DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA

ANNUAL REPORT

RESOURCE DEVELOPMENT BRANCH

PACIFIC REGION

1969

VANCOUVER, B.C.
March, 1970

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INTRODUCTION

The Resource Development Branch (formerly, the Fish Culture Branch) was reconstituted in 1948 to include among its major responsibilities the application of stream improvement measures to enhance salmon production. To cope with these responsibilities in British Columbia a technical staff, consisting of biologists and engineers, was established in the Pacific headquarters in Vancouver in 1949. Initially the objectives of the Branch were primarily directed toward the alleviation of known salmon obstructions and a program based on priority, costs and other factors was prepared with a view to completing one major fishway each year, commencing in 1951. This program was subsequently disrupted so that proper attention could be directed toward the many and varied fisheries problems arising from the hydro electric agency's proposals to tap the power potentials of many good salmon supporting streams. Accordingly assessments of industrial proposals and associated studies came to be the major occupation of the Branch during the middle and late 1950's. In addition, a section was established in 1957 to deal with pollution of waters inhabited by fish using as its authority Section 33 of the Fisheries Act.

By 1960 the Branch had developed a relatively strong technical staff and the hydro power problems were lessened as the result of major developments on the Peace and Columbia rivers. The Branch was thus in the position to direct greater efforts toward the enhancement of salmon production

by the application of stream improvement measures. Subsequently the Branch undertook projects involving the application of flow control and/or spawning channel principles. This resulted in the establishment of the following facilities: Robertson Creek spawning channel (1961) to provide new and improved spawning grounds for native runs of coho and chinook salmon and to create suitable conditions for an experimental transplant of pink salmon eggs; Nanika River hatchery and incubation channel (1961) to rehabilitate the sockeye salmon run to the Morice Lake system; Big Qualicum River flow control and spawning channel (1962) to enhance the freshwater survival of native runs of chum, chinook and coho salmon and to provide the facilities required for an experimental transplant of pink salmon; Fulton River spawning channel (1965) to increase the production of sockeye salmon fry in the Babine Lake area (the first step in a proposed six-year development program for this area). Although spawning channels and flow regulation were the major tools which the Branch employed in the 1960's in its development work a major fishway was constructed on the Meziaden River and a pre-fabricated (steep-pass) fishway was also installed on Kakweikan River. In addition to these major works the Branch carried out routine stream clearance projects to remove log jams, small landslides, beaver dams, etc.

During the 1960's the pollution section was enlarged to cope with the rapid increase in problems encountered in

the prevention, detection, assessment, and abatement of water pollution.

In 1961 the Resource Development Branch undertook as a major responsibility scientific studies and assessments, as required, to ascertain the status of various salmon stocks with a view to advancing recommendations for their effective management. The activities in this area have expanded to the extent that many major salmon and herring stocks in British Columbia are now under scientific study and/or management by personnel of this Branch.

Concurrent with fisheries development and management programs a study in artificial propagation of chinook and coho salmon commenced in 1968 to evaluate the hatchery technique and to consider its implementation in British Columbia. A part of this study includes transplant possibilities for coho salmon into upstream areas of watersheds where major obstacles have limited their distribution and for chinook salmon into watersheds that may later prove to be hatchery sites.

The many problems to salmon arising from development of natural resources within the province were long apparent and accordingly in 1964 a section was formed to protect the fisheries resource from the hazards of industrial water-use projects such as logging, water diversions, flood control, gravel removal, hydro electric installations and marine seismography.

Research technology is also being pursued to design, modify, invent, and put into practice instruments, equipment and systems required to carry out a wider range of studies in the field of fisheries biology and engineering.

The Branch is also engaged in a stream inventory program with a view to collecting specific information to assist in the development, regulation and protection of the resource.

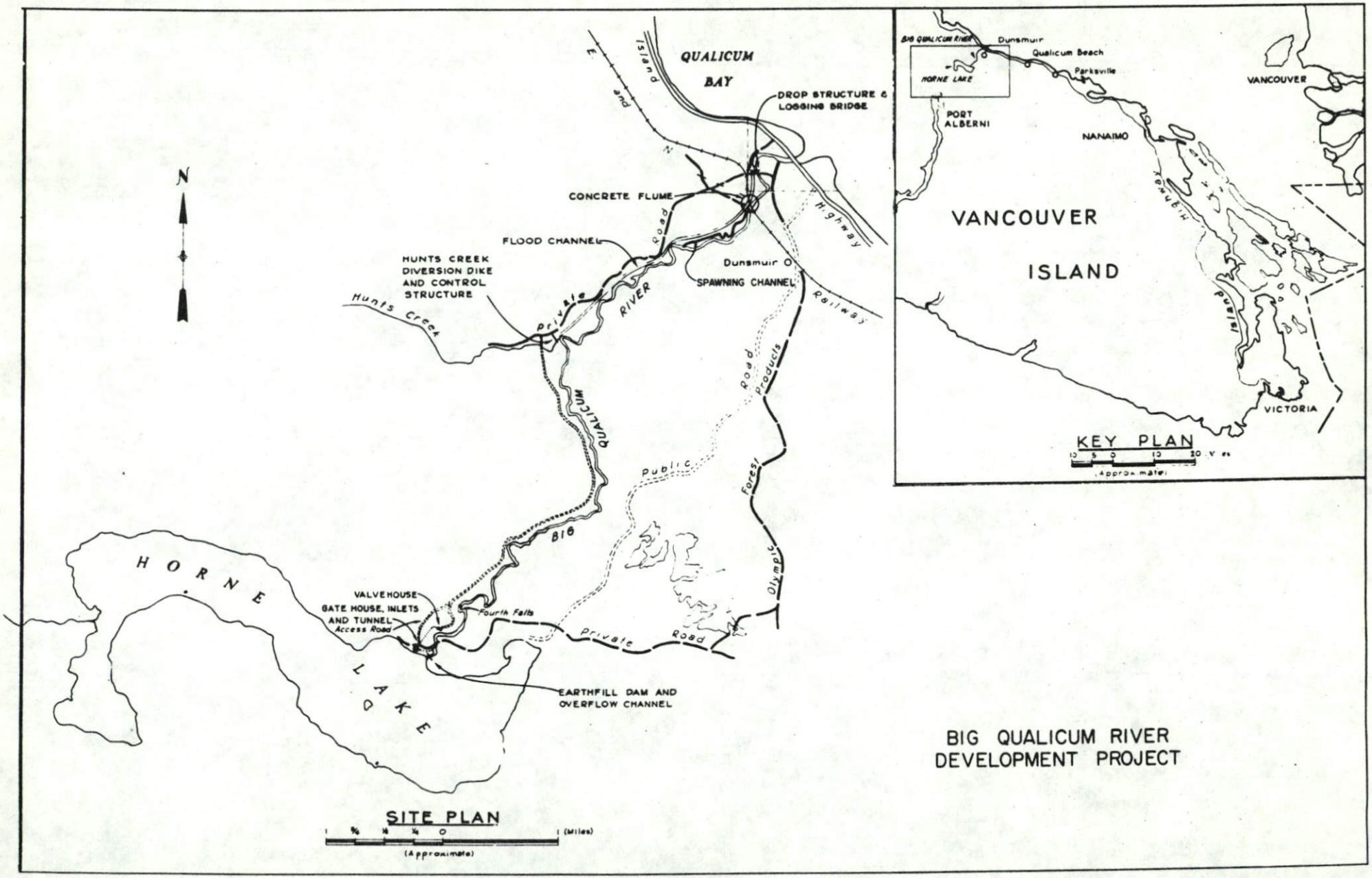
DEVELOPMENT PROJECTS, INVESTIGATIONS AND STREAM MAINTENANCE

Big Qualicum River

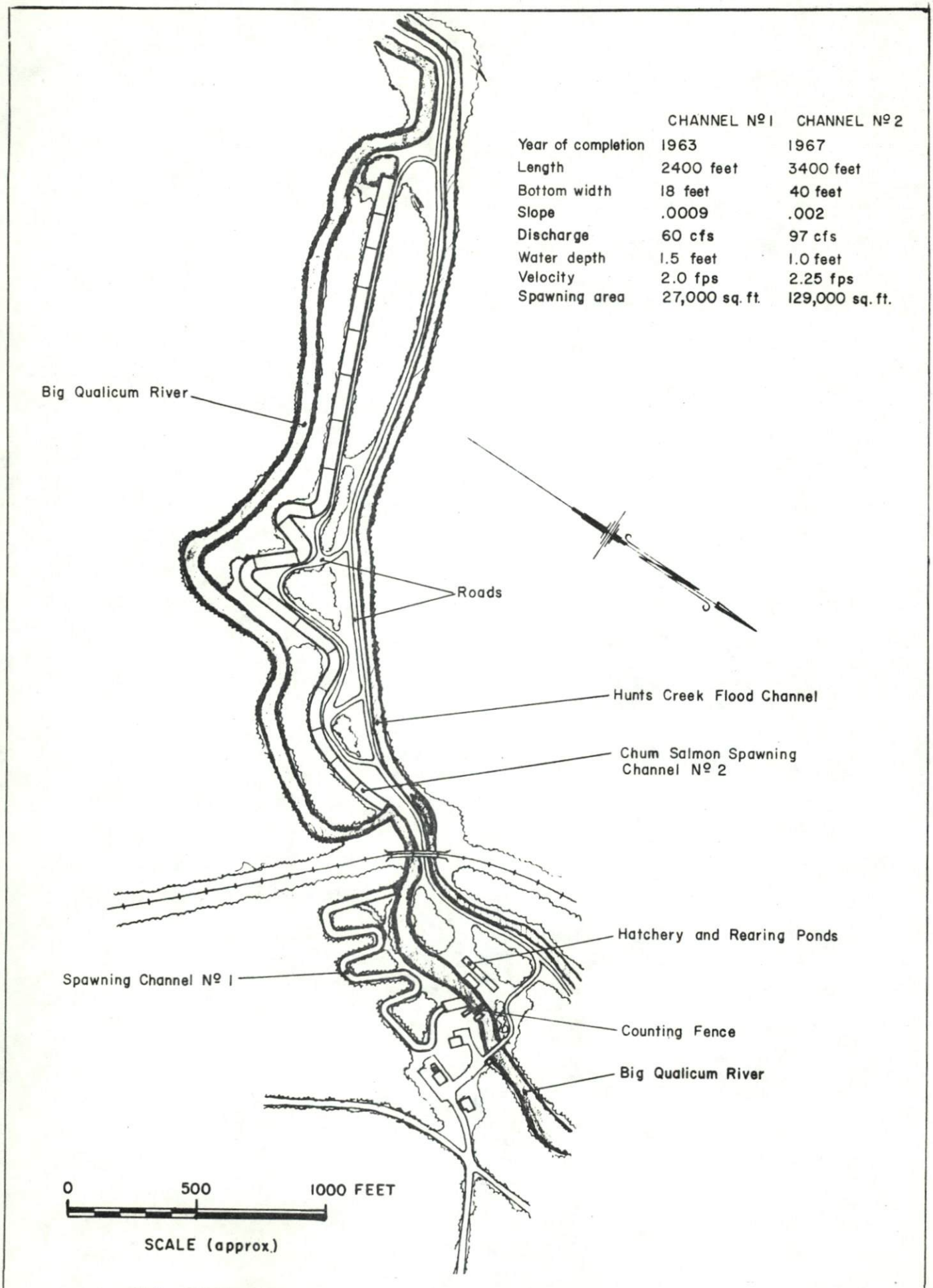
The biological investigations associated with the Big Qualicum Development Project were initiated in 1959 and ten consecutive years of assessment have now been completed. Since flow control was implemented on the Big Qualicum in 1963, the river has experienced neither floods nor drought. The effect of this environmental control is now being demonstrated by substantial increases in salmon production.

(1) Juvenile salmon production

The production of chum salmon fry totalled a record 53.5 million in 1969. This total was achieved despite a lower egg-to-fry survival rate in the main river of 16 percent. The 1963 to 1968 egg-to-fry survival average is 33 percent. It should be noted that the 1969 survival rate is still considerably higher than that encountered in uncontrolled streams. The lower survival may have been the



BIG QUALICUM RIVER DEVELOPMENT PROJECT



BIG QUALICUM RIVER SPAWNING CHANNELS

result of a degree of overspawning in certain areas combined with a particularly harsh winter during which prolonged periods of very low water temperatures were encountered.

The production of 130,680 wild chinook fingerlings from the river was the highest on record. The early emergent fry emigration totalled 189,000 of which 60,000 were captured and transferred to the hatchery for rearing to fingerling size.

The emigration of 38,875 coho smolts from the 1967 brood is considered to be a normal production for the river under the flow control regime. The production of 137,000 early emigrating coho fry, which are considered to be surplus to the system, was lower than that encountered in all other years since flow control was achieved and perhaps reflects both the lower adult escapement (1,650 as compared to the post-control average of 3,562) and the harsh winter conditions.

(2) Chum fry marking program

Chum fry marking was carried out for the fifth consecutive year with a record number being fin-clipped (Table I). The 2.68 million marked fry represents 5.0 percent of total production.

The five-year old chums of the 1964 brood stock, which were marked in 1965, returned to the Big Qualicum this year, thus completing the entire return from the first year of marking. Of the 762,000 river fry marked at that time (4.78 percent of the entire population) 7,330 marked adults have now been accounted for.

Table I. The number of chum fry marked annually since 1965. The fry marked are wild stock from the river except where specifically noted.

Year	Number Adipose	Number Marked Adipose Right Ventral Fins	Number Marked Adipose Left Ventral Fins	Total
1965	762,000	-	-	762,000
1966	-	177,750	192,900*	370,650
1967	-	419,344	154,253*	573,597
1968	-	408,800	408,800**	817,600
1969	-	448,500**	2,231,250	2,679,750

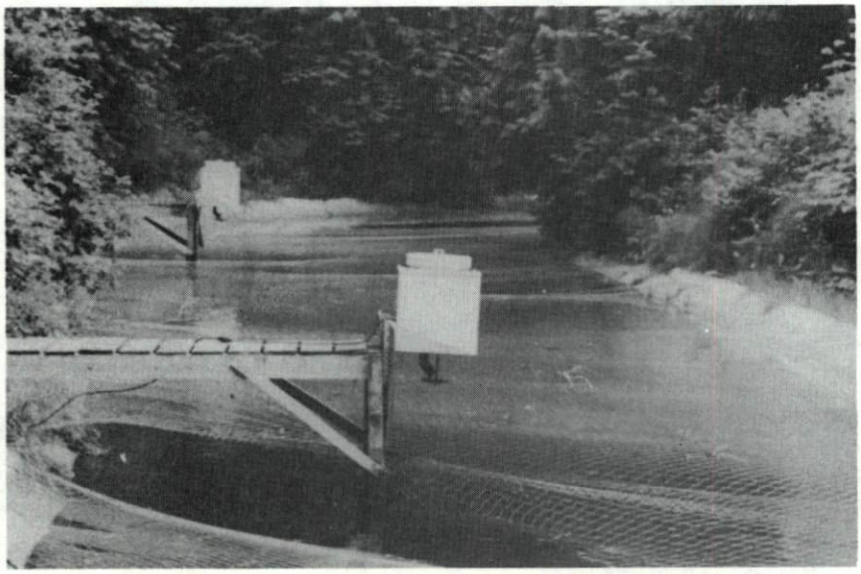
* No. 1 (old) spawning channel fry.
** No. 2 (new) spawning channel fry.

(3) Freshwater rearing of chum fry

The lower section of the original spawning channel has been converted into a chum fry freshwater rearing impoundment. In 1969, 2.6 million fry were captured in the river and placed in the channel. The fry were retained for approximately 45 days and fed by automatic feeders. Approximately 1.5 million fingerlings were released at an average weight of 3.0 gm. The group is identified by an adipose-anal fin mark.

(4) Adult salmon returns

The return of chum salmon to the Big Qualicum River amounted to 100,500 -- the second largest escapement on record and exceeded only by the 1968 total of 140,000 spawners.



The freshwater rearing area for chum salmon fry in the Qualicum spawning channel #1. Automatic feeders are located on piers throughout the channel. Bank to bank netting excludes certain predators.

The spawning distribution of the escapement was considered good, both water flow and temperatures have been optimum and excellent production of fry can therefore be expected.

The chinook salmon return of 2,393 adults and jacks (940) all but equalled the record return of 1959 (2,411) and represented almost a 100 percent increase over the post-control average of 1,229. The distribution of spawners was judged normal and spawning success was good.

The escapement of coho to the Big Qualicum totalled 2,170 and was, for the third consecutive year, substantially below the post-control average of 3,560 fish. Part of this decline is attributed to the failure of the Hunt's Creek run which has declined from a 900 fish average to the 100-200 range for the last three years. Coho returns to other rivers in the area were also reported as being below average in escapement.

An incidental migration of pink salmon, in the order of 250, was recorded.

(5) Chum salmon artificial spawning channel

The second year of operation of the new spawning channel again resulted in an outstanding chum fry production. The total fry output of 18.3 million represented an 81 percent egg-to-fry survival rate.

In the fall of 1969, 16,500 adults, including 8,700 females, completely utilized the channel without overspawning.

It is anticipated that a new fry production record will be established in the spring of 1970.

(6) Chum salmon commercial harvest

For the third consecutive year fin-clipped adult chum salmon, marked as fry when leaving the Big Qualicum River, were observed in substantial numbers in commercial landings. The two major chum salmon fisheries, Johnstone Strait and Fraser River, were closely monitored in order to recover marked Big Qualicum chums. On the basis of this survey it is estimated that about 150,000 Big Qualicum chum salmon were harvested in 1969.

