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# 1977 Chinook Investigations Associated with the McGregor River Diversion

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Fisheries and Marine Service  
Manuscript Report #1529

1977 CHINOOK SALMON INVESTIGATIONS  
ASSOCIATED WITH THE MCGREGOR RIVER  
DIVERSION

by

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## ABSTRACT

Diversion of the McGregor River flow from the Pacific draining into the Arctic drainage has been considered for power generation and flood control by B.C. Hydro and Power Authority. Investigations to determine the environmental impacts of this scheme to the Fraser River system were conducted in 1976-77 by B.C. Hydro while the Fisheries and Marine Service directed efforts toward the chinook early life history, smolting behaviour, and timing information of the McGregor stocks spawning in the headwaters. A mainstem spawning race of chinook was recorded for the first time. Preliminary investigations indicate significant chinook production may result from the overwintering sub-populations that were captured in May. On January 24, 1978, B.C. Hydro and Power Authority publically advised postponement of the project due to the possibility of transferring chinook salmon parasites to Arctic fish species. This action was precipitated largely by the discovery of the fish pathogen *Ceratomyxa shasta* in spawning chinook specimens.

This report documents all available information pertaining to the salmon fisheries resource in the McGregor River system.

## RESUMÉ

La B.C. Hydro and Power Authority envisage de détourner les eaux de la rivière McGregor, qui appartiennent au bassin du Pacifique, vers le bassin de l'Arctique afin de produire de l'électricité et de maîtriser les inondations. Cet organisme a mené en 1976-1977 des études concernant les incidences environnementales du projet sur le réseau du fleuve Fraser, alors que le Service des pêches et de la mer orientait ses travaux vers le début du cycle biologique du saumon quinnat, le comportement du smolt et l'évolution temporelle des stocks de la McGregor qui frayent dans son cours supérieur. On a pour la première fois observé une souche principale de reproducteurs chez le saumon quinnat. Les premières études montrent qu'une partie importante de la production de cette espèce peut être le fait des sous-populations capturées en mai après avoir passé l'hiver dans le cours d'eau. Le 24 janvier 1978, la B.C. Hydro and Power Authority a annoncé publiquement le renvoi à plus tard du projet à cause du risque de transfert de parasites du saumon quinnat à des espèces arctiques. Cette mesure a été précipitée par la découverte de l'agent pathogène *Ceratomyxa shasta* chez des spécimens de saumon quinnat en phase de reproduction.

Le rapport expose tous les renseignements connus sur les ressources de saumon du réseau de la rivière McGregor.

## 1. INTRODUCTION

### 1.1 Location, Project Description and Historical Perspective

The McGregor Diversion Project, as proposed by B.C. Hydro and Power Authority (B.C.H.P.A.) would have required the construction of a 140.2 meter earthfill dam in the Lower McGregor River Canyon (Plate 1). A 5,167 sq. km. reservoir would have been created and the flow forced over the James Creek divide to supplement the G.M. Shrum Generating Station, Site 1, and any additional generating sites that are eventually constructed downstream on the Peace River system. Average hydroelectric benefits at the G.M. Shrum and Site 1 generating stations would increase by approximately 360 additional MW with downstream sites C and E proposals boosting the potential to 485 MW, (B.C. Energy Board, 1972).

The McGregor River and its main tributary, Herrick Creek, are located near the western divide of the Rocky Mountains and arise from glaciers (Figure 1). Both systems flow northwesterly before flowing westerly through the Dezaiko Range and joining the Fraser River approximately 63 km. northeast of Prince George, British Columbia. James Creek is a tributary to Herrick Creek and has its headwaters in a series of three lakes separated by a low divide (Plate 2). Portage and Pacific Lakes (water surface elevation 749 m) drain southeast via James Creek into the McGregor River while Arctic Lake (water surface elevation 743 m) flows northeast into the Parsnip River in the Arctic drainage system. The narrow continental divide between these lakes rises to 757 m.



Plate 1 . Downstream view of the McGregor River Diversion Dam Site.



Plate 2 . The Arctic and Pacific Continental Divide , indicating  
Mcgregor Diversion Route .



Diversion of the McGregor River was considered primarily to reduce the flood threat to Lower Fraser River communities. The McGregor diversion would divert that river's flow through this divide.

Following the 1948 Fraser River flood, joint studies by the Federal and Provincial governments resulted in the 1963 report entitled "Flood Control and Hydroelectric Power in the Fraser River Basin". This report recommended the implementation of several schemes, designated "System E", which included the McGregor Diversion. The McGregor River project would divert about 25 percent of the total regulated portion of flood flow under the "System E" scheme and the McGregor mean flow represents 10 percent of the Fraser freshet at Hope. A later report by the B.C. Energy Board (1972) outlined how the McGregor Diversion hydro benefits could be integrated into British Columbia energy growth forecasts. B.C.H.P.A. commissioned International Power and Engineering Consultants (I.P.E.C.) to further the feasibility planning of the project in 1973.

Renewable Resources Consulting Service Ltd. was contracted by B.C.H.P.A. in early 1976 to investigate the fisheries implications and mitigation possibilities of project development. An inventory of fish species distribution and a study to delimit the potential for harmful parasite transfer between the Pacific-Arctic watersheds was initiated.

As a result of these studies a decision was made by B.C. Hydro and Power Authority in January, 1978 to postpone their Water Licence application. Their expressed reason related specifically to the potential consequences of transferring Pacific parasites into the Arctic drainage. A certified fish pathogen, *Certomyxa shasta*, found in spawning McGregor chinook salmon had the potential to infect Arctic fish species as a result of the diversion plan. The threat of floods remain and further consideration could still be given to the construction of a dam on the McGregor River at Lower Canyon for purposes of diversion to the Peace system, or for a non-diversion flood control project.

2. PURPOSE AND SCOPE OF THE FISHERIES AND MARINE SERVICE 1977 SALMON INVESTIGATIONS

Chinook salmon, *Oncorhynchus tshawytscha*, (Walbaum, 1792), largest of the Pacific salmon, spawn in the headwaters of the Fraser River and most of its major tributaries. The early life history of the majority of chinook races propagating in the Upper Fraser River have not been investigated thoroughly due in part to the inaccessibility of most of these regions. Recently, however, based on limited information contained in the 1963 Final Report by the Fraser River Board, International Power and Engineering Consultants Ltd., consultants to B.C.H.P.A., suggested fish-water release flows for chinook salmon downstream of the proposed dam site (I.P.E.C. 1973; IV-8). All chinook stocks

propagating above the dam site would be eliminated as a result of flooding of their spawning grounds. Compensation for any loss of McGregor fish stocks downstream of the dam site was suggested in the form of spawning channels or hatcheries.

It is the purpose of this report to document all available information pertaining to the salmon fisheries resource in the McGregor River. In the event of future project implementation or alternate non-diversion flood control schemes, flow release requirements will centre on the chinook life history, and knowledge of this life history, particularly smolting behavior and timing information, would be crucial for establishing the proper compensatory facilities required for those chinook races propagating above the dam site. Investigations to define these aspects more precisely were undertaken in 1977 by the Water Use Unit, Habitat Protection Division of Resource Services Branch.

The 1977 study concentrated on the distribution and escapements of spawning chinook within the McGregor River drainage. Special efforts were expended to determine whether mainstem spawning existed. The residency period of chinook juveniles was examined in spawning tributaries. In addition, dissolved oxygen concentrations were sampled during January 11-18, in all systems with potential spawning capacity in the McGregor drainage area.

The mainstem of McGregor River and Herrick Creek were earlier suspected to be unsuited to salmon spawning due to the heavy silt load maintained from spring breakup through to fall freeze-up. However, unseasonably mild temperatures during the winter of 1976-1977 and abnormally low snow and ice accumulation provided a rare opportunity for Fisheries and Marine Service staff to view extensive reaches of the McGregor River and Herrick Creek substrate. This survey revealed the existence of favourable gravel substrate throughout the mainstems of these streams which compared favourably to the known spawning areas in James Creek.

3. STATUS OF KNOWLEDGE OF CHINOOK SALMON  
IN THE MCGREGOR RIVER TO 1976

Chinook salmon were known to spawn in Seebach, Otter, Captain, James and Fontoniko creeks. There was no record of mainstem chinook spawning prior to 1977 and no other salmon species was known to migrate into or spawn in the system. The 1976 escapement to the four spawning tributaries located above the proposed Lower Canyon dam site was estimated by the Fisheries and Marine Service to be 0, 50, 500 and 250 in Otter, Captain, James and Fontoniko creeks, respectively; (pers. comm., J. Tuyttens, F.O., Prince George). Seebach Creek, the only spawning tributary below the dam site, supported approximately 200 salmon. The total chinook escapement to this system was reported to be 3,000 in the 1963 "Final Report of the Fraser River Board"; however, the 1955-72 estimated average of tributary chinook spawning was 614, Fisheries and Marine Service (1974).

Earlier historic information passed on from trappers and natives indicate 10,000 salmon may have utilized these accessible spawning areas of the McGregor drainage; (pers. comm., J. Tuyttens, F.M.S., Prince George; Fraser et al. (in prep.)).

#### 4. MATERIALS AND METHODS

##### 4.1 Juvenile Investigations

A full stream juvenile trapping facility and fyke net traps were installed on James Creek (Figure 2) commencing construction on April 30, 1977. The structure was prefabricated by Fisheries and Marine Service staff and transported by helicopter to the trapping site. Plate 3 illustrates the "W" trap design that operated on James Creek. Rectangular frames constructed of 2" x 4" lumber were screened with 1/4" square galvanized wire mesh to form 8' x 3' sections. A 3-foot wide - (10 mil) plastic apron was stapled to the bottom of each fence section to minimize bed scour and erosion. All screened fence units were joined together, anchored and braced with 3/4" reinforcing steel and further held in place with sandbagged abutments. Additional stability was provided by crossbracing the "V"-shaped areas with studs. From the downstream apex of each trap, a 2.6 meter long trough, constructed of plywood, was attached to receive the concentrated flow and smolts into a 4' x 3' x 3' weighted plywood holding pen. The upper receiving half of this pen was baffled from the downstream portion providing a relatively quiet holding area. These details are illustrated in Plates 4 and 5. This trap was operated intermittently during the freshet period April 30 - June 21, 1977 and continuously between August 19-28, 1977.

