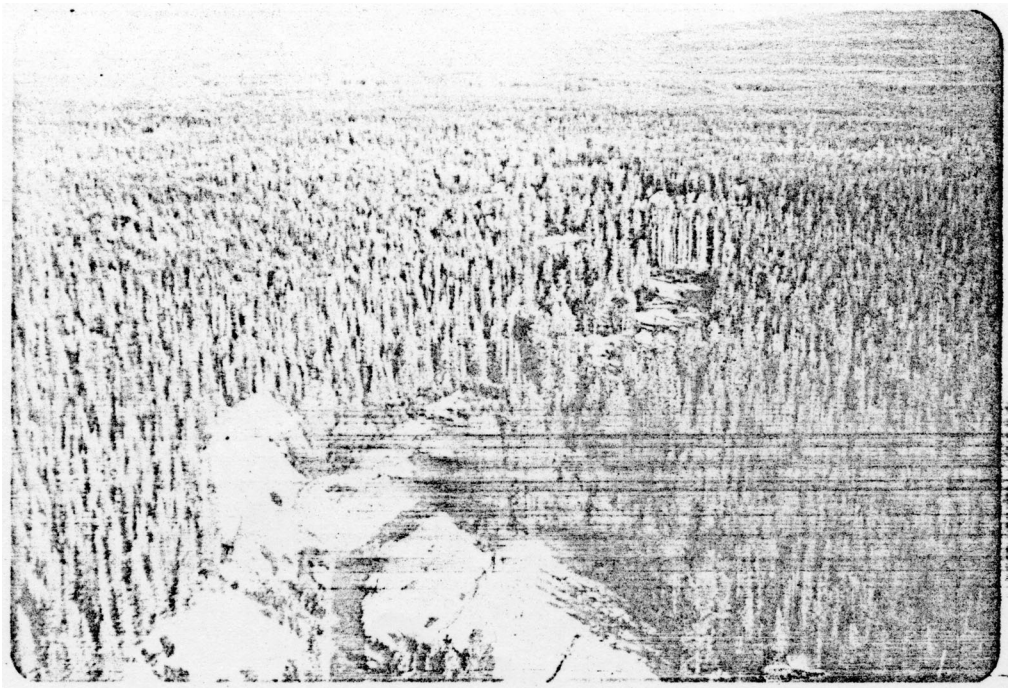


Photo 9. Lower portion of Reach 1 in Crystal Creek. Looking downstream. Note the wetted width occupies only about 1/5 of stream channel. (August 12, 1980)

Reach 2 - (R1 to headwaters)

- stream confined and more deeply entrenched by steeper valley walls
- much steeper gradient (5 to 20%)
- stream channel relatively straight
- boulders and large rocks more frequent in substrate
- several glaciers in headwaters
- very poor fish habitat
- fish presence unlikely

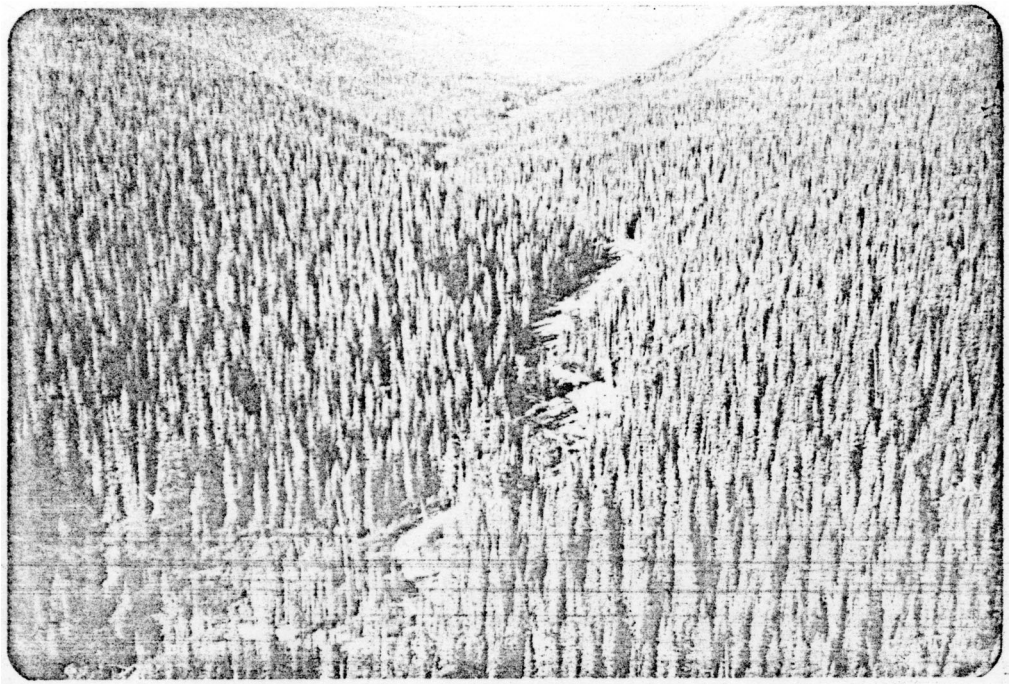


Photo 10. Lower portion of Reach 2 in Crystal Creek, looking upstream. (August 12, 1980.

C. UNNAMED TRIBUTARIES TO GOSNELL CREEK

Unnamed Creek A

- wetted width 1 meter
- average depth 10 centimeters
- silty bottom
- limited fish habitat
- electroshocking yielded 3 Dolly Varden

Unnamed Creek B

- stream not shown on N.T.S. 1:50,000 maps
- wetted width 1 meter
- average depth 10 centimeters
- no flow — "dead" water
- creek flows through a swamp channel;is 1½ meters deep, 1 meter wide
- substrate 100% muck
- several old beaver dams, probably barriers
- very poor rearing habitat
- electroshocking produced no fish

Unnamed Creek C - (mouth to Rl)

- stream incorrectly mapped on N.T.S. 1:50,000 maps. It terminates into beaver pond to the west rather than directly into Gosnell
- gravel substrate – possible spawning potential for coho and cutthroat
- wetted width 1½ meters

- spruce forest, open banks of willow along stream edge

- sampling yielded 8 coho and 10 cutthroats

- good fish habitat

(R1 to lake)

— old Beaver Dam at Lake outlet.

