Chapter Four

Observations from the 2006 Flood Event

Introduction

This Chapter focuses upon observations of impacts that occurred as a result of the 2006 flood event along the Kootenai River. The first part of Chapter 4 provides an estimate of damages prevented. The analysis used to estimate damages prevented is a standard method to help demonstrate the effectiveness of the public investment in water resources infrastructure and to assist in analyzing the appropriate level of flood reduction measures undertaken in an area. While Libby Dam provides both system[1] and local benefits, this report focuses upon presenting damages prevented in the local area only, due to time and funding limitations involved in preparing the system flood control information. Additionally there is a discussion of the impacts cited by Canada under the Columbia River Treaty. The second part of Chapter 4 provides monitoring results on the impacts to resident fish in Montana due to total dissolved gas (TDG) super-saturation levels in the river as a result of the flood event, as well as preliminary information concerning sturgeon movement and potential spawning activity in Idaho during 2006.

I. Estimate as to Damages Prevented in the Kootenai River Valley[2]

The area downstream of Libby Dam is a relatively complex hydrologic system of just under 100 miles of levees. These levees protect a predominantly agricultural land in 25 separate areas in Boundary County, Idaho, from Bonners Ferry to the Canadian border

The effect of operations at Libby Dam on damages prevented at downstream locations in the Kootenai River valley area is determined by comparing regulated (conditions with Libby Dam) and unregulated (conditions without Libby Dam) river stages at selected sites. Estimated damages with regulated and unregulated flows are based on a pre-flood inventory of the following damage categories: basic crops, hops, commercial structures, public structures, residential structures, outbuildings, farm buildings, and estimated emergency costs. The cost of flood fighting, damaged levees, and seepage damage, as well as any impacts in Canada are not included in the damages prevented estimate.

Damages prevented based on a comparison of regulated flows to unregulated flows are estimated at $27 to $45 million. Two of the Storage Areas with Hops farms, Storage Area 9 at River Mile (RM) 131, and Storage Area 18 at M 109, account for the majority of estimated damages, and Hops account for about half of those damages. Damages based on regulated flows

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[1] As one of the four projects addressed in the Columbia River Treaty, system benefits and impacts are realized not only in the United States, but also downstream in Canada.

[2] House Report No 98- 197 (1984) directs the U.S. Army Corps of Engineers to issue an annual report to Congress which includes an assessment of damages prevented, amongst other information concerning floods and flood damage reduction measures taken across the nation.

(peak of 55,000 cfs) are estimated[3] at $40,000 to $600,000. The estimated damages prevented are primarily the result of two predicted levee failures, the first at RM 156 and the other at RM 108. Therefore, damages prevented are estimated at about $26M to $45 million.

Two areas of significant uncertainty in calculating Damages Prevented involve estimating the river stages for the 50 mile stretch of the river between Bonners Ferry and the Canadian Border, and estimating the point at which levees are likely to fail. Estimated stages are based on the gauge at Bonners Ferry. The estimated failure point and resulting estimated damages were calculated using a reliability assessment incorporating probability analysis.

As a result of the 2006 event, B.C. Hydro, as the Canadian Entity under the Treaty, noted that the Libby reservoir had filled to an elevation slightly above 2459 feet, the normal full elevation, on June 17 and 18. No specific impacts in Canada as a result of the reservoir being at this elevation were noted.

