

DEPARTMENT OF FISHERIES OF CANADA

RESOURCES DEVELOPMENT BRANCH

PACIFIC AREA

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RESOURCE DEVELOPMENT BRANCH

In 1965, the Fish Culture Development Branch, which formerly was an arm of the Conservation and Development Service, was elevated in status to the Resource Development Service; with field offices in the various Areas becoming Resource Development Branches.

The principal responsibilities of the Resource Development Branch in the Pacific Area are: (1) to protect the fisheries resource from the harmful effects of industrial and other water-use projects, (2) to expand the resource by the application of techniques developed through research, and (3) to undertake 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 of the Branch continued to expand in all three fields in 1965, maintaining the trend of recent years.

Fisheries problems stemming from industrial developments continued to require the attention of a sizeable staff. Establishment of several new pulp mills, and expansions of existing ones, posed major problems in connection with the development of methods for safely disposing of large quantities of plant wastes; and with the diversion of large volumes of water from salmon-supporting rivers. Considerable attention was directed also toward log-driving, denudation of watersheds,

gravel removal from river beds for construction of roads, and other problems associated with the rapidly-expanding forest industry in British Columbia.

As in 1964, mining activities continued at an accelerated pace throughout the Area, and these gave rise to serious fisheries problems caused by water diversions and disposal of wastes. Irrigation, flood-control, and other water-use projects were also investigated during the year.

Aside from routine operating problems, the major activity of the Branch in connection with hydroelectric developments was directed toward the fisheries problems at the Puntledge River hydroelectric development, where the Branch provided the basic design and oversaw construction of a new spawning channel, built by B. C. Hydro and Power Authority, to accommodate the upriver run of early chinook salmon.

During the year the Branch also continued to work closely with major oil companies undertaking seismic surveys in coastal waters to ensure that their operations did not conflict with the fisheries resource.

Major undertakings in the field of salmon development projects were initiated in 1965 when contracts were let for the construction of a \$700,000 fishway at Meziadin Falls on the Nass River system, and a \$500,000 spawning channel on Fulton River, tributary to Babine Lake. The latter is the first stage of a proposed five-year \$5,000,000 program looking to developing the potential of Babine Lake as a sockeye salmon nursery area.

Operation and assessment of the Big Qualicum River salmon development project constituted an important part of the 1965 program. Results obtained to date have been most encouraging.

Several unforeseeable developments of an emergency nature occurred during the year which required the immediate attention of the Branch. An enormous landslide on the Tahltan River, the major sockeye producer in the Stikine watershed, created an impassable obstruction which necessitated the implementation of a helicopter airlift to pass the 1965 spawning migration. Moreover, a major change in the course of the Phillips River in mid-October, cut off the direct flow to heavily-seeded pink salmon spawning grounds and it was necessary for the Branch to excavate a \$40,000 channel to divert the river back to its natural bed. A similar problem was alleviated at the Teaquahan River by the construction of a dyke.

Surveys and investigations of spawning streams, particularly those in the lower Fraser Valley, Vancouver Island, and the Queen Charlotte Islands were continued during the year and certain watersheds have been selected for more intensive study as possible development projects for the future. Similarly, a number of reported obstructions were surveyed and several of these received immediate attention.

During 1965, the salmon management activities of the Branch included: test-fishing and sockeye salmon enumeration studies on the Nass River; an exploratory test-fishing operation on the Stikine River; adult sockeye enumeration studies at

Rivers Inlet, complemented by a study to measure juvenile sockeye abundance in Owikeno Lake; regulatory studies on the Johnstone Strait pink and chum salmon; tagging of coho as part of a distribution study in the Strait of Georgia; regulatory studies on the Fraser River chinook and chum salmon; and the assumption by the Branch of regulatory responsibilities on the Skeena River Management Committee.

DEVELOPMENT

Big Qualicum River Project

The program initiated in 1959 to assess the effects of flow control on the freshwater survival of chum, coho, and chinook salmon in the Big Qualicum River was continued in 1965, and interesting comparisons can now be drawn from available data. For instance, in the four years immediately prior to implementation of flow control, chum salmon egg-to-fry survival rates averaged 11.2 percent, with a range of 5-17 percent; whereas figures of 25.2 percent and 24.5 percent have been recorded in the two succeeding years (1963-64 and 1964-65) when river flows were being controlled. Similarly, the magnitude of the seaward migration of coho fry at the enumeration site, which is regarded as a measure of the abundance of emergent fry, has increased from a maximum of 64,000 recorded under natural conditions to approximately 500,000 under the controlled-flow conditions which prevailed over the winter of 1964-65. It is of interest to note also that fry emigrations produced by coho spawning stocks of comparable size have been recorded as 0.3 percent of the potential egg deposition, under natural conditions, as

compared with 4.3 percent with flow control. On the other hand, the output of coho smolts, migrating after one year of stream residence, has been relatively steady, with no significant increase being noted during the first summer of flow control. It should be pointed out, however, that although the average river discharge during the two low-flow months of August and September was above normal in 1964 it did not exceed the minimum daily discharge which occurred in some study years prior to implementation of the flow control project.

The magnitude of the 1965 seaward migration stemming from the 1964 brood of chinook salmon represented 12 percent of the estimated potential egg deposition, which is substantially less than the 19.8 percent survival rate of the eggs deposited by the 1963 brood, but it is still in excess of all those recorded under natural conditions. Year-to-year variations which have been observed in the quality of chinook fry migrants, particularly with regard to their sizes and their dates of entry into saltwater, are such that their actual numbers may not be indicative of the potential adult production.

In the spring of 1965 the adipose fins of approximately 750,000 seaward-migrating chum salmon fry were removed so that the adult returns would be readily identifiable, providing the basis for measuring the Big Qualicum's contribution to a commercial fishery involving a number of different races.

