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CONTRIBUTION OF COLUMBIA RIVER HATCHERIES TO HARVEST OF
1963 BROOD FALL CHINOOK SALMON (Oncorhynchus tshawytscha)

by

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ABSTRACT

A marking experiment was designed in which fall chinook salmon (Oncorhynchus tshawytscha) from 12 Columbia River hatcheries were marked in 4 consecutive years to estimate their contribution to the sport and commercial fisheries. The study was planned and executed by scientists of the Fisheries Research Board of Canada, U.S. Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service (formerly Bureau of Commercial Fisheries),^{3/} and fishery agencies of the States of Alaska, Washington, Oregon and California.

Sampling for marked fish was conducted in most ocean fisheries for chinook salmon from Avila Beach, California to Pelican, Alaska, as well as on the Columbia River. This report delineates and summarizes the estimated contribution of the total hatchery releases of the 1963 brood based on the returns for the 6.0 million marked fish released in the third year of the study. Estimates of the contributions of the 1961 and 1962 broods were published in 1969 and 1970, respectively.

The estimated catch of the 1963-brood fish that originated from the hatcheries under study was 531,935, or about 19.5 percent of the total catch of chinook salmon of that brood in the fisheries sampled. The estimated net value of this catch (primary) was about \$3,550,483, in comparison with production costs of \$842,020. The benefit-to-cost ratio was 4.2:1.

The net value of the catch of fall chinook salmon of the 1963 brood that originated from all Columbia River hatcheries (including those not participating in the marking experiment) was estimated at \$4,341,607.

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3/ Bureau of Commercial Fisheries was transferred from Fish and Wildlife Service, U.S. Department of the Interior, to U.S. Department of Commerce in October 1970. It was designated as National Marine Fisheries Service and was combined with other Federal bureaus and services to form the National Oceanic and Atmospheric Administration (NOAA).

INTRODUCTION

The U. S. Government has financed the Columbia River Fishery Development Program, a cooperative effort of the States of Oregon, Washington and Idaho, since its inception in 1949. This project is designed to increase production of salmon (Oncorhynchus spp.) and steelhead trout (Salmo gairdneri) in the Columbia River. The Columbia Fisheries Program Office, National Marine Fisheries Service (formerly Bureau of Commercial Fisheries),^{3/} Portland, Oregon, administers the project.

A marking experiment was begun in 1962 by the Columbia Fisheries Program Office to estimate the contribution of hatchery-reared fall chinook salmon to commercial and sport fisheries of the Pacific Coast. The study was planned and executed by scientists of the Fisheries Research Board of Canada, U.S. Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, and fishery agencies of the States of Alaska, Washington, Oregon and California. Beginning with the 1961 brood (which was marked and released in 1962) the marking was continued through 4 consecutive years, ending in 1965. Sampling for these marked fall chinook salmon was started in 1963 and ended in 1969.

A detailed account of the experiment design, with methods and procedures used for marking the fish and estimating the contribution of the 1961 brood, was presented by Worlund, Wahle and Zimmer (1969). Discussion of basic theory with essential formulas and supporting basic data tables will not be repeated in this report.

This report has been prepared with a format similar to the one that was developed by Worlund et al. and was followed in the report on the 1962-brood fall chinook (Rose and Arp, 1970). Appendix table 1 lists tables by number that are common to all three, or in some cases two of these reports. These tables contain data pertinent to the development of contribution estimates, and comparison of the tables will help to point out similarities and differences between the three broods of fish.

Twelve hatcheries produced about 90 percent of the fall chinook salmon that were propagated in hatchery facilities in the Columbia River system during the 4-year period of marking in preparation for the contribution studies. These hatcheries were selected to participate in the marking program. Five other hatcheries which also reared fall chinook salmon contributed to the experiment by supplying cost accounting and production data. Table 1 lists the participating and non-participating hatcheries included in the experiment.

Table 1.--Columbia River hatchery facilities contributing to
1963-brood fall chinook salmon

Hatchery	Agency ^{1/}
PARTICIPATING	
1) Grays River	WDF
2) Elokomín	WDF
3) Kalama Falls and Lower Kalama	WDF
4) Washougal	WDF
5) Little White Salmon	BSFW
6) Spring Creek	BSFW
7) Big White Salmon egg taking and rearing facilities	BSFW
8) Klickitat	WDF
9) OxBow	FCO
10) Cascade	FCO
11) Bonneville	FCO
12) Big Creek	FCO
NON-PARTICIPATING	
13) Abernathy	BSFW
14) Lewis River and Speelyai	WDF
15) Toutle	WDF
16) Skamania	WDG
17) Klaskanine	FCO
18) Sandy	FCO
19) Eagle Creek	BSFW

^{1/} FCO--Fish Commission of Oregon
WDF--Washington Department of Fisheries
WDG--Washington Department of Game
BSFW--Bureau of Sport Fisheries and Wildlife

MARKING

Some juvenile chinook salmon at all the 12 participating hatcheries were marked each year by removing the adipose fin and a portion of the right or left maxillary bone. In addition to this common mark, 4 special marks were used each year to study variation within the 12 participating hatcheries. Two of these marks were allotted to Spring Creek and Kalama hatcheries, and the other two marks were rotated among 8 of the remaining hatcheries (i.e., two different hatcheries in each of the four years of marking). Marks used for the 1963 brood are listed in table 2.

Table 2.--Marks of Columbia River 1963-brood fall chinook salmon and ages in catches and escapements by sampling years (1965-68)

Mark ^{1/}	Release site	Year of sampling			
		1965	1966	1967	1968
		-----Year of life-----			
Ad-RM	12 hatcheries	2	3	4	5
Ad-LV-RM	Spring Creek	2	3	4	5
Ad-RV-RM	Kalama	2	3	4	5
LV-RM	Klickitat	2	3	4	5
RV-RM	Big Creek	2	3	4	5
Number of marks in catches and escapements.....		5	5	5	5

^{1/} Ad: Adipose; LV: left ventral; RV: right ventral;
LM: left maxillary; RM: right maxillary.

RELEASE OF FISH

Table 3 shows estimated numbers of 1963-brood fall chinook salmon released for each mark type, the proportion of fish that were marked, and ratios of marked to unmarked fish.

Table 3.--Estimated numbers and mark ratios of fall chinook salmon released from study hatcheries for 1963 brood year

Common mark	Origin	Marked	Unmarked	Ratio marked/unmarked	Special marks	Total release of marked and unmarked
Ad-RM	All hatcheries	5,986,464 ^{1/}	51,816,621 ^{2/}	0.1155	2,308,978 ^{3/}	60,112,063

Special mark	Origin	Marked	Unmarked	Ratio marked/unmarked
Ad-LV-RM	Spring Creek	751,243	5,945,727	0.1264
Ad-RV-RM	Kalama	456,158	3,945,603	0.1156
LV-RM	Klickitat	521,610	2,085,287	0.2501
RV-RM	Big Creek	579,967	1,215,796	0.4770
	Subtotal	2,308,978		

1/ Includes Ad-RM marked fish released from four hatcheries with special marks.

