EVALUATION OF THE JOHN DAY DAM NORTH FISH LADDER MODIFICATIONS, 2009 – 2010.

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March 18, 2011

EXECUTIVE SUMMARY

The jumping and holding behavior of adult salmonids in the fishways of John Day Dam have been a problem since initial construction in 1968. After nine years of studies by the Fisheries Field Unit (FFU), tests indicated that providing a direct passage route upstream through the flow control section would reduce jumping. In 2003 this section of the south fish ladder was reconstructed with a full length slot and submerged orifice design which has eliminated fish jumping and improved passage times. In response to this success the Corps of Engineers moved forward with the rebuild of the north ladder during the 2009 - 2010 winter maintenance period. The north ladder flow control section redesigned weirs include a full length central slot with a submerged orifice along the south wall similar to weirs installed on the south ladder in 2003. This report presents the results of the pre-and post-construction evaluation conducted to determine whether adult salmonids continue to jump or experience delays in the newly designed flow-control section of the north ladder. Our objectives: 1. Estimate the jump rate by adult salmonids in the flow control section before and after ladder modifications. 2. Determine the degree of downstream movement through the John Day north ladder count station before and after ladder modifications.

The FFU began observations of the north ladder at the overflow and flow control sections on September 1 continuing through October 28, 2009. The observations were concluded the following year during the same time span, September and October of 2010. The study area was defined as the first seven pools above and below the count station window. The study, conducted in a manner similar to the 2003 south ladder evaluation, determined that in 2009 there were 2.28 jumps per observation hour, of which most were in pool 2 downstream of the count station. In 2010, observers did not witness a single jump.

The downstream movement of salmonids through the count station window at the John Day north ladder had been the highest of all count stations on the lower Columbia River. The average percentage of downstream movement for salmonids over five seasons (2005-2009) at the John Day north ladder was 40.1% with Bonneville Bradford Island ladder second highest at 14.8%. In 2010 the percentage of downstream movement by salmonids dropped to 7.7% at the John Day north ladder.

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INTRODUCTION

BACKGROUND

John Day Dam has had a long documented history of salmonids jumping and holding within the north and south fish ladders since the dam was constructed in 1968. Over the years many studies have been done by the FFU to uncover the causal action of the jumping behavior. The affects of shading part of the ladder (Wright 1996, Jonas 1999), opening the removable sills (Dresser and Stansell 1998), water quality parameters (Cordie 1995, Langeslay 1998), and closing the diffuser (Jonas and Madson 2000) were all tried but none of these tests provided the solution to the problem. Throughout these studies observers did note that jumping primarily occurred on the south side of the ladders. Jumping activity occurred most in the months of September and October, and was predominantly by steelhead (*Oncorhynchus mykiss*). In 2000, the FFU tested both a surface slot and a submerged orifice in the south ladder; a significant reduction in jumping was observed with each treatment [slot $P<0.05$, orifice $P<0.05$ (Jonas and Madson 2001)]. In 2001, the slot and orifice were tried in combination; a significant reduction in jumping was also observed with this treatment [$P \leq 0.001$ (Jonas and Madson 2002)]. Following these findings the Portland District Corps of Engineers redesigned the south ladder flow control section using the slot and orifice concept.

Prior to 2002 the flow control section at both north and south fish ladders created a serpentine flow pattern that forced upstream migrants to swim through a continuous series of clockwise and counterclockwise turns. This section was rebuilt with a central full length slot and submerged orifice weir in the winter of 2002 - 2003 at the south ladder to provide direct upstream passage routes. The new configuration was very successful at eliminating both the proclivity for jumping and holding by salmonids prevalent in that ladder (Jonas et. al. 2004). However, jumping by salmonids was still a concern at the north ladder and an even larger concern was the downstream movement of salmonids through the count station window. The count station at the north ladder is located close to the ladder exit in the transition area between the flow control and over flow sections. This differs from the south ladder in which the count station is located closer to the ladder entrance. Steelhead counts at the John Day north ladder have shown the highest down counts of all the dams along the Columbia River (Beck 2003). Excessive downward movement through the count window makes it problematic to accurately count and speciate ascending fish. To ameliorate fish passage through the transitional section of the north ladder and to reduce or eliminate jumping behaviors, the north ladder upper flow control section was rebuilt during the 2009-2010 winter maintenance season. The new flow control section design is similar to that of the south ladder with a full depth central vertical slot and an 18” x 18” submerged orifice located near the south fishway wall.

