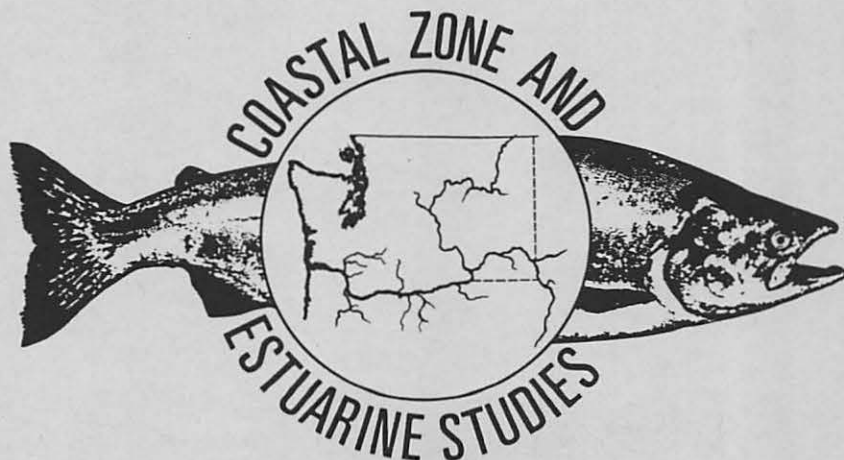


**Relative Survival of Subyearling  
Chinook Salmon  
That Have Passed Bonneville Dam  
Via the Spillway or Second Powerhouse  
Turbines or Bypass System:  
Adult Recoveries Through 1991**

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## INTRODUCTION

During the summers of 1987-1990, differentially marked upriver bright stock (URB) juvenile fall chinook salmon (Oncorhynchus tshawytscha) were released simultaneously through a turbine and the bypass system at Bonneville Dam Second Powerhouse (Fig. 1). Additional releases were made 1) into the tailrace at the downstream edge of the turbine boil, 2) about 2 km downstream from the dam, and 3) through the spillway. However, none of these release sites were used in all 4 years. Each year, about 2 million fish were released. For about 2 months after release, juvenile salmon were seined in the Columbia River estuary (at Jones Beach), 157 km downstream from Bonneville Dam. Recovery percentages from seining were used to estimate short-term comparative passage survival for fish groups sent through the various passage routes.

Estuarine recovery percentages of juvenile fish provided startling evidence concerning relative survival among groups through all 4 years of study. Recovery percentage of bypass-released fish was low relative to other release groups, but was variable, ranging from 0.44 to 0.80% (Table 1). In the first 2 years, recovery percentages for bypass-released groups were significantly less ( $P < 0.05$ ) than for turbine-released groups; mean differences were 10.8% in 1987 and 13.6% in 1988. In the last 2 years, recovery percentages for bypass-released groups remained less than for turbine-released groups, but neither difference was statistically significant (3.3% in 1989 and 2.5% in 1990). However, the combined data from all 4 years indicated a significant difference in recovery percentages, with 7.6% less for bypass-released groups than for turbine-released groups ( $P < 0.05$ ). For 3 years of data, recovery percentages for bypass-released groups averaged 14.1, 7.3, and 3.6% less than for tailrace-released groups. Combined data showed an 8.3% lower recovery for bypass groups, indicating a significant difference in relative survival compared with tailrace-released groups. Relative survival for groups

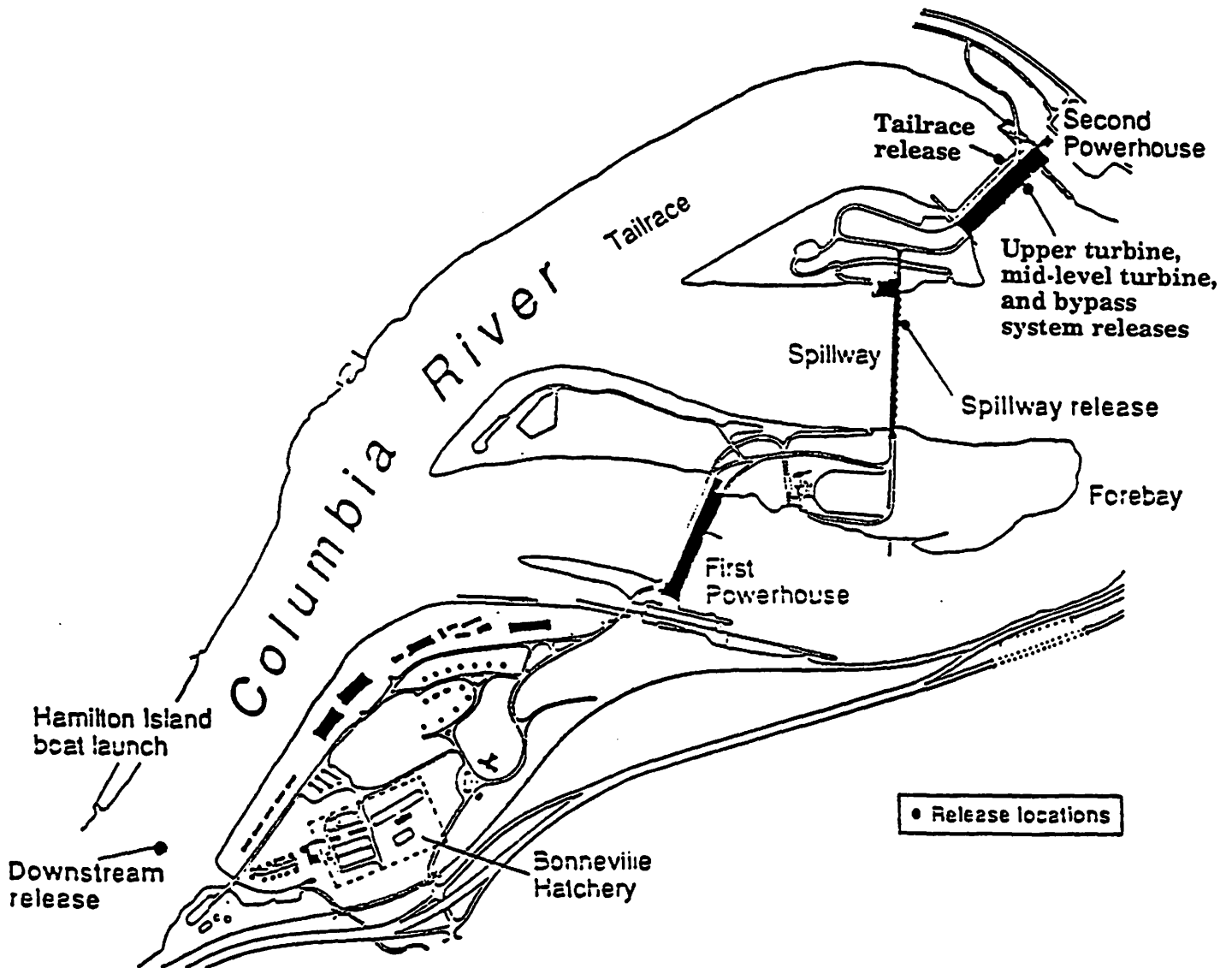


Figure 1.--Schematic of Bonneville Dam and vicinity showing release locations for subyearling chinook salmon during 1987-90 studies.

Table 1.--Summary of juvenile recovery percentages and percentage differences among groups, Bonneville Dam passage survival study, 1987-1990.

