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Chinook Salmon Enhancement in the Lillooet -
Birkenhead Rivers System - watershed information,
juvenile studies, spawning ground surveys and
hatchery operations 1975 - 1978.

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March, 1979

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SUMMARY

Reconnaissance surveys, in fall 1975 and 1976 and summer 1977, preceded the first year of hatchery production on the Birkenhead River. Gee trapping proved very little chinook overwintering in Birkenhead and Upper Lillooet River areas, but some rearing in Lillooet Lake. 2 x 3 and 4 x 4 downstream trapping proved fry migration peaked in early April on the Birkenhead River and mid-April at the outlet of Lillooet Lake. Seining and 4 x 4 trapping showed chinook fingerlings reared in Lillooet Lake and above for 2½ months, then migrated in late June. Overwintering smolt exit numbers peaked late May-early June. Spawning ground surveys showed Birkenhead chinook to be 82-100% 3 and 4 years olds at a mean size of 70 and 76 cm. orbital-hypural length respectively, with sub 1 adults making up 53-92% of spawners. Adults for egg takes were captured by snagging, shooting, sportfishing or gillnetting, with attempted adult holding in a floating pen resulting in 84% mortality. The incubation box was completed in fall 1976, with the first 20,000 eggs planted in September 1977 and ponded in ^{March} April 1978. Box fry, at .45 gm exit weight and 40 mm exit length were 2.45 gm and 62 mm in length at release 89 days later, for a mean growth rate of 1.9%. 14,793 box fry were adipose fin clipped and nose tagged then released on July 20, 1978.

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INTRODUCTION
Introduction

As part of the salmonid Enhancement program, the Fisheries Service of the Department of the Environment initiated biological and engineering feasibility studies in the Lillooet River watershed in 1975.

Of prime importance was the rehabilitation of the chinook salmon in the Birkenhead River. In spite of a 3 year chinook sport fishing closure, yearly restrictions of Mount Currie Indian band harvest to 25 fish, and additional protection given to early chinook in the Lower Fraser River fishery, yearly escapements declined recently to 200 fish from 1000 in 1969-70.

In early 1975, Fisheries service preliminary studies for salmon enhancement began. Engineering studies involved site selection, hydrologic data, groundwater supply potential and a review of man's activities in the watershed. Access road construction and site clearing for the pilot hatchery commenced in late August, 1976 and by the end of September, the well, instream intake gallery, 2" water pipeline and a single incubation box were completed.

The fry produced from this hatchery are hopefully forerunners of increased adult chinook returns to the river to enhance the native fishery, encourage the opening of a local sport fishery, and lead to native and public involvement as well as provide some increase in the catch of the Fraser River fishery.

Biological studies involved ... *rec. of spawning area & access*
water temp. & depth
stock status, etc.
clearing, etc.

REVIEW OF WATERSHED INFORMATION
(1) Review of Watershed Information

GENERAL DESCRIPTION

The Lillooet River has its source approximately 160 km north of Vancouver at the Lillooet Ice Cap. It flows southeast for 90 kilometers through Lillooet Lake, then on to Harrison Lake, 55 km to the southeast¹ (Fig. 1). The Birkenhead River is the major tributary of the system and has been one of the proposed sites of an enhancement project to rehabilitate runs of chinook salmon. Several surveys have been carried out on the Birkenhead in 1975 and 1976. The Birkenhead watershed has an area of 596 square kilometers and is located approximately 5 kilometers from Pemberton (Fig. 2 and B.C. Topographical Sheets 92G and 92J). The Lillooet River is extremely turbid during all months of the year and carries a heavy silt load into Lillooet Lake. Visibility remains poor in Lillooet Lake and the lower Lillooet River (Fig. 3). In contrast, the Birkenhead River is clear for most of the year (Fig. 4). Flow records indicate that maximum discharges occur in June on the Birkenhead and in July on the upper Lillooet (Appendix A). This run-off regularly raises the level of Lillooet Lake over 2 metres and inundates the Joffre Creek Road at the Birkenhead River bridges. The minimum flow usually occurs in February for the Lillooet River, while the Birkenhead low flow normally occurs in March. Temperature fluctuations in the Birkenhead follow a normal pattern based on Int. Pacific Salmon Fisheries Commission Data (Appendix B).

Elevations in the watershed vary from 2280 metres in headwater

¹ This report covers the Lillooet watershed down to Harrison Lake. The Harrison drainage will be covered in a separate report.

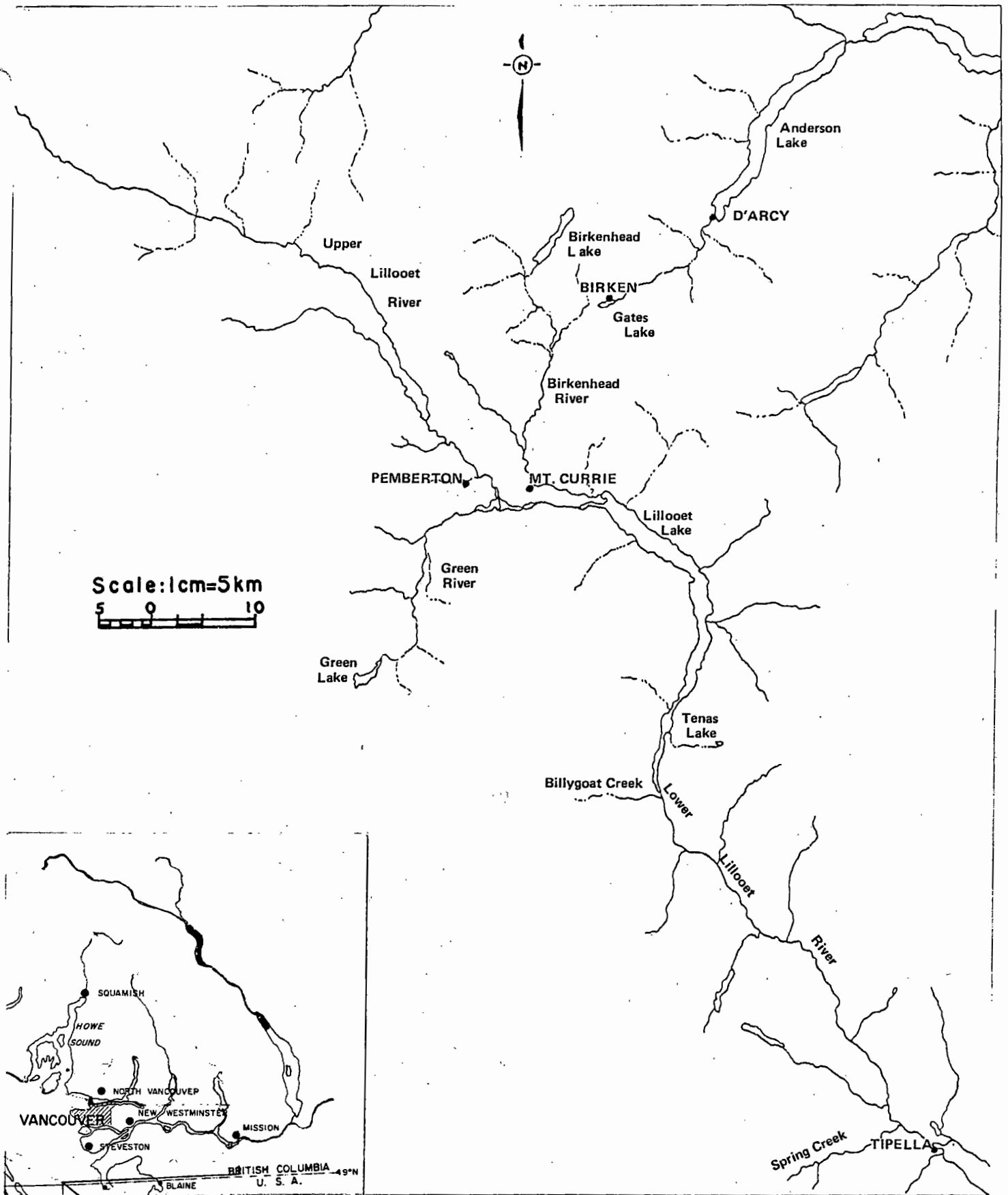


Fig. 1. Map of Birkenhead-Lillooet watershed study area showing tributaries and relationship to the Lower Mainland of British Columbia (inset).

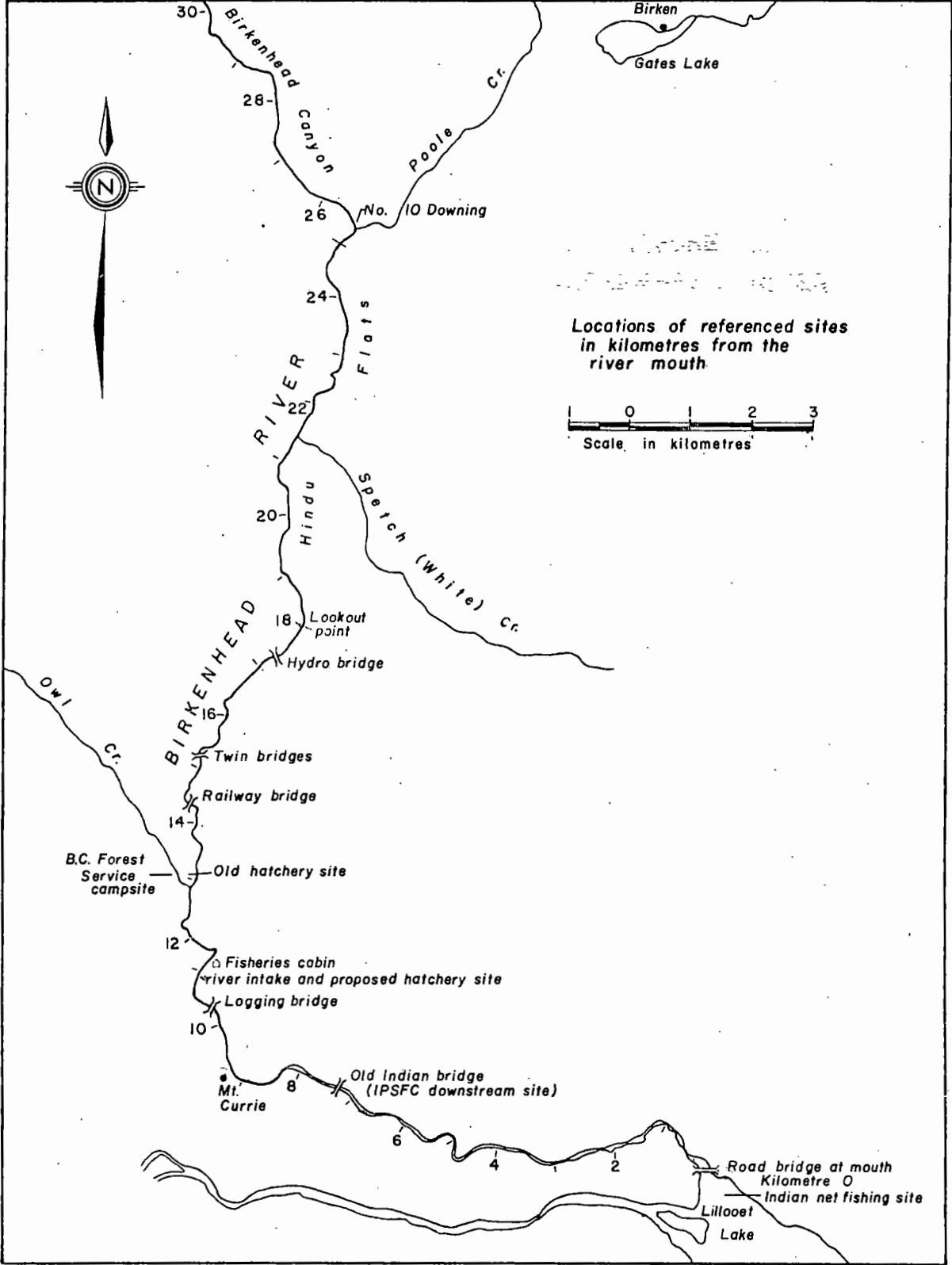
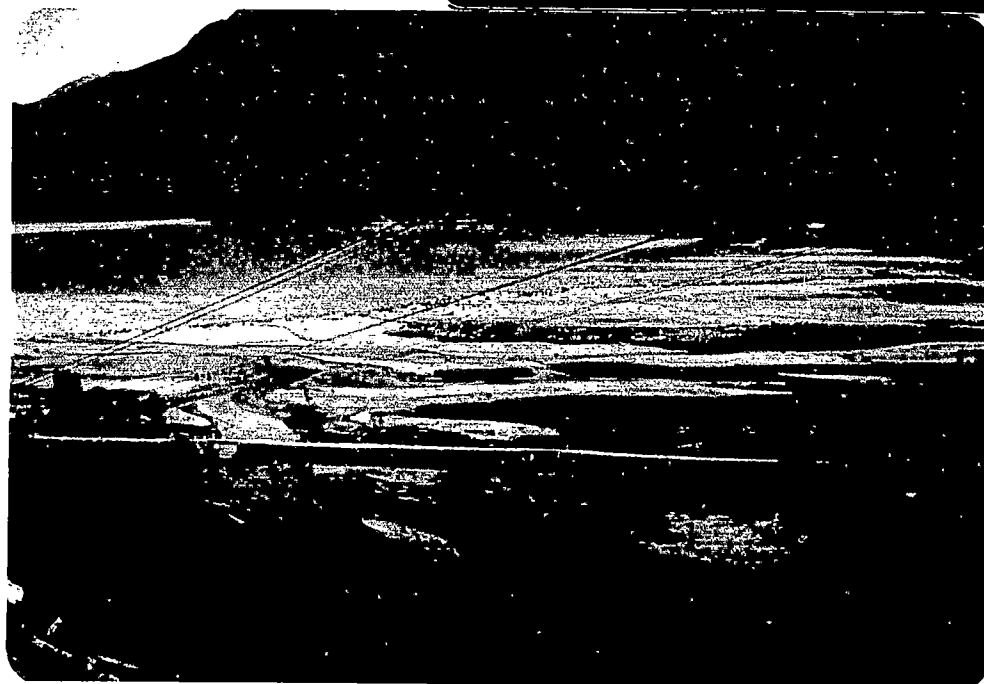
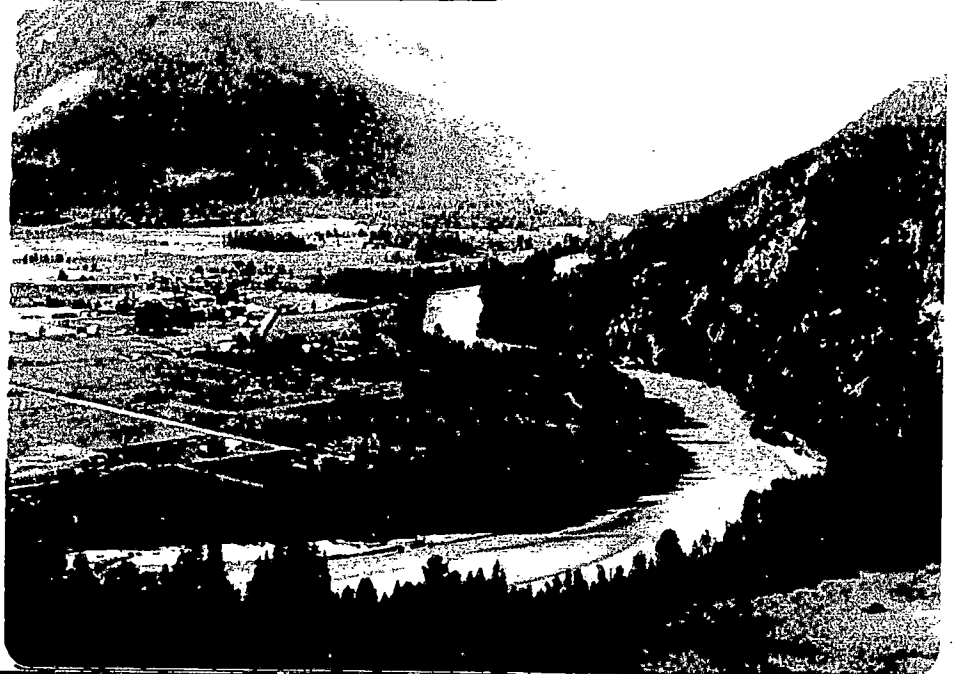


Fig. 2. Birkenhead River and tributaries showing points of interest.



Typical section of the Upper Lillooet River. Note murky colour and many channelled flood plain.

Lillooet River near Pemberton. The river has a very narrow channel compared to upper areas due to the extensive dyking.



Looking south over Lillooet Lake at the mouths of the Birkenhead (foreground) and Lillooet Rivers. The Joffre Creek Road crosses the Birkenhead at this point.

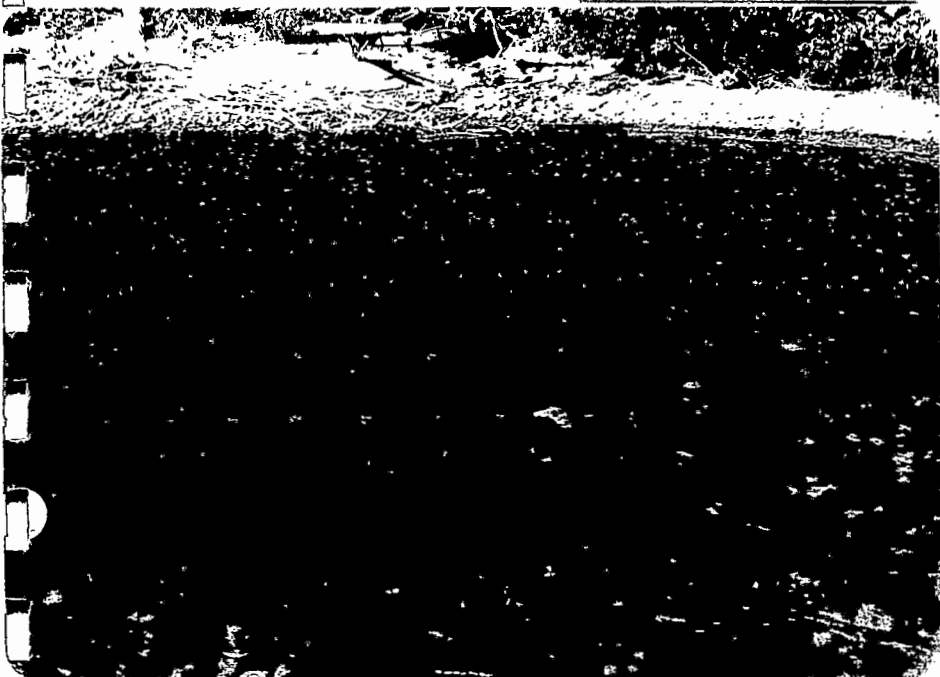
Figure 3



Birkenhead Lake. Looking north east. Outlet stream (Taillefer Creek) in the foreground.



Birkenhead River spawning grounds, "Hindu Flats" area.



Chinook and Sockeye salmon spawning in the "Hindu Flats" area, Birkenhead River. Sept. 1975.

Figure 4

areas to 10 metres at the outflow on Harrison Lake. Average temperatures at Pemberton vary from -6°C in January to 19°C in July, while average ppt. varies from 2.67 cm in July to 17.22 cm in November. (Atmospheric Env. Serv., Env. Canada). The largest snowfall usually 1-1.5 metres of standing snow from January to March.

Vegetation zones within the watershed vary from Coastal Western Hemlock through the upper and lower Lillooet, to Interior Douglas fir in the Birkenhead River valley. Higher elevations give way to Sub-alpine Spruce and Alpine communities.

Highway 99 from Squamish is the main access route to Pemberton and Mt. Currie, the major settlements in the area. Active logging in the Pemberton area is responsible for the construction of the many access roads in the watershed. Two roads, one on either bank of the Upper Lillooet, extend approximately 45 kilometres west of Pemberton at present and plans are being made to extend the right bank road into the Meagre Creek drainage in 1977. The Birkenhead River is accessible from the road joining Mt. Currie and D'arcy. There is a good gravel road from Mt. Currie which follows the east shore of Lillooet Lake and the Lower Lillooet River to Port Douglas on Harrison Lake. This road closely parallels the lower Birkenhead River and Lillooet Lake providing easy access at many locations. There is also a logging road extending up the west bank of the Lower Lillooet from Harrison Lake to Lillooet Lake. Other methods of access include aircraft, boats, and the B.C. Railway, which follows the Green and Birkenhead River valleys.

Lillooet River and Lake are most easily surveyed using jet powered shallow draft boats. The lower Birkenhead (up to km 8) and

the Lillooet River from Lillooet Lake to Pemberton have been travelled by Fisheries personnel using a 16 ft. smoker craft with a 65 h.p. jet outboard. The Upper Lillooet was felt to be accessible up to the confluence of Meagre Creek by boat, while all of the Lower Lillooet is probably accessible provided the craft has sufficient power to negotiate the faster flowing areas. Launching sites are scarce. However, the Forest Service has a gravel ramp at the head of Lillooet Lake, near the Indian net fishing site (Fig. 2), and a good concrete ramp at their Twin One Creek campsite about 8 km down the lake.

HUMAN INFLUENCES

The human activities of major concern to the Fisheries Service in the watershed are farming, logging and the maintenance of several B.C. Hydro transmission lines. Farming is confined to the Lillooet River valley (Fig. 5) while logging is carried out in all parts of the watershed and is still increasing (Fig. 6).

Activities associated with farmland improvement have had the greatest impact on the watershed from a fisheries point of view. During 1948, "Lillooet Narrows" (Fig. 15) was dredged to lower the level of Lillooet Lake and dry large swamp areas on the Lillooet River delta. Since then the Pemberton Diking Commission has diked the lower 40 km of the Lillooet River for flood control and farmland protection in the Pemberton area. In addition, the Lillooet was straightened and Green River, Miller Creek, Ryan River and Pemberton Creek were dredged or rechanneled, then dyked (Burnett et al, 1952). It seems likely that large rearing areas and many spawning areas for salmon and trout species were eliminated when the drainage work was completed.

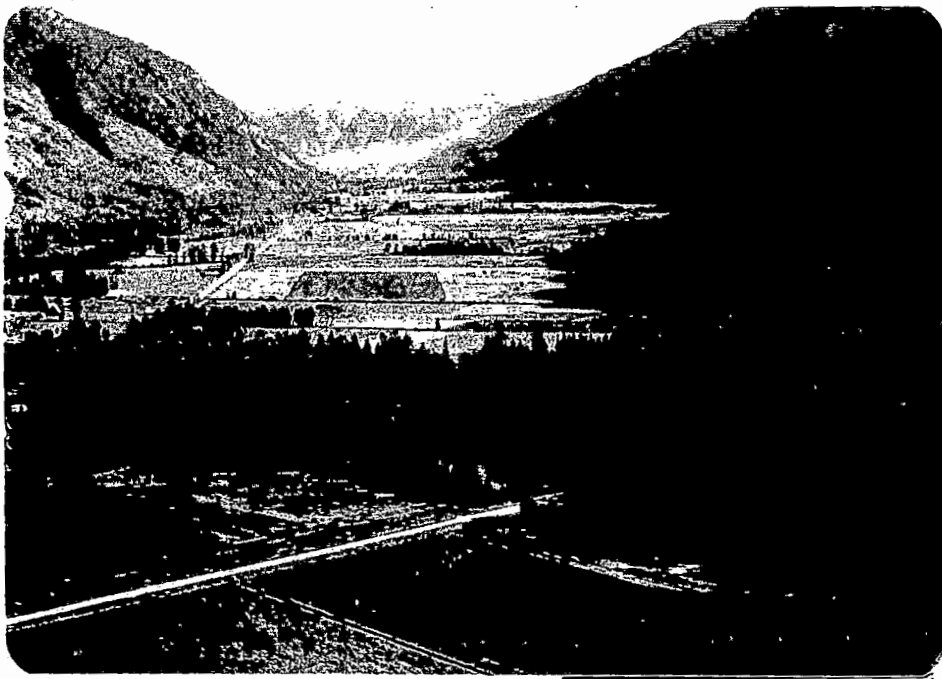


Fig. 5. Farmland in the Lillooet River valley - looking East toward Pemberton.

Fig. 6. Logged area in the headwater valley of the Birkenhead River - West of Birkenhead Lake.



Fig. 7. Birkenhead River showing the proximity of the 4 hydro power lines to the river.

Logging has not had as significant an influence on the water-courses as the diking. However, two recorded instances have had direct effects on salmon runs in South Creek and Railroad Creek (Fig. 14). In the winter of 1963, to prevent the flooding of a timber lot, South Creek was diverted into a flood channel which flowed directly into the Lillooet River. The timber was then harvested since many of the trees had been killed by the flooding. The diversion apparently eliminated coho and sockeye spawning areas and at present there are no runs to South Creek (J. Bentley, pers. comm.). In November 1971, (when coho were present) a crossing was constructed on Railroad Creek. Local residents reported that fill material was pushed into the channel and many fish were stranded and injured. Other general effects of logging are the accompanying changes in run-off patterns and water temperature regimes associated with slash areas.

B.C. Hydro has four powerlines running adjacent to the Birkenhead River from km 13 to km 26 (Owl Creek to Poole Creek, Fig's. 2 and 7). B.C. Hydro has also done some surveys on the Upper Lillooet River (Meagre Creek area) into the possibilities of developing a geothermal power plant using the hot springs in the area. There are no definite plans as yet.

Spraying of the powerline right-of-ways is undertaken as required; generally less frequently than once a year. The herbicides currently used are 2, 4-D; 2, 4, 5-T and Picloram. Spraying programs are policed by the B.C. Interdepartmental Pesticide Committee, the Environmental Protection Service (EPS) and the Habitat Protection Directorate of the Fisheries Service (HPD). The herbicides, in

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concentrations as low as 1 ppm are known to be toxic to salmonids (EPS, 1975), but care is taken that they are not applied near any of the major water courses. However, small or intermittent streams are inevitably sprayed. Due to the length of the river affected and the amount of spraying done every year, it is unlikely that EPS can adequately monitor all the adverse effects caused by these known toxic chemicals. It is significant that a major concern of that agency is the killing of the stream bank vegetation and the associated loss of stream bank cover through the spraying program.

Herbicides are also applied directly to the right-of-ways of both the B.C. Railway and the highway. Although the effects of the spraying by all three of these agencies is probably minimal, a great deal of care and monitoring is warranted due to the toxic effects of these chemicals.

The B.C. Railway and the provincial highway run close to the Birkenhead River for a distance of approximately 21 km, climbing 190 metres in this distance. Derailments ^{have occurred} ~~are common~~ on the B.C. Railway, and the close proximity of the river to the railway ^{has} ~~could~~ resulted in foreign material being deposited in the river. In July 1972, several loaded railcars were overturned and wood chips were deposited in the river. This spill had a relatively minor impact but other cargo could have much greater potential for stream degradation. The Dept. of Highways is continuing improvement work on the road between Spetch Creek and Birken but it has had no significant impact on the river.

There has been mining exploration in the area of the Lillooet-Birkenhead watershed but no producing mine has resulted to date.

Some diamond drilling has been done in the areas of Owl Lake and Tenquille Lake.

Land development in the drainage has been minimal except in the immediate area of Pemberton. Two large subdivision developments have been proposed, one on Owl Creek and the other on Ryan Creek. Both have been notified of the stringent conditions regarding protection of the stream environment and it appears that these have discouraged the developers.

The 1100 Indians on the Mt. Currie Reserve represent 40% of the total population in the Pemberton Valley. The local school has requested that students be involved in any salmon enhancement work undertaken in the area. Since the native people have a vested interest in the salmon populations they should be informed of all developments and their participation should be encouraged whenever possible.

Since the Lillooet system is relatively close to the heavily populated lower mainland, the sports fisheries on the rivers have a special significance as a recreational resource. The Pemberton Rod & Gun Club is interested in the proposed salmon enhancement work and is anxious to re-establish the presently closed sport fishery.

FISHERIES RESOURCE

The Lillooet River system supports populations of chinook salmon (Oncorhynchus tshawytscha), sockeye salmon (O. nerka), coho salmon (O. kisutch), steelhead (Salmo gairdneri) and sea-run cutthroat (S. clarki clarki), as well as resident rainbow trout (S. gairdneri), cutthroat trout (S. clarki clarki), Dolly Varden char (Salvelinus malma), Rocky Mountain whitefish (Prosopium williamsoni), kokanee (O. nerka), sturgeon (Acipenser transmontanus), and burbot (Lota lota).

Escapements of chinook salmon to the Birkenhead River have shown a substantial decline in recent years, while sockeye and coho have maintained stable populations (Table 1). Coho escapements to the Lillooet River show large fluctuations between years, while sockeye have shown a marked decline (Table 1). Coho are known to spawn in many small unnamed tributaries of the Upper Lillooet, for which there are no spawning reports (T. Richardson, pers. comm.). Although there are only a few coho found in each stream, the large numbers of such streams and the lack of information on mainstem spawning probably make the total escapement estimates very low.

The Lillooet River is accessible to anadromous fish up to a falls approximately 16 kilometers above Meagre Creek (Fig. 8). No information is available for spawning distributions in the Lillooet River due to the turbidity. Tributary spawning is limited by the steep valley walls to that portion of the streams remaining on the valley floor (usually less than 3 km).



Fig. 8. Falls on the Upper Lillooet River. Estimated height 15 metres. The streambed downstream is similar, as far as Meagre Creek.



Fig. 9. Rock Falls at the lower end of the Birkenhead canyon (km 26). Total drop is approximately 2 metres but note passable chute to the left.

Table 1. Chinook, Coho and Sockeye Escapements
to the Lillooet-Birkenhead System.
 (5 year averages 1940-1974 and yearly
 escapements 1965-1976)

5 Year Period	Lillooet R. ¹		Birkenhead River			Poole Cr. Coho
	Coho	Sockeye	Coho	Chinook	Sockeye ²	
1940-44	6555	7569	5200	1380	62,600	205
1945-49	7850	2420	16200	930	100,000	1488
1950-54	6525	870	6050	900	84,000	395
1955-59	421	62	1750	1300	41,500	75
1960-64	1478	125	3300	750	55,500	90
1965-69	1904	110	2940	670	63,200	254
1970-74	3715	250	3800	550	67,200	300
Yearly Escapements:						
1965	1600	200	3500	750	30,000(30,000)	200
1966	1675	200	3500	750	81,000(81,000)	200
1967	1500	100	3000	100	58,000(58,000)	200
1968	1175	50	3500	750	84,000(84,000)	200
1969	3570	0	1200	1000	63,000(63,000)	470
1970	4925	75	3000	1500	52,000(73,000)	200
1971	7500	50	3500	250	34,000(32,000)	700
1972	1925	475	3500	400	75,000(114,000)	200
1973	1750	175	1500	200	100,000(139,000)	200
1974	2475	475	7500	400	75,000(173,000)	200
1975	6175	625	1200*	200*	75,000(93,000)	100*
1976	1000	400	4000*	200*	35,000(108,000)	100*

SOURCE: Fisheries Service Spawning Reports. District #2, Area 29.

¹Totalled escapements for the Upper Lillooet including all tributaries.
 Individual escapements are shown in Appendix C.

²International Pacific Salmon Fisheries Commission estimates in brackets,
 from IPSFC Annual Reports.

*Reconnaissance survey estimates.

Recovery of a female chinook salmon above Birkenhead Lake in September 1875 confirmed that the Birkenhead River is passable to the lake. The normal limit of migration on the Birkenhead River is Kilometre 25 where rock falls and fast water in the canyon area make further ascent difficult (Fig. 9). The preferred spawning area for Birkenhead chinook and coho is "Hindu Flats" while the largest concentration of sockeye spawn near Mt. Currie (Fig. 10). It should be noted that there are also chinook, coho and steelhead recorded as "present" in Sloquet (Spring) Creek on the Lower Lillooet River and chum salmon to Smith Creek at the outlet of Lillooet Lake.

The Lillooet and Birkenhead salmon runs support three Indian fisheries :one at Port Douglas, one at Skookun^rchuck and the major one at the mouth of the Birkenhead on Lillooet Lake (Fig. 11). The first two have an insignificant effect on the runs since effort is minimal (1-4 nets) and catches are low. The Mount Currie band, on the other hand, takes a significant number of salmon from each run (Table 2). The large catches of chinook and coho relative to the Birkenhead escapements (Table 1) suggest that runs, other than Birkenhead's, are contributing to this fishery.

The chinook salmon run also supported a significant sport fishery up until the protective closure in 1976². Fisheries officers estimated the chinook catch at 91 in 1974 and 64 in 1975 (J. Krywchuk, pers. comm.). The salmon derby held by the Pemberton Rod & Gun Club

²1976 The lower Fraser R. gillnet fishery was reduced to 1 day from 2 days/wk. and opening changed from March 15 to April 19. Chinook sport fishing closed in the Fraser R. to the Harrison R. confluence Feb. 1 to April 18. Harrison R. closed Feb. 1 through August 1 and upper areas closed until Feb. 1 - Oct. 3. Mt. Currie Indian Fishery limited, by voluntary agreement, to 25 fish per season.

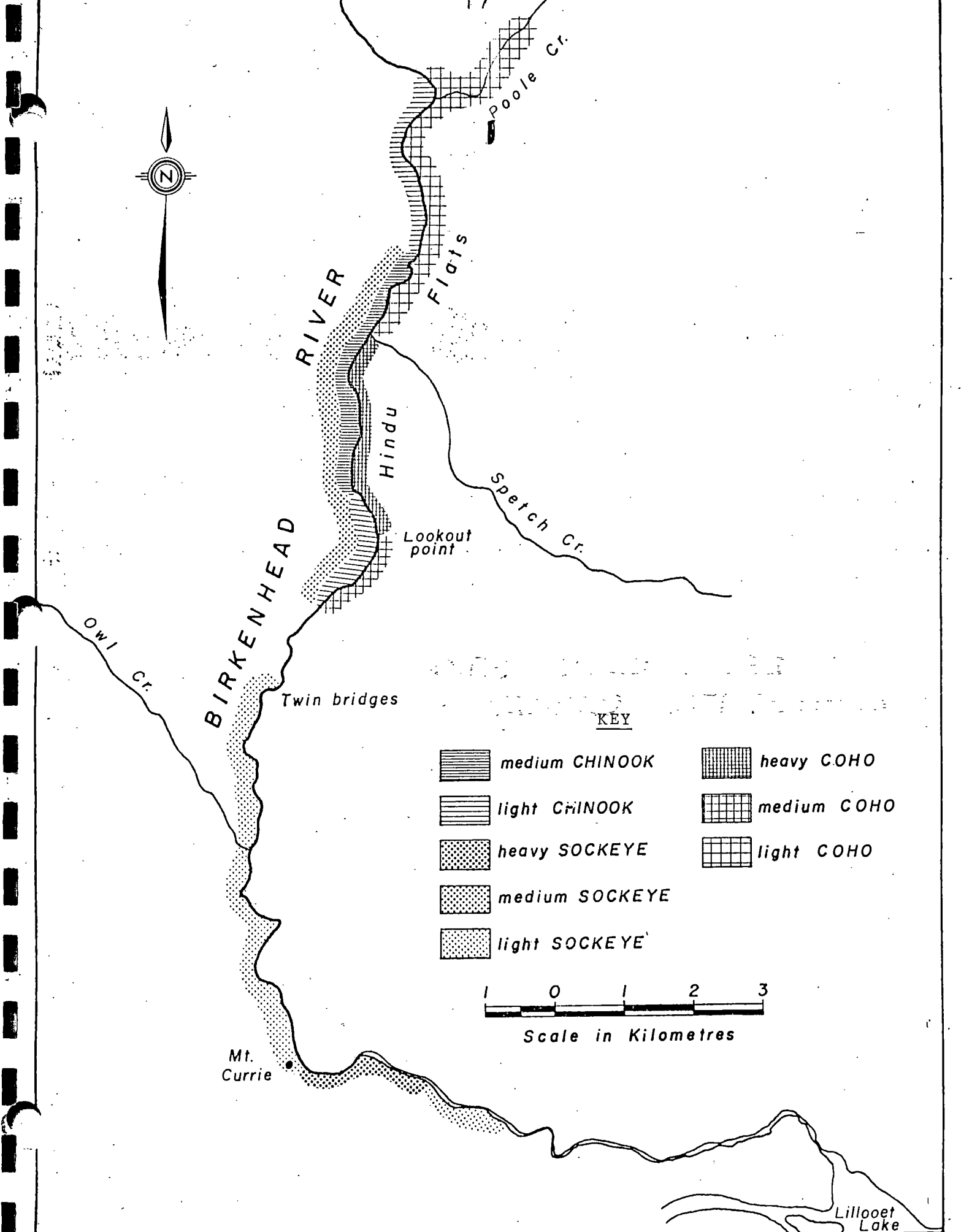


Fig. 10 Birkenhead River salmon spawning distribution



Figure 11. Mt. Currie Indian Band fishing site on the shore of Lillooet Lake showing Sockeye on drying racks.

Table 2. Estimated Indian ^aGillnet ^cCatches by the Mt. Currie Band. at the mouth of the Birkenhead River.

<u>Year</u>	<u>Chinook</u>	<u>Coho</u>	<u>Sockeye</u>
1967	N.R.	N.R.	5,325
1968	132	427	5,613
1969	N.R.	N.R.	3,860
1970	N.R.	N.R.	6,000
1971	N.R.	N.R.	6,100
1972	N.R.	650	3,835
1973	75	300	3,500
1974	100	860	11,500
1975	100	3,000	9,000
1976	30	2,000	7,500

N.R. _ No Report

Source: J.L. Bentley, Fisheries Officer, Mission.

gives an indication of relative abundance of chinook salmon in the Lower Lillooet from 1967 to 1975 (Table 3).

Migration timing for anadromous species is similar to other systems except for chinook salmon. Information gathered from Indian and sport fisheries, indicates that chinook salmon are present in the system for an unusually long period (Table 4). Additional information indicates that runs of chinook are present in the Lillooet system, which do not spawn in the Birkenhead. Large unspawned chinook have been netted in Lillooet Lake at the mouth of the Lillooet and Birkenhead Rivers during late October and November, after the Birkenhead run is finished (J. Bentley and Bob Racine, pers. comm.). There is also a report that spawned chinook have been caught in the Lillooet River below Tenas Lake in October (A. Starks, pers. comm.). This evidence suggests that there are distinct runs of chinook salmon which spawn in the Upper and Lower Lillooet Rivers. This assumption could account for the unusual timing attributed to the Birkenhead chinook.

Population estimates for steelhead, sea-run cutthroat and resident species are not available but some information from sport fishing has established the species present and their size. Steelhead up to 9 kil^oograms have been caught in the Lower Lillooet and Lillooet Lake near the river mouth, from January through March. Large rainbow (1.4 - 2.7 kg) are also caught in the Birkenhead River during October and November, but it has not been determined if they are lake residents or actual steelhead (P. Caverhill, pers. comm.). Sea-run cutthroat are occasionally caught in the Lower Lillooet. Dolly Varden char, Rocky Mountain whitefish and rainbow

Table 3.

PEMBERTON ROD & GUN CLUB SALMON DERBY catch results.

1967 - 1975

<u>Year</u>	<u>Approx. No. Spring Salmon Entered</u>	<u>Location of Largest Caught</u>	<u>Weight of Largest Fish (Lbs.)</u>
1967	10-12	Lower Lillooet River between Cowan & Rogers Cr. "19 Mile"	32
1968	3	Lillooet Lake at Mouth of Birkenhead	19
1969	15-20	Lower Lillooet River at Confluence of Rogers Cr. "25 Mile"	29
1970	15-20	"25 Mile"	30
1971	15-20	"25 Mile"	31
1972	10	"25 Mile"	25
1973	12	"25 Mile"	29
1974	5	"25 Mile"	23
1975	2	"25 Mile"	19

- mile posts marked in miles from Pt. Douglas on Harrison Lake.

- derby held on a 2 day weekend in the last half of April for each year. Avg. number of anglers 25-30.

SOURCE: B. Ross & A. Starks - members Pemberton Rod & Gun Club.

Table 4. Timing of Salmon runs in the Lillooet - Birkenhead System.

<u>River</u>	<u>Species</u>	<u>Arrive</u>	<u>End</u>		
Lillooet River	Coho	October	December		
Green River	Coho Sockeye	October September	December October		
Pemberton Creek (1 Mile)	Coho	October	December		
Ryan Creek	Coho Sockeye	October October	January November		
John Sandy Creek	Coho Sockeye	October September	January November		
Railroad Creek	Coho Sockeye	October September	January November		
25 Mile (Sampson) Creek	Coho	November	December		
Miller Creek	Coho	October	December		
Salmon Slough	Coho	October	January		
<u>Birkenhead River</u>					
		<u>Arrive</u>	<u>Start</u>	<u>Peak</u>	<u>End</u>
Coho		Oct. 10	Oct. 25	Nov. 15	Dec. 7
Sockeye		Aug. 15	Sept. 1	Sept. 21	Oct. 15
	<u>Lillooet Narrows</u>	<u>Birk R. Mouth Lillooet Lake</u>	<u>Birk R. Below Km. 17</u>	<u>Peak</u>	<u>End</u>
Chinook	Mar.-Apr.	Apr.-June	June-Aug.	Sept. 10	Sept. 30

Source: Coho and Sockeye - Fisheries Service Spawning Reports
Chinook - Personal Communications, F. Wheeler, J. Bentley
and A. Starks.

trout are present in virtually all accessible streams in the watershed. Rainbow trout are commonly caught in Birkenhead Lake, Tenquille Lake and the Owl Lakes. Birkenhead Lake also supports populations of Dolly Varden char, Rocky Mountain whitefish, kokanee and squawfish. The B.C.Parks Branch has constructed a campsite on Birkenhead Lake and the lake is supporting increasing numbers of anglers. A creel survey in the summer of 1974 indicated a catch of .52 fish per hour (P. Caverhill, pers. comm.). Sturgeon have been seen but never caught in the Lillooet River.

PREVIOUS FISHERIES-RELATED PROJECTS

There has been substantial past interest in the Birkenhead River mainly due to the large escapements of sockeye. The federal Fisheries Service operated a sockeye hatchery at the mouth of Owl Creek from 1905 to 1936. Data from the hatchery (Table 5) indicates that adult returns did not improve and the program was terminated.

Some chinook eggs were taken during the operation of this hatchery, notably in 1906, 1913, 1918, and 1919. No other information on these fish was given except that the eggs taken in 1906 were obtained at "Tenas Rapids" below Tenas Lake.

This hatchery was also an incubation and distribution site for rainbow trout eggs obtained at Lloyds Creek Station near Kamloops. The Owl Lakes, Green Lake, Alta Lake, Tenquille Lake, Gates Lake, and others in the Pemberton area were all stocked with rainbow fry from this hatchery. There was also an attempt to establish a lake whitefish fishery on Lillooet Lake by stocking it with fry, shipped as eggs from Sarnia, Ontario. The outcome of this project was not documented.

Table 5. Pemberton Hatchery Data 1905-36.

Year	Estimated # of Female Sockeye*	No. of Eggs Taken (X103)	Sockeye Fry Released (X103)	Coho Eggs Taken (X103)	Coho Fry Released (X103)	Chinook Eggs Taken (X103)	Chinook Fry Released (X103)
1905-06	7,907	21,350	17,450	600			
06-07	7,962	21,500	10,500			150	120
07-08	10,378	28,000	18,300	1500	1300		
08-09	7,666	20,700	18,200	1000	890		
09-10	10,370	28,000	25,200				
10-11	2,592	7,000	6,750	1500	750		
11-12			12,130		1090		
12-13	9,259	25,000					
13-14			22,950				50
14-15			14,935		788		
15-16			23,892				
16-17							
17-18	1,981	5,350	5,004	740	667	30	27
18-19	4,413	11,915	10,915	45	40	45	35
19-20	11,357	30,665	28,260				
20-21	9,630	26,000	23,536				
21-22	9,630	26,000	20,538				
22-23	9,630	26,000	12,108				
23-24	11,344	30,629	7,370				
24-25	11,555	31,200	19,295				
25-26	14,970	40,418	23,280				
26-27	16,796	45,350	21,450				
27-28	13,704	37,000	20,525				
28-29	12,967	35,010	21,350				
29-30	6,667	18,000	16,799				
30-31	13,040	35,210	21,434				
31-32	7,565	20,425	19,146				
32-33	8,411	22,710	21,330				
33-34	3,955	10,680	9,977				
34-35	7,555	20,400	19,309				
35-36	9,040	24,410	23,493				
1936	E N D O F R E C O R D						

*Average fecundity for Birkenhead Sockeye 4500 eggs/female 60% recovery for egg takes yields 2700 eggs/female. Personal Commun. Jim Woody, I.P.S.F.C.

The International Pacific Salmon Fisheries Commission (IPSFC) has operated downstream traps on the Lillooet system in several years (Table 6). Timing of the trapping operations were directed at the sockeye migrations so the duration of the trapping period is not necessarily applicable to chinook and coho. Small numbers of juveniles of other species were also captured.

The IPSFC has also performed tag and recovery enumeration programs on the Birkenhead sockeye since 1939. Information from these programs is used to calculate yearly escapements (Table 1) and sex composition. The Birkenhead population has an unusually large percentage of jacks compared to other races in the Fraser River System. Scale samples from Birkenhead sockeye indicate that there are two distinct populations, a Harrison Lake type and a Lillooet Lake type. These are distinguished by the lower freshwater circuli counts for the Lillooet type. A greater proportion of returning jacks were found to have reared in Harrison Lake compared to similar proportions for adult (4 and 5 year old) fish of the same year (J. Woody, pers. comm).

Table 6.

IPSFC DOWNSTREAM TRAPPING RESULTS
LILLOOET-BIRKENHEAD SYSTEM

Date	Location	Gear	Salmon Species Caught	Total No. Caught	Date Of Peak Catch	Reference
May 10-12 1953	"Lillooet Narrows"	5x5 Fyke Net (Ruskin Type)	Sockeye Smolts Coho	153 440	May 11 May 10	S.R. Killick IPSFC
Apr. 28-May 18 1954	"Lillooet Narrows"	5x5 Fyke Net (Ruskin Type)	Sockeye Fry Sockeye Smolts Coho Fry Coho Smolts Chinook Fry	20 264 201 54 59	May 7 May 13 May 7 May 13 Apr. 30	S.R. Killick IPSFC
Mar. 21-May 14 1961	Birkenhead R. "Indian Bridge" km 7	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	258,154 670 76 937 2	Mar. 22 May 10 May 10 May 2	R. Kent S.R. Killick IPSFC
Mar. 27-May 24 1962	Birkenhead R. "Indian Bridge" km 7	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	89,227 409 4 535 1	May 10 May 22 - May 2 -	T. Gjernes S.R. Killick IPSFC
Mar. 27-May 16 1963	Birkenhead R. km 5	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	238,241 2802 2 988 0	Apr. 26 Apr. 16 - Apr. 24 -	T. Gjernes S.R. Killick IPSFC

Source: IPSFC Records. More complete data in Lillooet River System Data File. Fisheries & Marine Service, FRWC Division.