OBJECTIVES

1. Estimate the jump rate by adult salmonids in the John Day north ladder flow control section before and after ladder modifications.

2. Determine the degree of downstream movement through the John Day north ladder count station before and after the modifications.

SITE DESCRIPTION

John Day Dam is located on the Columbia River at river mile 215.6 (346.9 km). The project has two fish ladders to accommodate adult fish passage, one on the south (Oregon) side of the river and one on the north (Washington) side. The study site was located on the north ladder, specifically in the vicinity of the count station where the ladder transitions from a flow control section to an overflow section. Figure 1 shows the serpentine type flow control section as seen from the upper walkway at the count station in 2009, and Figure 2 shows the slot and orifice configuration from the same vantage point in 2010 after the modification.

Figure 1. Design of the John Day Dam north ladder flow control section as seen from the count station catwalk in 2009. Overhead netting placed to keep fish from jumping out of the ladder.

Figure 2. View of the rebuilt flow control section prior to water up for fish passage season in 2010 at the John Day Dam north ladder.

METHODS

JUMP EVALUATION

Sampling at the John Day north ladder occurred during two separate fish passage seasons. Observations were taken in the fall of 2009 and 2010 to provide a pre- and post-construction comparison. Previous data (Jonas and Madson 2001) was used to determine sample times and duration. Observations began the first week of September and ended the last week of October of both fish passage seasons. On-site samplers observed for four hours per day Monday through Thursday (2 hours flow control, 2 hours overflow) recording data in one hour blocks. Observation location was randomly assigned to an AM or PM shift (Appendix tables A1 and A2). Samplers recorded jumps by location in the ladder (by pool) identifying fish to species whenever possible. A jump was considered to occur when a fish completely exited the water. The study area was defined as the first seven pools upstream (flow control) and the first seven pools downstream (overflow) of the count station. Pools were numbered from one to seven beginning at the count station and increased numerically both upstream and downstream. Any jumps in pools outside the study area and other activity, such as nosing or lunging partially out of the water, were recorded in the comment section.

DOWNSTREAM MOVEMENT

The downward movement of salmonids, primarily steelhead, through the count window at the John Day north ladder has long been a concern. Fred Cleaver (1973) of National Marine Fisheries Service stated the following: "*This problem has persisted since the new counting station and regulating section of the ladder were put into operation last year and has greatly confounded the task of accurately identifying and counting various species of fish that ascend the ladder. Elimination of the drop-back activity would improve counting accuracy*". It was hoped that the rebuild of the north ladder flow control section would ameliorate this problem. To evaluate whether the rebuild was effective in addressing downstream movement (also referred to as drop back), we used the method developed by Beck and Stansell (2004) to measure downstream movement of fish through weirs at Bonneville Dam. They used the proportion of down counts divided by the total of up counts plus down counts (down / (up + down)) as a measure of downstream activity at a given point in a ladder (i.e. submerged orifice, overflow weir, or count window). We applied this to fish count data collected from fish ladders at Bonneville, The Dalles, and John Day dams from 2005 to 2010. In this report we present the proportion as a percentage.

RESULTS

JUMP EVALUATION

PRE-CONSTRUCTION (2009)

Observations began on September 8, and were to continue until November 5. After three weeks of reduced activity in October, observations were ended on October 29. A total of 274 jumps were tallied in our study area during 120 hours of observation. Of the 274 jumps, 67 were in the flow control section and 207 were in the overflow section. Overall there were 2.28 jumps per observation hour at the north ladder. All of the jumpers that were identified to species during our observations were steelhead. A summary of the jump data can be found in Table 1.

