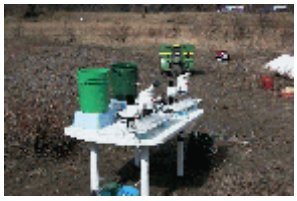
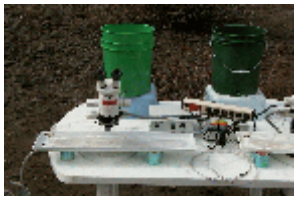
Gas Supersaturation Monitoring
Below Bonneville Dam
March 2000

















GAS SUPERSATURATION MONITORING REPORT
FOR MARCH 2000 SPILL
ON THE COLUMBIA RIVER BELOW BONNEVILLE DAM

U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
9317 N.E. Highway 99, Suite I
Vancouver, WA 98665

Monitoring Report for March 9-16, 2000, Spill at Bonneville Dam

Introduction:

To aid the downstream migration of tule fall chinook salmon smolts scheduled to be released from Spring Creek National Fish Hatchery in March of 2000 State and Federal Salmon Managers requested in System Operational Request (SOR) 2000-03 flows of 265 thousand cubic feet per second (Kcfs) and spill volumes that produce a maximum total dissolved gas level of 120% in the tailrace of Bonneville Dam. To protect chum and fall chinook salmon redds below Bonneville Dam at the Ives Island complex (Figure 1) from high levels of total dissolved gas in the tailrace of the dam the Salmon Managers also requested sufficient water depth for gas compensation. The Salmon Managers estimated that 265 Kcfs flow would provide this water depth.

The US Fish & 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 9 through 16, 2000. 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 February 10, 2000 meeting. The WDOE provided the adjusted TDG standard previously on March 8, 1999. The adjusted TDG standard expires in the year 2003. 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 2000 spill period. This report summarizes the results of this monitoring program.

Operations:

Spring Creek National Fish Hatchery released 8,177,725 tule fall chinook salmon on March 9 at 0800 hours. Bonneville Dam began spilling water over the spillway gates on March 9 at 2000 hours to aid downstream migration of the juvenile tule fall chinook salmon released earlier in the morning at Spring Creek National Fish Hatchery.

The Salmon Managers requested spill to continue beyond March 16 if real-time monitoring indicated that large numbers of juvenile fish were continuing to pass the project. The number of fish observed passing through Bonneville Dam after seven days of spill (Table 1, Figure 2) was an order of magnitude greater than observed in past years prompting the fishery agencies and tribes to request spill on a day by day basis for the remainder of the requested 10 day spill period. The action agencies, citing the cost of spill and the number of fish observed, as justification, denied the request. Spill for fish passage was terminated at 2000 hours on March 16, 2000.

The Salmon Managers requested that the Bonneville Dam Second Powerhouse (PH2) have first use priority for power generation during the spill period. The Salmon Managers believed that greater use of

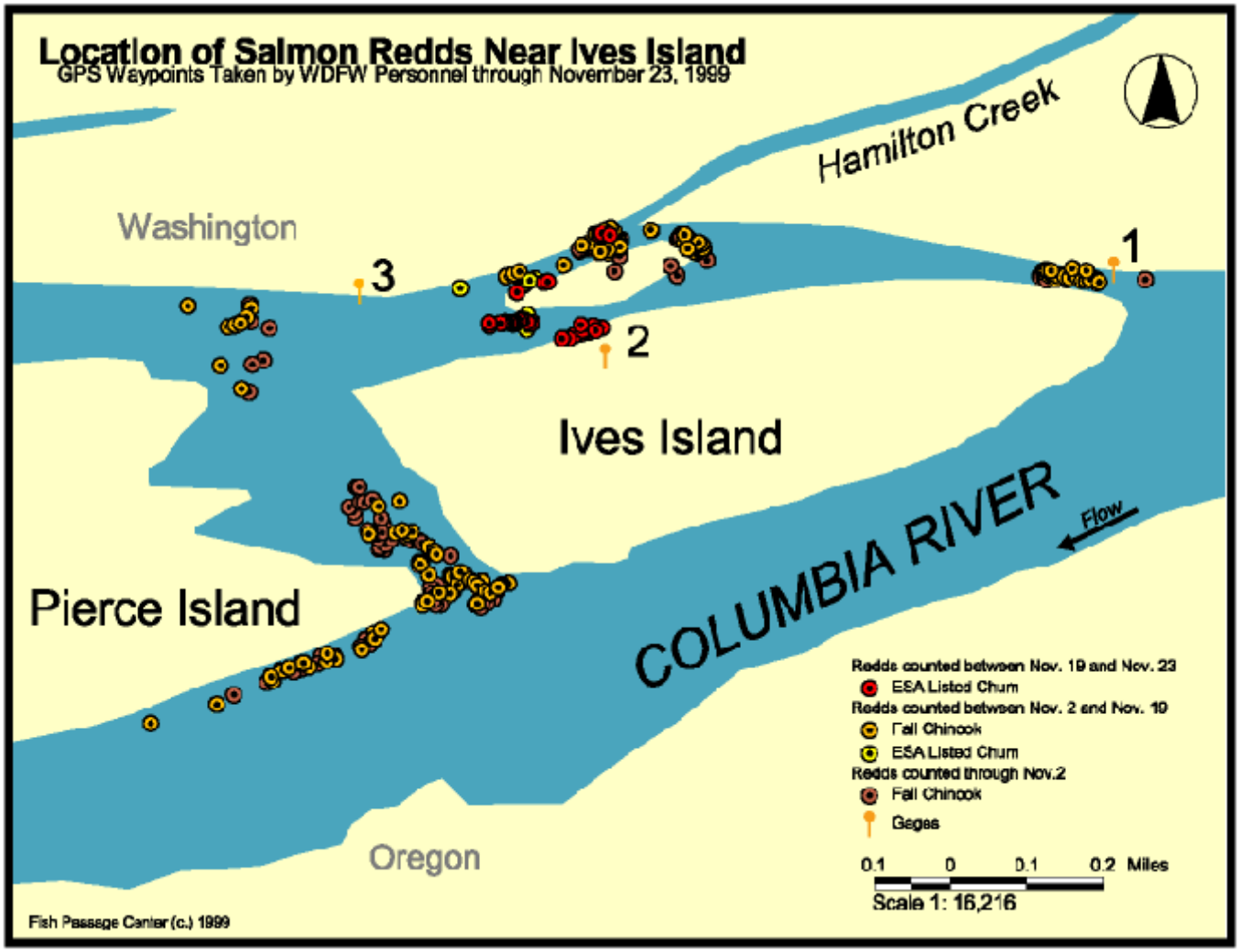


Figure 1. Location of Salmon Redds observed by WDFW personnel November, 1999.

Table 1. Fish Passage Index Counts at Bonneville Dam, combined subyearling chinook.

# of days into spill	Index count Spill starts March 9, 2000	Date	Index count Spill starts March 18, 1999	Date	Index count Spill starts March 13, 1998	Date	Index count Spill starts March 13 1997	Date	Index count Spill Starts March 14, 1996
1	139	03/09/2000	0	03/13/99	67	03/13/99	--	03/14/96	363,338
2	1,228	03/10/2000	270,000	03/14/99	68,537	03/14/99	--	03/15/96	123,190
3	516,102	03/11/2000	18,237	03/15/99	97,799	03/15/99	--	03/16/96	20,287
4	1,104,556	03/12/2000	18,197	03/16/99	29,807	03/16/99	--	03/17/96	8,729
5	47,187	03/13/2000	5,315	03/17/99	11,368	03/17/99	--	03/18/96	1,819
6	22,308	03/14/2000	1,355	03/18/99	9,790	03/18/99	--	03/19/96	545
7	7,019	03/15/2000	1,197	03/19/99	3,740	03/20/99	1,745	03/20/96	341
8	7,286	03/16/2000	394	03/20/99	2,211	03/21/99	1,156	03/21/96	457
9	3,236	03/17/2000	177	03/21/99	1,264	03/22/99	1,916	03/22/96	243
10	2,275	03/18/2000	184	03/22/99	809	03/23/99	886	03/23/96	207
11	2,108	03/19/2000	455	03/23/99	676	03/24/99	1928	03/24/96	66
12	1,370	03/20/2000	229	03/24/99	543	03/25/99	1472	03/25/96	0
12 day total			315,511		226,611		9,103		519,222
4 day total			306,434		196,210		----------		515,544
Percentage of fish counted in the first four days of 12 day count			97.1		86.6		----------		99.3