2/ Includes unmarked fish released from four hatcheries with special marks.

3/ From four hatcheries with special marks.

MARK SAMPLING AREA AND INTENSITY

Total catches of chinook salmon in the fisheries that were sampled and numbers of fish that were examined each year for marks and age are given in table 4. Data are shown for 1965, 1966, 1967 and 1968. During this 4-year period, most of the chinook salmon fisheries were sampled from Avila Beach, California to Pelican, Alaska. Sampling was discontinued in Alaska during the 1968 sampling season.

During the 4 years of sampling, 19.9 percent of the total catch of 10.3 million fish was examined for marks and 1.2 percent was sampled for age. Mark sampling percentages for the 4 years were 19.8, 21.3, 20.3 and 18.0.

Table 4.--Catches of chinook salmon and number of fish examined for marks and age, 1965-68

Year	Catch ^{1/} of chinook salmon		Sampled for marks	Sampled for age
	1963 brood	Total catch		
1965.....	157,456	2,572,919	508,731	33,818
1966.....	1,424,010	2,681,507	570,994	38,556
1967.....	982,055	2,560,266	518,351	27,407
1968.....	166,528	2,443,778	440,290	21,816
Total...	2,730,049	10,258,470	2,038,366	121,597

^{1/} Catch data is only for fisheries that were sampled.

RECOVERIES OF MARKED FISH

Table 5 summarizes all marks of Columbia River hatchery origin (1963 brood) recovered in the fisheries. This includes partial or incomplete marks, designated in the data reports (1966-70) as possible or probable hatchery marks. A total of 7,476 marked fish was recovered during the 4 years of sampling. This compares with 9,578 recoveries for the 1961 brood and 2,748 for the 1962 brood. About 64 percent of the marked fish were taken as 3-year-olds in 1966 and about 29 percent in 1967 as 4-year-olds. Kalama hatchery varied slightly from this pattern, with 47 percent in 1966 and 39 percent in 1967.

Table 5.--Marked 1963-brood-year fall chinook salmon of Columbia River hatchery origin recovered in the fisheries, 1965-68^{1/}

Origin of mark	Mark	Year of capture				Total
		1965	1966	1967	1968	
-----Number of fish-----						
All hatcheries...	Ad-RM	171	3,363	1,518	163	5,215
	Ad	24	320	158	23	525
Spring Creek.....	Ad-LV-RM	39	394	166	8	607
	Ad-LV	3	18	9	1	31
Kalama.....	Ad-RV-RM	8	128	112	28	276
	Ad-RV	3	18	9	3	33
Klickitat.....	LV-RM	18	209	63	5	295
	LV	6	61	23	7	97
Big Creek.....	RV-RM	15	205	71	1	292
	RV	15	56	30	4	105
Total.....		302	4,772	2,159	243	7,476

^{1/} Includes partial or incomplete marks designated as possible or probable hatchery marks in the data reports (1966-70).

Distribution of recoveries for each year by region of capture and type of fishery is shown in table 6. Only full mark recoveries are listed.

Distribution of the total mark recoveries shows that the greatest numbers were taken in the northern part of the total sampling range. Recoveries for the 1961 and 1962 broods showed the same trend. Marked fish from Kalama hatchery again ranged farther north than fish from the other hatcheries, according to recovery data. Proportionately more Kalama marks were recovered in the British Columbia troll fishery than marks from any of the other hatcheries and 7 Kalama marks were recovered in southeast Alaska. Only two other marks from the 12 study hatcheries, both Ad-RM, were taken in Alaska.

Mark recoveries in the Columbia River gill net fishery followed the same general trend as the two previous broods. Klickitat and Big Creek marked fish were recovered in greatest numbers in 1966 as 3-year-olds, while marks from the 12 study hatcheries and Spring Creek were recovered in greater numbers in 1967. Almost half the total marks from Kalama were recovered in 1968, which suggests even more strongly than the data for the 1962 brood that Kalama fish matured later than the main body of hatchery fish.

Table 6.--Marked 1963-brood Columbia River chinook salmon recovered by year, region of capture, and type of fishery, 1965-68^{1/}

Origin and type	Year	California		Oregon		Washington			Puget Sound	British Columbia			S. E. Alaska		Columbia River			
		Sport	Com- mer- cial	Sport	Com- mer- cial	Sport	Commercial			Sport	Commercial		Commercial		Sport	Commercial		
							Troll	Gill net	Troll		Gill net	Purse seine	Troll	Gill net		Gill net	Dip Net	
-----Number of recoveries-----																		
All hatcheries (Ad-RM)	1965	0	0	0	1	112	1	0	9	8	0	0	0	0	0	0	39	1
	1966	0	4	34	171	387	1,153	1	6	1,264	0	(*)	0	(*)	0	313	30	
	1967	0	1	21	30	57	109	7	3	766	0	0	2	(*)	0	515	7	
	1968	0	1	0	1	7	4	0	0	41	0	0	(*)	(*)	0	109	0	
Spring Creek (Ad-LV-RM)	1965	0	0	0	0	26	0	0	0	3	0	0	0	0	0	10	0	
	1966	1	0	7	8	52	133	0	1	150	0	(*)	0	(*)	0	42	0	
	1967	0	0	1	3	7	8	0	1	86	0	0	0	(*)	0	60	0	
	1968	0	0	0	0	0	0	0	0	2	0	0	(*)	(*)	0	6	0	
Kalama (Ad-RV-RM)	1965	0	0	0	0	5	0	0	1	0	0	0	0	0	0	2	0	
	1966	0	0	2	3	23	33	1	0	57	0	(*)	3	(*)	0	6	0	
	1967	0	0	3	0	7	18	0	0	71	0	0	4	(*)	0	9	0	
	1968	0	0	0	0	1	1	0	0	11	0	0	(*)	(*)	0	15	0	
Klickitat (LV-RM)	1965	0	0	0	0	16	1	0	1	0	0	0	0	0	0	0	0	
	1966	1	0	1	9	22	59	0	0	64	0	(*)	0	(*)	0	18	35	
	1967	0	1	2	2	6	6	0	1	31	0	0	0	(*)	0	11	3	
	1968	0	0	0	0	0	0	0	0	5	0	0	(*)	(*)	0	0	0	
Big Creek (RV-RM)	1965	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	
	1966	0	1	2	9	23	56	0	0	89	0	(*)	0	(*)	0	25	0	
	1967	0	0	2	1	7	3	3	0	36	0	0	0	(*)	0	19	0	
	1968	0	0	0	0	0	0	0	0	1	0	0	(*)	(*)	0	0	0	

*No sampling.

^{1/} All sport fishing is by rod and reel. Commercial fishing is by trolling, unless otherwise noted.

Marked fall chinook salmon of the 1963 brood recovered in hatchery and tributary stream escapements are presented in appendix table 2 and summarized in table 7. Entire returns were examined for marks at the hatcheries while only a portion of the escapement was sampled in tributary streams. Stream sampling was omitted in 1967 and 1968 because of shortage of funds.

