A SUMMARY OF THE BENTHIC MACROINVERTEBRATE FAUNA (2006 AND 2007) FROM ICELANDIC RIVER; WASHOW BAY CREEK; GRASSMERE, PARKS, WAVEY, NETLEY, and WILLOW CREEKS; FISH LAKE DRAIN; and FISHER RIVER

A Data Report Prepared
for

East Interlake Conservation District

by

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1.0 INTRODUCTION

In Manitoba, watershed management and water quality analysis has become a priority for many Conservation Districts. Traditionally, methods have involved the compilation of physical and/or chemical information to assess water quality. More recent efforts have evolved around the collection of macroinvertebrates and the development of rapid bio-assessment techniques to assist in the evaluation of watershed health.

Macroinvertebrates can respond to a range of stream disturbances, as such they can be used to determine aquatic ecosystem health and integrity (Gibbons et al 1993; Milner and Roberts 1997). However, successful assessments require knowledge of the life cycles of aquatic insects, specific tolerance levels of individual species, and well established sampling protocols (e.g., number of stations, time of sampling, habitat stratification, etc.) (Milner and Roberts 1997; USDA 1998).

The East Interlake Conservation District (EICD) invited North/South Consultants Inc. to develop a rapid bio-assessment technique for streams in their region. The methodologies were to be a broad and repeatable characterization of the benthic macroinvertebrate fauna within streams of the EICD for future bioassessment comparisons. This document outlines the methodologies developed for invertebrate collection along: Icelandic River, Washow Bay Creek, Grassmere, Parks, Wavey, Netley, and Willow creeks; Fish Lake Drain; and Fisher River. Results from Year I and II, including a comparison between years, are presented within this document in tabular form.

2.0 METHODS

The sampling methods prescribed in this document are meant to provide a broad, repeatable characterization of the benthic macroinvertebrate fauna of streams within the East Interlake Conservation District. Methodologies are based on those described in: Plafkin et al. (1989); Zamora-Munoz and Alba-Tercedor (1996); Wright et al. (2000); and Hughes (2001).

2.1 SAMPLING APPARATUS

Kick-net sampling is highly versatile and can be used on rock, sand, gravel and mud bottoms. The kick net used was constructed of 500 µm nitex mesh, and had an aperture of approximately 0.25 m^2 (see photo).

The Tall-Ekman™ dredge has a 0.023 m^2 opening and attached lead weights to assist in substrate penetration, when lowered from a bridge or other structure.

2.2 FIELD METHODOLOGY

Sites were selected in the vicinity of existing water quality stations (if possible) and to maximize the diversity of the habitat types, and shallow enough to allow wading and kick-net sampling across the entire width of the stream. If sites were not wadeable, sampling locations were selected and conducted along the shoreline of the stream. In the event that the water was too deep and/or fast for a kick net sampler, samples were collected from a boat using a Tall-Ekman™ grab within a one km area of a water quality station. Sites were also selected to represent pool/riffle habitat in both 'natural' (e.g., riparian cover, non-channelized) and 'disturbed' areas (e.g., denuded riparian, channelized reaches).

The field technician stood in the selected site with their back facing upstream, agitating the substrate and moving the kick-net in a sweeping motion above the disturbed area to capture dislodged or escaping invertebrates. The technician passed over an approximate 1m^2 area twice in a standard time interval (e.g. three minutes); emptying the net contents into a bucket frequently to reduce sample loss and net clogging. Depending on the location and year, one to five samples ($1m^2$ samples) were collected.

Fine material (e.g., silt or mud) was washed from the samples by agitating the bottom of the kick net bag in the stream water. Large pieces of debris were also removed from the sample. Cleaned samples were then placed into individually labelled sample jars and preserved in a 10% formaldehyde solution for subsequent identification and enumeration.

2.2.1 Data Collection

Date and time of sample collection, UTM coordinates for each location, water temperature and depth, and surface velocity were recorded at each site. Coordinates were taken with a hand held GPS unit, temperature was recorded to the nearest ±0.5 ^{o}C with a hand held thermometer, and surface velocities were measured with a Model 1210, Price Type AA current meter.

For each sample, substrate composition, primary production composition, and riffle-pool sequence were recorded. Observations with respect to stream bank vegetation, extent of forest cover along shoreline, extent of canopy coverage over the stream channel, and other conditions such as construction activities or the presence of livestock or wildlife in the vicinity of the stream were also recorded.

Digital photographs were taken at each site.

Note – The number of sites were reduced in 2007 (compared to 2006) to fit within budgetary constraints.

2.3 LABORATORY ANALYSIS

Samples were thoroughly cleaned and rinsed (with cold water) through a series of stacked sieves (i.e., 1.00 mm on top followed by a 500 micron on the bottom). The stacking and rinsing procedure allowed for the clearing of any remaining silt and debris (which increases sorting efficiency) and for debris and large/rare organisms to be ‘fractioned out’ (i.e., removed). Large/rare organisms included large beetles, large water bugs, crayfish, etc.