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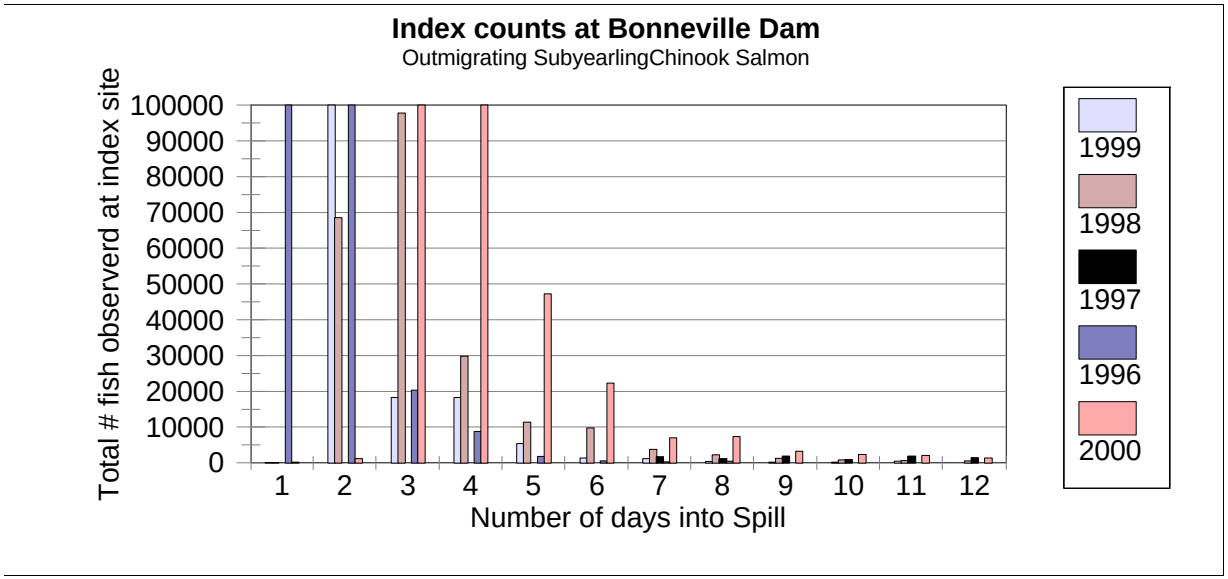


Figure 2. Fish Passage index counts during past spill periods at Bonneville Dam and number of days passed since start of spill.

the second powerhouse would direct water with lower TDG levels along the Washington side of the river where the salmon redds were located.

Biological Monitoring

The biological monitoring program included collecting at least 100 juvenile salmonids and resident fish each sampling day during the period of spill and examining them for signs of GBT. Sampling was conducted on March10 and March 11. Personnel from the USFWS who examined fish for signs of GBT had been trained on examination techniques by staff from the Fish Passage Center. Jerry McCann, the Fish Passage Center staff member who trained USFWS staff, also examined fish with CRFPO staff on March 11. The same USFWS personnel had also conducted biological sampling and examined fish for signs of GBT during the March 1998, and 1999, spill period at Bonneville Dam.

Fish were captured by Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) personnel using a 100-foot-long beach seine in near shore areas of the Columbia River and Ives Island side channel at sampling sites that they continuously monitor for emerging and stranded fry. Figure 3 displays the locations of WDFW/ODFW beach seining sites. Biologists used microscopes to examine captured fish for signs of GBT. A minimum of 10x magnification was used for viewing fins and a minimum of 15x magnification was used for viewing the lateral line. As in the March 1999 sampling procedure the same ranking system used to rank unpaired fins was also used to rank percent of gas bubbles observed in the lateral line.

A total of 169 fish were captured and examined for signs of GBT (Table 2). Of this total, 34 fish were examined on March 10 and 135 fish were examined on March 11. After more than 100 fish were examined on March 11 data were collected on an additional 155 fish but they were not examined for signs of GBT (Table 2). No signs of GBT were observed in any of the fish examined.

Monitoring of Physical Conditions

Staff from the USFWS used a Common Sensing meter borrowed from the USGS Biological Resources Division in Cook, WA and a Hydrolab Minisonde borrowed from the USACE in The Dalles, OR to take real time TDG measurements (Table 3) at various locations (Figure 4) from a boat on the Columbia River during the spill period. A USFWS Hydrolab Minisonde was deployed in the Ives Island side channel prior to the spill period on February 24 to collect TDG and dissolved oxygen (DO) data. Water depth data were collected from two depth sensors that were deployed in the Ives/Pierce Island side channel prior to the spill period. One was located at the head of the Ives Island channel and the other at the site of the highest chum salmon redd in the channel. Water depth data were collected and transmitted to the CRFPO every other hour for display on the Fish Passage Center's Internet website (www.fpc.org) .

The USFWS Hydrolab Minisonde was programed on February 24 to start taking hourly samples on March 5 at 0800 hours. The Minisonde had a leap year software bug that set the wrong date in the sampling data on March 1st of 2000. The Minisonde reported power loss failure on March 13 at 1400 hours. New batteries were installed in the Minisonde on March 16 at 1100 hours and it was redeployed. On March 30, 2000 the Minisonde was removed from Ives Island side channel and its

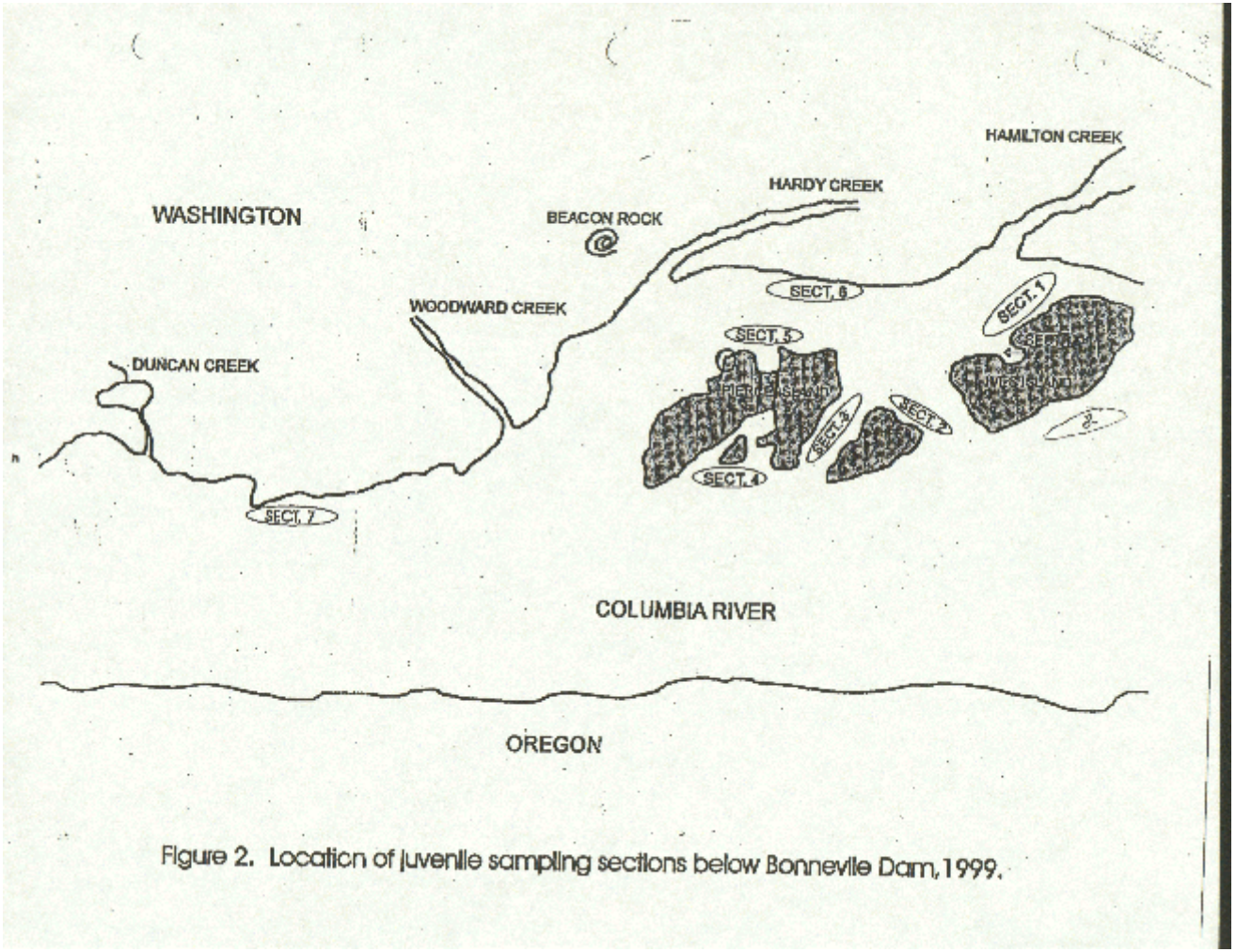


Figure 3. WDFW 1999 juvenile fall chinook and chum salmon sampling sites near Ives and Pierce Islands.