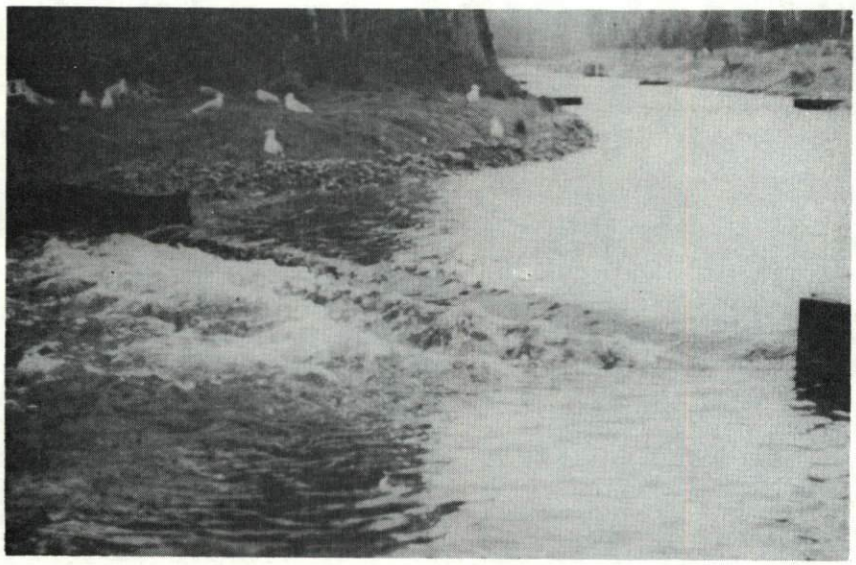
(7) Streambed improvement

Streambed improvement was carried out on the Big Qualicum River in 1969 for the third year in a row. This year the spawning area was expanded another 13,000 sq yd to provide, in total, 49,000 sq yd of newly created spawning area in the three year period. In addition, the existing spawning beds were reconditioned and extensive areas of gravel compaction eliminated.

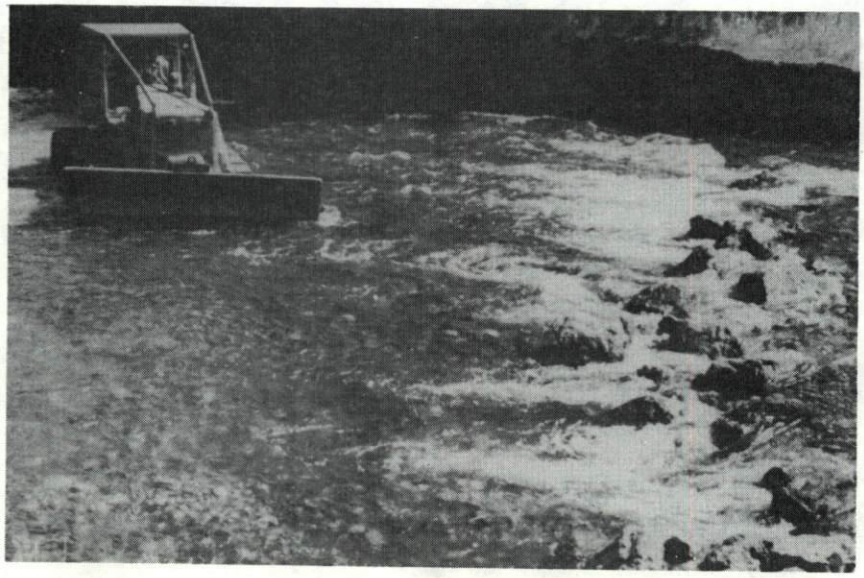
The expansion phase of streambed improvement has now been completed and a total of 134,000 sq yd of spawning area is presently available to chum salmon in the Big Qualicum system.

(8) Public relations

In 1969 the general public again demonstrated a strong interest in the work of the Department. Over 20,000 people visited the project. In addition, more than 2,000 students



A section of Qualicum spawning channel #2. About 870 chum salmon spawned in each of the 19 sections in 1969.



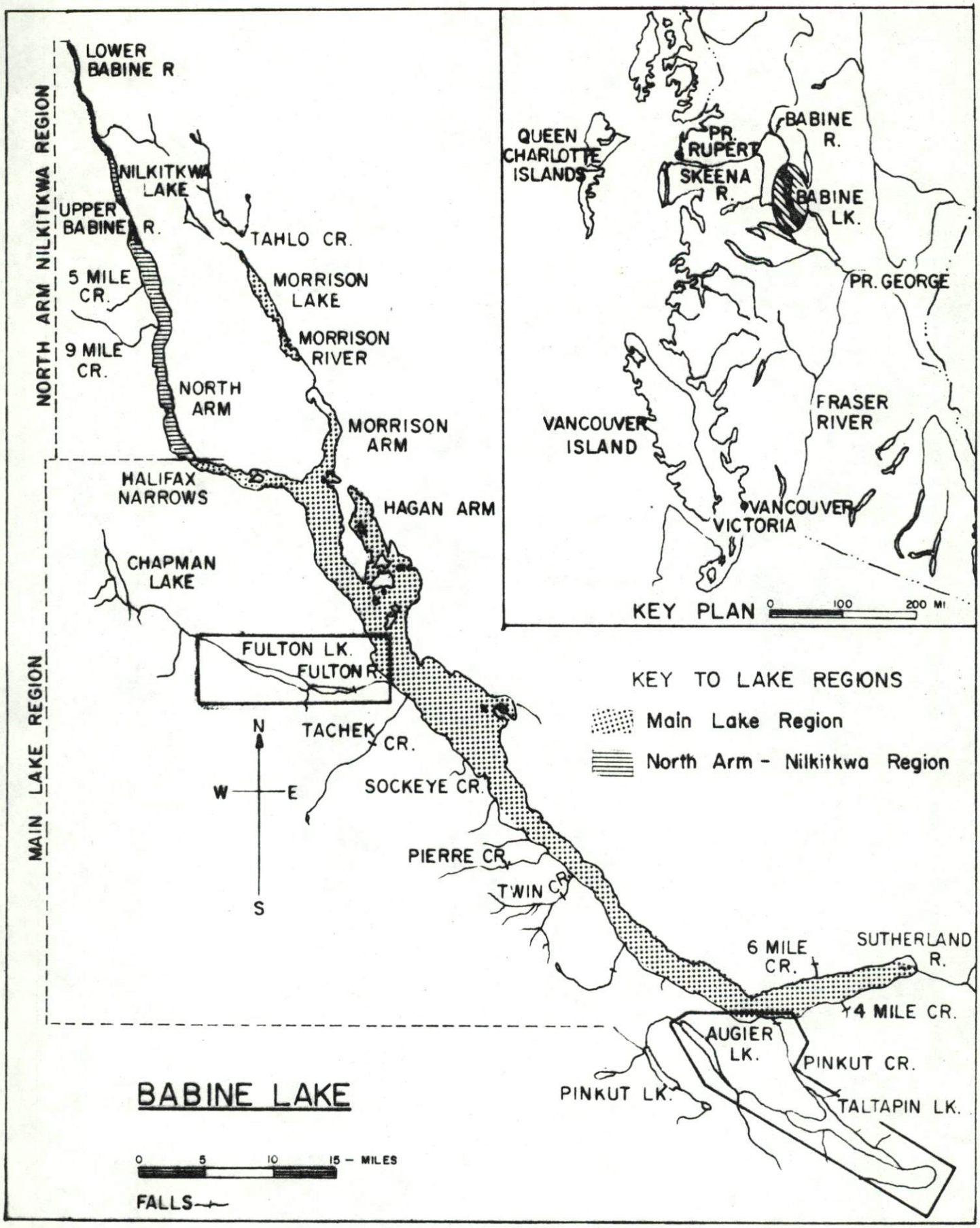
An example of stream improvement in the Big Qualicum River. A rock weir is being installed to adjust water depth and velocity to chum salmon spawning requirements.

from various Vancouver Island schools were conducted around the project while taking part in school sponsored biological field trips.

During the spring and summer of 1969 the flow regime of the river was adjusted in order to maintain Horne Lake, the Big Qualicum project reservoir, at a level sufficient to assure that full recreational potential of the lake would be realized. Horne Lake is a popular fishing and camping site in the area.

Babine Lake Sockeye Development Program

The spawning channel technique was introduced in the Babine Lake area in 1965 when the Branch constructed a sockeye salmon spawning channel on the Fulton River. This was the first step in a six-year, 8.5 million dollar development program looking toward a substantial increase in the number of sockeye salmon fry entering Babine Lake. This was important in order to realize the smolt production potential of the main basin of Babine Lake -- this being thwarted under natural conditions by the lack of spawning grounds. A second channel was added in 1967, this time at Pinkut Creek, the principal south-end tributary to Babine Lake. In 1969 the initial stage for spawning channel No. 2, Fulton River, was completed. The total spawner capacity for facilities completed to date in the Babine area is 165,000 sockeye. Budgetary limitations will result in a delay of one year to 1971 in completion of the second phase of the major channel located on the Fulton River. This development is designed to produce 1,250,000 adult sockeye annually of which 1,000,000 will be taken in the commercial fishery.


LOWER BABINE R
NORTH ARM NILKITKWA REGION
NILKITKWA LAKE
UPPER BABINE R.
TAHLO CR.
5 MILE CR.
MORRISON LAKE
9 MILE CR.
MORRISON RIVER
NORTH ARM
MORRISON ARM
HALIFAX NARROWS
HAGAN ARM
CHAPMAN LAKE
FULTON LK.
FULTON R.
MAIN LAKE REGION
N
W
E
S
TACHEK CR.
SOCKEYE CR.
PIERRE CR.
TWIN CR.
6 MILE CR.
SUTHERLAND R.
4 MILE CR.
AUGIER LK.
PINKUT CR.
PINKUT LK.
TALTAPIN LK.
BABINE LAKE
0 5 10 15 — MILES
FALLS
QUEEN CHARLOTTE ISLANDS
PR. RUPERT
SKEENA R.
BABINE R.
BABINE LK.
PR. GEORGE
FRASER RIVER
VANCOUVER ISLAND
VANCOUVER
VICTORIA
KEY PLAN
0 100 200 MI
KEY TO LAKE REGIONS
Main Lake Region
North Arm - Nilkitkwa Region

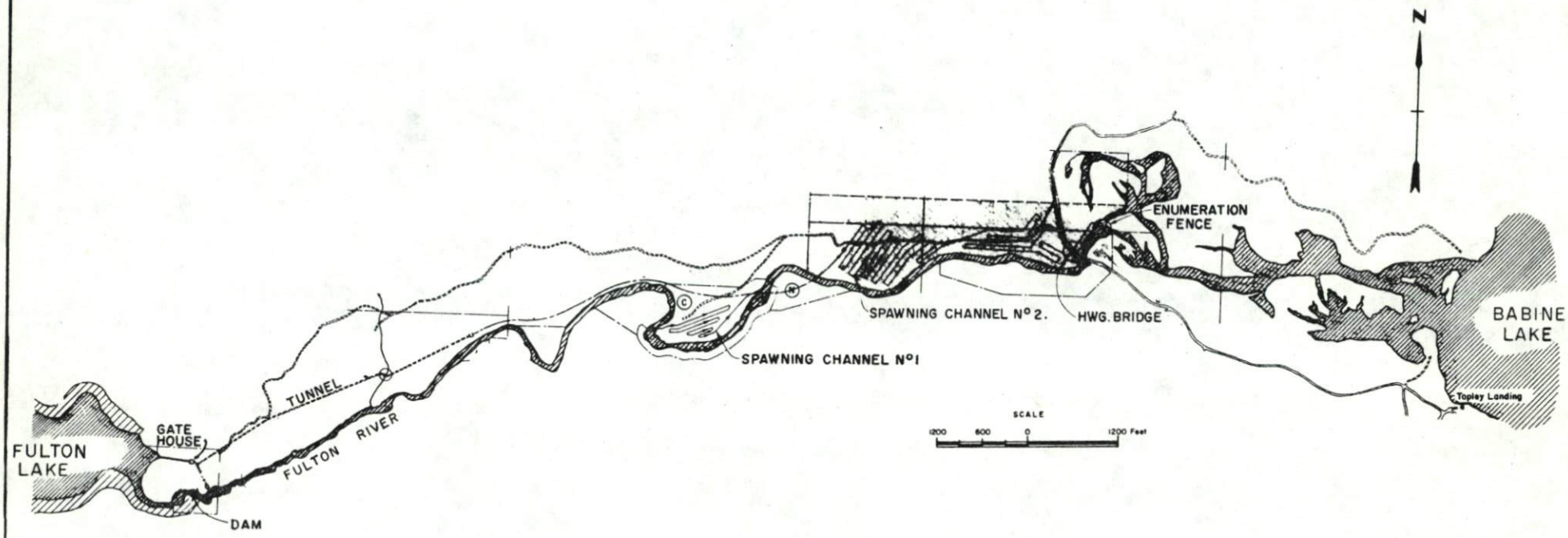
(1) Fulton River fry production

The 1969 spring fry enumeration program gave a calculated production of 57.7 million, the largest output since the enumeration program was initiated in 1961. Spawning channel No. 1, which had an egg deposition of 55.2 million in 1968, produced 24.7 million fry for an egg-to-fry survival rate of 44.7 percent, while the river production of 33 million fry, from 213.2 million eggs, indicated a 15.5 percent survival rate. Overall survival was 21.5 percent, identical with that of the previous year, but only one-half that of the winter of 1966-67. A prolonged period of abnormally cold weather early in 1969 may have been a contributing factor to the higher than expected egg-to-fry mortality.

Sockeye fry produced in the Fulton River spawning channel in 1969, and those produced in the natural Fulton River were compared for quality. The quality indices selected for study were:

1. weight, length and development stage,
2. predation vulnerability,
3. swimming endurance.

Analysis of the length and weight data revealed that channel fry in 1969 were both heavier and longer than river fry. Channel fry were also better developed at emergence than river fry. This situation was the reverse of that in 1968, though both river and channel populations in 1969 were longer, heavier and more mature than in 1968.



	CHANNEL No 1	CHANNEL No 2	
		1st Stage	2nd Stage
Year of completion	1965	1969	(1971)
Length	4860 ft.	9635 ft.	7485 ft.
Bottom Width	28 ft.	50 ft.	50 ft.
Slope	.0009	.002	.002
Discharge	70 c.f.s.	100 c.f.s.	100 c.f.s.
Water Depth	1.3 ft.	1.0 ft.	1.0 ft.
Velocity	1.8 f/s	2.0 f/s	2.0 f/s
Spawning area	123,400 sq.ft.	450,300	354,200

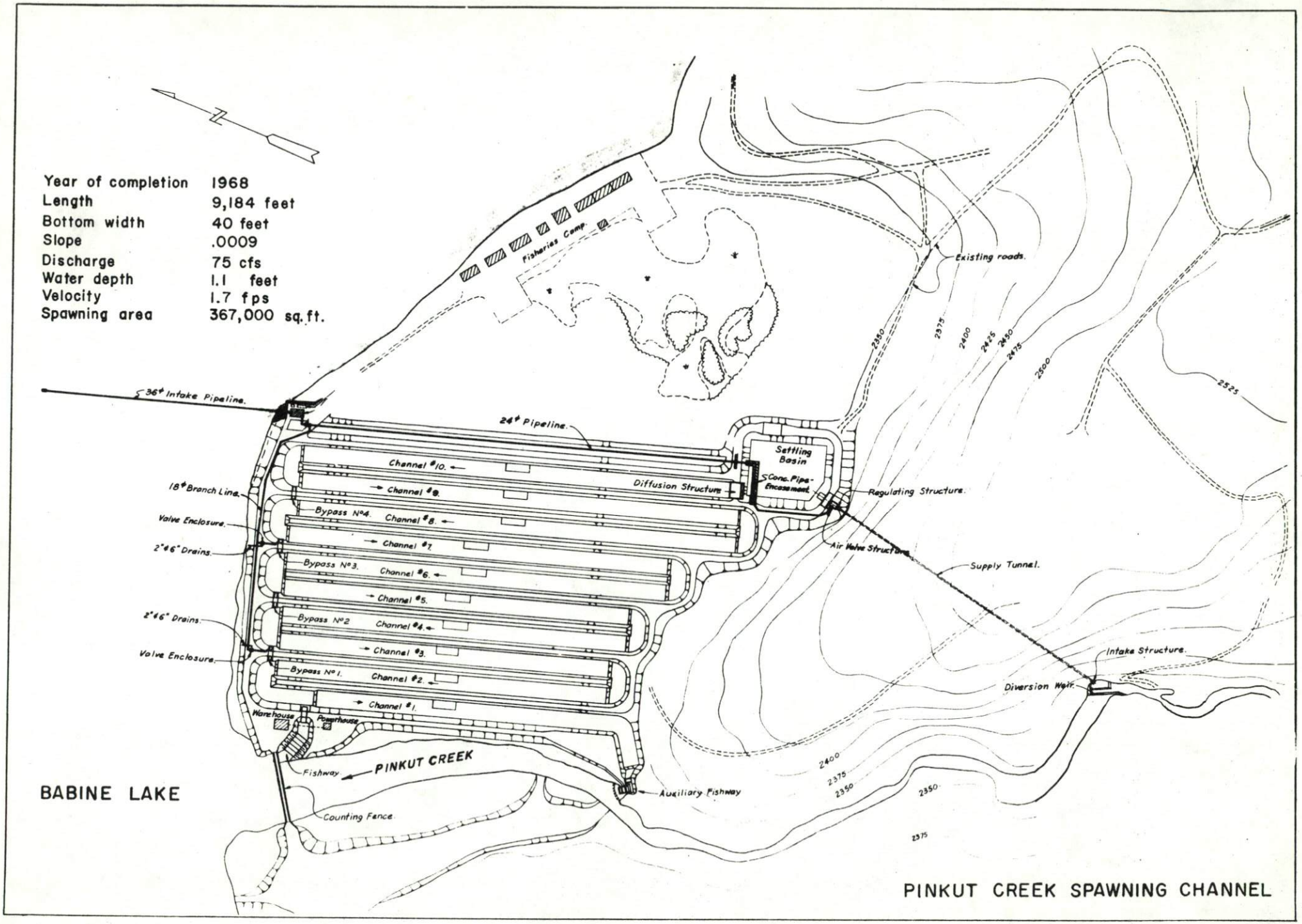
FULTON RIVER GENERAL LAYOUT

There was no significant difference between river and channel fry in swimming endurance, nor were the channel fry significantly different from river fry in their vulnerability to predation. Swimming endurance is apparently a function of size, larger fry displaying greater endurance than smaller, while vulnerability to predation depends upon three independent factors: fitness, absolute abundance and relative abundance.

(2) Pinkut Creek fry production

The Pinkut spawning channel was completed in 1968 and made its first contribution to Pinkut fry production in 1969. The total fry output of creek and channel was 12.3 million, this from an egg deposition of 51.2 million for a survival rate of 24.0 percent. The survival rate for the channel which contributed 10.4 million fry to the total was 33.3 percent -- less than one-half of the mean survival rate of channels in their first year of operation, but three times that of the river which produced 1.9 million fry. This was largely due to severe winter conditions which caused major ice damage to channel berms and subsequent dewatering and sedimentation of some channel sections.

