

Appendix L

Gas Bubble Trauma Monitoring And Data Reporting For 2011

**Fish Passage Center
Portland, Oregon**



FISH PASSAGE CENTER

1827 NE 44th Ave., Suite 240, Portland, OR 97213

Phone: (503) 230-4099 Fax: (503) 230-7559

<http://www.fpc.org>

e-mail us at fpcstaff@fpc.org

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Mr. David Ponganis
U.S. Army Corps of Engineers
Northwestern Division
PO Box 2870
Portland, OR 97208-2870

Dear Mr. Ponganis,

As per our agreement, we are providing both you and Mr. Paul Wagner of NOAA Fisheries with a copy of our "Gas Bubble Trauma Monitoring and Data Reporting for 2011". This report summarizes data collected during the 2011 juvenile salmonid migration.

Please feel free to contact us if you require any additional information.

Sincerely,

Michele DeHart
Fish Passage Center Manager

CC: Laura Hamilton, COE
Paul Wagner, NOAA Fisheries

Gas Bubble Trauma Monitoring and Data Reporting for 2011

Overview

The goal of the juvenile salmonid gas bubble trauma (GBT) monitoring program is to determine the relative extent that migrating juvenile salmonids have been exposed to harmful levels of total dissolved gas. The determination is based upon the prevalence and severity of GBT induced bubbles on the fish. The data are reported to the fisheries management entities, the water quality agencies of Washington and Oregon, and are available to other interested parties through Fish Passage Center weekly reports and daily postings to the FPC web site during the season (<http://www.fpc.org/smolt/gasbubbletrauma.html>).

The monitoring of juvenile salmonids in 2011 for gas bubble trauma (GBT) was conducted at Mid-Columbia, Lower Columbia and Snake River sites. Fish were collected and examined for signs of GBT at Bonneville Dam and McNary Dam on the Lower Columbia River, and at Rock Island Dam on the Mid-Columbia River. The Snake River monitoring sites were Lower Granite Dam, Little Goose Dam, and Lower Monumental Dam. Sampling occurred two days per week at the Columbia River sites and one day a week at each of the Snake River sites throughout the spring and summer spill programs.

The goal of the sampling program was to sample 100 salmonids of the most prevalent species (limited to chinook and steelhead) during each day of sampling at each site, with the proportion of each species sampled dependent upon their prevalence at the time of sampling. Yearling Chinook and steelhead were sampled through the spring at all the sampling sites. Once subyearling Chinook predominated in the smolt collections, the program shifted from sampling yearling Chinook and steelhead to sampling subyearling Chinook, which continued through the end of August. Examinations of fish were done using variable magnification (6x to 40x) dissecting scopes. The eyes and unpaired fins were examined for the presence of bubbles. The bubbles present were quantified using a ranking system based on the percent area of the fins or eyes covered with bubbles (Table L-1).

Table L-1
Ranking criteria used in monitoring for signs of gas bubble trauma.

Rank	Sign
0	no bubbles present
1	up to 5% of a fin area or eye covered with bubbles
2	6% to 25% of a fin area or eye covered with bubbles
3	26% to 50% of a fin area or eye covered with bubbles
4	> than 50% of a fin area or eye covered with bubbles

Additional information was recorded for each fish including; species, age, fork length, fin clips, and tags. The examination procedures were similar to those used in past years of the program (see the GBT Monitoring Protocol <http://www.fpc.org/smolt/gasbubbletrauma.html> for details of exam procedures). All sampling sites were at dams, where fish could be collected from the juvenile fish bypass system. Fish to be examined for GBT were collected at the separator at juvenile salmonid

transportation collection sites, and by the standard collection methods at Rock Island and Bonneville dams.

