A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye, and Chum Salmon in the Columbia River Basin—Past and Present

SPECIAL SCIENTIFIC REPORT-FISHERIES No. 618

UNITED STATES DEPARTMENT OF COMMERCE
Maurice H. Stans, *Secretary*

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE
Philip M. Roedel, *Director*

Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye, and Chum Salmon in the Columbia River Basin—Past and Present

By
LEONARD A. FULTON

Special Scientific Report—Fisheries No. 618

Washington, D.C.
December 1970

CONTENTS

NOTE

Until October 2, 1970, the National Marine Fisheries Service, Department of Commerce, was the Bureau of Commercial Fisheries, Department of the Interior. Throughout the body of this report, which was prepared for printing before October 2, the older term is used.

Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye, and Chum Salmon in the Columbia River Basin—Past and Present

By

LEONARD A. FULTON, Fishery Biologist
National Marine Fisheries Service Biological Laboratory
Seattle, Washington 98102

ABSTRACT

Past spawning areas (those removed from use before 1969) and present ones (those in use in 1969) are described for steelhead trout, *Salmo gairdneri*; coho salmon, *Oncorhynchus kisutch*; sockeye salmon, *O. nerka*; and chum salmon, *O. keta*.

The different species characteristically spawn in the following areas: (1) steelhead trout — in streams of all sizes (widely dispersed throughout the watershed, (2) coho salmon — in small streams (mostly in the lower tributaries) and in a few areas in the middle watershed, (3) sockeye salmon — in lakes and tributaries of lakes (in the middle portion of the watershed), and (4) chum salmon — in lower portions of tributaries that enter the Columbia River below The Dalles Dam.

All four species have lost many spawning areas because of water-use developments and changes in the watershed resulting from logging, highway construction, agricultural cultivation, placer mining, and dumping of wastes.

Serious depletion of the runs of all four species is evident from the available data (the commercial catches before 1938 and since 1938 augmented by information on escapement and sport catch).

The future prospects are fair for steelhead trout, good for coho salmon, and poor for sockeye and chum salmon.

INTRODUCTION

Populations of salmon and trout in the Columbia River basin formerly were larger than they are today, and the fish spawned in more tributaries and streams than they now do. Each species discussed here — steelhead trout, *Salmo gairdneri*; coho salmon, *Oncorhynchus kisutch*; sockeye salmon, *O. nerka*; and chum salmon, *O. keta* — had distinctive distributions.

Steelhead trout were widely dispersed (and still are except in the upper Columbia River[1]); they spawn in streams of all sizes. They were often most numerous in the upper parts of tributary watersheds. They reportedly spawned in the main Columbia as far upstream as the Canadian border and in tributaries of the lower part of the upper Columbia River; the uppermost stream was the Pend Oreille River. (They may have moved into the headwaters of the Columbia but documentation is lacking.) In the Snake River drainage steelhead trout were as far upstream as Rock Creek in southeastern Idaho.

[1] In referring to the major sections of the Columbia River drainage, I have defined the lower river as the area below McNary Dam, the middle river as the area between McNary and Chief Joseph Dams, and upper river as the area above Chief Joseph Dam.

Coho salmon, which spawned as far upstream as the Spokane River in the Columbia drainage and in the Grande Ronde River (Snake River Basin) but principally in tributaries of the lower river, were also scattered in several tributaries of the middle river. Sockeye salmon were distributed in eight lake systems, mostly in the middle and upper watershed. Chum salmon spawned in the lower portions of most streams below John Day Dam.

The abundance of the different species in the Columbia River is compared in tables 1 and 2. Table 1 shows the relative numbers of each species, and table 2 the weight of the landings. The order of fish in the total run (table 1) varies from the order in weight of landings (table 2), because of differences in weight per fish and in the proportion of the run caught. Chinook, *O. tshawytscha*, are by far the most abundant salmon in the Columbia River Basin; the river produces more of this species than any other stream in the world (Washington Department of Fisheries, 1959). For the 20-year period, 1947-66 (table 2), production of chinook salmon was seven times greater than that of steelhead trout, the next species in abundance. The catch of all species except coho and sockeye salmon was lower in 1957-66 than in 1947-56. Decreases were 47 percent for steelhead trout, 46 percent for chinook salmon, and 93 percent for chum salmon; increases were about 18 percent for coho salmon and 6 percent for sockeye salmon.

As a sequel to the report on spawning areas and abundance of chinook salmon in the Columbia River Basin (Fulton, 1968), the present report contains similar information on the remaining species of salmon and trout of commercial importance: steelhead trout and coho, sockeye, and chum salmon. The fifth species of Pacific salmon, pink (*O. gorbuscha*), is rare in the Columbia River and is therefore not discussed. Past spawning areas refer to those taken out of use before 1969; present spawning areas refer to those in use during 1969.

Sources of information were described in the previous report and are listed in tables 3, 5, 8, 9, and in the literature cited section of this report. Some data on steelhead trout are from the annual reports of the Fishery Division of the Oregon State Game Commission (Oregon State Game Commission, 1958-64).

Table 1.—Average annual commercial and sport catch, escapement, and total run of salmon and trout in the Columbia River, 1958-67

Species	Catch		Escapement	Total run
	Sport	Commercial		
	Number of fish			
Chinook salmon .	[1] 39,400	277,400	409,000	[2]725,800
Coho salmon ...	[3]107,500	144,600	294,700	[2]546,800
Steelhead trout .	[4]180,900	82,800	39,000	[5]302,700
Sockeye salmon .	[6]	65,800	72,500	138,300
Chum salmon ..	[6]	2,400	27,900	30,300

[1] Includes 12,700 fish caught in the lower Willamette River and 26,700 in the sport fishery at the mouth of the Columbia (1964-67).

[2] These are minimal estimates because large numbers of chinook and coho salmon are taken in the ocean troll fishery. An unknown number of these fish are of Columbia River origin.

[3] Sport catches estimated at mouth of the Columbia River and lower Columbia River area to Bonneville Dam.

[4] Average sport catch for 1962-66 in the Columbia River and tributaries.

[5] Unknown numbers of spawners in tributaries below Bonneville Dam are lacking from total run.

[6] No sport fishery exists for sockeye and chum salmon.

Table 2.—Annual landings of salmon and trout by the commercial fishery in the Columbia River, 1947-66, in thousands of kilograms and (in parentheses) thousands of fish[1]

Year	Chinook salmon	Steelhead trout	Coho salmon	Sockeye salmon	Chum salmon
	Thousands of kilograms and fish				
1947	7,847 (843)	735 (180)	679 (150)	326 (211)	225 (55)
1948	7,888 (899)	641 (157)	532 (117)	44 (30)	474 (116)
1949	4,890 (584)	362 (89)	407 (90)	11 (8)	247 (61)
1950	4,726 (529)	413 (101)	475 (105)	77 (50)	318 (78)
1951	4,549 (454)	484 (154)	539 (97)	77 (46)	241 (59)
1952	3,294 (386)	528 (189)	487 (102)	276 (166)	140 (340)
1953	3,143 (326)	528 (226)	208 (46)	66 (41)	113 (26)
1954	2,409 (298)	820 (155)	137 (31)	110 (67)	145 (29)
1955	3,893 (466)	624 (163)	272 (63)	91 (60)	57 (13)
1956	3,710 (451)	346 (108)	209 (52)	130 (81)	21 (4)
1957	2,685 (368)	335 (99)	177 (46)	109 (65)	15 (3)
1958	2,918 (348)	307 (91)	76 (19)	328 (197)	40 (8)
1959	2,084 (269)	305 (109)	54 (15)	288 (185)	20 (4)
1960	1,782 (284)	328 (94)	72 (18)	179 (120)	7 (1)
1961	1,887 (243)	324 (101)	174 (41)	72 (41)	8 (2)
1962	2,480 (338)	328 (99)	272 (66)	24 (14)	22 (4)
1963	1,971 (235)	441 (117)	227 (58)	22 (14)	7 (1)
1964	2,034 (286)	193 (56)	891 (204)	31 (21)	11 (2)
1965	2,786 (344)	231 (65)	863 (232)	10 (6)	3 (1)
1966	1,618 (203)	177 (47)	1,957 (439)	8 (4)	5 (1)
Averages for different periods					
1947-56	4,911 (523.6)	616 (152.2)	422 (85.8)	114 (76.0)	236 (47.5)
1957-66	2,595 (291.6)	332 (87.8)	497 (113.8)	120 (66.7)	16 (2.6)
1947-66	3,753 (407.6)	474 (120.0)	459 (99.8)	117 (71.4)	126 (25.1)

[1] Data are from Fish Commission of Oregon and Washington Department of Fisheries (1968), except for numbers of coho and chum salmon for the years 1947-63 which are from Ward, Robison, and Palmen (1963).

Unpublished data on runs and spawning were provided by Charles J. Campbell, Wendel H. Stout, and James A. Hewkin of the Oregon State Game Commission; Robert T. Gunsolus, Lawrence Korn, Jack M. Van Hyning, Lincoln S. Pearson, and Robert N. Thompson of the Fish Commission of Oregon; Thomas K. Meekin, Clinton E. Stockley, and Henry O.

Wendler of the Washington Department of Fisheries; Ralph W. Larson, Robert J. Rennie, and Dorian C. Lavier of the Washington Department of Game; and Eugene M. Maltzeff, Roy J. Wahle, Donovan R. Craddock, and Richard L. Major of the Bureau of Commercial Fisheries.

STEELHEAD TROUT

Steelhead trout are rainbow trout that go to sea when young and return to fresh water to spawn. They may spawn more than once, and return to the sea after each spawning but the percentage that survive to spawn more than once is usually small. Their life history is variable but in the Columbia River most remain in fresh water one or two years and return to spawn in their fifth or sixth year.

Sport fishermen do not usually catch them in salt water but in stream areas designated for sport fishing. They are usually difficult to catch but are prized and "steelhead fishing" is one of the most popular sports. Their flesh is pink and or red and has excellent flavor, especially when fresh from the ocean. Flavor and firmness of flesh is lost after prolonged periods in fresh water and as spawning time approaches.

On the basis of periods of migration in the lower Columbia River, steelhead trout have been classified as either winter or summer run. The winter run enters the river from November to April; the summer run enters from May to October. Winter-run steelhead trout spawn primarily in tributaries of the Columbia River below Bonneville Dam; most of the summer-run fish spawn in tributaries above Bonneville Dam. Although both runs migrate during different seasons, they spawn at the same time — during the winter and spring. The two runs are treated together in this report. The chief difference between the two runs (other than the period of migration) is the stage of development of the gonads at the time the fish enter the river: those of the winter fish are far more advanced than those of the summer fish.

Spawning Areas

Past and present spawning areas of steelhead trout are illustrated in maps 1 through 6. Map 1 shows the entire Columbia River; maps 2 to 6 give details for smaller areas.

To supplement the information on spawning areas shown on the maps, table 3 provides data on stream length and approximate location of spawning areas as well as notes and references on each stream. The streams are in sequence, proceeding upstream from the Columbia River and are numbered in the left-hand column to help identify the relation of each stream to its nearest tributary.

Steelhead trout are widely distributed in the Columbia Basin; their distribution is similar to that of spring chinook salmon. Because they migrate and spawn before seasonal low-water periods, steelhead trout have fared better than spring chinook salmon in some areas where water is heavily used for irrigation.

Little is known on the former migration of steelhead trout into the upper Columbia River; it is not known if this species migrated above the Arrow Lakes before the runs were blocked by Grand Coulee Dam in 1939. Gilbert and Evermann (1894) reported that in 1894 steelhead trout were abundant at the mouth of the Pend Oreille River, 1,200 km. from the ocean, and in the lower Spokane River, 1,035 km. upstream. In the upper Snake River drainage, steelhead trout formerly ascended upstream to Rock Creek, 1,479 km. from the ocean. Runs have been cut off from the upper Snake River since 1964, when it was decided not to pass anadromous fish above Hells Canyon Dam.

Abundance

Oregon is the only State in the Columbia River Basin that harvests steelhead trout commercially; thus, table 2 shows the commercial take for Oregon only. Washington declared steelhead trout a game fish in 1929, and this action removed this species from commercial exploitation. Washington fishermen, however, frequently catch steelhead trout while fishing for salmon in the Washington side of the river; since it is illegal to land them in Washington, they send them to Oregon. Idaho has never had a commercial fishery for the species. According to Craig and Hacker (1940), a few steelhead trout may have been included with the pack of spring chinook salmon during the

Table 3.–Spawning areas of steelhead trout in the Columbia River Basin–past and present

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
1.	Lewis and Clark River	40	13	Most of stream above tidewater.	Dam, about 22 km. up, has fishway but may be partial barrier at times.	Best spawning area, 1st 5 km. above tidewater.	29, 30
2.	Youngs River	29	16	Lower 0.8 km. Youngs R. (above tidewater), Klaskanine R., and its North Fork.	Barth Falls on Klaskanine R. laddered in 1964, opening new area.	Many good riffles, but only small run. Natural run bolstered by hatchery production.	29
3.	Grays River	26	34	Some of Grays R., lower Left, North, and South Forks and tributaries.	More available now.	Many good spawning areas; falls made passable, increasing spawning areas. Most spawning in upper tributaries.	1, 38
4.	Big Creek	21	37	Scattered areas.	About same as present.	Some fish allowed to pass above hatchery racks, but most reared at hatchery of O.F.C. (Fish Commission of Oregon) at km. 5.	29
5.	Gnat Creek	14	38	Small stretch above tidal area.	Same as present.	Run mostly reared in hatchery of O.G.C. (Oregon Game Commission). A few spawn in stream.	29
6.	Skamokawa Creek	11	54	Lower 6 km. above tidal area.	Same as present.	Small stream, supports run.	1, 38
7.	Elokomin River	24	61	Throughout main stream above tidal area.	Not as large as now.	Has good spawning area above first 5 km. and in lower parts of tributaries. Logging caused erosion and left silt and brush to clog streams. Stream clearing opened areas.	29
8.	Clatskanie River	40	80	Throughout main stream and lower Beaver Cr.	Not as large as now.	Clatskanie Falls laddered in 1950's. Beaver Creek blocked by falls about 6 km. up. Fish use available area.	
9.	Mill River	10	85	Above km. 1.6 for several km. and lower Little Mill Cr.	Not as large as now.	Falls about 3 km. up laddered in 1951. Good spawning area.	1, 38
10.	Abernathy Creek	21	86	Lower 16 km. above tidewater.	Not as large as now.	Excellent spawning areas. Improvements in passage at falls should allow increased production.	1, 38
11.	Germany Creek	19	90	Midportion	Not as large as now.	Logjam that blocked fish removed in late 1940's; many good spawnings riffles.	1, 38
12.	Cowlitz River	208	109	Most of main Cowlitz R. and tributaries listed below.	Areas inundated by Mayfifield and Mossyrock Reservoirs.	Cowlitz system is one of top producers of steelhead trout in Washington. Has 120 km. good spawning and rearing habitat. A large hatchery was built to compensate for losses at dams, and only fish in surplus of rearing capacity are released above dam.	1, 38
12A.	Coweeman Creek	53	2	Mostly in upper portion.	Not as large as now.	Stream improvement and passage at barriers have increased spawning area. Good fishing stream.	1, 38
12B.	Ostrander Creek	16	11	Most of stream.	Not as large as now.	Many barriers were present when surveyed in 1936 and in 1950. Best spawning area in lower 3 km., but small areas are scattered throughout most of stream. Fishways now allow access to upper spawning areas.	1, 38
12C.	Arkansas Creek	3	24	Lower North and South Forks.	Probably some loss caused by silting, but more area now available because of improvements.	Formed by junction of forks, this small stream was adversely affected by logging in the 1920's and 1930's. Second-growth timber has improved water quality again. Many brush and logjams removed. North Fork, 16 km. long, has only a small amount of spawning gravel. South Fork, 14.4 km. long, has excellent areas in middle third and a small run of steelhead trout. One of many streams improved by Lower Columbia Fisheries Development Program of U.S.F.W.S. (U.S. Fish and Wildlife Service).	1, 38
12D.	Toutle River	83	27	Most of main Toutle R. and North Fork, Hoffstadt and Coldwater Creeks.	Same as present.	An excellent stream for steelhead trout spawning and rearing. Has considerable amount of spawning area in main stem and North Fork which is sometimes called the main Toutle R. Small runs go into Hoffstadt and Coldwater Creeks. Other tributaries described below.	1, 38
12D1.	South Fork Toutle River	45	21	Lower two-thirds.	Same as present.	This large tributary has many good spawning areas in most of indicated area. Canyonous area, km. 8 to 15, has excellent succession of pools and riffles. Little spawning in its tributaries.	1, 38

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
12D2.	Green River	51	42	Lower two-thirds, and lower Devils Cr.	Same as present.	Another large tributary of the Toutle R. with good spawning areas. Best areas in lower 8 km. and for 8 km. below Big Falls, which is a total barrier. (Toutle River Hatchery passes steelhead trout above its collection facility.)	1, 38
12E.	Olequa Creek	32	35	Lower part and Stillwater Creek.	Same as present.	Pollution, siltation and obstructions were problems for many years. Passage is restored and pollution abated (at least in part). A few fish use this stream.	1, 38
12F.	La Camas Creek	35	43	Midsection.	Same as present.	Good spawning and rearing areas; supports a small run of species.	1, 38
12G.	Tilton River	42	102	Lower and middle portions.	Mayfield Reservoir inundated lower 3 km.	Many excellent spawning areas in lower river above Mayfield Reservoir.	1, 38
12H.	Cispus River	80	147	Main Cispus R. and lower North Fork.	Same as present.	Lower 53 km. and lower North Fork contain excellent spawning areas.	1, 38
13.	Kalama River	67	120	Most of Kalama R. and a few tributaries.	About same as present.	About 48 km. of excellent spawning area became accessible in 1956 as result of new fishway at falls and dam 18 km. above mouth. Has good run.	1, 38
14.	Lewis River	144	139	River km. 11 to 32.	Area above Merwin Dam lost.	Fair numbers still use area below Merwin but failure of passage at Merwin, Yale, and Swift Dams has prevented use of good upriver spawning areas.	1, 38
14A.	East Fork Lewis River	67	8	Lower 50 km.	Same as present.	Numerous falls are low water barriers. Steelhead trout reported to ascend to Sunset Falls, 50 km. up; good stream.	1, 38
14B.	Cedar Creek	32	26	Most of main Cedar Cr.	More available now.	All except lower part blocked until old mill dam removed in 1946 and other improvements made.	1, 38
15.	Milton Creek	32	144	Middle portion.	Same as present.	Supports small run. Water depleted during summer because of diversion.	29
16.	Scappose Creek	10	146	Middle portion and North Fork.	Same as present.	Small stream, has small run of steelhead trout.	29
17.	Salmon Creek	35	150	Upper part.	Upper stream.	Pollution and compacted gravel with silt have spoiled areas.	1, 35
18.	Willamette River	303	162	Upper half main Willamette R.	Same as present.	Main river spawning scattered throughout upper half. Has many good areas.	29, 40
18A.	Johnson Creek	35	27	Midsection.	Lower portion.	Small stream, has some good spawning areas.	29, 40
18B.	Clackamas	128	34	Upper Clackamas R., Clear, Deep, Eagle, and Fish Creeks. North Fork, Roaring, Oakgrove Fork, Collawash and Hot Springs Fork Rivers.	Area inundated by dams. May have had spawning gravel.	Upper Clackamas has many excellent spawning and rearing areas. Runs appeared to be on increase during the late 1960's, possibly because of better survival through passage facilities at Nortb Fork Dam. Eagle Cr. National Fish Hatchery rears some of the run. This system supports a good sport fishery.	29, 40
18C.	Abernethy Creek	21	40	Main Creek and tributary, Holcomb Cr.	Not as large as now.	Removal of obstruction in 1953-55 increased use of stream. Small run.	29, 40
18D.	Tualatin River	112	45	Upper Gales Cr.	About same as present.	Number of steelhead trout using stream unknown but may be substantial. Chief deterrent is low summer flow during rearing period.	29, 40
18E.	Mollala River	80	58	Main Mollala, and lower North Fork Rivers, Butte and Abiqua Creeks, Upper Milk Cr.	Same as present.	Has excellent spawning areas.	29, 40
18F.	Yamhill River	18	80	North Yamhill and upper South Yamhill Rivers.	Unknown.	Spawning has been observed in recent years by personnel of O.F.C.	29, 40
18G.	Rickreall Creek	48	142	None.	Probably some reduction.	Good spawning gravel present throughout most of length, but low flows, pollution from sewage, and probably high summer temperatures limit value of stream.	29, 40
18H.	Luckiamute River	83	173	None.	Unknown.	Stream has good potential for rearing steelhead trout. A falls blocks run from upper Little Luckiamute R.	29, 40

