PHASE 2 Technical Memorandum for Red and Assiniboine Ammonia Criteria Study

From: M. Lawrence
Task Leader, Fish Behavior Workstream

To: City of Winnipeg Project Management Committee
Study Team Members

Subject: **Fish Behavior Technical Memorandum # FB 02**

Title: **BIOLOGICAL AND ENVIRONMENTAL DATA FROM EXPERIMENTAL NETTING IN THE VICINITY OF THE NEWPCC OUTFALL, OCTOBER, 1999**

Prepared by: M. Lawrence and C.C. Barth

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1.0 INTRODUCTION

The North End Water Pollution Control Centre (NEWPCC) outfall is located approximately 100 m upstream of the Kildonan Settlers Bridge, on the Red River. As part of the fish behavior workstream of the City of Winnipeg ammonia criteria study, hoopnetting was conducted during fall, 1999, in the vicinity of the NEWPCC outfall to determine the abundance and diversity of fish species utilizing the outfall area.

2.0 METHODS

Hoopnetting was conducted at four sites in the vicinity of the NEWPCC outfall between 04 and 08 October (Figure 1). Hoopnetting sites #1, #2, and #3 were located approximately 85m, 150m and 350m downstream of the NEWPCC, respectively. The fourth, site #4, was located approximately 400m upstream of the NEWPCC outfall, and was used as a control site.

Each hoopnet was set approximately 25 m from the right bank (looking upstream), oriented to catch fish moving upstream, and checked daily. Once fish were removed from the hoopnet, the net was set back into the river in the same area. Each hoopnet was 1.2 m in diameter, constructed of 6.45 cm^2 nylon mesh, and had 10 m long wings.

2.1 WATER SAMPLING

Water sampling was conducted at all four hoopnet sites prior to each net set. Water depth was measured with a weighted graduated rope (±1 cm). Water temperature, pH, and dissolved oxygen were measured at 0.5 meter depth intervals with a multi-parameter meter (Horiba). A 1.5 L Kemmerer water sampler was used to collect water from the surface and bottom for measurement of total ammonia. Total ammonia (mg/L) was determined by using a Palintest photometer. Unionized ammonia (mg/L) was calculated using the following equation:

$$NH_3 \text{ (mg } NH_3\text{/L)} = \text{total ammonia (mg/L)}/10^{(0.09018+(2729.92/273.16+\text{temperature (°C)})-pH)} + 1)$$

A fifth water sampling site, was located immediately downstream of the NEWPCC outfall (Figure 1), and was sampled concurrent with the sampling conducted at the hoopnet sites.

At this site, pH, water temperature, dissolved oxygen and total ammonia were measured only at the surface.

2.2 FISH DISTRIBUTION AND ABUNDANCE

All fish captured were enumerated by species, measured for fork length (±1 mm), and round weight (± 25 g), and examined for the presence of deformities, erosion, lesions, and/or tumours (DELTS).

Aging structures were collected from freshwater drum (*Aplodinotus grunniens*), walleye (*Stizostedion vitreum*), white sucker (*Catostomus commersoni*) and northern pike (*Esox lucius*). Dorsal spines were collected from freshwater drum and walleye; left pectoral rays were collected from white sucker and northern pike.

3.0 RESULTS

3.1 WATER SAMPLING

A summary of the measurements taken during hoopnetting in the vicinity of the NEWPCC outfall is presented in Appendix 1. Total ammonia concentrations were highest at sites immediately downstream of the NEWPCC outfall, with values ranging from 0.68 mg/L to 9.6 mg/L. In comparison, total ammonia concentrations were lowest at the control site (hoopnet site #4) with values ranging from 0.01 mg/L to 0.11 mg/L. In general, total ammonia concentrations declined with increasing distance downstream from the NEWPCC outfall.

Similarly, water temperatures decreased with increasing distance downstream from the NEWPCC outfall. Water temperatures were consistently highest (range of 9.8°C to 11°C) immediately downstream of the outfall site. Observed water temperatures at hoopnet sites #1 and #2, located approximately 85 and 150m downstream of the NEWPCC outfall, respectively, showed higher temperatures than those observed at the control site (hoopnet site #4). Water temperatures observed at hoopnet site #3 (located approximately 350m downstream of the NEWPCC outfall) were similar to those observed at the control site (range of 8.4°C to 9.0°C).