The runoff (January -July) volume for the 2011 water year was above average in both the Snake and Columbia rivers. Runoff (January-July) was 139% of average (1971-2000) above Lower Granite and 133% of average above The Dalles Dam. The 2011 water year had higher than average flows early in the season in the Snake (Figure L-1) and Lower Columbia (Figure L-2) rivers during April, as upstream reservoirs were drawn down to flood control elevations. High sustained flows occurred from mid May to mid July. These high flow conditions resulted in uncontrolled spill at several of the federal hydro-electric projects that, in turn, resulted in TDG levels that were well above the TDG waiver levels.

Figure L-1.
Average daily flows at Lower Granite Dam
2011, 2010, and the 10 year average

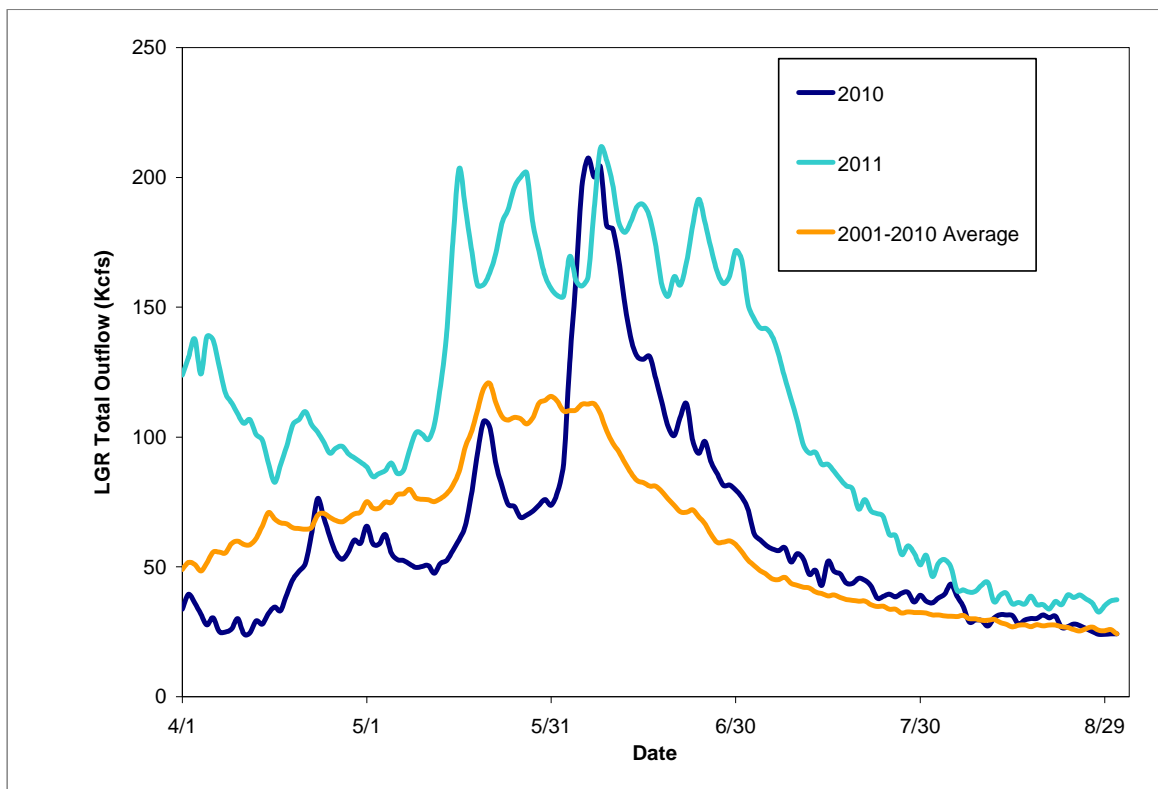
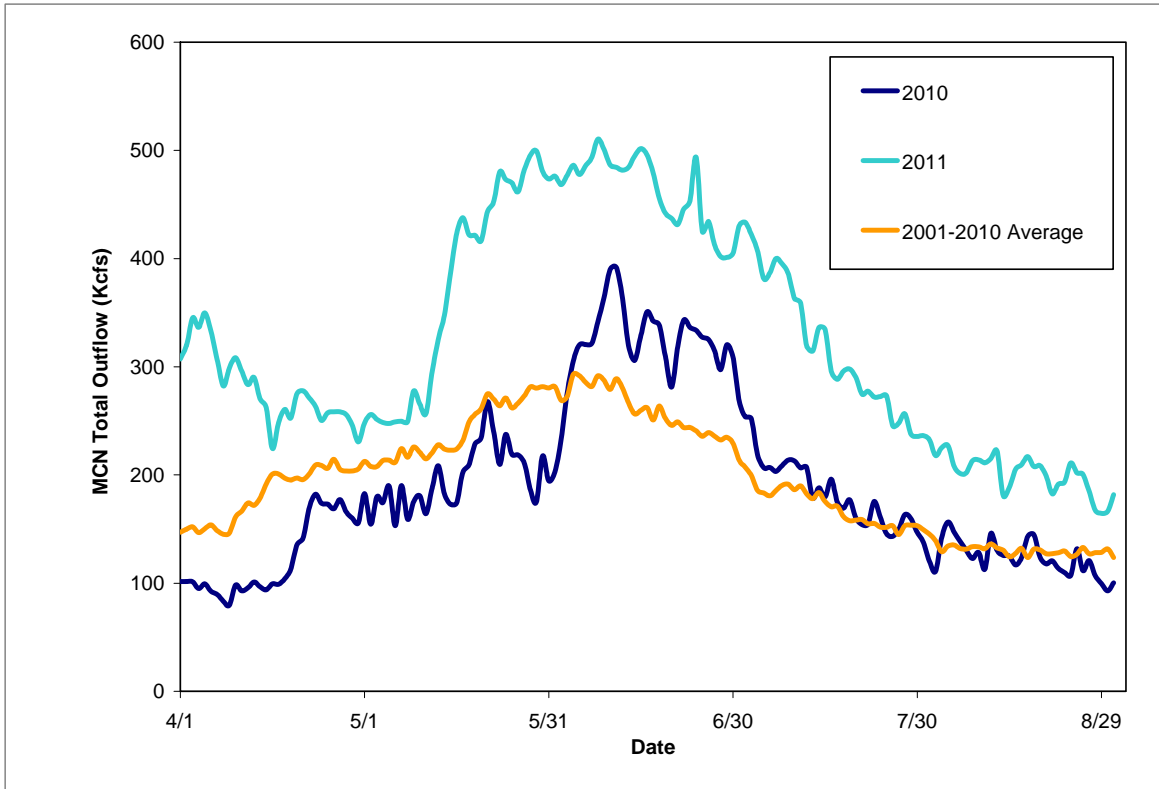