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
18I.	Santiam River	18	174	None.	None.	Main Santiam used as passageway and possible rearing area during cooler months.	29, 40
1811.	North Santiam River	147	18	Most of main stream and lower ⅔ of Little North Santiam R.	Upper main stream and 540 km. of tributaries cut off by Detroit and Big Cliff Dams.	Steelhead trout collected at Minto Racks averaged 1,000 adults in 1952-59. Eggs taken to Santiam Hatchery (O.F.C.). Little North Santiam has run which spawns naturally.	29, 40
1812.	South Santiam River	101	18	Upper South Santiam, Thomas, Crabtree, Wiley, and Canyon Creeks.	Wiley Cr. Falls laddered, increasing area. No former area cut off.	Important producer; has good spawning and rearing areas.	29, 40
1812A.	Middle Santiam River	48	67	Middle Santiam R. and Quartzville Cr.	Lower portion of Middle Santiam R. inundated by dams.	Has many excellent spawning areas. Green Peter, and Foster Dams, may reduce value of this tributary in addition to loss of spawning area. Some reared at Middle Santiam Hatchery (O.F.C.); the remainder spawn naturally.	29, 40
18J.	Calapooya River	115	192	Upper part.	Same as present.	Finley Dam blocked upper river for 100 years; washed out in 1949. Best spawning gravel in upper area. Depleted run not built up yet.	29, 40
18K.	McKenzie River	138	282	Upper half Mohawk R.	See note.	Steelhead trout in small numbers after runs introduced in 1956. Apparently, no prior use of McKenzie by species.	29, 40
18L.	Middle Fork Willamette River	123	303	Fall and Winberry Creeks and main Middle Fork below Dexter R. Dam.	Probably little use by species before they were introduced.	Although it seems likely that this species spawned in the Middle Fork and the O.G.C. believes they did, the O.F.C. offers evidence that they did not occur naturally. An egg-taking and eyeing station established in 1911 would have trapped any steelhead trout had they been present. Stock introductions were made in the 1950's and adults returned to Dexter Holding Pond since 1957; others spawn in the areas designated. Fish trapped at Dexter Dam for rearing at Willamette Hatchery (O.F.C.).	29, 40
19.	Washougal River	58	189	Main Washougal, lower Little Washougal, and lower half, West Fork.	Not as large as now owing to fishway construction over Salmon Falls and removal of old dams.	Many obstructions were made passable in this system. One of the better "steelhead fishing streams" in southwestern Washington. Skamania Hatchery of W.D.G (Washington Department of Game) rears part of run.	1, 35
20.	Sandy River	72	192	Sandy R. and tributaries.	Some losses in 43 km. stretch below Marmot Dam.	O.G.C. stocks stream with young steelhead trout. Upper Sandy has good spawning areas. Provides a good sport fishery throughout.	29
20A.	Bull Run River	40	26	Lower 5 miles.	Upper portion	Scattered spawning areas below dams used by small run.	29
20B.	Salmon River	51	56	Lower half.	About same as now.	A good share of run to main Sandy R. spawns in this tributary.	29
21.	Hamilton Creek	11	226	Lower portion above slough area.	Same as present.	Small streams used by small run up to impassible falls, 6.4 km. above mouth.	1, 35
22.	Eagle Creek	18	234	Lower 3 km.	Bonneville pool inundated lower stream.	Small number of steelhead trout use this stream to falls.	29
23.	Herman Creek	11	240	Lower 1.6 km.	Bonneville pool inundated some spawning areas.	Impassable falls, 1.6 km. above mouth, limits migration. Small run.	29
24.	Wind River	51	248	Upper Wind R., Trout and Panther Creeks.	Not as large as now.	Upper good spawning areas open again after being blocked for many years by small lumber dam 22 km. up. Dam removed in 1947. Stream noted for summer steelhead sport fishing. Species able to ascend Shipperd Falls during high water, but fish ladder made ascent easier. Other stream improvements.	1, 35
25.	Little White Salmon River	27	259	Lower 0.8 km. above Bonneville pool.	Bonneville pool inundated lower 2.6 km.	A few steelhead trout spawn in small area available. Two falls block upper area.	1, 35
26.	Big White Salmon River	64	269	Lower 1.6 km. above Bonneville pool.	Lower part of main stem and area above Condit Dam (3 km. above mouth).	Steelhead trout known to have migrated as far as Trout L. Condit Dam, constructed in 1912, had a fishway; some steelhead trout were reported to have ascended. Ladder removed in a few years as not successful in passing salmon. In 1937 Bonneville Dam flooded lower part of stream.	1, 35

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
27.	Hood River	18	270	Midsection, East, West, and Middle Forks and Neal Cr.	About same as present.	Steelhead trout runs depleted by flow diversions without adequate screening and diminished streamflow. Diversions now mostly screened. Has fair-sized runs now and supports a sport fishery. Has spring-summer and winter runs.	23, 29
28.	Klickitat River	152	288	Upper Klickitat and Little Klickitat Rivers.	Falls were laddered, opening new areas.	After improvement in passage and stocking, the runs have increased. An excellent stream for spawning, rearing, and sport fishing.	1, 38
29.	Chenoweth Creek	19	296	Lower 1.6 km.	About same as present.	Small stream, has small run. Summer flows are too low and warm for best growth.	20, 29
30.	Mill Creek	16	303	Lower 3 km.	Water supply dam limits migration.	Water depletion limits use of stream during summer—small run.	29
31.	Fifteenmile Creek	64	307	Scattered in most of main stream. Best area in upper reaches.	Some loss in middle and lower portion.	Fair to good spawning potential, but irrigation withdrawals reduce use. Stream intermittent in lower half during summer.	20, 29
32.	Deschutes River	392	326	Stretches in lower 160 km. of main stream.	Crooked Metolius and upper Deschutes Rivers and Squaw Cr.	Good steelhead trout stream. Some area lost because juveniles failed to pass through reservoirs. Run, which formerly went above hydro projects, now reared at hatchery. A new hatchery will be built to compensate for losses at dams.	20, 22
33.	John Day River	364	333	Tributaries of upper John Day R., parts of Rock, Butte, and Thirty-mile Creeks, North and Middle Forks, and tributaries of the South Fork R.	Some reduction though not located.	Spawning areas are chiefly in numerous small tributaries. Steelhead trout have fared better than salmon. Many excellent areas.	20, 22
34.	Umatilla River	191	463	Birch and Meacham Creeks, South and North Forks.	Butter Cr. and some sections of tributaries taken out of production by withdrawal of water for irrigation.	Excellent spawning areas in upper portions. Fish able to remain because of early migration through lower river. Water overappropriated; lower portion and many stretches become nearly dry during summer.	22, 24, 33
35.	Walla Walla River	90	503	Upper Walla Walla R. and its tributaries.	Some tributaries removed from production.	Irrigation has reduced value and taken some sections out of production. Formerly had good runs; has good sport fishery.	5, 22, 33
35A.	Touchet	99	32	Upper portion and tributaries.	Lower River.	Has numerous spawning, rearing, and resting areas. No serious barriers to migration, although some lower sections have low water during summer.	5, 22, 33
36.	Snake River	1,600	519	Scattered spawning areas above Ice Harbor pool to Hells Canyon Dam.	Main river spawning was lost by inundation. Because this species spawns during high water, it is difficult to see spawning activity and locate areas.	One of the best tributaries in the Columbia system. Many good spawning areas in the middle and upriver portions. Sport catch from 20,000 to 55,000 during recent years. Until 1964, run went above Swan Falls Dam to spawn. Run normally migrating above Middle Snake River Area was cut off, and fish are reared at hatchery for planting in tributaries entering below Hells Canyon Dam. Many tributaries of this system have excellent spawning and rearing areas (see following).	9, 10, 11, 19, 21, 26, 27, 28
36A.	Palouse River	240	96	None.	None.	Palouse Falls blocks fish. No record of use by salmon and trout in lower 10 km.	26
36B.	Tucannon River	96	101	Middle and upper Tucannon R., Cummings and Panjah Creeks.	Much area of lower stream damaged by floods, dredging, and diking in 1965.	Remnant of former large runs of spring- and fall-run fish. Small sport fishery.	26
36C.	Clearwater River	120	224	Perhaps small stretches used in addition to tributaries listed below.	About same as now.	Lewiston Dam remained passable because the fish pass during favorable periods. Counts at Lewiston Dam varied from 3,000 to over 33,000, 1950-61.	21, 26, (4)
36C1.	Lapwai Creek	45	24	Main stream and tributaries.	About same.	Small stream, supports small run of steelhead trout. Irrigation practices are limiting factor.	21, 26, (4)
36C2.	Potlatch Creek	83	27	Upper third of Potlatch Cr.	About same.	Water-use has limited value of stream; only small run remains.	21, 26, (4)
36C3.	Big Canyon Creek	46	56	Most of Big Canyon Cr. and lower and middle Little Canyon Cr.	About same.	This stream and its chief tributary have spawning areas. Later in the season the flow becomes low and the young must move elsewhere.	21, 26, (4)

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
36C4.	North Fork Clearwater River	216	69	Most of main North Fork, lower one-half of Little North Fork, and Kelly Cr., and lower portions of many small tributaries.	About same.	Many kilometers of excellent spawning and rearing areas. North Fork produces large steelhead trout, many weighing over 9 kg. Sport fishermen took about 14,000 in 1957-58. Dworshak Dam, now under construction, will inundate about 45 percent of spawning area in North Fork drainage. Hatchery propagation will be used to compensate for spawning area losses, but plans for passage of fish above dam are uncertain at this time.	26, (4)
36C5.	Orofino Creek	54	72	Lower Orofino Cr. and lower tributary.	About same.	Series of falls 10 km. up blocks fish. Low stream flow and high summer temperature reduce value.	21, 26, (4)
36C6.	Lolo Creek	64	86	Most of Lolo Cr.	About same.	Has many tributaries with suitable spawning areas, but only small portion used. Stream has fault in common with others in area—low water.	21, 26, (4)
36C7.	Lawyer Creek	59	107	Lower portion.	About same.	Low flows and turbid water caused by silt detract from this small stream. In spite of this, small runs of steelhead trout persists.	21, 26, (4)
36C8.	Middle Fork Clearwater River	38	120	Throughout Middle Fork and tributaries.	About same.	Large amount of spawning available in main Middle Fork but fish prefer upriver areas. Stream improvements in progress.	21, 26, (4)
36C8A.	Lochsa River	114	38	Throughout Lochsa R. and many small tributaries.	Same.	System has many excellent spawning areas with resting pools and rearing areas. Steep terrain, accompanied by large rubble, limits spawning to lower sections of tributaries.	21, 26, (4)
36C8B.	Selway River	160	38	Throughout main Selway R. and many small tributaries.	New areas opened, larger now.	Because large part of considerable spawning area in Selway is within a wilderness area, it is especially valuable trout habitat. Selway Falls, 32 km. up, has been laddered, opening up new excellent areas.	21, 26, (4)
36C8C.	South Fork Clearwater River	120	120	Lower section.	Stream blocked by dam about 32 km. above mouth for 14 years.	Fish ladder at Washington Water Power Company Dam, destroyed by high water in 1949, was not replaced. Dam removed in 1963 to permit passage to upstream spawning and rearing areas. Restocking and stream improvement program now under way, which should put many excellent tributaries into use again.	21, 26, (4)
36D.	Asotin Creek	22	234	Upper Asotin Cr., North and South Forks.	About same.	Formerly supported large runs. Still produces fair run, has many good shallow riffles with adequate resting pools.	26
36E.	Grande Ronde River	320	272	Most of upper and middle main stream tributaries—Lookingglass, Clark, Phillips, Indian, Willow, Catherine, Five-Point, Beaver, Meadow, and Sheep Creek. Other tributaries listed below.	Some reduction in upper Grande Ronde and tributaries due to gold dredging and channel relocation.	Steelhead trout, once abundant in this system, are now fewer, but still contribute substantially to sport and lower river commercial fisheries.	26, 33
36E1.	Joseph Creek	72	8	Joseph Cr., and its tributaries, Cottonwood, Swamp, Crow, and Chesnimnus Creeks, and smaller tributaries in system.	Same.	Reported to have good run. Logging has been detrimental.	26, 33
36E2.	Wenaha River	35	72	Main Wenaha R. and tributaries, Crooked and Butte Creeks, North and South Forks, and number of smaller tributaries.	Same.	Large amount of suitable spawning area; fair sized, but depleted run.	26, 33
36E3.	Wallowa River	88	130	Most of main Wallowa R., and Dry, Hurricane, and Prairie Creeks. Larger tributaries listed below.	Part of Hurricane and Prairie Creeks.	Former large runs are reduced somewhat but still a good producer.	26, 33

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
36E3A.	Minam River	72	16	Upper Minam and lower little Minan and North Minan Rivers.	Lower Minam R.	Steelhead trout fare slightly better than salmon because of habit of migrating and spawning in high water period. Splash dam operations caused loss of lower river.	26, 33
36E3B.	Big Canyon Creek	32	19	Most of stream.	Same.	Excellent spawning areas, but becomes nearly dry at times in late summer.	26
36E3C.	Bear Creek	40	35	Most of stream.	Same.	Excellent spawning areas. Number of irrigation diversions takes most of summer flow.	26
36E3D.	Lostine River	40	43	Lower and middle portions.	Same.	Many excellent spawning areas.	26
36F.	Salmon River	641	299	Middle and upper main Salmon R., lower Wind R., Whitebird, Slate, Crooked, Big Mallard, Bargamin, and Chamberlain Creeks. Other tributaries listed below.	Same as now.	One of most productive streams in Columbia River Basin. Has many excellent spawning and rearing areas. Large numbers caught by sportfishermen annually.	27, (4)
36F1.	Little Salmon River	69	131	Lower and middle portions main stream and Rapid R.	Same as now.	Good spawning areas throughout most of stream.	27, (4)
36F2.	South Fork Salmon River	128	213	Throughout South Fork, Secesh R., East Fork, and Johnson Cr.	Same as now.	Former large runs attest to value of spawning area. Stream is still good producer.	27, (4)
36F3.	Middle Fork Salmon River	170	306	A few sections of Middle Fork and most of Big Clover, Camas, Loon, Sulphur, Bear Valley, and Marsh Creeks, and tributaries.	Same as now.	Largest and most productive tributary. Excellent spawning areas in tributaries.	27, (4)
36F4.	Panther Creek	69	325	Most of Panther Cr. and lower parts of tributaries.	Some reduction caused by mining.	Mining stopped in 1961. Stream improvement needed to restore dredged areas. Rather small run.	27, (4)
36F5.	North Fork Salmon River	37	366	North Fork and lower parts of tributaries.	Some reduction caused by mining.	Dredging has stopped. Stream has good shade cover and good spawning riffles.	27, (4)
36F6.	Lemhi River	96	402	Most of Lemhi R. and lower portions of tributaries.	About same as now.	Spawning areas abundant and of excellent quality. Now that diversions are screened, increased production should be possible.	27, (4)
36F7.	Pahsimeroi River	48	472	Lower 16 km. of Pahsimeroi R.	About same as now.	Heavy agricultural use of water limits rearing capacity screening recently accomplished, should improve survival of young. Good spawning area in section indicated.	27, (4)
36F8.	East Fork Salmon River	51	362	Most of its length and lower parts of tributaries.	Same as now.	Supports good run. Has many kilometers of excellent spawning area.	27, (4)
36F9.	Yankee Fork	40	576	Most of its length and chief tributary, West Fork.	Some reduction in dredged area.	Gold dredging has caused damage to streambed. Rehabilitation of areas needed, but small run still present.	27, (4)
36F10.	Valley Creek	34	595	Most of Valley Cr. and lower parts of tributaries.	Some reduction in dredged area.	Former gold dredging adversely affected spawning areas; good run still persists.	27, (4)
36G.	Imnaha River	120	304	Throughout main Imnaha R., and Cow, Lightning, Horse, Little Sheep Creeks, and several other tributaries.	About same as now.	Supports substantial run of steelhead trout. Sportsmen catch many in areas open to fishing.	27
36H.	Pine Creek	51	430	None.	Portion of upper Pine and Fish Creeks.	Low flows caused by irrigation diversion reduced value of stream, but a small run was still present when run was stopped at Hells Canyon Dam in 1964.	27
36I.	Indian Creek	26	432	None.	Lower and upper areas may have been used.	Small run spawned in this small stream before run was cut off in 1964 by Hells Canyon Dam.	(4)
36J.	Wildhorse Creek	26	440	None.	Most of Wildhorse and Lick Creeks.	Had a small run till 1958 when fish were transplanted elsewhere before construction of Oxbow Dam.	(4)

See footnotes at end of table.

Table 3.–Spawning areas of steelhead trout in the Columbia River Basin–past and present–Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
36K.	Powder River	183	470	None.	Upper Powder and N. Powder Rivers and tributaries, Eagle Creek.	Irrigation, mining, and logging depleted runs in main Powder R., but areas not eliminated until Thief Valley Dam constructed in 1931.	27
36L.	Burnt River	125	522	None.	Middle and upper main Burnt R., North and South Forks, and a few of their tributaries.	Residents reported large run many years ago. Excessive irrigation, gold dredging, and Unity Dam (without fish passage) caused depletion. Taken from production by Oxbow Dam.	27
36M.	Weiser River	131	547	None.	Portions of main Weiser R. and tributaries.	Small run until 1963 when it was decided that fish passage was failing at Brownlee Dam. Irrigation diversions without screening and low flows reduced runs before this.	9, 27, (4)
36N.	Payette River	115	571	None.	Main Payette R., Squaw Cr., North, Middle, and South Forks.	Many kilometers of excellent spawning areas lost when dam blocked runs in 1914. Black Canyon Dam built later took out most of remaining area. Much depleted run will be cared for by hatcheries or diversion, owing to passage failure at Brownlee Dam.	27, (4)
36O.	Malheur River	267	576	None.	Upper Malheur R. and tributaries.	Former large runs completely depleted by irrigation dams and diversions.	28
36P.	Boise River	122	606	None.	Throughout main Boise R., North, Middle, and South Forks, and Tributaries.	Good-sized runs more than 50 years ago. Pollution and irrigation projects destroyed all but small run that continued until cut off in 1964.	28, (4)
36Q	Owyhee River	240	608	None.	Main Owyhee R. and most tributaries.	Former spawning area extended to headwaters; stream was known as good producer of steelhead more than 50 years ago. Runs were depleted before construction of Owyhee Dam in 1933. This dam, 42 km. above mouth, does not have a fishway.	28
36R.	Bruneau River	64	770	None.	Main Bruneau R. and lower portions of tributaries.	Irrigation practices caused extinction of runs.	28, (4)
36S.	Canyon Creek	51	773	None.	Lower portion.	Small stream, now largely diverted for irrigation. Once had small run.	28, (4)
36T.	Malad River	160	888	None.	Most of Malad R. and Little Wood R.	Numerous impassable irrigation dams and unscreened diversions destroyed former runs.	28, (4)
36U.	Salmon Falls Creek	64	917	None.	Lower portion.	In common with other streams of area, irrigation projects were responsible for depleting run.	28, (4)
36V.	Rock Creek	72	952	None.	Lower portion.	Historical upper limit for steelhead trout migration in Snake R. and longest migration (1,472 km.). No runs for many years due to irrigation demands.	28, (4)
37.	Yakima River	317	536	Upper Yakima R., parts of Naches R., and Satus and Toppenish Creeks.	Formerly much more extensive in tributaries.	Irrigation diversions and dams reduced productive capacity. Has many excellent spawning areas.	2
38.	Wenatchee River	88	749	Throughout main Wenatchee R., lower Mission, Peshastin, Icicle, Chiwaukim and Nason Creeks, Chiwawa, Little Wenatchee, and White Rivers.	About same as now.	Had good runs. Sport fishery takes 600 to 1,000. Grand Coulee salvage program moved fish into these streams. Because this fish is difficult to see during high water, exact spawning areas are unknown.	2, 13, 15, 16, 18
39.	Entiat River	83	774	Entiat and Mad Rivers.	About same as now.	Former good runs were depleted but later augmented by introduction of fish during Grand Coulee program. Entiat National Fish Hatchery rears part of run.	2, 13, 15, 16

See footnotes at end of table.

