



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

MEMORANDUM

TO: Bill Tweit, WDFW
Guy Norman, WDFW

Michele DeHart

FROM: Michele DeHart

DATE: May 27, 2011

RE: Columbia & Snake Rivers Smolt Monitoring Program Gas Bubble Trauma

In response to your request the FPC staff summarized the Smolt Monitoring Program gas bubble trauma monitoring data collected to-date during the 2011 juvenile spring migration. Each year the Smolt Monitoring Program (SMP) is conducted to collect consistent and continuous data on the juvenile salmon and steelhead downstream migration. The real-time data and the historic SMP data provide a basis for the fishery managers and hydrosystem operators and regulators in their consideration of river operations, and the potential effect on juvenile salmon passage.

The May mid-month run-off volume forecast for the Columbia basin above The Dalles Dam is 124% of average, 120% of average above Grand Coulee, and 140% of average above Lower Granite Dam. Given the high volume runoff projections the high inflows to reservoirs are expected to continue for several weeks. At the present time the river system is being managed for flood control, by targeting a flow of 480 Kcfs at The Dalles Dam.

The present spill and flow levels are the result of the high run-off volume. Due to these very high flows, which are currently in excess of the powerhouse capacities at all Snake River and Lower Columbia River projects, the spill levels are in excess of the Court Ordered spill for fish passage requirements at all FCRPS projects.

We have summarized our conclusions from the review in the following points:

- Historic data show that typically, GBT levels have not reached action levels (levels of occurrence that would indicate a need to reduce spill operations) during periods when TDGS levels were within the water quality agency waiver limits of 115% forebay and 120% tailwater TDGS.
- Studies have shown that juvenile salmon are distributed vertically in the river to allow for depth compensation. Fish that are confined to net pens will be limited in how deep they descend in the water column and so will be more vulnerable to dissolved gas levels and will exhibit and develop signs and trauma that may not be exhibited by migrating salmonids.
- Signs of GBT are a result of concentration and exposure time. Fish that are actively migrating have a shorter exposure to high gas areas, and are less likely to develop signs of GBT when compared to migrating salmonids. Fish confined to a net pen will have longer exposure times.
- At the present time gas levels have exceeded the 115/120% at all projects in the Mid Columbia, Snake and lower Columbia rivers.
- The SMP gas bubble trauma monitoring has shown low incidence of signs at most projects, with a maximum of 4.8% GBT at Lower Monumental Dam on May 25th.
- The GBT monitoring action criteria was established by NOAA on the basis of literature and research. To date, neither of the action criteria have been met at the Mid-Columbia, Snake, or lower Columbia monitoring sites.
- The water quality agencies of the states have established a 7Q10 flow above which it is recognized that there are no available actions to reduce uncontrolled flow and uncontrolled spill. The 480 Kcfs flood control target at The Dalles Dam exceeds the 7Q10 flow.

GBT Monitoring:

As part of the state TDG waivers, biological monitoring for Gas Bubble Trauma (GBT) is conducted throughout the Mid-Columbia, Snake, and Lower Columbia rivers. There are two action criteria for the curtailment of voluntary spill under this biological monitoring. First, spill can be curtailed if 15% of the examined fish show signs of fin GBT, regardless of their rank. Second, spill can be curtailed if 5% of the examined fish show severe signs ($\geq 26\%$ fin occlusion) of GBT. GBT monitoring at each of the sites typically takes place once or twice a week.

Rock Island Dam is the only site in the Mid-Columbia River where GBT examinations are conducted as part of the GBT monitoring program. These examinations are typically conducted twice a week. To date, the 12-hour average TDG levels (based on Oregon methodology) in the Rock Island Dam forebay have ranged from 104.9 to 125.0%. These 12-hour average TDG levels in the Rocky Reach Dam tailrace and downstream of Grand Coulee Dam have ranged from 104.9 to 127.6% and 103.6 and 134.4%, respectively. Despite these high levels of TDG, GBT monitoring at Rock Island Dam has revealed low incidence of GBT, with a maximum incidence of 2% of examined fish on May 26th (Figure 1).