A comparison of Pinkut Creek fry production revealed that the 1969 fry survival rate of 9.9 percent for the natural stream was slightly less than the previous five-year average (10.6 percent). This was associated with sedi-


Year of completion 1968
Length 9,184 feet
Bottom width 40 feet
Slope .0009
Discharge 75 cfs
Water depth 1.1 feet
Velocity 1.7 fps
Spawning area 367,000 sq. ft.
Fisheries Comp.
Existing roads.
36" Intake Pipeline.
24" Pipeline.
Settling Basin
5' Conc. Pipe-Encasement
Diffusion Structure
Regulating Structure.
Air Valve Structure
Supply Tunnel.
Intake Structure.
Diversion Weir.
18" Branch Line.
Valve Enclosure.
2"46" Drains.
Channel #10.
Channel #9.
Bypass No4. Channel #8.
Channel #7.
Bypass No3. Channel #6.
Channel #5.
Bypass No2 Channel #4.
Channel #3.
Bypass No1. Channel #2.
Channel #1.
Warehouse
Powerhouse
PINKUT CREEK
Fishway
Auxiliary Fishway
Counting Fence
BABINE LAKE
2350
2375
2400
2425
2450
2475
2500
2525
PINKUT CREEK SPAWNING CHANNEL

mentation occurring in the natural stream as a result of Departmental construction projects during the previous summer.

(3) Fulton River adult escapement

The sockeye escapement to the Fulton River in 1969 totalled 154,000 of which 49,000 (more than 30 percent) were 3_2's or jacks. The total adult spawning stock was distributed as follows:

River	60,000
Channel No. 1	21,000
Channel No. 2	24,000
Total	105,000

The portion of Channel No. 2 that was completed in 1969 can accommodate 80,000 adults. The target allotment of sockeye which were to spawn in the new channel was 50,000 fish. This reduced total was thought necessary because of the operational unknowns of a new channel subjected to severe winter conditions. Behavioural irregularities of sockeye on entering the new channel and the loss of attraction flows following overtopping of the Fulton Lake dam on September 24 resulted in the channel being seeded 26,000 short of the reduced goal.

The reluctance of fish to advance up the channel led to operational changes causing a disruption and delay in the timing of fish entry. The loading and distribution problems were alleviated when supplemental river water was pumped

into the channel. On investigation it was found that (1) the channel water registered higher readings for alkalinity, $CaCO_3$ and Ca than for river water, and (2) the source of increased alkalinity, $CaCO_3$ and Ca was occurring within Channel No. 2. These differences were assumed to be associated with the leeching action from freshly poured shotcrete berms. Continual readings will be made on a once-a-month basis to monitor water quality differences. It is anticipated that within a year the shotcrete will age to the point where the rate of leeching action will sharply decrease and be undetectable.

The calculated egg deposition for the Fulton system totalled 156.9 million, with 30.2 million in Channel No. 1, 36.9 million in Channel No. 2, and 89.9 million in the river. Total apparent egg deposition, despite the increased spawning area provided by completion of one phase of Channel No. 2, was 25 million less than the nine year average (from 1961 to 1969 inclusive) of 182 million. However the November hydraulic sampling indicated survival rates (to the eyed egg stage) of 67 percent in Channel No. 1, 92 percent in Channel No. 2 and 81 percent in the river. Since it is possible to maintain flow control in the river throughout the period of egg and larvae incubation as well as in the channels, better-than-average survival could contribute to a high level of fry production in the spring of 1970.

(4) Pinkut Creek adult escapement

The Pinkut spawning channel, which was completed in time to accommodate the 1968 run, has increased the available spawning area for the Pinkut escapement more than fivefold. That which formerly supported an optimum run of 14,000 in the creek alone, can now accommodate an optimum run of 81,000 in the creek and channel.

The escapement of sockeye to Pinkut Creek in 1969 totalled 44,000 of which 7,000 or 16 percent were jacks. In all, 37,000 adults returned, 8,000 to the creek and 29,000 to the spawning channel, thus the escapement was far below that considered to be optimum for the system. Total egg deposition was 51.2 million, 11.0 million in the creek and 40.2 million in the spawning channel. While egg deposition was disappointing, November hydraulic sampling provided an encouraging note. Survival to the eyed egg stage in November was 91 percent in the channel and 87 percent in the creek.

(5) Construction

The Babine Lake Development program entered the fifth year of a six-year construction program in 1969 and included the following projects: stage one of Fulton River Spawning Channel No. 2, 48 in. diameter water supply line, entrance fishway, enumeration building and laboratory, bank stabilization and drainage program, and the third phase of the Fulton Lake reservoir clearing operation.

The Fulton Lake reservoir clearing was under the direct supervision of F. F. Slaney and Company Limited, consulting

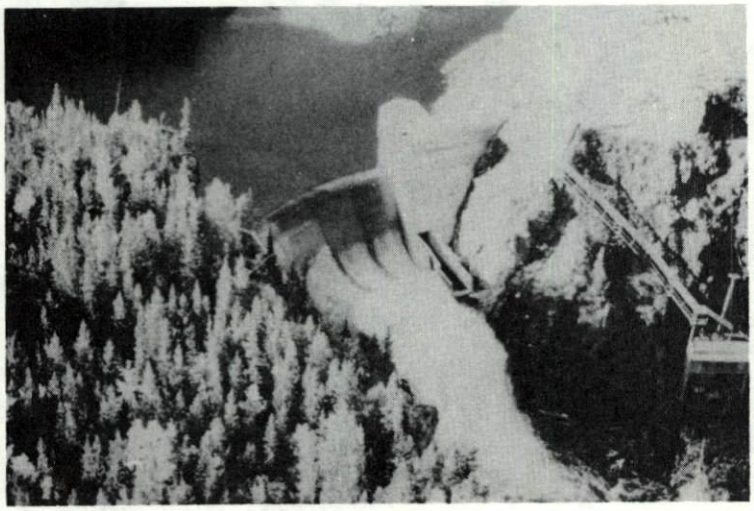
forest engineers. During the spring and early summer, a slash burning operation was carried out to burn, without handling, as much reservoir debris as possible. Following the slash burning, all remaining merchantable timber from the previous clearing contracts was shipped to Prince Rupert for export. In conjunction with the log salvage operation, debris collection booms, which stretched the full width of Fulton Lake, were inspected and maintained in preparation for the fall debris collection operation. With rising lake levels in mid September the remaining debris floated to the surface and accumulated along the shoreline. The Department's tug boat and several dozer-boats bag-boomed the floating debris and towed the booms to specified areas where a large crane equipped with automatic grapples stockpiled the debris at specially prepared sites for future burning. By December 31, 1969, 60 percent of the reservoir debris was either burned or piled for burning.

Alberta Utility Builders Limited commenced work in March on 5,400 lineal ft of 48 in diameter pipeline which takes water from Fulton Lake to Spawning Channel No. 2. Extra costs were incurred in stabilizing an earth slope which began to slide and crushed or distorted 120 ft of completed pipeline. The damaged pipe was removed and 100,000 cu yds of earth were removed from the slide area. Drilled soil samples were obtained, an intricate system of pipe seepage drains were installed, special rip-rap and drainage

cobbles were placed and an extensive program of open ditches and culverts were incorporated in the pipeline right-of-way to stabilize the slide. A 155 ft long pipe carrying trestle was built and new pipe was laid through the stabilized slide area. The pipeline was completed and in full operation by August at a cost of $500,000.

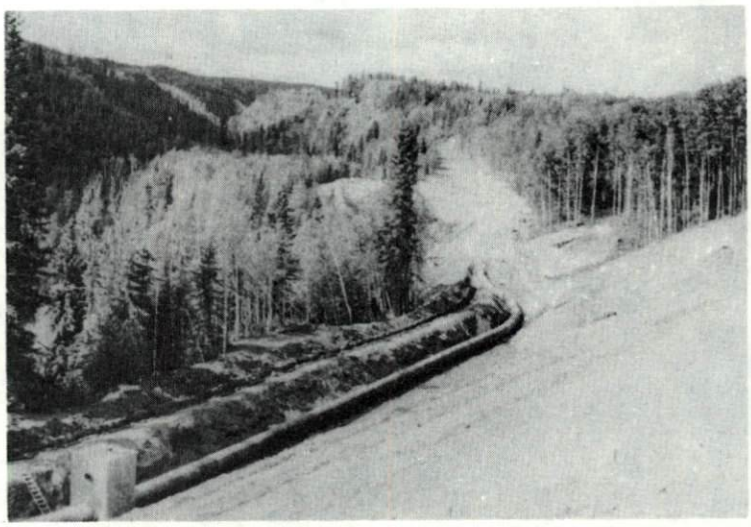
Construction of the Fulton River Spawning Channel No. 2 was resumed in February by earthworks contractor F. D. MacDougal Limited. One hundred and eleven thousand cu yds of silt and gravel were placed, compacted and shaped to complete the roadways, berms and channels. Total earthwork cost for Spawning Channel No. 2 was $360,000. While the earthwork was in progress, and at a cost of $700,000, Manning Construction built 18 control structures, applied shotcrete berm protection and placed 23,000 cu yds of spawning gravel. Construction of the structures, which control both water and fish distribution, required 1,340 cu yds of concrete, 173,000 lbs of reinforcing steel and 21,000 lbs of metalwork. To prevent erosion and damage from the spawning fish, the channel side slopes were covered with 350,000 sq ft of shotcrete (pneumatically applied concrete). Five hundred thousand sq ft of spawning channel was completed in time for the fall adult escapement.

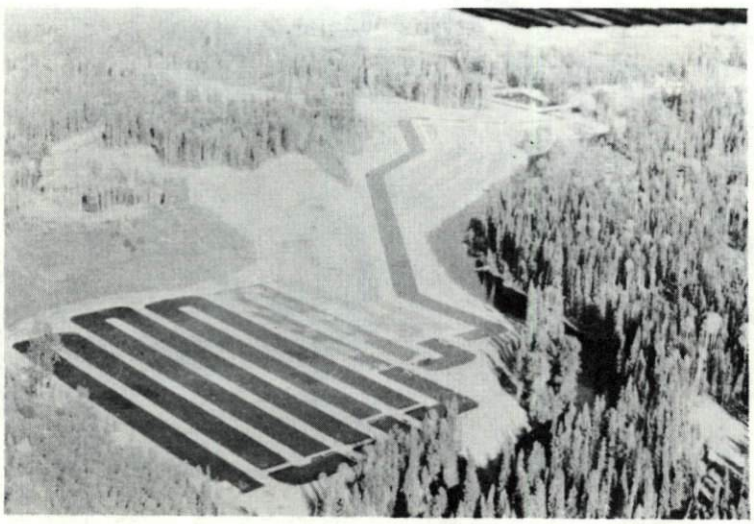
In addition to supervising all contracts in the Fulton area, the Department's engineering personnel also completed various force account work. In February, utilizing low water elevations a sheet piling fishway was built at the



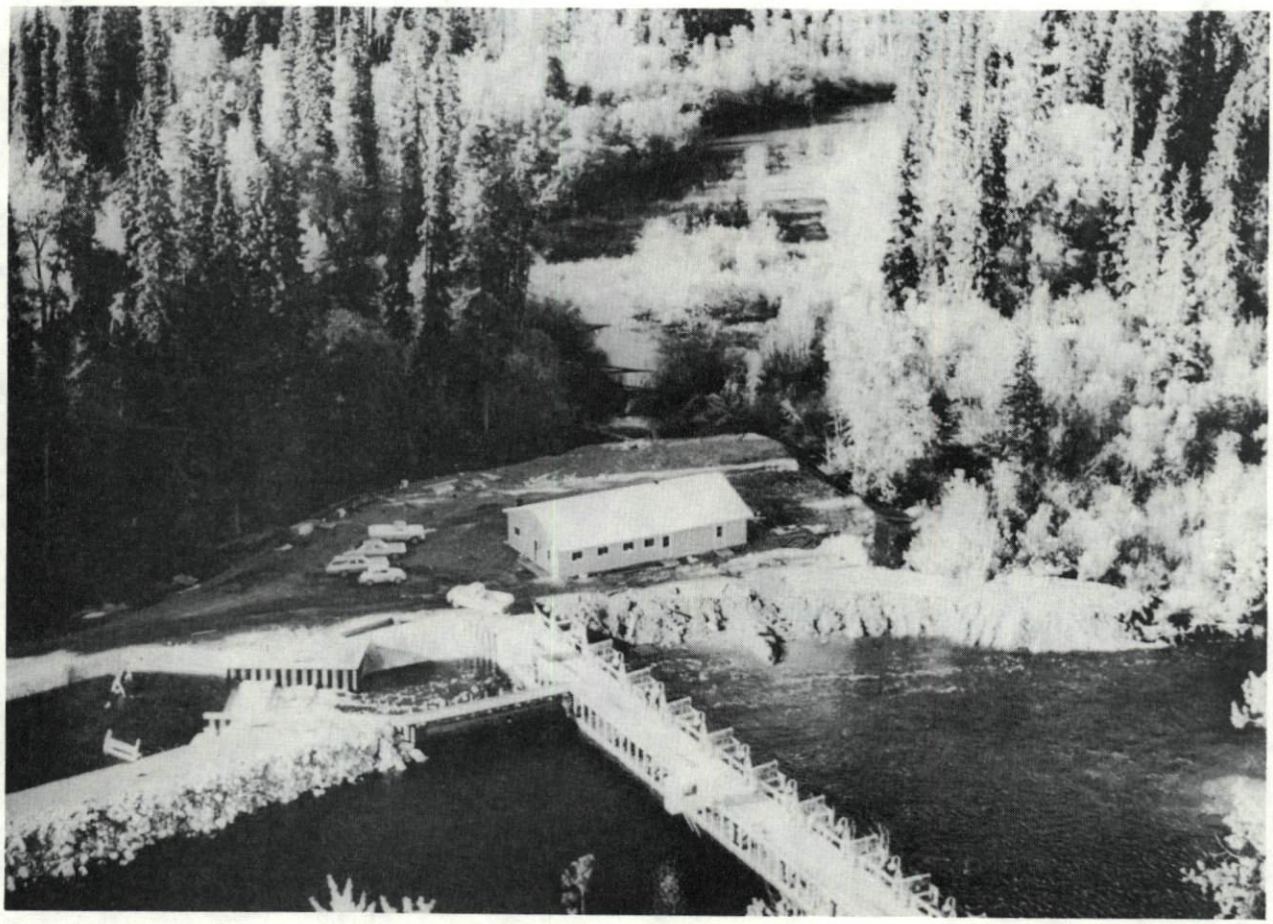
Impoundment dam at outlet of Fulton Lake.

48-inch diameter pipe-line from Fulton Lake to spawning channel #2.





First phase of spawning channel #2, Fulton River.



Fulton River counting fence, laboratory
and entrance to spawning channel #2.

entrance to Spawning Channel No. 2. Construction of the Fulton River Enumeration Building commenced in June and was completed in September. The building is to be used primarily for fry enumeration and as a wet laboratory. This installation can also be modified to serve as a storage building during the winter months. Thirty acres of soil slopes, borrow pits, roadways and pipeline right-of-way were sprayed with grass seed, mulch and fertilizer which stabilized the loose soils and thereby greatly reduced the amount of silt carried into the spawning areas by the fall run-off. An eroding creek was stabilized with rip-rap slopes and concrete weirs. A rip-rap toe filter was placed on the outside berm adjacent to the Fulton River. Force account work including fishway, enumeration building, silt stabilization and rip-rap cost $140,000.

The Department's engineering personnel built, at a total cost of $85,700, an auxiliary fishway, warehouse and powerhouse at the Pinkut Creek spawning channel. The auxiliary fishway at the channel's entrance can be used to admit spawners into the channel in the fall. It can also be used as a diffuser which prevents the Pinkut Creek spawners from entering the channel yet passes the channel flow into the Pinkut Creek spawning area. Construction of the warehouse and powerhouse commenced in June and was completed in September. The warehouse contains facilities for fry enumeration as well as a general storage area. Two 13.5 kilowatt diesel electric generators, located in the powerhouse, are used to energize

the warehouse and counting fence.

(6) Fulton River flow regulation

Upon completion of the Fulton River dam in late 1968, the Fulton Lake reservoir was utilized for the first time to supplement low flows in the Fulton River during the winter of 1968-69. Even though limited storage was available it was possible to substantially improve the minimum winter flow over what would have been available under natural conditions.

Our small network of snow courses and remote weather stations in conjunction with other data was used successfully in predicting the very low run-off volume to the Fulton Lake reservoir in 1969. The river peak flow was reduced to 2,150 cfs and the required reservoir storage level was achieved when desired (by June 22).

The fall run-off volume was unusually large after a dry period up to mid September. As there is only limited storage available for the control of fall freshets, the dam was overtopped by September 24 and a peak river flow of 700 cfs occurred on October 1. The natural inflows had reached a peak of 1,200 cfs about a week earlier.

The winter run-off to the end of 1969 has been fairly heavy and the reservoir was at full pond at the end of the year. A minimum winter discharge of 200 cfs will be maintained until the 1970 spring run-off.

(7) Hydrometeorological program

The comprehensive hydrometeorological program, initiated in 1966 to develop criteria for the design and operation of spawning channels, regulating works, and reservoirs, was continued in 1968. Data collection was intensified on the Fulton Lake reservoir to study the effects of the impoundment on water temperatures in the reservoir and through the regulating works. A better understanding of the capabilities of the intake works with respect to selective withdrawal of water at various temperatures is expected from this study.

Basic hydrometric and climatological data collection was continued in 1969 at Fulton River, Pinkut Creek, and Morrison River in order to serve all the engineering, biological and operational requirements associated with the Babine Lake project.

