

**Gas Supersaturation Monitoring Report
during Corner Collector Operation and Spill
at Bonneville Dam March 2-5, 2005**

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Introduction

To aid the downstream survival of about 7.4 million tule fall Chinook (*Oncorhynchus tshawytscha*) juveniles scheduled for release from the Spring Creek National Fish Hatchery on March 2, 2005, the U.S. Fish and Wildlife Service (Service) reached an agreement with the Action Agencies (Bonneville Power Administration (BPA), and U.S. Army Corps of Engineers (Corps)) in March 2004 for the provision of Bonneville Dam Power House 2 Corner Collector (B2CC) operation for the March 2005 and 2006 releases. Sufficient depth for compensation from gas supersaturation, as measured by total dissolved gas (TDG) over listed chum salmon (*O. keta*) redds below the Bonneville Dam project was requested. It was calculated by Service biologists that the anticipated level of flow and B2CC operation would produce a maximum TDG level not exceeding 120% in the tailrace of Bonneville Dam and a maximum TDG level not exceeding 105% above the chum and fall Chinook salmon redds below Bonneville Dam at the Ives Island complex and across the river along the Oregon shore, including the Multnomah Falls area (Figures 1 and 2).

The Service requested a TDG waiver from the Oregon Department of Environmental Quality (ODEQ) and an adjusted dissolved gas standard from the Washington Department of Ecology (WDOE) for spill at Bonneville Dam for a ten day period in March, 2004. These requests were made to allow for TDG saturation up to 115% as measured at the Camas/Washougal monitoring station (RM 122) and 120% in the Bonneville Dam tailrace, as measured at the Warrendale monitoring stations (RM 140) on the Washington and Oregon shores, respectively. The Oregon Environmental Quality Commission approved this request at its February 6, 2004 meeting. The Oregon waiver was a multiyear waiver for spill through March 2007. The WDOE provided the adjusted TDG standard on February 27, 2004. The WDOE adjusted TDG standard expired on February 27, 2005. A new exemption was issued by WDOE in March 2005 to the Corps, which included actions at Bonneville Dam for the March release. This exemption extends through February 2008 and applies to Corps dams on the Columbia and Snake Rivers in Washington State.

This report summarizes the results of the 2005 March release and the monitoring for TDG during the B2CC operation.

Operations

The March group of tule fall Chinook smolts (7.35 million) were released on Wednesday March 2, 2005. The Bonneville Powerhouse 2 Corner Collector (B2CC) operation was to last for a minimum of four days. The Service had requested six days for the best passage of the fish. An agreement was reached to operate the B2CC for four days and reevaluate the passage of the tule smolts and, if water were available, to possibly continue the operation for some extended amount of time. The Service goal was to pass 90-95% of the smolts during the B2CC operation period.

It was estimated that the elevated tailwater that was to accompany the B2CC operation would provide the necessary depth compensation to 108%, the estimated level of TDG expected to be generated by the B2CC operation. The operation was to begin if fish showed up at the juvenile sampling facility Thursday morning (March 3), or later at noon. The latest it could start would be Thursday afternoon, which was the latest the Bonneville Dam crew were available to open the gate until the following Monday morning. B2CC began operation about 3:40 PM Thursday afternoon. The B2CC was closed at 3:30 PM on Saturday March 5.

The Service monitored water quality (TDG) from the mainstem Columbia River gauges below Bonneville Dam (Warrendale and Camas/Washougal) and at the critical chum salmon redd locations using a Hydro-Lab Datasonde4 probe (preseason factory calibration) during the March 3-March 5 B2CC operational period.

Results

Biological Monitoring:

No biological monitoring for gas bubble trauma (GBT) was conducted in 2005 as the TDG levels did not exceed the 110% requirement. Passage timing of the tule smolts past Bonneville Dam was tracked with data collected by the Smolt Monitoring Program at the Juvenile Fish Facility. Passage data is shown in Table 1 and Figure 3. Approximately 61% of the Spring Creek tule smolts passed Bonneville Dam during the period of time the B2CC was operating.

Monitoring of Physical Conditions:

The Service monitored tailwater depth, TDG data from the tailrace monitor (Warrendale), and TDG data from the downstream monitor (Camas/Washougal) (Table 2). These data were collected and transmitted automatically for display on the Corps website:

<http://www.nwd-wc.usace.army.mil/report/total.html>

The Bonneville dam project tailwater height at Tanner Creek is also listed in Table 2 (Corps dataquery website: <http://www.nwd-wc.usace.army.mil/perl/dataquery.pl>).

