

December 2004

To: Marvin Shutters and David Clugston, USACE  
From: Tami Clabough and Chris Peery, University of Idaho

Re: Removable Spillway Weir (RSW) fallback evaluation 2002 and 2003; Letter Report.

The following is a summary of our evaluation of behavior and fallback of adult Chinook salmon and steelhead kelts in relation to the removable spillway weir (RSW) at Lower Granite Dam in 2002 and 2003. Our goal was to determine if operation of the RSW would increase the probability that adult salmon migrants would fallback at projects.

### Methods

In 2001, a Removable spillway weir (RSW) was installed at Lower Granite Dam in spillbay 1 to improve juvenile passage. In 2002 and 2003, the Removable Spillway Weir (RSW) was in operation and being tested for passing juveniles downstream at Lower Granite Dam. We used an underwater antenna array (at 4.5, 9.5, and 14 meters depth) to monitor fallback and behavior in and around the RSW for adult salmon and post-spawn steelhead (kelts).

In 2002, two (SRX/DSP) receivers (RGR antennas 1-5, SGR antennas 1-4) were connected to USGS's antenna configuration that monitored the RSW and spillbay 2 area (Figure 1). In 2003, a similar system was in place however one (SRX/DSP) receiver (ZGR) with 7 antennas was installed (Figure 2).

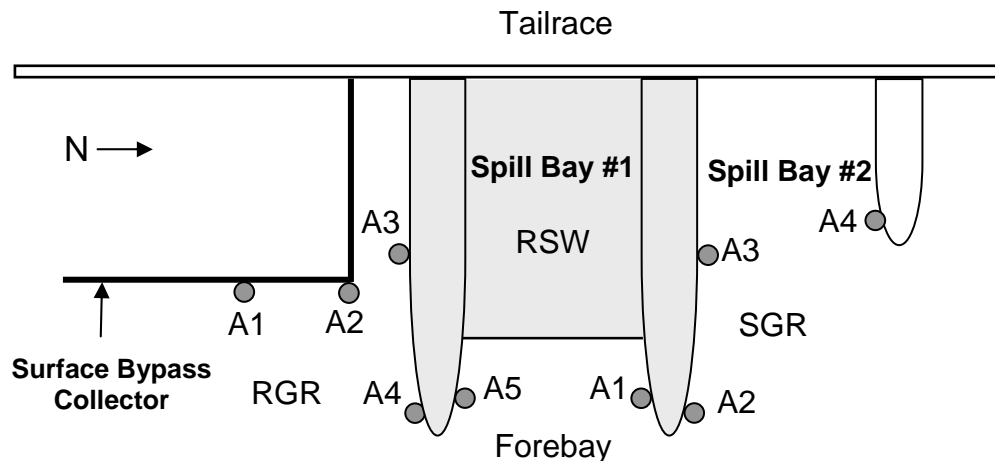


Figure 1. The 2002 underwater antenna configuration around the removable spillway weir in the forebay of Lower Granite Dam. Note each antenna site is made up of 3 underwater antennas deployed at 4.5, 9.5, and 14 meters and configured so a hit at any depth is recorded as that particular antenna site.

