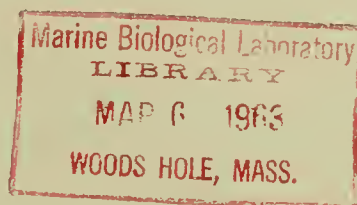


FALL CHINOOK SALMON RETURNS TO HATCHERIES IN THE BONNEVILLE DAM POOL AREA, 1945-60



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FISH AND WILDLIFE SERVICE

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by

Eugene M. Maltzeff and Paul D. Zimmer



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CONTENTS

	Page
Introduction.....	1
Seasonal runs of salmon.....	2
Hatcheries in Bonneville Dam pool area	2
Spring Creek National Fish Hatchery, Washington.....	4
Big White Salmon River weir, Washington.....	4
Little White Salmon National Fish Hatchery, Washington	7
Willard National Fish Hatchery, Washington.....	8
Carson National Fish Hatchery, Washington	8
Klickitat Hatchery, Washington	9
Ox Bow Hatchery, Oregon.....	10
Cascade Hatchery, Oregon	11
Bonneville Hatchery, Oregon.....	11
Natural spawning.....	13
Summary	13
Acknowledgment.....	13
Literature cited.....	13

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ABSTRACT

From 1938 through 1960 annual fall chinook salmon migrations over Bonneville Dam declined. During the last 16 years, numbers of young salmon released and returns of adults to hatcheries increased slightly. The annual average fall chinook salmon counts at Bonneville Dam between 1945 and 1948 were about 270,700 fish, of which 7.4 percent returned to the hatcheries. In more recent years average annual counts over Bonneville Dam dropped to about 153,000 fish; however, numbers of fish returning to hatcheries increased to about 22.1 percent of the total.

During 1945-60 approximately 104,000 fall chinook salmon (with a potential of about 247 million eggs) spawned naturally in streams on which hatcheries are located.

Hatchery records for 1945-60 indicate combined annual totals of adult fall chinook salmon returning either to the hatchery or hatchery stream were nearly 489,000 fish. For the same period, releases of fry and fingerlings from the hatcheries totaled about 572,988,000 fish.

During 1945-60 combined totals of hatchery and natural spawning fall chinook salmon were more than 529,000 fish, having a potential of approximately 1,317 million eggs.

INTRODUCTION

This report has been prepared to show the contribution of hatcheries located in Bonneville Dam pool area in relation to escapement of fish over Bonneville Dam.

In 1938, the Columbia River system was subjected to a great change. A major hydroelectric development was placed in operation

at Bonneville Dam, and another, at Grand Coulee, was nearing completion. Since that time many additional dams have been constructed not only in the main stem of the Columbia River but also in many important tributary streams. Each structure has to some degree adversely affected the runs of migratory fish. Mortalities to fingerlings and adults at each power dam plus loss of spawning and rearing areas in inundated sections of streams

have placed a tremendous burden on artificial propagation as a means of stemming a rapid decline in fish populations.

The situation became so critical that in 1949 Congress authorized initiation of a salmon restoration program of a magnitude heretofore unheard of.¹ Artificial propagation has played an important part in the restoration program. Some hatcheries have been successful in not only maintaining, but also increasing, runs of fish returning to their facilities. Adverse water temperatures and disease problems have contributed to limited production at other hatcheries. A greatly expanding sport fishery and an extensive commercial fishery have also contributed to the decline.

SEASONAL RUNS OF SALMON

Columbia River chinook salmon, *Oncorhynchus tshawytscha*, passing Bonneville Dam between March 1 and May 31 are referred to as spring chinook. Actually the spring migration develops in the lower Columbia River even earlier. Peak movement at Bonneville Dam occurs between April 15 and May 31. Average size of adult fish is about 15 pounds.

Summer-run chinook salmon passing Bonneville Dam from June 1 to August 15 generally do not show a well-defined peak in movement as do the spring fish. Large-sized individuals migrating in early July and August are prize fish, often weighing over 30 pounds.

For convenience, the separation between summer and fall runs of chinook salmon has been arbitrarily set at mid-August. Total period covered by the fall run is from August 16 to December 31. Undoubtedly there is some slight overlap of summer and fall runs. Periods given for spring, summer, and fall chinook conform to Corps of Engineers' procedure at Bonneville Dam (U.S. Army, Corps of Engineers, North Pacific District, 1960).

