Columbia River Fisheries Development Program

U.S. Department of Commerce

Mitchell Act

To provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior is authorized and directed to establish one or more salmon-cultural stations in the Columbia River Basin in each of the States of Oregon, Washington, and Idaho. Any sums appropriated for the purpose of establishment such stations may be expended, and such stations shall be established, operated, and maintained, in accordance with the provisions of the Act entitled "An Act to provide for a five-year construction and maintenance program for the United States Bureau of Fisheries", approved May 21, 1930, insofar as the provisions of such Act are not inconsistent with the provisions of this Act.

Sec. 2. The Secretary of the Interior is further authorized and directed (1) to conduct such investigations, and such engineering and biological surveys and experiments, as may be necessary to direct and facilitate conservation of the fishery resources of the Columbia River and its tributaries; (2) to construct and install devices in the Columbia River Basin for the improvement of feeding and spawning conditions for fish, for the protection of migratory fish from irrigation projects, and for facilitating free migration of fish over obstructions; and (3) to perform all other activities necessary for the conservation of fish in the Columbia River Basin in accordance with law.

Sec. 3. In carrying out the authorizations and duties imposed by section 2 of this Act, the Secretary of the Interior is authorized to utilize the facilities and services of the agencies of the States of Oregon, Washington, and Idaho responsible for the conservation of the fish and wildlife resources in such States, under the terms of agreements entered into between the United States and these States, without regard to the provisions of section 3709 of the Revised Statutes, and funds appropriated to carry out the purposes of this Act may be expended for the construction of facilities on and the improvement of lands not owned or controlled by the United States: Provided, that the appropriate agency of the State wherein such construction or improvement is to be carried on first shall have obtained without cost to the United States the necessary title to, interest therein, right-of-way over, or licenses covering the use of such lands.

Approved May 11, 1938, amended August 8, 1946
(52 Stat. 345) (60 Stat. 932)

COLUMBIA RIVER FISHERIES DEVELOPMENT PROGRAM

January 1981

U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary

National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator

National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator for Fisheries

January 2, 1981

To Our Readers

The States of Washington, Oregon, and Idaho, as well as the Federal Government, have made concerted efforts to maintain the anadromous fish runs in the Columbia River system. A large part of the cooperative effort has been coordinated through the Columbia River Fisheries Development Program. This booklet covers the many activities and accomplishments of dedicated State and Federal fish biologists, fish culturists, and engineers who have combined their talents and energies to enhance and maintain stocks of Columbia River Pacific salmon and steelhead trout that contribute to various fisheries from Alaska to California at a highly favorable benefit-cost ratio.

Information presented in this report provides individuals and agencies concerned with the conservation and enhancement of Pacific salmon and steelhead trout a convenient reference to the activities associated with the Columbia River Fisheries Development Program.

H.A. Larkins
Regional Director

CONTENTS

ANADROMOUS SALMONIDS

Before an effective discussion of the Columbia River Fisheries Development Program can be undertaken, it is necessary to first develop an understanding of the fish making up the anadromous salmonid resource. The term salmonid refers to members of the genus, *Oncorhynchus* (salmon), the genus *Salmo* (trout), and the genus *Salvelinus* (char). Anadromous is a term that when applied to fish indicates that the fish spends a portion of its life in salt water before returning to fresh water to spawn.

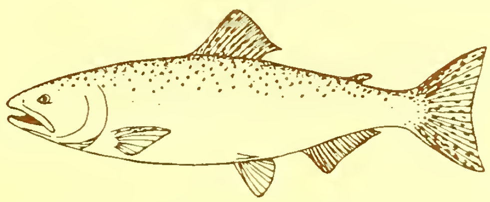
There are six species of Pacific anadromous salmon, the chinook or king salmon—*O. tschawytscha,* the coho or silver salmon—*O. kisutch,* the pink or humpback salmon—*O. gorbusha,* sockeye, red, or blueback salmon—*O. nerka,* chum salmon—*O. keta,* and Masu or cherry salmon—*O. masu* (Figure 1). Of these, only the masu salmon is not indigenous to North America.

While all the species of trout and char can be anadromous, only the steelhead trout *(S. gairdneri),* and the sea run cutthroat trout *(S. clarki)* are of major importance to the Pacific Coast (Figure 1).

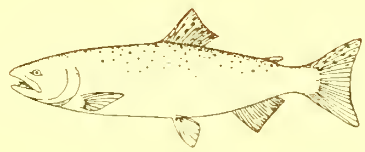
With one notable exception, the general life cycles of the anadromous salmon and trout are essentially the same (Figure 46 — Inside Back Cover). All species spawn in freshwater lakes and streams or in brackish water near the mouth of rivers flowing into salt water. After hatching, the fry spend a period of one day to eighteen months rearing prior to migrating to the ocean for the saltwater portion of their life cycle. After spending one to five years in salt water, sexually mature fish normally return to the place where they originally hatched to complete the cycle. The difference in life cycles in salmon and trout is that all salmon die after spawning and trout may return to the ocean to repeat the cycle a number of times.

Figure 1

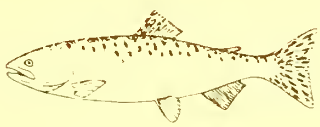
Anadromous salmonids native to the Pacific Coast of North America.



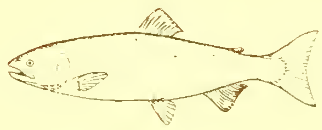
Chinook Salmon
(Oncorhynchus tschawytscha)



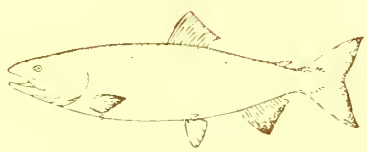
Coho Salmon
(Oncorhynchus kisutch)



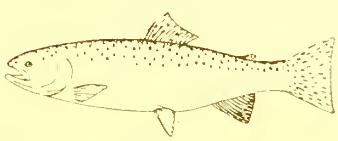
Pink Salmon
(Oncorhynchus gorbusha)



Sockeye Salmon
(Oncorhynchus nerka)



Chum Salmon
(Oncorhynchus keta)



Steelhead Trout
(Salmo gairdneri)

Sea-Run Cutthroat Trout
(Salmo clarki)

Of the indigenous species of salmon on the Pacific Coast, the chinook is the largest. The distribution of the chinook salmon is from southern California to Alaska as well as in the U.S.S.R. and northern Japan. While the record weight reported for a commercially caught chinook is 126½ pounds, few are caught that weigh over 50 pounds, with the average being between 18 and 25 pounds. They are the most desirable of marine game fish in northern waters and are subject to extensive ocean troll and sports fisheries as well as fisheries within the rivers on the Pacific Coast. The principal fishing areas stretch from Avila Beach, California, to southern Alaska.

In the Columbia Basin, chinook have been divided into three races based mainly on the time they return to the river to spawn. The races are designated either spring, summer, or fall and normally reflect how far upriver the returning adult fish migrate before spawning. In many cases the earlier a fish returns, the farther upstream its historical spawning grounds are. This pattern has been altered dramatically in recent years because of the many dams that have been built on the Columbia River system and the transplantation of many runs of the different races of fish to more suitable habitat.

Coho salmon have been known to occur as far south as the Coronado Islands in Mexico and on up into Alaska. On the Asiatic side of the Pacific, they range as far south as Japan. Coho have been caught which exceed 30 pounds, but the average size is around 10 pounds. There is an active sports and commercial fishery on the species in the ocean and the tributary streams which support a stock of coho.

Coho make up a major portion of the hatchery production of the Columbia River Basin hatcheries. They enter the river in late summer and early autumn and spawn from October to December.

Pink salmon are found in southern California to northwestern Alaska and along the Asian coast, but are not common south of Oregon. They are the smallest of the Pacific salmon averaging about 6 pounds when mature. Pink salmon normally spawn in the lower portions of rivers near or in tidewater. They are not fished extensively by sports fishermen but are an important commercial species.

Sockeye salmon range from southern Oregon to northwestern Alaska and Asia. They average from 5 to 7 pounds at maturity. Sockeye normally spawn in rivers fed by lakes and often use the lakes as rearing habitat for a year before migrating to salt water. As the sockeye salmon rarely take a hook, they are not a major contributor to the sports catch. It is, however, an extremely important commercial species, highly prized by commercial fishermen and consumers.

Chum salmon have a range similar to that for pink salmon. Like the pinks, chums primarily spawn in the lower reaches of coastal rivers and sometimes even utilize salt water areas for spawning. They average 10 to 12 pounds and are an important commercial species from Washington northward. Because of their light colored flesh, however, they are not as highly regarded by the consumer as are some other species of salmon.

The most important species of anadromous trout, based on fishing effort and hatchery production, is the steelhead trout. A steelhead is a rainbow trout that spends a portion of its life in salt water. They may exceed 36 pounds but most average 10 pounds at maturity. The range extends from Point Conception, California, to Alaska in North America as well as from Japan to Russia on the Asian Ocean coast. The fishery on steelhead is concentrated on the river as fish return to spawn and is mainly sports oriented.

In the Columbia River Basin, an extensive hatchery rearing program helps maintain steelhead in the face of increasing pressure and declining wild runs. Steelhead are divided into two races—winter and summer. As with the chinook this division is based mainly on the time of return to fresh water. Both races are present in the basin and their spawning grounds extend as far as Idaho and the middle Columbia tributaries in Washington.

The sea run cutthroat trout is a cutthroat trout that, like the steelhead trout, spends a portion of its life cycle in salt water. The range of their distribution extends from the Eel River in California to Southeastern Alaska. Sea run cutthroat usually reach a size of between 1 and 3 pounds. The fishery on this species is almost totally sports oriented and is confined to the fresh water streams to which this fish returns to spawn.

CONDITION OF THE RESOURCE

Pacific salmon and steelhead trout have played an important role in the history of the Pacific Northwest and the Columbia River Basin. Long before settlers and opportunity seekers came to the Northwest, tribes of Indians were involved in subsistence fishery. Using mainly spears and dipnets, Indians annually caught large quantities of salmon and steelhead which they preserved by drying or smoking (Figures 2 and 3). These preserved fish formed an important part of the Indians' food supply.

Figure 2

An Indian woman preparing salmon for smoking.

Figure 3

An Indian fishing camp with salmon drying on racks in the sun.

The first recorded non-Indian exploitation of the Columbia Basin salmonid resource was a salmon salting plant established in the lower river in 1832. Fish taken were packed in barrels of salt for shipment. Although this first enterprise proved to be a failure, the ones that followed were not and a major Northwestern industry was founded.

In 1866, William Hume established the first salmon cannery on the Columbia River at a site on the Washington shore 40 miles above Astoria. The pack this first year was 4,000 cases of canned salmon. By 1881 there were 34 canneries in operation and the total pack had increased to approximately 550 thousand cases from 37.5 million pounds of catch (Figure 4). In 1884, when the pack exceeded 620 thousand cases, fish were so numerous that tons of them were thrown overboard by fishermen because the canneries were not able to use them. Yearly catches fluctuated between 22 and 42 million pounds until in 1911 a record 49 million pounds were caught. The trend for the River catch from 1911 on has been generally negative. Some of the reasons for the decline are discussed in the "Habitat" section of this document.

