Evaluation of Fall Chinook and Chum Salmon Spawning Below Bonneville, The Dalles, John Day, and McNary Dams

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2000-2001 EVALUATION OF FALL CHINOOK AND CHUM SALMON SPAWNING BELOW BONNEVILLE, THE DALLES, JOHN DAY AND McNARY DAMS

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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

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INTRODUCTION

This report describes work conducted by the Oregon Department of Fish and Wildlife (ODFW) and the Washington Department of Fish and Wildlife (WDFW) from 1 October 2000 to 30 September 2001. The work is part of studies to evaluate spawning of fall chinook salmon (Oncorhynchus tshawytscha) and chum salmon (O. keta) below the four lowermost Columbia River dams under the Bonneville Power Administration's Project 99-003. The purpose of this project is twofold:

1) Document the existence of fall chinook and chum populations spawning below Bonneville Dam (river mile (RM) 145), The Dalles Dam (RM 192), John Day Dam (RM 216), and McNary Dam (RM 292) (Figure 1) and estimate the size of these populations.

2) Profile stocks for important population characteristics; including spawning time, genetic make-up, emergence timing, migration size and timing, and juvenile to adult survival rates.

Specific tasks conducted by ODFW and WDFW during this period were:

1) Documentation of fall chinook and chum spawning below Bonneville, The Dalles, John Day and McNary dams using on-water observations;

2) Collection of biological data to profile stocks in areas described in Task 1;

3) Determination of spawning population estimates and age composition, average size at return, and sex ratios in order to profile stocks in areas described in Task 1;

4) Collection of data to determine stock origin of adult salmon found in areas described in Task 1;

5) Determination of possible stock origins of adult salmon found in areas described in Task 1 using tag rates based on coded-wire tag recoveries and genetic baseline analysis;

6) Determination of emergence timing and hatching rate of juvenile fall chinook and chum below Bonneville Dam;

7) Determination of migration time and size for juvenile fall chinook and chum rearing in the area described in Task 6;

8) Investigation of feasibility of determining stock composition of juvenile fall chinook and chum rearing in the area described in Task 6;

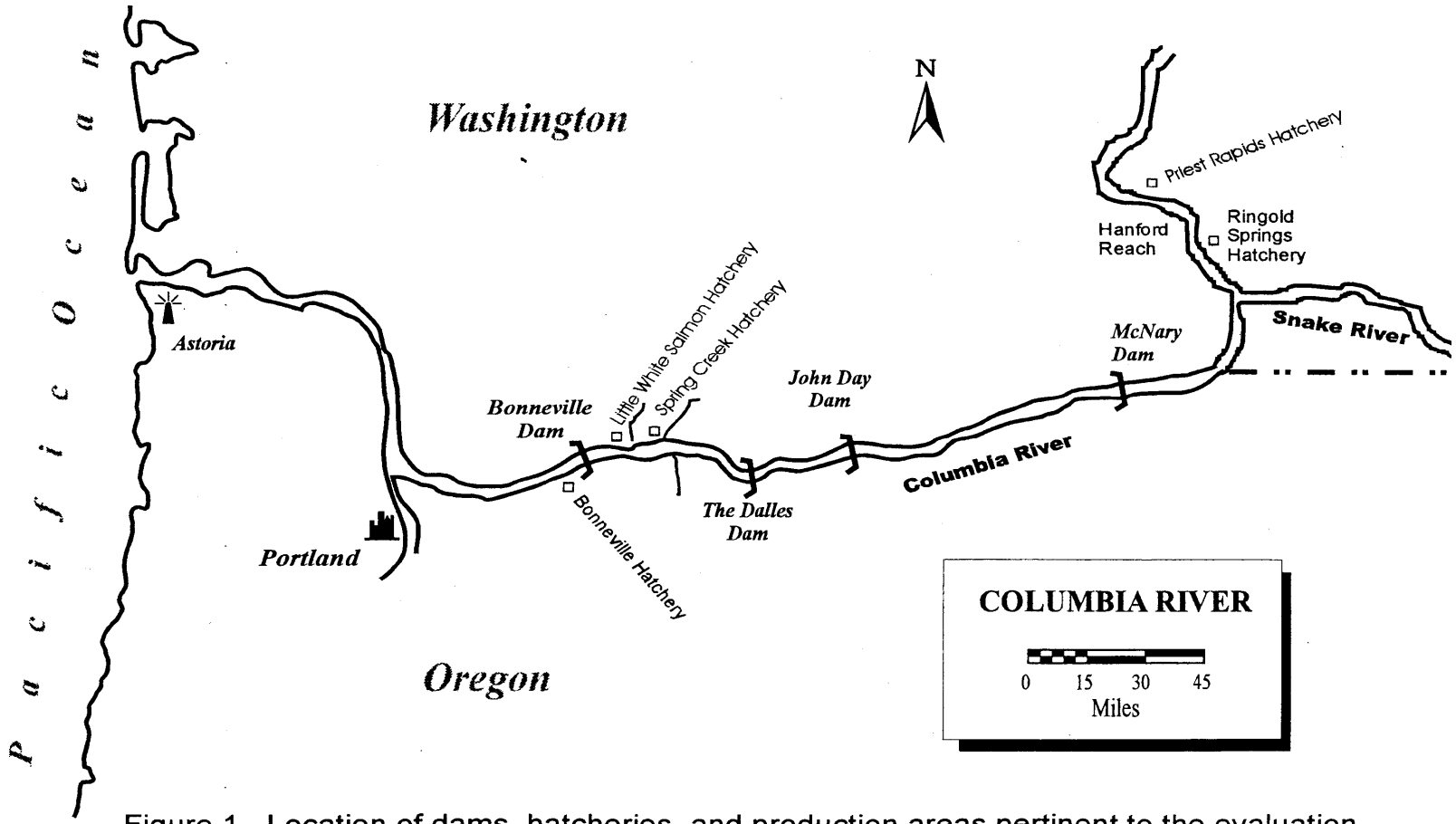

Figure 1. Location of dams, hatcheries, and production areas pertinent to the evaluation.

9) Documentation of entrapment in low-lying areas of juvenile fall chinook and chum rearing in the area described in Task 6;

10) Investigation of feasibility of determining juvenile to adult survival rate from coded-wire tagged juvenile fall chinook captured and tagged in the area described in Task 6.

METHODS AND MATERIALS

Adult study

Spawning ground surveys of fall chinook and chum salmon below Bonneville, The Dalles, John Day, and McNary dams occurred from 19 September 2000 through 03 January 2001. The below Bonneville Dam study area is approximately two miles downstream from the dam, between river miles 141.0-143.5. The area includes Pierce and Ives Islands as well as the main channel of the Columbia River. Primary spawning areas are within the island complex and along the shorelines of the islands adjacent to the main channel of the Columbia River. The study area below The Dalles Dam includes waters along both shorelines for two miles downstream of the dam. Approximately seven miles of both shorelines below the John Day and McNary dams were surveyed, including potential spawning habitat surrounding islands just below the John Day Dam. A weekly count of spawning redds and numbers of live and dead fish were made from the bow of a jet boat and by wading in shallow water. In addition, locations of newly formed spawning redds were recorded using global positioning system (GPS) receivers.

Fish carcasses were examined and biological data was collected to profile stock for age composition, average size at return, and sex ratios. Scales from sampled fish were removed and analyzed to determine total age. To assist in determining stock origin of salmon found in the study areas, carcasses were inspected for fin clips. The snouts of fish with adipose fin clips were removed and kept for coded-wire tag recovery and analysis.