Puntledge River

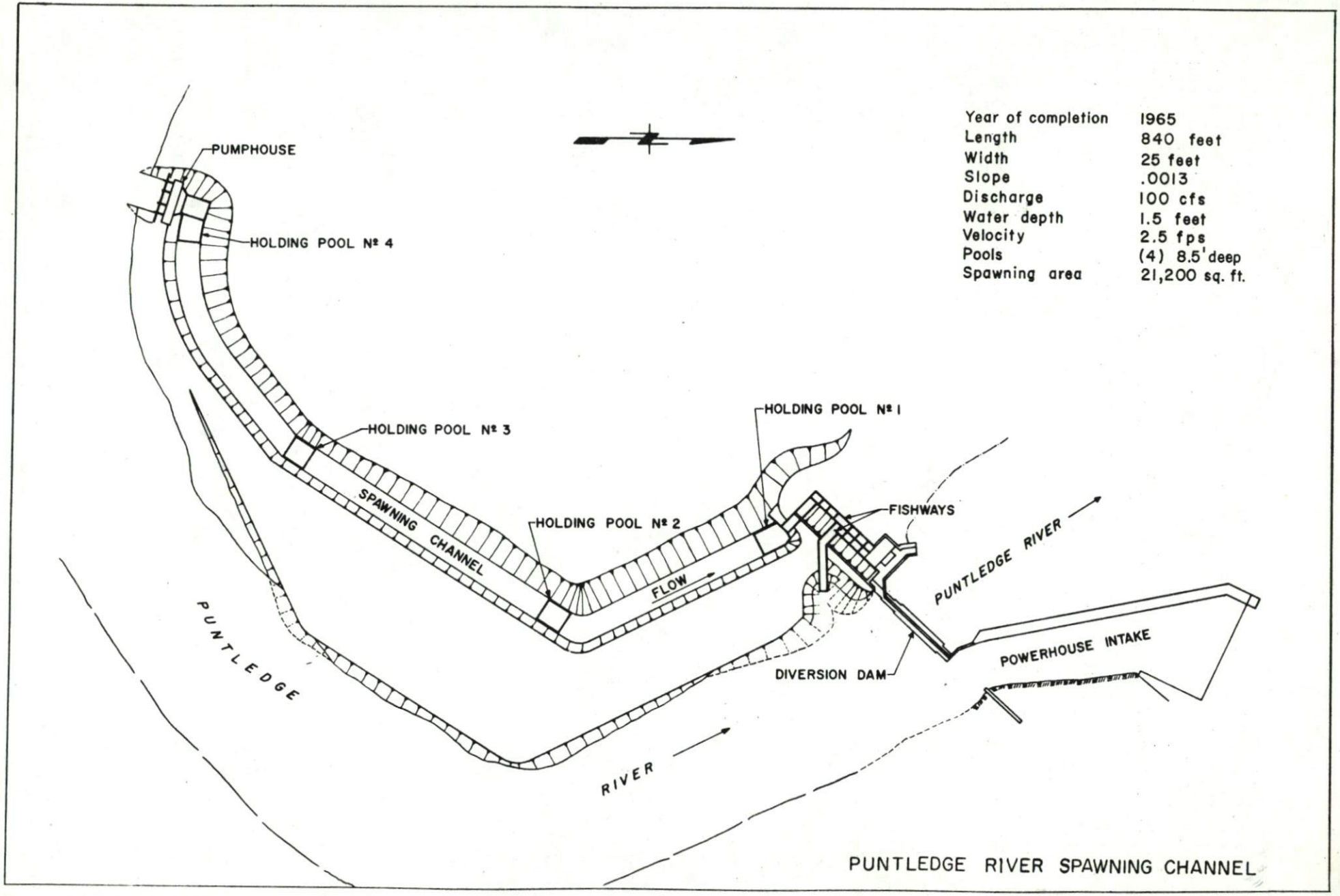
The 1969 field program at the Puntledge River included the following studies:

- enumeration of juvenile chinook salmon production at the Puntledge spawning channel;
- sampling and enumeration of the adult summer-run chinook escapement above Stotan Falls;
- investigation of the source of serious head injuries causing pre-spawning mortality of adult summer-run chinook;

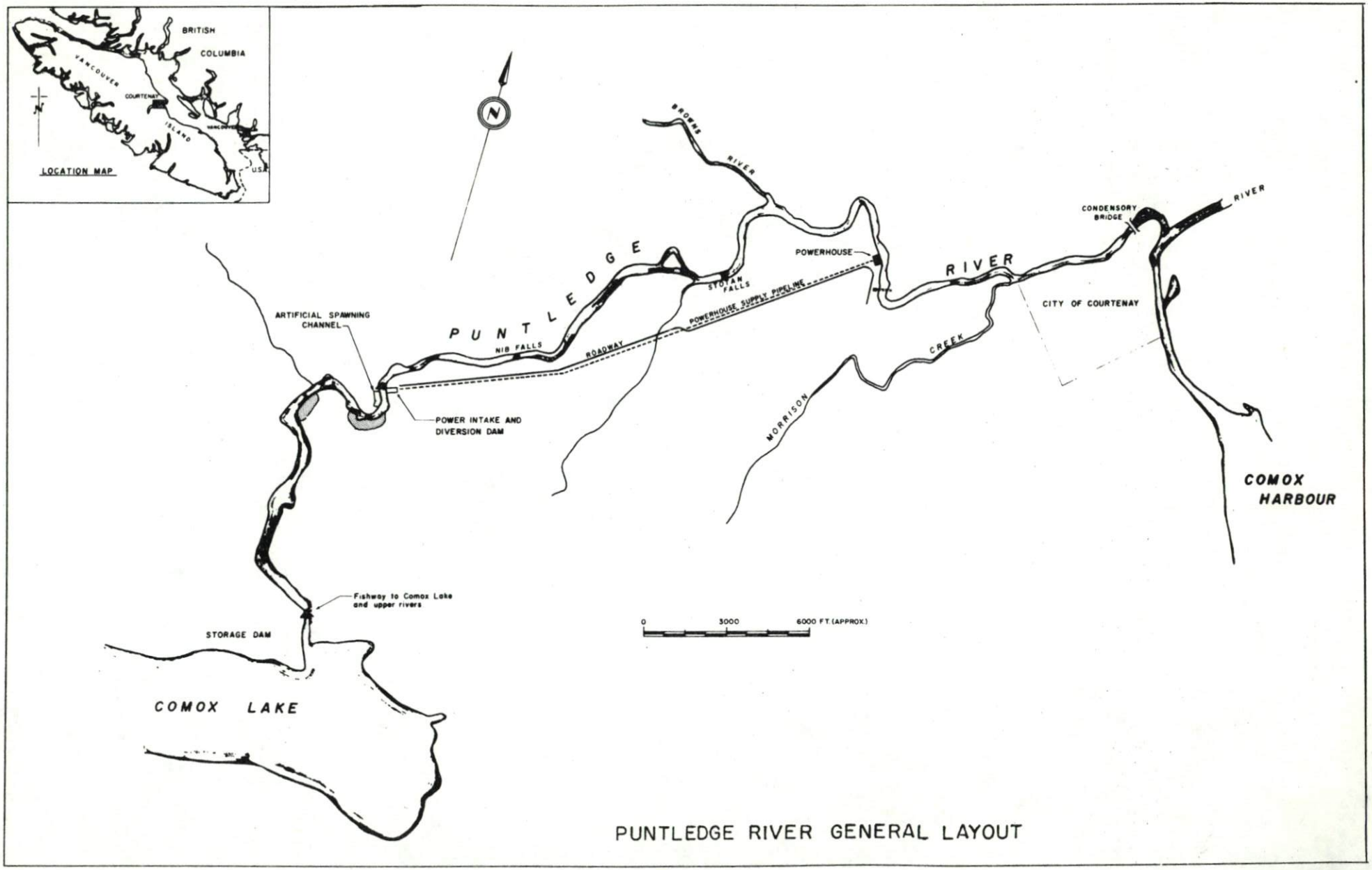
- enumeration and observation of the spawning distribution of the adult fall-run chinook escapement below the Puntledge powerhouse.

Incubation survival of 45 percent was obtained during the 1968-1969 winter incubation period resulting in the production of 186,000 chinook fry. This survival rate is the highest during the four years of juvenile production at the Puntledge spawning channel while the number of fry produced is the second highest. These results are attributed to optimal flow conditions at the channel during the winter incubation period. In past years, survival may have been affected by pumping failures which occurred in December, 1965, and February, 1968, and to a backwatering situation at the lower end of the channel which existed during the 1966-67 and 1967-68 incubation periods.

The escapement of summer-run chinook to the channel in 1969 of 232 chinook (50 females and 182 males) is the smallest of the five broods spawning at the channel since the first year of operation in 1965. An estimated 59 chinook (12 females and 47 males) spawned downstream of the channel bringing the total Puntledge summer-run chinook escapement to 291 salmon. The estimated egg deposition from 46 successfully spawned females is 193,000 which is the lowest to date. Escapements to the channel for the years 1965 to 1968 have numbered 248, 622, 672 and 324 adults respectively.



PUNTLEDGE RIVER SPAWNING CHANNEL



PUNTLEDGE RIVER GENERAL LAYOUT

With regard to the adult injury problem causing serious pre-spawning mortality at the channel, two steps were taken to facilitate fish passage at Stotan Falls in 1969. These were the construction of concrete baffles at lower Stotan Falls, a point of difficult passage, and the provision of moderate and stable flows of 400-500 cfs in the falls section of the river above the powerhouse during the June - August migration period. The latter was accomplished by permitting the powerhouse to operate on flows in excess of this amount available at the diversion dam. These measures would appear to have assisted migration as indicated by the low level of pre-spawning mortality (7.3 percent) observed at the channel. It has been recommended that the powerhouse be permitted to operate on this basis in 1970.

Float surveys were conducted to determine the distribution and abundance of the fall-run chinook escapement below the powerhouse. The estimate of the 1969 spawning population is 185 chinook, the lowest yet recorded for the Puntledge River.

Investigations

(1) Fraser River chums

The bio-engineering investigation of the chum salmon enhancement potential of the Fraser River system was continued in 1969. The biological studies are designed as a complement to the continuing chum salmon management investigation which

is carried out on the system.

The Vedder - Chilliwack River is one of the major chum salmon producing tributaries of the Fraser River system. As a result of dyke construction and other flood control measures, however, the area of high quality spawning gravel has been substantially reduced. A bio-engineering report has been prepared outlining a spawning area expansion proposal on the lower Vedder River in the vicinity of Ford and Hopedale roads. The proposal includes acquisition of the required land, installation of a flow control intake, construction of desilting ponds, and regrading and rehabilitation of natural dry channels behind the dyke. The project will increase the available spawning capacity by 20,000 chum salmon at a cost of $200,000. This proposal will be submitted for consideration in the 1971-72 estimates.

The current investigation on the Harrison River system is directed primarily to a detailed study of spawning distribution and density, interspecies competition, egg deposition and pre-emergent survival within the various habitat types of the system. On the basis of studies carried out to date, the area of available good quality chum salmon spawning grounds within the Harrison River system, including Harrison River, Chehalis River, Squakum Creek and Weaver Creek, is estimated at 161,000 sq yds. The optimum spawning capacity of the Harrison system, therefore, is in the order of 150,000 chum salmon. The major chum salmon spawning grounds within the Harrison River system are supplied

entirely or in part by ground water flows. An intensive investigation of ground water supplies must precede any major stock enhancement projects.

The chum salmon spawning grounds of the Stave River are located immediately downstream from the Ruskin Dam and hydroelectric plant, and are subjected to considerable daily fluctuation of water levels. Spawning distribution surveys and hydraulic redd sampling have been carried out on the Stave River and on the basis of the available data the capacity of the reliable chum salmon spawning grounds has been estimated at 75,000 fish.

(2) Kakweiken River

A bio-engineering report was prepared making recommendations for the construction of two vertical slot fishways at the obstructions existing on the Kakweiken River at an estimated cost of $300,000. It is anticipated that completed designs and drawings of the proposed fishways will be completed in early 1970 and that the project will be included in the 1971-72 estimates. (Further discussion appears under Johnstone Strait pink salmon.)

(3) Glendale River

A stream assessment survey was undertaken on the Glendale River in order to obtain hydrological and topographical information required in the design and preparation of cost estimates of facilities proposed to provide additional

spawning area for pink salmon frequenting that system. (Further discussion appears under Johnstone Strait pink salmon.)

(4) DeMamiel Creek

A water license was obtained and property acquired for the construction of a small flow control dam on DeMamiel Creek to regulate for low flows and therefore enhance production of the juvenile coho salmon populations. It is anticipated that the dam will be constructed in early 1970.

(5) Yakoun River

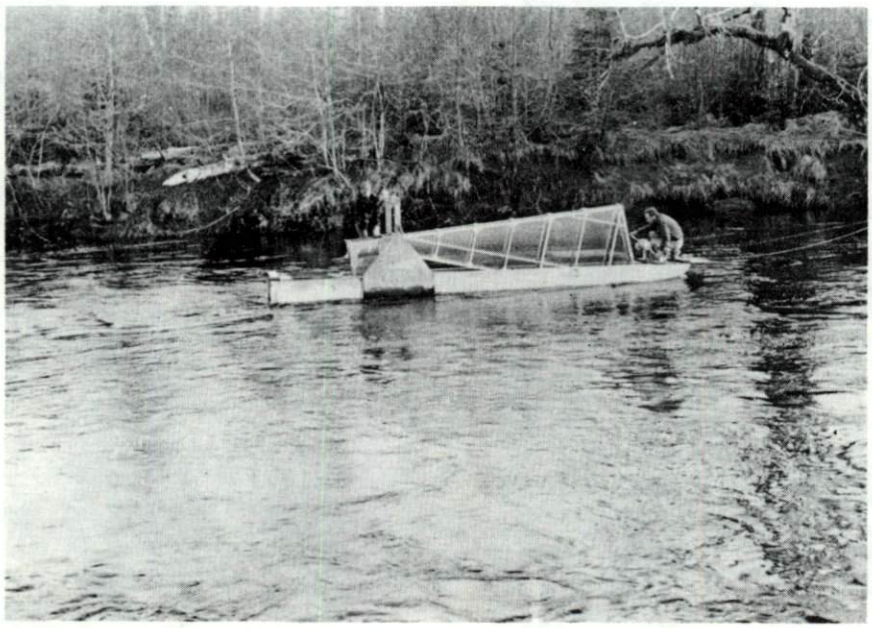
A downstream-migrant enumeration of pink salmon was conducted on the Yakoun River during April and May of 1969. The total production was calculated to be 50 million fry, representing a freshwater survival of 11.8 percent. Previously recorded freshwater survivals in this stream were 12.4 percent in 1965 and 18.7 percent in 1967. This study is being made to measure the range of freshwater survivals on this major salmon stream and to determine the effect, if any, from logging and related activities.

(6) Obstruction surveys

Preliminary biological and engineering surveys were undertaken to determine the justification and feasibility of alleviating obstructions to the migration of salmon on the Chemainus, Kwalate and Atlatzi rivers.

An engineering survey was undertaken at the obstruction existing on the Kcksilah River in order to obtain topo-

One-foot "wide" inclined plane trap for sampling emigrating juvenile salmonids in fishing position on the Yakoun River.



In cleaning position.

graphical and hydrographical information required in the design and the preparation of cost estimates of facilities required to bypass salmon above that location.

(7) Washwash River

A stream assessment survey which consisted of obtaining topographical and hydrological information was undertaken on the Washwash River in order to determine the feasibility and justification of implementing a river stabilization program to protect the sockeye spawning areas on that system.

Hydrological data was obtained from a water level recorder that was installed in 1968.

A road location survey was also undertaken between the mouth of Washwash River and South Bentinck Arm to determine the feasibility of providing access for heavy equipment required for the river stabilization program.

Artificial Propagation and Transplant Studies

(1) Experimental hatchery facilities

The experimental hatchery located on the Big Qualicum River has now been in operation for two years. In 1969 both coho and chinook were incubated and reared within the facilities. Approximately 460,000 chinook fingerlings were reared from the eggs of 160 females, while 50 coho females produced 75,000 smolts.

The three groups of chinook which composed the artificial incubation environmental study amounted to

301,190 fingerlings and were reared to a weight of 4.6 gm (99/lb) before release into the river. The chinooks were held an average of 104 days. The magnetic nose tag was applied, in four distinctive codes, along with an adipose fin-clip, to a small percentage of all four groups (wild included).

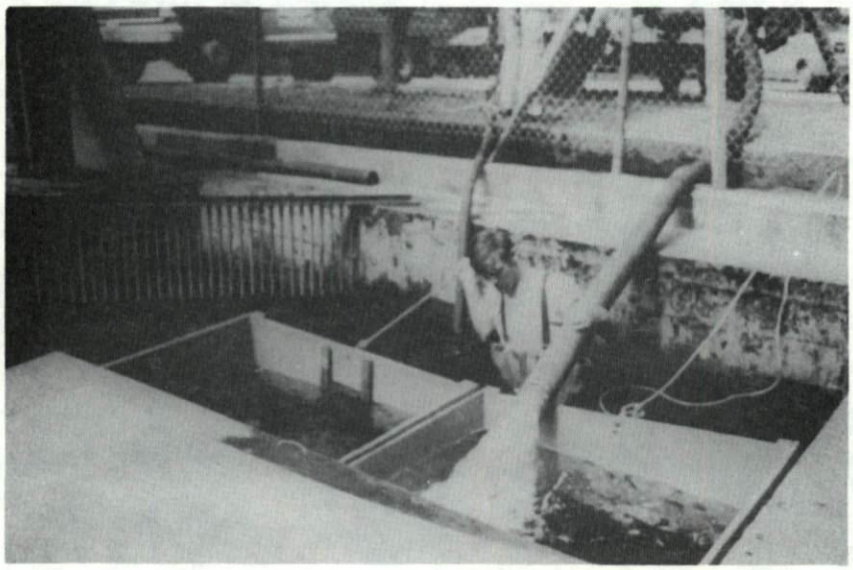
The emigration of wild fingerlings from the Big Qualicum amounted to 130,650, the largest on record. The wild emigrants averaged 5.4 gm (85/lb).

An additional 155,700 hatchery reared chinook fingerlings were transplanted. The Capilano River received 55,900 while 99,800 were transplanted to the Tsolum River. These transplant fingerlings weighed on the average 5.2 gm (87/lb). The transplants were observed to emigrate from their new rivers within one to three days.

An experiment is currently in progress which is designed to compare survival, growth, and quality of two groups of coho juveniles reared under separate diets. One group is fed exclusively Oregon Moist Pellet while the other is receiving the Swedish made diet "Ewos" Trout and Salmon Food.

To date (February, 1970) very little difference can be seen between the two groups. Mortality (15 percent) and growth (9.5 gm) are the same for both. Wild coho, sampled from the river, are considerably smaller in size (6.5 gm; 70/lb).

Chinook salmon fingerlings reared at the Big Qualicum River experimental hatchery in preparation for transplantation to the Capilano River.



The transplant chinook fingerling being introduced into the adult trapping device below the dam on the Capilano River.

The two experimental groups will be each distinctly tagged and released as smolts in the spring of 1970.

