Turbidity and Temperature Changes Associated with Whitewater Boating Flows

Black Canyon Bear River, Idaho

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SUMMARY

Idaho Department of Environmental Quality (DEQ) personnel deployed water quality data recording sondes before, during and after whitewater boating flow (WWBF) releases to record turbidity, temperature, dissolved oxygen, pH, and specific conductivity at frequent (15 minute or less) intervals. These data indicate marked changes in water quality associated with peak flows during these events; however both the intensity and duration of turbidity increases tended to decrease during subsequent events on an annual basis.

METHODS

YSI model 6920 sondes (Yellow Springs Instruments, Yellow Springs, Ohio) were deployed at the Black Canyon fishing access footbridge (Figure 1) prior to WWBF releases. Sondes were placed in a protective, open-ended PVC case with approximate 1.5 inch-diameter holes to allow free circulation of ambient water around the sonde probes. Temperature, specific conductivity, dissolved oxygen, pH, and turbidity were recorded at a maximum of 15 minute intervals. Turbidity increases and durations were determined from these data. Physicochemical data also were collected upstream of Grace Dam in the forebay and at the boater put-in below the flow release point to determine background. Presently, turbidity data are collected during three WWBF events each year (first, last and one intermediate event). Temperature data were collected year-round, except at Grace forebay, where the probe was in situ during summer months only. For comparative purposes the turbidity data have been evaluated against Idaho's water quality standard for turbidity which reads: "Turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than (50) fifty NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days" (IDAPA 58.01.02.250.02.e).

Sondes were calibrated in accordance using manufacturer's instructions (Yellow Springs Instruments, Yellow Springs, Ohio) and the Quality Assurance Project Plan for the Portneuf Basin Monitoring Project (IDEQ November 2009). Data quality was determined by simultaneous comparisons with freshly-calibrated sondes and post deployment calibrations.

Water temperature was recorded hourly or at more frequent intervals using Onset Corporation Water Temp Pro v2 data loggers at five locations (see Figure 1) – above Alexander Reservoir at Bailey Cr. Road, Grace forebay (surface), Highway 34 Bridge (approximately 600 feet downstream of Grace Dam), Mid-Black Canyon, and downstream of Black Canyon at the Footbridge/Take-out upstream of the Grace Power Plant. PacifiCorp also monitored temperature at the Grace Dam low-flow outlet beginning in 2012.