To assist in determining whether fish had successfully spawned, female carcasses were examined for the presence of eggs. Except for the Bonneville fall chinook group, tissue samples were collected from all populations for genetic stock identification (GSI). GSI work was not performed on the Bonneville fall chinook population since genetic baseline data for this group was completed in 1998.

A capture-recapture carcass tagging study known as the Worlund technique was used to assist in providing spawner population estimates for fall chinook. The mathematical model used to analyze the data was developed by G. Paulik (prepared by D. Worlund) of the University of Washington and is a use of the multiple release and recapture methods of G. Seber and G. Jolly (Biometrika Vol. 49, 1962). Each week newly discovered fall chinook and chum carcasses were marked with a different colored plastic tag and returned to their original location. The number of

new tags issued and the number of tags recovered from previous week's tagging were recorded. Carcasses found with a tag were mutilated to identify them as recoveries. A population estimate was generated after tag data was analyzed by the above method. The method used to estimate the 2000 spawner population for chum incorporated spawner curves created from survey data in conjunction with various factors which translate the area under the curve into estimates of spawner abundance. This method has successfully been used by WDFW to estimate Puget Sound chum escapement.

Juvenile study

The juvenile portion of the study investigated areas where spawning occurred below Bonneville Dam in 2000. To determine emergence timing, estimated hatching and emergence dates were calculated in temperature units (TU) which are measured in Celsius degree-days. The dates were calculated in TU from the initiation of spawning to hatching of eggs (500 ^{o} C. TU for chinook and 600 ^{o} C. TU for chum) and beginning and ending of emergence (1,000 ^{o} C. TU for chinook and 800 ^{o} C. TU for chum). Water temperatures used in TU calculations were taken from Bonneville Dam readings and from temperature gauges located in the Ives Island area and maintained by U. S. Fish and Wildlife Service and.

Sampling to determine the time and size juveniles reared in and migrated from the areas used for rearing began 16 January 2001. Surveys were conducted twice weekly through 16 July 2001. Sampling was conducted in seven designated locations below Bonneville Dam (Figure 2). The locations were selected by reason of their proximity to redds identified during spawning ground surveys in 2000, representative habitat and seining accessibility. Specific sampling areas within the seven locations changed with variations in river flows.

Two types of gear were used to capture juvenile fish in the study area. Shorelines were fished with four-foot deep stick seines with one-eighth inch mesh in lengths of 18 and 28 feet. The sampling crew also employed a 100-foot long, five-foot deep beach seine with one-sixteenth inch mesh. After the seines were set, they were immediately retrieved. In-water fishing time was approximately five minutes.

Captured fish were dip-netted into a five-gallon bucket containing anesthetic. Once anesthetized, fish were identified by species, measured for fork length and examined for fin clips. Developmental stage of fry was also noted (e.g., yolk sac or button-up fry). Processing time was five to ten minutes per set. After data was collected, fish were returned to the site of capture. Beginning and ending times for

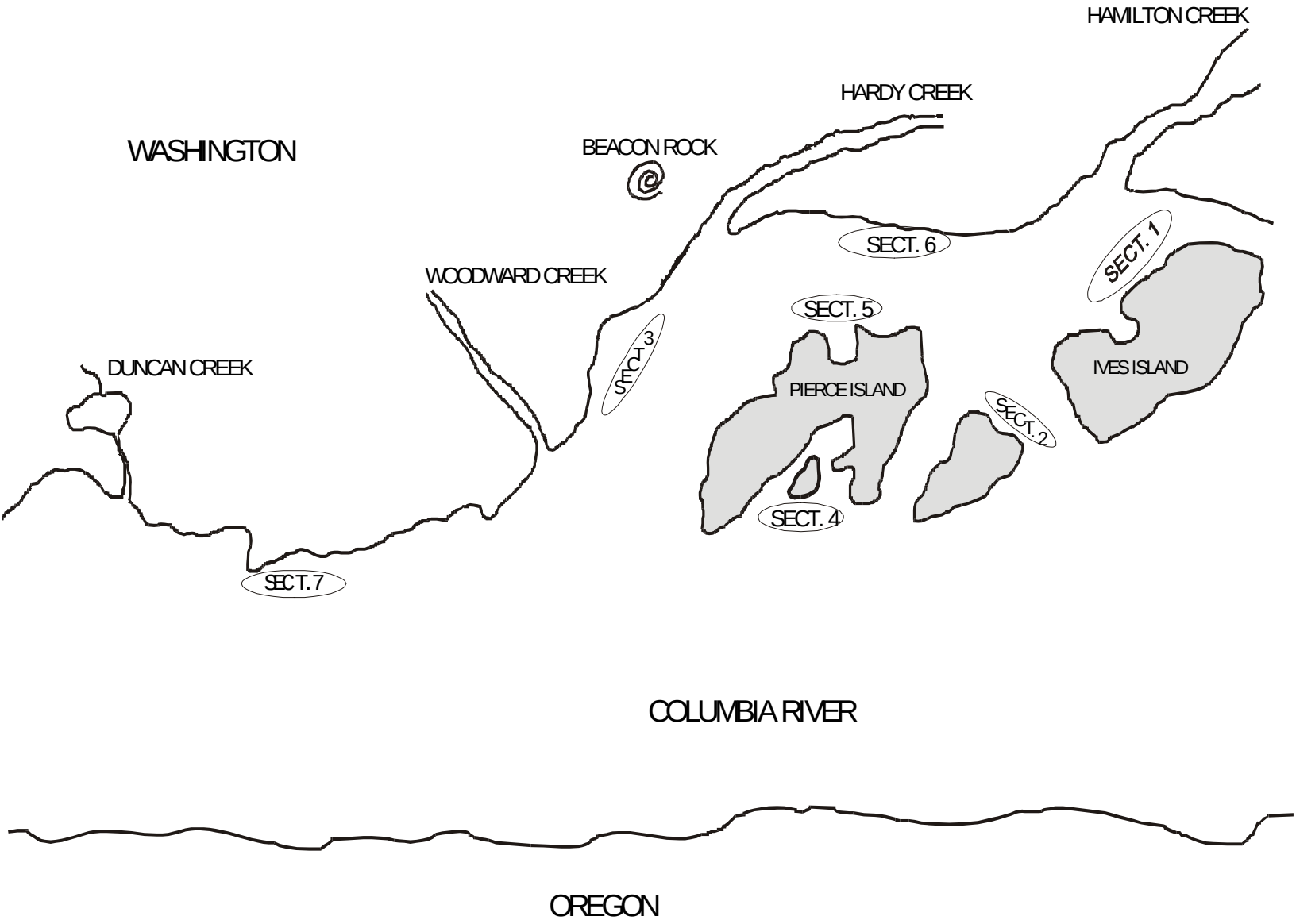

Figure 2. Location of juvenile sampling sections below Bonneville Dam, 2001.

each sampling period were recorded along with the number of sets fished and water temperatures. In addition, Bonneville Dam flows were noted and recorded for those periods when sampling occurred.

