

# **Appendix L**

## **Gas Bubble Trauma Monitoring And Data Reporting For 2012**

**Fish Passage Center  
Portland, Oregon**



## FISH PASSAGE CENTER

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November 2, 2012

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

Dear Mr. Proctor,

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 2012". This report summarizes data collected during the 2012 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 2012

## 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 2012 for gas bubble trauma (GBT) was conducted at Middle Columbia, Upper Columbia and Snake River sites. Fish were collected and examined for signs of GBT at Bonneville Dam and McNary Dam on the Middle Columbia River, and at Rock Island Dam on the Upper 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.**

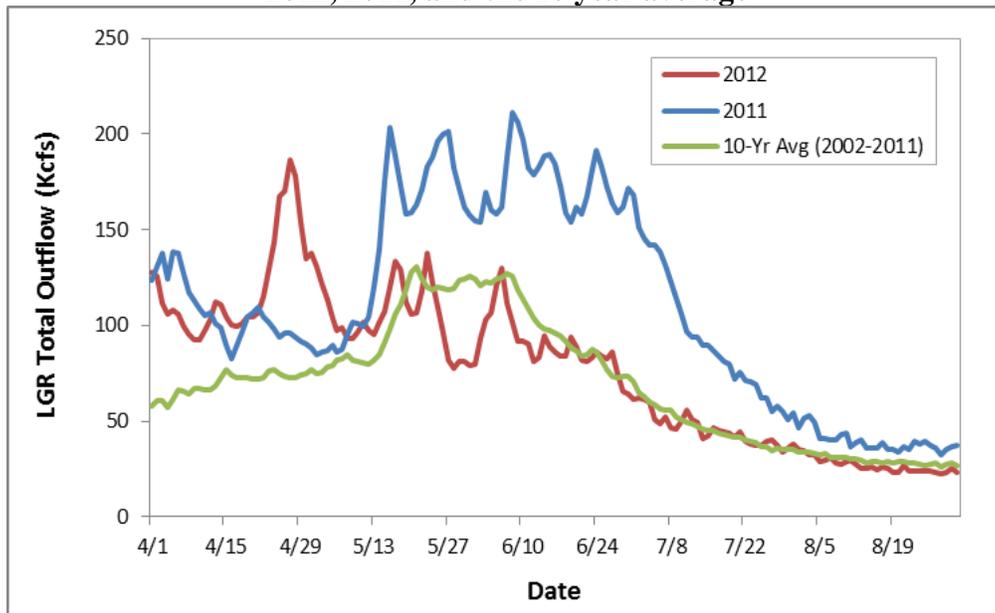
<b>Rank</b>	<b>Sign</b>
0	no bubbles present
1	up to 5% of a fin area or eye covered with bubbles
2	6% to 25% of a fin area or eye covered with bubbles
3	26% to 50% of a fin area or eye covered with bubbles
4	> than 50% of a fin area or eye covered with bubbles

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 <ftp://ftp.fpc.org/GBT/> 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