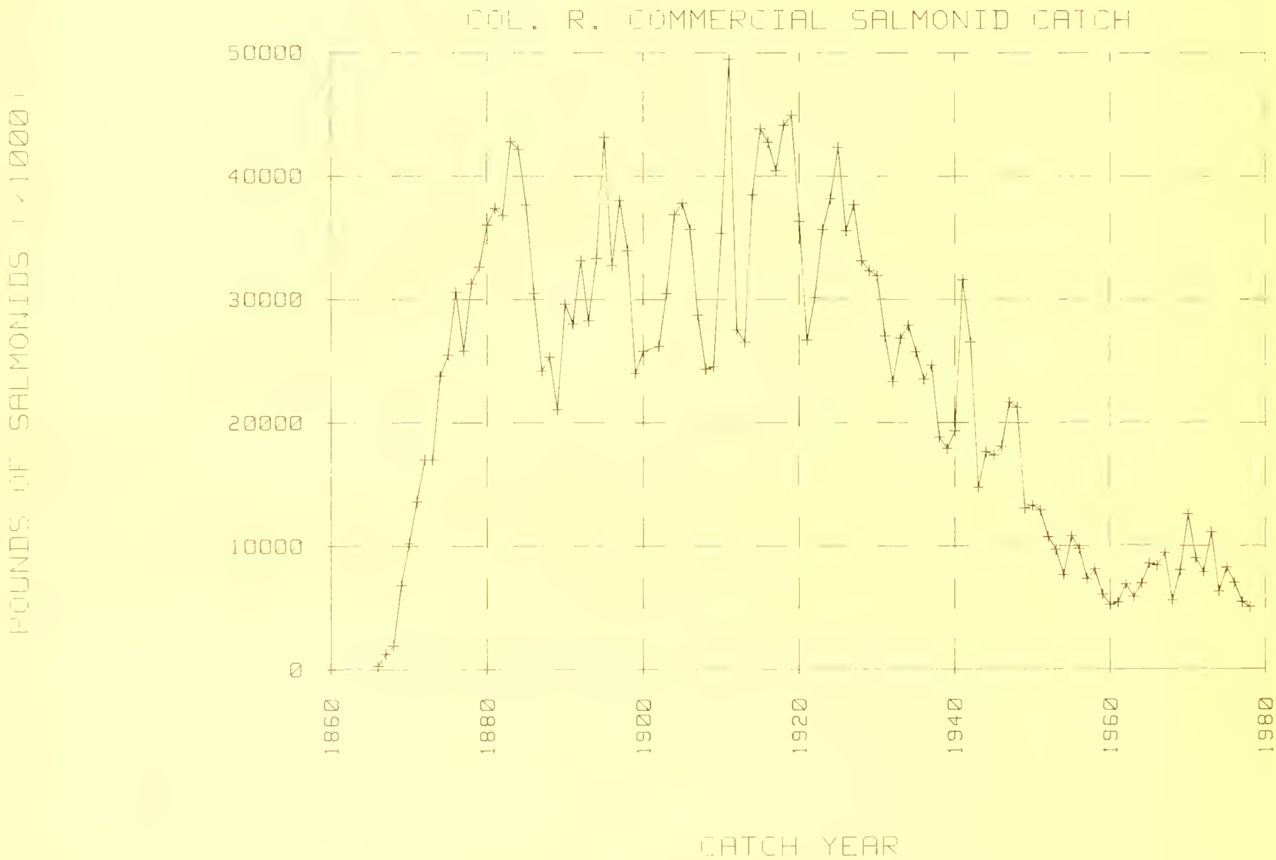


Figure 4

Historical commercial catch of anadromous salmonids (in thousands).

In these early years, commercial fishing took place almost exclusively within the coastal rivers. There were essentially no ocean commercial fisheries. In the case of the Columbia River, fishing extended from the mouth up to Celilo Falls, (River Mile 192), the area now inundated by The Dalles Dam. Most of the fishermen's efforts were concentrated in the lower 40 miles.

Depending on the area fished, different gear was used. Traps and pound nets proved effective in the lower river as did drag or beach seines on the lower river sandbars (Figure 5). Fixed and drifting gill nets were used in various reaches of the river (Figure 6) and fish wheels on the main stem (Figure 7) above the junction of the Willamette River (River Mile 101).

Figure 5

A horse seining operation in the Lower Columbia River in the 1910's.

Figure 6

Gillnet boats moored at Astoria in the early 1900's.

It is important to note that Figure 4 only includes commercial catches in the Columbia River. While the trend line for the catch after 1911 shows a dramatic decline, this does not accurately indicate the status of Columbia River salmonid stocks. As previously mentioned, prior to 1911 there were essentially no ocean fisheries and there were few closed periods during "in-river" fishing seasons. With rapid improvements in vessels, gear, and techniques, the ocean commercial fisheries gradually began to gain in importance. Additionally, a large ocean sport fishery developed. The impact of these two fisheries has severely reduced the "in-river" harvest. Fish of Columbia River origin that would have historically been available to river fishermen were instead being taken in the ocean. Also, seasons were by necessity shortened to protect the declining numbers of fish returning to the river.

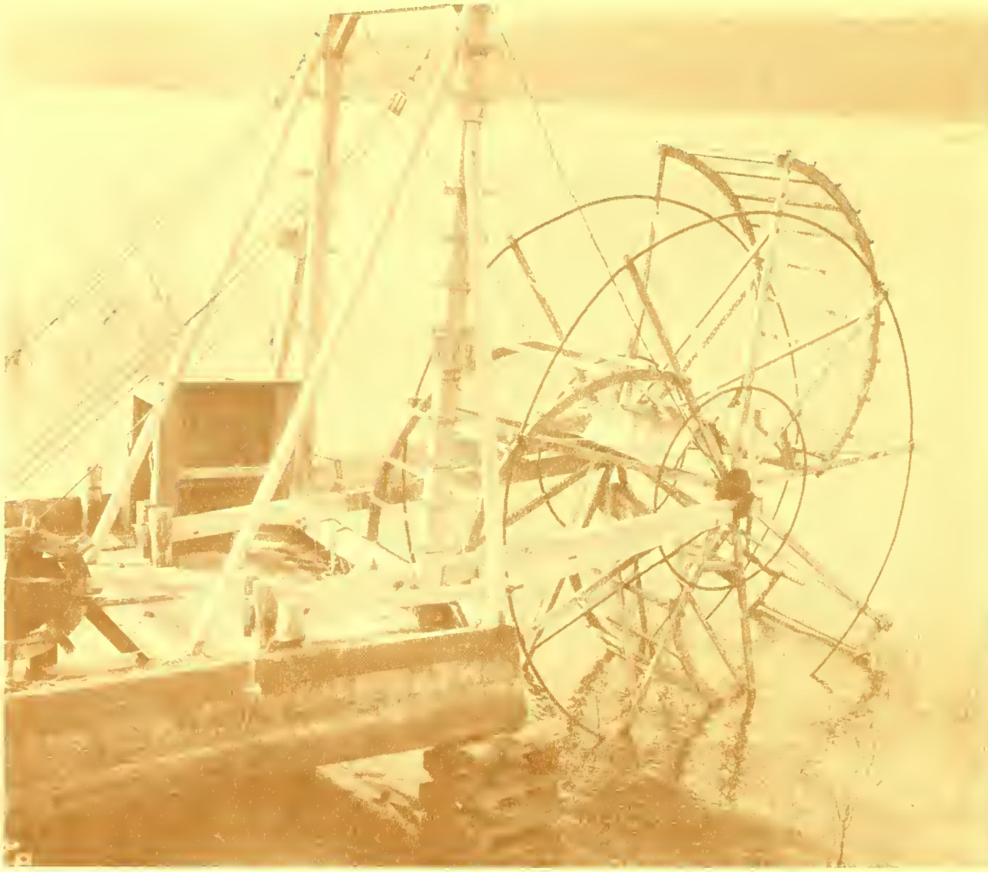


Figure 7

A scow fish wheel near Corbett, Oregon — 1910.

To get a true picture of the state of populations of Columbia River origin fish, it is necessary to add the ocean catches to those presented in Figure 4. Results of hatchery contribution studies conducted by the Columbia River Fisheries Development Program of the National Marine Fisheries Service are presented in Figures 37 and 38 in this document. While the catch data are only for hatchery fall chinook and coho for 4 and 2-brood years respectively, the estimated total weight of the catch each year, when added to that in Figure 4, would present an entirely different picture. Total catches of Columbia River origin fish would approach those prior to 1940.

Recreational fishing on the Columbia River during the same period was limited in scope. A considerable number of sportsmen did fish for salmon in the area of Willamette Falls and on the Clackamas River each spring (Figure 8), but their catch was small when compared to the commercial efforts. One of the most notable of these early sportsmen was the famous author, Rudyard Kipling.

HABITAT

The mainstream Columbia River is over 1200 miles long, stretching from Lake Columbia in Canada to the Pacific Ocean. Including tributaries, the Columbia River Basin drains approximately 259,000 square miles land (Figure 9), 39,500 square miles of which are in southeastern British Columbia. The U.S. portion of the Basin consists primarily of portions of the states of Oregon, Washington, and Idaho but also includes portions of the states of Montana, Wyoming, Nevada, and Utah.

Before the Basin was settled, salmon and steelhead were in great abundance. Spring and summer chinook salmon as well as sockeye salmon migrated almost 1200 miles upstream to the lower end of Lake Windemere in Canada to spawn, while coho salmon spawned in the Spokane River, 700 miles from the Pacific Ocean. Both spring chinook and steelhead reached the area of Rock Creek, a Snake River tributary in the area of Twin Falls, Idaho, 592 miles upstream. Figure 10 shows the extent of the Basin historically accessible to spawning.

Figure 8

Sports fishing in the Willamette River in the early 1900's.

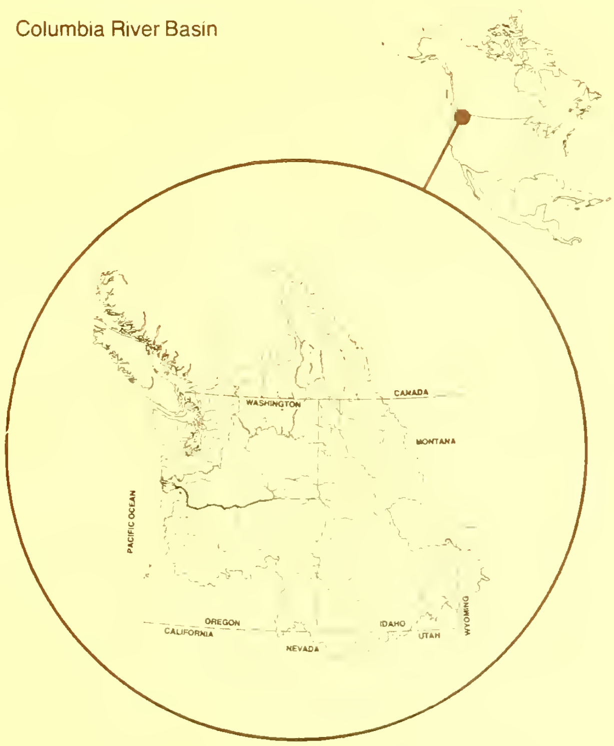


Figure 9

The Columbia River Basin.

Figure 10

The portions of the Columbia River Basin that are or have been accessible to anadromous salmonids.

Much of the original habitat has undergone drastic change and reduction with the onset of civilization. Development of the agriculture industry resulted in increased turbidity and caused changes in chemical and physical properties of the water (Figure 11). A demand for irrigation water developed in response to continually greater amounts of land being placed into cultivation (Figure 12). Many dams were built to divert water to meet these demands which in some cases resulted in greatly diminished or completely eliminated flows. These diversion dams were often built without fishways making them impassible to upstream migrating adult salmonids. Unscreened diversion intakes killed large numbers of downstream migrants as they entered irrigation canals and were diverted into farmers' fields.

Figure 11

Stream banks destroyed by over-grazing in adjacent fields.

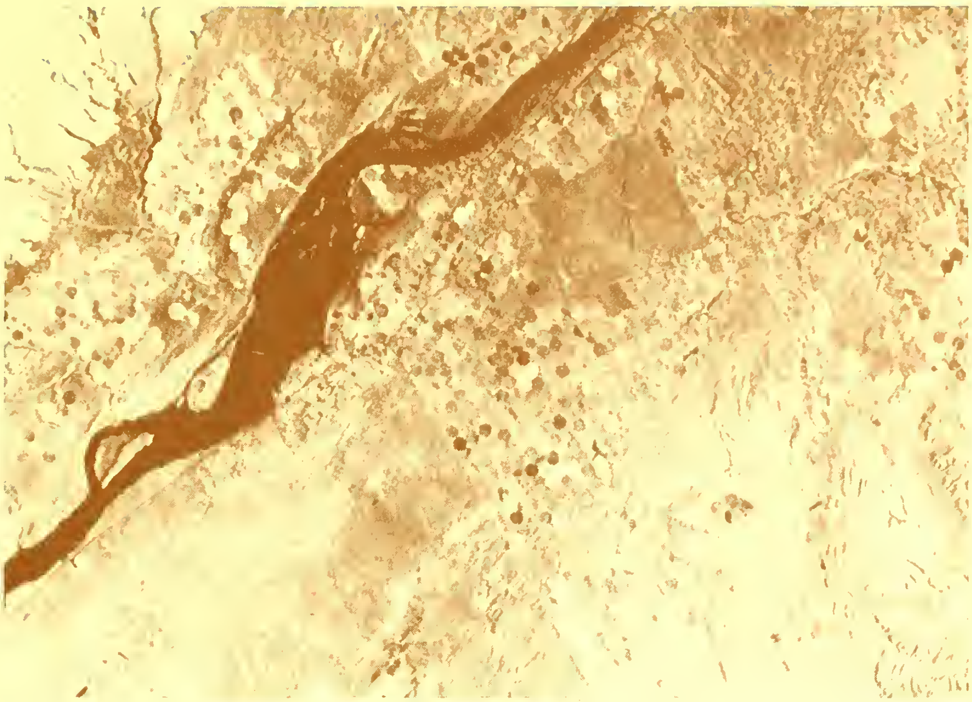


Figure 12

Circular pump irrigation systems in Columbia River drainage.

The extensive forested areas of much of the Basin have supported the development of a large and diversified wood-products industry (Figure 13). Logjams and wood wastes left behind by timber harvesting made large amounts of spawning and rearing habitat inaccessible (Figure 14). Early operations destroyed much of the natural forest cover resulting in rapid runoff, siltation, floods, low flows, high temperatures, debris, and destruction of food organisms.

