Appendix M

Gas Bubble Trauma Monitoring And Data Reporting For 2010

Fish Passage Center
Portland, Oregon

FISH PASSAGE CENTER

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

Dear Mr. Ponganis,

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 2010". This report summarizes data collected during the 2010 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 2010

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 2010 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 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 M-1).

Table M-1
Ranking criteria used in monitoring for signs of gas bubble trauma.

Rank	Sign
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, 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 http://www.fpc.org/smolt/gasbubbletrauma.html 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 2010 water year was below average in both the Snake and Columbia rivers. Runoff (January-July) was 75% of average (1971-2000) above Lower Granite and 79% of average above The Dalles Dam. The 2010 water year was different in that a cool spring weather pattern resulted in a delayed freshet and lower than average flows in the Snake (Figure M-1) and Lower Columbia (Figure M-2) rivers during April and most of May. However, in early June a strong Pacific jet stream brought storms with heavy precipitation to the Northwest. This unusually high storm input combined with snow melt, led to high flows that were above the powerhouse capacity of many projects. These 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 M-1.
Average daily flows at Lower Granite Dam
2010, 2009, and the 10 year average

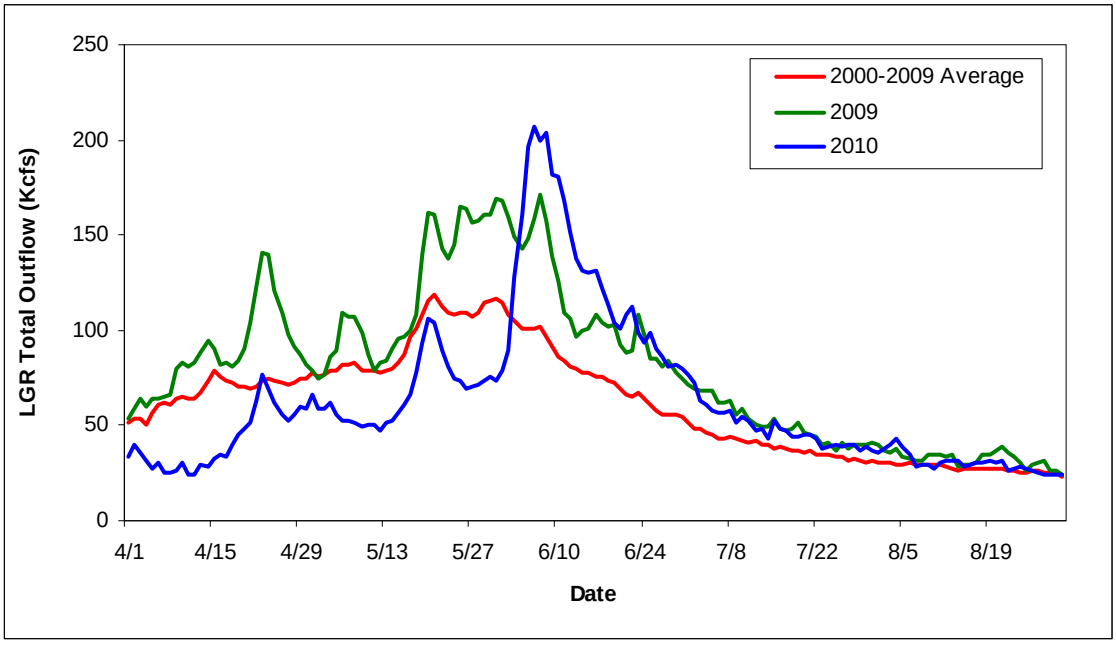
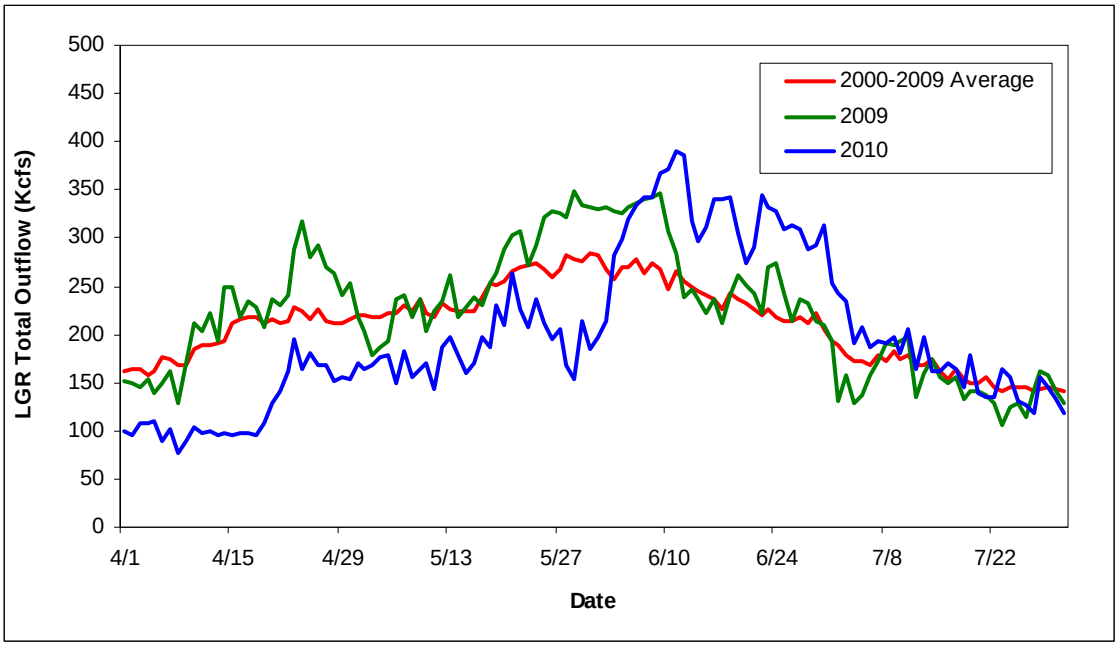


