Priest Rapids Hatchery Monitoring and Evaluation Annual Report for 2012-13

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Executive Summary

This report is the third annual report dedicated to monitoring and evaluating the Priest Rapids Hatchery (PRH) production of fall Chinook salmon. The PRH is located below Priest Rapids Dam adjacent to the Columbia River and has been in operation since 1963. The Monitoring and Evaluation program associated with PRH consists of nine objectives and is intended to evaluate the performance of the program in meeting hatchery and natural production goals. This report is intended to be cumulative, but also focus attention on the most recent year of data collection and production (2012-2013).

The PRH was originally built to mitigate for the loss of fall Chinook salmon that occurred from inundation of spawning grounds caused by the Priest Rapids Project. The hatchery is operated as an integrated program for the purpose of increasing harvest. The hatchery produces 5 million subyearling fall Chinook salmon for mitigation of inundation of spawning grounds caused by the Priest Rapids and Wanapum dams and 1.7 million subyearling fall Chinook salmon under contract with the United States Army Corps of Engineers for mitigation for John Day Dam.

The fall Chinook salmon produced at the PRH continue to have high survival before and after release from the hatchery. These fish contribute significantly to a variety of fisheries, such as fisheries off the coasts of Alaska and Canada and fisheries in the Columbia River.

The 2012 returns to PRH for both jacks (9,152) and adult fall Chinook salmon (18,785) were the highest on record. A total of 7,677 fish that returned to the volunteer trap at PRH were ponded for broodstock and 4,946 were spawned to meet egg take goals for multiple hatchery programs. The mortality rate of ponded adult fish was 36% which is the highest on record. The cause for the elevated mortality is uncertain; however, high densities of fish in the PRH volunteer trap may have been a contributing factor.

All ages except age-6 PRH origin fall Chinook salmon returning in 2012 were otolith marked. We used a combination of marks (e.g., otoliths, adipose clips, and coded-wire tags), to determine origin which is likely more accurate than the expansion of coded-wire recoveries to determine origin. The hatchery origin fish return at a younger age than natural origin fish. PRH origin fish are larger than natural origin fish at age-2 and 3, but smaller at older ages.

Hatchery origin fish released from PRH spawn throughout the Hanford Reach, but in 2012 were concentrated in the river reach downstream of Island #2 (River km 605), approximately 56 kilometers downriver of Priest Rapids Dam. Stray rates into other populations appear to be low based upon coded-wire tag (CWT) recoveries.

PRH origin fish were estimated to make up 7% of the spawning population in the Hanford Reach during 2012. All hatchery fish combined (including fish released from Ringold Hatchery and strays from outside the Hanford Reach) comprised 13% of the fall Chinook salmon on the spawning grounds. Otolith recoveries at PRH indicate that a very high percentage of hatchery broodstock are of PRH origin. There appears to be a strong negative bias in coded-wire tag based estimates that were previously used to estimate this variable. The proportion of natural influence (PNI) for Hanford Reach fall Chinook salmon including all hatcheries is estimated at 48%. An alternative estimated PNI specific to the contribution of PRH origin fall Chinook salmon is 63%. Both estimates for PNI are lower than optimum for an integrated harvest program (i.e. > 0.67), however the PNI has increased dramatically during the past few years. Low numbers of natural origin broodstock at PRH contributes to difficulty reaching the PNI target. Additional natural origin broodstock for PRH was collected at the Priest Rapids Dam off ladder adult fish trap and

from a pilot project in which anglers fishing in the Hanford Reach captured fish by hook and line. These additional fish increased the natural origin component of the broodstock from 6% to 12%. An alternative estimate for the proportion natural origin broodstock (pNOB) was developed for return year 2012 to account for the genetic influence on pNOB resulting from the PRH spawning protocol of mating one male with two females. It is intended to represent actual gene flow to the progeny instead of just the origin and number of parents used in spawning. The alternative pNOB for return year 2012 resulted in an estimate of 14% which corresponded to a PRH origin fall Chinook salmon PNI of 67%.

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1.0 Introduction

The Public Utility District No. 2 of Grant County, Washington (Grant PUD) produces and releases 5 million subyearling fall Chinook salmon from Priest Rapids Hatchery (PRH) as part of its mitigation for inundating habitat caused by the construction and operation of Priest Rapids and Wanapum Dams. The PRH is located on the east bank of the Columbia River immediately downstream of Priest Rapids Dam (Figure 1and 2). The Washington Department of Fish & Wildlife (WDFW) operates PRH which is owned, maintained, and funded by the Grant PUD. This report describes the monitoring and evaluation of Grant PUD's PRH program.

PRH also produces and releases 1.7 million sub-yearling smolts on-site for the U.S. Army Corps of Engineers (USACE) John Day Mitigation. PRH also serves as a broodstock collection location for other hatcheries in the region. PRH provides approximately 3.7 million eyed eggs for the USACE John Day Mitigation at Ringold Springs Hatchery (RSH). These eggs are transferred to Bonneville Hatchery and ultimately about 3.5 million sub-yearling smolts are transported to, acclimated, and released from RSH. During previous years, PRH has accommodated egg takes and/or incubated eggs for the Yakama Nation (YN) upper river bright (URB) fall Chinook salmon releases in the lower Yakima River at their Prosser facility. Additional eggs have also been taken for other programs such as WDFW's Salmon in the Classroom program and to support various research projects.

Grant PUD has developed guiding principles and approaches for the monitoring and evaluation (M&E) of all of its hatchery programs that are provided in an overarching M&E plan that encompasses all of its programs (Pearsons and Langshaw 2009). The M&E Plan for PRH is included in Section 11 and Attachment 5 of the Priest Rapids Hatchery and Genetic Management Plan (HGMP). This plan was reviewed and approved by the Priest Rapids Coordinating Committee's (PRCC) Hatchery Subcommittee (HSC).

Figure 1 Location of Priest Rapids and Ringold Springs hatcheries and the Hanford Reach.

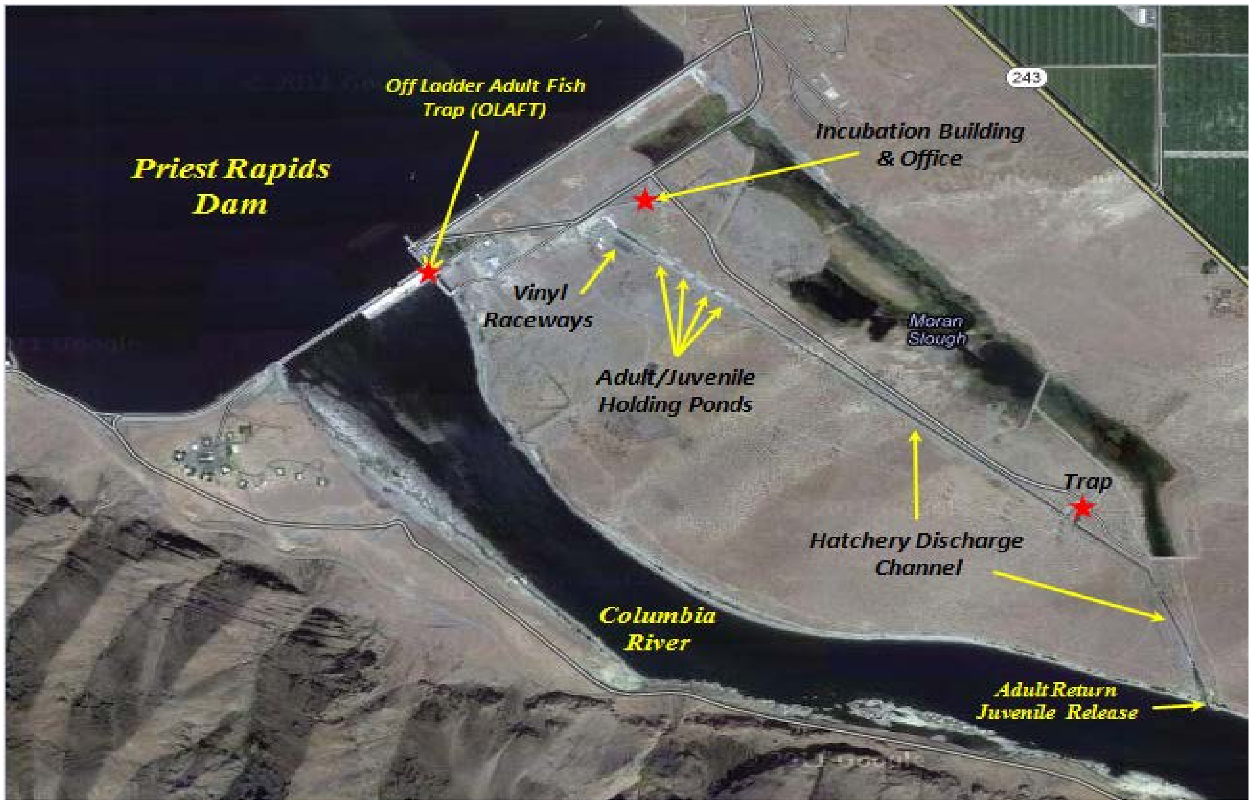

Figure 2 Priest Rapids Hatchery facility and Priest Rapids Dam OLAFT.

This report of the Grant PUD Priest Rapids Hatchery M&E program encompasses data collected during fiscal year (FY) 2012 - 13 as well as earlier years where data were available. The data presented in this report are preliminary and subject to change as new data and analyses become available. Please consult the most recent annual report in order to obtain the most current and accurate information. Objectives, hypotheses, measured and derived variables, and field methods that will be used to collect data are listed in Appendix A of this report.

2.0 Objectives

The objective of the PRH M&E plan is to evaluate the performance of the PRH program relative to the goals and objectives of the PRH program. The overarching goal of the PRH program is to meet Grant PUDs hatchery mitigation by producing fish for harvest while keeping genetic and ecological impacts within acceptable limits.

- **Objective 1**: Determine if the Priest Rapids Hatchery program has affected abundance and productivity of the Hanford Reach Population.
- **Objective 2**: Determine if the run timing, spawn timing, and spawning distribution of both the natural and Priest Rapids Hatchery components of the Hanford Reach population are similar.
- **Objective 3**: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the Priest Rapids Hatchery program. Additionally, determine if Priest Rapids Hatchery programs have caused changes in phenotypic characteristics of the Hanford Reach population.
- **Objective 4**: Determine if the Priest Rapids Hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the Hanford Reach adult-to-adult survival (i.e.,

natural replacement rate) and equal to or greater than the program specific hatchery replacement rate (HRR) expected value based on survival rates listed in the BAMP (1998).

- **Objective 5:** Determine if the stray rate of Priest Rapids Hatchery fish is below the acceptable levels to maintain genetic variation between stocks.
- **Objective 6:** Determine if Priest Rapids Hatchery fish were released at the programmed size and number.
- **Objective 7**: Determine if harvest opportunities have been provided using Priest Rapids Hatchery returning adults.
- **Objective 8**: Determine if the Priest Rapids Hatchery has increased pathogen type and/or prevalence in the Hanford Reach population.
- **Objective 9**: Determine if ecological interactions attributed to Priest Rapids Hatchery fish affect the distribution, abundance, and/or size of non-target taxa of concern that were deemed to be at sufficient risk**.**

3.0 Current Operation of Priest Rapids Hatchery

In 2012, 28,039 adult fall Chinook salmon returned to PRH (Table 1). The 2012 broodstock for PRH were collected at the hatchery volunteer trap, the Priest Rapids Dam Off Ladder Adult Fish Trap (OLAFT), and from the angler broodstock collection (ABC) fishery. The majority of the broodstock were collected from the PRH volunteer trap. The volunteer trap was operated from September 4 through December 3, 2012.

Table 1 Source and disposition of Chinook salmon collected for broodstock at Priest Rapids Hatchery, return year 2012.

Collection Location	Gender	Collected	Trap Surplused	Trap Mortalities	Ponded	Spawned	Pond Surplused	Pond Mortalities
Volunteer Trap	Males	13,163	11,005	138	2,020	1,355	185	480
	Females	5,724	534	124	5,066	3,052	148	1,866
	Jacks	9,152	9,093	56	3	1	0	2
	Total	**28,039**	**20,632**	**318**	**7,089**	**4,408**	**333**	**2,348**
OLAFT	Males	321	0	0	321	293	28	0
	Females	149	0	0	149	146	0	3
	Jacks	50	0	0	50	32	0	18
	Total	**520**	**0**	**0**	**520**	**471**	**28**	**21**
ABC Fishery	Males	41	0	0	41	40	0	1
	Females	26	0	0	26	26	0	0
	Jacks	1	0	0	1	1	0	0
	Total	**68**	**0**	**0**	**68**	**67**	**0**	**1**
Facility	**Total**	**28,627**	**20,632**	**318**	**7,677**	**4,946**	**361**	**2,370**

The PRH staff removed fish from the volunteer trap two to five days per week as needed to collect broodstock and surplus excess fish. Male fall Chinook salmon, both adult and jack, typically comprise the majority of the fish surplused at the trap. The first and last trapping days occurred on September 9 and December 3, respectively. Daily detections of PIT tagged adult Chinook salmon passing the array in the PRH discharge channel suggest that returns to the volunteer trap peaked around October 16 (Figure 3). These dates coincided with peak collection days at the volunteer trap.

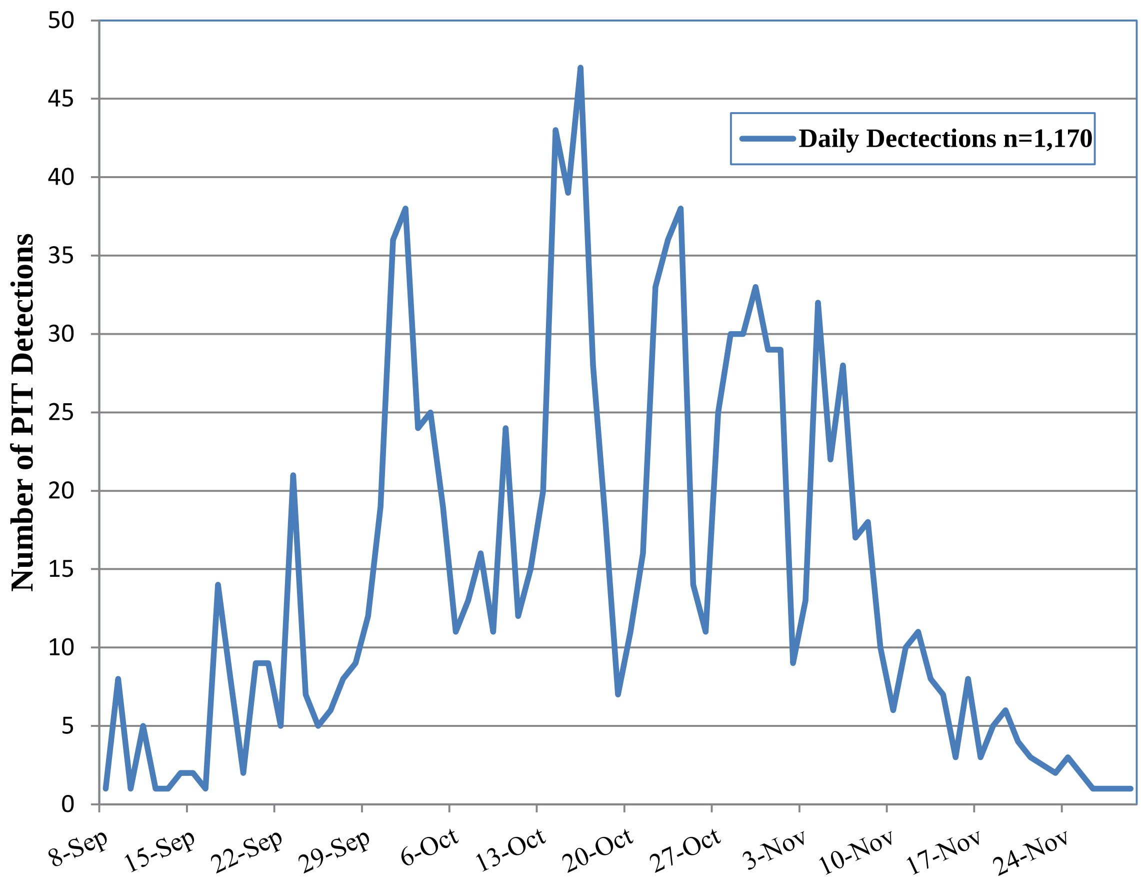

Figure 3 Daily detections of unique PIT tagged adult Chinook salmon which last known detection was at the PIT tag array located in the Priest Rapids Hatchery discharge channel, 2012.

The egg take goal for PRH is 11,819,000. The egg take of 13,583,159 eggs for the 2012 brood exceeded the goal by 1,764,159 eggs. Spawning (egg takes) at PRH occurred on eight days between October 22 and December 3, 2012. During the first spawn day, the eggs from a single female were stripped into a five gallon bucket and then the sperm from a single male were mixed with the eggs. Fertilized eggs are then transferred to an incubation room and placed in vertical incubation trays. The mating ratio changed to two females and one male for subsequent spawn days.

Eight batches of fry were moved from the vertical trays in the incubation building to outdoor vinyl raceways between January 23 and March 16. The fry are reared for approximately two weeks in the vinyl raceways so that they can be trained to feed and then transferred into the larger concrete ponds. All the fry are typically moved to the concrete holding ponds by early April. During the second to third week of June the sub-yearlings are released, one pond at a time, starting with the most downstream pond. These fish migrate down a one mile long channel (formerly the spawning channel) and then down the hatchery discharge channel and into the Columbia River.

4.0 Tagging and Marking

Roughly 6.7 million fall Chinook salmon are released annually from PRH of which 1.7 million are produced for the USACE mitigation obligations for the installation and operation of John Day Dam. Various mark types and rates have occurred at PRH over the years for both the Grant PUD and USACE mitigation fish (Table 2).

In 1977, PRH began adipose fin clipping and coded-wire tagging a portion of the juvenile fall Chinook released to determine PRH contributions to ocean and river fisheries. All broods of the John Day mitigation fish fall Chinook salmon released in 2007, 2009, 2010, 2011, and 2012 from PRH for the USACE were adipose clipped. Poor returns for broodyear 2007 precluded the production of USACE's John Day mitigation fish for the 2008 release.

Beginning with the 1993 broodyear, PRH began PIT (Passive Integrated Transponder) tagging a small portion of the release for the purpose of evaluating migration timing at mainstem dams. The USACE production at PRH does not have a coded-wire tag or PIT tagged group specific to this mitigation program.

During later winter of 2012, a PIT tag detection array was installed in the PRH discharge channel. Prior to 2012, PIT tagged Chinook salmon released from PRH could only be detected at the mainstem hydroelectric facilities (fish ladders and juvenile bypasses) or by manually scanning individual fish. The number of fish PIT tagged at PRH was substantially increased in 2012 to be able to evaluate survival and straying. Approximately 43,000 of the 6.7 million fall Chinook salmon released in both 2012 and 2013 were PIT tagged.

All PRH releases for both mitigation programs were 100% otolith marked beginning with the 2008 release. All annual releases from PRH have the same annual otolith pattern, but the pattern differs between years. Beginning with broodyear 2010, the fry transferred from PRH to Ringold Spring Hatchery have received a unique otolith mark. Otolith sampling at the hatchery and in the Hanford Reach provides increased precision in the determination of PRH origin returns to the hatchery and to estimate PRH origin fall Chinook contributions to the terminal sport fishery and the naturally spawning population of the Hanford Reach.

Since 1987, the U.S. Section of the Pacific Salmon Commission (PSC) has supported a coordinated project which seeks to capture and coded-wire tag 200,000 naturally produced juvenile fall Chinook salmon in the Hanford Reach. Fish are collected with seines over a ten day period between late May and early June. Fish are approximately 40-80 mm long at the time of capture. Recoveries from these tagged fish are used to estimate exploitation rates and interception rates for Hanford Reach natural origin fall Chinook salmon. These data have also been used to determine natural origin contributions to hatchery broodstock and more recently to estimate the number of natural origin juveniles produced in the Hanford Reach (Harnish et al. 2012).

Table 2 **Numbers of marked and unmarked fall Chinook salmon smolts released from Priest Rapids Hatchery.**

Broodyear	Total Released	Non Ad-Clip Released	AD/CWT	CWT Only	AD Only	Otolith Marked	PIT
1979	2,383,690	2,272,862	110,828				
1980	4,832,591	4,581,054	251,537				
1981	5,509,241	5,198,365	310,876				
1982	10,296,70	9,888,989	407,711				
1983	9,742,700	9,517,263	222,055		3,382		
1984	6,363,000	6,253,240	106,960		2,800		
1985	6,048,000	5,843,176	203,534		1,290		
1986	7,709,000	7,506,142	201,843		1,015		
1987	7,709,000	7,501,578	196,221		11,201		
1988	5,404,550	5,200,080	201,608		2,862		
1989	6,431,100	6,224,770	194,530		11,800		
1990	5,333,500	5,134,031	199,469				
1991	7,000,100	6,798,453	201,647				
1992	7,134,159	6,939,537	194,622				
1993	6,705,836	6,520,153	185,683				
1994	6,702,000	6,526,120	175,880			6,702,000	1,500
1995	6,700,000	6,503,811	196,189			6,700,000	3,000
1996	6,644,100	6,450,885	193,215				3,000
1997	6,737,600	6,541,351	196,249				3,000
1998	6,504,800	6,311,140	193,660				3,000
1999	6,856,000	6,651,664	204,336				3,000
2000	6,862,550	6,661,771	200,779				3,000
2001	6,779,035	6,559,109	219,926				3,000
2002	6,777,605	6,422,232	355,373				3,000
2003	6,814,560	6,415,444	399,116				3,000
2004	6,599,838	6,399,766	200,072				3,000
2005	6,876,290	6,676,845	199,445				3,000
2006	6,743,101	4,912,487	202,000		1,628,614		3,000
2007	4,548,306	4,345,738	202,568		813	4,548,306	3,000
2008	6,788,314	4,850,844	218,082		1,719,388	6,788,314	2,994
2009	6,776,651	4,438,953	605,000	1,026,605	1,696,451	6,776,651	1,995
2010	6,798,390	4,476,184	605,000	1,110,000	1,717,206	6,798,390	3,000
2011	7,056,948	3,651,655	605,293	605,295	2,785,701	7,056,948	42,844
2012	6,822,361	3,471,236	606,020	606,020	2,745,105	6,823,361	44,083
10yr (03-12) mean	**6,582,476**	**4,963,915**	**384,260**	**836,980**	**2,048,744**	**6,465,328**	**10,992**

WDFW operates the OLAFT at Priest Rapids Dam three days per week beginning in July and continuing through mid to late October. This project began in 1986 and was designed to sample steelhead to (1) determine upriver population size, (2) estimate hatchery to natural (wild) fish ratios, (3) determine age class distribution, and (4) evaluate the need for managing returning hatchery steelhead consistent with ESA recovery objectives. In 2009, WDFW began sampling fall Chinook salmon at the trap for run composition assessment. A study was initiated in 2010 to determine the efficacy of using the OLAFT to increase natural origin broodstock for the Priest Rapids Hatchery. In 2010, 2011, and 2012, adipose fin present and coded-wire tag (CWT) absent adult fall Chinook salmon were PIT tagged and released at the OLAFT to assess migration and spawning distribution. In addition, the OLAFT was used to collect potential natural origin fall

Chinook salmon for incorporation into the broodstock at PRH. This work is presented in Tonseth et al. (in preparation).

5.0 Life History – Hanford Reach Fall Chinook Salmon

The fall Chinook salmon population that spawns in the Hanford Reach is one of the largest and most productive in the United States (Harnish et al. 2012). The Hanford Reach is one of the last non-impounded reaches of the Columbia River. The Hanford Reach extends 51 miles from the city of Richland to the base of Priest Rapids Dam. Natural origin fall Chinook salmon emerge from the substrate in the spring and rear in the Hanford Reach until migration in the summer. Egg-to-fry survival has been estimated to be about 71% in the Hanford Reach (Oldenburg et al. 2012) and egg-to-presmolt has been estimated to be about 40.2% (Harnish et al. 2012). Both of these estimates are high when compared to other Chinook salmon populations (Harnish et al. 2012). Fall Chinook salmon interact with a variety of species in the Hanford Reach (Naiman et al. 2012). The age at maturity for naturally produced fish in the Hanford Reach varies between 2 and 6 years. The age of fish reported in this document begins with a birthday of the year that the parents spawned. The abundance of minijacks which mature at age-1 males is currently not known. Jacks, which are age-2 males, return to the Hanford Reach after spending roughly one year in the ocean. The majority of the natural origin adults return after having spent three to four years in the ocean (age-4 and 5). A small portion, typically less than 2%, will spend up to five years in the ocean and return as age-6.

6.0 Project Coordination

WDFW M&E staff dedicated to PRH worked in conjunction with PRH fish culture staff, the Columbia River Coded Wire Tag Recovery Program (CRCWTP), Region 3 Fish Management, the WDFW District 4 Fish Biologist, Upper Columbia River Steelhead Monitoring and Evaluation Team, and the Grant PUD biological science staff to complete all tasks included in the M&E Plan. In addition, samples collected at the hatchery and in the field were transported and analyzed by WDFW laboratories including the WDFW Scale Reading Lab and WDFW Genetics Lab, and the WDFW Otolith Lab. Coded-wire tags are processed at the WDFW District 4 office. Data and analysis collected in association with the PRH M&E and Hanford Reach population monitoring is incorporated into the Columbia River upper river brights (URB) fall Chinook salmon database for use in forecasting and managing fall Chinook salmon populations in the Columbia and Snake rivers and tributaries. WDFW secured and held all environmental permits necessary for the work.

7.0 Sample Size Considerations

We attempted to strike an appropriate balance between technical rigor, logistics, and financial investment when setting sample size targets. We used a phased approach to collect samples with sufficient accuracy and precision. In general, we attempted to oversample the raw samples such as carcasses and trap recoveries and then use post season analysis to determine if sub-sampling was necessary. The sample size target of systematic field sampling is 10% of carcasses in the Hanford Reach, 10% at the hatchery trap, and 25% of the broodstock.

Representative sample of otoliths by survey type were selected for processing to estimate origin by age class (Table 3). In most cases all otolith samples for a survey were processed if the sampling rate provided relatively low numbers of otolith sample or if there was a desire for higher accuracy. Subsamples of otoliths collected from the PRH volunteer trap and PRH broodstock were submitted for processing. The sizes of the otolith subsamples were determined for otolith analysis after the ages of the fish were determined by scale aging. After determining the ages of the fish sampled, subsample sizes were apportioned by age based on number of samples collected and the relationship between subsample size and deviation of the subsample size from the cumulative estimate of a variable.

Table 3 Percentage of population sampled by survey and otoliths processed, Broodyear 2012.