Figure 3 shows daily total discharge and spill at Bonneville Dam before, during, and after the spill and B2CC operations. Total discharge varied from 110-174 thousand cubic feet per second (Kcfs). Spill volume ranged from 0-2.3 Kcfs.

Figure 4 visually compares the TDG readings taken at the Bonneville Dam forebay and the sampling stations downstream of Bonneville Dam from February 27 through March 11 (before, during, and after the B2CC operation). The TDG levels ranged from 102-107 % in the Bonneville forebay. Neither of the two downstream gauges used for the monitoring of the operation (Warrendal and Camas/Washougal) went above 109.2 % during this time period. Recorded TDG levels at the Warrendale monitoring station varied from 102.2% to 108.8% during this time period. The TDG levels recorded at the Camas/Washougal monitoring station varied from 102.2 to 109.2%.

Table 3 summarizes the TDG data seen in Figures 3 and 4, and highlights the three day period (March 3-5) encompassing the actual 48 hour B2CC operation. Ambient TDG levels ranged from 102-107 % in the Bonneville forebay. Neither of the two downstream gauges used for the monitoring of the operation (Warrendal and Camas/Washougal) went above 108.4 % during this time period. TDG levels at the Warrendale monitoring station varied from 104.6% to 107.9% during this time period. The TDG levels recorded at the Camas/Washougal monitoring station varied from 103.3 to 108.4%.

Table 2 shows the measured TDG readings taken by the Service at the chum red sites. The TDG readings at the Multnomah Falls site were above the 105% limit without adequate depth compensation. Despite trying to adjust the operation to alleviate the problems, the B2CC operation was terminated after 48 hours of the planned minimum 96 hour operation.

Discussion

The Service was on the river Thursday afternoon before the B2CC operation began and measured 107% TDG at the Multnomah Falls site and 107%-109% TDG at the Ives/Pierce redd locations (Table 2). There was no depth compensation for redds along the shallow shorelines in either site (less than 1-2 inches).

TMT discussed the reasons for the unusually high TDG levels. It was thought that, aside from possible environmental factors, the attraction flow for the adult ladders coming

from the two end spill bays might be causing some of the problem. This attraction spill is a daytime operation only at this time of year. By shutting down the end spill bay flows and opening the B2CC, it was thought the gas levels would remain about the same, but we would have the benefit of a higher tailwater for depth compensation. TMT members agreed to this tactic. Despite the low numbers of tule smolts entering the juvenile sampling facility, the B2CC began operation about 3:40 PM Thursday afternoon. The Service left the river about 6:30 PM, March 3, the tailwater was coming up and TDG levels in the Ives area were declining.

The Service returned to the river Friday morning, March 4 to take measurements. Overnight the TDG readings at the Warrendale gauge peaked out at about 107.5% (Table 2). The morning measure at the Multnomah Falls site redds was 107%, but there was no depth compensation. The tide was about at the low point then and no visible compensation depth was apparent, in fact the river level was a few inches below that of the previous evening. In the Ives complex and across the river on the Oregon side by McCord Creek (Figure 1), the elevated tailwater was readily apparent. In the Ives complex there was a foot of water over the redds and the TDG measured about 106%. At the McCord Creek area a similar elevation increase was noted, but the one redd recorded there was previously under a foot of water. The TDG reading was about 107%. The problem area was at the Multnomah Falls site. Based upon the time of day the TDG readings were made, the B2CC operation appeared to be adding about 2% TDG without providing sufficient depth compensation at the Multnomah Falls site. Apparently, the unseasonably warm temperatures, low water conditions, and low tides were combining to make conditions challenging in that area to compensate for TDG levels.

At a Friday afternoon TMT conference call both NMFS and The Service reiterated their obligation and desire to protect the chum redds. It was decided that the only options were to cease the B2CC operation or provide more water for depth compensation. BPA and the Corps said there was still only a finite amount of water available. With the desire to provide protection to the Multnomah Falls chum redds and provide the best passage conditions for as much of the Spring Creek release as possible, several TMT members asked if raising the tailwater another foot for the duration of the remainder of the available water would be a possible solution. The Corps and BPA agreed to that proposal. It was believed that by providing a 13.5 foot tailwater there would be continued protection for the Ives area redds, and more protection for the Multnomah Falls redds via a diluted TDG level and some increase in the depth compensation than was seen so far.