Table 1. Observation hours, jump totals, and mean jumps per hour in the flow control (UP) and overflow sections (DOWN) surrounding the count station. John Day Dam, north ladder, 2009.

	SEPTEMBER		OCTOBER		
	Flow control	**Overflow**	**Flow control**	**Overflow**	***TOTAL***
Hours of observation	28	28	32	32	120
# of Jumps	53	102	14	105	274
Jumps/hour	1.89	3.64	0.44	3.28	2.28

Note: In September, 15 jumps were noted outside the study area, mostly upstream, and in October, 4 jumps were noted outside the study area also upstream.

Looking at the diurnal distribution of mean jumps per hour shows a late afternoon peak at 1600 and 1700 hours at the overflow section (Figure 3). The flow control section also shows an afternoon peak around 1500 hours (Figure 3).

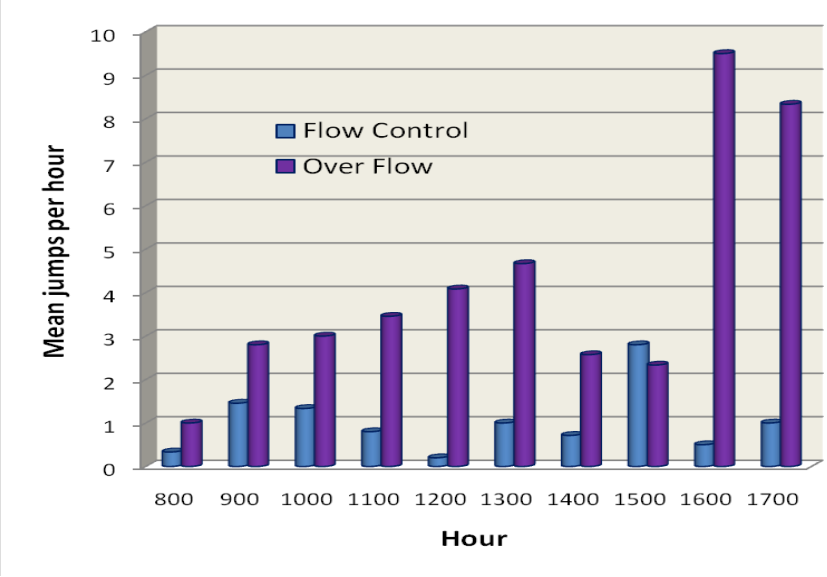

Figure 3. Observed mean jumps per hour by salmonids in the first seven pools upstream of the count station (flow control) and the first seven pools downstream of the count station (over flow) at the John Day north fish ladder in 2009.

The majority of jumps were seen in the overflow section downstream of the count station. Downstream pools closest to the count station were host to the highest jump totals (Figure 4).