Table 3.—Spawning areas of steelhead trout in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
40.	Methow River	114	838	Most of Methow R., Twisp, and Chewack Rivers, and Lower Beaver Cr.	About same as now.	Large runs formerly present. Irrigation and power dams caused depletion. Grand Coulee transplants augmented runs in 1939, after which runs increased. Several hundred taken annually by sport fishery.	2, 13, 15, 16
41.	Okanogan River	128	854	Scattered throughout main stem below L. Osoyoos to Omak Cr. and lower Similkameen R.	Salmon and Omak Creeks and upper Similkameen R.	Formerly had large runs, which are on increase again because of stocking by W.D.G. Rehabilitation of run into the upper Similkameen R. began in 1968.	2, 13, 15, 16, 18
42.	Spokane River	144	1,029	None.	Lower 80 km. and tributaries.	In 1909 Little Falls Dam, built 42 km. above the mouth, blocked runs from the principal spawning area. Numerous steelhead trout up until about 1918, after which they nearly disappeared. Grand Coulee completely blocked runs in 1939.	2, 19
43.	Pend Oreille River	160	1,194	None.	Lower 32 km. and available tributaries.	Steelhead trout were abundant near mouth in 1894. This was northernmost known migration of species in Columbia River system and one of longest migrations.	2, 19
44.	Columbia River	536	635	Mouth of Yakima R. to below Priest	Priest Rapids Dam to Canadian border.	With aid of aerial surveys, steelhead redds were seen during the spring spawning season in the stretch shown. In view of the spawning in present areas, it is reasonable to assume that the former areas shown in map 1 were also used by this species.	([5])

[1] The streams are listed in numerical sequence, proceeding upstream from the mouth of the Columbia. Streams that are direct tributaries of the Columbia are identified by numerals only; subtributaries are designated by a combination of numerals and letters.
[2] Location in kilometers above mouth of Columbia or kilometers above mouth of contributing drainage.
[3] References are numbered to facilitate location in Literature Cited.
[4] Unpublished information provided by Forrest R. Hauck, Biologist, formerly with the Idaho Department of Fish and Game, now with the Federal Power Commission, Washington, D.C. (October 21, 1961).
[5] Personal Communication, Ralph Larsen, Washington Department of Game, Olympia, Wash. (December 1969).

early days of the canned salmon industry in the Columbia River. Steelhead trout have been reported in the commercial canned pack since 1889. The largest pack of canned steelhead trout (2,231,663 kg.) was recorded in 1892; the smallest (177,354 kg.), in 1966.

Annual landings of steelhead trout in the Columbia River showed a downward trend in 1938-68 (fig. 1). The average annual packs were 616,000 kg. in 1947-56 and 332,000 kg. in 1957-66 (table 2). Curtailment of commercial fishing reduced the commercial catch especially in 1964-66, but the decrease does not necessarily reflect a decrease in abundance of steelhead trout. The escapement has been relatively stable over the past 10 years, fluctuating between 100,000 and 160,000 fish.

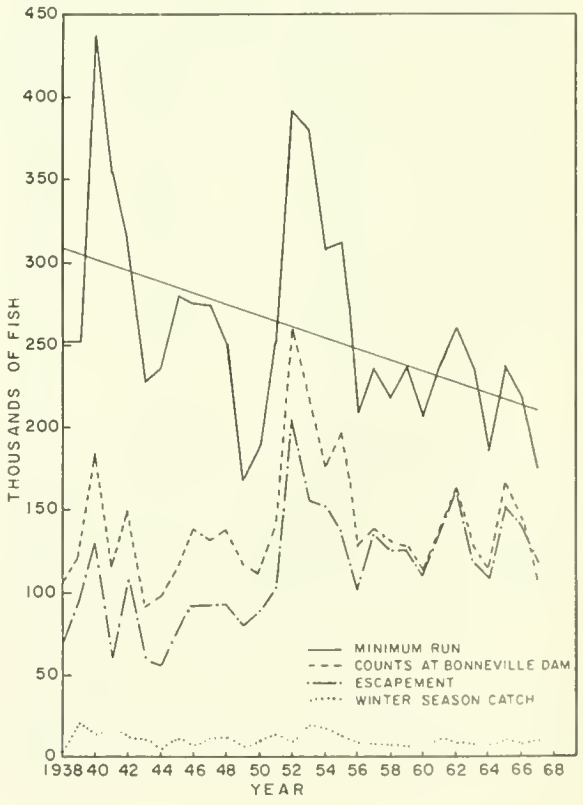


Figure 1.—Minimum run, counts at Bonneville Dam, and escapement of steelhead trout in the Columbia River, 1938-67. Minimum run includes winter and summer commercial catches below Bonneville Dam and counts at Bonneville Dam (sport catches of summer run below Bonneville Dam since 1964 also included). Straight line is derived by least squares method. [Data are from Fish Commission of Oregon and Washington State Department of Fisheries, 1968.]

Tabulations of the runs were obtained by adding commercial catches (winter and summer run) below Bonneville Dam to the counts of fish that pass Bonneville Dam (U.S. Army Corps of Engineers, 1966). The winter-run commercial catch averages only about 3 percent of the minimum run. Steelhead trout are seldom caught in the ocean by trolling gear. Thus, the portion of the total run not accounted for in figure 1 is the escapement (magnitude unknown) to tributaries below Bonneville Dam and the catch by the sport fishery in the tributaries and the winter-run sport catch in the main Columbia River.

The sport fishery is large; the average annual catch below Bonneville Dam was estimated at 89,000 fish for 1962-66. The average estimated sport catch in the Columbia River and its tributaries for 1962-66 was 117,000 summer-run fish and 62,000 winter-run fish (table 4).

In Idaho, the Salmon, Clearwater, and lower and middle Snake Rivers are the only streams that support runs of steelhead trout. Passage above Oxbow Dam was discontinued in 1964; all spawners are collected at Hells Canyon Dam and routed to hatcheries. Spawning and fishing areas eliminated by blockage at Hells Canyon Dam were the Payette, Weiser, Boise, and Snake Rivers. The size of the sport catch reflects to a degree the size of the spawning escapement to each tributary, though adverse fishing conditions result in a greater escapement in some years than in others and some fish are caught in wintering areas such as that below McNary Dam. Steelhead trout are not easily seen during spawning because they spawn during high water; consequently the number of spawners are not known.

Future of Steelhead Trout Runs

Most tributaries of the Columbia River are not overpopulated by steelhead trout spawners because of the extensive sport catch during the prespawning period, the commercial catch in Oregon, and various adverse factors. A number of hatcheries in the Columbia River Basin propagate steelhead trout and the returns of adult fish from hatchery plants are usually high. The prospect for continuation of steelhead trout runs at about 200,000 to 250,000 fish appears good, although some areas have been taken from production because steelhead trout failed to pass through the reservoirs.

COHO SALMON

Some coho salmon enter the mouth of the Columbia River to start their spawning migration in late August, but most of the run enters between mid-September and about mid-November. Young coho salmon invariably remain in fresh water for 1 year before migrating to the sea. Most of the young fish make the seaward migration about 18 months after the eggs are deposited in the gravel, feed in the ocean for about 18 months, and return to spawn in their third year. Some, mostly males, mature in their second year, after about 6 months in the ocean, and are called "jacks." Jacks are recognized by their small size — generally they are less than about 53 cm. long.

Three-year-old coho salmon weigh an average of 4.5 kg.; they spawn in the fall, usually within a week after they reach their spawning grounds. As the fish migrate upstream or approach maturity, their silvery appearance changes to deep red (deeper in males). The males develop a hooked nose, curved jaw, and a hump anterior to the dorsal fin; the females may become slightly humped and have slightly curved jaws.

Coho salmon are prized by sport fishermen because of their ability to put up a hard fight when hooked and their good eating quality. Major sport fisheries are along the coasts of Washington, Oregon, and California and in the Columbia River estuary. The flesh is medium red, and those caught in the ocean are especially delicious.

Spawning Areas

Coho salmon spawn predominantly in the tributaries of the lower Columbia River (maps 7, 8, and 9). Table 5 gives added information about the streams and runs of this species.

Coho salmon have been introduced into tributaries of the Willamette River system. Although the first generation of adults has returned to spawn and fry have been observed in the streams, it is not yet known whether runs of this species are permanently established. I have designated the areas where spawning now occurs.

Table 4.—Estimated sport catch of steelhead trout in the Columbia River and tributaries, 1962-66. Data are from summary tables prepared by the Washington Department of Game and the Oregon State Game Commission, and fishing harvest survey reports by the Idaho Department of Game

State and streams[1]	Year					Average
	1962	1963	1964	1965	1966	
WINTER-RUN CATCH	*Number of fish*					
Washington[2]:						
Cowlitz	8,445	8,548	11,574	10,317	14,315	10,640
Lower Columbia	6,869	7,503	5,769	5,451	9,367	6,992
Toutle (all forks)	6,003	5,591	5,751	5,088	6,542	5,795
Lewis (all forks)	5,104	5,646	3,219	4,298	8,303	5,314
Kalama	5,575	5,686	3,240	4,721	5,981	5,041
Washougal	5,038	4,192	3,237	4,219	4,461	4,229
Elokomin	1,958	2,931	2,446	1,660	3,160	2,431
Grays	1,875	1,582	4,008	2,422	2,000	2,377
Miscellaneous tributaries	2,375	2,031	2,012	2,362	3,338	2,424
Subtotal	43,242	43,710	41,256	40,538	57,467	45,243
Oregon[2]:						
Sandy	2,693	3,339	3,837	5,830	9,312	5,002
Clackamas	3,401	1,718	2,764	2,438	3,723	2,809
Columbia[3]	3,410	2,248	2,112	1,791	3,449	2,602
Big Creek	901	1,414	2,117	1,993	5,082	2,301
Willamette	2,832	1,437	1,624	1,895	1,730	1,904
Miscellaneous tributaries	2,980	1,561	1,941	1,601	2,857	2,188
Subtotal	16,217	11,717	14,395	15,548	26,153	16,806
Total winter-run	59,459	55,427	55,651	56,086	83,620	62,049
SUMMER-RUN CATCH						
Washington:						
Snake	21,841	15,635	9,904	10,854	12,972	14,241
Lower Columbia	8,195	8,688	9,297	9,388	14,176	9,949
Upper Columbia	12,759	7,893	5,406	7,868	11,094	9,004
Klickitat	1,828	1,485	1,898	3,254	8,093	3,312
Grande Ronde	3,985	2,117	2,189	3,077	3,090	2,892
Kalama	508	0	1,231	3,777	5,365	2,176
Yakima	1,492	1,241	1,174	2,425	3,069	1,880
Lewis	599	879	696	1,017	4,219	1,482
Miscellaneous tributaries	8,183	5,120	3,658	6,693	12,351	7,201
Subtotal	59,390	43,058	35,453	48,353	74,429	52,137
Oregon[2]:						
Columbia[3]	23,229	15,312	12,891	15,446	21,427	17,661
Deschutes	5,773	4,840	8,014	6,244	6,428	6,260
John Day	3,734	3,086	3,334	2,995	5,167	3,663
Snake	2,577	1,957	1,437	1,659	2,586	2,043
Hood	2,343	1,573	1,581	1,234	2,078	1,762
Grande Ronde	1,278	1,049	691	1,574	1,921	1,302
Miscellaneous tributaries	3,259	1,869	1,421	2,216	1,773	2,108
Subtotal	42,193	29,686	29,369	31,368	41,380	34,799
Idaho[4]:						
Salmon	19,584	34,807	11,175	10,157	10,209	17,186
Clearwater	13,088	13,993	4,253	7,214	6,339	8,977
Snake	6,562	5,990	2,274	1,746	3,421	3,999
Subtotal	39,234	54,790	17,702	19,117	19,969	30,162
Total summer-run	140,817	127,534	82,524	98,838	135,778	117,098
Grand total	200,276	182,961	138,175	154,924	219,398	179,147

[1] Rivers except where designated otherwise.
[2] Washington catches of winter-run fish are seasonal; i.e., fall of 1961 and winter of 1962 are included in the estimate for 1962. Oregon's estimates are on a calendar year basis.
[3] Because of the absence of a seasonal breakdown of the Columbia River catch before 1964, I derived the estimates for 1962-63 by taking 13 percent of the total catch for each year for the winter-run and 87 percent of the total as summer-run (the average percentages for 1964-67).
[4] Idaho catches are all summer-run fish.

Table 5.—Spawning areas of coho salmon in the Columbia River Basin—past and present

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
1.	Chinook Creek	12	10	About 3 km. area above tidewater	Same as present.	Small stream, has small quantity of suitable spawning area.	1, 38
2.	Lewis and Clark River	40	12	About 10 km. to 24.	Same as present.	First 5 km. above tidewater has best gravel. Supports small run.	29
3.	Youngs River	29	16	Tidewater to Youngs R. Falls (0.8 km. stretch).	Same as present.	Series of spawning riffles. Most of production is from plants of juveniles above falls.	29
3A.	Klaskanine River	3	11	Main stream, North and South Forks.	About the same as present.	Klaskanine Hatchery (O.F.C.) on North Fork rears most of large run. Fish in excess of hatchery needs are released to spawn.	29
4.	Bear Creek	10	30	Lower portion.	Same as present.	Small stream, supplies water for Astoria, Oreg. Falls 5 km. up is low water barrier.	29
5.	Grays River	26	34	Middle and upper portion and tributaries.	Not as large as now.	Grays River Hatchery operated by W.D.F. (Washington Department of Fisheries) since 1960, supplements production. Falls recently made passable to salmon.	1, 38
6.	Big Creek	21	37	Most of stream.	Same as present.	O.F.C. operates a permanent rack and trap structure, 5 km. up to take salmon for Big Creek Hatchery. Salmon in excess of hatchery capacity are released, and much of area above is used by spawners.	29
7.	Gnat Creek	14	38	Lower portion.	Unknown.	Prevalence of large rubble—little spawning area.	29
8.	Skamokawa Creek	11	54	Lower 6 km. and tributary Wilson Creek.	Same as present.	Small stream, supports small run.	1, 38
9.	Elokomin River	24	61	Throughout main stream above tidewater.	Same as present.	Elokomin Hatchery (W.D.F.) rears part of run.	1, 38
10.	Clatskanie River	40	80	Throughout main river and lower Beaver Creek.	Not as large as now.	Has small run. Falls, rapids, and logjams made passable, increasing spawning area.	1, 38
11.	Abernathy Creek	21	86	Lower 16 km.	Not as large as now.	Excellent spawning areas. Abernathy Falls laddered in 1951. Abernathy Fish Hatchery rears part of run.	1, 38
12.	Germany Creek	19	90	Midportion.	Not as large as now.	Good spawning areas up to falls.	1, 38
13.	Cowlitz River	208	109	Upper main Cowlitz R. tributaries listed below.	About same as present.	Cowlitz system is largest producer of coho salmon in Columbia Basin. Many kilometers of excellent spawning and rearing areas. Large percentage of run formerly went past Mayfield and Mossy Rock Dams to spawn. Most of run will be reared in a hatchery; fish in surplus of rearing capacity of hatcheries will be released for spawning in areas above dams.	1, 38
13A.	Coweeman River	53	2	Short section in midportion and lower Mulholland Cr.	Not as large as now.	Fishway at Coweeman Falls allows fish to use midriver areas. Considered to be a good coho salmon stream.	1, 38
13B.	Ostrander Creek	16	11	Most of main creek.	Not as large as now.	Removal of beaver dams, logjams has increased spawning area in this small tributary.	1, 38
13C.	Arkansas Creek	3	24	North and South Forks.	Same as present.	Arkansas Cr. is formed 3 km. up by union of North and South Forks. Spawning in two forks; lower portions are used as rearing areas.	1, 38
13D.	Toutle River	83	27	Upper Toutle R. and tributaries—Outlet, Alder, Hoffstadt, Bear, Deer, Castle, and Coldwater Creeks.	Same as present.	Large tributary, good producer, many excellent spawning and rearing areas. Its small tributaries have good areas.	1, 38
13D1.	South Fork	45	21	Upper main stream.	Same as present.	Many kilometers of fine holding pools and spawning riffles; many small tributaries nearly all too small or too steep for salmon.	1, 38
13D2.	Green River	51	58	Lower Green R. and lower Devil's Cr.	Hatchery blocked upper portion.	Fish spawn in fair numbers below Toutle R. Hatchery (W.D.F.) rack. Rest reared in hatchery.	1, 38

See footnotes at end of table.

Table 5.–Spawning areas of coho salmon in the Columbia River Basin–past and present–Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
13E.	Olequa Creek	32	35	Lower two-thirds and Stillwater Cr.	Same as present.	Good spawning area. Clearing of log and debris jams has put this stream in good shape after pollution was abated.	1, 38
13F.	La Camas Creek	35	43	Midsection.	Same as present.	Good spawning and rearing areas. Watershed now more stable because of reforestation.	1, 38
13G.	Salmon Creek	56	59	Lower portion and lower Cedar Cr.	Same as present.	Fair-sized run of coho salmon. Former large run nearly exterminated before 1932 because of flushing of logs and shingle bolts down channel. Erosion and silting still present from logging.	1, 38
13H.	Tilton River	42	102	Upper Tilton R. and North Fork.	About same as present.	Lower Tilton R. inundated by Mayfield Reservoir but not formerly used for spawning. Has excellent areas for spawning and rearing. Mayfield Dam may reduce value of spawning areas above this dam.	1, 38
13I.	Landers Creek	15	130	Lower part.	Same as present.	Excellent riffles in indicated area.	1, 38
13J.	Rainey Creek	16	136	Most of main stream.	Same as present.	Good run, large amount of suitable spawning area.	1, 38
13K.	Cispus River	80	147	Upper Cispus R., lower Niggerhead Cr., lower half North Fork.	Same as present.	Large valuable tributary, fair run of coho salmon but more heavily used by chinook; excellent spawning riffles and resting pools. Niggerhead Cr., and North Fork, largest Cispus tributaries, have excellent spawning areas and support fair-sized runs.	1, 38
13L.	Kiona Creek	16	162	Main stream.	Same as present.	Small stream, seems well suited for coho salmon; many excellent riffles and rearing areas.	1, 38
13M.	Silver Creek	19	168	Lower portion to impassable Silver Falls.	Same as present.	Seems especially suited for coho salmon.	1, 38
13N.	Willame Creek	14	189	Lower portion.	Same as present.	A falls 0.8 km. above the mouth believed to block this species. Cascades, falls, and boulders predominate in most of stream above the falls. Area available is well used.	1, 38
13O.	Johnson Creek	19	192	Lower portion to impassable falls.	Same as present.	Typical coho salmon stream.	1, 38
13P.	Skate Creek	22	197	None.	Lower portion.	Excellent spawning riffles were destroyed by home developer who rechanneled stream in 1965.	1, 38
13Q.	Butter Creek	16	200	None.	Lower portion.	Small stream, well suited for coho salmon. Several channels in lower flood plain provided spawning area. As in Skate Creek, home developer destroyed run in 1965.	1, 38
13R.	Lake Creek	8	202	None.	Lower Lake Creek.	Excellent spawning riffles, chiefly in lower 0.27 km. with small patches to a 7.5-m. falls were lost by construction and operation of Packwood Lake Dam.	1, 38
14.	Kalama River	67	120	Most of main stream and small tributaries.	Not as much as now.	Large number of coho salmon reared at two Kalama River hatcheries (W.D.F.). Ladder and hatchery trap at Kalama Falls. Surplus fish released to spawn in upper watershed.	1, 38
15.	Lewis River	144	139	See note.	Area above Merwin Dam and tributaries.	Believed not used now. Lewis R. formerly one of best producers in Columbia Basin, but runs depleted by Merwin Dam. Hatchery releases young below Merwin Dam and collects returning adults. Some young released in Merwin Reservoir, but because of low survival, reservoir will not be used for rearing in the future.	1, 38
15A.	East Fork	67	8	Lower half.	Same as present.	Good producer, with many kilometers of good spawning areas. Lucia Falls blocks salmon from upper 34 km.	1, 38
15B.	Johnson Creek	31	8	Lower part.	Same as present.	Lewis R. Hatchery (W.D.F.) is on this creek. Adults return from hatchery plants to this and Cedar Cr.	1, 38
15C.	Cedar Creek	32	26	Lower 24 km.	More available.	Old milldam, 3 km. up, blocked runs for 70 years until removed in 1946. Cedar Creek Falls, laddered in 1957, increased extent of migration 24 km. Good run.	1, 38

See footnotes at end of table.