(2) Assessment of U. S. hatcheries

Branch biologists assessed recent production success and technological advances of chinook and coho hatcheries in Washington and Oregon by visiting selected hatcheries operated by the Washington Department of Fisheries, the Bureau of Commercial Fisheries and the Oregon Fish Commission in company with biologists and hatchery administrators in these agencies, by reviewing hatchery literature and by attending two fish cultural conferences.

(3) Hatchery site studies

A suitable water supply has been found to be the most important attribute of a successful hatchery. Ground water, or its artificial equivalent, is considered vital for successful hatchery production of chinooks in British Columbia. A list of streams, selected on the basis of their chinook and coho runs, potential contribution to sport and commercial fisheries, water quality and various other criteria, was prepared and served as a basis for preliminary ground water surveys conducted in 1969. The following streams were surveyed by a geologist and those marked (*) were considered to have potential for ground water development.

DeMamiel Creek	Oyster River*
Goldstream River	Sakinaw Lakes
Cowichan-Koksilah Rivers*	Indian River*
Nanaimo-Haslam Rivers	Cheakamus River*
Tsolum-Puntledge Rivers	Capilano River*
Rosewall Creek*	Chilliwack River*
Black Creek	

Exploratory drilling will be conducted on some of the above streams.

(4) Coho extension

A program initiated in 1968 involving the experimental introduction of emergent coho fry into barren stream areas above obstructions was continued during 1969. Woodhus Creek, a tributary of the Oyster River on the central east coast of Vancouver Island, was chosen as the site of the pilot operation to develop this technique.

Downstream migrant traps were installed in the lower reaches of Woodhus Creek in 1969 to capture and enumerate seaward migrant coho yearlings resulting from the 1968 releases of 9,500 fry transferred from nearby Little Oyster River and an additional 16,400 fry transferred from the Big Qualicum River. The latter group were distinctively marked with an adipose fin clip. Yearling production was estimated to be 1,179 Little Oyster coho and 2,849 Big Qualicum coho representing survivals of 12.4 and 17.4 percent, respectively. Overall survival was 15.5 percent.

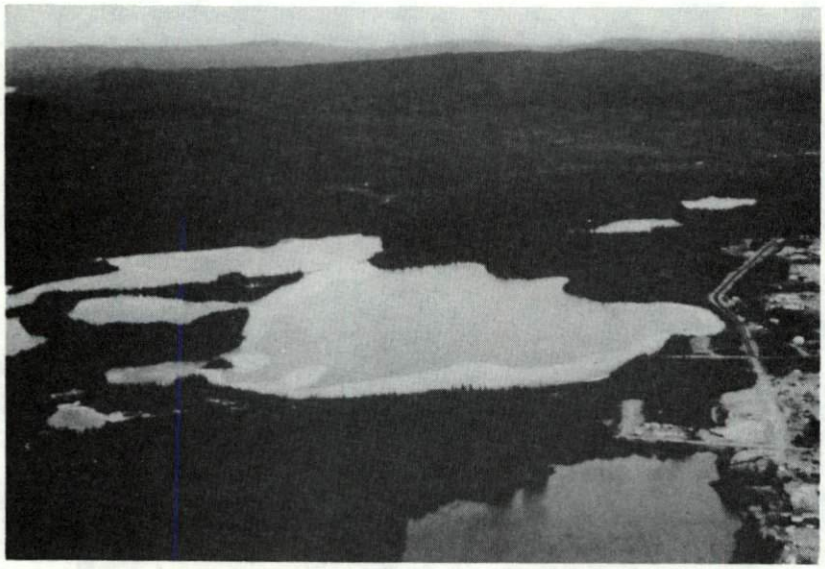
The 1969 fry introduction totalled 52,000 emergent coho captured in downstream migrant traps in the Little Oyster River. Fry were released at several points in Woodhus Creek to ensure uniform distribution within the stream.

An experimental introduction of coho fry was conducted in 1969 at Shawnigan Creek utilizing coho fry obtained during fry salvage operations at Goldstream River. Both streams flow into Saanich Inlet located on the lower east coast of Vancouver Island. Shawnigan Creek is a small, stable, lake-fed stream with a series of falls at tidewater which form a total obstruction to adult salmon.

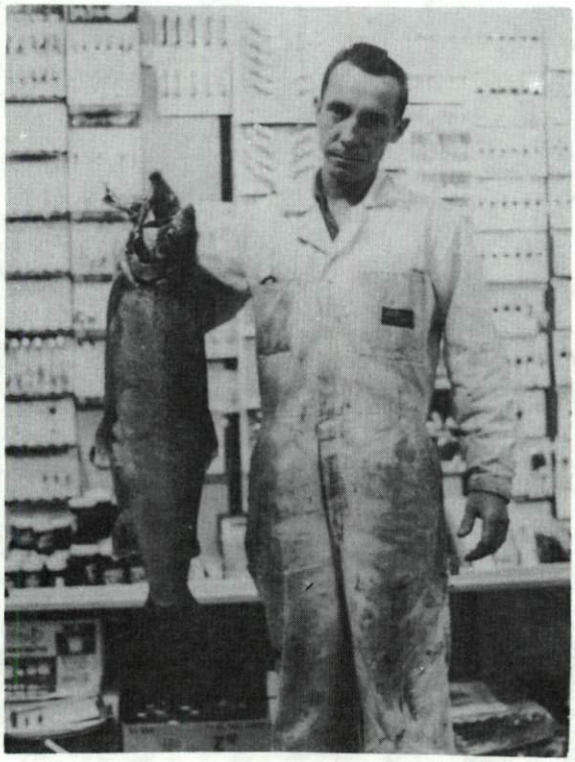
A total of 27,000 fry were transferred from Goldstream River. These were captured with fry salvage seines and released at several points in Shawnigan Creek. The operation involved staff of both the Resource Development Branch and the Conservation and Protection Branch. Trapping of yearling migrants will be conducted in 1970 to determine the success of the transplant.

(5) Yukon rainbow trout

Each year since 1959 the Department has planted rainbow trout eggs/larvae/fry in lakes located near one or more of three major population centres in the Yukon Territory to provide increased sport fishing opportunity. Further to this program, in 1969, the Department released 52,000 high quality rainbow trout fry into Wye Lake, a 440 acre body of



Wye Lake (440 acres); township of Watson Lake is seen on the right.



A 19 lb 4 oz rainbow trout caught in Long Lake in 1967; origin was the 1963 plant.

water alongside the township of Watson Lake. For this plant, spawn was obtained from a wild stock in British Columbia and incubated in a wooden box apparatus containing graded gravel and having controlled flow. The apparatus was anchored in a stream close to Watson Lake. Wye Lake had been poisoned in 1966 to eradicate a population of northern pike and planted with trout larvae in 1967 and 1968. However mortalities from known sources resulted in a very small trout population. Because of added precautions and new methods for the incubation of spawn and for the release of the fry it is expected that the juveniles in the 1969 plant had an excellent opportunity for survival and therefore a fishable trout population should materialize in 1971.

(6) Upwelling incubation experiment

A repeat of the 1967-68 high density incubation experiment was undertaken on the Harrison River system in 1968-69 using increased incubation flows. As a result of unusually high water levels in the Harrison River the experiment was flooded out shortly before fry emergence and, therefore, egg-to-fry survival and fry quality were not measured in 1969. The operation however did yield information on flow and oxygen consumption. At the maximum anticipated water temperature and at the most advanced larval stage it was calculated that 10 U.S. gal per minute of saturated flow per sq yd surface area would be sufficient to hold oxygen levels at 8 ppm or better throughout the incubation period

for a density of 100,000 eggs per cu yd. Greatest oxygen demand occurs immediately prior to fry emergence.

Stream Maintenance and Improvement Projects

(1) Puntledge River

Excessive pre-spawning mortality of chinook in the Puntledge spawning channel occurred in the years 1966 and 1967. The mortalities appeared to be largely the result of head injuries received prior to entering the channel and available evidence suggested that the injuries were received at Stotan and Nib Falls at the time of migration. Extensive drilling and blasting operations were undertaken at both locations in early 1968 to facilitate better passage through these areas.

The pre-spawning mortality of the 1968 chinook salmon was again excessively high, and again appeared to be the result of head injuries despite the improvements undertaken. Evidence suggested that the injuries were still being received at Stotan Falls where access conditions remained poor.

Further improvement work to ease chinook passage and prevent injuries was undertaken on Stotan Falls in early 1969. This consisted of blasting resting pools and installing concrete baffles in the middle falls section. A cable car was also installed at this location in order that observations could be made during the upstream migration. No passage difficulties were encountered by the 1969 chinook

migrants at middle Stotan Falls area. The incidence of head injuries of salmon entering the spawning channel was substantially reduced from the previous years.

(2) Phillips River

At Phillips River near Bute Inlet, the stream improvement work commenced in December 1968, and was completed in January 1969. This consisted of: (1) construction of a channel to by-pass silt-laden water to a point beyond the spawning grounds; (2) extension and reinforcement of existing dykes along the channel excavated by the Department in 1965; (3) blockage of the eroded lake controls; and (4) installation of a water recorder and cable crossing to obtain hydrological data on the system.

(3) Salloomt River

Remedial dyking and channelization work was undertaken on the Salloomt River near Bella Coola in the spring of 1969 to repair several breakthroughs caused by extreme high water the previous fall.

(4) Tahltan River

An inspection of the slide area and Descheeka Falls on the Tahltan River was made in the spring of 1969. This inspection revealed that the rock plug at Descheeka was functioning properly and although the river in the slide area had shifted, conditions appeared favourable for the successful migration of the 1969 sockeye run. This was

subsequently confirmed when more than 11,000 sockeye salmon were counted through the Alaska Department of Fish and Game's fence at the outlet of Tahltan Lake.

(5) Teaquahan (Eva) River

Channelization and dyking work was undertaken on the Teaquahan (Eva) River located at the head of Bute Inlet. The river had broken into numerous channels in the lower reaches and remedial action was necessary to confine the flow to several main channels suitable for spawning.

(6) Inches Creek

A small stream rehabilitation project was undertaken on Inches Creek prior to the arrival of chum salmon spawners in October. This work included the excavation of several holding pools, improvements to the streambed in the upper section of the creek and the excavation of intercepting trenches in order to increase the ground water discharge into that system.

(7) Judd's Slough

During late November water levels in the Squamish River dropped to such an extent that there was insufficient water available for some 15,000 chum spawners in Judd's Slough, a side channel of the Squamish River. Emergency work was undertaken to ensure an adequate supply of water into the system for spawning purposes. This consisted of the construction of a rip-rap diversion weir in the Squamish River immediately downstream of the entrance of a culvert

supplying water to Judd's Slough. The work provided an additional 18 inches of water in Judd's Slough and restored favourable spawning conditions.

(8) Stream clearance

Routine stream clearance projects undertaken during the year included the removal of log jams on: (1) the Shumahalt River in the Owikeno Lake area; (2) Koksilah River near Duncan; (3) Hemmingsen Creek, a tributary of the San Juan River; (4) White Rock Creek near Campbell River; and (5) Deserted River flowing into Jervis Inlet.

In addition, removal of extensive beaver dams and forest debris was undertaken on Swift Creek, Middle River, Takla Lake area and Sinmax (Pass) Creek in the Kamloops district and on the Chehalis and Harrison side channel areas in the lower mainland district.

Employment of Indians for stream clearance

To ease the critical unemployment situation among native Indians created by the closing of several canneries in the coastal areas of B. C., discussions were held among regional and headquarter officers in July 1969 to explore the possibilities of using Indian people to perform stream clearance work on B. C. salmon streams. Personnel of the Resource Development Branch met with the nine District Conservation Officers and their Fishery Officers to discuss the proposed program and to obtain a list of streams where marginal stream clearance and access trail cutting could be

carried out. From these meetings it was decided to proceed with a pilot project in the Bella Coola and Bella Bella areas as the unemployment of Indian people was highest in these areas.

The pilot program which commenced in September and terminated in November, provided employment for 19 individual Indian people for periods varying from three to six weeks. Fifteen miles of access trails were cut along the following rivers: Nooseseck, Necleetsconnay, Koeye, Kwakjusdis, Scribner, Gullchuck and Hawyette rivers. The cost of the program was $15,000 with the Department of Indian Affairs and Northern Development effecting a transfer of $10,000 to the Department of Fisheries and Forestry to cover wages. The Department provided the balance of the funds for purchase of equipment and costs of transportation, etc. The program was carried out under the supervision of personnel from the Resource Development Branch and the Conservation and Protection Branch.

FISHERIES MANAGEMENT

Salmon

(1) Nass River

Test-fishing, initiated in 1963 to provide a daily index of sockeye salmon escapement from the commercial

fishing area and thereby to assist in the management of the Nass River sockeye stocks, was continued in 1969. The 1969 program also included: (1) enumeration of the sockeye escapement to Meziadin Lake; (2) sampling of the Bowser and Meziadin lakes sockeye escapement for racial characteristics; and (3) estimation of sockeye escapements to Damdochax and Kwinageese rivers, and sampling of these for racial characteristics.

Escapement of sockeye to the Nass totalled 182,000 of which 136,000 entered Meziadin Lake and 21,000 returned to Bowser Lake. Escapements to Damdochax and Kwinageese totalled 10,000 and 15,000 sockeye respectively. Commercial gill net catch of sockeye in Area 3 (excluding those that have been classified as Skeena bound) was 91,000. Gill net catches of other species were: chinooks 10,000; coho 16,000; pinks 78,000; chums 53,000; and steelhead 1,000.

(2) Skeena River

The operational duties associated with management of the Skeena River salmon stocks were continued in 1969. These consisted of a day-to-day assessment of the magnitude of catch and escapement for the purpose of recommending regulatory changes throughout the season. In addition, personnel of the Resource Development Branch continued enumeration, through the use of tag and recovery and other techniques, of the pink salmon escapements to the system and the sockeye escapements to areas other than Babine Lake.

An analysis of test-fishing data from 1966 to 1968 inclusive was carried out and a conversion factor from test-fishing catch to estimated escapement was calculated by regression analysis. Echo sounding equipment was again used in 1969 to assess changes in vertical and lateral distribution of salmon as they pass through the test-fishing area. A sonic tagging program was initiated in 1969. The objective of this program, a co-operative study between Fisheries Research Board, University of Wisconsin and Resource Development, is to provide information on the rate of passage of sockeye through the estuarine area and its relation to tides, river currents, etc.

The usual tag and recovery program for enumeration of the pink salmon escapement to Lakelse River was supplemented by the use of the Bendix Acoustical Fish Counter. A similar unit is in use in Alaska but previous trials in B. C. have not been successful. The counting fence installed to calibrate the counter was washed out just prior to the peak of the run, so accurate assessment of the counter was not possible.

The 1969 sockeye run returned in predicted abundance, following a normal timing pattern. The pink salmon run was somewhat smaller than expected, but escapements approached the optimum for most spawning areas. Commercial catches of these species bound for Area 4 totalled 570,000 sockeye and 355,000 pink salmon. Other gill net catches for the area were 10,000 chinooks; 39,000 coho; 15,000 chums and 5,000 steelhead.

Part of the Bendix acoustical fish counter apparatus on the Lakelse River.

Sockeye escapement to the Skeena River (above test-fishing) totalled 681,000. The 650,000 to Babine was not far short of the desired goal but escapement to other areas was very light totalling only 17,000 in all, with 6,000 of this total going to streams that are tributary to Lakelse Lake.

The pink salmon escapement to the Skeena River totalled 873,000 and an additional 24,000 spawned in coastal streams. The 180,000 escapement to the Kispiox represents the best escapement since 1961 and the run is well on its way to recovery from the odd-year-cycle low of 23,000 spawners in 1965. The Babine River and Kitwanga River escapements were large at 90,000 and 190,000 respectively, and the Lakelse River escapement of 368,000 was an increase over the brood year. The Skeena River mainstem with 21,000 spawners had the second lowest escapement in the odd-year back to 1955.

(3) Rivers Inlet

The Rivers Inlet sockeye salmon catch totalled 750,000 in 1969, an estimated 70,000 to 100,000 of which were taken in a daylight troll fishery conducted within the inlet amongst the gill nets. The troll gear proved to be considerably more effective than gill nets during the day. As most boats trolling in the area were combination boats, they trolled during the day and gillnetted at night, with the result that there was a marked increase in effective effort.

Gillnet fleet at Rivers Inlet.

The fish scanning operation conducted at the head of the inlet in 1967 and 1968 was continued in 1969. The final adjusted estimate of total escapement was 300,000; the same as estimated on the spawning areas by staff of the Conservation and Protection, and Resource Development branches.

Tow-netting and limnological studies were continued on Owikeno Lake. Tow-netting catches indicated that the abundance of juveniles (brood 1968) for both the summer and fall towing periods was higher than the comparable periods for the 1963 brood (brood with largest returns recorded).

(4) Smith's Inlet

The Smith's Inlet sockeye salmon catch was 170,000 fish in 1969. The short fishing periods in the area resulted in reduced offshore exploitation and an escapement in excess of spawning requirements. The excess escapement was cropped by a fishery within the inlet, facilitated by special boundary movements.

A counting tower on the Docee River was staffed in 1969 but flooding during the upstream migration severely reduced the effectiveness of the operation. The spawning escapement was estimated to be approximately 100,000.

(5) Bella Coola

An exploratory fish scanning operation was conducted in North Bentinck Arm in 1969. The purpose of the program was to determine if it was feasible to enumerate salmon stocks in the area using this technique. It was found that a number of species of fish was present in the area and, as a result,

sampling by net in conjunction with sounding, would be necessary to determine species composition and abundance.

(6) Johnstone Strait pink salmon

The 1969 pink salmon catch in the Johnstone Strait study area totalled 464,000 fish, an exceptionally poor catch considering that it included many fish destined for the Fraser River. Detailed escapement figures are not yet available, but it appears that the total escapement to the study area was considerably below the very poor 1967 brood year escapement of 380,000. The optimum escapement is estimated to be approximately 1,502,000.

A study of the timing and migration routes of Kakweiken River and Glendale River pink stocks in the Tribune Channel - Knight Inlet area was conducted in 1969, and distinct differences in timing of the two stocks were determined for the year in question. A similar tagging program is proposed for the 1971 cycle year to corroborate the odd-year results indicated by the 1969 study.