(2) JUVENILE STUDIESIntroduction

This section of the Birkenhead-Lillooet study is divided into two distinct parts.

→ The fall 1975 and winter 1976-1977 Reconnaissance surveys were cursory examinations of the area. Basic objectives were to determine species present and distributions and to get a general overview of the watershed. Some sampling was done in both years to determine if juvenile chinook were present and to define possible rearing areas. Gee's traps, electrofishers and dipnets were used in these surveys. Effort was concentrated on the Birkenhead River and Upper Lillooet Lake.

The summer 1977 field program was more intensive, designed to pinpoint the timing of natural juvenile salmon migration, age and size at migration, rearing areas, and numbers and growth during the March to September study period. Some effects of predation were investigated. Methods of study were expanded to include downstream trapping, seining, gillnetting, shore trapping and creel surveys. Additional areas studied included Upper and Lower Lillooet Rivers and Lillooet and Tenas Lakes.

Species studied in both surveys included coho, chinook and sockeye salmon and rainbow and cutthroat trout.

Chinook juveniles generated the most interest in all surveys as this salmon population had dropped to a very low level and was in danger of extinction. Their timing and size at migration were of interest to provide guidelines for the rearing and release timing

of the fry planted in the incubation box at the hatchery site in the fall of 1977.

a) Reconnaissance Surveys 1975 and 1976.

METHODS

Accommodation

The crew (usually 2 men) stayed in a cabin on Gates Lake about 22 km north-east of Pemberton September 4 to December 24, 1975; August 26 to September 25 and December 7 to 13, 1976; and January 19 and 20, 1977.

Transportation

The crew travelled in a 3/4 ton crew cab pickup, trailering a 16 foot aluminum skiff powered by a 65 h.p. Mercury jet unit outboard for river exploration and Gee trapping.

Dipnetting

An aluminum-handled fine-mesh dip net was used to scoop juveniles in backwaters on the Upper Birkenhead River in late September and mid-October, 1975. This method was used ~~as an~~ ^{to} indicator ~~of~~ ^e of distribution and to facilitate identification of sighted fry.

Electroshocking

A Smith-Root type 8 "Electrofischer", provided and operated by Pemberton Conservation officer, Bob Lawrence, was used to stun juveniles in side channels of the Upper Birkenhead in late October, 1975. Stunned fish were recovered with dip nets, identified, then released. Some were preserved in 10% formalin.

Minnow Trapping

Gee's wire minnow traps, baited with frozen or fresh salmon roe (shown to be the most effective bait by Shepherd's 1975 and 1976 studies) were left overnight on bottom in 15 to 180 cm of water and marked by styrofoam net floats.

Birkenhead River, from the mouth to the lake, was trapped in early September 1976. The river from km 0 to km 15 (Fig. 2) and the North end of Lillooet Lake were trapped in January, 1977.

All captured fish were identified, counted and released except chinook, which were preserved in 10% formalin for later sampling.

RESULTS AND DISCUSSION

Dipnetting

Dipnetting confirmed ^{that} the upper Birkenhead River from Spetch Creek to Poole Creek ^{was utilized} as rearing areas ^{by} for coho and trout juveniles (Appendix D), but no chinook were captured.

Electroshocking

Electroshocking produced no chinook, but ~~showed~~ ^{we found to be} small numbers of trout and coho rearing at the mouth of Poole Creek and trout in Taillefer Creek (Appendix D).

Minnow Trapping

Fall 1976 Gee's trapping showed coho and trout juveniles overwintering from the mouth of the Birkenhead upstream to the hydro bridge (km 17). Only three chinook juveniles were taken, right at the mouth of the river (Appendix E).

Winter 1977 trapping produced no chinook, but showed over-

wintering coho in various sloughs in the low gradient flood plain near the mouth of the Birkenhead and along the upper Lillooet Lake shoreline (Appendix F).

The low chinook catch could have been caused by three factors:

1. most of the available juveniles had already left the system.
2. the method used was not effective for capturing chinook juveniles in low concentration areas.
3. areas sampled were not main rearing areas for 'stream type' chinook.

The large area into which Birkenhead chinook fry can disseminate probably makes their numbers low, even in favoured areas. Suspected rearing sites for Birkenhead chinook and coho included the Birkenhead River proper, Lillooet Lake, the lower Lillooet River and Harrison Lake.

The 1975 and 1976 sampling programs confirmed the use of the Birkenhead River (upper and lower) as a rearing area for coho, trout and some chinook, although the extent of their use could not be determined with the available data. The zero catch in Lillooet Lake may have been due to factors such as those mentioned above, especially since little effort was put into trapping in the lake. Since Birkenhead sockeye were known to rear in both Lillooet and Harrison Lakes, it was not unreasonable to assume that chinook and coho reared there also.

(b) Summer 1977 Field Program

Methods

Accommodation

The Birkenhead - Upper Lillooet group was again stationed at a cabin on Gates Lake from March 14 to September 9 (Fig. 1).

The Lower Lillooet - Lillooet Lake crew was stationed in a 31 foot fifth-wheel trailer set up in the Canfor logging camp on Billy Goat Creek about 10 km below the outlet of Lillooet Lake from March 15 to May 10. The trailer was moved on May 11 to an old airstrip at the outlet of Lillooet Lake (Fig. 12) and remained there until August 2.

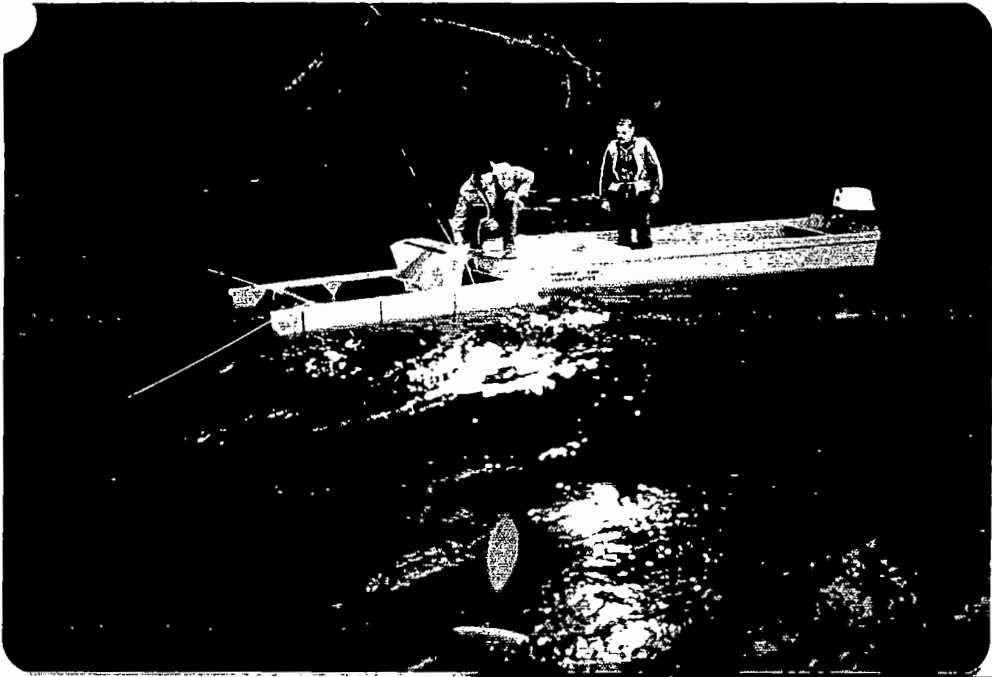
Transportation

The Birkenhead crew operated a rental pickup while the Lower Lillooet crew had a rental 4-wheel drive. On May 30 the combined crew was cut to 3 men operating both areas and usually both vehicles were at one site.

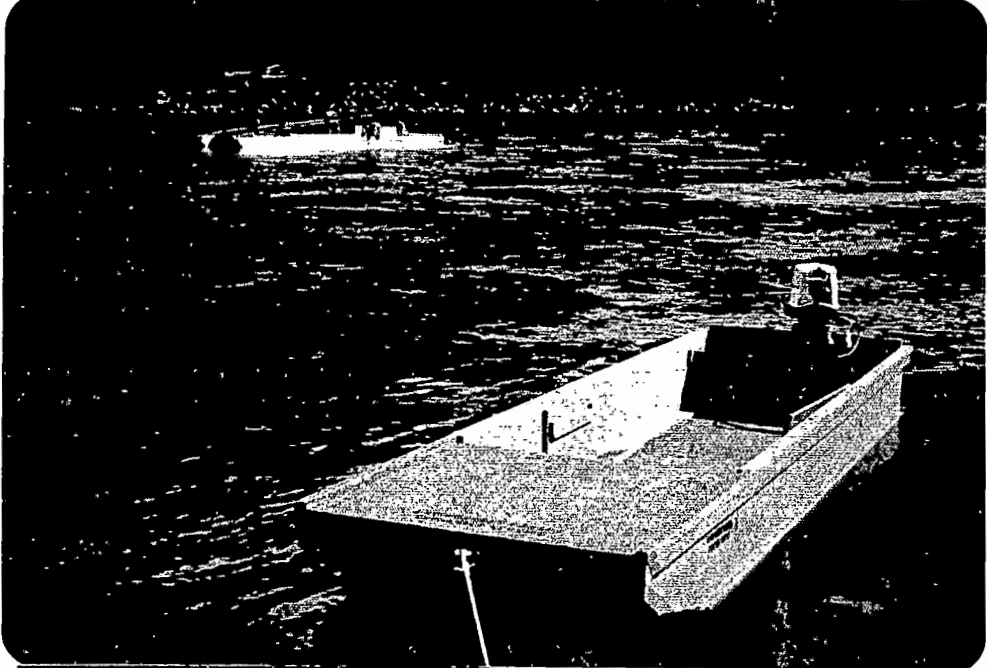
The Birkenhead area crew had a 16 foot plywood boat kept at the Twin Bridges (km 15) to check the Birkenhead River downstream trap. The Lillooet area crew had a 16 foot plywood boat with a 20 hp outboard motor and a 16 foot aluminum Smokercraft with a 65 hp jet outboard kept at the outlet of Lillooet Lake.

Downstream Traps

One 2 x 3 inclined plane trap (Fig. 12) was operated midstream just downstream of the Twin Bridges (km 15) on the Birkenhead River from March 15 to May 30 (Fig. 13)



Birkenhead River
2 x 3 downstream trap
at km 15.



Lower Lillooet River
4 x 4 downstream trap
at mile 25.5.



Final trailer site at
the outlet of Lillooet
Lake.

Fig. 12

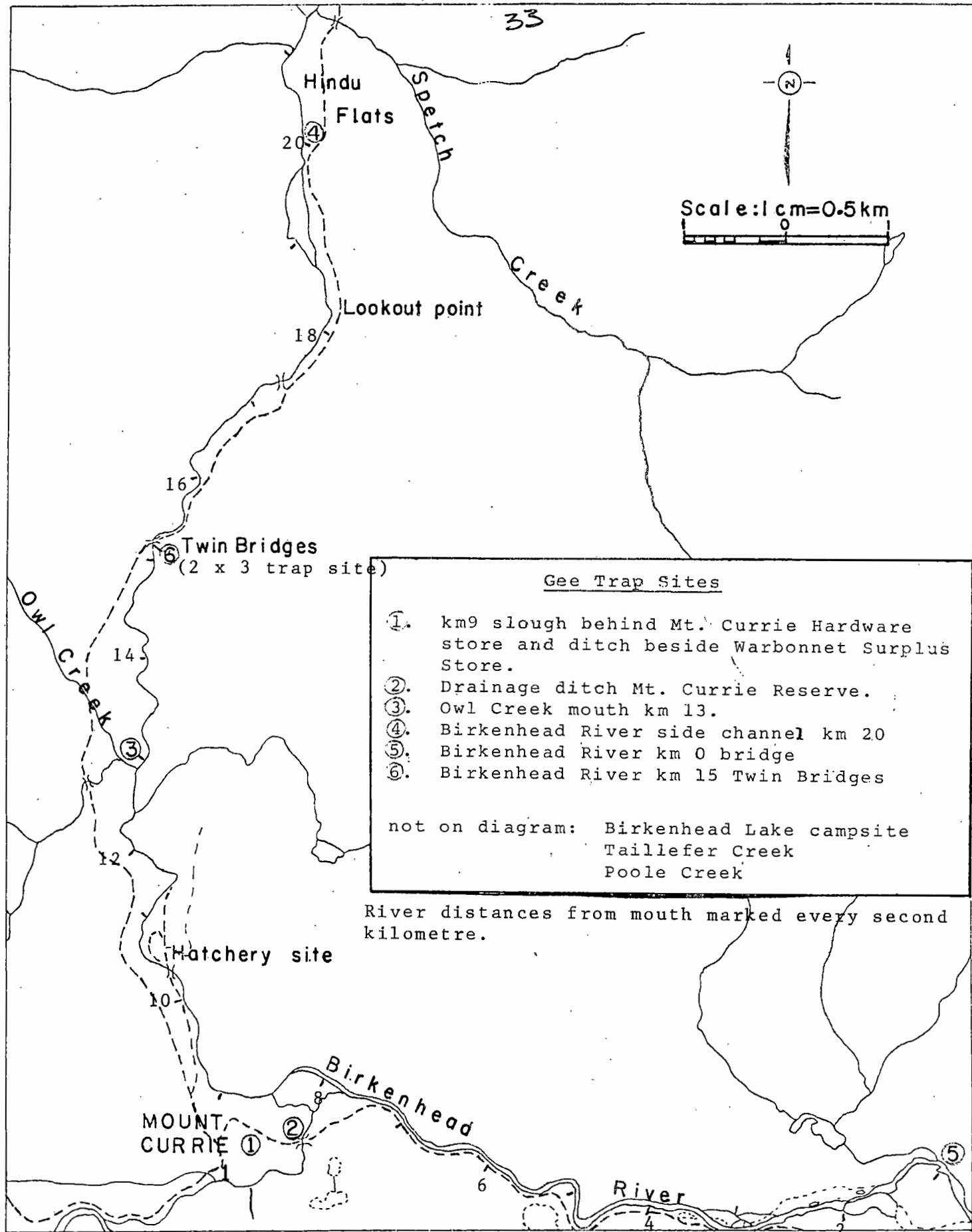


Fig. 13. Gee trapping sites in Birkenhead River area - summer 1977.

Another 2 x 3 trap was operated on the west bank of the Upper Lillooet River about 4 km north of Pemberton (140 m downstream of the confluence with Miller Creek) from April 27 to May 27 (Fig. 14).

A 4 x 4 inclined plane trap (Fig. 12) was operated midstream on the Lower Lillooet River at km 41 (measured from Tipella at the mouth) from March 29 - April 27. Excessive water velocity necessitated its movement to the outlet of Lillooet Lake along the eastern bank on April 29. Low water velocities here necessitated a move to about 0.4 km downstream on the east bank on June 1. The trap was fished daily here until July 31 then again from August 25 to September 6.

Dye Mark Releases

Dye mark releases were utilized on the Birkenhead River downstream trap to determine trapping efficiency. Coho and chinook fry were immersed in Bismarck Brown Y (concentration 1:120,000) for about 1 hour at the trap site, then transported about 2 km upstream and released at the Hydro bridge at about 2200 hours. At about 1000 hours the following morning, the 2 x 3 holding tank catch was enumerated for marked and unmarked fry.

Seven dye mark releases were performed between April 3 and May 14. At the dye concentrations used, no fry could possibly be recounted due to dye loss in the week average lapse between dye mark releases (Ward & Verhoeven, 1963). However, high water flows sinking the trap, biased sample counting of fry, reaction of fry to dyeing, and failure of the crew to properly tabulate results negated usefulness of 4 of the releases.

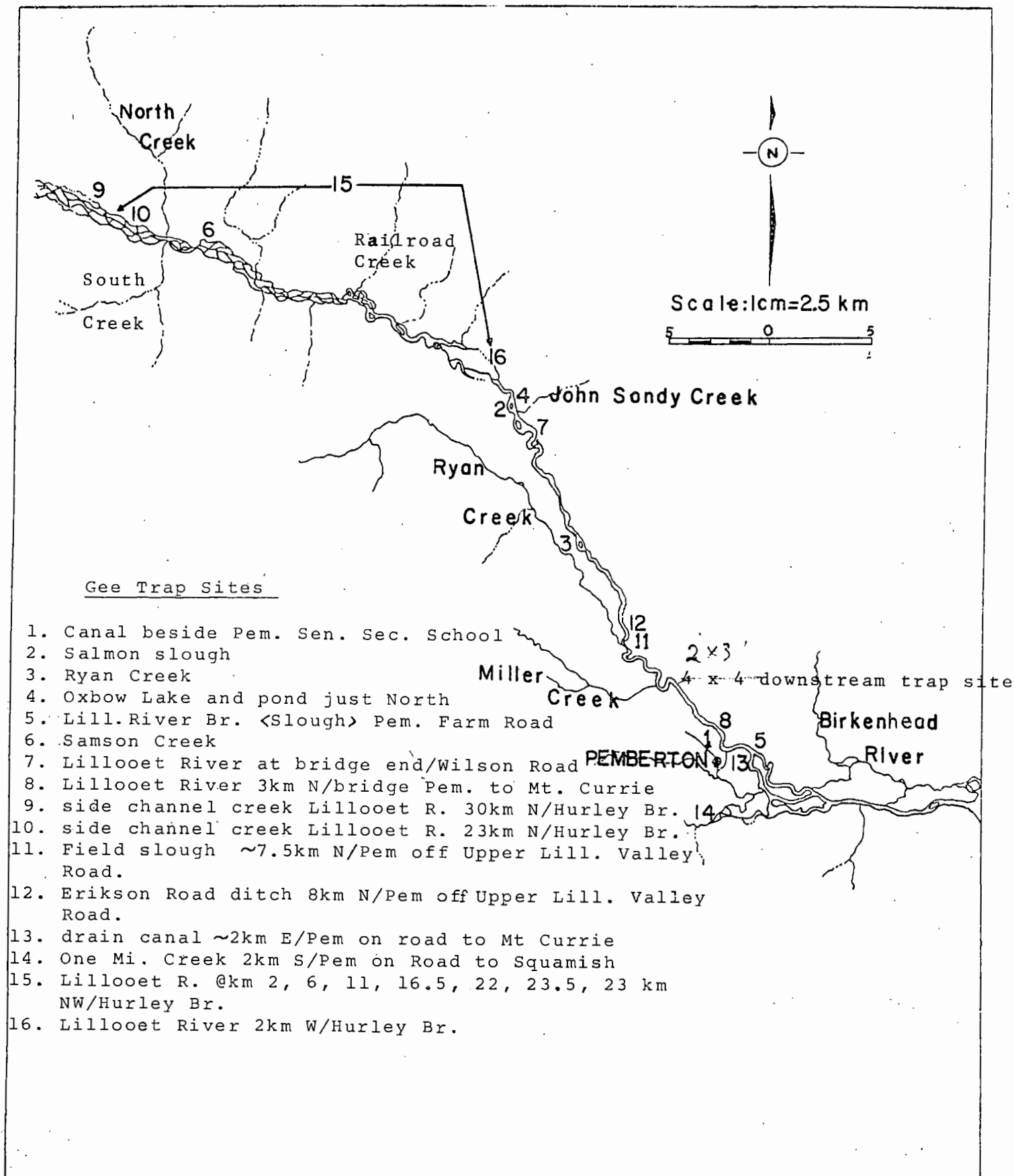


Fig. 14. Gee trapping sites in the Upper Lillooet River area - Summer 1977.

Normally the fry were counted individually into a bucket at the trap site preparatory to dyeing, transport and release; but in one case (see Appendix I) the fry were sample cup counted.

Gee's Minnow Trapping

Gee's minnow traps were set throughout April to mid-May using 1976 methods.

The Birkenhead River and sloughs were trapped from the mouth to Birkenhead Lake (Fig. 13) from March 21 to May 30. The Upper Lillooet River and sloughs were trapped from just east of Pemberton to 47.5 km north (Fig. 14) during the same period.

The Lower Lillooet area was trapped from within 2 km of Harrison Lake to halfway up Lillooet Lake (Fig. 1 and 15) from April 1 to July 15.

Traps in the Lower Lillooet Lake area were left only 3½ to 7 hours during daylight after July 3 as part of a coordination of gee trapping with 4 x 4 downstream trap and seine net catches of chinook yearlings in Lillooet Lake.

Four or five traps were set, one each at the 4 x 4 site ~~on~~ various seining sites July 3, 4, and 15 but no salmonids of any type were caught.

Juvenile Seining

On the Birkenhead River a 7.6 ^{1.2 m deep} ~~metre~~ #467 nylon Marquisette ~~1.2 m deep~~ net was used to seine smaller bars. On larger bars a 15.2 m ^{long} ~~long~~ 2.4 m deep nylon net was used. All sets here were made on foot, the lead man encircling the perimeter of the area to be netted.

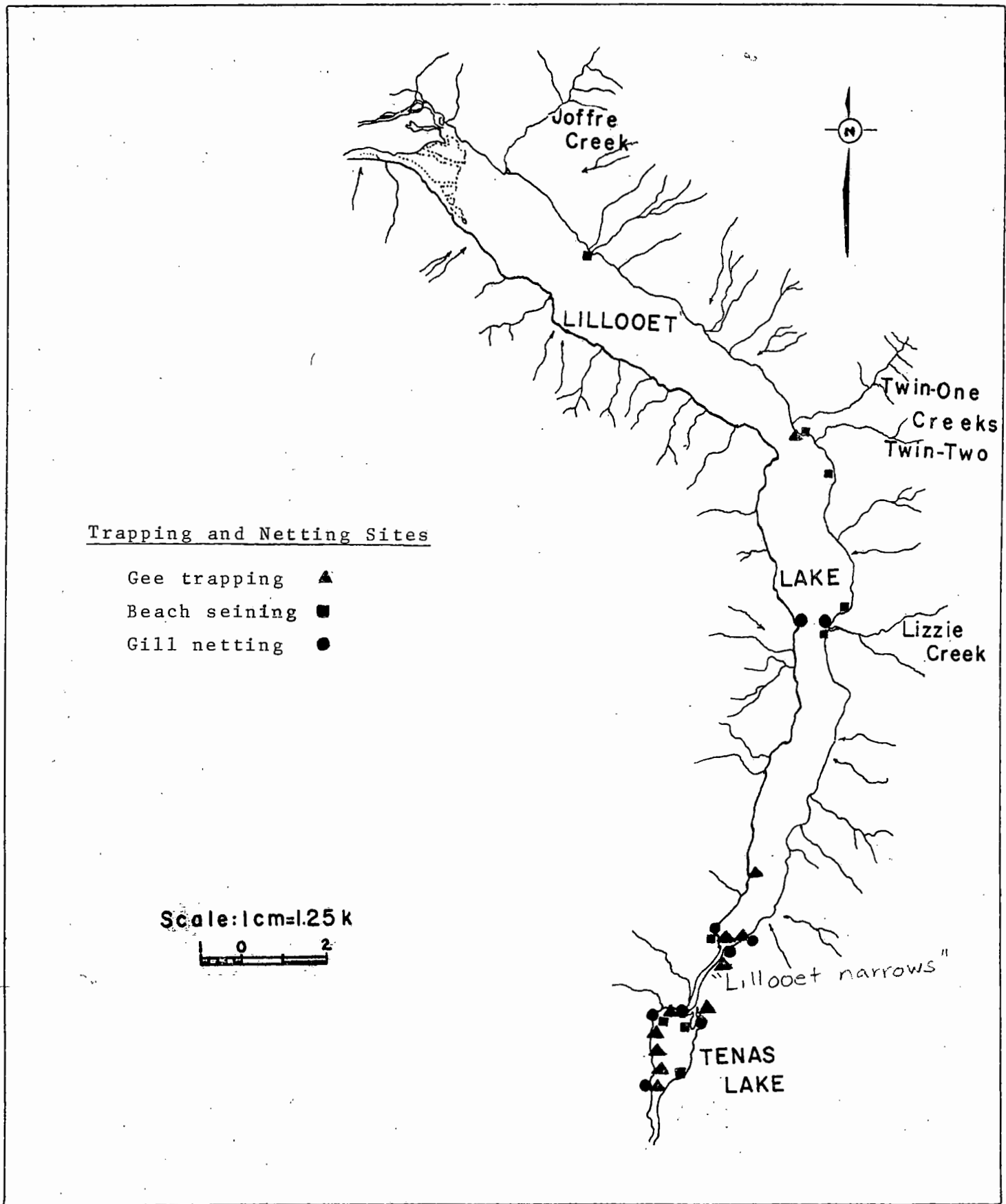


Fig. 15. Trapping and netting sites Lillooet and Texas Lakes
 - summer 1977.

Some exploratory seining was performed on the Birkenhead River in early June, but a specific program of seining the km 10 and 15 bars at least weekly was carried out in July. Sets were made during the period from 2300 to 0200 hours by vehicle headlights or propane lamplight. This method would tend to increase catches as the fry would be inshore and sedentary. (Edmundson et al, 1968).

Three sets were made in Tenas Lake with the 15.2 m seine, but the rest of the netting in the Lower Lillooet area was done with a 61 m long 2.4 m deep nylon juvenile beach seine. Sets on the Lower Lillooet were all made by feeding the net off the back of the boat as it encircled the area to be netted, then drying up the net and contents by hand on shore.

Seine netting was done in areas of favourable substrate only (levelled sand or gravel), with minimum boulders and snags.

Coordination of seine catches of chinook juveniles and their appearance in gill-netted predator stomachs was attempted at the outlet of Lillooet Lake and the top end of Tenas Lake in May and July. But predators in gill nets set where chinook smolts or fry were seined showed no evidence of this species.

Gill Netting

All gill netting for predator stomach analysis was done on Lillooet and Tenas Lakes and Lower Lillooet River (Fig. 15) using 15.2 m long nylon mesh nets 2.4 m deep. Mesh sizes varied from 25 mm (1") to 127 mm (5") stretched measure.

When used singly, the nets were anchored at both ends at right angles to shore, with inshore floats showing at the water surface

in about 3 m. of water, while the offshore floats were usually below the surface in 3 to 9 m of water. When used in tandem, the finer mesh net was inshore, with an extra anchor and floats joining the two nets.

Gill nets were checked at dawn and late evening every day, to increase chances of proper fry identification over this time period in the predators' stomachs (McKone, 1971; Steigenberger and Larkin, 1974).

Shore Trap

A shoreline lead-in trap was fabricated from 1.2 m high fine-mesh flyscreen stapled to broomhandles pushed into the lake bottom at the outlet of Lillooet Lake on the western shore. The broomhandles were angled shoreward from about the 1.2 m depth into the shallows, with the screen curved around to make a pocket dead-end in about 30 cm of water. The entrance to the pocket was deliberately narrowed and the screen curved to encourage the fry to swim in circles and not back through the opening by which they had entered.

On June 29 the flyscreen was extended offshore by a 15.2 m long 2.4 m deep juvenile beach seine anchored at the offshore end, angled shoreward and tied to the outer broomhandle.

The trap was ineffective in daylight so was checked after dark or very early in the morning.

Creel Survey

Sampling of angler catches (May 14 to July 10) was performed whenever an opportunity presented itself and figures generated from checking stomach contents are included in those of the predator study.

RESULTSInclined Plane Trapping1. Birkenhead River

The total number of chinook fry caught during 45 days of fishing was 20,323 for an average of 452 per day (Appendix G). The bulk of the migration occurred between March 22 and April 16 (Fig. 16), with the peak of 4,376 fry on April 8.

Coho fry catch totalled 14,089, for a daily average of 313 fry. The migration period was more prolonged than that of chinook fry, the bulk occurring from March 25 to May 20. There appears to be a bimodal peak, on April 7 at 986 fry and May 20 at 958 fry (Appendix G).

Coho smolt catch totalled 200 and at an average of 5 per day, with constantly low but continuous migration over the entire trapping period, a peak was impossible to pinpoint (Appendix G). No chinook smolts were taken.

Sockeye catch totalled 1,336,000 during 29 days (average 46,000+ per day) of counting. After April 20 sockeye counting was discontinued as it became too time-consuming.

From dyed mark release data (Appendix I), the 2 x 3 caught 1.7% to 10.2% of chinook fry and 1.8% to 3.0% of the migrating coho fry from the upper Birkenhead River. Variability in the data negated usefulness of these releases as an estimate of total fry migration.

2. Upper Lillooet River

The Upper Lillooet River 2 x 3, though operating intermittently for a month, caught only one sockeye fry and thus generated no data.

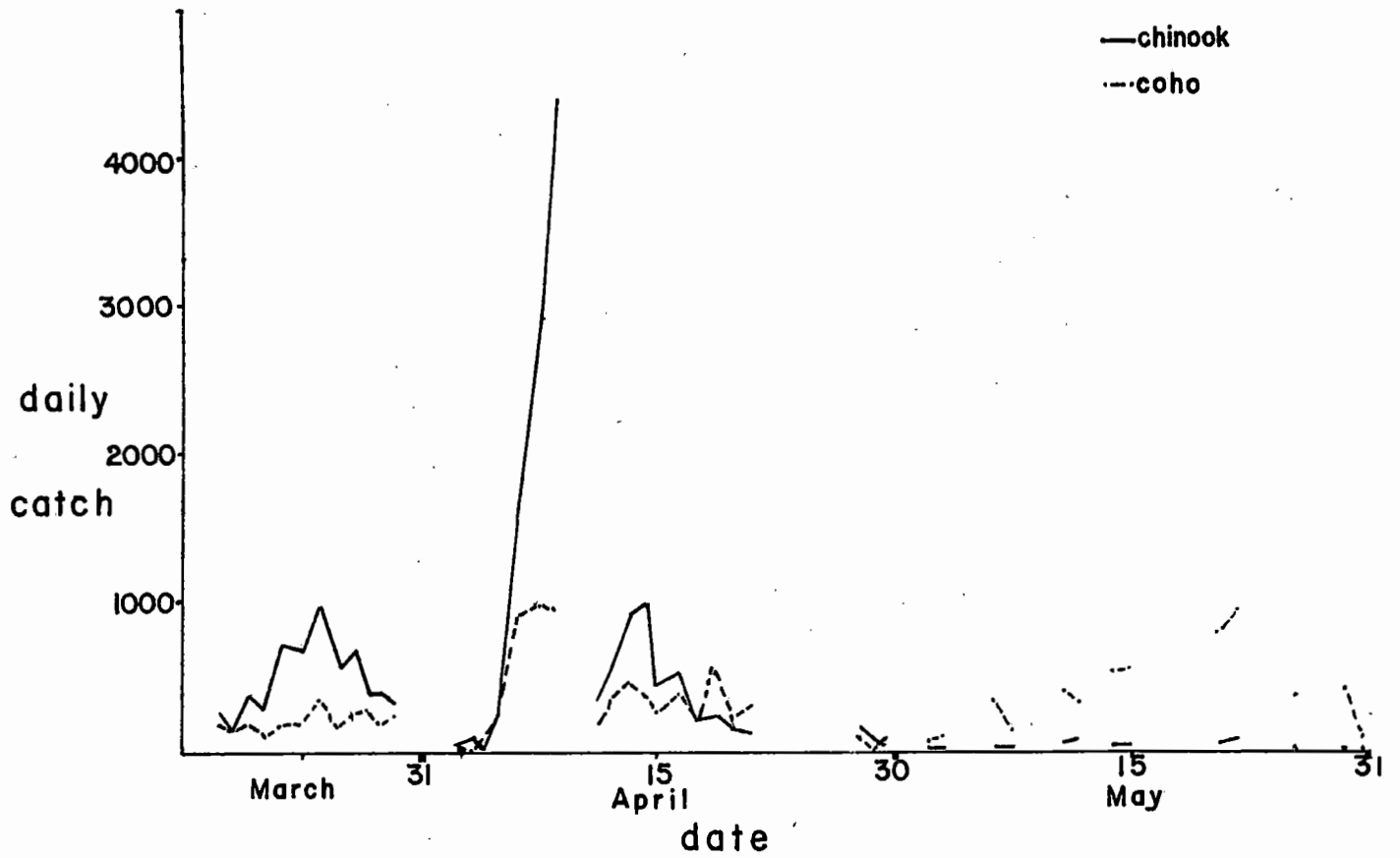


Fig. 16 . Graph of daily catch totals of chinook and coho salmon fry from the Birkenhead River 2 x 3 inclined plane trap, spring 1977.

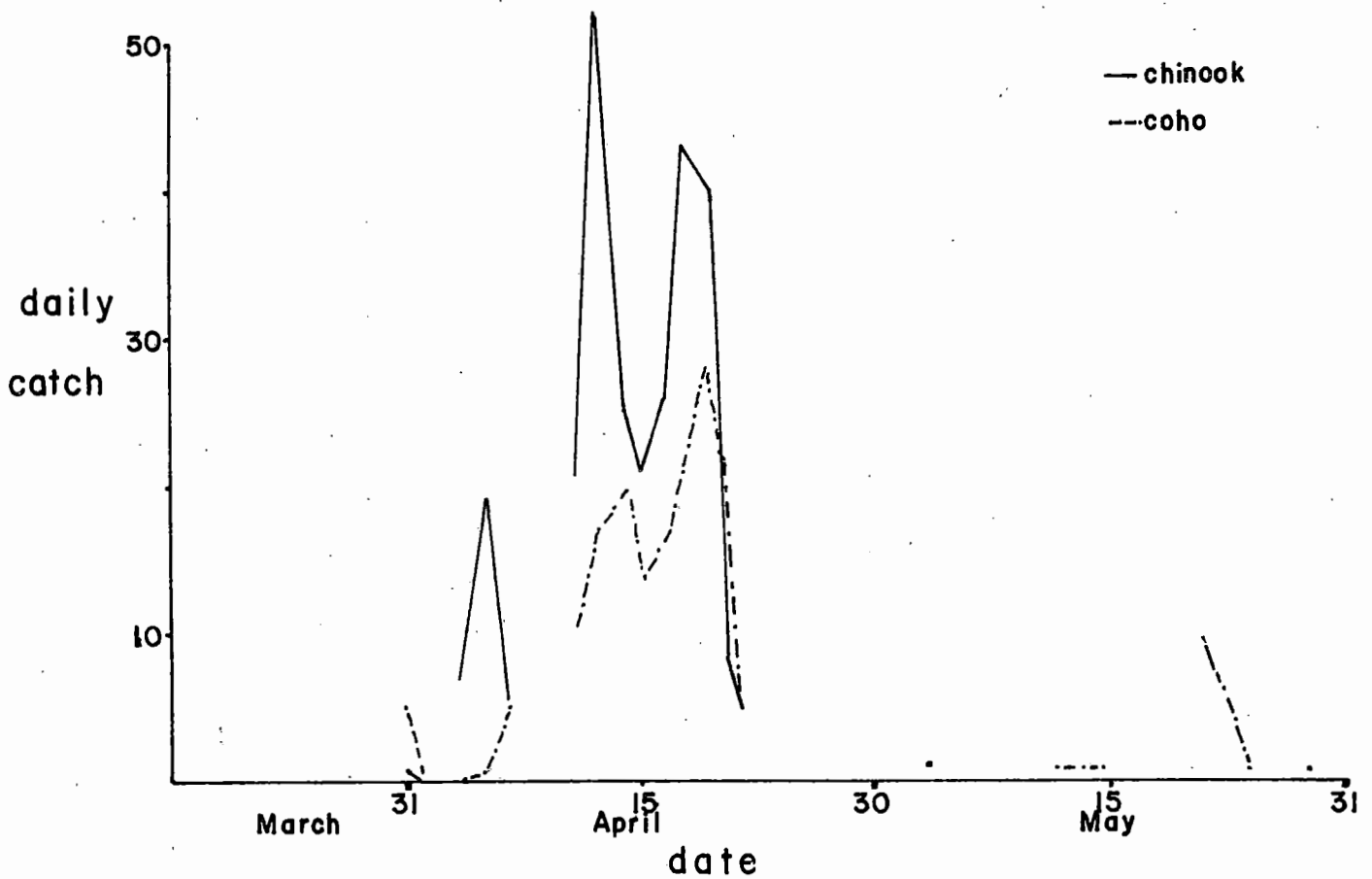


Fig. 17 . Graph of daily catch totals of chinook and coho salmon fry from the Lower Lillooet River 4 x 4 (mi. 25.5) inclined plane trap, spring 1977.

3. Lower Lillooet River

Chinook and coho fry catches at mile 25.5 (km 41) on the Lower Lillooet River peaked in mid-April (Fig. 17).

Thirty-one chinook smolts were caught throughout the 16 day fishing period, with no particular peak noted, while only 1 chinook smolt was caught.

Sockeye fry catches totalled 4,500 , with a peak catch on April 6. Sockeye smolts were taken regularly, peaking in mid-April (Appendix H).

The second site, at the outlet of Lillooet Lake, produced so few fry that no peaks could be determined (Appendix H).

Chinook fry catches at the third site totalled 240, for an average catch of 5 per day. The bulk of the migration occurred June 23 to July 3, with a peak on June 27 (Fig. 18).

Coho fry numbers were very low and well spread out over the trapping period, so a peak migration date is difficult to determine (Fig. 18).

Sockeye fry catches totalled 6,000 fry, with an obvious bulge in the middle two weeks of July (Appendix H).

Coho smolts were caught regularly in low numbers throughout most of June, though no obvious peaks occurred. Only 4 sockeye smolts were caught here.

Other species caught at sites 2 and 3 included: 85 Pacific lamprey (*Entosphenus tridentatus*), 300+ sculpin (*Cottus asper* and *C. aleuticus*) and 1 burbot (*Lota lota*).

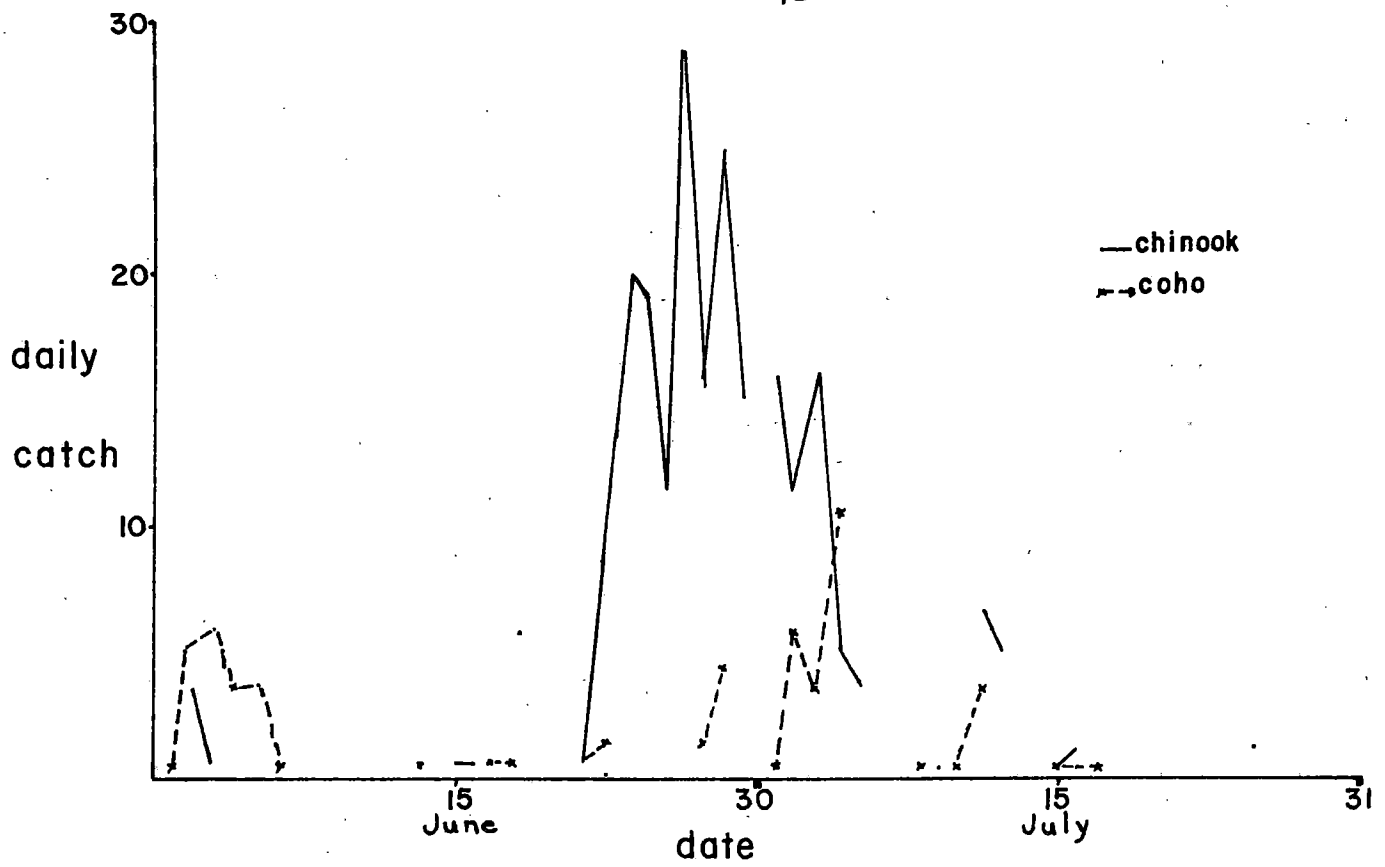


Fig. 18 . Graph of daily catch totals of chinook and coho salmon fry from the 4 x 4 inclined plane trap located below the outlet of Lillooet Lake - summer 1977.

Gee's Minnow Trapping

1. Birkenhead River

Only 4 chinook smolts were caught at km 20 in a side channel and at km 15 in a pool below the Twin bridges (Appendix J).

Coho smolt catches were almost evenly split, 249 being caught in adjacent sloughs and 207 in the river. Poole Creek and Mount Currie area ditches contained good numbers of smolts, but these were gone by early May. The Birkenhead River proper contained good smolt numbers even at the end of May.

No coho smolts were captured in either Birkenhead Lake or Taillefer creek. Poole Creek catches totalled 71 coho smolts.

2. Upper Lillooet River

Only 6 chinook smolts were caught in this area, in Samson Creek about 30 km upriver from Pemberton (Appendix K), all in early April.

Coho smolt catches totalled 146 in adjacent sloughs and 67 in the Lillooet River proper.

Good numbers of coho smolts were trapped in the upper section of the river until mid-May but their numbers in adjacent backwaters had declined by this time.

3. Lillooet Lake - Lower Lillooet area.

A total of 14 chinook smolts were captured in this area: 5 in the Lower Lillooet River near the outlet of Lillooet Lake from April 1 to 15; and 9 in a slough adjacent to Texas Lake in mid-May (Appendix L).

Coho smolt catches totalled 195 in adjacent sloughs and 6 in the Lillooet River proper. No coho smolts were caught in Lillooet Lake or Lower Lillooet River after mid-May, but coho and chinook

smolts in isolated backwaters were trapped there until high water in early June.

Total trap-nights fished in all Birkenhead and Lillooet areas combined was higher in the main rivers proper (87) as opposed to the backwater sloughs (79), so chinook numbers should have been higher as areas closely associated with or in the mainstream have been shown by Shepherd (1976) to be preferred chinook habitat. No estimates of population numbers were attempted as Bloom (1976) shows that even intensive trapping produces a catch variability that is too high to allow accurate prediction of true population numbers. Both Bloom (1976) and Shepherd (1976), however, prove Gee's trap catches to be very representative of species composition.

Juvenile Seining

a) Birkenhead River

Equal numbers of chinook (about 35) were caught at each bar but 10 times as many coho juveniles (59) were caught at the upper bar (km 15) as at the lower bar at km 10. (Appendix M).

b) Lillooet Lake - Lower Lillooet River

Chinook fry catches totalled 927 in lower Lillooet Lake and continued high from early May to late June. Chinook smolt catches totalled 367, with almost all caught late May to early June at the outlet of the lake (Appendix N).

Coho smolt catches were too small to be included, while coho fry numbers totalled 125, the majority being caught at the outlet of the lake in June.

Almost all the sockeye smolts were caught at the end of May at the lake outlet while sockeye fry catches were low and scattered throughout May and June. This was expected due to their pelagic lifestyle at this time of year (Rogers, 1972; McDonald, 1969 and 1973; Ricker, 1970 and 1941).

Other species seined included 25 trout (to 200 mm); 4 dolly varden (to 475 mm); 3 kokanee; 139 whitefish (to 300 mm); 19 squawfish (to 300 mm); 374 peamouth chub (to 250 mm); 12 suckers (to 500 mm); 150+ sculpin and 3 redbside shiner.

Two different sockeye fry movements were noted during the summer. Fry seen moving upstream along the shore in the Lower Lillooet River in early May could have indicated spawning downstream of there or may have been a reverse movement by fish formerly migrating downstream (McCart, 1967). Fry seen actively feeding in bright shallows, most moving uplake, were either more recently emerged fish in this area; or those having recently entered the lake; or fish making a close bypass to shore on a circuit of the lake (McDonald, 1969).

Chinook Juvenile Migration and Rearing Patterns

Dead pitches of 1975-78 adult chinook revealed two lifestyles of juvenile chinook in the Birkenhead-Lillooet system. Scale reading produced a sub 1 to sub 2 adult ratio ranging from 1.1:1 (1975) to 3.7:1 (1977). Most fry thus appear to move out of the system before the second winter, but a substantial number stay to overwinter in freshwater. The summer 1977 field reconnaissance delineated the migration patterns of these fry types, which are designated 0+ and 1+ fry.

a) 0+ Chinook Fry

Birkenhead River 2 x 3 trap catches of emergent-size chinook fry (43 mm mean fork length) totalled 20,300 with 10-90% migration occurring March 21 to April 21. The trap fished 2½ months (March 15 to May 30) with the peak of downstream fry migration to the lower Birkenhead River and Lillooet Lake occurring April 8.

No seining in the Lake proper was done in this period, so fry movement downlake couldn't be traced.

But the 4 x 4 trap at km 41 (23 km downriver of the lake outlet) on the Lower Lillooet River captured 277 migrating fry of a size (41 mm) comparable to Birkenhead fry. This trap was fished for less than a month (March 30 to April 27) and the peak migration occurred on April 13, 5 days later than the Birkenhead peak.