— closer vegetative canopy

— stream more entrenched; steeper side walls

— more instream debris

— rubble substrate with coarse sand

- suspected habitat for coho and cutthroat; not quite as good as previous reach

— small fish observed below beaver Dam (G. Hazelwood, pers, com.)

(small lake)

— fish seen rising (G. Hazelwood, pers. com.)

- angling yielded no fish

— lake is shallow, very soft bottomed

- fish probably overwinter in outlet/inlet streams

(inlet to small lake)

- substrate mainly organic matter

- vertical stream banks

- grass vegetation to stream edge

- wetted width 2 meters

- average depth 31 centimeters

- electorshocking produced no fish

Unnamed Creek D

— organic substrate

— closed spruce canopy

— possible rearing habitat in summer, but not in fall

— marginal, limited, fish habitat

Unnamed Creek E
Reach 1 - (mouth to R1)

— larger than previous 4 streams

— debris moderate and stable

— confined channel

— good gravels, some bars present

- potential spawning habitat in places

- sampling yielded 4 Dolly Varden and 2 cutthroats

Trib to R1 (from small lake to E)

- lake outlet undefined through alder swamp

— organic bottom

— no apparent flow

— poor fish habitat

Reach 2 — (R1 to end)

- this creek is the one flowing from the west

— more swampy than previous reach

— substrate contains more organic matter

- lower quality rearing habitat

- electroshocking produced only 1 Dolly Varden

Trib to R2

— this creek flows from the east

— much smaller stream, about 1/5 flow of mainstem

- small pockets of gravel
- open stream channel to upper swamp system
- some possible fish habitat

Creek E is one of the important unnamed tributaries to Gosnell Creek. The lower portion (Reach 1) has better fish habitat than the upper section.

Unnamed Creek F
Reach 1 - (mouth to R1)

- confined, single channel
- wetted width 3 meters
- fairly steep gradient
- stable creek

Photo 11. Unnamed Creek F near junction with Gosnell Creek. (August 12, 1980)

— gravels present; also large boulders

— possible spawning habitat

- good rearing habitat

- sample point produced 10 Dolly Varden, 8 coho, 1 cutthroat and 6 lampreys

Reach 2 - (R1 to end of all tributaries)

- often multiple channel

— organic streams to lakes area could not be followed by air

— beaver dams abundant

— marshes plentiful

- poor fish habitat

- electroshocking failed to capture any fish

— no outlet to small lake (see map notation)

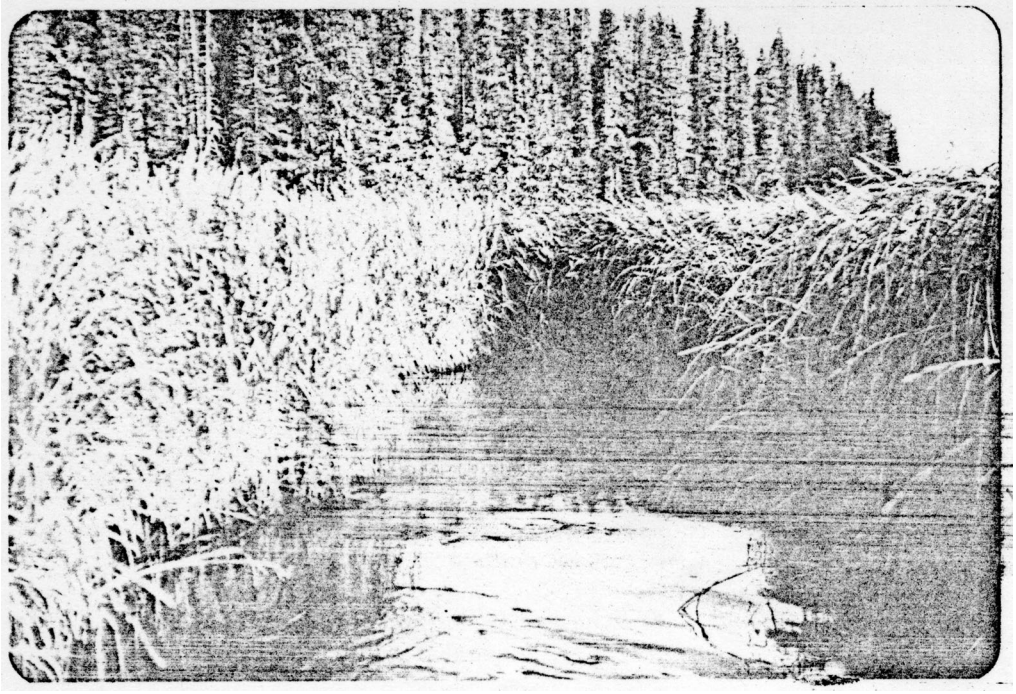


Photo 12. Unnamed Creek F in Reach 2 (August 14, 1980)

- inlets to small lake have no fishery value

The lower portion of Unnamed Creek F has good fish habitat. It is one of the more important unnamed tributaries to Gosnell Creek.

Unnamed Creek G

- stable, meandering stream
- some pockets of gravel
- some beaver dams present
- previous flights indicated meadows flood in spring so access is likely possible
- 2 Dolly Varden observed holding in gravel area. Possibly they were spawning
- 2 sample points produced 4 coho, 3 cutthroats, 6 Dolly Varden and 4 lampreys
- this is one of the more important unnamed tributaries to Gosnell Creek

Unnamed Creek H

- slow moving stream
- abundant marsh fringes
- stream bed composed of organic matter with patches of gravel scattered throughout
- frequent undercut banks
- good rearing habitat and possible spawning habitat
- electroshocking produced 14 coho juveniles while about 300 more were observed

Reach 2 — (R1 to lake)

— wetted width 4 meters

— gravel abundant

— debris moderate and stable

- good rearing and spawning habitat

- sampling produced 2 Dolly Varden, but no cohos

— suspect beaver dams in marsh area downstream are probably a barrier

- debris jam at lake outlet

— outlet was dry down to trib coming from the south

- suspect cutthroat trout in the lake (ripples observed in the water while flying over)

