Monitoring Report for March 18-28, 1999, Spill at Bonneville Dam

Introduction

The U.S. Fish and Wildlife Service (USFWS) requested a total dissolved gas (TDG) waiver from the Oregon Department of Environmental Quality and an adjusted dissolved gas standard from the Washington Department of Ecology (WDOE) for spill at Bonneville Dam for the period March 18 through 28, 1999. These requests were made to allow for TDG saturation up to 115% as measured at the Camas-Washougal monitoring station and 120% in the Bonneville Dam tailrace. The Oregon Environmental Quality Commission approved this request at its January 28, 1999 meeting. The WDOE provided the adjusted TDG standard on March 8, 1999. One of the conditions of the approved waiver and adjusted TDG standard was that the USFWS conduct biological and physical monitoring downstream of Bonneville Dam during the spill period and to provide reports of this monitoring.

The USFWS Columbia River Fisheries Program Office (CRFPO) monitored water conditions and examined fish collected below Bonneville Dam for signs of Gas Bubble Trauma (GBT) during the March 1999 spill period. This report summarizes the results of this monitoring program.

Operations

On the morning of March 18, 1999, Spring Creek National Fish Hatchery (NFH) released 4.2 million juvenile tule fall chinook salmon. The salmon management agencies requested that spill up to the 120% gas cap begin at 2000 hours on March 18 and continue for 24 hours per day through 2000 hours on March 28. This request was transmitted to the operating agencies via System Operational Request #99-1 (Attached). Voluntary spillway releases to assist fish passage began at Bonneville Dam on March 18, 1999 at 2000 hours when spill was increased from about 39 thousand cubic feet per second (kcfs) to about 151 kcfs. The total river flow volume at that time was about 236 kcfs.

The operating agencies only agreed to spill for 7 days with additional days contingent on juvenile fish passage information. On March 25, 1999, the project operators and regulators denied the salmon managers' request to spill for fish passage at Bonneville Dam through March 28. However, spill up to 150 kcfs at night and 75 kcfs during the day was provided through March 28. This occurred because river flow exceeded electrical power demand at times.

Biological Monitoring

The biological monitoring program included collecting juvenile salmonids and resident fish during the period of spill and examining them for signs of gas bubble trauma. Sampling was conducted on three days. Personnel from the USFWS who collected and examined fish for GBT had been trained on examination techniques by staff from the Fish Passage Center and U.S. Geological Survey (USGS) Biological Resources Division. The same USFWS personnel had also conducted biological sampling and examined fish for GBT during the March, 1998, spill

period at Bonneville Dam.

Fish were collected by electroshocking from a boat and seining on March 19, 21, and 23. Electroshocking was conducted in the main river channel below Bonneville Dam and near the side channel of Pierce and Ives islands (Figure 1). Staff from the USFWS electroshocked along the shorelines and in areas where depths did not exceed 3 meters to maximize electroshocking and fish collecting efficiency. Sampling crews collected fish with a 50-foot-long beach seine in nearshore areas of Pierce and Ives islands. Most of the fish were captured by seining. Most fish were collected and examined on March 19 near Ives and Pierce islands. This was also the day that the fish passage index count (270,000 subyearling chinook) at Bonneville Dam was the highest. On March 19, Washington Department of Fish and Wildlife personnel also provided fish caught by beach seining.

On March19 and 21 the sampling station was set up on the shore of Pierce National Wildlife Refuge (NWR) just downstream of Hamilton Island (Figure 1). A tent was set up to move sampling equipment into it in case of rain. On March 23 the sampling station was set up at the top of Pierce Island (Figure 1).