Rock Island Dam GBT and TDGS

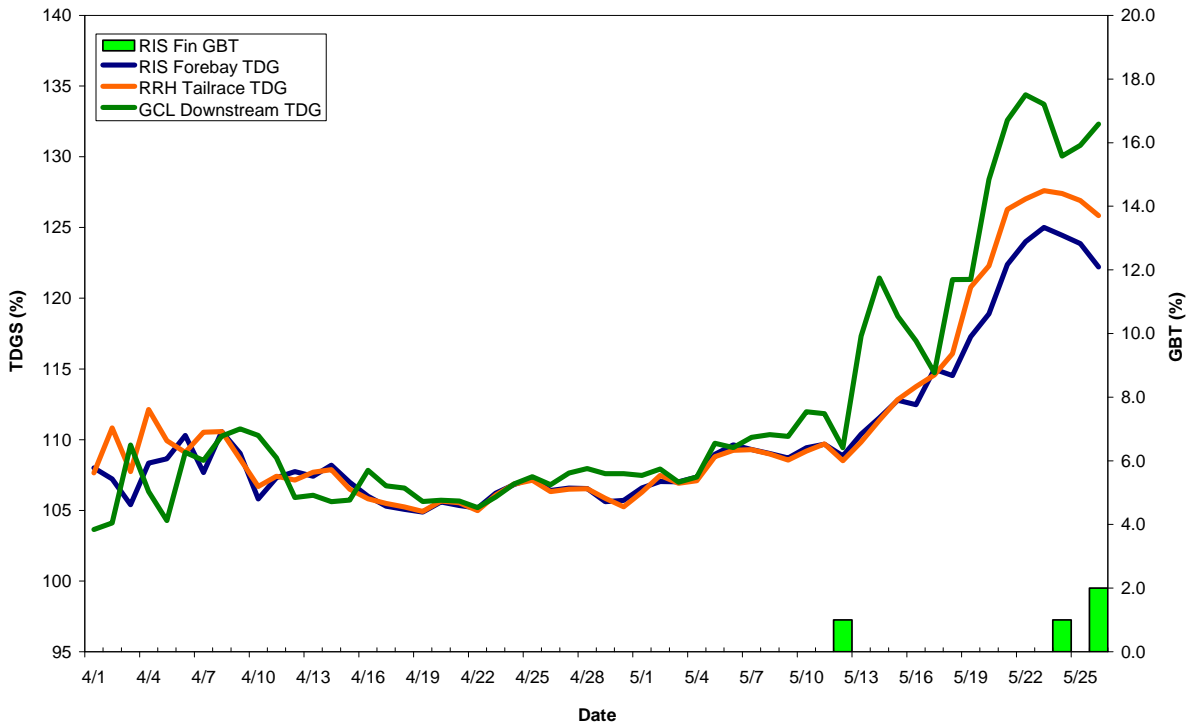


Figure 1. Percent of fish examined at Rock Island Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Rock Island Dam forebay, the Rocky Reach Dam tailrace, and downstream of Grand Coulee Dam.

Gas Bubble Trauma monitoring takes place at three sites in the Snake River: Lower Granite, Little Goose, and Lower Monumental dams. These examinations are typically conducted once a week at each site. GBT monitoring at Lower Granite Dam can be considered a baseline estimate, as there is little TDG production from the projects above LGR. To date, the 12-hour average TDG levels (based on Oregon methodology) in the Lower Granite Dam forebay have ranged from 103.2 to 107.4%, while the 12-hour average TDG levels in Dworshak Dam tailrace have ranged from 98.1 to 121.9%. GBT monitoring at Lower Granite Dam has revealed no incidences of GBT (Figure 2).