Figure L-2
Average daily flows at McNary Dam
2011, 2010 and the 10 year average



Results

In all, 15,302 juvenile salmonids were examined for GBT between April and August of 2011 (Table L-2). The fish were collected as part of the Smolt Monitoring Program.

Table L- 2.
Number of juvenile salmonids examined for signs of GBT at dams on the Lower Snake River and on the Columbia River from April to August 2011 as part of the GBT Monitoring Program.

Species	BON	MCN	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	1,974	2,502	416	703	0	1,350	6,945
Chinook Yearlings	1,165	1,127	465	520	309	926	4,512
Steelhead	290	371	864	549	739	1,032	3,845
Total	3,429	4,000	1,745	1,772	1,048	3,308	15,302

Fin signs were found in 382 or 2.5% of the total fish sampled at all sites (Table L-3). The fish examined and determined to have signs of GBT exhibited the fin signs that were most often rank 1, where less than 5% of a fin area was covered with bubbles. However, during the high river flow and total dissolved gas events the more severe signs of rank 2, 3 and 4 were observed in fish from the Snake River and at Rock Island Dam.

Table L-3

Number of juvenile salmonids found with fin GBT at dams on the Lower Snake River and on the Columbia River from April to August 2011 as part of the GBT Monitoring Program.

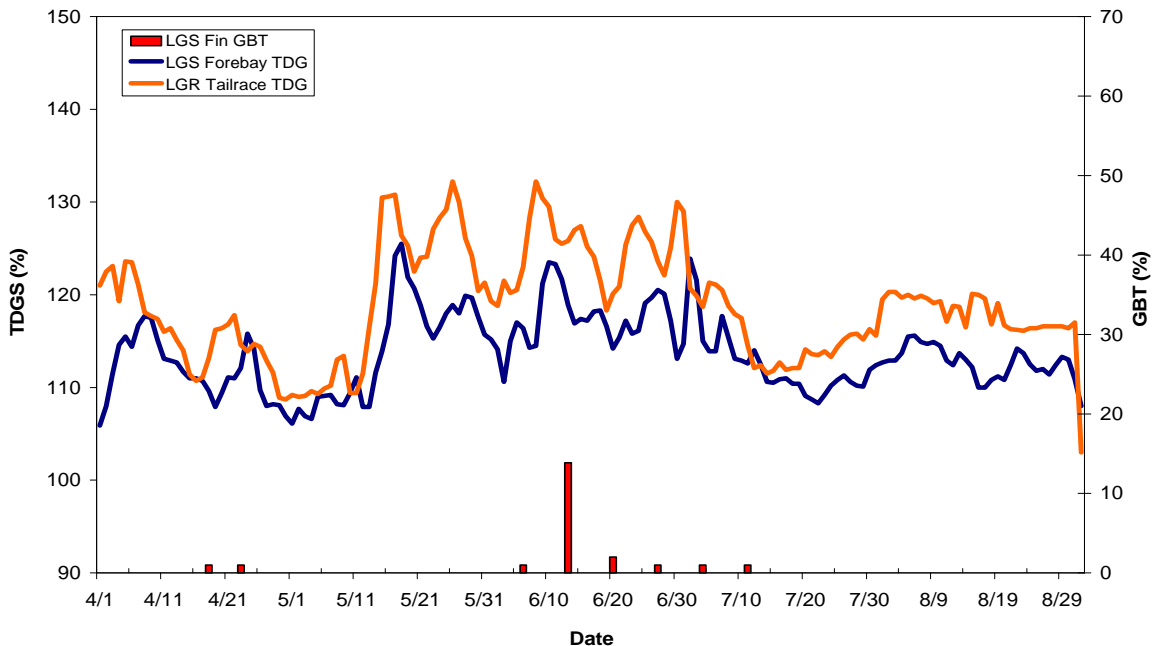
Sum of FinGBT	site						Grand Total
	BO1	LGR	LGS	LMN	MCN	RIS	
CH0	1		17	6	19	32	75
CH1	6	0	1	12	6	18	43
ST	3	0	4	33	6	218	264
Grand Total	10	0	22	51	31	268	382

The action criteria for GBT is established as 15% of fish showing any signs of GBT, or 5% of the fish sampled showing signs greater than rank 1. In 2011 there were no fish sampled with signs of GBT at Lower Granite Dam.

Little Goose Dam

Both the prevalence and severity of GBT signs increased during early June, and increased to a maximum of nearly 14% in the June 13th sample. During this time period stream flows had increased rapidly in the Snake River and the hydraulic capacity at Lower Granite Dam was limited due to one to two turbine units being out of service. Consequently, total dissolved gas levels in the Lower Granite tailrace exceeded the TDG criteria of 120% (Figure L-3) beginning in mid May and, with the exception of three days in June, continued above the 120% criteria in the tailrace until the early part of July. Peak 12- hour TDG measurements exceeded 130% in the Lower Granite tailrace when the high levels of GBT were observed at Little Goose Dam.