These fry were migrating immediately out of the upper part of the system to rear in lower sections of the Lillooet River, in Harrison Lake, or even farther downstream.

But fry also remain and rear in Lillooet Lake itself.

Seining at the outlet of Lillooet Lake produced 200 fry during the period May 3 to 15. Mean size of 47 mm proved some growth in the one month period since the Birkenhead migration peak.

The real peak in Lake outlet seining occurred June 16 to 23 when 700 fry in the 54 to 55 mm range were taken. These fry, rearing for an indicated 68-75 days in the lake, had shown 11-13 mm of growth in length during that period.

The sudden rise in numbers seined indicates downstream movement out of the system after 2½ months rearing in Lillooet Lake.

The 4 x 4 trap catches at the outlet of Lillooet Lake peaked June 27. But the June 23 to July 3 mean fry length of 45 mm indicates a different spawning timing in the system, rather than a downstream migration of rearing fry. The two month catch total of 240 fry is low for any definite conclusions on migration timing.

The 0+ fry appear to have the following migration pattern: they leave the Birkenhead River in early April and many pass through Lillooet Lake to rear lower in the system; a substantial number rear in Lillooet Lake 2 to 2½ months before moving downstream. An emergent-sized fry migration in late June suggests an extended period of chinook spawning in the upper Lillooet and Birkenhead systems.

b) 1+ Chinook Fry

The ratio of chinook fry to smolts captured by all methods of trapping on the Birkenhead River in 1977 was 5,100:1, so almost no rearing is indicated. The capture ratio of fry to smolts of 3.5:1 on Lillooet Lake - Lower Lillooet River, however, indicates extensive overwintering here.

Beach seining on Birkenhead River bars between July 5 and 26 produced 60 fingerlings of 65-83 mm. This capture of fingerlings past the peak migration shown by seining at the outlet of Lillooet Lake, suggests that these fish are destined to overwinter.

No chinook smolts were taken in the Birkenhead River 2 x 3. The Lillooet 4 x 4 downstream trap, however, produced 31 smolts in early April, so an early smolt migration is evident from higher up in the system.

Gee trap catches of 4 chinook smolts in the Birkenhead May 14 and 15; 6 smolts in Samson Creek off the Upper Lillooet River on April 4 and 5; and 14 smolts along the Lillooet Lake shoreline and in a side slough of Tenas Lake April 1 to May 14, prove that chinook overwinter in low numbers in these areas.

But seining on Lillooet Lake proved extensive overwintering in the lake or parts of the Lillooet and Birkenhead Rivers not sampled by Gee trapping. 359 chinook smolts in the 100 to 110 mm range were seined at the outlet of Lillooet Lake May 26 to June 13. This sudden capture of so many smolt-sized fish after low catches earlier and after suggests a downstream smolt migration peaking in early June.

The following 1+ fry migration is then suggested: small numbers overwinter in the Birkenhead and Upper Lillooet Rivers and sidesloughs to move out of these areas by mid-May; extensive overwintering occurs in Lillooet Lake with seaward migration peaking in early June at the lake outlet.

Length Sampling and Growth

1. Birkenhead River

Captured chinook and coho fry averaged 42.7 and 34.7 mm fork-length respectively (Table 7). These are very close to emergent sizes found by Edmundson et al (1968) and Lister and Genoe (1970); but about 5 mm larger than Shepherd (1976).

2. Lower Lillooet River

Very little growth is evident in chinook fry (Table 8) though this could be indicative of staggered spawning times higher

Table 7. Means and 95% confidence limits of fork lengths of coho and chinook fry caught in the Birkenhead River 2 x 3 downstream trap at km 15 in late April and early May and those seined on a bar in the same area, July 1977.

Date	Species	No. Sampled	MFL (mm) ¹
April 20-29	Coho	5	33.0 ± 3.76%
May 10		4	36.75 ± 9.6%
July 5-13		36	46.67 ± 4.9%
July 26		20	51.85 ± 7.3%
April 20-29	Chinook	10	42.9 ± 6.21%
May 10		4	42.25 ± 7.13%
July 5-13		27	65.33 ± 3.72%
July 26		7	83.14 ± 7.31%

¹ ranges are 95% confidence limits.

Table 8. Means and 95% confidence limits of fork lengths of coho and chinook fry captured in the Lower Lillooet River 4 x 4 downstream trap.

Month	Location	Species ¹	No. Sampled	MFL (mm)	95% confidence limits
<u>Coho</u>					
April 1-20	Lower Lillooet R mi 25.5		2	32.5	±19.55%
June 2-29	Lower Lillooet R .4km below outlet of Lillooet L.		10	56.2	±24.73%
July 1-31	Same		29	56.6	±11.21%
<u>Chinook</u>					
April 16	Lower Lillooet R mi 25.5		5	41.0	±37%
June 22-30	Lower Lillooet R .4km below outlet of Lillooet L.		51	44.8	±4.2%
July 1-3	Same		16	43.8	±7.2%

¹ No coho or chinook fry were caught at the Lake Outlet where the trap was fishing in May.

in the system. Coho fry show about 20 mm in growth in the two months from April to June (Table 8). Sockeye fry show about 25 mm growth from mid-May to mid-August (Fig. 19).

Larger coho smolts migrated earlier (Table 9), comparable to the findings of Hartman et al (1967) where the oldest and largest smolts in each age group migrated first.

Gee's Minnow Trapping

1. Birkenhead River

Coho smolts of age 1+ and 2+, at 91.7 and 110.3 mm respectively, averaged slightly larger than the same age classes in adjacent sloughs (Table 10).

The ratio of age 1+ coho smolts to age 2+ shown by Gee trapping here was 6:1; adults sampled in 1976 showed a ratio of 24:1.

2. Upper Lillooet River

Coho smolts of age 1+ in the adjacent sloughs here, at 96.9 mm averaged about 4 mm longer than those caught in the Lillooet River (Table 11).

Seven 2+ age class smolts were taken, averaging 10-15 mm larger than 1+ smolts at each trapping location.

The ratio of 1+ coho smolts to age 2+ shown by Gee trapping here was identical to the Birkenhead, at 6:1, but no adult sampling has been done for comparison.

3. Lower Lillooet River

Coho smolts of the 1+ age class, at 84 mm here (Table 12), averaged about 10 mm smaller than the same age class in the Upper Lillooet River. Slough smolts of the 2+ age class averaged the same

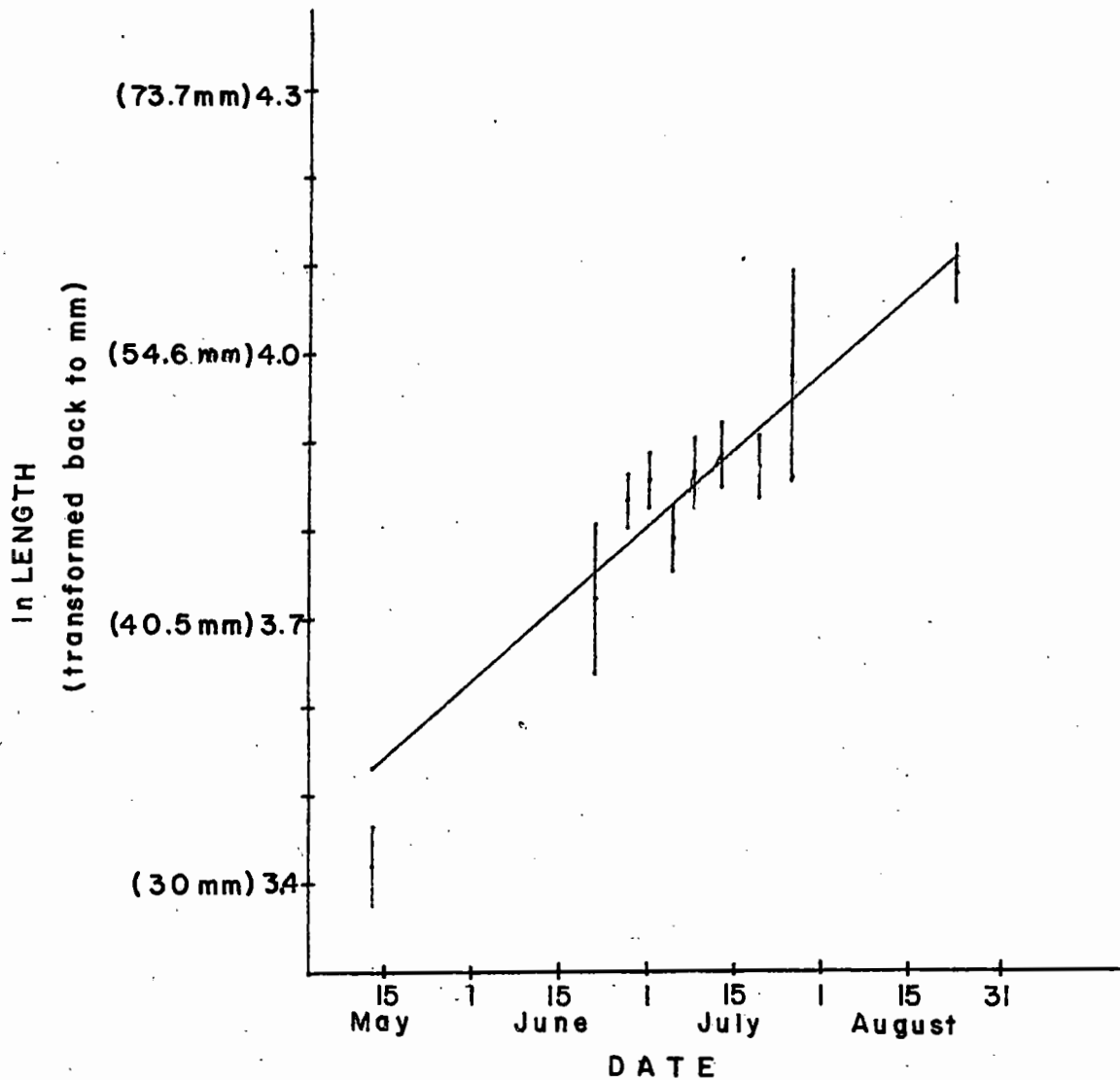


Fig. 19. Growth in length of sockeye fry caught in the Lower Lillooet River 4 x 4 downstream trap at mi. 25.5 in May and .4 km below the outlet of Lillooet Lake in June - July, 1977. Geometric means are plotted by date with 95% confidence intervals shown.

TABLE 9. Means and 95% confidence limits of fork lengths of coho smolts captured in the Lower Lillooet River 4 x 4 downstream trap. April 1 - July 31, 1977.

Month	Location	No. Sampled	Mean fork length (mm)	95% Confidence limits (mm)
April	Lower Lillooet R. mi 25.5	14	104.6	±7.48%
¹ June	Lower Lillooet .4 km below outlet of Lillooet Lake	36	105.0	±2.53%
July	Same	3	83.0	±10.79%

¹ No smolts caught at outlet of Lillooet Lake, where trap was fishing during May

TABLE 10. Means and 95% confidence limits of fork lengths of 1+ and 2+ age class coho smolts caught in Gee traps in the Birkenhead River area March 25 - May 15, 1977.

Location	Date	Age Class	No. Sampled	MFL (mm)	95% Confidence limits
Birkenhead River	Apr-16-May 15	1+	15	91.7	±9.37%
Birkenhead Sloughs	Mar 25-May 6	1+	24	87.4	±4.62%
Poole Creek	Mar 25-27	1+	13	82.9	±5.32%
Birkenhead River	May 5-15	2+	3	110.3	±41.54%
Birkenhead Sloughs	Mar 26-May 6	2+	6	102.8	±9.39%

¹ ranges are 95% confidence limits

TABLE 11. Means and 95% confidence limits of fork lengths of 1+ and 2+ age class coho smolts caught in Gee traps in the Upper Lillooet River area March 26 - May 9, 1977.

Location	Date	Age Class	No. Sampled	MFL (mm)	¹
Upper Lillooet R. proper	Apr 17-May 9	1+	18	92.3	±5.30%
Upper Lillooet R. Sloughs	Mar 26-May 1	1+	25	96.9	±5.74%
Upper Lillooet R. proper	May 9	2+	2	117.5	±16.22%
Upper Lillooet R. Sloughs	Mar 26	2+	5	106.0	±7.64%

¹ ranges are 95% confidence limits

TABLE 12. Means and 95% confidence limits of fork lengths of 1+ and 2+ age class coho smolts caught in Gee traps in the Lower Lillooet River area April 1 - May 14, 1977.

Location	Date	Age Class	No. Sampled	MFL (mm)	¹
Lower Lillooet R. proper	Apr 1-27	1+	7	84	±7.3%
Lower Lillooet R. Sloughs	Apr 5- May 14	1+	25	83.2	±6.31%
Spring Creek (mi 5 Lower Lillooet)	Apr 20	1+	4	94.3	±5.58%
Lower Lillooet R. Sloughs	Apr 5- May 14	2+	8	106.5	±6.18%

¹ ranges are 95% confidence limits

size as those in the Upper River sloughs, at 106 mm.

The ratio of age 1+ coho smolts to age 2+ smolts shown by Gee trapping in this area was 4.5:1.

Juvenile Seining

1. Birkenhead River

Both coho and chinook fry showed growth during the July growth period, with chinook growth rate about 50% ^{higher} ~~faster~~ than that of coho.

Coho fry averaged 20 mm and chinook fry about 40 mm growth in length over the 3 month period from late April to late July at km 15 (Fig 20).

Very few of the rainbow trout caught were sampled but two year olds averaged 150.5 mm while three year olds averaged slightly larger at 151.75 mm (Table 13).

2. Lillooet Lake - Lower Lillooet River

Chinook fry showed about 15 mm growth from mid-May to mid-July (Fig. 21) while coho sampling showed some growth (Table 14) and evidence of differing spawning times higher in the system.

Sockeye smolts showed some increase in size from mid-May to late June in lower Lillooet Lake (Table 15).

Predator Study

128 dolly varden char, 71 cutthroat trout, 7 rainbow trout, 19 squawfish, 60 peamouth chub, 10 whitefish, 1 kokanee and 2 sculpin were examined during this phase of the study. In addition, 56 peamouth chub, 7 suckers, 3 squawfish, 2 whitefish, and 1 chinook smolt were netted but released without sampling.

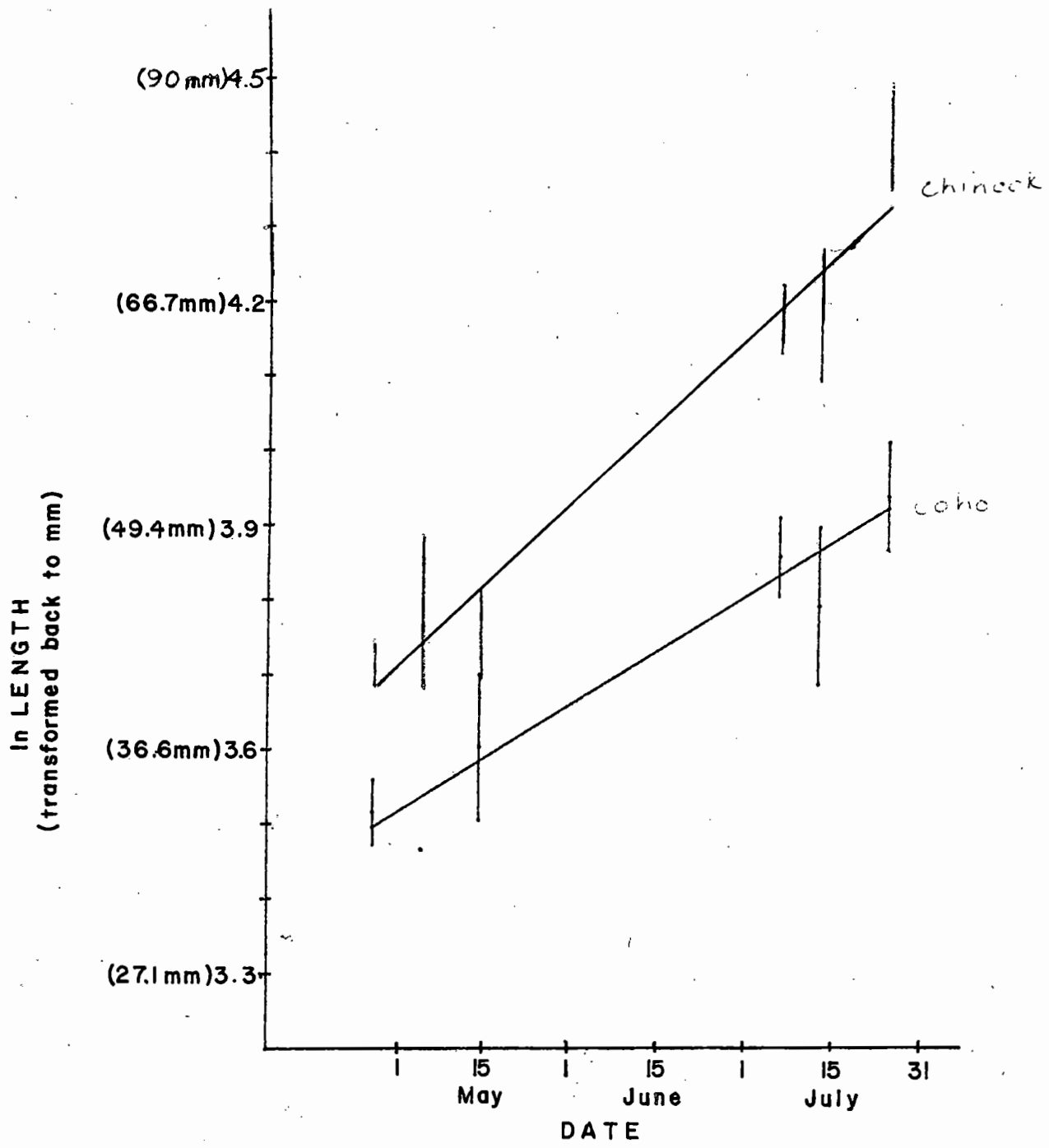


Fig. 20 Growth in length of chinook and coho fry caught in the Birkenhea River 2 x 3 incline plane trap in April - May and those seined on a bar in the same area in July, 1977. Geometric means are plotted by date with 95% confidence intervals shown.

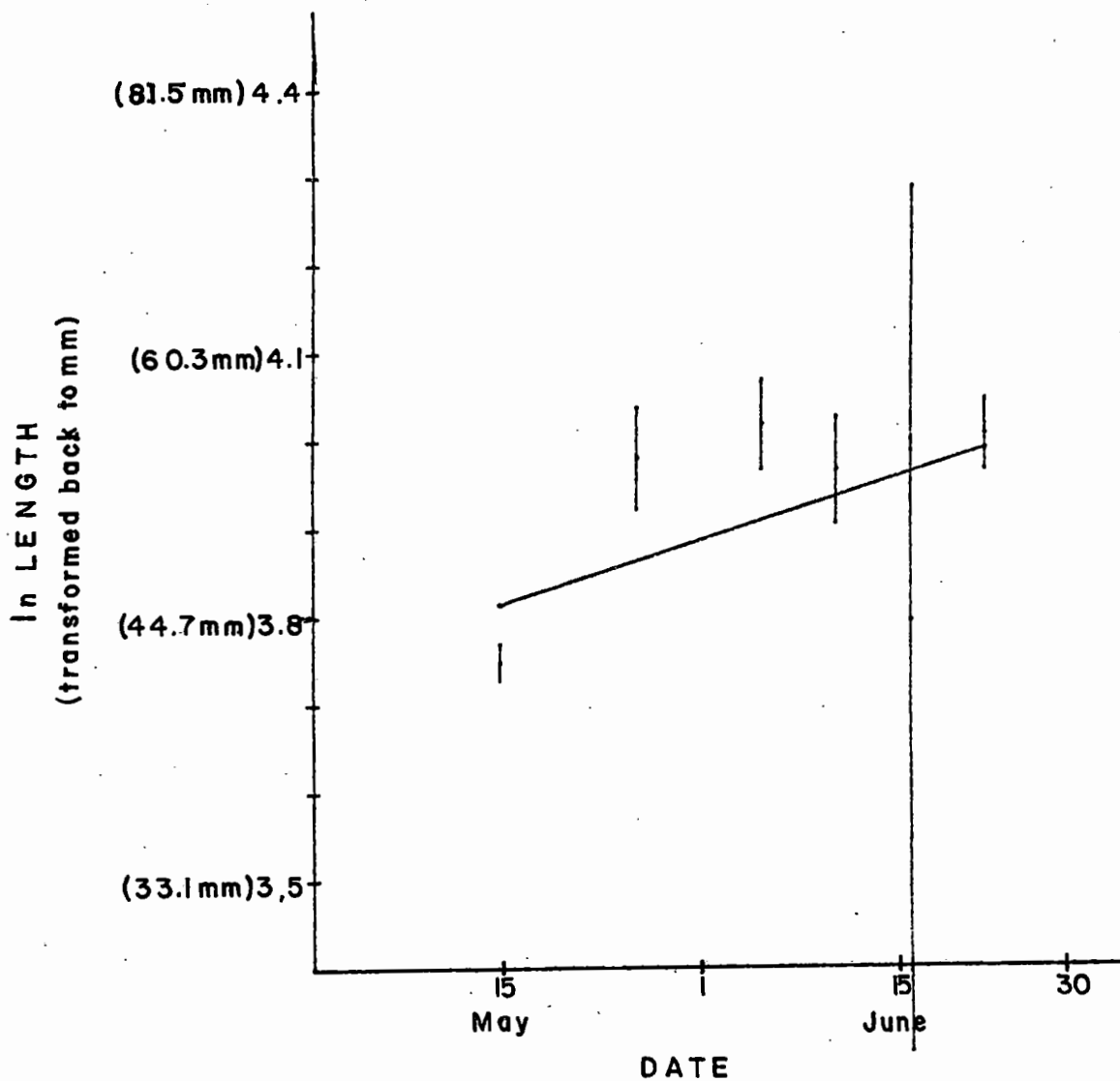


Fig. 21. Growth in length of chinook fry seined near the outlet of Lillooet Lake May 15 - June 23, 1977. Geometric means are plotted by date with 95% confidence intervals shown.

TABLE 13. Means and 95% confidence limits of fork lengths of rainbow trout seined on 2 bars of the Birkenhead River July 5-26, 1977.

Location	Age class	No. Sampled	MFL (mm) ²
km 10	2+	2	150.5 ± 37.99%
km 10	3+	4	151.75 ± 11.43%
km 15	all	3	141.7 ± 17.35%
10 ¹	all	18	148.1 ± 36.15%

¹ includes 2+ and 3+ age classes above.

² ranges are 95% confidence limits

TABLE 15. Means and 95% confidence limits of fork lengths of sockeye smolts (1+ age class) seined in Lillooet and Tenas Lakes May 12 - June 25, 1977.

Date	Location	No. Sampled	MFL (mm) ¹
May 12	Tenas Lake	5	90.0 ± 9.7%
June 4-16	Outlet Lillooet L.	3	120.3 ± 18.5%
June 17-25	Outlet Lillooet L. Upper Lillooet L. Tenas Lake	9	123.9 ± 14.1%

¹ ranges are 95% confidence limits

TABLE 14. Means and 95% confidence limits of fork lengths of juvenile coho and chinook caught in beach seines in the Lower Lillooet River area May 15 - July 15, 1977.

Date	Species	Age	Location	No. Sampled	MFL (mm) ¹
May 15-26	Chinook	0+	Outlet Lillooet L. Tenas Lake	31	46.5 ± 4.9%
June 4-11	Chinook	0+	Outlet Lillooet L. Tenas Lake	27	54.2 ± 3.9%
16-23	Chinook	0+	Outlet Lillooet L. Tenas Lake	33	55.0 ± 3.2%
June 25	Chinook	0+	Mid-Upper Lillooet Lake	5	57.2 ± 6.9%
July 8-15	Chinook	0+	Mid-Upper Lillooet Lake	10	60.5 ± 4.0%
June 6-11	Coho	0+	Outlet Lillooet L. Tenas Lake	5	61.8 ± 30.8%
16-23	Coho	0+	Outlet Lillooet L. Tenas Lake	9	69.2 ± 15.1%
25	Coho	0+	Mid-Upper Lillooet Lake	3	80.3 ± 34.1%
July 8-15	Coho	0+	Mid-Upper Lillooet Lake	31	57.3 ± 11.6%
May 26	Coho	1+	Outlet Lillooet L. Tenas Lake	10	107.0 ± 2.2%
June 4-6	Coho	1+	Outlet Lillooet L. Tenas Lake	15	114.3 ± 5.4%

¹ ranges are 95% confidence limits

Dolly varden, cutthroat trout, squawfish and whitefish, in that order, were the most destructive to salmon juveniles (Table 16). This order of destructiveness agrees with Ricker (1933, 1941, 1970) in Cultus Lake. No other species contained fish prey. The order of absolute destructiveness in Lillooet Lake, however, may be different as pointed out by Semko (1959) and Ricker (1970), as our netting was size selective; also the species breakdown caught in the nets may not have been representative of the species composition in the lake (ie. Cutthroat trout, while lower in consumption rate will make up for this by being more numerous than dolly varden in pelagic areas of the lake where no netting was attempted).

The most predaceous dolly varden was a 356 mm female which had consumed 24 sockeye fry plus an unidentified smolt just prior to swimming into the gill net, while the most predaceous cutthroat trout was a 238 mm. male with 10 unidentified fry in its stomach. Whitefish and squawfish never exceeded 3 fry apiece.

Dolly varden consumption of salmonid fry appeared to decrease throughout the summer months while that of cutthroat increased (Table 17). Ricker (1970) and Andrusak and Northcote (1971) found cutthroat to be important consumers of sockeye all year, though summer consumption was lowest; while char were bottom-fish and the pelagic summer life of sockeye lowered their predatory effect.

Dolly varden of the 300 to 399 mm size class and those of the 500 mm+ size class averaged 4 fry per fish examined, while the most destructive cutthroat were those in the 300-399 mm size class, containing an average of 3 fry apiece (Table 18). Ricker (1941) also found cutthroat of this size to be the most destructive sockeye predator.

Table 16. Percent stomach content composition of salmon fry predators examined in Lillooet and Tenas Lakes April¹² - July 16, 1977.

	Dolly Varden	Cutthroat Trout	Squawfish	Whitefish
No. examined	128	71	19	10
% empty	19.5	28.2	31.6	50.0
% containing sockeye fry	37.5	16.9	5.3	10.0
% containing unidentified fry	54.7	46.5	10.5	10.0
% containing sockeye smolts	6.3	-	-	-
% Containing unidentified smolts	6.3	-	-	-
% containing Chinook or coho fry	1.6	-	-	-
% containing chinook or coho smolts	1.6	-	-	-
% containing other fish prey	12.5	7.0	21.1	-
% containing insects	3.1	15.5	36.8	30.0

Table 17. Monthly stomach content composition of Dolly Varden and Cutthroat Trout containing salmonid fry May - July, 1977.

Month	Species	No. Examined	Sockeye per fish	Unidentified fry per fish	Other fry (coho, chinook)	All fry per fish
May	Dolly Varden	7	8.86	-	-	8.86
	Cutthroat	3	1.33	.67	-	2.0
June	Dolly Varden	33	1.76	2.0	.21	3.97
	Cutthroat	17	1.47	1.12	-	2.59
July	Dolly Varden	24	1.17	3.92	-	5.09
	Cutthroat	15	.47	2.73	-	3.20

Table 18. Fry destructiveness of various size classes of piscivorous fish caught in gill nets in Lillooet and Tenas Lakes April 12- July 16, 1977

Species	No. Sampled	Sockeye per fish	unid. fry per fish	Chinook fry per fish	All fry per fish ¹
<u>100 - 199 mm</u>					
Cutthroat	6		0.33	-	0.33
<u>200 - 299 mm</u>					
Cutthroat	51	0.5	0.9	-	1.4
Dolly	33	0.06	1.09	-	1.15
Squawfish	15	0.07	0.13	-	0.2
<u>300 - 399 mm</u>					
Dolly	43	0.9	3.07	0.12	4.09
Cutthroat	9	0.1	2.70	-	2.8
Whitefish	3	-	1.0	-	1.0
<u>400 - 499 mm</u>					
Dolly	14	0.5	0.9	-	1.4
Cutthroat	2	-	1.0	-	1.0
<u>500 mm + up</u>					
Dolly	4	0.8	2.8	0.4	4.0

¹ includes all fish examined whether containing fry or not.

Table 19. Means and 95% confidence limits of fork lengths of various age classes of cutthroat trout caught in gill nets, seine nets and the 4 x 4 downstream trap on Lillooet and Tenas Lakes, June 4 - July 15, 1977.

Age	No. Sampled	MFL (mm) ¹
1+	1	155.0
2+	5	202.6 ± 11.65%
3+	7	233.0 ± 17.22%
4+	3	238.33 ± 78.4%
5+	3	273.33 ± 52.48%

¹ ranges are 95% confidence limits

Of fish containing identifiable prey in their stomach, 87.4% of the dolly varden, 72.6% of the cutthroat, 40% of the whitefish, and 15.4% of the squawfish contained salmonid fry or smolts. All chinook or coho found (1 smolt, 2 fry) were in the stomachs of river dolly varden - no recognizable juveniles of either species were found in any other fish.

It was possible to compare McCart's (1967) findings on relative rates of predation in the river and the lake for two species. Contrary to his results, Lillooet and Tenas Lake dolly varden had a higher predation rate than those in the river (3.41 salmonid prey per stomach in the lake; 2.97 in the river - including all fish whether empty or not). For cutthroat trout, the predation rate in the lake and river were almost identical (1.45 salmonid prey per stomach in the lake; 1.68 in the river). Cutthroat trout, though ranging in size up to 45 mm., contained no prey larger than sockeye fry.

19 cutthroat trout were length and scale sampled, averaging from 155 mm at age 1+ to 273 mm at age 5+ (Table 19).

Other predators included Bonaparte's gulls (seen actively feeding on fry in Lillooet Lake narrows at the end of July); harlequin ducks (seen once on Lillooet Lake but regularly on the Birkenhead River in April); kingfishers; goldeneye ducks; and American and hooded mergansers. Allen (1953) and Hartman et al (1967) found no goldeneye containing sockeye but mergansers, gulls and harlequin ducks averaged to 7.8 sockeye per stomach. Studies by Munro and Clements (1932, 1936) showed salmonids making up 11-17% of the stomach contents of American mergansers, Munro (1948) could find no indication

(3.) SPAWNING GROUND SURVEYS
Spawning Ground Surveys 1975-1978

METHODS

Helicopter Flights

Helicopter flights were made every year to coincide as closely as possible to peak chinook spawning - all on early days in September - the 6th in 1975; the 9th in 1976; the 14th in 1977 and the 13th in 1978.

Conditions were generally good (the only overcast, windy day was in 1977), with the river low and clear, giving good visibility in shallow sections and poor to zero visibility in pools.

Both dead and live fish were counted and occurrence was noted by kilometre from the river mouth to the river canyon (km 26). As in flights over even sizable fish populations (Bevan, 1961), helicopter counts here have proven to be a very good index of adult chinook numbers.

Four counters accompanied the pilot: Fisheries technicians in the majority, accompanied by a Fisheries guardian or the local Conservation officer from Pemberton.

Dead Pitches and Sampling

As spawners began to die off, foot surveys were used to enumerate them and determine distribution. All chinook (both live and dead) were recorded by kilometre of occurrence; post-orbital-hypural length was measured; scale samples were taken (5 to 10 scales per side); and females were cut open to determine spawning success. Even unscale-able fish were noted by kilometre of occurrence.

In 1975 and 1976 it was felt that difficulties in assignments of age class might be overcome by more accurate aging techniques, so circuli counts were made on chinook scales in those 2 years (Appendix Q).

It was thought that differences in rearing areas and associated rates might produce false checks and other abnormalities in scale patterns. In 1977 penned adults and egg take fish were also included in dead pitch numbers; in 1978 the majority of samples were from fish killed on the bar for egg takes, ^{as} ~~with~~ only one walk of the river, ~~was made~~.

Two men walked each section of the river one on either bank. In 1975 and 1976, the river was walked from Mount Currie to the canyon in km 26; in 1977 from Owl Creek (km 13) to Poole Creek (km 25); in 1978 Hindu Flats (km 18 to 25) was walked.

Dead pitches commenced in mid-September and were terminated by the end of September every year. Coho sampling in 1975 and 1976 was done from early to late December.

RESULTSHelicopter Flights

Helicopter flights resulted in the sighting of from 103 adult chinook in 1975 to 247 in 1977. Estimates of chinook escapement to the river have proven to be about double the number sighted (Table 20).

A three year comparison from 1976-1978 (Table 21) shows a definite trend to the sighting of adults farther upriver every year; in 1976, 86.9% were sighted in the Hydro Bridge-Hindu Flats area; in 1977, 87.9% were sighted in the Hindu Flats area; and in 1978, 92.6% were sighted in the Hindu Flats-Poole Creek area. This could indicate greater utilization of upriver areas for spawning as a result of streambed changes, or visual bias (ie. adult capture has been concentrated farther upriver each year, so the helicopter crew was more familiar with and tended to look for, adults in these areas).

Dead Pitches and Sampling

Numbers of adults sampled with number of readable scales is as follows: 1975: 72(64); 1976: 55(43); 1977 132(122); 1978: 52(49) for an average of 89.4% readable scales.

Three and four year old chinook were the majority of every year's spawning stock, making up from 82 to 100% of the total spawners (Table 22). Upper Fraser-Thompson 3 and 4 year olds made up 82 to 95% of the spawning total (L. Kahl pers comm.). Five year olds made up 13-16% of total spawners in the first two years but only 0-3% in the last two years. Two year olds have been a small minority every year.

Table 20. Escapement estimates and basis of Fisheries estimates of chinook salmon on the Birkenhead River, 1975-78.

	Helicopter Sighted	Dead Pitched	Fisheries Crew Estimate	Fisheries Office Estimate
1975	103	72	200	200
1976	137	55	200	300
1977	247	161	500	600
1978	121	52	250	400-450

Table 21. Comparison of occurrence by general area of helicopter-sighted adult chinook salmon on Sept. 9, 1976, Sept. 14, 1977 and Sept. 13, 1978¹

Area	km.	mi.	1976		1977		1978	
			no.	%	no.	%	no.	%
below log bridge	5-10	3-6	-	-	4	1.6	-	-
below Twin bridges	10-15	6-10	6	4.4	3	1.2	2	1.6
Twin Bridges -canyon	15-17	10-11	7	5.1	7	2.8	3	2.5
Hydro Bridge	17-18	11-12	33	24.1	11	4.5	3	2.5
Hindu Flats	18-25	12-15	86	62.8	217	87.9	74	61.2
Poole Creek	25-27	15-17	5	3.6	5	2.0	38	31.4
Above Poole	27-28	17-18	-	-	-	-	1	0.8
			137	100.0	247	100.0	121	100.0

¹ 103 adults were sighted in 1975 mostly in Hindu Flats area but no definite breakdown was noted.

Table 22. Age composition of adult chinook sampled on the Birkenhead River, 1975-78 (includes readable scales only).

	Age									
	2		3		4		5		Totals (across	
	No. of fish	% of total	No. of fish	% of total	No. of fish	% of total	No. of fish	% of total	No. of fish	% of total

1975	-	-	15	23.0	19	30.0	-	-	34	53.0
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Sub 1 1976	1	2.0	14	33.0	17	40.0	1	2.0	33	77.0
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1977	3	3.0	73	59.0	19	15.0	1	1.0	96	78.0
------	---	-----	----	------	----	------	---	-----	----	------

1978	-	-	23	46.9	22	44.9	-	-	45	91.8
------	---	---	----	------	----	------	---	---	----	------

1975	-	-	2	3.0	20	31.0	8	13.0	30	47.0
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Sub 2 1976	-	-	-	-	4	9.0	6	14.0	10	23.0
------------	---	---	---	---	---	-----	---	------	----	------

1977	-	-	2	2.0	22	18.0	2	2.0	26	22.0
------	---	---	---	-----	----	------	---	-----	----	------

1978	-	-	-	-	4	8.2	-	-	4	8.2
------	---	---	---	---	---	-----	---	---	---	-----

	No.	%	No.	%	No.	%	No.	%
1975	-	-	17	61.0	8	13.0	64	100.0
1976	1	2.0	14	49.0	7	16.0	43	100.0
1977	3	3.0	75	33.0	3	3.0	122	100.0
1978	-	-	23	53.1	-	-	49	100.0

Data Discrepancy (7-7)

Sub 1 fish have been the majority every year, making up from 53% in 1975 to 92% in 1978, of the fish sampled. Overwintering fry numbers declined every year (Table 22). Sub 1 fish in the Upper Fraser are a clear majority, making up from 80-100% in 1975-1977.

No repetitive patterns, that could be associated with different rearing areas, were defined by the 1975 and 1976 circuli counts.

Orbital-hypural lengths for the various age classes from 1975 to 1978 were as follows: 49.5 cm for 2 year olds; 69.8 cm for three year olds; 75.8 cm for four year olds, and 77.0 cm for five year olds (Table 23). Upper Fraser-Thompson fish are smaller at all age classes, ranging from 11.9 cm shorter for two year olds to 2.3 cm shorter for five year olds from 1975 to 1977 (L. Kahl, unpub. reports).

Sub 2 fish are generally larger than the sub 1 fish as they generally return as 4 and 5 year olds, while sub 1 fish are grouped in the 3 and 4 year old classes. ^{In} 1976 ~~stands out as a year in which~~ all adults of all ages and sexes were noticeably smaller than the other three years. This relationship however, did not hold true in the Upper Fraser in the same year and in fact the reverse is true.

Spawning success has been very high on the Birkenhead River every year. In 1975, 80% of females were 100% spawned out, while the remainder were more than 50% spawned out. In 1976, 100% of the females were completely spawned out. In 1977, egg retention was close to 100% in only one female while the rest contained from 0 to 50 eggs. In 1978 all females were spawned out.

Coho dead recovery yielded 11 fish in 1975 and 142 in 1976.

Scale reading results show all 1975 coho to be 3_2 fish; while 97% of 1976 ^{coho} were 3_2 , with the remainder 4_3 fish.

Table 23. Means and 95% confidence limits of orbital-hypural lengths of all age classes of adult Chinook salmon sampled on the Birkenhead River, 1975-1978.

		AGE 1										All n
		2		3		4		5		M		
		M	F	M	F	M	F	M	F			
Sub 1	1975	49.0	52.6	74.3(±5.0)	70.1(±1.2)	78.9(±2.8)	76.9(±1.7)	-	-	73.9(21)	78	
	1976	39.5	-	63.2	62.5(±5.2)	64.4	72.3(±1.7)	-	70.5	55.7(3)	689	
	1977	52.1	-	69.9(±3.6)	69.4(±3.1)	84.1(±4.4)	76.4(±3.7)	89.8	-	71.5(23)	70	
	1978	-	-	76.3(±3.4)	72.5(±2.9)	81.0(±6.2)	77.2(±2.7)	-	-	78.0(14)		
Sub 2	1975	-	-	-	-	-	-	-	52.6	-		
	1976	-	-	-	-	69.9	67.1	82.0	79.8(±4.1)	73.9(3)		
	1977	-	-	57.0	59.8	76.3(±2.2)	70.8(±5.2)	-	76.1	74.9(14)		
	1978	-	-	-	-	79.0	72.5(±9.3)	-	-	79.0(1)		
Both	1975	49.0	52.6	74.3	70.1	78.9	76.9	-	52.6	73.9(21)		
	1976	39.5	-	63.2	62.5	68.1	71.7	82.0	78.3	64.8(6)		
	1977	52.1	-	69.0	69.2	78.5	74.2	89.8	76.1	72.8(37)		
	1978	-	-	76.3	72.5	80.7	76.5	-	-	78.1(15)		
Means		49.5		69.8		75.8		77.0				

1 95% confidence intervals in brackets.

2 numbers sampled in brackets.

Missing data in many age data

Introduction

The second hatchery on the Birkenhead River came into being in September, 1976 when a 50,000 egg capacity plywood upwelling gravel incubation box and associated river intake structure 310 m. upstream were installed by Fisheries engineers on the Fisheries property in km 11.

The first hatchery was built at the mouth of Owl Creek, 2.5 km upstream, at the turn of the century. Adult chinook were captured intermittently at Tenas Rapids on the Lower Lillooet River between 1900 and 1918 (30-150,000 eggs) and though the hatchery operated until 1936, no further mention is made of chinook being spawned (Table 5).

The hatchery operation section is in two parts: a) adult capture and b) incubation of eggs and juvenile rearing.

The first section chronicles changing adult capture methods. 1976 adult capture was spur-of-the moment, hot on the heels of incubation box completion and as such, was cursory and unsuccessful. Methods of capture were expanded in 1977, with emphasis on sport fishing and pen holding, but with snagging producing the majority of the egg take adults. Fall 1978 efforts were concentrated on snagging and shooting, but variety of capture techniques was extended and adult holding was ignored due to 1977 failure.

The second section summarizes the hatching and rearing of the first generation of hatchery fry, and their subsequent tag and release to bolster returning stocks in 1981.

(A) Adult Capturei) 1976 EffortsMethodsSnagging

Heavy sport fishing rods and reels were used, with treble hooks tied on high test line. Adults were spotted in shallower water and cast over, with hooks dragged downstream or across and set solidly into whichever part of the body the hook would imbed. The hooked fish was then snubbed hard and landed as fast, and in the case of females, as gently as possible.

Sport Fishing

Lighter gear was used in sport fishing: spinning rods and reels with Kitimat and Crocodile spoons terminally or floats and frozen salmon roe.

Four separate days of snagging and sport fishing were undertaken, from August 27 to Sept. 2, with all effort from the Lookout Pool (Hydro) at km 18 upstream to Poole Creek at km 25.

Gillnetting

One 7½" gillnet was set overnight at the downstream end of the logging bridge pool (at km 10) on September 1 and checked the following morning.

Several other methods were considered. Gaffing, spearing or stunning (via explosives or electric shock) were eliminated due to fear of damaging fish. Seining and snaring were not attempted due to the difficulty of finding suitable sites.

~~adults~~
RESULTS

Snagging

Snagging was the most successful capture method, with three males and five females landed. All females were spawned out, so no eggs resulted from this method.

Sport Fishing

One spawned out female and a jack were landed by this method.

Gillnetting

Fifteen sockeye were taken in the gillnet, but no chinook.

Attempts to capture contributing adults for an experimental egg plant were thus a complete failure in 1976. But capture efforts contributed data for the design of 1977 efforts.

ii) 1977 Adult Capture

~~Methods~~

Accommodation

Most of the crew were housed at the Birkenhead Resort on Gates Lake, as were volunteer fishermen. One or two members of the crew however, were housed in a camper on blocks beside an access road pushed through to the beach at the holding pen site from August to September (Fig. 22).

River Swims

Four swims of selected pools from km 10 to km 20 were carried out on the river using snorkel, mask and fins, and wet suit. Three swims preceded capture to pinpoint holding and thus possible fishing sites and to give some preliminary estimate of numbers of spawners to



Fig. 22. Site of adult holding pen at bridge below hatchery site. Note river and holding pen in far background.



Fig. 23. Sportfishing adult chinook at km 17 Hydro bridge on the Birkenhead River, fall 1977. Transport truck standing by on left.

be expected. A fourth float followed the helicopter flight by two days to determine numbers of adults not visible from the air in deeper pools. River swims have been shown to be very effective in the study of salmon, especially when concentrated in pools at low water levels, as they are here (Ellis, 1961).

All floats were carried out under conditions of bright sunlight and clear water to maximize visibility with a man on foot accompanying the floater as a safety measure. The swimmer would allow the current to drift him down the pool with a minimum of movement. Wider pools were drifted 2 or 3 times at varying distances from shore to maximize coverage.

The canyon was not floated due to difficulty of access and roughness of water, but this area has been shown to be a good holding area by Kingfisher success there.

Angling

Useful pre-capture information came via two members of the Kingfishers, a local sport-fishing club, who approached the Fisheries crew with data on angling success to be expected on the river (Table 25) and a detailed map of specific fishing sites.

From July 27 to August 21 adults were taken by float fishing with heavy sport-fishing gear using sockeye roe treated with borax or fresh roe from dead chinook as bait. Contributing adults were taken by one member of the crew, an office staff member and friend, or members of the Kingfishers fishing club (Fig. 23).

Fishing pressures was concentrated from the top of the canyon in km 17 to above the rip-rap in km 21 (Fig. 24). In all, fish were angled 16 days from July 27 but on the 17th (Sept. 1) and the

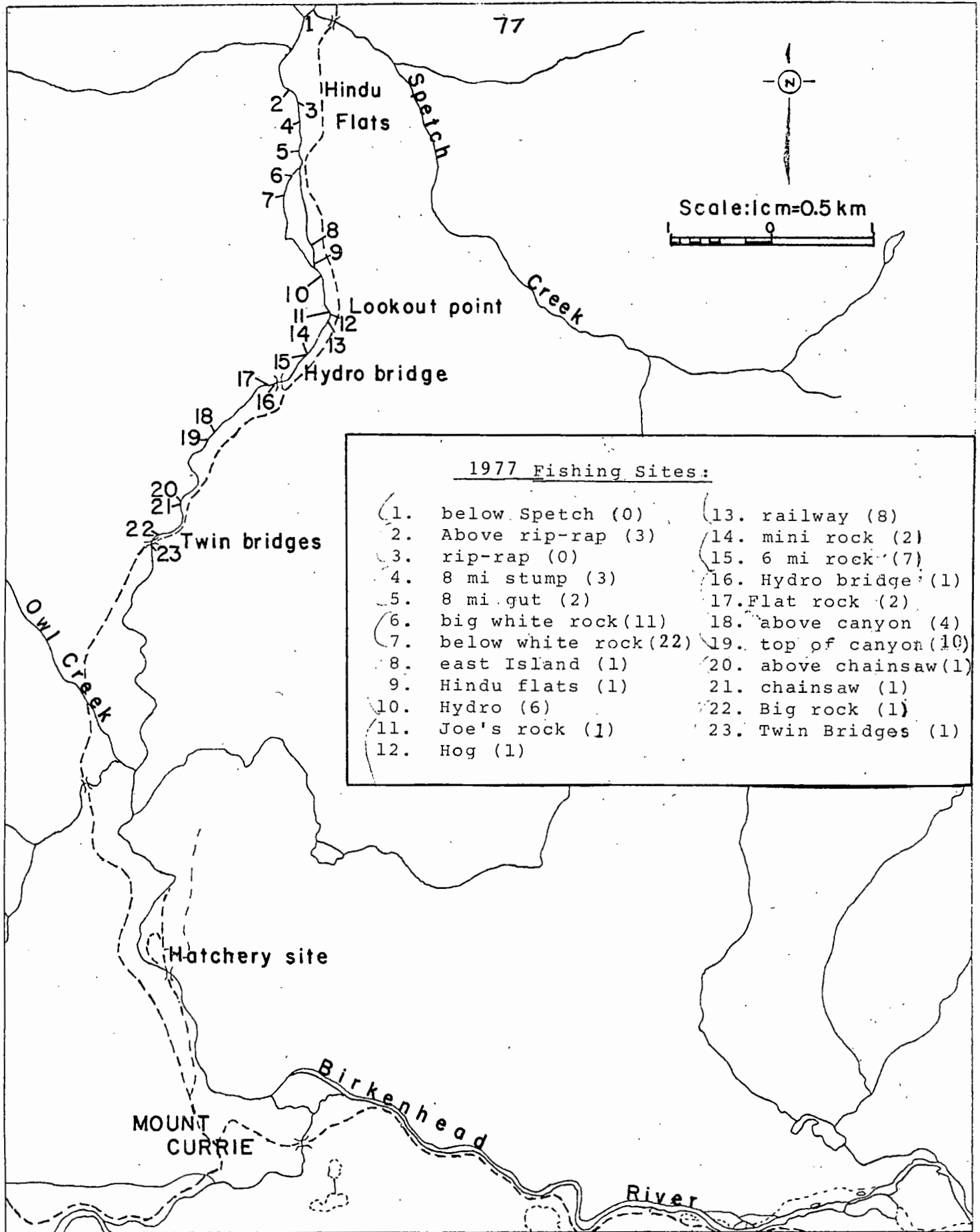


Fig. 24. Adult chinook salmon fishing sites on the Birkenhead River, fall 1977. (No. of fish hooked at each site in brackets).