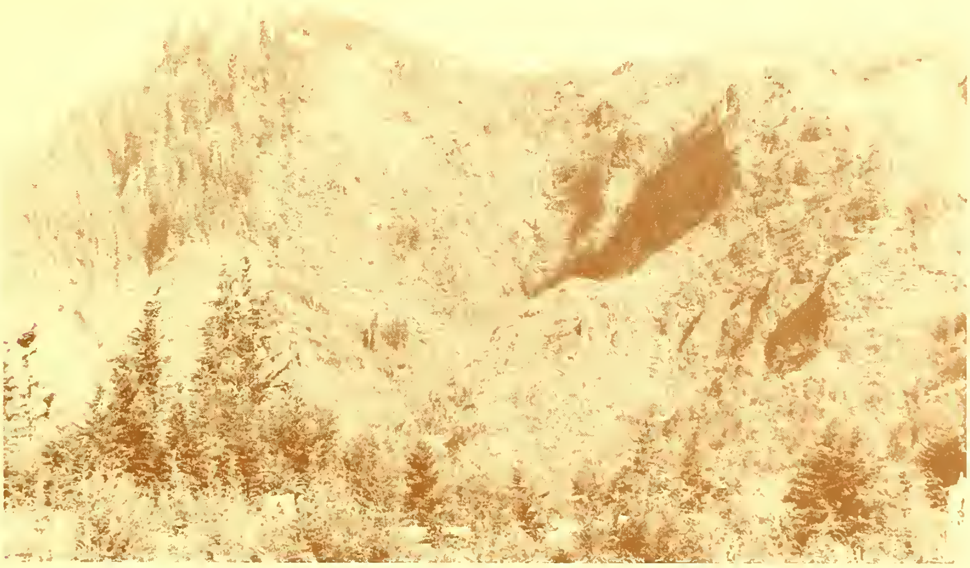


Figure 13

Douglas Fir clear-cut site in the Columbia River drainage.

Figure 14

A log jam blocking a small tributary of the Columbia River to passage of anadromous salmonids.

The mining industry has also had adverse effects on the spawning and rearing of fish in the Basin. The operations required and diverted large amounts of water from natural stream channels. Mine and gold dredge tailings as well as chemical effluents from the ore refining process have killed fish and damaged their spawning and rearing habitat as well as affecting other forms of aquatic life (Figure 15). Mining activities also have added to the siltation problem.

Urbanization and industrialization of the basin have been other causes of the degradation of available habitat (Figure 16). Industrial and domestic wastes have been discharged into the rivers and water withdrawals have reduced flows. Land fills associated with construction have encroached on river beds and flood plains.

Figure 15

A gold dredge operating in Idaho on the Yankee Fork of the Salmon River in 1941.

Figure 16

The Willamette River flowing through Portland, Oregon.

Starting in the 1930's, a series of large, multipurpose dams for hydroelectric power, flood control, and navigation were constructed on the main stem Columbia and Snake Rivers as well as on other Basin tributaries (Figures 17 and 18). Most of these, with the notable exceptions of Grand Coulee, Chief Joseph, and Hells Canyon Dams have fish passage facilities but they have reduced the normally free-flowing rivers to a series of reservoirs that disrupt both upstream and downstream migration. In addition, these dams kill or injure many of the young fish by forcing them to pass through the turbines. The reservoirs created by the dams have altered temperature patterns of the river making habitat unsuitable for salmon spawning and rearing. In the case of Grand Coulee and later Chief Joseph Dam, all access to upstream habitat extending up into Canada was blocked. Hells Canyon Dam blocked access to upstream habitat on the Snake River.

The portion of the Basin still accessible to salmon and steelhead after all the above mentioned modifications is also shown in Figure 10.

Figure 17

Hells Canyon Dam — a complete blockage to salmon in the Snake River in Idaho.

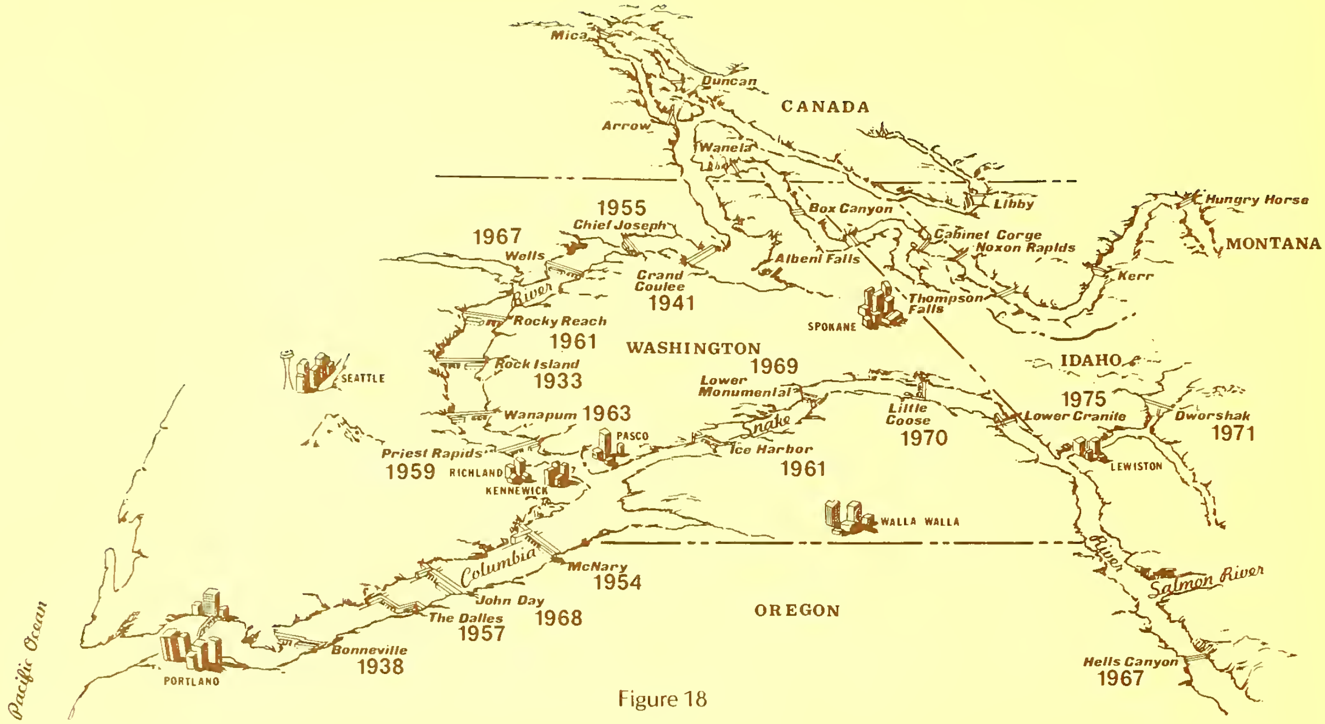


Figure 18

Locations at major dams in the Columbia River Basin.

COLUMBIA RIVER FISHERY DEVELOPMENT PROGRAM

The Congress in 1938 authorized the appropriation of $500,000 for surveys and improvements in the Columbia River watershed for the benefit of salmon and other anadromous fish (the "Mitchell Act", Public Law 75-502, May 11, 1938). This authorization recognized that in the years 1905-31 the Federal Government had received in excess of $500,000 from fishermen for leases of seining grounds on the Government-owned Sand Island and Peacock Spit in the mouth of the Columbia River. Further, it recognized that because of the destruction of favorable environmental conditions by deforestation, pollution, and water diversions, the salmon fishery of the Columbia river was in a serious and progressive decline. The purpose of this authorization was to reinvest the funds derived from the leases back into the resource.

Using the limited available funds, the U.S. Fish and Wildlife Service (USFWS) began a program of stream census and surveys 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, impassible waterfalls, log and debris jams, splash dams, and sources of pollution throughout the basin were cataloged.

On August 8, 1946, President Truman approved a congressional amendment (Public Law 79-676) to the Mitchell Act which removed the limitations on subsequent appropriations to be made by Congress for the development of the fisheries for anadromous species in the Columbia Basin (inside front cover). For the first time, the Secretary of Interior was authorized to utilize the facilities and services of the conservation agencies of the States of Idaho, Washington, and Oregon in developing the salmon resources of the region. The act, as amended, allowed a closer cooperation between the Federal Government and the States and permitted, for the first time, the transfer of monies to the States for specific work.

In 1947, the Columbia Basin Inter-Agency Committee, composed of State and Federal agencies concerned with the water-development projects of the basin, recognized that every effort should be put forth by the Federal Government to maintain the salmon fishery of the Columbia and its tributaries at the highest possible level of abundance in accord with development of other natural resources. After the fishery interests were denied a temporary moratorium on new dam construction, the Committee recommended the formation of the Lower Columbia River Fishery Development Program as the best means of maintaining the fishery. This recommendation was endorsed by the Federal River Basin Inter-Agency Committee, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation. The Corps of Engineers submitted a request to Congress for an initial appropriation in fiscal year 1949 to inaugurate the work. The 80th Congress recognized the situation and appropriated one million dollars for FY 1949. The resultant Lower Columbia River Fishery Development Program ("Program"), under the U.S. Department of Interior, brought into being a concerned plan for the development of salmon and steelhead in the basin watershed.

Until 1956, only the States of Oregon and Washington were actively engaged in the Program. The area included was that portion of the Columbia River and its tributaries below McNary Dam. In 1956, Congress instructed that the Program be activated above McNary Dam and Idaho became a participant in 1957. At this time the word "Lower" was dropped from the Program name.

Under the Program, emphasis has been placed on the following: expansion of artificial propagation; improvement of existing salmon rearing and spawning habitat in the tributary streams by removal of log jams, splash dams, and natural rock obstructions; construction and operation of permanent fishways either to facilitate passage at partial barriers or to provide access to areas not previously available to any anadromous fish; construction and operation of screens to protect downstream migrants from irrigation diversions; and an accelerated program of developing new and improved hatchery techniques.

In 1970, with a reorganization of Federal fisheries responsibilities, the oversight of the Program was transferred from the Department of Interior to the Department of Commerce. It is currently administered as part of the Environmental and Technical Services Division (ETSD) of the National Marine Fisheries Service (NMFS) in Portland, Oregon, in cooperation with the USFWS, Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), Washington Department of Game (WDG), and Idaho Department of Fish and Game (IDFG) (Figure 19).

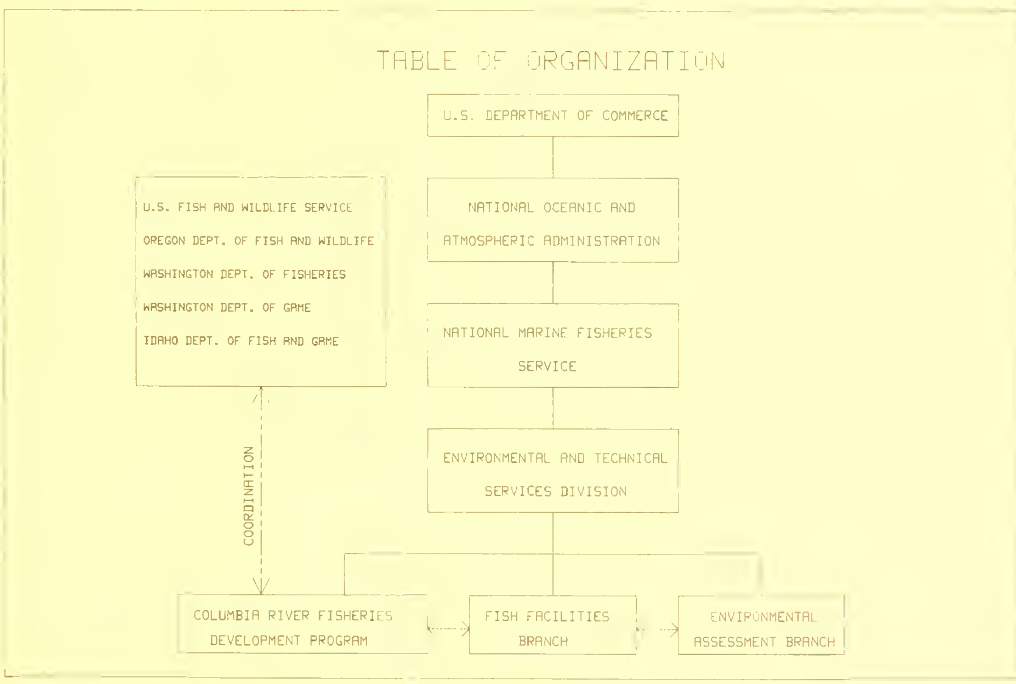


Figure 19

A portion of the organization of the Department of Commerce that includes the Columbia River Fisheries Development Program.