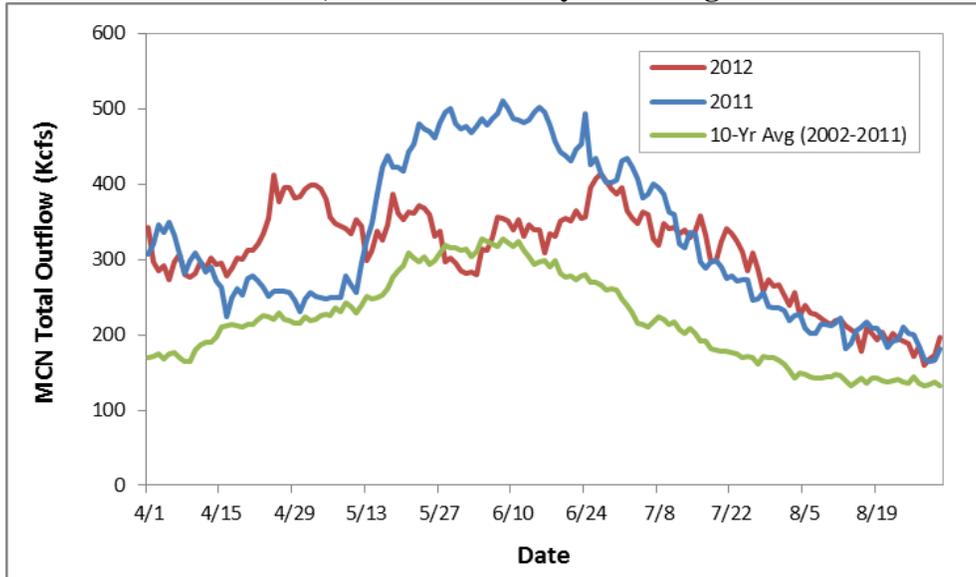
at juvenile salmonid transportation collection sites, and by the standard collection methods at Rock Island and Bonneville dams.

The runoff (January -July) volume for the 2012 water year was average or above average in both the Snake and Columbia rivers. Runoff (January-July) was 100% of average (1971-2000) above Lower Granite and 121% of average above The Dalles Dam. The 2012 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. River flows in the Snake River were average or slightly less than average from Mid-May through July. In the Columbia River, higher than average flows occurred from the early spring period through the end of August. 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**  
**2012, 2011, and the 10 year average**



**Figure L-2**  
**Average daily flows at McNary Dam**  
**2012, 2011 and the 10 year average**



**Results**

In all, 14,054 juvenile salmonids were examined for GBT between April and August of 2012 (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 2012 as part of the GBT Monitoring Program.**

Species	BON	MCN	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	1,858	2,379	492	575	0	1,257	6,561
Chinook Yearlings	1,301	1,380	392	636	374	816	4,899
Steelhead	104	279	610	504	452	645	2,594
<b>Total</b>	<b>3,263</b>	<b>4,038</b>	<b>1,494</b>	<b>1,715</b>	<b>826</b>	<b>2,718</b>	<b>14,054</b>

Fin signs were found in 96 or 0.68% 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 fish with signs of rank 2 were observed at McNary and Rock Island dams. No signs of rank 3 or 4 were observed in 2012.

**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 2012 as part of the GBT Monitoring Program.

Sum of FinGBT Species	Site						Grand Total
	BON	MCN	LMN	LGS	LGR	RIS	
CH0	2	9	0	1	0	24	36
CH1	9	13	3	1	0	9	35
ST	1	8	1	1	1	13	25
Grand Total	12	30	4	3	1	46	96