The 6.4 million pink salmon eggs taken from the Bear River stock and transplanted in the Qualicum spawning channel in 1964, in an effort to establish a self-perpetuating run,

resulted in an emigration of 3.0 million fry in the spring of 1965. This represents an egg-to-fry survival rate of 47 per cent, which is a substantial improvement over the 20 percent recorded in the previous year, when, prior to implementation of the flow control program, the 6.3 million eggs transplanted from the Cheakamus River stocks were subjected to heavy siltation during freshets.

The 1965 escapements to the Big Qualicum River were 19,000 chums, 3700 coho, and 1300 chinooks. The returns of chums and coho were down from the 35,000 and 5200 recorded in 1964, but the chinook return was up by 800. The six-year average escapements over the 1959-64 period have been 50,000 chums, 3700 coho, and 1150 chinooks. Only 75 adult pink salmon returned to the Big Qualicum River in 1965 and all of these are presumed to have originated from the 1963 transplant because the numbers of "strays" from other systems have not been significant in previous years.

In the summer of 1965 the spawning channel was reconstructed to eliminate defects which had developed as a result of bank erosion caused by salmon spawning along the margins. In this connection the channel width had been increased in some local areas by as much as 30 percent, causing substantial changes in the flow patterns within the channel and siltation of the spawning gravel.

After removal of the existing spawning gravel the channel sub-base was re-formed to a uniform cross-section and the banks were lined with sheets of corrugated asbestos board. The channel was then re-lined with new high-quality gravel.

The gravel extracted from the channel was distributed over approximately 8000 square yards of river bed in an area which had not previously been utilized for spawning purposes. In 1965, however, significant numbers of chum salmon spawned in this area, giving reason to believe that improvements of this type might be a worthwhile means of increasing salmon production in the natural river.

Runoff from the Big Qualicum watershed in 1965 was about average, and near-optimum flows were maintained in the lower river without having the reservoir approach critical levels.

Babine Lake Development Program

This is a proposed five-year \$5,000,000 construction program looking to the development of the potential of the main basin of Babine Lake as a nursery area for sockeye salmon - this potential being restricted under natural conditions by the lack of spawning grounds adjacent to the lake, as is indicated by data obtained from the Fisheries Research Board of Canada.

The first phase of the program was completed on schedule in October, 1965, when water was turned into a newly-constructed spawning channel adjacent to the Fulton River. This installation, which was completed at a cost of approximately \$500,000 will accommodate 24,000 sockeye spawners in its 4800-foot length. Although the channel was not completed in time to accommodate spawners in 1965, approximately 1,200,000 eyed sockeye eggs were planted in the channel in late November to provide valuable experience in connection with operating

problems caused by severe climatic conditions; to measure the efficiency of the channel in terms of egg-to-fry survival; and to facilitate tests of gear and techniques which will be



Aerial view of Fulton River Spawning Channel under construction, August, 1965. Fish entrance at lower right, water intake at upper left.

Creek... Fulton River... and...
pre...
Fulton, which represents 12-13 percent of the potential egg
deposition (70 million), and 4-5 million fry at Pinhook, which

problems caused by severe climatic conditions; to measure the efficiency of the channel in terms of egg-to-fry survival; and to facilitate tests of gear and techniques which will be employed for fry enumeration when the channel is brought into full production.

While construction of the Fulton River spawning channel was underway, engineering surveys and design studies were being pursued concurrently in preparation for the 1966 construction program, which calls for the expenditure of approximately \$1,100,000 for part of the flow-control works at Fulton and Taltapin Lakes and for a start on the spawning channel proposed for Pinkut (15-Mile) Creek.

During 1965, surveys of the Morrison River watershed were completed, and the data so obtained will be evaluated to determine whether or not a development project would be warranted at this location. The biological studies which were initiated at Fulton River in 1961 and at Pinkut Creek in 1964, were continued in 1965 to provide additional background information with respect to the sockeye runs and their natural environments. The data so obtained provides the basis for the design of the salmon development projects and will serve in future as a means of evaluating the worth of such projects.

The 1965 fry outputs from Fulton River and Pinkut Creek, as estimated by sampling of migrants at the former, and pre-emergent fry at the latter, were: 24-25 million fry at Fulton, which represents 12-13 percent of the potential egg deposition (187 million), and 4-5 million fry at Pinkut, which

represents approximately two percent of the potential egg deposition (228 million).

Comparison with results obtained in previous years reveals that the 1965 survival rates were low in both rivers. It should be noted, however, that unusually high discharges which occurred in the fall of 1964 resulted in above-normal marginal spawning, and that very severe winter conditions, with air temperatures dropping to as low as -45°F during the last half of December, probably contributed to the reduced survival. Furthermore, overcrowding on the Pinkut Creek spawning grounds resulted in abnormal losses of eggs during the spawning period.

On the basis of visual counts taken from towers overlooking each of the two rivers the 1965 sockeye spawning population to the Fulton River was estimated at 139,000 (11 percent jacks), with an estimated potential egg deposition of 182 million; while that at Pinkut Creek was 34,000 (30 percent jacks), with an estimated potential egg deposition of 59 million. Post-spawning hydraulic samplings undertaken at Pinkut Creek indicated that the actual deposition was 19.7 million eggs, or 33.4 percent of the potential, and that the actual live deposition at the time of sampling was 13.5 million eggs, or 23 percent of the potential.

The Fulton River spawning population was close to the optimum of 120,000, but the low flows and relatively high water temperatures which prevailed throughout August and September reduced the areas available for spawning, delayed spawning activity, and substantially altered the normal distribution of spawners. On the other hand, above-normal discharges occurring

in October and November resulted in relatively high water temperatures, and the accompanying enhancement of incubation rates tended to offset the rather late deposition of ova.

Low flows which prevailed in Pinkut Creek throughout the spawning- and early-incubation periods, did not delay spawning, but they did reduce the area available for spawning,



The entire structure is angled across the river in such a way that upstream-migrant fish, on encountering the sheet of water falling from the 280-foot crest, will be directed naturally to

the hydraulic sampler technique, 1965. The 670-foot-long concrete flume with 37 baffles of the vertical-slot type, will provide the means by which all fish can surmount the 35-foot obstruction posed by the upper and lower falls.