To date, the 12-hour average TDG levels (based on Oregon methodology) in the Little Goose Dam forebay have ranged from 105.9 to 125.5%, while the 12-hour average TDG levels in Lower Granite Dam tailrace have ranged from 108.7 to 132.2%. Gas Bubble Trauma monitoring at Little Goose Dam has revealed low incidence of GBT, with a maximum incidence level of 1% of the examined fish on April 18th and April 23rd (Figure 3). However, it is important to note that, due to full powerhouse outage since May 24th, GBT monitoring at Little Goose has not occurred since May 21st. The powerhouse at LGS is not expected to be back on-line until early next week (~May 3^{1st}), which means that GBT exams are not expected to resume until sometime thereafter.

Lower Granite Dam GBT and TDGS

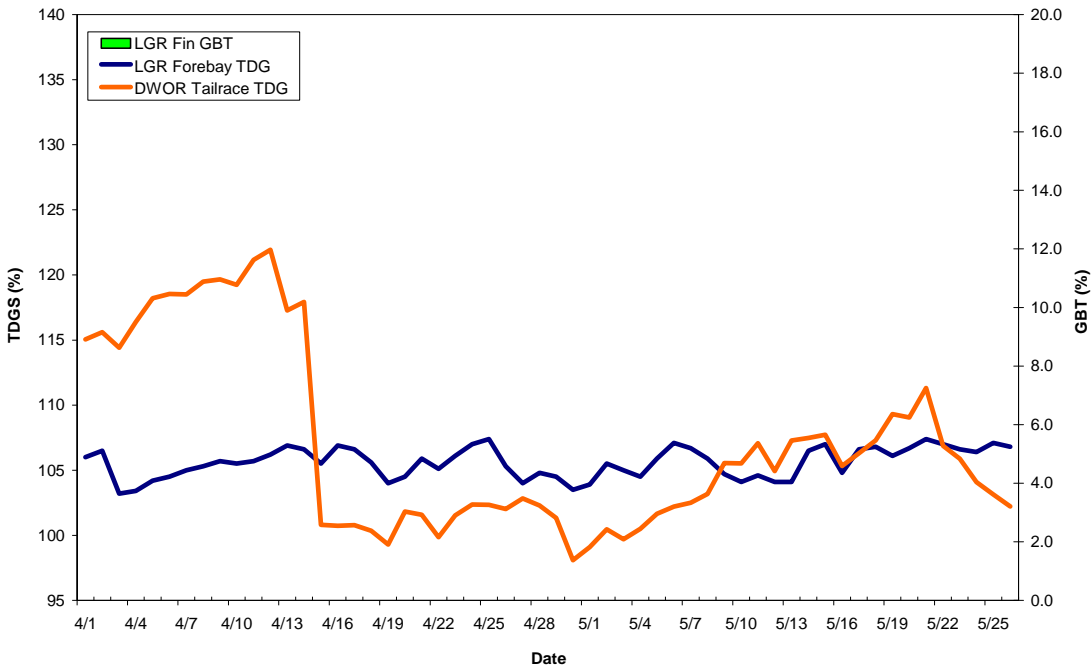


Figure 2. Percent of fish examined at Lower Granite Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Lower Granite Dam forebay and the Dworshak Dam tailrace.