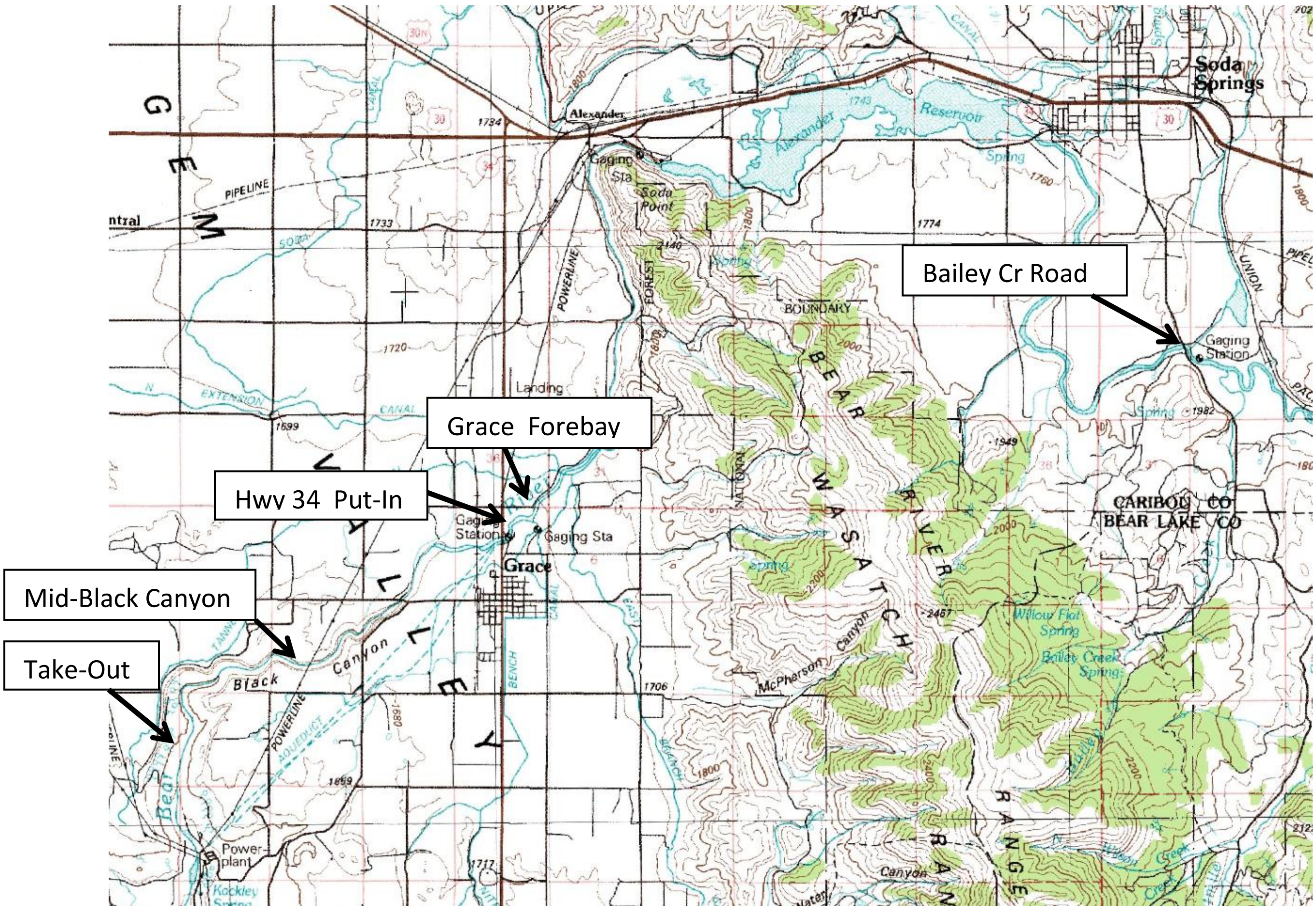


Figure 1. Locations for turbidity and temperature data collection.

RESULTS

Twenty-nine whitewater boating flow release events have been monitored by DEQ and Ecosystems Research Institute (ERI; Logan, Utah) since 2008 (Figure 2). Background turbidity (measured at the put-in site below Grace dam during, and at the take out prior to the arrival of WWBFs) ranged from 1-34 NTU. Turbidity was measured in the Grace forebay during several events and ranged from 17-40 NTU. Turbidity increases at the take out ranged from 34-1210 NTU over background (Figure 2). Generally, highest turbidities occur during the first several events of the year, with peak turbidities declining through the remainder of the season. Since turbidity monitoring began, each year's initial peak turbidity has declined (2009 and 2010 initial turbidities were similar). The peak turbidity for the inaugural WWBF in 2008 was measured from a single water sample acquired by IDFG staff at the onset/outset of the event.