Conversely, pH was elevated with increasing distance from the NEWPCC outfall. However, levels recorded at all hoopnet sites downstream of the NEWPCC outfall, were consistently below levels recorded at the control site.

3.2 FISH ABUNDANCE

Common and scientific names for all fish species captured in the vicinity of the NEWPCC outfall are provided in Table 1. A total of 458 fish, comprising 15 fish species, were captured; 73 from site #1, 39 from site #2, 24 from site #3, and 322 from site #4 (Table 2). Channel catfish were the most abundant species captured (n=253), followed by sauger (n=93), quillback (n=52), and white sucker (n=28). The largest catch occurred at site #4 (the control site) on 05 October, when 213 channel catfish, 7 sauger, and 3 white sucker were captured in one net set.

Relative abundance of each fish speices by hoopnet site is summarized in Figures 2 to 5. The fish species which comprised the majority of the catch differed between each hoopnet location. Quillback was the most abundant fish species caught at site #1 (53%), sauger (41%) at site #2, white sucker (41%) at site #3, and channel catfish (74%) at site #4. Notably, channel catfish were absent from hoopnet catches at sites #2 and #3 and quillback were absent from catches at the control site. Relative abundance of each fish species for the total hoopnet catch is summarized in Figure 6.

A total of 136 fish were captured downstream of the NEWPCC outfall. Quillback were the most abundant species captured below the outfall (38% of the total catch) followed by sauger (18%), and white sucker (15%) (Figure 7).

Catch-per-unit-effort (CPUE) (# of fish/hoopnet/hour) was calculated for each daily hoopnet set (Table 3) and summarized by hoopnet location (Table 4). Catch-per-unit-effort was highest at site #4 (3.46) and decreased with increasing distance downstream from the NEWPCC outfall (CPUE values of 1.06, 0.42, and 0.26 at sites #1, #2, and #3, respectively).

TABLES, FIGURES AND APPENDICES

Table 1. A list of fish species captured during hoopnetting in the vicinity of the NEWPCC outfall, October, 1999.

Common Name	Scientific Name	Abbreviation
Black crappie	*Pomoxis nigromaculatus*	BLCR
Burbot	*Lota lota*	BURB
Carp	*Cyprinus carpio*	CARP
Channel catfish	*Ictalurus punctatus*	CHCT
Freshwater drum	*Aplodinotus grunniens*	FRDR
Golden redhorse	*Moxostoma erythrurum*	GLDR
Northern pike	*Esox lucius*	NRPK
Quillback	*Carpoides cyprinus*	QUIL
Rock bass	*Ambloplites rupestris*	RCBS
Sauger	*Stizostedion canadense*	SAUG
Shorthead redhorse	*Moxostoma macrolepidotum*	SHRD
Silver redhorse	*Moxostoma anisurum*	SLRD
Stonecat	*Noturus flavus*	STON
Walleye	*Stizostedion vitreum*	WALL
White sucker	*Catostomus commersoni*	WHSC

Table 2. Number of fish captured by site in the vicinity of the NEWPCC on the Red River, October, 1999.

Species	Site #1	Site #2	Site #3	Site #4	TOTAL
BLCR	1				**1**
BURB				4	**4**
CARP	1	2	1	1	**5**
CHCT	15			238	**253**
FRDR	3	2	3	2	**10**
GLRD	1		1		**2**
NRPK		1			**1**
QUIL	39	11	2		**52**
RCBS		1			**1**
SAUG	6	16	3	68	**93**
SHRD	1	1	2		**4**
SLRD	1		1		**2**
STON				1	**1**
WALL			1		**1**
WHSC	5	5	10	8	**28**
TOTAL	**73**	**39**	**24**	**322**	**458**

Table 3. Summary of hoopnet set information at sites in the vicinity of the NEWPCC outfall, October, 1999.