Little Goose Dam GBT and TDGS

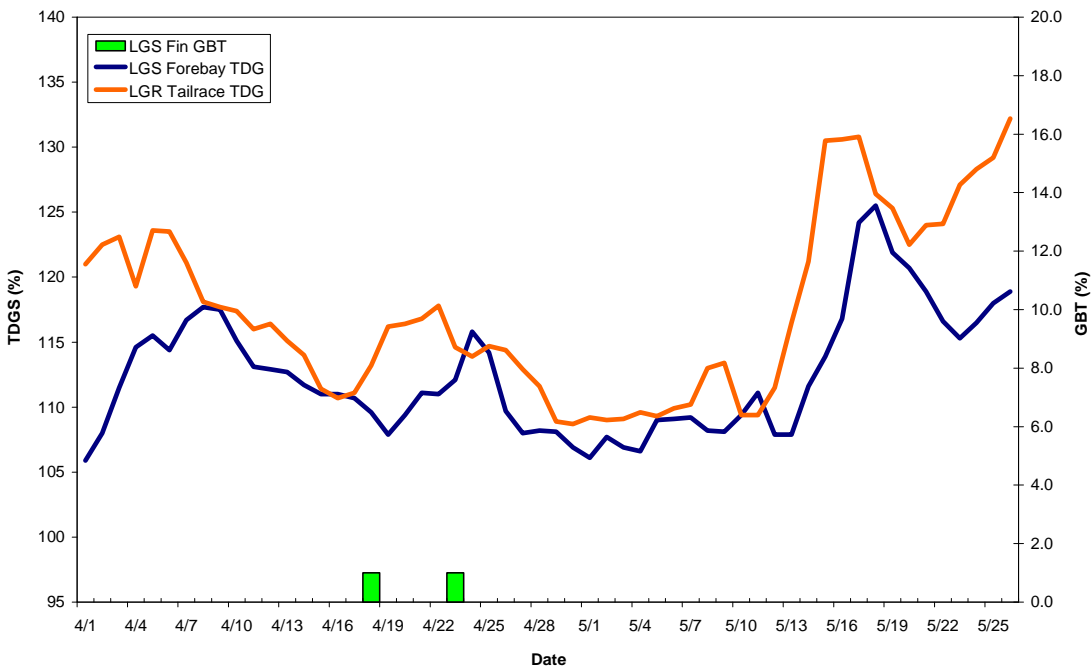


Figure 3. Percent of fish examined at Little Goose Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Little Goose Dam forebay and the Lower Granite Dam tailrace.

To date, the 12-hour average TDG levels (based on Oregon methodology) in the Lower Monumental Dam forebay have ranged from 105.0 to 138.3%, while the 12-hour average TDG levels in Little Goose Dam tailrace have ranged from 110.6 to 136.4%. The 12-hour average TDG in the Lower Monumental forebay and Little Goose tailrace have both been above 125% since May 16th. As mentioned above, Little Goose Dam has had a full powerhouse outage since May 24th. During this period full powerhouse outage, spill at LGS has been close to 100%. Also, transportation from LMN has been terminated on two separate occasions, from May 17-19 and from May 23 to present. When transportation from LMN is not occurring, there are no full samples for the SMP or GBT monitoring programs and bypassed fish are returned to the river without being sampled. However, a small condition sample is taken every three days, and in conjunction with that a GBT sample can be taken. On May 25th a condition sample was conducted at LMN as well as a GBT sample. Despite the high levels of TDG in recent days, GBT monitoring at Lower Monumental has revealed low incidence of GBT, with a maximum incidence level of 4.8% of the examined fish on May 25th (Figure 4). However, incidences of GBT have increased over the last week, particularly with the ~100% spill from LGS. The next GBT sample at LMN is expected to take place on May 28th.