Treatment	1987	1988	1989	1990	Average <sup>a</sup>
Recovery percentage					
Bypass	0.5764	0.4376	0.8007	0.5577 (0.5106) <sup>b</sup>	
Upper turbine	0.6402	0.5024	0.8298	nt <sup>c</sup>	
Mid-level turbine	0.6528	0.5104	0.8256	0.5721	
Tailrace	nt	0.5095	0.8637	0.5686 (0.5299) <sup>b</sup>	
Downstream	0.5567 <sup>d</sup>	0.5690	0.9061	nt	
Spillway	nt	nt	0.9604	nt	
Percentage difference from mid-level turbine-released groups <sup>e</sup>					
Upper turbine	-1.9	-1.6	0.5	nt	-1.0
Percentage difference from combined turbine-released groups <sup>f</sup>					
Bypass	-10.8*	-13.6*	-3.3	-2.5 <sup>b</sup>	-7.6*
Percentage difference from tailrace-released groups <sup>g</sup>					
Bypass	nt	-14.1*	-7.3	-3.6	-8.3*
Combined turbine	nt	-0.6	-4.2	0.6	-1.4
Percentage difference from downstream-released groups					
Tailrace	nt	-10.5*	-4.7	nt	-7.6*
Spillway	nt	nt	6.0	nt	6.0

<sup>a</sup> Weighted by year.

<sup>b</sup> In 1990, the first 11 turbine release groups were compromised, thus only the last 10 groups can be compared to bypass or tailrace release groups. All 21 groups were used for comparing the bypass to tailrace release groups, shown in parentheses.

<sup>c</sup> nt = not tested.

<sup>d</sup> The downstream release in 1987 was made at the shoreline, whereas all other releases were in mid-river.

<sup>e</sup> Percentage difference from indicated group = [(Treatment% - indicated group%) ÷ indicated group] × 100.

<sup>f</sup> Average of turbine groups released at the ceiling and at mid-depth of the intake.

<sup>g</sup> Tailrace release site was at the downstream side of turbine discharge boil, directly into or 46 m upstream from the bypass discharge plume.

\* Significant at  $\alpha = 0.05$ .

passing through the Bonneville Dam Second Powerhouse tailrace appeared to be poor. Recovery percentages for tailrace-released groups were significantly different (7.6% lower) than for downstream-released groups. Relative survival for spillway-released groups was evaluated only in 1989. The recovery percentage for spillway-released groups was not significantly different from that of downstream-released groups. Details of fish releases and juvenile recoveries are presented in Ledgerwood et al. (1990, 1991).

Coded-wire tag (CWT) recovery data for immatures and adults (hereafter termed adults) emanating from fish groups released through the 4 years of study will be used to estimate long-term relative survival of treatment groups. CWT returns to National Marine Fisheries Service provide the greatest number of data points and are the basis for comparing treatment groups for each release-year. CWT recovery data, collated by Pacific States Marine Fisheries Commission (PSMFC) as of 19 May 1992, were the basis for examining the geographical distributions and comparing recovery percentages to similar fish groups released by other fisheries agencies. Treatment groups with the highest annual recovery percentage as juveniles were selected to represent the Bonneville survival study in those comparisons.

### ADULT RECOVERIES

Adult fall chinook salmon CWT recoveries are incomplete, relative to the number that will be used in the final analysis. CWTs from adults recovered to date include: 4,134  $\leq$  5 years old from those released in 1987; 282  $\leq$  4 years old from those released in 1988; 791  $\leq$  3 years old from those released in 1989; and 261  $\leq$  2 years old from those released in 1990. The number of recoveries is extremely low; much lower than the predicted 0.5% for all the 2- to 5- year-old fish. Recovery percentages of fish from the present study are less than recovery percentages of similar groups of hatchery-released fish. Possible

reasons for the overall low recoveries, and their corresponding low survival estimates vary between years, as discussed below.

### 1987 Releases

Recoveries for 2- to 5-year-old fish from releases of subyearling fall chinook salmon in 1987 are nearly complete; 0.24% or about 52 fish per release group were recovered (Table 2). Based on recoveries to date, a difference in recoveries of about 11.9% would be necessary to prove a statistically significant difference between treatments (Appendix Table 1). Downstream groups were released at the shoreline and were recovered in significantly lower percentages than groups released at the dam (23.3% less than combined upper and mid-level turbine groups; Table 3). Recovery percentages for bypass-released groups averaged 5.3% greater than for combined turbine-released groups, but the difference was not significant. Upper turbine-released groups, thought to pass through the safest of the two turbine passage routes (closer to the blade hub), produced an average of 6.5% fewer recoveries than mid-level turbine-released groups, although this difference was not significant. Data for adult recoveries in 1992 will complete this data set, although few additional tag recoveries are expected. The complete data set will likely be insufficient to distinguish statistical differences between bypass- and turbine-released groups.

Differences in adult recoveries among treatment groups did not indicate the same survival tendencies as those observed in juvenile recoveries. Juvenile recoveries indicated that survival of bypass-released groups was significantly lower than combined turbine-released groups (10.8%; Table 1). Adult tag recovery data indicated just the opposite, although the difference was not significant (5.3%; Table 3).



Table 2.--Coded-wire-tag recoveries from adults which were released as subyearling fall chinook salmon during 1987 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.

Number of recoveries and (percent of release) <sup>a</sup> by release location										
Release date	Bypass system		Downstream		Mid-level turbine		Upper turbine		Totals <sup>b</sup>	
24 June	27	(0.1404) <sup>c</sup>	15	(0.1342)	14	(0.1587)	19	(0.1922)	75	(0.1564)
25 June	23	(0.1415)	21	(0.1350)	59	(0.1862) <sup>c</sup>	13	(0.0865)	116	(0.1373)
26 June	33	(0.1841)	18	(0.1121)	34	(0.2021)	57	(0.1995) <sup>c</sup>	142	(0.1745)
27 June	36	(0.2042)	47	(0.1392) <sup>c</sup>	16	(0.0944)	31	(0.1838)	130	(0.1554)
28 June	77	(0.2145) <sup>c</sup>	24	(0.1402)	44	(0.2666)	22	(0.1167)	167	(0.1845)
1 July	35	(0.2517)	24	(0.1531)	88	(0.2504) <sup>c</sup>	24	(0.1520)	171	(0.2018)
2 July	37	(0.2065)	26	(0.1457)	29	(0.1667)	76	(0.2163) <sup>c</sup>	168	(0.1838)
3 July	39	(0.2134)	53	(0.1573) <sup>c</sup>	37	(0.2004)	42	(0.2573)	171	(0.2071)
4 July	73	(0.2016) <sup>c</sup>	37	(0.2050)	52	(0.2827)	38	(0.2136)	200	(0.2257)
5 July	51	(0.2794)	31	(0.1715)	49	(0.2660) <sup>cd</sup>	50	(0.2806) <sup>d</sup>	181	(0.2494)
8 July	41	(0.2241)	47	(0.2598)	43	(0.2328)	97	(0.2722) <sup>c</sup>	228	(0.2472)
9 July	69	(0.3672)	97	(0.2627) <sup>c</sup>	72	(0.3848)	52	(0.2822)	290	(0.3242)
10 July	105	(0.2808) <sup>c</sup>	48	(0.2652)	61	(0.3228)	46	(0.2514)	260	(0.2801)
11 July	55	(0.2933)	46	(0.2518)	87	(0.2290) <sup>c</sup>	50	(0.2807)	238	(0.2637)
12 July	68	(0.3626)	38	(0.2103)	45	(0.2427)	128	(0.3507) <sup>c</sup>	279	(0.2916)
15 July	68	(0.3642)	113	(0.3058) <sup>c</sup>	57	(0.3209)	41	(0.2250)	279	(0.3040)
16 July	102	(0.2726) <sup>c</sup>	41	(0.2277)	54	(0.2861)	54	(0.2991)	251	(0.2714)
17 July	43	(0.2294)	52	(0.2805)	120	(0.3156) <sup>c</sup>	57	(0.3280)	272	(0.2884)
18 July	71	(0.3792)	35	(0.1889)	70	(0.3697)	123	(0.3378) <sup>c</sup>	299	(0.3189)
19 July	58	(0.3254)	77	(0.2103) <sup>c</sup>	48	(0.2623)	34	(0.1857)	217	(0.2459)
Totals	1,111		890		1,079		1,054		4,134	
No. released	434,880		435,099		423,294		427,112		1,720,385	
Mean recov. % <sup>e</sup>	0.2568		0.1978		0.2520		0.2356		0.2356 <sup>f</sup>	
ANOVA <sup>g</sup>	1		2		1		1			

<sup>a</sup> Calculated by dividing the number of observed recaptures by the number of fish released (adjusted for tag loss) and then multiplying by 100.