Table 5.–Spawning areas of coho salmon in the Columbia River Basin–past and present–Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
16.	Milton Creek	32	144	Middle portion.	Same as now.	Small stream, supports small run. A few use lower part of tributaries.	29
17.	Scappoose Creek	10	146	North and South Forks.	More now.	Pollution is problem in Scappoose Bay. Excellent spawning gravel throughout North Fork; South Fork has excellent gravel in upper portion. Ladder at Bonnie Falls opened more area.	29
18.	Salmon Creek	35	150	Upper part.	Lower stream.	Fair spawning areas in upper half of stream. Lower stream polluted from agriculture and gravel is compacted with silt.	1, 35
19.	Willamette River	303	162	None.	None.	Willamette R. is a migration route and possibly a rearing area. O.F.C. has made a concerted effort to establish coho salmon (also fall chinook) in tributaries of this system. It appears that first-generation fish and some second-generation fish have returned.	29, 40, (4)
19A.	Johnson Creek	35	27	Most of main stream.	Same as now.	Supports a few coho salmon. Best spawning gravel in upper portion of stream.	29, 40
19B.	Clackamas River	128	40	Upper portion and lower North Fork.	Probably some of stream areas inundated by dams.	Falls block migration in North Fork. Lower tributaries (not shown on map) have moderate-sized runs. Good prospects for increasing run.	29, 40
19B1.	Eagle Creek	37	26	Lower 18 km.	Not as large as now.	Good spawning area throughout stream. Migration limited by falls. Recent improvements in passage at falls in lower 18 km., and Eagle Creek National Fish Hatchery increased production in recent years.	29, 40
19B2.	Collawash River	19	93	Lower 11 km. of main stream, lower 10 km. Hot Springs Fork.	Same as now.	Gravel plentifully dispersed in areas of lower gradient; heavily forested, mountainous area.	29, 40
19C.	Abernethy Creek	21	40	Middle section main stream and tributary, Holcomb Cr.	Not as large as now.	Obstructions removed, 1953-55. Now supports fair numbers of coho salmon as well as other salmonids.	29, 40
19D.	Tualatin River	112	45	Upper Tualatin R., McKay, East Fork Dairy, Gales, and Scoggins Creeks.	Species introduced.	Decreased summer flows because of overappropriation of water. Believed coho salmon not present until introduced about 1920; now believed to have largest run migrating above Willamette Falls.	29, 40, (4)
19E.	Molalla River	80	58	Upper and middle portions, North Fork Milalla R.	Species introduced.	Used as passageway and rearing area. No coho salmon known before 1952 when juveniles were liberated into Milk Cr. and the North Fork. Adults returned to spawn. Other releases made in various tributaries. First generation returns indicate run may be successful.	29, 40, (4)
19E1.	Pudding River	88	1	None.	None.	Most of stream has mud-silt bottom and slight gradient; used as passageway.	29, 40
19E1A.	Butte Creek	54	30	Middle and upper areas.	Species introduced.	Spawning areas are spotty, lower areas are silty, middle and upper areas have mostly heavy gravel and bedrock, but suitable gravel is interspersed.	29, 40, (4)
19E1B.	Abiqua Creek	45	56	Section in midportion.	Species introduced.	Abiqua Falls blocks run about 32 km. up. Coho first introduced in 1958. This and subsequent plants have established runs.	29, 40, (4)
19E2.	Milk Creek	40	10	Middle and upper sections and tributaries.	Species introduced.	This stream stocked for several years, and returns indicated that it has good potential.	29, 40, (4)
19F.	Yamhill River	18	80	None.	None.	Used as passageway.	29, 40
19F1.	South Yamhill	96	18	Upper portion and tributaries, Mill Cr.	Species introduced.	Believed that salmon not present in Yamhill system before 1954. Yearly average of over 100,000 juveniles released into better tributaries. Small runs returned to most of tributaries.	29, 40, (4)
19F1A.	Willamina Creek	32	59	Lower half Coast Cr. and East Fork.	Species introduced.	Plants starting in 1954 are thought to have originated runs in this stream.	29, 40, (4)

See footnotes at end of table.

Table 5.—Spawning areas of coho salmon in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
19F2.	North Yamhill	46	18	Upper part and tributaries.	Species introduced.	Water sluggish in lower part; salmon must proceed to upper portion to spawn.	29, 40
19G.	Rickerall Creek	48	142	Small section in midportion.	None.	Hatchery plants established runs where none were present before. Low flows in summer limit use of lower stream, but ideal spawning gravel in part used.	29, 40, (4)
19H.	Luckiamute River	83	173	Upper Little Luckiamute R. and small tributaries of Luckiamute R.	Unknown.	Apparently small runs existed before 1955. Supplemented by hatchery releases since 1959; runs probably larger now, but stream not believed to be fully utilized.	29, 40, (4)
19I.	Santiam River	18	174	None.	None.	Used as passageway and possible rearing area.	29, 40
19I1.	North Santiam River	147	18	None.	None.	None native to stream nor have any been introduced.	29, 40
19I2.	South Santiam River	101	18	Midsection of Thomas and Wiley Creeks and tributaries, lower ⅗ of Crabtree Cr.	Species introduced.	Releases of juvenile coho salmon were made in 7 tributaries in 1959 and 4 in 1966. Fry were seen in the 4 streams in spring of 1969, the offspring from natural spawning.	29, 40, (4)
19J.	Calapooya River	115	192	Probably West Fork Brush Cr.	Species introduced.	Salmon fry were seen in West Fork Brush Creek, but species unidentified. Could be progeny of transplants.	29, 40, (4)
19K.	Marys River	64	211	Sections in Rock, Woods, Blakesley, and Mulkey Creeks.	Species introduced.	The listed tributaries were first stocked with yearling coho salmon in 1959 and 1966. Some fry were observed in each of the tributaries as a result of natural spawning. Too early to state if runs are established.	29, 40, (4)
19L.	McKenzie River	138	282	Mohawk R. and Camp Cr.	Species introduced.	Species unknown before transplants were made in recent years. Camp Cr. has excellent gravel in section 6-11 km. above mouth. Mohawk R. has good to excellent quantities of gravel that appear suitable for spawning. It is unknown whether runs will be firmly established.	29, 40, (4)
19M.	Middle Fork Willamette River	123	302	None in main stream.	None.	Used as passageway.	29, 40
19M1.	Hills Creek	16	13	Lower part.	None known.	A run is apparently established from stocking. Only the lower part is available.	29, 40, (4)
19M2.	Fall Creek	48	18	Upper portion.	Species introduced.	Coho salmon said to have spawned here many years ago appear to have been misidentified for spring chinook salmon.	29, 40, (4)
19M2A.	Little Fall Creek	29	5	None.	Questionable.	Same comment on Fall Cr. applies here. A falls blocks migration 19 km. up.	29, 40, (4)
19M2B.	Winberry Creek	13	6	Lower part.	Species introduced.	First-generation adults returned to spawn.	29, 40, (4)
19N.	Coast Fork Willamette River	80	302	Bear Creek.	Species introduced.	Fry were seen, probable results of spawning adults that returned from transplants.	29, 40
20.	Washougal River	58	189	Lower river, Little Washougal R., Winkler Cr., and West Fork.	Not as large as now.	Salmon Falls, laddered in 1956, opened several kilometers for spawning and allowed access to Washougal Hatchery (W.D.F.) 8 km. above falls. Hatchery rears variable part of run annually; rest spawn in stream below. Large run.	29
21.	Sandy River	72	192	Middle Sandy R. and Cedar Cr.	Salmon and Bull Run Rivers.	Marmot Dam, 43 km. above the mouth, even though equipped with fishway, causes difficulties in maintenance of runs. Hatchery operated by O.F.C. on Cedar Cr., rears coho salmon and other species. Unknown percentage of run uses stream above and below for spawning. Dam on Bull Run R. responsible for loss of run. Marmot Dam and diversion created low flows unfavorable for passage into upper river and tributaries.	29
22.	Hamilton Creek	11	230	Lower part, and Greenleaf Cr.	Same as present.	Small run, spawning area limited.	1, 35

See footnotes at end of table.

Table 5.—Spawning areas of coho salmon in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
23.	Tanner Creek	4	231	Little natural spawning.	Falls 1.6 km. above mouth historically blocked runs.	Little, if any, natural spawning, as Bonneville Hatchery (O.F.C.) intercepts run for hatchery rearing. Stream enters Columbia R. just below Bonneville Dam.	29
24.	Eagle Creek	18	234	Little natural spawning.	Falls 3 km. above mouth blocked runs.	Run mostly supported by Cascade Hatchery of O.F.C.; in some years no fish are allowed upstream of the hatchery rack or water supply control structure.	29
25.	Rock Creek	22	240	Lower 0.8 km.	Same as present.	Falls blocks migration about 1.6 km. above mouth.	1
26.	Herman Creek	11	242	Lower part.	Falls 1.6 km. above mouth blocked runs.	Oxbow Hatchery (O.F.C.) supports run. Almost all water is diverted from stream through hatchery holding ponds.	23, 29
27.	Wind River	51	248	Middle portion and tributaries.	Lower 2.4 km. flooded by Bonneville pool.	Area flooded by Bonneville pool was most of original spawning area. Not known to what extent salmon used this area but apparently coho did not use it before Shipperd Falls was made passable in 1955; coho salmon then introduced into system. Carson National Fish Hatchery annually rears part of run.	1, 35
28.	Lindsey Creek	6	255	Lower 0.4 km.	Same as present.	Small stream; has moderate to heavy use in available portion below falls.	23, 29
29.	Little White Salmon River	29	259	About 0.8 km. of spawning below hatchery rack.	Lower 0.8 km. inundated by Bonneville pool.	Nearly all coho salmon handled at Little White Salmon National Fish Hatchery. Series of falls above hatchery rack impassable to salmon.	1, 35
30.	Hood River	18	271	Section of main Hood R., East and West Forks, and Neal Cr.	Unknown.	Powerdale Dam impedes migration, but small run of coho salmon spawns above. Extent of former run unknown; most use in Neal Cr.	23, 29
31.	Klickitat River	152	288	Sections of main Klickitat and West Fork.	Species introduced.	Good-sized runs handled at Klickitat Hatchery (W.D.F.). Probably no native run of species due to difficult passage at several falls.	1, 38
32.	John Day River	364	333	Small section of Middle Fork.	Unknown.	Middle Fork John Day, tributary to North Fork, extends for 86 km. Gold dredging stopped by early 1940's; silt carried away by stream in some locations; small run reported by O.F.C. in 1961.	20, 22
33.	Walla Walla River	90	503	None.	Location unknown.	No record of former run, but probability good.	5, 22, 33
33A.	Touchet River	99	32	None.	Unknown.	Former run eliminated primarily by irrigation practices many years ago.	5, 22, 33
34.	Snake River	1,602	519	None.	None.	Main Snake R. used for passageway.	5, 22, 33
34A.	Tucannon River	96	101	None.	Location unknown.	Last run reported in 1929.	26
34B.	Clearwater River	120	239	None.	Location unknown.	Little known of location of spawning, but reported to have had run many years ago. Suspected areas shown on map.	9, 21, 26
34C.	Grande Ronde River	320	272	Unknown.	Lower section.	Coho salmon found spawning in main stem in 1940 by U.S.F.W.S. No evidence in 1958, but possibility of a few not ruled out.	26, 33
34C1.	Wenaha River	27	72	Lower portion.	Upper portion.	Exact location of former spawning area not determined, but coho salmon reported as still using Wenaha in 1940. None seen in 1957-59, but some adults seen in 1964.	26, 33
34C2.	Wallowa River	88	130	Upper section.	Probably some reduction.	Surveys by Oregon Fish and Game Commissions revealed spawning fish and redds in area indicated on map. Former large runs believed to have been depleted, but now partially restored.	26, 33
34C2A.	Minam River	72	16	None known.	Lower half.	Reported to have supported run. Removal of old dam and blasting of Minam Falls improved accessibility to upstream areas.	26, 33

See footnotes at end of table.

Table 5.—Spawning areas of coho salmon in the Columbia River Basin—past and present—Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
34C2B.	Lostine River	40	43	Lower portion.	Probably some reduction.	Coho salmon sparsely distributed over lower 8 km. of stream in 1957. Recently constructed fishway at water supply dam permits fish to use upstream areas also. No information on former runs but now increasing.	26, 33
34C3.	Catherine Creek	48	216	Unknown.	Main Stream.	Catherine Cr. reported to have had more coho than chinook salmon many years ago. Coho salmon may use stream today but have gone undetected. Coho fingerling found in downstream migrant traps in 1953, however.	26, 33
35.	Yakima River	317	536	Upper main Yakima R.	Part of upper main Yakima R., Cle Elum and Kachess Rivers, and Umptanum and Taneum Creeks, also Naches R. Other areas unknown.	Small run persists in Yakima watershed, where good runs formerly spawned. Umptanum and Taneum Creeks reported to have had good runs.	2
36.	Wenatchee River	88	749	Icicle Cr. below hatchery and main Wenatchee R. below Leavenworth.	Portions of Icicle and Nason Creeks.	Formerly large runs entered Wenatchee system to spawn. Icicle and Nason Creeks were only known productive areas but other tributaries were probably contributors. Leavenworth National Fish Hatchery, which reared coho salmon many years ago, resumed the work in 1963. Restocking has begun. Some returns from plants in Icicle Cr. realized as noted in text. In 1968 most spawners used the main Wenatchee R. downstream from Leavenworth.	2, 15, 16
37.	Entiat River	83	774	Entiat R.	Reduced somewhat but specific areas unknown.	A small run persists in this stream after decimation from early years. Some fry have been stocked in last few years.	2
38.	Methow River	114	838	Main stream downstream from town of Twisp.	Upper Methow and Twisp Rivers.	Methow R. supported large runs about 50 years ago. Coho salmon recently reintroduced from Winthrop National Fish Hatchery; small run returned from initial release. Few return to the hatchery. A small run spawns in the main stream below the Twisp R.	2, 15, 16
39.	Spokane River	144	1,029	None.	Probably lower 80 km. of Spokane R., and Little Spokane R.	Known to have supported run many years ago. Little information available on size of run or where fish spawned.	2

[1] The streams are listed in numerical sequences, proceeding upstream from the mouth of the Columbia. Streams that are direct tributaries of the Columbia are identified by numerals only; subtributaries are designated by a combination of numerals and letters.
[2] Location in kilometers above mouth of Columbia or kilometers above mouth of contributing drainage.
[3] References are numbered to facilitate location in Literature Cited.
[4] Personal communication, C. A. Weberg, Assistant Fisheries Director, Fish Commission of Oregon, June 4, 1969.

The longest distance that coho salmon are known to have migrated in the Columbia River was to the Spokane River, about 1,126 km. from the ocean (Gilbert and Evermann, 1894; Bryant and Parkhurst, 1950). Runs to the Spokane River were probably entirely eliminated before construction of Grand Coulee Dam in 1939. Dams on the Spokane River and heavy commercial fishing in the lower Columbia River were factors that eliminated the run. The farthest migrations of coho salmon today in the Columbia River Basin are to the Lostine and Wallowa Rivers of eastern Oregon, about 965 km. from the sea.

A search of the early literature shows no evidence of coho salmon in the upper Snake River. Evermann (1896a) noted, however, that the names "dog salmon," "silver salmon," "silver sides," "salmon belly," "chinook salmon," and "quinnat salmon," as used in Idaho, all referred to the single species, chinook salmon. Chinook salmon that arrived at the spawning grounds early were called silver salmon because of their bright, silvery appearance.

Abundance

Coho salmon were most abundant in the Columbia River in the early years of the fishery (fig. 2). Peak production was in 1925 when 3,600,000 kg. of canned and mild cured coho salmon were processed; the lowest catch on record was in 1959 when only 55,000 kg. were landed. After the peak catches in the 1920's,

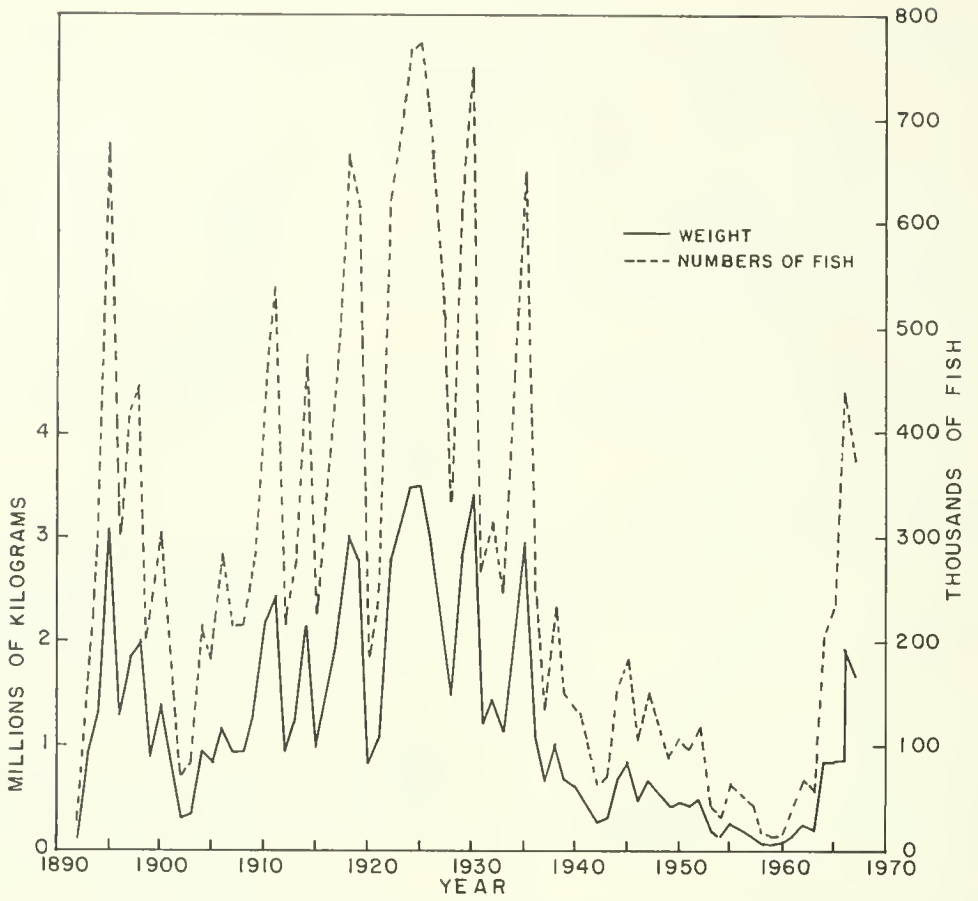


Figure 2.—Commercial catch of coho salmon in the Columbia River, 1892-1967. [Data for 1892-1936 from Craig and Hacker (1940), for 1937 from Ward, Robison, and Palmen (1963), and for 1938-67 from Fish Commission of Oregon and Washington Department of Fisheries (1968).]

the fishery experienced an almost continual decline to the record low in 1958-60. In 1967-68, however, the catch increased to about 2 million kg.