Photo 13. At Sample Point in lower end of Reach 2 on Creek H. Note the abundance of Gravels. (August 14, 1980)

Unnamed Creek I

— this one is considered to be representative of some of the other unsurveyed northern tributaries to the Gosnell

— gullies present, but defined stream channel absent

— spring—summer run—off course

— water dissipates into ground when it reaches Gosnell valley bottom

— no fishery values

Unnamed Creek J

— confluence with Gosnell is an alluvial fan

— some gravels present

- possible spawning and some limited rearing habitat

— further upstream gradient increases; possible rearing for Dolly Varden to base of mountain

— no point samples done on this creek

Unnamed Creek K

— lower end is alluvial fan similar to J

— possible spawning in fan area

— mainstem could support rearing for Dolly Varden and whitefish

- electroshocking produced no fish

Photo 14. Unnamed Creek K at sample point site (August 14, 1980)

Unnamed Creek L

- inlet stream dissipates into sedge periphery of lake
- small lake located about 1 km upstream of larger lake
- stream does not provide fish habitat
- larger lake provides excellent angling for cutthroat trout, up to 40 centimeters in length
- outlet of lake drops steeply over clay bank down to Gosnell Creek. It was dry August 14, but may allow fish passage during higher water flows.

Photo 15. North Fork of Gosnell Creek in Reach 1. (August 12, 1980.)

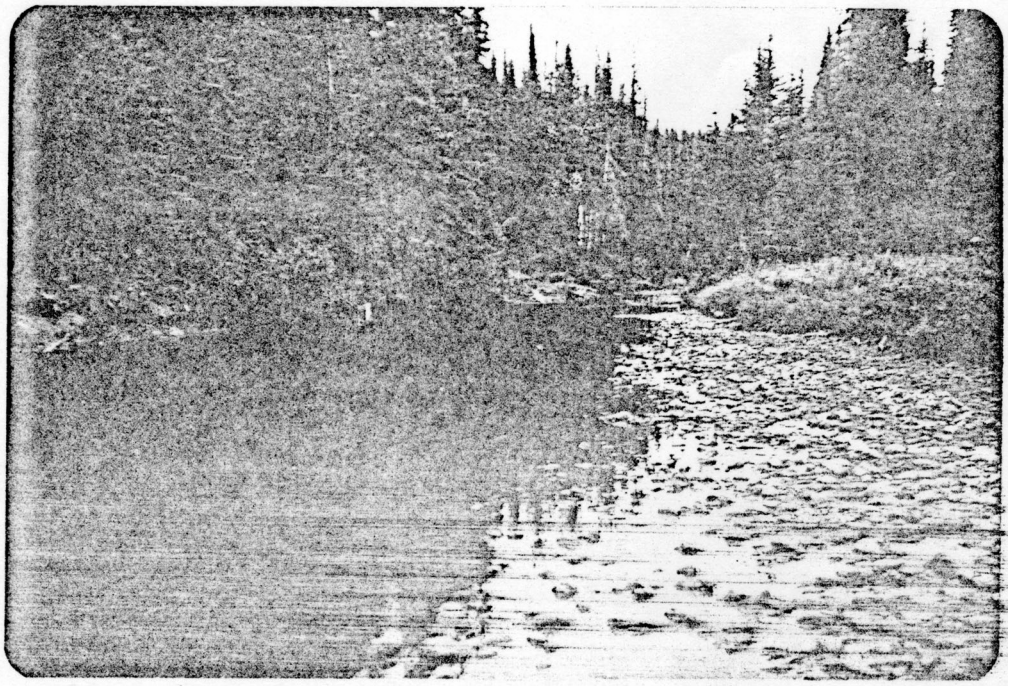


Photo 16. Proposed bridge crossing site on North Fork (Cox Creek) of Gosnell Creek. (August 13, 1980)

Unnamed Creek M

— no stream present in topographic depression

- no fish habitat values

Unnamed Creek N

— inlet streams to meadow not visible from the air

- fish are probably present in the section flowing through meadow

— isolated pools of water in the drainage

— probably marginal fish habitat

D. NORTH FORK (COX CREEK)

a. Mainstem

Reach 1 - (mouth to R1)

— very low flows

— frequent gravel bars

— several debris accumulations

— good rearing habitat

- 2 areas where radio tagged steelhead were spawning

— bridge crossing site in this reach

- 2 sample points produced 13 coho and 2 lampreys

- lamprey redds indicate spawning in this, reach

Reach 2 - (Rl to R2)

- straighter, more confined channel
- steeper gradient
- greater percentage of larges in substrate
- extensive canyon area — no barriers
- 4 meter bedrock cascading falls at upper reach boundary
- falls considered to be a barrier — removal could be a possible habitat enhancement project
- 1 sample point (electroshocking) yielded 18 coho, 33 rainbows and 1 Dolly Varden. In addition, angling at several various times in pool below falls has produced whitefish, steelhead, cutthroats and Dolly Varden.

