



# FISH PASSAGE CENTER

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November 25, 2014

Commissioner Melinda Eden  
Environmental Quality Commission  
Oregon Dept. of Environmental Quality  
811 SW Sixth Avenue  
Portland, OR 97204-1390

Dear Commissioner Eden:

We understand that in April of 2014 the US Army Corps of Engineers (COE) submitted a request to renew their current 5-year TDG modification. The COE's request is regionally supported as implementable by the State, Tribal and federal fishery agencies, as well as by other agencies and interested parties, as evidenced by the comments received during the public comment period from the: Columbia River Inter-Tribal Fish Commission, Oregon Department of Fish and Wildlife, State, Tribal and Federal Fishery Agencies' Joint Technical Staff, Bonneville Power Administration, Northwest River Partners and Pacific Northwest Generating Cooperative Power.

The request was discussed at the June 18<sup>th</sup> Environmental Quality Commission (EQC) Meeting. On the morning of the June 18<sup>th</sup> meeting the COE arranged a visit to the Smolt Monitoring Program sampling facilities at Bonneville Dam to observe Gas Bubble Trauma (GBT) monitoring. Unfortunately, the site visit was not coordinated with us, and GBT sampling for that day had already concluded.

Subsequent to the June meeting several questions were raised that were responded to in writing by the COE and Bonneville Power Administration (BPA). An agenda item was included for discussion by teleconference at the August 28<sup>th</sup> EQC meeting for the purpose of addressing further questions relative to the COE's waiver request. We were invited to attend that meeting in the event that questions were raised relative to the biological monitoring program. I was contacted the following day expressing that you wished to continue your visit to the SMP facilities at Bonneville Dam, or that I make myself available to meet with you prior to the November 5<sup>th</sup> EQC meeting, when the TDG modification request was to be addressed. Unfortunately by that date sampling for GBT had already ceased for the 2014 season, but I agreed to meet to pursue addressing your questions and provide information. Regrettably, while we wished to meet, it appeared that your schedule did not allow for that meeting to occur.

Since a meeting to discuss your questions did not occur, I am providing you with a brief summary of the historic information associated with the GBT Monitoring Program. Annually, we provide a summary of the results from that year's monitoring to the COE and they include it as part of their annual report for submittal to the DEQ. This year we included a historic summary, and this is taken from that report.

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## **Historical Summary (1995–2014)**

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 (TDG). The monitoring assesses the relative severity of exposure, and provides an “early warning” of potentially harmful levels of TDG. 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 ([www.fpc.org/smolt/gasbubbletrauma.html](http://www.fpc.org/smolt/gasbubbletrauma.html)). The fisheries management entities review the data in-season to determine if modifications to spill are necessary based on the GBT monitoring.

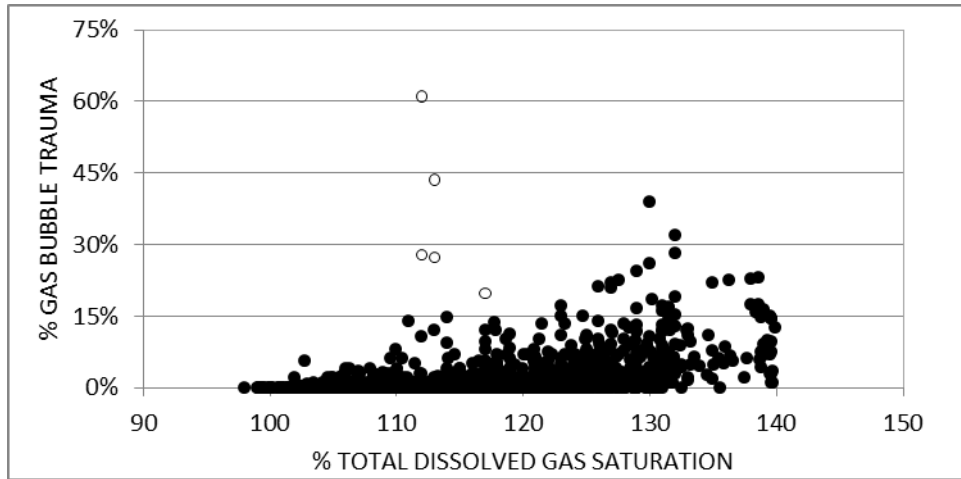
The Gas Bubble Trauma monitoring program has been implemented annually since 1995. There are twenty years of data available, and as a result of involuntary spill events, data for GBT are available over a wide range of total dissolved gas concentrations. In fact, over this historic record, observations have occurred at tailwater TDG levels as high as 140%. This has allowed the assessment of the impacts of TDG on the salmonid population over a wide range of tailwater TDG conditions.