Beginning shortly after 6 PM Friday night, the Bonneville Dam tailwater was raised to

13.5 feet. The TDG readings at Warrendale peaked at 107.9% Friday afternoon at 5 PM, with a day average of 107.2. The TDG readings at Warrendale peaked Saturday at 107.4% at 4 PM, with a day average of 106.4%. This TDG level was above the standard of 105% for the shallow redds at the Multnomah Falls site. The B2CC operation was terminated at 3:30 PM Saturday afternoon, March 5. There was a step down period of five hours with the tailwater maintained at 12.5 feet to keep the water from the B2CC moving down river and adding some dilution factor. After 9 PM the tailwater returned to a minimum of 11.5 feet.

Beginning Sunday morning the end bay attraction spill commenced again and the operating criteria was the same as was in effect prior to the start of the B2CC operation on Thursday. On Sunday the TDG peaked at 106.4% at 1 PM, with a day average of 105.3% and a project tailwater of 11.5 feet.

The Service and NOAA Fisheries agreed that the long term concerns of the Multnomah Falls area warrants further investigation. The Service and the Fish Passage Center encouraged the Corps to deploy a data logger at the Multnomah Falls site as soon as possible to begin to gather data on TDG and temperature for the remainder of the emergence time.

Summary

The Service monitored water quality (TDG) from the mainstem Columbia River gauges below Bonneville Dam (Warrendale and Camas/Washuogal) and at the critical chum salmon redd locations during the March 3-March 5 B2CC operational period.

Total dissolved gas levels recorded at the tailrace monitoring station (Warrendale) did not exceed the 120% waiver limit (107.9% actual). The TDG levels recorded at the Camas/Washougal monitoring station did not exceed the 115% waiver limit (109.2% actual).

The TDG levels measured by the Service for shallow redds at the Multnomah Falls site exceeded the 105% TDG limit. The B2CC operation was terminated after only two of the planned four days operation for Spring Creek smolt passage because of the concern for the chum redds.