<sup>b</sup> Calculated as the unweighted average of group recapture percentages for releases on that date.

<sup>c</sup> Double groups (40,000 vs. 20,000 fish); on 24 June about 20,000 vs. 10,000 fish.

<sup>d</sup> At release on 5 July 1987, diminished oxygen in the tank truck appeared to have caused mortality to portions of the mid-level turbine and upper turbine-released groups. The initial on-site mortality estimates were 50 and 10% respectively. Based on juvenile recovery data we changed the estimates to 100 and 50%. Those estimates were incorrect, thus we have altered them to 50 and 0% respectively.

<sup>e</sup> Weighted equally by block (i.e., by release day). Empirical standard error =  $\sqrt{\text{Mean Square Error} \div n} = 0.009850$ .

<sup>f</sup> Grand mean = average for treatment mean recovery percentage, used in ANOVA.

<sup>g</sup> Common number indicates no significant difference at  $\alpha = 0.05$ . Calculated detectable difference = 11.9% (see Appendix Table 1).

Table 3.--Summary of adult recovery percentages and percentage differences among groups, Bonneville Dam passage survival study, 1987-1990.

Treatment	1987	1988	1989	1990	Average <sup>a</sup>
Recovery Percentage					
Bypass	0.2568	0.0154	0.0339	0.0095 (0.0135) <sup>b</sup>	
Upper turbine	0.2356	0.0179	0.0323	nt <sup>c</sup>	
Mid-level turbine	0.2520	0.0138	0.0356	0.0125	
Tailrace	nt	0.0184	0.0413	0.0131 (0.0169) <sup>b</sup>	
Downstream	0.1978 <sup>d</sup>	0.0152	0.0387	nt	
Spillway	nt	nt	0.0410	nt	
Percentage difference from mid-level turbine-released groups <sup>e</sup>					
Upper turbine	-6.5	29.7	-9.3	nt	4.6
Percentage difference from combined turbine-released groups <sup>f</sup>					
Bypass	5.3	-3.1	-0.3	-24.0 <sup>b</sup>	-5.5
Percentage difference from tailrace-released groups <sup>g</sup>					
Bypass	nt	-16.3	-17.9	-20.1	-18.1
Combined turbine	nt	-13.6	-17.7	-4.6 <sup>b</sup>	-12.0
Percentage difference from downstream-released groups					
Bypass	29.8 <sup>d</sup>	1.3	-12.4	nt	-5.6 <sup>d</sup>
Combined turbine	23.3 <sup>d*</sup>	4.6	-12.1	nt	5.3 <sup>d</sup>
Tailrace	nt	21.1	6.7	nt	13.9
Spillway	nt	nt	5.6	nt	5.6

<sup>a</sup> Weighted by year.

<sup>b</sup> In 1990, the first 11 turbine release groups were compromised, thus only the last 10 groups can be compared to bypass or tailrace release groups. All 21 groups were used for comparing the bypass to tailrace release groups, shown in parentheses.

<sup>c</sup> nt = not tested.

<sup>d</sup> The downstream release in 1987 was made at the shoreline, whereas all other releases were in mid-river. Treatment differences using this datum are excluded from the average.

<sup>e</sup> Percentage difference from indicated group = [(Treatment% - indicated group%) ÷ indicated group] × 100

<sup>f</sup> Average of turbine groups released at the ceiling and at mid-depth of the intake.

<sup>g</sup> Tailrace release site was at the downstream side of turbine discharge boil, directly into or 46 m upstream from the bypass discharge plume.

\* Significant at  $\alpha = 0.05$ .

Adult recovery percentages of URB fall chinook salmon from the study were low compared to recoveries of URB fall chinook salmon released from Bonneville Hatchery in 1987 (Table 4). Fish released at the hatchery in September were recovered at 2 to 3 times the percentage of study fish. We believe that poor adult survival was a result of early release dates and small size of fish at release (4.5 g average; 101 fish/lb). Small size may be associated with a late egg take and stunting from prophylactic treatment for disease. Although the size of study fish did not change significantly during the release period, recovery percentages for adults showed a progressive increase in direct relation to release date (Table 2). Adult recovery percentages, averaged by week of release, increased from 0.162 to 0.214% in late June and early July to 0.281 to 0.306% in mid-July. Bonneville hatchery fish released in November were recovered as adults at a percentage similar to study fish. Also, adult recoveries of URB fall chinook salmon released elsewhere in the basin were recovered at percentages similar to those of study groups (Table 4).

Distribution of tag recoveries by area (Appendix Table 2) appeared similar to that of earlier broods of URB fall chinook salmon released from Bonneville Hatchery. About 74% of total recoveries were made from the Columbia River Basin: 41% from river fisheries; 21% from Bonneville Hatchery; 11% from Bonneville Pool hatcheries; and 1% strays to up-river sites. Recoveries from the 1991 fisheries in Canada and Alaska are presently unreported; when these data are recorded, this will diminish the distribution percentage for returns to the Columbia River Basin.

### 1988 Releases

Recoveries for 2- to 4- year-old fish from releases in 1988 averaged 0.02%, or about five fish per release group (Table 5). Recovery data will be nearly complete with 1992 CWT returns (age 5). Based on recoveries to date, a difference in recoveries of about 37.4% would be necessary to prove a statistically significant difference between

Table 4.--Adult recovery percentages for Bonneville Dam passage survival study releases compared to other releases of upriver bright fall chinook salmon (from PSMFC data base 19 May 1992).

Release Information						Recoveries	
CWT <sup>a</sup>	Source	Site	Date	Size (g)	Number	Number	%
1987 Releases							
232222	Bonn.Surv.Study	Mid-level turb. <sup>b</sup>	6/25-7/19	4.4	423,294	1122	0.27
074738	Bonneville Hat.	Tanner Cr.	9/8	21.9	143,042	787	0.55
074725	Bonneville Hat.	Tanner Cr.	9/8	21.4	64,106	331	0.52
074735	Bonneville Hat.	Tanner Cr.	9/8	19.6	81,012	596	0.74
074742	Bonneville Hat.	Tanner Cr.	9/8	20.3	76,299	630	0.83
074318	Bonneville Hat.	Tanner Cr.	11/5	35.2	110,468	311	0.28
074320	Bonneville Hat.	Tanner Cr.	11/5	34.4	107,515	289	0.27
633315	Klickitat Hat.	Klickitat	6/5	6.5	102,426	110	0.11
073914	Irrigon Hat.	Umatilla R.	5/8	7.5	121,076	330	0.27
B50714	Drano Lake Nets	Drano Lake	5/22	4.6	480,641	932	0.19
634261	Lyons Ferry Hat.	Lwr.Snake R.	6/1	9.5	251,646	244	0.10
634401	Lyons Ferry Hat.	Lwr.Snake R.	6/2	6.4	255,998	541	0.21
051921	Priest Rapids Hat.	Lwr.Yakima R.	5/4	3.9	196,980	137	0.07
051918	Priest Rapids Hat.	Yakima@Prosser	5/5	3.9	147,896	206	0.14
051922	Priest Rapids Hat.	Yakima@Prosser	5/27	7.0	489,950	21	0.00
634128	Priest Rapids Hat.	Columbia R.	6/25	8.3	201,779	171	0.08
1988 Releases							
232650	Bonn.Surv.Study	Downstream <sup>b</sup>	6/27-7/24	6 - 9	385,275	86	0.02
232631°	Rep.10 Surv.Study	Downstream	7/22	7.9	28,413	6	0.02
232641°	Rep.11 Surv.Study	Downstream	7/23	8.0	29,335	10	0.03
232650°	Rep.12 Surv Study	Downstream	7/24	9.5	29,383	18	0.06
074254	Bonneville Hat.	Tanner Cr.	6/1	5.2	53,333	22	0.04
074303	Bonneville Hat.	Tanner Cr.	8/8	11.5	53,014	90	0.17
074304	Bonneville Hat.	Tanner Cr.	11/3	34.6	52,809	66	0.12
073555	Bonneville Hat.	Tanner Cr.	3/7 <sup>d</sup>	51.0	24,352	84	0.34
075007	Irrigon Hat.	Umatilla R.	5/6	6.6	198,285	50	0.03
B50715	Little Wh.Sal.Hat.	Lwr. Yakima R.	5/17	1.6	383,855	9	0.00
0501010103	Yakima Net Pens	Upr. Yakima R.	5/18	3.8	236,469	1	0.00
635216	Lyons Ferry Hat.	Lwr. Snake R.	6/1	8.6	494,488	23	0.00
635232	Hanford Reach	Hanford	6/6	1.6	205,103	24	0.01
635226	Priest Rapids Hat.	Columbia R.	6/18	6.6	196,221	20	0.01