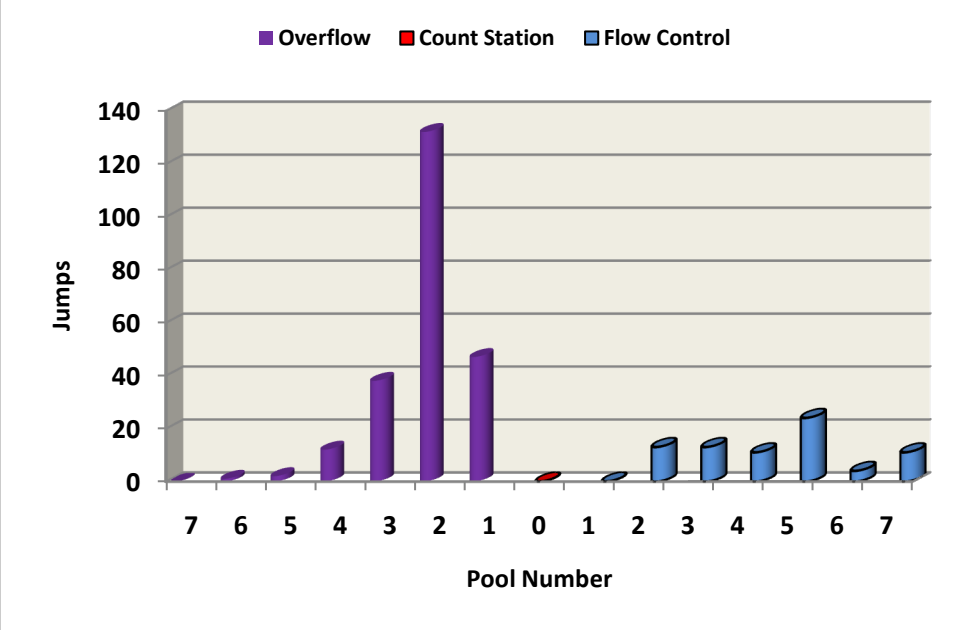

Figure 4. Total jumps per pool by salmonids in both the flow control and overflow sections at the John Day north fish ladder in 2009.

Salmonid mortalities were noted in 2009 as a result of fish jumping behavior. A steelhead was seen falling from the walkway at the overflow section to the ground below on September 21. A steelhead mortality was also found on the net above the overflow section over pool six on October 21.

POST-CONSTRUCTION (2010)

Observations began on September 6, 2010 and continued until October 28, 2010. During this time 112 hours of observations were taken. Observations were cut down to two per week starting on October 12 due to an absence of jump activity. No jumps were recorded in either the rebuilt flow control section or the overflow section of the north fish ladder throughout the 2010 study period.

DOWNSTREAM MOVEMENT

In the five years prior to the flow control section rebuild (2005 – 2009), the five year average percentage of downstream movement at the John Day north ladder count station was 40.1% for salmonids (Table 2); in simple terms, this means that 40% of the observations of salmonids through the count window were in the downstream direction. This was reduced to 7.7% downstream movement recorded in 2010, the year after the modifications (Table 3). For steelhead this reduction was even more dramatic; the five year average for steelhead was 43.8% compared to 5.3% after the ladder rebuild. Concomitantly steelhead passage efficiency increased from 56.2% to 94.7%. Please note that the value shown for "Salmonids" was derived directly from the upstream and downstream counts and is not the mean of values shown for each of the salmonid species. Downstream movement percentages for all salmonid species for the five years prior to the ladder rebuild can be found in Appendix Table B1.

PRE-CONSTRUCTION

Table 2. Five year average percentage downstream movement (down/(up+down)) at the count window for each species by ladder at Bonneville, The Dalles, and John Day dams 2005-2009.

	Bonneville Dam		**The Dalles Dam**		**John Day Dam**	
	Bradford Is.	***Washington***	***East***	***North***	***South***	***North****
Chinook	15.8%	11.1%	1.2%	6.1%	3.1%	31.0%
Steelhead	15.5%	12.2%	2.0%	9.7%	3.5%	43.8%
Sockeye	4.4%	3.1%	0.5%	2.1%	4.1%	33.6%
Coho	13.3%	8.9%	2.4%	6.9%	5.3%	35.4%
Salmonids	**14.8%**	**10.6%**	**1.4%**	**7.6%**	**3.4%**	**40.1%**

*Data not available for John Day north ladder in 2006 (files lost from north ladder count station computer).

POST-CONSTRUCTION

Table 3. Percentage downstream movement (down/(up+down)) at the count window for each species by ladder at Bonneville, The Dalles, and John Day dams 2010.