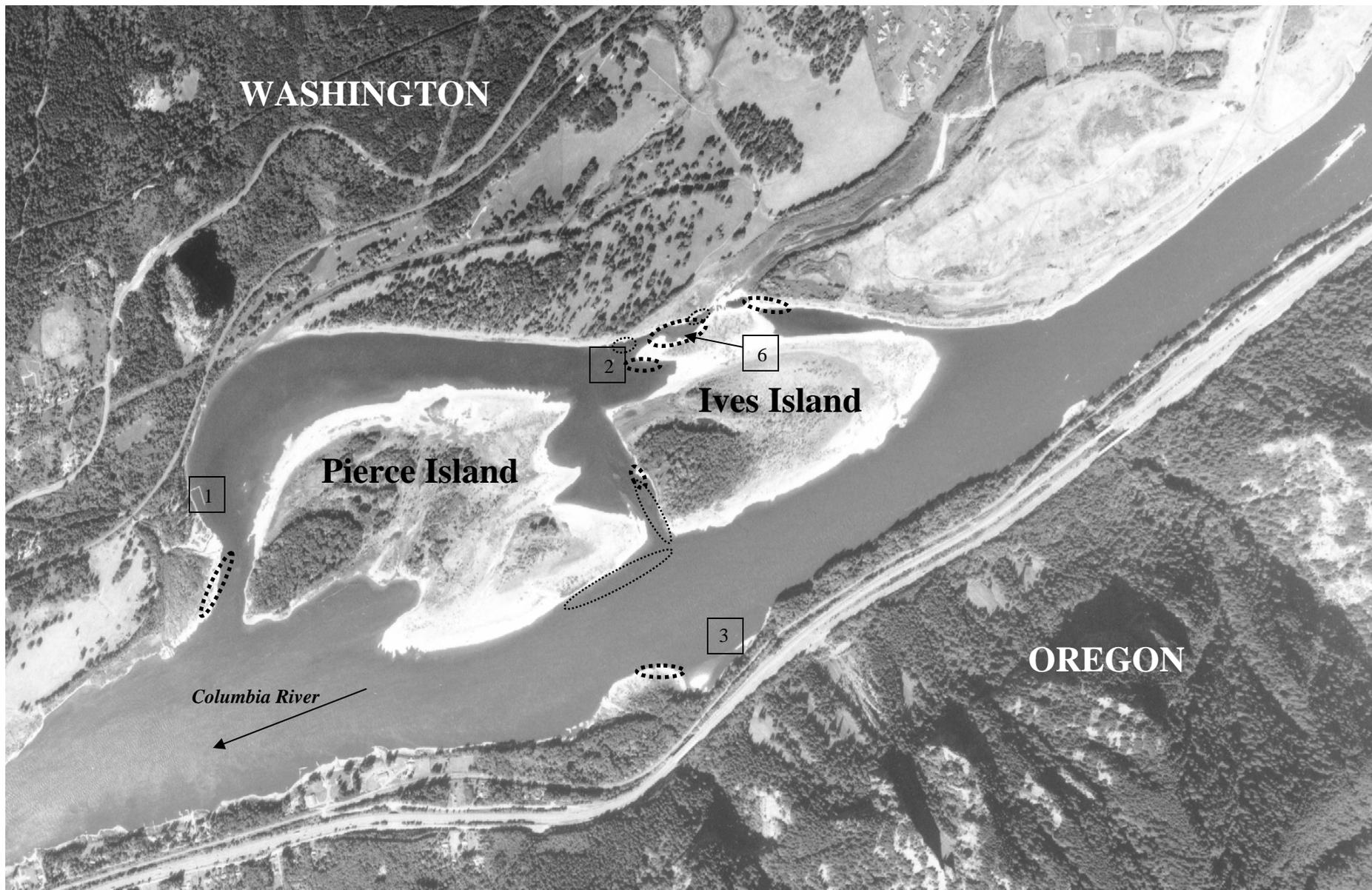


Figure 1. Location of salmon redds and TDG sample sites in the Ives/Pierce area below Bonneville Dam through December 16, 2004 surveys.