Site #	Date Set	Time Set	Date Pull	Time Pull	Set Duration (hours)	Total Catch	CPUE fish/hour	Comments
1	4-Oct	11:49	5-Oct	13:11	25.36	0	n/a	Net tampered with
2	4-Oct	12:18	5-Oct	12:36	24.30	19	0.78	
3	4-Oct	12:38	5-Oct	12:25	23.78	1	0.04	
4	4-Oct	11:30	5-Oct	13:20	25.83	223	8.63	
1	5-Oct	13:16	6-Oct	12:38	23.36	43	1.84	
2	5-Oct	13:08	6-Oct	12:17	23.15	12	0.52	
3	5-Oct	13:07	6-Oct	11:50	22.72	6	0.26	
4	5-Oct	14:40	6-Oct	13:15	21.58	38	1.76	
1	6-Oct	13:10	7-Oct	09:45	20.58	16	0.78	
2	6-Oct	12:35	7-Oct	10:08	21.55	3	0.14	
3	6-Oct	12:10	7-Oct	10:25	22.25	16	0.72	
4	6-Oct	13:40	7-Oct	10:49	21.15	9	0.43	
1	7-Oct	10:05	8-Oct	11:05	25.00	14	0.56	
2	7-Oct	10:20	8-Oct	10:52	24.53	5	0.20	
3	7-Oct	10:45	8-Oct	10:39	23.90	1	0.04	
4	7-Oct	11:02	8-Oct	11:27	24.42	52	2.13	

n/a - not available

Table 4. Cumulative catch-per-unit-effort (CPUE) for each site in the vicinity of the NEWPCC outfall, October, 1999.

Site #	Total Hours	Total Catch	Total CPUE
1	68.94	73	1.06
2	93.53	39	0.42
3	92.65	24	0.26
4	92.98	322	3.46

