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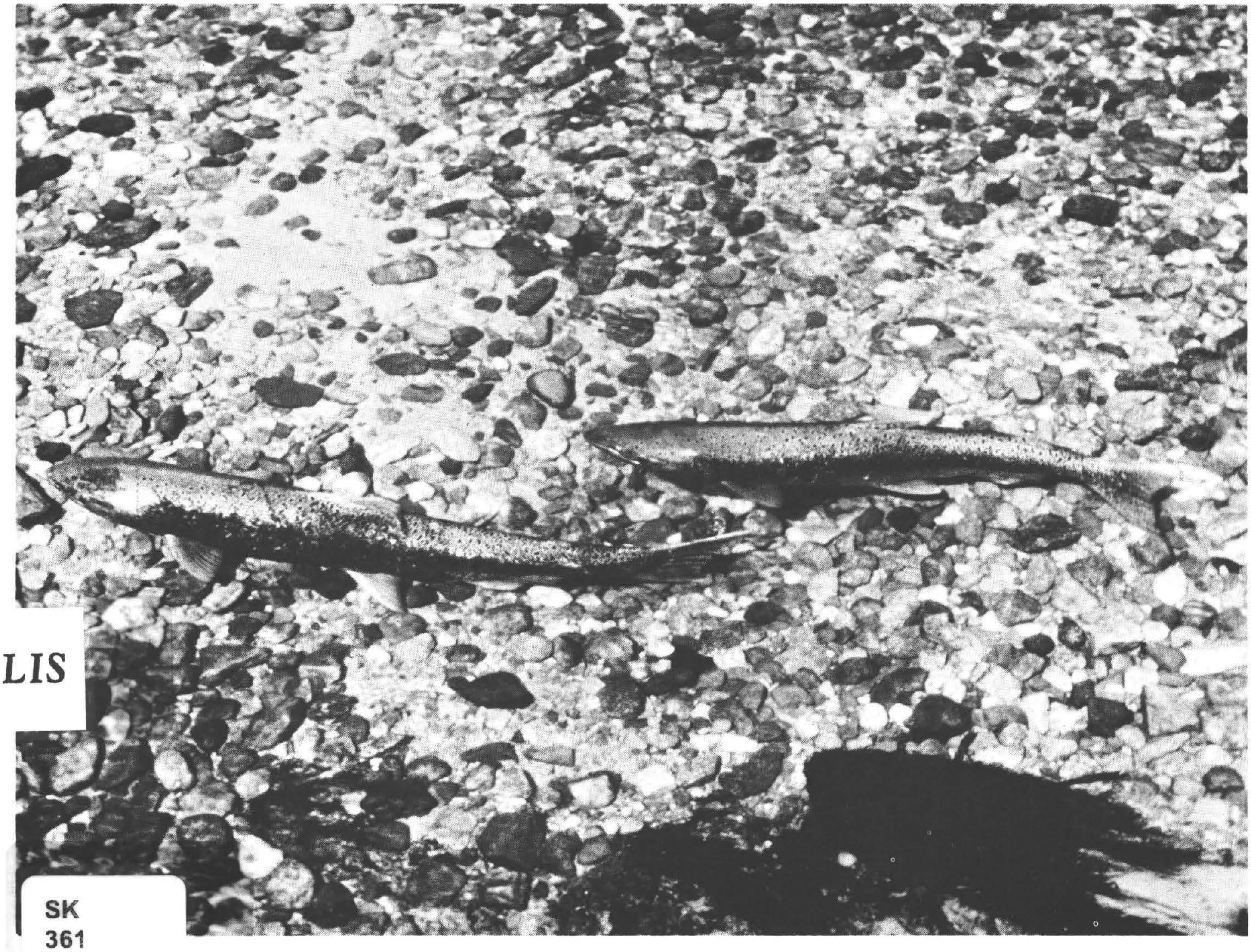
COLUMBIA RIVER FISHERY PROGRAM

Circular 192



UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

BUREAU OF COMMERCIAL FISHERIES

UNITED STATES DEPARTMENT OF THE INTERIOR
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COLUMBIA RIVER FISHERY PROGRAM - 1963

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Circular 192

Washington, D. C.
November 1964

Foreword

The Columbia Fisheries Program Office, established in 1958, is the principal representative of the Bureau of Commercial Fisheries in the Columbia Basin. It supervises the Bureau's major activities in the basin, except for biological and fish passage research, and is the Bureau's liaison office with State, Federal, and private agencies on salmon problems associated with water development projects in the basin.

The office's responsibilities are divided into three areas: The Columbia River Fishery Development Program, Water Resource Investigations, and Fish Facilities. Each of these responsibilities is described in the following report.

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COLUMBIA RIVER FISHERY PROGRAM*

For many years, commercial fishermen who fished the seining grounds on Government-owned Sand Island near the mouth of the Columbia River were required to pay a lease fee to the U. S. Treasurer. In 1938, the Congress authorized using these funds for study and improvement of the fishery. Surveys were conducted by the Fish and Wildlife Service to ascertain the factors influencing the fishery, and by 1942 most of the tributary streams of the Columbia River had been surveyed. Considerable data were accumulated regarding the various populations of salmon and steelhead. Unscreened diversions, impassable waterfalls, log and debris jams, splash dams, and sources of pollution throughout the basin were cataloged. The surveys revealed that changing habitat and environment resulting from expanded water use would necessitate mitigative measures to supplement production of salmon and steelhead populations.

In 1949 the Congress authorized use of additional Federal funds to rehabilitate the salmon runs in the lower Columbia River area. This was the beginning of the Columbia River Fishery Development Program, a Federally financed cooperative effort of the fishery agencies of Oregon, Washington, Idaho, and the U. S. Fish and Wildlife Service. Justification for the program was the recognized loss of fish and fish habitat at Federal water-use projects. Appropriations were included in the U. S. Corps of Engineers' dam construction program and then transferred to the Fish and Wildlife Service.

The objective was to develop maximum salmon and steelhead runs in the tributaries of the Columbia River below the site of the now completed McNary Dam. In 1957 the program was extended to include the upper basin above this point. Recent appropriations have been made through the U. S. Department of the Interior. Significant accomplishments have been realized through this program.

The Pacific Northwest, which includes Oregon, Washington, Idaho, and western Montana, has been one of the most rapidly developing areas in the United States in recent years. Both industrial and population growth have been particularly pronounced during the last two decades. A major factor in this development has been the available water supplies of the Columbia River system.

The Columbia River, draining two-thirds of the region, provides a multiplicity of potential values: abundant water supplies for irrigation, sites for major hydroelectric power development, inland navigation, large industrial and domestic water supplies, excellent recreational areas, and valuable fish and wildlife resources. All of these potentials have been developed.

Columbia River fish were one of the first resources to be utilized, and it still is important to the regional economy. The annual value of Columbia River commercial and sport fisheries for salmon and steelhead is conservatively estimated to exceed $20 million. This valuable contribution is being continued despite the complexity of problems caused by rapid regional growth. Unprecedented attention now is being directed towards preserving and maintaining these valuable fish resources through programs emphasizing research, development, and management. These programs are being carried on through the combined efforts of State, Federal, and private agencies. The Bureau of Commercial Fisheries, the Bureau of Sport Fisheries and Wildlife, and the fisheries agencies of Oregon, Washington, and Idaho are studying the problems confronting Columbia River fisheries. This report briefly summarizes the status of the resource, the changing environment, the harvest, progress in the fields of research and management, and plans for the future.

Before the settlement of the Columbia Basin, salmon and steelhead were in great abundance; catches during earlier years have not since been equaled. Much transformation of the original habitat has taken place. Agricultural development throughout the Columbia Basin has resulted in the demand for irrigation water. These demands have been met by placing dams across streams to divert part or all of the streamflow. Greatly diminished flow or the elimination of flow has been common. Dams often are impassable barriers to fish unless adequate fishways are installed.