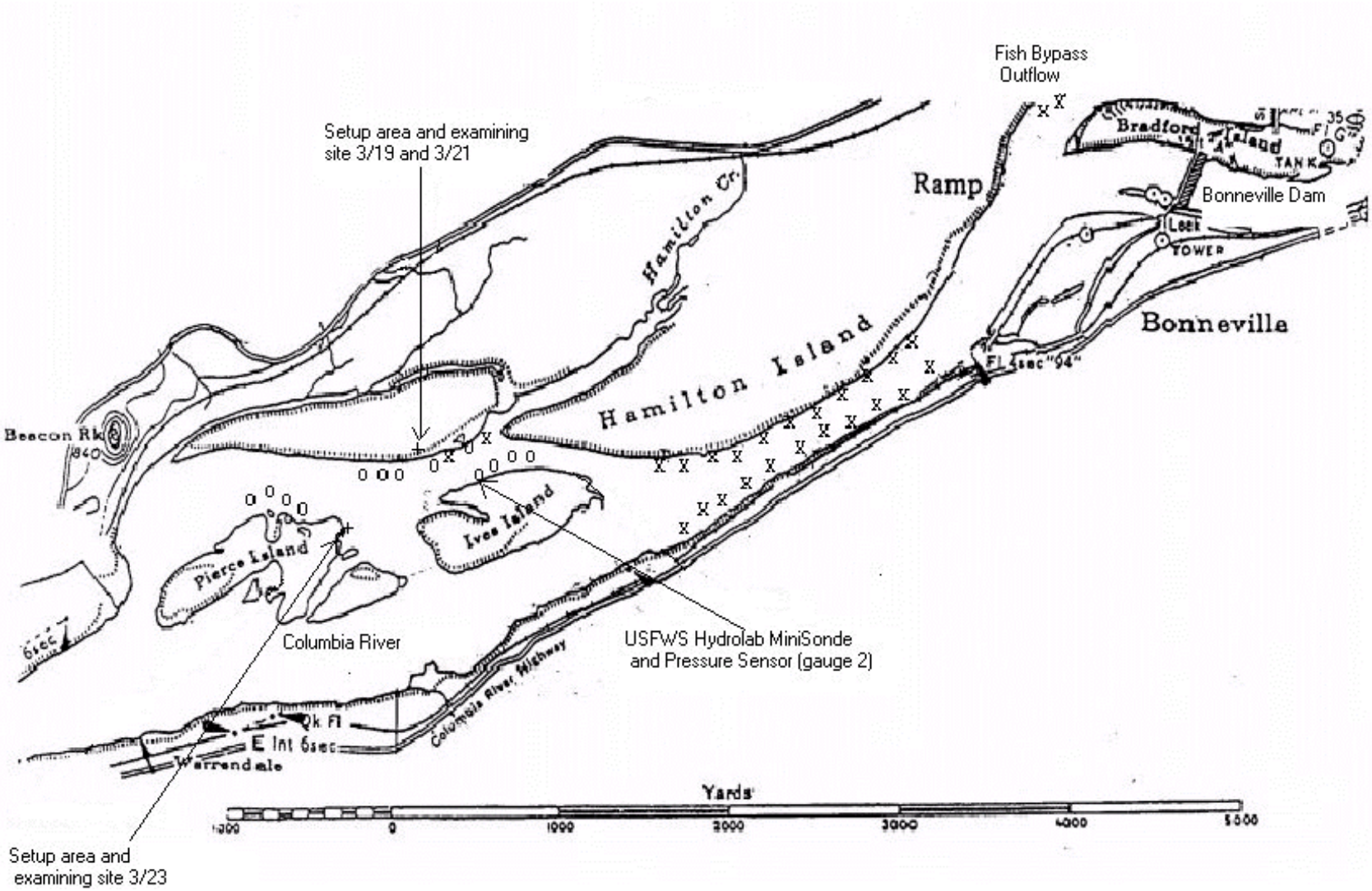
Captured fish were brought back to the sampling station and examined within 15 minutes of collection. Fish were examined according to regionally adopted protocols for GBT. The fish were anaesthetized and then examined under a microscope for signs of gas bubbles in the fins, eye and lateral line. The fish were allowed time to recover and then returned to the river. Other data that were collected included fish species, length, clipped fins, and other miscellaneous signs of injury. All data were recorded when the fish were examined.

A total of 145 fish were examined for signs of GBT. Of the fish examined, 122 were subyearling chinook salmon. Nine subyearling chinook were in the 0 to 49mm size range, 108 were in the 50mm to 120mm range, and 5 were in the 121mm to 160mm range. Other fish examined included 1 chum salmon fry (34mm), 1 cutthroat trout (232mm), 1 coho (38mm), 10 threespine sticklebacks, 4 largescale suckers, 5 northern pike minnows, and 1 prickley sculpin. No signs of GBT were observed on any fish released from Spring Creek NFH, resident fish, or salmonids rearing near Ives and Pierce islands. Table 1 summarizes the results of fish sampling for GBT. These results are similar to those from previous years when few or no fish had signs of GBT.

Monitoring of Physical Conditions

Physical conditions that the USFWS monitored included TDG, dissolved oxygen, and water depth over salmon redds (nests). Physical conditions were monitored continuously during the spill period.

The USFWS CRFPO deployed a Hyrolab Minisonde (Hydrolab Corporation, 12921 Burnet Rd. Austin, TX 78727) on March 9, 1999 offshore from Ives Island to monitor TDG levels in chum and fall chinook spawning and rearing areas (Figure 2). The Minisonde was placed at the same location as a pressure depth sensor previously installed and maintained by the USFWS CRFPO (Figure 2, gauge station 2) to measure water depth over the highest elevation chum salmon redd.



X = electroshocking sites + = examining station
0 = seining sites

Figure 1. March 1999 sampling sites.

Table 1. Summary of fish sampled for signs of GBT - March 1999 Spill at Bonneville Dam

Species	Size Range in mm	# fish samp. 03/19/99	# fish Samp. 03/21/99	# fish samp. 03/23/99	Total # of fish samp.	Total number of fish observed with bubbles in unpaired fins or eye: LL	DF	AF	CA	EY
Chinook	0-49	2	1	6	9	0	0	0	0	0
Chinook	50-120	87	12	9	108	0	0	0	0	0
Chinook	121-160	4	1	0	5	0	0	0	0	0
Chum	0-50	0	1	0	1	0	0	0	0	0
Coho	0-40	1	0	0	1	0	0	0	0	0
Cutthroat	200-250	1	0	0	1	0	0	0	0	0
Stickleback	0-70	4	3	3	10	0	0	0	0	0
Large Scale Sucker	300-450	2	2	0	4	0	0	0	0	0
Northern Pike Minnow	0-200	0	3	2	5	0	0	0	0	0
Prickley Sculpin	0-90	0	1	0	1	0	0	0	0	0
Totals		101	24	20	145	0	0	0	0	0