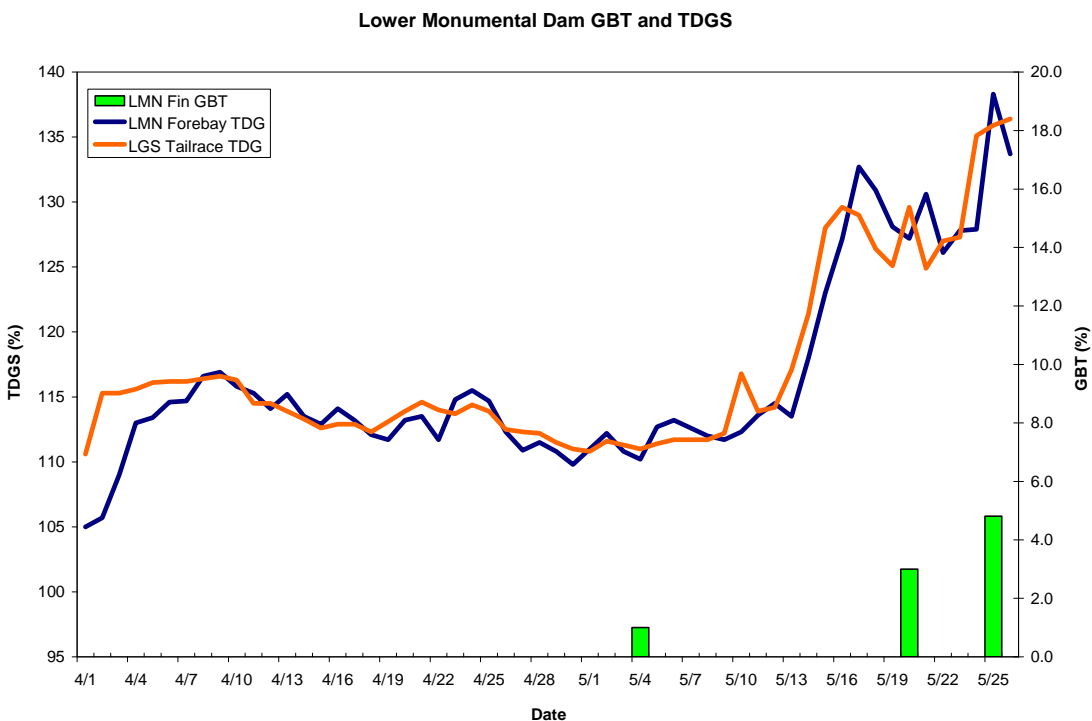


Figure 4. Percent of fish examined at Lower Monumental Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Lower Monumental Dam forebay and the Little Goose Dam tailrace.

Gas Bubble Trauma monitoring takes place at two sites in the Lower Columbia River: McNary and Bonneville dams. These examinations are typically conducted twice a week at each site. To date, the 12-hour average TDG levels (based on Oregon methodology) in the McNary Dam forebay have ranged from 106 to 118.4%, while the 12-hour average TDG levels in the Ice

Harbor Dam tailrace have ranged from 115.1 to 129.5%. GBT monitoring at McNary Dam has revealed low incidence of GBT (Figure 5).