Table 2. Summary of fish sampled for signs of GBT - March 2000 Spill at Bonneville Dam

Species	Size Range in mm	# of fish examined for signs of GBT	# of fish not examined		Number of fish observed with bubbles in unpaired fins or eye				
					LL	DF	AF	CA	EY
Chinook	0-49	8	0		0	0	0	0	0
Chinook	50-99	117	152		0	0	0	0	0
Chinook	100-149	29	0		0	0	0	0	0
Chinook	150-200	4	0						
Chum	38-41	5	0		0	0	0	0	0
Peamouth	63-66	5	0		0	0	0	0	0
Stickleback	54	0	1		0	0	0	0	0
Large Scale Sucker	64	0	1		0	0	0	0	0
Northern Pike Minnow	41	0	1		0	0	0	0	0
Sculpin sp.	60	1	0		0	0	0	0	0
Totals		169	155		0	0	0	0	0

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

Total # of fish seined = 324

Table 3. Common Sensing Meter Data, March 2000

Date	Time	Site #	Location	Com. Sens.	*Hydrolab	USFWS Ives I.	Skamania Station		Warrendale Station	
			Site	%TDG	%TDG	Hydrolab	%TDG	Time	%TDG	Time
03/10/00	9:40	1	SKAW Sta. 401	109.4		104.2	108.6	1000	114.9	1000
03/10/00	10:02	1	SKAW Sta. 401		107.9	104.2	108.6	1000	114.9	1000
03/10/00	10:25	7	Gage 2	106.1		104.2	108.6	1000	114.9	1000
03/10/00	10:40	7	Gage 2		106.1	103.8	108.9	1100	115.0	1100
03/10/00	11:16	9	MCQ drift @ HI RAmp	114.0		103.8	108.9	1100	115.0	1100
03/10/00	11:16	9	MCQ drift @ HI Ramp		114.2	103.8	108.9	1100	115.0	1100
03/10/00	11:49	4	Top of Pierce Chnl	105.4		104.9	109.3	1200	115.0	1200
03/10/00	12:15	5	OR shore across Pierce I.	115.4		104.9	109.3	1200	115.0	1200
03/10/00	12:22	3	Mid-river & DS	114.7		104.9	109.3	1200	115.0	1200
03/10/00	1:15	6	Mouth of Hamilton Ck.	105.3		103.4	109.4	1300	115.6	1300
03/10/00	2:47	9	MCQ Drift @ HI Ramp	118.8		104.3	109.9	1500	115.8	1500
03/10/00	2:55	11	OR Shore	113.7		104.3	109.9	1500	115.8	1500
03/10/00	3:09	10	HI Ramp	105.7		104.3	109.9	1500	115.8	1500
03/10/00	3:17	8	Gage 1	105.7		104.3	109.9	1500	115.8	1500
03/10/00	3:36	7	Gage 2	106.7		104.9	110.2	1600	116.1	1600
03/11/00	9:30	7	Gage 2	106.9		104.4	107.1	900	115.0	900
03/11/00	10:05	10	HI Ramp	105.2		104.4	108.8	1000	115.5	1000
03/11/00	10:15	11	OR Shore	109.9		104.4	108.8	1000	115.5	1000
03/11/00	10:25	9	MCQ Drift @ HI Ramp	112.5		104.4	108.8	1000	115.5	1000
03/11/00	10:33	9	MCQ Drift @ HI Ramp	115.7		104.7	111.0	1100	116.2	1100
03/11/00	1:15	10	HI Ramp	104.9		105.2	111.6	1300	115.9	1300
03/11/00	1:30	9	MCQ Drift @ HI Ramp	116.6		105.2	111.6	1300	115.9	1300
03/11/00	1:42	11	OR Shore	111.7	110.2	104.2	110.3	1400	115.8	1400
03/11/00	1:50	7	Gage 2	109.0		104.2	110.3	1400	115.8	1400
03/12/00	7:20	10	HI Ramp	104.4		104.8	110.9	700	116.3	700
03/12/00	7:35	9	MCQ Drift @ HI Ramp	116.0		104.9	110.7	800	116.2	800
03/12/00	8:00	7	Gage 2	106.0		104.9	110.7	800	116.2	800
03/15/00	09:20:00 to 11:15	7	Gage 2	109.0- 110.9			110.8	900	116.6	900
03/15/00	12:20	9	MCQ Drift @ HI Ramp	114.3			111.4	1200	116.7	1200
03/15/00	12:39	1	SKAW Sta. 401	110.7			111.3	1300	116.8	1300
03/15/00	12:56	2	WRNO Sta. 403	114.9			111.3	1300	116.8	1300

* A USACE Hydrolab was also used to take real time TDG measurements while hooked up to a laptop computer.

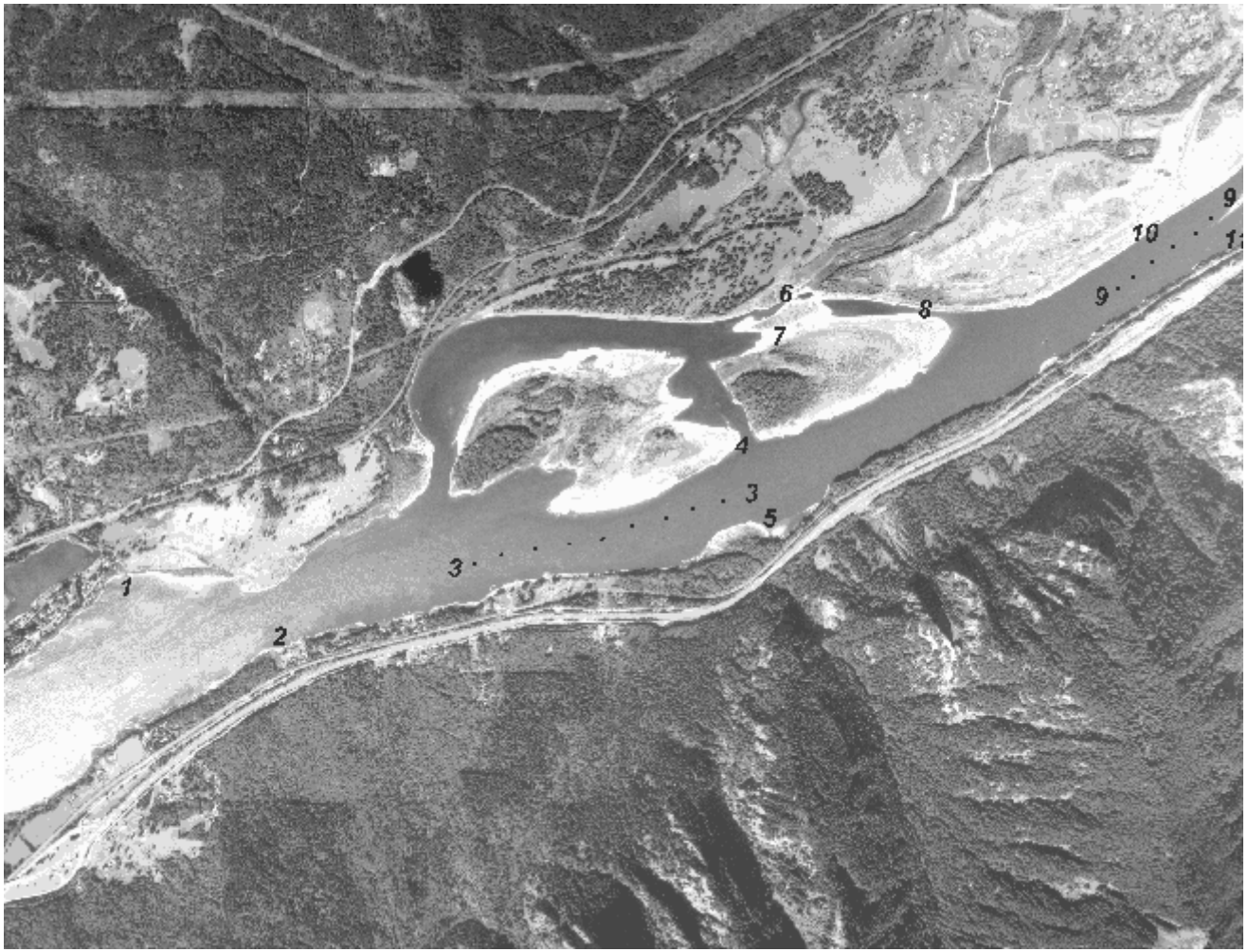


Figure 4. Aerial view of Common Sensing meter TDG sample sites.