	Bonneville Dam		The Dalles Dam		John Day Dam	
	Bradford Is.	***Washington***	***East***	***North***	***South***	***North***
Chinook	20.0%	13.5%	1.5%	5.6%	2.0%	3.0%
Steelhead	14.7%	11.9%	2.3%	8.0%	2.2%	5.3%
Sockeye	7.0%	3.0%	1.0%	1.0%	3.5%	10.7%
Coho	11.6%	8.4%	1.8%	8.0%	4.5%	8.9%
Salmonids	**15.3%**	**11.3%**	**1.5%**	**5.9%**	**2.4%**	**7.7%**

In 2010, sockeye had a downstream movement of 10.7% at the John Day north ladder, the highest of all salmonid species. During the sockeye passage season, Project Biologist Miro Zyndol noticed that sockeye were exhibiting a relatively high rate of drop back activity on the north ladder (Pers. Com. Miro Zyndol). On June 28th, 2010 he adjusted the hydraulics to increase the flow volume in the ladder and the following day the sockeye showed a dramatic reduction in downstream movement (Figure 5).

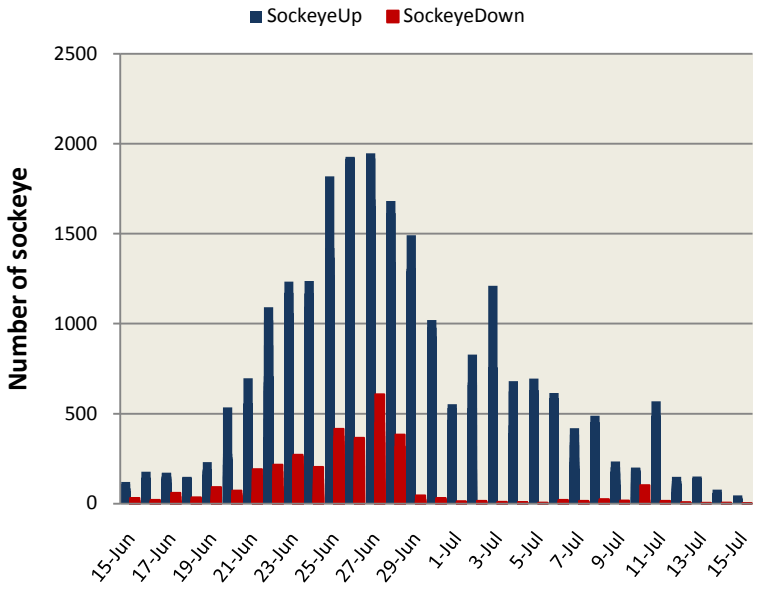

Figure 5. Sockeye passage counts at the John Day north fish ladder count station in 2010.

DISCUSSION

In 2009 the FFU recorded observations at the north fish ladder to collect base line data prior to a scheduled rebuild of the flow control section. Steelhead passage in September and October of 2009 far exceeded that of the ten year average (Figure 6), increasing the jumping activity at the fish ladder. The jumping was primarily seen just below the count station in the overflow section, an area that was not to be modified during the construction. So it remained to be seen whether the modifications to the flow control section would also reduce or eliminate jumping downstream of the count station. Of the steelhead mortalities recorded during the study one was found on the net covering the overflow section and the other was seen falling from the walkway downstream of the count station into an area of underbrush where upon further investigation another steelhead mortality was located. This indicates the possibility that there were additional mortalities in the thicket of blackberry brush that grows profusely underneath the ladder.