----- chinook spawning site chum spawning site [1] TDG sample site

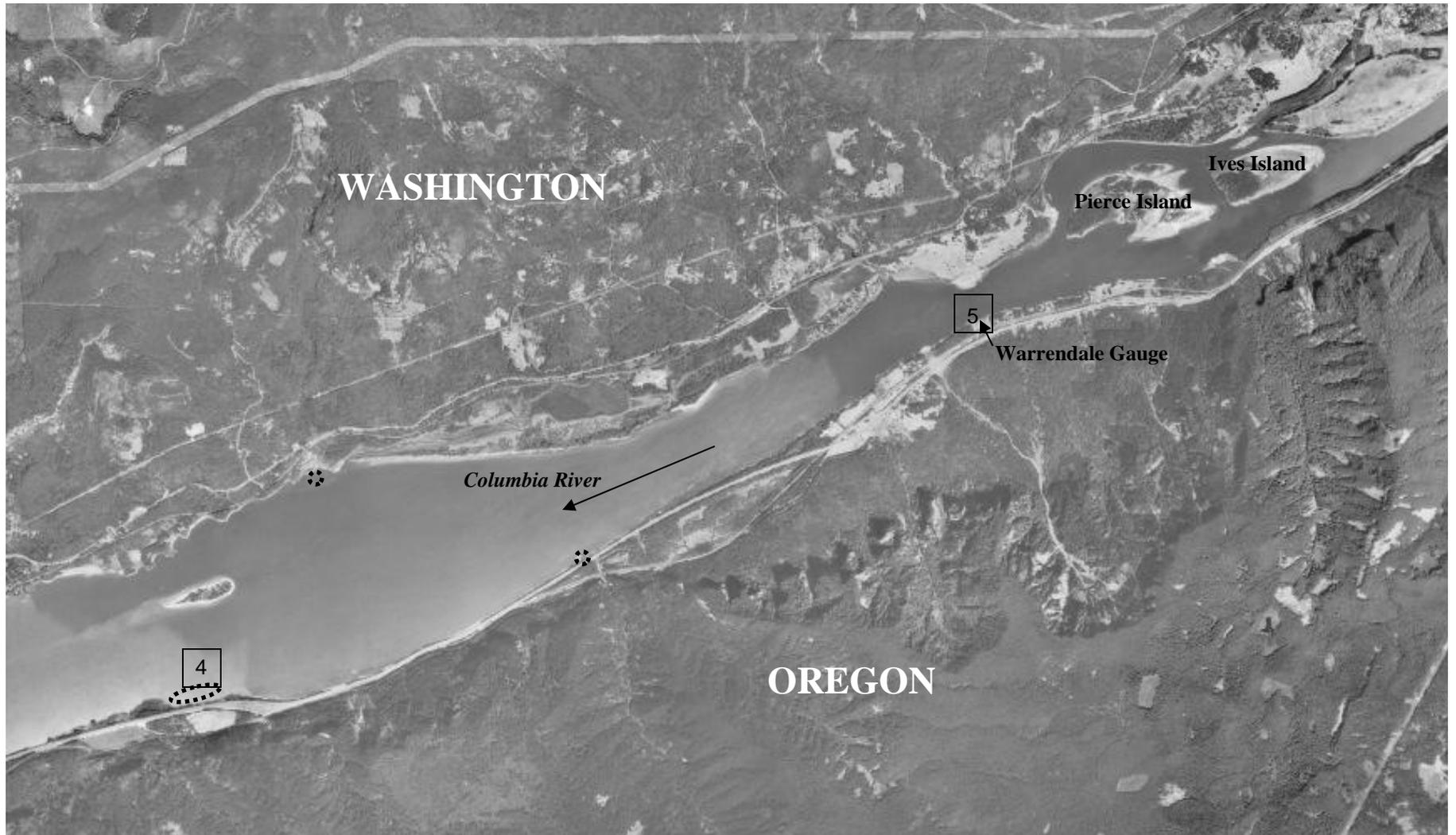


Figure 2. Location of salmon redds and TDG sample sites from Multnomah Falls to Warrendale below the Ives Island Complex through December 16, 2004 surveys.

⋯⋯⋯ chum spawning site

4 TDG sample site

Table 1. Fish passage index counts at Bonneville Dam (2000-04), combined subyearling chinook. Index counts are from Power House 2 beginning in year 2000. In all previous years index counts were from Power House 1.

Number of days into spill start	Spring Creek Release 03/02/05 B2CC		Spring Creek Release "B" 03/10/04 B2CC		Spring Creek Release "A" 03/01/04 Spill		Spring Creek Release 03/01/03 Spill		Spring Creek Release 03/11/02 Spill		Spring Creek Release 03/08/01 Spill	
	Index Count *	Date	Index Count *	Date	Index Count *	Date	Index Count *	Date	Index Count *	Date	Index Count *	Date
-1	35	03/02/05		03/10/04	----	03/01/04	----	03/09/03	----	03/11/02	----	03/09/01
1	33	03/03/05		03/11/04	----	03/02/04	----	03/10/03	847	03/12/02	----	03/10/01
2	8,924	03/04/05	50,260	03/12/04	20,825	03/03/04	256,056	03/11/03	17,434	03/13/02	----	03/11/01
3	387,479	03/05/05	242,411	03/13/04	173,388	03/04/04	62,621	03/12/03	367,558	03/14/02	----	03/12/01
4	264,004	03/06/05	52,319	03/14/04	123,449	03/05/04	16,830	03/13/03	187,981	03/15/02	59,454	03/13/01
5	89,485	03/07/05	18,647	03/15/04	26,718	03/06/04	5,861	03/14/03	158,610	03/16/02	31,679	03/14/01
6	29,584	03/08/05	7,230	03/16/04	4,464	03/07/04	940	03/15/03	11,607	03/17/02	18,041	03/15/01
7	13,558	03/09/05	7,322	03/17/04	6,740	03/08/04	1,148	03/16/03	5,645	03/18/02	5,075	03/16/01
8	6,037	03/10/05	4,644	03/18/04	3,678	03/09/04	708	03/17/03	3,718	03/19/02	4,760	03/17/01
9	6,785	03/11/05	3,829	03/19/04	2,331	03/10/04	576	03/18/03	1,672	03/20/02	3,024	03/18/01
10	2,846	03/12/05	6,186	03/20/04	2,310	03/11/04	745	03/19/03	2,624	03/21/02	2,531	03/19/01
11	2,898	03/13/05	5,976	03/21/04			386	03/20/03	756	03/22/02	4,782	03/20/01
12 Day Total	811,668		398,824		363,903		345,871		758,452		129,346	
5 Day Passage	779,476		363,637		344,380		341,368		732,430		91,133	
5 Day %	96.0%		91.2%		94.6%		98.7%		96.6%		70.5%	

---- no counts taken, no data available

bolded dates are first and last days of spill or Corner Collector operations

* Index counts are based on a 24 hour Smolt Monitoring Program sample collection counted about 8 AM on the listed date.