When unmarked juvenile chinook were first caught in the study area, the criterion used for differentiating chinook juveniles that were produced in the study area from upriver natural production and hatchery releases was based on the fork length of the sampled fish. Chinook less than 50 mm were assumed to be products of the study area. This assumption is based on the facts that juvenile chinook emerge within a size range of 35-40mm, hatcheries above Bonneville Dam release chinook at sizes greater than 60 mm and wild upriver chinook juveniles do not begin migrating until they are larger than 60mm. As the native juvenile chinook grew in size, the length criterion used to differentiate them from untagged upriver hatchery and wild production increased. This method was effective until the middle of June when upriver smolts of approximately the same size as study area chinook began migrating into the study area. Because of the close physical proximity of the study area to Hamilton Creek, it was not possible to determine whether juvenile chum caught and sampled in the study area were products of mainstem Columbia River redds or were the progeny of adults that spawned in nearby Hamilton Creek.

In order to determine a juvenile to adult survival rate for wild fall chinook found below Bonneville Dam, a part of the juvenile population was adipose fin clipped and coded-wire tagged. The tagging was conducted in the months of May and June 2001 when native fish began attaining the size of 47 mm fork length or greater. To avoid tagging fall chinook from outside the area, tagging was terminated in early June when fish of comparable size to the native population began migrating into the area from points above the dam. Evidence of juvenile fall chinook migrating into the area was established when adipose fin clipped chinook in the 75-80 mm fork length range began appearing in the study area catch.

Fish to be tagged were held in a net pen for approximately 24 hours prior to tagging. They were then transported to the tagging site, sorted, anesthetized, measured, and a standard length coded-wire tag was inserted into the fish's snout. After each fish was tagged it was passed along a tag detector unit to ensure that a tag was present in the fish. The tagged fish was then placed into a recovery bath before being placed into a net pen in the river. Twice daily fish were sampled for mean fork length. Several times a day fish were sacrificed to verify proper tag placement. At the end of each day, tagged fish were released into the main channel of the Columbia River, downstream of the study area. In addition, approximately one percent of all fish tagged were held for 48 hours and checked for tag retention before being released.

RESULTS AND DISCUSSION

Adult study

Spawning of fall chinook and chum below Bonneville Dam was documented by counts of live fish, redds and post-spawning mortality (Table 1). Based on spawning ground surveys, initiation of spawning below Bonneville Dam for bright stock fall chinook salmon was set at 20 October 2000. Initiation of spawning below Bonneville Dam for chum salmon was set at 6 November 2000.

Peak spawning for fall chinook salmon was determined to be 9 November 2000. Peak spawning for chum was set at 1 December 2000. A total of 225 redds and 225 adults were observed at peak spawning for fall chinook. A total of 95 redds and 215 adults were observed at the time set for peak spawning for chum. The date determined to be the end of spawning for fall chinook was 18 December 2000. The date set as the end of spawning for chum was 3 January 2001.

No fall chinook redds were found or carcasses sampled below McNary Dam. One fall chinnok carcass was found below The Dalles Dam. The areas below The Dalles and McNary dams offer minimal spawning habitat. Two redds and four live fall chinook were observed below the John Day Dam. A total of 19 fall chinook carcasses were also found below the dam.

Fall chinook spawning times in the above areas correspond to other late-spawning stocks of fall chinook found in the Columbia and Snake rivers. Timing of chum spawning below Bonneville Dam, is similar to that of chum spawning in nearby Hardy and Hamilton creeks.

Locations of salmon redds below Bonneville Dam were recorded using GPS waypoints. Figures 3 and 4 show approximate locations of these redds. Fall chinook redds were found below the mouth of Hamilton Creek, between Ives and Pierce islands and in the main channel along the north side of Pierce Island. The majority of chum redds were observed below the mouth of Hamilton Creek. Chum redds were also found close to the main channel of the Columbia River, between Ives and Pierce islands.

Below Bonneville Dam, fall chinook population estimates were made based on results of carcass tagging. A total of 420 fall chinook were tagged and a total of 258 tags were recovered. It was estimated that 704 fall chinook returned to spawn in the areas around Ives and Pierce islands.

Table 1. Columbia River mainstem spawning ground surveys, 2000-2001.

Below Bonneville Dam

Fall Chinook

Date	Redds	Live	Dead	Sampled	CWT recoveries	GSI samples
09/19/2000	0	0	0	0	0	0
09/26/2000	0	0	3	3	1	0
10/03/2000	0	0	0	0	0	0
10/10/2000	0	0	0	0	0	0
10/16/2000	3	5	0	0	0	0
10/20/2000	8	8	1	1	0	0
10/23/2000	25	25	0	0	0	0
10/27/2000	35	19	0	0	0	0
10/30/2000	90	103	1	1	0	0
11/03/2000	169	150	7	7	0	0
11/06/2000	166	251	14	14	0	0
11/09/2000	225	225	23	23	1	0
11/14/2000	28	101	44	44	0	0
11/17/2000	140	196	83	83	1	0
11/20/2000	46	58	0	0	0	0
11/21/2000	*	*	66	66	0	0
11/27/2000	114	43	82	81	2	0
11/30/2000	0	0	28	28	0	0
12/01/2000	*	20	40	40	1	0
12/04/2000	*	12	18	18	0	0
12/08/2000	*	3	23	22	0	0
12/12/2000	*	4	13	10	0	0
12/15/2000	*	0	6	6	0	0
12/18/2000	*	1	3	3	0	0
12/27/2000	*	*	1	1	0	*
01/03/2001	*	*	*	*	*	*
			456	451		

Below Bonneville Dam

Chum

Date	Redds	Live	Dead	Sampled	Comments	GSI samples
11/6/2000	15	18	0	0	0	0
11/8/2000	14	24	0	0	0	0
11/9/2000	*	42	0	0	0	0
11/13/2000	23	52	2	2	0	2
11/14/2000	*	*	*	*	*	*
11/17/2000	36	147	1	1	0	1
11/20/2000	48	140	7	7	0	7
11/21/2000	*	*	20	20	0	20
11/27/2000	27	56	29	29	0	23
12/01/2000	95	215	34	34	0	17
12/04/2000	77	189	24	24	0	0
12/08/2000	54	113	43	43	0	30
12/12/2000	*	61	12	12	0	0
12/15/2000	*	10	0	0	0	0
12/18/2000	*	47	12	12	0	7
12/27/2000	*	1	8	8	0	0
01/03/2001	*	0	3	3	0	1
			195	195		

Below The Dalles Dam

Fall Chinook

Date	Redds	Live	Dead	Sampled	CWT recoveries	GSI samples
10/18/2000	0	0	1	1	0	0
11/01/2000	0	0	0	0	0	0
11/16/2000	0	0	0	0	0	0
11/29/2000	0	0	0	0	0	0
			1	1		

Below John Day Dam

Fall Chinook

Date	Redds	Live	Dead	Sampled	CWT recoveries	GSI samples
10/17/2000	0	0	1	1	0	0
10/25/2000	0	0	2	2	0	0
11/02/2000	1	3	0	0	0	0
11/18/2000	*	*	*	*	*	*
11/15/2000	1	1	1	1	0	1
11/28/2000	0	0	4	4	0	1
12/05/2000	0	0	6	5	0	2
12/20/2000	0	0	5	5	0	3
			19	18		