A cursory examination of the sample was then conducted with a magnifying lamp. If the sample contained less than 300 individuals (approximately) the entire sample was sorted. If the sample contained more than 300 individuals it was ‘split’ until a sub-sample contained approximately 300 individuals. A 300-animal fixed count yields reliable estimates of relative abundance and allows samples to be processed in a much shorter time than if the whole sample was picked (Somers et al. 1998; Barbour et al. 1999; Flotemersch et al. 2006; .

To be counted, a specimen had to have enough intact body parts to permit its identification to the targeted level (i.e., Family) and it was required to have a head preventing duplicate counts. Larval exuviae and empty shells (e.g., snails and clams) and cases (e.g., caddis) were not counted in the 300-fixed count. If there were no 'live' Molluscs in the sample, a few empty shells were set aside for identification with the large/rare specimens. These were not included in the 300-animal fixed count. Samples were not pooled during the initial sorting/identification procedure.

2.4 DATA ANALYSIS

Invertebrates collected from each site could be pooled in order to carry out further analyses. Tall-Ekman samples were analyzed separately from the kick net samples.

The following 'Metrics for Analyses' (2006 and 2007 Summary) were used during analysis:

Individual and Total Taxa Abundance - This is simply a count of the number of benthic invertebrates that are found within a sample. In general, if water quality is poor then taxa richness is poor.

Percent Contribution of Dominant Taxon - This index is based on the individual and total taxa abundance metric listed above. It is the percentage that each taxon contributes to the entire sample.

Ephemeroptera, Plecoptera, and Trichoptera Index (EPT) - This index is a count of the number of EPT that are found in a sample. This is a useful index since most of the taxa found within these orders are very sensitive to environmental change and pollution. In general, higher numbers of EPT in relation to other benthic invertebrates indicates a stable stream environment that has not been exposed to a lot of pollution.

Ephemeroptera, Plecoptera, and Trichoptera/Chironomidae Index (EPT/C) - This index is the ratio of the number of EPT to C that are found in a sample. It is a useful index since chironomids are generally more tolerant of environmental change and pollution than EPT, which are considered to be sensitive to pollution. A stressed environment generally shows an imbalance between EPT and C, with a greater proportion of chironomids.

Family Biotic Index (FBI) - This index was developed by Hilsenhoff (1988) to understand organic pollution in streams in general terms. Benthic invertebrate families are assigned tolerance values (different families are able to tolerate environmental change more easily than others) which are summed (Appendix 2). This sum provides a general indication of water quality conditions within the stream. The higher the index value of a sample, the poorer the quality of the water (Table 1). This value should be used as an aid to determine where further studies need to be undertaken in future years. The following formula is used:

$$FBI = \sum (x_i * t_i)/n$$

x = the number of individual taxa, t = tolerance value, and n = total number of invertebrates in sample.

The development of the tolerance values for the EICD were based on information provided in: Bode et al. 1996; Hauer and Lamberti 1996; Hilsenhoff 1988; Plafkin et al. 1989; and discussions with D. Cobb (Department of Fisheries and Oceans, Winnipeg) and L. Caper (Entomologist, North/South Consultants Inc.) (Table 1).

Data was entered and summarized into MS Excel spreadsheets. Comparisons of watercourses between years were made, where possible, by reviewing and graphically presenting the calculated FBI index values. In some instances an average FBI index was calculated (i.e., when one site was in close proximity to another).

3.0 RESULTS

Complete data sets (in Excel format) for Years I and II, including photographs, are provided in digital format. Site locations (i.e., UTMs) are provided in Appendix 1. Field notes were submitted in 'hard-copy' to the EICD manager.

3.1 YEAR I (2006)

Results of the Year I macroinvertebrate bioassessment were provided to the EICD under separate cover (North/South Consultants 2007). However, this data is also provided in summary form in Table 2. The study area and sites sampled in 2006 are presented in Figure 1.

3.2 YEAR II (2007)

All indices were calculated with the exception of BMWP (defined in North/South Consultants 2007). The BMWP index was replaced with the Family Biotic Index (FBI); it was determined that FBI would provide a better indication of stream health compared to BMWP.

The following is a summary of the 2007 benthic invertebrate data collected from the following water bodies: Icelandic and Fisher (east arm) rivers; Washow Bay, Grassmere, Parks, Wavey, and Netley creeks; and the Fish Lake Drain (Figure 1). Under direction of the EICD Manager, Willow Creek was omitted from the study in Year II.

Washow Bay Creek – 3 Locations (Reach 1, 2, and 3) x 1 Site at each Location. Reach 1 is the farthest downstream while Reach 3 is the farthest upstream:

- Site 3, located the farthest upstream had a slightly greater number of invertebrates than Sites 1 or 2.
- Insects comprised the majority of the invertebrates at all three sites. Terrestrial invertebrates were not present at any of the sites.
- All three sites in the Washow Bay Creek had greater abundances of Chironomidae than EPT. EPT are more sensitive to environmental conditions than chironomids. In particular, Site 3 had approximately 19 times more chironomids than EPT.