data was downloaded to a laptop computer. The TDG levels recorded by the Hydrolab Minisonde appeared to be lower than expected. Measurements were taken after the spill with a Common Sensing meter borrowed from the US Geological Survey (USGS), a Hydrolab Minisonde borrowed from the US Army Corps of Engineers (USACE), and the USFWS Minisonde to compare measurements taken at the same time at a common sampling site. A correction factor for the differences in the TDG measurement values between the meters was determined and added to the USFWS Minisonde readings from Ives Island.

Results:

PH2 had first use priority over Powerhouse 1 (PH1) during the March 2000 spill.
Figures 5-7 compare average daily flow at PH2 with TDG levels recorded at the USGS Skamania monitoring site on the Washington side of the Columbia River and average daily flow at PH1 with TDG levels recorded at the USGS Warrendale moitoring site on the Oregon side of the Columbia River for spill periods March of 2000, 1999, and 1998. During the March 2000 spill when PH2 had greater use priority TDG levels recorded at Skamania were lower than the TDG levels recorded at Warrendale. The new fish bypass system at PH2 allowed for the change of first use priority to PH 2 rather than PH1. In previous years PH1 had first use priority. During the March1999 spill when PH1 had greater use priority the TDG levels recorded at Skamania were higher than the TDG levels recorded at Warrendale. During the 1998 spill when neither PH1 nor PH2 had first use priority the TDG levels at Skamania and Warrendale were similar in range.

Figure 8 displays the depth levels recorded by the USFWS pressure gauge near Ives Island during the spill period. The depth sensor was placed near a chum salmon redd, that represents the highest elevation redd closest to shore that could potentially be dewatered or not have sufficient water depth to allow for depth compensation of TDG. During the spill period the depth levels over the test redd varied from 3.81 feet at 266 Kcfs to 5.26 feet at 323 Kcfs.

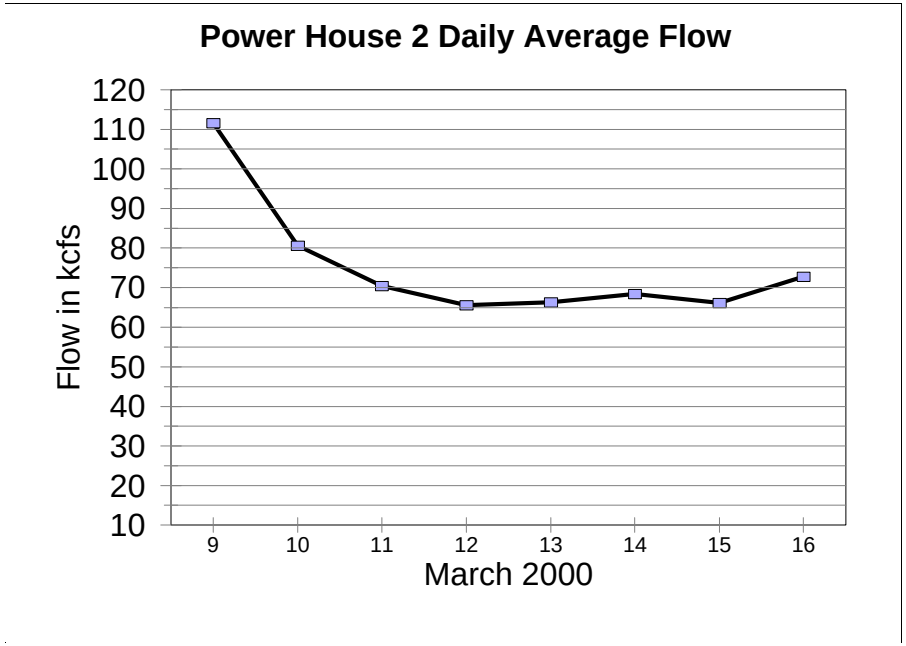
Figure 9 displays total discharge at Bonneville Dam during the spill period.
Total discharge varied from 188.1 Kcfs near the beginning of the spill period to 218.4 Kcfs near the end.

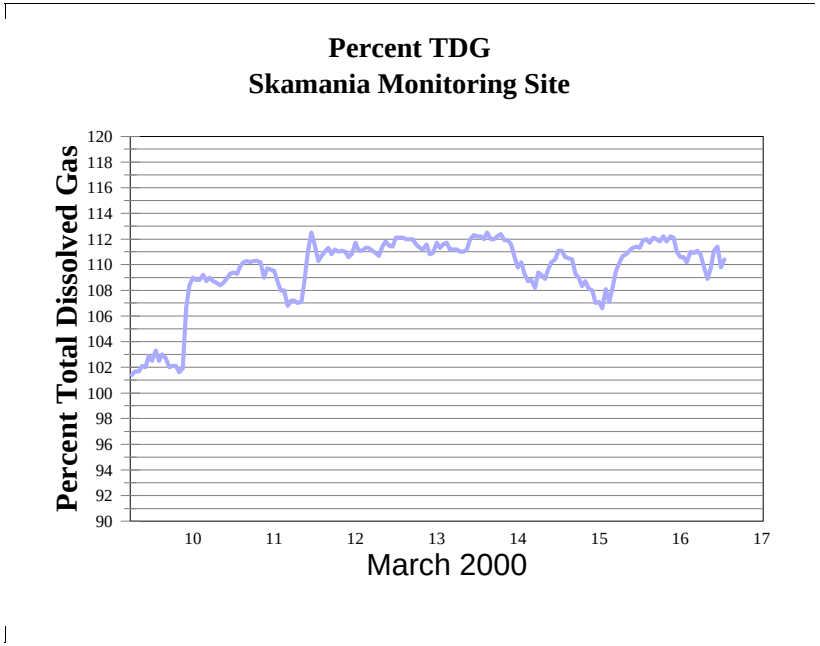
Figure 10 displays levels of spill during the March 2000 spill period.
Spill volume varied from 98 Kcfs to 120.7 Kcfs.

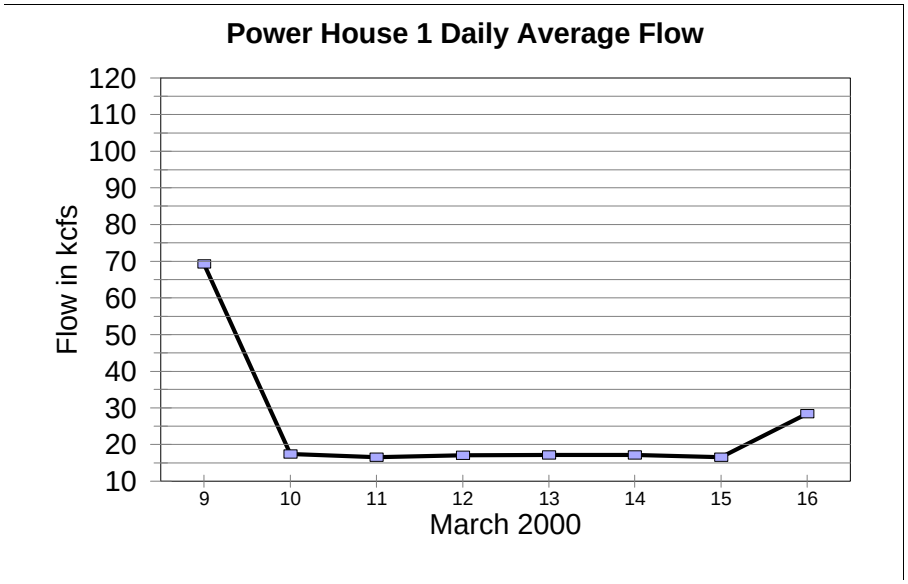
Figure 11 compares the TDG readings taken at the the various USGS sampling stations downstream of Bonneville Dam and the USFWS Hydrolab during the spill period.