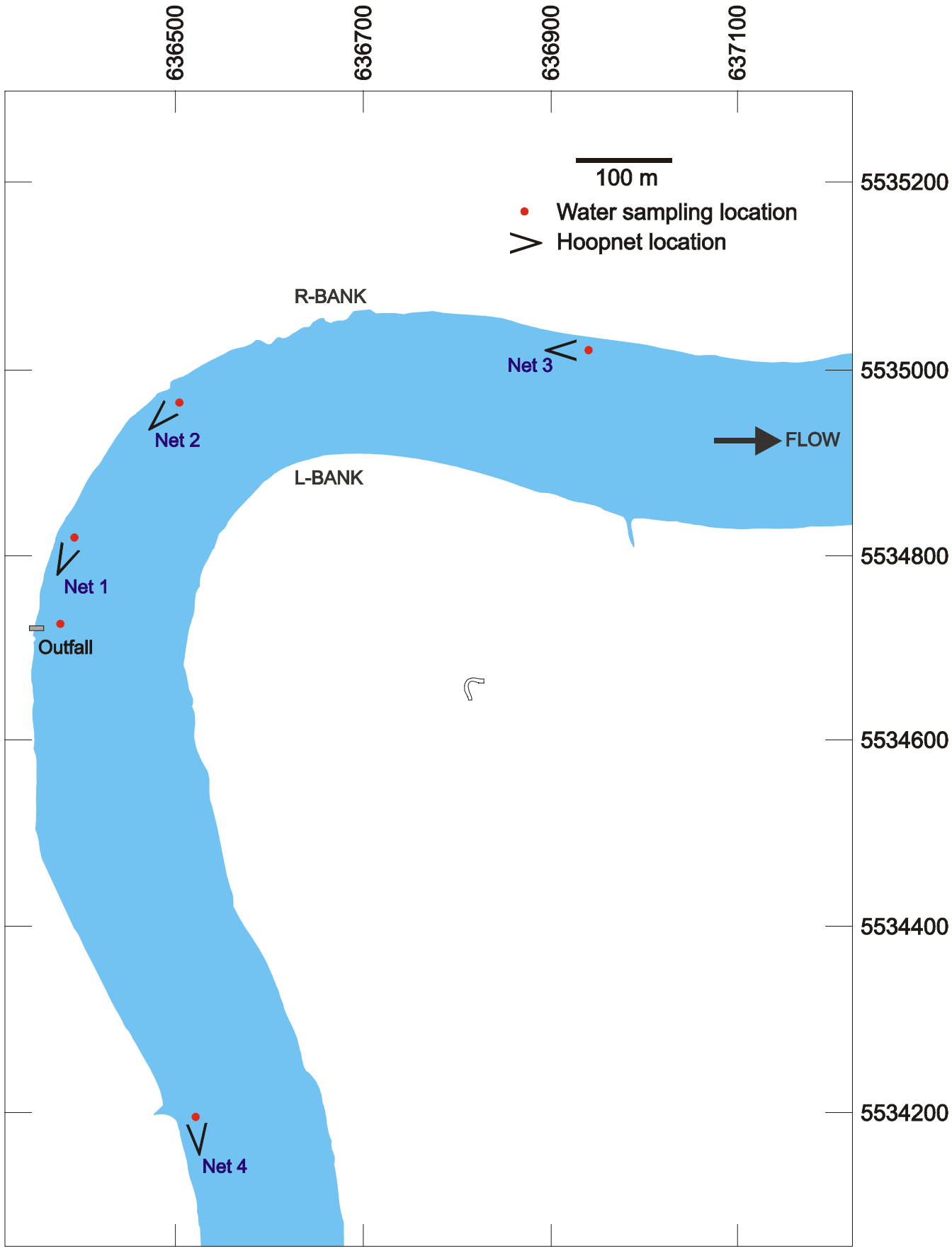

Figure 1. Hoopnet and water sampling locations immediately upstream and downstream of the NEWPCC outfall, October, 1999 (grid in UTMs).

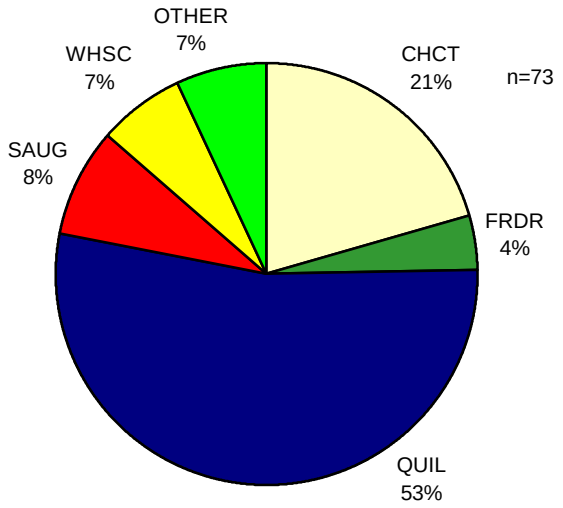

Figure 2. Relative abundance of fish species captured at hoopnet site #1 on the Red River, October, 1999.

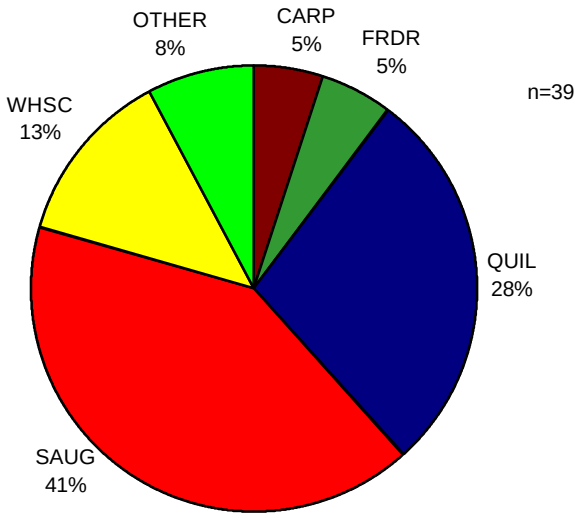

Figure 3. Relative abundance of fish species captured at hoopnet site #2 on the Red River, October, 1999.