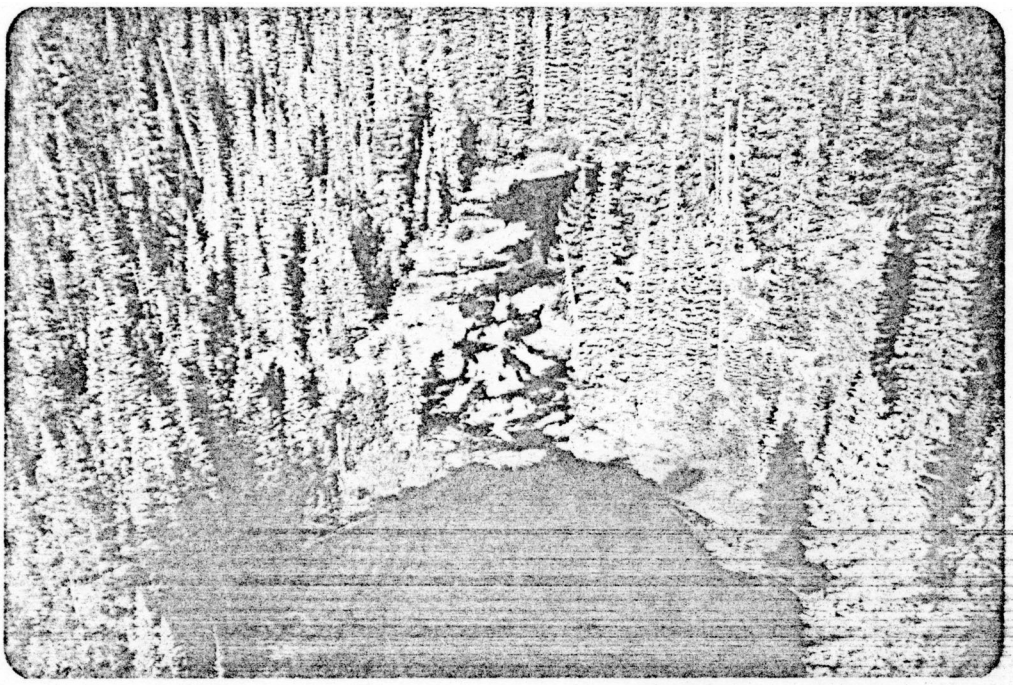


Photo 17. Aerial view of the falls on the North Fork of Gosnell Creek. Note the large pool at the base of the falls. This pool receives fairly heavy fishing pressure from people transported by helicopter. (August 12, 1980)

Reach 3 — (R2 to R3)

— stream meanders through extensive swamp areas

— channel not always well defined

— shrubs and grasses to stream edge

- good rearing habitat for cutthroat and coho

— angling in this reach yielded several large cutthroat up to 30 centimeters length

— no anadromous species found above the falls

— electroshocking just above the falls produced 1 Dolly Varden and 1 cutthroat trout

Reach 4 - (R3 to R4)

— creek becomes more confined

- single thread channel

— gravels abundant - good spawning habitat

— slightly steeper gradient

— some areas of large boulders in upper reach

— good rearing habitat

- 2 sample points yielded 10 cutthroats and 11 Dolly Varden

Reach 5 (R4 to R5)

- gradient less steep

- higher frequency of flood/side channels

- stream not always single channel

— several zones of slumping banks

— still good rearing habitat

— many gravel patches offering good spawning potential

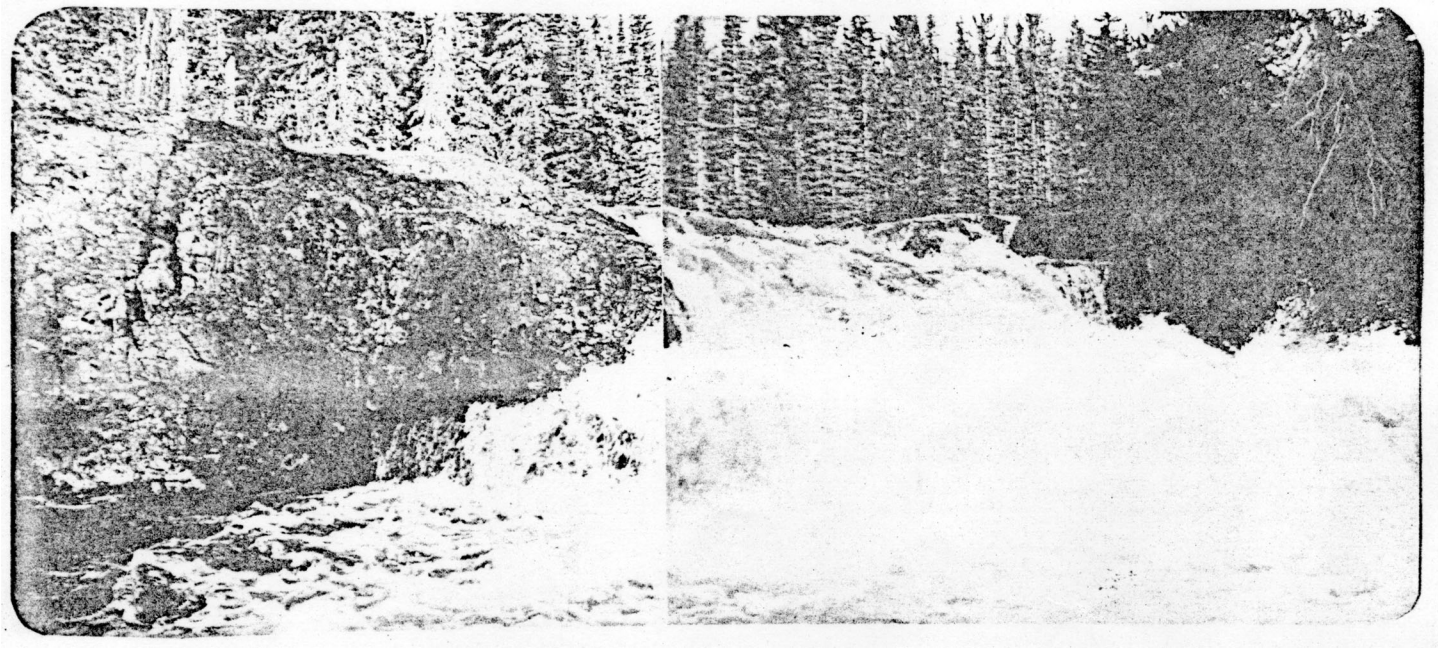


Photo 18. Falls on North Fork during high flows (June 3, 1980)