	Hatchery Surveys						Stream Surveys			
	PRH Trap	PRH Pond Mortality	PRH Pond Surplus	PRH Spawn	OLAFT spawn	ABC spawn	HR Sport Fishery	HR Stream	Priest Pool	Hatchery Discharge Channel
Population	20,950	2,348	333	4,408	520	68	18,854	57,631	72	207
Sampled	2,024	224	31	1,095	520	68	3,615	6,810	72	207
Population Sampled	9.7%	9.5%	9.3%	24.8%	100.0%	100.0%	19.2%	11.8%	100.0%	100.0%
Otolith (n=)	1,707	188	27	986	501	65	476	1,590	63	42
Otoliths Submitted	611	0	0	704	501	65	476	1,590	63	42
Population Submitted	2.9%	0.0%	0.0%	16.0%	96%	96%	2.5%	2.8%	87.5%	20.3%

8.0 Evaluation of Bias

There are at least two sources of bias that we attempted to evaluate during 2012. First was the bias associated with estimates generated using coded-wire tags. The second type of bias that was evaluated during 2012 was size and gender bias during carcass recovery.

Results from sampling the fall Chinook returns for 2010, 2011, and 2012 indicated that estimates of hatchery contributions to broodstock, the terminal sport fishery, and to escapement of the Hanford Reach calculated from otoliths were substantially different from estimates generated using coded-wire tags. It is likely that the estimates produced from the otoliths are unbiased (Hoffarth and Pearsons 2012).

This was of significant concern because many estimates such as stray rate, survival, origin, and harvest are dependent upon estimates generated from coded-wire tags. To assess the level of coded-wire tag recovery bias, comparisons of the proportion of PRH origin coded-wire tag returns to the coded-wire mark rate for individual ages by broodyear were made using the following equation:

$$\text{CWT Recovery Bias} = \frac{\text{\# of PRH Origin CWT Fish Recovered} \;/\; \text{\# of PRH Origin Fish Collected}}{\text{CWT Mark Rate for Broodyear}}$$

Where as:

# of PRH origin fish collected = Estimate of the number of PRH origin fish for a specific age/broodyear as determined by otoliths, scale aging, and expansion of age samples

# of PRH Origin CWT Fish Recovered = Number of PRH origin CWT fish for a specific age/brood recovered at the hatchery (100% sample)

CWT Mark Rate = CWT marking rate for the specific broodyear.

If a coded-wire tag bias did not exist, the proportion of PRH coded-wire tag returns to the PRH coded-wire tag mark rate should equal 1. As shown in Table 4, the estimated bias ranged from 0.57 to 1.16 for the different age/broods examined.

Table 4 Estimate of coded-wire tags bias for Priest Rapids origin returns to the hatchery.

Brood	Age	Proportion CWT Marked	# of PRH Origin CWT Fish Recovered	Estimated # of PRH origin Fish Collected	Proportion of PRH Origin Brood Return CWT	Proportion of PRH CWT Returns to the PRH CWT Mark Rate (CWT Recovery Bias)
2007	5	0.0445	48	928	0.052	1.16
2007	4	0.0445	280	10,977	0.026	0.57
2007	3	0.0445	410	14,078	0.029	0.65
2007	2	No otolith data collected during return year 2009				
2008	4	0.0318	81	2,982	0.027	0.85
2008	3	0.0318	127	5,606	0.023	0.71
2008	2	0.0318	57	2,578	0.022	0.69
2009	3	0.2429	2,309	13,545	0.170	0.70
2009	2	0.2429	628	3,082	0.204	0.84
2010	2	0.2371	1,497	8,896	0.168	0.71

It is unclear whether coded-wire tag estimates are biased because of 1) tag loss, 2) less than 100% detection of tags when scanned, 3) inappropriate expansion estimates, 4) differential survival or homing of tagged fish, or 5) incorrect estimates of the total number of fish released from PRH. In addition, the precision of coded-wire tag estimates for some broodyears is likely influenced by the low number of CWT recoveries.

Preliminary assessment of coded-wire tag wand detection efficiency was conducted at PRH during the 2010, 2011, and 2012 returns. During 2012, M&E staff randomly selected 110 adipose clipped fall Chinook salmon that were not coded-wire tagged as determine by scanning them with a coded-wire tag wand during routine sampling of fish from the PRH volunteer trap. The snouts were removed from each fish to increase the likelihood of detection and then passed through a V-detector.

Similar to test results for previous years, there was no additional coded-wire tag detections observed from the 110 fish sampled. Similar results were observed in 2010 and 2011 with fifty fish samples for each year.

In general, carcasses of smaller female and male fish are recovered at lower rates than older, larger, female fish (Murdoch et al. 2010). This can result in underestimates of smaller male fish and overestimates of larger female fish. This is particularly a problem when comparing samples collected at the PRH trap with samples collected in the Hanford Reach. Samples collected at the trap are more likely to represent the population in terms of size and age structure than carcasses collected in the Hanford Reach. Differences between samples could be the result of true biological differences or because of bias. We attempted to evaluate carcass recovery bias in the Hanford Reach, and the results of this evaluation are presented in section 5.0.

9.0 Origin of Adult Returns to Priest Rapids Hatchery

There were three sources for collection of adult Chinook salmon broodstock for PRH during the 2012 return: PRH volunteer trap, OLAFT, and angler broodstock collection fishery (ABC). The origin of fish collected at these locations was determined by examination of otoliths for the presence of a thermal mark unique to PRH. The otolith samples that did not possess a PRH thermal mark were classified as unknown. The very low recovery (<1%) of coded-wire tagged strays at PRH suggests that a high percentage of the unknown fish are of natural origin (See Section 1.9). Thus, in some sections of the report, we make a simplifying assumption that fish without a thermal mark are of natural origin. Similar to that observed in previous years, there is a large discrepancy between estimates of origin based on coded-wire tag and otoliths. Origin based on otolith sampling provides the most accurate data under the current marking regime at PRH. According to Jeff Grimm, WDFW Otolith Lab (personal communication, July 15, 2013) the error rate associated with determination of origin by otoliths is very low. Each otolith is independently read by two experienced lab staff. Upon completion of the second read, any discrepancies are read a third time to resolve the conflict. If the marks are poor quality, three staff independently read the otoliths. PRH staff does a fantastic job at creating the marks. They are high quality so require only two readers. Most discrepancies are clerical in nature (data entry). Discrepancies associated with the data for the Hanford fish were clerical and easy to resolve.

We present estimates based on CWT and otoliths to illustrate differences in the estimates as well as the potential for creating a correction to the historical database that was generated using CWTs.

All Chinook collected or transported to PRH regardless of source were sampled for the presence of a coded-wire tag. Broodstock collected at the OLAFT and angler broodstock collection (ABC) fishery were sampled for otoliths, scales (aging), gender, and length in addition to scanning for CWTs. All otolith samples for both groups were submitted to the WDFW Otolith Lab for examination to determine origin. Broodstock originating from the PRH volunteer trap were sampled at a rate of 1:4 for otoliths, scales (aging), gender, and length. Fish mortalities and surplus at the PRH volunteer trap and holding ponds were sampled at a 1:10 rate for otoliths, scales (aging), gender, and length.

Current sample rates at PRH are in excess of need to accurately assess origin of the returns to the hatchery. The number of samples submitted to the otolith lab is reduced based on the number of samples needed by age. Post spawn, the otoliths for broodstock were sub-sampled at a rate of 2:3. The fish mortalities and surplus from the volunteer trap and ponds were sub sampled for otoliths at a rate of 1:3, but only the samples collected for the volunteer trap were sent to the WDFW Otolith Lab for examination of origin. The origin of the PRH volunteer returns were estimated based on the results of the otolith sub sample. Otoliths from fish that died in the ponds and for fish in excess to spawning need were not examined for origin. These fish were assumed to be represented by fish of the same age collected at the trap. Therefore we assumed that hatchery and natural origin fish had similar mortality rates.

9.1 Origin Based on Otolith Recoveries

The proportion of PRH origin and natural origin adult returns to the PRH volunteer trap was estimated by combining the expanded samples for broodstock and fish surplused from the volunteer trap. The origin for all fish ponded for broodstock was assigned using the proportion of origin by age for the broodstock. The age composition for the ponded mortalities and surplus fish and the broodstock is similar.

The origin of fall Chinook salmon ponded and surplused from the volunteer trap were very similar, both were roughly 94% PRH origin and 6% Natural (Table 5). The percentage of PRH origin fish collected at the OLAFT and ABC fishery was 44% and 9%, respectively.

Table 5 Numbers of hatchery and natural origin Chinook salmon collected at Priest Rapids Hatchery, Priest Rapids Dam Off Ladder Adult Fish Trap, and angler broodstock collection fishery. Origin determined by otolith thermal marks specific to Priest Rapids Hatchery, the presence of coded-wire tags, or adipose clips.

Brood	Priest Rapids Hatchery Ponded Volunteer Returns [1]	Percent Origin	
		Hatchery Origin	Natural Origin [2]
2012	7,677 n = 651	93.6	6.4

Brood	Priest Rapids Hatchery Surplused from Trap [3]	Percent Origin	
		Hatchery Origin	Natural Origin [2]
2012	20,950 n = 557	94.4	5.6

Brood	Priest Rapids Hatchery Volunteer Return Total	Percent Origin	
		Hatchery Origin	Natural Origin [2]
2012	28,627	94.2	5.8

Brood	Priest Rapids Off Ladder Fish Trap Collection	Percent Origin	
		Hatchery Origin	Natural Origin [2]
2012	520 n = 500	43.8	56.2

Brood	Angler Broodstock Collection Fishery	Percent Origin	
		Hatchery Origin	Natural Origin [2]
2012	68 n = 65	9.2	90.7

[1] Includes PRH volunteer ponded returns that were either spawned, surplused or mortalities.
[2] Origin based on the absence of otolith marks, coded-wire tags, or adipose clips.

9.2 Origin Based on Coded-Wire Tag Recoveries

All Chinook salmon returning to PRH, and broodstock collected from the OLAFT and ABC fishery were sampled for the presence of coded-wire tags. No coded-wire tags were recovered from fish collected at the OLAFT and ABC fishery. This was because efforts were made to exclude coded-wire tagged fish from the collections. The lack of coded-wire tag detections in these collections also supports the earlier finding that coded-wire tag detections in the field appear to be accurate.

A total of 4,015 coded-wire tags were collected at PRH in 2012 of which 583 coded-wire tags were collected from the broodstock (Appendix B and Appendix C). Similar to previous years, expansions of coded-wire tag recoveries at PRH in 2012 accounted for 69% of the volunteer returns to the hatchery (Table 6). Assuming that these coded-wire tag expansion accurately reflect the proportion of hatchery origin fall Chinook salmon to PRH, 69% of the Chinook salmon in were hatchery origin leaving 31% of the origin unknown and potentially natural origin. PRH origin tags accounted for 98% of the hatchery origin tags recovered which is similar to historic coded-wire tag recovery rates.

Historically, roughly 70% of the fall Chinook salmon returning to PRH were hatchery origin based on coded-wire tag expansions (Hoffarth and Pearsons, 2012). However, this estimate of PRH origin fish based on coded-wire tags has averaged 58% from return year 2005 to 2012.

There were three natural origin Hanford Reach fall Chinook salmon coded-wire tags recovered at the hatchery in 2012. These fish were surplused from the volunteer trap. There is not an expansion factor for the natural origin coded-wire tag fish so there was no attempt to estimate the proportion of natural origin fish based on these three coded-wire tag recoveries.

In an effort to increase natural origin broodstock in return years 2011 and 2012, the majority of the adipose clipped Chinook salmon returning to the PRH trap were surplused. In 2012, this method of surplusing adipose clipped fish removed 86% of the coded-wire fish from the broodstock.

Table 6 Estimated proportion of hatchery and natural origin adult Chinook salmon returning to the Priest Rapids Hatchery volunteer trap based on coded-wire tag expansion. The entire collection was sampled for coded-wire tag.

Brood	Returns to Priest Rapids Hatchery Volunteer Trap	Origin based on Coded-Wire Tag expansions		Natural Origin [1]
		Priest Rapids Hatchery	Other Hatchery	
2005	10,616	0.622	0.006	0.329
2006	8,223	0.490	0.006	0.436
2007	6,000	0.671	0.004	0.525
2008	19,586	0.491	0.008	0.409
2009	12,778	0.428	0.003	0.540
2010	19,169	0.602	0.003	0.486
2011	20,823	0.613	0.006	0.381
2012	28,039	0.692	0.004	0.304
Mean	15,654	0.576	0.005	0.427

[1] The proportion not accounted for by coded-wire tag expansion is assumed to be of natural origin.

10.0 Broodstock Collection and Sampling

The fish collected from the OLAFT and ABC fishery were placed in separate ponds from the fish collected at the PRH volunteer trap to allow separate data collection and analysis of each group. Only a portion of the fall Chinook salmon released from PRH are externally marked (adipose clipped) to identify them as hatchery origin Chinook salmon. The determination of origin is reliant on a combination of coded-wire tags recoveries, otolith marks, and adipose clips. In 2012, the adult returns for age-2, 3, 4 and 5 fish were otolith marked. This allowed for two methods for estimating the origin of PRH broodstock: Coded-wire expansions and otolith sampling.

The broodstock collected at the PRH volunteer trap were systematically sampled at a 1:4 rate for otoliths, scales (aging), gender, and length. Post spawn, the otoliths for this group were randomly sub sampled for otoliths at a 2:3 rate and sent to the WDFW Otolith Lab for examination of origin. The origin of the PRH volunteer broodstock was estimated based on the results of the otolith sub sample. All broodstock were sampled for the presence of coded-wire tag. The coded-wire tag recoveries were categorized as in-sample and out-of-sample fish to facilitate the analysis of biological data associated with the in-sample coded-wire tag recoveries. All the broodstock collected at the OLAFT and ABC fishery were sampled for otoliths, scales (aging), gender, and length. The otolith samples for both groups were submitted to the WDFW Otolith Lab for examination to determine origin.

10.1 Origin of Broodstock

In an effort to increase natural origin broodstock in 2012, the majority of the adipose clipped Chinook salmon returning to the PRH trap were surplused. This method of surplusing adipose clipped fish removed 85.5% of the coded-wire tagged Chinook salmon from the broodstock; potentially reducing the ability to discern hatchery origin contributions to the broodstock via coded-wire tag analysis. Assuming that the fish ponded for broodstock were similar in origin as the entire PRH volunteer collection, all coded-wire tag returns were used for the determination of origin of the broodstock. This estimate of origin also makes the assumption that all fish that could not be identified to origin by coded-wire tags at PRH are of natural origin. Beginning in return year 2010, the examination of otolith marks from spawned fish was also used to determine origin. For this comparison, the assumption is made that fish not possessing an otolith mark, adipose clip, or coded-wire tag are natural origin fish. Chinook salmon in the broodstock subsample that did not possess an otolith mark but were marked with an adipose clip and/or coded-wire tag were classified as strays from other hatcheries.

In the otolith subsample for PRH volunteer broodstock, there were three non-otolith marked fish that were also adipose clipped, roughly 0.46% of the subsample. When expanded to the total broodstock, it is estimated that there were 20 non-otolith marked/adipose clipped fish in the broodstock that should be classified as fish from other hatcheries.

An estimated 30.4% of the broodstock originating from the volunteer trap was comprised of natural origin fish based on coded-wire tag recoveries. An estimated 12.0% of the broodstock originating from the volunteer trap was comprised of natural origin fish based on otolith marks (Table 7).

Table 7 Proportion of hatchery and natural origin Chinook salmon spawned at Priest Rapids Hatchery.

Brood	Broodstock Spawned	Origin based on CWT expansions			Origin Based on Otolith Mark		
		PRH	Other Hatchery	Natural Origin [1]	Other Hatchery	PRH	Natural Origin [2]
2005	5,288	0.622	0.006	0.372		N/A	N/A
2006	5,099	0.490	0.006	0.504		N/A	N/A
2007	2,096	0.671	0.004	0.325		N/A	N/A
2008	4,897	0.491	0.008	0.501		N/A	N/A
2009	4,389	0.428	0.003	0.569		N/A	N/A
2010	5,256	0.602	0.003	0.395		0.957	0.043 [3]
2011	5,444	0.613	0.006	0.381		0.966	0.034 [4]
2012	4,974	0.692	0.004	0.304	0.004[5]	0.882	0.119

[1] Natural origin estimated from the remaining fish not accounted for by expansions of CWT recoveries
[2] Natural origin estimated from the remaining fish not accounted for by otolith marks
[3] PRH origin determined based on otolith sub sampling of age-2 and 3 Chinook salmon in the broodstock.
[4] PRH origin determined based on otolith sub sampling of age-2, 3, and 4 Chinook salmon in the broodstock.
[5] Other hatchery fish based on otolith subsample that were adipose clipped fish without an otolith mark.

10.2 Influence of Additional Otolith Samples on Origin

To reduce labor costs, otoliths collected for both the Chinook salmon surplused and spawned were sub sampled prior to submission to the WDFW Otolith Lab for examination. The otoliths collected from fish surplused from the volunteer trap were submitted at a rate of 1:3. The otoliths collected from the spawned fish were submitted at a rate of 2:3. The age composition of fall Chinook salmon surplused from the volunteer trap was largely comprised of age-2 and 3 fish and the fish spawned were primarily age-3 and 4. There were relatively low numbers of otolith samples of age-4 and 5 for fish surplused from the volunteer trap as well as for the age-5 fish spawned. To improve the accuracy of the determination of origin by age for the fish surplused from the volunteer trap as well as for the fish spawned, the remaining otolith samples collected for age-4 and 5 fish were submitted for analysis. A comparison was completed to determine the effect of the additional otoliths on the age composition.

For the fish surplused from the volunteer trap, the addition of age-4 and 5 otolith samples reduced the estimated proportion of PRH origin age-4 fish from 100% to 87%. The estimated proportion of PRH origin age-5 fish did not change (Table 8).

Table 8 Proportion of Priest Rapids Hatchery origin by age of fall Chinook salmon surpluses from the Priest Rapids Hatchery volunteer trap based on otolith marks, broodyear 2012.

	PRH Origin Otoliths				Non PRH Origin Otoliths				Proportion PRH Origin			
Sample	Age-2	Age-3	Age-4	Age-5	Age-2	Age-3	Age-4	Age-5	Age-2	Age-3	Age-4	Age-5
n[1]	242	275	8	1	7	24	0	0	0.972	0.920	1.000	1.000
n+[2]	0	0	37	3	0	0	7	0	N/A	N/A	0.841	1.00
Total	242	275	45	4	7	24	7	0	0.972	0.920	0.865	1.000

[1] includes subsample (1:3) of otoliths taken from broodstock.
[2] Includes remaining otolith samples taken from broodstock to improve the accuracy of the determination of origin by age.
N/A = No additional samples submitted.

For the fish the spawned at PRH, the addition of the age-4 and 5 otolith samples reduced the estimated proportion of PRH origin age-5 fish from roughly 95% to 93%. The estimated proportion of PRH origin age-4 fish did not change (Table 9).

Table 9 Proportion of Priest Rapids Hatchery origin of fall Chinook salmon spawned at Priest Rapids Hatchery based on otolith marks, broodyear 2012.

	PRH Origin Otoliths				Non PRH Origin Otoliths				Proportion PRH Origin			
Sample	Age-2	Age-3	Age-4	Age-5	Age-2	Age-3	Age-4	Age-5	Age-2	Age-3	Age-4	Age-5
n[1]	0	265	253	91	0	12	25	5	0.000	0.957	0.910	0.948
n+[2]	0	0	0	41	0	0	0	5	N/A	N/A	N/A	0.891
Total	0	265	253	132	0	12	25	10	0.000	0.957	0.910	0.930

[1] includes subsample (2:3 rate) of otoliths taken from broodstock.
[2] Includes remaining otolith samples taken from broodstock to improve the accuracy of the determination of origin by age.
N/A = No additional samples submitted.

10.3 Broodstock Age Composition

Natural origin fall Chinook salmon were identified through systematic otolith sampling of the broodstock in 2012. The 2012 return was the first year that age composition for natural origin broodstock could be assessed with otoliths for the majority of the return (ages 2 - 5). Only one age-6 Chinook salmon, recovered from OLAFT, was sampled in the broodstock. Historically, attempts to use coded-wire tag recoveries to identify natural origin fall Chinook salmon in the broodstock proved inadequate. Coded-wire tag recoveries are too few to provide an accurate age composition or length frequency distribution. During the most recent seven years, natural origin fall Chinook salmon in the PRH broodstock have only been detected by coded-wire recoveries during one year, 2007. Sampling data for PRH prior to 2005 is not segregated between those Chinook salmon used for surplused and those fish ponded for broodstock. Additional inquires for data prior to 2006 need to be completed when time allows. The age composition for the entire broodstock (volunteers, OLAFT, and ABC fishery) for natural and hatchery origin spawners was generated after expanding the sample to account for differing sample rates. The historical broodstock age compositions are not directly comparable to 2012 broodstock age composition due to inconsistent methodology for assigning origin.

Hatchery origin age-3 and 4 fall Chinook salmon comprised 76% of the PRH broodstock in 2012. Both the hatchery and natural component of the broodstock consisted primarily of age-3 fish (Table 10). By design, few age-2 hatchery origin males are included in the broodstock. There were 19 natural origin and 27 PRH origin age-2 males recovered at the OLAFT added to the broodstock. There was only one age-6 fish sampled in the broodstock. This fish was a natural origin female and recovered from the OLAFT.

Table 10 Proportion of age class for hatchery and natural origin fall Chinook salmon spawned at Priest Rapids Hatchery, 2007 – 2012.

Brood	Origin	Age Composition					
		n =	Age-2	Age-3	Age-4	Age-5	Age-6
2007	Natural[1]	1	0.000	1.000	0.000	0.000	0.000
	Hatchery[1]	61	0.081	0.274	0.486	0.138	0.020
2008	Natural[1]	0	--	--	--	--	--
	Hatchery[1]	95	0.011	0.848	0.100	0.039	0.002
2009	Natural[1]	0	--	--	--	--	--
	Hatchery[1]	61	0.012	0.086	0.883	0.019	0.000
2010	Natural[1]	0	--	--	--	--	--
	Hatchery	133	0.016	0.755	0.111	0.118	0.000
2011	Natural[1]	0	--	--	--	--	--
	Hatchery[1]	22	0.010	0.229	0.753	0.008	0.000
2012	Natural[2]	379	0.032	0.435	0.400	0.131	0.002
	Hatchery[2]	871	0.006	0.487	0.376	0.130	0.000
Mean	**Natural**	**63**	**0.024**	**0.595**	**0.256**	**0.125**	**0.001**
	Hatchery	**207**	**0.023**	**0.447**	**0.452**	**0.075**	**0.004**

[1] Origin determined from coded-wire tag expansions
[2] Origin determined from coded-wire and otolith samples

A total of 4,408 Chinook salmon from the PRH volunteer trap were spawned. The PRH origin fish were mostly age-3. The natural origin broodstock consisted mostly of age-4 fish (Table 11). There were no age-2 or age-6 fish spawned from the volunteer trap group.

Table 11 Proportion of hatchery and natural origin fall Chinook salmon for each age class of broodstock collected from the PRH volunteer trap. (See file 2012 otolith sampling summary)

Brood	Origin	Age Composition					
		n =	Age-2	Age-3	Age-4	Age-5	Age-6
2012	Natural[1]	39	0.000	0.295	0.585	0.121	0.000
	Hatchery[1]	646	0.000	0.477	0.389	0.134	0.000

[1] Origin determined from “in-sample” otoliths, adipose clips and/or coded-wire tags.

A total of 519 Chinook salmon collected at the OLAFT were spawned to supplement 2012 broodstock. The collection consisted of 56% natural origin fish. The PRH origin and natural origin recovered at the OLAFT and spawned were primarily age-3 (Table 12). There were 19 natural origin and 27 PRH origin age-2 males and one age-6 natural origin female recovered at the OLAFT added to the broodstock.

Table 12 Proportion of hatchery and natural origin fall Chinook salmon for each age class of broodstock collected at the Off Ladder Adult Fish Trap.

Brood	Origin	Age Composition					
		n =	Age-2	Age-3	Age-4	Age-5	Age-6
2012	Natural[1]	281	0.048	0.540	0.257	0.151	0.004
	Hatchery[1]	219	0.106	0.687	0.136	0.071	0.000

[1] Origin determined from "in-sample" otoliths, adipose clips and/or coded-wire tags.
[2] One age-6 female assigned to natural origin based on the absence of marks or tags. The 2006 broodyear was not otolith marked.

A total of 68 fall Chinook salmon collected from the ABC fishery were spawned to supplement the 2012 broodstock. The collection consisted of 91% natural origin fish. Similar to other sources of broodstock, the PRH origin and natural origin recovered and spawned were mostly age-3 (Table 13).

Table 13 Proportion of hatchery and natural origin fall Chinook salmon for each age of broodstock collected from the Angler Broodstock Collection.

Brood	Origin	Age Composition					
		n =	Age-2	Age-3	Age-4	Age-5	Age-6
2012	Natural[1]	59	0.000	0.542	0.339	0.119	0.000
	Hatchery[1]	6	0.000	0.667	0.333	0.000	0.000

[1] Origin determined from "in-sample" otoliths, adipose clips and/or coded-wire tags.

10.4 Length by Age Class of Broodstock

The 2012 broodstock collected at the PRH volunteer trap and the OLAFT were high graded for gender, size, and/or origin. For example, fish that had an adipose clip or coded-wire tag were excluded from OLAFT collections.

Age-2 and 3 males were also generally excluded from the PRH volunteer trap and when broodstock abundance was sufficient, hatchery marked fish were excluded as well. The broodstock collected from the ABC fishery were not intentionally selected for gender, size, or origin.

Hatchery and natural origin 2012 broodstock were similar in size for age-3 and 4 fish. For the age-2 broodstock the hatchery origin fish were larger than the natural origin fish. At age-5, the natural origin was larger than the hatchery origin broodstock (Table 14). Similar to historic observations at PRH and the Hanford Reach, hatchery origin fall Chinook salmon tend to be a little larger at ages-2 and 3 and smaller at ages-4 and 5 than the natural origin fish (Table 15).

Table 14 Mean fork length (cm) at age (total age) of fall Chinook salmon sampled from each source of broodstock spawned at Priest Rapids Hatchery, 2012.

		Fall Chinook Fork Length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
Return Year	Origin	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Volunteer Returns	Natural				12	71	4	25	82	4	5	86	4			
	Hatchery				298	70	4	253	81	5	91	88	7			
OLAFT	Natural	19	43	4	151	67	6	70	83	6	40	91	5	1	91	0
	Hatchery	27	50	5	150	68	5	27	81	4	15	84	4			
ABC Fishery	Natural				32	66	6	20	85	6	7	90	6			
	Hatchery				4	68	6	2	85	0						

It is assumed for this analysis that all fish collected in the Hanford Reach, except for those that were of known hatchery origin (e.g., ad-clipped or CWT), were natural origin. N = sample size and SD = 1 standard deviation.