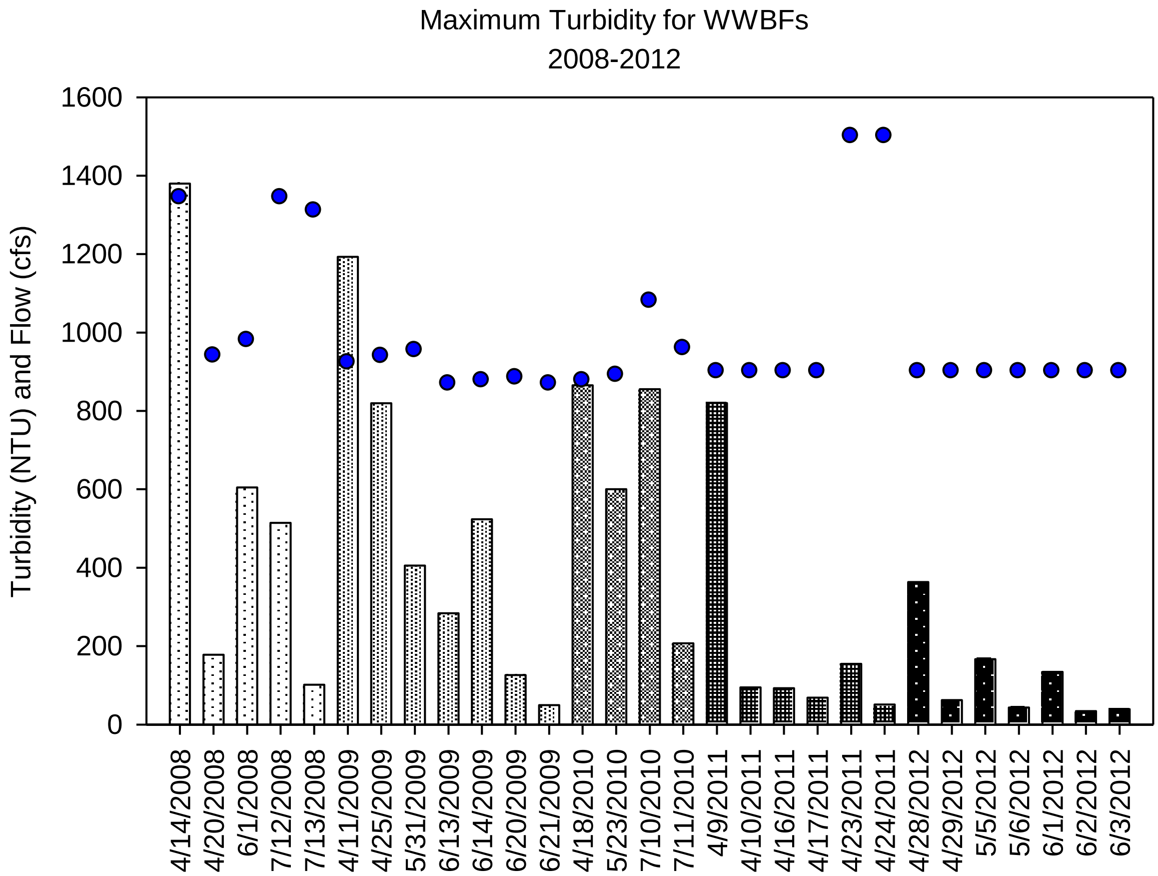
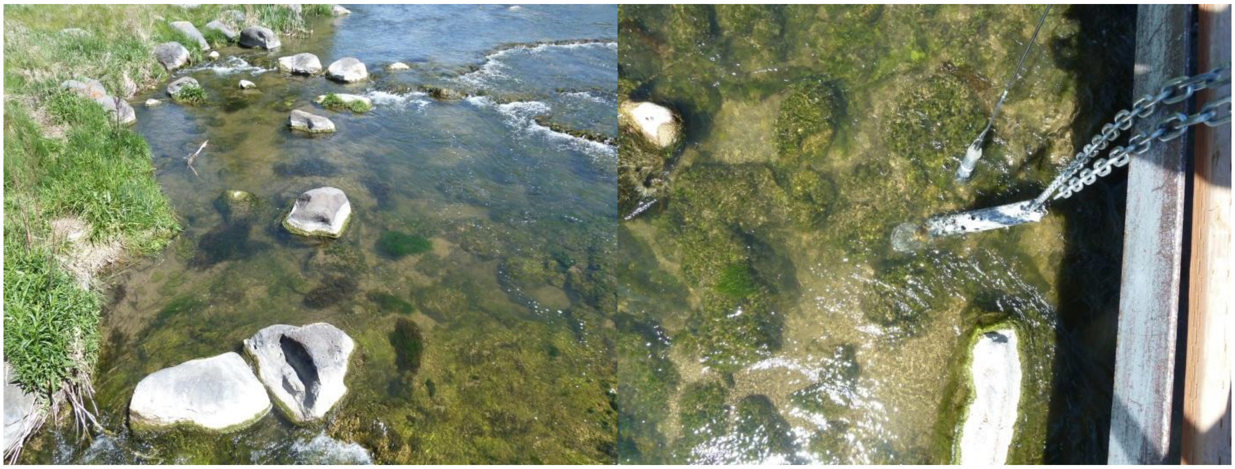


Figure 2. Peak turbidity – background for whitewater boater flow events, 2008-2012. Each year's data grouped by shading. Blue circles represent peak flow for each event.