LL = lateral line
DF = dorsal fin
AF = anal fin
CA = caudal fin
EY = eye

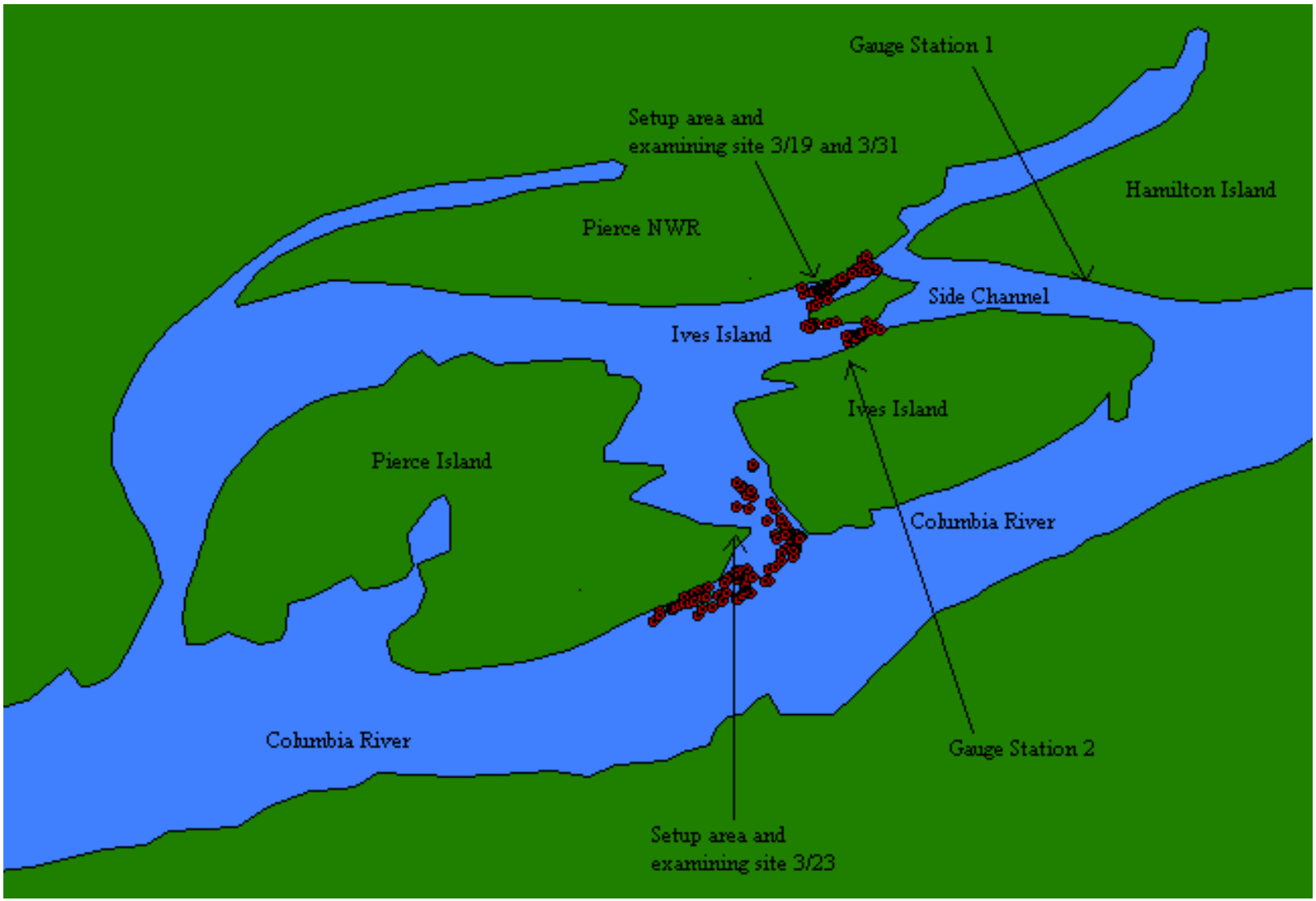


Figure 2. Fall Chinook and chum salmon spawning redd locations observed below Bonneville Dam in 1998.

Data were also gathered for TDG from the USGS monitoring stations located at Warrendale, Skamania, and Camas/Washougal.

Levels of TDG in the Ives Island side channel where fall chinook and chum salmon had spawned in 1998 were similar to those recorded by the USGS monitoring stations. Figure 3 compares the various levels of TDG recorded by USGS monitoring stations at Skamania, Warrendale, and Camas/Washougal and the USFWS monitoring site at Ives Island. TDG levels in the Ives Island side channel recorded by the USFWS Hydrolab Minisonde varied from a low of 98.4% on March 18 at 2100 hours to a high of 119.4% on March 19 at 1900 hours.