Table 15 Mean fork length (cm) at age (total age) of hatchery and natural origin fall Chinook salmon collected from volunteer broodstock for the Priest Rapids Hatchery program, N = sample size and SD = 1 standard deviation.

		Fall Chinook Fork Length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
Return year	Origin	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
2007	Natural	0			1	76	0	0			0			0		
	Hatchery	31	55	3	114	70	4	216	83	6	61	91	6	9	94	9
2008	Natural	0			0			0			0			0		
	Hatchery	3	45	3	429	73	4	51	84	5	20	91	4	1	73	0
2009	Natural	0			0			0			0			0		
	Hatchery	5	50	4	42	71	4	428	84	6	9	95	7	0		
2010	Natural	0			0			0			0			0		
	Hatchery	20	51	5	1,044	72	4	164	84	6	173	91	6	0		
2011	Natural	2	43	3	36	67	5	100	82	6	19	89	4	0		
	Hatchery	7	49	6	249	70	4	837	80	5	9	91	7	0		
2012	Natural	0			12	71	4	25	82	4	5	86	4	0		
	Hatchery	0			298	70	4	253	81	5	91	88	7	0		

10.5 Gender Ratios

PRH staff sort and select broodstock from the trap to meet their egg take goals and male-to-female spawner ratio. Additional broodstock was collected from the OLAFT and ABC fishery. Females comprised 63% of the 2012 broodstock collection, resulting in an overall male to female ratio of 0.58:1.00 which slightly higher than the historic mean ratio of 0.55:1.00 (Table 16).

Table 16 Numbers of male and female hatchery fall Chinook salmon broodstock at Priest Rapids Hatchery. Ratios of males to females are also provided.

Return Year	Males (M)	Females (F)	M/F Ratio
2001	1,697	3,289	0.52:1.00
2002	1,936	3,628	0.53:1.00
2003	1,667	3,176	0.52:1.00
2004	1,688	3,099	0.54:1.00
2005	1,962	3,326	0.59:1.00
2006	1,777	3,322	0.53:1.00
2007	850	1,301	0.65:1.00
2008	1,823	3,195	0.57:1.00
2009	1,531	3,000	0.51:1.00
2010	1,809	3,447	0.52:1.00
2011	1,858	3,000	0.62:1.00
2012	1,749	3,225	0.58:1.00
Mean	**1,696**	**3,084**	**0.55:1.00**

Extremely low numbers of coded-wire tagged natural origin fall Chinook salmon are recovered in the broodstock at PRH. Therefore, there is insufficient data to determine historical male-to female-ratios by origin (natural vs. hatchery) using coded-wire tag recoveries.

Unique for return year 2012, the age-2 through 5 PRH origin broodstock were otolith marked which provides data to determine male to female ratios by origin (natural origin vs. PRH origin). For this comparison, we assume that fish not possessing both an otolith mark and an adipose clip are natural origin fish. Prior to combining the samples from the three sources of broodstock, the volunteer broodstock sample was expanded to account for the 2:3 subsample rate for otoliths and a 2:3 subsample for in-sample coded-wire tags. The OLAFT and ABC fishery groups were 100% sampled for otolith and therefore did not need expanding.

In the volunteer broodstock otolith sample, there were three out of 42 non-otolith marked fish that were adipose clipped. Expanded to account for the 2:3 sample rate, there were 20 (0.46%) non otolith marked/adipose clipped fish in the broodstock that should be classified as fish from other hatcheries.

The addition of broodstock from OLAFT and ABC fishery more than doubled the natural origin spawners in the PRH broodstock. It also increased the male to female ratio for natural origin brood stock from 0.70:100 to 1.12:1.00. The addition of the OLAFT and ABC fishery broodstock slightly increased the male to female ratio for PRH origin broodstock (Table 17).

Table 17 Numbers of male and female natural origin and Priest Rapids Hatchery origin fall Chinook salmon spawned at Priest Rapids Hatchery, 2012. (Otolith sample size = 14.63% for PRH volunteer returns in the broodstock and 100% for OLAFT and ABC Fishery)

	Natural Origin Fall Chinook			Hatchery Origin Fall Chinook			
Broodstock Source	Males	Females	M/F	Males	Females	M/F	Total M/F ratio
PRH Volunteer Returns	105	147	0.70:1.00	1,251	2,905[a]	0.42:1.00	0.44:1.00
OLAFT	185	96	1.93:1.00	168	52	3.23:1.00	2.39:1.00
ABC Fishery	36	23	1.57:1.00	4	2	2.00:1.00	1.60:1.00
Total	326	266	1.23:1.00	1,423	2,959	0.48:1.00	0.54:1.00

[a] Included an estimated 20 stray Chinook salmon from other hatcheries.

10.6 Fecundity

The annual average fecundity for PRH was calculated as the proportion of the total number of females spawned to the total egg take. Fecundity for the 2012 broodstock sampled averaged 3,834 eggs per viable female which is less than the historic mean of 4,019 (Table 18). The lower facility fecundity is likely the result of higher than normal proportion of age-3 females spawned in broodyear 2102.

Table 18 Mean fecundity of fall Chinook salmon collected for broodstock at Priest Rapids Hatchery.

Return year	Egg Take	Viable Females	Fecundity/Female
2001	10,750,000	3,161	3,401
2002	12,180,000	3,489	3,491
2003	12,814,000	3,078	4,163
2004	12,753,500	3,019	4,224
2005	14,085,000	3,211	4,386
2006	13,511,200	3,217	4,200
2007[1]	5,067,319	1,249	4,057
2008	12,643,600	3,074	4,113
2009	13,074,798	2,858	4,575
2010	11,903,407	3,304	3,603
2011	12,693,000	3,038	4,178
2012	12,398,389	3,234	3,834
Mean	11,989,518	2,994	4,019

[1] Did not reach egg take goal.

Fecundity samples were taken from individual females at PRH during the 2010, 2011, and 2012 spawn. Lots of 60 egg samples were weighed to estimate fecundity for each female sampled. Fecundity samples were not identified as to the origin of the mothers. The average fecundity by age is given in Table 19. This information is useful for forecasting potential egg takes based on the numbers and age composition of the forecasted return.

Table 19 Fecundity at Age for fall Chinook salmon sampled the Priest Rapids Hatchery.

	Brood Year			
Age at Spawn	**2010**	**2011**	**2012**	**Mean by Age**
Age-3	3,698	3,538	3,638	3,680
Age-4	4,379	4,276	4,034	4,288
Age-5	4,652	4,380	3,600	4,632
Annual Mean	**3,986**	**4,183**	**3,932**	**4,051**
n=	**441**	**242**	**15**	**695**

The origin of fish sampled is not known.

The fecundity data was pooled for broodyears 2010, 2011, and 2012 to provide a regression formula to estimate fecundity based on length (Figure 4). The r^2 value for this regression is low at 0.275 but the regression formula may be useful for coarse predictions of egg production for different size fish.

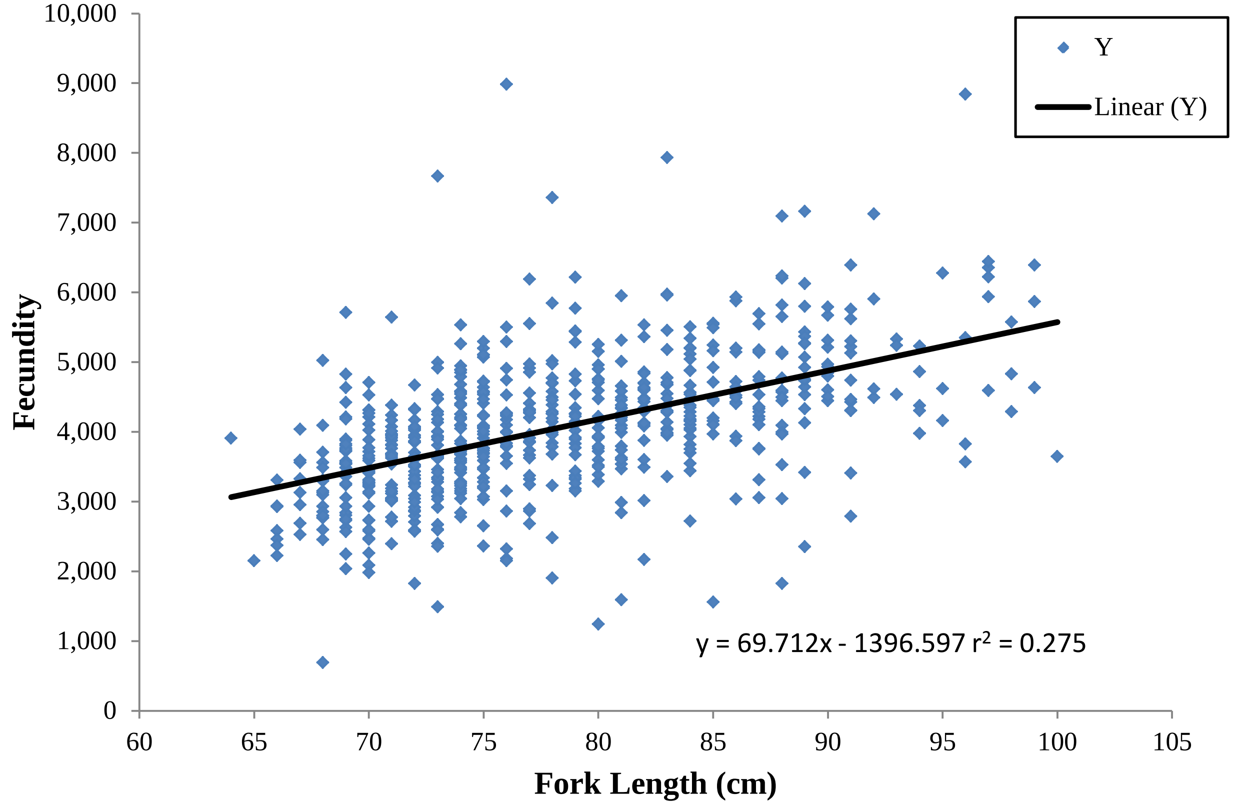

Figure 4 **Regression analysis of fecundity by fork length at Priest Rapids Hatchery, broodyears 2010 through 2012.**

11.0 Hatchery Rearing

11.1 Number of eggs taken

In 2012, 12,398,389 eggs were collected at the PRH facility. The egg take goal at PRH is calculated annually based on current program needs. In 2012 the egg take goal was 11,819,000 eggs. This goal is established to meet the fall Chinook salmon production goals at both PRH and RSH as well as provide eggs for the Salmon in the Classroom Program.

PRH incubates 7.7 million eyed eggs to produce a 6.7 million smolt release at the hatchery. An additional 3.7 million eyed eggs are needed to meet the program goal of eyed egg delivery to Bonneville Hatchery for the Ringold Springs Hatchery fall Chinook salmon production (USACE - John Day mitigation). Egg takes at PRH were sufficient to meet all hatchery production goals from 1984 through 2012, with the exception of 2007 (Table 20).

Table 20 Numbers of eggs taken from fall Chinook salmon broodstock collected at Priest Rapids Hatchery for the Hanford Reach and lower Yakima River programs.

Return Year	Number of Eggs Taken		Return Year	Number of Eggs Taken
1984	10,342,000		1999	16,089,600
1985	10,632,000		2000	15,359,500
1986	22,126,100		2001	10,750,000
1987	24,123,000		2002	12,180,000
1988	16,682,000		2003	12,814,000
1989	13,856,500		2004	12,753,500
1990	9,605,000		2005	14,085,000
1991	6,338,000		2006	13,511,200
1992	11,156,400		2007	5,067,319
1993	14,785,000		2008	12,643,600
1994	16,074,600		2009	13,074,798
1995	17,345,900		2010	11,903,407
1996	14,533,500		2011	12,693,000
1997	17,007,000		2012	12,398,389
1998	13,981,300		**10 year (03-12) Mean**	**12,094,421**

11.2 Number of acclimation days

Rearing of the 2012 brood fall Chinook salmon at PRH was similar to previous years with fish being incubated on well water before being transferred to intermediate vinyl raceways and then transferred to the concrete holding ponds for final acclimation before release into the Columbia River in June 2013. The egg takes from the 2012 brood were distributed into eight batches associated with the dates in which fish were spawned. The number of acclimation days ranged from 90 for the later egg takes to 143 for the earlier egg takes (Table 21).

Table 21 Number of days fall Chinook salmon fry were ponded at Priest Rapids Hatchery prior release.

Broodyear	Batch	Transfer Date	Release Date	Number of Days
2012	1	1/23/2013	6/16/2013	143
2012	2	2/2/2013	6/16/2013	134
2012	3	2/13/2013	6/12/2013	119
2012	4	2/13/2013	6/12/2013	119
2012	5	2/22/2013	6/13/2013	111
2012	6	3/9/2013	6/14/2013	97
2012	7	3/12/2013	6/14/2013	94
2012	8	3/16/2013	6/14/2013	90

11.3 Number released

In 2013, PRH released 6,822,361 subyearling fall Chinook salmon. The PRH release target goal is 6.7 million subyearlings with 1.7 million of these fish accounting for the USACE John Day Mitigation contribution. Fish were released between June 14 and June 16. During the previous ten year, PRH has averaged 6,578,000 smolts at release, with a range of 4,548,306 to 7,056,946 (Table 2).

11.4 Fish Size and Condition at Release

The goal for PRH is to release fall Chinook salmon smolts at 50 fish per pound. In 2013, the smolts were released at an average 47 fish per pound and 95 mm in fork length. The coefficient of variation of the fork length was 7.6. Past smolt releases from PRH have averaged 47 fish per pound (96 mm) with a CV of 7.4 over the most recent 22 years (Table 22).

Table 22 Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of fall Chinook smolts released from Priest Rapids Hatchery during broodyears 1991 – 2010. Size targets are provided in the last row of the table.

Broodyear	Release Year	Fork Length (mm)		Mean Weight		n=
		Mean	CV	Grams (g)	Fish/pound	
1991	1992	93	8.7	8.3	55	1,500
1992	1993	92	8.6	8.3	54	1,500
1993	1994	95	6.9	9.3	49	1,500
1994	1995	96	6.7	9.7	47	1,500
1995	1996	97	6.6	10.0	45	1,500
1996	1997	95	11.0	8.7	52	1,500
1997	1998	103	8.9	10.1	45	1,500
1998	1999	95	6.5	9.6	48	1,500
1999	2000	93	6.6	8.9	51	1,500
2000	2001	97	6.3	10.2	45	1,500
2001	2002	96	6.9	10.1	45	1,500
2002	2003	95	6.9	9.5	48	1,500
2003	2004	96	6.8	9.6	48	1,500
2004	2005	95	5.9	9.4	48	1,500
2005	2006	98	6.3	10.1	45	1,500
2006	2007	98	7.0	9.9	46	1,500
2007	2008	101	8.3	10.2	45	1,200
2008	2009	94	6.7	9.3	49	1,500
2009	2010	94	7.3	9.2	49	1,500
2010	2011	92	9.1	9.7	47	1,500
2011	2012	94	7.1	9.2	49	1,500
2012	2013	95	7.6	9.7	47	1,500
Mean		**96**	**7.4**	**9.5**	**47**	**1,486**
Targets				**9.1**	**50**	**1,500**

11.5 Survival Estimates

The survival rate for unfertilized egg to juvenile release for broodyear 2012 was 96% which is highest recorded since broodyear 2002 and notably higher than the historic mean of 86% (Table 23). Survival has ranged from a low of 74% in 2007 to a high of 96% in 2012. The unfertilized egg to eyed egg stage is the most critical life stage at PRH during incubation/juvenile rearing. The survival rate for broodyear 2012 during this stage was 87%, slightly lower than the historic mean.

Pre-spawn survival of adult Chinook salmon ponded at PRH for broodstock has averaged 89% since broodyear 2002. In 2012, survival of fish ponded for broodstock was only 69%. This was the second lowest survival rate on record. Survival of fish ponded for broodstock in broodyear 2011 was roughly 68% which was the lowest on recorded since broodyear 2002. The cause of the elevated mortality in unknown; however, in-season observations of high fish holding densities in the volunteer trap on clean-out days may suggest that the fish were stressed prior to ponding.

Table 23 Hatchery life-stage survival rates (%) for fall Chinook salmon at Priest Rapids Hatchery, broodyears 1989 – 2012. Survival standards for unfertilized egg to release are provided in the last row of the table. The survival standards are the mean survivals for the most recent 10 year period.

	Ponded to Spawned								
Broodyear	**Female**	**Male**	**Jack**	**Total**	**Unfertilized to Eyed Egg**	**Eyed egg to Ponding**	**Ponding to Release**	**Unfertilized Egg to Release**	**Standard Unfertilized Egg to Release[1]**
2002	0.835	0.829	0.705	0.828	0.880	0.995	0.979	0.858	0.875
2003	0.893	0.817	0.698	0.858	0.882	0.989	0.989	0.868	0.870
2004	0.958	0.915	0.646	0.845	0.881	0.975	0.985	0.846	0.867
2005	0.890	0.890	0.782	0.886	0.914	0.976	0.991	0.884	0.864
2006	0.918	0.924	0.695	0.913	0.897	0.975	0.981	0.859	0.866
2007	0.967	0.748	0.642	0.861	0.858	0.996	0.981	0.737	0.862
2008	0.943	0.896	0.877	0.924	0.902	0.973	0.877	0.877	0.857
2009	0.848	0.901	0.916	0.864	0.912	0.977	0.891	0.891	0.856
2010	0.803	0.831	0.803	0.809	0.913	0.985	0.977	0.841	0.856
2011	0.611	0.847	0.737	0.679	0.903	0.985	0.985	0.875	0.853
2012	0.6433	0.786	0.630	0.688	0.872	0.985	0.979	0.964	0.863
Mean	**0.846**	**0.853**	**0.739**	**0.832**	**0.892**	**0.983**	**0.965**	**0.864**	**N/A**

[1] Standard Unfertilized Egg to Release equals the mean for the previous ten-year's unfertilized egg to release survival rate.

11.6 Juvenile PIT Tag Detections at the Priest Rapids Hatchery Array

Historically, roughly 3,000 subyearlings at PRH were annually PIT tagged to assess timing, migration speed, and juvenile survival from PRH to McNary Dam. The analysis for these measures is reported annually by the Fish Passage Center (Appendix D). Approximately 40,000 additional juveniles were marked for the 2012 release to bolster the data collected for estimation of juvenile abundance at release, adult straying, adult migration timing, conversion rates from Bonneville Dam to McNary Dam to PRH, and smolt to adult survival rates, as well as fallback and re-ascension estimates at McNary, Ice Harbor, and Priest Rapids dams. Prior to the 2012 release, a PIT array consisting of six antennas was installed in the hatchery discharge channel to detected both juvenile out-migrants and adult returns.

The mean detection rate for the seven subyearling tag groups release in 2012 combined is 70% (Table 24). The detection rates by group varied from 50% to 81%. The last two groups released showed the lowest detection rates. The lower detection rate may have resulted from the inundation of the array caused by high river elevations during the release. The total discharge out of Priest Rapids Dam ranged between 238 kcfs and 251 kcfs between June 12 and June 16. The decrease in detection rates coincides with a spike in river flows which were 295 kcfs on June 20.

Table 24 Number of subyearlings PIT tagged, mark and release dates, and the number of unique tags detected at the array in the Priest Rapids discharge channel.

Broodyear	Coordinator ID	Tag File	Tagging Date	Release Date	Number Tagged	Number of Unique Detections	Percent Detected
2012	SMP	SMP12152.PR3	05/31/2012	06/12/2012	996	810	81%
2012	SMP	SMP12151.PR2	05/30/2012	06/16/2012	998	806	81%
2012	SMP	SMP12151.PR1	05/30/2012	06/20/2012	1,000	499	50%
2012	CSM	CSM12114.A03	04/23/2012	06/14/2012	9,948	6,673	67%
2012	CSM	CSM12114.A04	04/23/2012	06/15/2012	9,997	6,962	70%
2012	CSM	CSM12115.A02[a]	04/24/2012	06/16/2012	9,968	8,115	81%
2012	CSM	CSM12114.A01	04/23/2012	06/20/2012	9,937	6,276	63%
				Totals	**42,844**	**30,141**	**70%**

[a] Includes one fish from Tag File CSM12115.BO2

12.0 Adult Fish Pathogen Monitoring

At spawning, adult fall Chinook are sampled for viral pathogens and *Renibacterium salmoninarum* the causative agent for bacterial kidney disease (BKD). The risk of BKD was assayed using the ELISA. Results of adult broodstock BKD monitoring in 2012 indicated that nearly all females had ELISA values less than an optical density of 0.10 (Table 25). Viral inspections included sampling the ovarian fluid and kidney/spleen for pathogens. All results of viral testing in 2012 were negative (Table 25).

Table 25 ELISA test results to determine risk of bacterial kidney disease of adult female fall Chinook salmon broodstock at Priest Rapids Hatchery, broodyears 2008 – 2012.

Year	Stock	Number	%Below-Low	% Low	% Mod	% High
2008	Priest Rapids	60	100.0%	0.0%	0.0%	0.0%
2009	Priest Rapids	60	100.0%	0.0%	0.0%	0.0%
2010	Priest Rapids	60	100.0%	0.0%	0.0%	0.0%
2011	Priest Rapids	135	100.0%	0.0%	0.0%	0.0%
2012	Priest Rapids	60	98.3%	0.0%	1.7%	0.0%

Table 26 Viral inspections of fall Chinook salmon broodstock at Priest Rapids Hatchery.

Year	Date(s)	Stock	Life stage	Ovarian Fluid	Kidney/Spleen	Results
1991	28-Oct, 4, 13-Nov	Priest Rapids	Adult	150	60	Negative
1992	2,9-Nov	Priest Rapids	Adult	150	60	Negative
1993	25-Oct, 1-Nov	Priest Rapids	Adult	150	60	Negative
1994	7-Nov	Priest Rapids	Adult	60	60	Negative
1995	9,13,19,21-Nov	Priest Rapids	Adult	160	160	Negative
1996	17-Nov	Priest Rapids	Adult	60	60	Negative
1997	17-Nov	Priest Rapids	Adult	60	60	Negative
1998	16-Nov	Priest Rapids	Adult	60	60	Negative
1999	8-Nov	Priest Rapids	Adult	60	60	Negative
2000	13-Nov	Priest Rapids	Adult	60	60	Negative
2001	13-Nov	Priest Rapids	Adult	60	60	Negative
2002	13-Nov	Priest Rapids	Adult	60	60	Negative
2003	17-Nov	Priest Rapids	Adult	60	60	Negative
2004	8-Nov	Priest Rapids	Adult	60	60	Negative
2005	14-Nov	Priest Rapids	Adult	60	60	Negative
2006	6-Nov	Priest Rapids	Adult	60	60	Negative
2007	5-Nov	Priest Rapids	Adult	60	60	Negative
2008	3-Nov	Priest Rapids	Adult	60	60	Negative
2009	2-Nov	Priest Rapids	Adult	60	60	Negative
2010	15-Nov	Priest Rapids	Adult	60	60	Negative
2011	7,14, 21-Nov	Priest Rapids	Adult	180	180	Negative
2012	5-Nov	Priest Rapids	Adult	60	60	Negative

13.0 Juvenile Fish Health Inspections

Juvenile fish are visually inspected on a monthly basis following ponding. The 2012 broodyear juveniles were healthy throughout the rearing period (Table 27). Historical inspection results are provided in Appendix E.

Table 27 Juvenile fish health inspections for Priest Rapids Hatchery fall Chinook salmon.

Hatchery	Date	Species/Run	Stock	Broodyear	Condition
Priest Rapids	25-Mar-11	CHF	Priest Rapids	2010	Healthy
Priest Rapids	18-Apr-11	CHF	Priest Rapids	2010	Healthy
Priest Rapids	06-Jun-11	CHF	Priest Rapids	2010	Healthy
Priest Rapids	01-Mar-12	CHF	Priest Rapids	2011	Healthy
Priest Rapids	26-Apr-12	CHF	Priest Rapids	2011	Healthy
Priest Rapids	24-May-12	CHF	Priest Rapids	2011	Healthy
Priest Rapids	11-Feb-13	CHF	Priest Rapids	2012	Healthy
Priest Rapids	3-Mar-13	CHF	Priest Rapids	2012	Healthy
Priest Rapids	29-Apr-13	CHF	Priest Rapids	2012	Healthy
Priest Rapids	28-May-13	CHF	Priest Rapids	2012	Healthy

14.0 Redd Surveys

Redd surveys were performed in the Hanford Reach during 2012 by biologists with Environmental Assessment Services LLC under contract with Mission Support Alliance LLC. WDFW M&E staff did not successfully perform redd counts in the PRH discharge channel as done in previous years.

14.1 Hanford Reach Aerial Redd Counts

Aerial redd counts in the Hanford Reach were performed by Environmental Assessment Services, LLC on October 21 and 30, and November 18, 2012 (Appendix F). Two of the three flights occurred on the weekends when outflows at Priest Rapids Dam were lowered to near 50 kcfs in conjunction with ground-based redd surveys by Grant PUD and the WDFW at the Vernita Bar. Cloud cover and moderate wind resulted in less than optimal viewing conditions during the final flight on November 18. The peak redd count for the Hanford Reach area of the Columbia River in 2012 was 8,368 (Table 28). The peak spawning was estimated to occur near the time of the November 18 survey. The count for 2012 was the eighth highest since the surveys were conducted beginning in 1948 and higher than the ten-year mean (2003 to 2012) of 7,306 redds. Redd counts should be considered an index of the total number of redds in the Hanford Reach. Redds may not be visible during flights due to wind, turbidity, ambient light, and depth.

Table 28 Summary of fall Chinook salmon peak redd counts for the 1948 – 2012 aerial surveys in the Hanford Reach, Columbia River.

Year	Redds	Year	Redds	Year	Redds	Year	Redds
1948	787	1965	1,789	1982	4,988	1999	6,068
1949	313	1966	3,101	1983	5,290	2000	5,507
1950	265	1967	3,267	1984	7,310	2001	6,248
1951	297	1968	3,560	1985	7,645	2002	8,083
1952	528	1969	4,508	1986	8,291	2003	9,465
1953	139	1970	3,813	1987	8,616	2004	8,468
1954	160	1971	3,600	1988	8,475	2005	7,891
1955	60	1972	876	1989	8,834	2006	6,508
1956	75	1973	2,965	1990	6,506	2007	4,018
1957	525	1974	728	1991	4,939	2008	5,618
1958	798	1975	2,683	1992	4,926	2009	4,996
1959	281	1976	1,951	1993	2,863	2010	8,817
1960	258	1977	3,240	1994	5,619	2011	8,915
1961	828	1978	3,028	1995	3,136	2012	8,368
1962	1,051	1979	2,983	1996	7,618	**10-year (2003-12) Mean**	**7,306**
1963	1,254	1980	1,487	1997	7,600		
1964	1,477	1981	4,866	1998	5,368		

14.2 Redd Distribution

The main spawning areas observed during the 2012 counts were located near Vernita Bar and among Islands 4-6 (Table 29 & Figure 5). Historical redd counts by location from 2001 through 2012 are included in Appendix F of this report.