Daily observations of pink salmon behaviour beneath the Kakweiken River waterfalls were recorded in preparation for the proposed construction of a vertical slot fishway in the 1971-72 fiscal year. Escapement to the Kakweiken River in 1969 totalled approximately 45,000 pinks, and of these 22,000 utilized the existing steep-pass fishway and spawned above the waterfalls. A much higher percentage of the run most certainly would have moved beyond the falls had water

levels in the river permitted use of the fishway over a longer period of time. The pink salmon capacity of the river above the falls is estimated to be in excess of 250,000 fish.

(7) Johnstone Strait chum salmon

The return of chum salmon to the area from Johnstone Strait to the Fraser River was one of the best recorded in recent years. Commercial fishery landings in the area totalled 608,000 chum salmon and were distributed as follows: Johnstone Strait - 485,000, Georgia Strait - 34,000 and Fraser River - 89,000. Although final escapement estimates are not yet available a total return in excess of 1.5 million is indicated, representing a substantial increase over the 435,000 and 1,022,000 chum salmon recorded in the brood years 1965 and 1966.

Chum salmon management investigations were carried out in several areas in 1969. Index fishing with a purse seine vessel was undertaken in order to determine the relative abundance of chum salmon in upper Johnstone Strait. An intensive chum salmon tagging program was also carried out. A total of 14,300 migrating chum salmon were tagged in various areas including upper and lower Johnstone Strait, east coast of Vancouver Island areas adjacent to the Big Qualicum River, Satellite Channel and Cowichan Bay. An intensive stream survey and tag recovery program combined with public returns have accounted for over 25 percent tag recovery. This

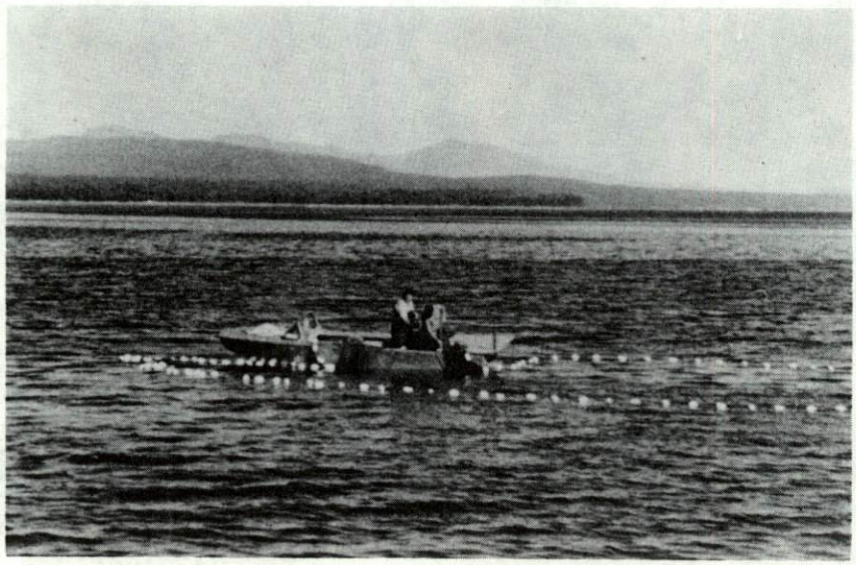
investigation is an important factor in the management of the Johnstone Strait chums in general and the Big Qualicum stock in particular. Forecasts of Qualicum chum returns are very favourable and tagging projects aid in assuring optimum harvest and escapement.

In addition to the purse seine index technique for determining abundance of chums, a sounder equipped vessel was used on an experimental basis to aid in establishing a better method of enumerating migrating chum salmon in the ocean. Results to date are encouraging and the project will be implemented again in 1970.

Throughout the spring and summer of 1969 an investigation into the early life history of chum salmon fry in the marine environment was carried out in the general area adjacent to the Big Qualicum River. This study is investigating a number of aspects of the chum salmon fry population dynamics. Factors such as growth rates, survival, predation, competition, nursery areas, and carrying capacity are being studied in detail. This study is assuming particular importance now that Big Qualicum River chum fry production is reaching levels which could possibly occupy fully, or even exceed, available rearing area.

(8) Fraser River chum salmon

Following a period of decline in both catch and escapement of chum salmon in the Fraser River system, a study was initiated in 1960 to assess the condition of the chum salmon stock and to acquire the information required for



Purse seine sampling for chum salmon fry in a marine investigation in the Qualicum area.

management and rehabilitation. A significant degree of rehabilitation has now been achieved and the current investigation is directed to obtaining information required annually for continued management of the fishery. The 1969 program included: enumeration of the total system and tributary spawning populations; test-fishing in the lower river; and enumeration of the total system fry output from the 1968 escapement. The 1969 chum salmon escapement totalled 414,000 fish. Escapements to the Harrison River system, Vedder - Chilliwack River system and the Stave River totalled 165,000, 53,000 and 75,000 respectively. The 1969 index of 39,000,000 chum fry resulted from the large 1968 escapement and was the highest recorded since the annual enumeration was started in 1962.

(9) Strait of Georgia chinook and coho

Over 750 coho salmon were tagged in Stuart Channel and Saanich Inlet between March 11 and April 2. Initial analysis of recoveries indicates that Stuart Channel coho proceeded north along the east coast of Vancouver Island, gradually advancing their northward extension throughout the spring and summer. Few were recovered on the west coast of Vancouver Island or north of Cape Lazo in the Gulf. In comparison, Saanich Inlet tagged coho were either caught in the vicinity of the tagging site or else on the west coast by troll gear. Apparently these rearing areas, separated by only 20 miles, differ grossly in their contribution to the resident coho population in the Strait of Georgia. In this regard we need

more information on stock composition in these and other winter rearing areas and on the effect winter rearing area has on the ultimate summer area of residency.

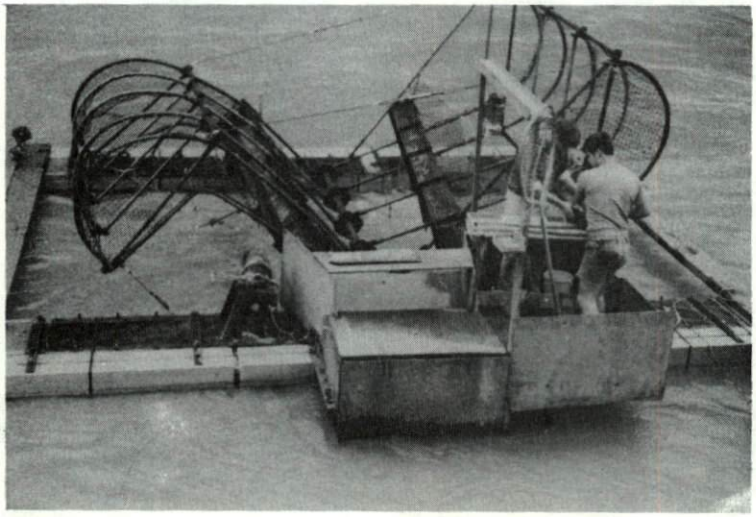
A final report summarizing chinook and coho taggings in the Gulf and adjacent waters from 1963 is presently being prepared.

Monitoring of sport catches in the Strait of Georgia during the spring of 1969 indicated a very low level of abundance for resident coho. This low level of abundance was confirmed by poor landings of coho following the July 1 troll opening. Due to concern over this situation and in order to maximize harvest benefits from the available stocks, a weekend closure to commercial trolling was imposed from mid July to the end of August.

(10) Fraser River chinook

Studies in 1969 consisted of two phases: (1) adult tagging by means of two fishwheels located in the Fraser Canyon above Hope; and (2) spawning ground surveys of seven major spawning populations. Objectives of the studies were to determine, from tagging, the migration timing of the seven spawning populations or races, to determine the spawning timing and distribution of these runs and, by means of scales and/or morphology, to attempt to identify racial characteristics.

Tagging results were disappointing. From the 725 chinook tagged there was a total of 59 recoveries of which 42 were taken by the Indian fishery near the tagging sites,



Fishwheel in the Fraser River canyon
to capture chinooks for tagging.

and 15 by commercial gill net fishery 50 to 100 miles downstream. In spite of fairly extensive recovery effort on the spawning grounds, only two tags were recovered.

Apparently, the fishwheels were selective for smaller chinooks; 520 of the 725 caught were jacks as opposed to only 222 jack sockeye in a total catch of 4,653. Analysis of chinook scales showed that the percentage of sub 2 fish in the catch ranged from 8 to 61 percent and demonstrated a progressive decrease throughout the June 22 to August 22 sampling period.

Spawning ground surveys were conducted on the Clearwater, Nicola, Adams, Lower Shuswap, South Thompson, Thompson and Chilko rivers. The number and distribution of spawning fish was recorded and biological samples taken from dead fish. Scale analysis showed that sub 2 fish (fish that rear one year in fresh water) predominated in the Nicola River while the Adams, South Thompson and Lower Shuswap rivers contained only sub 1 fish. Differences in length distribution and fresh water circuli counts existed between spawning populations and may indicate inherent racial characteristics.

(11) Juan de Fuca Strait coho

In June, 1967, Area 19 and Area 20 east of Sheringham Point were closed to all commercial fishing in an attempt to improve the fall sport catch of coho off Victoria - Sooke. A two-year study was initiated in 1967 of which one objective was assessment of the closure. Field studies were terminated in October 1968. Results have been analyzed and a draft report has been prepared.

Although research results revealed several factors that determine the level of sport fishing success in the Victoria area, improvement in sport fishing catches as a direct result of the closure could not be demonstrated.

Management recommendations and recommendations for further biological studies are presented in the report.

(12) West Coast Vancouver Island troll

Present Canadian ocean troll regulations prohibit the taking of chinook salmon under 26 inches in total length and the taking of coho of any size prior to June 15. During the April 15 - October 31 troll season fishermen take many pre-season coho and undersized chinooks which must be released. Many of these returned fish (called "shakers") undoubtedly die and represent a waste of the resource.

In 1968 an exploratory log book survey was conducted to assess the magnitude of the shaker problem. Results indicated that approximately 250,000 coho and 55,000 chinook salmon were released by trollers along the west coast of Vancouver Island during the April 15 - June 15 period.

In 1969, in co-operation with the Economics and Conservation and Protection branches, an expanded log book assessment program was conducted to determine the incidence of shakers in all areas throughout the trolling season. Log books were issued to 800 fishermen on a volunteer basis. Of these, 350 returned log book sheets totalling about 15,000 fishing days or approximately ten percent of the total

British Columbia troll effort. Preliminary analysis indicates that, in the west coast troll fishery during the April 15 to June 15 period, the shaker catch totalled 120,000 coho and 90,000 chinooks or about one-half and twice the 1968 estimates for these species. A high incidence was recorded on certain banks in statistical Areas 21 and 23. Estimates of shakers for other troll areas have not been compiled at this time.

On the basis of a preliminary 1968 study which indicated that terminal troll gear strongly affect shaker catches, a lure selectivity study was conducted in 1969. Results from this study which involved the assessment of three common trolling lures utilizing three chartered troll vessels are summarized below:

1. The rate of capture of coho on plugs was one-sixth and one-quarter of the rates on flasher-hootchies and spoons respectively.
2. The rate of capture of sub-legal sized chinooks on plugs was one-sixth and one-third of the rates on spoons and flasher-hootchies.
3. The rate of capture of legal sized chinooks was similar for all three lure types.

The above results are virtually identical to those from the 1968 study.

Troll tagging of chinook and coho was conducted in 1969 as another segment of studies on the shaker problem. During the tagging period which extended from March 17 to October 4, 2,100 coho and 3,700 chinooks were tagged. Analysis of tagging results is not complete at this time.

(13) Informal Committee on Chinook and Coho

In 1963, Canada and the United States formed an Informal Committee on Chinook and Coho composed of two representatives from each country. At present Canada's representatives are Mr. W. R. Hourston of the Department of Fisheries and Forestry, and Mr. K. Radway Allen of the Fisheries Research Board.

Each country was to "arrange for reviews of available information on migration and exploitation of chinook and coho salmon along the Pacific coast of North America pertaining to mutual management problems". Each country was to include information, if available, on timing, location and degree of intermingling of American and Canadian stocks.

It was agreed that a technical working group composed of two members from each country be appointed. Presently Canada's members are Dr. M. P. Shepard of the Department of Fisheries and Forestry (seconded from FRBC August, 1968) and Mr. Harold Godfrey of the Fisheries Research Board, Nanaimo. After an exchange of pertinent information independent reports were prepared by each country. The reports were submitted to the Informal Committee on Chinook and Coho at a meeting in Seattle on April 30, 1969. These were subsequently released for limited public distribution.

At the April 30 parent committee meeting it was recommended "that the Informal Committee continue in existence to arrange for further exchange of available information (since 1964), to co-ordinate present research programs of joint

interest and to develop proposals for research programs dealing with broad management problems of chinook and coho salmon, including the problem of interception of chinook and coho of one country bound for streams of the other".

Since the meeting, the working groups have prepared lists of data for exchange and have jointly proposed a co-ordinated coast wide chinook and coho marking program to determine contributions to fisheries of all important stocks which are subject to interception by fishermen of the other country. A second phase of this program would research problems associated with optimizing yields from chinook and coho stocks (determination of growth and mortality rates, maturity schedules, age compositions, etc.). The Technical Subcommittee also proposed that in the event that insufficient funds should be available for the full program, the two countries conduct co-ordinated research programs on one or more of the following problems:

1. Enumeration of "shaker" catches of chinook and coho;
2. Estimation of "shaker" hooking mortality;
3. Determination of factors affecting "residency" among chinook and coho;
4. Determination of selectivity of hook and line gear;
5. Determination of growth - maturity schedules of chinook salmon;
6. Identification and location of freshwater types of chinook and coho.

A meeting of the parent committee to consider the above research proposals was held in November, 1969, and a further meeting is scheduled for March, 1970.

Herring

(1) Juvenile herring "racial" investigation

In 1968 and 1969 a study was undertaken to determine whether or not juvenile herring populations can be identified on the basis of morphometric and meristic data. The initial study, using multivariate analyses, yielded significant differences between populations from three distinct regions on the Pacific coast; the west coast of Vancouver Island (Barkley Sound), the lower east coast of Vancouver Island (Nankivell Point), and the north coast (Prince Rupert). The study also showed that the multivariate analysis technique is a very powerful tool for identifying the population to which individual fish belong; i.e., that the identification of the components of a mixed stock is possible. Therefore, the technique may prove extremely valuable in the management of herring fisheries on mixed stocks.

The program was expanded in 1969 to include: A) A study of population differences between the subdivisions of a major geographical area (i.e. the west coast of Vancouver Island). Five relatively distinct subdivisions exist on the west coast of Vancouver Island: (1) Barkley Sound, (2) Clayoquot Sound, (3) Nootka Sound, (4) Kyuquot Sound, and (5) Quatsino Sound, each of which supports herring populations.

(B) An intensive study in Barkley Sound to discover whether or not the juvenile stocks within a discrete geographical subdivision of the coast can be considered as a single population.

(2) Spawn deposition survey

Pacific herring spawn adhesive eggs that adhere to vegetation growing primarily within and just below the intertidal zone. The length, width and intensity of each spawning is measured annually by officers of the Conservation and Protection Branch. Herring spawning-ground reports have been submitted to the Biological Station, Nanaimo, for analysis and the results reported annually in a circular series since 1955. However, commencing in 1970, published reports concerning herring spawn abundance will originate from the Resource Development Branch in Vancouver.

During a 25-year (1940-64) period the amount of herring spawn deposited along the British Columbia coast has averaged 199 miles. During the 1969 spawning season, 124 statute miles were recorded. Spawn deposition has been at very low levels since 1966 when only 85 miles were deposited, the lowest spawning on record. The low levels of spawn abundance resulted in regulatory measures curtailing commercial fishing in an attempt to increase the size of the spawning stocks. In 1969, spawn abundance increased from the 1968 level in all three Queen Charlotte Islands' subdistricts and five southern British Columbia subdistricts. On the

other hand, the extent of spawn in the northern and central British Columbia subdistricts decreased sharply to record or near record low levels.

(3) Monitoring and sampling program

When it became necessary, in 1967, to close the commercial herring reduction fishery along the British Columbia coast due to low levels of stock abundance, a program was initiated to estimate stock abundance by echo-sounding and sampling. This year (1969-70) the program is continuing, with the Conservation and Protection Branch surveying major herring fishing grounds by echo-sounder and Resource Development Branch providing species identification and size composition data with the aid of six chartered drum-seine vessels.

The pre-Christmas survey in the Strait of Georgia and Johnstone Strait areas indicated that these southern stocks are still at a low level of abundance. Northern and west coast of Vancouver Island stocks are still being assessed.

POLLUTION

Pulp and Paper

(1) Northwood Pulp Ltd. - Prince George

The poor performance of the biological treatment facilities continued at Northwood during 1969. A genuine improvement in suspended solids losses was evident during early 1969 but during the latter portion of the year, high

suspended solids levels were again entering the biological treatment facilities. BOD loadings to the facilities also increased and BOD removals averaged less than 60 percent. Discharge BOD's were almost always over the 80 ppm level specified by the Department and the companies' Pollution Control Permit. Negotiations were resumed with Northwood to obtain improved effluent treatment facilities. The Department requested primary clarification of all sewers followed by a minimum of 2.5 days biological treatment. The Company agreed to provide primary clarification for all sewers but indicated that they felt they could meet our standard of 80 ppm BOD in the effluent by modifying the present system to a "high-rate type" biological system. The technical evidence does not offer much hope of this modification allowing significant improvement in the efficiency of the system but the Provincial Pollution Control Branch would not back the Department up in our demands of the Company.

Northwood plan to have all their modifications and construction completed by October, 1970, so that we will have some idea of their facilities' efficiency by January 31, 1971.

(2) Columbia Cellulose - Prince Rupert

Columbia Cellulose reactivated the red liquor pipeline on May 23, 1969, after a six-month period of breakdown but the line was plagued by leaks in the pipeline on Ridley Island that allowed effluent to leak back into Porpoise Harbour. Many oxygen surveys were undertaken in Porpoise Harbour and Wainwright Basin with the general concensus being

that Winwright Basin could not support fish life due to very low dissolved oxygen values (i.e. 1 ppm) and that fish entering Porpoise Harbour could be stressed due to low oxygen values (i.e. 3-4 ppm).

The Company has undertaken waste surveys to aid in designing pollution abatement facilities. This information combined with better fiber recovery (i.e.fiber losses from sulphite mill may be fed to kraft mill) and a change to ammonia base in the sulphite mill will enable the Department to negotiate with the Company for facilities that may allow Porpoise Harbour and Wainwright Basin to return to adequate fish bearing waters. This may take a period of from three to seven years to complete.