On March 19 and 23, staff from the USFWS CRFPO also measured TDG with a hand held Common Sensing meter at various locations from Bradford to Pierce islands. These TDG readings were generally similar to those obtained at the USGS Skamania and USFWS Minisonde site at Ives Island. Figure 4 shows sites where USFWS CRFPO staff took those measurements.

Levels of TDG differed at the three USGS monitoring stations. The Warrendale monitoring station, which was located on the Oregon side of the Columbia River Bonneville Dam at river mile 140, never recorded 12 hour average TDG levels greater than 115%. The Skamania station, which was located at river mile 140 on the Washington side of the Columbia River, recorded 12 hour average TDG levels that ranged between 113% and 122% and exceeded 120% on 3 days. The Camas/Washougal site, located at river mile 122, had 12 hour average TDG levels between 112% and 118%.

The TDG levels at the USGS Camas/Washougal monitoring site varied from a low of 104.2% on March 18 at 0100 hours to a high of 119% on March 20 at 1600 hours. Levels of TDG were above 114% from 0300 hours March 20 to 1000 hours March 26 (Figure 4). From March 20 to March 25, the 12 hour average TDG level was greater than 115%.

The highest percent TDG reading of all the monitoring stations was at the Skamania (Bonneville tailrace) site. It recorded a high of 122.3% at 2200 hours on March 19, 1999. The time of this reading is also close to the highest spill level recorded at Bonneville Dam for the spill period. The spill level at Bonneville Dam for this corresponding time was 176.6 kcfs (Figure 5). The TDG level recorded at the Warrendale (also Bonneville tailrace) site during the same time period was 115%. The 12 hour average TDG exceeded 120% at the Skamania monitoring station on March 19, 20, and 22. At the Warrendale station, the 12 hour average TDG level never exceeded 115%.

Table 2 shows the 12 and 24 hour percent TDG daily averages for the USGS downstream monitoring sites. Total flow during the spill period ranged from 234.3 kcfs to 343.5 kcfs (Figure 6). Spill varied from a low of 73.2 kcfs to a high of 176.9 kcfs (Figure 5). Table 3 shows daily average flow through powerhouses 1 and 2, and spill (in kcfs) at Bonneville Dam.

Spill and TDG levels are controlled by the U.S. Army Corps of Engineers which operates Bonneville Dam. Levels of TDG can be controlled by adjusting spill volumes, but TDG production can vary depending on total river flow, forebay and tailwater elevations, gate settings,

water temperature, TDG level of water in the forebay, spill patterns and other factors. Frequent adjustments are necessary to control TDG levels. During the March, 1999, spill period, the Corps of Engineers made several adjustments in spill to try to maintain TDG at or below the waiver and adjusted standard levels.

Also of concern were impacts of elevated TDG levels on recently hatched fry from populations of chum and fall chinook salmon that spawned naturally near Pierce and Ives islands in the fall 1998. Calculations of egg incubation and hatching times indicated that sac fry could be present in river gravels during the requested spill period. Fish in the sac fry stage of development appear to be most vulnerable to GBT, with mortalities over 50% when TDG levels reach 120%. Mortality of sac fry begins when TDG reaches 105%.

Hydrostatic pressure on a fish alleviates the effect that supersaturation may have on GBT. Each foot of water depth compensates for about 3% saturation; 1 meter for about 10% saturation. Thus, one meter of depth would reduce the effect of a total gas pressure of 120% down to110%. The USFWS, therefore, constantly monitored water depth over the highest chum salmon redd during the spill period to ensure adequate depth compensation to protect sac fry from elevated levels of TDG. The USFWS was prepared to notify the Corps of Engineers to reduce spill if TDG levels were too high or if depth over the highest redd became too shallow.

Depth levels recorded at the USFWS Hydrolab Minisonde monitoring site varied from a low of 5.74 feet at 0600 hours (234.7 kcfs total flow) March 19 to a high of 10.59 feet at 2400 hours (341 kcfs total flow) March 28 (Figure 6). This corresponded to TDG compensation levels of about 17.2 % for the 5.74 foot and 31.8% for the 10.59 foot depths. The Fish Passage Center web site has a page that lists on-line real time data for the depth monitoring stations at Ives and Hamilton Island. The data are supplied by USFWS CRFPO (Joe Skalicky, Don Anglin). The web site address is http://www.fpc.org/rivrdata.html. The data are transmitted directly from the sensor to the Fish Passage Center.

Dissolved oxygen percent saturation varied during the March 18 to 28 period from a low of 85.9% (254 kcfs total flow) at 0900 hours to a high of 104.2% (249.6 kcfs total flow) at 1100 hours. Figure 7 compares dissolved oxygen , total river flow, and spill volume at Bonneville Dam.

Summary

In summary, the USFWS collected and examined fish for signs of gas bubble trauma, monitored water quality, and measured water depth over salmon redds during the March 18 to 28, 1999 spill period at Bonneville Dam. Biological sampling was conducted on March 19, 21, and 23. Biological monitoring showed that none of the fish that were collected and examined exhibited any signs of gas bubble trauma.