Table 29 Number of fall Chinook salmon redds counted in different reaches on the Hanford Reach area of the Columbia River during the October 2012 through November 2012 aerial redd counts. (Data provided by Mission Support Alliance – Environmental Assessment Services)

General Location	Approximate River (KM)	10/16	10/30	11/18	Peak
Islands 17-21	553	0	0	0	0
Islands 11-16	566	3	147	533	533
Islands 8-10	590	4	353	807	807
Near Island 7	593	12	425	700	700
Island 6 (lower half)	597	14	553	1,375	1,375
Island 4, 5 and upper 6	600	9	947	1,195	1,195
Near Island 3	603	1	225	475	475
Near Island 2	605	6	301	528	528
Near Island 1	607	4	160	340	340
Near Coyote Rapids	617	1	19	29	29
Midway (China Bar)	628	0	25	68	68
Near Vernita Bar	632	28	1,180	2,315	2,315
Near Priest Rapids Dam	638	0	0	3	3
Total		**82**	**4,335**	**8,368**	**8,368**

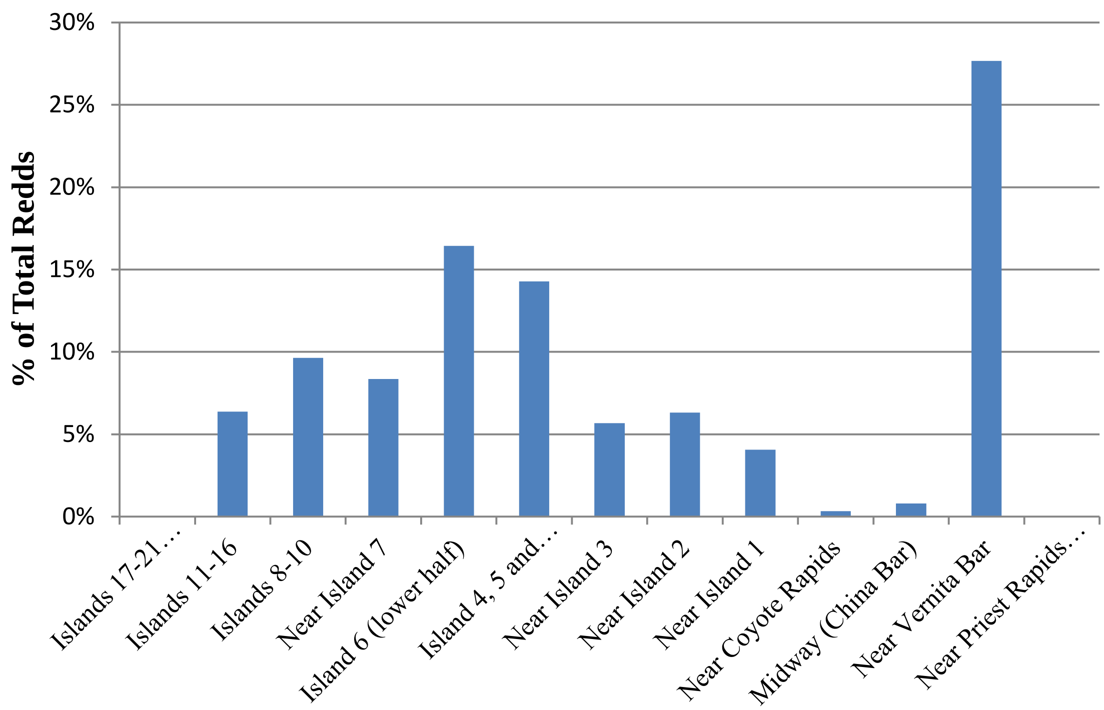

Figure 5 Distribution of fall Chinook salmon redd counts by location for the 2012 aerial surveys in the Hanford Reach, Columbia River. (Data provided by Mission Support Alliance – Environmental Assessment Service)

14.3 Spawn Timing

Based on aerial redd counts and Vernita Bar ground surveys, fall Chinook salmon spawning in the Hanford Reach during 2012 began in mid-October and ended after the third week of November. Flights were not conducted weekly during 2012. The last flight occurred on November 18 which was the last day of the Vernita Bar ground survey. Very minimal active spawning was observed during the Vernita Bar ground survey conducted on November 18. River temperatures in the Columbia River below Priest Rapids Dam, when spawning began, varied from 15°C (October 21) to 11.7°C (November 18).

14.4 Spawning Escapement

The estimated total escapement of fall Chinook salmon to the Hanford Reach for 2012 returns was 57,631 fish; 51,774 adults and 5,857 jacks (Table 28 Summary of fall Chinook salmon peak redd counts for the 1948 – 2012 aerial surveys in the Hanford Reach, Columbia River.). The estimated 2012 adult spawning escapement was lower than that of previous two years and the ten-year mean of 54,173 fish (Table 30 and 31).

Table 30 Calculation of escapement estimates for fall Chinook salmon in the Hanford Reach, 2012.

Count Source	Return Year 2012		
	Adult	Jack	Total
Priest Rapids Adult Passage	54,283	10,389	64,672
Fallback Adj[1]	14,281	2,733	17,014[1]
Ice Harbor Adult Passage	38,546	21,554	60,100
Prosser Adult Passage	3,807	733	4,540
Priest Rapids Hatchery	18,878	9,153	28,031
PRH discharge channel	191	16	207
Wanapum Tribal Fishery	7	1	8
Ringold Springs Hatchery	5,324	2,067	7,391
Yakima River Escapement (Below Prosser)	1,098	211	1,309
Yakima River Sport Harvest	704	294	998
Hanford Sport Harvest	13,141	5,713	18,854
Total	**121,698**	**47,398**	**169,096**
McNary Ladder Counts	173,472	53,255	226,727
Hanford Reach Escapement	**51,774**	**5,857**	**57,631**

[1] The Priest Rapids adult fish counts were reduced by 17,014 Chinook salmon based on the proportion of unique upstream PIT-tag detections of fall Chinook salmon at Priest Rapids Dam which were last observed in the Priest Rapids Hatchery discharge channel. These Chinook salmon were assumed to fallback over the dam and into the Hanford Reach.

The estimated adult Chinook salmon per redd is calculated by dividing the adult escapement to the Hanford Reach by peak number of redds reported in the redd survey. The estimated annual escapements to the Hanford Reach were not adjusted for prespawn mortality. For 2012, the estimated 6.2 per redd fish was slightly below the 10-year average of 6.9 fish per redd. (Table 31). Despite the lower than average escapement estimate for return year 2012, the aerial count of 8,368 redds was greater than the 10-year mean of 7,306 redds.

Table 31 Spawning escapement for fall Chinook salmon in the Hanford Reach for broodyears 1964 – 2012.

Return Year	Fish per Redd #	Redds	Total Spawning Escapement		Return Year	Fish per Redd #	Redds	Total Adult Spawning Escapement
1964	16.3	1,477	24,048		1989	7.5	8,834	65,913
1965	13.6	1,789	24,360		1990	6.2	6,506	40,117
1966	9.1	3,101	28,079		1991	6.5	4,939	31,971
1967	7.1	3,267	23,188		1992	6.0	4,926	29,449
1968	6.8	3,560	24,067		1993	10.7	2,863	30,650
1969	7.8	4,508	34,939		1994	8.7	5,619	48,857
1970	7.0	3,813	26,730		1995	12.2	3,136	38,381
1971	8.7	3,600	31,398		1996	4.9	7,618	37,548
1972	30.5	876	26,749		1997	4.5	7,600	34,007
1973	11.1	2,965	33,044		1998	5.5	5,368	29,410
1974	35.5	728	25,847		1999	4.5	6,068	27,012
1975	8.3	2,683	22,242		2000	6.5	5,507	36,027
1976	10.8	1,951	21,140		2001	7.1	6,248	44,140
1977	9.7	3,240	31,527		2002	8.6	8,083	69,342
1978	6.8	3,028	20,578		2003	9.4	9,465	89,312
1979	7.9	2,983	23,558		2004	9.4	8,468	79,464
1980	14.7	1,487	21,861		2005	8.2	7,891	64,355
1981	3.1	4,866	15,115		2006	7.2	6,508	47,095
1982	4.1	4,988	20,543		2007	2.1	4,018	13,887
1983	6.8	5,290	36,022		2008	4.2	5,618	23,361
1984	5.7	7,310	41,982		2009	5.3	4,996	26,346
1985	8.6	7,645	65,796		2010	9.1	8,817	80,408
1986	8.8	8,291	72,559		2011	7.4	8,915	65,724
1987	10.3	8,616	88,762		2012	6.2	8,368	51,774
1988	8.7	8,475	74,034		**Ten Year (03-12) Mean**	**6.9**	**7,306**	**54,173**

14.5 Hatchery Discharge Channel Redd Counts

The M&E staff attempted to perform weekly redd counts in the PRH discharge channel between November 3 and November 29. These surveys were attempted on November 3, 9, and 16. Staff was unable to identify specific redds due to high levels of superimposition in all areas with suitable spawning substrate. The majority of spawning activity was located in a 150m section of the discharge channel downstream of the volunteer trap.

15.0 Carcass Surveys

Stream (carcass) surveys were performed from November 2 through December 10, 2012. With support of the PRH M&E Program, the number of crews was increased from the typical two boats with a two person crew operating seven days a week to three boats with a three-person crew operating seven days per week. All recovered carcasses were sampled for the presence of a coded-wire tag and at a 1:4 rate for scales (age), otoliths, gender, length, and egg retention. All carcasses recovered were chopped in half after sampling to prevent the chance of double sampling.

Similar to methods for the 2010 and 2011 carcass surveys, the 2012 stream survey crews recorded the sections in which carcasses were recovered in the Hanford Reach and adjacent areas. The Hanford Reach survey is divided into Sections 1 through 5 (Figure 6). The Priest

Rapids Pool is designated as Section 6. The PRH discharge channel and the area of the Columbia River immediately below the discharge channel are designated as Sections 7 and 8, respectively. The fall Chinook salmon carcasses recovered in Section8 are likely wash outs from the hatchery discharge channel.

- Section 1. Priest Rapids Dam to Vernita Bridge (14 km)
- Section 2. Vernita Bridge to Island 2 (19 km)
- Section 3. Island 2 to Power line Towers at Hanford town site (21 km)
- Section 4. Power line Towers to Wooded Island (21 km)
- Section 5. Wooded Island to Interstate 182 Bridge (19 km)
- Section 6. Priest Rapids Pool (34 km)
- Section 7. Priest Rapids Hatchery discharge channel (0.5 km)
- Section 8. Columbia River at the mouth of the Hatchery discharge channel (0.5 km)

Figure 6 **Locations of aerial redd index areas and river survey sections in the Hanford Reach.**

15.1 Hanford Reach Carcass Survey: Section 1 – 5

Crews surveyed the river and shorelines by boat and by foot. The majority of the carcasses were collected in Sections 3 and 4 within and immediately downstream of large spawning areas (Table 26). It's apparent that carcasses from post spawn fall Chinook salmon in the Hanford Reach tend to be displaced downstream from the spawning areas and collect in eddies created by the island complexes within the Hanford Reach. Section 2 is largely comprised of relatively steep symmetrical shorelines with marginal spawning habitat. Historically, few carcasses are observed in Section 2.

15.1.1 Numbers Sampled: Sections 1 – 5

Staff sampled 6,814 Chinook salmon in the Hanford Reach in 2012, 12% of the estimated fall Chinook salmon escapement (Table 32). For the period of 1990 through 2012, river survey crews sampled an average of 6,145 fall Chinook salmon per year (Appendix G).

Table 32 Numbers and Percentages of fall Chinook salmon carcasses sampled within each survey section on the Hanford Reach.

Return Year	# 1	# 2	# 3	# 4	# 5	Total
2010	1,832 (18.7%)	519 (5.3%)	3,129 (32.0%)	3,362 (34.4%)	937 (9.6%)	9,779
2011	1,581 (18.8%)	160 (1.9%)	2,606 (31.1%)	2,622 (31.2%)	1,422 (16.9%)	8,391
2012	1,091 (16.0%)	149 (2.2%)	1,685 (24.7%)	2,213 (32.5%)	1,676 (24.6%)	6,814
Mean	**1,501 (18.0%)**	**276 (3.3%)**	**2,473 (29.7%)**	**2,732 (32.8%)**	**1,345 (16.2%)**	**8,328**

The survey effort was not equal for each section. The lower sections, 3, 4 and 5 were surveyed the most (Table 33). As the season progressed, crews focused their effort in the lower sections which provided higher chances to recover carcasses.

Table 33 Number of carcass surveys conducted by section in the Hanford Reach.

Return Year	# 1	# 2	# 3	# 4	# 5	Total
2010	21	6	26	26	11	90
2011	33	5	38	29	13	118
2012	19	4	26	28	24	101

15.1.2 Proportion of Escapement Sampled: Section 1 – 5

The spawning escapement for sections 1 through 5 was estimated by the proportion of redds counted in aerial surveys to the estimated escapement of natural spawners to the Hanford Reach (see Section 1.14 Redd Surveys).

Overall, 12% of the total spawning escapement of fall Chinook salmon in the Hanford Reach were sampled in 2012 (Table 34). The percentages of the escapement sampled among sections varied from 0% to 60%. The high sample rate in Section 4 is due to a combination of low numbers of redds identified in the section and a high amount carcass drift from redds located upstream.

Table 34 Number of redds and carcasses, total spawning escapement, and proportion of escapement sampled for fall Chinook salmon in Sections 1 through 5 of the Hanford Reach, 2012.

Survey Section	Total Number of Redds	Total Number of Carcasses	Spawning Escapement[1]	Escapement Sampled
HR-1	2,318	1,091	15,964	0.068
HR-2	965	149	6,646	0.022
HR-3	4,552	1,685	31,350	0.054
HR-4	533	2,213	3,671	0.602
HR-5	0	1676	0	0.000
Total	**8,368**	**6,814**	**57,631**	0.118

[1] Calculated based on percent of redds

15.1.3 Carcass Distribution and Origin

Two methods were used to estimate the origin of carcasses recovered in the sections 1 through 5. Historically, the assumption was made that all Chinook salmon unaccounted for from hatchery

Chinook salmon coded-wire tag expansions were assumed to be natural origin fall Chinook salmon. The origins based on this assumption were calculated for the 2012 carcass recoveries. In addition, origins of carcasses were determined by otoliths sub-sampled from the 2012 carcass recoveries.

PRH has annually otolith marked their entire juvenile releases beginning with progeny of broodyear 2007. For the 2012 returns, age-1 through 5 PRH origin fall Chinook salmon recovered during the carcass surveys were otolith marked. The age-6 PRH origin fall Chinook salmon were not otolith marked. However, since there were no age-6 fish recovered in the carcass surveys nor did any age-6 fish return to the PRH, it is assumed that few, if any, PRH origin age-6 fish spawned in the Hanford Reach.

Based on expansions of coded-wire tag recoveries, hatchery origin fish comprised 7% of the naturally spawning fall Chinook salmon in the Hanford Reach during return year 2012, similar to the historic mean (Table 35). Over the past 15 years (return years 1997-2011), hatchery origin Chinook salmon comprised 10% of the fall Chinook salmon spawning naturally in the Hanford Reach (Appendix H). During return year 2012, the percentage of hatchery origin fish estimated from expanded coded-wire tag recoveries consists of roughly 5% from PRH, 2% from RSH and <1% for other hatcheries.

Table 35 Numbers of natural and hatchery origin fall Chinook salmon carcasses sampled within Sections 1 through 5 of Hanford Reach based on expansions of coded-wire tag recoveries.

Return Year	Hanford Reach Sections							Proportion Hatchery Origin
	Origin	# 1	# 2	# 3	# 4	# 5	Total	
2002	Natural						7,704	
	Hatchery						698	0.083
2003	Natural						12,278	
	Hatchery						1,246	0.092
2004	Natural						9,935	
	Hatchery						907	0.084
2005	Natural						7,606	
	Hatchery						885	0.104
2006	Natural						5,627	
	Hatchery						345	0.058
2007	Natural						3,186	
	Hatchery						129	0.039
2008	Natural						5,202	
	Hatchery						253	0.046
2009	Natural						4,907	
	Hatchery						411	0.077
2010	Natural	1,751	473	3,020	3,242	909	9,395	
	Hatchery	81	46	116	125	28	396	0.040
2011	Natural	1,350	155	2,520	2,475	1,347	7,847	
	Hatchery	231	5	86	147	75	544	0.065
2012	Natural	1,142	149	1,526	2,081	1,510	6,308	
	Hatchery	49	0	159	132	166	506	0.074
Mean	**Natural**	**1,414**	**259**	**2,355**	**2,599**	**1,255**	**7,272**	
	Hatchery	**120**	**17**	**120**	**135**	**90**	**575**	**0.073**

The second estimate of origin of carcass recoveries is based on a combination of otolith recoveries in the carcass survey, in-sample coded-wire tag recoveries, and recovery of in-sample adipose clipped fish without a coded-wire tag or otolith mark. PRH origin fall Chinook salmon were identified by either the presence of an otolith specific to PRH or by the presence of a PRH origin coded-wire tag. Non adipose Chinook salmon without a coded-wire tag and without a thermal otolith mark were classified as strays from other hatcheries. The natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark.

It is estimated that overall 13.1% of fall Chinook salmon spawning in the Hanford Reach were hatchery origin (Table 36). The recovery of PRH origin spawners is estimated at roughly 7%. The recovery of strays from other hatcheries is estimated at roughly 6%. The majority of carcasses for both hatchery and natural origin were recovered in the lower three sections of the survey.

Table 36 Origin of Chinook salmon spawning in the Hanford Reach by section based on in-sample carcass recoveries, sample rate 1:4. n= 6,814.

Year	Origin	# 1	# 2	# 3	# 4	# 5	Total	Proportion of Sample
2012	PRH[1]	23	2	26	18	38	107	0.067
	Other Hatchery[2]	10	2	25	45	22	104	0.065
	Total Hatchery	**33**	**4**	**51**	**63**	**60**	**211**	**0.131**
	Natural[3]	228	30	347	460	333	1,398	0.869

[1] Priest Rapids Hatchery fish were identified by either the presence of thermal otolith mark or by the presence of a PRH origin coded-wire tag
[2] Other hatchery strays were identified as adipose clipped Chinook salmon without a coded-wire tag and without a thermal otolith mark.
[3] Natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark.

15.2 Priest Rapids Dam Pool Carcass Survey: Section 6

Carcass surveys in Section 6 during return year 2012 occurred on November 5, 13, and 25 and December 6. The number of surveys is half as many as was performed in the previous two years.

15.2.1 Number sampled: Section 6

Survey crews sampled 72 Chinook salmon in Section 6 during return year 2012 (Table 37).

Table 37 Number of fall Chinook salmon carcasses sampled within Section 6 (Priest Rapids Dam Pool).

Year	Section 6	
	# of Carcasses	# of Surveys
2010	123	8
2011	69	7
2012	72	4
Mean	**88**	**6**

15.2.2 Proportion of Escapement Sampled: Section 6

The spawning escapement for Section 6 was calculated by subtracting from the Priest Rapids Dam fall Chinook salmon passage count, the fall Chinook salmon passage at Wanapum Dam, tribal harvest of fall Chinook salmon in the Priest Rapids Dam pool and the estimated fallback of fall Chinook salmon at Priest Rapids Dam (Appendix I).

The 2012 fall Chinook salmon spawning escapement estimate for Section 6 is 20,755 fish. Overall, less than 1% of the total estimated spawning escapement in Section 6 was sampled in 2012 (Table 38). The spawning escapement estimate may be too high based on the low numbers of carcasses recovered in the four surveys. The fallback rate for fall Chinook salmon at Priest Rapids Dam may be much higher than the estimated 26%. The 2012 Chinook salmon adult passage over Priest Rapids Dam is roughly 68% greater than the 10-year average. The fall Chinook salmon adult passage over Wanapum Dam for return year 2012 is nearly identical to the 10-year average. The large increase in the spawning escapement should have dramatically increased the number of carcasses recovered.

Table 38 Carcasses sampled, total spawning escapement and proportion of escapement sampled for fall Chinook salmon in Section 6 (Priest Rapids Dam pool).

Survey Year	# of Surveys	# of Carcasses	Spawning Escapement	Escapement Sampled
2010	8	123	11,121	0.011
2011	7	69	11,362	0.006
2012	4	72	21,919	0.003
Mean	**6**	**88**	**14,801**	**0.006**

15.2.3 Carcass Distribution and Origin: Section 6

The origin of carcass recoveries is based on a combination of otolith recoveries in the carcass survey, in-sample coded-wire tag recoveries, and recovery of in-sample adipose clipped fish without a coded-wire tag or otolith mark. PRH origin fall Chinook salmon were identified by either the presence of an otolith mark specific to PRH or by the presence of a PRH origin coded-wire tag. Adipose clipped Chinook salmon without a coded-wire tag and without a thermal otolith mark were classified as strays from other hatcheries. The natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark.

It's estimated that roughly 29% of fall Chinook salmon spawning in the section-6 were hatchery origin (Table 39). Of the hatchery stray carcasses recovered, 26% were PRH origin and 3% were strays from other hatcheries. Natural origin fish composed 71% of the total carcass recovered.

Table 39 Origin of fall Chinook salmon spawning in Section 6 (Priest Rapids Dam Pool).

Year	Origin	Total	Proportion
2012	PRH[1]	18	0.257
	Other Hatchery[2]	2	0.029
	Total Hatchery	**20**	**0.286**
	Natural[3]	50	0.714

[1] Priest Rapids Hatchery fish were identified by either the presence of thermal otolith mark or by the presence of a PRH origin coded-wire tag

[2] Other hatchery strays were identified as adipose clipped Chinook salmon without a coded-wire tag and without a thermal otolith mark.

[3] Natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark.

15.3 Hatchery Discharge Channel: Sections 7 and 8 Carcass Survey

During return year 2012, crews performed eight carcass surveys in Section 7, the confluence of the discharge channel and river. Only two carcass surveys occurred in Section 8. It is assumed that most carcasses drift out of the discharge channel under full flow conditions. Attempts to survey those carcasses result in numerous surveys in Section 7. Performing carcass surveys in the discharge channel when it is at full flow is very difficult and dangerous. One survey was performed during full flow conditions. The last survey in Section 8 occurred after the PRH discharge was shut off and the channel reduced to very low levels of ground water flow.

15.3.1 Number sampled: Sections 7 and 8

Survey crews recovered and sampled 99 carcasses in the discharge channel (Table 40). An additional 108 carcasses were recovered and sampled in the Columbia River immediately downstream of the discharge channel. Crews conducted three surveys in Section 7 and ten surveys in Section 8.

Table 40 The number of fall Chinook salmon carcass surveys within Section 7 (Priest Rapids Hatchery Discharge Channel) and Section 8 (Columbia River at the confluence of the hatchery discharge channel).

	Section 7		Section 8		Total	
Year	# of Carcasses	# of Surveys	# of Carcasses	# of Surveys	# of Carcasses	# of Surveys
2010	87	1	123	9	210	10
2011	123	2	80	8	203	10
2012	99	3	108	10	207	13
2 Yr (2010 – 2011) Mean	**105**	**2**	**102**	**9**	**207**	**10**

15.3.2 Proportion of Escapement Sampled: Sections 7 and 8

The 2012 fall Chinook salmon spawning escapement estimate for Sections 7 and 8 is 207 fish (Table 41). The spawning escapement for these Sections was estimated based on the total number of carcasses recovered in the surveys. Crews were unable to successfully perform redd counts in the PRH discharge channel due to very high level of redd superimposition.

Table 41 Number of carcasses sampled, total spawning escapement and proportion of escapement sampled for fall Chinook salmon within Section 7 (Priest Rapids Hatchery Discharge Channel) and Section 8 (Columbia River at the confluence of the hatchery discharge channel).

Section	Total Number of Carcasses	Spawning Escapement	Escapement Sampled
# 7	99	207	0.478
# 8	108	0	0.000
Total	**207**	**207**	**1.000**

15.3.3 Carcass Distribution and Origin: Sections 7 and 8

Origin of carcass recoveries is based on a combination of otolith recoveries in the carcass survey, in-sample coded-wire tag recoveries, and recovery of in-sample adipose clipped fish without a coded-wire tag or otolith mark. PRH origin fall Chinook salmon were identified by either the presence of an otolith mark specific to PRH or by the presence of a PRH origin coded-wire tag. Adipose clipped Chinook salmon without a coded-wire tag and without a thermal otolith mark were classified as strays from other hatcheries. Natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark. It is estimated that 58% of fall Chinook salmon recovered in the Sections 7 and 8 were hatchery origin (Table 42). Of the hatchery stray carcasses recovered 47% were PRH origin and 11% were strays from other hatcheries. Natural origin fish comprised 42% of the total carcasses recovered.

Table 42 The origin of Chinook salmon carcasses recovered within Section 7 (Priest Rapids Hatchery Discharge Channel) and Section 8 (Columbia River at the confluence of the hatchery discharge channel).

Return Year	Origin	Total	Proportion
2012	PRH[1]	21	0.467
	Other Hatchery[2]	5	0.111
	Total Hatchery	**26**	**0.578**
	Natural[3]	19	0.422

[1] Priest Rapids Hatchery fish were identified by either the presence of thermal otolith mark or by the presence of a PRH origin coded-wire tag

[2] Other hatchery strays were identified as Non adipose Chinook salmon without a coded-wire tag and without a thermal otolith mark were.

[3] Natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark.

15.4 Carcass Bias Assessment

In 2012, crews tagged and released 989 of the carcasses collected during the river surveys to evaluate potential age (size) and gender bias that might be associated with the collection of post-spawn fall Chinook carcasses in the Hanford Reach. Carcasses collected and used for age composition were tagged with a 3” x 2 ½” numbered cow ear tag and released either near shore or mid river (Figure 7).

Figure 7 Tagged fall Chinook salmon, carcass bias assessment.