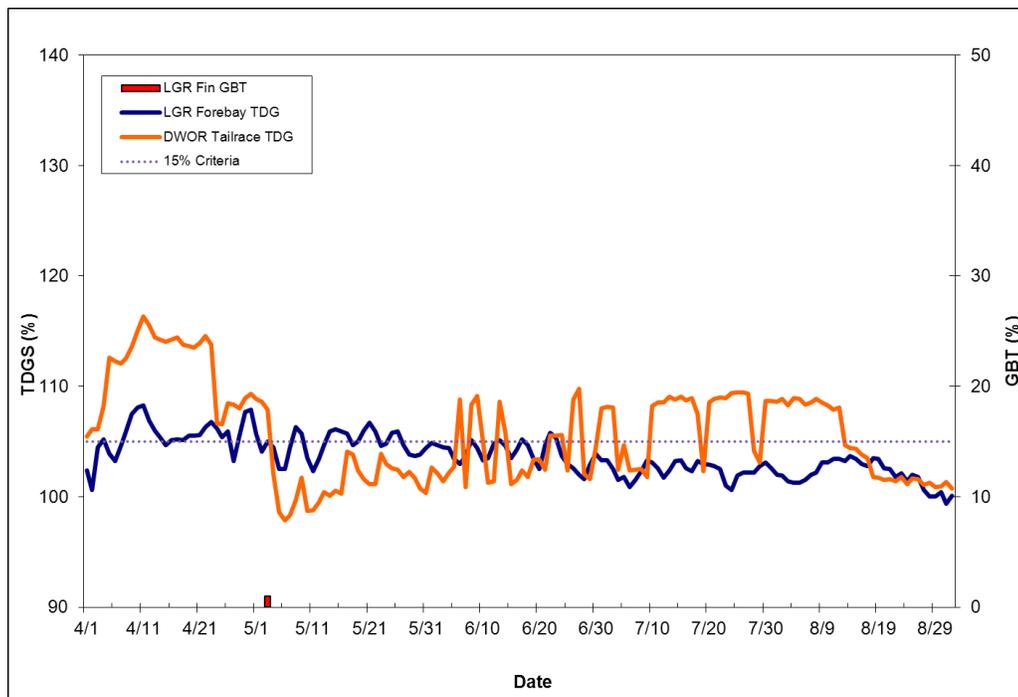
The action criteria for GBT is established as 15% of fish showing any signs of GBT, or 5% of the fish sampled showing signs greater than rank 1. Neither of these two action criteria was met in 2012.

**Lower Granite Dam (LGR)**

Total Dissolved Gas (TDG) in the Dworshak Dam tailrace never exceeded 120% in 2012 and TDG in the Lower Granite forebay never exceeded 115%. There was only one day in 2012 when fish at LGR exhibited signs of GBT. The GBT rate for this date (May 3<sup>rd</sup>) was 1.0% and GBT signs were at the rank 1 level.

**Figure L-3**

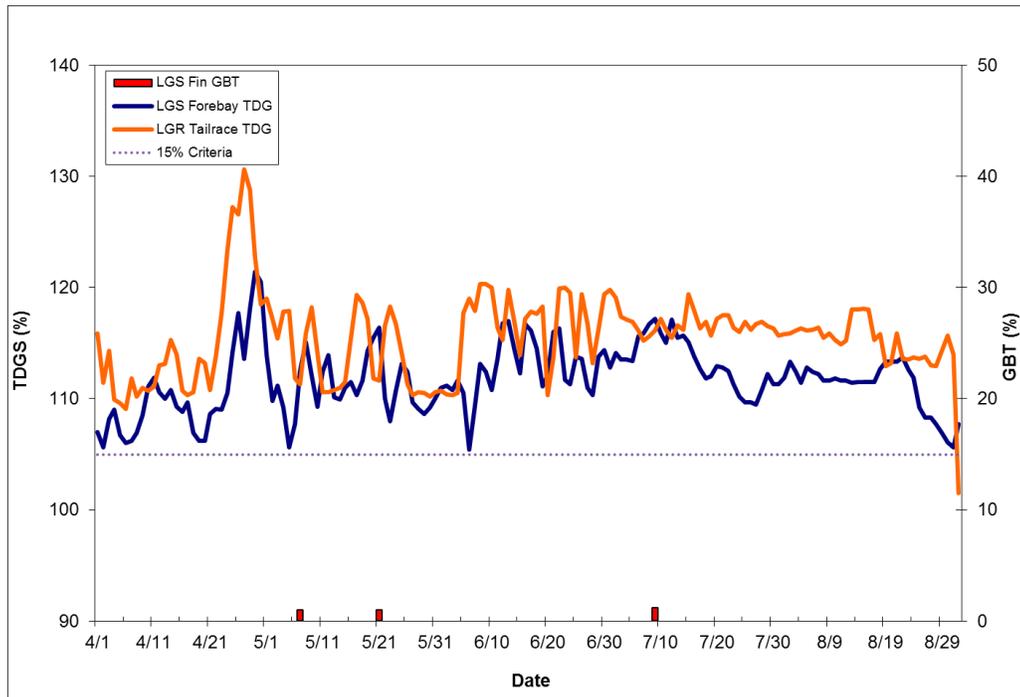
Percent GBT observed in the sample at Lower Granite Dam. Sampling occurred weekly between April 12 and June 14, 2012. Only days when signs of GBT were detected are displayed in the graph.