(3) Eurocan Pulp and Paper Co. Ltd. - Kitimat

Negotiations with the Company's consultants were continued to ensure that maximum protection of the fisheries resource is maintained. The facilities to be provided were agreed upon to be clarification of woodroom and all floor drain spillage followed by 8-hour detention tandem settling ponds, 5-day biological treatment in a lagoon then diffusion to the Kitimat River to allow maximum surface transport of the waste. Final negotiations should be completed by April 30, 1970.

(4) Rayonier Canada Limited - Port Alice

Representatives of Rayonier Canada Limited met with pollution staff members to compare and analyze the results of studies carried out in Neroutsos Inlet in 1969. The

Company has plans to install facilities to remove the bulk of the fiber losses. Conversion of the plant to an ammonia base mill from calcium base means that combustion of the very high BOD red liquor may be feasible as a means of lowering the oxygen demand of the mill on the inlet.

(5) MacMillan Bloedel Ltd. - Port Alberni

Construction of the clarifier and effluent treatment facilities for the Port Alberni mill was started in 1969 with tentative completion by July 1, 1970.

(6) Interior Pulp Mills - Intercontinental Pulp and Paper, Prince George Pulp and Paper and Kamloops Pulp and Paper

As these three mills tried for maximum output, the BOD and suspended solids levels increased at all the mills. Correspondingly bioassay results were poorer than 1968.

(7) Cariboo Pulp and Paper Ltd. - Quesnel

Weldwood and their consultants, Sandwell and Co. Ltd., met with the Department to outline the treatment facilities planned for this new mill. Complete primary clarification of all wastes, except bleach plant seal tanks followed by complete biological treatment for all wastes was promised.

(8) Bulkley Valley Pulp and Paper Ltd. - Houston

A preliminary meeting indicated that the Company was planning complete biological treatment for all waste with extensive water re-use. The Company also is considering waste water storage with discharge above a certain minimum river flow to prevent problem to the fishery.

Mining

(1) Mount Washington stabilization program

The Mount Washington tailings impoundment on Vancouver Island was given a spring seeding to supplement the fall 1968 planting. The grass grew well on the impoundment walls and is apparently preventing further erosion and breakdown of the impoundment.

(2) Surveys

A survey of mines in the Yukon and B. C. was carried out and the following mines were found to be causing a problem to their receiving waters:

(a) Cantung, N.W.T. - Canadian Tungsten Corp Ltd.

(b) Carcross, Y.T. - Arctic Gold and Silver Mines

(c) Hope, B. C. - Giant Mascot Mines Ltd.

Negotiations were completed with Anvil Mines, Venus Mines and Utah Construction and Mining regarding their developing properties and tailings disposal.

General

(1) Light industry

Approximately 50 industrial concerns bordering the Fraser River and Burrard Inlet were dealt with in 1969. Their processes were evaluated and the waste products bioassayed. When required, negotiations with technical personnel from the plants were conducted and assistance provided to render the wastes non toxic to fish.

(2) Okanagan lakes

In September, 1969, Resource Development technical personnel assisted Winnipeg based scientific personnel of the Fisheries Research Board in a preliminary limnological survey of lakes Okanagan, Skaha, and Osoyoos. This study was carried out as a result of the Federal-Provincial agreement designed to determine state of eutrophication of these lakes. It is expected that more extensive surveys of this nature will be carried out over the next three to four years.

(3) Pesticide application

The Department's technical staff again processed a large number of pesticide control applications from industry and municipal governments and assisted in the planning of major programs. Several lectures were also given at pesticide short courses on the fisheries problems related to the use of pesticides in British Columbia. In 1969 the persistent chlorinated hydrocarbons DDT and BHC were replaced by rapidly degrading and non-accumulative organophosphates in the major pest control programs.

(4) Port Moody

A survey of Burrard Inlet and Port Moody Arm was initiated in 1969 to determine the effects on the aquatic environment by the various industrial and domestic wastes which are currently added to these waters. Twenty stations were set up in the inlet and sampling was conducted on a monthly basis. The industrial processes and waste treatment

facilities were evaluated and the toxicity to salmon fry of the various effluents was determined. As a result negotiations with several industries were initiated to upgrade their pollution abatement facilities. The study will be continued in 1970.

(5) Fraser River

A study to ascertain the assimilative and reaeration capacity of the Lower Fraser River was initiated in 1969. This survey also included industry monitoring to evaluate waste treatment facilities and toxicity to juvenile salmonids of plant discharges. This survey will also be continued in 1970.

(6) Bella Coola

The Department was informed in 1969 that one or possibly two pulpmills may be located in the Bella Coola area. In order to determine the surface patterns of water movement at the head of North Bentinck Arm, floats were released in the estuary and river at various tidal stages and their movement recorded with a sextant. Two additional surveys were conducted to determine the extent of possible loss of spawning areas should a mill be constructed in the Bella Coola flats.

(7) Bark and fiber sources

The effects of bark and fiber deposits on the aquatic environment were studied in several freshwater and marine situations. The results of these preliminary surveys indicated that:

1. Log storage and booming grounds do not appear to have an immediate detrimental effect on the physical-chemical water quality. However, the substrate is altered considerably by the deposition of sunken logs, branches, bark and needles, and other logging debris which affect the composition of the benthic community.
2. The smaller deposits, such as hydraulic barker, wastes were found to cause a measurable deterioration of both the water quality and the substrate. These wastes, consisting mainly of fibers and small bark particles, have a slow settling rate and create a demonstrable turbidity problem. Once settled the cellulose deposits exert a biochemical oxygen demand on the overlying waters and reduce the dissolved oxygen to levels unsuitable for fish production. In addition to the BOD, gases are formed in the anaerobic zone which underlies the aerobic zone of decomposition. These gases eventually rise to the surface and often resuspend solid material as well as being inherently toxic to fish.

ENVIRONMENTAL PROTECTION

Flood Control and Water Diversions

(1) Shuswap River - Okanagan Lake water diversion

The Water Resources Service of the British Columbia Department of Lands, Forests and Water Resources proposed

in 1967 the diversion of up to 1,100 cfs from the Shuswap River at Enderby to Okanagan Lake via a canal.

The diversion is considered necessary to meet the growing need for water in the Okanagan watershed for agricultural, industrial and domestic water consumption.

In 1969, the Department, together with the International Pacific Salmon Fisheries Commission, completed initial bio-engineering studies on the two watersheds and prepared a comprehensive report dealing with the fisheries problems associated with the proposed diversion scheme, known as Scheme 3. This report indicates that the two dams proposed for the Shuswap River in Scheme 3 would completely obstruct the upstream migration of salmon, trout and kokanee. Fishways at these proposed dams could reduce the problems to some extent. However, losses could be expected to occur due to changes in water temperature, decreased velocities in impoundments, limited river flows and injury to downstream migrants over spillways. Flooding of the reservoirs would inundate present spawning areas.

The present annual commercial landed value and sport fish catch from the Shuswap River Basin is approximately $423,000. The potential of the Shuswap River as a salmon producer is considerably higher, and could be as high as $2,000,000 per year.

The Department's report proposes, as an alternate solution, a pumping scheme from Mara Lake, which would divert water to Okanagan Lake without the need for dams. This

would eliminate most of the fisheries problems associated with Water Resources Service's Scheme 3.

The Federal and Provincial Governments have since signed an agreement which calls for a four-year study involving an expenditure of up to $2,000,000, to develop a comprehensive plan for the management of the water resources in the Okanagan region.

(2) Fraser River flood control

In May 1968, the Federal and Provincial Governments initiated the Fraser River flood control program. Approximately $40,000,000 will be spent on dykes, pumps, floodboxes and other flood control works over the next ten years on the lower Fraser Valley. At the same time, the upstream storage requirements will be re-examined.

Mr. L. Edgeworth represents the Department on the Program Committee and a branch engineer has been appointed as a member of the pump and dyke working groups.

The early part of 1969 was taken up with establishing and adopting administrative procedures, design criteria and guide lines for working groups and consultants. By September 1969, nine municipalities had applied for assistance under the agreement. Some of these projects are now in various stages of design.

Through its appointed members the Branch assesses the various proposals, and possible fisheries problems resulting from proposed flood control measures are defined and recommendations presented to the Committee which provide for

maximum protection of the fishery consistent with the program.

(3) Tsolum River irrigation and flood control

The B. C. Water Resources Service issued a preliminary report in April 1968, on flooding, erosion and irrigation in the Tsolum River Valley. The report describes a number of schemes providing protection against a flood of 10,000 cfs and allowing storage of water for releases during the summer months for irrigation purposes.

During 1969, engineering and biological surveys were conducted to determine the effects of the Water Resources Service proposals on the fishery, and to investigate the possibilities of a joint Water Resources - Fisheries project which would benefit both the residents of Tsolum River Valley and the salmon stocks of the Tsolum River system. A draft report has been prepared.

(4) Cowichan River

A two-year program was initiated in 1968 and continued in 1969 to study the present environment of the Lower Cowichan River, and to recommend a system of flood control which would result in minimum damage to fishery resources. The study was prompted by a B. C. Water Resources report in 1967, which proposed channelization and dyking of the Lower Cowichan and Koksilah rivers to alleviate flooding in Duncan and the surrounding area. It is proposed to complete the program and present our recommendations in mid 1970.

(5) Quinsam River

Negotiations have been continued between the Department and engineering consultants for the Greater Campbell River Water District with respect to their proposal to divert water from the Quinsam River for domestic purposes. The Department has proposed alternatives which would minimize or eliminate damage to the fishery resources, but no agreement has been reached to date. The program of monitoring discharge and temperature was continued.

(6) Nicola River

(a) A B. C. Water Resources Service report on erosion and flood control on the Nicola - Coldwater rivers was reviewed and approved subject to the usual restrictions on timing of construction, gravel removal, etc.

(b) The University of British Columbia, sponsored by the B. C. Water Resources Service, is carrying out a study of the water resources of the Nicola - Kamloops area and has published Report No. 1 (Preliminary Appraisal). The study will continue and is expected to serve as a pilot study for similar investigations. A comprehensive review of the fishery resource of the area will be initiated in 1970.

(7) Marble River

Utah Construction and Mining Co. have made an application to divert 33.5 cfs from the Marble River. Preliminary surveys were conducted in an effort to determine the effects of the diversion on several natural obstructions in the river, and also if and where storage should be

provided. High water conditions prevented an accurate assessment of the situation and investigations will be continued.

(8) Water licence applications

Approximately 1,500 water licence applications were reviewed in 1969. Where necessary, fishery protective measures were developed or fish screens provided to minimize the hazard to the resource.

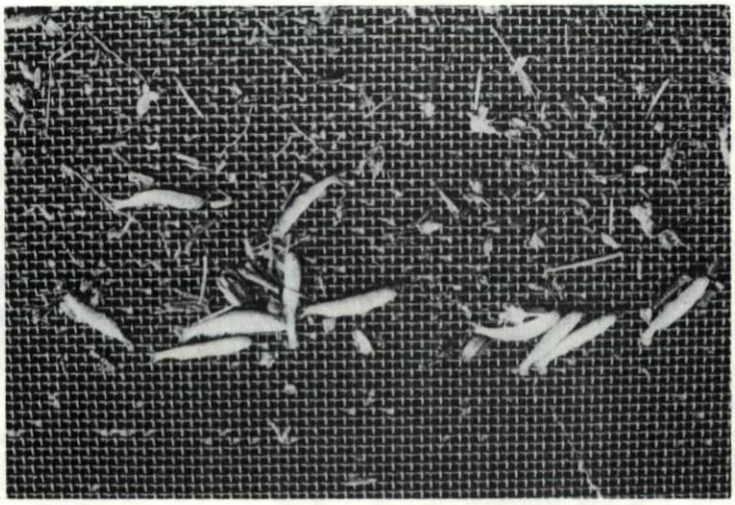
(9) Survey of intake screens

A 1968 study of intake screens found that a high percentage of permanently submerged intake screens were without screens, inadequately screened or in poor repair. The need for more frequent inspections of intake screens was evident and prompted the Branch to train two engineering technicians in scuba diving and to plan annual screen inspections.

As an initial project all water intakes in the South Thompson River between Shuswap Lake and Cache Creek were inspected, their respective intake conditions recorded and, where necessary, follow-up action taken.

The collected data were made available to the Conservation and Protection Branch. A format for a screen inventory was developed and is now in use by Conservation and Protection and Resource Development personnel.

Considerable biological and engineering effort was required to determine the cause and to recommend procedures to eliminate the high fry mortalities observed on the



Fry impinged upon the Crofton screen due to excessive water velocity: Cowichan River.

Diver preparing to inspect the Crofton Pulp Mill water intake screens: Cowichan River.

travelling screens installed by B. C. Forest Products on the Cowichan River. The Company is now undertaking measures to improve the flow pattern and to reduce velocities through their four intake screens. Further tests and observations will be necessary in 1970.

Logging and Related Activities

(1) Genesee River

The Genesee River watershed study on Owikeno Lake was initiated in 1967 to study relationships involving coastal B. C. logging practices and stream survival of salmonids.

During 1969, prelogging monitoring of the watershed continued on a regular basis. Physical parameters presently under investigation include: precipitation, discharge, air temperature, water temperature, gravel composition, gravel movement, bank erosion, suspended sediment and water chemistry. These are being associated with some of the following biological parameters which are also being researched: number and distribution of spawning sockeye, coho rearing, stream invertebrates and sockeye egg-to-fry survivals.

Continuously recording instrumentation on the watershed includes: a series of standard rain gauges, one snow gauge, one A-35 water level recorder with an associated temperature probe and tipping bucket rain gauge, one automatic pumping bottle water sampler and three Ryan temperature recorders.

All investigations are currently being done on a monthly basis throughout the calendar year. Discharge calibration has been made at the newly installed gauging weir.

(2) Miscellaneous

Negotiations continued with companies involved in forest harvesting to ensure maximum communication and to avoid conflict in areas of multiple resource activity.

Monitoring programs on log storage and dump sites were continued on Stuart and Owikeno lakes.

A bio-engineering survey was initiated at Kimsquit Beach, Dean Channel, in order to assess the effects of a log dump site adjacent to the beach spawning area.

A ground and aerial reconnaissance was conducted on the Nass River log drive. With the exception of two locations, potential obstruction or delay to upstream migrants is not considered possible. Measures have been recommended to eliminate the potential problem sites.

A preliminary study was begun on eulachon spawning distribution in the Nass River to determine if habitat utilized by spawning eulachons is endangered by log driving activities.

An investigation was begun on the Coquitlam River and its principal tributaries to determine the disposition of the coho and chum stocks utilizing the system, and to monitor the effects of logging on stream flows and water quality in Or Creek.

Power Development

(1) Whitehorse Rapids - Marsh Lake

The Northern Canada Power Commission have completed modifications to their transportation control structure at

the Whitehorse Rapids facilities after the addition of a third power unit. They also completed the reconstruction of the Marsh Lake Dam and have provided a four-baffle wooden fishway adjacent to the left abutment. The structure was inspected and approved by Branch personnel.

(2) Puntledge River

Engineering surveys were conducted on the Puntledge River to determine relationships between discharge and velocity in areas utilized by the fall run chinook population. The information will be used to determine whether flood peaks released from the B. C. Hydro reservoir at Comox Lake have caused gravel shifting and consequent loss of incubating eggs.

(3) Jones Creek

A gravel cleaning operation was carried out during August by B. C. Hydro and Power Authority in an effort to improve spawning conditions for the cycle year 1969. A total migration of 1,308 pink salmon were counted through the fence. Calculated egg deposition was 1,037,000. An automated water sampling instrument was installed in conjunction with a study being conducted on the relationship between suspended sediment and gravel quality.

(4) Jordan River

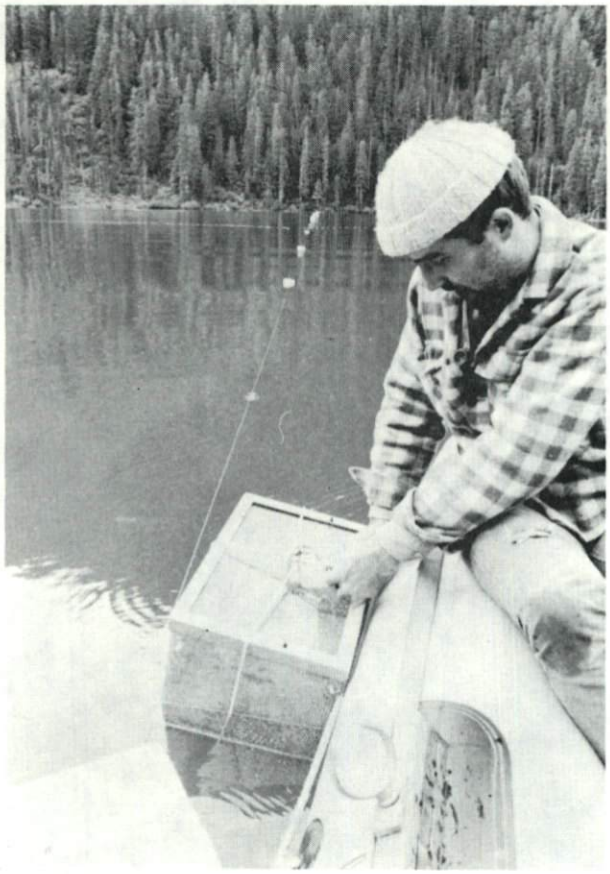
Construction of the new powerhouse and water delivery system has commenced. Several on-site inspections have been made. An estimate of the benefit-cost ratio represented in

maintaining the even-year pink salmon run by providing the necessary flow to the old tailrace channel has been prepared. Further meetings with the B. C. Hydro and Power Authority are planned.