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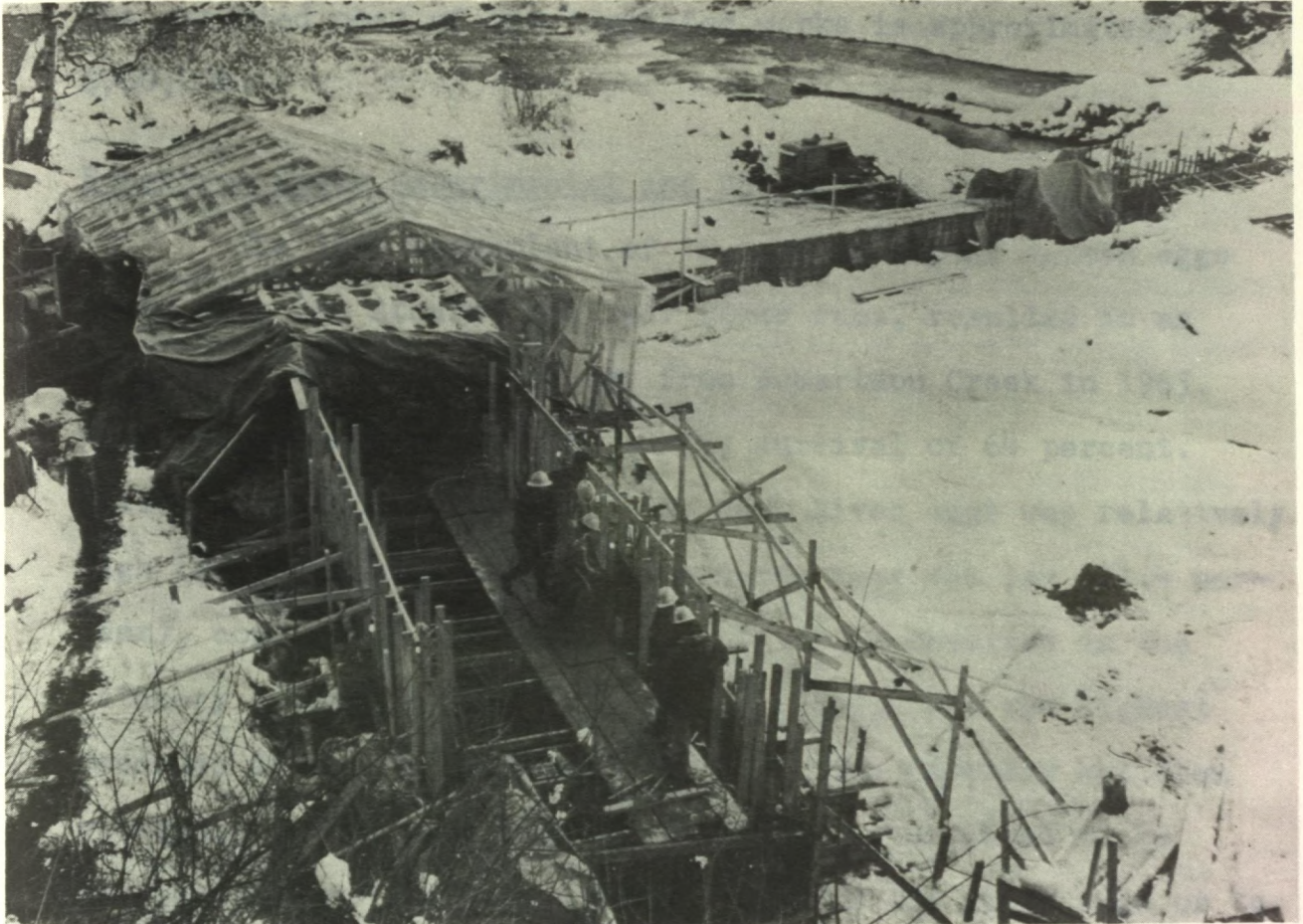
Low flows which prevailed in Pinkut Creek throughout the spawning- and early-incubation periods, did not delay spawning, but they did reduce the area available for spawning, and the accompanying low water temperatures retarded development during the early incubation period.

Meziadin River Fishway

In June, 1965, a contract was awarded for the construction of a fishway and barrier dam at Meziadin Falls on the Meziadin River, approximately 125 miles northeast of the city of Prince Rupert. When completed, these facilities will eliminate the serious losses and delays sustained at certain water levels by important stocks of sockeye salmon which spawn in Meziadin Lake and its tributaries.

The barrier dam is essentially a concrete sill mounted on the crest of the lower falls to create a minimum water surface drop of eight feet, which will be impassable to sockeye. The entire structure is angled across the river in such a way that upstream-migrant fish, on encountering the sheet of water falling from the 280-foot crest, will be directed naturally to the fishway entrance located on the left (north) bank. The 670-foot-long concrete fishway with 35 baffles of the vertical-slot type, will provide the means by which all fish can surmount the 35-foot obstruction posed by the upper and lower falls.

Good progress was made on the construction of these works in 1965 before the contractor had to close down the operation in mid-December because of severe winter conditions. His crews will be returning to the site in the spring of 1966, and it is expected that the entire project will be completed by July 1st in time to benefit the 1966 sockeye migration.



the high temperature at Robertson Creek. The Bear River transplant was made to compare survivals and returns from this late spawning stock with those of the Atnerka stocks and possibly determine the reason for poor survivals and returns.