**Little Goose Dam (LGS)**

Both the prevalence and severity of GBT signs at LGS were low in 2012. Signs of GBT were only detected on three occasions in 2012, with a maximum GBT rate of 1.2% on July 9<sup>th</sup> (Figure L-4). All incidences of GBT at LGS in 2012 were at the rank 1 level. Total dissolved gas levels in the Lower Granite (LGR) tailrace exceeded the 120% criteria for a short period in late April (Figure L-4). This was the only period in 2012 when TDG in the LGR tailrace exceeded the 120% criteria. On April 27<sup>th</sup>, the 12- hour TDG measurements exceeded 130% in the LGR tailrace.

**Figure L-4**  
**Percent GBT observed in the sample at Little Goose Dam. Sampling occurred weekly between April 9 and August 13, 2011. Only days when signs of GBT were detected are displayed in the graph.**

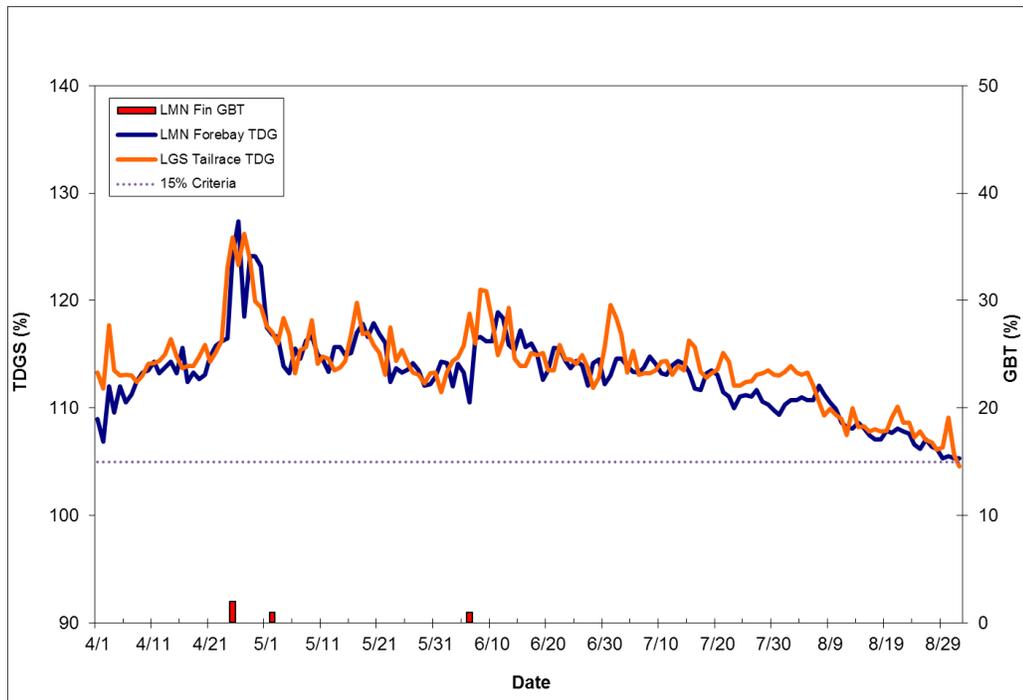


**Lower Monumental Dam (LMN)**

As with Little Goose Dam, there were only three occasions where signs of GBT were detected at Lower Monumental Dam in 2012. GBT rates at LMN never exceeded 2.0% and all incidences of GBT at LMN in 2012 were at the rank 1 level (Figure L-5). The highest GBT rate at LMN occurred on April 25<sup>th</sup>, when TDG in the LMN forebay was 124%. This high TDG in the LMN forebay was likely the result of increased spill from Little Goose Dam.