- FBI values indicate that water quality conditions in the Washow Bay Creek are poor (very substantial pollution likely) at all three sites (Table 2).

Icelandic River – 3 Locations (Reach 1, 2, and 3) x 1 Site at each Location. Reach 1 is the farthest upstream while Reach 3 is the farthest downstream:

- Site 3, located the farthest downstream of all the sites, had considerably more invertebrates than either Sites 1 or 2.
- Insects comprised the majority of the invertebrates at all three sites. Terrestrial invertebrates were not present at any of the sites.
- At all three sites on the Icelandic River, EPT were in greater abundance than Chironomidae. This is completely opposite to the results from the Washow Bay Creek, where Chironomidae were in greater abundance than EPT.
- FBI values indicate that water quality conditions ranged from fair (fairly substantial pollution likely) to fairly poor (substantial pollution likely), depending on location (Table 2).

Grassmere Creek – 1 Location x 3 Sites:

- Crustaceans dominated the catch at all 3 sites. Terrestrial invertebrates were not present at any of the sites.
- There were more EPT than chironomids at all three sites although EPT comprised a very small proportion of the catch at each site. Most of the catch was comprised of crustaceans.
- FBI values indicate that water quality conditions are very poor (severe organic pollution likely) at all three of the sites (Table 2).

Parks Creek – 1 Location x 3 Sites:

- Crustaceans, molluscs and insects comprised the majority of the catch at two of the sites in Parks Creek. Annelids were also present at one of these two sites. At the third site, annelids, crustaceans, and insects dominated the catch.
- Chironomidae abundance was greater than EPT abundance at two of the three sites. Chironomids are more tolerant of environmental change than EPT. These 2 sites, however, had very small abundances of all invertebrates. In contrast, the site with the greater number of chironomids than EPT had a substantially higher number of invertebrates overall, than that other two sites.
- FBI values indicate that water quality conditions are poor (very substantial pollution likely) at all three of the sites (Table 2).

Wavey Creek – 1 Location x 3 Sites:

- Insects dominated the catch at all three of the sites, however, crustaceans were also present in significant numbers at one site in Wavey Creek.

- EPT were present in greater abundances than chironomids at all three of the sites.
- FBI values indicate that water quality conditions range from fair (fairly substantial pollution likely) to poor (very substantial pollution likely) (Table 2).

Netley Creek – 3 Locations x 1 Site at each Location:

- Each of the three sites in Netley Creek was unique in its invertebrate composition. One site was comprised of annelids, crustaceans, and insects. The second site was dominated by annelids followed by insects. The third site was dominated by insects.
- EPT were in greater abundance than Chironomidae at two of the three sites.
- FBI values indicate that water quality conditions are fairly poor (substantial pollution likely) to very poor (severe organic pollution likely). The reason for the rating of very poor is due to the presence of annelids, which have high FBI tolerance values indicating that they are able to tolerate environmental change better than other invertebrate families (Table 2).

Fish Lake Drain – 1 Location x 3 Sites:

- Insects comprised the majority of the catch at all three sites in Fish Lake Drain. Terrestrial invertebrates were not present at any of the sites.
- EPT were in greater abundance than Chironomidae at all three sites.
- FBI values indicate that water quality conditions are fair (fairly substantial pollution likely) to fairly poor (substantial pollution likely) in Fish Lake Drain (Table 2).

east arm - Fisher River – 3 Locations x 1 Site at each Location:

- The east arm of the Fisher River had the greatest number of benthic invertebrates of all the rivers investigated in 2007. Insects dominated the catch at all 3 sites. Annelids were also present in relatively large numbers at one of the sites. Terrestrial invertebrates were not present at any of the sites.
- Chironomids were in greater abundance than EPT at all three of the sites.
- FBI values indicate that water quality conditions are poor (very substantial pollution likely) in the east arm - Fisher River (Table 2).

3.3 YEAR I AND YEAR II COMPARISONS

The following is a summary of comparisons drawn between sites sampled between Year I and II. Where possible direct comparisons were made between sites. However, changing conditions within water bodies (e.g., water flow, accessibility, etc) and modifications to the sampling program (i.e., number of sites to be sampled, specific areas on a watercourse) resulted in the adjustment of some sites (i.e., specific UTM locations) (Figure 1).

Washow Bay Creek Reach 2 from 2006 compared to Washow Bay Creek Site 1 from 2007 (Figures 1 and 2):

- Invertebrate abundances were lower in 2007 than in 2006. In 2006, abundances ranged from 17,236 to 38,949 individuals in the five samples. In 2007, abundance was lower at Site 1 with 2,851 individuals.
- Insecta clearly dominated the catch in all samples in Reach 2 in 2006 and at Site 1 in 2007.
- In 2006, EPT were in much greater abundance than Chironomidae in all 5 samples from Reach 2. This changed in 2007; Chironomidae occurred at a 2:1 ratio to EPT.
- FBI values indicate that water quality conditions were good (some organic pollution probable) in all 5 samples from Reach 2. In contrast, Site 1 from 2007 was indexed as poor (very substantial pollution likely) (Figure 2).