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Robertson Creek Experimental and Development Project

The 1964 transplant of 10.1 million pink salmon eggs taken from the Atnarko and Bear River runs, resulted in an emigration of 6.5 million fry from Robertson Creek in 1965, which represents a mean egg-to-fry survival of 64 percent. While incubation survival of the Bear River eggs was relatively high (89 percent), that of the Atnarko eggs was low (51.4 percent), continuing the high-mortality trend observed in the hatchery eyeing station (25 percent), which was the highest recorded during the six years in which the hatchery has been operating. This high rate of mortality is believed to be attributable to the long transit time for the green eggs or to the high temperature at Robertson Creek. The Bear River transplant was made to compare survivals and returns from this late spawning stock with those of the Atnarko stocks and possibly determine the reason for poor survivals and returns.

The 1963 deposition of 13 million pink salmon eggs (9.7 million by transplant, and 3.3 million by the adult returns from the 1961 transplant) produced a 1965 return of

approximately 2000 adults. Of these, 1646 returned to the spawning channel, while approximately 352 spawned elsewhere in the Somass River system, chiefly in the upper Stamp River. An additional 55 fish were reported to have been taken in the commercial and sport fisheries. There were no reports of fish straying to other streams discharging into Alberni Inlet.

The 1965 return of 2000 fish falls far short of the 13,000 required to replace the parent stock of 13 million eggs. Nevertheless, it was encouraging to note from a preliminary comparison of redd locations charted in 1963 and 1965 that the 1965 spawning distribution was more uniform and that superimposition was minimal. Moreover, pre-spawning mortality was less than two percent in 1965, as compared with 30 percent in 1963.

The calculated egg deposition of the 1965 pink salmon return was 1.7 million, of which 0.7 million were located in the experimental sub-channels. Spawning efficiencies in the sub-channels were studied, using density, water velocity, and proximity to riffles as experimental variables.

A Fisheries Research Board pathologist examined 43 moribund pink salmon for columnaris and other bacterial fish diseases. Microscopic examinations of gill filaments and media cultures were all negative for columnaris. This disease has been suspected as one of the major causes of high pre-spawning mortality recorded with pink salmon in 1963. It is probable that the marked improvement in the pre-spawning mortality rate is directly associated with the fact that the mean daily stream temperature was 3-5 degrees colder than that in 1963.

A total of 415 coho were transported by truck to a discrete section of the channel, where their spawning success and distribution were observed. Observations were made on the effect of a longitudinal centre gravel berm, riffles, and a sub-surface percolation bed on the spawning distribution of these coho. To determine the causes of the high pre-spawning mortality of this species in the channel approximately one-half of the spawners (200) were placed in the channel during the early period of upstream migration (September 1 to 21). The remainder were placed in the channel during the late period of migration approximately a month later. Fifty percent of the females in the early group and 11 percent of the females in the late group died before spawning. It is believed that the major portion of the early run normally enters Great Central Lake and spawns in tributaries to the lake while the later running coho spawn chiefly in the river below the lake. These later fish are probably the only coho that can be used in experimental studies in Robertson Creek.

The temporary eyeing station, installed in the test-flume, was dismantled, and the flume was turned over, on loan, to the Institute of Oceanography and the Fisheries Research Board to facilitate their joint study of a high-velocity test conduit.

During the year the Robertson Creek facilities were used to provide data and tests for the design of the large-scale downstream-migrant traps required at the Fulton River spawning channel.

Constricted reaches of the Boot Lagoon flowage, upstream of the spawning channel, were dredged to reduce the high head losses which threatened to restrict the availability of flows to the channel during low-water periods.

Nanika River Rehabilitation Program

The Nanika River hatchery which was constructed by the Department in 1960 to rehabilitate the severely depleted Nanika River sockeye run was operated as a production unit for the fourth consecutive year during the 1964-65 season.

In September of 1964, 13.6 million sockeye eggs were transferred from 15-Mile Creek on Babine Lake to the hatchery. A total of 12.1 million eggs were held in the hatchery to the fry stage while 1.5 million eggs were incubated to the eyed stage in the hatchery and then subsequently transferred to a small experimental incubation channel associated with the hatchery. Egg-to-fry survival in the hatchery and channel totalled 65 percent and 80 percent respectively.

With regard to fry quality, the channel-incubated fry were much larger than the hatchery-produced fry but were slightly smaller than the naturally-produced 15-Mile Creek fry. A comparative study, conducted on the sizes of pre-emergent fry from the incubation channel and from 15-Mile Creek, indicated that the naturally-produced 15-Mile Creek fry were larger because of pre-emergent feeding which occurred only in that system.

In recent years the Nanika River sockeye stock has shown definite signs of recovering and concern with respect to

its future status has eased considerably. For this reason, as well as the fact that hatchery-incubated fry have been of inferior size, the hatchery operation was limited in 1965 to the incubation of 3.4 million eyed eggs for transplantation to the Nanika incubation channel pending evaluation of the past four years production. This channel has been kept in operation for the current year as a means of assessing the operation of this type of facility under extreme winter conditions.

An adult return of age-4 sockeye, incubated in the hatchery during its first year of operation, was expected in 1965, but there were only a calculated 400 age-4 fish in the total return of 9700. Since a return of this magnitude could have been expected from the 1961 Nanika River native stock, the contribution of the hatchery-produced fish probably was not significant.

A biological program, initiated in 1961 to assess the contribution of the artificial transplants and the status of the native sockeye population, is being continued.

Tahltan River Slide

In April, 1965, a report was received that a large landslide had created an impassable obstruction in the lower reaches of the Tahltan River, the major sockeye-salmon-producing tributary of the Stikine River, which is approximately 300 miles north of the city of Prince Rupert.

Subsequent air- and ground surveys confirmed this report, noting that the slide had engulfed the natural river bed for a substantial distance, with the result that the river

was displaced several hundred feet from its former course. Several falls located along the new stretch of the river were obviously impassable to salmon.

When preliminary surveys clearly revealed that the slide was of such gigantic proportions that the cost of its removal would be prohibitive, studies were initiated to develop an alternative solution. It was obvious, however, that a permanent solution could not be undertaken in time to assist the 1965 migration because of the problems of access and the very short time available to develop and implement plans. Accordingly, steps were taken to effect a temporary solution by blasting channels through the obstructions, and, when these proved to be of little value, a helicopter airlift was implemented to convey salmon around the slide area.