The number of coho salmon landed in the Columbia River commercial fisheries in 1938-67 fluctuated from 15,000 to 1959 to 422,000 in 1966 (fig. 3). The count at Bonneville Dam varied from 790 in 1945 to 96,000 in 1967. The major reasons for the upward trend of the catch since 1960 (fig. 12) is undoubtedly increased production and better survival of hatchery fish.

The Fish Commission of Oregon and the Washington Department of Fisheries annually have counted spawning coho salmon in index areas in certain streams from 1952 to 1967. These agencies, however, have not estimated total spawning escapements because of the following difficulties: poor visibility caused by high water, the very extensive spawning grounds of the species, the necessity of repeating surveys to cover early and late runs in some tributaries, and the extended period that fish are on the spawning grounds (about 2 months). The first column of table 6 gives an approximation of the numbers of spawners. These estimates are based upon average index counts per mile of stream for 1964-67, multiplied by the number of miles of streams; exceptions were the Cowlitz, Willamette, Clackamas, and Sandy Rivers, for which counts at Mayfield, Willamette Falls, North Fork, and Marmot Dams were used.[2]

[2] Advice from Clint E. Stockley, Fishery Biologist, Washington Department of Fisheries, for Washington streams (April 1968) and Arthur L. Oakley, Fishery Biologist, Fish Commission of Oregon, for Oregon streams (April 1968).

In addition to those adult returns discussed in table 6, unknown numbers of coho salmon migrate to the following tributaries of the Columbia River: Washington tributaries—Little White Salmon River and Chinook, Skamokawa, Germany, and Rock Creeks; Oregon tributaries—Lewis and Clark, Youngs, Klaskanine, Sandy (below Marmot Dam), Hood, Wenaha, Wallowa, and Lostine Rivers and Bear, Big, Gnat, Milton, Scappoose, Johnson, Abernethy, and Lindsey Creeks. Average returns to the hatcheries of the Columbia River system in 1964-67 were 240,000 coho salmon, of which about 40 percent were 2-year-old males ("jacks"). Even if the large numbers of jacks are excluded from the counts, more coho salmon returned during the past few years than at any time in the history of the hatcheries.

The recent large runs have enabled fishery agencies to transplant eggs and fry to unproductive tributaries. Coho salmon have been planted in several tributaries of the Willamette River, including tributaries of the Tualatin, Mollala, Yamhill, Rickreall, Luckiamute, Santiam, Calapooya, Marys, McKenzie, Middle Fork Willamette, and Coast Fork Willamette Rivers. Fry and fingerling coho salmon were introduced into lower and middle tributaries of the Columbia River, such as the Klickitat, Yakima, Wenatchee, Entiat, Methow, and Okanogan Rivers.

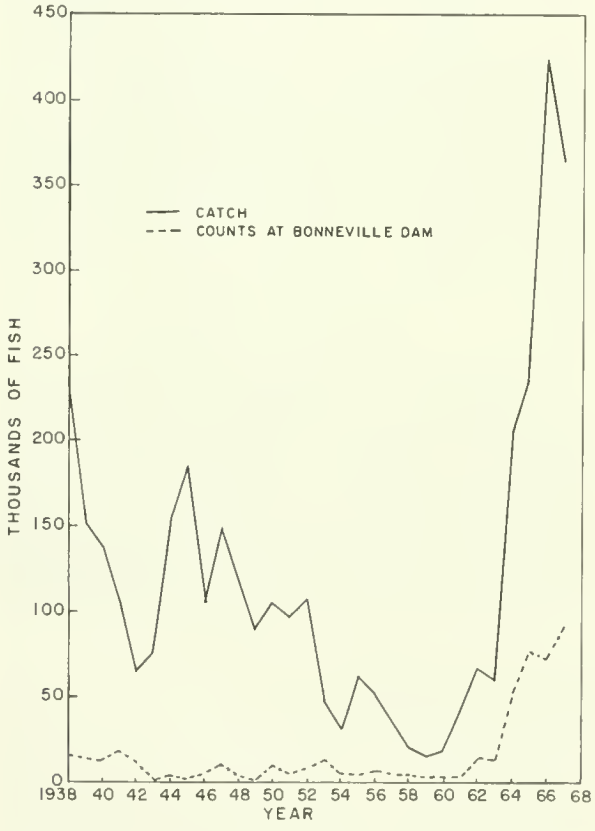


Figure 3.—Commercial catch of coho salmon in the Columbia River and counts at Bonneville Dam, 1938-66. [Data for 1938-62 from Ward, Robison, and Palmen (1963) and for 1963-67 from Fish Commission of Oregon and Washington Department of Fisheries (1968).]

Table 6.—Estimated numbers of coho salmon spawning and returning to hatcheries and tributaries of the lower Columbia River, 1964-67

Stream	Natural spawning	Returns to hatchery[1]
	Thousands of fish	
Klaskanine River	--	25
Grays River	4	12
Big Creek	--	19
Elokomin Creek	1	10
Abernathy Creek	1	--
Cowlitz River	[2]26	--
Toutle River	12	27
Other tributaries	4	--
Kalama River	5	28
Lewis River	2	3
Salmon Creek	1	2
Willamette River	0	--
Clackamas River	[3]2	6
Other tributaries	[4]8	--
Washougal River	2	38
Sandy River	[5]1	14
Hamilton Creek	1	--
Tanner Creek	--	24
Eagle Creek	--	17
Herman Creek	--	1
Wind River	2	--
Little White Salmon River	--	16
Klickitat River	--	3
Total	72	240

[1] Consists of about 40 percent "jacks."
[2] Count at Mayfield Dam. No spawning in lower main stem.
[3] Count at North Fork Dam. Hatchery is on Eagle Creek which is not included in this count.
[4] Count at Willamette Falls Dam.
[5] Count at Marmot Dam. An unknown number spawn in Sandy River and tributaries below Marmot Dam.

Returns of adult coho salmon to the Methow River from releases of yearling fish by the Winthrop Natioinal Fish Hatchery were disappointing—only small numbers came back in 1962-66. Some do not home to the hatchery as small numbers are observed by Washington Department of Fisheries personnel to spawn in the Methow River below the hatchery.

Transplants from lower Columbia River stocks to Icicle Creek, a tributary of Wenatchee River, have been more successful. In 1964, the Leavenworth National Fish Hatchery released about 465,000 yearling coho salmon into Icicle Creek; in 1966, 1,741 adult fish homed

to this hatchery. Releases have been made annually since 1964. High water in 1967 prevented hatchery personnel from trapping and counting all the fish, but about 50 adults and 385 jacks were captured out of the many that returned to the stream below the hatchery dam. In 1968, 2,200 fish were trapped at the hatchery and about 150 remained in Icicle Creek immediately downstream from the hatchery and several hundred more used the rest of Icicle Creek to spawn. These fish are larger than usual in the Columbia River and weighed from 5.5 to 6.8 kg. Thus, it appears that the stocks introduced have adapted to the conditions; the prospects of reestablishing a run of coho salmon to Icicle Creek is excellent.

The fishery agencies of Washington and Oregon have recently made annual estimates of the "minimum" run of coho salmon (table 7). The estimates are derived by combining the gill net catches below Bonneville Dam, the sport catch in the lower Columbia River, and counts at fishways and hatcheries. Coho salmon that spawn in many small streams below Bonneville Dam are not included nor are the ocean catches by sport and commercial fishermen.

Recent ocean catches along the coasts of southern British Columbia, Washington, Oregon, and California have been large, but the percentage of the catch that is of Columbia River origin is unknown. The recapture along the coast of many marked coho salmon from the Columbia River, however, indicates that the percentage may be large.

On the basis of rought estimates of catches and escapements in 1957, it is possible to arrive at an approximation of the total (rather than minimum) coho salmon run in the Columbia River in that year:

1. Ocean troll catch	184,428
2. Lower Columbia River sport catch	38,163
3. Offshore sport catch	59,666
4. Commercial fishery below Bonneville Dam	55,812
5. Count at Bonneville Dam	4,675
6. Spawning escapement below Bonneville Dam	70,000
Total	412,844

Data for the first three figures were from the Bureau of Commercial Fisheries (1960) and for items 4 and 5 from the Fish Commission of Oregon and the Washington Department of Fisheries (1968); data for item 6 appear in table 6. The percentage composition of the 1957 run was as follows: ocean catch, 59.1; Columbia River catch, 22.8; and escapement, 18.1. If this same percentage of ocean caught coho salmon is estimated for more recent years, it would give the following total runs for 1961-67: 475,880, 644,000, 593,000, 1,669,700, 2,029,500, 2,077,500, and 2,651,000.

Since 1963 the runs have increased, and the proportion of ocean catch to the other segments of the run may vary greatly from that in 1957. These estimates are given to show the possible magnitude of the coho salmon runs; their accuracy cannot be verified.

Future of Coho Salmon Runs

The future of coho salmon runs in the Columbia River appears good in view of the increase in 1960-67. Artificial propogation is believed to be mainly responsible because of the good returns of adult fish to streams where releases were made. Runs to Columbia River hatcheries were in excess of rearing capacities, and surplus fish and eggs were transported to

Table 7.—Estimated minimum run of coho salmon in the Columbia River, 1961-67

[Dashes indicate that no data are available]

Year	Hatchery recoveries	Landings below Bonneville Dam	Sold by Indians	Counts at Bonneville Dam	Sport catch in lower river	Minimum run
			Number of fish			
1961	--	38,000	--	3,000	85,500	126,500
1962	96,000	65,000	--	15,000	20,000	196,000
1963	66,000	60,000	--	13,000	36,000	175,000
1964	226,000	203,500	2,100	54,000	134,000	619,600
1965	207,000	232,000	3,200	76,000	250,000	768,200
1966	280,000	420,000	2,400	72,000	13,600	788,000
1967	252,000	365,000	11,500	96,500	300,000	1,025,000

other areas to start new runs. The possibility of expanding spawning runs to middle Columbia tributaries also appears good in view of the success at Icicle Creek. The prospects are good for an increase in size of the run to an average of about 5 million fish, providing water quality can be improved and that some unfavorable factor does not occur.

SOCKEYE SALMON

Sockeye salmon are fall spawners. The principal upstream migration starts in May and continues through August. The migrants reach their native lakes during July, August, and September before moving onto spawning grounds in streams or lake shoals. Runs of the upper Salmon River into Redfish Lake and to the Okanogan River start spawning in late September and peak in mid-October. The Wenatchee River fish spawn from early to late September.

Eggs hatch in the stream or lake gravel from January to March and the fry do not leave the gravel until most of the yolk is absorbed (March to May). The young fry swim into their native lake and remain variable periods of time. Most move out the next spring but others remain a year or two longer before migrating to the North Pacific Ocean. Most in the Columbia River mature at age 4 but many are 3 and 5 years old.

While in the ocean, sockeye salmon are sky blue above and silver below; upon their arrival at a lake system the upper portion fades to a pinkish gray. Just before the fish move onto the spawning ground, they turn crimson, or brick red, and the heads become a bright olive green. At spawning time, they are not easily frightened and are easy prey.

Sockeye salmon are highly regarded as food; their flesh is deep red, firmer than that of other salmon, and lends itself readily to canning. The quality of flesh of Columbia River sockeye salmon is outstanding—probably because it has a longer spawning migration than most stocks and has large reserves of fat. The fish in the Columbia River, however, are among the smallest of this species in the Pacific northwest. The average 4-year-old sockeye salmon of the Columbia River is about 1.7 kg., whereas the average Canadian and Alaska specimens weigh about 3 kg. The 3-year-old Columbia River sockeye salmon weighs about 1 kg.; the 5- or 6-year-old fish may weigh as much as 5 kg.

The sockeye salmon is the only one of the five species of Pacific salmon in North America that has successfully maintained itself wholly in fresh water on a large scale without the aid of artificial propagation. Kokanee, as the nonanadromous variety is called, are in most lakes where the anadromous form exists or existed.[3] They also have been successfully introduced into many cold-water lakes throughout the United States; they spawn naturally when suitable conditions are present, but in many areas artificial propagation is necessary.

Marking experiments in the Columbia and Fraser River systems have proved that kokanee sometimes migrate from their native lakes to the ocean and return as mature sockeye salmon. Kokanee from Lake Wenatchee were reared at Leavenworth National Fish Hatchery and marked by fin clipping. One group was released in Icicle Creek and the other in Lake Wenatchee. Mature sockeye salmon bearing these marks returned later to the lower Columbia River, where some were caught in the fishery; others returned to the Wenatchee area in numbers similar to those in other marking experiments on regular sea-run stock.[4] Cultus Lake, tributary of the Fraser River system in British Columbia, was the scene of another kokanee marking experiment (Foerster, 1947). Releases from the outlet of Cultus Lake returned as mature sockeye salmon of the same average size as the usual sea-run stocks. (In Wenatchee Lake kokanee produced mature sockeye salmon 0.09 to 0.18 kg. smaller than the normal sea-run variety.)

[3] Steelhead trout frequently become resident rainbow trout and also have the same ability to maintain themselves in fresh water. Clinton Stockley and Ken Kroll (biologists, Washington Department of Fisheries) report that a small population of chinook salmon has taken residency in Lake Cushman Reservoir (Washington State), spawning in an inlet stream, and feeding in the reservoir to maturity. Also, the first generation survival of coho and chinook salmon in the Great Lakes (Michigan and Superior) will be watched to see if these species can be permanently established.

[4] Manuscript by Mitchell G. Hanavan, Chief (retired), Branch of Anadromous Fisheries, Bureau of Commercial Fisheries, Washington, D.C., and Leonard A. Fulton.

Spawning Areas

Sockeye salmon are not as widely distributed in the Columbia River Basin as steelhead trout or chinook or coho salmon. Past and present rearing areas are as follows:

1. Arrow Lakes—Upper and Lower Arrow Lakes, Whatshan, and Slocan Lakes
2. Okanogan Lakes—Palmer, Osoyoos, Skaha, and Okanogan Lakes
3. Yakima Lakes—Bumping, Cle Elum, Kachess, and Keechelus Lakes
4. Wenatchee Lake
5. Payette Lake
6. Wallowa Lake
7. Redfish Lakes—Redfish, Alturas, Petit, and Yellowbelly Lakes, and
8. Suttle Lake

Map 10 shows these areas. Table 8 gives notes about the streams and spawning areas.

Wenatchee, Osoyoos, and Redfish are the only lakes that produce sockeye salmon today (map 10).

It is possible that sockeye salmon formerly migrated about 1,900 km. upstream from the ocean into the headwaters of the Columbia River; the presence of kokanee in Windermere and Columbia Lakes suggests that the anadromous form of the species once inhabited the area. The presence of sockeye salmon in the Columbia Lake area was never verified, but thorough investigations were not made before blockage of the runs by Grand Coulee Dam.

Attempts have been made from time to time to establish runs of sockeye salmon in other areas in the Columbia River Basin. For example, in 1916 stock from Yes Bay, Alaska, was taken to the Little White Salmon Hatchery and maintainede there for several generations (Bryant, 1949). Also, from 1939-45 transplants of native Columbia River stocks that formerly spawned in the upper Columbia River were made to Spirit Lake in the upper Toutle River drainage of the Cowlitz River basin, Suttle Lake in the Deschutes drainage, and to the Little White Salmon River. Quinault Lake stock from the Washington Coast was transplanted to Entiat River and Icicle Creek. Although marked fish from these plants returned to the Columbia River and were captured in the commercial fisheries, only a few migrated to the places of release (none to Spirit Lake, one to the Metolius River near Suttle Lake, eight to Little White Salmon, and one to the Entiat River).

During 1954-58 further attempts were made to establish runs of sockeye salmon in Spirit Lake and Lost Lake in the West Fork Hood River drainage (northeastern Oregon). About 400 adults returned to Spirit Lake, the result of planting 197,000 young fish. However, only a few returned to the Hood River system from a plant of 50,000 young fish. C. E. Stockley (biologist, Washington State Department of Fisheries; personal communication, 1969) has since advised that a kokanee population has been established in Spirit Lake, perhaps as a result of this stocking or the planting of kokanee at various times. Spirit Lake has a shortage of good spawning areas as most inlet streams are steep and have large boulders. It is possible that a sockeye salmon run could be established in Spirit Lake if additional spawning areas could be provided.

In the late 50's, the Washington Department of Fisheries made sporadic attempts to establish a run of this species in Merwin Reservoir on the Lewis River. To my knowledge no populations were established in this location.

Abundance

Sockeye salmon, as well as other species of anadromous salmon and trout, were formerly much more numerous in the Columbia River Basin. Records of canned sockeye salmon and early history of fishing in the spawning areas are our best indications of former abundance. The fishery for sockeye salmon in the lower Columbia River began in 1889 and quickly peaked in 1898 when 2,056,000 kg. were packed. Extreme yearly fluctuations in the catch were characteristic of the early fishery (fig. 4). The pack rapidly declined till 1910 when a slight upturn occurred. The first peak (2,056,000 kg.) was about 17 times the average of 1956-66 (120,000 kg.).

Fishing at or near the spawning grounds had already been in progress before the large commercial fishery began in the lower river. Indians traveled great distances to obtain their year's supply, which they usually dried or smoke-cured. When the early white settlers

Table 8.—Spawning areas of sockeye salmon in the Columbia River Basin—past and present

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
1.	Deschutes River	392	326	None.	None.		20, 22
1A.	Metolius River	64	178	None.	Suttle Lake and tributaries.	Suttle L. supported small run of sockeye salmon before 1930's. Runs blocked by 1.2-m. power dam and stationary upright screen at outlet. Sockeye salmon stocked 10 years in Pelton Reservoir; 289 adults returned to Pelton Dam 1956-61 and transplanted above dam to spawn. Run has since diminished.	20, 22
2.	Snake River	1,602	519	None.	None.	Used as passageway.	9, 10, 11, 19, 26, 27, 28
2A.	Grande Ronde	320	272	None.	None.	Formerly used as passageway.	9, 10, 11, 26, 33
2A1.	Wallowa River	88	130	None.	Tributaries to Wallowa L. and shoals of upper part of lake.	Wallowa L. supported fair-sized runs before turn of century. Already depleted run finished off in 1929 when 12-m. dam constructed at outlet of lake. Stationary screen placed at outlet to retain kokanee and trout. Wallowa L. regarded as excellent rearing area. Spawning gravel used by kokanee in inlet mostly destroyed by dredging and channelization during 1960's. Kokanee decimated. O.G.C. restocked lake with Canadian kokanee and created spawning areas.	26, 33
2B.	Salmon River	641	299	None.	None.	Used as migration route.	9, 10, 11, 19, 27
2B1.	Redfish Lake Creek	2	604	Redfish L.	Same as present.	Shoals, particularly on eastern shore of lake, are only spawning areas used by sockeye salmon. Kokanee or small redfish use Redfish L. Cr. above lake. Spawning areas not large.	9, 10, 11, 19, 27
2C.	Payette River	115	572	None.	Payette L. area.	System blocked in 1914 by dam. Evermann (1896a, 1896b) reported that large runs frequented this stream. Of the three Payette lakes (Payette, Lower Payette, Upper Payette). Payette was apparently only good spawning areas located at inlet of Payette and Upper Payette Lakes.	9, 10, 11, 19, 27
3.	Yakima River	317	537	None.	Cle Elum, Kachess, Keechelus, and Bumping Lakes and tributaries.	All four Yakima lakes had good sockeye salmon runs before dam construction at outlets. No fishways or fish-passage devices were provided. Spawning in lakes and streams tributary to lakes. Not reported in literature but sockeye salmon known to have existed in Bumping L. before dam at outlet.[4] Bumping R. is tributary to American R., a tributary of the Naches R.	2, 31
4.	Wenatchee River	88	750	Wenatchee L., Little Wenatchee and White Rivers, Nason Cr. Also recently scattered areas in Wenatchee R. from Icicle Cr. junction to its source.	Same as present.	Now one of the large producers in Columbia R. Basin. Original runs depleted during early 1900's. After improvements in 1933-38, under salvage program, some of the salmon passing Rock Island Dam were diverted to Wenatchee R. Excellent spawning areas in the main tributaries to Wenatchee L. Leavenworth National Fish Hatchery reared part of run until 1965.	2, 4, 6, 7, 13, 15, 16, 18, 37
5.	Okanogan River	128	855	Okanogan R. above Osoyoos L., some in Osoyoos L.	Tributaries of Okanogan and Skaha L. Also Palmer L. and its inlet stream, Sinlahekin Cr.	This is the other large producer in the Columbia Basin. Early runs were large. As mentioned above for Wenatchee, the Okanogan was recipient of Grand Coulee stocks. Good spawning areas in main stem above Osoyoos L.	2, 4, 6, 7, 13, 15, 16, 18, 37
6.	Arrow Lakes	160	1,264	None.	Arrow L. area and tributaries.	Combined length of Lower and Upper Arrow Lakes is about 160 km.; believed to have been producing about 85 percent of Columbia run before 1939 (when Grand Coulee Dam was built). Sockeye salmon probably used most of many tributaries of lakes. Lakes Whatshan, Slocan, Kinbasket, Windermere, and Columbia were probably producers of this species. Also, Chapman (1943) reported that sockeye salmon were present in Kuskanax Cr., tributary to Upper Arrow L. in 1938.	2, 4

[1] The streams are listed in numerical sequences, proceeding upstream from the mouth of the Columbia. Streams that are direct tributaries of the Columbia are identified by numerals only; subtributaries are designated by a combination of numerals and letters.
[2] Location in kilometers above mouth of Columbia or kilometers above mouth of contributing drainage.
[3] References are numbered to facilitate location in Literature Cited.
[4] Personal communication, Kingsley G. Weber, Fishery Biologist, BCF Biological Laboratory, Seattle, Wash. 98102, December 10, 1965.