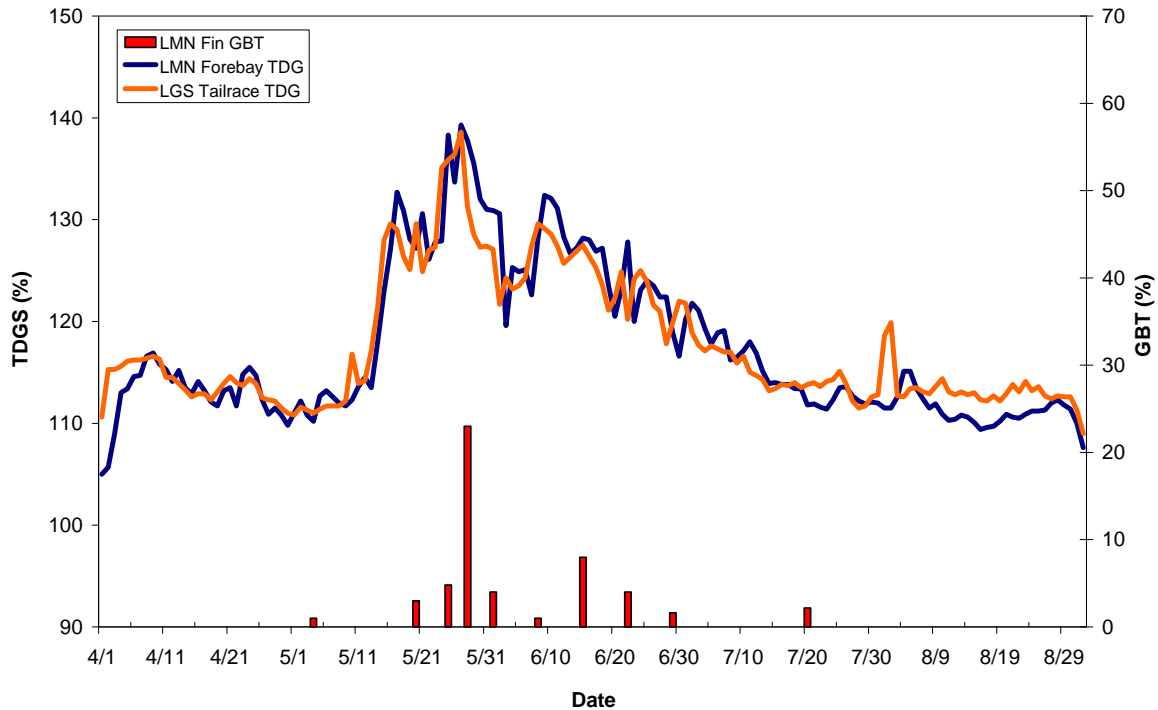
Figure L-3
Percent GBT observed in the sample at Little Goose Dam



Lower Monumental Dam

High levels of GBT were also observed at Little Monumental Dam. During late May the 15% action criteria was exceeded at Lower Monumental Dam (Figure L-4). A complete powerhouse outage at Little Goose Dam occurred from May 24th at 0600 hours to 1200 hours on June 1, 2011. The TDG below Little Goose exceeded 130% for a five day period and reached a 12 hour average high of 138.6%. The TDG levels greater than 130% were also observed at the Lower Monumental forebay gage during this time period. Both the incidence and severity of the signs of GBT (up to Rank 3 signs) increased during this period. The GBT decreased to below the action criteria once the Little Goose powerhouse resumed normal operations and TDG levels decreased to closer to 120% at the Lower Monumental forebay gage.