Figure M-2
Average daily flows at The Dalles Dam
2010, 2009 and the 10 year average



Results

In all, 13,624 juvenile salmonids were examined for GBT between April and August of 2010 (Table M-2). The fish were collected as part of the Smolt Monitoring Program.

Table M- 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 2010 as part of the GBT Monitoring Program.

	Sites						
Species	**BON**	**MCN**	**LMN**	**LGS**	**LGR**	**RIS**	**Total**
Chinook Subyearlings	1,914	2,336	587	758	130	1,128	6,853
Chinook Yearlings	1,317	1,052	292	333	5	603	3,602
Steelhead	272	387	543	509	655	803	3,169
Total	3,503	3,775	1,422	1,600	790	2,534	13,624

Fin signs were found in 49 or 0.36% of the total fish sampled at all sites (Table M-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 the more severe signs of rank 2, 3 and 4 were observed in fish from the Snake River.

Table M-3

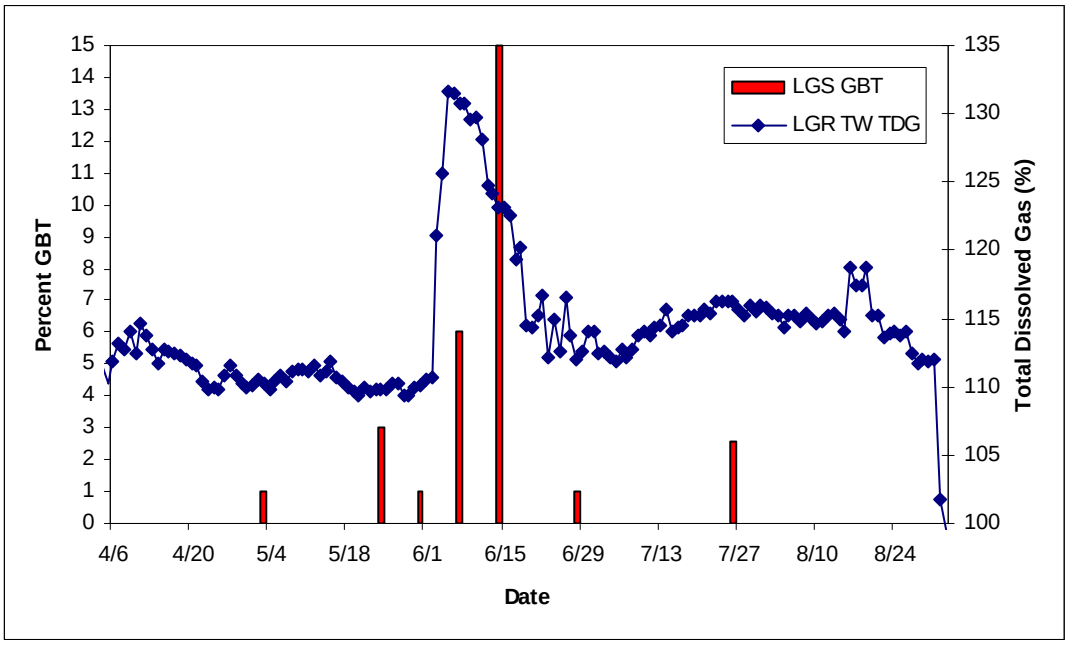
Number of juvenile salmonids found with fin GBT at dams on the Lower Snake River and on the Columbia River from April to August 2010 as part of the GBT Monitoring Program.

