

## **Gas Bubble Trauma Monitoring and Data Reporting for 2006**

### **Overview**

The monitoring of juvenile salmonids in 2006 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 Monumental Dam, Little Goose Dam, and Lower Granite Dam. Monitoring is normally conducted at all sites during the spring spill season and at Mid Columbia and lower Columbia river sites during the summer spill program. Summer monitoring at the Snake River sites did occur this year as a result of the Court ordered summer spill program. Summer spill in the Snake River occurred from June 20, 2006 until August 31, 2006.

Yearling chinook and steelhead were sampled through the spring at the Columbia River sites. Once subyearling chinook predominated smolt collections the sampling of subyearling chinook occurred at Columbia River sites to the end of August. Subyearling smolts were monitored in the Snake River during the summer spill period.

Sampling occurred two days per week at the Columbia River sites and one day a week at each of the Snake River sites during the time period that spill was implemented. The goal was to sample 100 salmonids of the most prevalent species (limited to chinook and steelhead) during each day of sampling at each site, the proportion of each species dependent upon their prevalence at the time of sampling. 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 in the fins were quantified using a ranking system based on the percent area of the fins covered with bubbles (Table 1).

**Table 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 covered with bubbles
2	6% to 25% of a fin area covered with bubbles
3	26% to 50% of a fin area covered with bubbles
4	> than 50% of a fin area covered with bubbles

The eyes of the fish were also examined and the eye with the highest amount of bubbles was ranked using the same criteria as was used for the fins. Additional information was recorded for each fish including, species, age, race, rearing disposition, 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 for details of exam procedures).

Sampling techniques varied somewhat based on the location. This year all sampling sites were at dams, where fish could be collected from the juvenile fish bypass system. At those dams where fish crossed separators the fish were collected as they entered the separator. Rock Island Dam is the only site where fish were held in a tank (up to 24 hours) prior to examination.

The runoff for the 2006 water year was 107% of average (1971-2000) at both Lower Granite and The Dalles Dam. This above average water year resulted in high flows during the latter part of May in both the Snake and lower Columbia resulting in TDG levels greater than 120%. In the Snake River a unit was out of service at Lower Granite Dam limiting the hydraulic capacity of that project throughout the spring and summer season. In addition, units 1-4 at John Day Dam were not available for operation, due to a T-1 line failure that occurred early in March, also limiting the hydraulic capacity of this project. However, while TDG exceedences greater than the 120% tailrace criteria did occur, the tailrace TDG at John Day Dam did not exceed 125% as it did at Lower Granite Dam.

**Results**

A total of 14,186 juvenile salmonids were examined for GBT between April and August of 2006 (Table 2).

**Table 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 2006 as part of the GBT Monitoring Program.**

Species	Site						Total
	BON	MCN	LMN	LGS	LGR	RIS	
Chinook Subyearlings	2,191	2,257	362	352	226	1,299	6,687
Chinook Yearlings	1,552	982	389	445	370	979	4,717
Steelhead	201	277	532	586	500	686	2,782
<b>Total</b>	<b>3,944</b>	<b>3,516</b>	<b>1,283</b>	<b>1,383</b>	<b>1,096</b>	<b>2,964</b>	<b>14,186</b>

Fin signs were found in 224 or 1.58% of the fish sampled at all sites (Table 3). No fish were found with severe fin signs (rank 3 or higher) while, 11 fish had fin rank 2, with the remainder having rank 1 signs.

**Table 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 2006 as part of the GBT Monitoring Program.**

Species	Site						Total
	BON	MCN	LMN	LGS	LGR	RIS	
Chinook Subyearlings	19	0	4	3	1	23	50
Chinook Yearlings	16	0	5	3	0	26	50
Steelhead	1	0	42	59	2	20	124
<b>Total</b>	36	0	51	65	3	69	224

Table 4 compares the 2006 estimates of the overall percentage of fish with signs of GBT to past years' estimates.

