2011 Current River Fish Habitat Assessment

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Prepared for:
Thunder Bay District Stewardship Council &
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Thunder Bay, ON

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ABSTRACT

Fish habitat mapping and electrofishing was conducted between August 31 and September 23, 2011 on the Current River below the Boulevard Lake dam and its mouth at Lake Superior. A total of 1063 fish of 10 species were caught during 10,976 seconds of electrofishing. Large fish species included one adult and five young of the year (YOY) walleye, 63 rainbow trout, 3 brook trout, and 32 YOY white sucker. Bedrock substrate comprises approximately 71% of the approximately 47,500 m^2 of channel habitat, with cobble comprising much of the rest, particularly in middle reaches near Cumberland Street. During the drought conditions observed during the survey, only 44% of the channel below the high water mark was wetted. Although pool habitats represent only about 35% of the wetted habitat at low flows, they provide significant fish habitat. In particular, the bedrock pools above the generating station encompass approximately about 2000 m^2 or 8% of the total channel area above the GS, but contained 477 fish of eight species. These fish habitat values have implications for water management planning, particularly minimum flows requirements in the bypass reach and its relation to leakage flows.

Cover photo: Current River below Boulevard Lake Dam on September 2011

1 INTRODUCTION

Several potential fish habitat issues have been identified for the lower reaches of the Current River between Boulevard Lake and Lake Superior including:

- stranding of anadromous fish e.g., rainbow trout in or below the fish ladder below the Boulevard Lake Dam;
- potentially poor recruitment of walleye due to limited spawning success
- poor spawning runs of rainbow smelt due to inappropriate flow regimes; and
- other potential, unidentified impacts on spawning and nursery habitat for native fish species (e.g. common white sucker, longnose sucker, cyprinids, sculpins) due to habitat limitation or flow regime.

Flow regime in the lower reach of the Current River below the Boulevard Lake Dam is currently governed by:

- Boulevard Lake (Current River) Water Management Plan March 2006;
- 1985 lease agreement between City of Thunder Bay and the Independent Electricity Market Operator IMO;
- 1992 Water Taking Permit 30/06/92-31/03/03;
- 1999 Operating procedure; and
- 2006 Water Taking Permit 08/09/06-20/07/16.

Condition 5.2 of the 2006 water taking permit indicates that the taking of water (including the taking of water into storage and the subsequent or simultaneous withdrawal from storage) shall be carried out in such a manner that streamflow is not stopped and is not reduced to a rate that will cause interference with downstream uses of water or with the natural functions of the stream. Although the current water management plan is in force until 2016, detailed habitat mapping would allow more informed discussion of minimum flow requirements in the interim. It would support efforts to ensure that Condition 5.2 of the 2006 Permit to Take Water are met and well as any compliance issues with respect to the federal Fisheries Act.

OMNR base mapping layers for the Current River mouth available from Ontario Ministry of Natural Resources (OMNR) are currently inadequate for fish habitat assessment due to extremely coarse scale (Figure 1). Detailed habitat mapping is considered a first step towards addressing fish habitat issues raised previously and movement towards recovery of Thunder Bay walleye populations. In addition, although there has been some fisheries assessment at the mouth of the Current River but no recent work in the river above the islands at the mouth (e.g. ,Geiling et al. 1996; Ball and Tost 1990). The purpose of the current study was to provide a current assessment of the fish habitat and community in the Current River to support future water management planning.

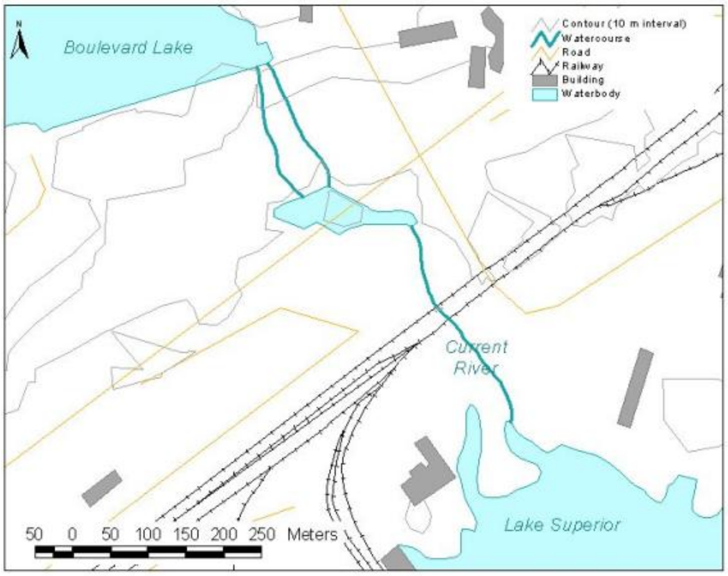

Figure 1. Existing OMNR NRIVS mapping for Current River mouth.

2 METHODS

Fieldwork was conducted on August 31 and Sept 27 by Rob Foster (RF), Julian Holenstein (JH), and Brian Ratcliff (BR), and Adam Foster (AF)(Table 1). Fieldwork focused on the Current River below the Boulevard Lake dam to the island at its mouth on Lake Superior (Figure 2).

Table 1. Summary of 2011 fieldwork at the mouth of the Current River.

Date	Observers	Activity
August 31	RFF, BR, JH	electrofishing, habitat mapping
September 2	RFF, BR	electrofishing, habitat mapping
September 9	RFF, JH	substrate mapping, habitat mapping
September 19	BR, JH	substrate mapping
September 27	RF, AF	habitat mapping

Electrofishing was conducted by a 2- or 3-person crew using a Smith-Root LR-24 backpack electrofisher (Figure 3). Electrofishing generally followed procedures outlined in OMNR (2002) and Stanfield (2005). Single-pass electrofishing was conducted in an upstream direction; barrier nets were not used as low flow conditions effectively created barriers to upstream passage allowing pools or short reaches to be sampled fairly discretely. The Quick Setup function on the LR-24 was used to determine initial electrofisher settings: this function selects a voltage level necessary to achieve 25 watts average power output through the water between electrodes. Typical initial settings were 25% duty cycle, 4.2 m/s pulse width, 400 V and 60Hz. Voltage settings and frequency settings were adjusted as necessary) to achieve levels necessary for fish capture. Work was carried out under Licence to Collect Fish for Scientific Purposes #1064504 issued by Thunder Bay District OMNR. Water temperature was 21° C during sampling.

Figure 2. Electrofishing reaches on the Current River below Boulevard Lake, August 31 and September, 2011.

Figure 3. Electrofishing below Shipyard Road bridge on August 31, 2011.

Habitat mapping from the Boulevard Lake dam down to the Current River mouth was conducted under low flow conditions (mainly leakage) generally following OMNR (1987) and Bain and Stevenson (1999).

In addition, more detailed substrate mapping was measured along 13 transects at the mouth of the Current River using techniques adapted from Bain and Stevenson (1999) and Stanfield (2005). The transect locations (Figure 5) were selected to be representative of habitat conditions at the mouth of the river and also encompass walleye spawning areas identified in Geiling et al. (2006). Transects were established from the high water mark, and each transect was generally oriented perpendicular to the riverbank, with the transect start and end points marked with spraypaint. A lead rope marked with 50 cm intervals was stretched between the endpoints transect. At each 50 cm interval, a 30 cm diameter ring was placed on the river bottom. The particle (e.g., gravel, cobble, etc) at the centre of the ring was selected and the width of its b-axis measured to the nearest mm. The largest particle in the ring was then selected and its b-axis measured as well. Any gravel in the ring (if not the centre or largest particle) was also noted. The degree of fine sediment on the particles was estimated using the following classes: 0-5%, 6-25%, 26-50%, 51-75%, >75%. Water depth (mm) was also recorded.