	Sites						
Species	**BON**	**MCN**	**LMN**	**LGS**	**LGR**	**RIS**	**Total**
Chinook Subyearlings	0	0	1	15	0	0	16
Chinook Yearlings	1	0	2	2	0	0	5
Steelhead	0	0	15	12	0	1	28
Total	1	0	18	29	0	1	49

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. There were no fish sampled with signs of GBT at Lower Granite Dam. In 2010 the action criteria for GBT were met at Little Goose Dam (Figure M-3). Fish were sampled with signs of GBT during May, but both the prevalence and severity of GBT signs increased during early June, and increased to a maximum of 15% in the June 14th sample. During this time period stream flows had increased rapidly in the Snake River and the hydraulic capacity at Lower Granite Dam was very limited due to Unit 3 being out of service. Consequently, total dissolved gas levels in the Lower Granite tailrace began to exceed the TDG criteria of 120% on June 3rd, increased to a high near 132% on June 6th, and continued to be above the 120% criteria in the tailrace until June 17th.

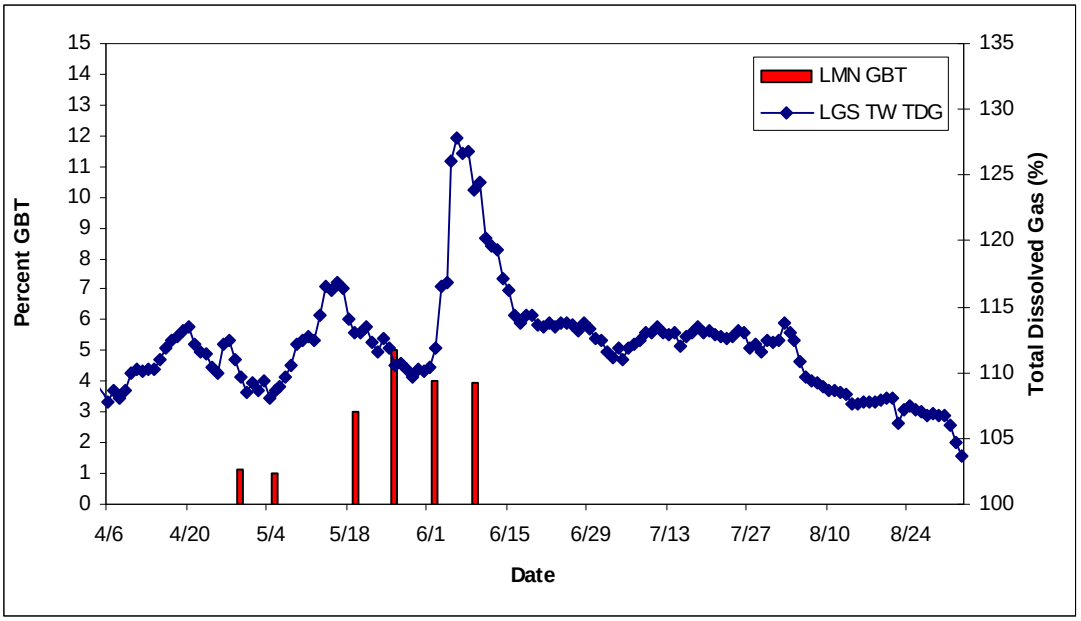
Figure M-3

Percent GBT observed in the sample at Little Goose Dam.



Higher levels of GBT were also observed at Little Monumental Dam; however, the occurrences did not exceed the action criteria (Figure M-4). This likely reflects lower TDG levels that were observed in the Little Goose tailrace. During the critical time period the TDG below Lower Granite exceeded 130%, whereas it did not exceed 130% below Little Goose Dam.

Figure M-4
Percent GBT observed in the sample at Lower Monumental Dam.