Diversion intakes not suitably screened kill young-downstream migrants. Mining operations have diverted water from natural stream channels. Mine tailings and chemical effluents from ore refining have damaged fish and other forms of aquatic life. Extensive forest cover of high commercial value has supported the development of a large and diversified wood-products industry. Early lumbering operations destroyed much of the natural forest cover, resulting in rapid runoff, siltation, low flows, high temperatures, debris, and destruction of food organisms. In recent years the expanding pulp industry has discharged harmful wastes into the streams. Other industrial and domestic wastes have contributed to unfavorable stream conditions. Hydroelectric power projects require tremendous dams, and these have created large reservoirs throughout the Columbia Basin. These structures have materially altered the habitat. Access to upstream spawning areas previously available has been effectively blocked first by impassable Grand Coulee Dam and now by the Chief Joseph Dam on the mainstem Columbia River and by Swan Falls Dam on the Snake River. Turbines have killed many young fish. Additional dams planned, or now under construction, will further reduce habitat, thus reducing fish production and jeopardizing the commercial and sport fisheries.

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RESOURCE

The Columbia River has supported a valuable commercial salmon fishery for over 100 years. Beginning about 1830, salmon were preserved with salt and shipped to the Hawaiian Islands, South America, the Orient, California, and the East Coast of the United States. In 1866 the first commercial cannery began on the Columbia River at Eagle Cliff in what is now Wahkiakum County, Wash., and by 1883 there were 39 canneries along the river. The salmon pack in 1866 was approximately 272,000 pounds; this increased to 43 million pounds in 1883. The all-time record of 49,480,000 pounds of commercially processed Columbia River salmon and steelhead was reached in 1911. This tremendous poundage did not include fish sold fresh and it never has been exceeded. In recent years the Columbia River commercial catch has been around 15 million pounds annually, including fish caught by trolling off the mouth of the river.

In the early days of the fishery the spring chinook supported the industry, but in the early 1900's fishermen began catching many summer and fall chinook. The total chinook catch declined from 1911 to 1935, with wide fluctuations. Beginning in 1912 a troll fishery in the ocean was started, and by 1919 over 1,000 boats trolled off the mouth of the Columbia River. The troll fishery has continued to develop a relatively high rate of harvest.

The commercial fishery for salmon and steelhead on the Columbia River now has four major fishing seasons: winter (February), spring (April-May), summer (June-July), and fall (late July-October). The length of these commercial fishing seasons is much less than in former years. For example, 272 days of commercial fishing were permitted below Bonneville Dam in 1938, but only 101.25 days in 1962 (fig. 1).

Fishing effort as measured by the number of Columbia River gill net licenses issued is also decreasing (fig. 2). A truer conception of the reduced fishing effort is obtained by considering both the reduced number of fishing days per year and the reduced number of nets. To this must be added the loss of area where commercial fishing may be prosecuted. This loss resulted from closing the river above Bonneville Dam to commercial fishing.

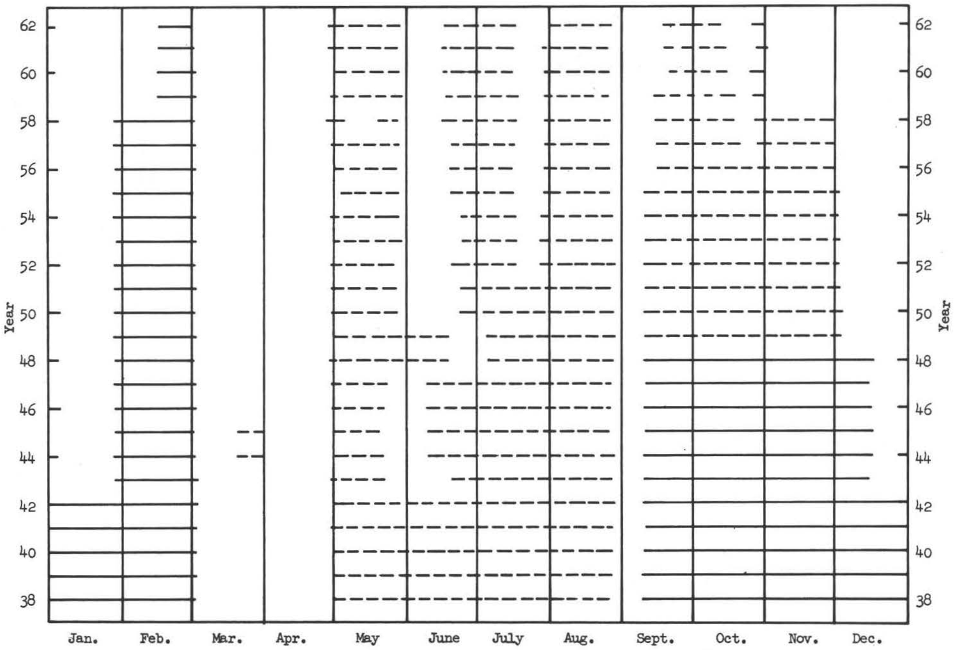

Figure 1.—Columbia River commercial fishing seasons below Bonneville Dam, 1938-62.

RESOURCE TRENDS

Columbia River salmon and steelhead populations fluctuate considerably. Five species represent the commercial catch: chinook, coho, sockeye, and chum salmon, and steelhead trout. The sport fishery primarily takes steelhead, chinook, and coho. Population trends are difficult to determine precisely because some catch data are incomplete or unavailable. Accurate figures on the sport catch never have been obtained. General trends can be determined by using various data including fish counts at Bonneville Dam, estimated escapements in lower river

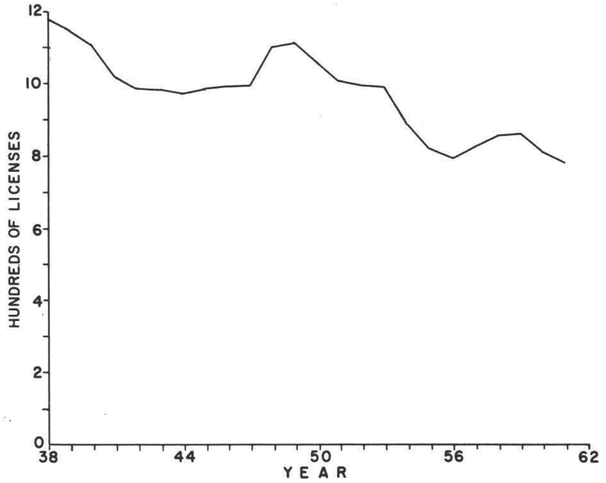

Figure 2.—Numbers of Columbia River gill net licenses issued, 1938-62.

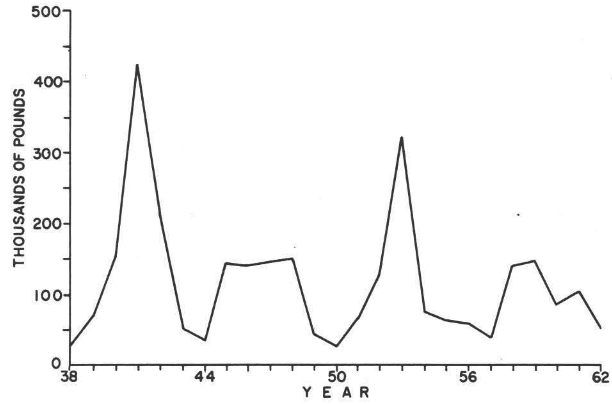

Figure 3.—Columbia River winter season chinook landings, January—March 1, 1938-62.

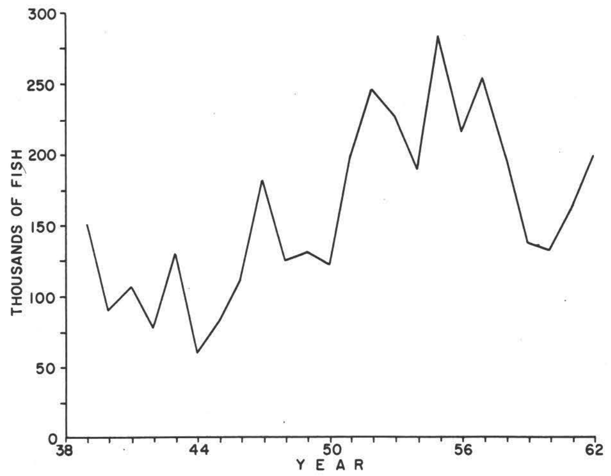

Figure 4.—Estimated numbers of upper river spring chinook entering the Columbia River, 1938-62.

tributaries, estimated sport catches, and river gill net catches. Statistics from the commercial catch in the river offer the most information. These data, however, must be used with reservation since they are influenced by environmental changes, sport fishing, gear restrictions, area closures, fishing seasons, and natural fluctuations in fish populations.