Figure 4. Transect #1 with lead line marked with 50 cm intervals, September 9 2011.

Figure 5. Location of substrate transects at the mouth of the Current River, September 2011. Note: City of Thunder Bay imagery date unknown (actual water levels were lower during sampling).

3 HABITAT

3.1 Flows

Aquatic habitats on the Current River between Boulevard Lake dam and its mouth at Lake Superior are primarily high energy lentic environments depending of discharge. The nature and extent of the fish habitat are highly dependent upon flows through the Boulevard Lake dam, which in turn are a function of precipitation in the watershed and the water management regime. During 2011 sampling, flows in the study area were almost entirely from leakage through the stop logs at the dam, with very little flow going over the dam and none through the fish ladder (Figure 2). There was below normal precipitation throughout much of the summer and therefore reduced flows at the time of sampling (Figure 6).

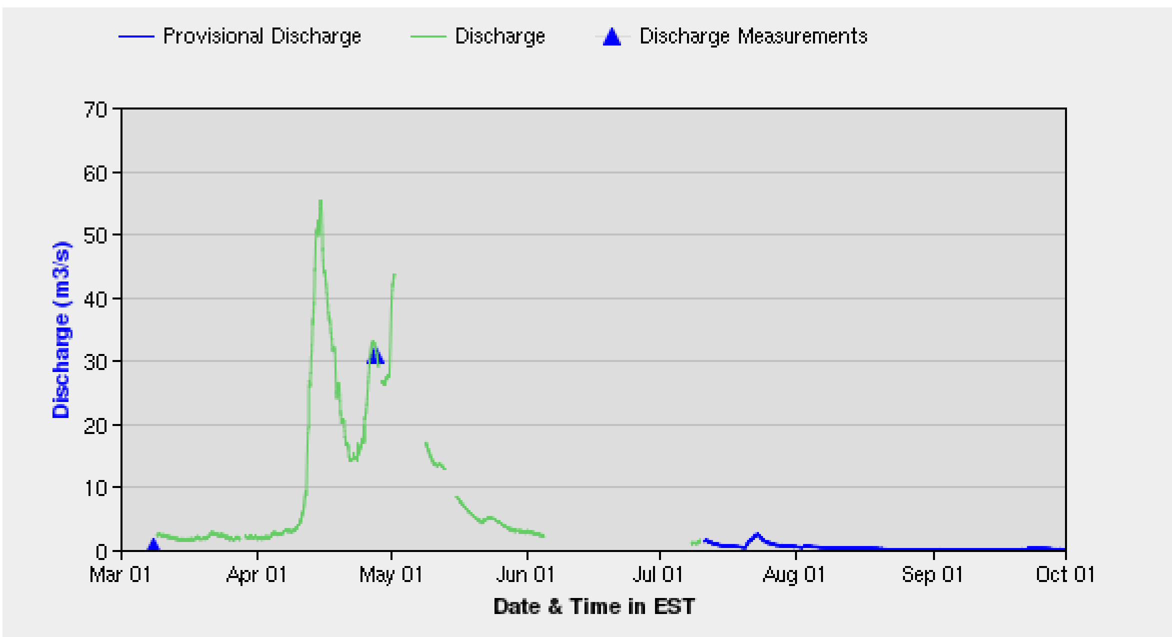

Figure 6. March-October 2011 discharge at Stepstone on the Current River (Environment Canada 2011), approximately 20 km upstream of the study area.

Figure 7. Leakage flows through the Boulevard Lake dam on August 31, 2011 during electrofishing.

3.2 Rivermouth Habitat

Water levels at the mouth of the Current River are strongly influenced by Lake Superior water levels since there is very little drop in elevation from the base of the bedrock sheets above the islands (Figure 8). Most of the riverine habitat during sampling at the mouth showed little or no visible flow across much of the transects surveyed (Appendix 2). Maximum water depths on the survey transects ranged from 14 to 76 cm (Figure 9, Table 2), with deeper water towards the open lake. Substrates were predominately cobble along surveyed transects although there are pockets of gravel among the coarser material. The proportion of gravel, sands, and silts appears to increase in deeper water farther downstream deeper water (>1 m) that could not be effectively sampled. The average size of regularly sampled particles (centre of sample ring) did not vary significantly between the main, middle, and secondary channels, but the average size of the largest particles was greater in the main channel (364 mm vs. 302 mm in middle channel and 263 mm in secondary channel). Transect water depths were greater in the secondary channel. Not surprisingly, there was a higher proportion of substrate with a silty film in the secondary (west) channel rather than in the main channel where increased flow keeps silts suspended. Under low flows, this suggests that suitability of cobble substrates in the secondary channel for walleye, white sucker and other species might be reduced compared to the main channel, particularly under low flow conditions. However, high spring flows may reduce this potential effect.

Figure 8. Bedrock pools at base of sheet above islands at mouth of the Current River. The red line marks the approximate upper limit of the effect of Lake Superior water levels.