Fish Culture

The Columbia River Fisheries Development Program has used all practical means to attempt to increase the abundance of salmonids in the Basin. The most important of these, both in effort and money spent (Table I), has been artificial culture of fish. Section 1 of the Revised Mitchell Act authorized the construction of fish hatcheries in Oregon, Washington, and Idaho. The Act further authorized the facilities and services of the State agencies to be used for construction and operation of these hatcheries.

The original plan for artificial propagation under the Program called for construction, enlargement, or renovation of 31 hatcheries over a ten year period. In 1949, part of the initial $1.0 million appropriation was used to start construction of Klickitat Hatchery and expansion of Spring Creek National Fish Hatchery. Due to changes in plan, a total of 21 of these were actually built (Figure 20 and outside back cover), the last being Grays River started in 1960 (Table II and III). All, except for Toutle, are still actively producing salmon and steelhead for release into the Basin. Spring Creek and Bonneville have both undergone very extensive reconstruction funded by the Corps of Engineers as mitigation for fish losses in the area above John Day Dam. Figure 22 shows the layout for a typical Program hatchery.

On 18 May 1980, the eruption of Mt. St. Helens in Washington caused a massive mud flow to crash down the North Fork of the Toutle River destroying anything in its path. Mud, volcanic ash, logs, and other debris backed up into the Green River and covered Toutle Hatchery, killing 165 thousand yearling coho salmon, 4.5 million fingerling coho, and 5.7 million fall chinook migrants. Resulting losses to the fisheries were estimated at over $8.6 million. In addition to the loss of the fish, the hatchery itself (Figure 21) and the Toutle River system suffered extensive damage. It is not known when the hatchery will be put back into operation or when stream conditions will improve enough to support the reestablishment of salmon populations.

Table 1 -- FUNDS EXPENDED BY THE COLUMBIA RIVER FISHERIES DEVELOPMENT PROGRAM 1949-1980

YEAR	CONSTRUCTION	O&M AND STUDIES	POLLUTION ABATEMENT	TOTAL
1949	$1,000,000	0	0	$1,000,000
1950	1,192,500	7,500	0	1,200,000
1951	2,118,813	94,130	0	2,212,943
1952	1,525,451	149,983	0	1,675,434
1953	2,935,000	476,885	0	3,411,885
1954	1,750,000	634,814	0	2,384,814
1955	1,000,000	1,080,305	0	2,080,305
1956	900,000	972,527	0	1,872,527
1957	1,400,000	1,274,133	0	2,674,133
1958	1,600,000	1,215,091	0	2,815,091
1959	1,600,000	1,404,498	0	3,004,498
1960	1,200,000	1,625,157	0	2,825,157
1961	1,400,000	1,964,429	0	3,364,429
1962	1,431,000	1,934,060	0	3,365,060
1963	1,608,200	2,056,563	0	3,664.763
1964	965,700	2,049,416	0	3,015,116
1965	588,000	2,273,900	0	2,861,900
1966	968,700	2,382,800	0	3,351,500
1967	1,050,000	2,429,000	0	3,479,000
1968	0	2,599,200	0	2,599,200
1969	420,000	2,571,800	0	2,991,800
1970	1,048,000	2,886,000	0	3,934,000
1971	0	2,939,400	0	2,939,400
1972	0	3,020,400	0	3,020,400
1973	0	3,314 000	0	3,314,000
1974	63,400	3,301,300	394,500	3,759,200
1975	1,095,000	3,799,800	495,700	5,390,500
1976	781,800	4,439,100	500,000	5,720,900
T Q 1/	0	1,179,900	9,400	1,189,300
1977	445,100	5,007,300	500,000	5,952,400
1978	217,000	5,646,600	500,000	6,363,600
1979	33,500	6,111,400	2,797,000	8,941,900
1980	9,100	6,385,100	500,000	6,894,200
TOTALS	$30,346,264	$77,226,491	$5,696,600	$113,269,355

1/ T Q refers to a three month period from July to September necessitated by a change in Federal fiscal year reporting dates

TABLE II - COLUMBIA RIVER FISHERIES DEVELOPMENT PROGRAM FACILITIES - COLUMBIA BASIN--WASHINGTON

Facility	General Location	Congressional District	Operating Agency 1/	Species Reared 1960-79 2/	Anadromous Releases 1979	Year Anadromous Operation Began	Funding Agency 1/
Washington Hatcheries							
Abernathy	Longview	3rd	USFWS	fc(sc,co,sh)	Yes	1959	NMFS, USFWS
Beaver Creek	Cathlamet	3rd	WDG	sh, src	Yes	1958	NMFS
Carson	Carson	4th	USFWS	sc, co (fc,sh)	Yes	1932	NMFS, USFWS
Elokomin	Cathlamet	3rd	WDF	fc, co (ch)	Yes	1954	NMFS
Grays River	Grays River	3rd	WDF	fc, co, ch	Yes	1961	NMFS
Kalama Falls	Kalama	3rd	WDF	fc, sc, co	Yes	1959	NMFS
Klickitat	Glenwood	4th	WDF	fc, sc, co	Yes	1950	NMFS
Little White Salmon	Cook	4th	USFWS	fc, sc, co,(ch)	Yes	1898	NMFS, USFWS
Willard	Cook	4th	USFWS	co (fc, sc)	Yes	1951	NMFS, USFWS
Skamania	Washougal	4th	WDG	sh (fc)	Yes	1956	NMFS, WDG
Spring Creek	Underwood	4th	USFWS	fc (co)	Yes	1901	NMFS, Corps, USFWS
Toutle	Toutle	3rd	WDF	fc, sc,co	Yes	1952	NMFS
Washougal	Washougal	4th	WDF	fc, co (ce)	Yes	1958	NMFS
Rearing Ponds							
Alder Creek	Toutle	3rd	WDG	sh	Yes	1973	NMFS, WDG
Big White Salmon	Underwood	4th	USFWS	fc, co	Yes	1901	NMFS, USFWS
Gobar	Toutle	3rd	WDG	sh	Yes	1975	NMFS, WDG
Ringold Salmon	Ringold	5th	WDF	fc, sc, co	Yes	1962	NMFS
Ringold Trout	Ringold	5th	WDG	sh	Yes	1962	NMFS

1/ USFWS-U.S. Fish and Wildlife Service, NMFS-National Marine Fisheries Service, WDF-Washington Department of Fisheries, WDG-Washington Department of Game, Corps-U.S. Army Corps of Engineers

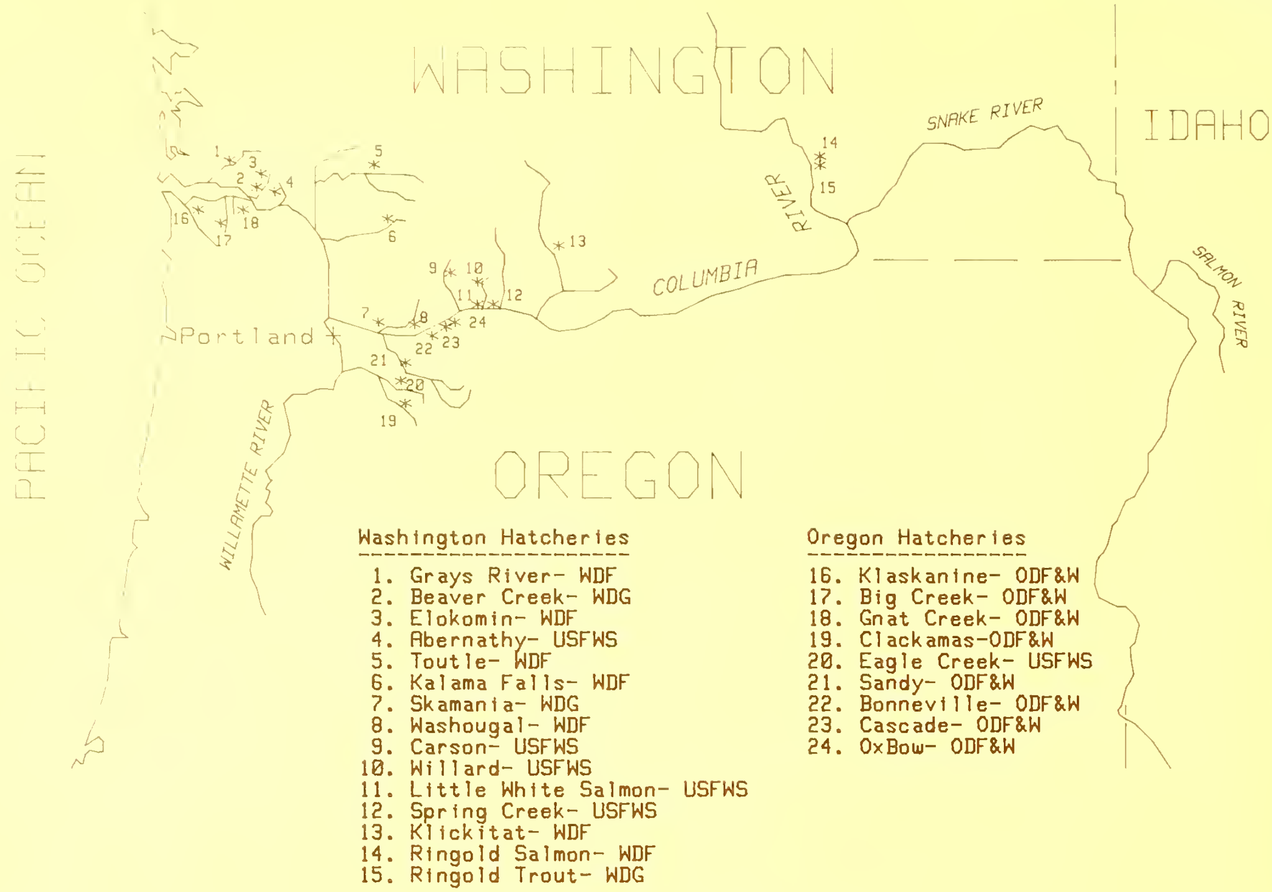
2/ fc-fall chinook salmon, sc-spring chinook salmon, co-coho salmon, ch-chum salmon, ce-cherry (masu) salmon, sh-steelhead trout, src-sea run cutthroat

TABLE III - COLUMBIA RIVER FISHERIES DEVELOPMENT PROGRAM - COLUMBIA BASIN--OREGON AND IDAHO

Facility	General Location	Congressional District	Operating Agency 1/	Species Reared 1960-79 2/	Anadromous Releases 1979	Year Anadromous Operation Began	Funding Agency 1/
Oregon Hatcheries							
Big Creek	Knappa	1st	ODFW	fc, co, sh (ch)	Yes	1938	NMFS, ODFW
Bonneville	Bonneville	3rd	ODFW	fc, co (sh)	Yes	1909	NMFS, Corps, ODFW
Cascade	Cascade Locks	3rd	ODFW	fc,co,(sc,ch)	Yes	1958	NMFS
Clackamas	Estacada	2nd	ODFW	sc	Yes	1979	ODFW, NMFS, PGE
Eagle Creek	Estacada	2nd	USFWS	sc,co,sh (fc)	Yes	1957	NMFS
Gnat Creek	Westport	1st	ODFW	sh (fc,sc,sh)	Yes	1960	NMFS
Klaskanine	Astoria	1st	ODFW	fc, co, sh	Yes	1911	NMFS, ODFW
OxBow	Cascade Locks	2nd	ODFW	fc, sc (co)	Yes	1938	NMFS, ODFW
Sandy	Sandy	2nd	ODFW	fc, co, (sc,sh)	Yes	1950	NMFS
Oregon Rearing Pond							
Wahkeena	Bonneville	3rd	ODFW	fc, co	Yes	1961	NMFS
Idaho Rearing Ponds							
Decker Flats	Stanley	2nd	IDFG	sc	No	1968	NMFS, USFWS, IDFG
Pahsimeroi	Challis	2nd	IDFG	smc, sh	Yes	1970	NMFS, IDFG

1/ ODFW-Oregon Department of Fish and Wildlife, USFWS-U.S. Fish and Wildlife Service, IDFG-Idaho Department of Fish and Game, Corps-U.S. Army Corps of Engineers, PGE-Portland General Electric

2/ fc-fall chinook salmon, sc-spring chinook salmon, smc-summer chinook salmon, co-coho salmon, ch-chum salmon, sh-steelhead trout



COLUMBIA RIVER FISHERIES DEVELOPMENT PROGRAM FUNDED HATCHERIES

Figure 20

Columbia River Fisheries Development Program hatcheries and rearing ponds in Oregon and Washington.

An addition to the original 21 hatcheries has been the Clackamas Hatchery built in the Willamette River drainage. Construction funds were provided by the Portland General Electric Company (PGE) and NMFS. Operation and Maintenance funding for this hatchery comes from the operating agency, ODFW, as well as from NMFS and PGE. PGE's involvement in the hatchery is compensation for losses of fish and spawning and rearing area caused by PGE hydroelectric projects. Construction was far enough along in 1979 to allow the first releases to be made in 1980.