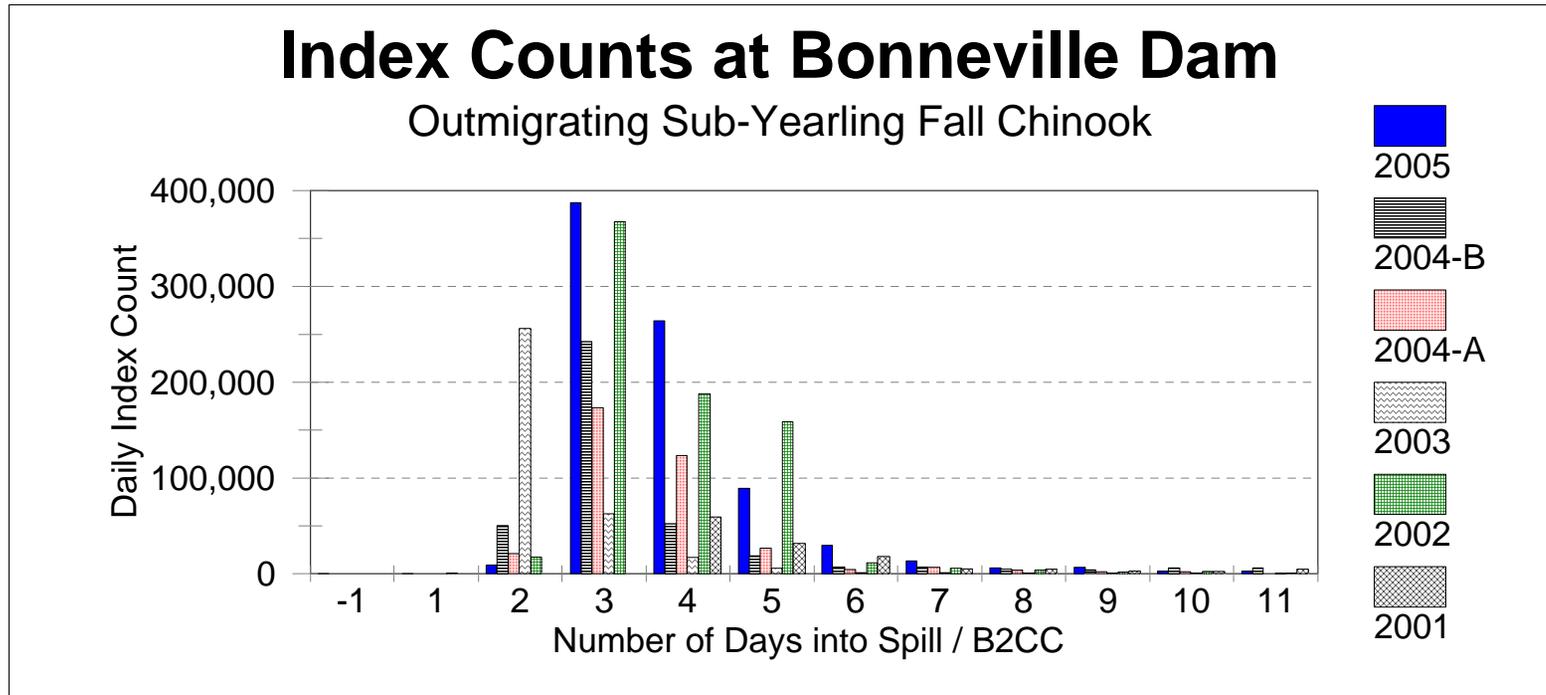


Figure 3. Fish passage index counts before and during spill periods at Bonneville Dam from 2001-2005.