* conditions did not allow for obsevations

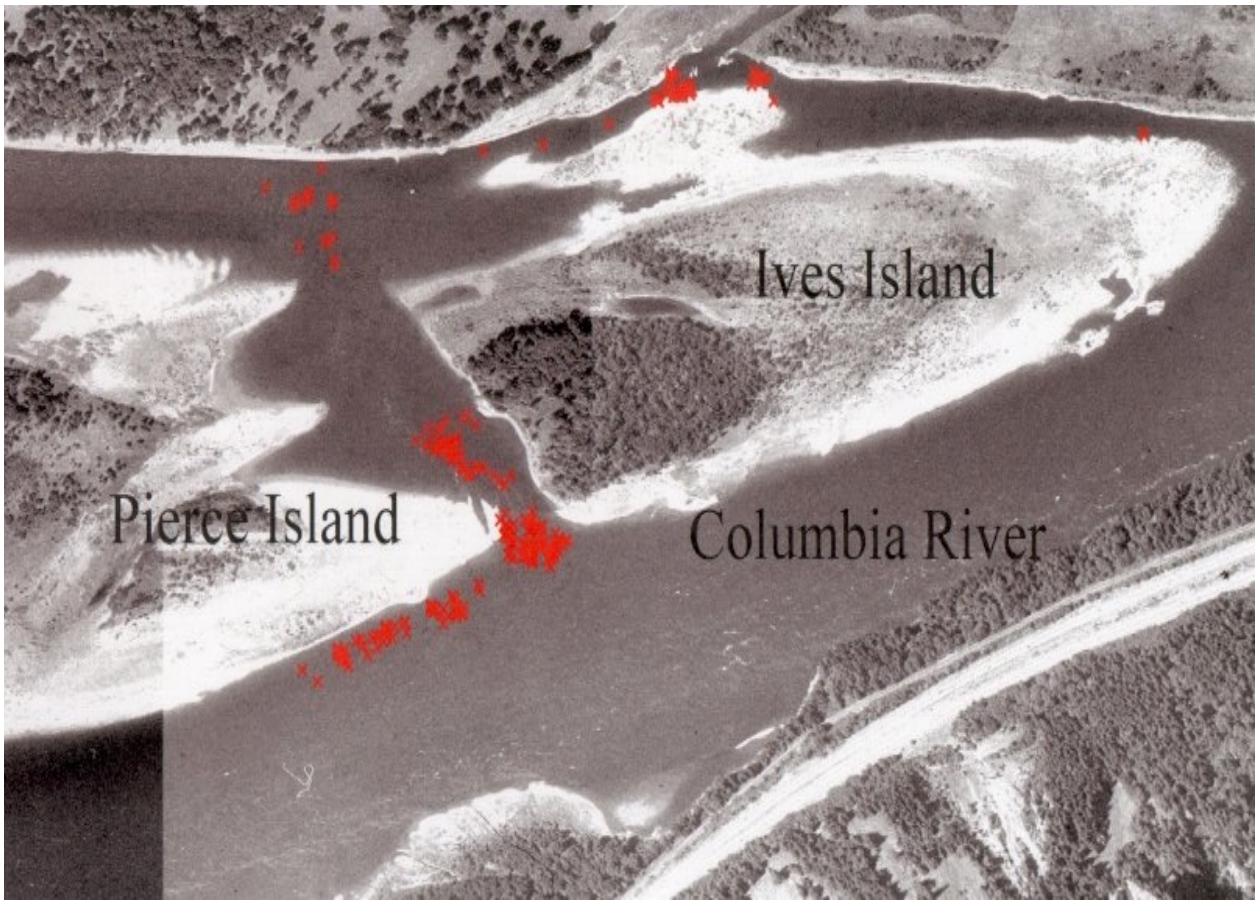

Figure 3. Location of fall chinook redds below Bonneville Dam, 2000.

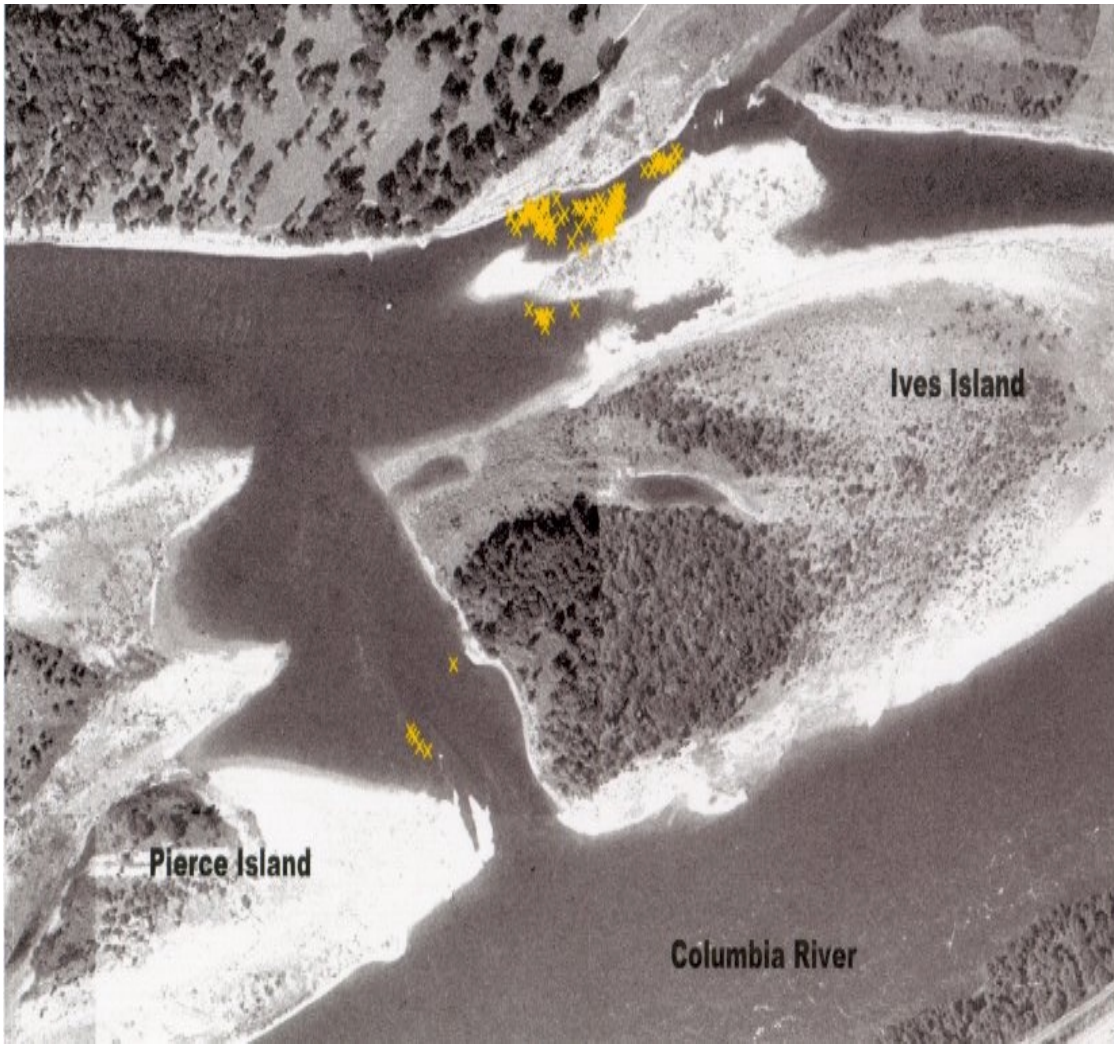

Figure 4. Location of chum redds below Bonneville Dam, 2000.