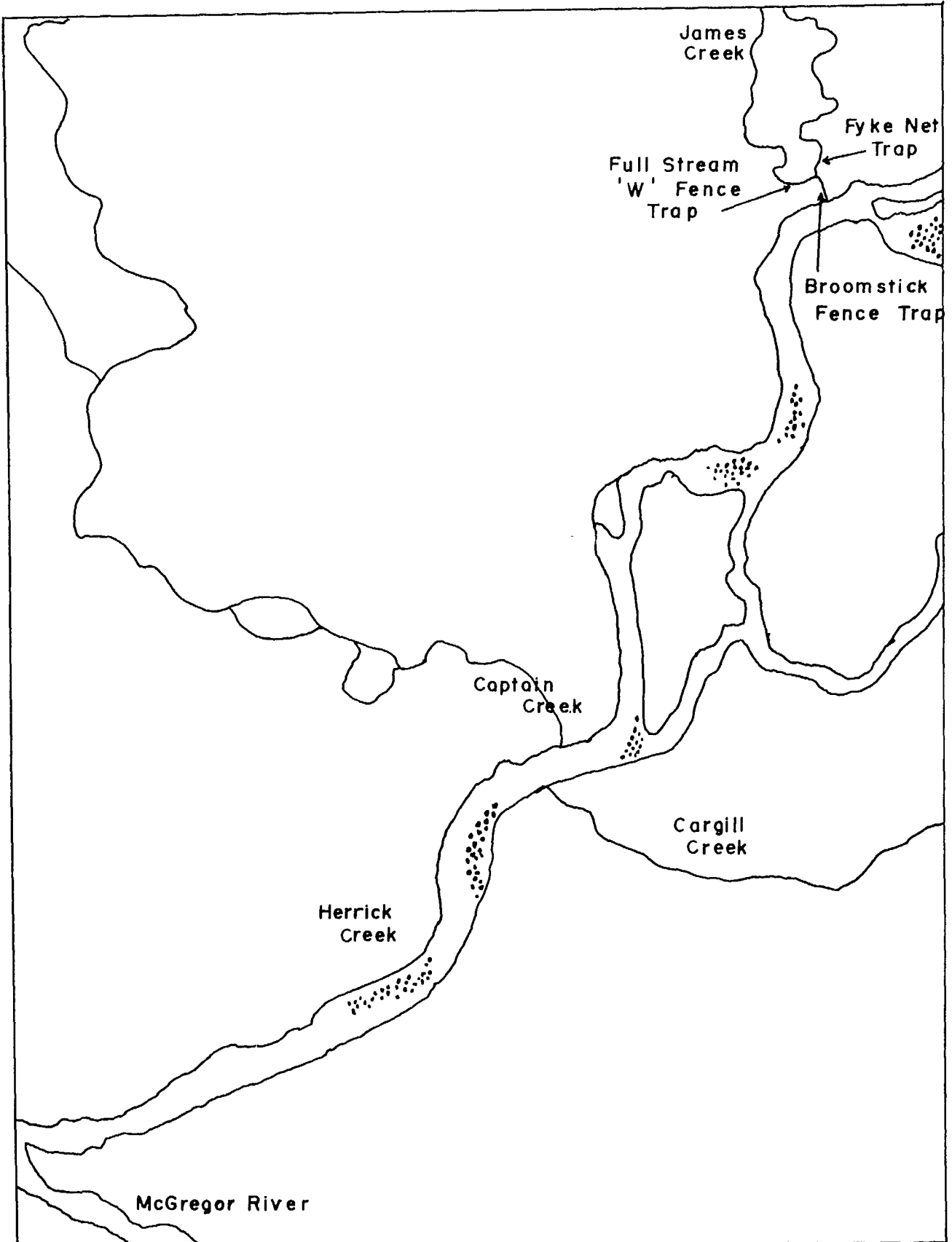


Fig. 2. James Creek Trap Locations

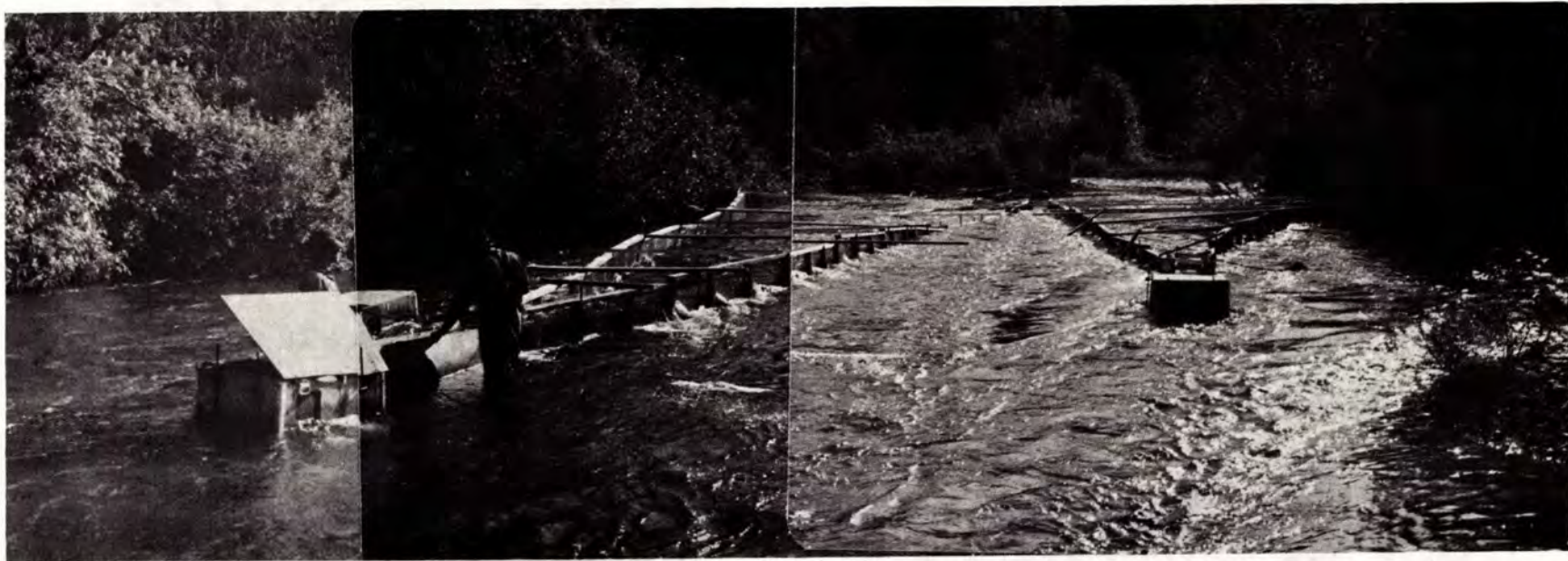


Plate 3 : "W" trap operating on James Creek, June 16, 1977.



Plate 4. Modified hinge trough assembly for downstream "W" trap.



Plate 5. Adjustable trough flow regulator for downstream smolt transport into live box.

Modified fyke net apparatus were used at times of high discharge in James, Fontoniko and Seebach Creeks. Traps consisted of a four-foot square rigid metal frame attached to approximately four meters of conical netting and terminated in an open canvas collar. Band clamps secured the canvas collar to a 3-meter length of PVC pipe of 15 cm. inside diameter. A plywood holding pen of the type previously described, was modified to accept the PVC piping. The height of the pipe insertion into the box was adjusted to provide sufficient transport flow through the pipe for captured smolts, Plates 6, 7 and 8). During the sampling periods every trap was checked for captured specimens and adjusted daily. Scale specimens and body length measurements were taken from captured specimens for laboratory inspection.

Beach seines provided data on some fry rearing areas in the mainstem Herrick and McGregor Rivers. Variable-sized beach seine sets were made from a jet-powered riverboat, or manually dragged, through representative habitats. These site locations appear in Figure 3. "G"-type minnow traps were baited with previously frozen Fraser salmon roe and distributed throughout the Lower James Creek and Herrick Creek area to augment juvenile sampling. In addition, a Coffelt BP-3 electroshocker was employed for fry collection.

Scale specimens were obtained from samples of chinook smolts and adults for age determination. Methodologies for salmon scale study have been set forth by Koo (1962) and Clutter and Whitesel (1956). The plastic impression procedure as described by Belton et al. (1964) was employed on projection equipment explained in Christie and Ryan (1975).



Plate 6: Modified fyke net installation, Seebach Creek, May 22, 1977.

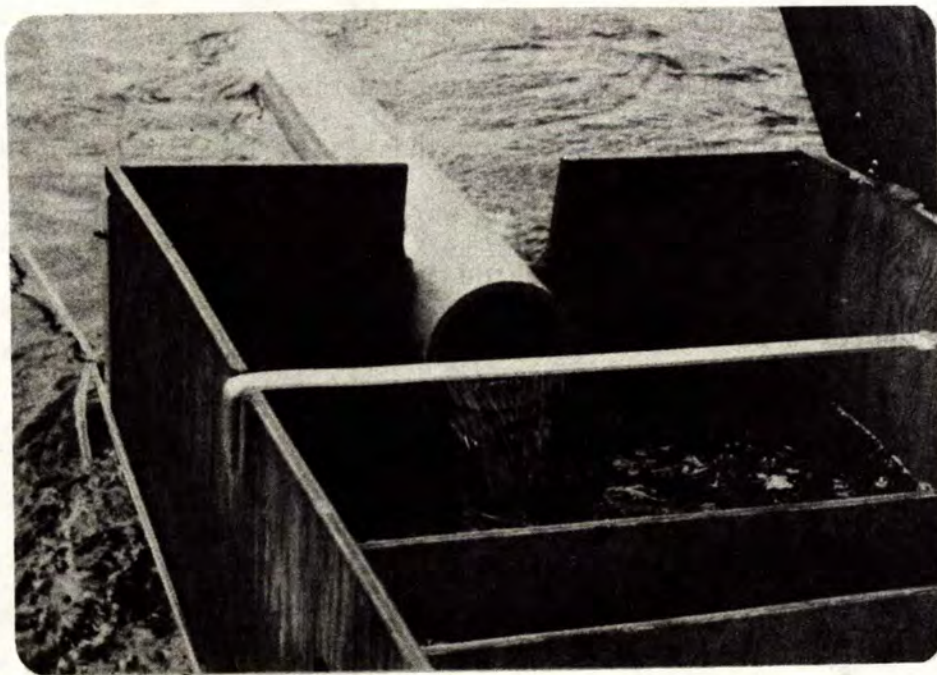


Plate 7: Interior of live box (Plate 5) showing fyke net tube inflow.



Plate 8: Interior of live box illustrating the staggered baffle arrangement which reduces turbulence and provides a sheltered holding region.

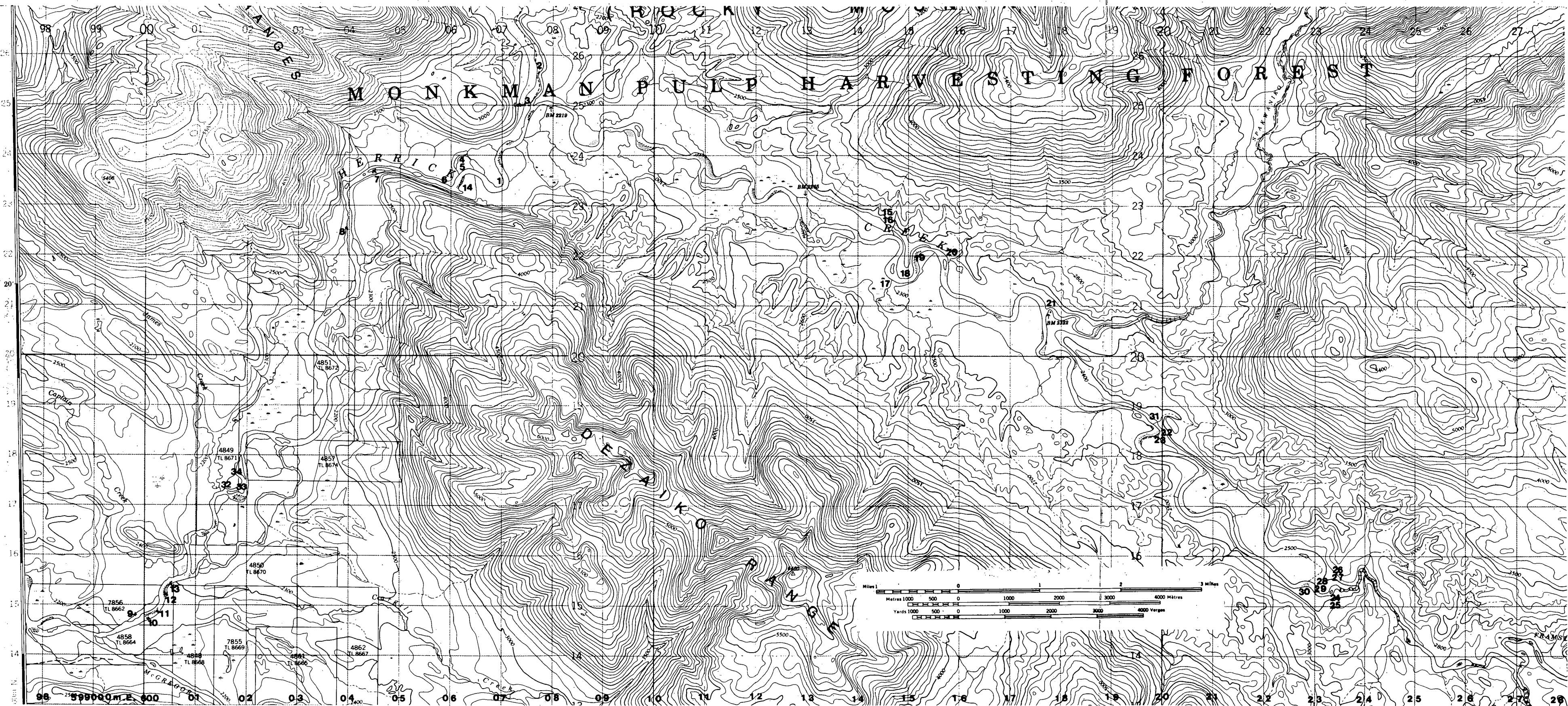


Fig. 3. Beach Seine locations, June 1977, as outlined in Table 2.

Discharge measurements were metered for James Creek during a rising flow period, May 9-15, 1977. A Weksler temperature recorder was in operation on James Creek from May 28 to July 13, 1977. Ryan 45-day temperature recorders were installed in Fontoniko and Herrick creeks, and McGregor River on May 28, 1977, and their locations are indicated on Figure 4.

Smolts captured in James Creek between August 9-28, 1977 were anaesthetized with trichaine methane sulfonate, (ms 222), marked with a partial dorsal clip (posterior 3-4 rays) and held in a live box. Scale specimens from a portion of these smolts were obtained. These marked fish were released for possible recapture on August 28, 1977 as an experiment to determine whether the Renewable Resources Consultant's seining program could determine migration movements and rates within the McGregor drainage.

#### 4.2 Adult Investigations

A full stream broomstick fence was incorporated into the juvenile trapping facility on James Creek approximately 100 meters upstream of the James-Herrick confluence commencing August 9, 1977. The first broomstick fence was removed and a second fence installed at the mouth of James Creek on August 24, 1977 (Plate 9), in an effort to capture a portion of the remaining chinook run. Most chinook declined to enter the traps and were subsequently beach seined.

Spawned salmon carcasses were recovered and measurements and scales taken daily throughout Herrick Creek and McGregor River. A single 50-foot long x 9-foot deep gill net was manipulated by ropes with jet riverboats and shore-based technicians through likely salmon spawning habitat in the mainstem Herrick Creek (Plate 10), locations indicated on Figure 3.