Most of the marked fish in the escapement and the fisheries were recovered in 1966 and 1967 as 3- and 4-year-olds. Numbers of marked fish in the escapement were almost equally divided between those two ages, while in the fisheries (table 5) the number of 3-year-olds was almost double that of the 4-year-olds. Comparing the 1963 brood with the two prior broods, most of the marked fish for the 1961 brood were recovered as 3-year-olds in fisheries and escapement, while most of the 1962-brood marked fish recovered in the fisheries were 3-year-olds and in the escapement 4-year-olds.

ESTIMATED CATCHES OF MARKED FISH

Methods used in this report to estimate the total catch of fish for each mark in each stratum (fishery, port or capture area, and time period) are explained in the report for the 1961 brood. Estimated numbers of marked 1963-brood fish caught in the fisheries, returning to the hatcheries or escaping to the tributary streams are listed in table 8. These include fish which had a partial or incomplete mark (e.g., Ad only instead of Ad-RM or Ad-LV only instead of Ad-LV-RM). The number of Ad only marked fish recovered in the fisheries (1,838) is about 9 percent of the number with the full mark of Ad-RM. This compares with 14 percent for the 1961 brood and 23 percent for the 1962 brood.

Total numbers of partially marked fish, expressed in percentages proportionate to their corresponding full marks, are summarized in table 9. Percentages of partial marks are lower than they were in the 1961 and 1962 brood mark recoveries. The occurrence of EV (either ventral) only marks in proportion to the Ad-EV and the Ad only marks was quite similar for all three broods in the ocean fisheries, but the 1963 brood varied from the other two in the Columbia River fisheries and escapement.

In the ocean fisheries the percentage of Ad-EV marks is about one-fourth that of the EV only marks. The Ad-RV and Ad-LV partial marks are assumed to occur as a result of maxillary regeneration, because double fin marks would hardly occur by chance. The Ad only marks appear to occur in the same way, because the percentage of occurrence is so near that of the Ad-EV marks. But the percentage of EV only marks is about four times that of the Ad-EV; so only one-fourth of these marks appear to have originated through maxillary regeneration. This seems to indicate that the origin of the rest of the EV only marks was not necessarily associated with the marking program of the Columbia River hatchery study.

Table 7.--Recoveries of 1963-brood fall chinook salmon in the Columbia River escapement by type of mark, recovery location, and year of capture, 1965-68

Origin of mark	Mark	Recovery location ^{1/}											
		Study hatcheries				Other hatcheries				Tributary streams ^{2/}			
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968
-----Number of recoveries-----													
All hatcheries	Ad-RM	103	1,164	957	117	1	0	2	0	3	57	(*)	(*)
	Ad	6	110	95	9	0	0	0	0	0	1	(*)	(*)
Spring Creek	Ad-LV-RM	22	253	58	12	0	0	0	0	0	0	(*)	(*)
	Ad-LV	1	20	7	1	0	0	0	0	0	0	(*)	(*)
Kalama	Ad-RV-RM	0	13	47	16	0	0	0	0	0	8	(*)	(*)
	Ad-RV	0	0	1	8	0	0	0	0	0	1	(*)	(*)
Klickitat	LV-RM	0	9	1	0	0	0	0	0	0	14	(*)	(*)
	LV	0	2	2	0	2	0	0	0	0	0	(*)	(*)
Big Creek	RV-RM	19	165	140	6	0	0	3	2	0	36	(*)	(*)
	RV	0	0	3	0	0	0	0	0	0	1	(*)	(*)
Total		151	1,736	1,311	169	3	0	5	2	3	118	(*)	(*)

*Not sampled.

1/ "Study hatcheries" include the 12 hatcheries participating in the marking program.

"Other hatcheries" include Abernathy, Speelyai and Toutle.

"Tributary streams" include those streams listed in appendix table 2.

2/ Data in table 7 are actual counts, and data in appendix table 2 are estimated.

Table 8.--Estimated number of marked fall chinook salmon of 1963 brood in catches, tributary spawning populations, and hatchery returns by type of mark, region of recovery, type of fishery, and year of capture, 1965-68

Region	Fishery type	Study hatcheries												
		Ad-RM				Ad				Total				
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968	
-----Number of fish-----														
Ocean fisheries:														
	Southeastern Alaska....	Commercial...	0	0	9	*	0	19	5	*	0	19	14	*
	British Columbia.....	Commercial...	55	4,483	2,246	201	7	434	280	42	62	4,917	2,526	243
	Washington.....	Sport.....	1,189	2,569	451	46	107	288	31	5	1,296	2,857	482	51
		Commercial...	5	3,227	464	10	0	178	31	2	5	3,405	495	12
	Oregon.....	Sport.....	0	193	73	0	0	23	25	0	0	216	98	0
		Commercial...	4	459	92	3	0	42	15	0	4	501	107	3
	California.....	Sport.....	0	0	0	0	0	7	0	0	0	7	0	0
		Commercial...	0	12	12	15	0	33	7	0	0	45	19	15
	Subtotal.....	(Sport.....	1,189	2,762	524	46	107	318	56	5	1,296	3,080	580	51
		(Commercial...	64	8,181	2,823	229	7	706	338	44	71	8,887	3,161	273
Freshwater fisheries:														
	Columbia River.....	Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
		Commercial...	121	1,182	2,418	317	3	104	121	29	124	1,286	2,539	346
	Total.....	All fisheries	1,374	12,125	5,765	592	117	1,128	515	78	1,491	13,253	6,280	670
Columbia River escapement:														
	Study hatcheries.....		103	1,164	957	117	6	110	95	9	109	1,274	1,052	126
	Other hatcheries.....		1	0	2	0	0	0	0	0	1	0	2	0
	Tributary streams.....		6	165	*	*	0	2	*	*	6	167	*	*
	Total.....	Escapement...	110	1,329	959	117	6	112	95	9	116	1,441	1,054	126

*Not sampled.

Table 8.--Estimated number of marked fall chinook salmon of 1963 brood in catches, tributary spawning populations, and hatchery returns by type of mark, region of recovery, type of fishery, and year of capture, 1965-68--Continued

Region	Fishery type	Spring Creek National Fish Hatchery												
		Ad-LV-RM				Ad-LV				Total				
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968	
-----Number of fish-----														
Ocean fisheries:														
	Southeastern Alaska....	Commercial...	0	0	0	*	0	0	0	*	0	0	0	*
	British Columbia.....	Commercial...	23	530	222	6	0	27	2	0	23	557	224	6
	Washington.....	Sport.....	104	306	83	0	16	23	20	0	120	329	103	0
		Commercial...	0	374	38	0	0	7	0	0	0	381	38	0
	Oregon.....	Sport.....	0	31	2	0	0	4	3	0	0	35	5	0
		Commercial...	0	26	5	0	0	2	0	0	0	28	5	0
	California.....	Sport.....	0	4	0	0	0	0	0	0	0	4	0	0
		Commercial...	0	0	0	0	0	0	0	0	0	0	0	0
	Subtotal.....	(Sport.....	104	341	85	0	16	27	23	0	120	368	108	0
		(Commercial...	23	930	265	6	0	36	2	0	23	966	267	6
Freshwater fisheries:														
	Columbia River.....	Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
		Commercial...	29	154	260	13	0	10	33	2	29	164	293	15
	Total.....	All fisheries	156	1,425	610	19	16	73	58	2	172	1,498	668	21
Columbia River escapement:														
	Study hatcheries.....		22	253	58	12	1	20	7	1	23	273	65	13
	Other hatcheries.....		0	0	0	0	0	0	0	0	0	0	0	0
	Tributary streams.....		0	0	*	*	0	0	*	*	0	0	*	*
	Total.....	Escapement...	22	253	58	12	1	20	7	1	23	273	65	13

*Not sampled.