At the Skamania TDG monitoring station TDG levels varied from101.6% to 112.5%. The 101.6% TDG reading was recorded on March 9 at 2100 hours with 95.4 Kcfs spill and 206.9 Kcfs total flow at Bonneville Dam. The 112.5% TDG reading was recorded on March 11 at 1200 hours with 108.5 Kcfs spill and 207.3 Kcfs total flow and also on March 13 at 1600 hours, with 120.1 Kcfs spill and 214.5 Kcfs total flow at Bonneville Dam..

2000 Spill Period
'March 9-16







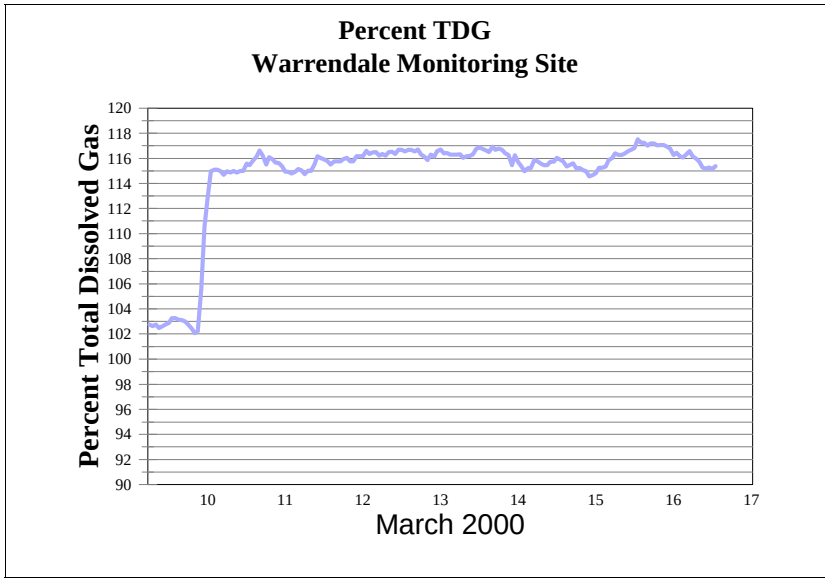
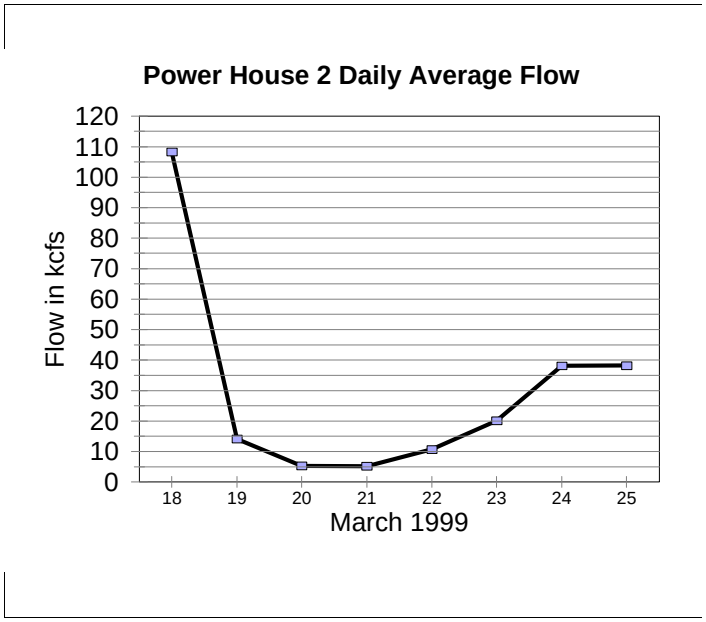
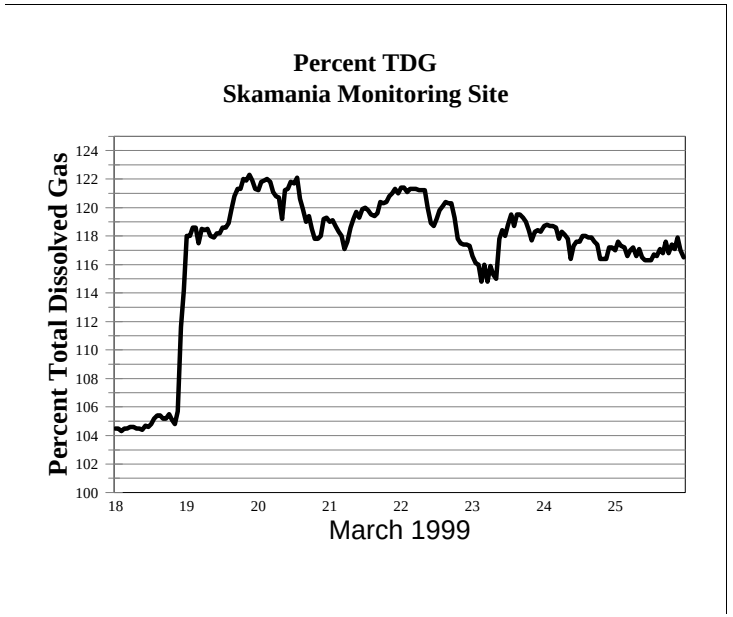
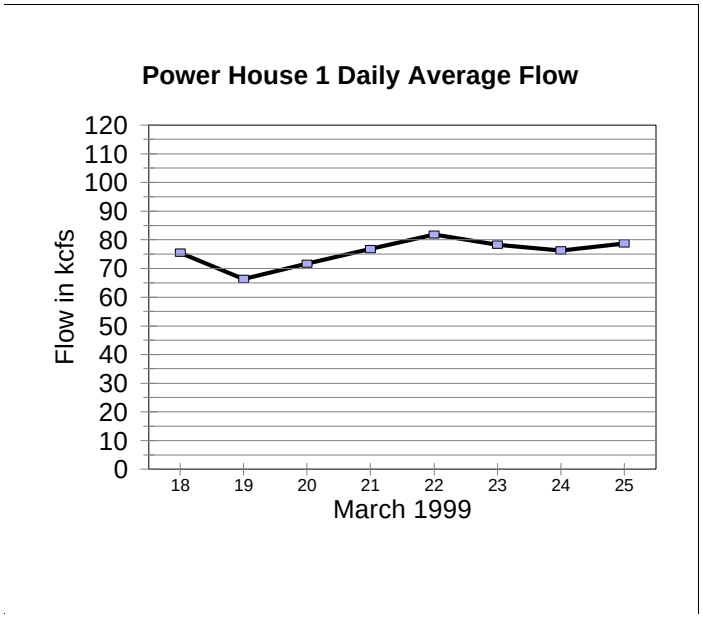


Figure 5. 2000 comparison of TDG levels downstream and average daily flow at Bonneville Dam Powerhouse 1 and Powerhouse 2