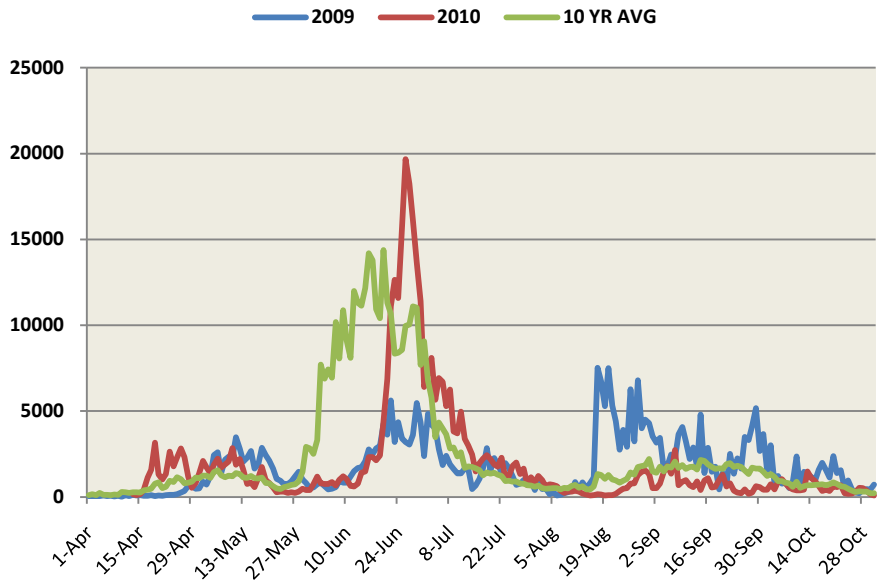

Figure 6. Total salmonid passage at the John Day north ladder April 1 through October 31.

Observations in 2010 were uneventful. Steelhead passage during September and October was considerably lower than the previous year (Figure 6). Jumping activity was absent as well as any observed holding above the count station. The flow control section of the ladder was rebuilt with increased freeboard and a long platform running its entire length (Figure 2) which made observations there a bit more challenging. In 2010 no mortalities were reported or observed.

The John Day north ladder count station has consistently had the highest percentage of downstream movement of all the count stations on the lower Columbia River. During the five years prior to the rebuild the percentage of downstream movement ran as high as 44% with the second highest percentage for any other ladder being 16.9% at Bonneville's Bradford Island ladder. Excessive downstream movement through the count station affected both count accuracy and passage times through the ladder. However fish passage through the count window in 2010 showed a significant decrease in downstream movement, an average of 7.7% of salmonids were counted swimming downstream through the count station. This percentage would have been lower yet if not for the unusual spike in downstream movement by sockeye in June. In fact, for steelhead, this percentage dropped from 43.8% to 5.3%. Action by project fisheries increasing the flow through the upper section by adjusting the stub weirs resulted in an immediate drop in downstream movement by sockeye through the count window.

The post-construction evaluation revealed a highly successful performance of the flow control section. The objectives, to improve passage and decrease downward movement, and to reduce or eliminate jumping in the ladder, were effectively addressed. However this section may need to be monitored for adequate flow requirements during years of increased fish presence in the ladder. We also recommend maintaining the netting atop the ladder for future protection.

ACKNOWLEDGMENTS

The authors would like to acknowledge the many people and agencies that contributed to the jump evaluations conducted on the John Day fish ladders from 1993 to 2003. This includes (but is not limited to) Fisheries Field Unit: Larry Beck, Bob Cordie, John Dalen, Tom Dresser, Sallie Jones, Marie Kopka, Mike Langeslay, Katrina Smolak, Robert Stansell, and Chris Wright. Pacific States Marine Fisheries Commission: Paula Jones, Greg Kovalchuk, Tammy Mackey, and Erin Wright. Idaho Cooperative Fish and Wildlife Research Unit: Michelle Feeley, Rudy Ringe, and Ken Tolotti.

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APPENDIX A

Table A1. Schedule of sampling for 2009 at the John Day Dam north ladder.