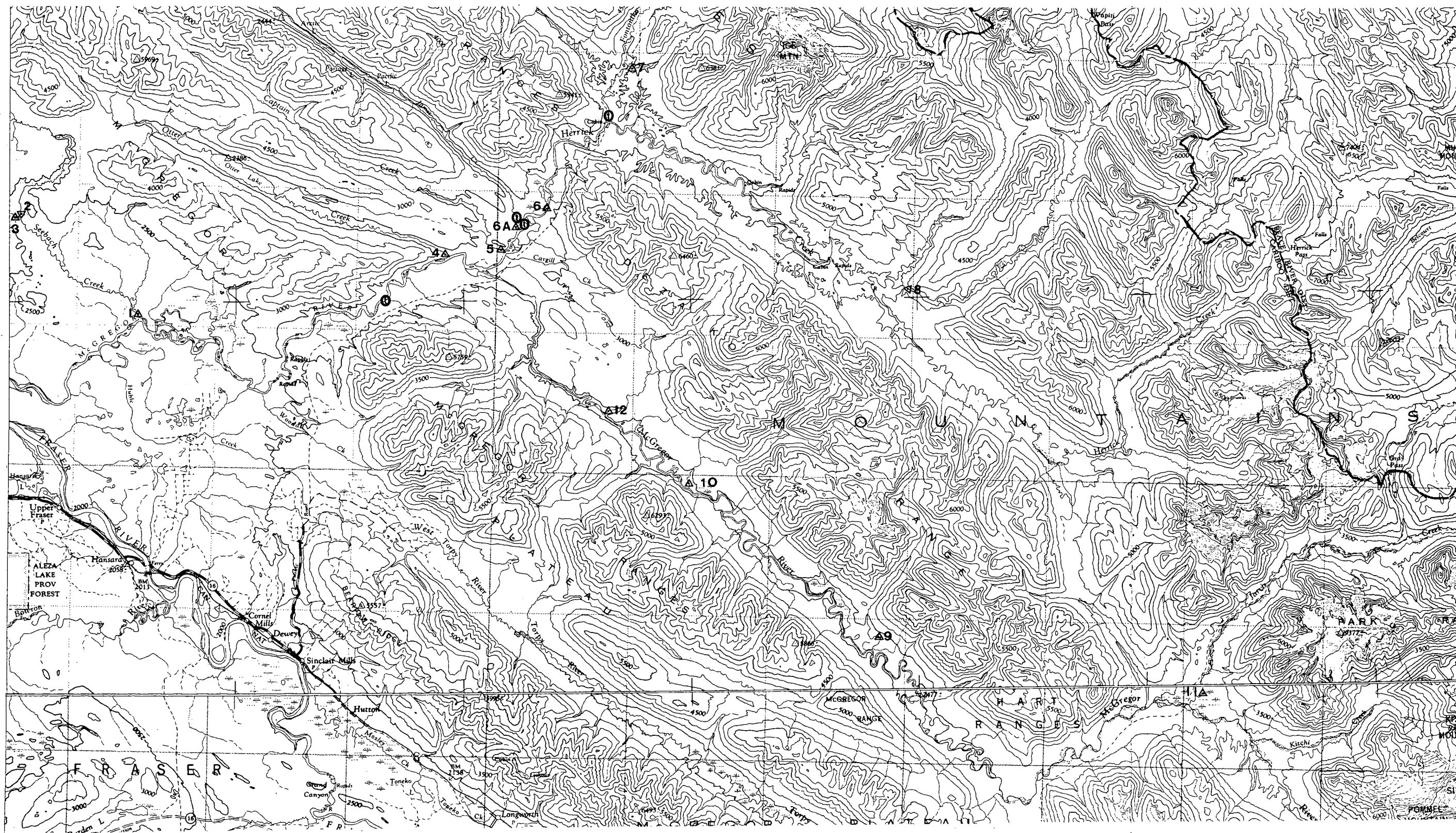


Fig. 4. McGregor River Winter Water Survey Station Locations. Δ

○ Temperature Recording Stations



Plate 9: Broomstick fence trap on James Creek upstream of Herrick Creek confluence.



Plate 10: Drift gill net set for adult chinook - Herrick Creek.

All live salmon captured were anaesthetized with a dilute solution of 2-phenoxyethanol. Body measurements and scale specimens were acquired and immediately thereafter each salmon was revived and released.

Aerial helicopter enumerations of spawning salmon were undertaken on the tributary and mainstem rivers in co-operation with Renewable Resources Consultants Ltd. on August 19 and 20, 1977.

#### 4.3 Winter Tributary Investigations

A survey of tributary streams with potential spawning was undertaken in the McGregor River drainage by the Fisheries and Marine Service between January 11 and 18, 1977, to determine the presence or absence of water. Dissolved oxygen was determined on-site with a YSI model 54A meter. Figure 4 identifies the Winter Water Survey stations.

Visual assessment of spawning substrate in the mainstem Herrick Creek and the McGregor River above the Seebach Creek confluence was completed in March 25-28, 1977.

### 5. RESULTS

#### 5.1 Juvenile Investigation

##### 5.1.1 Spring Program

Overwintering smolts (1+) were recovered from modified fyke net live traps and beach seines in Fontoniko, Herrick, James and Seebach creeks between April 30 and June 2 (Table 1). Estimates of the total out-migration of  $N_2$  smolts from these creeks were not completed due to variations in trapping effort and efficiency, diurnal streamflow fluctuations, and unknown migration variations.

TABLE 1: McGregor River Juvenile Chinook Catch Record for June, 1977

TIME	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
Upper Herrick River			(0+)6 (BS)			
Lower Herrick River			(0+)36 (BS) (0+)2 (G) (1+)2 (BS)			
Fontoniko Creek		(0+)1 (FN) (1+)1 (EF) (1+)3 (FN)	(0+)2 (G)			
James Creek		(0+)20 (FN) (1+)14 (FN)	(0+)34 (W)		(0+)450 (W) (0+)13 (G)	
Seebach Creek		(1+)56 (FN)				
Field Program Operations						
	April 28		June 20		August 19	August 28

Abbreviation Code: BS - Beach Seine  
 "G" - Gee Trap  
 FN - Fyke Net

EF - Electric Fisher  
 "W" - Fence

Juvenile Age  
 (0+) underyearlings  
 (1+) yearlings

The major trapping operations on James Creek from April 30 to May 23, 1977 indicated primarily night smolt movement. Twenty-three smolts were captured with scale age of 1+ (nose-fork length 66-102 mm.,  $\bar{X}$  = 87 mm., S.D. 11.88) which indicated an overwintering population.

During a typical James Creek (May 13, 1977) trapping period five smolts were captured in a single modified fyke net fishing approximately 6 percent of the 292 cfs discharge. A rating curve for James Creek and some discharge computations during May 1977 are contained in Figure 5.

By May 25, 1977 catch frequency of smolts in James Creek had dropped. Incidental numbers of fry-of-the-year were captured migrating into the mainstem Herrick Creek until this phase of the program was terminated on June 20, 1977.

Of all the McGregor tributaries which are accessible to chinook salmon, only James Creek contains a lacustrine environment within its watershed, and the overwintering smolts found in James Creek could be dependent on that limnetic region. Trapping operations were deployed on Fontoniko, Herrick and Seebach drainages, which are devoid of lake habitat, to shed more light on this dependency. A modified fyke net trap was installed on Seebach Creek, tributary to the McGregor below the dam site, .2 miles above the confluence on May 22, 1977. In 22 hours of trapping operations fifty-six overwintering smolts were captured ranging in size between 65 and 115 mm.,  $\bar{X}$  = 82 mm. S.D. 7.68, sample (n) = 56. A similar trap was installed at the mouth of Fontoniko Creek and another

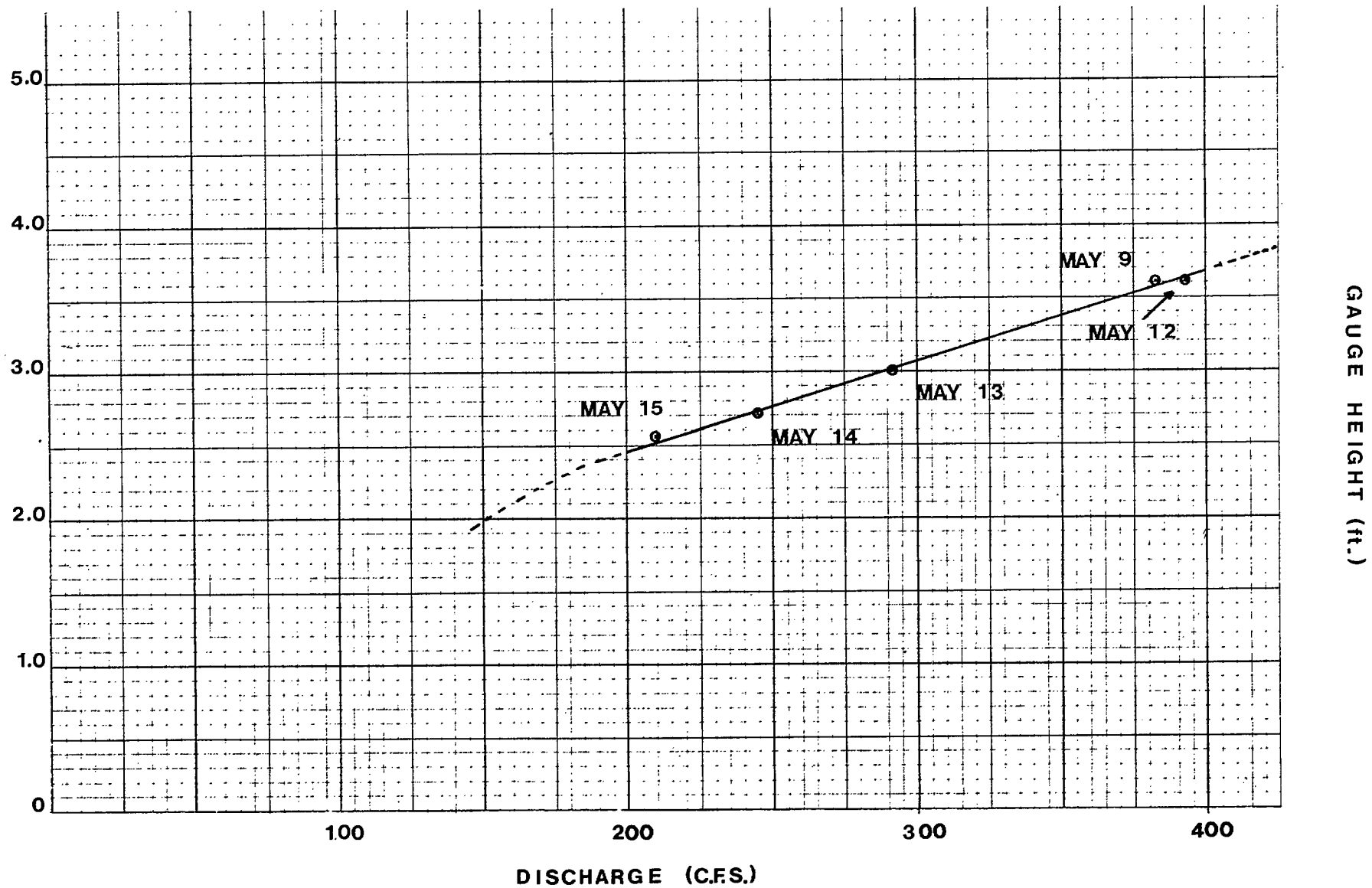


Fig.5 . Discharge measurement and rating for James Creek at Station no. 1, 1977.

approximately 3 km. above that confluence on the Upper Herrick Creek. The Fontoniko trap captured three 1+ smolts on May 22, 1977. Operational difficulties with the trap in Herrick Creek could not be overcome, so no fish were captured. Mainstem beach seine captures of 1+ smolts on June 18 and 19, 1977, sites #4 and #34 (Figure 3), could have been progeny from Fontoniko rather than mainstem Herrick production.

Beach seining programs were undertaken throughout the system and the data and locations are contained in Table 2 and located on Figure 3.

Unsuccessful "G"-trapping with roe bait was due to the ability of the fry to pass directly through the 1/4" rectangular mesh screen as a result of their small size in May.

Portable electrofishing was unsuccessful due to the low conductivity of the stream water.

#### 5.1.2 Fall Program

Four hundred and sixty-three underyearling smolts, rearing approximately 90 days, were captured in the full stream trapping fence during the period August 19-28, 1977 with a one day maximum of 110 on August 24, 1977. These fish were marked with an anterior dorsal fin clip, and released on August 28, 1977 with the intention of possible recapture in seining programs in progress by Renewable Resources Ltd. No results on this experiment

TABLE 2: MCGREGOR RIVER BEACH SEINE CATCH RECORDS FOR JUNE, 1977. LOCATION NUMBERS REFER TO FIGURE .

Map Location Number	System	Date	Flow	Substrate	Temp. °C	Beach Seine Size	Catch*, Comments. *Catch code on last table 2 page
1	Herrick	June 18	moderate	cobble, gravel	7°	100'	nil; much debris
2	Fontoniko	June 18	moderate	cobble, gravel	6°	100'	Mwf: 2    WS: 1
3	Fontoniko	June 18	slow	sand, silt, cobble	6°	100'	Mwf: 1
4	Herrick	June 18	slow	sandy, backwater	14.5°	100'	N <sub>1</sub> : 3,    N <sub>2</sub> : 1, Mwf: 122,    WS: 1
5	Herrick	June 18	slow	sandy, backwater	14.5°	100'	Mwf: 117,    WS: 1
6	Herrick	June 18	moderate	sand, cobble	7°	100'	Mwf: 43,    WS: 2
7	Herrick	June 18	slow	sand	7°	100'	Mwf: 65,    WS: 20, Burbot: 1
8	Herrick	June 18	slow	sand	7°	100'	Mwf: 25,    WS: 5
9	Herrick	June 18	moderate	sand	9°	100'	N <sub>1</sub> : 3
10	Herrick	June 18	slow	sand, gravel	9°	25'	N <sub>1</sub> : 5,    Mwf: 1, Sculpin: 1
11	Herrick	June 18	slow	sand, gravel	9°	25'	N <sub>1</sub> : 1,    Mwf: 1
12	Herrick	June 18	slow	sand	9.5°	100'	N <sub>1</sub> : 1,    Mwf: 70
13	Herrick	June 18	slow	sand	10°	50'	N <sub>1</sub> : 20,    Mwf: 104
14	Herrick	June 18	slow	sand, silt	10°	100'	N <sub>1</sub> : 2
15	Herrick	June 19	slow	sand	8.5°	100'	Nil