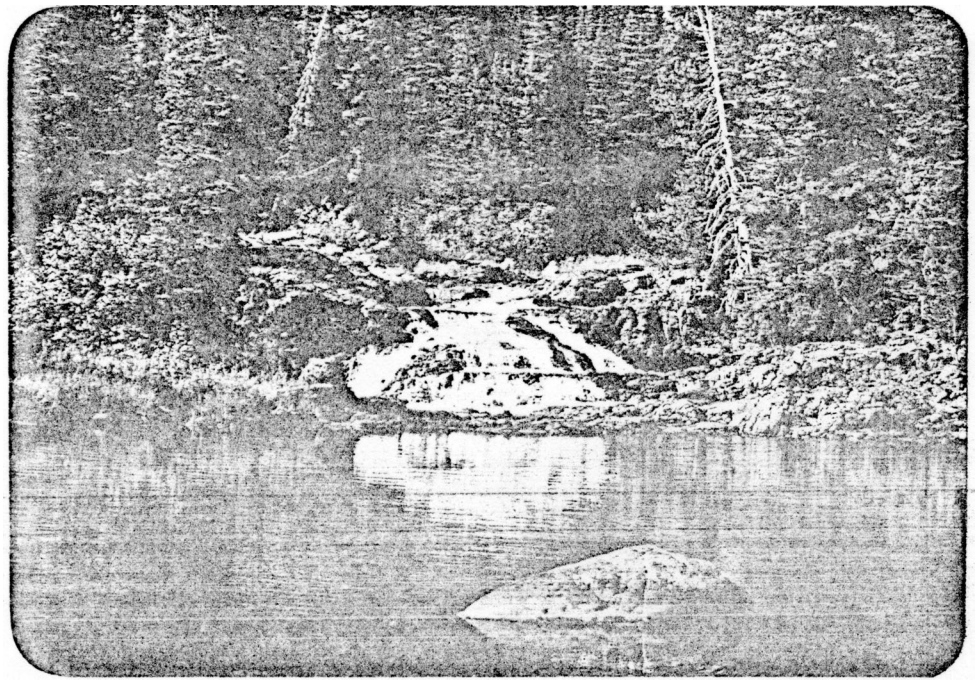


Photo 19. Falls on North Fork during 1ow flows (August 13, 1980)
(Photo courtesy of G. Hazelwood)

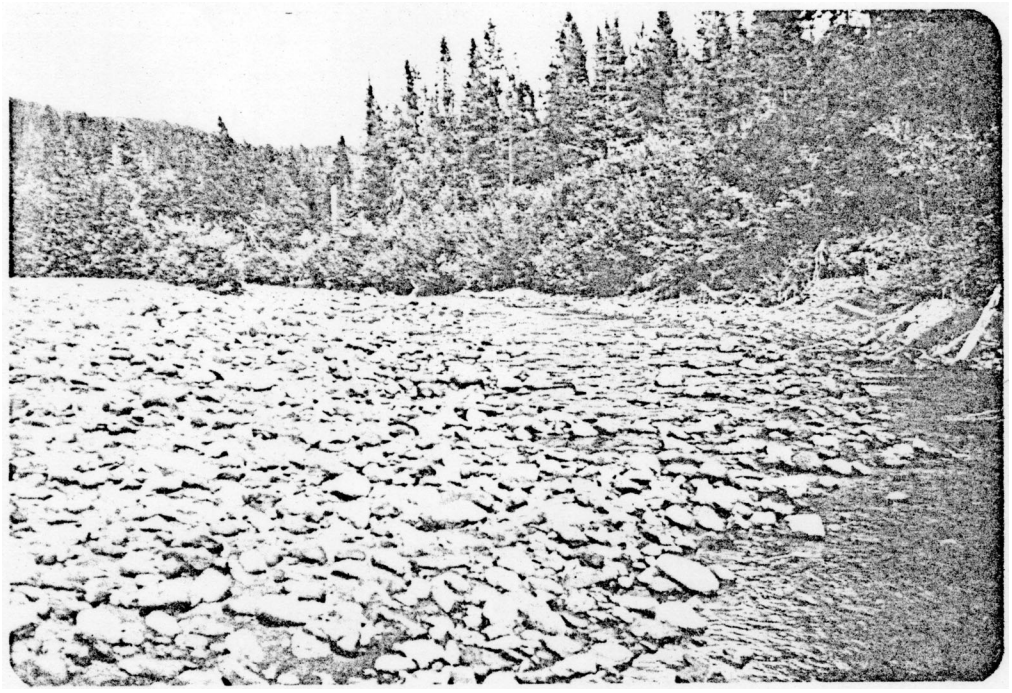


Photo 20. North Fork in upper part of Reach 4 (August 13, 1980)

Reach 6 — (R5 to headwaters)

- grasses and shrubs to stream edge
- fish seen rising in first lake - suspect they are cutthroat
- lily pads grow extensively on north side of lake indicating shallow depth
- stream between the two lakes is a channel through swampy marshland
- suspect cutthroat trout in second lake

Photo 21. Near headwaters of North Fork Creek just downstream from the lower lake. (August 12, 1980).

Unnamed northern tributary to Reach 6

- steep gradient
- nearly dry
- channel difficult to see from air
- — low fishery values, except for lower portion where cutthroats are suspected

b. “Wolf Creek”

- a wolf sighting on the western lake of the two near the headwaters resulted in the naming of this unnamed creek.

Reach 1 — (mouth to R1)

- confluence area has no defined channel

- immediately above, stream is confined by bedrock

— minor barriers scattered throughout for about 1 km. This probably restricts anadromous fish, especially during low flows

- sampling produced cutthroat trout and Dolly Varden in mainstem and cutthroat trout in tributary from small lake

— some beaver dams in vicinity of sample point

Reach 2 — (R1 to two large lakes)

— stream channel not so confined

— less bedrock

— some marsh areas adjacent to creek

— signs of beaver activity

— cutthroat trout angled in western (Wolf) lake and suspected in the other lake.

c. Kluck Lake area

- Most of the following information has been taken from Osmond-Jones, 1975.

Kluck Lake Outlet stream

— slow flowing stream

— some beaver dams

- abundant log debris

- open banks and food holding pools provide excellent opportunities for angling

- cutthroat trout abundant

— no spawning habitat

Kluck Lake

— maximum depth 18 meters (55 feet)

— gravel and sand patches near east shore

— most of shoreline has sedge, grasses and alder vegetation

- little reduction in dissolved oxygen with depth

— overall productivity considered to be moderate

- likely could support a sizeable sport fishery

- netting yielded 28 cutthroat trout, 26 mountain whitefish and 7 longnose suckers.

Kluck Creek (inlet to Kluck Lake)

— small creek

— frequent debris accumulations

— some large boulders

— some gravel bars

- reportedly good spawning and rearing potential

— numerous fry observed — thought to be cutthroat

- other fish, thought to be redside shiners, also observed.