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Table 8.--Estimated number of marked fall chinook salmon of 1963 brood in catches, tributary spawning populations, and hatchery returns by type of mark, region of recovery, type of fishery, and year of capture, 1965-68--Continued

Region	Fishery type	Kalama Falls State Salmon Hatchery											
		Ad-RV-RM				Ad-RV				Total			
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968
-----Number of fish-----													
Ocean fisheries:													
Southeastern Alaska....	Commercial...	0	5	12	*	0	0	2	*	0	5	14	*
British Columbia.....	Commercial...	0	221	187	42	0	20	8	3	0	241	195	45
Washington.....	Sport.....	102	116	46	8	36	23	7	4	138	139	53	12
	Commercial...	0	99	57	5	0	8	14	0	0	107	71	5
Oregon.....	Sport.....	0	20	13	0	2	0	0	0	2	20	13	0
	Commercial...	0	5	0	0	0	2	0	0	0	7	0	0
California.....	Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial...	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal.....	(Sport.....	102	136	59	8	38	23	7	4	140	159	66	12
	(Commercial...	0	330	256	47	0	30	24	3	0	360	280	50
Freshwater fisheries:													
Columbia River.....	Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial....	7	20	44	44	0	12	0	3	7	32	44	47
Total.....	All fisheries	109	486	359	99	38	65	31	10	147	551	390	109
Columbia River escapement:													
Study hatcheries.....		0	13	47	16	0	0	1	8	0	13	48	24
Other hatcheries.....		0	0	0	0	0	0	0	0	0	0	0	0
Tributary streams.....		0	19	*	*	0	2	*	*	0	21	*	*
Total.....	Escapement...	0	32	47	16	0	2	1	8	0	34	48	24

*Not sampled.

Table 8.--Estimated number of marked fall chinook salmon of 1963 brood in catches, tributary spawning populations, and hatchery returns by type of mark, region of recovery, type of fishery, and year of capture, 1965-68--Continued

		Klickitat State Salmon Hatchery											
Region	Fishery type	LV-RM				LV				Total			
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968
		-----Number of fish-----											
Ocean fisheries:													
	Southeastern Alaska.... Commercial...	0	0	0	*	0	5	36	*	0	5	36	*
	British Columbia..... Commercial...	0	249	102	17	0	101	18	62	0	350	120	79
	Washington..... Sport.....	108	111	51	0	20	19	12	0	128	130	63	0
	Washington..... Commercial...	3	165	17	0	3	45	6	0	6	210	23	0
	Oregon..... Sport.....	0	3	5	0	0	4	0	2	0	7	5	2
	Oregon..... Commercial...	0	25	8	0	0	17	0	0	0	42	8	0
	California..... Sport.....	0	4	0	0	0	0	0	0	0	4	0	0
	California..... Commercial...	0	0	8	0	4	20	8	0	4	20	16	0
	Subtotal..... (Sport.....	108	118	56	0	20	23	12	2	128	141	68	2
	Subtotal..... (Commercial...	3	439	135	17	7	188	68	62	10	627	203	79
Freshwater fisheries:													
	Columbia River..... Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
	Columbia River..... Commercial	0	110	62	0	0	9	5	0	0	119	67	0
	Total..... All fisheries	111	667	253	17	27	220	85	64	138	887	338	81
Columbia River escapement:													
	Study hatcheries.....	0	9	1	0	0	2	2	0	0	11	3	0
	Other hatcheries.....	0	0	0	0	2	0	0	0	2	0	0	0
	Tributary streams.....	0	113	*	*	0	0	*	*	0	113	*	*
	Total..... Escapement...	0	122	1	0	2	2	2	0	2	124	3	0

*Not sampled.

Table 8.--Estimated number of marked fall chinook salmon of 1963 brood in catches, tributary spawning populations, and hatchery returns by type of mark, region of recovery, type of fishery, and year of capture, 1965-68--Continued

Region	Fishery type	Big Creek Salmon Hatchery												
		RV-RM				RV				Total				
		1965	1966	1967	1968	1965	1966	1967	1968	1965	1966	1967	1968	
-----Number of fish-----														
Ocean fisheries:														
	Southeastern Alaska....	Commercial...	0	0	0	*	0	16	6	*	0	16	6	*
	British Columbia.....	Commercial...	0	27	89	3	0	104	43	18	0	131	132	21
	Washington.....	Sport.....	56	140	54	0	84	31	54	0	140	171	108	0
		Commercial...	0	150	29	0	0	37	3	0	0	187	32	0
	Oregon.....	Sport.....	0	13	8	0	0	2	11	0	0	15	19	0
		Commercial...	0	30	5	0	0	11	4	0	0	41	9	0
	California.....	Sport.....	0	0	0	0	0	12	8	0	0	12	8	0
		Commercial...	0	7	0	0	0	2	22	0	0	9	22	0
		(Sport.....	56	153	62	0	84	45	73	0	140	198	135	0
		(Commercial...	0	214	123	3	0	170	78	18	0	384	201	21
Freshwater fisheries:														
	Columbia River.....	Sport.....	0	0	0	0	0	0	0	0	0	0	0	0
		Commercial...	0	83	78	0	0	11	0	0	0	94	78	0
	Total.....	All fisheries	56	450	263	3	84	226	151	18	140	676	414	21
Columbia River escapement:														
	Study hatcheries.....		19	165	140	6	0	0	3	0	19	165	143	6
	Other hatcheries.....		0	0	3	2	0	0	0	0	0	0	3	2
	Tributary streams.....		0	41	*	*	0	1	*	*	0	42	*	*
	Total.....	Escapement...	19	206	143	8	0	1	3	0	19	207	146	8

*Not sampled.

Table 9.--Recoveries of partially marked fish by region of capture, type of fishery, and type of mark, 1965-68

Region	Fishery type	Partial mark ^{1/}		
		Ad-EV ^{2/}	Ad	EV
-----Percent-----				
Ocean fisheries:				
Southeastern Alaska...	Commercial	10.5	72.7	100.0
British Columbia.....	Commercial	4.6	9.8	41.5
Washington.....	Sport.....	14.4	9.2	29.7
	Commercial	4.8	5.4	20.5
Oregon.....	Sport.....	12.0	15.3	39.6
	Commercial	10.0	9.3	32.0
California.....	Sport.....	0.0	100.0	83.3
	Commercial	0.0	50.6	78.9
Subtotal.....	All.....	8.0	9.1	36.4
Columbia River fisheries..	All.....	9.5	6.0	7.0
Columbia River escapement:				
Study hatcheries.....		8.3	8.6	2.0
Other hatcheries.....		0.0	0.0	28.6
Tributary streams.....		11.1	1.6	2.0
Subtotal.....		10.6	8.4	2.5

1/ Data in table are ratios (average for all years) of estimated numbers of partial marks to estimated sum of partial marks and corresponding complete marks expressed in percent.