Water quality monitoring and records from the USGS Camas/Washougal data station showed that 12 hour average TDG levels exceeded 115% between March 20 and 25. Twelve hour average TDG levels at the Skamania monitoring station exceeded 120% on March 19, 20, and

22. At the Warrendale monitoring station twelve hour average TDG levels were never greater than 115%.

Water depth monitoring showed that the minimum depth over the highest elevation chum salmon redd was about 5.7 feet. This provided depth compensation which reduced total dissolved gas pressure by 17.2 % at redd surface level.

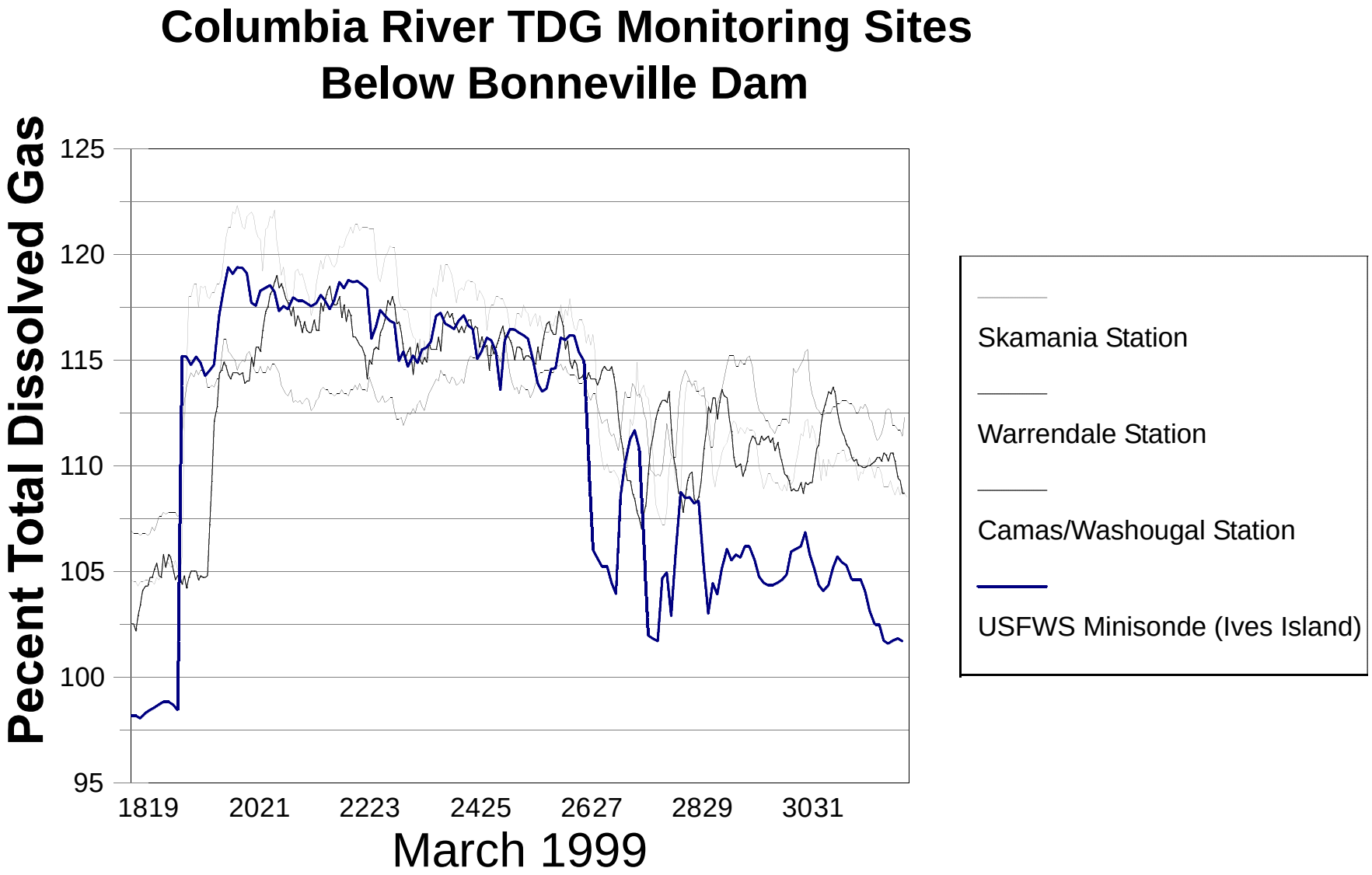


Figure 3. Comparison of Percent TDG levels recorded by USGS monitoring sites below Bonneville Dam and the USFWS Ives Island monitoring site.