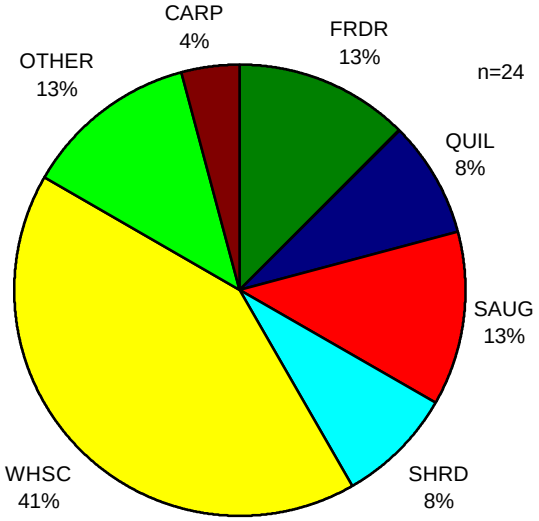

Figure 4. Relative abundance of fish species captured at hoopnet site #3 on the Red River, October, 1999.

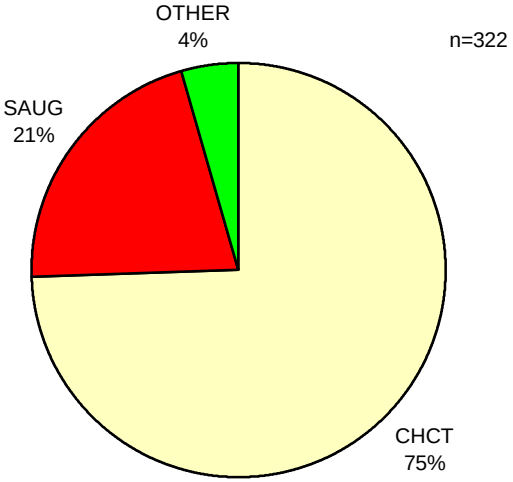

Figure 5. Relative abundance of fish species caught at hoopnet site #4 on the Red River, October, 1999.

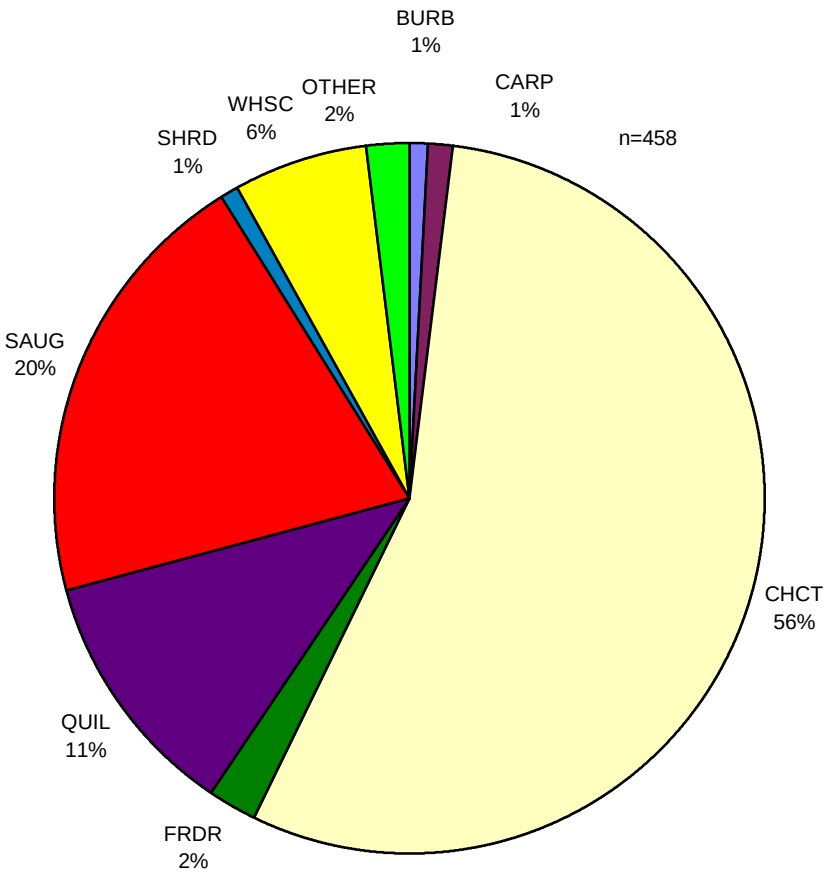

Figure 6. Relative abundance of fish species captured during the fall hoopnetting program in the vicinity of the NEWPCC, October, 1999 .