TABLE 2: CONTINUED

Map Location Number	System	Date	Flow	Substrate	Temp. °C	Beach Seine Size	Catch, Comments.
16	Herrick	June 19	slow	sand	8.5°	100'	Mwf: 9
17	Herrick	June 19	moderate	sand, cobble	6°	100'	Nil
18	Herrick	June 19	moderate	sand	9°	100'	Mwf: 30
19	Herrick	June 19	slow	sand	9°	100'	Mwf: 6
20	Herrick	June 19	moderate	sand	9°	100'	Mwf: 55
21	Herrick	June 19	moderate	cobble, sand	7°	100'	N <sub>1</sub> : 2, Mwf: 7
22	Herrick	June 19	slow	sand	7°	100'	Mwf: 1
23	Herrick	June 19	moderate	sand, cobble	7°	100'	Mwf: 7
24	Herrick	June 20	moderate	sand	5°	100'	Mwf: 5
25	Herrick	June 20	moderate	sand	5°	100'	Mwf: 13, Dolly Varden: 1
26	Herrick	June 20	slow	cobble	5°	100'	Mwf: 1
27	Herrick	June 20	moderate	cobble	5°	100'	Dolly Varden: 1
28	Herrick	June 20	moderate	sand	5°	100'	Mwf: 2
29	Herrick	June 20	moderate	cobble	5°	100'	much debris
30	Herrick	June 20	slow	sand	5°	50'	Mwf: 9

TABLE 2: CONTINUED

Map Location Number	System	Date	Flow	Substrate	Temp. °C	Beach Seine Size	Catch, Comments.
31	Herrick	June 20	slow	sand	5.5°	50'	Mwf: 2 N <sub>1</sub> : 2
32	Herrick	June 19	slow	silt	N/T	25'	Nil
33	Herrick	June 19	slow	sand, silt	N/T	25'	Mwf: 20, N <sub>1</sub> : 1
34	Herrick	June 19	moderate	sand, gravel	N/T	25'	Mwf: 12, N <sub>2</sub> : 1

## \*Catch Code:

Mwf - mountain white fish

WS - white sucker

N<sub>1</sub> - chinook (Fry of the year)N<sub>2</sub> - chinook (yearling smolt)

were available at this time. The size of the migration 0+ fry ranged between 42-61 mm.,  $\bar{X} = 51$  mm., S.D. sample (n) - 14. Due to the poor hydraulic operation of half of the full-stream trap, only a small portion of the smolt migration was captured.

## 5.2 Adult Investigations

### 5.2.2 Tributary Spawning Chinook Enumeration

Spawning chinook escapement were surveyed by helicopter on August 19-20, 1977. Estimates for tributaries and mainstem escapements are contained in Table 3 and spawning distribution indicated on Figure 6. Total 1977 tributary spawning assessments for Seebach, James and Fontoniko creeks included a 25 percent increased escapement factor for overlooked spawners and post survey immigration. Historic spawning records from 1955-1972 indicate an average tributary chinook escapement of 614 annually. The total estimated tributary escapement for 1977 was 625 not including the 33 mainstem spawning chinook discovered in Upper Herrick Creek. Weather during the surveys was clear and water conditions transparent in the known spawning tributaries. Turbid conditions prevailed in the McGregor and Herrick mainstems.

Chinook stocks spawning in Fontoniko and Captain creeks were considered to be well advanced past peak spawning due to their visually deteriorated physical appearance. The Seebach and James creek's stocks for the most part had not reached peak spawning activity by August 19-20, 1977, and appeared in prime spawning condition.

TABLE 3

## MCGREGOR RIVER SPAWNING SURVEY - AUGUST 19 - 20, 1977

Spawning Tributary	Location	Spawning Count Including Carcasses	Estimated Error Factor (Percent)	Total
A. Seebach Creek	1. Mainstem to Km. 24	90	25	112.5
	2. East Branch to Km.26 above Forks at Km. 17, (20/8/77).	77	25	96.25
B. Otter Creek	1. Lower 10 Km. to McGregor Confluence, (20/8/77).	0	-	0
C. Captain Creek	1. Herrick Creek to Km. 26 , 20/8/77).	21	25	26.25
D. James Creek	1. Herrick Creek to Pacific Lake, (19/8/77).	212	25	265
E. Fontoniko Creek	1. Mainstem from Herrick Creek Confluence to Forks,	0	25	0
	2. East Branch to Falls,	99	25	123.75
	3. West Branch, to Km. 6.	1	25	1.25
				625
F. Upper Herrick Creek	1. Mainstem	33		
		533	See Section 6.2	

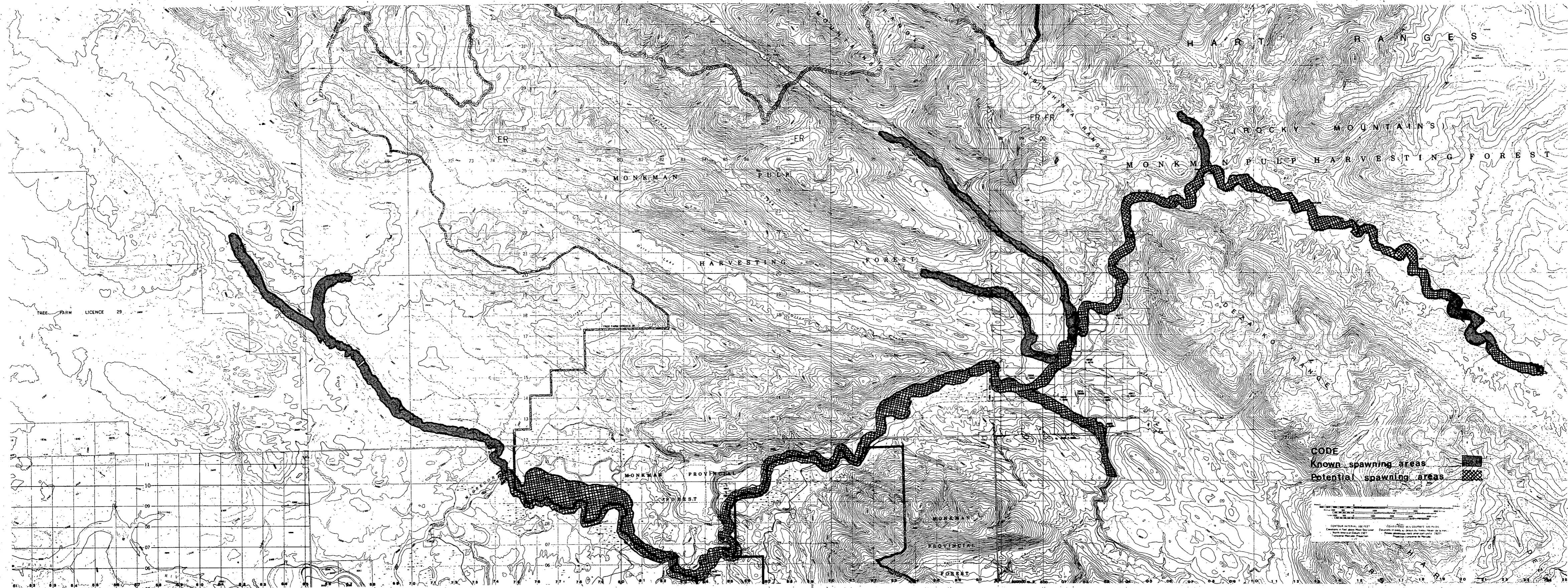


Fig. 6. Spawning Distribution in the McGregor River Drainage.

### 5.2.3 Mainstem Herrick Creek Spawning Chinook Enumeration

Herrick Creek is the main tributary to the McGregor River and roughly discharges the same quantity of water. Accessible regions for salmon spawning extend 45.7 km. above the McGregor-Herrick confluence to Herrick Falls. This drainage system has turbid water and characteristically low year-round temperatures due to glacial runoff effects.

Thirty-three mainstem spawning individuals were located in the Upper Herrick Creek area. Spawning carcasses noted in Figure 7 and Table 4 indicate additional activity throughout the mainstem reach of the Herrick and McGregor rivers above the launching site (Mile 22, Cargyll Road).

Actively spawning salmon were observed and some captured for scale specimens on August 25, 1977 in side channels in Upper Herrick Creek (see Figure 3). Visual observations were limited to the shallow river margins due to the poor water transparency and highly variable daily discharge resulting from summer glacial runoff.

Surfacing salmon in the mainstem Herrick Creek opposite the James Creek confluence suggested mainstem spawning in that vicinity.

### 5.3 Age and Freshwater Classification of Spawning Chinook

Scales from 27 trapped adult chinook or recovered carcasses in 1977 indicated 63 percent of the sample overwintered in

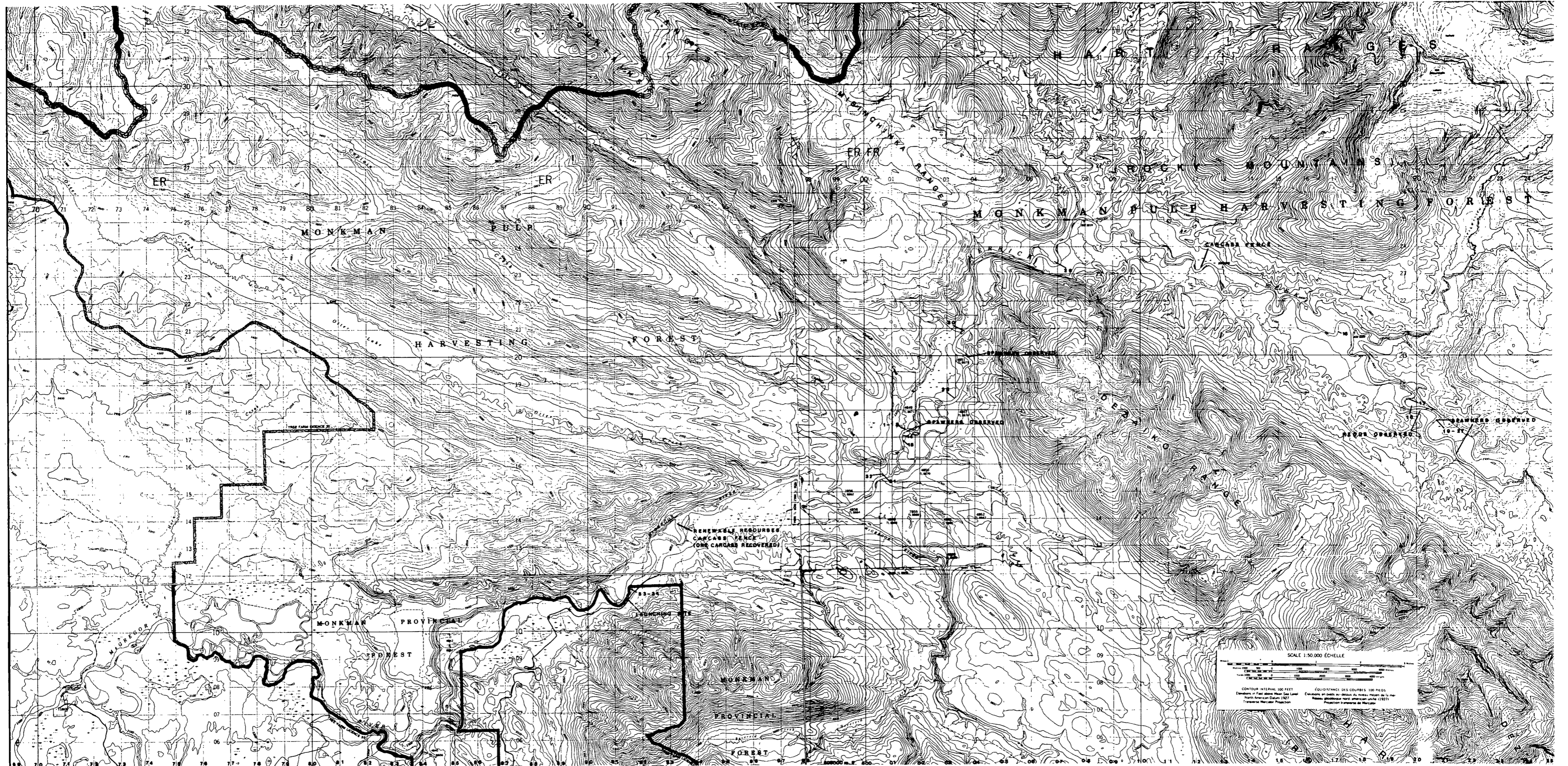


Fig. 7. 1977. Chinook Spawning, Carcass Recovery, and Drift Net Sets Outlined in Table 4.

Table 4: 1977 Adult Chinook Recovery Program

Figure 7 Map Location Number	Sample Date 1977	Sex (Male-M) (Fêmale-F)	Length (cm.)	Sampling Method	Age
1	August 20	Not determined	68.0	Capture (beach seine)	4 <sub>2</sub>
2	August 20	F	47.0	Spawned out carcass	4 <sub>2</sub>
3	August 21	F	75.2	Spawned out carcass	5 <sub>2</sub>
4	August 21	F	73.0	Capture (beach seine)	5 <sub>2</sub>
5	August 21	F	71.5	Semi-spawned carcass	4 <sub>1</sub>
6	August 21	M	50.5	Spawned out carcass	3 <sub>1</sub>
7	August 21	F	66.2	Spawned out carcass	-
8	August 23	M	49.5	Spawned out carcass	3 <sub>1</sub>
9	August 23	F F	73.0	Capture (fence trap)	*R
10	August 23	M	50.5	Capture (fence trap)	4 <sub>2</sub>
11	August 23	F	54.0	Spawned out carcass	4 <sub>2</sub>
12	August 23	M	49.0	Spawned out carcass	3 <sub>1</sub>
13	August 25	M	55.5	Capture (gill net)	4 <sub>2</sub>
14	August 26	F	71.0	Spawned out carcass	5 <sub>2</sub>
15	August 26	M	75.0	Spawned out carcass	5 <sub>2</sub>
16	August 26	F	80.0	Spawned out carcass	4 <sub>1</sub>
17	August 26	Not determined	67.2	Spawned out carcass	4 <sub>2</sub>
18	August 26	F	59.2	Spawned out carcass	-

\* Resorbed Scale

Table 4: continued.