**Table 4. Percent of sampled fish with signs of GBT estimated for the total fish observed.**

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total % Signs	3.3	3.2	1.0	0.3	0.2	0.001	0.7	1.5	0.18	0.46	1.6
% signs excluding RIS	4.2	4.3	1.6	1.4	0.2	0.1	0.7	0.5	0.18	0.11	1.4

The Biological Opinion Spill Program was managed using the data collected for total dissolved gas levels. However, signs of GBT in fins of juvenile fish, examined as part of the biological monitoring, are to be used to complement the physical monitoring program. NOAA Fisheries originally established the action criteria for the biological monitoring program at 15% prevalence of fish having fin signs or 5% with severe signs (rank 3 or greater) in fins. The action criteria were exceeded in 2006. The criteria were exceeded in the Snake River at Little Goose Dam (Figure 1) during late May and again at Lower Monumental Dam (Figure 2) during mid June. During late May the hydrosystem was in an uncontrolled spill situation when flow

### Little Goose Dam 2006

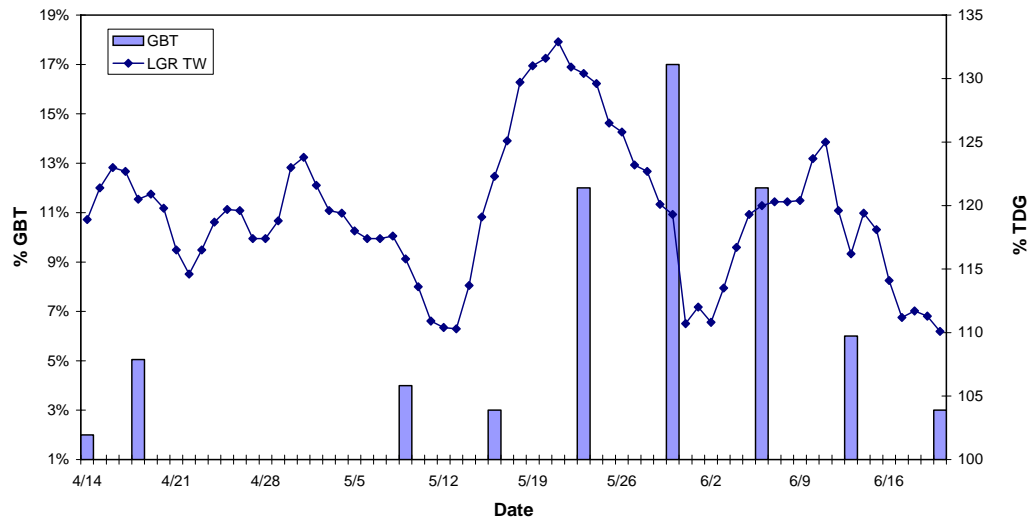


Figure 1. Percent signs of GBT observed in samples of juvenile salmon at Little Goose Dam and the upstream tailwater reading of total dissolved gas.