Table 4.--Continued

Release Information						Recoveries	
CWT <sup>a</sup>	Source	Site	Date	Size (g)	Number	Number	%
1989 Releases							
233204	Bonn.Surv.Study	Spillway <sup>b</sup>	6/22-7/22	6-10	349,769	122	0.03
075033	Bonneville Hat.	Tanner Cr.	6/26	6.7	100,166	20	0.02
075036	Bonneville Hat.	Mid-chan.Col. R.	6/26	7.4	101,050	22	0.02
074648	Irrigon Hat.	Umatilla R.	5/16	6.0	624,295	14	0.00
074763	Irrigon Hat.	Umatilla R.	10/18	41.6	153,249	11	0.01
0501010206	Little Wh.Sal.Hat.	Lwr. Yakima R.	6/1	3.0	380,071	1	0.00
0501010204	Yakima Net Pens	@ Dam on Yak. R.	5/30	6.3	282,302	1	0.00
635249	Priest Rapids Hat.	Columbia R.	6/29	8.1	201,608	14	0.01
635252	Hanford Reach	Hanford	6/10	- -	200,630	11	0.01
630228	Lyons Ferry Hat.	Lwr. Snake R.	6/8	5.0	226,478	4	0.00
635207	Lyons Ferry Hat.	Lwr. Snake R.	6/14	6.1	234,103	3	0.00
1990 Releases							
232639	Bonn.Surv.Study	Tailrace <sup>b</sup>	6/30-8/3	6-11	582,106	17	0.00
075409	Bonneville Hat.	Tanner Cr.	7/2	6.3	98,382	1	0.00
075407	Bonneville Hat.	Mid-chan Col.R.	7/2	6.4	93,127	6	0.01
052338	Little Wh.Sal.Hat.	Little Wh.Sal.R.	6/25	4.1	44,804	0	0.00
631459	Klickitat Hat.	Klickitat R.	5/17-6/7	6.0	234,841	0	0.00
075405	Irrigon Hat.	Umatilla R.	5/23	4.8	159,020	4	0.00
075327	Irrigon Hat.	Umatilla R.	10/16	51.5	136,876	2	0.00
052120	Little Wh.Sal.Hat.	Lwr. Yakima R.	5/15	2.5	156,966	0	0.00
0501010210	Yakima Net Pens	@ Dam on Yak. R.	5/18	4.5	237,065	1	0.00
630732	Priest Rapids Hat.	Columbia R.	6/19	8.0	194,530	2	0.00
630755	Hanford Reach	Hanford	6/5	- -	144,164	0	0.00
635550	Lyons Ferry Hat.	Lwr. Snake R.	6/8	8.3	484,918	3	0.00

<sup>a</sup> Coded-wire tag. More than one tag code may be represented by the release data; a list of tags represented is shown in Appendix Table 7.

<sup>b</sup> The treatment groups with the highest juvenile recovery percentage (lowest treatment effects) were used for comparison with other URB release groups.

<sup>c</sup> Sub-set of the 1988 Bonneville Dam passage survival study recovery data listed directly above.

<sup>d</sup> Released the following spring.

Table 5.--Coded-wire-tag recoveries from adults which were released as subyearling fall chinook salmon during 1988 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.

Release date	Number of recoveries and (percent of release) <sup>a</sup> by release location					Totals <sup>b</sup>
	Bypass system	Downstream	Tailrace	Mid-level turbine	Upper turbine	
27 June	4 (0.0137)	2 (0.0066)	4 (0.0136)	5 (0.0171)	7 (0.0238)	22 (0.0150)
28 June	5 (0.0165)	1 (0.0033)	3 (0.0099)	2 (0.0067)	3 (0.0100)	14 (0.0093)
29 June	2 (0.0067)	4 (0.0136)	3 (0.0100)	2 (0.0067)	3 (0.0103)	14 (0.0095)
30 June	4 (0.0134)	6 (0.0201) <sup>c</sup>	4 (0.0134)	4 (0.0133)	5 (0.0177)	23 (0.0156)
1 July	3 (0.0101)	4 (0.0133)	6 (0.0200)	6 (0.0203)	3 (0.0101)	22 (0.0148)
2 July	4 (0.0135)	2 (0.0034)	7 (0.0236)	3 (0.0100)	<sup>d</sup>	16 (0.0126)
13 July	4 (0.0135)	4 (0.0137)	3 (0.0100)	2 (0.0068)	5 (0.0168)	18 (0.0122)
14 July	8 (0.0274)	5 (0.0170)	4 (0.0135)	3 (0.0101)	7 (0.0237)	27 (0.0183)
15 July	4 (0.0135)	3 (0.0102)	4 (0.0140)	5 (0.0167)	7 (0.0233)	23 (0.0155)
22 July	5 (0.0160)	3 (0.0102)	6 (0.0213)	5 (0.0168)	3 (0.0102)	22 (0.0149)
23 July	4 (0.0135)	8 (0.0273)	4 (0.0143)	7 (0.0238)	9 (0.0304)	32 (0.0219)
24 July	8 (0.0266)	13 (0.0441)	17 (0.0568)	5 (0.0167)	6 (0.0202)	49 (0.0329)
Totals	55	55	65	49	58	282
Number released	357,823	385,275	353,410	356,644	324,244	1,777,396
Mean % recov. <sup>e</sup>	0.0154	0.0152	0.0184	0.0138	0.0179	0.0161 <sup>f</sup>
ANOVA <sup>g</sup>	1	1	1	1	1	

<sup>a</sup> Calculated by dividing the number of observed recaptures by the number of fish released (adjusted for tag loss) and then multiplying by 100.

<sup>b</sup> Calculated as the unweighted average of group recapture percentages for releases on that date.

<sup>c</sup> Group released at shoreline lateral to the normal release site; for ANOVA, this was treated as a downstream treatment.

<sup>d</sup> No fish released.

<sup>e</sup> Weighted equally by block (i.e., by release day). Empirical standard error =  $\sqrt{\text{Mean Square Error} + n} = 0.0020976$ .

<sup>f</sup> Grand mean = average for treatment mean recovery percentage used in ANOVA.