Washow Bay Creek Reach 3 from 2006 compared to Washow Bay Creek Site 2 from 2007 (Figure 1 and 2):

- Invertebrate abundance was considerably higher at Site 2 in 2007 (3,481 individuals) than from samples in 2006 in Reach 3 (ranged from 82 to 418 individuals).
- Insects clearly dominated the catch in 2007 at Site 2. In 2006, insects dominated in some of the 5 samples collected but not all. Terrestrial invertebrates contributed to the catches in 2006 but were not present at Site 2 in 2007.
- In both 2006 and 2007 Chironomidae were in greater abundance than EPT, however, the ratio of chironomids to EPT increased substantially in 2007 to approximately 1:9.
- FBI values indicate that water quality conditions were fair (fairly substantial pollution likely) to excellent (organic pollution unlikely) in Reach 2 in 2006. In 2007, water quality conditions dropped to poor (very substantial pollution likely).

Icelandic River Reach 2 from 2006 compared to Icelandic River Site 1 from 2007 (Figures 1 and 2):

- Invertebrate abundance was considerably higher at Site 1 in 2007 (3,163) than in samples from Reach 2 in 2006 (ranged from 241 to 888 individuals).
- Insects dominated in four of the five samples from Reach 2 in 2006. In 2007, insects dominated the catch from Site 1.

- In 2006, EPT dominated over chironomids in the catch in 3 of the 5 samples in Reach 2. In 2007, there were approximately 7 times more EPT than Chironomidae.
- FBI values indicate that water quality conditions from samples in Reach 2 in 2006 were very poor (substantial pollution likely) to good (some organic pollution probable). At Site 1 in 2007, conditions were found to be fair (fairly substantial pollution likely). Overall, water quality conditions changed little between these two years (Figure 2).

Grassmere Creek – 1 location with 5 sites from 2006 compared to 1 Location with 3 sites in 2007 (Figures 1 and 2):

- Invertebrate abundance was higher overall in 2007 than in 2006.
- In 2006, insects dominated at all sites; in 2007 crustaceans dominated.
- EPT dominated over chironomids at 3 of the 5 sites in 2006 and dominated over EPT at all three of the sites in 2007.
- FBI values indicate that water quality conditions from samples in 2006 were poor (very substantial pollution likely) to good (some organic pollution probable). In 2007, these conditions changed to very poor (severe organic pollution likely) at all three of the sites. This change to a much higher FBI value is due to the high number of crustaceans found in samples in 2007 versus 2006. Crustaceans are much more tolerant of environmental change than other invertebrates and consequently have a higher FBI value (Figure 2).

Parks Creek – 1 location with 3 sites in 2006 compared to 1 location with 3 sites in 2007 (Figures 1 and 2):

- Overall, invertebrate abundance was greater in 2006 than 2007. In 2007, benthic invertebrate density was quite low at two of the three sites.
- In 2006, crustaceans and insects dominated the catch at all three of the sites. In 2007, crustaceans, mollusks, and insects comprised the majority of the catch.
- In 2006, there were more chironomids than EPT at two of the three sites. In 2007, EPT dominated over chironomids at one site; chironomids dominated over EPT at the other two sites, however, neither EPT nor chironomids were in high abundances overall.
- FBI values indicate that water quality conditions were very poor (severe organic pollution likely) at 2 sites in 2006 and poor (very substantial pollution likely) at the other site. In 2007, water quality conditions were poor at all three sites. Between these two years water quality changed little (Figure 2).

Wavey Creek – 1 location with 4 sites in 2006 compared to 1 location with 3 sites in 2007 (Figures 1 and 2):

- Benthic invertebrates were abundant in both years, however, one site in 2006 had a considerably greater catch (27,149 individuals) than all other sites in 2006 and 2007.

- Insects dominated the catch at three of the four sites in 2006 and at all three sites in 2007. In 2007, however, crustaceans were also present in large numbers at one site.
- Chironomids were in greater abundance than EPT at three of the four sites in 2006 and at all three sites in 2007.
- FBI values indicate that water quality conditions were poor (very substantial pollution likely) at three sites and fairly poor (substantial pollution likely) at one site in 2006. In 2007, water quality conditions improved to fair (fairly substantial pollution likely) at one site but were fairly poor (substantial pollution likely) and poor (very substantial pollution likely) at the other two sites (Figure 2).