The fall chinook population number should be considered a minimum estimate since fish were also observed spawning in the deeper, main channel areas where

carcasses could not be recovered. A population of 529 chum was estimated to have returned to spawn in the Ives Island area.

Vital statistics were developed from biological samples to assist in determining stock origins of returning fish found spawning in the study area. Vital statistics of fall chinook populations found below Bonneville and John Day dams in 2000 include age compositions, mean fork lengths, and sex ratios (Tables 2-3). Fall chinook sampled below the dams showed similarities in male and female age class representation and age related mean fork lengths with other late-spawning stocks found in the Columbia River.

Table 4 contains vital statistics of chum sampled below Bonneville Dam. This year's age composition statistics of chum sampled in the study area were similar to other chum populations found in the lower Columbia River. For the above chum populations, three and four-year-old fish were the predominant age classes.

To further assist in determining the stock origin of salmon found below the dams, carcasses were sampled for fin clips and other external marks. A total of 478 fall chinook and 195 chum were sampled for marks below the four dams. Nine fall chinook carcasses were found to have adipose fin clips. All nine chinook carcasses were recovered below Bonneville Dam and all but two contained coded-wire tags. Two of the nine fish were bright fall chinook released as juveniles from Bonneville Hatchery's Tanner Creek. Of the remaining seven recoveries, one was a bright fall chinook from the Klickitat Hatchery and four were bright fall chinook released from the Snake River's , Lyons Ferry Hatchery. There were no marked chum found.

A total of 108 GSI samples were collected from chum carcasses found below Bonneville Dam. The above samples and samples collected in 1998 and 1999 were analyzed by WDFW geneticists in 2001. Evidence suggests that chum found spawning in the Columbia River around Ives Island show close genetic relationships with chum from nearby Hardy and Hamilton creeks. In addition, it is reasonable to assume that the Ives Island chum population is included in the Lower Columbia River Chum ESU. It must be noted that due to low flows in the fall of 2000, spawners from the above tributaries most likely mixed with fish spawning in the mainstem river and therefore influenced genetic collections made in the study area.

Below Bonneville Dam, bright fall chinook were sampled for GSI data by WDFW in 1996 and 1997. Analysis of 142 samples showed relatively small genetic differences between the below Bonneville Dam samples and samples taken from other Columbia River late-spawning stock fall chinook. The analysis suggests, bright chinook spawning below Bonneville Dam are genetically similar to other

Table 2. Estimated age composition, sex composition, and length of fall chinook chinook salmon that spawned below Bonneville Dam , 2000.

Age group	Number In Sample		% In Sample		Mean Fork Length (cm)		Length Range (cm)	
	Males	Females	Males	Females	Males	Females	Males	Females
2	6	0	3.6	0.0	48	-	46-50	-
3	11	12	6.6	7.3	72	75	58-88	61-88
4	45	87	27.1	52.4	95	87	78-115	71-104
5	3	2	1.8	1.2	103	98	97-108	92-103
Total	65	101	39.1	60.9				

Table 3. Estimated age composition, sex composition, and length of fall chinook salmon that spawned below John Day Dam, 2000.

Age group	Number In Sample		% In Sample		Mean Fork Length (cm)		Length Range (cm)	
	Males	Females	Males	Females	Males	Females	Males	Females
2	0	0	0.0	0.0	-	-	-	-
3	0	0	0.0	0.0	-	-	-	-
4	8	8	44.4	44.4	104	95	94-113	81-113
5	1	1	5.6	5.6	113	82	113	82
Total	9	9	50.0	50.0				

Table 4. Estimated age composition, sex composition, and length of chum salmon that spawned below Bonneville Dam, 2000.

Age group	Number In Sample		% In Sample		Mean POH Length (cm)		Length Range (cm)	
	Males	Females	Males	Females	Males	Females	Males	Females
2	0	0	0.0	0.0	-	-	-	-
3	31	20	18.5	11.9	78	70	68-88	63-78
4	58	50	34.5	29.8	83	75	67-92	66-85
5	5	4	3.0	2.3	86	77	81-91	72-75
Total	94	74	56.0	44.0				

bright fall chinook populations found in the Columbia River such as those found in the Hanford Reach and at Bonneville Hatchery.

Juvenile study

Hatching and emergence times for 2000 brood salmon below Bonneville Dam are contained in Table 5. Hatching and emergence times of fall chinook were estimated based on required temperature units that predict chinook and chum early life history and 2000-2001 Columbia River water temperatures taken in the study area. A peizometer placed 75 cm below the spawning gravel, near the mouth of Hamilton Creek showed upwelling water to be warmer than the surrounding water. The warmer upwelling water increased the water temperature in chum redds by approximately three degrees Celsius. An additional three degrees Celsius was factored into temperature unit calculations. The increase in estimated temperature increased the rate of estimated hatching and emergence times of chum found in the study area. Emergence of chum was estimated to have occurred from 15 February to 9 April 2001. Estimated peak emergence of chum took place 26 March 2001.

The majority of areas where fall chinook spawned were not subject to the above upwelling phenomenon. Except in those areas below Hamilton Creek, emergence of fall chinook began approximately 30 March and continued through 23 May. Peak emergence of fall chinook occurred 6 May 2001.

Sampling for post-emergent fry took place in locations identified in Figure 2. Based on emergence estimates, juvenile sampling began 30 January 2001. Sampling was terminated 16 July 2001 after it appeared that the majority of the fish had left the study area. A total of 8,210 juvenile chinook and 4,006 juvenile chum were sampled in areas below Bonneville Dam. Juvenile chinook were found rearing throughout the study area. Catch rates of gear used to capture juvenile chinook are contained in Table 6. Juvenile chum were found primarily in sections where chum spawned in 2000. Ninety-eight percent of the chum sampled came from sections one and three of the study area. Results of juvenile chum sampling are found in Table 7. Chum fry ranged in size from 34.0 mm to 85.0 mm in length, mean length was 45.5 mm. Juvenile chum were caught and sampled from 8 February to 11 June 2001. Peak catch of juvenile chum occurred 17 April. The majority of chum had migrated out of the area by early May at a size of 40-50 mm fork length.

Results of the below Bonneville Dam juvenile chinook sampling are found in Table 8. The table shows changes in the length distribution of juveniles caught in the study area during the sampling season. Recently emerged fish (juveniles less than 50 mm in length) were present in the catch from 30 January to 2 July. Peak catch of juvenile chinook 50 mm or less in fork length was 1 May. Until mid June, when smaller, wild upriver juvenile chinook began appearing in the sample, juvenile

TABLE 5. COLUMBIA RIVER WATER TEMPERATURES (°F) AND TEMPERATURE UNITS (°C) BELOW BONNEVILLE DAM, 2000-2001.