<sup>g</sup> Common number indicates no significant difference at  $\alpha = 0.05$ . Calculated detectable difference = 37.2% (see Appendix Table 1).

insufficient to draw substantive conclusions. Adult recovery percentages for URB fall chinook salmon from the present study were low compared to those of URB fall chinook salmon released from Bonneville Hatchery in 1988 (Table 4). Fish released at the hatchery in August were recovered at 8 times the percentage of study fish. At release, the size and condition of study fish appeared normal. However, the last group of study fish released were taken from Bonneville Hatchery production lots and were larger than study fish released earlier, weighing an average of 9.5 g each (48 fish/lb) compared to 8.0 and 7.9 g (56.5 and 57.5 fish/lb) respectively, for study fish released the previous 2 days. These production-lot fish were recovered as adults at a substantially greater percentage (0.06 compared to 0.03 and 0.02%, respectively). Adult recoveries of URB fall chinook salmon released elsewhere in the basin were recovered at percentages equal to or less than those of the study groups (Table 4). For the entire Columbia River Basin, adult contribution from 1988 releases of URB fall chinook salmon were poor. In particular, adult recoveries for study fish released in 1988 were only about 10 and 20% of those from 1987 and 1989 study groups (see Appendix Tables 2, 3, and 4 for comparison of similar-age adult recoveries).

Distribution of adult tag recoveries by area was similar to recoveries from study fish released in 1987. Recoveries from Alaska and Canada are not yet complete and further evaluation is inappropriate at this time (Appendix Table 3).

### 1989 Releases

Recovery for 2- to 3- year-old adults from 1989 releases of subyearling chinook salmon averaged 0.04%, or about 11 fish per release group (Table 6). Based on recoveries to date, a difference in recoveries of about 25.2% would be necessary to prove a

Table 6.--Coded-wire-tag recoveries from adults which were released as subyearling fall chinook salmon during 1989 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.

Release date	Number of recaptures and (percent of release) <sup>a</sup> by release location						Totals <sup>b</sup>
	Bypass system	Downstream	Tailrace	Mid-level turbine	Spillway	Upper turbine	
22 June	3 (0.0103)	5 (0.0168)	9 (0.0312)	3 (0.0102)	5 (0.0179)	4 (0.0137)	29 (0.0167)
23 June	3 (0.0103)	6 (0.0202)	3 (0.0104)	4 (0.0136)	1 (0.0036)	5 (0.0172)	22 (0.0126)
24 June	4 (0.0138)	3 (0.0101)	5 (0.0174)	2 (0.0068)	6 (0.0214)	4 (0.0137)	24 (0.0139)
6 July	5 (0.0168)	8 (0.0272)	6 (0.0202)	9 (0.0303)	11 (0.0377)	12 (0.0407)	51 (0.0288)
7 July	9 (0.0303)	11 (0.0374)	10 (0.0337)	5 (0.0168)	11 (0.0377)	6 (0.0203)	52 (0.0294)
8 July	9 (0.0303)	15 (0.0510)	9 (0.0303)	8 (0.0269)	8 (0.0275)	7 (0.0237)	56 (0.0316)
13 July	14 (0.0473)	12 (0.0405)	22 (0.0752)	10 (0.0338)	10 (0.0335)	14 (0.0474)	82 (0.0463)
14 July	12 (0.0405)	14 (0.0472)	13 (0.0444)	14 (0.0473)	20 (0.0670)	12 (0.0406)	85 (0.0478)
15 July	8 (0.0270)	11 (0.0370)	15 (0.0513)	21 (0.0709)	17 (0.0569)	7 (0.0237)	79 (0.0445)
20 July	20 (0.0678)	20 (0.0665)	15 (0.0504)	26 (0.0869)	22 (0.0744)	11 (0.0365)	114 (0.0638)
21 July	14 (0.0475)	9 (0.0300)	18 (0.0605)	7 (0.0234)	14 (0.0474)	11 (0.0366)	73 (0.0409)
22 July	19 (0.0651)	24 (0.0799)	21 (0.0706)	18 (0.0602)	20 (0.0673)	22 (0.0730)	124 (0.0694)
Totals	120	138	146	127	145	115	791
Number released	353,573	356,549	352,389	356,127	349,769	354,976	2,123,383
Mean recov. % <sup>c</sup>	0.0339	0.0387	0.0413	0.0356	0.0410	0.0323	0.0371 <sup>d</sup>
ANOVA <sup>e</sup>	1	1	1	1	1	1	

<sup>a</sup> Calculated by dividing the number of observed recaptures by the number of fish released (adjusted for tag loss) and then multiplying by 100.

<sup>b</sup> Calculated as the unweighted average of group recapture percentages for releases on that date.

<sup>c</sup> Weighted equally by block (i.e., by release day). Empirical standard error =  $\sqrt{\text{Mean Square Error} + n} = 0.0032863$ .

<sup>d</sup> Grand mean = average for treatment mean recovery percentage used in ANOVA.

<sup>e</sup> Common number indicates no significant difference at  $\alpha = 0.05$ . Calculated detectable difference = 25.2% (see Appendix Table 1).



statistically significant difference between treatments with a 95% confidence interval (Appendix Table 1). No differences of that magnitude were evident. The majority of recoveries should come from 4- to 5- year-old fish, to be recovered in 1993 and 1994.

Comparison of recoveries of study fish to those of other groups released in 1989 indicated similar recovery percentages (Table 4). However, the recovery percentages are not as large as those of 1987 releases. Recoveries of 2- and 3- year-old study fish released in 1989 are equivalent to about 70% of those for fish of similar age released in 1987 (Appendix Tables 2 and 4).

Distribution of adult tag recoveries by area is reported in Appendix Table 4, but is incomplete at this time.

#### 1990 Releases

Recoveries for 2-year-old study fish from releases of subyearling fall chinook salmon in 1990 averaged 0.02%, or about four fish per release group (Table 7). Based on recoveries to date, a recovery difference of about 26.7% would be necessary to prove a statistically significant difference between treatments with a 95% confidence interval (Appendix Table 1). No differences of that magnitude were evident. The majority of recoveries should come from age classes 3, 4, and 5, to be recovered in 1993, 1994, and 1995. Distribution of tag recoveries by area is reported in Appendix Table 5.

Table 7.--Coded-wire-tag recoveries from adults which were released as subyearling fall chinook salmon during 1990 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.