References:

Comiskey, James J., *Overview of Flood Damages Prevented by U.S. Army Corps of Engineers Flood Control Reduction Programs and Activities*, Journal of Contemporary Water Research and Education, Issue 130, pages 13 – 19 (March 2005). Accessible on the internet at: http://www.ucowr.siu.edu/updates/130/05%20comiskey.pdf

Bonners Ferry Flood Level Study Report, including the Kootenai River Channel Capacity Study Report, U.S. Army Corps of Engineers, Seattle District (30 Sept 2005), accessible on the internet at: http://www.nws.usace.army.mil/ers/reposit/BonnersFerryFloodLevelAssessmentFinalReport.pdf

II. Monitoring of Total Dissolved Gas and Resident Fish

A. TDG Monitoring During 2006 Spill at Libby Dam

In 2006, Libby Dam began releasing water via its spillway during the afternoon of June 8. Spillway releases ramped up from 8 kcfs on June 8, to 14 kcfs on June 9, and to a peak of 31 kcfs on June 17. Spillway releases remained at 31 kcfs until the afternoon of June 20, and then gradually ramped down to no spillway flow by the early afternoon of June 27. Total dissolved gas (TDG) saturation in the Kootenai River downstream of the dam increased as spillway flows increased. In areas close to the dam, the TDG saturation exceeded 110% on June 8, reached

[3] The recently completed Bonners Ferry Flood Level Study (BFFLS) was used as the best and most recent source of damage estimates for the damages prevented estimate. The theoretical estimates derived for the BFFLS model, even those for regulated flows, are different than the actual damages being reported for 2006. For instance, the local media has reported damage estimates in the $50-60 million dollar range that include impacts due to seepage, damages to levees, and other categories of damages; in addition, the Corps expended over $1.4 million in flood fighting along the Kootenai River in 2006 (see Appendix A). This highlights a challenge in comparing actual flood damages with those predicted by theoretical models, as a wide variety of random variables exists in real life which cannot always be accurately predicted in a modeling situation (i.e., such as rainfall rather than river stages acting as the determining factor in contributing to damages in an area).

124% on June 16, and peaked at about 130% between June 17 and June 20. TDG saturation dropped back below 110% on June 27. The highest TDG saturation occurred along the left bank of the river (looking downstream) since spillway releases tend to hug the left bank for some miles after exiting the spillway stilling basin on the left side of the dam.

B. Resident Fish Monitoring in Montana During 2006 Spill at Libby Dam

Montana Department of Fish, Wildlife, and Parks (MFWP) monitored fish in the Kootenai River for symptoms of gas bubble trauma (GBT) several times during spillway releases at Libby Dam in June 2006. Preliminary results of the monitoring have been made available by MFWP (Marotz, pers. comm. Oct. 5, 2006). MFWP monitoring used boat-mounted electrofishing apparatus to capture fish in the Kootenai River from the David Thompson Bridge (RM 221.6) downstream to Dunn Creek (RM 219.8). Electrofishing was conducted at night from a boat on June 12, 15, 19 and 22. It is important to note that electrofishing is capable of sampling only live fish. Dead fish are not available to this method, and if there were mortalities, then the effects of this incident on fish would be underestimated.

MFWP examined captured fish for symptoms of GBT such as injuries or gas emboli in the fins, eyes, and external tissues. The reported numbers of fish with GBT may have been underestimated since MFWP did not include fish with split fins unless gas bubbles or other localized hemorrhaging was also present. Additionally, observations of dead and dying kokanee, all with physical trauma, indicated that these fish had had passed through the spillway from Lake Koocanusa. After the June 12 survey, MFWP discontinued sampling of kokanee and focused on fish species that live in the river below the dam. Sampling intervals were also adjusted through the spill period in order to obtain necessary data while minimizing additional stress to fish populations to the maximum extent possible.

The incidence and severity of GBT symptoms in fish increased rapidly from the onset of spill on June 8. On June 8, fish captured along the left bank of the river had a substantially higher incidence of GBT symptoms than fish captured along the right bank. On June 15, the percentage of trout and mountain whitefish with GBT symptoms almost doubled, with the highest increases in incidence recorded along the right bank. By June 19, all bull trout captured had GBT symptoms, regardless of the side of the river. GBT in rainbow trout was observed in 67 percent of fish on the left bank and 86 percent of fish on the right bank. Mountain whitefish GBT symptoms were observed in 86 percent on the left bank and 80 percent on the right bank. By June 19, symptoms included multiple hemorrhages on the underside of fish in addition to the air bubbles in fins, eyes, and dermis, and on the operculum as well as split fins that were observed in earlier sampling. Incidence of GBT during the June 22 sampling was similar to the June 19 observations, although the severity of symptoms appeared to be slightly less.