The commercial fishery in the river is divided into several segments, by species, for analysis and discussion: spring, summer, and fall chinook salmon, summer and winter steelhead, sockeye salmon, and coho and chum salmon. To indicate trends in these various segments of the fishery, we rely on a combination of data.[1]

Chinook Salmon

An early segment of spring run chinook salmon enters the Columbia River in February and March. Most of these fish spawn in tributaries below Bonneville Dam, primarily in the Willamette River. We do not know the annual run size and escapement in this lower river area. Commercial landing records exhibit wide fluctuations due, in part, to special fishing seasons (fig. 3). Although the harvest records do not show a definite trend, they indicate that the populations maintain themselves under present conditions.

The bulk of spring-run chinook salmon spawn in the Salmon River, a Snake River tributary. Lesser numbers spawn in the upper Columbia River. This segment of the spring run passes Bonneville Dam from January 1 to May 31 with the peak of the run there occurring about mid-April. The runs have exhibited a general upward trend (fig. 4).

Summer-run chinook salmon migrate past Bonneville Dam from June 1 to August 15. The bulk of these fish spawn in the Salmon and Wenatchee Rivers. A peak run was reached in 1957 with some decrease since then (fig. 5).

Fall chinook salmon in the Columbia River have declined seriously, and all-time lows were recorded during the last decade (fig. 6). The fish pass Bonneville Dam from August 16 to December 31 and enter the river gill net fishery in August and September. Fall chinook spawn in the lower Columbia River tributaries in the main Columbia River up to Rock Island Dam and in the lower Snake River. Also, they constitute the main production at mid-Columbia River hatcheries.

[1] Commercial catch data from Washington Department of Fisheries and Fish Commission of Oregon records.

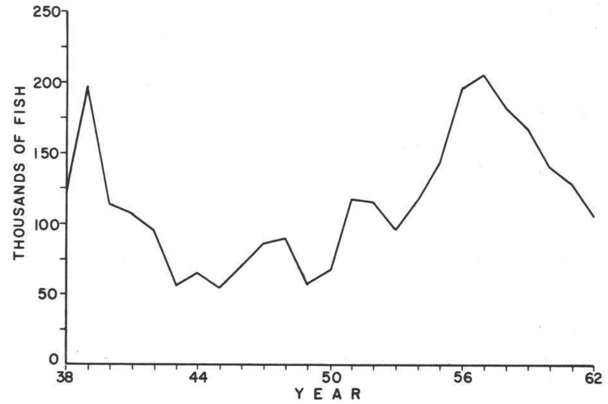

Figure 5.—Estimated numbers of upper river summer chinook entering the Columbia River, 1938-62.

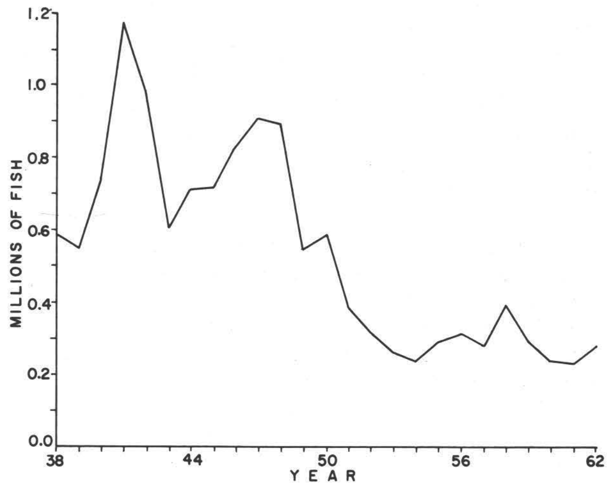

Figure 6.—Columbia River fall chinook commercial landings below Bonneville Dam plus Bonneville Dam counts, 1938-62.

Sockeye (Columbia River blueback) Salmon

Populations of Columbia River sockeye salmon have fluctuated widely (fig. 7). Only two major sockeye areas remain in the Columbia River system—the Wenatchee and Okanogan Rivers. The fluctuations in abundance can be attributed to a variety of conditions including abnormal water temperatures, high incidence of disease, low fresh-water and marine survival, and high level of harvest.

Summer Steelhead

In recent years summer steelhead appear to be maintaining themselves (fig. 8). These fish are caught from April through October, with the major landings during June and July. Commercial fishing for this species has been eliminated above Bonneville Dam; however, an intensive sport fishery has developed in the mid-Columbia area above Bonneville Dam as well as in the upper tributaries.

Winter Steelhead

The spawning areas for winter steelhead lie primarily in the tributaries below Bonneville Dam; thus, dam counts cannot be used to determine the size of the annual run. Winter steelhead are present in the lower Columbia River between November and April, and their abundance appears to be relatively stable as indicated by annual commercial landings (fig. 9).

Coho Salmon

Spawning coho salmon distribute themselves in Columbia River tributaries, both above and below Bonneville Dam. They enter the Columbia River from August

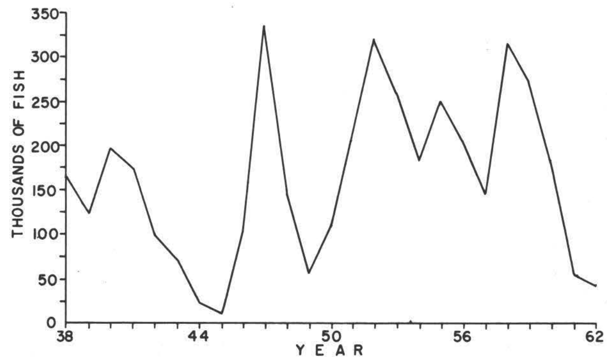

Figure 7.—Estimated numbers of sockeye entering the Columbia River, 1938-62.

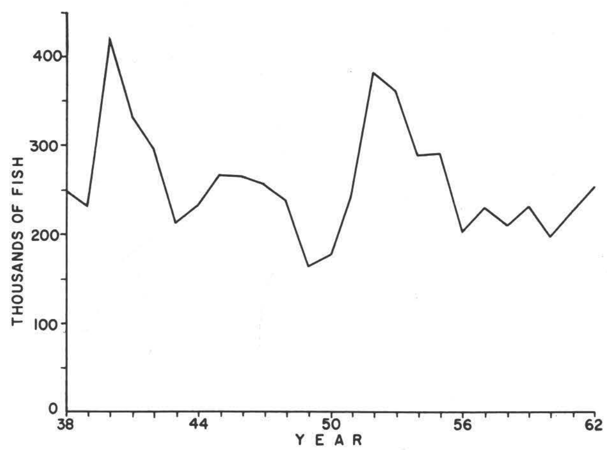

Figure 8.—Estimated numbers of summer steelhead entering the Columbia River, 1938-62.

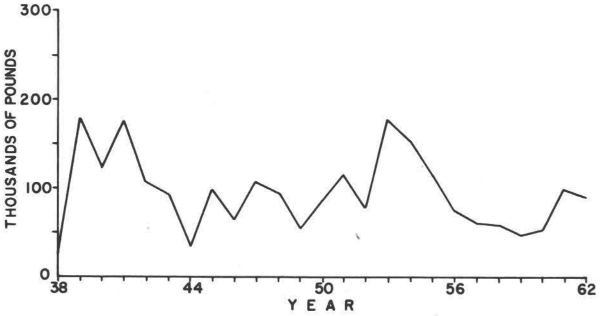

Figure 9.—Columbia River winter season steelhead landings, January—March 1, 1938-62.

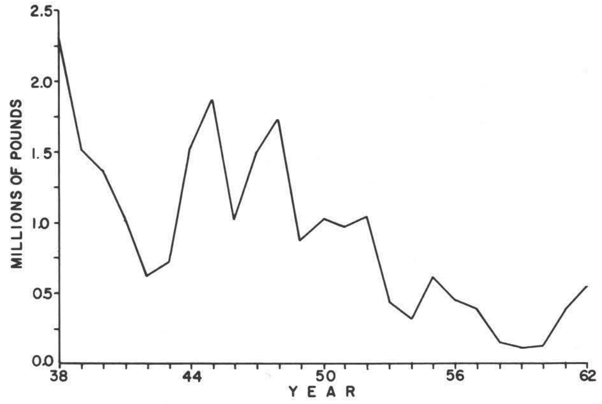

Figure 10.—Columbia River fall season coho landings, September-December, 1938-62.

through December and are caught by the river gill net fishery. Earlier in the year the rapidly maturing fish are subjected to an increasingly important ocean sport fishery as well as to the ocean troll fishery. A measure of coho salmon abundance includes index area counts in spawning tributaries, fishway counts, hatchery counts, and the commercial harvest. From a low commercial catch in 1959, there appears to be an encouraging trend upward (fig. 10).