¹1959 Review Report, Columbia River Fishery Development Program, Vol. I. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Portland, Oregon. May 1959.

In numbers of fish, fall chinook salmon represent the largest group of this species in the Columbia Basin. Size of fish ranges between 8 and 50 pounds and averages about 20 pounds. Many fall chinook salmon spawn in the main Columbia and Snake Rivers. In recent years many valuable spawning and rearing areas have been inundated, thus precluding their continued use.

A review of 23 years (1938-60) of fall chinook salmon counts at Bonneville Dam (table 1) discloses several interesting facts. During the first 11 years (1938-48) prior to advent of the Columbia River Fishery Development Program, the fall chinook salmon spawning run averaged 270,175 fish annually, and only the years 1939 (179,992) and 1944 (192,960) had runs below 200,000. However, during the last 12 years (1949-60) the fall chinook salmon spawning run averaged 152,517 fish annually, and the annual count dipped below 200,000 nine times. In addition, annual seasonal counts have been less than 100,000 fish three times. Cessation of the Indian fishery in the vicinity of Celilo Falls did not substantially increase spawning runs of fall chinook salmon, although a considerable portion (approximately 38 percent of 1947-54 Bonneville fall chinook salmon count) was taken by the Indians prior to construction of The Dalles Dam (U.S. Army, Corps of Engineers, Portland District, 1955).

HATCHERIES IN BONNEVILLE DAM POOL AREA

The salmon egg-taking and rearing stations in Bonneville Dam pool area (fig. 1) are located as follows: *in Washington:* Carson National Fish Hatchery, on Wind River; Little White Salmon and Willard National Fish Hatcheries, on Little White Salmon River; Big White Salmon River egg-taking and rearing station, on Big White Salmon River; Spring Creek National Fish Hatchery, located on Columbia River a short distance downstream from Big White Salmon River; and Klickitat Hatchery, on Klickitat River near Glenwood; *in Oregon:* Ox Bow Hatchery, on Herman Creek; and Cascade Hatchery, on Eagle Creek.

During 1945-60 nearly 489,000 adult fall chinook salmon returned to the hatcheries

Table 1.--Annual counts of adult fall chinook salmon
(jacks included), Bonneville Dam, 1938-60.^{1/}

Year	Number of fish	Year	Number of fish
1938	228,208	1949	169,388
1939	179,992	1950	242,913
1940	297,012	1951	131,739
1941	369,642	1952	214,288
1942	333,593	1953	97,335
1943	231,601	1954	100,499
1944	192,960	1955	95,157
1945	221,155	1956	125,985
1946	321,208	1957	122,535
1947	296,935	1958	244,864
1948	305,623	1959	189,115
		1960	96,381
Total	2,977,929	Total	1,830,199

^{1/} At Bonneville Dam male chinook salmon 16-18 inches in length are considered as jack salmon.

(tables 2 and 4).² Numbers given include fish handled at hatcheries and fish spawning naturally in hatchery streams. Annual counts at Bonneville Dam and returns to hatcheries are shown in figure 2. Annual returns as percent of Bonneville count are given in figure 3. In the same period (1945-60), approximately 1,070 million eggs were collected and 572,988,000 young fish were released as unfed fry or as fingerlings into Bonneville Dam pool

area (tables 4 and 5). Annual releases covering period 1944-56 and returns of 4-year-old fish (1948-60) are shown in table 3 and figure 4. Only fish released at these hatcheries and in Bonneville Dam pool area are represented in tabulations (tables 3 and 5). In some years, due to lack of adequate facilities, large quantities of eggs and fish were transferred outside Bonneville Dam pool area. Limited numbers of fish and eggs were provided for research studies being conducted in Columbia Basin and are not included. Figure 5 shows a typical spawn-taking operation.

²Data obtained from unpublished material furnished by Fish Commission of Oregon and Washington Department of Fisheries and from Columbia Fisheries Program Office Report of Activities, 1959-60.