**Figure L-5**

**Percent GBT observed in the sample at Lower Monumental Dam. Sampling occurred weekly between April 11 and August 8, 2011. Only days when signs of GBT were detected are displayed in the graph.**

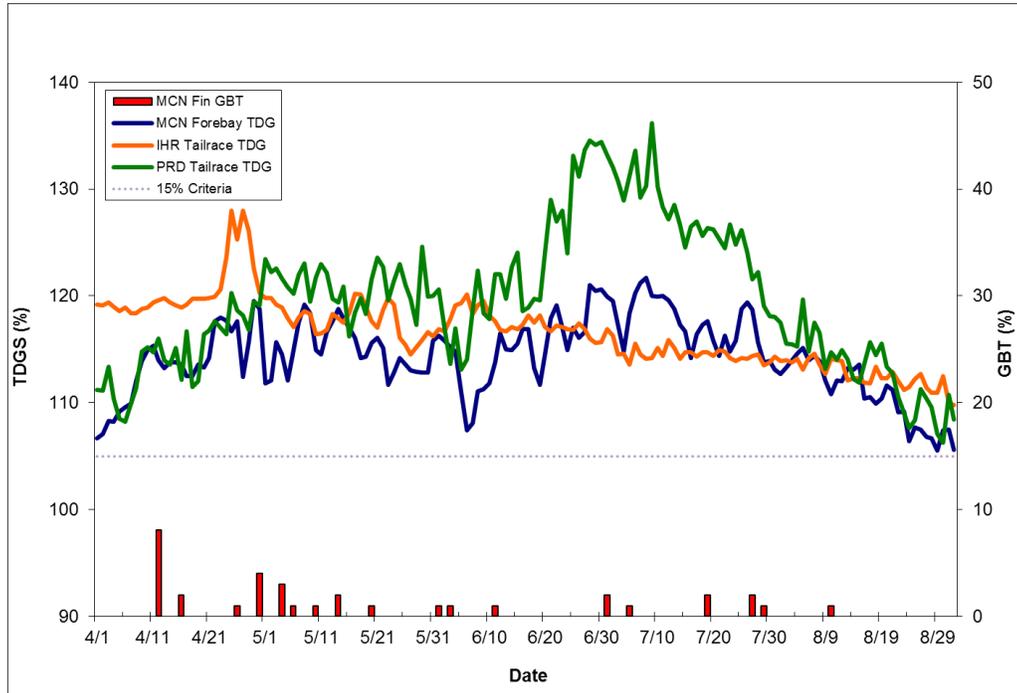


***McNary Dam (MCN)***

The TDG levels below Priest Rapids dams exceeded 130% at times; however, the TDG levels in the Ice Harbor tailrace and McNary forebay rarely exceeded 120% (Figure L-6). Incidence of GBT at McNary Dam in 2012 was higher than what was observed in the Snake River at Little Goose and Lower Monumental dams. In all, there were 18 days where signs of GBT were seen at MCN in 2012 (Figure L-6). Of these, the maximum rate of GBT was 8.1%, which occurred on April 12<sup>th</sup>(Figure L-6). Of the 30 fish that showed signs of GBT at MCN in 2012, all but one had rank 1 signs. There was only one fish in 2012 that had GBT signs in the rank 2 category.