Netley Creek – Site 1 in 2006 compared to Site 1 in 2007 (Figures 1 and 2):

- Benthic invertebrates were more abundant at this site in 2007 (2,291 individuals) than in 2006 (704 individuals);
- Insects dominated the catch in 2006, however, in 2007, crustaceans dominated followed by insects and annelids;
- EPT were in greater abundance in both years than chironomids. It's important to note that EPT and chironomids made up a much larger proportion of the overcall invertebrate catch in 2006 (335 individuals out of a total of 704) than they did in 2007 (440 individuals out of a total of 2,291).
- FBI values indicate that water quality conditions declined from fairly poor (substantial pollution likely) in 2006 to very poor in 2007 (severe organic pollution likely)

Netley Creek – Site 2 in 2006 compared to Site 2 in 2007 (Figures 1 and 2):

- Benthic invertebrates were more abundant at this site in 2007 (2,320 individuals) than in 2006 (824 individuals);
- Insects dominated the catch in 2006 while annelids dominated in 2007 followed by insects;
- Chironomids were in greater abundance at Site 2 in both 2006 and 2007. Chironomids comprised a larger portion of the overall catch (224 individuals out of a total of 824) in 2006 while chironomids and EPT comprised a smaller portion of the overall catch in 2007 (432 individuals out of a total of 2,320);
- FBI values were very similar between 2006 and 2007. In both years, water quality conditions were very poor (severe organic pollution likely).

Netley Creek – Site 3 in 2006 compared to Site 3 in 2007 (Figures 1 and 2):

- Similar to sites 1 and 2 on Netley Creek, there were more benthic invertebrates captured in 2007 (2,172 individuals) than in 2006 (1,068 individuals);
- Insects dominated the catch in both years at Site 3;
- Chironomids were in greater abundance in 2006 than EPT, however, in 2007, EPT dominated over chironomids and made up over half of all invertebrates caught in 2007.

- FBI values indicate that water quality was fairly poor in both years, however, there was a slight improvement in the FBI value from 2006 to 2007 (from 5.94 in 2006 to 5.76 in 2007).

Fish Lake Drain – 1 location with 4 sites in 2006 comparable to 1 location with three sites in 2007 (Figures 1 and 2):

- Benthic invertebrate abundances were similar between 2006 and 2007 with the exception of one site in 2007 where abundance was quite low (97 individuals).
- Insects dominated the catch at all sites in both 2006 and 2007.
- EPT were more abundant than chironomids at three of four sites in 2006 and at all sites in 2007.
- FBI values indicate that water quality conditions were fairly poor (substantial pollution likely) to good (some organic pollution probable) in 2006. In 2007 water quality conditions declined from 2006 to fair (fairly substantial pollution likely and fairly poor (Figure 2).

east arm - Fisher River –Site 2 in 2006 comparable to Site 2 in 2007 (Figures 1 and 2):

- Benthic invertebrate abundances were much higher in 2007 (16,795 individuals) than in 2006 (5,056 individuals) at Site 2.
- Insects dominated the catch in both 2006 and 2007.
- Chironomids were more abundant than EPT at Site 2 in both 2006 and 2007.
- The FBI value from Site 2 on the Fisher River in 2006 (i.e., 6.80) indicated that water quality conditions were poor (very substantial pollution likely). In 2007, the condition remained poor (i.e., 7.09).
- Water quality conditions remained consistent between these two years.

east arm - Fisher River –Site 3 in 2006 comparable to Site 3 in 2007 (Figures 1 and 2):

- Similar to Site 2 in the Fisher River, benthic invertebrate abundances were also higher in 2007 (10,380 individuals) than in 2006 (960 individuals) at Site 3.
- Insects dominated the catch in both 2006 and 2007.
- Chironomids were more abundant than EPT at Site 3 in both years.
- FBI values indicate that water quality was fairly poor (substantial pollution likely) in 2006 with an FBI value of 5.92) and declined to poor (very substantial pollution likely) in 2007 with an FBI value of 7.04.

east arm - Fisher River –Site 4 in 2006 comparable to Site 4 in 2007 (Figures 1 and 2):

- Benthic invertebrates were in greater abundance at Site 4 in 2006 (2,690 individuals) than they were in 2007 (892 individuals).

- Insects dominated in both 2006 and 2007, however, annelids and crustaceans were also an important part of the catch in 2007.
- Chironomids were more abundant than EPT in both years.
- FBI values indicate that water quality declined from fairly poor in 2006 (FBI value of 6.43) to poor in 2007 (FBI value of 7.22). The increase in value is likely due to the increased number of annelids and crustaceans found at this site in 2007. These invertebrates have a much higher tolerance value associated with them, indicating their tolerance to environmental stress.

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TABLES, FIGURES, and APPENDICES

Table 1. Hilsenhoff's family-level tolerance values used for the macroinvertebrate bioassessment.

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very Good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly Poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.00	Very Poor	Severe organic pollution likely

Table 2. Water quality classification based on the Family Biotic Index for benthic invertebrates collected in 2006 and 2007. Note: an 'X' denotes an individual site in the waterbody.