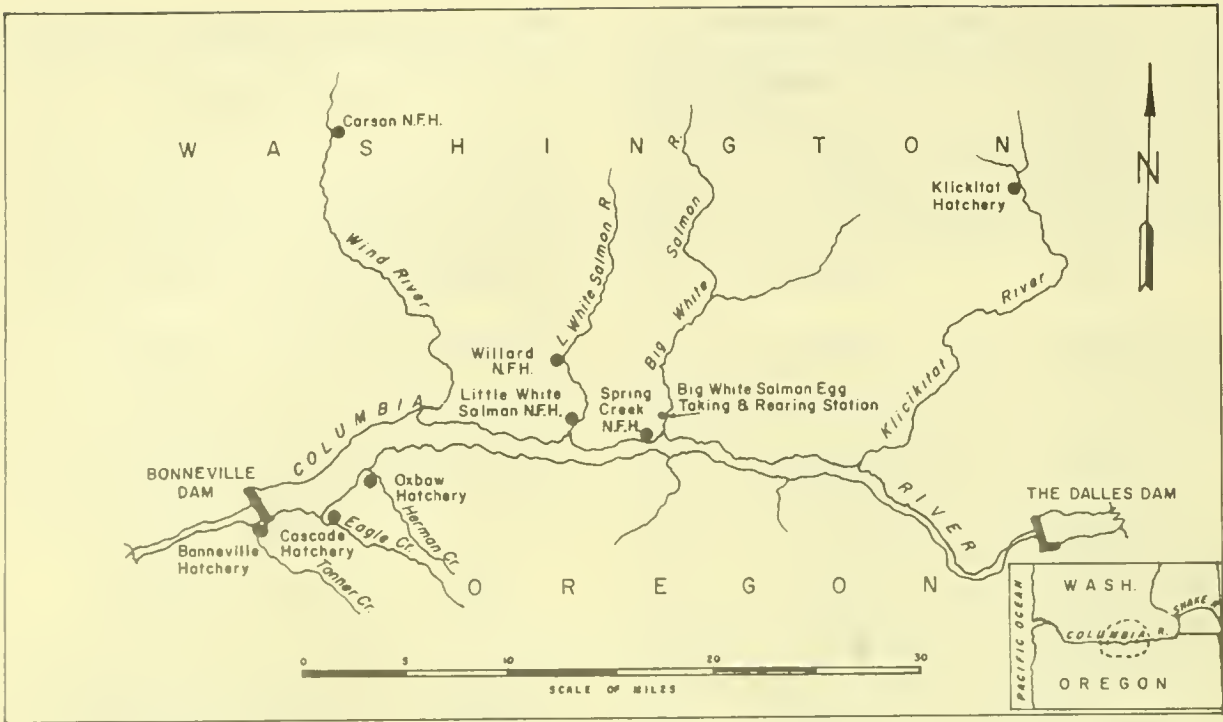


Figure 1.--Hatcheries located on Columbia River and tributary streams between Bonneville Dam and The Dalles Dam



Figure 2.--Adult fall chinook salmon annual counts, Bonneville Dam, and returns to hatcheries, 1945-60

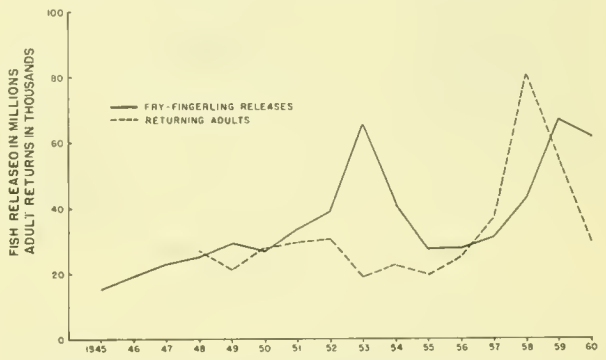


Figure 4.--Fall chinook salmon annual fry-fingerling releases, Bonneville Dam pool area, 1945-60



Figure 3.--Adult fall chinook salmon annual returns to hatcheries shown as percent of Bonneville count, 1945-60

Individual hatcheries listed in table 4 are described separately as follows:

Spring Creek National Fish Hatchery, Washington

Spring Creek National Fish Hatchery was established about 1900 and greatly expanded in 1953 (fig. 6). The station secures all of its water for operation from a natural spring. By use of eggs from Big White Salmon River a very successful run of fall chinook salmon has been created. This station exceeds all other

hatcheries of the Bonneville Dam pool area in numbers of returning adults (table 4) and in numbers of fish released (table 5). In 1945-60 approximately 107,300 female fall chinook salmon returned to Spring Creek hatchery, resulting in an egg take of approximately 536,500,000. At this station during the 16-year period over 166,100,000 fry and fingerlings have been released into the Columbia River (table 5). Additional fish and eggs have been

transferred from Spring Creek to other hatcheries of the lower Columbia River area. There is no area available for natural spawning at Spring Creek hatchery.