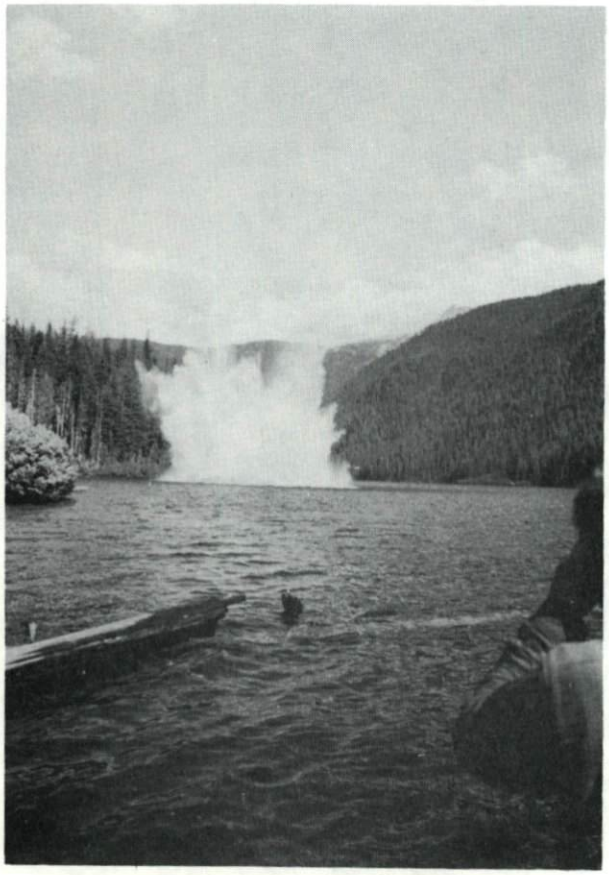
Marine Seismic Exploration

No marine seismic surveys involving conventional explosives took place in B. C. during 1969. Several companies conducted tests in the Gulf of Georgia, the Strait of Juan de Fuca and off the west coast of the Queen Charlotte Islands using alternate energy sources considered harmless to the fishery.

In conjunction with a Department of Energy, Mines and Resources (geophysical research) seismic program conducted at Greenbush Lake during August 1969, the Department undertook the first phase of a study designed to establish 'safe' parameters and to determine guidelines in cases involving the use of explosives in the aquatic environment. Utilizing coho and rainbow trout fry, tests were conducted using 300 and 30 lb charges. Approximately 1,500 fish were subjected to underwater detonations. Preliminary analysis reveals that a 300 lb charge of TNT is lethal within 650-700 feet of the shot point. A 30 lb charge of 60 percent Forcite was lethal within 250-300 feet. Crayfish experienced no mortality when placed within 20 ft of a 30 lb Forcite detonation. The second phase of the program is to be undertaken during the fall of 1970.



Coho fry being positioned at various depths and distances from the blast, Greenbush Lake.



Detonation of a 300 lb. charge at a depth of 40 ft., Greenbush Lake.

Miscellaneous

(1) Pump tests

A limited number of tests were conducted at the Robertson Creek experimental station to determine the feasibility of establishing a relationship between fry mortality and the standard pump parameters, i.e. rpm, head and discharge.

Tests were conducted on three different types of trash pump. With the pumps operating at predetermined rpm and discharges, groups of fry were introduced into the intakes, passed through the pumps and collected in a recovery chamber attached to the discharge line. The fry were then examined for immediate and delayed mortality.

The results of the tests showed strong evidence of fry mortality-pump parameter relationships. A report of the studies is presently being prepared.

(2) O'Ne-ell Creek

The amount of increase in suspended sediment load which resulted from the hydraulic removal of overburden at a jade mining site on upper O'Ne-ell Creek was monitored over sockeye spawning areas 3 to 4 miles downstream from the mine. No significant change was detected. Safe monitoring parameters (discharge and overburden load per unit of time) were established for future application.

(3) General construction

As a result of proposed highway construction bordering the Atnarko River two engineering inspections and a biological

survey of spawning and rearing distribution were made. Detailed negotiations with senior Highways Department personnel are continuing in an atmosphere of genuine co-operation.

Minor technical problems arising from general construction activities on the Fraser, Nicola, Fulton, Kitimat, Quesnel, Bulkley, Thompson, Nass, Indian, Wedeene, Nimpkish, Ishkheenickh and Quatse rivers were resolved without imposing unsatisfactory conditions upon the stream environments.

(4) Peace - Fraser

A seasonal investigation of the feasibility of pike from the Peace watershed gaining access to Pacific drainages was continued in 1969. A second aerial survey of the Peace - Fraser, Peace - Skeena headwaters was undertaken during the peak snowmelt period to confirm 26 locations tentatively identified in October 1968 as points of continuous (seasonal) water between the Pacific and Arctic drainages. Twelve of these sites were eliminated by virtue of the presence of impassable falls on the upper reaches of the Arctic water-courses. Most of the remainder must be confirmed by ground checks.

(5) Gravel removal

On-site inspections of gravel removal proposals were undertaken on the Kitimat, Somass, Vedder, Fraser, Okanagan and Squamish rivers and Portage Creek in connection with

road construction, flood control and pipeline crossings.

(6) Roberts Bank superport development

Discussions were held with representatives of local crab fishermen and with the National Harbours Board to clarify the Department's position with regard to alleged reduction in the availability of crabs in the area occupied by the recently completed, first phase of the port development. Fisheries Research Board studies in the area may be useful in indicating the effects of ultimate development on the future productivity of the area.

SPECIAL

Research Technology

(1) Underwater acoustics

Research directed toward fish counting was continued this year with the basic design of a counting system to be used along with a vertical echo sounder. Mathematical design was carried to completion and some logic circuit construction was begun but no tests of the complete system could be carried out because of the lack of a suitable echo sounder. This device will have the capability to record the number of echos received and to apply an internally generated correction factor which will correct the count for the shape of the beam pattern of the echo sounder and the boat speed.

Experiments in fish detection were carried out in Rivers Inlet using a Braincon underwater towed body and an

upward facing transducer. Some of the basic concepts and circuits of the counting system were tested at this time. This experiment proved valuable in learning more about the location of fish with respect to the depth at which they swim during the night. This work was done with equipment borrowed from Bedford Institute of Oceanography. Cost, complexity of operation, size of underwater body and power requirements of the equipment make the system used by BIO impractical for use on a small boat, by a non-electronics oriented operator.

(2) Blast monitoring: Project Edzoe

Together with the Environmental and Protection Group, research studies into the effects of explosive charges on fish were carried out at Greenbush Lake where the Department of Energy, Mines and Resources was conducting Project Edzoe. The Navy diving group from Esquimalt fired a series of 300 pound depth charges at a depth of 40 feet and a series of 30 pound 60 percent Forcite charges at a depth of 30 feet for study purposes. These charges are significant because the 300 pound charges are equivalent to hydrographic survey blasts and the 30 pound charges are similar to the charges both with respect to explosive type and charge size that probably will be used at First Narrows when it is increased in depth. The blasts were monitored using hydrophones and an oscilloscope equipped with a camera. The monitor unit was set up so that the blast triggered the sweep on the oscilloscope, and in this way, the peak pressures produced by the explosion were recorded. As a result of studies done on the data recorded

at Greenbush Lake, a device was designed and released for construction which will be able to record the peak pressures produced by an explosive charge. This device will be field tested in the coming year.

(3) Photo counter

Research directed toward enumeration of fry was continued this year with the construction and testing of a photographic counting device. The fry are forced to swim over a plate of plexiglass by a series of paddles. Under the plexiglass is an array of flashtubes. These flashtubes are triggered by a camera focused on the plate. The camera takes a picture whenever the space over the plexiglass is clear of paddles. The picture taken shows the fry as a silhouette. This device produced promising results but the flashtubes were not adequately sealed and failed before the fry from the rearing ponds at Qualicum were released, so the device did not function this year except to test the operation of the mechanical components. The problems experienced with the flashtubes have been solved and the system will be operating at Qualicum during the next season when the fry are released.

(4) Salmon egg counter

The egg counter developed by the Fisheries Research Board was examined at Qualicum, and it was determined that the feeding system and the detection circuitory could be improved. The system of feeding the eggs was redesigned so that operator attention and skill need be minimal. The

The detector was redesigned so that it counts eggs which are close together and moving rapidly. A splash proofed custom counter design was asked for so that the expense and complication of the system could be kept to a minimum. This makes the equipment robust and portable enough to be used anywhere that water pressure is available.

(5) Sub-gravel water velocity monitor

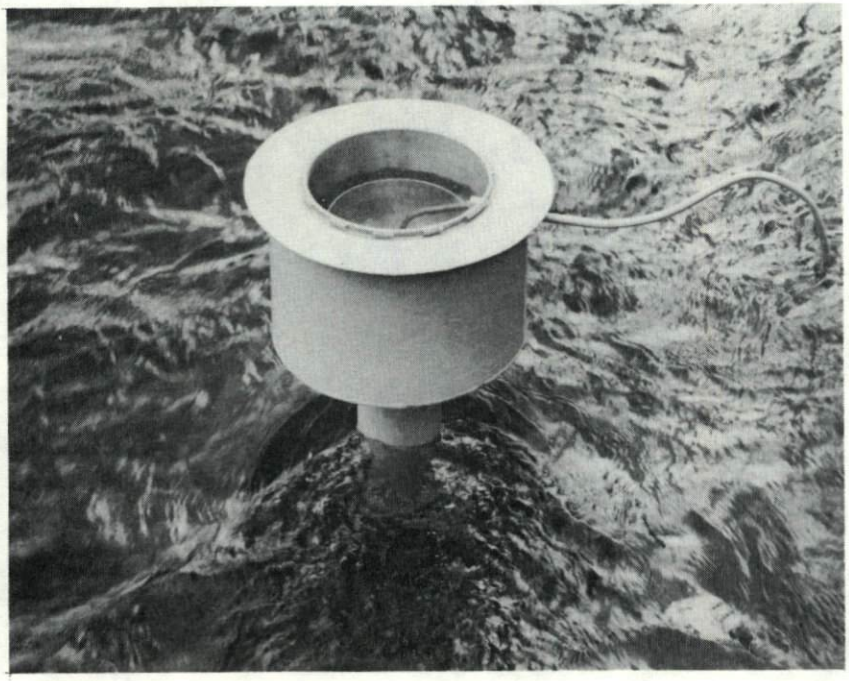
An instrument, which was developed through previous research into sub-gravel water velocity monitoring, was designed and tested. Results to date have been promising, but the instrument requires some refinements and testing before it can be sent out as a completely reliable field instrument.

(6) Sample splitter

A device to enumerate fry by taking a 10 percent sub-sample was designed and constructed. The unit was tested at Qualicum where records of the sample and the total escapement were kept. The sample splitter performed successfully during the time that records were kept.

(7) Gravel sampler

An in situ gravel sampler for removing spawning gravel for silt analysis was designed and built. The system uses circulating acetone cooled by solid CO_2 to freeze a sample of gravel around a standpipe which has been driven into the gravel. The system was tested at Qualicum and was found to take a reliable sample every time. It cannot,



Gravel sampler in position in riffle area.

Sample of frozen gravel from streambed.

however, take a gravel sample in very coarse gravel in fast riffles as the rapid subgravel water flow in this case will not freeze.

(8) Communications

A simple technique, suitable for use by the average field technician, was developed whereby field radios can be easily tuned for maximum output without any knowledge of radio theory. A technique for installing reliable antennas was devised. This technique makes use of a bow and arrow, and eliminates the need for climbing trees, and as a result, antennas are much easier to put up to a height from which they will give optimum performance.

A remote control facility was designed and constructed and set up for installation in the Vancouver office and the transmitter and receiver sites. This will be done as soon as the move of the receiver site to Westham Island is completed.

Resource Inventory

The objective of this program is to collect and disseminate information on the salmon stocks and salmon bearing watersheds within the Pacific Region in order to assist in the regulation, development and protection of the resource. To this end, the identification of salmon production streams was completed for this region with the printing of a directory for watersheds located in northern British Columbia and the Yukon. Field surveys were

Quaal River: relatively wide valley, low gradient, extensive pool area; major pink salmon producer; Kitimat area.

Brim River: narrowly confined stream, moderate to high gradient, coho salmon producer; Kitimat area.

Kitlope River: wide flood plain, moderate gradient; sockeye and coho salmon producer; Kitimat area.

carried out in statistical Areas 14 (Comox) and 6 (Kitimat) as a part of the data collection activity to assess environmental conditions and to measure spawning populations. Special attention was given to the important salmon stocks in these areas. The Department's first stream catalogue is scheduled for printing in 1970.

Maintenance and Operation of Facilities

Inspections were made in 1969 of Naden, Indian, Kadjusdis, Moricetown, Stamp, Sproat and Meziadin Rivers fishways to ensure that the structures were operating to their design requirements. As a result of these inspections maintenance and improvement work was carried out on the following facilities:

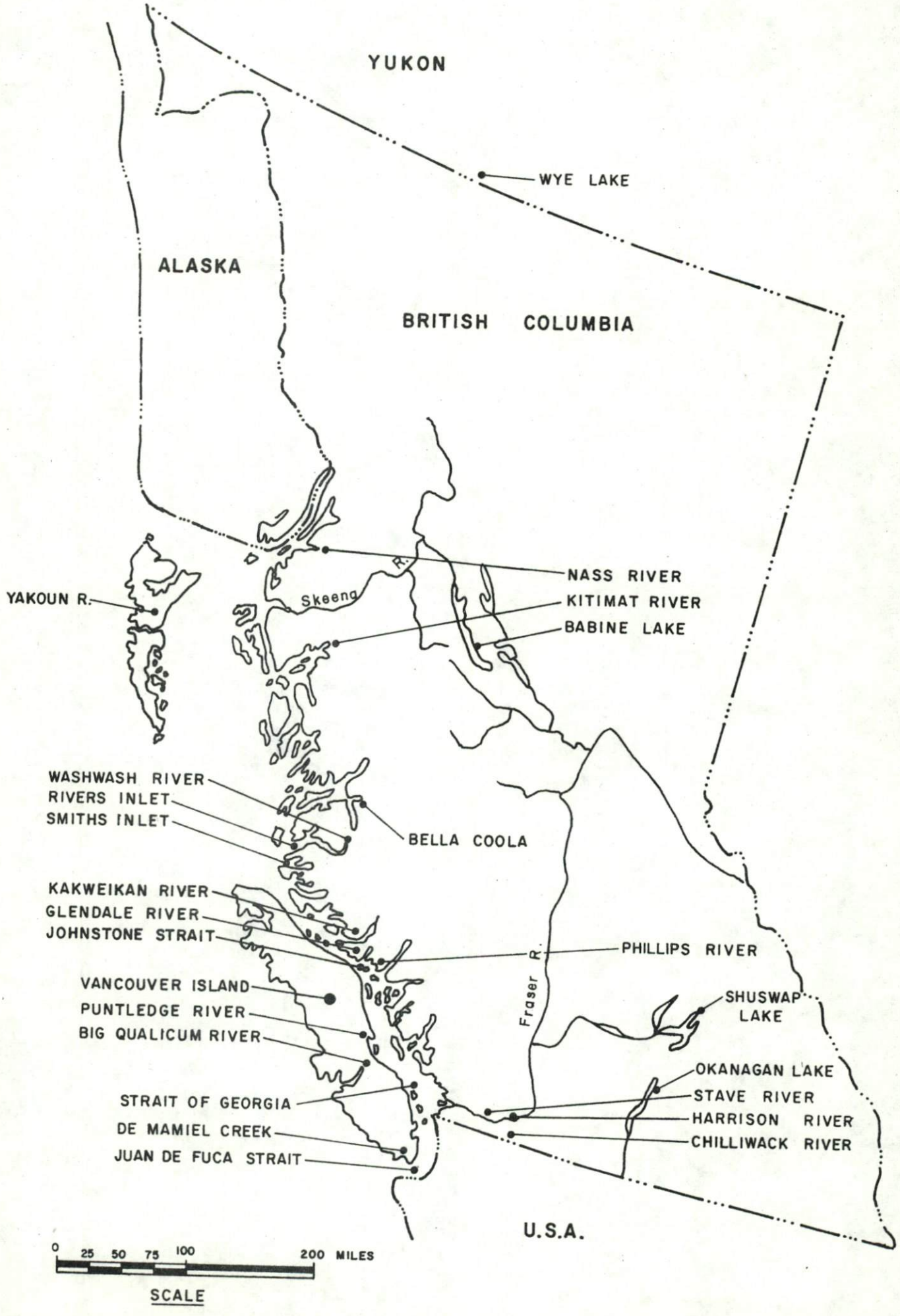
1. Kadjusdis Fishway - repaired several concrete baffles;
2. Meziadin Fishway - installed a chain-link guard fence to prevent public access on top of the fishway;
3. Stamp Falls Fishway - repaired log deflector wall;
4. Sproat Falls Fishway - painted grating and steelwork;
5. Skutz Falls Fishway - replaced missing gratings and removed logs from top of fishway;
6. Moricetown Fishway - galvanized gratings, replaced damaged steelwork and portion of trashrack.

In addition to the above, maintenance programs were carried out at all the region's spawning channels. This included cleaning spawning gravel in place at the Fulton No. 1, Pinkut Creek and Qualicum No. 1 and No. 2 channels. At Jones Creek Spawning Channel, B. C. Hydro removed, washed and replaced the spawning gravel in the upper nine section of the channel. The remaining sections of spawning gravel were cleaned in place. Additional maintenance work by B. C. Hydro included removing silt from desilting basins, repairing intake gate and repairing drop structures.

A repair program was undertaken at Pinkut Creek Spawning Channel as a result of ice damage during the 1968-69 winter. This included replacing washed out sections of berms and repairing damaged gates and structures. A revised winter operations program for 1969-70 has been set to minimize ice damage and includes making detailed observations of ice formation to aid in the design of a proposed warm water pumping system at this location.

Cypress Creek Field Station

Investigations were undertaken regarding the development of a temporary freshwater supply for the Cypress Creek fisheries field station. Several alternatives were considered, including the development of a supply from Cypress Creek and a ground water supply. In conjunction with these studies a test-well drilling program is proposed at the site in early 1970.


YUKON
WYE LAKE
ALASKA
BRITISH COLUMBIA
NASS RIVER
KITIMAT RIVER
BABINE LAKE
Skeena R.
YAKOUN R.
WASHWASH RIVER
RIVERS INLET
SMITHS INLET
BELLA COOLA
KAKWEIKAN RIVER
GLENDALE RIVER
JOHNSTONE STRAIT
PHILLIPS RIVER
Fraser R.
VANCOUVER ISLAND
PUNTLEDGE RIVER
BIG QUALICUM RIVER
SHUSWAP LAKE
OKANAGAN LAKE
STRAIT OF GEORGIA
STAVE RIVER
HARRISON RIVER
DE MAMIEL CREEK
CHILLIWACK RIVER
JUAN DE FUCA STRAIT
U.S.A.
0 25 50 75 100 200 MILES
SCALE