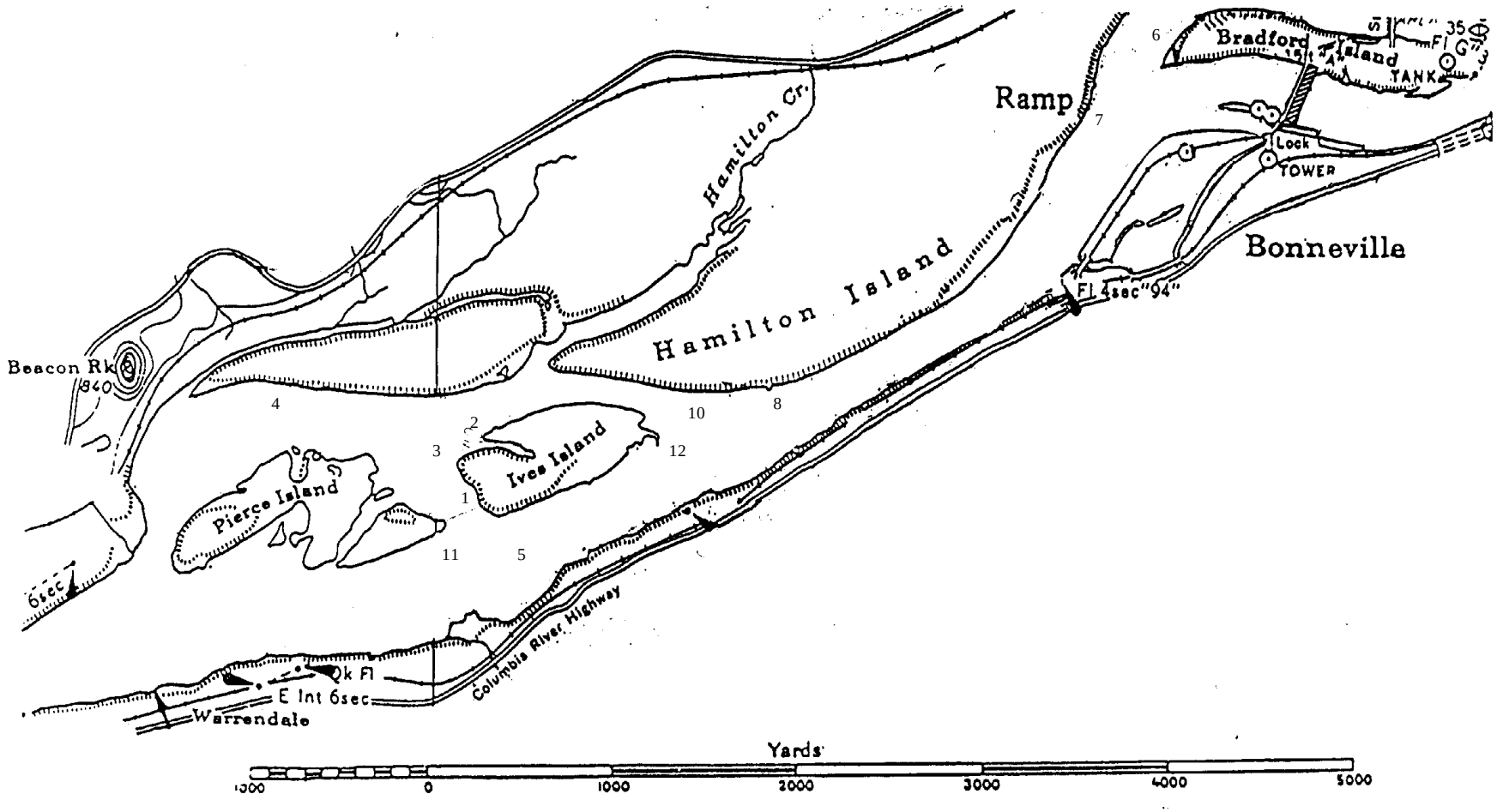
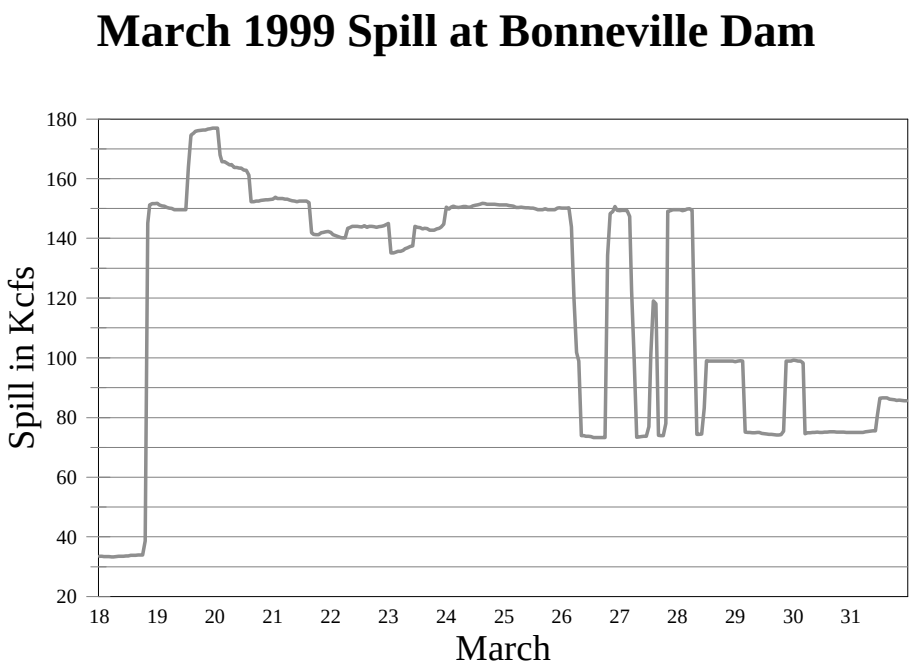


Figure 4. Common Sensing meter measurement locations.