Visual changes in water quality were documented (Figure 3) as flows increased on 1 June 2012. Photographs were taken upstream and downstream of the fishing access bridge as flows increased from base flow. Initial turbidity increases were easily seen (for example 2.6 to 14 and 14 to 27 NTU) with the naked eye. At turbidities > 50 NTU, large changes (±≥50 NTU) were still obvious with the unaided eye. Maximum turbidities occurred early during individual WWBF events, usually within 0.5 – 1 h. During 2012, the first few events of the season took longer (approximately 0.5 – 1 h) to reach maximum turbidities than subsequent events (10-15 minutes). During multiple day events (for example 1-3 June 2012), initial maximum turbidity far exceeded subsequent days' WWBF-induced turbidity increases (134 versus 37 and 27 NTU for days 1, 2 and 3 June 2012, respectively; Figure 4). The duration of exceedances (time while turbidity >50 NTU above background) declined during multiple-day WWBF



Turbidity = 2.6 NTU at 1128h

Turbidity = 14 NTU at 1148h

Turbidity = 27 NTU at 1148h 50s

Turbidity = 47 NTU at 1149h

Turbidity = 84 NTU at 1149h 53s

Turbidity = 107 NTU at 1150h 29s

Turbidity = 126 NTU at 1151h 15s

Turbidity = 142 NTU at 1152h 27s

Figure 3. Photographs of Bear River water at various turbidity levels during the WWBF event of 1 June 2012. In each case the photograph on the left was taken looking upstream, while the photograph on the right was taken looking downstream from the footbridge at the Black Canyon fishing access bridge.

events and over the course of events in the summer (Figure 5). During 2012, four of seven events monitored exceeded turbidity criteria (Figure 4).