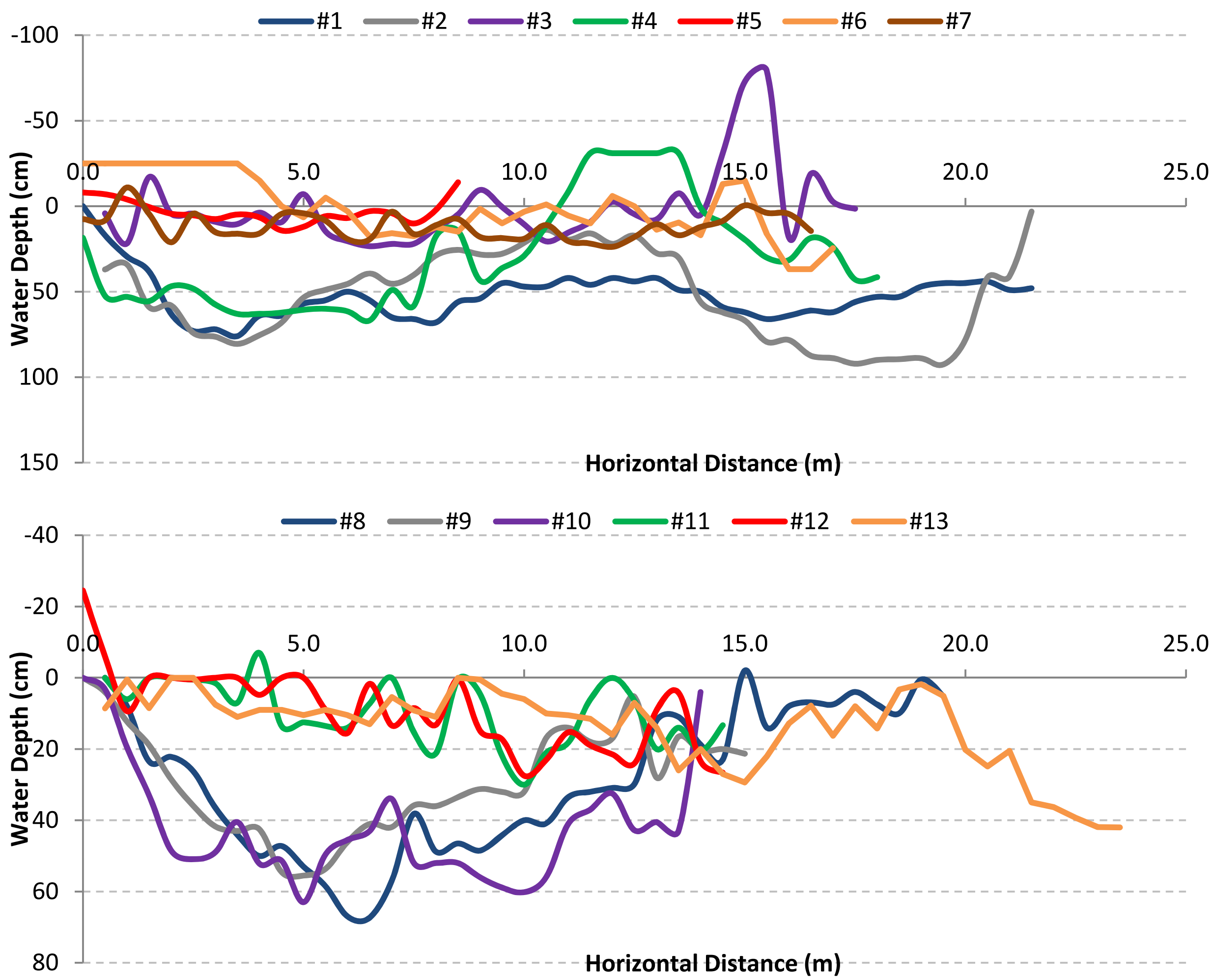

Figure 9. Cross-sectional profile of 13 substrate transects at the mouth of the Current River. See Appendix 2 for raw data and Figure 5 for location of transects.

Table 2. Summary of substrate size and maximum water depth for 13 transects at the mouth of the Current River, September 2011.

Channel	Transect #	Mean Median Axis Length (mm)		Max Water Depth (cm)
		Centre Particle	Largest Particle	
Secondary (W)	1	69	175	76
Secondary (W)	2	119	193	93
Secondary (W)	3	298	475	23
Secondary (W)	4	133	208	67
Middle	5	98	304	14
Middle	6	157	430	37
Middle	7	126	264	24
Middle	8	124	263	67
Middle	9	103	251	56
Main (E)	10	205	377	63
Main (E)	11	157	374	30
Main (E)	12	151	348	28
Main (E)	13	144	357	42

Figure 10. Secondary channel looking east on Sept 9, 20011.

3.3 Current River

Due to low water levels, approximately 56% of the Current River channel below the high water mark (as estimated by vegetation) was exposed bedrock or cobble during the September 2011 survey (Table 3). Only about 20% of the wetted area (10% of the total area) or 4600 m^2 was mapped as turbulent water e.g., rapids, riffles, or steps, typically less than 50 cm in depth. An additional 5300 m^2 was mapped as sheet indicating shallow (<20 cm), non-turbulent laminar flow over bedrock. Under higher water conditions this would likely be mapped as rapids. Under survey conditions, there was approximately 2500 m^2 of run, predominately in water <50 cm deep over cobble substrates; at higher flows, these would likely be turbulent and mapped as rapids. There was also approximately 800 m^2 some deeper runs near the mouth at Lake Superior in the main channel. The mouth of the secondary channel had no visible flow in September due to a gravel and cobble bar at the base of the bedrock sheet, and was largely mapped as a pool. It would likely be a run under higher flow conditions. About half of the channel below Shipyard Road was dry in September, but during higher discharge, water begins to flow along the west bank and through the secondary channel.

Pool habitats represent approximately 7100 m^2 under low flow conditions, approximately half of which are predominately bedrock. A series of eight bedrock pools are located along the east side of the channel in the main flow (Figure 11). The pools are approximately 1.5 to 3 m in diameter and up to 1.5 m in depth. Based on drill holes, they were apparently blasted out, presumably to enhance upstream fish passage towards the fish ladder. A series of 7 or 8 similar-sized pool appears to have been blasted out the slaty bedrock in the 100 m approaching the fish ladder as well. Although pool habitats represent only about 35% of the wetted habitat at low flows, they provide significant fish habitat. In particular, the bedrock pools above the GS encompass approximately about 2000 m^2 or 8% of the total channel area above the GS but contained 477 fish of eight species (Table 4, Figure 20).

Bedrock substrates dominate most of the surveyed reaches, accounting for approximately 34,00 m^2 or 71% of the total channel area. Cobble (approximately 8-25 cm diameter) accounted for a further 28%, with small amounts of boulder (>25 cm diameter), gravel, or concrete comprising the rest. Most of the cobble is within a 150 m stretch bisected by Cumberland Street (Figure 12) or adjacent to the islands at the river mouth on Lake Superior. These cobble, pebble, and gravel substrates can provide suitable spawning habitat for a number of fish species including walleye, white sucker, rainbow trout, and brook trout given suitable flows to provide oxygenation and prevent silt deposition. No sandy or silty substrates were mapped, although they are present in deeper water at the mouth and in small pockets mixed with gravel in the pool of reach #9.

Figure 11. Current River below Shipyard Road, Sept. 9 looking at main (upper photo) and secondary channels (lower photo). Arrow denote band of concrete that cuts across channel.

Table 3. Summary of Current River habitat types between Boulevard Lake dam and mouth at Lake Superior.

Turbulence	Habitat	Substrate	Depth (cm)	Area (m2)	% of total
	Bar	bedrock	0	21,839	45.9
	Bar	cobble	0	4,715	9.9
	Bar	concrete	0	406	0.9
Non-turbulent	Edgewater	bedrock	<50	401	0.8
Non-turbulent	Edgewater	boulder	<50	19	0.0
Non-turbulent	Edgewater	cobble	<50	688	1.4
Non-turbulent	Pool	bedrock	<50	2,502	5.3
Non-turbulent	Pool	bedrock	<100	1,054	2.2
Non-turbulent	Pool	cobble	<50	2,791	5.9
Non-turbulent	Pool	cobble	<100	690	1.5
Non-turbulent	Pool	boulder	<50	38	0.1
Non-turbulent	Pool	concrete	<50	10	0.0
Non-turbulent	Pool	gravel	<50	43	0.1
Non-turbulent	Run	bedrock	<50	307	0.6
Non-turbulent	Run	cobble	<50	1,333	2.8
Non-turbulent	Run	cobble	<100	808	1.7
Non-turbulent	Sheet	bedrock	<20	5,293	11.1
Turbulent	Rapids	bedrock	<50	883	1.9
Turbulent	Riffle	cobble	<50	2,210	4.6
Turbulent	Steps	bedrock	<50	1,521	3.2
			Total	47,550	100.0

Figure 12. Cobble substrates below Cumberland Street, Sept 3, 2011.