**Figure L-6**

**Percent GBT observed in the sample at McNary Dam. Sampling occurred twice weekly between April 12 and August 30, 2011. Only days when signs of GBT were detected are displayed in the graph.**

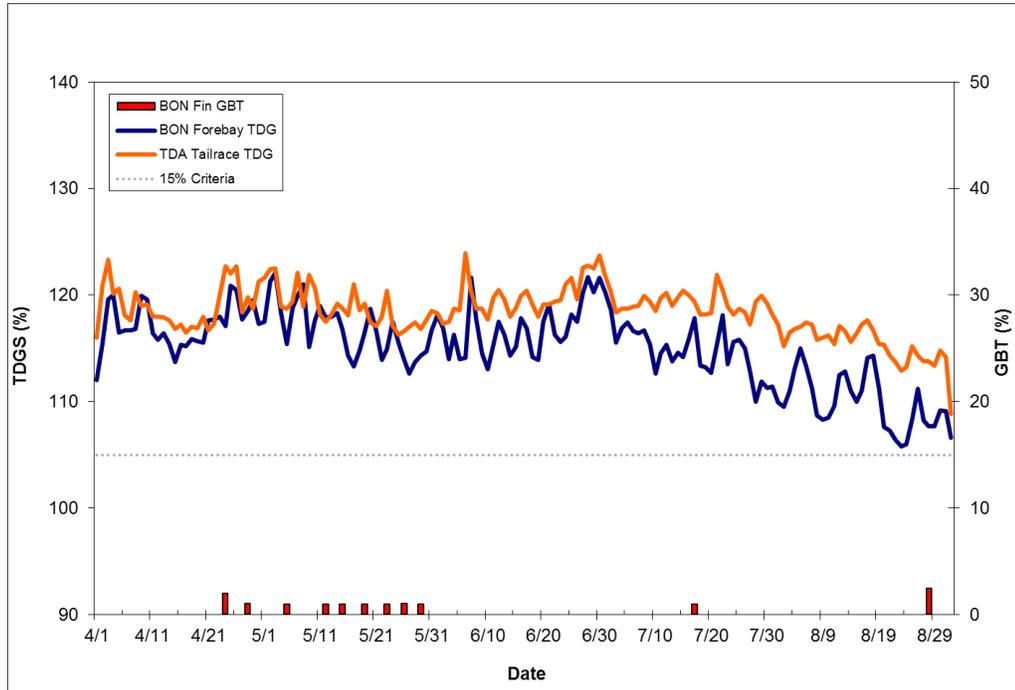


***Bonneville Dam (BON)***

At Bonneville Dam, there were 11 days in 2012 when fish showed signs of GBT (Figure L-7). Of these 11 days, the maximum GBT rate was 2.4%, which occurred on August 28<sup>th</sup> (Figure L-7). Of the 12 fish that exhibited signs of GBT at BON in 2012, only one had signs that were rank 2. All other signs of GBT at BON were rank 1.

**Figure L-7**

Percent GBT observed in the sample at Bonneville Dam. Sampling occurred twice weekly between April 7 and August 28, 2011. Only days when signs of GBT were detected are displayed in the graph.



**Rock Island Dam (RIS)**

At Rock Island Dam, there were 17 total days where signs of GBT were detected (Figure L-8). The maximum GBT rate at RIS in 2012 was 7.0%, which occurred on July 6<sup>th</sup> (Figure L-8). During this time, TDG in the Upper Columbia was high, particularly from Wells and Rocky Reach dams. These high TDG levels were due to increased spill at Wells and Rock Reach dams that remained until late July. Of the 46 fish that showed signs of GBT at RIS in 2012, only two had signs that were above rank 1. Both of these fish showed rank 2 signs in their caudal fins.

**Figure L-8**

**Percent GBT observed in the sample at Rock Island Dam. Sampling occurred twice weekly between April 18 and August 14, 2012. (Due to low fish sample numbers, no GBT sampling occurred between June 7 and July 6). Only days when signs of GBT were detected are displayed in the graph.**