Chum Salmon

The principal spawning areas for Columbia River chum salmon are in tributaries below Bonneville Dam. The fish enter the river from late September through December, mostly in October and November. Spawning peaks occur in tributaries nearest the ocean in early November, and in those tributaries near Bonneville Dam in late November. The fishery for chum salmon has been severely restricted since 1957, and the effect of these restrictions is evident in the harvest statistics (fig. 11). The decline of chum salmon may be due to a combination of factors affecting both fresh-water and marine survival. The decline in abundance is evident along the entire Pacific coast.

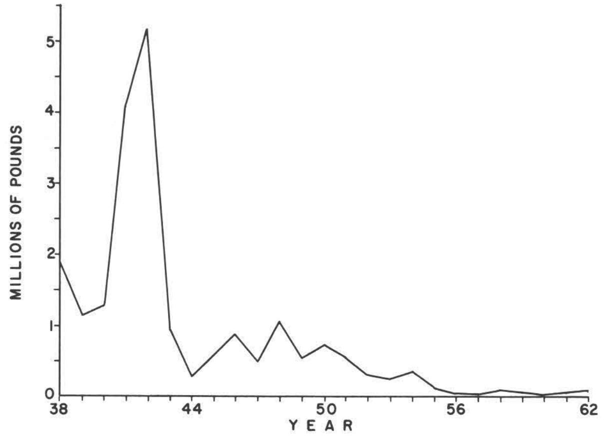

Figure 11.—Columbia River fall season chum landings, September-December 1938-62.

HABITAT

The face of the land in the Columbia Basin has been changed drastically in the last 150 years, and none of the changes has benefited salmon. Farming has resulted in lost spawning areas, depleted stream flows, increased turbidity of the remaining water, and in some instances changes in chemical and physical properties of the water. Logging has removed forest cover, and has hastened runoff which brings with it a number of evils—floods, low flows, silt, and high water temperatures. Mining has added silt and pollutants to the waters, and urban development and industry have depleted stream flows and added domestic and industrial wastes to the remaining waters. Starting in the 1930's, a series of multipurpose dams for flood control, hydroelectric-power, and navigation were constructed on the mainstem Columbia River, and with the completion of Wells Dam the Columbia will be a series of pools from tidewater to the Canadian border except for a 50-mile stretch below Priest Rapids Dam. So instead of a normal-flowing river, there is a series of pools that interfere with both upstream and downstream migrations of salmon. In addition, the dams which form those pools delay passage of the upstream migrants and kill many of the young. The pools also have changed the temperature patterns of the river, generally raising temperatures, thus decreasing further the suitability of the river for salmon and steelhead production. Dams now under construction or proposed for the mainstem Snake River will change it also into a series of pools with all of the attendant problems of successful fish passage and survival.

Dams have cut nearly in half the river area available to salmon and steelhead. Of the 190 miles of main-stem Columbia River still available in 1962, only 50 miles will remain after dams now under construction or authorized are completed. Even this remaining 50 miles is threatened by a potential project. The prospects for the Snake River are only slightly brighter; after the loss of 150 miles of the river now available to anadromous fish, only 190 miles will remain. Tributary streams also are being rapidly lost to salmon.

Columbia Basin conservation agencies are finding ways to compensate for this loss of river available to salmon and steelhead. Runs destroyed by dams are being re-established, hatcheries have been constructed and operated, and new methods of production are being sought. Two promising new methods are natural rearing ponds and artificial channels where fish can spawn. Upstream and downstream passage facilities, screens, and similar devices to keep fish out of hazardous areas are being improved.

THE DEVELOPMENT PROGRAM

The Columbia River Fisheries Development Program has used all known means to increase salmon abundance. Twenty-one hatcheries have been constructed or re-constructed on the lower river and its tributaries, obstructions have been cleared from 1,700 miles of tributary streams, 22 major fishways have been built over barriers, and about 160 minor falls have been improved. Loss of young fish has been reduced by installing over 600 screens in diversion ditches and canals. Operational studies have sought improvements in techniques and tools to improve salmon and steelhead production. Such studies have been made on fish-cultural techniques, on improvements to natural habitat, on methods for predator control, on spawning or incubation channels, and on pond rearing. A constant check has been made on the value of all measures put into actual use. Total expenditures from inception of the program through fiscal year 1963 are shown in table 1.

Table 1.—Funds available to the Columbia River Fishery Development Program, fiscal years 1949-63

Fiscal year	Construction	Operation and maintenance	Total
	Dollars	*Dollars*	*Dollars*
1949	1,000,000		1,000,000
1950	1,192,500	7,500	1,200,000
1951	2,118,813	106,187	2,225,000
1952	1,525,451	199,549	1,725,000
1953	2,956,681	627,419	3,584,100
1954	1,750,000	600,000	2,350,000
1955	1,000,000	970,000	1,970,000
1956	900,000	1,000,000	1,900,000
1957	1,400,000	1,250,000	2,650,000
1958	1,600,000	1,315,000	2,915,000
1959	1,600,000	1,415,000	3,015,000
1960	1,170,000	1,706,250	2,876,250
1961	1,400,000	1,915,000	3,315,000
1962	1,431,000	1,910,000	3,341,000
1963	1,626,000	2,095,000	3,721,000
Total	22,670,445	15,116,905	37,787,350

Hatcheries

Artificial propagation efforts under the Columbia River Fishery Development Program have been directed primarily toward increasing the fall chinook salmon run (fig. 12). The increasing importance of program hatcheries is demonstrated by the percentage of hatchery fall chinook represented in the Bonneville Dam count (table 2). In 1945 only 5.8 percent of the fall chinook passing over the dam were from hatcheries, but by 1958 one-third of the Bonneville fall chinook escapement was produced by hatcheries. In 1958-62 the number of hatchery fish in the Bonneville fall chinook count averaged over 28 percent.

Hatchery production of coho salmon, spring chinook salmon, and steelhead has been encouraging. A near record run of coho salmon was counted over Bonneville Dam in 1962, and all of these fish returned to hatcheries operating above the dam. Good progress has been made in establishing new hatchery runs of spring chinook salmon. A sizable run of spring chinook (averaging around 3,000 fish) now returns each year to Eagle Creek National Fish Hatchery. Before the hatchery, no spring chinook existed in Eagle Creek. Similar spring chinook runs have been established in Wind River. Good results are being obtained with steelhead, particularly in the Washougal River. A census of the sport fishery indicates the catch has doubled since the operation of the program hatchery on the Washougal River. Adult returns to the hatchery have increased about 200 per year to the holding capacity of 1,000 fish, and apparently the

Table 2.—Annual counts of adult fall chinook salmon (jacks included). Bonneville Dam and hatchery returns, 1945-62.

Year	Fish counted	Hatchery returns[1]	
	Number	*Number*	*Percent*
1945	221,155	12,752	5.8
1946	321,208	19,632	6.2
1947	296,935	24,822	8.4
1948	305,623	26,756	8.8
1949	169,388	21,233	12.5
1950	242,913	27,909	11.5
1951	131,739	29,917	22.7
1952	214,288	38,210	17.8
1953	97,335	18,657	19.2
1954	100,499	22,161	22.1
1955	95,157	19,722	20.7
1956	125,985	24,815	19.7
1957	122,535	37,834	30.9
1958	244,864	80,696	33.0
1959	189,115	54,182	28.7
1960	96,381	29,567	30.7
1961	110,442	23,890	21.6
1962	112,882	26,094	23.1
18-year total	3,198,444	538,849	
Average	177,691	29,936	

[1] Number given includes actual and calculated returns; percent given is hatchery returns as percent of Bonneville count.

Figure 12.—Taking spawn from fall chinook salmon at Spring Creek National Fish Hatchery.

survival of this race of fish depends more and more on hatchery production. The efficiency of hatcheries is being improved constantly through research efforts to develop effective disease control, fulfill nutritional requirements, and improve hatchery operational techniques.