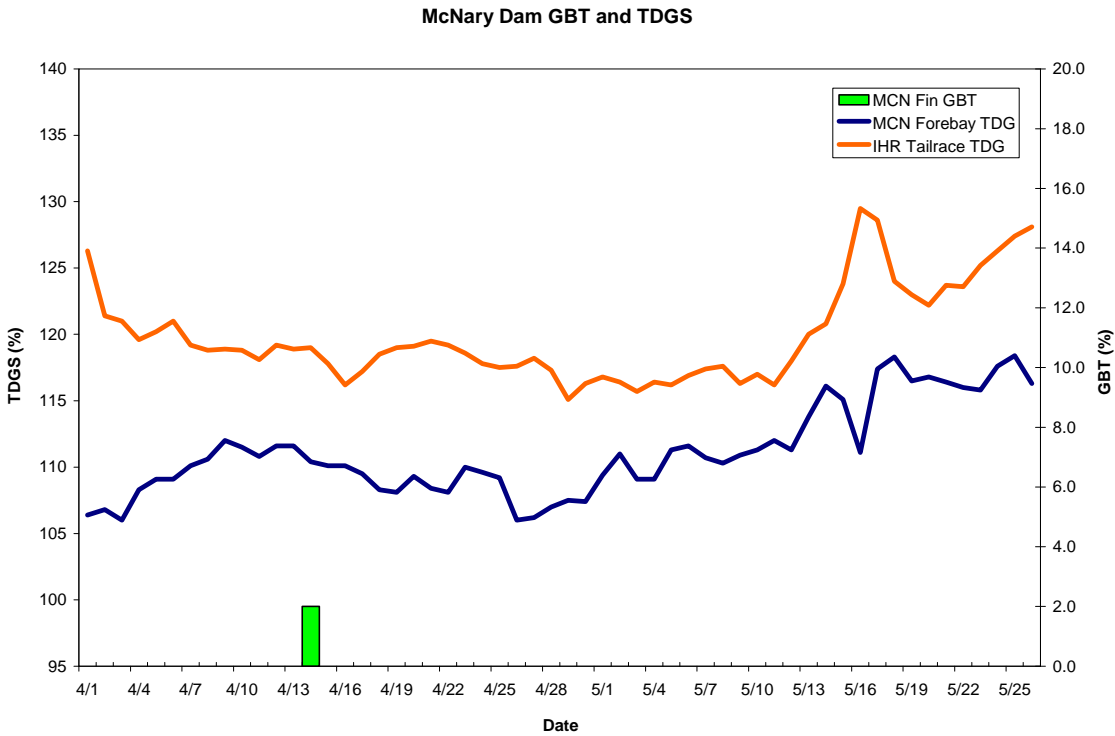


Figure 5. Percent of fish examined at McNary Dam showing signs of fin GBT with associated dissolved gas saturation levels in the McNary Dam forebay and the Ice Harbor Dam tailrace.

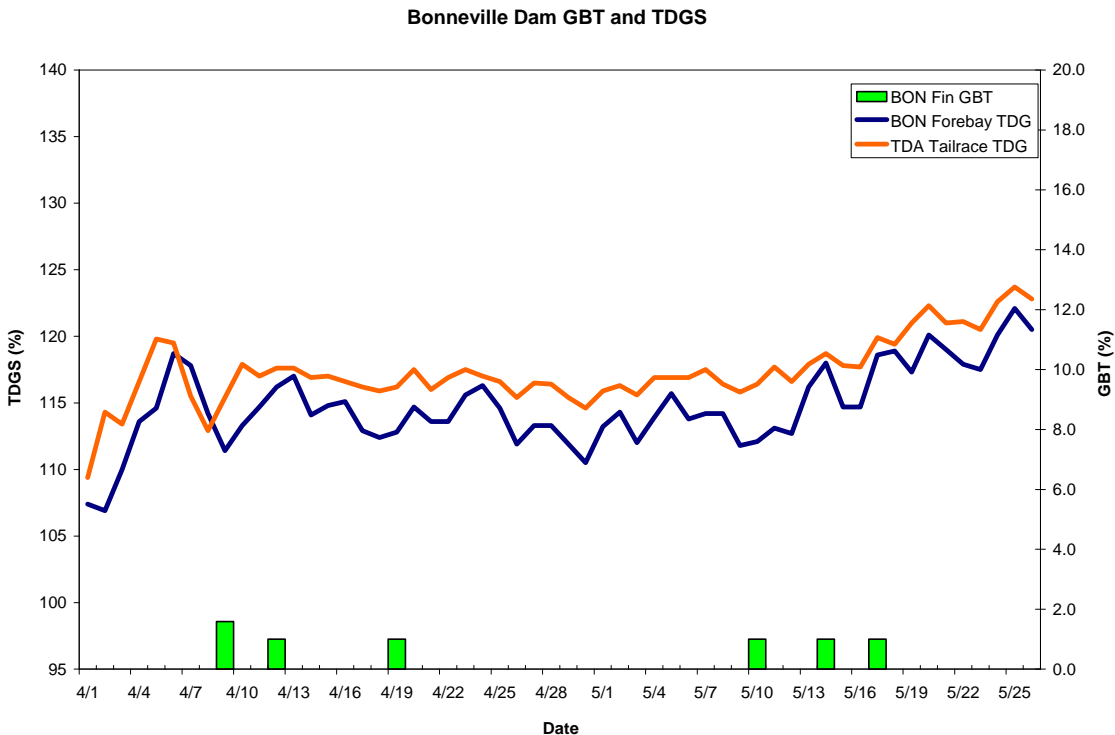


Figure 6. Percent of fish examined at Bonneville Dam showing signs of fin GBT with associated dissolved gas saturation levels in the Bonneville Dam forebay and The Dalles Dam tailrace.