2/ EV signifies "either ventral". Marks of same general type are combined.

Following the same procedure that was used in analysis of the 1961 and 1962 broods, estimated numbers of partially marked fish were combined with their corresponding full marks, except for the EV only marks. The estimated numbers of marked fall chinook salmon of Columbia River hatchery origin, indicated in this combination of marks, are summarized in table 10.

Table 10.--Estimated catch and escapement of marked fall chinook salmon of Columbia River hatchery origin by area of recovery, 1965-68

Recovery category	Type of mark				
	Ad-RM ^{1/}	Ad-LV-RM ^{1/} (Spring Creek)	Ad-RV-RM ^{1/} (Kalama)	LV-RM ^{2/} (Klick- itat)	RV-RM ^{2/} (Big Creek)
	-----Number of fish-----				
Ocean fisheries	17,399	1,856	1,067	876	611
Columbia River fisheries	4,295	501	130	172	161
Total fisheries ^{3/} ..	21,694	2,359	1,197	1,048	772
Total escapement ^{3/} ..	2,737	374	106	123	376

^{1/} Includes partial marks.

^{2/} Full marks only.

^{3/} Does not include marked fish that spawned in streams in 1967 and 1968.

Catch to escapement ratios and catch to number of fish at release ratios were given in the reports for the 1961 and 1962 broods for fish with the common mark at the 12 study hatcheries and fish with special marks at 4 individual hatcheries. Ratios for the individual hatcheries using special marks are not included in this report. These ratios would be distorted because of incomplete data on escapement to spawning grounds in streams adjacent to hatcheries and disparity in the distance that homing salmon travel in the Columbia River system on their way to hatchery or spawning grounds. As a result, true comparison between hatcheries or broods would be impossible.

The disparity in distance is especially significant for the 1963-brood hatchery fish with special marks, because the difference in stream travel distance between Big Creek and Klickitat hatcheries is about 179 miles. Fish bound for Klickitat hatchery not only travel farther than Big Creek hatchery fish, but they are exposed to intensive fisheries (gill net and dip net) most of the way. This also applies in varying degrees to Kalama and Spring Creek hatchery fish. Klickitat and Spring Creek fish are also forced to pass Bonneville Dam during downstream and upstream migration.

The ratio of catch to number at release for the Ad-RM marked fish is less subject to error than the special mark fish, because it is based on average catch figures for all the 12 study hatcheries and it is not affected by escapement figures. Of the 1963 brood released from the 12 study hatcheries with Ad-RM mark, an estimated 21,694 were taken in the various fisheries between 1965 and 1968. This indicates that the catch of Ad-RM marked fish per 1,000 released was about 3.62. This compares with catch of 1.40 Ad-LM marked fish per 1,000 released for the 1962 brood and 3.97 Ad-RM marked fish for the 1961 brood.

Tributary streams were not sampled in 1967 and 1968, as indicated in table 7, but an estimate of the number of Ad-RM fish spawning in those streams was obtained, based on the following indirect evidence:

- a) Stream survey data showing spawning distribution of marked fish of the 1963 brood in 1965 and 1966 (age 2 and 3);
- b) Spawning distribution in the streams of the 1961 brood at age 3, 4 and 5; and distribution of the 1962 brood at age 2, 3 and 4;
- c) Incidental observations of marked fish made during stream surveys by several fishery agencies.

Estimates based on these data indicate that a total of 170 Ad-RM marked fish spawned in tributary streams during 1967 and 1968. These estimates are not included in table 10 because actual sampling data are not available to substantiate the estimates.

ESTIMATED CATCH OF 1963 BROOD HATCHERY FISH

The report for the 1961 brood listed six assumptions which were considered necessary to estimate the contributions of hatchery-reared fall chinook salmon to the fisheries. These assumptions are:

- 1) A marked fish is identifiable as a marked fish throughout its life.
- 2) All observed chinook salmon having the kind of mark used on the hatchery-reared fish are indeed hatchery fish.
- 3) Chinook salmon are correctly aged from scale examinations and information on size of fish and date of capture.
- 4) Marked and unmarked hatchery fish have the same survival rates and maturity schedules.
- 5) Marked and unmarked hatchery fish have the same ocean distribution and are equally vulnerable to the fisheries.

- 6) Either the ocean distribution and timing of migration of fish from each of the hatcheries are the same or the same proportion of each hatchery's production is marked.

Validity of the assumptions was tested in various ways and reasonably established for the 1961 brood, except for number 4. This assumption was tested by comparing the ratios of marked to unmarked fish at times of release and return. There was an increase in ratios with age, which seemed to indicate that marking caused a delaying effect on the age of maturity. Also, the ratios for all ages combined were smaller than for those at release, indicating lower total survival for marked fish. For example, the survival of 1961-brood Ad-RM marked fish, based on data for all study hatcheries, was 56.2 percent of that for the unmarked fish.

Analysis of the 1962 brood in relation to assumption 4 revealed trends similar to the 1961 brood in delayed maturity and increased mortality for the marked fish. The proportion of marked fish showed a fairly uniform increase with age, but there was some fluctuation, especially between ages 2 and 3. Survival for the Ad-LM marked fish (1962 brood) for all study hatcheries was 38.7 percent of that for the unmarked fish.

Data for the 1963 brood related to assumption 4 are shown in table 11. These data point quite consistently toward delayed maturity and increased mortality for marked fish. The ratios in the age 5 column are especially interesting, because all four of these groups show a higher marked to unmarked ratio than the original release figures. This portion of the table definitely indicates delayed maturity.

Survival of marked fish relative to unmarked was significantly lower for the 1962 brood than for the 1961 brood and this trend continued in the 1963 brood. Survival for the Ad-RM marked fish based on data for all study hatcheries was $(0.042/0.1155) 100 = 36.4$ percent and for the four selected hatcheries $(0.043/0.1155) 100 = 37.2$ percent. Percentages for the 1961 brood were 56.2 and 60.4 and for the 1962 brood they were 38.7 and 43.9.

Table 11.--Marked to unmarked ratios for hatchery returns of 1963-brood fall chinook salmon by type of mark and age of fish

Mark	Origin	Age (years)				
		2	3	4	5	All ages
		-----Marked/unmarked-----				
Ad-RM	All study hatcheries	0.038	0.033	0.057	0.137	0.042
Ad-RV-RM	Kalama	0	.009	.023	.142	.023
Ad-LV-RM	Spring Creek	.020	.024	.047	.619	.027
Ad-RM	Selected hatcheries ^{1/}	.048	.036	.059	.150	.043

^{1/} Cascade, OxBow, Little White Salmon and Spring Creek hatcheries.