— no spawning habitat at small lake outlet stream

- headwater lakes probably have cutthroat

Unnamed Creek O

Reach 1 - (lake to R1)

- very small stream (wetted width 1 meter)

— very frequent debris accumulations

- extensive meandering through flat meadow—land
- some gravel bars
— frequent signs of beaver activity — probably restricts fish movement
- excellent rearing habitat
— some spawning habitat
— cutthroat fry identified
— no adult fish seen

Reach 2 - (R1 to headwaters)

- stream channel more confined
- steeper gradient
- no signs of fish seen while flying over lakes
- lake is more like a swamp

Unnamed Creek P

— frequent signs of beaver activity
- limited spawning gravel
- productivity considered to be low
- some cutthroat (20 to 25 cm) observed
— beaver dams likely restrict movements

APPENDIX B

GLOSSARY OF TERMS

FROM

AQUATIC SYSTEM INVENTORY AND ANALYSIS

RESOURCE ANALYSIS BRANCH

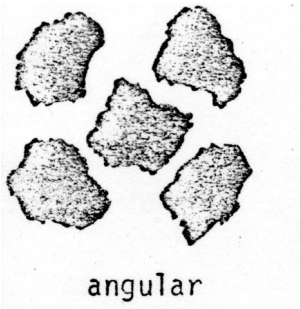
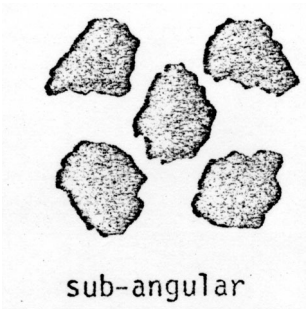
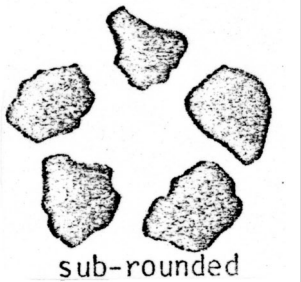
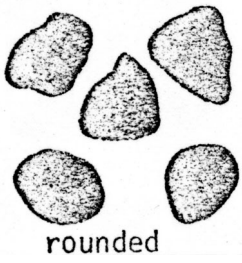
MINISTRY OF THE ENVIRONMENT

VICTORIA, B.C.

1977

The definitions of terms used in this glossary are from various sources: Arnette (1976) has been followed whenever possible; wetland classes indicated by * are provisional and dependent on the evolving Canada Wetland Classification; definitions of angularity class and texture are from the Terrain Classification System (1976); other terms follow standard texts or procedures.

angularity class - - The degree of roundness refers to the sharpness of edges and corners of a particle.

 angular	 sub-angular	A particle is angular and subangular if most of the edges and corners are sharp.
 sub-rounded	 rounded	A particle is rounded and subrounded if most of the edges and corners are smooth.

Note: Roundness should not be confused with sphericity; e.g. a nearly spherical particle may have sharp corners and be angular, while a flat pebble may not be spherical but still be well rounded as to its corners. See texture.

aquatic vegetation —- plant life growing in or on the water. Dominant (DOM) and co-dominant (CODOM) vegetation is identified by common name, species or genus.

average depth -- at a point cross-section, the average depth of water when multiplied by the width, equals the cross-sectional area. Measurements across the channel width should be made if access permits.

bank -- the rising ground bordering a stream channel below the level of rooted vegetation and above the normal streambed and designated as right or left facing downstream. See bank vegetation %, channel and texture.

bank vegetation % - - the percentages of ground coverage of each vegetation class found within 20 meters of the bank. Total may be greater than 100%. See overhang, and crown closure.

bank, % sloping - - the estimated length of banks that slope less than 45^0 (100% slope) expressed as a percentage of total bank lengths.

barrier - — an obstruction to all fish movement at all flows. Species specific and flow dependent barriers are mapped as obstructions.

bed - - bottom of a watercourse. See bed % and channel.

bed % - - the percentages of substrate classes found on the bottom of stream at a point sample. See substrate, composition.

*bogs - - bogs are peat-covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, chiefly Sphagnum. The water table is at or near the surface in the spring, and slightly below during the remainder of the year. The mosses often form raised hummocks, separated by low, wet interstices. The bog surface is often raised, or if flat or level with the surrounding wetlands, it is virtually isolated from mineral soil waters. Hence the surface bog waters and peat are strongly acid and upper peat layers are extremely deficient in mineral nutrients. Peat is usually formed in situ under closed drainage and oxygen saturation is very low. Although bogs are usually covered with Sphagum, sedge may grow on them. They may be treed or treeless, and they are frequently characterized by a layer of Ericaceous shrubs.

cascade - — a series of small steps or falls. Total height and length are mapped when available.

channel - - a natural or artificial waterway of perceptible extent which periodically or continuously contains moving water. It has definite bed and banks which serve to confine the water in a single (S) or multiple (M) thread. Also see cross-section, form and entrenchment.

channel stability — — the relative amount of channel migration caused by cutoffs, diversions and meander development as determined from an analysis of sequential aerial photographs and ground observations. Channel stability indicators are mapped as reach characteristics at 1:20,000 scale only:

- s single channel; usually entrenched and stable
- m single channel; regular meandering on a marshy flat, stable
- p single channel; regular, meandering non-catastrophic instability (i.e. gradual downstream progression)
- c single channel; irregular meandering, catastrophic instability (channel shifts by cutoff of meanders or diversion)
- b multiple channel; braided, non-catastrophic instability (channel shifts continuously by minor progressive cutoff and diversion)
- d multiple channel; catastrophic instability (channel stable or migrating slightly for long periods; infrequently new channels are formed by cutoff or diversion process)
- v single channel; stabilized by vegetation.

chute - — a confined and inclined section of stream channel usually with bedrock substrate and high velocity, smooth flowing water. Total height and length (m) are mapped when available.

complex reach - — contains a repetitive sequence of two identifiable reach types. A Reach Tally card is completed for each type and the reach symbol is complexed (see text).

cross-section types - — the section of the stream channel taken perpendicular to the stream centerline. Using the 1:50,000 scale, three cross-sectional types are differentiated:

confined (c) : the channel is entrenched or lateral movement is controlled at high and regular flows by banks,
bounded (b) : channel movement or flooding is limited by valley walls near the edge of the floodplain,
unconfined (u): the channel is not bounded by valley walls and much lateral movement or flooding is possible at high flows.