Since the initiation of artificial salmonid propagation programs on the Pacific Coast, large rearing ponds have been used to supplement hatchery production (Figure 22). In these, salmon and steelhead fry are raised to release size in a pseudo-natural environment. These ponds may be separate facilities such as the two Ringold rearing ponds operated by WDF and WDG, or satellite ponds of Program hatcheries like Herman Creek Ponds (OxBow Hatchery) (Figure 23) and Big White Salmon Ponds (Spring Creek NFH). Of the seven rearing ponds built under the Program in Oregon and Washington, all made releases in 1979.

Figure 21

Toutle Hatchery in Washington, a Program hatchery severly damaged by floods resulting from the eruption on May 18, 1980, of Mt. St. Helens.

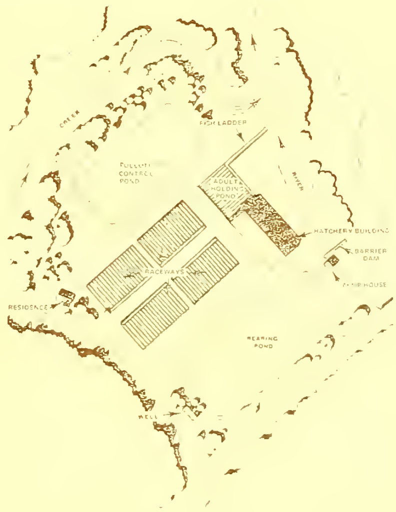


Figure 22

Layout of a typical anadromous fish hatchery.

Figure 23

Herman Creek Rearing Ponds near OxBow Hatchery, Cascade Locks, Oregon.

Program hatcheries and rearing ponds in Oregon and Washington are concentrated in the lower portion of the Columbia Basin with only the two Ringold facilities being above The Dalles Dam (Figure 20). Species of fish reared include spring chinook, fall chinook, coho, and chum salmon and both summer and winter run steelhead trout. The magnitude of migrant releases from these facilities for the years 1960-78 is shown in Tables IV and V. The totals from 1960 through 1976 amount to 74% by number and 57% by weight of the total Columbia Basin releases.

Table IV. - Migrant releases of chinook and coho salmon and steelhead trout - Pacific coast by Columbia River Development Program hatcheries (in thousands).

Release year	Fall chinook		Spring chinook		Summer chinook		Coho		Winter steelhead		Summer steelhead	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
1960	89,105.2	329.7	1,836.1	60.2	0.0	0.0	6,359.8	217.6	916.9	124.7	67.5	11.3
1961	46,640.1	305.5	827.3	30.0	0.0	0.0	14,182.8	507.4	605.1	65.2	303.1	43.2
1962	55,783.6	283.3	1,666.8	57.7	0.0	0.0	12,863.8	571.4	1,408.9	110.4	227.2	28.6
1963	58,845.0	325.8	2,391.4	85.0	0.0	0.0	19,589.1	756.8	1,027.7	83.9	366.7	53.6
1964	65,501.5	407.5	7,643.3	220.8	0.0	0.0	16,529.8	775.3	1,106.7	145.6	562.3	87.1
1965	56,191.0	370.5	3,042.4	102.0	0.0	0.0	17,919.4	853.9	1,352.9	174.8	595.3	73.5
1966	54,944.7	488.9	3,812.4	111.5	0.0	0.0	21,170.4	1,074.7	1,733.1	206.5	745.7	101.8
1967	55,118.5	497.8	5,484.8	177.5	0.0	0.0	20,208.9	1,000.3	1,411.1	161.4	855.7	126.3
1968	55,514.9	595.5	3,788.8	166.8	0.0	0.0	15,715.2	866.9	1,425.9	149.3	1,527.7	175.7
1969	57,927.3	574.1	3,496.8	164.4	0.0	0.0	18,620.3	1,103.7	1,494.9	171.6	822.7	96.6
1970	62,175.2	689.6	2,578.7	148.3	393.8	9.8	17,450.8	1,002.7	1,363.6	196.9	1,525.6	258.1
1971	63,277.3	483.3	3,784.3	238.9	400.3	13.9	21,281.2	1,207.2	1,287.4	151.7	1,130.3	156.1
1972	67,053.7	721.8	3,619.8	253.1	231.7	13.3	23,887.6	1,520.5	1,315.3	172.8	1,233.0	198.7
1973	70,384.2	831.4	4,822.9	401.3	217.1	4.3	20,879.2	1,196.4	1,385.9	223.5	1,151.4	189.4
1974	65,476.3	887.5	4,423.5	269.2	330.0	8.1	20,163.6	1,177.4	1,137.9	162.7	1,168.5	176.7
1975	70,455.2	918.9	5,229.8	326.7	114.6	2.9	21,104.2	1,382.9	937.3	144.7	1,025.3	153.9
1976	80,866.8	1,108.1	5,933.6	479.8	406.6	15.8	22,217.8	1,325.9	1,216.7	184.9	950.4	150.5
1977	94,821.9	1,028.8	5,073.9	372.5	234.4	5.7	26,331.5	1,555.9	1,201.6	203.7	1,015.7	150.8
1978	92,020.9	1,203.9	6,233.5	426.2	218.2	5.3	21,887.0	1,688.5	2,082.3	325.1	1,278.2	185.0
Total	1,262,103.3	12,051.9	75,690.1	4,091.9	2,546.7	79.1	358,362.4	19,785.4	24,411.2	3,159.4	16,552.3	2,416.9

Table V. - Migrant releases of chum and cherry salmon and sea-run cutthroat trout - Pacific coast-Columbia River Development Program hatcheries (in thousands).

Release year	Chum		Cherry		Sea-run cutthroat	
	Number	Pounds	Number	Pounds	Number	Pounds
1960	0.0	0.0	0.0	0.0	0.0	0.0
1961	63.6	0.4	0.0	0.0	6.9	0.8
1962	717.5	1.8	0.0	0.0	0.0	0.0
1963	1,770.8	2.5	0.0	0.0	6.4	0.8
1964	150.8	0.2	0.0	0.0	82.5	10.0
1965	205.3	0.3	0.0	0.0	85.9	13.6
1966	738.1	2.4	0.0	0.0	41.5	6.7
1967	524.1	3.0	0.0	0.0	119.4	23.9
1968	173.6	0.6	0.0	0.0	121.2	25.8
1969	129.9	0.3	0.0	0.0	35.3	7.5
1970	62.5	0.1	0.0	0.0	50.0	10.6
1971	0.0	0.0	0.0	0.0	40.1	8.0
1972	638.5	1.2	0.0	0.0	22.8	5.7
1973	563.6	1.4	1.8	0.1	27.0	9.0
1974	627.3	3.4	0.0	0.0	4.3	1.1
1975	0.0	0.0	0.0	0.0	0.0	0.0
1976	1,126.8	4.7	0.0	0.0	0.0	0.0
1977	961.3	1.9	0.0	0.0	0.0	0.0
1978	41.0	.1	0.0	0.0	0.0	0.0
Total	8,494.7	24.3	1.8	0.1	643.3	123.5

Hatchery involvement in Idaho under the Program has been limited. Efforts to improve Idaho's salmon runs have been concentrated on screening and stream improvement. The Pahsimeroi rearing facility was built partly with funds provided to Idaho Fish and Game (IDFG) for fishery related studies.

During the past decade, an increased awareness in the environment has caused all potential pollution sources to come under close scrutiny. Attention has been directed towards fish hatcheries as sources of water pollution. With this in mind, the NMFS developed a plan to construct and operate abatement facilities at all Program hatcheries which would reduce pollution levels in hatchery discharges to the legal limitations established by the U.S. Environmental Protection Agency. A schedule for building abatement facilities was developed by incorporating four planning steps:

Phase 1. Evaluate levels of pollution abatement for hatchery effluent and size, locate, private, provide cost estimates, and furnish architectural design for the facility;

Phase 2. Provide construction drawings for each facility;

Phase 3. Construct facility (Figure 24);

Phase 4. Operate facility.

The schedule for completion of the construction and placing the facilities in operation is shown in Figure 25. All pollution abatement facilities will be in operation by October 1, 1981.

Figure 24

Newly constructed pollution abatement facilities constructed by Little White Salmon NFH, Cook, Washington.

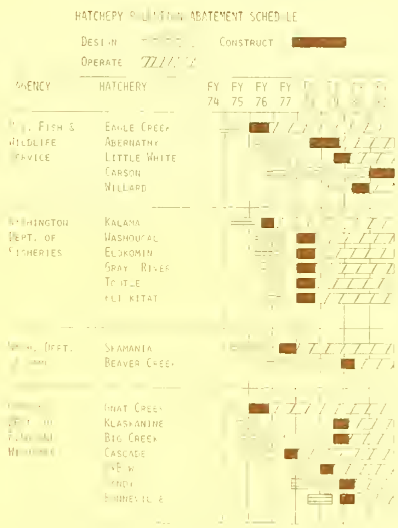


Figure 25

Construction schedule for pollution abatement facilities at "Program" hatcheries.

Stream Clearance and Improvement

Another means that has been used by the Columbia River Fisheries Development Program to increase the abundance of salmonids in the Basin has been the construction of fishways and the removal or modification of both natural and man-made barriers affecting fish migration. These activities, authorized and directed by Section 2 of the amended Mitchell Act, have opened nearly two thousand miles of prime rearing and spawning habitat formerly inaccessible to returning adult fish.

Although early efforts were directed to the area downstream of McNary Dam, in 1957 the Upper Columbia and Snake River drainages were included. A comprehensive survey was conducted which located, catalogued, and assessed the impact of any barriers. Each was evaluated on existing and potential spawning and rearing habitats. Priorities were assigned based on the surveys, engineering estimates, and projected results. With the exception of some projects in Idaho, construction was essentially completed by 1970.

Two different types of obstacles were involved; those which could be removed or modified, and those that required the construction of a fishway. In the case of many of the natural barriers such as small waterfalls and cascades, it was possible to blast or otherwise modify the obstruction so that fish could pass upstream without difficulty. Blasting and use of bulldozers also proved effective in removing man-made obstacles such as log jams, coffer dams and crib dams (Figure 26).

Figure 26

A crib dam on South Yamhill River, Oregon, before removal.

Where barriers were larger or more permanent, it was often necessary to construct fishways over them. The fishways (or ladders) consist of a series of connected artificial pools through which a fish is able to pass over an obstruction (Figure 27). Those constructed under the program varied in size from the small ladders built over 8 to 10 foot high falls on Wiley Creek in Oregon (Figure 28) and Scantygrease Creek in Washington to the massive ladders on the Wind and Klickitat Rivers in Washington, and over Willamette Falls in Oregon.

The benefits derived from the stream clearance and improvement work are readily visible. The 45-foot high Willamette Falls has always been an obstruction to migrating salmon. A series of ladders have been built over the falls since 1885 but these proved barely adequate even with numerous corrections that were made. In the 1960's passage problems were studied and a new ladder was designed.

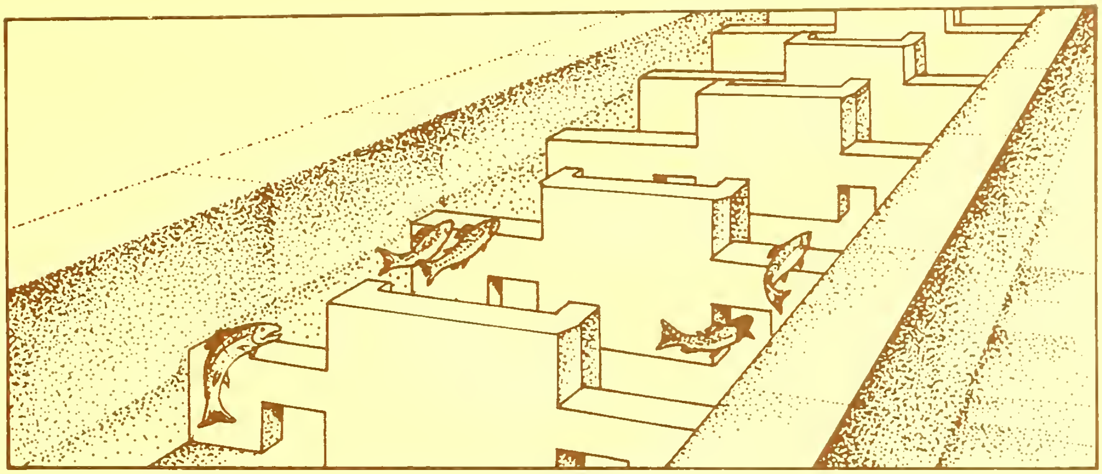


Figure 27

Drawing of fish ladder in operation.

Figure 28

A small fish ladder over a barrier on Wiley Creek in Oregon.

The fishway began operating with one entrance in February 1968. Three entrances were complete in October 1971 when the fishway was formally dedicated. A fourth entrance was finished in September 1975. The fishway has three legs which join below the counting station located at the top of the ladder near the single exit into the forebay (Figure 29). The cul-de-sac leg has its entrance farthest downstream, in a large bay where up to 29 industrial hydroturbines discharge, and has been designated entrance 1. Entrance 2 is located on the west side of the horseshoe area of the falls. Entrance 3 is located near the apex of the falls. And entrance 4 is located about 20′ above entrance 3 and on the same leg (Figure 30).