		Observer 1		Observer 2	
DATE	*day*	*FLOW CONTROL*	*OVER FLOW*	*FLOW CONTROL*	*OVER FLOW*
9/7/2009	m	HOLIDAY		HOLIDAY	
9/8/2009	t	AM1	AM2	*OFFICE*	
9/9/2009	w	PM2	PM1	PM1	PM2
9/10/2009	th	*OFFICE*		*OFFICE*	
9/14/2009	m	AM1	AM2	*OFFICE*	
9/15/2009	t	AM1	AM2	*OFFICE*	
9/16/2009	w	*OFFICE*		PM2	PM1
9/17/2009	th	*OFFICE*		PM1	PM2
9/21/2009	m	*OFFICE*	PM2	PM2	*OFFICE*
9/22/2009	t	AM1	AM2	*OFFICE*	
9/23/2009	w	AM1	*OFFICE*	*OFFICE*	AM1
9/24/2009	th	*OFFICE*		PM1	PM2
9/28/2009	m	*OFFICE*		AM1	AM2
9/29/2009	t	*OFFICE*		PM2	PM1
9/30/2009	w	AM2	AM1	*OFFICE*	
10/1/2009	th	PM1	PM2	*OFFICE*	
10/5/2009	m	AM1	AM2	*OFFICE*	
10/6/2009	t	*OFFICE*		AM1	AM2
10/7/2009	w	PM1	PM2	*OFFICE*	
10/8/2009	th	*OFFICE*		PM2	PM1
10/12/2009	m	HOLIDAY		HOLIDAY	
10/13/2009	t	*OFFICE*		AM1	AM2
10/14/2009	w	*OFFICE*		AM1	AM2
10/15/2009	th	PM2	PM1	*OFFICE*	
10/19/2009	m	*OFFICE*		AM1	AM2
10/20/2009*	t	PM2	PM1	*OFFICE*	
10/21/2009*	w	AM1	AM2	*OFFICE*	
10/22/2009	th	**	**	PM1	PM2
10/26/2009	m	AM1	AM2	*OFFICE*	
10/27/2009	t	AM2	AM1	*OFFICE*	
10/28/2009	w	*OFFICE*		PM2	PM1
10/29/2009	th	*OFFICE*		PM1	PM2
11/2/2009	m	*OFFICE*		AM1	AM2
11/3/2009	t	*OFFICE*		PM2	PM1
11/4/2009	w	AM2	AM1	*OFFICE*	
11/5/2009	th	PM1	PM2	*OFFICE*	

	Observer 1
am1	09:00 - 11:00
am2	11:00 - 13:00
pm1	13:00 - 15:00
pm2	15:00 - 17:00

	Observer 2
am1	08:00 - 10:00
am2	10:00 - 12:00
pm1	12:00 - 14:00
pm2	14:00 - 16:00

Table A2. Schedule of sampling for 2010 at the John Day Dam north ladder.

		OBSERVER 1		OBSERVER 2	
DATE	*day*	*FLOW CONTROL*	*OVER FLOW*	*FLOW CONTROL*	*OVER FLOW*
9/6/2010	m	HOLIDAY		HOLIDAY	
9/7/2010	t	AM1	AM2	PM1	PM2
9/8/2010	w	PM2	PM1	*OFFICE*	
9/9/2010	th	*OFFICE*		AM2	AM1
9/13/2010	m	AM2	AM1	*OFFICE*	
9/14/2010	t	AM1	AM2	*OFFICE*	
9/15/2010	w	*OFFICE*		PM2	PM1
9/16/2010	th	*OFFICE*		PM1	PM2
9/20/2010	m	PM2	PM1	*OFFICE*	
9/21/2010	t	*OFFICE*		*AM2*	AM1
9/22/2010	w	AM1	AM2	*OFFICE*	
9/23/2010	th	*OFFICE*		PM1	PM2
9/27/2010	m	PM1	PM2	AM1	AM2
9/28/2010	t	*OFFICE*		PM2	PM1
9/29/2010	w	*OFFICE*		*OFFICE*	
9/30/2010	th	AM2	AM1	*OFFICE*	
10/4/2010	m	*OFFICE*		*OFFICE*	
10/5/2010	t	*OFFICE*		*OFFICE*	
10/6/2010	w	PM1	PM2	AM2	AM1
10/7/2010	th	AM1	AM2	PM2	PM1
10/11/2010	m	HOLIDAY		HOLIDAY	
10/12/2010	t	PM1	PM2	*OFFICE*	
10/13/2010	w	*OFFICE*		AM1	AM2
10/14/2010	th	*OFFICE*		*OFFICE*	
10/18/2010	m	*OFFICE*		AM2	AM1
10/19/2010	t	PM2	PM1	*OFFICE*	
10/20/2010	w	*OFFICE*		*OFFICE*	
10/21/2010	th	OFFICE		*OFFICE*	
10/25/2010	m	*OFFICE*		*OFFICE*	
10/26/2010	t	AM2	AM1	*OFFICE*	
10/27/2010	w	*OFFICE*		PM2	PM1
10/28/2010	th	*OFFICE*		*OFFICE*	