Nets were employed to trap and hold salmon in a quiet reach of the river, from which they were transferred manually to a 45-gallon drum (half-full of water) suspended from a helicopter in such a way that the machine was able to hover for loading and unloading of the fish. A total of 10,914 salmon, most of which were sockeye, were transported by this means.

Unfortunately, the extremely low discharges which occurred in 1965 resulted in another complete obstruction at Descheeka Falls, some 20 miles upstream from the slide. A hastily-contrived dip-netting program finally resulted in 2000 salmon being passed around this obstruction.

Further attention will be directed toward the slide and Descheeka Falls in the spring of 1966, looking to developing permanent solutions to the fisheries problems they present.

River Diversions

The heavy rains which caused floods in many coastal streams in mid-October resulted in the Teanaman and Phillips Rivers changing courses, cutting off the flow to important spawning grounds which had been heavily seeded by the '555



logging channel which roughly parallels the river in the reach where spawning occurs. In order to divert these flows onto the spawning grounds a new channel, some 2800 feet long, is being excavated to a depth of several feet below the invert of the logging channel to connect the lake with the upper reaches of the spawning grounds. Total cost of the project, which is scheduled for completion in late February, 1966, is estimated to be \$40,000.

River Diversions

The heavy rains which caused floods in many coastal streams in mid-October resulted in the Teaquahan and Phillips Rivers changing courses, cutting off the flow to important spawning grounds which had been heavily seeded by the 1965 spawning stocks.

Inspections of both sites revealed that local drainage, coupled with continuing wet weather, was keeping the eggs moist, and that there was every reason to believe that substantial numbers could survive if the normal water supply was resumed as quickly as possible.

The Teaquahan River (Eva Creek), which is situated at the head of Bute Inlet, was diverted back to its original channel by means of a dyke constructed at the point of breakthrough. The cost of this project was borne jointly by the Department and a local logging firm, the Department's share amounting to approximately \$2,000.

At Phillips River, near Bute Inlet, the entire outflow from Phillips Lake was being discharged via an abandoned logging channel which roughly parallels the river bed in the reach where spawning occurs. In order to re-divert these flows onto the spawning grounds a new channel, some 2800 feet long, is being excavated to a depth of several feet below the invert of the logging channel to connect the lake with the upper reaches of the spawning grounds. Total cost of the project, which is scheduled for completion in late January, 1966, is estimated to be \$40,000.

Kakweiken River

The pre-fabricated steep-pass fishway installed at a falls on the Kakweiken River in 1964 performed well in 1965, as evidenced by "spot" counts which showed that pink salmon were moving through the structure at rates of up to 600 per hour. It is estimated that more than 30,000 adult pink salmon utilized this facility in 1965.

Investigations and Assessments

The Branch's long-range program to catalogue and define all salmon obstructions in the Pacific Area was continued in 1965, when surveys were undertaken at obstructions on the Kisplox, Cranberry, Kiteen, Bulkley, Bear, Marble, Zeballos, Mahatta, Waukass, and Tzoonie Rivers. On the basis of recommendations stemming from these surveys, remedial measures, involving the use of explosives, have since been undertaken on the Tzoonie, Waukass, and Marble Rivers.

Surveys initiated in 1964 for the purpose of formulating plans for rehabilitation of the declining stocks of chum salmon native to the lower Fraser River culminated in 1965 with the recommendation that attention be directed specifically toward increasing the fry output from the Vedder, Harrison-Chehalis, and Stave Rivers. Preliminary studies are now underway to develop plans for spawning channels on one or more of these systems.

In 1965, also, the Branch continued to pursue its study of the Yakoun River, Queen Charlotte Islands, in an effort to ascertain the reasons underlying the decline of a

pink salmon run which was once one of the largest on the Pacific coast. The returns since 1960 have fallen to as low as ten percent of those recorded a decade or two ago, and in view of this continuing trend studies have been initiated to determine whether or not freshwater survival is a major factor. The 1964 spawning population of 325,000 pink salmon was one of the best escapements recorded in recent years. The 1965 seaward migration was enumerated at 31,000,000 fry, which represents an egg-to-fry survival rate of 12.4 percent.

The Branch initiated a program on the Cowichan River system in 1965 to determine more precisely the magnitude of the salmon spawning stocks and to measure their freshwater survival rates. While the system supports substantial numbers of chum, coho, and chinook salmon, the latter were selected for the initial study because of a reported decline in the numbers of this species. The 1965 chinook spawning population was estimated by means of a tower count to be 8600. The program will continue with a study of the progeny of this chinook run during their downstream migration next spring.

In an effort to develop a full understanding of the factors which limit the abundance and availability of chinook salmon the Branch is undertaking salmon-tagging programs in the Strait of Georgia; measuring the freshwater survival rates of differing groups of seaward-migrating fry, and relating these to the adult returns; and recording water temperatures and other physical data in a number of watersheds with a view to determining their relative effects on freshwater survival. In addition, Branch personnel are maintaining a close liaison

with their counterparts in the United States to keep abreast of the results being obtained in a comprehensive assessment of the value of hatcheries and rearing ponds as a means of enhancing the production of chinook salmon. In due course, it is expected that these various studies will add valuable data to provide a firm basis for the formulation of a development program for chinook salmon in the Pacific Area.

INDUSTRIAL PROJECTS

Hydroelectric

The Branch's activities in 1965 with respect to hydroelectric developments were again confined mostly to operational problems arising at existing developments. One aspect of the long-standing fish-power problem at the Puntledge River hydro development was resolved in 1965, however, when discussions initiated by B. C. Hydro and Power Authority in mid-1964, culminated in an agreement in January, 1965 whereby the Authority would construct a spawning channel to accommodate the severely-depleted upriver run of early chinook salmon.