Possible effects of straying on the survival of marked fish relative to unmarked were considered for the 1963 brood, and the survival differential was calculated using the same general formula that was used for the 1961 brood (Worlund et al., 1969). Table 12 shows escapement recoveries and strays for Big Creek, Kalama, Spring Creek and Klickitat. Percentages of marked fish straying from the four hatcheries were 11.7, 5.7, 3.2 and 0.0. Big Creek hatchery fish led in percent of straying and distance strayed. Marked fish from this hatchery were recovered at Kalama, Cascade and Spring Creek hatcheries. In contrast to Big Creek, no strays were recorded for Klickitat hatchery.

Table 12.--Escapement recoveries of marked chinook salmon of 1963 brood by location of release and recovery and age at capture, 1965-68

Recovery location ^{2/}	Release location ^{1/}															
	Big Creek				Kalama				Spring Creek				Klickitat			
	Age				Age				Age				Age			
	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
	-----Number of fish-----															
Grays River.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Big Creek.....	19	173	136	4	0	0	0	1	.....	.....	.....	.....	.....	.....	.....	.....
Plympton.....	0	26	0	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Elokomin.....	0	7	2	0	0	1	0	0	.....	.....	.....	.....	.....	.....	.....	.....
Abernathy.....	0	0	3	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Toutle.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kalama.....	0	0	2	0	0	29	48	23	.....	.....	.....	.....	.....	.....	.....	.....
East Fork Lewis.....	.....	.....	.....	.....	0	2	0	0	.....	.....	.....	.....	.....	.....	.....	.....
Washougal.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tanner Creek (Bonneville).....	.....	.....	.....	.....	.....	.....	.....	.....	0	2	0	0	.....	.....	.....	.....
Eagle Creek (Cascade).....	0	0	0	1	.....	.....	.....	.....	0	2	2	0	.....	.....	.....	.....
Herman Creek (OxBow).....	.....	.....	.....	.....	.....	.....	.....	.....	0	4	0	0	.....	.....	.....	.....
Wind River.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Little White Salmon.....	.....	.....	.....	.....	.....	.....	.....	.....	1	0	1	0	.....	.....	.....	.....
Spring Creek.....	0	0	0	1	.....	.....	.....	.....	22	265	62	13	.....	.....	.....	.....
Big White Salmon.....	.....	.....	.....	.....	0	2	0	0	.....	.....	.....	.....	.....	.....	.....	.....
Klickitat.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	122	1	0
Total.....	19	206	143	8	0	34	48	24	23	273	65	13	0	122	1	0
Number of strays.....	0	33	7	4	0	5	0	1	1	8	3	0	0	0	0	0
Percentage of strays.....	0	16.0	4.9	50.0	0	14.7	0	4.2	4.3	2.9	4.6	0	0	0	0	0
Percentage of strays (all ages)	-----11.7-----				-----5.7-----				-----3.2-----				-----0-----			

1/ Big Creek: RV-RM; Kalama: Ad-RV-RM and Ad-RV; Spring Creek: Ad-LV-RM and Ad-LV; Klickitat: LV-RM.

2/ Recoveries in tributary streams were adjusted on the basis of the appropriate sampling ratios.

Calculations to find the probable number of nonhatchery fish that strayed into the four hatcheries between Bonneville and The Dalles dams (Spring Creek, Little White Salmon, OxBow and Cascade) are summarized in table 13. The number of nonhatchery strays is estimated to be 665 fish. This number is used to adjust for the possible effects that such strays would have on the calculated survival differential between marked and unmarked hatchery fish.

Total returns of marked (Ad-RM and Ad only) and unmarked hatchery fish to the four hatcheries are listed in appendix table 2. The returns were 1,607 marked and 36,964 unmarked fish. Adjusting for the estimated non-hatchery strays, the total number of unmarked fish would be $36,964 - 665 = 36,299$ fish. Using the adjusted figure, the marked to unmarked ratio would be $1,607/36,299 = 0.044$. Expressed in percent, the survival of marked fish relative to unmarked would be $(0.044/0.1155) 100 = 38.1$ percent.

The calculations established a range of survival values of marked fish relative to unmarked, with a median of 37.2 percent. Based on this median, the estimated total catch of 1963-brood hatchery fish is presented in table 14(a). The estimated catch of 531,935 fish comprised about 19.5 percent of the total catch of 1963-brood fall chinook salmon in the fisheries sampled.

The highest and lowest points in the total range of calculated survival values for the 1963 brood are 38.1 and 36.4 percent. This compares with 56.7 and 38.7 percent for the 1962 brood. Estimates of the total catch of the 1963-brood hatchery fish, based on the highest and lowest points of the range, are shown in tables 14(b) and 14(c). These catches are 520,004 and 542,245 fish, respectively.

The catch presented in table 14(b) is a conservative estimate, because it is based on the highest calculated survival. In contrast, the catch in table 14(c) is based on the lowest calculated survival. The difference in total catch between the two estimates is 22,241 fish.

Salmon carcasses that remain at the hatcheries after removal of spawn are used in several ways. These include sale to commercial processors and donation to various institutions and groups. These fish have been omitted from the catch estimates because they were not taken in the fisheries. They are included in the final estimate of the total harvest value of the 1963-brood fall chinook salmon that originated in Columbia River hatcheries.

Table 13.--Estimated number of nonhatchery chinook salmon of 1963 brood spawned at four hatcheries^{1/} between Bonneville and The Dalles dams, 1965-68

Item	Year of run				Total
	1965	1966	1967	1968	
Count at Bonneville Dam ^{2/}	134,469	135,095	160,434	139,354	569,352
Count at The Dalles Dam ^{2/}	87,096	69,018	114,316	76,991	347,421
Hatchery returns ^{1/}	12,025	31,021	16,911	15,606	75,563
Catch ^{3/}	25,051	7,008	35,146	26,177	93,382
Bonneville count minus The Dalles count minus hatchery return minus catch	10,297	28,048	0 ^{4/}	20,580	52,986
Percent of 1963 brood ^{5/}	9.6	49.3	47.6	2.6	
Number of 1963 brood year not straying	988	13,828	0	535	15,351
Percent straying ^{6/}	4.3	4.2	2.7	2.7	
Estimated number of 1963-brood fish straying into four hatcheries ^{1/}	44	606	0	15	665

1/ Spring Creek, Little White Salmon, OxBow and Cascade hatcheries.

2/ Counts for period August 26 to September 30.

3/ Chinook salmon catch between Bonneville and The Dalles Dam for period August 27 to September 30. Sport catch not included.

4/ The zero is used to indicate that there were no nonhatchery fish left in the Bonneville pool area to stray into the hatcheries. The remainder is actually a negative number (-5,939).

5/ Percent was determined by using summary of age composition data in data reports (1966-70).

6/ Estimates from Spring Creek mark (Ad-LV-RM) and Kalama mark (Ad-RV-RM) combined, table 12.