Columbia River hatcheries now generally follow a standard procedure in releasing juvenile fish adapted from results of many experiments to determine highest survival. Program hatcheries now release annually some 75 million fall chinook reared 90 days to about 3 inches long. Spring chinook are reared 1 year to approximately 6 inches long and about 7 million are released each year.

Coho salmon are reared for 1 year to a 6-inch length, and 25 million are released in the Columbia River drainage annually.

The highest survival of steelhead trout has been obtained by rearing this fish to approximately 8 inches. Fish in hatcheries having warm water (55° - 60° F.) throughout the year grow this large in 1 year. Stations with cold winter temperatures use water heaters to accelerate the growth to the 8 inches in 1 year. Annual releases of program hatchery-reared steelhead average about 1-1/2 million fish.

Chum salmon play a minor role in program hatcheries. Approximately 1 million of this species are reared in hatcheries for 30 days and released at a length of 1-1/2 inches.

Stream Improvement

Construction of fishways and removal of natural and manmade obstacles affecting the migration of adult salmon and steelhead trout has been a major activity of the Columbia Fishery Development Program (figs. 13 and 14).

Before actual construction or improvement, field surveys locate existing barriers or obstructions which completely stop or delay the migration of adult fish. In each case, the existing and potential spawning and rearing habitat above the obstructions is evaluated. Consideration then is given to engineering problems of construction, and priorities are established on the basis of field surveys, engineering estimates, and expected results.

Early in the program, major emphasis was placed on improvements on the lower Columbia River tributary streams below McNary Dam. Recently, increased effort has been placed on improving upstream migration conditions in the tributary streams of Idaho, eastern Oregon, and Washington (fig. 15).

There is ample proof that salmon and steelhead trout use spawning and rearing areas made available to them. Fish have been counted at some of the larger installations to evaluate the fishes' utilization of areas made accessible to them. At Shipperd Falls on the Wind River, fish counts demonstrate that increasing numbers of fish use the 25 newly available miles of river for spawning and

Figure 13.—Old crib dam on South Yamhill River, Oreg., before removal.

Figure 14.—Old crib dam on South Yamhill River, Oreg., after removal.

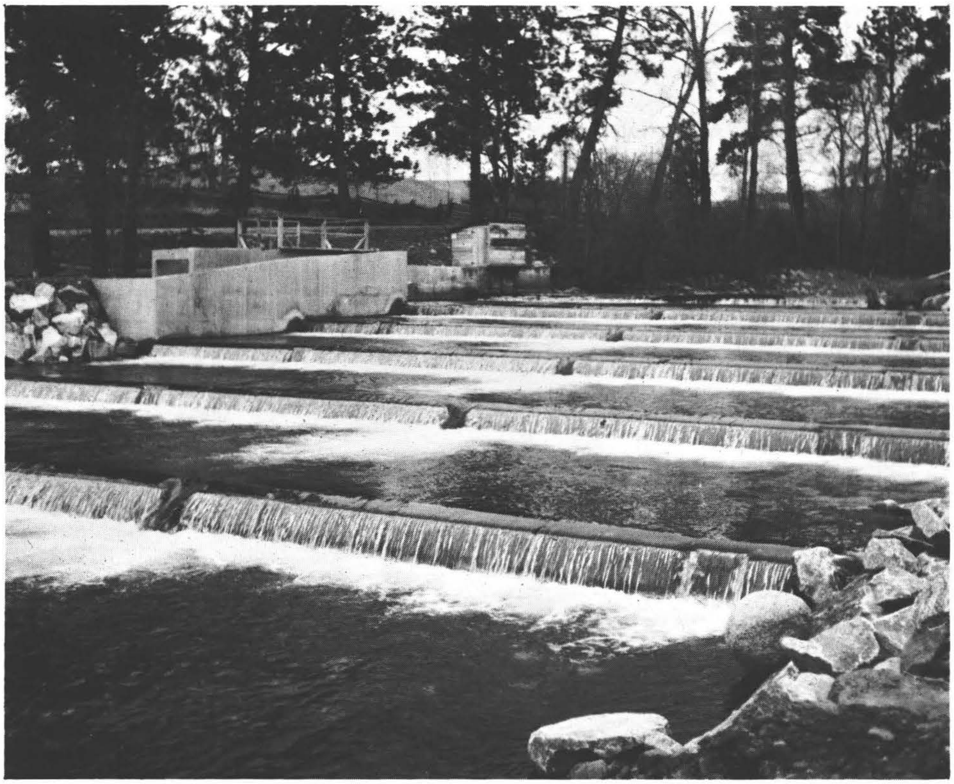

Figure 15.—Example of fishway extending full width of a dam. Lostine River, Oreg.

rearing (table 3). Before this fishway was built salmon were unable to pass this barrier. The coho and chinook salmon runs were established by hatchery releases. Table 4 shows estimated numbers of anadromous fish at four fishways over natural barriers on other streams. No identification of species was made at these installations.

A major development, still being planned is the construction of adequate fish-passage facilities at Willamette Falls, Oreg. These facilities will permit the full development of the salmon and steelhead trout potential of the Willamette River system. At present fall chinook salmon cannot pass Willamette Falls and spring chinook salmon and steelhead pass with difficulty.

Ever since the stream improvement program began in 1949, and as each improvement has been completed, field crews under State direction have maintained the facilities in proper operating condition. The operation and maintenance of fishways is now a significant and continuing activity under the Columbia River Fishery Development Program.

Table 3.—Fish counted at Shipperd Falls, Wind River, Wash.[1]

Species	1960	1961	1962
Spring chinook	855	1,032	2,516
Fall chinook	1,026	1,587	1,455
Steelhead trout	49	203	368
Coho	272	1,357	4,118
Total	2,202	4,179	8,457

[1] All figures represent minimal numbers as fish were counted only during peak of run.

Table 4.—1962 estimated number of salmon at fishways constructed and operated in Washington with Columbia River Fishery Development funds[1].

Kalama Falls, Kalama River	3,800
Lower Klickitat, Klickitat River	3,200
Salmon Falls, Washougal River	3,400
Cedar Creek Falls, Lewis River	1,000

[1] All figures represent minimal numbers as observations were made only during peak of run.

Unregulated logging practices during the early development of the basin resulted in considerable blockage to anadromous fish migrations. Logging debris in tremendous quantities and naturally formed log jams occur widely throughout the Columbia Basin. Many of these have been removed by the stream improvement program when they impede migration of fish.

Screening of Diversions

The greatly expanded program of irrigating dry and barren lands of the Columbia Basin has created many problems in protecting young downstream migrating salmon and steelhead trout from untimely death in farmers' fields. Lack of proper screening facilities in the early days of irrigation diversion resulted in losses of tremendous numbers of young migrants.

Since the Columbia River Fishery Development Program began, 631 screens of various designs have been constructed in Oregon and Idaho. Over 400 of the screens have been installed in the John Day River system in Oregon. Each year, traps are constructed at certain screens to measure their efficiency in diverting downstream migrants through bypasses. It is difficult to actually appraise the value of a fish screen in terms of adult survival of salmon and steelhead.

Bypass traps have furnished some interesting data. One bypass trap in a 30-day period at a screen on the main Salmon River in Idaho captured over 15,000 young salmon (fig. 16). Several screens on the Lemhi River in Idaho diverted young salmon at the rate of 4,000 fish per day.

The Lemhi River, prior to the screening of 85 diversions, had only a meager run of salmon. Spawning nest counts made in the early 1950's never exceeded 100 salmon nests. Coincident with the construction of screens and the removal of an old dam in the Lemhi, the salmon nest count has shown a phenomenal increase (table 5). The total salmon run in the Lemhi in 1961 was estimated to exceed 4,000 fish. This increase must be directly related to the screening and stream improvement program, because other streams in the immediate vicinity did not have this spectacular increase in fish numbers.

Prefabrication has become an important tool of the screening program. Where feasible, screens and the supporting structures are completely prefabricated before emplacement (figs. 17 and 18).

Screening is not confined entirely to irrigation diversions. Several power plants require screens, and a major screen structure is being planned for Willamette Falls, where two paper mills using water power and a hydroelectric power plant are located.

Figure 16.—Louver fish screen located in an irrigation diversion from the main Salmon River near Salmon, Idaho.