Since the destruction of the old fish ladder on June 1, 1970, all fish moving upstream have passed a viewing window in the counting station of this fishway except for the few fish that may have passed through the boat locks. A second viewing window is located near the top of the cul-de-sac leg.

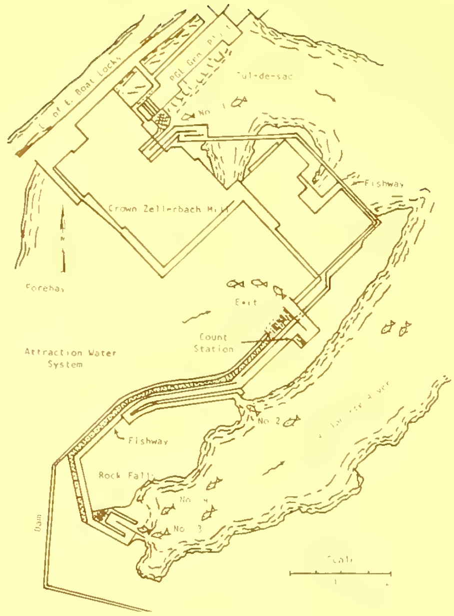


Figure 29

The Willamette Falls Fishway.

Figure 30

Aerial view of the Willamette Falls Fishway.

Thousands of fish pass over the falls every year destined for hatcheries and spawning grounds in the Upper Willamette River and its tributaries (Table VI). Using Columbia River hatcheries and Willamette River rearing ponds, an extensive program was conducted that successfully introduced fall chinook and steelhead above the falls. Figure 31 shows a section of the Santiam River from the air. Salmon redds or nests show up as light areas in the river bottom. It is estimated that over 1,000 fall chinook spawned in this area.

Several of the hatcheries constructed under the Program are on sites on streams above formerly impassible barriers. Carson National Fish Hatchery in Washington has operated successfully as a spring chinook hatchery since the construction of Shipperds Falls fish ladder (Figure 32). To reach Klickitat Hatchery, also in Washington, returning fish must negotiate five waterfalls, of which three were modified to permit passage and the others laddered. In all, 87 different fishways were built within the Basin under the Program.

TABLE VI - ADULT SALMONIDS COUNTED OVER WILLAMETTE FALLS

Year	Fall Chinook	Spring Chinook	Coho	Winter Steelhead	Summer Steelhead
1968	4,040	29,070	7,080	6,400	[illegible]
1969	6,820	31,110	12,400	8,400	[illegible]
1970	7,460	33,410	[illegible]	4,700	[illegible]
1971	4,800	42,900	17,410	[illegible]	[illegible]
1972	11,614	25,300	9,983	[illegible]	[illegible]
1973	21,861	40,500	5,174	17,300	1,790
1974	33,924	44,100	1,501	14,800	4,900
1975	32,877	17,800	5,922	6,100	2,900
1976	29,269	21,000	2,333	9,400	3,900
1977	25,742	38,500	1,007	13,600	[illegible]
1978	17,437	45,700	1,711	16,800	15,200
1979	9,905	25,500	1,787	8,700	7,600

Figure 31

Fall chinook redds or nests in a section of the Santiam River in Oregon.

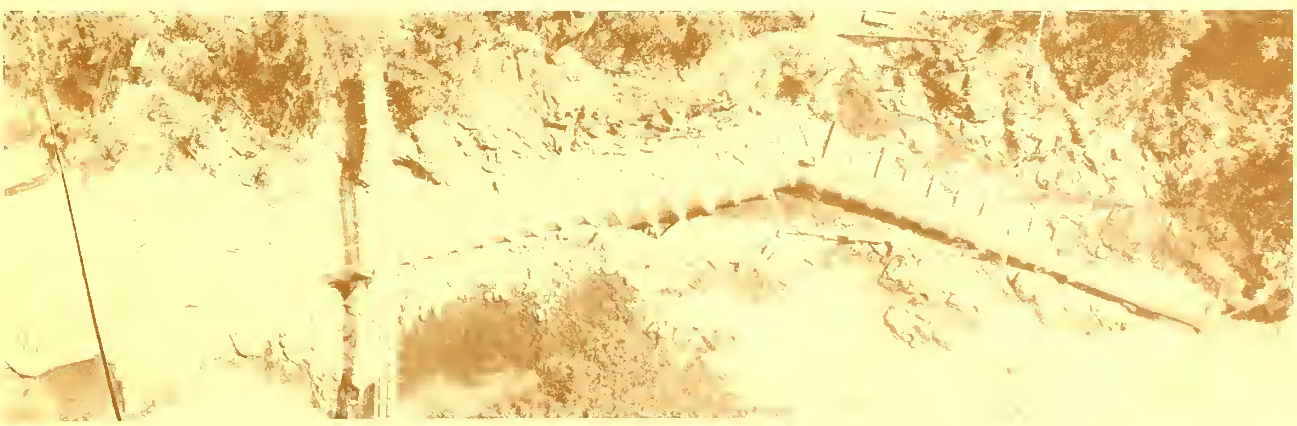


Figure 32

Aerial view of the Shipperd Falls fish ladder on the Wind River in Washington.

Diversion Screening

The greatly expanded program of irrigating dry and barren lands in the Columbia River Basin has created problems for young salmon and steelhead. One method of getting water used for this irrigation is the use of diversion ditches. Water is diverted out of the mainstream river and into ditches through which it flows to the points of use. Unfortunately, the periods of high water use coincide with the annual seaward migration of young salmon. If there are no barriers to block them, large numbers stray into the ditches and end up dying on the farmer's fields. Lack of proper screening has resulted in losses of tremendous numbers of these migrants (Figure 33).

Figure 33

An unscreened diversion ditch in the Salmon River Drainage, Idaho.

Since the Program began, over 600 irrigation diversions have been screened, more than 400 of which were built on the John Day watershed. Some have been phased out because of changes in methods of securing the irrigation water. Many of the current irrigation projects pump water from streams and spray it onto fields. All that is required in this type operation is a screen on the pump intake.

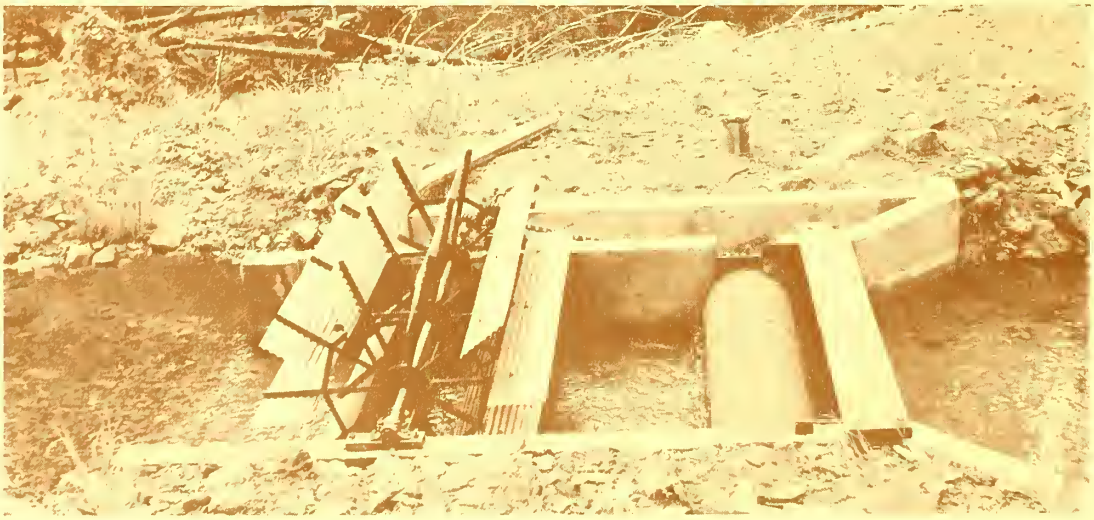


Figure 34

A water powered fish screen constructed on an irrigation diversion under the "Program."

There are many types of diversion screens in use. They may be stationary or rotating drum type (Figure 34) but all serve the same purpose, to allow the passage of water into the diversion while routing migrant fish back into the river or stream. Figure 35 shows the schematic drawing of a water powered drum screen. The reason for the rotating drum, which in this case is turned by the paddle wheel but may also be powered by an electric motor, is to prevent a buildup of debris on the screen. Since the drum rotates, any debris that collects will be washed off in the current when an 180° rotation is completed.

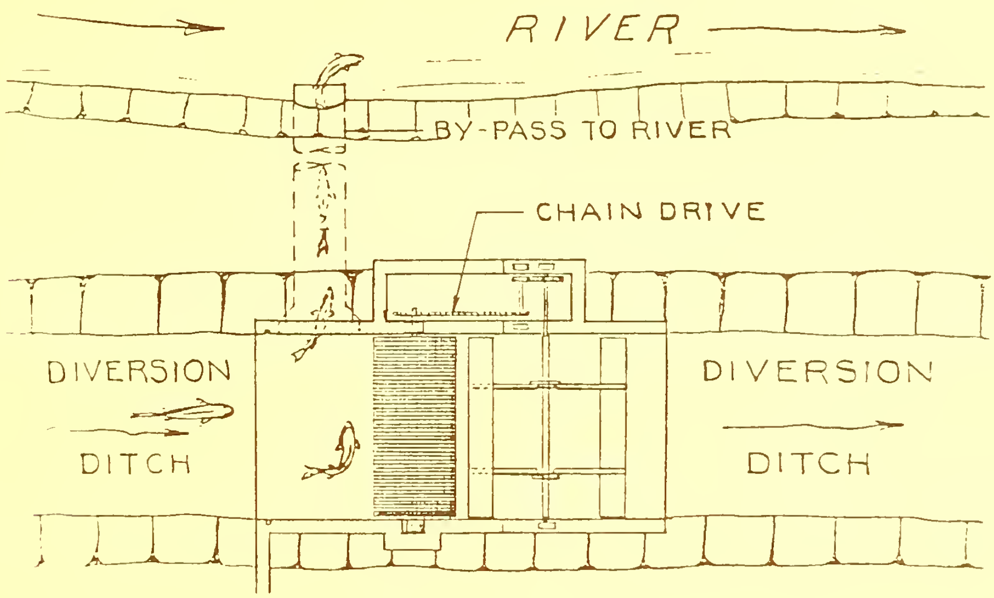


Figure 35

A schematic of a typical water powered fish screen showing its principles of operation.

Hatchery Evaluations

In the early 1960's the U.S. Bureau of the Budget required that evaluation studies be conducted on existing hatcheries before any new construction could take place. The first of these studies was conducted with fall chinook salmon. A percentage of the production at 13 Columbia Basin hatcheries for brood years 1962 to 1965 were marked with fin clips. Marked releases for the four years totalled almost 31 million fish. In 1963 through 1969, a program of coast-wide mark sampling checked for these marks in all ocean and river sport and commercial fisheries. Additionally, hatchery returns were sampled for marks. An evaluation of the recoveries and returns showed on the average that for every dollar spent on rearing the fish a return of $4.20 was realized (Figure 36). The releases during the four year study were estimated to have resulted in the catch of almost 1.5 million fall chinook (Figure 37).

A similar study on coho salmon released from 20 hatcheries in the basin in 1967 and 1968 resulted in an estimated catch of 2.1 million fish (Figure 38). The benefit/cost ratio for this group of fish was 7.0/1 (Figure 39).

Because of the amount of time that has passed since the first fall chinook study was organized and because there have been substantial changes in hatchery techniques, fish food, the fisheries, and fish marking, Program personnel are conducting and coordinating a new fall chinook evaluation study. The study, being partially funded by the Bonneville Power Administration, began with fish released in 1979 and will include those released through 1981 (Figure 40). The fish will be marked with an adipose fin coded wire nose tag mark (see page 30) and again all fisheries and returns will be sampled coastwide (Figure 41) for these marks. Preliminary evaluations will begin as soon as data are available, and final evaluations will be conducted after the last fish are caught in 1987.