Table 14(a).--Estimated catch of hatchery fall chinook salmon of 1963 brood by type of fishery and year of capture, 1965-68^{1/}

Fishery type	Year of catch				Total
	1965	1966	1967	1968	
	-----Number of fish-----				
Ocean sport	31,881	75,556	14,370	1,250	123,057
Ocean commercial	1,749	217,685	77,529	6,702	303,665
Columbia River sport	0	0	0	0	0
Columbia River commercial	3,046	31,603	62,104	8,460	105,213
Total	36,676	324,844	154,003	16,412	531,935

^{1/} Calculated on the median of the range of marked relative to unmarked survival of 37.2 percent.

Table 14(b).--Estimated catch of hatchery fall chinook salmon of 1963 brood by type of fishery and year of capture, 1965-68^{1/}

Fishery type	Year of catch				Total
	1965	1966	1967	1968	
	-----Number of fish-----				
Ocean sport	31,168	73,862	14,051	1,222	120,303
Ocean commercial	1,710	212,797	75,791	6,552	296,850
Columbia River sport	0	0	0	0	0
Columbia River commercial	2,978	30,896	60,707	8,270	102,851
Total	35,856	317,555	150,549	16,044	520,004

^{1/} Calculated on marked relative to unmarked survival of 38.1 percent.

Table 14(c).--Estimated catch of hatchery fall chinook salmon of 1963 brood by type of fishery and year of capture, 1965-68^{1/}

Fishery type	Year of catch				Total
	1965	1966	1967	1968	
	-----Number of fish-----				
Ocean sport	32,497	77,020	14,645	1,274	125,436
Ocean commercial	1,783	221,909	79,031	6,832	309,555
Columbia River sport	0	0	0	0	0
Columbia River commercial	3,105	32,214	63,310	8,625	107,254
Total	37,385	331,143	156,986	16,731	542,245

^{1/} Calculated on marked relative to unmarked survival of 36.4 percent.

ESTIMATED VALUE OF CATCH FOR 1963-BROOD HATCHERY FISH

The cost of producing fish released from the 12 hatcheries was estimated from 1964 fiscal year costs at individual hatcheries. Costs were apportioned between the brood year-species groups at each hatchery on the basis of estimated relative man-hours expended and relative size of each group. At each hatchery costs were divided into three categories:

- 1) Amortized and discounted capital investment
- 2) Fish food and drugs
- 3) Operational costs other than food

Capital investment in the hatcheries was amortized over 50 years and was charged a simple interest rate of 5 percent per annum, which amounts to 7 percent of the total capital investment chargeable to each year's operation. This 7 percent was then apportioned among the broods and species present by using the percentage of time spent caring for each group of fish. Cost of fish food and drugs during the fiscal year was apportioned according to the pounds of each brood year-species group produced. Operational cost other than food and drugs was apportioned the same as capital investment. Total cost of production of 1963 brood fall chinook at the 12 study hatcheries was calculated to be \$842,020.

For commercially caught fish, the economic value was determined from estimated landings and average prices paid to fishermen in 1965-68. We treated this as a net economic value for the same reasons as presented in the report for the 1961 brood.

Estimation of net value for the catch of hatchery chinook salmon by sport fishermen was made from an accepted net value per fish of \$8.87^{4/}

Calculation of total net value of the commercial and sport catch of fall chinook salmon that originated from the hatcheries under study is shown in table 15. The net value is estimated to be \$3,519,016.

The economic value of salmon carcasses was determined from the average price paid by commercial processors. Donations to various institutions and groups were valued at the same price. The estimated value of these fish is \$31,467; so the total harvest value of fall chinook salmon originating from the hatcheries under study is estimated to be \$3,550,483.

The benefit-to-cost ratio is obtained from the ratio \$3,550,483/\$842,020 and is estimated as 4.2:1. Estimated benefit-to-cost ratios based on minimum and maximum catches as shown in tables 14(b) and 14(c) are 4.1:1 and 4.3:1, respectively.

We assumed that the 13.5 million fish released from 7 other hatcheries not included in the study contributed to the fisheries in the same proportion as the 60.1 million from the study hatcheries. Based on this assumption, the estimated contribution of the 7 hatcheries is 119,486 fish, with a net value of \$790,460.

Based on the preceding estimates, the total value of the harvest of 1963-brood fall chinook salmon originating from all the Columbia River hatcheries is an estimated \$4,340,943.

SUMMARY

- 1) During the 4 years of marking at 12 hatcheries, 21.3 million fish (10 percent of the total production of 213 million) were marked with an adipose-maxillary mark. An additional 9.6 million were identified with special marks unique to a hatchery.
- 2) The 1963-brood release of 60.1 million fish included 6.0 million marked with a "common mark" (Ad-RM). Fish with marks unique to a hatchery were released from Spring Creek, Kalama, Big Creek and Klickitat hatcheries.
- 3) During the 4 years of mark sampling, which included 1963-brood fish (1965-68), an average of 19.9 percent of the chinook salmon catch was examined for marked fish.

^{4/} U.S. Department of the Interior, Bureau of Commercial Fisheries, Division of Economics, 1966. An economic evaluation of Columbia River anadromous fish programs. 52 pp. (Processed.)

- 4) Sampling for marked fish was conducted in most chinook fisheries, with a few exceptions, from Avila Beach, California to Pelican, Alaska. During the years indicated, there was no sampling in the following fisheries: 1966, British Columbia purse seine and southeast Alaska gill net; 1967, southeast Alaska gill net; 1968, southeast Alaska troll and gill net.
- 5) A total of 7,476 marked fish from the 1963 brood of possible Columbia River hatchery origin were recovered during the 4 years. The majority, 4,772, were recovered as age-3 fish in 1966.
- 6) Although marked fish were recovered in the ocean fisheries over the entire range of sampling, most were recovered from landings made north of the Columbia River mouth (Washington and west coast of Vancouver Island fisheries).
- 7) Seven marked fish, originating from Kalama hatchery, were the only fish (specific to a hatchery) recovered in the southeast Alaska fishery.
- 8) An estimated total of 21,694 marked (Ad-RM) fish that originated from the 12 study hatcheries was caught. An additional 2,737 escaped the fisheries and returned to spawn.
- 9) The catch ratio of Ad-RM marked fish from all 12 hatcheries in terms of numbers released was 3.62 per 1,000.
- 10) By assuming that marked and unmarked hatchery fish have the same ocean distribution, and that relative survival of marked fish was 37.2 percent of the survival of unmarked fish, we estimated that the total catch of hatchery fish (marked and unmarked) was 531,935.
- 11) The estimated catch of hatchery fish, 531,935, comprised about 19.5 percent of the total catch of 1963-brood fall chinook salmon in the fisheries sampled.
- 12) The estimated cost of rearing the fall chinook salmon of the 1963 brood released from the study hatcheries was \$842,020. The estimated harvest value of these fish was \$3,550,483. The benefit-to-cost ratio, therefore, was 4.2:1.
- 14) The estimated total value of the harvest of fall chinook salmon of 1963 brood that originated from all Columbia River hatcheries (including 7 hatcheries not participating in the marking experiment) was \$4,340,943.