To date, the 12-hour average TDG levels (based on Oregon methodology) in the Bonneville Dam forebay have ranged from 106.9 to 122.1%, while the 12-hour average TDG levels in The Dalles Dam tailrace have ranged from 109.4 to 123.7%. Gas Bubble Trauma monitoring at Bonneville Dam has revealed low incidence of GBT, with a maximum incidence level of 1.6% of the examined fish on April 9th (Figure 6).

Based on the GBT monitoring to date, neither of the criteria for curtailment of voluntary spill have been met at any of the GBT monitoring sites.

Historic Data:

Based on historic GBT monitoring in the years 1996 to 2007, the incidence of GBT in unpaired fins of fish has increased with increasing TDG levels measured at the upstream dam (Figure 7). Figure 7 shows the average percentage of fin signs in the GBT samples in relation to the level of TDG at the upstream tailrace TDG monitoring site. The figure combines data from Little Goose, Lower Monumental, McNary and Bonneville dams. The data reported are average percentages of signs for each rank at the TDG levels that occurred. Typically, GBT levels have not reached action levels—levels of occurrence that would indicate a need to reduce spill operations--during periods when TDG levels were within the water quality agency waiver limits of 115% forebay and 120% tailrace TDG. Biological action levels are set at 15% incidence of fin GBT or 5% severe fin signs. Severe signs are considered those where ranking of fin signs of 3 or 4 indicates severe GBT of greater than 25% fin area covered in bubbles. As can be seen from the figure severe signs do increase as TDG levels increase. There have been individual dates when the biological action criteria were exceeded, but those dates occurred during periods when the TDG waiver limits were exceeded and typically the system was experiencing uncontrolled spill operations.