Clearing of the site commenced in early February and water was turned into the channel on June 14th - the exact date on which chinooks were first sighted in the upper river. The channel is approximately 800 feet long, providing a spawning area capable of accommodating some 800 spawners, which is far in excess of spawning escapements recorded in recent years. The channel has been designed for expansion to accommodate 2500 spawners whenever such action is warranted.

Notable features of the channel are its pumped water supply and four deep (8'-6") holding pools.

Operation of the channel in 1965 proved to be most encouraging. The total escapement was enumerated at 270 chinooks, of which 236 (91 females) were distributed evenly throughout the channel while 34 remained in the river downstream of the channel entrance. Only 12 of those in the channel died without spawning, despite the fact that they were required to hold for up to four months in water temperatures which frequently exceeded 70°F. Egg deposition by the remainder was virtually complete.

During the year, also, liaison was established with representatives of a consulting engineering firm undertaking hydroelectric power investigations of the Nass, Stikine, Iskut, and other rivers in northwestern British Columbia.

Jones Creek

The pink salmon return to Jones Creek numbered approximately 3000. Approximately 2100 of these spawned in the channel and the remainder spawned in the unimproved stream below. This seeding is considered sufficient to maintain the run at the capacity of the spawning channel.

Water Supply

The development of fisheries protective measures at water diversions was again an important phase of the Branch's activities in 1965. In addition to a substantial number of small- to medium-sized diversions for mining, irrigation, and domestic purposes, the Branch was associated with the

development of screening facilities to exclude salmon fry from several major diversions. In this connection designs were developed for self-cleaning travelling screens at two new pulp mills being constructed at Prince George, and for a major addition to the existing pulp mill at Prince Rupert. Further discussions were held with representatives of the Tahsis Company Ltd. with regard to fisheries flow requirements in the Gold River downstream of the Company's planned diversion for its proposed pulp mill. At the year's end, negotiations were progressing well in connection with Granisle Mines Ltd. proposal to divert water from Babine Lake. Similarly, plans were being developed for a screened intake and fishway at a combined storage and diversion scheme planned by Wesfrob Mines Ltd. for diversion of water from Wright Lake, Tasu Sound, Queen Charlotte Islands.

Marine Seismic Explorations

Seismic explorations being undertaken in coastal waters by various oil companies continued to require the careful attention of this Branch in 1965. The British American Oil Company conducted a gas-exploder program in the Strait of Georgia; the Socony-Mobil Oil Company undertook preliminary conventional seismic programs in the offshore waters of Vancouver Island, Queen Charlotte Sound, and Hecate Strait; and Shell Canada Ltd. carried out their third major seismic survey using both the conventional seismic technique and the gas-exploder technique in offshore waters extending from Barkley Sound, on the west coast of Vancouver Island, to

north-central Hecate Strait. In each instance technical discussions with representatives of the companies led to the acceptance of a number of conditions which were designed to afford maximum protection to the fisheries.

In 1963 to 1965 inclusive, Shell Canada Limited detonated 32,885 seismic explosions, of which only 2214 resulted in observed fish kills, amounting to a total of 152,716 of all species. The fish killed were chiefly herring and rockfish with salmon of all age groups representing less than one percent. Fisheries recommendations, which resulted in the suspension of 3778 proposed shot points during this three-year program, illustrates the value of having a Departmental observer accompany the survey ships.

Further technical meetings were convened with representatives of Shell Canada Limited in late 1965 to discuss a seismic program proposed for January-March, 1966.

Logging

During the year two Ministerial Orders were issued to provide for regulation of log dumping, log towing and log driving in the Stellako and Tachie-Middle Rivers.

Observation of the 1965 log-driving operations in the Stellako River revealed that spawning areas were being damaged extensively as a result of flow diversions in the vicinity of log jams. Moreover, samples taken by the International Pacific Salmon Fisheries Commission before and after the drive showed the wood-fiber content of the spawning gravel had been increased.

With the completion in August of the Forest Service access road linking Rivers Inlet with Owikeno Lake, regulated

log-towing operations in the Whannock River were authorized, pending installation of loading and dumping facilities.

Satisfactory results are being obtained in connection with the incorporation of stream-protection clauses in timber sale contracts and cutting permits in the Prince George, Prince Rupert and Vancouver Forest Districts, and a request for extension of this arrangement to the Kamloops Forest District has been favorably received by the Forest Service.

Discussions have been arranged with representatives of a major logging operator in the Owikeno Lake watershed with a view to developing procedures to secure the protection of salmon-producing streams encompassed by or adjoining Timber Licences, which are exempt from the jurisdiction of the Forest Service.

As a result of site investigations, river development plans associated with log driving in the Nass River watershed were conditionally approved under the authority of a Ministerial Logging Order. Similarly, regulations for log-driving operations, and agreements with respect to river development proposals, on the Quesnel and Cariboo Rivers were achieved through the co-operation of the local logging company.

Liaison has been established with the B. C. Forest Service and several major logging operators in connection with the proposed construction of forest access roads adjacent to salmon-producing streams.

Discussions with officials of the B. C. Forest Service have been initiated with a view to undertaking experimental cutting practices to determine whether or not the potentially

deleterious effects which removal of forest cover can have on the stability of stream beds and runoff patterns can be eased.

Gravel Removal

In 1965 Ministerial Orders were issued to provide for the regulation of gravel removal from between the high water margins of the Vedder-Chilliwack, Homathko, Teaquahan, Nanaimo and Chemainus Rivers.

Through the co-operation of the Provincial Lands Branch, all applications to quarry gravel on Crown lands, directly administered by the Lands Branch and lying in or adjacent to salmon-producing streams are now referred to the Department. Control over gravel removal within the high water wetted perimeter of salmon streams on Crown lands administered by the B. C. Forest Service may soon be achieved through a forthcoming revision of the Stream Protection Clauses.