Only a few fish were observed in the Mid and Lower Columbia rivers (Figures M-5, M-6 and M-7) reflecting the overall lower TDG levels that were observed at these projects.

Figure M-5
Percent GBT observed in the sample at McNary Dam.

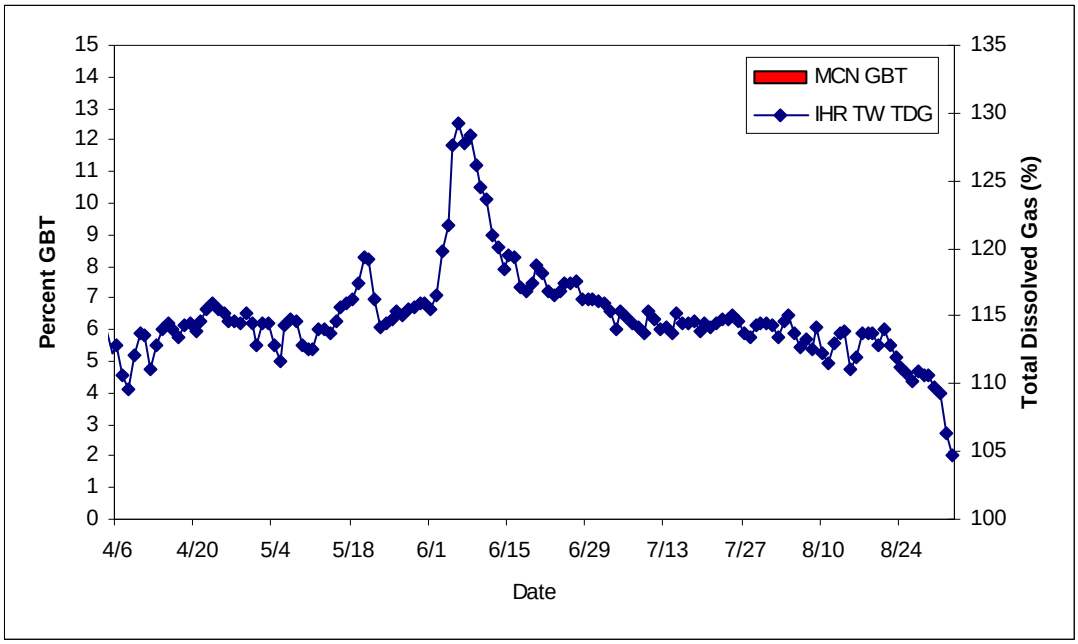


Figure M-6
Percent GBT observed in the sample at Rock Island Dam.

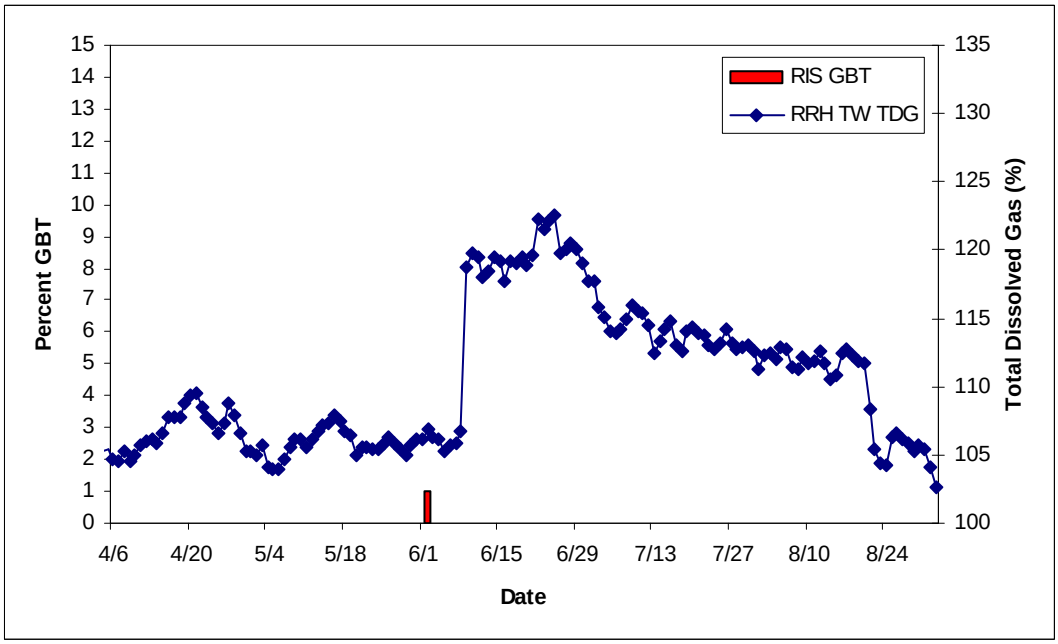


Figure M-7
Percent GBT observed in the sample at Bonneville Dam.