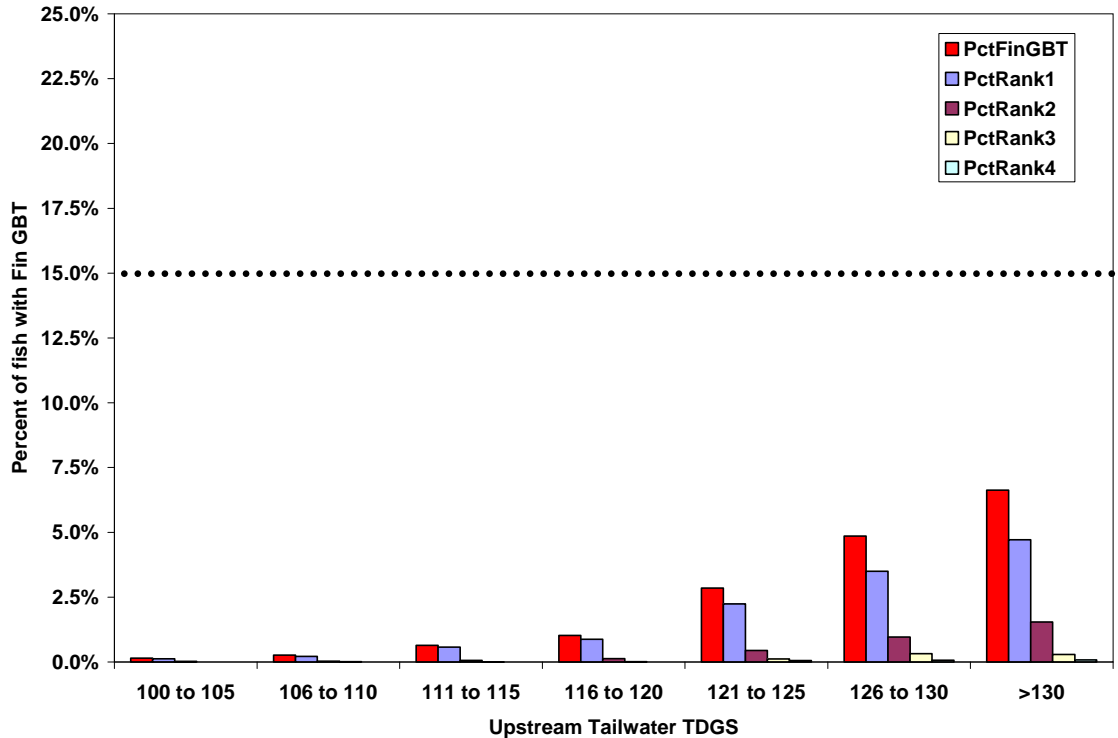


Figure 7. Fin GBT percentages for the years 1996 to 2007 from monitoring at Bonneville, McNary, Lower Monumental and Little Goose dams at increasing levels of average TDGS as measured at upstream dam tailwater monitors.

Depth Compensation:

The effect of increasing hydrostatic pressure on the solubility of dissolved atmospheric gas is the critical factor in the concept of “depth compensation” for organisms residing in surface waters determined to be supersaturated at the surface. For every one meter in depth the effective TDG concentration decreases 10%. Depth compensation is a critical factor that one must consider in evaluating the effects of TDG on Columbia and Snake River aquatic species. This fact is true for any body of water where organisms have access to depth.

7Q10 Flows:

The typical criterion for expressing the exemption from the water quality standard is called the 7Q10, which is the average peak annual flow for seven consecutive days that has a recurrence interval of ten years. A *minimum* 7Q10 is used in the water quality permit arena to designate a minimum flow to which permit conditions apply. However, for dissolved gas standards, the maximum 7Q10 is used.

Lower Columbia River 7Q10 flood flows*

<u>Site</u>	<u>Flow (cfs)</u>
Mc Nary Dam	447,000

John Day Dam	454,000
The Dalles Dam	461,000
Bonneville Dam	467,000

**Total Maximum Daily Load (TMDL) for Lower Columbia River Total Dissolved Gas*

References:

Total Maximum Daily Load (TMDL) for Lower Columbia River Total Dissolved Gas. September 2002. Prepared jointly by the Oregon Department of Environmental Quality and the Washington State Department of Ecology

Washington and Oregon State - Adaptive Management Team Resident Fish Literature Review.
Dr. Mark J. Schneider, June 20, 2008.



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DATA REQUEST FORM

Request Taken By: M. Deltart Date: 5/27/11

Data Requested By:
Name: Bill Tweit Phone: _____
Address: WDFW Fax: _____
Email: _____

Data Requested:
Summary of GBT to date

Data Format: Hardcopy Text Excel
Delivery: Mail Email Fax Phone

Comments:

Data Compiled By: FPC Staff Date: 5/27

Request # 466

Michele Dehart

From: Tweit, William M (DFW) <William.Tweit@dfw.wa.gov>
Sent: Friday, May 27, 2011 8:01 AM
To: Michele Dehart
Cc: Norman, Guy R (DFW); Le Fleur, Cindy (DFW); Morrill, Charles (DFW)
Subject: Update on 2011 gas bubble trauma monitoring effects

Michele,

Can you provide us with a summary of 2011 gas bubble trauma monitoring results to date in the Snake, mid-Columbia and the lower Columbia? Could you also include any incidental observations that you are aware of, such as the Douglas Co. PUD monitoring at Rocky Reach Dam this spring. If you could compare those results to our pre-season expectations for levels of GBT, that would prove useful as well. Thanks much, Bill T.