Release date	Number of recaptures and (percent of release) <sup>a</sup> by release location			
	Bypass system	Tailrace	Mid-level turbine	Totals <sup>b</sup>
30 June	3 (0.0118)	4 (0.0143)	4 (0.0146) <sup>c</sup>	11 (0.0136)
2 July	6 (0.0218)	2 (0.0073)	8 (0.0292) <sup>c</sup>	16 (0.0194)
3 July	1 (0.0036)	6 (0.0219)	4 (0.0145) <sup>c</sup>	11 (0.0133)
5 July	5 (0.0174)	2 (0.0073)	2 (0.0073) <sup>c</sup>	9 (0.0107)
6 July	1 (0.0036)	2 (0.0073)	0 (0.0000) <sup>c</sup>	3 (0.0036)
10 July	3 (0.0108)	4 (0.0146)	4 (0.0139) <sup>c</sup>	11 (0.0131)
11 July	7 (0.0254)	7 (0.0256)	3 (0.0105) <sup>c</sup>	17 (0.0205)
12 July	8 (0.0291)	13 (0.0476)	8 (0.0280) <sup>c</sup>	29 (0.0349)
13 July	7 (0.0255)	9 (0.0329)	7 (0.0245) <sup>c</sup>	23 (0.0276)
17 July	9 (0.0323)	7 (0.0243)	8 (0.0287) <sup>c</sup>	24 (0.0284)
18 July	2 (0.0071)	6 (0.0209)	5 (0.0179) <sup>c</sup>	13 (0.0153)
Sub totals <sup>d</sup>	52 (0.0171)	62 (0.0204)	53 (0.0172) <sup>c</sup>	167 (0.0182) <sup>e</sup>
Number released	302,756	304,673	307,553	914,182
20 July	2 (0.0071)	3 (0.0104)	3 (0.0107)	8 (0.0094)
21 July	1 (0.0035)	5 (0.0173)	3 (0.0107)	9 (0.0105)
24 July	8 (0.0293)	7 (0.0265)	7 (0.0282)	22 (0.0280)
25 July	1 (0.0037)	4 (0.0151)	4 (0.0161)	9 (0.0116)
26 July	5 (0.0183)	4 (0.0151)	3 (0.0121)	12 (0.0152)
27 July	5 (0.0183)	4 (0.0151)	2 (0.0081)	11 (0.0138)
31 July	1 (0.0037)	3 (0.0105)	2 (0.0078)	6 (0.0073)
1 Aug	3 (0.0110)	2 (0.0070)	1 (0.0039)	6 (0.0073)
2 Aug	0 (0.0000)	3 (0.0105)	4 (0.0156)	7 (0.0087)
3 Aug	0 (0.0000)	1 (0.0035)	3 (0.0117)	4 (0.0051)
Sub totals <sup>d</sup>	26 (0.0095)	36 (0.0131)	32 (0.0143)	94 (0.0123) <sup>e</sup>
Number released	274,591	277,433	257,841	
ANOVA <sup>f</sup>	1	1	1	
Totals	78	98	85	261
Number released	577,347	582,106	565,394	1,724,847
Mean % recov. <sup>d</sup>	0.0135	0.0169	---	0.0152 <sup>e</sup>
ANOVA <sup>f</sup>	1	1		

<sup>a</sup> Calculated by dividing the number of observed recaptures by the number of fish released (adjusted for tag loss) and then multiplying by 100.

<sup>b</sup> Calculated as the unweighted average of group recapture percentages for releases on that date.

<sup>c</sup> Release hose failure compromised survival of the first 11 releases--data not used in ANOVA.

<sup>d</sup> Mean recovery percentage weighted by block (i.e., by release day).

<sup>e</sup> Grand mean = average for treatment mean recovery percentage used in ANOVA.

<sup>f</sup> Common number indicates no statistical difference at  $\alpha = 0.05$ . Empirical standard error =  $\sqrt{\text{Mean Square Error} + n} = 0.0015491$  for three treatments of 10 releases, and = 0.001378 for two treatments of 21 releases. Detection difference = 26.7% for two treatments, and 39.8% for three treatments (see Appendix Table 1).

## CONCLUSIONS

Analysis regarding passage survival differences among various routes through Bonneville Dam Second Powerhouse, tailrace, and spillway will not be final for several years, pending completion of adult recovery data. The reported recovery data are preliminary, the status of which is reported in Appendix Table 6. Based on these preliminary data, adult contributions to the various fisheries and returns to hatcheries from study fish have been less than for other URB fall chinook salmon released at Bonneville Hatchery. Because of these low recovery percentages, our ability to identify statistically significant differences among treatments is much less than the planned 4 to 5% (at this date the range of detectable difference is 11.9 to 39.8%).

Trends observed in juvenile recovery data suggest bypass system passage did not substantially improve survival over turbine passage. Our ability to identify statistically significant differences among treatments was about 5% for juvenile recovery data from all years combined. We speculate that bypass-released fish had decreased survival as a result of: 1) increased predation because of point-source release location and water currents directing fish toward the shoreline, 2) increased predation because of poor predator avoidance due to stress and injuries from passage, and 3) increased indirect mortality because of synergistic effects of stress and injuries incurred from passage through the bypass system combined with the high water temperatures and diseases incurred during migration down the river. We must emphasize that these data represent only summertime conditions encountered by subyearling size fall chinook salmon at Bonneville Dam Second Powerhouse, tailrace, and spillway. Also, test fish used in this study were transported and released directly from a hatchery. Naturally migrating fish may not show these same trends because of differences in predator avoidance and migration behavior.

**ACKNOWLEDGMENTS**

Thanks to the outstanding efforts and excellent cooperation of the tag processing personnel at the Clackamas Laboratory, Oregon Department of Fish and Wildlife, we received adult tag data from Bonneville Hatchery returns early in the year. Early information was necessary to make systemwide decisions on allocation of URB fall chinook salmon or future testing.

We also acknowledge the extra efforts of the staff of PSMFC. As always, they quickly accommodated our requests for help in collecting large amounts of specialized recovery data.

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Appendix Table 1.--Analysis of treatment effects on adult fall chinook salmon recovery data from 1987-1990 tests using a randomized block ANOVA design where each day was considered a block (Sokal and Rohlf 1981).

$H_0$ : There was homogeneity between recovery distributions of treatments.

1987 Releases--

ANOVA Table

Source	Sum of squares	D.F.	Mean square	F	Significance level
Blocks	0.2532842	19	0.0133307		
Treatments	0.0429558	3	0.0143186	7.36	0.0003
Error	0.1109063	57	0.0019457		
Total	0.4071464	79			

Treatment	Count	Mean	Homogeneous groups*
Upper turbine	20	0.235565	1
Mid-level turb.	20	0.252045	1
Bypass	20	0.256805	1
Tailrace	20	0.197815	2
Grand mean		0.235558	

Fishers' Protected Least Significance Difference (FPLSD)

$$\text{FPLSD} = t_{(\alpha=0.05)(df=57)} \sqrt{(2\text{MSE}/r)} = 0.0279344.$$

$$\text{Detectable difference} = (\text{FPLSD}/\text{Grand mean})100 = 11.9\%$$

1988 Releases--

ANOVA Table

Source	Sum of squares	D.F.	Mean square	F	Significance level
Blocks	0.0022028	11	0.0002003		
Treatments	0.0001698	4	0.0000424	0.79	0.5396
Error	0.0023175	43	0.0000539		
Total	0.0046901	58			

One missing observation.

Treatment	Count	Mean	Homogeneous groups*
Upper turbine	11	0.0178636	1
Mid-level turb.	12	0.013750	1
Bypass	12	0.0153667	1
Tailrace	12	0.0183667	1
Downstream	12	0.0152333	1
Grand mean		0.016116	

$$\text{FPLSD} = t_{(\alpha=0.05)(df=43)} \sqrt{(2\text{MSE}/r)} = 0.00602.$$

$$\text{Detectable difference} = (\text{FPLSD}/\text{Grand mean})100 = 37.4\%$$

Appendix Table 1.--Continued.

## 1989 Releases--

## ANOVA Table

Source	Sum of squares	D.F.	Mean square	F	Significance level
Blocks	0.0224180	11	0.0020380		
Treatments	0.0008555	5	0.0001711	1.310692	0.2730
Error	0.0071802	55	0.0001305		
Total	0.0304537	71			

Treatment	Count	Mean	Homogeneous groups*
Upper turbine	12	0.0322583	1
Mid-level turb.	12	0.0355917	1
Bypass	12	0.0339167	1
Tailrace	12	0.0413	1
Spillway	12	0.041025	1
Downstream	12	0.03865	1
Grand mean		0.0371	

$$FPLSD = t_{(\alpha=0.05)(df=55)} \sqrt{(2MSE/r)} = 0.0093398$$

$$\text{Detectable difference} = (FPLSD/\text{Grand mean})100 = 25.2\%$$

## 1990 Releases--

## ANOVA Table

3 Treatments 10 Blocks					
	Sum of squares	D.F.	Mean square	F	Signif. level
Blocks	0.001141	9	0.000127		
Treat	0.000075	2	0.000037	1.498	0.2501
Error	0.000449	18	0.000025		
Total	0.001665	29			

Treatment	Count	Mean	Homogeneous groups*
Mid-level turb.	10	0.0095	1
Bypass	10	0.0131	1
Tailrace	10	0.0125	1
Grand mean		0.01169	

$$FPLSD = t_{(\alpha=0.05)(df=18)} \sqrt{(2MSE/r)} = 0.00465.$$

$$\text{Detectable diff.} = (FPLSD/\text{Grand mean})100 = 39.8\%$$

## ANOVA Table

2 Treatments 21 Blocks					
	Sum of squares	D.F.	Mean square	F	Signif. level
Blocks	0.003559	20	0.000178		
Treat	0.000122	1	0.000122	2.999	0.0987
Error	0.000816	20	0.000041		
Total	0.004498	41			

Count	Mean	Homogeneous groups*
—	—	—
21	0.01349	1
21	0.01690	1
	0.01520	

$$FPLSD = t_{(\alpha=0.05)(df=20)} \sqrt{(2MSE/r)} = 0.004066$$

$$\text{Detectable diff.} = (FPLSD/\text{Grand mean})100 = 26.7\%$$

\* Homogeneous groups are identified by a common number.