Those carcasses released near shore had the highest proportion of recaptures at 21% whereas only roughly 7% of those fish marked and released mid channel were recaptured (Table 43). Overall, roughly 14% of the marked fish were recaptured. Age and gender composition of the carcasses recaptured differed slightly from the composition at release for the age-2 and 3 males and age-5 females. The recovery rate is higher for larger fish. This was the second year that a carcass bias study was performed in conjunction with the Hanford Reach stream survey. Results provided in Table 44 for the 2011 carcass bias study show less recovery bias for small fish than that of the 2012 study; however, the percentage of age-2 and 3 fish marked during 2011 was lower than during 2012. Perhaps the higher percentage of larger fish marked in 2011 compared to 2012 contributed to the higher total carcass recovery rate (17%) in 2011.

Table 43 Summary of mark recapture of post-spawn fall Chinook salmon in the Hanford Reach, 2012.

	Release Location		Total
	Bank	Mid-Channel	Released
Released	491	498	989
Recaptured	103	34	137
Recapture (%)	**21.0**	**6.8**	**13.9**

Mark Release Fall Chinook Salmon

Gender	Age 2		Age 3		Age 4		Age 5		Age 6		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Male	43	4.3	225	22.8	155	15.7	99	10.0	0	0.0	522	52.8
Female	0	0.0	45	4.6	237	24.0	185	18.7	0	0.0	467	47.9
Total	**43**	**4.3**	**270**	**27.3**	**392**	**49.6**	**284**	**28.7**	**0**	**0.0**	**989**	**100.0**

Recaptures

Gender	Age 2		Age 3		Age 4		Age 5		Age 6		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Male	0	0.0	22	31.4	11	15.7	7	10.0	0	0.0	40	57.1
Female	0	0.0	2	2.9	17	24.3	11	15.7	0	0.0	30	42.9
Total	**0**	**0.0**	**24**	**34.3**	**28**	**40.0**	**18**	**25.7**	**0**	**0.0**	**70**	**100.0**

Bias (%)

Gender	Age 2	Age 3	Age 4	Age 5	Age 6	Total
Male	4.3	-8.7	0.0	0.0	0.0	-4.4
Female	0.0	1.7	0.0	3.0	0.0	4.4
Total	**4.3**	**-7.0**	**0.0**	**3.0**	**0.0**	**0.0**

Table 44 Summary of mark recapture of post-spawn fall Chinook salmon in the Hanford Reach, 2011.

	Release Location			Total
	Bank	Mid-River	Unknown	Released
Released	495	487	11	993
Recaptured	108	59	4	167
Recapture (%)	**21.8**	**12.1**	**36.4**	**16.8**

Mark Release Fall Chinook Salmon												
Gender	Age 2		Age 3		Age 4		Age 5		Age 6		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Male	26	2.6	82	8.3	230	23.2	63	6.3		0.0	401	40.4
Female		0.0	24	2.4	469	47.2	97	9.8	2	0.0	592	59.6
Total	**26**	**2.6**	**106**	**10.7**	**699**	**70.4**	**160**	**16.1**	**2**	**0.0**	**993**	

Recaptures												
Gender	Age 2		Age 3		Age 4		Age 5		Age 6		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Male	3	1.8	15	8.8	45	26.3	10	5.8		0.0	73	42.7
Female		0.0	3	1.8	74	43.3	21	12.3		0.0	98	57.3
Total	**3**	**1.8**	**18**	**10.5**	**119**	**69.6**	**31**	**18.1**	**0**	**0.0**	**171**	

Bias (%)						
Gender	Age 2	Age 3	Age 4	Age 5	Age 6	Total
Male	0.9	-0.5	-3.2	0.5	0.0	-2.3
Female	0.0	0.7	4.0	-2.5	0.0	2.3
Total	**0.9**	**0.1**	**0.8**	**-2.0**	**0.0**	**0.0**

16.0 Life History Monitoring

Life history characteristics of Hanford Reach fall Chinook salmon were assessed by examining carcasses on spawning grounds, fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

For the 2012 returns, the origin of fall Chinook salmon for the comparison of age and length at maturity is based on a combination of otolith recoveries, in-sample coded-wire tag recoveries, and recovery of in-sample adipose clipped fish without a coded-wire tag or otolith mark. PRH origin fall Chinook salmon were identified by either the presence of an otolith mark specific to PRH or by the presence of a PRH origin coded-wire tag. Non adipose Chinook salmon without a coded-wire tag and without an otolith mark were classified as strays from other hatcheries. The natural origin fish were identified by either a Hanford Reach origin coded-wire tag or by the presence of an adipose fin and the absence of an otolith mark and hatchery CWT.

The age composition for the natural origin fall Chinook salmon is assembled from the carcass recoveries in sections 1-5 of the Hanford Reach. The age composition for the PRH origin fall Chinook salmon is assembled from the volunteer returns to PRH. Prior to return year 2012, the determination of origin employed the assumption that all fish collected in the Hanford Reach, except for those that were of known hatchery origin (e.g., ad-clipped or coded-wire tagged), were natural origin.

The samples collected at PRH and in the Hanford Reach carcass surveys is expanded to account for different sample rates and then pooled by origin to provide larger sample sizes for both length and age by origin analysis. Despite pooling the samples, the sample size for natural origin age-2 Chinook salmon is small in comparison to the other age classes sampled.

Migration timing of hatchery and natural origin Hanford Reach fall Chinook salmon is determined from data collected at the Off Ladder Adult Fish Trap at Priest Rapids Dam. Fall Chinook salmon were sampled at the OLAFT from September 5 through November 14 in return year 2012. In addition, arrival timing to McNary Dam based on PIT tag observations at the adult fish ladder for both PRH and Hanford Reach origin fall Chinook salmon is provided; however, the PIT tag groups were relatively small (<100 fish).

16.1 Migration Timing

Adipose clipped and non-adipose clipped fall Chinook salmon sampled at the OLAFT were used as imperfect surrogates for hatchery and natural origin fall Chinook salmon. There is no hatchery production of fall Chinook salmon above Priest Rapids Dam and no marking programs for natural origin fall Chinook salmon above the dam. The estimated numbers for hatchery fish are likely to be accurate, but the estimated numbers of natural origin fish are likely to be muddled by a large number of unclipped PRH fish. For purposes of this analysis it is assumed that fall Chinook salmon migrating into the Hanford Reach have similar timing as those migrating above Priest Rapids Dam. There does appear to be sufficient numbers of adipose clipped Chinook salmon, presumably PRH origin, to estimate migration timing. Fall Chinook salmon are considered to begin passing Priest Rapids Dam on August 14. These estimates may be biased by late migrating summer Chinook that have a large component of adipose clipped hatchery production. The OLAFT studies (Tonseth et al. in preparation) and the return of adults from 40,000 PIT tagged juveniles will provide better estimates of migration timing in the future.

Based on sampling at the OLAFT during return year 2012, the arrival timing to Priest Rapids Dam for both hatchery and natural fall Chinook salmon was similar (Table 45).

Table 45 The week that 10%, 50% (median), and 90% of the natural (unclipped) and hatchery (clipped) origin fall Chinook salmon passed Priest Rapids Dam, 2009 – 2012. The average week is also provided. Migration timing is based on collection of run of the river Chinook salmon collected and sampled in the Off Ladder Adult Fish Trap at Priest Rapids Dam.

Survey year	Origin	Hanford Reach Fall Chinook Migration Time (week)			
		10 Percentile	50 Percentile	90 Percentile	Sample size
2009	Natural	34	37	41	1,269
	Hatchery	33	35	38	418
2010	Natural	37	39	41	1,988
	Hatchery	34	36	41	387
2011	Natural	34	38	42	2,732
	Hatchery	33	34	39	668
2012	Natural	36	39	43	844
	Hatchery	37	39	43	476
Mean	**Natural**	**35**	**38**	**42**	**1,708**
	Hatchery	**34**	**36**	**40**	**487**

We reviewed the PIT tag observations for both PRH and Hanford Reach natural origin fall Chinook salmon at the PIT tag arrays in the McNary Dam adult fish ladders to assess arrival timing. The sample size is relatively small due to the low numbers of both hatchery and natural origin fall Chinook salmon PIT tagged in the Hanford Reach. The adult PIT tag detections at McNary Dam are useful to compare migration timing then PIT tag detections at Priest Rapids Dam because very few Hanford Reach natural origin PIT tagged fall Chinook salmon pass upstream of Priest Rapids Dam; Hence, are not represented in the Priest Rapids Dam PIT tag observations. Similar to observations at the OLAFT, the PIT tag observations at McNary showed that arrival timing is similar between hatchery and natural origin fish (Table 46).

Table 46 The week that 10%, 50% (median), and 90% of the natural and hatchery origin fall Chinook salmon passed McNary Dam, 2010 – 2012. Migration timing is based on PIT tag passage of Hanford wild and Priest Rapids Hatchery in the adult fish ladder at McNary Dam.

Return Year	Origin	Hanford Reach Fall Chinook Migration Time (week)			
		10 Percentile	50 Percentile	90 Percentile	Sample size
2010	Natural	38	39	41	43
	Hatchery	36	39	40	24
2011	Natural	36	37	41	45
	Hatchery	36	38	39	17
2012	Natural	35	38	40	40
	Hatchery	36	37	39	23
Mean	**Natural**	**36**	**38**	**41**	**43**
	Hatchery	**36**	**38**	**39**	**21**

16.2 Age at Maturity

Historically, the age composition for hatchery origin returns to PRH was generated by pooling all of the sub samples for the volunteer trap and ponded fish after expanding for differing sample rates. The origin was assigned by location of survey due to the lack of identifiable hatchery marks and low coded-wire tag recoveries that were not representative for natural origin fish recovered at PRH. The age composition for natural origin returns was generated from all the samples collected within the carcass survey. Similar to the assignment origin for the hatchery survey, the origin was assigned by location of survey due to the lack of identifiable hatchery marks and low coded-wire tag recoveries that were non representative for natural origin fish recovered in the carcass survey. For the 2012 returns, the origin of fish for the age at maturity is based on otolith sampling.

The age composition of return year 2012 natural origin fall Chinook salmon spawning escapement in the Hanford Reach consists of primarily age-4 and 5 (Table 47). The smaller age-2 and 3 Chinook salmon may be under represented due to a size bias in the carcass survey. There was no age-6 Chinook salmon recovered during the Hanford Reach carcass survey.

The age composition of PRH origin volunteer fall Chinook salmon returning to the hatchery in return year 2012 is comprised of mainly of age-3 and 4 fish. There was no age-6 Chinook salmon sampled among the hatchery volunteer returns.

Table 47 Age compositions of natural origin and Priest Rapids Hatchery adult fall Chinook salmon sampled on spawning grounds in the Hanford Reach and at the Hatchery.

Survey Year	Origin	Age Composition (%)				
		2	3	4	5	6
1998	Natural	0.169	0.157	0.111	0.554	0.009
	Hatchery	0.104	0.647	0.114	0.135	0.001
1999	Natural	0.094	0.115	0.615	0.164	0.012
	Hatchery	0.003	0.261	0.717	0.018	0.001
2000	Natural	0.250	0.058	0.279	0.413	0.000
	Hatchery	0.082	0.085	0.429	0.404	0.000
2001	Natural	0.262	0.164	0.398	0.164	0.010
	Hatchery	0.060	0.685	0.195	0.057	0.004
2002	Natural	0.179	0.135	0.502	0.183	0.001
	Hatchery	0.023	0.434	0.512	0.031	0.000
2003	Natural	0.111	0.047	0.494	0.348	0.001
	Hatchery	0.138	0.128	0.663	0.071	0.000
2004	Natural	0.094	0.125	0.191	0.570	0.021
	Hatchery	0.051	0.697	0.120	0.131	0.000
2005	Natural	0.106	0.099	0.498	0.288	0.009
	Hatchery	0.013	0.287	0.639	0.059	0.002
2006	Natural	0.089	0.100	0.507	0.293	0.010
	Hatchery	0.039	0.184	0.447	0.326	0.004
2007	Natural	0.376	0.061	0.341	0.206	0.016
	Hatchery	0.573	0.161	0.202	0.057	0.008
2008	Natural	0.196	0.156	0.298	0.348	0.002
	Hatchery	0.058	0.864	0.050	0.028	0.001
2009	Natural	0.283	0.074	0.463	0.181	0.000
	Hatchery	0.244	0.087	0.657	0.012	0.000
2010	Natural	0.076	0.252	0.378	0.292	0.001
	Hatchery	0.139	0.762	0.056	0.043	0.000
2011	Natural	0.127	0.107	0.622	0.143	0.002
	Hatchery	0.155	0.288	0.552	0.005	0.000
2012	Natural	0.022	0.240	0.403	0.334	0.000
	Hatchery	0.335	0.515	0.114	0.036	0.000
Mean	**Natural**	**0.162**	**0.126**	**0.407**	**0.299**	**0.006**
	Hatchery	**0.134**	**0.406**	**0.364**	**0.094**	**0.001**

For 1998 – 1999, hatchery origin fish include all fish sampled at the hatchery regardless of true origin. Similarly, natural origin fish for the same years include all fish sampled in the stream surveys regardless of true origin. The hatchery origin fish reported for 2012 include only fish possessing hatchery marks or tags sampled at Priest Rapids Hatchery. Similarly, the natural origin fish reported for 2012 include only fish sampled in the stream surveys that did not possess any hatchery markings or tags.

For the 2012 adult returns, natural origin fall Chinook salmon from the Hanford Reach typically return at older ages than PRH origin fish (Figure 8). Age-4 and 5 fall Chinook salmon comprise the majority of natural origin returns to the Hanford Reach for return year 2012 and is similar to the age composition for the ten-year mean. Historically, PRH returns have been largely age-3 and 4 fish. The high number of hatchery origin age-2 returns in 2012 altered the age composition such that age-3 and 2 fish made up the majority of the PRH returns. There are very few recoveries of either natural or hatchery origin age-6 fall Chinook salmon in the stream and hatchery surveys.

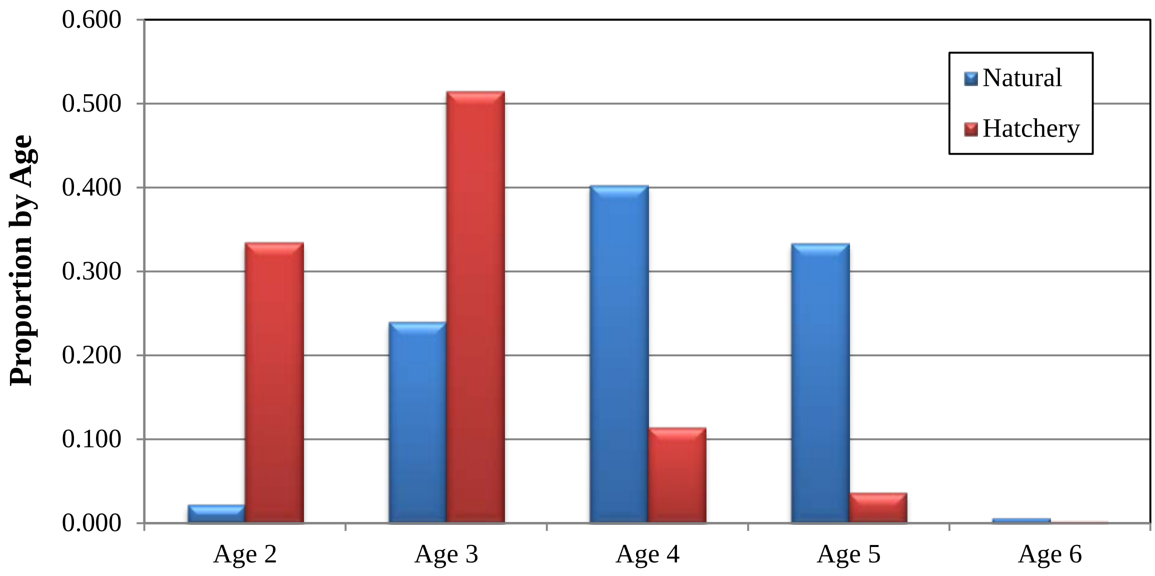

Figure 8 Age proportions of adult returns of natural and Priest Rapids Hatchery origin fall Chinook sampled at PRH and on spawning grounds in the Hanford Reach, Return Year 2012.

16.3 Size at Maturity

Historically, the length by age comparisons for hatchery origin returns to PRH were generated by combining all of the samples collected from the volunteer trap and ponded fish without previously expanding each sample group to account for differing sampling rates. The origin was assigned by location of survey due to the lack of identifiable hatchery marks and low coded-wire tag recoveries that were not representative for natural origin fish recovered at PRH. The age composition for natural origin returns was generated from the samples collected from the carcass survey. Similar to the assignment origin for the hatchery survey, the origin was assigned by location of survey due to the lack of identifiable hatchery marks and low coded-wire tag recoveries that were non representative for natural origin fish recovered in the carcass survey.

For the 2012 returns, the origin for the size at maturity comparison was determined by otolith marks. Natural origin fish sampled at PRH are not included this data nor are hatchery origin fish sampled in the stream surveys due to differing sampling methods. The length by age class for PRH origin fall Chinook salmon returning to PRH in 2012 was generated by combining non-expanded samples at PRH for volunteer trap (rate 1:10) and broodstock (rate 1:4). Otolith specimens for the mortalities and surplus of ponded fish (N=2,680) were not submitted for examination of origin. Hence, the data from this group is not included in the length by age comparison.

For the 2012 returns, there are some differences in length-at-age between natural and hatchery origin fall Chinook salmon (Table 48 and 49). Mean fork length of age-2 hatchery origin fall Chinook salmon is slightly larger than age-2 natural origin fall Chinook salmon. Mean lengths for age-3 fish of both groups are similar.

Mean length for natural origin age-4 and 5 fish are slightly larger than the hatchery origin fish. This trend is mirrored in the ten-year means for lengths by age.

Table 48 **Mean fork length (cm) at age (total age) of Priest Rapids Hatchery origin fall Chinook salmon sampled at Priest Rapids Hatchery and natural origin fall Chinook salmon sampled in the Hanford Reach that spawned naturally. The mean is based on a ten-year period (2002 – 2011); n = sample size and SD = 1 standard deviation.**

Return Year	Origin	Fall Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	n	SD	Mean	n	SD	Mean	n	SD	Mean	n	SD	Mean	n	SD
2001	Natural	44	83	4	70	293	6	86	748	6	96	320	8	99	17	10
	Hatchery	46	85	5	71	973	5	85	272	7	94	81	7	99	5	6
2002	Wild	44	17	4	70	227	6	86	860	7	98	309	8	97	1	0
	Hatchery	44	25	5	70	488	5	85	547	6	99	33	8		0	
2003	Wild	44	32	5	65	118	7	86	1,423	7	95	819	8	111	2	21
	Hatchery		0			0			0			0		0		
2004	Wild	46	31	4	69	251	6	82	428	6	93	1,085	7	96	12	9
	Hatchery	52	80	4	69	1,040	5	82	196	6	92	170	6		0	
2005	Wild	48	19	5	70	229	6	84	1,157	6	94	669	8	103	22	10
	Hatchery	49	12	6	70	281	5	81	628	6	93	58	7	94	2	11
2006	Wild	47	34	4	69	42	7	86	194	8	93	288	7	96	6	9
	Hatchery	55	19	4	70	93	6	84	246	6	91	183	6	103	2	10
2007	Wild	50	25	5	68	71	6	85	395	6	95	239	8	97	18	5
	Hatchery	49	31	4	69	115	5	83	215	6	91	61	6	94	9	9
2008	Wild	48	20	4	70	202	6	84	386	6	96	450	8	99	2	6
	Hatchery	45	3	3	73	429	4	84	51	5	91	20	4	73	1	0
2009	Wild	46	24	5	69	85	6	84	532	7	94	208	8		0	
	Hatchery	50	5	4	71	42	4	84	428	6	95	9	7		0	
2010	Wild	50	34	4	72	642	6	86	962	6	96	744	8	91	2	1
	Hatchery	52	22	5	71	1,149	4	84	170	6	91	180	6		0	
2011	Wild	48	50	4	70	243	5	84	1,468	7	92	340	7	96	5	6
	Hatchery	48	308	4	69	652	4	80	1,419	5	92	13	7		0	
2012	Wild	45	33	4	68	372	6	84	604	7	92	481	7		0	
	Hatchery	48	281	3	68	636	5	81	268	9	87	93	7		0	
Mean	**Wild**	**47**		**4**	**70**		**6**	**85**		**7**	**95**		**8**	**98**		**8**
	Hatchery	**49**		**4**	**70**		**5**	**83**		**6**	**93**		**6**	**91**		**10**

Table 49 Mean fork length (cm) at age (total age) of Priest Rapids Hatchery origin fall Chinook salmon sampled at Priest Rapids Hatchery and natural origin fall Chinook salmon sampled in the Hanford Reach that spawned naturally. n = sample size and SD = standard deviation.

Return Year	Origin	Male fall Chinook salmon fork lengths (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2012	Wild	45	33	4	68	328	6	85	260	8	98	154	8		0	
	Hatchery	48	281	3	67	453	5	83	59	6	93	22	9		0	
Return Year	Origin	Female fall Chinook salmon fork lengths (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2012	Wild		0		71	44	5	83	344	5	89	327	5		0	
	Hatchery		0		71	183	4	81	209	4	86	71	5		0	

The origins of fish were determined by examination of otolith.

16.4 Contribution to Fisheries

Coded-wire tag data from fisheries, spawning grounds, or from hatcheries in the Pacific Region are stored in the Regional Mark Processing Center (RMPC) database. The RMPC is the central repository for all coded-wire tagged and otherwise associated release, catch, sample, and recovery data regarding anadromous salmonids in the greater Pacific Coast Region of the United States of America (RMPC Strategic Plan 2006-2009). The Regional Mark Information System database (RMIS) within the RMPC provides specific recovery data for individual tag codes, along with the sample rate used to derive the total number of recoveries by fishery type. The RMIS database is the primary tool for estimating the survival and extraction rate of adipose fin-clipped and coded-wire tag hatchery releases. The RMIS database was queried for tag recoveries on May 2, 2013 to provide recoveries of coded-wire tagged PRH origin fish. The database for the 2006 brood may not be complete until January 1, 2014.

Beginning with the 2010 release year, a portion of the non-adipose clipped smolts release from PRH was coded-wire tagged as part of a double index tag study to evaluate the effect of mark selective fisheries. We are currently reviewing the data collected in the RMPC database to evaluate the results of the double index tagging for the PRH origin fish.

Fall Chinook salmon released from PRH supplement Pacific Ocean harvest for both commercial and sport fisheries from Washington to Southeast Alaska as well as Columbia River commercial, sport, and treaty tribal harvest. The Hanford Reach sport fishery for fall Chinook salmon is an extremely popular fishery. The fishery runs from August 1 to October 22 annually. In 2012, 18,854 fall Chinook salmon were harvested during this fishery, 13,141 adults and 5,713 jacks. Based on coded-wire tag expansions from tags recovered from the Hanford Reach sport fishery, 21% of the sport harvest in the Hanford Reach was comprised of PRH origin fall Chinook salmon (Table 50). Adult returns from Ringold Springs Hatchery comprised 10.5% of the sport fishery. All other hatcheries combined represent 1.3% of the harvest. Recent data from otolith samples indicates that coded-wire tag expansions may underestimate the number of PRH origin Chinook salmon returns at the hatchery and this is likely the situation when evaluating hatchery contributions to the sport fishery and the natural spawn. Otoliths were collected to determine origin in the sport fishery in 2012 in addition to coded-wire tags. The results from the otolith data for the 2012 Hanford Reach fall Chinook salmon sport fishery suggests that 35% were PRH origin fish, 2,621 more fish than estimated by coded-wire tags.

Table 50 Hatchery fall Chinook salmon contributions to harvest in the Hanford Reach fall Chinook salmon fishery. Coded-wire tag recoveries from RMIS database expanded by sample rate and tag rate.

	Harvest & Sampling			CWT Expansions			% of Harvest		
Year	**Harvest**	**Sampled**	**% Sampled**	**PRH**	**RSH**	**Other**	**PRH**	**RSH**	**Other**
2003	7,190	1,848	25.7	510	424	43	7.1	5.9	0.6
2004	8,787	2,255	25.7	276	62	23	3.1	0.7	0.3
2005	7,974	1,834	23.0	1,200	265	35	15.0	3.3	0.4
2006	4,508	1,296	28.7	683	66	10	15.1	1.5	0.2
2007	6,466	1,812	28.0	929	50	89	14.4	0.8	1.4
2008	7,013	1,593	22.7	304	66	22	4.3	0.9	0.3
2009	8,806	1,741	19.8	520	0	10	5.9	0.0	0.1
2010	12,499	2,475	19.8	1,157	399	10	9.3	3.2	0.1
2011	14,262	2,715	19.0	1,558	663	121	10.9	4.6	0.8
2012	18,854	3,615	19.0	3,974	1,974	237	21.1	10.5	1.3
Mean	9,636	2,118	23.1	1,111	397	60	10.6	3.1	0.6

Coded-wire tag data for PRH origin fall Chinook salmon that possessed an adipose clip were reviewed to assess contributions to ocean, commercial, tribal, and sport fisheries. The largest proportion of the harvest of PRH origin fall Chinook salmon occurred in ocean fisheries followed by Zone-6 tribal harvest. For broodyears 1997 through 2006, 51% of the reported harvest was taken in ocean fisheries (Table 51).

Table 51 Coded-wire tag recoveries from the RMIS database by broodyear and harvest type expanded by tag rate and sample rate.

			Columbia River Fisheries						
	Ocean Fisheries		*Tribal*		*Commercial*		*Recreational*		
Brood Year	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Recoveries (*N*)**
1997	1,100	37%	1,506	50%	304	10%	91	3%	3,001
1998	6,580	48%	3,956	29%	1,066	8%	1,981	15%	13,583
1999	14,190	55%	5,908	23%	2,410	9%	3,458	13%	25,966
2000	4,938	61%	1,583	20%	1,099	14%	412	5%	8,032
2001	17,758	57%	6,612	21%	1,554	5%	5,484	17%	31,410
2002	3,779	51%	1,240	17%	576	8%	1,869	25%	7,463
2003	1,871	55%	570	17%	226	7%	757	22%	3,424
2004	562	49%	364	32%	214	19%	0	0%	1,140
2005	10,699	52%	5,975	29%	998	5%	2,871	14%	20,543
2006	1,023	44%	713	31%	288	12%	298	13%	2,322
Mean	**6,250**	**51%**	**2,843**	**27%**	**874**	**10%**	**1,722**	**13%**	**12,729**

17.0 Straying

It has not been determined by fishery co-managers what constitutes independent populations for the purpose of evaluating straying of PRH fall Chinook salmon. However, distribution of PRH origin fish spawning in areas outside of the target stream is presented. The presumptive target spawning location for PRH origin fall Chinook salmon includes the section of Columbia River from McNary Dam to Wanapum Dam.