Waterbody 2006	Water Quality (based on Family Biotic Index)						
	Excellent	Very Good	Good	Fair	Fairly Poor	Poor	Very Poor
Icelandic River Reach 1							XXXXX
Icelandic River Reach 2			XX	XX			X
Icelandic River Reach 3	XXXXX						
Washow Bay Creek Reach 1						XXXX	X
Washow Bay Creek Reach 2			XXXXX				
Washow Bay Creek Reach 3	X	XXX		X			
Grassmere Creek			X	X	X	XX	
Parks Creek						X	XX
Wavey Creek					X	XXX	
Netley Creek					XX		X
Willow Creek				XX		X	
Fish Lake Drain			XX	X	X		
east arm - Fisher River					XX	X	

Waterbody 2007	Water Quality (based on Family Biotic Index)						
	Excellent	Very Good	Good	Fair	Fairly Poor	Poor	Very Poor
Icelandic River Reach 1				X			
Icelandic River Reach 2					X		
Icelandic River Reach 3				X			
Washow Bay Creek Reach 1						X	
Washow Bay Creek Reach 2						X	
Washow Bay Creek Reach 3						X	
Grassmere Creek							XXX
Parks Creek						XXX	
Wavey Creek				X	X	X	
Netley Creek					X		XX
Willow Creek	-	-	-	-	-	-	-
Fish Lake Drain				XX	X		
east arm - Fisher River						XXX	

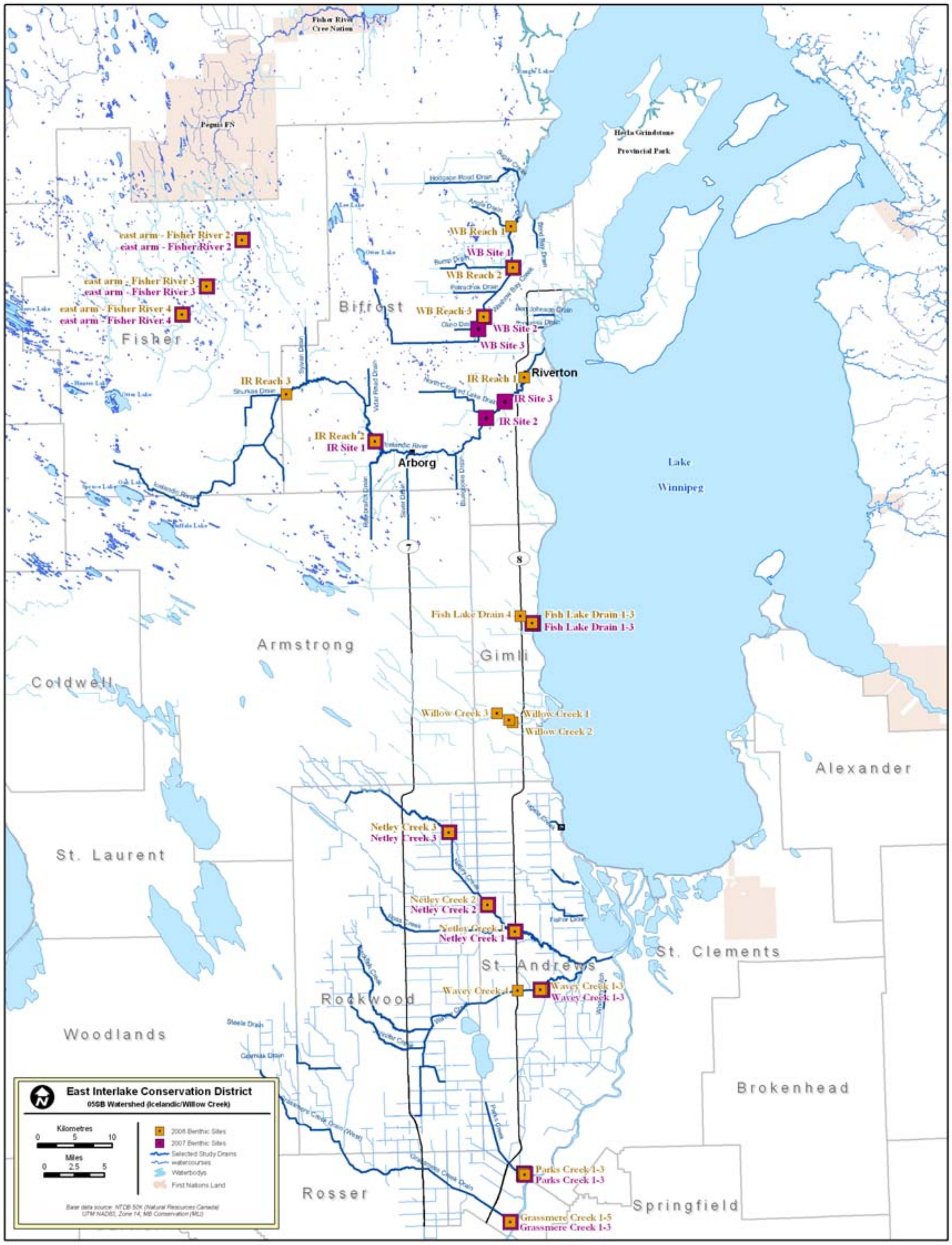
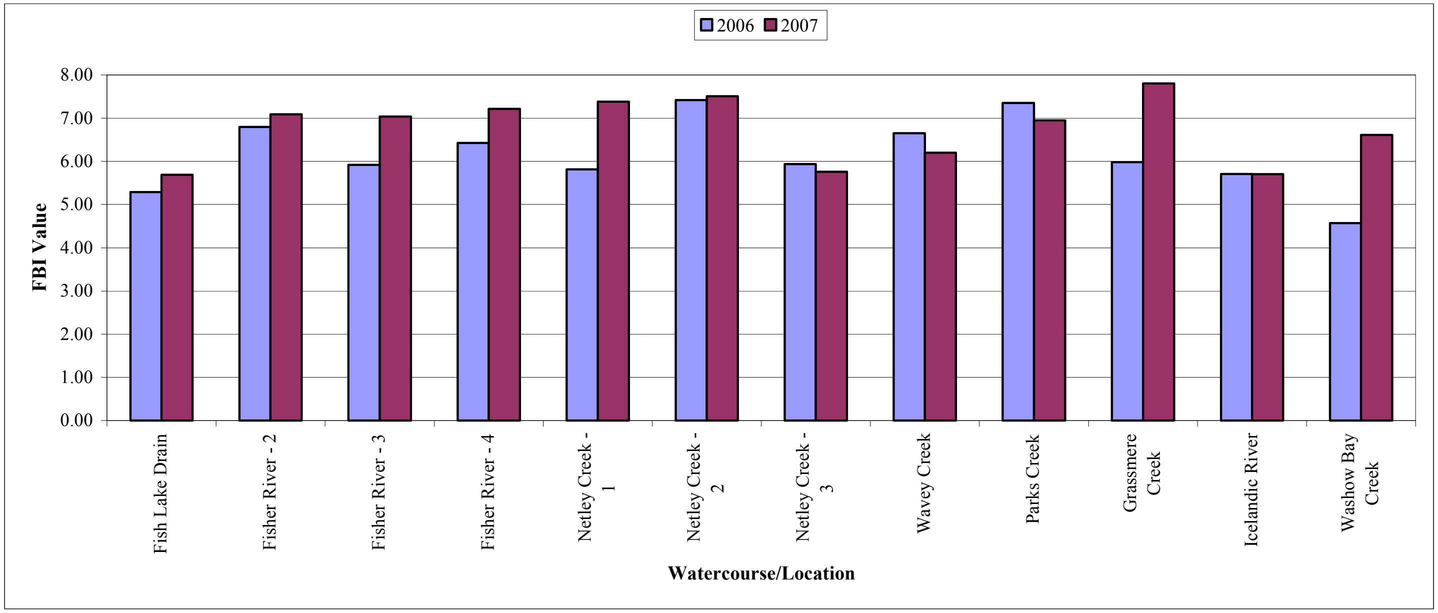