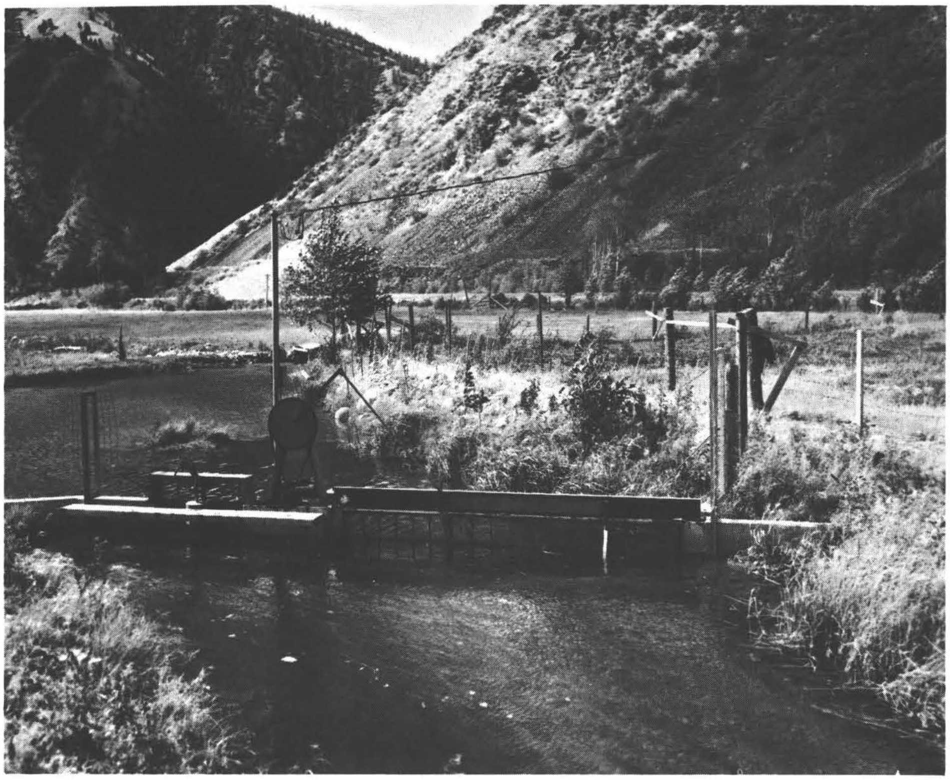

Figure 17.—Perforated-plate fish screen located in the North Fork of Salmon River drainage near Salmon, Idaho.

Figure 18.—Installing prefabricated wall sections of a vertical perforated-plate fish screen in the Pahsimeroi River drainage near Salmon, Idaho.

Figure 19.—Biologists checking for marks and collecting biological data.

Table 5.—Salmon nest count, Lemhi River, Idaho.

Year	Nests
	Number
1959	524
1960	1,434
1961	1,871

Appraisal of Project Results

Activities under appraisal include both inspection and evaluation of hatchery operations, Wind River spring chinook salmon transplantations, stream clearance, and constructed fishways and screens.

A cooperative Federal-State evaluation study now is underway to measure the contribution to the commercial and sport fisheries of fall chinook salmon produced at Columbia River hatcheries. Annually, for 4 years, approximately 10 percent of each hatchery's production will be marked by excision of fins. Fish marking, or fin-clipping, of approximately 7 million fish began in 1962, and approximately the same number will be marked each year through 1965. First returns of marked fish have been limited as the fish were 2-year-olds in 1963. Because of the small size of the fish, they were found principally in the sport fisheries of Oregon and Washington and in the Columbia River. Existing mark-sampling programs from Alaska to California are being expanded by adding program funds to provide the greatest effort ever undertaken in sampling the extensive commercial and sport fisheries of the West Coast (fig. 19).

An important phase of the study to measure hatchery contribution to the sport fishery is a coordinated program of aerial and ground surveys initiated in 1963 on the Columbia River between Tongue Point, near the mouth of the river, and Klickitat River approximately 180 miles upstream. This area of river was divided into sections, and the numbers of fishermen, boats, and marked and unmarked fish were counted.

A second hatchery evaluation study also is underway. In 1961, approximately 1 million sockeye salmon were fin-clipped as part of a study to measure the contribution of Leavenworth National Fish Hatchery to the Columbia River gill net fishery, the only sockeye fishery. Approximately 1 million, or roughly one-third of the production, will be marked each year for 4 years. The mark-sampling program is being conducted by the Fish Commission of Oregon on the sockeye fishery. First returns from this experiment were recovered in 1963 as 3-year-old fish (fig. 20). Creel census data are being collected on the Lake Wenatchee sport fisheries to measure the contribution of the planted sockeye fingerlings to the local sport fishery. Information collected to date indicates many of these hatchery-planted sockeye salmon are taken in the local sport fishery before migrating to the ocean.

The Wind River spring chinook salmon transplantation study began in 1955 with the transfer of 500 adult salmon from the fishways at Bonneville Dam to Carson National Fish Hatchery. This transfer will be continued annually through 1965. Counts of spring chinooks at Shipperd Falls, a complete barrier to them until a fishway was built there, totaled 855 fish in 1960, 1,032 in 1961, and 2,516 in 1962. Some of these fish entered the Carson National Fish Hatchery holding ponds approximately 20 miles upstream from the mouth. In 1961, 429,700 eggs were taken from the natural returns to the hatchery, and in 1962, 3 million eggs were taken. Fish not entering the hatchery were observed successfully spawning in the stream gravel above and below that point.

Figure 20.—Biologists examining fin-marked salmon from hatchery evaluation program.

In the fall of 1962, more chinook and coho salmon eggs were taken than the lower Columbia River hatcheries could use. Some of the excess eggs were used to test several designs of incubation boxes. Boxes were tested on the Clackamas, McKenzie, and Metolius Rivers, and at Depot Springs on the Columbia. Most results were excellent. The boxes, containing selected gravel, were placed in protected areas alongside the stream where a good spring water supply was available. After the protected eggs hatched in the gravel, the young emerged and moved to the stream to feed and grow (fig. 21).

Operational Studies

The Operational Studies Program investigates ways to get more results out of each Fishery Development Program dollar. The program seeks ways to improve the effectiveness and efficiency of fish-rearing facilities and of screens, and to improve production of salmon and steelhead trout in hatcheries and in nature (fig. 22). Studies on fish disease, nutrition, and problems directly associated with fish passage are excluded since research on these activities is financed from other sources.

Investigations under this program fall into four main classes: (1) development of fish-cultural techniques (fig. 23), (2) improvement of natural habitat, (3) predator control, and (4) controlled natural rearing.

Because the number of investigations was large, they were contracted with research organizations in Oregon, Idaho, and Washington. All of the State fish and game agencies, as well as several universities, undertook contracts. The Bureau's Biological Laboratory in Seattle, Wash., and the Bureau of Sport Fisheries and Wildlife undertook several contracts. Funds available for the investigations were $500,000 in each of fiscal years 1961 and 1962, and $510,000 in 1963.

Most of the investigations are still underway, and many of them show progress. A new salmon fry grader developed by Oregon State Game Commission has been put into widespread use. Experiments on the introduction of spring chinook into the Selway River (figs. 24 and 25) and of steelhead trout into the South Fork Clearwater both obtained good survival from egg to migrant stage, as did the experiments with chum salmon in an artificial channel at Abernathy. Experiments on pond rearing of young salmon and trout from fry to migrant size showed good survival of good quality fish (fig. 26). Young coho salmon and steelhead trout introduced into salt water suffered a delayed mortality. This led investigators to suspect that both the size of migrant and the seasonal time of migration into salt water may be critical factors in the migrant's successful transition from fresh to salt water.

Selective toxins to control scrapfish have been sought. One toxin, within time limits, will kill young squawfish (the most destructive of the several predators of salmon) but will not kill young salmon.

The search for a method of mass-marking young salmon for later identification also has progressed. The drug tetracycline, administered with the fishes' food, forms a deposit on bone surfaces, and can be detected later as a yellowish fluorescent band within the bones.

Salmon literature was compiled by bringing together published reports on salmon in a 108-volume "Salmon Compendium" indexed by subject, location of study, author, and periodical. This initial 108-volume set covers literature published from 1900 through 1959; supplemental volumes including publications through 1963 are in preparation.