The 2006 monitoring is consistent with monitoring during Libby spill in 2002. Over time, exposure to high TDG saturation results in increased frequency and severity of GBT symptoms. For example, about half the sampled bull trout exhibited GBT symptoms by the 8^{th} day of spill (in 2006). After June 19^{th}, 2006, (the 11^{th} day of spill), all bull trout examined had GBT symptoms. Hemorrhaging on the underside of these fish increased during peak TDG concentrations of about 130 percent, and then appeared to decrease when TDG concentrations decreased to about 125 percent on June 22 during ramp down of spillway flows.

In addition to the monitoring during the spill in 2006, electrofishing surveys this fall and in the spring of 2007 will allow MFWP to evaluate the potential effects of fish populations that may be related to mortality or fish displacement during the 2006 flood event. Preliminary data may be available by the end of 2007. Results of the monitoring are summarized in Table 1 below.

Table 1. Results of Monitoring for Gas Bubble Trauma in Kootenai River Fish in June 2006

Riverbank (looking downstream)	Category	Bull Trout	Rainbow Trout	Westslope Cutthroat Trout	Mountain Whitefish	Coarse Scale Sucker	Fine Scale Sucker	Rainbow/Cutthroat Hybrid	Kokanee	Northern Pikeminnow	Redside Shiner	Grand Total
6/12/2006 (14 kcfs spill that day & 4 total days of spill @ Libby Dam)												
Left	# w/o GBT symptoms	0	17	0	9	3	1	1	0	0	1	32
Left	# w/ GBT symptoms	0	6	0	5	1	2		20	0	0	34
Left	Total #	0	23	0	14	4	3	1	20	0	1	66
Right	# w/o GBT symptoms	4	16	0	17	0	0	0	4	0	0	41
Right	# w/ GBT symptoms	0	1	0	4	0	0	0	1	0	0	6
Right	Total #	4	17	0	21	0	0	0	5	0	0	47
	# w/o GBT symptoms	4	33	0	26	3	1	1	4	0	1	73
	# w/ GBT symptoms	0	7	0	9	1	2	0	21	0	0	40
	Total #	4	40	0	35	4	3	1	25	0	1	113
6/15/2006 (14 kcfs spill that day & 7 total days of spill @ Libby Dam)												
Left	# w/o GBT symptoms	2	7	0	8	0	0	0	not recorded	0	0	17
Left	# w/ GBT symptoms	1	17	0	13	0	0	0	not recorded	1	0	32
Left	Total #	3	24	0	21	0	0	0	not recorded	1	0	49
Right	# w/o GBT symptoms	1	7	0	10	0	0	0	not recorded	0	0	18
Right	# w/ GBT symptoms	1	14	0	12	0	0	0	not recorded	0	0	27
Right	Total #	2	21	0	22	0	0	0	not recorded	0	0	45
	# w/o GBT symptoms	3	14	0	18	0	0	0	n/a	0	0	35
	# w/ GBT symptoms	2	31	0	25	0	0	0	n/a	1	0	59
	Total #	5	45	0	43	0	0	0	n/a	1	0	94
6/19/2006 (31 kcfs spill that day & 11 total days of spill @ Libby Dam)												
Left	# w/o GBT symptoms	0	7	0	3	0	0	0	not recorded	0	0	10
Left	# w/ GBT symptoms	7	14	1	19	0	0	0	not recorded	0	0	41
Left	Total #	7	21	1	22	0	0	0	not recorded	0	0	51
Right	# w/o GBT symptoms	0	3	0	4	0	0	0	not recorded	0	0	7
Right	# w/ GBT symptoms	9	19	0	16	0	0	0	not recorded	0	0	44
Right	Total #	9	22	0	20	0	0	0	not recorded	0	0	51
	# w/o GBT symptoms		10		7	0	0	0	n/a	0	0	17
	# w/ GBT symptoms	16	33	1	35	0	0	0	n/a	0	0	85
	Total #	16	43	1	42	0	0	0	n/a	0	0	102
6/22/2006 (ramp down from 22 kcfs to 16kcfs spill that day & 14 total days of spill @ Libby Dam)												
Left	# w/o GBT symptoms	0	1	0	3	0	0	0	not recorded	0	0	4
Left	# w/ GBT symptoms	7	21	1	17	0	0	0	not recorded	0	0	47
Left	Total #	7	22	1	20	0	0	0	not recorded	0	0	51
Right	# w/o GBT symptoms	0	2	0	5	0	0	0	not recorded	1	0	8
Right	# w/ GBT symptoms	4	20	0	19	0	1	0	not recorded	0	0	44
Right	Total #	4	22	0	24	0	1	0	not recorded	1	0	52
	# w/o GBT symptoms	0	3	0	8	0		0	n/a	1	0	12
	# w/ GBT symptoms	11	41	1	36	0	1	0	n/a	0	0	91
	Total #	11	44	1	44	0	1	0	n/a	1	0	103
Wrap-up of 2006 Electrofishing Surveys												
	Total # w/o GBT symptoms	7	60	0	59	3	1	1	4	1	1	137
	Total # w/ GBT symptoms	29	112	2	105	1	3	0	21	1	0	275
	Total #	36	172	2	164	4	4	1	25	2	1	412