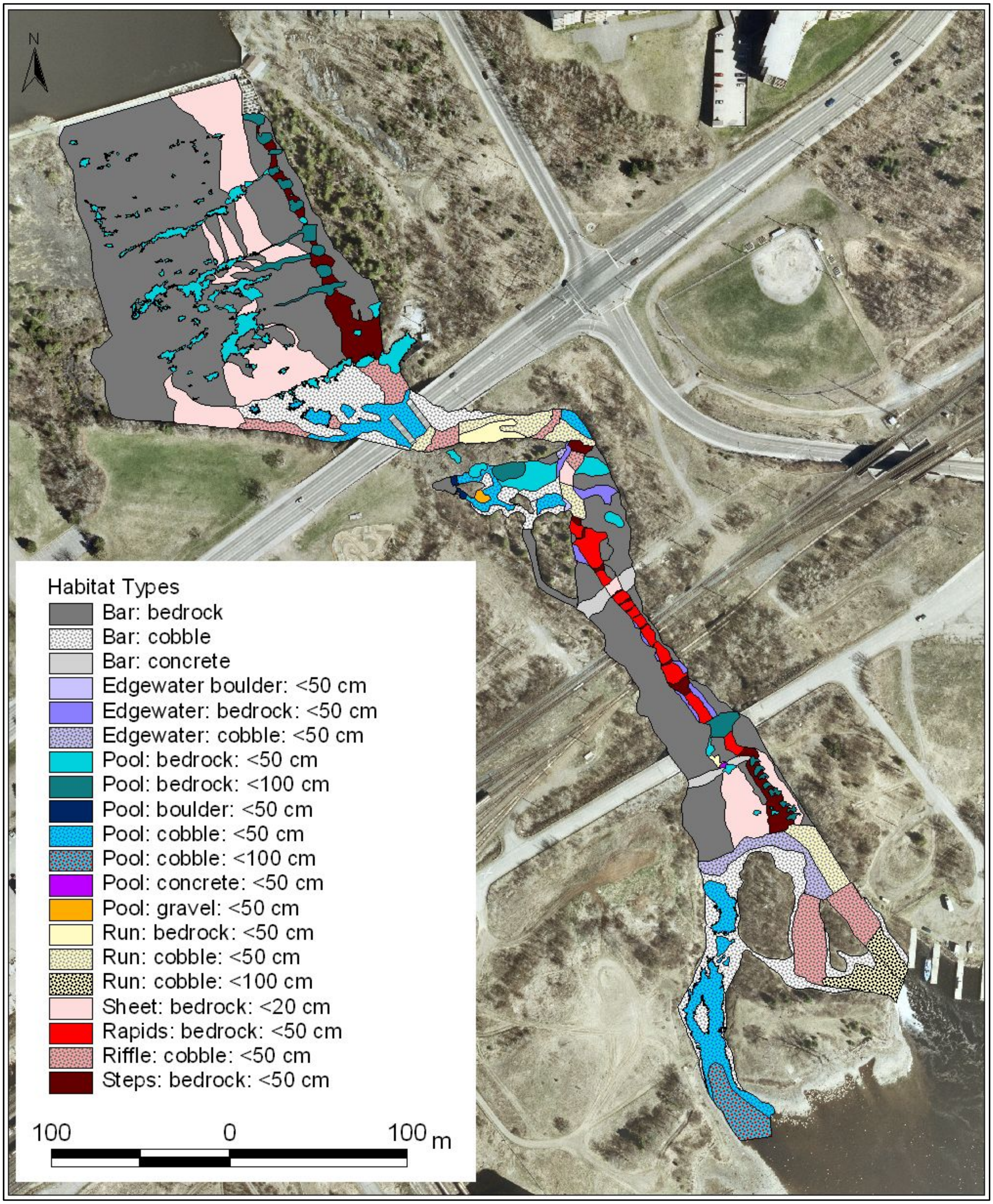

Figure 13. Fish habitat mapping for the Current River between Boulevard Lake and Lake Superior based on Aug-Sept 2011 low flows (note: image was taken during higher flow period).

4 FISH COMMUNITY

A total of 1063 individuals of ten species of fish were sampled by electrofishing on August 31 and September 3 from the Current River below Boulevard Lake dam downstream to the islands at its mouth (Figure 14, Table 4). The fish community was dominated by species typical of lotic (flowing) environments in northwestern Ontario (Holm et al. 2009; Hartviksen and Momot 1987). Additional sampling at other times of the year and at the river mouth would likely yield other fish species; at least 15 species of fish have been recorded from the Current River (Nelson et al. 2007; Hartviksen and Momot 1987). Young of the year (YOY) smallmouth bass were observed in 2011 in shallow water near the islands at the mouth of the Current River but were not sampled during electrofishing.

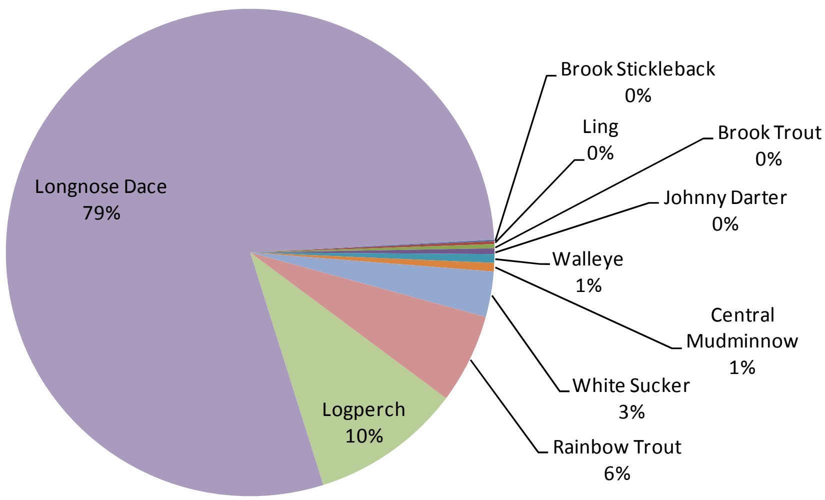

Figure 14. Proportion of fish species sampled in the Current River below Boulevard Lake by 2011 electrofishing (0% represents <1%).

Longnose dace (*Rhinichthys cataractae*) was the most widely distributed and abundant species, accounting for nearly 4/5 of the fish caught. Both adult and YOY longnose dace were present, ranging in size from 37 to 124 mm in total length (TL). Logperch (*Percina caprodes*) were also abundant (n=106), with numerous mature individuals up to 112 mm TL. Surprisingly, six central mudminnows (*Umbra limi*) were caught on the Current River, mainly in a large pool off the main channel (Reach 9); this species is typically associated with still or slow-moving lentic environments.

Rainbow trout (*Oncorhynchus mykiss*) were the most abundant large fish species sampled with 63 individuals sampled, occurring from lowermost pool at the mouth of the Current River to the pool at the base of the fish ladder at the dam. Rainbow trout were caught in both riffle and pool habitats, but were typically caught in fast water at the head of pools. Rainbow trout ranged from 55 to 228 mm FL with a mean of 128 mm ± 42. The majority of fish was 120-160 mm and likely represents two year classes (Figure 15). In comparison, only 3 brook trout (*Salvelinus fontinalis*) were caught: one below Cumberland Street and two in small (2m x 4m) bedrock pools above Cumberland Street. They ranged in size from 72, 200, and 245 mm (FL). These fish may be potentially resident, assuming there is sufficient flow in these reaches to support overwintering.

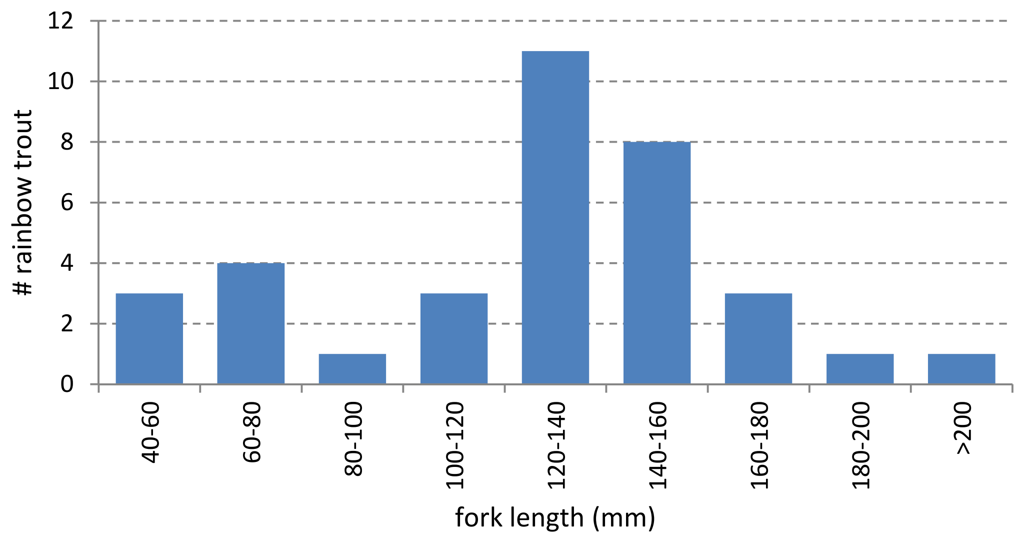

Figure 15. Size distribution of rainbow trout electrofished below Boulevard Lake dam and the mouth of the Current River in 2011.