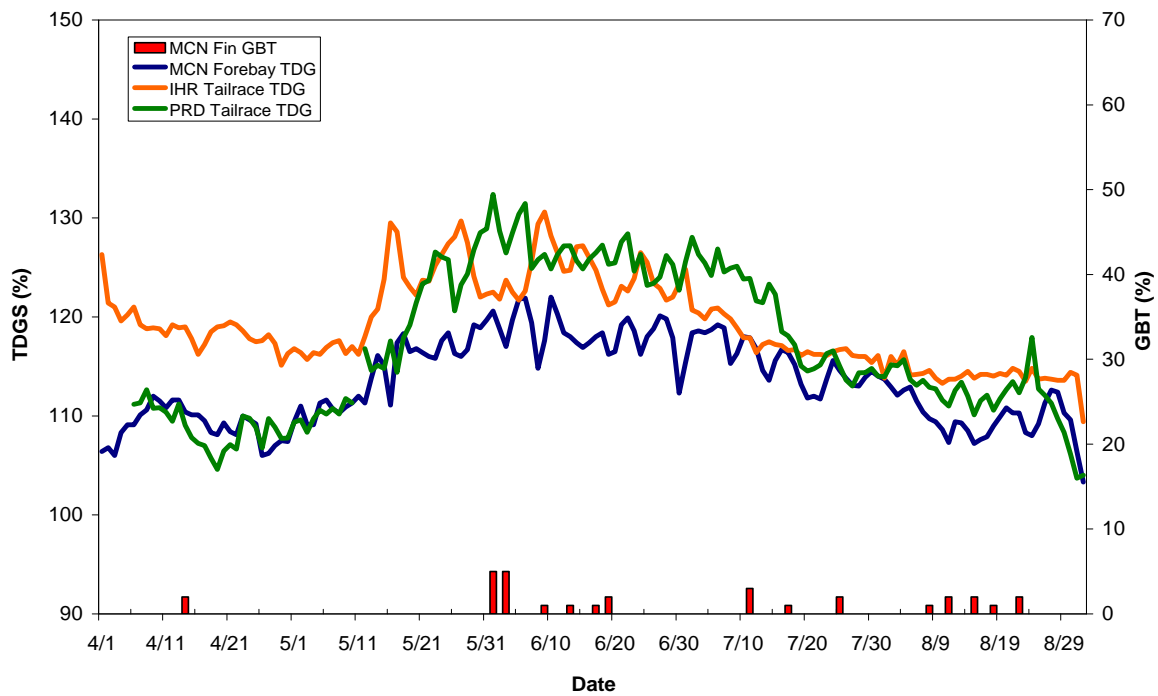
Figure L-4
Percent GBT observed in the sample at Lower Monumental Dam.



McNary Dam

The TDG levels below Ice Harbor and Priest Rapids dams exceeded 130% at times; however, the forebay levels at McNary Dam rarely exceeded 120%. This was reflected in the GBT data (Figure L-5) where, the incidence of GBT at McNary Dam was lower than observed in the Snake River at Little Goose and Lower Monumental dams.