C. Sturgeon Monitoring in Idaho

Idaho Fish and Game (P. Rust, pers. comm.) monitored white sturgeon movement in Idaho during the spring of 2006, in the weeks leading up to and following the onset of spill at Libby Dam. Fixed receivers were used to monitor presence of radio-tagged adult sturgeon in the Kootenai both below and above the Highway 95 Bridge at Bonners Ferry. Five fish were recorded near the receiver located across from the Kootenai River Inn (river kilometer 246.8), just above the highway bridge, including 3 prior to spill (May 20-22, May 22-23, May 24) and 2 following the June 8 commencement of spill (June 13, and June 23).

Other tagged sturgeon were located near or below Bonners Ferry as follows (Highway 95 bridge is about rkm 244.8):

RKM		Number of adults observed
248.6		2 possibly 3
246.8		5
245.9	(south side just above HWY 95 Br.)	5
245.8	(south side just above HWY 95 Br.)	9 (detected 4 that could not be detected from S. Side)
244.5	(Ambush Rock)	12
243.5		23
239.0		23
235.2		27
230.5	(Shorty's Island)	30
244.6	(just below Fleming Creek)	29
214.6		30
209.4		28

Sturgeon eggs were found near Bonners Ferry, not far downstream of the bridge (rkm 245.5 and 245.6) near newly-placed riprap on the right bank, on June 28, after onset of spill. Incubation for sturgeon eggs lasts about 21 days, but egg mats are normally checked much more frequently than that, so the eggs would have been spawned after onset of spill.

Other spawning may have occurred in other locations before and after spill commenced. More will be known in about 2-3 years concerning the success of 2006 sturgeon reproduction, when juveniles are more easily accessible to conventional sampling gear.

Sturgeon eggs were outplanted June 3-27, 2006, mostly in side channels because of difficulty and danger working in the main channel in high flows. No larvae from these efforts were recovered in subsequent sampling efforts, nor were any other sturgeon larvae caught in any sampling in the main channel or elsewhere.

Gillnetting for juveniles 2 years or older began in July, resulting in about 190 hatchery-reared and 5 wild-spawned juveniles being captured.

Sturgeon in Idaho were not affected by GBD from spill, because they occur below Kootenai Falls, which “resets” gas levels at about 118% saturation.