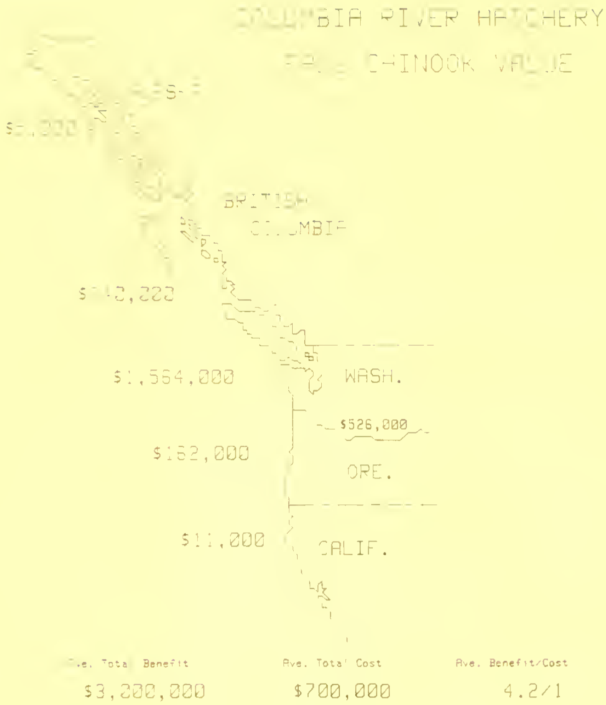


Figure 36

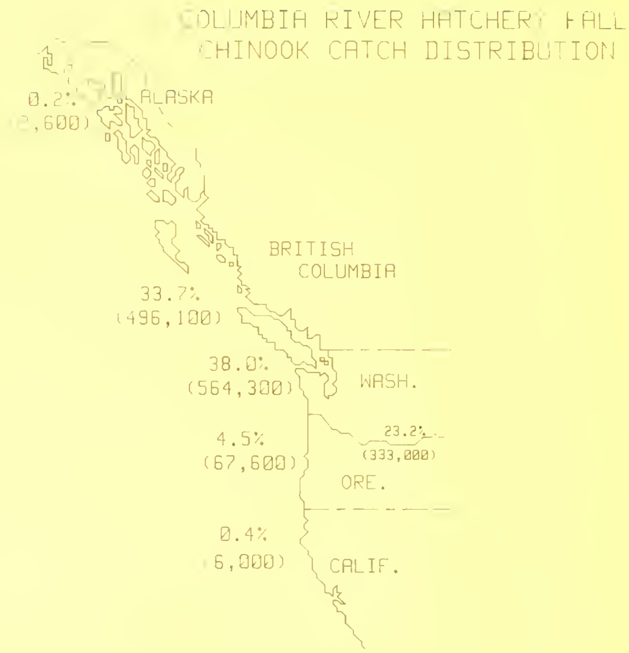


Figure 37

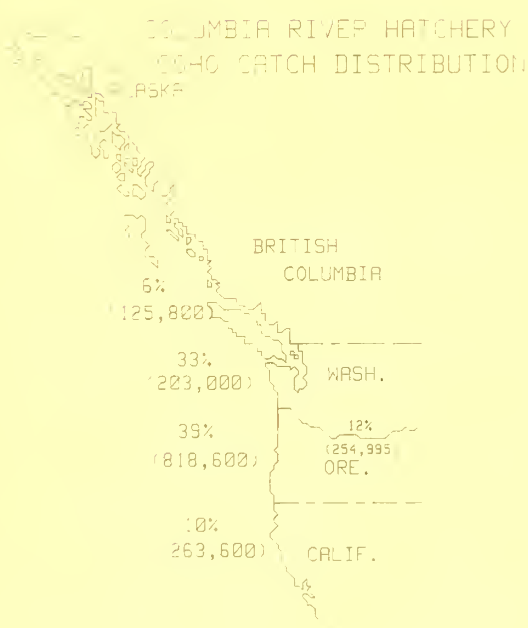


Figure 38

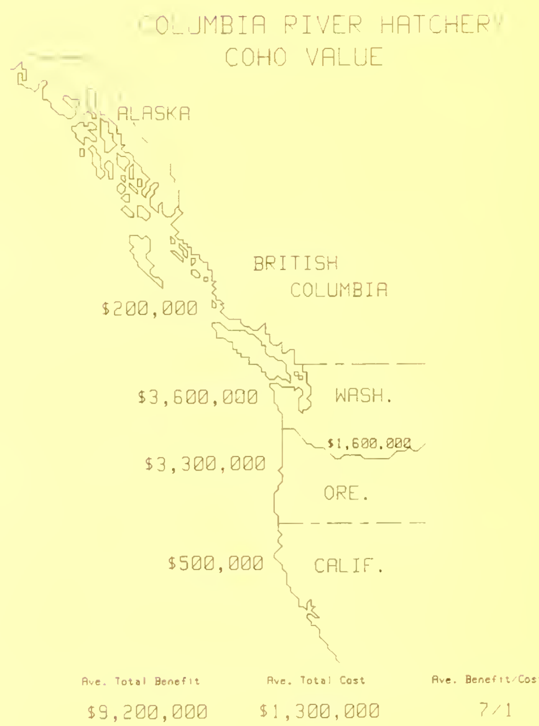


Figure 39

Figure 40

NMFS Mobile Fish Marking Facility built as part of the Bonneville Power Adminstration, Department of Energy funded "Fall Chinook Hatchery Evaluation Study."

Figure 41

The area and ports where sports and commercial salmon catches are sampled for marked fish.

Hatchery Improvement Studies

In addition to placing the National Marine Fisheries Service in a lead role in protecting the anadromous salmonid resource of the Columbia River Basin, activities conducted under the Columbia River Fisheries Development Program have resulted in major advancements in the field of fish culture. Considerable time is spent by Program personnel on studies aimed at improving the quality of fish produced, increasing their contribution and chances for survival, and improving general hatchery techniques. The studies are either coordinated by NMFS personnel or by the State fish agency and USFWS personnel at Program-funded facilities. Work is normally done by the fishery agencies or under contract to educational institutions or private consultants.

One of the prime concerns in any fish cultural operation is the quality of food fed to young fish. Prior to Program-sponsored research, the diets in use were combinations of ground animal and fish flesh mixed with ingredients such as milk and milk by-products and cereal grains. These "wet" diets had to be prepared daily at each hatchery and were labor consuming. The diets were of questionable nutritional value and provided a source of disease from the raw fish used. Wet diets were difficult to feed and resulted in problems of cleanliness in the rearing areas. With funds and support by the Program, two new diets were developed. The Oregon Moist Pellet formula (OMP), developed jointly by the Oregon Fish Commission (now the Oregon Department of Fish and Wildlife) and Oregon State University, and Abernathy Dry Granule formula, developed at Abernathy Fish Cultural Development Center (USFWS), are in wide use in both Program and non-Program hatcheries. Both of these open formula diets are commercially prepared and shipped to hatcheries. They are easy to handle and readily accepted by the fish. Growth using these diets has been excellent, and the formulas are constantly being reviewed from possible improvements.

The search for a method of mass-marking large numbers of salmon and steelhead as required in the conduct of evaluation studies has resulted in the development of two new marking techniques. The first, a terramycin mark, was originally discovered as a by-product of studying the use of tetracyclene on the bones of humans. Supported by the Progam, presonnel from USFWS used this research to develop a technique to mark fish and ODFW began to use the technique on a production basis. The mark results from the ingestion of tetracyclene mixed with the fish's food. The drug is deposited in the fish's bones and is detectible as a fluorescent yellow ring when the bones are viewed in a special wave length fluorescent light under a microscope. Since there is normally no way of determining externally whether the fish has a terramycin mark, this method is limited in its use to studies that are based on returns to hatcheries. Here the fish can be easily sampled for marks.

To facilitate identification of fish in the fishery as well as on return to the hatcheries, a second technique was developed. This combines the use of a metal coded wire tag which is injected into the snout of the small fish (Figure 42) and the removal of the adipose fin from the back of the fish. The removal of the adipose fin serves as an indicator which, by agreement of all fishery agencies on the Pacific coast, signals the presence of an internal tag. The tag itself is only .042 inch long and contains information on its surface in the form of binary notches or a combination of colored bands. Although the work done by WDF with Program funds only produced a prototype tag, this research served as a foundation for the development of the tags that are currently in use world-wide. Well in excess of 100 million fish have been marked using this technique.

Studies are being supported by Program personnel and funds to investigate and develop a physiological indicator or set of indicators that can be used to determine a young salmon's or steelhead trout's readiness to migrate into salt water. If a hatchery is to rear and release fish with the least impact on the native or wild populations, it is important that the hatchery fish spend as little time as possible in the rearing areas of the rivers and estuaries and move rapidly into the ocean to begin the saltwater phase of their life cycle. Fish that are released either too soon or too late will either spend the time in the rearing areas competing for food and facing predation until they are ready to migrate or they will residualize and never migrate. Currently, the basis for determining the release timing for hatchery fish is often less than scientific. The decision may be based on necessity — lack of food or too much food can drastically alter a projected release date. Overcrowding of a hatchery can force the release of fish before the projected date. Manager's intuition or other arbitrary determination methods are also often used to make the release determination. The possibility of using one or more physiological parameters measureable at hatcheries to determine the migration readiness is being studied by personnel of the NMFS Northwest and Alaska Fisheries Center in Seattle in cooperation with the various agencies operating Program-funded hatcheries.

Figure 42

A cross section of the nose of a small chinook salmon showing a coded wire tag in place (enlarged approximately 7 times).

Another cooperative study being funded by the Program involves the serial release of coho from hatcheries operated by the ODFW and WDF to determine optimum release times. Three separate releases are being made at one-month intervals starting in May at each of four hatcheries, two in each state. To make sure only one variable, time, is being evaluated, the fish are being reared so that size is held constant for all releases. Each group is being marked with an adipose-coded wire tag mark and the evaluation of the different release dates will be based on catch and survival. This study is being meshed with the Program supported physiological work.

Other possible indicators of migration readiness are being examined as they are proposed and will be studied if promising.

An example of a study conducted by NMFS personnel is one just completed to determine the feasibility of creating or enhancing the fishery in a specific area by releasing hatchery salmon into that area. Homing ability and contribution to the fisheries of coho salmon released at Willard Hatchery and at a remote site on Youngs Bay in the Columbia River estuary were examined and compared (Figure 43). The results show that the fish homed to their release site and the fish that were transplanted into the estuary contributed four times as well as those released at Willard, 166 miles upstream from the Pacific Ocean. The implications of these results on salmon management are great. They show that it is possible to transplant coho and have these fish contribute to fisheries that may be historically short of fish.

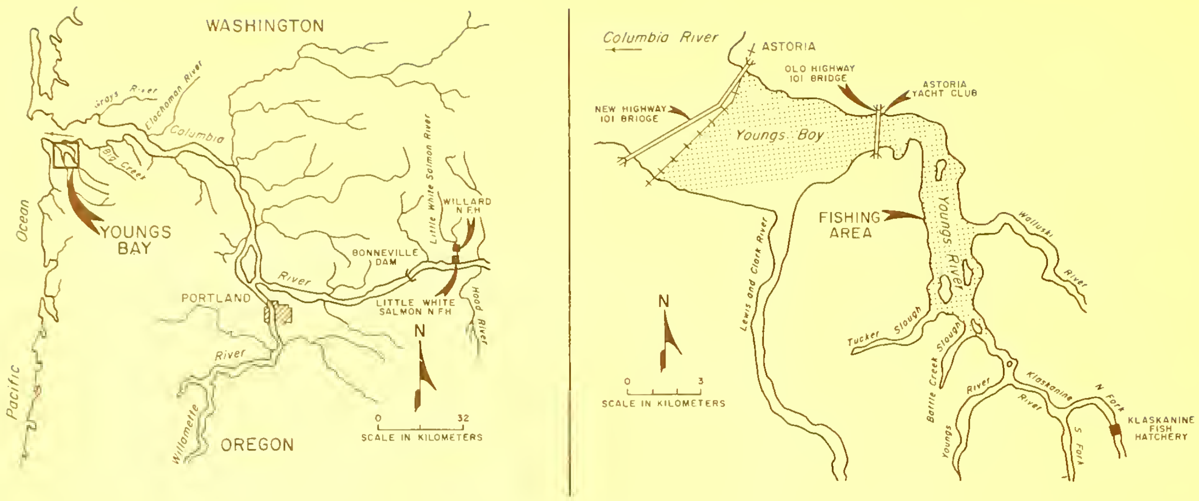


Figure 43

Maps of the Columbia River coho homing study area showing location of Willard and Little White Salmon NFH and detailed features of the Youngs Bay region.

A final example of the type of hatchery improvement study being funded by the Program is a study being conducted by WDG to assess the impact of hatchery steelhead trout on the native populations of steelhead and cutthroat trout. By using the procedure of genetically marking all hatchery steelhead released into the Kalama River, the study, when completed, will determine if the hatchery fish adversely affect the native fish, the life's history of the hatchery as well as the native fish, and the relative status of the Kalama River steelhead populations. A sidelight to this study is important because of the location of the study area. The primary study site is Gobar Rearing Pond on Gobar Creek, a tributary of the Kalama River, which is in close proximity to Mt. St. Helens and the area affected by the eruption (Figure 44). Data gathered to date in connection with the steelhead study may serve as important baseline data when the effects of the eruption are evaluated.

Figure 44

Mt. St. Helens and surrounding area after the devastating eruption May 18, 1980. Photo courtesy of Henry Whitacre.