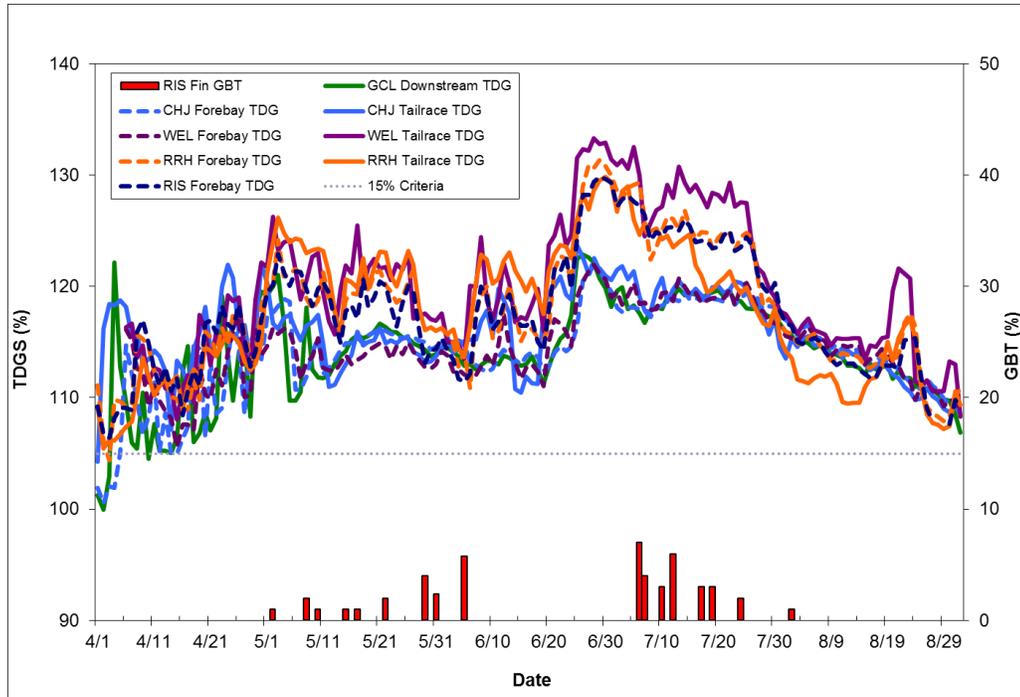


Table L-4 compares the 2012 estimates of the overall percentage of fish with signs of GBT to past years' estimates. This is not meant as a measurement of overall GBT, but is used to easily display the annual relative magnitude of GBT compared to past years'. As can be seen in the table the overall annual incidence of GBT in 2012 was in the mid-range among the past 16 years.

**Table L-4**

**Percent of sampled fish with signs of fin GBT estimated for the total fish observed in each year 1996 to 2012.**

<b>Year</b>	<b>Total % Signs</b>	<b>% Signs excluding RIS</b>
<b>1996</b>	3.3	4.2
<b>1997</b>	3.2	4.3
<b>1998</b>	1	1.6
<b>1999</b>	0.3	1.4
<b>2000</b>	0.2	0.2
<b>2001</b>	0.001	0.1
<b>2002</b>	0.7	0.7
<b>2003</b>	1.5	0.5

<b>2004</b>	0.18	0.18
<b>2005</b>	0.46	0.11
<b>2006</b>	1.6	1.4
<b>2007</b>	2.4	2.9
<b>2008</b>	0.5	0.7
<b>2009</b>	0.29	0.23
<b>2010</b>	0.36	0.43
<b>2011</b>	2.5	0.95
<b>2012</b>	<b>0.68</b>	<b>0.44</b>

## Discussion

The Biological Opinion Spill Program is managed, whenever possible, using the data collected for total dissolved gas levels (physical monitoring). The GBT biological monitoring is meant to complement the physical monitoring program. GBT sampling was successfully accomplished for the 2012 migration season. The GBT sampling program also provides information on the impact to fish when uncontrolled spill occurs and gas levels exceed the total dissolved gas waiver limits.

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 2012 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 and the above average Columbia River runoff that led to high levels of spill in the Upper Columbia in July are all reflected in the observations of GBT at the monitoring sites this year.