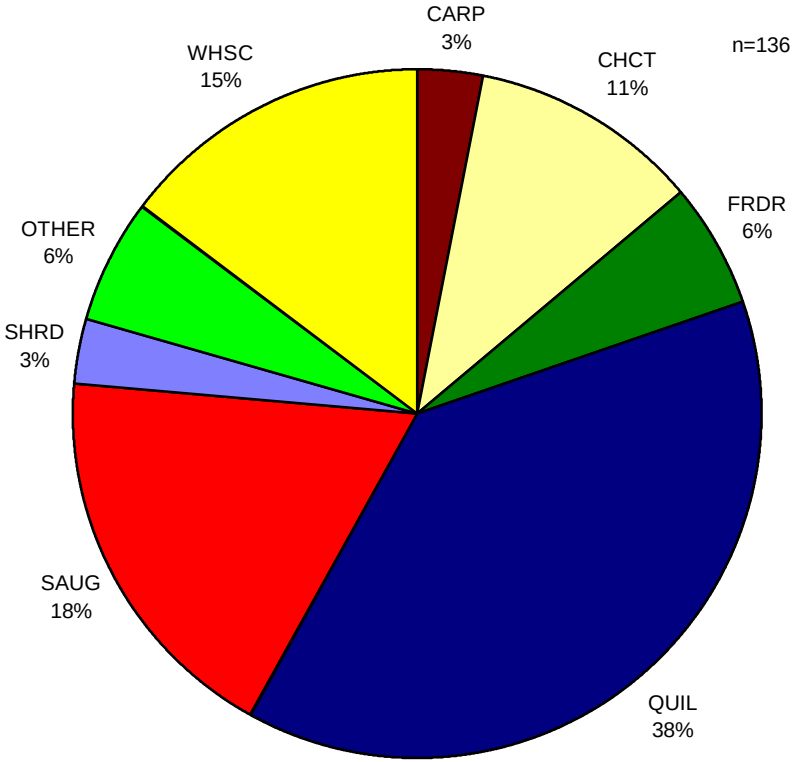

Figure 7. Relative abundance of fish species captured at sites downstream of the NEWPCC on the Red River, October, 1999 .

Appendix 1. Summary of physical and chemical measurements taken in the vicinity of the NEWPCC, October, 1999.