Figure 1. Study area and macroinvertebrate sampling sites from 2006 and 2007.



FBI Values Used For Graphic:

Watercourse/Location	***2006***	***2007***
Fish Lake Drain	Average of 4 sites (5.29)	Average of 3 sites (5.69)
Fisher River -2	Actual of 1 site (6.80)	Actual of 1 site (7.09)
Fisher River -3	Actual of 1 site (5.92)	Actual of 1 site (7.04)
Fisher River -4	Actual of 1 site (6.43)	Actual of 1 site (7.22)
Netley Creek -1	Actual of 1 site (5.82)	Actual of 1 site (7.38)
Netley Creek -2	Actual of 1 site (7.42)	Actual of 1 site (7.51)
Netley Creek -3	Actual of 1 site (5.94)	Actual of 1 site (5.76)

FBI Values Used For Graphic:

Watercourse/Location	***2006***	***2007***
Wavey Creek	Average of 4 sites (6.65)	Average of 3 sites (6.20)
Parks Creek	Average of 3 sites (7.35)	Average of 3 sites (6.95)
Grassmere Creek	Average of 5 sites (5.98)	Average of 3 sites (7.80)
Icelandic River	Average of 5 sites (5.71)	Actual of 1 site (5.70)
Washow Bay Creek	Average of 5 sites (4.57)	Actual of 1 site (6.61)

Figure 2. Yearly FBI (Family Biotic Index) results for watercourses at comparable sites between 2006 and 2007. *Note 1* – Table 1 outlines the FBI value and "degree of organic pollution". *Note 2* – Icelandic River Site 2 in 2006 and Site 1 in 2007; Washow Bay Creek Site 2 in 2006 and Site 1 in 2007.

Appendix 1. Sample locations (i.e., UTMs) for water courses sampled in 2006 and 2007 (EICD macroinvertebrate bioassessment program).