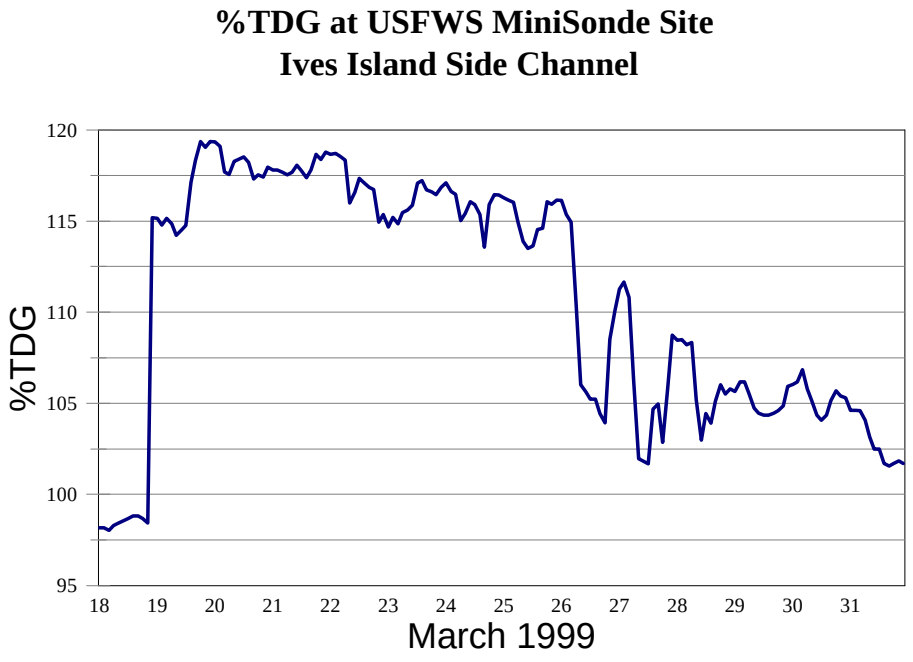


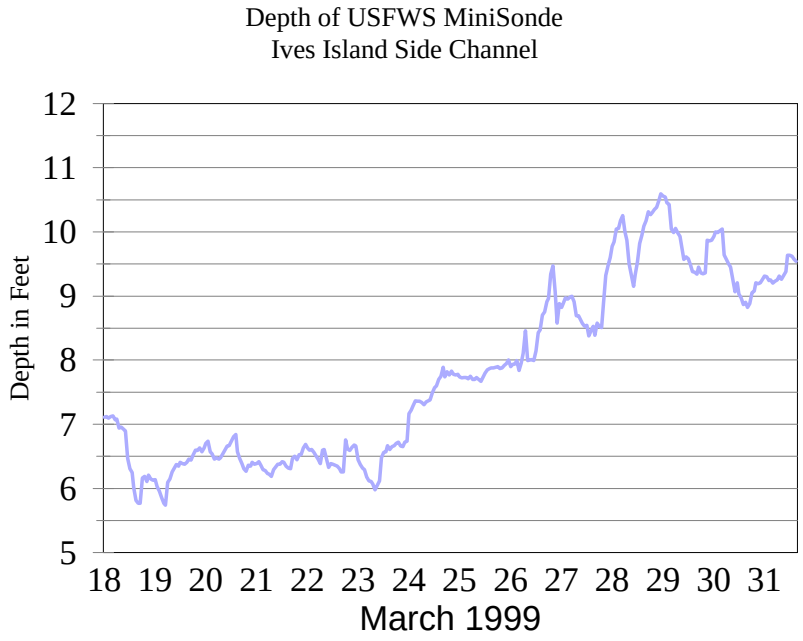
Figure 5. Comparison of Spill at Bonneville Dam and TDG levels recorded at Ives Island monitoring site.

Table 2. March 1999 Total dissolved gas percent saturation, 12 and 24 hour averages at Lower Columbia River sites.

	Bonneville				Warrendale				Skamania				Camas\Wash.			
	#	24h	12h		#	24h	12h		#	24h	12h		#	24h	12h	
Date	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High	hr	Avg	Avg	High
03/18/99	0	103	103	103	24	108	108	113	24	106	107	114	24	104	105	106
03/19/99	0	103	103	104	24	115	115	116	24	119	121	122	24	109	111	115
03/20/99	0	103	104	104	24	114	115	115	24	120	122	122	24	117	118	119
03/21/99	0	103	103	104	24	113	114	114	24	120	120	121	24	117	118	119
03/22/99	0	104	104	105	24	113	114	114	24	120	121	121	24	116	117	118
03/23/99	0	106	106	107	24	114	114	115	24	118	119	120	24	116	117	117
03/24/99	0	107	107	108	24	115	115	116	24	118	118	119	24	116	116	117
03/25/99	0	107	108	109	24	114	115	115	24	117	117	118	24	116	116	117
03/26/99	0	107	107	108	24	113	114	114	24	112	115	117	24	114	115	115
03/27/99	0	105	106	106	24	112	113	114	24	111	113	115	24	110	112	114
03/28/99	0	106	107	108	24	114	115	115	24	112	113	114	24	111	113	114