The spawning escapement of PRH origin fall Chinook salmon by brood year is determined from coded-wire tag recoveries collected during spawning surveys. The coded-wire tag recoveries are expanded for mark rate and sampling rate to estimate total spawning escapement. The overall rate for fish from each brood year that spawned outside of the presumptive target area was calculated from the estimated recoveries of PRH origin fish from spawning grounds within and outside of the presumptive target area. Coded-wire tag recoveries at non-target hatcheries and adult fish traps are not included. These fish are not considered strays because the fish were not able to leave the facilities on their own volition.

Coded-wire tag data reported to RMIS is expanded by a sample rate generated by the agency reporting the data. In some cases, the estimated number of tags reported is less than the number actually observed. This typically occurs when the sample rate is unknown, not reported, or biased (Gilbert Lensegrav, WDFW, personal communication). In these instances, the observed number was used instead of the estimated number to calculate the numbers of PRH origin fall Chinook salmon recovered by location.

There are three target rates for straying given in the 2010 version of the PRH Hatchery Genetics Management Plan:

1). Stray rate for PRH origin fall Chinook salmon should be less than 5% of total brood return.
2). Stray rate for PRH origin fall Chinook salmon should be less than 5% of the spawning escapement for other independent populations based on run year.
3). Stray rate for PRH origin fall Chinook salmon should be less than 10% of the spawning escapement of any non-target streams within the independent population based on run year.

Except for the 2006 brood year, less than 5% of the PRH fall Chinook salmon were estimated to spawn outside of the presumptive target spawning area (Table 52). The 2006 brood is the only brood year found at rates greater than 5% outside of the presumptive target area. Roughly 37% of the estimated recoveries for the 2006 brood occurred in the Chelan River. For the 2006 brood there were a total of 19 estimated coded-wire tag recoveries at PRH and 11 estimated coded-wire tag recoveries in the Chelan River.

Table 52 Estimated number and proportions of Priest Rapids Hatchery fall Chinook salmon spawning escapement to Priest Rapids Hatchery and streams within and outside of the presumptive target stream by broodyear. Coded-wire tag recoveries are expanded by mark rate and sample rate for each broodyear.

Brood Year	Number of PRH Origin Recoveries	Homing Target Hatchery		Target Stream[1]		Outside of Target Stream	
		Number	Proportion	Number	Proportion	Number	Proportion
1992	9,037	7,630	0.844	1,037	0.115	370	0.041
1993	25,966	21,144	0.814	4,821	0.186	0	0.000
1994	1,692	1,385	0.818	308	0.182	0	0.000
1995	30,655	23,414	0.764	7,207	0.235	34	0.001
1996	13,552	10,034	0.740	3,517	0.260	0	0.000
1997	3,172	2,690	0.848	483	0.152	0	0.000
1998	18,167	11,833	0.651	5,867	0.323	467	0.026
1999	27,333	15,467	0.566	11,867	0.434	0	0.000
2000	4,759	3,690	0.775	1,069	0.225	0	0.000
2001	25,375	15,875	0.626	9,469	0.373	31	0.001
2002	5,288	3,769	0.713	1,519	0.287	0	0.000
2003	3,034	2,034	0.670	949	0.313	51	0.017
2004	1,133	1,133	1.000	0	0.000	0	0.000
2005	21,379	17,103	0.800	4,241	0.198	34	0.002
2006	1,000	633	0.633	0	0.000	367	0.367
Mean	**12,769**	**9,189**	**0.751**	**3,490**	**0.219**	**90**	**0.030**

[1] Target stream includes the Columbia River between McNary and Wanapum dams as well as the Yakima River below Prosser Dam.

Examination of coded-wire tag recoveries by return year for presumptive non-target streams or areas show that PRH fall Chinook salmon seldom exceed more than 5% of the spawning escapement. However, for multiple return years, greater than 5% of the spawning escapement for the Chelan River consisted of PRH origin fall Chinook salmon (Table 53). The percentage of PRH origin spawners into presumptive non-target streams is not currently being determined for many of the recovery sites, but recent PIT tagging efforts will result in this capacity in the future.

Table 53 Proportion of fall/summer Chinook spawning populations by return year comprised of Priest Rapids Hatchery fall Chinook from 1990 – 2006 brood releases.

Return Year	Presumptive Non-Target Stream		
	Okanogan Summer Chinook	White Salmon fall Chinook	Chelan River[1]
1996	0.000	0.209	0.000
1997	0.000	0.000	0.000
1998	0.000	0.000	0.000
1999	0.000	0.000	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.339
2002	0.000	0.000	0.229
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.000	0.000	0.000
2006	0.000	0.000	0.000
2007	0.000	0.000	0.000
2008	0.015	0.000	0.000
2009	0.000	0.000	0.066
2010	0.000	0.000	0.328
2011	0.000	0.000	0.000
2012	0.000	0.000	0.000

[1]The Chelan River spawning population is a mix of both summer and fall Chinook salmon strays and is not considered an independent population. This location was included to show contributions of PRH strays to this group of fish.

18.0 Genetics

Genetic tissue was collected from each Chinook salmon spawned at PRH during 2012. Staff from the Columbia River Inter-Tribal Fish Commission (CRITFC) obtained a tissue sample after each fish was spawned. In total, 4,946 specimens were collected to support their work associated with genetic stock identification and parentage based tagging. The data collected is currently being archived by CRITFC. During 2010, WDFW staff collected 100 genetic tissue samples from both the Priest Rapids Hatchery broodstock and then naturally spawning broodstock from the Hanford Reach. WDFW did not collect genetic samples during 2011 or 2012.

19.0 Proportion of Natural Influence

A method for indexing the domesticating risk of a supplementation program is to determine the influence of the hatchery and natural environmental selection on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). The ratio pNOB/(pHOS+pNOB) is termed the Proportionate Natural Influence (PNI). The larger the PNI ratio, the greater the estimated strength of selection of the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, PNI should be > 0.5 and for integrated hatchery programs the HSRG recommends a PNI ≥ 0.67 (HSRG/WDFW/NWIFC 2004).

Unique for the 2012 returns, age-2 through 5 PRH origin fall Chinook salmon were otolith marked. Estimates for (pNOB) and (pHOS) were calculated from the proportion of fish sampled possessing an otolith mark to fish sampled not possessing an otolith mark. In-sample recoveries of coded-wire tags and non-otolith marked fish possessing an adipose clip are included in the analysis to account for other hatchery origin strays. The Columbia River Coded-Wire Tag Recovery Program has been conducting stream surveys in the Hanford Reach for many years to collect data for run reconstruction and to recover coded-wire tags from the naturally spawning fall Chinook salmon population of the Hanford Reach. Prior to return year 2010, only estimates from coded-wire tag recoveries could be used to determine hatchery influence on the naturally spawning population.

In addition to establishing goals for the proportion of natural origin Chinook salmon to be incorporated into the hatchery broodstock (pNOB), the HSRG (Hatchery Scientific Review Group) set targets for the maximum proportion of hatchery origin Chinook that should be allowed to contribute to natural origin fall Chinook salmon spawning in the Hanford Reach (pHOS) for an integrated hatchery program. The HSRG recommends a maximum proportion of hatchery influence on the spawning grounds of 0.30 for the Hanford Reach if it is to be managed as an integrated hatchery program.

The pNOB calculated from the combination of in-sample otolith marks, coded-wire tags, and adipose clips for the 2012 broodstock is 12% (Table 54). The 2012 broodstock was comprised of 4,408 fish from the volunteer trap, 501 from the OLAFT and 65 from the ABC fishery. The pNOB for return years 2010 and 2011 is based on otolith marked broodstock for a limited number of age classes.

Table 54 Proportion of naturally produced Chinook salmon in the Priest Rapids Hatchery broodstock (pNOB) based on otolith marks, in-sample coded-wire tags and adipose clips.

Return Year	PRH Origin	Non-PRH		pNOB
		Other Hatchery[4]	Natural	
2010[1]	713	9	28	0.037
2011[2]	955	5	32	0.032
2012[3]	4362	20	592	0.119

[1] pHOS calculated for Ages 2 through 3
[2] pHOS calculated for Ages 2 through 4
[3] pHOS calculated for Ages 2 through 5
[4] Includes fish from other hatcheries and adipose clipped fish without otolith marks

The pHOS for the Hanford Reach was calculated from the proportion of in-sample fall Chinook salmon that possessed an otolith mark, coded-wire tag, or adipose clip to the total number of in-sample fish. For the 2012 returns, we estimate a pHOS of 13% (Table 55). The pHOS specific to the presence of PRH origin fish, based on in-sample otolith data, is 7% for the 2012 returns.

Table 55 Proportion of hatchery Chinook salmon on the spawning grounds (pHOS) in the Hanford Reach using a combination of an otolith, coded-wire tags, and adipose clip marks.

Return Year	Natural Origin	Hatchery Origin Spawners			PRH pHOS	Total pHOS
		PRH	Other[4]	Total		
2010[1]	482	124	8	132	0.205	0.215
2011[2]	814	59	30	89	0.068	0.099
2012[3]	1398	107	104	211	0.071	0.131

[1] pHOS calculated for Ages 2 through 3
[2] pHOS calculated for Ages 2 through 4
[3] pHOS calculated for Ages 2 through 5
[4.] Includes fish from other hatcheries and adipose clipped fish without otolith marks

The PNI for the Hanford Reach includes all hatchery origin fish that pass on their genetics to the natural production. The influence of PRH origin fish on PNI is given to show the contribution by the PRH program.

For return year 2012, the contribution of all hatchery origin fish to the natural spawn provides an estimated PNI of 48%. The PNI for return years 2010 and 2011 represents only age classes otolith marked (Table 56). For return year 2012, the PNI specific to PRH's contribution to pHOS is estimated at 63%.

Historically, pHOS, pNOB and PNI were estimated from expansions of coded-wire tag recoveries in the hatchery and stream surveys. The pNOB estimated from coded-wire tags requires the assumption that fish unaccounted for by the code-wire tag expansions are natural origin fish. As discussed in section 1.8 and section 1.9 of this report, this assumption significantly over estimates pNOB and PNI and under estimates pHOS. Estimates of pNOB, pHOS, and PNI based on code-wire tags expansions are presented in Table 56. In future years we hope to establish a relationship between pNOB and pHOS estimates generated by coded-wire tags and otolith marks in order to adjust the historical PNI estimates generated by coded-wire tags.

Table 56 Proportionate Natural Influence (PNI) of the Hanford Reach fall Chinook salmon supplementation program based on expanded coded-wire tag recoveries of all fish surveyed and sub-sampling for otoliths marks.

Return Year	pNOB based on All Non CWT are Natural Origin	pHOS	PNI
2001	0.155	0.094	0.622
2002	0.145	0.101	0.589
2003	0.132	0.099	0.571
2004	0.229	0.081	0.739
2005	0.370	0.106	0.777
2006	0.507	0.057	0.899
2007	0.326	0.041	0.888
2008	0.501	0.046	0.916
2009	0.568	0.077	0.881
2010	0.392	0.040	0.907
2011	0.381	0.075	0.836
2012	0.304	0.045	0.871
Mean	**0.334**	**0.074**	**0.791**

PNI derived from otoliths

Return Year	pNOB	PRH origin pHOS	All Hatchery Combined pHOS[4]	PRH origin PNI	All Hatchery Combined PNI
2010[1]	0.037	0.205	0.215	0.153	0.147
2011[2]	0.032	0.068	0.099	0.320	0.244
2012[3]	0.119	0.071	0.131	0.626	0.476

[1] pHOS calculated for Ages 2 through 3
[2] pHOS calculated for Ages 2 through 4
3. pHOS calculated for Ages 2 through 5
[4.] Includes fish from other hatcheries and adipose clipped fish without otolith marks

19.1 Alternative pNOB and PNI

An alternative pNOB was developed to account for the genetic influence on pNOB resulting from the PRH spawning protocol of spawning one male x two females. It is intended to represent actual gene flow to the progeny instead of the origin and number of parents. However, it should be noted that although PNI was intended to index gene flow, the alternative method of estimating pNOB as described below has not been peer-reviewed or used elsewhere. The alternative pNOB is calculated by assigning scores to the estimated matings of males and females based on origin during the spawning of the 2012 broodstock. For example, hatchery x hatchery matings = 0.0 points, hatchery x wild matings equal = 0.5 points, and natural x natural matings = 1.0 points. The scores of all of matings were averaged to generate the overall alternative pNOB. The origins of fish spawned were based primarily on otolith marks as done for the conventional pNOB calculation previously discussed. The matings were assigned assuming there were no natural x natural crosses since there was a low proportion (<0.07) of natural origin fish in the PRH volunteer broodstock.

In addition, the fish from the OLAFT and ABC fishery were spawned with fish from the PRH volunteer broodstock. Hence, there is a low chance that natural origin fish from the OLAFT and ABC fishery were mated with the relatively few natural origin fish from the PRH volunteer broodstock.

The PNI generated from the alternative pNOB calculation is slightly higher than the PNI calculated from the conventional pNOB calculation from the matings of one natural origin male x two hatchery origin females. For example, the alternative pNOB calculation for the mating of one natural origin male x two hatchery origin females is (0.5 + 0.5 / 2 females) = 0.5, whereas the conventional pNOB calculation for this mating equals (1 natural / (1 natural + 2 hatchery) = 0.33. The alternative and conventional pNOB values are given in Table 57 for each source of broodstock and the total broodstock spawned at PRH during brood year 2012.

The alternative pNOB of 0.141 increased PNI to 0.518 which is slightly higher than the PNI of 0.476 based the on conventional pNOB of 0.119. It should be noted that both the conventional and alternative pNOB values are nearly the same if the fish from OLAFT and ABC fishery are removed from the PRH broodstock. This similarity in pNOB is primarily due to the low numbers of natural origin fish in the PRH volunteer broodstock. In addition, during the first spawn for the 2012 brood year, the matings were one male x one female crosses which eliminates the power of the alternative pNOB to increase PNI. It is estimated that nine natural origin females and nine natural origin males were spawned along with 386 hatchery origin fish during the first spawn.

Table 57 Conventional and alternative calculations of pNOB and PNI for the Priest Rapids 2012 Broodstock.

Conventional pNOB = pNOB/(NOB + HOB)			
PRH Broodstock Return Year 2012	**HOB**	**NOB**	**pNOB**
PRH Volunteer Broodstock Only	4,156	252	0.057
OLAFT, ABC, & PRH Volunteers Combined	4,382	592	0.119
PNI (pHOS of 0.131 and pNOB of 0.119) = 0.476			
Alternative pNOB = Total Score / Total Females in Broodstock			
PRH Broodstock Return Year 2012	**Total Score**	**Total Female**	**pNOB**
PRH Volunteer Returns	174.0	3,052	0.057
OLAFT, ABC, & PRH Volunteers Combined	454.5	3,225	0.141
PNI (pHOS of 0.131 and pNOB of 0.141) = 0.518			

20.0 Natural and Hatchery Replacement Rates

The numbers of hatchery-origin recruits (HOR) were estimated from expanded coded-wire tag recoveries for brood year returns to the Priest Rapids Hatchery and the Hanford Reach of the Columbia River. Coded-wire tag expansion rates for natural origin fall Chinook salmon have not been calculated for the Hanford Reach. Therefore, the assumption was made that returns not accounted for by HOR coded-wire tag recoveries are natural-origin recruits (NOR). Recent data indicates that that coded-wire tag data likely underestimates the true number of HOR recruits. Hence, our assumption overestimates the number of NOR recruits.

In years following 2006, using otolith marks to estimate origin will improve the HOR and NOR estimates. Currently, we only have complete otolith data for the 2007 brood year.

Hatchery replacement rates (HRR) were calculated as the ratio of HOR to the parent broodstock at PRH. This broodstock is an estimate of the number of fish spawned at PRH to produce the target release of 6.7 million subyearling fall Chinook salmon. Similarly, natural replacement rates (NRR) for the Hanford Reach URB fall Chinook salmon were calculated as the ratio of NOR recruits to the parent population spawning naturally in the Hanford Reach stream.

Harvest estimates for HOR recruits were calculated from the proportion of the expanded coded-wire tag recoveries in the fisheries to the total number expanded coded-wire tags recovered. Since there is not a coded-wire tag mark rate for NOR recruits, the harvest rates for HOR recruits were used as an indicator for similar brood years of NOR recruits.

For brood years 1996 through 2006, HRR without harvest for Priest Rapids Hatchery fall Chinook salmon averaged 3.92 and NRR for fall Chinook salmon in the Hanford Reach without harvest averaged 1.24 (Table 58).

Based on coded-wire tag recoveries, an average of 56% of the PRH adult recruits and 69% of the natural origin adult recruits for brood years 1996 through 2006 were harvested in ocean and freshwater fisheries. For brood years 1996 through 2006, HRR with harvest included averaged 8.59 and NRR averaged 4.09. The HRR should be greater than or equal to 5.30 (the target value in Murdoch and Peven 2005).

Table 58 Broodstock collected, spawning escapement, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR, with and without harvest) for natural origin fall Chinook salmon in the Hanford Reach.

Brood Year	Broodstock Spawned	Natural Spawning Escapement	Harvest not included				Harvest included[1]			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1996	2,859	43,249	13,584	28,849	4.75	0.67	26,205	59,899	9.17	1.38
1997	2,726	43,493	3,002	44,416	1.10	1.02	6,037	88,349	2.21	2.03
1998	3,027	35,393	18,464	93,999	6.10	2.66	31,932	222,865	10.55	6.30
1999	2,619	29,812	27,093	114,867	10.34	3.85	52,099	239,319	19.89	8.03
2000	2,619	48,020	4,665	56,422	1.78	1.17	12,508	89,983	4.78	1.87
2001	2,908	59,848	25,059	71,359	8.62	1.19	55,789	129,548	19.19	2.16
2002	3,160	84,509	5,277	47,813	1.67	0.57	12,744	81,600	4.03	0.97
2003	2,781	100,508	3,021	31,605	1.09	0.31	5,974	63,937	2.15	0.64
2004	3,002	87,696	1,109	22,747	0.37	0.26	3,262	34,465	1.09	0.39
2005	3,023	71,967	21,107	64,011	6.98	0.89	61,122	97,777	20.22	1.36
2006	2,729	51,701	998	54,288	0.37	1.05	3,347	77,344	1.23	1.50
Mean	**2,859**	***59,654***	**11,216**	***57,307***	***3.92***	***1.24***	**24,638**	***107,735***	***8.59***	***2.42***

[1] Harvest rates for NORs was estimated using the HRRs harvest rates for similar brood years as an indicator stock.

21.0 Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) are calculated as the expanded number of adult coded-wire tags recovered divided by the number of coded-wire tagged smolts released.

The SARs for hatchery fall Chinook salmon released from PRH for brood years 1992 through 2005, have averaged 0.0037 (Table 59). The SARs for the PRH origin 2006 brood is 0.0005; one of the lowest on record and notably less than the historic mean. Hatchery fall Chinook salmon are annually released as subyearling smolts.

Table 59 Smolt-to-adult ratios (SARs) for Priest Rapids Hatchery fall Chinook salmon.

Brood Year	Tag Code	Number of Tagged Smolts Released	Estimated Adult Captures	SAR
1992	635010	194,622	448	0.0023
1993	635540	185,683	1,479	0.0080
1994	635711	175,880	108	0.0006
1995	636001	196,189	1,786	0.0091
1996	636328	193,215	762	0.0040
1997	630517	196,249	183	0.0009
1998	631030	193,660	946	0.0049
1999	631333	204,346	1,573	0.0077
2000	630672	200,779	370	0.0018
2001	631382	219,926	1,810	0.0082
2002a	631392	101,020	124	0.0012
2002a	631768	254,353	545	0.0021
2003a	632575	225,989	264	0.0012
2003a	632574	173,127	88	0.0005
2004	633076	200,072	100	0.0005
2005	633173	199,445	1,718	0.0086
2006	633894	202,000	100	0.0005
Mean		**195,091**	**730**	**0.0037**

[a] Brood years with multiple coded-wire tag groups.

The SARs for Hanford Reach natural origin fall Chinook salmon for brood years 1992 through 2006 have averaged 0.0029 (Table 60). The SAR for the Hanford Reach natural origin 2006 brood is 0.0007; one of the lowest on record and notably less than the historic mean. The SARs for both the PRH and natural origin broods were similarly low.

Table 60 Smolt-to-adult ratios (SARs) for Hanford Reach natural origin fall Chinook salmon.

Brood Year	Number of Tagged Smolts Released	Estimated Adult Captures	SAR
1992	203,591	829	0.0041
1993	95,897	485	0.0051
1994	148,585	74	0.0005
1995	146,887	340	0.0023
1996	92,262	111	0.0012
1997	199,896	365	0.0018
1998	129,850	784	0.0060
1999	213,259	2,378	0.0112
2000	204,925	362	0.0018
2001	127,758	519	0.0041
2002	203,557	338	0.0017
2003	207,168	199	0.0010
2004	163,884	147	0.0009
2005	203,929	301	0.0015
2006	263,478	356	0.0007
Mean	**173,662**	**506**	**0.0029**

22.0 ESA/HCP Compliance

22.1 Broodstock Collection

Unclipped and untagged fall Chinook salmon adults were collected at the OLAFT at Priest Rapids Dam and the ABC fishery in the Hanford Reach to be used as brood stock at PRH. Per the 2012 Priest Rapids OLAFT study plan and consistent with the 2012 broodstock collection protocols, up to 734 natural-origin (adipose fin present, non-coded-wire tagged) adults were targeted for collection between 1 September and 15 November at the OLAFT. Actual collections occurred between 5 September and 14 November and totaled 570 fall Chinook. ESA Permit 1347 provides authorization to conduct fall Chinook broodstock collection activities at Priest Rapids Dam with an indirect take of steelhead (hatchery and/or wild) not to exceed 10 fish.

During 2012, broodstock collection activities were concurrent with the Priest Rapids steelhead run composition sampling covered under Section Permit # 1395. As such no steelhead take occurred from fall Chinook broodstock activities. Chinook not collected for broodstock were sampled as described in 2012 OLAFT Study plan and released upstream. All other fish encountered were passed at the trap site and were not physically handled.

22.2 Hatchery Rearing and Release

The juvenile fall Chinook salmon from the 2012 brood year reared throughout their life-stages at PRH without incident. The 2013 smolt release totaled 6,822,361 URB fall Chinook salmon, representing 102% of the production objective and was compliant with the 10% overage allowable in ESA Section 10 Permit 1347.

22.3 Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, and 1395, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Grant PUD Hatchery facilities during the September 2012 through June 2013 collection and rearing periods.

22.4 Ecological Risk Assessment

One of the regional objectives in the GPUD M&E plan is to conduct an ecological risk assessment on non-target taxa of concern to determine if additional M&E is necessary (Pearsons and Langshaw 2009). The methodology that is being used to assess risks is presented in Pearsons et al. 2012 and Pearsons and Busack 2012. A copy of the Abstract and Next Steps are reprinted here, however limited activity on this task has been completed during the past year.

Abstract

Ecological risks of Pacific salmon (spring, summer, and fall run Chinook, coho, and sockeye salmon) and steelhead trout hatchery programs operated between 2013 and 2023 in the Upper Columbia Watershed will be assessed using Delphi and modeling approaches.

Committees composed of resource managers and public utility districts identified non-target taxa of concern (i.e., taxa that are not the target of supplementation), and acceptable hatchery impacts (i.e., change in population status) to those taxa. Biologists assembled information about hatchery programs, non-target taxa, and *ecological interactions and this information will be provided to expert panelists in the Delphi process to facilitate assessment of risks and also used to populate the Predation, Competition, and Disease (PCD) Risk 1 model. Delphi panelists will independently estimate the proportion of a non-target taxa population that will be affected by each individual hatchery program. Estimates from each of the two approaches will be independently averaged, a measure of dispersion calculated (e.g., standard deviation), and subsequently compared to the acceptable hatchery impact levels that were determined previously by committees of resource managers and public utility districts. Measures of dispersion will be used to estimate the scientific uncertainty associated with risk estimates. Delphi and model results will be compared to evaluate the qualities of the two approaches. Furthermore, estimates of impacts from each hatchery program will be combined together to generate an estimate of cumulative impact to each non-target taxa.*

22.5 Methods and Next Steps

Experts that have been identified by the resource committees will be invited to participate in a Delphi approach to assess risks (Figure 2). These Delphi panelists will be provided with the information templates populated by the local experts so that all of the panelists in the Delphi process have access to the same, most relevant information. In addition, the opportunity to ask clarifying questions will be provided. Delphi panelists will independently estimate the proportion of a non-target taxa population that will be affected by each individual hatchery program (Pearsons and Hopley 1999). Impacts will be described as the impact to abundance, size at age, and spatial distribution of an NTTOC.

These estimates will be averaged, a measure of dispersion calculated, and subsequently compared to the acceptable hatchery impact levels that were determined previously by resource committees. Measures of dispersion will be used to estimate the scientific uncertainty associated with risk estimates. It is expected that pairings of hatchery target fish and NTTOC for which little data exist will produce high levels of dispersion. Furthermore, estimates of impacts from each hatchery program will be combined together to generate an estimate of cumulative impact to each non-target taxa.

The PCD Risk 1 model will also be populated with the same information templates that will be provided to the Delphi panelists. Modeled results will provide the opportunity to compare risk assessments between expert opinion and the model such as has been described by McCarthy et al. (2004). If results are correlated, then future changes to programs or improvement in data templates could be assessed using the model instead of reconvening Delphi panelists. In addition, risks could also be compared to PCD Risk 1 model results that have been conducted on hatcheries in western Washington and perhaps evaluate bias associated with expert opinion (McCarthy et al. 2004). Furthermore, the model allows for opportunities to assess various risk reduction strategies by conducting multiple model runs with different inputs (Pearsons and Busack, 2012).

The data templates have been completed and have been stored in a database. Data templates were distributed to organizations responsible for hatchery programs in the middle Columbia region so that they could complete PCD Risk 1 model runs. The plan was to complete all model runs before the Delphi panel was convened. This plan was intended to identify any gross errors or missing data from the templates.

Grant PUD has completed 36 of its 46 PCD Risk 1 model runs and has organized the outputs of the model runs into a spreadsheet. Ten of the model runs would not run to completion and it appears that there may need to be an adjustment of the model before the model runs can be completed. Other organizations such as Douglas County Public Utility District, Yakama Nation, and United States Fish and Wildlife Service have also made progress in completing model runs. It is anticipated that the risk assessment will be completed after other organizations have completed their portions of the risk assessment.

After the risk assessment is complete, results will be used by managers to reduce risks if necessary, modify monitoring and evaluation plans, and adaptively manage programs. For example, if risks are unacceptably high and the scientific uncertainty is acceptable; then modification of the hatchery program might occur (Pearsons and Hopley 1999; Ham and Pearsons 2001). Alternatively, if risks appear sufficiently high, but scientific uncertainty is high, then additional monitoring and evaluation or studies may be necessary to assess risk at the desired level of certainty.