### Lower Monumental Dam 2006

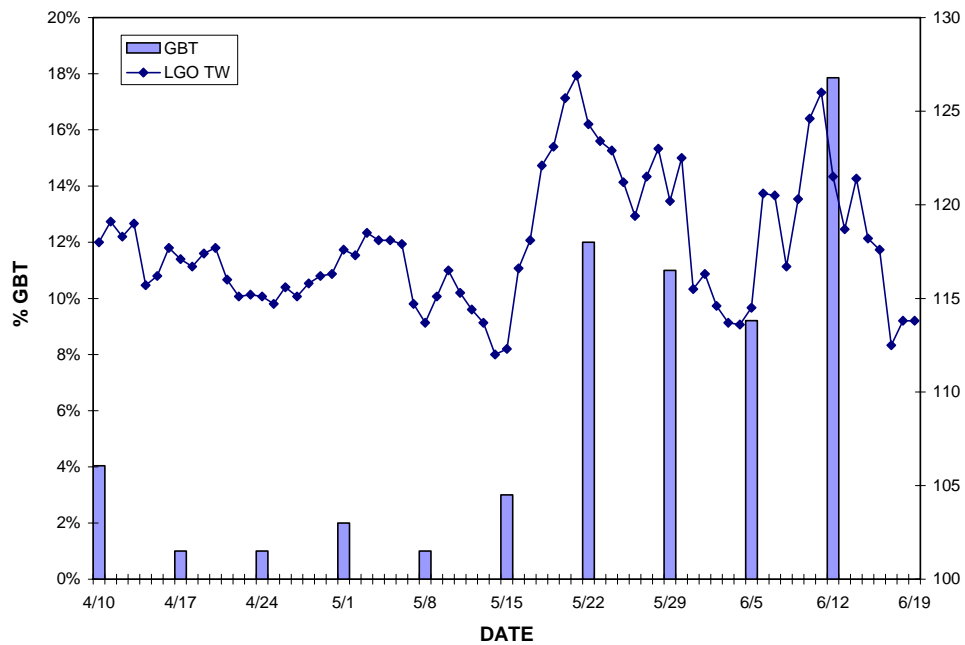


Figure 2. Percent signs of GBT observed in samples of juvenile salmon at Lower Monumental Dam and the upstream tailwater reading of total dissolved gas

exceeded powerhouse capacity at the Snake River projects. Total dissolved gas levels had exceeded 130% upstream just prior to the criteria being exceeded at Little Goose Dam.

Later in the spring season the incidence of GBT again increased at the Snake River projects (and exceeded the GBT criteria at Lower Monumental Dam) as a result of project operations for the management of excess market spill after the spring peak flows had passed. This occurred during mid-June of 2006. At the time the Action Agencies' management of spill attempted to meet water quality standards during daytime hours, which resulted in spill levels well in excess of the Court's order during nighttime hours. This management resulted in periods when TDG levels may have been significantly higher than if attempts had been made to manage spill to a lower overall daily average. A management approach attempting as best as possible to evenly distribute spill over the 24-hour period may have resulted in an overall lower TDG values that might have had less impact on fish. This type of management should be implemented in future years.

The prevalence and severity of fin signs in juvenile salmonids sampled in the Lower Snake and Lower Columbia rivers reflects changes in TDGS conditions in the river from year to year. The occurrence of severe signs in 1996 and 1997, and the increase in exceedences of the NMFS action criteria, reflected a significant increase in the number of days when TDGS rose above 125% in the forebays of these dams. In other years few fish were observed with severe signs of GBT, reflecting the more moderate conditions found in the river. The data for the past five years is displayed in Tables 5 and 6.

**Table 5. The number of days when TDGS levels were above 120% and 125% at representative forebay monitors in the Lower Snake and Lower Columbia Rivers from April 1 to August 31.**

TDGS Monitor	2006		2005		2004		2003		2002	
	days >120	days >125	days >120	days >125	days >120	days >125	days >120	days >125	days >120	days >125
Lower Granite	0	0	0	0	0	0	0	0	0	0
Little Goose	1	0	0	0	0	0	7	2	1	0
Lower Monumental	0	2	0	0	0	0	7	2	5	0
Ice Harbor	0	0	0	0	0	0	4	0	0	0
McNary (Oregon) <sup>a</sup>	0	0	0	0	1	0	1	1	0	0
Bonneville	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>20</b>	<b>6</b>	<b>6</b>	<b>0</b>

<sup>a</sup> 2002 data used Washington monitor at McNary due to missing data from Oregon monitor during July and August.

**Table 6. The number of days when NMFS GBT criteria of 15% prevalence or 5% severe signs were exceeded at sites in the Lower Snake and Lower Columbia rivers from April 1 to August 31.<sup>ab</sup>**

Site	2006	2005	2004	2003	2002
Lower Granite	0	0	0	0	0
Little Goose	1	0	0	0	0
Lower Monumental	1	0	0	0	2
Ice Harbor	0	0	0	0	0
McNary	0	0	0	0	0
Bonneville	0	0	0	0	0
<b>Total</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>

<sup>a</sup> Based on dates when at least 30 fish of the species exhibiting signs were captured.