A study designed to assess the gravel replacement potential of the Yakoun and Mamin Rivers, Queen Charlotte Island was initiated in 1964 and is continuing. To date the data shows that the Yakoun River which is characterized by a headwater lake and relatively poor bankside deposits has a low replacement potential. The Mamin which is devoid of headwater lakes, has fairly extensive areas with good bankside deposits and a higher average gradient has a considerably higher replacement potential. However, rehabilitation of spawning areas in the lower Mamin River which were destroyed by past gravel removal operations is not proceeding rapidly.

POLLUTION

Pulp Mills

Lengthy negotiations with representatives of pulp mills under construction in the Fraser River watershed were successfully concluded in 1965 when agreement was reached with regard to the facilities to be provided to reduce losses of toxic chemicals and for the treatment of non-recoverable wastes.

Bio-assays of the treated effluent issuing from the newly-completed pulp mill at Kamloops show that the effluent is being rendered harmless to fish.

Negotiations concerning the type and extent of the facilities to be employed at a new pulp mill on Muchalat Arm (Gold River) to reduce losses of toxic chemicals and particulate material are progressing well, and the owners have agreed to install an outfall diffuser which will dilute untreatable wastes to levels which will not be toxic to fish.

Pesticides

A good liaison has been established between the Branch and most major users of pesticides in British Columbia. These include: insecticides for the control of mosquitoes and forest-defoliating insects; herbicides for the control of brush alongside roads, railways, and power line rights-of-way; sodium arsenite for the control of marine borers; and copper sulfate for the control of snails which transmit swimmer's itch. Fish-protective measures required by the Department in

connection with the application of pesticides impose such restrictions as: (1) application must precede the appearance of fish in the spray area; (2) untreated buffer swaths must be maintained between the spray areas and waters frequented by fish; (3) insecticides which are non-toxic to fish at concentrations which are effective for the control of the pest in question must be employed wherever possible; and (4) the mixing of chemicals, cleaning of spray equipment, and disposal of surplus spray materials near any water course are strictly prohibited.

To facilitate field measurements, the Branch has recently developed a technique by means of which concentrations of insecticides can be measured rapidly in the field. This technique involves the addition to the insecticide of a fixed proportion of a fluorescent dye which is detectable with a fluorometer, so that the pesticide concentration may be calculated.

Industrial Pollution

At the Department's request, effluent disposal facilities have been provided at a number of new industrial plants, involving wastes from mine-mill operations, plating shops, a steel plant, and a chlorine and caustic soda manufacturing plant.

APPLIED RESEARCH

The applicability of electronic counters as a means of enumerating salmon escapements to the spawning grounds was

investigated in some detail during the year. An excellent unit has been developed by the U. S. Fish and Wildlife Service in cooperation with an electronics firm, and while production models are not available it is believed that plans could be obtained on loan for assembly of such a unit if the need arises here. Tests of a counter, designed and manufactured by Irish interests, proved that this instrument was too slow for registering the passage of large numbers of fish in a short period of time, and that it could not be modified readily to do so. Investigations into the possibilities of employing a sonar system for enumeration of adults ascending large rivers were undertaken during the year, and in view of the encouraging results these will be continued in future.

Tests of low-cost probes which were developed during the year for measurement of dissolved oxygen concentrations in any type of spawning gravel proved that these instruments were reliable, and it is now felt that they can be used successfully as fixed sampling points for measurement of dissolved oxygen levels in the field. Tests were also undertaken in connection with a technique for measuring water velocity through spawning gravel, and apparatus which will simplify the field procedure has now been ordered. A device which can accurately measure increments of sediment in spawning gravel at the depths of egg deposition was developed and is now in the final stages of calibration.

A B. C. Hydro and Power Authority proposal to provide a high-voltage direct-current interconnection of Vancouver

Island and the mainland, with a saltwater return, introduced a threat to the salmon stocks which frequent the areas in the vicinity of the terminals; and tests were initiated in 1965 to determine the sensitivities of various species of salmon to the voltage gradients which can be expected. These tests will be continued in early 1966 with a view to developing recommendations for fisheries protective measures.

MISCELLANEOUS

In recent years the Branch has kept abreast of all applications for water licences and placer leases in the Province in order to ensure that suitable fish-protective facilities are provided at those sites where such are required. These responsibilities were transferred to the Conservation and Protection Branch in 1965, although this Branch is still called upon for advice in connection with those of a technical nature.

Engineering advice and assistance was given to the Fisheries Research Board in connection with the design of facilities to accommodate a proposed experimental transplant of lobsters from the Atlantic coast.

The major landslide which occurred on the Chilcotin River on August 19, 1964 was inspected by the Branch and the International Pacific Salmon Fisheries Commission in the late spring and again in late July to ensure that the 1965 salmon migrations would not be impeded. On both occasions prevailing conditions were regarded as satisfactory, and salmon subsequently passed through this reach without difficulty. It

appears that the slide area and the river channel are now reasonably stable, so no further action is contemplated at this time.

SALMON MANAGEMENT

Rivers Inlet

As in the past six years, tow-netting was conducted on Owikeno Lake during 1965, to provide an index of juvenile sockeye abundance. Moreover, an enumeration of the Rivers Inlet adult sockeye salmon stocks was conducted through the use of a "dichotomous technique" which is based on measurements of changes in size and age composition of the stock resulting from selective removal by the gill-net fishery. The enumeration studies indicate that a relatively poor escapement to Owikeno Lake of less than 250,000 sockeye salmon occurred in 1965.

Strait of Georgia Chinook and Coho Investigation

As a result of biological studies conducted during 1963 and 1964, several regulation changes were implemented in the Strait of Georgia during the 1965 season to correct a trend which had developed in the sport and commercial fisheries toward the harvest of chinook and coho salmon at a younger age and therefore smaller size. These included a reduction in the commercial troll season from ten months to four and one-half months, beginning April 15; a postponement of the commercial troll opening date for coho salmon from June 15 to July 1; and a reduction in the sports bag limit from four salmon or eight

grilse or an aggregate of eight salmon and grilse to an aggregate of four salmon over twelve inches in length.