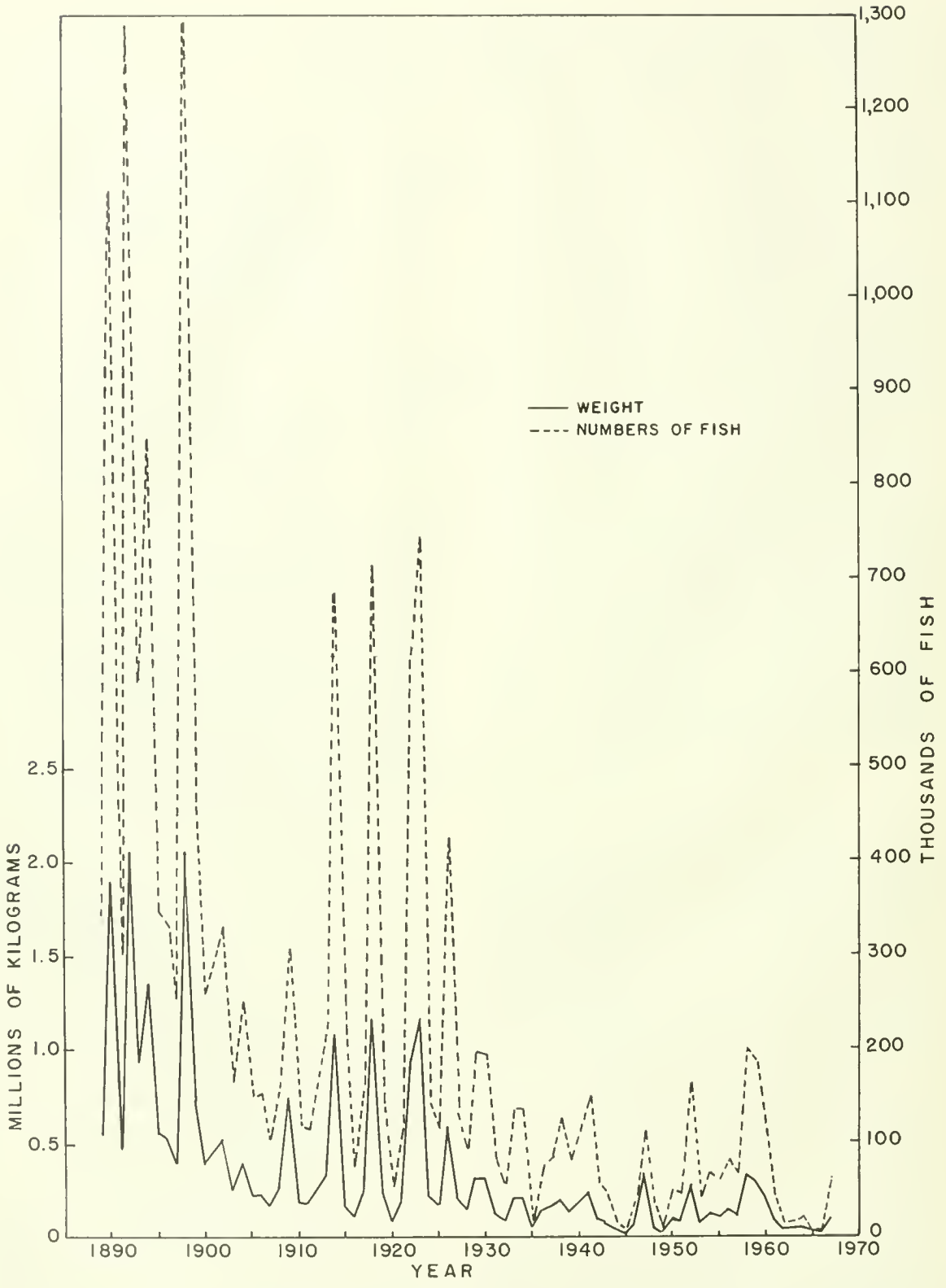


Figure 4.—Commercial catch of sockeye salmon in the Columbia River, 1889-1967. [Data for 1889-1936 from Craig and Hacker (1940), for 1937 from Ward, Robison, and Palmen (1963), and for 1938-67 from Fish Commission of Oregon and Washington Department of Fisheries (1938).]

reached Redfish, Payette, and the Yakima Lakes in about 1850, the runs were still large, though variable. When more people moved into the area, larger numbers of sockeye salmon were taken from the spawning beds and soon the white man started a commercial fishery at some of the areas.

Evermann (1896a), ichthyologist of the U.S. Fish Commission, while investigating the extent of Pacific salmon in Idaho during 1894, reported that two firms fished Payette Lake in 1870-78. One firm processed as many as 75,000 sockeye salmon from Payette Lake in 1 year, but by 1878, because of the few fish available, it was not profitable to continue. Wallowa Lake had a smaller fishery; Evermann and Meek (1898) reported that 2,000 fish were caught at the head of this lake in 1894.

Evermann (1896a) and Evermann and Meek (1898) noted that sockeye salmon and kokanee were caught in Redfish, Alturas, and Petit Lakes of the Upper Salmon River drainage in Idaho. These early investigators did not find great numbers of sockeye salmon in the area, though occasional large runs were reported by residents.

Robison (1957), in reviewing the former sockeye salmon runs of the Columbia River, stated that this species was extremely abundant in the Upper Yakima River Basin before 1850 and probably made up a good portion of the catch for the entire Columbia River. Crib dams, however, at the outlets of Cle Elum, Kachess, and Keechelus Lakes blocked runs as early as 1905.

The Salmon River of Idaho was never a large producer of sockeye salmon because of the low productivity of its clear, cold lakes—Redfish, Alturas, Petit, Stanley, and Yellowbelly—and the lack of spawning grounds. Moreover, the area's production was limited by the construction of Sunbeam Dam in 1913, about 576 km. above the mouth. The fishway was ineffective as fish could not enter it during low-water stages. Occasionally, under favorable circumstances, a few sockeye and chinook salmon were thought to have gone around one side of the dam through a tunnel. In effect, the dam removed the upper Salmon River from production until 1934 when it was partially breached and finally removed (Parkhurst, 1950b). About 200 sockeye salmon were seen spawning in Redfish Lake during October 1942; in 1955, the number had increased to 4,000 but subsequent runs were under this figure. Apparently the run maintained during the period of difficult passage by (1) the migration of young kokanee from the lake to the ocean and (2) the successful passage of a few sockeye salmon around Sunbeam Dam.

About 1921, the Okanogan River was blocked by Vaseux Dam, 24 km. above Osoyoos Lake. A wooden fishway was constructed to pass salmon, but it soon became inoperative, and was never repaired or replaced. Consequently, Okanogan and Skaha Lakes were blocked from production. They were apparently large producers at one time; they are large and have a rich supply of plankton. Osoyoos Lake (about 14 km. long and from 3 to 6 km. wide) is productive and has never been blocked from salmon. On the other hand, Vaseux Lake (about 1 km. long) was never suitable for rearing of sockeye salmon because of its shallowness.

The last lakes to be taken from production of sockeye salmon were those of the Upper Columbia—Lower and Upper Arrow, Whatshan, Slocan, Kinbasket, Windermere, and Columbia Lakes. These lakes were cut off by the construction of Grand Coulee Dam in 1939, at which time most of the remaining sockeye salmon of the Columbia River were composed of these stocks.

In 1938, the Washington Department of Fisheries (1938) estimated the number of spawners in the upper Columbia River system by counting the sockeye salmon that passed through the fishways at Rock Island Dam on the Columbia River, at Tumwater Dam on the Wenatchee River, and at Zosel Dam on the Okanogan River just below Osoyoos Lake.

Counts at Rock Island Dam for 1935-37 were 14,012, 16,516, and 15,091; at Tumwater Dam, 889, 29, and 65; and at Zosel Dam, 264, 895, and 2,162. Apparently, the spawning escapement to the upper Columbia River was low, especially to the Wenatchee and Okanogan River systems. After the counts in the two streams were subtracted from those at Rock Island Dam, the counts were 12,859, 15,583, and 12,764 fish for the 3 years. In other words,

92, 94, and 85 percent of the total that had passed Rock Island Dam migrated to the upper Columbia River.[5]

When Grand Coulee Dam was built, sockeye salmon that spawned in the upper Columbia River were intercepted at Rock Island Dam and transplanted to the Wenatchee and Okanogan Rivers. Before this transplant, numerous improvements were made in these streams to protect the fish during migration. Runs that were successfully transplanted are maintained in these streams.

The spawning escapement, as reflected by counts at Rock Island Dam, range from a low of less than 1,000 in 1941 to about 170,000 in 1966 (fig. 5). The escapement in 1941 was responsible for a small run (11,000 fish) in 1945. At the next cycle (1949) the run was well on its way to recovery with 53,000 sockeye salmon, and the 1953 run had an estimated total of 260,000 fish. Runs during the next two cycle years (1957 and 1961) declined, however.

The trend of the Columbia River sockeye salmon run, as indicated by the least squares method, demonstrates a slight upward slope since 1938. It appears that the highs are nearly equal to the lows and the average run is about 150,000 fish.

Apparently the decline in abundance of this species (from the records of the fishery in 1895-1925), therefore, was the result of the combined effect of the commercial fisheries in the lower river, fishing on the spawning grounds, and complete blocking of most spawning grounds.

Future of Sockeye Salmon Runs

Runs of sockeye salmon in the Columbia River could be quickly jeopardized by unfavorable conditions at either or both of the two major production areas. Poor survival of spawning stock was recognized as a serious problem by Craddock and Parks (1962), who estimated that only about 10,000 spawners of the escapement of 20,000 was left in 1961 to perpetuate the run. If a proposed water use

[5] It was later discovered that Zosel Dam was not "fish tight" and unknown numbers were able to swim under its gates. We now realize that the percentage of the sockeye salmon from the upper Columbia River was smaller than indicated.

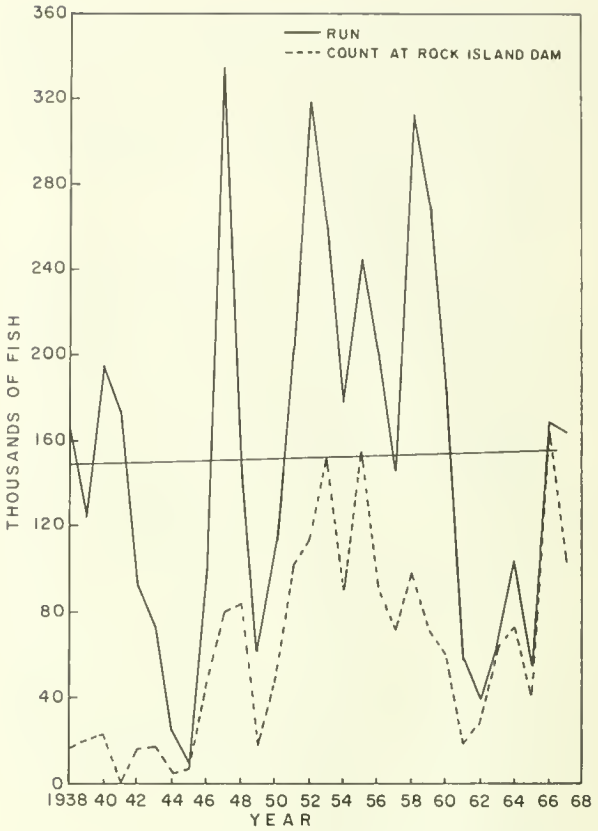


Figure 5.—Sockeye salmon runs of the Columbia River and counts at Rock Island Dam, 1938-67. Straight line is derived from the least squares method. [Data from Fish Commission of Oregon and Washington Department of Fisheries (1968).]

development for the Wenatchee River (now being held in abeyance) were developed, the runs would be even more difficult to maintain and might be completely eliminated.

In the Okanogan River, often a large percentage of the spawning population is made up of the smaller 3-year-old sockeye salmon rather than of the usual 4-year-old fish. The 3-year-olds have a large percentage of males (60 percent or greater).

The numbers of each age group that pass Rock Island and Zosel Dams on the main Columbia and Okanogan Rivers, respectively, have been compared with those observed on the spawning grounds; a preferentially higher survival of 3-year-old fish was noted. Moreover, the smaller sockeye salmon have fewer eggs. Water temperatures above the optimum during July, August, and September in the Okanogan River caused unknown numbers of

adult migrants to die before spawning. Higher than optimum temperature during spawning probably caused loss of eggs deposited in the beginning of the season.

It is not possible to predict the future of this species in the Columbia River basin because of the discontinuance of artificial propagation at Leavenworth National Fish Hatchery, the impounding of most of the river, and the presence of the other potentially adverse conditions cited above.

CHUM SALMON

Chum migrate into the lower tributaries of the Columbia River; they enter the Columbia River from October through December and spawn shortly after entering fresh water.

Chum salmon mature predominantly in their fourth year, although 3- and 5-year-old fish are common. In the Columbia River, age 4 fish weigh 3.6 to 5.4 kg. and average about 4.5 kg. Chum salmon are principally taken in the river gill net fishery. Because chum salmon do not usually take a lure, they are not part of the sport catch, nor are they usually caught by commercial trollers.

The spawners are grayish green on their dorsal surface with blotches of pink, grey, and green laterally and are sometimes referred to as calico color. The young emerge from the gravel upon hatching, soon start on their seaward migration, and grow rapidly after they reach the ocean.

The flesh of chum salmon is pale pink and is regarded as inferior to the other species of salmon, ranking as the lowest grade of canned salmon along the Columbia River. One of the more common methods of processing this species is smoking.

Spawning Areas

Chum salmon spawn in the lower tributaries of the river (map 11). Table 9 lists the producing areas, length of stream in kilometers, and distance from the mouth.

This species spawns in the lower portions of tributaries (map 11); the principal tributaries are: Grays, Elokomin, Lewis, and Washougal Rivers and Big, Mill, Abernathy, Germany, Milton, Hardy, and Hamilton Creeks.

Most of the chum salmon that enter the Columbia River spawn in tributaries below The Dalles Dam, 309 km. above the mouth. An average of 27 chum salmon passed through the fishways at The Dalles Dam in 1957-63, whereas an average of 801 passed Bonneville Dam during the same period. Most of these fish probably spawned in tributaries between the two dams, as the fishery was closed.

Former spawning areas were located in the Kalama River, lower portions of Little White Salmon River and Hamilton, Rock, and Herman Creeks, and areas along margin of river banks in the main Columbia River (the latter four areas were inundated in 1938 by the pool created by Bonneville Dam). The areas lost are not extensive, however, and made up only a small portion of the total available spawning areas. Many of the spawning riffles in the lower portions of tributaries of the lower Columbia River, however, received heavy layers of silt when the area was logged many years ago and are now unsuitable for spawning.

Abundance

Chum salmon were also formerly much more abundant in the Columbia River. Craig and Hacker (1940) stated that it is not possible to draw conclusions on their relative abundance from data on commercial canning because this species fluctuates in abundance and the annual catch often depends on the market for cheaper grades of salmon. Nevertheless, the canning and commercial catch—the only available indexes of relative abundance (fig. 6)—show some production over the entire period of the fishery.

Maximum and minimum productions of chum salmon in the Columbia River were 3,854,000 kg. in 1928 and 3,000 kg. in 1965. The low catches since 1957 was partially due to curtailment of the fishery. For the most part, chum salmon are currently protected from the commercial harvest in the Columbia River by closures in October and all of November. Chum salmon are not taken by offshore fisheries. Reduced fishing, however, has not produced the expected increase in spawners in the Columbia River. A similar decline of this species occurred along the entire Pacific Coast according to the Fish Commission of

Table 9.—Spawning areas of chum salmon in the Columbia River Basin—past and present

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
1.	Lewis and Clark River	40	13	Lower portions.	About same as present.	Small run, but well suited for spawning. Run blocked by dam at km. 24.	29
2.	Youngs River	29	16	About 1.6 km. section above tidewater to Youngs R. Falls.	Same as present.	Practically continuous spawning riffles in available section.	29
2A.	Klaskanine River	3	11	Lower North Fork.	Same as present.	A few chum salmon reported in North Fork.	29
3.	Bear Creek	10	30	Lower portion.	About same as present.	Small run reported in suitable areas to a dam 8 km. up.	29
4.	Grays River	26	34	First 8 km. above tidewater, lower Left Fork, and Crazy Johnson Cr.	Not as large as now.	Grays R. Hatchery of W.D.F., operated since 1960, supplements production. Upper portion was blocked by falls but is now available. Good survival of eggs in Crazy Johnson Cr., concentrated spawning in spring-fed area.	1, 38
5.	Big Creek	21	37	Km. 1.6 to 4.8	About 10 km. stretch above hatchery.	Big Creek Hatchery of O.F.C. blocks run at km. 5. Hatchery rears part of run.	29
6.	Gnat Creek	14	38	Lower portion.	Same as present.	Small stream, has little spawning area. Much of streambed is bedrock or large rubble.	29
7.	Skamokawa Creek	11	54	Lower 6 km. above tidal influence.	Same as present.	Small stream, extent used by chum salmon unknown.	1, 38
8.	Elokomin River	24	61	First 3 to 5 km. above tidal influence.	Same as present.	Fair-sized run enters to spawn. Elokomin Fish Hatchery (W.D.F.) rears part of run.	1, 38
9.	Clatskanie River	40	80	Main R. and lower Beaver Cr.	None available now.	Spawning gravel adequate for several thousand salmon in 13-km. section above tidewater. Spawning area was added when Clatskanie Falls was made passable in 1950. Beaver Cr. has about 5 km. of spawning area, above tidewater to Beaver Cr. Falls.	29
10.	Mill Creek	10	85	Lower portion.	Same as present.	Supports good run in lower reaches.	1, 38
11.	Abernathy Creek	21	86	Lower portion.	Same as present.	Abernathy National Fish Hatchery supplements production; good spawning areas.	1, 38
12.	Germany Creek	19	90	Most of Germany Creek.	Same as present.	Many good spawning areas; good run.	1, 38
13.	Coal Creek	22	99	About 5 km. stretch above lower slough area.	Same as present.	Spawning limited by falls, high portion of large rubble, and bedrock. Only a few chum salmon use stream.	1, 38
14.	Cowlitz River	208	109	None in main Cowlitz R.	Main Cowlitz R. in vicinity of Mayfield Reservoir.	Chum salmon pass through lower tributary. Former area inundated by reservoir.	1, 38
14A.	Coweeman River	53	2	Lower part.	Same as present.	Small run uses lower part of this tributary. A few chum salmon may spawn in lower Ostrander, Arkansas, Salmon, Olequa, and La Camas Creeks, and Toutle R. but none observed in recent years.	1, 38
15.	Kalama River	67	120	None.	Lower part.	A few chum salmon, reported in past, but no established run believed in stream at present.	1, 38
16.	Lewis River	144	139	Below Merwin Dam.	Same as present.	Small run spawns in this stream. Some reared for a period at the Lewis R. Hatchery (W.D.F.), but none in recent years.	1, 38
16A.	East Fork Lewis River	67	8	Lower portion.	Same as present.	Used by a few more chum than the main Lewis R. Good spawning area, designated on map.	1, 38
17.	Milton Creek	32	144	Lower portion.	Same as present.	Formerly had a much larger run than now. Streamflow reduced because water supply taken by town of St. Helens.	29
18.	Salmon Creek	35	150	Lower portion.	Same as present.	Small run use this small stream. Summer flows become rather low, but are high when chum salmon use the stream.	1, 36
19.	Washougal River	58	189	Lower Washougal R. and tributary.	Same as present.	A fair run of chum salmon enters this tributary during fall when sufficient water is present to dilute effluents from the Camas Paper Mill.	1, 35

See footnotes at end of table.