FISH FACILITIES

As indicated in Figure 19, Columbia River Fisheries Development Program Office personnel often work closely with those of the Fish Facilities Branch (FFB) concerning Program activities. The FFB provides engineering and biological expertise for the design and operation of fish passage and fish protective facilities, as well as for facilities that may be required to direct, trap, or collect fish at dams, fish hatcheries, or other installations.

Services provided to the Program Office are divided into three areas—design, review, and inspection. Most of the design work involves conceptualization during the planning phase of a project. FFB engineers and biologists work with the various fisheries related agencies in developing preliminary plans which are functional and feasible. In the case of Willamette Falls fish ladder, FFB engineers contributed significantly to the original design. In addition to actual design work, the FFB also advises concerned agencies on types of facilities to use in constructing Program projects.

Project and plan reviews are the services most frequently provided by the FFB for the Program Office. They examine project proposals and plans that are submitted, commenting on the designs, and requesting modifications when necessary (Figure 45). FFB personnel have been closely involved with plans developed under contract with a private consultant firm for the pollution abatement facilities that have been built or are being built at Program hatcheries (Figure 24). They examine drawings for fish ladders and other construction planned by the fishery agencies for financing with Program funds.

Figure 45

Adult salmon trapping facilities of Applegate Dam on the Rogue River in Oregon. The project was designed with the assistance of the Fish Facilities Branch.

Once construction begins on a Program project, the engineers of FFB visit the project site to inspect the construction and make recommendations when necessary to the agency actually having the construction done. Upon completion, they often take part in the final inspection to assure quality of work before the project is accepted.

In addition to their Program related work, the FFB; 1. reviews and passes judgment on the adequacy of fish facility designs for federal, federally-funded, Federal Energy Regulation Commission, Nuclear Regulatory Commission license, and Anadromous Fish Act (Public Law 89-304) projects; 2. inspect the operation of fish facilities at projects in the Columbia Basin; 3. participate in interagency committees dealing with the design and review of fish facilities, and other problems associated with fish protection in the Columbia Basin and other parts of the country; and 4. respond to requests from other regions and agencies for assistance in designing fish protective facilities.

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Selected Bibliography of Program Publications

LARSON, D.M., R.J. WAHLE, R.Z. SMITH and W.G. BROWN
1978. Estimated economic benefits to visitors of selected Columbia River fish hatcheries. Spec. Rpt. 515. Agr. Exp. St., Ore. St. Univ., 44 p.

VREELAND, R.R., R.J. WAHLE, AND A.H. ARP
1975. Homing behavior and contribution to Columbia River fisheries of marked coho salmon released at two locations. Fish. Bull., U.S., 73:717-725.

WAHLE, R.J., R.O. KOSKI, and R.Z. SMITH
1979. Contribution of 1960-63 brood hatchery-reared sockeye salmon, *Oncorhynchus nerka,* to the Columbia River commercial fishery. Fish. Bull., U.S. 77:229-242.

WAHLE, R.J. and R.R. VREELAND
1978. Bioeconomic contribution of Columbia River hatchery fall chinook salmon, 1961 through 1964 broods, to the Pacific Coast salmon fisheries. Fish. Bull., U.S. 76:179-208.

WAHLE, R.J., R.R. VREELAND, and R.H. LANDER.
1974. Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific salmon fisheries. Fish. Bull., U.S. 72:139-169.

WAHLE, R.J. and R.Z. SMITH
1979. A historical and descriptive account of Pacific Coast anadromous salmonid rearing facilities and a summary of their releases by region 1960-76. U.S. Dept. Commer., Natl. Mar. Fish. Serv., Spec. Sci. Rep. Fish. 40 p.

WAHLE, R.J. and W.D. PARENTE. P.J. JURICH, and R.R. VREELAND.
1975. Releases of anadromous salmon and trout from Pacific Coast rearing facilities, 1960 to 1973. U.S. Dep. Commer., Natl. Mar. Fish. Serv., Data Rep. 101, 443 p. on 7 microfiche.

WORLUND, D.D., R.J. WAHLE, and P.D. ZIMMER.
1969. Contribution of Columbia River hatcheries to harvest of fall chinook salmon *(Oncorhynchus tschawytscha).* U.S. Fish. Wildl. Serv., Fish. Bull. 67:361-391.

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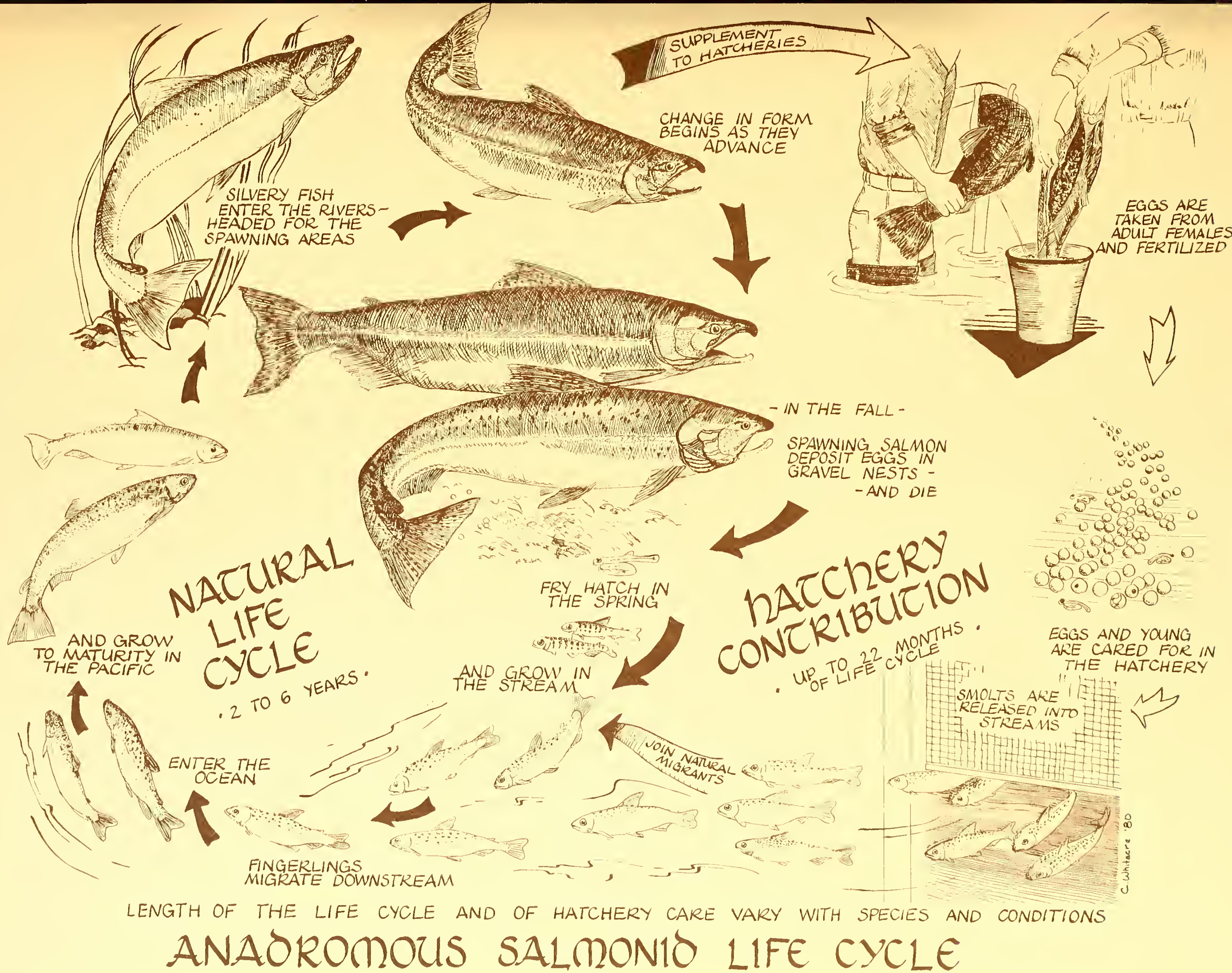
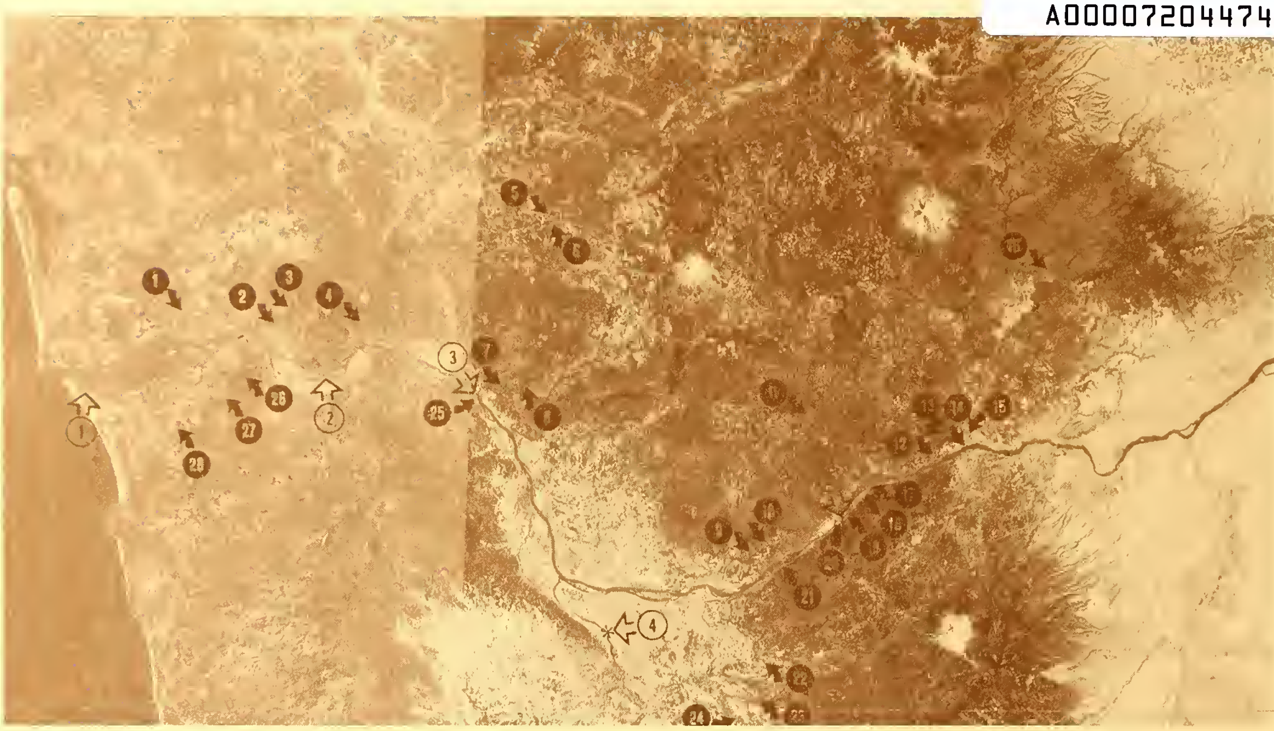


Figure 46

A general life cycle for both natural and hatchery adadromous salmonids.



NMFS Activities in the Columbia River Basin
Solid Circles — CRFDP Rearing Facilities (Operating Agency)

1. Grays River Hatchery (WDF)
2. Beaver Creek Hatchery (WDG)
3. Elokomin Hatchery (WDF)
4. Abernathy Salmon Cultural Development Center (USFWS)
5. Toutle Hatchery (WDF)
6. Alder Creek Pond (WDG)
7. Kalama Falls Hatchery (WDF)
8. Gobar Pond (WDG)
9. Skamania Hatchery (WDG)
10. Washougal Hatchery (WDF)
11. Carson NFH (USFWS)
12. Little White Salmon NFH (USFWS)
13. Willard NFH (USFWS)
14. Spring Creek NFH (USFWS)
15. Big White Salmon Ponds (USFWS)
16. Klickitat Hatchery (WDF)
17. Herman Creek Ponds (ODFW)
18. OxBow Hatchery (ODFW)
19. Cascade Hatchery (ODFW)
20. Bonneville Hatchery (ODFW)
21. Wahkeena Pond (ODFW)
22. Sandy Hatchery (ODFW)
23. Eagle Creek NFH (USFWS)
24. Clackamas Hatchery (ODFW)
25. Trojan Ponds (ODFW)
26. Gnat Creek Hatchery (ODFW)
27. Big Creek Hatchery (ODFW)
28. Klaskanine Hatchery (ODFW)

Not Shown

Ringold Trout Pond (WDG)
Ringold Salmon Pond (WDF)
Decker Flats Pond (IDFG)
Pahsimeroi Hatchery (IDFG)

Open Circles — Other NHFS Facilities in Columbia River Basin

1. Hammond Field Station (NMFS Seattle)
2. Jones Beach Sampling Site (NMFS Seattle)
3. Prescott Field Station (NMFS Seattle)
4. Environmental & Technical Services Division (NMFS Portland)
5. North Bonneville Field Station (NMFS Seattle)

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