	Observer 1
am1	09:00 - 11:00
am2	11:00 - 13:00
pm1	13:00 - 15:00
pm2	15:00 - 17:00

	Observer 2
am1	08:00 - 10:00
am2	10:00 - 12:00
pm1	12:00 - 14:00
pm2	14:00 - 16:00

APPENDIX B

Table B1. Percentage of downstream movement (down/(up + down)) at the count window for each species by ladder at Bonneville, The Dalles, and John Day dams, 2005 - 2009.

	Bonneville Dam		The Dalles Dam		John Day Dam	
	Bradford Is.	*Washington*	*East*	*North*	*South*	*North*
2005						
Chinook	13.8%	11.6%	0.8%	4.5%	3.3%	34.5%
Steelhead	17.4%	13.7%	1.7%	9.2%	4.1%	44.4%
Sockeye	5.0%	3.2%	0.4%	2.0%	4.6%	35.3%
Coho	14.8%	9.2%	1.8%	6.0%	4.0%	32.3%
Salmonids	**14.8%**	**11.5%**	**1.1%**	**5.5%**	**3.7%**	**41.0%**
2006						
Chinook	15.1%	8.3%	0.7%	4.8%	3.0%	*
Steelhead	16.3%	11.3%	1.6%	12.6%	3.7%	*
Sockeye	5.2%	2.6%	0.4%	1.7%	3.9%	*
Coho	14.0%	8.5%	1.4%	4.8%	5.5%	*
Salmonids	**15.0%**	**9.2%**	**1.0%**	**8.7%**	**3.4%**	*
2007						
Chinook	18.9%	10.2%	1.1%	8.8%	3.9%	40.0%
Steelhead	15.9%	11.8%	1.4%	8.8%	4.1%	45.4%
Sockeye	4.9%	3.2%	0.7%	2.2%	4.4%	38.7%
Coho	13.4%	10.3%	1.8%	8.0%	7.1%	36.3%
Salmonids	**16.9%**	**10.6%**	**1.2%**	**8.5%**	**4.3%**	**44.0%**
2008						
Chinook	14.6%	10.0%	1.2%	6.0%	3.0%	28.1%
Steelhead	13.3%	10.9%	1.7%	7.3%	3.3%	43.2%
Sockeye	2.3%	1.8%	0.3%	3.7%	3.4%	27.1%
Coho	9.2%	7.5%	1.5%	6.9%	4.4%	36.4%
Salmonids	**12.2%**	**8.8%**	**1.2%**	**6.7%**	**3.2%**	**36.7%**
2009						
Chinook	16.6%	15.2%	2.0%	6.6%	2.1%	21.5%
Steelhead	14.6%	13.5%	3.6%	10.7%	2.2%	42.0%
Sockeye	4.8%	4.5%	0.6%	0.8%	4.0%	33.4%
Coho	15.3%	8.9%	5.4%	8.9%	5.3%	36.5%
Salmonids	**14.9%**	**12.8%**	**2.7%**	**8.6%**	**2.6%**	**38.6%**

* Data not available (files lost from north ladder count station computer).