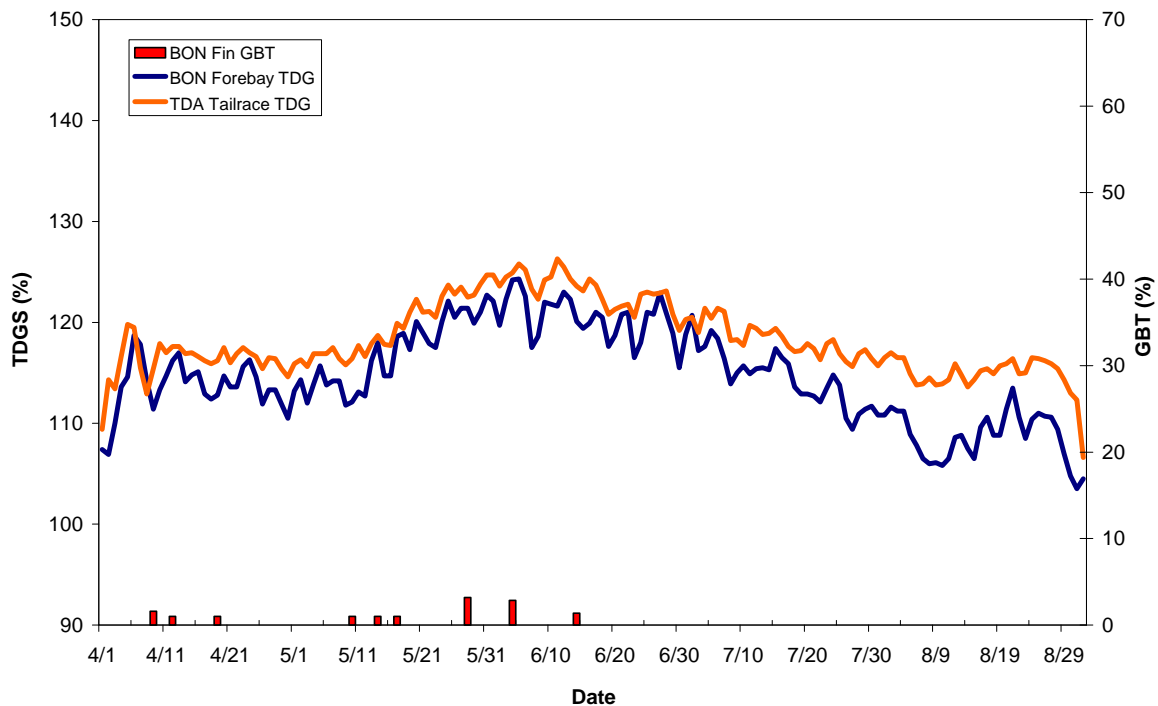
Figure L-5
Percent GBT observed in the sample at McNary Dam.



Bonneville Dam

Few fish were sampled at Bonneville Dam with signs of GBT (Figure L-6). In part, the lower incidence reflects the lower TDG values that were observed in the Lower Columbia River. In addition, due to increased debris accumulation the fish screens at Bonneville Dam were removed beginning on May 19th and continuing until July 12th. The fish sampled at the project during this period reflect those fish that volitionally entered the gatewell system and may not accurately reflect the total population passing the project. The incidence of GBT did not exceed 4% this year.

Figure L-6
Percent GBT observed in the sample at Bonneville Dam.



Rock Island Dam

Grand Coulee Dam was operated for flood control during most of the spring and early summer season. This resulted in high levels of TDG entering the Mid Columbia River below Chief Joseph Dam, and the high levels of spill and TDG continued through the Mid Columbia projects. TDG levels in the forebay of Rock Island Dam exceeded 120% on May 21st, hovered near 130% from May 30th until June 7th, and remained above 120% until July 14th. These high levels of TDG are reflected by GBT incidence (Figure L-7) in several samples collected between 5/31 and 6/23.

Figure L-7
Percent GBT observed in the sample at Rock Island Dam.