Figure 7 Map Location Number	Sample Date 1977	Sex (Male-M) (Female-F)	Length	Sampling Method	Age
19	August 26	M	66.5	Capture (Gill net)	4 <sub>2</sub>
20	August 26	M	70.5	Capture (gill net)	R R
21	August 26	F	80.0	Capture (gill net)	4 <sub>1</sub>
22	August 26	M	70.5	Spawnd out carcass	R
23	August 26	F	84.0	Capture (gill net)	R
24	August 26	F	72.0	Capture (gill net)	R
25	August 26	F	66.0	Capture (gill net)	44 <sub>2</sub>
26	August 26	F	73.0	Capture (gill net)	5 <sub>2</sub>
27	August 26	M	76.0	Capture (gill net)	4 <sub>1</sub>
28	August 25	M	78.9	Spawnd out carcass	4 <sub>1</sub>
29	August 27	M	83.5	Spawnd out carcass	5 <sub>2</sub>
30	August 21	M	82.8	Spawnd out carcass	5 <sub>2</sub>
31	August 25	F	?	Spawnd out carcass	4 <sub>2</sub>
32	August 29	M	49.0	Spawnd out carcass	4 <sub>1</sub>
33	August 23	M	78.6	Spawnd out carcass	4 <sub>1</sub>
34	August 22	M	79.6	Spawnd out carcass	4 <sub>1</sub>

fresh water. Freshwater scale patterns of stream-type smolts captured in the spring of 1977 indicated a similar growth pattern near the focus of the scales removed from the overwintering adult spawners.

The ascribed scale ages and corresponding lengths of chinook salmon recovered within the McGregor drainage during 1977 are indicated in Table 4. These limited data suggest mature chinook salmon spawning in the McGregor River with tributaries are primarily of the four (65 percent) and five (26 percent) year categories.

A more detailed discussion of the interpretation of freshwater residency and adult age determination is contained in a separate report by Tutty and Yole (1978).

#### 5.4 Winter Water Investigations

Tributary surveys were conducted by the Fisheries and Marine Service between January 11-18, 1977. Dissolved oxygen concentrations are contained in Table 5 and correspond to locations identified in Figure 4. All tributaries had some flow during the survey; however ice prevented discharge measurements.

Mainstem substrate surveys were conducted between March 25-28, 1977, during an ice-free and transparent water period.

Table 5: MCGREGOR RIVER WINTER WATER SURVEY

Calibration (Winkler) 10.2 @ 20°C @ 760 Mm Hg = (YSI) 12.6 @ 20°C @ 760 Calibration Factor - 2.4ppm.

Station	#H2O Temp. °C.	Air Temp. °C.	Dissolved Oxygen (D.O.)	Calibrated D.O.	D.O. Altitude Correction (.92)	Percent Saturation
January 11/77 1 Seebach Creek	+1°C	-8°C	12.6	10.2	9.3	(71%)
2 Seebach East Fork	+1°C	-8°C	15.1	12.7	11.7	(89%)
3 Seebach West Fork	+1°C	-8°C	15.2	12.8	11.8	(90%)
4 Otter Creek	+1°C	-8°C	16.6	14.2	13.0	(99%)
5 Captain Creek	+1°C	-8°C	116.2	13.8	12.7	(97%)
6 Herrick Creek	+1°C	-8°C	14.4	12.0	11.0	(84%)
January 12/77 6A James Creek	+1°C	-8°C	15.8	13.4	12.3	(94%)
7 East Fontoniko Creek	+1°C	-8°C	15.2	12.8	11.8	(98%)
8 Framstead Creek	+1°C	-8°C	15.4	13.0	12.0	(92%)
9 Heddrick Creek	+1°C	-8°C	15.8	13.4	12.3	(94%)
10 Gleason Creek	+1°C	-8°C	15.7	13.3	12.2	(93%)
January 18/77 11 Jarvis Creek	+1°C	-8°C	14.8	12.4	11.4	(87%)
12 Logan Creek	+1°C	-8°C	15.6	13.2	12.1	(92%)

## 6. DISCUSSION

The life histories of McGregor River chinook stocks have never been thoroughly investigated. Circumstantial information from past unrelated fisheries programs reinforces some of the juvenile, smolt, and adult data determined in this study. The most recent detailed and broad account on the chinook of the Fraser system is contained in a report by Fraser et al. (in prep.)

### 6.1 Spawning

The Fraser River chinook stocks are classified in two distinct groups based on flesh colour (Milne, 1964). Early migrating red-fleshed chinook represent two-thirds of the population in the system and spawn in the Thompson and upper tributaries of the Fraser, (Fraser et al., in prep.) Later migrating white-fleshed chinook spawn generally in lower tributaries.

The evolutionary timing of salmon spawning migrations, in part, are influenced by temperature, river discharge, and distance of the journey. These factors induce genetic selection best suited to enhance the survival of each race.

The largest component of the Upper Fraser chinook stocks migrate through the Fraser River estuary in March and April. However, arrival of adult chinook salmon to the spawning regions within the Upper Fraser River is protracted over several months. Chatwin et al. (1963) captured migrating adult chinook salmon near Shelley, B.C. from July 1 to September 2, 1961 and from July 13 to August 29, 1962.

Aerial chinook spawning surveys of the McGregor River tributaries have been conducted annually by the Fisheries and Marine Service, between August 10 to 25 of most years. Total tributary chinook spawning from Fisheries Spawning Reports in the McGregor River averages 614 annually (Fisheries and Marine Service, 1974). These spawning reports could reflect the most convenient survey time, and may not consistently signify the heaviest concentration of spawners. Indeed, intraspecific differences between peak spawning period in the separate tributary chinook races observed during 1977 naturally casts some doubt on the consistency of earlier escapement estimates. The escapement surveys of 1977 were of a more vigorous nature than any earlier efforts. Since the estimated tributary escapement of 625 is near the (1955-1972) mean, the 1977 run was considered below average due to the enumeration effort intensity.

The 1977 investigations recorded 33 mainstem chinook spawning in the Upper Herrick Creek. Spawned chinook carcasses were also recovered along the lower mainstem Herrick Creek and between the McGregor River confluence and Cargyll Road landing at Mile 22. The lack of any earlier record of mainstem spawning is probably attributable to the extremely glacial water conditions which prevail throughout the spawning period. The existence of a spawning population in the region downstream from Cargyll Road past the damsite area to Seebach Creek confluence was not investigated in this survey. However, since suitable substrate for spawning exists in that area, as indicated during the winter substrate observations, some spawning stocks most probably utilize this area as well.

## 6.2 Incubation

Recently emerged chinook fry were observed schooling in side channels of James Creek on May 3, 1977. Chinook fry with evaginated yolk sacs were beach-seined in 5.5°C waters of Herrick Creek on June 20, 1977. This would indicate a prolonged incubation duration (9-10 months) of stocks spawning in the colder mainstem system. Figure 8 presents a graph approximating the thermal conditions of incubating salmon in James and Herrick creeks based on known water temperatures in 1977 and best estimates. The incubation period is more prolonged in the colder mainstem than the warmer James Creek tributary.

Throughout the incubation and pre-emergence phases, eggs and alevins remain in the intragravel environment. Sufficient water and dissolved oxygen must be continuously available to prevent dessication or asphyxiation of the eggs. In the high snowbound regions in the McGregor drainage, winter flows decline markedly after freeze-up, and most of the available stream flow is believed to be from ground water sources. If naturally upwelling ground water is deficient in dissolved oxygen, which has been the case for several potential hatchery sites in B.C. (op. cit. K. Sandercock F.&M.S.), oxygen levels could be held at low concentrations by the effect of ice and deep snow cover forming a barrier preventing re-aeration of ground water. In addition, natural uptake of dissolved oxygen by stream-dwelling fauna and flora could further depress any existing low levels.

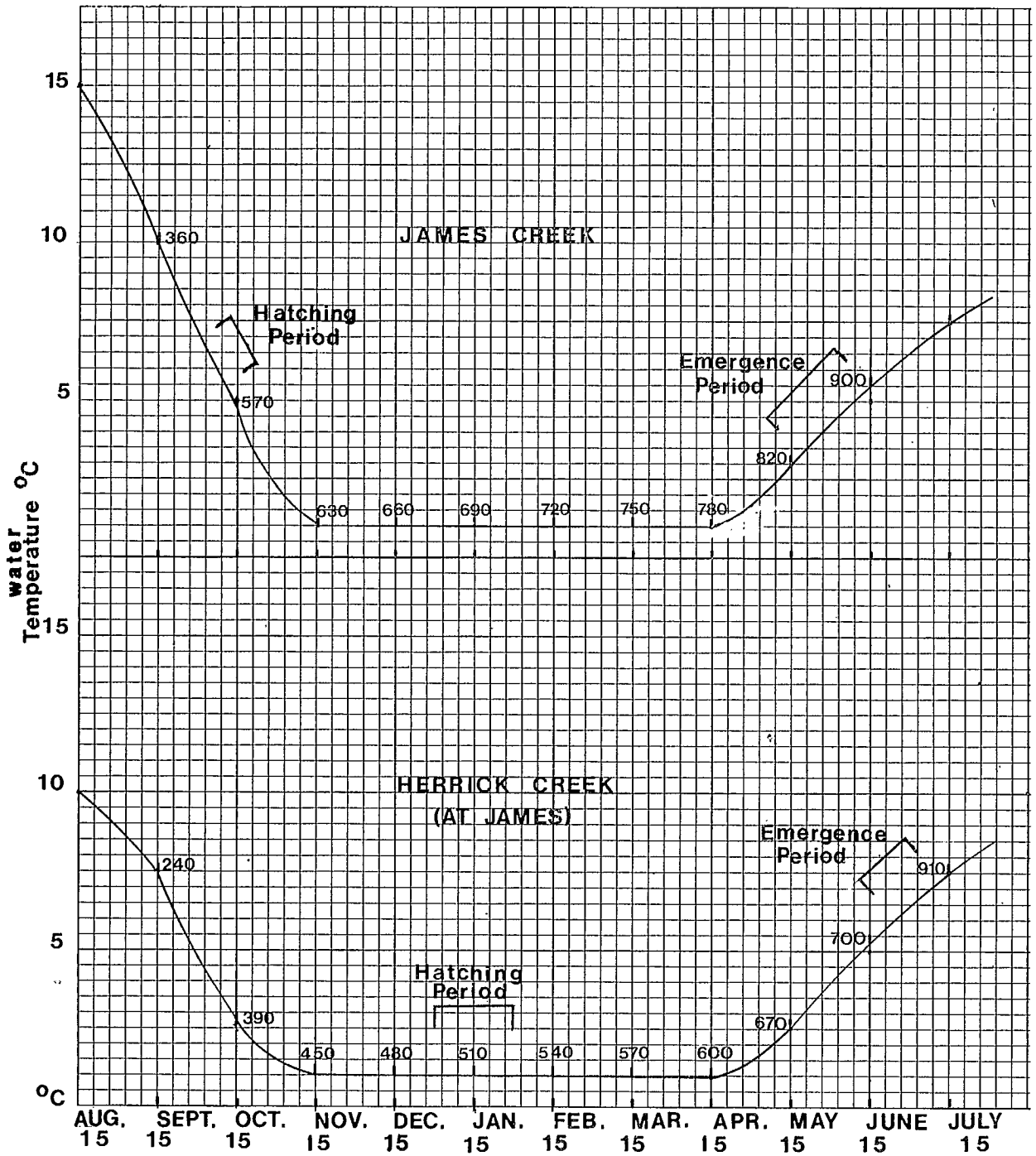


Figure 8 . Approximate Thermal Requirements of Mainstem, Herrick and James Creek Incubating Stocks .

Water samples obtained from the mouth of Seebach Creek by the Fisheries and Marine Service during low flows in January were found to contain only 71 percent oxygen saturation on January 11, 1977 (Table 5). Extreme and prolonged winter conditions could magnify this trend and may aggravate incubation mortality.

### 6.3 Rearing

#### 6.3.1 James Creek

James Creek sustains a population of stream-type chinook that out-migrate in May approximately one year after emergence. The smolting period probably begins after ice-out some time in April of each year and appears to decline by June 1.

During this period of trapping, incidental catches of fry-of-the-year were also collected, indicating some movement to the mainstem River. This migration behaviour has been observed in other systems and does not necessarily mean the rearing capacity of the stream has been exceeded. Considering the small chinook escapement to James Creek, a probable explanation has been suggested by Hoar (1951). Thigmotactic and visual stimuli necessary to maintain fry orientation is lost at night and rheostatic movement in response to the loss of stimuli result in temporary nocturnal downstream displacement. Reimers (1973) has suggested this initial movement is a benefit by assuring rapid post-emergence dispersal of juveniles without excessive energy costs through social mechanisms.

A fry-of-the-year smolt migration was also apparent from trap captures during August 19-28, 1977. This migration most likely would build during the summer and decline by fall freeze-up. It was not possible to determine the shape of the migration curve during the short trapping period.

#### 6.3.2 Fontoniko Creek

During May 20-21, 1977 three stream-type smolts were captured in Fontoniko Creek with one fyke net, indicating over-wintering behavior of the rearing juvenile population. This glacial tributary system is devoid of lake habitat and maintains a cold year-round temperature regime and would most likely retard growth and cause a prolonged rearing duration.