**Appendix Table 2.—Distribution of observed adult recoveries by age and location for URB fall chinook salmon released as juveniles during 1987 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.**

Recapture location	Number of recaptures at age					Recaptures by location	
	2 (1988)	3 (1989)	4 (1990)	5 (1991)	6 (1992)	No.	%
Release location: All							
Number released: 1,720,385							
Ocean sport fishery, Alaska	1	3	3	0*		7	0.2
Ocean net fishery, Alaska	16	5	7	0*		28	0.7
Ocean troll fishery, Alaska	0	14	380	0*		394	9.5
Ocean sport fishery, British Columbia	0	6	6	0*		12	0.3
Ocean net fishery, British Columbia	37	28	26	0*		91	2.2
Ocean troll fishery, British Columbia	2	85	345	0*		432	10.4
Ocean sport fishery, Washington	3	21	17	3		44	1.1
Ocean net fishery, Washington	0	14	0	0		14	0.3
Ocean troll fishery, Washington	1	13	21	0		35	0.8
Ocean sport fishery, Oregon	1	0	3	1		5	0.1
Ocean troll fishery, Oregon	1	7	2	10		20	0.5
Ocean fishery, California	0	0	0	3		3	0.1
Columbia R. sport fishery, Oregon	0	6	0	0		6	0.2
Columbia R. sport fishery, Washington	0	0	4	2		6	0.2
Columbia R. net fishery, Youngs Bay	0	5	5	0		10	0.2
Columbia R. net fishery, Zones 1-5	3	144	239	221		607	14.7
Columbia R. net fishery, Zone 6 (fall)	5	114	603	329		1,051	25.4
Stream survey, Big White Salmon River, CRM 168.3	0	2	1	0*		3	0.1
Stream survey, Umatilla River, CRM 288.8	0	2	1	0*		3	0.1
Stream survey, Columbia River, CRM 361.7	0	0	3	0*		3	0.1
Columbia R., Bonneville Hatchery, CRM 144.5	102	267	312	195		876	21.2
Columbia R., Cascade Hatchery, CRM 146.0	65	46	1	1		113	2.7
Columbia R., Little White Salmon NFH, CRM 161.1	23	61	110	129		323	7.8
Columbia R., Spring Creek NFH, CRM 166.5	1	0	4	0		5	0.1
Columbia R., Priest Rapids Hatchery, CRM 397.1	4	0	3	0*		7	0.2
Snake R., Lyons Ferry Hatchery, SRM 58.0	1	16	16	0*		33	0.8
Umatilla R., 3-Mile Trap	0	2	0	0*		2	-
Quinalt R. sport fishery, Washington	0	0	0	1		1	-
Totals	266	861	2,112	895		4,134	100.0

\* Coded-wire-tag recoveries for 1991 not complete.



**Appendix Table 3.--Distribution of observed adult recoveries by age and location for URB fall chinook salmon released as juveniles during 1988 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.**

Recapture location	Number of recaptures at age					Recaptures by location	
	2 (1989)	3 (1990)	4 (1991)	5 (1992)	6 (1993)	No.	%
Release location: All							
Number released: 1,777,396							
Ocean sport fishery, Alaska	0	0	0*			0	0.0
Ocean net fishery, Alaska	2	0	0*			2	0.7
Ocean troll fishery, Alaska	0	12	0*			12	4.2
Ocean sport fishery, British Columbia	0	0	0*			0	0.0
Ocean net fishery, British Columbia	4	5	0*			9	3.2
Ocean troll fishery, British Columbia	0	17	0*			17	6.0
Ocean sport fishery, Washington	0	5	1			6	2.1
Ocean net fishery, Washington	0	0	0			0	0.0
Ocean troll fishery, Washington	0	2	0			2	0.7
Ocean sport fishery, Oregon	0	1	0			1	0.4
Ocean troll fishery, Oregon	0	3	0			3	1.1
Ocean fishery, California	0	0	0			0	0.0
Columbia R. sport fishery, Oregon	0	0	0			0	0.0
Columbia R. sport fishery, Washington	0	0	0			0	0.0
Columbia R. net fishery, Youngs Bay	0	0	0			0	0.0
Columbia R. net fishery, Zones 1-5	2	6	21			29	10.3
Columbia R. net fishery, Zone 6 (fall)	0	29	51			80	28.4
Stream survey, Big White Salmon River, CRM 168.3	0	0	0*			0	0.0
Stream survey, Umatilla River, CRM 288.8	0	0	0*			0	0.0
Stream survey, Columbia River, CRM 361.7	0	0	0*			0	0.0
Columbia R., Bonneville Hatchery, CRM 144.5	11	30	33			74	26.2
Columbia R., Cascade Hatchery, CRM 146.0	9	2	0			11	3.9
Columbia R., Little White Salmon NFH, CRM 161.1	7	10	13			30	10.6
Columbia R., Spring Creek NFH, CRM 166.5	0	0	0			0	0.0
Columbia R., Priest Rapids Hatchery, CRM 397.1	0	1	0*			1	0.4
Snake R., Lyons Ferry Hatchery, SRM 58.0	2	2	0*			4	1.4
Umatilla R., 3-Mile Trap	0	1	0*			1	0.4
Quinault R. sport fishery, Washington	0	0	0			0	0.0
Totals	37	126	119			282	100.0

\* Coded-wire-tag recoveries for 1991 not complete.

**Appendix Table 4.--Distribution of observed adult recoveries by age and location for URB fall chinook salmon released as juveniles during 1989 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.**

Recapture location	Number of recaptures at age					Recaptures by location	
	2 (1990)	3 (1991)	4 (1992)	5 (1993)	6 (1994)	No.	%
Release location: All							
Number released: 2,123,383							
Ocean sport fishery, Alaska	0	0*				0	0.0
Ocean net fishery, Alaska	5	0*				5	0.6
Ocean troll fishery, Alaska	0	0*				0	0.0
Ocean sport fishery, British Columbia	0	0*				0	0.0
Ocean net fishery, British Columbia	37	0*				37	4.7
Ocean troll fishery, British Columbia	0	0*				0	0.0
Ocean sport fishery, Washington	2	1				3	0.4
Ocean net fishery, Washington	0	0				0	0.0
Ocean troll fishery, Washington	0	0				0	0.0
Ocean sport fishery, Oregon	0	1				1	0.1
Ocean troll fishery, Oregon	0	1				1	0.1
Ocean fishery, California	0	0				0	0.0
Columbia R. sport fishery, Oregon	0	0				0	0.0
Columbia R. sport fishery, Washington	1	0				1	0.1
Columbia R. net fishery, Youngs Bay	0	0				0	0.0
Columbia R. net fishery, Zones 1-5	6	82				88	11.1
Columbia R. net fishery, Zone 6 (fall)	26	70				96	12.1
Stream survey, Big White Salmon River, CRM 168.3	0	0*				0	0.0
Stream survey, Umatilla River, CRM 288.8	0	0*				0	0.0
Stream survey, Columbia River, CRM 361.7	0	0*				0	0.0
Columbia R., Bonneville Hatchery, CRM 144.5	181	212				393	49.7
Columbia R., Cascade Hatchery, CRM 146.0	73	11				84	10.6
Columbia R., Little White Salmon NFH, CRM 161.1	38	40				78	9.9
Columbia R., Spring Creek NFH, CRM 166.5	0	0				0	0.0
Columbia R., Priest Rapids Hatchery, CRM 397.1	1	0*				1	0.1
Snake R., Lyons Ferry Hatchery, SRM 58.0	0	0*				0	0.0
Umatilla R., 3-Mile Trap	3	0*				3	0.4
Quinault R. sport fishery, Washington	0	0				0	0.0
Totals	373	418				791	100.0

\* Coded-wire-tag recoveries for 1991 not complete.