(Water temperatures are from USFWS Ives Island temperature gauge)

	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBURARY		MARCH		APRIL		MAY		JUNE	
	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's	TEMP	TU's
DAY	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)
1	63	17	55	13	43	6	39	4	37	3	39	4	45	7	50	10	57	14
2	63	17	55	13	43	6	37	3	37	3	39	4	45	7	51	10	57	14
3	63	17	55	13	43	6	39	4	37	3	39	4	45	7	51	10	58	14
4	63	17	54	12	43	6	39	4	37	3	39	4	45	7	51	11	58	14
5	61	16	54	12	43	6	37	3	37	3	40	4	45	7	51	11	58	15
6	61	16	54	12	43	6	39	4	37	3	40	4	45	7	51	11	59	15
7	61	16	54	12	43	6	37	3	37	3	40	5	45	7	52	11	59	15
8	59	15	52	11	43	6	37	*3*	37	3	40	5	45	7	52	11	59	15
9	59	15	52	11	43	6	37	*3*	37	3	41	5	45	7	52	11	59	15
10	59	15	50	10	43	6	37	*3*	37	3	41	5	45	7	52	11	59	15
11	59	15	50	10	41	5	37	*3*	37	3	41	5	45	7	52	11	59	15
12	59	15	50	10	41	5	37	*3*	37	3	41	5	45	7	52	11	59	15
13	59	15	50	10	41	5	37	*3*	37	3	41	5	45	7	52	11	59	15
14	59	15	50	10	41	5	37	*3*	37	3	41	5	46	8	53	12	59	15
15	59	15	48	9	41	5	37	*3*	37	3	41	5	46	8	53	12	61	16
16	59	15	48	9	41	5	37	*3*	37	3	41	5	46	8	54	12	61	16
17	59	15	46	8	41	5	37	*3*	37	3	42	6	46	8	54	12	61	16
18	59	15	46	8	41	5	37	*3*	37	3	42	6	48	9	54	12	61	16
19	59	15	45	7	41	5	37	*3*	37	3	42	6	48	9	55	13	61	16
20	59	15	45	7	41	5	37	*3*	37	3	43	6	48	9	54	13	61	16
21	57	14	45	7	39	4	37	*3*	37	3	43	6	48	9	55	14	61	16
22	55	13	45	7	39	4	37	*3*	37	3	43	6	48	9	55	14	61	16
23	55	13	45	7	39	4	37	*3*	37	3	43	6	48	9	56	15	61	16
24	55	13	45	7	39	4	37	*3*	37	3	43	6	49	10	57	15	61	16
25	55	13	45	7	39	4	37	*3*	37	3	43	6	50	10	57	15	61	16
26	55	13	45	7	39	4	37	*3*	37	3	44	7	50	10	57	15	63	17
27	55	13	45	7	39	4	37	*3*	37	3	44	7	50	10	57	15	64	18
28	55	13	45	7	39	4	37	*3*	37	3	44	7	51	10	57	15	64	18
29	55	13	45	7	39	4	37	*3*	37	3	44	7	50	10	57	15	64	18
30	55	13	45	7	39	4	37	*3*			45	7	51	10	57	15	64	18
31	55	13			39	4	37	*3*			45	7			57	15		
TOTAL	--	455	--	277	--	154	--	97	--	87	--	167	--	247	--	390	--	471
MEAN	58.4	14.7	48.6	9.2	40.9	5.0	37.6	3.1	37.4	3.0	41.7	5.4	46.8	8.2	53.7	12.5	60.3	15.7

REQUIRED TEMPERATURE UNITS (TU'S)

FALL CHINOOK	(°C)
EYE OUT	250
HATCHING	500
EMERGENCE	1000

CHUM	
EYE OUT	400
HATCHING	600
EMERGENCE	800

CUMULATIVE TU'S (°C) SINCE INITIATION AND END OF SPAWNING

FALL CHINOOK

		EYED OUT		HATCHING		EMERGENCE			
EVENT	DATE	TU	DATE	TU	DATE	TU	DATE	+2°C/day	+3°C/day
BEGIN SPAWNING	10/16	258	11/3	502	11/30	1000	3/30	2/8	1/20
PEAK SPAWNING	11/9	254	12/11	502	2/21	1000	5/6	4/4	3/20
END SPAWNING	12/4	253	2/8	506	4/3	1002	5/23	4/28	4/16

CHUM

		EYED OUT		HATCHING		EMERGENCE				
EVENT	DATE					T	+2°C	+3°C	GW TU*
BEGIN SPAWNING	11/06	401	1/7	602	3/1	804	4/7	3/6	2/15	1/4
PEAK SPAWNING	12/01	400	3/4	604	4/7	805	5/1	4/7	3/26	2/10
END SPAWNING	12/18	402	3/29	607	4/23	805	5/14	4/20	4/9	3/5

* GW = peizometer temperatures at 72 cm below the riverbed surface.

Table 6. Catch rates of juvenile chinook caught with stick and beach seines below Bonneville Dam, 2001.

Week	Date	# chinook	# stick sets	# caught in stick	# beach sets	# caught in beach	chinook per stick	chinook per beach
1	30-Jan	7	-	-	7	2	-	0.3
2	1-Feb	1	-	-	6	1	-	0.2
2	6-Feb	23	-	-	6	23	-	3.8
3	8-Feb	1	-	-	6	1	-	0.2
3	12-Feb	0	-	-	6	0	-	0.0
4	16-Feb	1	-	-	5	1	-	0.2
4	20-Feb	0	-	-	5	0	-	0.0
5	22-Feb	7	5	1	6	6	0.2	1.0
5	27-Feb	2	4	0	7	2	0.0	0.3
6	2-Mar	7	3	0	5	7	0.0	1.4
6	6-Mar	1	6	0	5	1	0.0	0.2
7	9-Mar	20	3	17	5	3	5.7	0.6
7	12-Mar	175	4	13	6	162	3.3	27.0
8	16-Mar	127	3	10	4	117	3.3	29.3
9	21-Mar	89	3	1	4	117	0.3	29.3
9	23-Mar	80	4	21	5	59	5.3	11.8
10	27-Mar	202	5	5	6	197	1.0	32.8
10	30-Mar	280	5	17	7	210	3.4	30.0
11	3-Apr	146	5	13	5	133	2.6	26.6
11	6-Apr	143	5	10	6	133	2.0	22.2
12	10-Apr	124	3	14	6	110	4.7	18.3
12	13-Apr	284	5	35	7	249	7.0	35.6
13	17-Apr	193	5	29	5	164	5.8	32.8
13	20-Apr	593	9	53	6	540	5.9	90.0
14	23-Apr	415	5	23	6	392	4.6	65.3
14	1-May	1156	-	-	6	1156	-	192.7
15	7-May	884	2	77	6	806	38.5	134.3
16	13-May	709	-	-	7	709	-	101.3
17	20-May	465	4	4	5	461	1.0	92.2
18	29-May	639	-	-	7	639	-	91.3
19	4-Jun	185	-	-	7	185	-	26.4
20	11-Jun	424	-	-	7	424	-	60.6
21	18-Jun	200	-	-	7	200	-	28.6
22	25-Jun	392	3	42	7	350	14.0	50.0
23	2-Jul	83	-	-	8	83	-	10.4
24	9-Jul	115	1	0	7	115	0.0	16.4
25	16-Jul	37	-	-	7	37	-	5.3

Table 7. Fork length information of juvenile chum sampled below Bonneville Dam, 2001.