Big White Salmon River Weir, Washington

Big White Salmon River weir and spawning ponds are closely associated with Spring Creek hatchery. Taking of salmon eggs in this river

Table 2.--Annual counts of adult fall chinook salmon (jacks included), Bonneville Dam, and hatchery returns, 1945-60.

Year	Bonneville count-- number of fish	Hatchery returns ^{1/}	Percent ^{2/}	Number of hatcheries ^{3/}
1945	221,155	12,752	5.8	5
1946	321,208	19,632	6.2	5
1947	296,935	24,822	8.4	5
1948	305,623	26,756	8.8	5
1949	169,388	21,233	12.5	5
1950	242,913	27,909	11.5	5
1951	131,739	29,917	22.7	5
1952	214,288	38,210	17.8	5
1953	97,335	18,657	19.2	7
1954	100,499	22,161	22.1	7
1955	95,157	19,722	20.7	7
1956	125,985	24,815	19.7	7
1957	122,535	37,834	30.9	7
1958	244,864	80,696	33.0	8
1959	189,115	54,182	28.7	8
1960	96,381	29,567	30.7	8
16-year total	2,975,120	488,865		
Average	185,945	30,554	16.4	

^{1/} Totals given include actual and calculated returns.

^{2/} Hatchery returns as percent of Bonneville count.

^{3/} Number of hatcheries in operation including Big White Salmon River weir and spawning ponds.

Table 3.--Fall chinook salmon annual fry-fingerling releases by brood year, 1944-56, and adult returns to hatcheries, 1948-60.

Brood year ^{1/}	Fry and fingerling release ^{2/}	Year of return	Adults ^{3/}	Percent return ^{4/}
1944	15,091,000	1948	26,756	0.18
1945	19,212,000	1949	21,233	0.10
1946	22,968,000	1950	27,909	0.12
1947	24,892,000	1951	29,917	0.12
1948	28,989,000	1952	38,210	0.13
1949	26,469,000	1953	18,657	0.07
1950	33,549,000	1954	22,161	0.07
1951	39,274,000	1955	19,722	0.05
1952	65,303,000	1956	24,815	0.04
1953	40,246,000	1957	37,834	0.11
1954	27,308,000	1958	80,696	0.30
1955	27,828,000	1959	54,182	0.19
1956	30,566,000	1960	29,567	0.10
Total	401,695,000		431,659	
13-year average	30,900,000		33,204	0.11

^{1/} Brood year refers to year eggs collected.

^{2/} Figures rounded to nearest 1,000.

^{3/} Only dominant 4-year-old class considered.

^{4/} Beyond 1957, 4-year-old class is not dominant.

began about 1900 and is still continued. In recent years concrete rearing ponds were constructed adjacent to the weir. Eggs secured are incubated at Spring Creek hatchery, and fry returned to Big White Salmon River ponds for rearing. Racks are installed to divert fish to the spawning ponds. Each year,

however, many fish spawn naturally in the river (table 6). Total number of salmon estimated to have entered Big White Salmon River in period 1945-60 is approximately 80,000 (table 7). Nearly 76,230,000 fry and fingerlings were released during this period (table 5).

Table 4.--Eggs collected and adult fall chinook salmon returning to hatcheries in Bonneville Dam pool area, 1945-60.^{1/}

Hatchery	Adult returns				Eggs collected
	Male	Female	Jack	Total	
Spring Creek	118,300	107,300	38,300	263,900	536,500,000
Fig White Salmon	16,300	20,800	3,100	40,200	104,000,000
Little White Salmon	39,700	41,200	4,100	85,000	206,000,000
Willard ^{2/}	--	--	--	--	--
Carson ^{3/}	6,300	6,900	600	13,800	34,500,000
Klickitat	2,900	4,500	1,600	9,000	22,500,000
Ox Bow	30,200	28,900	7,900	67,000	144,500,000
Cascade	4,600	4,400	1,200	10,200	22,000,000
Total	218,300	214,000	56,800	489,100	1,070,000,000

^{1/} In some instances sex ratios for Ox Bow, Cascade, Klickitat, and Carson were calculated by using Spring Creek and Little White Salmon data for period 1945-60. Numbers of adults rounded to nearest 100, and eggs estimated at 5,000 per female.