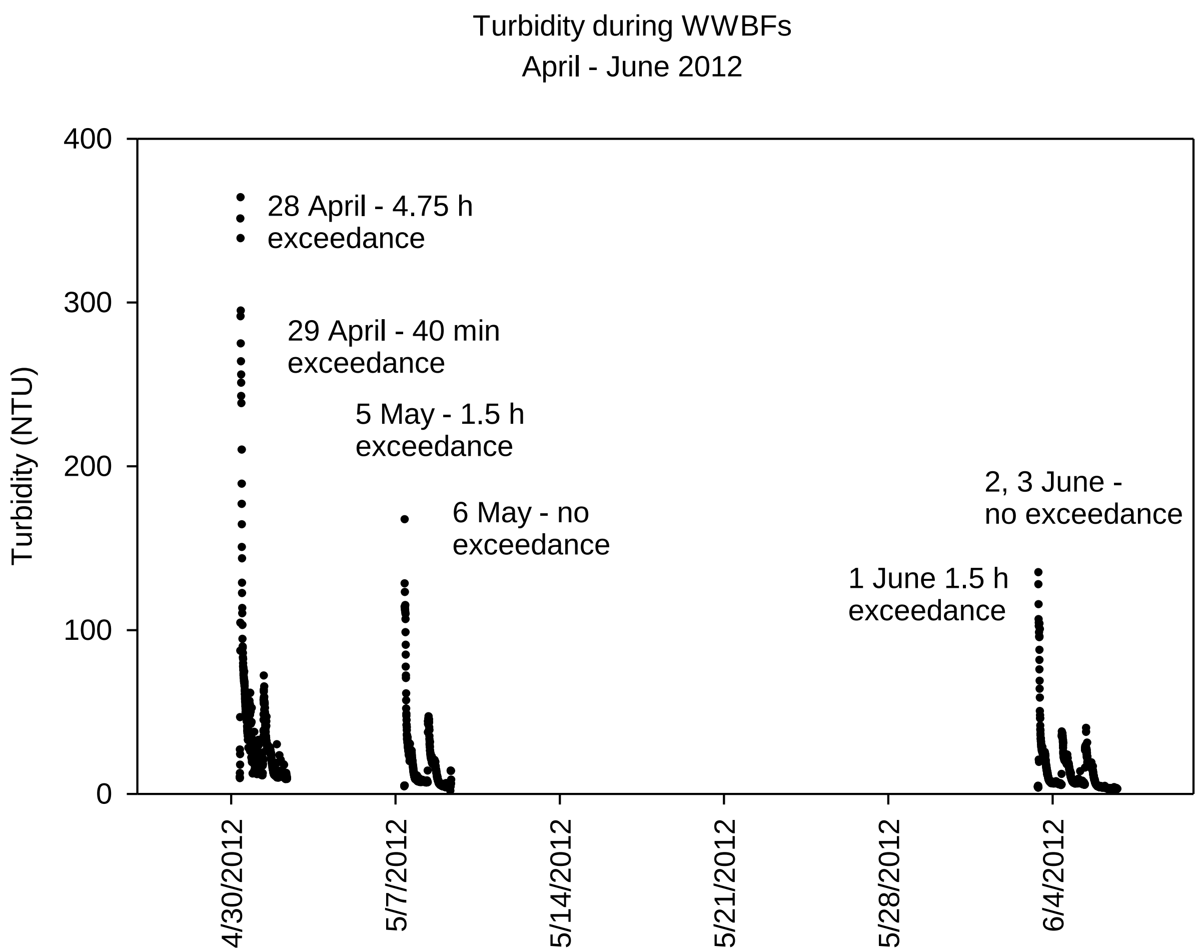


Figure 4. Turbidity data for monitored 2012 WWBF events. Peak flow was 900 cfs for all 2012 WWBFs.

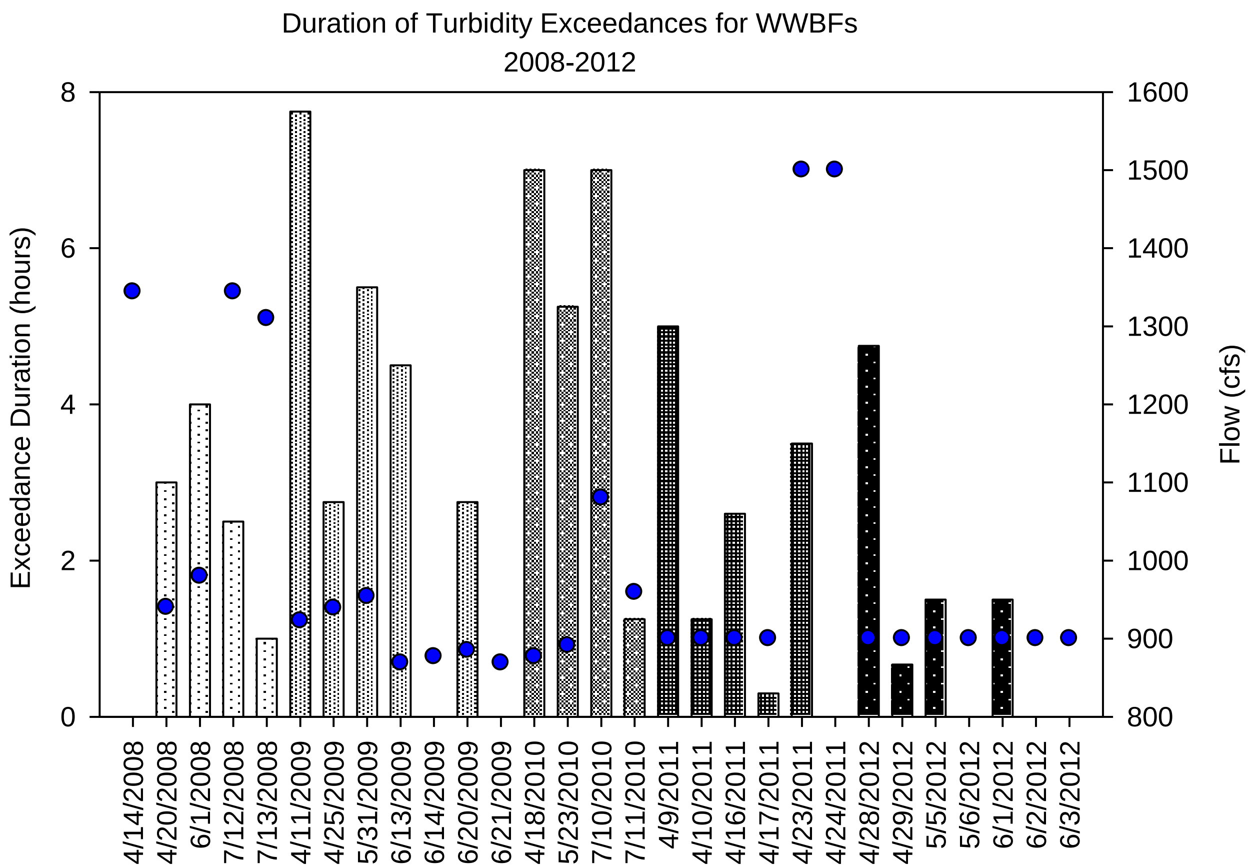


Figure 5. Duration in hours of turbidity > 50 NTU above background during WWBFs. Each year's data grouped by shading. The event of 4/14/2008 was not monitored; however, the duration of exceedance for that event was likely > 4 hours. Duration of 6/14/2009 event is not known due to sonde fouling. Blue circles represent peak flow for each event.