The 1965 field program included: (1) a study to measure the susceptibility of maturing coho to hook and line gear in the Juan de Fuca - Sooke area; (2) a tagging program in Discovery Passage to determine the ultimate distribution of coho grilse which demonstrate a mass movement northward each fall through lower Johnstone Strait; and (3) a study, based on sampling by commercial troller, to define overwintering areas for coho grilse in the extreme northern and southern regions of the Strait of Georgia.

Johnstone Strait

The 1965 pink salmon returns to all regions of the British Columbia coast were much lower than expected and the Johnstone Strait return approximated only one-third of that expected on the basis of pre-season studies. As a result of this low return a very stringent fishing pattern was applied throughout the period of the pink salmon migration. The 1965 commercial catch totalled only 674,000 which constitutes only one-third of the average catch recorded over the previous seven odd-year cycles. Assessment of the 1965 escapement is not complete at this time but indications are that it will be only a fraction of the 1.4 million goal set for the region.

On the basis of pre-season studies on the status of the Johnstone Strait - Fraser River study area stocks, a 1965 return of 680,000 chum salmon was predicted. Such a return would have constituted in total, less than one-half the

escapement level recorded during the pre-1956 period of high production. Because of the low return anticipated for 1965, no commercial fishing for the purpose of exploiting chum salmon was permitted in the entire Johnstone Strait - Fraser River region.

In order both to obtain a measure of the strength of the run as it developed and also to acquire pertinent age composition data, fishing by chartered purse-seine vessel was conducted in Blackfish Sound, located in the upper straits region, throughout the chum salmon migration period.

Fraser River Chum Salmon Investigation

In 1965, the Branch continued the investigation which was initiated in 1960 to assess the condition of the Fraser River chum salmon stock; to determine the factors responsible for a decline in both the escapement and commercial catch since the mid-1950's; and to acquire the additional information required for management and rehabilitation of the stock. The Fraser River study has been closely integrated with an overall assessment presently being conducted on the chum salmon stocks indigenous to the Johnstone Strait - Fraser River region. As a result of studies conducted to date, it has been possible to design fishing patterns that provide a maximum degree of protection to the peak of the major Fraser River stock, not only during its period of passage through Area 29, but also through the Johnstone Strait and Strait of Georgia fishing areas. The 1965 Fraser River program included: enumeration of both system and tributary spawning; test-fishing in the

lower river; test-fishing and tagging in the estuary; and enumeration of the total system chum salmon fry output from the 1964 escapement.

Although virtually no exploitation was permitted on the Fraser River in 1965, the system spawning escapement totalled only 185,000 fish which constitutes a very slight improvement over the brood escapements of 1961 and 1962.

With regard to downstream fry enumeration, the 1965 studies indicated that the total fry output from the 1964 spawning was considerably greater than that measured during the previous three years.

Fraser River Chinook Salmon

In 1964, a chinook salmon test-fishing program was initiated on the Fraser River and this program was continued in 1965. Analysis of the results of the 1965 program, which extended from April 1st to late September, has shown that the test-fishing procedure has provided a reliable measure of escapement.

Stikine River

An exploratory fishing program was conducted in the Canadian waters of the Stikine River with two chartered "mosquito"-type commercial gill-net boats in an effort to determine the feasibility of conducting a self-supporting commercial fishery in the area. Although a 25-mile segment of the river was explored, an eight-mile area of the main Stikine was considered to be the only region where drift gill-nets could be operated.

Nass River

A test-fishing program, which was initiated in 1964 to provide a daily index of sockeye escapement from the commercial fishing area and thereby to assist in the management of the Nass River sockeye stocks, was continued in 1965. In addition:



The 1965 season was characterized by returns of both sockeye and pink salmon at lower levels than anticipated. Commercial catches of these species totalled 250,000 and 143,000 respectively. The 1965 season was also among the lowest on record. The sockeye catch was moderate but probably did not reflect the actual magnitude of the stock as fishing was curtailed during the peak of the sockeye migration to provide for necessary sockeye and pink salmon escapements.

Nass River

A test-fishing program, which was initiated in 1963 to provide a daily index of sockeye escapement from the commercial fishing area and thereby to assist in the management of the Nass River sockeye stocks, was continued in 1965. In addition to the test-fishing operation, the 1965 program included:

(1) enumeration of the sockeye escapement to Meziadin Lake; (2) exploratory tow-netting in Meziadin Lake as part of an assessment of sockeye production; and (3) sampling of the escapements to Meziadin, Bowser, Damdochax and Kwinageese Lakes for racial characteristics.

Skeena River Salmon Management Committee

The first phase in the transfer of operational duties associated with management of the Skeena River salmon stocks, from technical staff of the Fisheries Research Board to that of the Resource Development Branch was completed in 1965, when the latter assumed responsibility for the development of the 1965 regulations.

The 1965 season was characterized by returns of both sockeye and pink salmon at lower levels than anticipated. Commercial catches of these species totalled 291,000 and 143,000 respectively. Chinook and chum salmon catches were also among the lowest on record. The coho catch was moderate, but probably did not reflect the actual magnitude of the stock as fishing was curtailed during the peak of the coho migration to provide for necessary sockeye and pink salmon escapements.

The sockeye escapement to the Skeena system totalled 660,000, of which 580,000 entered the Babine system. The Bulkley - Morice and Lakelse Lake sockeye escapements of 20,000 and 33,000 respectively were the best in recent years. Pink escapements to early streams and to the main stem of the Skeena were generally light. The escapement to Lakelse River, however, totalled 835,000 pinks, which is considered to be within the optimum range. The coho escapement, as indicated by test-fishing catches, was the best on record, while the chinook escapement was moderate, and the chum escapement poor.

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