Excluding Rock Island Dam samples, a total of 2,488 daily exams have occurred over the time period, with a total of 288,083 fish examined. (The daily sample size criteria based on the monitoring protocol is 100 fish. In this analysis some flexibility was considered and all daily samples with greater than 75 fish were included). The GBT monitoring program has consistently shown over the years that signs of GBT are minimal when TDG is managed to the present dissolved gas standards associated with the implementation of the Federal Columbia River Power System (FCRPS) Biological Opinion Spill program.

In all the years when TDG and GBT have been collected (2,488 samples), there have only been 34 instances when the 15% GBT criterion was exceeded. Of those 34 instances, five (open circles in Figure L-9) can be attributed to late migrating steelhead smolts. At the time these steelhead smolts were collected at Little Goose Dam approximately 98% of the juvenile steelhead migrating that year had already passed this project. These late migrating fish were observed in the forebay of the dam on the surface, had prolonged migration times, and were likely residualizing (see [www.fpc.org/documents/memos/136-07.pdf](http://www.fpc.org/documents/memos/136-07.pdf)). These fish may be considered anomalous, and were likely present due to the very low flow conditions that occurred that year. The other 29 times the biological criteria were exceeded occurred when TDG was greater than 120%. Of these 29 exceedences, 26 (90%) were observed at TDG concentrations greater than 125%. The following graph (Figure L-9) shows the summary of the 2,488 daily exams as a function of TDG.

**Figure L-9**

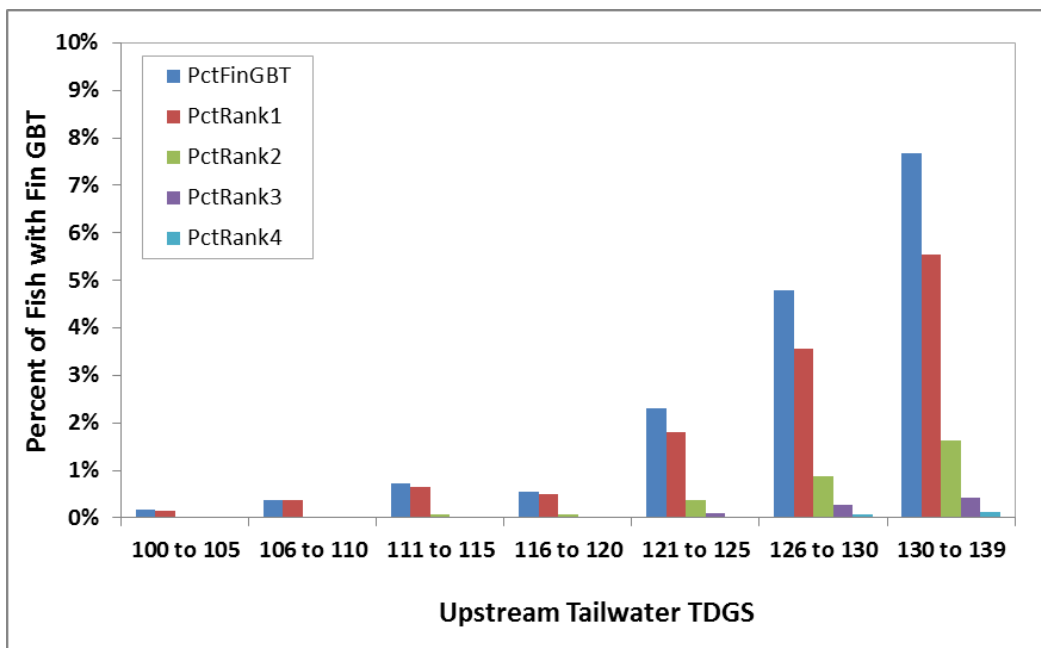
Percent GBT observed as a function of TDG observed. TDG measured at the tailwater of the upstream project at the Snake River projects and at John Day Dam tailwater for the Columbia River samples. Open circles indicate observations for late migrating steelhead observed in 2002 and 2007.



Over the historic record there have been several instances where GBT data were collected during periods of uncontrolled spill that lead to higher levels of TDG. This allows fish collected over the years to be sorted into groups that migrated under similar TDG levels (Figure L-10). The following graph summarizes the gas bubble trauma data collected over the years of the implementation of the GBT Monitoring Program as a function of the total dissolved gas levels.