#### 6.3.3 Seebach Creek

The spring freshet in Seebach Creek subsided earlier than in the tributaries above the damsite. Trapping on May 22, 1977, after peak freshet, captured substantial (56) stream-type smolts overnight, (see Plate 11). This low gradient system is not glacially fed and contains warmer summer water temperatures than other tributaries. As a result of the higher temperatures, Seebach Creek would be the most likely tributary to promote growth and thereby reduce chinook rearing duration. However our sampling indicates the effects of temperature does not necessarily dictate early smolt migration.



Plate 11: Twenty-two hour catch on Seebach Creek,  
May 22, 1977: 56 *Oncorhynchus tshawytscha*,  
3 *Salmo gairdnerii*, 2 *Salvelinus malma*,  
2 Catostomidae

7. CONCLUSIONS

Escapement to the spawning grounds began approximately mid-July and lasted to September 15, 1977.

The 1977 spawning escapement to the McGregor River tributaries were approximately 625 chinook.

Mainstem chinook spawning was observed for the first time in Upper Herrick Creek. Spawmed carcasses were also recovered in the McGregor River below the Herrick Creek confluence.

The size of mainstem spawning populations could not be determined but may be significant since 33 chinook were observed during the spawning period during extremely turbid water conditions.

Population production was primarily due to overwintering juvenile sub-populations based on scale interpretation of freshwater age.

Ninety-day ocean-type chinook smolted from James Creek during the third week of August, 1977.

Fontoniko, James and Seebach Creeks are known to produce overwintering stream-type juveniles.

Stream-type chinook smolts are known to migrate from these tributaries between April 30 and May 22, 1977.

8. RECOMMENDATIONS FOR FURTHER STUDY

If further consideration is to be given to the construction of a dam on the McGregor River at James Canyon, either for purposes of diversion to the Peace system or for a non-diversion flood control project, the following studies specific to the McGregor River system are recommended:

- i) Determine the extent of mainstem chinook spawning in the McGregor River and Herrick Creek.
- ii) Determine flow requirements for mainstem chinook populations below the proposed dam site.
- iii) Examine winter water quality conditions to determine limitations to successful incubation in tributaries containing salmon populations.
- iv) Examine year-round water quality conditions in inaccessible tributaries to determine their ability to sustain stocks that may be considered for enhancement.

- v) Define whether Seebach Creek water temperatures are dangerously high for rearing chinook survival during peak summer weather extremes.
- vi) Evaluate the dependency of chinook production on overwintering stream-type juveniles.
- vii) Determine the cost-benefit of stock enhancement options based on ocean-type and stream-type production.

Additional studies to determine the consequences of a McGregor River project on the Fraser River system would also be required.

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APPENDIX I

SOME MCGREGOR DRAINAGE WATER TEMPERATURE RECORDS

- FIGURE 1      Graph of Diurnal water temperature recordings for  
                  McGregor River at Cargill Landing,  
                  May 27 to July 24, 1977.
- FIGURE 2      Graph of Dirunal water temperature recordings for  
                  Herrick Creek at James Creek,  
                  May 27 to July 23, 1977.
- FIGURE 3      Graph of Diurnal water temperature recordings for  
                  James Creek,  
                  May 27 to July 14, 1977.
- FIGURE 4      Graph of Diurnal water temperature recordings for  
                  Fontoniko Creek,  
                  May 28 to July 28, 1977.

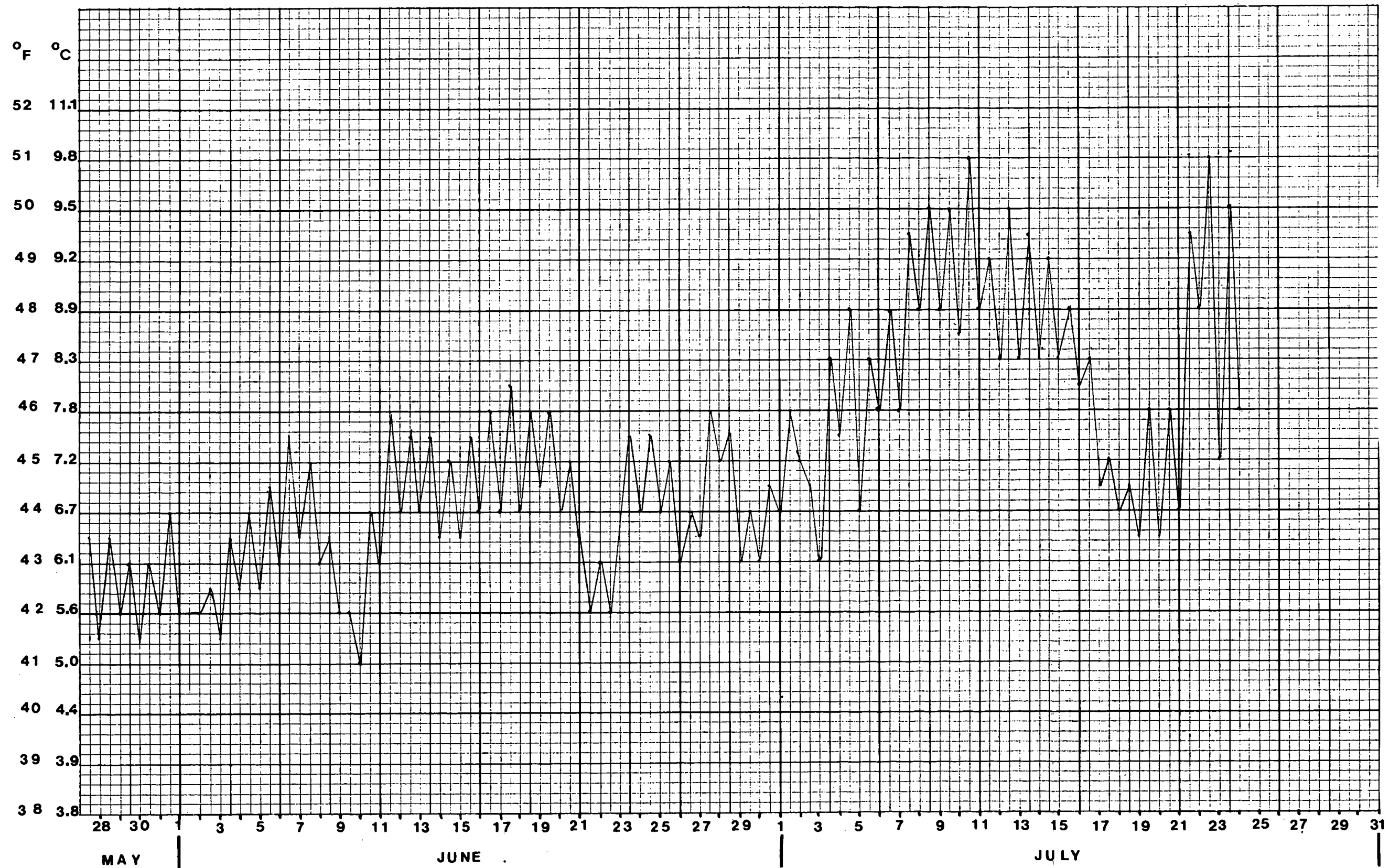


Fig. 1 . Diurnal water temperature recordings for McGregor River at Cargill Landing, May 27 to July 24, 1977.

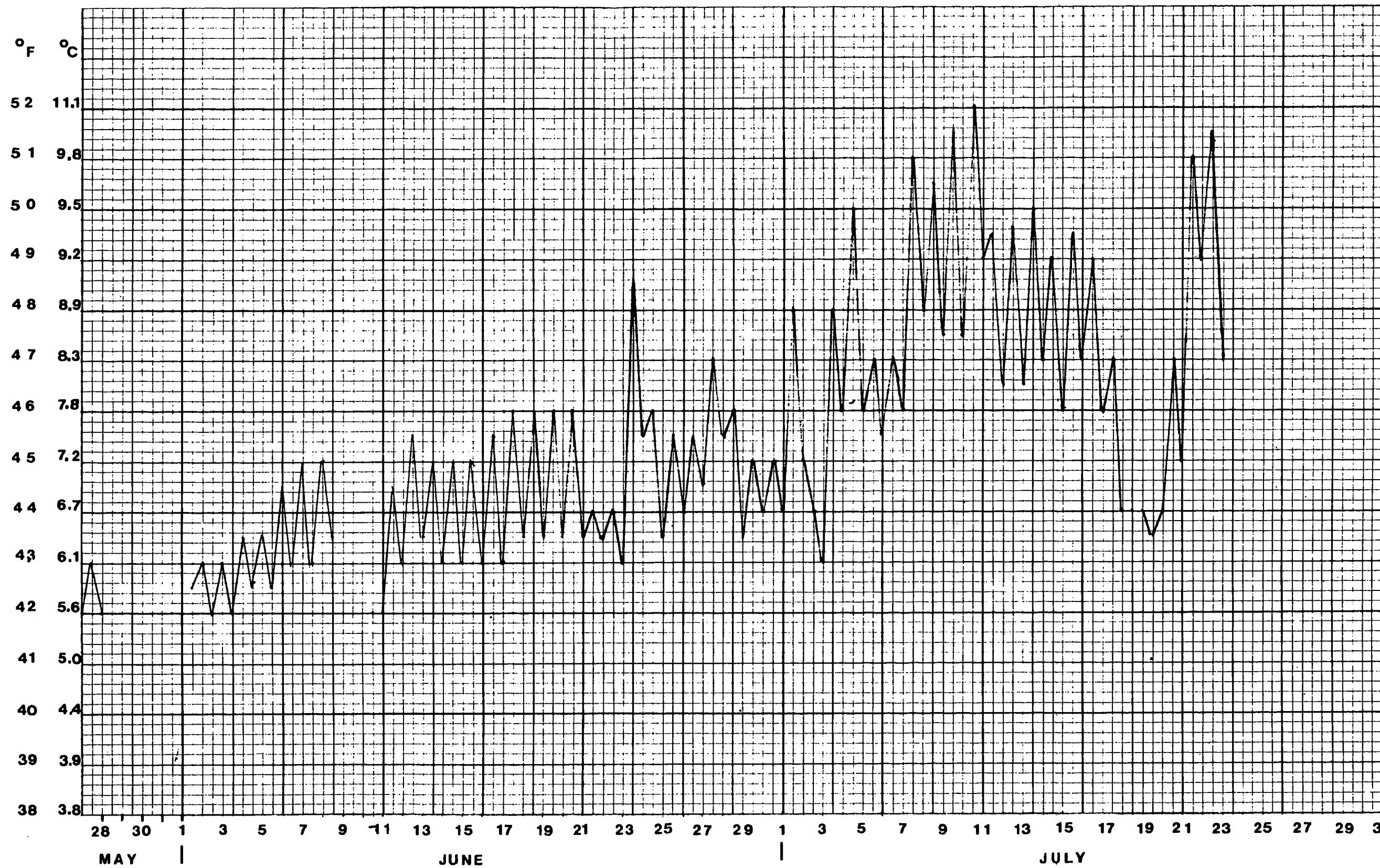


Fig. 2. Diurnal water temperature recordings for Herrick Creek at James Creek, May 27 to July 23, 1977.

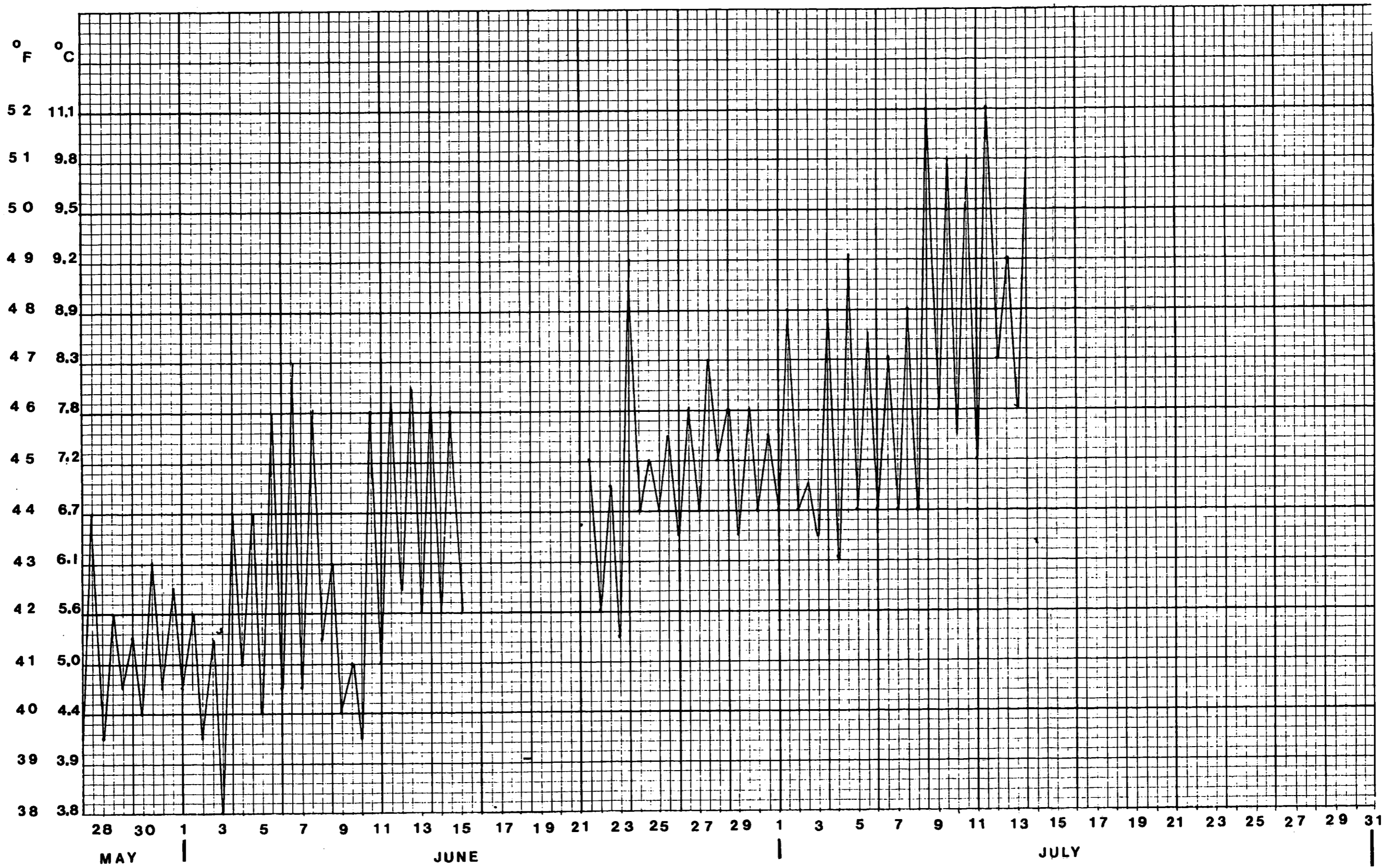


Fig. 3. Diurnal water temperature recordings for James Creek, May 27 to July 14, 1977.

