MEMORANDUM

TO: Russell Scranton, BPA

FROM: Michele DeHart, FPC

DATE: February 27, 2020

SUBJECT: Summary of Gas Bubble Monitoring Program and details on reporting.

On February 25, 2020, the Fish Passage Center (FPC) received your questions, via e-mail, regarding the GBT Monitoring Program protocols and reporting procedures. The following information is provided, in response to those questions.

Background on GBT Monitoring for Salmonids

The objective of the juvenile salmonid Gas Bubble Trauma (GBT) Monitoring Program is to provide a measure of the exposure to harmful levels of total dissolved gas (TDG) experienced by migrating juvenile salmonids. The monitoring assesses both the incidence and severity of exposure, and provides an “early warning” of potentially harmful levels of TDG. The GBT Monitoring Program began and has been implemented since 1995. The development of the current program was based upon laboratory research that tracked the onset and development of gas bubble trauma signs in juvenile Chinook salmon and steelhead (Maule et al 1997a, Maule et al 1997b, Mesa et al. 2000). The monitoring program was developed within the framework of the Dissolved Gas Technical Work Group (DGTWG) co-chaired by the National Marine Fisheries Service (NMFS) and Environmental Protection Agency (EPA). The DGTWG was an interagency task force that reviewed research, evaluated monitoring results, and made recommendations on both biological and physical monitoring. The DGTWG developed the action criteria currently implemented (5% severe, 15% occurrence). The action criteria and biological thresholds are addressed in the following discussion.
In the first year of implementation of the GBT Monitoring Program, the DGTWG assembled an expert panel to evaluate the biological monitoring program. Panel members observed the monitoring and examined juvenile salmonids at dams. Based on the expert panel recommendations, and experience in the field in 1995, the DGTWG agreed to a few important modifications made after the first year, including the use of minimum 10X magnification to replace the 3X magnification that had been used. In addition, gill exams were not recommended because the examination was considered lethal and not appropriate for monitoring. In subsequent years, fish exams were carried out with dissecting microscopes (minimum 10X magnification), examining the unpaired fins and eyes for signs of GBT. Exams of the lateral line were carried out for several years but eventually the DGTWG decided those were unnecessary. By 2000 the biological monitoring was set and closely resembles the program currently being implemented.

In 2020, the GBT Monitoring Program will use the same protocol that was used in 2019. Under this protocol, GBT Monitoring personnel target a sample size of 100 total target salmonids (i.e., Chinook and steelhead) per GBT sample. Table 1 provides a breakdown of the locations, frequency, duration, and methods of fish collection for the GBT Monitoring Program, under the current protocol.

Table 1. Locations, frequency, duration, and methods of fish collection for GBT Monitoring Program.

<table>
<thead>
<tr>
<th>Region</th>
<th>Site</th>
<th>Frequency of Sampling</th>
<th>Duration of Sampling</th>
<th>Method of Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snake</td>
<td>LGR</td>
<td>Once per week</td>
<td>April-June</td>
<td>Separator</td>
</tr>
<tr>
<td></td>
<td>LGS</td>
<td>Once per week</td>
<td>April-August</td>
<td>Separator</td>
</tr>
<tr>
<td></td>
<td>LMN</td>
<td>Once per week</td>
<td>April-August</td>
<td>Separator</td>
</tr>
<tr>
<td>Lower Columbia</td>
<td>MCN</td>
<td>Twice per week</td>
<td>April-August</td>
<td>Separator</td>
</tr>
<tr>
<td></td>
<td>BON</td>
<td>Twice per week</td>
<td>April-August</td>
<td>Sample Tank</td>
</tr>
<tr>
<td>Upper Columbia</td>
<td>RIS</td>
<td>Twice per week</td>
<td>April-August</td>
<td>Sample Tank and/or Entering Trap</td>
</tr>
</tbody>
</table>

At Lower Granite Dam (LGR), GBT Monitoring only occurs in the spring. Once subyearling Chinook predominate the samples at LGR, and collecting the target sample size of yearling Chinook and steelhead is no longer possible, GBT Monitoring at LGR is terminated. This is done to limit handling of listed subyearling Chinook when TDG levels above the project are generally very low.

Sampling at each of the three Snake River sites occurs once per week. Every effort is made to limit overlap in sampling dates between sites. For example, the sampling days at LGR, Little Goose (LGS), and Lower Monumental (LMN) should not all be the same and, ideally, occur throughout the week. Sites are encouraged to coordinate sampling schedules to the degree possible. Sampling at each of the three Columbia River sites occurs twice per week. The frequency of GBT Monitoring at the three Columbia River sites may be reduced to once per week in the summer, when temperatures increase to unsafe levels and/or when sample size requirements cannot be met. In addition, sampling at Bonneville Dam (BON) may be temporarily reduced to once per week in mid-April and early May when Spring Creek NFH releases subyearling fall Chinook tules above the project. This is necessary to limit handling of these listed fish and is only necessary for 2-3 days post-release. Finally, GBT Monitoring may
be terminated in the summer if/when meeting sample size requirements is not possible and/or increased mortality is observed as a result of compounded effects of sampling/handling and warming temperatures. Termination of GBT Monitoring for these reasons will typically only occur if TDG levels are below the standards of 120% in the tailrace and/or 115% in the forebay.