Water temperature patterns varied among sites (Figure 6). Grace forebay surface temperature was recorded in 2012 only, exhibiting slightly higher maximum temperatures than those recorded downstream of Grace dam at Highway 34. Highest maximum temperatures were recorded in the Middle Black Canyon reach. Lowest maximum temperatures were recorded at the Black Canyon takeout above Grace power plant.

DISCUSSION

Since 2008, initial WWBF turbidity peaks generally have declined (Figure 2). In 2012, WWBFs were provided 2 or 3 days in a row, with higher flows in between events than in previous years (for a description of these flows see the Final Agreement for Black Canyon Boater Flows: Extended Study Period and Adaptive Management, April 18, 2012). During these events, subsequent WWBFs only exceeded criteria during the first paired WWBF event (the 29 April WWBF following the 28 April WWBF exceeded the turbidity criterion). This differs from past years when individual WWBFs spaced over the season would each generate high turbidity (for comparison among years, see Figure 2). It appears that grouping WWBFs together avoids resetting the situation for repeat high turbidity spikes.

Temperature records indicate the warming effect of the Black Canyon reach, while temperatures in the downstream reach of Black Canyon are mitigated by cooler spring inflows . These spring inflows also prevent freezing during winter months. The low level outlet at Grace dam was only operated intermittently during 2012; therefore extensive comparisons to Grace forebay surface water temperatures are not feasible. Future monitoring of low-level outlet temperature may confirm the postulate that water exiting Grace dam appears cooler than that at the surface. Temperature monitoring will continue at all locations during ensuing years of WWBF turbidity monitoring.