Figure 16. Rainbow trout electrofished from the large pool at Reach the Current River

Figure 17. Brook trout and small bedrock pool where it was found.

One adult walleye (*Sander vitreus*) and 5 YOY were sampled during 2011 electrofishing. YOY walleye were caught in several bedrock pools above and below Cumberland Street (Figure 18). The adult was approximately 350 mm in size (it escaped measurement) and was found in the large pool at the base of the largest step midway between the dam and Cumberland Street (Figure 19). This pool was approximately 10 m x 30 m with a maximum depth of 1.8 m with a bedrock substrate. A YOY walleye was caught in this pool as well. The ability of walleye to access this reach of river during the spawning period is unknown and may vary from year to year. The adult and all YOY walleye may represent downstream drift from walleye populations in the Current River above Boulevard Lake Dam rather than fish that originated in Lake Superior. A total of 32 YOY white suckers (*Catostomus commersonii*) were also sampled, and ranged in size from 35 to 162 mm TL (mean 75 ± 20 mm). They have generally similar spawning requirements as walleye, and may have originated upstream of Boulevard Lake. The two ling (*Lota lota)* sampled were also in small bedrock pools, and could be downstream migrants (“drop-downs”) or could be resident.

Figure 18. YOY walleye and pool where it was electrofished.

Figure 19. Large pool in Reach 15 where adult walleye was electrofished.

Table 4. Summary of electrofishing catch from the Current River, Sept 2011. See Figure 2 for location of reaches.

Reach	Location	Shocking Duration (sec)	Rainbow Trout (Y0-Y2)	Brook Trout (YOY/Adult)	Ling	White Sucker (YOY)	Logperch	Walleye (YOY & 1 adult)	Central Mudminnow	Johnny Darter	Longnose Dace	Brook Stickleback	All Species
1. Island to Shipyard Road	Bedrock sheet and pools	627	8								2		10
2. Island to Shipyard Road	Riffles and pool under Shipyard Road Bridge	253	1				1				4		6
3. Island to Shipyard Road	Bedrock Side Channel	399	9			2	1				16		28
4. Shipyard Road to Lower CN Bridge	Bedrock riffles and pools	411	3								16		19
5. Lower CN Bridge to Upper CN Bridge	Bedrock riffles and pools	542	8								20		28
6. Upper CN Bridge to Cumberland	Bedrock riffles and pools to concrete	360	7								19		26
7. Upper CN Bridge to Cumberland	Bedrock riffles and pools from concrete to bend	1193	8	1		1	1	1			82	1	95
8. Upper CN Bridge to Cumberland	Bedrock riffle at bend	440					3				36		39
9. Upper CN Bridge to Cumberland	Large mixed substrate pool on S. side of bend	776				1	6		4	4	52		67
10. Upper CN Bridge to Cumberland	Pools and riffles at bend and upstream	1325	4			12	19	1			112		148
11. Under Cumberland Bridge	Pool	695	2			1	9		1		61		74
12. Cumberland Bridge to GS	Riffles	337					1				45		46
13. Cumberland St. to Boulevard Lake Dam	Bedrock pool at base of bedrock sheet	638	2		1	4	10	1			33		51
14. Cumberland St. to Boulevard Lake Dam	side channel	441				1	8		1		76		86
15. Cumberland St. to Boulevard L.Dam	main channel up to biggest ledge	585	2			6	9	2			138		157
16. Cumberland St. to Boulevard Lake Dam	bedrock pools from ledge to fish ladder	844	6				9				67		82
17. Cumberland St. to Boulevard Lake Dam	bedrock pools to south of main channel	1110	3	2	1	4	29	1			61		101
	Total	10,976	63	3	2	32	106	6	6	4	840	1	1,063

Figure 20. Current River between Boulevard Lake dam on October 3, 2011. Arrows denote locations where selected fish species were caught.

5 CONCLUSIONS

The field survey conducted under drought conditions in 2011 indicate that the Current River below Boulevard Lake has more fish habitat values than previously documented, even under low flow conditions. In addition to typical small fish species that might be expected for highly scoured and shallow bedrock habitats, there were also a surprising number and diversity of larger fish species, including sport fish such as rainbow trout, brook trout, and walleye. Downstream movement of YOY and adult walleye from above Boulevard Lake as suggested by this study could potentially contribute to the recovery of stocks in Thunder Bay that have been as in need of rehabilitation by Hoff (2001).

The bedrock pools between the dam and the GS at least temporarily support fish when there is sufficient flow to maintain suitable dissolved oxygen and water temperatures. At the time of sampling, nearly all of this flow was provided by leakage as there was little or no flow over the dam. This unquantified leakage flow appears to be very important in the maintenance of these fish habitat values, and should be considered when setting minimum flow requirements for this bypass reach during water management planning. Elimination of leakage in an effort to increase hydropower generation efficiency without a corresponding increase in flows over the dam could degrade fish habitat.

6 ACKNOWLEDGEMENTS

Julian Holenstein, Brian Ratcliff, and Adam Foster assisted with fieldwork. The City of Thunder Bay loaned 1:2000 digital imagery. OMNR provided detailed elevation data.

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Appendix 1. Habitat Photos along the Current River below Boulevard Lake Dam, September 2011. See Figure 2 for location of reaches.

Reach #1 below Shipyard Road with bedrock pools and steps, Sept. 9.

Reach #2 below Shipyard Road bridge with bedrock pools and steps, Sept. 27.

Reach #3 side channel south (river right) of main channel below Shipyard Road, Sept 9.

Reach #4 between Shipyard Road and first (downstream) railway bridge, Sept 27.

Reach #5 below 2nd railway bridge looking upstream, Sept 27.

Concrete sheet in Reach #6 above 2nd railway bridge looking downstream, Sept 27.

Reach #7 above upstream railway bridge looking upstream, Sept 27.

Reach #8 below Cumberland Street looking downstream, Aug 31.

Reach #9 below Cumberland Street looking east, Sept 27.

Reach #10 below Cumberland Street looking upstream, Sept 27.

Reach #11 at Cumberland Street looking upstream, Sept 27.

Reach #12 above Cumberland Street looking upstream, Sept 27.

Reach #13 above Cumberland Street looking west, Sept 27.

Reach #14 above Cumberland Street looking downstream, Sept 27.

Reach #15 above Cumberland Street looking east, Sept 27.

Reach #16 above Cumberland Street looking upstream, Sept 27.

Reach #17 above Cumberland Street looking east, Sept 27.

Reach #17 above Cumberland Street looking downstream from dam, Sept 9.

Appendix 2. Substrate transect data at the mouth of the Current River, September 2011. See Figure 5 for location of transects.