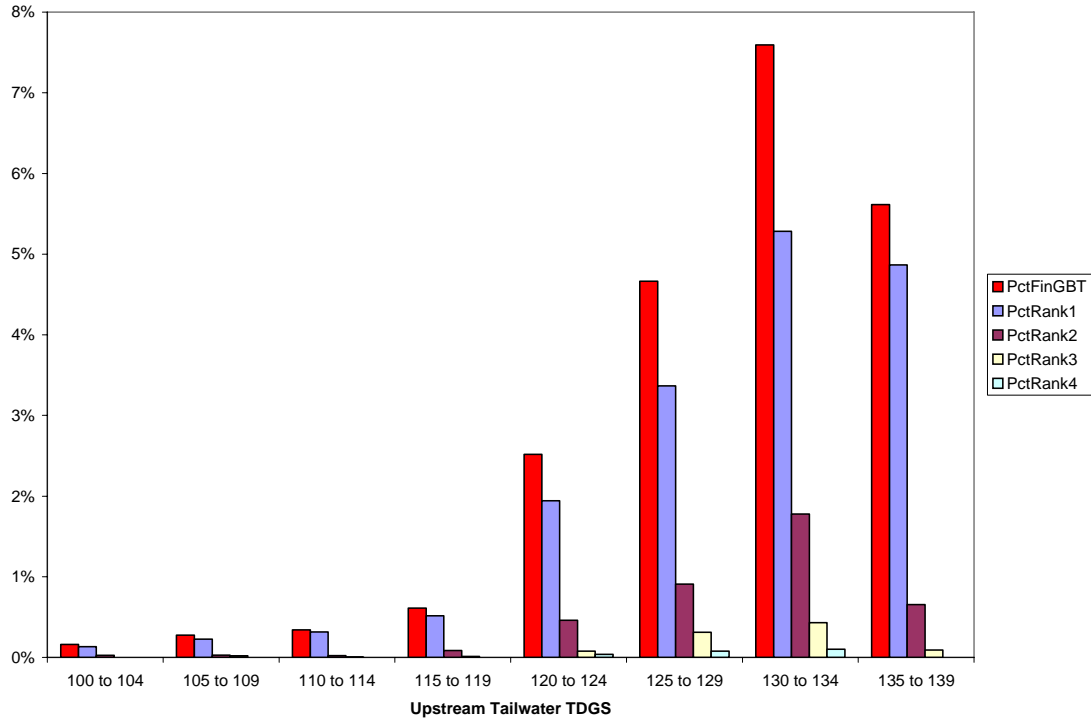
<sup>b</sup> More than 5% of fish showed severe signs on only 1 date in each year 1996 & 1997 and on those same dates the prevalence of fin signs was greater than 15%.

## Discussion

GBT sampling was successfully accomplished for the 2006 migration season. In general, more fish were observed with signs of GBT this year than have been observed since the high flow years of 1996 and 1997. This high level of signs reflects the overall water conditions and the limitations of project operations at Lower Granite and John Day dams.

This year, as in previous years, the number of fish showing fin signs appears to be proportional to the levels of TDGS experienced by fish. Very few fish were observed with GBT when the river was within the 120% tailrace criterion. Figure 3 shows the data for all years combined (1995-2005) as a function of tailrace total dissolved gas. The incidence and severity of GBT does not increase until the total dissolved gas levels in the tailrace exceed 120% and are well in excess of those experienced in a controlled spill program.

The 2006 sample year again included summer sampling in the Snake River that was conducted for the implementation of the court ordered injunctive relief spill program. A total of ten juvenile migrants (out of 942 sampled) were detected in the Snake River spread over several days during the beginning of summer time period (June 20 to August 31). The signs detected were Rank 1, meaning that less than 5% of an unpaired fin was affected with bubbles. It can be concluded that the spill experienced by the subyearling migrants in the Snake River during the summer of 2006 did not result in concern for GBT in subyearling migrants.



**Figure 3. Percentage of all Fish Examined for GBT at Little Goose, Lower Monumental, McNary and Bonneville dams from 1995 to 2005 that showed fin any GBT as well as the percent by TDG category based on upstream tailwater monitor and fish travel time from that site. Fin ranks are: rank 1 – less than 5% fin area covered with bubbles, rank 2 – 5 to 25%, rank 3 – 26 to 50% and rank 4 – greater than 50%.**