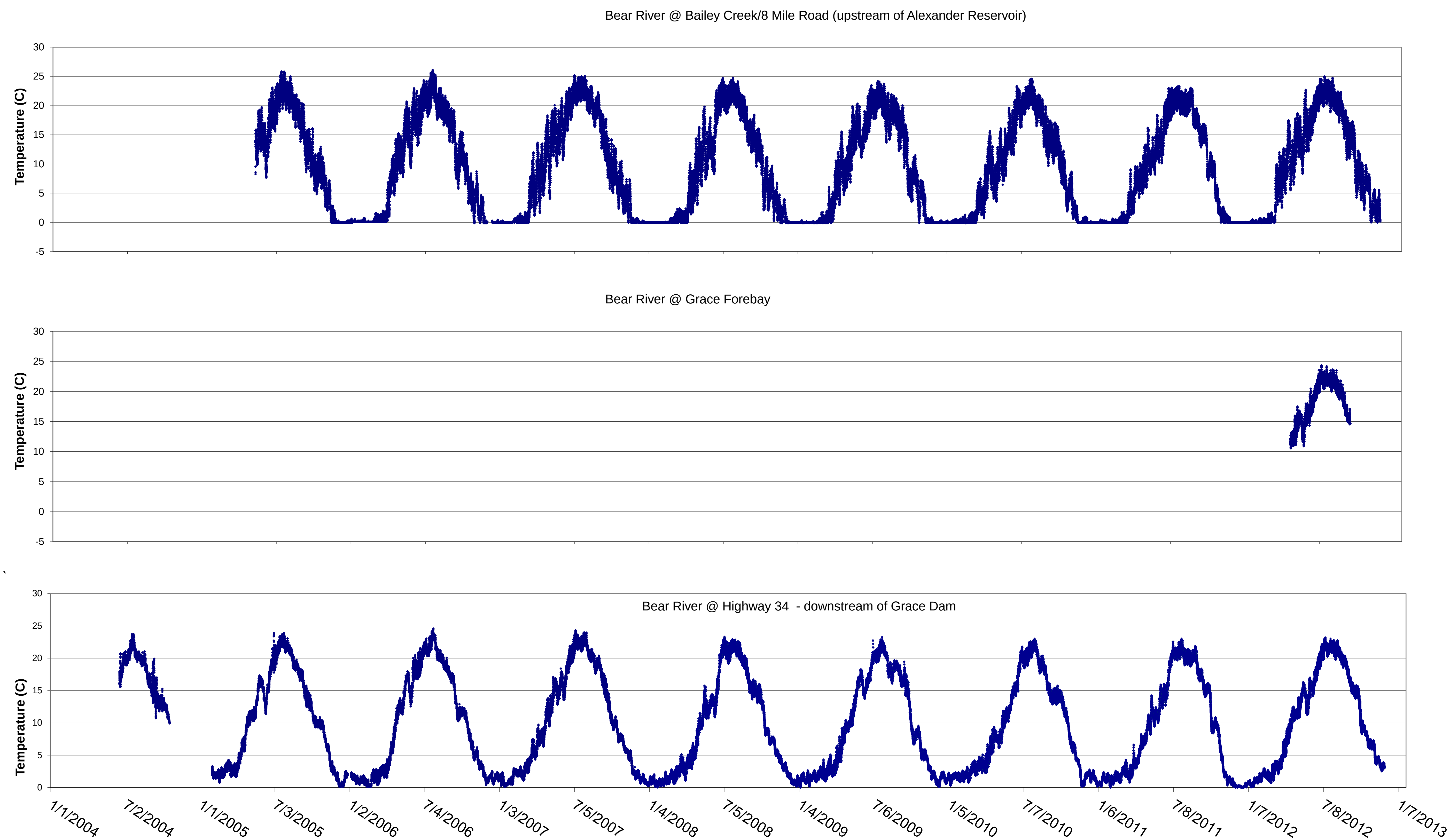


Figure 6. Bear River water temperature at various locations upstream and downstream of Black Canyon; Grace, Idaho (2004-2012)