18th (Sept. 3) days of fishing, contributing adults were snagged by bare treble hooks on their redds or in deeper pools below white rock pool in km 19.

Tether Tests

To test the viability of holding fish at the spot where they were angled for future truck transport, egg or sperm taking, or appointed helicopter pickup, a tether test was initiated on the first day of angling. Tethers were surgical tubing terminally, pushed into the mouth of the fish and out the gill openings, then tied to allow unhindered gill movements. This tubing was attached by swivels to heavy monofilament line or tied to a rope.

Transfer Tube Tests

One possible method of transporting adults partway to the holding site after capture was in some form of container to restrain movements of the fish as it floated downstream. The container could be removed further down the river and easily loaded into the transport truck.

As the most inaccessible stretch of the river was from the hydro bridge in km 18, down through the canyon in km 17 and 16, (Fig. 2), tests had to be conducted here on the viability of this transport method.

A 15 cm by 1 metre long tube was fabricated of aluminum, with one end screened, and the other end a solid lockable hinged door. About 15 cm back from the screened end, slots provided water circulation near the fish's gills. Styrofoam encased in aluminum attached full length on one side provided flotation to about neutral buoyancy.

Two test were conducted. In the first, the tube was tossed off the hydro bridge (at 17 km) at high water level on June 7 - it never reached the Twin bridges. A walk of the canyon on July 13 showed no sign of it. On July 13, at lower water levels, a new container and 6 identical canister-length sticks identified by flagging tape were tossed off the Hydro bridge at 2 minute intervals. The fifth stick arrived 35 minutes later at Twin bridges; the canister and stick #2 were found in the upper end of the canyon. The tube was retrieved and tossed back into the river twice in successively lower pools of the canyon, but never arrived at the Bridges. On September 27 a badly battered tube was found 0.3 km downriver from the bridges - the door was off and the latches were gone.

Due to the inconsistency of these tests, the tube was abandoned as a part of the transport system.

Transport

During fishing, the transport truck and tank were parked closeby or within tow-way radio contact with the fishermen. The tank used was the Blaney Creek chum transport tank (Fig. 25), a 250 gallon capacity 3/4" plywood and 2 x 4 framed box, divided in two, with drain plugs at the back end. A hinged, jointed lid provided separate access to the 2 sections and permitted refilling of the box at the Hydro bridge after every delivery to the holding pen and subsequent draining of the tank. The box is provided with air tubes, but no aeration of the tank water was done during this fall's fishing.

Hooked fish were landed as quickly as possible and slipped into



Fig. 25. Blaney transport tank in 3/4 ton pickup being refilled after trip to holding pen.



Fig. 26. Two men carrying adult chinook in stretcher uphill to waiting transport truck at White Rock pool, km 20.

an open plastic bag snapped to a specially designed aluminum dip net handle by surgical tubing. The bag was tied at both ends with plastic electrical ties and the fishing line was cut. The bag, containing water and fish, was tied securely to a stretcher, which was rushed to the transport tank for unloading (Fig. 26). At first, holes were punched in the plastic carrying bags for intercirculation with transport tank water. Later, fish were released from the bag and allowed to swim freely in the tank, to be easily rebagged at the holding pen site.

Holding Pen

A floating holding pen for the adult chinook was prefabricated at the North Vancouver warehouse and assembled on site at the km 10 pool just below the log bridge (.5 km downstream of the hatchery site).

The floating frame for the holding pen consisted of four 4 x 4 downstream trap aluminum pontoons on each side, joined at each end by 3/4" plywood decking to form a rectangle. The holding pen was constructed of an angle iron-supported box frame. The pen had 1/2" plywood sheathing sides; but bottom, ends and divider panels were constructed of PVC plastic pipe gridding. Water could thus flow freely lengthwise through the pen. The pen was held in a stationary but adjustable position about 20' offshore in 4-6 feet of water by 4 corner cables and ropes to trees on each bank (Fig. 27).

Adjustments in pen height for various operating procedures and water depths were facilitated by small winches at each corner on the 3/4" decking. A thermograph box on the downstream deck with a sensor on the river bottom monitored pen temperatures. A 50 gallon capacity plywood box on the upstream deck provided a confined

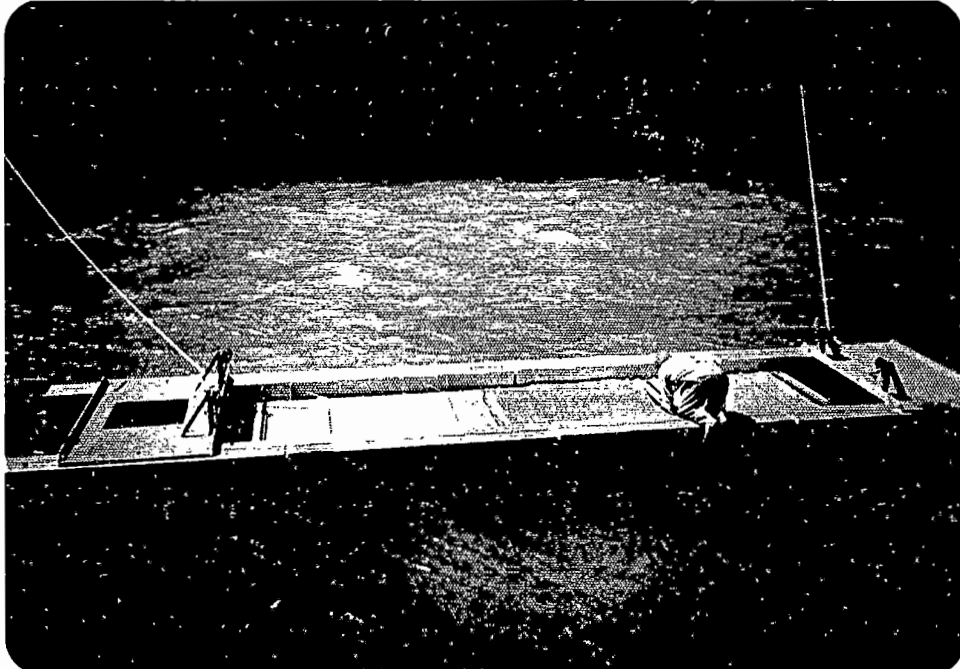
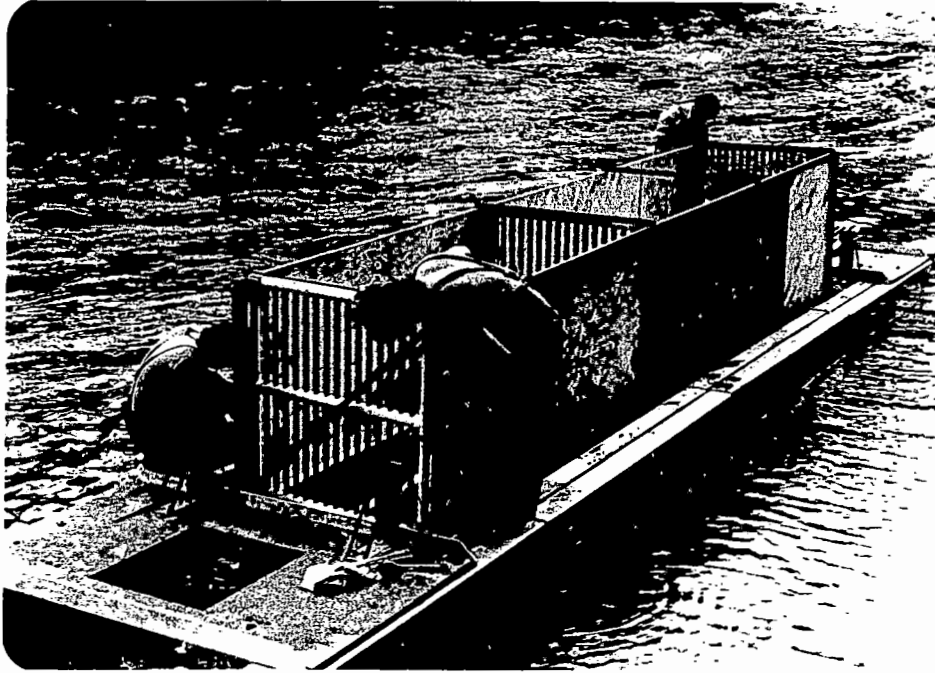


Fig. 27. Adult chinook holding pen below km 10 log bridge,
Birkenhead River.
Top: assembled.
Bottom: pen lowered to holding position, offshore.

place to anesthetize fish for malachiting or checking for ripeness. Plywood baffles 18" wide full height in the pen on the front and divider panel provided dead water areas. Long aluminum handled dip nets with bags of perforated 'shelter-lite' were handy for non-damaging capture of fish in the pen or as a recuperating surface for anesthetized fish.

Malachiting

In an effort to control fungus on adults being held in the pen, malachite green was painted on infected areas at a concentration of about 1:19,000 (1 gm. to 5 U.S. gallons of water) right in the plywood knockout box. The first few fish were painted right in the 20 gallons of knockout water with 5 ml. of 2-phenoxy added, but later fish were just allowed to bathe in the solution.

On August 29 fish were knocked out at a concentration of 40 ml. of 2-phenoxy to 20 gallons of water; painted while being held over the pen; allowed to recuperate while resting on the dip net; then allowed to swim freely when looking strong. Some fear of harming the eggs by allowing the fish to bathe in the malachite solution prompted the change in treatment. Wood (1974) describes swabbing lesions on adults at 1:15,000 and stronger malachite concentrations every 3 days, but warns against exposing the gills to this solution. On September 1 the females were knocked out using 35 ml. 2-phenoxy in 20 gallons of water, checked for ripeness, then painted using the August 29 technique and malachite concentration.

Sperm Tests

On three occasions milt was taken from males on the bar and chilled according to Withler methods (see Appendix 5). Sperm from the first two (August 29 - Sept. 1), taken in glass jars and sealtite abgs respectively, was stored in the cabin fridge but later discarded due to uncertainties about quality.

On September 3 a big male was tethered below white rock pool and used to fertilize eggs from two females killed on the bar that evening. The eggs were taken in a Thermos jug and fertilized with a mixture of fresh sperm and chilled sperm stored on ice for about half an hour. Preliminary indications of survival of these eggs after dead picking was about 86%.

RESULTSRiver Swims

Early floats in May showed very few adult chinook in the river. On May 12, one 8 - 12 pounder was sighted at Hydro bridge pool. Log Bridge (km 10) and rip-rap (km 21) pools were also floated. On May 30 another single fish was sighted, an 8 - 10 pounder at the log bridge. Twin bridges and rip-rap were also checked.

A swim on July 7 started showing concentrations of adults farther upriver closer to the spawning grounds. Eleven adults were sighted: 6 at white rock pool; 3 at hydro bridge pool and 2 at big rock pool. None were evident at twin bridges or log bridge pools.

The September 16 float of pools in the km 18 to 20 area showed very few adults, and it was the concensus of the crew that this was a rough check of those missed on the helicopter flight as most fish

had moved out of the pools and into upstream or downstream riffle areas.

Angling

89 adult chinook were hooked in all, with an almost exact 50-50 split by sex. Of those hooked, 30.3% eventually got away and ^{24.7}~~27.4~~% were transported and died in the pen (Table 24). Only two died due to severe bleeding from the gill arches which was the primary cause of death in other tests (Faulk et al, 1974).

Of those fish hooked, 37.1% were caught in the big white rock pool and the runs and pools directly downstream in km 20. The pools and runs at the top of the canyon produced 15.7% of the hooked fish, while the railway - hog hole area (in km 18) produced 10% (Table 25).

Kingfisher's summer 1976 results show^{ed} a much more even distribution, greater downriver production, and g^{ave} a good indication of earlier holding sites. Holding sites include Twin bridges - big rock in km 16; 8 mile gut; Hydro bridge and just below; 8 mile stump - rip-rap; 6 mile rock -mini rock; and railway-hog area (Table 25). Their avoidance of the white rock pool area, and their concentration of effort earlier in the summer resulted in a different catch distribution than Fisheries' efforts.

Tether Tests

A female about 16 pounds caught at 1900 hours on July 27 was tethered to a log jam in big white rock pool. She was silver bright when caught but darkened quickly. by next morning she had silvered up again and appeared strong and active. She was checked once a day for the next 5 days and appeared healthy, but died about 1500 hours

Table 24. Angling results for Birkenhead River adult chinook, July 27 - Sept 3, 1977.

	males	females	unidentified	Total
lost(hooked, escaped)	5	4	27	36
died on beach(bled to death)	-	2	-	2
released (Jacks, green females from pen, spermed male)	5	2	-	7
died on tether	-	1	-	1
broke tether	1	2	-	3
died in transit	1	1	-	2
died in pen(from ½-19½ days)	8	14	-	22
escaped from pen	6	-	-	6
killed for egg take	3	7 ¹	-	10
	29	33	27	89

¹ includes 2 females killed on bar.

Table 26. Summary of Birkenhead adult chinook holding pen results, July 28 - Sept. 3, 1977.

	Male	Female	All Fish
Brought to pen	18	22	40
Dead on arrival	1	1	2
% mortality	50	68	60
Mean holding time of dead fish (range)	9.8 (½-12 3/4)	10.9 (½-20)	10.5
Mean holding time of live fish (range)	1.3 (½-3)	8.4 (½-15)	4.4

Table 25. Percent of fish hooked at each fishing site during capture of Birkhead River chinooks May-August, 1976 by Olmsted, Reid and Penner and July 27 - Sept. 3, 1977 by Fisheries personnel.

Site [2]	1976		1977	
	No.	%	No.	%
below white rock	[1]	-	22	24.7
top of canyon and above canyon	8	8.0	14	15.7
big white rock	[1]	-	11	12.4
railway	3	3.0	8	9.0
6 mi. rock	6	6.0	7	7.9
hydro	2	2.0	6	6.7
8 mi. stump	9	9.0	3	3.4
above rip-rap	[1]	-	3	3.4
8 mi rock(5) below hydro (8)	26	26.0	2 each	6.7
East Island(2) Hindu ats(1) Joe's rock(Ø) hog hole(6) Hydro bridge(4) above chainsaw(Ø) chain- saw(Ø), big rock (13) twin bridges (13)	39	39.0	1 each	10.1
below Spetch(Ø) rip-rap (2)	2	2.0	-	-

[1] no data

[2] 1976 individual site totals in brackets

on August 3rd, having survived almost 7 days on the tether.

At various peak-times during sport fishing, adults were tethered for periods of 20 minutes to 1½ hours with no obvious adverse effects (though tethered fish are grouped toward the lower end of the survival list, Appendix 2). Two females tethered overnight on August 10 at the top of the canyon in km 17 escaped (One on ^a conventional tether broke the surgical tubing; one on a rope tailtether broke the stick to which it was tied).

Holding Pen

American experience has shown good results with floating pens in salt water (50% mortality in 51 days) even with such finicky species as sockeye (Hunter and Farr, 1970). Holding ponds dug in the ground with good water flow to ensure a high dissolved oxygen supply (Burrows, 1960) have shown survivals in the 80% range over several months; ponds with even higher flows but with stagnant areas have proven ^{as} distross with as low as 35% survival averages (Fish, 1944). 2 x 4 framed, plywood bottomed, net lined pens floating or on bottom in shallower water, combined with presorting of ripe adults upon seining gave Atnarko excellent results in 1977-78 (R. Hilland, pers. comm.).

A total of 38 adult chinook were held in the pen for periods of time varying from ½ to 20 days. Most (22) died in the pen, but six males escaped and eight females from the pen were used in egg takes, with two green females released (Table 24).

Average survival time for females and males that died in the pen was an identical 10.1 days while holding time of fish surviving egg take averaged 8.4 days for females and 1.3 days for males (Table

26). The longest lived female spent 20 days in the pen, with 12 3/4 days being the male record (Appendix R). In general, at other holding sites, female survival was higher ^{than that of males} (eg. Burrows, 1960).

None of the males held more than 24 hours survived to egg take while 2 females did so. The poor survival could be attributable to many factors. Fish tethered for a while after capture appear lower on the survival list; and some mishandling (carrying bag out of water, dropping of fish) took place, but in only a few instances. The battle to land fish commenced a lactic acid buildup in their systems (Parker and Black, 1959; Parker et al, 1959), though spawning salmon appear to be protected from this phenomenon to some extent (Parker et al, 1959). This buildup may not have killed fish immediately, but may have had a delayed effect, even to 10 days later (Bouck and Ball, 1966; Gronlund et al (1968)). This lactic acid buildup accumulated through handling and transportation stresses (Balck, (1966) and was probably aggravated by malachiting procedures. Wood (1974) suggests a bath of 1 ppm malachite solution so the 5 ppm bath used on pen fish probably had some toxic effect, though his ^{diagnostic} symptoms of pale gill colour and skin mottles were not evident. The temperature in the plywood knockout box reached 20°C within minutes, and high temperature is another predisposing factor to death by malachite poisoning (Wood, 1974). The restricting confinement of the pen (Parker and Black, 1959) and changes in water temperature from the place they were caught to where they were held also contributed to this buildup of lactic acid (Pegal^e and Remorov, 1965).

Whether hooks were left in the fish after landing had no apparent effect on survival (see Appendix R), but leaving deeply imbedded hooks in has been shown to increase survival (Mason and Hunt, 1967).

The use of single hooks increases chances of hooking mortality due to their being generally inhaled more deeply into the throat and imbedded more deeply in flesh (Klein, 1965; Stringer, 1967).

Temperature over time in the holding pens also had an effect. The mean daily temperature in the pen was 1.1°C less than the mean daily temperature upstream at the km 15 bridge between August 24 and September 4 (Table 27). A fish held in the pen from when fishing started to egg take would have accumulated 42.5C thermal units less at the pen than upstream. But using a trend which seems evident from I.P.S.F.C. temperature data and pen thermograph data, the mean daily temperature difference was even higher in July than in September. Owl Creek inflow, groundwater inflow and the depth of the river here all contributed to the drop in temperature. Indications are then, that a fish held in the pen could have accumulated as much as 68C thermal units less than a fish holding upriver. This difference in water temperature between where they are held and where they normally spawn has been pinpointed as a cause of delayed maturity and excessive mortality in adult salmon (Reingold, 1968).

Fish weighed after death in the pen varied from 16-18 pounds for 3 year olds to 27 pounds for 4 year olds (Table 28).

Sperm Tests

A summary of tests by several authors is shown in Appendix C, with survivals of 76-91.5% for chinook sperm and ova after a short period of storage.

Table 27. Comparison of daily mean temperatures between the holding pen pool (at km 10) and the Twin bridges I.P.S.F.C. (km 15) thermograph data during the latter part of adult chinook holding, summer 1977.

Date	Km 10 temp °C	km 15 temp °C
Aug. 24	10.4	12.5
25	11.25	12.9
26	11.1	12.8
27	10.6	12.1
28	10.7	11.8
29	10.7	12.2
30	9.9	11.9
31	11.9	12.6
Sept 1	11.9	12.4
2	11.4	11.7
3	11.9	12.2
4	11.4	11.7

Table 28. Mean orbital-hypural lengths and corresponding mean weights of adult chinook salmon sampled from the holding pen on the Birkenhead river, Aug. 9 - Sept. 4, 1977.

Sex	Age	No. Sampled	Mean Length	Mean Weight l
Female	3 ₁	7	67.9 cm	16.6 lb.
	4 ₂	1	77.1	25 lb.
Male	3 ₁	3	68.1	18 lb.
	4 ₁	1	81.0	27 lb.
	4 ₂	3	73.0	20 lb.

l hand-held spring scale used in weighing.

iii) 1978 Adult Capture

Methods

Transportation

The crew used a 3/4 ton crew cab pickup, a 4-wheel drive Jimmy and a Fisheries station wagon for transporting fishermen and gear.

Accommodation

The crew (from 3 to 5 men) were all housed at the Birkenhead Lodge on Gates Lake on all fishing days except the first two which were spent at the Whistler Inn in Whistler.

Test Fishing

Three days of sport fishing were done prior to adult capture to pinpoint adult holding areas. In July, orange or silver flatfish on spinning reels were used; in August, floats and sockeye roe on single action reels were employed.

Tethering

Tethers used were identical to fall 1977 style. The only two fish tethered (on August 30) broke off or were cut free within four days, so no conclusions on tethering could be made in 1978.

Adult Capture

Capturing was done in teams: One man snagging, shooting or netting; the other packing gear and spotting fish (Fig. 28). This operation took place over 13 days - on August 30 and 31 and September 3 to 13.



Fig. 28. Returning from snagging-throw net trip above white rock pool.

Fig. 29. Adult chinook snagging-buck on in last pool below white rock pool.



Fig. 30. Making adult seine set in rip-rap pool.

Before setting out, two 'Trapper Nelson' packsacks were filled each with the following gear: large plastic bags for roe, small plastic bags for sperm, metal egg-taking pans, one gallon plastic Thermos jugs with ice, paper towelling, felt pens, notebooks, scale books, tweezers, wool mitts, tethers, spare fishing line and six by eight foot plastic sheets for rain protection.

a) Snagging

Heavy snagging gear was used: 40 pound test monofilament line with weights and treble hooks tied on the end, with technique identical to that of 1976.

Fish had to be sighted to be effectively snagged (Fig. 29) so two days of rain with high, coloured river conditions at the initiation of capture lowered effectiveness of this method.

b) Shooting

All shooting was done by the head Technician, Bill Foye, with his .357 magnum pistol.

Fish had to be in shallow water, preferably with the upper half exposed, to be dispatched quickly. It was necessary to hit females in the head to prevent damage to the eggs, but males could be hit anywhere that would stop them.

c) Gill net-Fixed

Three gill net mesh sizes were used: 6,9, and 9½ inches.

Two sets were made with 9 inch gill nets tied to either shore with one or two men holding up the float line and standing on the lead line to keep it as close to bottom as possible. One set was

made with the six inch mesh net in a similar manner.

Curved bottom contour, water velocity in the areas netted, and mesh breakage when struck by fish negated the usefulness of this capture method.

d) Gill net - Drift

Several sets were made drifting the full 50 foot net through pools, but on the fifth day, a 9½ inch net was cut up into two smaller nets about 12 feet long by 8 and 10 feet deep. These smaller nets were used as throw nets, tossed with a long rope attached, upstream of spawning fish or pools containing fish and allowed to drift to entangle the fish. These nets were never very effective for adults were spooked downstream or around the sides by net movement or movement of the thrower.

e) Sport Fishing

Sport fishing with a float and sockeye roe on single action reels was tried early in adult capture. Fish taken on the first 2 days were green and later fishing (September 5 and 6) proved fruitless as fish were spawning.

f) Adult seine

A 100 foot adult seine was used to encircle fish in pools early in the capture (Fig. 30) but later a 25 foot seine was used. Water velocity, bottom debris and lack of fish concentrations or inability to encircle fish effectively reduced their usefulness almost to nil.

Adult capture this fall was concentrated from 6 mile rock (km 17.5) to just above Poole Creek at km 25.3 (Fig. 31).

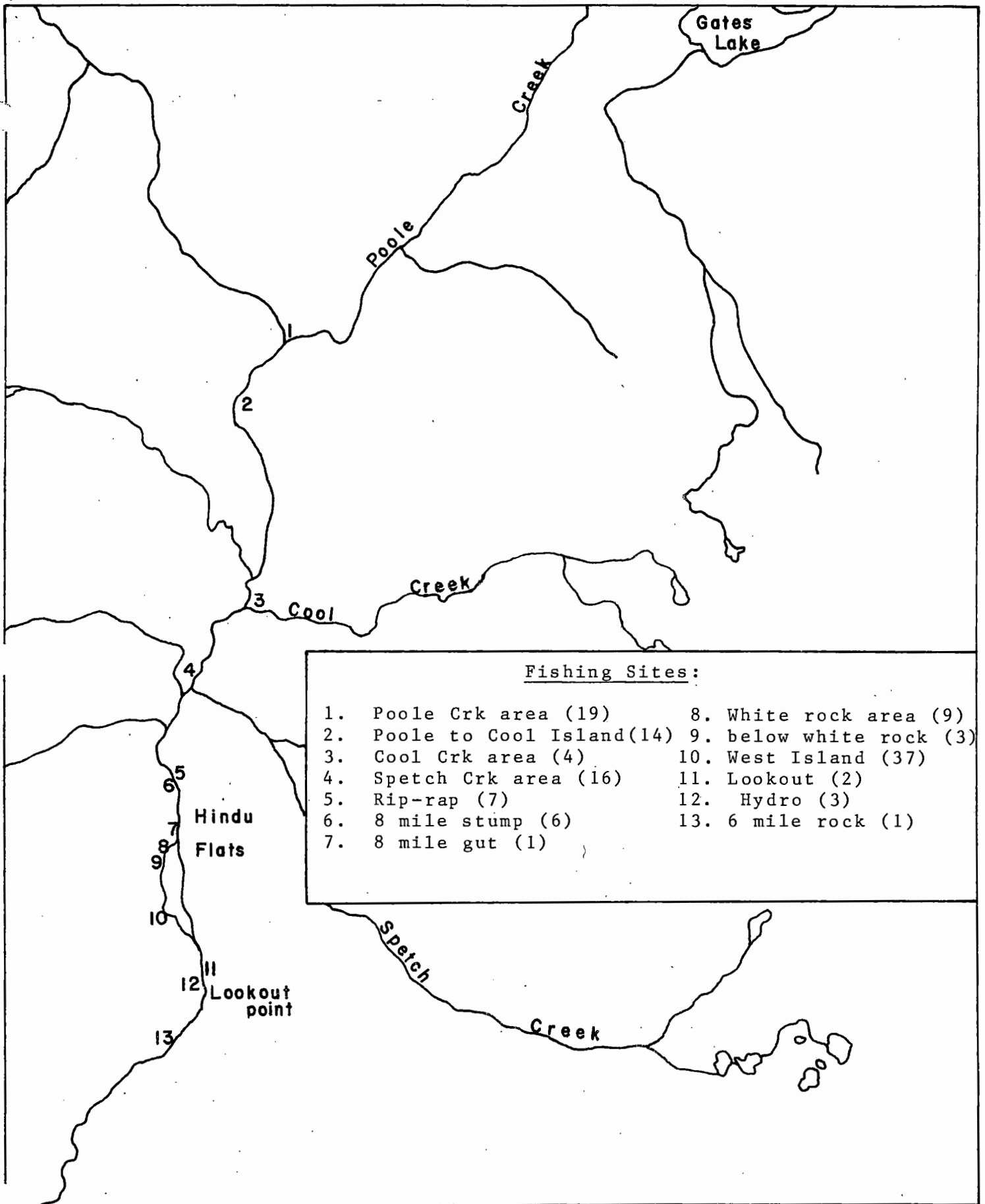


Fig 31 Adult chinook salmon fishing sites on the Birkenhead River, fall 1978
(No. of fish hooked at each site in brackets).

RESULTS AND DISCUSSIONTest Fishing

Three days of test fishing preceeded adult capture.

On July 19, an 8 pound male was landed and a 25 pound male was lost at Lookout (km 18), with another fish on and two or three seen jumping in the same pool.

On August 24, eight salmon from 2 to 25 pounds were taken at six mile rock; next day 2 salmon were taken at Lookout pool and one at rip-rap pool.

At the end of August, the river had risen and darkened, so no attempt was made to net these concentrations. When the river dropped and lightened up by the third day of capture the fish had dispersed into shallower areas to spawn.

Adult Capture

Snagging was the most effective method of adult capture, with 53 fish landed by this method. Shooting was also very effective, producing 28% of the fish used in egg takes (Table 29). Drift gill nets produced only 2 of the egg take fish and the other three methods none.

Most productive of the nine major fishing areas was West Island-Lookout in km 18 where 32% of the fish were hooked. Following closely was Poole Creek and the area immediately below at 31% of hooked fish (Table 30).

Comparison with 1977 data show^s that 45% of that year's fish were taken down river from 1978 fishing sites (Table 30). The later fishing in 1978 could have meant that fish had moved out of earlier

Table 29. Summary of capture methods, effort and results during Birkenhead River adult chinook capture July 27-Sept 3, 1977 and August 30-Sept. 13, 1978 (1977 results in brackets).

Method	No of Days	Hooked, netted or Hit		No. Lost		No. used in Eggs takes	
		♂	♀	♂	♀	♂	♀
Snagging	13(2)	41	57	23	22	15(4)	17(5)
Shooting	4(-)	7	5	-	1	5	4
Gill net-drift	4(-)	5	2	1	-	2	-
Gill net-fixed	3(-)	1 or 2		all		-	-
Adult Seine	2(-)	-	2	2		-	-
Sport Fishing	4(16)	-	1	1		-(-)	-(2)
		121 or 122		51 or 52		22	21

lower holding areas up into spawning areas or there was a general upstream shift.

36% more fish were hooked in 1978 though spawning estimates were 100% higher in 1977 (Table 30).

Snagging was the most effective capture method for egg take contribution in both years (Table 31); but sport fishing in 1977 produced a landing rate of 59% of fish hooked while the best landing rate for snagging was 44% in 1978.

Contributing fish to egg takes of 1978 were well distributed over a much larger stretch (7.5 km) of river than the 4.2 km stretch for contributing adults in 1977 (Table 32), so a wider genetic diversity appears evident this year.

Table 30. Comparison of number of fish and percentage of total catch at each fishing site during Birkenhead River adult chinook capture, July 27 - Sept. 3, 1977 and Aug. 30 - Sept. 13, 1978.

Site ¹	1977		1978	
	No.	%	No.	%
Poole and just above (at km 25.3)	n/f	-	19	15.7
Poole → Cool Creek	n/f	-	19	15.7
Spetch area (at km 21.5)	0	0	16	13.2
Above rip-rap	3	3.4	n/f	-
Rip-rap-8 mi stump (km 20.6)	3	3.4	13	10.7
8 mi. gut	2	2.2	1	0.8
Big White rock and runs below (km 19.7)	33	37.1	12	9.9
W. Isle	n/f	-	37	30.6
Hydro-Lookout-E. Isle (km 18)	8	9.0	2 (plus 1 or 2 lost)	1.7
Joe's rock	1	1.1	n/f	-
Railway-hog	9	10.1	n/f	-
6 mi.-mini rock (km 17.5)	9	10.1	2	1.7
Hydro bridge- Flat rock	3	3.4	n/f	-
Top of canyon (km 16.5)	14	15.8	n/f	-
Chainsaw and above	2	2.2	n/f	-
Big rock-Twin bridges (km 15.2)	2	2.2	n/f	-
Totals	89	100.0	121	100.0

¹ distances in km from river mouth.

Table 31. Number of contributing fish to egg takes of Sept. 3-4, 1977 and Sept. 4-13, 1978 at Birkenhead incubation site by method of capture.

Method	Contributing Fish			
	1977		1978	
	♂	♀	♂	♀
Snagging	5	4	15	17
Shooting	-	-	5	4
Sport Fishing	-	3	-	-
Gill netting - drift	-	-	2	-

Table 32. Number of contributing chinook to egg takes of 1977 and 1978 at the Birkenhead incubation site by site of capture.

Site	1977		1978	
	♂	♀	♂	♀
Poole Cr. and ^a Above (km 25.5)	-	-	2	5
Poole → Cool Isle	-	-	3	3
Cool Cr. Area	-	-	1	4
Spetch Cr. Area	-	-	6	5
Rip-rap-8 mi. stump (km 20.5)	-	1	5	1
8 mi. gut	-	1	-	-
White rock pool and runs below	5	4	1	1
W. Isle (km 18)	-	-	5	2
Top of canyon (km 16.3)	-	1	-	-

(B) Incubation and Rearing - Spring 1978MethodsEgg Plants

Eggs to be planted were obtained in two separate egg takes. Those taken September 3 were from two females snagged and killed on a bar in km 19. The eggs were stripped in to a gallon thermos jug and fertilized with a combination of fresh sperm from a big male tethered there and some of his sperm taken and chilled for one half hour previously (after Withler methods, Appendix S). These eggs were then rushed by truck to the incubation site to be planted in the section nearest the head box, partitioned off by lath.

Egg^s taken September 4 were from 5 females held in the adult holding pen downstream (Fig. 27) where were killed with ventral aortas slit, and hung to drain, then wiped clean and stripped of eggs. Three males were killed at the holding site (sperm from one male dead overnight was also used) and fertilization took place at the incubation site after a few minutes transportation.

All eggs were surface planted on a nylon netting on the gravel surface about 8 cm below the water surface.

Determination of egg numbers planted were made using Imperial quart containers to measure rough volumes, assuming the eggs were cubes, (a lot of ovarian fluid was present in the containers), and basing average egg sizes on 30 cm ruler counts made on eggs from dead females on August 25 and September 2 and 4.

Fall and Winter Operating Procedures

On September 4 an expanded metal protector was nailed over the box outlet to discourage predators and in the first week of October a plywood shack was built to house the incubation box, thermograph and other assorted gear. (See Fig. 32).

A backhoe was brought in September 1 to run back and forth over the instream infiltration gallery and to build up the intake lagoon walls to increase water flow to the incubation box. The machine was used again to break ice in the lagoon to ensure water flow on January 12.

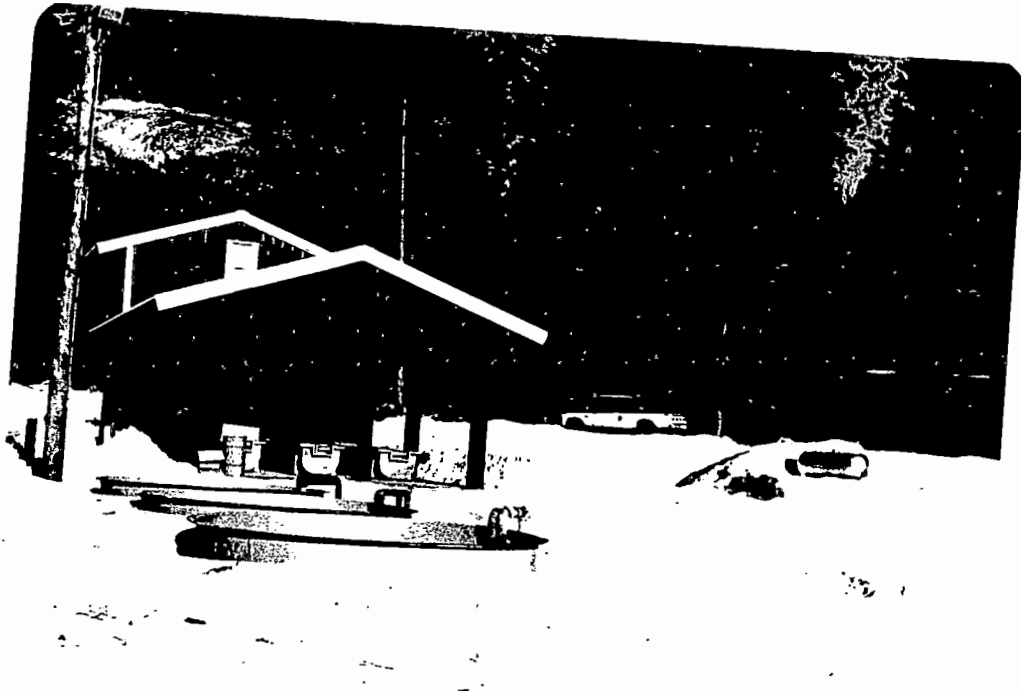
Malachite green as a fungus preventive was dripped into the head tank of the incubation box at a concentration of 1:445 by weight (42.5 gm thoroughly mixed in 5 U.S. gallons of water) over a half hour period every 3 or 4 days from September 17 to October 28. At the same flow, Wood (1974) advises a drip-bottle concentration of 1:750 (5 gm mixed in 1 U.S. gallon of water) over a one hour period.

Dead eggs were picked with hand-made tweezers on four separate days from October 28 to December 28.

Surface levels in the lagoon and well were read each time the site was visited (at least twice weekly) by a local casual employee.

A thermograph was maintained in the incubation shack to monitor daily incubation box water temperature fluctuations.

On March 2 the rearing tank was levelled in a shallow hole dug out by a backhoe downstream of the incubation shack. An aluminum flume connected it to the outlet of the incubation box. The 20 foot long round-bottomed tank was covered with sectional 3/4 inch plywood panels with openings cut in and screened over (see Fig. 33). Per-



AYF
removed
these 2
photos

Fig. 32. Inside the incubation shack-incubation box in foreground; thermo graphs (box and river) on back walls.

Fig. 33. Birkenhead incubation site, km 11 Birkenhead River. Rearing tank in foreground, incubation shack in background, crew trailer on right.

forated aluminum panels edged with foam rubber divided the tank into sections for separation of wild and incubation box fry. A marquisette net was mounted at the outlet of the flume to catch migrating fry.

Accommodation

On March 21 a 17½ foot trailer was parked in the clearing at the site to house the crew (usually one man but at times up to five).

Fry Enumeration

Until March 21, migrating fry were caught in a net in the outlet box and returned to the incubation box. After this date, fry were counted singly by dipnet from the marquisette catch net and released into the rearing tank.

Dead fry were siphoned out during tank cleaning or dipnetted out when sighted during fry feeding.

Wild Fry Capture

Three different migrant traps were used in the Birkenhead River to capture wild chinook fry to be transported to a separate section of the rearing the tank.

A 2 x 3 downstream trap was rigged to a pulley on a thirty foot cedar gin pole suspended over the river (Fig. 34) about ¼ mile upstream from the incubation site. The pulley permitted adjustment of the trap to desired fishing locations to at least halfway across the river. The trap was emptied in the morning, beached to dry until late afternoon, then cleaned and refloated to fish overnight.

It was fished regularly during April, but sank on the 28th to be refloated May 4 only to sink and never be used again.

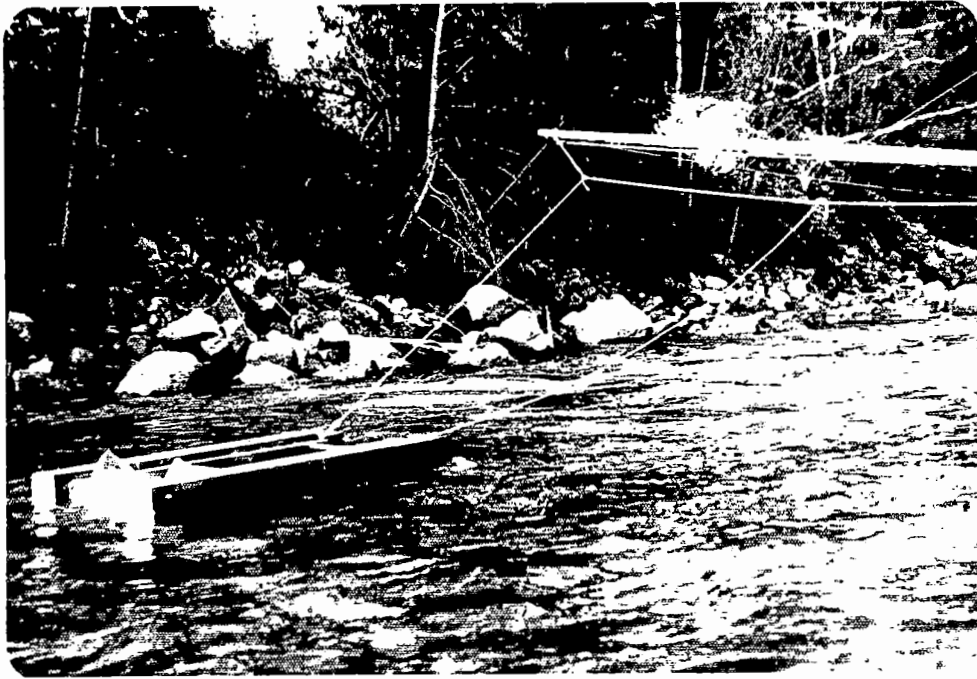


Fig. 34. 2 x 3 downstream trap setup - gin pole out over river on right



Fig. 35. Nose tagging in the incubation shack - fry anesthetized in MS222 pan at centre, placed in net at left for fin clipping, then dropped into plastic tube for nose tagger on right; tag detector out of sight in foreground.

A 'Foye' trap was constructed from a 30 cm diameter screen cone at the upstream end, tapered over its 60 cm length to fit into a two inch plastic pipe which extended 60 metres downstream, to empty into a marquisette catch net. A lead-in weir of fine screen on stakes with wings 3.6 m apart at the upstream end formed a funnel to guide fry into the cone (Fig. 36). The trap was fished irregularly as the cone plugged quickly and water did not draw well down the long plastic pipe. It was swept downstream April 27, never to be reconstructed again.

A 30 x 60 cm fyke net was staked out about 3 metres offshore, opposite the incubation site, at irregular intervals. Debris problems negated its usefulness after May 19.

Feeding

Fry were hand-fed at 1 to 2 hour intervals during daylight hours (6-8 feedings per day). Palmer et al (1951) show this feeding frequency provides the best growth and highest percentage weight gain with least food wasted.

A feeding schedule of two thirds of the recommended OMP feeding chart rate was followed, but individual feeding amounts were varied according to feeding intensity exhibited by the fry.

Sampling

a) Fry

Fry were individually weighed on an Ohaus 750 gm. capacity balance beam scale April 21-29. They were anesthetized with 9 ml of 2-phenoxyethanol in five U.S. gallons of water; individually measured on a plastic smolt board; towelled dry before weighing;

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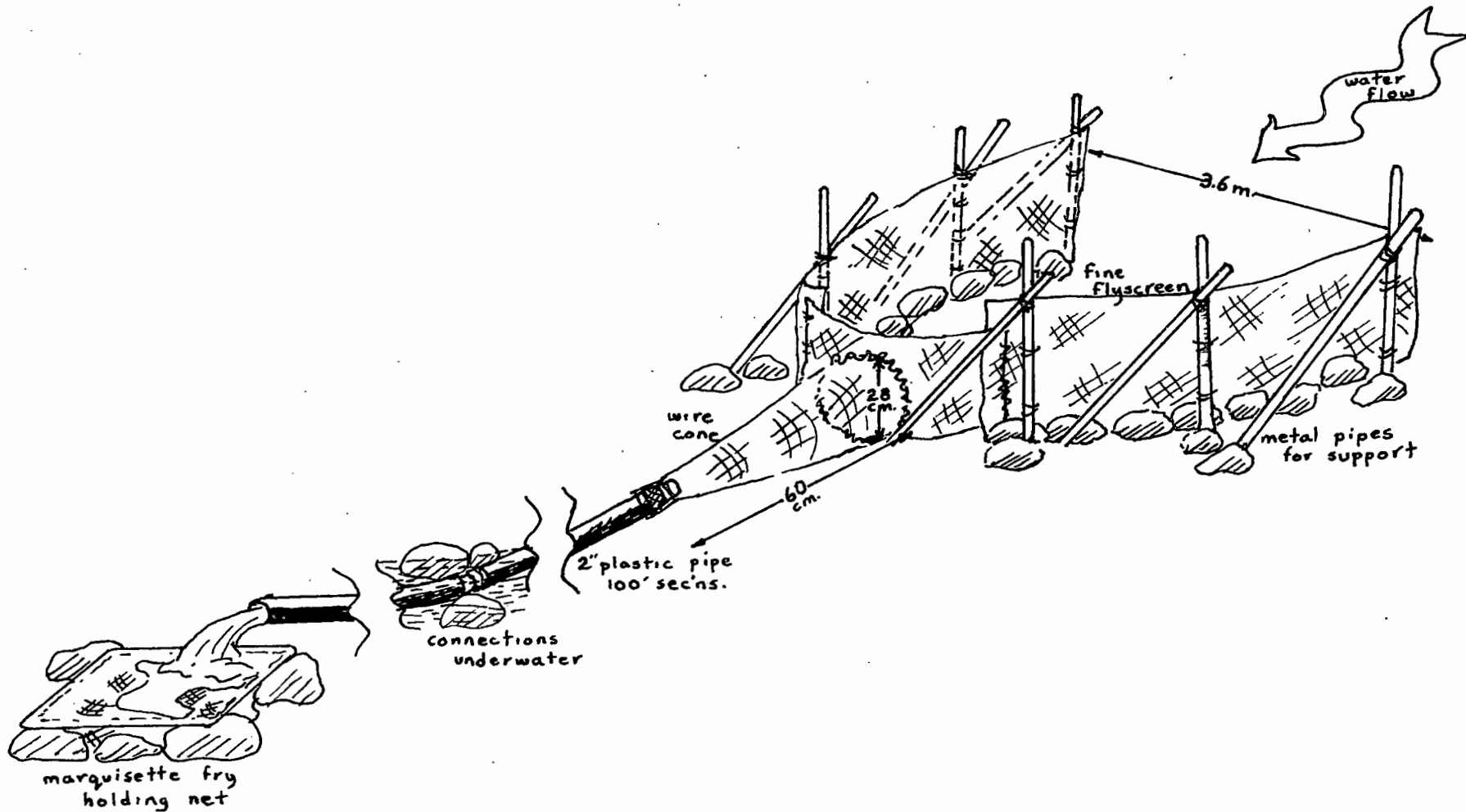


Fig. 36. Sketch of 'Foye' trap constructed to catch migrant fry in the Birkenhead River, spring 1978.

then quickly dropped into a^f aerated recovery bucket.