Table 3. Daily average flow through power house 1 & 2, and spill (in kcfs) at Bonneville Dam

Date	Spill	PH1	PH2				
03/18/99	53.2	75.5	108.3				
03/19/21	161.6	66.3	14.1				
03/20/99	161.0	71.7	5.3				
03/21/99	149.1	76.7	5.2				
03/22/99	143.0	81.8	10.7				
03/23/99	140.5	78.3	20.1				
03/24/99	151.0	76.3	38.1				
03/25/99	150.2	78.7	38.2				
03/26/99	108.5	83.1	91.6				
03/27/99	110.3	82.0	98.0				
03/28/99	110.3	86.6	124.0				



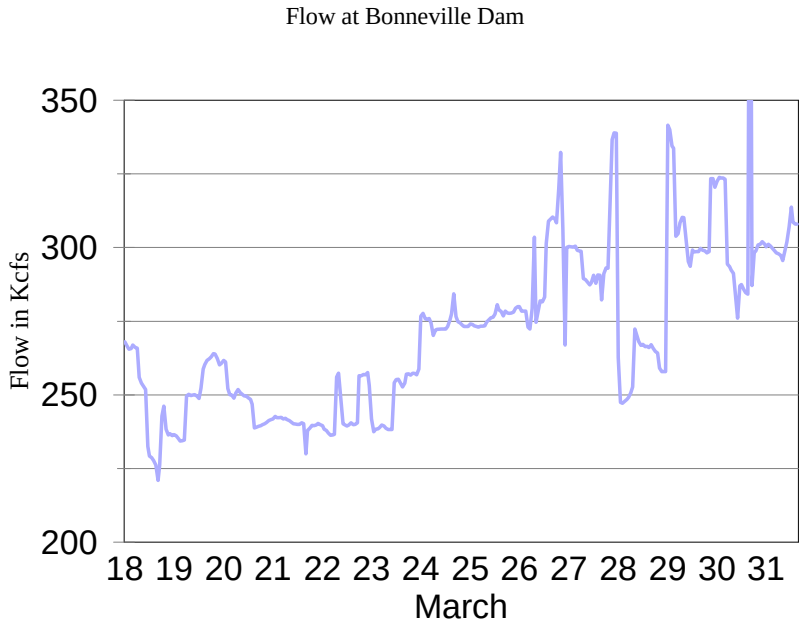
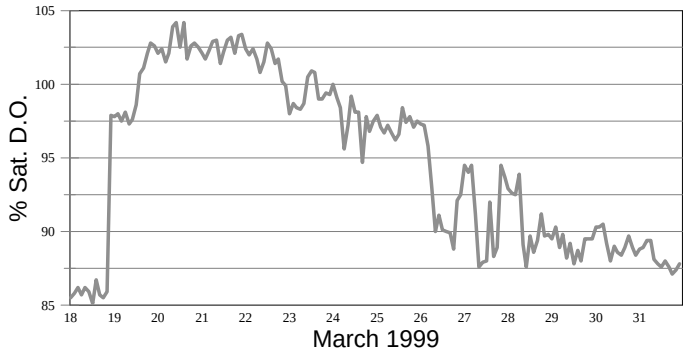


Figure 6. Comparison of depth over monitoring location and total flow.

DO % Saturation - Ives Island
Side Channel Monitoring Site



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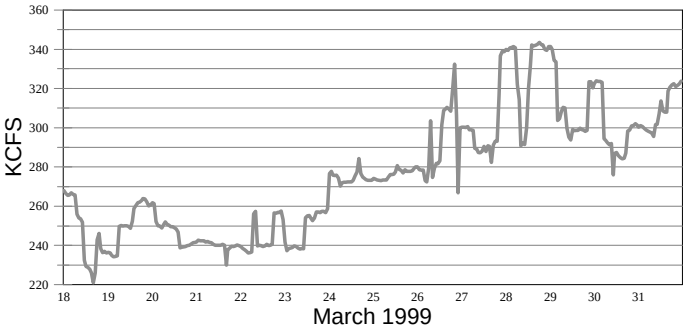
Ives Island



Spill at Bonneville Dam

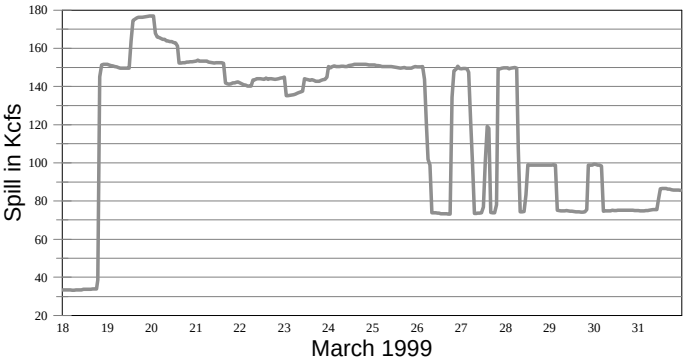


Figure 7. Comparison of DO percent saturation, total discharge, and spill.