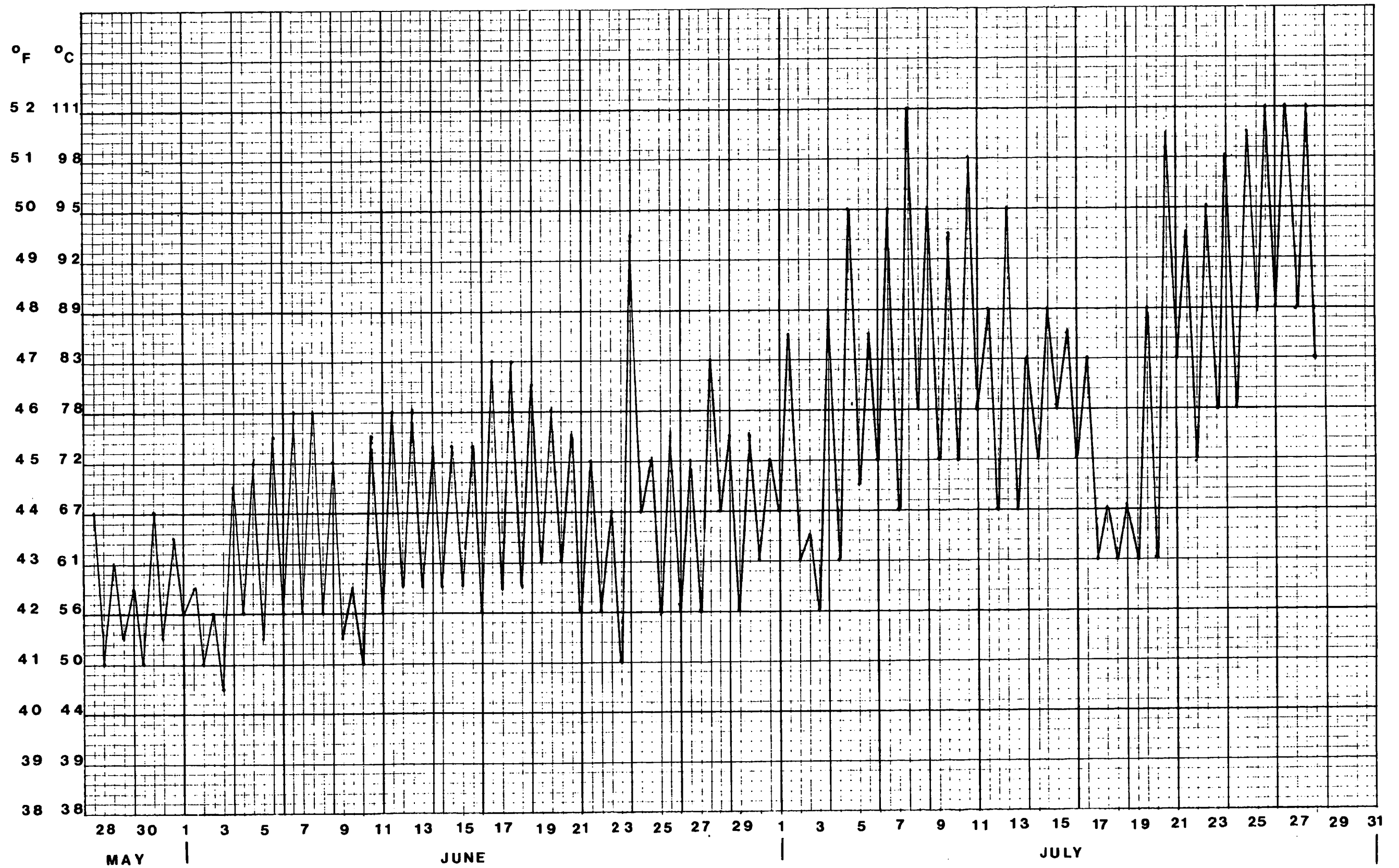


Fig.4. Diurnal water temperature recordings for Fontoniko Creek, May 28 to July 28, 1977.

APPENDIX II

WATER SURVEY OF CANADA FLOW DATA

McGREGOR AND FRASER RIVERS

FLOW RECORDS (1961-1974)

APPENDIX 3:1

WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

JANUARY

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	-	6,310	-	23,900	-	25,100	-	42,600	-	-	-
1961	1,560	6,330	22.8	25,100	6.2	24,600	6.3	41,500	3.8	-	-
1962	2,000	6,520	30.7	-	-	21,500	9.3	35,000	5.7	-	-
1963	2,480	9,110	27.2	28,200	8.8	30,500	8.1	45,900	5.4	-	-
1964	1,140	6,650	17.1	-	-	21,900	5.2	38,700	2.9	-	-
1965	1,380	7,370	18.7	-	-	25,200	5.5	39,400	3.5	-	-
1966	1,190	6,740	17.6	15,900	7.5	19,800	6.0	31,300	3.8	41,600	2.9
1967	1,240	7,290	17.0	-	-	26,000	1.8	41,100	3.0	57,300	2.2
1968	1,650	8,630	19.1	20,600	8.0	30,900	5.3	53,500	3.1	78,800	2.1
1969	1,260	6,020	20.9	17,600	7.2	23,500	5.4	36,500	3.5	45,200	2.8
1970	1,530	7,540	21.1	19,800	8.0	23,200	6.9	35,600	4.5	43,400	3.7
1971	1,660	5,580	29.7	16,200	10.2	18,800	8.8	30,200	3.5	36,900	4.5
1972	1,110	6,370	17.4	-	-	16,200	6.9	27,300	4.1	35,000	3.2
1973	1,170	5,950	19.7	-	-	22,000	5.3	34,800	3.4	51,300	2.9
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	1,490	6,640	21.5	19,400	8.0	22,100	6.4	32,500	4.0	48,700	3.0

APPENDIX 3:2

WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

FEBRUARY

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	-	6,100	-	21,000	-	22,900	-	37,300	-	-	-
1961	1,490	6,800	21.8	19,800	7.5	22,100	6.7	36,100	4.1	-	-
1962	3,100	12,600	24.0	-	-	32,600	9.5	50,000	6.2	-	-
1963	2,350	11,100	21.2	30,100	7.8	34,600	6.8	57,200	4.1	-	-
1964	1,140	6,810	16.7	-	-	21,800	5.2	35,400	3.2	-	-
1965	2,630	7,960	33.0	-	-	24,400	10.8	38,700	6.8	-	-
1966	1,010	5,780	17.5	15,800	6.4	21,800	4.0	30,200	3.3	37,700	2.7
1967	1,030	7,170	14.4	-	-	25,000	4.1	38,900	2.6	52,800	2.0
1968	1,840	10,200	18.0	21,100	8.7	33,000	5.6	51,100	3.6	72,900	2.5
1969	824	5,400	17.1	15,600	5.9	24,200	3.8	34,800	2.7	40,900	2.3
1970	963	5,990	16.1	21,600	4.5	24,400	8.9	35,800	2.7	43,700	2.2
1971	1,850	6,080	31.7	17,300	11.7	20,800	9.3	36,400	5.3	51,900	3.7
1972	1,919	4,680	41.0*	-	-	18,300	10.5	30,300	6.3	38,400	5.0
1973	1,923	5,330	36.1	-	-	21,000	9.2	29,700	6.5	39,100	4.9
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	1,560	6,570	23.8	18,400	7.4	22,600	6.9	30,300	4.4	47,175	3.2

\* Maximum proportion of McGregor discharge to the Fraser River at Shelley.

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

MARCH

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	-	5,910	-	21,500	-	22,400	-	35,300	-	-	-
1961	1,460	6,460	22.6	21,300	6.9	23,500	6.2	35,600	4.1	-	-
1962	1,650	7,470	22.1	-	-	21,600	7.6	28,500	5.8	-	-
1963	1,590	10,500	15.1	28,600	5.0	35,200	4.5	51,600	3.1	-	-
1964	1,140	5,630	20.2	-	-	19,600	5.8	31,100	3.7	-	-
1965	2,370	7,980	29.7	-	-	26,100	9.1	38,300	6.2	-	-
1966	1,060	6,120	17.3	17,000	6.2	21,600	4.9	31,000	3.4	38,300	2.8
1967	957	7,290	13.1	-	-	23,200	4.1	34,100	2.8	42,500	2.3
1968	7,190	16,500	43.6	28,200	25.5	43,100	16.7	64,700	11.1	87,000	8.3
1969	862	5,680	15.2	14,700	5.9	20,800	4.1	31,700	2.7	37,000	2.3
1970	1,000	6,430	15.6	20,300	4.9	23,600	4.2	33,900	2.9	40,100	2.5
1971	1,010	5,000	20.2	15,300	6.6	18,400	5.5	29,700	3.4	38,900	2.6
1972	1,960	6,510	30.1	-	-	31,800	6.2	52,900	3.7	75,400	2.6
1973	910	6,600	13.8	-	-	20,700	4.4	30,000	3.0	39,800	2.3
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	1,780	6,660	21.4	18,300	8.4	22,500	6.4	28,600	4.3	49,900	3.2

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## APRIL

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	-	22,500	-	54,300	-	50,800	-	89,300	-	-	-
1961	4,580	23,100	19.8	46,900	3.8	50,000	9.2	74,600	6.1	-	-
1962	8,430	30,900	27.3	56,500	14.9	58,600	14.4	83,900	10.0	-	-
1963	5,970	26,500	22.5	49,700	12.0	53,600	11.1	75,300	7.9	-	-
1964	2,070	10,700	19.3	32,400	6.4	35,700	5.8	52,700	3.9	-	-
1965	3,850	20,700	18.6	-	-	50,100	7.7	74,000	5.2	-	-
1966	7,040	22,000	32.0	54,500	12.9	53,900	13.1	86,400	8.1	107,000	6.6
1967	2,390	14,900	16.0	-	-	34,400	6.9	47,500	5.0	54,300	4.4
1968	10,600	21,000	50.5	37,900	28.0	44,200	24.0	62,200	17.0*	74,200	14.3**
1969	4,050	22,500	18.0	54,200	7.5	58,800	6.9	82,300	4.9	88,500	4.1
1970	2,550	15,700	16.2	31,900	8.0	36,900	6.9	49,800	5.4	59,200	4.3
1971	3,700	21,200	17.5	36,900	10.0	38,700	9.6	54,900	6.7	62,900	5.9
1972	6,020	20,500	29.4	-	-	51,500	11.7	74,200	8.1	82,600	6.5
1973	4,200	19,300	21.8	-	-	40,400	10.4	54,600	7.6	62,900	6.7
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	5,030	18,500	23.8	43,000	12.1	42,800	10.6	58,100	7.4	76,500	6.6

\* Maximum proportion of McGregor River discharge to the Fraser River at Hope.

\*\* Maximum proportion of McGregor River discharge to the Fraser River at Mission.