23.0 Acknowledgments

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Appendix A
A Summary of Monitoring and Evaluation of Performance Indicators

This section describes how the "Performance Indicators" listed will be monitored. Results of "Performance Indicator" monitoring is evaluated annually and used to adaptively manage the Priest Rapids Hatchery URB fall Chinook salmon program to meet "Performance Standards." An outline of the objectives, hypotheses, measured and derived variables, and field methods that will be used to collect data are presented below.

Objective 1: Determine if the Priest Rapids Hatchery program has affected abundance and productivity of the Hanford Reach Population.

- Ho1.1: The annual number of hatchery produced fish that spawn naturally is less than or equal to the number of naturally and hatchery produced fish taken for broodstock.

- Ho1.2: The annual change in the number of naturally spawning fish is less than or equal to the annual change observed in the reference condition (e.g., standard to be developed by HSC).

- Ho1.3: The annual change in the number of naturally produced adults is less than or equal to the annual change observed in the reference condition (e.g., standard to be developed by HSC).

- Ho1.4: The annual change in the NRR is less than or equal to the annual change observed in the reference condition (e.g., standard to be developed by HSC).

- Ho1.5: The productivity of the natural spawning population is not influenced by the % hatchery origin fish on the spawning grounds

- Ho1.6: The juveniles/parent of the supplemented condition ≤ juveniles/parent of the reference condition (e.g., standard)

- Ho1.7: The relationship between proportion of HOS and juveniles/parent is ≤ 1.

- Ho1.8: The slope of Ln (juveniles/redd vs redds) of the supplemented condition ≤ Slope of Ln (juveniles/redd vs redds) of the reference condition. (conduct only if suitable reference can be found)

Measured and Derived Variables:

- o Number of hatchery and naturally produced fish on the Hanford Reach spawning grounds annually
- o Number of hatchery and naturally produced fish removed for broodstock annually
- o Number of hatchery and naturally produced fish harvested
- o Number of spawning fall Chinook salmon in the Hanford Reach
- o Number of natural origin juveniles in the Hanford Reach

Methods that will be used to collect data

- Redd surveys, adult counts at dams, carcass surveys, Priest Rapids Hatchery trap sampling, hatchery spawning sampling, harvest sampling, juvenile marking and tagging

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and Priest Rapids Hatchery components of the Hanford Reach population are similar.

- Ho2.1: Migration timing Hatchery = Migration timing Naturally produced

- Ho2.2: Spawn timing Hatchery = Spawn timing Naturally produced

- Ho2.3: Spawner distribution Hatchery = Spawner distribution Naturally produced

Measured and Derived Variables:

- Ages of PR Hatchery and Hanford Reach produced fish sampled via pit tags or stock assessment monitoring
- Time (ordinal date) of arrival at Bonneville, The Dalles, John Day, McNary and Priest Rapids Dams
- Time (ordinal date) of PR Hatchery and Hanford Reach produced female salmon carcasses observed on spawning grounds within defined reaches
- Time (ordinal date) of ripeness of fall Chinook salmon captured for broodstock
- Average daily temperature of fish holding water
- Location (GPS coordinate) of female salmon carcasses observed on spawning grounds. (The distribution of hatchery and naturally produced redds may be evaluated if marking or tagging efforts provide reasonable results)

Methods that will be used to collect data:

- Adult counts at dams, carcass surveys, Priest Rapids Hatchery trap sampling, hatchery spawning sampling, harvest sampling, juvenile marking and tagging

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the Priest Rapids Hatchery program. Additionally, determine if Priest Rapids Hatchery programs have caused changes in phenotypic characteristics of the Hanford Reach population.

- Ho3.1: Allele frequency Hatchery = Allele frequency Naturally produced = Allele frequency Donor pop

- Ho3.2: Age at Maturity Hatchery = Age at Maturity Naturally produced

- Ho3.3: Size at Maturity Hatchery = Size at Maturity Naturally produced

- Ho3.4: Effective population size time x = Effective population size time y

Measured and Derived Variables:

- Microsatellite genotypes
- Size (length), age, and gender of PR Hatchery and Hanford Reach produced salmon carcasses collected on spawning grounds
- Size (length), age, and gender of PR Hatchery broodstock
- Size (length), age, and gender of fish at stock assessment locations (e.g., Priest Rapids Dam)

Methods that will be used to collect data:

- Adult counts at dams, carcass surveys, Priest Rapids Hatchery trap sampling, hatchery spawning sampling, juvenile marking and tagging

Objective 4: Determine if the Priest Rapids Hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the Hanford Reach adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific hatchery replacement rate (HRR) expected value based on survival rates listed in the BAMP (1998).

- Ho4.1: HRR Year x ≤ NRR Year x

- Ho4.2: HRR ≤ Expected value per assumptions in BAMP

Measured and Derived Variables:

- Number of PR Hatchery and Hanford Reach fish on spawning grounds
- Number of PR Hatchery and Hanford Reach fish harvested
- Number of PR Hatchery and Hanford Reach fish collected for broodstock
- Number of broodstock used by brood year (PR Hatchery and Hanford Reach fish)

Methods that will be used to collect data:

- Redd surveys, adult counts at dams, carcass surveys, Priest Rapids Hatchery trap sampling, hatchery spawning sampling, harvest sampling, juvenile marking and tagging

Objective 5: Determine if the stray rate of Priest Rapids Hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

- Ho5.1: Stray rate Hatchery fish < 5% of total brood return

- Ho5.2: Stray hatchery fish < 5% of spawning escapement of other independent populations[1]

- Ho5.3: Stray hatchery fish < 10% of spawning escapement of any non-target streams within independent population[1]

[1] This stray rate is suggested based on a literature review and recommendations by the ICBTRT.
It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program-specific basis and decisions made by the PRCC HSC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

Measured and Derived Variables:

- o Number and percent of PR Hatchery carcasses found in non-target and target spawning areas
- o Number and percent of PR Hatchery fish collected for broodstock.
- o Number and percent of PR Hatchery fish taken in fishery.
- o Number and percent of PR Hatchery carcasses found in non-target and target spawning aggregates.

Methods that will be used to collect data:

- Carcass surveys, Priest Rapids Hatchery trap sampling, hatchery spawning sampling, harvest sampling, juvenile marking and tagging, sampling at fish ladder trap

Objective 6: Determine if Priest Rapids Hatchery fish were released at the programmed size and number.

- Ho6.1: Hatchery fish Size = Programmed Size

- Ho6.2: Hatchery fish Number = Programmed Number

Measured and Derived Variables:

- o Length and weights of random samples of hatchery smolts.
- o Numbers of smolts released from the PR Hatchery.

Methods that will be used to collect data

- Sampling of juveniles in hatchery, juvenile marking and tagging

Objective 7: Determine if harvest opportunities have been provided using Priest Rapids Hatchery returning adults.

- Ho 7.1: Number of harvested Priest Rapids Hatchery fish > 0

Measured and Derived Variables:

- o Numbers of PR Hatchery fish sampled in all sport and commercial harvest.
- o Total harvest by fishery estimated from expansion analysis.

Methods that will be used to collect data:

- Harvest sampling (CWT collection from harvest, analysis of PRH Chinook from ocean and lower Columbia commercial and tribal harvest), juvenile marking and tagging

Objective 8: Determine if the Priest Rapids Hatchery has increased pathogen type and/or prevalence in the Hanford Reach population.

- Ho8.1: Pathogen index z supplemented population Time x = Pathogen index supplemented population Time y

- Ho8.2: Hatchery disease Year x = Hatchery disease Year y

Measured and Derived Variables:
- o Incidence of disease in PR Hatchery juveniles and adults.
- o Incidence of disease in Hanford Reach produced juveniles and adults.
- o Evaluation of impacts to incidence of disease may require use of a reference population and/or controlled experiments. The above parameters would also be required for reference populations used to evaluate impacts from disease.

Methods that will be used to collect data:
- Sampling of adults and juveniles at Priest Rapids Hatchery

Objective 9: Determine if ecological interactions attributed to Priest Rapids Hatchery fish affect the distribution, abundance, and/or size of non target taxa of concern that were deemed to be at sufficient risk

- Ho9.1: NTTOC abundance Year x through y = NTTOC abundance Year y through z

- Ho9.2: NTTOC distribution Year x through y = NTTOC distribution Year y through z

- Ho9.3: NTTOC size Year x through y = NTTOC size Year y through z

Measured and Derived Variables:
- o Ecological risk assessment for Hanford Reach NTTOC
- o Containment objectives
- o Distribution, abundance, and/or size of NTTOC

Appendix B
Recovery of coded-wire tags collected from Chinook salmon spawned at Priest Rapids Hatchery during return year 2012.

Coded-wire tag recoveries from fish spawned at Priest Rapids Hatchery, 2012									
Code	Tags	Brood	Run	Stock	Release Location	CWT Release		Exp factor	Total Return
						Date	#		
090224	1	2008	Fall	Umatilla Hatchery	Umatilla R.	2009	157,305	1.0	1
090227	1	2008	Fall	Priest Rapids	CR@Ringold	2009	137,509	25.5	26
090246	3	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	300,737	1.0	3
094508	1	2008	Fall	Umatilla R.	Umatilla R.	2009	26,324	8.7	9
220310	1	2009	Fall	Lyons Ferry	Snake R@Pittsburg L	2010	100,619	2.0	2
612760	1	2008	Fall	Lyons Ferry	Magrudor Corridor	2009	100,761	1.0	1
634391	26	2007	Fall	Priest Rapids	CR@Priest Rapids	2008	202,568	22.5	584
634799	38	2008	Fall	Priest Rapids	CR@Priest Rapids	2009	216,137	31.4	1,193
635290	87	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,185	4.1	358
635294	96	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	205,892	4.1	395
635484	39	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,184	4.1	161
635485	26	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,314	4.1	107
635486	72	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	206,523	4.1	296
635487	79	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	221,057	4.1	325
635488	34	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	205,096	4.1	140
635489	77	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	185,948	4.1	317
635974	1	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	99,800	4.0	4
Total Wire Recovered				583	Estimated Total spawned				3,922

Appendix C
Recovery of coded-wire tags collected from adult Chinook salmon surplused from Priest Rapids Hatchery during return year 2012.

Coded-wire tag recoveries from fish surplused (includes mortalities)									
Code	Tags	Brood	Run	Stock	Release Location	CWT Release		Exp factor	Total in Return
						Date	#		
090134	1	2007	Fall	Umatilla Hatchery	Umatilla R.	2008	134,400	1.0	1
090226	2	2008	Fall	Umatilla Hatchery	Umatilla R.	2009	146,802	1.0	2
090227	4	2008	Fall	Priest Rapids	CR@Ringold	2009	137,509	25.5	102
090245	4	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	181,452	1	4
090324	9	2009	Fall	Priest Rapids	CR@Ringold	2010	205,935	17	149
090327	6	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	161,815	1.0	6
090328	2	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	157,373	1.0	2
090329	5	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	159,167	1.0	5
090330	3	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	160,612	1.0	3
090331	1	2009	Fall	Umatilla Hatchery	Snake R@Hells Canyon	2010	213,949	3.2	3
090355	1	2009	Fall	Umatilla R.	Umatilla R.	2011	261,953	1.005	1
090433	1	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	138,055	1.0	1
090434	4	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	138,007	1.0	4
090435	2	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	141,332	1.0	2
090436	1	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	140,958	1.0	1
090488	3	2010	Fall	Priest Rapids	CR@Ringold	2011	222,916	15.6	47
090492	1	2010	Fall	Umatilla R.	Umatilla R.	2012	90,390	1.0	1
106482	1	2009	Fall	Snake River	Snake R@Hells Canyon D.	2010	61,977	1.1	1
220121	1	2010	Fall	Lyons Ferry	Snake R@Pittsburg L	2011	100,987	2.0	2
220205	1	2010	Fall	Lyons Ferry	Magrudor Corridor	2011	103,007	1.0	1
220207	1	2010	Fall	Lyons Ferry	Luke's Gulch	2011	99,115	1.0	1
220208	1	2010	Fall	Lyons Ferry	Luke's Gulch	2011	101,688	1.0	1
220305	1	2008	Fall	Lyons Ferry	Snake R@Capn Johns	2010	70,925	1.0	1
220307	1	2009	Fall	Lyons Ferry	Clearwater R@Big Canyon	2010	100,461	2.5	3
220309	2	2009	Fall	Lyons Ferry	Snake R@Capn Johns	2010	100,778	2.606	5
220310	2	2009	Fall	Lyons Ferry	Snake R@Pittsburg L	2010	100,619	2.014	4
220313	1	2009	Fall	Lyons Ferry	Snake R@Pittsburg L	2011	93,103	1.0	1
220320	1	2010	Fall	Lyons Ferry	Snake R@Capn Johns	2012	81,042	1.0	1
610424	1	2008	Fall	Hanford URB Wild	Hanford Reach	2009	53,804		0
610437	1	2010	Fall	Hanford URB Wild	Hanford Reach	2011	37,116		0
610440	1	2010	Fall	Hanford URB Wild	Hanford Reach	2011	18,874		0
634391	22	2007	Fall	Priest Rapids	CR@Priest Rapids	2008	202,568	22.5	494

Coded-wire tag recoveries from fish surplused (includes mortalities)									
Code	Tags	Brood	Run	Stock	Release Location	CWT Release		Exp factor	Total in Return
						Date	#		
090134	1	2007	Fall	Umatilla Hatchery	Umatilla R.	2008	134,400	1.0	1
090226	2	2008	Fall	Umatilla Hatchery	Umatilla R.	2009	146,802	1.0	2
090227	4	2008	Fall	Priest Rapids	CR@Ringold	2009	137,509	25.5	102
090245	4	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	181,452	1	4
090324	9	2009	Fall	Priest Rapids	CR@Ringold	2010	205,935	17	149
090327	6	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	161,815	1.0	6
090328	2	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	157,373	1.0	2
090329	5	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	159,167	1.0	5
090330	3	2008	Fall	Umatilla Hatchery	Umatilla R.	2010	160,612	1.0	3
090331	1	2009	Fall	Umatilla Hatchery	Snake R@Hells Canyon	2010	213,949	3.2	3
090355	1	2009	Fall	Umatilla R.	Umatilla R.	2011	261,953	1.005	1
090433	1	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	138,055	1.0	1
090434	4	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	138,007	1.0	4
090435	2	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	141,332	1.0	2
090436	1	2010	Fall	Umatilla Hatchery	Umatilla R.	2011	140,958	1.0	1
090488	3	2010	Fall	Priest Rapids	CR@Ringold	2011	222,916	15.6	47
090492	1	2010	Fall	Umatilla R.	Umatilla R.	2012	90,390	1.0	1
106482	1	2009	Fall	Snake River	Snake R@Hells Canyon D.	2010	61,977	1.1	1
220121	1	2010	Fall	Lyons Ferry	Snake R@Pittsburg L	2011	100,987	2.0	2
220205	1	2010	Fall	Lyons Ferry	Magrudor Corridor	2011	103,007	1.0	1
220207	1	2010	Fall	Lyons Ferry	Luke's Gulch	2011	99,115	1.0	1
220208	1	2010	Fall	Lyons Ferry	Luke's Gulch	2011	101,688	1.0	1
220305	1	2008	Fall	Lyons Ferry	Snake R@Capn Johns	2010	70,925	1.0	1
220307	1	2009	Fall	Lyons Ferry	Clearwater R@Big Canyon	2010	100,461	2.5	3
220309	2	2009	Fall	Lyons Ferry	Snake R@Capn Johns	2010	100,778	2.606	5
220310	2	2009	Fall	Lyons Ferry	Snake R@Pittsburg L	2010	100,619	2.014	4
220313	1	2009	Fall	Lyons Ferry	Snake R@Pittsburg L	2011	93,103	1.0	1
220320	1	2010	Fall	Lyons Ferry	Snake R@Capn Johns	2012	81,042	1.0	1
610424	1	2008	Fall	Hanford URB Wild	Hanford Reach	2009	53,804		0
610437	1	2010	Fall	Hanford URB Wild	Hanford Reach	2011	37,116		0
610440	1	2010	Fall	Hanford URB Wild	Hanford Reach	2011	18,874		0
634391	22	2007	Fall	Priest Rapids	CR@Priest Rapids	2008	202,568	22.5	494

Coded-wire tag recoveries from fish surplused (includes mortalities)									
Code	**Tags**	**Brood**	**Run**	**Stock**	**Release Location**	**CWT Release**		**Exp factor**	**Total in Return**
						Date	#		
634799	43	2008	Fall	Priest Rapids	CR@Priest Rapids	2009	216,137	31.4	1,351
635181	1	2009	Fall	Lyons Ferry	Lyons Ferry	2010	199,629	1.0	1
635182	3	2009	Fall	Irrigon Hatchery	Grande Rhonde	2010	197,251	2.0	6
635274	86	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	99,800	4.0	342
635290	214	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,185	4.1	881
635294	209	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	205,892	4.1	860
635299	1	2009	Spring	Methow River	Methow River	2011	222,120	1.0	1
635484	247	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,184	4.1	1,017
635485	240	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	207,314	4.1	988
635486	204	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	206,523	4.1	840
635487	228	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	221,057	4.1	939
635488	267	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	205,096	4.1	1,099
635489	190	2009	Fall	Priest Rapids	CR@Priest Rapids	2010	185,948	4.1	782
635699	231	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	204,091	4.0	918
635764	176	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	200,099	4.0	699
635766	269	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	204,091	4.0	1,068
635970	113	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	199,600	4.0	449
635971	154	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	204,590	4.0	612
635972	183	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	199,600	4.0	727
635973	184	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	200,099	4.0	731
635974	101	2010	Fall	Priest Rapids	CR@Priest Rapids	2011	99,800	4.0	401
Total Wire Recovered				3,432		Estimated Total Return			15,560

Appendix D
Letter from Fish Passage Center providing an update for in-river travel times for Priest Rapids Hatchery origin subyearlings fall Chinook salmon smolts form the 2002 – 2012 releases.

FISH PASSAGE CENTER
1827 NE 44th Ave., Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org
e-mail us at fpcstaff@fpc.org

December 28, 2012

Mr. Glen Pearson
Priest Rapids Hatchery
P.O. Box 937
Mattawa, WA 99349

Dear Glen-

The Fish Passage Center has been marking fish from the Priest Rapids Hatchery facility over the last several years as part of the Smolt Monitoring Program (SMP). For purposes of this program, data are collected on both the juvenile and adult life stages. The SMP provides information for in-season management of the hydrosystem and post-season analyses to the federal, state, and tribal fishery agencies. We would like to share with you an update of some of the information we developed under the SMP program for the fish used from the Priest Rapids Hatchery facility in 2012 and past years.

Under the Smolt Monitoring Program, information is collected on the timing, migration speed, and survival from the hatchery to McNary Dam. Priest Rapids Hatchery divides the release of PIT-tags over three release dates. Table 1 below provides estimates of minimum, median, and maximum travel times to McNary Dam from each of the year's releases. Also provided are estimates of the 95% confidence limits around the estimated median travel time.

In addition, we are providing a table that presents the estimated 10%, 50%, and 90% passage dates of Priest Rapids fall Chinook juveniles at McNary Dam for each of the years of tagged release groups: early (Table 2), middle (Table 3), and late (Table 4). Also, Figures 1-3 are provided as illustrations of how the arrival timing of the 2012 smolt releases relate to last year's releases, as well as the 10-year average arrival timing for the three releases (2002-2011).

Table 1. Priest Rapids Hatchery subyearling Fall Chinook Travel Times to McNary Dam

Release Date	Migration Year	Travel Time (Days) Min	Med	Max	Confidence Limits 95% Lower	Upper	Priest Rapids Flow (Kcfs)
16-Jun	1997	4.3	21.2	65.4	18.5	21.9	182.2
20-Jun	1997	1.3	11.9	54.4	11.4	12.6	153.7
24-Jun	1997	4.3	10.6	38.9	9.7	11.1	110.4
13-Jun	1998	2.6	7.4	39.1	7.03	8.01	
25-Jun	1998	2.5	9.6	27.4	9.2	9.9	
14-Jun	1999	3.8	13	39.6	12	13.6	184.7
18-Jun	1999	3.2	10.5	34.3	9.7	11.2	185.6
23-Jun	1999	2.2	11.7	57.2	11	12.2	196.3
15-Jun	2000	5.1	12.1	49.9	11.5	13.1	136.5
19-Jun	2000	4.4	13.4	37.4	12.3	14.2	138.1
27-Jun	2000	4.3	11.5	43	11.2	13.1	137.6
11-Jun	2001	4.9	14	46.8	13.6	14.6	93.6
15-Jun	2001	7.2	13.2	60	12.8	14	94.2
19-Jun	2001	6.8	13.9	57.8	13.7	14.1	95.1
11-Jun	2002	5.2	14.1	41.8	13.7	14.9	222.3
15-Jun	2002	5.9	11.4	39.9	11.1	13.2	223.6
19-Jun	2002	3.9	11.3	38.9	10.2	13.1	234.2
12-Jun	2003	3.9	11.1	41.7	10.6	11.4	148.0
16-Jun	2003	4.2	9.3	34	8.9	9.8	143.3
20-Jun	2003	4.5	11.1	35.8	10.9	11.4	138.1
14-Jun	2004	3.9	6.2	19.6	6.1	6.6	150.3
18-Jun	2004	3.2	6.8	21.6	6.5	7.0	139.1
22-Jun	2004	2.7	5.9	27.2	5.6	6.0	129.8
9-Jun	2005	3.4	7.8	28.2	7.2	8.4	
13-Jun	2005	3.2	5.5	22.9	5.4	6.1	
17-Jun	2005	0.2	7.0	19.4	6.7	7.3	
12-Jun	2006	3	10.8	27.5	8.3	12.3	
16-Jun	2006	3.4	12.1	25	11.1	12.4	
20-Jun	2006	3.2	9.9	22.3	9.3	10.5	
13-June	2007	5.3	15.6	35.8	13.8	17.6	157.9
17-June	2007	3.9	11.8	31.4	11.0	12.8	151.7
21-June	2007	4.8	10.0	23.5	9.0	11.1	148.0
12-June	2008	3.8	17.0	39.3	15.4	19.4	211.4
16-June	2008	4.4	17.2	33.8	16.0	19.5	207.4
20-June	2008	4.2	16.7	31.3	15.9	17.6	200.4
11-June	2009	4.2	16.4	40.7	14.8	18.4	149.1
15-June	2009	4.8	14.2	36.7	12.4	15.7	147
19-June	2009	6	16.5	31	14.6	17.7	134.3
9-June	2010	2.8	13.6	29.3	12.7	15.7	203.5
13-June	2010	5.2	16.8	33.1	15.8	18.3	216.8
17-June	2010	2.5	13.9	30.7	12.8	15.2	224.4
15-June	2011	2.8	10.0	34.0	8.5	12.0	297.7
19-June	2011	3.0	14.0	36.0	11.0	16.0	272.0
23-June	2011	2.8	12.2	31.9	9.8	14.5	264.2
12-June	2012	6.9	25.6	40.1	24.1	26.4	286.6
16-June	2012	5.5	22.9	36.9	21.1	26.1	293.1
20-June	2012	8.9	19.9	38.8	18.5	23.4	301.2

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Table 2. Estimated 10%, 50%, and 90% passage dates of Priest Rapids Hatchery subyearling fall Chinook at McNary Dam (Early releases).

Migration Year	Release Date	10% Passage Date	50% Passage Date	90% Passage Date
1997	16-Jun	23-Jun	5-Jul	19-Jul
1998	13-Jun	18-Jun	20-Jun	28-Jun
1999	14-Jun	20-Jun	27-Jun	11-Jul
2000	15-Jun	22-Jun	26-Jun	6-Jul
2001	11-Jun	21-Jun	25-Jun	2-Jul
2002	11-Jun	19-Jun	25-Jun	6-Jul
2003	12-Jun	18-Jun	23-Jun	29-Jun
2004	14-Jun	19-Jun	20-Jun	25-Jun
2005	19-Jun	14-Jun	17-Jun	27-Jun
2006	12-Jun	17-Jun	23-Jun	1-Jul
2007	13-Jun	22-Jun	28-Jun	9-Jul
2008	12-Jun	23-Jun	29-Jun	8-Jul
2009	11-Jun	20-Jun	28-Jun	7-Jul
2010	9-Jun	16-Jun	23-Jun	4-Jul
2011	15-June	20-Jun	25-Jun	11-Jul
2012	12-June	24-Jun	7-Jul	13-Jul

Table 3. Estimated 10%, 50%, and 90% passage dates of Priest Rapids Hatchery subyearling fall Chinook at McNary Dam (Middle releases).

Migration Year	Release Date	10% Passage Date	50% Passage Date	90% Passage Date
1997	20-Jun	25-Jun	2-Jul	12-Jul
1998	N/A	N/A	N/A	N/A
1999	18-Jun	24-Jun	28-Jun	10-Jul
2000	19-Jun	26-Jun	1-Jul	11-Jul
2001	15-Jun	24-Jun	28-Jun	4-Jul
2002	15-Jun	23-Jun	26-Jun	9-Jul
2003	16-Jun	23-Jun	25-Jun	2-Jul
2004	18-Jun	23-Jun	25-Jun	27-Jun
2005	13-Jun	17-Jun	18-Jun	23-Jun
2006	16-Jun	22-Jun	28-Jun	4-Jul
2007	17-Jun	23-Jun	29-Jun	9-Jul
2008	16-Jun	23-Jun	3-Jul	10-Jul
2009	15-Jun	23-Jun	29-Jun	8-Jul
2010	13-June	22-Jun	30-Jun	7-Jul
2011	19-June	25-Jun	3-Jul	12-Jul
2012	16-June	30-Jun	9-Jul	17-Jul

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Table 4. Estimated 10%, 50%, and 90% passage dates of Priest Rapids Hatchery subyearling fall Chinook at McNary Dam (Late releases).