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
1	0.0	380	380	6-25	0.0			
1	0.5	75	115	76-100	17.0			
1	1.0	36	151	76-100	29.5			
1	1.5	131	225	76-100	38.2			
1	2.0	9	330	76-100	63.0			
1	2.5	13	85	76-100	73.0			
1	3.0	100	105	76-100	72.0			
1	3.5	18	139	76-100	76.0			
1	4.0	57	139	76-100	64.0			
1	4.5	66	153	76-100	64.0	y		
1	5.0	59	185	76-100	57.0			
1	5.5	38	202	76-100	55.0			
1	6.0	52	365	76-100	50.0			
1	6.5	94	161	76-100	55.0	y		
1	7.0	81	192	76-100	65.0	y		
1	7.5	110	120	76-100	66.0			
1	8.0	28	235	76-100	68.0			
1	8.5	66	205	76-100	56.0			
1	9.0	14	335	76-100	54.0			
1	9.5	66	321	76-100	45.0			
1	10.0	125	172	76-100	47.0			
1	10.5	71	235	76-100	47.0			
1	11.0	185	205	76-100	42.0	y		
1	11.5	41	185	76-100	46.0	y		
1	12.0	115	145	76-100	42.0	y		
1	12.5	10	180	76-100	44.0	y		
1	13.0	28	200	76-100	42.0	y		
1	13.5	90	130	76-100	49.0	y		
1	14.0	110	155	76-100	50.0	y		
1	14.5	8	135	76-100	59.0	y		
1	15.0	105	152	76-100	62.0	y		
1	15.5	18	185	76-100	66.0	y		
1	16.0	18	105	76-100	64.0	y		
1	16.5	231	231	76-100	61.0	y		
1	17.0	11	175	76-100	62.0	y		
1	17.5	36	145	76-100	56.0	y		
1	18.0	27	135	76-100	53.0	y		
1	18.5	81	245	76-100	53.0	y		
1	19.0	15	110	76-100	47.0			
1	19.5	10	110	76-100	45.0			CWD / bark
1	20.0	105	105	76-100	45.0			CWD / bark

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
1	20.5	25	25	76-100	44.0	y		CWD / bark
1	21.0	25	25	76-100	49.0	y		CWD / bark
1	21.5	51	51	76-100	48.0	y		CWD / bark
2	0.5	20	150	76-100	37.0	y		
2	1.0	350	350	76-100	34.0			
2	1.5	130	130	76-100	59.0	y		
2	2.0	235	260	76-100	58.0			
2	2.5	33	145	76-100	74.1			
2	3.0	75	75	76-100	76.3	y		
2	3.5	85	123	76-100	80.5			
2	4.0	29	85	76-100	75.4	y		
2	4.5	40	139	76-100	68.1			
2	5.0	18	131	76-100	53.4	y		
2	5.5	98	136	76-100	48.9			
2	6.0	64	135	76-100	45.4			
2	6.5	195	195	76-100	39.3			
2	7.0	94	202	76-100	45.4			
2	7.5	24	202	76-100	40.2	y		
2	8.0	220	220	76-100	28.8			
2	8.5	132	132	76-100	25.5			
2	9.0	45	202	76-100	28.2			
2	9.5	132	132	76-100	27.8			
2	10.0	64	165	76-100	21.4			Rusty Crayfish
2	10.5	195	275	76-100	13.8			
2	11.0	175	275	76-100	19.5			
2	11.5	218	218	76-100	15.9			
2	12.0	249	249	76-100	22.0			
2	12.5	155	249	76-100	17.2			
2	13.0	80	315	76-100	27.5			
2	13.5	89	315	76-100	30.0			
2	14.0	31	112	76-100	56.0	y		
2	14.5	118	118	76-100	62.1			
2	15.0	282	282	76-100	66.8			
2	15.5	175	175	76-100	79.3			
2	16.0	92	232	76-100	78.2			
2	16.5	125	232	76-100	87.4			
2	17.0	75	155	76-100	88.8			
2	17.5	82	140	76-100	92.1			
2	18.0	62	122	76-100	89.9	y		
2	18.5	45	83	76-100	89.4			
2	19.0	42	78	76-100	88.9			
2	19.5	40	68	76-100	92.5			
2	20.0	35	255	76-100	78.1			
2	20.5	244	244	76-100	41.8			
2	21.0	122	475	76-100	41.0			

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
2	21.5	320	320	76-100	3.1			
3	0.5	88	280	6-25	4.2			
3	1.0	280	280	76-100	21.8			
3	1.5	605	605	0-5	-17.0			
3	2.0	162	605	76-100	4.4	y		
3	2.5	10	470	76-100	4.4	y		
3	3.0	27	470	76-100	9.2			
3	3.5	55	118	76-100	10.5			
3	4.0	420	420	76-100	3.8			
3	4.5	420	420	76-100	9.4			
3	5.0	341	341	0-5	-7.0			
3	5.5	105	341	76-100	14.8			
3	6.0	62	154	76-100	20.5			
3	6.5	19	205	76-100	23.4			
3	7.0	104	472	76-100	22.1			
3	7.5	78	146	76-100	22.0			
3	8.0	130	165	76-100	12.9			
3	8.5	295	295	76-100	4.8			
3	9.0	405	405	76-100	-9.5			
3	9.5	145	190	76-100	0.5			
3	10.0	25	128	76-100	10.7			
3	10.5	165	165	76-100	20.6			
3	11.0	730	730	76-100	15.4			
3	11.5	145	730	76-100	9.2			
3	12.0	221	221	76-100	-2.5			
3	12.5	145	212	76-100	4.8			
3	13.0	39	185	6-25	7.8			
3	13.5	135	205	0-5	-7.5			
3	14.0	100	285	6-25	5.0			
3	14.5	1520	1520	0-5	-31.0			
3	15.0	1520	1520	0-5	-73.0			
3	15.5	1520	1520	0-5	-79.0			
3	16.0	51	1520	6-25	18.4			
3	16.5	331	331	0-5	-19.0			
3	17.0	25	434	0-5	-2.5			
3	17.5	18	530	6-25	1.5			
4	0.0	890	890	0-5	18.5			
4	0.5	155	160	76-100	52.4			
4	1.0	65	122	76-100	53.0	y		
4	1.5	82	82	76-100	55.5	y		
4	2.0	15	94	76-100	46.8	y		
4	2.5	22	31	76-100	48.2	y		
4	3.0	10	35	76-100	57.5	y		
4	3.5	20	162	76-100	63.0	y		
4	4.0	11	11	76-100	62.9	y		

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
4	4.5	0	0	76-100	62.3			bare shale
4	5.0	0	0	76-100	60.5			bare shale
4	5.5	0	0	76-100	60.0			bare shale
4	6.0	0	0	76-100	61.5			bare shale
4	6.5	0	0	76-100	66.8			bare shale
4	7.0	45	45	76-100	49.0			
4	7.5	315	470	76-100	58.2			
4	8.0	470	470	76-100	17.6			
4	8.5	470	470	76-100	14.5			
4	9.0	53	302	76-100	43.5			
4	9.5	39	172	76-100	36.2			
4	10.0	36	171	76-100	28.9			
4	10.5	215	215	76-100	11.3			
4	11.0	160	298	0-5	-8.5			
4	11.5	213	298	0-5	-31.0			
4	12.0	30	210	0-5	-31.0			
4	12.5	25	272	0-5	-31.0			
4	13.0	39	150	0-5	-31.0			CWD
4	13.5	185	185	0-5	-31.0			
4	14.0	41	190	6-25	0.9			
4	14.5	94	245	76-100	10.0			
4	15.0	115	215	76-100	19.5			
4	15.5	230	230	76-100	30.1			
4	16.0	282	282	76-100	31.5			
4	16.5	342	341	76-100	18.5			
4	17.0	240	240	76-100	23.9			
4	17.5	10	655	76-100	42.9			
4	18.0	0	0	76-100	41.5			bare shale
5	0.0	61	375	0-5	-8.0	y		
5	0.5	20	200	0-5	-7.0	y		
5	1.0	85	215	0-5	-4.0	y		
5	1.5	113	325	6-25	0.5	y		
5	2.0	135	231	6-25	4.4	y		
5	2.5	90	165	6-25	5.3	y		
5	3.0	162	205	6-25	7.5	y		
5	3.5	58	530	6-25	4.8	y		
5	4.0	39	439	6-25	6.5	y		
5	4.5	70	410	6-25	14.2	y		
5	5.0	55	410	6-25	12.0	y		
5	5.5	24	265	6-25	5.8	y		
5	6.0	205	205	6-25	6.9	y		
5	6.5	20	199	6-25	2.9	y		
5	7.0	124	275	6-25	4.1	y		
5	7.5	79	260	6-25	10.1	y		
5	8.0	360	380	6-25	2.1	y		