Using the 1:20,000 scale, channel cross-section types are increased to the following:

confined (1:20,000)
- C Canyon; bedrock entrenched
- V Ravine; unconsolidated material or incompetent bedrock

unconfined (1:20,000)
- E Steep ephemeral; unconfined on a steep bedrock slope
- F Fluvial fan
- P Wide floodplain channel(s)
- S Slough; unconfined tributary channel on a valley flat

bounded (1:20,000)
- B Narrow floodplain constricted between terrace scarps or valley wall
- D Depression wetland other than a lake along the course of a channel.

crown closure - - the closure over a stream created by overstorey vegetation. It is expressed as a percentage of the channel area so covered.

Debris - - allochthonous organic materials deposited within the floodplain. The abundance of debris is described as low, moderate or high. Debris that has been transported or is in the process of being moved is unstable (u). Anchored debris is considered stable (s). See obstructions.

D90 - - the diameter of substrate which is larger than 90% of the remainder.

entrenchment - - the degree of stream incision resulting from fluvial processes. See channel.

ephemeral stream - - a stream that wholly or partially disappears during dry periods.

*fens - - fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base. They are covered by a dominant component of sedges, although grasses and reeds may be associated in local pools. Sphagnum is usually subordinate or absent, with the more exacting mosses being common. Often there is much low to medium height shrub cover and sometimes a sparse layer of trees. The waters and peats are less acid than in bogs of the same area, and sometimes show somewhat alkaline reactions. Fens usually develop in restricted drainage situations where oxygen saturation is relatively low and mineral supply is restricted. Usually very slow internal drainage occurs through seepage down very low gradient slopes, although sheet surface flow may occur during spring melt or periods of heavy precipitation.

flood channel — — a channel that contains water at high flows. The channel may be connected to the main stream and is characterized by water of low velocity. Spatial occurrence is described as being nil, low (L), moderate (M) or high (H).

floodplain — - the flat land bordering a stream and subject to periodic flooding. It is constructed by the process of the present stream. See floodplain width.

floodplain width - — the width of the flat land bordering a stream that shows obvious signs of flooding and/or channel shift. See floodplain.

flow character - — the surface expression of the water that is determined by water velocity, volume and substrate. It is described at the time of survey as:

placid - tranquil, sluggish
swirling - eddies, boils, swirls,
rolling - unbroken standing waves
broken - riffles, rapids, jumps
tumbling - cascades, usually over large boulders or rock outcrops.

More than one term may be used to describe flow character.

form - - the appearance of the channel pattern within a reach. It is described as:

Straight (S) – little or no curving
Irregular (I) – no clear pattern of lateral movement
Meandering (M) – clear pattern of lateral movement identified by formation of oxbows or winding curves. Pattern ranges from tortuous to curving.

height thalweg - - the thalweg is a line connecting the deepest points in a stream channel; the height of the thalweg at a point is the vertical distance between the deepest point and the top of the stream bank.

invertebrates - - aquatic macro-invertebrates. Usually identified are insects by family and other arthropods, annelid worms and molluscs. Dominant (DOM) and next most common (C0D0M) are noted.

karst - - a comprehensive term applied to limestone or dolomite areas that possess a topography peculiar to and dependent upon underground solution and the diversion of surface waters to underground routes.

mainstream azimuth - - the angular distance in, the horizontal plane measured clockwise from true north to the stream outlet from the stream head.

*marshes - - marshes are grassy, herb dominated wet areas, periodically inundated up to a depth of 2 m or less with standing or slowly moving water. Surface water levels may fluctuate seasonally, with declining levels exposing drawdown zones of matted vegetation or mud flats. Marshes are subject to a gravitational water table, but water remains within the rooting zone of plants during at least part of the growing season. The substratum usually consists of mineral or organic soils with a high mineral content, but there is little peat accumulation. Waters are usually circumneutral to alkaline, and there is a relatively high oxygen saturation. Marshes characteristically show zonal or mosaic surface patterns of vegetation, comprised of unconsolidated grass and sedge sods, frequently interspersed with channels or pools of open water. Marshes (may be bordered by) peripheral bands of trees and shrubs, but the predominant vegetation consists of a variety of emergent non—woody plants such as rushes, sees, reedgrasses and sedges. Where open water areas occur, a variety of submerged and floating aquatic plants flourish.

obstruction - — any object or formation that may impede, block, or hinder waterfiow and/or fish migration. Types distinguished are falls, cascades/chutes, beaver dams, culverts, velocity and other barriers. Height(m) is mapped when available, (see text). See barrier.

overhang closure -- the closure over a stream created by understorey vegetation within 1 m of normal water surface. It is expressed as a percentage of the channel area.

point sample - - a spot sample on a stream. The point may be defined in any useful manner, such as a very short reach (area visible at a road crossing or helicopter landing site), a particular bank channel or a single bank (for water sample site, beach seining, etc.).

point number - - (Point of) is a non-repetitive number within a coded watershed system. Numbers are accessed in the data file in combination with the system and reach number. Point numbers are placed on the map at this point.

*pond - — a body of still water, smaller than a lake.

pool control % - - the percentage of each factor which controls the occurrence of pools in a reach.

profile - - a description of the longitudinal profile of the stream channel. At a 1:50,000 scale, it will be stepped (s) which is a repetitious sequence of slopes or forms (such as pool-riffle, confined-unconfined), or regular (r), which is a continuous or homogeneous profile (such as all rapids). At a 1:20,000 scale, profile is assumed regular and not mapped.

reach - — the basic biophysical mapping unit for the Aquatic Systems Inventory. It is characterized by relatively homogeneous properties which will vary according to the scale of the survey. Properties are homogeneous within the reach and include slope, channel and/or biological parameters. See complex reach.

reach number — - is the distance in km from the system mouth to the lower reach boundary (see Digitizing). The distance is correlated with map and data file information. See reach sequence number.

reach tally card - - a tally of average values for a reach i.e. values represent estimates of substrate composition and descriptions of form, profile and cross-section etc. for the entire reach. See Table 2.1, text.

reach sequence number — - reaches are numbered sequentially upstream from the mouth (1, 2...n). These numbers are mapped at the upstream reach boundary symbol. It is correlated with data file information. See reach number.

riffle - - a shallow rapid in a stream, where the water surface is broken into waves by obstructions wholly or partially submerged. A riffle may be drowned out at high water.

rooted width - - the width of the stream channel between rooted vegetation on either bank.