1999 Spill Period
March 18-25







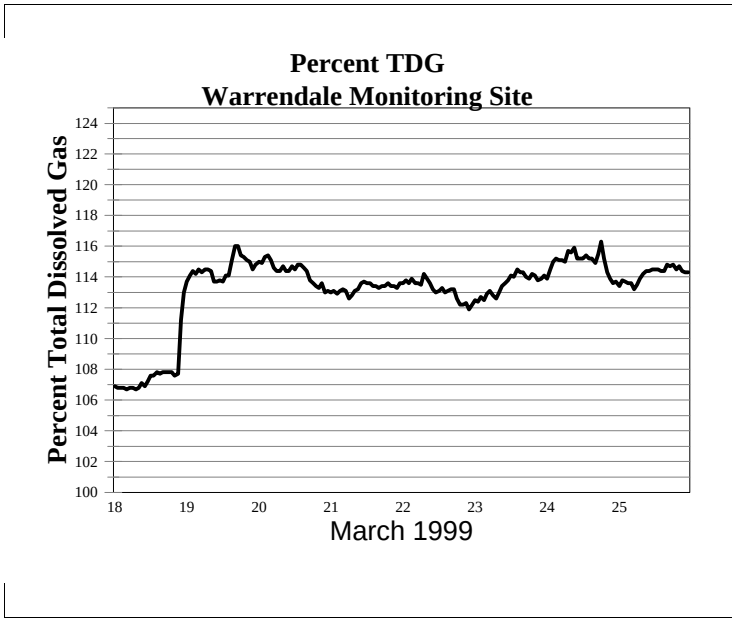
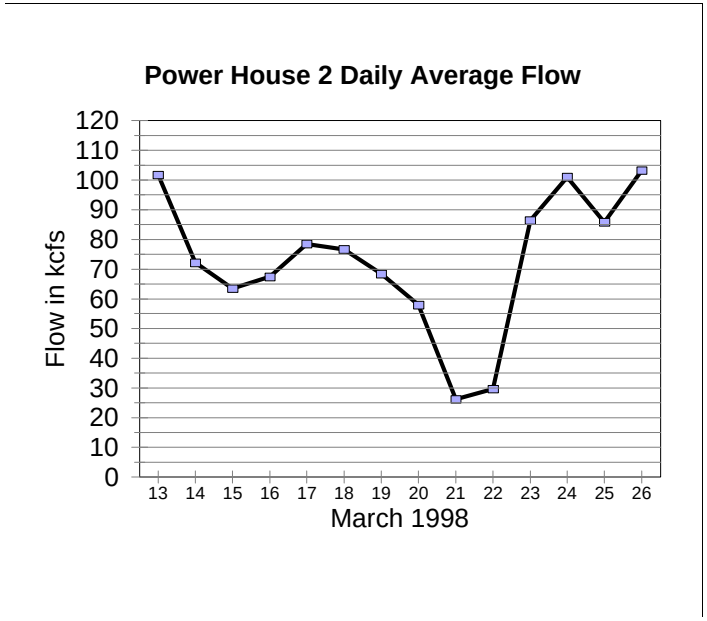
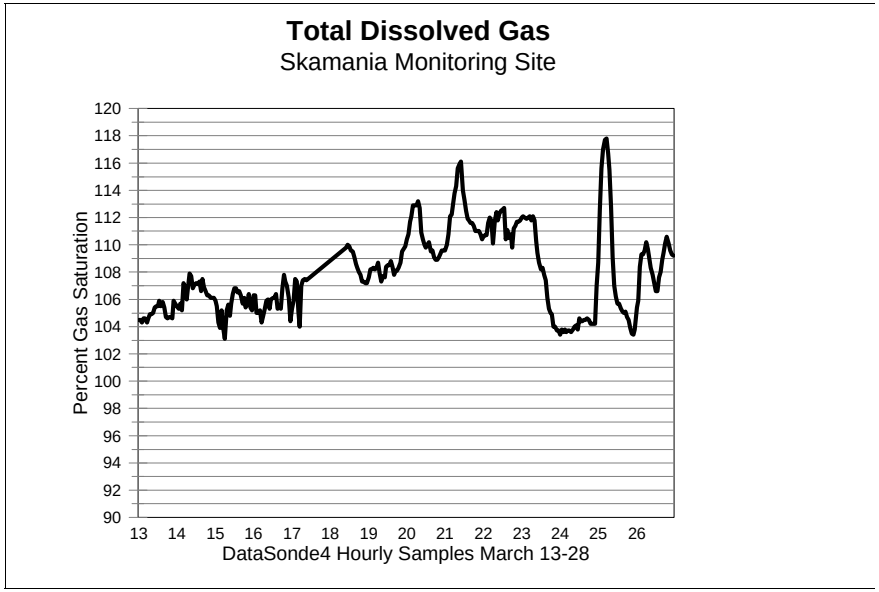
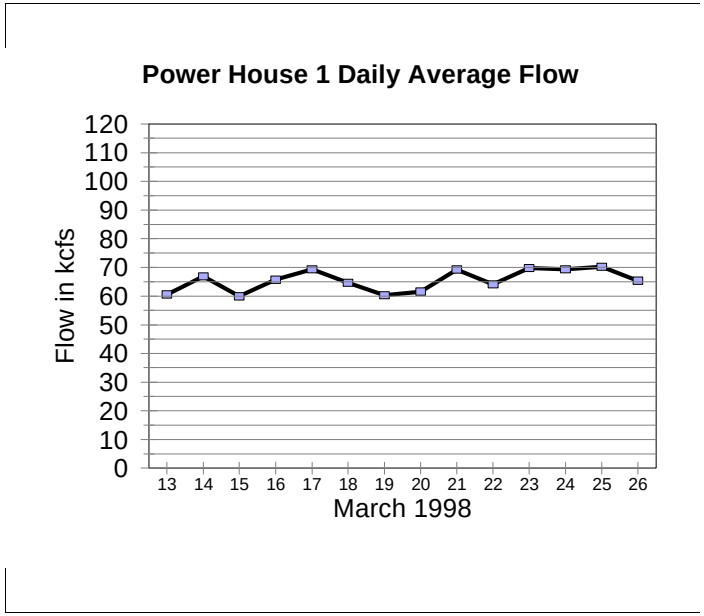


Figure 6. 1999 comparison of TDG levels downstream and average daily flow at Bonneville Dam Powerhouse 1 and Powerhouse 2

1998 Spill Period
March 13-23







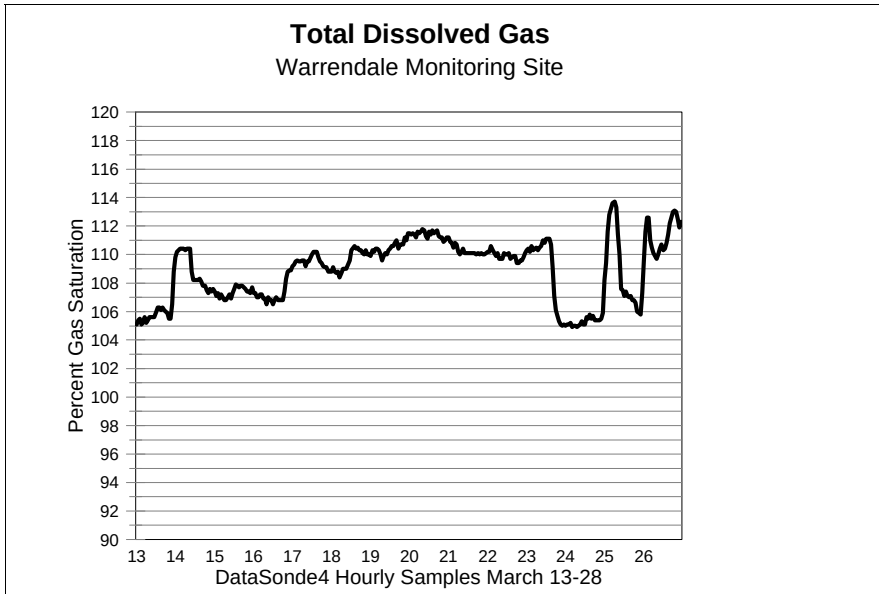


Figure 7. 1998 comparison of average daily flow at Bonneville Dam Powerhouse 1 and Powerhouse 2 and TDG levels downstream.

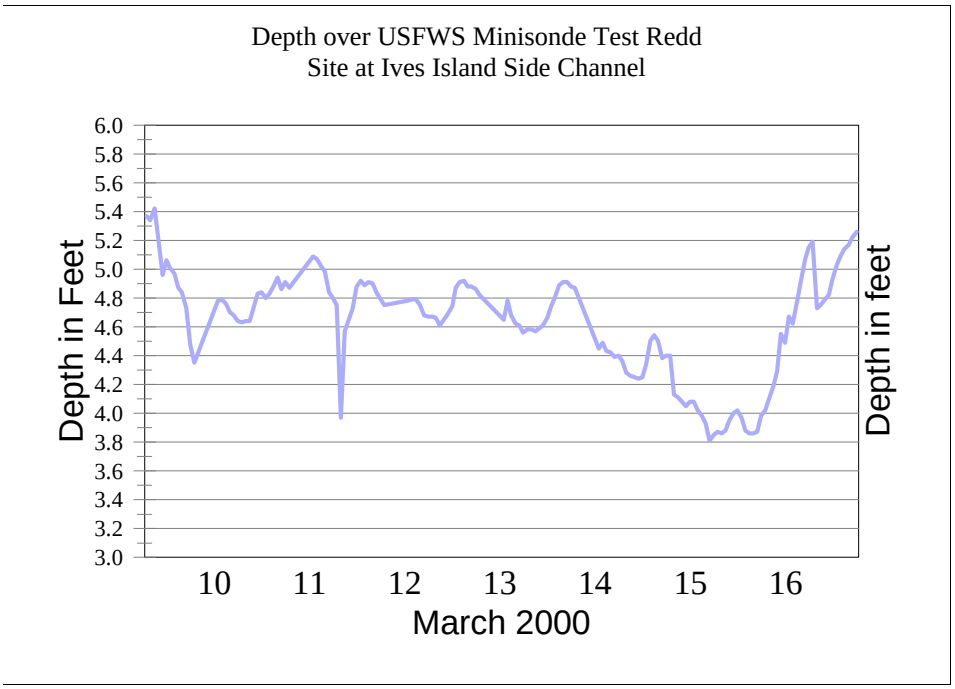


Figure 8. Depth levels recorded over the test redd site, March 2000 spill.