^{2/} Willard hatchery is located on Little White Salmon River and all adults returning to that stream are trapped at Little White Salmon hatchery.

^{3/} Includes fish handled and eggs taken at the Wind River rack between 1945 and 1954.

Little White Salmon National Fish Hatchery, Washington

Little White Salmon National Fish Hatchery, located on Little White Salmon River, has been in operation since 1898 and is the second hatchery in importance of production in the Bonneville Dam pool area. In 1945-60 this station has accounted for approximately 85,000 fish, or about 17 percent of all adults handled at Bonneville Dam pool area hatcheries (table 4). During the 16-year period, 1945-60, nearly 151,764,000 young salmon have been released into Bonneville Dam pool area (table 5).

It is estimated that approximately 6,800 adult fall chinook salmon have spawned

naturally in Little White Salmon River during period 1945-60 (table 6). Estimates are based on observations by hatchery personnel. A larger population of natural spawners is believed to have existed in the Little White Salmon River prior to 1959, when a barrier dam and new fishway were constructed. Since then larger numbers of fish have moved into the ponds and fewer have spawned naturally. In recent years all releases of fall chinook salmon fingerlings raised at Little White Salmon National Fish Hatchery have been released into the Columbia River at Cook, Washington, to avoid predation in Drano Lake.

Table 5.--Total years of operation and fry and fingerlings released at Bonneville Dam pool area hatcheries, 1945-60.

Hatchery	Years of operation	Fish released
Spring Creek	60	166,119,000
Big White Salmon	60	76,230,000
Little White Salmon	62	151,764,000
Willard	8	46,842,000
Carson	23	32,528,000
Klickitat	10	32,847,000
Ox Bow	46	55,745,000
Cascade	3	10,913,000
Total		572,988,000

Willard National Fish Hatchery, Washington

Willard National Fish Hatchery, located on Little White Salmon River upstream from Little White Salmon National Fish Hatchery, has been in operation since 1953. During first year of operation young fish were released at the hatchery. Releases of fish are now made into the Columbia River at Cook, Washington, just downstream from the mouth of Little White Salmon River. Fish are trucked to this release site to avoid heavy squawfish predation in Drano Lake, at the mouth of Little White Salmon River, and the possibility of fish entering the water intake system at Little White Salmon hatchery.

Eggs for Willard hatchery are provided by Spring Creek or Little White Salmon hatcheries. There are no adult salmon handled at Willard hatchery. A rack is installed annually at Little White Salmon hatchery and all fish are diverted to holding and spawning facilities at that station. During the 8-year period of operation, 1953-60, more than 46,842,000 fall chinook

salmon fry and fingerlings were released from this station (table 5).

Carson National Fish Hatchery, Washington

Carson National Fish Hatchery, located on Wind River, was established in 1937. For many years eggs were obtained at a rack located a short distance above the mouth of the river.

Shipperd Falls, located several miles above the mouth of Wind River, was a complete barrier to fall chinook salmon until 1956, when a fishway was constructed over the falls and a large area was thus made available for natural spawning. Since that time all fall chinook salmon entering the river are permitted to spawn naturally both above and below the falls. Eggs and fry are now provided Carson hatchery from either Spring Creek or Little White Salmon hatcheries.

During 1945-54 approximately 13,800 fall chinook salmon were taken at a rack near the



Figure 5.--Typical spawn-taking operation, Bonneville Dam pool area hatchery

mouth of Wind River and the eggs transferred to Carson hatchery for incubation. Since 1954 approximately 17,000 fall chinook salmon have been counted over Shipperd Falls fishway and periodic surveys have indicated considerable natural spawning below the falls.

Estimated numbers of fall chinook salmon spawning naturally in Wind River for 1945-60 are given in table 6.

In 1945-60 approximately 32,528,000 fry and fingerlings have been released into Wind River to perpetuate the run (table 5).