After May 8 the fry were bulk sampled: A light plastic cup filled with water was tared on the balance beam scale; fry were dip-netted from the rearing tank and shaken to allow excess water to drain; the fry were dropped into the container and weighed; they were then counted and the bulk weight was divided by this number to give average weight per fry.

b) Physical and Chemical

After March 27, lagoon water levels were measured and well levels were read daily. After May 1, the river level at the km 10 log bridge gauge was also noted daily.

River temperatures were taken daily by hand-held thermometer starting March 26, but after May 19, these temperatures were monitored continuously by a 30 day thermograph with its sensor in the river bottom.

Water flow rates through the rearing tank were measured daily at the outlet end by timing the filling of a five gallon plastic bucket.

Oxygen levels were measured regularly at outlet and inlet ends of the rearing tank using a Hach kit beginning April 23. Testing was originally done in the morning, but in keeping with Elliott's (1969) findings of maximum oxygen consumption from 1200 to 1700 hours, testing was done in the afternoon in the last few weeks of rearing.

Tagging

All incubation box fry were fin clipped and nose tagged July 18 and 19 (see Fig. 35). Fry were dipped from the rearing tank into an aerated 5 gallon bucket, immobilized in a solution of cool MS 222 and adipose fin clipped, nose tagged with a binary coded nose tag (nose tag injector and detector developed by Technical Research Company, Seattle, Washington), then passed through the quality control detector to be either rejected to an untagged-fry holding net or released into the rearing tank for recovery.

Heads of 1 or 2 fry were split hourly with a scalpel to determine tag placement.

Post-Tagging

100 randomly selected fry were run through the quality control device to check overnight tag retention.

100 fry caught randomly after crowding in the holding tank were accurately length and weight sampled using a Mettler P1200 electric balance.

Tagged fry were held overnight July 19 to determine immediate mortality and released about dark (2100 to 2200 hours) on July 20.

20 randomly selected fry were taken live on ice in a plastic bag to Nanaimo for testing for all ^cbacterial, viral and parasitic agents known to cause losses among cultured fish.

RESULTS & DISCUSSION

Egg Plants and Hatching

An estimated 3,171 eggs were planted in the first section of the incubation box on September 3. The following morning an estimated 15,122 eggs were planted in the larger section. This 130 litre box is designed to accommodate about 50,000 alevins (54-58,000 eggs were planted in this style experimental box at Inches Creek in the fall of 1976) and at a final accurate exit count, via egg picks and individual fry count (assuming minimal alevin mortality in the gravel) of 19,720, the box was at less than half capacity this fall.

The soft egg ruler count and quart container method of egg plant estimation was 10% short of actual numbers. 1977 estimates on the Kitimat River using an identical method were 8% short of actual egg plant numbers (Brian Allen, pers. comm.).

A differential mortality rate between the 2 sections occurred during the egg developmental stages. In the smaller section, 446 eggs or 14.06% died; in the larger section 4,057 or 26.8% died. Differences could be due to better water flow to the smaller section closer to the head tank or excess trauma suffered by eggs in females transported and held in the holding pen. Inches Creek dissolved oxygen levels in 4 separate experimental boxes averaged less than one ppm. different between areas closer to or farther from the head tank in 1977 and 1978, so this may not be a pertinent factor. Eggs from Stamp River females trucked and held up to 6 weeks to maturity at Robertson Creek had the highest egg morality (8.2%) of 4 methods of fertilization and egg taking (Armstrong, 1973).

The eggs began hatching on October 27 at 539 accumulated Centigrade thermal units (ACTU), with 50% hatch complete at 575 ACTU, and was complete on December 10 at 698 ACTU. Nechako River chinook eggs hatched at about 500 ACTU in spring 1977 (L. Kahl, pers. comm.), while Big Qualicum eggs hatched at 519-547 ACTU in 1976 and 1977 (Fraser et al, unpub. report, 1977).

Water Levels

The most critical months (i.e. those when lagoon and well water height differences were greatest) were October-November and February (Table 33). The outlet pipe from the well to the incubation box is located at elevation 739.5 ft. At times water levels within the well were within 1.3 ft. of the top of the pipe.

River levels rose steadily from January to June to an average of 2 feet higher and the excessive velocity, silt and debris played havoc with and put an end to, all wild juvenile trapping by mid-May. Twenty-six year flow averages to 1971 show this trend - a steady rise to 10 times the discharge in June as in January (Appendix A).

Fry Enumeration

Fry began exiting the incubation box about February 20 at 790 to 800 ACTU but numbers were small. Fry migration peaked at over 2800 on April 20 at 990-995 ACTU (Fig. 37). The bulk (10-90%) of the migration occurred over a 10 day period from April 15-24. Big Qualicum chinook fry were ponded at 789-792 ACTU in 1976-1977 (Fraser et al, unpub. report, 1977); while Puntledge fry were ponded at 960-974 ACTU in 1976-1977 (T. Perry, pers. comm.).

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Table 33. Low water levels, Birkenhead River intake lagoon & well at incubation site, km 11; Sept, 14, 1977 - July 20, 1978

Month	Well low (ft.)	Date	Lagoon Low (ft.)	Date	Avg. Diff. for mo. (ft.)	Avg. Well Ht.
Sept.	742.58	29	745.92	29	3.3	742.64
Oct.	740.80	21	745.80	21	4.4	741.58
Nov.	741.00	11, 24	745.80	24-28	4.8	741.15
Dec.	741.8	1	744.00	29	3.1	742.23
Jan.	741.88	30	744.00	11	3.2	741.94
Feb.	741.50	7	745.60	7-21	3.9	741.74
Mar.	741.95	7	745.75	7	2.74	743.36
Apr.	742.90	24-25	746.05	7, 16-17	3.02	743.26
May	742.60	29-31	746.10	29	3.37	742.93
June	742.95	1	746.4	1	3.01	744.16
July	742.80	18-20	746.30	12-13, 20	3.5	743.17

Table 34. Trap catch summaries Birkenhead River, April 5 - May 19, 1978.

Trap	Dates fished	Chinook fry catch	No. days Fished	avg/day	to rear. tank	Other Species
2 x 3	Apr 5-28	1108	23	48.2	1080	Coho fry Sockeye fry coho smolts rainbow trout sculpin
Fyke	Apr 5	5	1		5	coho fry
	May 11-19	146	7	20.9	132	sockeye fry coho smolts
'Foye'	Apr 5-27	55	13	4.2	52	coho fry sockeye fry

Wild Fry Capture

a) 2 x 3 Downstream Trap

The 2 x 3 trap was fished regularly and 1080 fry were placed in the rearing tank (Table 34). In 1977, the Birkenhead 2 x 3 at km 15 took 13,933 chinook fry in 17 days of fishing.

b) Fyke Net

The fyke net caught 137 wild chinook fry (Table 34).

c) 'Foye' Trap

The 'Foye' trap captured 52 wild chinook fry.

1,269 wild fry in total were placed in the rearing tank.

Sampling

a) Balance Beam Scales

Figures for individual balance beam weighing of fry are contained in April figures of Appendix U, but this sampling method was felt to be inaccurate due to the small size of the fry.

b) Bulk Sampling

Bulk sampling for weight determination was used after April (see Appendix U for figures) and was used as the basis for both growth curves.

c) Physical and Chemical

Incubation box outflow during incubation averaged 75 l/min (19.8 U.S.gpm) and fell below the almost constant maximum level of 75.7 l/min (20 U.S. gpm) for only 3 short stretches in the first and second weeks of April and the second week of May (Table 35).

Mean dissolved oxygen levels at rearing tank inflow and outflow fell steadily from 12.8 and 11.6 ppm respectively at the beginning of the rearing period to 7.8 and 5.3 ppm respectively at tagging time (Table 35). Individual outlet levels as low as 4 ppm closely approached Chapman's (1939) level of obvious stress at 3.6 ppm.

Mean oxygen saturation levels at the tank inlet ranged from over 100% during the rearing period to 73% in the last week of rearing (Table 35) while outlet saturations fell from 97% to 50%.

Rearing tank water temperatures rose to a daily mean of 11.3°C. Temperatures for maximum growth of chinook fry have been shown to vary from 15-18.6°C at constant temperatures (Brett et al, 1969; Banks et al, 1971; Hokanson et al, 1977) to means of 12.2 - 15.5 °C for fluctuating temperatures (Fraser et al, 1977 unpub.; Hokanson et al, 1977).

River temperatures during the latter part of the rearing period averaged 0.6°C lower than incubation box temperatures (Table 35).

Mortality

Egg to release mortality for incubation box fry was 23.5% with only 1.34% incurred at the rearing stage (Table 36). Big Qualicum 1973 rearing experiment showed a rearing mortality of 23.7% (Fraser et al, 1977 unpub.) while Atnarko rearing in fibreglass tubs showed mortalities of 3.5-4.6% in 1977 and 1978 (R. Hilland, pers. comm.), so Birkenhead 1978 rearing losses appear to be low.

Big Qualicum 1973 chinook showed a distinctly unimodal mortality curve, peaking after 48 days of rearing. Birkenhead box fry mortality appears to be bimodal: at 33 and 42 days after initial ponding.

Table 35. Physical and chemical characteristics of the Birkenhead River and the incubation box and rearing tank during fry rearing March - July, 1978.

Period Ending	Mean River Temp.	Mean daily Head B _{ox} Temp. (°C)	Mean rise in tank inflow to outflow temp	Mean dis O ₂ level (ppm)		Mean O ₂ Sat. (%)		Mean box water flow (Usgpm)	
				inflow	outflow	inflow	outflow		
Mar 31	n/a	3.6	n/a	n/a	n/a	n/a	n/a	20	
Apr 7	n/a	3.8	n/a	n/a	n/a	n/a	n/a	19.8	
14	"	4.6	0.8	"	"	"	"	18.9	
21	"	4.8	0.3	"	"	"	"	19.5	
30	"	5.3	0.8	12.8	11.6	104	97	19.4	
May 7	n/a	5.4	0.6	12.2	11.2	100	93	19.0	
14	"	5.7	0.6	12	11	100	92	19.9	
21	5.1	6.4	0.5	12	11	101	94	20	
31	6.7	6.4	0.5	12	11	101	94	20	
June 7	7.0	7.2	0.3	12	11	103	95	19.8	
14	6.6	7.3	0.5	12	11	103	96	20	
21	7.4	8.1	0.4	12	11	105	98	20	
30	8.2	8.8	0.6	13	10	116	90	20	
July 7	9.7	10.0	0.6	12	8	110	74	20	
14	9.5	10.4	0.8	11.1	7.8	102	73	20	
20	10.4	11.3	0.7	7.8	5.3	73	50	20	
Means	7.8	6.8	0.6	11.7	10.0			19.8	
Rearing Temp:		Mean: 7.5 °C							
		Range: 4.5 - 11.4 °C							

Table 36. Summary of capture and mortality of incubation box and wild chinook fry, Birkenhead River site 1977-78.

<u>INCUBATION BOX FRY</u>				
<u>No. of Females used</u>	<u>No. of Males used</u>	<u>Estimated Egg Plant</u>	<u>Egg Pick Mortality</u>	<u>Cumulative Fry Migration</u>
7	5	18,293	4,057	15,663
<u>Actual Egg Plant</u>	<u>Actual Fecundity</u>	<u>Egg Mortality</u>	<u>Rearing Mortality</u>	<u>Tagging Mortality</u>
19,720	2,817	20.57%	1.34% (210)	2.19% (338)
<u>Tagged Fry Released</u>	<u>Egg to release mortality</u>			
15,095	23.45% (4,625)			

<u>WILD FRY</u>			
<u>No. of Fry Captured</u>	<u>No. of fry Poned</u>	<u>Capture Mortality</u>	<u>Rearing Mortality</u>
1,318	1,269	3.72% (49)	4.26% (54)
<u>Wild Fry Released</u>	<u>Capture to Release Mortality</u>		
1,215	7.81% (103)		

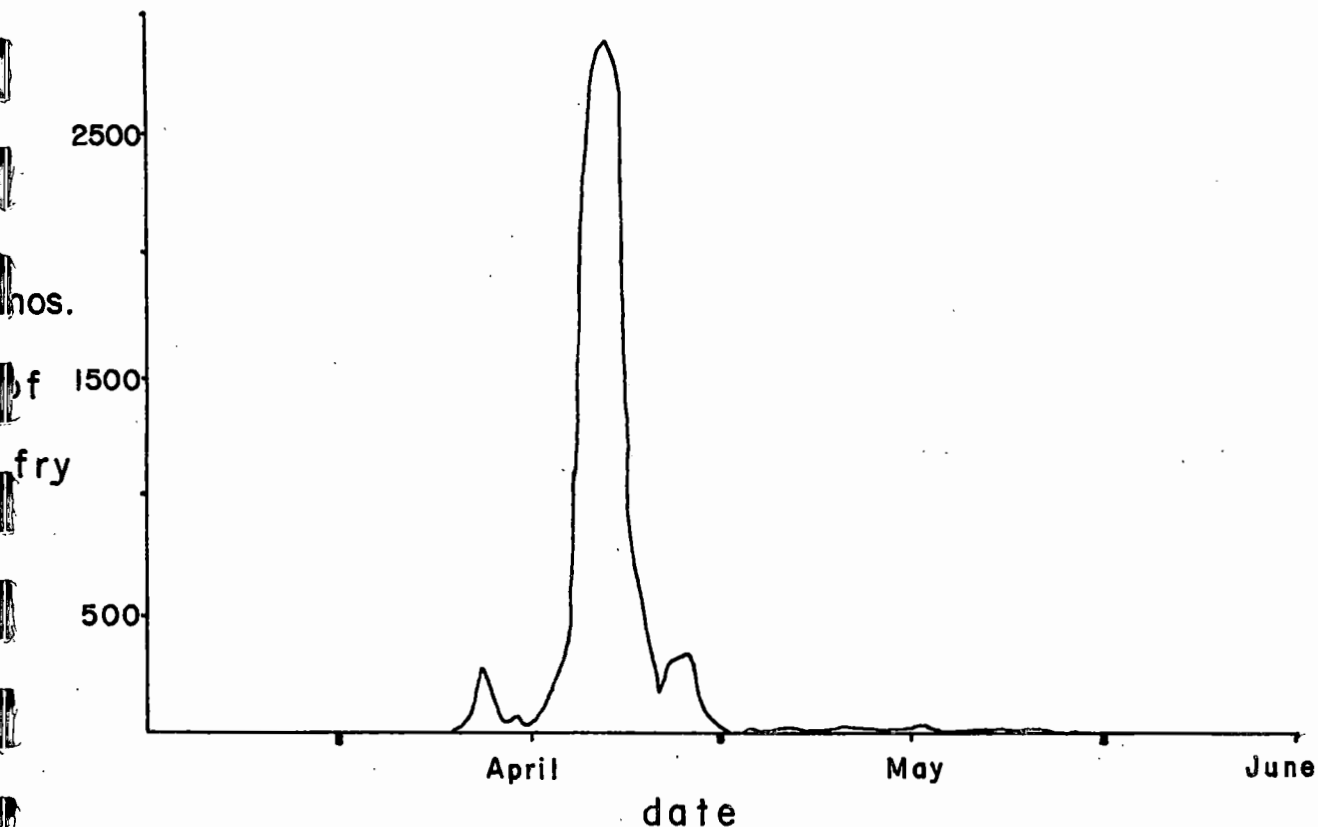


Fig. 37. Daily chinook fry outmigration from the Birkenhead incubation box, March 21 - June 12, 1978.

Table 37. Feeding schedule for incubation box and wild chinook juveniles reared at the Birkenhead River site March 24 - July 18, 1978.

Date	Food Fed(mm)	OMP sched. Fry Size(gm)	Birk. Fry Size(gm)	Fry/pound
Mar 24-31	Mash	0.38-0.65	.45	1008
Apr 1-June 6	0.8(1/32")	0.65-0.91	.45-1.14	1008-398
June 7-July 3	1.2(3/64")	0.91-1.81	1.14-1.99	398-228
July 4-July 18	1.6(1/16")	1.81-3.02	1.99-2.44	228-186

Table 38. Feeding rate of incubation box and wild chinook fry in the Birkenhead rearing tank during the 89 day feeding period, April 21 - July 18, 1978.

Mean Temp. °C	Recommended am't to be fed (kg. wet wt.)	Amount of Food Fed (kg. wet wt.)	Difference	Mean Feed Rate (% Body wt. per day)
7.49	60.96	55.61	-8.8%	2.64%

But a closer examination of conditions in the rearing tank explain the distinct 2 peaks: at 33 days fry exit numbers were at a peak, so losses were due to excessive fry numbers in the small catch net and 2 days of balance beam sampling immediately prior; at 42 days, fry migration numbers were at the 97.4% mark, so an inferior fry was migrating and this fact coupled with 2 days of fry sampling immediately prior explains the second peak.

Capture to release mortality of wild fry was 7.8%, split about evenly between death in various traps and rearing tank mortality. No excessive mortality occurred in any given day and any increase in mortality could be explained by sampling immediately prior or excessive velocity in various traps predisposing fry to short lives in the tank.

Feeding Schedule

The fry were started on 0.8 mm OMP pellet 36 days earlier and 0.2 gm smaller than recommended in the OMP schedule due to their indifference toward mash. All other pellet sizes were fed starting later than recommended (Table 37).

Initiation of serious feeding (attempting to closely follow the OMP schedule) coincided with the date of 50% migration (April 21) although light feeding had begun March 22.

The fry were fed at a mean feed rate of 2.64% for the 89 day pellet feeding period for a total of 8.8% less food by weight than recommended (Table 38). The recommended mean feed rate of 3.1% per day at Birkenhead temperatures is well below the 5.8% level fed at Big Qualicum in 1973, where temperatures were higher (Fraser et al, 1977 unpub.).

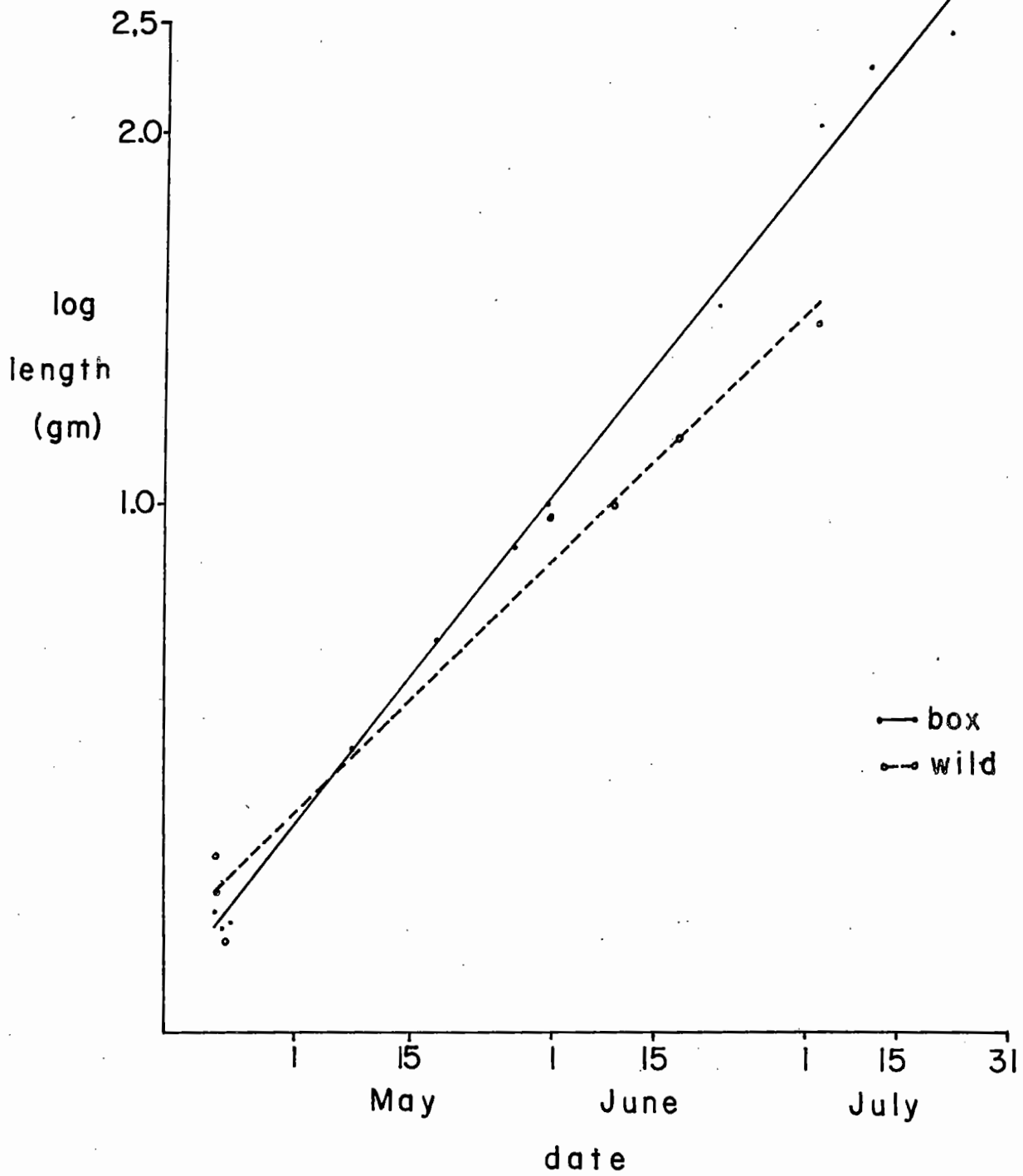


Fig. 38. Graph of growth in weight of Birkenhead ^J Juvenile chinook. May 8 - July 20, 1978.

Table 39. Summary of food conversion and loading rates of incubation box and wild fry in the Birkenhead rearing tank, April - July, 1978.

Biomass of fry(kg) Apr 21		Biomass of fry(kg) July 18		Biomass increase (kg. wet. wt.)	Mean biomass (kg)
<u>Incubation</u>	<u>Wild</u>	<u>Incubation</u>	<u>Wild</u>		
5.28	.41	37.46	1.99	33.76	22.57
Food Fed (kg. wet wt.)		Food Conversion (wet)		Mean Flow l/min(USgpm)	Loading rate(kg/l/min) Mean (range)
55.61		1.65		74.94 (19.8)	.30 (.08-.52)
				Mean rearing volume m ³ (cu ft)	Loading rate(kg/m ³) Mean (range)
				1.925 (68.01)	11.7 (3.0-20.5) 0.73 lb/cu ft (0.18-1.28)

Table 40. Summary of rearing and growth of incubation box and wild chinook fry, Birkenhead River site 1977-78.

<u>INCUBATION BOX FRY</u>								
<u>Date of 50% mig.</u>	<u>Date of Release</u>	<u>Mean Days Reared</u>	<u>Mean Length (mm)</u>		<u>Mean wt. (g)</u>		<u>Growth rate (% per day)</u>	
			<u>in</u>	<u>out</u>	<u>in</u>	<u>out</u>	<u>lgth</u>	<u>wt.</u>
Apr. 21	July 20	91	39.42	61.81	.463	250	0.489	1.853

WILD FRY

<u>Date of 50% Capture</u>	<u>Date of release</u>	<u>Mean Days Reared</u>	<u>Mean Lgth (mm)</u>		<u>Mean wt. (gm)</u>		<u>Growth rate (% per day)</u>	
			<u>in</u>	<u>out</u>	<u>in</u>	<u>out</u>	<u>lgth</u>	<u>wt.</u>
Apr. 16	July 20	96	39.9	n/a	.511	1.70	n/a	1.252

was experienced at Atnarko in 1977 where box fry had achieved taggable size 10 days earlier, but had to be held until downstream-trapped wild fry had achieved that size (R. Hilland, pers. comm.).

Size at release had been shown to have a bearing on survival to maturity of salmon (Senn and Noble, 1968; Johnson, 1970; C. MacKinnon; pers. comm. about Puntledge results) but time of release is very important. Big Qualicum River experiments showed that releases within a week of 50% migration showed better survivals than earlier releases. Competition and predation can complicate these results however (eg. 1968 brood chinook at Big Qualicum River). Birkenhead 2 x 3 downstream results in 1977 showed chinook fry peak in early April, with rearing taking place in the lake until late June before exit to the Fraser estuary. Scale reading results show sub 2 adults comprise 22-47% of the population, so substantial rearing occurs in the system.

Rearing and release of the fingerlings must then be correlated with local natural chinook rearing and migration patterns. July 20 may be a late release time, as natural migration is about one month earlier, following June patterns of other areas (Atnarko for example, where every attempt is made to get chinook fry to taggable size of 140 per pound by June 21 - R. Hilland, pers. comm.).

Birkenhead chinook however, were at 311 to the pound (1.46 gm) at June 22, which is too small to tag. The solution then may be to rear to smolt size and release in the following spring.

Disease

No major incidence of loss to any recognizable disease occurred during the rearing period. Eleven fry were removed from the box fry section of the rearing tank with either low temperature disease symptoms or body fungus, between April 22 and May 15. 4 fry were removed from the wild fry section with fungus or body deformities in the same period.

The sample of 20 box fry to the Nanaimo lab showed no sign of any infectious disease and blood hematocrits were within the normal range.

Tagging

15,095 nose tagged fry (Code: agency 02; data 16/55) were released into the Birkenhead River on July 20. Of 338 mortalities during tagging, 68% (230) appeared to die as a result of tagging and handling. 20.4% (69) were considered mortalities after they jumped from the rearing tank or holding buckets into a small pool surrounding the rearing tank. Other incidental mortality factors included headsplits for tag placement or fry jumping from buckets onto the ground.

Tagging mortality then was 2.2%. This compares with 0.84-1.6% tagging mortality experienced at Atnarko in 1976-78 (R. Hilland, pers. comm.); and 0.04-1.02% experienced on the Chilcotin River in 1977 and 1978 (L. Kahl, pers. comm.).

On the basis of the tag retention check, 98% of the incubation box fry released, or 14,793 Birkenhead fry were actually bearing a nose tag upon release into the river. This 2% overnight tag loss

compares with 0.8 to 1.3% loss in $\frac{1}{2}$ to 2 days on the Chilcotin in 1977 and 1978 (L. Kahl, pers. comm.); and 1.5% loss at Big Qualicum River in 1973 (Fraser et al, 1977 unpub.).

1,244 untagged fry (mostly wild fry) were released into the river at the same time.

1978 Egg Takes

Methods

Adults were stripped on the beach immediately after landing. Females were stunned by a blow to the head, then the tail was severed. They were allowed to bleed until dry, then wiped clean and slit open with eggs stripped into pans or directly into plastic bags to be quickly placed on ice in the Thermos jugs. The carcass was then length and scale (10) sampled.

Males were simply landed, wiped clean, and restrained to be milked of sperm by squeezing 2 or 3 streams into plastic bags which were quickly put into the Thermos jug. The fish was then immediately returned to the river, with no sampling performed.

Results

An estimated total of 21,262 eggs were planted in eighth separate egg takes from September 4 to 12 (Table 41). Using 1977 figures, where an estimated 18,293 eggs were planted but actual figures were 10% higher at 19,720, the actual figure for the 1978 plant is 22,900 eggs.

Females stripped in 1977 averaged 2,614 eggs apiece while those in 1978, taken later on in spawning off their redds, averaged just over 1,000 eggs per female (Table 42).

Table 41. Egg take summary, Birkenhead River Adult Chinook, fall 1978.

Date	Fish Used		30 cm ruler egg count 1	Volume planted(ml)	Est. no. of Eggs planted
	♂	♀			
Sept. 4	3	1	42	950	2,607
9	4	3	40	775	1,837
10	2	2	42	825	2,264
10	3	3	40	1,035	2,453
11	2	5	38	(2)	2,000
11	3	2	40	925	2,193
12	3	3	39	1,200	2,636
12	2	2	39	2,400	5,272
Totals	22	21		~ 9,000	21,262

1 eggs measured while soft.

(2) no volume determined before eggs planted in incubation box.

Table 42. Comparison of egg takes, Birkenhead site, Sept. 3-4, 1977 and Sept. 4-12, 1978.

	Fish Used		Egg Volume Planted	Estimated no. of eggs planted	eggs/1	eggs/♀
	♂	♀				
1977	5	7	7,500	18,293	2,439	2,614
1978	22	21	~9,000	21,262	2,362	1,013

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Appendix A. Monthly and annual mean discharges in cubic metres per second and cubic feet per second for the Lillooet, Birkenhead and Green Rivers.

	Lillooet River near Pemberton Station No. 08MG005 Drainage Area 2162 sq. km Period of Record 1914-1973		Birkenhead River at Mt. Currie Station No. 08MG008 Drainage Area 596 sq. km Period of Record 1945-1971		Green River near Pemberton Station No. 08MG003 Drainage Area 855 sq. km Period of Record 1913-1951	
	Mean CMS	(Mean CFS)	Mean CMS	(Mean CFS)	Mean CMS	(Mean CFS)
JAN	32.0	(1130)	7.8	(277)	14.7	(519)
FEB	30.6	(1080)	8.3	(293)	12.8	(451)
MAR	31.7	(1120)	7.4	(263)	13.9	(492)
APR	58.0	(2050)	13.3	(470)	31.4	(1110)
MAY	157.2	(5550)	42.2	(1490)	74.8	(2640)
JUNE	281.5	(9940)	70.8	(2500)	112.4	(3970)
JULY	317.2	(11200)	54.4	(1920)	107.9	(3810)
AUG	265.9	(9390)	25.2	(890)	75.6	(2670)
SEPT	159.4	(5630)	15.9	(561)	49.3	(1740)
OCT	98.8	(3490)	15.3	(539)	39.9	(1410)
NOV	55.5	(1960)	14.4	(508)	26.8	(946)
DEC	40.2	(1420)	11.2	(397)	20.0	(707)
YEAR	127.4	(4500)	23.9	(843)	47.9	(1690)

N.B. cubic metres per second calculated from cubic feet per second data.

SOURCE: Env. Canada Historical Streamflow Summary. British Columbia to 1973. Water Survey of Canada, Inland Waters Directorate, Water Resources Branch, Ottawa, 1974.

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Appendix B. Four year Average of Monthly Mean Water
Temperatures in the Birkenhead River
(1973 -1976).

<u>MONTH</u>	<u>AVERAGE TEMPERATURES (°C)</u>
January	1.6
February	2.2
March	3.4
April	5.2
May	6.4
June	7.4
July	9.7
August	11.2
September	10.3
October	7.4
November	3.8
December	3.1

SOURCE: International Pacific Salmon
Fisheries Commission thermograph data.
Daily maximum, minimum and mean temperatures
from 1965-1976 available in the Lillooet -
Birkenhead data file.

Thermograph located at kilometre 15 (Twin
Birdges) on the Birkenhead River.

APPENDIX C . Coho and sockeye escapements to the Upper Lillooet River and tributaries.
 (5 year averages 1940-1974 and yearly escapements 1965-1976)

5 Year Period	Fisheries Officer	Lillooet Mainstem		Green River		Pemberton (1 Mile) Cr.		Miller Cr.		Ryan Cr.		Salmon Slough		John Sandy Cr.		Railroad Cr.		25 Mile (Sampson) Cr.	
		Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye	Coho	Sockeye
1940-44	Winlow	4000	2450	545	430	80	0	350	605	395	255	320	(190)	25	20	50	19	790	3600
1945-49	Reynolds	5625	450	206	162	100	(1945)**	406	131	69	1044	599	(50)	6	8	0	0	850	575
1950-54	Reynolds	5140	750	100	25	25		70	20	875	75	315	(1950)**	0	0	NR	0	0	0
1955-59	Reynolds	115	17	80	20	19		25	25	30	(1950)**	115		5	0	20	0	12	0
1960-64	Reynolds	300	(1957)**	500	125	25		19	(1956)**	360		100		19	0	70	0	85	0
1965-69		425		400	110	40		30		440		330		56	0	139	0	69	0
1970-74		1250		1120	0	135		80		380		150		55	12	620	150	6	180

Yearly Escapements:

1965	Reynolds	75		400	200	25		25		400		200		75	0	200	0	200	0
1966	Reynolds	750		200	200	25		25		400		200		0	0	75	0	NR	NR
1967	Reynolds	300		500	100	50		50		250		200		50	0	100	0	0	0
1968	Reynolds	200		300	50	50		0		250		150		100	0	50	0	75	0
1969	Reynolds	800		600	0	50		50		900		900		0	0	270	0	0	0
1970	Wheeler	1500		1500	0	400		75		700		0		0	0	750	75	0	0
1971	Wheeler	2500		2500	0	200		150		400		400		150	50	1200	450	0	00
1972	Bentley	750		400	0	25		75		200		200		75	0	200	75	0	400*
1973	Bentley	750		400	0	25		75		200		75		25	0	200	75	NR	100*
1974	Bentley	750		400	0	25		25		400		75		25	0	750	75	25	400
1975	Bentley	3500		400	200	25		75		200		1500		25	225	400	200	25	200
1976	Bentley	400		300	0	25		25		100		50		0	0	50	100	50	300

Source: Fisheries Service Spawning Reports, District #2, Area 29.

NR - No Report

* From Int. Pacific Salmon Fisheries Commission Records

** Year of last recorded escapement

Appendix D. Juvenile Sampling Results on the Birkenhead River, 1975.

Date	Equip. used	Location	Species Caught	Number Caught	Remarks
Sept. 25	Dip Net	km 34	Trout	Present	
26	Dip Net	km 19	Trout	Present	
		km 19	Coho	3	
		km 25	Trout	Present	
		km 25	Coho	3	
Oct. 16	Dip Net	km 22	Trout	Present	
		km 22	Coho	7	
22	Electro Shocker	km 34	Trout	14	
23	Electro Shocker	km 25	Dolly Varden	2	Average length 210 mm.
		km 25	Rainbow Trout	33	Average length 48.9 mm.
		km 25	Coho	11	Average length 73.7 mm.

Appendix E. Gee's Minnow trapping results on the Birkenhead River, Sept. 7-17, 1976.

Date (Time) Set	Date (Time) Lifted	Location	Catch
Sept. 7 (PM)	Sept. 8 (AM)	Km 17 Hydro Br. (2 traps)	1 trout (8 cm)
Sept. 7 (PM)	Sept. 8 (AM)	Km 15 Hwy Br. (2 traps)	2 coho, 4 sculpin
Sept. 7 (PM)	Sept. 8 (AM)	Km 10 Logging Br. (2 traps)	5 coho, 1 trout (12 cm), 12 sculpi
Sept. 8 (AM)	Sept. 8 (PM)	North West end of Lillooet Lake (6 traps)	0
Sept. 8 (PM)	Sept. 9 (AM)	Km 1	2 chinook, 3 coho, 10 sculpin
Sept. 8 (PM)	Sept. 9 (AM)	Km 2	9 coho, 1 trout (12 cm), 2 sculpin
Sept. 8 (PM)	Sept. 9 (AM)	Km 3	0
Sept. 8 (PM)	Sept. 9 (AM)	Km 5	17 coho, 1 trout (6 cm), 15 sculpin
Sept. 8 (PM)	Sept. 9 (AM)	Km 6	1 trout (8 cm), 3 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	1 coho
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	5 coho, 1 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	2 coho
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	1 coho, 4 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	3 coho, 2 sculpin
Sept. 13 (PM)	Sept. 14 (AM)	Km 1 river mouth & Km 1 (12 traps)	1 chinook, 13 coho, 3 whitefish 59 sculpin
Sept. 14 (PM)	Sept. 14 (PM)	Taillefer Cr. at outflow of Birkenhead Lake (5 traps)	1 dolly varden, 2 rainbow trout

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APPENDIX F. GEE'S MINNOW TRAPPING RESULTS ON THE
BIRKENHEAD-LILLOOET SYSTEM JANUARY 19 & 20, 1977

<u>Date (Time) Set</u>	<u>Date (Time) Lifted</u>	<u>Location</u> ¹	<u>Catch</u>
Jan. 19 (PM)	Jan. 20 (AM)	Km 9 slough behind Mt. Currie Hard- ware (2)	74 Coho
Jan. 19 (PM)	Jan. 20 (AM)	Km 15, Twin Bridges (3)	3 Coho 1 Dolly Varden (~13 cm) 1 Trout (~8 cm)
Jan. 19 (PM)	Jan. 20 (AM)	Km 7 Indian Br. (2)	13 Coho
Jan. 19 (PM)	Jan. 20 (AM)	Km 7 side channel (2)	3 Coho 13 Sculpins
Jan. 19 (PM)	Jan. 20 (PM)	Km 0 Bridges at River Mouth (3)	1 Sculpin
Jan. 19 (PM)	Jan. 20 (PM)	Lillooet Lake Shore at Indian Net Site (2)	9 Coho
Jan. 19 (PM)	Jan. 20 (PM)	1 Km east of Lillooet Lake Head on North Shore (2)	0
Jan. 19 (PM)	Jan. 20 (PM)	3 Km east of Lillooet Lake Head on North Shore (2)	0
Jan. 19 (PM)	Jan. 20 (PM)	5 Km East of Lillooet Lake Head on North Shore (2)	1 Sculpin

1 no. of traps in brackets

Appendix G. Daily catch of salmonids taken in the Birkenhead River 2 x 3 inclined plane trap at km 15, March 17 - May 30, 1977.

Date	Chinook Fry	Coho Fry	Sockeye Fry	Coho Smolts
Mar. 15	trap installed			
17	264	177	13,216	2
18(1)	127	124	17,262	4
19	340	136	22,270	7
20	294	96	19,933	4
21	707	162	29,641	10
22	660	176	28,028	3
23	980	337	33,938	4
24	554	124	41,207	2
25	685	204	42,484	3
26	377	217	38,222	
27	387	155	36,580	1
28	325	239	32,276	2
Apr. 2(1)	52	52	20,558	1
3	73	12	22,911	1
4	15	86	40,280	1
5	258	258	75,078	3
6	1,535	889	109,338	3
7	2,992	986	114,036	7
8(2)	4,376	946	81,695	12
11	324	194	28,350	9
12	555	337	55,853	12
13	898	448	43,700	3
14	1,001	356	49,484	3
15	441	252	49,644	5
16	509	436	58,691	3
17	214	214	59,813	1
18	241	588	60,241	
19	170	218	56,939	5
20	161	299	54,464	
26(2)				8
27(3)	158	123		5
28	100	15		
29	54	48		
May 2	11	65		2
3	20	94		2
6	40	333		3
7	20	144		2
10(3)	78	449		13
11	82	305		8
14	49	527		8
15(3)	45	564		9
19	47	777		8
20	59	958		8

cont'd

Appendix G. Cont'd

Date	Chinook Fry	Coho Fry	Sockeye Fry	Coho Smolts
May 25	22	383		9
28	14	443		4
30	9	143		
31	trap removed			
	<hr/>	<hr/>		<hr/>
	20,323	14,089		200

- (1) Cup sample counts: March 18-28; April 2-20, 28.
 Visual estimate of all species: April 8.
 Visual estimate of chinook : April 4.
 Individual counts: all other days.
- (2) trap sunk and full of debris: April 8-10, 21-26.
- (3) Crew stayed at trapsite cleaning and counting every few hours
 overnite: April 27-29; May 1, 2, 10-11, 15, 19, 20, 25, 28, 30, 31.

Appendix H. Daily catch of salmonids taken in the Lillooet River 4 x 4 inclined plane trap at 3 sites, March 31 - August 29, 1977.

Date	Fry			Smolts		
	Chinook	coho	sockeye	chinook	coho	sockeye
Lillooet River (mi. ^{25.5} 22.5 <i>25.5</i>)						
Mar. 30	trap installed					
31	1	5	601			
Apr. 1		1	495			
4	7		565			
5	19	1	646			1
6	6	5	733	1		1
12	21	11	307	4		6
13	53	17	205	4		4
14	26	20	148	1		3
15	21	13	193	5		13
16	27	17	147	5		14
17	43	21	106			10
18	40	28	86	1		20
19	8	18	152	6	1	5
20	5	6	107	2		10
25			1			
27				2		2
28	trap removed					
Outlet Lillooet Lake						
Apr. 29	trap installed					
			1			
May 2			2			
3	2		1			
4			1			
5			1			
11			13			
12		1	9			
13		1	1			
14		1	3			
15			7			
16			2			
17			2			
20			1			
21		10				
22		7	1			
23		2				
24			1			
25			5			
26		1				
29			1			
June 1		1	2			
	trap moved downstream					

cont'd.

Appendix H. Cont'd

Date	Fry			Smolts		
	Chinook	Coho	Sockeye	Chinook	Coho	Sockeye
Lillooet River (.4 km below lake outlet)						
June	1	trap installed	1			
	2	3	5	1	3	
	3	1	6		8	
	4		3		7	
	5		3	4	9	
	6		1	2	6	
	10				5	
	12		1		2	
	13		1		2	
	14				1	
	15	1		1	4	
	16	1		5	4	1
	17		1	11	1	
	18	6	1	10	3	
	19			14		
	20			28		
	21	1	1	29	2	1
	22	8	2	18	2	2
	23	13		1		
	24	20		1		
	25	18		1		
	26	12		2		
	27	28		3		
	28	16	2	30		
	29	25	4	16		
	30	15		48		
July	1	17	1	103	3	
	2	12	6	55		
	3	17	3	42		
	4	5	11	28		
	5	3		28		
	8		1	16		
	9	1		66		
	10		1	79		
	11	7		541		
	12	5	3	276		
	15	1	1	798		
	16	2	1	908		
	17		1	321		
	21			267		
	22			34		
	23			546		
	24			196	2	
	25	2		423		
	26			189		

cont'd.

Appendix H. Cont'd

Date	Fry			Smolts		
	Chinook	Coho	Sockeye	Chinook	Coho	Sockeye
July 29			121		1	
30			478		1	
31			123		1	
Aug. 27		7	97			
29		12	66			
Sept 6		19	32			
	trap removed.					

APPENDIX I. Dyed mark release data for the Birkenhead River 2 x 3 downstream trap at km 15 (Twin Bridges) April 2 - May 13, 1977.

Date/time of release	No Released		No. Recovered		% Recovery	
	Chin	Coho	Chin	Coho	Chinook	Coho
Apr 2 ¹ 2200 hr.	52	52	74	12	142.3	23.1
Apr 19 2200 hr.	305	133	31	4	10.2	3.0
May 5 ²	58	163	1	3	1.7	1.8
May 13 2200 hr.	150	200	(3)	(3)	2	2

1 Figures based on a sample cup count.

2 Time of release not recorded

(3) Actual figures not recorded

APPENDIX J. .Gee's Minnow trapping results in the Birkenhead River
area, March 21 - May 30, 1977

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
<u>Sloughs:</u>				
3	Mar 21	Mar 22	km 9 slough behind Mt. Currie Hardware Store	50 coho
1	Mar 24	25	km 9 slough	60 coho 1 sucker
1			km 9 ditch beside Warbonnet Surplus Store Mt. Currie	16 coho
1	Mar 25	26	km 9 drainage ditch along Mt. Currie to Lillooet Lk. road	23 coho
1			km 9 Warbonnet ditch	trap lifted
1	Mar 26	27	km 9 drainage ditch	30 coho
1			km 9 Warbonnet	13 coho
1	27	28	km 9 drainage ditch	26 coho
1			km 9 Warbonnet	trap stolen
Few	May 5	6	km 9 drainage ditch	30 coho
Few	May 6	7	km 9 Warbonnet ditch	1 coho
<u>Birkenhead River:</u>				
Several	Apr 2	3	km 31 Taillefer Creek	∅
Several	Apr 8	9	km 13 Owl Crk. mouth	1 coho
3	14	15	km 20 side channel	no data
Several	15	16	" " " "	36 coho
Several	May 4	5	" " " "	23 coho
Few	5	6	km 0 bridge at mouth	57 coho
Few	6	7	km 20 side channel	8 coho
Few	9	10	km 13 Owl Crk. mouth km 15 Twin Bridges	∅ 12 coho 1 rainbow trout
Few	14	15	km 20 side channel km 15 Twin Bridges	8 Coho, 2 chiri 8 Coho, 2 chiri
Few	15	16	Birkenhead Lk. campsite	∅
2	24	25	km 15 Twin Bridges	27 coho, 1 rainbow trout

cont'd.

APPENDIX J. (con't)

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
1	27	28	km 15 Twin Bridges	4 coho, 2 sculpin
Several	30	31	km 15 Twin Bridges	23 coho
<u>Poole Creek</u>				
1	Mar 24	25	Km 25 Poole Creek	27 coho
1	25	26	km 25 Poole Creek	14 coho
1	26	27	km 25 Poole Creek	27 coho
1	27	28	km 25 Poole Creek	.2 coho
2	May 6	7	km 25 Poole Creek	∅
Few	9	10	km 25 Poole Creek	1 coho
2	24	25	km 25 Poole Creek	∅

APPENDIX K. Gee's minnow trapping results in the Upper Lillooet River area, March 24 - May 25, 1977.

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
<u>Sloughs</u>				
1	Mar 24	Mar 25	Canal beside Pemberton Secondary School 1.5 km North of Pemberton	∅
1	Mar 25	26	Salmon Slough 15 km North of Pemberton beside Upper Lillooet River	7 coho
1	26	27	Salmon Slough	17 coho
1	27	28	Salmon Slough	21 coho 1 cutthroat trout
Few	Apr 3	4	Ryan Crk 12.5 km north of Pem; Oxbow Lk and pond just north 20 km north of Pem.	
Few	3	4	Slough between Lillooet R. bridge and Pem. farm road 2.5 km East of Pem.	few coho, lot of rainbow trout and sculpin
Few	4	5	Samson Crk 30 km North-west of Pem.	6 chinook, 11 shiner
2	Apr 30	May 1	Ryan Crk tributary to Lillooet R. 12.5 km north of Pem.	2 coho, 10 coarse fish
1			field slough 7.5km north of Pem. off of Upper Lillooet Valley Road	No Data
3			Erikson Road ditch 8 km north of Pem. on Upper Lillooet Valley Road	33 coho, 54 coarse fish, 2 rainbow trout
1	May 1	2	Field slough 7.5 km north of Pem.	∅
1			Rutland Manor drain canal 2 km east of Pem toward Mt. Currie	6 coho
1			One-mile crk 2km south of Pem. toward Squamish	∅

cont'd.