Site #	Date	Sample Time	Sample Depth (m)	Water Temperature (^{o}C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia (mg/L)	Unionized Ammonia[1] (mg/L)
1	4-Oct-99	13:20	Surface	9.50			0.74	n/a
1	4-Oct-99		0.50	9.50				
1	4-Oct-99		1.00	9.50				
1	4-Oct-99		1.50	9.50				
1	4-Oct-99	13:18	Bottom				0.59	n/a
2	4-Oct-99	13:06	Surface	9.50			0.45	n/a
2	4-Oct-99		0.50	9.50				
2	4-Oct-99		1.00	9.50				
2	4-Oct-99		1.50	9.50				
2	4-Oct-99	13:05	Bottom				0.57	n/a
3	4-Oct-99	12:57	Surface	9.20			0.63	n/a
3	4-Oct-99		0.50	9.20				
3	4-Oct-99		1.00	9.40				
3	4-Oct-99		1.50	9.30				
3	4-Oct-99		2.00	9.30				
3	4-Oct-99		2.50	9.30				
3	4-Oct-99	12:53	Bottom				0.55	n/a
4	4-Oct-99	13:36	Surface	8.80			0.04	n/a
4	4-Oct-99		0.50	8.80				
4	4-Oct-99		1.00	8.80				
4	4-Oct-99		1.50	8.80				
4	4-Oct-99		2.00	8.80				
4	4-Oct-99		2.50	8.80				
4	4-Oct-99		3.00	8.80				
4	4-Oct-99		3.50	8.80				
4	4-Oct-99	13:32	Bottom				0.03	n/a
Outfall	4-Oct-99	13:26	Surface	11.00			0.68	n/a
1	5-Oct-99	11:45	Surface	9.10		7.59	1.80	n/a
1	5-Oct-99		0.50	9.10		7.71		
1	5-Oct-99		1.00	9.10		7.78		
1	5-Oct-99		1.50	9.10		7.88		
1	5-Oct-99	11:40	Bottom				0.56	n/a
2	5-Oct-99	12:01	Surface	9.10		8.55	1.70	n/a
2	5-Oct-99		0.50	9.10		8.67		
2	5-Oct-99		1.00	9.10		8.71		
2	5-Oct-99	11:58	Bottom				1.30	n/a
3	5-Oct-99	12:13	Surface	8.80		8.65	0.88	n/a
3	5-Oct-99		0.50	8.70		8.72		
3	5-Oct-99		1.00	8.70		8.84		
3	5-Oct-99		1.50	8.70		8.95		
3	5-Oct-99		2.00	8.80		9.21		
3	5-Oct-99		2.50	8.80		9.36		
3	5-Oct-99	12:09	Bottom				0.62	n/a
4	5-Oct-99	11:28	Surface	9.00		7.72	0.05	n/a
4	5-Oct-99		0.50	8.90		7.70		
4	5-Oct-99		1.00	8.80		7.69		
4	5-Oct-99		1.50	8.80		8.03		
4	5-Oct-99		2.00	8.70		7.99		
4	5-Oct-99	11:24	Bottom				0.11	n/a
Outfall	5-Oct-99	11:51	Surface	9.80		8.17	4.50	n/a

Appendix 1. (continued)

Site #	Date	Sample Time	Sample Depth (m)	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia (mg/L)	Unionized Ammonia[1] (mg/L)
1	6-Oct-99	11:25	Surface	9.10	7.76	7.68	2.00	0.0197
1	6-Oct-99		0.50	9.10	7.77	7.72		
1	6-Oct-99		1.00	9.00	7.78	7.73		
1	6-Oct-99		1.50	9.00	7.78	7.82		
1	6-Oct-99		2.00	9.10	7.79	8.07		
1	6-Oct-99	11:20	2.50	9.00	7.77	8.13	2.70	0.0270
2	6-Oct-99	11:35	Surface	9.10	7.83	7.81	2.80	0.0324
2	6-Oct-99		0.50	9.10	7.84	7.83		
2	6-Oct-99		1.00	9.10	7.76	7.92		
2	6-Oct-99	11:30	1.50	9.10	7.76	8.02	2.80	0.0276
3	6-Oct-99	11:45	Surface	9.00	7.95	7.87	0.90	0.0136
3	6-Oct-99		0.50	8.80	7.99	7.86		
3	6-Oct-99		1.00	8.80	8	7.93		
3	6-Oct-99		1.50	8.90	7.96	8.11		
3	6-Oct-99		2.00	8.90	7.93	8.12		
3	6-Oct-99	11:40	2.50	8.90	7.94	8.28	2.20	0.0322
4	6-Oct-99	11:05	Surface	8.70	8.35	7.61	0.02	0.0007
4	6-Oct-99		0.50	8.60	8.34	7.50		
4	6-Oct-99		1.00	8.60	8.32	7.65		
4	6-Oct-99		1.50	8.60	8.31	7.78		
4	6-Oct-99		2.00	8.50	8.29	7.93		
4	6-Oct-99		2.50	8.50	8.26	8.17		
4	6-Oct-99		3.00	8.50	8.24	8.37		
4	6-Oct-99	11:00	3.50	8.50	8.21	8.67	0.01	0.0003
Outfall	6-Oct-99	11:13	Surface	10.00	6.97	7.30	6.30	0.0109
1	7-Oct-99	9:00	Surface	9.20	7.8	7.41	3.40	0.0370
1	7-Oct-99		0.50	9.10	7.74	7.27		
1	7-Oct-99		1.00	9.10	7.81	7.46		
1	7-Oct-99		1.50	9.10	7.78	7.55		
1	7-Oct-99		2.00	8.90	7.82	7.64		
1	7-Oct-99		2.50	8.90	7.84	7.83		
1	7-Oct-99		3.00	8.90	7.83	8.12		
1	7-Oct-99	8:58	3.50	8.90	7.83	8.34	3.40	0.0387
2	7-Oct-99	9:20	Surface	8.80	8	7.76	4.50	0.0748
2	7-Oct-99		0.50	8.80	7.92	7.65		
2	7-Oct-99		1.00	8.80	7.87	7.66		
2	7-Oct-99	9:17	1.50	8.80	7.88	7.73	2.50	0.0316
3	7-Oct-99	9:30	Surface	8.30	8.32	7.85	0.32	0.0105
3	7-Oct-99		0.50	8.30	8.28	7.71		
3	7-Oct-99		1.00	8.40	8.28	7.74		
3	7-Oct-99		1.50	8.40	8.24	7.79		
3	7-Oct-99		2.00	8.40	8.24	7.91		
3	7-Oct-99	9:25	2.50	8.40	8.21	8.17	0.82	0.0212
4	7-Oct-99	8:42	Surface	8.60	8.47	7.20	0.04	0.0019
4	7-Oct-99		0.50	8.60	8.47	7.35		