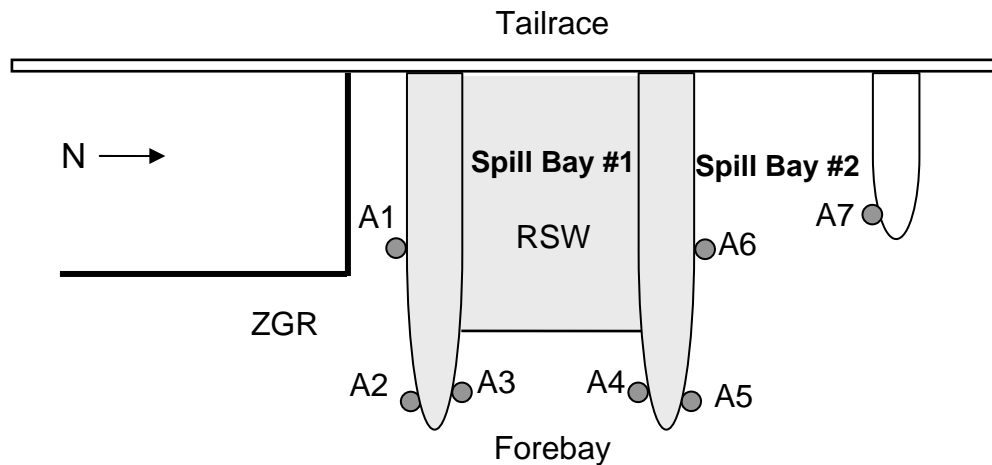


Figure 2. The 2003 underwater antenna configuration around the removable spillway weir in the forebay of Lower Granite Dam. Note each antenna site is made up of 3 underwater antennas deployed at 4.5, 9.5, and 14 meters and configured so a hit at any depth is recorded as that particular antenna site.

A fish was considered to have fallen back when it was recorded in the forebay or upstream of a dam at a telemetry site and then subsequently recorded at a telemetry site downstream of the dam. Due to antenna coverage in 2002 and 2003, the exact route of fallback could not be determined because all routes were not monitored (spillways, turbines, etc.). Therefore, fallback through the RSW was recorded as “likely” based on fish behavior and hits on 2 or more telemetry RSW antenna sites in the forebay of the dam. Fish that only had hits on one RSW antenna site (during RSW operation) were recorded as “possible” RSW fallbacks. Fish that had hits on RSW antennas while the RSW was not running were recorded as spillway or other route fallbacks.

Fish that were tagged at Lower Granite in 2002 (acoustic MAP tags) were not included in this analysis because these fish were released directly into the ladder and their behavior within the immediately vicinity of the forebay of the dam may have differed from those originally tagged at Bonneville Dam. One MAP fish “likely” fell back through the RSW but was not included in the fallback total.

A steelhead was considered post-spawn (kelt) if it was detected in a spawning area during the historic spawning period (March through June) prior to being detected at Lower Granite Dam and showed consistent downstream migration afterwards.

## Results - 2002

In 2002, the treatments for testing the RSW ran from April 15<sup>th</sup> until June 7<sup>th</sup>. Three operational scenarios were tested, night time spill (~60 kcfs; gas cap), spill through RSW (6.7 kcfs) plus spill (15.8 kcfs; total 22.2 kcfs) through bays 2-8 (RSW+16), and spill through RSW (6.7 kcfs) plus spill (8.5 kcfs; total 15.2 kcfs) through bays 3, 5, 6, 7, and 8 (RSW+8). However, due to forced

spill these conditions were not always met (Table 1). Radio-tagged fish did not start passing Lower Granite Dam until 2 May 2002; therefore, there were 17 days during the test period (11 days of RSW operation) that were not monitored by radio-tagged fish.

Table 1. Average, minimum, and maximum flow and spill (kcfs) conditions during treatment testing in 2002.

Treatment	Flow			Spill		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Gas Cap	82.7	56.3	133.7	29.7	14.4	61.1
RSW+16	83.3	51.8	112.2	28.2	15.1	59.9
RSW+8	79.9	51.8	112.2	24.4	15.1	42.0
RSW+6*	108.7	107.8	109.6	56.5	53.1	59.9

\*Note RSW+6 was during last 2 days of treatment schedule only

### *Spring/Summer Chinook Salmon*

Total fallback for spring/summer Chinook salmon at Lower Granite Dam in 2002 was 3.4% (11/321); 3 fish did not reascend. During the 54 days of the experiment, 250 radio-tagged spring/summer Chinook salmon passed Lower Granite Dam. Of those, 49 fish had records on RSW antennas and five of those salmon fell back. Three fish fell back during the RSW+16 treatment and the other 2 fish fell back during the RSW+8 treatment.