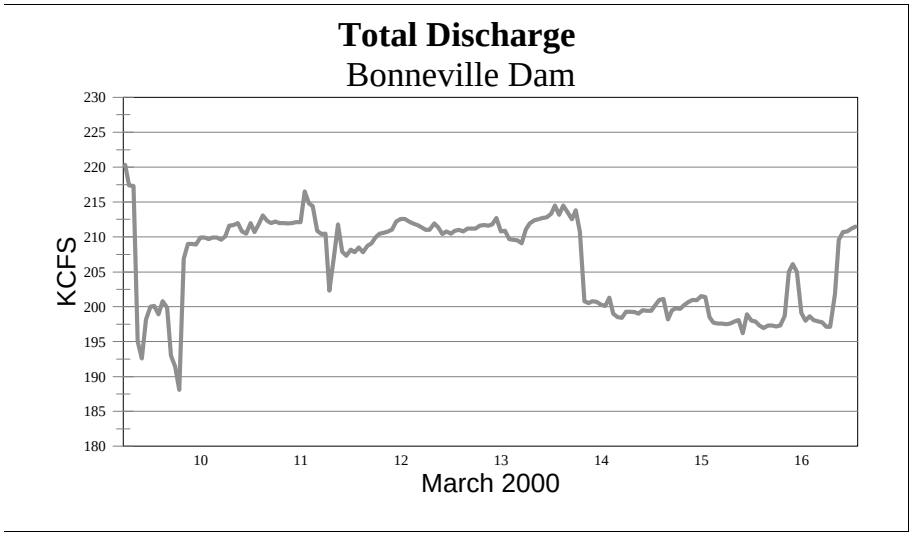


Figure 9. Total discharge from Bonneville Dam, March spill 2000.

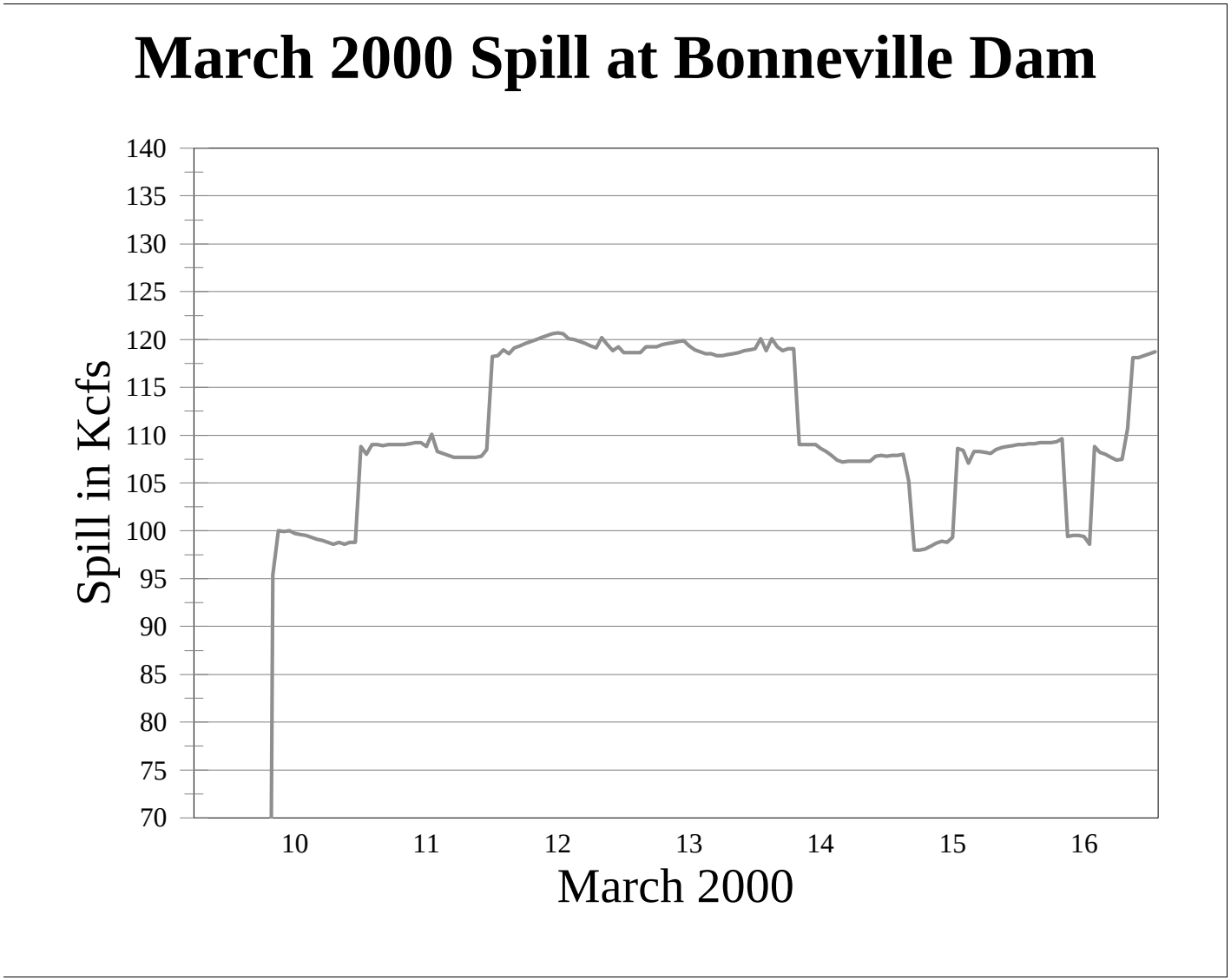


Figure 10. Spill levels at Bonneville Dam during the March 2000 spill period.