WATERBODY	**2006 SITE/SAMPLE UTMs (14U) and COMMENT**									
	1	**Comment**	**2**	**Comment**	**3**	**Comment**	**4**	**Comment**	**5**	**Comment**
Grassmere Creek	638513 5537985	Sample #1	638513 5537985	Sample #2	638513 5537985	Sample #3	638513 5537985	Sample #4	638513 5537985	Sample #5
Parks Creek	just u/s of 3	Sample #1	640314 5544399	Sample #2	640449 5544227	Sample #3	not in 2006		not in 2006	
Wavey Creek	642730 5568935	Sample #1	just d/s of 3	Sample #2	642548 5568935	Sample #3	639489 5568821	Sample #4	not in 2006	
Netley Creek	639148 5576772	Sample #1	635475 5580330	Sample #2	630295 5590067	Sample #3	not in 2006		not in 2006	
Fish Lake Drain	641503 5618071	Sample #1	641478 5618075	Sample #2	641444 5618097	Sample #3	639889 5619023	Sample #4	not in 2006	
Fisher River	not in 2006		602659 5669416	Sample #2	597913 5663161	Sample #3	594593 5659408	Sample #4	not in 2006	
Icelandic River	640412 5650979	5 Samples	620432 5242385	5 Samples	608549 5648741	5 Samples	not in 2006		not in 2006	
Washow Bay Creek	638603 5671240	5 Samples	638911 5665678	5 samples	634981 5659047	5 Samples	not in 2006		not in 2006	
Willow Creek	638829 5604754	Sample #1	638378 5605065	Sample #2	636745 5605992	Sample #3	not in 2006		not in 2006	

WATERBODY	**2007 SITE/SAMPLE UTMs (14U) and COMMENT**									
	1	**Comment**	**2**	**Comment**	**3**	**Comment**	**4**	**Comment**	**5**	**Comment**
Grassmere Creek	638539 5538007	Sample #1	638530 5538009	Sample #2	638524 5538007	Sample #3	not in 2007		not in 2007	
Parks Creek	640424 5544261	Sample #1	640314 5544399	Sample #2	640449 5544227	Sample #3	not in 2007		not in 2007	
Wavey Creek	642730 5568935	Sample #1	d/s of Sample #3	Sample #2	642548 5568935	Sample #3	not in 2007		not in 2007	
Netley Creek	639148 5576772	1 sample	635475 5580330	1 sample	630295 5590067	1 sample	not in 2007		not in 2007	
Fish Lake Drain	641503 5618071	Sample #1	641478 5618075	Sample #2	641444 5618097	Sample #3	not in 2007		not in 2007	
Fisher River	not in 2007		602659 5669416	1 sample	597913 5663161	1 sample	594593 5659408	1 sample		
Icelandic River	620432 5642385	1 sample	635248 5645545	1 sample	637715 5647738	1 sample	not in 2007		not in 2007	
Washow Bay Creek	638911 5665678	1 sample	634981 5659089	1 sample	634201 5657461	1 sample	not in 2007		not in 2007	
Willow Creek	not in 2007		not in 2007		not in 2007		not in 2007		not in 2007	

Appendix 2. Invertebrate taxa with corresponding tolerance values (Tolerance values based on: Bode et al 1996; Hauer & Lamberti 1996; Hilsenhoff 1988; Plafkin et al 1989; Barbour et al. 1999; and communications with D. Cobb (DFO) and L. Capar (NSC).

Taxa	Tolerance Value
Annelida	
Oligochaeta	8
Hirudinea	10
Total Annelida	
Crustacea	
Ostracoda	8
Amphipoda	
Gammaridae	5
Haustoriidae	5
Talitridae	8
Decapoda	6
Total Crustacea	
Arachnida	
Acarina	6
Mollusca	
Bivalvia	
Unionidae	6
Pisidiidae	8
Gastropoda	
Hydrobiidae	6
Lymnaeidae	6
Physidae	8
Planorbidae	7
Valvatidae	8
Ancylidae	6
Total Mollusca	
Platyhelminthes	4
Hydrozoa	5
Insecta	
Megaloptera	
Sialidae	4
Odonata	
Anisoptera	
Aeshnidae	3
Corduliidae	4
Gomphidae	1

Appendix 2. Continued.

Taxa	Tolerance Value
Libellulidae	3
Zygoptera	
Calopterygidae	5
Coenagrionidae	8
Coleoptera	
Curculionidae	
Dytiscidae	5
Dytiscidae	5
Elmidae	4
Elmidae	4
Gyrinidae	4
Gyrinidae	4
Haliplidae	5
Haliplidae	5
Hydrophilidae	5
Hydrophilidae	5
Hemiptera	
Corixidae	5
Corixidae	5
Nepidae	8
Notonectidae	5
Pleidae	5
Ephemeroptera	
Baetidae	4
Caenidae	6
Ephemerellidae	1
Ephemeridae	4
Heptageniidae	3
Isonychiidae	2
Leptophlebiidae	2
Siphlonuridae	7
Tricorythidae	4
Trichoptera	
Helicopsychidae	3
Hydropsychidae	4
Hydroptilidae	4
Lepidostomatidae	1
Leptoceridae	4
Limnephilidae	3
Philoptamidae	3
Molannidae	6
Phryganeidae	4
Polycentropodidae	6
Plecoptera	
Chloroperlidae	0

Appendix 2. Continued.

Taxa	Tolerance Value
Perlodidae	2
Diptera	
Ceratopogonidae	6
Chaoboridae	8
Chironomidae	7
Chironomidae	7
Dolichopodidae	4
Empididae	6
Empididae	6
Ephydridae	6
Muscidae	6
Sciomyzidae	6
Simuliidae	6
Simuliidae	6
Stratiomyidae	7
Tabanidae	5
Tipulidae	3