Table 9.–Spawning areas of chum salmon in the Columbia River Basin–past and present–Continued

Number[1]	Stream	Length	Distance above mouth[2]	Spawning areas		Notes	References[3]
				Present	Past		
		Km.	*Km.*				
20.	Hardy Creek	6	229	Lower portion.	Same as present.	Has good-sized run for small area available. Apparently, eggs have good survival in gravel.	1
21.	Hamilton Creek	11	231	Lower portion.	Same as present.	This tributary has a run of chum salmon that use available area. Right bank has spring-fed area that may support survival.	1, 35
22.	Rock Creek	22	240	Lower 0.8 km.	A falls 1.6 km. up blocks run.	Small Washington stream believed to support a few chum salmon. Heavy rubble and boulders but limited spawning areas among them.	1
23.	Herman Creek	11	242	Lower 1.6 km.	A falls 1.6 km. up blocks run.	Occasionally, chum salmon are taken at Oxbow Hatchery (O.F.C.).	29
24.	Little White Salmon River	29	259	About 0.8 km. of spawning below hatchery rack.	Lower 0.8 km. inundated by Bonneville pool.	Some years a few chum salmon appear at the hatchery racks. A few spawn below the racks.	1, 35
25.	Columbia River		232	None.	In main stem in stretch about 232-248 km. above mouth.	This species formerly used small gravel in slow water near the shore for spawning. No information on numbers or probability of survival. May have been strays from some of the tributaries.	(4)

[1] The streams are listed in numerical sequences, proceeding upstream from the mouth of the Columbia. Streams that are direct tributaries of the Columbia are identified by numerals only; subtributaries are designated by a combination of numerals and letters.
[2] Location in kilometers above mouth of Columbia or kilometers above mouth of contributing drainage.
[3] References are numbered to facilitate location in Literature Cited.
[4] Clint Stockley, Washington Department of Fisheries, Vancouver, Wash. Personal communications, April 1968.

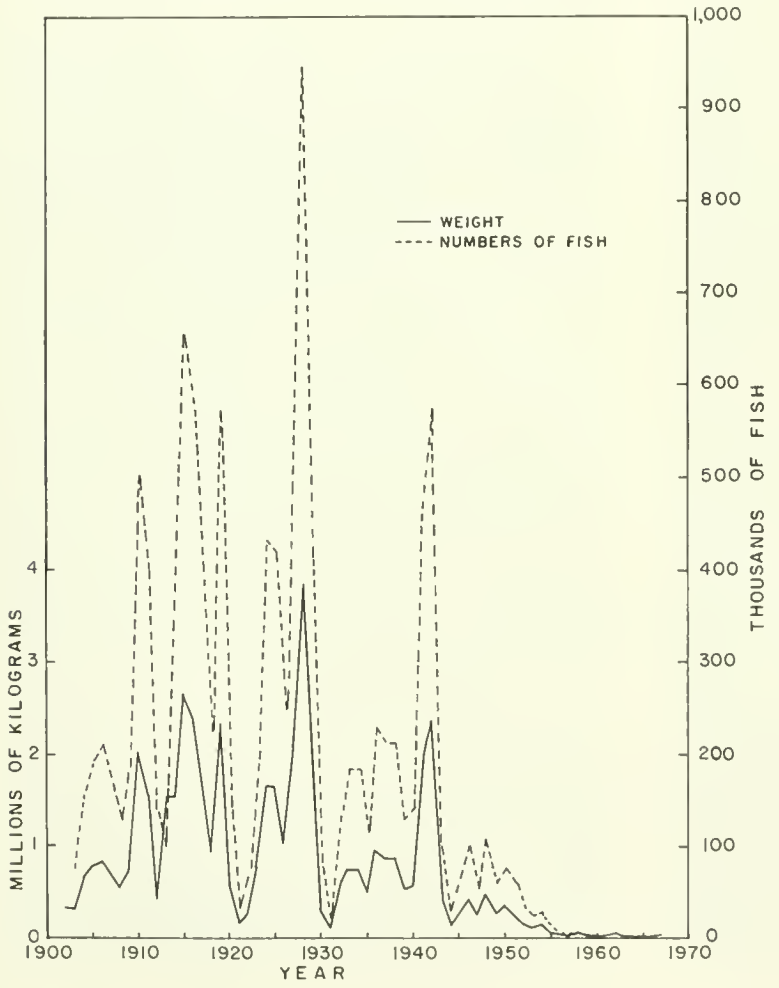


Figure 6.–Commercial catch of chum salmon in the Columbia River, 1902-67. [Data for 1902-36 from Craig and Hacker (1940), for 1937 from Ward, Robison, and Palmen (1963), and for 1938-67 from Fish Commission of Oregon and Washington Department of Fisheries (1968).]

Oregon and Washington Department of Fisheries (1968).

C. E. Stockley (1966), commenting on the near disappearance of the chum salmon runs along the coast of North America, reported that some of the many causes are: (1) wholesale destruction of spawning areas through clear-cut logging, which resulted in compaction of the gravel of spawning riffles by silt; (2) construction of dams, such as Bonneville, which flood lower areas of streams characteristically used by this species; (3) predation by sharks in the open seas; and (4) in general, disturbance of its former ecological niche, which has probably increased predation or competition or both. Another important cause for the decrease in chum salmon may well be that the larger numbers of yearling coho salmon in the lower Columbia River prey more heavily on chum salmon fry before they move out to sea.

Future of Chum Salmon Runs

Runs of chum salmon in the Columbia River have been low in the past several years. The 3.8 million kg. caught in 1928 is equivalent to 850,000 fish (based on a 4.5-kg. average weight per fish). By comparison only 560 chum salmon were caught in the fishery in 1965; 497 ascended Bonneville Dam, and the fewest fish in many years were on the principal spawning grounds.

The type of spawning area used by this species has been the least affected by the construction of dams as far as passage is concerned, but perhaps the more subtle changes in the lower portions of streams such as siltation and compaction of gravel have had a more serious effect on the survival of eggs and fry. Chum salmon seem unable to adapt to new spawning areas upstream, as sockeye, chinook, and coho salmon appear to have done.

In summary, this species has failed to respond to almost complete closure of the fishery since 1959. Chum salmon stocks along the Pacific Coast from Alaska to Oregon are declining, indicative of some common adverse factor. At this time the future of this species in the Columbia River is discouraging.

SUMMARY

Information about the areas in which steelhead trout and coho, sockeye, and chum salmon spawn in the Columbia River basin is scattered in many detailed, lengthy reports. Because these reports cover many tributaries, it is difficult to draw conclusions on which to base decisions about management of the salmon fisheries or about needs for research. Furthermore, many data are not published. Accordingly I have summarized relevant publications and unpublished data through 1969 in the present report; information on chinook salmon was similarly summarized in a previous report (Fulton, 1968).

In my study of the steelhead trout and the species of salmon reported here, I considered three main aspects of each species; spawning areas, abundance, and the future of the Columbia River runs.

Steelhead Trout

Spawning areas.—Steelhead trout have been eliminated from many spawning areas above dams such as Merwin Dam on the Lewis River and Hells Canyon Dam on the Snake River. The chief spawning areas in the tributaries of the Columbia River are located, in order of importance, in the following rivers: Salmon, Clearwater, Cowlitz, Washougal, Lewis, Kalama, Grande Ronde, John Day, Willamette, Sandy, Hood, Deschutes, and Imnaha.

Although steelhead trout move throughout the year from the ocean into the Columbia River, they all spawn in the winter or spring. Those entering during the winter November to April) predominantly spawn in the tributaries below Bonneville Dam, and those entering during the summer (May to October) predominantly spawn in the tributaries above Bonneville Dam. Some steelhead trout return to the Columbia to spawn two or more times.

Abundance.—The early runs of steelhead trout in the Columbia River Basin were large. About 2 million kg. was packed, for example, during the peak year of 1892. The smallest pack—177,000 kg.—was in 1966. Since 1929, Oregon is the only state in which this species is processed commercially. Large sport catches are taken in Washington, Oregon, and Idaho.

Future of the steelhead trout runs.—Since 1938, the runs of steelhead trout in the Columbia River have gradually declined. The present greater survival of steelhead trout raised in hatcheries, however, should help to stabilize the runs at about 200,000 to 250,000 fish per year.

Coho Salmon

Spawning areas.—Formerly, the concentration of spawning was in the lower tributaries but many fish used the middle and upper tributaries also. This species now spawns predominantly in lower tributaries. In order of importance, the rivers for natural spawning are the Cowlitz, Toutle, Willamette (including the Clackamas River and other tributaries), Kalama, and Grays; the streams for hatchery production are Washougal River, Kalama River, Toutle River, Klaskanine River, Tanner Creek, Big Creek, Eagle Creek, Little White Salmon River, Sandy River, Grays River, Elokomin River, and Eagle Creek (Clackamas River).

The production of coho salmon in hatcheries has recently become important because the techniques of hatchery management have been improved—namely, the development of pelletized food, rearing of the fish to the yearling stage, and better treatment of diseases.

Abundance.—The commercial production of coho salmon, which was formerly our best indicator of the abundance of this species, reached a peak of about 3.6 million kg. in 1925 and a low point of 55,000 kg. in 1959. Since 1960, the commercial take of coho salmon has been on the increase; the catch in 1967 of about 2 million kg. was the largest in recent years. During the last 6 years, offshore catches by sport and commercial fishermen have increased greatly. Many of the coho salmon caught offshore originated in the Columbia River.

Future of the coho salmon runs.—Since the alltime low in 1959, the runs of coho salmon in the Columbia River have increased markedly because of the increasing survival of juveniles raised in the hatcheries. Present runs average about 2 to 3 million coho salmon per year; it is expected that future runs will probably average about 5 million coho salmon per year.

Sockeye Salmon

Spawning areas.—Sockeye salmon originally spawned in eight systems of lakes in the Columbia River. Of the original eight systems, only three are producing today. The run, however, is almost entirely supported by fish from Lake Wenatchee and Lake Osoyoos.

Abundance.—The runs of sockeye salmon fluctuate widely in abundance. The largest single pack of canned salmon — 2 million kg. — was in 1898. The smallest pack — 4,000 kg. — was in 1941. The average for the 10-year period from 1956 to 1966 was 120,000 kg.

Future of the sockeye salmon runs. — Since 1929, the runs of sockeye salmon in the Columbia River have declined markedly from those of earlier years.

Despite this marked decline, however, the sockeye has shown resiliency. After being almost destroyed in 1938-45, it recovered and again faced destruction in 1961, but recovered. The present data, however, point to another decline.

Three relatively new factors may influence the future of the sockeye salmon in the Columbia River; namely, (1) hatcheries have stopped rearing them, (2) most of the Columbia River downstream from the rearing areas is now impounded, and the impoundments reduce the survival of downstream migrants, and (3) improvements in natural spawning areas that have been proposed, if effected, may increase the number of juveniles in the downstream migrations. With two adverse factors and one possibly favorable factor, the net results are not predictable.

Chum Salmon

Spawning areas.—Chum, the least abundant salmon on the Columbia River, spawns in late autumn or early winter. Characteristically, it has short spawning migrations and accordingly spawns in tributaries of the lower Columbia River. The tributaries on the north side—that is, those on the Washington side, are the heaviest producers. The most important producers, in order of importance are:

Grays River, Elokomin River, Lewis River, Washougal River, Abernathy Creek, Big Creek, and Hamilton Creek.

Abundance.—The last year of high production of chum salmon was 1942, when 600,000 fish, or 2.3 million kg., were processed. The highest production (3.9 million kg.) was in 1928, and the lowest (3,000 kg.) was in 1965. The future of chum salmon in the Columbia River is in doubt, inasmuch as runs have continued to decline. Some of the spawning areas were inundated by the construction of Bonneville Dam. In other localities, siltation caused by deforestation and by the flushing of logs down the channels of streams has destroyed spawning areas.

Future of the chum salmon runs. — Commercial production, although not necessarily reflecting actual abundance, is the only record we have. This record indicates that the runs suffered a sharp decline in 1944. In 1957, the fishery was curtailed to encourage recovery. Unfortunately, the reduced fishing has not resulted in the expected increase in the number of spawners in the Columbia River. This decline is in common with that of other stocks of chum salmon from Oregon to Alaska. Accordingly, this run will probably be too small for commercial harvesting in the foreseeable future.

LITERATURE CITED

(References are numbered to facilitate citation in tables.)

1. BRYANT, FLOYD G.
   1949. A survey of the Columbia River and its tributaries with special reference to the management of its fishery resources. Part 2. Washington streams from the mouth of the Columbia River to and including the Klickitat River (Area I). U.S. Fish Wildl. Serv., Spec. Sci. Rep. 62, 110 pp.
2. BRYANT, FLOYD G., and ZELL E. PARKHURST.
   1950. Survey of the Columbia River and its tributaries.—Part IV Washington streams from the Klickitat and Snake Rivers to Grand Coulee Dam, with notes on the Columbia and its tributaries above Grand Coulee Dam, (Area III). U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 37, 108 pp.
3. BUREAU OF COMMERCIAL FISHERIES.
   1960. Review report, Columbia River Fishery Development Program. U.S. Fish Wildl. Serv., Bur. Commer. Fish., Portland, Oreg., vol. 1, 33 pp., vol. 2, append. A-I, 149 pp. [Processed.]
4. CHAPMAN, WILBERT McLEOD.
   1941. Observations on the migration of salmonid fishes in the upper Columbia River. Copeia 1941 (4): 240-242.
5. COLUMBIA BASIN INTERAGENCY COMMITTEE.
   1957. Columbia River Basin Fishery Program—Part 2, Inventory of streams and proposed improvements for development of the fishery resources limited to tributaries above McNary Dam. Columbia Basin Interagency Comm., Fish. Steering Comm., Portland, Oreg., 100 pp. [Processed.]
6. CRADDOCK, DONOVAN R.
   1958. Spawning escapement of Okanogan River blueback salmon (*Oncorhynchus nerka*), 1957. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 275, 8 pp.
7. CRADDOCK, DONOVAN R., and NORMAN B. PARKS.
   1962. Spawning escapement of Columbia River blueback salmon (*O. nerka*), 1961. U.S. Fish Wildl. Serv., Bur. Commer. Fish., Seattle, Wash., 17 pp. [Processed.]
8. CRAIG, JOSEPH H., and ROBERT L. HACKER.
   1940. The history and development of the fisheries of the Columbia River. U.S. Bur. Fish., Bull. 49: 133-216.
9. EVERMANN, BARTON W.
   1896a. A preliminary report upon salmon investigations in Idaho in 1894. Bull. U.S. Fish Comm. 15: 253-284. (Doc. 301.)

10. 1896b. A report upon salmon investigation in the hearwaters of the Columbia River in state of Idaho, in 1895, together with notes upon the fishes observed in that State in 1894 and 1895. Bull. U.S. Fish Comm. 16: 149-202. (Doc. 318.)
11. EVERMANN, BARTON W., and SETH EUGENE MEEK.
1898. A report upon salmon investigations in the Columbia River Basin, and elsewhere on the Pacific Coast in 1896. Bull. U.S. Fish Comm. 17: 15-84. (Doc. 352.)
12. FISH COMMISSION OF OREGON and WASHINGTON STATE DEPARTMENT OF FISHERIES.
1968. The 1967 status report of the Columbia River commercial fisheries. Fish. Comm. Oreg. and Wash. State Dep. Fish., 91 pp., 32 tables, 30 figs. [Processed.]
13. FISH, FREDERIC F., and MITCHELL G. HANAVAN.
1948. A report from the Grand Coulee fish-maintenance project 1939-1947. U.S. Fish Wildl. Serv., Spec. Sci. Rep. 55, 63 pp.
14. FOERSTER, R. E.
1947. Experiment to develop sea-run from land-locked sockeye salmon (*Oncorhynchus nerka kennerlyi*). J. Fish. Res. Bd. Can. 7: 88-93.
15. FRENCH, ROBERT R., and R. J. WAHLE.
1960. Salmon runs—Upper Columbia River, 1956-57. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 364, 15 pp.
16. 1965. Salmon escapements above Rock Island Dam, 1954-60. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 493, 18 pp.
17. FULTON, LEONARD A.
1968. Spawning areas and abundance of chinook salmon in the Columbia River Basin—past and present. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 571, 26 pp. + maps.
18. GANGMARK, HAROLD A., and LEONARD A. FULTON.
1952. Status of Columbia River blueback runs, 1951. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 74, 29 pp.
19. GILBERT, CHARLES H., and BARTON W. EVERMANN.
1894. A report upon investigations in the Columbia River Basin with descriptions of four new species of fishes. Bull. U.S. Fish Comm. 1: 169-207.
20. HAAS, JAMES B., and H. C. WARREN.
1961. Environmental survey report pertaining to salmon and steelhead in certain rivers of Eastern Oregon and the Willamette River and its tributaries. Part III. Survey Reports of the Deschutes and John Day Rivers and Fifteen Mile Creek. Fish Comm. Oreg., Res. Div., (Contract with U.S. Dep. Int., Fish Wildl. Serv., Bur. (Comm. Fish., Contract No. 14-17-001-178, Amend.), 52 pp. [Processed.]
21. MURPHY, LEON W., and HOWARD E. METSKER.
1962. Inventory of Idaho streams containing anadromous fish including recommendations for improving production of salmon and steelhead. Part II. Clearwater River Drainage. Idaho Dep. Fish Game, (Contract with U.S. Dep. Int., Fish Wildl. Serv., Bur. Comm. Fish., Contract No. 14-19-001-431, June 1962), 196 pp. [Processed.]
22. NIELSON, REED S.
1950. Survey of the Columbia River and its tributaries. Part 5, Area IV. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 38, 41 pp.
23. OREGON STATE GAME COMMISSION.
1963a. The fish and wildlife resources of the Hood Basin, Oregon, and their water use requirement. A report to the State Water Resource Board, Federal Aid to Fish Restoration. Oreg. State Game Comm., Portland, Oreg., Project F-69-R-1, Job No. 1, 32 pp., app. [Processed.]
24. 1963b. The fish and wildlife resources of the Umatilla Basin, Oregon and

their water use requirements; A report to State Water Resources Board. Oreg. State Game Comm. [Portland, Oreg.], 34 pp., app. I-V. [Processed.]

25. OREGON STATE GAME COMMISSION.
1958-64. Annual report of Fishery Division. Oreg. State Game Comm., Portland, Oreg. Various pagination. [Processed.]

26. PARKHURST, ZELL E.
1950a. Survey of the Columbia River and its tributaries. Part 6. Area V. Snake River system from the mouth through the Grande Ronde River. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 39, 58 pp.

27. 1950b. Survey of the Columbia River and its tributaries. Part 7, Area VI. Snake River from above the Grande Ronde River through the Payette River. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 40, 95 pp.

28. 1950c. Survey of the Columbia River and its tributaries. Part 8, Area VII. Snake River above Payette River to upper Salmon Falls. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 57, 19 pp.

29. PARKHURST, ZELL E., FLOYD C. BRYANT, and REED S. NIELSON.
1950. Survey of the Columbia River and its tributaries. Part 3, (Area II). U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 36, 103 pp.