Appendix 1. (continued)

Site #	Date	Sample Time	Sample Depth (m)	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia (mg/L)	Unionized Ammonia[1] (mg/L)
4	7-Oct-99		1.00	8.60	8.44	7.42		
4	7-Oct-99		1.50	8.50	8.41	7.48		
4	7-Oct-99		2.00	8.50	8.38	7.41		
4	7-Oct-99		2.50	8.50	8.35	7.63		
4	7-Oct-99		3.00	8.40	8.36	7.93		
4	7-Oct-99	8:40	3.50	8.40	8.35	8.14	0.01	0.0004
Outfall	7-Oct-99	8:54	Surface	11.00	7.34	6.77	9.60	0.0420
1	8-Oct-99	9:53	Surface	9.20	7.92	7.10	3.20	0.0458
1	8-Oct-99		0.50	9.20	7.8	7.07		
1	8-Oct-99		1.00	9.10	7.77	7.18		
1	8-Oct-99		1.50	9.10	7.76	7.23		
1	8-Oct-99		2.00	9.00	7.76	7.42		
1	8-Oct-99		2.50	9.00	7.82	7.72		
1	8-Oct-99	9:50	3.00	9.10	7.73	7.83	2.30	0.0212
2	8-Oct-99	10:12	Surface	9.00	8.02	7.38	3.00	0.0530
2	8-Oct-99		0.50	8.90	8.06	7.42		
2	8-Oct-99		1.00	8.80	8.1	7.44		
2	8-Oct-99		1.50	8.70	8.04	7.47		
2	8-Oct-99		2.00	8.70	8.04	7.55		
2	8-Oct-99	10:08	2.50	8.70	8.11	7.99	3.10	0.0655
3	8-Oct-99	10:21	Surface	8.70	8.14	7.70	1.74	0.0394
3	8-Oct-99			8.70	8.13	7.60		
3	8-Oct-99			8.70	8.12	7.63		
3	8-Oct-99			8.60	8.13	7.71		
3	8-Oct-99			8.60	8.12	7.74		
3	8-Oct-99	10:25		8.60	8.11	7.91	1.60	0.0336
4	8-Oct-99	9:38	Surface	8.70	8.4	7.15	0.03	0.0012
4	8-Oct-99		0.50	8.60	8.39	7.09		
4	8-Oct-99		1.00	8.60	8.39	7.19		
4	8-Oct-99		1.50	8.60	8.37	7.37		
4	8-Oct-99		2.00	8.50	8.35	7.48		
4	8-Oct-99		2.50	8.50	8.33	7.64		
4	8-Oct-99		3.00	8.50	8.31	7.81		
4	8-Oct-99	9:34	3.50	8.50	8.29	8.05	0.05	0.0016

[1] calculated values

n/a - data not available