*shallow open water — — shallow open water which is locally known as pond or slough, is relatively small, non-fluvial body of standing water occupying a transitional stage between lakes and marshes. In contrast to marshes, these waters impart a characteristic open aspect, with proportionately large expanses of permanent surface water that lack emergent cover, except for relatively narrow zones adjoining shorelines.

side channel - - a channel connected to the main stream at low and high water. It is characterized by low velocity flows. Spatial frequency is described as being Nil, low (L), moderate (M),or high (H).

sink — - the point at which a stream disappears into fluvial material. -

slope - - a) Reach Slope

the length of reach divided by the change in elevation between the downstream and upstream ends of the reach. Derived from topographic maps, it is expressed to the nearest 0.1% between 0% and 3%, and to the nearest 1% above 3%.

b) Point Slope

the slope at a point as read from a clinometer to the nearest 0.5%

slump -- - active mass wasting of surfical material from banks or valley walls into stream channels. Length of the slump is mapped and digitized (see text).

substrate - - the material 20-30 cm deep that comprises the stream bed. See substrate composition.

substrate compaction - - the relative density or looseness of substrate caused by sedimentation, mineralization and/or imbrication. See substrate.

substrate composition - — three size ranges are identified at 1:50,000 and expressed as a percentage of total substrate:

fines (F) 0-2 mm
gravels (G) 2-100 mm
rock (R) bedrock

A fourth category, larges, is computed as a residual and is material larger than 100 mm but not bedrock: L=10-F-G-R. At 1:20,000 the D90 diameter is added to the reach symbol.

substrate stability - — flowing water causes the movement of the stream substrate. An indication of the mobility of the substrate is the presence of:

braiding (Brd.) - anastomosing stream flow,
bars (Bar) - deposits of sand and gravel which are built up and removed by stream flows,
islands (Is) - distinguished from bars by being composed of consolidated or unconsolidated material and supporting well-established vegetation.

*swamps - - are woody plant dominated where standing to gently flowing waters occur seasonally or persist for long periods at the surface. Frequently there is an abundance of pools and channels indicating subsurface water flow. The substrate is usually continually water-logged. Waters are circumneutral to moderately acid in reaction, and show little deficiency in oxygen or in mineral nutrients. The substrate consists of mixtures of transported mineral and organic sediments or peat deposited in situ. The vegetation cover may consist of coniferous or deciduous trees, tall shrubs, herbs and mosses. In some regions, Sphagnum may be abundant.

texture - - the size, roundness and sorting of particles in unconsolidated clastic sediments.

1. Descriptive terminology

Specific Clastic Terms		Common Clastic Terms	
b	bouldery	a	blocky
k	cobbly	r	rubbly
p	pebbly	g	gravelly
s	sandy	f	fines
~~s~~	silty		
c	clayey		

2. Definition of Common Clastic Terms.

Blocky: An accumulation of angular particles greater than 256 mm in size.

Rubbly: An accumulation of angular particles with a size range of 2-256 mm, but may include interstitial sand.

Gravelly: An accumulation of two or more size ranges of rounded particles greater than 2 mm but may include interstitial sand.

Fines: A mixture of silt and clay; may also contain a minor fraction of fine sand.

3. Application of the Specific and Common Terms in the Textural Classification of Clastic Sediments.

<table>
<tr><td colspan="2">SIZE (mm)
ROUNDNESS</td><td>mm 256</td><td>64</td><td>2</td><td>.062</td><td>.0039</td></tr>
<tr><td rowspan="2">SPEC-IFIC</td><td>ROUNDED</td><td>BOULDERY</td><td>COBBLY</td><td>PEBBLY</td><td colspan="3"></td></tr>
<tr><td>ROUND or ANGULAR</td><td colspan="3"></td><td>SANDY</td><td>SILTY</td><td>CLAYEY</td></tr>
<tr><td rowspan="3">COMMON</td><td>ROUNDED</td><td colspan="4">GRAVELLEY</td><td colspan="2"></td></tr>
<tr><td></td><td colspan="5"></td><td>FINES</td></tr>
<tr><td>ANGULAR</td><td>BLOCKY</td><td colspan="4">RUBBLY</td><td colspan="2"></td></tr>
</table>

a. No more than two specific and/or common terms will be used together, e.g. pebbly rubble or sandy cobble.

b. A subordinate textural component will not generally be shown if it constitutes less than 25% of the total volume of the deposit.

thread — - a line created by the directional flow of a stream within the main channel(s). It is classified as single (s) or multiple (m). See channel.

total pool % - - the amount of pool area in a reach expressed as a percentage of the reach area. See pool control.

turbidity - - the clarity of the water as measured by the depth to which the bottom is still visible.

velocity - - the time of rate of motion; the distance traveled divided by the time taken to travel that distance. On the point sample card it is the chip or surface velocity unless a current meter is used. Method of measurement should be noted.

visibility - — the distance (m) which a swimmer with face mask can see underwater.

watershed - - the area drained by a particular stream or lake. If a watershed boundary is mapped, the watershed has a code number and associated information in the data file.

_____ Major watershed boundary e.g. 23 Pine River; two digit watershed code.

- - - Sub-watershed boundary e.g. 23-0400 Sukunka River; tributary to Pine River. (Six digit watershed code).

---- Minor watershed boundary e.g. 23-0400=040 Burnt River; tributary to Sukunka. Also, 23-0400-040-010 Brazion Creek; tributary to Burnt River. See Appendix