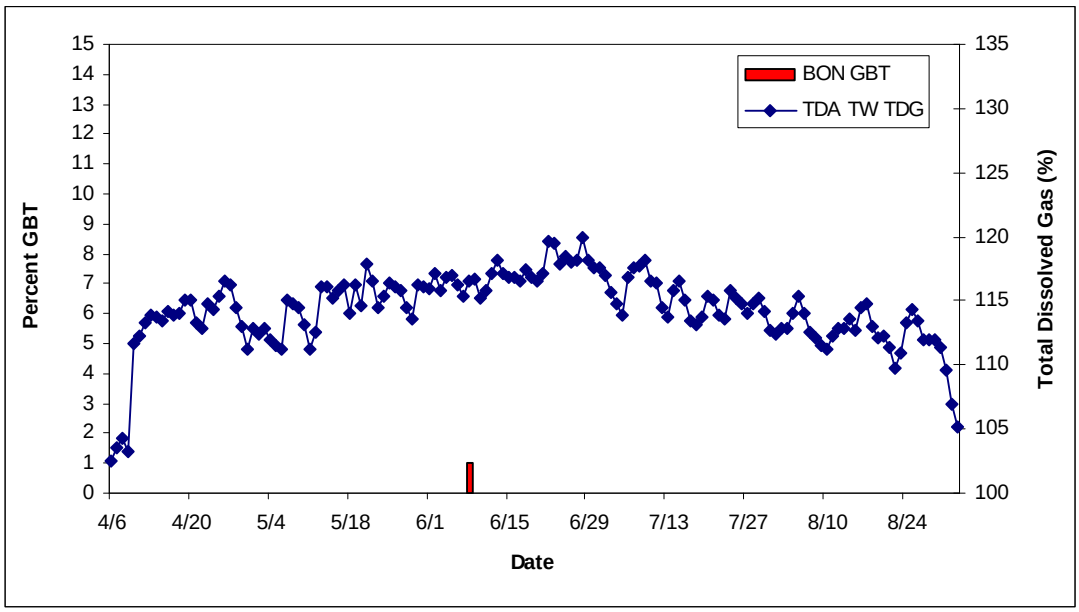


Table M-4 compares the 2010 estimates of the overall percentage of fish with signs of GBT to past years' estimates. As can be seen in the table the overall annual incidence of GBT in 2010 was on the lower end of the range observed in past years, in spite of the incidences of high GBT for a period in the Snake River. This was likely due to the relatively short period of time that the high flows and spills occurred.

Table M-4
Percent of sampled fish with signs of fin GBT estimated for the total fish observed in each year 1996 to 2010.

Year	Total % Signs	% Signs excluding RIS
1996	3.3	4.2
1997	3.2	4.3
1998	1	1.6
1999	0.3	1.4
2000	0.2	0.2
2001	0.001	0.1
2002	0.7	0.7
2003	1.5	0.5
2004	0.18	0.18
2005	0.46	0.11
2006	1.6	1.4
2007	2.4	2.9
2008	0.5	0.7
2009	0.29	0.23
2010	**0.36**	**0.43**

Discussion

The Biological Opinion Spill Program was managed; whenever possible, using the data collected for total dissolved gas (TDG) levels. The GBT biological monitoring is meant to complement the physical monitoring program.

GBT sampling was successfully accomplished for the 2010 migration season. 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. Signs of GBT begin to increase as TDG increases above the criteria levels and will approach the action criteria for GBT when TDG levels are near the 130% supersaturation levels in the tailraces of dams. This was again observed in 2010 in the Snake River at Little Goose Dam. However, it is important to note that when TDG levels approach the 130% the hydro system is always in an uncontrolled spill situation, and there are no actions that can be taken. The high flow/spill event in the Snake River was relatively short lived (about two weeks) and afterwards TDG levels decreased and signs of GBT also decreased. The TDG levels in the Lower Columbia River were near the waiver limits and few fish were observed with signs of GBT.