APPENDIX K. (con't)

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
1	May 2	3	Erikson road ditch	16 coho, 6 coarse fish
Few	4	5	Salmon Slough	11 coho, 3 rainbow trout
Few	9	10	Erikson road ditch	6 coho, 1 coarse fish
Few	13	14	Samson Slough	27 coho
1	24	25	Erikson road ditch	no data
<u>Lillooet River</u>				
Few	Apr 4	5	Wilson road bridge 15km north of Pem.	7 coho
Few	5	6	" " "	no data
Few	7	8	" " "	few cutthroat Trout
Few	14	15	3km north of bridge on Pem to Mt. Currie road	no data
Few	16	17	Side channel creek 30km north of Hurley Bridge	6 coho
			Side channel Creek 23km north of Hurley bridge	21 coho, 1 dolly varden 1 sculpin.
7	May 8	May 9	at 2,6,11,16.5,22, 23.5, and 28 km from turnoff to Hurley railway pass (17.5km north of Pem.)	32 coho 1 dolly varden 17 sculpin
1	13	14	at 2 km west of Hurley bridge	1 coho
1			Wilson road bridge	Trap lifted

APPENDIX L. Gee's minnow trapping results in the Lower Lillooet River area April 1 - July 15, 1977.

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
<u>Sloughs</u>				
2	Apr 4	5	Mi 27 Slough Lillooet River Road	31 coho
3			Mi 29 Beaver Pond	∅
3	Apr 19	20	Mi 2 Slough Lillooet River Road	49 coho, 5 trout
1			Mi 5 Spring Creek	4 coho
5	May 2	3	Mi 31.5 Lillooet River Backwater	38 coho, 2 trout 38 sculpin
4	13	14	Mi 38 Tenas L. east side slough	73 coho, 9 chin 28 sculpin
<u>Lake and River</u>				
2	Apr 1	2	Outlet Lillooet Lake West side	1 chin, 4 sculpin
3			Tenas L. West side	2 chin, 8 sculpin
3	14	15	Tenas L. West side	1 chin, 3 sculpin
2			Outlet Lillooet Lake West side	1 chin, 2 sculpin 1 dolly varden
3	26	27	Outlet Lillooet Lake West side	1 coho, 9 sculpin
2			Tenas L. West side	4 coho, 7 sculpin
5	27	28	Outlet Lillooet Lake East side	1 coho, 29 sculpin 1 trout
3	May 13	14	Tenas L. West side	14 sculpin
2			Outlet Lillooet Lake West Side	12 sculpin
5	16	17	Lillooet L. 2km north of outlet west side	38 sculpin
5	17	18	Lillooet L. 2 km north of outlet east side	24 sculpin
2	July 3	3	Tenas Lake west side	∅
1			Tenas Lake east side	1 sculpin
1			.4km below outlet Lillooet L. east side	1 sculpin

cont'd.

<u>No. of Traps</u>	<u>Date Set</u>	<u>Date Lifted</u>	<u>Location</u>	<u>Catch</u>
1	July 4	4	Outlet Lillooet L. west side	5 sculpin
1			Tenas Lake west side	Ø
1			Tenas Lake east side	4 sculpin
1			.4km below outlet Lillooet L. east side	5 sculpin
4	July 15	15	Lillooet L. east side 13.3 km north of outlet	1 peamouth chul

APPENDIX M. Seine netting results Birkenhead River June 7 - July 26, 1977.

<u>Date</u>	<u>Location</u>	<u>Gear</u>	<u>No. of Sets</u>	<u>Catch</u>
June 7	km15 Twin Bridges	25' marquisette	2	1 coho fry, 1 lamprey
10	farm pond R. Fach residence 5 km east of Pemberton	25'	8	136 coho smolts
July 5 ¹	km 15 Twin Bridges	25'	2	11 chinook fry, 9 coho fry, 4 coho smolt
	km10 log bridge	25'	5	7 chinook fry, 4 rainbow trout, 2 whitefish
6	km 10	50' nylon	2	11 chinook fry, 7 rainbow trout, 7 white fish
	km 15	25'	1	9 chinook fry, 14 coho fry, 4 coho smolts
12	km 10	50'	1	6 chinook fry, 1 coho fry, 3 rainbow trout, 11 whitefish, 3 sculpin
	km 15	25'	2	2 chinook fry, 2 coho fry
13	km 10	50'	1	6 chinook fry, 1 coho fry, 9 whitefish, 2 sculpin
	km 15 ²	25'	1	7 chinook fry, 13 coho fry
26	km 10	50'	1	2 chinook fry, 6 coho fry, 7 whitefish, 3 rainbow trout
	km 15	25'	1	7 chinook fry, 20 coho fry, 1 coho smolt, 3 rainbow trout

1. higher number of sets here reflect unfamiliarity, experimentation.
 2. higher catch here reflects protective breakwater built upstream of netting site on previous night.

APPENDIX N. Beach seine catches of salmon juveniles. Lillooet and Tenas Lakes May 3 - July 11, 1977.

Date	Location ²	Chinook Smolt	Chinook Fry	Coho Fry ¹	Sockeye Smolt	Sockeye Fry
May 3-15	Tenas Lake North End (6)	1	176	2	5	40
26	Lillooet Lake (2)	243	11	-	144	-
June 4-13	" (7)	116	188	32	4	2
16-23	" (6)	-	290	76	8	54
23	Tenas L. North End (3)	2	218	-	4	2
July 11	Outlet Lillooet Lake (1)	-	3	1	-	-
June 25	Upper Lillooet Lake (2) (4km s/Birk. mouth)	5	6	1	10	10
July 8	" (2)	-	6	7	-	-
July 8-15	Mid-Lillooet L. 9.3 to 13.3km (4) north of outlet	-	23	5	-	1
May 26	" (1)	-	6	1	-	1

1 almost no coho smolts caught so not included in totals

2 No. of seine sets in brackets

APPENDIX O. Shore trap catches at the outlet of Lillooet Lake,
west side, June 22-30, 1977.

Date	Comments	Time checked	Catch
June 22	installed 1900 hr.	2230 hr 2400 hr	1 chin fry, 1 coho fry 1 coho fry, 1 sculpin
23		0700 hr	∅
24		0800 hr	-
25		0800 hr	-
29	reset with 50' seine extension	2330 hr	5 coho fry, 1 coho smolt 9 sockeye fry, 3 sculpin
30	washed out by high water, not reset		

APPENDIX P. Mean fork lengths of various species of Lillooet Lake
fish taken in 1" (25mm) to 5" (227mm) gill nets
April 12 - July 16, 1977.

Net size	Species	No. Measured	MFL (mm)	Range (mm)
1"	Chinook	1	110	
2"	Cutthroat	47	234.5	175-325
	Dolly	39	208.1	200-330
	Peamouth Chub	14		184-263
	Squawfish	12	227.5	200-250
	Whitefish	4	230.0	206-250
	Rainbow	4	233.3	225-249
	Sucker	1	270.0	
3"	Dolly	51	359.4	275-525
	Cutthroat	18	312.2	210-450
	Sucker	4	319.0	300-338
	Squawfish	3	347.3	317-382
	Whitefish	2	297.5	290-305
4"	Dolly	4	526.5	425-700
	Cutthroat	2	254.5	250-259
5"	Cutthroat	1	306.0	

Appendix Q. Age Composition and Mean 1st Year Circuli Counts of Sampled Chinook on the Birkenhead River in 1975 and 1976 (Includes Readable Scales Only).

A G E

		2			3			4			5			Totals (Across)	
		No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	#	%
Sub 1	1975	0	0		15	23	14.3	19	30	18.5	0	0		34	53
	1976	1	2	18	14	33	20.4	17	40	18.2	1	2	18	33	77
Sub 2	1975				2	3	15.0	20	31	17.6	8	13	18.6	30	47
	1976							4	9	19.8	6	14	18.2	10	23
Totals (down)	1975	#	%		#	%		#	%		#	%		64	100
	1976	1	2		14	33		21	49		7	16		43	100

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Appendix R. Survival of Birkenhead River penned adult chinook in km 10
log bridge pool, July 28 - Sept. 3, 1977¹

Date Caught	Lgth. of Transport ⁵	Hook	Time Caught ²	Tethered	Mis-handling	Weather	Survival in days ³
Females:							
Aug 9	avg.	out	AM	-	-	hot	20
13	avg.	out	Mid	-	-	hot	19 3/4
13	avg.	in	PM	.3 hr	-	hot	19 1/2
Aug 8	avg.	out	PM	-	-	cool	16 1/2
July 28	avg.	in	AM	-	-	cool	15
Aug 20	avg.	out	AM	-	-	hot	15 ⁴
Aug 21	avg.	out	Mid	.25 hr	-	cool	14 ⁴
Aug 21	avg.	out	AM	-	out of water	cool	13
Aug 20	avg.	out	PM	-	-	cool	12 1/2
5	long	in	AM	-	-	cool	10 1/2
Aug 9	avg.	out	PM	.25 hr	-	cool	9 2/3
Aug 9	avg.	out	Mid	.5 hr	-	hot	7 5/6
6	avg.	in	AM	-	-	cool	5 1/2
Males:							
Aug 16	avg.	in	PM	-	-	hot	12 3/4
16	avg.	in	PM	-	-	hot	12 2/3
13	avg.	in	AM	1/2 hr	-	cool	11 5/6
16	avg.	out	AM	-	dropped	cool	11
16	avg.	in	Mid	1 hr	-	hot	10 5/6
21	avg.	out	PM	-	-	cool	9 2/3
16	avg.	in	AM	-	-	cool	9

1 no escapes^e or egg take fish included

2 AM - dawn to 10 A.M.; Mid = 10 A.M. to 2 P.M.; PM = 2 P.M. to Dark

3 only fish surviving > 24 hours incl.

4 released Sept. 4

5 short = < 12 min; avg. = 12-15 min., long = > 15 min.

Appendix S. Withler method of sperm taking for chilled storage (pers. comm. with Ted Perry, August, 1977).

to collect:

- kill fish with whack on tip of snout ($\frac{1}{2}$ -1" from the tip) rather than back of head to prevent internal bleeding.
- wipe scales very clean (tacky) → blood, mucous, water will reduce storage efficiency.
- waste "watery" fluid - inject remainder in erlenmeyer or other suitable flask - seal - store at 1-4°C - make sure about 50% air in container (i.e. 1:1 air to seminal fluid).

to use:

- after storage acclimate sperm by putting container in water of temperature at which fertilization will be carried out (optimum temp. about 10°C).
- pour sperm on eggs dry-mix-add diluting water afterwards, if at all. (sperm dies rapidly when exposed to water).

to check:

- place drop of sperm on slide - coverslip - mount at 200x
- drop water at edge of coverslip - sperm will become active at water-seminal fluid interface (will expire in 15-20 sec.)

modifications:

- 1) Smith & Quistorff, 1943: males killed by hooking, to exhaustion
 - leave sperm in as males not stripped for 2.5 and 5 hour period gave hatching mortalities only 5.5% and 7.1%, respectively (control = 6.1%)
 - males stripped, sperm stored, gave hatching mortalities of 9.5% and 45.9% after 2.5 and 5 hours storage, respectively.

2) Poon & Johnson, 1970 : to dilute sperm with water or not?

- eggs & sperm both stored at 6°C: sperm with water added just before mixing: diluted sperm fertilized 90% up to 21 hours; undiluted sperm up to 12 hours (pink salmon).

McNeil and Bailey, 1975: milt should be mixed with water as dilution activates sperm, increases rate of fertility.

- mix at least 1:1 but not over 3:1 (water:milt)

3) - stored milt should be protected from light.

- handle females gently, do not shake eggs out too vigorously, don't intermix sperm and ova too roughly as broken eggshells interfere with fertilization.
-

Appendix T. Sperm and ova fertility experiments under varying conditions, from literature cited.

Authors, conditions	Species	Temp.	Fert. Sperm	Ova
Rutter, 1902; open jar	chinook	24.4°C	74% to 24 hr	
		"	0% after 48 hr	
open jar	chinook	"	100%	after 12 min.
			99%	after 30 min.
			76%	after 50 min.
Smith & Quistorff, 1943 open jar (controls=93.9% fert.)	chinook	6.1-70°C	91.5% 2.5 hr	
		"	54.1% 5 hr	
			(up to & incl. hatching)	
fully sealed vial	chinook	"	90% 5 hr	
♂ killed, sperm not stripped immed.	chinook	?	94.5% 2.5 hr after death	
			92.9% 5 hr after death	
Barrett, 1951 (air:milt=10:1) closed container	chum	2.5-5.8°C	90% to 1.2 days	
	chum	"	75% to 1.8 days	
	chum	"	50% to 4.5 days	
(800 eggs: pint of air)	chum	2.5-5.8°C	90%	to 2.75 days
	chum	"	75%	to 4.5 days
closed container			50%	to 6.4 days
Foerster, 1965 50:1 - water: sperm in air	sockeye	?	91.5% after 1½ hr	
			10.9% after 8 hr	
	sockeye	"	90% after 25 hr	
			4.4% after 72 hr	
300-1,000 ova: 250cc water in air	sockeye	?	46.8%	after 2 min.
			3.6%	after 12 min.
	sockeye	"	80%	up to 96 hr
Withler & Humphreys, 1967 air:milt= 9:1 closed container	sockeye	8-9°C	90% up to 18 hr	
	sockeye	"	75% up to 25 hr	
		"	50% up to 30 hr	
air:ova = 32:1 closed container	sockeye	"	90%	up to 25 hr
		"	75%	up to 46 hr
		"	50%	up to 68 hr
Withler & Humphreys, 1967 (air:milt = 9:1) closed container	pink	8-9°C	90% up to 38 hr	
			75% up to 52 hr	
			50% up to 65 hr	
(air:ova = 32:1)	pink	8-9°C	90%	up to 7 hr
			75%	up to 31 hr
			50%	up to 55 hr

cont'd.

Appendix T. Con't

Authors, conditions	Species	Temp.	Fert %	Sperm	Ova
Withler & Morley, 1968 (air:milt = 9:1) Closed container "	Sockeye	1.7-3.7°C	90%	up to 110 hr	
		$\bar{x}=2.9^{\circ}\text{C}$	75%	up to 142 hr	
			50%	up to 182 hr	
(air:ova - 8:1)	Sockeye	"	90%		up to 85 hr
			75%		up to 185 hr
			50%		up to 240 hr
(air:milt - 9:1)	Pink	2.6-3.7°C	90%	up to 68 hr	
		$\bar{x} = 3.2^{\circ}\text{C}$	75%	up to 125 hr	
			50%	up to 158 hr	
(air:ova = 8:1)	Pink		80%		to 38 hr
			75%		to 77 hr
			50%		to 105 hr

Appendix U . Summary of length and weight sampling of wild and Incubation box chinook fry, Birkenhead site, April 21 - July 20, 1978.

<u>Box Fry</u>					
Date	No. Sampled	Mean Length(mm)	Mean wt.(mg)	Cond. Coeff (Q) ¹	
April 21	60	39.5	459.7	1.16	
22	59	39.5	445.3	1.13	
23	60	39.3	450.2	1.15	
26	30	38.7	550.5	1.42	
27	30	39.4	454.7	1.15	
29 ²	10	39.6	480.0	1.21	
May 8	35	-	631.4	-	
18	53	-	768.3	-	
28	48	-	916.7	-	
June 1	45	-	997.8	-	
9	15	-	1466.7	-	
17	26	-	1432.7	-	
18	25	-	1401.6	-	
22	24	-	1458.3	-	
July 4	n/a	-	2060.0	-	
6	29	-	2243.1	-	
10 ³	14	-	2300.0	-	
20 ⁴	100	61.8	2456.0	0.40	

<u>Wild Fry</u>					
April 21 ⁵	30	39.9	511.3	1.28	
22 ⁶	24	39.2	434.6	1.11	
26	30	40.0	582.4	1.46	
27 ²	30	39.6	520.7	1.31	
June 1	45	-	982.0	-	
9	12	-	1000.	-	
17	22	-	1,140	-	
July 4(3)	n/a	-	1410	-	

1 Condition coefficient derived using $Q = \frac{W(10^5)}{L^3}$ where W= weight in grams and L= length in millimetres.
 2 All April fry individually weighed on Ohaus balance beam scale.
 3 June-July 10 fry bulk sampled on Ohaus scale with no length determinations made.
 4 Fry individually weighed on Mettler electric balance.
 5 Wild fry caught randomly from rearing tank.
 6 Wild fry from 2 x 3 downstream trap.

LILLOOET - BIRKENHEAD RIVER SYSTEM

Review of Fisheries Information
and Report on
Reconnaissance Surveys

- KEITH SIMPSON -

5th fl.
6592

Environment Canada
Fisheries and Marine Service
Pacific Region
Southern Operations Branch
Fraser River West Coast Division

February 1977

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LILLOOET - BIRKENHEAD SYSTEM

Review of Fisheries Information &
Report on Reconnaissance Surveys
February 1977

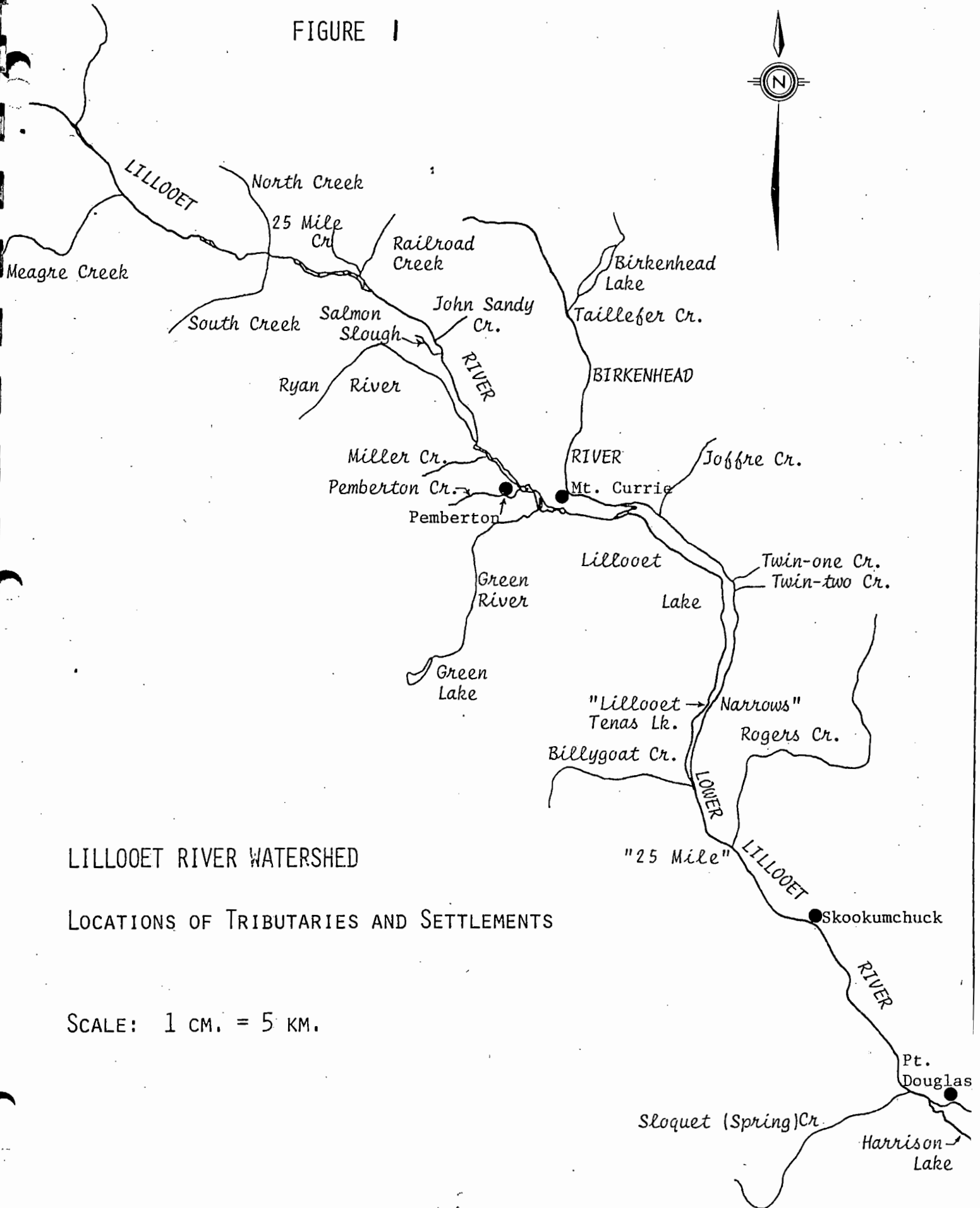
INTRODUCTION

The Lillooet River has its source approximately 160 km north of Vancouver at the Lillooet Ice Cap. It flows southeast for 90 kilometers through^{arch} Lillooet Lake, then onto Harrison Lake, 55 km to the southeast,¹ (see Fig. 1). The Birkenhead River is the major tributary of the system and has been one of the proposed sites of an enhancement project to rehabilitate runs of chinook salmon. Several surveys have been carried out on the Birkenhead in 1975 and 1976. The Birkenhead watershed has an area of 596 ~~sq~~ square kilometers and is located approximately 5 kilometers from Pemberton (Fig. 2 and B.C. Topographical Sheets 92G and 92J). The Lillooet River is extremely turbid during all months of the year and carries a heavy silt load into Lillooet Lake. Visibility remains poor in Lillooet Lake and the lower Lillooet River (Fig. 3). In contrast, the Birkenhead River is clear for most of the year (Fig. 4). Flow records indicate that maximum discharges occur in June on the Birkenhead and in July on the upper Lillooet (Appendix A). This run-off regularly raises the level of Lillooet Lake over 2 metres and inundates the Joffre Cr. Rd. at the Birkenhead River bridges. The minimum flow usually occurs in February for the Lillooet River, while the Birkenhead low flow normally occurs in March. Temperature fluctuations in the Birkenhead follow a normal pattern based on Int. Pacific Salmon Fisheries Commission Data (Appendix B).

Elevations in the watershed vary from 2280 metres in

¹This report covers the Lillooet watershed down to Harrison Lake. The Harrison drainage will be covered in a separate report.

FIGURE 1



LILLOOET RIVER WATERSHED

LOCATIONS OF TRIBUTARIES AND SETTLEMENTS

SCALE: 1 CM. = 5 KM.

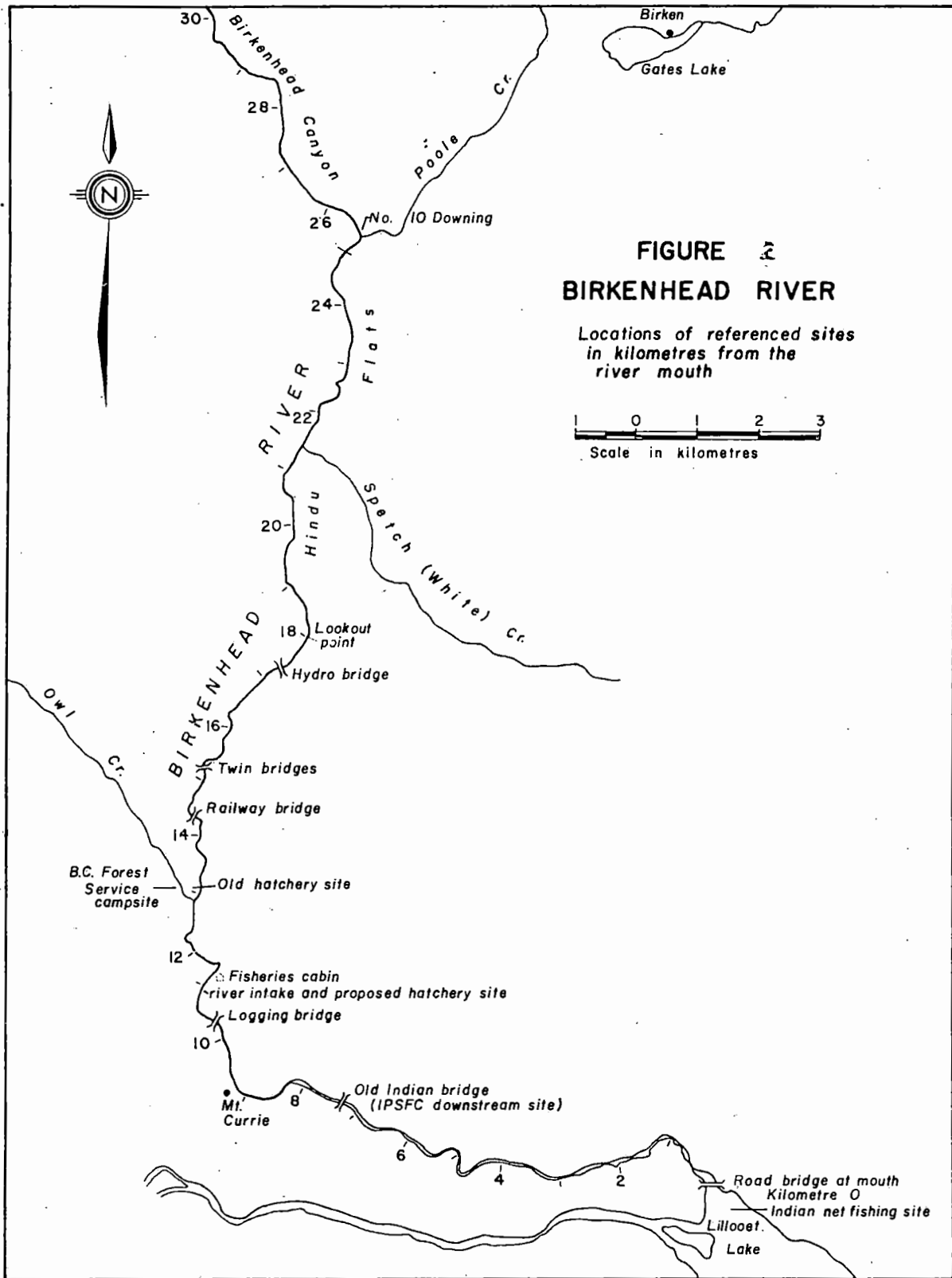
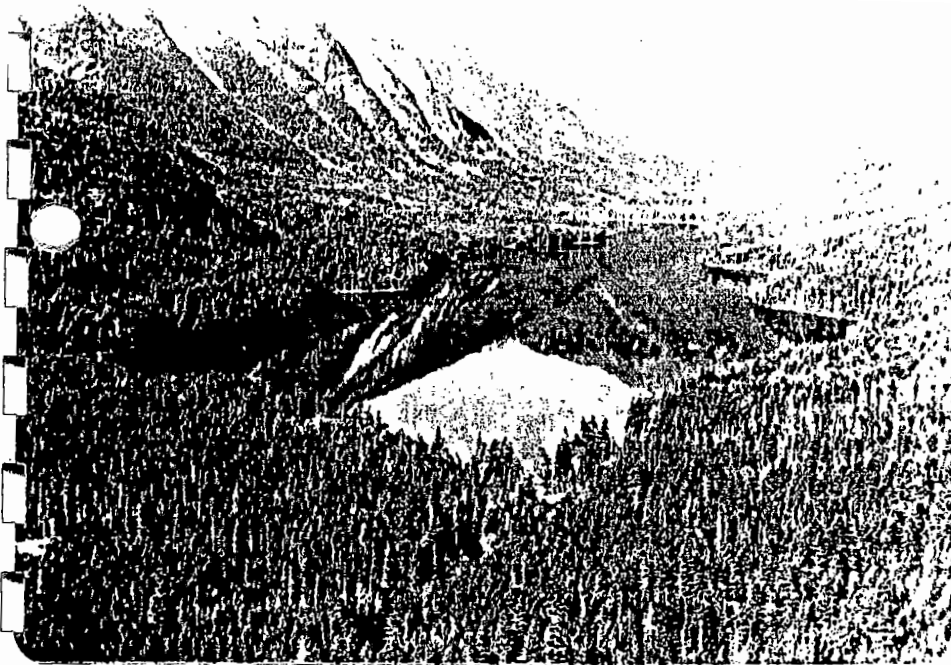


FIGURE 2
BIRKENHEAD RIVER

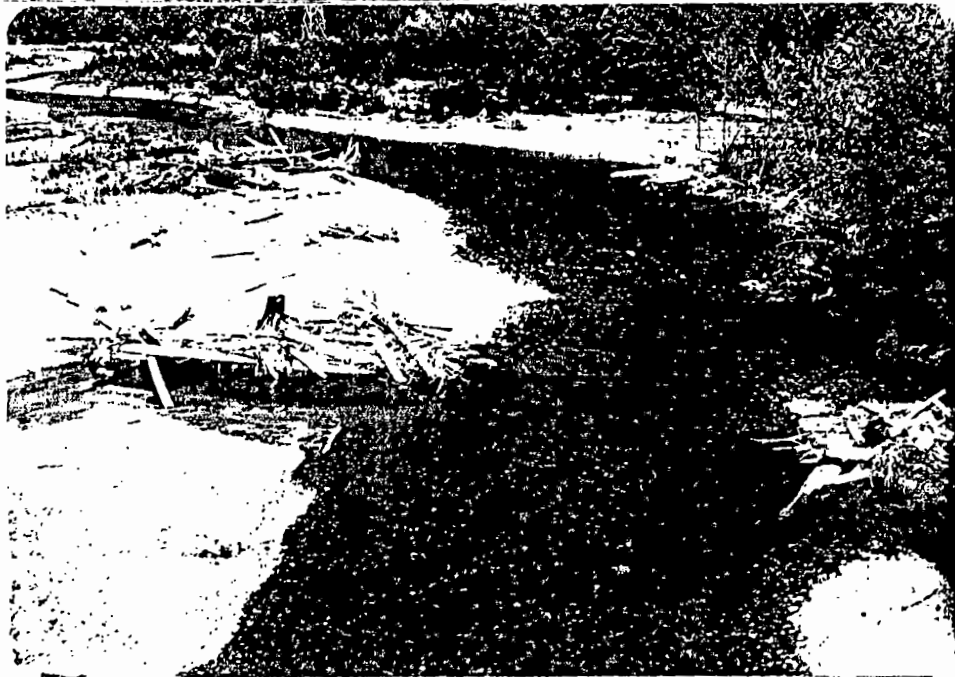
Locations of referenced sites
in kilometres from the
river mouth

0 1 2 3
Scale in kilometres

Birkenhead Lake.
Looking north east. Out-
let stream (Taillefer
Creek) in the foreground.



Birkenhead
River spawning
grounds, "Hindu Flats"
area.



Chinook and
Sockeye salmon spawning
in the "Hindu Flats"
area, Birkenhead River
Sept. 1975.

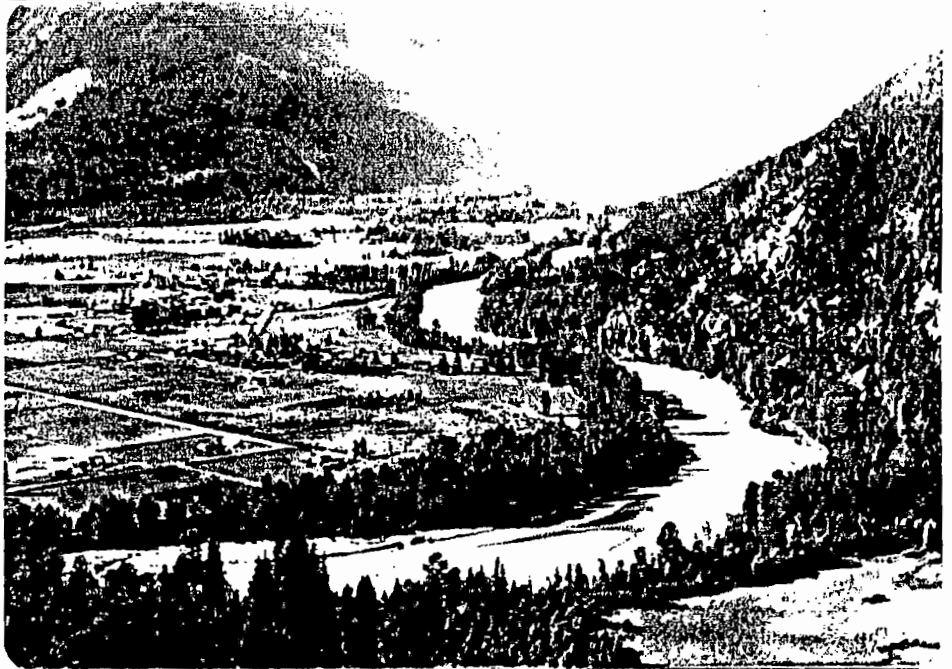


FIGURE 4



Typical section of the Upper Lillooet River. Note murky colour and many channelled flood plain.

Lillooet River near Pemberton. The river has a very narrow channel compared to upper areas due to the extensive dyking.



Looking south over Lillooet Lake at the mouths of the Birkenhead (foreground) and Lillooet Rivers. The Joffre Creek Road crosses the Birkenhead at this point.

FIGURE 3

headwater areas to 10 metres at the outflow on Harrison Lake. Average temperatures at Pemberton vary from -6°C in January to 19°C in July, while avg. ppt. varies from 2.67 cm in July to 17.22 cm in November. (Atmospheric Env. Serv., Env. Canada). The largest snowfall usually occurs in December (~ 95 cm) and there is usually 1 - 1.5 metres of standing snow from January to March.

Vegetation zones within the watershed vary from Coastal Western Hemlock through the upper and lower Lillooet, to Interior Douglas fir in the Birkenhead River valley. Higher elevations give way to Sub-alpine Spruce and Alpine communities.

Highway 99 from Squamish is the main access route to Pemberton and Mt. Currie, the major settlements in the area. Active logging in the Pemberton area is responsible for the construction of the many access roads in the watershed. Two roads, one on either bank of the Upper Lillooet, extend approximately 45 kilometres west of Pemberton at present and plans are being made to extend the right bank road into the Meagre Creek drainage in 1977. The Birkenhead River is accessible from the road joining Mt. Currie and D'arcy. There is a good gravel road from Mt. Currie which follows the east shore of Lillooet Lake and the Lower Lillooet River to Pt. Douglas on Harrison Lake. This road closely parallels the lower Birkenhead River and Lillooet Lake providing easy access at many locations. There is also a logging road extending up the west bank of the Lower Lillooet from Harrison Lake to Lillooet Lake. Other methods of access include aircraft, boats and the B.C. Railway, which follows the Green and Birkenhead River valleys.

Lillooet River and Lake are most easily surveyed using jet powered shallow draft boats. The lower Birkenhead (up to km 8) and the Lillooet River from Lillooet Lake to Pemberton have been travelled using a 16 ft. smoker craft with a 65 h.p. jet outboard. The Upper Lillooet was felt to be accessible up to the confluence of Meagre Creek by boat, while all of the Lower Lillooet is probably accessible provided the craft has sufficient power to negotiate the faster flowing areas. Launching sites are scarce, however, the Forest Service has a gravel ramp at the head of Lillooet Lake, near the Indian net fishing site (Fig. 2) and a good concrete ramp at their Twin One Creek campsite about 8 km down the lake.

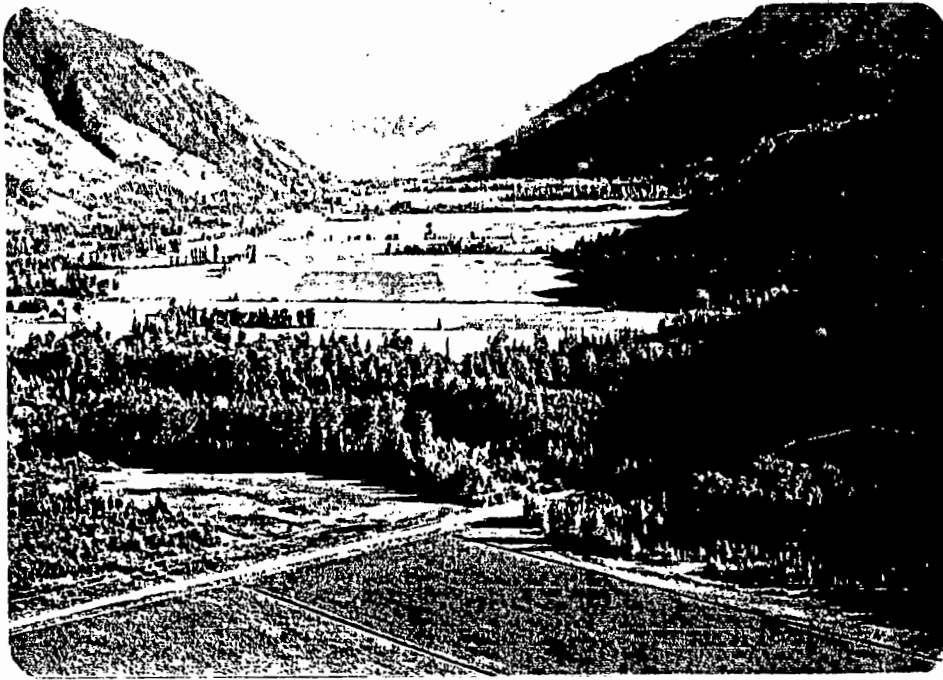


Fig. 5. Farmland in the Lillooet River Valley.
Looking east toward Pemberton.



Fig. 6. Logged area in the Headwater Valley of
the Birkenhead River. West of Birkenhead Lake.



Fig. 7 Falls on the Upper Lillooet River. Estimated height 15 metres. The stream-bed downstream is similar, as far as Meagre Creek.



Fig. 8 Rock Falls at the Lower end of the Birkenhead Canyon (km 26). Total drop is approximately 2 metres but note passable chute to the left.

The major activities in the watershed are farming and logging. Farming is confined to the Lillooet River valley (Fig. 5) while logging is carried out in all parts of the watershed and is still increasing (Fig. 6).

FISHERIES RESOURCE

The Lillooet River system supports populations of chinook salmon (Oncorhynchus tshawytscha), sockeye salmon (O. nerka), coho salmon (O. kisutch), steelhead (Salmo gairdneri) and sea-run cutthroat (S. clarki clarki), as well as resident rainbow trout (S. gairdneri), cutthroat trout, (S. clarki, clarki), Dolley Varden char (Salvelinus malma), Rocky Mountain whitefish (Prosopium williamsovi), kokanee (O. nerka) and sturgeon (Acipenser transmontanus).

Escapements of chinook salmon to the Birkenhead River have shown a substantial decline in recent years, while sockeye and coho have maintained stable populations (Table I). Salmon escapements to the Lillooet River show large fluctuations between years, Coho are known to spawn in many small unnamed tributaries of the Upper Lillooet, for which there are no spawning reports, (T. Richardson, pers. comm.). Although there are only a few coho found in each stream, the large numbers of such streams and the lack of information on mainstem spawning probably make the total escapement estimates very low. (~~Table I~~).

The Lillooet River is accessible to anadromous fish up to a falls approximately 16 kilometres above Meagre Creek (Fig. 7). No information is available for spawning distributions in the Lillooet River due to the turbidity. Tributary spawning is limited by the steep valley walls to that portion of the streams remaining on the valley floor (usually less than 3 km). Recovery of a female chinook salmon above Birkenhead Lake in September 1975 confirmed that the Birkenhead River is passable to the lake. The normal limit of migration is Kilometre 25 where rock falls and fast water in the canyon area make further ascent difficult (Fig. 8). The preferred spawning area for Birkenhead chinook and coho is "Hindu Flats" while the largest concentration of sockeye spawn near Mt. Currie

TABLE I

Chinook, Coho and Sockeye Escapements
to the Lillooet-Birkenhead System.
 (5 year averages 1940-1974 and yearly
 escapements 1965-1976)

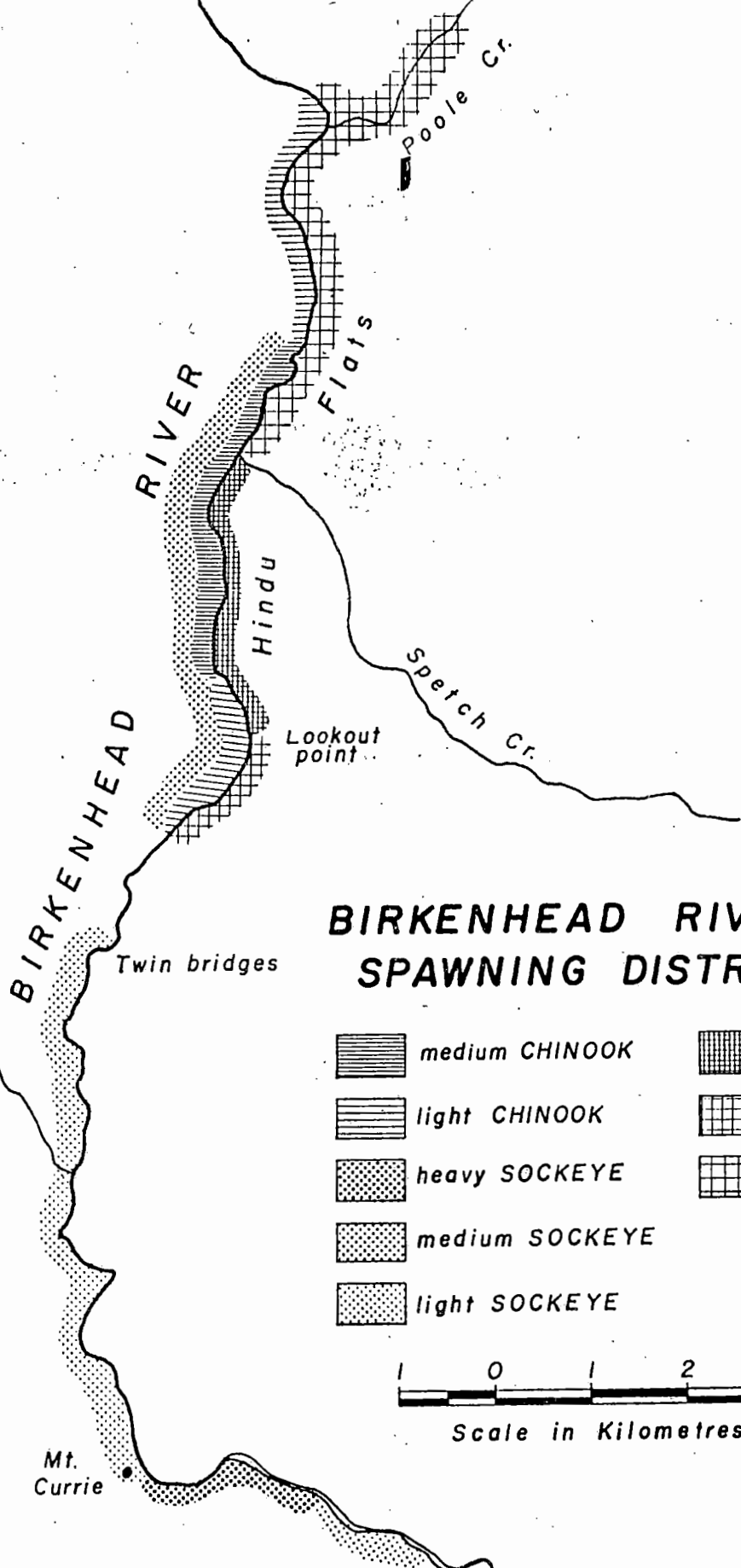
5 Year Period	Lillooet R. ¹		Birkenhead River			Poole Cr. Coho
	Coho	Sockeye	Coho	Chinook	Sockeye ²	
1940-44	6555	7569	5200	1380	62,600	205
1945-49	7850	2420	16200	930	100,000	1488
1950-54	6525	870	6050	900	84,000	395
1955-59	421	62	1750	1300	41,500	75
1960-64	1478	125	3300	750	55,500	90
1965-69	1904	110	2940	670	63,200	254
1970-74	3715	250	3800	550	67,200	300
Yearly Escapements:						
1965	1600	200	3500	750	30,000(30,000)	200
1966	1675	200	3500	750	81,000(81,000)	200
1967	1500	100	3000	100	58,000(58,000)	200
1968	1175	50	3500	750	84,000(84,000)	200
1969	3570	0	1200	1000	63,000(63,000)	470
1970	4925	75	3000	1500	52,000(73,000)	200
1971	7500	50	3500	250	34,000(32,000)	700
1972	1925	475	3500	400	75,000(114,000)	200
1973	1750	175	1500	200	100,000(139,000)	200
1974	2475	475	7500	400	75,000(173,000)	200
1975	6175	625	1200*	200*	75,000(93,000)	100*
1976	1000	400	4000*	200*	35,000(108,000)	100*

SOURCE: Fisheries Service Spawning Reports. District #2, Area 29.









¹Totalled escapements for the Upper Lillooet including all tributaries. Individual escapements are shown in Appendix C.

²International Pacific Salmon Fisheries Commission estimates in brackets, from IPSFC Annual Reports.

*Reconnaissance survey estimates.



BIRKENHEAD RIVER SPAWNING DISTRIBUTIONS

- | | |
|--|---|
|  medium CHINOOK |  heavy COHO |
|  light CHINOOK |  medium COHO |
|  heavy SOCKEYE |  light COHO |
|  medium SOCKEYE | |
|  light SOCKEYE | |



Lillooet Lake

(Fig. 9). It should be noted that there are also chinook, coho and steelhead recorded as "present" in Sloquet (Spring) Creek on the Lower Lillooet River.

The Lillooet and Birkenhead salmon runs support three Indian fisheries, one at Port Douglas, one at Skookumchuck and the major one at the mouth of the Birkenhead on Lillooet Lake (Fig. 10). The first two have an insignificant effect on the runs since effort is minimal (1 - 4 nets) and catches are low. The Mount Currie band, on the other hand, takes a significant number of salmon from each run (Table II). The large catches of chinook and coho relative to the Birkenhead escapements (Table I) suggest that runs, other than Birkenhead's, are contributing to this fishery.

The chinook salmon run also supported a significant sport fishery up until the protective closure in 1976². Fisheries officers estimated the chinook catch at 91 in 1974 and 64 in 1975 (J. Krywchuk, pers. comm.). The salmon derby held by the Pemberton Rod & Gun Club gives an indication of relative abundance of chinook salmon in the Lower Lillooet from 1967 to 1975 (Table III).

Migration timing for anadromous species is similar to other systems except for chinook salmon. (~~Table IV~~). Information gathered from Indian and sport fisheries, indicates that chinook salmon are present in the system for an unusually long period (~~March--October~~) (Table IV). Additional information indicates that runs of chinook are present in the Lillooet system, which do not spawn in the Birkenhead. Large unspawned chinook have been netted in Lillooet Lake at the mouth of the Lillooet River during late October and November, after the Birkenhead run is finished (J. Bentley, pers. comm.). There is also a report that spawned chinook have been caught in the Lillooet River, below Tenas Lake, in October (A. Starks, pers. comm.). This evidence suggests that there are distinct runs of chinook salmon which spawn in the Upper and Lower Lillooet Rivers. This assumption could account for the unusual timing attributed to the Birkenhead chinook.