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
5	8.5	62	380	0-5	-14.0			
6	0.0	515	515	0-5	-25.0			
6	0.5	44	150	0-5	-25.0			
6	1.0	30	375	0-5	-25.0			
6	1.5	95	375	0-5	-25.0			
6	2.0	31	145	0-5	-25.0			
6	2.5	25	119	0-5	-25.0			
6	3.0	29	265	0-5	-25.0			
6	3.5	20	110	0-5	-25.0	y		
6	4.0	19	280	0-5	-15.0	y		
6	4.5	75	455	0-5	0.0	y		
6	5.0	18	265	6-25	6.5			
6	5.5	295	295	6-25	-5.0			
6	6.0	102	295	6-25	3.0			
6	6.5	48	282	6-25	17.8			
6	7.0	81	340	6-25	15.8			
6	7.5	49	172	6-25	17.5			
6	8.0	82	205	6-25	12.2			
6	8.5	43	190	6-25	14.9	y		
6	9.0	145	490	6-25	1.5			
6	9.5	19	490	6-25	10.0			
6	10.0	95	230	6-25	3.2			
6	10.5	490	490	6-25	-1.0			
6	11.0	180	290	6-25	5.5	y		CWD
6	11.5	89	200	6-25	10.0			
6	12.0	200	295	26-50	-6.0			
6	12.5	80	329	26-50	0.0			
6	13.0	60	340	26-50	13.8			
6	13.5	340	95	26-50	9.5			
6	14.0	40	650	26-50	17.0	y		
6	14.5	650	650	0-5	-13.0			
6	15.0	650	650	0-5	-15.0			
6	15.5	320	390	51-75	16.2			
6	16.0	140	3909	51-75	36.8			
6	16.5	65	390	51-75	36.8			
6	17.0	330	330	51-75	24.5			
7	0.0	72	510	76-100	7.5			
7	0.5	70	720	76-100	8.3			
7	1.0	720	720	76-100	-11.0			
7	1.5	175	180	76-100	4.5			
7	2.0	100	142	76-100	21.1			
7	2.5	145	145	76-100	4.3			
7	3.0	16	190	76-100	15.2	y		
7	3.5	83	162	76-100	16.1			
7	4.0	58	235	76-100	15.9			

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
7	4.5	220	220	76-100	4.5			
7	5.0	155	155	76-100	4.2			
7	5.5	95	215	76-100	8.5			
7	6.0	75	120	76-100	19.3			
7	6.5	62	245	76-100	19.4			
7	7.0	119	245	76-100	3.2			
7	7.5	65	160	76-100	16.3	y		
7	8.0	93	195	76-100	11.1	y		
7	8.5	140	230	76-100	7.5			
7	9.0	122	152	76-100	18.0			
7	9.5	116	150	76-100	18.6	y		
7	10.0	130	130	76-100	19.0			
7	10.5	105	220	76-100	11.0			
7	11.0	36	332	76-100	20.5			
7	11.5	70	332	76-100	21.8	y		
7	12.0	85	285	76-100	23.8	y		
7	12.5	390	390	76-100	18.0	y		
7	13.0	150	390	76-100	10.5	y		
7	13.5	58	320	76-100	17.0	y		
7	14.0	235	315	76-100	12.1			
7	14.5	58	260	76-100	8.6			
7	15.0	138	202	0-5	-0.5			
7	15.5	11	230	76-100	3.9	y		
7	16.0	64	230	76-100	4.5	y		
7	16.5	38	250	76-100	14.5			
8	0.5	118	280	76-100	0.0			
8	1.0	260	280	76-100	8.0			
8	1.5	110	170	76-100	23.5			
8	2.0	65	122	76-100	22.2			
8	2.5	331	331	76-100	26.2			
8	3.0	65	220	76-100	36.5			
8	3.5	200	310	76-100	44.0			
8	4.0	105	240	76-100	50.0			
8	4.5	290	290	76-100	47.2			
8	5.0	92	360	76-100	53.0			
8	5.5	170	400	76-100	58.5			
8	6.0	82	348	76-100	67.0			
8	6.5	40	122	76-100	67.3	y		
8	7.0	22	210	76-100	57.0			
8	7.5	390	390	76-100	38.2			
8	8.0	86	510	76-100	48.8			
8	8.5	135	510	76-100	46.5			
8	9.0	50	220	76-100	48.5			
8	9.5	115	253	76-100	44.2			
8	10.0	225	225	76-100	40.0			

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
8	10.5	26	245	76-100	40.9			
8	11.0	225	225	76-100	33.5			
8	11.5	102	172	76-100	32.0			
8	12.0	135	212	76-100	30.9			
8	12.5	12	235	76-100	29.8	y		
8	13.0	163	213	76-100	12.0			
8	13.5	96	150	76-100	11.0			
8	14.0	51	205	76-100	18.8			
8	14.5	55	230	76-100	23.0			
8	15.0	270	270	76-100	-2.0			
8	15.5	85	250	76-100	14.0			
8	16.0	36	230	76-100	8.0			
8	16.5	60	155	76-100	6.9			algae
8	17.0	100	162	76-100	7.5			
8	17.5	85	243	76-100	4.0			
8	18.0	90	213	76-100	7.5			
8	18.5	102	210	76-100	10.0			
8	19.0	98	425	76-100	0.5			
8	19.5	91	425	76-100	5.2			
9	0.0	42	140	0-5	0.0			
9	0.5	20	65	76-100	4.0	y		
9	1.0	54	98	76-100	12.3	y		
9	1.5	30	66	76-100	18.9	y		
9	2.0	35	110	76-100	28.5	y		
9	2.5	21	50	76-100	35.9	y		
9	3.0	20	25	76-100	41.7	y		CWD
9	3.5	9	31	76-100	43.0	y		CWD
9	4.0	15	29	76-100	42.5	y		
9	4.5	15	41	76-100	54.5	y		
9	5.0	22	22	76-100	55.5	y		
9	5.5	15	145	76-100	53.6	y		
9	6.0	18	50	76-100	46.0	y		
9	6.5	36	233	76-100	41.0	y		
9	7.0	15	100	76-100	41.9	y		
9	7.5	78	155	76-100	35.8	y		
9	8.0	53	115	76-100	36.0	y		
9	8.5	29	85	76-100	33.5	y		
9	9.0	113	330	76-100	31.2			
9	9.5	31	353	76-100	32.0			
9	10.0	110	580	76-100	32.0			
9	10.5	580	580	76-100	16.9			
9	11.0	75	580	76-100	14.0			
9	11.5	72	385	76-100	18.0			
9	12.0	99	385	76-100	17.0			
9	12.5	390	390	76-100	5.3			