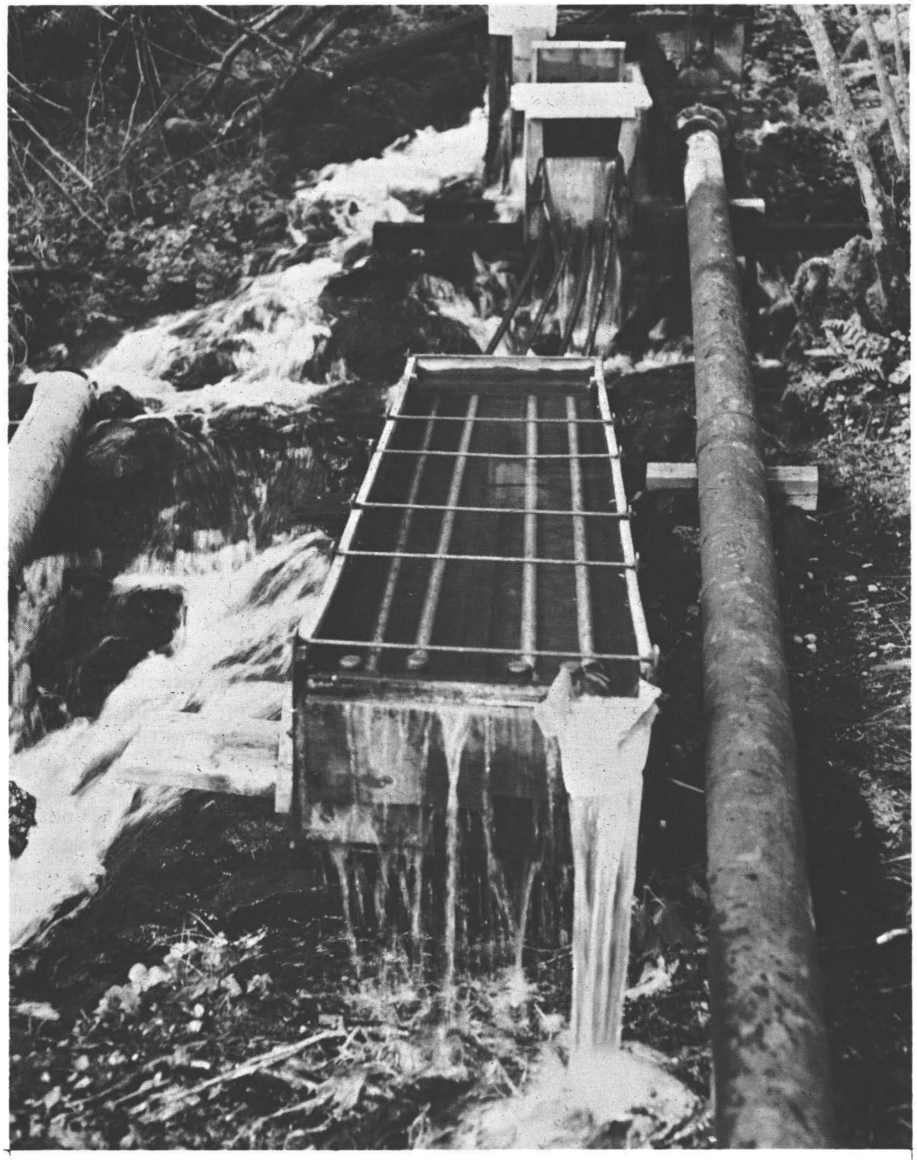

Figure 21.—Incubation box at Depot Springs, Wash., showing perforated water supply pipes on bottom of box prior to filling box with gravel.

Figure 22.—Dredger tailings used to make salmon spawning riffles in Clear Creek, a tributary of North Fork John Day River. An Oregon State Game Commission project.

Figure 23.—Salmon fingerling counting device developed by Washington Department of Fisheries as an Operational Studies project.

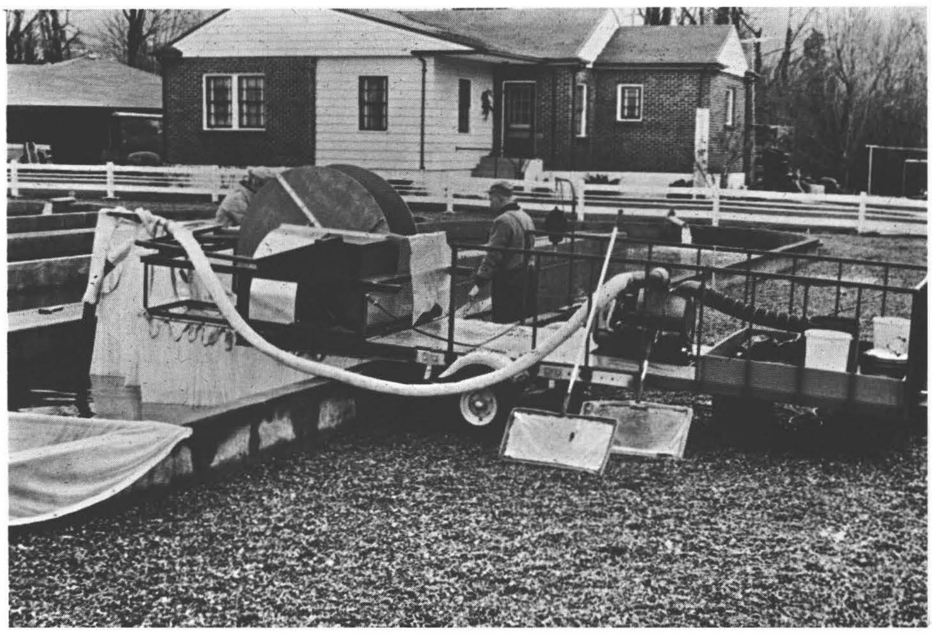

Figure 24.—Planting spring chinook salmon eyed eggs in Bear Creek, a tributary to Selway River, Idaho. An Idaho Department of Fish and Game Operational Studies project.

Figure 26.—Controlled natural-rearing pond for coho salmon at Waukeena near Multnomah Falls on Columbia River. A Fish Commission of Oregon Operational Studies project.

Figure 25.—Eyed spring chinook salmon eggs in shipping containers prior to placing in gravel. Bear Creek, Selway River, Idaho.

WATER RESOURCE INVESTIGATIONS

The Federal Government recognized the need to protect fish resources at private hydroelectric power projects through provisions in the Federal Water Power Act of June 10, 1920, as amended. This Act provides that the Federal Power Commission shall require the licensee to construct, operate, and maintain, at his own expense, such fishways as the Secretary of the Interior may prescribe. Through passage of the Coordination Act of March 10, 1934, as amended, development agencies must consult with the U. S. Fish and Wildlife Service to determine economical and practical methods for passing fish over any dam constructed by the Federal Government or by a private agency under Federal license.

In the Columbia River Basin, the Bureau of Commercial Fisheries investigates anticipated effects, on fish, of proposed water development projects. Projects investigated range from major hydroelectric, irrigation, and flood control projects down through drainage channel improvement, and harbor projects. Measures recommended for safeguarding affected fish resources cover the major categories of adequate over winter storage, flow maintenance, upstream and downstream passage facilities, screens, supplemental production facilities, and seasonal scheduling of project construction activities.

As a result of close working relationships with project planners, more facilities are included for fish and project plans and operations are modified to maintain the best possible conditions for fish.

A few of the projects having fish facilities as a result of improved cooperation are the Corps of Engineers Willamette Basin projects, the Bureau of Reclamation Columbia Basin, Touchet, and Yakima projects; Eugene Water and Electric Board, Carmen-Smith project; Chelan County Public Utility District, Rocky Reach project; Douglas County Public Utility District, Wells project; and Portland General Electric, Pelton and North Fork projects.

FISH FACILITIES

In the Columbia Fisheries Program Office a small staff of biologists and engineers develops functional designs for a wide variety of fish facilities required at water-development projects. They have worked mainly on Columbia Basin projects, but they have helped on projects ranging from the proposed huge Rampart Project on the Yukon River in Alaska to irrigation and power projects in California. They also developed plans to improve existing facilities.

Major innovations have been developed at City of Tacoma's Mayfield Dam on the Cowlitz River and Douglas County Public Utility District's licensed Wells Dam on the Columbia River. At Mayfield Dam, the entire hydroelectric water supply of 12,000 c.f.s. passes through louvers that divert downstream migrants into a bypass (fig. 27). This is the first time that the entire water supply of a large hydroelectric project has been "screened" for fish. Incorporation of hydro-combine units into the several piers of Wells Dam makes this project quite unusual—in fact, it is the only one in this country. Discharge of the turbine water underneath the spillway section presents a new fish attraction and passage problems, and an ingenious plan employing a jet of water will be used to attract fish to fishways at both ends of the dam.