During the hours (days) of RSW operation (RSW+16 and RSW+8 combined), 170 radio-tagged spring/summer Chinook passed the dam. Of those, 31 fish had records on RSW antennas and five fish (2.9%) fell back. The five fish that fell back during RSW operation were “likely” to have fallen back through the RSW based on fish behavior and radio telemetry records. All five fish reascended and passed Lower Granite Dam. Eighty radio-tagged spring/summer Chinook passed the dam during the period with the nighttime spill treatment (gas cap), 18 fish had records on RSW antennas and none fell back.

### *Kelts*

During the 2002 test period (April 15<sup>th</sup> –June 7<sup>th</sup>), 24 radio-tagged kelts were recorded on RSW antennas and 23 fell back. Five kelts, were “likely” to have fallen back through the RSW, 10 “possibly” fell back through the RSW, 8 fell back through unmonitored spillways or by some other route (RSW not operating), and 1 kelt did not fall back.

## Results – 2003

In 2003, the treatments for testing the RSW ran from April 14<sup>th</sup> until May 31st. Two operational scenarios were tested, night time spill (gas cap), which included 12 h of no spill during day and 12 h of spill to gas cap at night, and 24 h operation of RSW with 14 kcfs spill (Table 2.)

Table 2. Average, minimum, and maximum flow and spill (kcfs) conditions during treatment testing in 2003.

Treatment	Flow			Spill		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Gas Cap	91.9	69.0	192.0	30.9	0.0	146.0
RSW	82.8	67.0	176.0	24.5	19.0	102.0

### *Spring/Summer Chinook Salmon*

Overall, fallback for spring/summer Chinook salmon at Lower Granite Dam in 2003 was 2.3% (7/309); 3 fish did not reascend. The experiment lasted 48 days in 2003, during which 172 radio-tagged spring/summer Chinook salmon passed Lower Granite Dam. Of those, 94 fish had records on RSW antennas and 3 fish fell back. Two fish fell back during the RSW treatment and 1 fish fell back during the gas cap.

During the hours (days) of RSW operation, 97 radio-tagged spring/summer Chinook passed the dam. Of those, 59 fish had records on RSW antennas and two fish (2.0%) fell back. The two fish that fell back during RSW operation were “likely” to have fallen back through the RSW based on fish behavior and radio telemetry records. One of the two fish that fell back during the RSW treatment did not reascend Lower Granite Dam.

Seventy-five radio-tagged spring/summer Chinook passed the dam during the period with nighttime spill treatment (gas cap). Of those, 36 fish had records on the RSW antennas and one fish fallback (1.3%) during spill and reascended the dam.

### *Kelts*

During the 2003 test period (April 14<sup>th</sup> – May 31st), 36 radio-tagged kelts had records on RSW antennas and all 36 fell back. Eleven kelts, were “likely” to have fallen back through the RSW, 18 “possibly” fell back through the RSW, and 7 fell back through unmonitored spillbays or other routes while the RSW was not operating.

## Discussion

In 2002, fallback through the RSW could have been underestimated due to not having radio-tagged fish passing the dam during the first 11 days of the RSW treatment. We were unable to determine the exact route of fallback because not all potential routes were monitored. However, when fallback levels during RSW operation (2.9%) were compared to total spring and spring/summer fallback percents (3.2% and 3.4% respectively), fallback during RSW operation was not higher than total spring/summer fallback for that year. In 2003, we found similar results, where fallback during RSW operation (2.0%) was not measurably higher than the overall percent fallback for spring/summer Chinook salmon (2.3%). Furthermore, fallback percentages for 2002 and 2003 fell within the range of spring/summer Chinook fallback percents in years prior to installation of the RSW: 1% (1/101) in 1996, 5.8% (17/292) in 1997, 4.3% (10/230) in 1998, 2.9% (7/238) in 2000, 0.6% (3/538) in 2001.

Most steelhead kelts that reached Lower Granite Dam fell back at the dam; many, it appears, via the RSW. It is generally believed that passage through the RSW to be more benign than by other routes at the dam, although there is as yet no evidence to support this supposition. If true, operation of the RSW could benefit and improve kelt passage at Lower Granite Dam, and other projects. However, further study is needed to determine the number and fates of steelhead kelts passing downstream of Lower Granite Dam through the RSW.