**Figure L-10**

Percent of all fish collected from 1995–2014 showing signs of GBT at given TDG levels.



From Figure L-10 two things are apparent. The incidence of fish observed with signs of GBT and the severity of those signs increases with increasing levels of TDG supersaturation. This is consistent with the research on which the monitoring program was developed. And, secondly, signs of GBT are almost non-existent below 120% TDG, begin increasing slightly between 121 and 125% TDG, and then increase in both incidence and severity above 125% TDG.

Data collected over the past 20 years strongly suggest that the Biological Monitoring serves as an effective management tool providing “early warning” of potentially harmful levels of TDG. What we have learned from the historic data is that the “early warning” signs are not triggered at TDG levels less than 120% at the tailwater monitors. Most observations indicating potential harm occurred above TDG levels of 125% as measured at the tailwater TDG monitors.

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We have been asked, and are prepared, to present the information relative to the GBT Monitoring program, and answer any questions that arise, at the January 6–7 EQC meeting. We have also been advised that you wish to meet with Dean Ballinger, who is a fisheries technician that works for the Smolt Monitoring Program at Bonneville Dam. You expressed that you wished to continue a conversation that occurred during the site visit to Bonneville Dam on June 18<sup>th</sup>. We can certainly arrange that encounter if you wish. Our staff at Bonneville Dam is very experienced and conducts the sampling procedure at the project with expertise. However, their overall knowledge of the Gas Bubble Trauma Monitoring program implementation and the historic analyses is beyond their job scope of work. Therefore, I will make myself available for this meeting to address any questions you may have.

In a discussion with you after the November 5<sup>th</sup> EQC meeting you said that Dean had shared some observations of unexpected mortality. I have spoken with Dean Ballinger regarding any information that he might have shared with you. Dean believed you were referring to an instance he relayed during the June 18<sup>th</sup> tour. The instance took place during late May of 2011, which was an extremely high river flow and uncontrolled spill period during that year. As a result, dissolved gas levels in the river during this period were considerably higher than the states’ water quality standards ([www.nwd-wc.usace.army.mil/ftppub/water\\_quality/12hr/201105.html](http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/201105.html)).

Dean was responsible for providing researchers from Kintama Research Services with fish for their study. The researchers maintained their research fish in a shallow water tank for a period prior to tagging. Dean advised that at the present high TDG levels and the shallow tank, it would be appropriate to use a degassing column. The researchers did not use the column, and greater than 50% of their fish died in the shallow tank. This result is not surprising to us since research shows that water depth affects the incidence of gas bubble trauma in fish. Total dissolved gas (TDG) supersaturation is described relative to surface (ambient atmospheric) pressure. As depth increases the total pressure causes the amount of atmospheric gases the water will hold in an equilibrium state to increase relative to the water’s surface pressure. The compensation rate is about 10% of saturation or 74 mm Hg per meter of depth. As long as the pressure remains constant or increases, the dissolved gases have no propensity to come out of solution to form bubbles. Only when the pressure is substantially reduced do the gases have a substantial tendency to come out of solution and form bubbles (Weitkamp, 2008). This mortality in the shallow tank is consistent with laboratory experiments (Mesa et al., 1997). Results from Mesa et al. (1997) showed that juvenile Chinook confined in water 28 cm deep at a TDG level of 130% began to die after 5 hours of exposure, reaching about 50% mortality at 9 hours. And, at 120% TDG in the shallow water the mortality rate

followed a sigmoid curve reaching about 43% at 58 hours. However, in the natural environment, fish commonly spend much, and in many cases all of their time at depths greater than 1 meter.

Our SMP project staffs usually have limited availability during winter months. However, if still needed, Dean has agreed to several dates when he is available to meet via conference call. These include December 4, 5, 8, 12, 17, 18 and 19. In order to facilitate the discussion at the meeting and to answer your questions, we request that you provide your questions in writing to us prior to the meeting date for our consideration.

Sincerely,



Margaret J. Filardo, Ph.D.

cc: Paula Calvert, DEQ  
Gene Foster, DEQ  
Ed Bowles, ODFW  
Tom Rien, ODFW  
Erick Van Dyke, ODFW  
Rock Peters, COE  
Steven Fischer, COE  
Gayle Lear, COE  
Agnes Lut, BPA

## References

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- Weitkamp, D.E. 2008. Total Dissolved Gas Literature 1980-2007: An Annotated Bibliography. Report from Parametrix to Avista Inc. Chelan County PUD, Douglas County PUD, Grant County PUD, and Tacoma Power, January 2008.