A novel plan is being developed to provide spawning areas for many thousands of salmon in a major irrigation canal. This use of the Tehama-Colusa Canal, Calif., is being planned in cooperation with the Bureau of Reclamation, the Bureau of Sport Fisheries and Wildlife, and the California Department of Fish and Game. If this new spawning area can be provided, it will compensate in part for the extensive spawning areas destroyed by some water-development projects in California.

Other activities of the Fish Facilities staff include inspecting and evaluating fish facilities (figs. 28 and 29). Because of major deficiencies in maintenance and operation, several State fish and game agencies and the Bureau of Commercial Fisheries cooperate in the inspections. The problem is complex because of the diversity of agencies constructing dams and the diversity of ideas and attitudes among several conservation agencies involved.

Designing a facility is one thing; knowing how well it works is another. Several evaluation programs study this. Pelton Dam facilities on the Deschutes River, Oreg., have been evaluated and facilities at four other projects are being studied—Mayfield Dam on Cowlitz River, Carmen-Smith on McKenzie River, North Fork Dam on Clackamas River, and Brownlee-Oxbow Dams on Snake River. Three other evaluation programs are being planned: the Corps of Engineers' Cougar project on the South Fork McKenzie River and Green Peter-Foster projects on the Middle Santiam River, and the Chelan County Public Utility District's Rock Island Dam on the Columbia River.

Figure 28.—Construction of concrete-lined spawning channel for fall chinook salmon. When completed the channel will be filled with graded gravel for use by spawning salmon. Priest Rapids Dam on mainstem Columbia River.

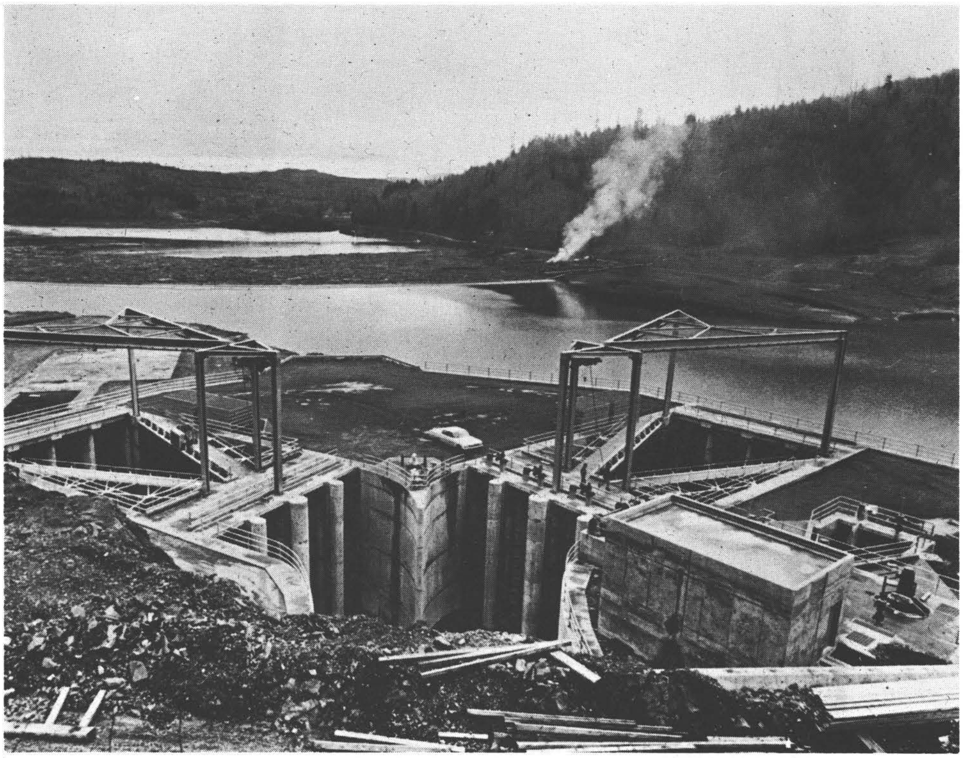

Figure 27.—Mayfield Dam louver structure for diverting downstream migrating salmon and steelhead into a bypass, Cowlitz River, Wash.

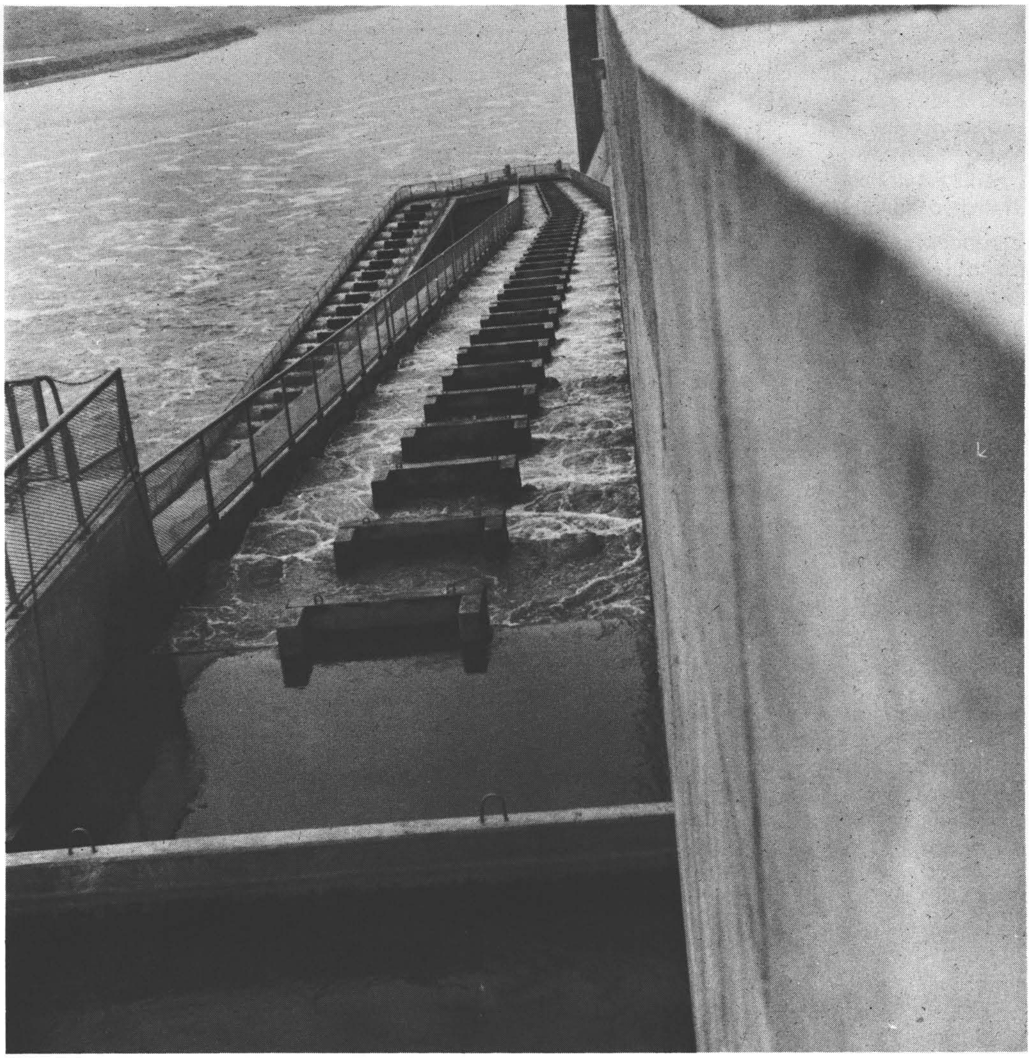

Figure 29.—One-to-ten slope fishway at Ice Harbor Dam, Snake River, Wash.—a design which results in considerable savings in construction costs due to decreased length.

THE FUTURE

Economic growth in the Columbia River Basin will demand an increase in the number of multipleuse water projects, and the effects of these projects as well as of industrial and population growth will pose challenging problems to conservationists.

Artificial propagation, habitat improvement, and research already accomplished have been effective in maintaining and augmenting the fish resources. Constructive efforts along these lines will continue and we believe the fish resources of the basin can be preserved at their present level of production and even increased.

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