Klickitat Hatchery, Washington

First hatchery operations on Klickitat River occurred in 1950. However, significant num-

bers of fall chinook salmon were first planted in 1949. Returns from these and subsequent plants were first observed in 1953 when "jacks" appeared in small numbers. In 1956 fishways were completed in lower Klickitat River thereby making available extensive spawning areas previously inaccessible to fall chinook salmon. Some fish have been trapped at the fishway for artificial propagation, and the remainder allowed to pass upstream for natural spawning.

In period 1953-60 approximately 9,000 fall chinook salmon were spawned artificially at Klickitat Hatchery (table 4) and approximately 10,900 fall chinook salmon spawned naturally in Klickitat River (table 6). An Indian fishery exists near the mouth of the Klickitat River. Estimated total catch by Indians in the period



Figure 6.--Spring Creek National Fish Hatchery, Washington

1953-60 is 5,600 fish.³ A minor sport fishery also exists in this area. Additional eggs from other stations have been transferred to Klickitat Hatchery to augment the newly established runs. To date over 32,847,000 fry and fingerlings have been released from this station (table 5).

Ox Bow Hatchery, Oregon

In Oregon the main fall chinook salmon producing station is Ox Bow Hatchery on Herman Creek. This station, established in 1914, ranks third in number of adults handled as compared with other hatcheries in Bonneville Dam pool area. During 1945-60 nearly 67,000 adult salmon have returned to the

hatchery racks (table 4) and the hatchery has released over 55,745,000 fry and fingerlings (table 5).

Natural spawning has occurred in this hatchery stream only in 1946, 1950, and 1952. In those 3 years approximately 400, 600, and 2,400 salmon, respectively, were estimated to have spawned naturally in Herman Creek (table 6). Recently constructed trapping and spawning facilities located at the lower end of Herman Creek now prevent salmon from utilizing the natural spawning area above.

Cascade Hatchery, Oregon

Cascade Hatchery, located on Eagle Creek, was established in 1958. Each year a rack is installed a short distance above the mouth of the stream. Prior to 1958 Bonneville hatchery

³Data furnished by Washington Department of Fisheries at Vancouver, Washington.

Table 6.--Estimated numbers of adult fall chinook salmon and calculated egg potential of salmon spawning naturally in hatchery streams tributary to Bonneville Dam pool area, 1945-60.^{1/}

Hatchery stream	Male	Female	Jack	Total	Estimated egg potential ^{2/}
Spring Creek	--	--	--	--	--
Big White Salmon River	16,100	20,600	3,100	39,800	103,000,000
Little White Salmon River	3,200	3,300	300	6,800	16,000,000
Wind River	17,300	16,800	4,500	38,600	84,000,000
Klickitat River	4,900	4,700	1,300	10,900 ^{3/}	23,500,000
Herman Creek	1,000	2,200	200	3,400 ^{4/}	11,000,000
Eagle Creek	1,800	1,800	500	4,100	9,000,000
Total	44,300	49,400	9,900	103,600	246,500,000

^{1/} Sex ratios of estimated natural spawners calculated from hatchery data and rounded to nearest 100. Figures for estimated egg potential rounded to nearest 1,000.

^{2/} Egg potential based on 5,000 per female.

^{3/} Period covered, 1955-60.

^{4/} Years of data, 1946, 1950, and 1952.

personnel conducted spawn-taking operations on Eagle Creek and transferred the eggs to that station. With exception of a release of 81,400 fish in 1949, no other fry or fingerlings were returned to Eagle Creek from Bonneville Hatchery. In its first 3 years of operation Cascade Hatchery handled nearly 10,200 adults (table 4). Since 1958 approximately 10,913,000 fry and fingerlings have been released from Cascade Hatchery into Eagle Creek (table 5).

Estimates of number of fish allowed to spawn naturally in Eagle Creek are given in table 6.

The stream is definitely limited for natural reproduction with an impassable falls one mile above the mouth.

Bonneville Hatchery, Oregon

For many years the source of eggs for Bonneville Hatchery, located immediately

downstream from Bonneville Dam, came from fall chinook salmon trapped at the rack on nearby Eagle Creek. The eggs were incubated in the hatchery, and the young fish released into Tanner Creek, which is a source of water supply for Bonneville Hatchery.

Adult salmon in Tanner Creek were normally handled about the same time as at Eagle Creek, and the egg collections were combined. No attempt was made to maintain identity of the stocks. For this reason it is not possible today to determine the size of the former runs into Eagle Creek.