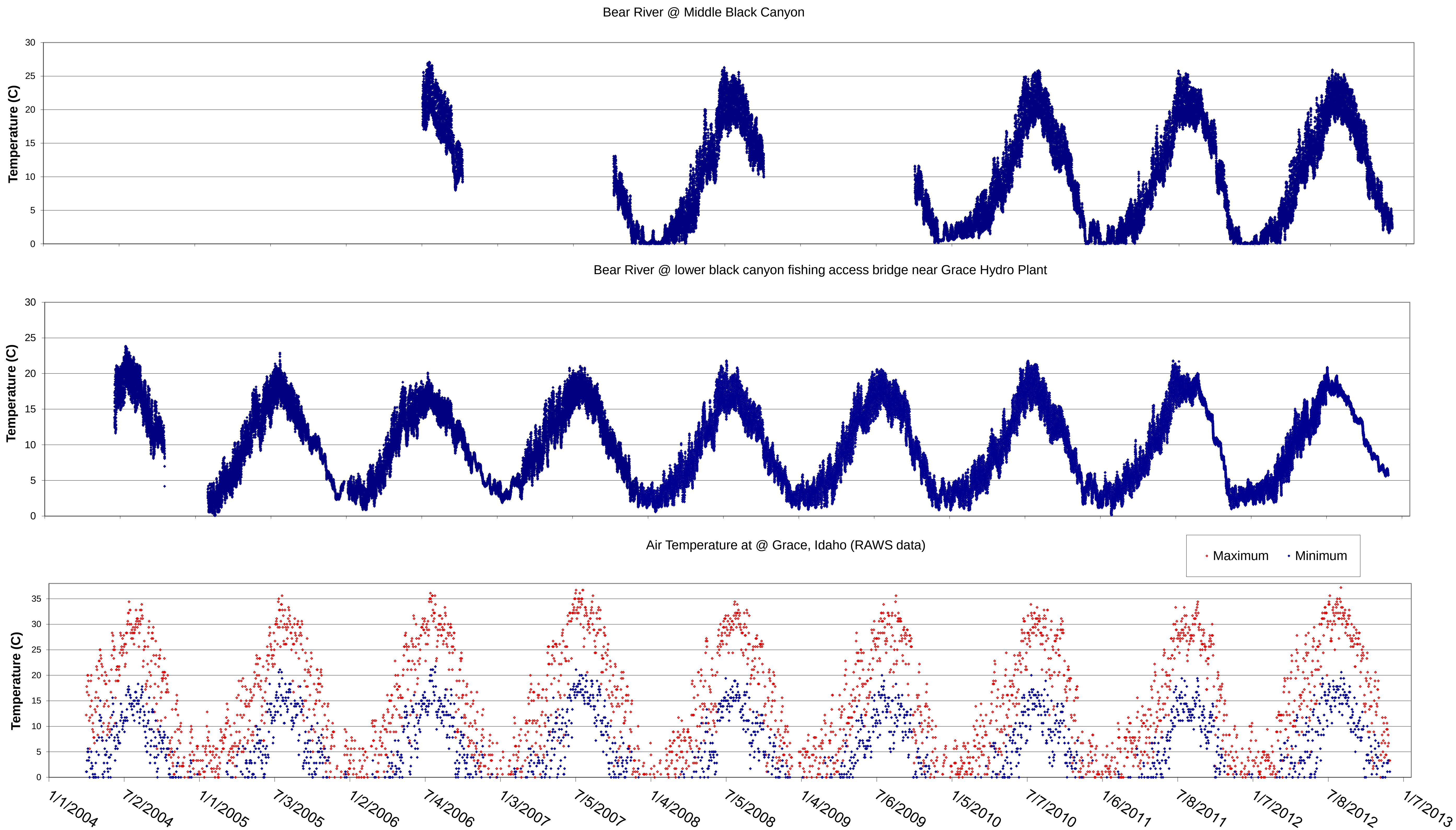


Figure 6 (continued). Bear River water temperatures in and downstream of Black Canyon (2004-2012). Maximum and minimum air temperatures at Grace are also shown for the period.

Appendix. Summary of turbidity data collected during WWBF events.

Date	Measured By:	Black Canyon general backgrd turbidity before event (NTU)	Grace Forebay turbidity (NTU - max)	Put In turbidity (NTU)	highest turbidity (NTU)	SSC (mg/L	difference from up-down/ before and after	Duration (hrs) >50 above background	Tempera-ture change (~C)	peak Q
4/14/2008	IDFG	7		20	1380	3460	1373	no sonde	NA	1344
4/20/2008	DEQ	7		17.6	178.2		171.2	3	-0.1	940
6/1/2008	ERI	4	20	15.1	604.6		600.6	4	0.8	980
7/12/2008	ERI	3	40	26	514.2		511.2	2.5	2.5	1344
7/13/2008	ERI	3		34	101.6		98.6	1	2	1310
4/11/2009	ERI	8		10.9	1193.1		1185.1	7.75	-1.4	923
4/25/2009	ERI	6		9.3	819.3		813.3	2.75	0.6	939
5/31/2009	ERI	1	22	11.4	405.7		404.7	5.5	0.8	954
6/13/2009	ERI	2	24	20.8	283.6		281.6	4.5	0.3	869
6/14/2009	ERI	2		16.9	523.8		521.8	sonde fouled	0.2	877
6/20/2009	ERI	2		11.1	126.3		124.3	2.75	0.1	885
6/21/2009	DEQ	2		13.8	49.4		47.4	0	0	869
4/18/2010	DEQ	3	7-12		865.3		862.3	7	-0.6	877
5/23/2010	DEQ	3	8-14	8.1	600.4		597.4	5.25	0.7	891
7/10/2010	DEQ	2	12-20	15	855.7		853.7	7	1.2-1.6	1080
7/11/2010	ERI	2		16.6	207		205	1.25	0.3-1.2	959
4/9/2011	DEQ	7			820		813	5	-1.9	900
4/10/2011	DEQ	7			95		88	1.25	NA	900
4/16/2011	DEQ	20		21	92.6		72.6	2.6	0	900
4/17/2011	DEQ	20		18	68.6		48.6	0.3	-0.2	900
4/23/2011	DEQ	27		28	154.8		127.8	3.5	0	1500
4/24/2011	DEQ	27		21	51.2		24.2	0	-0.1	1500
4/28/2012	DEQ	9		9.6	363.4		354.4	4.75	0.3	900
4/29/2012	DEQ	11		8.4	62.6		51.6	0.67	0.3	900
5/5/2012	DEQ	4		10.4	166.8		162.8	1.5	-0.4	900
5/6/2012	DEQ	6		10.9	43.3		37.3	0	0.2	900
6/1/2012	DEQ	3		8.3	134.4		131.4	1.5	0.2	900
6/2/2012	DEQ	5			34.3		29.3	0	0.3	900
6/3/2012	DEQ	5			39.4		34.4	0	0.1	900
Mean		7	27	16	374		366	3	0	998
Median		5	23	15	178		171	3	0	900
Max		27	40	34	1380		1373	8	3	1500
Min		1	20	8	34		24	0	-2	869
S.Deviation		7	9	7	376		378	2	1	194