At the three Snake River sites and at McNary Dam (MCN), sampling for GBT Monitoring occurs directly at the separator. This eliminates holding in shallow tanks for prolonged periods, which can lead to bias results in GBT incidence rates. Sampling from the separator is not possible at Rock Island (RIS) and BON. Instead, GBT sampling at these two sites occurs from the sample tank (BON) or a combination of the sample tank and as fish enter the sample trap (RIS). Every effort is made to minimize the amount of time that examined fish are held in the shallow sample tank/trap.

**Reporting of GBT Monitoring Data**

*GBT Data Queries*

Data from GBT Monitoring samples are recorded using a data entry program developed and maintained by the FPC. Within 24-hours of collection, GBT data are electronically transmitted to the FPC where they are instantly processed into our servers. Once data are processed into the servers, they are available to the general public via a web queries. The main web page for accessing GBT Monitoring data is [http://www.fpc.org/smolt/gasbubbletrauma.html](http://www.fpc.org/smolt/gasbubbletrauma.html) (Figure 1). From this page, the user can choose whether they wish to query data from the current year ([http://www.fpc.org/smolt/gbtqueries/GBTwebsum_currentyear_query.html](http://www.fpc.org/smolt/gbtqueries/GBTwebsum_currentyear_query.html)) or historical years ([http://www.fpc.org/smolt/gbtqueries/GBTwebsum_query.html](http://www.fpc.org/smolt/gbtqueries/GBTwebsum_query.html)) (Figure 1). From these queries, the user chooses the project, species, and date(s) for their query (Figure 2). The query will return GBT monitoring data, summarized by date, species, and age (Figure 3).
Figure 1. Main Gas Bubble Trauma Monitoring data page on FPC website (http://www.fpc.org/smolt/gasbubbletrauma.html)

Figure 2. Example of GBT Monitoring Data Historical Query (historic data, 1996-2019). http://www.fpc.org/smolt/gbtqueries/GBTwebsum_query.html
GBT Reports

In addition to the GBT Monitoring data queries, data from the most recent two-weeks of GBT monitoring are summarized and presented in a Two Week GBT Monitoring Report (http://www.fpc.org/currentdaily/gbtsumbybatchdate.pdf). This report provides a project by project summary of GBT results, by date, for the most recent two-weeks of GBT sampling (see Figure 4 for an example). This report is updated periodically throughout the day, as FPC receives new data. A link to this report is also available via the main GBT Monitoring data webpage (http://www.fpc.org/smolt/gasbubbletrauma.html) (Figure 1).

Figure 3. Example of data returned by GBT Monitoring Data Historical Query (historic data, 1996-2019).
Biological Thresholds and GBT Monitoring Frequency

The total dissolved gas (TDG) water quality standards for Washington Department of Ecology (DOE) and Oregon Department of Environmental Quality (DEQ) include biological thresholds for the potential reduction of voluntary spill, based on GBT Monitoring data. These thresholds include: 1) GBT incidence rates exceed 15% for a single sample or 2) severe GBT incidence rates (i.e., Ranks of 3 or 4) exceed 5% for a single sample. It is important to note that these biological thresholds were first developed by a sub-group of the DGTWG and have been present for over two decades.

These action criteria were developed based on laboratory studies that found that, generally, the onset of mortality occurred when 60% of the fish held in shallow tanks (18 inches) showed external signs of GBT (i.e., fin bubbles). And, the signs of GBT were progressive, meaning the longer the exposure, the greater the incidence. However, researchers found that the incidence of signs were somewhat variable, relative to the length of time fish were exposed to TDG (see Mesa et al. 1999). Based on the uncertainty in the progression of signs seen in the laboratory, the action levels were set at 15% with any signs and 5% with severe signs to provide a large margin of safety, so that protective actions could be taken well in advance of the onset of mortality in salmonids (FPC 2007).

The GBT Monitoring Program is not planning to do anything different in 2020, in terms of monitoring frequency, even if GBT rates approach these biological thresholds. In the early years, the DGTWG provided oversight on the GBT Monitoring Program, including input that lead to the current GBT sampling frequency. As you know, the SMP has been flat funded since 2017 and, therefore, no additional funds are available to increase the frequency of GBT Monitoring if/when GBT rates approach these biological thresholds (Table 1).
Literature Cited