Table 15.--Estimated value of the catch of fall chinook salmon of 1963 brood released from twelve study hatcheries, by type of fishery

Fishery	Age	Fish	Sample size	Average weight ^{1/}		Total weight		Value per unit catch ^{2/}	Total value
				Lbs.	Kg.	Lbs.	Kg.	Dollars	Dollars
Sport.....	All	123,057	Number of fish					8.870 ^{3/}	1,091,516
Ocean commercial.....	2	1,749	80 ^{4/}	6.43	2.92	11,246	5,107	.380	4,273
	3	217,685	824	8.55	3.89	1,861,207	846,795	.450	837,543
	4	77,529	101	13.49	6.13	1,045,866	475,253	.633	662,033
	5	6,702	71	21.30	9.68	142,753	64,875	.780	111,347
	Columbia River commercial	2	3,046	41	6.07	2.76	18,489	8,407	.360	6,656
	3	31,603	152	18.29	8.31	578,019	262,621	.352	203,463
	4	62,104	427	24.41	11.10	1,515,959	689,354	.347	526,038
	5	8,460	88	27.61	12.55	233,581	106,173	.326	76,147
Total.....		531,935	.....	.....	.....	5,407,120	.....	.....	3,519,016

^{1/} Weights for ocean commercial fisheries are dressed weights, and those for Columbia River fisheries are round weights. Original weights were in pounds for Ad-RM marked fish.

^{2/} Entries for commercial fisheries (dollars per pound) are based on prices paid for Washington State troll landings, obtained from Dale Ward, Washington Department of Fisheries (personal communication).

^{3/} U.S. Department of the Interior, Bureau of Commercial Fisheries, Division of Economics, 1966. An economic evaluation of Columbia River anadromous fish programs. 52 pp. (Processed.)

^{4/} Weights are for unmarked fish. Insufficient sample of marked fish.

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Appendix Table 1.--Key to tables common to evaluation reports for
1961-, 1962- and 1963-brood fall chinook salmon

Table number		
Brood year 1963	Brood year 1962	Brood year 1961
1	--	--
2	--	2
3	1	4
4	2	6
5	3	7
6	4	8
7	5	9
8	6	10
9	7	12
10	8	13
11	10	14
12	11	15
13	12	16
14	13	17
15	14	20

Appendix Table 2.--Marked and unmarked returns of fall chinook salmon
of 1963 brood year to Columbia River hatcheries
and tributary streams

Recovery location	Group	Year of return			
		1965	1966	1967	1968
-----Number of fish-----					
Hatcheries:					
Grays River.....	Unmarked	17	95	(**)	0
	Ad-RM	0	3	(**)	0
Big Creek.....	Unmarked	488	2,659	898	15
	Ad-RM	9	56	61	4
	Ad	2	0	0	0
	Ad-RV-RM	0	0	0	1
	RV-RM	19	162	136	4
Elokomin.....	Unmarked	2	1,530	408	23
	Ad-RM	0	28	20	1
	Ad	0	1	1	0
	Ad-RV-RM	0	1	0	0
	RV-RM	0	3	2	0
Kalama.....	Unmarked	28	1,335	2,045	162
	Ad-RM	0	30	112	26
	Ad	0	0	5	3
	Ad-RV-RM	0	12	47	15
	Ad-RV	0	0	1	8
	RV-RM	0	0	2	0
	RV	0	0	2	0
Washougal.....	Unmarked	17	29	(**)	(**)
Bonneville.....	Unmarked	621	6,790	5,303	358
	Ad-RM	20	204	260	37
	Ad	0	23	13	1
	Ad-LV-RM	0	2	0	0
Little White Salmon.....	Unmarked	372	7,166	3,892	213
	Ad-RM	11	166	166	25
	Ad	0	35	42	2
	Ad-LV-RM	1	0	1	0
	LV	0	2	0	0
Cascade.....	Unmarked	59	3,779	2,197	67
	Ad-RM	8	94	109	7
	Ad	1	5	11	0
	Ad-LV-RM	0	2	1	0
	Ad-LV	0	0	1	0
	RV-RM	0	0	0	1
	RV	0	0	1	0
Spring Creek.....	Unmarked	1,092	11,165	1,316	21
	Ad-RM	46	476	109	12
	Ad	3	38	8	2
	Ad-LV-RM	21	245	56	12
	Ad-LV	1	20	6	1
	RV-RM	0	0	0	1
OxBow.....	Unmarked	114	3,082	2,371	58
	Ad-RM	9	74	119	5
	Ad	0	8	15	1
	Ad-LV-RM	0	4	0	0
	LV	0	0	1	0

Appendix Table 2.--Marked and unmarked returns of fall chinook salmon of 1963 brood year to Columbia River hatcheries and tributary streams--Continued

Recovery location	Group	Year of return			
		1965	1966	1967	1968
-----Number of fish-----					
Hatcheries--Continued					
Klickitat.....	Unmarked	38	935	50	0
	Ad-RM	0	33	1	0
	LV-RM	0	9	1	0
	LV	0	0	1	0
Toutle.....	Unmarked	212	602	1,085	209
Abernathy.....	Unmarked	1,569	1,703	218	6
	Ad-RM	1	0	2	0
	RV-RM	0	0	3	2
	LV	2	0	0	0
Speelyai.....	Unmarked	515	95	1	0
Tributary streams:^{1/}					
Grays River.....	Unmarked	18	248	(*)	(*)
	Ad-RM	0	4	(*)	(*)
Big Creek.....	Unmarked	101	357	(*)	(*)
	Ad-RM	0	10	(*)	(*)
	RV-RM	0	11	(*)	(*)
Kalama.....	Unmarked	483	1,396	(*)	(*)
	Ad-RM	0	36	(*)	(*)
	Ad	0	2	(*)	(*)
	Ad-RV-RM	0	17	(*)	(*)
Washougal.....	Unmarked	4	162	(*)	(*)
Little White Salmon.....	Unmarked	7	322	(*)	(*)
	Ad-RM	0	2	(*)	(*)
Big White Salmon.....	Unmarked	56	2,453	(*)	(*)
	Ad-RM	0	10	(*)	(*)
	Ad-RV	0	2	(*)	(*)
Klickitat.....	Unmarked	781	3,759	(*)	(*)
	Ad-RM	4	73	(*)	(*)
	LV-RM	0	113	(*)	(*)
East Fork Lewis.....	Unmarked	56	1,655	(*)	(*)
	Ad-RM	0	5	(*)	(*)
	Ad-RV-RM	0	2	(*)	(*)
Wind River.....	Unmarked	0	588	(*)	(*)
	Ad-RM	0	7	(*)	(*)
Plympton.....	Unmarked	100	532	(*)	(*)
	Ad-RM	2	14	(*)	(*)
	RV-RM	0	26	(*)	(*)
	RV	0	1	(*)	(*)
Elokomin.....	Unmarked	84	324	(*)	(*)
	Ad-RM	0	4	(*)	(*)
	RV-RM	0	4	(*)	(*)

*Not sampled.

**No fall chinook salmon collected for spawning.

^{1/} Total return of marked fish for tributary stream estimated from mark recoveries.