²1976 The lower Fraser R. gillnet fishery was reduced to 1 day from 2 days/wk. and opening changed from March 15 to April 19. Chinook sport fishing closed in the Fraser R. to the Harrison R. confluence Feb. 1 to April 18. Harrison R. closed through August 1 and upper areas closed until Oct. 3. Mt. Currie Indian Fishery Limited, by voluntary agreement, to 25 fish per season.

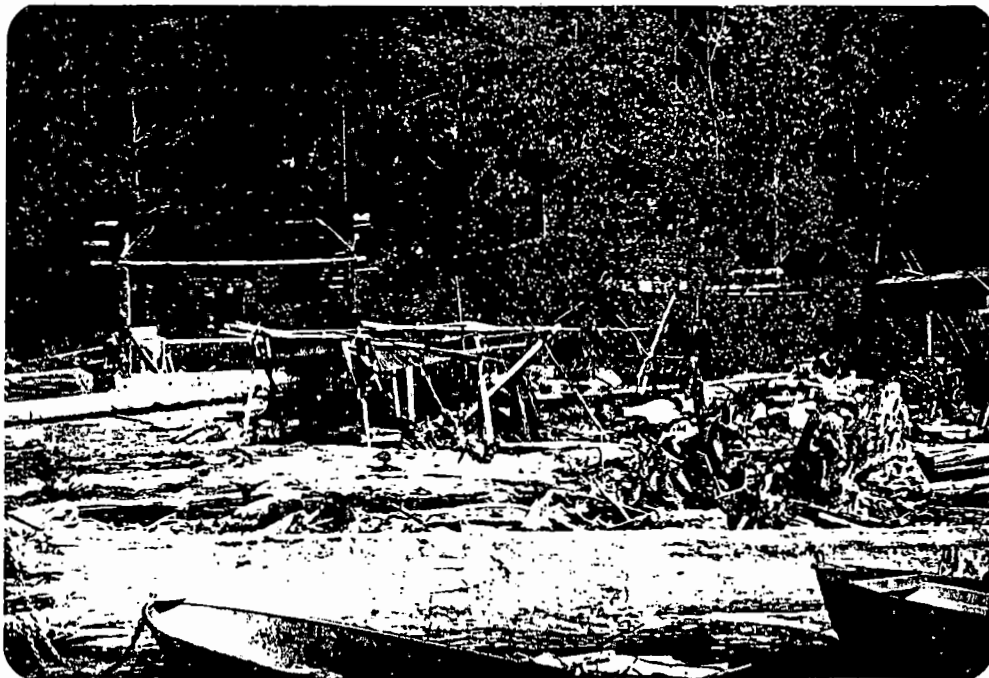


Figure 10: Mt. Currie Indian Band Fishing site on the shore of Lillooet Lake showing Sockeye on drying racks.

TABLE II
BIRKENHEAD RIVER

Estimated Indian Gillnet, Catches by the Mt. Currie Band.

<u>Year</u>	<u>Chinook</u>	<u>Coho</u>	<u>Sockeye</u>
1967	N.R.	N.R.	5,325
1968	132	427	5,613
1969	N.R.	N.R.	3,860
1970	N.R.	N.R.	6,000
1971	N.R.	N.R.	6,100
1972	N.R.	650	3,835
1973	75	300	3,500
1974	100	860	11,500
1975	100	3,000	9,000
1976	30	2,000	7,500

N.R. — No Report

Source: J.L. Bentley, Fisheries Officer, Mission.

TABLE III

PEMBERTON ROD & GUN CLUB SALMON DERBY

1967 - 1975

<u>Year</u>	<u>Approx. No. Spring Salmon Entered</u>	<u>Location of Largest Caught</u>	<u>Weight of Largest Fish (Lbs.)</u>
1967	10-12	Lower Lillooet River between Cowan & Rogers Cr. "19 Mile"	32
1968	3	Lillooet Lake at Mouth of Birkenhead	19
1969	15-20	Lower Lillooet River at Confluence of Rogers Cr. "25 Mile"	29
1970	15-20	"25 Mile"	30
1971	15-20	"25 Mile"	31
1972	10	"25 Mile"	25
1973	12	"25 Mile"	29
1974	5	"25 Mile"	23
1975	2	"25 Mile"	19

- mile posts marked in miles from Pt. Douglas on Harrison Lake.

- derby held on a 2 day weekend in the last half of April for each year. Avg. number of anglers 25-30.

SOURCE: B. Ross & A. Starks - members Pemberton Rod & Gun Club.

TABLE IV

Timing of Salmon runs in the Lillooet - Birkenhead System.

<u>River</u>	<u>Species</u>	<u>Arrive</u>	<u>End</u>		
Lillooet River	Coho	October	December		
Green River	Coho Sockeye	October September	December October		
Pemberton Creek (1 Mile)	Coho	October	December		
Ryan Creek	Coho Sockeye	October October	January November		
John Sandy Creek	Coho Sockeye	October September	January November		
Railroad Creek	Coho Sockeye	October September	January November		
25 Mile (Sampson) Creek	Coho	November	December		
Miller Creek	Coho	October	December		
Salmon Slough	Coho	October	January		
<u>Birkenhead River</u>					
		<u>Arrive</u>	<u>Start</u>	<u>Peak</u>	<u>End</u>
Coho		Oct. 10	Oct. 25	Nov. 15	Dec. 7
Sockeye		Aug. 15	Sept. 1	Sept. 21	Oct. 15
	<u>Lillooet Narrows</u>	<u>Birk R. Mouth Lillooet Lake</u>	<u>Birk R. Below Km. 17</u>	<u>Peak</u>	<u>End</u>
Chinook	Mar.-Apr.	Apr.-June	June-Aug.	Sept. 10	Sept. 30

Source: Coho and Sockeye - Fisheries Service Spawning Reports
Chinook - Personal Communications, F. Wheeler, J. Bentley
and A. Starks.

Population estimates for steelhead, sea-run cutthroat and resident species are not available but some information from sport fishing has established the species present and their size. Steelhead up to 9 kilograms have been caught in the Lower Lillooet and Lillooet Lake near the river mouths, from January through March. Large rainbows (1.4 - 2.7 kg) are also caught in the Birkenhead River during October and November, but it has not been determined if they are lake residents or actual steelhead (P. Caverhill, pers. comm.). Sea-run cutthroat are occasionally caught in the Lower Lillooet. Dolly Varden char, Rocky Mountain whitefish and rainbow trout are present in virtually all accessible streams in the watershed. Rainbow trout ^{are} commonly caught in Birkenhead Lake, Tenquille Lake and the Owl Lakes. Birkenhead Lake also supports populations of Dolly Varden char, Rockie Mountain whitefish, kokanee and squawfish. The B.C. Parks Branch has constructed a campsite on Birkenhead Lake and ^{the lake} it is supporting increasing numbers of anglers. A creel survey in the summer of 1974 indicated a catch of .52 fish per hour (P. Caverhill, pers. comm.). Sturgeon have been seen but never caught in the Lillooet River.

PREVIOUS FISHERIES RELATED PROJECTS

There has been substantial past interest in the Birkenhead River mainly due to the large escapements of sockeye. The Federal Fisheries Service operated a sockeyehatchery at Owl Creek from 1905 to 1936. Data from the hatchery (Table V), indicates that adult returns did not improve and the program was terminated.

Some chinook eggs were taken during the operation of this hatchery, notably ⁱⁿ 1906, 1913, 1918 and 1919. No other information on these fish was given except that the eggs taken in 1906 were obtained at "Tenas Rapids" below Tenas Lake.

This hatchery was also an incubation and distribution site for rainbow trout eggs obtained at Lloyds Creek Station near Kamloops. The Owl Lakes, Green Lake, Alta Lake, Tenquille Lake, Gates Lake and others in the Pemberton area were all stocked with rainbow fry from this hatchery. There was also an attempt to

TABLE V
Pemberton Hatchery Data 1905-36

Year	Estimated # of Female Sockeye*	No. of Eggs Taken (X10 ³)	Sockeye Fry Released (X10 ³)	Coho Eggs Taken (X10 ³)	Coho Fry Released (X10 ³)	Chinook Eggs Taken (X10 ³)	Chinook Fry Released (X10 ³)
1905-06	7,907	21,350	17,450	600			
06-07	7,962	21,500	10,500			150	120
07-08	10,378	28,000	18,300	1500	1300		
08-09	7,666	20,700	18,200	1000	890		
09-10	10,370	28,000	25,200				
10-11	2,592	7,000	6,750	1500	750		
11-12			12,130		1090		
12-13	9,259	25,000					
13-14			22,950				50
14-15			14,935		788		
15-16			23,892				
16-17							
17-18	1,981	5,350	5,004	740	667	30	27
18-19	4,413	11,915	10,915	45	40	45	35
19-20	11,357	30,665	28,260				
20-21	9,630	26,000	23,536				
21-22	9,630	26,000	20,538				
22-23	9,630	26,000	12,108				
23-24	11,344	30,629	7,370				
24-25	11,555	31,200	19,295				
25-26	14,970	40,418	23,280				
26-27	16,796	45,350	21,450				
27-28	13,704	37,000	20,525				
28-29	12,967	35,010	21,350				
29-30	6,667	18,000	16,799				
30-31	13,040	35,210	21,434				
31-32	7,565	20,425	19,146				
32-33	8,411	22,710	21,330				
33-34	3,955	10,680	9,977				
34-35	7,555	20,400	19,309				
35-36	9,040	24,410	23,493				

1936 E N D O F R E C O R D

*Average fecundity for Birkenhead Sockeye 4500 eggs/female 60% recovery for egg takes yields 2700 eggs/female. Personal Commun. Jim Woody, I.P.S.F.C.

establish a whitefish fishery on Lillooet Lake by stocking it with ^{whitefish} fry, shipped as eggs from Sarnia, Ontario. The outcome of this project was not documented.

The International Pacific Salmon Fisheries Commission (IPSFC) has operated downstream traps on the Lillooet system in several years. Tabel VI shows a summary of the data for each trapping site. Timing of the trapping operations were directed at the sockeye migrations so the duration of the trapping period is not necessarily applicable to chinook and coho. Small numbers of juveniles of other species were also captured.

The IPSFC has also performed tag and recovery enumeration programs on the Birkenhead sockeye since 1939. Information from these programs is used to calculate the yearly escapements (Table I) and percentages of males, females and jacks (3 year old males). The Birkenhead population has an unusually large percentage of jacks compared to other races in the Fraser River System. Scale samples from Birkenhead sockeye indicate that there are two distinct populations, a Harrison Lake type and a Lillooet Lake type. These are distinguished by the lower fresh water circuli counts for the Lillooet type. A greater proportion of ^{recovery} the jacks ~~sampled~~ were found to have reared in Harrison Lake compared to similar proportions for adult ^{of the same year} (4 and 5 year olds) fish (J. Woody, pers. comm.). It appears that ~~rearing areas in the Lillooet - Birkenhead system requires~~ more careful study to determine ^{the Lillooet} environmental effects ~~on the salmon populations present.~~ *of the different rearing areas on the salmonid populations present.*

TABLE VI

IPSFC DOWNSTREAM TRAPPING
LILLOOET-BIRKENHEAD SYSTEM

Date From - To	Location	Gear	Salmon Species Caught	Total No. Caught	Date Of Peak Catch	Reference
May 10-12 1953	"Lillooet Narrows"	5x5 Fyke Net(Ruskin Type)	Sockeye Smolts Coho	153 440	May 11 May 10	S.R. Killick IPSFC
Apr.28-May 18 1954	"Lillooet Narrows"	5x5 Fyke Net(Ruskin Type)	Sockeye Fry Sockeye Smolts Coho Fry Coho Smolts Chinook Fry	20 264 201 54 59	May 7 May 13 May 7 May 13 Apr.30	S.R. Killick IPSFC ..
Mar.21-May 14 1961	Birkenhead R. "Indian Bridge" km 7	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	258,154 670 76 937 2	Mar.22 May 10 May 10 May 2	R. Kent S.R. Killick IPSFC
Mar.27-May 24 1962	Birkenhead R. "Indian Bridge" km 7	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	89,227 409 4 535 1	May 10 May 22 - May 2 -	T. Gjernes S.R. Killick IPSFC
Mar.27-May 16 1963	Birkenhead R. km 5	2x3 inclined Plane	Sockeye Fry Coho Fry Coho Smolts Chinook Fry Chinook Smolts	238,241 2802 2 988 0	Apr.26 Apr.16 - Apr.24 -	T. Gjernes S.R. Killick IPSFC

Source: IPSFC Records. More complete data in Lillooet River System Data File. Fisheries & Marine Service, FRWC Division.

FISHERIES & MARINE SERVICE RECONNAISSANCE SURVEYS 1975 and 1976

More recent work has been undertaken by the Federal Fisheries Service, mainly on the Birkenhead River. These surveys were conducted from September 25, 1976. Additional trips were made December 7-13, 1976 and January 19 and 20, 1977. The basic objectives of the 1975 and 1976 surveys were to determine species present, numbers, timing and spawning areas, and to get a general overview of the watershed. Some juvenile sampling was done in both years mainly to determine if juvenile chinook were present and to define possible rearing areas. In 1976 attempts were also made to capture adult chinook for an experimental egg plant. Methods used for these surveys are shown in Appendix D.

Helicopter flights were made on the Birkenhead in both years during the peak of chinook spawning (September 6, 1975 and September 9, 1976). In both years the weather was clear, water levels were moderate and visibility was excellent and it was felt that approximately 50% of the chinook present were counted. One ^{one} hundred ~~and three~~ were counted in 1975 while 137 were sighted in 1976. Dead recovery and live counts commenced in mid-September and were terminated by September 30 for both years. In total, 72 were recovered in 1975 and 55 in 1976, confirming the low aerial counts (details in Lillooet-Birkenhead data file).

Based on these surveys, chinook escapements were estimated at 200 fish for both years. In view of the additional protection given early chinooks in the lower Fraser River fishery and the reduced fishery by the Mt. Currie Indians in 1976, the chinook run should have shown a substantial increase over 1975. The continued small escapement reaffirms the need for additional efforts to rehabilitate the chinook run.

Coho dead recovery yielded 11 fish in 1975 and 142 in 1976 (details in the Lillooet-Birkenhead data file). Two men spent 4 days (Dec. 7, 9, 12, and 13) on recovery in 1976 while one man was stationed at Birkenhead until December 24 in 1975. Unusual flooding in November of 1975 and hazardous freezing conditions made the 1975 recovery very poor compared to 1976, when water levels were exceptionally low.

Population estimates are probably less precise for coho than for chinook salmon but it appears that coho are maintaining a healthy escapement. Scale reading results for 1975 showed all coho to be 3₂, while in 1976, 97% were 3₂ with the remainder 4₃.

Age class assignments for chinook salmon reveal that the majority are in the sub 1 category, indicating that most fry migrate to salt water prior to their first winter (Table VII) Twice the percentage of fish were assigned to the sub 2 class in 1976, indicating that more fish in that brood year overwintered as juveniles. This increase in the sub 2 category could also be due to the difficulties in reading chinook scales. It has been thought that differences in rearing areas and associated growth rates may produce false checks and other abnormalities in the scale patterns. Circuli counts were made for all chinook scales and some coho scales but no repetitive patterns, that can be associated with different rearing areas, have been defined.

Juvenile sampling was given only minor consideration in 1975 but received more attention in 1976. Coho were captured in almost all locations while only 3 chinook were captured (Appendix D and E). The capture of 3 juveniles indicated that at least some chinook rear in the Birkenhead River. This low catch could be caused by three (3) main factors:

1. most of the available juveniles (70%) have probably already left the system
2. the method used may not be effective for capturing chinook juveniles in low concentration areas (Appendix D)
3. areas sampled may not be the main rearing areas for the "stream type" chinook.

The large area into which Birkenhead fry may disseminate probably makes their numbers low, even in favoured areas. Confirmed and suspected rearing sites for Birkenhead chinook and coho included the Birkenhead River proper, Lillooet Lake, Lower Lillooet River and Harrison Lake.

The 1975 and 1976 sampling programs confirmed the use of the Birkenhead River (upper and lower) as a rearing area for coho, trout, and some chinook, although the extent of their use cannot be determined with the available data. The zero catch in Lillooet

TABLE VII

BIRKENHEAD RIVER 1975 & 1976

AGE COMPOSITION & MEAN 1st YEAR CIRCULI COUNTS
OF SAMPLED CHINOOKS. (INCLUDES READABLE SCALES ONLY)

A G E

		2			3			4			5			Totals (Across)	
		No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	No. of Fish	% of Tot.	Mean Circ. Cnt.	#	%
Sub 1	1975	0	0		15	23	14.3	19	30	18.5	0	0	..	34	53
	1976	1	2	18	14	33	20.4	17	40	18.2	1	2	18	33	77
Sub 2	1975				2	3	15.0	20	31	17.6	8	13	18.6	30	47
	1976							4	9	19.8	6	14	18.2	10	23
Totals (down)	1975	#	%		#	%		#	%		#	%		64	100
	1976	1	2		14	33		21	49		7	16		43	100

Lake may be due to factors such as those mentioned above, especially since little effort was put into trapping in the lake. Since Birkenhead sockeye are known to rear both in Lillooet and Harrison Lake, it is not unreasonable to assume that chinook and coho rear there also. More intensive sampling using additional methods (eg. downstream traps, seining, etc.) are probably necessary to determine rearing distributions, migration patterns and timing.

Attempts to capture adult chinook for an experimental egg plant³ commenced on August 26, 1976. In total 11 fish were captured (2 jacks, 6 females and 3 males), all using hook and line (Appendix D). Unfortunately all the females had already completely spawned so attempts to capture more were abandoned on September 2nd. One night's gillnetting (Km 10) yielded 13 sockeye and 1 Dolly Varden trout.

It appears that attempts to capture adult chinook must be commenced earlier in the summer if usable eggs are to be obtained. Information on timing (Table IV) indicates that "fresh" fish are probably available in the river below the spawning grounds from June to August. Unfortunately this period corresponds with the highest flows in the Birkenhead River (Appendix A). Early August would probably be the best time to attempt capture since it has the lowest flows during the time period considered. This would also reduce the holding time for unripe adults. Sport fishing appears to be the best method to capture the small number of fish required in 1977, however, additional methods should be considered for future larger scale operations.

HUMAN INFLUENCES

The human activities which are of major concern to the Fisheries Service are logging, farming and the maintenance of several B.C. Hydro transmission lines.

³ A 50,000 egg capacity upwelling gravel incubation box and river intake structure were installed in Sept. 1976 by Fisheries Service Engineers, on the Fisheries property (km 9 Birkenhead River, Fig. 2).

Activities associated with farmland improvement have had the greatest impact on the watershed from a fisheries point of view. During 1948, "Lillooet Narrows" (Fig. 1) was dredged to lower the level of Lillooet Lake and dry the large swamp areas on the Lillooet River delta. Since then the Pemberton Diking Commission has diked the lower 40 km of the Lillooet River for flood control and farmland protection in the Pemberton area. In addition, the Lillooet was straightened and Green River, Miller Creek, Ryan River and Pemberton Creek were either dredged or re-channeled, then dyked (Burnett et al, 1952). It seems likely that large rearing areas ^{and many} for salmon and trout species were eliminated when the drainage work was completed.

Logging has not had as significant an influence on the watercourses as the diking, however, two recorded instances have had direct effects on salmon runs in South Creek and Railroad Cr. (Fig. 1). In the winter of 1963, to prevent the flooding of a timber lot, South Creek was diverted into a flood channel which flowed directly into the Lillooet River. The timber was then harvested since many of the trees had been killed by the ^{flooding} ~~spawning~~. The diversion apparently eliminated coho and sockeye ^{spawning} areas and at present there are no runs to South Creek (J. Bentley, pers. comm.). In November 1971, (when coho were present) a crossing was constructed on Railroad Creek. Local residents reported that fill material was pushed into the channel and many fish were stranded and injured. Other general effects of logging are the accompanying changes in run-off patterns and water temperature regimes associated with slash areas.

B.C. Hydro has four ~~the~~ powerlines running adjacent to the Birkenhead River from km 13 to km 26 (Owl Creek to Poole Creek, Fig's. 1 and 11). B.C. Hydro has also done some surveys on the Upper Lillooet River (Meagre Cr. area) into the possibilities of developing a geothermal power plant using the hot springs in the area. There are no definite plans as yet.

Spraying of the powerline right-of-ways is undertaken as required; generally less frequently than once a year. The herbicides currently used are 2, 4-D, 2,4,5-T and Picloram. Spraying programs are policed by the B.C. Interdepartmental Pesticide Committee, the Environmental Protection Service (EPS) and the Habitat Protection

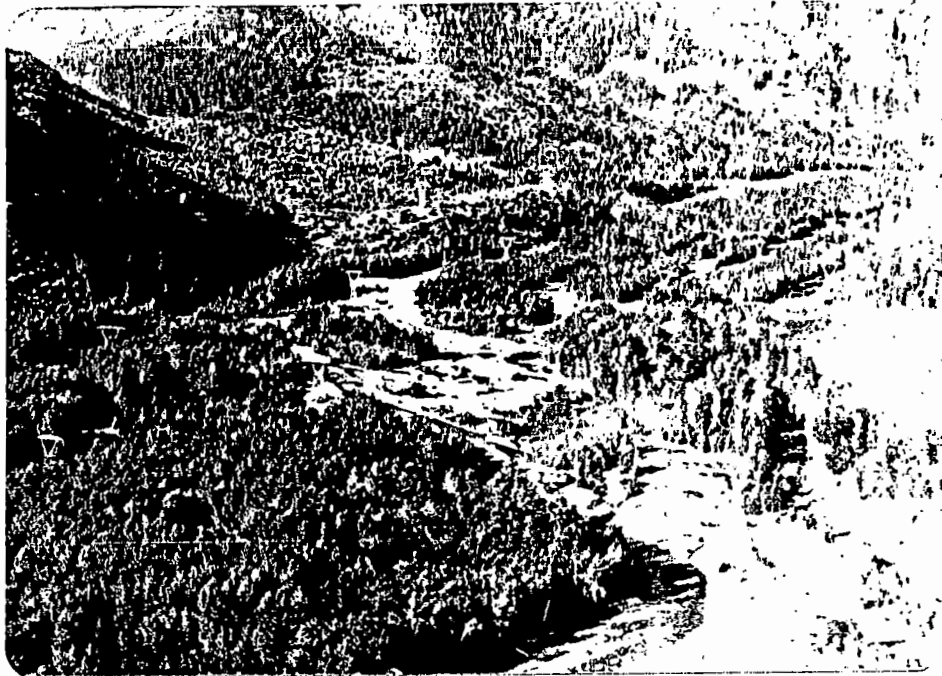


Figure 11. Birkenhead River showing the proximity of the 4 hydro power lines to the river.

Directorate of the Fisheries Service (HPD). The herbicides, in concentrations as low as 1 ppm are known to be toxic to salmonids (EPS, 1975), but care is taken that they are not applied near any of the major water courses. However, small or intermittent streams are inevitably sprayed. Due to the length of the river affected and the amount of spraying done every year, it is unlikely that EPS can adequately monitor all the adverse effects caused by these known toxic chemicals. It is significant that a major concern of that agency is the killing of the stream bank vegetation and the associated loss of stream bank cover through the spraying program.

Herbicides are also applied directly to the right-of-ways of both the B.C. Railway and the highway. Although the effects of the spraying by all three of these agencies is probably minimal, a great deal of care and monitoring is warranted due to the toxic effects of these chemicals.

The B.C. Railway and the provincial highway run close to the Birkenhead River for a distance of approximately 21 km, climbing 190 metres in this distance. Derailments are common on the B.C. Railway, and the close proximity of the river to the railway could result in foreign material being deposited in the river. In July 1972, several loaded railcars were overturned and wood chips were deposited in the river. This spill had a relatively minor impact but other cargo could have much greater potential for stream degradation. The Dept. of Highways is continuing improvement work on the road between Spetch Cr. and Birken but it has had no significant impact on the river.

There has been mining exploration in the area of the Lillooet - Birkenhead watershed but no producing mine has resulted to date. Some diamond drilling has been done in the areas of Owl Lake and Tenquille Lake.

Land development in the drainage has been minimal except in the immediate area of Pemberton. Two large subdivision developments have been proposed, one on Owl Creek and the other on Ryan Creek. Both have been notified of the stringent conditions regarding protection of the stream environments and it appears that these have discouraged the developers.

The 1100 Indians on the Mt. Currie Reserve represent 40%

of the total population in the Pemberton Valley. The local school has requested that students be involved in any salmon enhancement work undertaken in the area. Since the native people have a vested interest in the salmon populations they should be informed of all developments and their participation should be encouraged whenever possible.

Since the Lillooet system is relatively close to the heavily populated lower mainland, the sports fisheries on the rivers have a special significance as a recreational resource. The Pemberton Rod & Gun Club is interested in the proposed salmon enhancement work and is anxious to re-establish the presently closed sport fishery.

APPENDIX A

Monthly and annual mean discharges in cubic metres per second and cubic feet per second for the Lillooet, Birkenhead and Green Rivers.

	Lillooet River near Pemberton Station No. 08MG005 Drainage Area 2162 sq. km Period of Record 1914-1973		Birkenhead River at Mt. Currie Station No. 08MG008 Drainage Area 596 sq. km Period of Record 1945-1971		Green River near Pemberton Station No. 08MG003 Drainage Area 855 sq. km Period of Record 1913-1951	
	<u>Mean CMS</u>	<u>(Mean CFS)</u>	<u>Mean CMS</u>	<u>(Mean CFS)</u>	<u>Mean CMS</u>	<u>(Mean CFS)</u>
JAN	32.0	(1130)	7.8	(277)	14.7	(519)
FEB	30.6	(1080)	8.3	(293)	12.8	(451)
MAR	31.7	(1120)	7.4	(263)	13.9	(492)
APR	58.0	(2050)	13.3	(470)	31.4	(1110)
MAY	157.2	(5550)	42.2	(1490)	74.8	(2640)
JUNE	281.5	(9940)	70.8	(2500)	112.4	(3970)
JULY	317.2	(11200)	54.4	(1920)	107.9	(3810)
AUG	265.9	(9390)	25.2	(890)	75.6	(2670)
SEPT	159.4	(5630)	15.9	(561)	49.3	(1740)
OCT	98.8	(3490)	15.3	(539)	39.9	(1410)
NOV	55.5	(1960)	14.4	(508)	26.8	(946)
DEC	40.2	(1420)	11.2	(397)	20.0	(707)
YEAR	127.4	(4500)	23.9	(843)	47.9	(1690)

N.B. cubic metres per second calculated from cubic feet per second data.

SOURCE: Env. Canada Historical Streamflow Summary. British Columbia to 1973. Water Survey of Canada, Inland Waters Directorate, Water Resources Branch, Ottawa, 1974.

APPENDIX B

Four year Average of Monthly Mean Water
Temperatures in the Birkenhead River
(1973 -1976).

<u>MONTH</u>	<u>AVERAGE TEMPERATURES (°C)</u>
January	1.6
February	2.2
March	3.4
April	5.2
May	6.4
June	7.4
July	9.7
August	11.2
September	10.3
October	7.4
November	3.8
December	3.1

SOURCE: International Pacific Salmon
Fisheries Commission thermograph data.
Daily maximum, minimum and mean temperatures
from 1965-1976 available in the Lillooet -
Birkenhead data file.

Thermograph located at kilometre 15 (Twin
Birdges) on the Birkenhead River.

PRELIMINARY FEASIBILITY STUDY

BIRKENHEAD RIVER

EVALUATION FOR

CHINOOK AND COHO ENHANCEMENT

DRAFT

Prepared for:

F. J. Fraser, Senior Biologist
Johnstone Strait - Fraser River
Juan de Fuca Division

February 3, 1976

SUMMARY

A preliminary feasibility study, to evaluate the potential of utilizing the Birkenhead River for the establishment of a chinook and coho salmon hatchery, was undertaken from September 5 to December 24, 1975.

Indigenous species determined were: coho salmon, sockeye salmon, chinook salmon, steelhead trout, rainbow trout, and dolly varden char. Escapements into the river, were estimated at 200 chinook and 1,200 coho. Coho began entering on October 28 and had reached spawning areas when the survey was terminated. The native fishery at the mouth of the river took an estimated 500 coho and 100 chinook.

A five or six foot high fall located approximately 17.5 miles from Lillooet Lake was felt to be the greatest deterrent to further upstream migration. Passage was possible since 1 adult chinook was recovered at mile 21~~1~~ (Taillefer Creek).

Although spawning was concentrated from 11 to 15.5 miles upstream, it was concluded that, of the lower 17 miles of river a high percentage of quality spawning areas were being utilized, either by the two species of concern or by sockeye. Also, sufficient

donor stocks of chinook and coho do presently exist, albeit in barely adequate quantities, to consider preliminary stages of hatchery development.

A recommendation is made for the earlier initiation of chinook study as records and local reports indicate these fish arrive well prior to the time this project began. It is also suggested that Taillefer Creek be considered for rearing transplanted juveniles.

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*Separate
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INTRODUCTION

The Birkenhead River, located 100 miles north of Vancouver on the British Columbia mainland, has a drainage area of 230 square miles (Figures 1 & 2). The system, approximately ~~32 miles~~ ^{51 km} in length, has three major tributaries: Taillefer Creek, Poole Creek, and Owl Creek (Map 1). Taillefer Creek drains the only major lake in the system, Birkenhead Lake, (Fig. 3) into the river. Two small lakes are found on Owl Creek. The Birkenhead system arises near Sun God Mountain in the Cadwallader Range, and drains into Lillooet Lake.

Metric
596 sq
Kilometres

Fig. 3. Looking north-east on Birkenhead Lake.

Gradient on the river varies from steep to very minimal on the lower river.

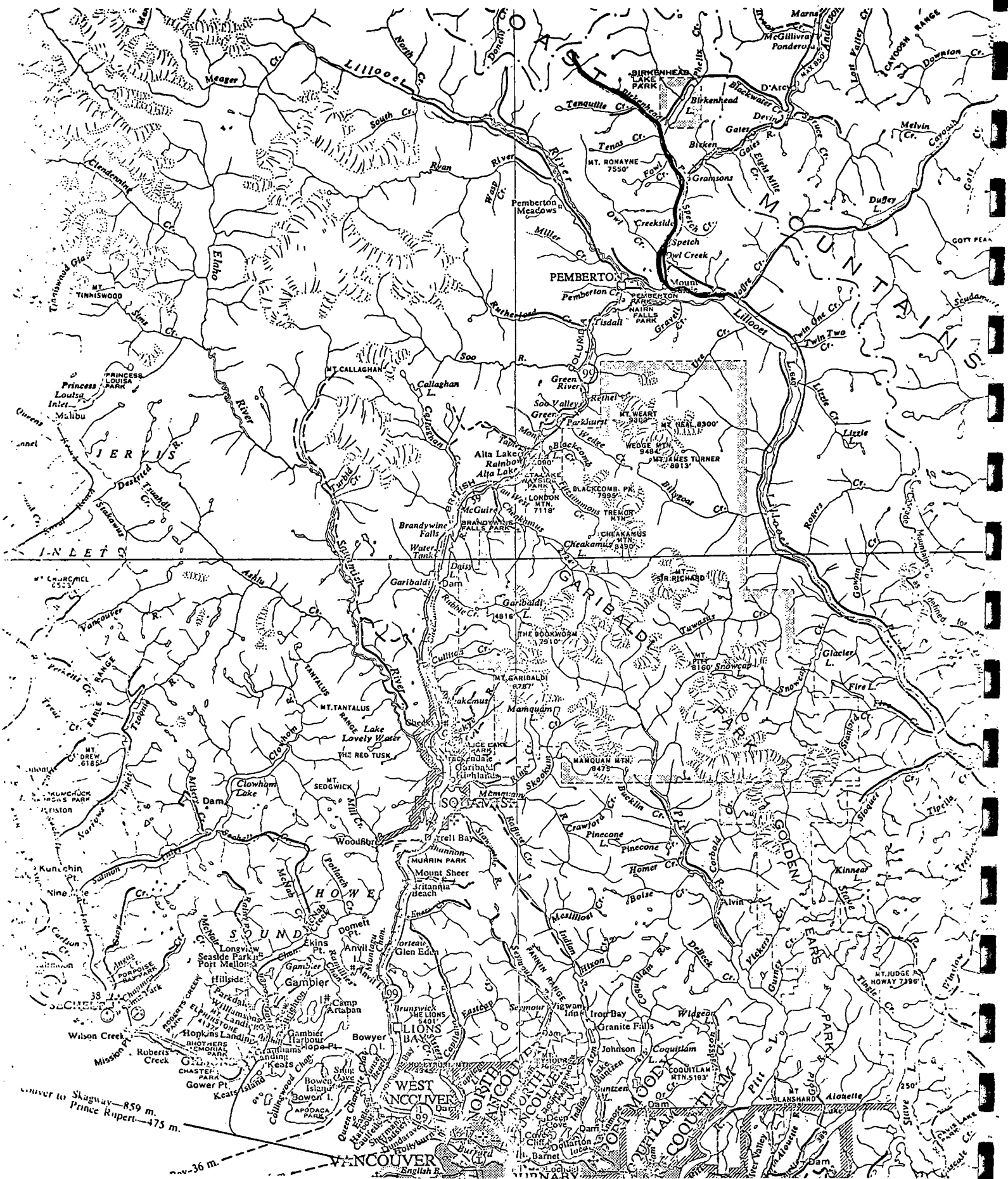


Figure 1. Birkenhead River - Location (scale: 1 inch = 10 miles)

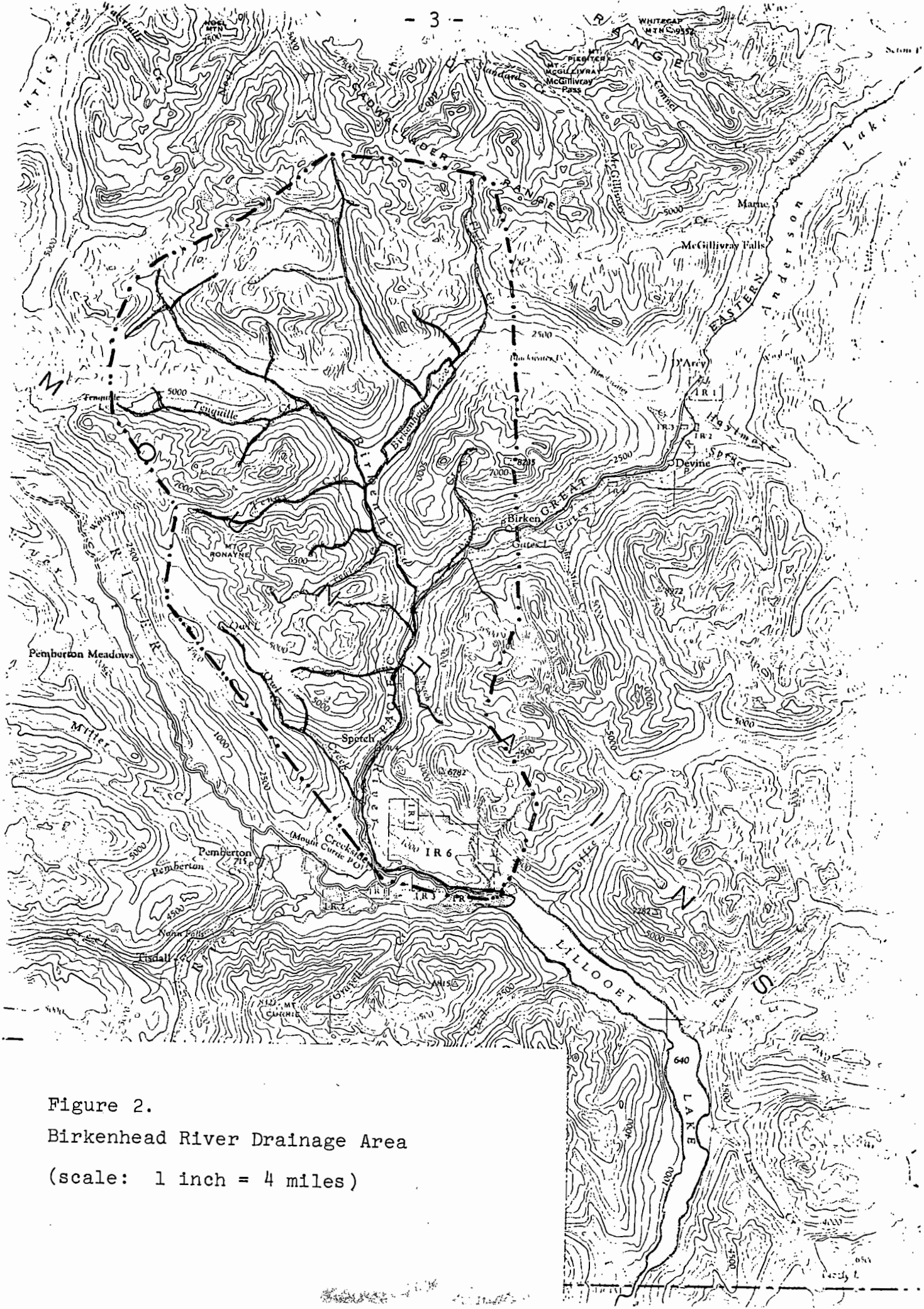


Figure 2.
Birkenhead River Drainage Area
(scale: 1 inch = 4 miles)

Metric

The eight miles of river above Taillefer Creek drops 2,700 feet in elevation. It levels off to the Poole Creek junction dropping only 800 feet in 7.5 miles. From here the river levels considerably, descending but 850 feet in the final 16.5 miles to Lillooet Lake.

Historically, anadromous fish species have included up to 130,000 sockeye salmon (Oncorhynchus nerka), 35,000 coho salmon (O. kisutch), 3,500 spring salmon (O. tshawytscha), steelhead trout (Salmo gairdneri), and cutthroat trout (S. clarki clarki). (Appendix A). Resident stream and lake populations include rainbow trout (S. gairdneri), dolly varden char (Salvelinus malma), kokanee (O. nerka), and whitefish (Coregonus). (Appendix "A").

Falls, five to six feet high, (Fig. 4&5) are located approximately 17.5 miles from Lillooet Lake and seem to deter further upstream migration by salmon (Map 2). The river through the canyon, extending from the falls to Taillefer Creek, has a boulder/cobble substrate and frequent five foot plus diameter boulders strewn about. These components combine to produce riffle - pool conditions throughout. Taillefer Creek, considered for study purposes as part of the useable Birkenhead River, is of very low gradient and has numerous pool areas and slight ripple sections.

note

Fig. 4.

Fig. 5.

Figures 4 & 5. Falls - located 17.5 miles upstream from mouth of Birkenhead River.

Presently, no active logging, or other land use operation exists adjacent to the river.

The only cultural features present are light residential development, parks ^{and (example) records at} the mouth of Owl Creek and around Birkenhead Lake, and B. C. Hydro right-of-ways- four of which parallel the river from approximately eight to sixteen miles upstream. ^PThis report is the result of a preliminary investigation to determine the feasibility of ^{rehabilitating} ~~constructing~~ a chinook and coho salmon ~~hatchery~~ ⁱⁿ ~~of~~ the Birkenhead River.

OBJECTIVES

This project was a preliminary step in a thorough investigation of the Birkenhead River to determine the feasibility of constructing a chinook and coho salmon hatchery. Its primary objective was to investigate the indigenous fish populations and potential donor stocks of the river, and to estimate adult escapements, timing and spawning distributions.

METHODS

The survey was conducted from September 1, to December 24, 1975. Access to the Birkenhead River was obtained via: the Mt. Currie-D'Arcy highway; the Mt. Currie to Lillooet Lake section of the Duffey Lake road; the Birkenhead Lake Park road; and a hydro access road approximately 11 miles upstream ^{34 -} ~~(Map 1)~~.

APPENDIX A (cont'd)

Escapement Average Since 1934

	<u>Coho</u>	<u>Chinook</u>	<u>Sockeye</u>
1934-49	8,460	940	59,140
1950-59	3,900	1,100	62,750
1960-69	3,020	710	59,410
1970-74	3,800	550	67,229

Approximate Timing of Birkenhead Salmon Runs

	<u>Arrival</u>	<u>Spawning</u> - start	<u>peak</u>	<u>end</u>
Chinook	April 15	May 15	June 1	September 30
Sockeye	August 15	September 1	September 21	October 15
Coho	October 10	October 25	November 15	December 7

A helicopter survey, in a 'Bell jet ranger', was undertaken September 6, 1975: to observe chinook and/or coho adult populations, to locate and identify possible fish barriers; and to obtain a general impression of the watershed.

Ground level reconnaissance streambank
~~Closer examination~~, was carried out by walking and rubber-
flecting
~~rafting~~ portions of the river on a daily basis, weather and water levels permitting. Scale and otolith samples were obtained from spawned chinook and coho and recovered by crews of one, two, and three men. In addition, orbital-hypural lengths and success of spawning for either sex was noted. ~~To ensure a chance of readable scales, samples were taken from both sides of the fish with ten from each side for chinook, and five from each side for coho.~~

Fish presence and diversity was determined in some locations using a Smith-Root Type 8 'Electro-fisher' and dip net. 'Shocking' was carried out in Taillefer Creek on October 22, and two backwater areas on the left bank of the main-stem Birkenhead on October 23 just upstream of confluence with Poole Creek (^{See} Map 1). Dipnetting was carried out in Taillefer Creek on September 25, and in various sites on miles 12 & 16 on September 26, and mile 14 on October 16 of the Birkenhead River.

To facilitate the relating of samples obtained to geographical position, the river was divided into miles and marked off correspondingly on a forestry road location map (N.T.S. #F92J/7-E Scale: 1 inch = $\frac{1}{2}$ mile),

Thermographs, installed on the river at 6.75 and 22.25 miles upstream, were operated from Sept. 30-Oct. 27, 1975 to obtain a temperature profile for the upper and lower river.

RESULTS AND DISCUSSION

The helicopter flight revealed 103 chinook and approximately 50,000 sockeye, with both species concentrating in the area extending from 11.5 to 16 miles upstream. This area is known ~~to~~ *to* as 'Hindu flats'. No major hazards to fish migration were noted from the air. A series of log jams (Fig. 6) about 12.5 miles upstream extended for 50 to 100 yards but were not considered to hinder fish progress as large numbers were seen just upstream. Areas which appeared suitable for spawning extended from 3.5 to 9, and 11 to 16.5 miles upstream (Fig. 7 & 8) and about 1 mile of the 1.25 mile length of Taillefer Creek.

Fig. 6. Typical nature of log jams in 'Hindu flats' area.

Fig. 7. Characteristic spawning area of
'Hindu flats'.

Fig. 8. Spawning chinook and sockeye.

Seventy-two chinook spawners (27 male; 45 female) were sampled with well over half being found in mile 12 and 13. From the scale sampling, 66 of the 72 were readable. Results are shown in the following table. (also see Appendix B).

Table 1. Age composition and size of sampled chinooks

	<u>Male</u>				<u>Female</u>			<u>Total</u>				<u>% Age from Scales</u>
	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
Sub 1	1	7	4	0	9	15	0	1	16	19	0	
Sub 2	1	1	6	2	1	13	7	1	2	19	9	
Total	1	8	10	2	10	28	7	1	18	38	9	

% Age Composition

	<u>Male</u>				<u>Female</u>			<u>Total(assumes 50:50 sex ratio)</u>				
	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>Total</u>
Sub 1	4.8	33.3	19.0	0	20.0	33.3	0	2.4	26.7	26.2	0	= 55.3
Sub 2	-	4.8	28.6	9.5	2.2	28.9	15.6	-	3.5	28.7	12.5	= 44.7
	4.8	38.1	47.6	9.5	22.2	62.2	15.6	2.4	30.2	54.9	12.5	=100.0

Post orbital-hypural lengths (cm)

	<u>Male</u>				<u>Female</u>			<u>Total(assumes 50:50 ratio)</u>					<u>sex</u>
	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>		
Sub 1	43.4	72.2	79.0	-	69.6	75.2	-	43.4	70.0	77.1	-		
Sub 2	-	54.6	79.5	75.2	52.6	71.0	75.6	-	53.6	75.3	75.4		
	43.4	70.0	79.3	75.2	67.9	73.3	75.6	43.4	69.0	76.2	75.4		

No chinooks were recovered after September 30, 1975. (Appendix "B"). Total number of chinooks in river for September was estimated at 200 fish.

Eleven coho had been recovered by December 24, 1975; one of these from Poole Creek, the balance from the Birkenhead. All were aged from the scale samples with the results as in the following table (see also Appendix "C").

TABLE 2. Age composition and size of sampled coho.

Ages from scales		Mean Orbital-Hypural lengths (cm)	
	Age 3		
No. Males	8	Males	58.3
No. Females	3	Females	55.8
Total No. sampled	11	Mean	56.5

Note: all samples were sub 2's.

First entry of coho was noted on October 28, 1975 and they were still entering at the completion of the study. In total, approximately 400 coho were observed in the river. Heaviest influx appears from November 16 to December 13, 1975 with the majority in miles 11 to 14 (Appendix "D"). Extremely high discharge in early November precluded any earlier observations. A total of 1,200 coho is being put forward as a "best estimate" based on nos. sighted and knowledge of river conditions.

Dip-netting was not very successful as most sites sampled provided lots of cover for the fast moving fry. Samples which were obtained revealed rainbow trout fry in Taillefer Creek and in miles 12, 14, and 16 of the Birkenhead River. The latter areas also yielded small numbers of coho; 13 from both mile 12

and 16 and 7 from mile 14. Samples were placed in labelled jars and preserved in a 10% Formalin solution.

Electro-shocking on Taillefer Creek yielded 14 trout in a quarter - mile left bank sample. Birkenhead shocking yielded the following:

TABLE 3. Electro-shocking results - Birkenhead River.

<u>Species</u>	<u>No.</u>	<u>Ave. length (mm)</u>
Dolly varden char (<u>Salvelinus malma</u>)	2	210
Rainbow trout (<u>Salmo gairdneri</u>)	33	48.9
Coho salmon (<u>Oncorhynchus kisutch</u>)	11	73.7 (54-85)

A nearby site yielded 6 coho and 11 trout fry before it was abandoned because algae led to recovery problems.

Temperature profiles for October showed that temperatures for the upper and lower Birkenhead River fluctuated with great similarity. The upper river was consistently 3° to 5° F colder than the lower (Appendix "E"). Maximum and minimum temperatures for the month were:

	<u>Maximum (°F)</u>	<u>Minimum (°F)</u>
Upper River	48.7	35.8
Lower River	51.3	40.9

Ages for chinook salmon, as sampled in the Birkenhead River, compare quite well with those found for chinook samples obtained from the upper Fraser River in September and October of this year.