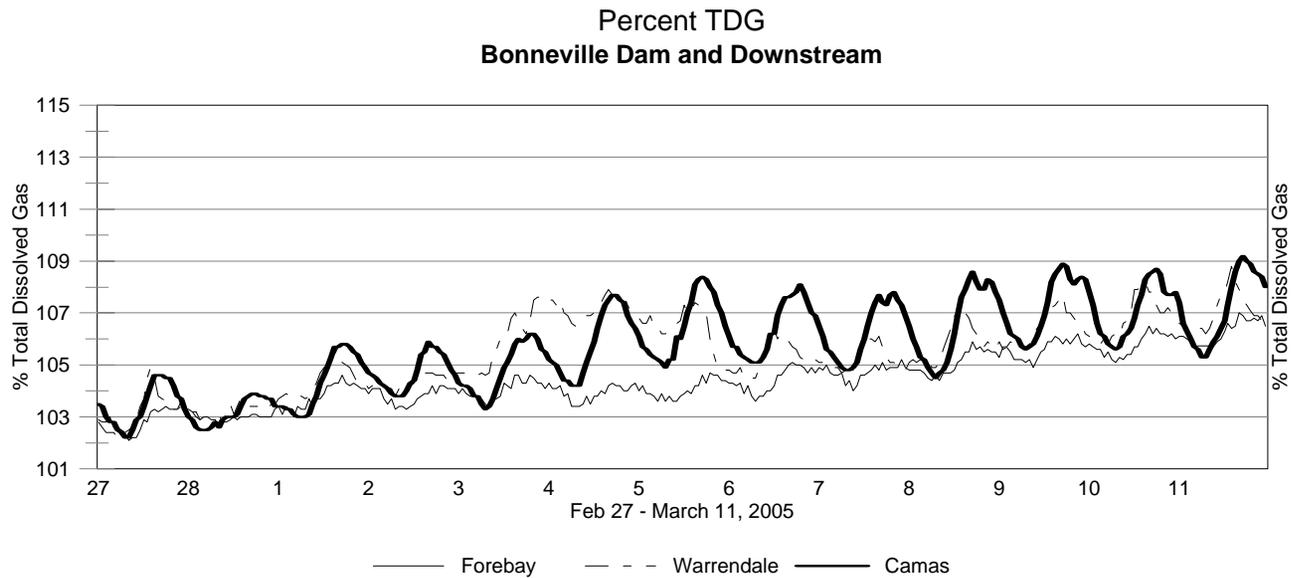


Figure 4. Percent saturation of Total Dissolved Gas at Bonneville Dam and downstream gauges, February 27 through March 11, 2005.

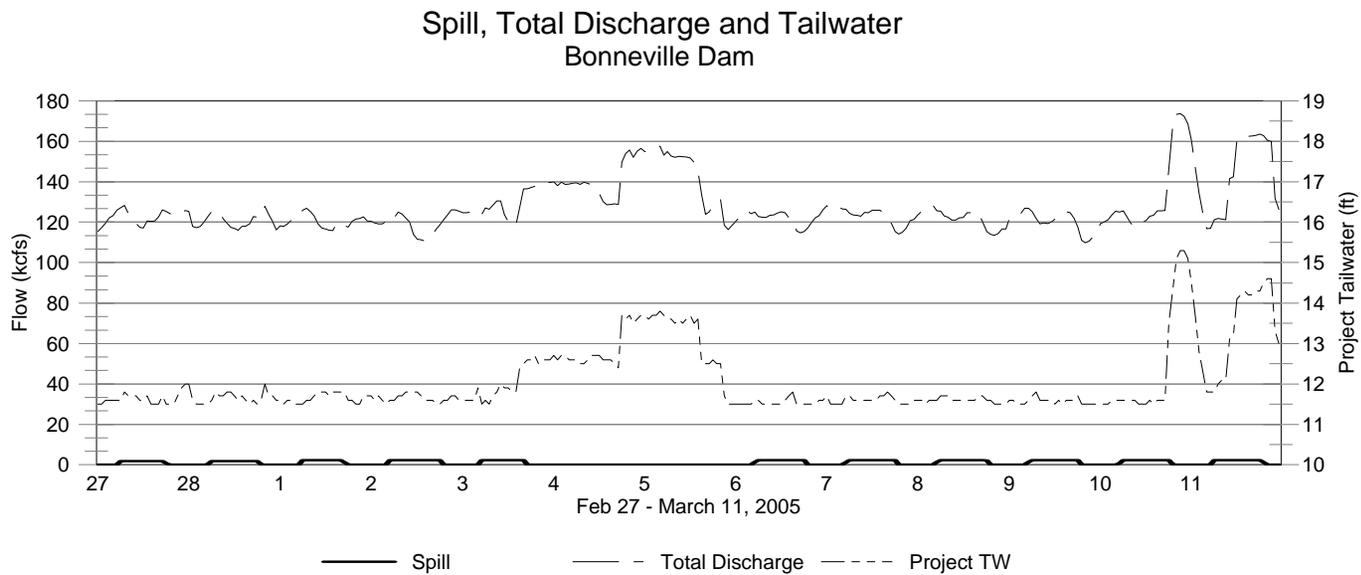


Figure 5. Spill, flow, and tailwater elevation at Bonneville Dam, February 27 through March 11, 2005.