**Appendix Table 5.--Distribution of observed adult recoveries by age and location for URB fall chinook salmon released as juveniles during 1990 to evaluate passage survival at Bonneville Dam. PSMFC database listings through 2 February 1992 and rack recoveries during 1991 at Bonneville, Cascade, and Little White Salmon Hatcheries.**

Recapture location	Number of recaptures at age					Recaptures by location	
	2 (1991)	3 (1992)	4 (1993)	5 (1994)	6 (1995)	No.	%
<hr/>							
Release location: All							
Number released: 1,724,847							
Ocean sport fishery, Alaska	0 <sup>a</sup>					0	0.0
Ocean net fishery, Alaska	0 <sup>a</sup>					0	0.0
Ocean troll fishery, Alaska	0 <sup>a</sup>					0	0.0
Ocean sport fishery, British Columbia	0 <sup>a</sup>					0	0.0
Ocean net fishery, British Columbia	0 <sup>a</sup>					0	0.0
Ocean troll fishery, British Columbia	0 <sup>a</sup>					0	0.0
Ocean sport fishery, Washington	0					0	0.0
Ocean net fishery, Washington	0					0	0.0
Ocean troll fishery, Washington	0					0	0.0
Ocean sport fishery, Oregon	0					0	0.0
Ocean troll fishery, Oregon	0					0	0.0
Ocean fishery, California	0					0	0.0
Columbia R. sport fishery, Oregon	0					0	0.0
Columbia R. sport fishery, Washington	0					0	0.0
Columbia R. net fishery, Youngs Bay	0					0	0.0
Columbia R. net fishery, Zones 1-5	16					16	6.1
Columbia R. net fishery, Zone 6 (fall)	8					8	3.1
Stream survey, Big White Salmon River, CRM 168.3	0 <sup>a</sup>					0	0.0
Stream survey, Umatilla River, CRM 288.8	0 <sup>a</sup>					0	0.0
Stream survey, Columbia River, CRM 361.7	0 <sup>a</sup>					0	0.0
Columbia R., Bonneville Hatchery, CRM 144.5	108					108	41.4
Columbia R., Cascade Hatchery, CRM 146.0	82					82	31.4
Columbia R., Little White Salmon NFH, CRM 161.1	47					47	18.0
Columbia R., Spring Creek NFH, CRM 166.5	0					0	0.0
Columbia R., Priest Rapids Hatchery, CRM 397.1	0 <sup>a</sup>					0	0.0
Snake R., Lyons Ferry Hatchery, SRM 58.0	0 <sup>a</sup>					0	0.0
Umatilla R., 3-Mile Trap	0 <sup>a</sup>					0	0.0
Quinault R. sport fishery, Washington	0					0	0.0
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	261					261	100.0

<sup>a</sup> Coded-wire-tag recoveries for 1991 not complete.

**Appendix Table 6.--Status of PSMFC recovery data (as of 19 May 1992) used for comparisons of Bonneville survival study to other releases of URB fall chinook salmon, 1987-1990.**

CWT recovery data sets available in PSMFC recovery files <sup>a</sup>												
Year	Recovery agency <sup>b</sup>											
	CDFG	ODFW	WDF	WDW	IDFG	CDFO	ADFG	FWS	NMFS	NIFC	QDNR	METL
									(AK)			
87	V	V	V	I	NR	V	V	V	S	V	V	I
88	V	V	V	I	NR	V	V	V	NR	V	V	I
89	V	V	V	I	NR	V	V	I	NR	V	V	I
90	V	V	V	NR	NR	V	V	V	NR	V	S	I
91	I	I	I	I	NR	I	I	NR	NR	NR	NR	I

<sup>a</sup> I = Incomplete data set, but available data are validated and online. V = Fully (finalized) validated and online data set. S = Submitted but not yet validated data set. NR = Not reported at this time in PSMFC format.

<sup>b</sup> CDFG = California Dept. of Fish and Game; ODFW = Oregon Dept. of Fish and Wildlife; WDF = Washington Dept. of Fisheries; WDW = Washington Dept. of Wildlife; IDFG = Idaho Dept. of Fish and Game; CDFO = Canadian Dept. of Fisheries and Oceans; ADFG = Alaska Dept. of Fish and Game; FWS = U.S. Fish and Wildlife Service; NMFS = National Marine Fisheries Service; AK = Alaska; NIFC = Northwest Indian Fisheries Commission; QDNR = Quinault; METL = Metlakatla.

#### INCOMPLETE DATA SETS

- 1) WDW's recoveries in the mainstem Columbia River have been reported through ODFW.

However, recoveries in Columbia River basin tributaries and Puget Sound are unreported.

- 2) Metlakatla (METL) has reported recoveries for its fisheries through ADFG. However, hatchery returns are unreported at this time.

**Appendix Table 7.--Coded-wire-tag codes of marked groups used for adult recovery comparisons (Table 4)\* of Bonneville survival study to other releases of URB fall chinook salmon, 1987-1990.**

<b>1987 Releases</b>	
232053, 58, 60, 63, 2105, 10, 15, 17, 20, 25, 30, 35, 37, 40, 45, 50, 55, 57, 60, 2202, 07, 12, 14, 17, 22	
074719, 21, 37, 38	
074722, 25	
074732, 35	
074741, 42	
074315, 16, 17, 18	
074129, 4309, 19, 20	
633315	
073912, 13, 14	
B50101, 02, 03, 04, 05, 06, 0201, 02, 0713, 14,	
634259, 61	
634262, 4401	
051915, 19, 20, 21	
051916, 17, 18	
051922	
634128	
<b>1988 Releases</b>	
232504, 14, 25, 35, 44, 55, 52, 2601, 11, 21, 31, 41, 50	
074254	
074303	
074304	
073555	
075007	
B50107, 0615, 0708, 09, 10, 11, 12, 15	
0501010101, 02, 03	
635211, 13, 14, 16	
635232	
635226	
<b>1989 Releases</b>	
232801, 13, 25, 37, 49, 61, 3108, 21, 32, 44, 56, 3204	
075030, 33	
075034, 36	
074646, 47, 48	
074753, 54, 57, 58, 60, 63	
0501010205, 06	
0501010202, 03, 04	
635249	
635252	
630226, 28	
635204, 07	
<b>1990 Releases</b>	
232453, 56, 59, 62, 2505, 10, 17, 23, 29, 34, 40, 46, 53, 58, 2603, 09, 15, 20, 27, 33, 39	
075408, 09	
075406, 07	
052337, 38	
630416, 631459	
075403, 04, 05	
075322, 23, 24, 25, 26, 27	
0501010207, 11 and, 052120	
0501010208, 09, 10	
630732	
630755	
635544, 47, 49, 50	

\* Coded-wire-tag codes listed in each row represent the combined groups used for comparison in Table 4. The order of groups is the same on both tables.