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
9	13.0	183	390	76-100	28.0			
9	13.5	193	421	76-100	16.5			
9	14.0	421	421	76-100	20.5			
9	14.5	221	421	76-100	20.0			Rusty Crayfish
9	15.0	165	1000	76-100	21.3			
10	0.0	174	255	0-5	0.0			
10	0.5	185	210	26-50	3.2		y	
10	1.0	142	560	26-50	19.6		y	
10	1.5	255	560	26-50	33.0		y	
10	2.0	55	570	26-50	48.5		y	
10	2.5	42	320	26-50	50.9		y	
10	3.0	490	490	26-50	49.0		y	
10	3.5	490	490	26-50	40.5		y	
10	4.0	70	350	26-50	52.2		y	
10	4.5	115	390	26-50	51.3		y	
10	5.0	160	280	26-50	63.0		y	
10	5.5	165	420	26-50	49.5		y	
10	6.0	73	333	26-50	45.5		y	
10	6.5	210	230	26-50	43.0		y	
10	7.0	220	220	26-50	34.0		y	
10	7.5	110	290	26-50	52.0		y	
10	8.0	85	400	26-50	52.0		y	
10	8.5	192	312	26-50	52.0		y	
10	9.0	83	312	26-50	56.0		y	
10	9.5	384	384	26-50	58.9		y	
10	10.0	95	384	26-50	60.2		y	
10	10.5	55	300	26-50	56.0		y	
10	11.0	145	510	26-50	41.0		y	
10	11.5	510	510	26-50	37.0		y	
10	12.0	392	392	26-50	32.5		y	
10	12.5	10	392	26-50	42.8		y	
10	13.0	322	355	26-50	40.5		y	
10	13.5	272	272	26-50	43.0		y	
10	14.0	430	430	26-50	4.0		y	
11	0.5	105	295	0-5	0.0			
11	1.0	85	295	0-5	6.0			
11	1.5	115	830	0-5	0.0			
11	2.0	830	830	0-5	0.0			
11	2.5	20	830	0-5	0.5			
11	3.0	33	450	6-25	1.5		y	
11	3.5	160	340	6-25	7.0		y	
11	4.0	240	240	6-25	-7.0			
11	4.5	45	240	26-50	13.5		y	
11	5.0	21	230	26-50	12.5		y	
11	5.5	235	235	26-50	13.5		y	

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
11	6.0	15	235	26-50	14.0		y	
11	6.5	51	440	26-50	7.2		y	
11	7.0	440	440	0-5	0.0			
11	7.5	50	440	26-50	15.3		y	
11	8.0	25	173	26-50	21.2		y	
11	8.5	332	332	26-50	0.5		y	
11	9.0	320	332	26-50	4.5		y	
11	9.5	120	320	26-50	22.0		y	
11	10.0	93	310	26-50	30.0		y	
11	10.5	90	222	26-50	21.0		y	
11	11.0	102	220	26-50	18.2		y	
11	11.5	220	220	26-50	6.0		y	
11	12.0	263	438	26-50	0.0	y		
11	12.5	36	330	26-50	6.5		y	
11	13.0	50	330	26-50	20.0		y	
11	13.5	92	240	26-50	14.0		y	
11	14.0	135	195	26-50	20.5		y	
11	14.5	234	820	26-50	13.3		y	
12	0.0	28	370	0-5	-24.5			
12	0.5	380	380	0-5	-6.0			
12	1.0	70	220	6-25	9.4			
12	1.5	199	199	0-5	0.0			
12	2.0	130	310	0-5	0.0			
12	2.5	39	210	0-5	0.5	y		
12	3.0	82	220	0-5	0.0	y		
12	3.5	333	333	0-5	0.0			
12	4.0	40	610	6-25	4.8			
12	4.5	91	610	0-5	0.0			
12	5.0	200	200	0-5	0.0			
12	5.5	110	250	26-50	9.1			Rusty Crayfish
12	6.0	25	235	26-50	15.5		y	
12	6.5	235	235	26-50	1.7		y	
12	7.0	12	250	26-50	13.4		y	
12	7.5	287	287	26-50	8.5		y	
12	8.0	25	453	26-50	13.2		y	
12	8.5	285	320	26-50	0.5		y	
12	9.0	35	295	26-50	14.9		y	
12	9.5	90	550	26-50	17.3		y	
12	10.0	220	550	26-50	27.5		y	
12	10.5	145	270	26-50	23.0		y	
12	11.0	221	270	26-50	15.3		y	
12	11.5	272	362	26-50	19.0		y	
12	12.0	20	530	26-50	21.5		y	
12	12.5	155	305	26-50	24.0			
12	13.0	112	462	26-50	9.1			

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
12	13.5	462	462	26-50	4.2			
12	14.0	185	340	26-50	23.5			
12	14.5	42	340	26-50	26.6			
13	0.5	15	145	6-25	8.6	y		
13	1.0	11	499	6-25	0.5	y		
13	1.5	45	499	6-25	8.5	y		
13	2.0	170	270	6-25	0.0	y		
13	2.5	230	320	6-25	0.0	y	y	
13	3.0	160	320	6-25	7.5	y	y	
13	3.5	360	360	26-50	11.0	y	y	
13	4.0	210	420	26-50	9.0	y	y	
13	4.5	95	195	26-50	9.0	y	y	
13	5.0	45	300	26-50	10.5	y	y	
13	5.5	215	300	26-50	9.0	y	y	
13	6.0	15	290	26-50	10.5	y	y	
13	6.5	290	290	26-50	13.0	y	y	
13	7.0	90	183	26-50	5.4	y	y	
13	7.5	54	570	26-50	9.2	y	y	
13	8.0	62	570	26-50	11.0	y	y	
13	8.5	420	1000	26-50	0.0	y		
13	9.0	39	1000	0-5	0.5	y		
13	9.5	5	1000	6-25	4.5	y		
13	10.0	50	220	26-50	6.0	y		
13	10.5	65	115	26-50	10.0	y	y	
13	11.0	93	230	26-50	10.5	y	y	
13	11.5	20	230	26-50	11.5	y	y	
13	12.0	25	210	26-50	16.0	y	y	
13	12.5	19	220	26-50	7.0	y	y	
13	13.0	85	310	26-50	14.0	y	y	
13	13.5	70	390	26-50	26.0	y	y	
13	14.0	162	390	26-50	20.0	y	y	
13	14.5	53	152	26-50	27.0		y	
13	15.0	230	230	26-50	29.4		y	
13	15.5	162	340	26-50	22.1		y	
13	16.0	340	340	26-50	12.8		y	
13	16.5	320	320	26-50	7.8		y	
13	17.0	190	293	26-50	16.3		y	
13	17.5	230	230	26-50	8.0		y	
13	18.0	272	272	26-50	14.2		y	
13	18.5	330	373	26-50	3.3		y	
13	19.0	283	372	26-50	1.8		y	
13	19.5	232	232	26-50	5.1		y	
13	20.0	30	530	26-50	20.2		y	
13	20.5	31	270	26-50	24.9		y	
13	21.0	210	210	26-50	20.5		y	

Transect #	Distance (m)	Median Diameter (mm)		Silt (%)	Water Depth (cm)	Gravel	Visible Flow	Notes
		Point	Largest					
13	21.5			26-50	35.0		y	bare shale
13	22.0			26-50	36.3		y	
13	22.5			26-50	39.3		y	
13	23.0			26-50	41.9		y	
13	23.5			26-50	42.0		y	