30. RICH, WILLIS H.
1948. A survey of the Columbia River and its tributaries with special reference to the management of its fishery resources—Part I, Introduction. U.S. Fish Wildl. Serv., Spec. Sci. Rep. 51, 26 pp.

31. ROBISON, ROBERT S.
1957. The Yakima River—historical and present Indian fishery. State Wash. Dep. Fish., [Seattle], April 30, 1957, 13 pp. text, [4 pp.] figs. [Processed.]

32. STOCKLEY, CLINT.
1966. What happened to the chum salmon? Pac. Fisherm. 64(8): 14-16.

33. THOMPSON, ROBERT N., and JAMES B. HAAS.
1960. Environmental survey report pertaining to salmon and steelhead in certain rivers of Eastern Oregon and the Willamette River and its tributaries. Part 1. Survey report of Eastern Oregon Rivers. Fish Comm. Oreg., Res. Div., Clackamas, Oreg., (Contract with U.S. Dep. Int., Fish Wildl. Serv., Bur. Commer. Fish., Contract No. 14-17-001-178, June 1960), 432 pp., 134 tables, 160 figs., app. A, B, and C. [Processed.]

34. U.S. ARMY CORPS OF ENGINEERS.
1966. Annual fish passage report, North Pacific Division, Bonneville, The Dalles, McNary, and Ice Harbor Dams, Columbia and Snake Rivers, Oregon and Washington 1966. U.S. Army Eng. Dist., Portland and Walla Walla, [Wash.], Corps Eng., 15 pp. test, 71 tables, 28 pl. [Processed.]

35. UNITED STATES FISH AND WILDLIFE SERVICE.
1951. Lower Columbia River Fisheries Development Program Basin Reports.—Washougal River Area, Big White Salmon River Area, Little White Salmon River Area, and Wind River Area. U.S. Fish. Wildl. Serv. [Columbia River Develop. Progr., Portland, Oreg.]. Separate area reports, various pagination. [Processed.]

36. WARD, DALE, ROBERT ROBISON, and ARTHUR PALMEN.
1963. 1963 fisheries statistical report. Wash. Dep. Fish., 73d Annu. Rep.: 127-216.

37. WASHINGTON DEPARTMENT OF FISHERIES.
1938. Report of the preliminary investigations into the possible methods of preserving the Columbia River salmon and steelhead at the Grand Coulee Dam. Prepared for

U.S. Bur. Recl. by State Wash. Dep. Fish. in cooperation with the Dep. Game and U.S. Bur. Fish., 101 pp. [Processed.]

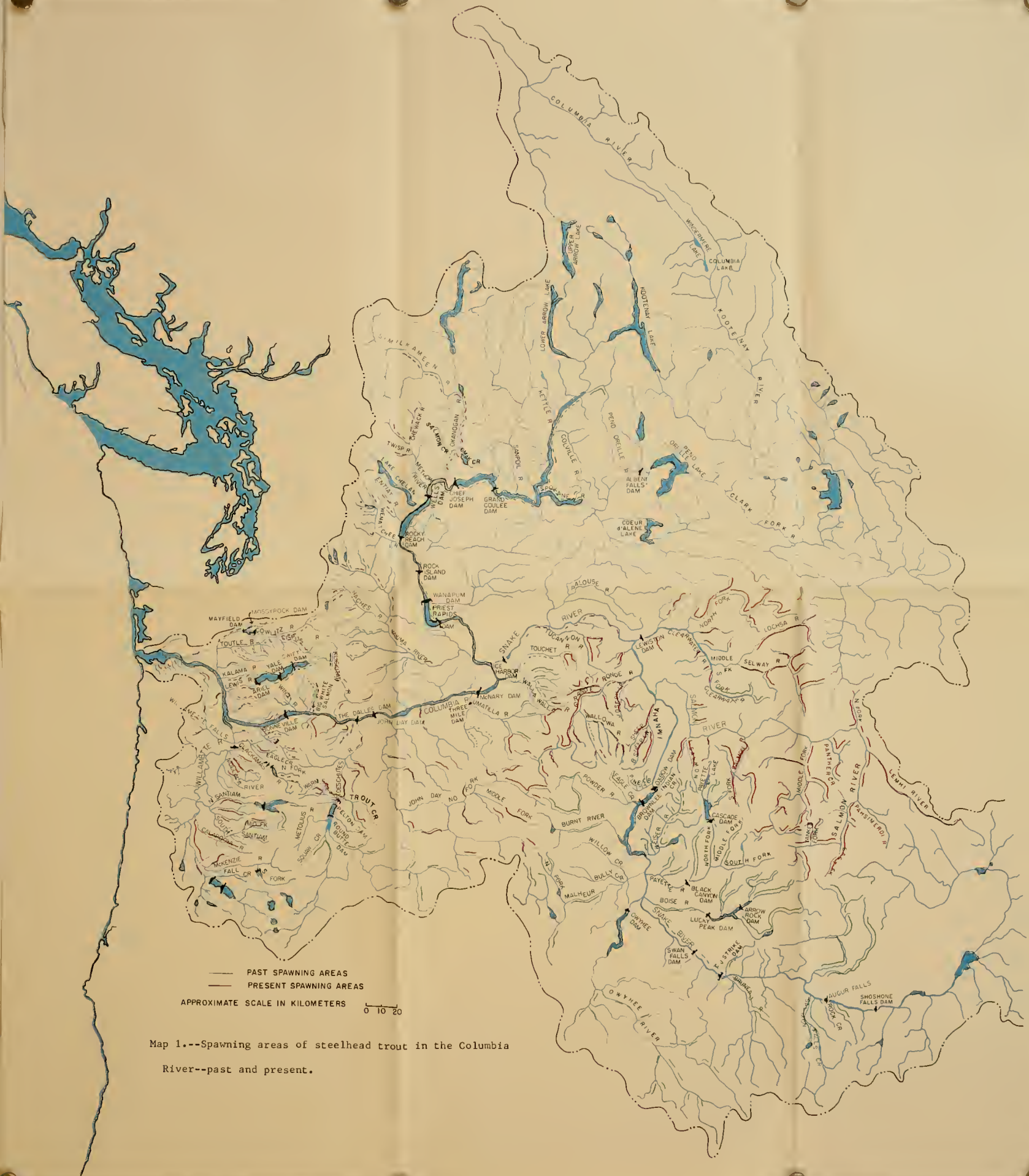
38. 1951. Lower Columbia River Fisheries Development Program, Basin reports of Grays River Area, Elokomin Area, Kalama River Area, Abernathy Area, Cowlitz Area, Lewis River Area, Klickitat River Area, Wash. State Dep. Fish. [Olympia] with collaboration of U.S. Fish Wildl. Serv. [Columbia River Develop. Progr., Portland, Oreg.]. Separate area reports, various pagination. [Processed.]

39. 1959. Contributions of Western States, Alaska and British Columbia to salmon fisheries of the North American Pacific Ocean, including Puget Sound, Straits of Juan de Fuca and Columbia River. Wash. State Dep. Fish., Fisheries 2, 83 pp.

40. WILLIS, RAYMOND A., MELVIN D. COLLINS, and RAY E. SAMS.
1960. Environmental survey report pertaining to salmon and steelhead in certain rivers of Eastern Oregon and the Willamette River and its tributaries. Part II. Survey Reports of the Willamette River and its tributaries. Fish Comm. Oreg., Res. Div., Clackamas, Oreg., (Contract with U.S. Dep. Int., Fish Wildl. Serv. Bur. Commer. Fish., Contract No. 14-17-001-178, June, 1960), 554 pp., 150 tables, 174 figs., app. A, B, and C. [Processed.].

MS. #2043

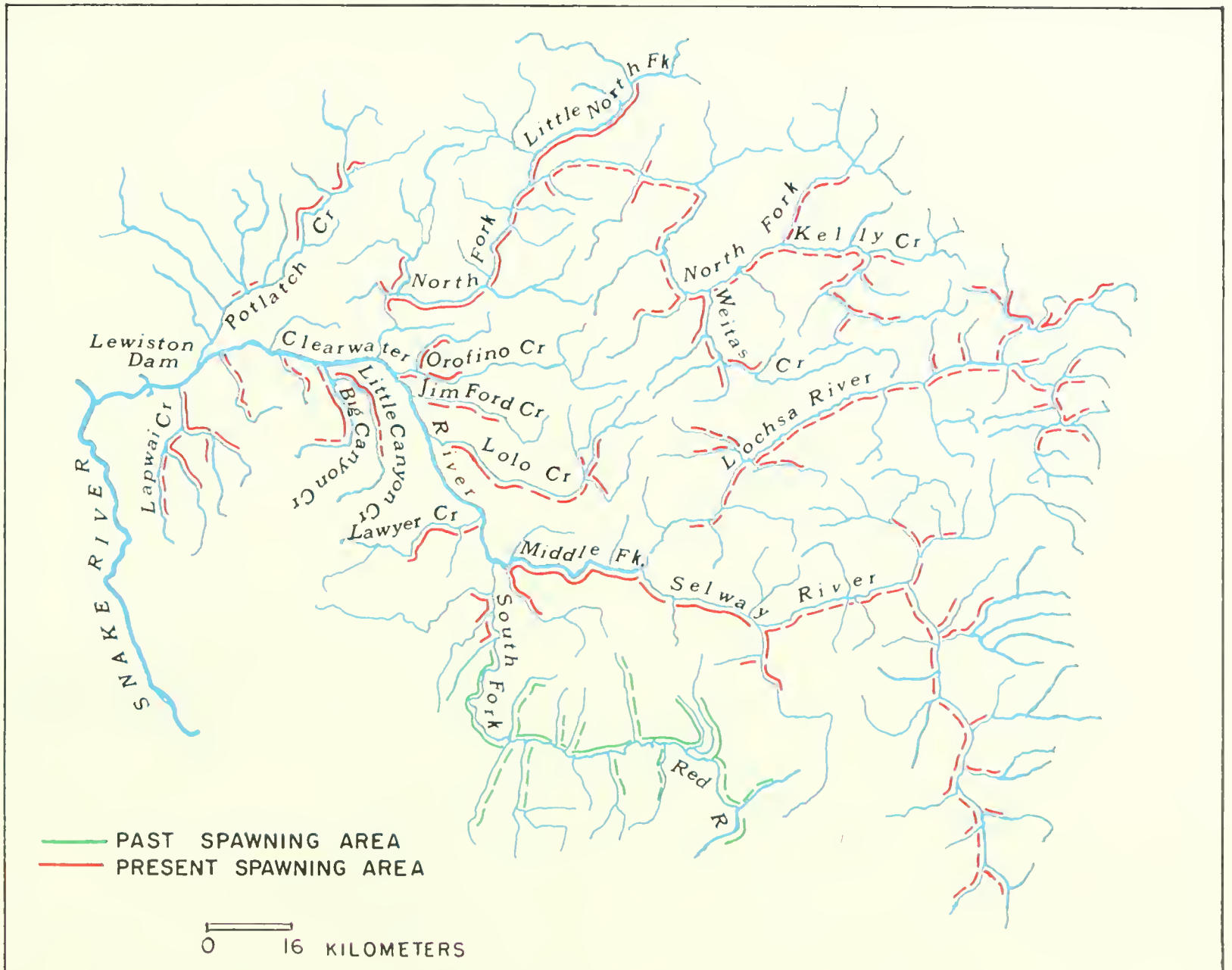
GPO 998-457



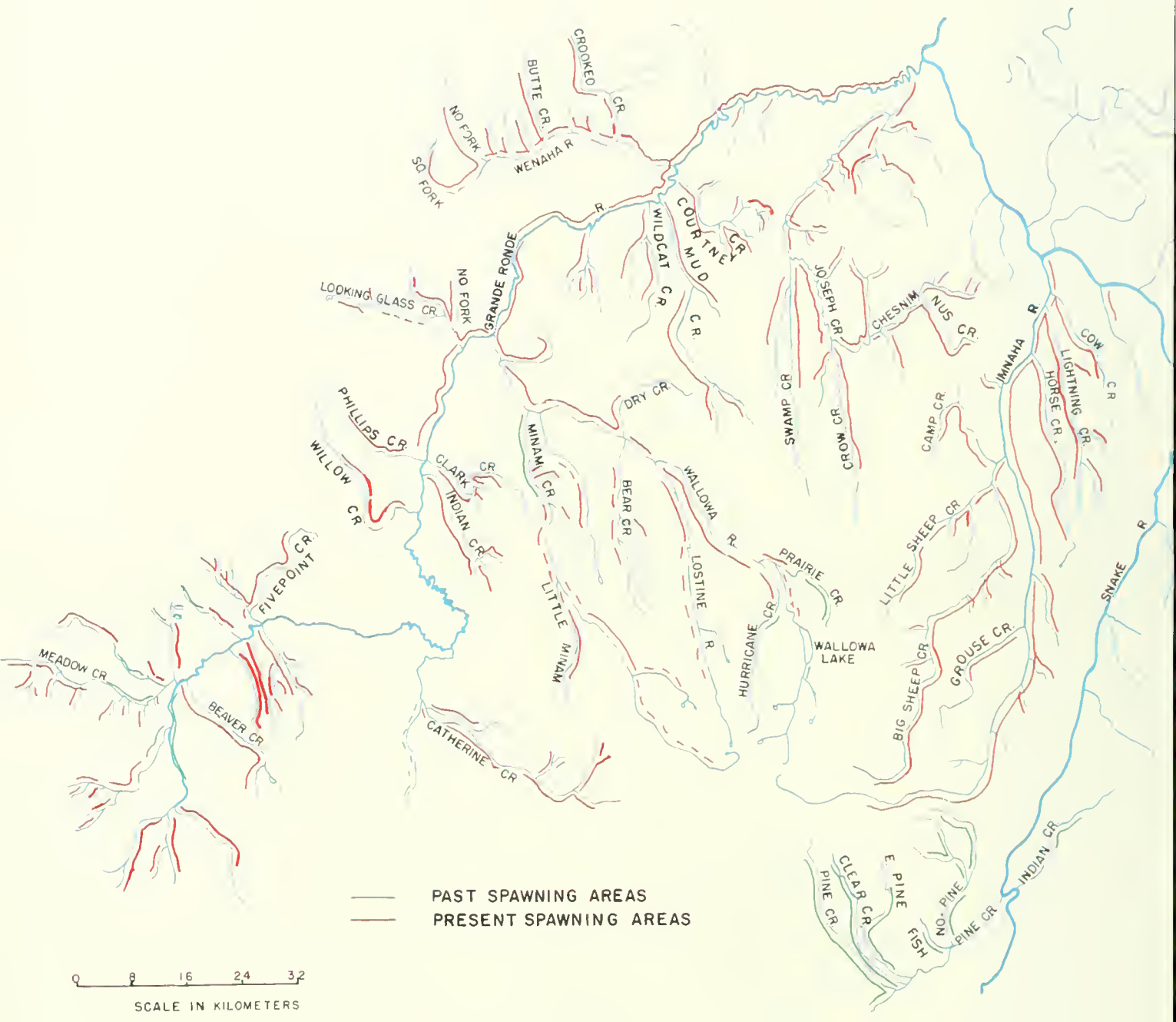
Map 1.--Spawning areas of steelhead trout in the Columbia River--past and present.

Map 2.---Spawning areas of steelhead trout in tributaries of the lower Columbia River--past and present.

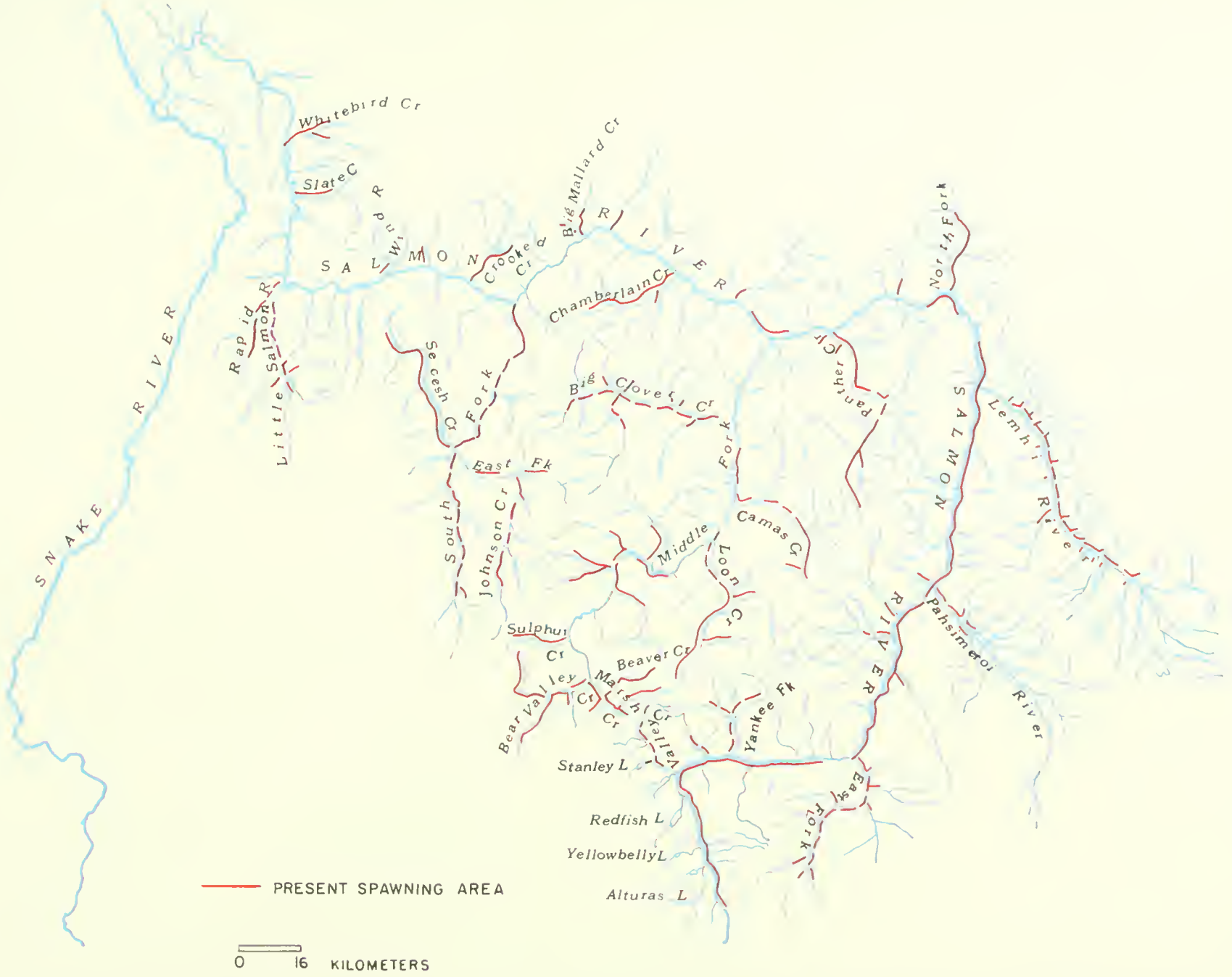
Map 3.--Spawning areas of steelhead trout in the Willamette River Basin--past and present.



Map 4.--Spawning areas of steelhead trout in the Clearwater River Basin--past and present.



Map 5.--Spawning areas of steelhead trout in the Grande Ronde and Imnaha Rivers and Pine and Indian Creeks--past and present.



Map 6.--Spawning areas of steelhead trout in the Salmon River Basin--past and present.

Map 7.--Spawning areas of coho salmon in the Columbia River Basin--past and present.

Map 8.--Spawning areas of coho salmon in tributaries of the lower Columbia River--past and present.

Map 9.--Spawning areas of coho salmon in the Willamette River Basin--past and present.

Map 10.---Spawning areas of sockeye salmon in the Columbia River Basin-- past and present.

Map 11.--Spawning areas of chum salmon in the Columbia River Basin--past and present.

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS UNIT
BLDG. 67, NAVAL SUPPORT ACTIVITY
SEATTLE, WASHINGTON 98115

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE

Return this sheet to above address, if you do NOT wish to receive this material ☐, or if change of address is needed ☐ (indicate change and give ZIP Code).