NATURAL SPAWNING

Natural spawning of fall chinook salmon in tributaries to Bonneville pool is believed confined primarily to Wind, Little White Salmon,

Table 7.--Estimated numbers of fall chinook salmon returning to hatchery streams, and total egg potential of hatchery and natural spawning, Bonneville Dam pool area, 1945-60.^{1/}

Hatchery and stream	Male	Female	Jack	Total	Per- cent	Estimated total egg potential
Spring Creek -- Columbia River	118,300	107,300	38,300	263,900	44.5	536,500,000
Big White Salmon -- Big White Salmon River	32,400	41,400	6,200	80,000	13.5	207,000,000
Little White Salmon -- Little White Salmon River	42,900	44,500	4,400	91,800	15.5	222,500,000
Willard -- Little White Salmon River	--	--	--	--	--	--
Carson -- Wind River	23,600	23,700	5,100	52,400	8.8	118,500,000
Klickitat -- Klickitat River	7,800	9,200	2,900	19,900	3.3	46,000,000
Ox Bow -- Herman Creek	31,200	31,100	8,100	70,400	11.9	155,500,000
Cascade -- Eagle Creek	6,400	6,200	1,700	14,300	2.4	31,000,000
Total	262,600	263,400	66,700	592,700	100.0	1,317,000,000

^{1/} Numbers of adults rounded to nearest 100.

Big White Salmon, and Klickitat Rivers, and Eagle and Herman Creeks. A hatchery or some type of spawn-taking facility exists on each of these streams. Hood River and several minor streams have small numbers of fall chinook salmon spawning in them. Estimated numbers of fall chinook salmon spawning naturally in major tributaries of Bonneville pool are given in table 6.

SUMMARY

Fish counting at Bonneville Dam was initiated in 1938, and reliable comparisons of annual fall chinook salmon migrations are available.

During the period 1945-60 the estimated number of fall chinook salmon spawning naturally in streams on which hatcheries are located in Bonneville Dam pool area was approximately 104,000 fish. Of these, about 49,000 were females having a potential of about 247 million eggs. Total fish spawning naturally represent about 21 percent of salmon handled at the stations and about 3.5 percent of total Bonneville Dam counts of fall chinook salmon from 1945 to 1960.

During 1945-60 Spring Creek and Little White Salmon hatcheries, together with the Big White Salmon River station, have accounted for about 389,000, or about 79.6 percent, of all fall chinook salmon adults returning to hatcheries in Bonneville pool area. In addition, approximately 394,113,000 fry and fingerlings, or about 69 percent of all hatchery liberations, have come from these facilities during the same period. Data on returns to these stations are reliable except for certain instances when estimates of females present in Big White Salmon River have been determined from the numbers of eggs taken.

Combined numbers of female fall chinook salmon handled at hatcheries and those spawning naturally on hatchery streams during 1945-60 total approximately 263,000 fish, with a potential of 1,317 million eggs. Total of all fall chinook salmon counted in hatchery streams during the same period is approximately 592,700.

Best available data on adult fall chinook salmon returning to the hatcheries in Bonneville Dam pool area are in the 16-year period,

1945-60. During this time 2,975,127 fall chinook salmon negotiated Bonneville Dam fish ladders. Average annual count has been 185,945 (table 2).

Annual returns of adult fall chinook salmon to the hatcheries of the Bonneville Dam pool area when compared to the annual counts of fish passing Bonneville Dam show an upward trend (fig. 2). In 1945, 5.8 percent of adult fall chinook salmon ascending Bonneville Dam fishways returned to the hatcheries. This increased to 33.0 percent in 1958, and declined slightly in later years (table 2).

Fry-fingerling releases of 1944-brood-year were first observed as 4-year-old adults in 1948 (table 3). From 1944 to 1956 a total of 401,695 million fry and fingerling salmon were released by the hatcheries, and in period 1948-60, 431,659 fish returned as adults.

Only the 4-year-old age group is considered, since fish of this age are dominant in the fall run. Brood year as used in this report refers to calendar year of egg collection.

Beginning with 1958 an increase of 3-year-old fish appeared in numbers of fall chinook salmon taken at Little White Salmon and Spring Creek hatcheries.⁴

ACKNOWLEDGEMENT

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