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## MAY

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	14,300	46,800	30.6	91,100	-	92,700	15.4	155,000	9.2	-	-
1961	19,300	62,500	30.9	105,000	18.4	110,000	17.5	185,000	10.4	-	-
1962	17,100	49,500	34.5	84,100	20.3	88,700	19.3	147,000	11.6	-	-
1963	15,300	51,900	29.5	91,800	16.7	100,000	15.3	156,000	9.2	-	-
1964	14,800	56,000	26.4	95,300	15.5	99,400	14.3	141,000	10.5	-	-
1965	14,200	60,100	23.6	118,000	12.0	124,000	11.5	184,000	7.7	207,000	6.9
1966	19,700	71,100	27.7	119,000	16.6	126,000	15.6	187,000	10.5	217,000	9.1
1967	20,000	72,900	27.4	130,000	15.4	140,000	14.3	191,000	10.5	214,000	9.3
1968	18,000	68,000	26.5	116,000	15.5	126,000	14.3	185,000	9.7	200,000	9.0
1969	16,000	50,300	31.8	86,100	18.6	95,500	16.8	182,000	8.8	219,000	7.3
1970	16,800	56,300	29.8	80,500	20.7	89,000	18.9	128,000	13.1	140,000	12.0
1971	18,400	66,100	27.8	112,000	16.4	122,000	15.1	216,000	8.5	246,000	7.5
1972	24,600	79,600	30.9	134,000	18.4	141,000	17.4	228,000	10.8	250,000	9.8
1973	19,400	69,000	28.1	-	-	114,000	17.0	174,000	11.1	188,000	10.3
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	17,700	63,100	29.0	105,000	17.0	114,000	16.0	172,000	10.2	209,000	9.0

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## JUNE

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	21,700	69,600	31.2	138,000	15.7	148,000	14.7	246,000	8.8	-	-
1961	21,700	72,800	29.8	132,000	16.4	146,000	14.9	275,000	7.9	-	-
1962	21,600	78,100	27.7	131,000	16.5	145,000	14.9	246,000	8.8	-	-
1963	20,900	75,300	27.8	132,000	15.8	145,000	14.4	235,000	8.9	-	-
1964	32,600	122,000	26.7	220,000	14.8	229,000	14.2	361,000	9.0	-	-
1965	21,500	84,400	25.6	152,000	14.1	164,000	13.1	261,000	8.2	296,000	7.2
1966	21,700	78,900	27.5	141,000	15.4	152,000	14.3	248,000	8.8	299,000	7.3
1967	35,500*	123,000	28.9	202,000	17.6	217,000	16.4	352,000	10.1	417,000	8.5
1968	24,000	83,100	28.9	152,000	15.8	165,000	14.5	279,000	8.6	317,000	7.6
1969	18,200	61,100	28.8	109,000	16.7	122,000	14.9	230,000	7.9	295,000	6.2
1970	27,000	89,500	27.5	131,000	20.7	142,000	19.1	232,000	11.7	270,000	10.0
1971	20,200	77,900	25.9	128,000	15.8	141,000	14.3	268,000	7.5	310,000	6.5
1972	34,700	120,000	28.9	206,000	16.8	211,000	16.4	380,000	9.1	436,000	8.0
1973	23,200	79,900	29.0	-	-	132,000	17.6	218,000	10.6	244,000	8.5
1974											
1975											
MEAN	24,600	80,500	28.2	139,000	16.3	156,000	15.3	251,000	9.0	320,000	7.9

\* Maximum recorded McGregor discharge.

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

JULY

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	19,400	75,300	25.8	139,000	13.9	152,000	12.8	248,000	7.8	-	-
1961	11,000	35,500	36.0	82,300	13.4	97,200	11.3	157,000	7.0	-	-
1962	18,600	69,200	24.9	131,000	14.2	141,000	13.2	215,000	8.7	-	-
1963	15,200	53,800	28.3	106,000	14.3	117,000	13.0	184,000	8.3	-	-
1964	21,400	73,500	29.1	153,000	14.0	171,000	12.5	276,000	7.8	-	-
1965	15,300	59,900	25.5	112,000	13.7	121,000	12.6	178,000	8.6	210,000	7.3
1966	16,700	63,800	26.2	118,000	14.2	130,000	12.8	209,000	8.0	266,000	6.3
1967	18,200	66,600	27.3	128,000	14.2	142,000	12.8	232,000	7.8	278,000	6.5
1968	19,500	75,300	25.9	145,000	13.4	160,000	12.2	255,000	7.6	301,000	6.5
1969	8,330	33,000	25.4	73,600	11.4	84,200	10.0	146,000	5.7	182,000	4.6
1970	11,800	43,100	27.4	79,500	14.8	88,800	13.3	134,000	8.8	169,000	7.0
1971	13,800	53,900	25.6	98,900	14.0	110,000	12.5	197,000	7.0	238,000	5.8
1972	13,800	58,000	23.8	-	-	146,000	9.5	259,000	5.3	311,000	4.4
1973	13,800	52,200	26.4	-	-	107,000	12.9	177,000	7.8	210,800	6.6
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	15,500	55,600	26.8	109,000	13.8	125,000	12.2	198,000	7.6	241,000	6.1

APPENDIX 3:8

WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

AUGUST

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	11,900	39,800	29.9	81,200	14.7	86,700	13.7	130,000	9.2	-	-
1961	7,280	24,400	29.8	59,000	12.3	68,700	10.6	105,000	6.9	-	-
1962	14,800	49,800	29.7	100,000	14.8	110,000	13.5	159,000	9.3	-	-
1963	9,530	35,800	26.6	74,700	12.8	82,100	11.6	126,000	7.6	-	-
1964	18,100	60,700	29.8	118,000	15.3	126,000	14.4	178,000	10.2	-	-
1965	9,420	39,200	24.0	80,100	11.8	87,400	10.8	128,000	7.4	159,000	5.9
1966	12,400	44,100	28.1	81,600	15.2	89,600	13.8	135,000	9.2	170,000	7.3
1967	11,400	37,200	30.6	76,600	14.9	81,900	13.9	127,000	9.0	162,000	7.0
1968	8,240	33,500	24.6	79,200	10.4	87,700	9.4	133,000	6.2	163,000	5.1
1969	11,900	41,600	28.6	69,000	17.2	77,500	15.4	112,000	12.6	136,000	8.8
1970	9,230	27,600	33.4	53,900	17.1	60,500	15.3	85,600	10.8	108,000	8.5
1971	8,080	32,700	24.7	70,200	11.5	80,600	10.0	126,000	6.4	166,000	4.9
1972	8,470	32,000	26.5	-	-	92,900	9.1	146,000	5.8	177,000	4.8
1973	6,870	28,600	24.1	-	-	66,800	10.3	104,000	6.6	135,000	5.1
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	10,500	35,300	27.9	73,700	14.0	83,900	12.3	126,000	8.2	153,000	6.4

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## SEPTEMBER

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	9,240	32,300	28.6	68,500	13.5	71,900	12.9	104,000	8.9	-	-
1961	10,900	29,000	37.6	61,600	17.7	68,300	16.0	95,000	11.6	-	-
1962	6,850	25,400	27.0	57,000	12.0	66,300	10.3	95,800	7.2	-	-
1963	10,400	32,000	32.5	62,600	16.6	69,100	15.1	101,000	10.3	-	-
1964	9,870	36,400	27.1	75,000	13.2	80,400	12.3	119,000	8.3	-	-
1965	4,530	19,500	23.2	48,500	9.3	53,400	8.5	78,900	5.7	95,000	4.8
1966	7,830	25,400	30.8	56,200	13.9	60,700	12.9	88,600	8.8	110,000	7.1
1967	8,210	24,500	33.5	50,400	15.3	54,800	15.0	83,800	9.8	108,000	7.6
1968	9,770	32,900	29.7	64,600	15.1	71,500	13.6	109,000	9.0	131,000	7.5
1969	10,400	36,300	28.7	64,400	16.1	71,700	14.5	96,700	10.8	118,000	8.8
1970	8,960	23,000	39.0	42,500	21.1	46,800	19.1	63,800	14.0	78,100	11.5
1971	7,040	23,500	30.0	50,600	13.9	56,800	12.4	83,300	8.5	105,000	6.7
1972	4,340	17,400	24.9	-	-	53,700	8.1	80,400	5.4	101,000	4.3
1973	9,200	22,700	40.5	-	-	40,800	22.5	59,500	15.5	74,900	12.3
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	8,400	26,200	30.9	53,500	14.9	60,700	13.8	85,000	9.6	102,000	7.8

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## OCTOBER

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	11,700	33,900	34.5	62,200	18.8	64,500	18.1	98,200	11.9	-	-
1961	12,900	37,500	34.4	63,100	20.4	67,200	21.0	95,400	13.5	-	-
1962	9,520	29,500	32.3	55,900	17.0	61,300	15.5	88,800	10.7	-	-
1963	9,770	27,800	35.1	50,300	19.4	58,500	16.7	81,700	12.0	-	-
1964	11,000	37,800	29.1	74,400	14.8	79,600	13.8	122,000	9.0	-	-
1965	13,400	34,200	39.2	54,100	24.8	58,000	23.1	80,800	16.6	98,900	13.5
1966	8,530	27,600	30.9	54,700	15.6	57,300	14.9	83,500	10.2	101,000	8.4
1967	7,570	24,100	31.4	42,500	17.8	45,000	16.8	72,900	10.4	102,000	7.4
1968	8,300	25,300	36.8	51,300	16.2	56,400	14.7	85,900	9.7	103,800	8.1
1969	6,580	25,800	25.5	53,300	12.3	59,700	11.0	88,400	7.4	109,000	6.0
1970	5,310	17,500	30.3	36,000	14.8	40,200	13.2	54,200	9.8	62,300	8.5
1971	6,730	21,400	31.4	42,100	16.0	46,500	14.5	66,700	10.1	80,600	8.3
1972	9,040	24,000	37.7	-	-	49,500	18.3	68,400	13.2	79,200	11.4
1973	9,670	34,700	27.9	-	-	53,100	18.2	73,500	13.2	87,700	11.0
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	9,290	25,600	32.3	46,100	17.3	53,000	16.4	70,200	11.3	91,500	9.2

## WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

## NOVEMBER

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	4,240	17,600	24.1	40,900	10.4	45,600	9.3	73,500	5.6	-	-
1961	6,800	22,000	30.3	35,300	19.3	40,800	16.7	60,800	11.2	-	-
1962	9,880	30,800	32.1	57,800	17.1	62,800	15.7	95,650	10.3	-	-
1963	3,050	13,000	23.5	30,600	10.0	33,500	9.1	57,600	5.3	-	-
1964	4,860	20,500	23.7	46,000	10.6	49,800	9.8	77,200	6.3	-	-
1965	6,930	18,500	37.5	37,200	18.6	42,000	16.5	68,900	10.1	98,100	7.1
1966	4,420	16,100	27.5	36,400	12.1	39,400	11.2	59,400	7.4	78,100	5.7
1967	6,740	21,600	31.2	42,300	15.9	44,600	15.1	71,200	9.5	99,900	6.7
1968	5,360	21,600	24.8	46,400	11.6	52,500	10.2	80,400	6.7	107,000	5.0
1969	5,490	20,900	26.8	43,200	12.7	48,500	11.3	70,900	7.7	83,600	6.6
1970	2,330	9,040	25.8	20,500	11.4	24,100	9.7	36,000	6.5	43,800	5.3
1971	6,850	18,200	37.6	34,400	19.9	39,200	17.5	54,600	12.5	66,900	10.2
1972	3,370	14,800	22.8	32,500	10.4	38,900	8.7	52,900	6.4	63,700	5.3
1973	2,780	18,400	15.1	-	-	39,300	7.1	57,100	4.9	77,200	3.6
1974	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-
MEAN	5,220	18,100	27.4	36,300	13.8	41,000	12.0	55,800	7.9	79,800	6.2

APPENDIX 3.12

WATER SURVEY OF CANADA, BRITISH COLUMBIA, DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

DECEMBER

YEAR	McGREGOR @ L.C. STA.08KB003	FRASER R. @ SHELLEY STA.08KB001	%	FRASER R. @ BIG BAR ST.08MD018	%	FRASER R. @ TEXAS CR. STA.08MF040	%	FRASER R. @ HOPE STA.08MF005	%	FRASER R. A MISSION STA.08MH024	%
1960	1,660	8,420	19.7	24,100	6.9	28,800	5.8	44,300	3.7	-	-
1961	2,050	7,060	29.0	-	-	20,900	9.8	32,000	6.4	-	-
1962	4,040	15,500	26.1	33,000	12.2	37,300	10.8	62,700	6.4	-	-
1963	2,000	8,780	22.8	-	-	25,300	7.9	45,800	4.4	-	-
1964	1,140	6,340	18.0	-	-	24,900	4.6	46,100	2.5	-	-
1965	2,680	8,680	30.9	20,700	12.9	24,700	10.9	42,100	6.4	59,800	4.5
1966	2,019	9,230	21.8	-	-	31,200	6.4	53,800	3.7	87,500	2.3
1967	2,480	12,500	19.8	23,200	10.7	26,600	9.3	44,100	5.1	60,100	4.1
1968	2,240	9,130	24.5	21,700	10.3	29,700	7.5	47,500	4.7	65,800	3.4
1969	3,600	13,400	26.9	30,300	11.9	35,300	10.2	52,200	6.9	63,500	5.7
1970	1,220	6,380	19.1	15,100	8.1	16,600	7.3	28,600	4.3	36,700	3.3
1971	2,080	10,000	20.8	19,300	10.8	21,700	9.6	32,100	6.5	40,700	5.1
1972	1,220	7,110	17.2	-	-	23,600	5.2	35,300	3.5	47,400	2.6
1973	1,170	11,300	10.4	-	-	24,300	4.8	40,000	2.9	59,300	2.0
1974	2,880	-	-	-	-	-	-	-	-	-	-
1975	2,150	-	-	-	-	-	-	-	-	-	-
MEAN	2,110	9,290	21.9	25,500	10.5	26,200	7.9	40,100	5.6	57,900	3.7

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14 YEAR MEAN MONTHLY FLOWS @ MCGREGOR RIVER AND  
AS A % OF THE FLOW AT LOWER STATIONS

MONTH	MCGREGOR @ LOWER CANYON	FRASER @ SHELLEY	FRASER @ BIG BAR	FRASER @ TEXAS CR.	FRASER @ HOPE	FRASER @ MISSION
JANUARY	1,490	21.5	8.0	6.4	4.0	3.0
FEBRUARY	1,560	23.8	7.4	6.9	4.4	3.2
MARCH	1,780	21.4	8.4	6.4	4.3	3.2
APRIL	5,030	23.8	12.1	10.6	7.4	6.6
MAY	17,700	29.0	17.0	16.0	10.2	9.0
JUNE	24,600	28.2	16.3	15.3	9.0	7.9
JULY	15,500	26.8	13.8	12.2	7.6	6.1
AUGUST	10,500	27.9	14.0	12.3	8.2	6.4
SEPTEMBER	8,400	30.9	14.9	13.8	9.6	7.8
OCTOBER	9,290	32.3	17.3	16.4	11.3	9.2
NOVEMBER	5,220	27.4	13.8	12.0	7.9	6.2
DECEMBER	2,110	21.9	10.5	7.9	5.6	3.7