Migration Year	Release Date	10% Passage Date	50% Passage Date	90% Passage Date
1997	24-Jun	30-Jun	4-Jul	10-Jul
1998	25-Jun	1-Jul	4-Jul	10-Jul
1999	23-Jun	28-Jun	4-Jul	17-Jul
2000	27-Jun	5-Jul	8-Jul	22-Jul
2001	19-Jun	30-Jun	3-Jul	20-Jul
2002	19-Jun	25-Jun	29-Jun	11-Jul
2003	20-Jun	27-Jun	1-Jul	9-Jul
2004	22-Jun	27-Jun	28-Jun	30-Jun
2005	17-Jun	22-Jun	24-Jun	27-Jun
2006	20-Jun	26-Jun	30-Jun	5-Jul
2007	21-Jun	27-Jun	1-Jul	9-Jul
2008	20-Jun	29-Jun	7-Jul	16-Jul
2009	19-Jun	27-Jun	5-Jul	11-Jul
2010	17-Jun	24-Jun	1-Jul	9-Jul
2011	23-June	29-Jun	5-Jul	14-Jul
2012	20-June	2-Jul	10-Jul	19-Jul

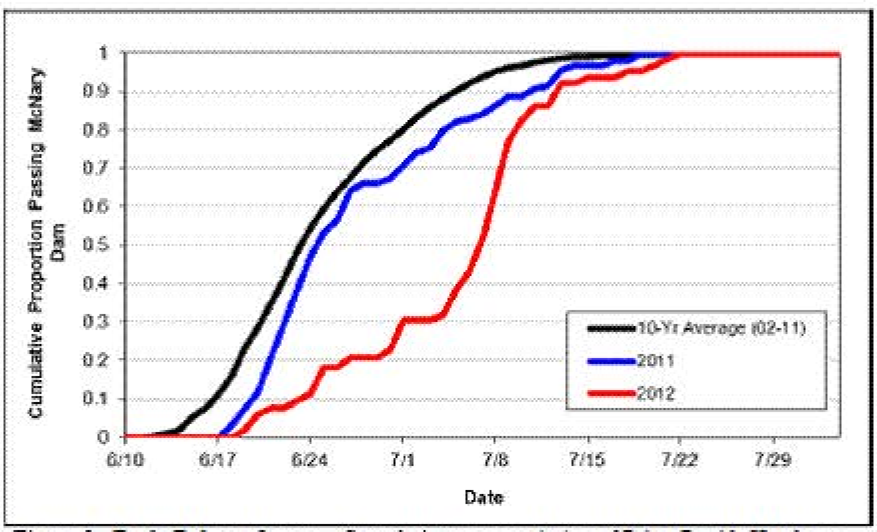

Figure 1. Early Release Group – Cumulative passage timing of Priest Rapids Hatchery subyearling fall Chinook to McNary Dam.

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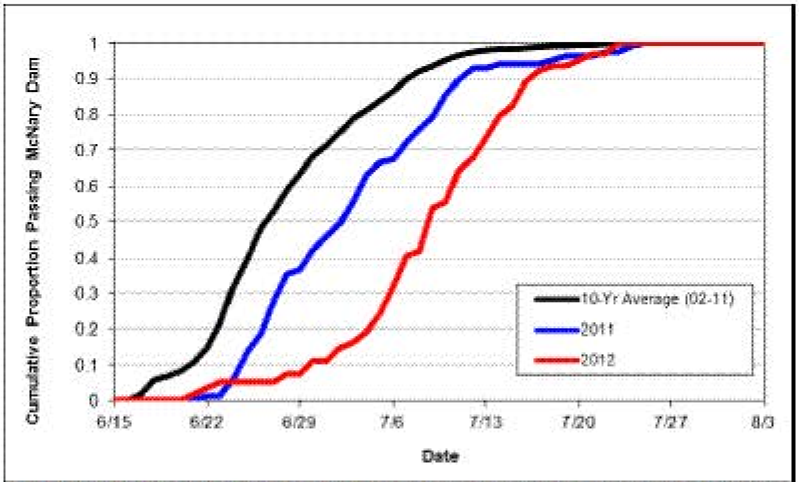

Figure 2. Middle Release Group – Cumulative passage timing of Priest Rapids Hatchery subyearling fall Chinook to McNary Dam.

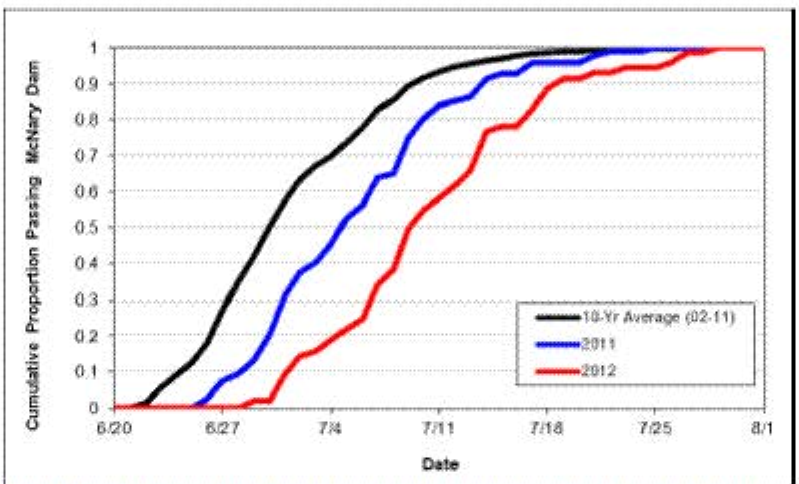

Figure 3. Late Release Group – Cumulative passage timing of Priest Rapids Hatchery subyearling fall Chinook to McNary Dam.

Finally, Table 5 provides estimates of survival from release at the hatchery to McNary Dam, along with the upper and lower confidence limits on these estimates. These yearly survival estimates are for all releases of subyearling fall Chinook within a given migration year.

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Table 5. Priest Rapids Hatchery subyearling fall Chinook survivals (Release to McNary Dam)

Release Dates	Migration Year	Survival (Rel-MCN)	95% Confidence Limits Lower	Upper
June 16-24	1997	0.568	0.458	0.679
June 13-25	1998	0.840	0.639	0.940
June 14-23	1999	0.757	0.679	0.836
June 15-27	2000	0.666	0.577	0.755
June 11-19	2001	0.746	0.670	0.794
June 11-19	2002	0.697	0.627	0.767
June 12-20	2003	0.633	0.590	0.677
June 14-22	2004	0.775	0.689	0.861
June 09-17	2005	0.655	0.573	0.729
June 12-20	2006	0.671	0.577	0.765
June 13-21	2007	0.686	0.564	0.808
June 12-20	2008	0.646	0.485	0.807
June 11-19	2009	0.626	0.510	0.742
June 9-17	2010	0.647	0.514	0.780
June 15-23	2011	0.820	0.567	1.073
June 12-20	2012	0.500	0.358	0.642

We hope that the information we have provided regarding the use and application of information from the groups that have been marked at the hatchery over the last several years is of some use to you. If you would like any additional information regarding these releases please feel free to contact us.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

Cc: Pete Hassemer, IDF&G
Bill Tweit, WDFW
Jay Hesse, Nez Perce
Tony Nigro, ODFW
FPAC

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Appendix E
Juvenile fish health inspections for Priest Rapids Hatchery fall Chinook salmon.

Hatchery	Date	Species	Stock	Brood Year	Condition
Priest Rapids	02-Mar-95	CHF	Priest Rapids	1994	Healthy
Priest Rapids	31-Mar-95	CHF	Priest Rapids	1994	Digestive System Dysfunction
Priest Rapids	08-May-95	CHF	Priest Rapids	1994	Healthy
Priest Rapids	08-Jun-95	CHF	Priest Rapids	1994	Healthy
Priest Rapids	04-Mar-96	CHF	Priest Rapids	1995	Healthy
Priest Rapids	15-Apr-96	CHF	Priest Rapids	1995	Healthy
Priest Rapids	20-May-96	CHF	Priest Rapids	1995	Healthy
Priest Rapids	10-Jun-96	CHF	Priest Rapids	1995	Healthy
Priest Rapids	25-Feb-97	CHF	Priest Rapids	1996	Healthy
Priest Rapids	28-Mar-97	CHF	Priest Rapids	1996	Healthy
Priest Rapids	25-Apr-97	CHF	Priest Rapids	1996	Healthy
Priest Rapids	28-Jun-97	CHF	Priest Rapids	1996	Healthy
Priest Rapids	27-Feb-98	CHF	Priest Rapids	1997	Healthy
Priest Rapids	01-Apr-98	CHF	Priest Rapids	1997	Healthy
Priest Rapids	06-May-98	CHF	Priest Rapids	1997	Healthy
Priest Rapids	03-Jun-98	CHF	Priest Rapids	1997	Healthy
Priest Rapids	23-Feb-99	CHF	Priest Rapids	1998	Healthy
Priest Rapids	22-Mar-99	CHF	Priest Rapids	1998	Healthy
Priest Rapids	23-Apr-99	CHF	Priest Rapids	1998	Healthy
Priest Rapids	25-May-99	CHF	Priest Rapids	1998	Dropout Syndrome & Bacterial
Priest Rapids	08-Sep-99	CHF	Priest Rapids	1998	Bacterial Kidney Disease
Priest Rapids	06-Mar-00	CHF	Priest Rapids	1999	Healthy
Priest Rapids	14-Apr-00	CHF	Priest Rapids	1999	Healthy
Priest Rapids	16-May-00	CHF	Priest Rapids	1999	Healthy
Priest Rapids	12-Jun-00	CHF	Priest Rapids	1999	Healthy
Priest Rapids	23-Feb-01	CHF	Priest Rapids	2000	Healthy
Priest Rapids	05-Apr-01	CHF	Priest Rapids	2000	Healthy
Priest Rapids	07-May-01	CHF	Priest Rapids	2000	Healthy
Priest Rapids	06-Jun-01	CHF	Priest Rapids	2000	Healthy
Priest Rapids	13-Feb-02	CHF	Priest Rapids	2001	Healthy
Priest Rapids	01-Mar-02	CHF	Priest Rapids	2001	Coagulated Yolk Syndrome
Priest Rapids	22-Apr-02	CHF	Priest Rapids	2001	Healthy
Priest Rapids	10-Jun-02	CHF	Priest Rapids	2001	Healthy
Priest Rapids	07-Mar-03	CHF	Priest Rapids	2002	Healthy
Priest Rapids	15-Apr-03	CHF	Priest Rapids	2002	Healthy
Priest Rapids	02-Jun-03	CHF	Priest Rapids	2002	Healthy
Priest Rapids	01-Apr-04	CHF	Priest Rapids	2003	Healthy
Priest Rapids	06-May-04	CHF	Priest Rapids	2003	Healthy
Priest Rapids	07-Jun-04	CHF	Priest Rapids	2003	Healthy
Priest Rapids	11-Mar-05	CHF	Priest Rapids	2004	Healthy
Priest Rapids	14-Apr-05	CHF	Priest Rapids	2004	Healthy

Appendix F
Summary of fall Chinook salmon redd counts for the 2012 aerial surveys in the Hanford Reach, Columbia River.

Environmental Assessment Services, LLC
350 Hills Street
Richland, Washington 99354
November 21, 2012

To: April Johnson, MSA

From: Paul Wagner, EAS

Subject: November 18, 2012 Fall Chinook Aerial Redd Count.

Summary

The third 2012 fall Chinook redd count aerial survey was conducted on Sunday November 18 from a Cessna 182 single engine fixed wing aircraft contracted through Bergstrom Aircraft Inc. The surveyor was Paul Wagner (EAS) and the pilot was Dave McCurry (Bergstrom Aircraft). Departure time from the Pasco Airport was approximately noon and the flight lasted just over 2 hours.

The area surveyed was the Columbia River from just upstream of the I-182 bridge in Richland to just downstream of Priest Rapids Dam. Wind was moderate and viewing conditions were only fair due to cloud cover. Hourly discharge from Priest Rapids Dam was low and stable and ranged from 50.7 kcfs to 53.3 kcfs during the flight. It takes approximately 8 hours for a change in discharge at Priest Rapids Dam to translate to the downstream most extent of the Hanford Reach. At the start of the survey, river flows were found to be relatively high at the bottom of the Reach owing to high (i.e., 178 kcfs at 0400 hours) nighttime discharge. However, flows dropped to as we progressed upsteam and all historic spawning areas were found to be surveyable.

A total of 8,368 redds were counted during this survey (Table 1). Two thousand two hundred and sixty four of these redds were observed within areas adjacent to Hanford Site operations (Table 2).

The 8,368 redds counted during the November 18, 2012 flight are approximately equal to the number of redds counted on the November 20, 2011 (8,472) survey and a few hundred less than the final 2011 season maximum count of 8,915. The 2012 maximum redd count total is the eighth highest on record since counting began in 1948. Illustrations of historical redd count areas as well as eight new sub-areas created in 2011 to better monitor the abundance and distribution of fall Chinook redds in areas adjacent to Hanford Site operations are included in Figure 1 for reference.

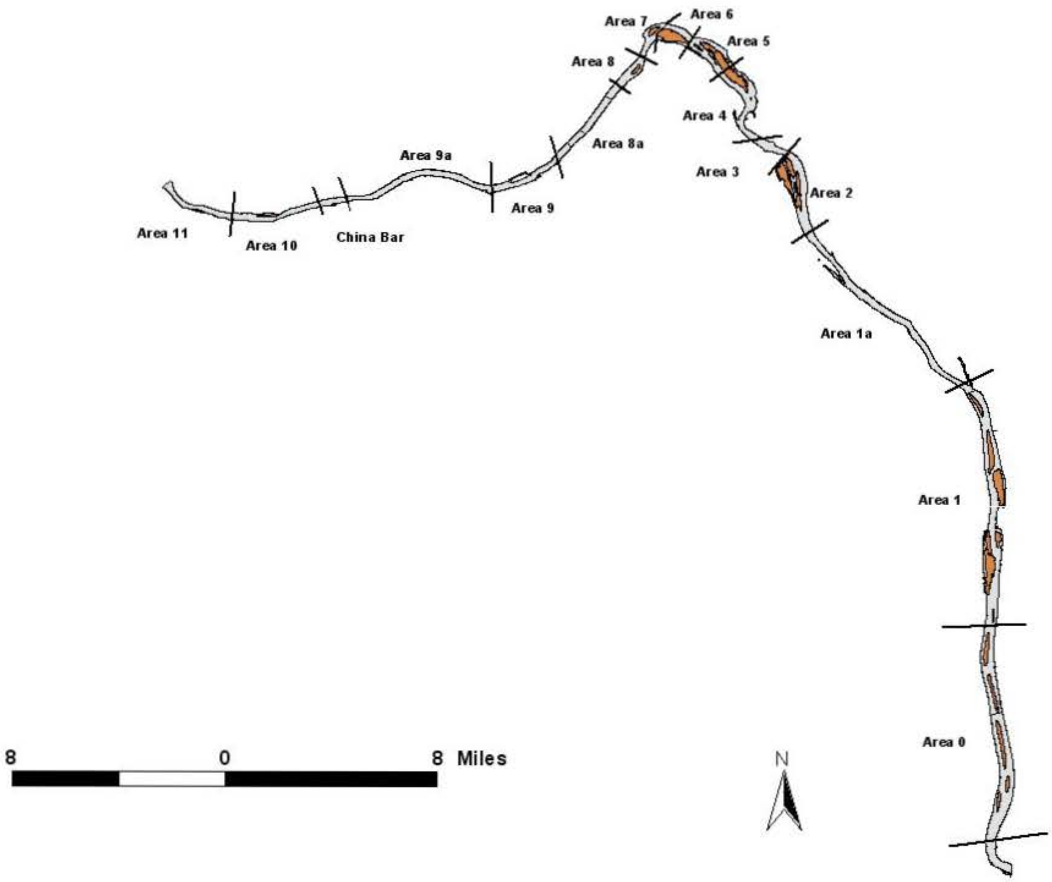
Table 1. Summary of fall Chinook salmon redd counts for the 2012 aerial surveys in the Hanford Reach, Columbia River.

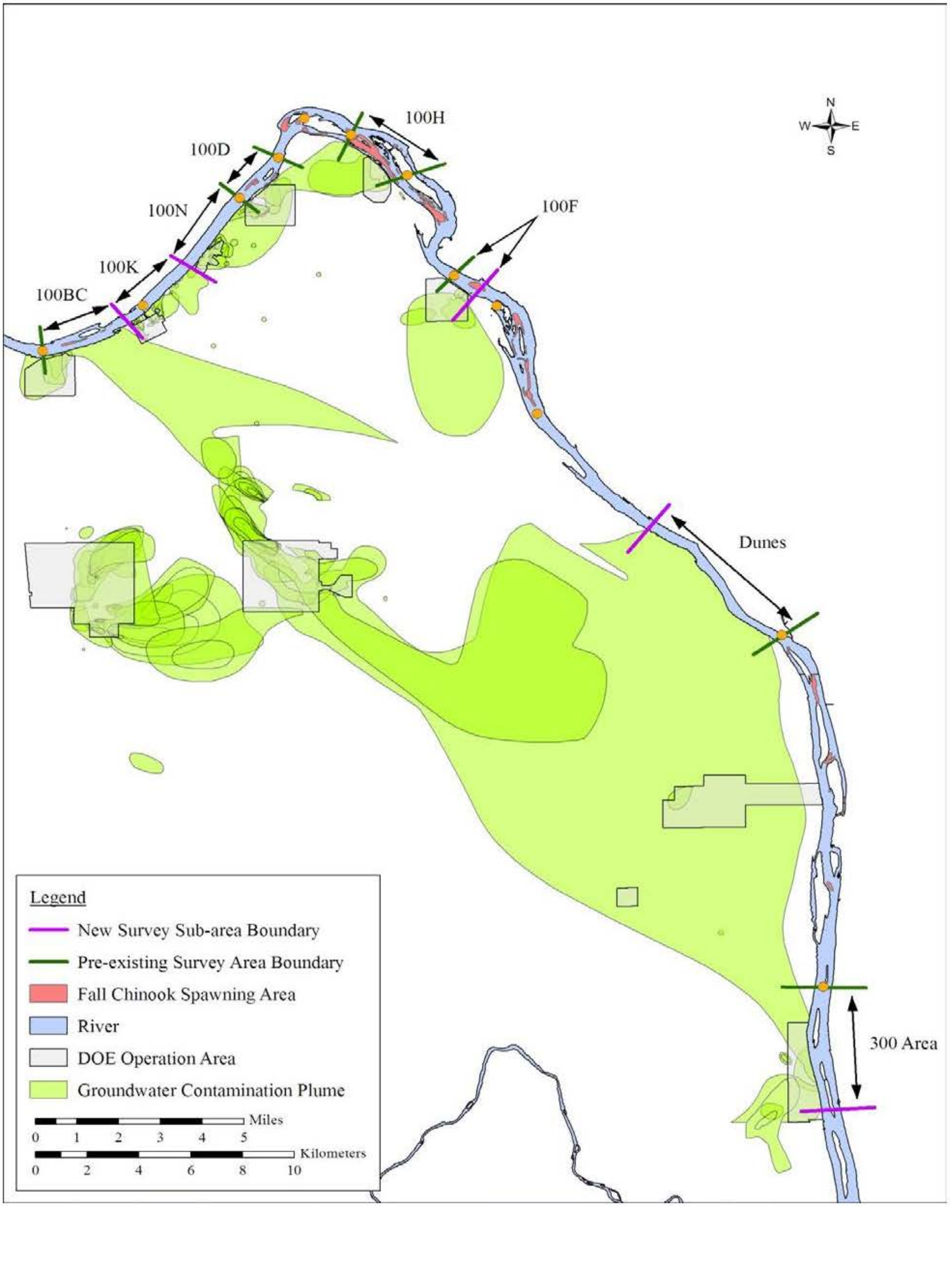
Area	Description	10/21/2012	10/30/2012	11/11/2012	11/18/2012	Maximum Count
0	Islands 17-21 (Richland)	0	0	NA	0	0
1	Islands 11-16	3	147	NA	533	533
2	Islands 8-10	4	353	NA	807	807
3	Near Island 7	12	425	NA	700	700
4	Island 6 (lower half)	14	553	NA	1,375	1,375
5	Island 4, 5 and upper 6	9	947	NA	1,195	1,195
6	Near Island 3	1	225	NA	475	475
7	Near Island 2	6	301	NA	528	528
8	Near Island 1	4	160	NA	340	340
9	Near Coyote Rapids	1	19	NA	29	29
	Midway (China Bar)	0	25	NA	68	68
10	Near Vernita Bar	28	1,180	NA	2,315	2,315
11	Near Priest Rapids Dam	0	0	NA	3	3
	TOTAL	82	4,335	NA	8,368	8,368

Table 2. 2012 summary of fall Chinook aerial redd counts by Hanford Site sub-sections.

Hanford Site Sub-area	10/21/2012	10/30/2012	11/11/2012	11/18/2012	Maximum Count
300 Area	0	0	NA	0	0
Dunes	0	0	NA	0	0
100F	12	425	NA	700	700
100H	9	947	NA	1,195	1,195
100D	4	160	NA	340	340
100N	0	0	NA	0	0
100K	0	0	NA	0	0
100BC	1	19	NA	29	29
TOTAL	26	1,551	NA	2,264	2,264

Figure 1. Illustrations of the Hanford Reach of the Columbia River and Historic Fall Chinook Aerial Survey Redd Count Areas (Top) and Sub-Areas Specific to the Hanford Site (Bottom).




100H
100D
100N
100F
100K
100BC
Dunes
300 Area
N
W
E
S
Legend
New Survey Sub-area Boundary
Pre-existing Survey Area Boundary
Fall Chinook Spawning Area
River
DOE Operation Area
Groundwater Contamination Plume
Miles
0 1 2 3 4 5
Kilometers
0 2 4 6 8 10

Number and percent of fall Chinook salmon redds counted in different reaches of the Columbia River, 2001-2012. Data for years 2001-2010 was provided by Pacific Northwest National Laboratory. Data for years 2011 – 2012 was provided by Environmental Assessment Services, LLC.

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Islands	297	509	554	337	708	36	302	371	176	562
Islands	480	865	1,133	867	1,067	435	338	416	722	870
Near	350	280	455	415	500	873	311	360	380	457
Island 6	750	940	1,241	1,084	1,229	289	615	753	878	1,135
Island 4.	1,130	1,165	1,242	1,655	1,130	934	655	960	796	1,562
Near	460	249	475	325	345	1,305	152	230	285	244
Near	780	955	850	960	895	523	455	555	459	657
Near	35	235	270	330	255	253	47	148	160	324
Coyote	16	63	354	180	304	150	10	29	34	49
China	20	25	85	75	28	52	3	35	1,090	299
Vernita	1,930	2,755	2,806	2,240	1,430	1,658	1,135	1,731	16	2,658
Total	**6,248**	**8,041**	**9,465**	**8,468**	**7,891**	**6,508**	**4,023**	**5,588**	**4,996**	**8,817**

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Islands	5%	6%	6%	4%	9%	1%	8%	7%	4%	6%
Islands	8%	11%	12%	10%	14%	7%	8%	7%	14%	10%
Near	6%	3%	5%	5%	6%	13%	8%	6%	8%	5%
Island 6	12%	12%	13%	13%	16%	4%	15%	13%	18%	13%
Island 4.	18%	14%	13%	20%	14%	14%	16%	17%	16%	18%
Near	7%	3%	5%	4%	4%	20%	4%	4%	6%	3%
Near	12%	12%	9%	11%	11%	8%	11%	10%	9%	7%
Near	1%	3%	3%	4%	3%	4%	1%	3%	3%	4%
Coyote	>1%	1%	4%	2%	4%	2%	>1%	1%	1%	1%
China	>1%	>1%	1%	1%	>1%	1%	>1%	1%	22%	3%
Vernita	31%	34%	30%	26%	18%	25%	28%	31%	>1%	30%

Location	2011	2012	Ten-Yr (2002-11)
Islands	676	533	**423**
Islands	814	807	**753**
Near	670	700	**470**
Island 6	1,181	1,375	**935**
Island 4.	1,524	1,195	**1,162**
Near	525	475	**414**
Near	653	528	**696**
Near	295	340	**232**
Coyote	44	29	**122**
China	67	68	**176**
Vernita	2,466	2,318	**1,890**
Total	**8,915**	**8,368**	**7,271**

Location	2011	2012	Ten-Yr (2002-11)
Islands	8%	6%	**6%**
Islands	9%	10%	**10%**
Near	8%	8%	**6%**
Island 6	13%	16%	**13%**
Island 4.	17%	14%	**16%**
Near	6%	6%	**6%**
Near	7%	6%	**10%**
Near	3%	4%	**3%**
Coyote	>1%	>1%	**2%**
China	1%	1%	**2%**
Vernita	28%	28%	**26%**

Appendix G
Historical numbers of Chinook salmon carcasses recovered during the annual Hanford Reach fall Chinook salmon carcass survey.

Return Year	Total
1990	2,194
1991	2,519
1992	2,221
1993	3,340
1994	5,739
1995	3,914
1996	4,529
1997	5,053
1998	4,456
1999	4,412
2000	10,556
2001	6,072
2002	8,402
2003	13,573
2004	11,030
2005	8,491
2006	5,972
2007	3,115
2008	5,455
2009	5,318
2010	9,779
2011	8,391
2012	6,814
Mean	**6,145**

Appendix H
Historical proportion of hatchery and wild origin Chinook salmon estimated by expanded coded-wire tag recoveries collected during fall Chinook salmon carcass surveys in the Hanford Reach.

Return Year	Origin	Total	Hatchery Origin (%)
1997	Natural	4,377	
	Hatchery	676	13.4%
1998	Natural	4,210	
	Hatchery	246	5.5%
1999	Natural	3,645	
	Hatchery	767	17.4%
2000	Natural	7,947	
	Hatchery	2,609	24.7%
2001	Natural	5,697	
	Hatchery	375	6.2%
2002	Natural	7,704	
	Hatchery	698	8.3%
2003	Natural	12,278	
	Hatchery	1,246	9.2%
2004	Natural	9,935	
	Hatchery	907	8.4%
2005	Natural	7,606	
	Hatchery	885	10.4%
2006	Natural	5,627	
	Hatchery	345	5.8%
2007	Natural	3,186	
	Hatchery	129	3.9%
2008	Natural	5,202	
	Hatchery	253	4.6%
2009	Natural	4,907	
	Hatchery	411	7.7%
2010	Natural	9,395	
	Hatchery	396	4.0%
2011	Natural	7,847	
	Hatchery	544	6.5%
2012	Natural	6,308	
	Hatchery	506	7.4%
15 yr (97 – 11) Mean	**Natural**	**6,638**	
	Hatchery	**669**	**9.5%**

Appendix I
Estimated escapement for fall Chinook spawning in the Priest Rapids Dam pool.

Priest Rapids Pool Escapement

Count Source	2012		
	Adult	Jack	Total
Wanapum Adult Passage[1]	21,290	5,125	26,415
Wanapum Dam Fallback Adjustment	Unknown	Unknown	
Priest Rapids Fallback Adjustment[2]	14,255	2,728	16,983
Wanapum Tribal Fishery Above PRD	209		
OLAFT	492	27	519
Priest Rapids Pool Sport Fishery	685	0	685
Total	36,931	7,880	43,917
Priest Rapids Adult Passage[3]	54,283	10,389	64,672
Priest Rapids Dam Pool Escapement	**17,352**	**2,509**	**20,755**

[1] Wanapum Dam passage for fall Chinook based on counts from August 15 through November 15.

[2] Fallback estimate based on fallback rate for 3 ROR PIT groups (BO AFF, OLAFT, COLR3)

[3] Priest Rapids passage for fall Chinook based on counts from August 18 through November 15.