Table 2. USFWS TDG field measurements below Bonneville Dam during the 2005 Spring Creek release.

Sample Site	Date	Time Probe into Water	Time of Sample	Probe Depth feet	Probe Temp °C	Probe ¹ TDG Pressure mmHG	Baro Pres mmHG Warrendale (WRNO)	Probe %TDG	%TDG Warrendale (WRNO)	Time of Sample
1 Beacon Rock Boat Ramp	03-Mar	01:32 PM	02:16 PM	1.87	6.3	812	762	106.6%	106.2%	02:00 PM
2 Fish Wheel Pilings*	03-Mar	02:25 PM	02:45 PM	0.47	7.45	831	762	109.1%	106.8%	03:00 PM
3 OR shore, McCord Ck	03-Mar	02:51 PM	03:01 PM	3	5.8	811	762	106.4%	106.8%	03:00 PM
4 Warrendale	03-Mar	03:10 PM	03:30 PM	3	5.9	802	762	105.2%	107.0%	04:00 PM
5 Multnomah Falls redds	03-Mar	03:43 PM	04:00 PM	2	6.5	817	762	107.2%	107.0%	04:00 PM
5 Multnomah Falls redds	03-Mar	03:43 PM	05:40 PM	2	6.3	812	762	106.6%	106.4%	06:00 PM
4 Warrendale	03-Mar	05:55 PM	06:02 PM	3	5.4	799	762	104.9%	106.4%	06:00 PM
3 OR shore, McCord Ck	03-Mar	06:09 PM	06:12 PM	3	5.4	797	762	104.6%	106.4%	06:00 PM
2 Fish Wheel Pilings*	03-Mar	06:17 PM	06:22 PM	3	5.9	809	762	106.2%	106.2%	07:00 PM
1 Beacon Rock Boat Ramp	03-Mar	06:27 PM	06:32 PM	3	6.6	815	762	107.0%	106.2%	07:00 PM
5 Multnomah Falls redds	04-Mar	09:55 AM	10:20 AM	1	6.4	818	768	106.5%	106.8%	10:00 AM
3 OR shore, McCord Ck	04-Mar	10:48 AM	11:08 AM	1	5.3	819	768	106.6%	106.9%	11:00 AM
1 Beacon Rock Boat Ramp	04-Mar	11:18 AM	11:38 AM	3	5.5	805	768	104.8%	106.9%	12:00 PM
6 Ives Island redds	04-Mar	12:04 PM	12:24 PM	1	5.9	812	768	105.7%	106.9%	12:00 PM
4 Warrendale	04-Mar	12:51 PM	01:15 PM	3	5.4	818	768	106.5%	107.0%	01:00 PM

¹ Hydro-Lab Datasonde4 probe was used. Pre-season calibration at factory.
 * Downstream from the mouth of Hamilton Creek.

<u>Feb 27-Mar 11, 2005</u>				<u>TDG % Saturation</u>		
	SPILL (KCFS)	TOTAL FLOW (KCFS)	Project TW (ft)	Bonneville Forebay (BON)	Warrendale (WRNO)	Camas (CWMW)
Average	1.0	127.7	12.0	104.4	105.5	105.7
Minimum	0.0	109.9	11.5	102.1	102.2	102.2
Maximum	2.3	173.6	15.3	107.0	108.8	109.2

<u>Mar 3-Mar 5, 2005</u>				<u>TDG % Saturation</u>		
	SPILL (KCFS)	TOTAL FLOW (KCFS)	Project TW (ft)	Bonneville Forebay (BON)	Warrendale (WRNO)	Camas (CWMW)
Average	0.4	137.5	12.7	104.0	106.5	105.7
Minimum	0.0	116.3	11.5	103.4	104.6	103.3
Maximum	2.3	157.6	13.8	104.7	107.9	108.4

Table 3. Summary of spill, total flow, tailwater elevation (TW), and percent TDG for a 14 day period (February 27-March 11) before, during and after B2CC operations, and the three day period (March 3 - 5) encompassing the 48 hour B2CC operation.