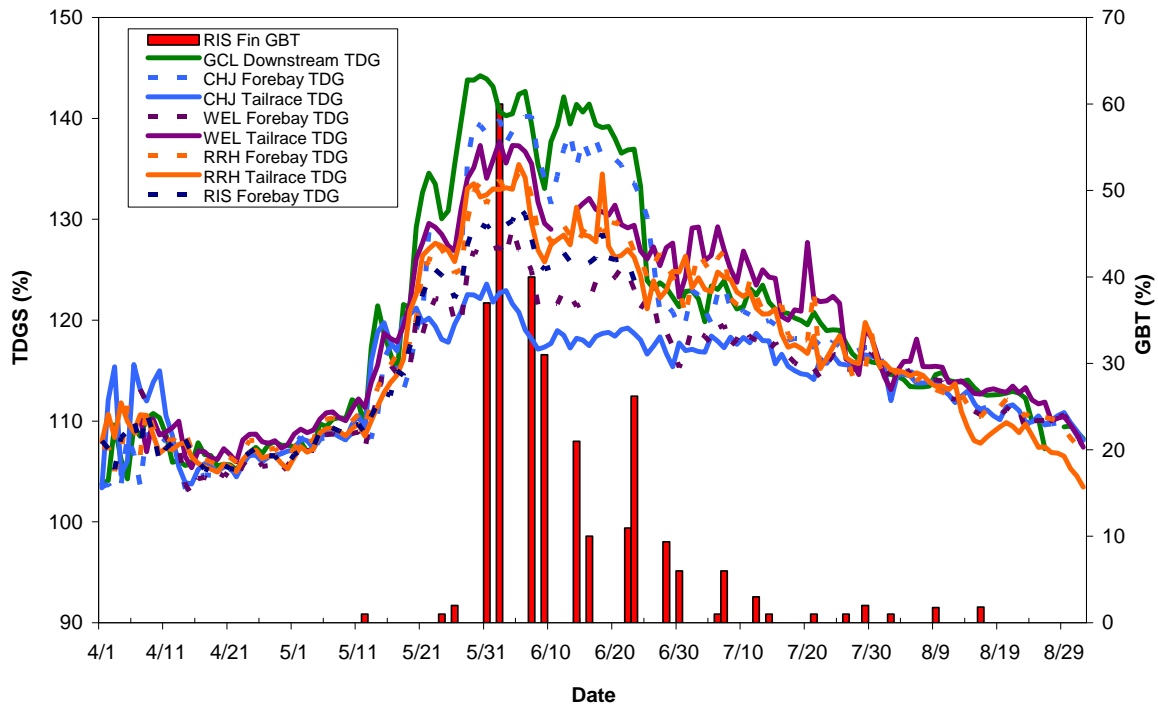


Table L-4 compares the 2011 estimates of the overall percentage of fish with signs of GBT to past years' estimates. This is not meant as a measurement of overall GBT, but is used to easily display the annual relative magnitude of GBT compared to past years'. As can be seen in the table the overall annual incidence of GBT in 2011 was on the higher end of the range observed in past years, reflecting the higher TDG levels encountered this year.

Table L-4

Percent of sampled fish with signs of fin GBT estimated for the total fish observed in each year 1996 to 2011.

Year	Total % Signs	% Signs excluding RIS
1996	3.3	4.2
1997	3.2	4.3
1998	1	1.6
1999	0.3	1.4
2000	0.2	0.2
2001	0.001	0.1
2002	0.7	0.7
2003	1.5	0.5
2004	0.18	0.18
2005	0.46	0.11
2006	1.6	1.4
2007	2.4	2.9
2008	0.5	0.7
2009	0.29	0.23
2010	0.36	0.43
2011	2.5	0.95

Discussion

The Biological Opinion Spill Program is managed; whenever possible, using the data collected for total dissolved gas levels. The GBT biological monitoring is meant to complement the physical monitoring program. GBT sampling was successfully accomplished for the 2011 migration season.

The GBT monitoring program has consistently shown over years' of implementation that signs of GBT are minimal when TDG is managed to the criteria levels of 115/120% TDG. In fact, very few signs of GBT are observed when forebay levels of TDG are near 120%. Signs of GBT begin to increase as TDG increases above the criteria levels, and will approach the action criteria for GBT at higher levels of TDG.

Historical observations suggest that this usually occurs when TDG levels are near the 130% supersaturation levels in the tailraces, or forebays, of dams. This same response to TDG levels was again observed in 2011 in the Snake River at Little Goose, Lower Monumental dams and at Rock Island Dam. However, it is important to note that when TDG levels approach the 130% range the hydro system is always in an uncontrolled spill situation, and there are no actions that can be taken. The high flow/spill experienced in the Snake River, the powerhouse outage at Little Goose Dam, the above average Columbia River runoff that necessitated the operation of Grand Coulee Dam for flood control are all reflected in the observations of GBT at the monitoring sites this year.