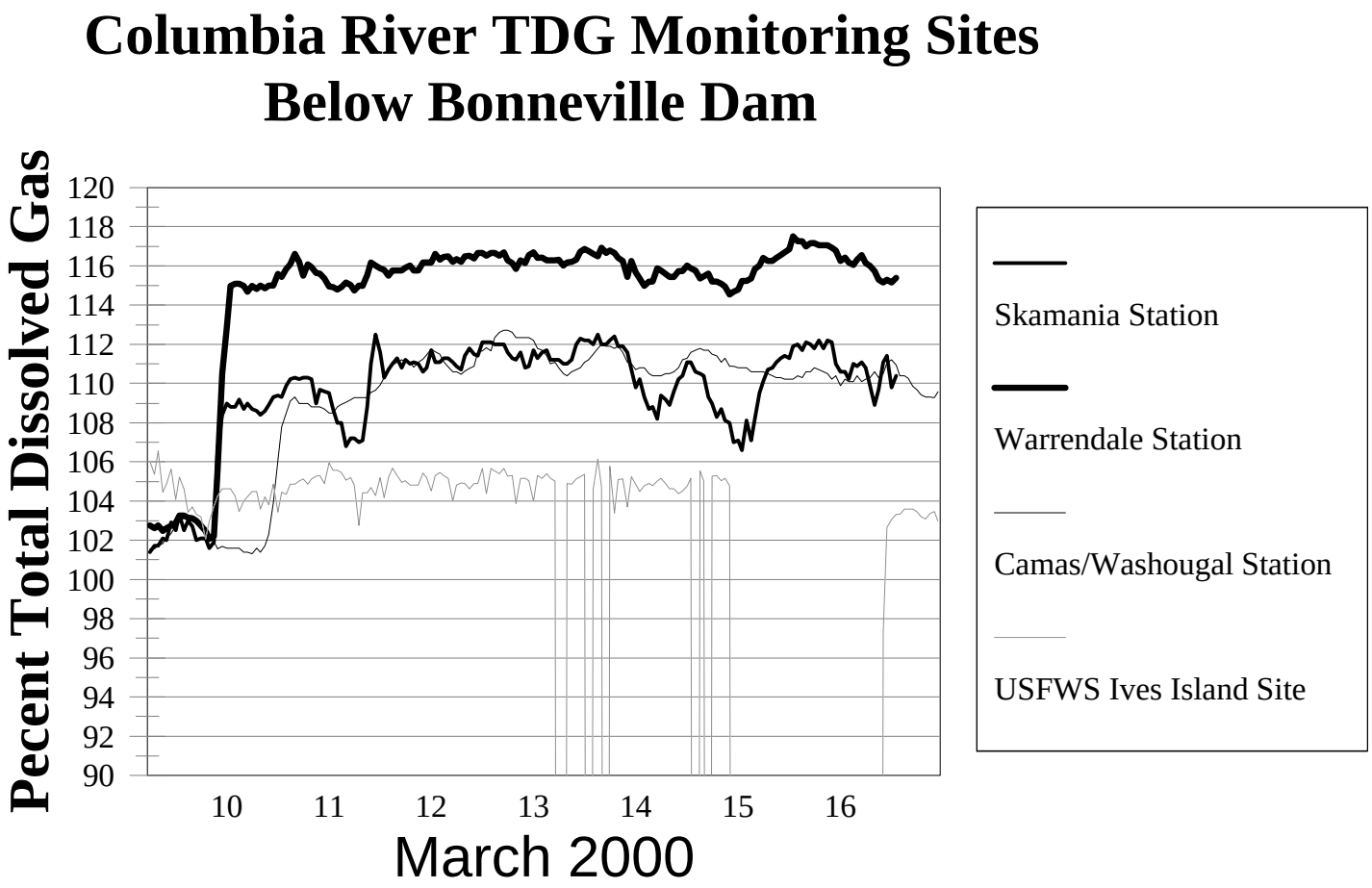


Figure 11. TDG levels at various sampling locations downstream of Bonneville Dam.

TDG levels recorded at the Warrendale TDG monitoring Station varied from 102.1% to 117.5%. The 102.1% TDG reading was recorded on March 9 at 2100 hours with 95.4 Kcfs spill and 206.9 Kcfs total flow at Bonneville Dam. The 117.5% TDG reading was recorded on March 15 at 1400 hours with 109 Kcfs spill, and 197.9 total flow at Bonneville Dam.

TDG levels recorded at the Camas/Washougal TDG monitoring station varied from 101.3% to112.7%. The 101.3% TDG reading was recorded on March 10 at 0700 hours with 98.8 Kcfs spill and 210.1 Kcfs flow at Bonneville Dam. The 112.7% TDG reading was recorded on March 12 at 1800 and 1900 hours with 119.2 Kcfs spill and 211.2 Kcfs flow at Bonneville Dam.

TDG levels recorded by the USFWS Hydrolab Minisonde at Ives Island when adjusted with a correction factor varied from 102.1% to 106.2%. The 102.1% TDG reading was recorded on March 9, at 2000 hours with 1.6 Kcfs spill and 188.1 Kcfs total flow at Bonneville Dam. The 106.2% TDG reading was recorded on March 13 at 1600 hours with 120.1 Kcfs spill and 214.5 Kcfs total flow at Bonneville Dam.

Total dissolved oxygen levels recorded by the Ives Island USFWS Hydrolab Minisonde during the spill period are displayed in Figure 12.

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 9 to 16 spill period at Bonneville Dam. Biological sampling was conducted on March 10 and 11. Biological monitoring showed that none of the fish that were collected and examined exhibited any signs of gas bubble trauma.

Water depth monitoring showed that the minimum depth over the highest elevation chum salmon redd was about 3.81 feet. This provided depth compensation which reduced total dissolved gas pressure by 8.4 % at redd surface level.

TDG levels recorded at the Skamania and Warrendale monitoring stations near the Bonneville Dam tailrace did not exceed 120%. TDG levels recorded at the Camas/Washougal monitoring station did not exceed 115%.

The fall chinook and chum salmon spawning areas along the Ives Island complex are on the Washington side of the Columbia River just upstream of the Skamania monitoring site. First use priority of PH2 over PH1 appeared to help reduce TDG levels along the Washington side of the Columbia River at the Skamania monitoring station (river mile 140) when compared to TDG levels recorded for the same time period at the Warrendale monitoring station (river mile 140) along the Oregon side of the Columbia River.

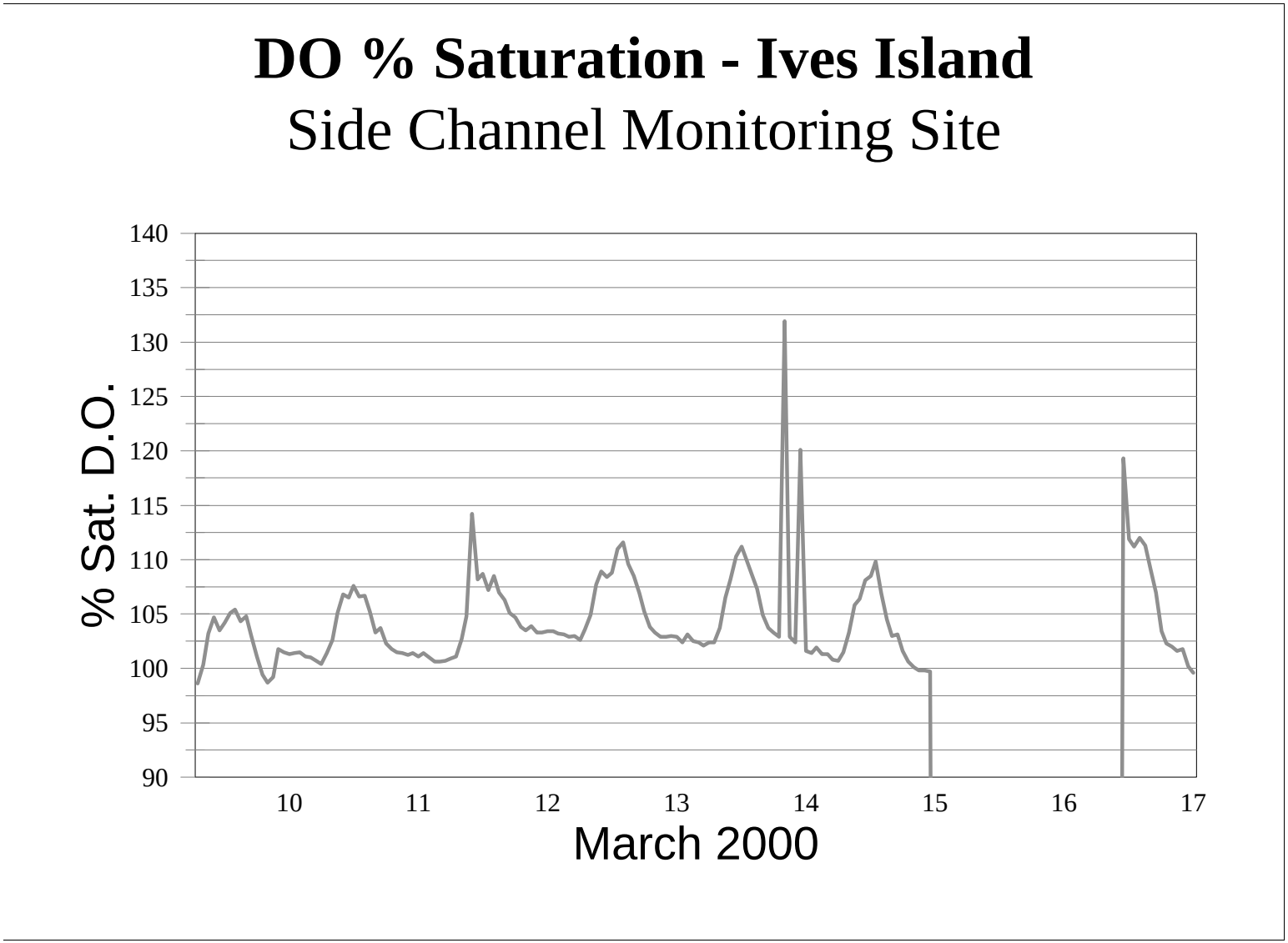


Figure 12. Dissolved oxygen levels recorded by USFWS MiniSonde, March spill 2000.