Date	Number	Fork length range (mm)	Mean Fork Length (mm)
8-Feb	2	37.0 - 39.0	38.0
13-Feb	1	38.0	38.0
22-Feb	5	34.0 - 41.0	37.0
27-Feb	13	37.0 - 52.0	41.0
2-Mar	37	37.0 - 44.0	40.0
6-Mar	56	35.0 - 42.0	39.0
9-Mar	154	35.0 - 47.0	40.0
12-Mar	49	36.0 - 49.0	39.0
13-Mar	13	37.0 - 44.0	40.0
16-Mar	131	37.0 - 43.0	39.0
20-Mar	8	36.0 - 43.0	40.0
21-Mar	39	35.0 - 43.0	39.0
23-Mar	97	36.0 - 47.0	41.0
27-Mar	169	34.0 - 50.0	41.0
30-Mar	196	36.0 - 50.0	42.0
3-Apr	229	35.0 - 54.0	42.0
6-Apr	162	34.0 - 59.0	42.0
10-Apr	561	35.0 - 56.0	41.0
13-Apr	446	37.0 - 65.0	43.0
17-Apr	1,024	37.0 - 65.0	43.0
20-Apr	113	37.0 - 63.0	45.0
23-Apr	435	34.0 - 67.0	46.0
1-May	33	41.0 - 60.0	50.0
7-May	19	37.0 - 79.0	51.0
13-May	8	39.0 - 61.0	55.0
20-May	2	58.0 - 64.0	61.0
29-May	3	72.0 - 80.0	76.0
11-Jun	1	85.0	85.0
Total	4,006	34.0 - 85.0	45.5

Table 8. Fork length distribution of juvenile chinook sampled below Bonneville Dam, 2001.

				Number of chinook in millimeters										
Week	Date	Total	Range	30-39	40-49	50-59	60-69	70-79	80-89	90-100	Chinook > 100 mm	Mean length chf < 100	% chf < 60 mm	% chf 61- 100 mm
1	30-Jan	7	48-152		1	1					5	50	100	0
2	01-Feb	1	123	-	-	-	-	-	-	-	1	0	0	0
2	06-Feb	23	115 - 158	-	-	-	-	-	-	-	23	0	0	0
3	08-Feb	1	49	-	1	-	-	-	-	-	0	49	100	0
3	12-Feb	0	-	-	-	-	-	-	-	-	0	0	0	0
4	16-Feb	1	127	-	-	-	-	-	-	-	1	0	0	0
4	20-Feb	0	-	-	-	-	-	-	-	-	0	0	0	0
5	22-Feb	7	45 - 139	-	2	-	-	-	-	-	5	47	100	0
5	27-Feb	2	43 -44	-	2	-	-	-	-	-	0	44	100	0
6	02-Mar	7	34 -42	5	2	-	-	-	-	-	0	38	100	0
6	06-Mar	1	38	1	-	-	-	-	-	-	0	38	100	0
7	09-Mar	20	34 - 85	13	5	1	-	-	1	-	0	39	95	5
7	12-Mar	175	33 - 78	41	39	8	59	28	-	-	0	41	50	50
8	16-Mar	127	39 - 77	2	7	5	60	53	-	-	0	48	11	89
9	21-Mar	89	37 - 77	2	10	11	40	26	-	-	0	49	26	74
9	23-Mar	80	37 - 75	5	16	1	27	31	-	-	0	43	28	73
10	27-Mar	202	37 - 178	5	22	8	35	123	6	1	2	45	17	82
10	30-Mar	280	37 - 155	6	13	10	20	193	22	-	16	47	10	84
11	03-Apr	146	33 - 88	7	33	4	10	83	9	-	-	44	30	70
11	06-Apr	143	37 - 88	5	23	13	46	33	23	-	-	44	29	71
12	10-Apr	124	36 - 181	14	34	4	12	29	26	1	4	43	42	55
12	13-Apr	284	37 - 91	19	188	23	11	18	23	2	-	45	81	19
13	17-Apr	193	36 - 85	17	156	11	5	4	-	-	-	44	95	5
13	20-Apr	593	36 -97	56	298	32	12	52	129	14	-	43	65	35
14	23-Apr	415	36 - 142	17	199	44	7	23	92	31	2	46	63	37
14	01-May	1156	31 - 140	95	772	90	12	21	109	52	5	51	83	17
15	07-May	884	34 - 140	93	477	236	24	4	27	19	4	49	91	8
16	13-May	709	35 - 151	62	233	246	79	16	9	30	34	53	76	19
17	20-May	465	34 - 107	1	138	232	73	10	2	5	4	54	80	19
18	29-May	639	39 - 119	2	49	226	173	113	48	9	19	63	43	54
19	04-Jun	185	40 - 195	0	13	38	55	30	31	13	5	68	28	70
20	11-Jun	424	40 - 106	0	3	17	90	142	133	34	5	76	5	94
21	18-Jun	200	48 - 109	0	1	11	36	61	64	24	3	77	6	93
22	25-Jun	392	44 - 95	0	4	9	49	188	119	23	0	77	3	97
23	02-Jul	83	43 - 100	0	2	0	4	25	46	5	1	80	2	96
24	09-Jul	115	51 - 112	0	0	4	6	8	53	43	1	85	3	96
25	16-Jul	37	54 - 123	0	0	3	1	3	17	12	1	84	8	89
Totals		8,210		468	2,743	1,288	946	1,317	989	318	141		55	43

chinook caught in the study area that were less than 65 mm in length were thought to be products of the study area. This assumption was based on Columbia River fish passage data that showed that up until the middle of June upriver chinook marked releases consisted mainly of juvenile chinook larger than 65 mm in length.

As water temperatures increased below Bonneville Dam, mean fork length of chinook rearing in the study area increased. From 20 April to 11 June mean fork length of chinook increased from 43.0 mm to 76.0 mm, a growth rate of 0.67 mm/day. Wild juvenile chinook reared below Bonneville Dam until they attained a size of approximately 65 to 80 mm in length, at which time they began migrating from the area. Until the middle part of June all chinook found in the study area greater than 80 mm in length were believed to be part of upriver hatchery releases since adipose-clipped chinook greater than 80 mm in length would often appear in the catch after upriver hatchery releases. Peak migration of study area fall chinook occurred from late May through the early part of June. By 2 July juvenile chinook less than 60 mm in length represented only two percent of the population below Bonneville Dam.

To assist in determining stock composition of juvenile chinook using the rearing areas below Bonneville Dam, sampled fish were examined for fin marks. Hatchery released juveniles with adipose fin clips aided in determining stock composition. When hatchery fish with fin clips appeared below the dam they were typically of a larger size than the wild chinook rearing in the area. Since the unmarked component of the hatchery releases were the same size as the marked component, native wild fish could easily be differentiated from any hatchery released chinook. This rule of thumb was useful until June when migrating upriver juvenile chinook of similar age and size began sharing the study area with resident wild fish. Numbers and mean lengths of marked juvenile chinook are presented in Table 9.

Since there are no chum hatcheries above the dams and nearby Hardy Creek and Hamilton Creek chum are not fin marked for assessment purposes, no marked chum were observed in juvenile sampling. Chum from nearby creeks could not be differentiated from the population found rearing in the Columbia River.

To determine future juvenile to adult survival rate, ocean distribution and fishery contribution of wild fall chinook found below Bonneville Dam, 10,402 juvenile fall chinook were coded-wire tagged and released in May and June 2001. Table 10 shows results of tagging including total number of chinook handled, number of tagged fish, number of fish released, mortality rate, mean length of tagged fish and the number of fish that were sampled but not tagged because they were either too small or too large.

Table 9. Adipose fin clipped fall chinook sampled below Bonneville Dam, 2001.