TABLE 4. Age comparison for chinook salmon.

	<u>Age 2</u>	<u>Age 3</u>	<u>Age 4</u>	<u>Age 5</u>
% Birkenhead River	4.6	54.5	39.4	1.5
% Upper Fraser	3.6	61.7	34.4	0.3

Indian catches from 1967-76 are shown in Table 5. Indian fishing is confined mainly to the mouth of the river where gill nets are set in the murky lake water just west of the clear inflow of the Birkenhead. Effort varies thru the season, with as many as 14 nets set during the peak of sockeye and coho runs and 3-10 nets during less productive periods. (J. Bentley, pers. comm.).

TABLE 5. Birkenhead River. Estimated Indian Gillnet Catches

<u>Year</u>	<u>Chinook</u>	<u>Coho</u>	<u>Sockeye</u>
67	NR	NR	5,325
68	132	427	5,613
69	NR	NR	3,860
70	NR	NR	6,000
71	NR	NR	6,100
72	NR	650	3,835
73	75	300	3,500
74	100	860	11,500
75	100	3000	9,000
76	30	2000	7,500

NR - No report

Source: J.L. Bentley, Fisheries Officer, Mission

Poole Creek, which enters the Birkenhead River about 16 miles from the mouth, was an area of mixed reports during this survey. The local Fishery Officer estimated 150 coho in this stream up to November 20, 1975. Our crew observed only three and these just upstream from the mouth - the dead recovered excepted, as it was found about one-quarter mile upstream. It should be noted that there is nothing to suggest that coho do not enter this stream, as access and spawning conditions are considered very good for much of the lower two miles of this stream.

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The Birkenhead River can be broken into five general physical sections from the mouth upstream:

- i) 3.5 miles - meandering, slough-like, with sand and gravel bottom material.
7 Km
- ii) 6 miles - moderate ripples and runs, few pools, small boulders, and gravel substrate. Used moderately for sockeye spawning.
Km 16
- iii) 2 miles - minor canyon type area, large boulder sections, numerous waterfalls and fast runs.
Km 17
- iv) 5 miles - 'Hindu flats', river is braided through much of this section, pool and light ripple conditions abound, 2 to 3 inch gravel predominates, many back-waters and small side streams, used heavily and extensively by sockeye, coho, and chinook.
Km 26
- v) 4.5 miles - large boulders, many cascade sections, almost entirely steep-walled canyon area with moderate gradient to water surface.
in 33
- vi) 1 mile - (Taillefer Creek) - good spawning gravel, moderate flows, light ripple and pool conditions.
in 35

An extremely high runoff, which occurred in early November, exceeded any other for this time of year according to 27 years of records (Appendix ~~1~~ ¹⁰ ~~10~~ ¹⁰). It was estimated at 8,800 cfs by a Mount Currie gauge reading. Major alterations in the river course occurred only in the area of 'Hindu flats' as a result of the torrent. In

this area the main flow of the river shifted from the west to the east side of the river. At the termination of this project the river had settled back to its pre-flood level and had not noticeably resulted in any spring salmon spawning areas drying up due to the shift. It is, however, suspected that in some locations the substrate may have been entrenched to the extent that egg depositions could have been disturbed.

Confirmed rearing areas for salmon were found only in the 'Hindu flats' area. Sites are located in many side channels and backwaters of this region. As well, many 'islands' contained pools, with minimal flows, which had numerous fry. A number of these pools were observed to have dried up during low water levels - as is the norm from December through March. Other sites which were felt to have good rearing potential were: lower quarter mile of Poole Creek; base of creek which enters from west bank at upstream end of mile 12; any of numerous pools and backwaters found in the lower four miles of the Birkenhead River; and approximately one-half the length of Taillefer Creek. (Fig. 9 & 10).

Fig. 9.

Fig. 10.

Figures 9 & 10 . Taillefer Creek - stream sections showing rearing potential for salmon.

It should be noted that from 1905 to 1935 the 'Pemberton' hatchery existed on Owl Creek and was used almost exclusively for the propagation of sockeye salmon. There was, however, some work done with coho salmon with varying amounts being taken as follows:

1913 -	420	coho adults
1914 -	1,726	coho adults
1916 -	490	coho adults
1917 -	94	coho adults
1918 -	490	coho adults

Corresponding fry releases are not available, but in 1908, 1.3 million and in 1909, 0.9 million fry were liberated.

CONCLUSIONS

Chinook salmon enter the river prior to September and finish spawning by the end of September. Coho salmon first arrive in late October and have not terminated spawning by late December. Adult chinook scale samples indicate that 45% were sub 2's while all coho were 3's.

Chinook, coho and sockeye spawners combine to utilize a high percentage of the linear length of suitable spawning area, but chinook and coho concentrate in that area extending from 11 to 15.5 miles upstream.

The waterfall which begins the main canyon starting 17.5 miles upstream is a deterrent rather than a barrier to further upstream salmon migration.

Observed rearing sites on the Birkenhead River are plentiful although none are very extensive. Most are small pools located in the 'Hindu flats' area.

Sufficient donor stocks - estimated at 200 chinook and 1,200 coho - were present in the river this year to consider further study to be directed towards enhancement of these species.

RECOMMENDATIONS

I suggest that chinook salmon study be implemented earlier in the year than was the case for this study, as historical records indicate they enter the river as early as late April. This would

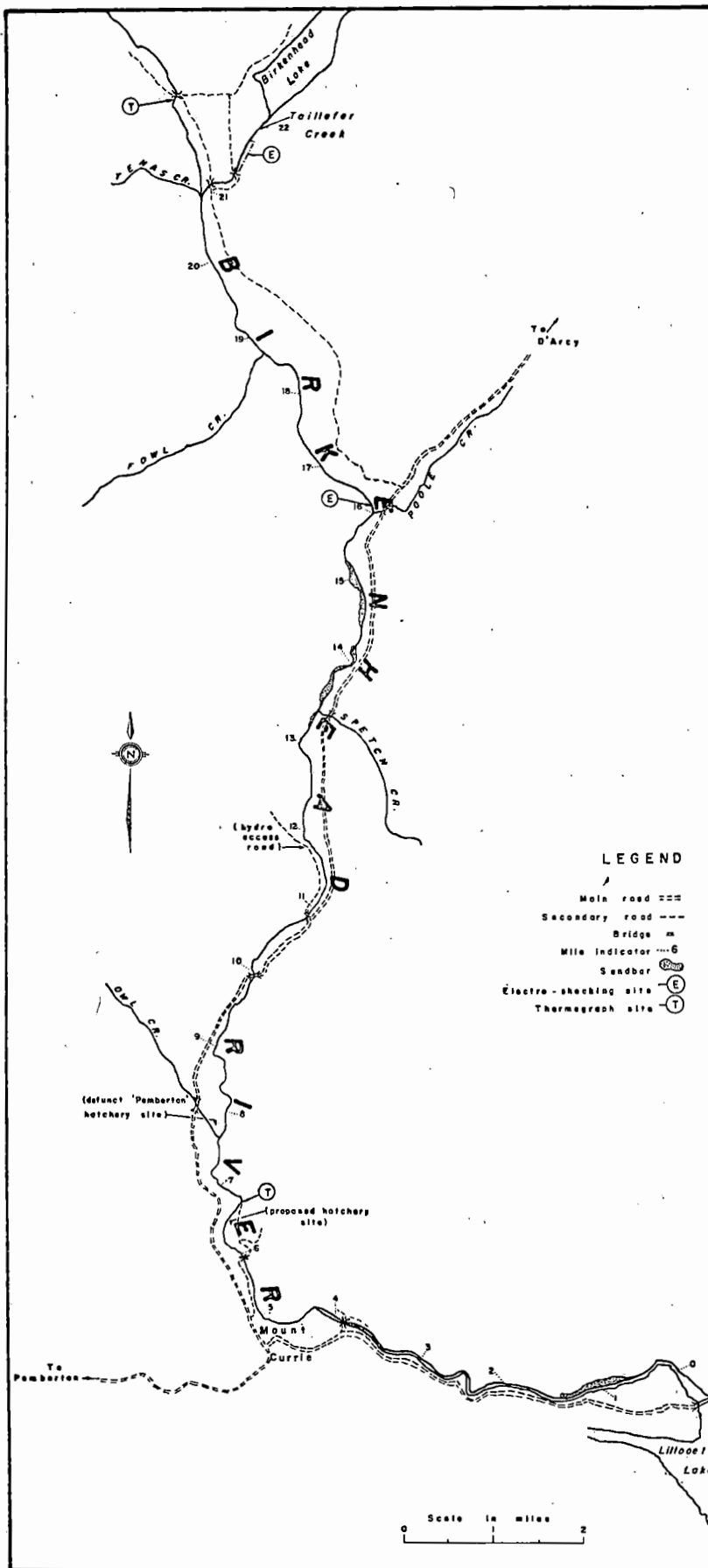
ensure more accurate appraisal of the timing and numbers of this run.

Also, I recommend that an appeal be made to the Indian fishery by the mouth of the river to take fewer chinooks for three to four years in exchange for some other consideration, as well as the prospect of an enhanced fishery from which they could benefit in the future.

It is also recommended that consideration be given to removal or lowering of the falls at the base of the canyon, as this partial migration barrier may have kept coho and chinook runs below their production potential.

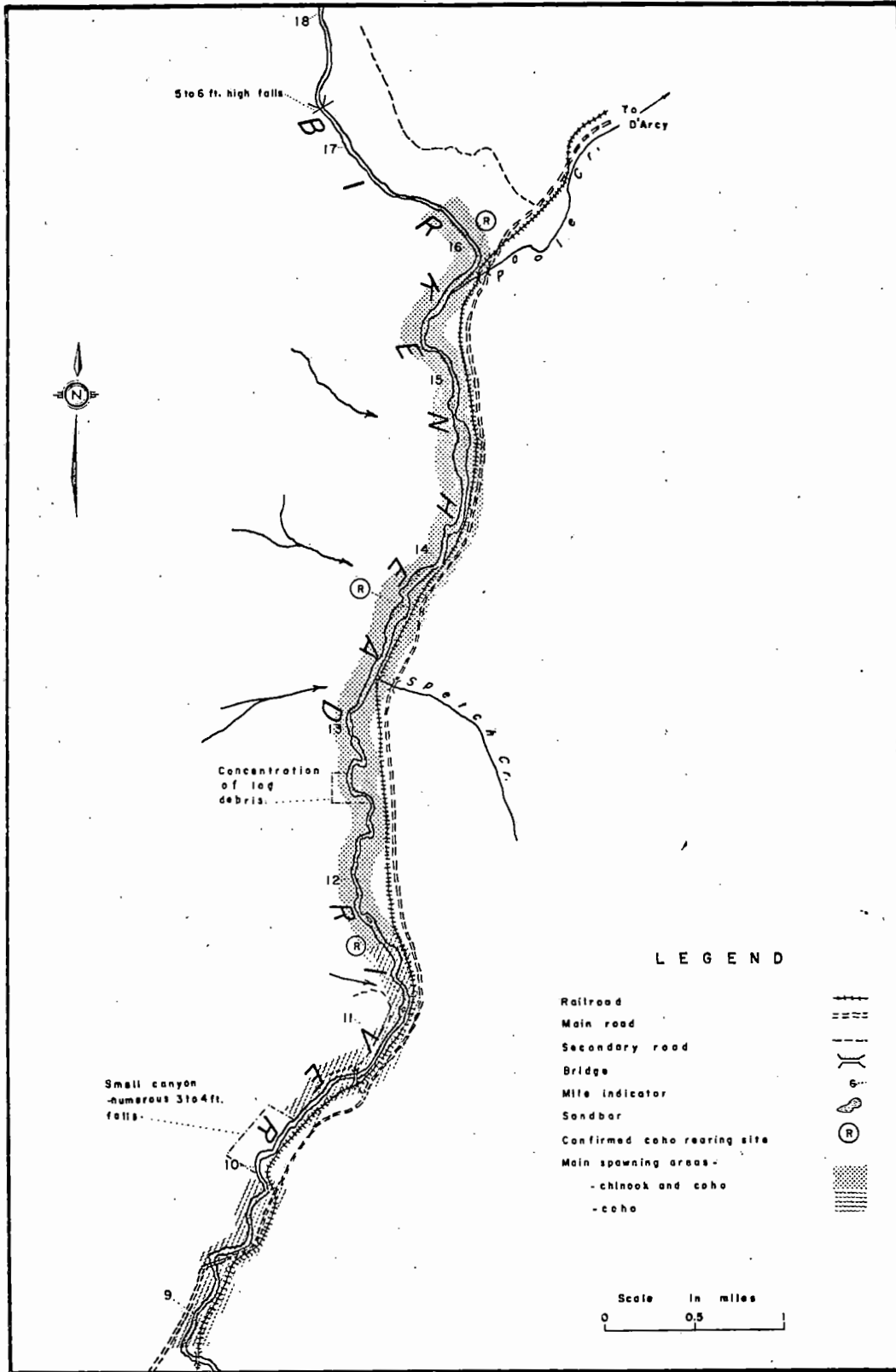
Alternatively, I would advise that Taillefer Creek be considered as a site in which to liberate coho fry for rearing purposes. Further study, for suitability of this stream in this regard, is recommended.

MAP - I



BIRKENHEAD RIVER
-Extent of Study Area-
(1975)

Scale 1:25 inches = 1 mile



BIRKENHEAD RIVER
 - Major Chinook and Coho
 Spawning Area -
 (1975)

APPENDIX A

Fishery Officer Estimates of Birkenhead Escapements

	<u>Coho</u>	<u>Chinook</u>	<u>Sockeye</u>		<u>Coho</u>	<u>Chinook</u>	<u>Sockeye</u>
1934	1,500	750	15,000	1955	1,500	750	50,000
1935	750	400	35,000	1956	3,500	750	65,000
1936	N/A	200	75,000	1957	1,500	3,500	35,000
1937	N/A	400	35,000	1958	1,500	750	22,500
1938	7,500	750	35,000	1959	750	750	35,000
1939	N/A	N/A	N/A	1960	3,500	750	39,000
1940	3,500	400	35,000	1961	2,500	750	49,627
1941	3,500	3,500	50,000	1962	2,500	750	52,000
1942	15,000	750	75,000	1963	3,500	750	67,151
1943	1,500	750	35,000	1964	3,500	750	69,939
1944	3,500	1,500	38,000	1965	3,500	750	30,000
1945	25,000	750	80,000	1966	3,500	750	81,134
1946	N/A	N/A	N/A	1967	3,000	100	58,036
1947	1,300	750	130,000	1968	3,500	750	83,907
1948	35,000	750	100,000	1969	1,200	1,000	63,343
1949	3,500	1,500	90,000	1970	3,000	1,500	52,146
1950	3,500	750	90,000	1971	3,500	250	34,000
1951	7,500	750	105,000	1972	3,500	400	75,000
1952	15,000	750	125,000	1973	1,500	200	100,000
1953	3,500	1,500	60,000	1974	7,500	400	75,000
1954	750	750	40,000				

APPENDIX A (cont'd)

Fishery Officer Estimates of Poole Creek Escapements
(Birkenhead River Tributary)

<u>Year</u>	<u>Coho</u>	<u>Year</u>	<u>Coho</u>	<u>Year</u>	<u>Coho</u>
1935	200	1948	1,500	1961	75
1936	N/A	1949	750	1962	75
1937	N/A	1950	200	1963	75
1938	1,500	1951	750	1964	200
1939	N/A	1952	750	1965	200
1940	400	1953	200	1966	200
1941	200	1954	75	1967	200
1942	200	1955	200	1968	200
1943	25	1956	25	1969	470
1944	200	1957	50	1970	200
1945	3,500	1958	75	1971	700
1946	N/A	1959	25	1972	200
1947	200	1960	25	1973	200
				1974	200

Timing for Poole Creek Coho

	Arrival	Spawning		
		- start	peak	end
Coho	October	October	November	December

Note: No escapements are listed for Owl, Tenas, Tenquille, Fowl, or Spetch (White) Creek.

APPENDIX B

Details of Chinook Dead Recovery

Birkenhead River

Chinook Spawner Recovery - September 1975

Date	Location (Mile) (a)	Sex	Colour (b)	Length (cm)	Comments	Age by Reader	
						#1	#2
1	10	M	W	42.4	apparently spawned out	R	R
2	12	F	W	74.9	100% spawned	4 ₁	4 ₂
3	12	F	W	76.2	100% spawned	4 ₁	5 ₂
4	16	M	P	74.2	100% spawned - head largely devoured	R ₁	3 ₁
5	16	M	P	72.0	100% spawned	R	R
6	16	M	P	43.4	100% spawned	2 ₁	2 ₁
7	16	F	W	71.6	100% spawned	4 ₁	4 ₁
8	16	M	W	75.5	0% sp. (Milt sacs full)	3 ₁	3 ₁
9	16	M	P	75.6	100% spawned	3 ₁	4 ₂
10	16	M	W	77.9	0% spawned	4 ₁	R
11	16	F	P	72.7	100% spawned	3 ₁	4 ₁
12	16	M	W	78.8	100% spawned	4 ₁	4 ₁
13	16	F	P	72.4	100% spawned	3 ₁	3 ₁

(a) as per reference map

(b) i.e. redspring or whitespring - 'R' or 'W' (or "pinky")-'P'

APPENDIX B (cont'd)

Date	Location (Mile)	Sex	Colour	Length (cm)	Comments	Age by Reader	
						#1	#2
14	16	M	W	75.5	Some milt remaining	<u>4</u> ₁	<u>5</u> ₂
15	16	M	P	75.2		4 ₁	4 ₁
16	16	M	W	77.8	100% spawned	4 ₁	4 ₁
17	16	F	P	67.8	≈ 30 eggs left	3 ₁	3 ₁
18	16	F	P	72.3	100% spawned	3 ₁	4 ₂
19	16	F	P	81.2	≈ 30 eggs left, good condition	4 ₁	4 ₁
20	16	F	P	76.0	100% spawned, good condition	3 ₁	4 ₂
21	16	F	P	67.5	100% spawned	3 ₁	4 ₂
22	16	F	P	77.9	3 eggs left	4 ₁	4 ₁
23	16	F	P	71.2	100% spawned	3 ₁	4 ₂
24	16	F	P	68.9	100% spawned	3 ₁	4 ₂
25	16	F	W	83.1	5 eggs left	R	R
26	16	F	W	68.6	Left side damaged scales taken as close to area as possible 100% spawned	3 ₁	3 ₁
27	16	F	W	76.2	100% spawned	5 ₂	5 ₂
28	16	F	W	67.8	7 eggs left	3 ₁	4 ₂
29	16	M	W	74.9		4 ₁	5 ₂
30	17	M	P	79.1	100% spawned. Right side scale area damaged. Scales taken 1" forward	3 ₁	4 ₂

APPENDIX B (cont'd)

Date	Location (Mile)	Sex	Colour	Length (cm)	Comments	Age by Reader		
						#1	#2	
31	17	11	F	P	65.0	100% spawned, excellent condition	3 ₁	3 ₁
32	17	11	M	P	84.3	100% spawned	4 ₁	4 ₂
33	17	11	F	P	81.7	≈ 20 eggs left	4 ₁	4 ₁
34	18	5	M	P	84.1	100% spawned, good condition. Had been caught & tied in water behind log jam.	4 ₁	4 ₁
35	18	6	M	P	76.7		3 ₁	3 ₁
36	18	5	M?	-	76.2	Fish in very bad condition. Managed to locate only 1 otolith. Scales could not be taken.		
37	19	12	F	W	67.6	100% spawned	3 ₁	3 ₁
38	19	12	M	W	55.1	100% spawned	3 ₁	3 ₁
39	19	12	M	W	73.4	50% spawned-fair quantity milt left	3 ₁	3 ₁
40	19	13	F	P	52.6	100% spawned	2 ₁	3 ₂
41	19	13	F	P	73.8	100% spawned	4 ₁	5 ₂
42	19	13	F	P	78.4	100% spawned. Still living, very good condition.	4 ₁	4 ₁
43	19	13	F	P	71.2	Several hundred eggs remaining	3 ₁	4 ₂
44	19	12	F	P	78.7	100% spawned. Slimy & decomposing	4 ₁	5 ₂
45	19	12	F	P	76.0	100% spawned. Good condition	3 ₁	5 ₂

very

APPENDIX B (cont'd)

Date	Location (Mile)	Sex	Colour	Length (cm)	Comments	Age by Reader		
						#1	#2	
46	19	12	F	P	83.0	100% spawned	4 ₁	5 ₂
47	19	12	M	P	79.0	100% spawned, poor condition	3 ₁	4 ₂
48	19	12	F	P	72.2	100% spawned	3 ₁	3 ₁
49	19	13	F	W	72.4	100% spawned	3 ₁	4 ₂
50	19	13	M	W	81.3	100% spawned	4 ₁	4 ₂
51	19	13	F	W	75.6	100% spawned	4 ₁	4 ₁
52	19	14	F	P	69.9	200 eggs left	3 ₁	3 ₁
53	19	14	F	P	74.9	100% spawned	4 ₁	4 ₁
54	19	14	F	P	67.3	100% spawned	3 ₁	4 ₁
55	19	15	F	W	74.3	100% spawned	4 ₁	4 ₁
56	19	15	F	P	71.8	100% spawned	3 ₁	4 ₂
57	19	15	M	P	54.6	some milt remaining	2 ₁	3 ₂
58	23	15	F	P	69.3	15 eggs left	3 ₁	3 ₁
59	23	15	F	P	74.0	100% spawned, mushy decomposing	3 ₁	3 ₁
60	23	15	F	W	73.8	100% spawned	3 ₁	4 ₂
61	23	14	F	P	77.5	100% spawned	4 ₁	4 ₁
62	24	13	F	P	74.6	100% spawned, old mushy decomposing	4 ₁	4 ₁
63	24	13	F	P	67.0	100% spawned, scales taken over wider area	3 ₁	4 ₁

APPENDIX B (cont'd)

	<u>Date</u>	<u>Location (Mile)</u>	<u>Sex</u>	<u>Colour</u>	<u>Length (cm)</u>	<u>Comments</u>	<u>Age by Reader</u>	
							<u>#1</u>	<u>#2</u>
64	24	13	F	W	67.5	100% spawned, scales taken over larger area, very good condition	3 ₁	4 ₂
65	24	12	F	P	67.5	100% spawned, scales over larger area, soft fairly old	3 ₁	4 ₂
66	24	12	M	very P	74.9	100% spawned, scales over large area poor condition	3 ₁	3 ₁
67	24	12	M	W	77.8	100% spawned, covered with fungus, very poor condition	3 ₁	4 ₂
68	24	12	F	P	65.5	100% spawned, soft, much fungus	3 ₁	5 ₂
69	24	12	M	P	77.8	100% spawned, extremely rotten, no scales taken.		
70	30	16	F	P	73.7	75 eggs	4 ₁	4 ₁
71	30	16	F	P	80.0	spawned	4 ₁	4 ₁
72	25	11	M	P	75.8	100% spawned, very rotten, covered in fungus	3 ₁	3 ₁

APPENDIX C

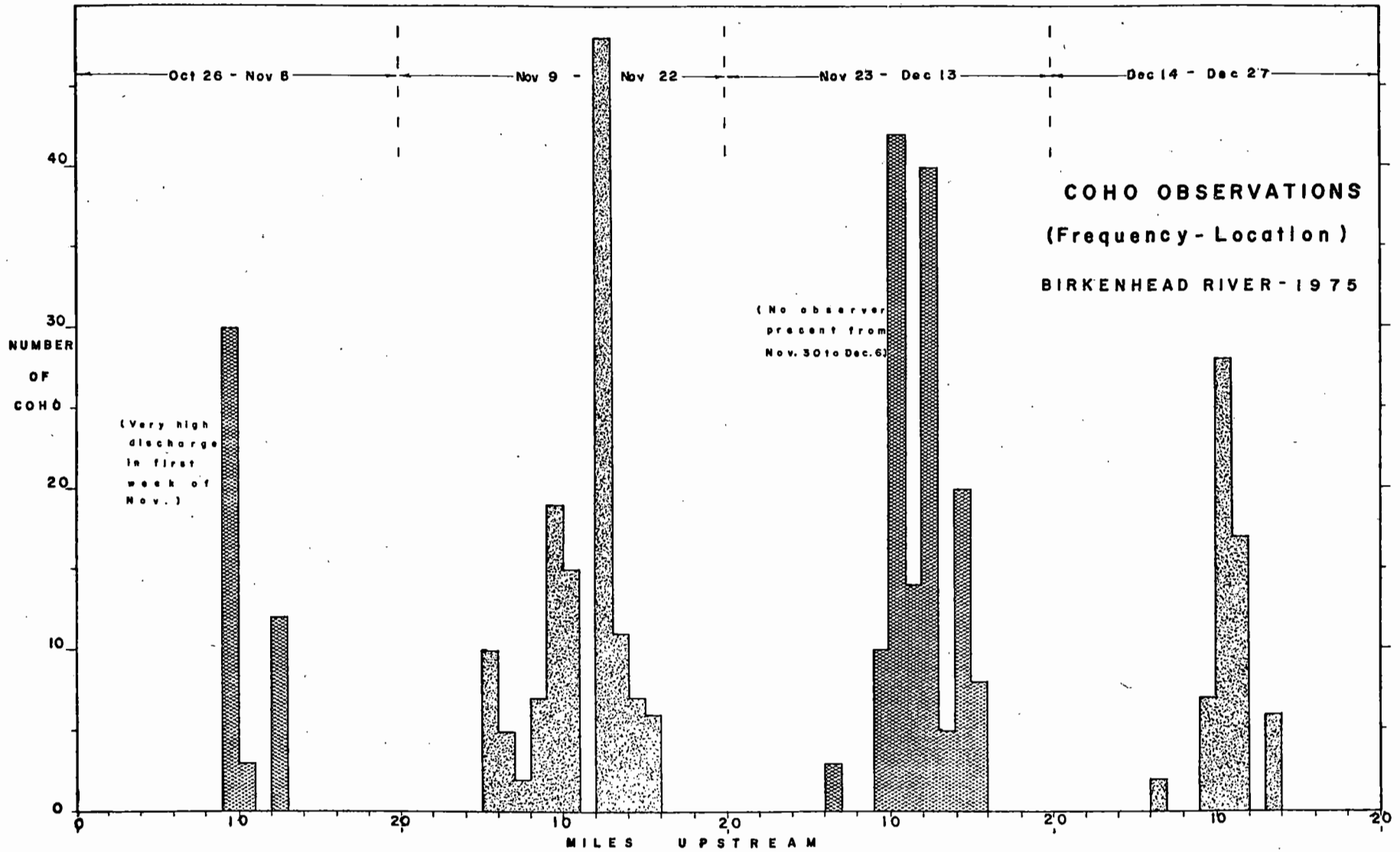
Details of Coho Dead Recovery

Birkenhead River

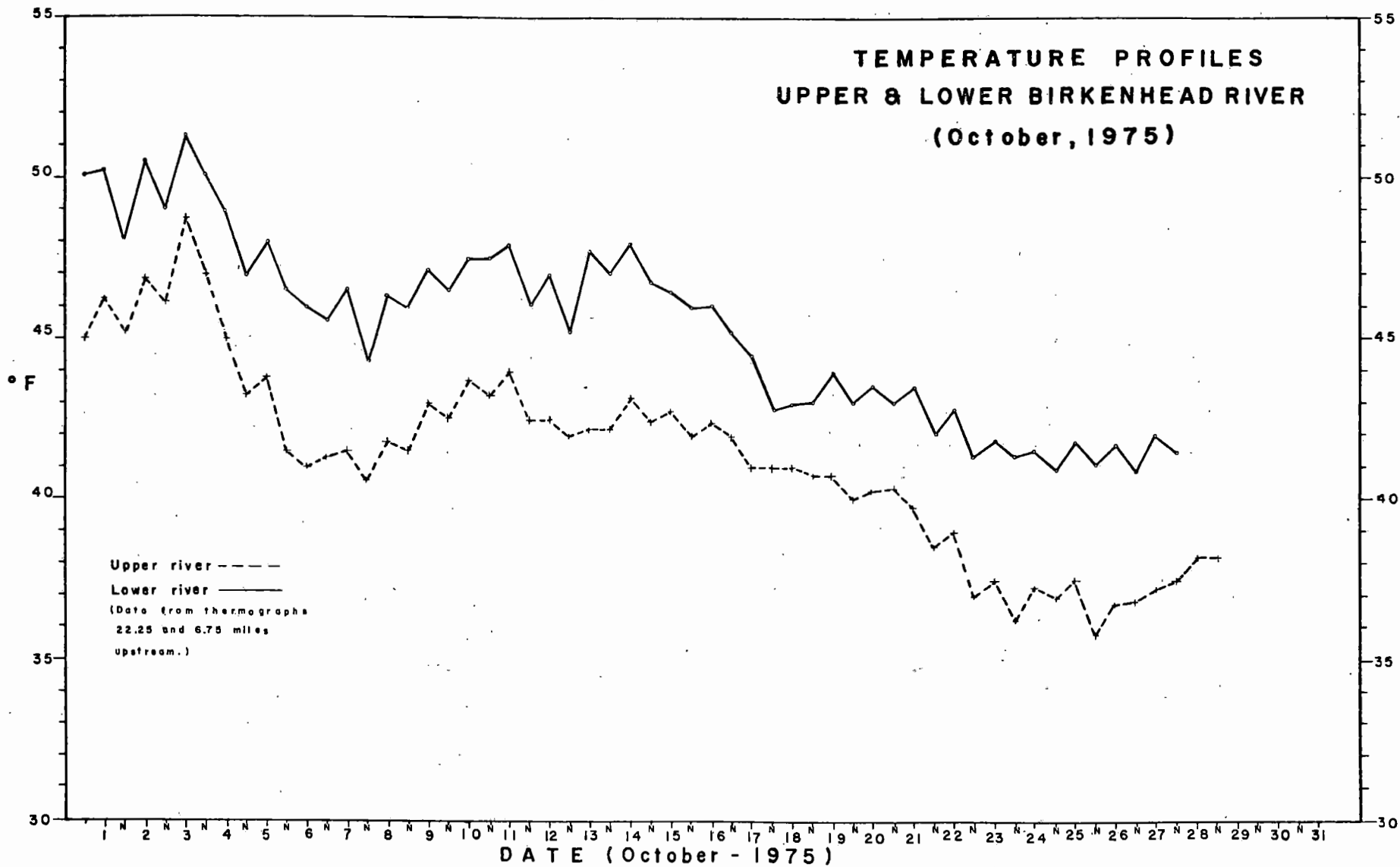
Coho Salmon Spawner Recovery - November 1975

<u>Date</u>	<u>Location (Mile)</u>	<u>Sex</u>	<u>Length (cm)</u>	<u>Comments</u>	<u>Age</u>
1 Nov. 26	Poole Ck. opp. mi. 16	M	46.3	Only 1 otolith found. 50% spawned Good shape.	3 ₂
2 26	11	F	55.9	Only 1 otolith found. 100% spawned Some fungus	3 ₂
3 26	11	M	59.1	No otoliths found. 100% spawned, head rotten, otherwise good cond.	3 ₂
4 27	12	M	57.2	100% spawned - good condition	3 ₂
5 Dec. 9	7	M	53.4	100% spawned - good condition	3 ₂
6 10	13	M	45.1	50% spawned - good cond. but internal flesh pale	3 ₂
7 10	13	F	60.2	100% spawned, very rotten, no oto- liths found (Spring?)	3 ₂
8 11	11	F	59.3	100% spawned - good condition 1 otolith broken in dissection	3 ₂
9 11	11	M	65.4	100% spawned - good condition	3 ₂
10 17	13	M	57.8	100% spawned - very good condition	3 ₂
11 23	11	M	62.3	100% spawned - somewhat fungussed up	3 ₂

APPENDIX D



APPENDIX E



APPENDIX F

Mean Monthly and Daily Extreme Discharges
for the Birkenhead River at Mount Currie

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BIRKENHEAD RIVER AT MOUNT CURRIE - STATION NO. 08NG008

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1945	---	---	---	---	---	---	---	659	---	---	---	---	---	1945
1946	154	136	209	449	---	---	1490	873	471	202	101	122	---	1946
1947	115	200	272	665	1670	1510	1250	697	457	328	247	236	640	1947
1948	217	---	140	359	---	---	1320	870	689	743	---	---	---	1948
1949	---	---	151	461	1500	1820	---	416	275	---	---	---	---	1949
1950	---	---	230	246	1250	2610	2530	1320	981	524	813	819	---	1950
1951	---	---	---	748	1720	2340	2190	728	432	411	251	222	---	1951
1952	159	194	164	466	1610	2060	1800	840	396	247	215	167	698	1952
1953	273	326	234	422	1610	1880	1800	857	483	611	688	434	805	1953
1954	329	369	277	337	1360	2190	2490	1520	890	603	1230	633	1020	1954
1955	318	254	197	316	715	2520	3600	1320	656	726	628	257	964	1955
1956	114	98.6	111	608	2010	2200	2010	902	701	---	368	---	---	1956
1957	---	167	147	401	2580	2410	1290	677	666	280	242	254	---	1957
1958	269	292	314	408	2250	2580	1010	548	445	693	449	573	822	1958
1959	337	184	189	529	1580	2330	2060	832	633	650	368	298	837	1959
1960	154	138	235	541	1110	2270	1960	899	473	475	357	303	744	1960
1961	427	450	424	484	1830	3340	2090	983	485	583	295	196	967	1961
1962	293	410	182	510	985	2200	1510	949	433	607	678	671	787	1962
1963	354	1010	390	341	1240	2370	1630	814	522	674	709	543	861	1963
1964	440	273	211	354	838	2780	2500	1150	706	720	581	332	908	1964
1965	197	203	332	598	1320	2080	1520	798	291	736	990	368	788	1965
1966	266	151	504	858	1180	2260	2210	740	519	522	377	538	848	1966
1967	266	296	259	263	1210	4550	1680	728	443	764	811	412	973	1967
1968	725	895	701	414	1010	2640	3090	1260	774	685	709	919	1120	1968
1969	---	---	---	837	2390	4160	1590	740	646	582	375	276	---	1969
1970	218	188	211	301	674	2310	923	342	419	253	203	168	534	1970
1971	195	316	235	312	2160	2480	2360	---	---	---	---	---	---	1971
MEAN	277	293	263	470	1490	2500	1920	890	561	539	508	397	843	MEAN

LOCATION - LAT 50 20 20 N DRAINAGE AREA 230 SQ MILES
LONG 122 43 40 W NATURAL FLOW

BIRKENHEAD RIVER AT MOUNT CURRIE - STATION NO. 08NG008

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1945	---	---	---	---	1945
1946	---	---	90.0 CFS ON NOV 25 *	---	1946
1947	---	1900 CFS ON MAY 27	96.0 CFS ON FEB 5	468000 AC-FT	1947
1948	---	---	---	---	1948
1949	---	---	---	---	1949
1950	---	4010 CFS ON JUN 13	---	---	1950
1951	---	3250 CFS ON JUL 3	---	---	1951
1952	---	3300 CFS ON JUN 5	146 CFS ON NOV 28	507000 AC-FT	1952
1953	---	2740 CFS ON JUL 11	158 CFS ON JAN 1	583000 AC-FT	1953
1954	---	3460 CFS ON JUL 1	239 CFS ON MAR 31	740000 AC-FT	1954
1955	---	6110 CFS ON JUL 21	156 CFS ON DEC 31	698000 AC-FT	1955
1956	---	3420 CFS ON MAY 20	96.0 CFS ON MAR 3	---	1956
1957	---	3370 CFS ON JUN 5	126 CFS ON FEB 22	---	1957
1958	---	4540 CFS ON MAY 28	190 CFS ON FEB 16	595000 AC-FT	1958
1959	---	3400 CFS ON JUN 21	108 CFS ON MAR 17	606000 AC-FT	1959
1960	---	3140 CFS ON JUL 8	115 CFS ON JAN 20	540000 AC-FT	1960
1961	---	5030 CFS ON JUN 4	163 CFS ON DEC 16	699000 AC-FT	1961
1962	---	3670 CFS ON JUN 16	158 CFS ON MAR 28	570000 AC-FT	1962
1963	---	3460 CFS ON JUN 17	230 CFS ON JAN 23	638000 AC-FT	1963
1964	---	4460 CFS ON JUL 8	189 CFS ON MAR 26	659000 AC-FT	1964
1965	---	4030 CFS ON NOV 3	167 CFS ON JAN 24	571000 AC-FT	1965
1966	---	3410 CFS ON JUL 8	139 CFS ON MAR 1	613000 AC-FT	1966
1967	---	9820 CFS ON JUN 22	210 CFS ON JAN 14	704000 AC-FT	1967
1968	---	12800 CFS ON JUN 27 *	284 CFS ON OCT 17	814000 AC-FT	1968
1969	---	5740 CFS ON JUN 15	---	---	1969
1970	---	3230 CFS ON JUN 8	149 CFS ON DEC 22	387000 AC-FT	1970
1971	---	---	---	---	1971
				611000 AC-FT	MEAN

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

COHO AND SOCKEYE

APPENDIX C

ESCAPEMENTS TO THE UPPER LILLOOET RIVER AND TRIBUTARIES

(5 year averages 1940-1974 and yearly escapements 1965-1976)

5 Year Period	Fisheries Officer	Lillooet Mainstem		Green River		Pemberton (1 Mile) Cr.		Miller Cr.		Ryan Cr.		Salmon Slough		John Sandy Cr.		Railroad Cr.		25 Mile(Sampson) Cr.	
		Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye	Coho	Socketeye
1940-44	Winlow	4000	2450	545	430	80	0	350	605	395	255	320	(190)	25	20	50	19	790	3600
1945-49	Reynolds	5625	450	206	162	100	(1945)**	406	131	69	1044	599	(50)	6	8	0	0	850	575
1950-54	Reynolds	5140	750	100	25	25		70	20	875	75	315	(1950)**	0	0	NR	0	0	0
1955-59	Reynolds	115	17	80	20	19		25	25	30	(1950)**	115		5	0	20	0	12	0
1960-64	Reynolds	300	(1957)**	500	125	25		19	(1956)**	360		100		19	0	70	0	85	0
1965-69		425		400	110	40		30		440		330		56	0	139	0	69	0
1970-74		1250		1120	0	135		80		380		150		55	12	620	150	6	180

Yearly Escapements:

1965	Reynolds	75		400	200	25		25		400		200		75	0	200	0	200	0
1966	Reynolds	750		200	200	25		25		400		200		0	0	75	0	NR	NR
1967	Reynolds	300		500	100	50		50		250		200		50	0	100	0	0	0
1968	Reynolds	200		300	50	50		0		250		150		100	0	50	0	75	0
1969	Reynolds	800		600	0	50		50		900		900		0	0	270	0	0	0
1970	Wheeler	1500		1500	0	400		75		700		0		0	0	750	75	0	0
1971	Wheeler	2500		2500	0	200		150		400		400		150	50	1200	450	0	00
1972	Bentley	750		400	0	25		75		200		200		75	0	200	75	0	400*
1973	Bentley	750		400	0	25		75		200		75		25	0	200	75	NR	100*
1974	Bentley	750		400	0	25		25		400		75		25	0	750	75	25	400
1975	Bentley	3500		400	200	25		75		200		1500		25	25	400	200	25	200
1976	Bentley	400		300	0	25		25		100		50		0	0	50	100	50	300

(160*)

Source: Fisheries Service Spawning Reports, District #2, Area 29.

NR - No Report

* From Int. Pacific Salmon Fisheries Commission Records

** Year of last recorded escapement

Appendix C

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APPENDIX D

BIRKENHEAD RIVER

Methods for 1975 and 1976 Reconnaissance Surveys

Helicopter flights and foot surveys were used to enumerate and obtain distributions of spawning chinook and coho in the Birkenhead River. Chinook distributions were estimated from counts for each kilometer of river covered during the flights in 1975 and 1976. Foot surveys followed the flights and continued through the coho spawning season. Most effort was concentrated on the "Hindu Flats" area while all areas from Mt. Currie (km 8) to Birkenhead canyon (km 26) were covered at least once. Two men walked each section of the river, one on either bank. Number of live fish seen was recorded for each kilometer and all dead were sampled for length, condition, sex, colour, success of spawning and scales (20 or 10/fish; details in Lillooet-Birkenhead data file). It should be noted that there are many dead sockeye at the time of the chinook and coho dead recoveries and considerable effort was put into the chinook recovery. The chinook recovery programs were terminated when numbers of dead dwindled and live chinook were no longer observed. Effort for coho recovery was less intensive than for chinooks due to poor weather in 1975 and limited time in 1976.

Juvenile sampling in 1975 was carried out intermittently (Appendix E) using dip nets and also an "Electro Fisher". Backwaters and side channels were the main areas sampled. Stunned fish were recovered with the dip nets, identified, then released. Some were preserved in 10% formalin.

Gee's wire minnow traps were used to capture juveniles in 1976. These were set at many locations from kilometer 0-18, using salmon roe bait. A 16 ft. smokercraft with a 60 h.p. Mercury jet, provided easy access on the lower Birkenhead (up to km 8). Most traps were left overnight and all were allowed to sink to the river

APPENDIX D (cont.)

bottom, and were marked with styrofoam floats. All captured fish were identified, counted and released except chinook which were preserved in 10% formalin, for sampling. Other methods of capture were considered such as seining or electro-shocking but necessary equipment was not available and few suitable sites were located.

Several methods were considered for capturing adult chinook in 1976. Gaffing, spearing or stunning (via explosive or electric shock) were eliminated due to the danger of damaging the fish. Seining and snaring were not attempted due to difficulties in finding suitable sites. Fish were mainly in fast water riffle areas or deeper pools. Most areas were either inaccessible or had no beach area from which to seine efficiently. A 7½" mesh gillnet was set overnight in a pool at kilometer 10 (just downstream of the logging bridge), but only sockeye were captured. Of the methods considered, only sport fishing was successful. Snagging or jigging was most effective, but some fish were taken on spoons (Kitimat, crocodile) and bait (roe).

Throughout the time period of the chinook surveys in 1976 assistance was given to Fisheries engineers installing the river intake and pipeline for the water supply to the 50,000 egg incubation box.

APPENDIX E

BIRKENHEAD RIVER 1975

JUVENILE SAMPLING

<u>Date</u>	<u>Equip. used</u>	<u>Location</u>	<u>Species Caught</u>	<u>Number Caught</u>	<u>Remarks</u>
Sept. 25	Dip Net	km 34	Trout	Present	
26	Dip Net	km 19	Trout	Present	
		km 19	Coho	3	
		km 25	Trout	Present	
		km 25	Coho	3	
Oct. 16	Dip Net	km 22	Trout	Present	
		km 22	Coho	7	
22	Electro* Shocker	km 34	Trout	14	
23	Electro shocker	km 25	Dolly Varden	2	Average length 210 mm.
		km 25	Rainbow Trout	33	Average length 48.9 mm
		km 25	Coho	11	Average length 73.7 mm

* Smith-Roote type 8 "Electro-Fisher"

APPENDIX E (cont.)

Details of Minnow trapping results in the Birkenhead River Sept. 7-17, 1976
 (Gee's wire minnow traps with chum salmon roe bait).

Date (Time) Set	Date (Time) Lifted	Location	Catch
Sept. 7 (PM)	Sept. 8 (AM)	Km 17 Hydro Br. (2 traps)	1 trout (8cm)
Sept. 7 (PM)	Sept. 8 (AM)	Km 15 Hwy Br. (2 traps)	2 coho-4 sculpin
Sept. 7 (PM)	Sept. 8 (AM)	Km 10 Logging Br. (2traps)	5 coho-1 trout-(12cm)- 12 sculpin
Sept. 8 (AM)	Sept. 8 (PM)	6 traps in North West end of Lillooet Lk.	0
Sept. 8 (PM)	Sept. 9 (AM)	Km 1	2 chinook-3 coho- 10 sculpins
Sept. 8 (PM)	Sept. 9 (AM)	Km 2	9 coho-1 trout(12 cm)- 2sculpin
Sept. 8 (PM)	Sept. 9 (AM)	Km 3	0
Sept. 8 (PM)	Sept. 9 (AM)	Km 5	17 coho-1 trout (6cm)- 15 sculpin
Sept. 8 (PM)	Sept. 9 (AM)	Km 6	1 trout (8 cm)-3 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	1 coho
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	5 coho-1 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	2 coho
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	1 coho-4 sculpin
Sept. 13 (AM)	Sept. 13 (PM)	Km 1	3 coho-2 sculpin
Sept. 13 (PM)	Sept. 14 (AM)	Km 1 12 traps set in vicinity of river mouth & Km 1. Total catch was:	1 chinook(escaped) 13 coho- 3 whitefish. 59 sculpin
Sept. 14 (PM)	Sept. 14 (PM)	5 minnow traps set in Taillefer Cr. (outflow of Birkenhead lake) Total catch:	1 dolly varden 2 rainbow trout

APPENDIX E (cont.)

DETAILS OF MINNOW TRAPPING RESULTS ON THE
BIRKENHEAD-LILLOOET SYSTEM JANUARY 19 & 20, 1977

<u>Number of Traps</u>	<u>Date (Time) Set</u>	<u>Date (Time) Lifted</u>	<u>Location</u>	<u>Catch</u>
2	Jan. 19 (PM)	Jan. 20 (AM)	Km 9 slough behind Mt. Currie Hard- ware	74 Coho
3	Jan. 19 (PM)	Jan. 20 (AM)	Km 15, Twin Bridges	3 Coho 1 Dolly Varden (~13 cm) 1 Trout (~8 cm)
2	Jan. 19 (PM)	Jan. 20 (AM)	Km 7 Indian Br.	13 Coho
2	Jan. 19 (PM)	Jan. 20 (AM)	Km 7 side channel	3 Coho 13 Sculpins
3	Jan. 19 (PM)	Jan. 20 (PM)	Km 0 Bridges at River Mouth	1 Sculpin
2	Jan. 19 (PM)	Jan. 20 (PM)	Lillooet Lake Shore at Indian Net Site	9 Coho
2	Jan. 19 (PM)	Jan. 20 (PM)	1 Km east of Lillooet Lake Head on North Shore	0
2	Jan. 19 (PM)	Jan. 20 (PM)	3 Km east of Lillooet Lake Head on North Shore	0
2	Jan. 19 (PM)	Jan. 20 (PM)	5 Km East of Lillooet Lake Head on North Shore	1 Sculpin

- Equipment used - Gee's Minnow Traps with
frozen Chum salmon roe bait.