Week	Date	Number of chinook marked	Fork Length range (mm)	Mean length(mm)	Total chinook sampled	% of sample marked
1	30-Jan	0	-	-	7	0
2	01-Feb	0	-	-	1	0
2	06-Feb	0	-	-	23	0
3	08-Feb	0	-	-	1	0
3	12-Feb	0	-	-	0	0
4	16-Feb	0	-	-	1	0
4	20-Feb	0	-	-	0	0
5	22-Feb	0	-	-	7	0
5	27-Feb	0	-	-	2	0
6	02-Mar	0	-	-	7	0
6	06-Mar	0	-	-	1	0
7	09-Mar	0	-	-	20	0
7	12-Mar	0	-	-	175	0
8	16-Mar	7	65 - 72	69	127	6
9	21-Mar	7	66 - 74	70	89	8
9	23-Mar	3	68 - 74	71	80	4
10	27-Mar	7	60 - 73	69	202	3
10	30-Mar	5	73 - 82	76	280	2
11	03-Apr	3	72 - 79	75	146	2
11	06-Apr	5	65 - 85	80	143	3
12	10-Apr	3	58 - 80	70	124	2
12	13-Apr	0	-	-	284	0
13	17-Apr	0	-	-	193	0
13	20-Apr	7	69 - 95	85	593	1
14	23-Apr	3	78 - 98	87	415	1
14	01-May	6	76 - 91	85	1156	1
15	07-May	0	-	-	884	0
16	14-May	1	92	92	710	0
17	21-May	1	55	55	465	0
18	29-May	2	89 - 94	92	639	0
19	04-Jun	21	61 - 95	84	185	11
20	11-Jun	11	81 - 99	91	424	3
21	18-Jun	19	71 - 109	90	200	10
22	25-Jun	2	77 - 92	85	392	1
23	02-Jul	0	-	-	83	0
24	09-Jul	1	78	78	115	1
25	16-Jul	0	-	-	37	0
		114			8,210	1.4

Table 10. Wild juvenile fall chinook tagged and released below Bonneville Dam, 2001.

Date	Number Sampled	Number Tagged	Mortallity	Mortality Rate	Number Tagged Released	Mean Length Tagged	Untaggable Fish	Percent Untaggable
05/02/01	167	111	22	19.8	89	51.3	56	34
05/03/01	558	420	49	11.7	371	51.2	138	25
05/08/01	804	656	43	6.6	613	54.9	148	18
05/09/01	905	475	9	1.9	466	50.0	430	48
05/10/01	1217	806	43	5.3	763	51.0	411	34
05/15/01	992	634	26	4.1	608	55.9	358	36
05/16/01	717	519	62	12.0	457	56.0	198	28
05/17/01	1152	744	19	2.6	725	53.5	408	35
05/18/01	1111	791	29	3.7	762	54.6	320	29
05/22/01	460	417	41	9.8	376	58.6	43	9
05/23/01	1623	1251	65	5.2	1186	55.8	372	23
05/25/01	643	524	12	2.3	512	58.8	119	19
05/30/01	638	638	40	6.3	598	58.9	0	0
05/31/01	1586	1304	127	9.7	1177	63.1	282	18
06/01/01	388	359	0	0.0	359	61.2	29	7
06/05/01	767	640	32	5.0	608	59.5	127	17
06/06/01	670	598	11	1.8	587	65.1	72	11
06/08/01	187	145	0	0.0	145	66.1	42	22
Totals	14,585	11,032	630	5.7	10,402	57.0	3,553	24

Coded-wire tagging of wild juvenile fall chinook began 2 May when sampling data showed that the majority of chinook rearing below Bonneville Dam were at least 47 mm in length. Tagging was completed 8 June when the goal of 10,000 marked chinook was met. Had the above goal not been met by the middle of June, the tagging project would have been terminated because of the increasing probability of inadvertently marking unmarked hatchery and upriver, wild juvenile chinook. By mid-June juvenile chinook native to the study area had grown in size to where they were indistinguishable from fish that were migrating from areas above Bonneville Dam.

As the project proceeded, the number of fish that were sampled and found to be too small (<47 mm) or too large (>65 mm through mid-May, >75 mm after mid-May) to tag decreased. During the first nine days of tagging, 68% of the collected fish were tagged. Mean fork length of those fish was 53.2 mm. During the last nine days of tagging 86% of all sampled chinook were marked, mean length was 60.8 mm. Average daily mortality of all fish that were tagged and checked before release was 5.7%.

SUMMARY AND CONCLUSIONS

A total of 478 returning adult fall chinook and 195 adult chum were sampled below Bonneville, The Dalles, John Day and McNary dams in 2000. The peak redd count below Bonneville Dam in 2000 for adult fall chinook was 225. The peak redd count below Bonneville Dam for adult chum was 95. Peak spawning time below Bonneville Dam for fall chinook was 9 November. Peak spawning time for chum occurred 1 December. There were estimated to be a total of 704 fall chinook spawning below Bonneville Dam in 2000. The 2000 adult chum population below Bonneville Dam was estimated to be 529 spawners.

Temperature unit data suggests that below Bonneville Dam, 2000 brood, fall chinook emergence began on 30 March and ended 23 May 2001, with peak emergence occurring 6 May. 2000 brood, juvenile chum emergence below Bonneville Dam began 15 February and continued through 9 April 2001. Peak chum emergence below Bonneville Dam took place 26 March. A total of 8,210 juvenile chinook and 4,006 juvenile chum were caught and sampled below Bonneville Dam in 2001.

Juvenile chum migrated from the study area in the 40-50 mm fork length range. Peak migration occurred during the month of April. Results of juvenile chinook sampling corroborates the temperature unit estimate of peak emergence of 2000 brood fall chinook and suggests migration from rearing areas took place from late May through June 2001 when juvenile fall chinook were in the 60 to 80 mm fork length size range.

Adult and juvenile sampling below Bonneville Dam provided information to assist in determining the stock of fall chinook and chum spawning and rearing below Bonneville Dam. Based on observed spawning times, adult age and sex composition, GSI analysis, juvenile emergence timing, juvenile migration timing and juvenile size at the time of migration, it appears fall chinook using the area below Bonneville Dam are a late-spawning, bright stock of fall chinook. Observed spawning times, adult age and sex composition, GSI analysis, juvenile emergence timing, juvenile migration timing and juvenile size at the time of migration, suggests chum spawning and rearing below Bonneville dam are similar to stocks of chum found in Hamilton and Hardy creek.

PLANS FOR FY 2001

We are planning to continue collecting data to determine the status of fall chinook and chum spawning below Bonneville, The Dalles, John Day and McNary dams. We are planning to collect biological data from the fish spawning below Bonneville, The Dalles, John Day and McNary dams to profile stocks and determine stock origins. We will continue to estimate emergence timing of juvenile fall chinook and chum below Bonneville Dam. We are planning to sample juvenile populations to determine migration time and size at time of migration for juvenile fall chinook and chum rearing below Bonneville Dam. We will continue to monitor entrapment of juvenile chinook and chum below Bonneville Dam. We will attempt to coded-wire tag more than 10,000 juvenile fall chinook below Bonneville Dam to determine juvenile to adult survival rate and ocean distribution.

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APPENDIX A

Sampling data of incidentally caught juvenile salmonids

Appendix Table A. Mean fork lengths of juvenile coho, chinook, cutthroat, steelhead and sockeye caught and sampled below Bonneville Dam, 2001.

	Coho	Chinook >100	Cutthroat	Steelhead	Sockeye
Adipose fin clip					
Number	100	7	0	3	0
Mean Length	142.6	142.0	0.0	205.0	0.0
No adipose fin clip					
Number	312	58	3	5	2
Mean Length	75.0	130.3	260.6	171.0	158.5